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System Solution Guide - Preview

On Board Charger (OBC)

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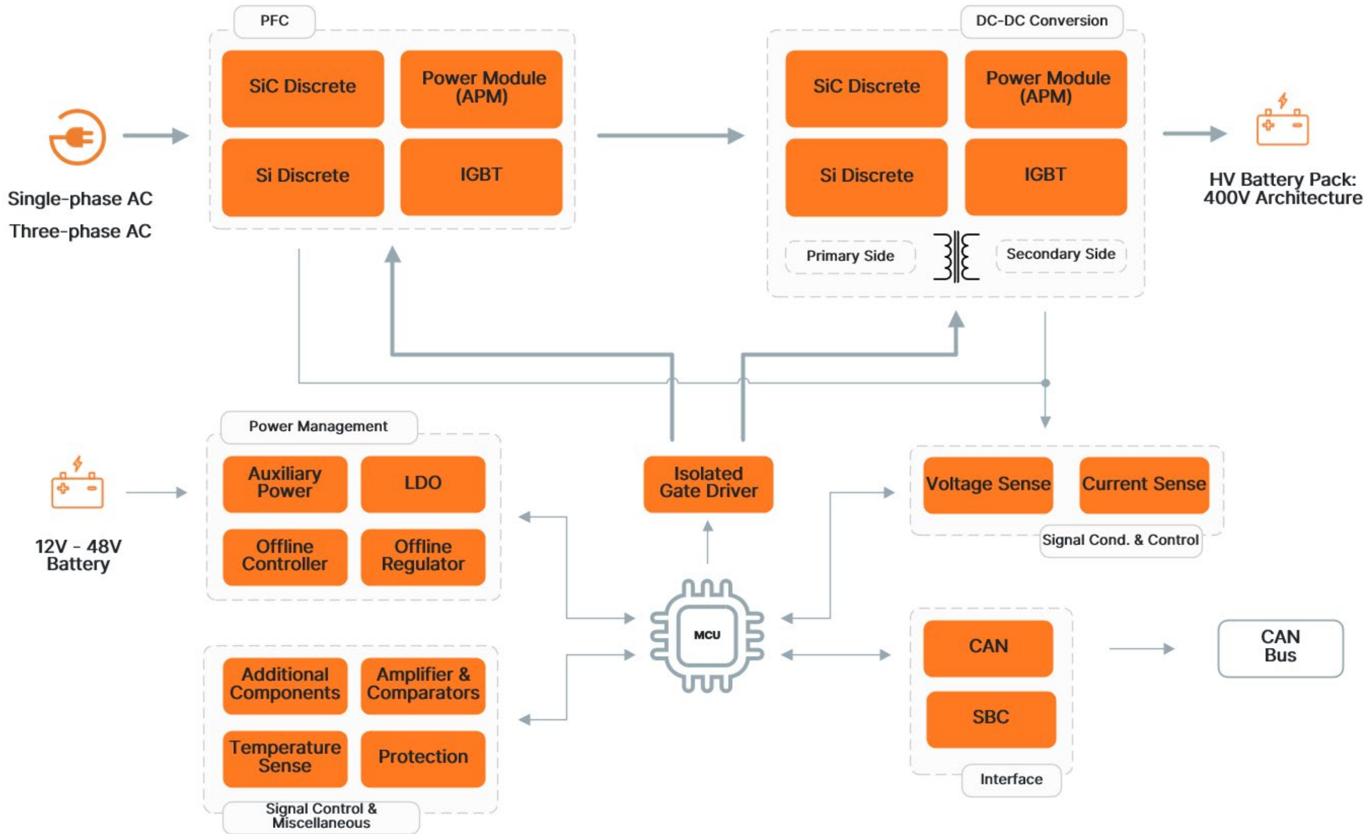
On Board Charger – Block Diagram

On Board Charger power stage (PFC, DC-DC) uses different power components depending on the voltage of the EV battery pack. The diagram below is for a 400V EV battery architecture, which requires power switching devices rated up to 650V. Voltage margin is necessary for the high currents and voltage transients.

Interactive block diagram on onsemi.com also includes a block diagram variant for 800V EV battery architecture, with power discrete devices and automotive power modules rated up to 1200V.

The block diagram also includes **isolated gate drivers**, **auxiliary power supplies** and various controllers. Signal measurement and conditioning can be achieved with **OpAmps**, **CSA**, and temperature sensing. **CAN and LIN transceivers** ensure fast and reliable communication within the automotive network. To support MCU operation, **ESD protection devices** with fast transient clamping capability and low capacitances protect the integrity of critical signals.



Use our Interactive Block Diagrams Tool

Open IBD Tool

EliteSiC MOSFETs for OBC

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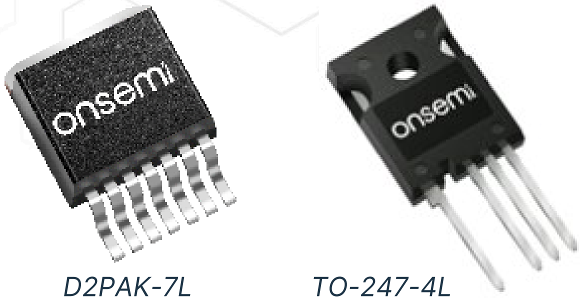
How EliteSiC MOSFETs Improve OBC Performance

As the trend in electric vehicle OBC design moves rapidly to higher power and higher switching frequency operation, the demand for SiC MOSFETs for this application is also growing. EliteSiC is the brand name of **onsemi's** SiC technology. Designers are adopting the Bridgeless PFC topology using the EliteSiC MOSFET due to its superior switching performance and small reverse recovery characteristics. The 1200V EliteSiC MOSFETs are extensively utilized in 800V battery automotive architecture.

- The planar design ensures no drift in $R_{DS(ON)}$, $V_{GS(TH)}$, or body diode voltage drop over their lifetime, and they can operate with negative gate drive voltages.
- The recommended on–state gate voltage for these MOSFETs is 18 V, but they can still work down to 15 V to remain compatible with gate drive circuitry designed for older generation SiC MOSFETs.



D2PAK-7L *TO-247-4L*

Explore SiC Discretes

Explore EliteSiC Power Modules

The onsemi M3S is the second generation of 1200V EliteSiC MOSFETs. It focuses on improving switching performance while reducing specific resistance R_{SP}. The M3S strikes an excellent balance between conduction and switching losses, making it ideal for hard–switching applications like PFC. Additionally, M3S low $R_{DS(ON)}$ values position them as strong contenders for soft–switching applications (such as LLC, CLLC, Phase Shifted Full Bridge), where switching losses are significantly reduced by virtue of the circuit topology, so that conduction losses become the dominant loss component. In-depth comparison of M1 and M3S SiC MOSFET generations is explored in the AND90204 Application Note. (Requires webpage login to open)

The M3S require less total gate charge $Q_{G(TOT)}$ than the 1st generation named M1, which significantly reduces the amount of sinking and sourcing current from gate drivers, as shown in Figure 4. M3S further reduces FOM (Figure of Merit) factor in $R_{DS(ON)}$ * $Q_{G(TOT)}$ by 44% compared to its older M1 counterpart.

Figure 5. shows the improved switching performance of M3S at the given conditions, with 40% lower E_{OFF}, 20–30% lower E_{ON}, and 34% lower total switching loss than M1. In high switching frequency applications, it will cancel any disadvantage of potentially higher $R_{DS(ON)}$.

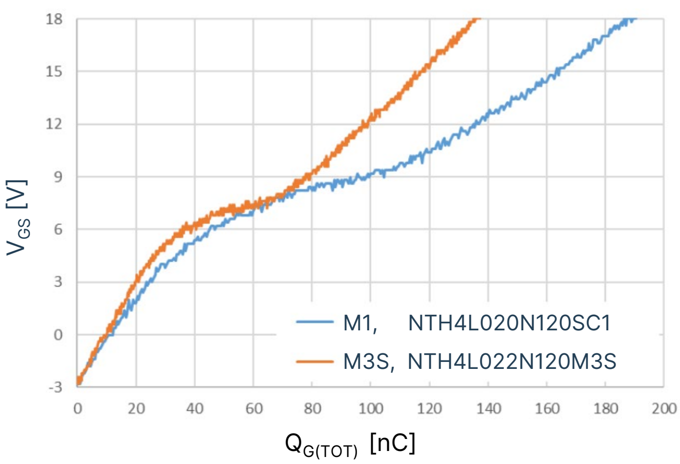


Figure 4: Total Gate Charge $Q_{G(TOT)}$ [nC] @ 800V / 40A, driven by constant 10mA

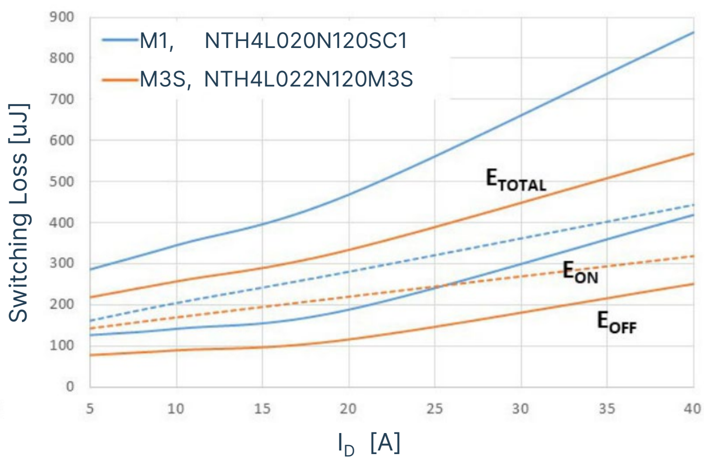


Figure 5: Switching Losses by drain current I_D [A] @ V_{DS} = 800V, V_{GS} = -3V / 18V, R_G = 4.7 mΩ

Isolated Gate Drivers for OBC

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Isolated Gate Drivers in HV Application with SiC MOSFETs

As SiC MOSFETs are increasingly used in automotive power electronics applications, it has become necessary to use special drivers. Isolated gate drivers are designed to meet the highest switching speeds and system size constraints required by SiC technologies, by providing reliable control of MOSFETs and also IGBTs. It is critical to optimize the gate drive voltage for speed to minimize switching losses and take full advantage of the power switching devices.

The challenge of SiC MOSFETs compared to Si MOSFETs is the control of the gate threshold voltage. SiC MOSFETs have a greater dependence on the gate voltage at the recommended gate drive voltage than Si devices. SiC MOSFETs require a higher positive gate drive voltage (+20 V) and, depending on the application, a negative OFF gate voltage in the range of −2 V to −6 V, as they exhibit a lower V_{GS} threshold that could lead to unwanted turn−on of the SiC MOSFET. Follow **onsemi's** guideline for using an isolated gate driver to efficiently drive SiC MOSFETs in **Application Note AND90063/D**.

onsemi has several isolated gate drivers available for SiC MOSFETs and Si Power MOSFETs, as well as IGBT gate drivers. Galvanic isolation component roadmap will further improve propagation delay and higher CMTI with new features. Broad portfolio of gate driver evaluation boards enables rapid prototyping.

NCV51561 and NCV51563 Isolated Dual Channel Gate Drivers

The NCV51561 and NCV51563 are isolated dual channel gate drivers with 4.5A/9A Source/Sink peak current. They are designed to drive Si and SiC power MOSFETs. They offer short and matched propagation delays. Try the NCV51561 Evaluation Board and test your isolated gate driver application.

- NCV51561 or NCV51563 can be used in any possible configurations of two low-side, two high-side switches or a half−bridge driver (Figure 7.) with programmable dead time
- Typical 36 ns propagation delay with 5ns max delay matching , Independent UVLO Protection
- Single or Dual Input Modes via ANB, 5 kV galvanic isolation allows peak voltage of up to 1500 (1850) V_{DC}
- CMTI ≥ 200 kV/µs , SOIC-16WB with 8mm creepage distance

Find Evaluation Board

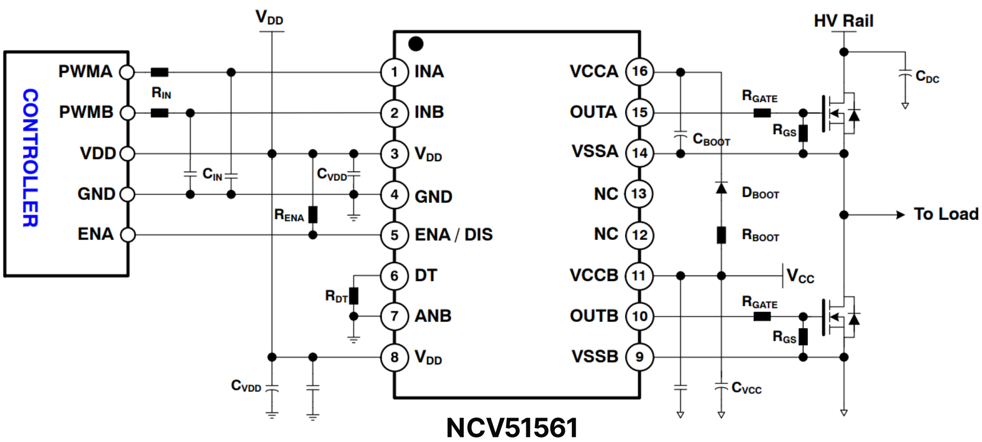
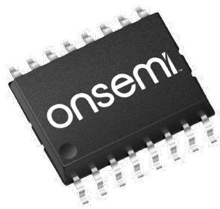
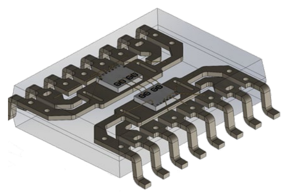


Figure 7: Typical Application Circuit with the NCV51561 or NCV51563.





Look inside the SOIC-16 package of the NCV51561.

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