Unlocking the potential of Multi Level Inverters with Integrated GaN Technologies

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Bodo's Wide Bandgap Event 2025

Making WBG Designs Happen

GaN

Cambridge GaN Devices at a Glance

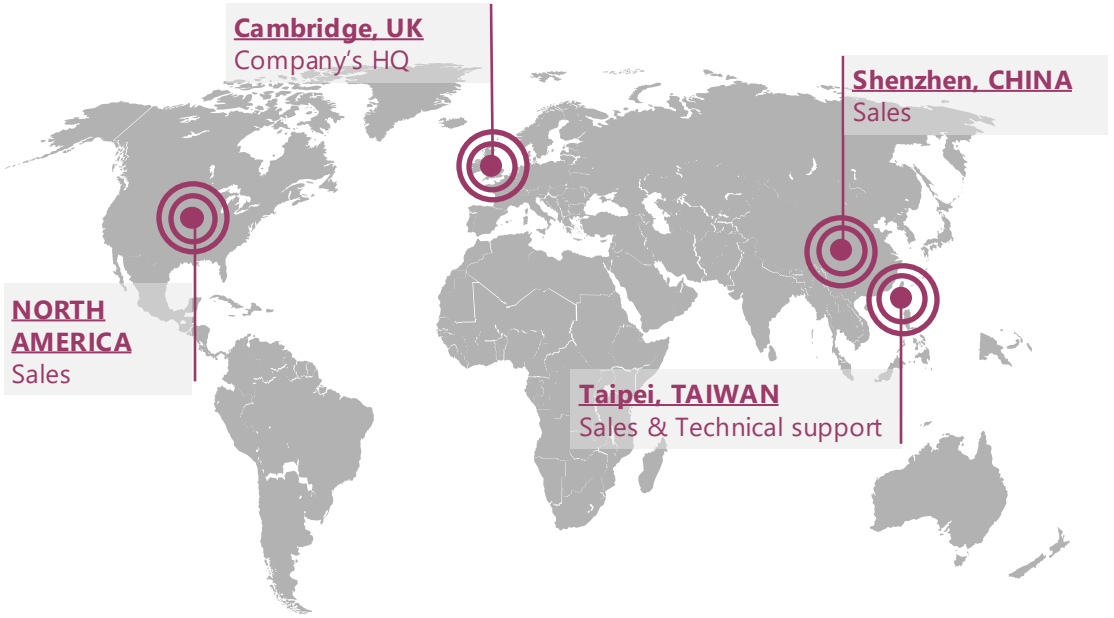
The Fast-paced Scaleup Making Green Electronics Possible

A fabless semiconductor company designing, developing and commercializing **energy-efficient GaN-based power devices and ICs**

Operating from
4
Locations

Innovation
130+
Patent applications

Employees
~60
And expanding



Knowledge

Academic excellence and industry expertise combined

Innovation

Innovative power solutions that help protect the environment

Sustainability

Eco-compatible business measures (**ESG**)

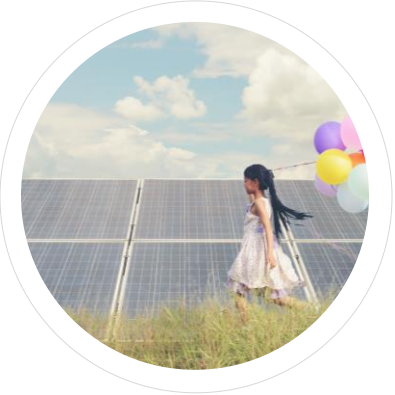
Collaboration

Cooperation, empowerment, respect, listening to customers, employees and partners

CGD Vision

Leveraging ICeGaN® for use in automotive applications

FOCUS — **2023 >**



INDUSTRIAL

Volume reduction

High efficiency

DATACENTRE and TELECOM

Achieving high power density and efficiency for Next Gen AI Data Centers

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AUTOMOTIVE

Component downsizing

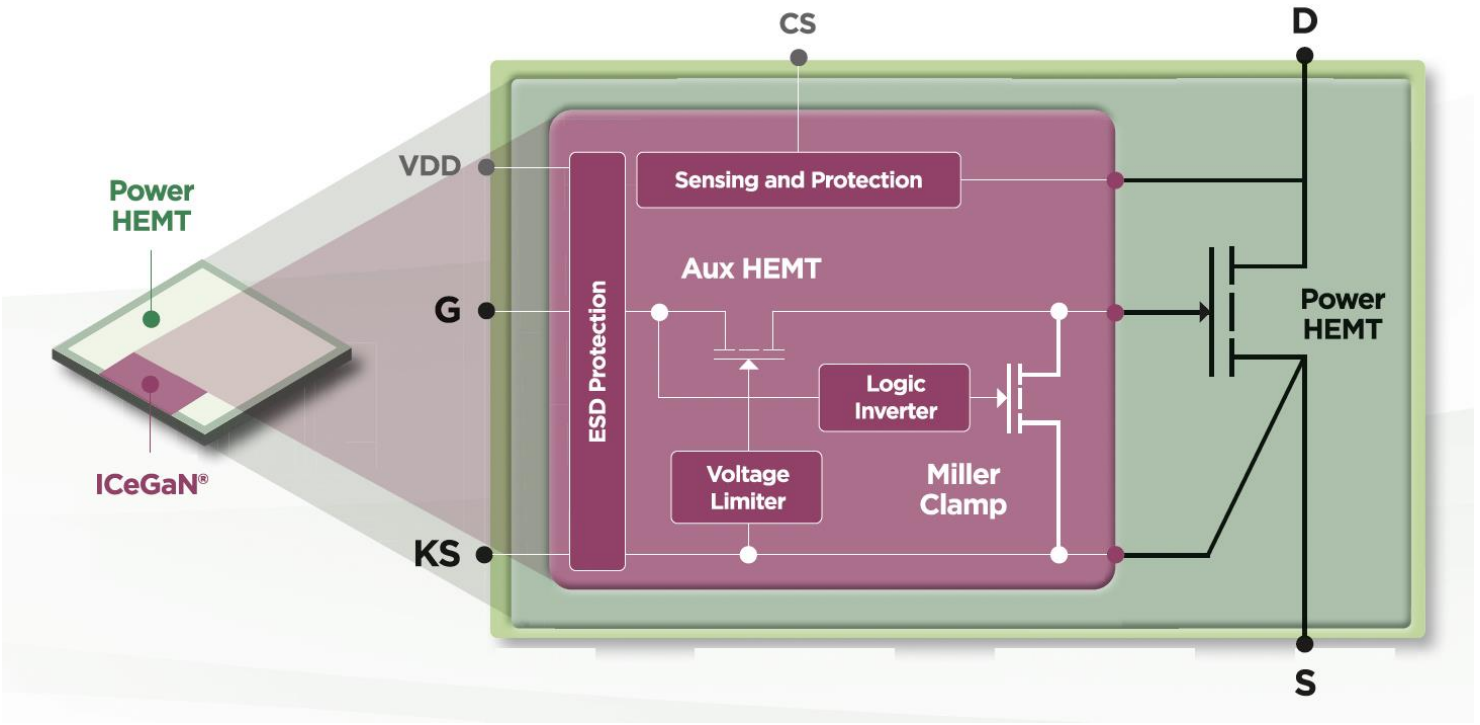
Reduced form factor OBCs and DCDC converters

Reduced system losses

Lightweight and compact motors

ICeGaN®: Easy-to-Use GaN power transistors

Combined System Performance with Ease of Use



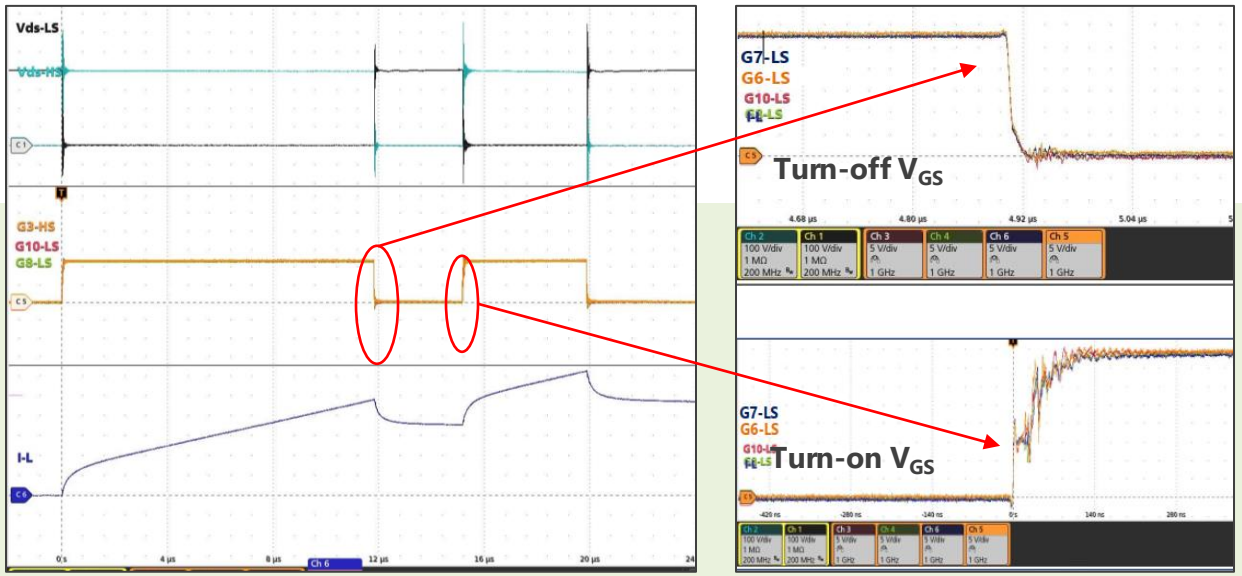
- ✓ Monolithically integrated features
- ✓ Aux HEMT for increased Vth ~3V
- ✓ Miller clamp for unipolar operation & safe turn off
- ✓ Current sense and protection for increased functionality
- ✓ Better noise immunity & reliability

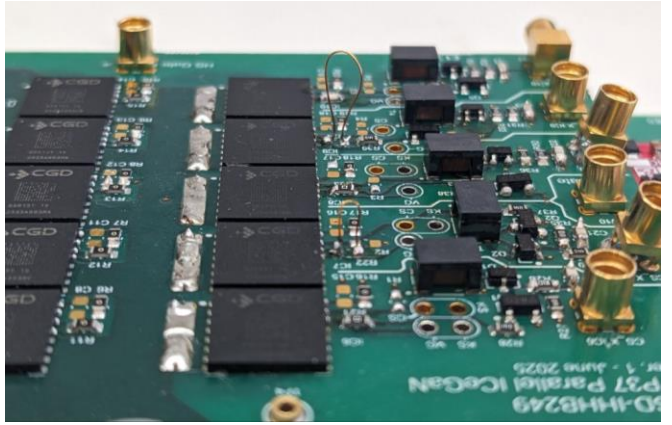
Scaling ICeGaN® for High Power

ICeGaN Offers Ease-of-Paralleling with Standard MOSFET and IGBT Gate Drivers

ICeGaN Half-Bridge Paralleling Test – x5 / 55 mΩ

Double pulse test (650 V / 65 A)





Tests show 5 pcs of ICeGaN in parallel with

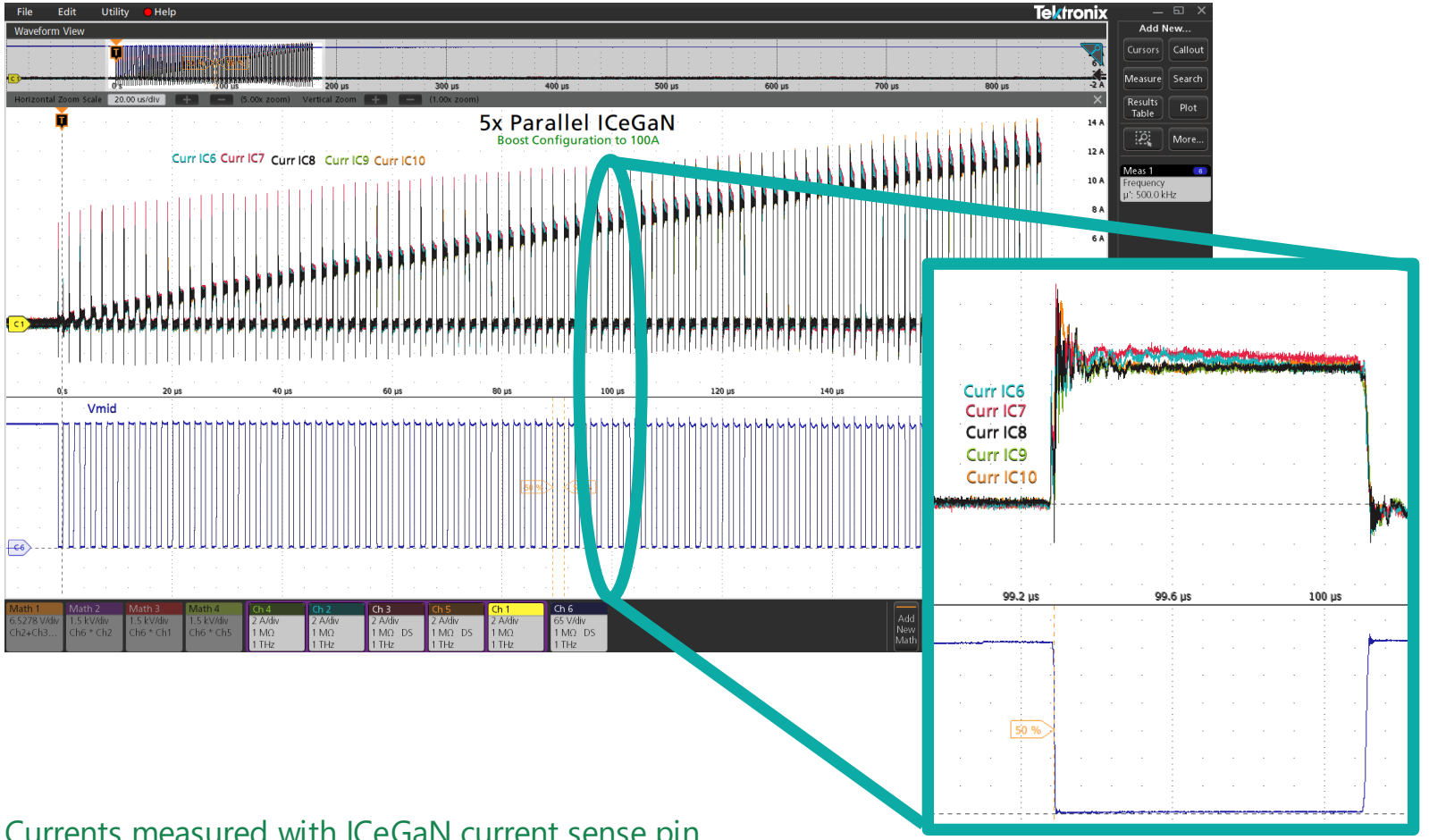
Clean and Stable Switching

waveform at 400 V/65 A hard-switching without parasitic oscillation.

ICeGaN simplifies GaN adoption in high-power industrial and automotive applications

ICeGaN® for high power & frequency

5x parallel ICeGaN devices behave like a single switch.



Currents measured with ICeGaN current sense pin.

Testing Parameters:

- 400 V input
- 500 kHz switching frequency (90 pulses)
- Peak current 100 A

ICeGaN features combine to create an **effective single switch** that has 5x the rated current of an individual device.

No de-rating is needed for x5 ICeGaN in parallel.

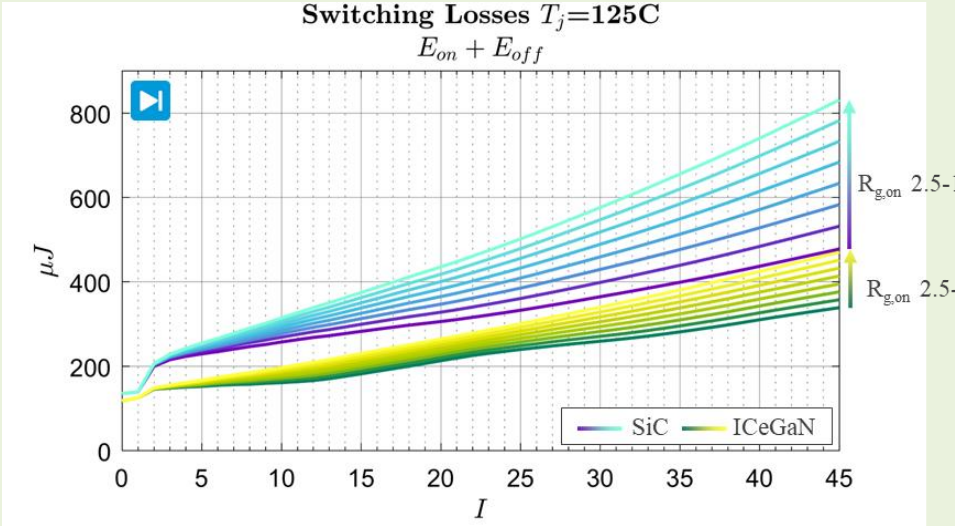
ICeGaN® Benefits versus state of the art SiC

Switching losses comparison of ICeGaN versus SiC

ICeGaN® enables a 30 – 60 % reduction in switching losses*:

- Enabling higher switching frequency operation
- Higher system efficiencies

*compared to a state of the art SiC Discrete MOSFET for the same voltage and RDSon class.



Benefits of Higher Switching Frequency:

- Low Current ripple --> Reduction in Copper Losses
- Low Flux ripple --> Lower Iron Losses
- Low Charge Ripple --> Reduction in DC Link Capacitor

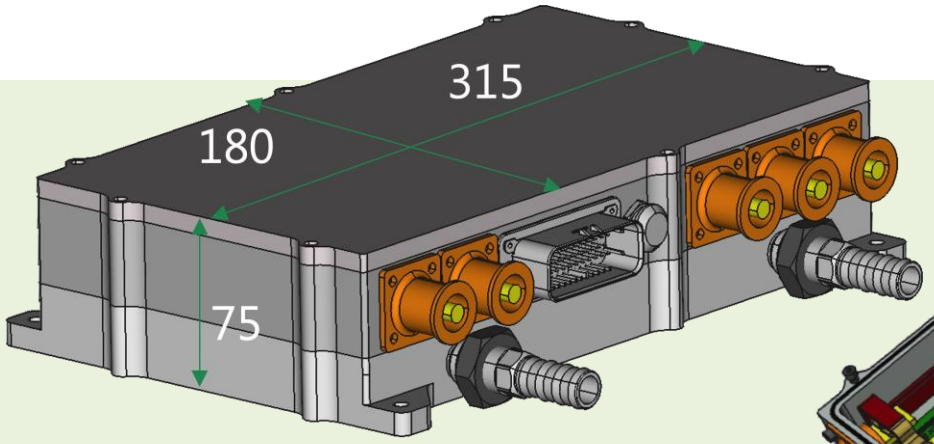
PEIC Power Electronics Innovation Center

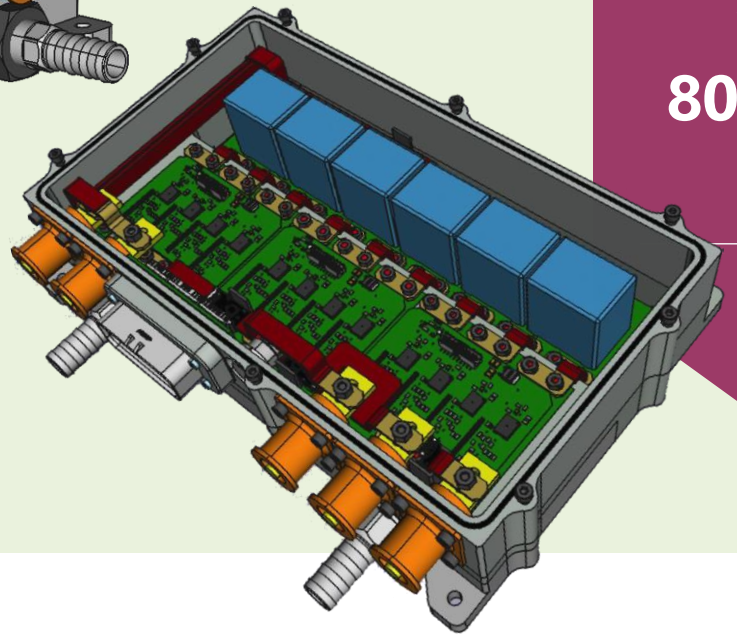
ICeGaN® enables a higher frequency operation

*Simulation results

ICeGaN® in Automotive Traction Inverter

Demo Board: Mechanical Integration





ICeGaN-based traction inverter including
PCB boards, connectors, cooling system

Volume :
< 4,2 L

High power density :
25 -30 kW/L

V_{IN} :
800 V_{DC}

Peak Current:
180 A_{pk}
125 A_{rms} (10 s)

P_{OUT} :
100 kW (peak),
75 kW
(continuous)

Data provided by IFP Energies nouvelles

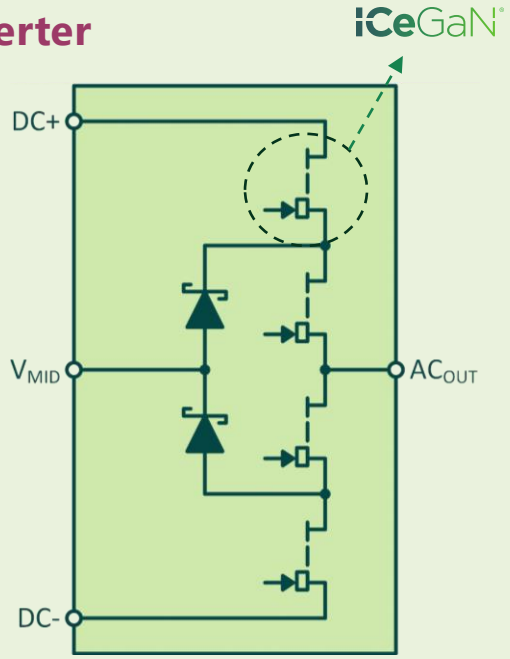
Increase the power density of your Traction Inverter with CGD's ICeGaN

ICeGaN® in 3-level NPC Inverter

Advantages of 3-level NPC Inverter in Electric Vehicles

3-level NPC Inverter

- Allows for the use of 650 V power devices with 800 V DC bus
- Reduced switching loss due to lower switching voltage than 2-level inverter
- Improved efficiency through utilisation of GaN devices



Single phase of 3-level NPC inverter

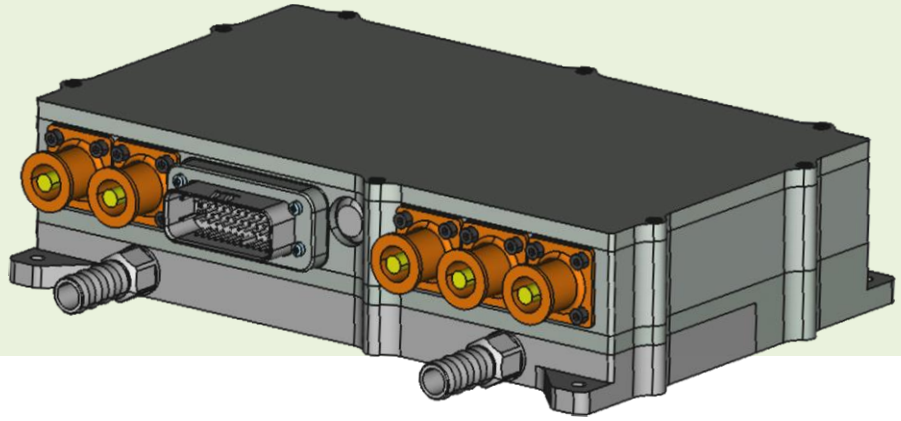
Advantages for Electric Vehicles

Increase in WLTP range* & consequent reduction in charging cycles of batteries

OR

Reduction in battery volume and consequent cost for the same WLTP range.

***WLTP range**: maximum distance an EV will travel on a single charge, based on a standardised test.



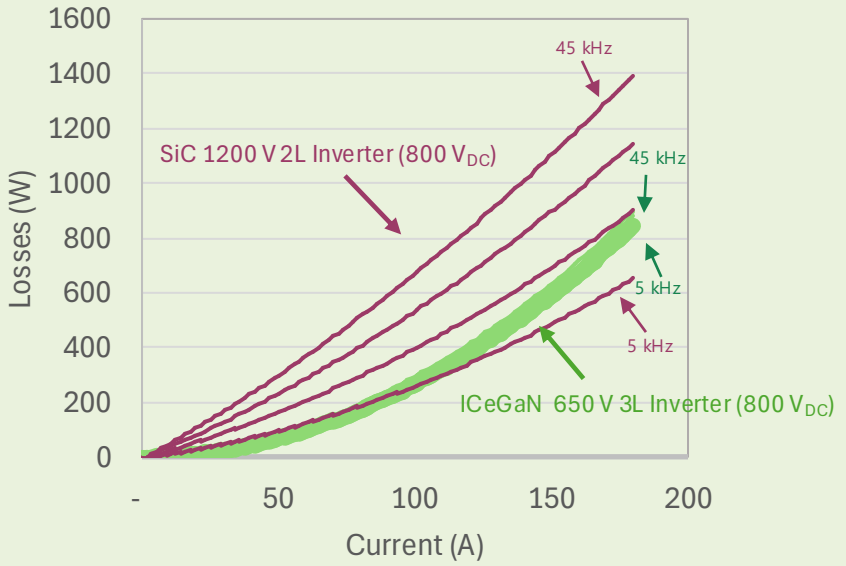
Data provided by IFP Energies nouvelles

3-level NPC inverter allows use of efficient power devices, improving the EV performance

ICeGaN® Benefits in Automotive Traction Inverter

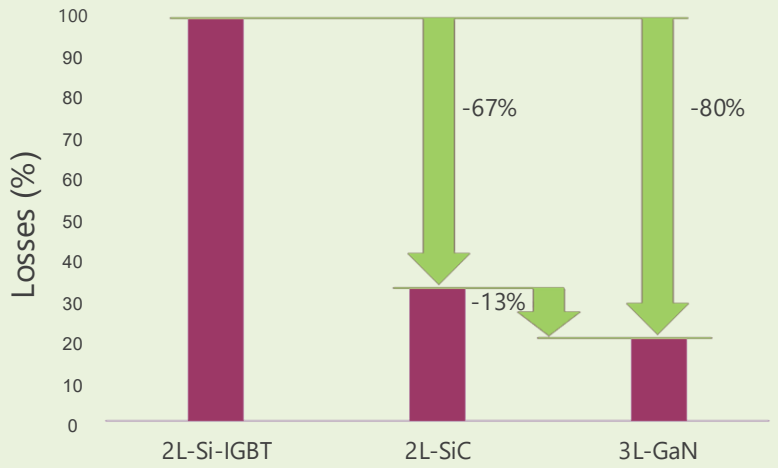
GaN-based 3L-inverter vs IGBT-based & SiC-based 2L-inverters

Switching frequency impact*



GaN has excellent switching properties, hence the system with GaN is less dependent on switching frequencies than with SiC counterparts

Power loss comparison



Test conditions: f_{SW} = 40 kHz for a 90 kW traction inverter

Increasing the switching frequency can lead to a reduction of the motor iron losses, smaller filters and smaller DC caps

Data provided by IFP Energies nouvelles

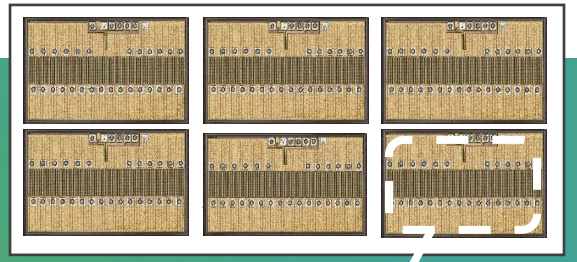
GaN outperforms SiC at high-frequency operation, allowing for smaller total packaging

*Simulation results

Simple use of ICeGaN® for power modules

Ease of integration and parallel implementation

ICeGaN 3 phase module composition with monolithic die



Single ICeGaN die [1 placement]

- One die placement with all the benefits of the ICeGaN interface
- Monolithic solution for simpler module construction and parallel use
- Simplified BOM for gate driver development
- Optimized power density and use of cavity area

Discrete 3 phase module composition with GaN die and separate interface IC

Discrete GaN die and Si IC [2 placements]

- Alternative solutions require an additional interface IC or multiple external components
- Additional cost in components and placement
- More complex layout and challenging gate loop parasitics
- More challenging to use die in parallel

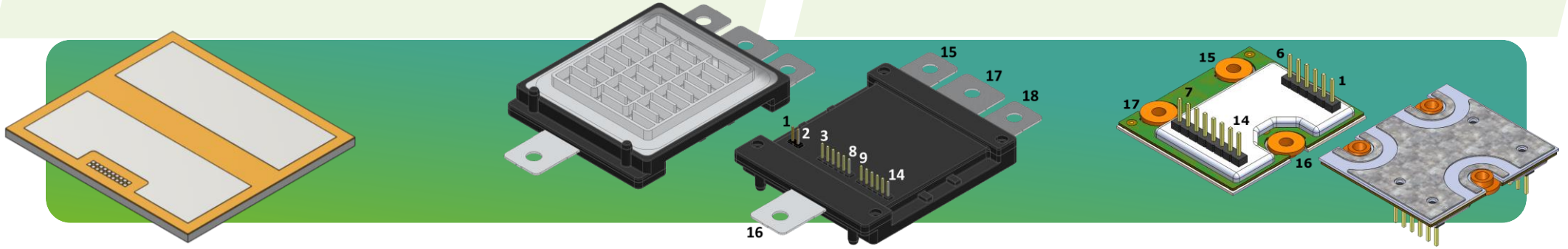
CGD Product Development

Building products to address automotive traction inverters

- Lower Rdson to address high power class application in automotive and industrial verticals
- Metallisation process to facilitate the use in power modules, i.e. top metal dimensions compatible with Cu clips or Al ribbon bond
- KGD die availability

Evaluation modules for R&D

- Modules aid customer / partner development of ICeGaN® in automotive and industrial verticals
- Build proof of concept for multi-level and hybrid approach to high power inverters.
- To better understand the entire application and system use case



Dare to innovate differently

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