

EE463

STATIC POWER CONVERSION – I

HARDWARE PROJECT PRESENTATION

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OUTLINE

- Project Requirements
- Proper Topologies
- Simulation Results
- Analytical Calculations
- Component Selections
- Conclusion

Project Requirements

- Power input with 3-phase or 1-phase AC grid (Adjustable with variac)
- Output: Adjustable DC output ($V_{out,max} = 180V$)

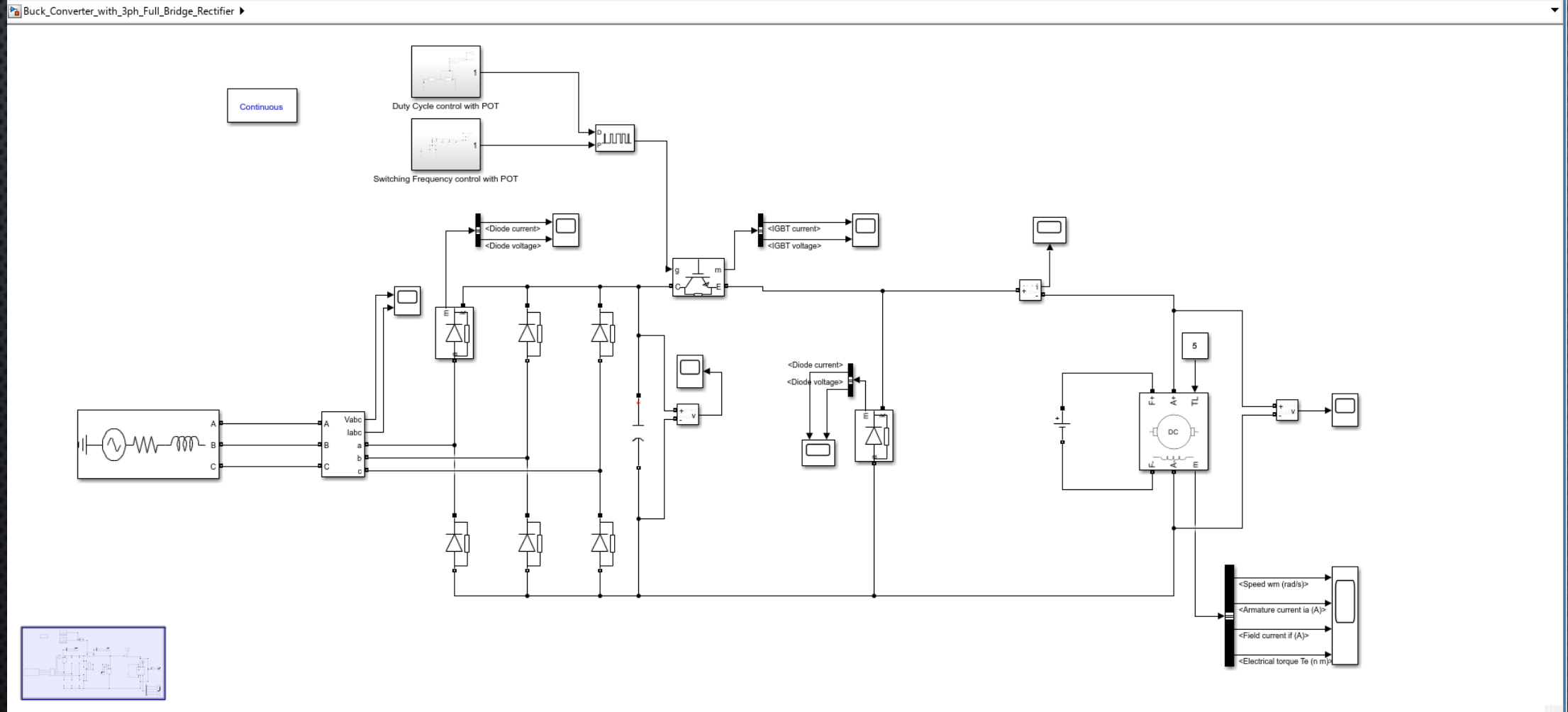


Proper Topologies

- Thyristor rectifier
 - Better for high power applications
 - Phase control is possible
 - Control circuitry is complex and costly
- Dimmer circuit
 - Easier to control output voltage level
 - Easier to utilize four-quadrant operation
 - Control circuitry is complex and costly
 - Requires high filtering components
- Diode rectifier and buck converter
 - Easier to construct
 - Easier to control output voltage level
 - Basic control circuitry
 - Lacks phase control

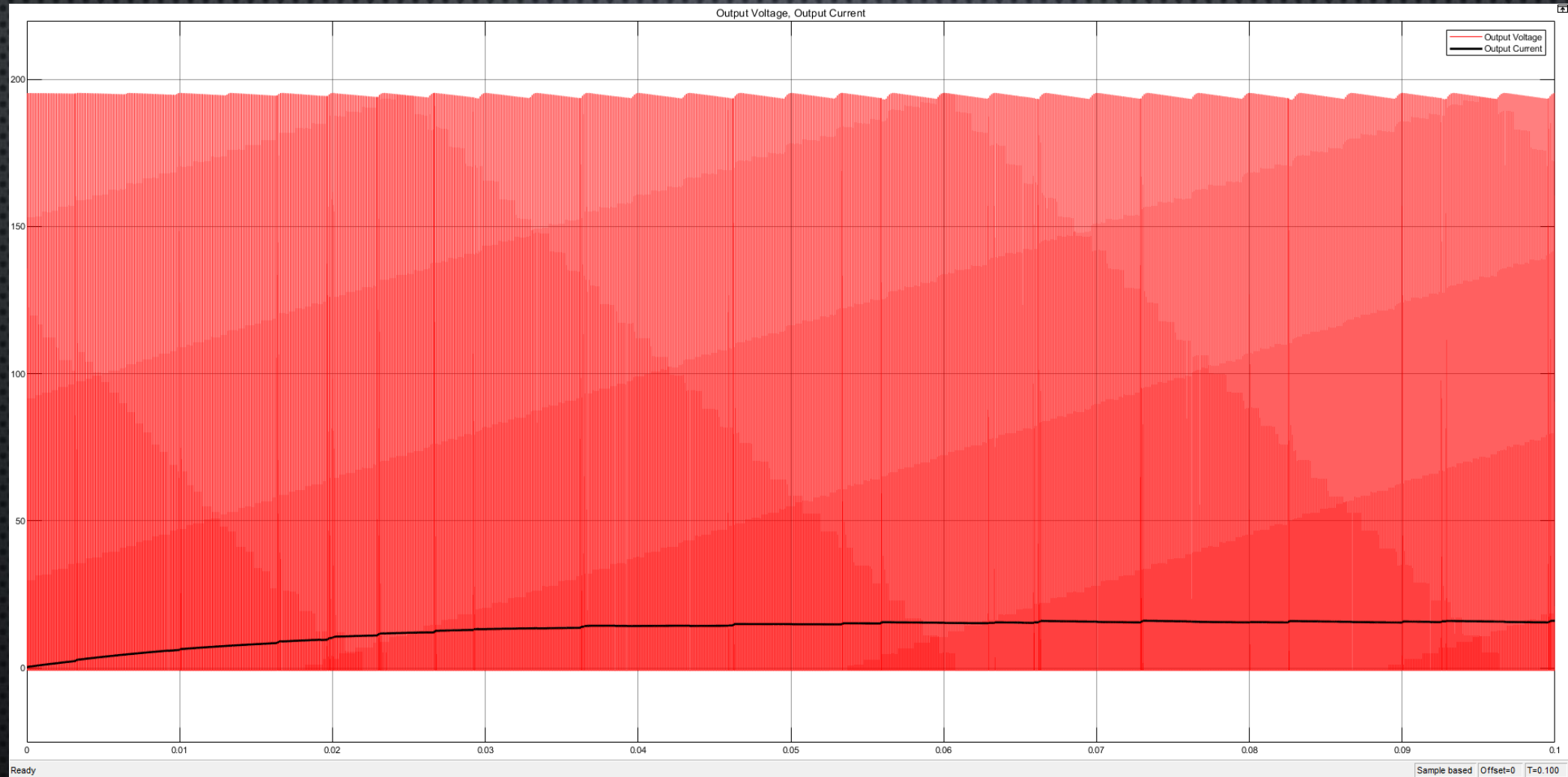
Selected Topology

Diode Rectifier and Buck Converter with manual
Duty Cycle and Switching Frequency Control



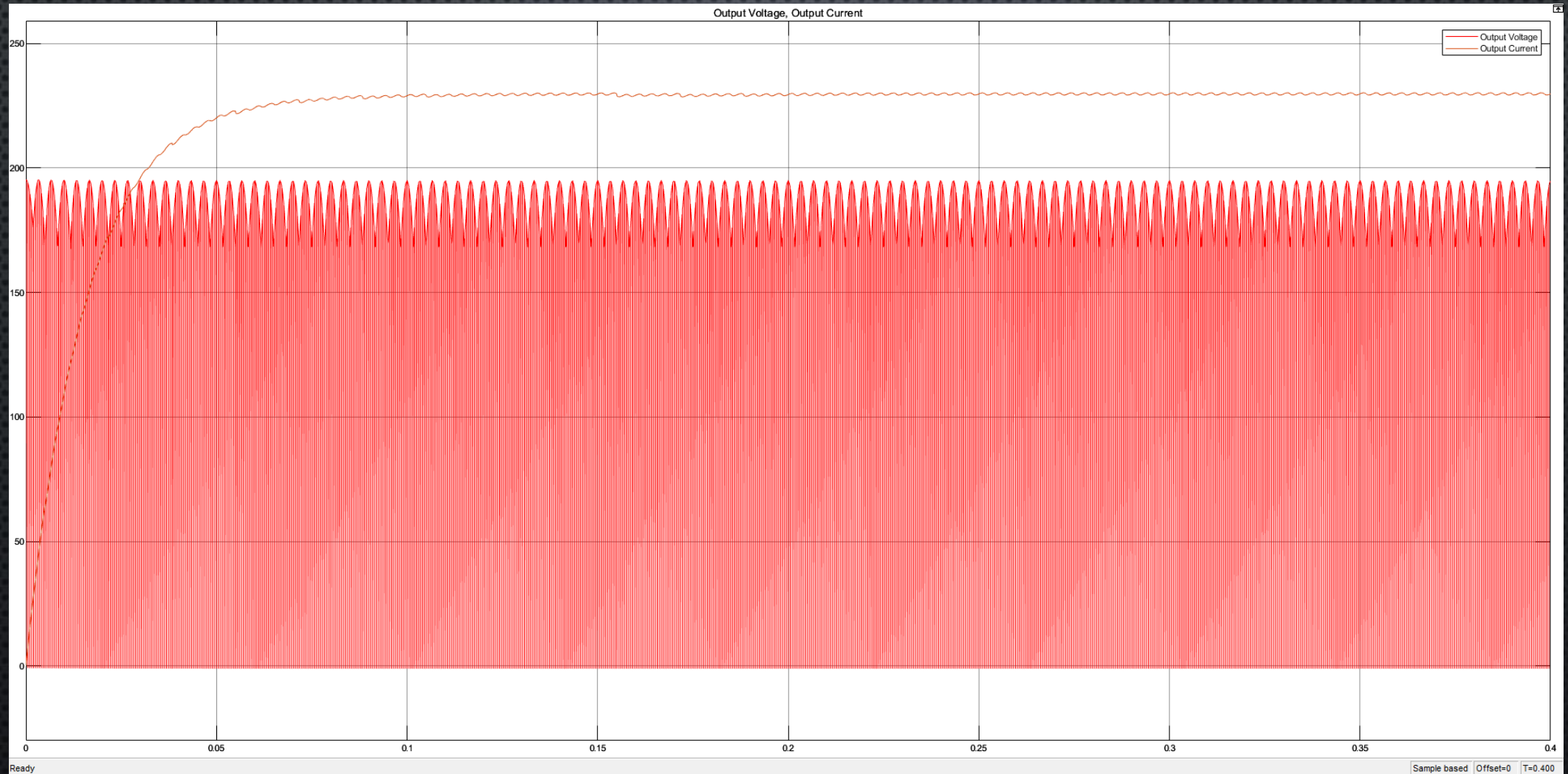
Simulation Results(with RL load)

0.2 Duty Cycle – 10 kHz switching frequency



Simulation Results(with RL load)

0.9 Duty Cycle – 2 kHz switching frequency



Analytical Calculations

$$V_{d,max} = 1.35 * V_{l-l,rms} * \sqrt{2},$$

$$\text{for } V_{l-l,rms} = 140 \text{ V}, V_{d,max} = 198 \text{ V}$$

$$P_{out} = V_{out} * I_{out}$$

for efficiency of 70%

$$I_{out} = \frac{2 \text{ kW}}{180 \text{ V} * 0.7} = 16 \text{ A}$$

$$\Delta i_L = \frac{V_o * (1 - D)}{L * f_s}$$

$$\text{for } V_o = 180 \text{ V}, D = 0.2,$$

$$L = 12.5 \text{ mH}, f_s = 2 \text{ kHz}$$

$$\Delta i_L = 1.44 \text{ A}$$

$$\text{for } V_o = 180 \text{ V}, D = 0.9,$$

$$L = 12.5 \text{ mH}, f_s = 10 \text{ kHz}$$

$$\Delta i_L = 1.30 \text{ A}$$

Component Selection

IGBT	>400V	>25A
RECTIFIER	>400V	>25A
CAPACITOR	400V	3 x 470 μ F
POTENTIOMETER		1-100k Ω
Fast Diode	>400V	>25A
Microcontroller Raspberry Pi Pico		

Conclusion

- Testing
- Integration
- PCB Design