Modernizing Industrial Low Voltage Motor Drives with Silicon Carbide

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THREE-PHASE MOTOR DRIVE SYSTEM (25 KW)



Comparison Si-IGBT based system vs Silicon Carbide based system

- Efficiency → Energy Savings
- Effect of increased switching frequency
 - System size optimization
 - System cost optimization

SIC REMAINS COOLER THAN SI EVEN WITH SMALLER HEAT SINKS 77% SMALLER HEAT-SINK (VOLUMETRICALLY) FOR SIC INVERTER



25 KW INVERTER, <u>FSW = 8 KHZ</u>, 77% SMALLER HEAT-SINK FOR SIC INVERTER: 0.31L (1.6°C/W) VS 1.37L (0.73°C/W) DIMENSIONS: WS FM3 → 34MM X 63MM, IGBT MODULE → 57MM X 63MM

UP TO 50% LESS LOSSES IN AN OPTIMIZED 22KW AFE WITH SILICON CARBIDE

Silicon IGBT Design

• IGBT 20 kHz

- Power density 3.5 kW/L
- Peak efficiency 97.2%





AC Source

AC-DC

Wolfspeed Full SiC Design

- SIC MOSFET 45 kHz
- Power density of >4.6 kW/L
- Peak efficiencies of 98.5%



SILICON CARBIDE ENABLES COMPACT DRIVES

3-phase supply, 25 kW system, 8 kHz inverter frequency (reduced sic inverter heat-sink)



Upgrading the PFC

Upgrading the inverter

= Full Silicon Carbide solution

- **HOW** Replace IGBT based AFE with Silicon Carbide MOSFET
- Replace IGBTs with Silicon Carbide MOSFETs
 - Reduced SiC Heat Sink by 77%

- Most popular upgrade to implement
- 1.3 % efficiency improvement over silicon boost PFC
 - Losses reduced by 325 W

WHY

- **1.1% efficiency improvement** over IGBTs
- Losses reduced by 275 W
- Similar junction temperature as IGBT with 77% bigger heat sink

• Simple drop-in replacements

- Up to 600 W* reduction in losses
- 2.4%* overall efficiency improvement

* Higher ambient temperatures would lead to further differences.

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25 KW SILICON CARBIDE SOLUTION ENERGY SAVINGS (8 KHZ INVERTER)

Payback rate scenario:

- You replace competitive 1200 V silicon power devices in your unit with Wolfspeed 1200 V silicon carbide devices. This replacement is more expensive up front.
- You use your unit for 15 years, saving a total of 23,173 kWh / 7,183 Euros

Total cost of ownership for moving to silicon carbide:

Rated Power	25,000 W
Expected Efficiency Improvement	2.4%
Power Savings	605 W
Annual Operation	8200 Hours
Average Load Condition	Multiple
kWh/year usage	64,370 kWh
kWh/year savings	1545 kWh
Electricity cost*	0.31 Euro/kWh
Annual Operating Cost*	19,954 Euro
Annual Savings*	479 Euro

*Electricity cost = Germany's rate as of December 2023.

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SIC ENABLES SUPERIOR PERFORMANCE EVEN AT HIGHER SWITCHING FREQUENCIES



IGBTs unable to reach 15 kVA

25 KW INVERTER, <u>FSW = 16 KHZ</u>, 41% REDUCED SIC MOSFET HEAT SINK : 0.80L (0.99 °C/W) VS 1.37L (0.73 °C/W)

WOLFSPEED SILICON CARBIDE ENABLES NEXT-GENERATION INDUSTRIAL EMBEDDED MOTOR DRIVES

Up to 2.6% overall efficiency improvement in 25 kW system

Improved power density with system cost and size optimization

Beyond 20 kHz reduced audible noise

Enhance motor performance with faster rotation speeds and precise control





We harness the power of Silicon Carbide to change the world for the better

