



System Solution Guide - Preview

EV Auxiliary Systems



[onsemi.com](https://www.onsemi.com)



Table of Contents

Get Latest
Version

Overview	03
Rapid Electrification of Automotive Industry is Reshaping Auxiliary Systems	04
System Description	05
Semiconductor Product Categories in EV Auxiliary Systems	06
Solution Overview	07
Block Diagram – EV Battery Heating and Cooling	08
Introducing Automotive Smart Power Modules SPM® - ASPM27 and ASPM34	09
Block Diagram – HVAC E-compressor	11
Block Diagram – HVAC Heater	12
High Voltage Power Discrete Components for EV Auxiliaries	13
Isolated Gate Drivers: Reliable, High-Performance Control for HV Switches	14
Junction Isolated Gate Drivers for Cost-Driven Designs and Applications	15
Block Diagram – Body Control Module (BCM)	16
Brushless and Stepper Motor Drivers in EV Auxiliary Applications	17
High-Efficiency 40 - 100 V MOSFETs for Robust EV Auxiliary Applications	18
Block Diagram – Door Control Module (DCM)	19
Brushed Motor Driver ICs for Body and Door Control Applications	20
Specialized Driver ICs for Body and Door Control Applications	21
Recommended Products	22



System Solution Guide
EV Auxiliary
Systems

Register now to unlock all System Solution Guides



1



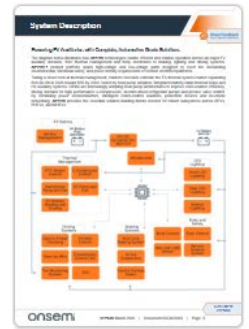
2



3



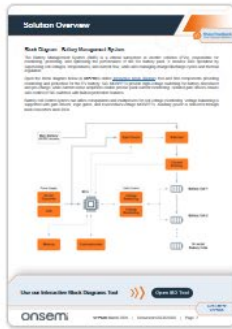
4



5



6



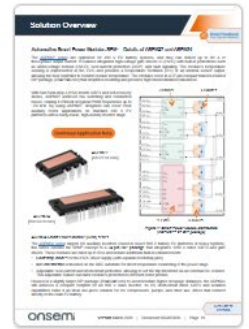
7



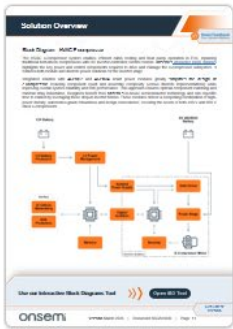
8



9



10



11



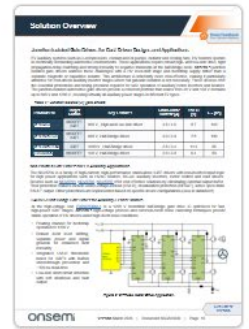
12



13



14



15



16



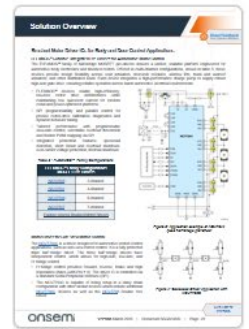
17



18



19



20

Semiconductor Product Categories in EV Auxiliary Systems

EV auxiliary systems rely on a diverse set of semiconductor components that enable efficient power conversion, sensing, actuation, communication and protection. Modern EV subsystems depend on increasingly sophisticated semiconductor content as complexity grows and energy efficiency becomes essential for maximizing driving range. Semiconductors underpin the control of heat pumps, various heaters, refrigerant valves and other major contributors to energy consumption, especially in extreme climates.

1. Power Switching & Conversion Devices

- [MOSFETs](#), [IGBTs](#) and [SiC devices](#) are key power semiconductors used in motor inverters, driver stages and DC-DC converters within HV and LV networks. [ASPM modules](#) provide a fully-featured inverter output stage with integrated gate drive. Top Cool MOSFETs enable scalable power delivery for LV auxiliaries across BEVs, HEVs and MHEVs.

2. Motor Drivers and Gate Drivers

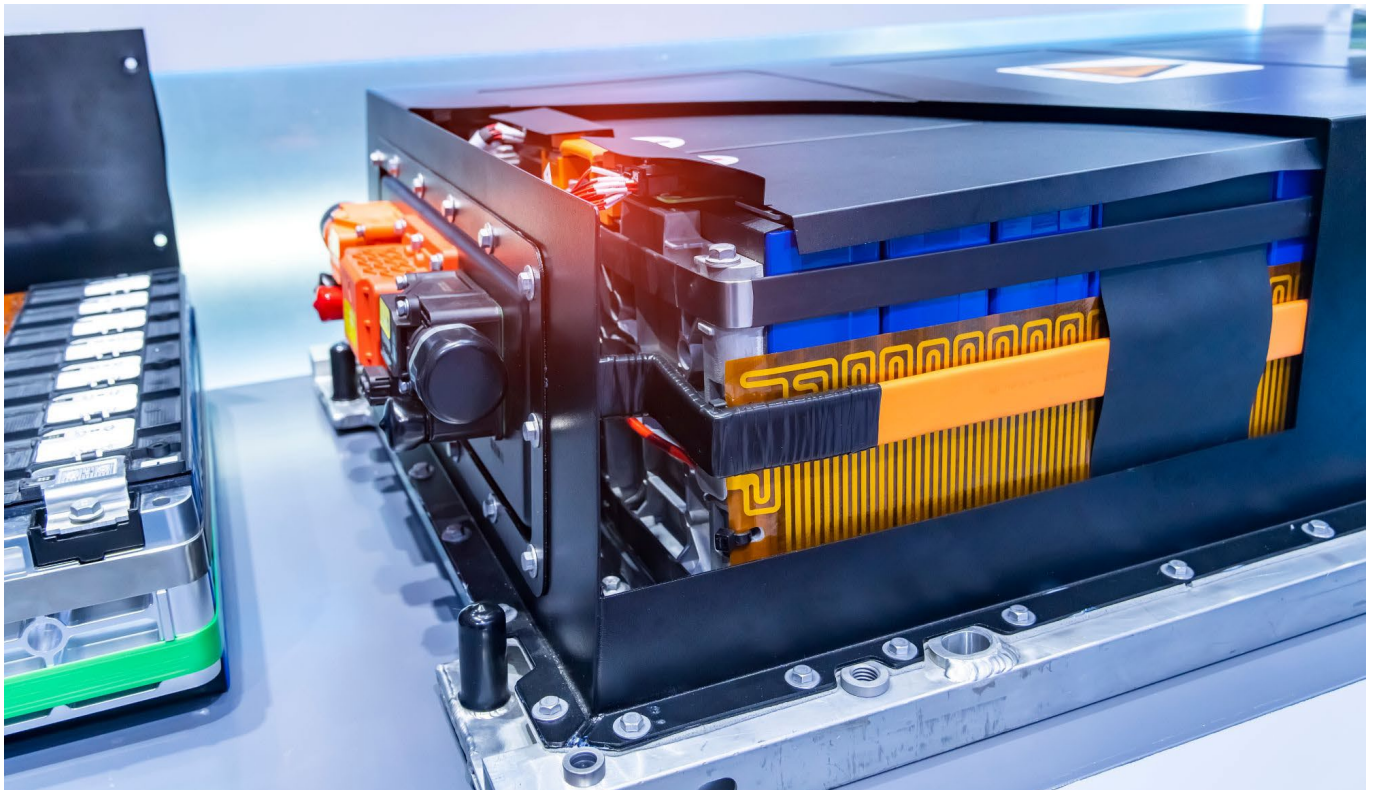
- BLDC and PMSM motors are used in pumps, actuators and compressors, requiring precise control electronics. [Gate drivers](#), [Stepper motor](#) and [BLDC motor](#) driver ICs manage switching behavior, torque response and protection features, ensuring reliable operation across varying temperature and load conditions.

3. Power Management ICs and LV Protected Switches

- [LDOs and voltage regulators](#), [load switches](#), [e-fuses](#), [SmartFETs](#) and other supervisory ICs support stable and safe power distribution networks. Protection devices safeguard against faults, manage inrush current and maintain regulated supply rails for various actuators and safety electronics.
 - Automotive PMICs - [NCV92310](#), [NCV97200](#), [NCV97310A](#) and [NCV97311A](#).

4. Communication and Networking Components

- Auxiliary modules and ECUs connect via automotive [10BASE-T1S Ethernet](#), [CAN](#) or [LIN](#). Transceivers, PHYs and [EMI/ESD protection](#) devices ensure robust communication, especially as zonal architectures and distributed LV networks continue expanding.



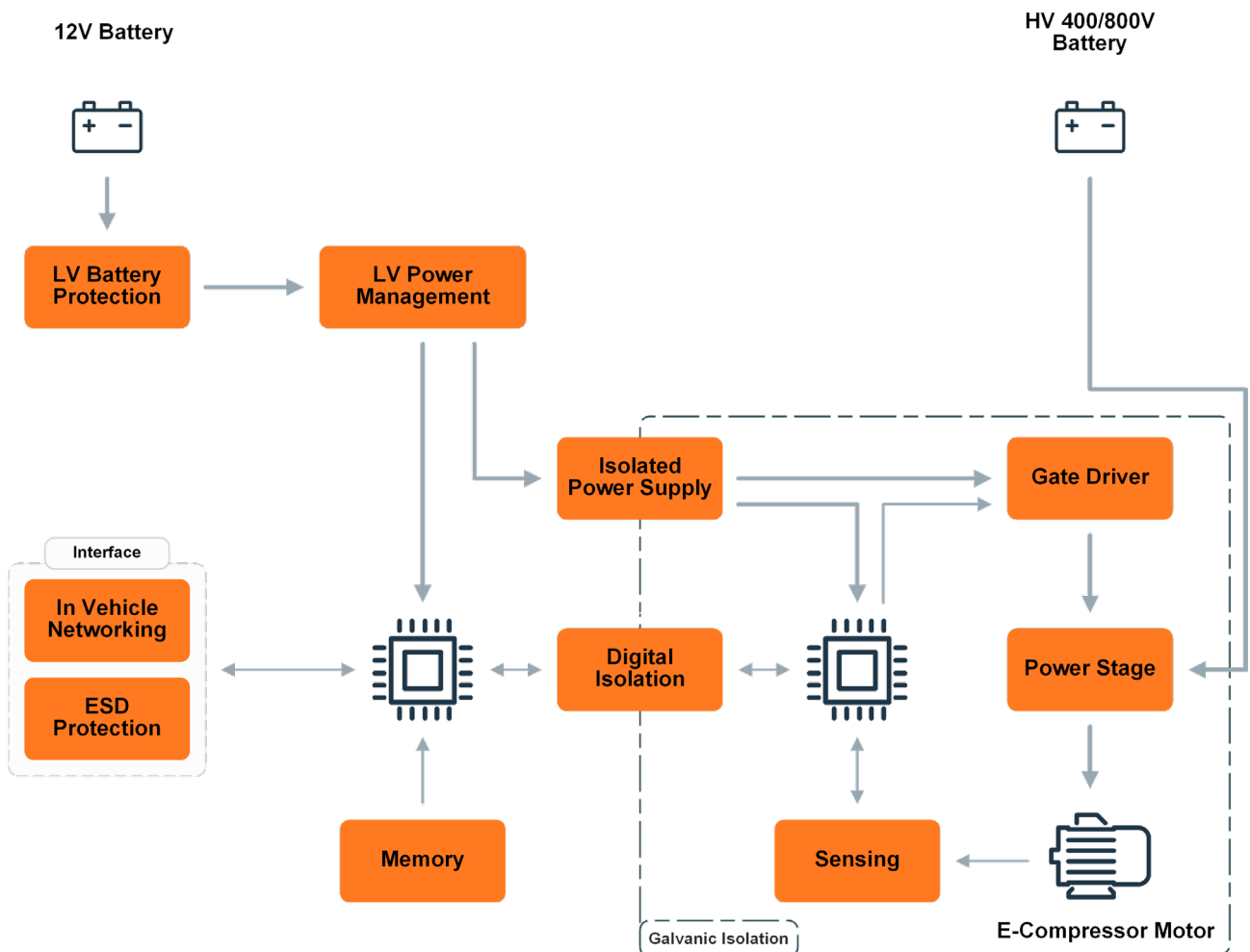
Block Diagram

Get Latest Version

Block Diagram – HVAC E-compressor

The HVAC e-compressor system enables efficient cabin cooling and heat pump operation in EVs, replacing traditional belt-driven compressors with HV inverter-controlled electric motors. [onsemi's interactive block diagram](#) highlights the key power and control components required to drive and manage the e-compressor subsystem. It features both module and discrete power solutions for the inverter stage.

Integrated solution with **ASPM27** and **ASPM34** smart power modules greatly simplifies the design of e-compressor, reducing component count and assembly complexity (versus discrete implementations) while improving overall system reliability and EMI performance. This approach ensures optimal component matching and minimal stray inductance. Designers benefit from **onsemi's** in-house semiconductor technology and can expedite time to market by leveraging these drop-in inverter blocks. These modules deliver a compelling combination of high-power density, automotive-grade robustness and design convenience, covering the needs of both 400 V and 800 V class e-compressors.



Use our Interactive Block Diagrams Tool



Open IBD Tool

Automotive Smart Power Modules SPM® – Details of ASPM27 and ASPM34

The [ASPM27 series](#) are optimized for 400 V EV battery systems, and they can deliver up to 60 A of three-phase output current. It features integrated high-voltage gate drivers IC (HVIC) with built-in protections such as under-voltage lockout (UVLO), over-current protection (OCP), and fault signaling. The module's temperature sensing is implemented in the LVIC and provides a temperature feedback (V_{TS}) or an internal sensor output, allowing the host controller to monitor module temperature. The modules come in a 27-pin compact transfer-molded DIP package (45×27×6 mm) that simplifies mounting and provides high shock/vibration robustness.

With fast Field-stop 4 (FS4) trench IGBTs and soft-recovery diodes, ASPM27 achieves low switching and conduction losses, making it efficient at typical PWM frequencies up to ~20 kHz. By using ASPM27, designers can cover most auxiliary motor applications on standard 400 V EV platforms with a ready-made, high-density inverter stage.

Download Application Note

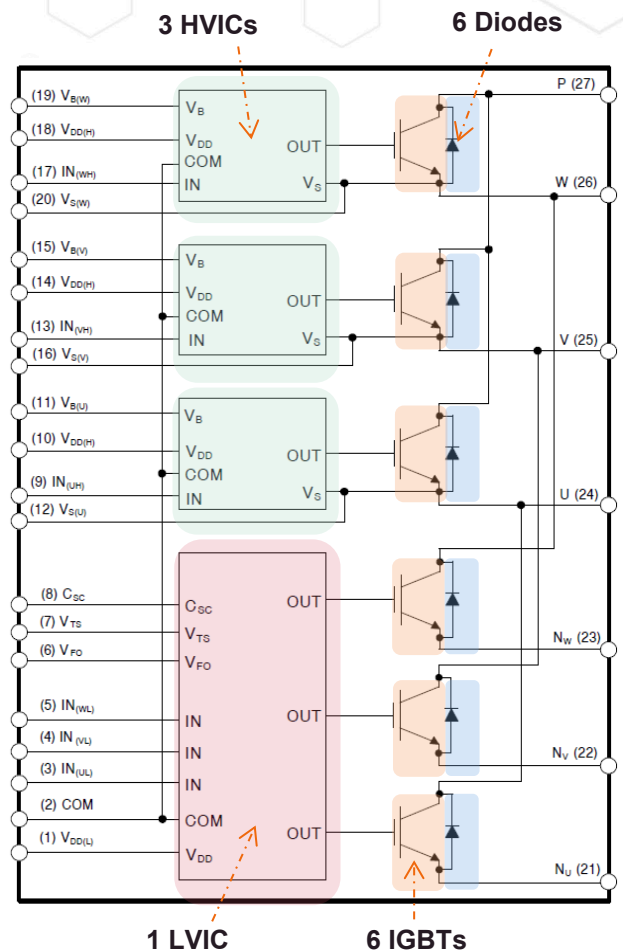
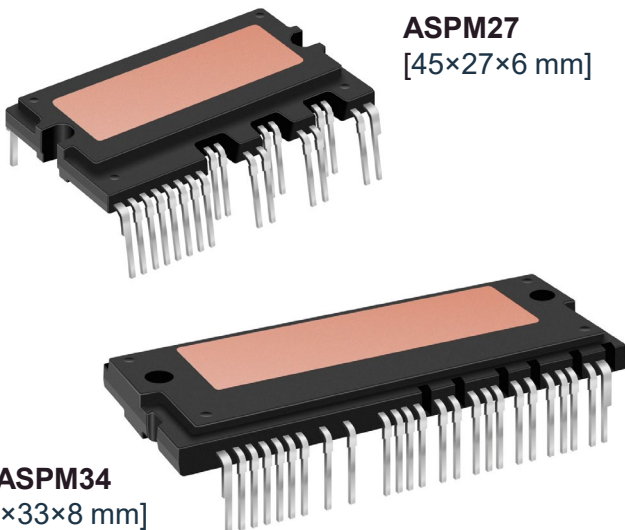


Figure 1: Smart Power Module architecture (ASPM27 – 27 DIP package)

ASPM34 Smart Power Module (SPM) series

The [ASPM34 series](#) targets HV auxiliary inverters (found in newer 800 V battery EV platforms or heavy hybrids), this series extends the SPM® concept to a **34-pin DIP package** that integrates 1200 V rated IGBTs and gate drivers. These modules are rated up to 50 A and include additional built-in enhancements:

- **Bootstrap diodes** for the HVIC driver supply (with separate bootstrap pins)
- **NTC thermistor** embedded on the DBC substrate for direct temperature monitoring of the power stage
- Adjustable over-current and short-circuit protection, allowing to set the trip threshold via an external R_{SC} resistor. This adjustable feature can tailor module's protection to different motor profiles.

Housed in a slightly larger DIP package (80×33×8 mm) to accommodate higher creepage distances, the ASPM34 still achieves a compact footprint for an 800 V class inverter. Its HV short-circuit rated IGBTs and isolation capabilities make it an ideal one-piece solution for HV compressors, pumps, and other aux. drives that connect directly to the main EV battery.

Automotive Discrete MOSFETs

Get Latest Version

High-Efficiency 40 - 100 V MOSFETs for Robust EV Auxiliary Applications

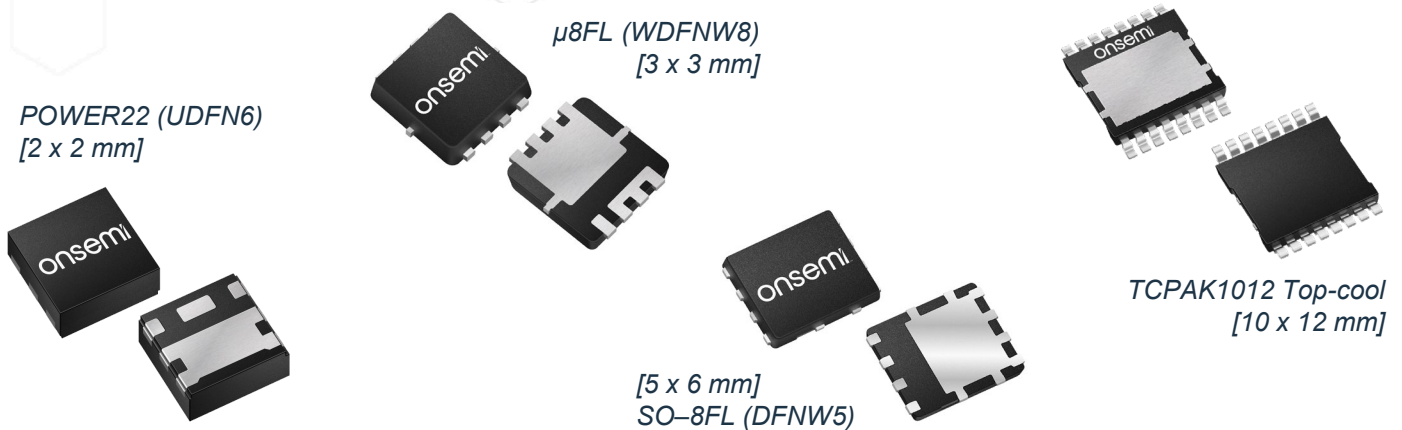
onsemi's 40 - 100 V automotive MOSFET portfolio delivers the switching efficiency, ruggedness and thermal performance required for the wide range of EV auxiliary loads powered from 12 V and 48 V networks. As vehicles transition toward multi-voltage and zonal architectures, auxiliary systems demand compact, low-loss power stages capable of handling fast transients and inductive loads. onsemi's advanced MOSFET technologies, including PowerTrench® and Top Cool packaging, reduce conduction and switching losses, enable higher power density and improve thermal behavior in confined spaces. Find below high-density packages in industry standard footprints.

12 V Systems →

Find Products

Find Products

← 48 V Systems



PowerTrench® T10 MOSFET Technology: 40 V and 80 V MOSFETs

T10 is onsemi's latest PowerTrench® technology node after the successful T6 and T8 generations. T10-M features an application-specific architecture with the lowest $R_{DS(ON)}$ and a soft body diode, specifically optimized for motor control and load switching. T10-S is designed for switching applications, prioritizing lower output capacitance.

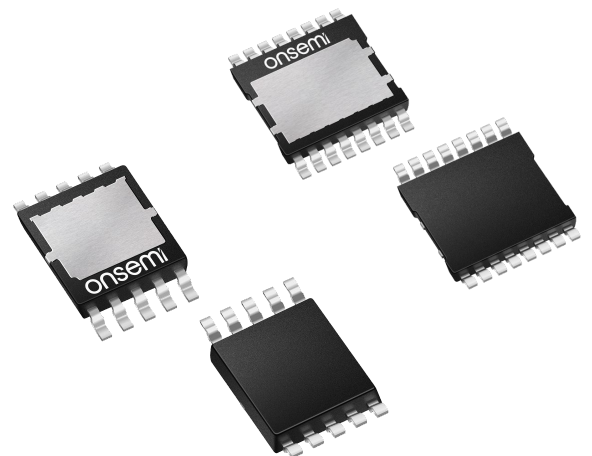
- Improved Figure of Merit - FOM ($R_{DS} \times Q_{OSS}/Q_G/Q_{GD}$) enhances performance and overall efficiency.
- Industry leading soft recovery body diode (Q_{rr} , T_{rr}) reduces ringing, overshoots and noise.

Top Cool MOSFET Power Packages (TCPAK)

onsemi has released new TCPAK1012 top cool package available in larger [10 x 12 mm] footprint, featuring the PowerTrench® T10 80V technology. Building on the success of established compact TCPAK57 [5 x 7 mm] package, top cool packages deliver enhanced power handling capability, while maintaining the thermal management advantages that eliminate the PCB body from heat conduction path.

TCPAK exposes the lead frame (drain) of the MOSFET on its top side, enabling direct heat transfer to a heatsink instead of dissipation through the PCB. Learn more in Top Cool Package for Power MOSFETs Application Note.

- [NVMJST0D9N04C](#) 40V MOSFET in TCPAK57, 1.07 m Ω .
- [NVBYST0D6N08X](#) 80V MOSFET in TCPAK1012, 0.64 m Ω .



Top Cool MOSFETs with exposed drain on the top for heat-transfer.
TCPAK57 [5.1 x 7.5 mm] - Left
TCPAK1012 [10 x 12 mm] - Right

Download Application Note

Frequently Asked Questions (FAQ)

What is the scope of the EV Auxiliary Systems - System Solution Guide from onsemi?

1 The full version of the System Solution Guide provides a comprehensive overview of electrified auxiliary systems used in modern BEV, HEV and PHEV platforms. It covers powertrain auxiliaries, thermal management, HVAC and body electronics, supported by system block diagrams and recommended semiconductor products. Readers gain insight into system architectures, trends and **onsemi's** automotive grade products portfolio for scalable, reliable designs of EV auxiliary applications.

How do onsemi's automotive Smart Power Modules simplify motor drive and inverter designs?

2 The Smart Power Modules (SPM[®]), including ASPM27 and ASPM34, integrate IGBTs, diodes, gate drivers and built-in protections into a compact module solution. By replacing dozens of discrete components with one module, they simplify motor inverter PCB design, improve EMI performance and enhance reliability compared to discrete designs. Optimized for 400 V and 800 V EV platforms, these modules enable easier development of e-compressors, pumps, cooling fans and other high-voltage auxiliaries.

Why are isolated gate drivers useful in EV auxiliary high-voltage systems?

3 Isolated gate drivers provide safe, high-performance control of IGBTs and MOSFETs in EV auxiliary inverters and heating/cooling systems. **onsemi's** isolated drivers offer high CMTI, reinforced isolation and variety in source/sink currents to handle fast switching and high dV/dt. These features protect low-voltage control electronics and improve robustness, functional safety in HV auxiliary applications.

Why are top-side cooled MOSFETs gaining traction in modern automotive power electronics?

4 Top cool MOSFETs are optimized for high-current automotive applications where efficiency, robustness and thermal headroom are critical. The new top cool TCPAK packages help to reduce PCB temperature and improve power density. TCPAK exposes the lead frame (drain) of the MOSFET on its top side, enabling direct heat transfer to a heatsink instead of dissipation through the PCB. This method avoids cooling through the PCB body via thermal vias.




How are brushless (BLDC) and stepper motor drivers used in EV auxiliary applications?

5 Brushless DC (BLDC) and stepper motor drivers are widely used in EV auxiliary systems such as pumps, valves and body electronics actuators. **onsemi** motor driver ICs provide precise torque control, integrated protection and wide voltage support for 12 V - 48 V subsystems. This enables scalable, reliable, energy-efficient operation across auxiliary actuators. Additionally, discover several application-specific drivers, such as side-view mirror control and lock-motor driver located in vehicle doors.

onsemi™

Intelligent Technology. Better Future.

Register now to unlock all System Solution Guides and get additional exclusive benefits!

-  Join the conversation on community forum.
-  Utilize Elite Power Simulator & other developer tools.
-  Watch exclusive webinars and seminars.

 [Open full System Solution Guide](#) 



onsemi, the onsemi logo, and other names, marks, and brands are registered and/or common law trademarks of Semiconductor Components Industries, LLC dba "onsemi" or its affiliates and/or subsidiaries in the United States and/or other countries. onsemi owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of onsemi's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. onsemi reserves the right to make changes at any time to any products or information herein, without notice. The information herein is provided "as-is" and onsemi makes no warranty, representation or guarantee regarding the accuracy of the information, product features, availability, functionality, or suitability of its products for any particular purpose, nor does onsemi assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using onsemi products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by onsemi. "Typical" parameters which may be provided in onsemi data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. onsemi does not convey any license under any of its intellectual property rights nor the rights of others. onsemi products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use onsemi products for any such unintended or unauthorized application, Buyer shall indemnify and hold onsemi and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that onsemi was negligent regarding the design or manufacture of the part. onsemi is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.