

Nuremberg, 7 – 9 May 2019

# 650V GaN Technology for a New Generation of OBCs, DC/DCs and Inverters in EVs

The Highest Efficiency with GaN

GaN  
layout

Package  
design

Electronic  
design

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# Agenda



- Vision for the xEV market
- VisiC GaN advantages
- xEV power systems using VisiC GaN
- Summary

# VisIC's Vision → xEV Market Needs



Lightweight and high density designs

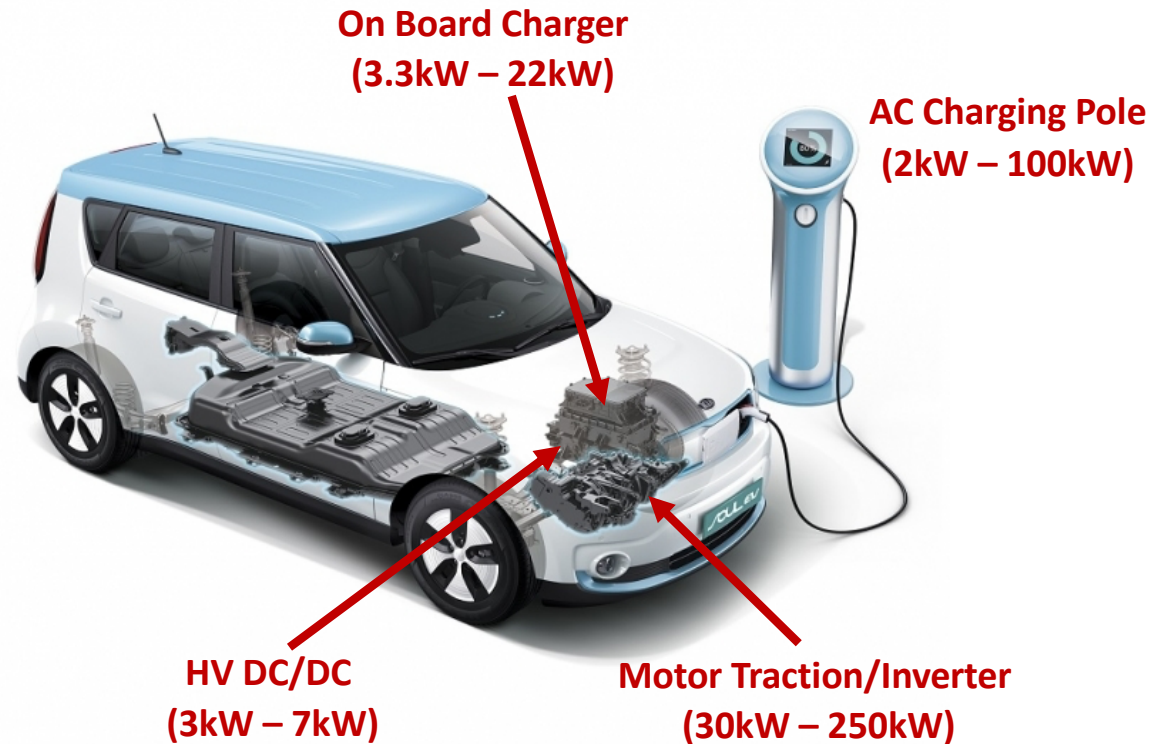
Cool and efficient power conversion

High quality and reliability

Fast charging and long range

VisIC Technologies is able to provide the **highest performance** and **most reliable solution** to the **EV market**, based on GaN power devices

# Where does VisIC fit in xEVs

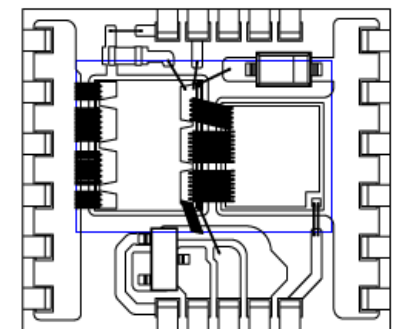
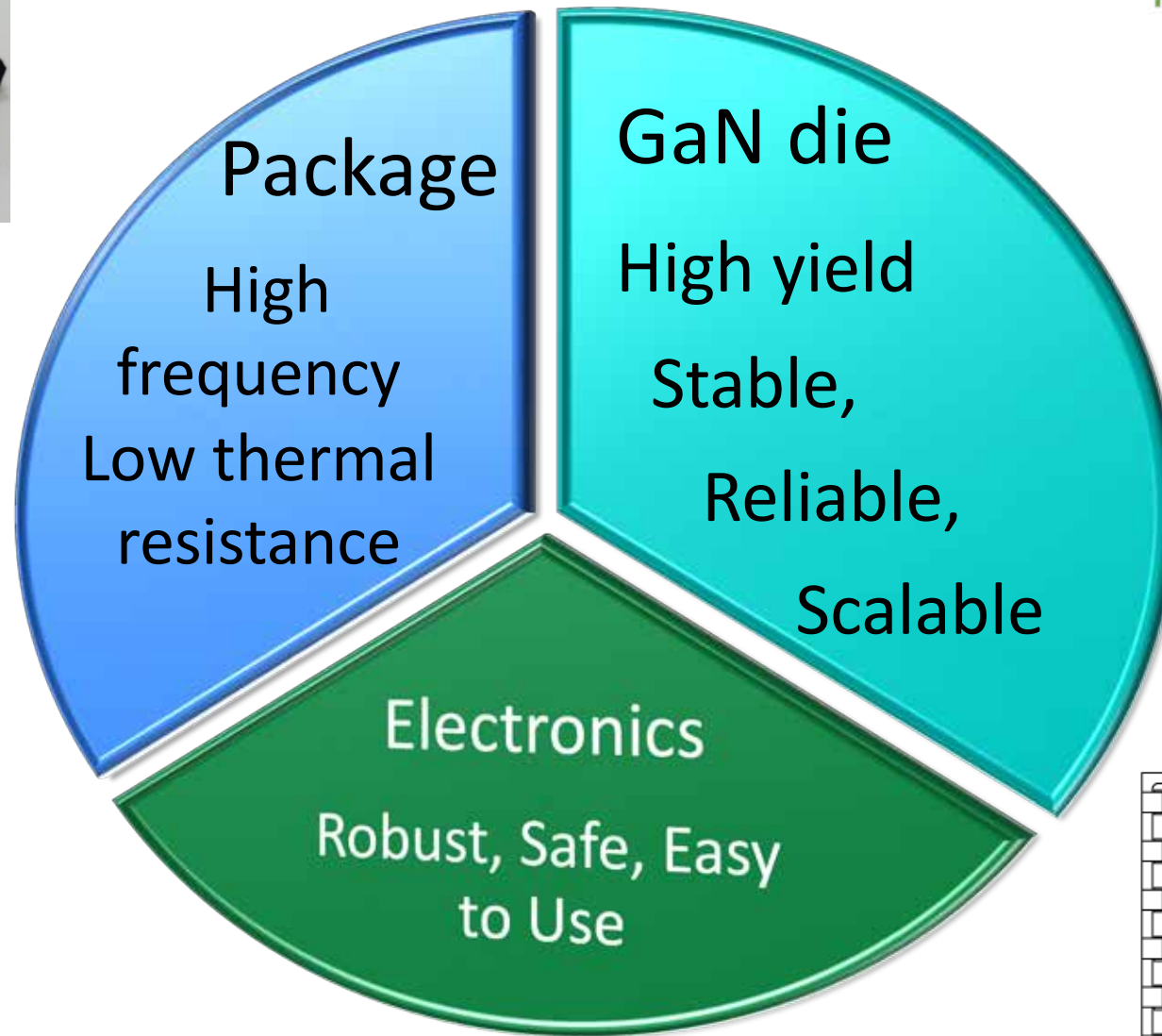


The power switch defines the performance and efficiency of all HV power systems in the car

# VisIC GaN Advantages

The highest efficiency with GaN

# Innovation → Performance excellence



VisiC: A small step in design, a GiaNt leap in efficiency

Company confidential

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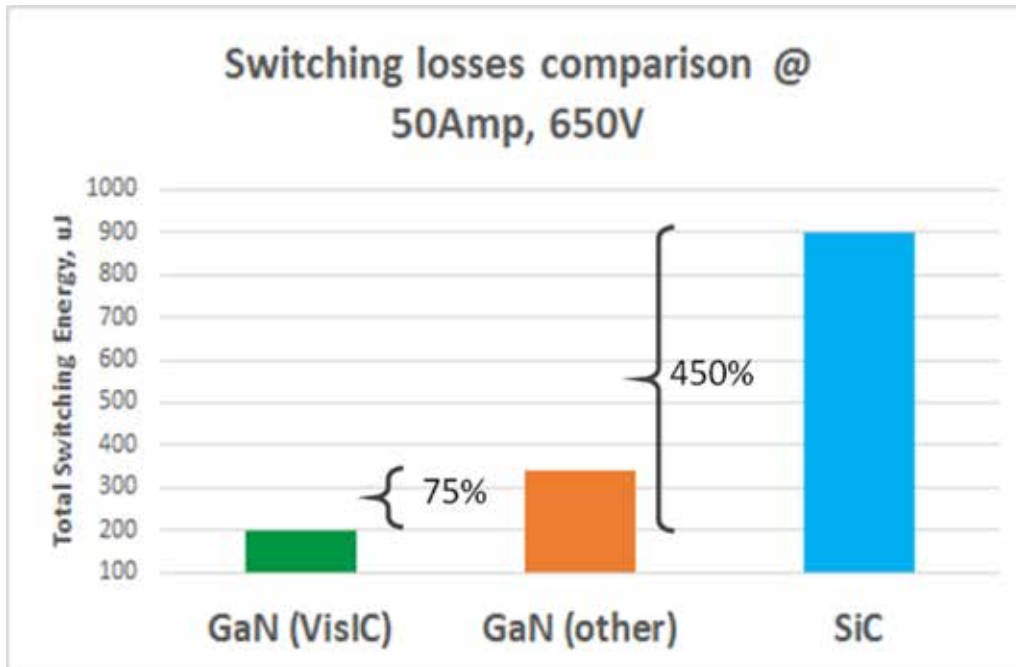
# Our Products → System Value



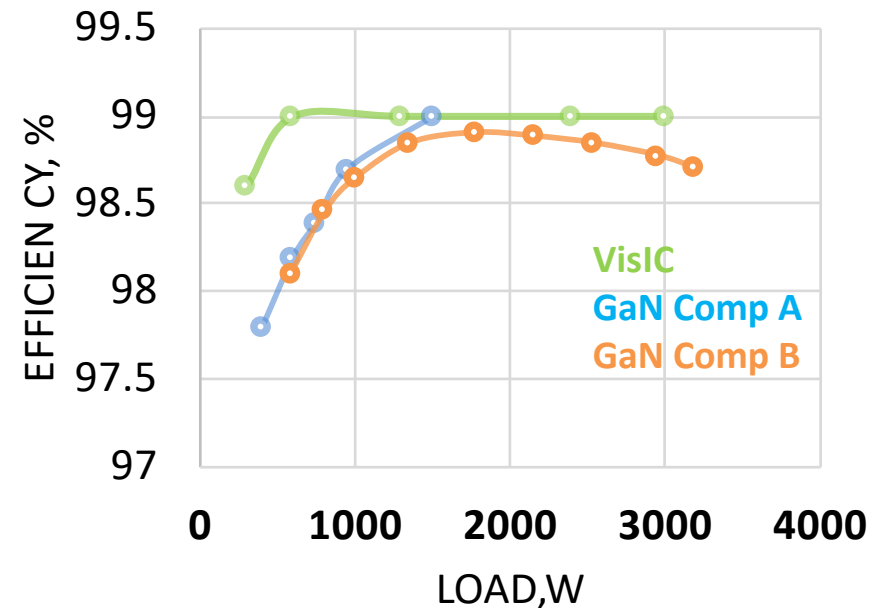
## 3 Main Advantages

1. Extremely low switching energy
  - Low switching losses: Higher frequency → Efficiency/Density!
2. High thermal conductive packaging
  - 2.5kV isolated package: More power → Cool operation/Density!
3. Robust and easy to use
  - Direct Drive D-mode approach → Reliable!
  - Standard drivers: 0-15V → Cost Efficient!
  - High noise immunity: 5V threshold → Robust!

# Advantage 1: Lowest Switching Energy



## 400V Buck Converter Efficiency Comparison at 100kHz

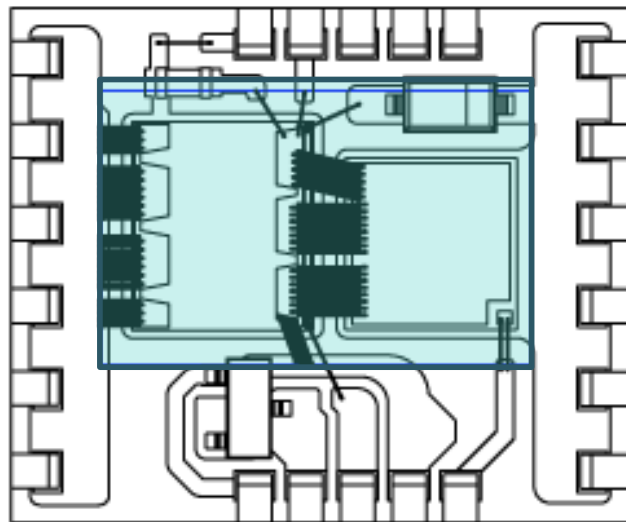


Direct product measurements, package and  
add-I electronics included

Automotive devices used for the comparison

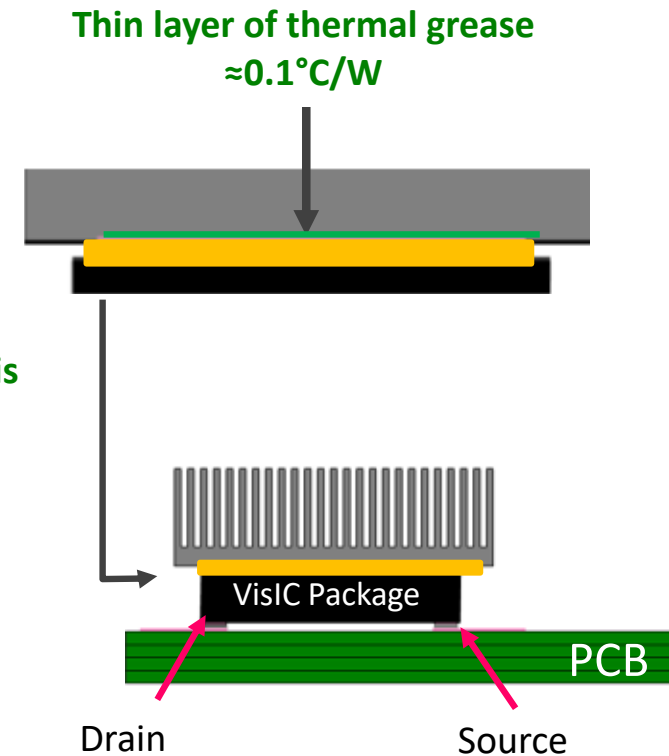


# Advantage 2: Highest Thermal Conductivity



Embedded AlN  
Under GaN

No thermal pad is  
needed  
2.5 kV isolated  
package!



Best  $\theta_{\text{junction to heatsink}}$   
GaN solution on the market

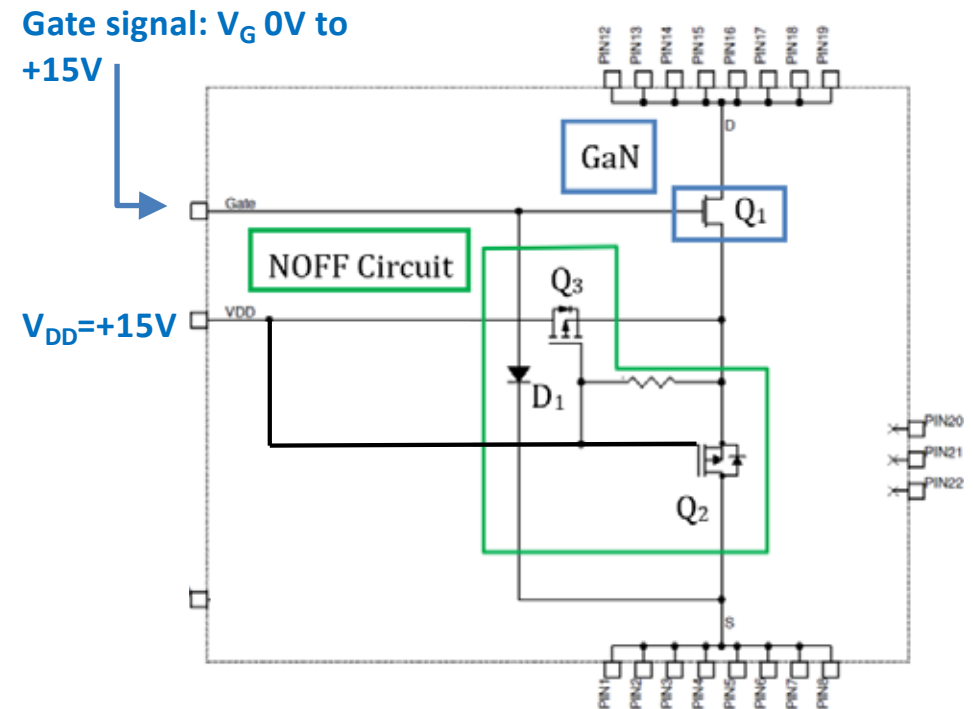


# Advantage 3

## Easy to Use and Robust



- D-Mode Direct Drive circuit
  - Not Cascode
  - With driver protection
- $V_{TH}$  is + 5V
  - Use with standard drivers with gate voltage 0V to +15V
  - No negative drive voltage needed
- Controllable slew rate – gate resistor
  - Easy paralleling

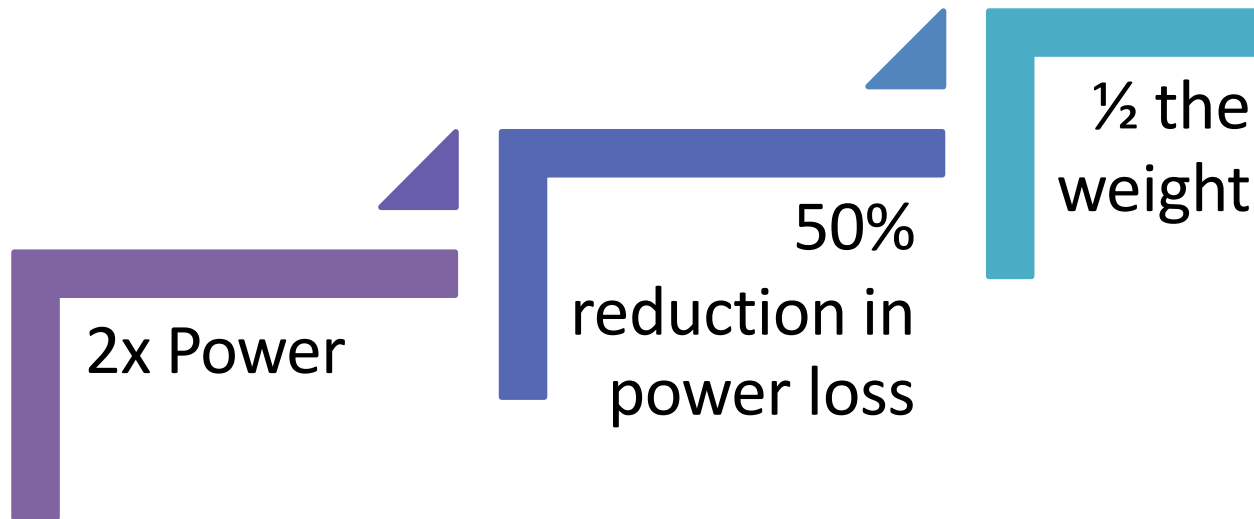
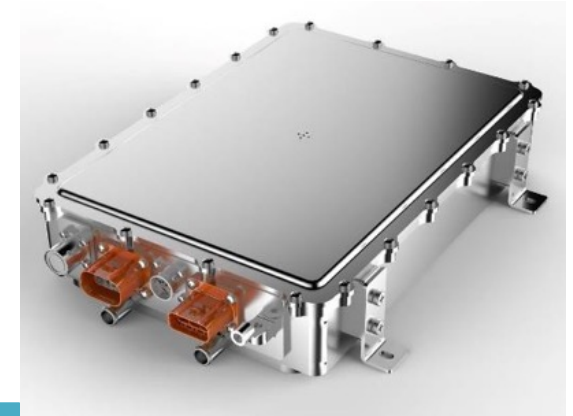


# xEV Power Systems Using GaN

# On Board Chargers and DC/DCs



Replacement of Si MOSFETs by VisiC's GaN in both PFC and DC/DC stages enables essential system advantage

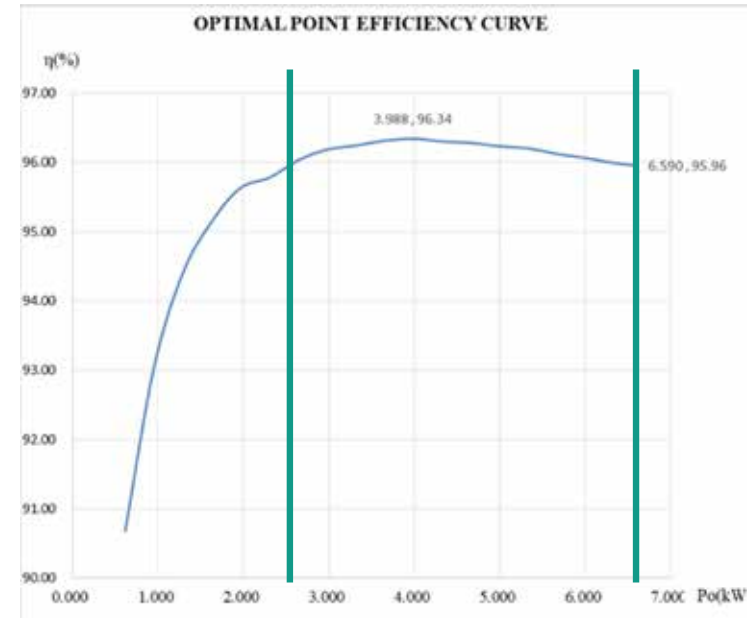


**VisiC's GaN: double power, smaller size, lower cost**

# GaN Unidirectional OBC, 6.7 kW



	VisiC GaN V22	Si MOSFET
Dimensions, mm	230D x 170W x 60H	450D x 200W x 70H
Weight, kg	4.5	10
Power, kW	6.7	6.6
Efficiency, %	> 96%	93% - 94%
Power density, kW/L	2.8	1.04
HV transistors count	6	10



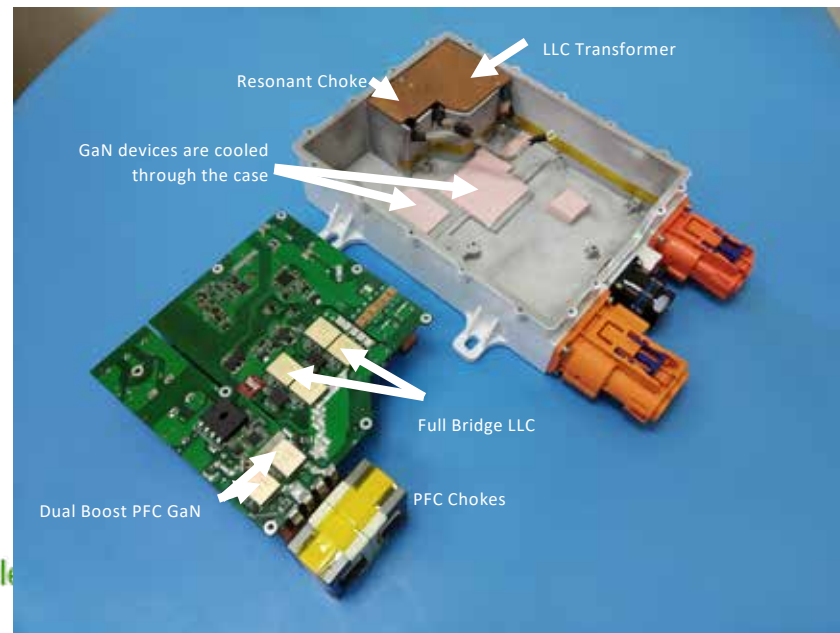
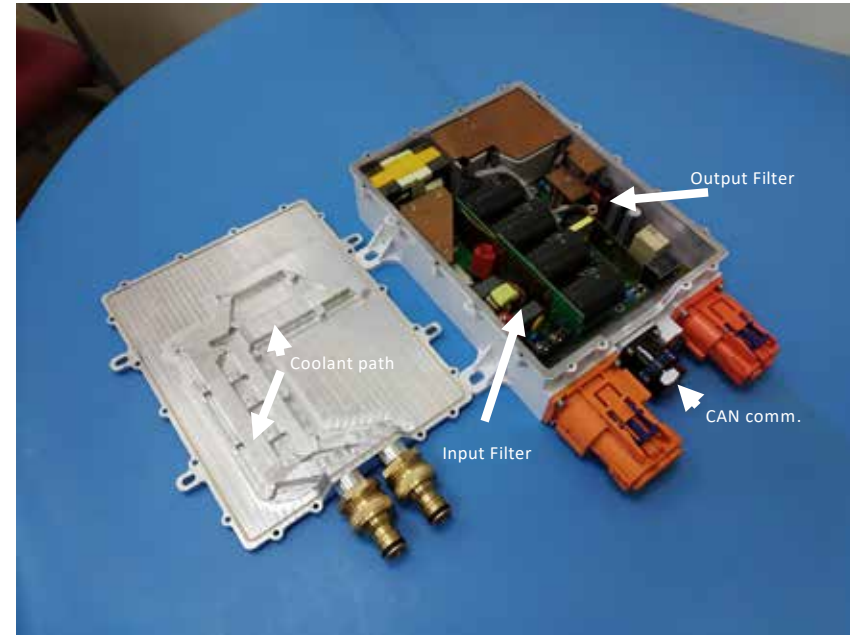
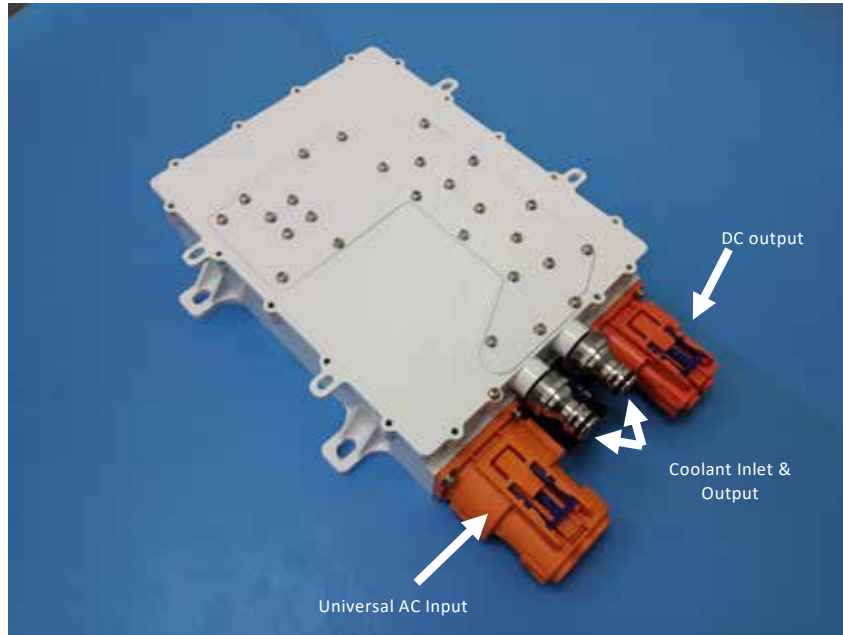
Smallest 6.7kW / 2.3L OBC available

2.8 kW/L → highest power density

V22N65A enables next generation 6.7kW OBC

→ higher efficiency, smaller size and comparable cost

# Design Flexibility



**Design Package Available**

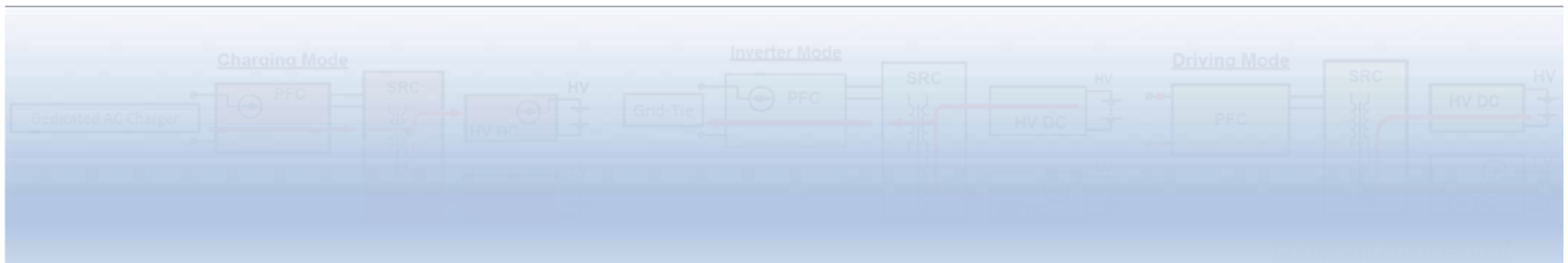
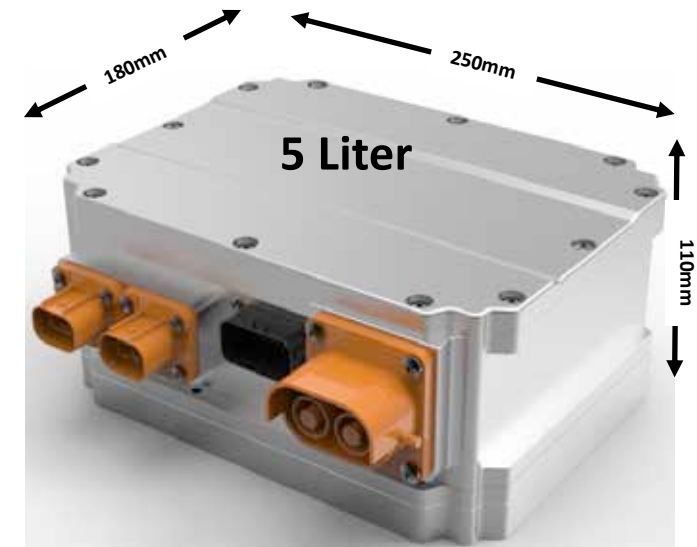
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# OBC + DC/DC Integration



## Smallest 7.2kW / 5L Bi-directional OBC + DC/DC

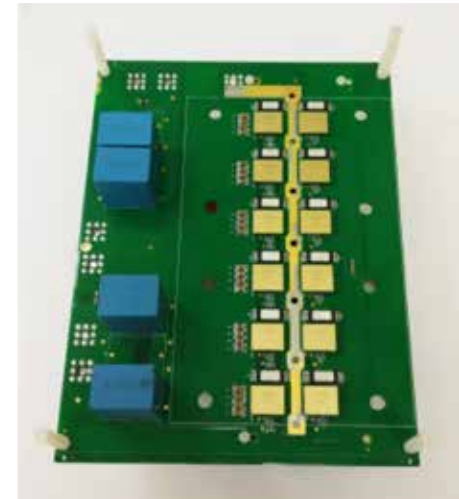
- Efficiency: > 96%
- # of devices: total 14 of V22N65ACA
- $V_{OUT}$  :
  - 200...430V Charger
  - 85 ... 265 V inverter
  - 14 V LVDC



# High Power Inverters - Drive

## Now also with GaN

- $I_{peak} = 600A$
- 6x V22 devices parallel per leg
- Bus voltage = 400V
- Equal current distribution with trace compensation
- Liquid cooling
- 98% efficiency @ 100kHz, 300A, hard switching





# DC Fast Charging



Modular design for 100kW+ charging power

## State of the Art

10-15kW modules

95% Efficiency

1kW/L power density

Can reach 1 Ton



## With VisiC GaN

20-30kW modules

97% Efficiency

4kW/L power density

Below 250kg

**Robust 500 V  
operation**

½ Footprint

¼ Weight

~50% reduction in Power Loss

# Summary

- Innovation in GaN semi, packaging & system for power electronics
  - State-of-the-art power devices and modules
- Direct Drive D-Mode Technology - Robust
  - Easy to use with standard drivers, 5V threshold voltage
- Automotive supply chain
  - Design for 650V automotive qualification

Lowest  
RDS(ON) of  
650V device

VisiC  
Technologies



**Thank you for your attention**

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