SiC Traction Inverter Overview

Highlights

- E-mobility Power Blocks
- SiC benefits in Traction Inverter
- Full System Power Board SiC for Traction
SiC key applications in electric vehicles

**Traction Inverter**
- High power inverter stage to drive the *traction motor* of the vehicle
- Replace Si IGBTs and Diodes by **SiC MOSFETs** results in:
  - Higher efficiency
  - Smaller form factor
  - Less cooling efforts

**On Board Charger**
- **Charging the battery** of plug-in HEVs and EVs from the 1-phase or 3-phase power grid
- Different architectures and topologies in automotive require **supporting scalable solutions**
- Smaller form factor & weight
Main Inverter for HEV/EV

E-mobility: SiC Traction Inverter

- Usually 3-phase permanent magnet motors are used for traction
- Operating voltage from 48V to 800V
- Bi-directional
  - Feed the electric motor when driving the wheels
  - Stream energy back on HV Bus when breaking the vehicle
- Nominal power ranging from 10 kW (ICE assistance) to 200 kW (pure EV)

<table>
<thead>
<tr>
<th>Vbus</th>
<th>400V</th>
<th>700-800V</th>
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<tbody>
<tr>
<td>SiC MOSFET</td>
<td>650V / 750V</td>
<td>1200V</td>
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Si IGBT vs SiC MOSFET—Traction Inverter

- **IGBT + Diode**
  - 400V DC Bus
  - Vbus = 400V, 160kW peak, MI=0.5
  - SiC 2 to 4% higher efficiency

- **SiC Gen 3**
  - 750V ~ 3x smaller die area
  - Vbus = 750V, 210kW peak, MI=0.5
  - SiC 3.5 to 8% higher efficiency

- 1200V ~ 5x smaller die area
Power Loss Traction Inverter SiC vs IGBT

SiC Significant Lower Power Loss at all Loads

Overall energy losses comparison @ 10kHz vs working load

Typical Load at Driving Cycle
80% Lower Loss

Power Loss Traction Inverter
SiC vs IGBT

Power Loss Comparison

Pswitching
Pconduction

0 50 100 150 200 250 300 350 400 450

Power[W]

ADP86012W2 IGBT 1200V 1200V SiC IGBT 1200V 1200V SiC IGBT 1200V 1200V SiC IGBT 1200V

10% 25% 50% 100%

Typical Load: 80% Lower Loss
ACEPACK Drive Six-pack Module

Smaller Size & Lower Losses → More Power Achievable with SiC

- DC-link: 750Vdc
- PWM Strategy: Bipolar
- 10kHz
- Peak Power 10 sec
- MI = 1, Cos(phi) = 0.8
- $T_{\text{fluid}} = 65^\circ C$

1200V IGBT+Diode based

1200V Gen2

ACEPACK DRIVE
ADP86012W2
1200V Gen2

ACEPACK DRIVE
ADP450120W3
1200V Gen3

110kW (220kW peak)

110kW (220kW peak)

140kW (280kW peak)

180kW (360kW peak)
SiC Traction Inverter Eval Board

Highlights

- Compact High Power Motor Drive
- 400V and 700-800V bus
- Driving Board and Motor Control included
Power Module

ADP86012W2 – 1200V
ADP50075W2 – 750V

Power Board Block Diagram

Control Board

SPC58NN487
Motor Control FW Included

Driving Board

STGAP1AS / L95xx
Isolated Gate Drivers

ADPxxxxW2 + STEVAL-APD001K1
Power Inverter Traction Eval Board

KEY PRODUCTS

1. ADP86012W2 (1,200V 3.5 mOhm), ADP50075W2 (750V 2.0 mOhm): ACEPACK DRIVE SiC Modules
2. STGAP1AS or L95xx: isolated single gate drivers
3. A7986: Buck Boost switching regulator up to 3A
4. A6902: Buck switching regulator up to 1°
5. SPC58xx: 32 bit Automotive MCU
6. TVS and Diodes

Liquid Cooling Case Included
Thank you