

D³GaN - breaking the boundaries of EV inverter efficiency

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**Bodo's
Wide Bandgap
Event 2024**

Making WBG Designs Happen

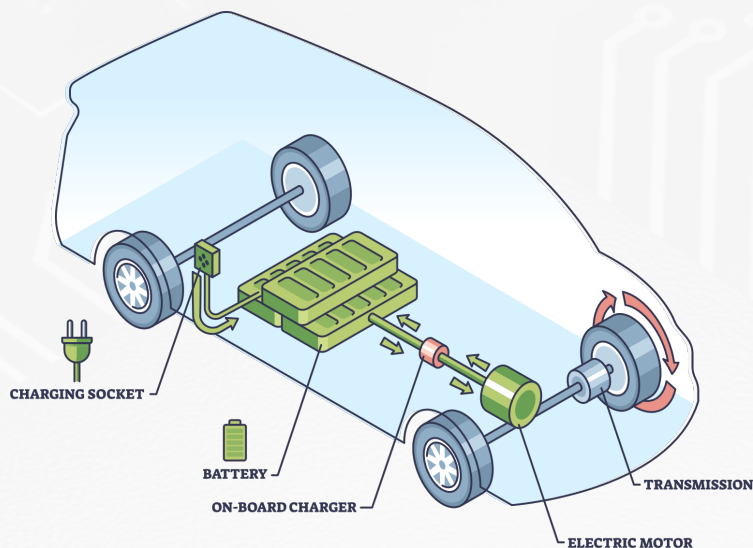
GaN

VisIC D³GaN

Traction Inverters with SiC Performance @ Si Costs

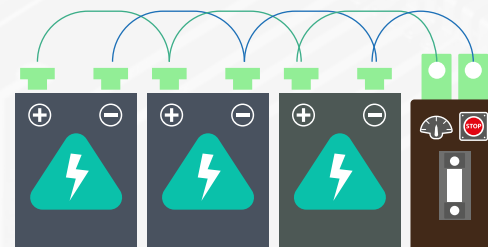
lower vehicle cost, longer driving distances,
better energy-efficiency





GaN: 10% smaller,
up to \$1,000 less

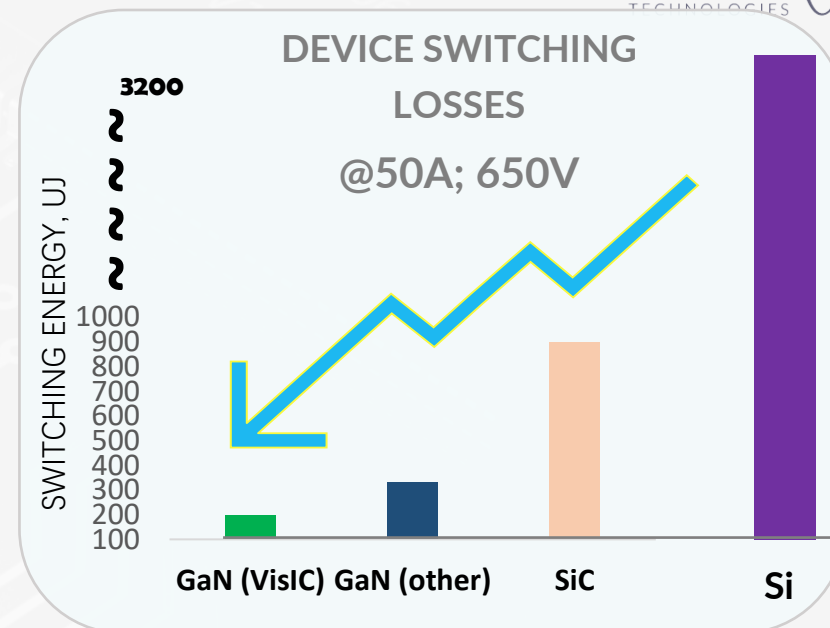
Smaller Battery



Inverter

High efficiency

High efficiency



GaN: up to 20% longer,
>\$1,000 value

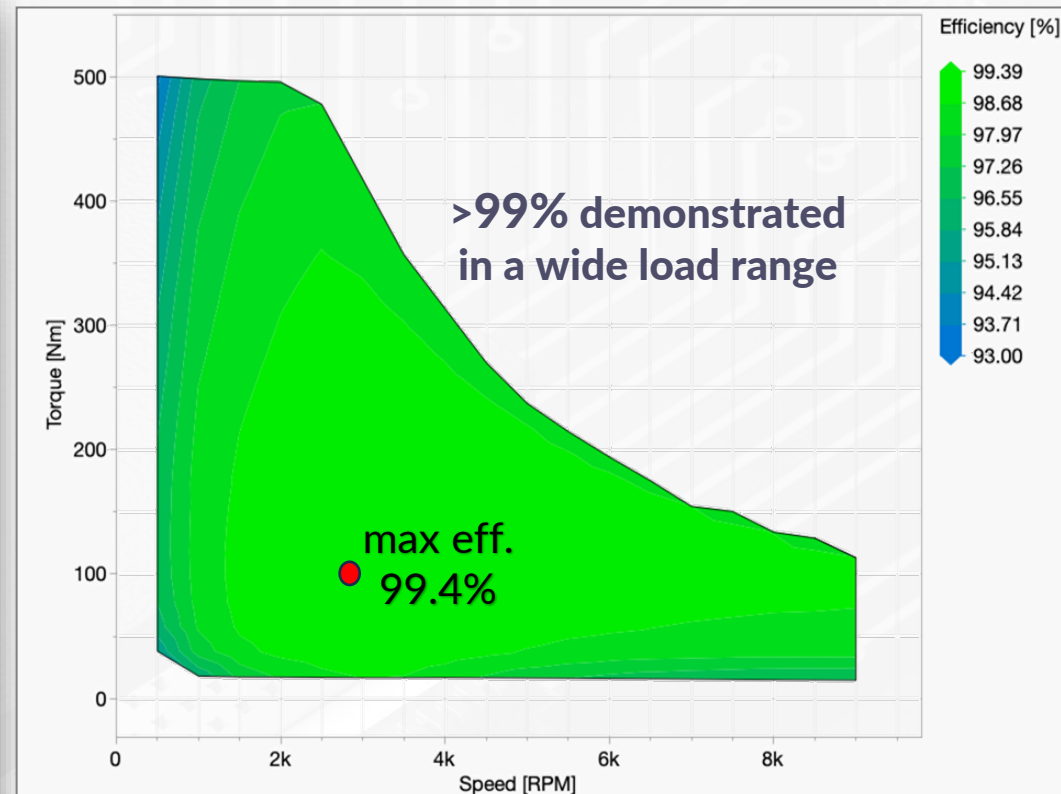
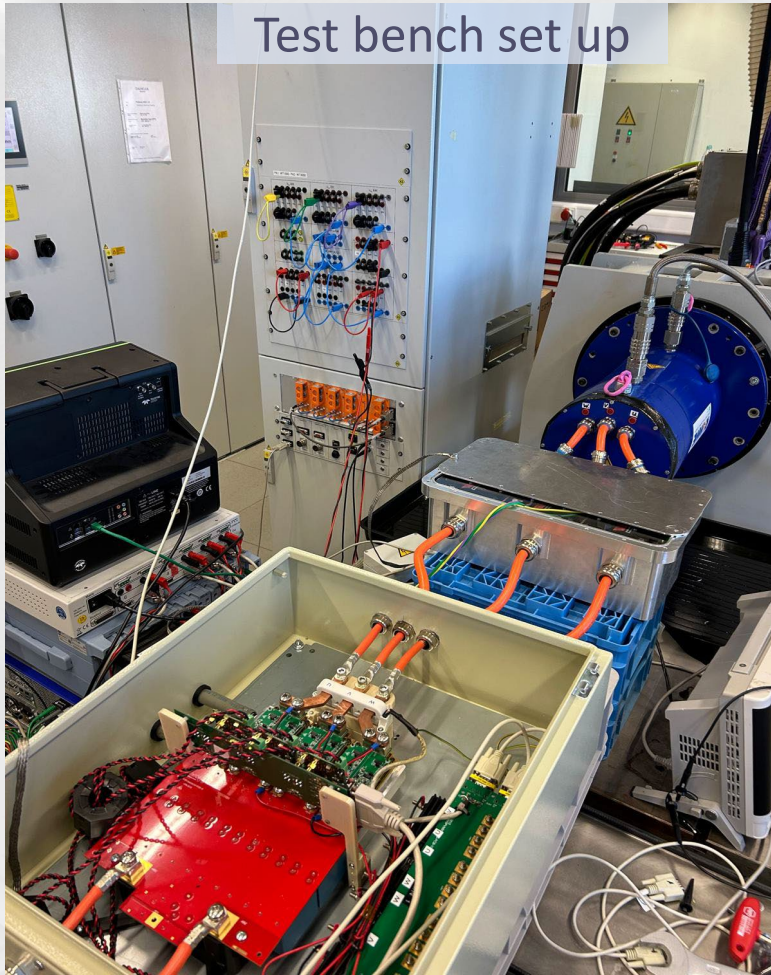
Longer drive distance

Reference to Tesla SiC → 4% efficiency
improvement → 10% driving distance

VM022 Prototype tested at OEM test bench

VisIC D³GaN drives a 140kW e-Machine on OEM Test Bench

Test bench set up



Voltage 400V

Current 350A_{RMS}

Speed 500 – 9000 min⁻¹

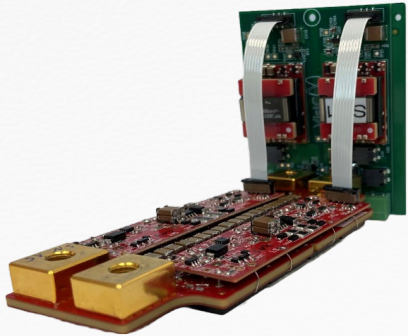
VM22 Gen 1 Dice

R_{dson} 2.2mΩ

VM022 Prototype tested at OEM test bench

Detailed results:

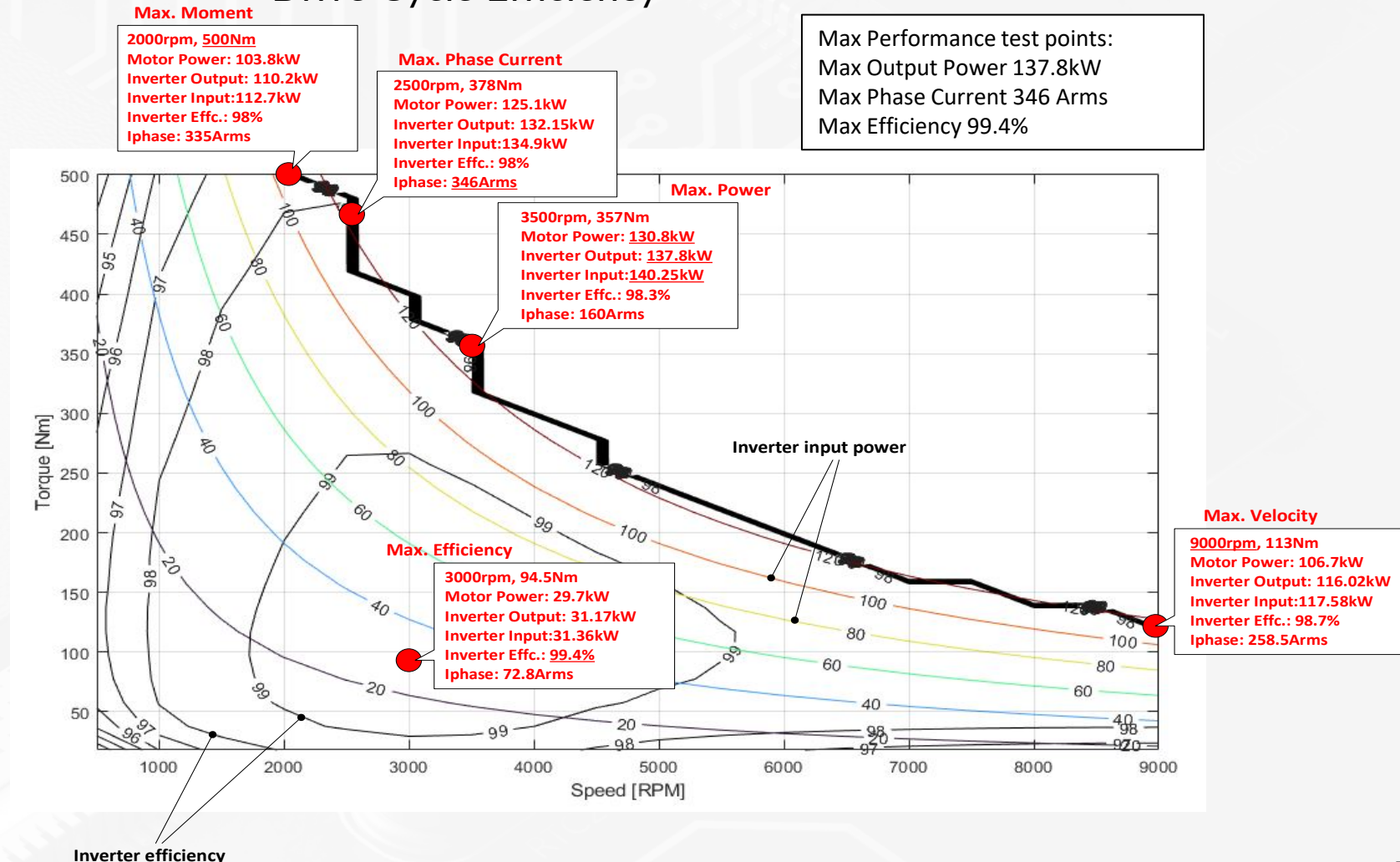
VM022 Module Prototype
(by far not optimized module)



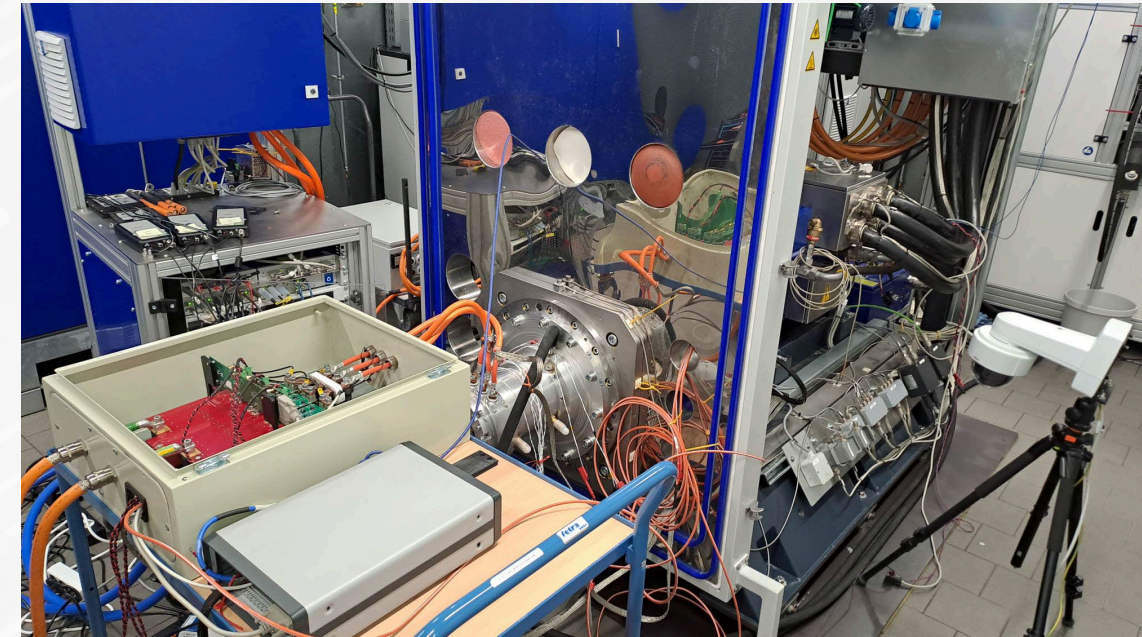
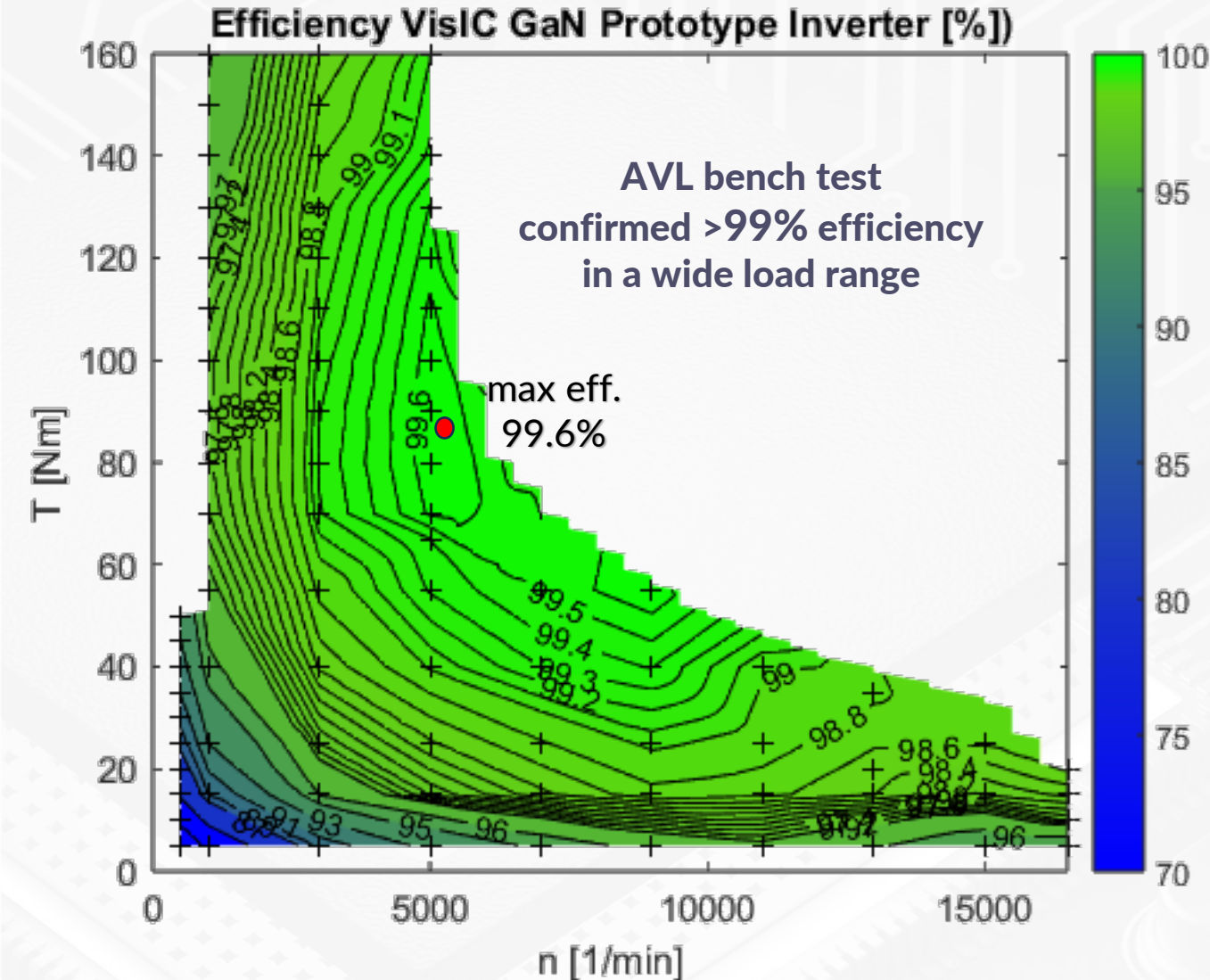
VM022 Inverter Power Core



Drive Cycle Efficiency



Oct 2024: Dyno Tests @ AVL Regensburg



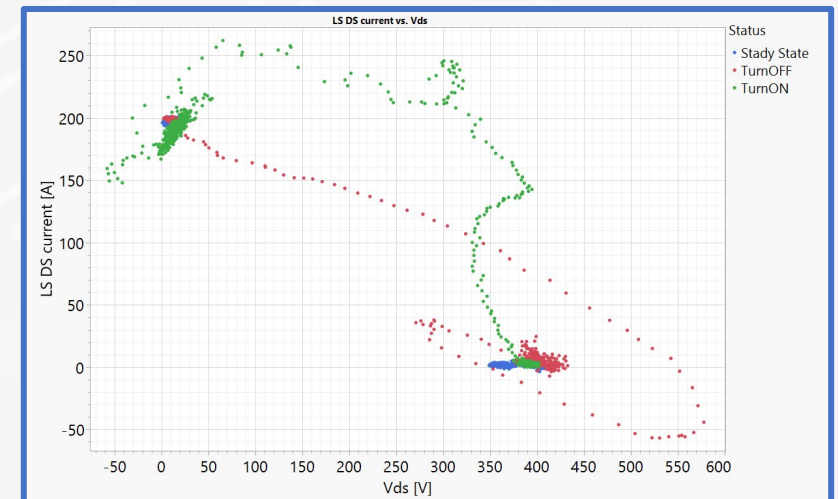
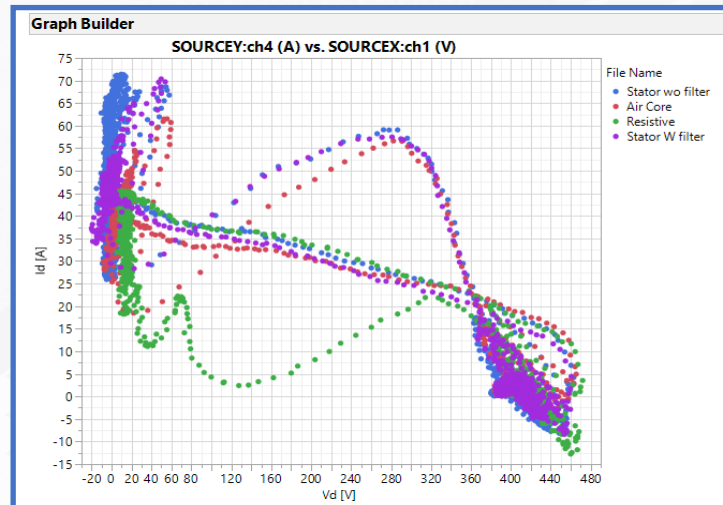
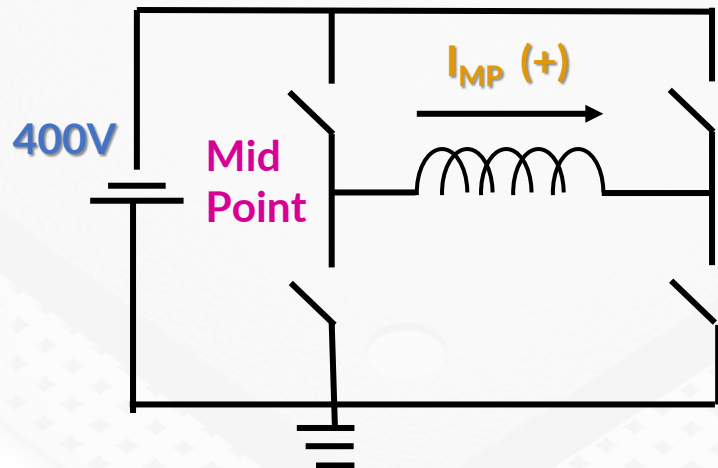
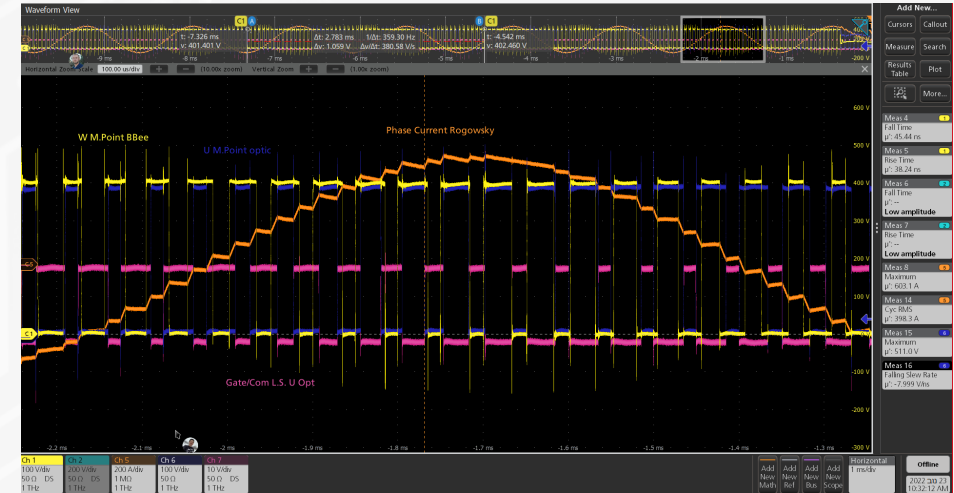
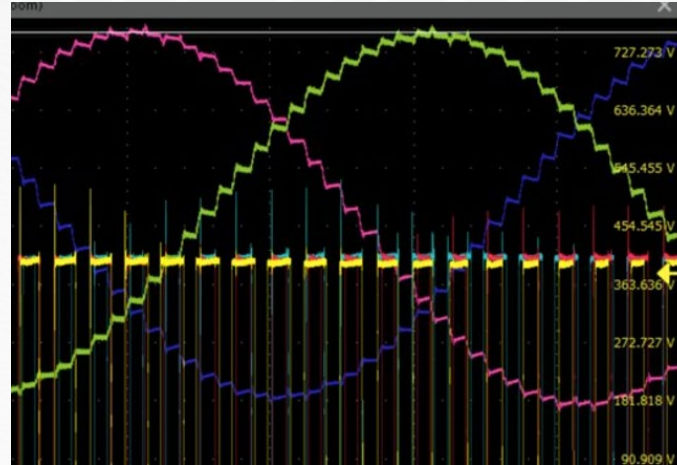
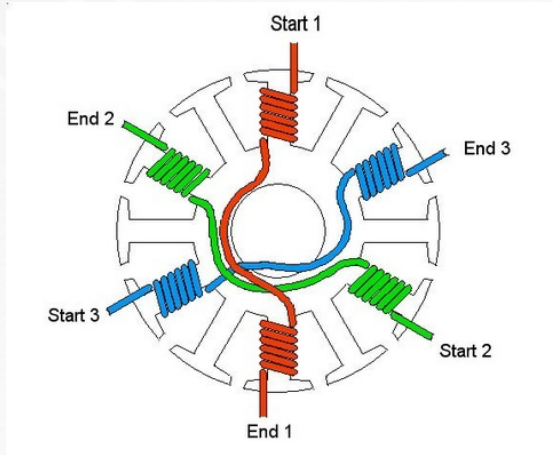
- Max. Efficiency: >99,5%* (400V, 10kHz, 9kmin⁻¹, 55Nm)
- DUT Gen. 1 GaN: latest Generation will improve further Performance and Efficiency
- Max current: 330Arms
- Sensitivity of Switching Frequency (5 – 14 kHz) have been measured – analysis ongoing

* Value might even be higher – is matter of closer evaluation

Tech Performance is proven
What about robustness & costs?

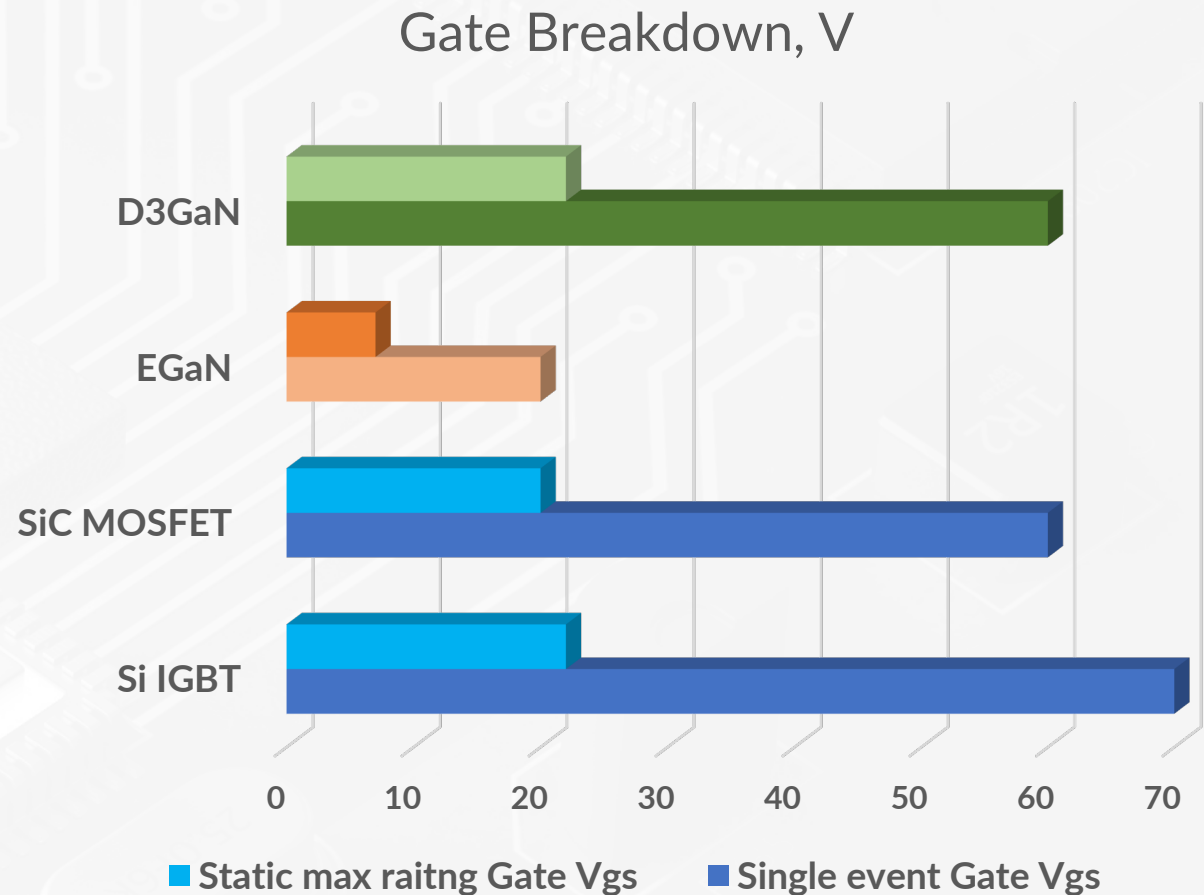
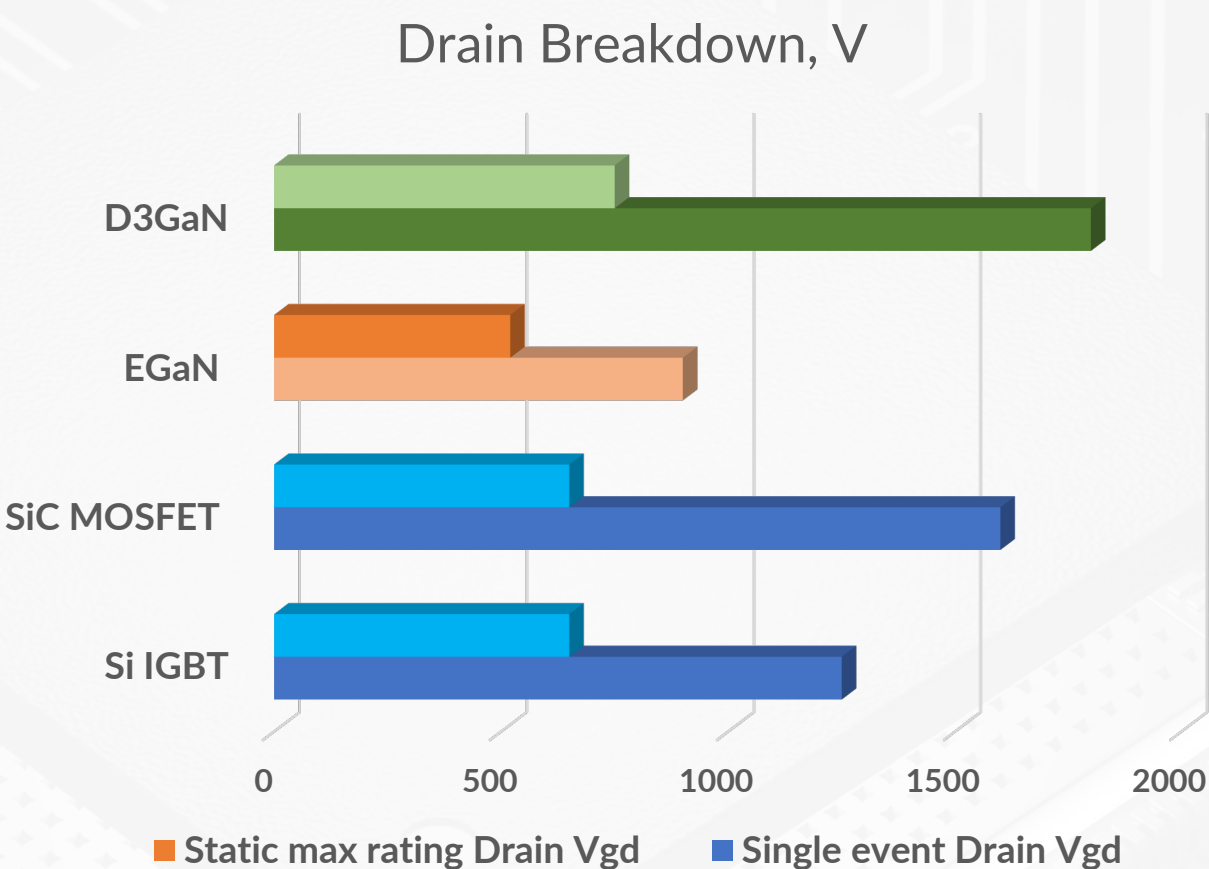
Transistor Operation in Inverters – hard switching

Sine wave of 800 Hz is generated by high frequency switching of 10 kHz (IGBT) to >25 kHz (SiC, GaN)



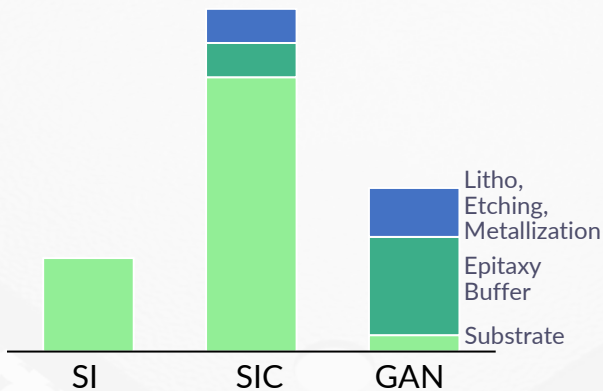
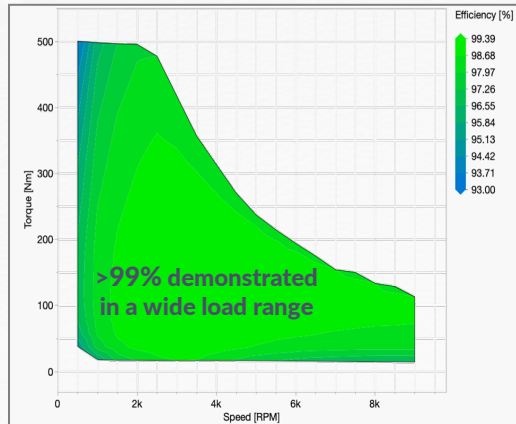
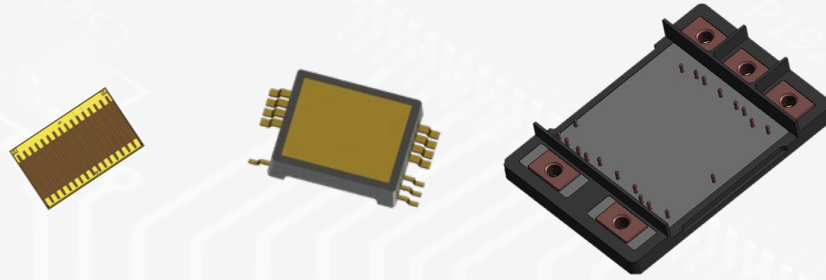
High frequency switching is causing voltage over shots which needs to be handled by the GaN devices

Semi Technology Robustness for Inverter



D³GaN - robustness as known from IGBT / SiC is allowing D³GaN to be used in high power inductive applications

Summary



- D³GaN provides outstanding inverter efficiency over drive cycle is proven:

- OEM test bench results
- AVL test bench results

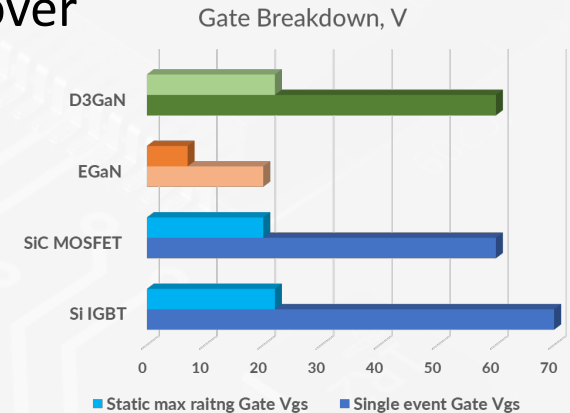
- Automotive Robustness is given and proven

- High break down voltages
- Short Circuit robustness

- EV cost down to realize affordable urban vehicles

- better inverter efficiency, especially in low load conditions vs SiC
- reduction of battery size to achieve same driving distances vs IGBT

- *D³GaN is the technology implementation to support the requirements of efficient traction inverters and affordable EVs*



THANK YOU