

CHAPTER 5

MECHANICAL/ELECTRICAL INTERFACE

5.1 Description

The interface between LV and SC consists of mechanical and electrical interfaces. Through mechanical interface, the payload is mated with the LV mechanically, while the electrical interface functions to electrically connect the LV with SC.

5.2 Mechanical Interface

5.2.1 Composition

LM-2C provides two typical types of mechanical interface: Explosive Bolt Interface and Clampband Interface.

5.2.2 Explosive Bolt Interface

5.2.2.1 General Description

The SC is installed on the SC adapter by explosive bolts directly. The SC adapter is mounted to a dispenser on the CTS or the LV adapter of stage-2.

The typical layout of explosive bolt interface is shown in **Figure 5-1**.

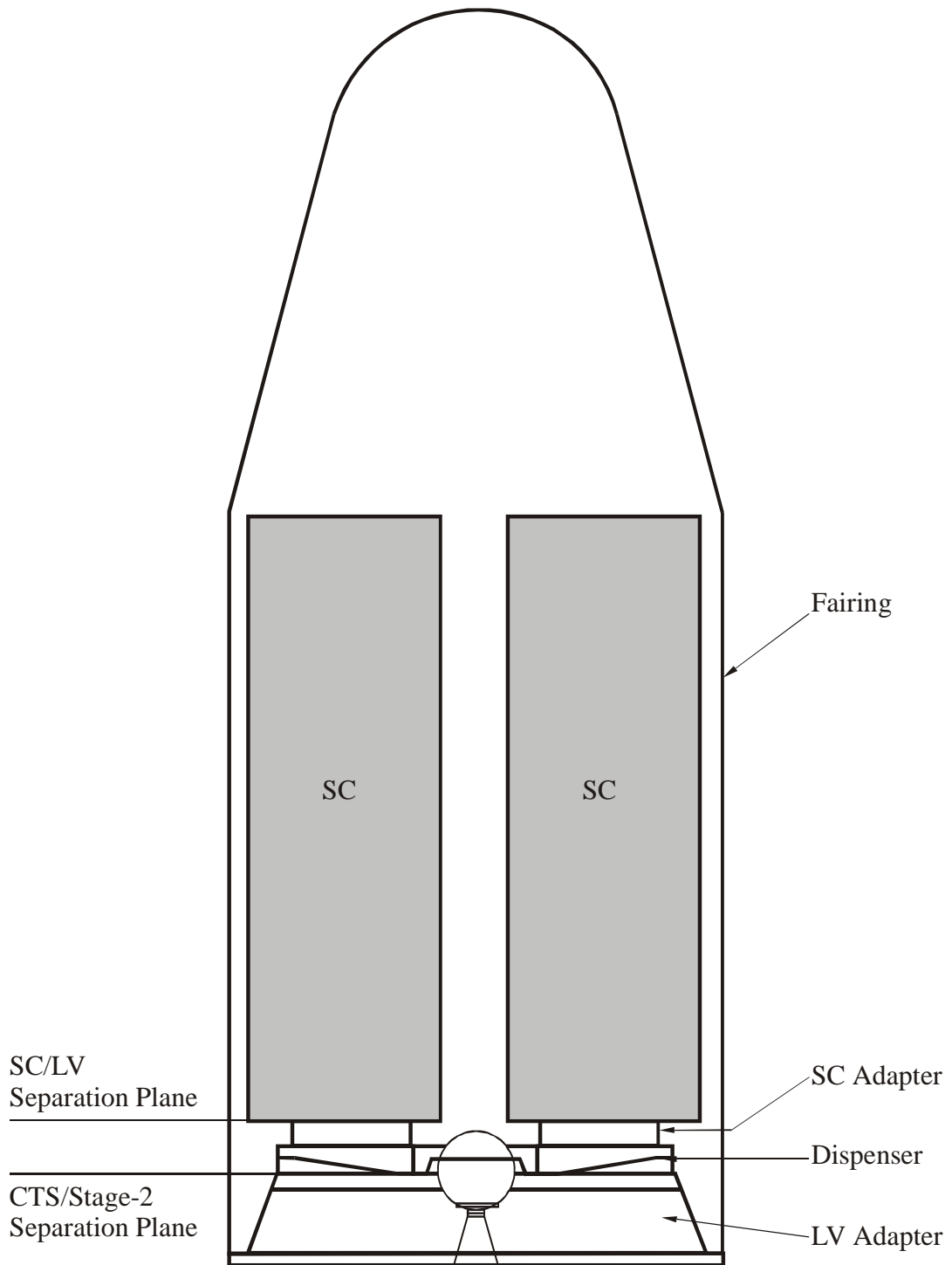


Figure 5-1 Typical Explosive Bolt Interface

5.2.2.2 SC Adapter

The configuration of SC adapter is varied to satisfy different mission requirement and SC structure. The typical SC adapter is as shown in **Figure 5-2**.

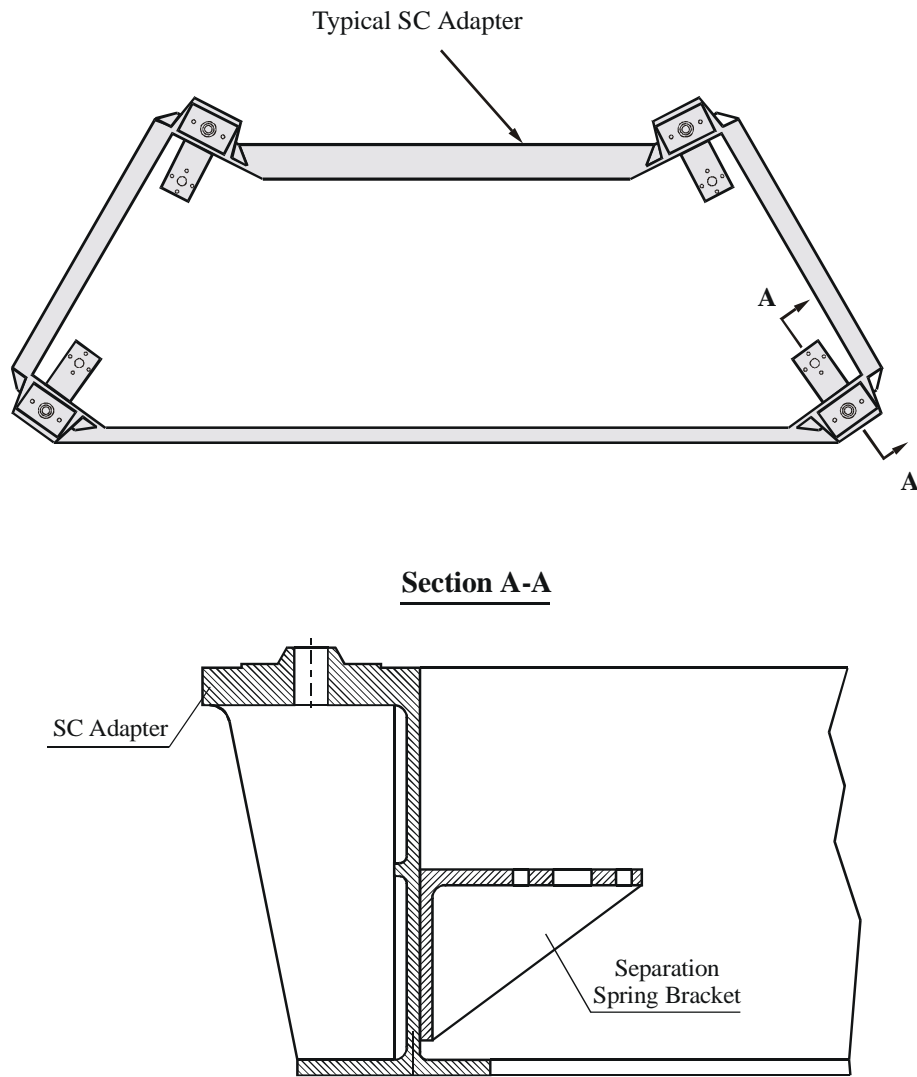


Figure 5-2 Typical SC Adapter

5.2.2.3 SC/LV Separation System for Explosive Bolt Interface

The separation mechanism is composed of separation system and explosive bolts. After the unlocking of explosive bolts, the SC and dispenser will be separated from LV by the pre-compressed springs. The forces and numbers of separation springs, the types and numbers of explosive bolts will be defined according to SC/LV separation requirement. The typical separation mechanism is shown in **Figure 5-3**.

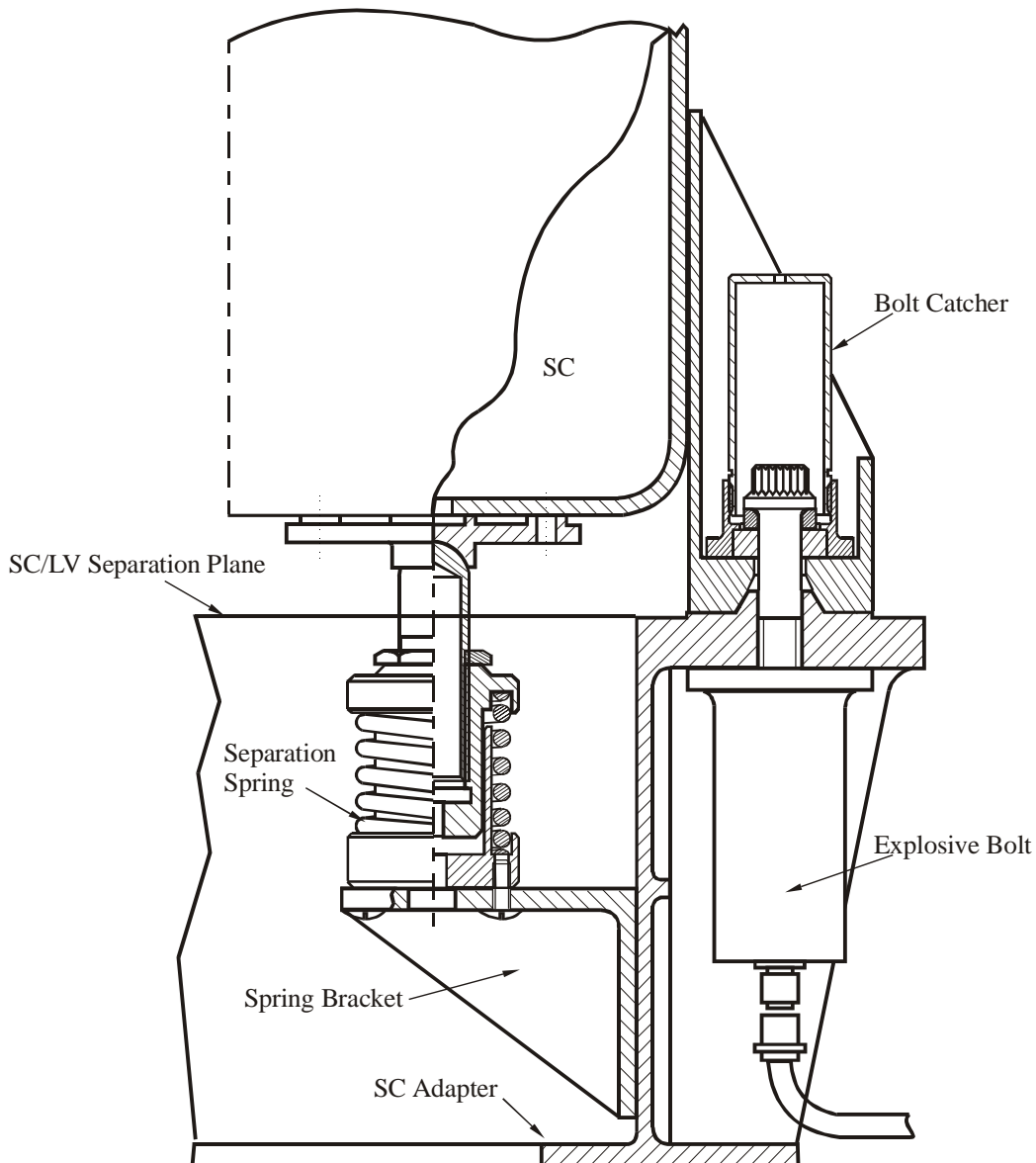


Figure 5-3 Typical Separation Mechanism for Explosive Bolt Interface

5.2.3 Clampband Interface

5.2.3.1 General Description

The clampband interface includes three parts: payload adapter, LV adapter, clampband separation system. The SC is mounted on the launch vehicle through payload adapter and LV adapter. The bottom ring of the payload adapter mates with LV adapter by 70 bolts, while the bottom ring of the LV adapter connects to the LV Stage-2. The top ring of the payload adapter is mated with the interface ring of the SC through a clampband. On the payload adapter, there are separation springs for the LV/SC separation, cables and connectors mainly used by SC. See **Figure 5-4**.

LM-2C provides two types of clampband interfaces, which are 937B and 1194A. User should contact CALT if other interface is needed.

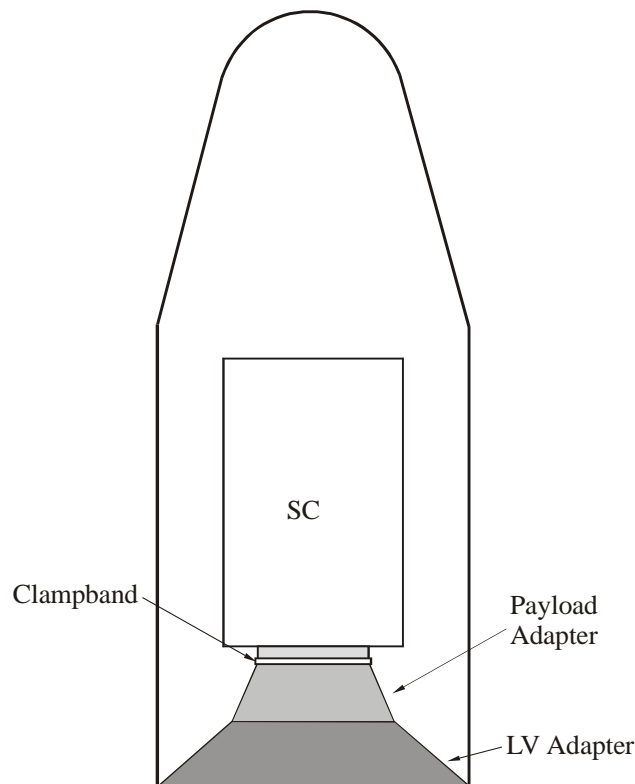


Figure 5-4 Typical Clampband Interface

5.2.3.2 Payload Adapter

- **937B Interface**

The 937B payload adapter is a 900mm-high truncated cone, whose top ring diameter is standard 945.26mm and bottom ring diameter is 1748mm. Refer to **Figure 5-5a&b**. The top ring, for mating with the SC, is made of high-strength aluminum alloy.

The adapter is a composite honeycomb sandwich structure. The core of the sandwich is made of aluminum honeycomb. The facesheets are made of carbon fiber composite. The total mass of the adapter is 55kg, including the separation springs, cables and other accessories.

- **1194A Interface**

The 1194A payload adapter is a 650mm-high truncated cone, whose top ring diameter is 1215mm and bottom ring diameter is 1748mm. Refer to **Figure 5-6a&b**. The top ring, for mating with the SC, is made of high-strength aluminum alloy.

The adapter is a composite honeycomb sandwich structure. The core the sandwich is made of aluminum honeycomb. The facesheets are made of carbon fiber composite. The total mass of the adapter is 53 kg, including the separation springs, cables and other accessories.

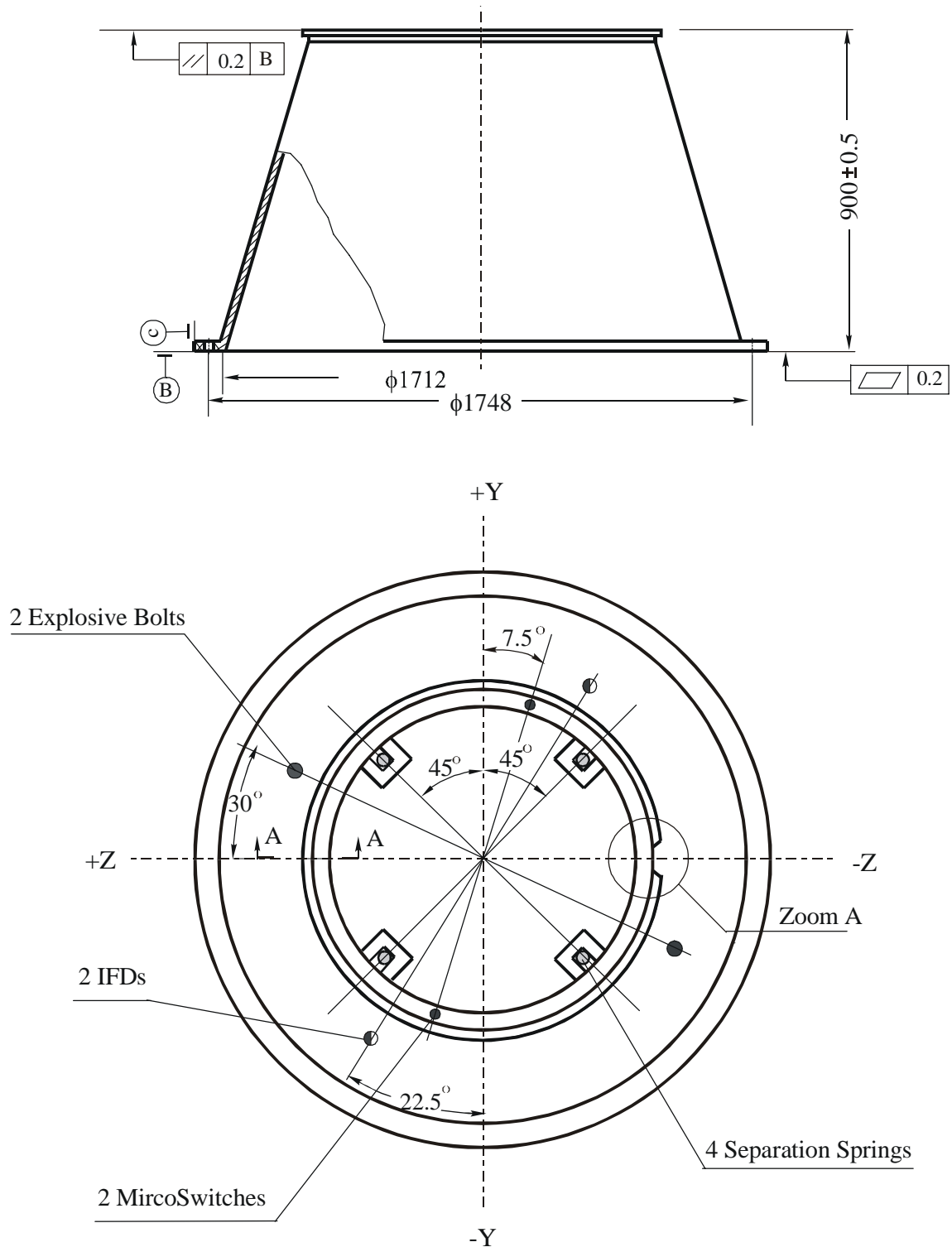


Figure 5-5a 937B Payload Adapter

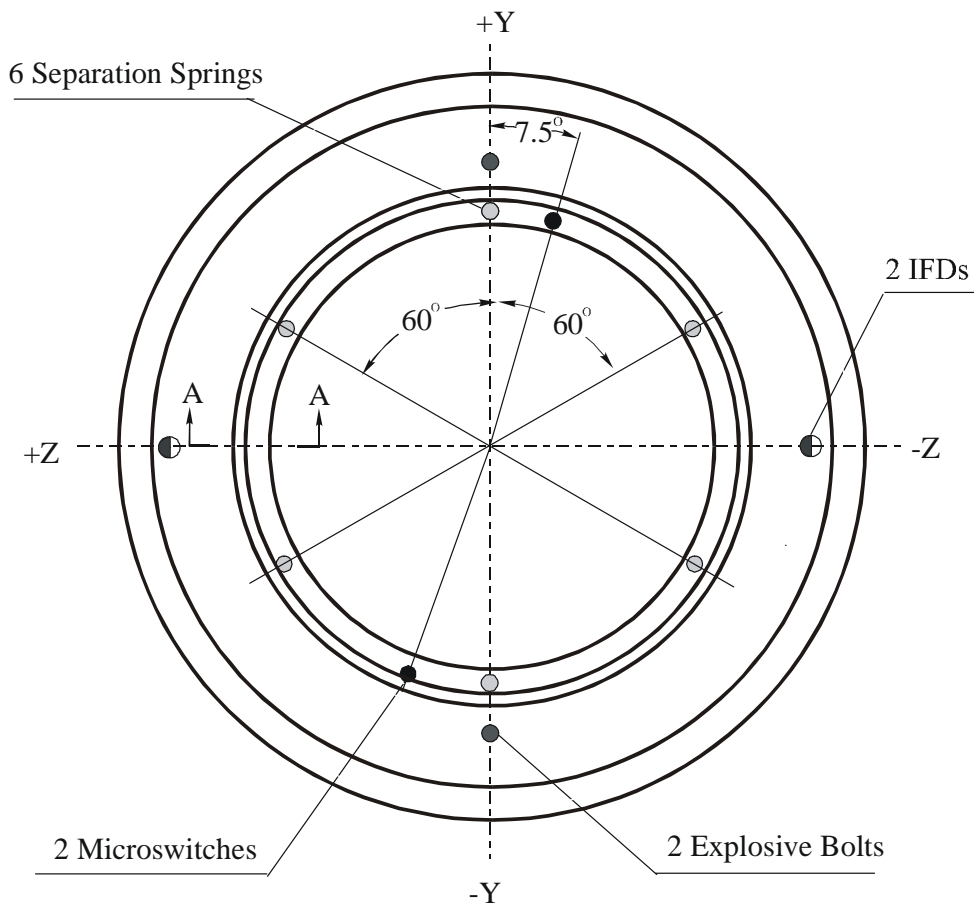
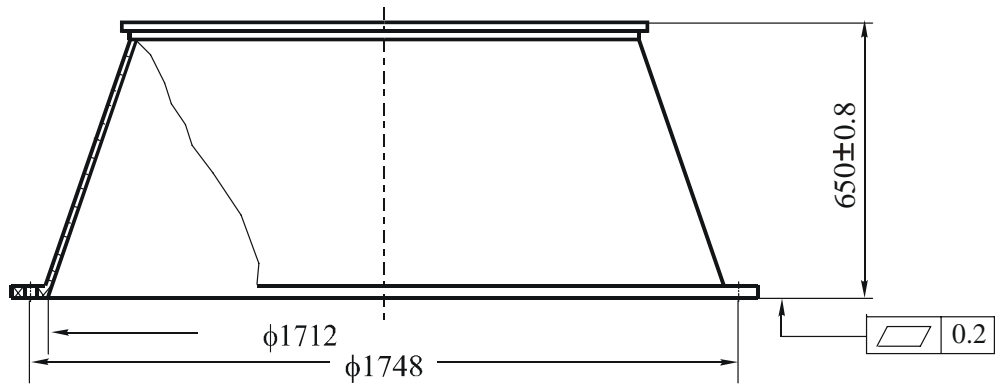


Figure 5-6a 1194A Payload Adapter

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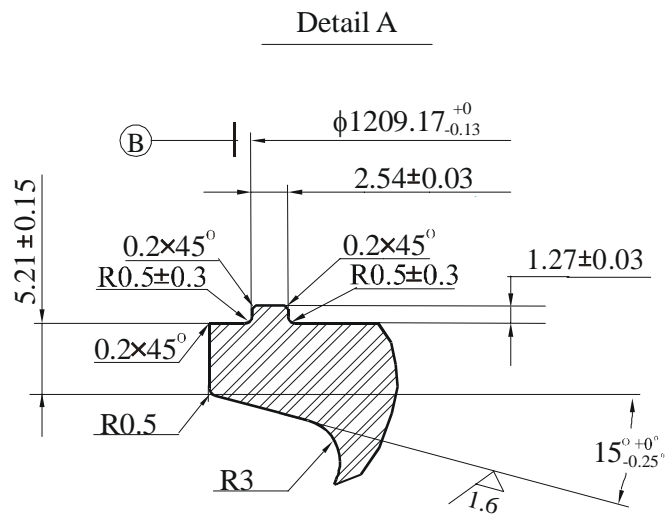
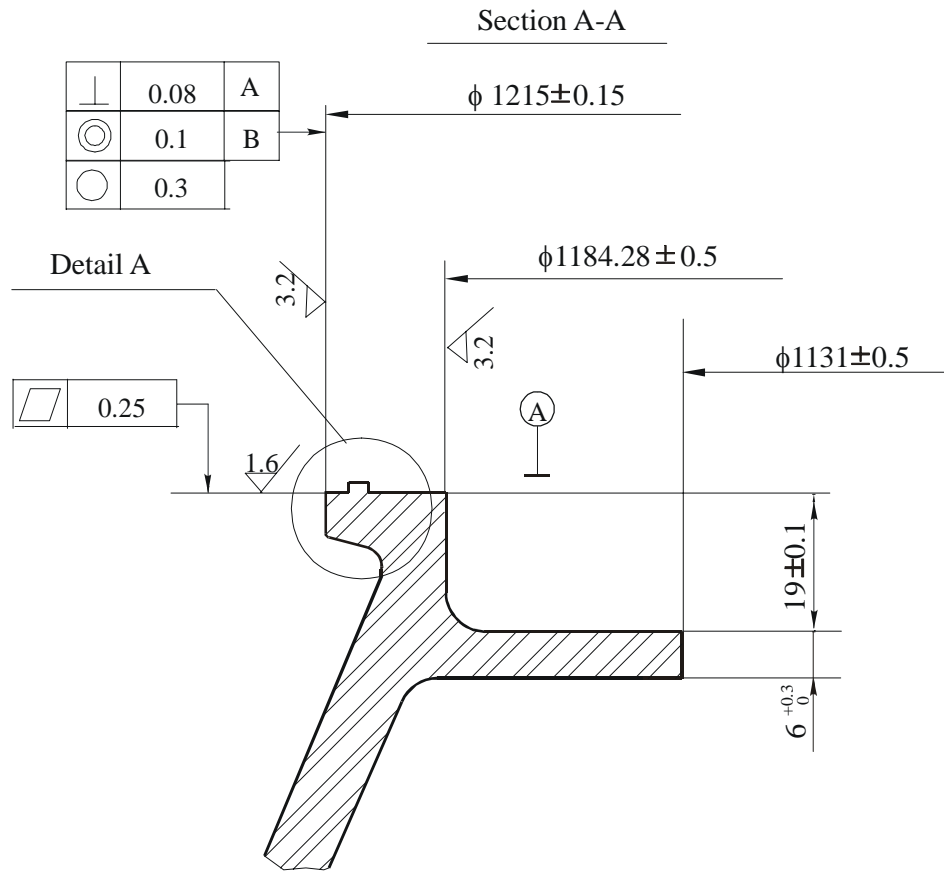


Figure 5-6b 1194A Interface

5.2.3.3 Clampband Separation System

The clampband separation system consists of clampband system and separation spring system. The clampband system is used for locking and unlocking the SC. The separation spring system is mounted on the payload adapter, which provides relative velocity between SC and LV.

Figure 5-7a,b,c,d&e shows the clampband separation system.

- **Clampband System**

The clampband system consists of clampband, non-contamination explosive bolts, V-shoes, lateral-restraining springs, longitudinal-restraining springs, etc. See **Figure 5-7a**.

The clampband has two halves. It is 50mm wide and 1.0mm thick. The clampband is made of high-strength steel.

The clampband system has two non-contamination explosive bolts. Each bolt has two igniters on the two ends, so each bolt can be ignited from both ends. The igniter on the end has two igniting bridge-circuits. As long as one igniter works, and even only one bridge-circuit is powered, the bolt can be detonated and cut off. There are totally 4 igniters and 8 bridge-circuits for the two bolts. Any bridge of these 8 works, the clampband can be definitely unlocked. So the unlocking reliability is very high. The maximum allowable pretension of the explosive bolt is 70kN.

The V-shoes are used for clamping the interface ring of the SC and the top ring of the adapter. The 26 V-shoes for the clampband are symmetrically distributed along the periphery. The V-shoes are made of high-strength Aluminum.

The lateral-restraining springs connect the both ends of the two halves of clampband. The lateral-restraining springs are used for controlling the outward movement of the clampband (perpendicular to LV axial axis) and keep the sufficient payload envelope. Refer to **Figure 5-7b&c**. There are totally 8 lateral-restraining springs in 2 types.

The longitudinal-restraining springs restrict the movement of the separated clampband toward SC. The two halves of the clampband will be held on the adapter and be kept from colliding with the SC.

During the installation of clampband system, 10 strain gauges are installed on the each half of the clampband. Through the gauges and computer, the strain and pretension at each measuring point can be monitored in real time. A special designed tool is used for applying the pretension. Generally, the pretension is $24.2+1.0/-0$ kN. While the pretension can be adjusted according to the specific requirements of the SC and the coupled load analysis results.

For the convenience and safety of the SC during clampband installation, the bottom of the SC is needed to be 85mm away from the SC/LV separation plane, or there should be a distance of 20mm between the lateral-restraining springs and the bottom of SC. CALT is now designing the narrow clampband to benefit the performance of installation.

- **Separation Spring System**

The separation spring system includes springs, bracket, pushing rod, etc. Refer to **Figure 5-7d** and **Figure 5-7e**. The separation springs and their accessories are mounted on the adapter. The system can provide a SC/LV separation velocity higher than 0.5m/sec.

5.2.4 Anti-collision Measures

5.2.4.1 Second Stage

The second stage will re-enter atmosphere in about 40 days no matter the LV with or without CTS. After the separation of second stage, some measures have been adopted to avoid the collision of second stage with CTS.

5.2.4.2 CTS

After the separation of Payload/CTS, the CTS will turn to the reverse direction and use the remained the propellant in RCS to reduce the altitude of CTS. The CTS will return to earth in about 80 days.

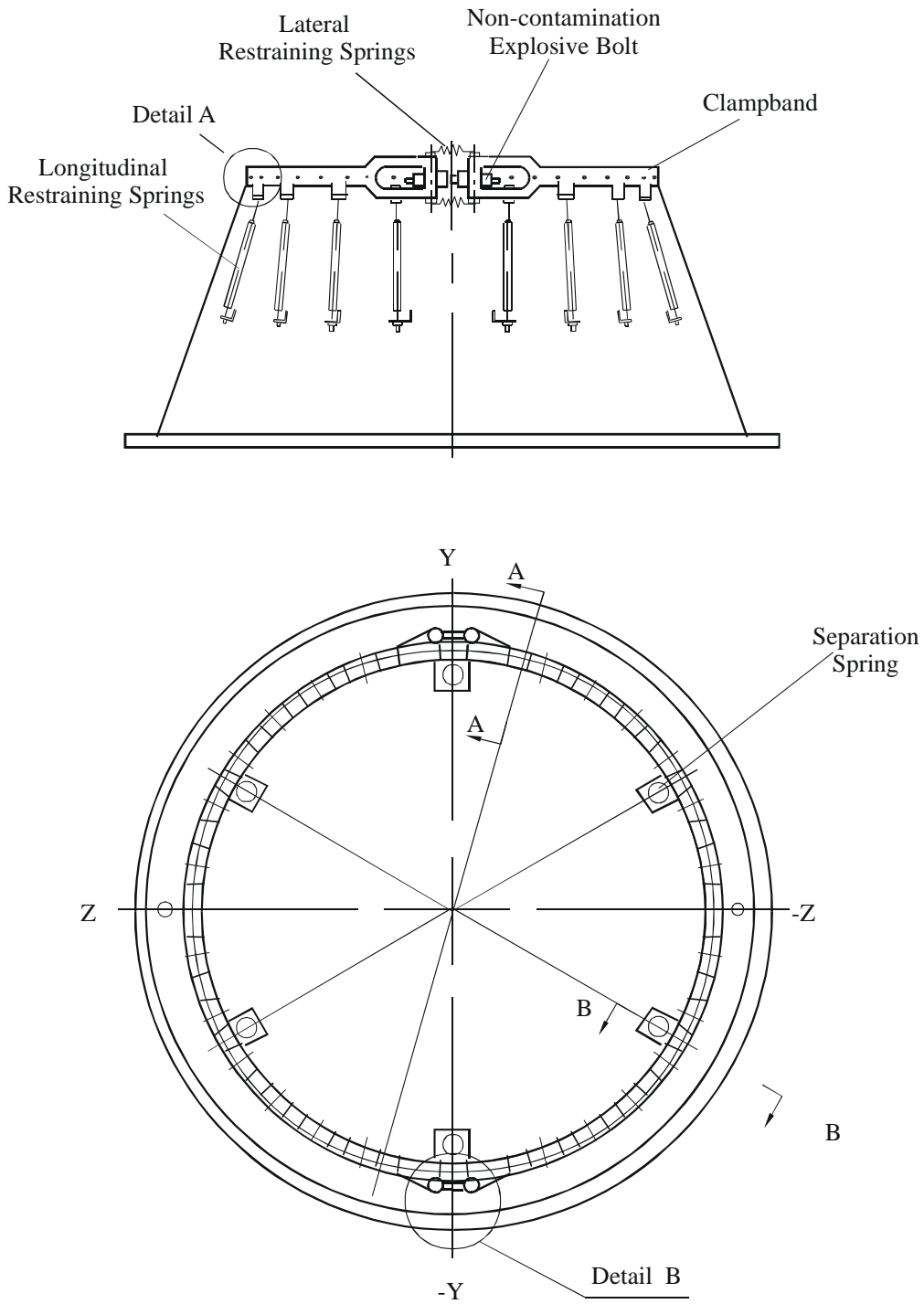
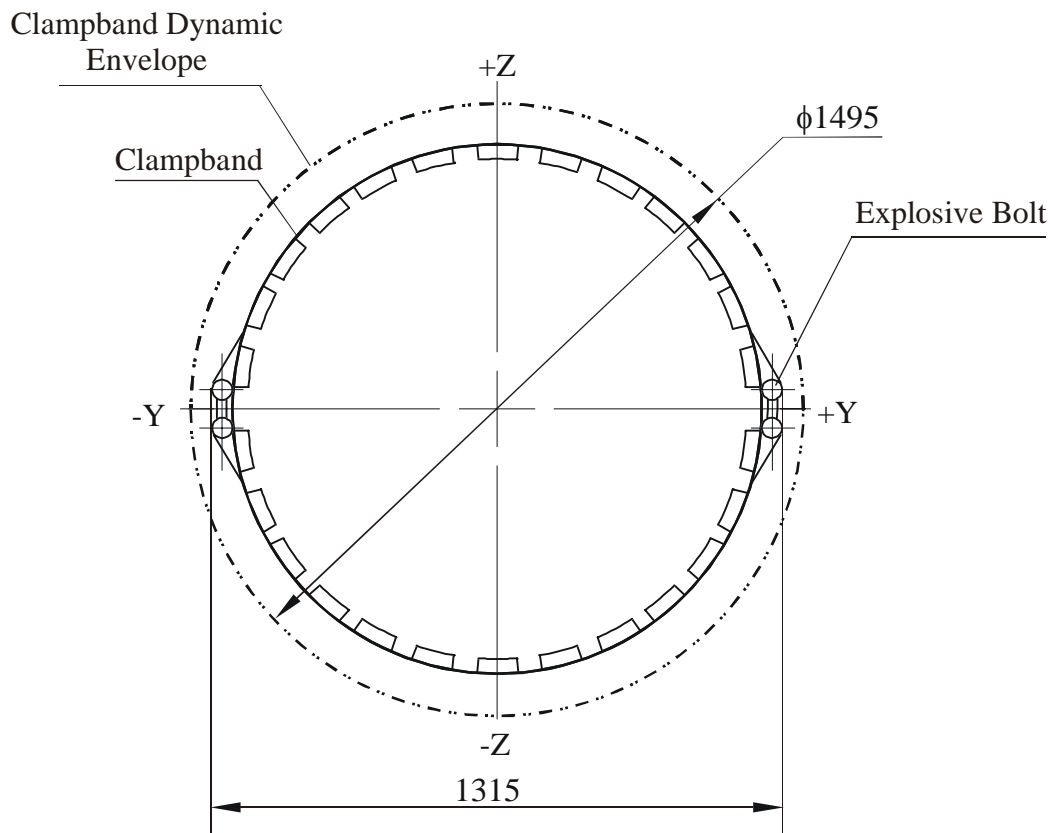


Figure 5-7a Clampland System



**Figure 5-7b Clampband Dynamic Envelope
(For 1194A interface only)**

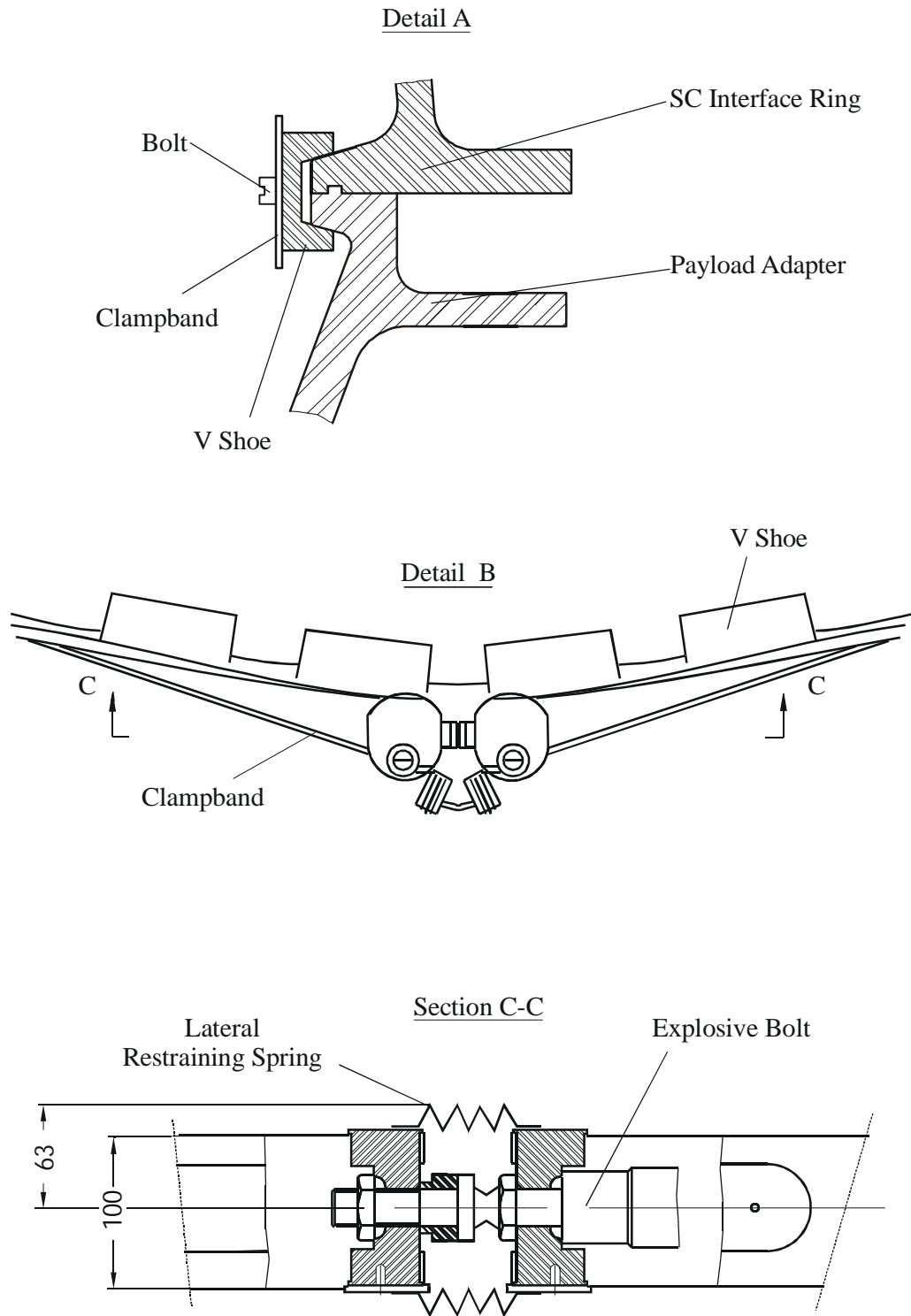


Figure 5-7c Clampband in Detail

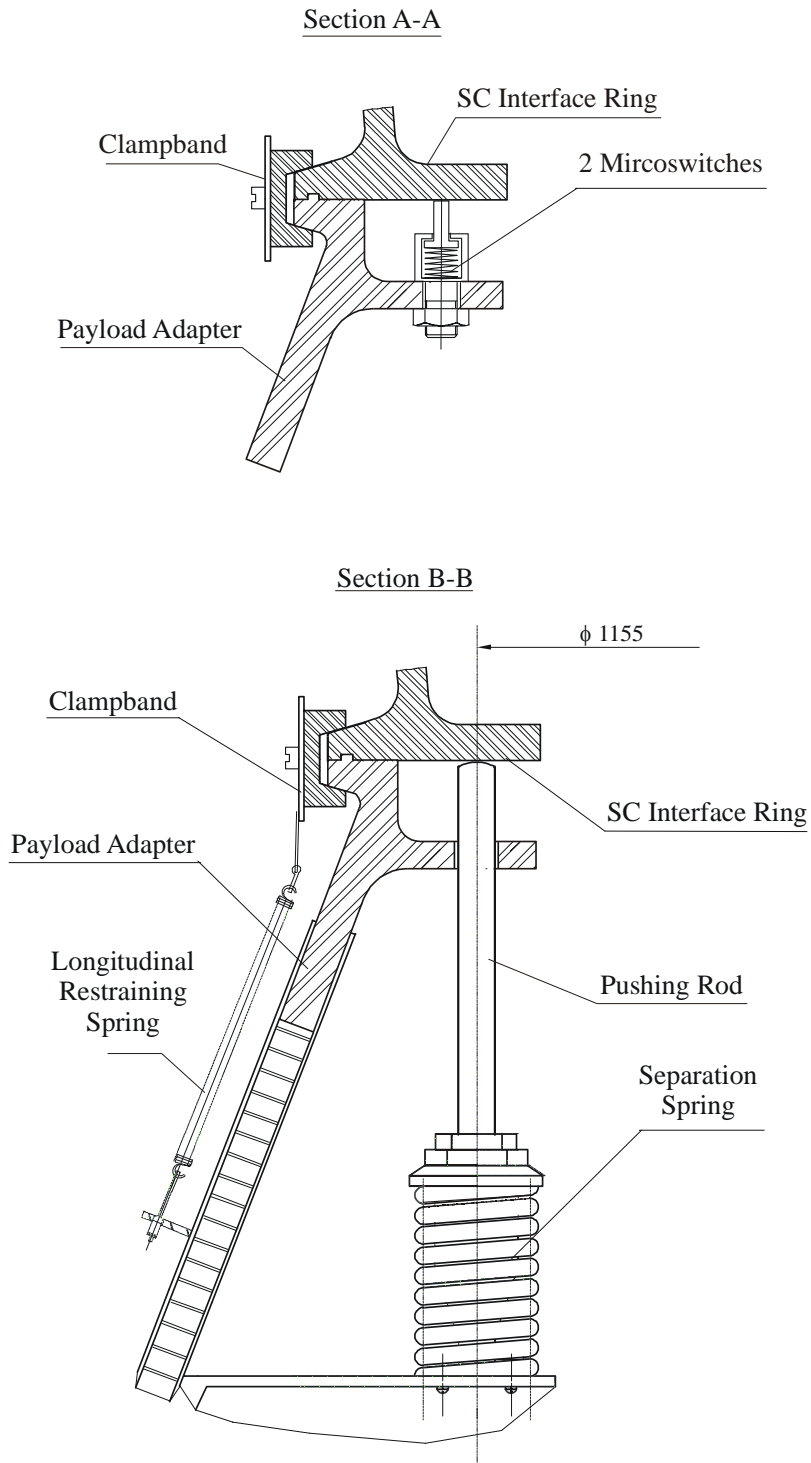


Figure 5-7d SC/LV Separation Spring

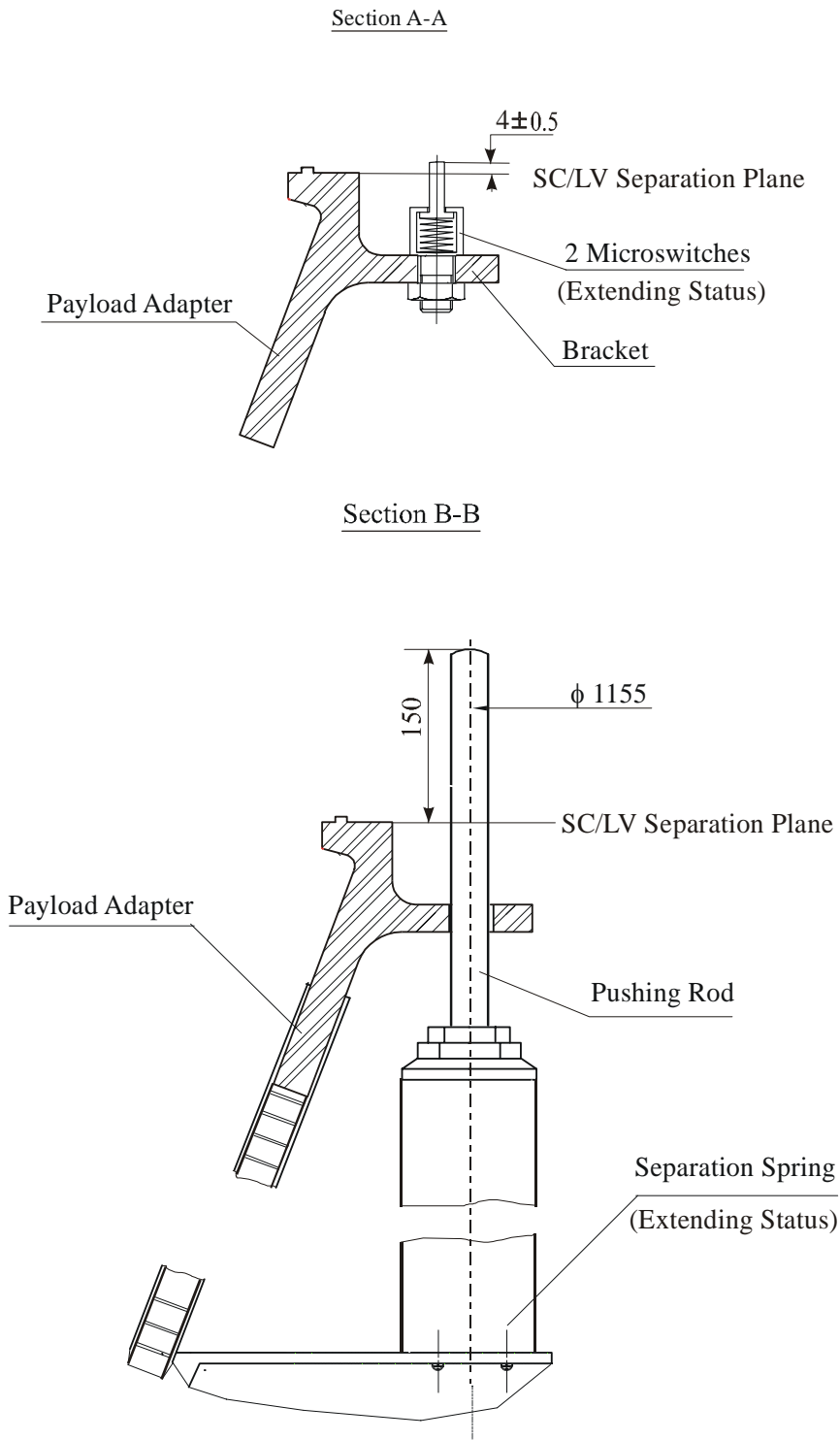


Figure 5-7e SC/LV Separation Spring (Extending Status)

5.3 Electrical Interface

The SC is electrically connected with SC's electrical ground support equipment (EGSE) through SC/LV electrical interface and umbilical cables provided by LV side. By using of EGSE and the umbilical cables, SC team can perform wired testing and pre-launch control to the SC, such as SC power-supply, on-board battery charging, wired-monitoring on powering status and other parameters.

The typical umbilical system consists of onboard-LV Parts and ground parts. Refer to **Figure 5-8, 5-9**. The practical networking will be designed for dedicated SC according to User's needs.

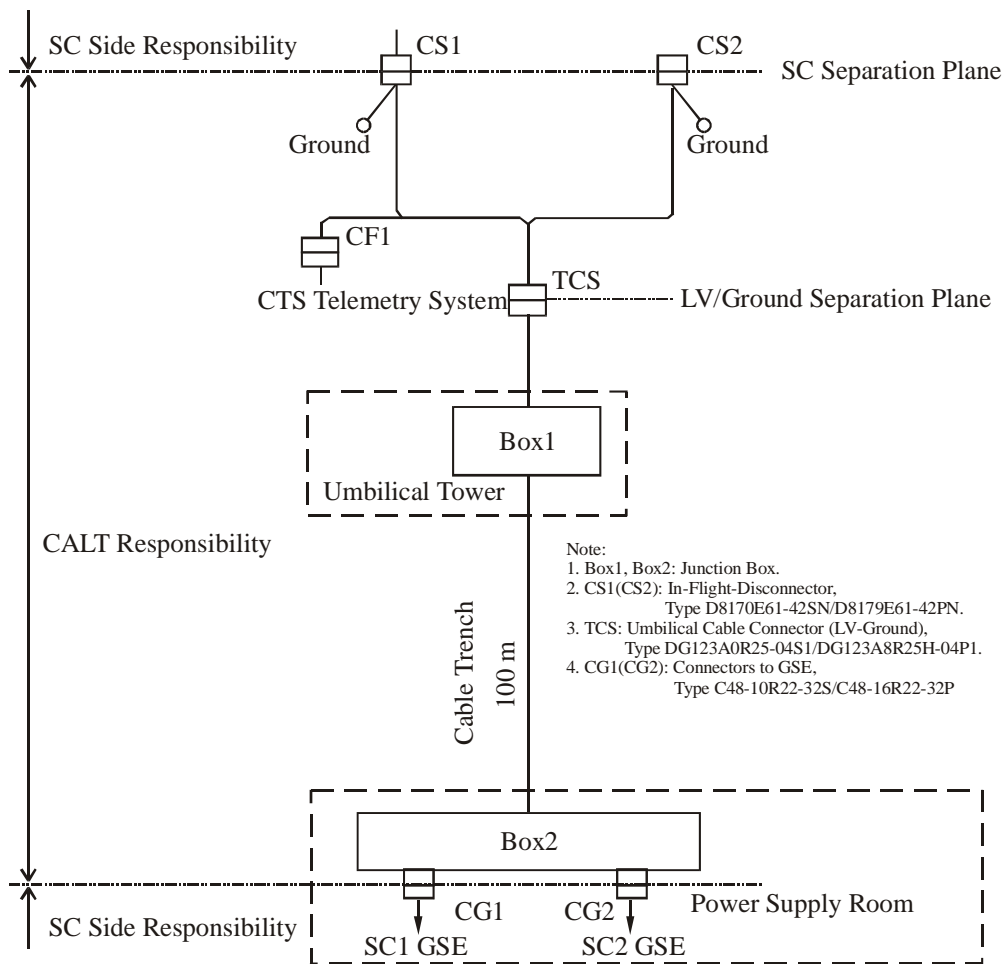


Figure 5-8 Ground Umbilical Cable

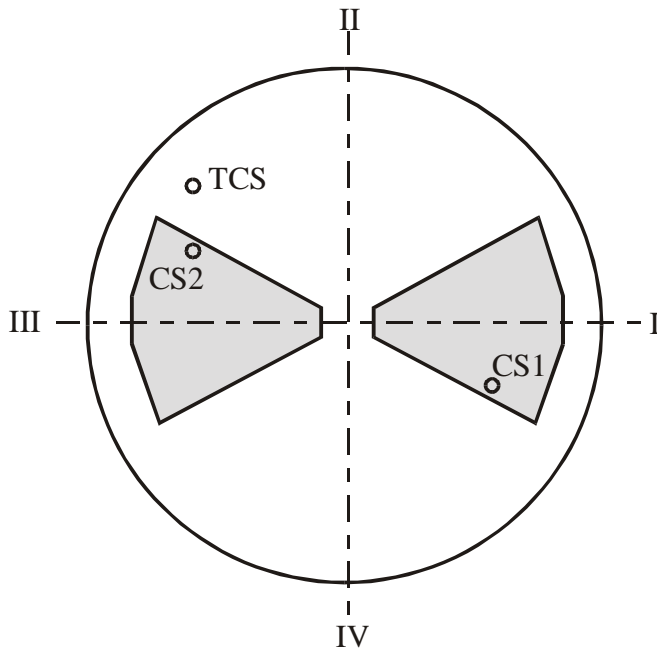
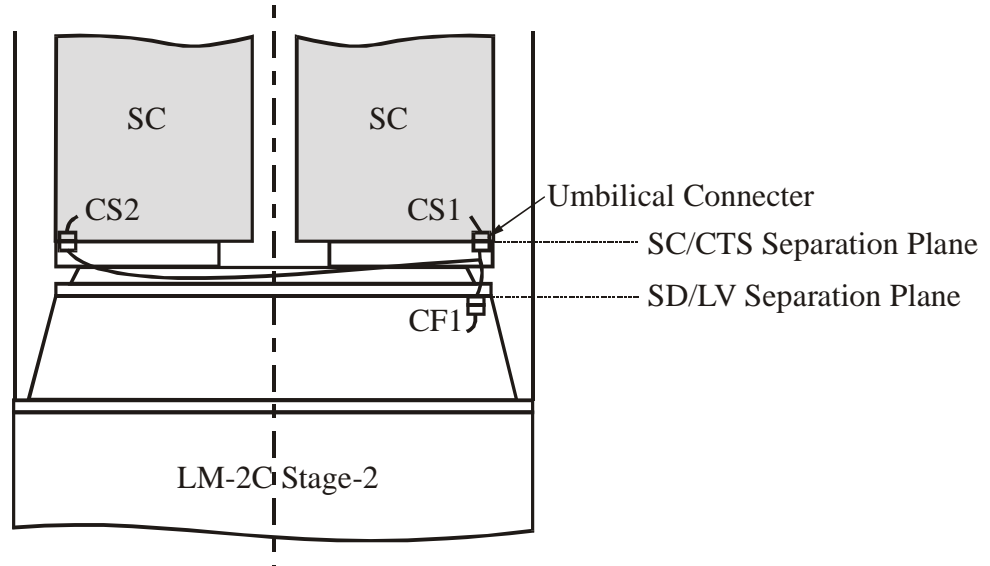


Figure 5-9 On-board Umbilical Interface

5.3.1 In-Flight-Disconnectors (IFDs)

5.3.1.1 Quantity

The quantity of IFDs will be determined according to specific mission requirements. The detailed location will be coordinated between SC and LV sides and finally defined in ICD.

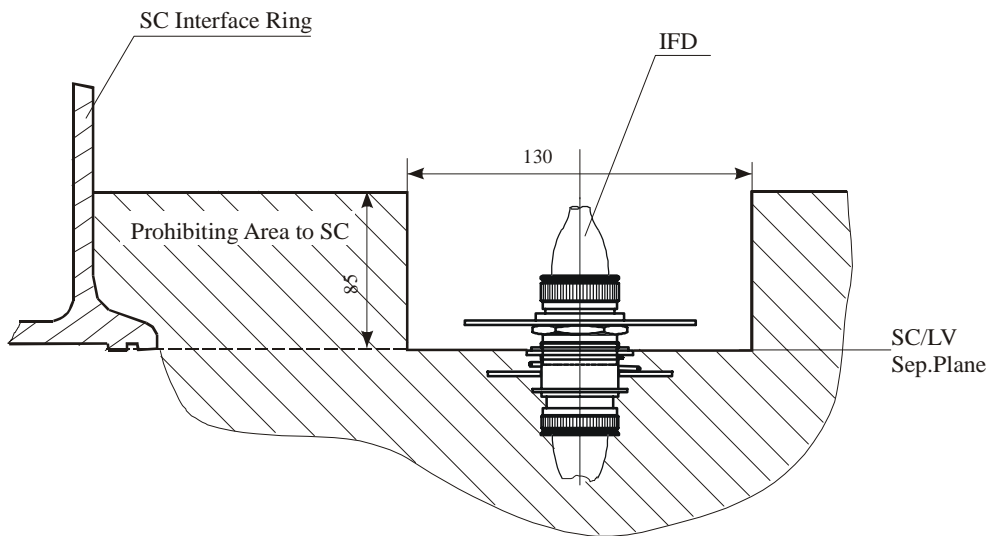


Figure 5-10 Typical IFD Location

5.3.1.2 Types

Generally, the IFDs are selected and provided by the user. It is suggested to use following DEUTSCH products. (DEUTSCH Engineered Connecting Devices, California, US)

LV Side	SC Side
D8179E61-42PN	D8170E61-42SN

User can also select other products of DEUTSCH or Chinese-made products.

5.3.1.3 IFD Supply

It is recommended that the user provide the whole set of the IFDs to CALT for the soldering on the umbilical cables. The necessary operation and measurement

description shall also be provided.

5.3.1.4 Characteristics of IFD

SC side shall specify characteristics of the IFDs. The specific contents are pin assignment, usage, maximum voltage, maximum current, one-way maximum resistance etc. CALT will design the umbilical cable according to the above requirements.

5.3.2 Umbilical System

The umbilical system consists of onboard-LV parts and ground cable parts. The following describes the details on one satellite.

5.3.2.1 Onboard-LV Umbilical Cable

(1) Composition

The Onboard-LV cable net comprises the cables from the IFDs to TCS. These umbilical cables will fly with LV.

Whereas:

Code	Description
CS1(CS2)	IFD, Technological interfaces between SC adapter and LV
CF1	Interface between umbilical cable and LV TM system, through which the SC/LV separation signal is sent to LV TM system
TCS	Umbilical cable connector (LV-Ground)
Ground	Grounding points to overlap the shielding of wires and the shell of LV

(2) Generation of Separation Signal

There are break-wires on the plugs of IFD which can generate SC/LV separation signals. The SC will receive the SC/LV separation signals once the break-wires circuitry break when SC/LV separates.

In the same way, there are break-wires on the sockets of IFDs which are mounted on

the SC side. The LV can acquire the separation signal through the break-wires circuitry break when SC/LV separates. This separation signal will be sent to LV's telemetry system through CF1 interface. Refer to **Figure 5-11** for the break-wire's circuitry. The break-wire's allowable current: $\leq 100\text{mA}$, allowable voltage: $\leq 30\text{V}$.

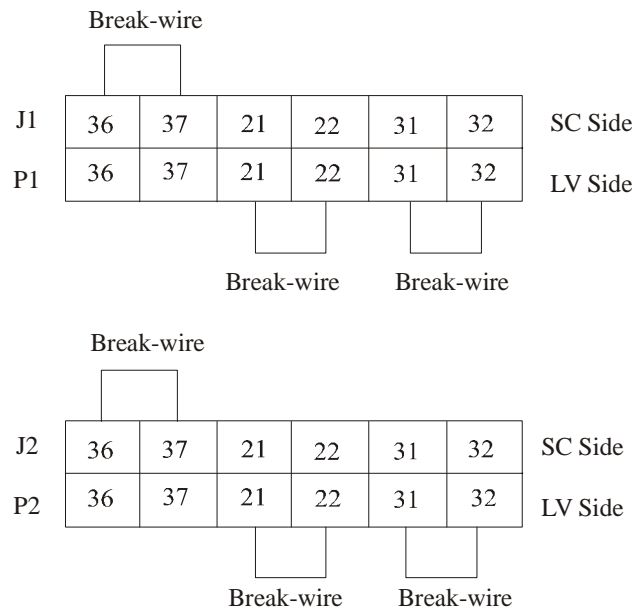


Figure 5-11 Break-wire for SC/LV Separation Signal

5.3.2.2 SC Ground Umbilical Cable Net

(1) Composition

The ground umbilical cable net consists of umbilical cable connector, cables, box adapters, etc. Refer to **Figure 5-8** and **Figure 5-9**.

Whereas:

Code	Description
TCS	TCS is the umbilical connector which connect the LV and ground cables. The disconnection of TCS is performed automatically or manually. If the launch was terminated after the disconnection, TCS could be reconnected within 60min.

BOX1	BOX 1 is a box adapter for umbilical cable that is located on the umbilical tower. (If needed, BOX 1 can provide more interfaces for the connection with SC ground equipment.)
BOX2	BOX 2 is another box adapter for umbilical cable that is located inside the SC Blockhouse on ground. Other SC ground support equipment are also located inside the Blockhouse.

(2) Interface on Ground

SC side will define the detailed requirement of ground interfaces. The connectors to be connected with SC ground equipment should be provided by SC side to LV side for the manufacture of cables.

If LV side couldn't get the connectors from SC side, this ground interface cable will be provided in cores with pin marks.

(3) Types of connectors to GSE (CG1,CG2)

The following connectors are recommended:

At the end of umbilical: C48-10R22-32S

At the end of GSE: C48-16R22-32P

5.3.2.3 Umbilical Cables and Performance

The types and characteristics of cables are as follows:

✧ Onboard-LV Cable Net

Generally, ASTVR and ASTVRP wires are adopted for the onboard-LV cable net:

ASTVR, 0.5mm², fiber-sheath, PVC insulation;

ASTVRP, 0.5mm², fiber-sheath, PVC insulation, shielded.

For both cables, their working voltage is ≤500V and DC resistance is 38.0Ω/km (20°C). The single core or cluster will be shielded and sheathed.

✧ Ground Cable Net

- Single-Core Shielded Cable: KYVRP-52×0.5 mm², KYVRP-24×0.5 mm².
- Number of cores: 52, 24
- 80 cores/cable, 0.5mm²/core; Working voltage: ≤60V; DC resistance (20°C) of each core: 38.0Ω/km.

✧ Twin-twist Shielded Cable

- KSEYVP77-2×3×0.5, 6 pairs of twin-twisted cores, 0.5mm²/core.
- Each twisted pair is shielded and the whole cable has a woven wire net for shielding.
- Impedance: 75Ω.

Twin-twist shielded cable (KSEYVP) are generally used for SC data transmission and communication. Single-core shielded cable (KYVRPP) is often used for common control and signal indicating. KYVRP-1 cable is adopted for SC's power supply on ground and multi-cores are paralleled to meet the SC's single-loop resistance requirement.

Under normal condition, the umbilical cable (both on-board and ground) has a insulation resistance of $\geq 5M\Omega$ (including between cores, core and shielding, core and LV shell)

5.3.2.4 Umbilical Cable Disconnect Control

LV side is responsible for the pre-launch disconnection of umbilical cable , which can be pull out manually 80minutes before launch or disconnected automatically 15minutes prior ignition.

5.3.3 Anti-lightning, Shielding and Grounding

In order to assure the safety of the operations of both LV and SC, some measures have been taken for anti-lightning, shielding and grounding.

- ✧ The cable has two shielding layers, the outer shielding is for anti-lightning while the inner shielding is for anti-interference.
- ✧ The inner shield of on-board cable is connected to BOX 2 through TCS. There is a special point connecting the shield to the GSE of SC in BOX 2 .
- ✧ The inner shield is insulated to ground.

5.3.4 Continuity of SC "Earth-Potential"

The SC should have a reference point of earth-potential and this benchmark should be near to the SC/LV separation plane. Generally, the resistance between all other metal parts of SC (shell, structures, etc.) and this benchmark should be less than 10mΩ under a current of 10mA.

There is also a reference-point of earth-potential at the bottom of the adapter. The resistance between LV reference point at the adapter and SC reference should be less than $10\text{m}\Omega$ with a current of 10mA . In order to keep the continuity of earth-potential and meet this requirement, the bottom of SC to be mated with adapter should not be treated chemically or treated through any other methodology affecting its electrical conductivity.

5.3.5 Miscellaneous

If required, the LV time sequence system can provide some signals to SC through the onboard-LV cables and connectors. These signals can either be power-supply or dry-loop signals to be defined by SC side.

Any signal possibly dangerous to the flight can not be sent to the payload during the whole flight till SC/LV separation. Only LV/SC separation can be used as the initial reference for all SC operations. After LV/SC separation, SC side can control SC through microswitches and remote commands.

If the customer needs some telemetry data regarding the SC flight, those data could be transmitted through the LV telemetry system. Details of this issue can be coordinated between CALT and customer.