

# INTO THE WIND



## TEAM:

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Mason Ulrich (Hardware Lead)

## SUPERVISOR/CLIENT:

Joe Law

## INSTRUCTOR:

Herb Hess

# Objective

Design and implement a rotor side converter to monitor a DFIG's Torque, Current and Voltage output in order to command an input waveform that will stabilize the DFIG with the grid at 60Hz.

# Value Proposition

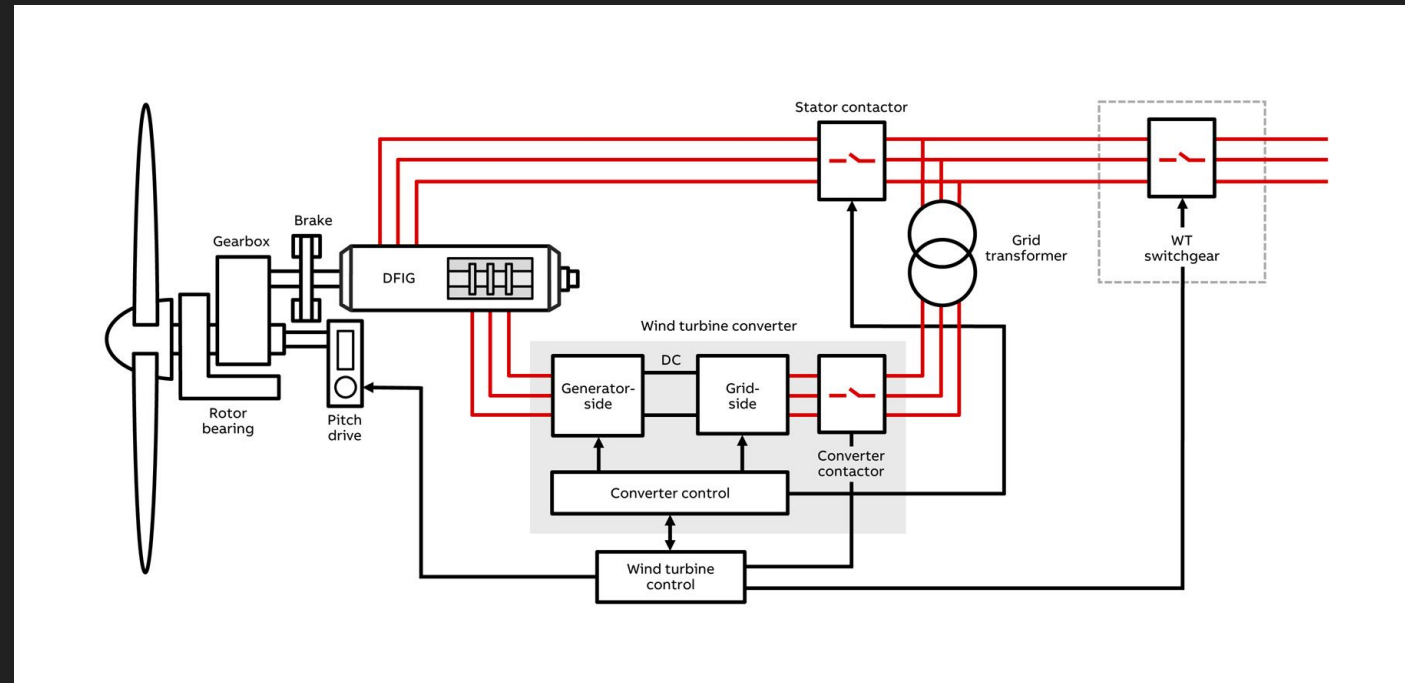
Completion of this project will assist in the advancement of wind energy systems by allowing further research to be conducted on subsynchronous resonance of a doubly fed induction generator (DFIG).

# Background

- Use in Type III wind energy systems
- Need for research of advanced topics
- Desire for lab based test system

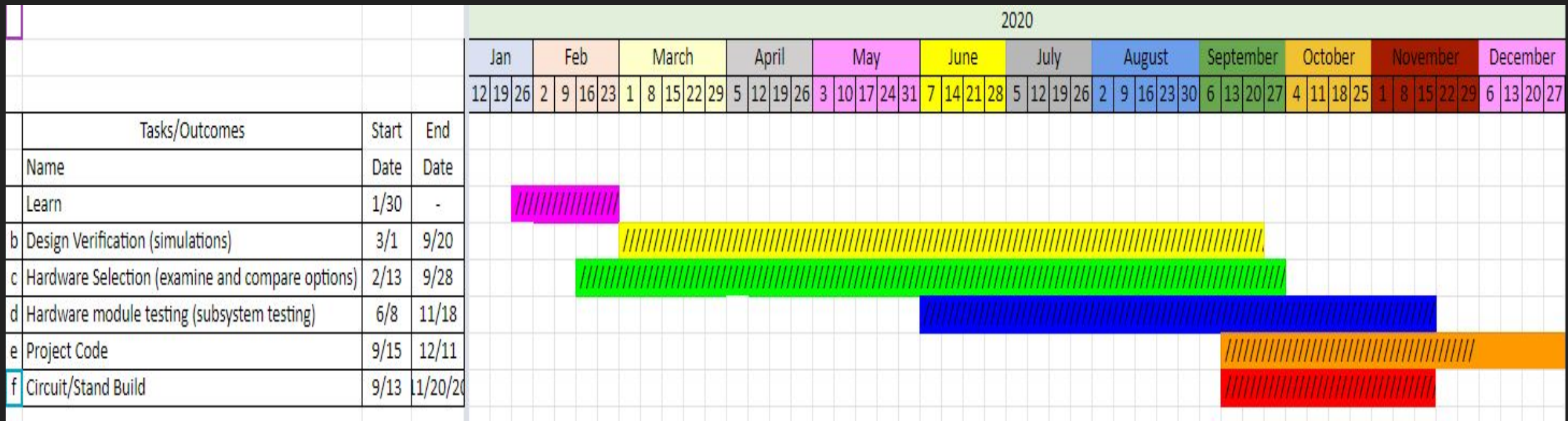
# Requirements

- Modular
- Robust



# Conceptual Development

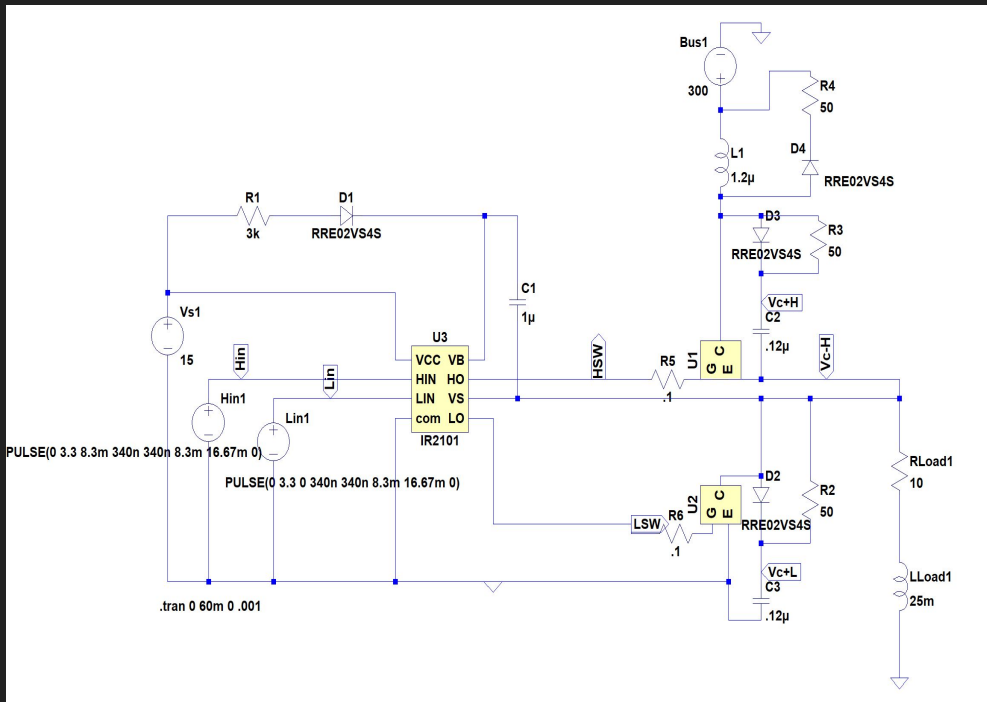
- Learn
- Design verification
- Hardware selection
- Hardware module testing
- Project code
- Circuit/Stand Build



# EVALUATION

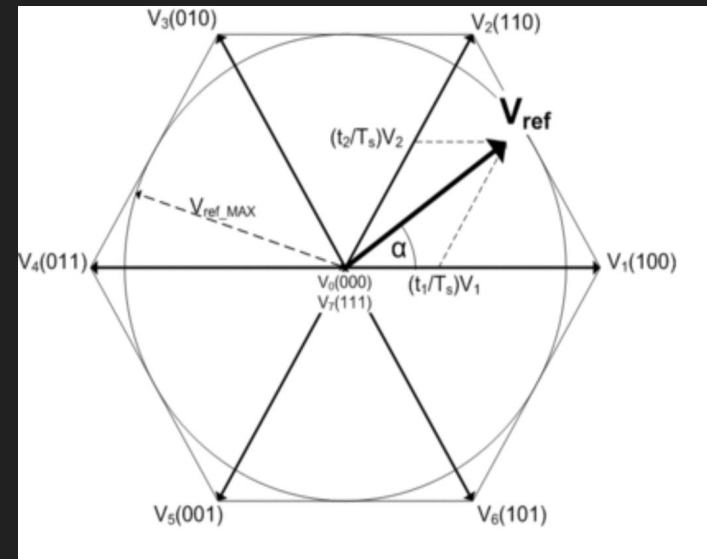
## Learning

- ▶ Power Electronics
- ▶ Controls Flow



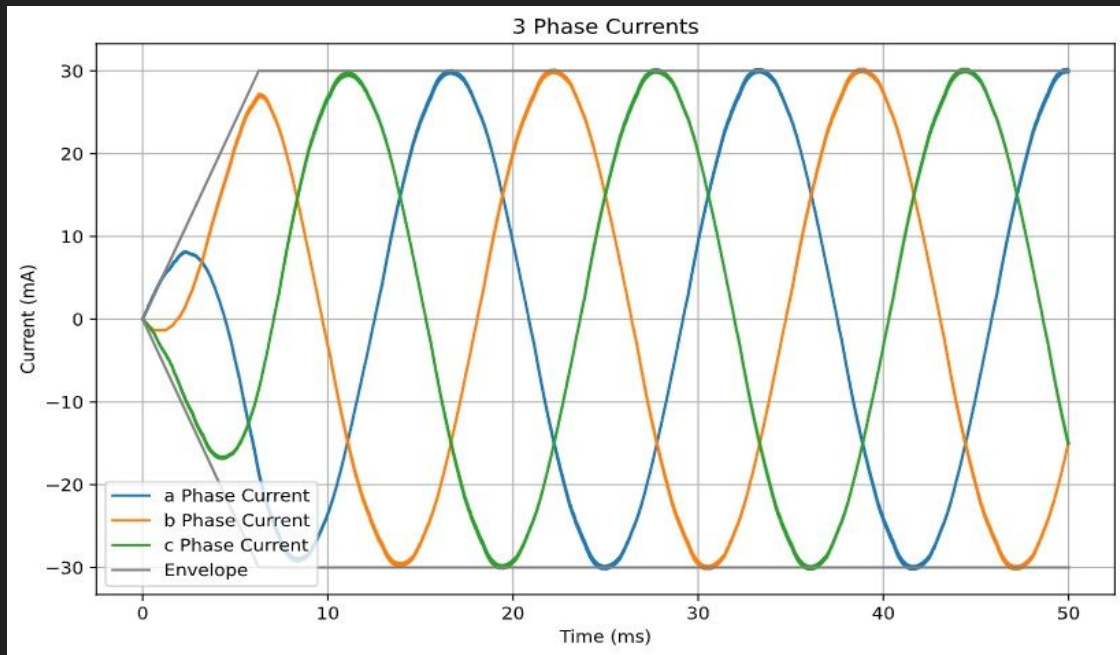
## Design Verification

- ▶ Space Vector Simulations
- ▶ PWM Scale Tests
- ▶ Spice Simulations

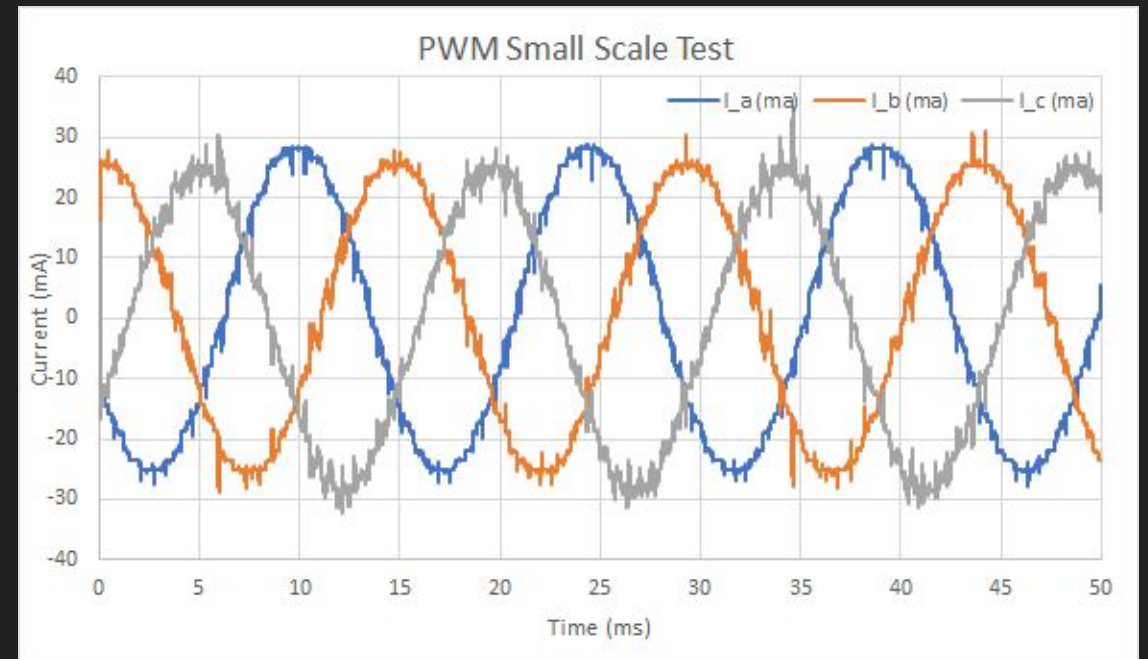


# Space Vector Modulation Testing

- ▶ Python simulation of Space Vector Modulation
- ▶ PWM Small Scale Testing
- ▶ Uses Gate Drivers, Power MOSFETs, and a 3-phase Y circuit with R-L load



Simulated



Measured

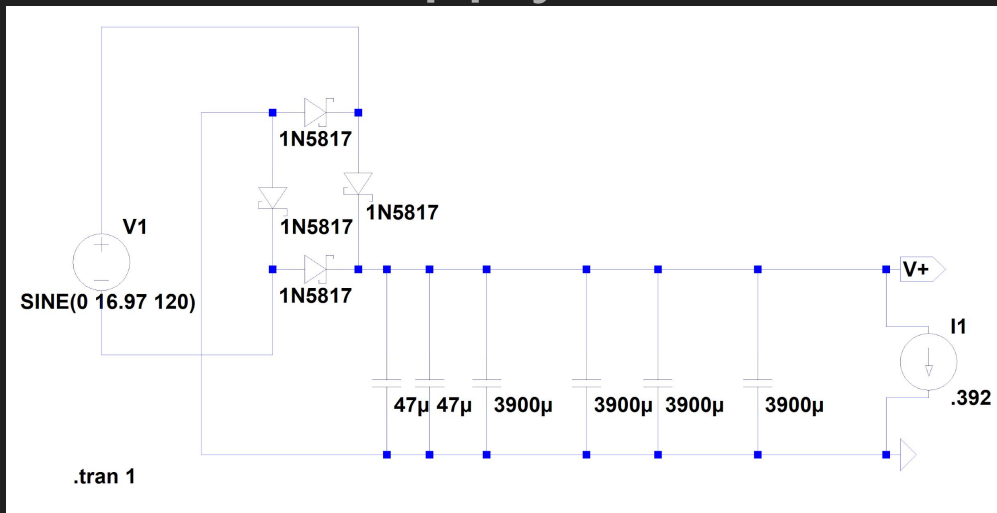
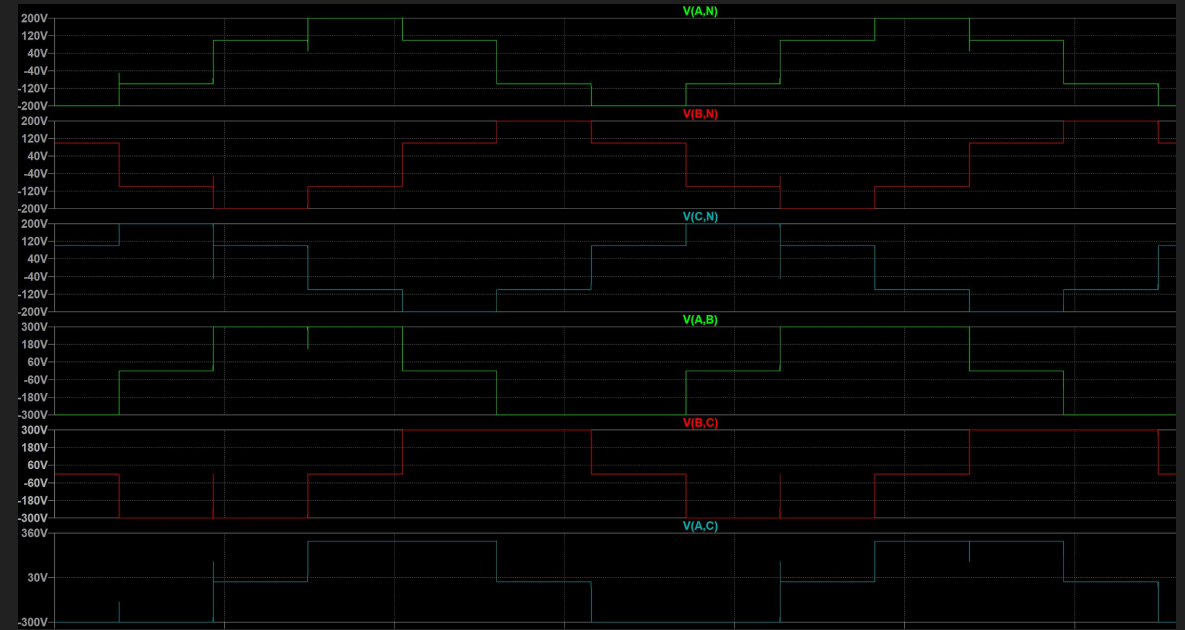
# Spice Simulations

▶ Single leg and H-Bridge

▶ Snubbers

▶ Ideal 6-step

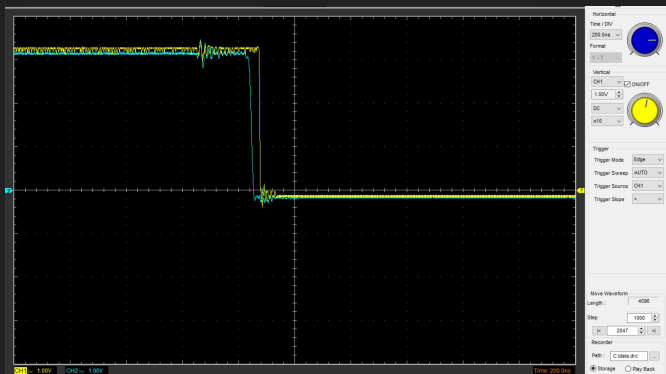
▶ HV Power Supply



# EVALUATION

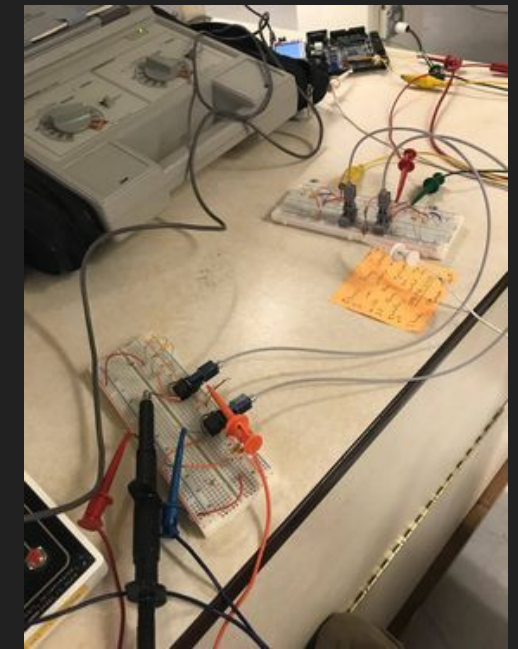
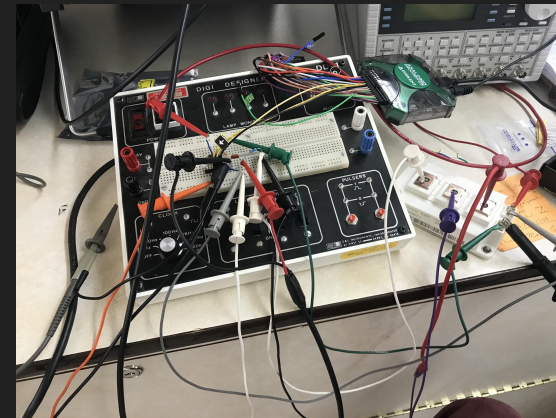
## Hardware Selection

- ▶ Identify components needed
- ▶ Define component parameters
- ▶ Verify specifications and compare options



## Hardware Module Testing

- ▶ Test Plan Development
- ▶ Assemble components individually
- ▶ Test in isolation
- ▶ Subsystem Tests

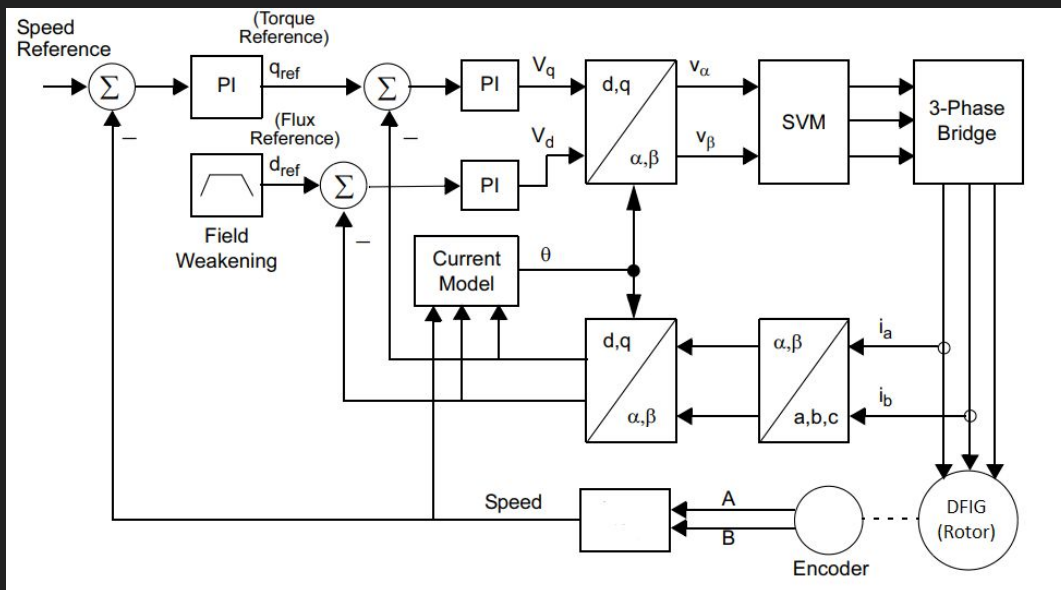




# EVALUATION

## Project Code

- ▶ Test subsystems
- ▶ Basic control code
- ▶ Integrate and finalize



## Circuit/Stand Build

- ▶ Manufacturing/soldering PCBs
- ▶ Mounting and system connection

Optics for gate commands and fault/enable pins of GD

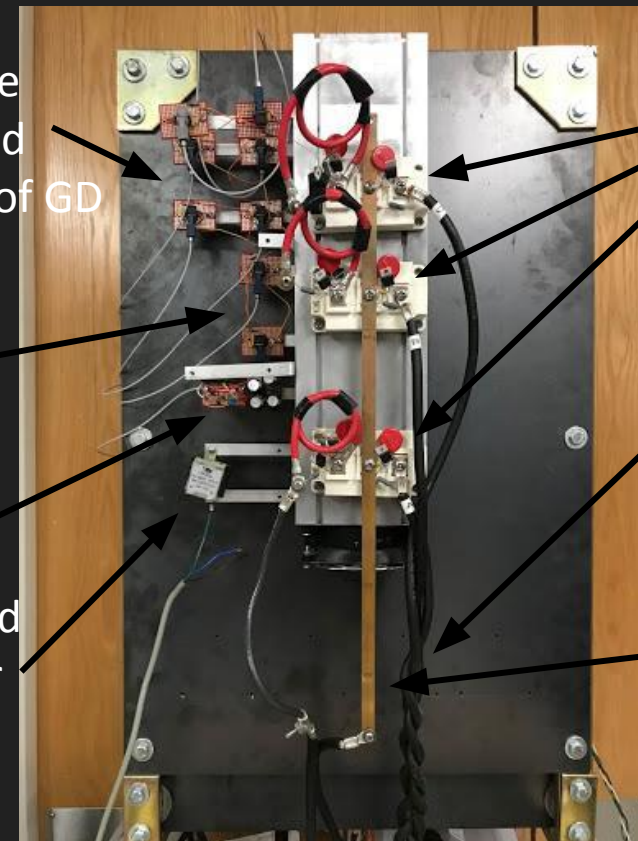
GD mount location

Rectifier, DC-DC converter and transformer

Protection Components

Output Cables

Negative Rail



# Key Attributes to Design

Modular Components

High margin specifications

Protection and isolation of components

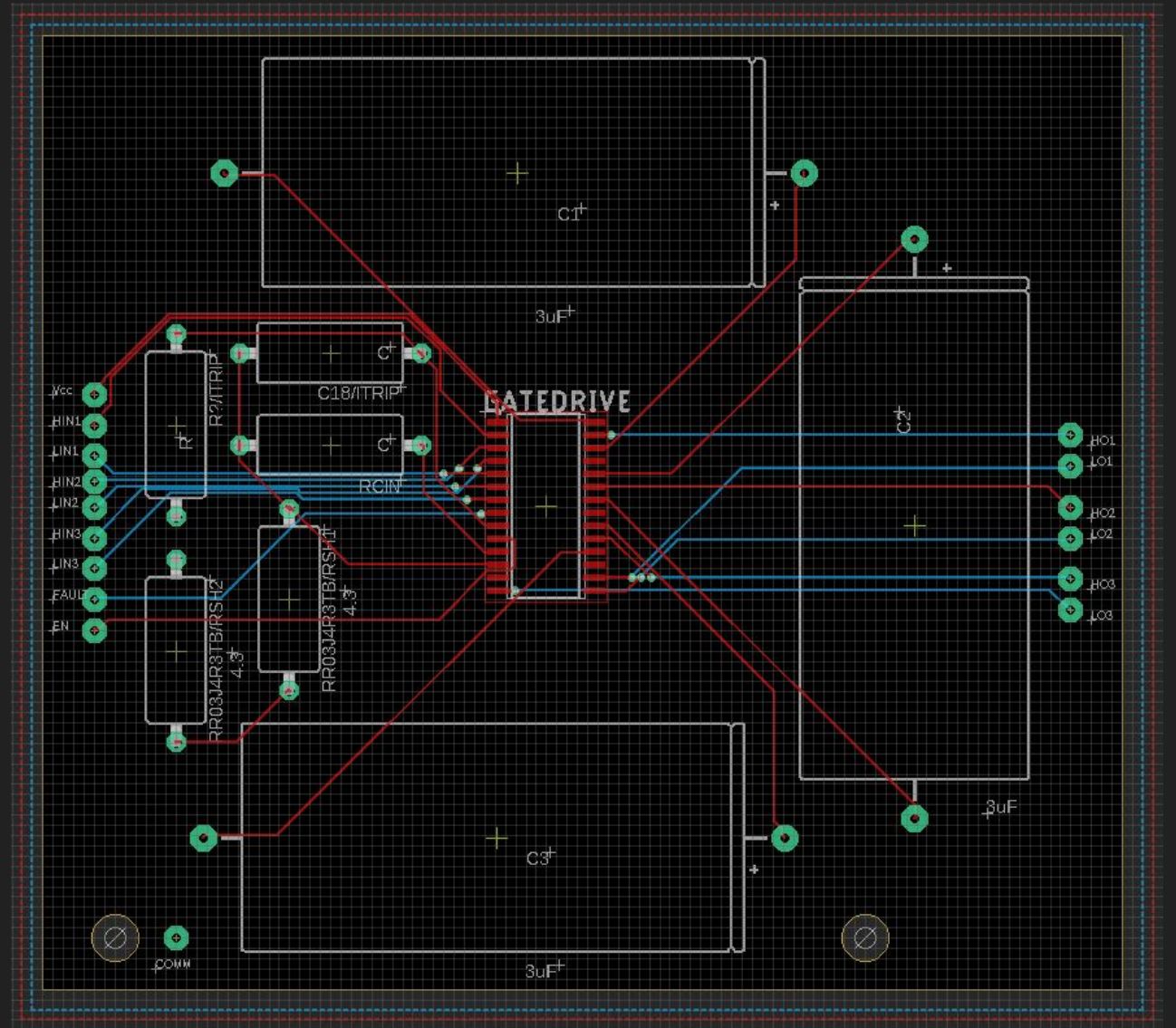
Fine tuned turn on procedure

Electrical noise resistance

Components are accessible for updates, testing, and research

# Manufacturing

- ▶ Perf board hand soldering
- ▶ PCB fabrication\*
- ▶ Stand dismantle
- ▶ Stand rebuild\*
- ▶ Control systems and sensors\*

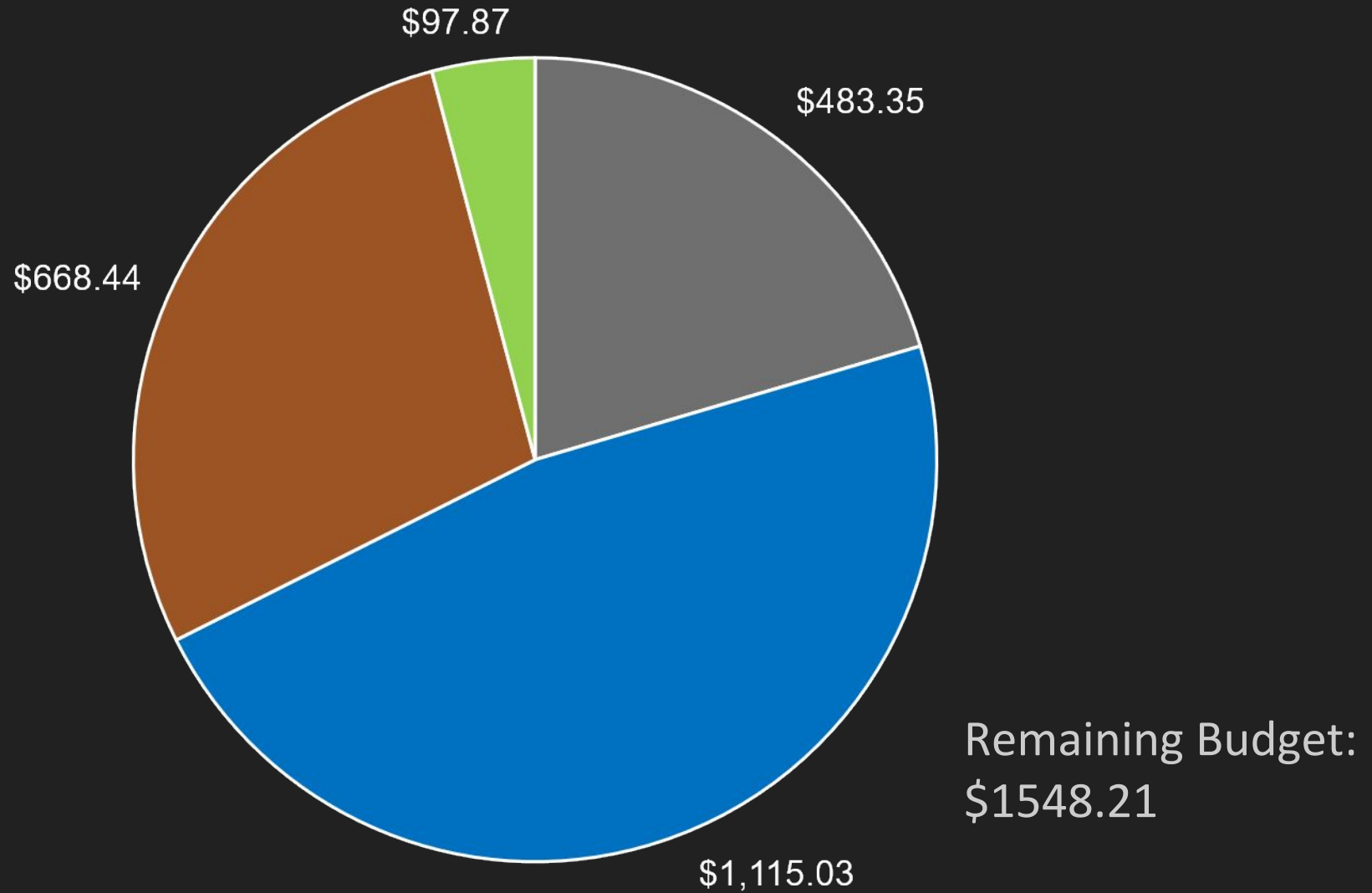


\*marks areas where challenges arose

# Future Development

- ▶ IGBT heatsink mounting
- ▶ GD PCB fabrication (gerbers provided)
- ▶ LV side stand configuration
- ▶ Field Oriented Control (FOC)
- ▶ Full scale integration & system testings with FOC
- ▶ Testings with wind turbine simulator and sensors

# Budget



□ Power Electronics

□ Controller & Modules

□ Isolation Components

□ Shipping



THANKS FOR LISTENING