In-Cabin Wireless Charging Solution with a Highly Integrated Controller
Energy consumption is expected to increase, as are the transport, commercial, residential, and industrial sectors. As a result, there is a substantial increase in demand, which is a consequence of the rising global standard of living. By reducing the true cost of energy, people can live better. The driving factor is the cost of energy, which is badly skewed by out-of-period cleanup expenses.

Efficiency of conversion, especially regarding power usage, is a significant factor. Wide-bandgap semiconductors will contribute significantly to energy efficiency. Silicon carbide and gallium nitride have witnessed increasing success in the semiconductor device market in recent years. GaN is now used in mobile device chargers and charging systems. On the other hand, SiC devices have primarily been used in the field of electric mobility. In 2017, electric-vehicle manufacturers like Tesla chose to use SiC-based motor controllers, which boosted the efficiency of their systems.

In this issue, Subramanyam Sankaran, director of product marketing for USB Automotive Solutions at Infineon Technologies; introduces Infineon’s first-generation wireless charging solution for automotive applications that integrates the latest Qi transmitter, DC/DC controller, gate drivers, sensing/protection peripherals, and configurable flash memory.

In the other article, Daniel Makus, global application manager for xEV and EV charging at Infineon Technologies, Christian Mentin, senior scientist at Silicon Austria Labs; and Rafael A. Garcia Mora, system application engineer for OBC applications at Infineon Technologies, analyze the immediate challenges facing OBC designers and discuss changes in how they are using wide-bandgap devices. They also consider how thermally managed device packaging and assembly techniques can help significantly improve OBC power density before presenting two reference designs that push the boundaries of currently attainable levels of power density and can provide pointers for how even higher levels will be realized in the future.

Other topics of this issue include wireless battery management, power-conversion design trends, PCB design, and more. Moreover, we will analyze why the cost of energy is key to sustainability. In his keynote address at the Green Engineering Summit, Alex Lidow, CEO of EPC, emphasized that the cost of energy is comprised of multiple components.

From Nov. 15 to 18, electronica 2022 will bring the international electronics industry together at the Munich exhibition grounds. AspenCore is once again pleased to host the Power Electronics Forum at electronica (Hall A4/Booth 473) with keynotes, panel discussions, and technical presentations. Visit powerelectronicsforum.eetimes.com for the agenda and on-demand version after the event.

Yours Sincerely,
Maurizio Di Paolo Emilio
Editor-in-Chief, Power Electronics News
The AspenCore Guide to

Silicon Carbide

Silicon Carbide (SiC), a wide-bandgap semiconductor, is driving a profound transformation of power electronics and clean energy systems. This 145-page guide offers a detailed analysis of the market trends and an in-depth discussion of key aspects of SiC power technology.
Automotive In-Cabin Wireless Charging Solution with Highly Integrated Controller

Key features, benefits, and application examples of Infineon’s highly integrated WLC1515 wireless charging controller

By Subramanyam Sankaran, director of product marketing for USB Automotive Solutions at Infineon Technologies

The Wireless Power Consortium (WPC) manages the respective specification release for this technology. Currently, at version 1.3.2, the new release of Qi specification clearly demonstrates the intent for safe, high-power (>5 W) wireless charging by adopting features such as enhanced foreign object detection (FOD), transmitter authentication with private key storage, and protocol features for better interoperability. The Baseline Power Profile (BPP) of the Qi specification limits the maximum delivered power to 5 W, while the Extended Power Profile (EPP) supports a power transfer of up to 15 W.

Powerful smartphones are enabled with fast wired charging over a USB-C interface. The user experience of charging speed using Qi wireless power transfer is still evolving, paving the way for new solutions. This article introduces Infineon’s first-generation wireless charging solution for automotive applications that integrates the latest Qi transmitter, DC/DC controller, gate drivers, sensing/protection peripherals, and configurable flash memory. Our programmable solution offers higher levels of flexibility along with the integration benefits, enabling designers to scale higher power levels and allow OEMs to offer differentiated features while remaining Qi-compatible.

Automotive Wireless Charging Solution: Implementations

WLC1515: Integrated buck-boost and inverter power stage

Infineon’s WLC1515 transmitter controller IC is a highly integrated Qi-compliant wireless transmitter with an integrated DC/DC controller, gate drivers for MOSFETs, and hardware-controlled protection features.

The WLC1515 uses the integrated buck-boost controller to generate the required bridge voltage to power the full-bridge inverter, which, in turn, supplies the PTx LC tank to deliver power to the PRx. The buck-boost converter supports an input voltage range of 4.5 V to 24 V.

The integrated gate drivers of the WLC1515 are designed to control a full-bridge or half-bridge inverter, depending on the Qi specification type and the operating scenario. The MP-A13 coil-based transmitter system shown in Figure 1 uses fixed-frequency variable-input voltage control for the inverter stage.

WLC1515 application use cases

The Qi-certified automotive wireless charging solution can be segmented into three spaces:

- Base model: This includes the WLC1515 and the OPTIGA™ Trust Charge device.
- Mid-range model: This includes the base model with a PSoC™ microcontroller (MCU) to support the controller area network (CAN) bus interface of the vehicle with additional GPIOs.
- High-end model: This includes the base model with a TRAVEO™ T2G MCU to support the CAN bus, NFC, and AutoSAR.

The base model offers a Qi-certified solution with a local interconnect network (LIN) interface to communicate with the vehicle’s board control module. The mid-range model offers a Qi-certified solution with a supplement MCU (PSoC™) to support the CAN interface and GPIOs to support the fan and additional interfaces.

The high-end model offers a Qi-certified solution with a supplement MCU (TRAVEO™ T2G) to support AutoSAR compliance, CAN interface, NFC stack, and GPIOs to support the fan and additional interfaces.

Secure communication and authentication

The Qi EPP standard requires bidirectional in-band communication. The communication from PTx to PRx is based on a frequency shift keying (FSK) scheme implemented by the PTx, alternating the carrier-wave frequency. The communication from PRx to PTx is based on an amplitude shift keying (ASK) scheme created by modulating the load on the PRx side, causing a reflection to appear on the PTx, which is filtered and decoded.

The Qi 1.3.x specification mandates authentication for EPP power delivery greater than 5 W. It follows the public key cryptography that relies on a public and private key pair to encrypt and decrypt the content. The private key is the most sensitive secure credential and must be stored securely. The public key is typically a part of the binary certificate, and this certificate is transmitted to the recipient through the in-band communication medium.

According to the Qi specification, the PTx must securely host the product unit’s private key in a storage subsystem for digital signature purposes. This private key is used to digitally sign the Challenge Authentication Response from the power transmitter device. Our solution uses the OPTIGA™ Trust Charge device for this private key storage (Figure 1).*
Foreign object detection

WLC1515 transmitter controller also supports enhanced FOD based on Q factor, resonance frequency, power loss, and overtemperature (if a thermistor is used) methods. The Q factor and resonance frequency measurements are used for FOD before the power delivery phase. The PRx reports the Q factor and resonance-frequency values to the transmitter coil. The PTx compares the reported values with its expected values in situ to determine the presence of a foreign object. A scaling factor is used to convert the PRx-reported Q factor and resonance-frequency values to those equivalent to the reference transmitter coil and to accommodate measurement variations.

The power loss method is mainly used during the power transfer phase. The power loss FOD uses the PTx power measured at the buck output, which is fed to the inverter bridge. This PTx power is further adjusted by tuning FOD coefficients to account for inverter losses and friendly metal losses. After computing the calibrated PTx power, the result is compared against the latest PRx reported power value. An FOD event is logged if the difference between the calibrated PTx power and PRx power exceeds the \( P_{\text{loss}} \) threshold.

To prevent erroneous disconnects and improve user experience, WLC1515 uses an adaptive algorithm that distinguishes between real FOD versus \( P_{\text{loss}} \) arising from poorly coupled PRx. The FOD coefficients and the \( P_{\text{loss}} \) thresholds are fully configurable to adapt to the system design.

Figure 1: In-cabin wireless charging solution with WLC1515 (bottom) vs. a standard discrete solution (top)

Figure 2: Key components of the WLC1515 solution demo board response of attenuation, input impedance, and output impedance

CONCLUSION

The past few years have seen very rapid development in the components and applications of smart charging technologies. While a great deal of focus has been on standardizing wired charging toward USB-C to enable universal connectors, there is also a growing trend to make charging more pervasive and convenient for various user groups — this is the prime mover for wireless charging.

Our wireless charging solutions with Infineon’s OPTIGA™ Trust Charge Authentication offer a compelling bill-of-materials value proposition to OEMs looking to develop Qi v3.2-compliant transmitters. The key features, such as adaptive FOD, support for proprietary protocols, DC/DC controller integration, and software libraries, make our platform unique and well-positioned to cater to proprietary as well as emerging Qi standards for inductive wireless charging.

We also invite you to visit our digital platform, the perfect hub to dive deeper into the various technologies we will be showcasing at electronica 2022 — both during and after the event. Scan the QR code to visit our website and find out more.

For More Information

- Sánchez et al. (Sept. 7, 2021). “Technical Supporting Study to Assess the status of Wireless Charging.” European Commission, Fraunhofer I2M.
- Wireless Power Consortium Qi Specification
Signposting a Roadmap Toward Higher-Power-Density EV OBCs

Key challenges, impactful innovations, and WBG solution enablers for major OBC trends

By Daniel Makus, global application manager for xEV and EV charging at Infineon Technologies; Christian Mentin, senior scientist at Silicon Austria Labs; and Rafael A. Garcia Mora, system application engineer for OBC applications at Infineon Technologies

The highly dynamic nature of the automotive industry means that designers of on-board chargers (OBCs) for electric vehicles are faced with a set of goalposts that are constantly moving, as regulations relating to efficiency and grid integration are continuously reviewed and updated.

To stay ahead of the game, designers are now pursuing ambitious targets, such as increasing the importance of high-power-density levels of OBCs. If the state-of-the-art density was less than 2 kW/L yesterday, current designs are going toward 4 kW/L and suppose to increase to more than 6 kW/L by the end of the decade. Charting a course toward achieving this figure over the longer term will be multi-faceted, requiring wide-bandgap (WBG) semiconductors in novel circuit topologies and innovations in packaging on-board assemblies.

In this article, Infineon takes stock of the immediate challenges facing OBC designers and discusses changes in how they are using WBG devices. It also considers how thermally managed device packaging and assembly techniques can help significantly improve OBC power density before presenting two reference designs that push the boundaries of currently attainable levels of power density and can provide pointers for how even higher levels will be realized in the future.

OBCs: DESIGN CHALLENGES

The role of the OBC in an EV is to convert AC grid power into a DC voltage to charge the traction battery. When not used, it is transported around within the vehicle, its size and weight negatively impacting vehicle range. There are six critical and interrelated challenges facing OBC designers (Figure 1):

- Need for higher-power classes
- Increase power density to reduce the size and weight of the EV OBC to extend the range
- Maximize efficiency to enable higher power density and reduce charging time
- Bidirectional operation to provide grid stability and backup
- Rising battery voltages (from 400 V to 800 V) to reduce current and associated heating on cables and connectors
- Balancing performance and cost

Figure 1: Key challenges facing OBC designers

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EVOLUTION IN WBG DEVICE TOPOLOGIES

Designers are already successfully exploiting the superior capabilities of WBG technologies to meet these challenges, but how they use them is still evolving.

Higher-power classes are leading to changing topologies and how solutions are implemented. For example, designers are increasingly moving toward active and efficient rectifiers and fast-switching topologies to increase the power density in active devices and reduce passive components, such as inductors and capacitors. Also, the wide voltage offering here is important, which enables the coverage of different battery voltages and also native three-phase topologies in design.

PACKAGING INNOVATION: TOP-SIDE COOLING

The heat-conduction path for high-power surface-mounted electronic devices is usually vertically downward from the component toward the printed-circuit board (PCB), which is bonded to a cold plate — so-called “bottom-side cooling” (BSC) — but this creates a compromise between thermal performance and PCB usage. Infineon has developed innovative packaging, which allows discrete semiconductors and power ICs to be top-side-cooled (TSC) and also delivers additional benefits in the design of OBCs.

With BSC, a cold plate is usually attached to the bottom side of the PCB. This prevents components from being placed on one side of the board, effectively halving the attainable power density. Semiconductor devices are thermally bonded to the PCB, which means they function at the same temperature as the board. As the maximum operating temperature of a PCB (Tg) is lower than the operating temperature of most power devices, their advantages cannot be fully exploited (Figure 2).

With TSC, a cold plate is bonded to the top side of the power components, thus allowing components to be placed on both sides of the PCB and enabling WBG
devices to operate over their entire temperature range. While an insulated metal substrate (IMS) can improve performance, many of these solutions become multi-board assemblies that use the IMS only for power devices and FR4 for drivers and passive components, significantly increasing design and manufacturing complexity.

The thermal resistance between the semiconductor junction and the cold plate is the critical thermal design parameter determining the ability to conduct heat. Thermal simulations of TSC show it to be 35% better than ISC and provide better thermal performance than back-side cooling with IMS, but with additional cost savings. As TSC allows all components to be placed on a single, double-sided PCB, a device can be placed directly opposite its driver, thereby significantly reducing PCB parasitic effects and enhancing system performance while reducing the amount of electrical stress on power components (Figure 3).

Infineon’s QDPAK devices are designed to take advantage of the benefits of TSC, and these offer several features that make them suitable for use in various applications. They also offer easy assembly with a nominal footprint of 20.96 × 15.00 mm and a consistent 2.3-mm height throughout the series. QDPAK devices can dissipate large amounts of power up to 35 W (depending on the thermal interfaces and entire cooling system) and have multiple pins dedicated to the drain and source connections, making them ideal for high-current applications. Their symmetrical, parallel lead layout also ensures mechanical stability and easy assembly and testing.
different power semiconductor technologies are used in the same design (Figure 5).

MOSFET packages can be thermally bonded to a cold plate in several ways. Still, the most straightforward and most effective approach is to place a single thermally conductive gap filler between a MOSFET and its heatsink. This approach also has the advantage of allowing the production process to be fully automated. While the gap filler can provide sufficient electrical isolation, for extra safety, an additional isolation foil can be used to provide further electrical isolation without significant deterioration in thermal performance.

**HOW TO ADDRESS OBC POWER DENSITY EVOLUTION**

Infineon collaborated with Silicon Austria Labs to develop a 7-kW automotive OBC design to demonstrate high power density utilizing SiC and TSC package innovation.

This is a single-phase, isolated, bidirectional charger with an integrated low-voltage 2.4-kW, 12-V output. The reference design, which occupies a volume of about 3.2 kW/L (including the case and connectors), uses Infineon’s TSC 750-V SiC MOSFETs1 to achieve an overall peak efficiency of about 97%, including the PFC and CCM converters (Figure 6).1

Toward an even high-power-density class, Infineon collaborated with the Power Electronic Systems Laboratory, ETH Zürich, on a super-high-density OBC design based on GaN HEMT technology.2

By combining advanced control and modulation schemes with the superior behavior of these devices under different switching conditions, the uncased power density of the final charger design, which measured 17.8 × 400 × 140 mm³, was 10 kW/L.

This feasibility study shows effectively that there is a lot of further power density increase with the right technology/package/topology combination achievable. Of course, while there are some topics to solve and enable such technology in mass production, this is the key focus of Infineon R&D departments together with key stakeholders in the industry. We all look forward to seeing the successful market introduction of GaN in the coming years, where the need for higher power density could be solved with designs like that.

**SUMMARY**

Reduction in weight and volume will be the key challenges supporting the range increase of EVs in the future. Small and lightweight OBCs will be part of this evolution.

While practical OBCs with a power density of 10 kW/L may not yet be achievable, Infineon has demonstrated how its innovative WBG devices and packaging technologies can be combined to produce prototype reference designs with power densities. With the fast move toward higher EV efficiencies, the need for higher power density in OBCs will be further accelerated than previously thought.

For more information, please scan the QR code to visit our webpage for OBC solutions.

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1. Mentin, C. “Project Tiny Power Box.” Silicon Austria Labs.
Only Optocouplers Meet or Exceed International Safety Standards for Insulation and Isolation.

Stringent evaluation tests show Broadcom optocouplers deliver outstanding safety performance and exceptional high voltage protection. Alternative galvanic isolation technologies such as capacitive and magnetic isolators do not perform anywhere near the levels of insulation and isolation provided by Broadcom optocouplers.
Wireless BMS Enables Smart Battery Ecosystem Solutions

By Stephan Prüfling, product manager for battery management systems at AVL, and Norbert Bieler, director of business development for e-mobility at Analog Devices, Inc.

Electrification of passenger cars and commercial vehicles is entering a new phase of market penetration. The shift away from technology feasibility demonstration to the mass production of premium vehicles is obvious. The commercialization of technology leads to more optimized and affordable vehicles.

Nevertheless, most current-generation electric vehicles are still considered to be expensive or less attractive when compared with conventional combustion-engine cars. Consequently, cost reduction and improved performance are key to ensuring a successful and sustainable market growth. Reductions in size, weight, and cost impact the competitive edge of battery systems over a vehicle’s complete life cycle. On the other hand, the extension of the driving range will also have a significant impact on their market attractiveness and competitiveness. Furthermore, as the increasing numbers of EVs reach the end of their life, car manufacturers will even be competing for the value to be derived from second-life batteries recovered from scrapped vehicles.

Out of this demand, news about battery innovations tends to highlight the new battery packaging concepts and new materials that might one day be able to store more charge than today’s lithium technology. A different part of the battery — the battery management system (BMS), which monitors the state of charge (SOC) and state of health (SOH) of the battery — tends to go under the radar but needs to follow and support battery innovation.

Here, the new wireless BMS (wBMS) technology, developed by Analog Devices Inc. and pioneered by General Motors in its modular Ultium battery platform, is now in mass production. The wBMS gives car manufacturers a new competitive edge across the whole of a battery’s life — starting from when battery modules are first assembled to operation in an EV to disposal and even, if needed, into the battery’s second life.

The intention for the wBMS technology development was based on an analysis of the drawbacks of the communications wiring in today’s conventional EV battery packs. This analysis drew on ADI’s expertise: It supplies the market’s most accurate BMS ICs in the wireless communications field. ADI also developed the world’s most robust mesh networking technology for industrial environments.

In a conventional EV battery pack, each cell is measured by a battery management IC. Data from the battery management IC is then communicated back to the pack ECU through wiring. This requirement for communications inside the battery reflects the complex architecture of a large battery pack: It is typically made up of modules, each of which contains multiple cells. Natural production variations mean that each cell has individual characteristics that vary within a specified tolerance range. To maximize battery capacity, lifetime, and performance, the key parameters of battery operation — voltage, charge/discharge current, and temperature — need to be monitored and logged individually for each module.

This is the reason why an EV’s battery requires a means to transfer data from each module or cell, where voltage and temperature are measured, to the ECU processor (see Figure 1). Traditionally, these connections have been made with wires: Wired connections have the advantage of being familiar and well-understood.

However, there is also a list of disadvantages related to wires: A copper wiring harness adds additional weight and occupies space that, if filled by a battery cell, would provide extra energy capacity. Additionally, the wiring needs to be fastened on battery housing structures and connectors can potentially suffer from a mechanical failure, especially under vibration and shock conditions.

In other words, wires increase development effort, manufacturing cost, and weight while also reducing mechanical reliability and usable space. This results in reduced driving range. By removing the wiring harness, the car manufacturer gains new flexibility to meet a vehicle’s design requirements for the form factor of its battery pack.

The complexity of a battery’s wiring harness also makes the assembly of a battery pack difficult and expensive: Wired packs must be assembled and the connections must be terminated manually. This is a costly and hazardous process because high-voltage EV battery modules are supplied charged. To maintain the safety of the assembly process and to protect production-line workers, rigorous safety protocols are applied.

Out of those reasons, there are then strong reasons for OEMs to introduce a robust wireless technology in new EV battery system platforms.

wBMS: A NEW SMART APPROACH

The wBMS is a complete solution that is easy for the automotive manufacturer to integrate into a battery pack. It supplies the market’s most accurate BMS ICs in the wireless communications field. ADI also developed the world’s most robust mesh networking technology for industrial environments.

Figure 1: A typical multicomponent wired BMS network (left) and the simpler arrangement made possible by wBMS technology (right)
Battery assembly: The only connections that a battery module requires are the power terminals, which can readily be made in a highly automated process. By eliminating manual labor for assembly and testing, this also avoids safety risks to assembly-line workers (see Figure 2). Furthermore, the modules can be tested and matched before installing inside the battery.

Battery assembly: The only connections that a battery module requires are the power terminals, which can readily be made in a highly automated process. By eliminating manual labor for assembly and testing, this also avoids safety risks to assembly-line workers (see Figure 2). Furthermore, the modules can be tested and matched before installing inside the battery.

Data management: The wBMS technology makes it easy to read out critical battery data from each intelligent module. This means that the condition of the batteries can be determined individually. This data can, for instance, provide information about the SOC and SOH of a module. In combination with data from when the module was originally produced, this allows the optimal usage in its second-life application and the provision of a detailed set of specifications for each module on sale. The ready availability of this data increases the resale value of the modules.

Disposal: The recyclable metal and potentially hazardous materials inside a battery pack require approved and regulated disposal arrangements. The simple connections and absence of a communications wiring harness make removal of battery modules easier and quicker than that of a wired battery.

Servicing: Secure wireless capability means that the condition of the battery pack can be conveniently analyzed by diagnostics equipment in an authorized garage without touching the pack. If a malfunction is detected, a faulty module can easily be removed and replaced. A wireless configuration simplifies installation of a new module in the battery system.

Second life: With the increasing number of vehicles, a market is emerging for second-life batteries recovered from scrapped EVs and repurposed for applications like renewable-energy storage systems and electric power tools. This additionally creates a new source of value for EV manufacturers, which are responsible for the recycling or disposal of the batteries in scrapped EVs, as wBMS allows a simpler integration of the modules for second-life applications.

COMPLETE SOLUTIONS FOR wBMS BY ADI

The wireless network protocol implemented by ADI in the wBMS system has the automotive industry’s requirement for reliability, safety, and security under all operating conditions based on the network-wide time-synchronization technology. The use of the wBMS in a mass-production EV from General Motors is a proof of its reliability in the harshest environments: The wBMS-based battery has been run over hundreds of thousands of kilometers in more than 100 test vehicles, on-road and off-road, and in environments ranging from a desert to the frozen north and under the toughest conditions.

With the wBMS, ADI also supports automotive manufacturers’ programs in compliance with the ISO 26262 functional safety standard. The radio technology and the networking protocol have been developed in such a way that the system is resilient in noisy environments and provides secure communication between the monitoring units and the manager using a sophisticated encryption technology. The security measures avoid spoofing of data transmitted on the wireless network by an unintended recipient, such as a criminal or hacker. Furthermore, the transmitted data is received without any modification of the contents, and the intended recipient knows exactly which source has sent a message.

LIFETIME MANAGEMENT OF THE VALUE OF THE BATTERY

Across the entire battery pack’s lifetime, from initial assembly through disposal to second life, the wBMS capability embedded in the battery pack ensures that the vehicle’s manufacturer and its owner can easily track the condition of the battery, maintain performance and safety, and maximize the value. The entire system, including the interactions between the battery modules’ cell-monitoring units and the ECU, is handled by ADI's technology, with configuration settings defined by the manufacturer.

The wBMS technology is also backed by ADI’s battery-life-cycle insight service (BLIS) technology. This provides edge-based and cloud-based data software to support traceability, production optimization, monitoring in storage and transit, early failure detection, and lifetime extension. Together, the wBMS and BLIS technologies enable automotive manufacturers to gain higher returns on their investments in battery pack development and production, improve the economics of their EV business strategies, and help accelerate the market’s shift toward a low-carbon, sustainable future for personal mobility.

The key to designing and enabling such battery solutions with a wBMS is system understanding, as well as methods and tools that support the design and technologies described before. AVL offers the full range of simulation, testing, engineering capabilities, and experience to successfully drive these innovations together with their customers and bring them into the market by making them ready for series production. AVL is currently working on battery ecosystem solutions through developing data analytics methodologies, predictive functionalities supported by using virtual development, and vehicle and battery data to increase the lifetime and performance of batteries.

Together with ADI, AVL is working to provide smarter BMS solutions to their customers all over the world by combining the strength of both companies.
The Application and Features of Cincon’s PFC750 AC/DC Power Supply

By Cincon Electronics

While the concept of energy saving is popular among industries today, almost all the power supply manufacturers are expecting a breakthrough in the feature of lower power consumption with high efficiency.

According to the “Energy Star” guideline, consumer products over 100 W are suggested to reach at least a 0.9 power factor (PF) to promote energy efficiency. PF is also crucial to reduce energy consumption: The higher it is, the less power wasted on running the devices.

Cincon’s new PFC750 module not only reaches a PF of 0.99 but comes with appealing features when combining DC/DC converters. In the following paragraphs, we will discover more about PF and power-factor correction (PFC), as well as PFC750’s applications.

WHAT ARE PF AND PFC?

Power factor is a digit between –1 and 1 that represents the efficiency of incoming power usage in an AC system. It is normally defined by the ratio of real power and apparent power (see Figure 1).

Practically, the harmonic phenomenon occurs when the current and voltage are distorted and away from normal waveforms. To be more specific, the harmonic currents exist at the point that the line voltage goes beyond the cross-voltage, which causes current from the bulk capacitor and results in the waveform being discontinued. These harmonic currents contribute to reactive power, which lowers the value of the apparent power.

Figure 1: PF and harmonic current distortion

Power-factor correction is a method to adjust the harmonic distortion and reduce reactive power by overlapping the voltage and current waveforms.

There are “passive” and “active” modes to maximize the effectiveness of PFC. The active mode employs a boost converter to enhance the switching frequency and control the shape of the waveform of the input current. The passive mode utilizes an inductor and capacitor to decrease the effect of the peak current. Both methods are applicable; however, the operation of active PFC adjusts the PF value more efficiently and directly. That’s why active mode is more popular than passive mode.

CINCON’S PFC750 MODULE

As mentioned, Cincon’s PFC750 module successfully achieves the criterion of a 0.99 PF with a 750-W power supply. Its specification is a standard half-brick, low-profile AC/DC power converter with the universal input range of 90–264 VAC and a high 390-VDC output.

Accordingly, the PFC750 is designed by a boost converter; thus, its efficiency performs up to 96.5%. The working case temperature ranges from –40°C to 100°C (–40°F to 212°F). On top of that, this module has a more extended lifetime than usual because there is no existing electrolytic cap inside.

The most common way of applying the PFC750 module is to partner with DC/DC converters: to take the AC/DC module as the front end and the DC/DC converter as the back end.

<table>
<thead>
<tr>
<th>No.</th>
<th>Label</th>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AC1</td>
<td>AC input</td>
<td>AC power source input</td>
</tr>
<tr>
<td>2</td>
<td>AC2</td>
<td>AC input</td>
<td>AC power source input</td>
</tr>
<tr>
<td>3</td>
<td>AUX</td>
<td>Auxiliary power</td>
<td>Auxiliary output: 13 VDC</td>
</tr>
<tr>
<td>4</td>
<td>ENA</td>
<td>Power good</td>
<td>This pin voltage will be pulled down once power is ready; otherwise, it will stay open*</td>
</tr>
<tr>
<td>5</td>
<td>–Vo</td>
<td>Negative voltag output</td>
<td>Negative power output pin</td>
</tr>
<tr>
<td>6</td>
<td>R</td>
<td>Inrush current limit</td>
<td>Inrush current could be reduced by external resistor</td>
</tr>
<tr>
<td>7</td>
<td>+Vo</td>
<td>Positive voltage output</td>
<td>Positive power output pin</td>
</tr>
</tbody>
</table>

*The enable pin is designed to connect to the remote on/off pin of the DC/DC converter as a power-good signal.

Figure 2: PFC750 mechanical drawing

Figure 3: Application circuitry
In some cases, this combination performs better results by adding external components. Features such as hold-up time, inrush current limit, and power-good signal are well developed consequently.

In other words, system designers can decide whether they need it or not, which gives them a lot of flexibility in designing the power circuitry.

Figure 4 shows the prototype of the evaluation board combination of the PFC750 and CFB750-300S. It has been verified and meets the EMI Class A standard. With this demo board, a quick performance evaluation can be done by the engineers.

The volume of external components can be modified immediately. Other recommended PFC750 combinations are CHB300-300S (two) or CQB150-300S (four) in parallel; both are DC/DC converters with high-voltage input. This combination improves the configurable structure to be implemented efficiently in the system.

CONCLUSION

Cincon’s PFC750 module is designed with built-in active PFC and features a low profile, compact size, and high efficiency. Engineers who design power-loop circuitry can utilize the space optimally, even under harsh restrictions. The PFC750 module offers a fine solution to system engineers regarding the combination of AC/DC and DC/DC converters.
A Thermally Optimized, Two-Layer Automotive PCB Design to Meet CISPR25 Class 5

By Ralf Ohmberger, application engineer, and Francesc Estragués, application engineer, both at Monolithic Power Systems

Automotive electronics suppliers are faced with escalating cost pressures in the race to produce autonomous, connected, and electrified solutions. One effective way to reduce design costs is by using two-layer automotive PCBs. However, two-layer PCBs require special care, as they can have poor thermal characteristics, which leads to compromised performance.

In this article, an automotive expert will use MPS’s MPQ4323-AEC1 to provide practical advice on how the schematic and layout designs for two-layer PCBs can be fine-tuned to achieve the best possible thermal characteristics and stay well within the standards for CISPR25 Class 5.

USING A TWO-LAYER LAYOUT

The required number of layers depends on the PCB space and the number of components, as well as the planned production costs. A hardware designer often has only two available layers. In a two-layer automotive PCB design, DC switching power supplies require careful component placement to meet EMC and thermal requirements.

THE METHOD

For this article, we tested nine two-layer layouts. Each layout had unique component positions and slight modifications compared with the other PCBs, as well as different placements for the polygons and vias (see Figure 1). The purpose of using nine layouts was to find a successful solution with improved EMC and thermal performance. This article will focus on the differences between the thermal and EMC performances between these layouts.

RECOMMENDATIONS FOR A TWO-LAYER LAYOUT

By following certain design rules, it is possible to achieve a solution that has been optimized for thermal and EMC. Figure 2 shows an example of a circuit using MPS’s MPQ4323-AEC1, a DC power switching supply that meets automotive EMC CISPR25 Class 5 requirements while using a thermally optimized two-layer layout.

Figure 3 shows the PCB component placement using the schematic from Figure 2.

The inductor (L3) acts as effective heatsink (see Figure 4). In this example, the switching node on pin 12 must have a small surface area so that it does not act as an emitting antenna due to its fast-changing voltage (high dU/dt). Place the inductor as close as possible to pin 12, as the short distance allows for optimal heat flow into the inductor. For excellent EMC, place the marked side of the inductor winding so that it aligns with pin 12. This allows the outer copper windings of the inductance to shield the inductor coil’s noisy inner area, which has a high dU/dt. Figure 5 shows the heat distribution in the package.
The most effective pins to transfer heat into the PCB are V\text{IN}, P\text{GND}, and SW. The internal lead frame connects these pins directly to the high-side and low-side MOSFETs. The lead frame is internally soldered under the die for effective heat flow.

The die is hotter closer to the MOSFET, as that is where the heat is internally generated. This effect can be seen on the white area on the package (maximum 67.8˚C) when compared with the magenta area (about 62˚C). The thermal conductivity of copper is 388 W/mK, while that of silicon is 180 W/mK. This means that heat distributes more evenly in copper. Note that the measured temperatures are on the package's surface — the internal die temperature is hotter by a few degrees.

The analog pins (BOOT, V\text{CC}, A\text{GND}, FB, PG, and EN) do not have such efficient thermal conductivity when compared with the MOSFETs, whose inner length on the lead frame is shorter. Therefore, when designing the layout, the power pins (V\text{IN}, P\text{GND}, and SW) should have large copper surfaces to cool the device. The top layer near the power pins is the most effective heatsink.

A via that is placed between the top GND layer and the bottom GND layer has a more effective heat flow when it is closer to a power pin. It is recommended to place vias in the hotter locations. However, ensure that there are not too many vias placed next to each other. Too many holes can hinder the heat flow on the top layer due to the lack of copper.

It is important that the top layer has a direct copper connection for heat flow. The bottom layer deteriorates due to the thermal series connection with the vias. To improve thermal convection, it is recommended to place a DC power switching supply on the top layer.

Table 1 lists the characteristics for both solutions. The lower temperature on the MPQ4323-AEC1 is the result of MPS’s advanced package technology, which allows for more heat to flow into the PCB.

**EMC RESULTS**
Figure 8 shows the EMC measurement CISPR25 Class 5 results for the MPQ4323-AEC1’s conducted emissions and radiated emissions between 150 kHz and 30 MHz.

Figure 9 shows the EMC measurement CISPR25 Class 5 results for the conducted emissions and radiated emissions between 30 MHz and 200 MHz.

Figure 10 shows the EMC measurement CISPR25 Class 5 results for the conducted emissions and radiated emissions between 200 MHz and 1 GHz.

All EMC measurements are below the required limits, even though it is typically a demanding task to pass automotive EMC requirements using only a two-layer PCB. A four-layer PCB is the common, standard solution for an automotive DC switching power supply, but a four-layer layout increases costs. The methods in this article show that a two-layer PCB can pass automotive EMC requirements while keeping the thermal rise low.

**RECOMMENDED PCB LAYOUT**
Figure 11 shows the recommended PCB layout. The top layer shows the V\text{IN} Y-shaped polygon, which has a low impedance and noise. On the top layer, there are no vias and conductors placed near the IC. Vias from the top to bottom layer are placed close to the power pins only if there is heat flow.
Excellent component placement results in only three traces between both layers (marked in red on the bottom layer). The longest trace is the V_{OUT} sensing trace that goes to the FB feedback resistors. V_{OUT} is quiet (good for EMC) and is not sensitive to immunity. These traces are fully encapsulated in the bottom GND layer, which shields traces against EMC.

The V_{OUT} trace between C13 and R4 should be routed away from the switching node to improve immunity against the switching node's fast-changing e-field. The distance and the shielding within the GND layer reduce the coupling.

The most sensitive trace is between R6 and the feedback (FB, pin 7). This trace should be routed on the top layer, and it should be as short as possible (a few millimeters long). There should be a large, uninterrupted GND plane under the IC, which means that the three traces on the bottom layer should not cut the GND plane near the IC. Cutting a GND plane increases its impedance in relation to its frequency. An intact GND plane is the basis for good EMC and circuit performance.

Consider the following when designing a two-layer automotive PCB:

- The top layer has better heat flow than the bottom layer.
- Vias placed close to a power pin have a better heat flow compared with vias that are further away.

Follow the guidelines below to optimize a two-layer PCB:

- Maximize the copper area for the power pins, as they have the greatest effect on effective heat flow into the PCB.
- Give the power pins a higher priority than the analog pins for the heatsink.
- Place the marked side of the inductance as close as possible to the switching node and minimize its copper area.
- Do not cut the cooling power polygons with conductor traces. This is particularly important in the immediate vicinity of the power pins, as this could greatly reduce the heat flowing from the pin into the PCB.

After considering each laid trace and its impact on the interference, emission, and immunity, choose the best possible position, trace width, and via connection accordingly.

**CONCLUSION**

It is possible to create a cost-effective, two-layer PCB design that can perform well in harsh environments. A low-cost design can pass the EMI test with CISPR25 and OEM limits with sufficient margin, which we have demonstrated using the MPQ4323-AEC1. In this automotive PCB design, the IC can achieve close to full output operation under ambient temperatures that are approximately 100 °C when operating at 400 kHz and approximately 80 °C when operating at 2.2 MHz when given a sufficient copper area for dissipation. MPS has designed a thermal enhanced lead frame for higher efficiency, resulting in a thermally superior solution that can work within compact and space-constrained systems.
Why the Cost of Energy Is Key to Sustainability

By Maurizio Di Paolo Emilio, editor-in-chief of Power Electronics News

The price of anything is proportional to the cost of the energy necessary to get that thing. Even gasoline poured into employees’ tanks and other types of energy required during the many phases of manufacturing are the true costs. In his keynote address at the Green Engineering Summit, Alex Lidow, CEO of EPC, emphasized that the cost of energy is comprised of multiple components and that we must consider the cost of energy, not the price, when analyzing these component costs. Then what are these components?

According to Lidow, there are six costs associated with energy: the cost of generating it, the cost of distributing and storing it, the cost of converting it, the cost of using it, and the cost of cleanup. This last cost is arguably the most significant. The first five of these costs are in-period costs, which means it is very clear how much it costs to generate and how much it costs to distribute and store. But what is out of period, and electricity accounts for only 30% of energy consumption.

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“Why is electricity intrinsically more efficient? Electricity is a journey of electrons, which have almost no mass. Therefore, transporting electricity is extremely cheap compared with transporting natural gas, coal, and oil. Electricity is therefore a good way to shift energy use to a more efficient method. Just think of electric cars compared with petrol cars. During his presentation, Lidow analyzed the equation that governs it.

“The equation includes production, distribution, storage, conversion, consumption, and reclamation. Each of these phases in coal, natural gas, and all renewables consists of a number of components with varying costs. The most important thing to consider is storage. Because sunshine and wind are not accessible 24 hours a day, seven days a week, storage is a crucial aspect of wind and solar power. As Lidow stressed, “It is thus vital to add the aspect of storage, which has been one of the primary impediments to a more widespread use of these sorts of energy sources.”

Coal, natural gas, and oil are exceedingly simple and inexpensive to store at very high densities. As a result, as the price of batteries decreases, storage becomes more affordable and the transition to renewable energy gets simpler. However, as Lidow pointed out, reclamation costs must be considered.

Clean coal does not exist, so coal cleanup is highly difficult. Similar problems exist for natural gas and nuclear power, the cleanup of which, as Lidow said, has never been thoroughly studied. Therefore, each of these equations must be examined. This widespread shift in energy sources is essential for reducing global warming and pollution on a massive scale when considering the effect on the environment.

The most suitable industry for the transition from natural gas/coal and oil to electricity is transportation, including electric automobiles.

“In this shift in energy use, four elements are driving the change: storage, batteries, electric cars, and electric planes,” said Lidow. “The efficiency with which we can convert electricity is a key element, sometimes..."
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Consuming half of the energy itself. As we become more intelligent in our energy consumption, the equation will probably become simpler. And of course, there is the cleanup and reclamation of electricity, which does not only depend on how it was generated, whether from a coal-fired power plant or a solar panel, but also on the electricity itself, which has certain elements, such as the reclamation of all the electrical equipment we have. How do we recycle it? Can we simply landfill them? Or can we find better ways to recycle and neutralize in our environment all the electrical gadgets that we consider almost disposable?

**ELECTRICITY CONSUMPTION**

Approximately 46% of all electricity is used by motors. The motors in your refrigerator, air conditioners, electric trains, and industrial automation are in the millions and billions. This represents 46% of the total power utilized in 2011. With the development of digital technology, it is projected that energy and power consumption would increase significantly over the years.

Efficiency of conversion, especially regarding power usage, is a significant factor. Several kilowatts of electricity may originate from an overhead power line. The voltage must then be reduced to provide the 0.8 V required to power the computer’s CPU. This needs many conversion processes.

"Over the years, enormous progress has been made in conversion efficiency," said Lidow. "When I started working in this field in the late 1970s, the bipolar transistor was the key element in power conversion, with different ways of converting electricity from one voltage to another. However, with the arrival of the MOSFET and its cousin, the IGBT, I had the great honor of being present at the beginning of MOSFET development and was one of the pioneers in that area. And I think it is now well established that 30% to 40% of the electrical energy used was saved by switching from bipolar to MOSFETs. The higher speed, lower production cost, smaller size, and lower resistances— all these elements have contributed to better electricity utilization but also to changing topologies from the old linear power supplies to high-efficiency switched-mode power supplies, and all these elements have resulted in huge savings."

We are now undergoing another revolution: the transition from silicon to wide-bandgap semiconductors like gallium nitride and silicon carbide. Lidow said that GaN and SiC will gradually replace MOSFETs and IGBTs in new uses, ultimately accounting for 100% of all new applications in the coming years.

Lidow said that owing to GaN, a significant amount of energy may be saved. First, we can save about 30% of the energy used by power supplies. And then about 20% of the energy produced by solar panels now may be conserved with the use of GaN, which makes solar panels considerably more efficient. An additional 10% of all the electricity used for motion can also be conserved.

Therefore, a tremendous potential is estimated at over 1,000 TWh saved, or almost 8% of the total energy consumed for power today. Electric cars are an often-mentioned method of converting petroleum into energy. Figure 2 depicts the global energy usage in 2012, 51% of which is for industrial purposes. The equivalent of 2,300 megatons of oil is used for transportation, which accounts for 26.6% of the total (1 megaton of oil corresponds to 11.63 TWh).

"However, the bottom line is that transport consumes 26,750 TWh annually, 70% of which are road vehicles, totaling 18,700 TWh, and less than 1% of these road vehicles are electric," said Lidow. "If the world converted to electric transportation, there would be a huge opportunity for the market."

Battery electric vehicles utilize about one-third as much energy as internal-combustion–engine vehicles, which represents a significant energy savings. If all automobiles were converted to electric, about 12,000 TWh per year would be saved. Now, GaN or SiC may power the motors of these automobiles. The benefit over silicon is about 10% to 15%. Thus, the total prospective annual energy savings vary from 100 to 1,800 TWh.

**CONCLUSION**

What about the increasing energy consumption in this world? "I started this journey thinking that I would do something great for the world by improving energy efficiency; then we would all consume less energy and pollute the environment less," said Lidow. "But then I realized it was a myth. And the myth, the idea I want to dispel, is that you cannot reduce energy consumption by improving energy efficiency. On the contrary, you probably create more demand for energy."

Lidow cited an example: Suppose that in one year, you used $1,000 of electricity to power your car. That’s a lot. And let’s assume that the car is 10% more efficient. So instead of $1,000, you spent $900 to power your car. What are you going to do with the other $100? You’re going to spend it on something that has its own cost of energy hours. So in the end, you increase your standard of living, you add another $100 to spend, but you do not reduce your energy consumption.

Let’s examine energy consumption. According to Lidow’s 2018 forecasts, energy consumption is expected to increase, as are the transport, commercial, residential, and industrial sectors. As a result, there is a substantial increase in demand, which is a consequence of the rising global standard of living.

"I said at the outset that the cost of energy affects all other costs," said Lidow. "Therefore, by reducing the true cost of energy, people can live better. And our challenge is to reduce the cost of living or increase the living standard without destroying the environment."

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characteristics and Application Tradeoffs

By Sonu Daryanani, contributing writer for Power Electronics News

Gallium nitride HEMT devices are at the forefront of creating new opportunities as well as replacing existing silicon-based designs in a wide range of power-conversion and power-delivery applications. In this article, we will review some of the key device characteristics of some of the more widely available HEMTs and try to highlight some of the tradeoffs on each one.

The two most widely used approaches to GaN HEMTs for power applications are:

- The e-mode approach, where the device could be formed with a p-GaN Schottky gate and result in a Vt of about 1.7 V. Examples of this approach would be devices offered by GaN Systems, GaN Power International, and Innoscience, to name just a few. A notable exception to the relatively low Vt for e-mode devices is the offering from Cambridge GaN Devices, which offers >2-V e-mode devices through some innovative design approaches.

- The cascode approach, where a low-voltage Si MOSFET is essentially placed in series and creates the gate drive. Higher Vt can be achieved, and Transphorm, Nexperia, and others offer some examples of this.

E-mode devices have the advantage of using some of the intrinsic benefits of the GaN HEMT, such as no reverse-recovery loss due to lack of a p-n junction in the drain/source, as well as simpler/lower parasitics from not having an additional device in series. One big disadvantage, however, is the poor margin for gate drive and a susceptibility to gate noise from the low Vt.

The cascode approach solves the poor gate margin of the e-mode and offers a more robust gate. This, however, is at the expense of potentially having higher switching losses from reverse recovery (Qrr) in the Si FET. Approaches taken to mitigate this are discussed later.

Some important application performance examples are listed below and a comparison is made between the two device approaches listed above.

**HARD-/SOFT-SWITCHING CHARACTERISTICS OF GaN HEMTs**

Examples of hard switching (HS) include synchronous buck/boost converters and continuous-conduction-mode totem-pole PFC AC/DC converters. Both conduction and switching losses affect the overall efficiency. In hard switching, turn-off losses can dominate due to reverse recovery and junction capacitance charge. The loss from input gate capacitance switching-node charge/discharge also has a major role at high frequencies. The high di/dt and dv/dt from high-frequency HS also place third-quadrant hard-commutation requirements on the device, which can be another loss component. Within this realm of HS, e-mode devices offer potentially lower losses due to the lack of the body diode and no Qrr. The factor to consider, though, is the low Vth of most e-mode devices, which are then prone to an oscillatory response under high-frequency HS and maybe need a negative gate bias to turn the device off completely. This can significantly complicate the gate driver circuitry.

Cascode devices with the higher Vth offer more Vth margin and perhaps a simpler unipolar gate drive. Not needing negative turn-off voltages. The potential downside is the higher Qrr from the presence of the Si MOSFET. Solutions have been proposed to this, such as Texas Instruments’ (TI’s) LMG352xR030-Q1 device, which features a Si integrated gate driver with the GaN HEMT that drives the gate voltage of the GaN HEMT negative to turn it off in a switch-off event, all while keeping the cascoded Si FET on, preventing the reverse loss of the Si device. Cascoded devices can also place design constraints on HS converters for the maximum reverse di/dt at a switch-off transition. This is from the gate of the GaN HEMT getting a high positive voltage from the recovery of the body diode within the cascaded Si MOSFET. This can reduce the transconductance of the GaN device and create more loss when operated at a higher-than-rated di/dt.

The dead-time loss component in the converter can also play a bigger role when a negative Vth is needed in the off state, as explained below. Because the GaN HEMT is a lateral n-channel without a p-body, reverse third-quadrant operation is essentially the HEMT operating backwards; i.e., a channel turn is required for the Vds > Vth. This, however, depends on the state of the gate terminal during this, as shown in Figure 1.

In the case that a negative Vth is needed to ensure full turn-off, as for some e-mode devices, the added Vth will increase the effective Vth. Conversely, if a positive Vth could be applied during the third-quadrant operation, it would lower the effective Vth. The dead-time loss in a converter Rth × Vth × Tdead, where Tdead is the dead-time. Compared with Si MOSFETs, where the Vth < 1 V, GaN Vth can be much higher, especially for e-mode HEMTs. A solution implemented in TI’s LMG352xR030-Q1 chip termed the ideal diode mode

as where an adaptive gate drive is used to turn the GaN FET on when a negative Vth is sensed, moving the curve as shown in Figure 1 to the right and lowering dead-time loss. The Si MOSFET in the cascoded structures presents a freewheeling diode with a lower turn-on voltage, hence presenting a net lower Vth compared with the e-mode devices, which is useful in synchronous rectification, e.g., for motor drives.

Examples of soft-switching (SS) include zero-voltage switching (ZVS), such as an LLC auxiliary circuit that injects a resonant pulse that reduces to zero the voltage across the switch that has to be turned on, as shown in Figure 2.

Turn-on losses are therefore minimized. Because switching losses are minimized, it’s the conduction loss that can dominate SS topologies. A low output charge on the HEMT device (Ciss) is also key, as this lowers the peak magnetizing current. An analysis was done that compared HS and SS for the Transphorm TPH3205WSB cascode HEMT, and it was concluded that ZVS is preferred when efficiency is the primary target and that SS performed better, especially at high switching frequencies. Böcker et al. also showed that dynamic Rθss degradation could play a role in HS losses and SS was an advantage from this aspect.

**SCWT FOR GaN HEMTs**

In motor drive applications, power devices need to withstand overload or fault conditions that can create a situation in which the device is under both high-voltage and high-current conduction with the device in saturation. High temperatures can result in

![Figure 1: Vth as a function of off-state Vth](image1)

![Figure 2: ZVS soft-switching reduces turn-on losses.](image2)
catastrophic damage. The power device and its gate driver need to work together to shut the device off, with 1 µs previously considered as a normal response time for this. Several studies on GaN HEMTs have reported much shorter short-circuit withstand times (SCWTs), thought to be from high current densities, especially in low-<i>V<sub>dsat</i></i> devices. The SCWT drops dramatically as the <i>V<sub>ds</sub></i> is raised up, with many studies showing <500 ns at a <i>V<sub>ds</sub></i> ≥ 400 V. A lower <i>V<sub>ds</sub></i> also helps, with the degradation in SCWT at high <i>V<sub>ds</sub></i> thought to be from hole accumulation under the gate. A study to compare cascoded versus e-mode HEMTs showed that the <i>l<sub>sat</sub></i> fall in cascoded devices from the short-circuit (SC) thermal event was lower than for the e-mode devices, which makes them less robust to the SC event. The larger percentage drop in <i>l<sub>sat</sub></i> on the e-mode devices from self-heating helps to strengthen its SC behavior.

An SCWT safe operating region was presented in a study in which the authors also studied the effects of repeated SC events. The study found that although a single SC event at a <i>V<sub>ds</sub></i> of 400 V and <i>V<sub>gs</sub></i> of 6 V allowed for a large SCWT (>300 µs), repeated SC events resulted in an SCWT of only 20 ns under these bias conditions. A significant derating of the <i>V<sub>ds</sub></i> and/or <i>V<sub>gs</sub></i> was necessary to improve this time. The authors concluded that the heat confinement in the thin GaN channel layer created mechanical stress, which caused the failure. A method for improving SCWT was patented by Transphorm. This approach, dubbed the active region of the channel under the gate, thereby reduces <i>I<sub>sat</sub></i> and improves SCWT, though at an <i>R<sub>ds</sub></i> penalty that could range from 10% to 30%. When paired with a desaturation detection (DESAT) gate driver, an 800-nS detection was obtained at <i>V<sub>ds</sub></i> = 400 V and the full <i>V<sub>ds</sub></i> = 12 V. Several fast SC detection methods have been proposed, and it’s clear that this field will need significant development to validate the use of GaN HEMTs in motor control applications, especially at voltages ≥ 400 V.

**PACKAGING**

The cascode topology is more robust for gate voltage and is hence more immune to parasitic inductance/capacitance to a certain extent than the e-mode counterparts. Some cascode devices have been packaged in thermally robust packages like the TO-247. E-mode devices, to a large degree, are more prone to gate noise issues, and careful consideration of package-related parasitics has to be done. As a result, a lot of the offerings for this have been in leadless planar packages. Technology development at the package level is therefore essential to assure the high thermal sinking needed in these high-power-density devices. Having a Kelvin source connection also allows for more accurate gate control without the common source indultance. GaN Systems has come up with an innovative GaNPX package that offers low thermal resistance.

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**For More Information**


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**Buck Converter IC with Adaptive Power Sharing**

By Maurizio Di Paolo Emilio, editor-in-chief of Power Electronics News

Power system design includes many tradeoffs between design parameters, such as size, cost, efficiency, and load transient performance. To design the power stage, various features like transient tolerance, ripple voltage, and load characteristics must be established. System designers are concentrating on enhancing the efficiency of power conversion using new circuit topologies via better control of battery characteristics to develop a system with a longer runtime and a smaller footprint. Low efficiency corresponds to increased power dissipation, which must be adequately handled. Lower switching frequencies lower switching losses, but higher switching frequencies provide greater performance and quicker transient response.

**Silanera Semiconductor** has introduced an intelligent power-sharing buck converter power IC. The new SZPL3002A buck converter IC with an integrated USB-PD/FC port controller reduces the amount of components required to perform 65-W fast-charger and adapter applications with up to four ports substantially. This power IC features intelligent power sharing using a fully integrated USB-PD controller, MCU, and VCONN cable communications protocol within this highly efficient DC/DC buck converter.

In an interview with Hubie Noto, Silanera Semiconductor’s director of product marketing, he said that the SZPL3002A power IC meets an efficiency of 98% by integrating a high-efficiency synchronous buck converter and an advanced port controller into a single 5 × 5-mm QFN package.

The PD controller acts from behind the scenes intelligently by equalizing power. The device works with switching frequencies starting from 667 kHz and going down to 1 MHz.

“This device has another unique feature that we call power-saving mode,” said Noto. “When you don’t have any load connected, usually other people just do standby, which can normally still consume power. In our case, if the user initially selects in the design to switch to power-saving mode, the DC/DC portions turn off completely, but the PD controller is still running. The PD controller then continues to monitor the DC line with less-than-microwatt consumption.”

The inbuilt port controller supports USB PD V3.0 Type-C interfaces as well as QC2.0/3.0/4.0/5.0-type A/C connections. The controller facilitates power sharing and port-power rebalancing capability.
across two, three, or four ports, ensuring that port power responds to the demands of a specific device regardless of when connections are established.

**THERMAL PROTECTION**

"Many people are concerned about the connection overheating," said Noto. "The reason for this is because they are not fully evaluated when they are plugged in. All of these connections eventually come loose. When they lose their VBUS connections, they make contact intermittently, which may produce heat, as it causes high resistance. The whole temperature cavity is detected by our integrated circuit. When it becomes too hot, it is best to switch it off or lower its power. Our system swings into defense mode. If the temperature reaches a programmable warning level, the SZPL3002A renegotiates a lower power level (lower current) with a connected device. If the temperature continues to increase past a programmable critical level, the port disconnects.

The new SZPL3002A has five pre-loaded power contract configurations that are configurable, allowing OEMs to employ a single device across numerous product designs. Power rebalancing redistributes underutilized power to previously connected ports, while safe power throttling cuts current automatically when temperature criteria are met.

Many charger manufacturers require NTC measurements near Type-C output connectors. Type-C connector contacts can become resistive due to dirt/ lint, creating high temperatures at the connector. This can lead to scorching or system-wide charging unit shutdown. Some companies have external NTC inputs but only for executing catastrophic shutdowns for overtemperature conditions.

The SZPL3002A has operating firmware code as well as USB port-configuration memories, which need to be programmed for proper operation. Three connection methods to the SZPL3002A are available for programming: Connect to the Type-C USB port connector to the target PortIC on the application PCB; connect to an optional zero-insertion-force socket PCB to program (lose PortIC devices, e.g., the SZ-PROGSOCK-3002-00); connect via I2C lines to stake headers on the target PCB to the PortIC.

**EVALUATION BOARD**

The SZPL3002AA-EVB01 evaluation board is a design sample for multiproport shared power operation in SZPL3002A devices. This platform features three SZPL3002A ICs for three ports and two 2CA USB applications. The SZPL3002A may provide both fixed output voltages and programmable power supply profiles for quick charging of linked devices. The device also supports the Qualcomm QuickCharge protocols, QC2.0/3.0/4.0/4.0+, and hence can handle both Type-A and Type-C output ports.

An I2C bus is included, enabling inter-IC communication between SZPL3002A devices for advanced applications like shared power, numerous outputs, and charging ports. The bus also makes it easier to program OTP memory in the devices. Contract
setups for two 65-W Type-C PD ports and an 18-W QuickCharge Type-A port are pre-programmed within the device.

$V_{in}$ and $V_{out}$ may be monitored using Kelvin connections. Each port has a $2 \times 2$ header pin to detect input currents, allowing for reliable performance assessments of efficiency as well as line and load control. Changes to the output voltage, soft start, operating frequency, and power contracts are discussed further in the user handbook.

**CO$_2$ POWER MANAGEMENT CHALLENGES**

In terms of electrical conversion efficiency, increased technical efficiency in the power industry has had a major role in lowering CO$_2$ emissions, followed by a rise in the percentage of energy generated from renewable sources and the use of fossil fuels with lower carbon content. The emissions from power production and consumption are critical for planning and monitoring greenhouse-gas-emission-reduction activities involving the electrical industry.

It has recently been calculated that no-load power consumption accounts for about two-thirds of a mobile phone's power usage. As Silanna pointed out, reducing power losses is critical for optimizing energy waste. The energy spent by chargers and adapters connected to electrical outlets but not to the relevant devices is referred to as no-load power.

The goal is to create devices that use the least amount of power under zero load to maximize energy efficiency. Silanna’s CO$_2$ Smart Power idea highlights the company's attitude of working relentlessly to develop more efficient products that contribute to sustainability by using less energy and performing better. In most instances, this instantly translates into improved goods and systems that consume less power and hence contribute less to damaging CO$_2$ emissions.

DC/DC converters are intricate systems. Even when simplified by highly integrated ICs, they still need complex component computations and weighted IC controller choices. Furthermore, they are susceptible to board layout and parasitic components (i.e., characteristics of a component that are not ideal, such as resistance in a capacitor or capacitance in a MOSFET switch).

Through the USB connection, devices may operate as a power supply or a user. USB Power Delivery offers quicker peripheral charging and allows devices like smartphones, tablets, and laptops to be powered through the USB connection, eliminating the need for mains power adapters. A network monitor may power a laptop through a USB-C connector, serve as a hub for peripherals like external hard drives, and receive and show video data from the laptop. Power lines need protection in addition to devices for effective power-switching solutions.
Integrating Multiple Discrete Capacitances Into a Solid-State Device

Although semiconductor switching devices have received a lot of attention to make these advances, capacitance may also be a significant design component in helping engineers satisfy energy storage, filtering, leveling, and tuning needs.

By Maurizio Di Paolo Emilio, editor-in-chief of Power Electronics News

Power system designers are constantly under pressure to attain larger power densities and improved conversion efficiencies, whether it is for data servers for the internet of things or data centers. Although semiconductor switching devices have received a lot of attention to make these advances, capacitors may also be a significant design component in helping engineers satisfy energy storage, filtering, leveling, and tuning needs.

However, capacitor development has not kept pace with changes seen in the semiconductor world and even leading technologies such as multilayer ceramic capacitors (MLCCs). MLCCs are monolithic electronics made up of layers of metal electrodes and ceramic dielectrics that alternate. High temperatures are used during the fabrication of the laminated layers of MLCCs to create a sintered, volumetrically effective capacitive device. A conductive termination barrier is then incorporated at the exposed ends to complete the connection.

Empower Semiconductor (Empower) developed its own 220-nF capacitor technology (E-CAP) to complement its series of integrated voltage regulators (IVRs) after recognizing the drawbacks of traditional capacitors. In an interview with Power Electronics News, Steve Shultis, senior vice president of sales and marketing at Empower, discussed how the advantages of E-CAP have allowed the firm to profit from advancements in IVR systems. “E-CAP combines a variety of discrete capacitances into one solid-state component,” he said. “In order to take advantage of their superior performance, size, configurability, durability, and stability, Empower now provides E-CAP silicon capacitor solutions in a number of difficult application areas.

“We spent a lot of time realizing that even the highest-performance ceramic capacitors would not be able to sustain our 100-MHz or 200-MHz switching frequency for the first generation of IVRs when we were developing the initial IVR platform four years ago,” he added. “We thus realized that we needed something new, and together with our partner TSMC, we found a technique that utilized this technology and became specialists in designing for it. We are moving it in a path that, like IVR, involves power management and was not previously considered.”

Empower revealed that its partner is TSMC, with whom there is collaboration in implementing E-CAP. “The intellectual property of the design is ours, but through TSMC, you can use their process, so you can take the intellectual property and apply it to another process,” said Shultis.

Shultis emphasized the ability of E-CAP technology to achieve thickness levels of less than 50 µm, which is perfect for supporting next-generation data-intensive systems that demand high-frequency operation and maximum efficiency from the smallest form factors, as well as in the IoT, wearables, mobile, and processor sectors, where size, performance, and flexibility are crucial. E-CAP solutions help designers lower the cost of the BoM and the risk of circuitry failure.

“With more capacitors integrated into a given area, you can put a lot more capacitors into a smaller area, giving you flexibility for a range of common applications below 4 V,” said Shultis. “High-voltage work necessitates specialized processing with tradeoffs.

Figure 1: E-CAP-based solution provides >5× density compared with standard MLCCs. (Source: Empower Semiconductor)

Last week, Empower Semiconductor announced that it has expanded its E-CAP family of silicon capacitors with new technologies that offer further breakthroughs in density and performance. The latest E-CAP solutions offer densities of 11 µF/mm². In addition to the density, thickness levels can be achieved below 50 µm in overall height. Multiple matched capacitance values from 75 pF to 6 µF (at 2 V) can be integrated into a single die to create custom integrated capacitor arrays. Packaging options based on bumps, pads, and pillars allow designers to choose the best solution based on specific system constraints (Figures 1 and 2).

E-CAP TECHNOLOGY

E-CAP integrates multiple capacitors into a single solid-state device, offering the flexibility and efficiency of silicon. According to Shultis, the technique combines an enhanced equivalent series inductance (ESL) and equivalent series resistance (ESR) characteristic that significantly lowers parasitics with a capacitor density that is nearly 5× greater than that of leading MLCCs.

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Power system designers are constantly under pressure to attain larger power densities and improved conversion efficiencies, whether it is for data servers for the internet of things or data centers. Although semiconductor switching devices have received a lot of attention to make these advances, capacitors may also be a significant design component in helping engineers satisfy energy storage, filtering, leveling, and tuning needs.

Power system designers are constantly under pressure to attain larger power densities and improved conversion efficiencies, whether it is for data servers for the internet of things or data centers. Although semiconductor switching devices have received a lot of attention to make these advances, capacitors may also be a significant design component in helping engineers satisfy energy storage, filtering, leveling, and tuning needs.
Empower is scouting the landscape for potential new prospects. Additionally, unlike MLCCs, which require several devices to account for derating from voltage, temperature, and age, E-CAP has minimal or no requirements for AC or DC bias derating. As a result, there is no longer a need to “over-spec” capacitance needs to take derating into consideration.

“Calculations are needed to determine the appropriate temperature, voltage, DC rating, etc., while using MLCCs,” said Shultis. “Due to low derating from voltage, temperature, and age, E-CAP does not need overdesign. To demonstrate this, we may cite our outstanding performance in terms of qualification, dependability, and client production. The ESL is the other non-negligible component, which is why high-performance decoupling systems often employ it, as only a small amount of inductance is required and is provided by the capacitor throughout the whole line. There are ceramic capacitors with low inductance, but they normally cannot achieve single-digit picohenry values and are more costly, as they are made of highly customized and specialized ceramics.”

### Flexible Capacitors with an Ultra-low ESL of as little as 15 pH and a Package Height of 50 µm are Available through E-CAP for Use in Mobile and Wearable Devices to Data Center Servers and IoT Devices.

E-CAP has a lower impedance at high frequencies due to its better frequency response and stronger ESL. According to the results, Figure 3 shows that the number of components can be reduced by 40% through the use of E-CAP while simultaneously lowering the impedance at high frequencies to half that achieved with the traditional MLCC-based solution.

“According to Figure 4, our roadmap is meant to offer a variety of options; however, as we speak with more and more customers and applications, we understand that a sizable percentage of the market has a general requirement for 200 nF or 400 nF,” said Shultis. “We have already put a few second-generation multicap-type designs into practice. The one with 18 capacitors is most likely to become a regular item: 18 200-nF capacitors are included in the easily accessible product, although the array is roughly 2 x 2 mm, has a 400-µ pitch, and has a total capacitance of about 4.8 µF. Thus, it may be used in the majority of PCB-mounting situations. The second generation can go below 50 µ in thickness. The very small decoupling capacitors on the underside of the substrate are so thin that they can fit within the height limits, even for mounting after soldering or inside substrates or PCB layers, so we are working on these packaging technologies and how this can be done.”

Shultis asserted that E-CAP capacitors are secure for usage in magnetic field conditions and resistant to low-frequency noise (Figure 5). “This is a challenge for some low-frequency applications using MLCCs,” he said. “We have run into this issue on a few occasions. Additionally, nickel plating on the pads of ceramic capacitors makes them troublesome for use in medical applications, as it is magnetic-field-sensitive.”

**Figure 3:** Example design replaces 10 MLCCs with one E-CAP die; single-die solution for nine-capacitor requirement for ultra-high-density application. (Source: Empower Semiconductor)

**Figure 4:** Empower E-CAP design examples (Source: Empower Semiconductor)

**Figure 5:** MLCC construction vs. silicon trench capacitor (Source: Empower Semiconductor)
Silicon carbide and gallium nitride have witnessed increasing success in the semiconductor device market in recent years. GaN is now used in mobile device chargers and charging systems. Companies like Apple, Samsung, and Xiaomi have chosen GaN-based chargers that provide high power densities while maintaining, or even decreasing, the weight of these components. These chargers utilize power GaN high-electron–mobility transistor (HEMT) chips offered by companies like GaN Systems and Navitas Semiconductor.

On the other hand, SiC devices have primarily been used in the field of electric mobility. In 2017, electric-vehicle manufacturers like Tesla chose to use SiC-based motor controllers, which boosted the efficiency of their systems. This has kickstarted a race toward developing high volumes of SiC devices to meet the increasing amount of EVs that are being introduced into the market.

Their popularity begs the question: What is so special about these new semiconductor materials, and why are they being looked at as alternatives to silicon? As explained by Victor Veliadis in his July 28, 2022, PSMA webinar, “SiC Power Technology Status and Barriers to Overcome,” “SiC and GaN materials have a critical electric field that is about 10× higher than that of silicon, with a bandgap that is 3× higher. In a semiconductor system, the drift layer is what holds its rated voltage, which makes the thickness and doping levels of this layer determine the voltage capability of the device.”

For a specific rated voltage, the thickness of the drift layer is inversely proportional to the critical electric field. This implies that GaN and SiC devices of a particular voltage capability have drift layers that are 10× thinner than those of silicon devices. These factors drive design changes and have major implications in semiconductor design.

Due to their thinner drift layers, SiC devices are smaller in size, which decreases their capacitance. These devices can therefore efficiently switch at frequencies much higher than what is possible with silicon. As a result of the higher switching frequency, the size of passive components and magnetic devices like inductors also decreases. This leads to a significant reduction in the overall size of the system, which increases its power density. Furthermore, the large SiC bandgap and high thermal conductivity allow for high temperature operation with simplified cooling management; further decreasing system weight and volume.

None of this is to say that either SiC or GaN is superior or that silicon is obsolete. The choice of semiconductor material to be used will depend on the specifications of the application in which they are deployed. Silicon is still a strong contender in devices rated from 15 V to 650 V while also being much cheaper and more reliable, whereas GaN has been gaining popularity in low-power applications like mobile chargers and similar charging systems. As previously mentioned, GaN is the only viable wide-bandgap alternative to silicon in low-power applications, as SiC operation is impractical at voltages below 650 V.

**GALLIUM NITRIDE AND SILICON CARBIDE**

GaN enables a power-factor-correction (PFC) technology known as “totem-pole bridgeless PFC topology.” On the other hand, a traditional silicon boost solution would have a diode bridge where two of the diodes are constantly on. This would contribute to significant losses but is mitigated by GaN due to its essentially zero reverse recovery. 100-V GaN devices are also being deployed at data centers, as server racks are increasingly moving toward 48 V. Furthermore, 650-V GaN devices can also be deployed and run for PFC circuitry. SiC is suitable for higher-power applications than what is possible using GaN and is available in voltages ranging from 650 V to 3.3 kV, with higher-voltage devices being developed.

Stephen Russell, subject matter expert for power devices at Tech Insights, said during a company webinar, “Gallium nitride has truly found its killer app in replacing silicon and USB-C chargers for mobile devices. 2021 [was] a watershed year in market acceptance, and we only expect this momentum to continue. Gallium nitride’s real advantage, however, is its switching; it is the only viable wide-bandgap replacement for silicon at voltages less than 600 V.”

**What Does the Future Hold for WBG Devices?**

By Maurizio Di Paolo Emilio, editor-in-chief of Power Electronics News

The U.S. Vibrant SiC Fab Infrastructure Mirrors that of Si

SiC fab infrastructures (Source: Victor Veliadis)
All of these devices compete heavily at the 650-V capacity, which is important, as these devices are used in the 400-V capacity bus for EVs.

EVs are a critical application for these newly adopted high-bandgap devices, as the market is expected to expand. This transformation is taking place owing to the rapid electrification across sectors and increased consciousness about emissions. They can be seen in motor drivers, DC/DC converters, on-board chargers, etc.

SiC is expected to have an edge in the EV sector, as more and more manufacturers are moving toward 800-V EV systems, due to its efficient high-voltage operational capability. Transitioning to higher-voltage systems enables higher power delivery while maintaining the same current levels. This allows copper conductors and other components to be smaller, lighter, and less expensive.

Manufacturers like Porsche, Audi, BYD, and Hyundai are already working on 800-V battery systems, while Lucid has a 900-V system under development. As Velis said, “Moving to 800 V while keeping the current the same doubles the power, with smaller losses. This reduces heavy copper cables, bringing lighter weight and space-saving advantages.”

Once adopted successfully into the EV space, the demand for SiC devices will further increase manufacturing. This will eventually scale down prices similar to silicon-based devices after mass production. The decrease in cost is an important step, as these devices are more expensive than silicon, with SiC material costing almost 2× to 3× as much as silicon.

Apart from the high cost, manufacturing SiC has its own set of challenges, such as the presence of defects and slower fabrication times compared with silicon, and SiC devices are less rugged. This discourages people from adopting SiC-based systems and is a challenge to overcome. Due to their high-voltage potential, SiC devices are excellent candidates for deployment in power applications like HVDC transmission and renewable energy systems. For example, in the case of PV applications, although the SiC device cost is 3× higher than that of silicon wafers, the overall system cost is lower due to the reduction in the size of the passive elements.

Despite the challenges they face, wide-bandgap devices are projected to be widely adopted across many industries and markets. Today, SiC and GaN are the only wide-bandgap semiconductor materials with commercially available power devices for a wide range of applications. Depending on their device power ratings, these materials can find applications in a variety of industries.

There are also projections showing that the SiC market is expected to be worth $6.5 billion by 2027. GaN devices will dominate the low-power mobile application industry, with more devices expected to reach the market with power densities higher than 20 W/mm². These devices are expected to bring significant efficiency improvements and offer user convenience.

Unfortunately, SiC substrate and GaN epitaxy on silicon substrate production is more complicated and labor-intensive than that of silicon wafers, and this drives up cost. Moreover, the SiC and GaN market is much smaller, and it is a long way from a large-scale standardized division of labor, as the main process technologies are in the hands of a few select businesses. To overcome such issues, SiC and GaN must be mass-produced, which will bring economies-of-scale cost reductions.

As part of the Green Deal, the European Union has set an ambitious goal of achieving carbon neutrality by 2050 and has decided to ban the sale of new fossil-fuel cars after 2035. Electric-car unit sales grew last year by nearly 70%, to 2.3 million, but some barriers to electric-vehicle adoption can only be overcome by effective strategies and practices.

In a panel session at the recent Energy Tech Summit in Warsaw, Poland, e-mobility pundits discussed six ways to make mass-market EV adoption a reality.

**MANAGING CHARGING LOAD**

Public transportation is an effective way for cities to reduce greenhouse gas emissions. Last year, London Mayor Sadiq Khan announced that all new buses would be electric and that the bus fleet would be fully electric by 2034 or sooner. Austria, Denmark, and the Netherlands have also committed to having 100% of new buses use zero-emission technologies in the coming years.

“The main challenge is not increasing public transport ridership” but achieving public transit fleet electrification, said Amos Haggiag, co-founder and CEO of Optibus. “If you take the 10,000 to 11,000 buses in London and make them electric, there isn’t enough electricity to power them all. You have to spread the charging load in a way that you won’t have too many vehicles charging at the same time. A lot of the work we do is to prioritize when you charge, how long you charge, and which vehicle to use.”

Founded in 2014, Optibus has developed a cloud-native AI platform that plans and runs public transit networks in 1,000 cities around the world.
“We are the AI engine used to design the routes, the networks, the timetables, and the frequency of transit systems,” said Haggag.

Optibus has just closed a $100 million Series D round of funding, bringing the total raised so far to $260 million.

GENERATING POWER LOCALLY
The need to decentralize electricity production is becoming a major factor of change.

“One of the principal problems that we see is the ability to generate the power locally, far away from the grid, in a way that’s sustainable, and to be able to deploy chargers in a much quicker way without the regulatory delays or the other utility delays that are ubiquitous both in North America and in Europe,” said Martin Lynch, COO of FreeWire Technologies.

FreeWire was founded in 2014 to address the growing need for ultra-fast EV charging infrastructure.

“We’re looking to fundamentally change the way energy is deployed away from the grid and building up distributed energy storage systems for our customers, as well as being able to deploy fast electric-vehicle charging using lithium-ion batteries,” said Lynch.

FreeWire’s Boost Charger is claimed to deliver fast charging (up to 150-kW output) while minimizing stress on the local power grid with the help of a built-in 160-kWh battery. The product can provide fast charging to two EVs simultaneously.

“We differentiate ourselves from our competitors in terms of really reducing the load on the grid and being able to support grid deployment of electric-vehicle charging, knowing that the grid around the world is limited in terms of both energy and power-distribution capabilities,” said Lynch.

The first generation has reached mass production, and the next generation is expected in the next several weeks.

CREATING A FRICTIONLESS EXPERIENCE
The user experience must be frictionless, with certainty of access to charging points, whether on highways or in rural areas. More EV charging stations should also be installed alongside public structures, such as office buildings, supermarkets, and universities.

“People are not going to go into something that’s inconvenient,” said John de Souza, president and co-founder of Ample, which has developed a modular battery-swapping approach as an alternative or complement to charging stations.

Recharging also needs to be faster. An Uber driver can either drive and make money or spend 12 hours a week at a charging station and earn 30% less, said de Souza.

“If you’re making a living from your car, and you’re effectively losing a lot of your revenue, it can be pretty rough.”

A cultural shift is needed before massive adoption, the panelists said.

“We have to change the habits of drivers that are used to filling their car with gas or petrol and then going on for the next three or four days,” said Lynch. “We need to change the way that we charge our cars — not trying to fill up, but doing smaller charges more frequently, at work and other places like homes, apartments, or condos, as well as in public places.”

EASING CHARGING AND RANGE ANXIETY
A recent survey released by EV shows that those who already own an EV are less prone to range anxiety and less concerned about charging infrastructure. The top motivation for second-time EV buyers is that “EVs now have more range,” and only 27% of EV owners are concerned about charging infrastructure.

Things are different for first-time buyers. Anxiety about charging and range is a common concern that keeps combustion-engine car owners from switching to EVs.

Battery swapping, a common concept in China, aims to avoid range anxiety by allowing electric cars to extend their range by exchanging a discharged battery for a charged one at a swapping station. At the station, the battery swap takes about the same time that it takes to fill a combustion-engine car’s tank.

San Francisco–based Ample is bringing its battery-swapping business model to Europe and Japan later this year.

“We wanted to be able to work across manufacturers and wanted to deploy infrastructure very quickly, so we came up with this modular battery-swapping approach,” said de Souza. “We developed the small battery modules that we can fit into different vehicles by making [the module] adaptive, so it doesn’t require any changes from the OEM.”

LEVERAGING DATA
In April, the Mercedes-Benz Vision EQXX vehicle drove more than 1,000 km from Sindelfingen, Germany, to Cassis, in southern France, on a single charge. Data analysis had a role to play in reaching this milestone.

“With increasing electrification of the cars and with more and more electromobility, there are definite needs and demands that are coming onto the infrastructure, and we believe that the data we generate in the cars can be very helpful in mitigating the worst outcomes and making this demand or this changeover much smoother,” said Carsten Kaefert, product and category owner for energy-related data products at Mercedes-Benz.

The data generated by EVs provides key insights such as driving habits, geolocation, battery charge, and the availability of charging systems. It also informs utilities and distribution system operators (DSOs) of where the load generated by EV charging is greatest and the demand for electricity for driving is highest, allowing DSOs to focus their investments where they are most needed and enabling a transition to cheaper and faster e-mobility, said Kaefert.

“We should use the different types of information we can get, be it from the vehicles, from the infrastructure, from all the parties involved in the whole chain [e.g., smart charging, green energy sources] and integrate that data to better understand it,” Kaefert said. “Then I think we can turn that challenge into an opportunity to use EVs and their batteries to stabilize and improve the networks that we have.”

ENHANCING COLLABORATION
The EV industry is multidisciplinary, with contributions from many cross-industry sectors. As the adoption of EVs accelerates, collaboration is required on an entirely new scale, the panelists said.

“We are at a unique point in history where we see this dramatic change in society in terms of how we transport people and products,” said Lynch. Challenges persist in such critical areas as vehicle charging time, driving range, and access to efficient EV charging stations, but the mass electrification of transport is well under way.

“We have all the technologies in place to succeed,” but the deployment can only be effective and profitable if governments and regulations support it, Lynch concluded.

Ignas Mikutis, CEO of charging station contractor Elinta Charge, extended an invitation: “I would like to encourage everyone to look for the opportunities to review the technologies we already have in place, and we will discuss how to work forward finding this consensus between governments, businesses, and the people who are eventually driving the EVs.”

This article originally ran on EE Times Europe.
EPC Opens New Motor Drive Center of Excellence

EPC has opened a new design application center near Turin, Italy, to focus on growing motor drive applications based on GaN technology in the e-mobility, robotics, drones, and industrial automation markets.

EPC has opened a new design application center near Turin, Italy, to focus on growing motor drive applications based on GaN technology in the e-mobility, robotics, drones, and industrial automation markets. The specialist team will support customers in accelerating their design cycles and define future integrated Circuits for power management with state-of-the-art equipment to test applications from 400 W to 10’s of kW.

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1200V Rating Achieved on Vertical GaN Power Devices

Odyssey Semiconductor Technologies has announced that it has achieved the stated goal of 1200V rating on vertical GaN power field-effect transistors (FETs)

Odyssey Semiconductor Technologies, a semiconductor device company developing novel high-voltage power switching components based on proprietary gallium nitride (GaN) processing technology, has announced that it has achieved the stated goal of 1200V rating on vertical GaN power field-effect transistors (FETs). The company will begin using this tested technology to create product samples in Q4 2022 for scheduled Q1 2023 customer and internal evaluations.

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New DIN Rail Power Supplies for Industrial Applications

The WDA series of DIN Rail power supplies provides high performance thanks to its high-runner component construction.

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Enhancing Electrification and Sustainability with Battery Technology

In this podcast we will analyze battery technology with Vincent Platiniage, CEO and co-founder of OneD Battery Sciences which has developed SINANODE, a set of technologies that “supercharge” the amount of energy stored, speed of charging, power delivered to EV batteries. This proprietary and patented technology increases energy density and lifetime while reducing costs of EV batteries. Let’s talk with Vincent.

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Wine Down Friday with Steve Shultis, SVP, Empower Semiconductor

Steve Shultis has an outstanding track record of delivering results in both sales and business leadership positions over his more than 20 years in the semiconductor and electronics industries. His most recent roles included VP & GM at Foxconn Interconnect Technologies, and Sr. Director of Marketing & Sales at Foxconn Optical Interconnect Technologies where he managed half a US billion dollars in revenues.

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