This is a standalone specification intended for payload designers. Planetary Systems Corporation does not design or manufacture payloads but can recommend vendors.

DESCRIPTION

These payloads are designed to be fully contained within a Canisterized Satellite Dispenser (CSD, canister or dispenser) during launch. A CSD encapsulates the payload during launch and dispenses it on orbit. CSDs reduce risk to the primary payload and therefore maximize potential launch opportunity. They also ease restrictions on payload materials and components. This specification currently encompasses four payload sizes, 3U, 6U, 12U and 27U.

The payloads incorporate two tabs running the length of the ejection axis. The CSD will grip these tabs, providing a secure, modelable, preloaded junction.

The payload may use the CSD to restrain deployables. The allowable contact zones are defined.

A payload can be built to this specification without knowledge of the specific dispenser within it will fly. Similarly, dispenser manufacturers will be ensured of compatibility with payloads that conform to this specification.

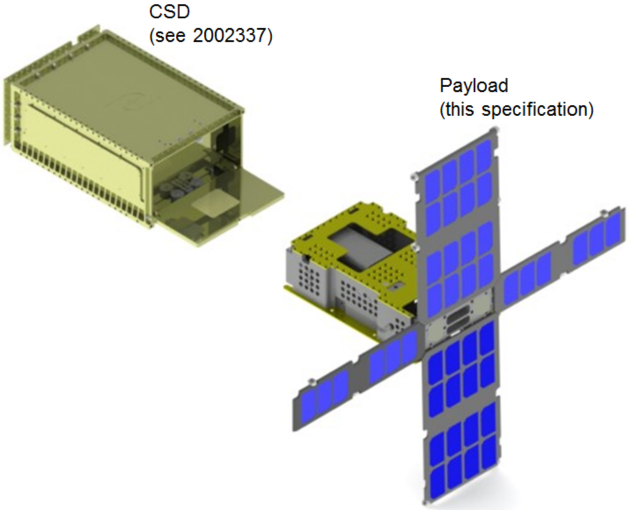


Figure 1: Payload Deploying from CSD

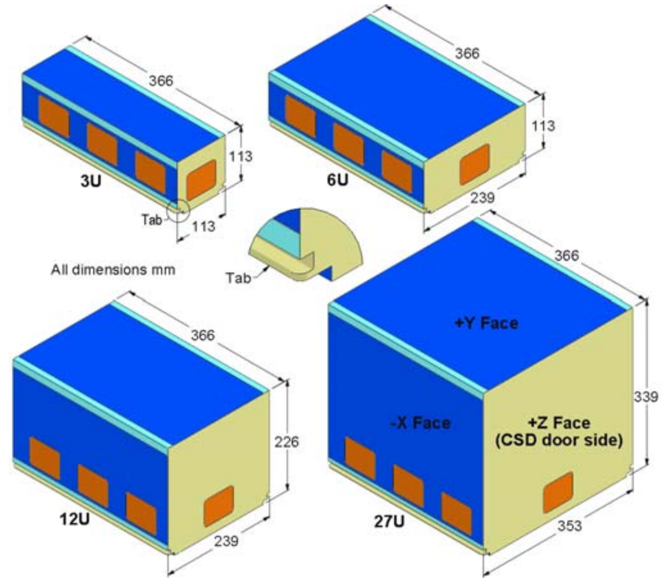


Figure 2: Payloads

CONTENTS

REVISION HISTORY

Revision	Release Date	Created By	Reviewed By
-	25-Jul-2012	RH	WH
A	06-Aug-2013	RH	WH

Changes from previous revision:

- *Parameters*: Changed EL, DC_-Y.
- *Common Requirements*: Note 1, changed tab material from 6061-T6 to 7075-T7 and changed surface finish from chem-film to hard anodize. Added several more notes.
- *Figure 5:* Changed Tab fillets. Increased payload volume near Tabs. Added missing dimensions.
- *Recommended Test & Integration*: Changed reference document.
- Added *Predicting Design Limit Loads.*
- Added *Separation Electrical Connector Attachment.*
- Added *Tips and Considerations.*
- Added *Anticipated Improvements.*

PARAMETERS

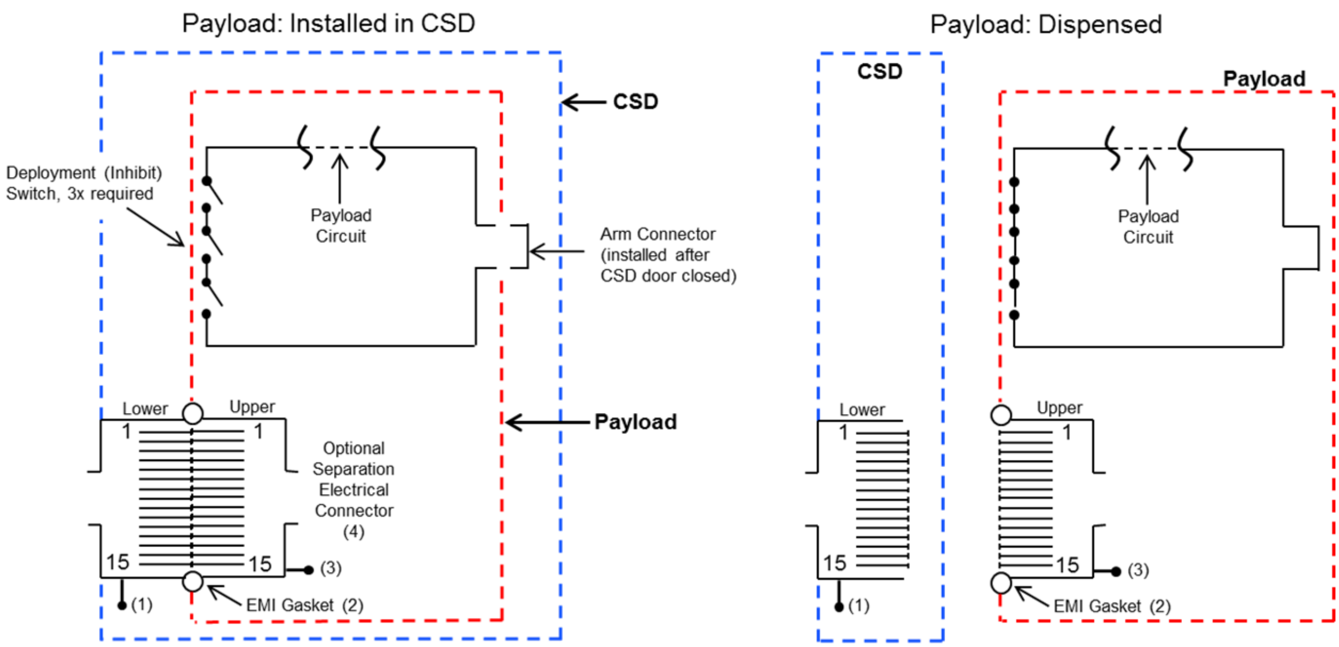
Symbol	Parameter	Conditions	Unit	3U		6U		12U		27U	
				Min	Max	Min	Max	Min	Max	Min	Max
M	Mass	At launch	kg [lb]	0	6.0 [13.2]	0	12.0 [26.4]	0	24.0 [52.9]	0	54.0 [119.0]
CM_X	Center of mass, X	Stowed in CSD	mm [in]	-20 [-0.79]	20 [0.79]	-40 [-1.57]	40 [1.57]	-40 [-1.57]	40 [1.57]	-60 [-2.36]	60 [2.36]
CM_Y	Center of mass, Y	Stowed in CSD	mm [in]	10 [0.39]	70 [2.76]	10 [0.39]	70 [2.76]	55 [2.17]	125 [4.92]	100 [3.94]	180 [7.09]
CM_Z	Center of mass, Z	Stowed in CSD	mm [in]	133 [5.24]	233 [9.17]	133 [5.24]	233 [9.17]	133 [5.24]	233 [9.17]	133 [5.24]	233 [9.17]
Depth	Maximum payload depth, +Y dimension		mm [in]	0	106.6 [4.197]	0	106.6 [4.197]	0	219.7 [8.650]	0	332.8 [13.102]
Width	Maximum payload width from origin, ±X dimension		mm [in]	0	56.55 [2.226]	0	119.7 [4.713]	0	119.7 [4.713]	0	176.25 [6.939]
Tab Width	±X dimension		mm [in]	112.7 [4.437]	113.1 [4.453]	239.0 [9.409]	239.4 [9.425]	239.0 [9.409]	239.4 [9.425]	352.1 [13.862]	352.5 [13.878]
Tab Length	+Z dimension		mm [in]	361 [14.21]	366 [14.41]	361 [14.21]	366 [14.41]	361 [14.21]	366 [14.41]	361 [14.21]	366 [14.41]
EP_Y	Ejection plate contact zone, +Y dimension from origin		mm [in]	-	100 [3.94]	-	100 [3.94]	-	213 [8.39]	-	326 [12.84]
DC_X1	Deployable contact zone with CSD, ±X face near +Y face		mm [in]	91.4 [3.598]	-	91.4 [3.598]	-	204.5 [8.051]	-	317.6 [12.504]	-
DC_X2	Deployable contact zone with CSD, ±X face near -Y face		mm [in]	-	20.3 [0.799]	-	20.3 [0.799]	-	20.3 [0.799]	-	20.3 [0.799]
DC_+Y	Deployable contact zone with CSD, +Y face (1)		mm [in]	43.85 [1.726]	-	107.0 [4.213]	-	107.0 [4.213]	-	163.55 [6.439]	-
DC_-Y	Deployable contact zone with CSD, -Y face (1)		mm [in]	31.2 [1.228]	-	94.3 [3.713]	-	94.3 [3.713]	-	150.9 [5.941]	-
F_{DS}	Force from deployment switches, summated, Z axis	When contacting CSD ejection plate	N	0	5.0	0	5.0	0	5.0	0	5.0
D_{DS}	Payload separation from ejection plate necessary to change deployment switch state, Z axis		mm [in]	1.3 [0.05]	12.7 [0.50]	1.3 [0.05]	12.7 [0.50]	1.3 [0.05]	12.7 [0.50]	1.3 [0.05]	12.7 [0.50]
F_{FD}	Friction force deployables impart on CSD walls during ejection	summated (all 4 sides)	N	0	2.0	0	2.0	0	2.0	0	4.0
F_{ND}	Normal force deployables impart on CSD walls during ejection	per wall	N	0	9.0	0	9.0	0	9.0	0	9.0
EL (2)	External load on payload, any direction	supported solely by tabs	g	0	85	0	60	0	43	0	30
TML	Total Mass Loss	Per ASTM E 595-77/84/90	%	0	1.0	0	1.0	0	1.0	0	1.0
CVCM	Collected Volatile Condensable Material	Per ASTM E 595-77/84/90	%	0	0.1	0	0.1	0	0.1	0	0.1
DP	CSD de-pressurization rate	During launch	psi/ sec	0	0.5	0	0.5	0	0.5	0	0.5
D_X	Location of optional separation electrical connector, +X dimension		mm [in]	40.80 [1.606]	41.06 [1.616]	103.96 [4.093]	104.22 [4.103]	103.96 [4.093]	104.22 [4.103]	160.50 [6.319]	160.76 [6.329]

(1) Some contact zones are not present on the 3U. Refer to Figure 5 for locations.
(2) Actual loads dependent on specific dynamic response of payload. See *Predicting Design Limit Loads*.

COMMON REQUIREMENTS

1. Tabs shall be 100% continuous 7075-T7 aluminum alloy. Other aluminum alloys of equivalent or stronger yield strength may be substituted. Tabs shall also be Hard Anodized per MIL-A-8625, Type III, Class 1. All dimensions apply AFTER hard anodize. Note that Anodize thickness refers to the total thickness (i.e. 0.001 total thickness = 0.0005 penetration + 0.0005 build-up). Max surface roughness of Tabs = 0.8 µm Ra. Contact CSD manufacturer if multi-piece payload or tab discontinuities are desired.
2. Tabs shall run the entire length of the payload. No portion of the payload may extend beyond the tabs in the +Z or –Z directions.
3. The structure comprising the –Z face (face that contacts CSD ejection plate) may be a uniform surface or consist of discrete contact points. The discrete contact points shall be located such that they envelope the payload’s C.M. and the three deployment switches.
4. Deployment (inhibit) switches shall reside in specified zone on -Z face. Switches will activate upon contact with CSD ejection plate.
5. Safe/Arm plug, if necessary, shall reside in specified zone on +Z (preferred), +X, or -X face.
6. All non-constrained deployables shall be hinged near the +Z face to minimize snagging hazards during ejection. The deployables shall be tested with the CSD prior to flight.
7. -Z face of payload shall withstand a 400 N force imparted by CSD ejection plate during launch due to vibration.
8. Electrical grounding to the CSD shall occur through the Separation Electrical Connector shell and/or contact with the ejector plate via the –Z face. Both areas may go intermittent during launch so plan accordingly.
9. The two tabs and the structure that contacts the CSD ejection plate on the –Z face are the only required features of the payload. The rest of the payload may be any shape that fits within the max dynamic envelope.
10. No debris shall be generated that will inhibit separation.
11. A fit check with a CSD shall be performed at the earliest possible time.

ELECTRICAL SCHEMATIC



1) The metal shell conducts to the CSD via conductive surface treatments.
2) Required to assure electrical continuity between shells. Retained by Upper.
3) The metal shell conducts to the Payload via conductive surface treatments.
4) Optional connector is an in-flight disconnect. Produced by Planetary Systems Corp. See document 2001025 at www.planetarysys.com.

Figure 3: Electrical Schematic

DIMENSIONS

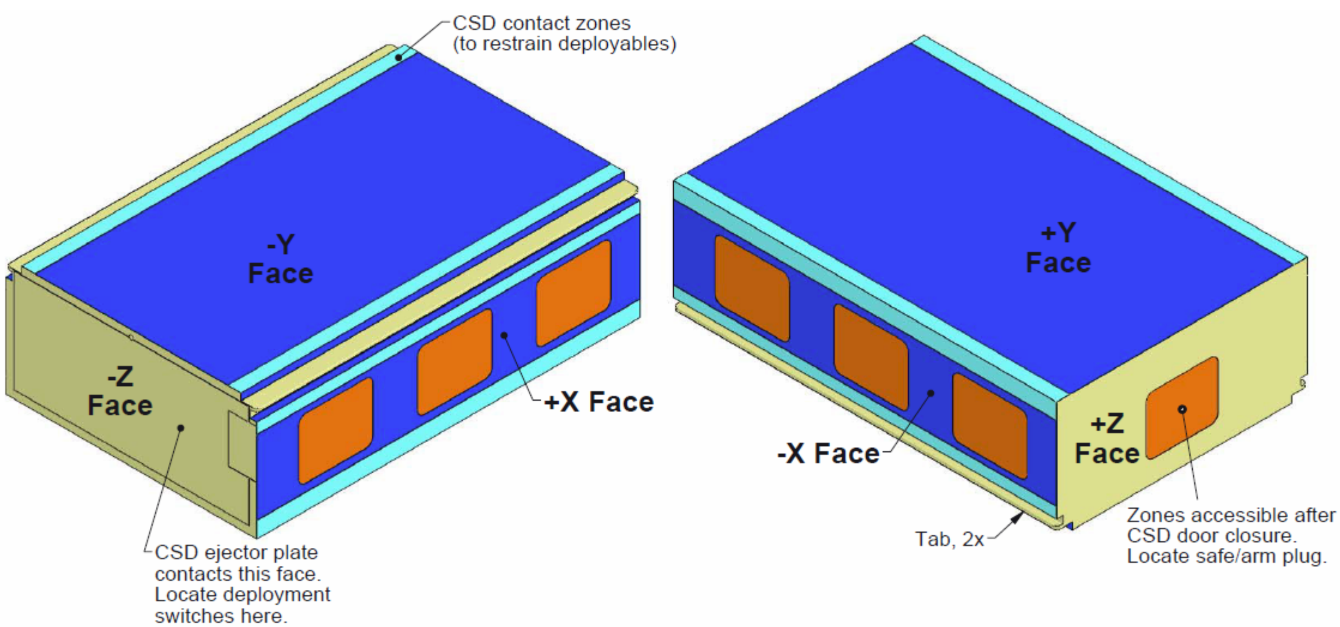
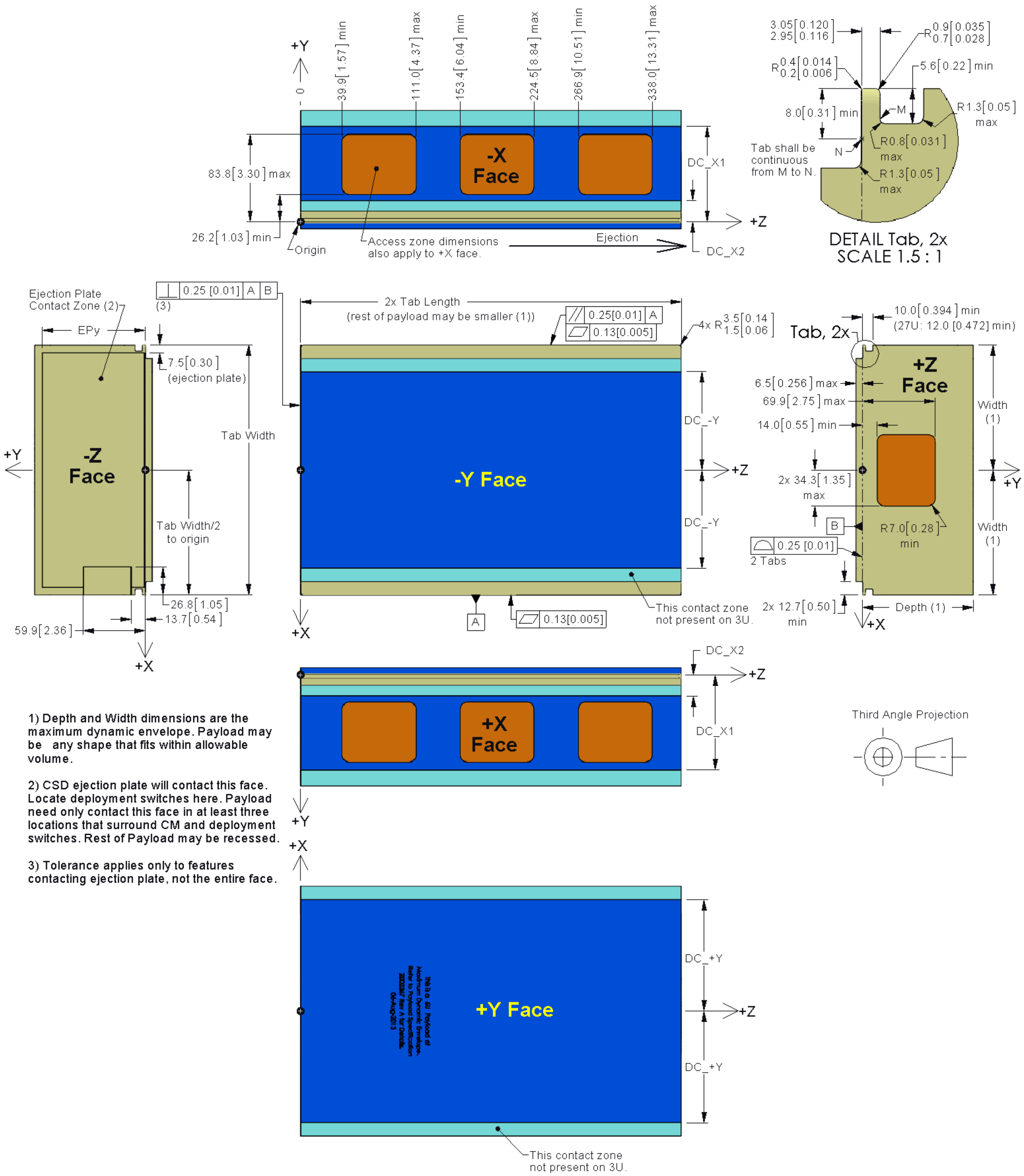


Figure 4: Payload Features (6U Shown)



1) Depth and Width dimensions are the maximum dynamic envelope. Payload may be any shape that fits within allowable volume.

2) CSD ejection plate will contact this face. Locate deployment switches here. Payload need only contact this face in at least three locations that surround CM and deployment switches. Rest of Payload may be recessed.

3) Tolerance applies only to features contacting ejection plate, not the entire face.

Figure 5: Payload Dimensions, mm [in]

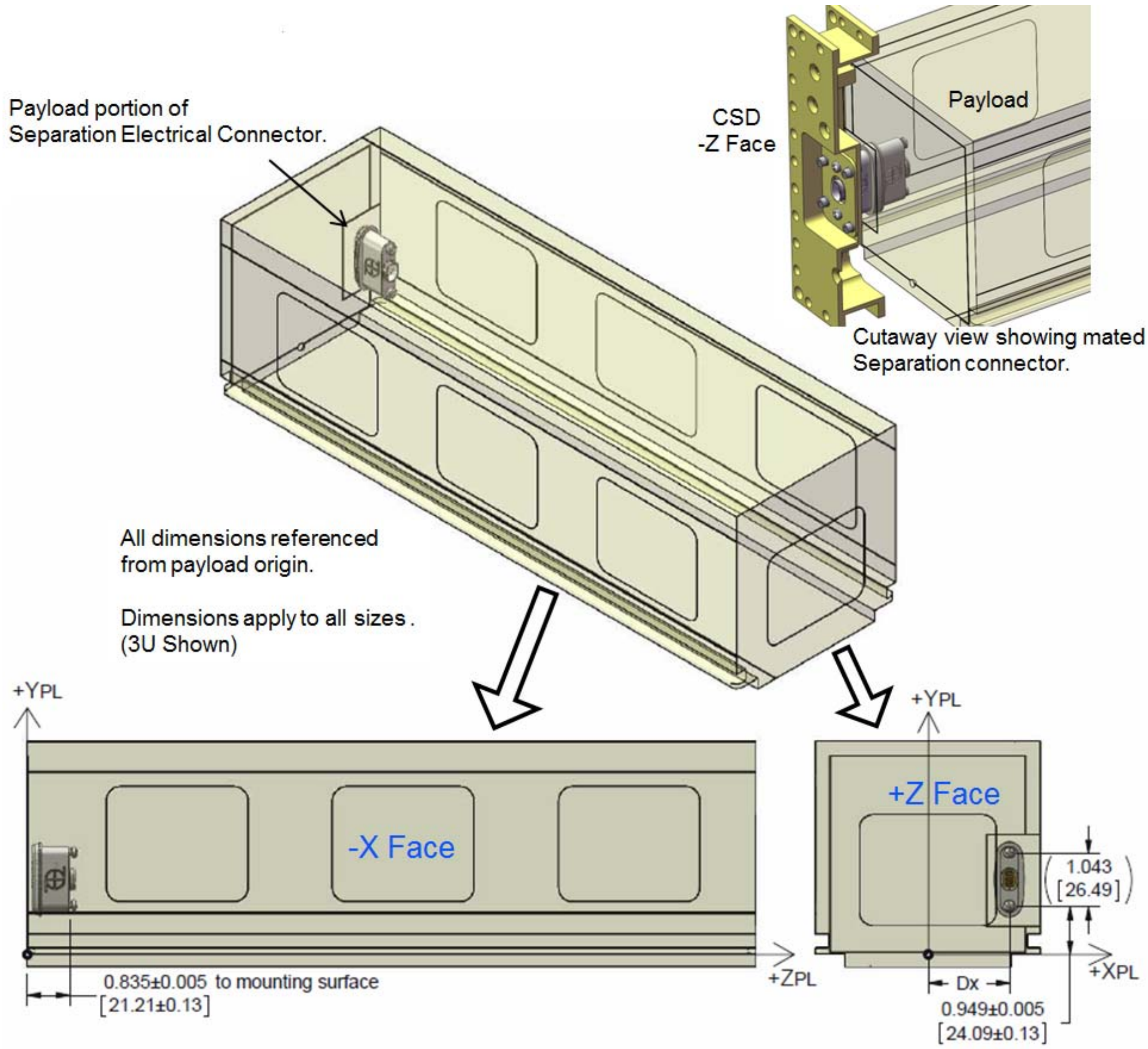
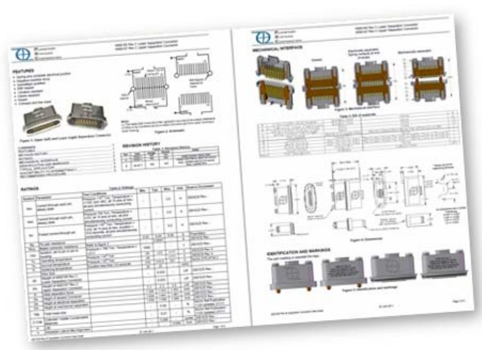


Figure 6: Location of Optional Separation Electrical Connector (In-Flight Disconnect)

For more information on the Separation Electrical Connector see PSC document 2001025 Separation Connector Data Sheet.



BENEFIT OF TABS

Preloading the payload to the CSD 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.

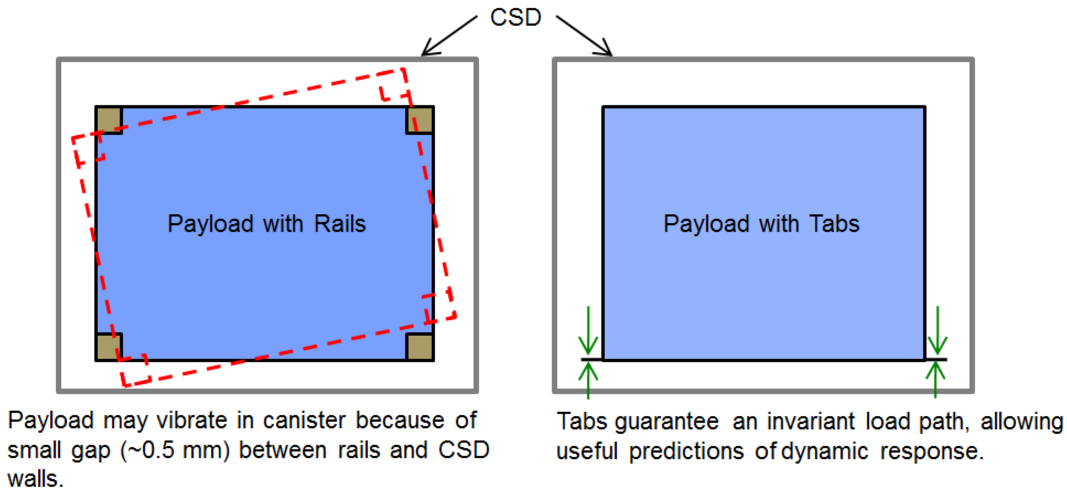


Figure 7: Tabs vs. Rails

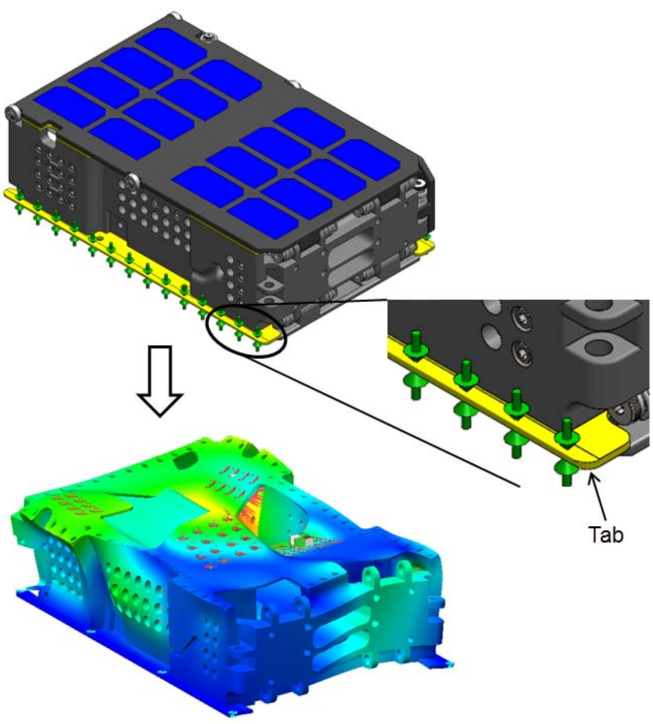


Figure 8: Prediction of 6U Dynamic Response

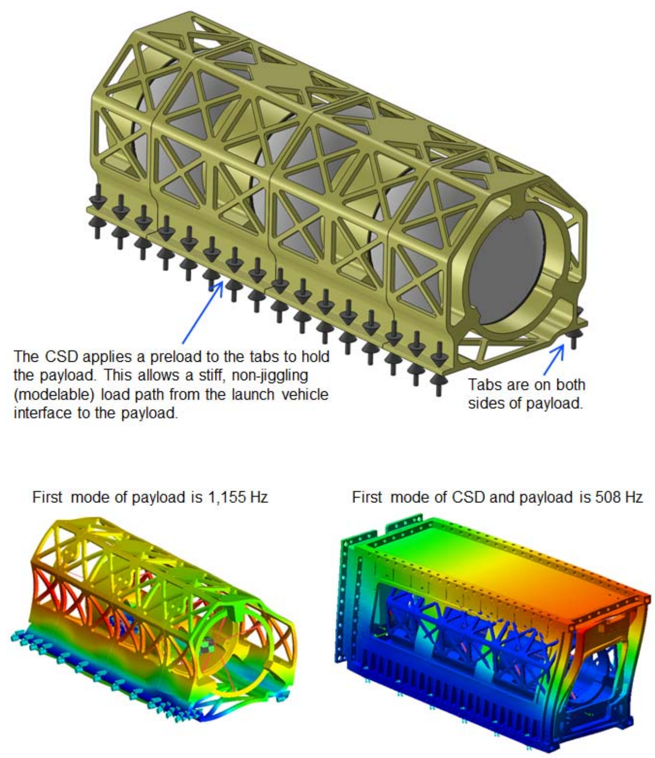
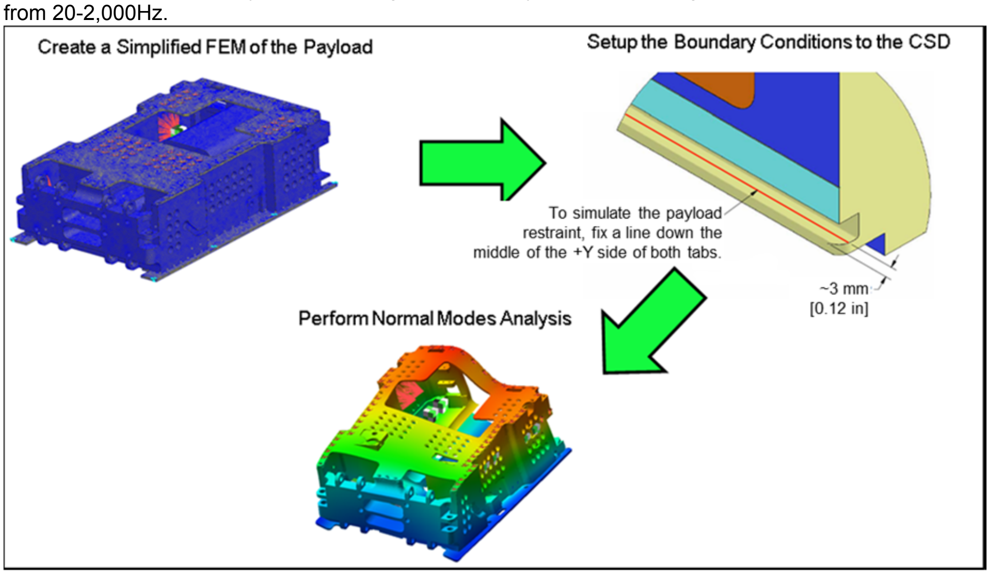


Figure 9: Prediction of 3U Dynamic Response

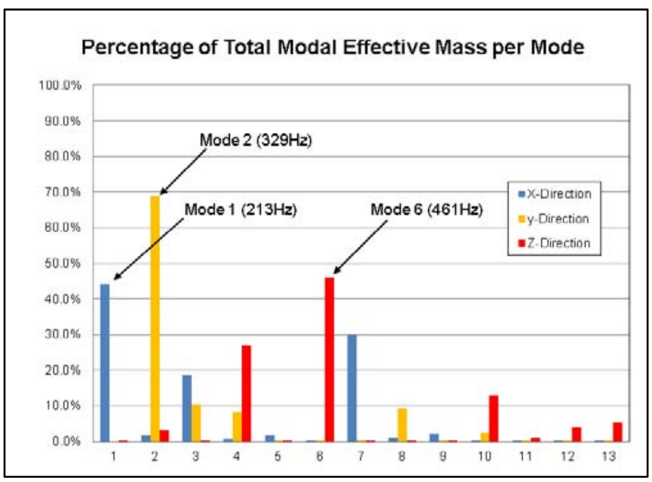
PREDICTING DESIGN LIMIT LOADS

The maximum structural loading typically results from the dynamic response during random vibration testing and/or shock testing. These loads are dependent on the mass, stiffness, and dampening properties unique to each payload. The method below provides a rudimentary means of predicting these loads.

1) Create a simplified model of the payload consisting of the primary structure and significant components for a Normal Modes Analysis from 20-2,000Hz.



2) Identify the dominant resonant frequencies and mode shapes for each orthogonal direction (X, Y, Z). These modes can be identified as having the highest percentage of Modal Effective Mass relative to all modes modeled within the frequency bandwidth stated above.

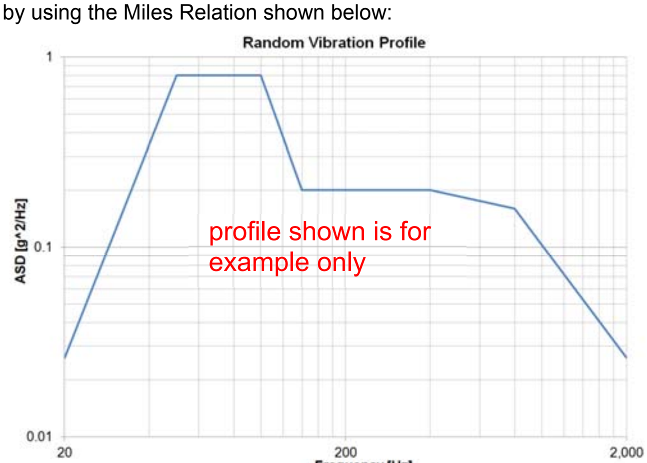


3) The response for a random vibration profile can be predicted by using the Miles Relation shown below:

$$\mathbf{Grms} = \sqrt{\mathbf{0.5 * \pi * f_n * Q * ASD}}$$

Grms [g] = 1σ acceleration response
f_n [Hz] = natural frequency (frequency of selected mode)
Q [-] = $\frac{1}{2*\zeta}$ = quality factor (use 10 as an estimate if unsure)
ζ [-] = critical dampening
ASD [g^2/Hz] = input acceleration spectral density at the desired frequency f_n

Assume the peak response is 3σ = 3*G_{rms}



CSD CONSTRAINED DEPLOYABLES

The payload may use the CSD to constrain deployables in designated areas as defined in the Parameters and Dimensions sections. At these designated contact zones the CSD interior surface shall be 1.3mm [0.05 in] from the maximum allowable dynamic envelope of the payload defined as 'Width' and 'Depth'. Only the portion of the payload directly contacting the CSD Walls (bearing, etc.) may exceed the payload dynamic envelope.

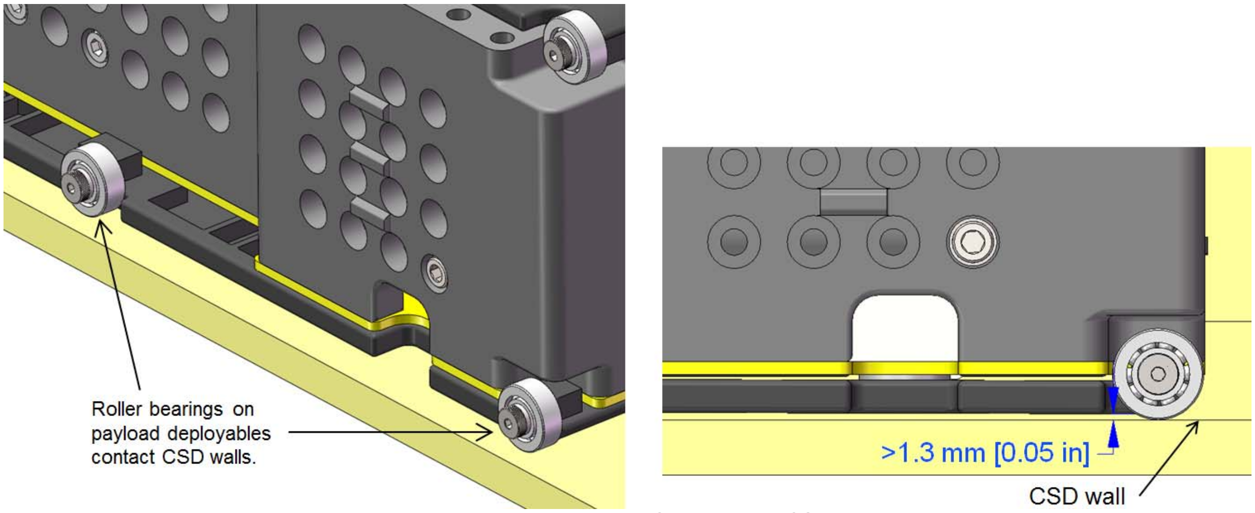


Figure 10: Deployable Contact with CSD

It is recommended that the feature holding the roller bearings be compliant and lightly preload the bearings against the CSD wall. This will constrain the deployables and minimize rattling during launch.

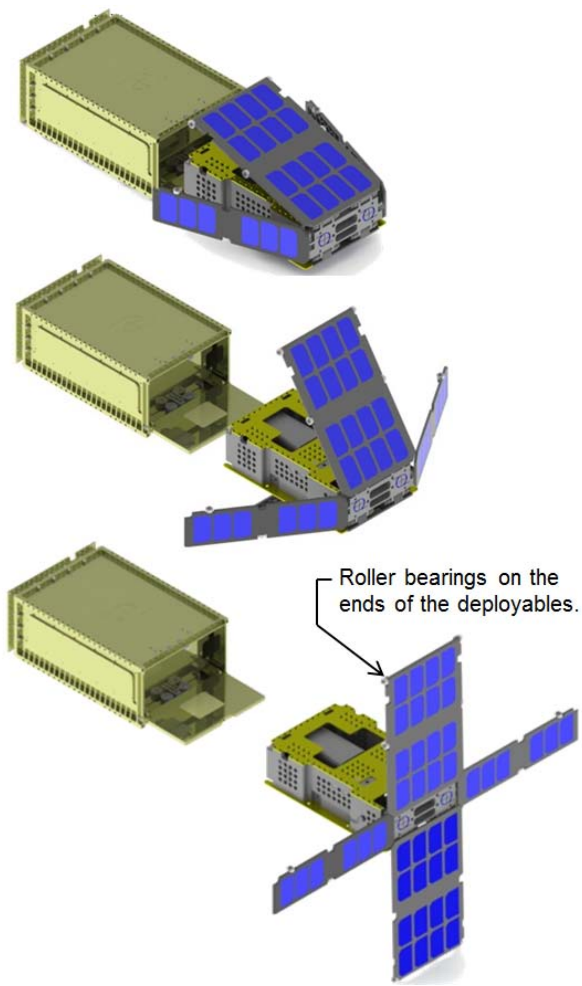


Figure 11: Payload Dispensing from CSD

TYPICAL APPLICATIONS

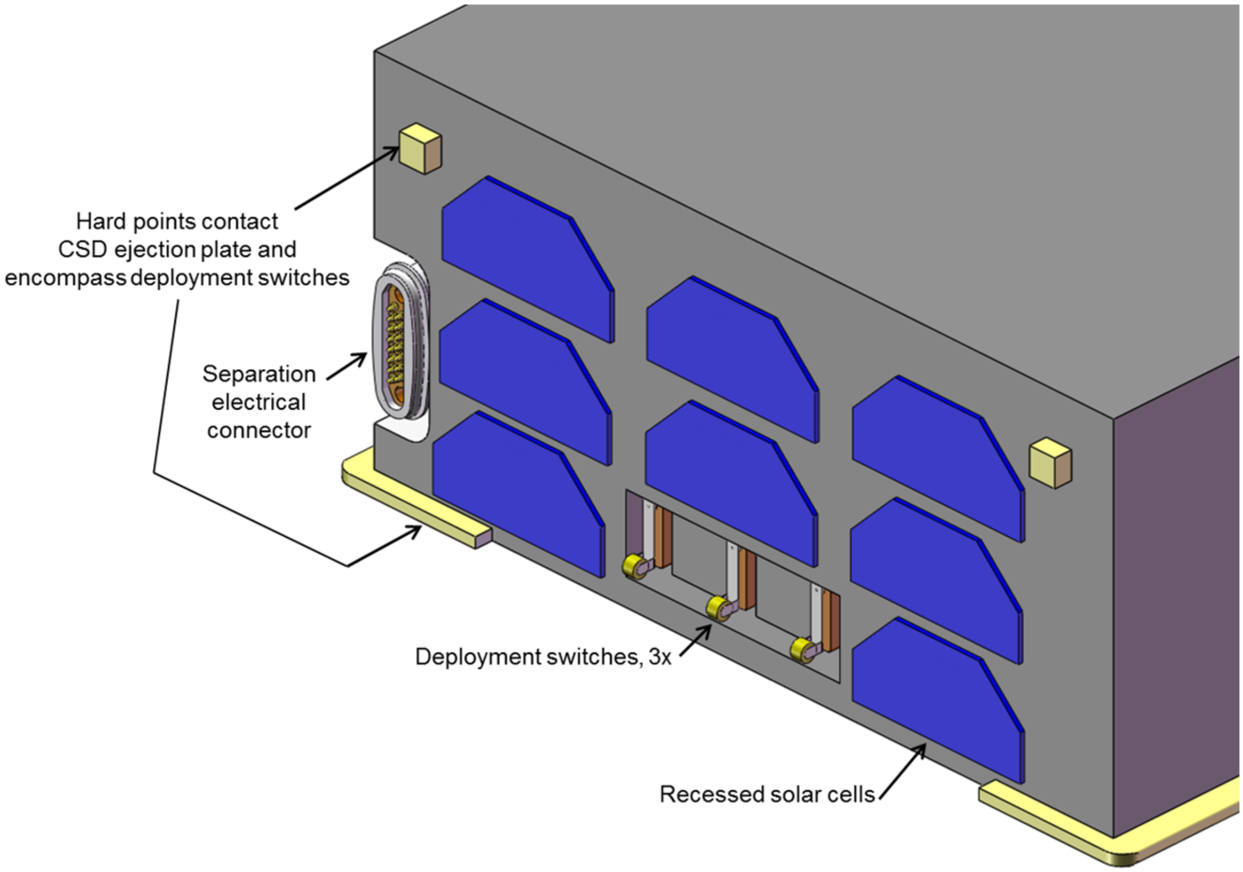


Figure 12: Example of Payload –Z Face

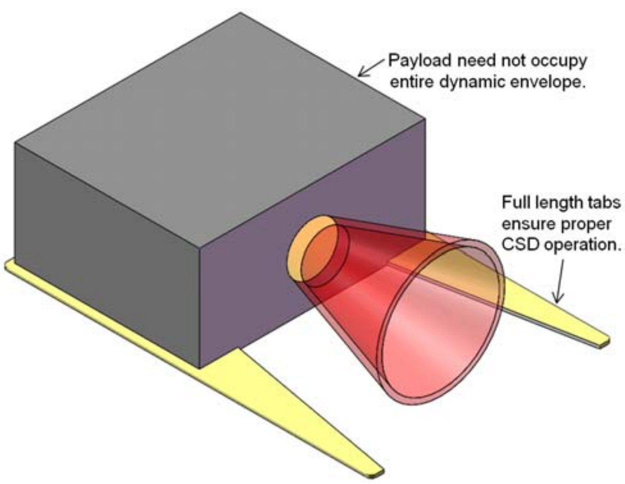


Figure 13: 6U Payload Example

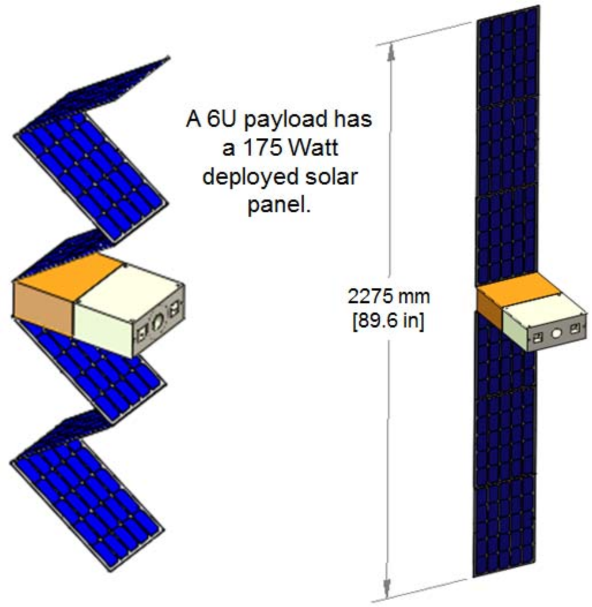


Figure 14: Solar Array Potential

SEPARATION ELECTRICAL CONNECTOR ATTACHMENT

The figures below show a typical means of mounting the separation electrical connector. It only need be mounted via the flat face that contains the two #4 screws. Additional support around the side of the connector shell is unnecessary. An open cutout in the mounting bracket is beneficial as it allows the connector to be removed after the harness is wired.

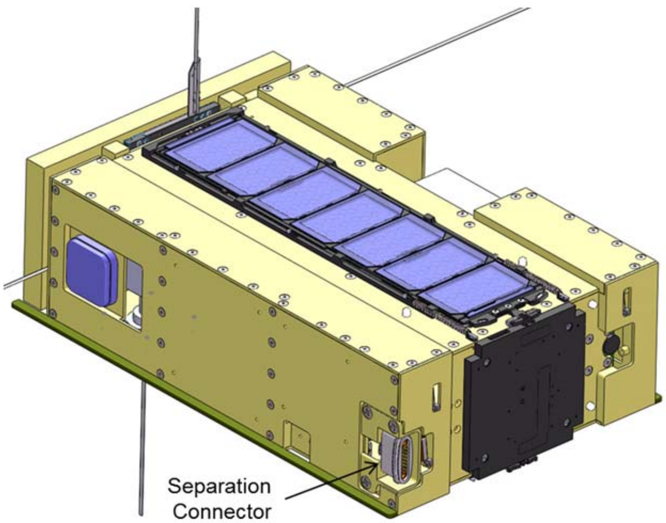


Figure 15: Separation Electrical Connector on Payload

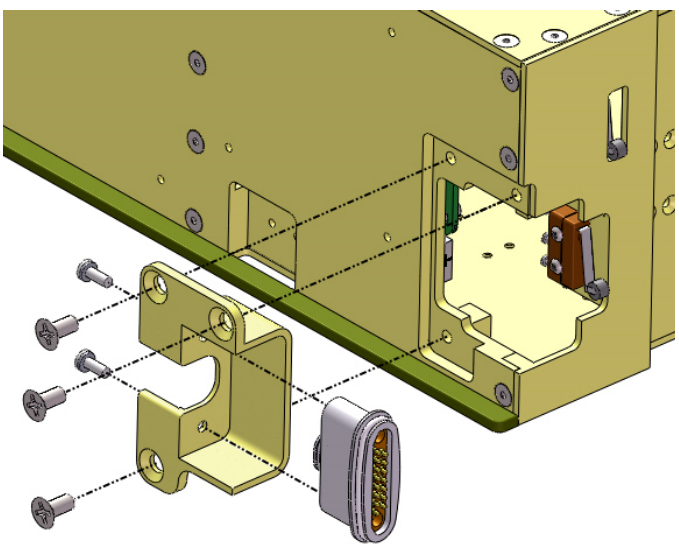
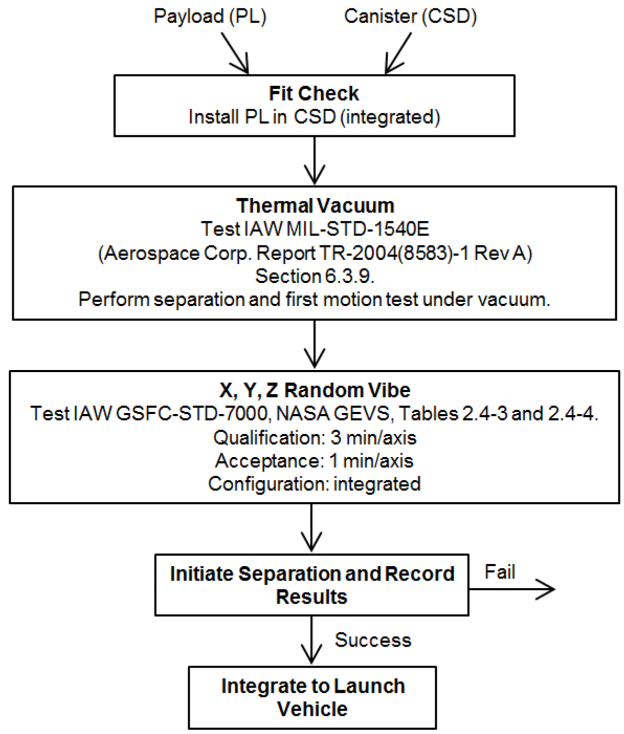


Figure 16: Separation Electrical Connector Mounting Example

RECOMMENDED TEST AND INTEGRATION

Test levels are for launch environment, not necessarily on-orbit.



TIPS AND CONSIDERATIONS

1. Electrical Wiring: Include the electrical harness in the CAD model. Ensure there are sufficient routing options, strain relief and clearances. Also, the harness can consume a significant portion of the allowable payload mass.
2. Installation in CSD: The payload may end up being installed vertically in the CSD (gravity in –Z). Add a removable handle on the +Z face to aide installation.
3. CSD Ejection: When possible, verify complete ejection of the payload from the CSD during testing.
4. Machining Tolerances: Ensure all part tolerances are such that the tabs will meet the required flatness and profile requirements even after the structure is assembled.

CAD MODELS

Solid models of the payloads at their maximum dynamic envelope and detailed models of example payloads are available for download at www.planetarysys.com.

ADDITIONAL INFORMATION

Verify this is the latest revision of the specification by visiting www.planetarysys.com.

Please contact info@planetarysystemscorp.com with questions or comments. Feedback is welcome in order to realize the full potential of this technology.

ANTICIPATED IMPROVEMENTS

The following changes may be implemented in the next revision.

1. Increase Depth (+Y height) of 3U payload to enable conversion of existing CubeSat structures.
2. Allow deployment switches on additional faces. This would benefit modular payloads.
3. Allow non-continuous tabs.
4. Allow tabs to be made from 6061-T6 and similar strength aluminum.

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