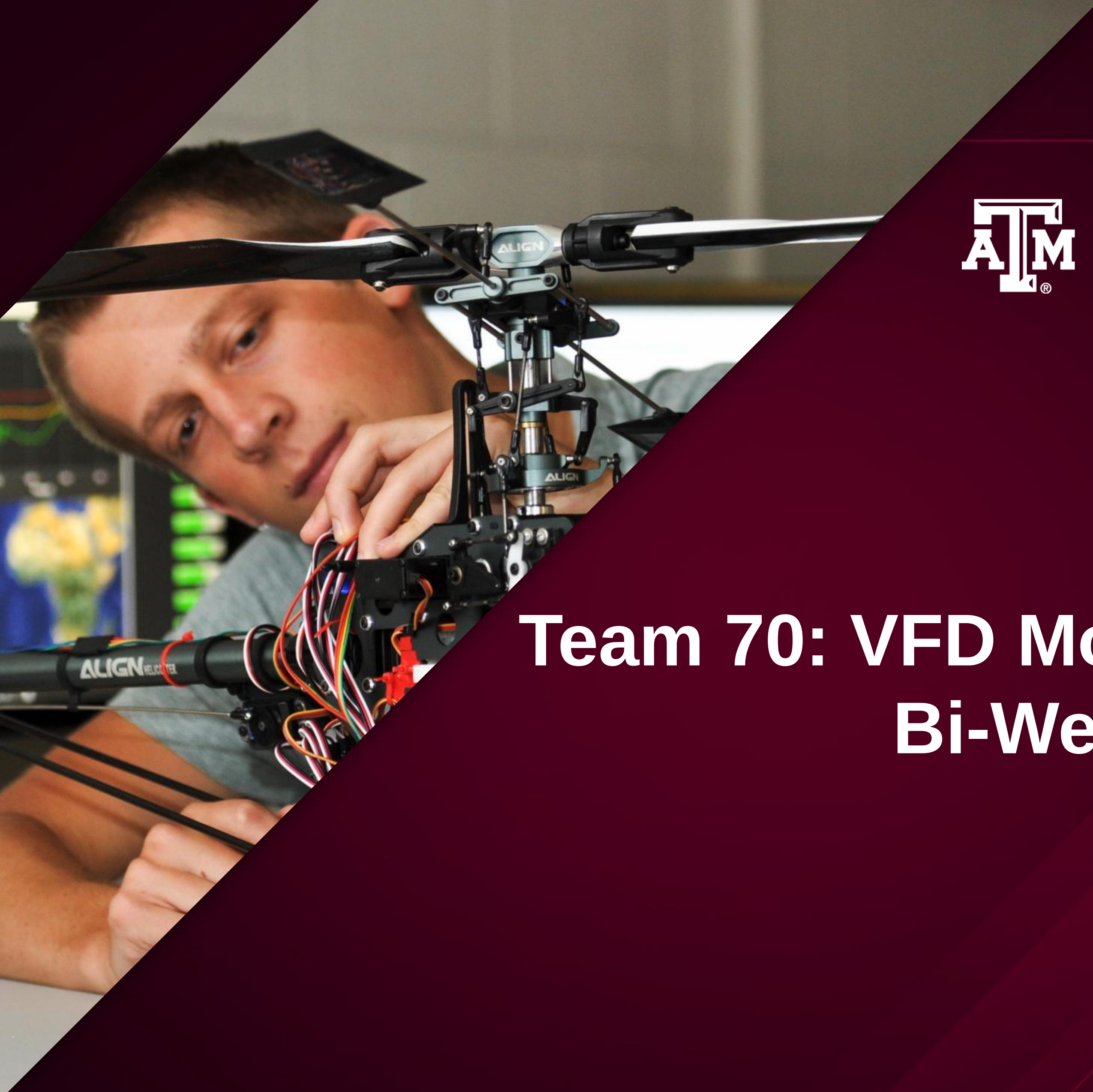

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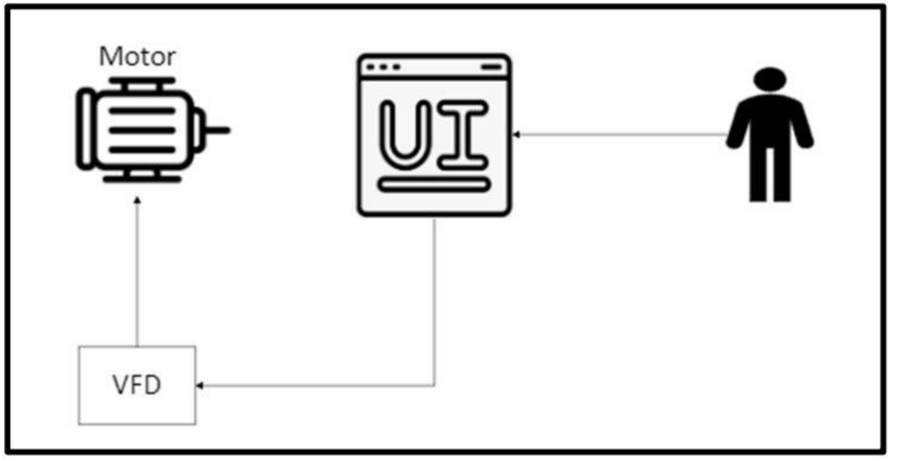
Team 70: VFD Motor Controller Bi-Weekly Update 2

Mackenzie Miller
Andrew Nguyen
Aidan Rader
Ryan Regan
Sponsor: John Lusher
TA: Ali Alenezi

Project Summary

- Problem: Traditional motor control systems cannot adjust to varying load demands, resulting in poor energy efficiency, excessive heat generation, and premature component failure

- Solution: Develop a Variable Frequency Drive (VFD) motor control system to adjust frequency and voltage to load demands



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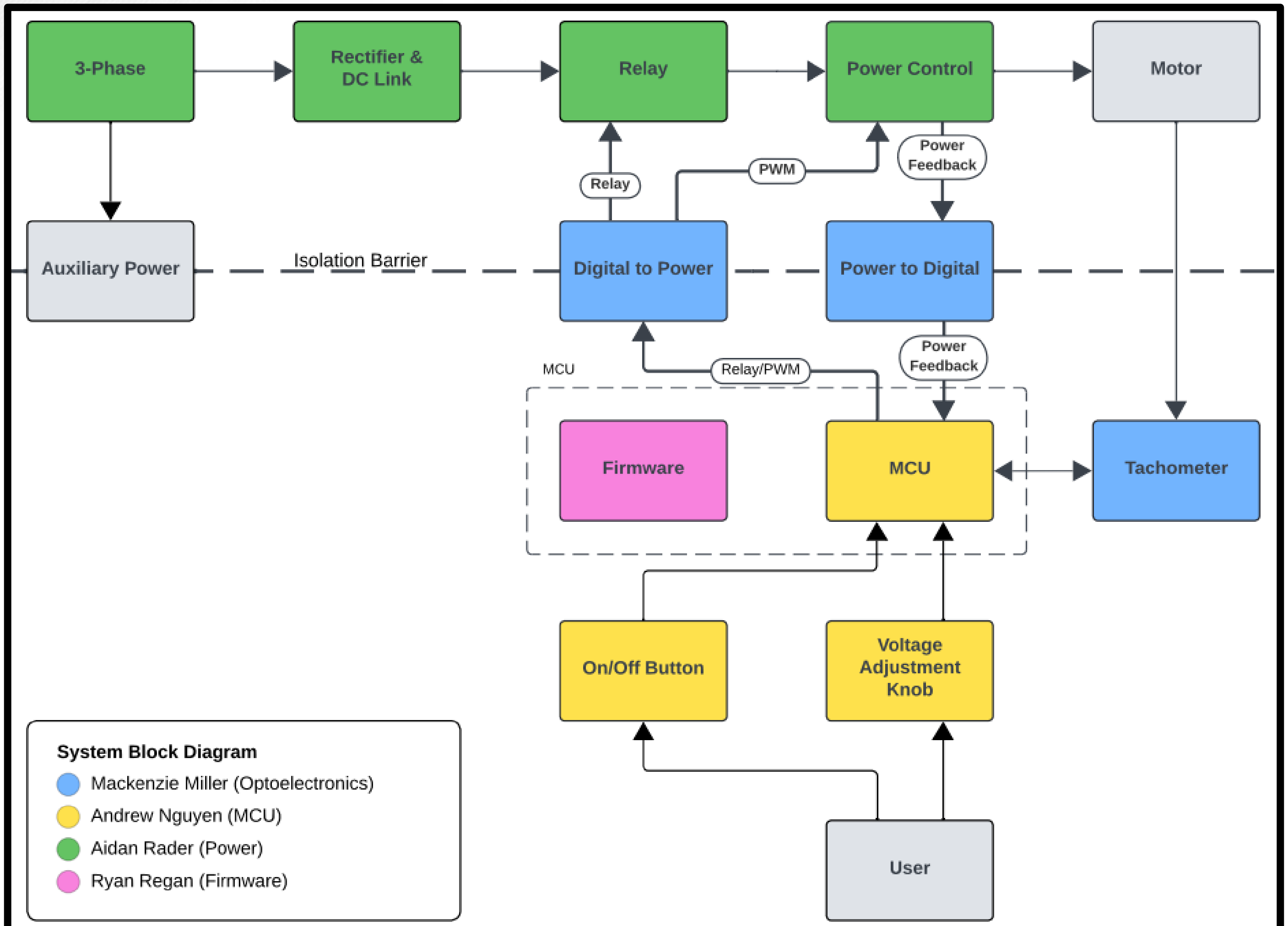
Project/Subsystem Overview



Project Timeline

2/12	2/19	3/7	3/19	4/2	4/16	4/28
Subsystem PCBv1 Design & Testing	Auxiliary Power & MCU/Firmware Integration	PWM Control Integration	System Integration	System Testing	System Validation	Demo, Showcase, & Report

Optoelectronics

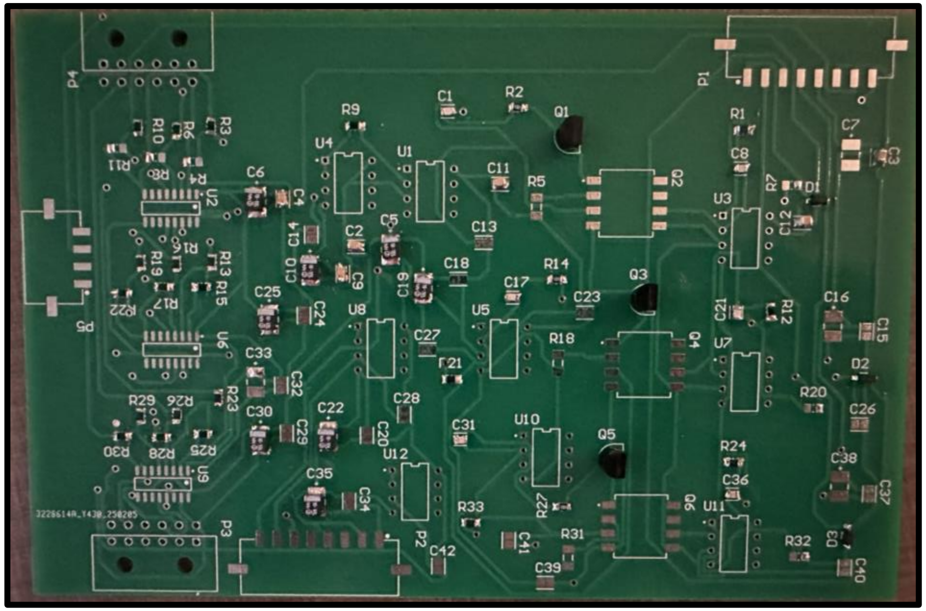
Mackenzie Miller

Accomplishments since last update 20 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Received PCB board - Partially assembled (pending delivery of parts) - Basic integration with firmware for PWM control	- Fully populate board - Retry integration with firmware with new components - Begin integration with MCU

Optoelectronics

Mackenzie Miller

- New board
- Old board had component failure while trying to integrate second time
- New board to be operational as soon as parts are delivered
- Attempt to retry integration with firmware then MCU



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Microcontroller

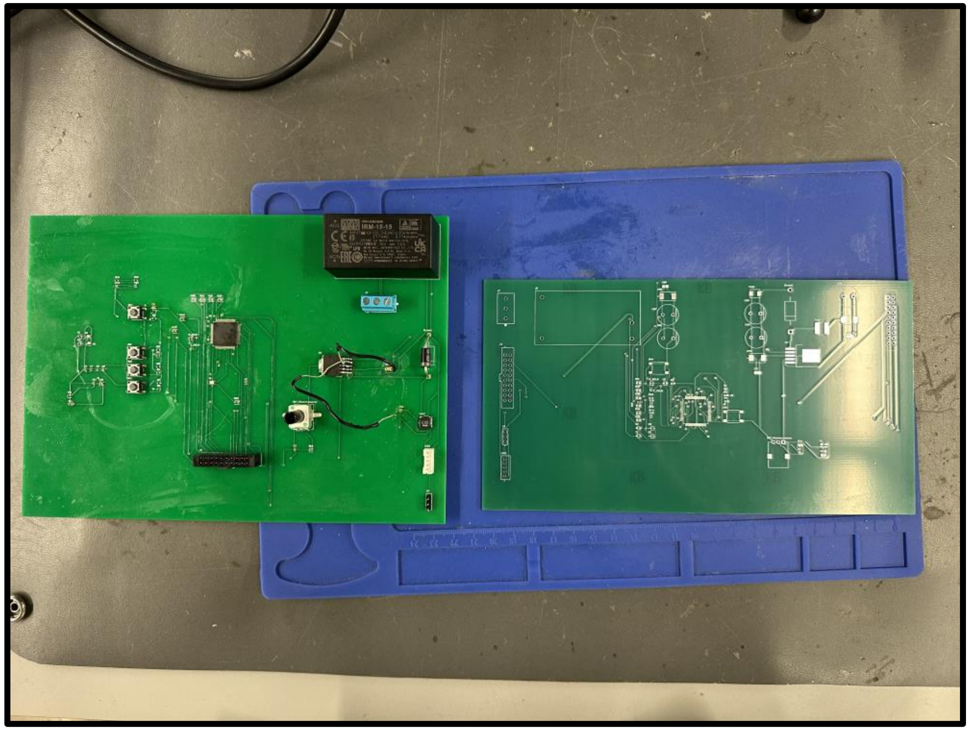
Andrew Nguyen

Accomplishments since last update 27 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Received PCB board - Ordered necessary parts - Partially assembled board	- Finish assembling the rest of the board once final parts come in. - Test AC/DC converter and buck converter - Begin integrating with firmware code and optoelectronics

Microcontroller

Andrew Nguyen

- Made board more compact
- Added capacitors to buck converter and AC/DC power supply
- Redesigned buck converter



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Power

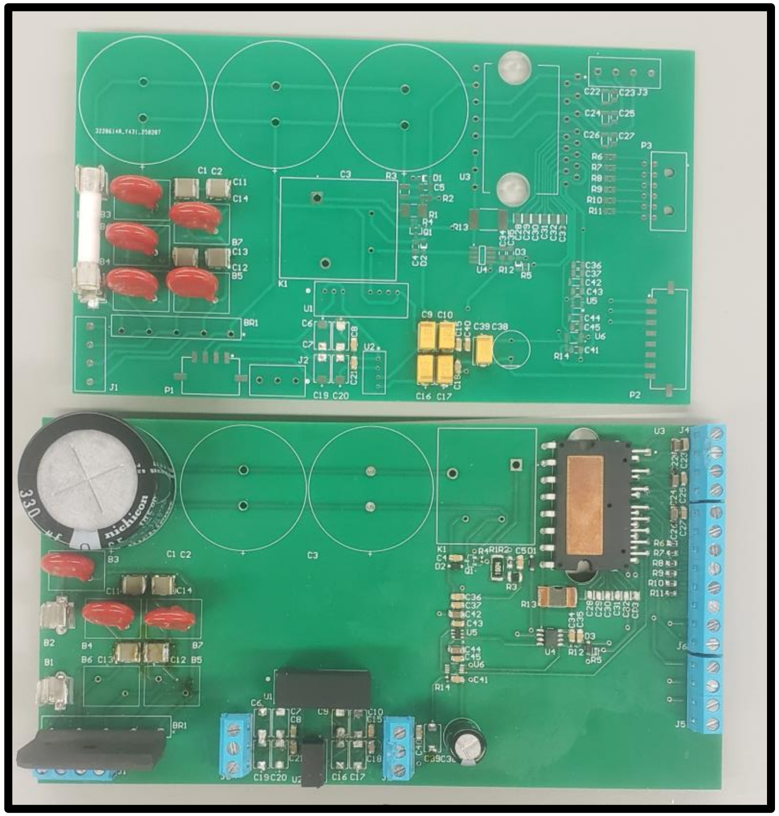
Aidan Rader

Accomplishments since last update 33 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Routed PCBv1 - Ordered PCBv1 - Ordered Parts Order 4 - Assembling PCBv1 towards Auxiliary Power Integration	- Integrating Auxiliary Power with Microcontroller - Assembling entire PCBv1 (sprained thumb) - Integrate Auxiliary Power with Optoelectronics - Integrate PWM Control - Integrate Relay Control

Power

Aidan Rader

- PCBv1 improvements
  - Increased board density
  - Changed screw connectors to ribbon
  - Aligned connectors to system's physical orientation
  - Added missing 2 pin connector for 2 phase to 15V Converter
  - Added missing 3.3V to iso5V converter pin
- Rectifier, DC link, 15V to iso15V converter work
- Relay is waiting on parts order 4
- Power control is waiting on parts order 4



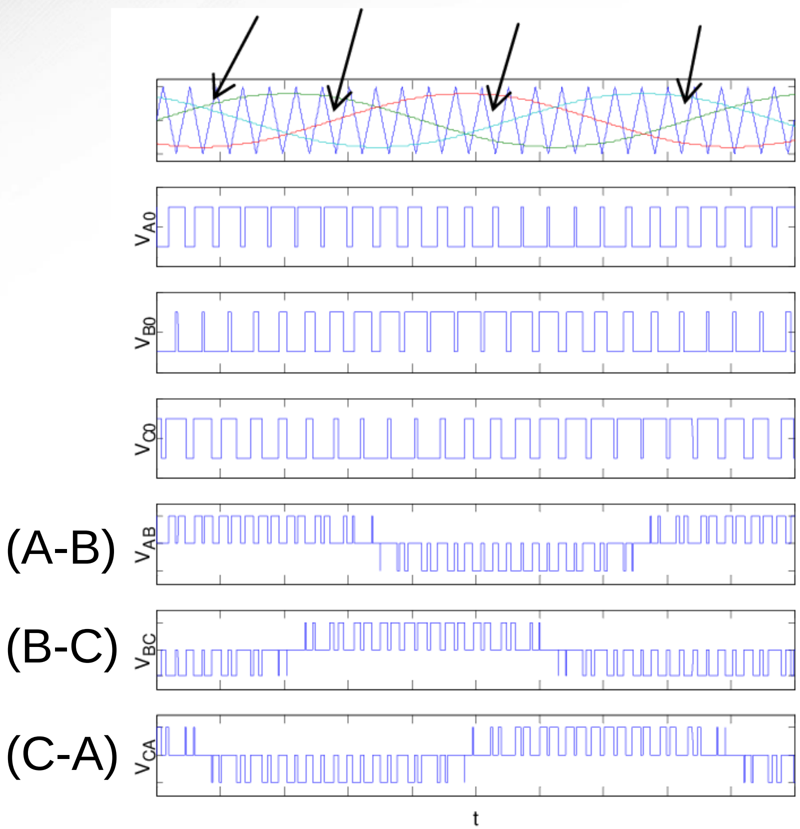
Firmware

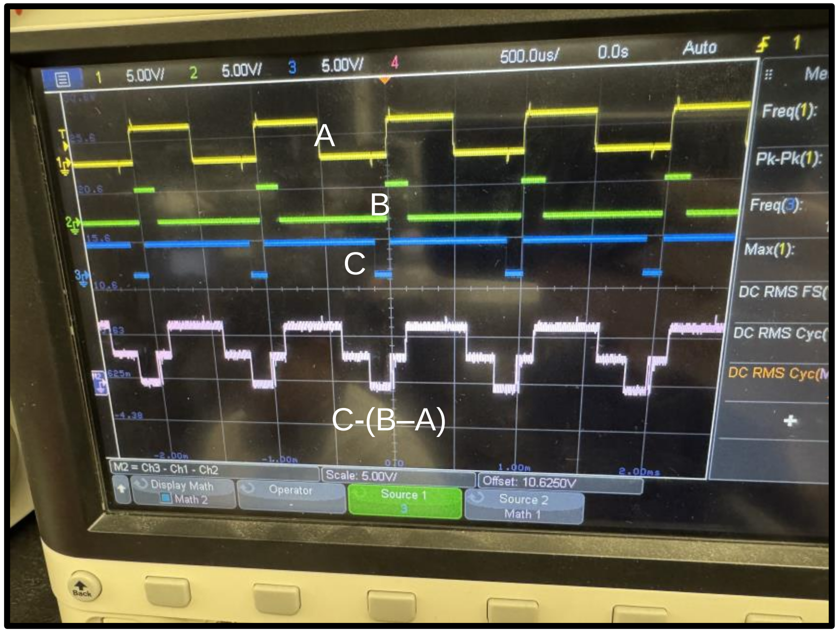
Ryan Regan

Accomplishments since last update 30 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Produced Different types of sine waves with oscilloscope - Researched usage of PICKIT debugger to program/integrate with microcontroller subsystem - Powered the programmed dev board with voltage source instead of direct connection to laptop (for integration with optoelectronics subsystem) - Basic integration with Optoelectronics subsystem; PWM signal communication (needs debugging)	- Further research the PICKIT debugger to ensure quick integration with microcontroller subsystem - Continue integration with Optoelectronics subsystem when new PCB/components arrive - Begin power subsystem integration and use it's output to further tune firmware's output frequencies

Firmware

Ryan Regan



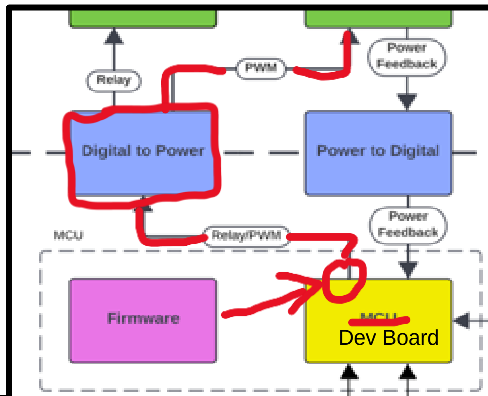


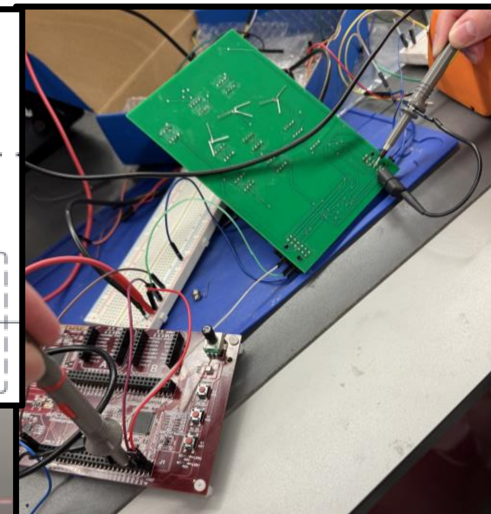
PWM Signal Integration

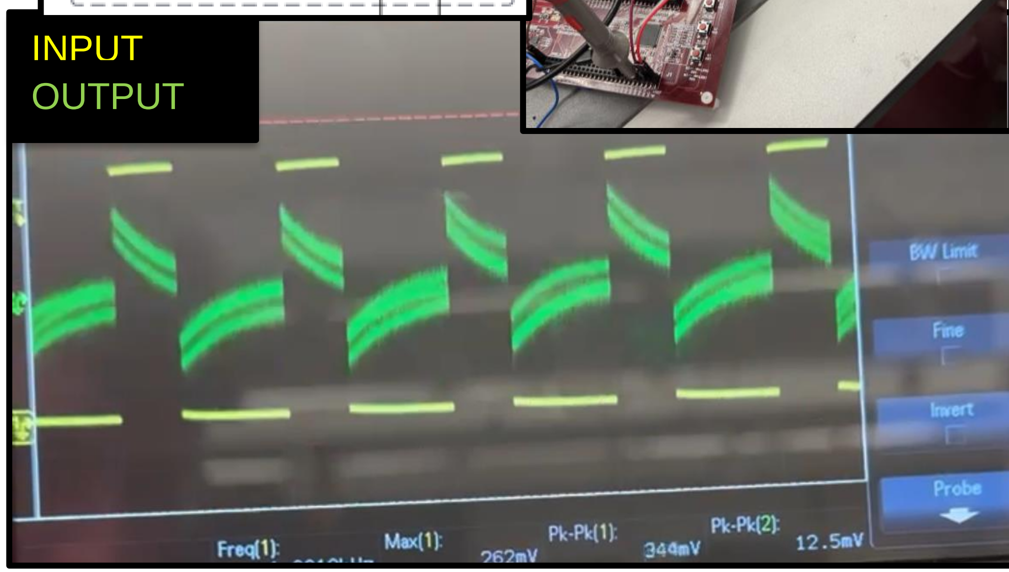
Mackenzie Miller & Ryan Regan

Optoelectronics and Firmware:

- Firmware sent PWM waves using dev board to Optoelectronics PCB
- Output similar to input
- Magnitude and noise of output did not match
- Potentiometer was still able to effect output signal's frequency





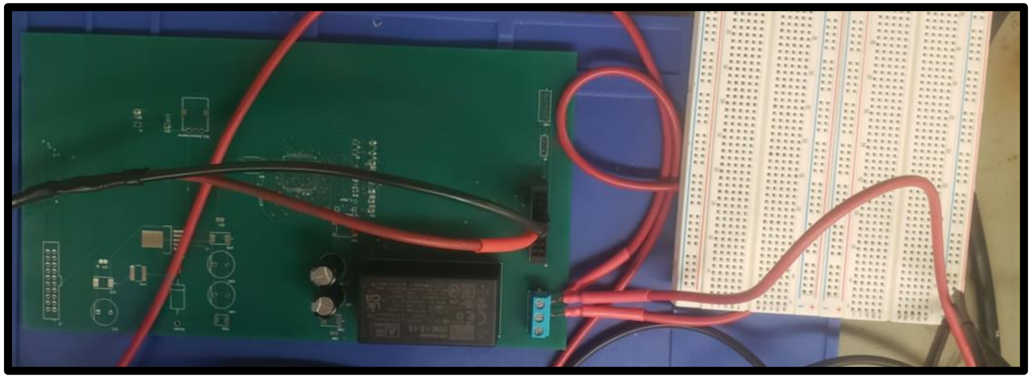


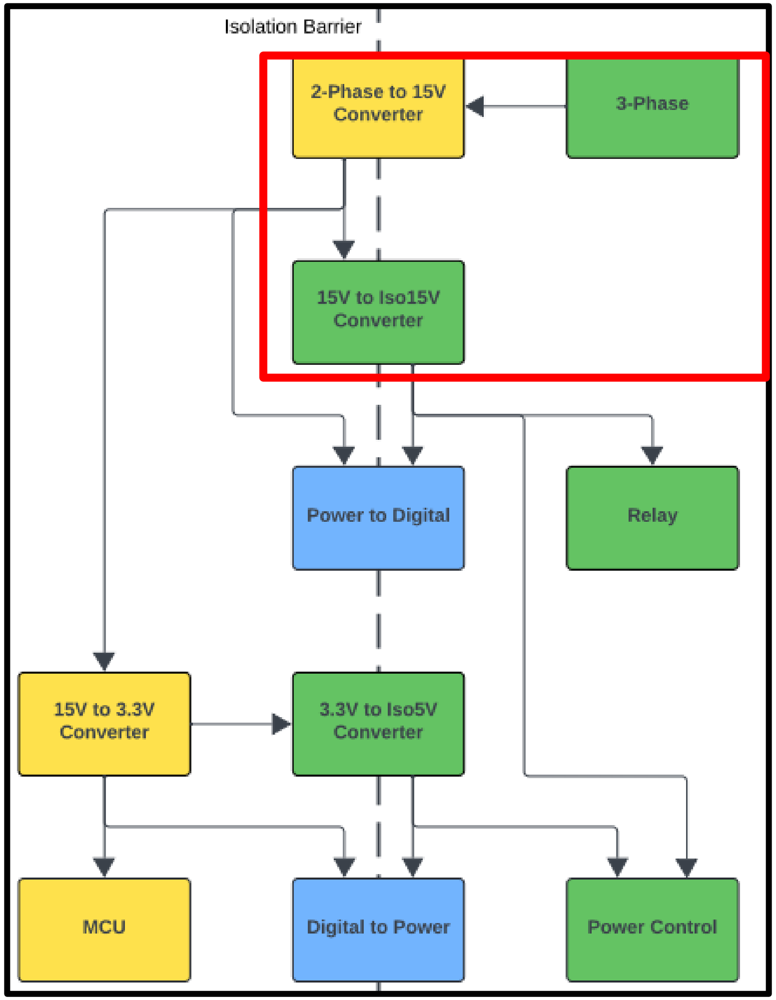
Auxiliary Power Integration

Andrew Nguyen & Aidan Rader

MCU and Power:

- Assembling these components first
- Testing 2-Phase to 15V Converter
    - Simulating 2-phase with oscilloscope and function generator
- Testing 15V to Iso15V Converter
    - Simulating 15 with dc power supply





Execution Plan

	1/16	1/23	1/30	2/6	2/13	2/20	2/27	3/6	3/13	3/20	3/27	4/3	4/10	4/17	4/24	Date
PCBv1s Design (Full Design Review)																1/28
Status Update Presentation 1													Not Started			1/29
PCBv1s Order													In Progress			2/6
Parts Order 4													Completed			2/11
PCBv1s Assembly													Behind Schedule			2/12
Firmware Validation																2/12
Status Update Presentation 2																2/12
Auxilary Power Integration																2/19
MCU/Firmware Integration																2/19
PWM Control Integration																2/26
Relay Control Integration																2/26
Status Update Presentation 3																2/26
Power Feedback Integration																3/7
Tachometer Integration																3/7
System Integration																3/19
Status Update Presentation 4																3/19
System Testing																4/2
System Housing Design																4/2
Status Update Presentation 5																4/2
System Validation																4/16
System Housing Fabrication																4/16
Final Presentation																4/16
Final Demonstration																4/24
Engineering Project Showcase																4/25
Final Report																4/28

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 208VAC.	Measure with multimeter and check if the voltage is 208VAC.	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	Oscilloscope displays each of the three phases of the PWM sine wave.	Connect oscilloscope probes to the set output pins for the PWM signals, ensure that the signals' duty cycles span from 0-100% and are rougly separated by thirds.	Tested	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
3.2.3.9	Optoelectronics Voltage Constraint	The optoelectronics subsystem shall convert the voltage it receives down to a voltage in the range of 15-20 V.	Test at full power where the opto receives ~60 V. Use a multimeter to measure voltage level on other side of opto barrier.	Untested	Mackenzie
3.2.3.10	Digital to Power Continuity	The digital to power opto-isolators shall have a voltage of 0V across each component when connecting input to output.	Use a multimeter to ensure that the voltage across each digital isolator is zero.	Tested- retest with new parts	Mackenzie

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Validation Plan

Paragraph #	Test Name	Success Criteria	Methodology	Status	Responsible Engineer(s)
3.2.3.11	Power to Digital Continuity	The power to digital opto-isolators shall have a voltage of 0V across each component when connecting input to output	Use a multimeter to ensure that the voltage across each power isolator is zero.	Tested- retest with new parts	Mackenzie
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	Firmware Code Compiles	MPLab firmware successfully compiles without errors or warnings	Attempt to compile code in MPLab and examine output logs to check for errors or warnings	Tested	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}.	Tested	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}.	Tested	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
TBD	User Interface	User is able to change the speed of the rotating PWM values by turning the potentiometer.	Change potentiometer position to lowest, highest, and middle notch to observe that the target frequency of the system is close to 60, 10, and 35 respectively, and the rotating PWM values change pace accordingly	Tested	Ryan
TBD	Frequency Testing	Code properly changes the frequency of the PWM signals	Use oscilloscope or a timer to measure the PWM waves to ensure that the program's target frequency is similar to the actual frequency of the PWM signals.	Untested	Ryan
TBD	Debugger Connection	The Microcontroller shall be able to properly communicate with Pickit4 debugger	Connect the Pickit4 Debugger to microcontroller PCB using the 5 pin connector and ensure that MPLAB X IDE can recognize the device.	Untested	Andrew

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Thank you