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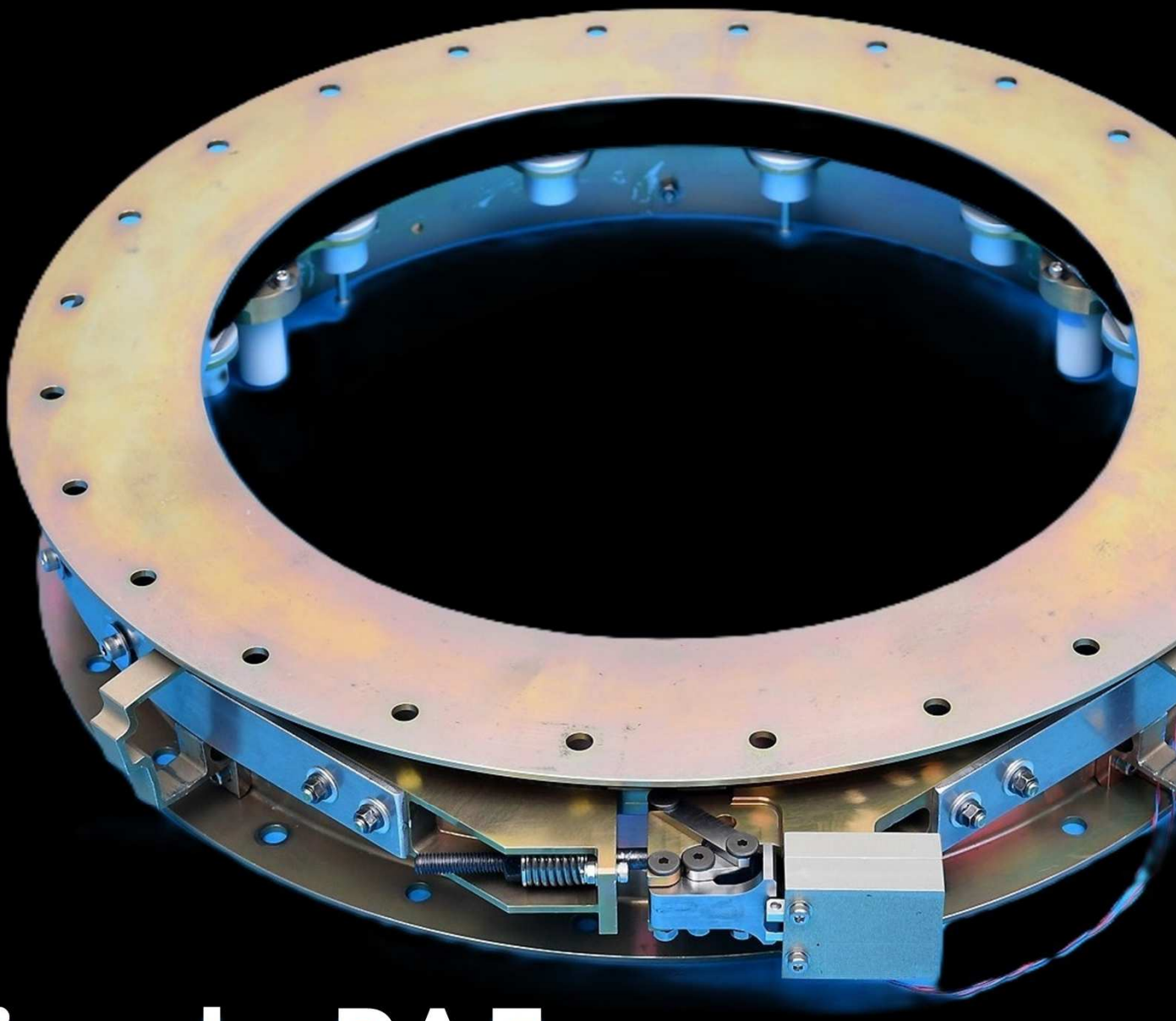


Simple PAF User's Manual

Small satellite separation system
Revision 0 February 2026

Table of Contents

1. Introduction

This document provides reference information for customers of small satellites or small payloads who consider separation mechanisms from rockets. This document is revised occasionally. Please contact us for interpretation or details of the contents of this document.

Simple PAF is a compact and reliable separation mechanism designed for small satellites or payloads. Developed by Japan's leading satellite separation experts, it brings the proven reliability of large-scale separation systems into a compact design. It features a user-friendly design that allows for simple operation. Simple PAF is compatible with a wide range of launch vehicles, making it a flexible solution for various missions. It will contribute to the successful deployment of various small satellites and payloads in space.

1. 1 Features

1) Low cost／Short delivery time

Simple PAF has a simple design and mechanism. These enable us to offer low costs and short delivery times.

- Optimizing component design for simplicity
- Reducing the number of parts
- Only bolt fastening is used for assembly.

2) Low shock

Simple PAF uses non-pyrotechnic devices in the separation mechanism. These enables us to achieve low shock levels, below 1000 Gsrs.

3) Not subject to EAR and ITAR

Simple PAF is not subject to U.S. export controls as EAR and ITAR as of January 2026. However, it is necessary for the user (exporter) to determine the violation of the latest laws and regulations of each country in export control.

4) Adoption of non-pyrotechnic devices

Since no pyrotechnic devices are used in the separation mechanism, Simple PAF is not subject to the restrictions of Japan's Explosives Control Act, which regulates the handling, storage, and transportation of explosive materials to ensure public safety.

5） Simplification of operability

Simple PAF adopts the Maruman clamp band system, allowing for easy operation with fastening required at only one location. No special qualifications are needed for assembly, enabling users to perform the work themselves. Technical support and guidance are also available upon request.

1．2 Overview

SimplePAF supports two main types of mechanical interfaces: 15M and 8M.

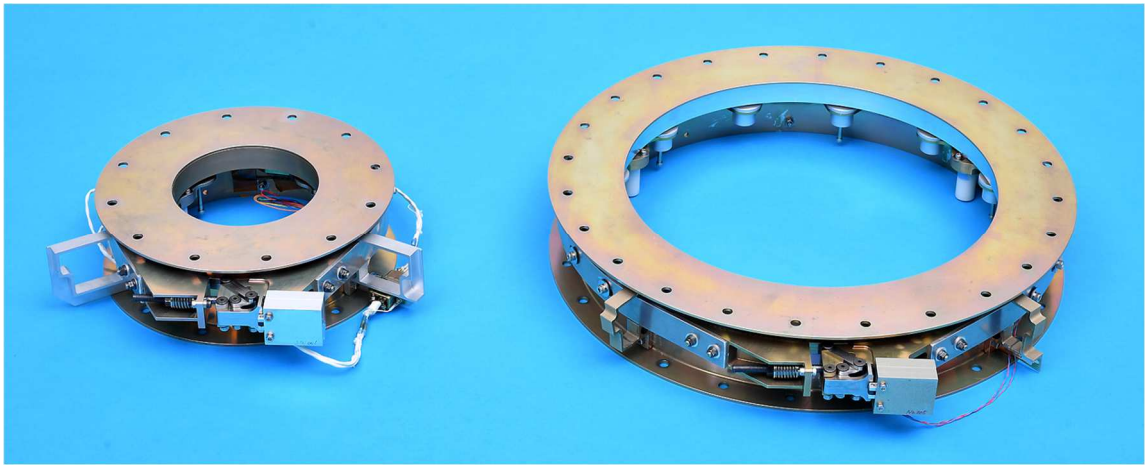
Additional interface types are planned for future release to meet a wider range of application needs.

Table 1.2-1 Simple PAF Type and Overview

Type		Simple PAF 8M	Simple PAF 15M
Mechanical Interface with Satellite	Pitch Circle Diameter(PCD)	203.2mm(8in)	381.0mm(15in)
	Number of Bolts	12	24
	Bolt standard	NAS6204-xx：1/4in Hex head bolt	
	Fastening torque	7.1~8.6N・m	
Electrical Interface with Satellite		Separation confirmation Switch 2ch or 3ch：Options UMB（Signal Lines 14ch）：Options	
Satellite Frame Mass		0.4kg*1	0.8kg*1
Mechanical Interface with Launch Vehicle	Pitch Circle Diameter(PCD)	203.2mm(8in)	381.0mm(15in)
	Number of Bolts	12	24
	Bolt standard	NAS6204-xx：1/4in Hex head bolt	
Electrical Interface with Launch Vehicle		2 Operating Lines：Standard Separation confirmation Switch 2ch：Options UMB（Signal Lines 14ch）：Options	
Satellite Release Spring		6 Springs	12 Springs
Band Clamping Force		6kN	6kN or 8.4kN*2
Total Mass of Simple PAF		2.4kg*1	3.6kg*1

*1：Except for accessories such as separation confirmation switches, and umbilical lines.

*2：Clamping force varies according to satellite mass, center of gravity and static acceleration.



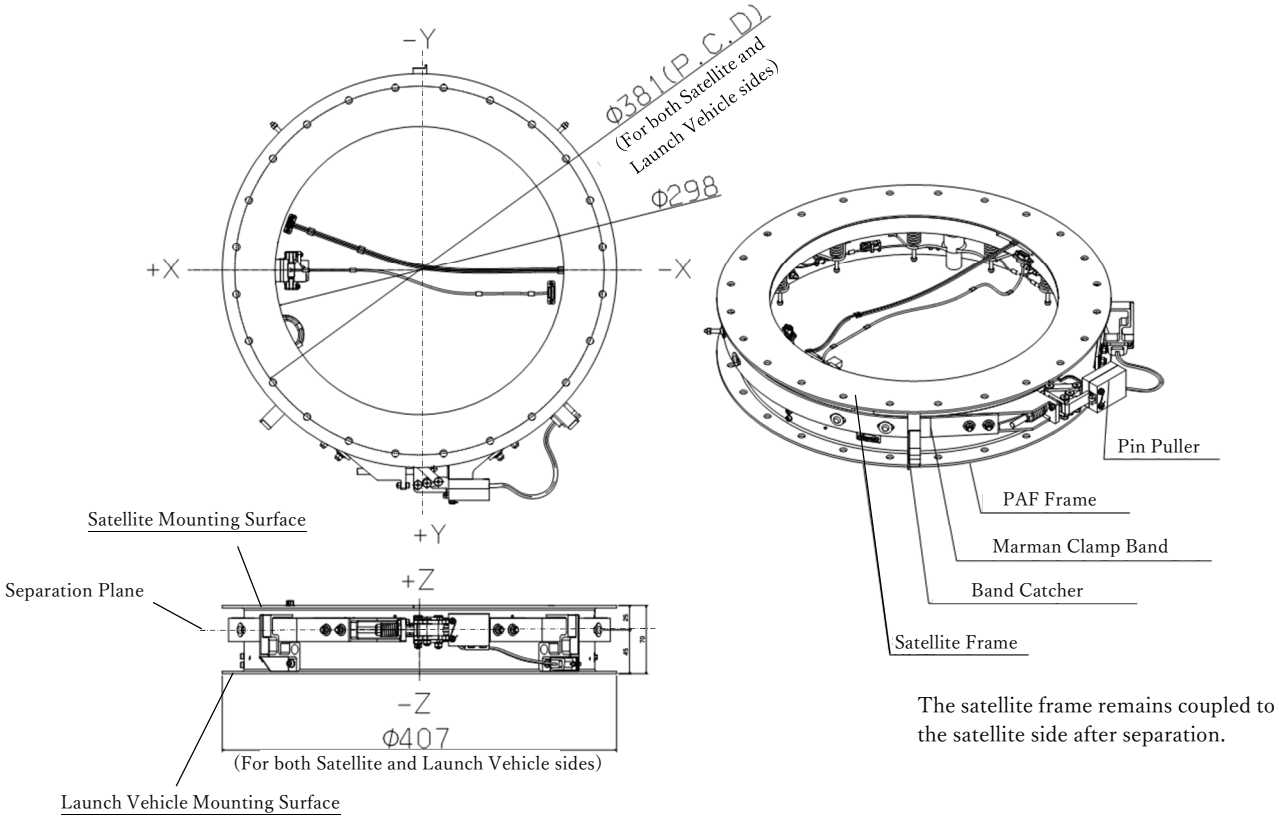
Simple PAF 8M Simple PAF 15M

Picture 1.2-1 Appearance of Simple PAF

2. System Configuration

2. 1 Component Configuration of Simple PAF

Simple PAF utilizes a highly reliable Maruman clamp band system to ensure secure coupling between frames. The band is released at a single pin puller location, and the separated band is captured by three band catchers. This configuration achieves reliable separation with a minimal number of components. [Figure 2.1-1]
The combination procedure is very simple. First, the satellite frame is attached to the satellite, and then the satellite with the satellite frame attached is connected to the PAF. Finally, the PAF can be connected to the rocket side to complete the combination.



Origin : X axis, Y axis is the center of the frame, Z axis is the separation plane

Figure 2.1-1 Overview of PAF Components (15M Type)

2．2　Available Options

The following optional components are available for Simple PAF. Users can select from these options based on their specific requirements.

・Separation Confirmation Switch for Satellite；3ch (Figure 2.2-1)，2ch (Figure 2.2-2)
・Separation Confirmation Switch for Launch Vehicle；2ch (Figure 2.2-3)
・Umbilical Line (Figure 2.2-4)

Specifications other than those listed above can be requested by the user. These will be handled as custom orders through mission-specific modifications.

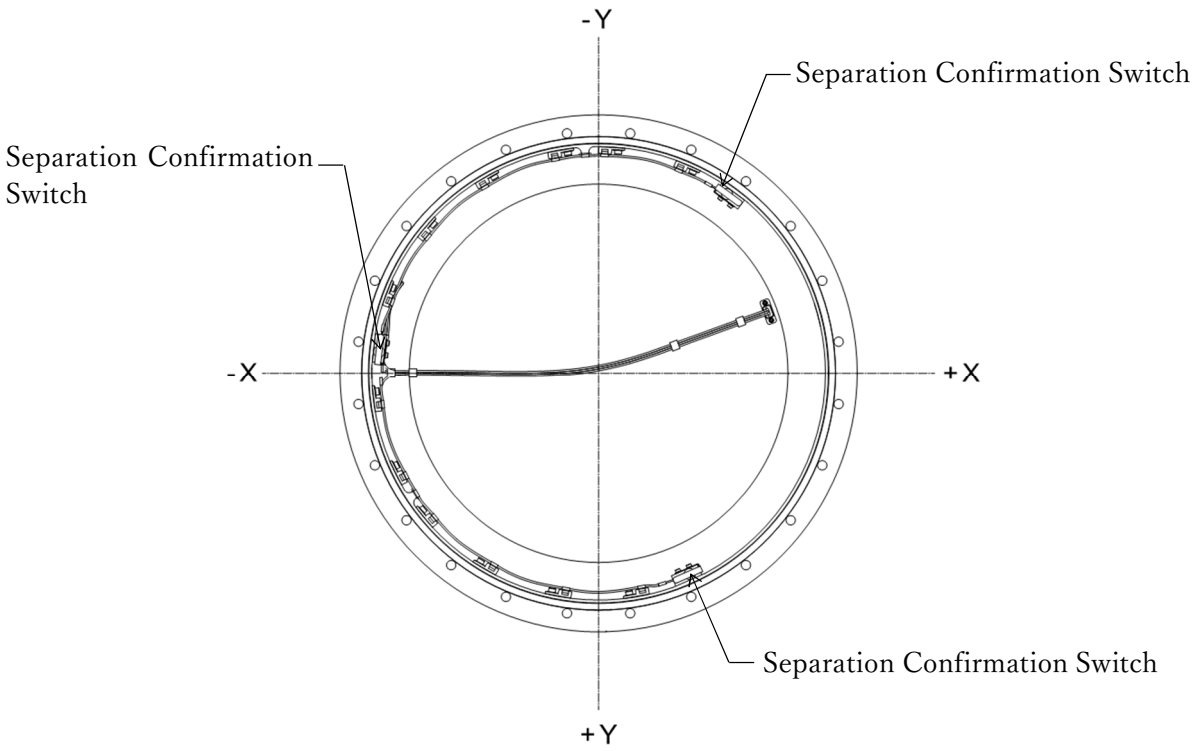


Figure 2.2-1　Separation Confirmation Switch for Satellite；3ch (15M Type)

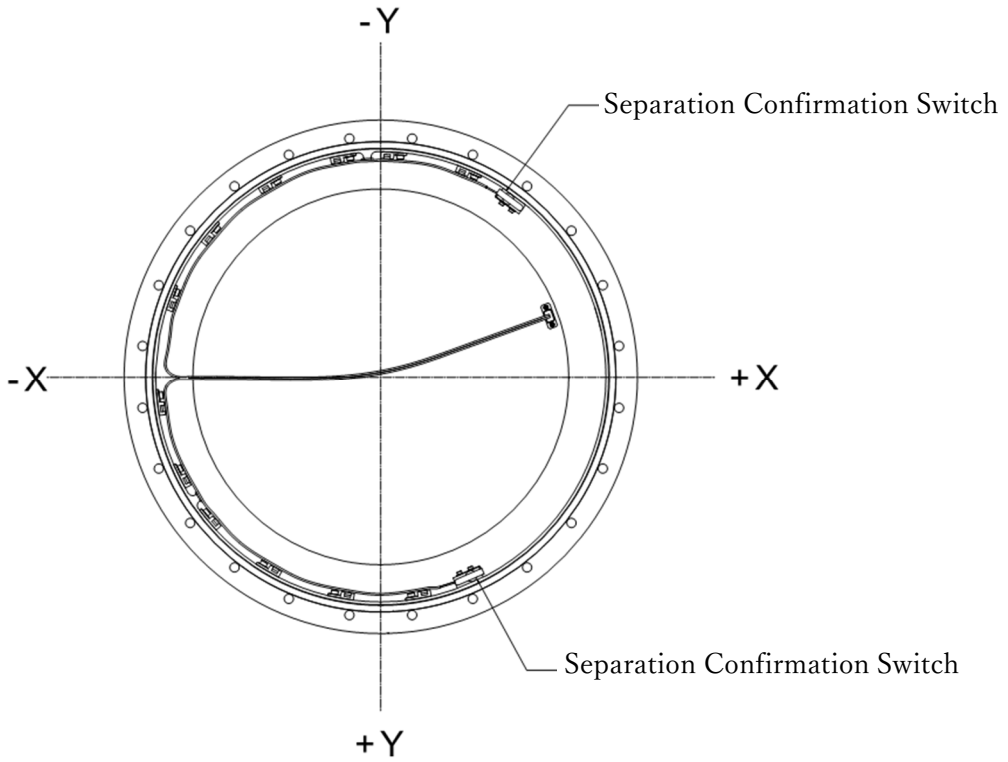


Figure 2.2-2 Separation Confirmation Switch for Satellite ; 2ch (15M Type)

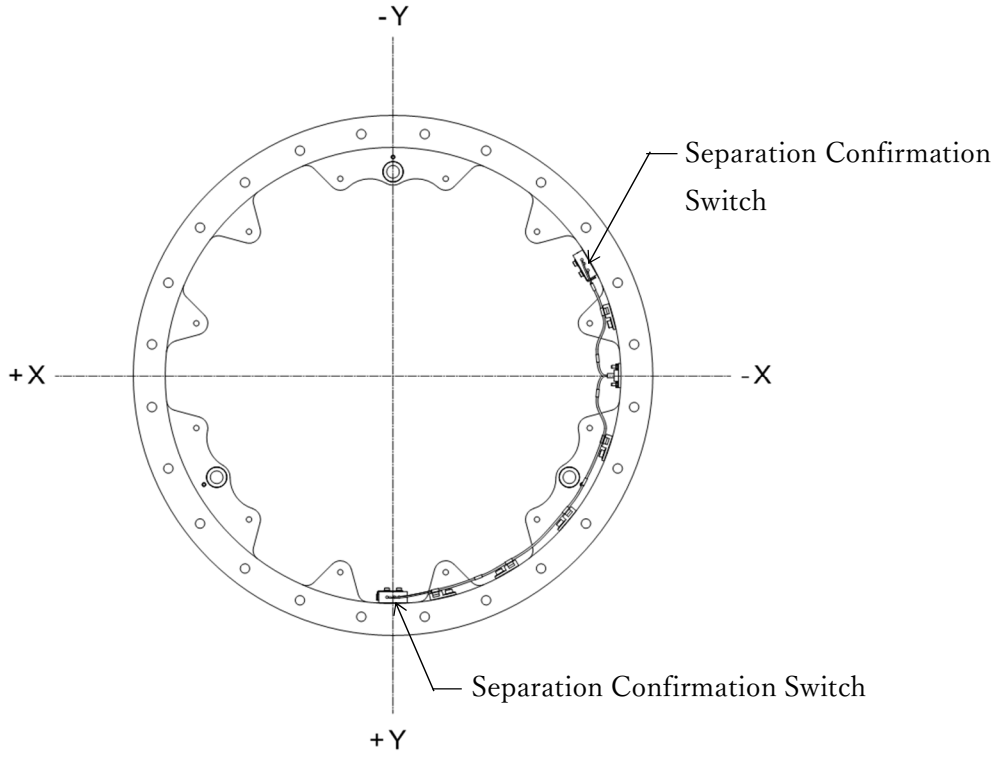


Figure 2.2-3 Separation Confirmation Switch for Launch Vehicle ; 2ch (15M Type)

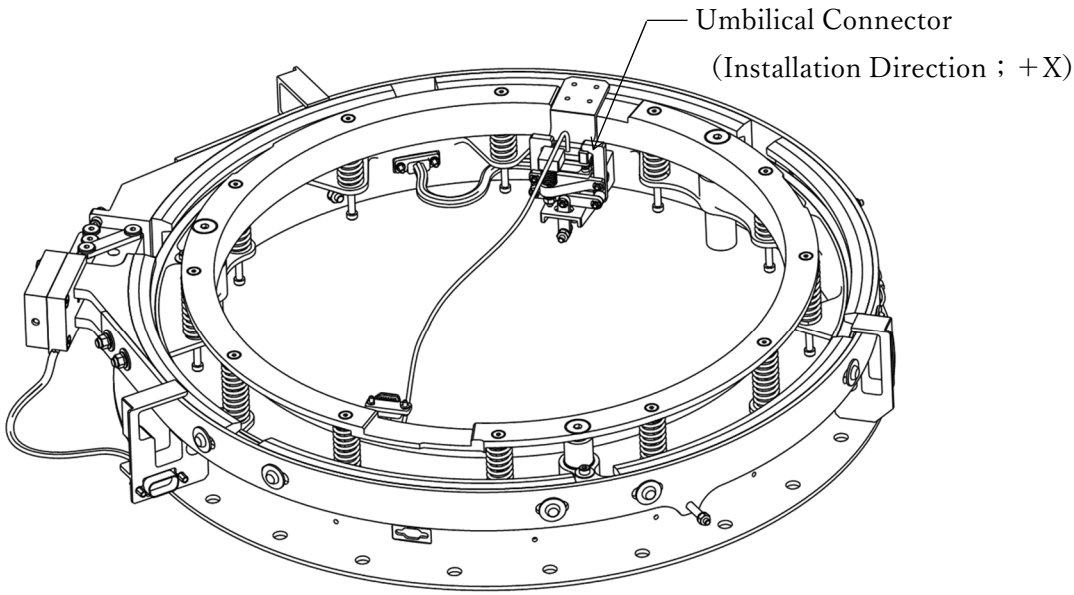


Figure 2.2-4 Umbilical Line (15M Type)

3. Interface

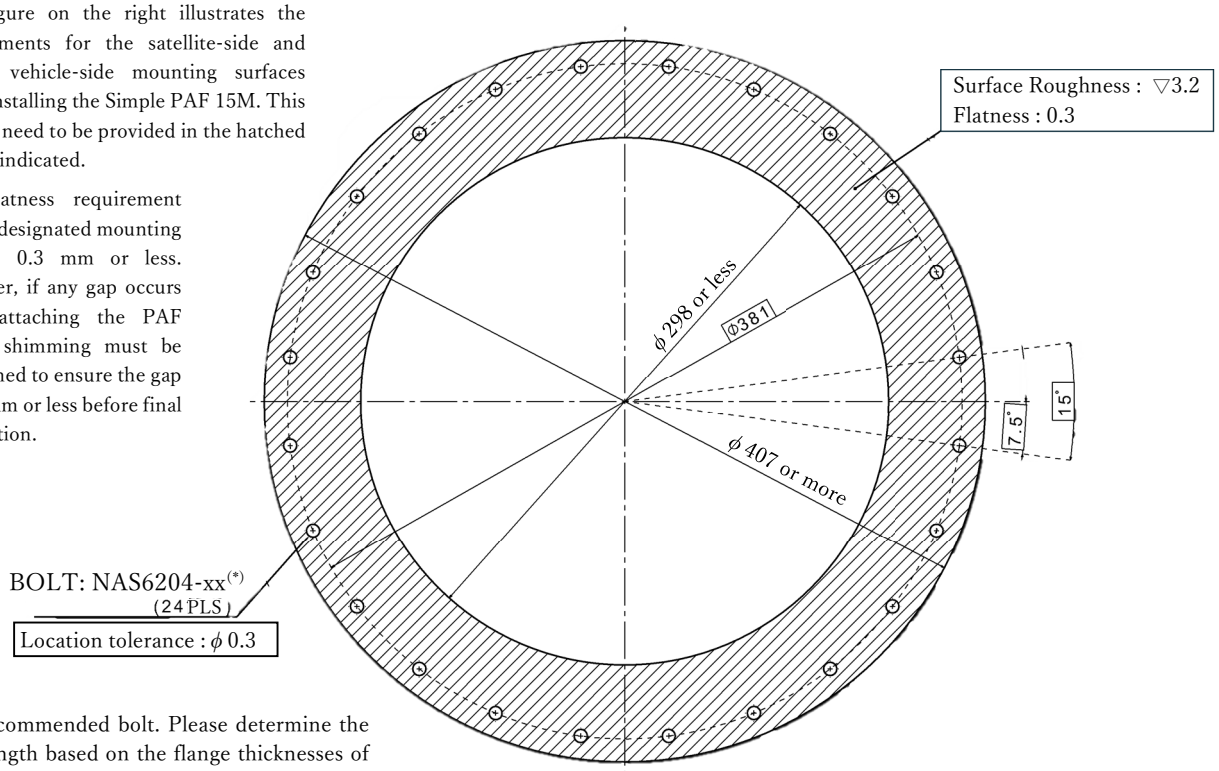
3. 1 Mechanical Interface

3. 1. 1 Interface Plane

The mounting plane specifications for the satellite side and launch vehicle side, which interface with the frame of Simple PAF, are shown below.

The figure on the right illustrates the requirements for the satellite-side and launch vehicle-side mounting surfaces when installing the Simple PAF 15M. This surface need to be provided in the hatched area as indicated.

The flatness requirement for the designated mounting area is 0.3 mm or less. However, if any gap occurs when attaching the PAF frame, shimming must be performed to ensure the gap is 0.2 mm or less before final installation.



(*) Recommended bolt. Please determine the grip length based on the flange thicknesses of both the satellite and launch vehicle sides.
The flange thickness of the PAF-side frame is 2.5 mm on both the satellite and launch vehicle sides.

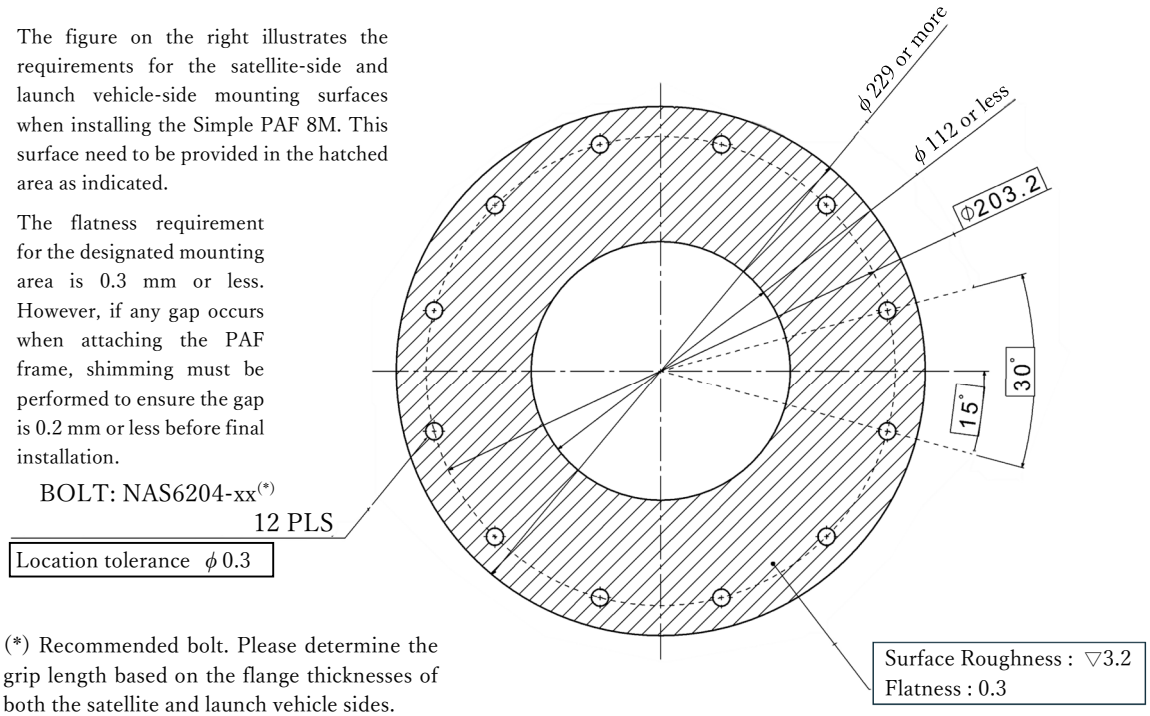
Unit : mm, except where otherwise noted

Fasteners for mounting the PAF to the satellite and launch vehicle sides (such as bolts, nuts, inserts, washers, and shims) should be prepared by the user. It is recommended that nuts or inserts are self-locked feature. Note that KHI can provide them if requested, but they will be treated as Mission Modification (M/M).

Figure 3.1.1-1 Simple PAF 15M Mechanical Interface with Satellite and Launch Vehicle

The figure on the right illustrates the requirements for the satellite-side and launch vehicle-side mounting surfaces when installing the Simple PAF 8M. This surface need to be provided in the hatched area as indicated.

The flatness requirement for the designated mounting area is 0.3 mm or less. However, if any gap occurs when attaching the PAF frame, shimming must be performed to ensure the gap is 0.2 mm or less before final installation.



(*) Recommended bolt. Please determine the grip length based on the flange thicknesses of both the satellite and launch vehicle sides.
The flange thickness of the PAF-side frame is 4.0 mm on the satellite side and 4.5 mm on the launch vehicle side.

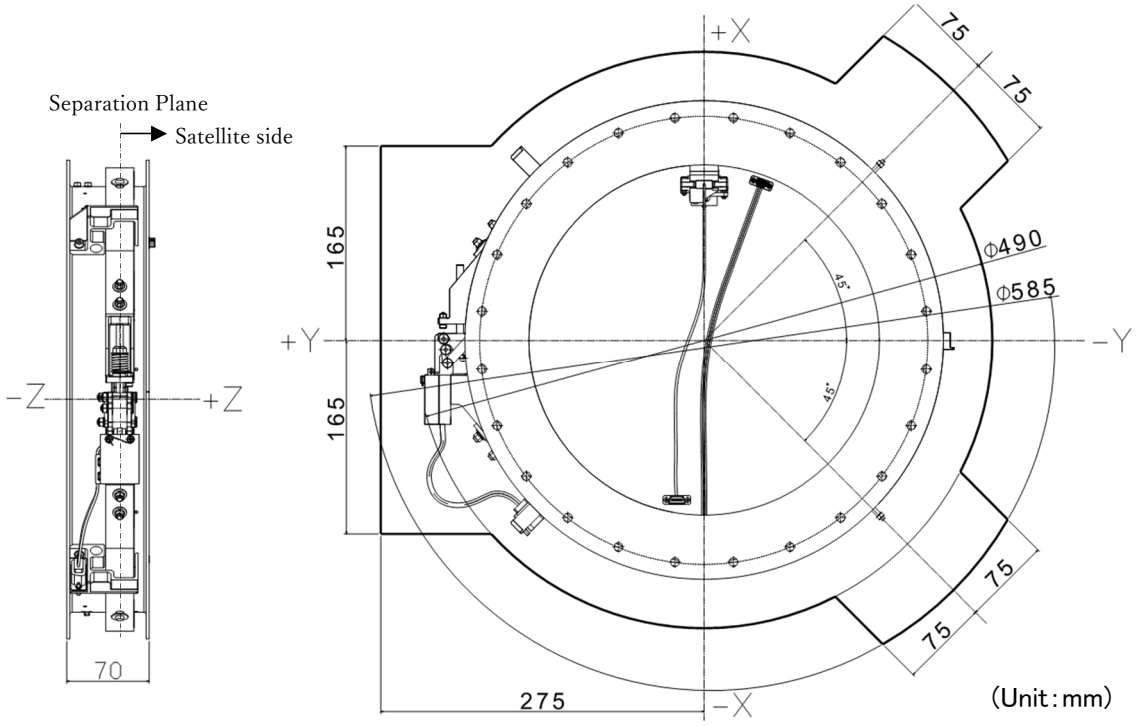
Unit : mm, except where otherwise noted

Fasteners for mounting the PAF to the satellite and launch vehicle sides (such as bolts, nuts, inserts, washers, and shims) should be prepared by the user. It is recommended that nuts or inserts are self-locked feature. Note that KHI can provide them if requested, but they will be treated as Mission Modification (M/M).

Figure 3.1.1-2 Simple PAF 8M Mechanical Interface with Satellite and Launch Vehicle

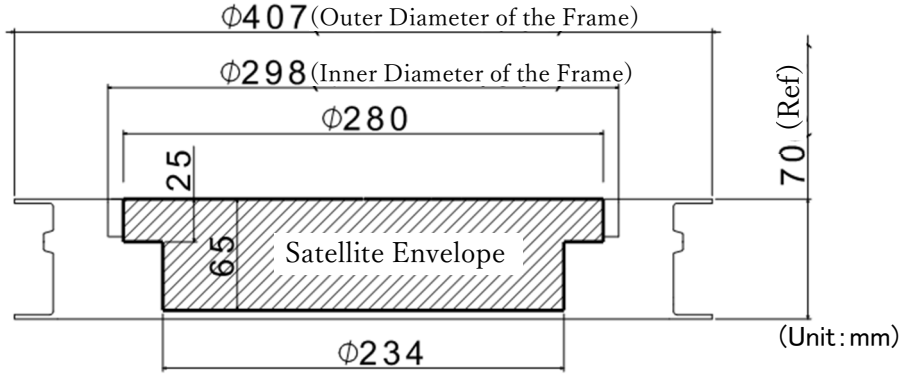
3．1．2 Envelope Requirements

The satellite envelope areas of both the outer and inner sides of the PAF are shown below, because it is necessary to consider the moving area during band separation and the space during the coupling operation, even if they do not interfere with the PAF.



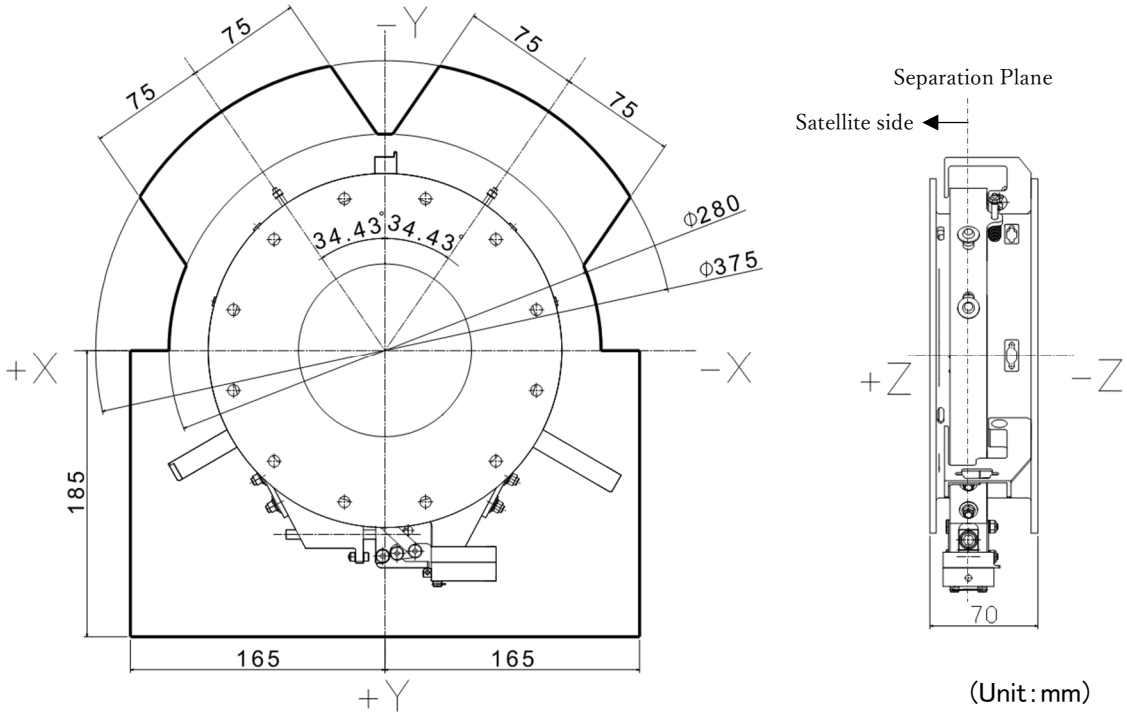
The outer contour line (bold line) shown above indicates the satellite envelope area, which defines the region where satellite structures are permitted. This area takes into account the dynamic behavior of the clamp band during separation, as well as the required working space.

Figure 3.1.2-1 Satellite Allowable Area Outside Simple PAF 15M



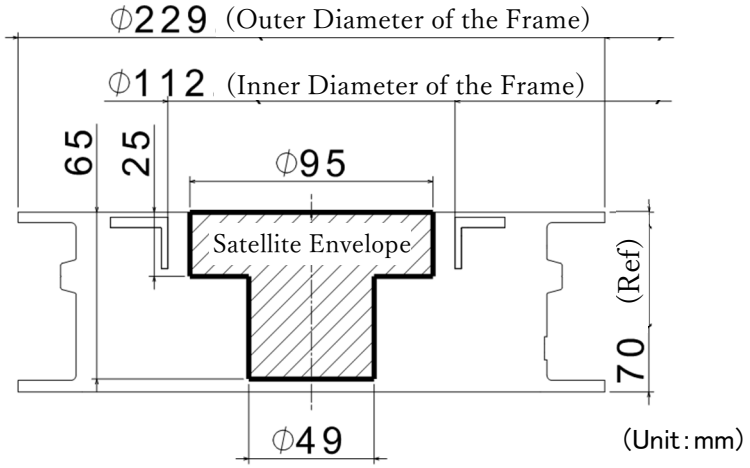
The hatched area shown above represents the satellite envelope area, where satellite structures are permitted. However, considering dynamic deformation caused by static acceleration and vibration environments, satellite components must not extend beyond this designated area. Additionally, when an umbilical line is installed, potential interference with its components and the wiring of the satellite-side separation confirmation switches must be separately evaluated.

Figure 3.1.2-2 Satellite Allowable Area Inside Simple PAF 15M



The outer contour line (bold line) shown above indicates the satellite envelope area, which defines the region where satellite structures are permitted. This area takes into account the dynamic behavior of the clamp band during separation, as well as the required working space.

Figure 3.1.2-3 Satellite Allowable Area Outside Simple PAF 8M



The hatched area shown above represents the satellite envelope area, where satellite structures are permitted. However, considering dynamic deformation caused by static acceleration and vibration environments, satellite components must not extend beyond this designated area. Additionally, when an umbilical line is installed, potential interference with its components and the wiring of the satellite-side separation confirmation switches must be separately evaluated.

Figure 3.1.2-4 Satellite Allowable Area Inside Simple PAF 8M

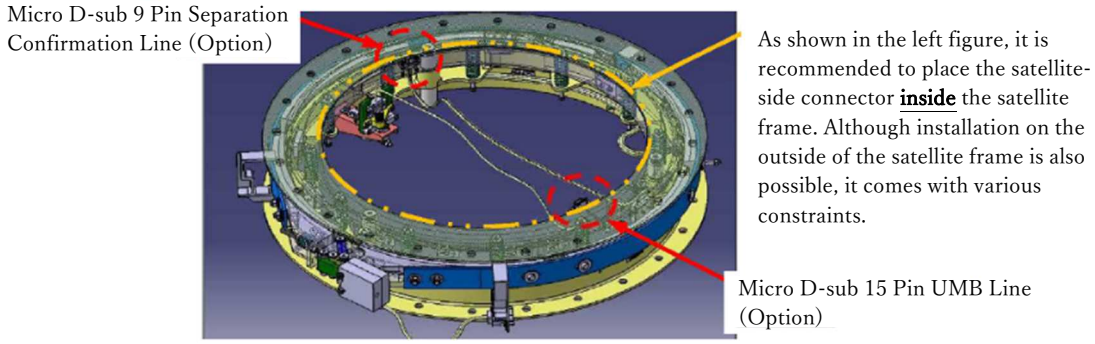
3．2 Electrical Interface

3．2．1 Connector Interface

Specifications for interface connectors with the launch vehicle and the satellite are shown below. These specifications apply to both the 15M and 8M models.

Function	Connector Part Number : Recommended Item*1		Installation Point
	PAF-side	Satellite-side	
Separation Confirmation Line	MDM-9SHV37K-A174	MDM-9PH***-A174 Use *** to select the line type and related settings. ※Jack Post : #2-56UNC-2A	Satellite
UMB Line	MDM-15SHV37K-A174	MDM-15PH***-A174 Use *** to select the line type and related settings. ※Jack Post : #2-56UNC-2A	Satellite

*1 : It is recommended to select either a recommended connector or one that is compatible. Non-compatible connectors can also be supported, but they will require a custom design.

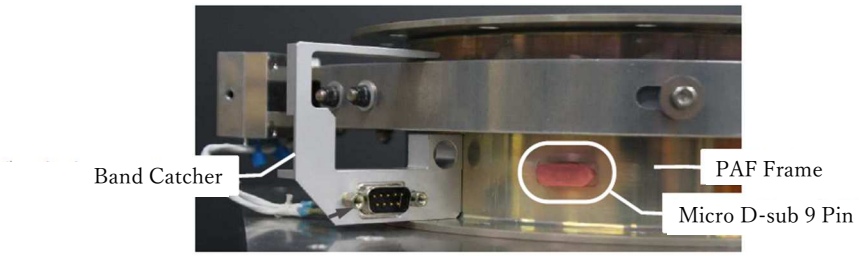


Example of interface connector installation with the satellite (This fugure shows the Simple PAF 15M.)

Figure 3.2.1-1 Satellite Interface Connector (15M / 8M)

Function	Connector Part Number : Recommended Item[*1]		Installation Point
	Launch Vehicle-side ; Recommended Item(*1)	PAF-side	
Separation System Line	M24308/4-1Z	M24308/2-1Z	Band Catcher
Separation Confirmation Line	MDM-9SH***-A174 Use *** to select the line type and related settings. ※Jack Screw : #2-56UNC-2B	MDM-9PHV37P-A174	PAF Frame
UMB Line	MDM-15SH***-A174 Use *** to select the line type and related settings. ※Jack Screw : #2-56UNC-2B	MDM-15PHV37P-A174	PAF Frame

*1 : It is recommended to select either a recommended connector or one that is compatible. Non-compatible connectors can also be supported, but they will require a custom design.



Example of interface connector installation with the launch vehicle (This photo shows the Simple PAF 8M.)

Figure 3.2.1-2 Launch Vehicle Interface Connector (15M / 8M)

3．2．2 Wiring Interface

Wiring diagrams for the actuation line, separation confirmation line, and umbilical (UMB) line are shown below.

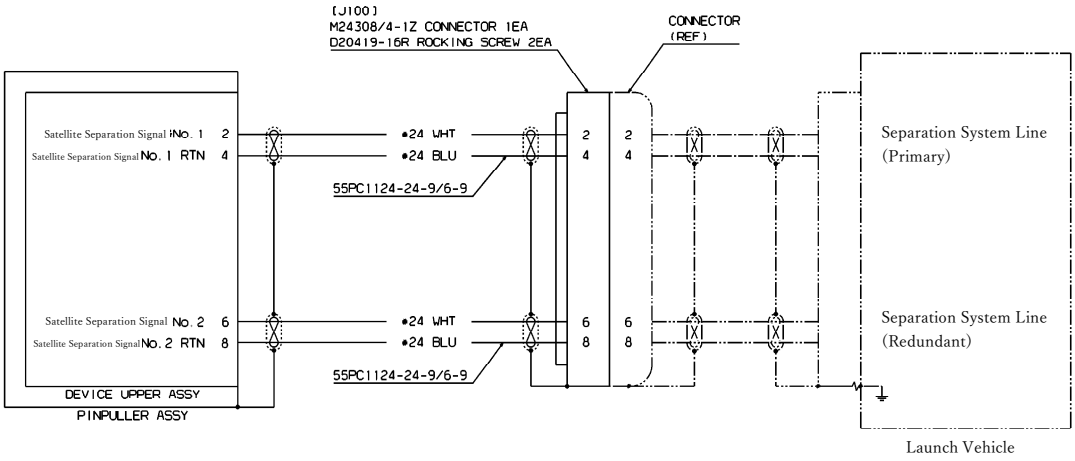
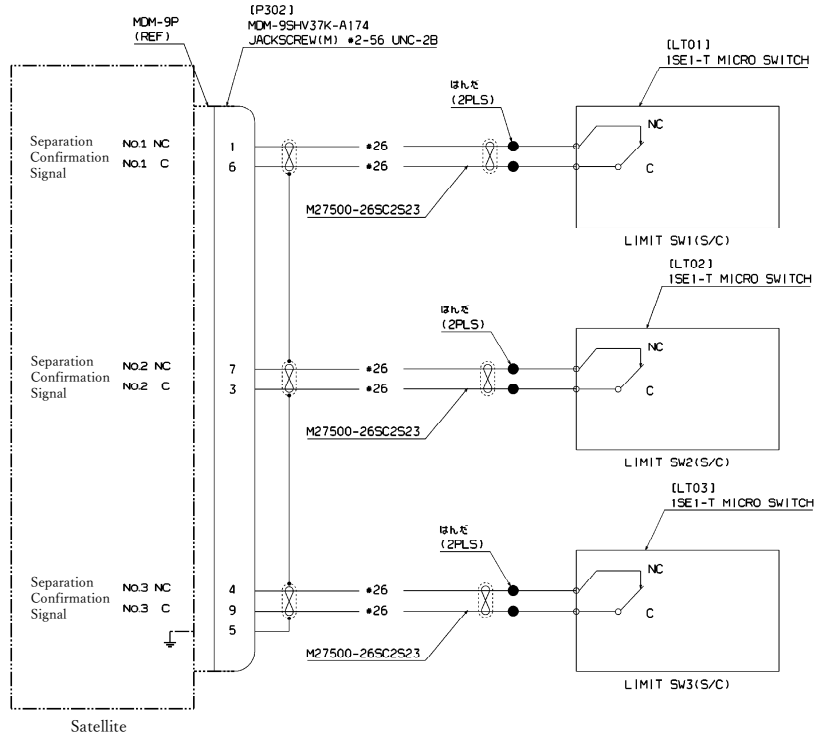
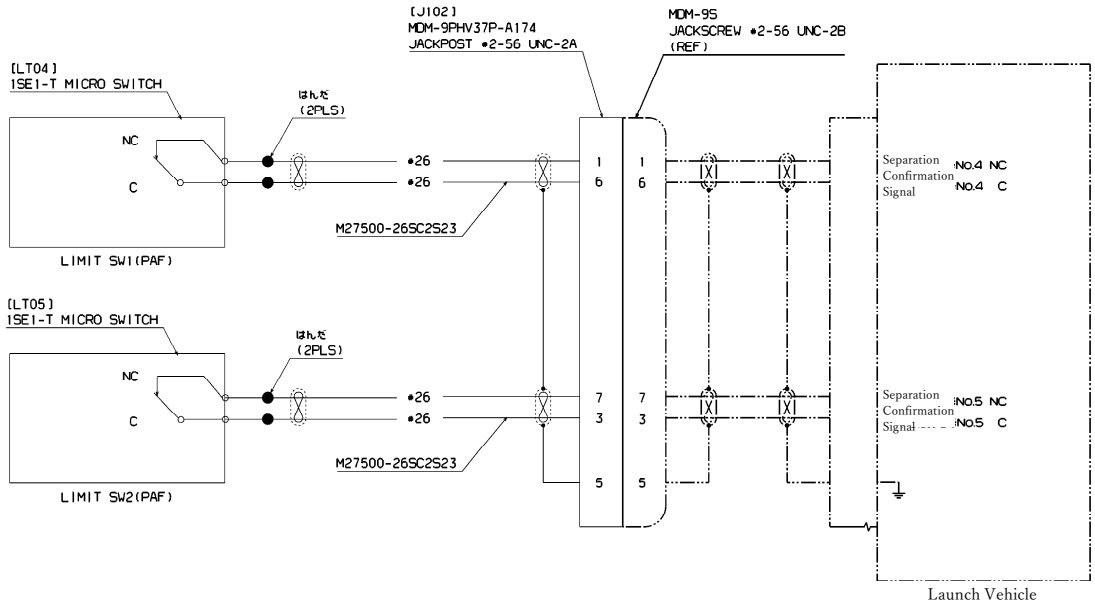


Figure 3.2.2-1 Actuation Line Wiring Diagram (Mounted on Launch Vehicle)(15M/8M)



Note: In this diagram, wiring is shown connected to the Normally Closed (NC) terminals of the microswitch. However, wiring to the Normally Open (NO) terminals is also possible.

Figure 3.2.2-2 Separation Confirmation Line Wiring Diagram (Mounted on Satellite)(15M/8M)



Note: In this diagram, wiring is shown connected to the Normally Closed (NC) terminals of the microswitch. However, wiring to the Normally Open (NO) terminals is also possible.

Figure 3.2.2-3 Separation Confirmation Line Wiring Diagram (Mounted on Launch Vehicle)(15M/8M)

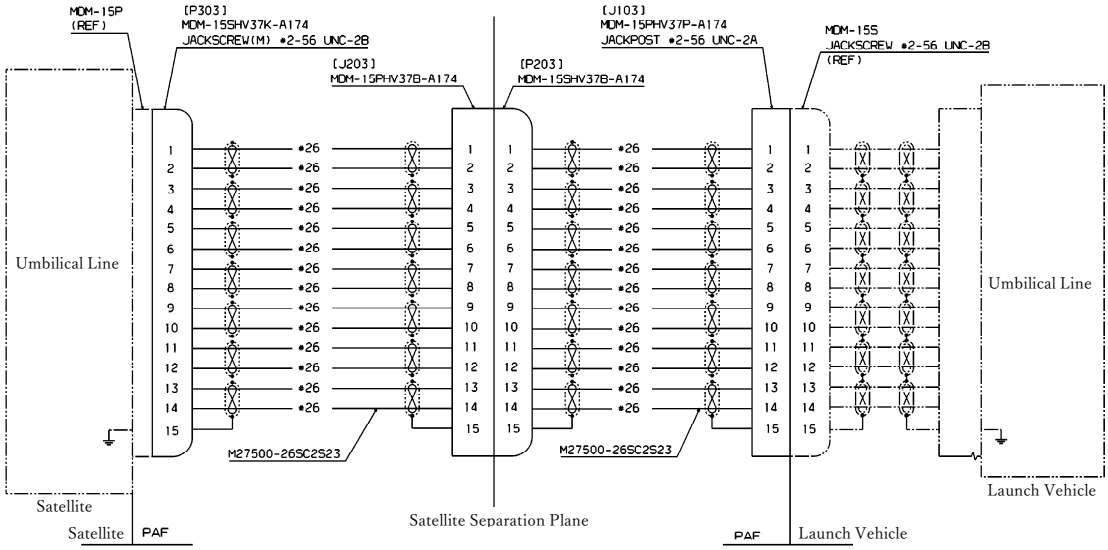


Figure 3.2.2-4 UMB Line Wiring Diagram (Satellite / Launch Vehicle) (15M/8M)

3．2．3 Separation Signal Interface

The operation of Simple PAF is constrained only by current and actuation time; voltage is not a limiting factor. The required conditions for current and actuation time are shown below. Please set the current and the actuation time within the allowable range.

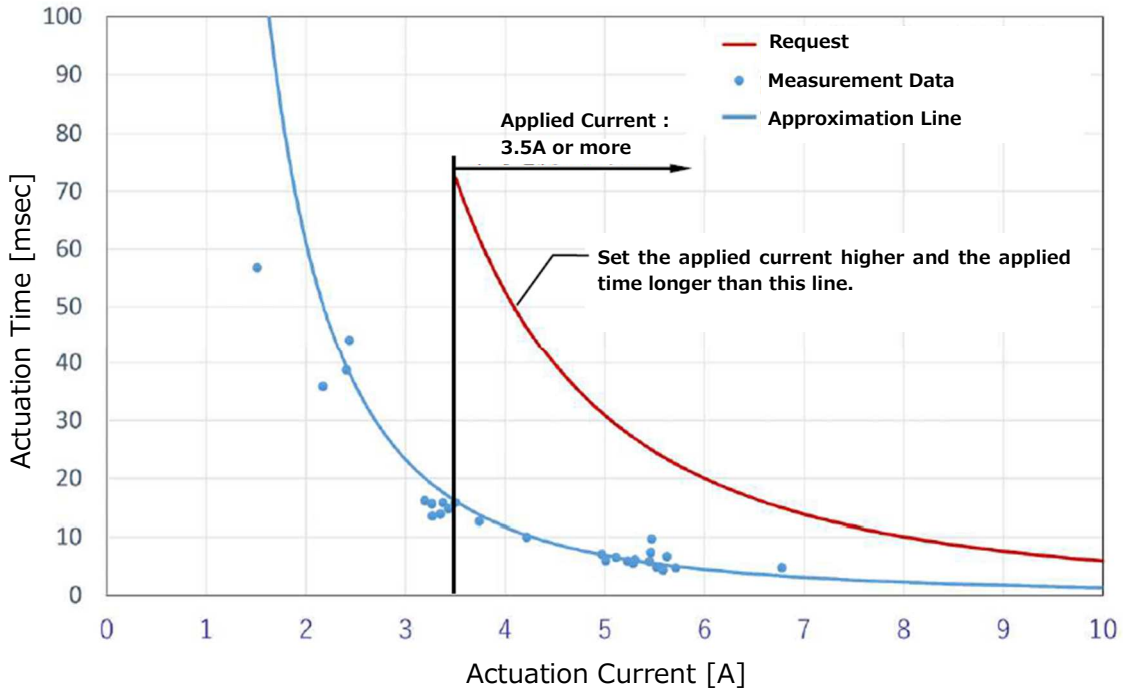


Figure 3.2.3-1 The relationship of the current and the actuation time (15M / 8M)

4. Specifications

4. 1 Maximum Load / Stiffness

Regarding the maximum load of Simple PAF, it has been verified that the components can withstand equivalent axial loads (Limit) in this range. For detailed information, please contact KHI.

Table 4.1-1 Equivalent axial load*1

Type	Simple PAF 8M	Simple PAF 15M
Equivalent axial loads(Limit)	-55.9~+53.3kN	-91.2~+86.0kN

*1 : Set the pull direction 「+」

The most suitable type of Simple PAF is selected according to the requirements of the rocket and the rigidity and mass characteristics of the satellite. The following table shows the maximum mass of a satellite as an estimate. However, the rigidity of the satellite may limit the maximum mass, so it is advisable to choose a larger diameter type. For detailed information, please contact KHI.

Table 4.1-2 Maximum mass of a satellite*1

Type	Simple PAF 8M	Simple PAF 15M
Maximum mass of a satellite	100kg	250kg

*1 : This is an estimate. The mass changes depending on the position of the center of gravity and the response of the vibration environment.

4．2 Separation Velocity

The satellite is pushed out by a spring-loaded satellite deployment plate while maintaining horizontal alignment via guide mechanisms. The springs are selectable from light, medium, or heavy types depending on the satellite's mass. No load adjustment is required based on the satellite's center of gravity.

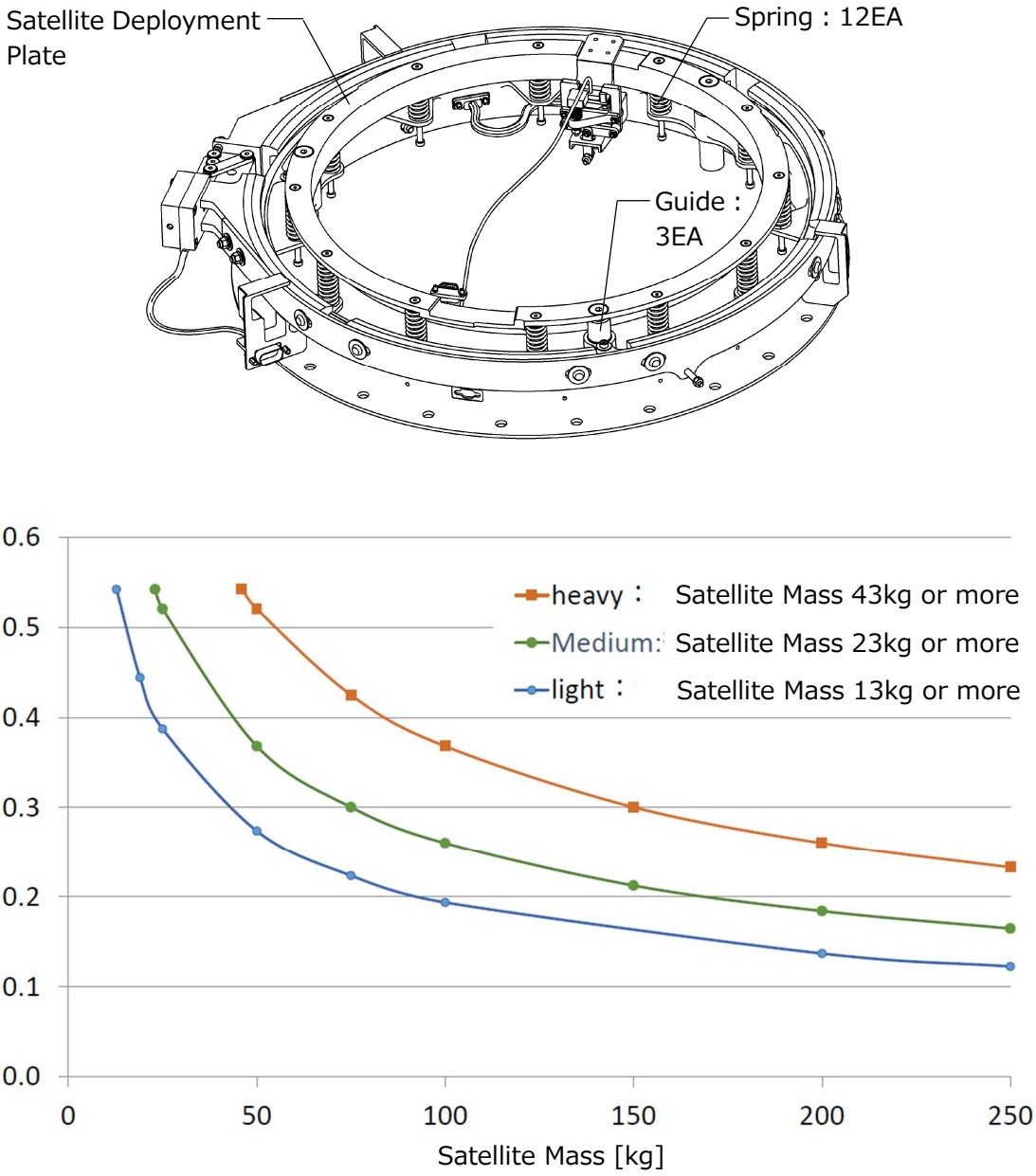
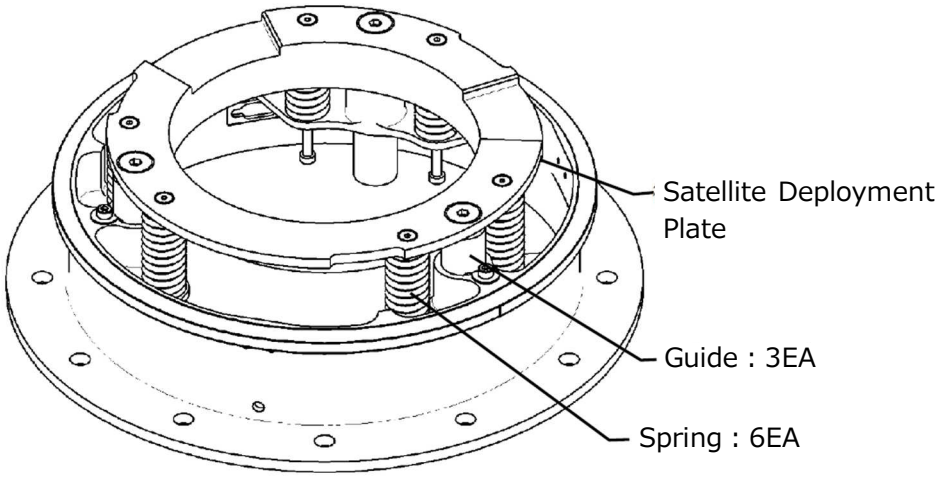


Figure 4.2-1 Overview of Satellite Release Mechanism and Relationship Between Satellite Mass and Separation Velocity (Analyses) – Simple PAF 15M



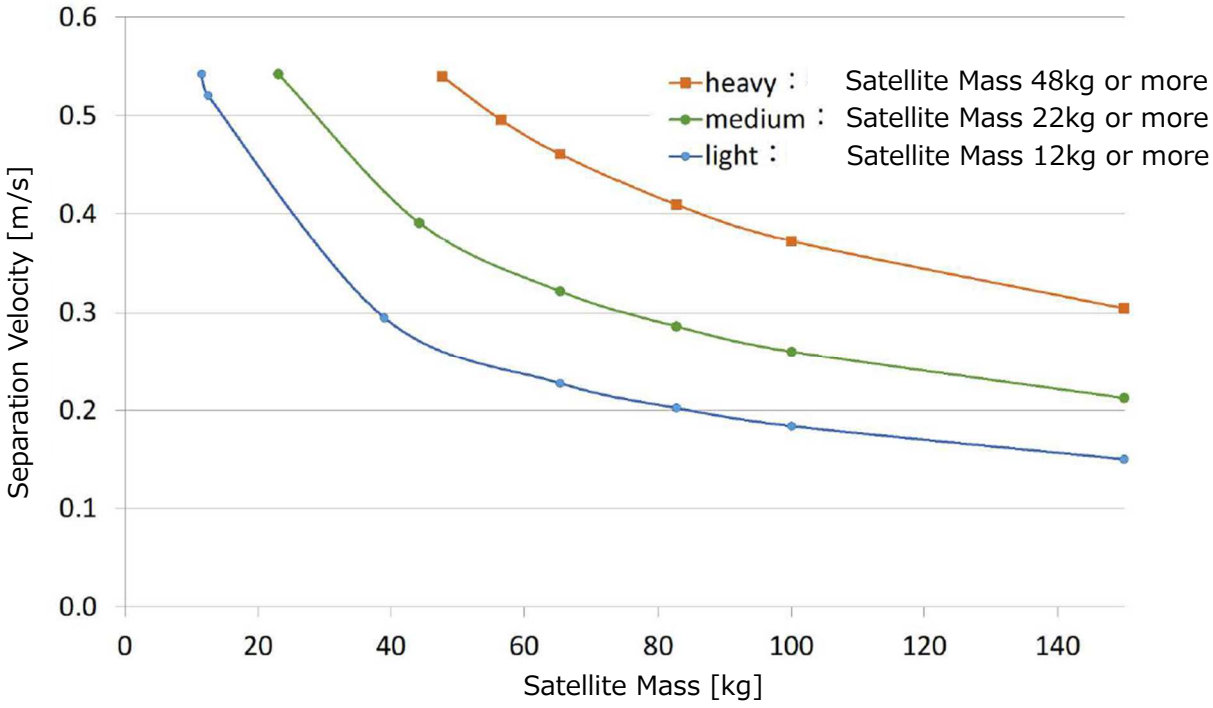


Figure 4.2-2 Overview of Satellite Release Mechanism and Relationship Between Satellite Mass and Separation Velocity (Analyses) – Simple PAF 8M

4．3 Separation Angular Velocity（Tip-off Rate）

The satellite's separation angular velocity caused by the PAF during release can be calculated by dividing the torque impulse (obtained using the equation below) by the satellite's moment of inertia.

$$\text{The Torque Impulse} = 0.36 \times (5 + 1000 / 3 \times L) \ [\text{deg/sec} \cdot \text{kg} \cdot \text{m}^2]$$

Here, L [m] represents the offset of the satellite's center of gravity — the distance from the center of the plane perpendicular to the release direction to the center of gravity.

4．4 Separation Shock

The separation shock is shown below. The shock level was low, at less than 400 Gsrs. The test was produced higher shock levels, as the mock satellite (including the satellite frame) was relatively light — 3.6 kg for the 15M model and 3.0 kg for the 8M model.

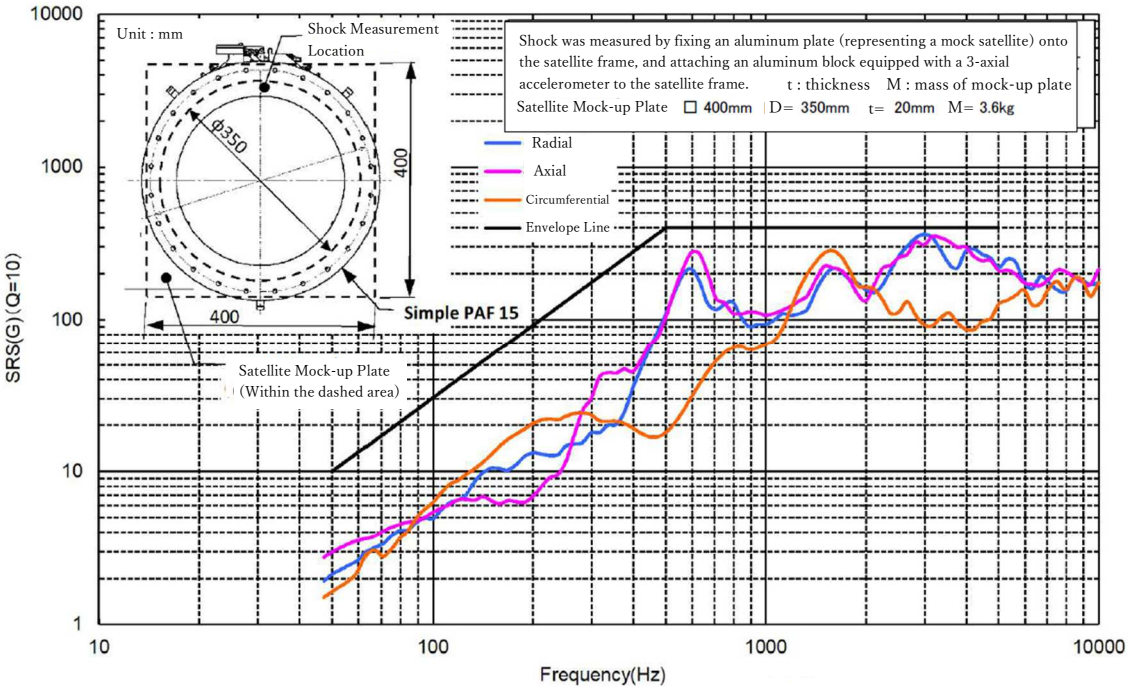


Figure 4.4-1 Shock Response Spectrum (Mock satellite: 3.6 kg (including satellite frame)) - Simple PAF 15M

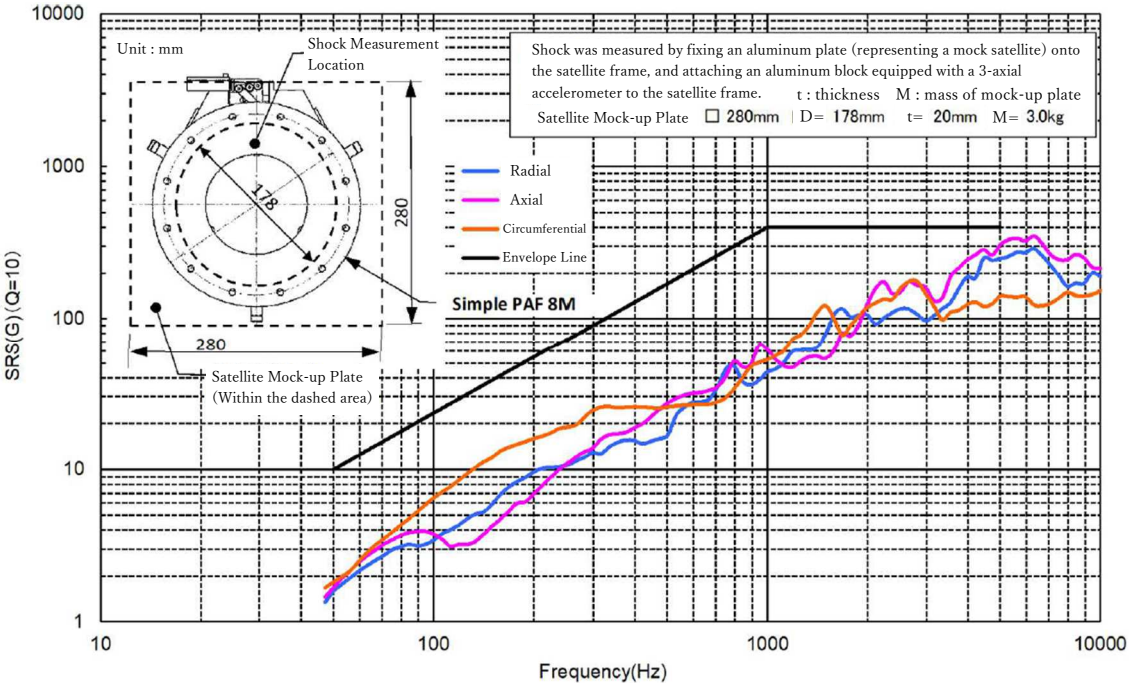


Figure 4.4-2 Shock Response Spectrum (Mock satellite: 3.0 kg (including satellite frame)) - Simple PAF 8M

4．5 Mass Properties

It shows the center of mass gravity and the moment of inertia.

Table 4.5-1 Center of mass gravity*1 and Moment of inertia*1

Type			Simple PAF 8M	Simple PAF 15M
Satellite Frame	Center of mass	X	0.1mm	- 0.6mm
		Y	0.6mm	- 0.2mm
		Z	17.9mm	17.4mm
	Moment of inertia	X	1,800kgmm^2	10,700kgmm^2
		Y	1,800kgmm^2	10,600kgmm^2
		Z	3,600kgmm^2	21,200kgmm^2
Total of Simple PAF*2	Center of mass	X	- 1.8mm	- 1.2mm
		Y	16.2mm	17.8mm
		Z	- 3.0mm	- 1.7mm
	Moment of inertia	X	12,900kgmm^2	62,500kgmm^2
		Y	9,800kgmm^2	50,600kgmm^2
		Z	21,000kgmm^2	110,700kgmm^2

*1 : The nominal value is shown. See Figure 2.1-1 for X, Y and Z axes

*2：Excluding equipment (Separation Confirmation Switch, Umbilical Line)