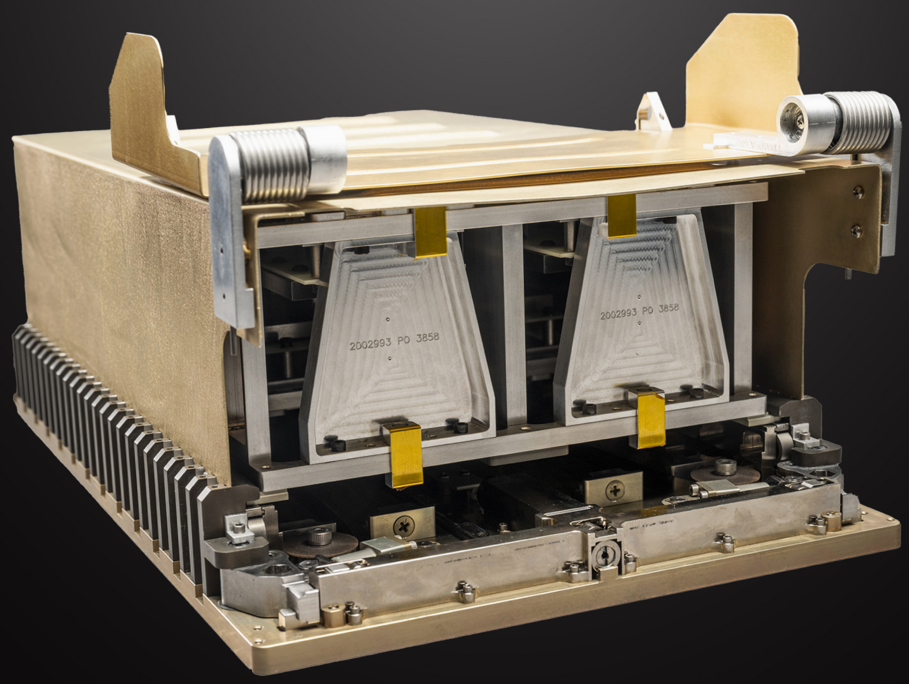

ADVANCED SATELLITE DISPENSER

Data Sheet | 2004600

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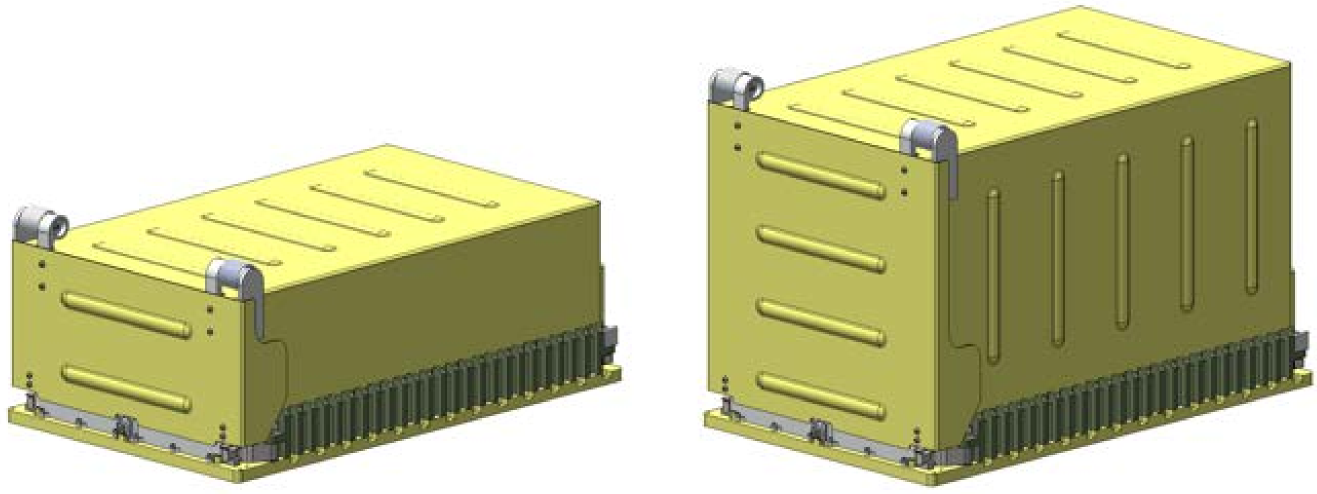
rocketlabusa.com

ROCKET LAB



6U and 12U ASDs

Feature	Benefit
Preloaded Payload Tabs	A modelable load path to the payload enables strength at critical locations like reaction wheel bearings to be accurately calculated.
Customizable Payload Volume	Payload's tabs are the only required mechanical interface. If not utilizing Walls, the payload volume can significantly increase.
Low Tip-Off	Payloads stabilize rapidly. Precision tabs and a linear way combine to minimize separation disturbance torques.
Motor Driven Initiator	Creates the lowest cost, most reliable dispensing mechanism that resets in seconds without consumables.
Robust Structural Design	Withstands extreme shock, vibration and thermal environments.
Payload Electrical Connector	Allows communication and charging between payload and launch vehicle prior to and during launch.
Conductive External Surfaces	Prevents surface charging.
ASD-Constrained Deployables	Greatly reduces the cost and complexity of payload deployables like solar panels and antennas by using the ASD's internal walls to constrain instead of burn wires.
Complete Payload Separation	Demonstrates whole system reliability during testing.
Manual Door Release	Allows the ASD to be opened without releasing the payload.
Constant-Force Ejection Spring	Ensures positive, constant force margin throughout ejection.
Low External Volume	Increases packaging density on launch vehicle.
Largest Internal Volume	Payloads have 25% more volume and can be longer than standard CubeSats.
Fully Removable Walls	Ensures access to payload.
Reverse Polarity Protection	Ensures deployment even if electrical polarity is reversed.
State Switch	Indicates payload occupancy and enables calculating dispensing velocity.
Fully Documented	Mechanical and electrical interfaces and CAD models available for download allowing rapid and low-cost design.
Parametric Design	Commonality allows users easy understanding of electro-mechanical interface for 6U and 12U sizes.
Lowest Cost	Reduced mission cost through simplified design, test and integration.

Payload Compatibility: The ASD is compatible with payloads that meet current payload specification 2004630-.

TABLE OF CONTENTS

1. DESCRIPTION

The Advanced Satellite Dispenser (ASD) is a reliable, testable, and cost-effective deployment mechanism for small payloads that comply with Planetary Systems Corp by Rocket Lab (PSC-RL) document *2004630 ASD Payload Specification Addendum*. The walls and door are optional meaning the ASD can fly with or without canisterization. This flexibility allows customers to utilize the tab interface while having the freedom to significantly increase the payload's volume. Most external surfaces are electrically conductive chem-film aluminum alloy. The ASD is not ESD sensitive. This data sheet encompasses 6U and 12U sized ASDs.

The ASD is easy to use and operate. After inserting the payload, the operator turns two stow links with a hex key to securely preload the payload's tabs. The optional walls and door can be installed before or after payload insertion. To deploy the payload the LV only need power a DC brush motor. The motor releases the optional door and then unlatches the preload system, permitting the payload to eject. The initiator is open-loop, meaning no feedback control is required. There are no pyrotechnics or consumables so the payload can be reintegrated in less than a minute. The motor, an excellent torque transducer, provides invaluable insight to the health of the mechanism by monitoring voltage and current during each operation.

Figure 1-1: ASD with and without walls (6U shown)

2. BENEFITS OF PRELOADED TABS

Preloading the payload to the ASD by virtue of clamping the tabs creates a stiff invariant load path. This allows for accurate dynamic modeling to predict responses in anticipation of vibratory testing and space flight.

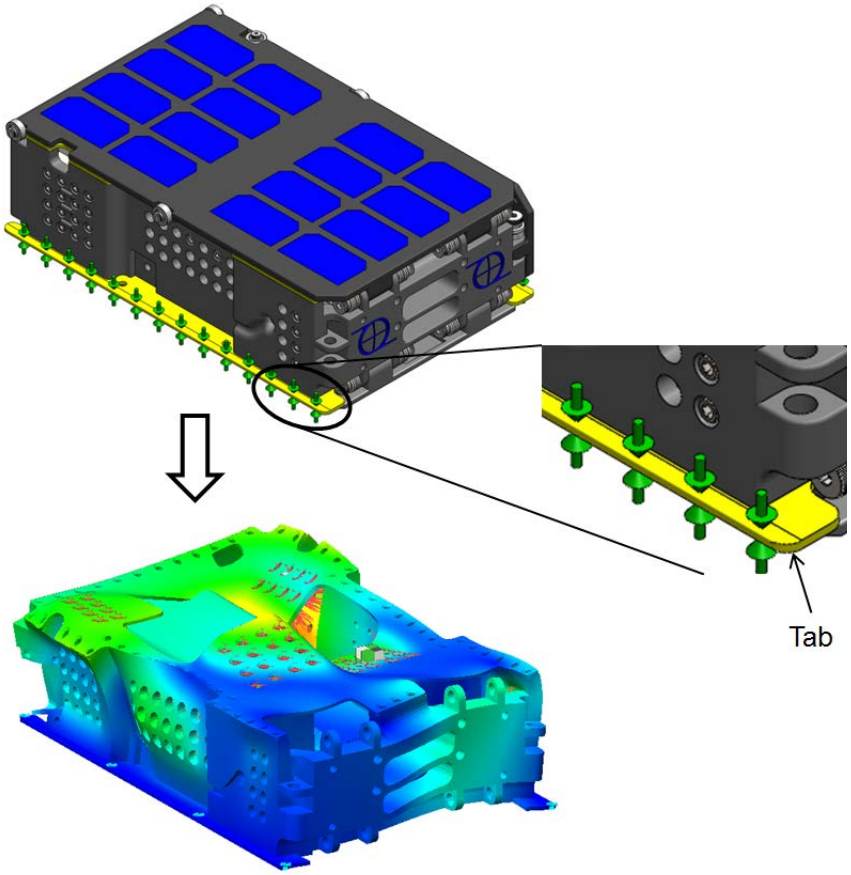


Figure 2-1: 6U payload predicted dynamic response

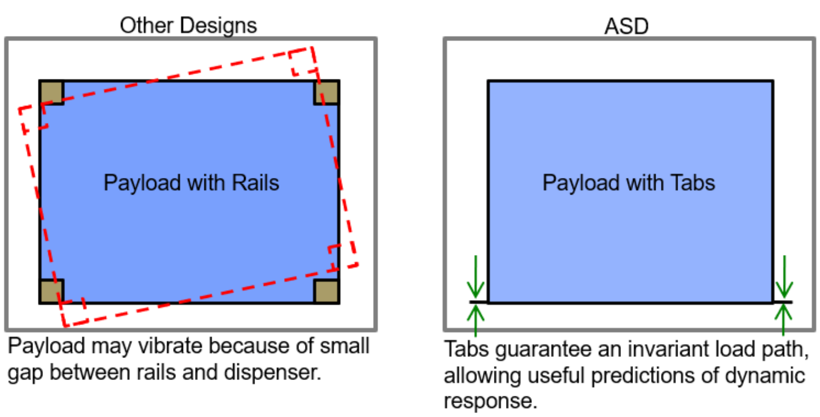


Figure 2-2: Benefit of tabs vs. rails

Preloaded tabs allow for accurate dynamic modeling that can be used to predict fatigue of structures, mechanisms, electronics, PCBs, solder junctions, etc.

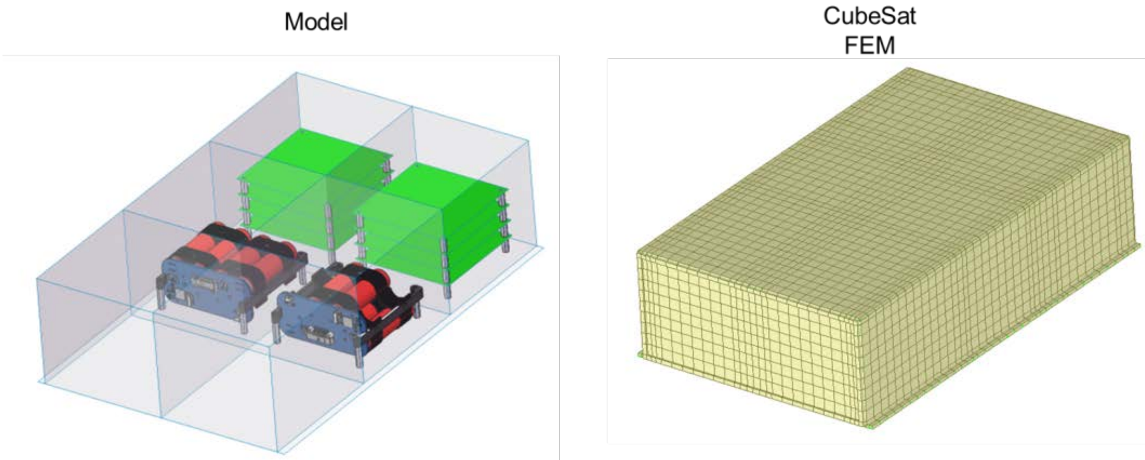


Figure 2-3: Satellite model and FEM

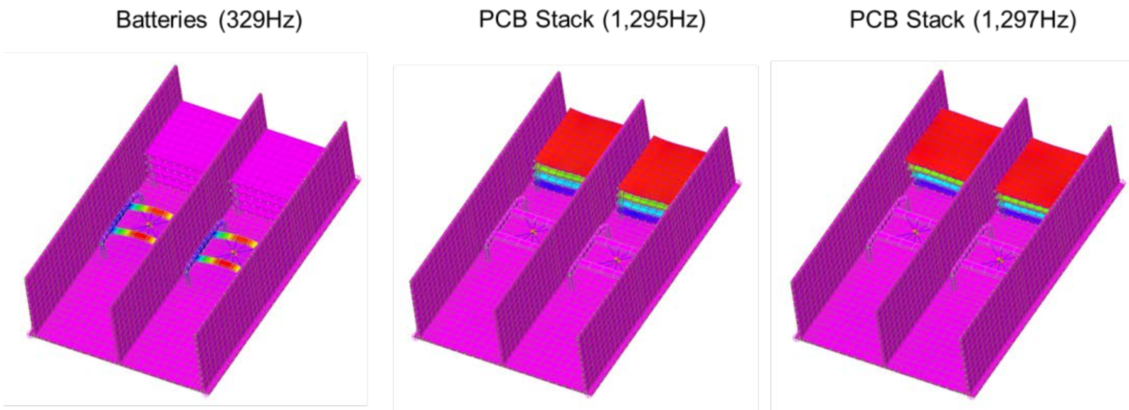


Figure 2-4: Normal modes analysis of satellite elements

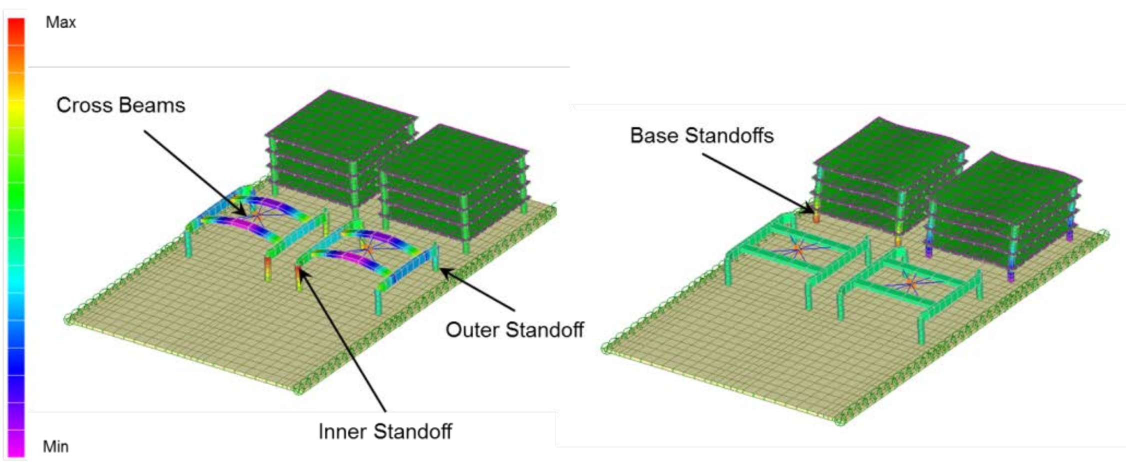


Figure 2-5: Identifying components with high strain

The ASD's unique ability to preload tabs attached to the payload guarantees a stiff, invariant load path from launch vehicle to payload. The input to the ASD is transferred through the tabs to the payload, verifying there is no slipping or gapping within the system. Figure 2-6 below shows a 25kg payload being excited to almost 30g as an example.

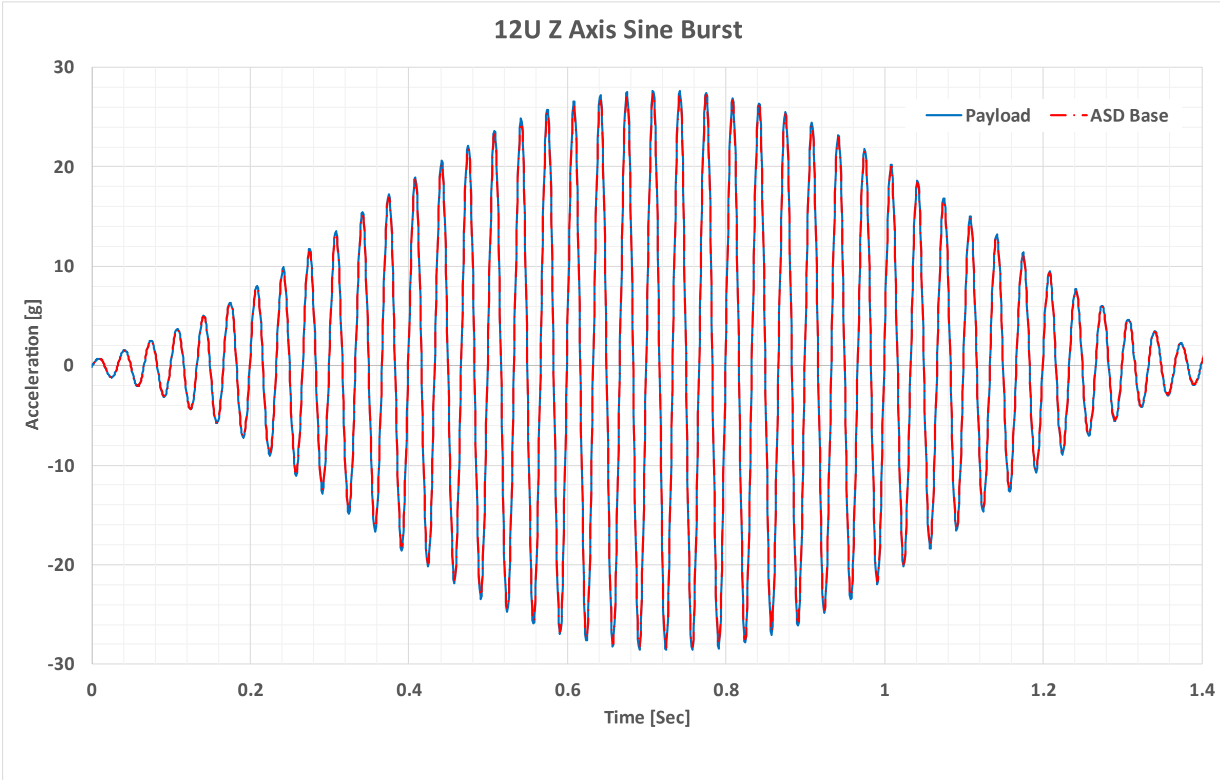


Figure 2-6: Actual payload and ASD response during a sine burst test

Preloaded tabs allow designers to accurately model and predict their payload response with high confidence. The sine sweep profiles below demonstrate no change in load path (slipping) from the ASD to the payload after sine burst and random vibration exposure.

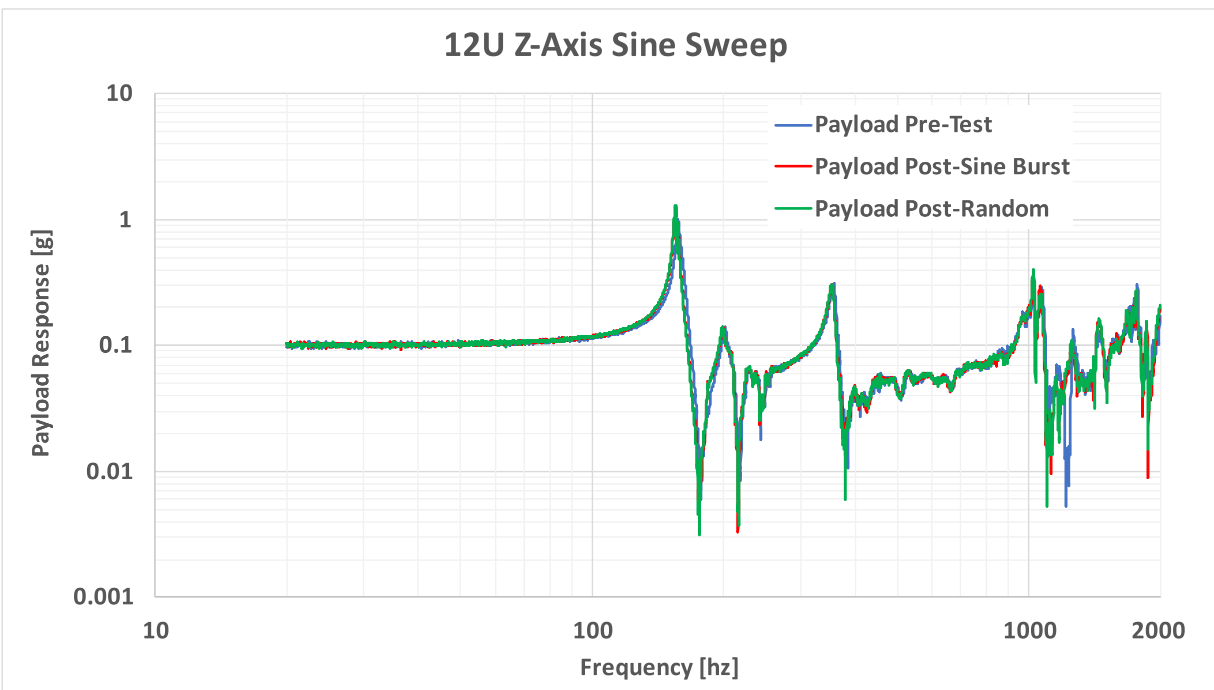


Figure 2-7: Actual payload sine sweeps

3. PARAMETERS

Table 3-1: Parameters

Doc. Sec.	Symbol	Parameter	Conditions	Units	6U		12U	
					Min	Max	Min	Max
-	-	PSC Assembly Number		-	4001053-6		4001053-12	
-	M	Mass (1)	Empty, no walls installed. ±3%	lb [kg]	8.15 [3.70]		8.26 [3.75]	
-	M_w	Mass of Wall Assembly	±5%	lb [kg]	1.93 [0.88]		3.00 [1.36]	
4	Height	Height without walls, +Y	Base to the top of Ejection Plate	in [mm]	4.18 [106.2]	4.38 [111.3]	7.13 [181.1]	7.33 [186.2]
4	$Height_w$	Height with walls, +Y	Base to the top of hinge	in [mm]	7.02 [178.3]	7.22 [183.4]	11.87 [301.5]	12.07 [306.6]
4	Width	Width, ±X		in [mm]	10.63 [269.9]	10.83 [275.0]	10.63 [269.9]	10.83 [275.0]
4	CM_X	Center of Mass, ±X	No Walls or Sep Conn, Ejection Plate position as if payload installed	in [mm]	-0.23 [-5.8]	0.17 [4.3]	-0.23 [-5.8]	0.17 [4.3]
4	CM_Y	Center of Mass, ±Y	No Walls or Sep Conn, Ejection Plate position as if payload installed	in [mm]	0.52 [13.2]	0.92 [23.4]	0.58 [14.7]	0.98 [24.9]
4	CM_Z	Center of Mass, ±Z	No Walls or Sep Conn, Ejection Plate position as if payload installed	in [mm]	8.99 [228.3]	9.39 [238.5]	8.88 [225.6]	9.28 [235.7]
4	CM_{XW}	Center of Mass, ±X	Walls & Sep Conn present, Ejection Plate position as if payload installed	in [mm]	-0.20 [-5.1]	0.20 [5.1]	-0.20 [-5.1]	0.20 [5.1]
4	CM_{YW}	Center of Mass, ±Y	Walls & Sep Conn present, Ejection Plate position as if payload installed	in [mm]	1.34 [34.0]	1.74 [44.2]	2.44 [62.0]	2.84 [72.1]
4	CM_{ZW}	Center of Mass, ±Z	Walls & Sep Conn present, Ejection Plate position as if payload installed	in [mm]	9.18 [233.2]	9.58 [243.3]	9.08 [230.6]	9.48 [240.8]
4	MOI_X	X-Axis Mass Moment of Inertia	About CM, no Walls or Sep Conn, Ejection Plate position as if payload installed	$lb*in^2$ [$kg*m^2$]	247 [0.072]	273 [0.080]	256 [0.075]	282 [0.083]
4	MOI_Y	Y-Axis Mass Moment of Inertia	About CM, no Walls or Sep Conn, Ejection Plate position as if payload installed	$lb*in^2$ [$kg*m^2$]	365 [0.107]	403 [0.118]	372 [0.109]	412 [0.121]
4	MOI_Z	Z-Axis Mass Moment of Inertia	About CM, no Walls or Sep Conn, Ejection Plate position as if payload installed	$lb*in^2$ [$kg*m^2$]	124 [0.036]	137 [0.040]	126 [0.037]	140 [0.041]
4	MOI_{XW}	X-Axis Mass Moment of Inertia	About CM, Walls & Sep Conn present, Ejection Plate position as if payload installed	$lb*in^2$ [$kg*m^2$]	360 [0.105]	398 [0.117]	514 [0.151]	568 [0.166]
4	MOI_{YW}	Y-Axis Mass Moment of Inertia	About CM, Walls & Sep Conn present, Ejection Plate position as if payload installed	$lb*in^2$ [$kg*m^2$]	478 [0.140]	528 [0.155]	548 [0.161]	606 [0.178]
4	MOI_{ZW}	Z-Axis Mass Moment of Inertia	About CM, Walls & Sep Conn present, Ejection Plate position as if payload installed	$lb*in^2$ [$kg*m^2$]	185 [0.054]	205 [0.060]	308 [0.090]	340 [0.100]
4	MOI_D	Door's X-Axis Mass Moment of Inertia	About door hinge axis	$lb*in^2$ [$kg*m^2$]	3.7 [1.1E-3]	4.1 [1.2E-3]	21.4 [6.3E-3]	23.6 [6.9E-3]
10	S	Quantity of Ejection Springs		-	2		2	
6to8	V	Voltage Provided from Launch Vehicle to initiate	Power to pins 1 & 2, return from pins 3 & 4	Vdc	24.0 to 32.0			
6to8	R_{DI}	Winding Resistance of Initiator (2)	assume ±10% tolerance, includes internal ASD wiring, see note for temperature dependence	Ω	13.3			
6to8	L_{DI}	Inductance of Initiator	At terminals	mH	0.925			
6to8	I_P	Peak Current Draw from Initiator (3)	<0.005 sec	A	1.4 to 3.3			
6to8	I_C	Continuous Current Draw from Initiator (4)		A	0.03 to 0.5			
6to8	T	Time to Initiate (4)	-34 to +71 °C, <10e-5 Torr	s	0.04 to 0.20			
6to8	R_S	Switch Terminal Resistance	Occupancy switch, closed circuit, includes internal ASD wiring, -44 to +81 °C	ohm	0.046 to 0.107			
6to8	I_{SR}	Current Capacity of Switch, Resistive	28 Vdc, <1e-4 Torr, occupancy switch	A	2.5			
6to8	I_{SI}	Current Capacity of Switch, Inductive	28 Vdc, <1e-4 Torr, occupancy switch	A	1.5			
10	PT	Payload Travel Required for Occupancy Switch State Change	+Z travel from launch position	in [mm]	12.94 [328.7]	13.00 [330.2]	12.94 [328.7]	13.00 [330.2]
-	FEP_V	Ejection Plate Force on Payload (5, 6)	During launch due to vibration (assuming 100g response)	lbf [N]	0 [0]	47.1 [210]	0 [0]	58.5 [260]
10	FEP_S	Ejection Plate Force on Payload (6)	During separation, force per ejection spring, ±15% due to friction and spring variation	lbf/spring [N/spring]	3.45 [15.3]			
4	LVF	Launch Vehicle Flatness (7,8)	As a result of attaching, the LV shall not deform the ASD interface surface more than listed.	in [mm]	0.01 [0.25]			
-	TML	Total Mass Loss	Per ASTM E 595-77/84/90	%	<1.0			
-	CVCM	Collected Volatile Condensable Material	Per ASTM E 595-77/84/90	%	<0.1			
-	DP	LV De-Pressurization Rate (7)	During launch	psi/s	<1.0			
9	T_S	Survival Temperature	Qualification limits + 10 °C margin	°F [°C]	-47.2 to 177.8 [-44 to 81]			
9	T_O	Operational Temperature	Acceptance test limits	°F [°C]	-11.2 to 141.8 [-24 to 61]			
-	L	Life	Allowable number of stows by customer before refurbishment is required	-	30			

1) Does not include Separation Connector (in-flight disconnect). Add 0.07 lb for the Connector and mounting bracket. The tolerance accounts for machining variation of ASD components.
2) Actual winding resistance can be calculated by R_{DI} = 13.3*(1+.0039*(Temperature [°C]-25)). The '13.3' is nominal room temperature tolerance. If using a DMM, the resistance may be artificially high due to the low test current outputted by the DMM.
3) Actual Peak Current can be calculated by $I_P = V/R_{DI}$.
4) Initiator will continue to draw current (I_C) until power is cut from LV. This is not detrimental to the ASD. LV may leave power on up to 1 s after initiation.
5) The ASD's Ejection Plate is sandwiched between the payload and the ASD's hard stops on the back of the baseplate when stowed. However, during vibration the Ejection Plate may resonate, causing it to repeatedly impact and gap the payload's -Z face. This force assumes a conservative 100g dynamic response of the Ejection Plate impacting the payload.
6) FEP_V and FEP_S shall not be used to predict velocity. Due to friction, velocity will be lower. See Section 10 for velocity estimate.
7) These are requirements imposed on the launch vehicle.
8) Ensures the payload will properly eject from the ASD. If the LV interface is much stiffer than the ASD (thick plate) its flatness will need to be held to the allowable ASD deformation. Isolation systems naturally attenuate this issue.

4. MECHANICAL INTERFACE

- Dimensions apply to all ASD sizes unless the view specifically states otherwise (Ex. “6U only”).
- The external ASD mounting surface is 7075-T73 aluminum alloy with chemical film per MIL-DTL-5541, Class 3, color gold/yellow surface treatments. The colors in the images below are representative, however PSC-RL may change specific parts without notice.
- Solid models of each ASD, in STEP format, are available for download on PSC-RL’s website. Use these to ensure proper bolt access to adjoining vehicles.
- The optional Wall’s and Door’s typical wall thickness are .040 in. This data can be useful for thermal and radiation analysis.
- The ASD can be mounted on its -Z face with the use of GSE, see Section 15 for more details.

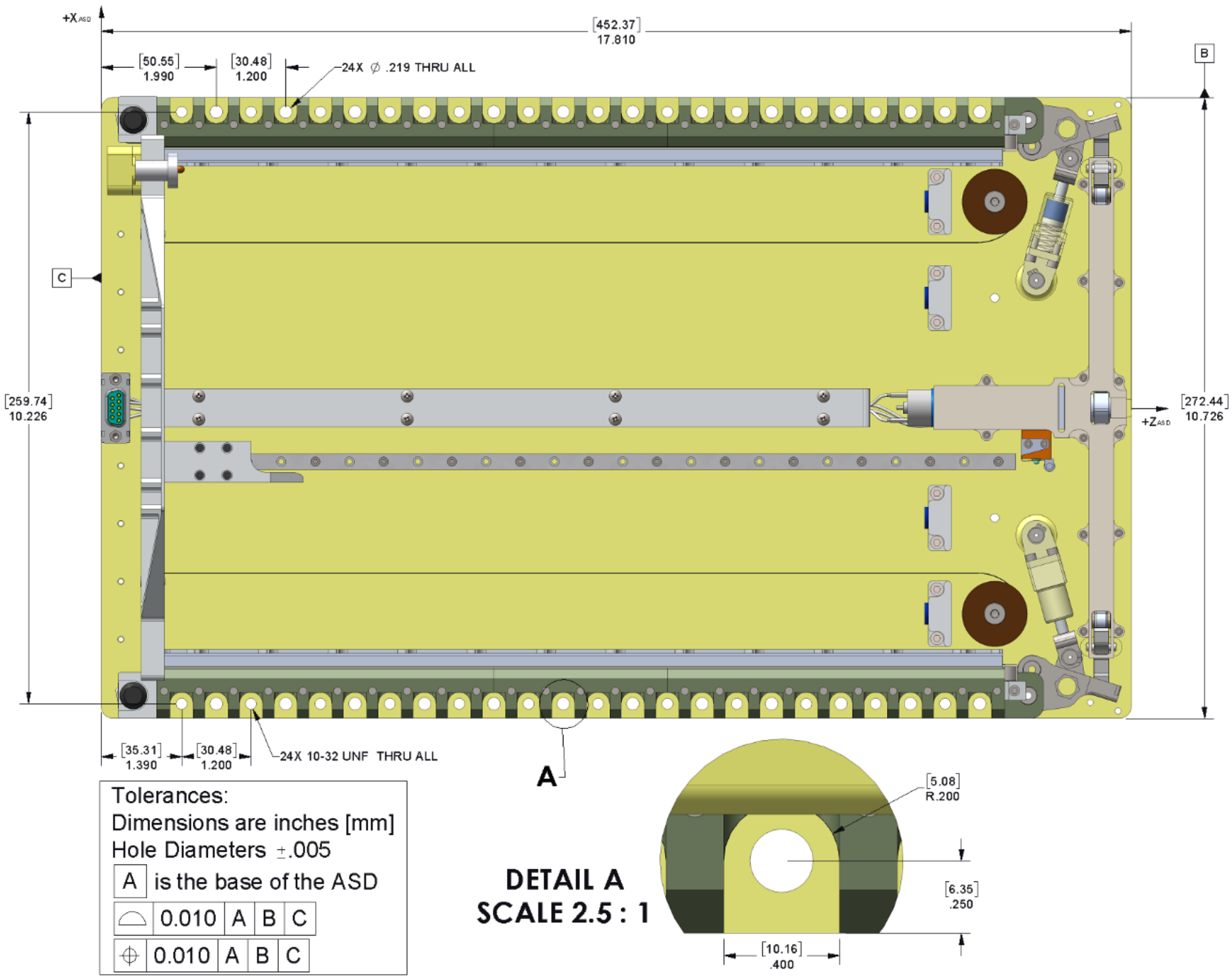


Figure 4-1: ASD mechanical interface dimensions

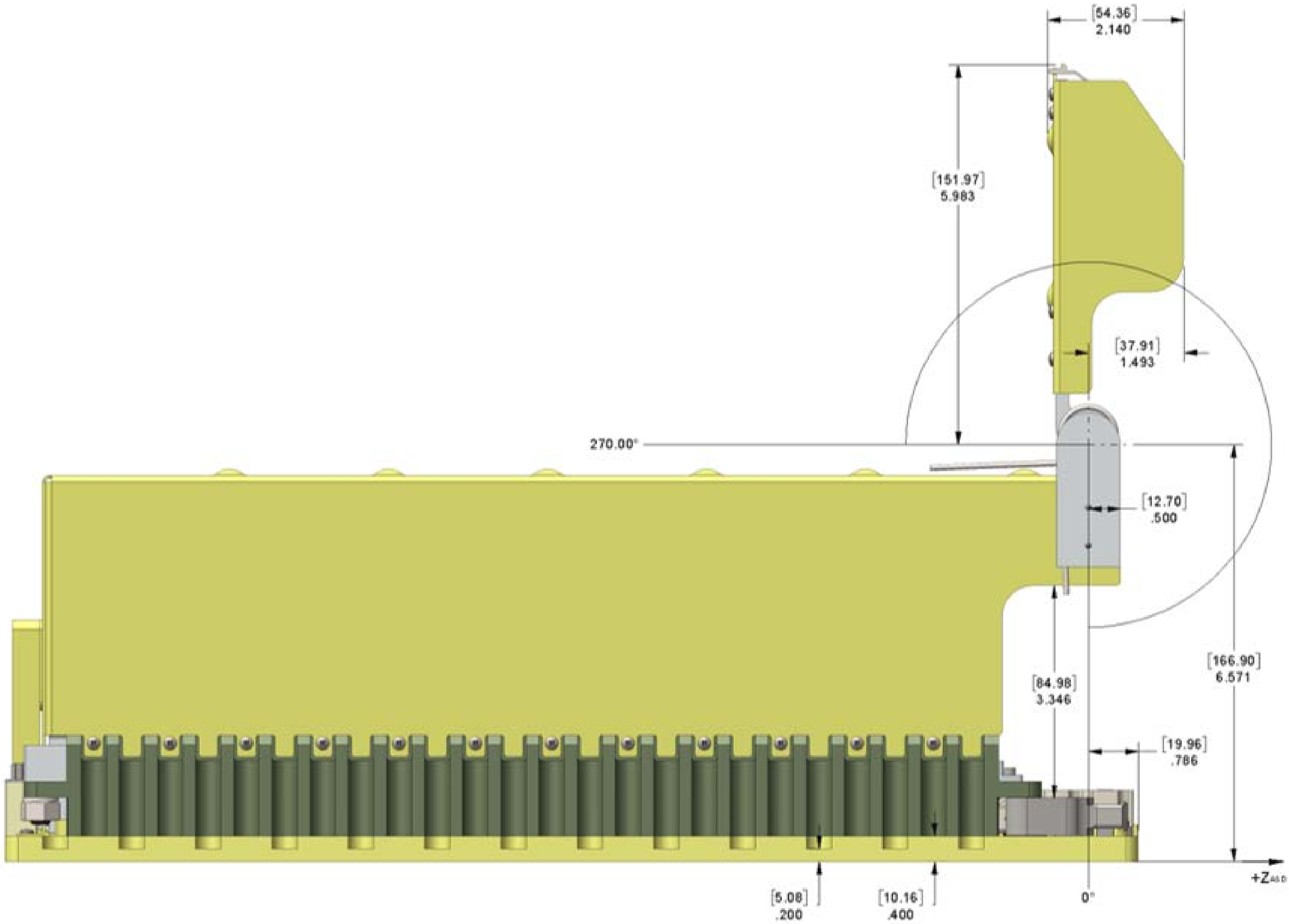


Figure 4-2: 6U Door Opening Dimensions

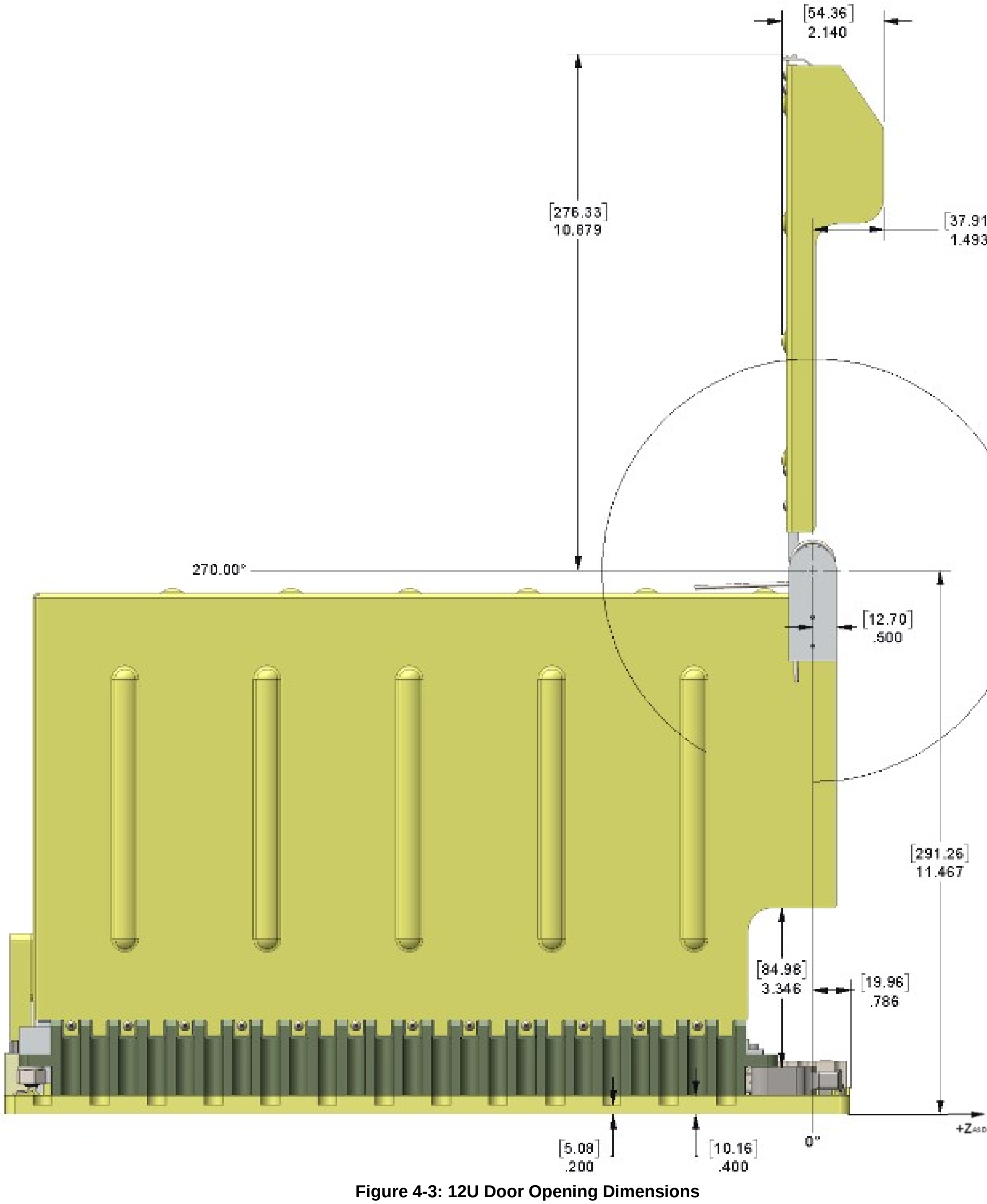


Figure 4-3: 12U Door Opening Dimensions

5. PAYLOAD IN ASD

The ASD can be flown with or without the Walls Assembly to give the customer flexibility on payload volume.

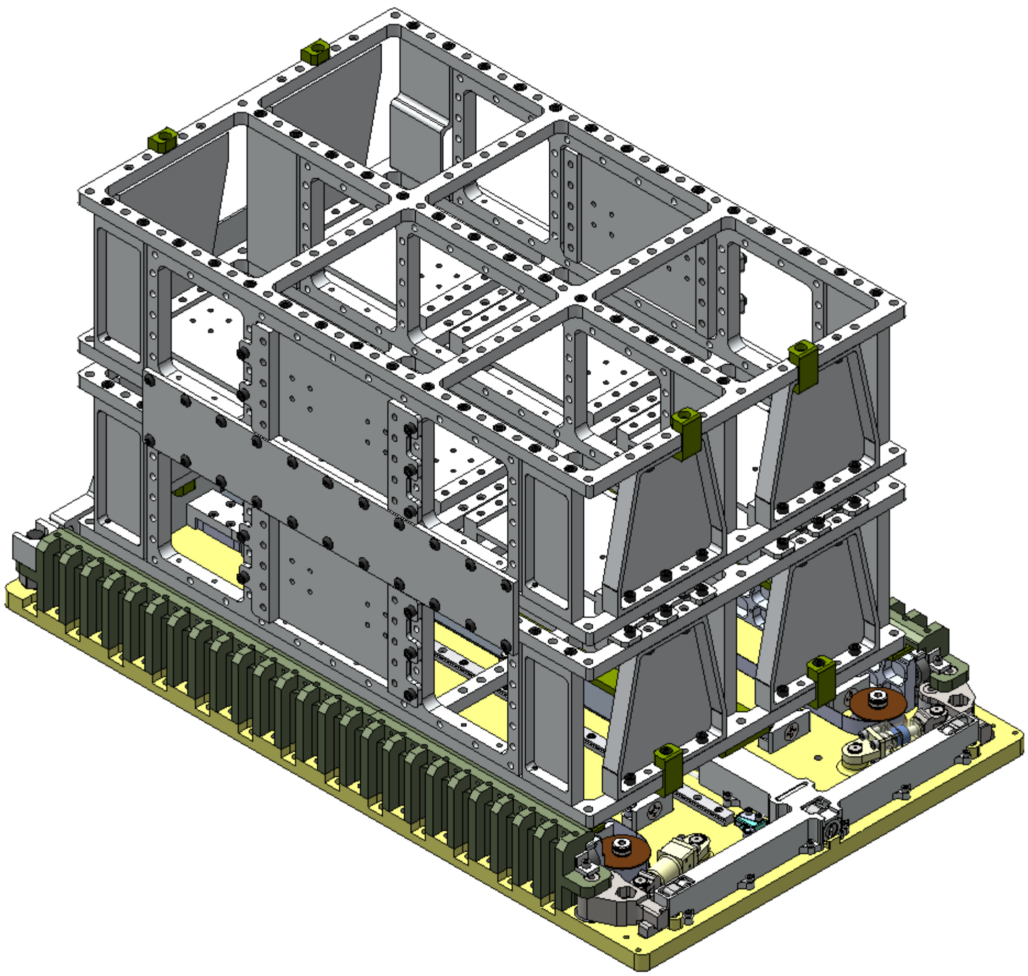


Figure 5-1: Payload location in ASD

Note that an ASD will not accommodate two 3U payloads. Despite the available volume, the ASD will not properly preload the tabs or restrain the payloads. See Figure 5-2.

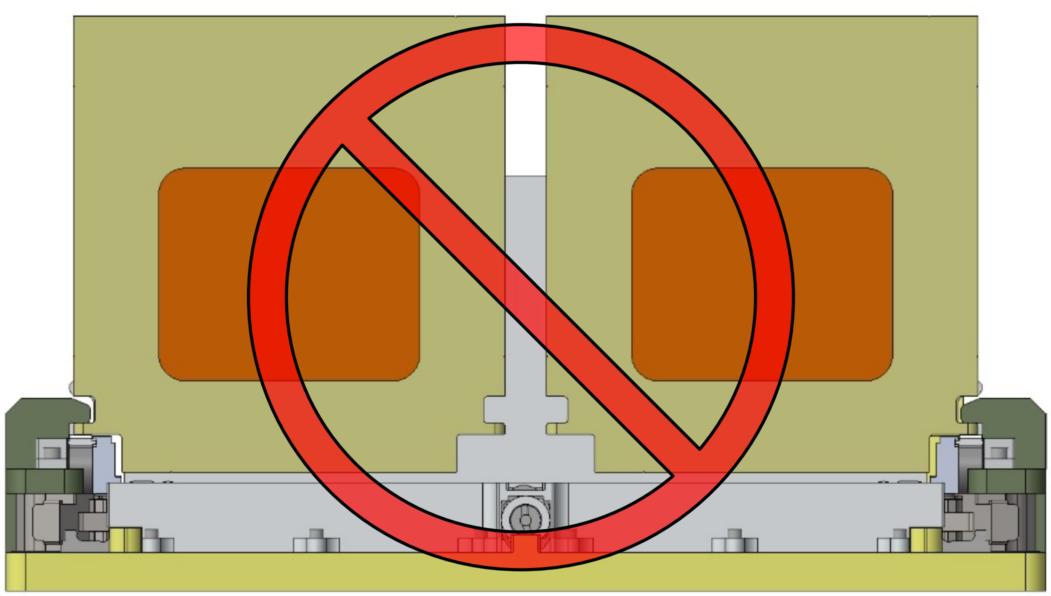


Figure 5-2: Two 3U payloads cannot be installed in an ASD

6. ELECTRICAL INTERFACE

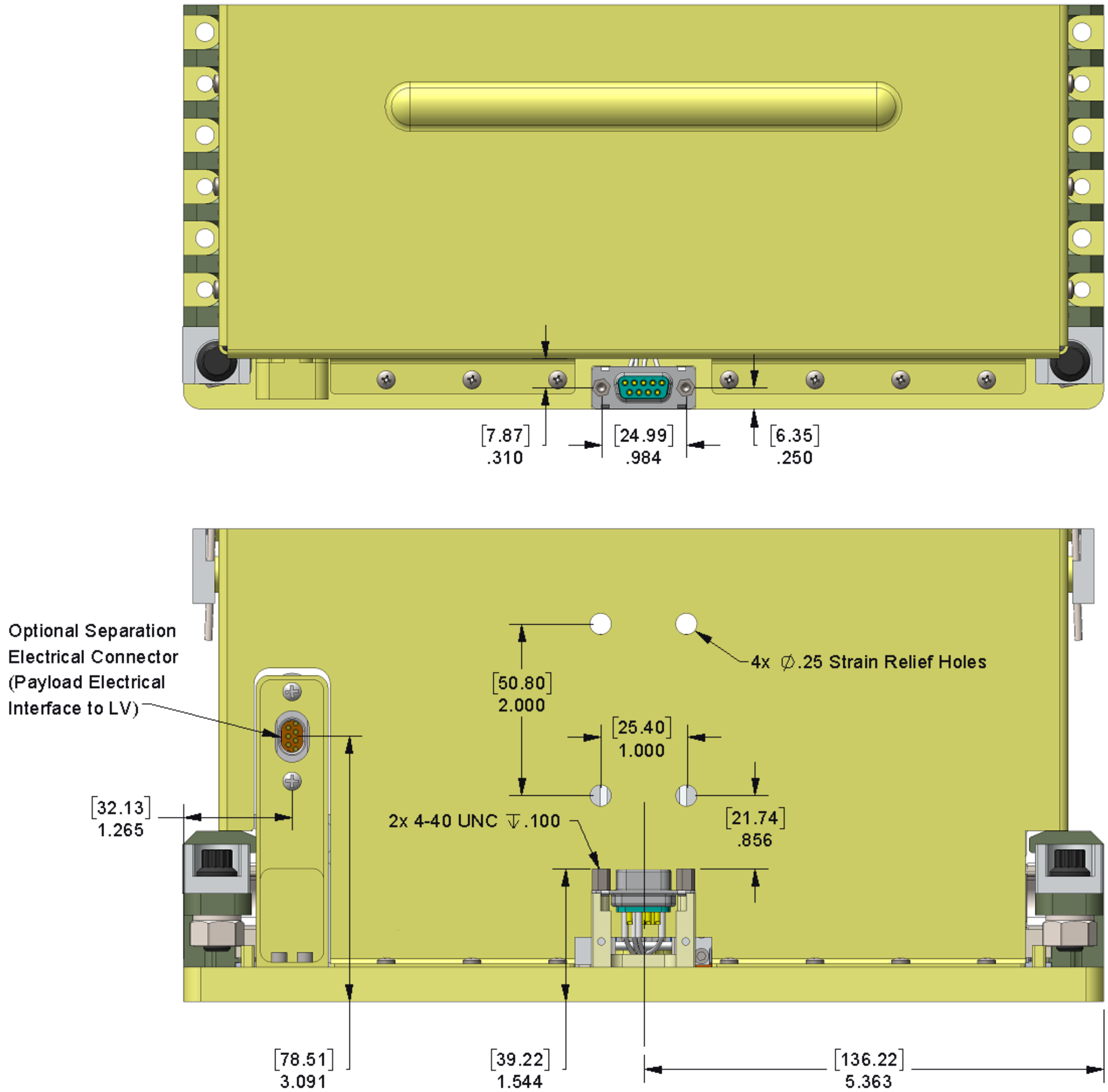


Figure 6-1: Launch vehicle electrical interface

7. ELECTRICAL SCHEMATIC

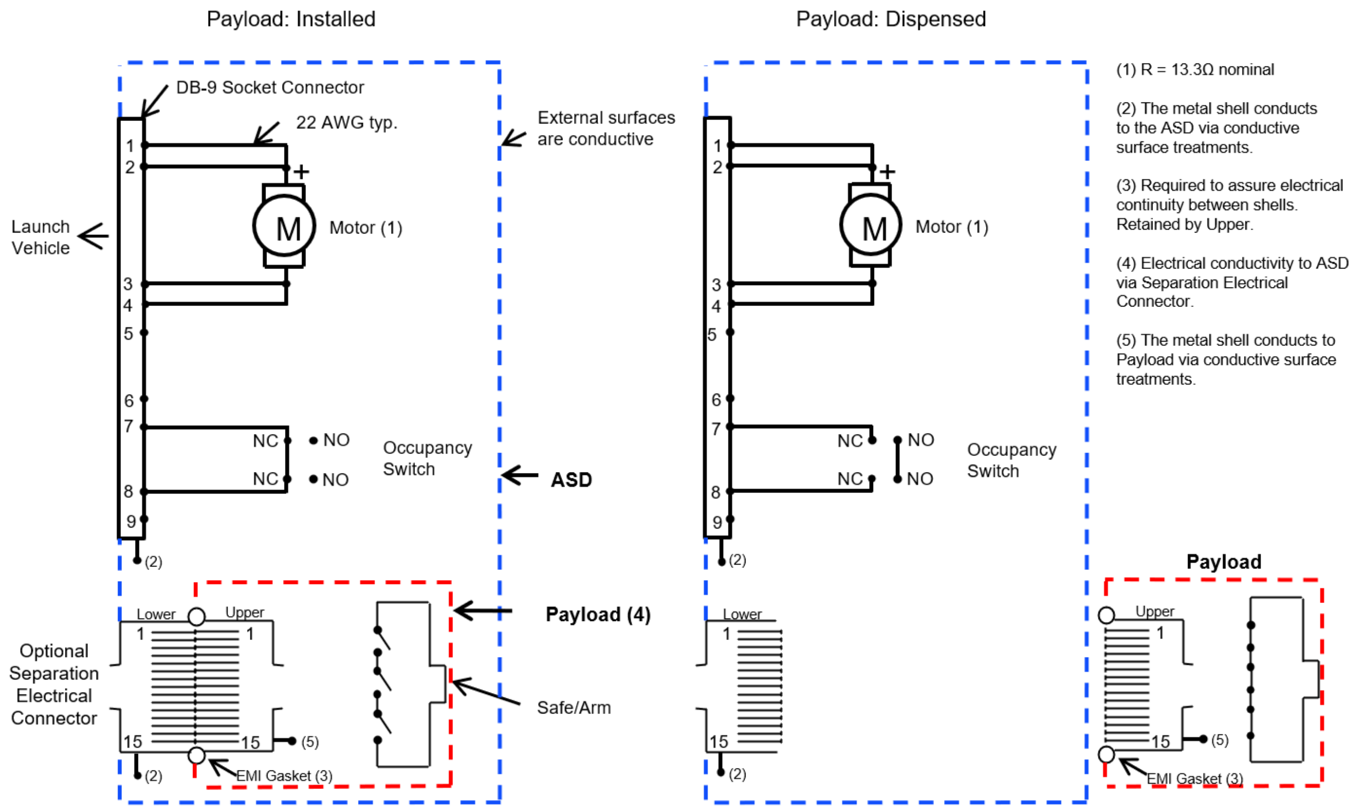


Figure 7-1: ASD electrical schematic

The Separation Electrical Connector is an in-flight disconnect (IFD). It is a custom connector provided by PSC-RL that has significant space-flight heritage. It can be used to transmit power or telemetry. It can also be wired as a loopback to indicate separation. The launch vehicle side of the connector must be removed from the ASD prior to the initial payload installation. It may be re-attached to the ASD after payload installation. This ensures proper alignment of the connector halves. For more information see PSC-RL document 2001025 Separation Connector Data Sheet on PSC-RL's website.

The Separation Connector can also be used for payload inhibits. If doing so, it is recommended to use three loop-back circuits, all of which must go open. This is due to the potential intermittencies in the pins at high shock and vibration levels. See Figure 7-2.

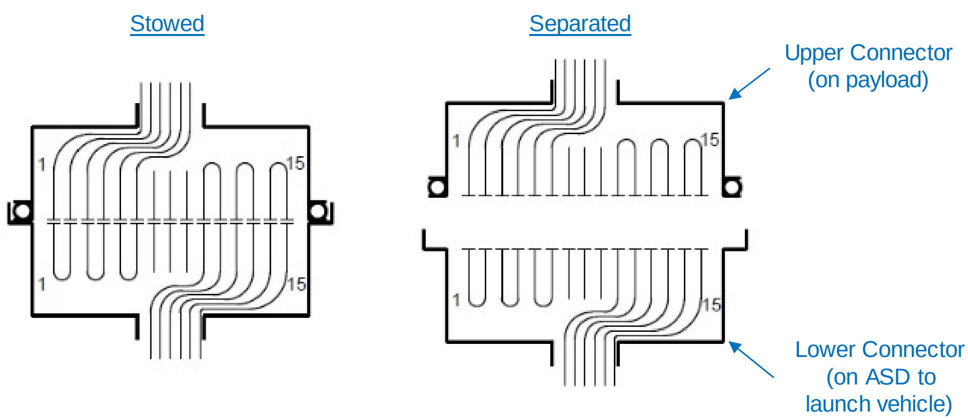


Figure 7-2: Example Separation Connector loop-back wiring

During qualification testing, PSC-RL monitored the electrical continuity of the Separation Connector, Motor, and Occupancy Switch. See Figure 7-3 for the circuit. The Separation Connector had 14 of its 15 pins wired in series through loopbacks.

In thermal vacuum testing all circuits remained electrically closed across all temperatures.

During shock and random vibration testing the components were monitored at ≥10 kHz per channel to detect intermittencies. All three items exhibit non-detrimental intermittencies. The frequency and duration of the intermittencies varies with ASD size, excitation axis, mounting face and payload dynamic response. Electrical designers should be aware of these potential intermittencies to design their hardware and software accordingly. Figure 7-4 and Figure 7-5 show example intermittency during 14.1 grms random vibration. The units of time are seconds in the figures below.

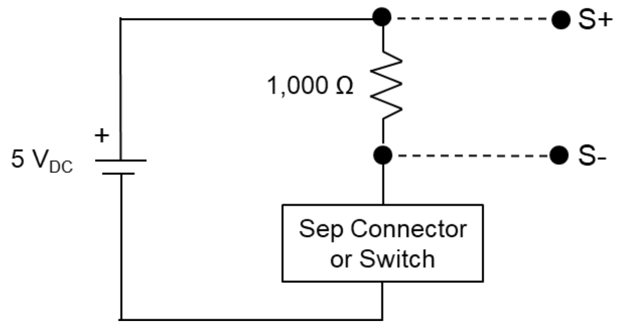


Figure 7-3: Measurement circuit

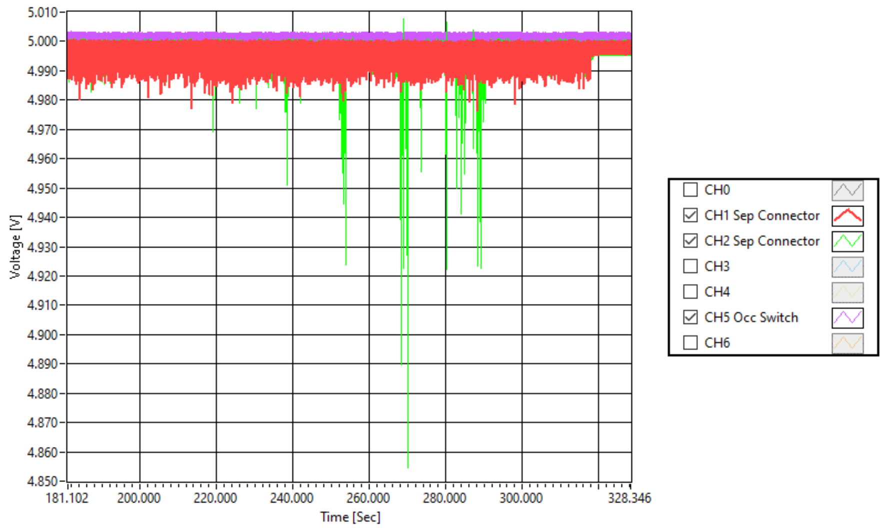


Figure 7-4: Example random vibration intermittency

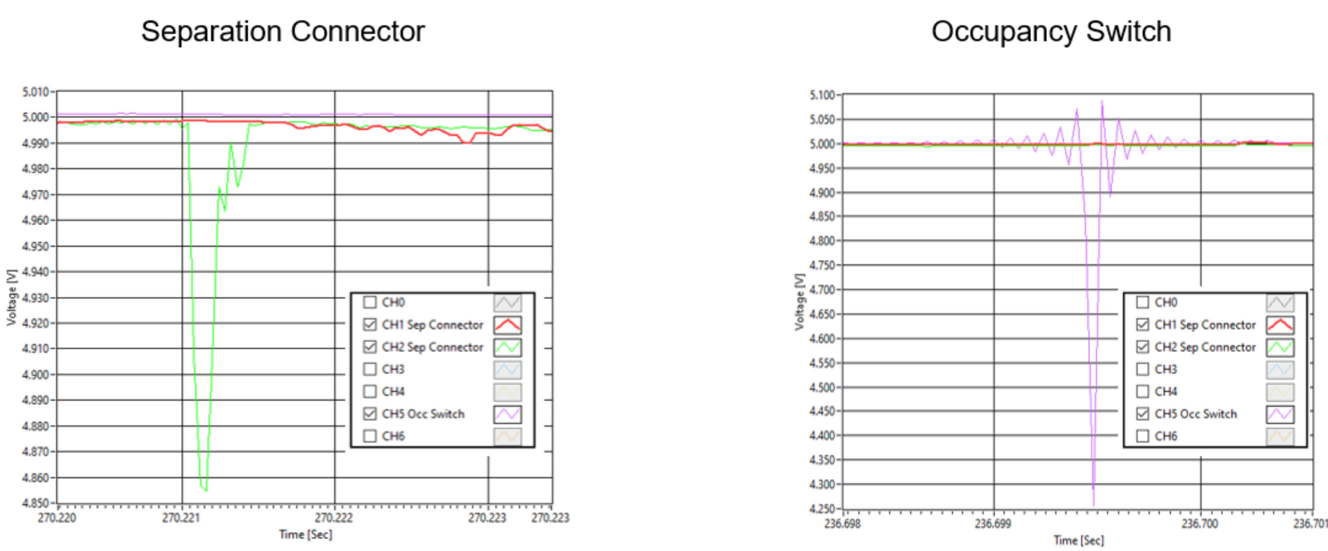


Figure 7-5: Typical duration of discrete intermittencies

8. INITIATION ELECTRICAL PROFILES

The ASD uses a DC brush motor to initiate separation. The motor is an excellent transducer and for every operation PSC-RL records the voltage and current profiles from the motor. This enables the health of the mechanism to be safely and inexpensively measured in testing and spaceflight. The torque margin can also be estimated.

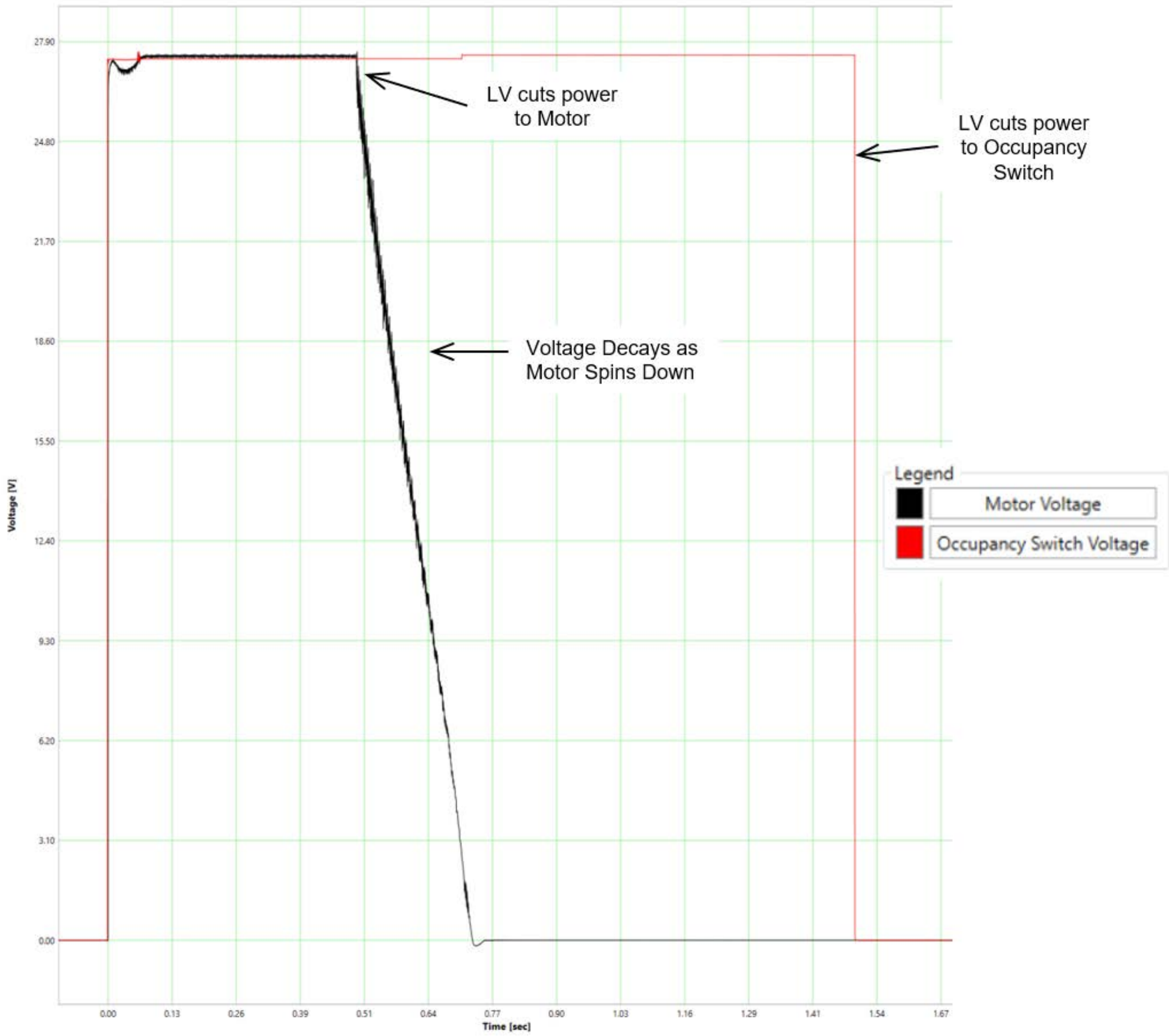


Figure 8-1: Example initiation voltage profile

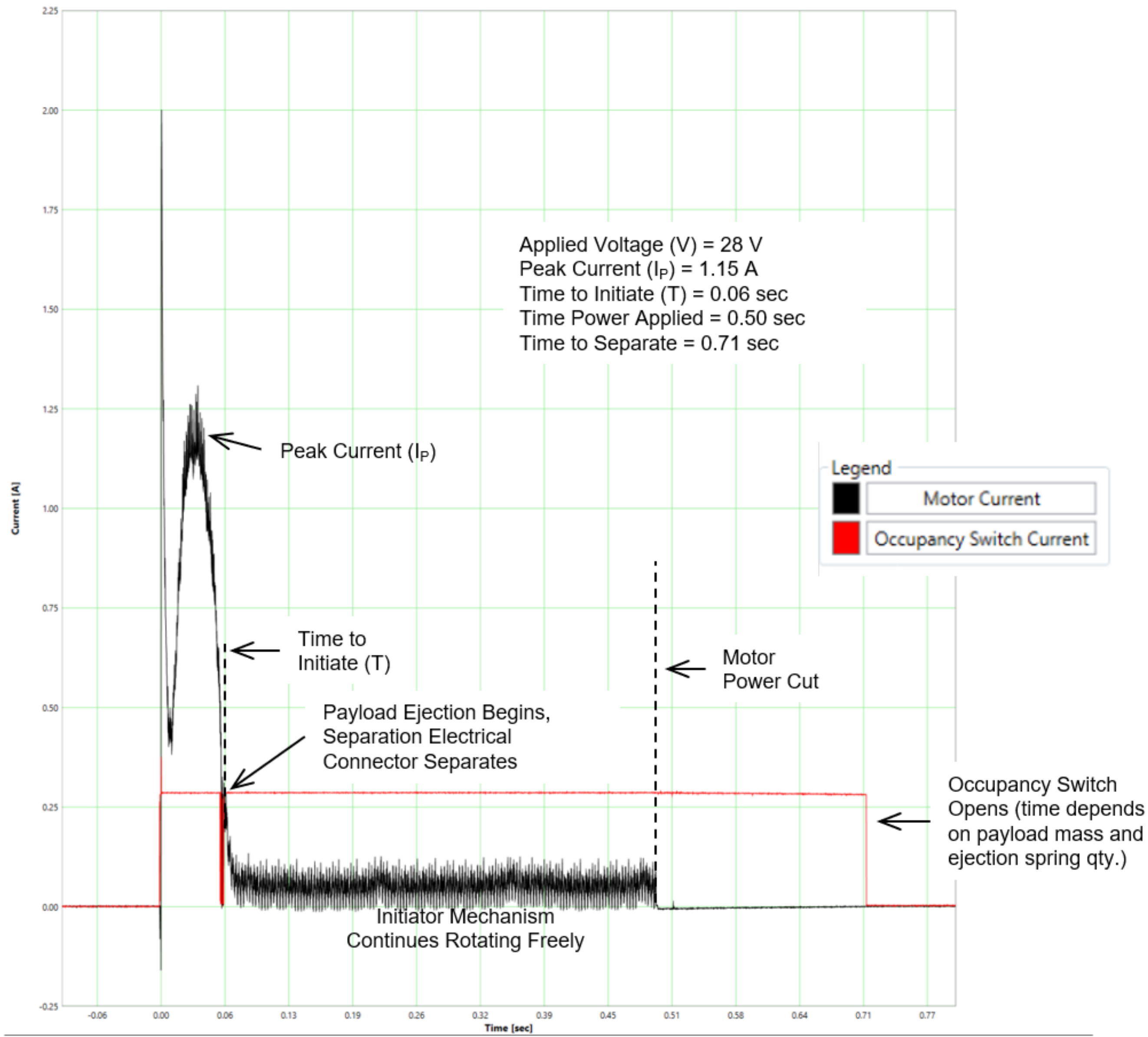


Figure 8-2: Example initiation current profile

PSC-RL monitors the state of the occupancy switch during separation. The ejection velocity of the payload can be approximated using the timing between initiation time and the occupancy switch activation and assuming constant ejection acceleration from the ASD's constant force spring.

$$V \cong \frac{2 * D}{T_O - T}$$

V is ejection velocity [length/time]
D is distance between Ejection Plate's stowed and deployed positions [length] see Figure 10-2
T_O is the Occupancy Switch opening time [time]
T is the initiation time [time]

9. ENVIRONMENTAL TESTING

All flight ASDs undergo environmental tests to verify workmanship.

PSC-RL records voltage and current during all operations. Flight ASDs perform > 12 separations during testing (EDUs perform 10). ‘Separation’ is defined as the payload fully ejecting from the ASD. ‘Initiation’ is defined as the preload releasing but the payload not fully ejecting, typically due to orientation with respect to gravity.

The ASD mounting interface is the -Y face for all PSC-RL testing. PSC-RL typically uses 24x (12x per side) high strength .190-32 UNF socket head cap (SHC) screws torqued 45 to 50 in·lb for vibration testing. Example PN is NAS1351N3-12.

9.1 Test Summary

All levels in Table 9-1 may be exceeded at PSC-RL’s discretion.

Table 9-1: Test levels

Test	Parameter	Use			
		Qualification	**Proto-Flight**	**Acceptance (Flight)**	**EDU**
Benchtop Separations (1)	Separations [-]	100	10	10	10
Thermal Vacuum	Temperature [°C]	-34 to +71	-29 to +66	-24 to +61	Not Tested
	Pressure (at separation) [Torr]	<1.0E-4			
	Cycles [-]	27	20	4	
	Separations [-]	4 (temps & voltages at extremes)	2 (temps & voltages at PSC-RL’s discretion)	1 (temp & voltage at PSC-RL’s discretion)	
Random Vibration (2, 4)	Level [g_{rms}]	14.1 (NASA GEVS qual)		7.3	Not Tested
	Duration [s/axis]	180	60	60	
	Excitation Axes [-]	X, Y, Z			
	Payload Mass [kg]	6U: 12 12U: 24	Varies	≤6.5	
Sine Burst (3)	Payload Response [lbf]	1,450		Not Tested	Not Tested
	Cycles, per axis [-]	3			
	Excitation Axes [-]	X, Y, Z			
Shock (4)	Level [g]	See Figure 9-3		Not Tested	Not Tested
	Impacts per Axis [-]	3	2		
	Payload Mass [kg]	See Random Vibration			

(1) 1atm, ~23°C. A separation is also performed after random vibration, after sine burst and after shock.
(2) The total dynamic response of the payload is affected by mass distribution, stiffness and damping. Therefore, specifying a maximum allowable payload mass is not productive. To ensure sufficient margin, customers should tune their payload to limit the MPE 3σ response to 80% of the sine-burst test level or verify with an EDU ASD. This is very conservative as the total 3σ payload response during qualification testing far exceeded the sine burst levels.
(3) The peak input acceleration chosen depends on the payload’s mass according to Newton’s second law F=ma.
(4) Levels are inputs near the ASD’s LV mounting interface.

9.2 Thermal Vacuum (TVAC)

Testing is conducted in one of PSC-RL's thermal vacuum chambers. The ASD is bolted or clamped via the -Y face to a conductive plate. A heat exchanger pumps refrigerant through tubing on the underside of the plate to conductively heat and cool the ASD. At completion of cycling the payload separates while in the chamber.

Figure 9-1: TVAC testing an ASD in one of PSC-RL's chambers. Conveyors allow complete payload dispensing (see Section 16).

9.3 Random Vibration

The ASD is bolted or clamped via the -Y face to an interface plate and tested in all 3 axes. An electrodynamic shaker imposes a random vibration profile in accordance with typical launch vehicle minimum workmanship levels.

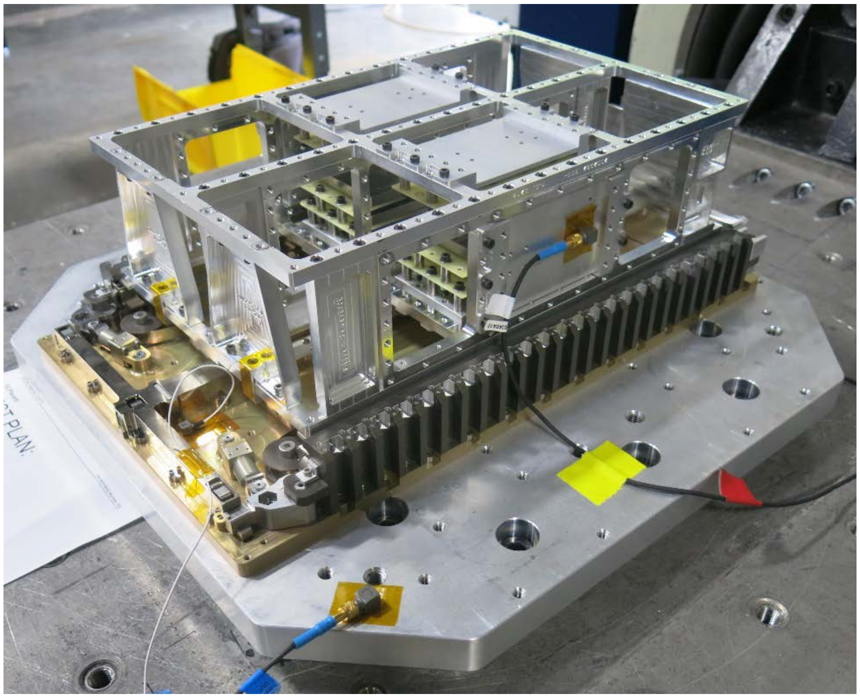
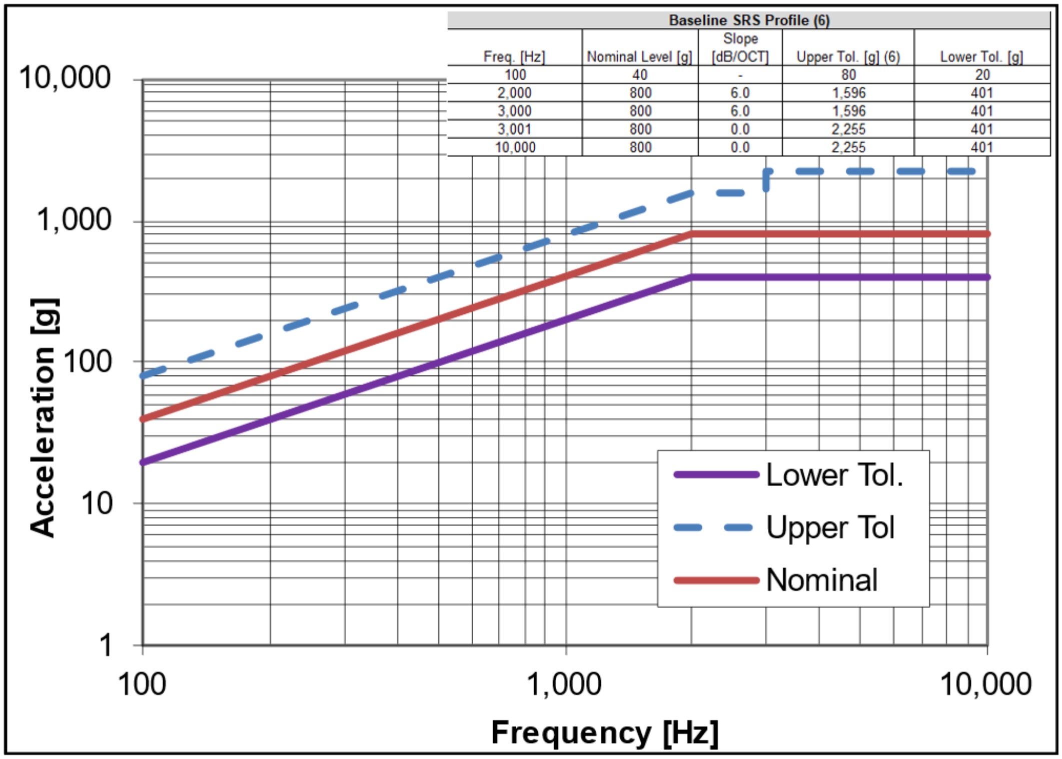


Figure 9-2: Typical ASD acceptance random vibration test setup

9.4 Applied Shock (not a standard test)

Shock testing is only performed on qualification and proto-flight units. Figure 9-3 shows the qualification applied shock SRS. For each impact and axis >50% of the curve is above the nominal specification. Both the positive and negative SRSs shall meet the tolerance. This is measured at the ASD interface surface, <2 in from the ASD. Figure 9-4 and Figure 9-5 show representative test setups.



Baseline SRS Profile (6)				
Freq. [Hz]	Nominal Level [g]	Slope [dB/OCT]	Upper Tol. [g] (6)	Lower Tol. [g]
100	40	-	80	20
2,000	800	6.0	1,596	401
3,000	800	6.0	1,596	401
3,001	800	0.0	2,255	401
10,000	800	0.0	2,255	401

Figure 9-3: ASD applied shock specification

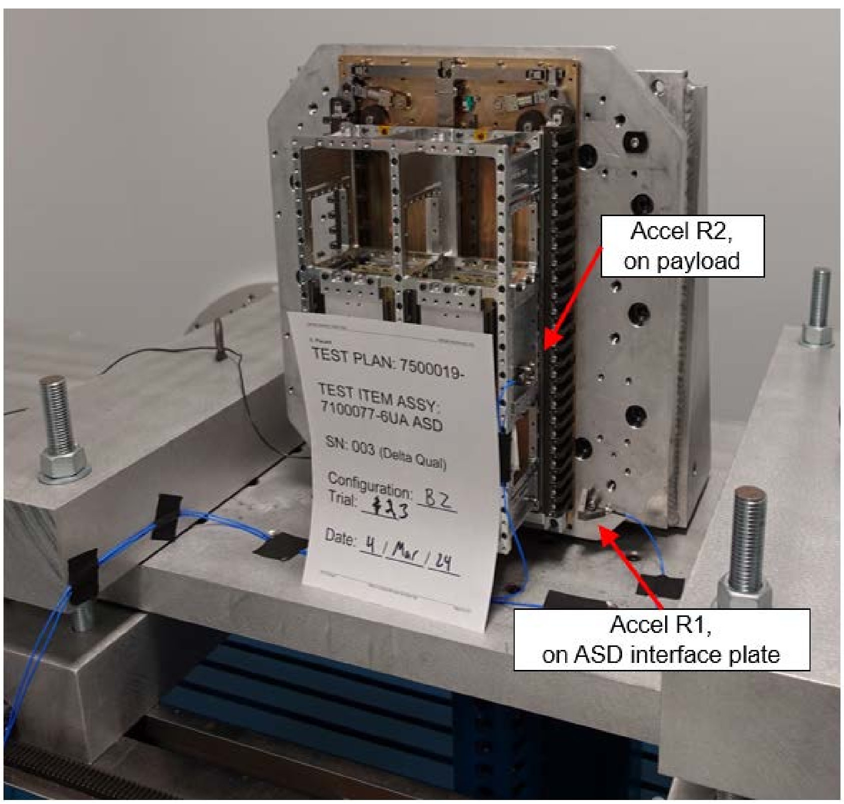


Figure 9-4: Qualification applied shock test setup, 6U, Z axis, no walls

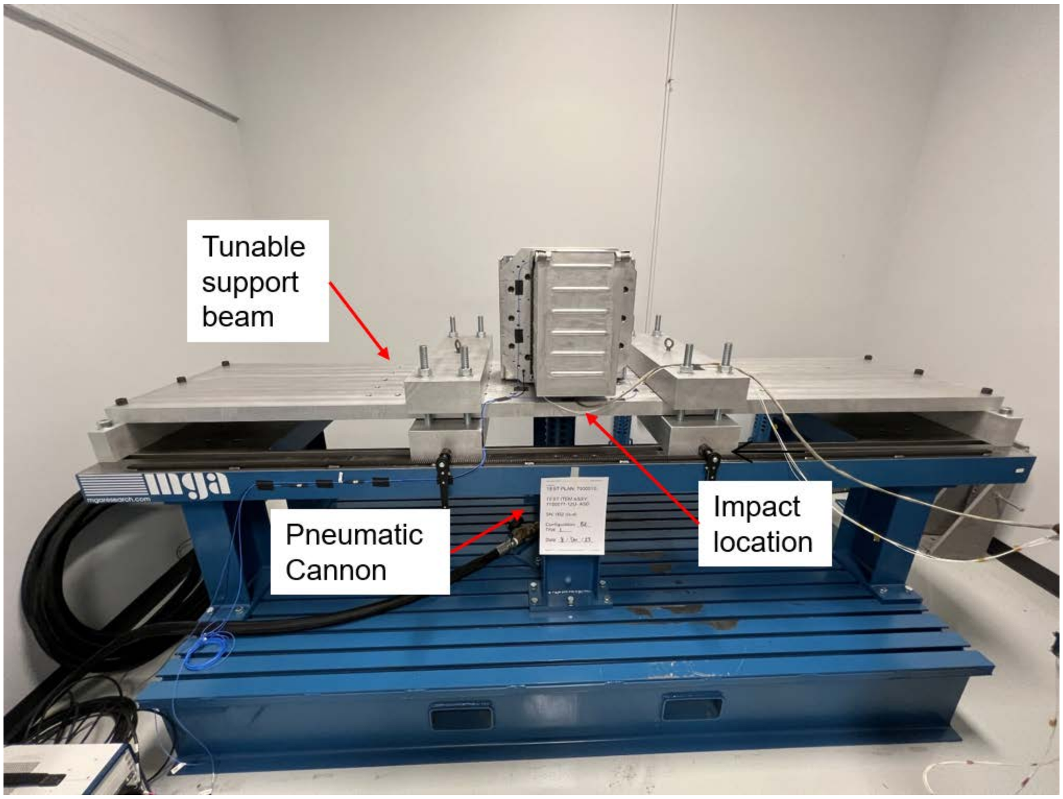


Figure 9-5: PSC-RL's shock test fixture

9.5 Generated Shock (not a standard test)

The ASD was operated several times to measure the shock generated as a result of initiating the payload. Results are shown below. Note the results are highly dependent on several test specific parameters, including but not limited to

- Interface plate's mass, material, resonances and damping
- Attachment fastener qty and preload
- Accelerometer's distance from the ASD
- Payload mass and dynamic response
- Accelerometer's location on the payload

The data presented in this section was collected while the ASD was bolted to a solid aluminum plate resting on an isolation mat. Two payloads with different masses were used during testing.

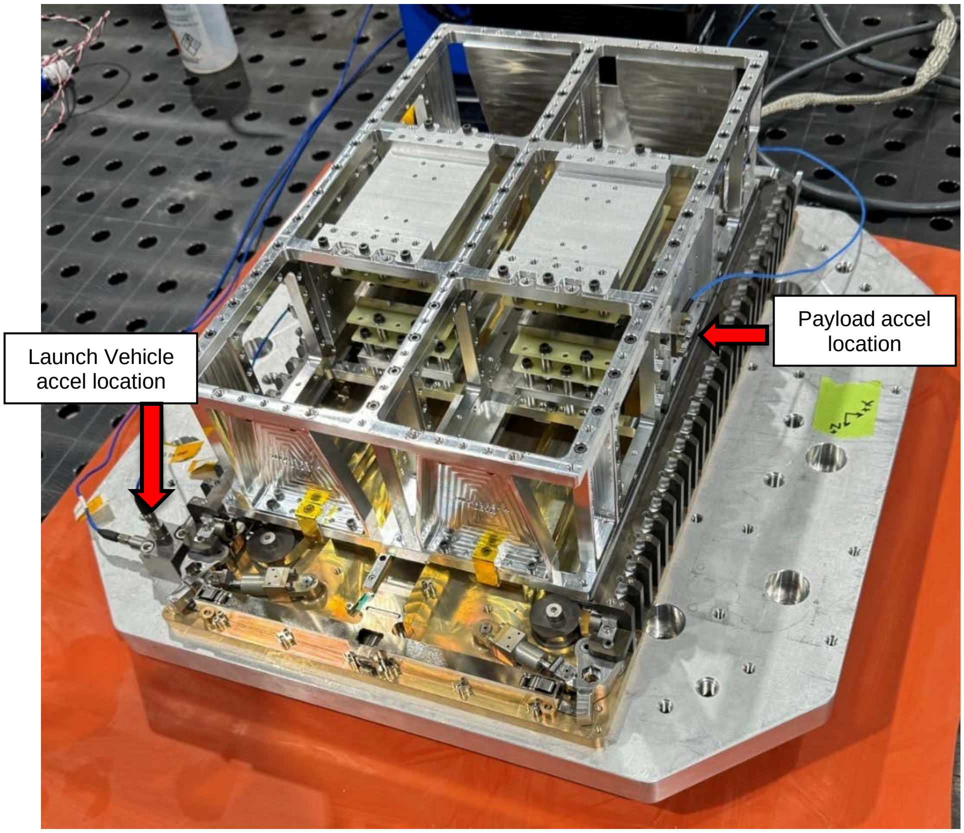


Figure 9-6: Generated shock, light payload test setup

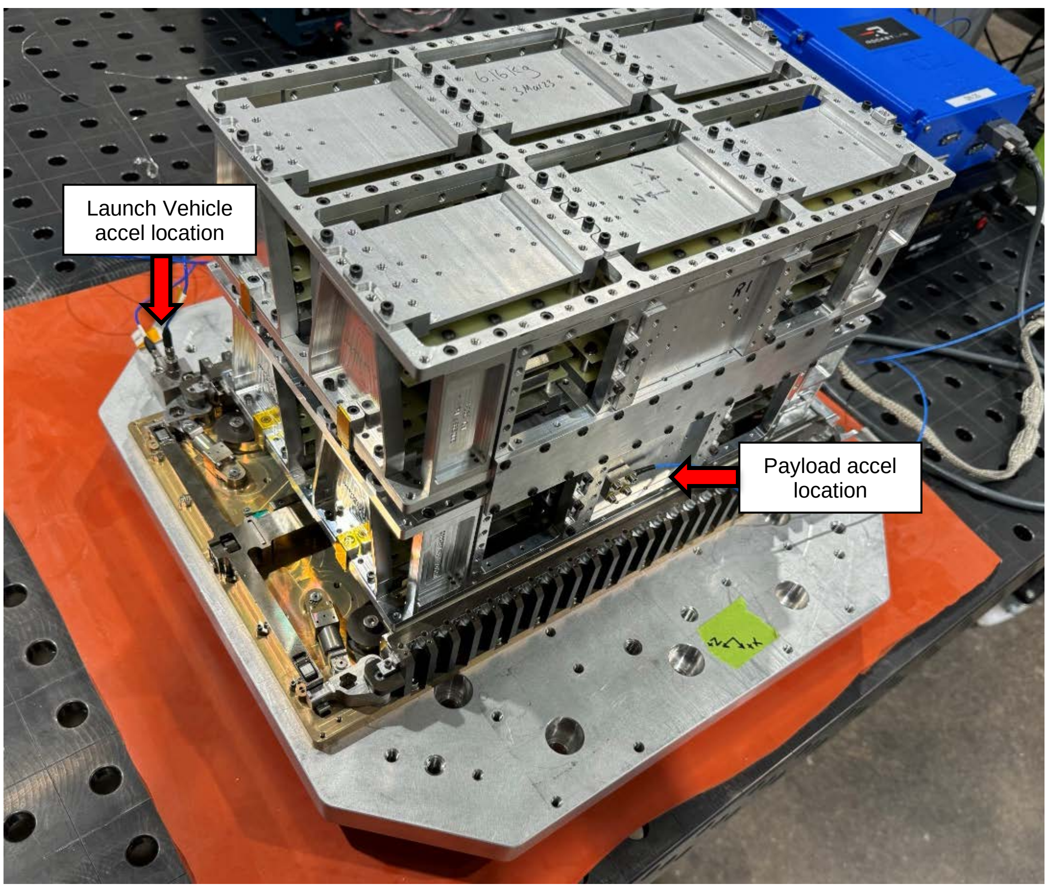


Figure 9-7: Generated shock, heavy payload test setup

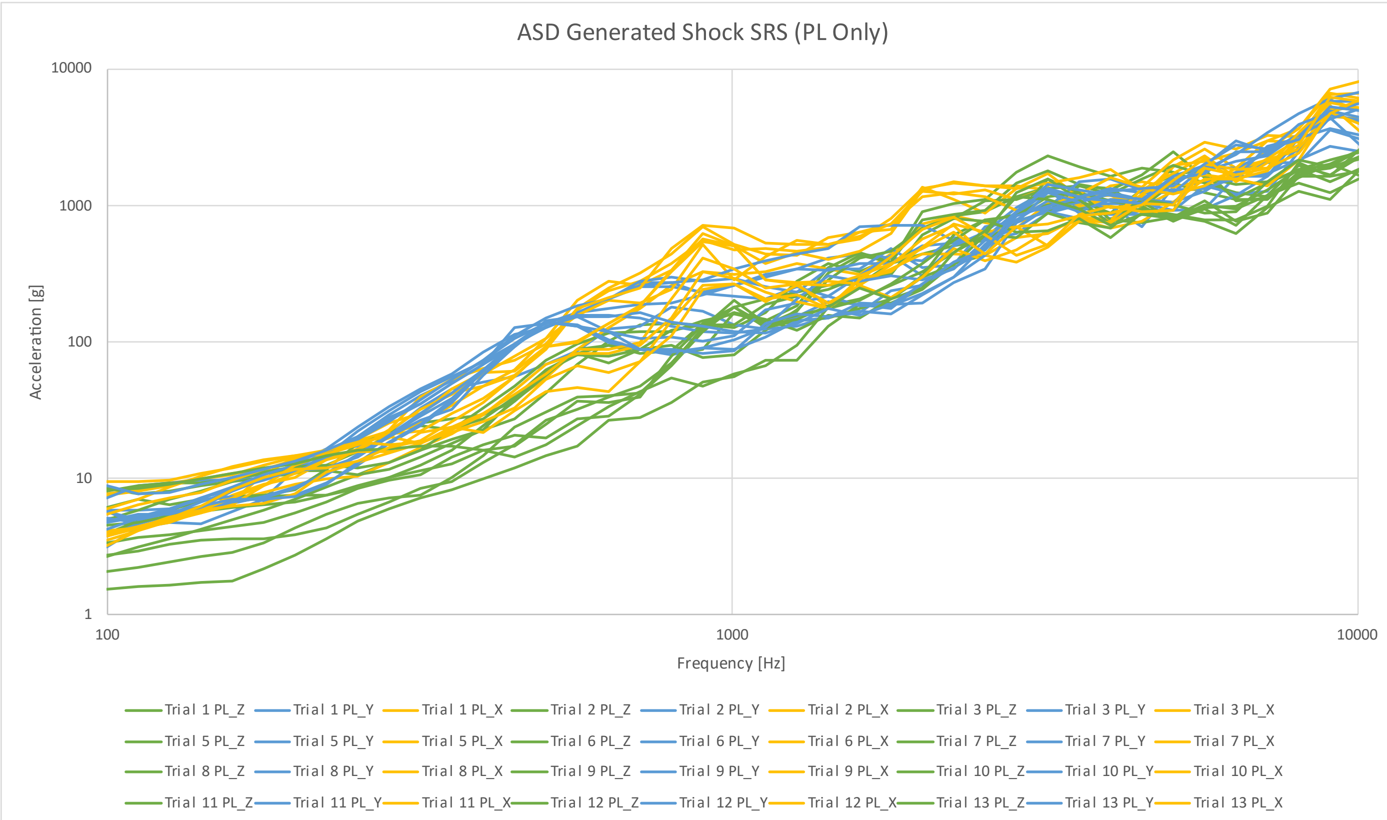


Figure 9-8: Shock measured on the payload

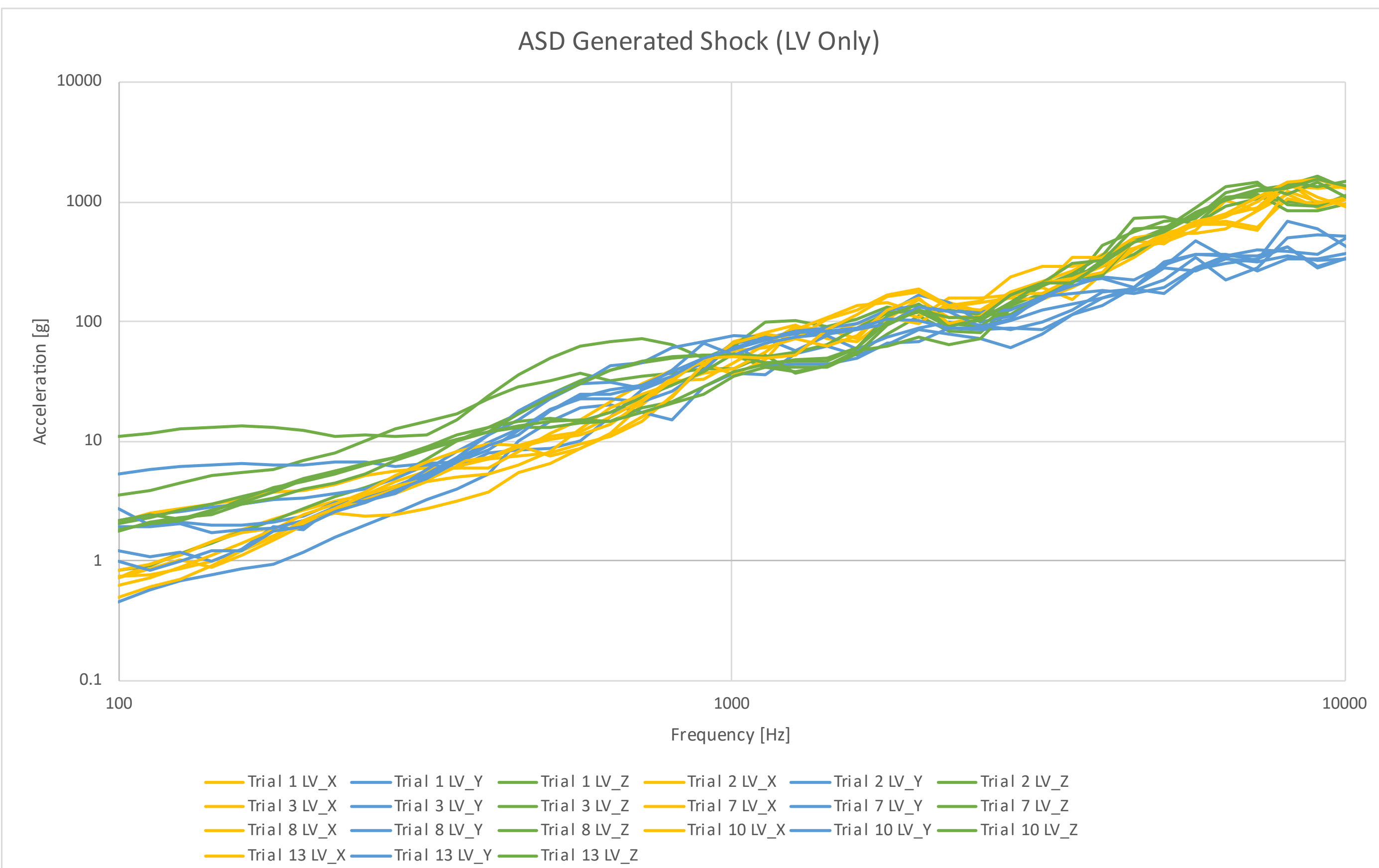


Figure 9-9: Shock measured on the aluminum plate

10. PAYLOAD EJECTION

The graph below provides estimated payload ejection velocities. These apply at room temperature. See Figure 10-3 for typical scatter.

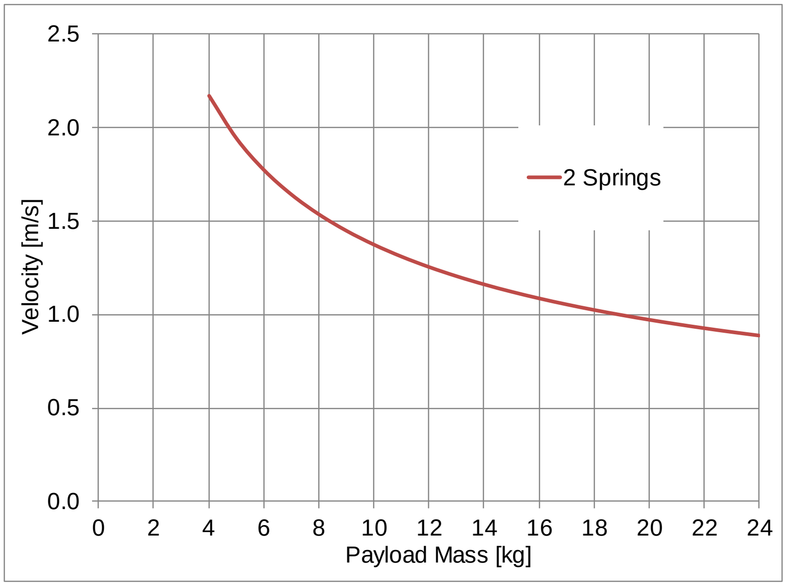


Figure 10-1: Estimated payload ejection velocity

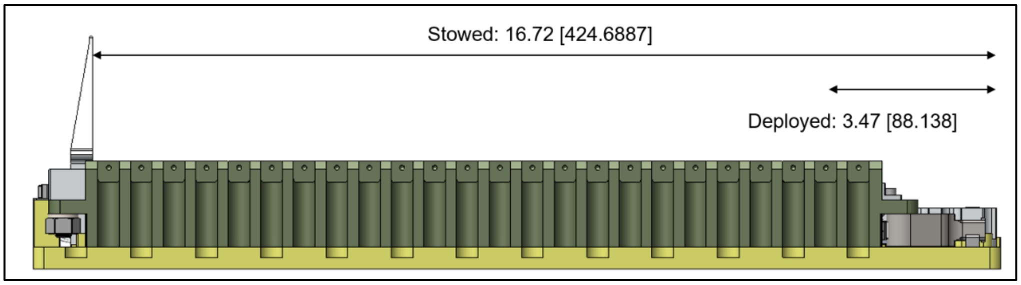


Figure 10-2: Ejection Plate travel

Figure 10-3 shows the payload Separation Time for the 6U qualification benchtop test performed under 1g at ambient temperature and pressure. Gravity likely causes an increase in separation time due to the added friction between the payload's tabs and ASD which would not be present in flight. Time to separate was calculated using the delta from power initially applied and occupancy switch changing state. Lower applied voltage results in a longer Time to Initiate (release the preload on the payload's tabs) as can be seen from the figure. See section 8. The mass of the payload used was 4.94 kg.

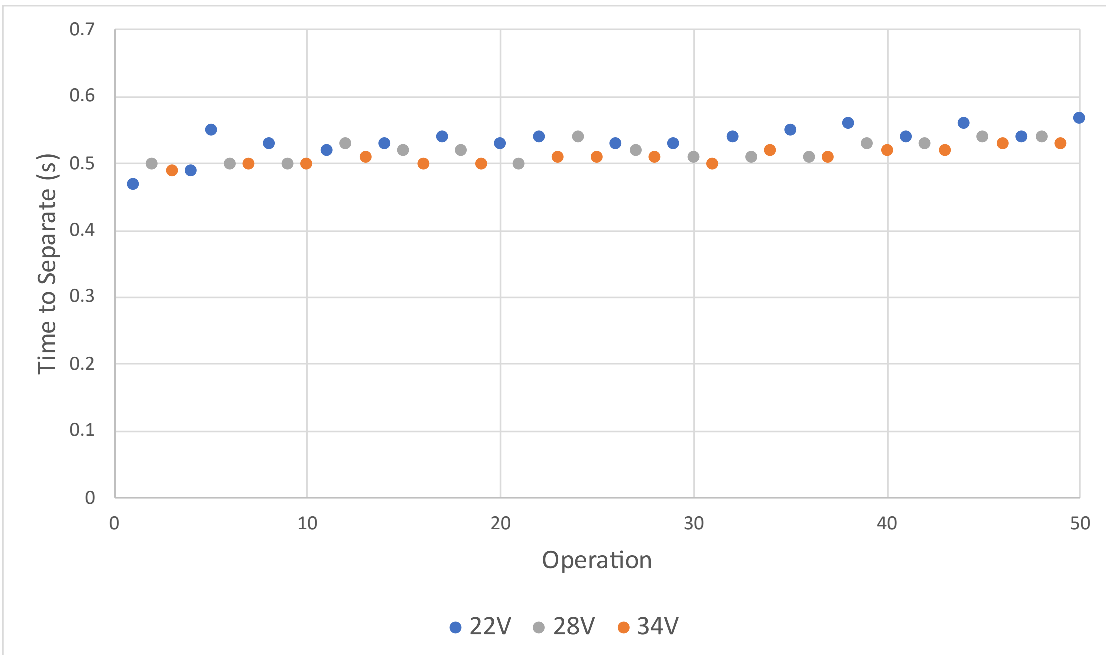


Figure 10-3: 6U qualification benchtop separation summary

11. ALLOWABLE PAYLOAD RESPONSE

The 3σ RSS total payload response due to all loading shall not exceed the recommendations in Table 9-1.

Simply claiming a dispenser can accommodate a certain payload mass is not productive because every payload has a unique dynamic response. The loading on the ASD is affected by the variable stiffness, damping, and effective mass of each payload. Figure 11-1 illustrates the extreme difference in response of two payloads of the same mass. Higher damping within the payload and/or isolation between the ASD and launch vehicle greatly increases the mass capability.

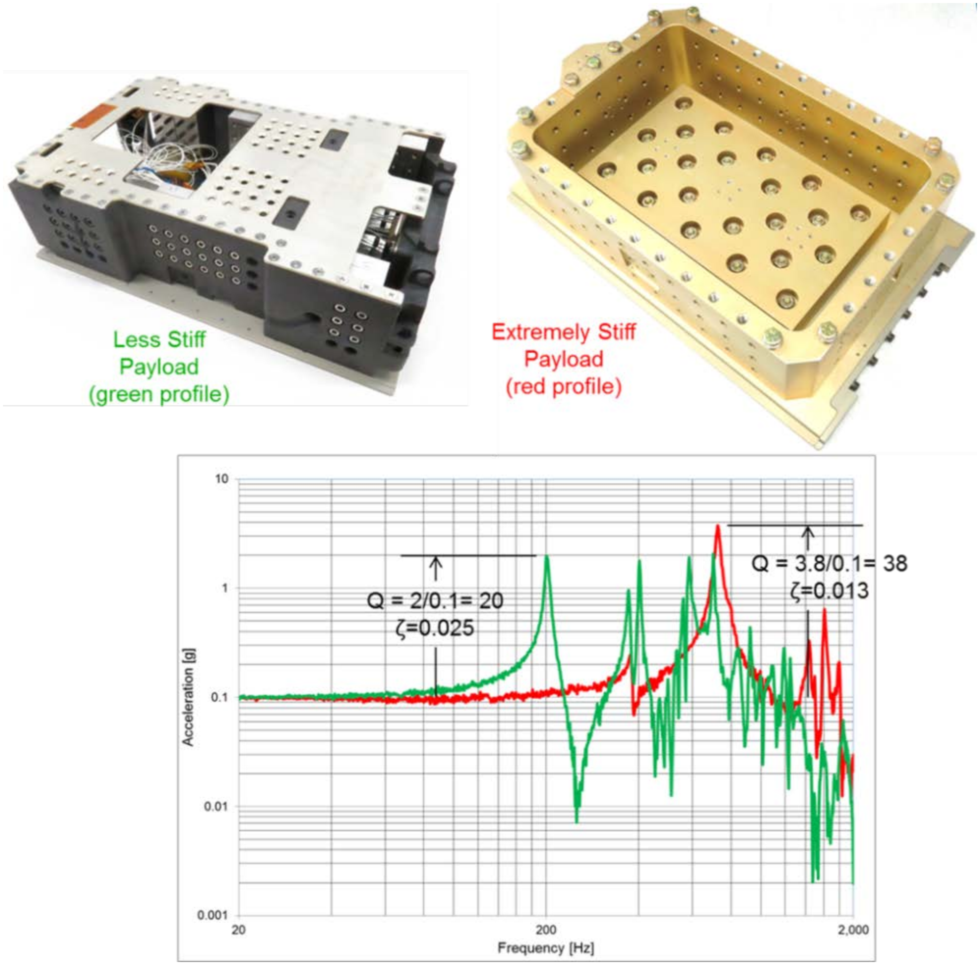


Figure 11-1: Payload response comparison

As a further example a 12 kg 6U payload exhibited a lower total response than a 9 kg payload despite being 33% heavier. Both were tested in the same dispenser with the same 14.1 g_{rms} input.

It is important to note that the total response limit does not typically result from the quasi-static launch acceleration multiplied by payload mass. For example if the launch vehicle provides an 10g launch load factor on a 12U, the payload mass likely cannot be 145 lb as resonances and low damping can create higher effective responses than 10g. Isolation systems can increase damping and move the resonant frequency. This is what larger vehicles do: coupled loads analysis, then if the response is too high, isolate or strengthen.

12. OPERATION AND INTEGRATION

Payload installation and integration is quick and straightforward. The payload may be installed either before or after the ASD has been attached to the LV interface. Operating the initiator after installation and verifying reliable dispensing of the payload is essential to ensure proper operation in the final flight configuration. PSC-RL document *3000396 ASD Operating and Integration Procedure* shall be used for all payload installations, ASD operations, and launch vehicle integration. Further, only trained personnel shall use the ASD. See section 20 and PSC-RL's website for details.

13. ASD CONSTRAINED DEPLOYABLES

The ASD is capable of constraining deployables. Document *2004630 ASD Payload Spec Addendum* (ref. 3) provides details on allowable contact locations of deployables to the inside of the ASD.

14. REDUCING DYNAMIC LOADING ON PAYLOAD

The use of isolation systems benefits the payload by increasing allowable payload mass and/or reducing fatigue loading of sensitive components. PSC-RL does not offer an isolation system as a product however all isolators tested to date drastically reduced the random vibration response and shock acceleration. The figures below show the significant reduction in loading during random vibration and shock testing of a Canisterized Satellite Dispenser (CSD).

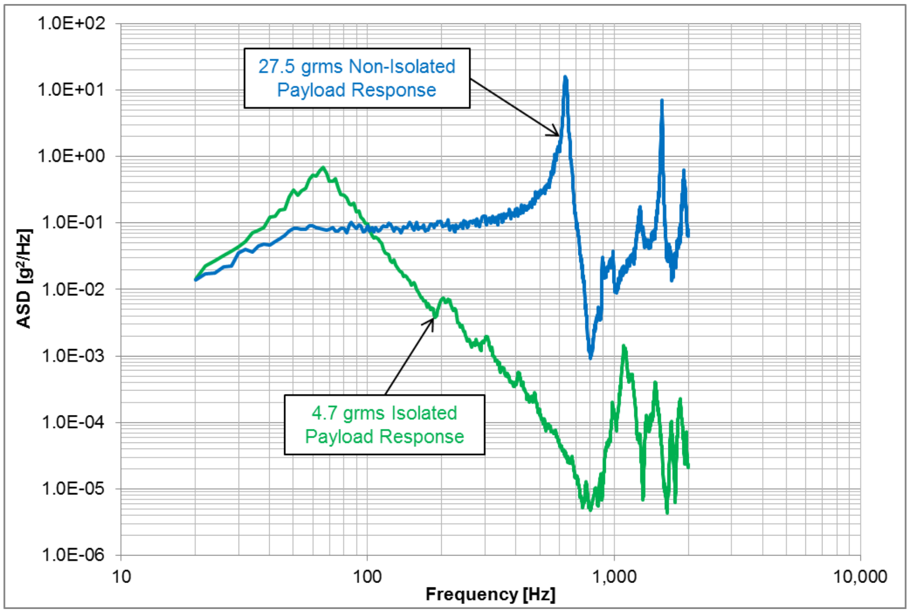


Figure 14-1: Isolation system benefits during random vibration testing

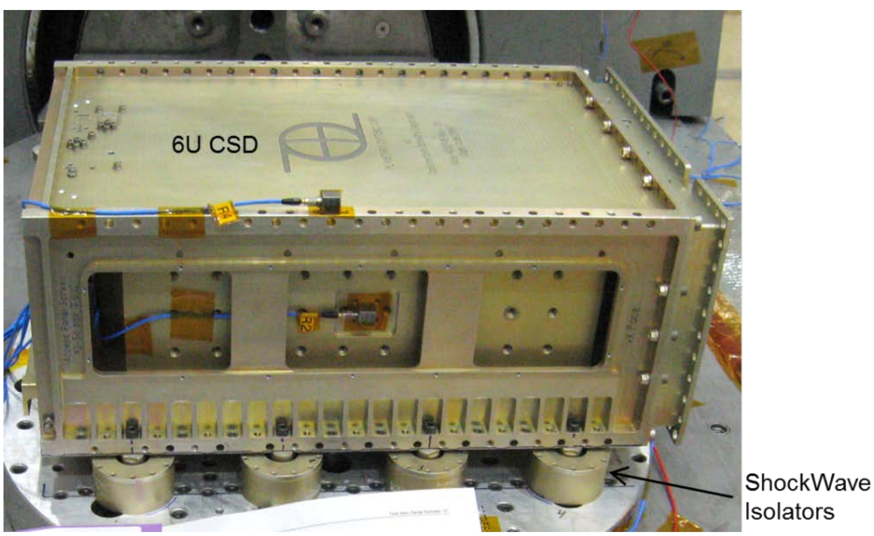


Figure 14-2: 6U CSD vibration test with Moog CSA ShockWave isolators

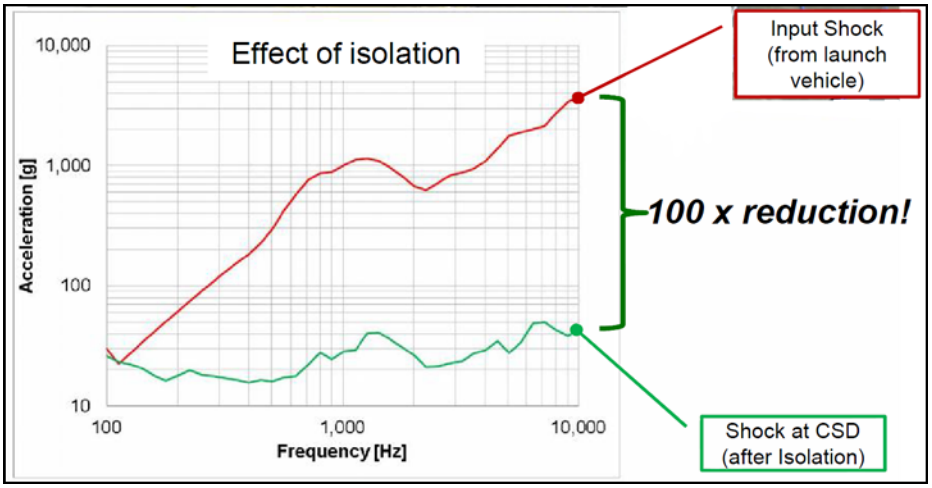


Figure 14-3: Isolation benefits during shock testing

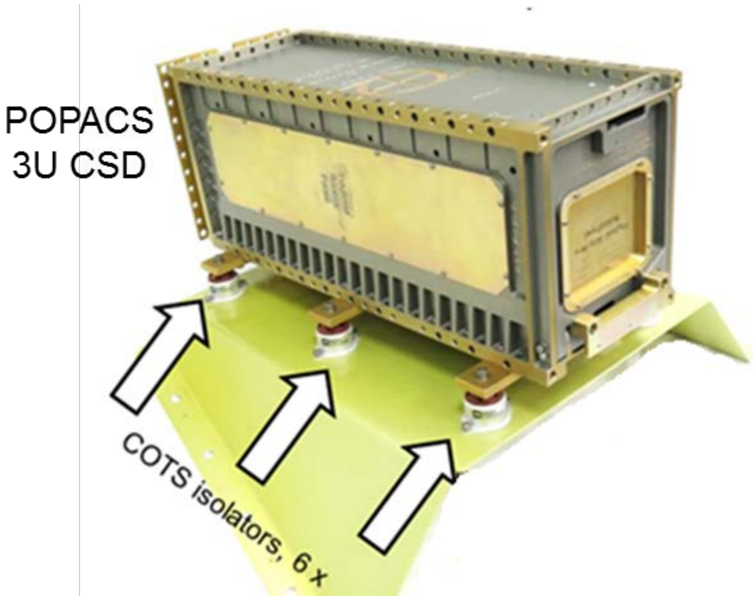


Figure 14-4: COTS isolators used on POPACS mission

15. ASD APPLICATIONS

The ASD can be mounted on its -Z face using simple machined brackets. The below examples show the ASD mounted within the SpaceX Rideshare standard CubeSat volume in different configurations. PSC-RL does not currently sell brackets.

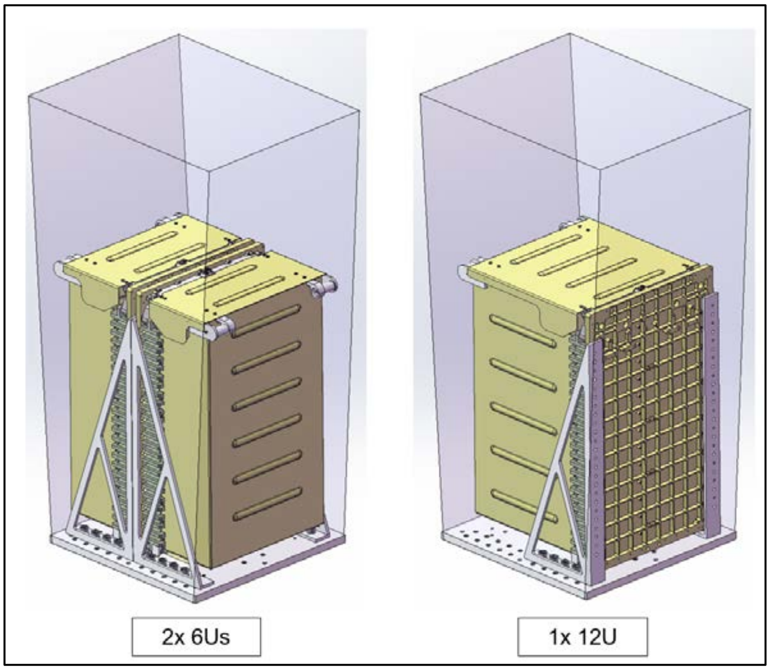


Figure 15-1: SpaceX Rideshare attachment options

The ASD can be flown with or without walls. This allows the customer to be unrestricted in the +/- X, +Y, and +Z axes. Excluding the exterior dimensions, ensure the payload remains compliant with *2004630 ASD Payload Spec Addendum*.

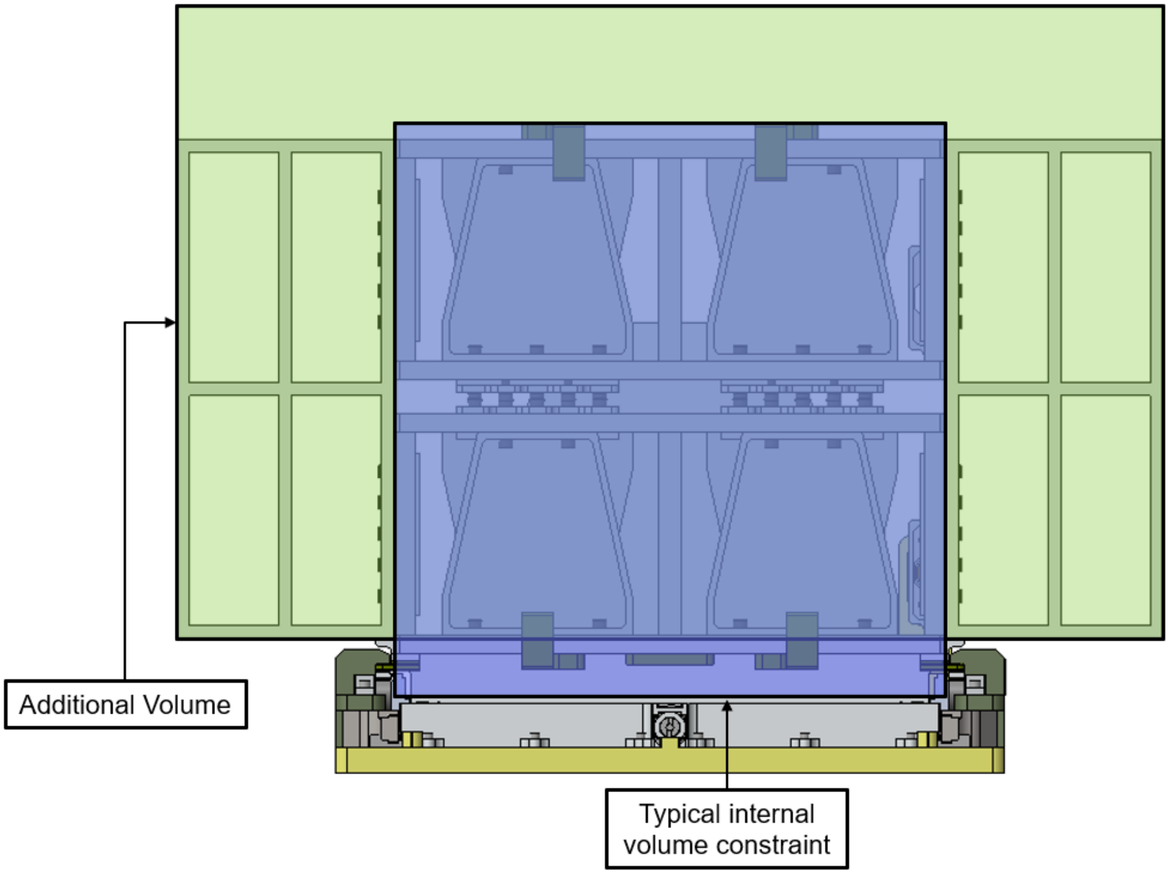


Figure 15-2: Example of extended XY payload volume

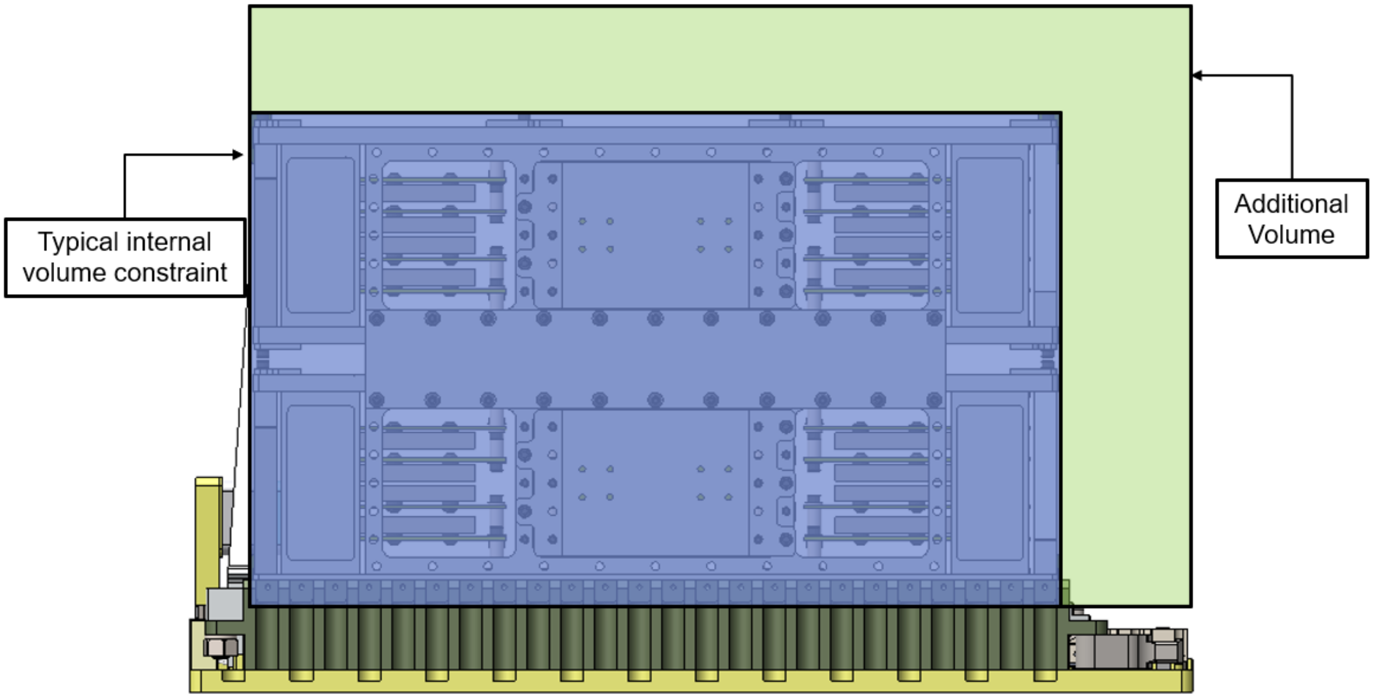


Figure 15-3: Example of extended YZ payload volume

The ASD, much like the CSD, can accommodate multi-piece payloads. Each discrete payload remains rigidly clamped via the tabs. The payloads need not occupy the entire length of the ASD (this may require a custom matched ASD).

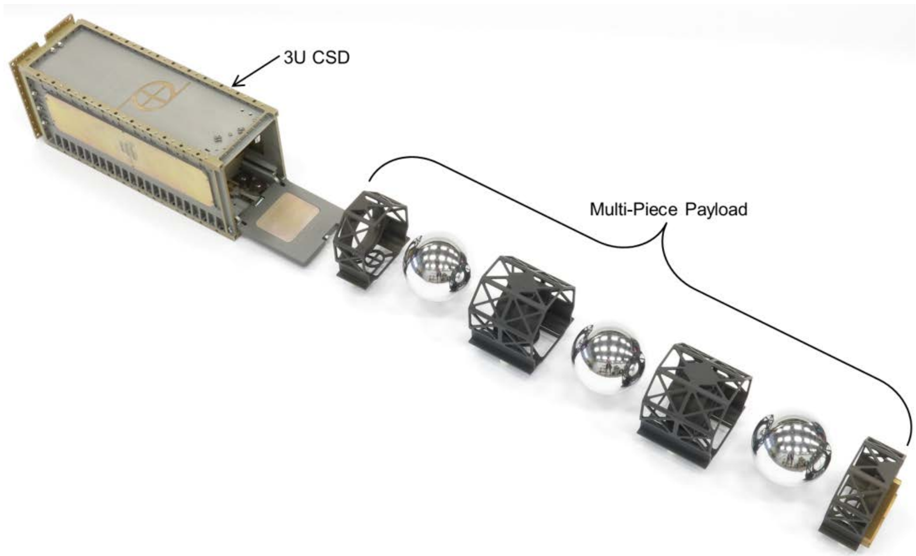


Figure 15-4: A single CSD/ASD can dispense multiple payloads (ref. 2, 6)

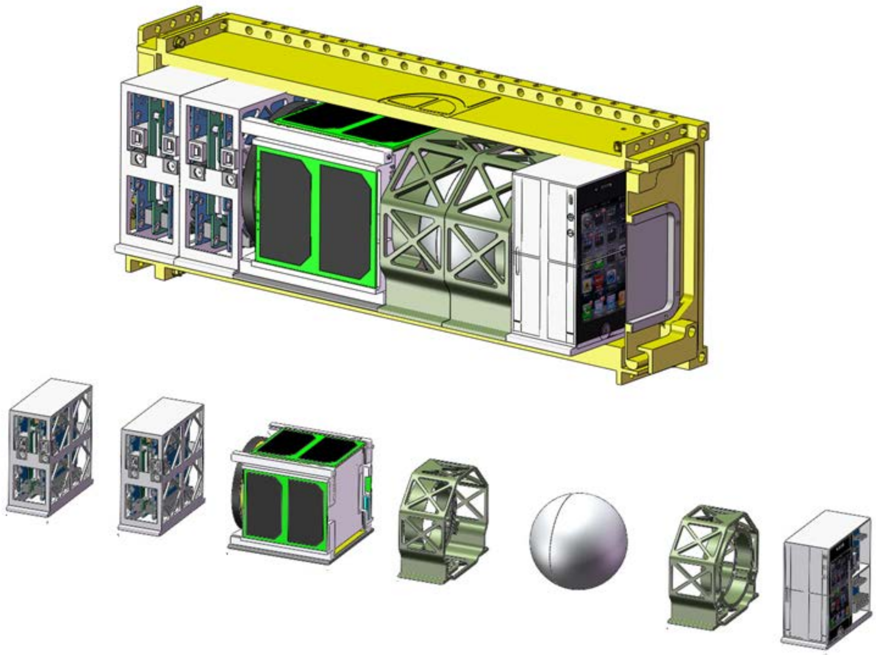


Figure 15-5: Multiple payloads in a CSD (also applies to ASD)

The ASD can accommodate existing CubeSats. Fastening custom tabs to an existing CubeSat allows for seamless integration into the ASD (see Figure 15-6). PSC-RL does not sell these custom tabs.

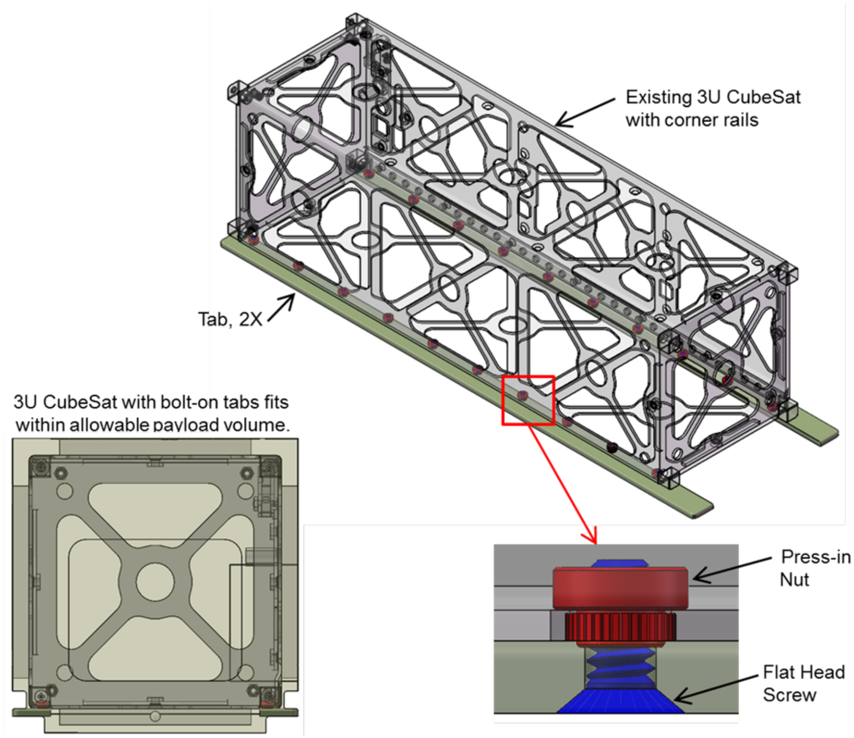


Figure 15-6: CubeSat with bolt-on tabs

The ASD can be used without the wall assembly when the size of the payload renders canisterization impractical or the payload exceeds the allowable internal volume.

16. TEST SUPPORT EQUIPMENT

PSC-RL is pleased to share the Information in this section for purposes of edification. This Information and associated equipment are not supported by PSC-RL. PSC-RL makes no warranty or representation (express or implied, statutory or otherwise) as to the accuracy or completeness of any Information disclosed in this section. PSC-RL shall have no liability to the Receiving Party or any of its Representatives or any third party arising from the use by the Receiving Party of the Information provided in this section.

Payload Separation Conveyor

Verifying full separation of the payload from the ASD is the only way to develop complete confidence in proper operation. For all testing PSC-RL employs a custom conveyor mechanism that allows the payload to fully eject by rolling on ball bearings. This is not available for sale but PSC-RL can provide a CAD model of the components from which the customer can design and manufacture their own.

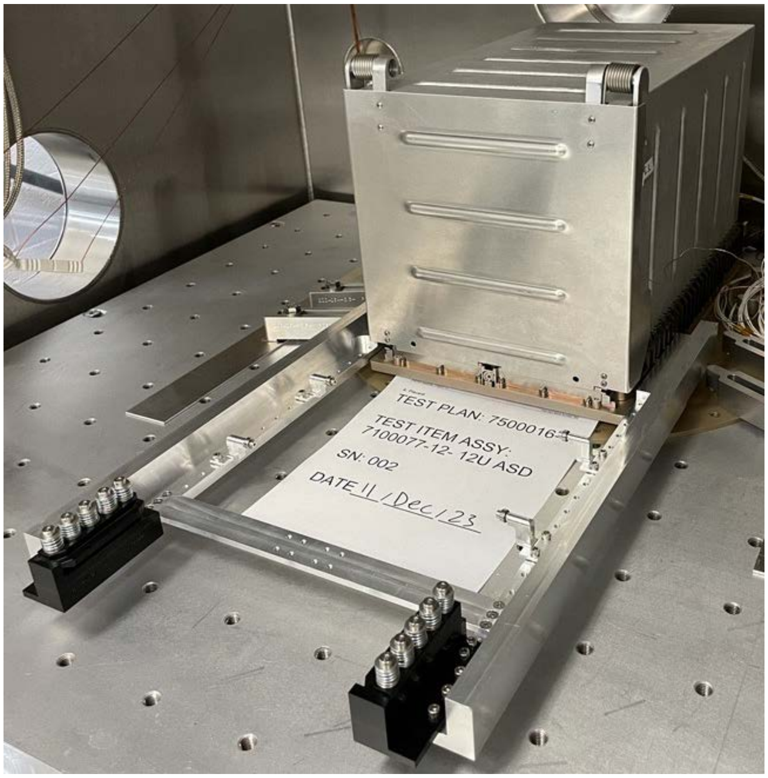
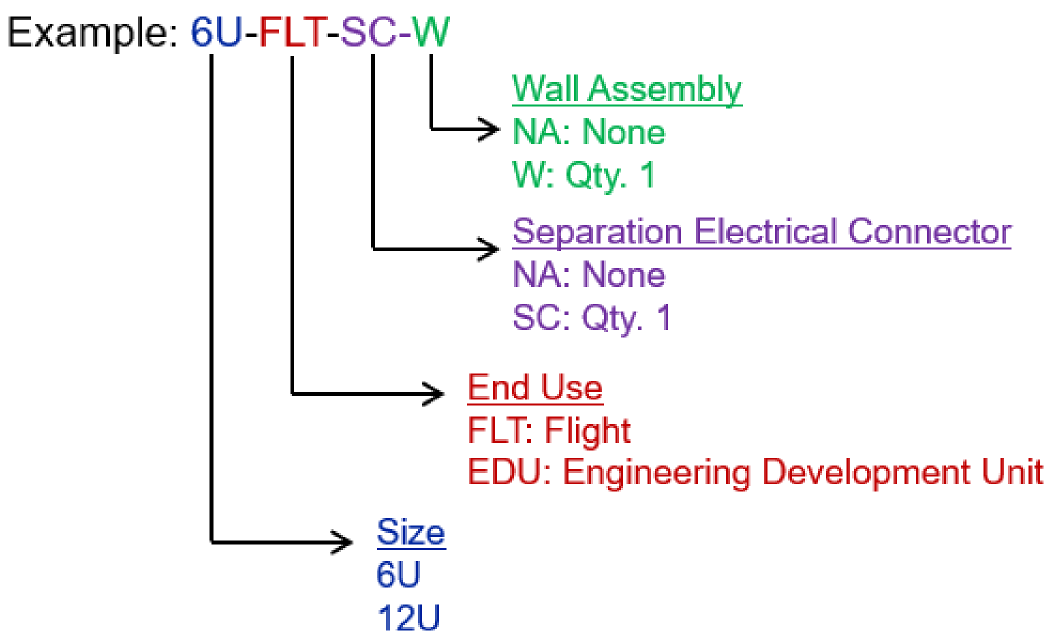


Figure 16-1: ASD with conveyor in TVAC

17. SPECIFYING AND ORDERING

When ordering an ASD specify the exact configuration using the following system.



EDUs will be indelibly marked “NOT FOR FLIGHT”.

18. TYPICAL LEAD TIME

For the most up to date lead times please contact psc.info@rocketlabusa.com.

19. COST

For the most up to date prices please contact psc.info@rocketlabusa.com. Due to the time savings and reliability inherent to the ASD, the total cost of ownership is lower than comparable dispensers. A payload can be deployed from the ASD, re-loaded, and ready for another deployment in a matter of minutes, greatly reducing the time and cost per operation during test and integration.

Table 19-1: ASD benefits

Item	ASD	Other Dispensers
Verify full separation (ejection) of the payload from the dispenser during test.	✓	
Quickly restow payload after TVAC test without refurbishment.	✓	
Quickly restow payload after vibration test without refurbishment.	✓	
Remove/swap payload from dispenser after installation on LV without disturbing stack or refurbishing initiator.	✓	
Safe/arm payload via door on densely packed LV where there is no access to sides of dispenser.	✓	
Predict failure modes, like fatigue, via accurate dynamic modeling prior to build, test and launch.	✓	
Attach and remove Walls and Door with or without payload installed.	✓	
Utilize the electrical connector to charge and communicate with payload after integration and during launch.	✓	

20. TRAINING

Training is required prior to installing a payload, operating the ASD or integrating. Failure to obtain training prior to this will void the warranty. Training is offered at PSC-RL with the purchase of an ASD.

21. RELIABILITY

Prior to spaceflight, each ASD is separated numerous times to verify operability. These include operations conducted during acceptance testing by PSC-RL and additional operations performed by the customer. As shown in Table 21-1, the ASD allows the user to verify operation multiple times before flight.

Table 21-1: Comparison of dispenser operations before launch

	ASD	Competing Dispensers
Typical quantity of operations on non-refurbished flight unit	>15	≤1

PSC-RL tests development and qualification units to examine reliability limits and inform the allowable limits of ASDs in ground test and space flight. A typical qualification campaign will result in >100 separation tests on a single ASD. The initiation electrical telemetry for every operation is recorded on PSC-RL's data acquisition systems.

Because of the reusability of the ASD and the high production rate, it is inexpensive to amass test data that is several orders of magnitude larger than competing systems. The ASD was designed to be reusable with the intent of demonstrating reliability.

PSC-RL constantly advances the ASD technology to increase reliability during ground test and in flight. By continually building and testing, PSC-RL engineers are made aware of trends that may compromise reliability.

22. STORAGE REQUIREMENTS

Store the ASD in a sealed enclosure in relative humidity of less than 95% (non-condensing) at temperatures from 0 to 50°C. PSC-RL should be contacted prior to operation if any of the storage durations are exceeded.

Table 22-1: ASD allowable storage duration

ASD State	Max. Storage Duration [yr]
No Payload	5
Payload Installed	1

23. TIPS AND CONSIDERATIONS

1) The ejection spring force is often much less than the payload weight. Installing a removable handle to the payload's +Z face aides vertical installation of the payload into the ASD.
2) When deploying horizontally in 1g the payload will fall during ejection. This will damage the payload's tabs as high forces are created near end of travel due to reaction of gravity induced moments. To avoid damage either guide the payload on rollers (conveyor) or prematurely stop it >3 inches early and then remove by hand.
3) The ASD has numerous .190-32 UNF threaded holes and thru holes on the exterior surface that can be used to attach auxiliary features. They can also be used to attach custom or COTS lifting hardware.

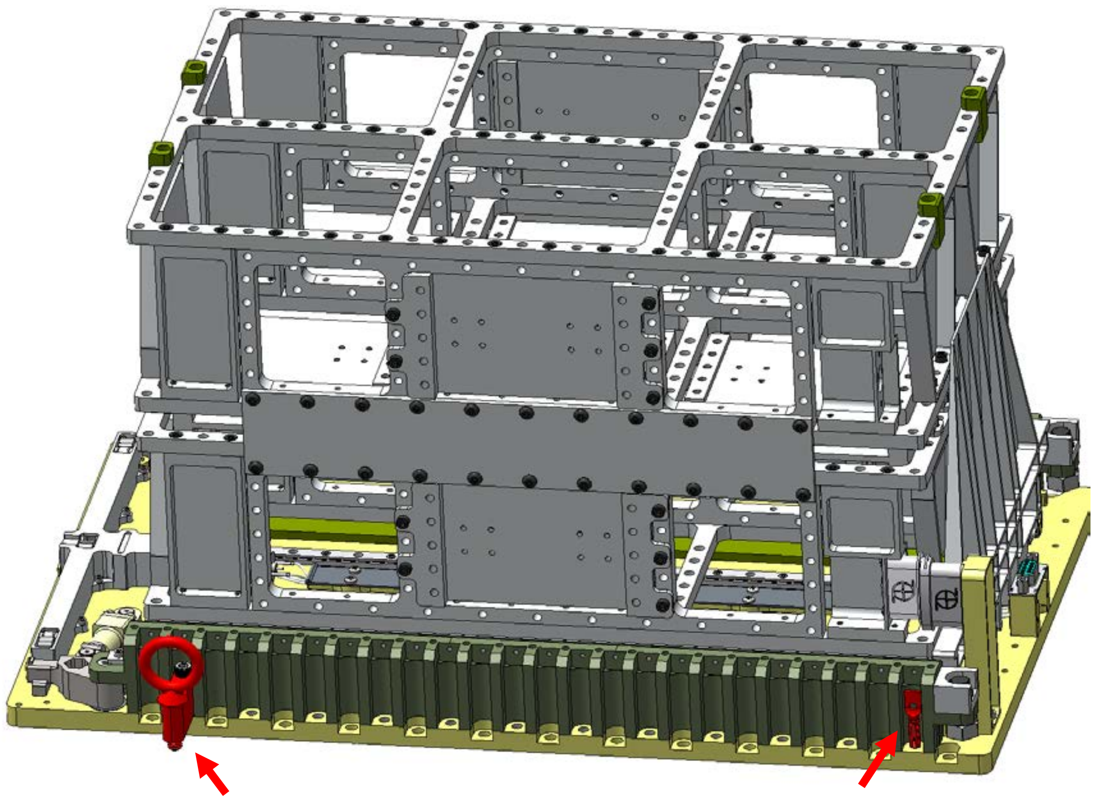


Figure 23-1: 12U ASD with various examples of eyebolts for lifting

24. CAD AND FINITE ELEMENT MODELS

Simplified CAD models of the ASD, in STEP format, are available at rocketlabusa.com/space-systems/separation-systems/. Finite element models (FEMs) are available by contacting psc.info@rocketlabusa.com.

25. REFERENCES

1 Hevner, Ryan; Holemans, Walter, "An Advanced Standard for CubeSats", Paper SSC11-II-3, *25th Annual AIAA/USU Conference on Small Satellites*, Logan, UT, August 2011.

2 Holemans, Walter; Moore, Gilbert; Kang, Jin, "Counting Down to the Launch of POPACS", Paper SSC12-X-3, *26th Annual AIAA/USU Conference on Small Satellites*, Logan, UT, August 2012.

3 *2004630 ASD Payload Specification Addendum*, Planetary Systems Corp by Rocket Lab., Silver Spring, MD, September 2024.

4 *Separation Connector Data Sheet*, 2001025 Rev C, Planetary Systems Corp, Silver Spring, MD, July 2013.

5 *CubeSat Design Specification*, Rev 12, California Polytechnic State University, CA, Aug 2009.

6 Hevner, Ryan, "Lessons Learned Flight Validating an Innovative Canisterized Satellite Dispenser", Paper 978-1-4799-1622-1/14, *2014 IEEE Aerospace Conference*, Big Sky, MT, January 2014.

7 Clark, Pamela; Holemans, Walter; Bradley, Wes, "Lunar Water Distribution (LWaDi)-- a 6U Lunar Orbiting spacecraft", *11th Annual Summer CubeSat Developers' Workshop*, Logan, UT, 02-03 August 2014.

8 Azure, Floyd; Hevner, Ryan; Holemans, Walter; Moore, Gil; Williams, Ryan, "Lessons Learned Testing and Flying Canisterized Satellite Dispensers (CSD) for Space Science Missions", *3rd Annual Lunar Cubes Workshop,* Palo Alto, CA, 13-15 November 2013.

9 Azure, Floyd; Hevner, Ryan; Holemans, Walter; Kalman, Andrew; Ridenoure, Rex: Twiggs, Robert; Walkinshaw, Tom; Williams, Ryan, "Innovative Uses of The Canisterized Satellite Dispenser (CSD)", *11th Annual CubeSat Workshop*, San Luis Obispo, CA, 25 April 2014.

10 Hevner, Ryan; Holemans, Walter; Williams, Ryan, "Canisterized Satellite Dispenser (CSD) as a Standard for Integrating and Dispensing Hosted Payloads on Large Spacecraft and Launch Vehicles", *30th Space Symposium*, Colorado Springs, CO, 21 May 2014

11 Azure, Floyd; Hevner, Ryan; Holemans, Walter, "Lessons Learned Measuring 3U and 6U Payload Rotation and Velocity when Dispensed in Reduced Gravity Environment", *12th Annual CubeSat Workshop*, San Luis Obispo, CA, 21 April 2015.

12 Azure, Floyd; Hevner, Ryan; Holemans, Walter, "Methods to Predict Fatigue in CubeSat Structures and Mechanisms", *12th Annual Summer CubeSat Developers' Workshop*, Logan, UT, 08-09 August 2015.

13 Parkinson, Ron, "Properties and Applications of Electroless Nickel", Nickel Development Institute

26. ADDITIONAL INFORMATION

Verify this is the latest revision of the specification by visiting rocketlabusa.com/space-systems/separation-systems/. Please contact psc.info@rocketlabusa.com with questions or comments. Feedback is welcome in order to realize the full potential of this technology.

PSC-RL does not design or manufacture payloads.

27. REVISION HISTORY

Revision	Release Date
- (initial release)	24Sep2024