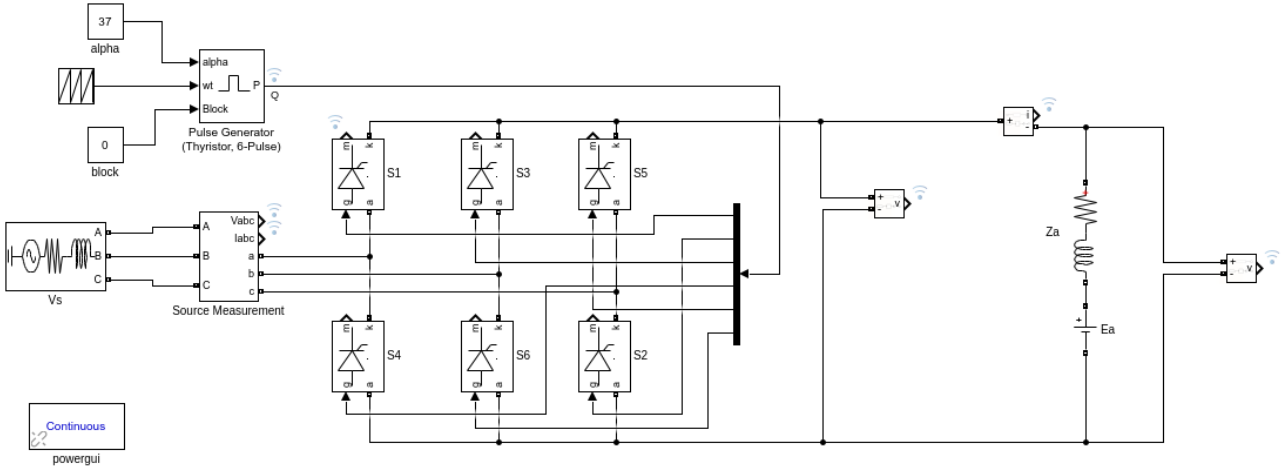
Blue Smoke Team Hardware Project Design

Topology Options

1. Three-phase thyristor rectifier (SCR)
2. Three-phase diode rectifier + buck converter
3. Single-phase thyristor rectifier (SCR)
4. Single-Phase Diac-Controlled Triac Rectifer

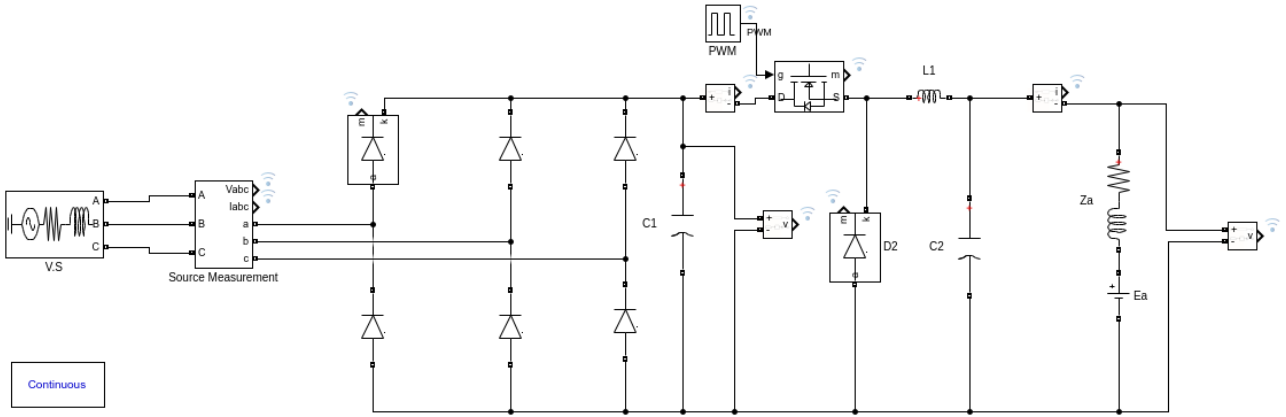
Option 1: Three-phase Thyristor Rectifier (SCR)



Option 1: Three-phase Thyristor Rectifier (SCR)

Advantages	Disadvantages
• Higher average output voltage attainable • Less ripple compared to single-phase rectifier	• Requires firing circuits for six thyristors • Firing control must be synchronized with input AC voltage

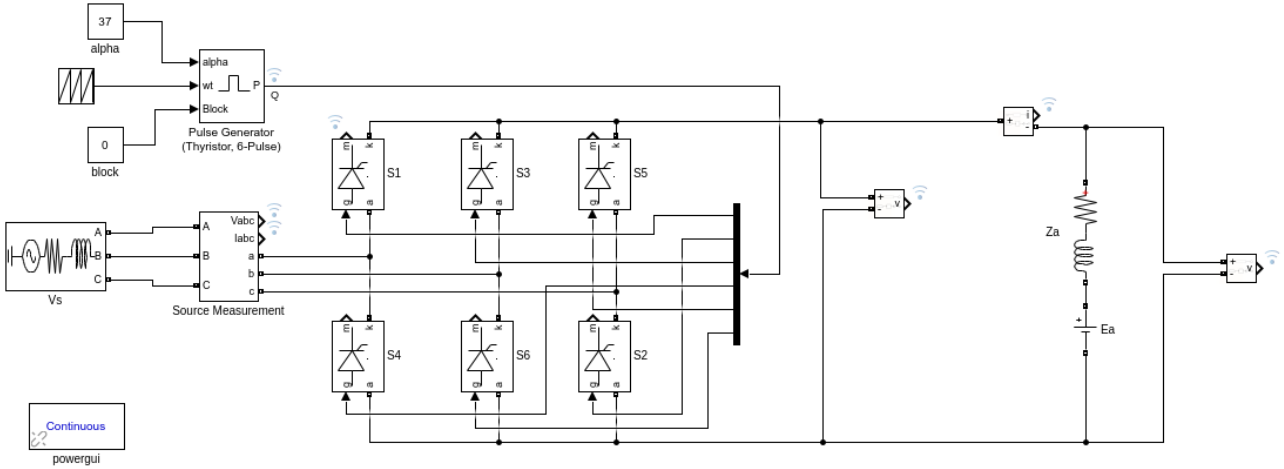
Option 2: Diode Rectifier + Buck Converter



Option 2: Diode Rectifier + Buck Converter

Advantages	Disadvantages
• Fast and accurate control of output is possible	• Requires capacitor & inductor • Many components

Option 3: Single-phase Thyristor Rectifier (SCR)



Option 3: Single-phase Thyristor Rectifier (SCR)

Advantages	Disadvantages
• Fewer thyristors compared to three-phase (4 vs 6)	• Available output voltage is less compared to three-phase AC input • Still requires firing circuits for four thyristors • Firing control must be synchronized with input AC voltage

Single-Phase Diac-Controlled Triac Rectifer

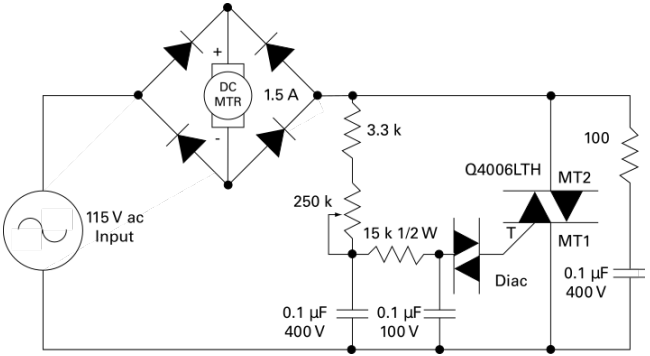
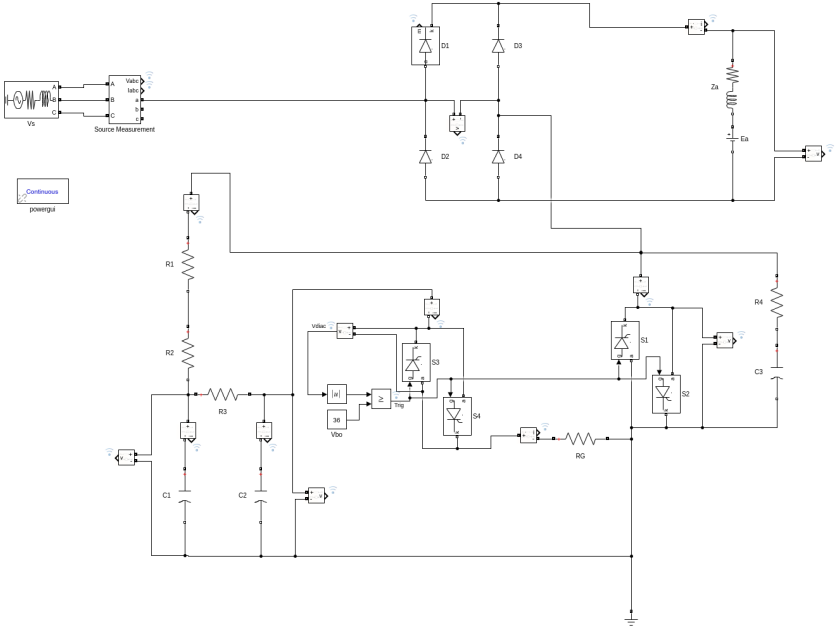


Figure 1. Circuit Diagram from Littlefuse Application Note AN1003

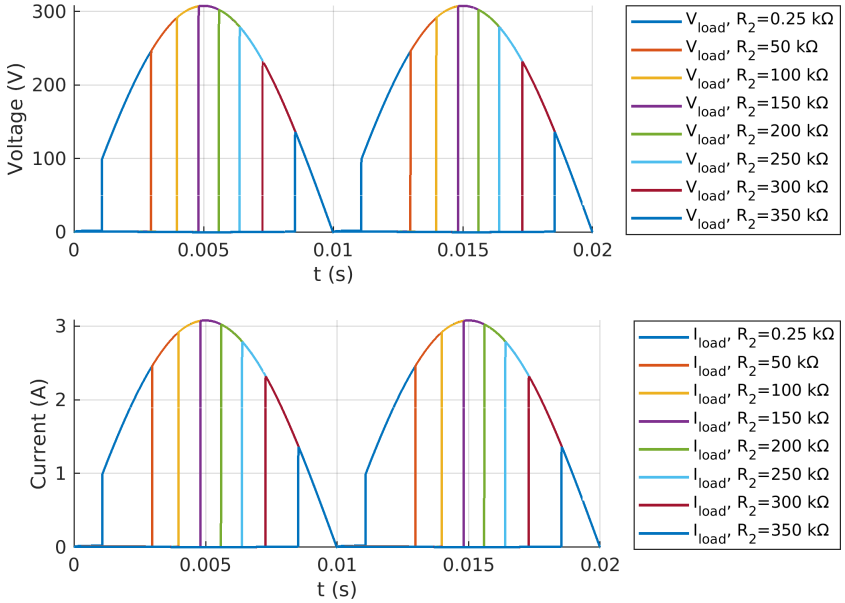
Single-Phase Diac-Controlled Triac Rectifer



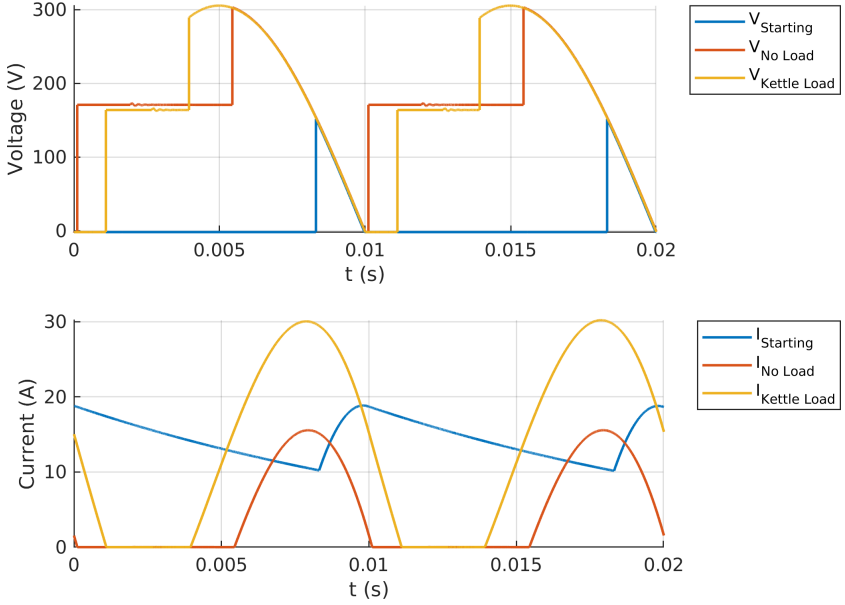
Single-Phase Diac-Controlled Triac Rectifer

Advantages	Disadvantages
• Circuit is very simple with few components • Single control circuit needed	• Introduction of feedback control difficult to incorporate

Simulation Results



Simulation Results



Key Component Ratings

Maximum component stress from simulation results

- Triac: V_{max} = 311 V, I_{rms} = 17.6 A
- Diode Bridge: V_{max} = 306 V, I_{rms} = 12.5 A (per diode)
- Resistors: All < 1/4 W. (But Littlefuse application note recommends 1/2 W for R_3)
- Capacitors: < 60 V

Project Plan

- Complete bill of material
- Procure components (Direnc.net + Konya Sokak)
- Build prototype
- Test on increasing loads (load bank then motor)
- Troubleshoot & modify prototype as needed
- Once working prototype is obtained, as time allows
    - Consider modifications for feedback in firing circuit
    - Add remaining touches like enclosure, PCB, etc