Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

ECEN 403 Final Presentation
Team 70: VFD Motor Controller

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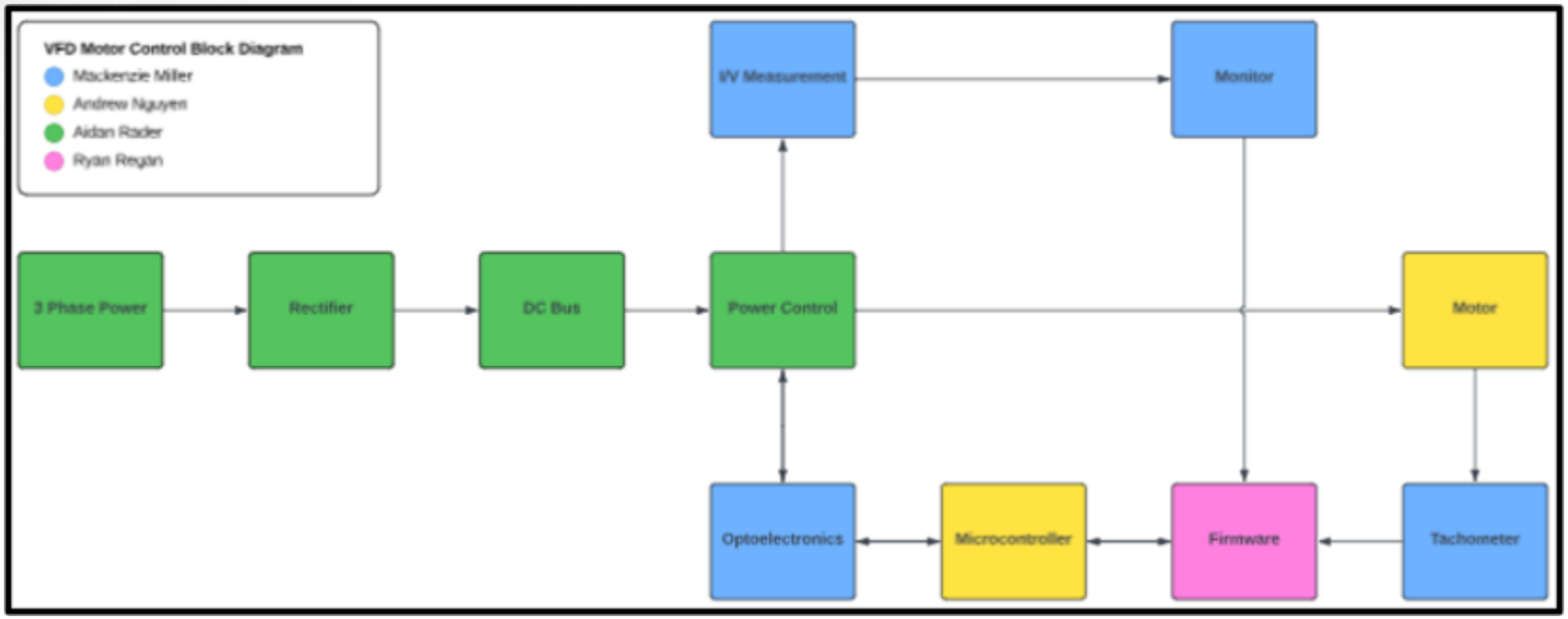
Ryan Regan
Sponsor: John Lusher

Overview

- Problem Statement: A motor control system is needed for an AC induction motor. Traditional motor control systems cannot adjust to varying load demands, resulting in poor energy efficiency, excessive heat generation, and premature component failure.

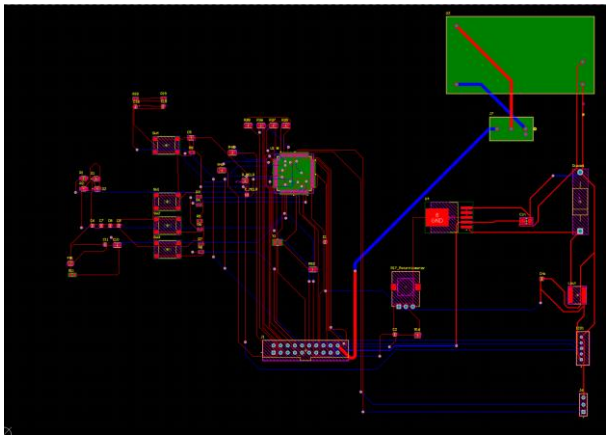
- Solution Proposal: Develop a Variable Frequency Drive (VFD) motor control system to adjust frequency and voltage to load demands, resulting in improved motor controllability, optimized energy efficiency, enhanced safety, and extended component lifespan.

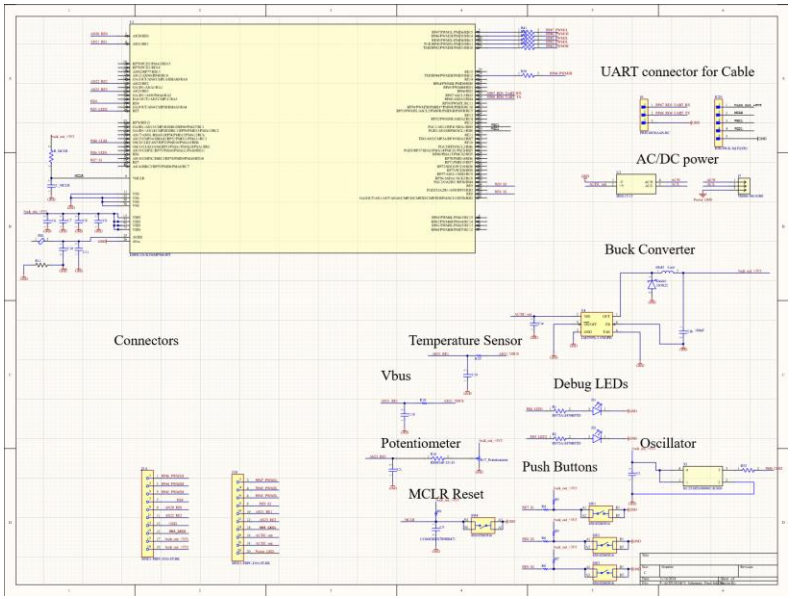
Overview


VFD Motor Control Block Diagram
Mackenzie Miller
Andrew Nguyen
Aidan Rader
Ryan Regan
I/V Measurement
Monitor
3 Phase Power
Rectifier
DC Bus
Power Control
Motor
Optoelectronics
Microcontroller
Firmware
Tachometer

Microcontroller

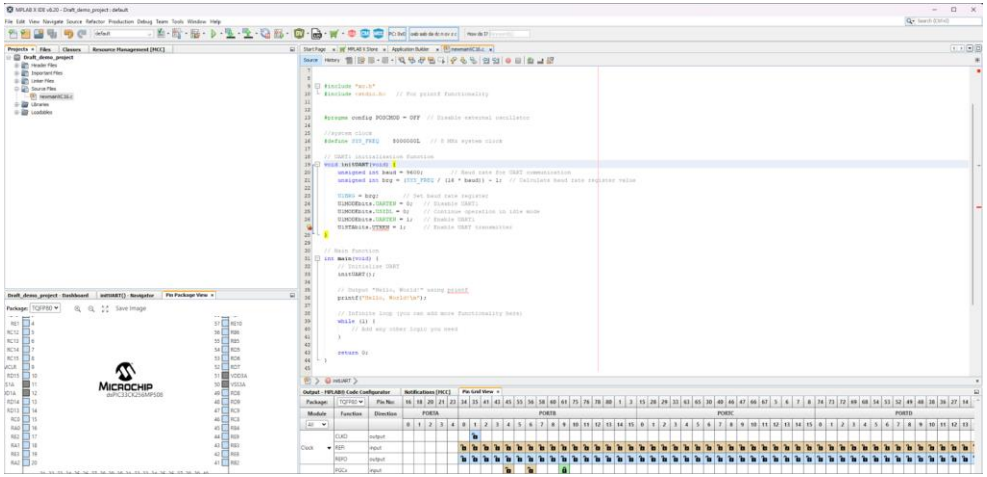
- Finished PCB and schematic designs





MCU Continued

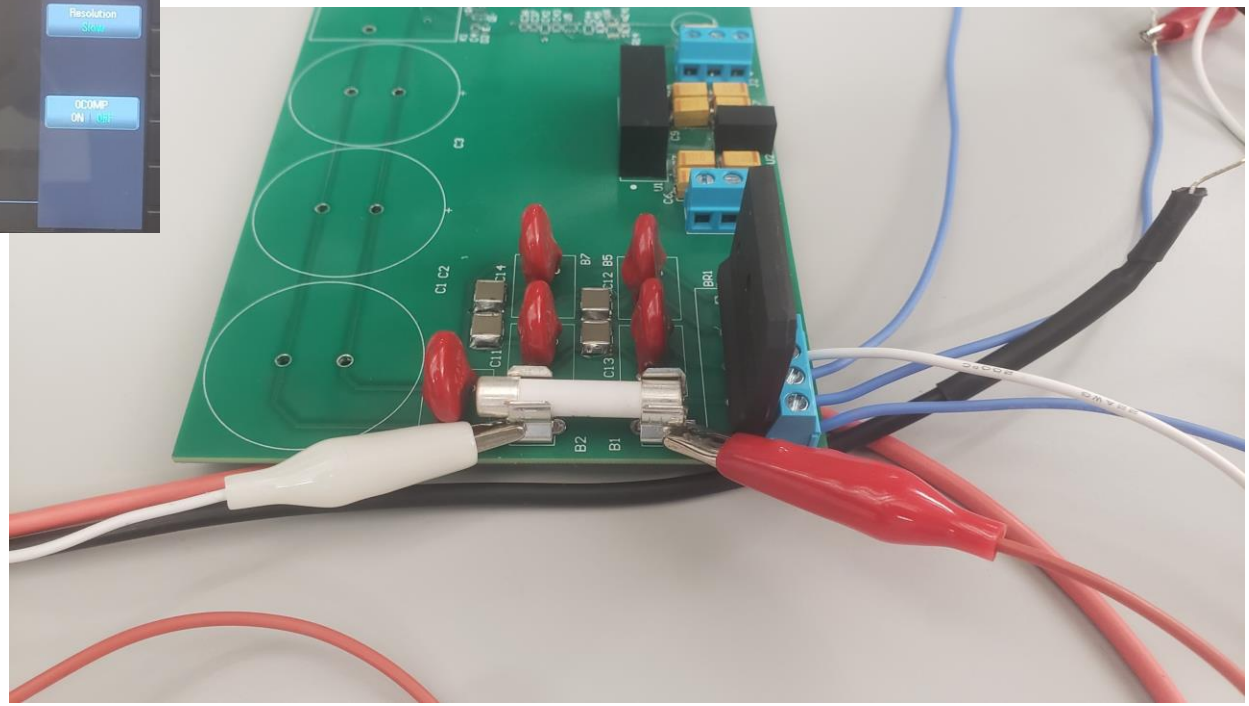
- Practiced soldering using soldering kit while I waited for parts come in
- Ran simulations on schematic
- Began code for final demo



Power

Aidan Rader

Task	Status
PCB Fabrication	Complete
Rectifier 5VAC to 6.1VDC	Complete
Fuse < 0.5Ω	Complete



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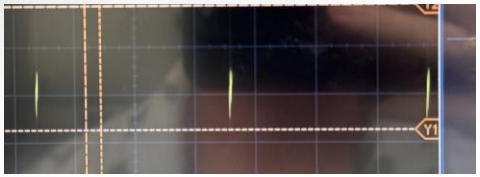
Power

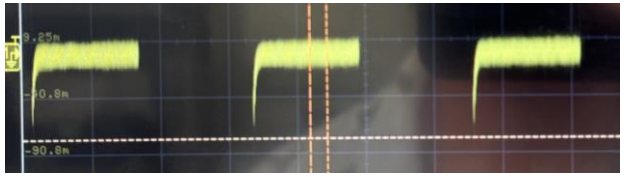
Aidan Rader

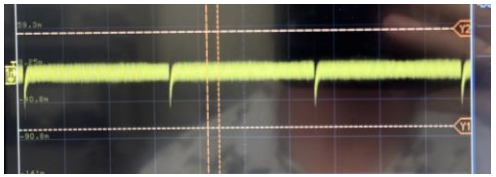
Firmware

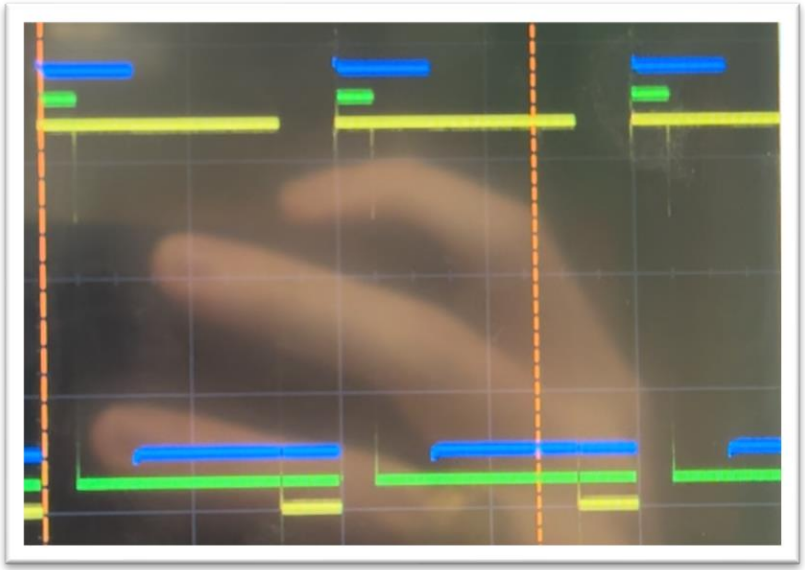
- Firmware for development board to produce three-phase PWM signals completed.
- Potentiometer can change the frequency of the PWM wave by increasing the code's step size while iterating through sine wave table.

Firmware Continued





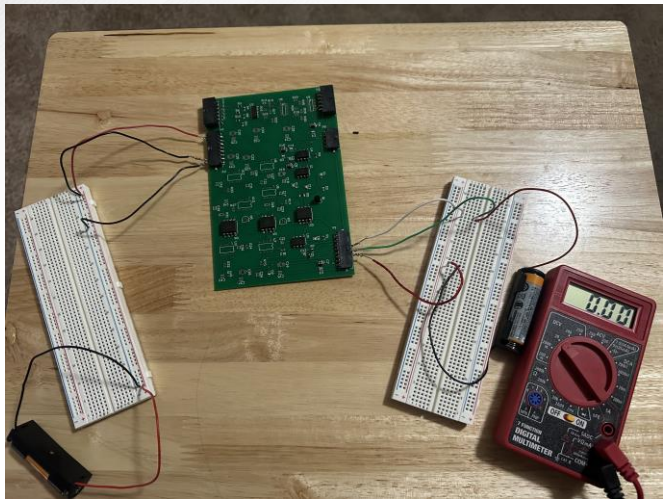


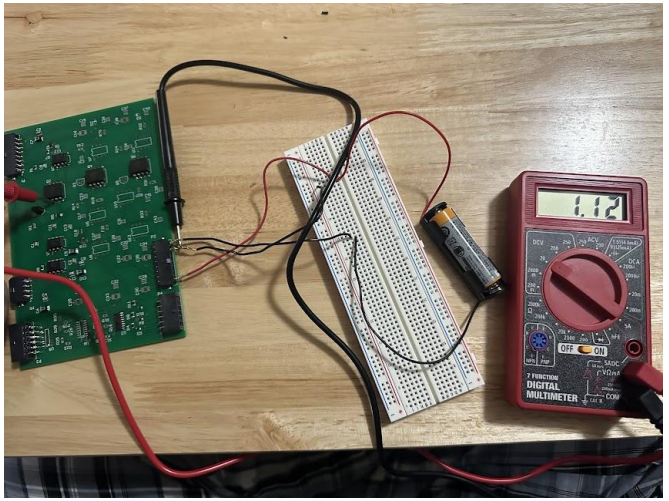


Optoelectronics

- Assembled 1/3 of PCB board
- Tested for continuity at low power
- Remaining 2/3 to be assembled this week

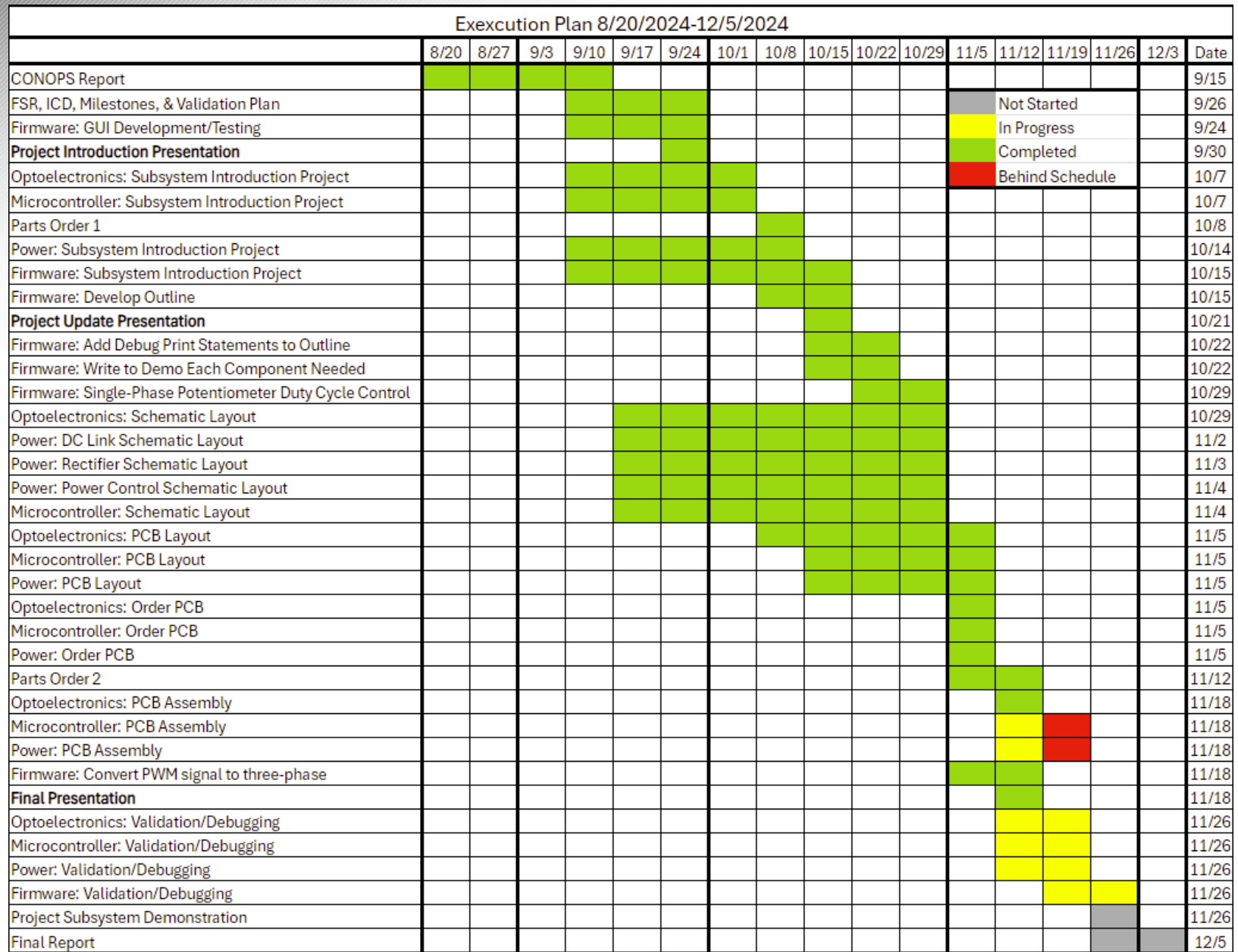
Optoelectronics Continued





Task	Status
PCB Fabrication	Complete
PCB Assembly	In progress

Exexcution Plan 8/20/2024-12/5/2024



Validation Plan

Paragraph #	Test Name	Success Criteria	Methodology	Status	Responsible Engineer(s)
3.2.1.1	Speed and Torque Requirement	Motor shall operate within speed range of 0RPM to 1800RPM and torque range of 0lb-ft to 0.729lb-ft.	Input motor with voltage and check if it achieves 0RPM and 0lb-ft. Repeat for 300RPM, 600RPM, 900RPM, 1200RPM, 1500RPM, 1800RPM.	Untested	Andrew, Ryan
3.2.1.2	Frequency Requirement	System shall operate within frequency range of 5Hz to 60Hz.	Input system with frequency generator set to 5Hz and check if the motor runs smoothly. Repeat for 10Hz, 20Hz, 30Hz, 40Hz, 50Hz, 60Hz.	Untested	All
3.2.1.3	Temperature Requirement	System shall operate within temperature range of 0˚C to 70˚C.	Place system in freezer set to 0˚C and check if the motor runs smoothly. Repeat with oven set to 70˚C.	Untested	All
3.2.3.2	Input Voltage Level	System input voltage shall be $208V_{AC}$.	Measure with multimeter and check if the voltage is $208V_{AC}$.	Untested	Aidan
3.2.3.3	Input Noise and Ripple	System shall not exceed ripple range of 0V to 0.165V.	Measure with multimeter and check if the voltage exceeds 0V to 0.165V.	Untested	Andrew
3.2.3.4	External Commands	External commands shall be documented in appropriate ICD.	Show to teaching team and check with them for approval.	Untested	All
3.2.3.5	Visual Output	System shall display output measurements on GUI.	Input system with known values and check if the output measurements match. Repeat for six additional sets of known values.	Untested	Ryan
3.2.3.6	Connectors	System shall use terminal blocks for power and signal connections.	Observe power and signal connections and check if they are are terminal blocks.	Untested	Mackenzie, Andrew, Aidan
3.2.3.7	Overtemperature Shutdown	System shall automatically shut down if sensor exceeds temperature range of 0˚C to 70˚C.	Place sensor in freezer set to -1˚C and check if sensor is triggered. Repeat with oven set to 71˚C.	Untested	Mackenzie
3.2.3.8	Built in Test	System shall generate and evaluate test signals to assess failure status.	Compare generated values with known values and check if the failure statuses match. Repeat for six additional sets of values.	Untested	All
TBD	Inputs	The parameters are within the expected range.	Confirm that all electrical parameters (voltage, current, power) remain within safe and expected ranges under varying conditions.	Untested	All
TBD	Communication Testing	Firmware is successfully uploaded, and system can communicate to PC.	Verify that data transfer between the VFD controller and the PC is reliable and supports functions like setting parameters and uploading firmware.	Untested	Andrew, Ryan
TBD	Controller Performance	Motor spins according to user defined parameters.	Validate that the system operates efficiently and delivers accurate motor control across the expected range of operating conditions.	Untested	All
TBD	MCU Voltage Step Down	MCU converts the voltage it is given to 3.3V.	Measure the voltage of the signals being sent to the MCU and measure that the MCU converts it to 3.3V.	Untested	Mackenzie, Andrew
TBD	Rectifier Full System	System input voltage shall be rectified from $208V_{AC}$ to $295V_{DC}$.	Measure with multimeter and check if the voltage after the rectifier is $295V_{DC}$.	Untested	Aidan
TBD	Rectifier Power Subsystem	System input voltage shall be rectified from $5V_{AC}$ to 7.1 V_{DC}.	Input $5V_{AC}$ at differing angles of 120˚ on three waveform generators. Measure with multimeter and check if the voltage after the rectifier is 7.1 V_{DC}.	Untested	Aidan
TBD	Isolated 15V Conversion	System shall convert $15V_{DC}$ to isolated $15V_{DC}$.	Input $15V_{DC}$ on a dc power supply. Measure with multimeter and check if the voltage after the converter is $15V_{DC}$.	Untested	Aidan
TBD	Isolated 5V Conversion	System shall convert $3.3V_{DC}$ to isolated $5V_{DC}$.	Input $3.3V_{DC}$ on a dc power supply. Measure with multimeter and check if the voltage after the converter is $5V_{DC}$.	Untested	Aidan

Remaining Tasks

- Microcontroller: Solder parts onto PCB, debug PCB, prepare for demo. For 404: ensure connections are correct to put all PCBs together, may need to redesign pcb/schematic to align with the other PCBs
- Firmware: Before project demo, figure out proper scale for PWM signal, and add more debugging tools for future use and to ensure code is running exactly as intended. For 404: test dev board code with motor, then alter the firmware to work with our own microcontroller

Remaining Tasks Continued

- Optoelectronics: Finish assembling PCB, test at full power, make sure PCB connectors are compatible with the other PCBs. For 404: implement tachometer on motor – connections are currently routed on PCB

Remaining Tasks Continued

403 Tasks	Status
15V to Isolated 15V	assembled, not successfully validated
3.3V to Isolated 5V	assembled, not successfully validated
DC Link	not assembled, not validated
Power Control PWM Signals	not simulated
Power Control	not assembled, not validated (needs PWM signals)

- 404 Tasks: simulate circuit, redesign PCB (connectors facing outwards, fuse clip spacing, MCU 3 phase connector, increase PCB density), full motor control at 208VAC