VFD Motor Control

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**Execution and Validation Plan**

REVISION – 1

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**Execution Plan**

A green snake on a white background

Description automatically generated

*Figure 1: Execution Plan*

**Validation Plan**

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| 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 |
| 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 208VAC to 295VDC. | Measure with multimeter and check if the voltage after the rectifier is 295VDC. | Untested | Aidan |
| TBD | Rectifier Power Subsystem | System input voltage shall be rectified from 5VAC to 7.1 VDC. | Input 5VAC at differing angles of 120˚ on three waveform generators. Measure with multimeter and check if the voltage after the rectifier is 7.1 VDC. | Tested | Aidan |
| TBD | Isolated 15V Conversion | System shall convert 15VDC to isolated 15VDC. | Input 15VDC on a dc power supply. Measure with multimeter and check if the voltage after the converter is 15VDC. | Tested | Aidan |
| TBD | Isolated 5V Conversion | System shall convert 3.3VDC to isolated 5VDC. | Input 3.3VDC on a dc power supply. Measure with multimeter and check if the voltage after the converter is 5VDC. | 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 |
| 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 the voltage across the isolators have 0V and no continuity. | Tested | Mackenzie |
| 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 |  |  |  |