

Wide Bandgap Gains Acceptance

APEC 2018 from March 4 – 8 in San Antonio/Texas provided a highly professional technical program and exposition, the conference began with 18 Education Seminars organized into 6 parallel tracks, followed by 6 Keynotes in the Plenary session. The exhibition featured around 300 companies.

The technical papers were organized into 63 sessions with nearly 600 papers, along with 25 industry sessions featuring an additional 130 presentations. "Besides all of these presentations, sessions and events to attend, I always find that is connecting with my peers, friends and colleagues face-to-face, catching-up with what new things they are working on, and discovering the latest trends in their realm that is the most rewarding aspect of attending APEC", commented General Chair Eric



APEC 2018 exhibition floor featured more than 300 companies

Person. I as attendee agree because the most important informations can be gathered in informal personal talks.

As in previous years SiC and GaN played a major role in the conference sessions as well as on the exhibition floor, but the focus has been shifted from basic technologies towards applications.

At the Plenary Session two European speakers referred to the advantages

of SiC. Johann W. Kolar, ETH Zurich, talked about the 'Vienna Rectifier and Beyond'. Twenty years ago at APEC 1998 a single stage isolated three-phase PWM rectifier system was introduced. The topology is a unidirectional three-phase three-switch three-level PWM modulator or a three-phase diode bridge with an integrated boost converter. It is useful wherever six-switch converters are used for achieving sinusoidal mains current and controlled output voltage, when no energy feedback from the load into the mains is available. In practice, use of the Vienna Rectifier is advantageous when space is at a sufficient premium to justify the additional hardware cost. "Future designs are based on SiC MOSFETs to increase efficiency and reduce size and weight considerably", Kolar pointed out.

Also ABB's Principal Scientist, Muhammad Nawaz, highlighted the advantages of SiC in future power converters for the windmills or electrical drives.

More power for SiC

IXYS Corporation, which was acquired by Littelfuse (www.littelfuse.com) in January 2018, and Monolith Semiconductor Inc., a fabless developer of SiC technology in which Littelfuse holds a controlling interest, exhibited their growing power semiconductor portfolio. The IXYS acquisition adds new technologies for the manufacturing of power modules, high-temperature/low-loss discretes, medium- and high-power thyristors, fast recovery diodes and rectifiers, industrial IGBTs, MOSFETs, driver and control ICs, and optical and solid-state relays. These new product lines complement existing Littelfuse technologies, which include low-power thyristors, ignition IGBTs, and SiC Schottky diodes and MOSFETs. "During the last few years, IXYS and Littelfuse have been expanding their product platforms to pursue many of the same markets. The IXYS acquisition gives Littelfuse customers a single source for power semiconductors, so no matter what the application is, we can support it with the delivery and application support customers need on a global scale", commented Corey Deyalsingh, Director Power Semiconductors at Littelfuse. "With the support of the PowerAmerica Institute, X-FAB, through collaboration with Monolith, is accelerating the commercialization of SiC power devices by leveraging the economies of



Entry of the APEC 2018 exhibition floor



Littelfuse's Director Power Semiconductors Corey Deyalsingh (left) and Monolith Semiconductor's CEO Sujit Banerjee explained the planned power semiconductor roadmap

scale, automotive quality standards, and equipment set that X-FAB uses for its Silicon wafer fabrication line into its SiC foundry model. X-FAB currently fabricates wafers for ten different SiC companies in the same facility, each with its unique set of device designs and process sequences. By consolidating the resources necessary and the demand from both Silicon and SiC customers, X-FAB can produce 6-inch SiC wafers at the same rate as some of the world's leading integrated device manufacturers that operate captive fabs. This gives us a competitive advantage," added Sujit Banerjee, CEO Monolith Semiconductor.

At APEC a 1200 V SiC N-channel MOSFETs was added to the first-generation portfolio of power semiconductor devices. Shown were also a Dynamic Characterization Platform for characterizing SiC device switching behavior and the Gate Drive Evaluation Platform for studying the optimal device driving conditions for specific applications. Also Texas Instruments exhibited its 10 kW, 1 kV, 3-phase, 3-level SiC-Based Grid Tie Inverter Reference Design for a transformer-less solar string inverter with 99 % peak



TI's 10 kW, SiC-based grid tie inverter reference design for a transformer-less solar string inverter with 99 % peak efficiency

efficiency and 50 kHz switching using Monolith SiC MOSFETs at Littelfuse's and TI's booth.

UnitedSiC (www.unitedsic.com) announced the UJ3C series of cascaded 650 V SiC FETs (manufactured also by X-FAB) as drop-in replacements for Silicon Superjunction MOSFETs. Available in standard TO-220, TO-247 and D2PAK-3L packages, they operate with standard Si-MOSFET gate drive, offering low on-resistance at 27 mΩ and gate charge. Used for power factor correction and DC/DC conversion in both hard-switched and ZVS-switched systems, applications include electric vehicle (EV) chargers, power supplies, motor drives and renewable energy inverters. The maximum drain current (ID) ratings for these SiC cascoded transistors ranges from 31 A to 85 A. A built-in low Qrr body diode eliminates the need for an anti-parallel diode. Anup Bhalla, UnitedSiC's VP of Engineering said, "With ESD-protected gates (HBM class 2) and strong avalanche capability these SiC FETs are both more economical and more rugged than GaN devices with comparable ratings. In the most demanding applications, such as EV charging, we are now seeing a clear preference for SiC technology for both new designs and to replace silicon Superjunction MOSFETs in existing systems."

ON Semiconductor's (www.onsemi.com) released family of 650 V SiC diodes includes surface mount and through hole packages ranging from 6 A to 50 A. All of the diodes provide zero reverse recovery, low forward voltage, temperature independent current stability, high surge capacity and positive temperature coefficient. The company also plans to release SiC and GaN FETs in the near future.

GaN is going higher power levels

EPC (www.epc-co.com) launched the EPC2112 and EPC2115 enhancement-mode monolithic GaN power transistor with integrated driver. The EPC2112 is a 200 V, 40-mΩ eGaN FET plus gate driver. The EPC2115 is an IC with dual 150 V, 70-mΩ eGaN FETs plus gate drivers. Both products are capable of operating up to 7 MHz and are available in low inductance 2.9 mm x 1.1 mm

BGA surface-mount passivated die. The integrated driver is specifically matched to the eGaN device to yield optimal performance under various operating conditions. Performance is further enhanced due to the small, low



GaN Systems' CEO Jim Witham presents a newly launched Insulated Metal Substrate

inductance footprint. Monolithic integration eliminates interconnect inductances for higher efficiency at high frequency. This is especially important for high frequency applications such as resonant wireless power, and high frequency DC/DC conversion. As design examples for these new ICs, two differential class-E amplifier development boards are available. The EPC9089 is an AirFuel compatible class 4 (33 W) and uses the EPC2112. The EPC9088 is a class 3 (16 W) amplifier using the EPC2115. The EPC2112 is also featured in a new demonstration board, the EPC9131, for a 300 kHz SEPIC converter low voltage DC/DC application.

The company also introduced two GaN power modules for DC/DC conversion, increasing efficiency across the 48 V to point-of-load power architecture. The EPC9205 is a high-power density PCB-based power module for 48 V – 12 V conversions while the EPC9204 address the 20 V conversion with an ultra-thin profile PCB-based power module. The EPC9205 is an 80 V, 10 A PCB-based power module featuring the 100 V EPC2045 eGaN FET for “plug and play” evaluation of the high performance gained with GaN power transistors.

GaN Systems (www.gansystems.com) announced an expansion of the company's GaN power transistors (supplied by TSMC) with new products focused on industrial, automotive, and renewable energy applications. To mention is the 100 V, 120 A, 5 m Ω GaN E-HEMT GS-010-120-1-T, suited for the growing 48 V applications in the automotive, industrial, and renewable energy industries which require power systems with high power levels in smaller size form factors. The transistor is footprint-compatible with the 100 V, 90 A GS61008T, enabling to add further power by substituting the GS-010-120-1-T without changing the board. The new GS-065-120-1-D 120 A, 650 V GaN E-HEMT increases the power density of 20 to 500 kW power conversion systems, including automotive traction inverters, very high power on-board chargers (OBC), large-scale energy storage systems, and industrial motor drives. “This is the most pivotal GaN product on the market to be optimized for modules and is compatible with both embedded and

traditional module technology,” stated Jim Witham, CEO of GaN Systems. For the consumer and data center applications, several integrated half-bridge with driver have been highlighted. New design tools including several evaluation boards such as the newly launched Insulated Metal Substrate (IMS) Evaluation Platform, which provides a flexible, low cost, high power development platform for high-efficiency power systems with 3 kW or higher applications, have been shown.

Navitas Semiconductor (www.navitassemi.com) introduced its GaNFast™ power ICs, based on the TSMC 650 V GaN Process, enabling the ‘Mu One’, a universal 45 W power adaptor with a 14 mm ultra-slim profile. GaN power IC (half-bridge with driver) is combined with USB-PD power delivery protocol and a type C connector to realize a slim adapter that can charge a laptop or fast-charge a smartphone. “GaN power ICs have up to 20x the performance of Silicon chips. By operating at high frequency and increased efficiency, GaNFast power ICs reduce the size, weight and cost of components such as transformers, heatsinks, and printed-circuit boards. This is a significant achievement to pack this much power in such a low-profile outline”, said Gene Sheridan, Navitas CEO. The company additionally announced the smallest mobile adapter enabled by GaNFast power ICs. The 27 W Active Clamp Flyback design delivers 5x greater power than standard smartphone chargers and is 2x higher power density. With universal input voltage capability and a Type C connector with USB-PD 3.0 and Qualcomm Quick Charge™ 4.0 features, this lightweight reference design delivers an extremely portable charging solution.

Dialog Semiconductor (www.dialog-semiconductor.com) also introduced such a 650 V GaN half-bridge already last year. But this year's focus was on GreenPAK™ SLG46824 and SLG46826 Configurable Mixed-signal ICs (CMICs), following the acquisition of Silego Technology. These devices support in-system programming using a simple I²C serial interface. This allows the installation of an un-programmed GreenPAK on the PCB, and supports programming of the Non-Volatile Memory (NVM) in-system, for

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IGBT modules



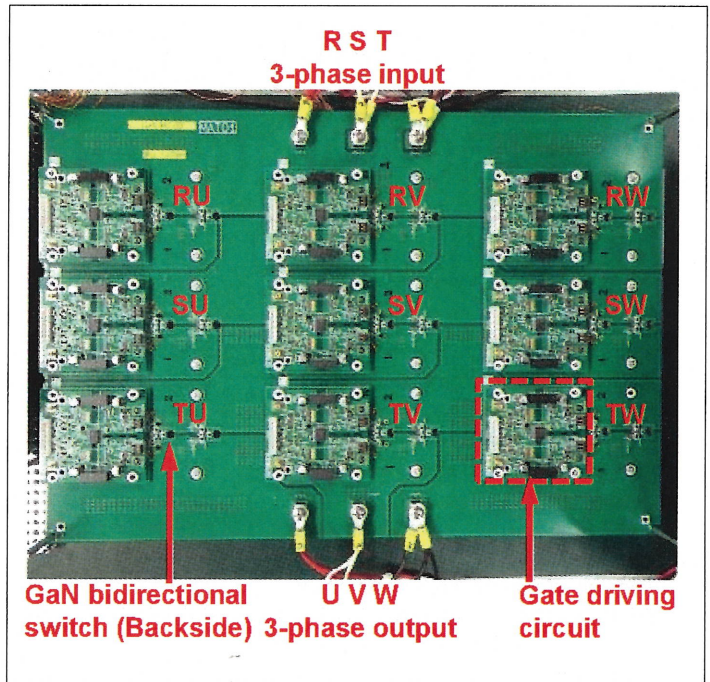


Avitas' CEO Gene Sheridan presented a travel adapter based on its 650 V GaN half-bridge

easy system checkout. This flexibility is also beneficial in the production environment, as it is easy to modify the configuration or add functionality to these devices by programming the non-volatile memory on the production line. The NVM on this device is specified for 1,000 erase/write cycles. Additionally, the SLG46826 includes 2 kbits of EEPROM emulation memory that can replace an I²C-Compatible Serial EEPROM on the customer's board, supporting storage of backup configuration data, a checksum or a serial number. Available in a 2.0 x 3.0 mm 20-pin STQFN package, both CMICs are equipped with low power consumption analog and digital resources like analog comparators (ACMPs), an internal voltage reference, power-on reset, and more advanced digital resources, like multi-function macro-cells. Combining the low power analog comparators with the internal low power voltage reference consumes 2.5 μ A typical for two ACMPs that are continuously monitoring external signals.

Texas Instruments (www.ti.com) announced two GaN FET drivers for designs in speed-critical applications such as light detection and ranging (LIDAR) and 5G radio-frequency (RF) envelope tracking. The LMG1020 and LMG1210 can deliver switching frequencies of 50 MHz while improving efficiency and enabling five times smaller solution sizes previously not possible with Silicon MOSFETs. With a minimum pulse width of 1 ns, the LMG1020 50-MHz low-side GaN driver enables high-accuracy lasers in industrial LIDAR applications. The small wafer-level chip-scale (WCSP) package of 0.8 mm by 0.2 mm helps minimize gate-loop parasitics and losses.

The LMG1210 is a 50-MHz half-bridge driver designed for GaN FETs up to 200 V. The device's adjustable dead time control feature is designed to improve efficiency by as much as 5% in high-speed DC/DC converters, motor drives, Class-D audio amplifiers as well as other power-conversion applications. Designers can achieve high system-noise immunity with the highest common-mode transient immunity (CMTI) of more than 300 V/ns. The company also introduced several new power management chips that enable designers to boost efficiency and shrink power-supply and charger solution sizes for personal electronics and handheld industrial equipment. Operating at up to 1 MHz, TI's new chipset combines the UCC28780 active amp flyback controller and the UCC24612 synchronous rectifier controller to help cut the size of power supplies in AC/DC adapters and USB Power Delivery chargers in half. For battery-powered electronics that need



Panasonic's GaN 373 matrix converter with nine GaN bidirectional switches and gate driving circuits

maximum charging efficiency in a small solution size, the bq25910 6-A three-level buck battery charger enables up to a 60% smaller-solution footprint in smartphones, tablets and electronic point-of-sale devices.

Finally, high-efficient three-phase to three-phase matrix converters using GaN bidirectional switches with both high current and high breakdown voltage were discussed by Panasonic at the conference. The GaN switch with dual gates works as a bidirectional switch by a single device, while a conventional bidirectional switch consists of four devices by two IGBTs and two diodes. In addition, the GaN bidirectional switch is also free from the voltage offsets for the current conduction so that the GaN-based matrix converter enables small size and highly efficient AC/AC conversion. Improvement of the device performance including the recessed gate enables low on-state resistance with stable operation free from current collapse. The maximum drain current reaches 100 A together with breakdown voltage of 1340 V. The fabricated three-phase to three-phase matrix converter exhibits the maximum conversion efficiency of 98% at 1 kW output power with the expectation that the maximum output power can reach 10 kW or more by the high current device.

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