On the Road to New Frontiers

PCIM Europe 2014 ended on May 22 with a positive outcome. Approximately 8,000 visitors have come to Nuremberg to inform themselves about new products and services in power electronics, power quality and intelligent motion during May 20-22. In total 391 exhibitors and 97 representing companies exhibited an extensive range of products and services to the trade visitors on an area of 20,000 square metres. At the conference, which took place in parallel to the exhibition, over 700 participants caught up with the latest perspectives and developments of Power Electronics, Intelligent Motion, Renewable Energy and Energy Management sectors.

Again Power Electronics Europe actively participated within this event by co-sponsoring the Best Paper Award (BPA) as well as hosting a Panel Discussion on the hot topic “SiC/GaN versus Silicon – Competition or Coexistence?”. The BPA (price money plus expenses for visiting PCIM Asia 2015) was handed over on occasion of the opening ceremony by PEE Editor Achim Scharf (left) to Martel Tsirinomeny from LEI-EPFL Lausanne, Switzerland.

PCIM Awards and Panel
The title of the winning paper: Configurable Modular Multilevel Converter (CMMC) for a Universal and Flexible Integrated Charging System. Electric Vehicles owners are confronted by the limited compatibility of available charging infrastructures. Therefore, this paper is focused on presenting a Configurable Modular Multilevel Converter (CMMC) for a universal and flexible integrated charging system. This concept is designed for a large range of charging infrastructure; from AC household basic supply to AC or DC ultrafast charging.

Also the three Young Engineer Awards have been handed over to Hidekazu Umeda, Panasonic, Japan, for the paper ‘Highly Efficient Low-Voltage DC-DC Converter at 2 – 5 MHz with High Operating Current Using GaN Gate Injection Transistors’, Gang Yang, Valeo, France, ‘High Efficiency Parallel-parallel Interleaved LLC Resonant Converter for HV/LV Conversion in Electric/Hybrid Vehicles’, and Vinoth Kumar Sundaramoorthy, ABB Switzerland, ‘Simultaneous Online Estimation of Junction Temperature and Current of IGBTs Using Emitter-auxiliary Emitter Parasitic Inductance’.

PEE’s well accepted Panel Discussion “SiC/GaN versus Silicon – Competition or Coexistence?” took place on the second day (May 21, 2:00-4:30 pm) in the Industry Forum. Silicon Carbide and more recently Gallium Nitride have gained more and more interest by power electronics designers particularly for inverter and power supply applications. But Silicon technology is still moving forward. Thus the intention of this panel discussion was to inform PCIM visitors about the pros and cons of SiC and GaN in relation to progress in Si also in certain applications such as power supplies and renewable energies, about company-specific technologies and product roadmaps, and last but not least market trends. Thus the panel represented the leading companies in Silicon, Silicon Carbide, Gallium Nitride as well as Packaging Technologies. Silicon Carbide and more recently Gallium Nitride have gained more and more interest by power electronics designers particularly for inverter and power supply applications. But Silicon technology is still moving forward. Thus the intention of this panel discussion was to inform PCIM visitors about the pros and cons of SiC and GaN in relation to progress in Si also in certain applications such as power supplies and renewable energies, about company-specific technologies and product roadmaps, and last but not least market trends. Thus the panel represented the leading companies in Silicon, Silicon Carbide, Gallium Nitride as well as Packaging Technologies. Panelist were (left to right in the photo) ABB (Munaf Rahimo, Corporate Executive Engineer), Cree (John Palmour, CTO), EPC (Alex Lidow, CEO), GaN Systems (Geoff Haynes, VP Business Development), Infineon (Gerald Deboy, Senior Principal for Power Management & Supply), International Rectifier (Michael Briere, Consultant), Mitsubishi Electric (Gourab Majumdar, CTO/Fellow), Semikron (Thomas Grasshoff, Head Intern. Product Management), Toshiba Europe (Georges Tchouangue, Chief Engineer Appl. Engineering), and Transphorm (Pritim Panikh, President). The panel agreed that new power semiconductors will open new business opportunities besides the existing and also growing Silicon markets and that new packaging technologies are necessary to squeeze out the
possibilities of the newly power semiconductors. Due to the interest of the audience the time was exceeded by 30 minutes to a total of 2.5 hours.

**New Frontiers with GaN**

One of the well accepted PCIM Sessions were ‘New Frontiers of Power Electronics with GaN’ featuring five papers.

David Reusch from EPC ([www.epc-co.com](http://www.epc-co.com)) opened this session with the paper ‘Improving Performance of High Speed GaN Transistors Operating in Parallel for High Current Applications’. The objective of paralleling devices is to combine multiple higher on-resistance devices to appear and operate as a single, lower on-resistance device allowing for higher power handling capability. To effectively parallel devices, each device should equally share current.

Larry Spaziani from Canadian GaN Systems ([www.gansystems.com](http://www.gansystems.com)) spoke about ‘Lateral GaN Transistors – A Replacement for IGBTs in Automotive Applications’. The current drive-train power requirements of most hybrid vehicle (HV) and electric vehicles (EV) are met by using Silicon IGBT devices. Higher performance can be achieved with GaN power transistors because they can provide lower on resistance, higher operating temperatures and smaller systems. The improvements offered by the GaN devices are yet to be realized in deployed subsystems. Several groups of researchers are experimenting and reporting upon GaN transistors that are aimed at replacing Si IGBTs. The results achieved by GaN Systems were presented. Shown were the package types used by IR/Delphi and GaN Systems. GaN Systems designs use a source sense electrode and no bond wires. This ensures that the devices can be driven cleanly, on- and-off, and free of source power electrode generated noise. “Market researchers forecast a HEV power module market of $3.5 billion in 2020. Through multi-level converters requiring 1200 V in automotive applications GaN devices might be feasible”, Spaziani pointed out.

David C. Sheridan from RFMD ([www.rfmd.com](http://www.rfmd.com)) presented ‘Ultra-Low Loss 600V – 1200V GaN Power Transistors for High-Efficiency Applications’ based on SiC substrates. While 650V is likely the first entry for GaN power devices, 1200V GaN switches have not been widely reported. Using the same base technology as the 650V products, 1200 V die were fabricated with breakdown voltages exceeding 1500V as suitable margin for over-voltage protection. Since superfundation technology is not yet capable of 1200 V devices, the switching performance was compared to similarly rated 1200 V SiC MOSFETs which have already shown performance advantages over Si IGBTs. Bi-directional power devices have been a continuing topic of research and device design to enable specific topologies and applications such as matrix converters for direct AC/AC conversion. A normally-on GaN device has no barrier to current flow in both forward and reverse direction and can be configured efficiently into a bidirectional switch with each blocking mode sharing the same drift region.

**Panel Discussion**

PEE’s discussion panelists “SiC/GaN versus Silicon – Competition or Coexistence?”

The objective of paralleling devices is to combine multiple higher on-resistance devices to appear and operate as a single, lower on-resistance device allowing for higher power handling capability. To effectively parallel devices, each device should equally share current.

The effectiveness of paralleling. For high speed devices such as GaN FETs, the increased switching speeds amplify the impact of parasitic mismatches. Thus this paper studied the impact of in-circuit parasitic imbalances on parallel performance for higher speed GaN devices. A background of the impacts of the common source inductance, high frequency loop inductance, and gate inductance on switching performance was also included (see also our cover story).

To improve the parallel performance of high speed GaN devices also the parasitic imbalance contributed by the PCB layout must be minimized. This work looked at different parallel layouts and assess their ability to provide parallel performance similar to an optimized single transistor design. Different parallel designs were created, each containing four devices in parallel and operating from 48 V to 12 V at a switching frequency of 300 kHz. In total, eight 100 V EPC2001 eGaN FETs were used to achieve output power up to 480 W.

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Panasonic’s ([www.jp.panasonic.com](http://www.jp.panasonic.com)) Tatsuo Morita presented a ’99.3 % Efficiency of Boost-up Converter for Totem-pole Bridgeless PFC Using GaN Gate Injection Transistors’. In this paper, a highly efficient operation of a boost-up converter for bridgeless PFC using normally-off GaN Gate Injection Transistors (GIFs) in a novel totem-pole output circuitry has been introduced. The normally-off device by a single chip with flip-chip assembly
Proposed Totem-pole PFC with Panasonic’s GaN GItS

are often operated at low PWM frequencies (6–20 kHz), as there is little benefit to increase the switching losses will increase with no corresponding reduction in the size of the magnetic (motor) as its size is based on the torque/power requirements. So applying a GaN device capable of switching at much higher frequencies in this application might not appear to make sense at first, but this paper showed that, for a given size power stage, GaN clearly outperforms both IGBTs and Si FETs in conduction loss, switching loss, and EMI, not only at full power but especially at light load.

This is particularly important for compressor motor drives used in refrigeration and HVAC applications, which commonly operate at <25 % of full load. Also the low reverse recovery charge of GaN cascode device, and the correspondingly low hard-switched turn-on current spike significantly reduces the conducted EMI. In conclusion - drive applications, particularly at light load, can benefit from the 9x improved Qrr of the GaN cascode over IGBT antiparallel diode, and 160x improved over Silicon FREDFET – and its independence of temperature. This results in a significant improvement in efficiency, and an overall reduction in conducted EMI. The reduced dissipation allows higher power density and enables further integration of the inverter into a monolithic GaN device for extremely high power density.

Drives for Power Devices

Bernhard Strzalkowski from Analog Devices (www.analog.com) stressed isolation issues in his paper ‘Maximum power limit for withstand insulation capability of IGBT/MOSFET gate drivers’. The power density of modern power inverter rises continuously. This is due to constantly increasing performances of MOSFETs and IGBTs as well as of the gate drivers. One unpredictable system fault can cause damage or explosion of power switches. On the other hand, new high performance gate drivers exhibit excellent propagation delay, high bandwidth, over-current protection and high integration level. Those drivers provide a small form factor because the electrical isolation is already integrated on the driver chip. This electrical isolation can be performed by means of integrated high voltage micro-transformers or capacitors.

Therefore, for high power density inverters, the gate driver isolation safety performance needs to be investigated and validated. The isolation reliability must be analyzed in the worst case, when power-switches destruct. The paper investigated the gate driver’s isolation behavior by intentional destruction of IGBT/MOSFET power switches. High-voltage isolation test confirmed withstand of electrical micro-isolation.

Infineon’s (www.infineon.com/eicedriver) Wolfgang Frank introduced a novel IGBT driver concept called EiceDriver Safe with his paper ‘Online adjustable gate current control IC solves dv/dt problems in electric drives’. The tuning of commutation speed of currents between freewheeling diodes and IGBT plays an important role in respect of the EMI behavior of power electronics. High dv/dt means a large stress for the motor winding insulation and motor bearings as well as it causes conducted and radiated interferences with the supply in general. Many works for speed control of IGBT turn-on are known. The paper presented the benefits of a novel gate drive IC which offers an online adjustment feature for dv/dt in respect of the switching waveforms. A control means that countermeasures for reducing the dv/dt (e.g. filters) can be reduced or even skipped, which is an important step towards system cost reduction.

Packaging and Thermal Aspects

Samuel Hartmann described in the paper ‘Packaging Technology Platform for Next Generation High Power IGBT Modules’ ABB’s (www.abb.com/semiconductors) approach for new module layouts. To enable smaller and more cost efficient inverter designs, new power modules are designed for low losses, reliable operation at high temperature, high current and high switching frequencies. The IGBT module design presented features large Silicon active area for low on-state losses, good internal temperature distribution, high current conductor leads with well-designed electromagnetic behavior and highly reliable joining techniques. While keeping the outline of the HiPak module unchanged the design of the conductor leads and the substrate are optimized. An increase of the active IGBT area by 7 % and of the active diode area by 42 % is achieved. This allows higher output power especially in applications where the...
diode is normally limiting. The design can also be used with the reverse conducting Bi-Mode IGBT (BiGt). In this case all chips are dissipating equal thermal power which leads to uneven temperature distribution with the chip arrangement as in the existing HiPak design. With the new design, the temperature distribution is improved by having only 12 chips arranged in the mid of the module.

Fuji’s (www.fujielectric.co.jp) Motohito Hori announced a novel ‘Compact, Low Loss and High Reliable Next Generation Si IGBT Module with Advanced Structure’. To achieve the further miniaturization of power modules, low thermal impedance of the whole module structure is needed, i.e. through thick copper foil on the DCB substrate. This thick copper pattern contributes to reduce the thermal impedance. The advanced structure was researched originally for the small size of next generation devices such as SiC and allowed for about 30% shrinked chip size compared with conventional structure. Thanks to this improvement, same current and voltage rated Si IGBT power module features about 50 % footprint size of conventional power module at higher power and thermal cycling capability.

With the paper ‘Hybrid substrate - A future material for power semiconductor modules’ Curamik’s (www.curamik.com) Xinhe Tang introduced a hybrid substrate comprising of copper, ceramic and aluminum that combines the thermal and electrical performance of the copper with the corrosion resistance of aluminum. The manufacture process has been developed by bonding aluminum to DBC using an adhesive. The aluminum side can be directly contacted to water to improve cooling efficiency without worry about corrosion. The performance and reliability testing are undertaken.

Robert Christopher Burns from AB-Mikroelektronik (www.ab-mikro.at) showed in the paper ‘Vertical Integration Power Modules for Double Sided Cooling Applications using Aluminum Conductors and Thick Film Dielectrics’ possibilities for 3D integration. Challenges, advantages, and manufacturability of a vertical chip stacked power module for double sided cooling applications by...
using low cost materials and flexible processes. Vertical stacked power modules can be cooled on both sides reducing the overall thermal resistance which directly impacts the power per area. Using aluminum conductor plates in combination with thick film dielectrics allows for a compact, cost effective, and light weight power module which makes this technology a great choice for applications where high performance at a low cost is required.

**Exhibition Product Innovations**

Avago (www.avagotech.com) displayed the implementation of Amantys' (www.amantys.com) Power Insight™ protocol using Avago’s 50 MBd Versatile Link™ transmitters and receivers. The combined solution enables an IGBT gate driver with intelligent optical link management and on-board condition monitoring and diagnostics capabilities. It optimizes system power efficiency, cost and availability for inverters targeting renewable energy, industrial motor drive and transportation applications. Amantys Power Insight provides several important capabilities including monitoring of key system parameters at the IGBT switch during system operation, reporting back detailed fault codes which help the system operator understand the nature of problems in the switch, and configuring the switching characteristics of the IGBT module remotely to match operational demands. “Our vision is to improve the availability and reliability of power systems through the intelligent control of power,” commented Erwin Wolf, CEO at Amantys. “Avago Technologies has been supplying Versatile Link products to the power electronics industry for more than two decades,” said Martin Weigt, VP of Avago’s Industrial Fiber Product Division. “As real-time condition monitoring, diagnostics and adjustment are becoming increasingly important we will continue to enhance our link products with innovative features to improve system efficiency.”

Cree (www.cree.com/power) announced a new 40 mΩ, 1200 V SiC MOSFET and a 300 A, 1200 V half-bridge power module aimed at expanding applications in solar and industrial inverters as well as EV chargers and three phase power supplies for induction heating and other industrial automation systems. In addition, Cree introduced a low current 1SC0450V single driver core for IGBT modules with blocking voltages of 4.5 kV and 6.5 kV. This compact driver enables IGBTs to be paralleled using only one driver core. The 1SC0450V is based on the SCALE-2 chip set and a partial-discharge-free, low-coupling-capacitance, high-voltage DC/DC transformer for test voltages up to 10.4 kV RMS and a partial discharge extinction voltage of 7800 Vpeak. The driver core measures 60 mm x 90 mm x 27.50 mm. “Our family of high-voltage gate driver cores, which includes the 2SC0535T 3.3 kV and 2SC0635T 4.5 kV dual gate driver cores, reduces component count, thereby making designs more compact and reliable”, said System Engineering Director Michael Hornkamp. “These gate driver cores are suitable to drive all 4.5 kV and 6.5 kV IGBT modules currently available on the market. Target markets include traction and other high-voltage applications.”

GaN Systems (www.gansystems.com) announced five new normally-off 650 V GaN transistors. The GS66502P, GS66504P, GS66506P and GS66508P are respectively 8.5 mΩ, 1200 V MOSFET to bring SiC advantages to server, telecom, industrial and LED lighting power supplies. The latest SiC power module (www.cree.com/power/CAS300M12BM2) is available with multiple gate driver options and is pin compatible to standard 62-mm half-bridge modules, including IGBT modules rated at 450 A or more. “This new power module is yet another example of our commitment to the commercialization of SiC-based power electronics,” said Cengiz Balkas, VP Power and RF. “Utilizing our experience in SiC power devices, we have extended the benefits of SiC power modules to the 100 kW to 1 MW power range for applications such as induction heating, central solar inverters and active front-end motor drives. These new power modules are introduced at a breakthrough price-performance point below $500 that unlocks cost savings in these applications”. At display were also reference designs for a 50 kW solar inverter and a high-speed ZVS DC/DC converter.

CT Concept’s (www.IGBT-Driver.com) announced the 2SC0450T 3.3 kV and 2SC0635T 4.5 kV dual gate driver cores, reduces component count, thereby making designs more compact and reliable”, said System Engineering Director Michael Hornkamp. “These gate driver cores are suitable to drive all 4.5 kV and 6.5 kV IGBT modules currently available on the market. Target markets include traction and other high-voltage applications.”

GaN System’s CEO Girvan Patterson introduced 650 V GaN FETs Photo: AS

A/165 mΩ, 17 A/82 mΩ, 25 A/55 mΩ and 34 A/41 mΩ parts, while the GS43106L is a 30 A/60 mΩ cascode. The new 650 V enhancement mode parts feature zero reverse recovery charge and are delivered in near chip-scale PX package which eliminates wire bonds. “With these new 650 V parts as well as our recently-announced 100 V family we offer a wide range of parts which are available for sampling now. Applications include high speed DC/DC converters, resonant converters, AC motor drives, inverters, battery chargers and switch mode power supplies,” President Girvan Patterson stated.

Infineon’s (www.infineon.com/power) High Power IGBT Modules (IrM³) can be used even longer in the near future. More robust construction and greatly improved thermal conductivity behavior increase the average life time in comparison to previous models by a factor of up to 11 under the same conditions of use. The significantly longer life time of the IHAB-H Enhanced modules is based on two central modifications. First of all, a newly implemented manufacturing technology enables more robust
bond wire connections. This increases the resilience of the module components in power cycling associated with switching. The power cycling behavior of the IHM-B Enhanced has improved by a factor of two compared to the previous model. Secondly, the thermal conductivity is increased by the combination of an AlSiC base plate with AlN substrates. Depending on the topology the thermal resistivity drops by 16 – 18 %.

“When with the IHM-B Enhanced modules we are introducing a new manufacturing technology and a new substrate material. These advances have proven themselves in practical testing since the end of 2012 in challenging applications such as wind mills,” said product manager Björn-Christoph Schubart. Volume production is scheduled for August 2014.

International Rectifier (www.irf.com) introduced a new generation of SIP (System-In-Package) IPMs which shrinks and simplifies the design of appliance motor drive applications including air conditioners, fans, compressors and washing machines. These IPMs feature trench IGBTs and a three-phase gate driver IC plus thermo-mechanical technology to further improve thermal performance and system efficiency by delivering increased power density and enhanced reliability. The new devices are pin-to-pin compatible with the existing IRAM SiP1A series. “Improving the previous IRAM generation was not an easy task.

However, the new IR platform utilizes state-of-the-art technology for intelligent power modules to address the growing demand for more efficient motor drives”, IR’s director of IGBT Application Engineering, Andrea Gorgorino, pointed out. The company also launched compact IPMs for low power motor drive applications including fans, pumps, air purifiers and refrigerator compressor drives in a compact 12 mm x 29 mm SOP/DIP package. These so-called µIPM family offers a cost effective power solution by leveraging industry standard footprints and processes compatible with various PCB substrates. The family of 32 new devices features high-voltage FredFET MOSFETs specifically optimized for variable frequency drives with voltage ratings of 250 V or 500 V paired with driver IC tuned to achieve balance between EMI and switching losses. The µIPMs offer DC current ratings up to 4.6 A to drive motors up to 150 W without a heatsink and are available in both through-hole and surface mount package options.

LEM (www.lem.com) announced the addition of three new HO series of current transducers which extend nominal current measurement up to 250 A and offer a range of mounting options such as PCB or panel or busbar, and integrating the
inductance. Also a 6.5kV IGBT module of the next generation chip set of 7th gen IGBTs and diodes have been announced which are capable of turning off 4500 A. Therefore it is confirmed that the current rating of the new 6.5 kV IGBT module is able to be increased up to 1000 A from 750 A of conventional modules. Besides these offering the company already introduced full-SiC 3.3 kV power modules for traction applications.

ROHM (www.rohm.com) demonstrated its new 3rd gen 1200/650 V SiC MOSFETs based on Trench Gate structure technology, marking another development of SiC MOSFET which the company started back in 2010. Compared to conventional planar MOSFETs which have JFET regions increasing the on-resistance, the new MOSFET types only reach about half of the same on-resistance over the whole temperature range while the stability of the Gate oxide film and of the Body Diode remains as high as with 2nd gen SiC.

ROHM introduced 1200/650 V SiC Trench MOSFETs of its 3rd generation

MOSFETs. Since the issues regarding oxide breakdown during high drain-source voltage have been overcome, the result is higher reliability and increased current-carrying capability at reduced cell density, and reduced conductivity loss and switching loss. The company already developed SiC planar MOSFETs which have suppressed the degradation of parasitic PN junction diodes when forward current penetrates. Now, the low on-resistance of the trench SiC MOSFETs improves inverter power density and switching. The parasitic body diode shows minimal reverse recovery behavior and degradation caused by its conduction is widely eliminated. Available in TO-247 3L package or bare dies and 1200/650 voltage ratings, on-resistance varies between 22 and 40 mΩ.

In addition to the 600/650 V and 1200 V Semikron (www.semikron.com) MiniSKiiP power modules, 1700 V modules with 6-pack and Converter-Inverter-Brake (CIB) circuit topology are now available. The migration from 400/480 V AC to 600/690 V AC voltage levels used in industrial applications becomes increasingly popular in the process industry due to cost savings based on reduction of motor size, cable cross section, max. load current, total power losses, cable voltage drop during normal operating condition, motor start-up current, or feeding transformer size. For the first time MiniSKiiP Spring Technology is available for power ratings higher than 40 kW. The benefits are lower material costs as compared to traditional inverter designs because the expensive bus-baring of the load connectors can be replaced by a cost-efficient PCB connection. In combination with a fast, solder-free assembly, this allows for reducing the system costs by up to 15 percent. The spring contacts make the layout of the printed circuit board (PCB) simpler and more flexible because the PCB does not need holes for soldering pins. The MiniSKiiP Dual’s output of up to 90 kW requires higher current-carrying capability of the PCB, which e. g. can be achieved by using a 105 μm standard metal coating on the PCB. This allows for load currents up to 180 A RMS, which used to be reserved for modules with screw mounted busbars so far. The family concept of SEMiX® is expanded by the introduction of the 1200V SEMiX 3p press-fit half bridge IGBT modules for nominal currents of 300 A, 450 A and 600 A in the same housing size. The SEMiX 3p press-fit comes with an optimized internal design, now making 600 A nominal current possible in housing size 3, leading to lower cost per output power. Finally, Press-Fit expands the SEMiTO® product family as an alternative concept to solder mounting. Press-Fit mounting ensures easy and fast mounting of the module and PCB in one step, reducing the assembly time and cost by eliminating the solder process. Regarding SiC in power modules CSO Peter Sontheimer envisions certain applications such as windmills along with sintered die attach and SiN connectivity.

Chinese Starpower (www.starpower europe.com) took the opportunity at PCIM to enter the European market by opening a logistics center in Cadenazzo
The company produces power modules with state-of-the-art production facilities, such as a fully automated production and testing line in compliance with ISO 9001 standard. The product spectrum comprises standard IGBT half-bridge modules in the power range of 600 V, 1200 V and 1700 V up to 500 A as well as 6-pack and 7-pack modules and IPMs. "Owing to the experience and expertise in R & D and industrial production of power electronics modules, StarPower is in a position to offer competitive products on high-quality level," states Peter Frey, Managing Director and founding member of the European subsidiary. Frey brings with him 22 years of sales experience in power electronic modules and systems. "Our sales exceeded €60 million mainly in China with production figures of 150,000 modules per month. Besides the standard modules we have higher power traction modules and also SiC MOSFET activities", added CEO Hua Shen. Chips are supplied from ABB, Infineon and IR, substrates from Curamik, soldering is used for die-attach and wire-bonding for connectivity - thus standard technology. Modules are Econopack/flow pin-compatible.

Toshiba's (www.toshiba-components.com) latest 650 V power MOSFETs are based on the company's fourth generation superjunction DTMOS IV deep trench process and are available in seven different compact packages. Devices can be supplied with an integrated fast recovery diode (FRD). Thanks to the DTMOS IV technology, the new MOSFETs combine ultra-low on resistance with reduced die size, leading to very small form factors without power loss penalties. A strong advantage of the DTMOS IV deep trench process compared to a standard superjunction process, is the lower thermal coefficient of on-resistance over temperature. DTMOS IV also minimizes MOSFET output capacitance, and an optimized gate-drain capacitance delivers improved dv/dt switching control. The company also announced a family of low-voltage Trench-MOSFETS based on the U-MOS IX-H process. The new MOSFETs deliver leading FOM and will be initially available in 40 V versions, having a typical on-resistance of 0.7 mΩ and a typical output capacitance of 1930 pF. The TPHRB504PL is supplied in an ultra-miniature SOP-Advance package measuring 5 mm x 6 mm. Target applications include DC/DC converters, synchronous rectification and other power management circuitry where low-power operation, high-speed switching and minimum PCB real estate are needed.

Victor (www.vicorpower.com) announced a new platform of isolated, regulated DC/DC converter modules based on the company's Converter housed in Package (ChiP) platform. This ChiP DCM platform spans DC/DC conversion requirements from 12 V to 420 V input and 12 V to 55 V output. Coupled with FPA and ZVS regulators, these power components enable dense, efficient and scalable source-to-load power system solutions. At PCIM two pre-configured ChiP DCMs have been shown. The first is a 4623 (46 mm x 23 mm) 600 W ChiP DCM, with nominal 290 V input and 13.8 V output for applications such as high-voltage Li-Ion battery to 12 V systems. "This is a new generation of bricks optimized for automotive applications", said Rob Russell, VP of Product Marketing. The second is a 3623 (36 mm x 23 mm) 320 W ChiP DCM with 16-50 V input range and nominal 28 V output, optimized for 28 V MIL-COTS systems. ChiP DCMs provide up to 76 W/cm? power density and 93 % efficiency, with parallel array capability of up to eight units. Both ChiP DCMs are available for order today from Victor and its authorized distributors such as Hy-Line (www.hy-line.de).

Vincotech (www.vincotech.com) has rolled out a new set of power modules for UPS and solar applications. These flowMNPC 4w 2g come in flowSCREW 4w housings and feature MNPC topology. The 400 A and 600 A devices have been equipped with a different class of 1200 V and 650 V IGBTs and diodes to improve efficiency and optimize inverters and are also available with a thermal interface made of phase-change material. Mitsubishi’s latest 6.1 generation IGBTs and diodes in the half-bridge path, paired with 650 V semiconductors in the neutral clamp path, improve the performance in the target applications. Featuring a power PDB design, the modules' commutation inductance is very low so no snubber capacitors are needed. Additionally new SiC-based modules featuring SiC MOSFETs have been introduced in two versions. One is a flow3xPHASE 0 SiC three-phase inverter module with 3x BUCK/BOOST and split output topology; the other is a flow3xBOOST 0 SiC with three-channel boost circuits. "At switching frequencies of 50 kHz and above the use of the SiC MOSFET’s internal body diode makes sense", said Werner Obermaier, Director Product Marketing. "We use Cree’s and Rohm’s second generation SiC MOSFETs in our modules". They achieve >99 % peak efficiency at 64 kHz and are equipped with integrated DC-link 600 V ceramic capacitors. The company now makes use of sintering for the die attach in certain modules. "Though the market faces ups and downs, we steadily gained market share over the years. The downturn in photovoltaics was compensated by industrial applications and we are looking for better results in the foreseeable future", CEO Joachim Fietz pointed out.

Vincotech’s CEO Joachim Fietz expects growing market share in power modules Photo: AS

The latest 650 V power MOSFETs are based on the company’s fourth generation superjunction DTMOS IV deep trench process and are available in seven different compact packages. Devices can be supplied with an integrated fast recovery diode (FRD). Thanks to the DTMOS IV technology, the new MOSFETs combine ultra-low on resistance with reduced die size, leading to very small form factors without power loss penalties.

StarPower was founded in 2005 in Jiaxing near Shanghai and presently has 350 employees. The company produces power modules with state-of-the-art production facilities, such as a fully automated production and testing line in compliance with ISO 9001 standard. The product spectrum comprises standard IGBT half-bridge modules in the power range of 600 V, 1200 V and 1700 V up to 500 A as well as 6-pack and 7-pack modules and IPMs. "Owing to the experience and expertise in R & D and industrial production of power electronics modules, StarPower is in a position to offer competitive products on high-quality level," states Peter Frey, Managing Director and founding member of the European subsidiary. Frey brings with him 22 years of sales experience in power electronic modules and systems. "Our sales exceeded €60 million mainly in China with production figures of 150,000 modules per month. Besides the standard modules we have higher power traction modules and also SiC MOSFET activities", added CEO Hua Shen. Chips are supplied from ABB, Infineon and IR, substrates from Curamik, soldering is used for die-attach and wire-bonding for connectivity - thus standard technology. Modules are Econopack/flow pin-compatible.

Toshiba's (www.toshiba-components.com) latest 650 V power MOSFETs are based on the company’s fourth generation superjunction DTMOS IV deep trench process and are available in seven different compact packages. Devices can be supplied with an integrated fast recovery diode (FRD). Thanks to the DTMOS IV technology, the new MOSFETs combine ultra-low on resistance with reduced die size, leading to very small form factors without power loss penalties. A strong advantage of the DTMOS IV deep trench process compared to a standard superjunction process, is the lower thermal coefficient of on-resistance over temperature. DTMOS IV also minimizes MOSFET output capacitance, and an optimized gate-drain capacitance delivers improved dv/dt switching control. The company also announced a family of low-voltage Trench-MOSFETS based on the U-MOS IX-H process. The new MOSFETs deliver leading FOM and will be initially available in 40 V versions, having a typical on-resistance of 0.7 mΩ and a typical output capacitance of 1930 pF. The TPHRB504PL is supplied in an ultra-miniature SOP-Advance package measuring 5 mm x 6 mm. Target applications include DC/DC converters, synchronous rectification and other power management circuitry where low-power operation, high-speed switching and minimum PCB real estate are needed.

Victor (www.vicorpower.com) announced a new platform of isolated, regulated DC/DC converter modules based on the company’s Converter housed in Package (ChiP) platform. This ChiP DCM platform spans DC/DC conversion requirements from 12 V to 420 V input and 12 V to 55 V output. Coupled with FPA and ZVS regulators, these power components enable dense, efficient and scalable source-to-load power system solutions. At PCIM two pre-configured ChiP DCMs have been shown. The first is a 4623 (46 mm x 23 mm) 600 W ChiP DCM, with nominal 290 V input and 13.8 V output for applications such as high-voltage Li-Ion battery to 12 V systems. "This is a new generation of bricks optimized for automotive applications", said Rob Russell, VP of Product Marketing. The second is a 3623 (36 mm x 23 mm) 320 W ChiP DCM with 16-50 V input range and nominal 28 V output, optimized for 28 V MIL-COTS systems. ChiP DCMs provide up to 76 W/cm? power density and 93 % efficiency, with parallel array capability of up to eight units. Both ChiP DCMs are available for order today from Victor and its authorized distributors such as Hy-Line (www.hy-line.de).

Vincotech (www.vincotech.com) has rolled out a new set of power modules for UPS and solar applications. These flowMNPC 4w 2g come in flowSCREW 4w housings and feature MNPC topology. The 400 A and 600 A devices have been equipped with a different class of 1200 V and 650 V IGBTs and diodes to improve efficiency and optimize inverters and are also available with a thermal interface made of phase-change material. Mitsubishi’s latest 6.1 generation IGBTs and diodes in the half-bridge path, paired with 650 V semiconductors in the neutral clamp path, improve the performance in the target applications. Featuring a power PDB design, the modules' commutation inductance is very low so no snubber capacitors are needed. Additionally new SiC-based modules featuring SiC MOSFETs have been introduced in two versions. One is a flow3xPHASE 0 SiC three-phase inverter module with 3x BUCK/BOOST and split output topology; the other is a flow3xBOOST 0 SiC with three-channel boost circuits. "At switching frequencies of 50 kHz and above the use of the SiC MOSFET’s internal body diode makes sense", said Werner Obermaier, Director Product Marketing. "We use Cree’s and Rohm’s second generation SiC MOSFETs in our modules". They achieve >99 % peak efficiency at 64 kHz and are equipped with integrated DC-link 600 V ceramic capacitors. The company now makes use of sintering for the die attach in certain modules. "Though the market faces ups and downs, we steadily gained market share over the years. The downturn in photovoltaics was compensated by industrial applications and we are looking for better results in the foreseeable future", CEO Joachim Fietz pointed out.