Utilization of GaN in Industrial Power Module Packages

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Bodo's Wide Bandgap Event 2024

Making WBG Designs Happen

GaN

Why GaN for future designs?

PERFORMANCE

- High switching frequency
- Reduced heat loss and higher efficiency
- High power density

COSTS

- Competitive in 650V class
- Lower substrate costs for GaN-on-Si
- Lower energy consumption compared to SiC
- Scalability to larger wafer diameters

SUPPLY CHAIN

- GaN-on-Si leverages installed Silicon substrate capacity
- Multiple players available on the market

GaN on today's market

Low-power consumer applications

State-of-the-art solution

Industrial solutions

Suitable power module packages missing

Enablers of GaN for high-power applications

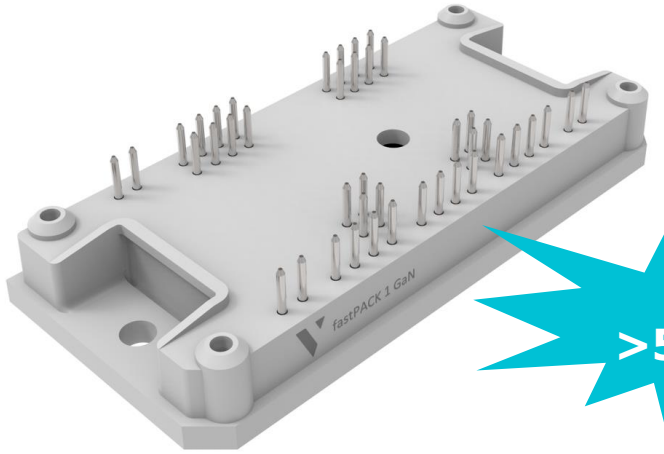
fastPack 1 GaN 2-in-1: H-bridge *10mΩ*, or Half-bridge *5mΩ*

Vincotech offers industry standard package for GaN technology and takes WBG to the next level.

Features:

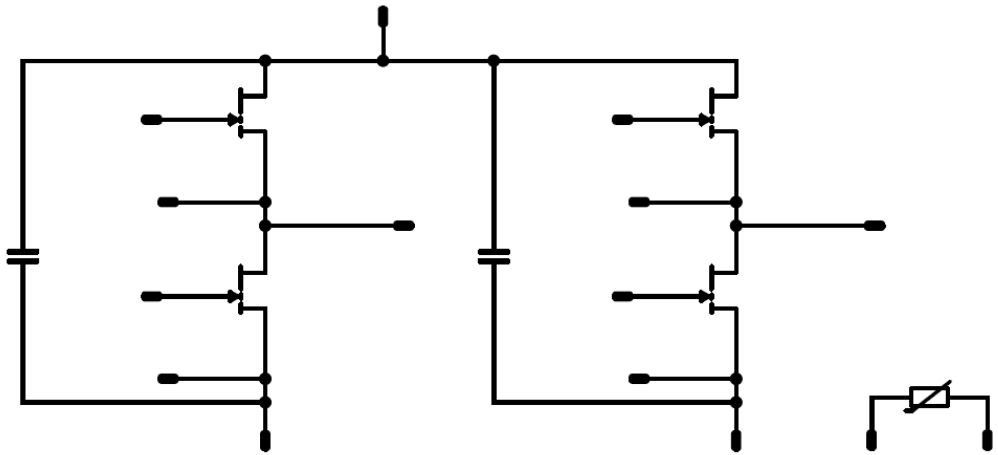
- 2-in-1 topology: H-Bridge, or Half-bridge module based on E-mode GaN HEMTs
- Utilizing Vincotech's standard process for soldering and bonding
- Suitable for use of external gate drive
- Integrated snubber capacitors
- Low loop inductances

Target applications:



f_{sw} >500kHz

fastPack 1 GaN in flow 1 housing

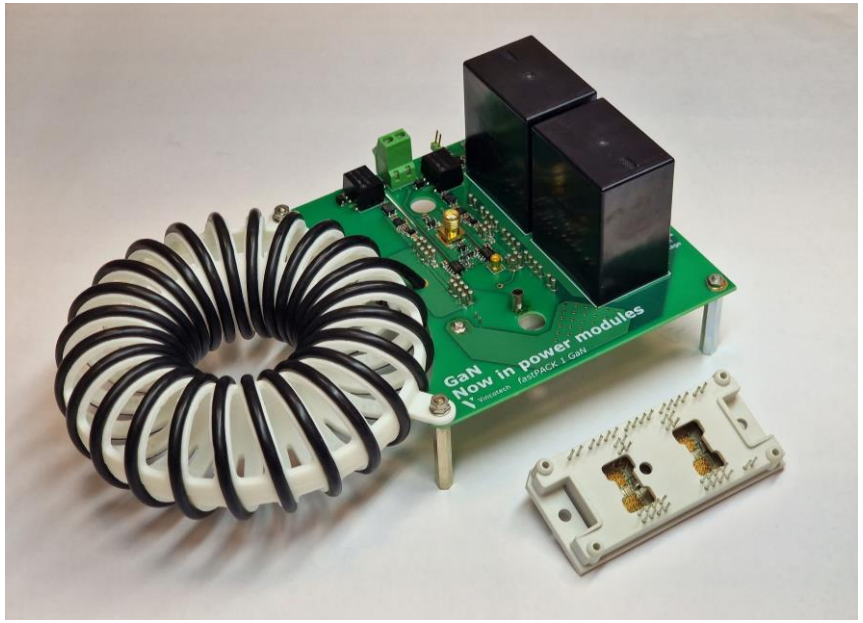


H-bridge with snubber capacitors and NTC

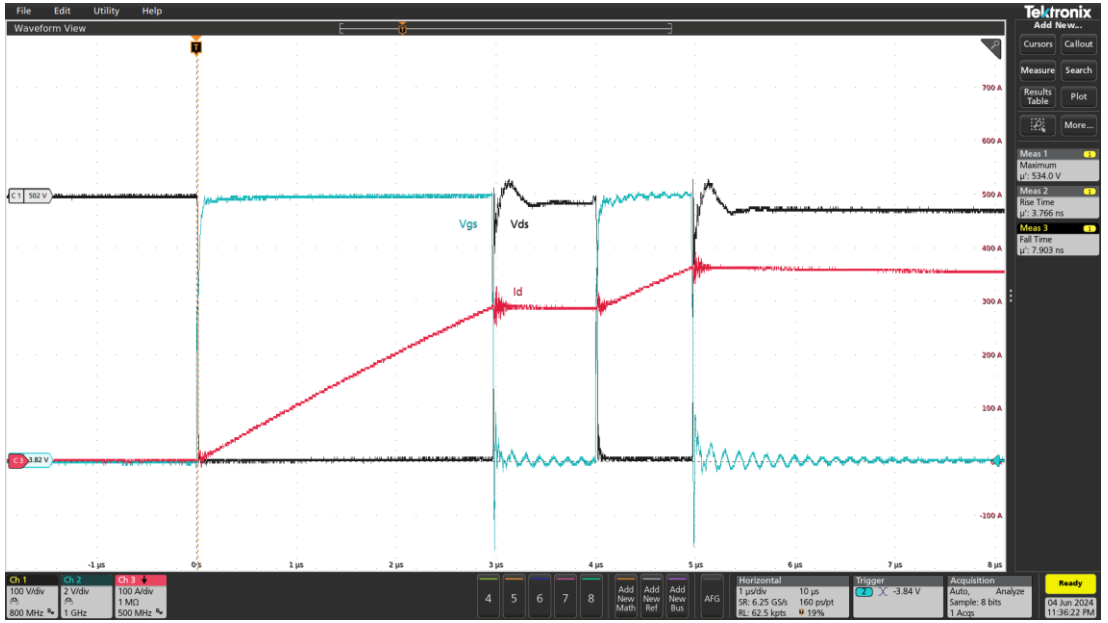
Can it really work with an external gate drive?

Yes! *fastPack 1 GaN* power module works with external gate drive on PCB

- Capable of reaching high dv/dt slew rates over 150V/ns
- Provides design flexibility
- Enables control over the voltage overshoots and EMI by adjusting dv/dt and di/dt slew rates



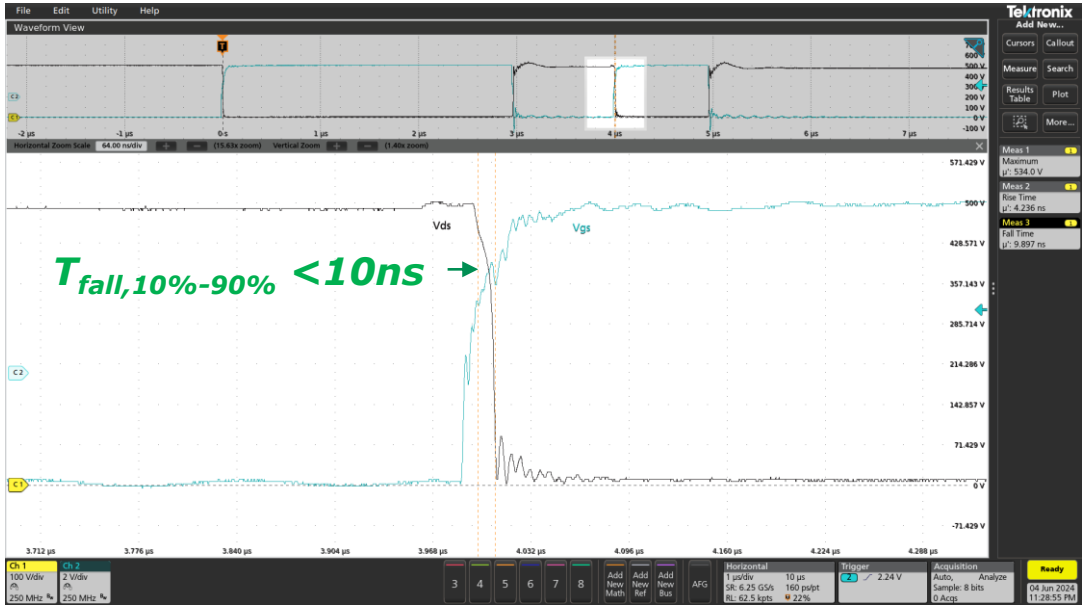
GaN double-pulse demonstrator board



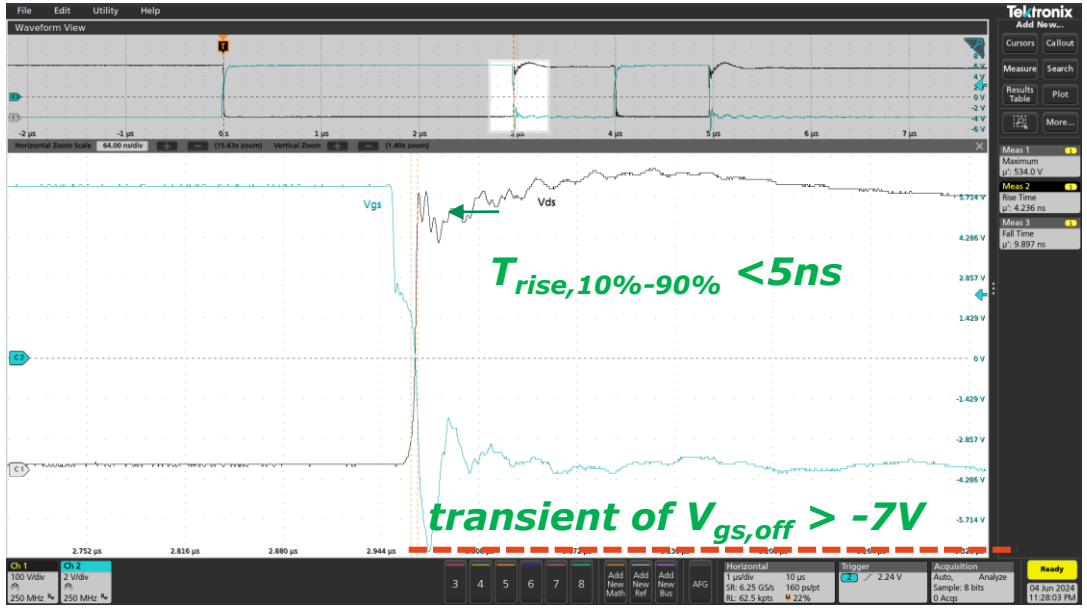
Red shows the load current measured by Rogowski coil

Double-Pulse Measurements with GaN demonstrator board

- The effect of stray inductances in the power loop is eliminated by integrated snubber capacitors
- The Kelvin connection to the source excludes the common source inductance from the gate drive loop



No voltage overshoot at 300A with integrated capacitors

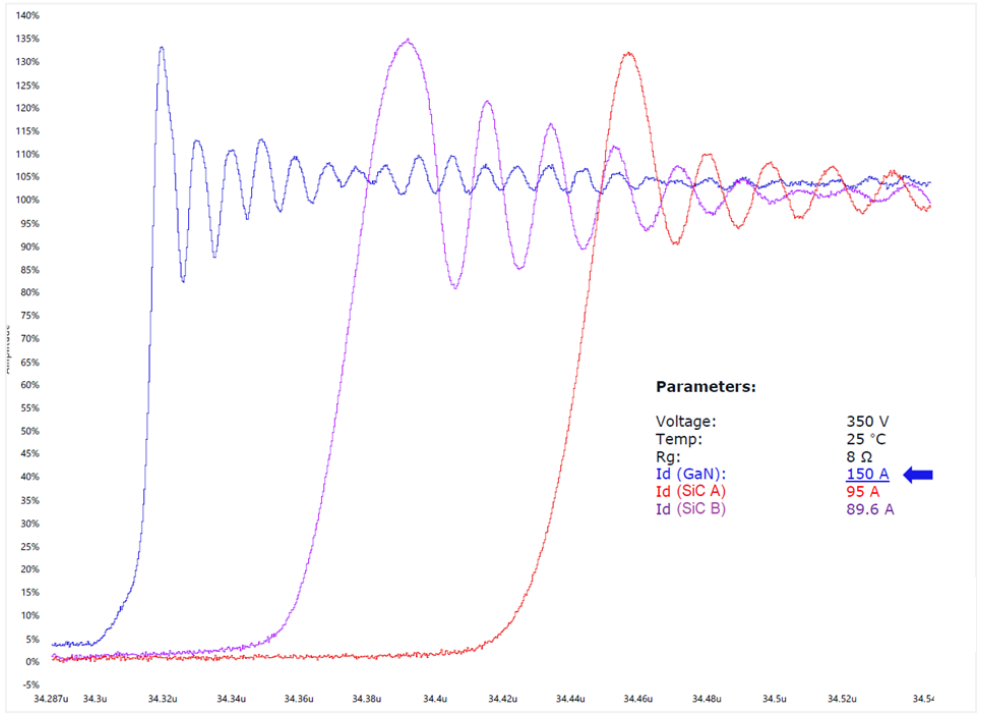


Safe margin to the absolute maximum rating of transient negative gate voltage

Benchmark GaN vs. SiC

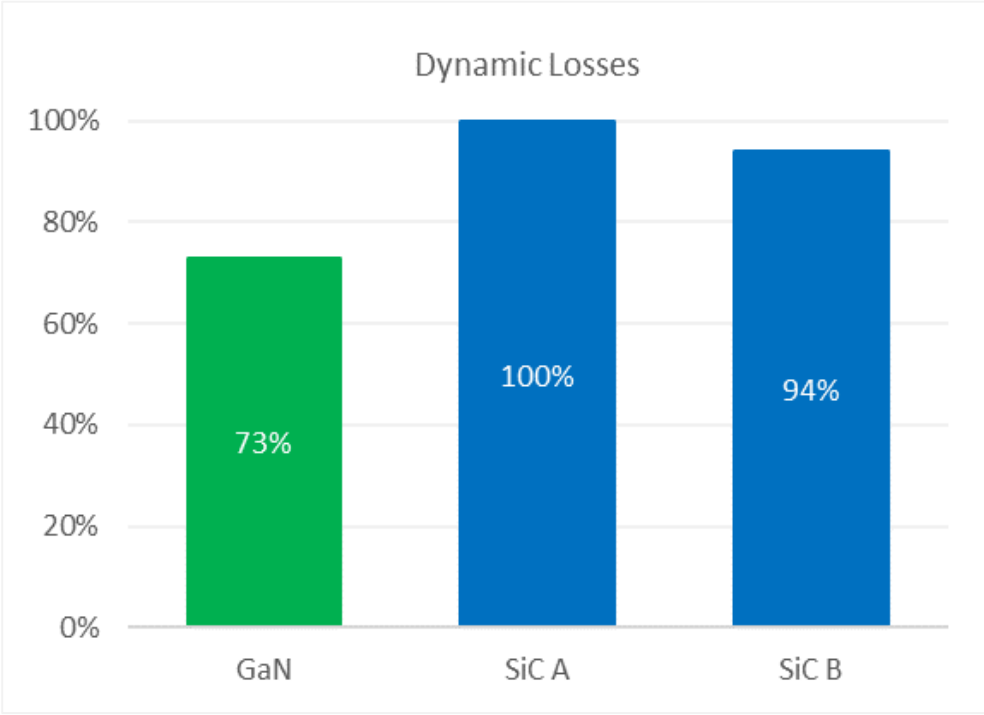
Comparison of voltage overshoots (without snubber capacitors) and dynamic losses

@Tj=25°C; Vdc=350V, same Rg



GaN can switch 50% higher current with same voltage overshoot

@Tj=25°C; Vdc=350V, Id=100A, same Rg



GaN shows > 20% lower dynamic losses

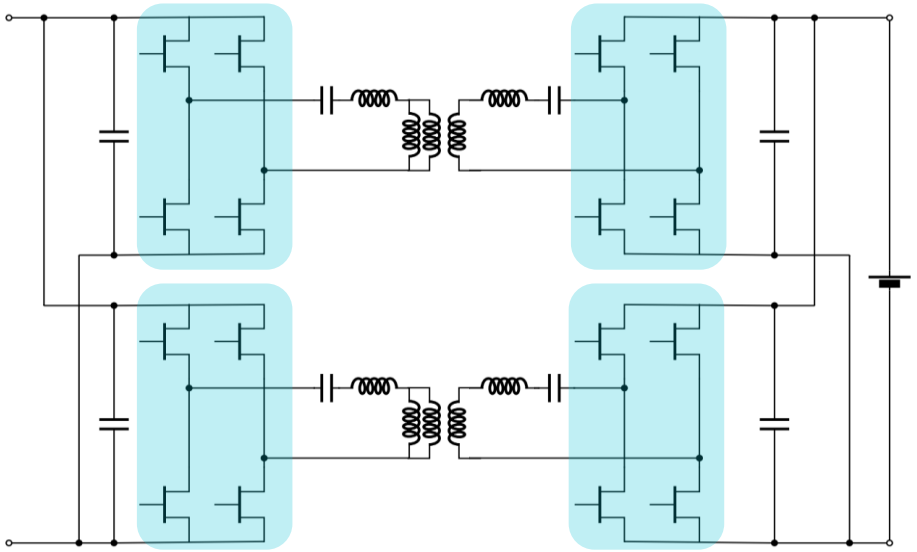
Target applications of *fastPack 1 GaN*

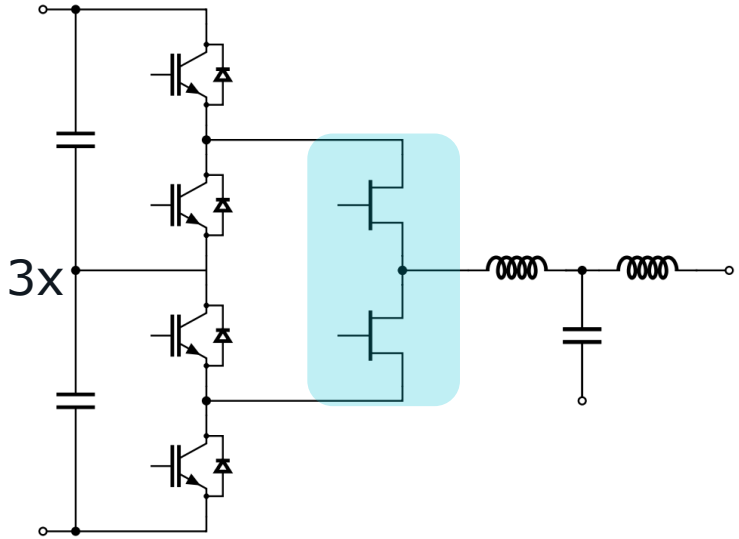
10mΩ H-bridge for fast DC-chargers

- 400Vdc, or 800Vdc charging with cascaded GaN H-bridges
- High switching frequency above 500kHz
- Fastest turn-off time and zero Qrr

5mΩ half-bridge for PV-string inverters

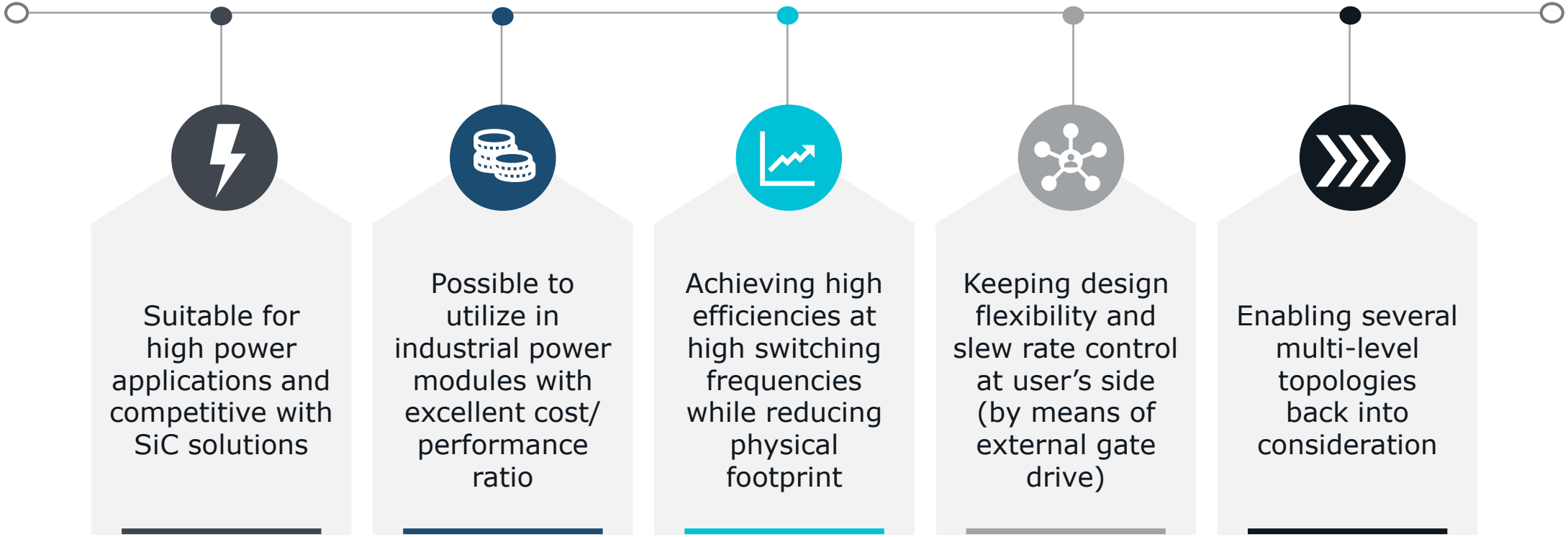
- 3L-ANPC with GaN for inner modulation
- Up to 75kW, switching at 100kHz
- High efficiency > 99%





Key takeaways

GaN in power modules



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Thank you!