



Document Number	03252-DOC-INS02
Revision	05
Title	Moab Test Procedures

#### Revision History:

Rev	Action	Date
01	Official Start to Document Tracking	6/30/20
02	Update dates on .bat files image. Step 9 and 10 added to Servo Calibration Test Procedure. Corrected document number in footer	7/2/20
03	Updated acceptable behavior for ball balancing in Brain mode	7/28/20
04	Updated Production Software test commands for compatibility with software load 2.4.1.	9/24/20
05	Updated Production Software reference date to 9/25/20	9/25/20

#### Ref Documents:

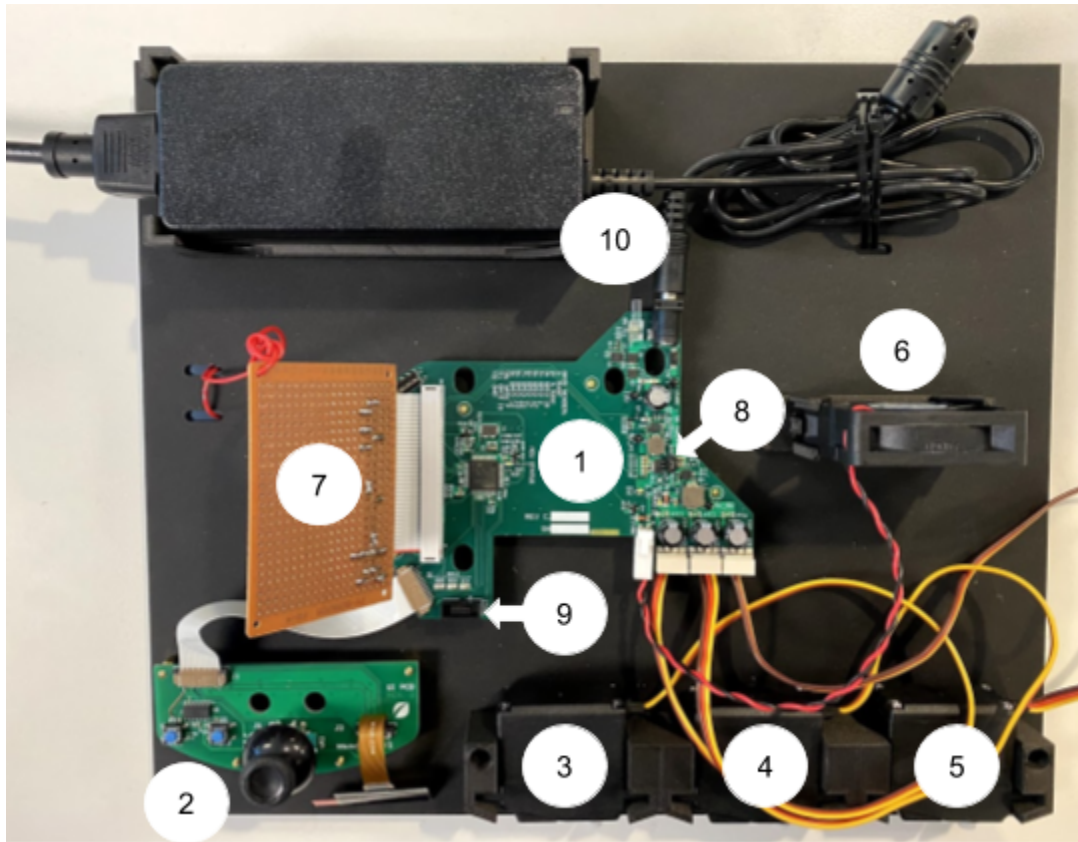
Rev	Title	Document Number
02	Moab V2 Assembly Instructions	03252-DOC-INS01

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# Board Test

## Board Test Fixture



## Board Test Fixture Components

1. Main Board (Device Under Test)
2. UI Board (Device Under Test)
3. Servo 3
4. Servo 2
5. Servo 1
6. Fan
7. Protoboard
8. 2 Pin Jumper
9. JTAG Header
10. Power Supply

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## Board Test Setup

1. Place Main Board and UI Board onto fixture
2. Connect UI board to Main Board with FPC cable
3. Plug 3 servos into beige connectors in order from left to right
4. Plug fan into white connector
5. Plug 40 wire ribbon cable into loopback protoboard
6. Place 2 Pin Jumper on main board pins
7. Connect JTAG programmer to box connector on Main Board
8. Connect Power Supply to Main Board
9. Use J-LINK software to flash test firmware to microcontroller (see next page)

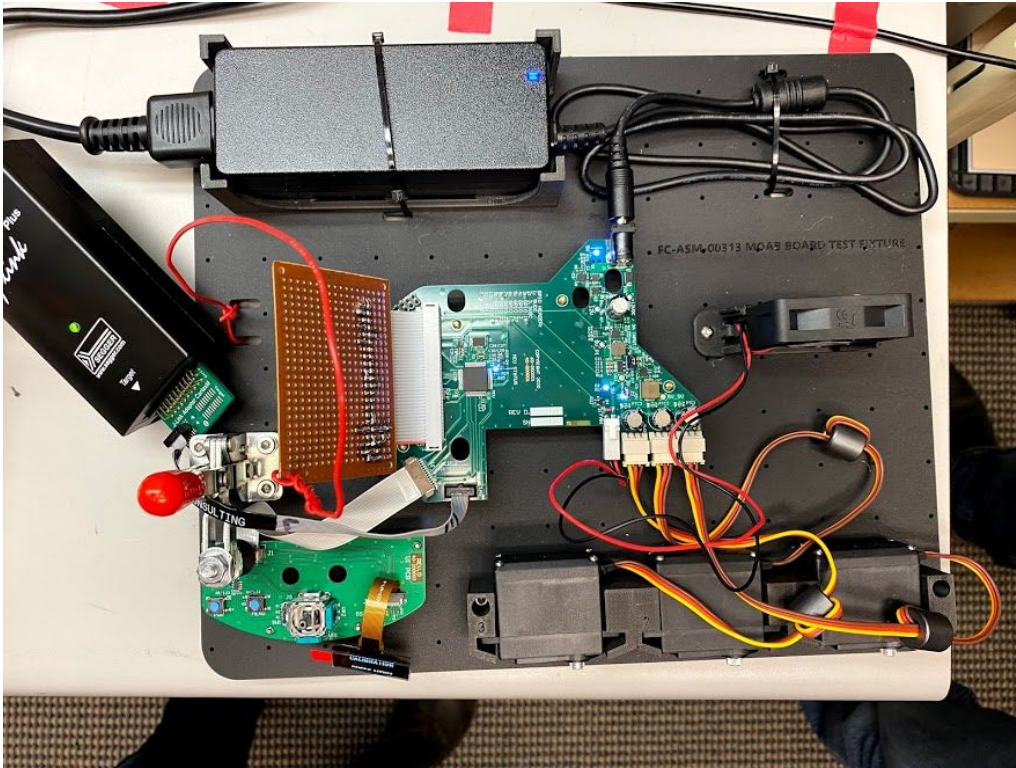
## Firmware\_test Programming Procedure




1. **(Only for Test Station Setup)** Download the J-Link software from SEGGER's site (<https://www.segger.com/downloads/jlink/>)

The screenshot shows the SEGGER website's J-Link Software and Documentation Pack page. The page has a blue header with the SEGGER logo and navigation links. Below the header, there's a section titled 'J-Link Software and Documentation Pack' with a list of features and links to 'Release Notes' and 'More Information'. A 'Click for downloads' link is also present. Below this, there's a table with columns for 'Version', 'Date', 'File size', and 'Download'. The first row is for the Windows version, and its 'Download' button is circled in red.

	Version	Date	File size	Download
J-Link Software and Documentation pack for Windows <small>Installing the software will automatically install the J-Link USB drivers and offers to update applications which use the J-Link DLL. Multiple versions of the J-Link software can be installed on the same PC without problems; they will co-exist in different directories.</small>	V6.80b	[2020-06-05]	49,516 KB	DOWNLOAD
J-Link Software and Documentation pack for macOS	V6.80b	[2020-06-05]	34,311 KB	DOWNLOAD
J-Link Software and Documentation pack for Linux, DEB installer, 32-bit	V6.80b	[2020-06-05]	32,637 KB	DOWNLOAD
J-Link Software and Documentation pack for Linux, DEB installer, 64-bit	V6.80b	[2020-06-05]	43,171 KB	DOWNLOAD
J-Link Software and Documentation pack for Linux, RPM installer, 32-bit	V6.80b	[2020-06-05]	32,650 KB	DOWNLOAD
J-Link Software and Documentation pack for Linux, RPM installer, 64-bit	V6.80b	[2020-06-05]	38,365 KB	DOWNLOAD
J-Link Software and Documentation pack for Linux, TGZ archive, 32-bit	V6.80b	[2020-06-05]	32,702 KB	DOWNLOAD
J-Link Software and Documentation pack for Linux, TGZ archive, 64-bit	V6.80b	[2020-06-05]	43,247 KB	DOWNLOAD
J-Link Software and Documentation pack for Linux ARM systems <small>Note: This package is only needed in the special case of J-Link being controlled by a Linux system which is running on an ARM hardware (so J-Link is connected via USB/Ethernet to this ARM system that is running Linux). In case J-Link is just connected to a PC running Linux, the "J-Link software &amp; documentation pack for Linux" is the correct package. <small>Note: This package comes without drivers.</small></small>	V6.80b	[2020-06-05]	22,189 KB	DOWNLOAD

2. Ensure the Moab is connected to power and the JTAG connector (from the J-Link) into the socket on the main board.



3. Double click the *FIRMWARE\_TEST* batch file from 6/29/20.
  -  FIRMWARE\_PRODUCTION.bat
  -  FIRMWARE\_TEST.bat
  -  Production FW upload ilink
4. Wait while the script runs. When it's completed, type "exit" into the command prompt. Press enter.
5. After a moment, the Moab unit should boot into its test mode
  - a. If the unit doesn't boot into test mode:
    - i. Pull the barrel jack power plug and reinsert to power cycle the board
    - ii. If the board still doesn't boot into test mode, run the .bat file again
    - iii. If the board still doesn't boot, set it aside for further date inspection
6. Follow the instructions displayed on the OLED (outlined in Board Test Procedures below) until the board-level tests are completed
  - a. If all board level tests pass, expected results are observed, and there are no stalls within the process, remove the power jack and sort board into a bin for assembly
  - b. If any of the board level tests fails to complete, set bot aside for further date inspection

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## Board Test Procedures

Button Test		
#	Test Step	Expected Results
1	Press MENU button when prompted	"MENU BUTTON PRESSED"
2	Press POWER button when prompted	"POWER BUTTON PRESSED"
3	Press thumbstick button when prompted	"JOYSTICK BUTTON PRESSED"

Joystick Calibration		
#	Test Step	Expected Results
1	Press MENU button to get thumbstick offset	"PLEASE WAIT" displayed, prompt for next step
2	Rotate stick slowly in circles to get minimum/maximum values, press MENU when done	Displayed maximum and minimum values no longer change
3	Verify thumbstick calibration	Thumbstick is centered at (0,0) and ranges from -100 to 100 at minimum/maximum for both X and Y axes.
4	Press MENU to write calibration to OTP	"CALIBRATION WRITTEN"

Peripheral Test		
#	Test Step	Expected Results
1	Press MENU button to begin test	
2	<No Action> Servo 1 check	Servo 1 actuates first (right servo)
3	<No Action> Servo 2 check	Servo 2 actuates second (center servo)
4	<No Action> Servo 3 check	Servo 3 actuates third (left servo)
5	Press MENU to test fan	
6	<No Action> Fan check	Fan comes on for 2 seconds

Communication Test		
#	Test Step	Expected Results
1	Press MENU button to begin test	
2	<No Action> SPI check	"SPI OK"
3	<No Action> UART1 check	"UART1 OK"
4	<No Action> UART2 check	"UART2 OK"
5	<No Action> Testing Complete	"MOAB PASS"

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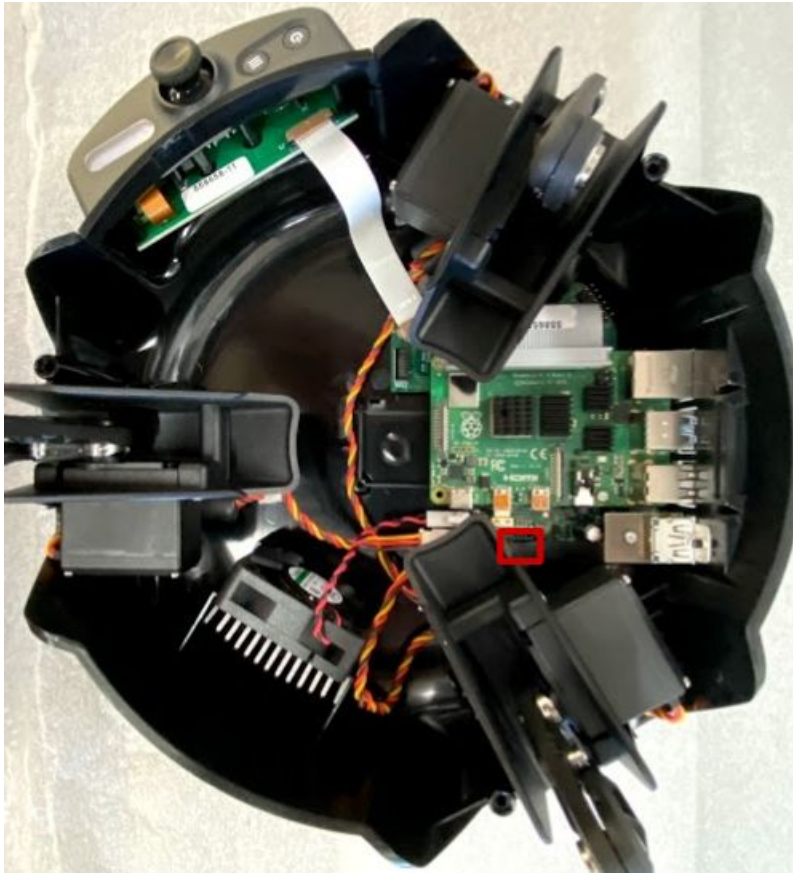
# Servo Calibration

## Servo Calibration Station Components

1. Power Supply
2. Test Balance Plate
3. Protractor
4. 2-Dimensional Fluid Level
5. JTAG Programmer (to write production firmware)
6. 2 Pin Jumper (item 8 in board test fixture components)



## Servo Calibration Station Setup

1. Level tabletop for calibration, surface must be level within 1 degree
2. Place device on leveled tabletop
3. Ensure 2 Pin Jumper is attached to the main board

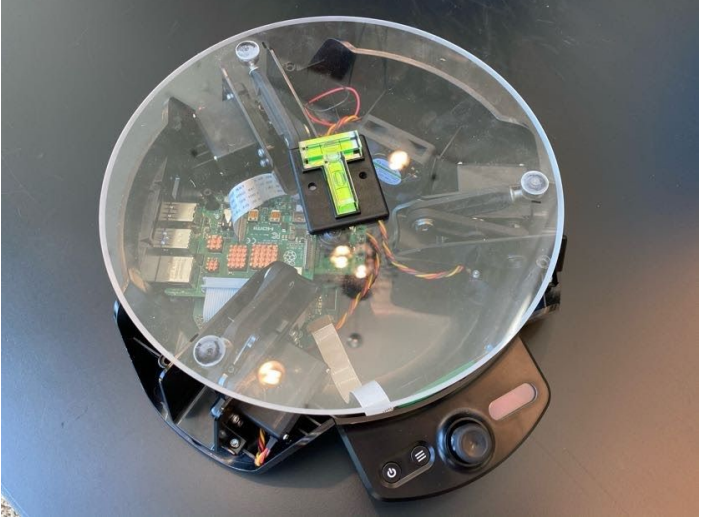




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## Servo Calibration Test Procedure

Servo Calibration		
#	Test Step	Image of step
1	Hold down MENU button while inserting the Power Supply	"SERVO CALIBRATION" displayed
2	Use the thumbstick (up to increase angle, down to reduce angle) to set servo 1 to 90 degrees, (as close as practical, but at least within 1 degree) press MENU when done	
3	<p>Use thumbstick to set servo 1 to the maximum angle (the point just before the arm would make contact with the housing). Press MENU when done.</p> <p>Be careful servo does not actually touch the servo channel stopping point as it is possible to overdrive the servo. It is better to have a small gap between the arm and the servo channel stopping point than set the servo to overdrive</p>	
4	Repeat steps 2 and 3 for the other two servos.	



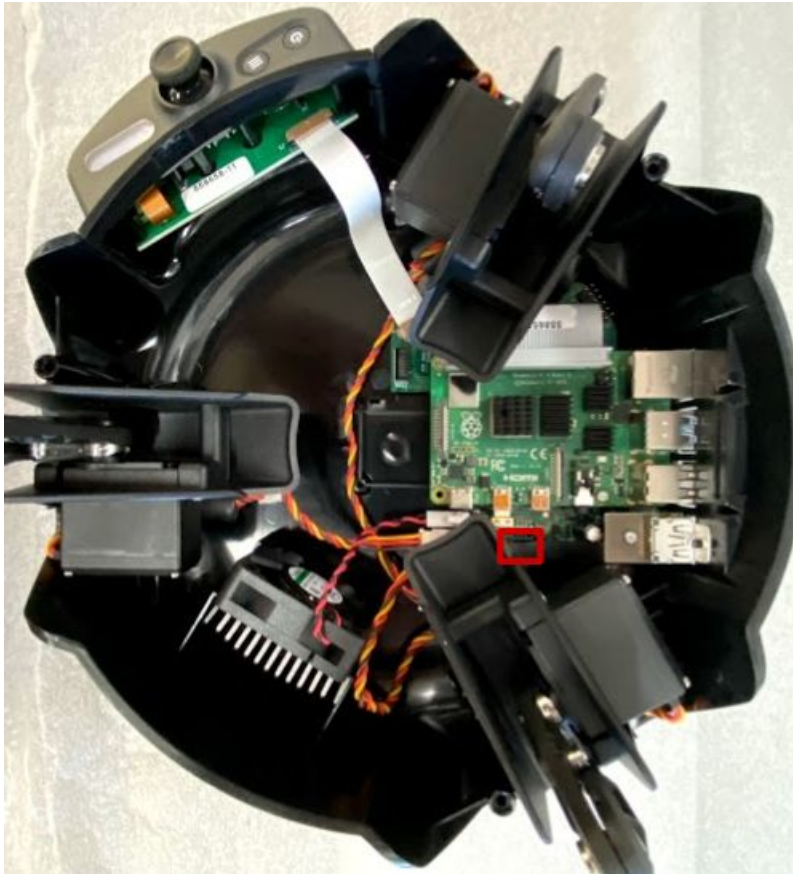
5	Connect the test balance plate and place a 2 plane level on top of it.	
6	As before, move the thumbstick up/down to adjust the angles of each servo to level the plate. Select between servos by moving the joystick left/right. When the plate is level (as close as practical, but at least within 1 degree) press MENU to proceed.	
7	Repeat step 6 for the middle and bottom plate positions.	

8	Press MENU again to write the calibration to OTP.	
9	Unplug the power supply barrel jack	
10	Continue on to Production Software Initialization	

# Production Software Initialization

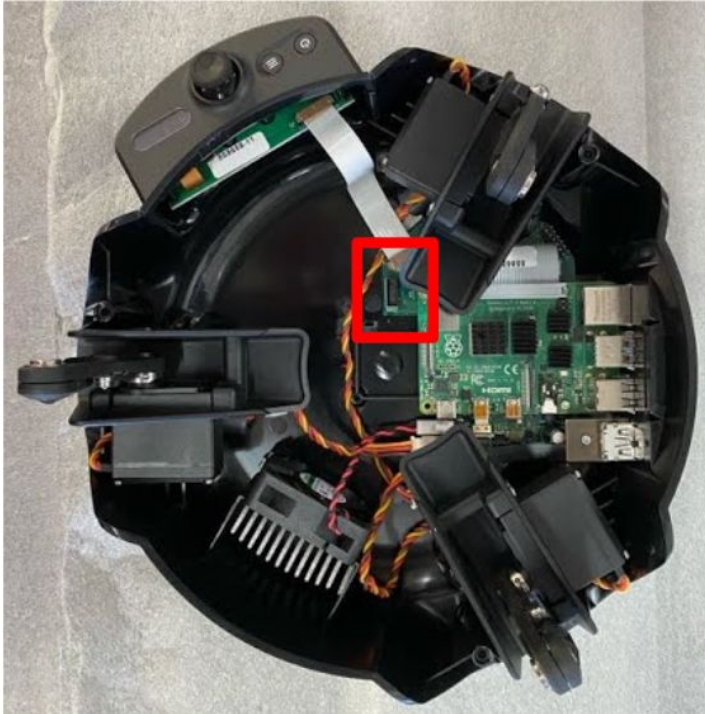
## Firmware\_production Programming Procedure

1. Ensure 2 Pin Jumper is attached to the main board






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2. Attach the Jlink programmer from the computer to the Jtag header on the main board

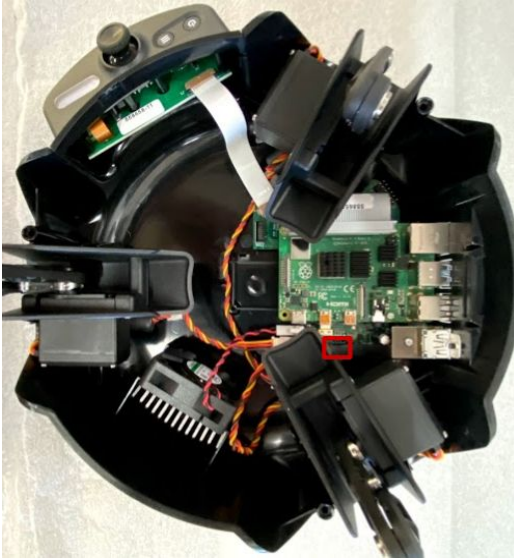


3. Connect the power supply to the Moab unit.
4. In the previously unzipped folder, *Uploading Firmware*, double click the *FIRMWARE\_PRODUCTION* batch file from 9/25/20.

 **FIRMWARE\_PRODUCTION.bat**  
 **FIRMWARE\_TEST.bat**  
 **Production FW upload ilink**
5. After a moment, the Moab unit should boot into its normal operation (with new production firmware)
  - a. If the unit doesn't boot with with the production firmware:
    - i. Pull the barrel jack power plug and reinsert to power cycle the board
    - ii. If the board still doesn't boot with the production firmware, run the batch file again
7. Unplug the barrel jack power plug from the Moab unit

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8. Remove the 2 Pin Jumper from the main board. Non-conductive tweezers may be needed.



9. Plug the barrel jack back into the Moab unit and ensure the unit boots up (roughly 1min boot time).

## Procedure

Production Software Test		
#	Test Step	Expected Results
1	Attach the computer monitor (via HDMI) and keyboard (via USB).	The computer monitor displays the linux terminal window and requests a login.
2	Login to the terminal.  login: <b>pi</b> password: <b>raspberry</b>	
3	Enter <b>diagnose</b> into the terminal.  Should report 14 tests, and 0 failures. Nothing should appear in red.	<pre>pi@moab~ \$ diagnose ✓ Year is at least 2020 ✓ DNS working ✓ pymoab permissions nominal ✓ libmoab permissions nominal ✓ Docker is running ✓ Hostname is "moab" ✓ Pi UART disabled ✓ Camera detected ✓ splash details on login is executable ✓ power/fan/moab services started without GPIO error ✓ fan and power services are running ✓ /home/pi/moab/docker-compose.yml exists ✓ docker-compose is installed and can launch ✓ docker-compose has containers up  14 tests, 0 failures</pre>


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4	Test the camera system (5 seconds):  <b>raspivid -w 300 -h 300</b>	Ensure the video is clear and does not display a blurry image. The 3 etched calibration marks should be in focus.
5	Type <b>sudo shutdown now.</b>	Monitor will revert to its off state and internal LEDs should turn off.
6	Unplug HDMI, USB, and power jack peripherals and move the bot to the final testing location.	N/A

## Final Software Checkout

Final Software Flow Check: Ensuring core functionality of the robot works as expected. Software checkout should take place in an approved lighting environment.

Final Software Flow Check		
#	Test Step	Expected Results
1	Navigate with the thumbstick by flicking in the upward direction to “CALIBRATION” mode. Select with a press of the thumbstick.	Plate should raise and notify the user “Place the ball in center using a clear ball stand. Then click joystick to confirm”.
2	Place the Orange ping pong ball in the white triangle on the plate using the calibration stand.	Ball will be in the center with the calibration stand’s three corners aligning with the plate’s three center etchings. 
3	Press down on the thumbstick.	If a calibration is successful, the OLED screen will display a checkmark in a circle and/or the words “Success”. Continue on to <b>step 4</b>  If an X is displayed and/or the words “Failed” are displayed then something has gone wrong and

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		attempt again from <b>step 1</b> . If a bot fails twice in a row, set aside and mark reason for failing.
4	Remove the ping pong ball and calibration stand then tap the Menu button. Move the joystick down once and press the thumbstick to select Manual Mode.	Plate should raise and OLED should display "MANUAL"
5	Rotate the thumbstick around the edges of its physical boundary in a full 360degree circle.	The plate should mimic thumbstick movement, ensuring the plate doesn't collide with any portion of the robot base. If bot does not mimic joystick direction or plate collides with housing, set aside and mark reason for failing.
6	Tap the Menu button. Navigate with the thumbstick by flicking in the downward direction to "CLASSIC" mode. Select with a press of the thumbstick.	Plate should raise and OLED should display "CLASSIC"
7	Hover the ball 2 inches above the center of the plate, and let go within 5 seconds of hovering.	The ball should successfully balance within 1 inch of the nearest center triangle plate etching  In Brain mode, any successful sustained balancing is acceptable, i.e., does not have to be in center of plate
8	Pickup and move the ball to within one inch of the plate edge and release in a similar fashion to how <b>step 7</b> was conducted.	The ball should successfully balance within 1 inch of the nearest plate etching. Repeat this step ( <b>step 8</b> ) using a plate location on an opposing side of the plate.  In Brain mode, any successful sustained balancing is acceptable, i.e., does not have to be in center of plate
9	Tap the Menu button. Navigate with the thumbstick by flicking in the downward direction to "BRAIN" mode. Select with a press of the thumbstick.	Plate should raise and OLED should display "BRAIN"
10	Perform <b>step 7 - step 8</b> while in Brain mode.	Follow the same steps pass/fail procedure. If the bot fails, ensure to mark it failed in Brain mode.
11	Test procedure complete. If none of the steps fail the bot has passed and the top can be screwed into place	