

## 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

The SC is mounted on the launch vehicle through a payload adapter. The bottom ring of the adapter mates with the VEB of LM-3B by bolts. The top ring of the 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.

#### 5.2.2 Payload Adapter

##### 5.2.2.1 Summary

The top ring of the adapter, without any chemical treatment, connects with the interface ring of the SC through an international widely-used interface. The bottom ring of the adapter is 1497mm in diameter and it is connected with the VEB via 70 bolts. LM-3B provides four types of mechanical interfaces, which are 937B, 1194, 1194A and 1666 respectively. User should contact CALT if other interface is needed.

##### 5.2.2.2 937B Interface (Encapsulation-on-pad)

The 937B interface adapter is a 900mm-high truncated cone, whose top ring diameter is 945.26mm and bottom ring diameter is 1748mm. Refer to **Figure 5-1a** and **Figure 5-1b**. 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.

#### **5.2.2.3 1194 Interface (Encapsulation-on-pad)**

The 1194 interface adapter is a 650mm-high truncated cone, whose top ring diameter is 1215mm and bottom ring diameter is 1748mm. Refer to **Figure 5-2a** and **Figure 5-2b**. 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 53kg, including the separation springs, cables and other accessories.

#### **5.2.2.4 1194A Interface (Encapsulation-on-pad)**

The adapter is 450mm high, see **Figure 5-3a** and **Figure 5-3b**.

#### **5.2.2.5 1194A Interface (Encapsulation-on-BS3)**

The adapter is 450mm high, see **Figure 5-4a** and **Figure 5-4b**.

#### **5.2.2.6 1666 Interface (Encapsulation-on-pad)**

The adapter is 650mm high, see **Figure 5-5a** and **Figure-5b**.

#### **5.2.2.7 1666 Interface (Encapsulation-in-BS3)**

The adapter is 450mm high, see **Figure 5-6** and **Figure 5-6b**.

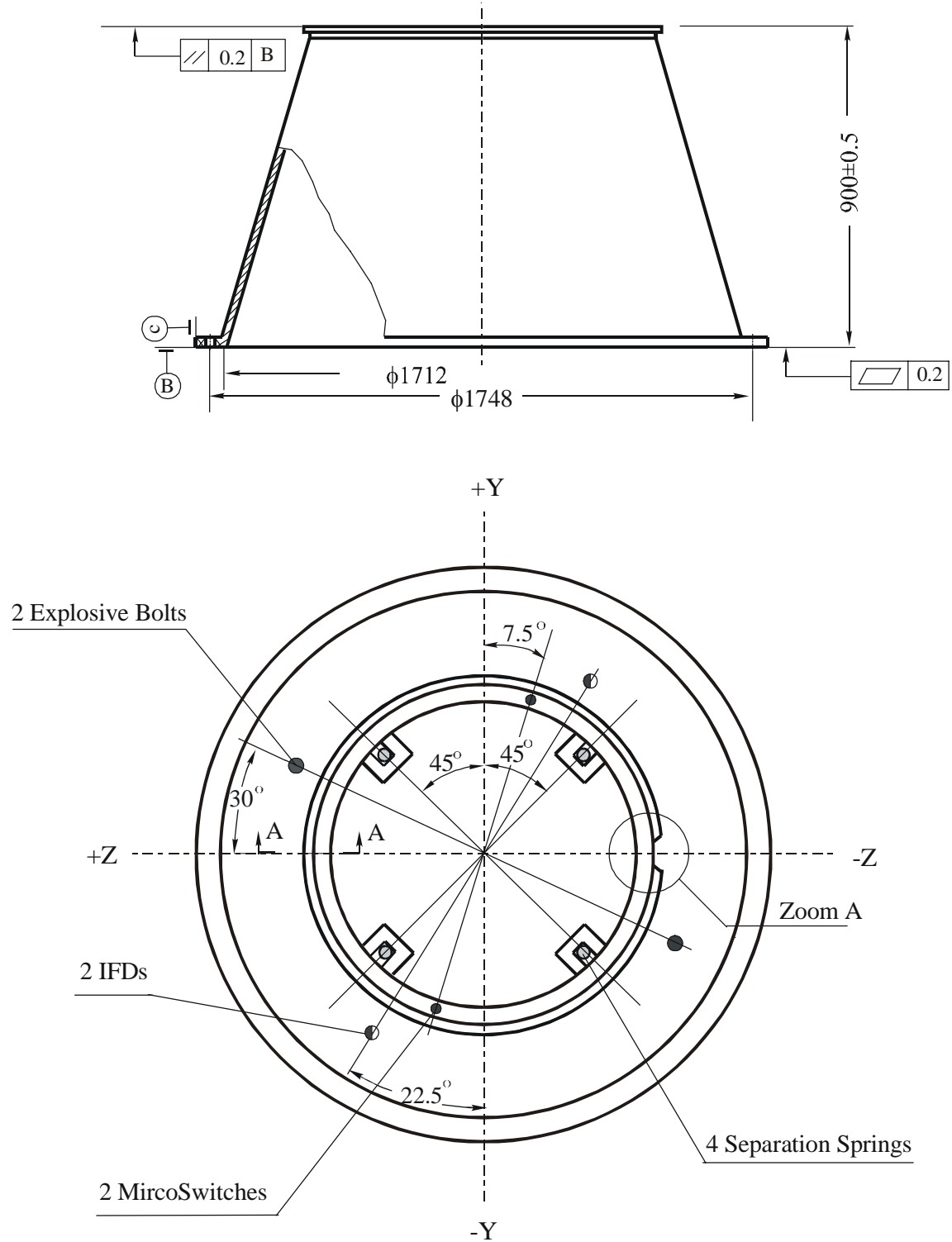


Figure 5-1a 937B Payload Adapter (Encapsulation-on-pad)

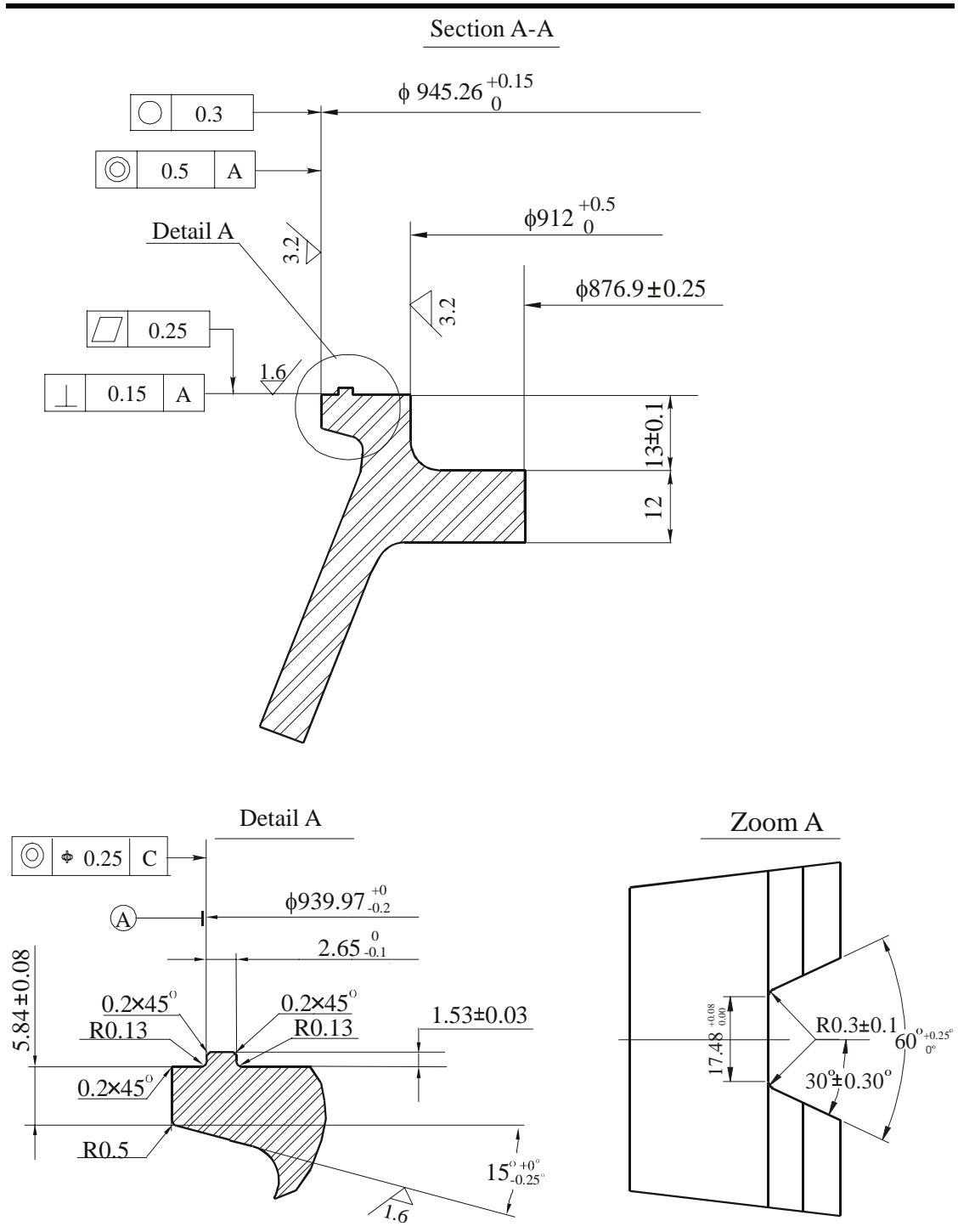
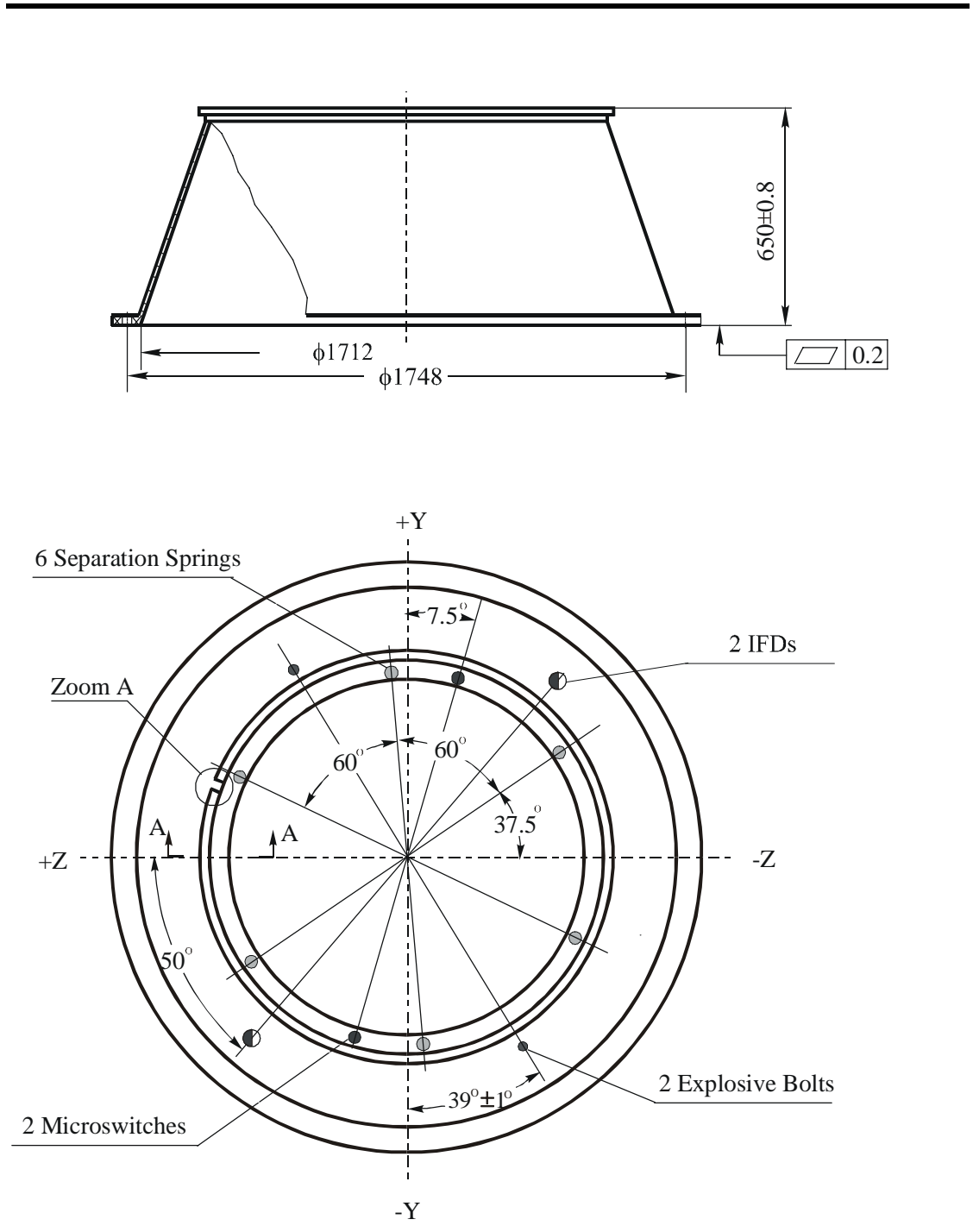


Figure 5-1b 937B Interface (Encapsulation-on-pad)



**Figure 5-2a 1194 Payload Adapter (Encapsulation-on-pad)**

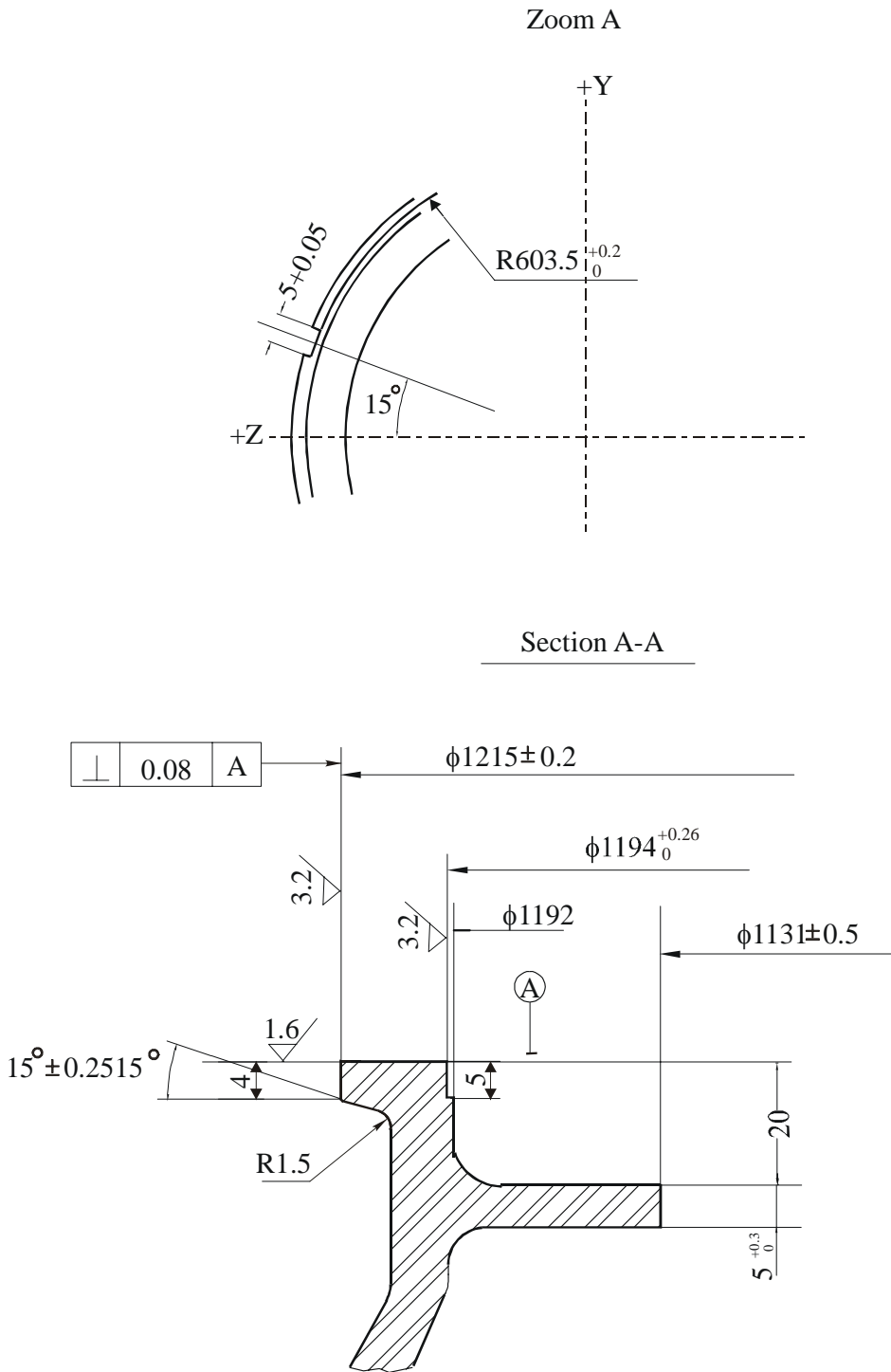
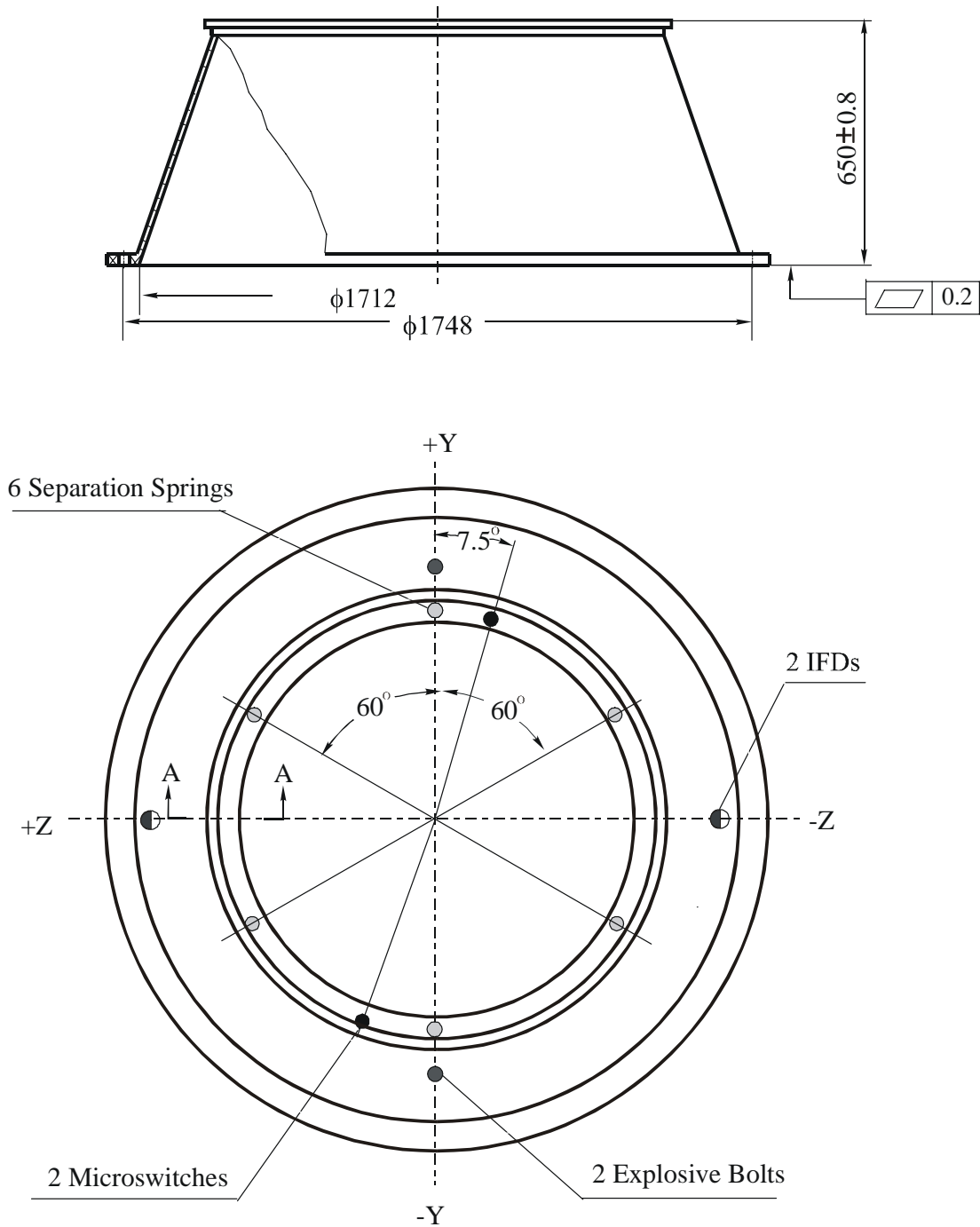


Figure 5-2b 1194 Interface (Encapsulation-on-pad)



**Figure 5-3a 1194A Payload Adapter (Encapsulation-on-pad)**

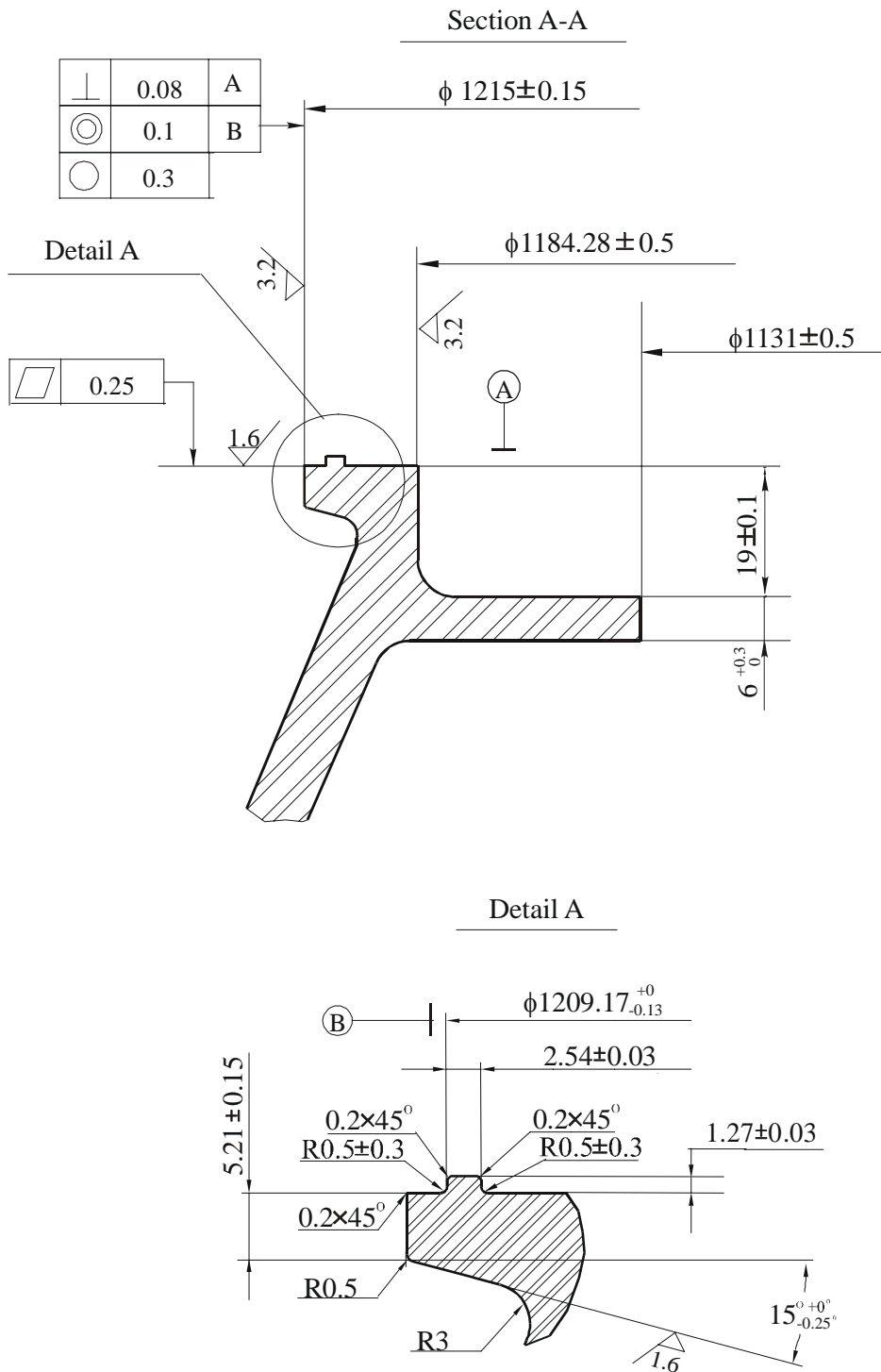


Figure 5-3b 1194A Interface (Encapsulation-on-pad)



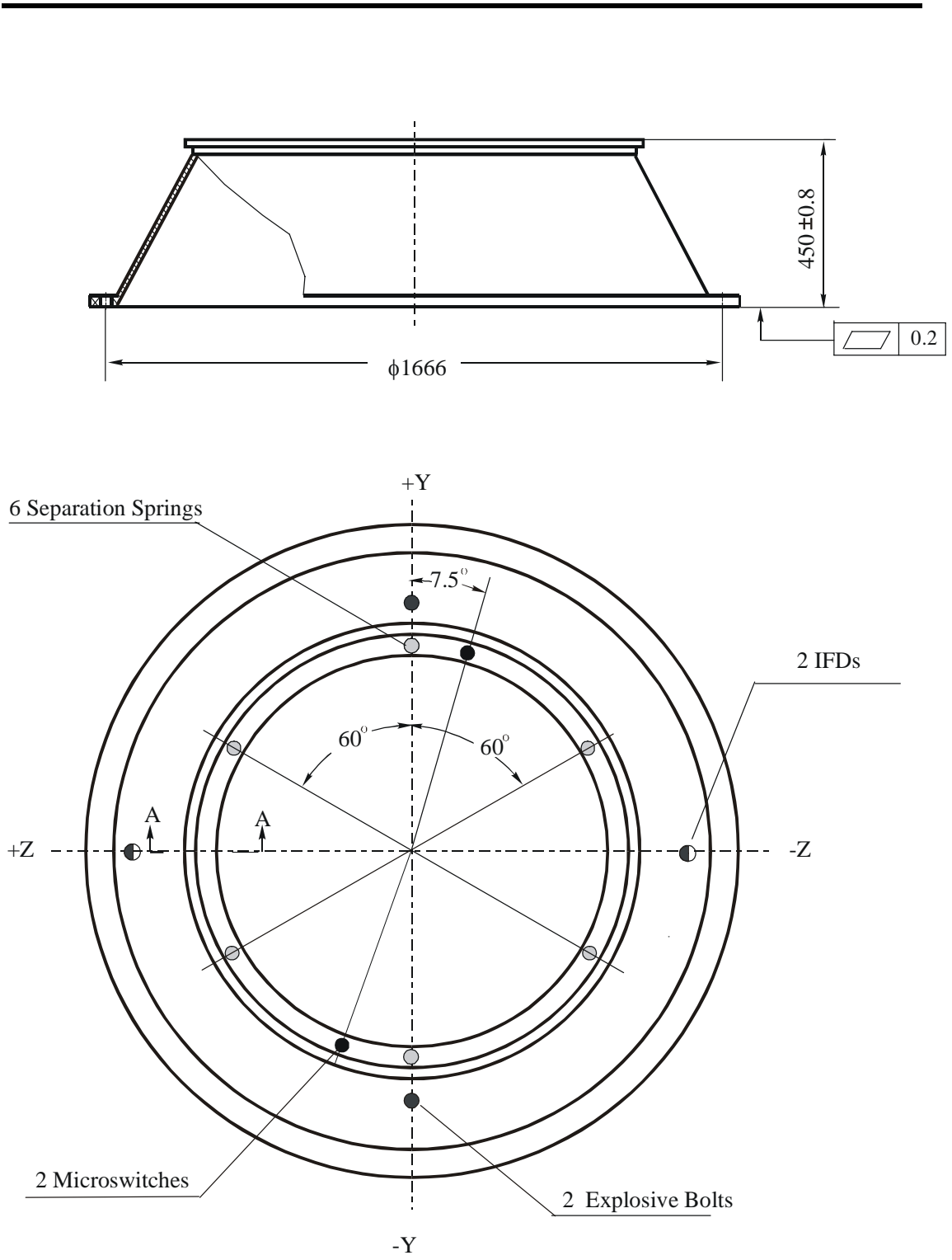
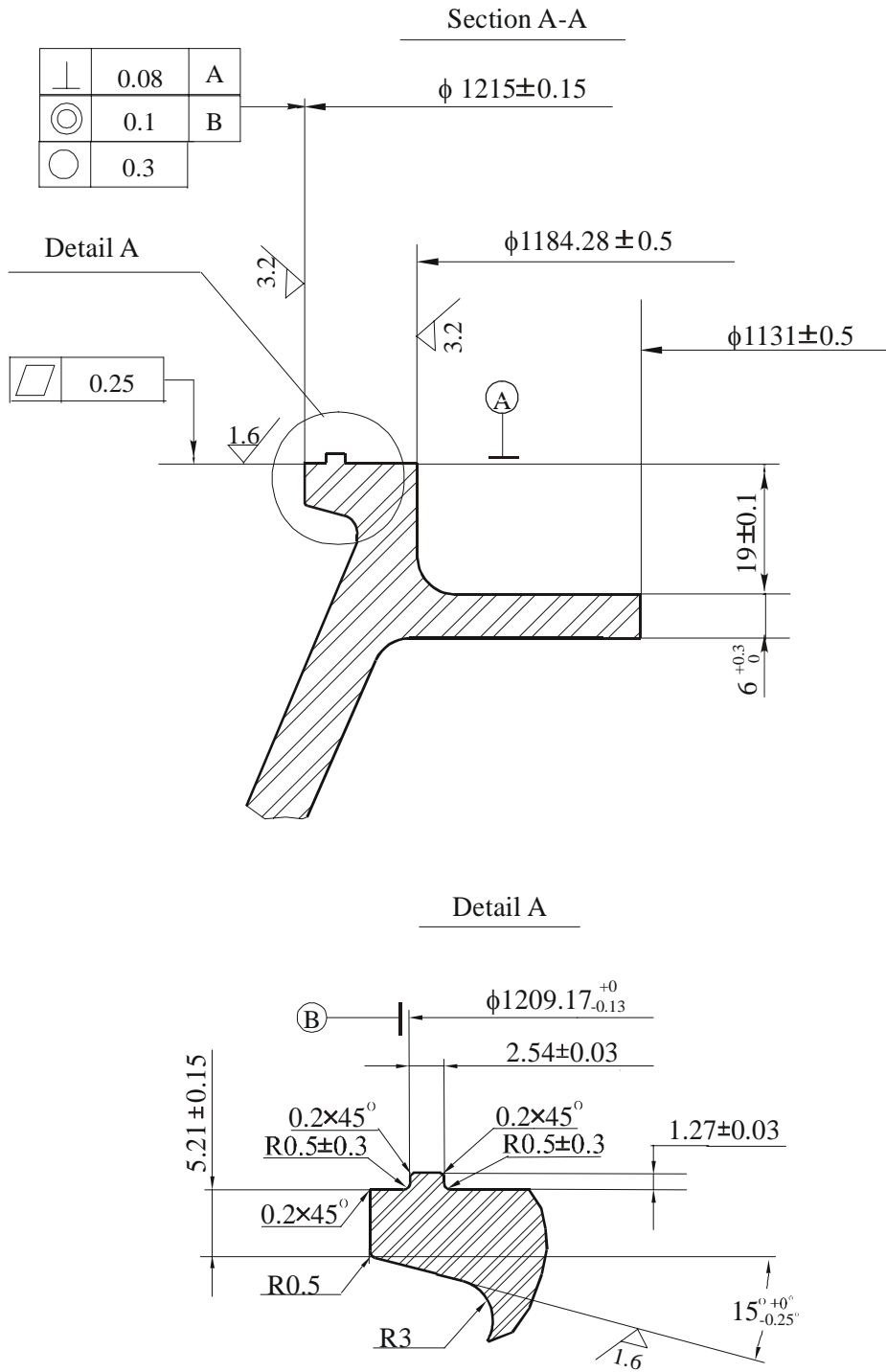


Figure 5-4a 1194A Payload Adapter (Encapsulation-in-BS3)



**Figure 5-4b 1194A Interface (Encapsulation-in-BS3)**

**(TO BE ISSUED LATER)**

**Figure 5-5a 1666 Payload Adapter (Encapsulation-on-pad)**

**(TO BE ISSUED LATER)**

**Figure 5-5b 1666 Interface (Encapsulation-on-pad)**

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**Figure 5-6a 1666 Payload Adapter (Encapsulation-in-BS3)**

**(TO BE ISSUED LATER)**

**Figure 5-6b 1666 Interface (Encapsulation-in-BS3)**

### 5.2.3 SC/LV Separation System

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

**Figure 5-7a,b,c,d,&e** show the SC/LV separation system.

#### 5.2.3.1 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. This requirement has been considered in the fairing envelopes.

#### **5.2.3.2 Separation Springs**

The separation springs 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. It can also provide lateral spinning rate not less than  $1.0^\circ/\text{sec}$  according to user's requirement.

#### **5.2.4 Anti-collision Measures**

LM-3B has adopted some measures to prevent itself from re-contact with the SC after the SC/LV separation. Two seconds from the instant of separation, the Helium bottle on the third stage of LM-3B will automatically blow out Helium gas in a direction of  $45^\circ$  away from the moving SC. So the reaction thrust will slow down the launch vehicle to make a farther distance between SC and LV.



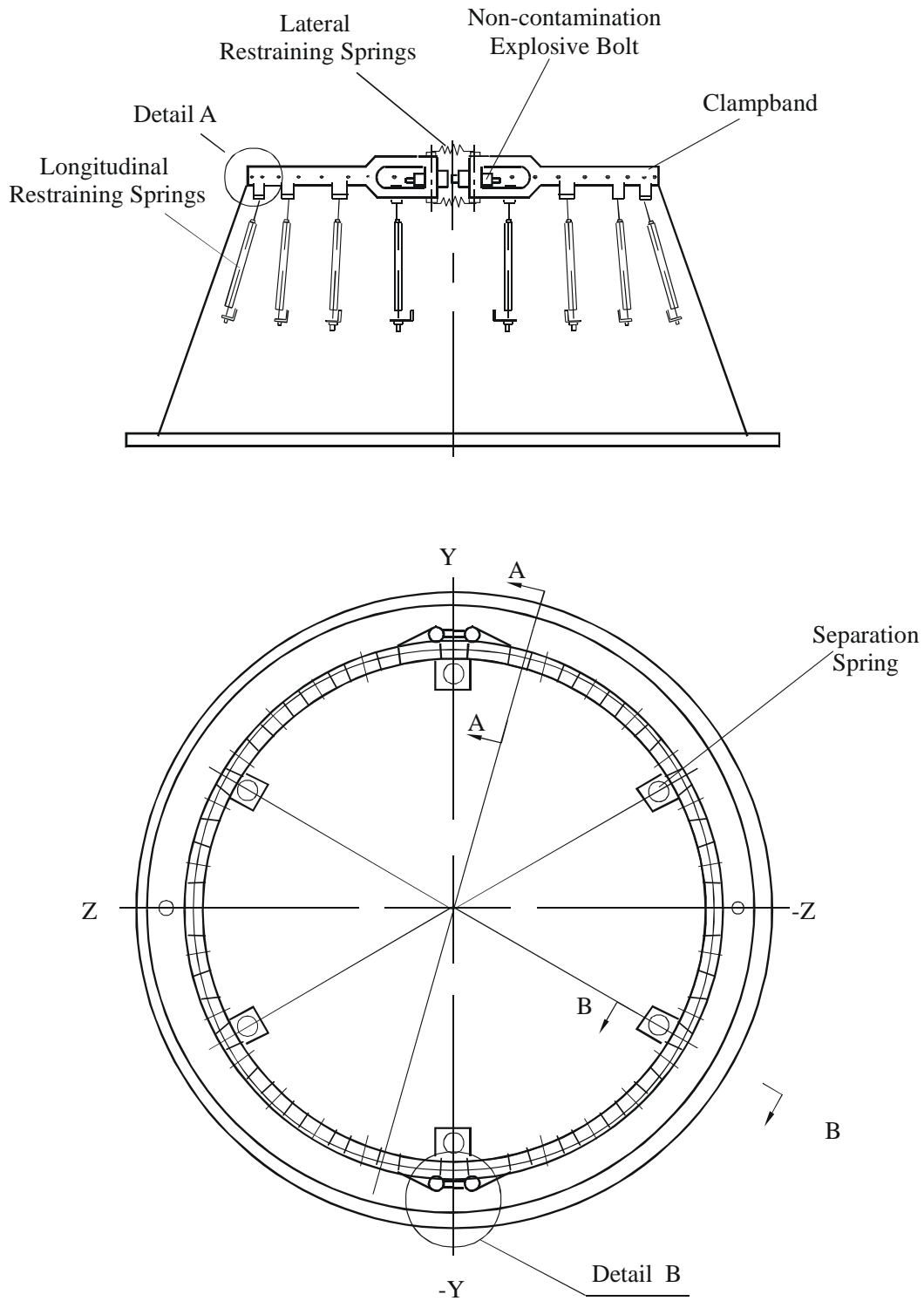
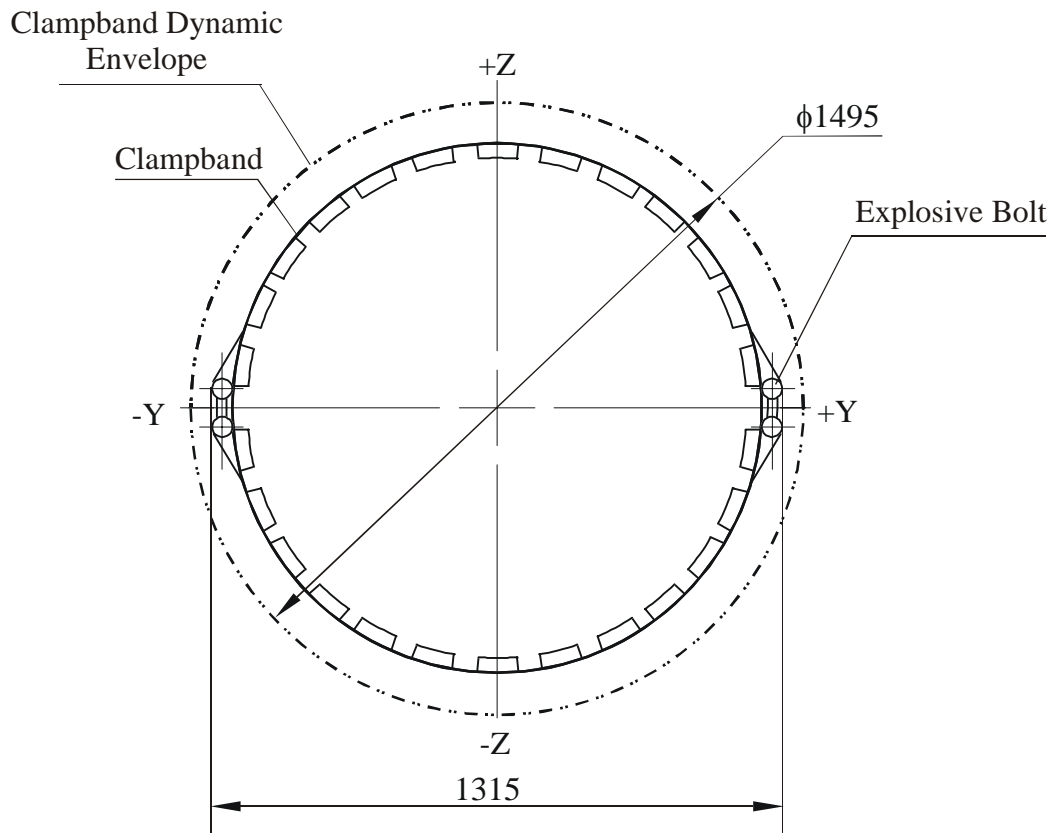


Figure 5-7a Clampband System



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

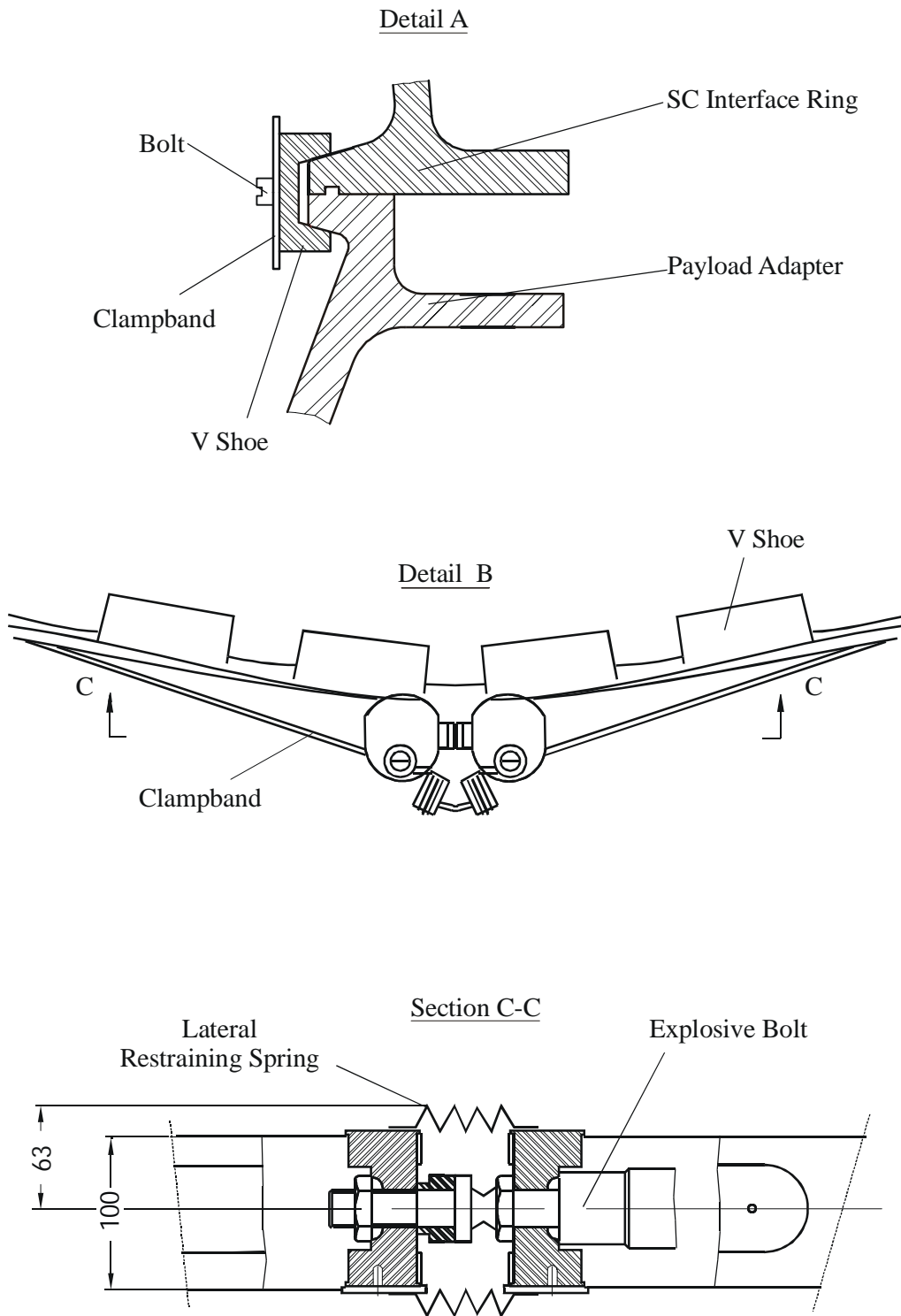
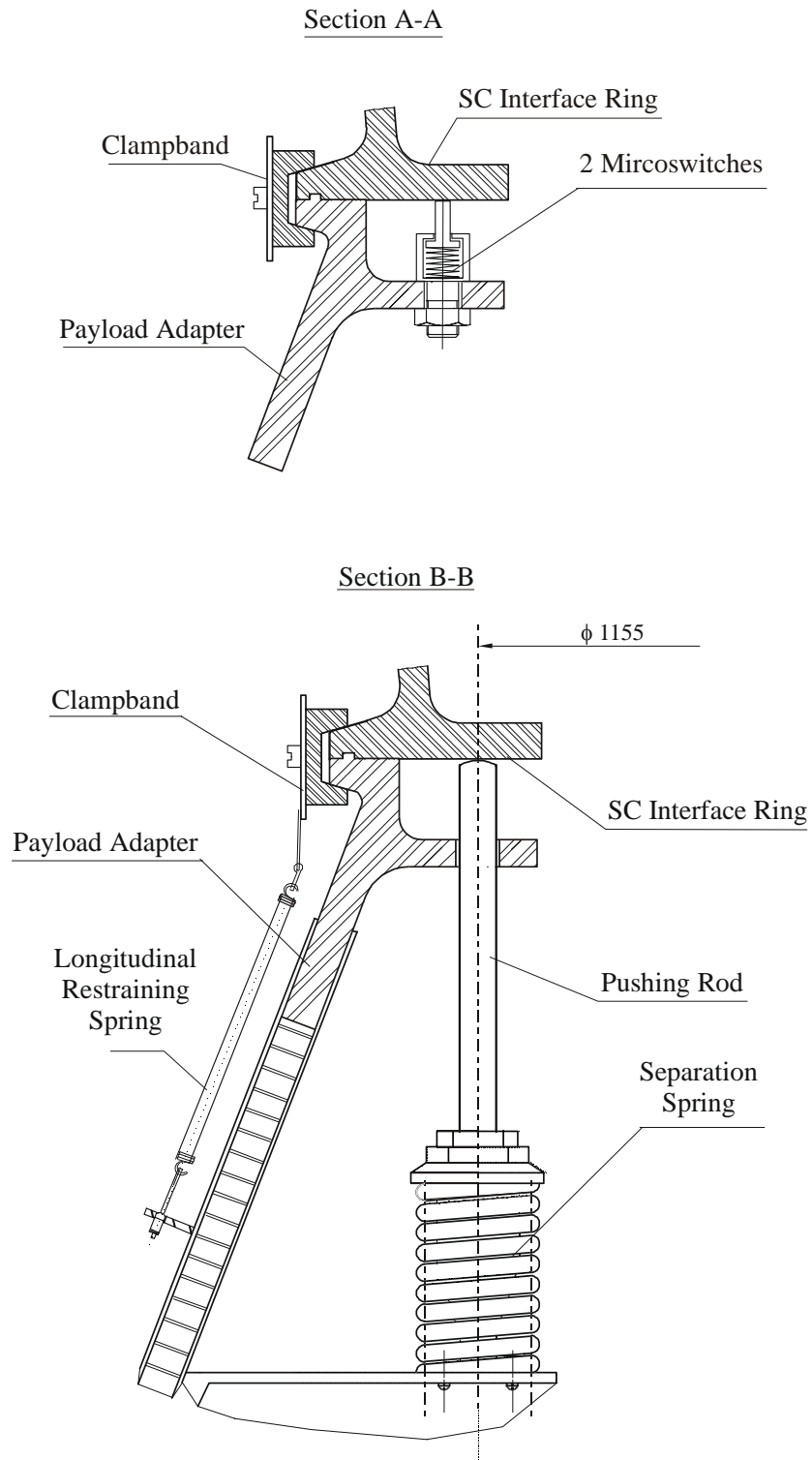
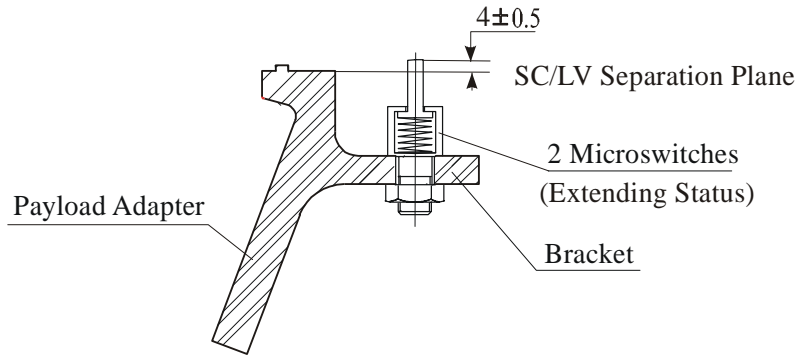


Figure 5-7c Clampband in Detail



**Figure 5-7d SC/LV Separation Spring**

Section A-A



Section B-B

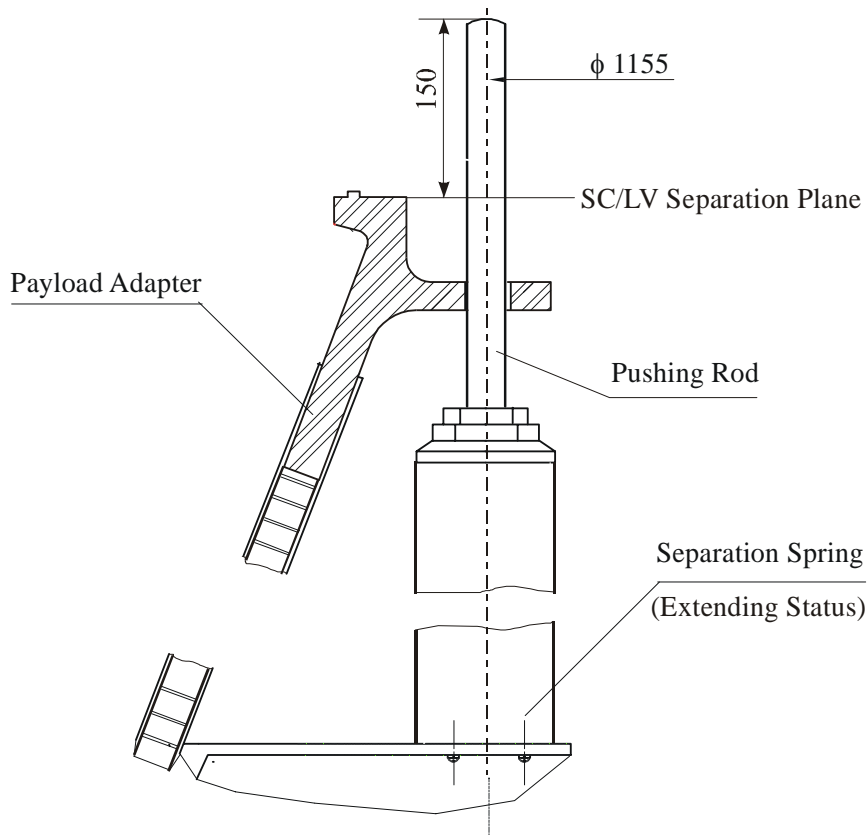


Figure 5-7e SC/LV Separation Spring (Extending Status)

## 5.3 Electrical Interface

### 5.3.1 Summary

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 umbilical system consists of onboard-LV Parts and ground parts. Refer to **Figure 5-8** and **Figure 5-9**. The 350m-cable from Launch Control Console (LCC) to Umbilical Tower, EB26/EB36, BOX3, BOX4, and Power-supply 1&2 are the common to different missions. The onboard-LV cable, as well as ground cable from WXTC to ED 13,14&15 and BOX1 & BOX2, will be designed for dedicated SC according to User's needs. In order to assure the quality of the product, the umbilical system will be provided to the User after undergoing pre-delivery acceptance test and insulation/conductivity checkouts in the launch site.

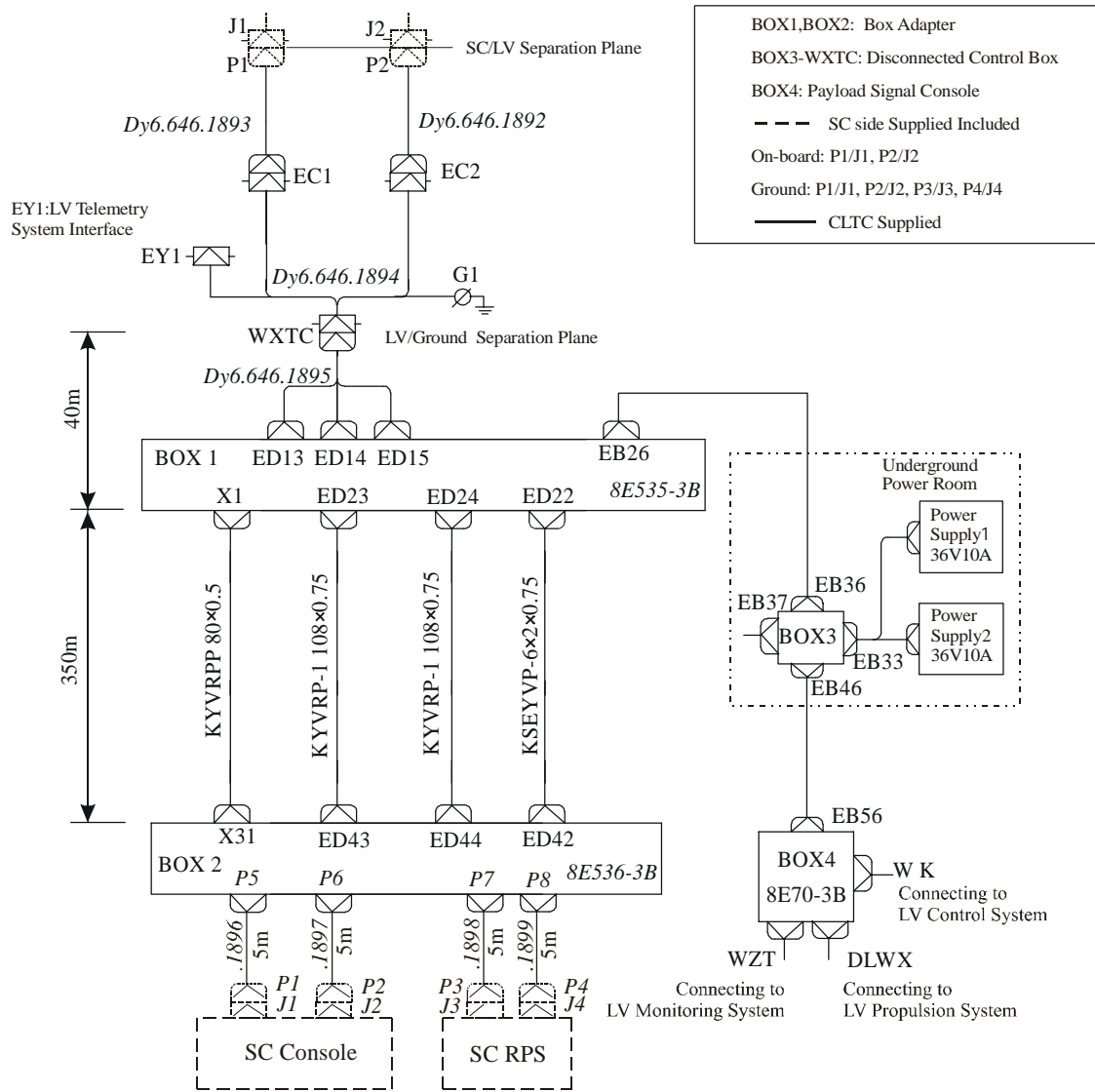


Figure 5-8 Umbilical Cable for SC

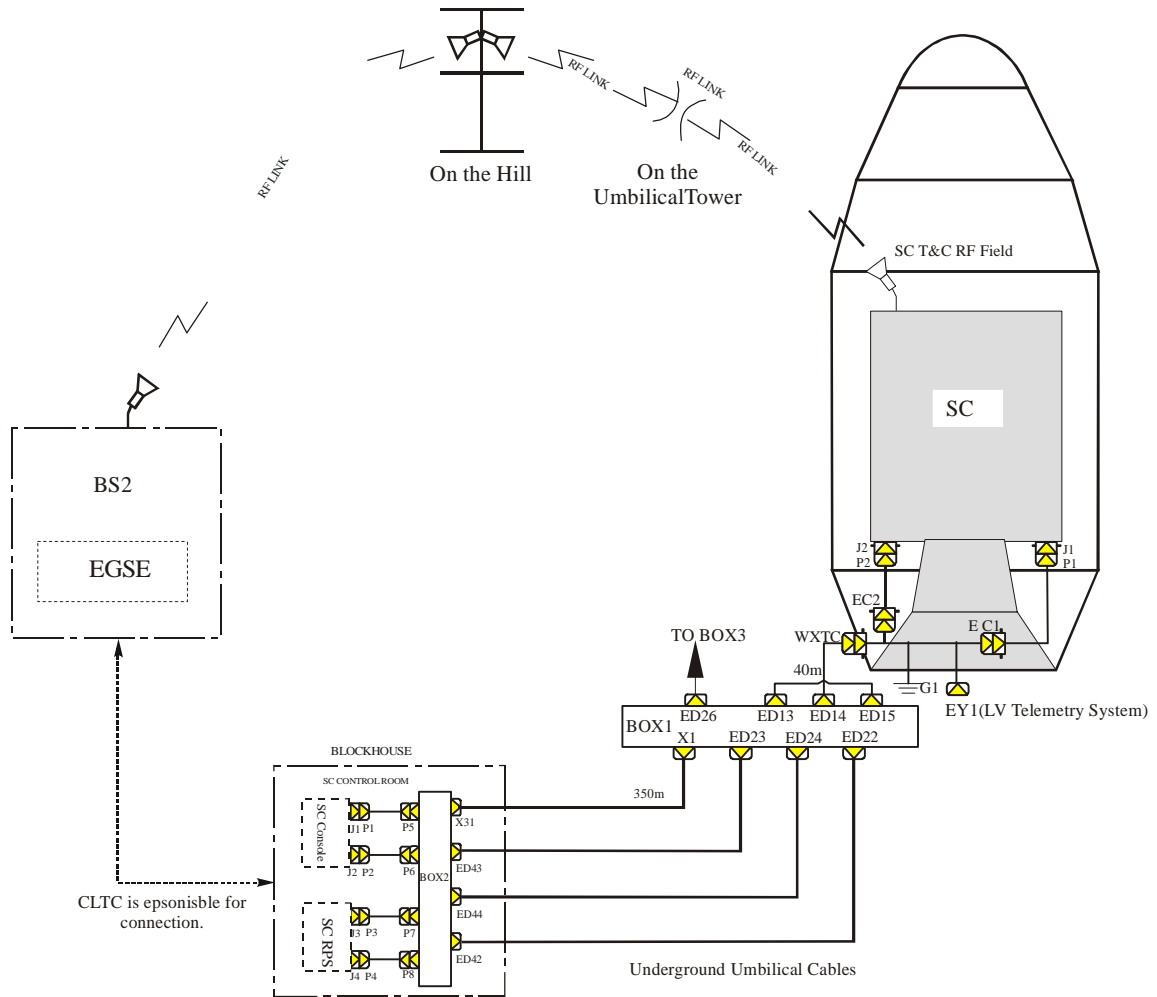


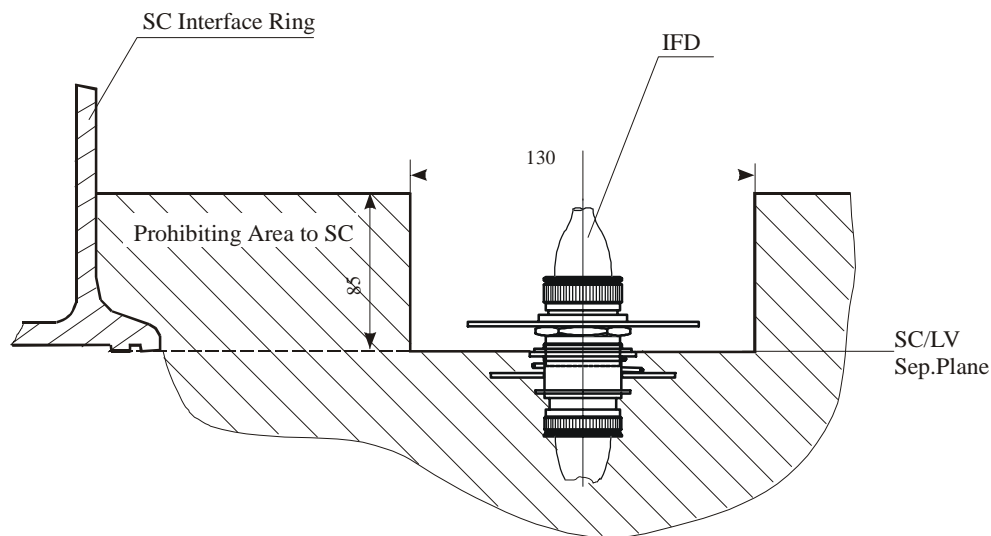
Figure 5-9 On-board and Ground Umbilical Interface



### 5.3.2 In-Flight-Disconnectors (IFDs)

#### 5.3.2.1 Quantity

There are two IFDs symmetrically mounted outside the top ring of the payload adapter. The detailed location will be coordinated between SC and LV sides and finally defined in ICD. See **Figure 5-10** for typical IFD location.



**Figure 5-10 Typical IFD Location**

#### 5.3.2.2 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	
Code	Type	Code	Type
P2	D8179E37-OPN	J1	D8174E37-OSN
P2	D8179E37-OPY	J2	D8174E37-OSY

**Note:**

- (1) The IFDs will separate when disengagement reaches 13.5mm. User can also select other DEUTSCH product according to its needs, such as DBAS7061.
- (2) Following Chinese-made products are also available, YF8-64 (64 pins), FD-

20(20 pins), FD-26(26 pins), FD-50(50 pins), etc.

### 5.3.2.3 IFD Supply

Generally, User provides 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. (If the user selects the Chinese-made connectors, CALT will provide the halves installed at the SC side.)

### 5.3.2.4 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.

## 5.3.3 Umbilical System

The umbilical system consists of onboard-LV parts and ground cable parts.

### 5.3.3.1 Onboard-LV Umbilical Cable

#### (1) Composition

The Onboard-LV cable net comprises the cables from the IFDs (P1, P2) to WXTC. These umbilical cables will fly with LV.

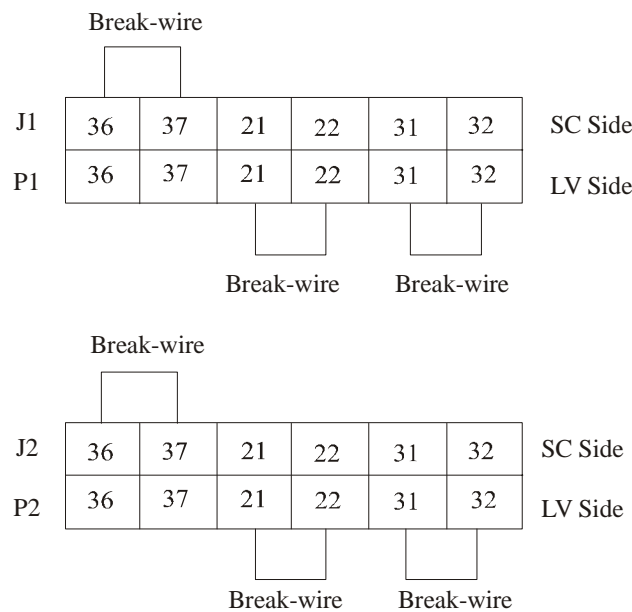
Whereas:

Code	Description
P1、 P2	LV/SC electrical connectors at LV side which is crimp-connected to the cables.
EC1、 EC2	Technological interfaces between SC adapter and LV
EY1	Interface between umbilical cable and LV TM system, through which the SC/LV separation signal is sent to LV TM system
WXTC	Umbilical cable connector (LV-Ground)
G1	Grounding points to overlap the shielding of wires and the shell of LV

(2) Circuitry of separation signal

There are four break-wires on the IFDs P1 & P2, which 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 two break-wires on the IFDs J1 & J2. The IFDs will send the SC/LV separation signal to LV once the break-wires circuitry break when SC/LV separates. This separation signal will be sent to LV's telemetry system through EY1 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**

There are two microswitches on the payload adapter to give the mechanical separation signal. This separation signal will also be sent to LV's telemetry system.

### 5.3.3.2 Ground Umbilical Cable Net

#### (1) Composition

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

Whereas:

Code	Description
WXTC	<p>WXTC is umbilical cable connector (LV-Ground) whose female half (socket) is installed at the wall of the VEB, while the male half (pin) is attached to the top end of ground cable. The disconnection of WXTC is electrically controlled. (The disconnection is powered by BOX 3 and controlled by BOX 4. In the mean time, forced disconnection is also used as a spare separation method.) Generally, WXTC disconnects at about 8min prior to launch. If the launch was terminated after the disconnection, WXTC could be reconnected within 30min.</p> <p>The SC should switch over to internal power supply and cut off ground power supply at 5 minutes prior to WXTC disconnection. Therefore, during disconnection only a low current monitoring signal (such as 30V, <math>\leq 100\text{mA}</math>) is permitted to pass through the WXTC.</p>
BOX1	<p>BOX 1 is a box adapter for umbilical cable that is located inside the SC Cable Measurement Room on Floor 8.5 of the umbilical tower. (If needed, BOX 1 can provide more interfaces for the connection with SC ground equipment.)</p>
BOX2	<p>BOX 2 is another box adapter for umbilical cable that is located inside the SC Blockhouse on ground. Other SC ground support equipment (RPS, Console, etc.) are also located inside the Blockhouse.</p>
BOX3	<p>This is a relay box for the disconnection of the umbilical cable. BOX 3 is located inside the under-ground Power-Supply Room. Box 3 is powered by 2 DC regulated power supply sets. These two power supply sets are in “working-state” sparing to each other.</p>
BOX4	<p>BOX 4 is located inside Blockhouse. It is for the control of the pre-launch disconnection of SC (Payload) umbilical cables.</p>

## (2) Interface on Ground

Generally, there are four interfaces on ground, namely, two for SC Console (P1/J1&P2/J2), and the other two for SC power supply (P3/J3&P4/J4). SC side will define the detailed requirement of ground interfaces. Those connectors (P1,P2,P3,P4) to be connected with SC ground equipment should be provided by SC side to LV side for the manufacture of cables.

Location	Code	Specification	Quantity
LV side interfaces	P1	To be defined by SC side	2
	P2		2
	P3		2
	P4		2

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

SC side can also provide this ground cable. The length of this cable is about 5 meters. If so, LV side will provide the connectors (as Y11P-61) to connect with BOX 2.

## (3) Type &amp; Performance

The type and performance of the umbilical cables are listed in **Figure 5-8**.

## ✧ Onboard-LV Cable Net

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

ASTVR, 0.5mm<sup>2</sup>, fiber-sheath, PVC insulation;

ASTVRP, 0.5mm<sup>2</sup>, fiber-sheath, PVC insulation, shielded.

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

## ✧ Ground Cable Net

## ● Single-Core Shielded Cable

KYVRPP 80×0.5, Copper core, PV insulation, copper film plating on PV for shielding of each core, PVC sheath, woven wire net for shielding of cable; 80

cores/cable,  $0.5\text{mm}^2/\text{core}$ ; Working voltage:  $\leq 60\text{V}$ ; DC resistance ( $20^\circ\text{C}$ ) of each core:  $38.0\Omega/\text{km}$ .

- Ordinary Insulation Cable

KYVRP-1  $108\times 0.75$ , copper core with PV insulation, PVC sheath, woven wire for shielding, flexible; 108 cores/cable,  $0.75\text{mm}^2/\text{core}$ ; No shielding for each core, woven tin-plated copper wire for shielding of cable; Working voltage:  $\leq 110\text{V}$ ; DC resistance ( $20^\circ\text{C}$ ) of each core:  $28.0\Omega/\text{km}$ .

- Twin-twist Shielded Cable

KSEYVP  $6\times 2\times 0.75$ , 6 pairs of twin-twisted cores,  $0.75\text{mm}^2/\text{core}$ . Each twisted pair is shielded and the whole cable has a woven wire net for shielding. Impedance:  $100\Omega$ .

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  $\geq 10\text{M}\Omega$  (including between cores, core and shielding, core and LV shell)

### 5.3.3.3 Umbilical Cable Disconnect Control

LV side is responsible for the pre-launch disconnection of umbilical cable through BOX3 and BOX 4, see **Figure 5-12**.

Inside the underground Power Supply Room, there are two  $36\text{V}/10\text{A}$  DC regulated power supply which will provide power for the cables. They are all in working condition sparing to each other.

Generally, according to the count-down launch procedure, only after LV side has received the confirmation that SC has turned to internal power and SC is normal, could the order of umbilical cable disconnection be sent out.

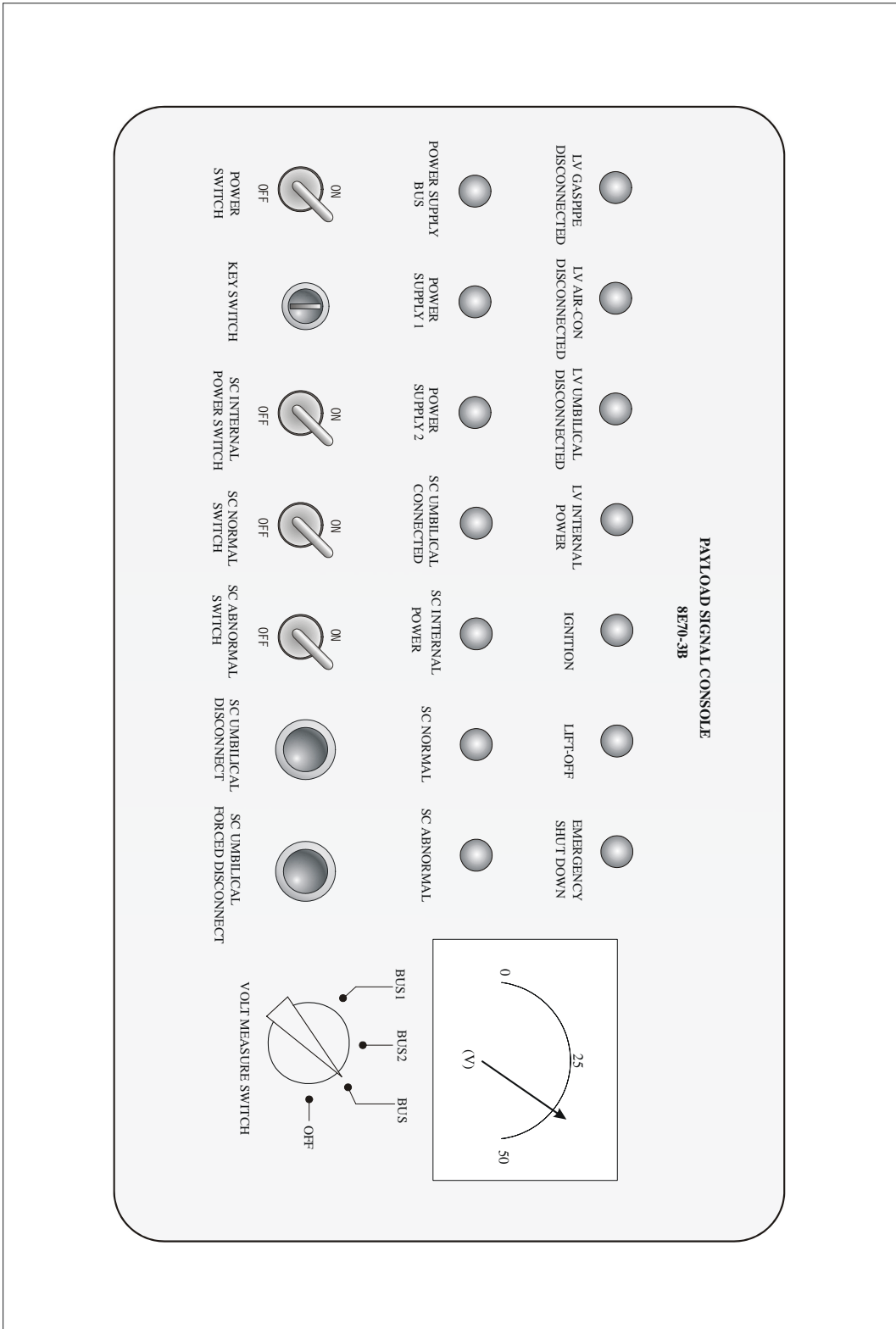


Figure 5-12 Illustration on the Control Panel of BOX4

### 5.3.4 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.

- (1) The cable has two shielding layers, the outer shielding is for anti-lightning while the inner shielding is for anti-interference.
- (2) For the cables from WXTC to BOX 2, the outer shielding (anti-lightning) has a grounding point every 20m. These grounding measures can assure the lightning and other inductance to be discharged immediately. The grounding locations are either on the swing rods or the cable's supporting brackets.
- (3) The inner shield has a single grounding. The inner shields of the on-board cables are connected to BOX 2 through WXTC. BOX 2 has a grounding pole.
- (4) The inner and outer shields are insulated with each other inside the cables.

### 5.3.5 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  $10\text{m}\Omega$  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.

### 5.3.6 Miscellaneous

#### 5.3.6.1 SC/LV Separation Control

- (1) The characteristics of the explosive bolts on the clampband is as follows:
 

Ignition Method:	Two-end Ignition (Two Bridges on Each End)
Quantities:	2 (Redundancy Design)
Ignition Resistance:	0.9~1.2 $\Omega$ for one Bridge
Ignition Current:	5~10A for one Bridge
- (2) Ignition Signal



According to the flight procedures and time sequence, the onboard computer and programmer send out ignition signal to the explosive bolts to separate LV/SC reliably.

The ignition signal has following characteristics:

Battery voltage:	30±3V,
Signal duration (Impulse width):	≥200ms
Working current:	5~10A

### **5.3.6.2 Special Signal Service**

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.

### **5.3.6.3 Special Statement**

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.

## 5.4 RF Links

### 5.4.1 RF Relay Path

The Launch Site can provide RF link from EGSE to SC either in BS or on the umbilical tower.

RF link path consists of points A (BS2), B (Relay Station), C (Umbilical Tower), and D (BS3). Refer to **Figure 5-13**.

At point C, there are two antennas, one of which points to SC and the other points to relay station (Point B). There are also two antennas at Point B. The two antennas have the function of amplifying signals. There are interfaces in BS2 to convey the RF signals from/to EGSE.

### 5.4.2 Characteristics of RF Link

#### (1) Frequency

C Band:           Up-link: 5925~6425 MHz  
                       Down-link: 3700~4200 MHz

Ku Band:           TBD

#### (2) Signal Level

C Band: See following table  
 Ku Band: TBD

Frequency	SC Antenna		EGSE	
	EIRP	PFD	Input	Output
Telemetry	37dBm		-70dBm	
Command		-85dBW/m <sup>2</sup>		30dBm

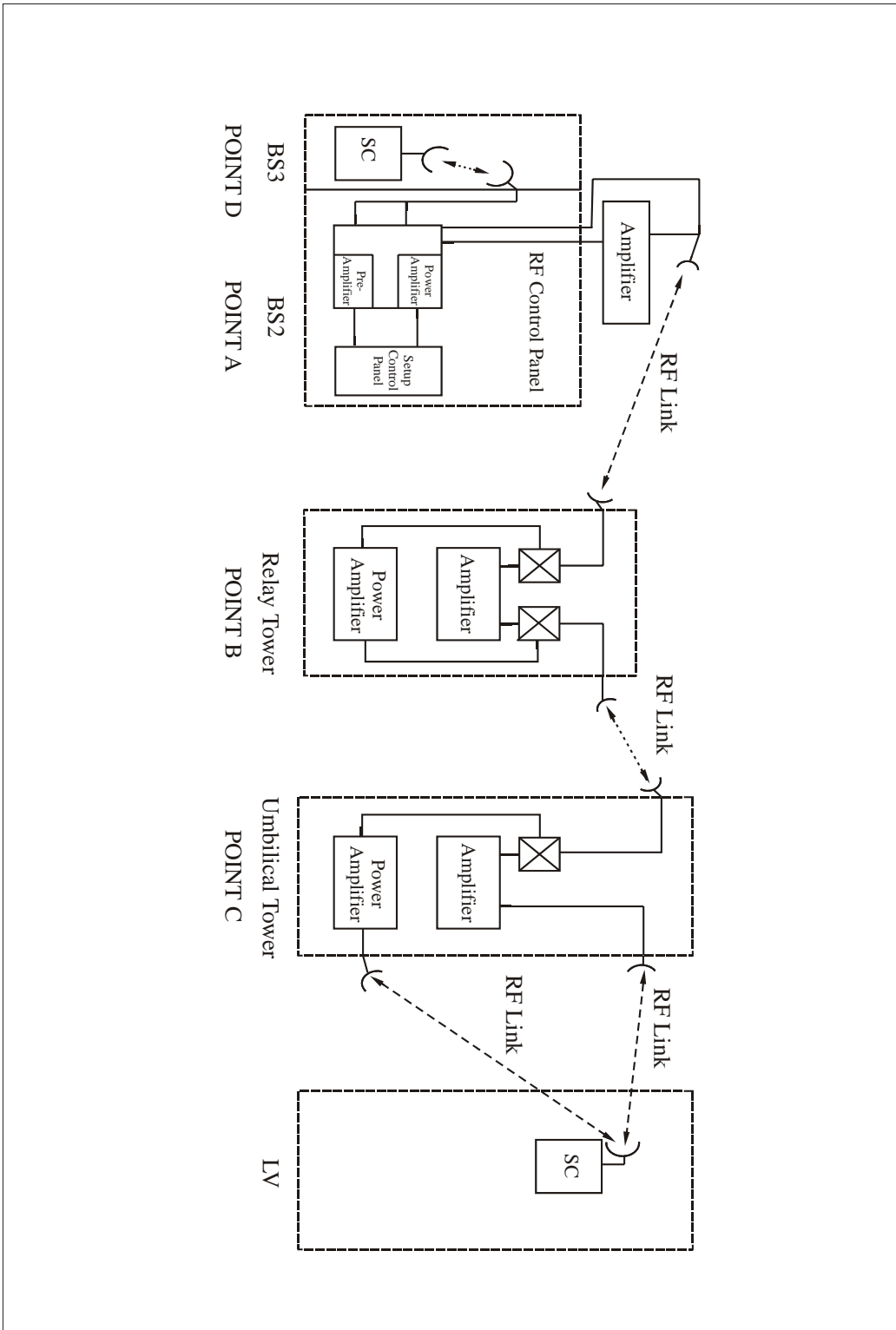


Figure 5-13 RF Links

5-35