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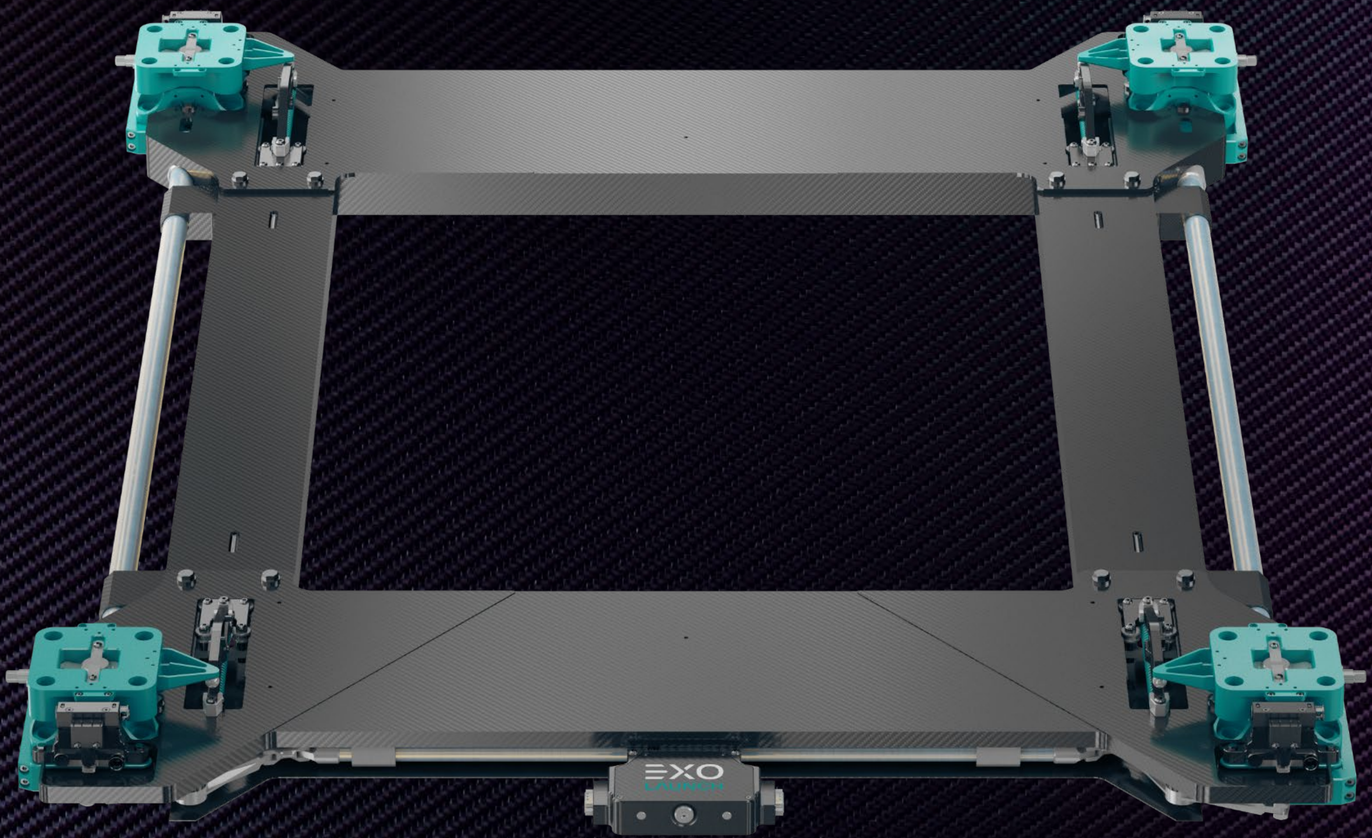

Quadro Versa
User Manual

Microsatellite Separation System
Revision 1.0 | August 2025

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Version	Author	Review	Date	Changes
1.0	CP	MT/MF/DC	08 Aug 2025	Initial release.

Quick Reference

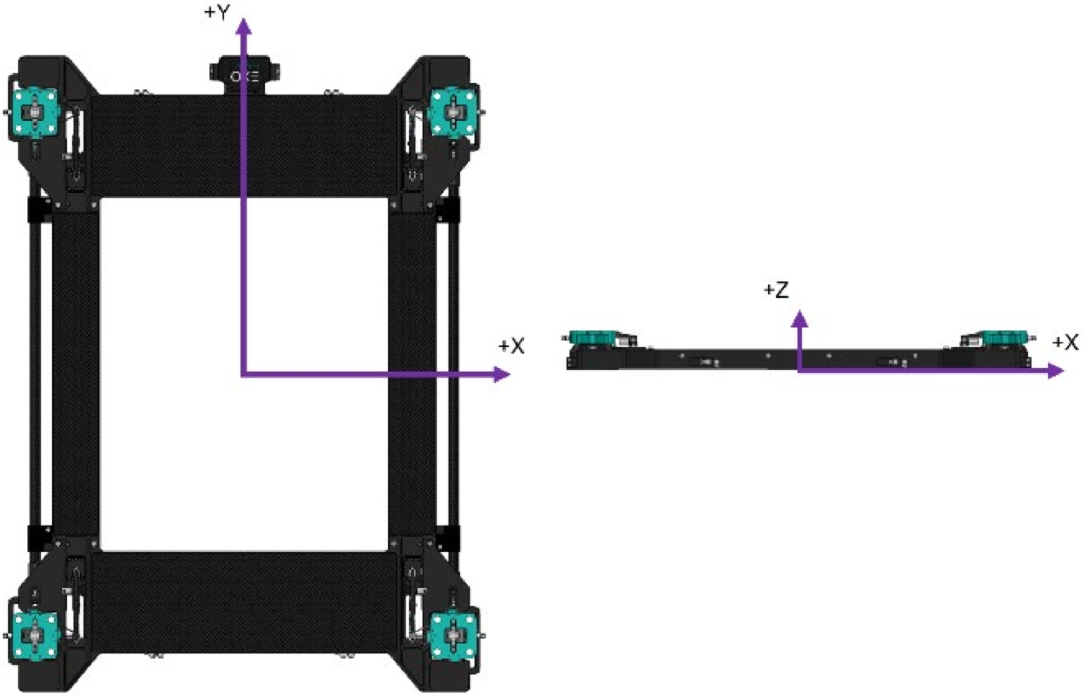


Figure 1: Quadro Versa Coordinate System

Table 1: Quadro Versa Characteristics Overview.

Parameter		Section	Quadro Versa
Mounting Pattern	HDRM Spacing (X) [mm]	2.4	Variable
	HDRM Spacing (Y) [mm]		
	HDRM Spacing (X) [in]		
	HDRM Spacing (Y) [in]		
	Number of Fasteners		16
	Fastener Type		M12 or ½"-20
	Flatness Tolerance [mm]		0.2
Mass [kg]	S-Adapter [kg each]	2.2	0.54
	L-Adapter [kg]		Variable
	Combined Mass [kg]		
Maximum Load per HDRM [N]	Axial [kN]	2.6	±44
	Lateral (Shear) [kN]		±37
	Bending [Nm]		1200
Separation	Nominal Separation Signal	2.11	28VDC for 0.5s
	Average Separation Time [s]		0.1
Thermal [°C]	Lower Operating Limit	-	-34
	Upper Operating Limit		+79
	Lower Survival Limit		-55
	Upper Survival Limit		+130

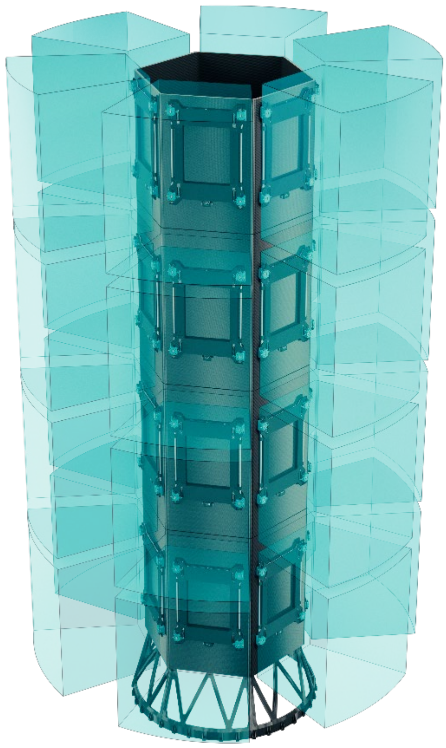
1

Introduction

1.1 What is Quadro Versa

Quadro Versa expands the capabilities of Exolaunch's microsatellite separation systems with a four-point solution offering tailored interface sizing to satellites weighing up to 1000 kg and flying on SpaceX Rideshare plates. Versa has been designed for compatibility with the SpaceX four-point interfaces, and it is easily scalable to any size from 24"x16" up to 40"x40". Larger satellites over 1000 kg and with larger footprints are also covered by Versa, which offers unrivaled strength, stiffness and reliability.

- **LOW MASS**
  Optimized for mass, Quadro Versa offers the best flyaway mass vs. capability of any four-point system.
- **SHOCK-FREE DEPLOYMENT**
  No pyrotechnics ensures that even the most sensitive payloads remain intact after deployment.
- **LOW TUMBLING**
  The patented CarboNIX pusher arm system has an average tip-off rate of 0.6 deg/s in all three axes.
- **FAST RESET TIME**
  Simple but robust magnetic locks are easy to operate and quick to reset.
- **FLIGHT HERITAGE**
  Critical subsystems like lock mechanism and pusher arms have flight heritage across dozens of missions.
- **ITAR-FREE**
  Quadro Versa is not subject to export restrictions of any kind.



From the ground up, Quadro Versa has been designed to simplify every step of your satellite mission.

- Fully mechanically actuated. No need for multiple synchronized deploy signals or signal multiplexers to actuate the four points.
- Quickly and easily resettable, making it possible to perform integrated functional testing with your satellite in the launch configuration for maximum reliability.
- Low cost, fast lead time, and no export restrictions.

1.2 Components and Features

Quadro Versa is designed around four Hold-Down and Release Mechanisms or HDRMs. These elements are located at the corners of the Versa system and serve as the load path between the satellite and the launcher. The rest of the Versa system supports the synchronized release of the HDRMs and the controlled deployment of the satellite. The key elements of the Versa system are shown below.

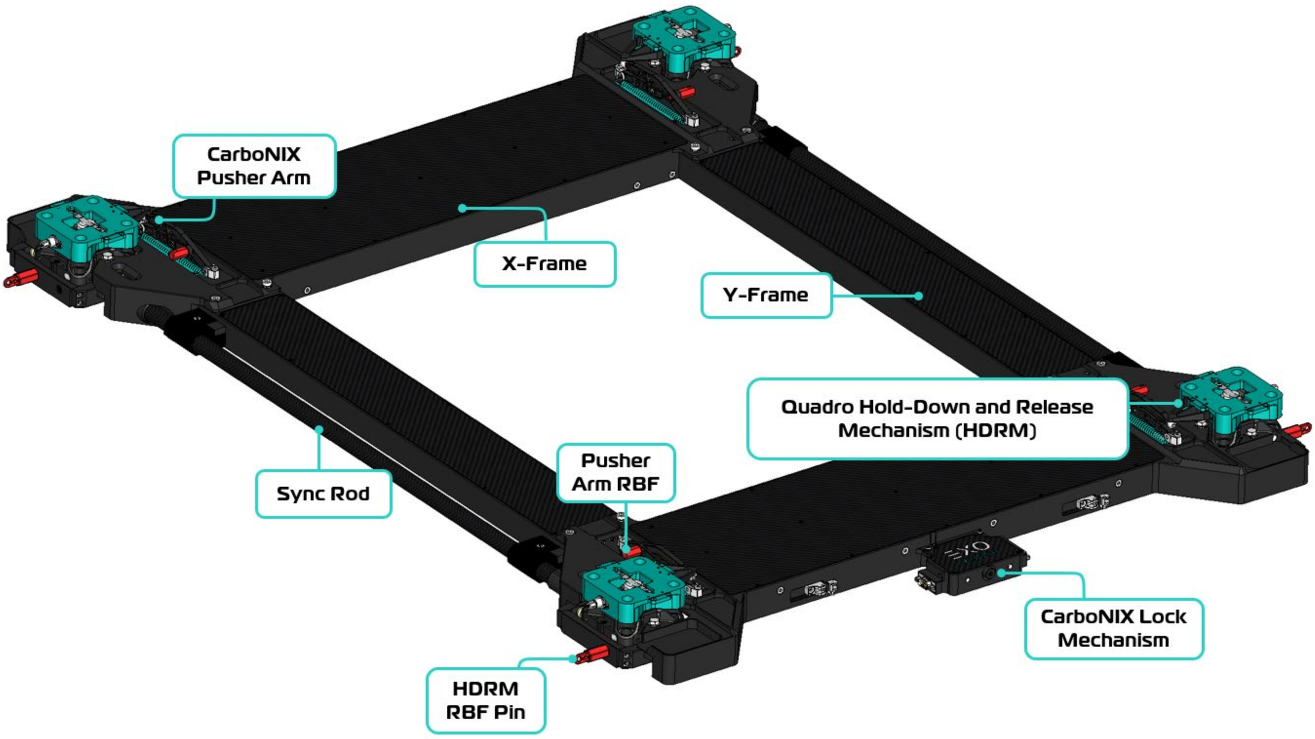


Figure 2: Quadro Versa Components Overview.

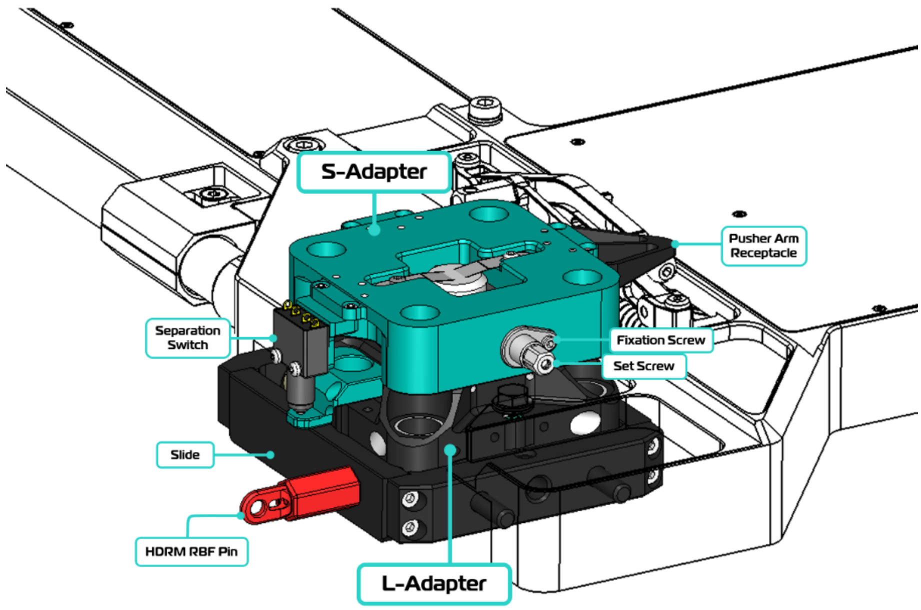


Figure 3: Quadro Versa Hold-Down and Release Mechanism (HDRM)

1.3 Qualification Status

Quadro Versa has been tested extensively following Exolaunch's testing philosophy and requirements from various launch vehicle operators, primarily SpaceX, as well as the SMC-S-016 standard. In every test, Versa has demonstrated outstanding reliability and robustness. The Versa has been demonstrated to be the stiffest four-point system for microsatellites on the market today.

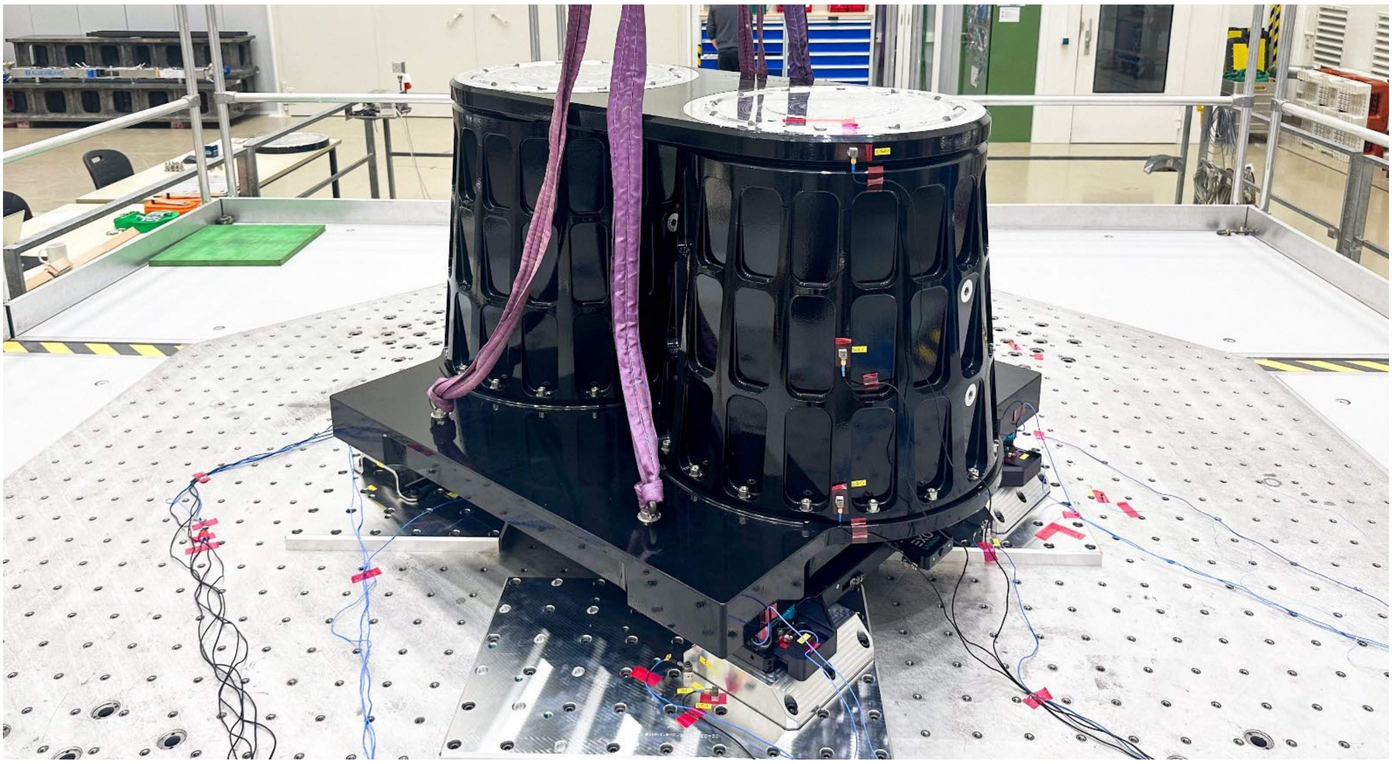
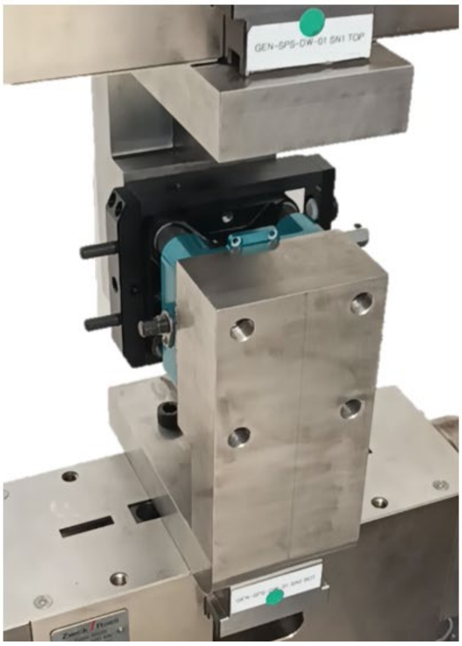


Figure 4: Quadro Versa Qualification Campaign

Exolaunch pushes the limits of testing with every Exolaunch separation system, and Quadro Versa is no exception. The Versa HDRMs have been tested and pushed beyond the load cases experienced in flight, validating and providing a thorough understanding of the system's design margins. This test methodology provides the understanding needed to guarantee flawless performance and reliability for customer missions.



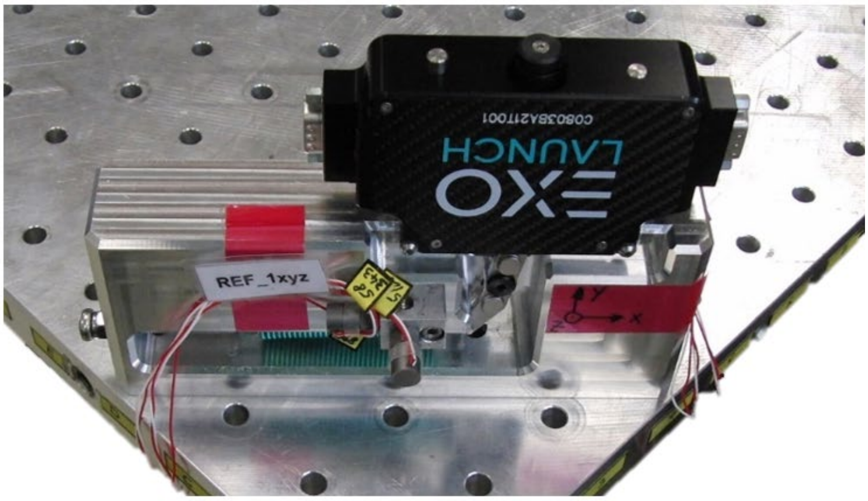


Figure 5: Quadro Versa HDRM Strength Verification (left) and Lock Mechanism Shock Qualification (right).

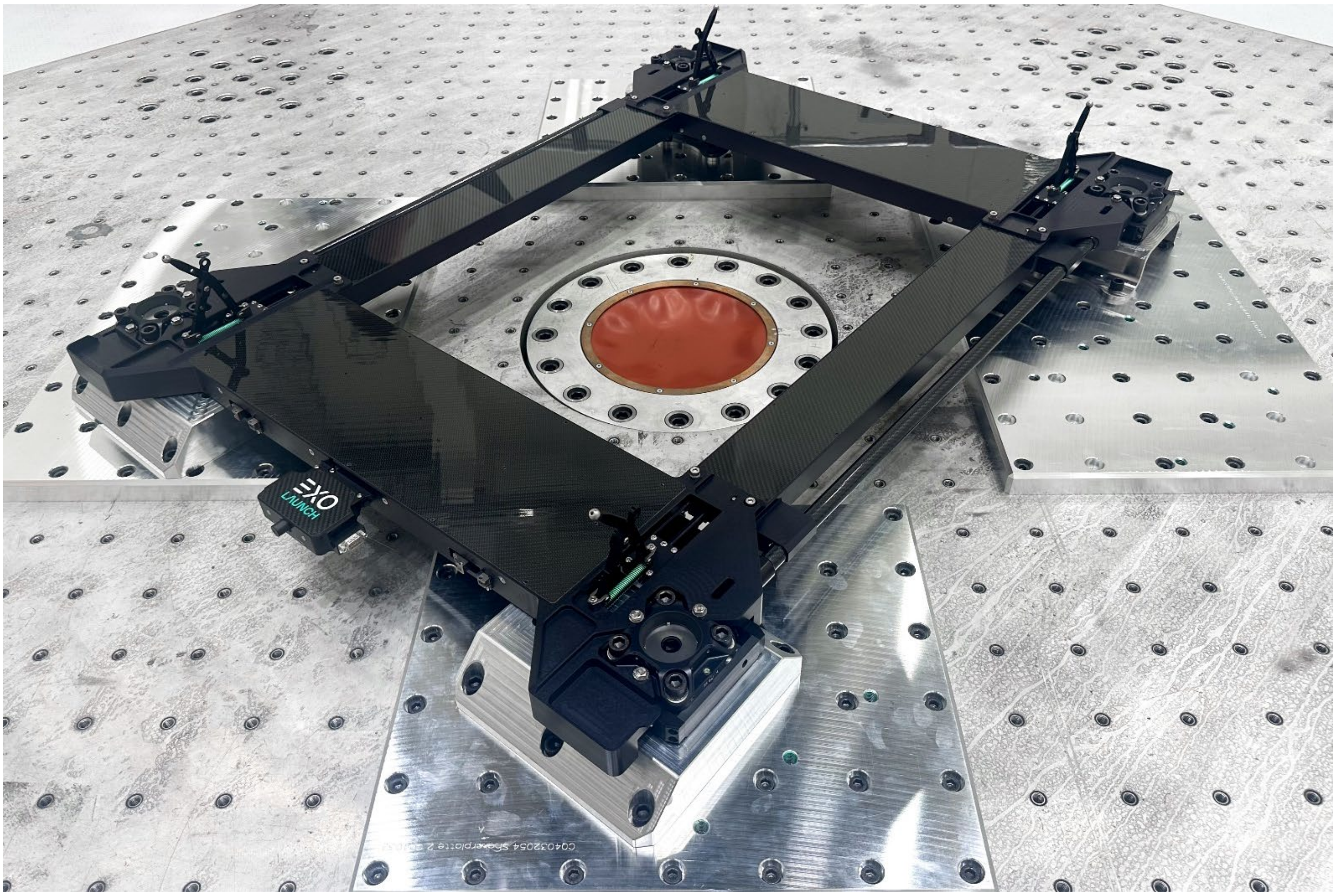


Figure 6: Quadro Versa System During Vibration Qualification Testing.

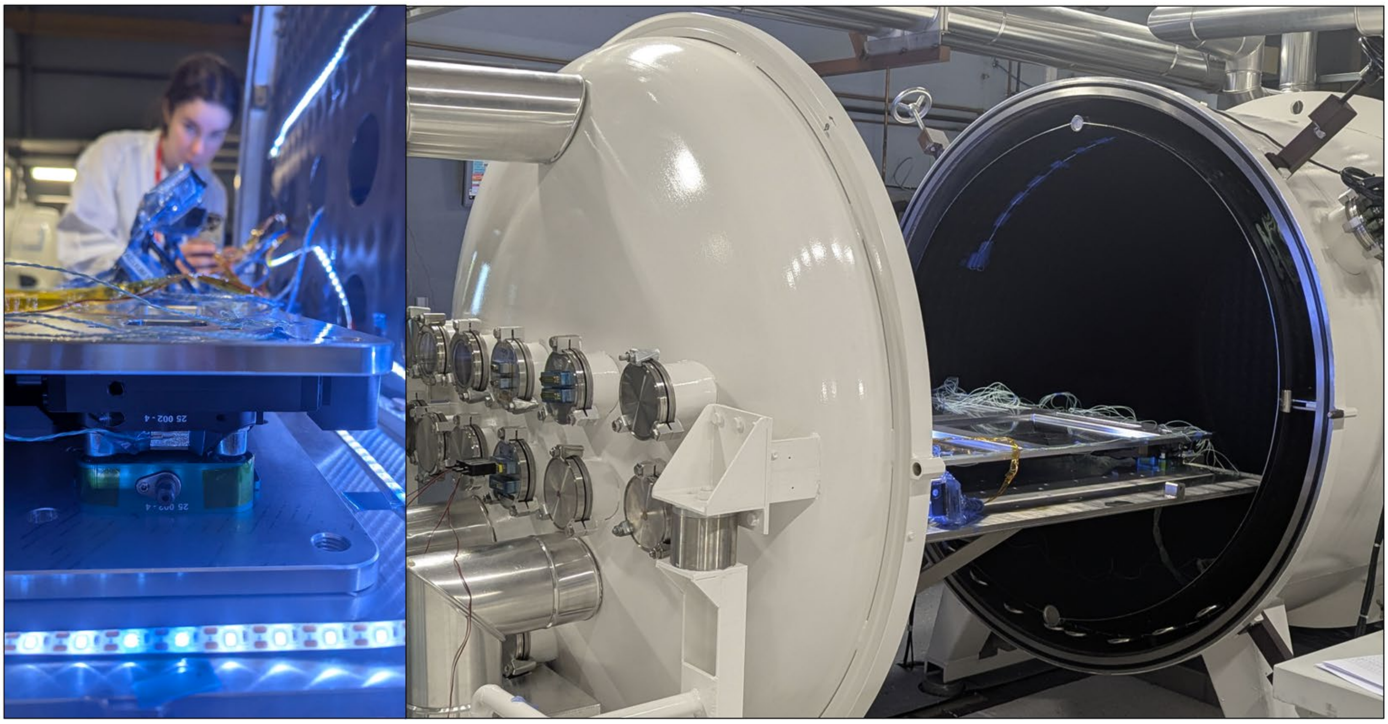


Figure 7: Quadro Versa System During TVAC Qualification Testing.

1.4 Deployment Sequence

1. The deploy command opens the redundant magnetic locks, and the inhibit pin is released.
2. Now free to move, the spring-driven synchronization mechanism opens all four HDRM points simultaneously. The synchronized release is entirely mechanical, and a single deploy command is sufficient to open all four points.
3. With the HDRMs open, the satellite is no longer held to the launch vehicle. The pusher arm system starts pushing the satellite away from the vehicle generating the separation velocity. The synchronization of the four pusher arms achieves a highly smooth and stable deployment.
4. Two internal telemetry switches toggle when (1) the synchronization mechanism has reached its open position and when (2) the pusher arm system is fully extended. The launch vehicle reads these signals through the same DSub-9 connector used to provide the deploy command.

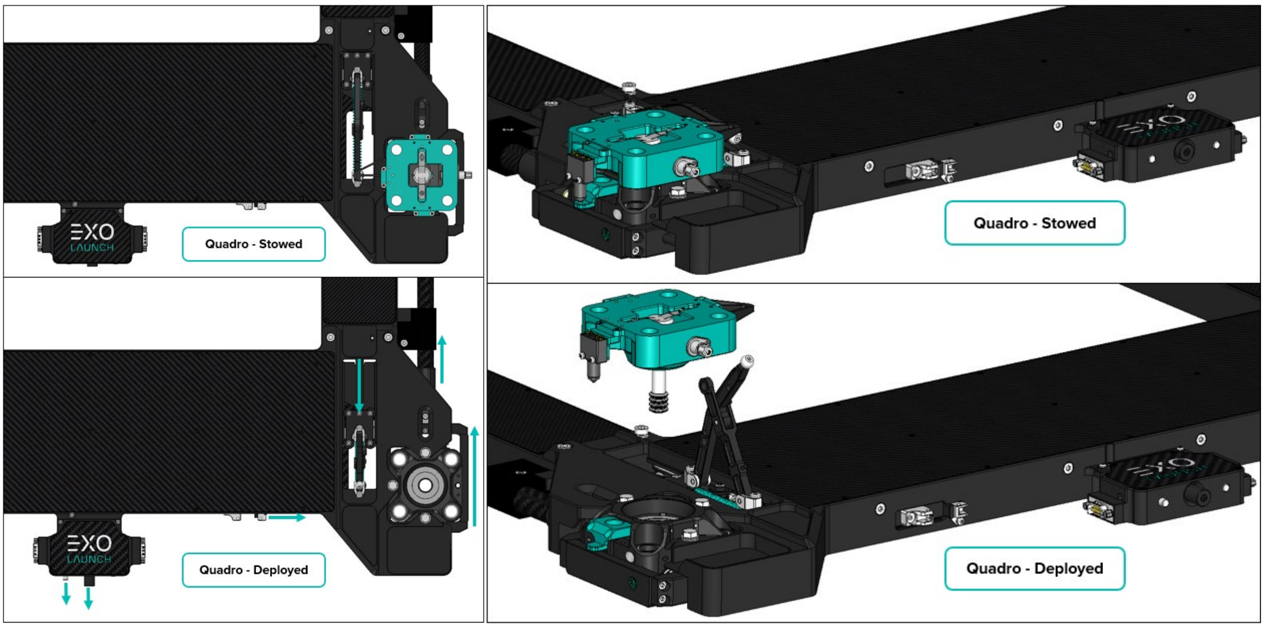


Figure 8: Quadro Versa Step-by-step Deploy Sequence.

2

System Description

2.1 Coordinate System

The Z-Axis is parallel to the deployment direction and defined at the geometric center of the four HDRMs, with +Z pointing towards the satellite. The origin of the coordinate system is where the Z-Axis intersects the L-adapter mounting plane. The +Y direction points towards the lock mechanism and is aligned with the footprint of the four point interface. The X-Axis is defined by the right hand rule.

The Quadro Versa coordinate system is defined in the same manner for all sizes.

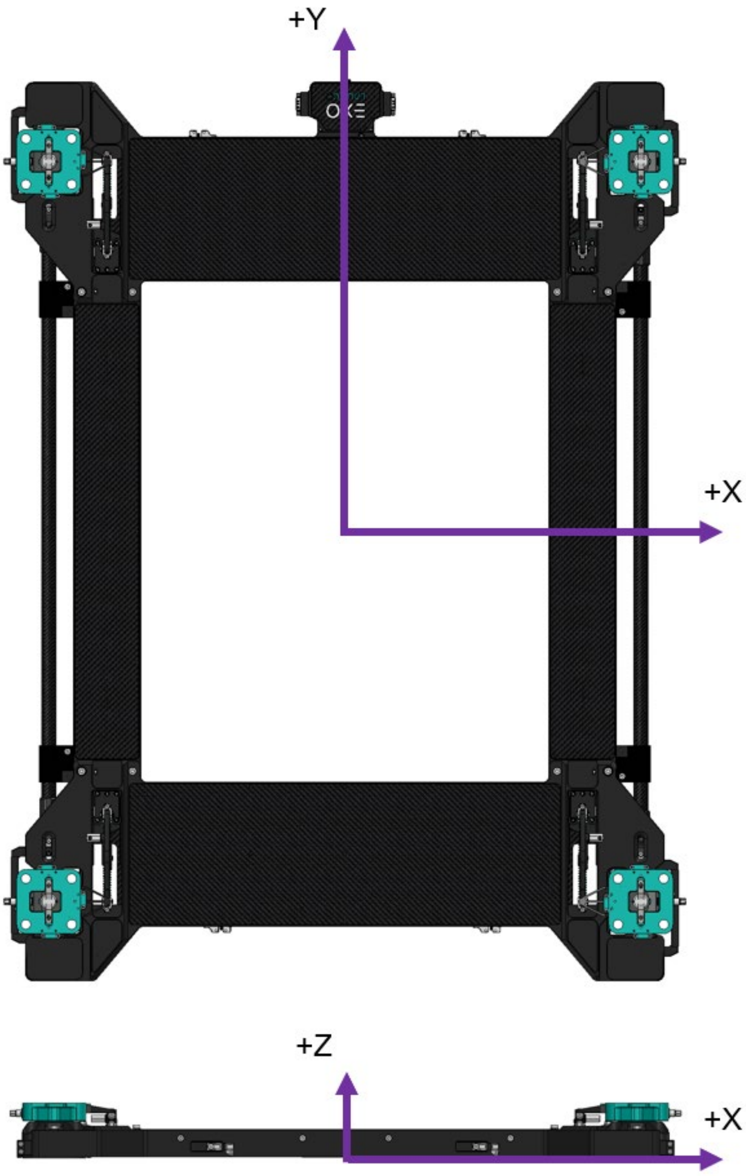


Figure 9: Quadro Versa Coordinate System

2.2 Mass Properties

System masses are given here for the various configurations of Quadro Versa, not including mounting fasteners, separation switches or separation connectors. Detailed mass properties are available upon request. Note the numbering convention – the first two digits of a Versa size denote the HDRM spacing along the Y-axis in inches, and the last two digits denote the HDRM spacing along the X-axis in inches.

Table 2: Quadro Versa Mass Properties

L-Adapter [kg]		X-Axis						
Y-Axis	Size	16	20	24	28	32	36	40
	24	11.6	12.4	13.1	13.9	14.6	15.4	16.1
	28	11.9	12.7	13.4	14.2	14.9	15.7	16.4
	32	12.2	13.0	13.7	14.5	15.2	16.0	16.7
	36	12.5	13.3	14.0	14.8	15.5	16.3	17.0
	40	12.8	13.6	14.3	15.1	15.8	16.6	17.3
S-Adapter [kg]		2.2						

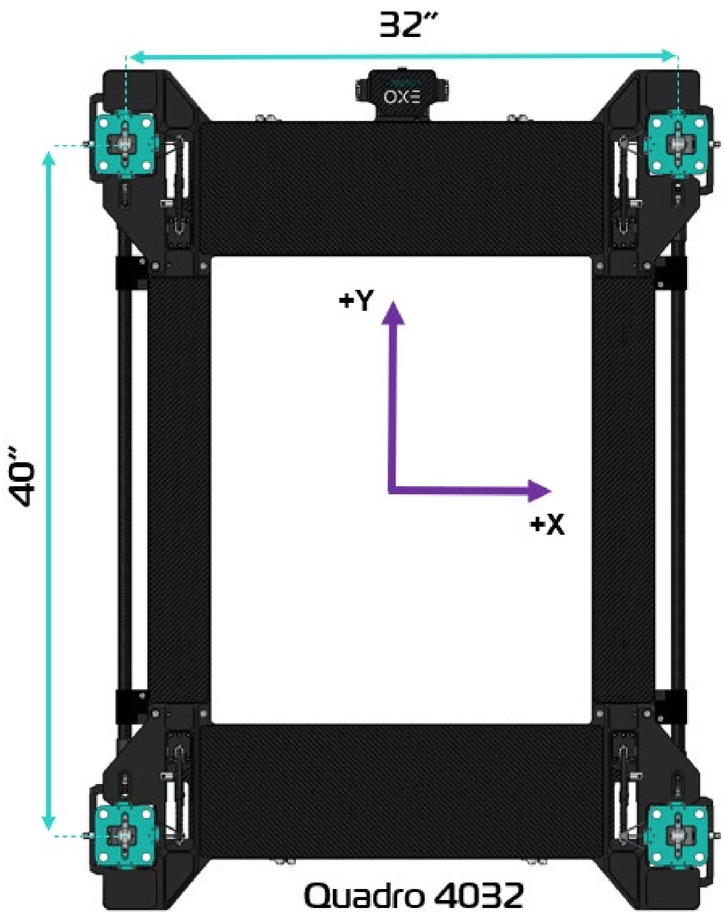


Figure 10: Quadro Sizing Principle

Since the frame holding the lock mechanism is heavier than the two perpendicular frames, it is generally recommended to select a Quadro Versa configuration which holds the lock mechanism on the shorter side. E.g. Versa 4032 has lower mass than Versa 3240. The Versa configurations highlighted in red in Figure 11 are available, but should only be selected if the satellite baseplate design requires the respective location of the lock mechanism.

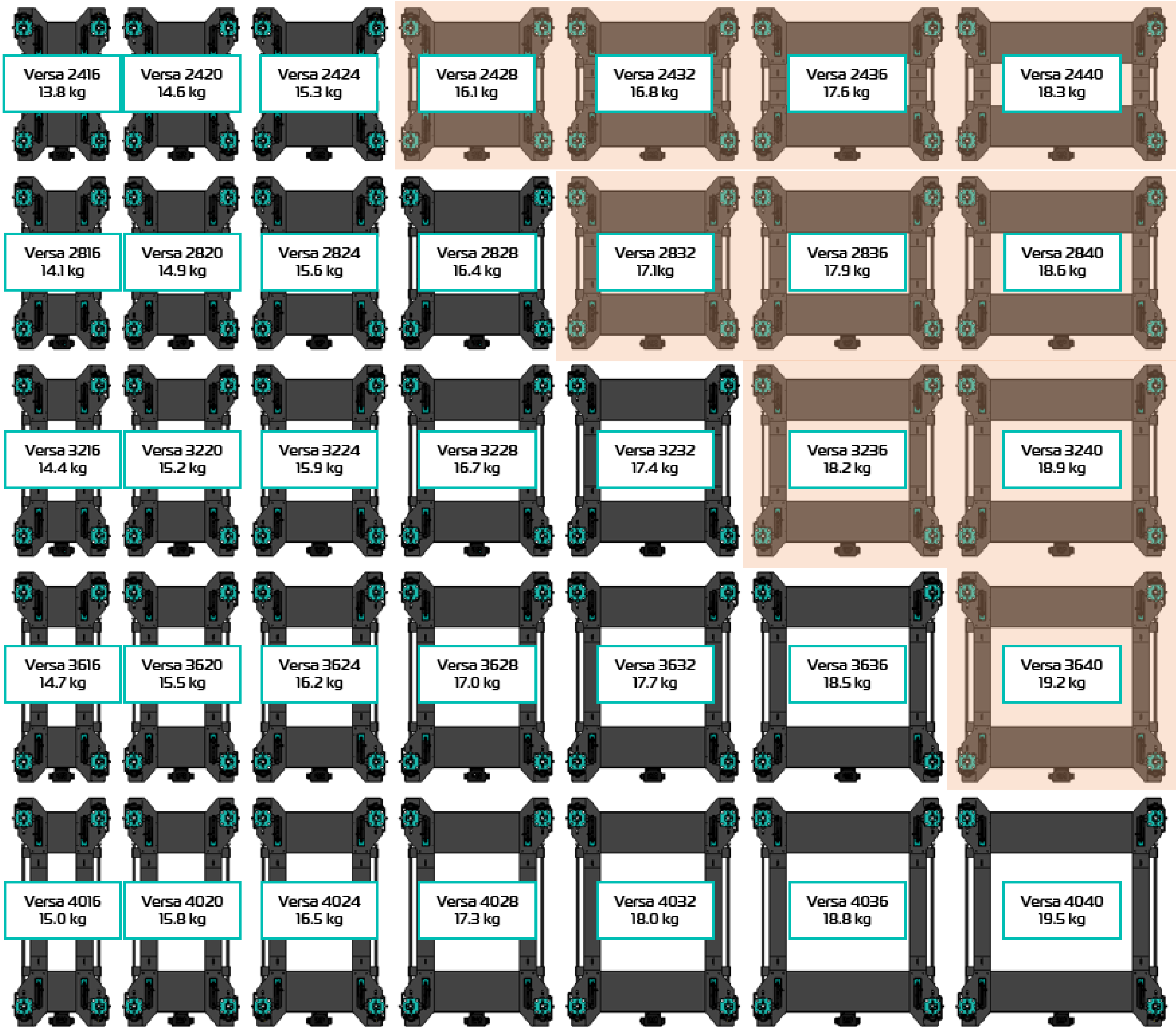


Figure 11: Quadro Versa System Mass for Different Sizes.

2.3 Mounting Interface

Quadro Versa can be mated with the launch vehicle and the satellite at each HDRM in the following way:

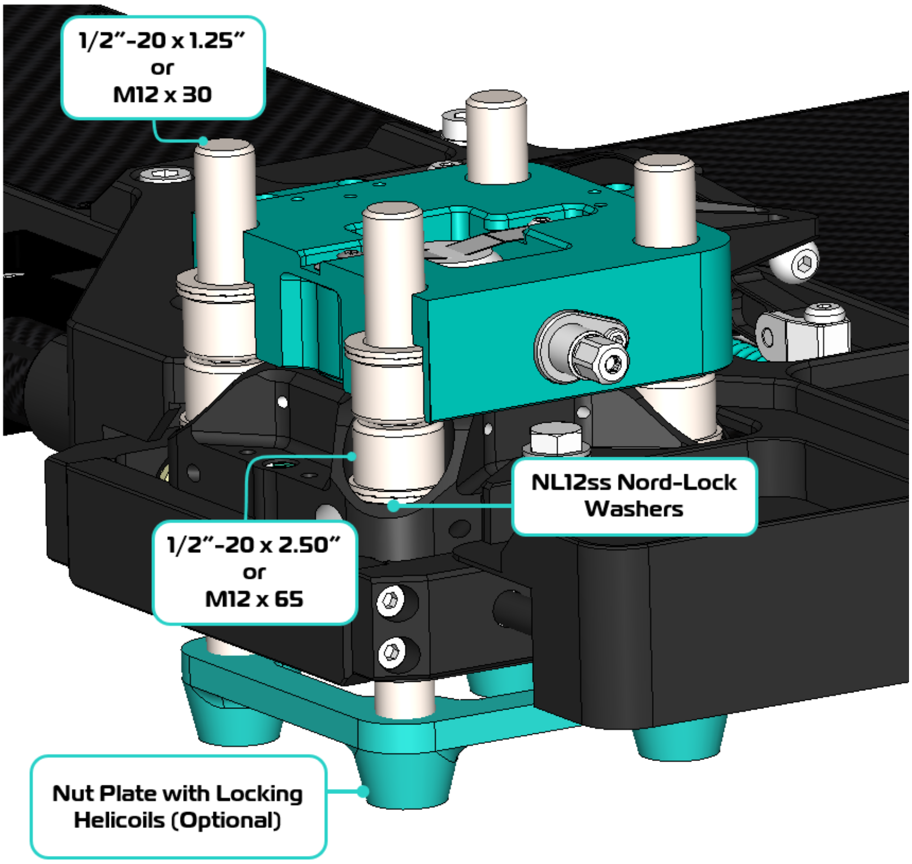


Figure 12: Quadro Versa Mounting Configuration

Note: Fastener length is dependent on launch adapter and spacecraft hole definition. Exact fastener type, size, strength, thread locking, lubrication, torque values and procurement responsibility are agreed upon in the mission-specific customer ICD.

2.4 Mechanical Interfaces

The mechanical interface definition is dependent on the configuration. Detailed mechanical interface definitions can be found in Appendix A3.1.4A. Exolaunch requires customers to provide measurement reports of the satellite-side interface to verify adherence to the defined Exolaunch (and launch vehicle) interface requirements.

2.5 Keep-Out Dimensions

The spacecraft and launch vehicle must not interfere with the function of the Quadro Versa mechanisms. To verify that Versa has sufficient clearance from the spacecraft, a dedicated fitcheck will be conducted. Contact Exolaunch to receive the appropriate CAD model for fitcheck purposes.

2.6 HDRM Positioning

Each HDRM is fixed to the primary system structure with three positioning screws. When these screws are loosened, the HDRMs can "float" within a defined circular area (D = 1.5mm). This allows the system to absorb manufacturing tolerances on the spacecraft side. Tightening these screws fixes their position to the main structure and relative to each other. As part of the final integration with the spacecraft and launcher, access to these screws is required to ensure the correct positioning of the HDRMs with respect to the satellite interfaces.

In addition, the thru-holes on the L-adapters offer a defined play to account for manufacturing tolerances on the launcher side.

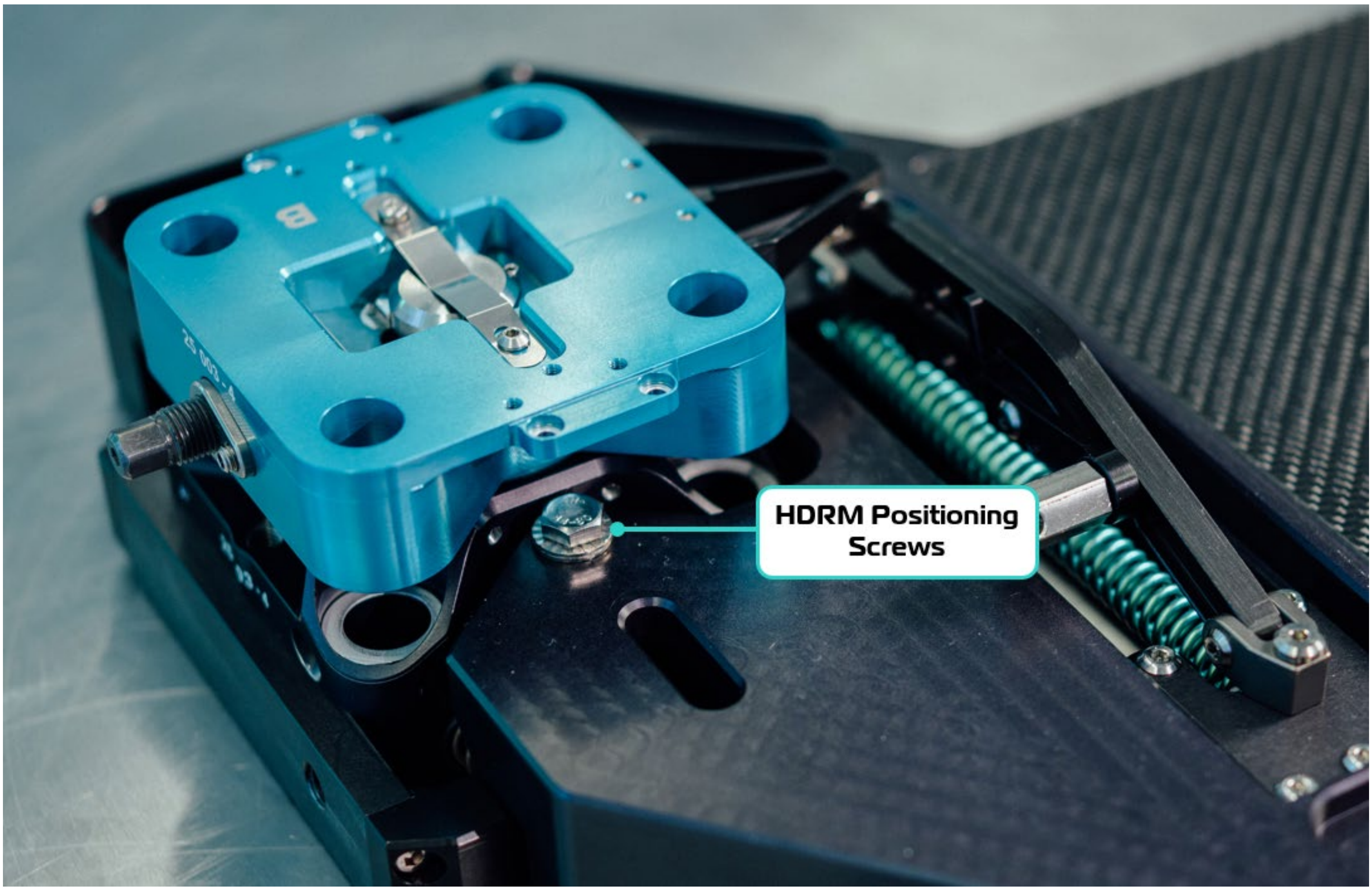


Figure 13: HDRM Positioning Screws

2.7 S-Adapter Orientation

The S-adapters can be oriented in one of two directions, with the preload screw pointing along either the Versa X or Y-axis. The Y-axis orientation should be considered the default orientation, but for tool access reasons the X-axis may be preferred. The selected orientation will be captured in the mission-specific ICD.

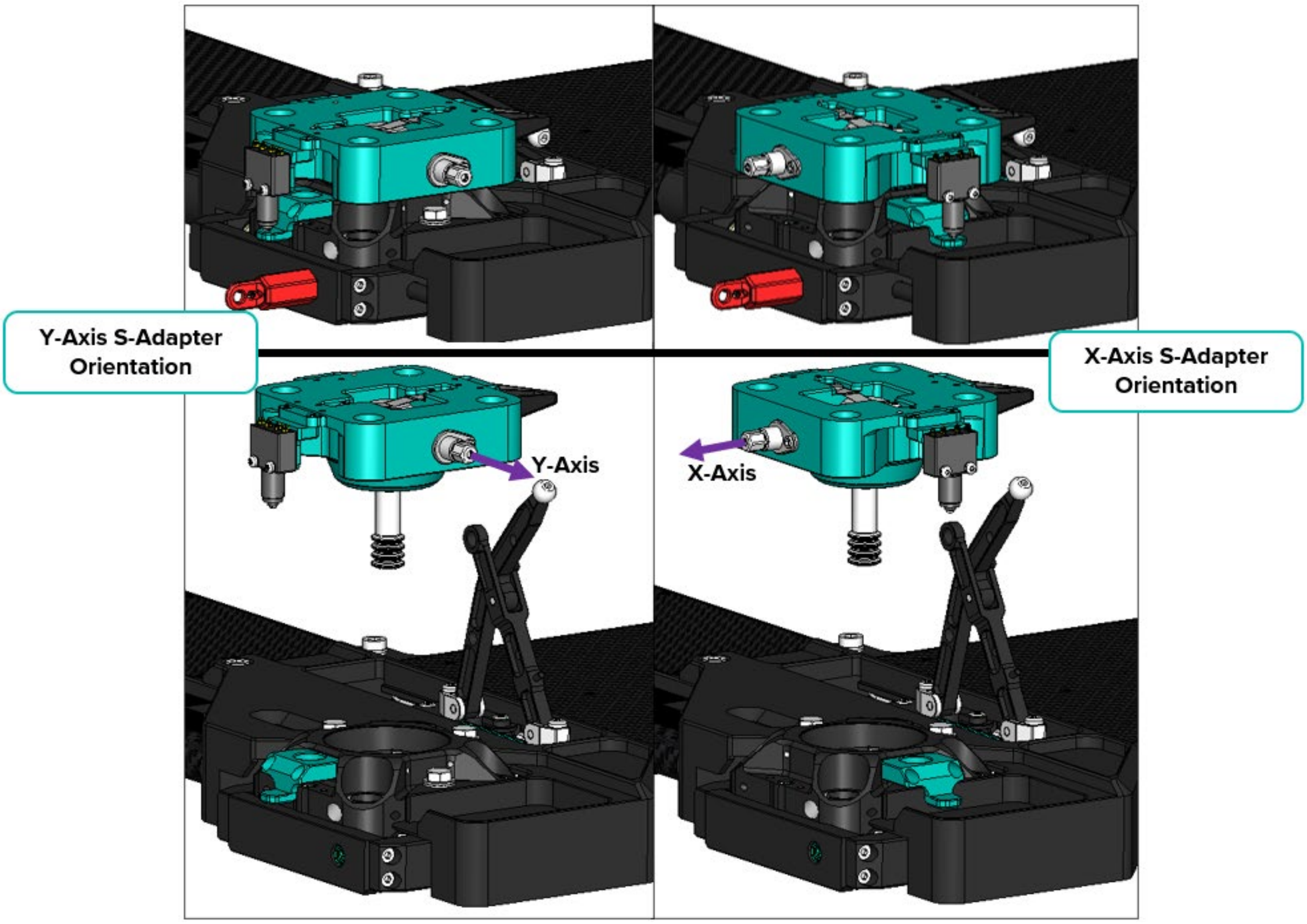


Figure 14: S-Adapter Orientation based on Preload Screw Alignment

2.8 Maximum Loads

The maximum capability of Quadro Versa is determined by the launch vehicle loads as well as the mass and Center of Gravity (CoG) of the satellite. Versa has been qualified to bound the mass properties limits that are defined in the SpaceX Rideshare Payload User's Guide (RPUG). Note that for comparison with the RPUG mass/CoG curves the Versa mass and CoG height must be included in all calculations.

The HDRMs have further been qualified in a static configuration, see Figure 5, to the loads listed in Table 3. These loads should be considered as the **established capability of the HDRMs, not the strength limits**. If customer maximum predicted loads are outside these limits, contact Exolaunch to discuss a delta qualification.

Table 3: Quadro Versa HDRM Maximum Loads

Maximum Axial Force [kN]	±44
Maximum Shear Force [kN]	±37
Bending Moment [Nm]	1200

2.9 Stiffness and FEM Modeling

Quadro Versa is exceptionally stiff. Stiffness has been verified using multiple methods, including deformation measurement under static load and dynamic correlation from vibration test results.

Exolaunch can provide a correlated FEM in .bdf format for use with NASTRAN solvers. Four HDRM FEMs should be mounted at the appropriate satellite interface using rigid connections. Contact Exolaunch to receive the Versa FEM.

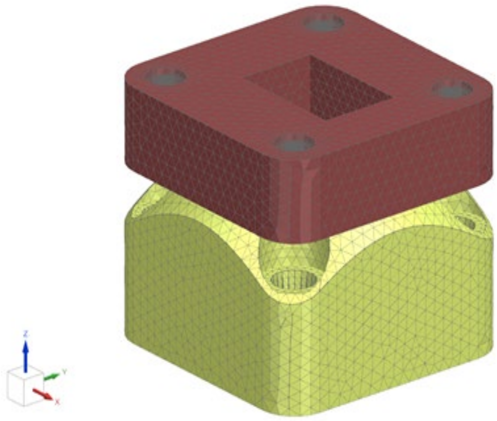


Figure 15: Quadro Versa HDRM Finite Element Model

2.10 Deployment Velocity

Separation velocity depends on the spacecraft mass and the strength of the separation springs. The spring strength can be tailored through a selection between three available spring types, or a combination, to match the desired deployment velocity. Using springs of different strengths has no effect on the tip-off rate. Figure 16 illustrates the deployment speed for different spacecraft masses and different spring energies.

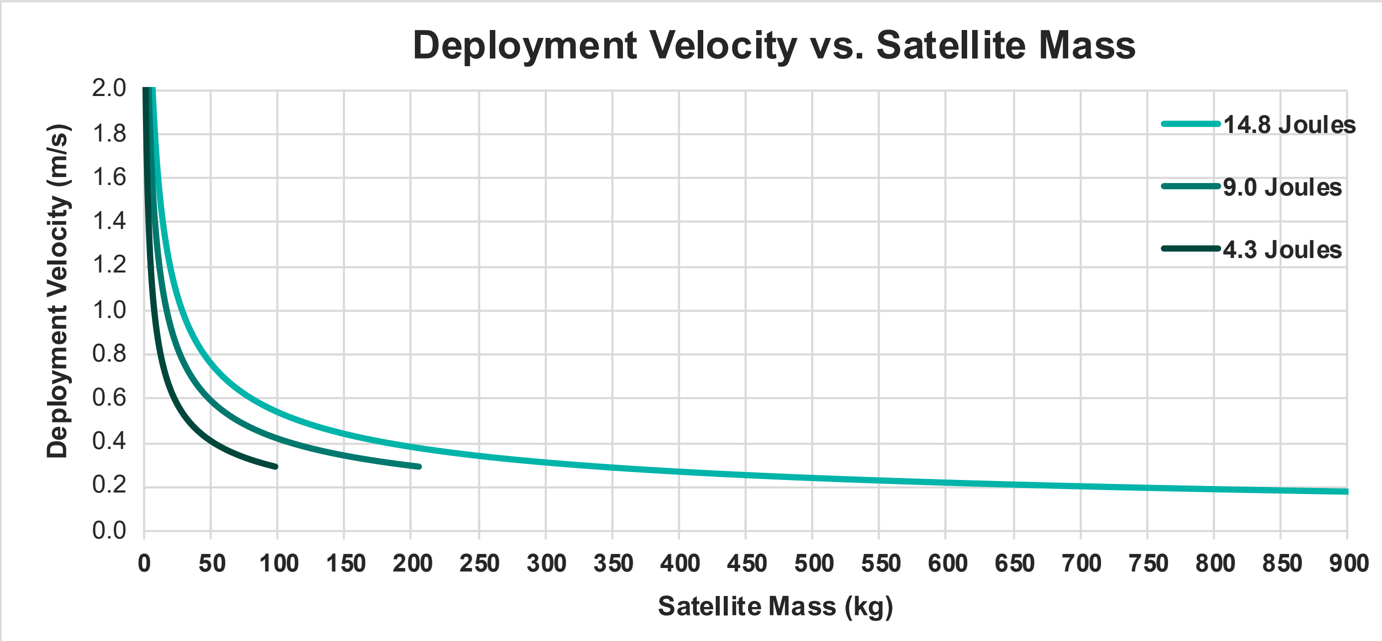


Figure 16: Quadro Versa Separation Velocity

The spring sets have a total energy tolerance of about 10%. Precise spring strengths can be measured to increase the precision to 2%. Table **4** shows the minimum and maximum values of the separation energy for each of the four springs. Combination of different spring types is allowed. For separation velocity calculations, the equation for kinetic energy can be used.

$$KE = \frac{1}{2}mv^2$$

Table 4: Spring Set to Minimum and Maximum Energy

Number of springs	4
Spring 1 (brown) [J]	1.1
Spring 2 (black) [J]	2.2
Spring 3 (green) [J]	3.7

2.11 Tip-Off Rates

Quadro Versa uses the same pusher-arm system for deployment as the popular Exolaunch CarboNIX microsatellite separation system. Due to the unique design of this system, all four pusher arms will extend at the same speed, regardless of the loads each individual arm faces. For this reason, the satellite will separate with near-zero initial rotation, independent of the satellite mass distribution.

Results from satellites deployed in space show an average rotation rate of 0.6 deg/s across all three axes. No axis rotation higher than 2.3 deg/s has been recorded from satellites deployed by CarboNIX.

Table 5: Examples of customer-reported tip-off rates for different satellite types.

No.	Satellite Mass [kg]	CG RSS Eccentricity [mm]	Spring Energy (J)	Deploy Velocity [m/s]	Tip-Off Rate [deg/s]			
					X	Y	Z	ABS MAX
1	110	5	4.4	0.28	-0.40	1.09	-0.54	**1.09**
2	110	5	15.5	0.53	0.13	0.34	0.04	**0.34**
3	110	5	9.4	0.41	0.25	0.40	1.90	**1.9**
4	99.7	11	15.5	0.56	0.28	-0.59	0.97	**0.97**
5	104.4	26.7	15.5	0.54	0.12	1.97	0.65	**1.97**
6	89.6	28	9.4	0.46	-0.60	-1.01	0.98	**1.01**
7	116.7	16.1	15.5	0.52	0.97	0.12	2.20	**2.2**
8	90.9	24.1	15.5	0.58	1.47	0.61	-0.77	**1.47**
9	91.7	36.1	9.4	0.45	-0.59	-0.41	-0.37	**0.59**
10	90.8	28	15.5	0.58	1.02	-0.83	0.51	**1.02**
11	89.9	35.7	15.5	0.59	0.27	0.03	0.79	**0.79**
12	108.8	15.7	15.5	0.53	0.05	1.39	1.34	**1.39**
13	110	5	4.4	0.28	0.50	0.50	0.90	**0.9**
14	89.6	28	10.4	0.48	-0.70	-0.49	0.80	**0.8**
15	105	26.7	15.5	0.54	0.02	1.80	2.22	**2.22**
16	91.4	34.3	15.5	0.58	1.45	0.25	-0.23	**1.45**
17	110	5	15.5	0.53	-0.29	-0.10	-0.26	**0.29**
18	110	5	9.4	0.41	-0.31	-0.28	-0.78	**0.78**
19	90.4	22.7	15.5	0.59	-0.80	-0.25	0.13	**0.8**
20	88.7	13.7	9.4	0.46	0.03	0.70	0.54	**0.7**
21	89.3	28	13.9	0.56	0.48	0.49	0.61	**0.61**
22	96.1	12.8	13.9	0.54	-0.80	0.59	1.89	**1.89**
23	21.9	6.6	4.4	0.63	1.38	0.73	1.21	**1.38**
							Max tip-off rate (deg/s)	**2.22**

2.12 Electrical Properties

2.12.1 DSub-9 Connectors

The Quadro Versa locking mechanism has two male DSub-9 connectors (Harting 09674095615). Each connector is identical, and either one or both connectors can be used to actuate Versa.

Figure 17: Quadro Versa DSub-9 Primary Deploy and Telemetry Connectors.

Table 6: Quadro Versa DSub-9 Pinout

Pin	Designation	Function	Continuity Check Across Pins
1	Clamp Ring TM1	Closed after deployment	
2	Pusher Arm TM2	Closed after deployment	
3	-	-	
4	Actuator 2	Return	1.2V ± 10% drop across pins, using multimeter* in Diode mode.
5	Actuator 2	VCC	
6	Clamp Ring TM1	Closed after deployment	
7	Pusher Arm TM2	Closed after deployment	
8	Actuator 1	Return	1.2V ± 10% drop across pins, using multimeter* in Diode mode.
9	Actuator 1	VCC	

*Explosion-safe multimeter not required.

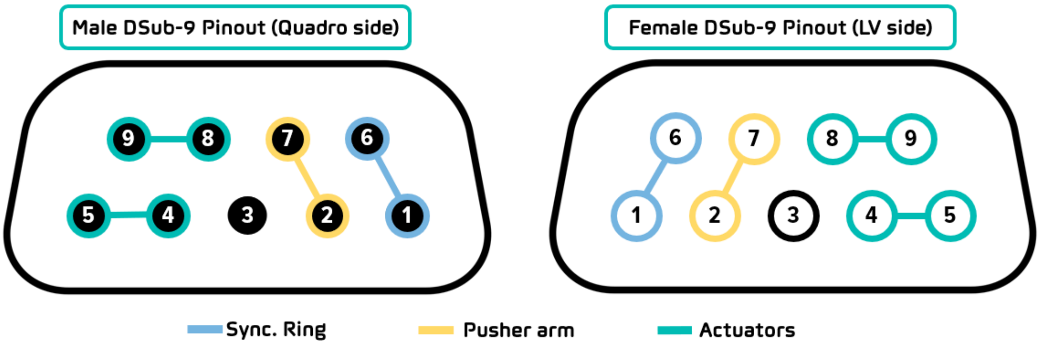


Figure 18: DSub-9 Pinout Visualization Male and Female Side.

2.12.2 Separation Signal

Quadro Versa uses two permanent electromagnets at the heart of the locking mechanism. Similar to a solenoid, these devices use a permanent magnet to hold Versa locked in place, without power, until the separation signal is received.

Holding force [N]	70	Minimum All-fire Current [mA]	160
Voltage Drop	1.2V ± 5%	Nominal Separation Current [mA]	280
Nominal Voltage [V]	28	Maximum Current [mA]	500
Voltage Range [V]	24-36	Nominal Pulse Duration [ms]	500
Maximum No-fire Current [mA]	25	Duty Cycle (cycle time 30s)	10%

Table 7: Permanent Electromagnet Properties

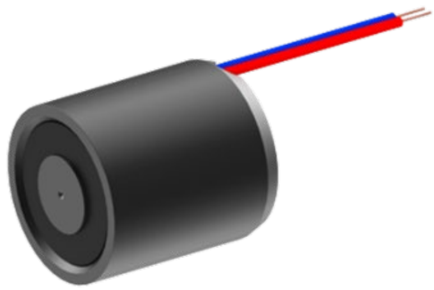
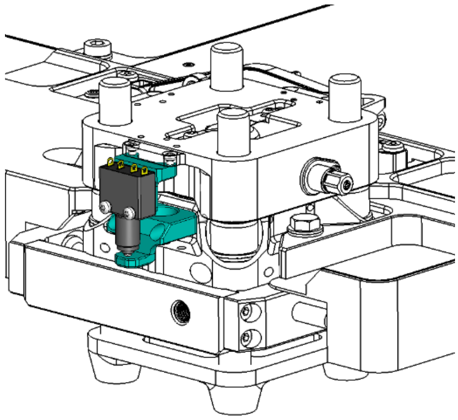
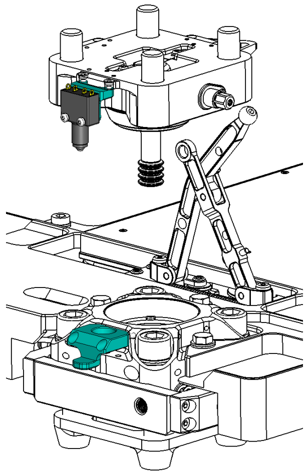
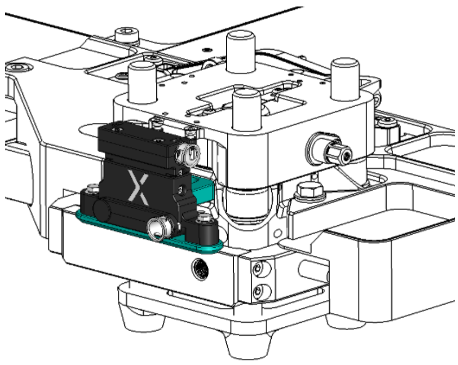
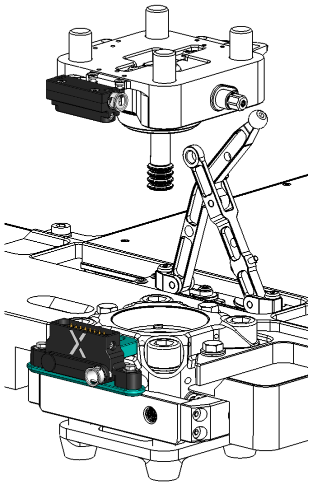
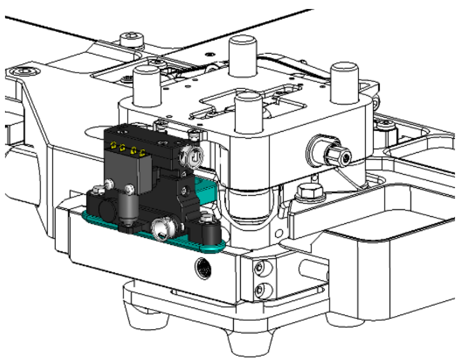
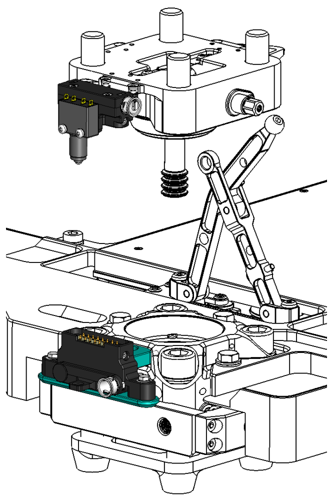


Figure 19: Permanent Magnet

2.12.3 Quadro Versa Accessories

Quadro Versa uses nearly the same accessories as CarboNIX, with slightly modified mounting geometries. Switches are used by the satellite to detect deployment from the launch vehicle, while separation connectors enable the use of umbilical lines to the launch vehicle. Accessories can be mounted to any of the four HDRMs.

Table 8: Quadro Versa Accessories

Separation Switch The preferred option for satellite separation detection. ITW-401000 switches have extensive flight heritage.		
Separation Connector Umbilical connector for satellite connectivity. Can be used for satellite charging or fitted with breakwire loops for deployment detection (not required).		
Separation Switch/Connector Umbilical connector housing is modified to include mounting holes for the separation switch. Can be used in situations where a large number of umbilical pins is required and cable routing to various HDRMs is limited.		

2.12.4 Grounding

Quadro Versa provides an electrically conductive path from the satellite interface to the launch vehicle directly through the primary structure and mounting fasteners, eliminating the need for dedicated grounding straps. The satellite manufacturer is responsible for ensuring that the Versa mounting fasteners are electrically connected to the rest of the satellite structure.

2.13 Thermal Properties

For thermal modeling exercises, the following measured thermal properties of the Quadro Versa system can be used.

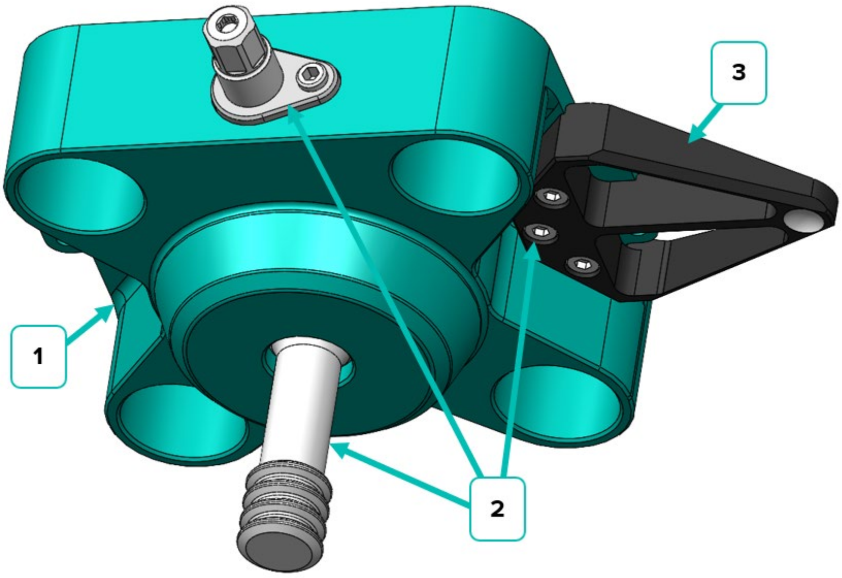


Figure 20: Quadro Versa S-Adapter Materials

Table 9: Quadro Versa S-Adapter Thermal Properties

No.	Color	Emissivity	Absorptivity
1	Green	0.85	0.58
2	Silver	0.11	0.42
3	Black	0.89	0.72

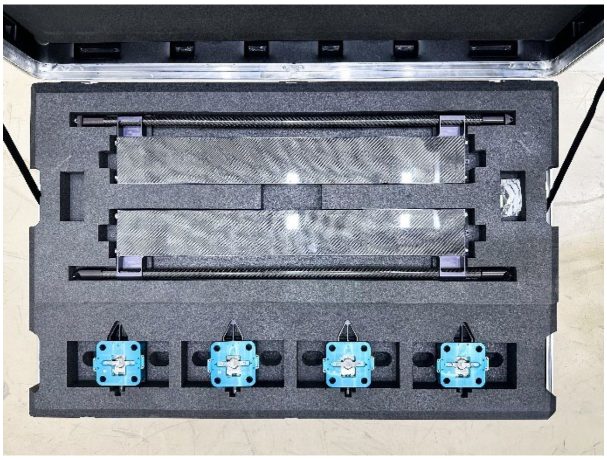
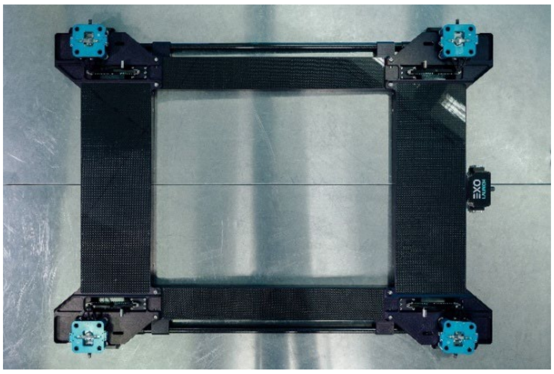
3

Installation and Operation

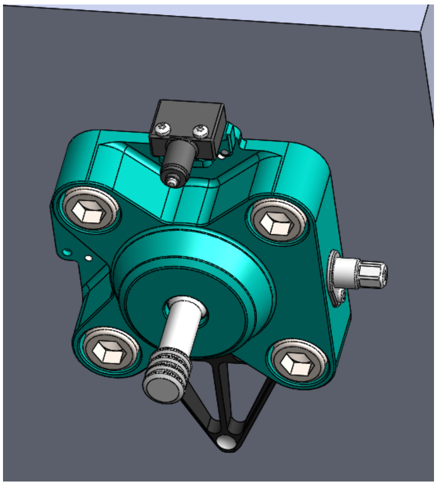
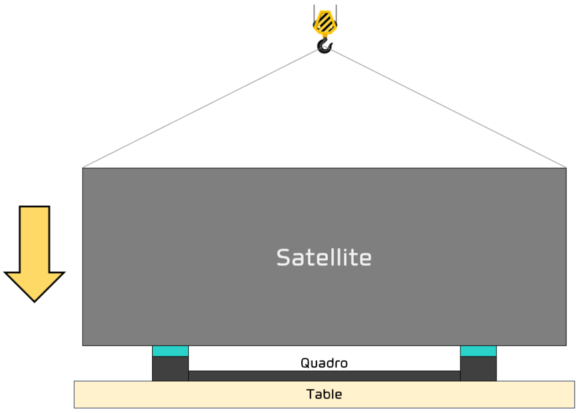
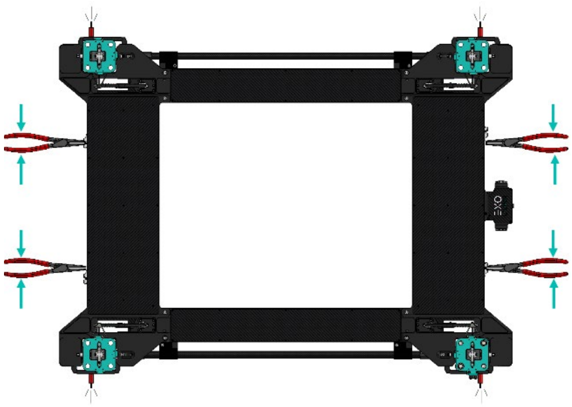
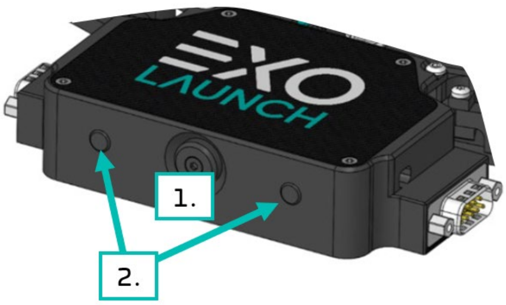
3.1 Installation Procedure Overview

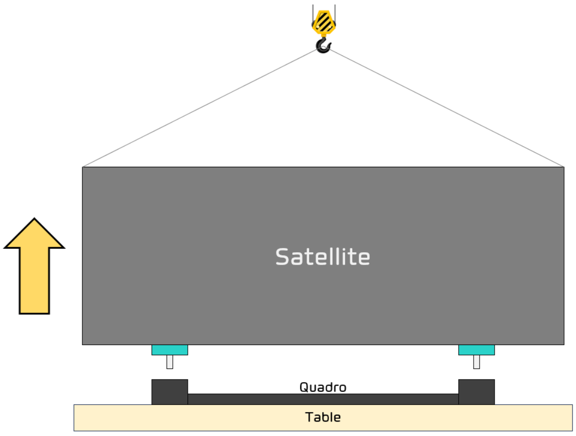
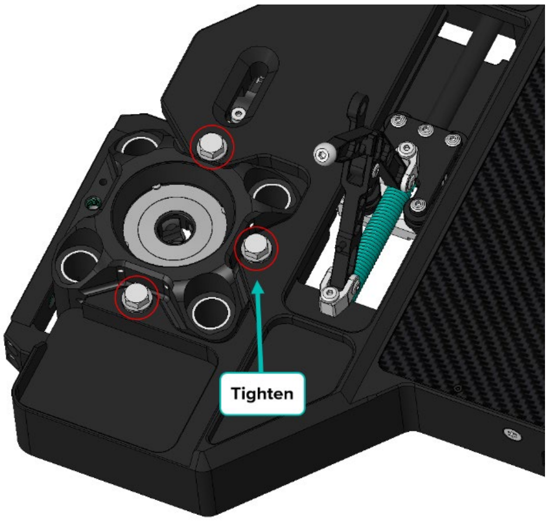
The following procedure provides a high-level overview of the installation process of Quadro Versa and shall not be used for actual operation of the system. A detailed procedure is available on request.

3.1.1 Preparation

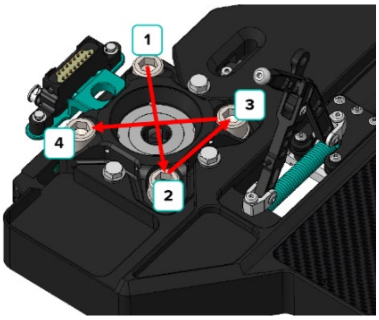
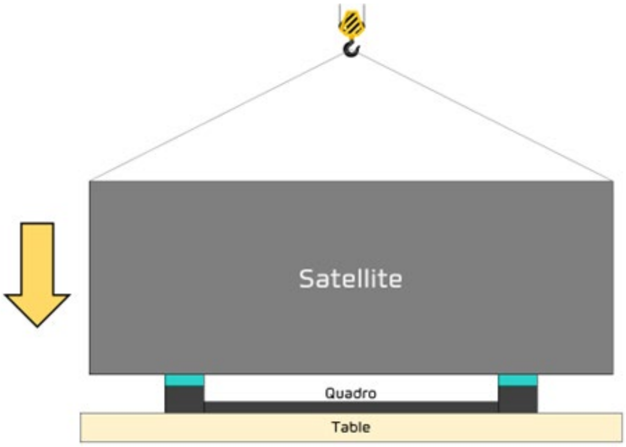
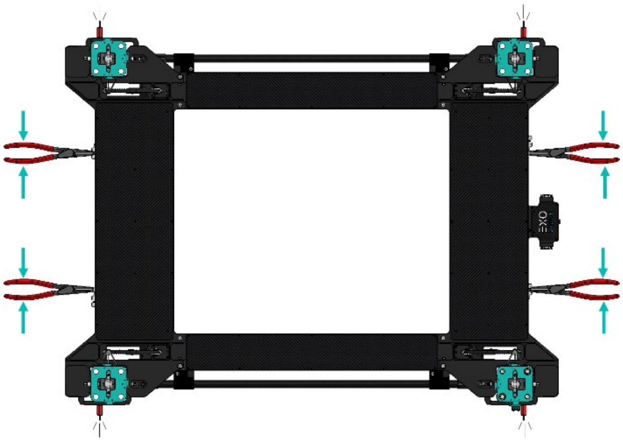
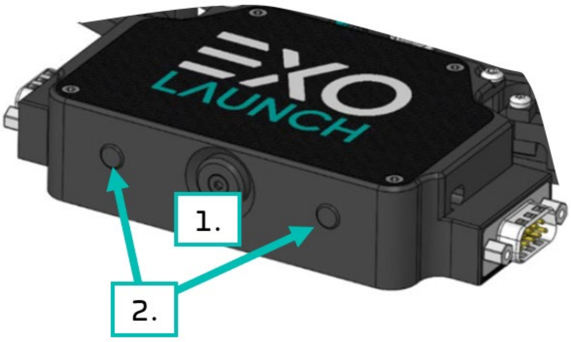
1.	**Initial condition:** Quadro Versa is shipped partially disassembled in a low-energy state, with all springs in their relaxed position. Assembly of the system to a test- or flight-ready state shall only be performed by Exolaunch personnel. The following steps assume a fully assembled Versa system.	
2.	Place the L-adapter on a stiff, flat, and clean surface capable of holding the weight of the spacecraft.	
3.	Loosen the three fixation screws holding each HDRM to the Versa structure (12 screws total).	

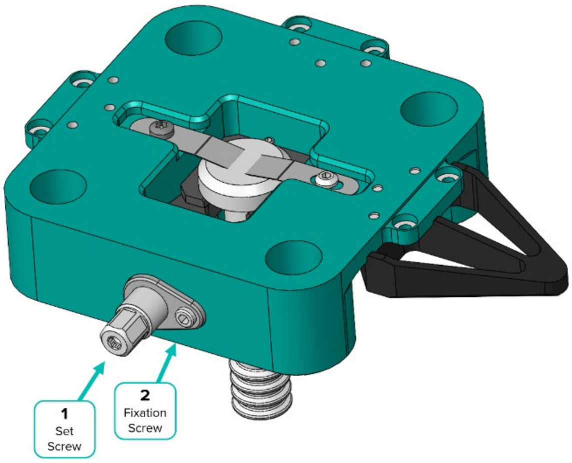
3.1.2 S-Adapter Installation And L-Adapter Alignment

4.	Install the S-adapters to the spacecraft baseplate.	
5.	Lower the satellite onto the L-adapters. With the HDRMs loosened, they will move into alignment with the S-adapters.	
6.	Clamp the Quadro Versa system.	
7.	Engage the lock mechanism.	

8.	Release the lock mechanism.	
9.	Lift the satellite.	
10.	Torque all 3 Fixation Screws on each HDRM.	

3.1.3 Launch Vehicle Installation

11.	Mate the L-Adapter to the launch vehicle mounting interface with 4x M12 and NL12ss washers.	
12.	Lower the satellite onto the L-adapters. Note that the alignment steps should have already been performed at this point.	
13.	Clamp the Quadro Versa system.	
14.	Engage the lock mechanism.	

15.	For each HDRM: 1. Preload the system by torquing the preload screw (set screw) to 25 Nm. 2. Torque the fixation screw to 2 Nm.	
16.	The system is now ready for flight	

A

Appendix

A.1. Quadro Versa Mounting Interface Definition

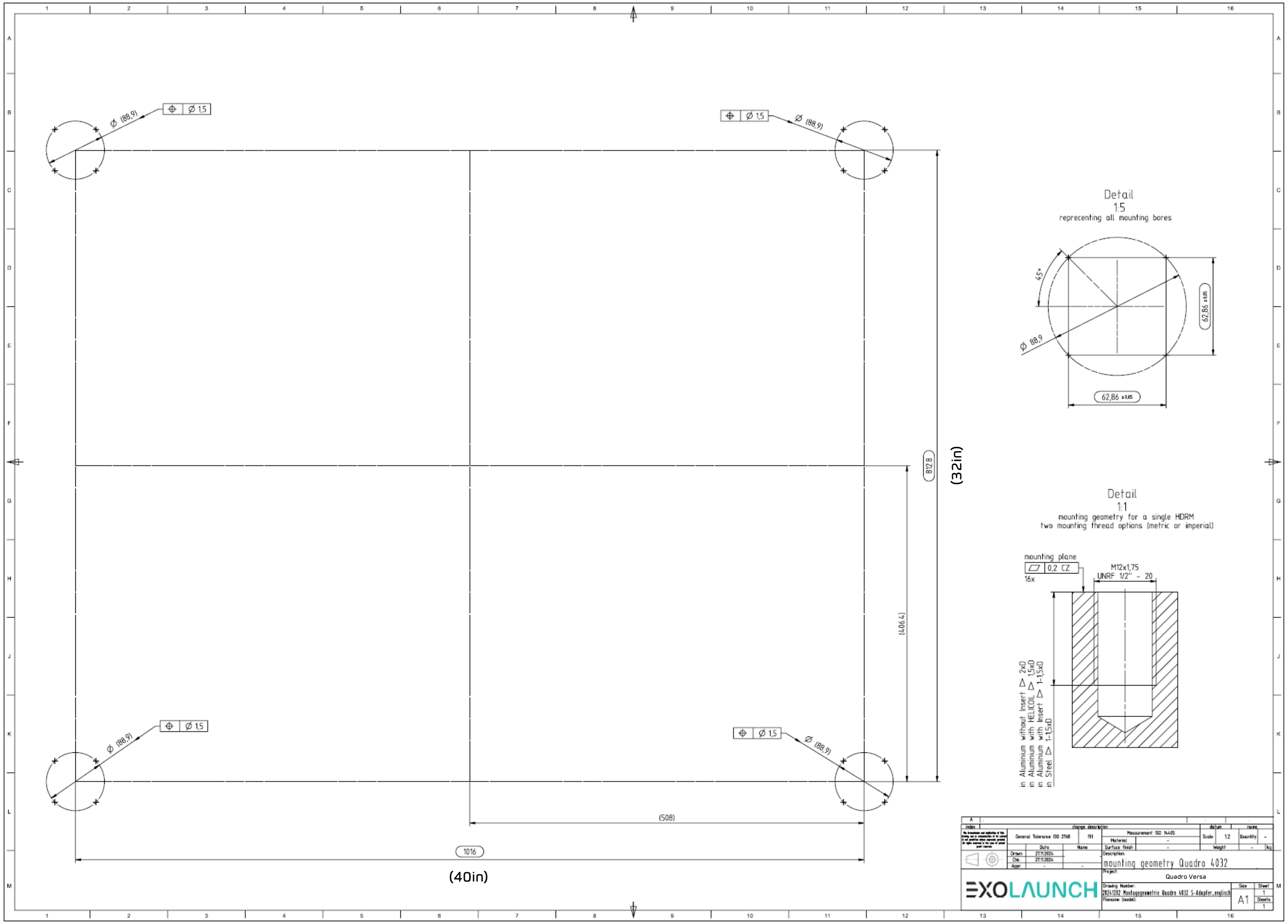


Figure 21: Quadro Versa Mounting Interface (Spacecraft or Launcher Interface). HDRM Spacing Depends on System Size.

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