



# ST PowerGaN for eMobility

**ST PowerGaN  
G-HEMT 650 V and 100 V E-MODE**



**Miniaturization of xEV components**



**The many benefits of GaN**



**7.4 kW, 800 V, 300 kHz  
single-phase converter with PowerGaN**



## GaN: future of power electronics



**High 2DEG electron mobility**  
– Smaller device (for given  $R_{ds(on)}$  &  $V_{ds(max)}$ )

**Low Capacitance & Gate Charge**  
– Faster Switching

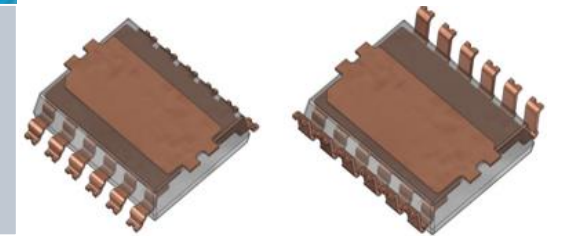
**Zero Reverse Recovery Charge ( $Q_{rr}$ )**



# PowerGan - G-HEMT 650 V and 100 V E-MODE

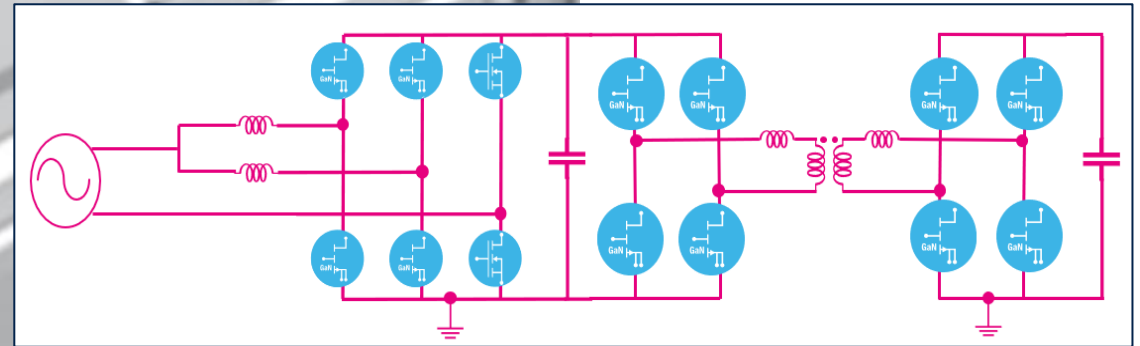
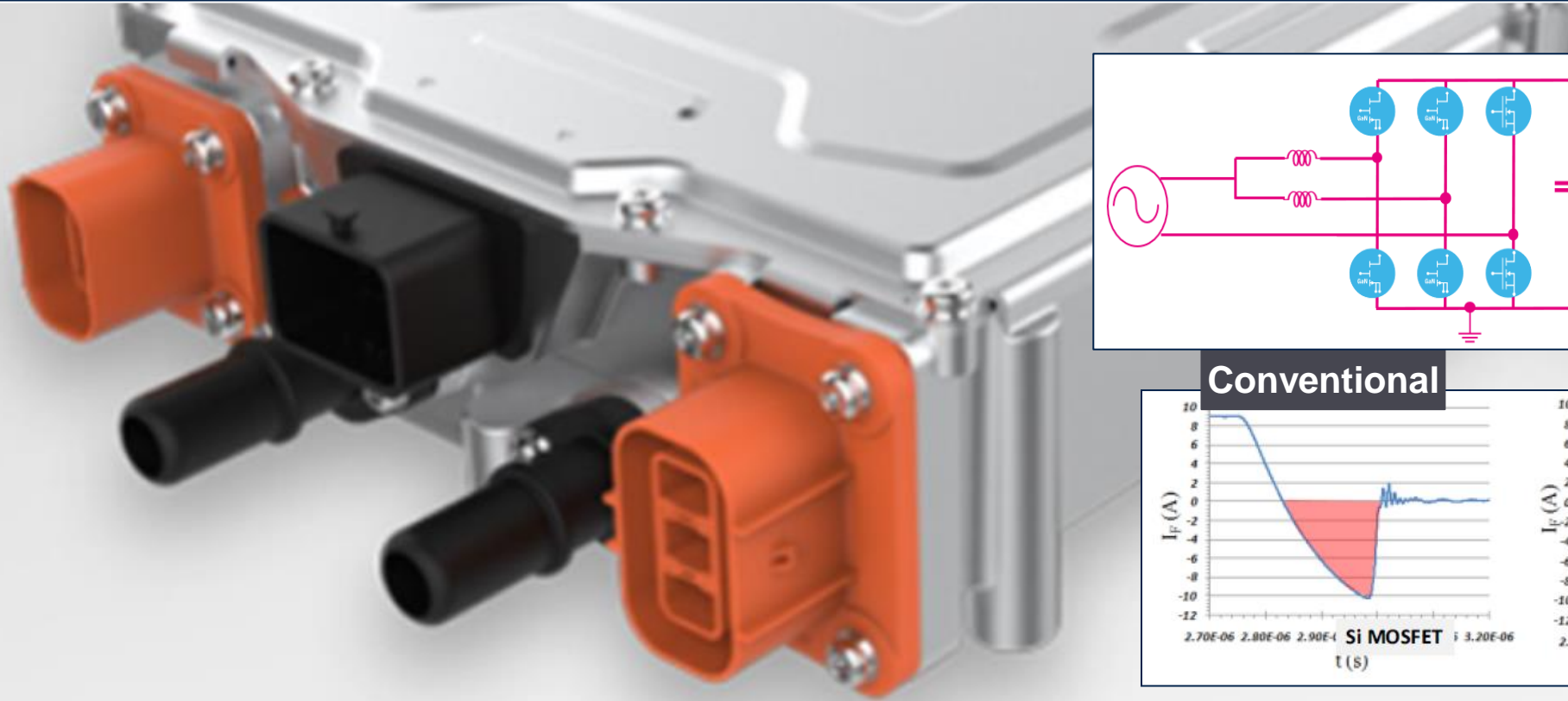
For fast-switching and medium power applications

Ultrafast, easily parallelable zero Qrr  
E-mode GaN HEMT

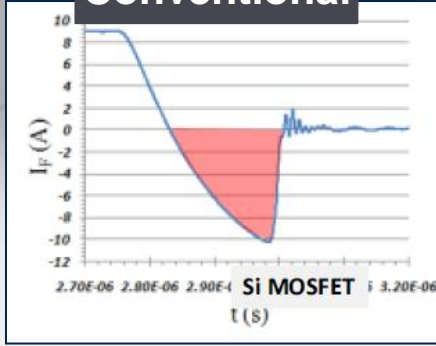


# Miniaturization of xEV components

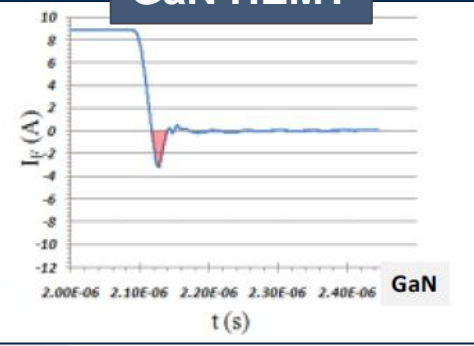
Thanks to the fast and clean switching performance of GaN



Conventional



GaN HEMT



# The many benefits of GaN

Excellent efficiency in hard- and soft-switching topologies



Lower conduction losses

Better  $R_{DS} \times Q_G$  vs silicon

Low on-resistance ( $R_{DS(on)}$ )

Low capacitances ( $C_{rss}$ ,  $C_{oss}$ )

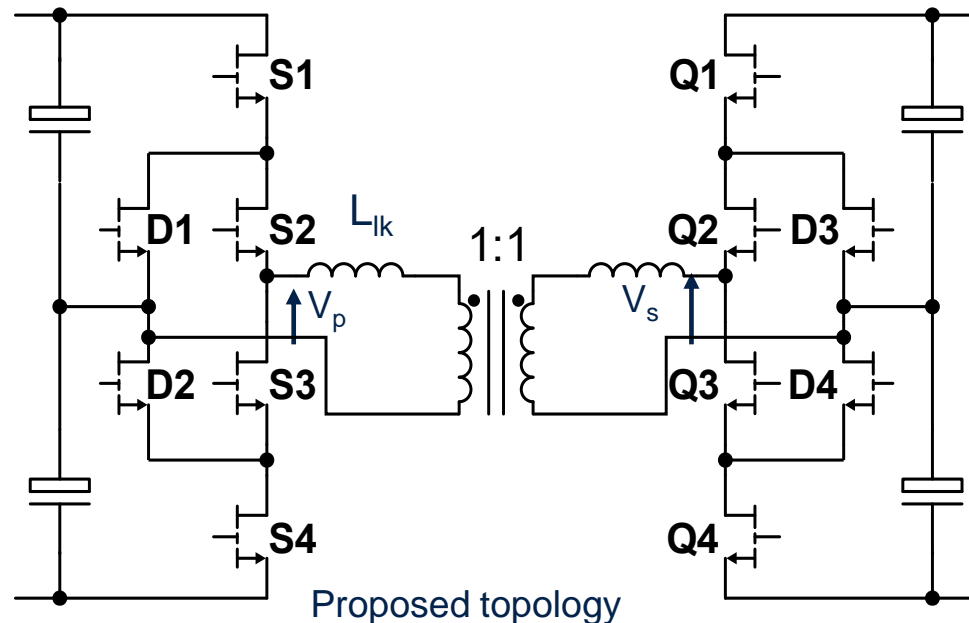
Unbeatable recovery charge  $Q_{rr}$

Lower power losses & smaller passives & less filter components



# 7.4 kW, 800 V, 300 kHz single-phase converter with PowerGaN

## Proposed topology and modulation strategy



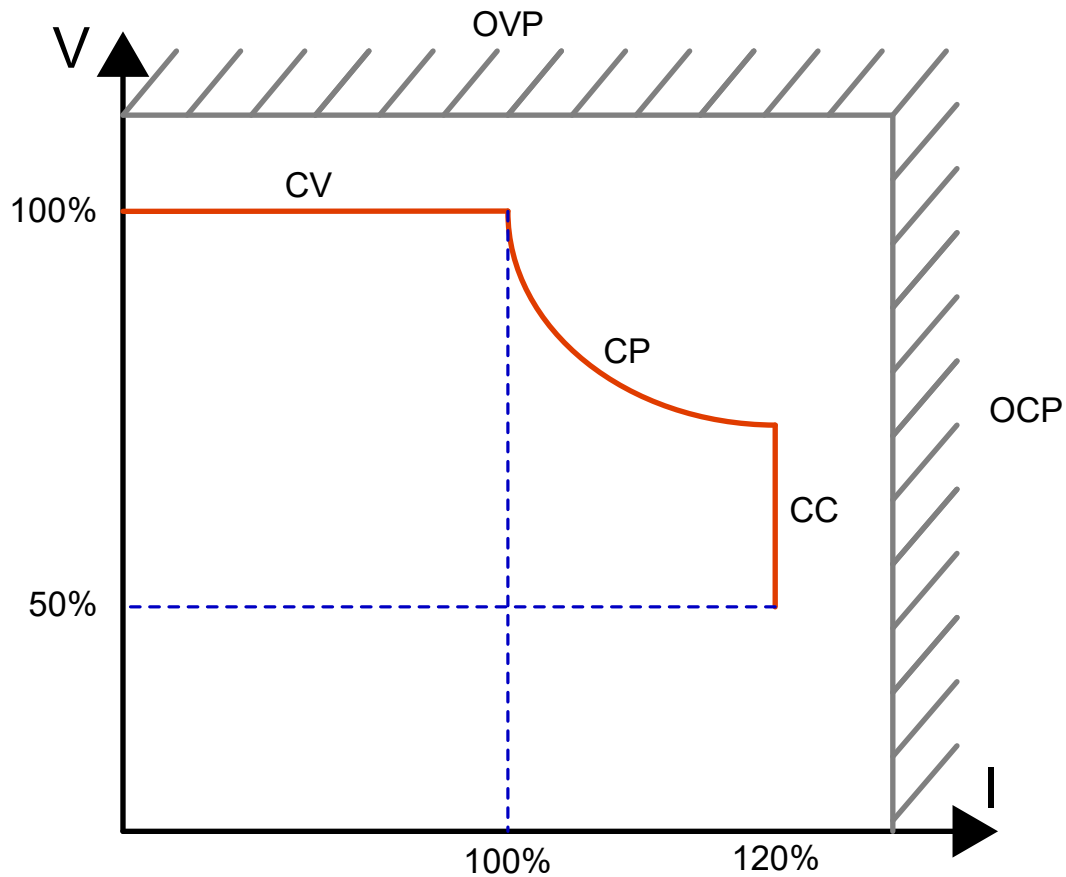
### Phase shift modulation strategy

- Easy digital implementation
- All switches are at 50% duty cycle
- Natural middle point voltage balancing

### Three level primary and secondary voltage

- Multiple degrees of freedom
- Reduce the power transfer inductor size
- Very Low harmonic content

# Operation regions and detailed specifications of 7.4 kW DC-DC stage



I-V and operation regions of the OBC

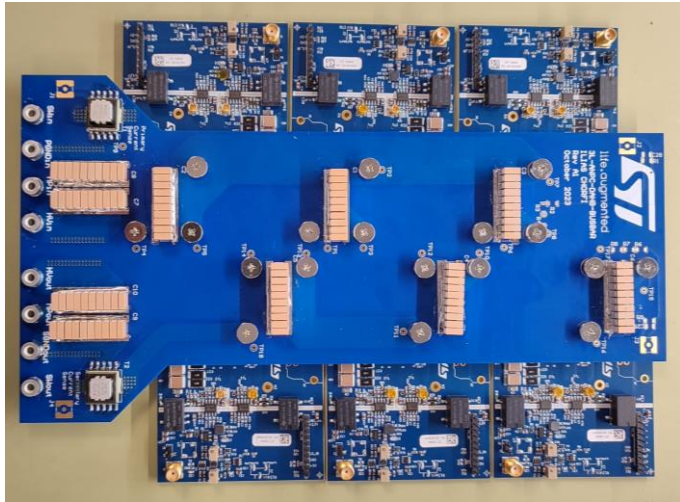
Converter must be able to operate at CC, CV and CP in order to properly charge a Li-Ion battery

Nominal operation curve (Red line) defined by the software (& BMS)

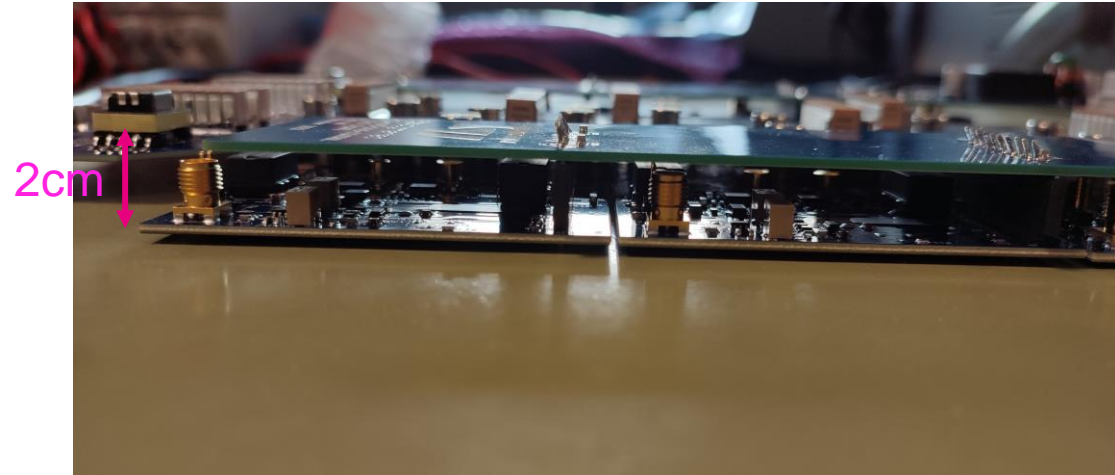
Voltage and current limitations defined by hardware to avoid destruction of the converter. Over-temperature results in power derating



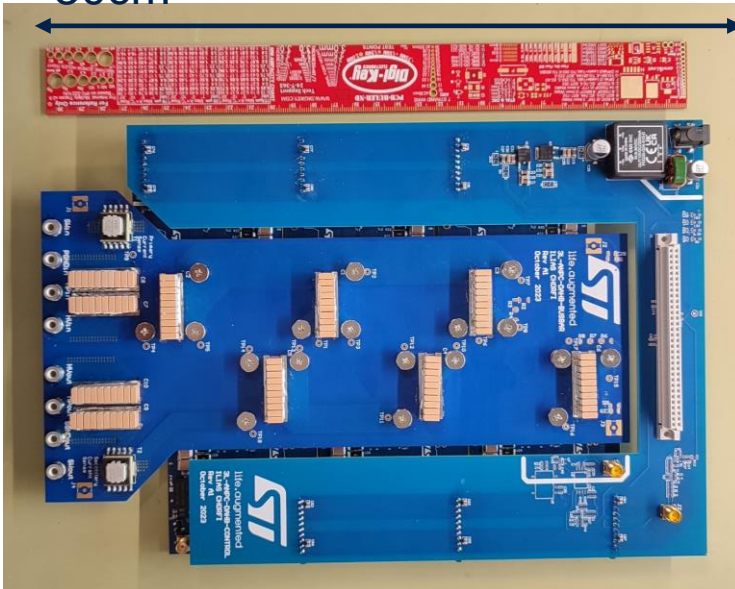
# 7.4 kW, 300 kHz Liquid-cooled prototype



30cm



2cm



20cm

Stacked design for better modularity and easier to debug

Compatible with all the top-side cooled GaN packages

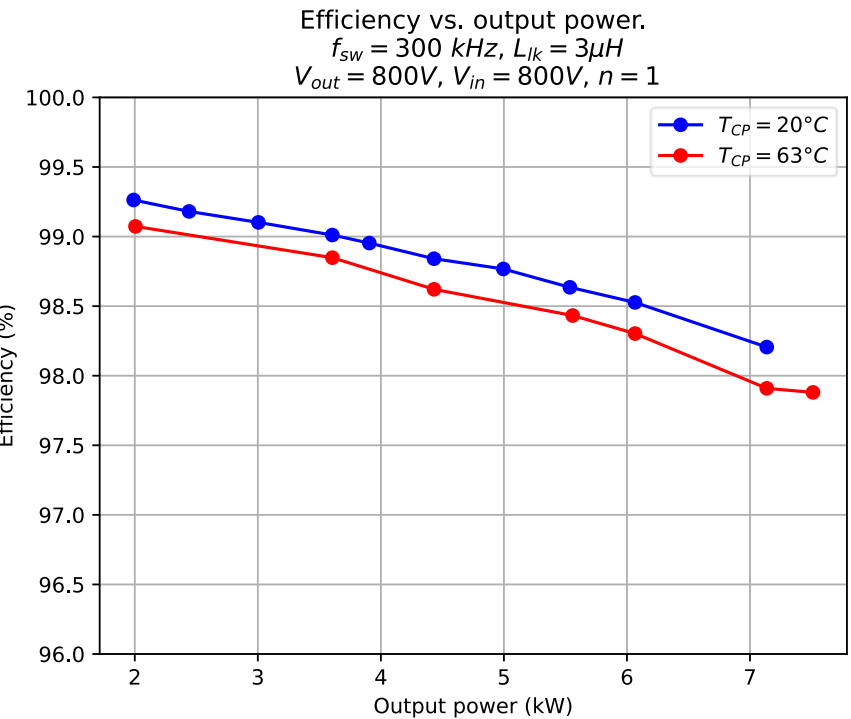
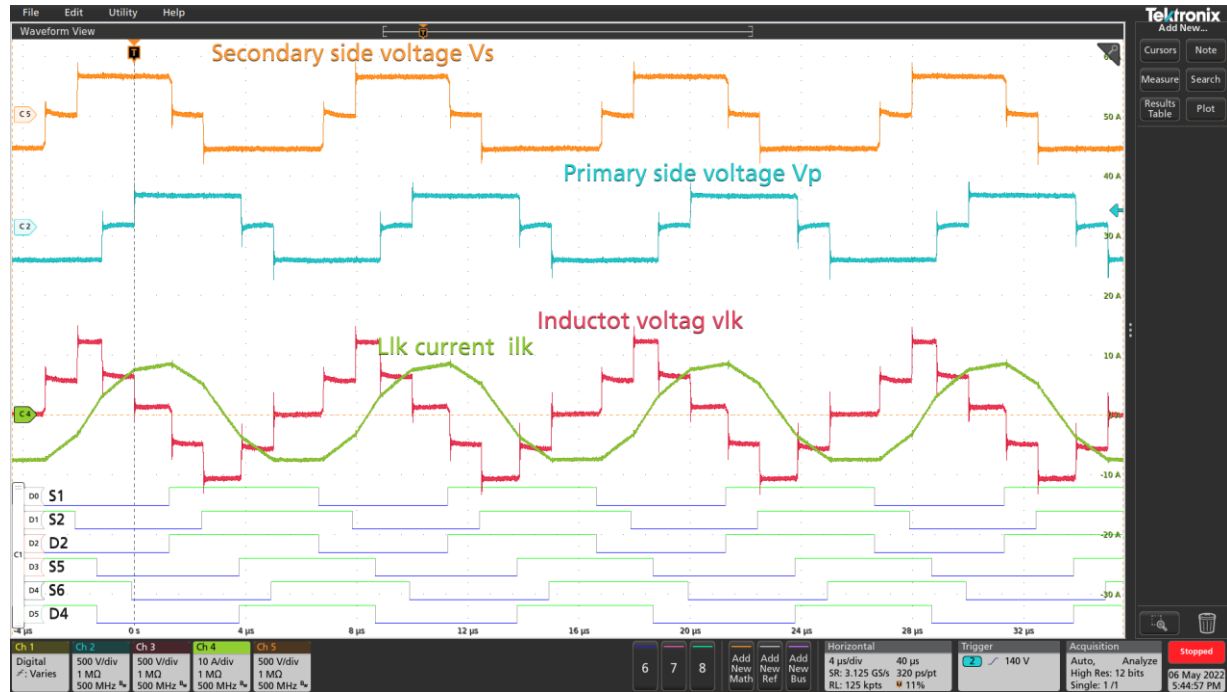
Volume = 1.2 L -> Power density = 6.2 kW/L







# Experimental results



Efficiency using SGT40R65ALD GaN devices with cold plate temperature of 20°C and 63°C (automotive cold plate)

7.4 kW operation is achieved at  $f_{sw}=300 \text{ kHz}$  while maintaining good efficiency

