

Potential GaN Bidirectional Switch Applications

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Outline

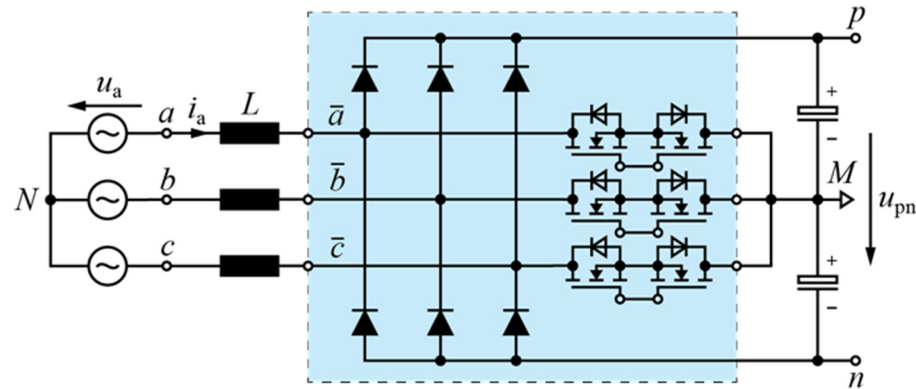
- ▶ *3- Φ PFC Rectifier Topologies*
- ▶ *3- Φ Motor Drive Topologies*



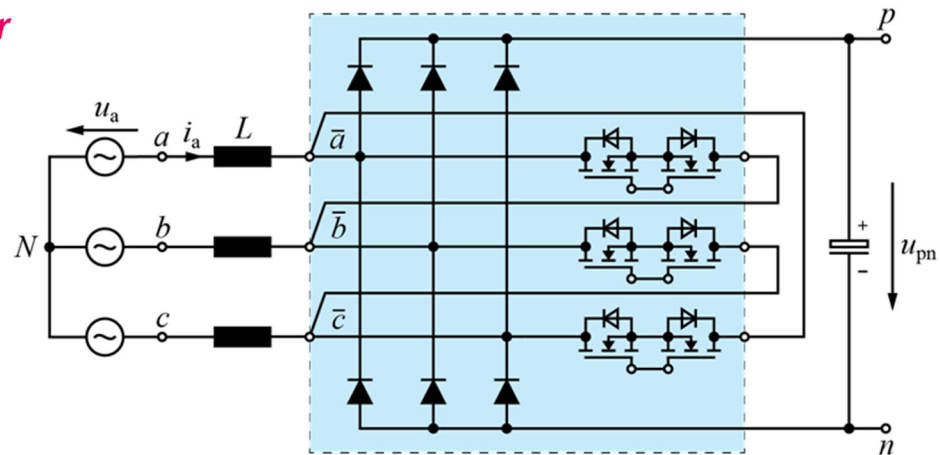
————— *3- Φ PFC Rectifier Topologies* —————

3- Φ PFC Rectifier Topologies

■ Vienna Rectifier



■ Delta-Switch Rectifier



Vienna Rectifier

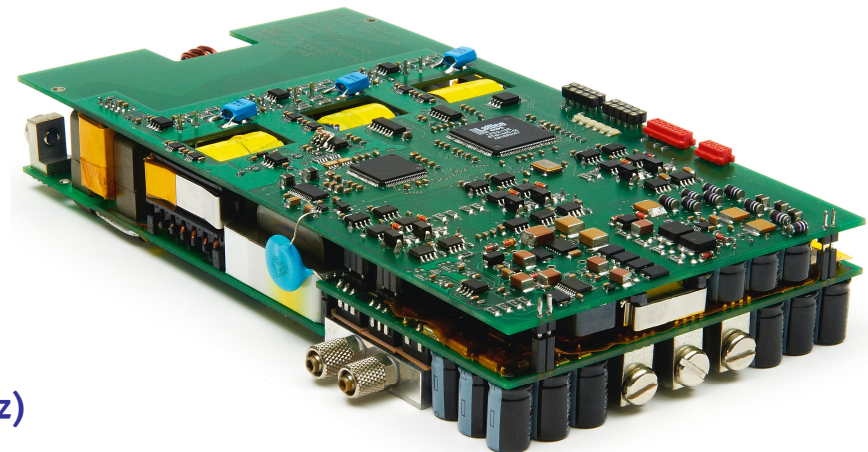
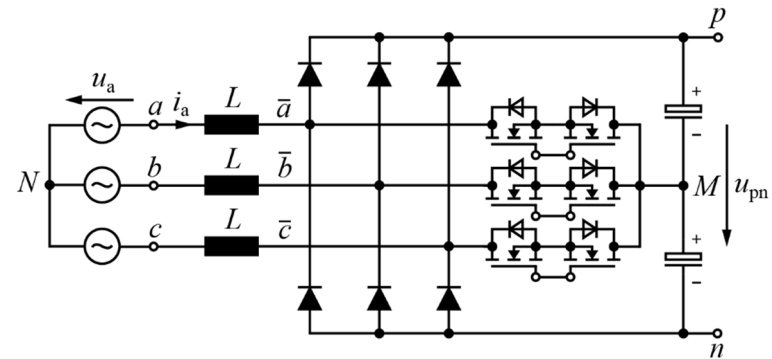
- Highly-Compact Demonstrator System
- **CoolMOS & SiC Diodes**
- Coldplate Cooling

$P_o = 10 \text{ kW}$
 $U_N = 400V_{AC} \pm 10\%$
 $f_N = 50\text{Hz or } 360 \dots 800\text{Hz}$
 $U_o = 800V_{DC}$

$\eta = 96.8\%$

★ $\rho = 10 \text{ kW/dm}^3$

► $THD_i = 1.6\% @ f_N = 800\text{Hz} (f_p = 250\text{kHz})$



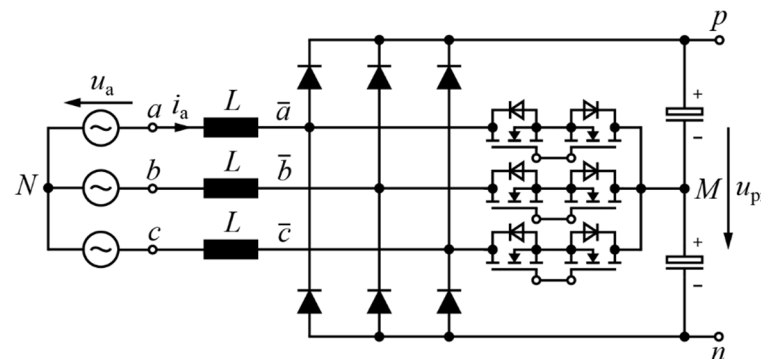
Vienna Rectifier

- Highly-Compact Demonstrator System
- CoolMOS & SiC Diodes
- Coldplate Cooling

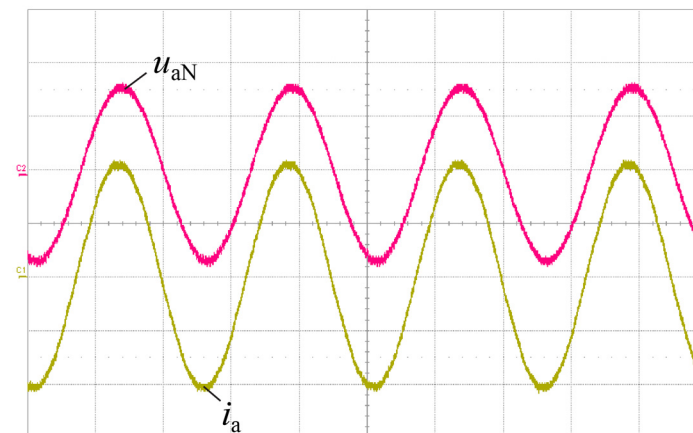
$P_o = 10 \text{ kW}$
 $U_N = 400V_{AC} \pm 10\%$
 $f_N = 50\text{Hz or } 360 \dots 800\text{Hz}$
 $U_o = 800V_{DC}$

$\eta = 96.8\%$
 $\rho = 10 \text{ kW/dm}^3$
 $f_p = 250\text{kHz}$

- ▶ $THD_i = 1.6\% @ f_N = 800\text{Hz}$
- ▶ System Allows 2- Φ Operation

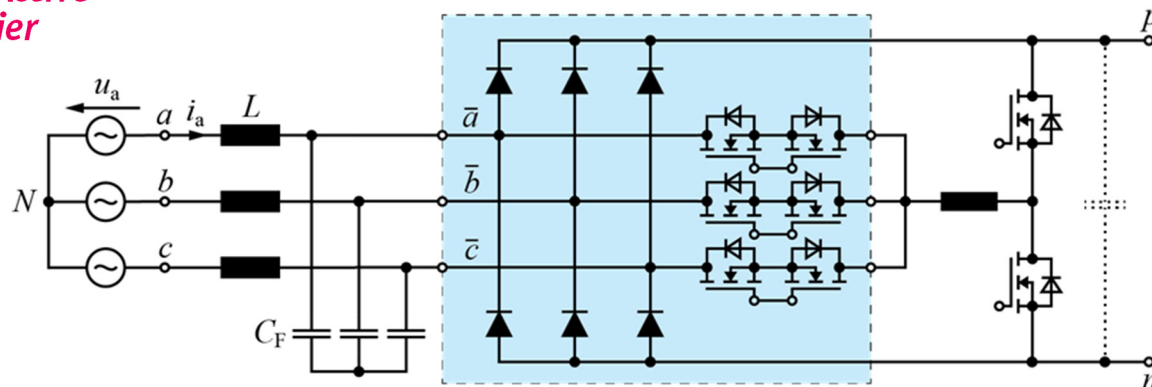


10A/Div
 200V/Div
 0.5ms/Div

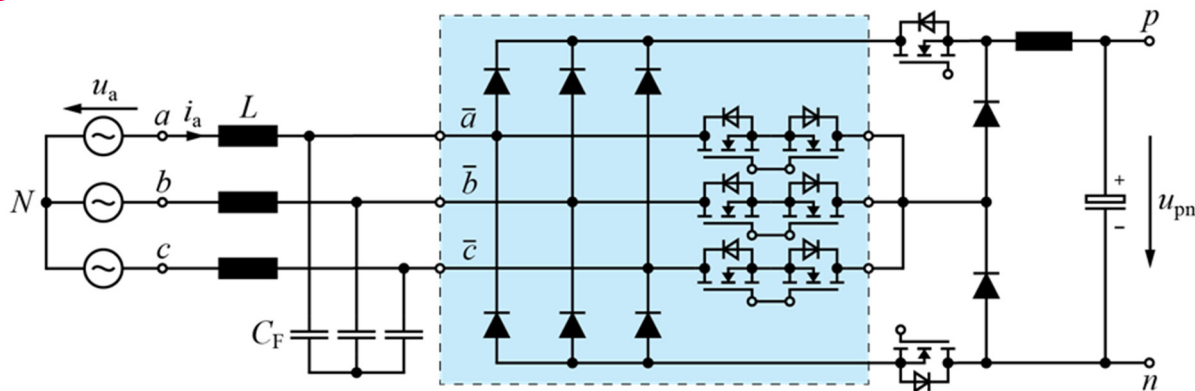


3- Φ PFC Rectifier Topologies

- **Integrated Active Filter Rectifier**



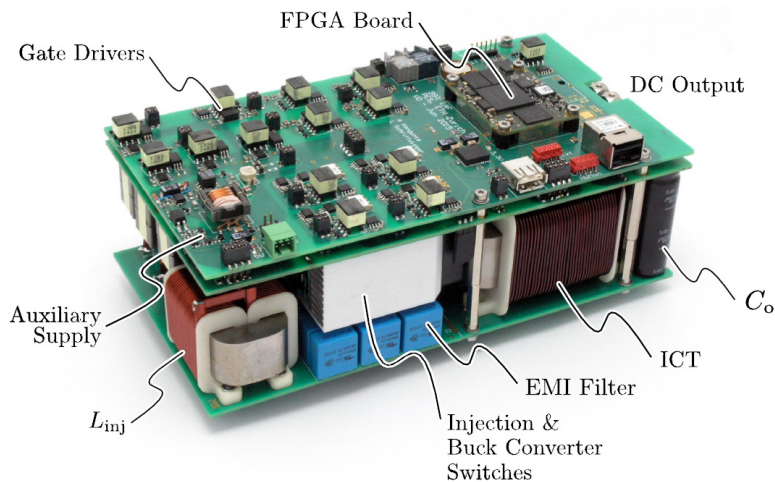
- **SWISS Rectifier**



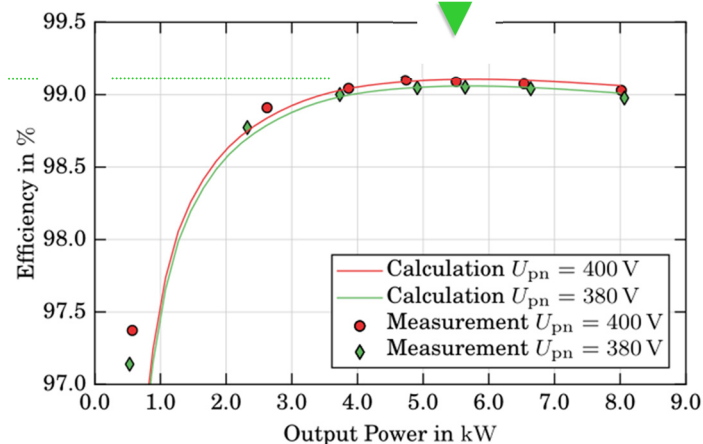
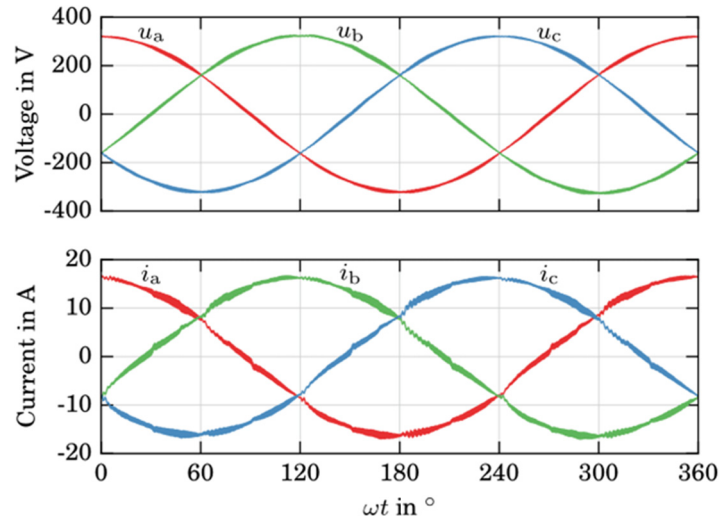
IAF Rectifier Demonstrator

- Efficiency $\eta > 99.1\%$ @ 60% Rated Load
- Mains Current $THD_I \approx 2\%$ @ Rated Load
- Power Density $\rho \approx 4\text{kW}/\text{dm}^3$

$P_o = 8\text{ kW}$
 $U_N = 400\text{V}_{AC} \rightarrow U_o = 400\text{V}_{DC}$
 $f_s = 27\text{kHz}$



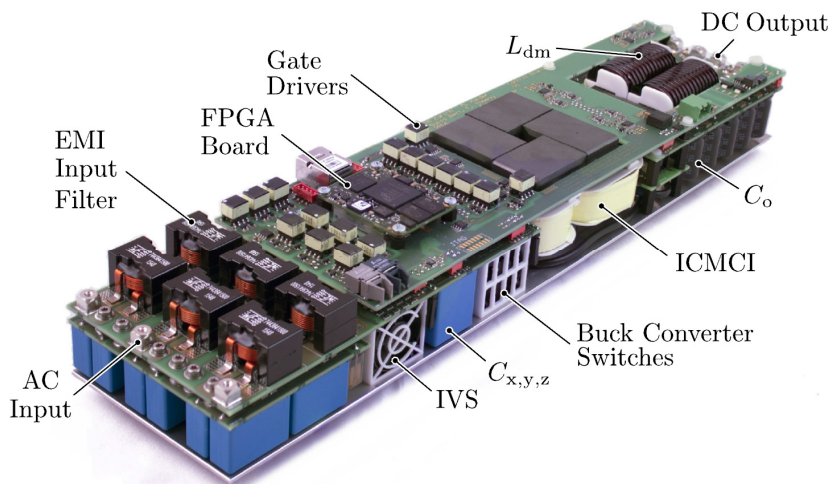
- ▶ SiC Power MOSFETs & Diodes
- ▶ 2 Interleaved Buck Output Stages



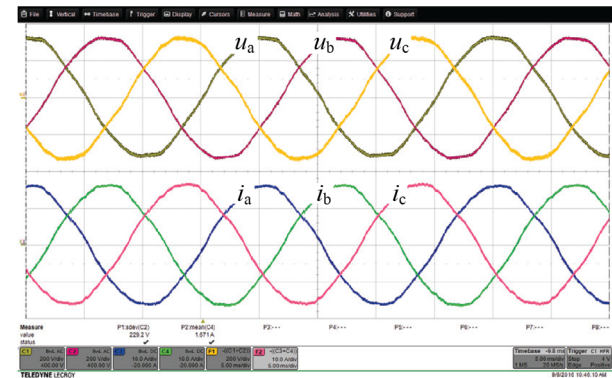
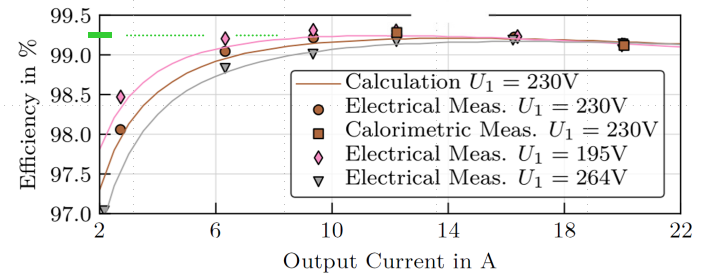
Swiss Rectifier Demonstrator

- Efficiency $\eta = 99.26\%$ @ 60% Rated Load
- Mains Current $THD_I \approx 0.5\%$ @ Rated Load
- Power Density $\rho \approx 4\text{kW}/\text{dm}^3$

$P_o = 8\text{ kW}$
 $U_N = 400\text{V}_{AC} \rightarrow U_o = 400\text{V}_{DC}$
 $f_s = 27\text{kHz}$

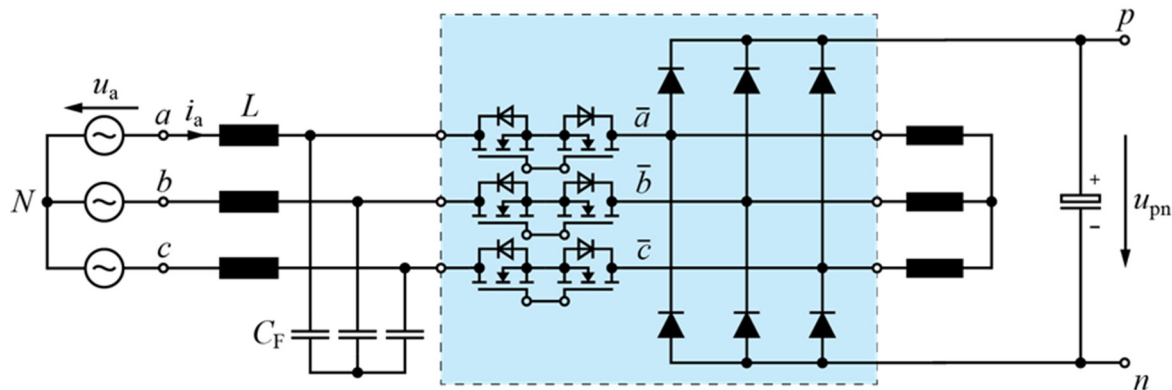


- ▶ SiC Power MOSFETs & Diodes
- ▶ Integr. CM Coupled Output Inductors (ICMCI)



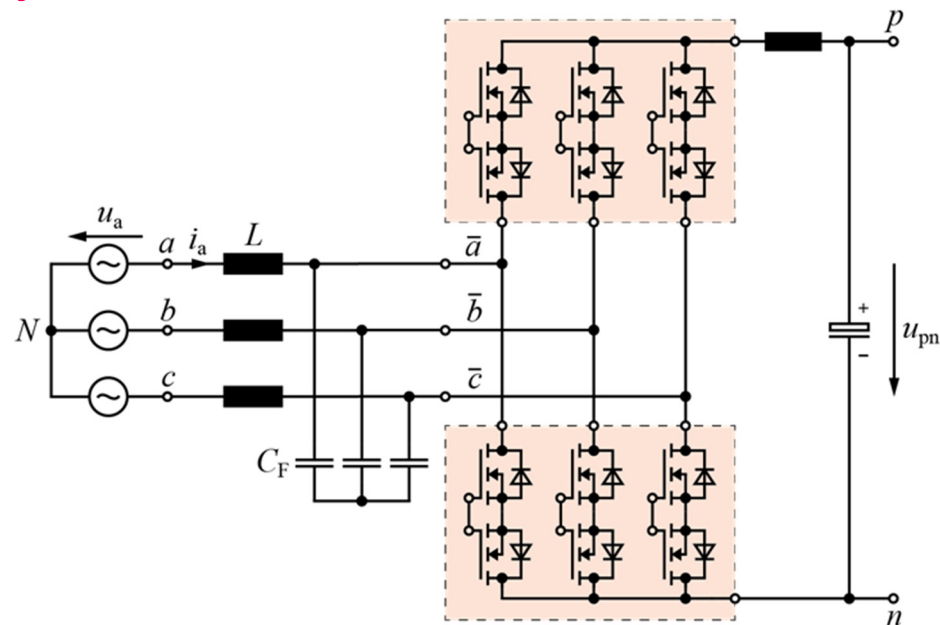
3- Φ PFC Rectifier Topologies

■ Buck-Boost Rectifier



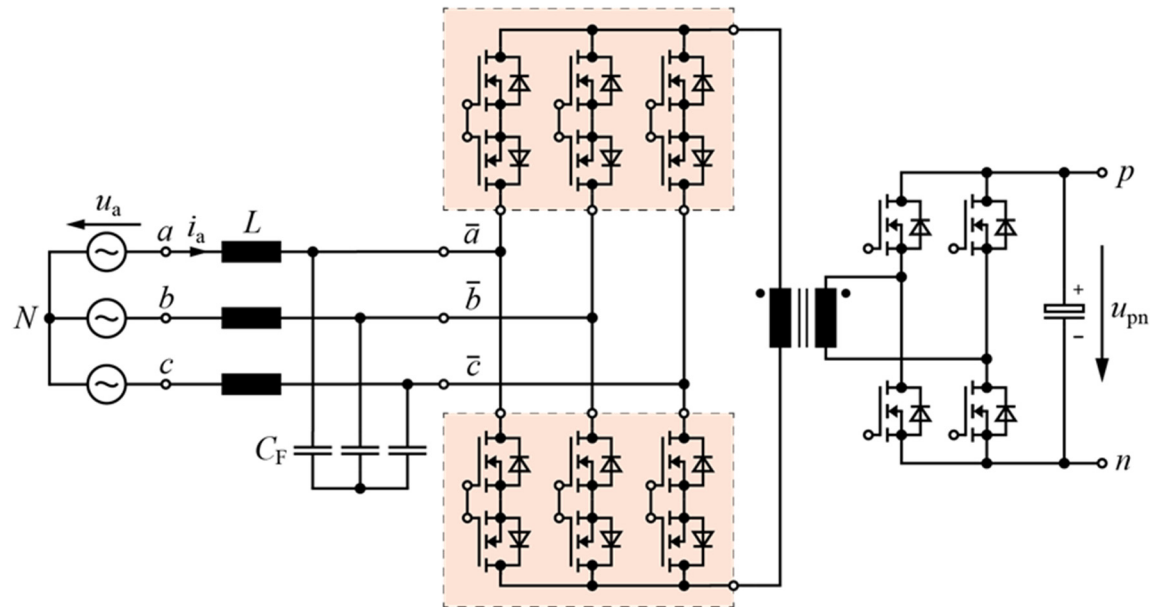
3- Φ PFC Rectifier Topologies

- *Bidirectional Unipolar Output Buck-Type Rectifier*



3- Φ PFC Rectifier Topologies

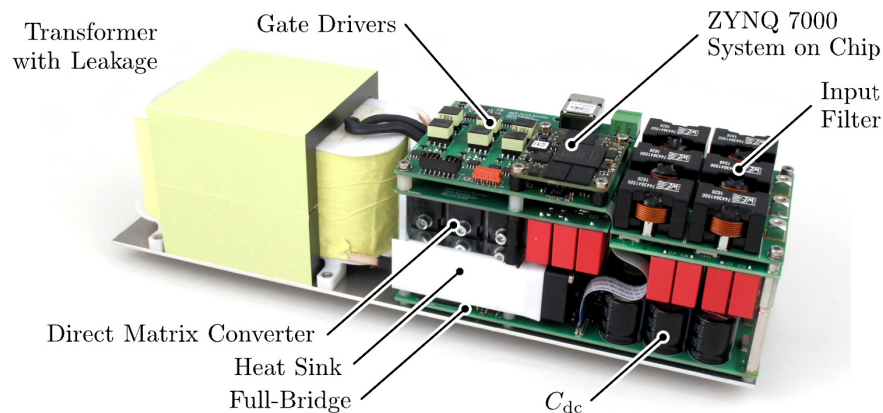
- *Isolated Matrix-Type Buck-Boost Rectifier*



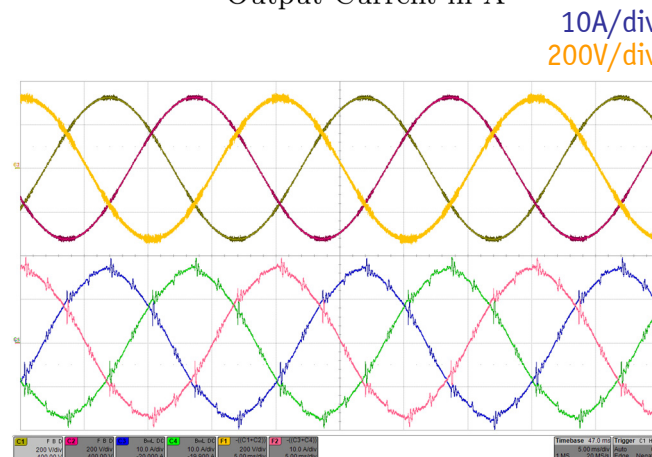
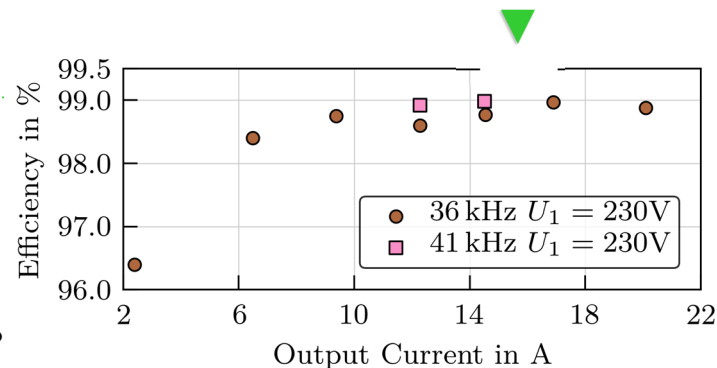
Isolated Matrix-Type PFC Rectifier

- Efficiency $\eta = 98.9\%$ @ 60% Rated Load (ZVS)
- Mains Current $THD_I \approx 4\%$ @ Rated Load
- Power Density $\rho \approx 4\text{kW}/\text{dm}^3$

$P_o = 8\text{ kW}$
 $U_N = 400\text{V}_{AC} \rightarrow U_o = 400\text{V}_{DC}$
 $f_s = 36\text{kHz}$



- ▶ 900V / 10mΩ SiC Power MOSFETs
- ▶ Opt. Modulation Based on 3D Look-Up Table

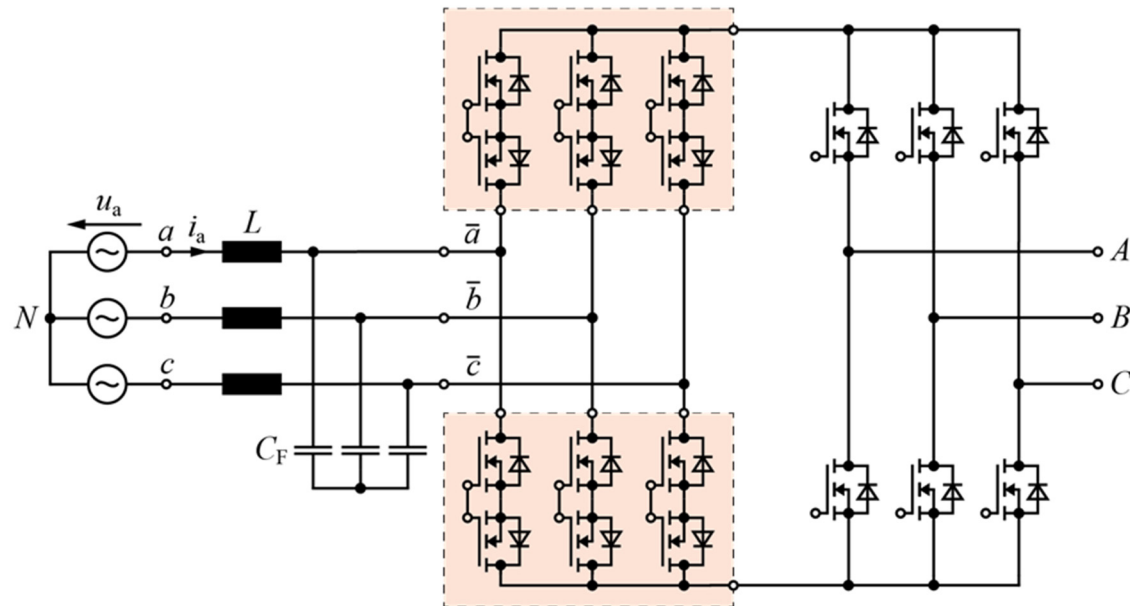


————— **3- Φ Motor Drive Topologies** —————

*All Rectifier Systems
Shown Before Could be
Used as **Inverters** if Built for
Bidirectional Power Transfer*

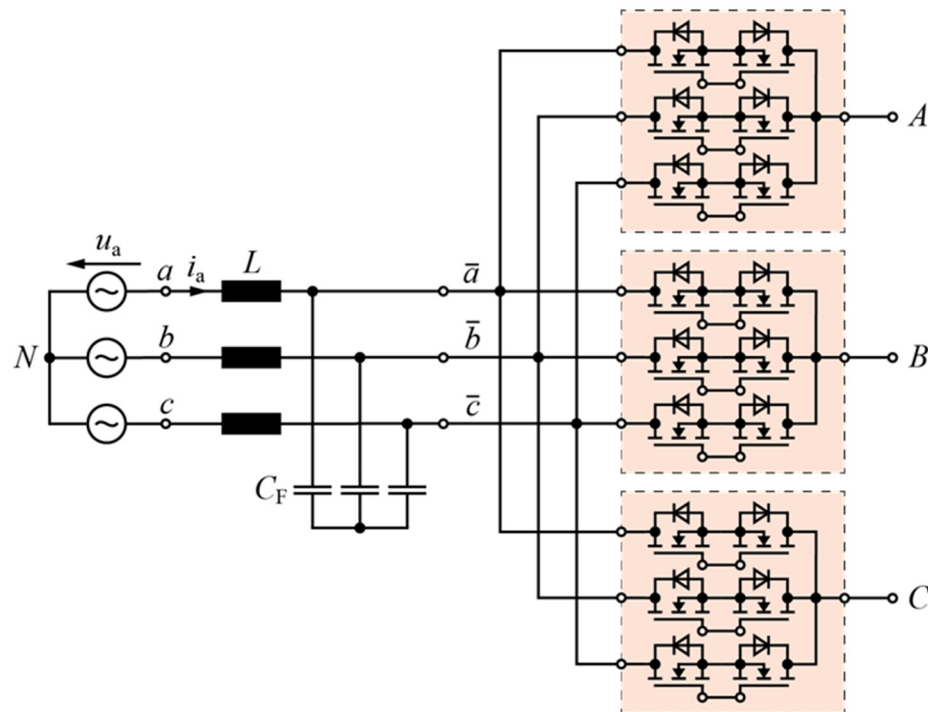
3- Φ Matrix Converter

■ Indirect Matrix Converter



3- Φ Matrix Converter

■ Direct Matrix Converter



Thank You !

