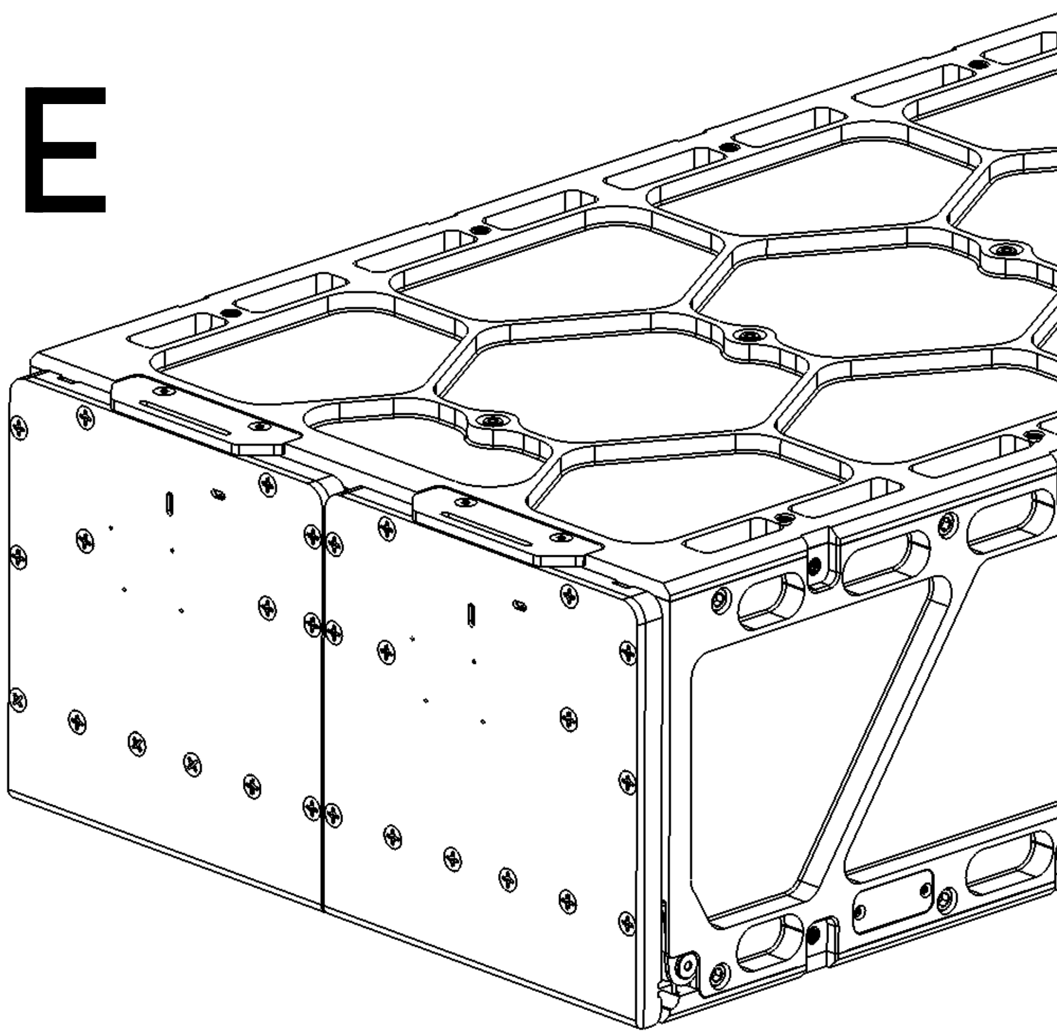
XCD-3U/6U USER'S GUIDE

XTD-100084
Revision 1.0



REVISIONS

Rev	By	Date	Description
1.0	TH & AK	1/20/23	Initial Release

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ADDITIONAL DOCUMENTATION

Document Number	Description
N/A	Launch Isolation Vibration for CubeSat Dispenser
XTD-100XXX	LRM-65 ICD
XTD-100XXX	XCD 6U to 3U Conversion Procedure

ACRONYM DEFINITIONS

Acronym	Description
XCD	XTERRA CubeSat Dispenser
RBF	Remove Before Flight
BOM	Bill of Materials
TBD	To be determined / Work in progress

NOTE: This document is a work in progress and additional information will be added as it becomes available. Feedback sent to the authors is welcomed.

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1. INTRODUCTION

Designed and built on over a decade of space systems deployment expertise with over 300 satellite deployments on legacy systems, the XTERRA CubeSat Dispenser (XCD), builds upon this experience to create a new generation of American made CubeSat dispensers. With our patent-pending modular approach to CubeSat dispenser design, the XCD is designed to vastly reduce costs, cut lead times, and remove pain points from traditional CubeSat dispenser offerings.

Users of CubeSat dispensers, often find they need to access particular areas of a satellite once its integrated. This is traditionally achieved using access panels, however, these access panels are often insufficient to provide access to the locations users need to access on the satellite, such as for RBF pins removal. The XCD alleviates this issue by giving you the most access to your satellite (~70% of the exterior on a 6U) of any deployer through our unique clamshell design.

Additionally, user's often need to purchase 1U through 3U, and 6U form factor dispensers separately to cover potential dimensional or manifesting changes that can occur prior to flight. This problem is exacerbated by the often-tight schedules typical of launch date driven projects which may result in a change to the manifest last second. With the XCD, this is no longer a problem since the user can convert the dispenser between 6U and 3U satellites on their own in approximately an hour. No more waiting months for a vendor to get a legacy dual or quad pack converted. Additionally, our novel spacer system allows us to rapidly produce spacers for custom length satellite you may want to fly, further decreasing operational complexity and lead time.

The XCD is rapidly resettable, offers exceptional access to the satellite, allows the users to convert between different form factors on their own, all at a fraction of the cost and with significantly reduced lead times. No dispenser on the market rivals the flexibility or convenience of the XCD.

2. SYSTEM OVERVIEW

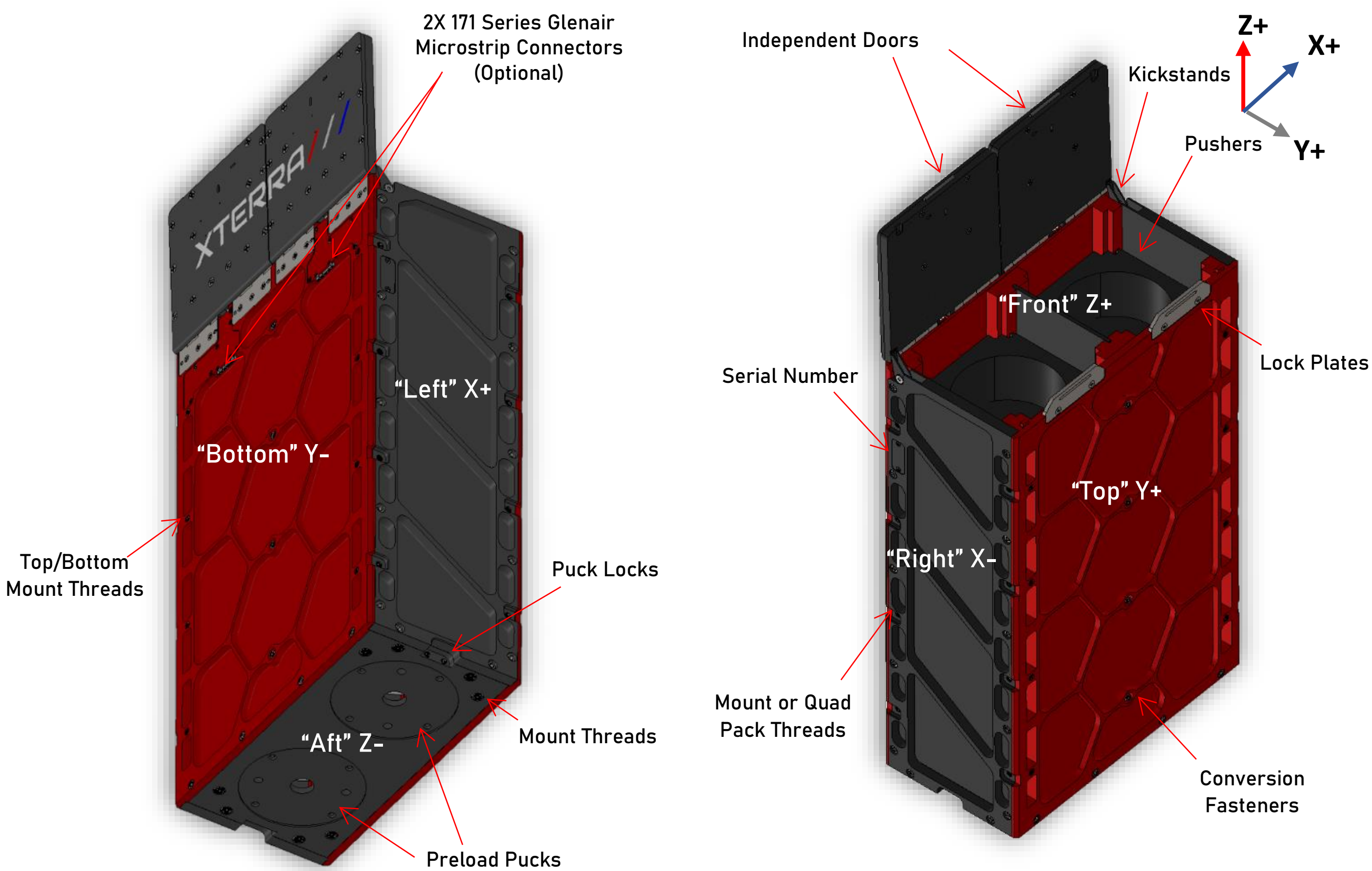

Figure 1: XCD-3U/6U Overview

3. UNIQUE DISPENSER FEATURES

3.1 PUCK PRELOAD & SPACERS

Custom satellite spacers to accommodate partially loaded dispensers or non-standard satellite have been radically simplified using the XCD puck design. This spacer design allows for a very short lead time spacer at a fraction of the cost of a traditional solution. Details in section 5.2.

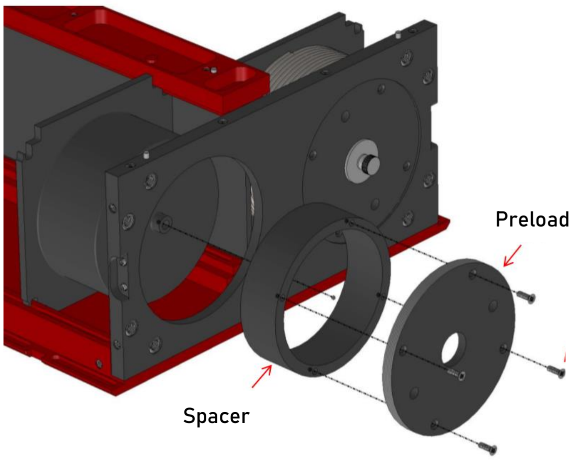

Figure 2: Puck and Spacer Details

3.2 RAPIDLY RESETTABLE

The ability to reset rapidly is key to many customer needs. Each independent door is reset using provided tools with no special training required. Details TBD.

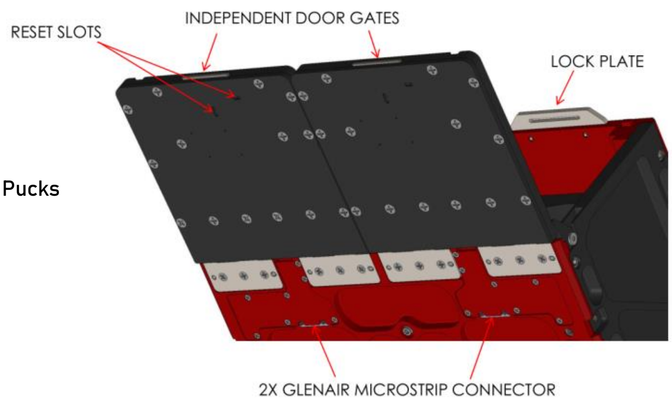

Figure 3: Independent Doors and Connector Details

3.3 QUAD PACK CONFIGURATION

Integrated features allow two dispensers to be fastened together with optional joiner plates and fasteners to create the popular "quad pack" configuration.

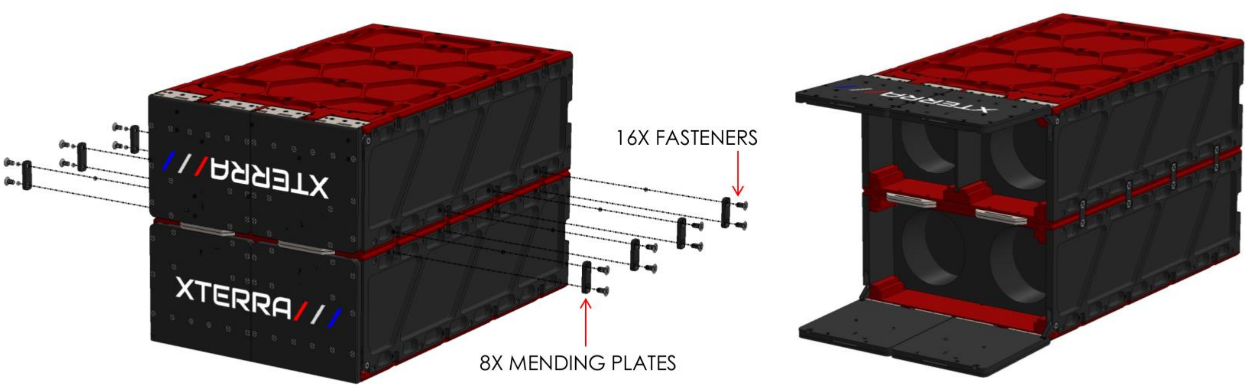

Figure 4: Quad Pack with mending plates and fasteners

3.4 CLAMSHELL & 3U/6U CONVERSION

Users shouldn't have to order a brand-new dispenser if their customers have different form factors or different satellite lengths. Nor should they need to wait months to convert an existing dispenser. Time is crucial. With that in mind converting the XCD takes only hours with no special training and can support the industry standard 366mm maximum length cubesat in either 3U or 6U form factors. This feature also allows a satellite to be fully integrated with the clamshell portion of the dispenser removed for maximum surface exposure before final integration. See 5.6 for further detail. Additional guidance on conversion is available upon request.

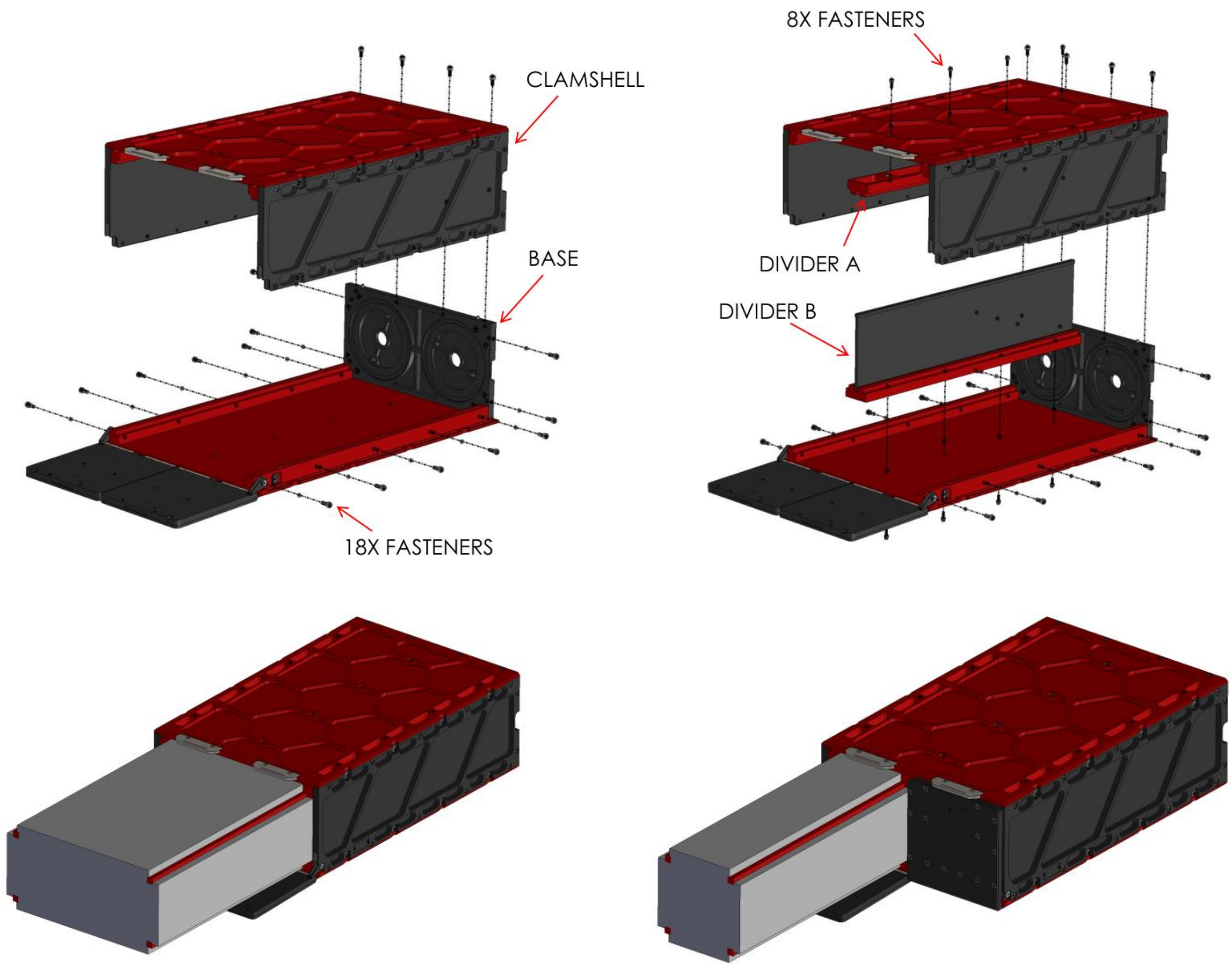

Figure 5: Configuration Change

4. SATELLITE FUNDAMENTALS

4.1 FORMATS AND DIMENSIONS

The XCD is designed to house up to 6U of payloads in either configuration up to 3U in length. The 6U config houses up to a single 6U while the 3U config houses up to two 3U payloads. The 3U config can have multiple 1U or 2U satellites stacked at any length if the stack height does not exceed the maximum allowable length per tube or impede deployment. Dimensions are in [mm] and in.

Satellite Format	3U	6U
Mass (kg)	6.5 Max	13 Max
Rail to Rail Length (mm)	366 Max	366 Max

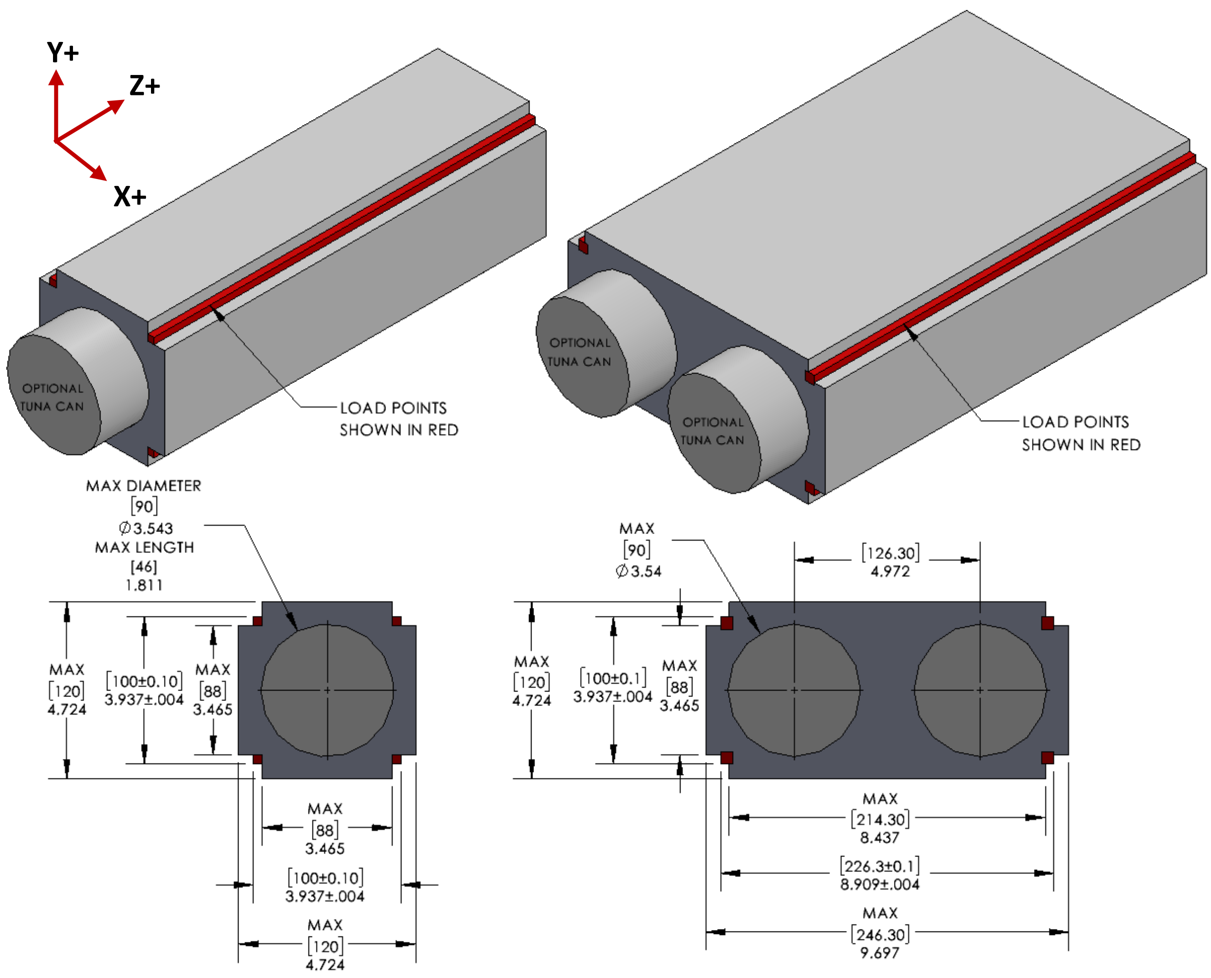

Figure 6: Satellite Profile and Mass

4.2 RAILS

CubeSats must have 4X rails along the Z axis as shown in Figure 7 in red. These will directly interface with the dispenser rails during launch and will be the guiding surface during deployment. Each CubeSat rail shall have a minimum width in the X and Y of 6mm. Noncontinuous rails are acceptable, however each CubeSat rail must have a minimum length of 25.4mm from the Z+ and Z- faces to be able to take launch loads and ensure a smooth deployment. Exceptions can be made, contact Xterra if needed.

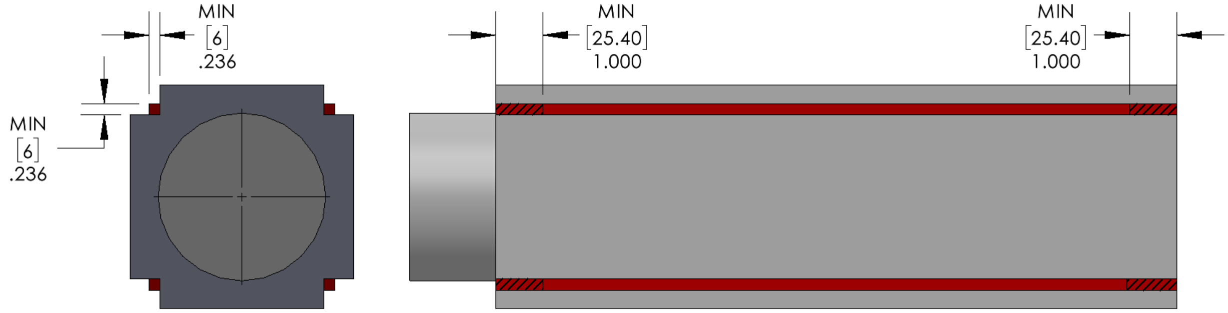

Figure 7: Rail profile

4.3 DEPLOYABLE APPENDAGES

It is recommended any deployable satellite appendages are constrained through launch and at deployment. Appendages can be constrained by the dispenser, but fit checks are highly recommended to ensure a reliable deployment.

4.4 INHIBIT/ACTIVATION SWITCHES

Switches that activate the satellite after deployment may be positioned anywhere compression is guaranteed between the satellite and the dispenser. Typically, these are switches on the ends of the rails in the Z axis or along sides of the rails in the X or Y axis. They can also be located at the front or rear face of the satellite if this face is colinear with the doors or pusher plate. A simplified dispenser CAD model can be provided for a digital fit check to ensure that switches will compress as desired.

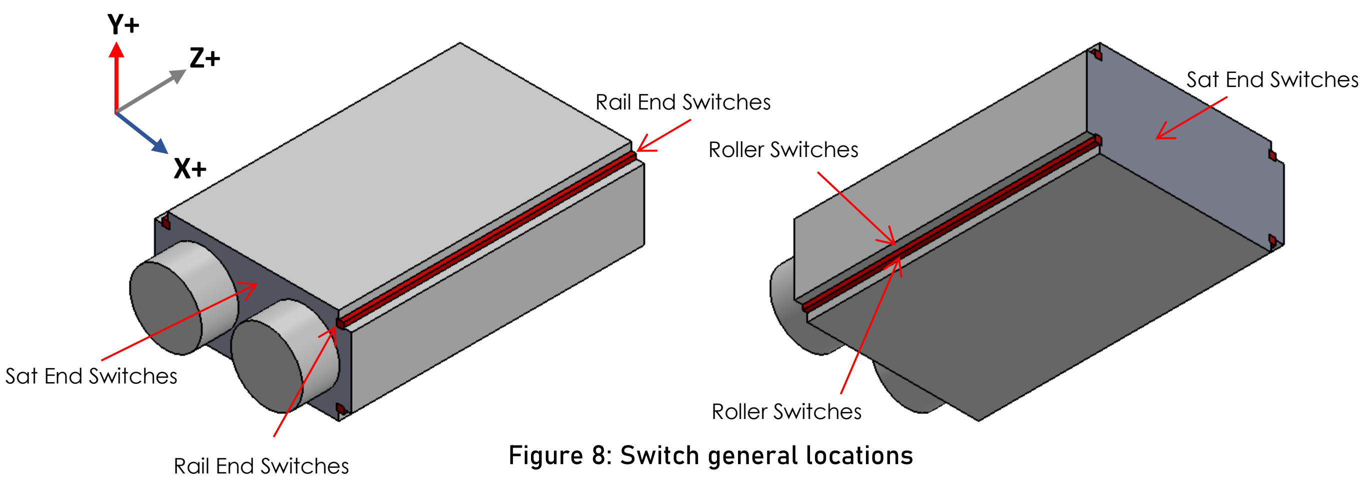

Figure 8: Switch general locations

5. DISPENSER FUNDAMENTALS

5.1 MASS, DIMENSIONS, AND MOUNTING INTERFACES

Dimensions for the dispenser in 6U or 3U configuration are the same. Top Y+ face and bottom Y- face threaded features are mirrored on both sides. Right X- face and left X+ face threaded features are mirrored on both sides. Embedded connectors are on the Y- face of the dispenser as shown.

Configuration	3U	6U
Empty Dispenser Mass (kg)	5.4	4.7

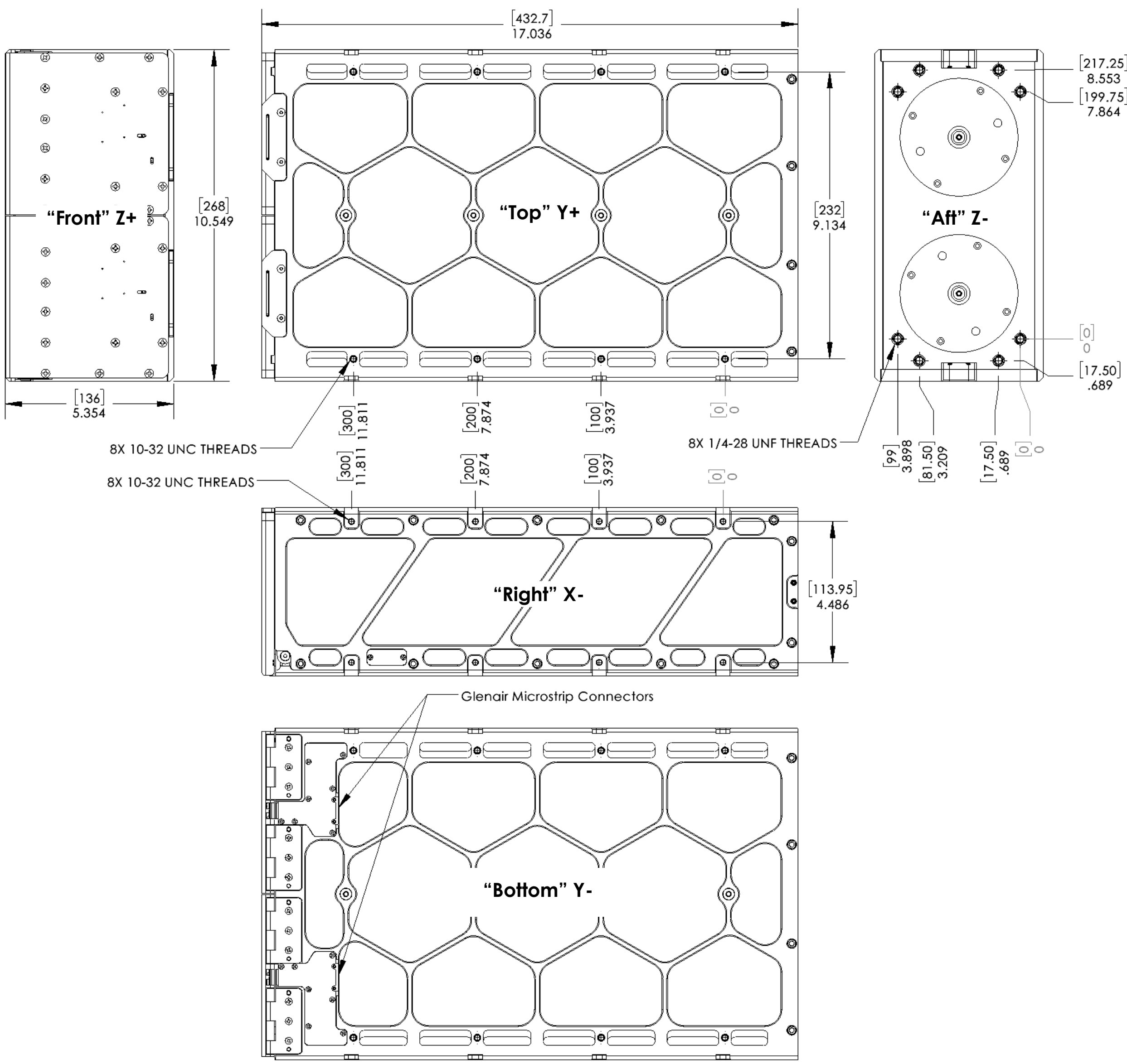

Figure 9: Dispenser profile and mass

5.2 LOADING BOLTS AND PUCK PRELOADING

With a payload installed, the threaded puck is the mechanism by which preload is applied along the deployment axis. By clamping the satellite on the Z- and Z+ face rather than along the rails, the satellite sees less energy transferred to the satellite during exposure to the flight environment and greatly improves the rail to satellite interface, decreasing the risk of hanging/catching on rails often associated with systems that use "dynamic rails". This CalPoly presentation explains why this is and shows evidence for less energy being transferred to the satellite with this approach. Additionally, the deployer may be mounted on dampers to further decrease the energy transferred to the satellite.

Once the payload is inside the satellite, the puck is torqued to TBD using a spanner and torque wrench. Once the puck is torqued, it is locked with two set screws as shown in Figure 10 which are torqued to 3in-lb each. The puck should only be completely removed if the need arises to install a spacer (see section 5.6). Whenever a satellite is not in a tube a loading bolt should be used to restrain the pusher plate as shown in Figure 11.

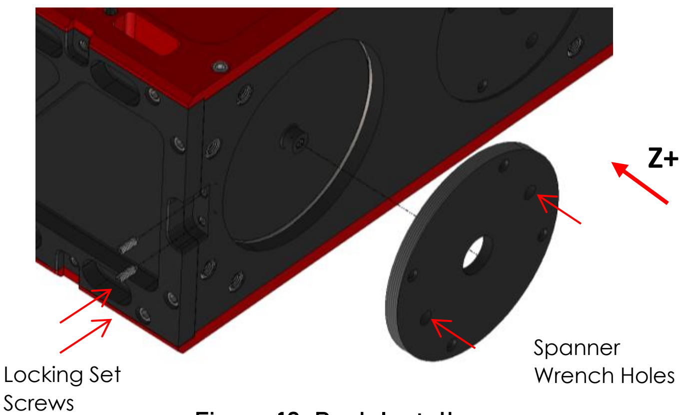

Figure 10: Puck Install

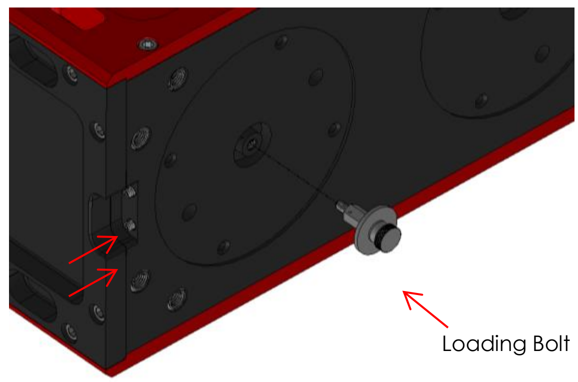

Figure 11: Loading Bolt Install

5.3 DOOR FEATURES

Doors on the XCD are independent in all configurations and are held in place by a lock plate which constrains the gate on the actuator. Once the actuator is fired the doors open and at a 92° angle and are locked in place with an integrated spring-loaded kickstand to ensure that doors do not recontact satellites while they are being deployed.

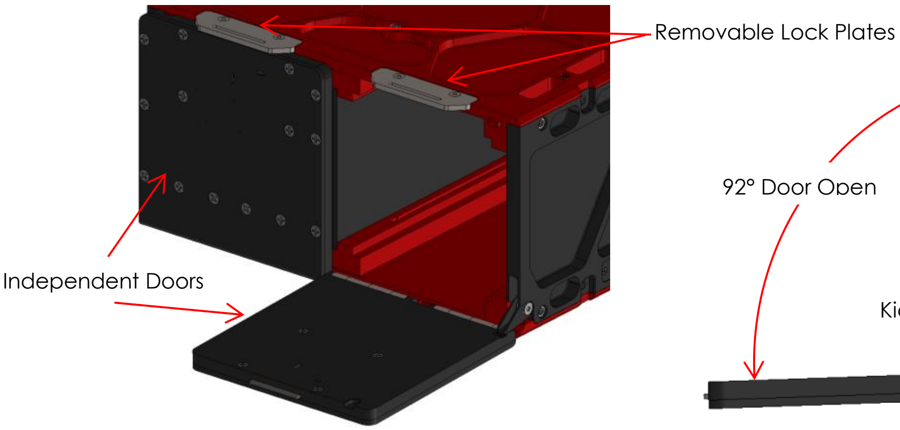

Figure 12: Independent Doors

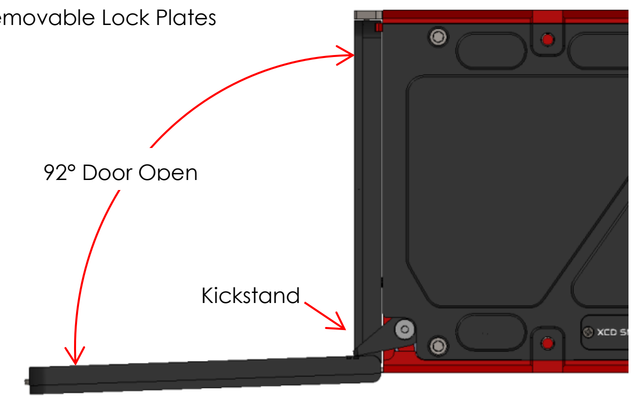

Figure 13: Open Door Locked

5.4 DEPLOYMENT CONFIRMATION

Confirming that the satellite has left the dispenser is a critical part of the mission. The XCD has switches embedded in the rails that send a signal once the pusher plate has reached the end of its stroke. This feature works with the dispenser in either the 3U or 6U configuration as the switches are located on both rail sections as shown in Figure 14.

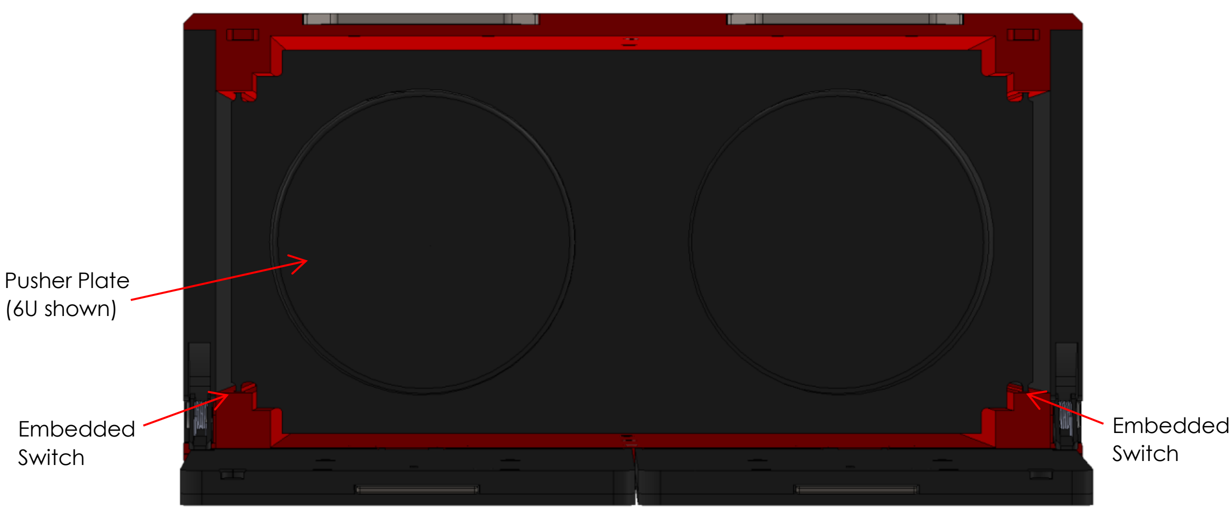

Figure 14: Deployment Confirmation Switches

5.5 DEPLOYMENT DYNAMICS

Deployment velocities shown in Figure 15 assume full pusher plate stroke with the mass specified. Payloads that only occupy a partial length of a tube will deploy at a different velocity. If payloads mass is outside of the range shown and/or partial stroke deployments are to be considered, custom deployment velocity analysis can be done upon request. Tip-off is largely dependent on the CG of the satellite but typically tip-off will be less than 10 deg/s.

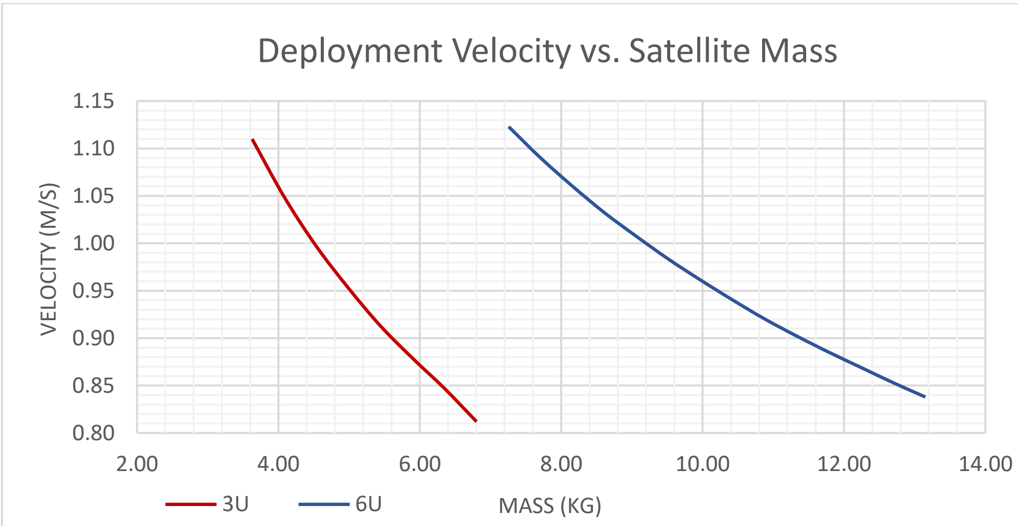

Figure 15: Deployment Velocity

5.6 SATELLITE ACCESS

This feature allows satellites to be fully integrated and accessed with more available surface area than any dispenser on the market. 3U and 6U configurations can both take advantage of this feature. Optional hardware holds both doors closed while the clamshell is off can be added to your order and can be installed as needed for this feature. Once the hardware is in place, tech tight the thumb screws hold the doors in place. Now the clamshell can be removed if needed to expose the maximum amount of satellite surface area as shown in Figure 16.

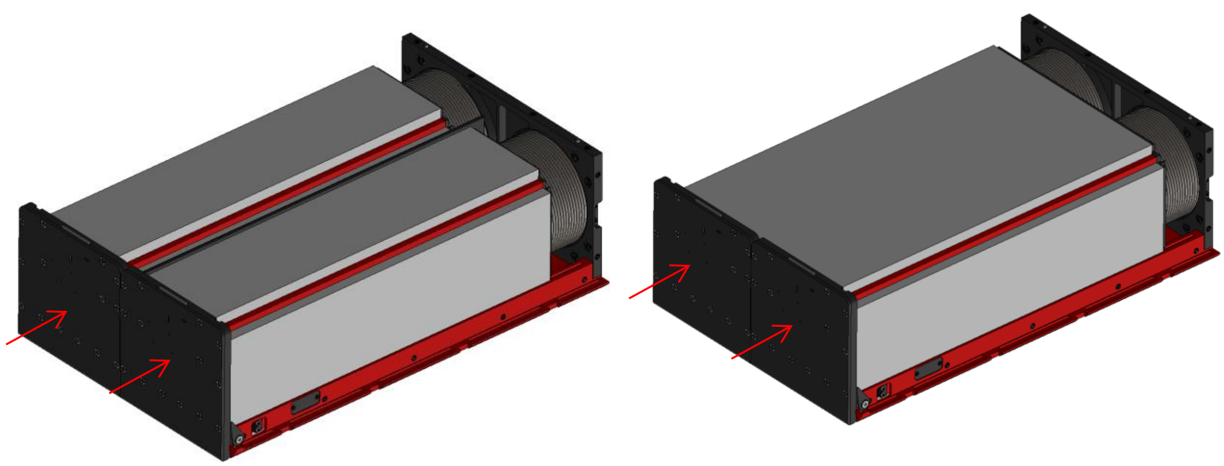

Figure 16: Satellite Access

5.7 SATELLITE SPACING

Custom length cylindrical spacers can be ordered to accommodate almost any length of satellite. Fasteners come with the spacer and installation is as simple as removing the puck, fastening the spacer to the puck, and reinstalling the puck. Detailed procedures are available upon request.

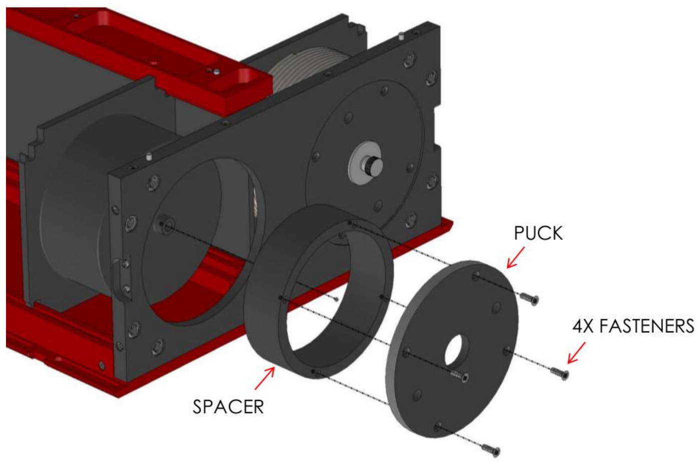

Figure 17: Spacers

6. ELECTRICAL CHARACTERISTICS

6.1 ELECTRICAL COMPONENTS

Three types of electrical components are used in the XCD-3U/6U, two microswitches enable signal feedback to ensure deployment has been completed, two LRM-65 actuators are embedded in the doors to open the doors when commanded, and the two Glenair 171 microstrip connectors which are connected to the microswitches and actuators. The LRM-65 data sheet is available upon request or at xterra.space/space-mechanisms.

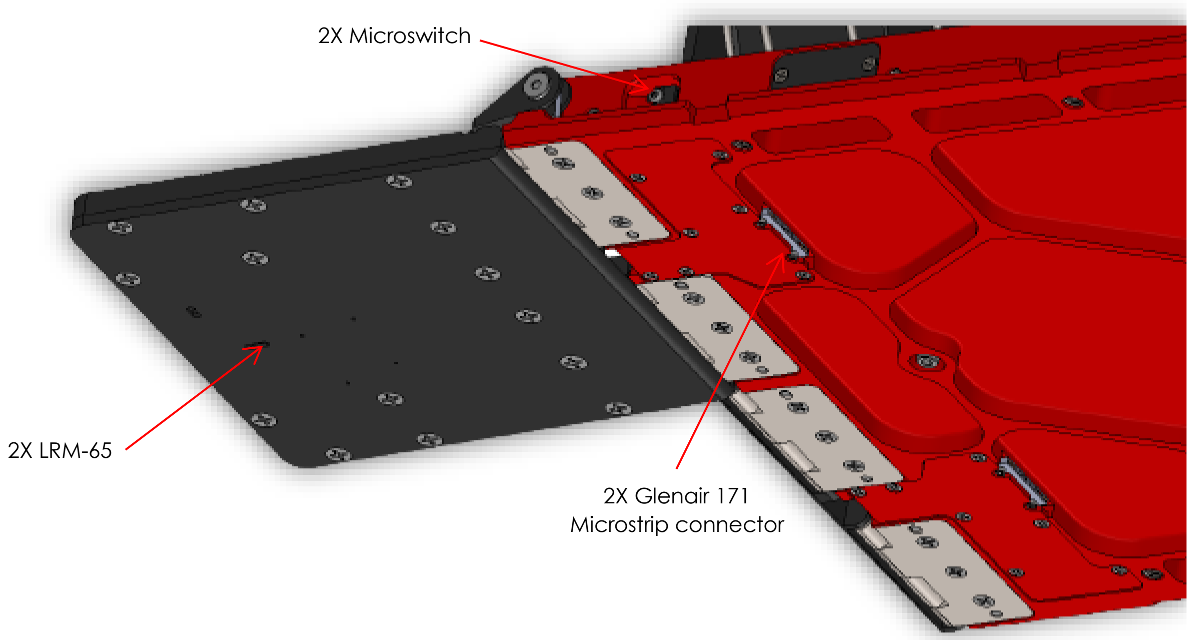

Figure 18: Electrical Components

6.2 HARNESS & INTERFACE OPTIONS

Options for customers are to have harness wires lead out of the connector location or have a preinstalled Glenair 171 Microstrip female end connector preinstalled. This would come with the male end connector for customers to wire themselves as needed. Please note that when wiring for a 3U deployment each connector would be wired separately for each door, however when flying in the 6U configuration each harness or connector would need to be wired to a common connector to open both doors simultaneously.

Figure 19: 3U vs 6U Harness

6.3 ACTUATOR PROPERTIES

The XTERRA XCD-3U/6U is powered by two XTERRA LRM-65 actuators. The LRM-65 actuator is an electrically redundant, fully resettable, shape memory alloy, low-profile 65lbf latch type release mechanism providing .110” of travel with an initial pull force of 65lbf in a flat package only .250” thick. The LRM-65 utilizes the same planar SMA initiator as all of XTERRA's SMA actuator offerings, the XTi5.

Figure 19 shows the nominal actuation time for a single channel of the XTi5 vs the supplied current at various temperatures.

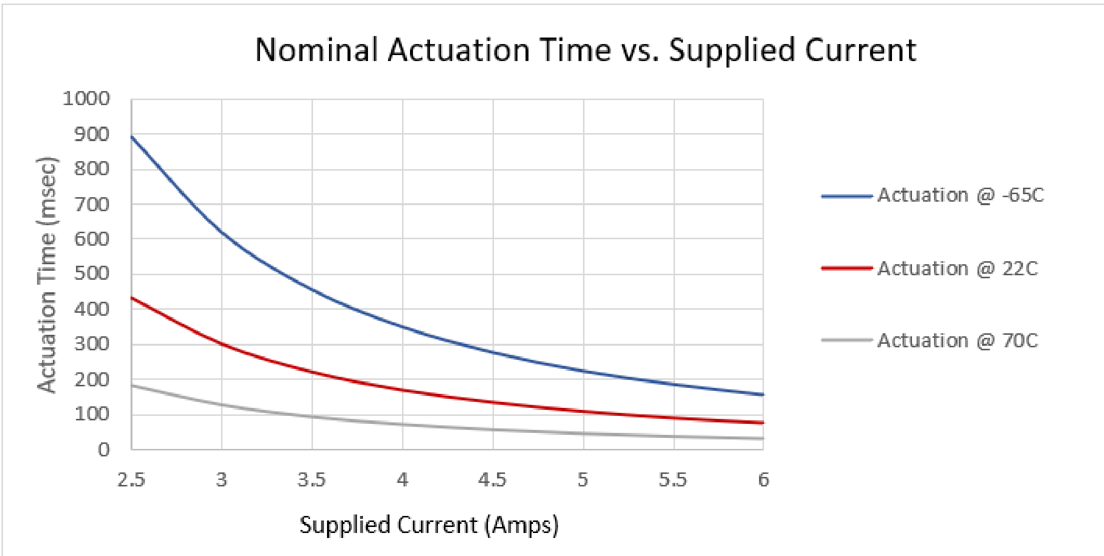

Figure 20: Nominal Actuation Time vs. Supplied Current at Various Temperatures

Many factors outside the manufacturer's control can affect this actuation time and it is always advisable to perform functionality testing with your flight unit under anticipated flight conditions prior to flight to ensure it will operate as expected.

The XTi5 features two independent electronic switching circuits which cut power to the SMA elements at the end of their contraction, preventing the SMA elements from annealing during use, and making the device fully reusable. To utilize these channels a minimum supplied current of 2.5 amps per channel is required. In addition to these two active channels, there are two additional “bypass” channels which operate in parallel to the switching circuits and can be used to check the health of the SMA elements during integration and may also be used to function the device in a single use fashion by applying a current directly to the SMA elements if so desired.