Power Semiconductors Abound AT CES 2020

by David G. Morrison, Editor, How2Power.com

When you think of the CES show, your first thought may not be of MOSFETs, IGBTs and power ICs and modules. But this massive tech show has become a showcase for many of the latest SiC, GaN and silicon power components being developed for the countless applications exhibited at CES and even applications you might not see at CES. In their meeting rooms, hotel suites, and sometimes even on the show floor, power semiconductor manufacturers displayed the latest application examples, both customer products and reference designs, using their parts.

Automotive applications, particularly electric vehicles, figured prominently in these demos, and encompassed a long list of applications ranging from traction inverters, on-board chargers, dc-dc converters and battery management systems to power solutions for vehicle displays, lighting, audio amplifiers, ADAS cameras and LIDAR systems. Wireless charging, ac-dc adapters and USB-PD-based power supplies (including adapters) were other popular subjects of power semiconductor company demos.

Some other interesting applications for power components included drones, robots, wireless ear buds, and power banks—which like the previously named applications were all products that could be seen on the floors of the main exhibition halls. Some of the more exotic applications concerned use of wireless power/charging (ex. underwater drones, inductive heating of food, sneakers and through-wall power). The demos and reference designs shown by semiconductor companies for all these various applications contained the vendors' discrete power devices, power modules, voltage regulators and power management ICs (PMICs).

With SiC components playing a growing role in EVs, and GaN devices making inroads in LiDAR, wireless power, adapters, and other uses, CES continues to be an important forum for showing reference designs and customer product examples for the latest wide-bandgap components. In addition, it has also become a place for power semiconductor manufacturers to discuss their future plans for wide-bangap development, production and marketing. For example, at CES 2020, one SiC supplier explained how they've expanded their SiC capacity to go from serving just automotive applications to now address industrial uses. Meanwhile, several power semi companies described what will be their first forays into GaN.

I've noted previously that CES' scope has gone beyond the original consumer focus to encompass industrial and other markets. Once again, this trend was evident in the semiconductor companies' exhibits where they showed demos, reference designs, and components for industrial motor drives and power supplies, power conversion in data centers, and building automation to name a few non-consumer areas.

In this article, I describe some of the many power-related demos, customer product examples and reference designs exhibited by power semiconductor companies at CES 2020, which was held Jan. 7-10 in Las Vegas. And while my focus here is on power components, I also touch on some of the non-power parts—the analog ICs and sensors, which were exhibited and demo'd. These developments help to provide some of the larger context in which the mainstream power semiconductor companies are creating their power parts. This article is a follow-up to my initial coverage of CES 2020 where I discussed the trends and developments seen in the main exhibition halls.*

*"CES 2020: Automotive And Health Fields Drive Much Tech Development," How2Power Today, January 2020.

STMicroelectronics

In their suites at the Wynn Encore hotel, STMicroelectronics presented numerous power-related demos. In the area of electromobility, the company displayed an EV traction inverter reference design employing SiC modules capable of working from 800-V and 400-V buses, providing 300 to 400 A to drive a motor. In this demo, the need to reduce switching losses and deliver high peak current in compact designs motivated the change from IGBTs to SiC MOSFETs. Key parts for this demo are noted in the table below.

ST also showed a demo of a 21-kW solution for an on-board charger, which combined three 7-kW SiC modules, as well as an automotive bidirectional 1-kW boost/3-kW buck, dc-dc reference design employing digital control. While these were similar to demos shown last year at CES, those earlier demos did not have full boards including parts such as the SPC58 microprocessor, the L9502 drivers, and the ACEPACK Drive module, which has yet to be announced.

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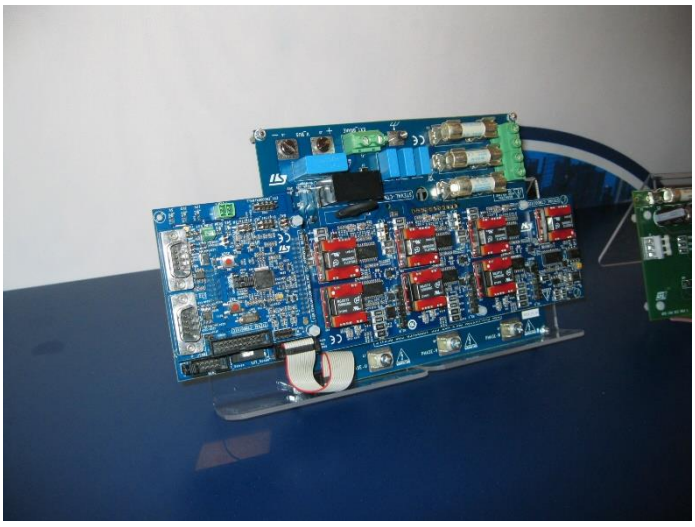
Table. ST components used in EV demos

Function	Description	ST parts
Traction inverter	Very compact traction-inverter solution stackup of SiC MOSFET-based ACEPACK drive module, gate driving board and control board with aux power supply. Capable of driving EV and HEV high-power electric motors. Also includes liquid-cooled heatsink. Company offers full motor control firmware support.	• ADP86012W2 • STGAP1AS • SPC58NN84E7 • A7986 • A6902 • STPSxx • ESDCAN05
On-board charger	21-kW SMD modular solution for on-board chargers included three modules of 7 kW each in totem-pole configuration with SiC MOSFETs to reduce component count. Input SCRs are used for inrush current limiting.	• STCTH35N65G2 • STPSC20065GY • STTH30L06GY • TN3050H-12GY • STB46N60DM6AG • STGAP1AS • SPC58xx
Dc-dc converter	Automotive bidirectional 1-kW boost/3-kW buck converter reference design for evaluation of digitally controlled switched mode power supply.	• SPC58NE84C3 • Automotive-grade low-voltage MOSFET • Schottkys • Drivers • Op amps

According to ST, the company has reached a turning point in its production of SiC power components. Up until now, automotive has driven and taken up nearly all of the company's SiC manufacturing capacity. However, thanks to recent expansions in this capacity, the company is now able to offer SiC products to the industrial market. With that in mind, the company presented demos such as a three-phase 7.5-kW motor drive for industrial applications based on the ACEPACK1 module with a 1200-V Gen2 SiC MOSFET six-pack for inverters. An example application for this inverter would be a robotic arm.



ST's STEVAL-HKI001V2 is retrofitted with a new 1200-V SiC six-pack ACEPACK1 Module for >7.5-kW operation.

Another industrial demo was a flyback-based, auxiliary power supply for converting a 400-V to 1200-V input to a 48-V output. Its use of the company's discrete SiC MOSFETs enables it to deliver 90 W without a heatsink or 175 W with a small heatsink.

While ST's work in SiC has been ongoing for years, the company is now making forays into GaN power devices. At CES, the company displayed examples of what will be its first offerings, 650-V and 100-V enhancement-mode FETs. The company expects to offer engineering samples of these parts this year with full production coming in Q1 of 2021. These parts will be offered in innovative, bond-free packages that support their operation at high switching frequencies.

While it's natural that automotive is a focus of demos at CES, the presence of demos for industrial applications like those just mentioned, highlights the fact that CES is much broader than consumer electronics. And we find

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other examples along these lines in ST's demos for the data center, where they showed some of their offerings for stepping down a 48-V bus to an intermediate voltage. One of these was a switched tank converter (STC) stepping down 54 V to an unregulated 12 V, delivering up to 1 kW.

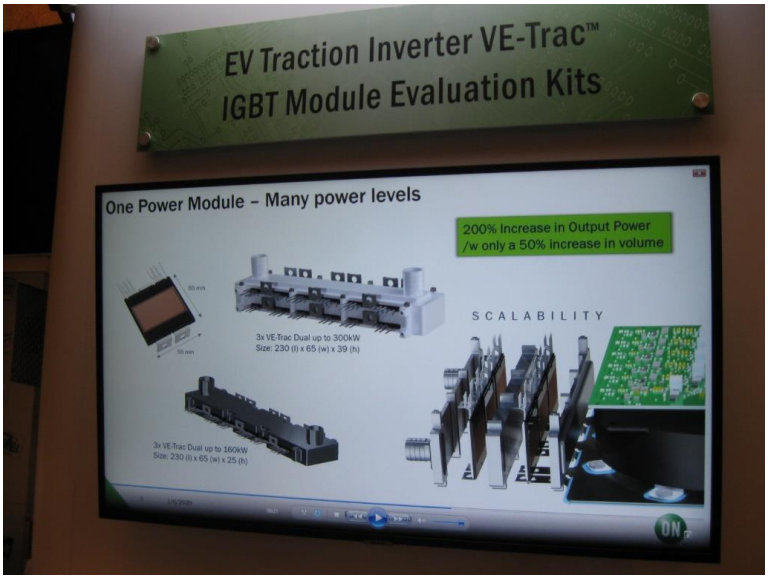
The STC has been demo'd prominently at recent APECs. However, the company is now seeing a demand for a regulated intermediate bus in the data center, and with this need its customers are opting for the company's StackedBuck (STB) topology. At CES, ST demo'd a 54-V to 12-V STB converter that scales up to 3.2 kW using four 800-W cells. According to the company, with either of these solutions, customers are opting to stick with multiphase point-of-load (buck) converters for the second power stage that steps the intermediate bus voltage down to the 1-V or lower IC supply voltages.

ON Semiconductor

As with ST, ON Semiconductor, in their meeting room at the Venetian/Sands Expo, exhibited demos and displays for a range of components and applications. In the automotive area, Maurizio Acosta, marketing and applications manager for the Automotive-HEV/EV Power Solutions Group, showed me demos of ON's power modules for EV traction inverters. These included their new VE-TRAC inverter modules, which were announced in December—VE-Trac Direct and VE-Trac Dual. VE-Trac direct is a full three-phase inverter module with six IGBT switches and a direct liquid-cooling package. This is essentially a second source of the HybridPACK from Infineon.

VE-Trac Dual, on the other hand, is an innovative half-bridge module with dual-side (liquid) cooling that is also electrically isolated on both ends. The modules enable scalable designs and the dual-sided cooling enables these designs to achieve higher power density. This module is initially being offered with 750-V and 1200-V IGBTs, but SiC versions are planned.

At CES, the company showed eval kits for both VE-Trac Direct and VE-Trac Dual. The VE-Trac Direct EZ Eval Kit (NVH820S75L4SPB-EVK) consists of a single VE-Trac Direct power module (NVH820A75L4SPB) mounted in a cooling jacket, with a six-channel gate driver board and a dc link capacitor. The kit does not include a PWM controller or external current sensors.



ON's display for the VE-Trac Dual showed off its scalability and ability to increase power output via its dual-side liquid cooling.

The VE-Trac Dual EZ Eval Kit (NVG800A75L4DSC-EVK) consists of three VE-Trac Dual power modules (NVG800A75L4DSC) mounted on a dual-side cooling heatsink, with a six-channel gate-driver board, dc link capacitor and external hall-effect current sense feedback for motor control (but no PWM controller). This kit allows customers to build and test a complete inverter just by connecting their control board.

Also in the automotive area, the company showed a demo of a 60-W USB PD 3.0 power supply with the PPS (programmable power supply) protocol in the company's Strata development environment. This demo included the FUSB3307, a fully integrated USB-C PD 3.0 adaptive charging controller. The company showed a similar board last year, which required a microcontroller. However, with the functionality provided by the FUSB3307, that MCU is no longer needed. The FUSB3307 is due to be released in Q2 of this year and the demo board will follow.

Still within automotive, the company presented a 48-V, high current version of its eFuse, which is targeting applications in mild hybrids. This IC mimics a fuse, but provides both inrush and overvoltage protection. This 48-V eFuse was originally developed for cloud computing but has migrated to automotive and other applications. Look for this device (NIS3070) to be released soon.

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ON's exhibit also included a demo of a 24-V eFuse intended for industrial relay replacement and motor protection. In the demo, performance of the eFuse was compared with that of a PTC, which is commonly used in such industrial applications. Both the eFuse and the PTC are resettable; however as semiconductor devices eFuses provide faster, more controllable and more repeatable operation.

Other demos in the ON exhibit included the NCP81295/96 co-packaged hot swap controller + FET + current sense amplifier; the NCP3284/5, a 4.5-V to 18-V input, 30-A point-of-load buck converter; a motor control system solution; vision sensors for automotive and industrial applications; a BT Mesh network, and temp and pressure sensors for smart office building (building automation, HVAC).

Infineon Technologies

In their meeting room at the Venetian/Sands Expo center, representatives from Infineon briefed me on their GaN and SiC developments. In the GaN area, the company has released a 600-V CoolGaN power device (GaN enhancement-mode power HEMT). This type of part is optimized for server power supplies which are said to be one of the most active areas for GaN due to the requirement for Titanium+ efficiencies of greater than 96%. While silicon-based superjunction MOSFETs can deliver up to 97% and higher efficiency, they can't deliver the density levels offered by GaN switches.

Also notable, there is a general trend toward introduction of 650-V devices as these are needed in telecom and 5G. Infineon plans to introduce a 650-V GaN transistor as part of an expanded offering for customers looking for more V_{DS} headroom. Examples include applications requiring 277-Vac or higher input.

Meanwhile, Infineon's development of the 600-V CoolGaN devices continues and the company is working on a monolithically integrated 600-V GaN FET and driver with 70-mΩ and 190-mΩ on-resistances as well as a 600-V 42-mΩ device. Both are in the development stages this year.

Efforts to develop lower-voltage GaN devices also continue. Late last year, Infineon launched a 400-V version of its CoolGaN devices targeting Class D audio applications, where GaN enables smoother switching and a more linear class D output stage. (See GaN Power Transistors Target High-End Audio And SMPSs, How2Power Today, December 2019).

Beyond this, the company is developing 100-V and 200-V GaN parts and is in the early stages of sampling of these parts to select customers. These are expected to be released in 2021.

In the SiC product area, Infineon has 1200-V SiC discretes and modules as well as 650-V products that were launched after CES 2020, in February.

Rohm Semiconductor

In Rohm Semiconductor's exhibits in their meeting room at the Venetian/Sands Expo center, there were numerous power-related demos previewing new products the company has been developing. In the automotive area, marketing manager Tetsuya Sumida explained that the company is proposing a complete wireless charging solution for EVs. While the eval board for such a solution is still being developed, the company was able to show the SiC devices and gate drivers that will enable it. Similarly an EV traction inverter is being prepared and should be ready in time for APEC.

Rohm's exhibits included their existing 1200-V SiC modules, including a 1200-A model that was announced a few months prior to CES. Meanwhile, the company is preparing to introduce its first GaN FET, which will be a 150-V part from GaN Systems. Rohm is sampling this part now and expects to release it this year. Looking ahead, the company is developing its own 450-V GaN HEMTs. However, these devices are said to be at least two to three years away.

Returning to the automotive area, EVs are certainly not the only focus of component development for power semiconductor companies as these companies continue to develop specialized power management ICs for the various vehicle functions. For example, at CES, Rohm previewed a chip targeting advanced driver assistance systems (ADASs). The part, which was not yet released, is a special PMIC for ADAS cameras.

In-vehicle displays are another area whose power management requirements are spurring PMIC development. One of the parts displayed by Rohm was the BM81810MUV, a power management IC for TFT-LCD panels which are used in car navigation, in-vehicle center panels, and instrument clusters. This IC incorporates a VCOM amplifier and gate pulse modulation (GPM) in addition to the power supply for the panel driver (SOURCE, GATE, and LOGIC power supplies). Moreover, this IC has a built-in EEPROM for sequence and output-voltage-setting

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retention. Although this is an older part, it's notable as part of a larger trend. As we'll see, other chipmakers were also showing PMICs to satisfy the changing vehicle display requirements.

While Rohm's work on wireless charging for EVs was noted above, they also demo'd a 15-W Qi-compliant wireless charging design for charging a smart phone. This particular design used three coils in the transmitter. The 15-W power enables fast charging.

Rohm's demos also included a new regulator, the Nano-cap LDO. Unlike a standard LDO, which requires an output cap of 1 to 10 µF for stability, the Nano-cap LDO can operate with much less capacitance. A higher-current, faster-response version can operate with as little as 100 nF. However a lower-current, lower-response version, requires potentially 0 nF (i.e. no output cap).

As Kenji Nakada, application engineer for Rohm's Automotive and Industrial Segment explained, this LDO does not integrate the capacitance, but rather uses a different architecture which senses voltage *and current* to ensure stability. The part is also interesting because it has a competitive I_Q of 1 µA, while still maintaining fast response (two parameters which are usually tradeoffs). The company expects to sample Nano-cap LDOs in the second half of 2020 with production coming next year.

Rohm's BA8290s series op amp, which is touted as the industry's first noise tolerant op amp, offering high EMI immunity was also displayed. The company is now trying to expand the lineup with two-channel and four-channel versions.

Some other power-related parts on display included PMICs for the iMX series processors from NXP and contactless current sensors, including a new one that operates up to 200 A. The established power semiconductor companies that exhibit at CES tend to also exhibit their sensor products, which can be quite wide ranging.

In Rohm's case, besides the current sensor, they showed a pressure sensor for measuring atmospheric pressure for determining altitude. This sensor is precise enough to determine on which floor of a building the sensor is located. Other sensors addressed earthquake detection or measurement of water level. The company's LEDs for automotive tail lights and a VCSEL, a surface mount laser diode, were also on display as was embeddable Bluetooth Low Energy module.

Efficient Power Conversion

While some of the broad-portfolio power semiconductor companies discussed their activities in GaN at CES, some taking their first steps in this area, some of the GaN specialists were also there. Mainly these companies used CES to highlight the success of their GaN power devices in a range of applications, including the huge adapter market.

In their suite in the Venetian hotel, Efficient Power Conversion (EPC), displayed a variety of their customers' products. These included application areas that they've been working with for years—LiDAR, wireless power, drones and class D audio amplifiers. But the latest demos illustrate how the range of uses within certain categories is growing. There are some fairly exotic products here—something which could also be said for the CES exhibition as a whole.

For example, in the wireless power area, the company's eGaN chips are being used to implement wireless charging in shoes, hearing aids and a fitness monitoring ring. Misty Robotics' small robotic platform also uses GaN power semiconductors for wireless charging of the robot as do the latest robotic vacuums.

One of the more exotic applications for wireless power is in providing "in-wall" power, which might also be described as through-wall power. EPC showed some demos of such technology from jjPlus, which calls it "wireless charging for infrastructure". One demo illustrated in-wall power being used to route power wirelessly to 5G equipment mounted on the exterior of a home. Given the challenges of running new ac power cables in existing infrastructure, wireless power may be a necessary technology when deploying 5G wireless in residences.

While not a wireless charging application, Myant's Skiin Heated Base Layer clothing certainly qualifies as an exotic application for GaN. Here, EPC's devices are used in a boost converter. This product and other EPC demos are pictured below.

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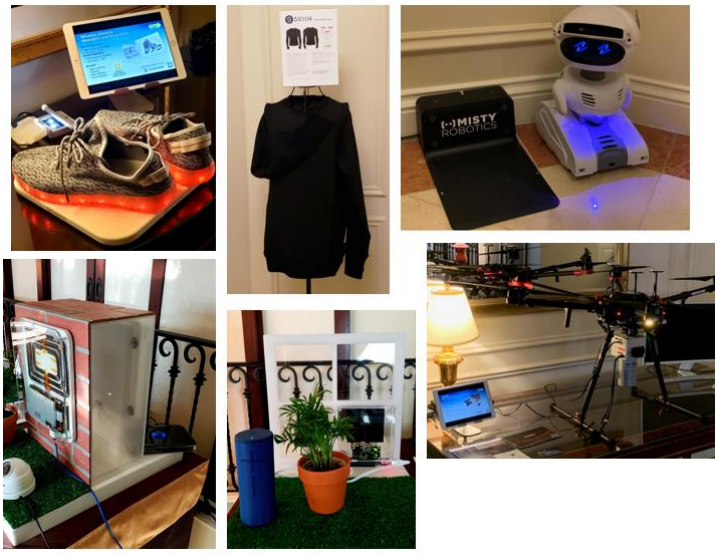
LiDAR imaging systems continue to be a key application area for EPC's GaN, which is used to flash the laser. EPCs demos included LiDAR products from Velodyne and Phoenix Lidar. One demo included a drone using GaN both for powering motors and in its LiDAR.

While EPC has also previously shown class D audio amplifiers using GaN, there were multiple customer examples this year in their suite. EPC's CEO, Alex Lidow noted that GaN's fast switching enables it to greatly reduce intermodulation distortion in class D audio amps, so GaN transistors are pushing Class D amplifiers—valued in the past mainly for their high efficiency—to higher levels of audio performance (audio fidelity).

LiDAR is used for mapping and navigation, and is being applied to ADAS and autonomous driving—among many applications. Class D audio is of course for automotive too. But LED headlamps represent yet another automotive application for GaN and a very bright LED truck headlamp demo in the EPC suite demonstrated GaN's usefulness in driving high brightness LEDs.



EPC's product demos showed applications of GaN in shoes (for wireless charging),powering Myant's Skiin Heated Base Layer clothing, wireless charging the MISTY Robotics robot, powering motors and LiDAR in a drone, and providing wireless power through walls in the last two examples.

Navitas Semiconductor

Meanwhile, in their booth in the South Hall of the Las Vegas Convention center, Navitas Semiconductor displayed example after example of GaN-based ac-dc adapters for smart phones and laptops. These adapters are very small for their 45-W and 65-W ratings, using Navitas' GaN ICs to increase power density. Most of these adapters are after-market products. But one Chinese cell phone maker, Opi is shipping adapters using Navitas' parts, which manufactures their chips at TSMC using a modified version of TSMC's standard GaN process.

Navitas displayed numerous examples of their customers' use of GaN ICs to shrink power adapters.

While some of the customer product examples can be seen below in the photo of a Navitas display case, these were not the only signs of GaN's inroads into consumer power supply products. Walking through other parts of the South Hall exhibition, I saw adapter companies like Omnia, TMXTEC and HyperJuice touting the benefits of GaN too. At their booth, HyperJuice advertised the "world's first 100-W GaN charger".

According to Navitas' Steve Olivier, VP of Sales & Marketing, as Navitas' GaN power ICs continue to see adoption in in these aftermarket products, and log more hours of reliability data, the company expects more smart phone OEMs to adopt Navitas' GaN chips for use in the power adapters shipped with phones.

Maxim Integrated

It's been noted that some of the application areas relevant to CES drive PMIC development. This trend was also evident in Maxim Integrated's exhibits at the Venetian/Sands Expo. Once again, automotive was the culprit. Szukang Hsien, executive business manager for Maxim Integrated's Automotive Business Unit provided a

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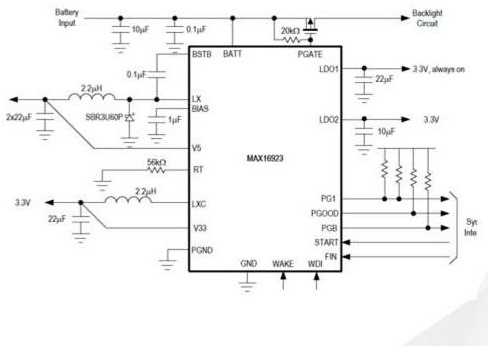
presentation on the MAX16923, which is described as the industry's first automotive display PMIC. This chip, which was specifically announced at CES, offers a high level of integration with regulators for generating four power rails. The MAX16923 features both a high-voltage and a low-voltage buck converter, and a high-voltage and a low-voltage LDO, plus a watchdog timer. The IC also has various EMI mitigation techniques to help customers tackle their EMI problems. This part was announced January 6.

Hsien noted some of the trends influencing this PMIC's development. He explained that there are more and more displays—up to 10 or more—in a single vehicle. Going forward, traditional needle-based instrument clusters will be replaced by digital instrument clusters, while HVAC buttons will be replaced by displays. In addition, e-mirrors will replace the traditional backup (rearview) and side mirrors, according to Hsien.

Features

- High voltage non-sync 2.1A buck converter
- High voltage low stand by Iq (14.5µA, typ) 100mA LDO
- Low voltage 1.6A Buck converter
- Low voltage 180mA LDO
- P_{GOOD} on HV buck, HV LDO and others
- Watchdog
- PGATE control for LED driver with no PGATE control
- Spread spectrum
- Programmable switching frequency
- 20pins 4 x 4mm package



The MAX16923 automotive four-output display PMIC with watchdog.

Requirements for small solution size, stringent EMC requirements (Class 5, automotive), and shorter development time also contributed to the need for an integrated power solution. Previous power management schemes for automotive displays required seven chips and a 700-mm^2 footprint to generate the various supply rails. The MAX16923 combines with the MAX20069, which generates TFT bias, to provide a two-chip solution with a 480-mm^2 footprint.

Another power-related component introduced by Maxim Integrated at CES was the MAX20340 two-pin bidirectional dc powerline communications (PLC) IC. This device is said to shrink the power and communication footprint by up to 80% in True Wireless earbuds. It enables simultaneous charging and communication (between ear buds and case) over a single contact. This communication channel can be used to communicate the battery status of the charge case back to ear buds and then back to the phone, tablet or PC to display to the user.

The MAX20340 eliminates pins and discrete devices needed to communicate between a charging dock and true wireless earbuds as well as other low-voltage end products such as rings and other small wearables.

Dialog Semiconductor

At Dialog Semi's suite in the Venetian, they displayed a variety of customer products using their power ICs. One example was the Oppo Reno Ace Smart Phone, which contained a hefty 4000-mAh battery. To obtain that capacity, it put two Li-ion cells in series, which doubles the battery voltage into the 6-V to 9-V range. According to Faisal Ahmad, director of marketing at Dialog, this phone and others use the DA9313 charge pump to do a 2:1 stepdown of the battery voltage with 98% peak efficiency.

Dialog also displayed a reference design for a power bank with value-added features. It included a switched capacitor direct charger for fast charging of a 1s-configuration of parallel cells. It also had a haptic driver to vibrate the power bank to let you know it is charged. Another product example highlighted use of Dialog's driver IC for direct backlighting.

Meanwhile Tony Lai, director of marketing for Dialog's Power Conversion Business Unit pointed out some ac-dc adapter examples using Dialog's ac-dc controller and other chips. These included some small 48-W and 65-W adapters. The company's controller now uses a ZVS topology to enable design of higher-power adapters with higher switching frequency and high efficiency, leading to small adapter designs. These also take advantage of digital compensation. According to Lai, they'll be able to shrink the adapters even further in the near future, by going to GaN power switches.

Meanwhile, those interested in the company's versatile, configurable mixed-signal ICs, known as GreenPAKs, may be interested in a new, high-voltage version of these devices known as HVPAK. According to Dima Mymrikov, senior technical development business manager, HVPAK devices are intended to drive a brushed dc motor or stepper motor. These devices could become available as soon as April.

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Texas Instruments

At Texas Instruments' meeting room in the Las Vegas Convention Center, the company showcased demos of several power-related ICs for automotive. One was the TPS929120 12-channel LED driver, a device intended for use in animation and pixel control for rear automotive lamps. According to Xianghao Meng, TI's system manager/business lead—wide VIN LED drivers, a digitized interface was required for animation and was implemented in this chip. Meng noted that this interface represents a big change for automotive. This multi-channel driver uses TI's Flexwire protocol and the CAN physical interface for long-distance robustness. The TPS929120 was in pre-production at the time of CES, with production scheduled to start in February.

TI's exhibit showed example implementations of the three EV powertrain functions—the traction inverter, high-voltage dc-dc converter and on-board charger. The C2000 MCU enables all three to be implemented in a single enclosure.

In TI's EV power train exhibit, a focus was on the application of the C2000 microcontroller, which is now in its third generation, in the EV's traction inverter, dc-dc converter and on-board charger. According to Olivier Monnier, marketing manager for the C2000 MCUs, some customers are leveraging the performance of the C2000 microcontroller to implement all three of these power converter functions using one C2000 controller. Monnier notes that combining the three functions in a single box enables a 50% reduction in size and weight. TI's exhibit provided an example showing integration in two boxes.

Battery management represents another important area for EVs, where there are requirements for charging 400-V, 600-V and 800-V batteries. In these applications, there's a requirement for communicating cell-level data every 100-ms to the battery management system. This data is needed for functional safety diagnostics.

One of TI's demos highlighted the CC2642, a device which senses temperature and voltage data for 6 to 16 battery cells and communicates this data via RF to the battery management system. The link uses a Bluetooth Low Energy network in combination with a 2.4-GHz ISM proprietary protocol. Daniel Torres, product marketing engineer for automotive connectivity at TI said using this wireless link to transmit cell data eliminated the need for a physical cable, which allows for more modular design of the battery while also making it more manufacturable. According to Torres, this technology is a few years away from being implemented in real cars.

Microchip Technology

In its meeting room at the Las Vegas Convention Center, Microchip Technology exhibited a number of customer product examples using their devices. These covered a wide range of application areas. As with the other semiconductor companies, one of these was for automotive. This was a demo of Ion's battery management system, which uses Microchip's dsPIC33 controller and implements a Bluetooth Low Energy link.

Product marketing manager Vijay Bapu showed a demo of a 200-W wireless power reference design, which used a controller Microchip developed for high-power wireless charging. This demo, which was also shown at the last APEC, is said to work well in applications such as robotic vacuums, robotic lawn mowers, industrial robots, underwater drones and swimming pool lighting.

Microchip also has devices for the standards-based wireless chargers. They noted that their dsPIC33 core and peripherals enable efficient implementation of Qi chargers, particularly in automotive applications.

One of their customer examples was a combination Qi wireless charger and inductive heater developed by Inductive Intelligence. When not being used to charge a Qi-compliant product, the product could be used to heat coffee or specially packaged foods. This is an intriguing concept, which if successful, could spawn a new category of convenience foods that would be alternatives to microwaveable products. Inductive Intelligence had a booth on the show floor at CES where they showed the same end product.

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One of Microchip's dsPIC digital signal controllers is used in the design of a transmitter that performs both wireless charging of Qi-compliant devices and inductive heating of specially packaged foods.

Microchip's dsPIC33 controller has also been finding use in wired charging and a demo at CES showed it carrying out the charger functionality for USB-PD. A dsPIC33-based charger can deliver 45 W per port as demonstrated via the company's new dual-port evaluation board.

The company also showed a universal USB-PD hub demo. The hub negotiates power delivery contracts with various peripherals using the Type C connector, enabling power to be shared intelligently based on how the system is programmed.

One other power-related demo illustrated the continuing evolution of power over Ethernet. Microchip's room-size "model house" demonstrated how the IEEE 802.3bt 90-W standard can be used for building automation, using Cat 6 wiring for transmitting HVAC power and controls.

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