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15kW Bi-directional Vienna PFC

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Power Discrete Group – Product Marketing Manager

Agenda

1 Demo board Introduction

2 Modified Vienna Topology Comparison

3 Bidirectional PFC architecture and control

4 Demo board summary

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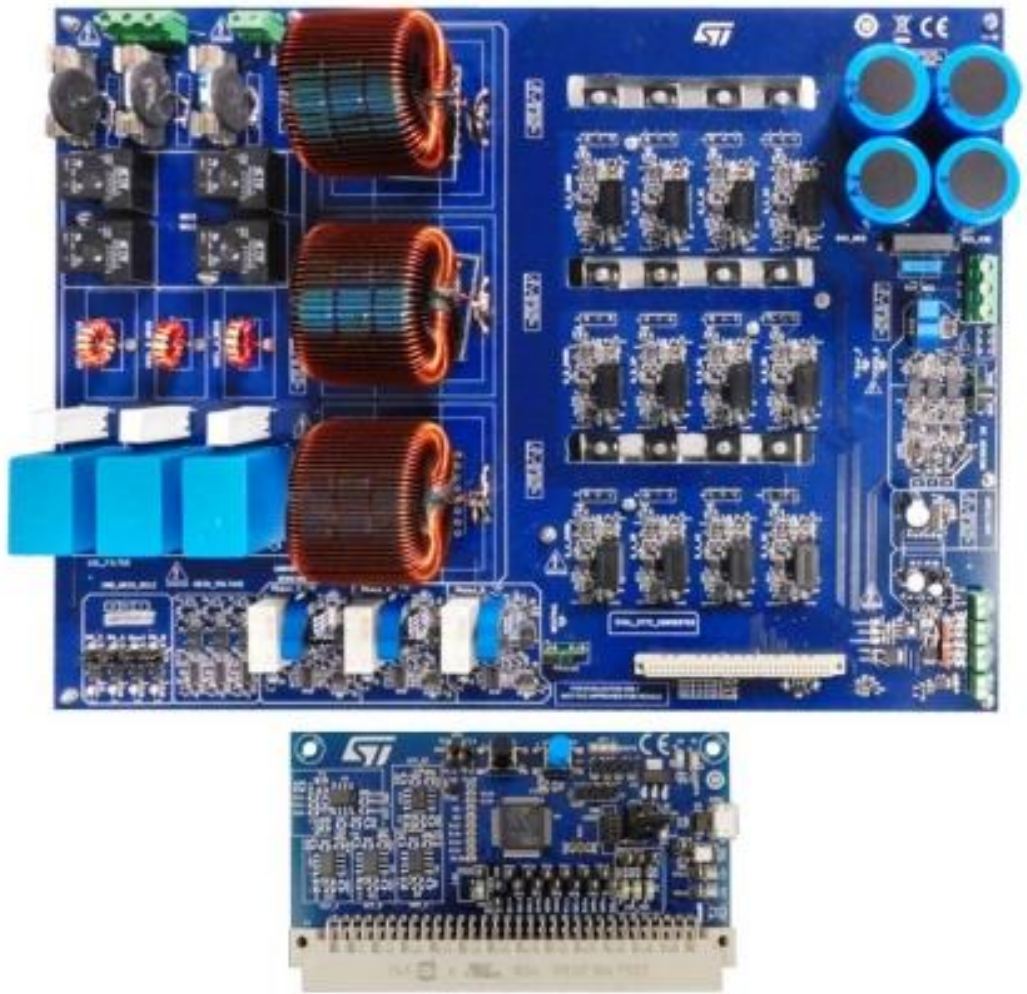
15kW 3L T-Type Converter PFC



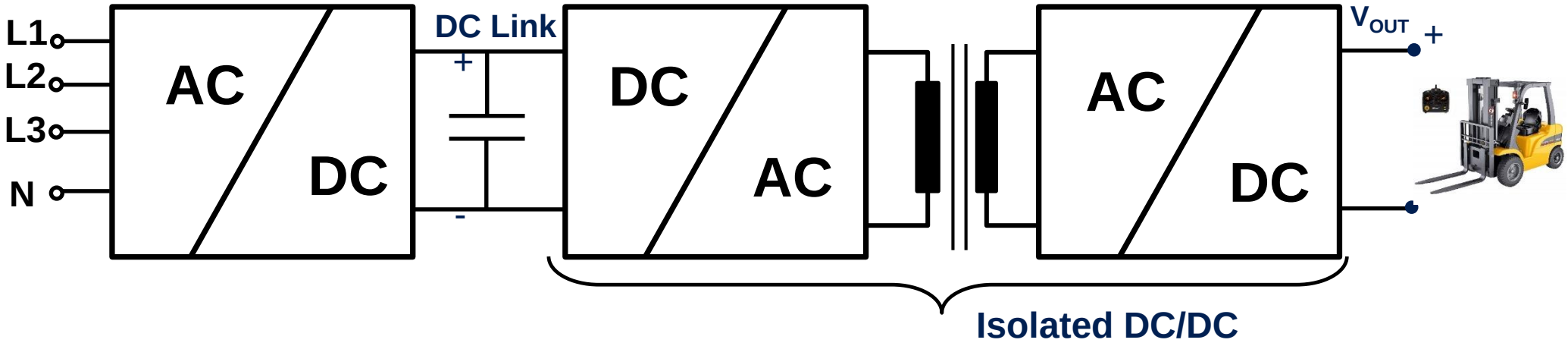
Main specs

- Pout = 15kW @ Vin = 380Vac & Vout =800V
- PF > 0.98 @ 20% load
- THD < 5% @ 20% load ɲ>97% @ 20% load
- CCM decoupling current control loop
- Active & Reactive power control
- Grid Connection capability
- Switching frequency = 70kHz
- I_ripple = 2.5A
- VDC_ripple = 10Vpp

Key products

- **STM32G474** (32 bit Microcontroller)
- **SCTW40N120G2V** (70mΩ 1200V SiC MOSFET)
- **SCTW35N65G2V** (55mΩ 650V SiC MOSFET)
- **STGAP2S** (Galvanic Isolated Gate Driver)
- **STPS1L30A, STPS2H100A, STTH1L06A, STPS1150A, STPS2L60A** (SiC, Schottky and Ultrafast diodes)
- **STS6NF20V** (N-channel 20 V, STripFET II Power MOSFET)
- **TSV911IDT, TSV912IDT, TSV914IDT** (wide-bandwidth rail to rail Op-Amps)
- **STLM20W87F** (Analog temperature sensor)
- **LD29080DT50R, LD29080S33R**, (LDOs)
- **VIPer26K** (High Voltage Converter)

Industrial On-board Charger
System Concept



Parameter	Value
Input voltage	L_x-L_y → 400 V_{AC} L_x-N → 230 V_{AC}
DC Link Voltage	400..1000 V
Nominal Power	11..22 kW
Output Voltage	200..500 V_{DC} for 400 V_{DC} Batteries 500..900 V_{DC} for 800 V_{DC} Batteries

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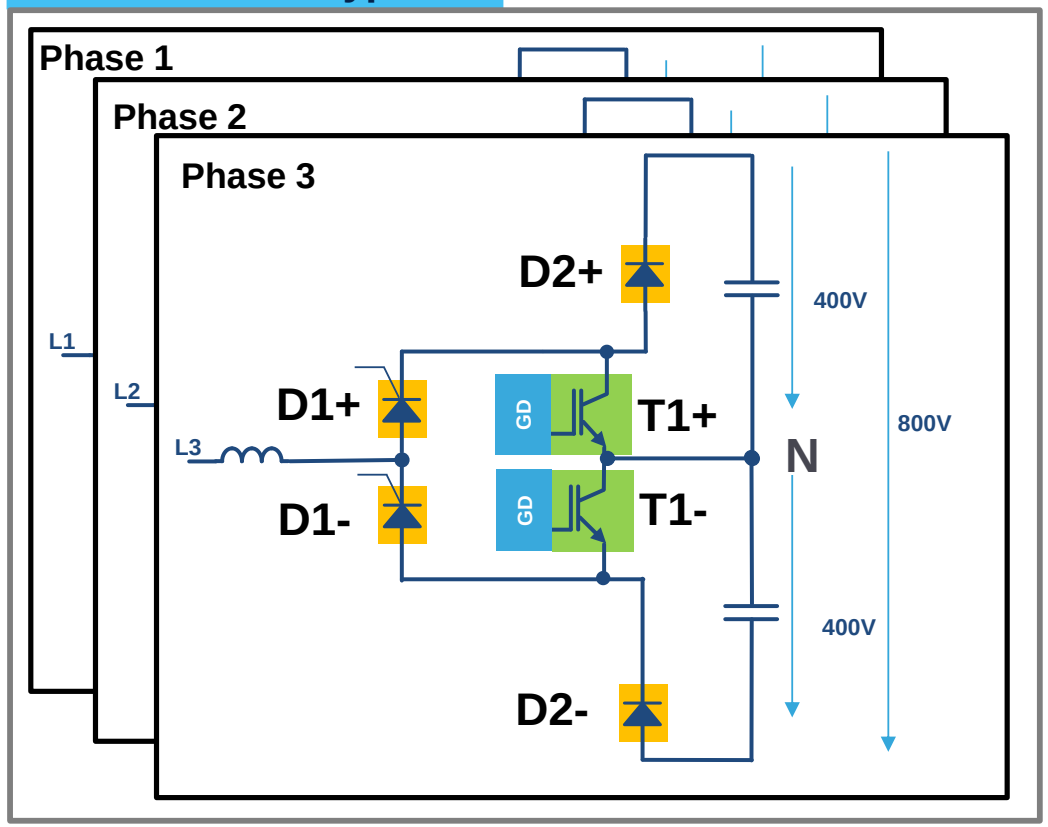
Modified Vienna Rectifier Topology Comparison

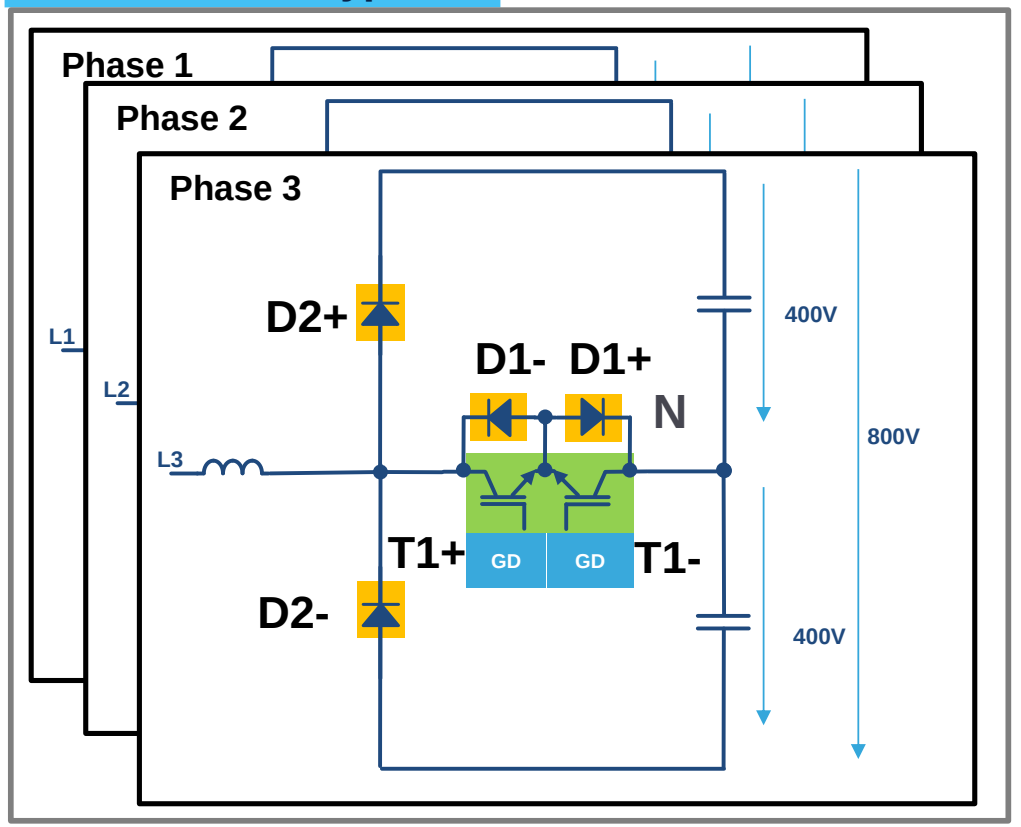
Mod. Vienna Type 1



+ All 650V rated devices
→ lower cost

- 2 devices in the main current path (D1&D2) → lower efficiency

Mod. Vienna Type 2



+ 1 devices in the main current path (D2)
→ Higher efficiency

- Need 1200V diodes (D2), typically SiC.
→ Higher cost

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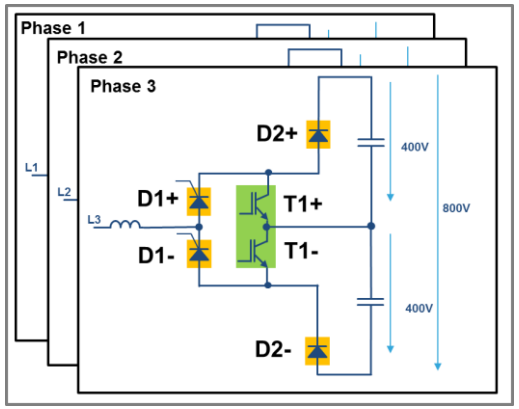
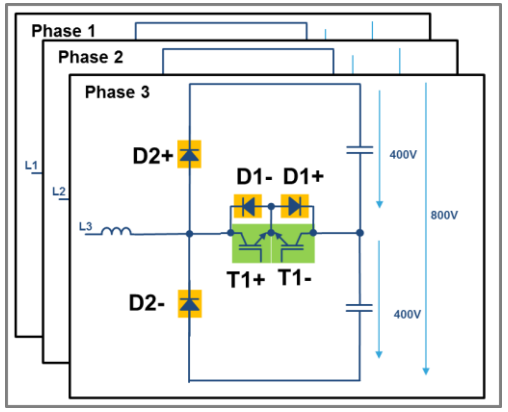
Topology Comparison

Efficiency Comparison @ P_{out}=20 kW

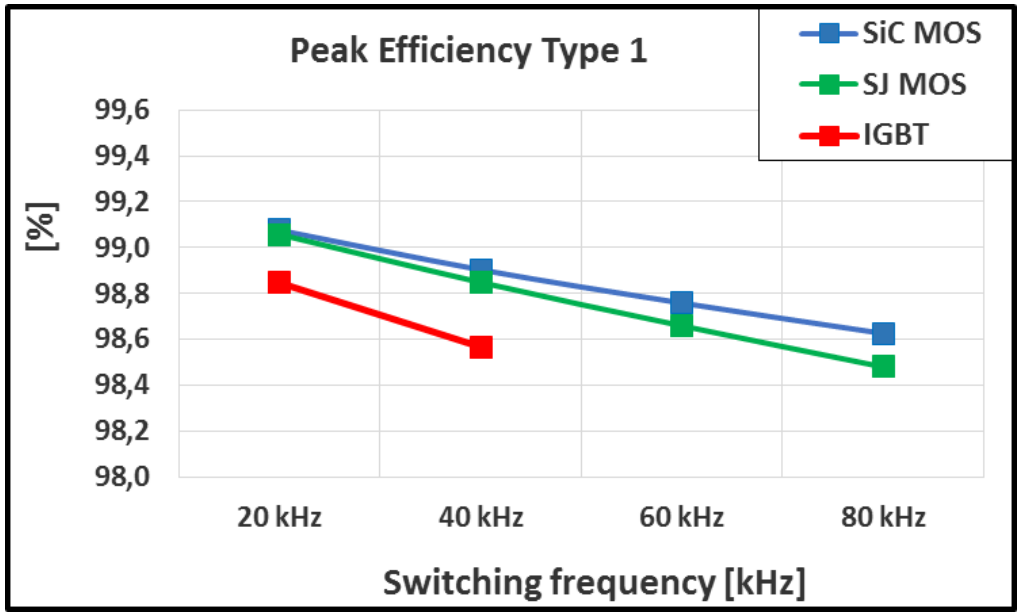
Vienna rectifier Type 1

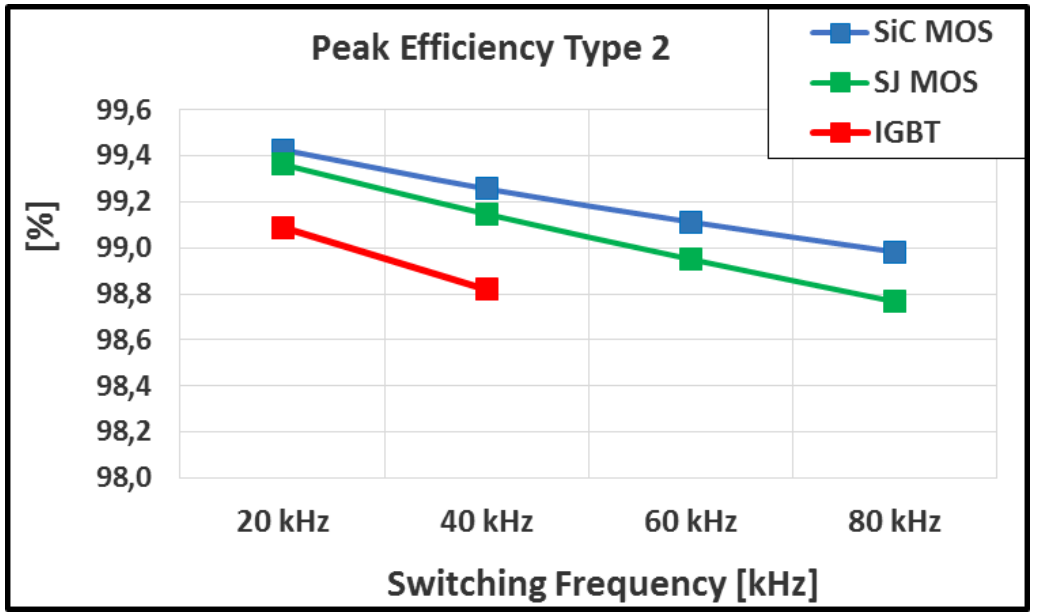


Vienna rectifier Type 2



	Mod. Vienna Type 1	Mod. Vienna Type 2
D1	STBR6012W	---------
T1	STGW40H65DFB-4 STW88N65M5-4 SCTW90N65G2V-4	
D2	STPSC40065C	STPSC40H12C





Simulated efficiency @ T_j = 125°C, considering only semiconductor losses.

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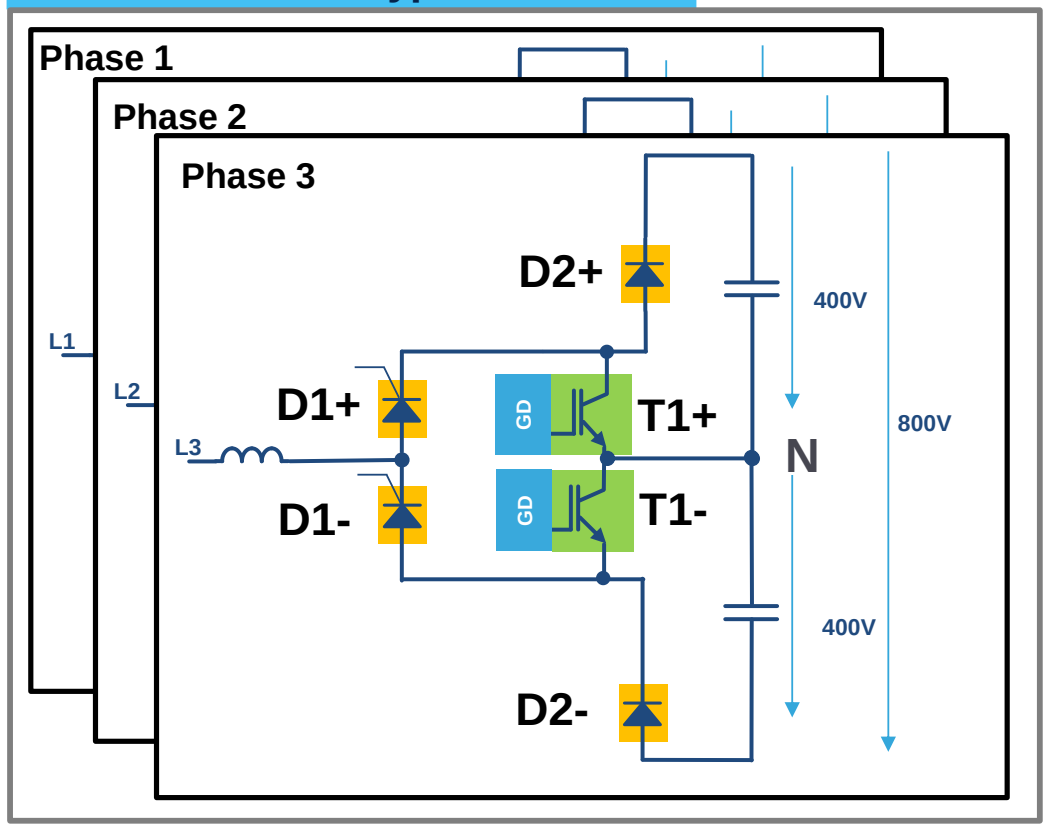
Modified Vienna Rectifier Topology Comparison

Modified Vienna Type 1



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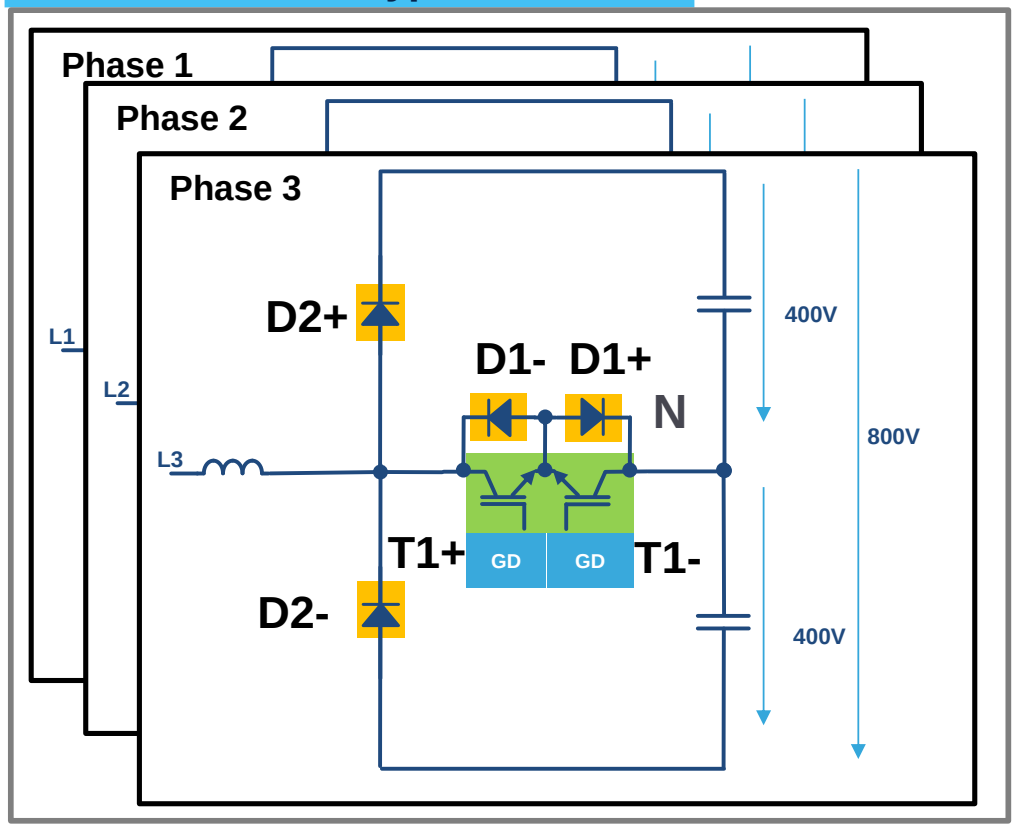
Modified Vienna Type 2



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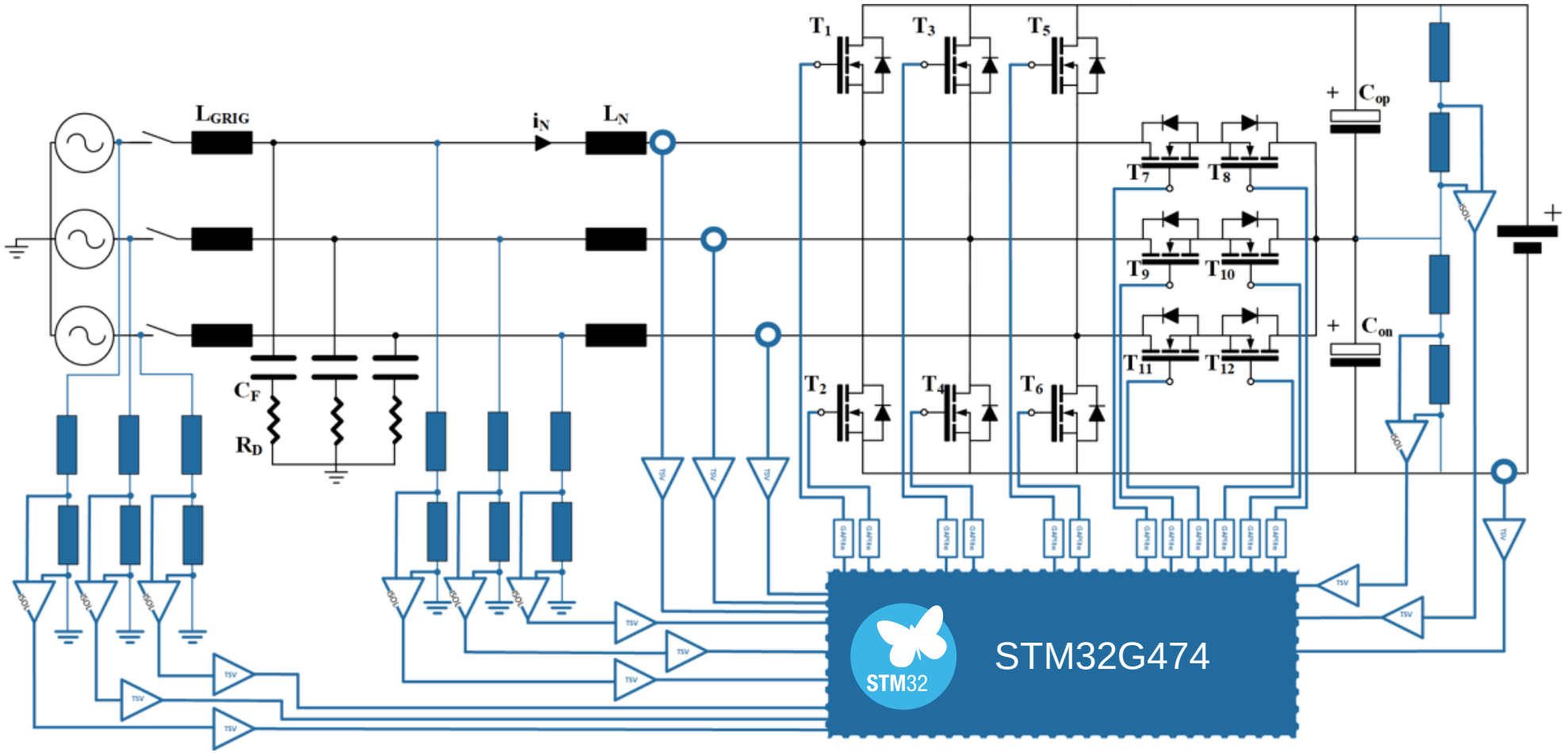
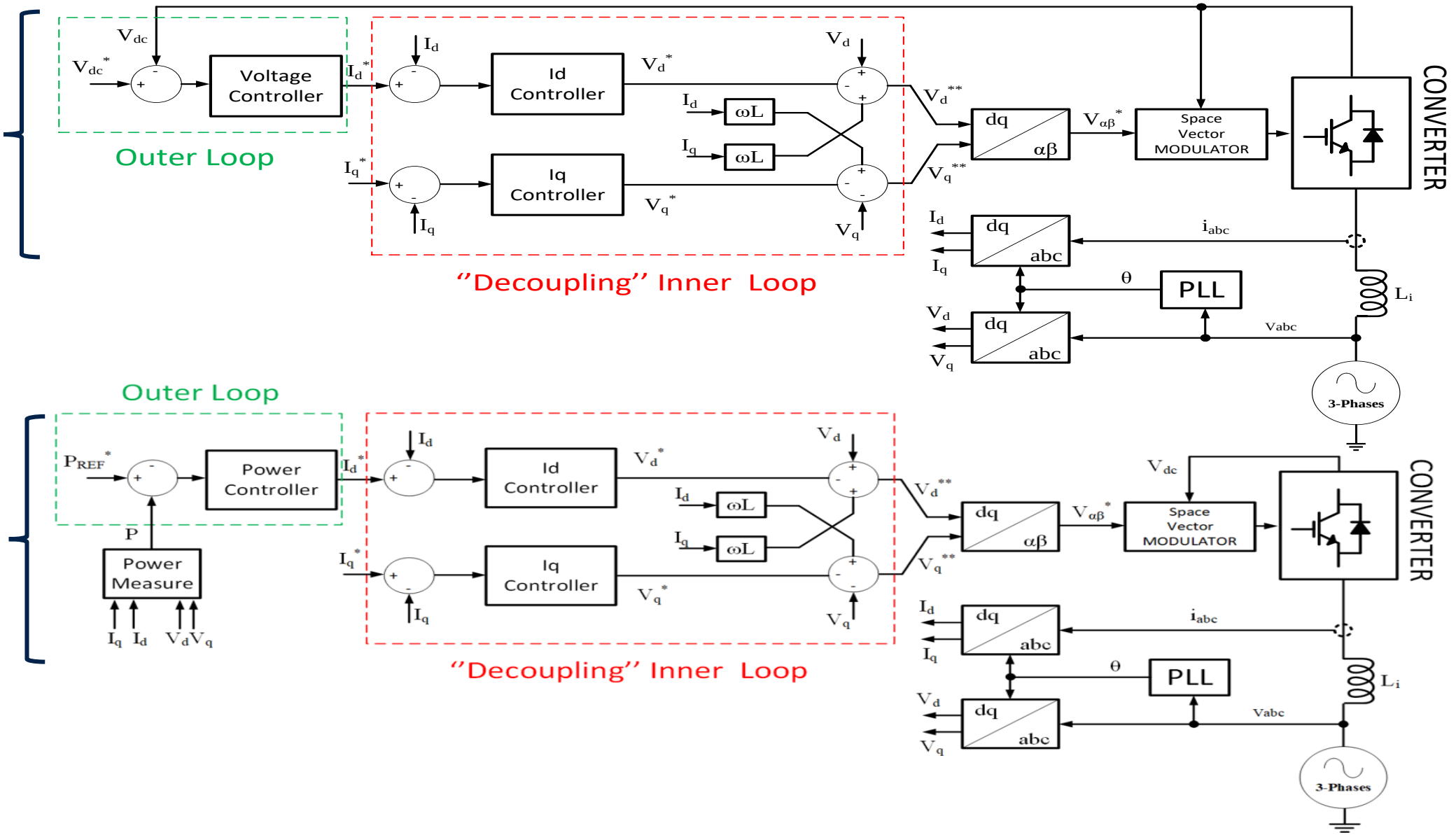
Bidirectional PFC - system architecture



Bidirectional Control

Grid to Battery

Battery to Grid



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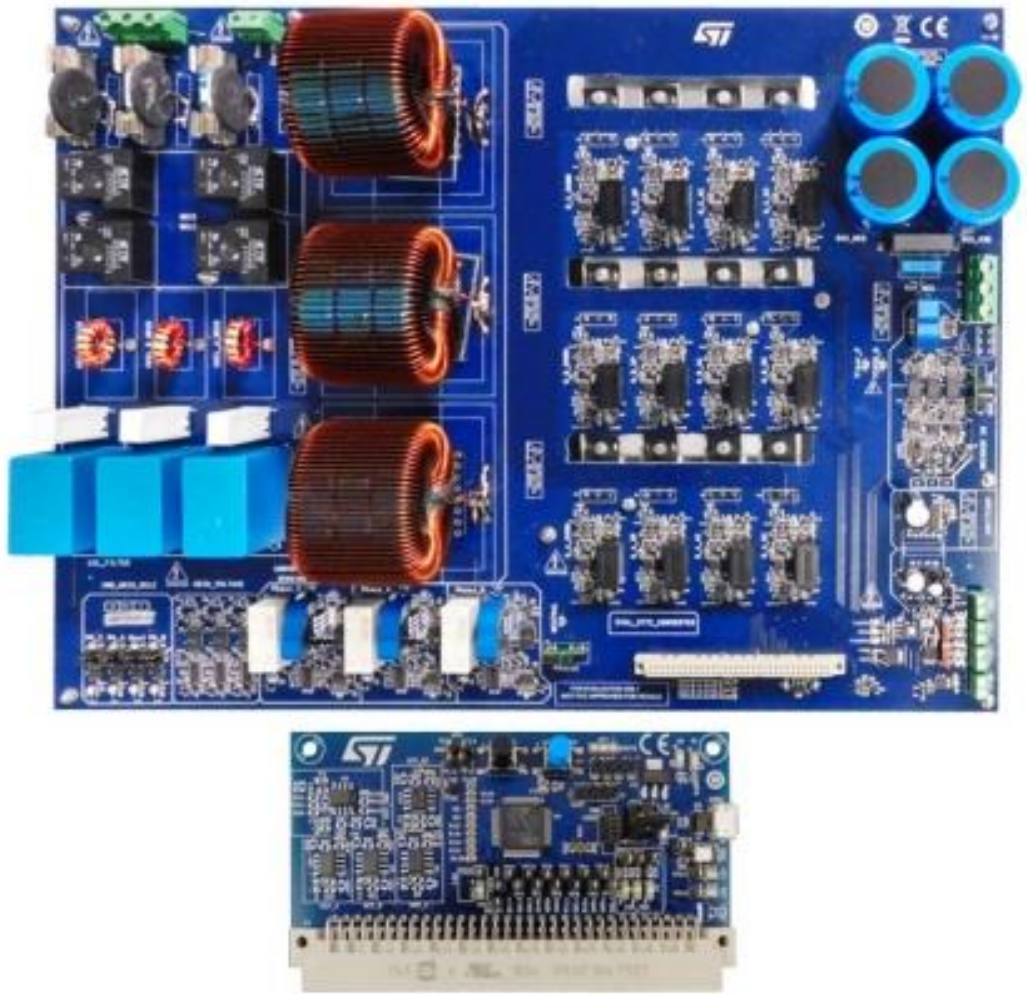

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Thank you

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