Use Cases of SiC Technology in Industrial Applications

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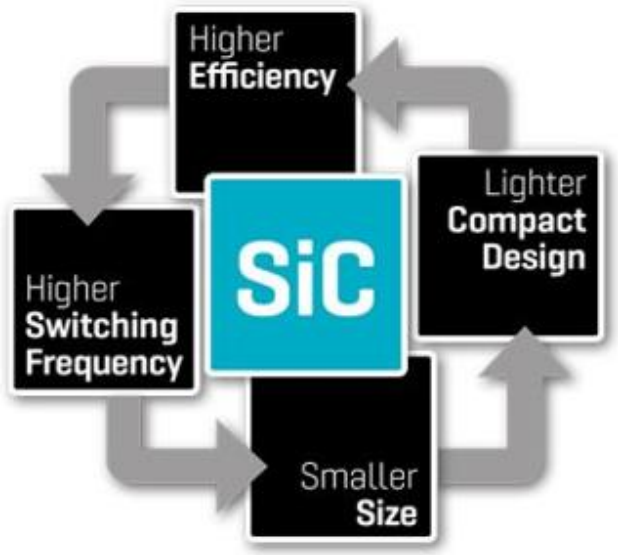
Bodo's Wide Bandgap Event 2024

Making WBG Designs Happen

SiC

Use cases of SiC technology in industrial applications



Where does increased SiC content offer superior cost-performance ratio?

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Heat pumps and HVAC

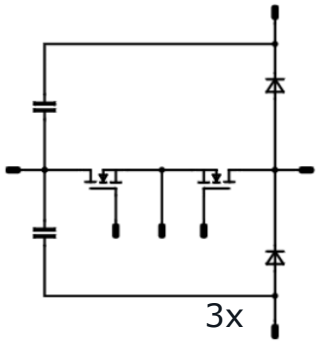
New regulations and standards drive heating and cooling systems to higher efficiency levels. SiC makes it easy to meet the requirements

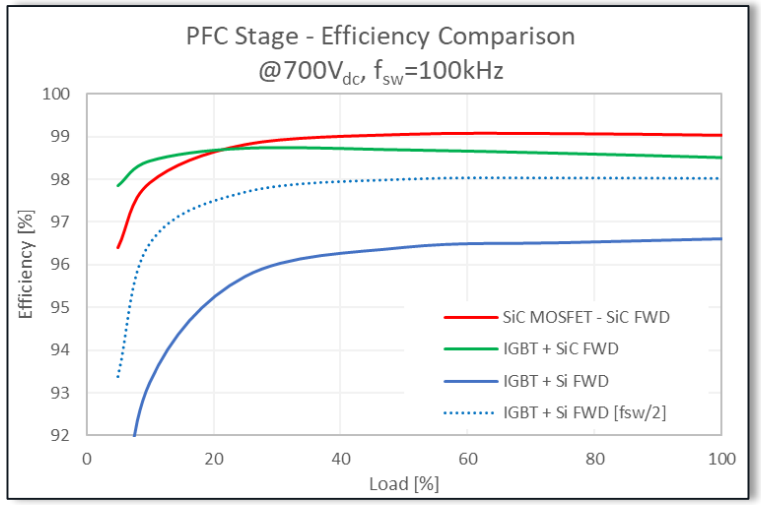
SiC in PFC converters

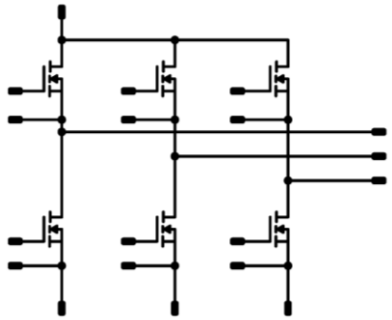
- More compact design
- More energy efficient
- Cost savings for system components
- Use of SiC diodes is crucial

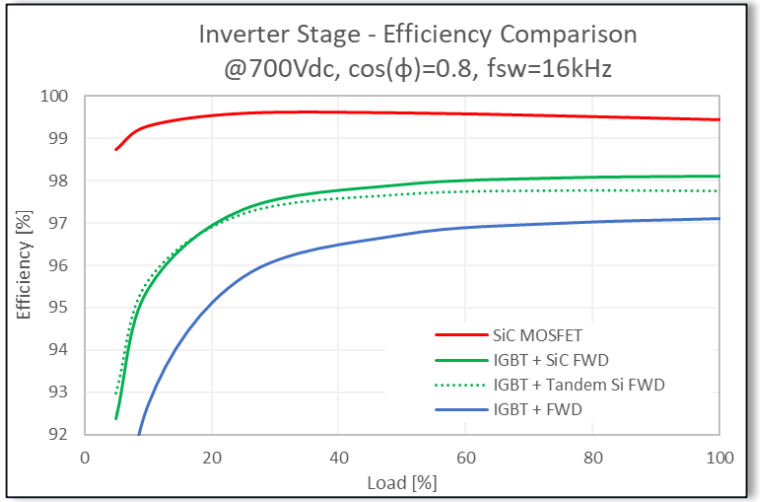
SiC in motor inverters

- High efficiency across entire load profile
- Increasing power density
- Reducing audible noise level
- More cost-effective solution for end users over the product lifetime









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EV chargers

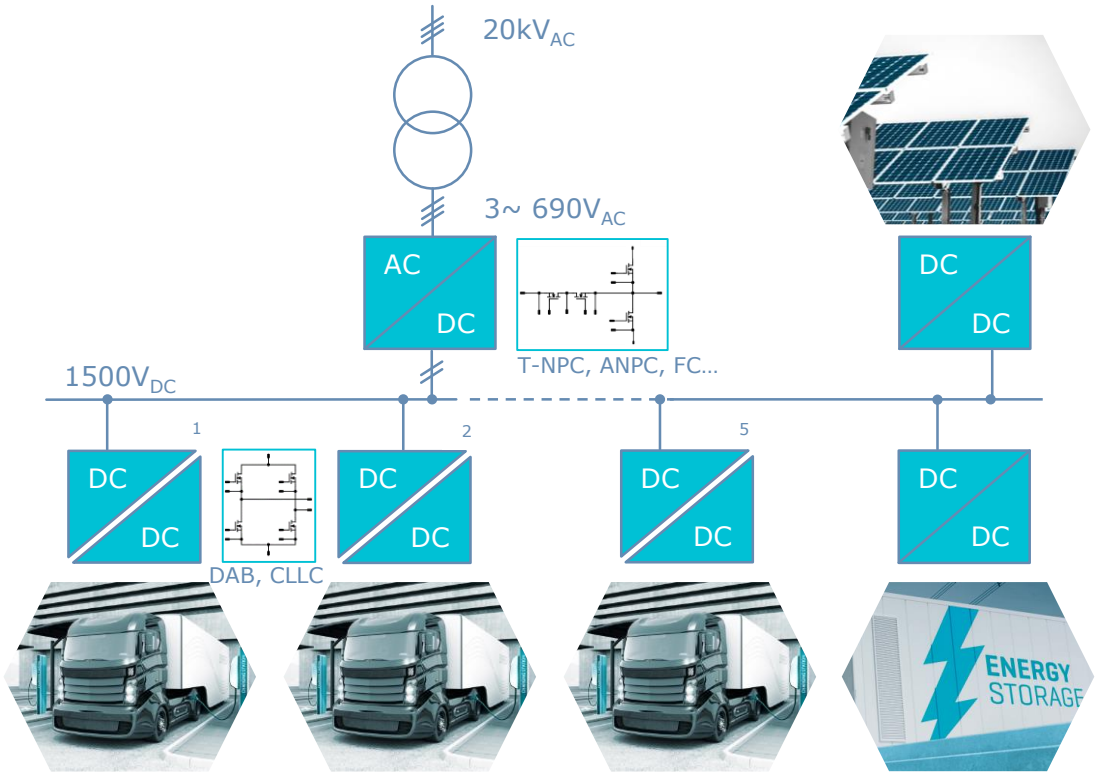
Increasing power density with SiC is the key factor towards to megawatt charging power

Today's megawatt charging systems (MCS)

- Megawatt charging systems mainly reuse infrastructure for fast charging systems CCS
- Stacking existing 1000Vdc subunits to higher power based on 650 V & 1200 V SiC devices

NEXT generation MCS

- DC-coupled system at 1500Vdc, simplifying integration of renewables & ESS
- Centralized PFC stage, or SST connected directly to MV grid and modular DC/DC stage
- More focus is needed on system reliability
- Needs of wide range SiC components from 1.2 kV to 2.x kV SiC



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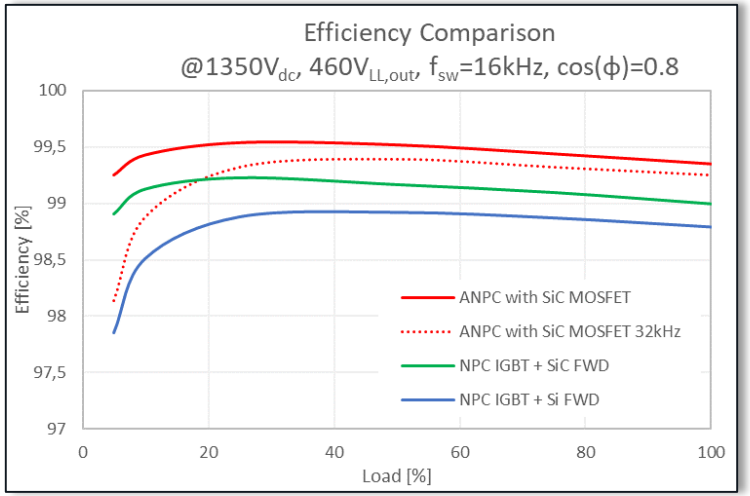
Solar and ESS systems

SiC is well established in commercial, utility-scale string and central PV-inverters. However, SiC content in ESS is growing faster for higher efficiency needs

PV inverter and ESS with SiC content

- Hybrid solutions (IGBTs with SiC FWD) are already popular choice in PV inverter topologies
- SiC MOSFETs offer increased power density and higher efficiency, crucial for bi-directional power conversion systems (PCS)
- High switching frequencies and reducing inductor size and weight
- Higher overload capability required for PCS
- For 1500V_{dc} systems ANPC inner modulation with SiC MOSFETs are popular solution offering reduced number of SiC components and achieving optimal cost-performance ratio



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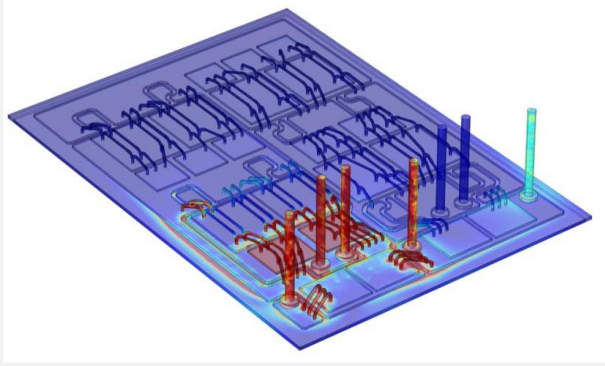
Challenges in SiC high-power module design

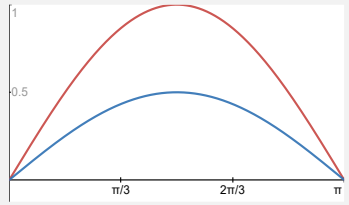
Switching hundreds of Amperes is only possible with chip paralleling

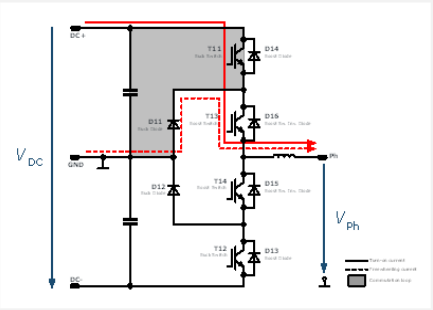
- **Low inductive commutation and gate loops**
  - Low overshoot
  - Less oscillation
  - Lower R_g can be applied → lower switching losses
- **Symmetric commutation and gate loops**
  - Matching stray inductances
  - Balanced current sharing and dynamic losses
- **Don't underestimate thermal design!**
  - Homogeneous R_{th} of individual MOSFETs
  - Symmetric T_j increase → take care of $V_{GS,th}$

Design verification with 3D-FEM simulation



$$L_{com,\,loop} = 3.58\,nH$$





VINCOTECH offers >10 years expertise in SiC power module design!

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Choose best-fit SiC components

MULTIPLE SOURCES, MORE CHOICES

- Chip-independent power module manufacturer
- Access to the world's leading SiC makers planar and trench technologies
- Wide range of SiC components from 650V to 2.3kV
- Greatest freedom of choice and design flexibility tailored to customer's needs
- Reliable supply chain

Vincotech´s digital product samples based on pre-characterized switching pairs to shorter iterations and design time

VINcoSIM + plecs

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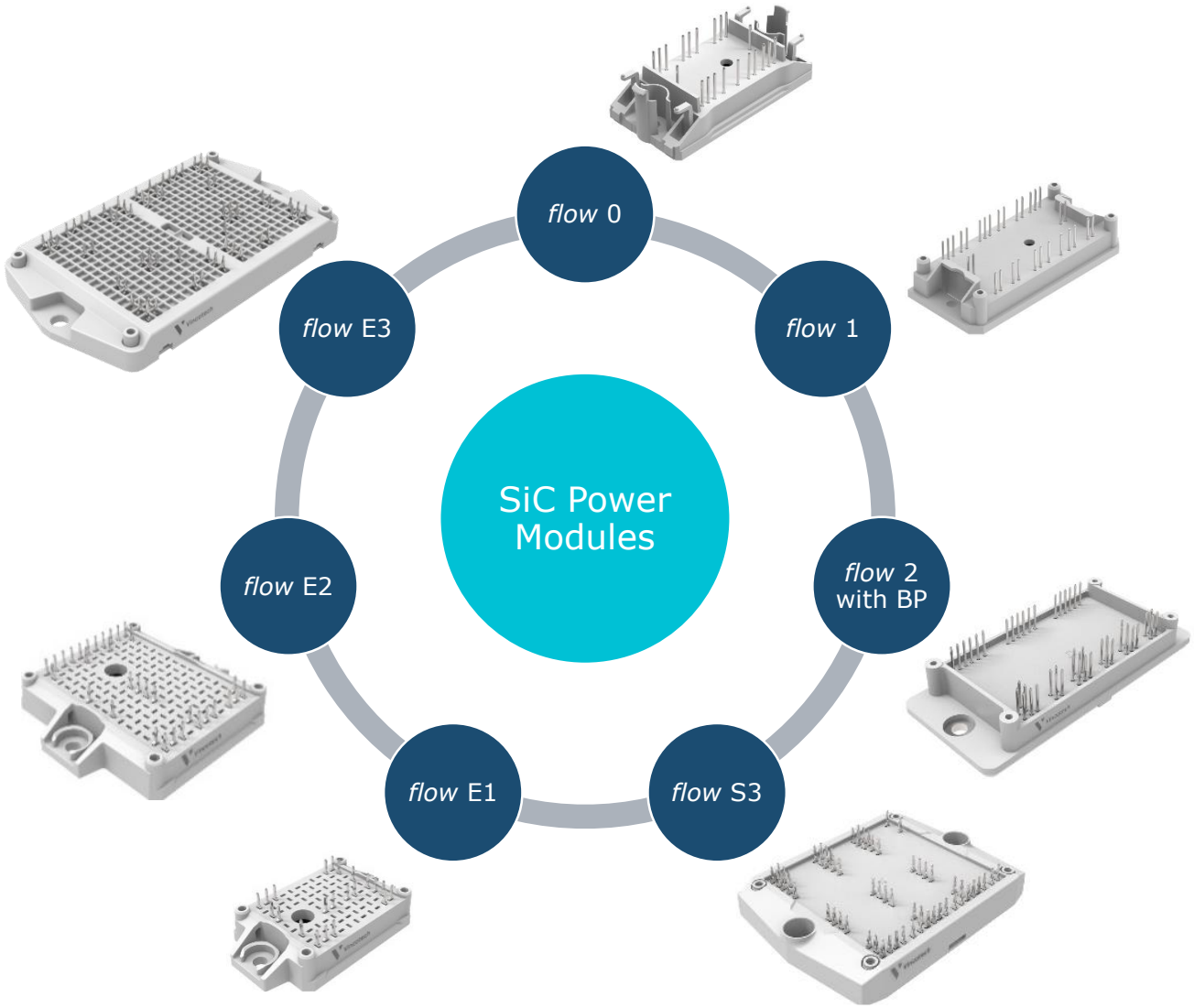
Housing portfolio for SiC technology



KEY BENEFITS

- **Higher switching frequency** in low inductive housings
- **Multi-sourced SiC-components** for more freedom of choice and lower risk in the supply chain
- **Improved power cycling capability** with advanced die attach technology
- **Superior thermal performance** with AlN, or Si_3N_4 and homogenous R_{th} distribution
- **Integrated DC capacitors** to mitigate voltage overshoot
- **Press-fit pins and pre-applied TIM** to reduce production cost

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EMPOWERING **YOUR IDEAS**

Thank you!