System Solution Guide - Preview

EV Auxiliary Systems

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Full Guide Preview

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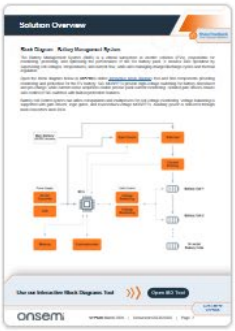

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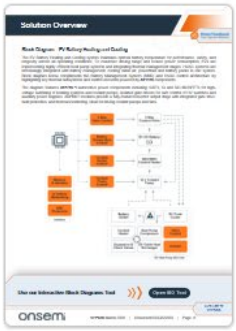

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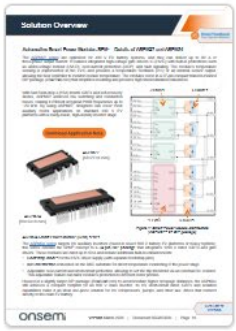

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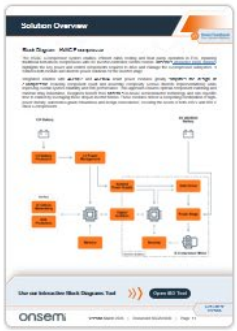

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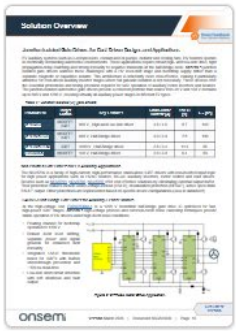

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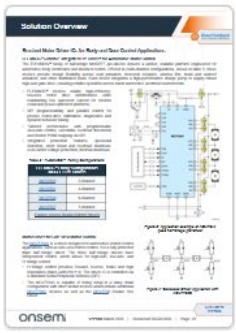

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Products for EV Auxiliary Systems

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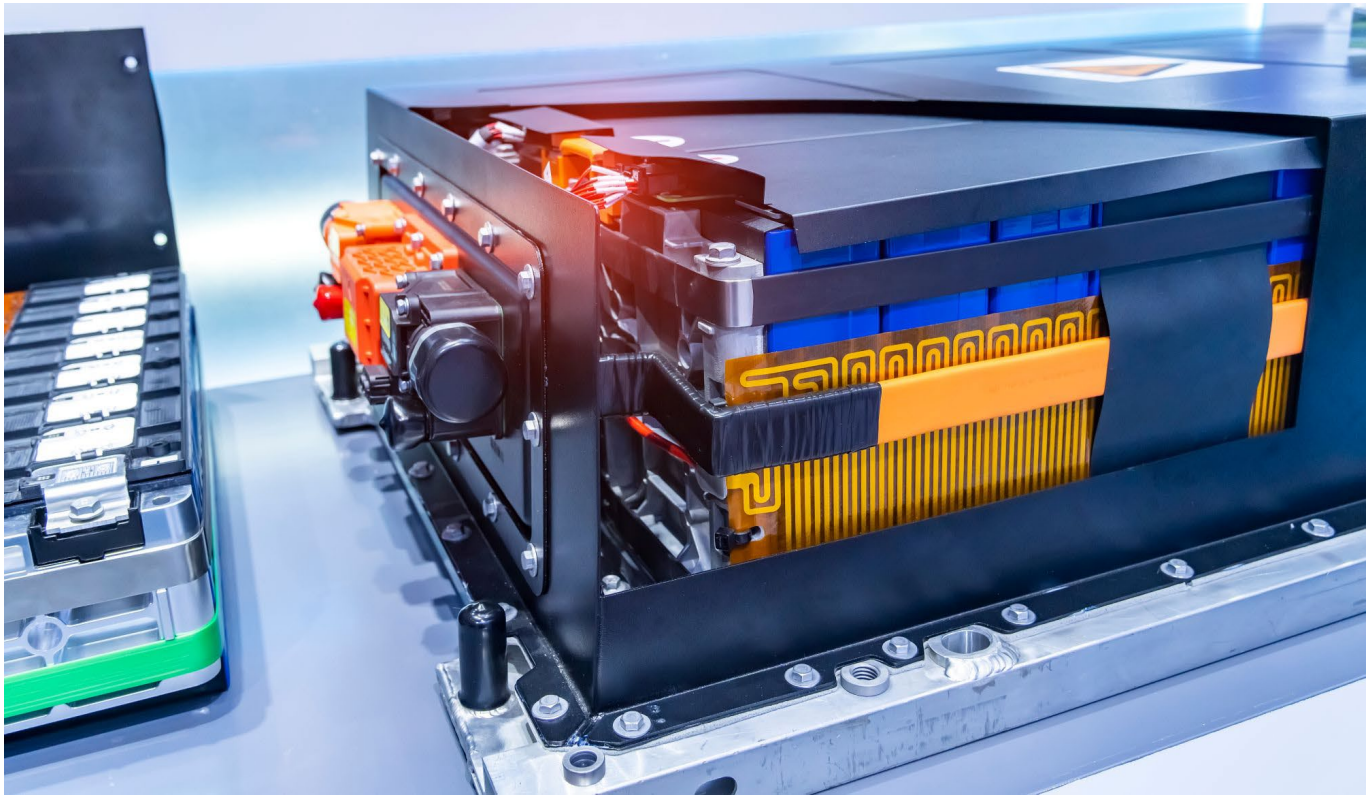
Semiconductor Product Categories in EV Auxiliary Systems

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

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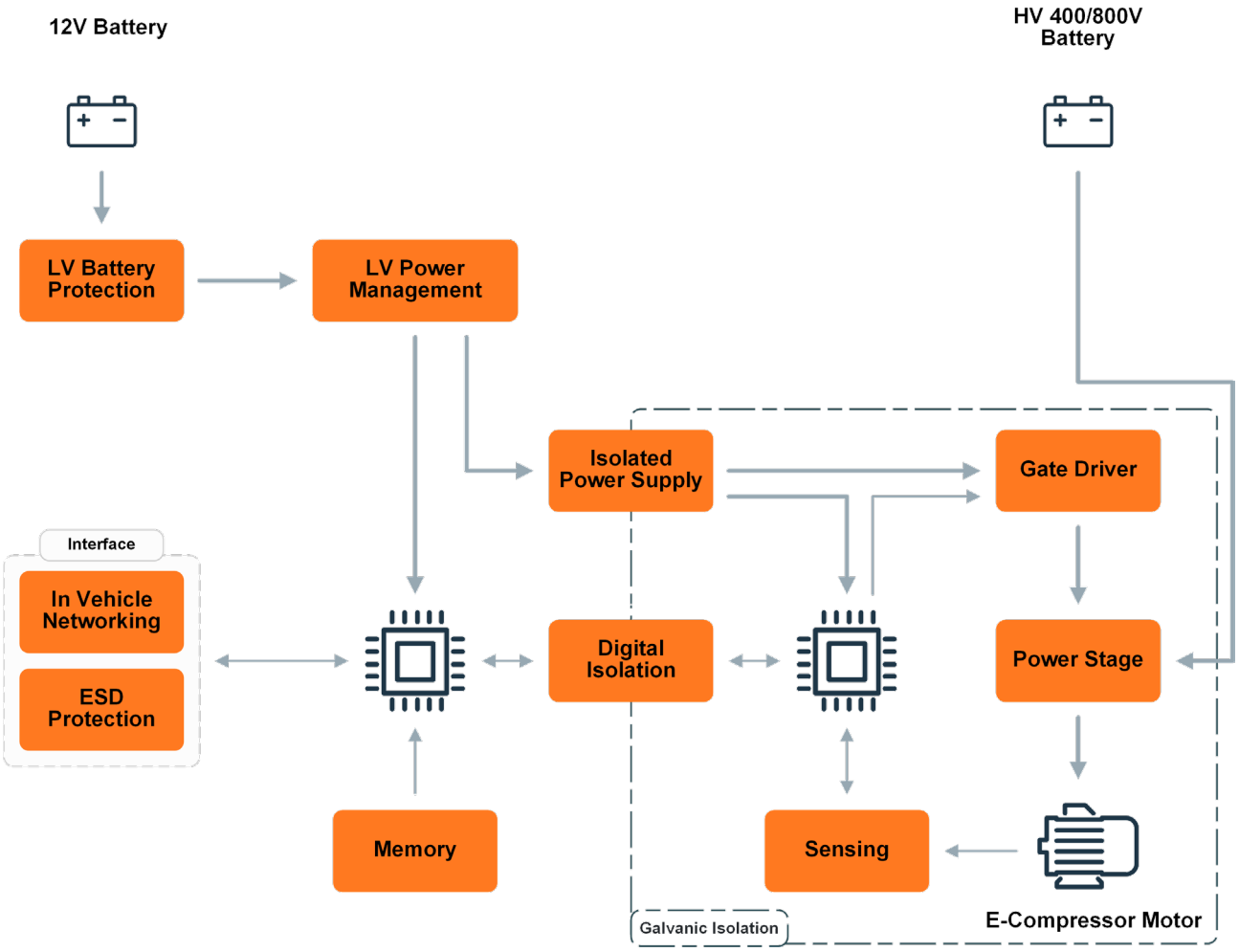
Block Diagram – HVAC E-compressor

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

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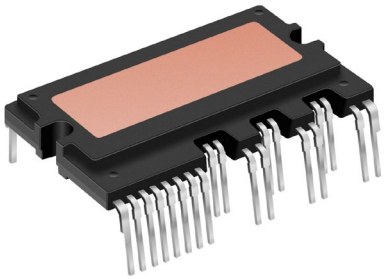
Automotive Smart Power Modules SPM® – Details of ASPM27 and ASPM34

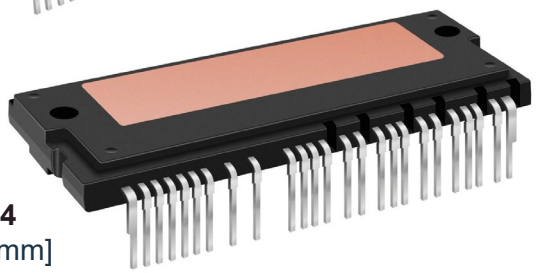
The ASPM27 series are optimized for 400 V EV battery systems, and they can deliver up to 60 A of three-phase output current. It features integrated high-voltage gate drivers IC (HVIC) with built-in protections such as under-voltage lockout (UVLO), over-current protection (OCP), and fault signaling. The 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



ASPM27
[45×27×6 mm]



ASPM34
[80×33×8 mm]

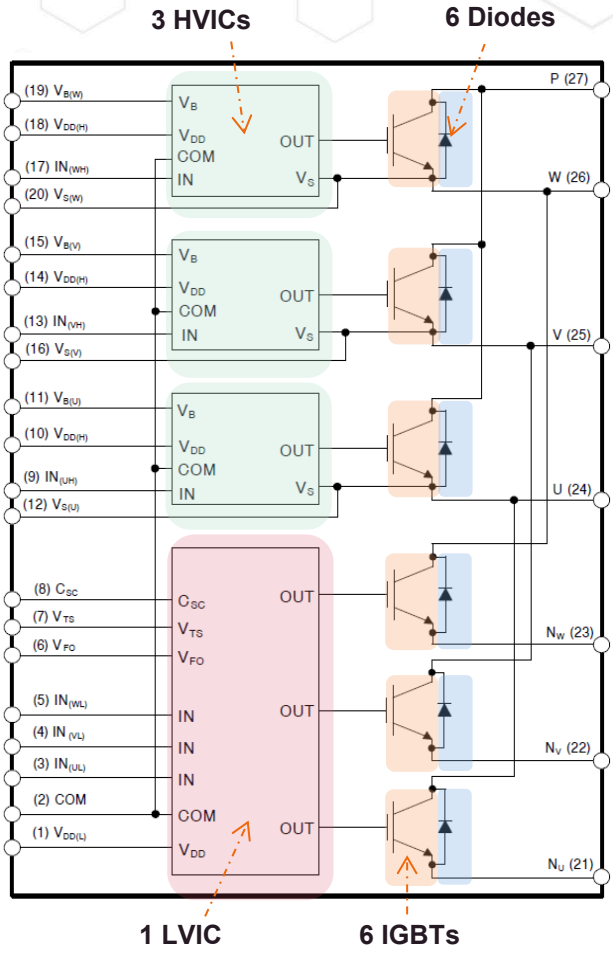


Figure 1: Smart Power Module architecture (ASPM27 – 27 DIP package)

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

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

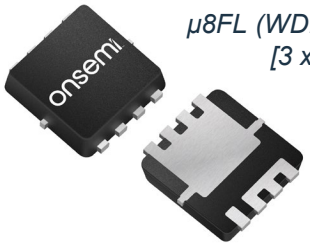
onsemi's 40 - 100 V automotive MOSFET portfolio delivers the switching efficiency, ruggedness and thermal performance required for the wide range of EV auxiliary loads powered from 12 V and 48 V networks. As vehicles transition toward multi-voltage and zonal architectures, auxiliary systems demand compact, 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.

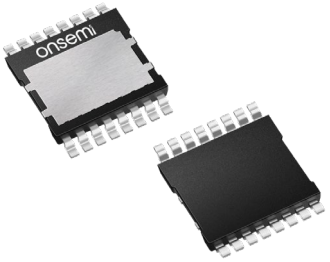
12 V Systems → Find Products

Find Products **← 48 V Systems**

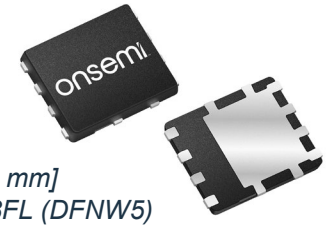
POWER22 (UDFN6)
[2 x 2 mm]

µ8FL (WDFNW8)
[3 x 3 mm]





TCPAK1012 Top-cool
[10 x 12 mm]



[5 x 6 mm]
SO–8FL (DFNW5)

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} x Q_{OSS}/Q_G/Q_{GD}) enhances performance and overall efficiency.
- Industry leading soft recovery body diode (Qrr, Trr) reduces ringing, overshoots and noise.

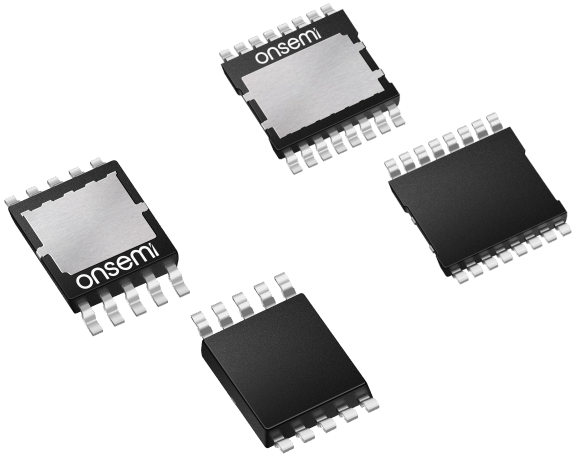
Top Cool MOSFET Power Packages (TCPAK)

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 mΩ .
- NVBYST0D6N08X 80V MOSFET in TCPAK1012, 0.64 mΩ .

Download Application Note



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

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.

EV Auxiliary Systems

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