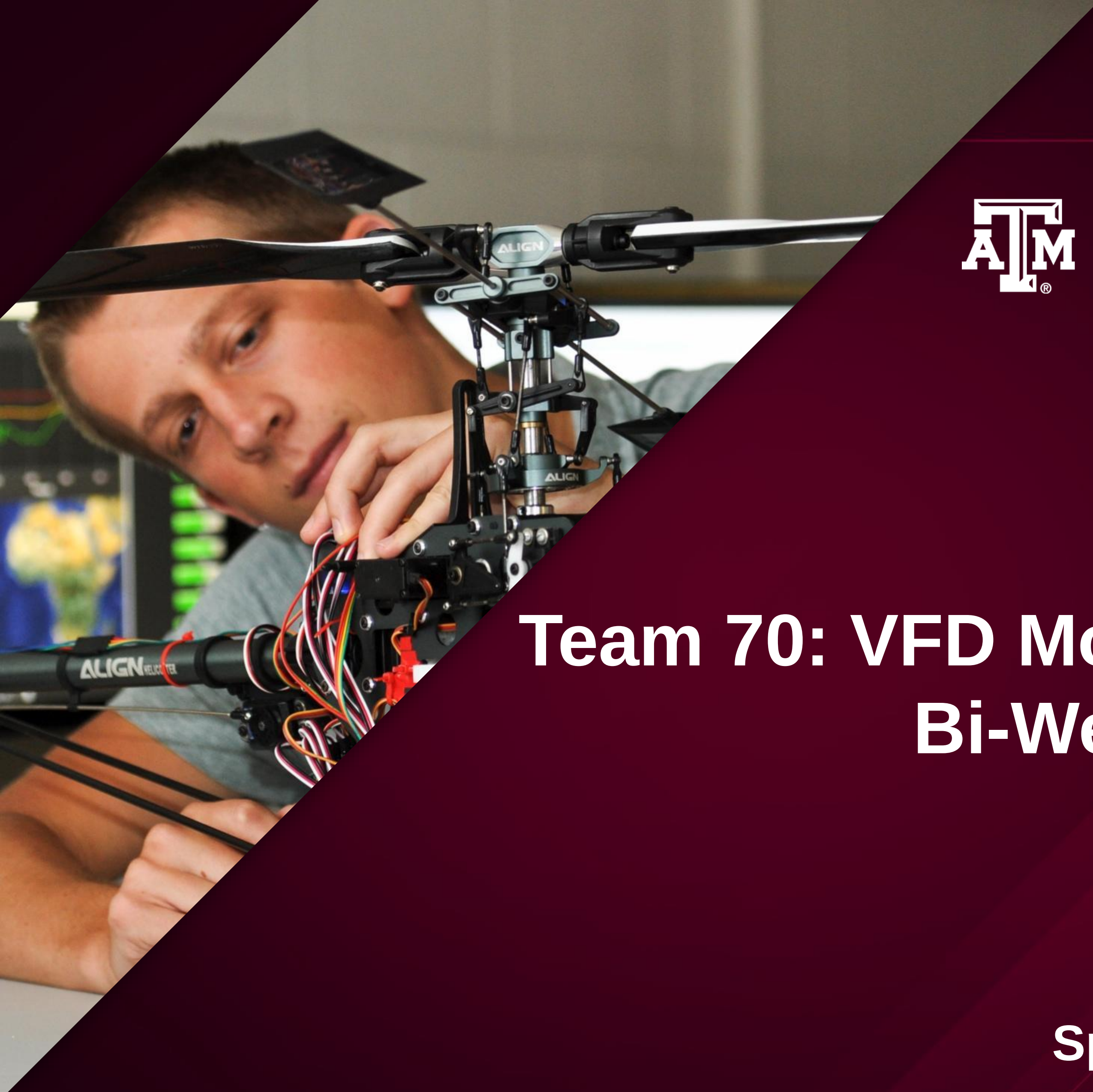


Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

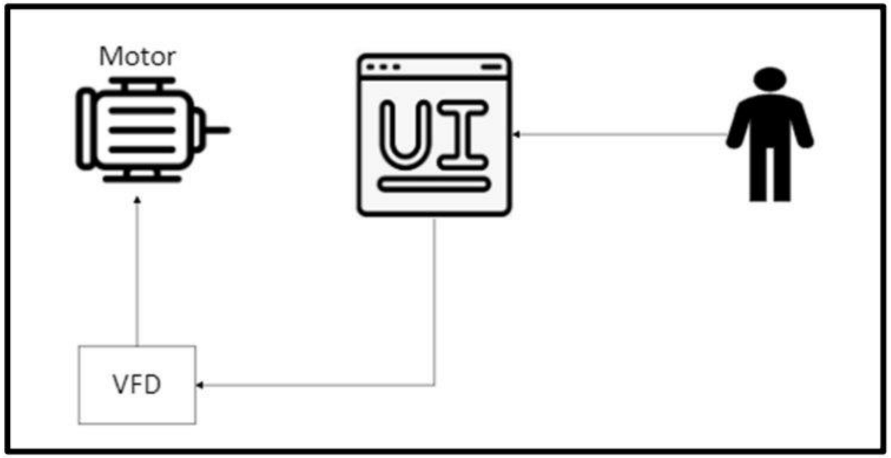
Team 70: VFD Motor Controller
Bi-Weekly Update 1

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

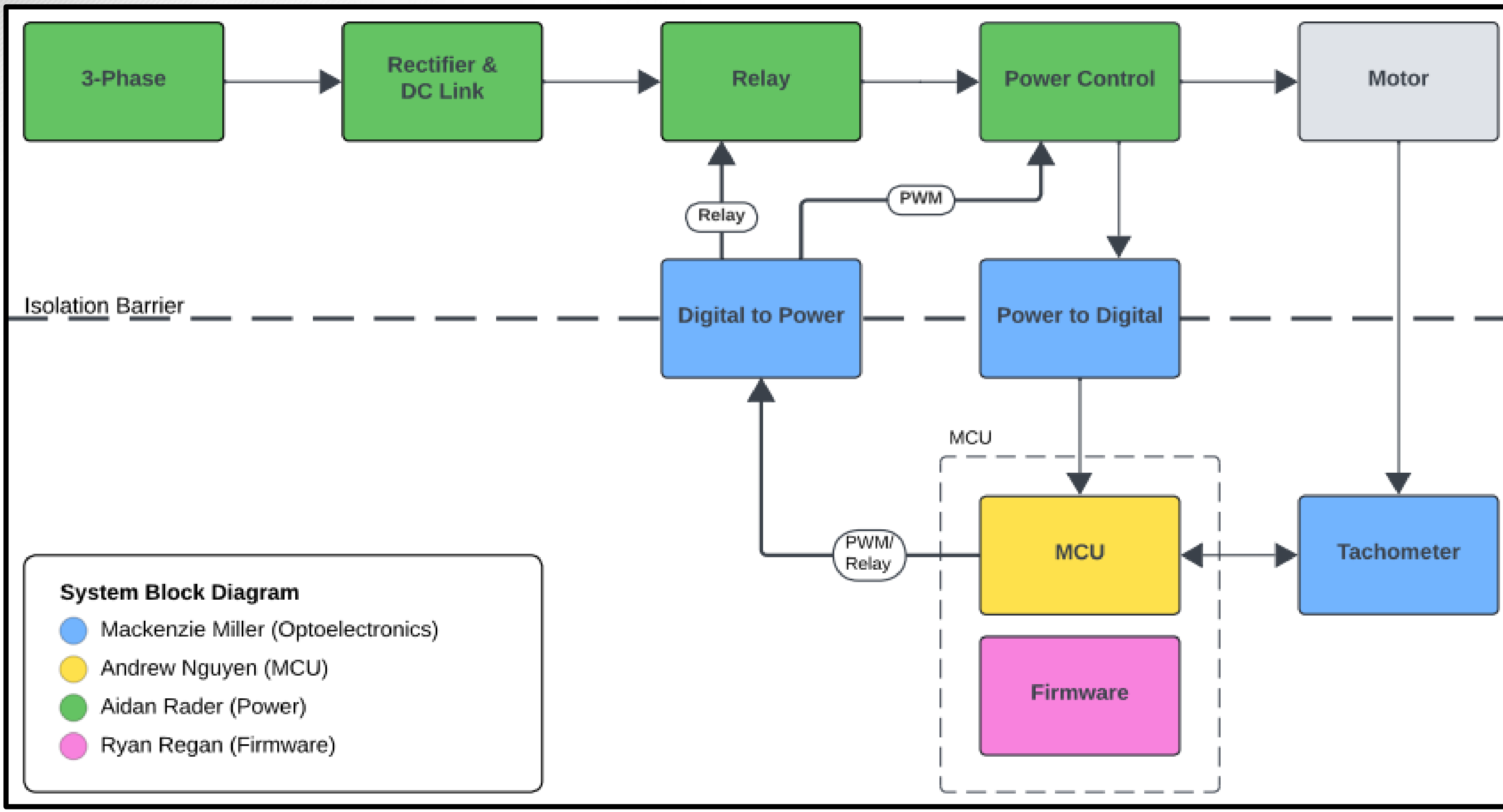
Project Summary

- 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

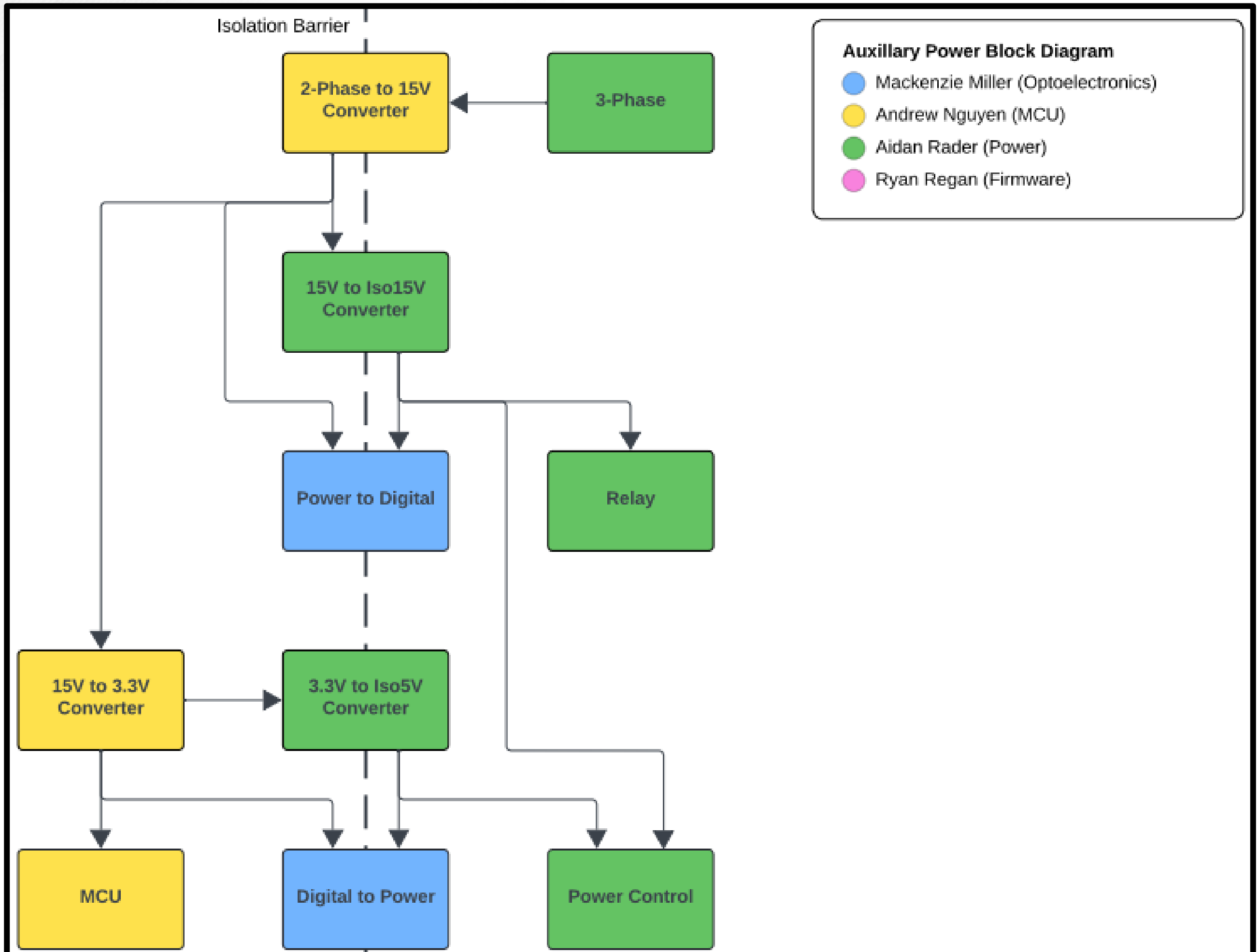


Project/Subsystem Overview

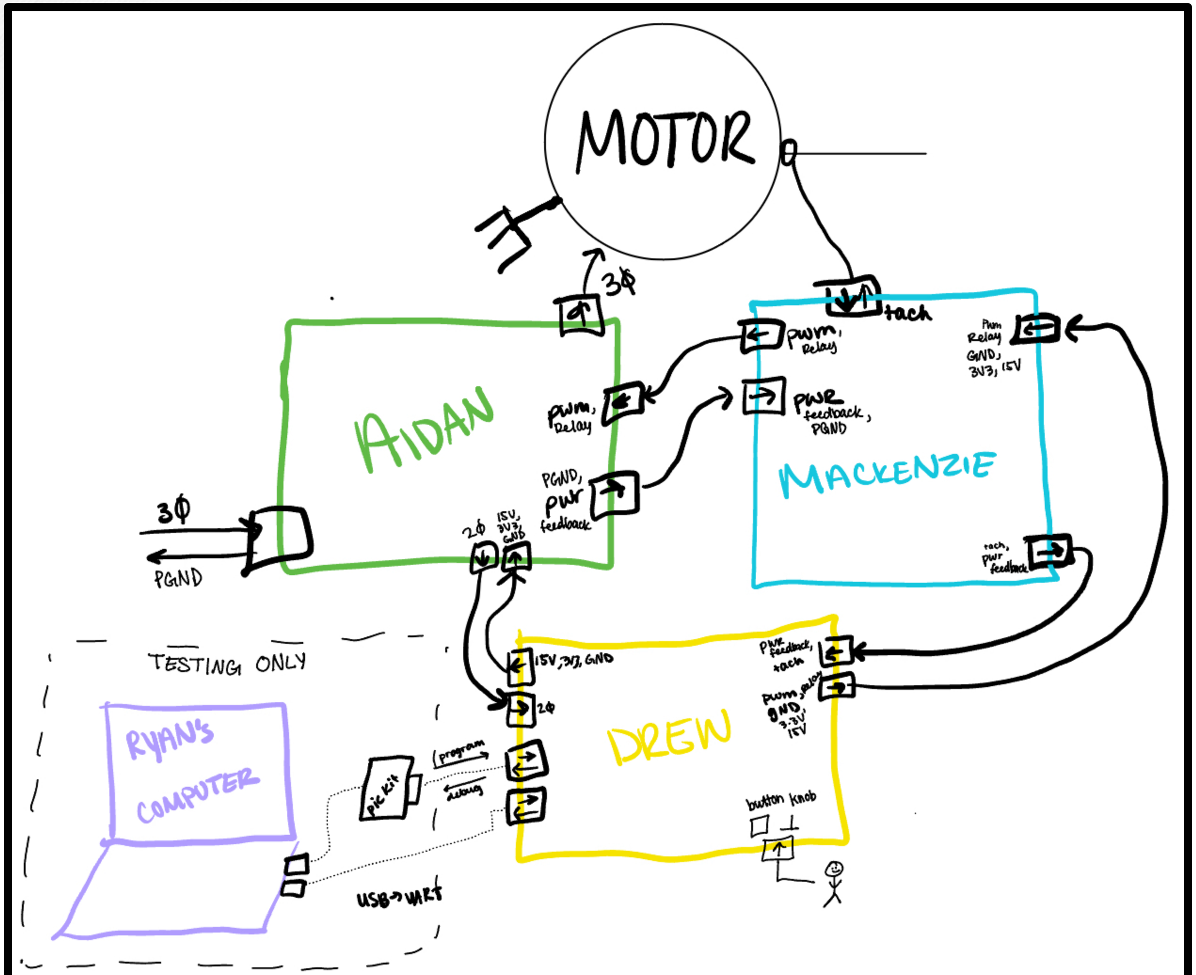


Auxiliary Power – See Next Page

Project/Subsystem Overview



Full Design Review



Planned Physical Orientation

Major Project Changes for 404

No major changes are being made for 404

Project Timeline

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

Optoelectronics

Mackenzie Miller

Accomplishments since 403 14 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Redesigned PCB to prepare for integration - Completed a Design Review	- Order new PCB and parts and assemble new board - Order tachometer and attach to motor

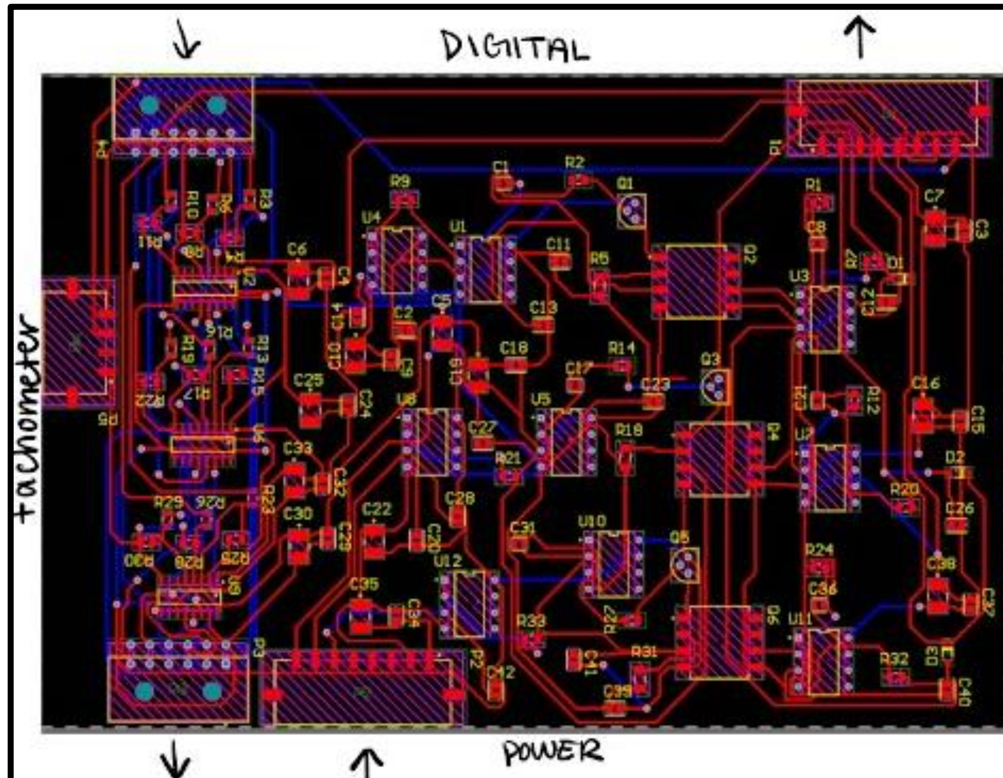
Optoelectronics

Mackenzie Miller

- PCB is functional – one digital isolator does not work

- Op-amps were getting hot at the beginning – did not maintain proper isolation between 15V and iso15V during initial testing

- PCB rerouting consisted of moving connectors around for convenience when integration starts



Dwight Look College of ENGINEERING TEXAS A&M UNIVERSITY

Microcontroller

Andrew Nguyen

Accomplishments since 403 15 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Revised connector, buck converter, and MCU schematics. Rerouted and rearranged PCB layout for easier integration - Ordered PCB board.	- Order new parts - Begin assembling PCB

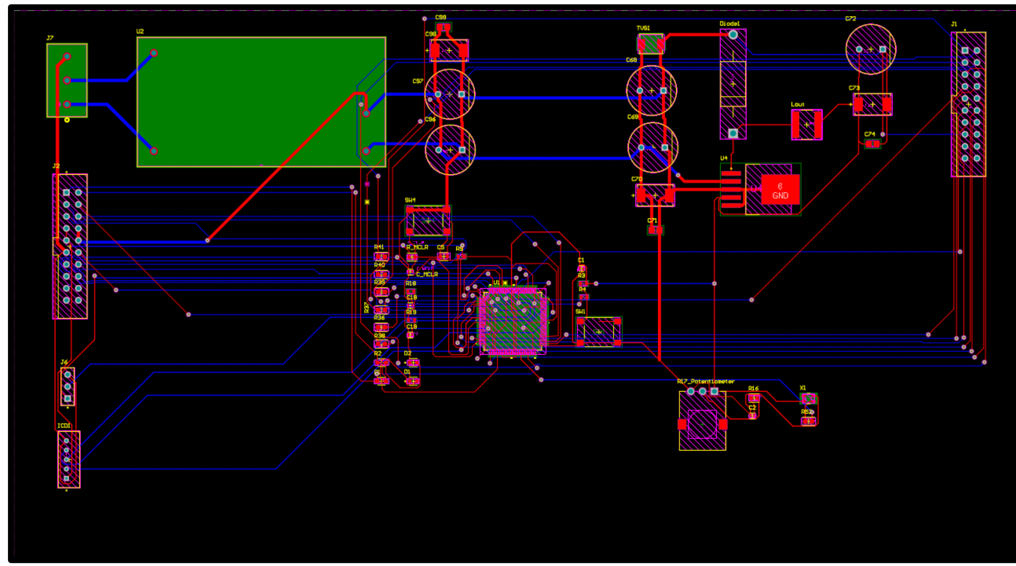
Microcontroller

Andrew Nguyen

- Original PCB did not provide MCU with proper voltage and some parts were heating up

- New PCB has updated trace widths as I forgot to increase the width of a few lines along with updated buck converter, MCU, and connector design

- Board layout changed to make integration easier



Power

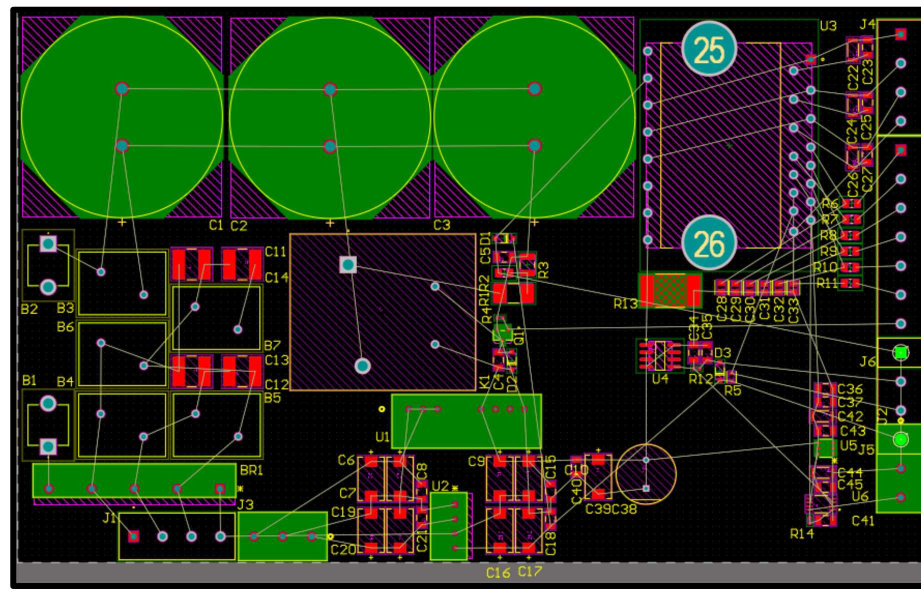
Aidan Rader

Accomplishments since 403 30.5 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Completed Full Design Review - Designed PCBv1	- Routing PCBv1 (pending Altium access) - Ordering PCBv1 - Ordering Parts Order 4 - Testing iso5V to 3.3V Converter - Test Power Control - Assemble PCBv1 - Start Auxiliary Power Integration (15V, 3.3V, iso15V, iso5V)

Power

Aidan Rader

- Full Design Review
    - 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
    - Short due to connecting power supply to wrong pin



Firmware

Ryan Regan

Accomplishments since 403 15hrs of effort	Ongoing progress/problems and plans until the next presentation
- Verified correct voltage of PWM waves - Found a temporary/loophole fix for the problem with the frequency range being too low - Discussed integration and validation strategies with team	- Find out how to display PWM sine wave on oscilloscope, and use it to calibrate the frequency more accurately - Integrate with microcontroller PCB and debug

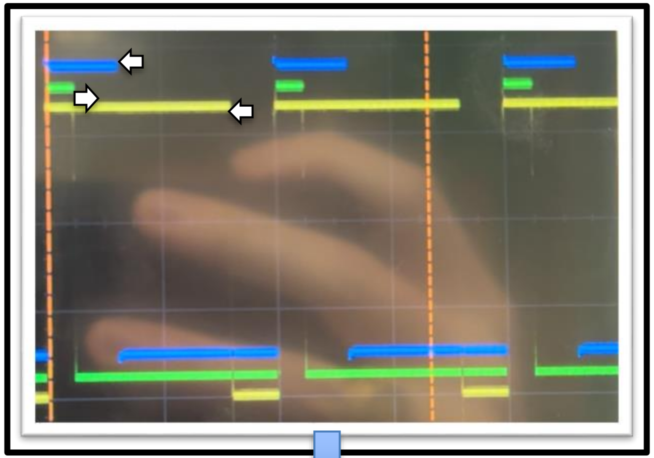
Dwight Look College of ENGINEERING TEXAS A&M UNIVERSITY

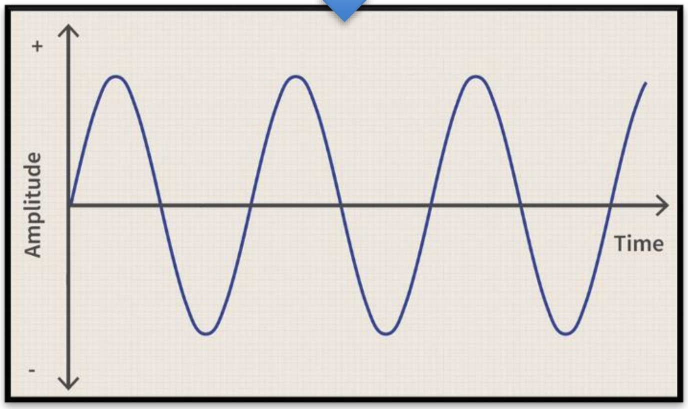
Firmware

Ryan Regan

- Temporary/loophole frequency fix:
  - Change PWM frequency variable used for calculations within code
  - This fix could be permanent if I am able to calibrate it to have to correct frequency bounds for the motor (10-60Hz)

- Need to find out how turn the separate three phases displayed into a singular sine wave on the oscilloscope, this will allow for simpler calibration and a better visualization of the output – specifically frequency changes





Parts Ordering Status

- Order PCBv1s
  - Optoelectronics: 1/30
  - Microcontroller: 1/29
  - Power: 1/30 or 1/31 (pending Altium access)
- Order Tachometer: 1/30
- Order Parts Order 4: 1/30

Part Number	Name	Notes	Quantity	$/unit	Actual ($)	Receipt	Vendor Link	Delivery Date	Group Member	Block Diagram
2N7002-TP	mosfet	order 4	3	0.13	0.39		mouser		Aidan	Relay
NKE0305SC	3.3/iso5, converter	order 4	1	8.28	8.28		mouser		Aidan	power control
IKCM30F60GD	power control	order 4	1	19.15	19.15		digikey		Aidan	power control

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
PCBv1s Order													Not Started			1/29
Parts Order 4													In Progress			1/29
Status Update Presentation 1													Completed			1/29
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
Status Update Presentation 3																2/26
PWM Control Integration																3/7
Relay Control Integration																3/7
Power Feedback Integration																3/19
Tachometer Integration																3/19
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

Dwight Look College of ENGINEERING TEXAS A&M UNIVERSITY

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

Thank You