Test Report for Completed PCBs

Follow-up from test plan for PCB1:

This section will comment on passed and failed criteria with notes taken into consideration and debugging measures taken.

testing procedure for a more detailed process to follow. Measure the input voltage and the output voltages of both regulators. Test the continuity of the stepper input and output signals, and the corresponding signals of the DC motor as well as the continuity of the power and motor connectors.

Test Procedures:

Functional Testing for Power Systems:

Set V Batt and R5VT3V3R input using the lab bench power supply, measure output using personal multimeter from output source to ground.

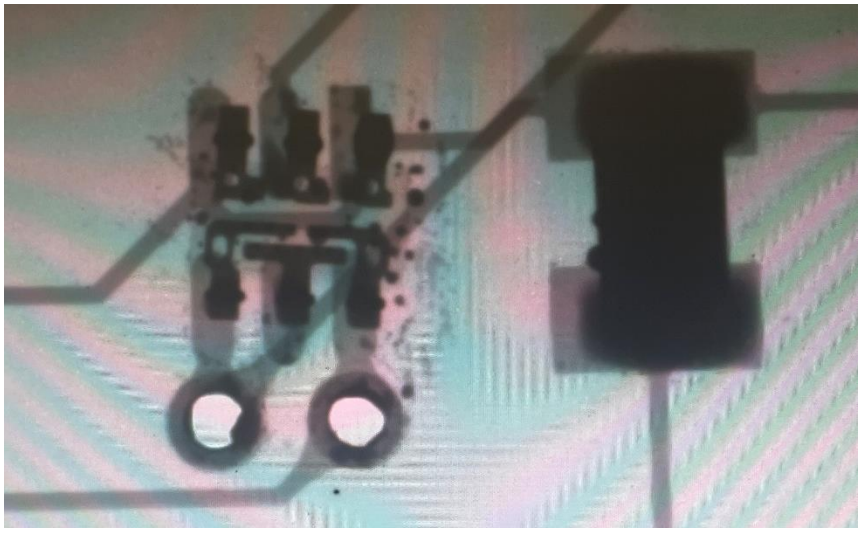
5V Voltage Regulator (14.8V 1mA IN to 5V @ 3A OUT)			
Circle Pass if 5V is measured at the output	Set input at J2 V Batt to 14.8V 1mA (max)	Measure MCU5V Output: 5.08 @ **J1**	(Pass) / Fail
		Measure R5VT3V3R Output: 5.08 @ **J5**	(Pass) / Fail
		Measure MCU5V Output: 5.8 @ **J6**	(Pass) / Fail
		Measure MD5V Output: 5.08 @ **J7**	(Pass) / Fail
5V Voltage Regulator (30V 1mA IN to 5V @ 3A OUT)			
Circle Pass if 5V at the output	Set input at J2 V Batt to 30V 1mA (max)	Measure MCU5V Output: 5.08 @ **J1**	(Pass) / Fail
		Measure R5VT3V3R Output: 5.08 @ **J5**	(Pass) / Fail
		Measure MCU5V Output: 5.08 @ **J6**	(Pass) / Fail
		Measure MD5V Output: 5.06 @ **J7**	(Pass) / Fail
3V3 Voltage Regulator (5V to 3V @ 0.3A)			
Circle Pass if 3.3V at the output	Set input at **J5** R5VT3V3R to 5V, 1mA	Measure IC3V3A Output: 0 @ **J8**	Pass / (Fail)
		Measure IC3V3B Output: 0 @ **J12**	Pass / (Fail)

Functional Testing for Motor Drivers:

Perform continuity tests on the inputs to the outputs of the motor driver ICs using personal multimeter at a lab bench with proper ESD equipment:

Stepper Motor Driver: U3 SMD

During the test procedures, PCB1 passed all the 5V tests but failed the 3V3 tests. The TPS62932 regulator responsible for converting 5V to 3.3 was misaligned as shown in the x-rayed image below. It was also observed that both diodes meant to indicate the 5V and 3V3 rails had been energized were backwards. Further debugging is required to determine the solution for these issues. More on debugging PCB1 later.



After the x-ray images were taken, the misaligned TPS62932 was replaced with a new one and resoldered to the board with a hot air rework station. Still the circuit did not perform as expected. Later, once the thermal images were taken, it was observed that the circuit was drawing current through the 5V regulator as expected but not through the 3V3 regulator as hoped. This can be shown in the figure below with the 5V regulator showing the highest temperature and the surrounding area along certain traces glowing red.

Commenting on the results from the motor drivers, the signal continuity could not be measured between their input and output pins since there is amplifier circuitry between them. This means that the functional tests for both U3 and U4 would fail.

The same ICs were tested while power was being supplied to the EN and Vs pins, 0.5V was found at the EN pin instead of 5V additional errors were found for U3. Further debugging for both motor driver ICs is required to determine the source of these errors.

Stepper Motor Driver: U3 SMD

Signal continuity between	pin 2 & 3	Pass / Fail
	pin 9 & 8	Pass / Fail
	pin 12 & 13	Pass / Fail
	pin 1 & 18	Pass / Fail
DC Motor Driver: U4 TH		
Signal continuity between	pin 1 & 3	Pass / Fail
	pin 9 & 6	Pass / Fail
	pin 7 & 11	Pass / Fail
	pin 10 & 14	Pass / Fail

The remainder of tests passed for the motor and power connectors. Below are Zach McEwen's notes from testing the PCB1.

Traceability and Documentation:

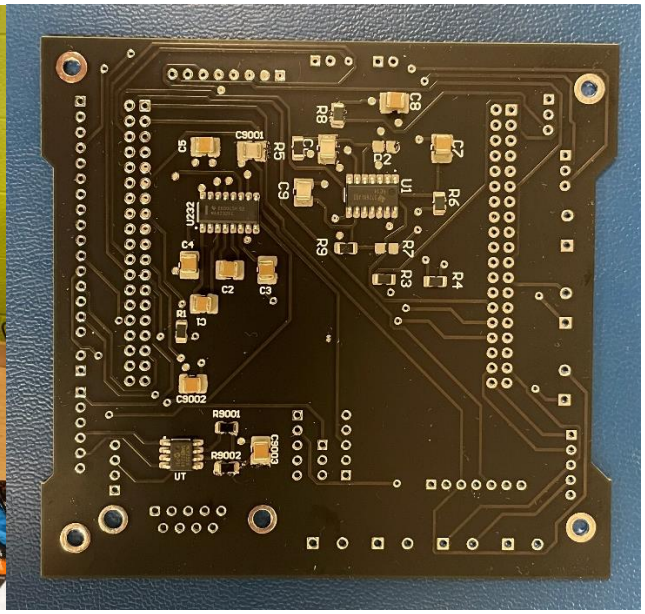
Test results will be documented in test procedures. Any deviations from expected results can be recorded in the Notes Section below:

NOTES:

- D5V, D3V Backward
- MCU need power to read continuity
- U3 1,11 Enable is reading 0.5V
- No continuity between
- 1.09, 2.09 at 1,9 respectivly
- Refer to M.C datasheet for IC internal circuit

Results from PCB2:

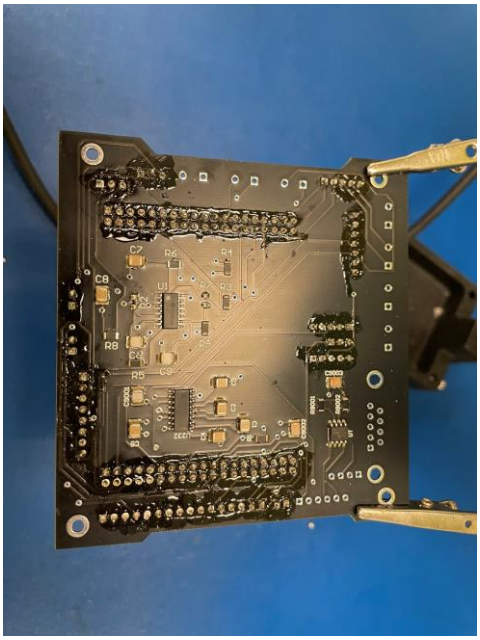
This section will cover testing of PCB2 and debugging actions taken and next steps. The first image below shows solder paste being applied to PCB2 and the next image shows it after the SMD components have been placed.



Once the components had been placed the board was place in the Protoflow oven. Unfortunately the graph for this pass was lost.

Soldering TH components:

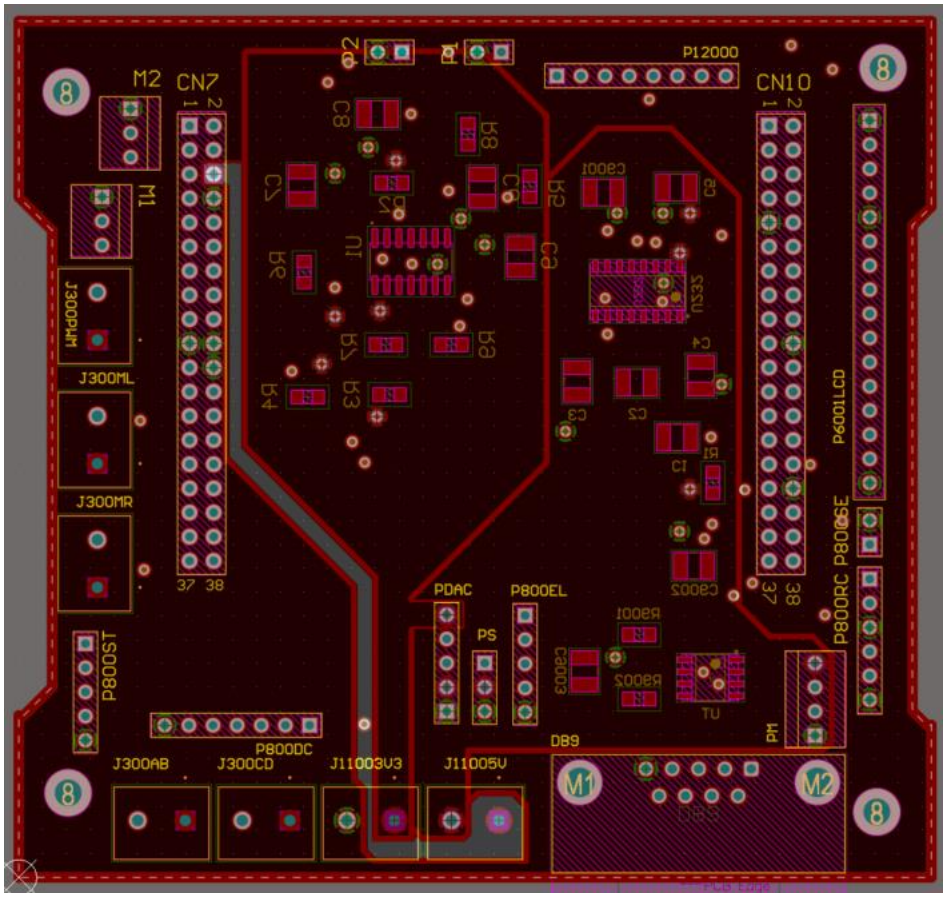
Soldering the various headers and terminal connectors for PCB2 was really fun, with the main challenging being finding a soldering iron that wasn't corroded. I found that applying plenty of flux and tinning the tip of the soldering iron help things run smoothly. I will remember to flux the connection points on the board before inserting the headers. Below is an image of PCB2 partially completed with plenty of flux on the many of the connection points.



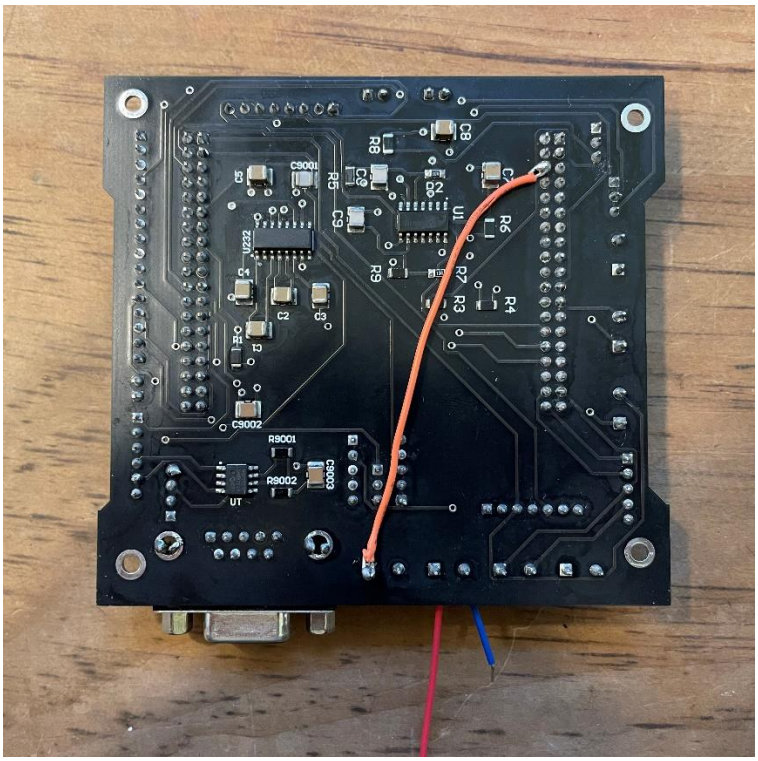
One flaw in the design of PCB2 is the placement of CONN 6 POS Header P12000 and 2 Pin Headers P1 and P2 which sit below the STM32 microcontroller making it not possible to interface with the keypad or limit switch circuitry designed into this board.

To remedy this, these pins will be desoldered and flipped so that the male pins are facing down and away from the MCU.

Another problem with this design was discovered when verifying the power planes that supply 3.3V and 5V to various parts of the circuit. The MCU5V plane when tested was found to be defective, as it did not take 5V from the J11005V terminal to pin 6 of CN7 38pin header (see path in grey highlighted in the image below).



To remedy this, a wire was soldered to these pins to bridge the missing connection. See image below:



Remaining X-Ray Images of ICs:

Image shows U3 from PCB1

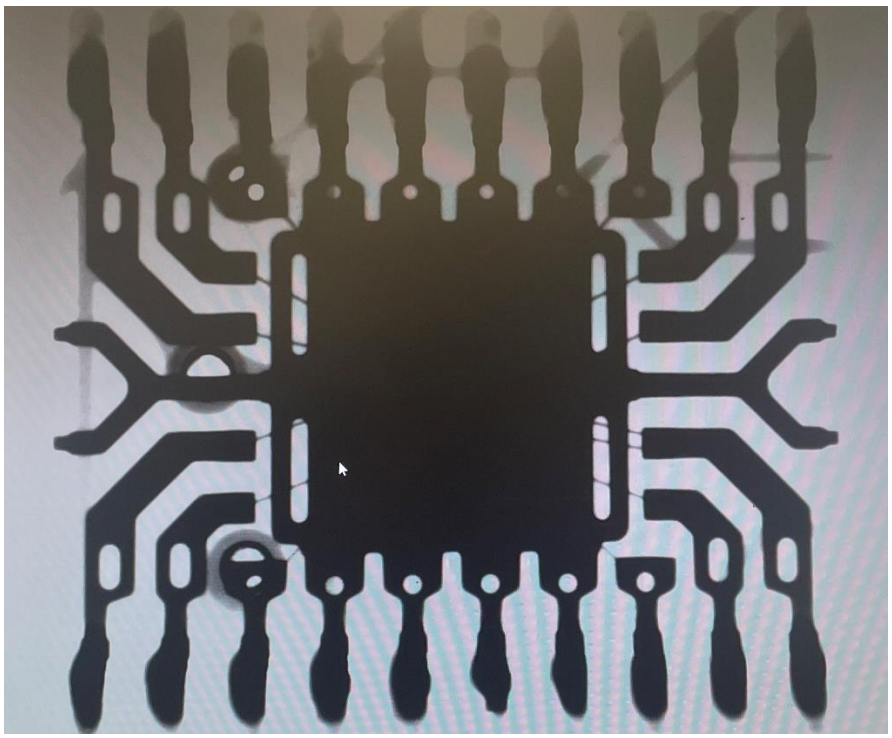
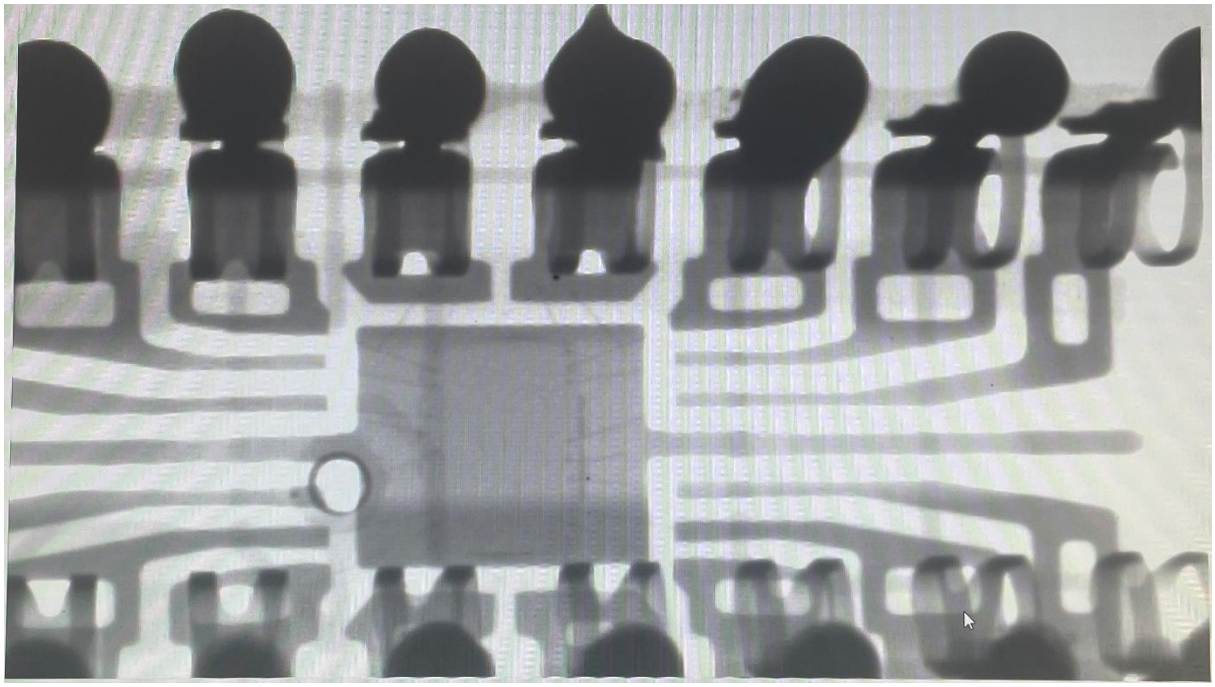


Image shows U4 from PCB1



(K.D)

2024/ Mar 5/4

Test Plan for PCB1

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Test Objectives and Scope:

The main purpose of this testing is to verify the functionality of the 5V and 3.3V Regulators. The scope of the testing is for the two main regulators on the power and motor driver PCB (in blue). Additionally, continuity across the inputs and output of the motor driver ICs will be tested. Finally continuity at the power and motor driver terminal connectors will be measured.

One way you can test the reliability of the 5V regulator is if it operates within the stated range that i was designed to handle. For example, will the 5V regulator reliably convert a 14.8-30V input to 5V a 3A consistently or does the 3.3V regulator convert a 5V input to a 3.3V input at 300mA (see below for the regulators used).

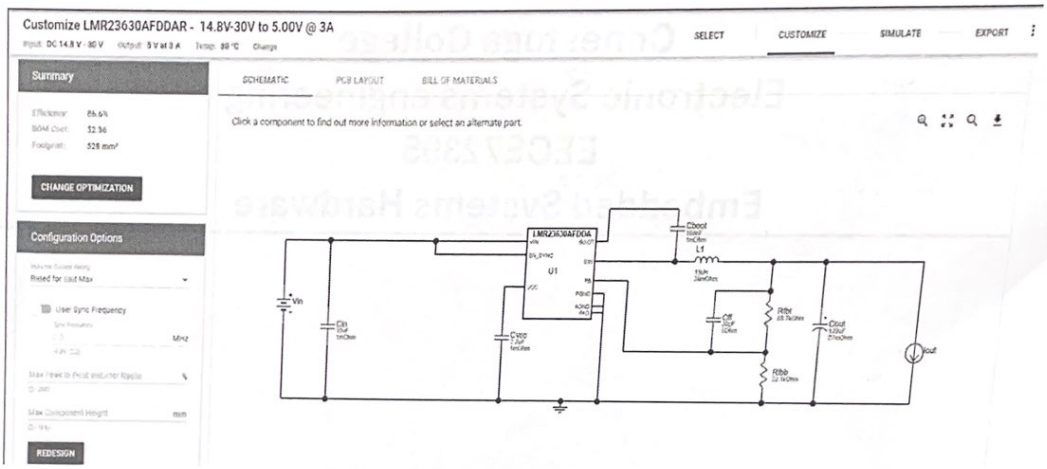
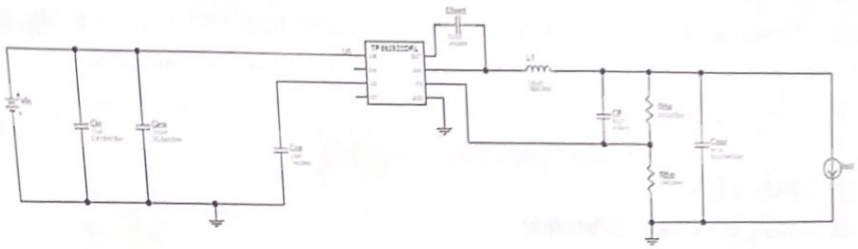


Figure 1: 5V Regulator



TPS62932 Compare

3.8-V to 30-V input, 2-A, 200-kHz to 2.2-MHz, low-IQ synchronous buck converter in SOT-583 package

Efficiency: 92.4% BOM Cost: $0.90 Footprint: 493 mm² BOM Count: 10

Topology: Buck Frequency: 500 kHz IC Cost: $0.19 | 1ku

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Figure 2: 3.3V Regulator

It's **important** to **test the stability of the output voltage** of both regulators, that the voltage remains consistent within the specified limits under varying loads either 14.8V or 30V.

Another critical thing to consider is the **temperature performance** of the regulator ICs, this may be more challenging to test in the lab as there is limited access to the temperature camera.

It's critical that all of the jumpers' points get tested before they are connected to the rest of the circuit with 0 ohm resistors.

Test Environment and Equipment:

The chosen test environment is the 2nd year ESE classroom / labs at one of the lab benches. The primary tools which will be used are the lab bench power supply the helping hands and a fluke 12 multimeter owned by Kyle Dick.

To mimic real world conditions, an anti-static mat and arm bracelet will be required to perform all testing in addition to safety glasses.

Test Types and Levels:

Functional Testing:

Follow the previous testing methodology to verify that the PCB performs as intended. Refer to the

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testing procedure for a more detailed process to follow. Measure the input voltage and the output voltages of both regulators. Test the continuity of the stepper input and output signals, and the corresponding signals of the DC motor as well as the continuity of the power and motor connectors.

Test Procedures:

Functional Testing for Power Systems:

Set V Batt and R5VT3V3R input using the lab bench power supply, measure output using personal multimeter from output source to ground.

5V Voltage Regulator (14.8V 1mA IN to 5V @ 3A OUT)			
Circle Pass if 5V is measured at the output	Set input at J2 V Batt to 14.8V 1mA (max)	Measure MCU5V Output: 5.08 @ **J1**	(Pass) / Fail
		Measure R5VT3V3R Output: 5.08 @ **J5**	(Pass) / Fail
		Measure MCU5V Output: 5.8 @ **J6**	(Pass) / Fail
		Measure MD5V Output: 5.08 @ **J7**	(Pass) / Fail
5V Voltage Regulator (30V 1mA IN to 5V @ 3A OUT)			
Circle Pass if 5V at the output	Set input at J2 V Batt to 30V 1mA (max)	Measure MCU5V Output: 5.08 @ **J1**	(Pass) / Fail
		Measure R5VT3V3R Output: 5.08 @ **J5**	(Pass) / Fail
		Measure MCU5V Output: 5.08 @ **J6**	(Pass) / Fail
		Measure MD5V Output: 5.06 @ **J7**	(Pass) / Fail
3V3 Voltage Regulator (5V to 3V @ 0.3A)			
Circle Pass if 3.3V at the output	Set input at **J5** R5VT3V3R to 5V, 1mA	Measure IC3V3A Output: 0 @ **J8**	Pass / (Fail)
		Measure IC3V3B Output: 0 @ **J12**	Pass / (Fail)

Functional Testing for Motor Drivers:

Perform continuity tests on the inputs to the outputs of the motor driver ICs using personal multimeter at a lab bench with proper ESD equipment:

Stepper Motor Driver: U3 SMD

Signal continuity between	pin 2 & 3	Pass / Fail *
	pin 9 & 8	Pass / Fail *
	pin 12 & 13	Pass / Fail *
	pin 1 & 18	Pass / Fail *
DC Motor Driver: U4 TH		
Signal continuity between	pin 1 & 3	Pass / Fail *
	pin 9 & 6	Pass / Fail *
	pin 7 & 11	Pass / Fail *
	pin 10 & 14	Pass / Fail *

Functional Testing for Motor and Power Connectors:

Perform continuity tests on the power and signal terminal connectors using personal multimeter at a lab bench with proper ESD equipment:

Continuity to Power Screw Type Terminal Connectors		
Circle Pass if continuity exists between specified tests points	J1 (MCU5V) & pin1 of J3005V	Pass / Fail
	J6 (IC5V) & pin2 of J3005V	Pass / Fail
	J12 (IC3V3B) & pin1 of J3003V3	Pass / Fail
	Pin 14 (U3) & pin2 of J3003V3 (GND)	Pass / Fail
Continuity to Stepper Motor Outputs Screw Type Terminal Connectors		
Circle Pass if continuity exists between specified tests points	From U3 L293DD SMD to P23 Terminal Connector	
	pin 3 U3 to pin 1 P23	Pass / Fail
	pin 8 U3 to pin 2 P23	Pass / Fail
	pin 13 U3 to pin 3 P23	Pass / Fail
	Pin 18 U3 to pin 4 P23	Pass / Fail
Continuity to Stepper Motor Outputs Screw Type Terminal Connectors		
Circle Pass if continuity exists between specified tests points	From U4 L293D TH to P33 Terminal Connector	
	pin 3 U4 to pin 1 P33	Pass / Fail
	pin 6 U4 to pin 2 P33	Pass / Fail
	pin 11 U4 to pin 3 P33	Pass / Fail
	Pin 14 U4 to pin 4 P33	Pass / Fail

Test Data and Metrics:

Expected outcomes:

- Voltage logged in the test procedure for both regulators.
- Continuity between selected pins, recorded as pass or fail in the test procedure.
- Images taken where voltage is outside of the expected range (acceptable criteria), indicating the input and output pins for the voltage regulators and the pair of pins where measuring continuity.

Acceptance Criteria: +/- 5% when calculating voltages.

Defect Reporting and Resolution:

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- Report defective solder joints with a photo and a note of where it's located in the Traceability and Documentation section.
- Where there is no continuity between pins, a note with its location will be made for later inspection.
- Defective traces, vias or stenciling can also be addressed with a note or an image posted to th Traceability and Documentation section.

Addressing Issues:

- All rework and debugging will be performed by the owner of the board.
- Any design changes will be addressed in the next revision.
- Where there are issues with soldering, rework will be performed, and new components used where necessary.
- Key issues will be documented in lessons learned section of MBSE.

Traceability and Documentation:

Test results will be documented in test procedures. Any deviations from expected results can be recorded in the Notes Section below:

NOTES:

- D5V, D3V Backward
- Multimeter power to read continuity
- U3 1,11 Enable is reading 0.5V
- No continuity between
- 1.09, 2.09 at 1,9 respectivly
- Refer to M.C datasheet for IC internal circuit

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Risk Assessment:

Addressing Potential Risks:

- There could be a possible problem with U2 and may require additional testing to confirm continuity between pin 1 and 3 and OL everywhere else.
- R9 is not soldered to the board yet as it did not arrive with the rest of the shipment of parts.
- Ensure there is no continuity between any of the remaining resistor pads on the PCB, once proper operation has been confirmed, these will be populated by 0-ohm resistors.

Approval and Sign-Off:

Reviewed and approved by a second year ESE student. Testing may begin once sign-off is completed.

Name: Zach McEwen

Date March 13th 2024