Going the extra mile: HybridPACK™ Drive CoolSiC™

Mark Münzer, Vice President Innovation & Emerging Technologies
3 May 2021
Optimal choice of technology for EV traction inverters

HybridPACK™ Drive
CoolSiC™ MOSFET for rear axle

- Focus on Range: SiC
- Large battery: SiC
- Small battery: IGBT

HybridPACK™ Drive
IGBT for front axle

- Focus on cost: IGBT

Focus on:
- Longer range
- Compact size
- System cost
SiC reduces energy consumption in main inverter by 69%.

**Energy reduction 7.6%**

<table>
<thead>
<tr>
<th>SI 400V*</th>
<th>SIC 400V</th>
<th>SIC 800V</th>
</tr>
</thead>
<tbody>
<tr>
<td>WLTP consumption (Wh/km)</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Basic consumption</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: 'Effect of a SiC™ MOSFET in traction inverter of electric drive train', PCIM 2018
SiC Trench technology out-performs Planar demonstrating more protection vs. traditional Trench

- **SiC Planar**
  - ✓ Low complexity process
  - ✓ Good shielding of oxide possible

- **SiC Trench**
  - ✓ Low channel resistance
  - ✓ Shrink potential higher than in planar DMOS

- **Infineon Trench**
  - ✓ Low channel resistance
  - ✓ Shrink potential higher than in planar DMOS
  - ✓ Oxide corners shielded by folded double trench
  - ✓ Long experience in trench know-how

- ✓ Sophisticated process know-how needed

- ✗ Very low channel mobility
- ✗ Limited shrink options
- ✗ Protection of oxide corners needed
CoolSiC™ optimized performance and reliability

Instead of exploiting full potential of performance, IFX turns this budget into much higher reliability
Multiple planar vendors announced TRENCH roadmap 2022+

› Infineon has accumulated years of expertise in Trench tech already
› Infineon’s refined Trench offers higher reliability vs. other vendors
Main Inverter: scaling from Infineon Si to SiC
HP-Drive™ CoolSiC™ offers safe migration to shorten T2M

'Develop the best solution for your strategy based on industry's only complete CoolSiC™ power portfolio:

- Performance, cost, time to market, support, high volume capability @ Infineon Quality'

Customer's integration level per choice

* preliminary, non-bidding
Scalable
HybridPACK™ Drive
CoolSiC™ Solution

For the same footprint, SiC allows to scale the inverter to higher power
## Success story of HybridPACK™ Drive

<table>
<thead>
<tr>
<th>EDT2</th>
<th>25 years of Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>More than 1 Mio. pcs shipped</td>
</tr>
<tr>
<td></td>
<td>› 25 years of IGBT/Diode Know-how</td>
</tr>
<tr>
<td></td>
<td>› &gt; 25 successful customer relationships</td>
</tr>
<tr>
<td></td>
<td>› Ramp-up in &gt; 10 worldwide platforms in next 2 years</td>
</tr>
<tr>
<td></td>
<td>&gt;20 BEV platforms with HybridPACK™ Drive in production</td>
</tr>
<tr>
<td></td>
<td>&gt;20 platforms</td>
</tr>
<tr>
<td></td>
<td>HybridPACK™ Drive</td>
</tr>
</tbody>
</table>

### EDT2 Highlights:
- **XPeng:** P7
- **Nio:** ES8, ES6, EC6
- **Volkswagen:** ID.3 and MEB cars
- **Li Auto:** LiXiang One
- **Weltmeister:** EX5

- Infineon Power Technology Inside
- Infineon is partner in Volkswagen's strategic supplier network FAST
First automotive frame module in the market
Hyundai has chosen Infineon's CoolSiC™ products for their next generation EVs

General CoolSiC™ value contribution to customers

Higher mileage with the same battery capacity
› Trench based SiC devices increase power efficiency compared to alternative technologies

Easy scalability from IGBT to SiC-based inverters
› HybridPACK™ CoolSiC™ power modules and EiceDRIVER™ high-voltage drivers allow upgrade from IGBT to SiC in the same footprint

Additional value for Infineon's customers
› Unique automotive quality and reliability levels
› High-volume production track record of dedicated electro-mobility products
HybridPACK™ Drive CoolSiC™ MOSFET
1200 V SiC for EV Traction inverter scalable from Si counterpart

› B6 Full-bridge module
› Vbr=1200 V; Output power scalability with chip population
› Direct Cooled pin-fin base plate
› Hybrid-PACK™ Drive: Same package as IGBT B6 module

FS03MR12A6MA1B
1200 V / 400A (8 chips per switch)
RDS(ON) typ. 2.75 mΩ

FS05MR12A6MA1B
1200 V / 200A (4 chips per switch)
RDS(ON) typ. 5.5 mΩ

› Increasing battery utilization by 5-10%
› Higher power density for system size reductions
› Lower conduction losses in light load condition and lower switching losses compared to Si IGBTs

Source: Infineon internal assessment, Oct. 2020
CoolSiC™ EVKIT optimized for both 400 and 800 V

- Logic Board
  - AURIX™
- Gate Driver Board
  - EiceDRIVER™-E
- Power module
  - HybridPACK™ Drive
  - CoolSiC™ MOSFET
- Water Cooling System
- PCB connector
  - PressFIT

SiC

12 V Battery

HV Battery

Galvanic Isolation

Q3-2021
SiC technical support material available

Samples
Available

Data sheet
Available

App note
Available

IPOSIM
May 2021