SPACE Lab Capstone System Test Procedure

Date: _____ / _____ / _____ _____:_____

yyyy mm dd hh ii

Part Number: _____

Initials: _____, _____, _____,

_____, _____, _____

Test Result: _____

Test Objective

To verify through testing that requirement Sys.3 will be met by the de-scoped test stand design. Known impulses will be applied to the test stand by dropping a known mass on a string from a given height that will impart its momentum onto the thruster mounting shelf. Pendulum displacement will be measured using the IL-30 laser displacement sensor, and data will be recorded on a thumb drive using an oscilloscope. Thruster mass will be simulated using calibrated masses, impulse values will be changed by changing the known mass on the string. Tests will be conducted on the 0.020” and 0.025” flexures, results will be used to validate our model, and data will be extrapolated to lower flexure thicknesses. Data extrapolation will be necessary due to the low impulse values being measured using 0.010” and 0.015” thick flexures.

Equipment Required

Qty	Description	Specs/test	Check
1	*De-scoped Test Stand Assembly*	*Default configuration (with flexure set FX2)*	
2	*Flexure Sets*	*8 flexures per set: FX3, FX4*	
2	*Thruster Shelfs*	*Config. 1 & Config. 2*	
-	*Thruster Placeholder Weights*	*0 - 10 kg, in 0.1 kg increments*	
1	*Oscilloscope*	*Supplied by SPACE Lab*	
1	*Computer*		
1	*Bubble Level*	*Concentric*	
1	*Masking Tape Roll*		
4	*Test Weights*	*50, 75, 100 g*	
1	*Roll of string/fishing line*	*~0.245 g/m*	
1	*Slow motion camera*	*iPhone, 240 fps slow motion*	
1	*Ruler*	*Must include cm markings*	
1	*Digital Mass Scale*	*1 gram resolution*	

Test Plan

1.0: Setup	
1.01: Install flexure set to be verified Note: See replacement instructions for removing and installing flexures.	OK? _____
1.02: Reference Impulse flexure sizing to record the highest and lowest impulses that the flexure is rated for use, as well as the corresponding total mass (shelf and thruster mass) applied to the pendulum for that impulse. Record the values in the test plan.	OK? _____
1.03: Install PPT mount shelf Config 1 as shown in Fig. 1.	OK? _____
1.04: Place bubble level onto leveling system radial strut as shown in Fig. 2.	OK? _____
1.05: Using bubble level, adjust bolts on the base plate until the test stand is level with additional use of shims as necessary.	OK? _____
1.06: Place thruster placeholder mass on PPT mount shelf to the rated value of the flexure for the impulse being tested.	OK? _____
1.07 Secure thruster placeholder weight with masking tape.	OK? _____
1.08: Connect wiring for IL-1000 in accordance with test stand wiring diagram as shown in Fig. 3.	OK? _____
1.09: Secure PPT wiring to the thruster shelf via waterfall clamps and masking tape in accordance with the test stand wiring diagram as shown in Fig. 3.	OK? _____
1.10: Place bubble level onto leveling system frame radial strut as shown in Fig. 2.	OK? _____
1.11: Secure a 50 - 100 g test weight to stand using atm impulse procedure. Choose the weight to apply a sufficiently close impulse to the rated value being measured.	OK? _____
1.12: Attached the test pendulum to the test stand such that the weight will strike the front edge of the thruster shelf within an angle range of 15° to 30° from the vertical as shown in Fig. 4.	OK? _____
1.13: Set up the slow-motion camera to be in plane with the swinging motion of the test pendulum, at the same height as the collision point.	OK? _____

1.14: Secure ruler to pendulum frame using masking tape, within the frame of the camera.	OK? _____
2.0: Preliminary Safety Checks	
2.01: Mark all exposed high voltage areas with masking tape.	OK? _____
2:02: Ensure the area immediately surrounding the test pendulum is clear.	OK? _____
2.03: Ensure thruster placeholder weight is properly secured to the thruster shelf.	OK? _____
3.0: Power Up	
3.01: Power on IL-1000.	OK? _____
3.02: Confirm data outflow of IL-1000 on computer.	OK? _____
3.05: Power on oscilloscope.	OK? _____
3.06: Set grid on oscilloscope to 1.00V increment.	OK? _____
3.07: Set trigger on oscilloscope to edge.	OK? _____
3.08: Set camera ready to film in slow motion mode.	OK? _____
4.0: Test	
4.00: Begin with lower impulse and mass test case the flexure is rated for (as recorded in step 1.02) and shelf Config. 1 installed. The waterfall and magnetic damper should not be installed.	OK? _____
4.01: Pull test weight into position as shown in Fig. 4, then release.	OK? _____
4.02: Verify the scope displays a resolved output.	OK? _____
IF: Multiple output traces do not display the expected results.	OK? _____

Go to 6.0, Shut Down.	OK? _____
4.03: Start the slow motion camera.	OK? _____
4.04: Pull test weight into position as shown in Fig. 4, then release.	OK? _____
4.05: Stop the slow motion camera.	OK? _____
4.06: Wait 30 seconds post strike to re-strike to allow time for oscillations to damp out.	OK? _____
IF: Test stand does not return to steady state within 30 seconds, dampen oscillations manually.	OK? _____
4.07: Save oscilloscope trace to flash drive under naming convention [PptName]_[TestType]_###, record file name in printed test plan.	OK? _____
4.08: Repeat steps 4.03 - 4.07 three times.	OK? _____
4.09: Repeat steps 4.01 - 4.08 for the upper impulse and mass test case.	OK? _____
4.10: Repeat steps 4.01 - 4.09 with shelf Config. 2 installed as shown in Fig. 5.	OK? _____
4.11: Install the waterfall to the test stand.	OK? _____
4.11a: Clamp any waterfall wires into the clamp on the outer frame of the test stand.	OK? _____
4.11b: Clamp the other ends of any waterfall wires into the clamp on the pendulum body. Allow the wires to hang with some slack.	OK? _____
4.12: Repeat steps 4.01 - 4.10 for pendulum with the waterfall installed.	OK? _____
4.13: Remove waterfall from test stand.	OK? _____
4.14: Install the magnetic damper to the test stand.	OK? _____
4.14a: Remove the top panel of the test stand.	OK? _____
4.14b: Insert the magnet into the holder, adjusting the set screw as needed.	OK? _____
4.15: Repeat steps 4.01 - 4.10 with the magnetic damper installed.	OK? _____

5.0: Post Test	
5.01: Confirm all .csv data file contain relevant impulse data(i.e. nonzero file size)	OK? _____
5.02: Confirm all oscilloscope traces are saved to a destination as a .csv file.	OK? _____
5.03: Export as a .csv file for documentation.	OK? _____
5.04: Confirm files are saved to a secure destination.	OK? _____
6.0: Shut Down	
6.01: Shut off power from: IL-1000.	OK? _____
6.02: Disconnect wires from test stand assembly as shown in Fig. 3.	OK? _____
6.03: Store test stand in Senior Capstone Room.	OK? _____
6.04: Return test pendulum to SPACE Lab.	OK? _____

Appendix:

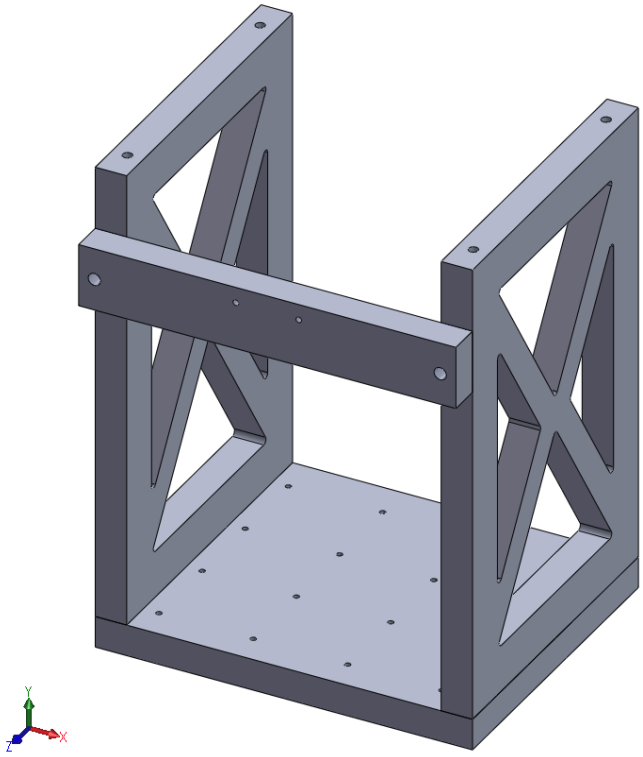

Fig.1: Shelf Configuration 1

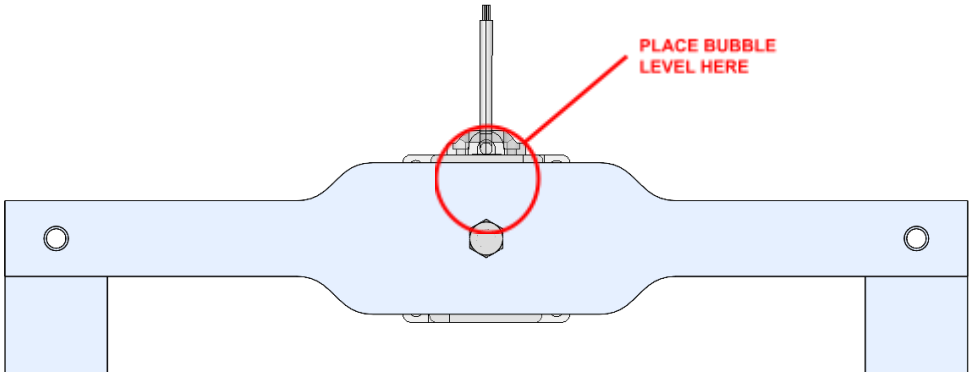

Fig. 2: Bubble level placement diagram

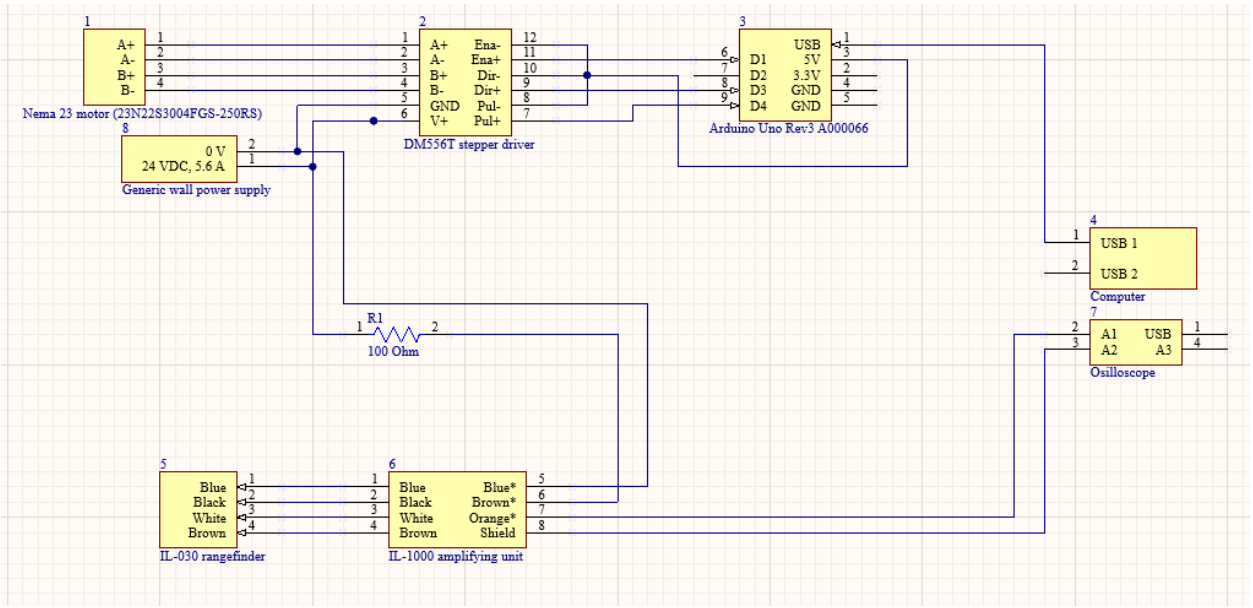

Fig. 3: Wiring diagram

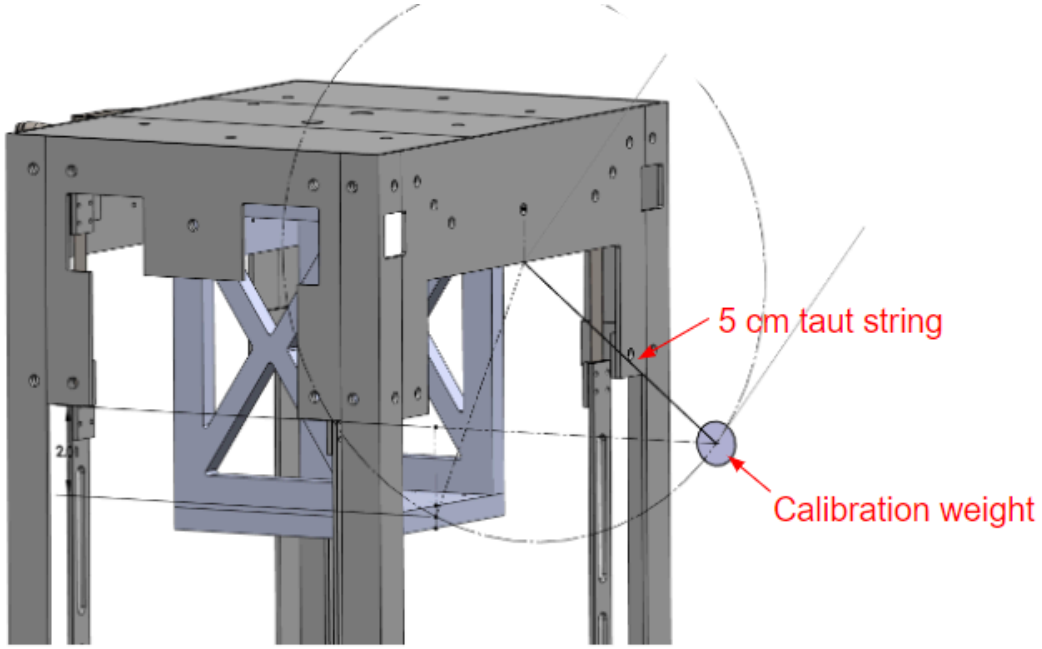

Fig. 4: System Test Schematic

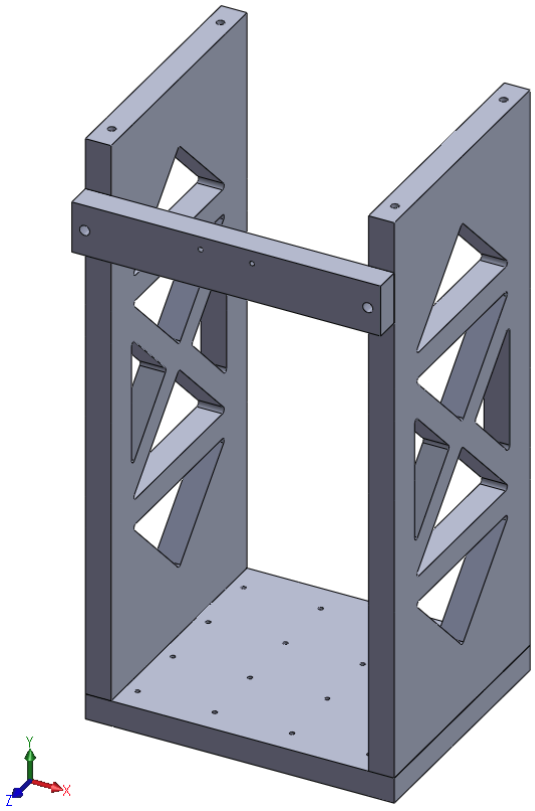

Fig. 5: Shelf Configuration 2

Change Log

Ver	Date	By	E-mail	Change
1.0	05/03/2024	Nathan Cheng Ben Fetters Lillie LaPlace	nkcheng@uw.edu bfetters@uw.edu llapla@uw.edu	Initial Release
2.0	05/18/2024	Kai Laslett-Vigil Lillie LaPlace	klaslett@uw.edu llapla@uw.edu	Revised after TA feedback and descoping of leveling system
3.0	05/20/24	Winston Wilhere	wilhere@uw.edu	Rewrote step 4