USA001948

Space Flight Operations Contract

Cargo Systems Manual (CSM): Hubble Space Telescope Space Support Equipment Servicing Mission 3B

STS-109

Final, Rev A

January 23, 2002

Contract NAS9-20000

United Space Alliance

Verify that this is the correct version before use

USA001948
Final, Rev A

Cargo Systems Manual (CSM): Hubble Space Telescope Space Support Equipment Servicing Mission 3B

Prepared by

Original signature obtained

Robert L. Harvey, Book Manager
USA/Cargo Integration and Operations

Approved by

Original signature obtained

Joe Cavallaro, Lead Payload Officer
NASA/Cargo Integration and Operations

Original signature obtained

Graham Collins, Manager/SFOC Representative
USA/Cargo Integration and Operations

ww_7

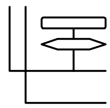
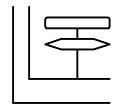
Contract NAS9-20000

REVISION LOG

REV LTR	CHNG NO	DESCRIPTION	DATE
Preliminary		Internal distribution (not released to SELS)	03/02/01
Basic		POWG inputs incorporated	07/10/01
Final		FOR DNs incorporated	10/18/01
Rev A		Incorporates CH #1 – 15	01/23/02
		Pen and Ink Changes	02/28/02

Pen and Ink Changes to the HST SSE CSM, February 28, 2002

1. DRAWING 1.4-2

ZONE E-6/7: WAS:  IS: 

ZONE U-7: Remove the /6 from the line. ADD 2 lines from PDU 3 to line. ADD 3 lines from PDU 4 to line.

ZONE U-6: The FHST 2 should connect to PDU 3 not PDU 2.

2. Pg. 2-1 Section 2.1 Second Paragraph

Was: The FSS interfaces hardline commanding…

Is: The FSS provides hardline commanding….

3. Pg. 2-11 Berthing Latches

Was: Three separate…apart on the perimeter of the BAPS (Drawing 2.2).

IS Three separate…apart on the BAPS (Drawing 2.2).

4. Pg. 2-24 BAPS Pivoter Second Paragraph

Was: In the event of a pivoter failure, the BAPS post must be installed….

Is: In the event of a pivoter failure, the BAPS Support Post (BSP) must be installed…

Was: The BAPS post is discussed later in this section

Is: The BSP is discussed later in this section

BAPS Rotator (Mechanical) Last sentence

Was: …refer to Figure 2-15.

Is: …refer to Figure 2-15 for permitted Rotator positions

5. Pg. 2-67 Second Line

ADD: There are no FSS structural heaters

6. Pg. 2-71 Second Line

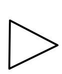
Was: …between…that would be used in a…

Is: …between…that can be used in a…

7. DRAWING 2.4-1

ZONE A-7: ADD NOTE 13: FHST Shutter closed powered directly from SSP CAB PL3, bypassing IPCU. SSP TB driven by IPCU Relay

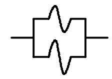
ADD NOTE 14: EPDSU MODULE CURRENT SENSOR: The sensor is broken into 3 separate sensors. The A sensor measures the current going to SSPC X-1. The B sensor measures the current going to SSPC X-2. The C sensor measures the current going to SSPC X-3, the DC/DC converter, and the power the current sensor requires.

ZONE F-5: The NOTE  7 in the DASHED block should be 13

ZONE L-1: The 7A Fuse should be a 15 A Fuse

DRAWING 2.4-1 (continued)

ZONE M-7: The 4 CNTRL Lines beneath the (4) Add Fuses to each line
The Fuses are (top to bottom) 5A,5A,10A,5A

ZONE M/L-6: Replace the 7A Fuse with  Both Fuses are 5A.

ZONE N: In all Mods add a Note ▷ 14.

ZONE N-3: Just prior to the (2) add a ∿ 10A to the line.

ZONE O-1/8: For all ON/OFF CONTROL LOGIC boxes in the MODs.
Delete the C on the lines to the left/ Add a P.
Add a C to the lines to the Right.
In ALL MODS, the 2A Fuse leading to the Filter should be 1A.

8. DRAWING 2.4-2

ZONE A-7: ADD NOTE 14: EPDSU MODULE CURRENT SENSOR: The sensor is broken into 3 separate sensors. The A sensor measures the current going to SSPC X-1. The B sensor measures the current going to SSPC X-2. The C sensor measures the current going to SSPC X-3, the DC/DC converter, and the power the current sensor requires.

ZONE G-7: The Fuses in the 5 lines should be (Top to bottom): 5A, 5A, 10A, 5A, Deleted, 10A

ZONE H: Add a NOTE 13 to each module.

ZONE J: In all MODs, the 2A Fuse leading to the Filter should be 1A.

ZONE J-5: Add a Diode ◀ before the 2.7K resistor coming out of MOD1

ZONE J-6/7: Remove the 4 Diodes outside (left) of the MODs.

ZONE K-7: On the line beneath the 35A fuse, there should be a /6 indicating 6 individual lines.

9. DRAWING 2.6

Delete the Table in Zone W-V 3-2

Add Table 1 (Last page)

ZONE C-2: Add Note 12: Monitor is route through AMSB.
ZONE D-4: Break the Tachometer Telemetry lines and Add a NOTE 12
ZONE D-7: Break the Tachometer Telemetry lines and Add a NOTE 12
ZONE F-2: Remove Diode on End of Travel/Beginning of Travel Lines in the Selection Unit 3
ZONE F-5/6: Remove Diode on End of Travel/Beginning of Travel Lines in the Selection Unit 3

10. DRAWING 3.2

ZONE A-3: NOTE 4: WAS: FMDM HEATER….
IS: FMDM RADIATOR PLATE HEATER
ADD NOTE 5: WIRES Separate outside PDSU

ZONE C-6: Add : with THERM B in the box to the LOPE directly under the Telemetry bubble.

ZONE E-6: Add: with THERM A in the box to the LOPE directly under the Telemetry bubble.

ZONE F-3: Add with THERM B in the box to the ESM connecting to the Telemetry take off.

ZONE F-4: Add with THERM B in the box to the ESM connecting to the Telemetry take off

ZONE K-5: Add a resistor to the Telemetry take off prior to the FMDM

ZONE L-4: ADD a NOTE 5 to the connection leading to RELAY DRIVER 13.

ZONE M-4: ADD a NOTE 5 to the connection leading to RELAY DRIVER 12.

ZONE O-4: Add a resistor to the telemetry take off prior to the FMDM

ZONE P-3: WAS: FMDM B, IS: FMDM A
WAS: FMDM A, IS: FMDM B

ZONE V-8: WAS:cb2, IS: cb4

11. DRAWING 4.2

ZONE G/I-5/8: AXIAL SIPE.
The Heaters in the ASIPE are mislabeled. Sequence (top to bottom) should be 8,16,7,10,17,9,12,18,11,20,21,2,13,1,4,14,3,6,15,5,19,22.

ZONE L-6: On ESS 2A-1, add a 10A fuse inside the EPDSU, after the HTR A take off.

ZONE L-4: On ESS 2B-1, add a 10A fuse inside the EPDSU, after the HTR B take off.

ZONE M-5: On ESS1B-1, Add a 1A fuse .

ZONE M-7: On ESS1A-1, Add a 1A fuse .

ZONE N: On all current sensors Add an A inside the block, and add with a 1A fuse connecting to the bus leading to the filter.

12. **Pg. 5-1** **Section 5.1 Second Paragraph**

Was: …the overall weight of the RAS…

Is: …the overall weight of the RAC…

Section 5.1.1 Last Paragraph

Was: …Jettison Handle, Portable Connector Trays (2), …

Is: …Jettison Handle, Connector Stowage Bracket (2), …

13. **Pg. 5-2** **Second Line**

Was: …, 112 pounds with the SM3B….

Is: …, 122 pounds with the SM3B….

14. **Pg. 5-20** **Section 5.1.7**

Was: secured with Velcro and a restraint strap.

Is: secured with Velcro and a 1/4 turn button latch.

15. **Pg. 5-22** **Section 5.4 First Bullet**

Was: stored on the MULE for SM-3B

Is: stored on the RAC for SM-3B

16. **DRAWING 6.1-2**

ZONE B-2: NOTE 4: Was: MN BUS INT PWR SWITCH is switchguard protected.

IS: MN BUS INT PWR SWITCH and ESS/MN SW ENA are switchguard protected with a Wicket Safety Cap.

ZONE G-8: ADD A NOTE ▷ 4 beside the ESS/MN SW ENA.

17. **DRAWING 6.1-4**

ZONE R-7: WAS: S18, IS: S4

18. TABLE 1 For Drawing 2.6

SYSTEM 1 (S46) MECHANISM SELECTION								
PL SEL (S37)	RET LAT SW	DESCRIPTION	TLM REL	TLM LAT	DC BUS	CNTRL BUS	AC PWR	MDM
1	1(S36)	FSS AMSB-A SYSTEM	V54X8111E	V54X8113E	MN A	AB1	AC1	OA3
2	4(S44)	SAC KEEL LATCH	V54X8241E	V54X8243E	MN A	AB1	AC1	OF4
2	5(S45)	FSS KEEL LATCH	V54X8251E	V54X8253E	MN A	AB1	AC1	OF2
3	1(S36)	RAC PORT FWD LATCH	V54X8311E	V54X8313E	MN A	AB1	AC1	OF2
3	2(S42)	RAC STBD FWD LATCH	V54X8321E	V54X8323E	MN A	AB1	AC1	OF2
3	3(S43)	RAC PORT AFT LATCH	V54X8331E	V54X8333E	MN A	AB1	AC1	OF2
3	4(S44)	RAC STBD AFT LATCH	V54X8341E	V54X8343E	MN A	AB1	AC1	OF2
3	5(S45)	RAC KEEL LATCH	V54X8351E	V54X8353E	MN A	AB1	AC1	OF2
SYSTEM 1 (S47) MECHANISM SELECTION								
PL SEL (S37)	RET LAT SW	DESCRIPTION	TLM REL	TLM LAT	DC BUS	CNTRL BUS	AC PWR	MDM
1	2(S42)	FSS AMSB-B SYSTEM	V54X8122E	V54X8124E	MN B	BC1	AC2	OF2
2	4(S44)	SAC KEEL LATCH	V54X8242E	V54X8244E	MN B	BC1	AC2	OF1
2	5(S45)	FSS KEEL LATCH	V54X8252E	V54X8254E	MN B	BC1	AC2	OF1
3	1(S36)	RAC PORT FWD LATCH	V54X8312E	V54X8314E	MN B	BC1	AC2	OF1
3	2(S42)	RAC STBD FWD LATCH	V54X8322E	V54X8324E	MN B	BC1	AC2	OF1
3	3(S43)	RAC PORT AFT LATCH	V54X8332E	V54X8334E	MN B	BC1	AC2	OF1
3	4(S44)	RAC STBD AFT LATCH	V54X8342E	V54X8344E	MN B	BC1	AC2	OF1
3	5(S45)	RAC KEEL LATCH	V54X8352E	V54X8354E	MN B	BC1	AC2	OF1

Cargo Systems Manual (CSM):
Hubble Space Telescope
Space Support Equipment
Servicing Mission 3B

LIST OF EFFECTIVE PAGES

The current status of all pages in this document is as shown below:

Page No.	Change No.
Preface	Final, Rev A
i - viii	Final, Rev A
1-1 – 1-10	Final, Rev A
(Section 1 Drawings)	Final, Rev A
2-1 – 2-74	Final, Rev A
(Section 2 Drawings)	Final, Rev A
3-1 – 3-28	Final, Rev A
(Section 3 Drawings)	Final, Rev A
4-1 – 4-27	Final, Rev A
(Section 4 Drawings)	Final, Rev A
5-1 – 5-25	Final, Rev A
(Section 5 Drawings)	Final, Rev A
6-1 – 6-102	Final, Rev A
(Section 6 Drawings)	Final, Rev A
7-1 – 7-6	Final, Rev A
A-1 – A-5	Final, Rev A
B-1 – B-10	Final, Rev A
C-1 – C-3	Final, Rev. A

PREFACE

This document has been prepared by United Space Alliance (USA) under contract to Operations Division, National Aeronautics and Space Administration (NASA) Lyndon B. Johnson Space Center (JSC), Houston, Texas, with documentation support from Hernandez Engineering, Inc. (HEI).

Comments concerning the general contents of this manual should be directed to DO5/Robert Harvey, (281) 244-0230.

PURPOSE

This is the Final Rev A version of the Cargo Systems Manual (CSM) prepared for early flight control team preparations and review for the STS-109/SM-3B mission.

The Cargo Systems Manual: Hubble Space Telescope (HST) Space Support Equipment (SSE) is intended to provide a single comprehensive source for technical and operational data on those elements of the HST support hardware involved in the performance of joint space shuttle/HST operations for the completion of Servicing Missions (SMs). Detailed descriptions of space shuttle interfaces to the SSE are also provided, allowing an end-to-end understanding of the integrated space shuttle/HST flight configuration for the SM. This CSM is intended for use by JSC Mission Control Center (MCC) personnel, flight planning and procedure development personnel, flight and ground crew training personnel, and STS flight crews supporting the HST project through its planned lifetime. The schematic diagrams and structural drawings provided in this document reflect the current information available and are produced in accordance with the Mission Operations Directorate (MOD) Drafting Standards, Revision C, dated April 1987.

SCOPE

This document describes the HST vehicle support hardware to be flown on SM-3B and the interface of that hardware to the orbiter. Although no detailed payload operation procedures are included, this document provides the basis of technical data for understanding those procedures documented in the HST SM Flight Operations Support Annex. Any technical data beyond that necessary to understand those procedures is provided for completeness in describing the HST SM system. In general, ground equipment or ground operations descriptions are not included. Further detailed information on the HST ground-based operations system for controlling the orbiting vehicle is not provided.

DESCRIPTION

This volume provides technical data on the SSE that will be used to support an HST servicing mission. The SSE consists of four major structural components: the Flight Support System (FSS), Multi-Use Lightweight Equipment (MULE) carrier, Second Axial Carrier (SAC) and the Rigid Array Carrier (RAC). This

CSM addresses each of the components and their interfaces to each other, the orbiter, and the HST. The HST CSM, JSC-29029, provides the source for technical data on the HST.

Section 1 presents an overview of the SSE and the SM operations concept.

Section 2 describes the FSS and includes all relevant data on FSS interfaces to the orbiter, HST, and other SSE equipment. Section 2 is composed of subsections that discuss FSS structures, mechanisms, electronics, thermal control, avionics systems, and visual aids the crew will use.

Section 3 describes the MULE and includes all relevant data on MULE interfaces to the orbiter and other SSE equipment. Section 3 is composed of subsections that discuss MULE structures, mechanisms, electronics, thermal control, and avionics systems.

Section 4 describes the SAC and its interfaces to the orbiter and the other SSE equipment. The SAC structures, mechanisms, electronic, thermal control, avionics systems, and visual aids are also described.

Section 5 details the RAC physical description, thermal control, and external interfaces.

Section 6 describes the displays and controls available to the crew and MCC.

Section 7 addresses the safety issues concerned with the SSE.

Appendix A contains acronyms used in this book, Appendix B contains the FMDM system description, and Appendix C contains information on document change control.

ACKNOWLEDGMENTS

The book manager would like to acknowledge the contributions of the JSC payload engineers who contributed their time toward producing this document at various stages of its development: Jeff Hanley, Jeff Larson, John McCullough, Todd Batten, Ben Pawlik, Chuck Moede, Rob Banfield, and Bryan Janda.

Also, the book manager would like to acknowledge those who helped get the book together. Each member of the SSE OPS team owned a part of this book and without their help, the book could not have been produced: Troy McCracken, Margaret Gibb, Cari Goulard, Jeremy Owen, Larissa Smit, Scott Ede, and Michele Di Benedetto.

Lastly, the book manager would like to express deep appreciation and respect to the following people who have spent a lot of effort and hard work on the book's text and drawings: Sofia Stachel of Orbital, and the following group from HEI: Vicki Atkins, Barbara Bowen, Greg Carter, Cadie Howard, Lillie Langston-Polat, Peggy Levy, Allison Meyer, Brandi Ricicar, Stephanie Settlemire, and Ann Wiseman. Without their diligence, this book would not have been publishable.

CONTENTS

Section **Page**

Section **Page**

Appendix

TABLES

Table		Page

FIGURES

Figure

Figure		Page

Figure **Page**

DRAWINGS

Drawing **Page**

1.0 INTRODUCTION

1.1 BACKGROUND

The purpose of the Servicing Mission (SM) is to upgrade the scientific capabilities, repair or replace failed equipment on the Hubble Space Telescope (HST), and provide a reboost capability when needed. By using the Space Shuttle Program to provide scientific instrument upgrading and subsystem maintenance, the useful and effective operational lifetime of the HST will be extended to a decade or more.

The HST is designed for on-orbit servicing and refurbishment. Repairs to the HST will be made during SMs, which consist of a shuttle launch, ascent, rendezvous with HST, grapple, Extravehicular Activity (EVA) servicing, reboost (if required or available consumables allow), redeployment of the HST, shuttle entry, and landing.

This Cargo Systems Manual (CSM) describes the Space Support Equipment (SSE) required for the SM. It describes the actual HST in sufficient detail for the reader to be able to understand the operation of the SSE, but does not contain sufficient information to understand the HST. The HST is described in the HST CSM (see Section 1.4, Applicable Documentation).

1.2 SPACE SUPPORT EQUIPMENT HARDWARE OVERVIEW

1.2.1 Physical Overview

The payload complement for the fourth planned SM (SM-3B) includes the Flight Support System (FSS), the Second Axial Carrier (SAC), the Rigid Array Carrier (RAC), the Multi-Use Lightweight Equipment (MULE) carrier, and a Goddard Space Flight Center (GSFC)-supplied HST Payload General Support Computer Assembly (HPGSCA) with a special data processing board. A physical overview of the SSE is shown in Drawing 1.1. The HPGSCA is located in the crew compartment.

The FSS provides a maneuverable servicing platform for the HST, as well as electrical power control and monitoring interfaces between HST and the orbiter. The FSS has a similar configuration to that flown on SM-1 (STS-61), SM-2 (STS-82), and SM-3A (STS-103). The FSS consists of the A cradle and a Berthing and Positioning System (BAPS) with additional HST SM avionics. The FSS will provide the platform for the HST during the SM. Interfaces for the orbiter support services are provided through a set of Standard Interface Panels (SIPs) (port and starboard) just aft of the FSS. The FSS Avionics consist of two Enhanced Power Distribution and Switching Units (EPDSUs), two Flexible Multiplexer/Demultiplexers (FMDMs), the Advanced Mechanism Selection Box (AMSB), two Power Conditioning Units (PCUs), Junction Box (J-Box), and the Interface Power Control Unit (IPCU). The FSS is supported by two Payload Retention Latch Actuators (PRLAs) and one keel trunnion.

The SAC uses the HST Pallet Assembly as the primary structure retained by four PRLAs and one keel trunnion. The SAC carries the Advanced Camera for Surveys (ACS) to orbit and will return the Faint Object Camera (FOC) to Earth in the Axial Science Instrument Protective Enclosure (ASIPE). Eight Magnetically Damped Isolators (MDIs) support the ASIPE. The Orbital Replaceable Unit (ORU) Plate Assembly (OPA) will carry the HST Power Control Unit (PCU) on the Starboard (STBD) side of the SAC. The New Outer Blanket Layer (NOBL) Transporter (NT) is mounted under the aft end of the pallet, and will carry the NOBLs that remain from SM-3A. The Near Infrared Camera and Multi-Object Spectrometer (NICMOS) CryoCooler (NCC) will also be located on the SAC on the SAC Adapter Plate (SAP) on the port side of the carrier pallet. The Under Pallet Storage (UPS) container is mounted under the forward end and will transport both the Primary and Secondary Cross Aft Shroud Harnesses (CASHs). The SAC also carries a number of Crew Aids and Tools (CAT) for the PCU changeout. The SAC EPDSU is mounted to the aft end of the pallet and provides the power, command, and telemetry interface to the orbiter.

The RAC uses a Spacelab pallet as the primary cradle and will support and carry the Solar Array (SA) 3s to orbit and return the SA-IIs (rolled) to Earth. The Bi-Stem Braces will also fly on the RAC, along with the Diode Box Assemblies (DBAs). The Solar Array (SA-II) Drive Adapter (SADA) Clamp Pickup Assembly (CPUA) and the forward and aft latches will also be transported on the RAC. There will be two Auxiliary Transport Modules (ATMs) located on the aft end of the pallet. The RAC has no power or telemetry and is fixed in the payload bay with four PRLAs and one keel trunnion. This is the only carrier that will have Active Latches for all PRLAs and the keel trunnion.

The MULE is built on the Upper Atmospheric Research Satellite (UARS) Airborne Structure Equipment (UASE) cradle structure, with a flight history of STS-48 (UARS) and STS-95 (HOST). The MULE has a three-trunnion interface, one keel and two longeron trunnions. The MULE carries the Electronic Support Module (ESM), the Large ORU Protective Enclosure (LOPE), the NICMOS Cooling System (NCS) radiator, and the Small ORU Protective Enclosure (SOPE). The SOPE and LOPE carry a complement of CAT. The Avionics for the MULE consist of a Power Distribution and Switching Unit (PDSU) and two FMDMs.

A functional view of the Orbiter/SSE structural interfaces is shown in Drawing 1.1.

1.2.2 Systems Overview

A functional overview of the SSE systems is shown in Drawing 1.2. The flight crew will control DC power to the FSS through the orbiter Standard Switch Panel (SSP) and the FSS AC mechanisms via GPC SM SPEC 212 and switches on panel A6U. Section 6 addresses displays and controls for the SSE.

Primary control and monitoring of the HST will be provided via a Radio Frequency (RF) link to the orbiter, using Payload Signal Processor (PSP) bypass mode for the telemetry. The HPGSCA, with its special signal processing board, will be connected to the Payload Data Interface Panel (PDIP) and used to interface the Payload Interrogator (PI) to the Payload Data Interleaver (PDI) to allow data communications using the HST data formats that the PI/PDI do not support. In the event of an HPGSCA failure, a passive plug is installed at the PDIP as an alternate data path. Some functions of the HST are controlled and monitored via GPC SPEC 210. HST displays and controls are addressed in the HST Cargo Systems Manual.

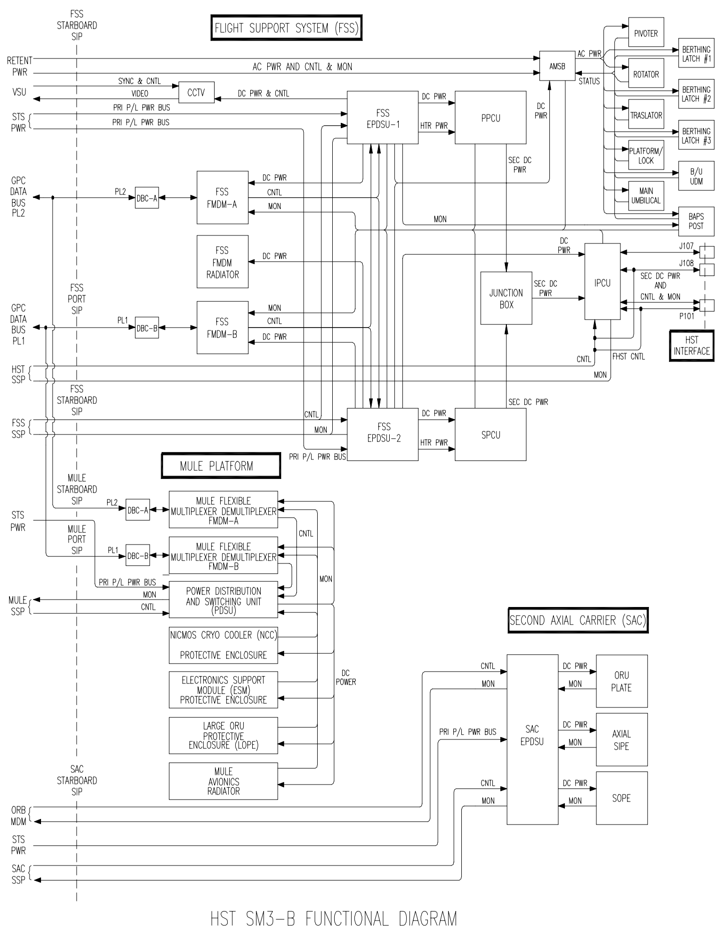


Figure 1-1. Functional overview of servicing mission power/data routing

The FSS provides conditioned power and hardline power control to the HST. The power flow from the orbiter to the FSS to the HST is shown in Drawing 1.4. The servicing platform is configured with drive and brake/locking systems, a latching and release system, a platform pivot capability with drive and brake/locking systems, a rotating capability with drive and brake/locking systems, a Close Circuit Television, and electrical interfaces to the HST. The FSS draws power from the orbiter payload primary bus and supplies regulated power to the HST through the Direct Power Converters (DPCs), J-Box, IPCU, and umbilical. Reference Figure 1-2 for a functional overview of the SSE/HST conditioned power control and routing.

FSS mechanisms are used to position the HST for servicing. The mechanisms are controlled via the General Purpose Computer (GPC) SM SPEC 212 and the PRLA switches on panel A6U. The GPC input and feedback data are channeled through one of the FSS FMDMs to select and monitor the mechanism to be driven.

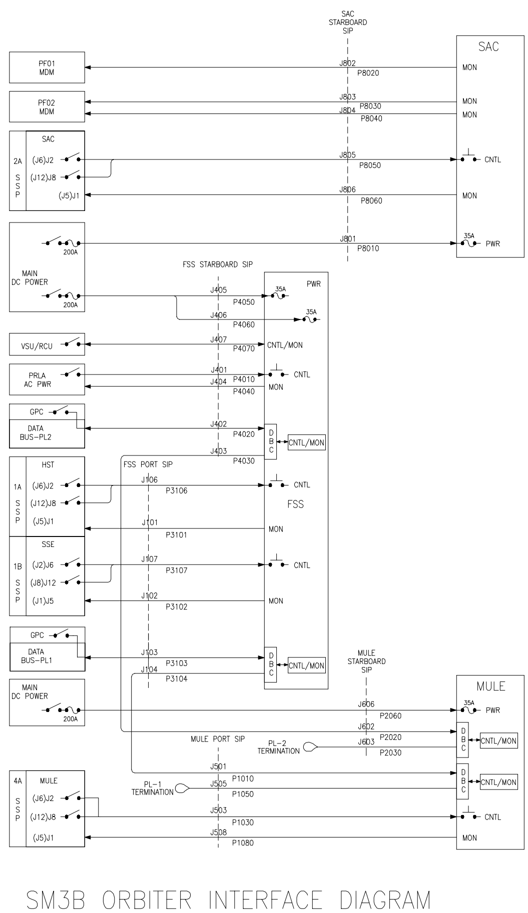


Figure 1-2. Functional overview of the orbiter interfaces

Actual mechanism activation occurs via switches on the A6U panel. For the second SM (SM-2), the BAPS Support Post (BSP) was modified to allow for remote operations similar to any of the FSS mechanisms. When the BSP is installed, it limits the BAPS operation between 43.8° and almost 90°. When the BAPS is pivoted up, it limits the travel to less than 90° and prevents the automatic mechanism termination. The BAPS will be pinned in this position during the normal servicing activities to prevent inadvertent damage to the HST solar arrays during EVA activities. When the BAPS is pivoted down to the 43.8° position, it automatically locks in position. This is the nominal landing position for SM-3B. The latch can be released either via normal mechanism control or EVA operation. The FSS is addressed in detail in Section 2.

The MULE is a reusable flight-qualified carrier designed to transport HST ORUs and CATs to orbit. Its primary complement consists of the ESM and the NCS Radiator. Additionally, it provides contingency hardware stowage in the Large ORU Protective Enclosure (LOPE) and the Small ORU Protective Enclosure (SOPE). The MULE provides stowage and environmental protection for ORUs during all phases of the mission. The MULE physical overview can be seen in Drawing 3.1. The MULE's avionics and heater services are controlled via the Standard Switch Panel (SSP) and are monitored via SSP talkbacks and GPC SM SPEC 211. The shuttle provides structural, electrical, and command/telemetry interfaces to the MULE. The MULE/STS interfaces are detailed in Drawing 1.3. The MULE provides stowage and environmental protection for ORUs during all phases of the mission. The MULE is addressed in detail in Section 3.

The Second Axial Carrier (SAC), Drawing 4.1, is a reusable, reflown structure that provides transportation, load isolation, environmental control and protection for the SIs, ORUs, and CATs and tether positions to perform on-orbit servicing.

The Pallet Assembly (PA), Axial Scientific Instrument Protective Enclosure (ASIPE), ORU Plate Assembly (OPA), NOBL Transporter (NT), Under Pallet Stowage (UPS), and SAC Adaptor Plate (SAP) are the principle structures of the SAC.

The secondary structures are the units carrying additional ORUs and CATs for EVAs. The SAC's avionics and heater services are controlled via the SSP and are monitored via the SSP talkbacks and GPC SM SPEC 211. The SAC's interfaces with the orbiter are detailed in Drawing 1.3 and are addressed in detail in Section 4.

A functional description of the STS/SSE power routing is shown in Drawing 1.3.

The RAC is mounted in the forward section of the orbiter payload bay. The RAC, shown in Drawing 5.1, uses a SpaceLab Pallet (SLP) as the primary structure cradle. The SLP contains the Center Support Structure (CSS), port and starboard shelves, and ORUs.

The RAC is designed to transport new SA3 wings to orbit and return old SA2 wings to Earth. The RAC is used to transport other ORUs and CATs to and from orbit during the HST servicing mission. The RAC also incorporates crew aids, portable foot restraint sockets and tether positions to perform on-orbit servicing. The RAC has no electrical equipment and is designed to be thermally passive.

The RAC is mounted in the forward section of the orbiter payload bay. The RAC, shown in Drawing 5.1, uses a Spacelab Pallet as the primary structure cradle. The Spacelab Pallet contains the Center Support Structure (CSS), port and starboard shelves, and several CATs and ORUs.

1.3 SPACE SUPPORT EQUIPMENT MISSION OVERVIEW

1.3.1 Payload Configuration

Drawing 1.1 provides an overview of the payload bay configuration for the SM.

1.3.2 Prelaunch Operations

None of the SSE components are powered during prelaunch or ascent.

1.3.3 Mission Operations and Constraints

For SM-3B, the orbiter will launch on a direct insertion trajectory to the HST orbit, estimated to be between 310 and 320 nautical miles (n. mi.), with a 28.45° inclination. Once the spacecraft has been properly configured, the orbiter will rendezvous with the HST, grapple and berth the HST to the FSS, connect external orbiter power to the HST via umbilical, and service the spacecraft accordingly.

STS-109 will carry a crew of seven for a 12-day mission, with five scheduled EVA days to accomplish mission objectives.

Two EVA teams, with two crewmembers each, provide alternating support for each EVA day. One team performs EVAs on FD4, FD6, FD8, and the other team performs EVAs on FD5 and FD7. FD9 and FD10 are reserved in case an unscheduled EVA is required to properly configure the HST before deployment. Nominal deployment will take place on FD9. The EVA teams are cross-trained for all servicing activities to accommodate off-nominal situations that might require shuffling the EVA teams and crewmembers.

The STS-109 Mission will replace the SAs, the PCU, and the Diode Box Controllers (DBCs). The Mission will also remove the FOC and replace it with the ACS, install the NCC, install 2 of the remaining 4 NOBLs from SM-3A and the RWA. All replaced hardware will return in their respective carriers.

FD1

The crew will activate the SSE on Flight Day 1 (FD1).

FD2

On FD2, the crew will perform a checkout and survey of the SSE as well as activate and checkout the orbiter Remote Manipulator System (RMS). Also on FD2, the FSS will be configured for berthing to the HST.

FD3

The orbiter will rendezvous with, grapple, and berth the HST on FD3. Once berthed, three latches are closed to secure the HST to the FSS, and the crew will then perform a survey of the HST. The FSS will be pivoted to 75 degrees, which will enable the crew to view HST's solar arrays edge on and allow for uninhibited rotation. In order to prepare for solar array replacement, HST will first be rotated to the –V2 forward position to retract one array and then rotated to the +V2 forward position to retract the other array. Once the arrays have been retracted, HST will be rotatated to –V3 forward and pivoted back to the nominal position of 90 degrees for the duration of crew sleep.

FD4 through FD8 will be used to perform five 6-hour EVAs for HST servicing.

Daily SSE Activities

During the Daily Setup, the BAPS Support Post (BSP) Pip-Pins will be installed, and any translation aids that are required will be deployed. The Daily Closeout will remove the BSP Pip-Pins, inspect the Main Umbilical, and retract any deployed Translation Aid.

FD4

On FD4, HST will first be rotated to the –V2 position in order to replace that solar array and then pivoted to 85 degrees in preparation for EVA 1. The pivot is to allow the EVA crewmembers to install the BAPS Support Post. HST will then be pivoted back to 90 degrees. The first of two new solar arrays will be installed, as well as a new Diode Box Assembly (DBA). Upon completion of replacement of the –V2 solar array, HST will be rotated back to –V3 for the night.

FD5

While the crew is in the EMU Purge and Prebreath procedure for EVA 2, the HST will be rotated to the +V2 position. The EVA will install the new solar array on the +V2 side, along with a new DBA. A new Rate Wheel Assembly will also be installed during EVA 2. Once the crew is in the Airlock, the HST will be rotated back to the –V3 position for a Solar Array Slew and Battery Charging for the HST.

FD6

The crew will perform EVA 3 to change out the PCU. External power to the telescope will be powered off by the crew in preparation for the change out and then replaced after the new PCU is installed.

FD7

On FD7, HST will be rotated to the –V2 position in preparation for EVA 4, which will install the Advanced Camera for Surveys (ACS) and the Electronics Support Module. The last of the PCU Changeout will be finished during this EVA. After the EVA, the HST will be rotated to the +V3 position, rather that –V3, for the duration of crew sleep in order to survey the +V3 side.

FD8

HST will be rotated to the +V2 forward position on FD8 for EVA 5. This is in support of the Aft Shroud Latch Repair (ASLR) Kit installation, followed by the NICMOS Cooler System (NCS) and the NCS Radiator.to the HST will then be rotated to the –V3 forward position once the EVA has been completed.

FD9

HST deployment is nominally scheduled for FD9, which includes external power off, release preparations, HST release from FSS, and RMS release. The FSS will be stowed shortly thereafter on FD9.

FD9 is also held for the contingency EVA day, should it be required.

FD10, 11, 12

FD10 is nominally a crew off-duty day, but can be used as an contingency deploy day, should FD9 become an EVA day. Cabin stow occurs on FD11. The SSE Equipment will be deactivated prior to landing on FD12. The mission also allows for two additional on-orbit days for the shuttle to protect against weather conditions or shuttle contingency delays before landing.

1.4 APPLICABLE DOCUMENTATION

Cargo Systems Manual: Hubble Space Telescope - All Flights, JSC-29029, Basic + applicable PCNs.

Command and Data Annex, Annex 4, HST SM 3B, NSTS-14009, Rev.G.

HST SM 3B, Flight Safety Compliance Data Package, P-44-062, TBD.

Shuttle Orbiter/Cargo Element Interfaces ICD, ICD-A-14009-SM, “See Current Version.”

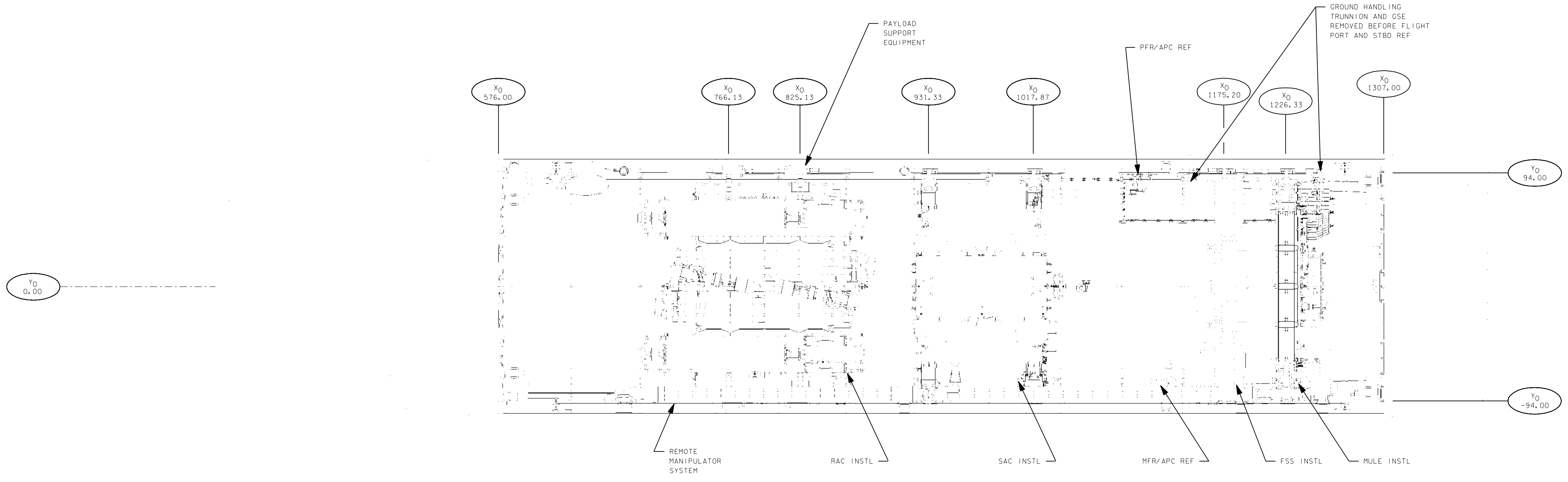
Space Shuttle Systems Handbook, JSC-11174, Volume 1.

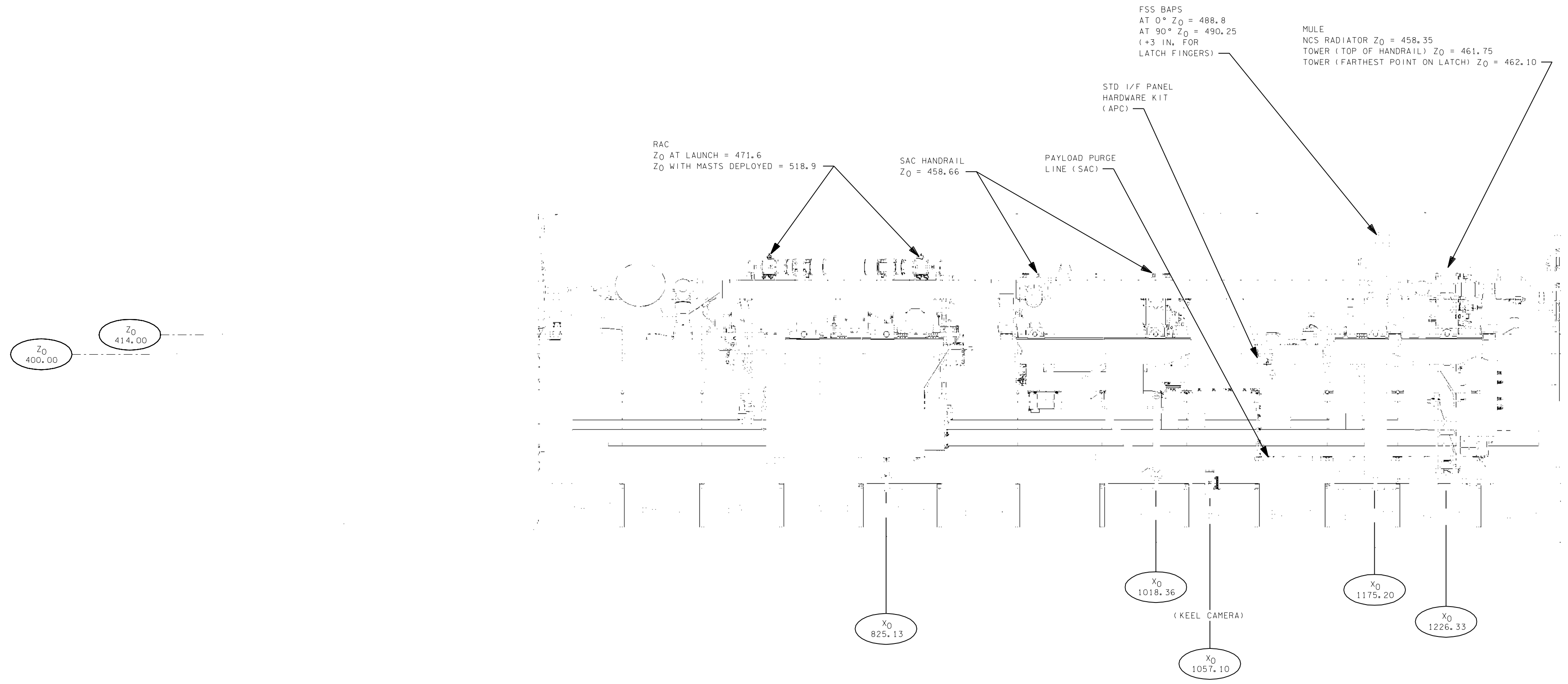
ANNEX 1, HST SM 3B, NSTS-14009, Rev G.

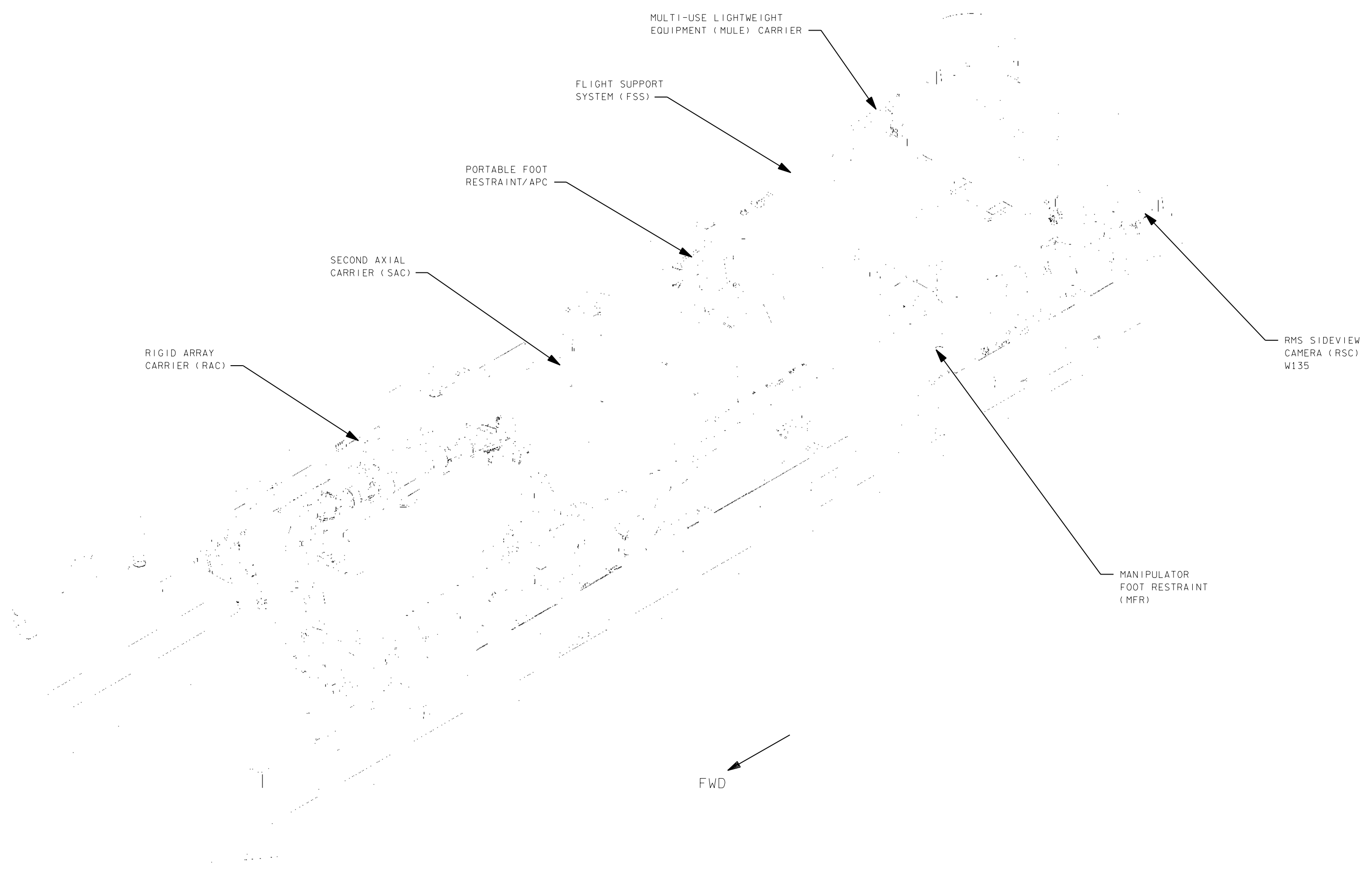
CIR Data Package

ANNEX 2, HST SM 3B, NSTS-14009, REV G.

DATE: 09/25/01	NAME: MDU	VERSION: CHK;8
DATE: 10/16/01	NAME: MDU	VERSION: REL;7
DATE: 01/24/02	NAME: MDU	VERSION: REL;8







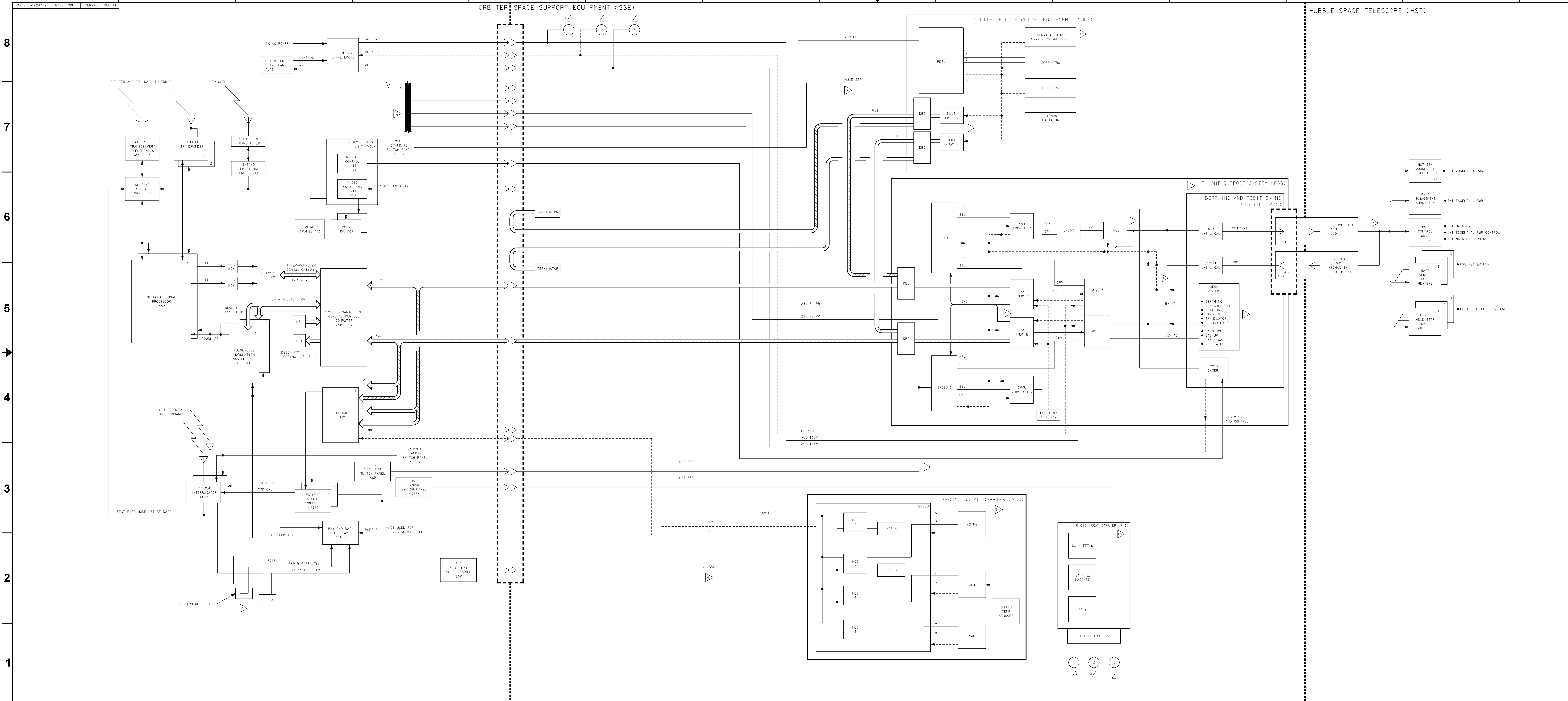
SSE H/W PHY O/V

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN			
DR		SSE HARDWARE PHYSICAL OVERVIEW	
ENGR R. HARVEY			
ENGR			
APP			
APP		HST SSE CSM	DWG NO 1.1
CADS		STS-109	
LTR / PCN		66 X 34	SHEET 1 OF 1

USA001948

DATE: 01/24/02	NAME: MDU	VERSION: REL;11

DATE: 10/16/01	NAME: MDU	VERSION: REL;10
DATE: 12/06/01	NAME: SVJ	VERSION: CHK;10
DATE: 01/24/02	NAME: MDU	VERSION: REL;11



15 FOR MORE DETAIL SEE DRAWING 3.2

14 FOR MORE DETAIL SEE DRAWING 4.2

13 RAC HAS NO DIRECT POWER OR DATA CONNECTIONS. THE RAC DOES HAVE ACTIVE LATCHES

12 HST TELEMETRY IS ROUTED FROM EACH PI TO SEPARATE CONNECTORS ON THE PDIP. 2 TURNAROUND PLUGS ROUTE THE TELEMETRY TO THE PDI. A HPGSCA CAN REPLACE THE TURNAROUND PLUG TO ADD ADDITIONAL CAPABILITY. NORMALLY THE PRIME STRING WILL HAVE A HPGSCA INSTALLED AND THE BACKUP STRING WILL HAVE A TURNAROUND PLUG INSTALLED

11 FOR MORE DETAIL SEE DRAWING 2.6

10 ONLY BSP TELEMETRY IS DIRECT TO FMDM, OTHER MECH TELEMETRY IS VIA AMS B

9 FOR MORE DETAIL SEE DRAWING 2.4-1 AND 2.4-2

8 FHST SHUTTLE CONTROL IS DIRECT FROM SSP - BYPASSES IPCU

7 FOR HST DATA SEE JSC-29029 HST CSM DRAWING 10.1

6 MULE FMDM ONLY USED FOR TELEMETRY (NO COMMANDS)

5 FSS FMDM CNTL - DPC'S, AMSB, AND CAMERA PWR

4 ALL SAC HTR CNTL IS VIA SSP

3 MULE SSP CNTL-FMDM A AND B, SURVIVAL HTR A AND B, SOPE HTR A AND B, ESM HTR A AND B

2 FSS SSP CNTL - FMDM A AND B, FSS HTRS A AND B, CCTV HTR, PPCU, AND SPCU

NOTES: 1. LEGEND:
- POWER
- CMD
- DATA
- ORB CMD

2 HST SSE FUNCT O/V

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DSGN M. GILLESPIE	12/16/92	
DR		HST SERVICING MISSION SPACE SUPPORT EQUIPMENT FUNCTIONAL OVERVIEW
ENGR T. McCRACKEN		
ENGR		
APP		
APP		HST SSE CSM — DWG NO 1.2
CADS		STS-109
LTR / PCN		82.5 X 34 — SHEET 1 OF 1

USA001948

NOTES: 1 NOT USED ON STS-109 BY SSE/HST

2. REFERENCE SSSH DRAWING 2.2 BASIC REV F

3 SEE DRAWING 6.1-2 FOR MORE DETAILS

1 ORB/SSE PWR I/F

SIGNATURE		DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN L. BUCHANAN		11/14/79	ORBITER TO SSE ELECTRICAL POWER INTERFACE	
DR B. BOWEN		01/12/84		
ENGR R. HARVEY				
ENGR				
APP				
APP			HST SSE CSM	DWG NO 1.3
CADS			STS-109	
LTR	PCN		93.5 X 34	SHEET 1 OF 1

USA001948

USA001948

ORBITER SPACE SUPPORT EQUIPMENT (SSE)
IPCU
EPDSU 1
EPDSU 2
PPCU
SPCU
V-BOX
EXTERNAL MAIN BUS RELAYS/MOTOR SWITCHES
INTERNAL ESSENTIAL BUS RELAYS
EXTERNAL ESSENTIAL BUS RELAYS
INTERNAL MAIN BUS RELAYS
6 RESERVED
5 THE MA TRANSPONDERS, RECEIVE PWR FROM THE ESS BUS. IN THE EVENT OF AN AUTO FAIL OVER, THE MA TRANSPONDER WILL RESET ITSELF. SEC 2.6.1.2.4 DETAILS OF THE HST CSM THE RESET CHARACTERISTICS
4 WHEN EITHER OF THESE PARAMETERS INDICATES ON, THE CREW SM DISPLAY WILL SHOW INTERNAL POWER. WHEN ALL OF THESE INDICATE OFF, THE CREW DISPLAY WILL SHOW EXTRNAL PWR
3 RESERVED
2. CONNECTOR J101 IS THE PRIMARY FSS UMBILICAL INTERFACE TO THE HST
NOTES: 1. CONNECTORS J107 AND J108 PROVIDE INTERFACE BETWEEN THE POWER CONTROL UNIT (PCU) AND THE HST FSS UMBILICAL TOWER ON THE HST AFT SHROUD. IF THE J101 UMBILICAL FAILS TO MATE. THE J107 AND J108 CONNECTORS CAN BE MATED BY EVA
13 DPC ON/OFF MSID
12 DPC CURRENT MSID
4 SSE/HST PWR O/V
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
SSE/HST
POWER OVERVIEW
SIGNATURE
DATE
DSGN V. HUNTER
09/14/01
DR
ENGR M. GIBB
ENGR
APP
APP
CADS
DWG NO
1.4
HST-SSE CSM
STS-109
SHEET 1 OF 2
126.5 X 34
LTR
PCN

USA001948

NOTES:

1. RELAYS K7A, K8A, AND K9A ARE CLOSED BY CAPACITIVE DISCHARGE IF EXT ESS BUS PWR IS REMOVED. IF EXT PWR IS LOST, AN AUTOMATIC TRANSITION TO INT PWR WILL OCCUR
2. WHEN EITHER OF THESE PARAMETERS INDICATES ON, THE CREW SM DISPLAY WILL SHOW INTERNAL POWER. WHEN ALL OF THESE INDICATE OFF, THE CREW DISPLAY WILL SHOW EXTRNAL PWR
3. THE MA TRANSPONDERS, RECEIVE PWR FROM THE ESS BUS. IN THE EVENT OF AN AUTO FAIL OVER, THE MA TRANSPONDER WILL RESET ITSELF. SEC 2.6.1.2.4 OF HST CSM DETAILS THE RESET CHARACTERISTICS
4. AXIAL: RADIAL MICRO SWS ARE HELD OPEN BY INSTALLED SI's. REMOVAL OF INSTRUMENT WILL CLOSE SWITCHES AND POWER THE INDICATOR LIGHTS

4 SSE/HST PWR O/V 2

SIGNATURE	DATE	
DSGN S. JAMES	10/29/01	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DR		SSE/HST POWER OVERVIEW
ENGR M. GIBB		
ENGR		
APP		
APP		HST-SSE CSM — DWG NO 1.4
CADS		STS-109
LTR / PCN		121 X 34 — SHEET 2 OF 2

2.0 FLIGHT SUPPORT SYSTEM

2.1 FSS PHYSICAL DESCRIPTION

The FSS, shown in Drawing 2.1, is reusable flight-qualified hardware that provides the mechanical, structural, and electrical interfaces between the HST and the orbiter for payload retrieval and on-orbit servicing. The FSS centerline of the cradle A structure is located in the orbiter payload bay at X_0 of 1175.20 inches. The FSS attaches to the orbiter payload bay via two PRLAs and an active keel latch. Interfaces for orbiter support services are provided with a set of Standard Interface Panels (SIPs) (port and starboard) just aft of the FSS.

The Berthing and Positioning System (BAPS) platform provides a three-point retention interface for the HST. The BAPS provides rotation and pivot capabilities for positioning the HST. The centerline of the HST and BAPS during HST attached operations will be at X_0 of 1149.20 inches with the body of the HST extending forward and aft of that point in a radius of 84.00 inches (excluding appendages) (See Drawing 2.2). The HST attaches to the FSS BAPS via three berthing latches located on the BAPS ring at 120° intervals. HST power is supplied via the FSS umbilical located on the BAPS structure. Figure 2-1 illustrates the utilization of the FSS platform during on-orbit servicing operations. Power from the orbiter is supplied through FSS avionics and an FSS umbilical interface to the HST. The FSS interfaces hardline commanding to a selected group of HST power functions (main power, essential power, Fixed Head Star Tracker (FHST) shutter control, HST worklight sockets and latch indicator power, and Rate Sensing Unit (RSU) heater power). General commanding of the HST is through Payload Interrogator (PI) Radio Frequency (RF) links from the Space Telescope Operations Control Center (STOCC). A select group of telemetry is displayed in the orbiter for crew information, while the complete set of telemetry is sent to the STOCC. The FSS thermal control system consists of heaters on the avionics and MultiLayer Insulation (MLI) on structural components. The FSS provides the following services:

a. Rotation platform with drive and brake/locking systems

b. Latching and release system that is compatible with the HST

c. Platform pivot capability with drive and brake/locking systems

d. Electrical interfaces between the orbiter and the HST

e. Hardline commands for FHST SHUTTER OP/CL, RSU SURVIVAL HTR PWR ON/OFF, SSM WK LIGHT PWR ON/OFF, INT ESS BUS PWR ON/OFF, INTERNAL MAIN BUS PWR ON/OFF

f. Select set of SSP talkback (tb) status and FMDM telemetry measurements

The baseline FSS is reflown hardware. Modifications to the FSS for the HST SM-3B have been identified in Table 2-1.

Table 2-1. FSS changes for SM-3B

Changes	Components	Reason
Additions	Temperature sensor	Sensor was added on the FSS . This sensor will be used for another data point for temperature
	90 degree converter	Contingency CAT stowed in FSS PFR Socket, alternate stowage not available
	Auxiliary PFR Extender (APE)	Holds PFR out of socket
	SI auxiliary handhold	Removed from the FSS and installed on the FOC. Used for transporting the FOC to the ASIPE for return during failed RMS scenario
	Berthing Assist and Restraint (BAR)	EVA contingency tool for closing a berthing latch in the event of a failed CDU
Modifications	Second EPDSU	Enhanced unit replaces PDSU-1 to provide separate DPC on/off status and control
	AMSB	Replaces MSB and provides primary method to select FSS mechanisms (CDUs) for operation with new current sensor and mechanism tachometer services, which assists in detecting a mechanism stall and provides cues other than visual to detect mechanism movement
	FMDM and EPDSU-1 radiators increased	Addition of MULE increases FSS overall environmental temperature
	Portable Foot Restraint and APE latch redesign	FSS envelope constraints
Deletions	Containment Environmental Package (CEP) with pressure sensor	Both CEPs have been removed from the FSS

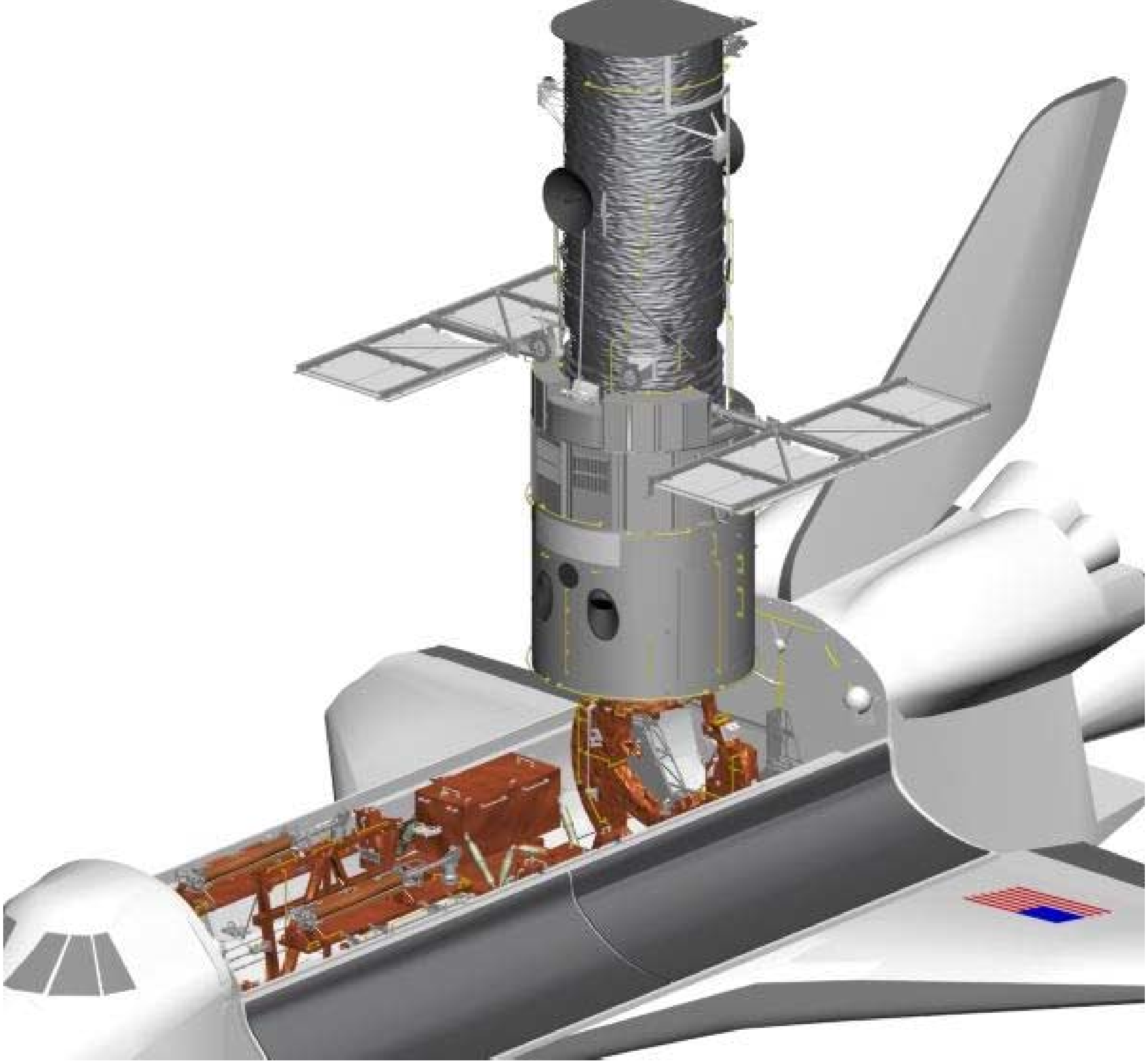


Figure 2-1. HST Berthed with SA 3s, on FSS

2.1.1 FSS Structural Elements

The design configuration of the FSS contains two main structural elements:

a. FSS HST cradle A with the latch beam - The cradle A is a 16-inch-thick semimonocoque cradle used for the SM. It has two longeron trunnions and one keel trunnion. The cradle supports the BAPS, avionics, electrical equipment, handholds, and crew aids. The latch beam is a structural stiffener bolted to cradle A to increase the load carrying capability of the cradle. The avionics and electrical equipment are mounted to this structure.

b. BAPS - The BAPS is a remotely operated servicing platform that is capable of rotating, translating, and pivoting. It is equipped with remotely operated berthing latches and umbilical connectors that interface with the HST on orbit. The BAPS provides spacecraft positioning capability. The BAPS pivots about an axis parallel to the orbiter Y-axis and perpendicular to the plane of the ring. When pivoted to its horizontal orientation, it is rotated about the orbiter Z-axis to orient the HST for servicing or deployment. The BAPS houses the blind mate, main Umbilical Actuator (UA), providing an electrical interface to the HST. The BAPS also supports a Closed Circuit Television (CCTV) to monitor berthing of the HST. The FSS BAPS is shown in detail in Drawing 2.2.

FSS Cradle A Structures

The FSS consists of a statically determinate support system for the cradle A. The cradle A is restrained in the orbiter Z-X plane by two sill trunnions located in the orbiter bay at X_0 of 1175.2 inches. The cradle A structure contains a keel trunnion constraining the y-translation that engages into an orbiter active keel fitting/latch.

Cradle A provides the primary structure for supporting the FSS attachment hardware, the BAPS, and the latch beam. The cradle is designed to survive without yielding for all specified load conditions imposed by the orbiter, including launch, landing, and on-orbit. All on-orbit HST inertial loads are transmitted from the spacecraft berthing pins through the berthing latches and adapter arms of the BAPS, into the FSS cradle A, and then into the orbiter longeron and keel payload retention systems. The latch beam is used to support some of the FSS Avionics, as well as to improve the overall stiffness of the cradle characteristics. The BAPS houses the Main Umbilical (P101), providing an electrical interface to the HST. The BAPS mechanically interfaces with a pivoter mechanism on the starboard side and a journal bearing on the port side. Both are supported by adapter arms bolted to the cradle structure. The web segments and intercostals are machined from 6061-T6 aluminum alloy; the rolled skins are 7075-T6 aluminum alloy (thin sheet), and the trunnion support structures are 2219-T852 aluminum alloy. The web orbiter interfacing trunnions are 6Al-4V titanium alloy, and all the permanent and interface attachment bolts are A286 stainless steel. Steel rivets fasten the aluminum structure, and all surfaces are anodized and/or painted to prevent corrosion. Cradle A contains two filtered, outboard-facing vent holes located above the orbiter longeron trunnions, and the latch beam contains two downward-facing filtered vents located on the bottom surface of the structure. All intercostals contain redundant vent holes that relieve stresses due to pressure differentials. The SM FSS cradle A configuration is shown in Drawing 2.1.

Berthing and Positioning System Structures

The BAPS, a remotely operated platform, is mounted on the FSS cradle A adapter arms (Figure 2-2). The BAPS acts as a service platform for HST during SMs.

The BAPS is constructed with two concentric structural components: a rotating ring that provides the berthing platform for the HST and a nonrotating ring, which is the BAPS structural interface to cradle A. The rotation platform is capable of ±175° of rotation from the null position (Drawing 2.2). The null position is defined when berthing latch 1 is forward on the BAPS ring (toward the crew cabin). This position corresponds to 120 degrees in the HST reference system, which means HST positions from 295 to 305 cannot be placed forward towards the crew cabin. The BAPS is launched in the stowed position with the rotator in the berthing position. The stowed berthing position lies along the orbiter X-axis and faces toward the orbiter cabin (120° clockwise rotation from the null position). The rotating platform is equipped with remotely operated berthing latches and umbilical connectors that mate with passive capture hardware on the HST aft bulkhead. The BAPS is attached to a pivot arm that enables the BAPS to be pivoted from the stowed to the HST berthing position. The BAPS supports a CCTV camera to aid HST berthing with the BAPS. An Aft Flight Deck (AFD) crewmember operates the RMS to berth the HST to the BAPS berthing latches. Once the HST is berthed to the BAPS, the V1 axis of the HST is perpendicular to the centerline of the orbiter cargo bay with the +V3 axis of the HST pointing aft and the -V3 axis pointing forward toward the crew cabin parallel to the X-axis of the orbiter. The HST can be rotated about the orbiter Z-axis, using the BAPS to orient the HST for servicing.

A translator mechanism allows the BAPS to be translated ±1.75 inches perpendicular to the BAPS plane. The translator is not nominally planned for use.

The BAPS Support Post (BSP) is a telescoping tube installed on-orbit by the EVA crew to help stabilize the BAPS ring from on-orbit and landing loads. The tube provides a supplementary stiff load path for the pivoter. Details on the BSP can be found in Section 2.1.2.

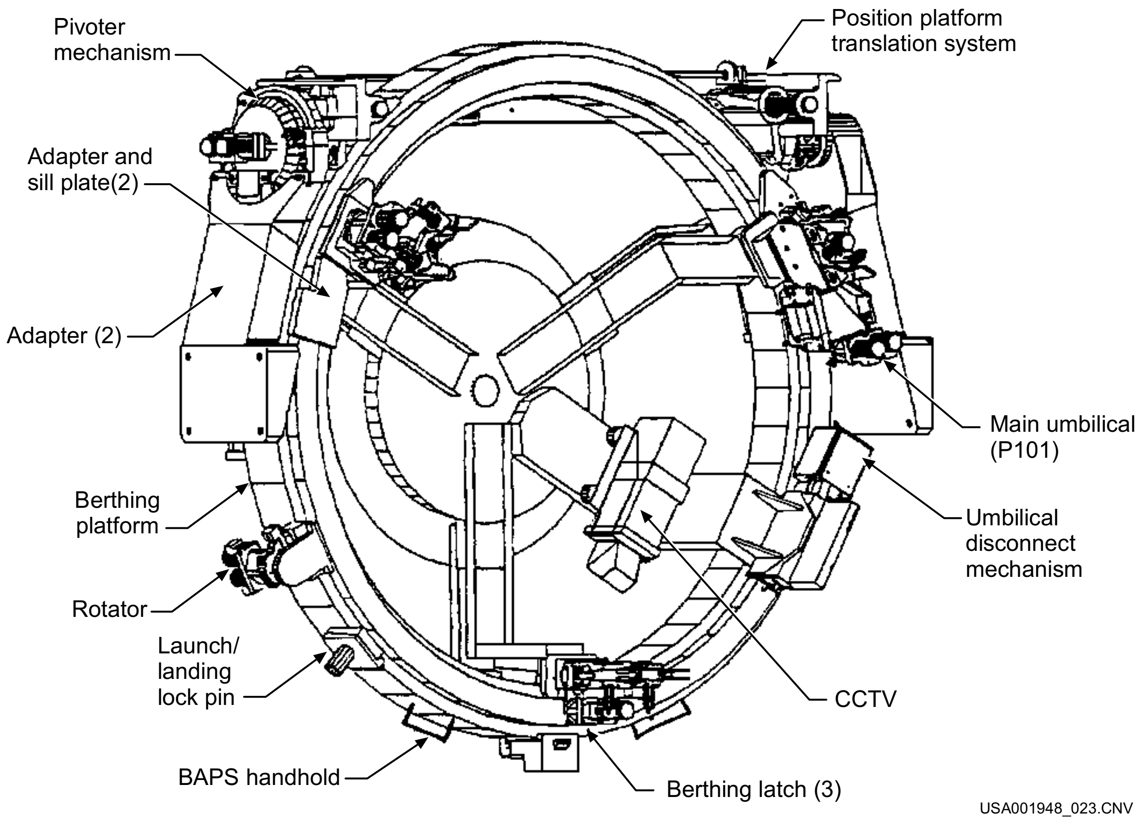


Figure 2-2. Berthing and positioning system

2.1.2 FSS Mechanisms

The FSS, as configured to support the HST SM, contains ten motor-driven mechanisms that perform eight separate functions as listed below:

a. Berthing latches (3) - secure the HST to the BAPS at three equidistant and latch locations.

b. Main umbilical actuator mechanism (1) - provides the primary electrical interface between the HST and the FSS.

c. Backup umbilical (Umbilical Disconnect Mechanism (UDM)) (1) – Used as a backup device in the event of a main umbilical actuator mechanism failure. EVA crew must connect umbilicals; mechanism is used to disconnect the umbilicals.

d. Rotator (1) - rotates the BAPS (and HST, if berthed) about the centerline of the BAPS platform.

e. Pivoter (1) - pivots the BAPS platform about an axis parallel to Y0.

f. Translator (1) - moves the BAPS platform perpendicular to the plane of the platform.

g. Downlock (1) – Located on the Cradle, the Downlock, secures the BAPS for orbiter launch and landing (if needed).

h. BAPS support post latch (1) - Locks the BSP in the fully retracted position to support reboost or landing loads.

Visual aids associated with the positioning of the mechanisms are discussed in Section 2.5.

Common Drive Units (Mechanical)

Each FSS mechanism is driven by a dual-torque, small, or large Common Drive Unit (CDU), depending on the application as shown in Table 2-2. Mechanism times recorded during the previous flights are also shown in Table 2-2. Each CDU consists of a pair of three-phase 115 V, 400 Hz motors with speed reduction gearing and a spur gear (Figure 2-3). The large CDU provides a no-load speed of 70 rpm, when operated in single motor operation and 140 rpm for dual motor. The small CDU uses a smaller motor with additional gear reduction to provide a no-load speed of 8 rpm for one motor and 16 rpm for dual motor operation. Both units deliver 275 in-lb stall torque to the output shaft. The dual-torque unit delivers 280 or 92 in-lb of stall torque to the output shaft at 3.75 rpm. Once power is supplied to the CDU, the no-load speeds are reached nearly instantaneously. Each CDU is capable of starting on two phases, and the expected times for mechanism travel will not significantly increase. The current draw per phase for each of the three units is shown in Table 2-2.

All three types of units contain an automatic electromechanical brake system that engages when power is removed. When the brake is applied, the complete gear train from the motor to the CDU output drive shaft is locked to prevent being back-driven in either direction. The dual-torque, small, and large CDUs are shown in Figure 2-4. One of two motors is used for nominal operations.

All types of CDUs contain a tachometer that reads off the output shaft of the motor. However, only the pivoter, rotator, and translator tachometers have available telemetry. If dual motor operations are selected, the tachometer reading for the selected FMDM will not read the increased speed, since it is reading the output shaft of the motor and not the output of the differential. The tachometer data is an AC voltage that is routed to the AMSB, where it is rectified and sent to the FMDM.

Each mechanism on the FSS has a redundant Beginning of Travel (BOT) and End of Travel (EOT) microswitch that cuts off power to the CDU before the mechanism hits its hard stop. Both A and B microswitches share one mechanical plunger, but each has its own microswitch electronics subassembly; hence, the microswitch indications are zero fault tolerant mechanically, but single fault tolerant electronically. In the event of a mechanical plunger failure, the FMDM can command the AMSB to override the BOT/EOT indications, allowing the motor to drive. For a microswitch electronic subassembly failure indicating BOT/EOT, the mechanism can be driven from the alternate AMSB by switching to the alternate FMDM and port moding to the secondary PL data bus. This allows the FMDM to receive the secondary microswitch telemetry and drive the selected mechanism.

Table 2-2. FSS mechanism applications and drive times

Mechanism	Qty	CDU type	Nominal operation time [1]	Nominal amps per phase	Total amps[2]
Pivoter[3] (low torque)	1	Dual torque	1428 ± 90 sec for 90° or 15.87 sec/deg (8 deg/min)	0.15	0.45
Rotator (high torque only)	1	Dual torque	731 ± 19 sec for 180° or 4.06 sec/deg (8 deg/min)	0.14	0.41
Translator	1	Small CDU	170 ± 5 sec for 1.75 in. or 97.1 sec/in.	0.30	0.82
Downlock	1	Large CDU	24 ± 2 sec	1.00	2.73
Berthing latch	3	Large CDU	18 ± 2 sec	1.00	3.0
Main umbilical	1	Small CDU	8 ± sec for 4.5 inch-stroke (mate/demate)	0.30	0.77
Backup umbilical (UDM)	1	Small CDU	4 ± sec (demate only)	0.30	0.77
BSP latch	1	Small CDU	< 1 sec	0.30	

1. Times are for single-motor operation. Dual-motor contingency operation times are approximately one-half of listed times. Travel time margins include variations over the orbiter-specified AC frequency range of 400 ± 7 Hz.

2. The total amperage for the BSP latch cannot be measured due to the quickness of the operation (less than 0.1 sec).

3. The high torque can be selected for the pivoter but is used for ground operations only. High torque is not planned to be used in nominal or malfunction procedures.

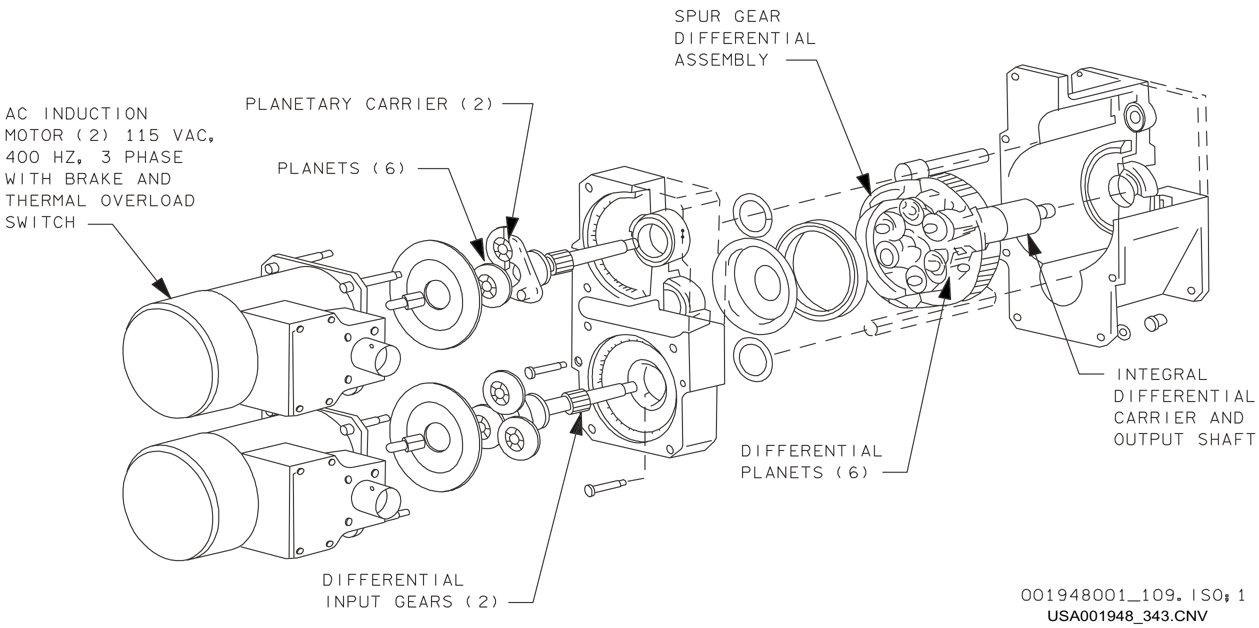
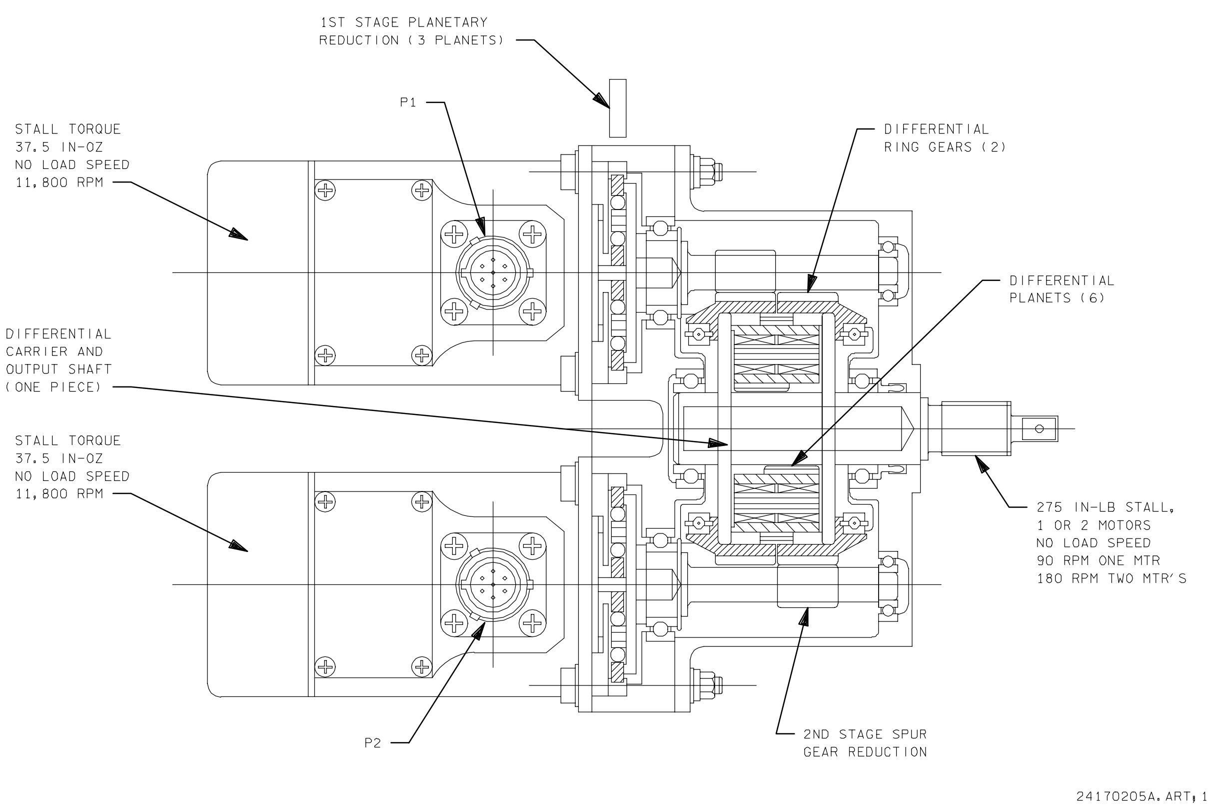
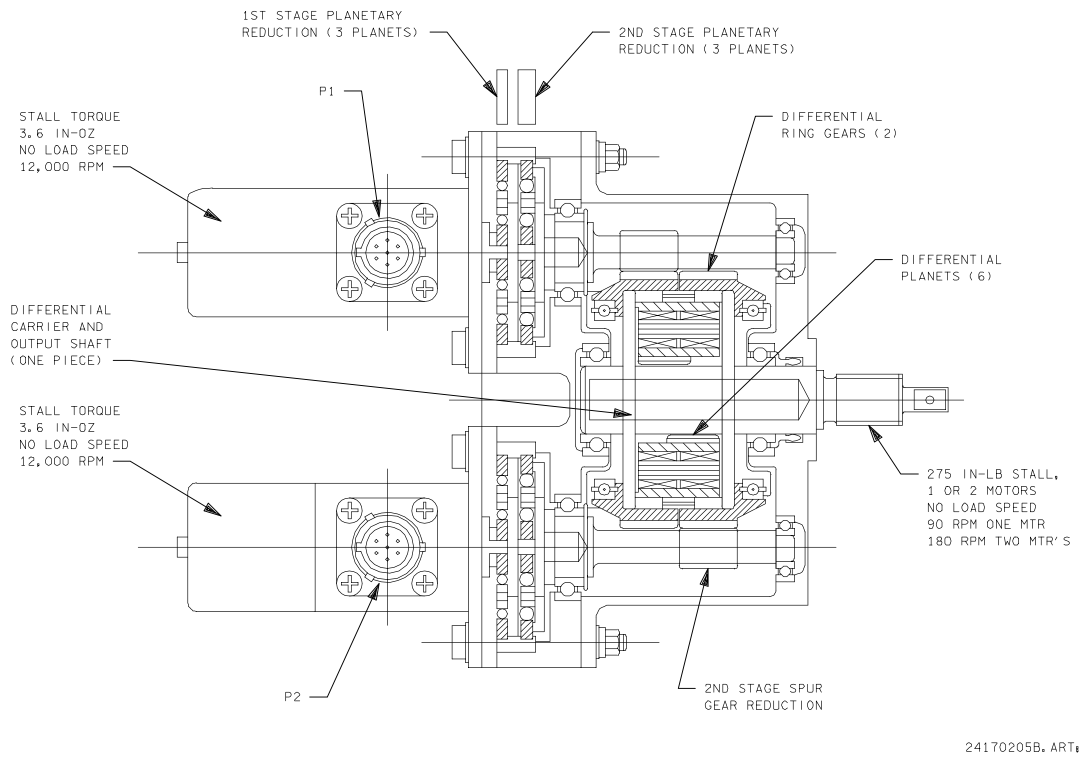


Figure 2-3. CDU detail



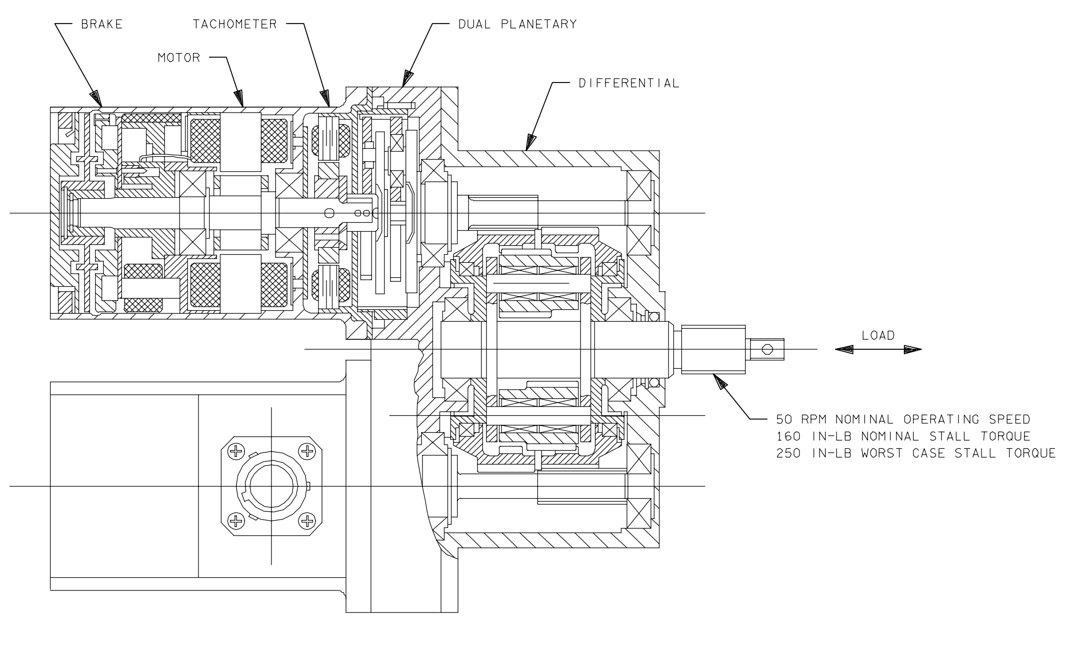
(a) Large

Figure 2-4. Motor configurations



(b) Small

Figure 2-4. Motor configurations (continued)



(c) Dual torque configuration (large unit)

Figure 2-4. Motor configurations (concluded)

The CDU mechanical design has several redundant features to maintain operability in the event of a failure. In the event of a jammed motor, a course of action is to switch to the secondary motor by powering on the alternate FMDM and driving the motor with the secondary LOGIC POWER system. This option prevents a total failure if one motor or reduction gear unit fails. If the differential fails or the mechanism is jammed, both motors can provide torque to the output shaft through the outer ring gears. This option drives the mechanism with both CDUs, creating more torque and decreased movement times. This requires repowering the original FMDM and driving both motors using LOGIC POWER Systems 1 and 2 simultaneously. Following these actions, there is no additional redundancy within the CDU. However, all mechanisms, except for the translator, are provided with an EVA override capability for disengagement.

Prior to implementing one of the above-mentioned workarounds, careful consideration should be taken as to what position the pivoter, berthing latches, and the main umbilical are in, should a second failure occur. In some cases, these mechanisms may violate Payload Bay (PLB) envelope constraints and rapid safing flight rules. One additional workaround is to install electrical jumpers from the CDUs of one mechanism and route power to the CDUs of another mechanism. This is an EVA task and the procedure is documented in the EVA checklist. This case can be used to work around an AMSB mechanism selection failure internal to the AMSB. Once in this configuration, the following should be kept in mind.

a. The BOT/EOT indications on the SPEC 212 page are no longer valid. These indications are coupled with the mechanism being selected and, for this case, the mechanism not physically moving. The PRLA talkbacks are still valid, and the crew can use SPEC 097 for microswitch verification.

b. To drive the mechanism in the reverse direction, an Override Enable command must be sent to disable any inhibits that may be sensed from the nonmoving mechanism BOT/EOT microswitches.

Berthing Latches (Mechanical)

Three separate berthing latches are located 120° apart on the perimeter of the BAPS (Drawing 2.2). The latch mechanism is a symmetrical linkage system driven by an acme-threaded screw that is powered by a CDU. These three latches close around their respective HST berthing pins to secure the HST during on-orbit servicing. The HST is centered and aligned as each latch is sequentially closed around each of the berthing pins. The subsequent umbilical mating can be accomplished without compensating for large misalignment between interfaces, due to the latches centering HST.

The Berthing Latches are operated in a manner such that HST will be caged, then captured. The on-orbit procedure drives one latch at a time to a position approximately halfway closed, once the berthing pin is below the horizontal white stripe on each latch. The pin is in the caged position, and the next latch is driven to the caged position. The third latch is then driven to the completely closed position. Driving each of the remaining two latches to the closed position then follows this operation. By performing the operation in this manner, the HST berthing pins will not be pulled out of the latch envelope during the latching operation.

A pin-to-berthing latch clearance gap of approximately 0.001 in. is established to permit relative axial motion between pin and latch. In addition, the opened jaws of the latches provide a ramping guide (Drawing 2.3) to accommodate the RMS position control inaccuracies of ±2.0 in. and ±1.0° (half-cone angle) for berthing (see Figure 2-9).

The Berthing Attachment Restraint (BAR) is contingency hardware for the Flight Support System (FSS). In the event that a berthing latch fails to capture and secure an HST berthing pin, the BAR would be installed to replace the failed latch. Installing the BAR would allow the crew to use the RMS for the remainder of the servicing mission while also constraining HST for FSS BAPS pivot and rotate maneuvers. The BAR is shown in Figure 2-5.

Should a berthing latch fail to grapple HST during rendezvous and capture, the remaining operational berthing latches should be completely closed before the BAR is installed. HST must be fully constrained by two berthing latches and the RMS for the installation of the BAR to be successful. By performing this operation, the existing berthing latch jaws can be rotated out of the latch housing, thereby making it possible to install the BAR. Once the jaws are clear, the BAR is inserted from right-to-left over the HST berthing pin. The mechanism is designed to accommodate .5 in. of misalignment between the berthing pin and the FSS berthing latch saddle. Once the hole in the leftmost arm of the BAR is aligned with the hole in berthing latch housing, one of the pip pins tethered to the BAR should be installed. With the left pin installed, the tool can be rotated to engage the second pin. Once this has been done, the EVA bolt should be torqued to a minimum of 12.5 ft-lb. This operation will adequately seat the berthing pin into the latch saddle. Figure 2-6 shows the BAR installed onto the FSS BAPS with the berthing pin captured.

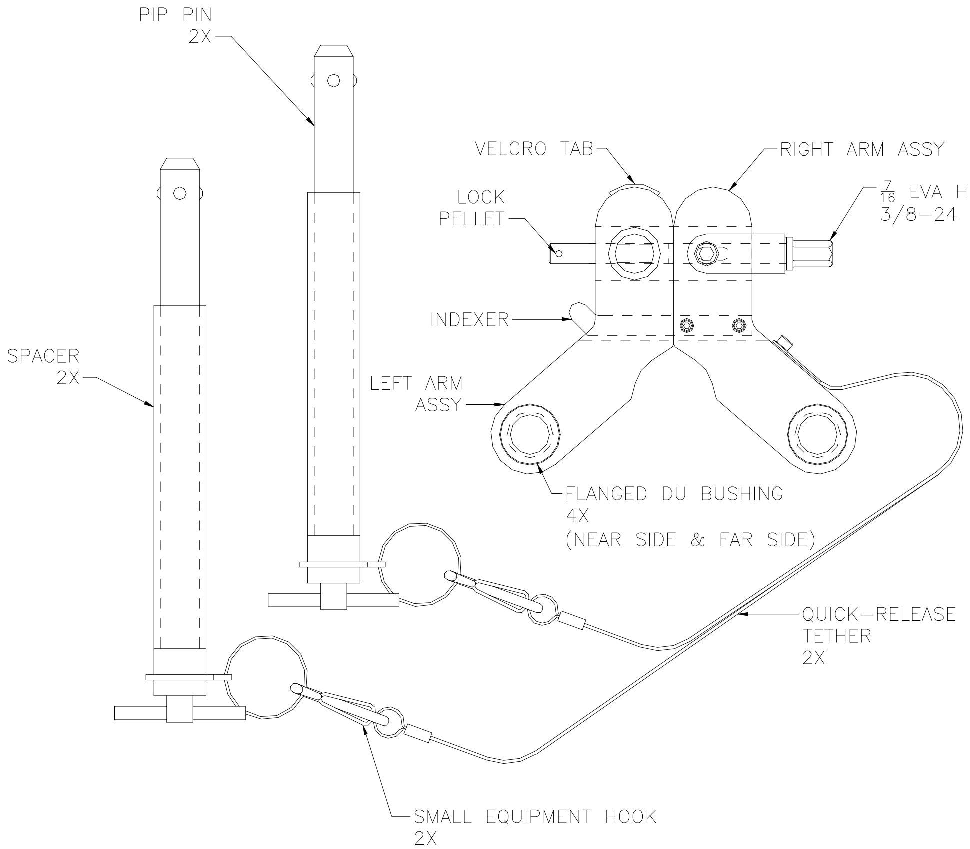


Figure 2-5. BAR overview

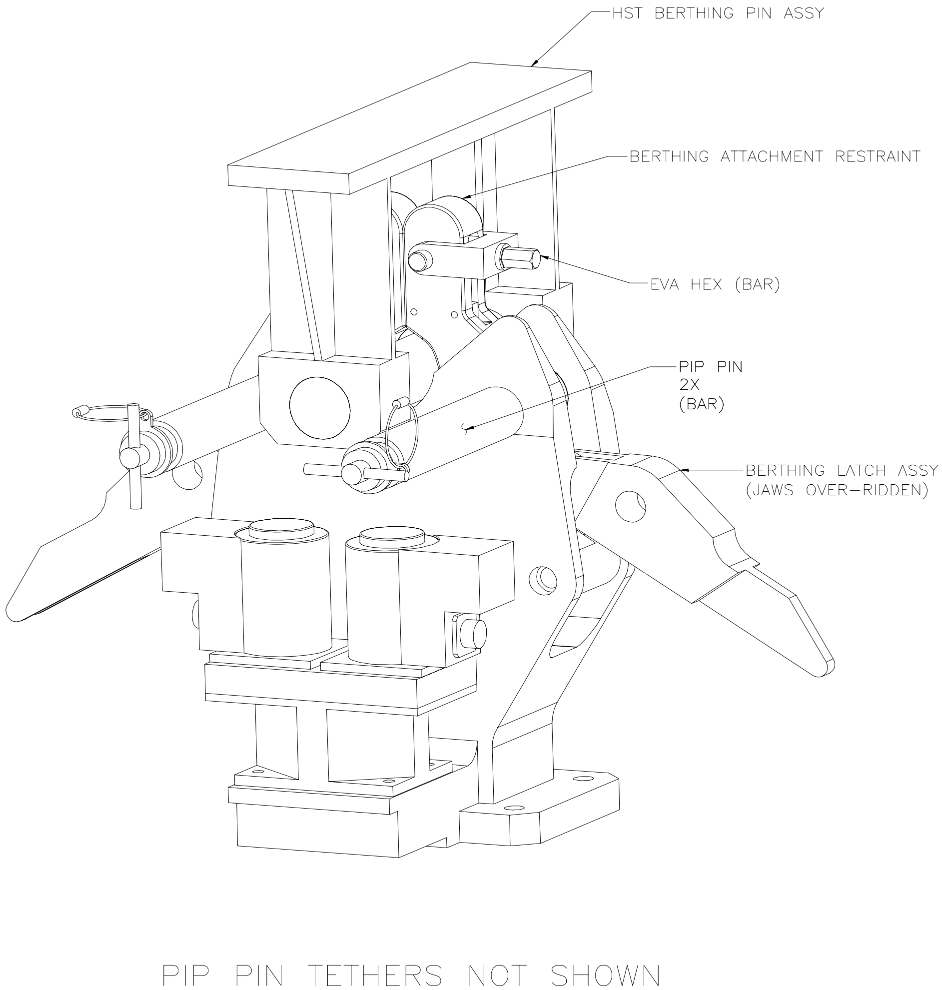


Figure 2-6. BAR installed

At the end of an EVA day, the BAR must be secured away from the HST berthing pin in order to meet rapid deploy requirements. Before the BAR is disengaged, the RMS must be grappled to the HST to provide the third constraint. Once this has occurred, the first step in releasing the BAR is back-driving the EVA hex. Next, the leftmost pip pin should be actuated and removed. The removed pip pin can then be inserted into either berthing latch jaw through-hole, as shown in Figure 2-7. The mechanism can then be rotated about the rightmost pip pin away form the HST berthing pin. The Velcro tab on the left arm of the BAR can be used to secure the mechanism to the BAPS. At the beginning of the next EVA day, the BAR can be reinstalled by rotating it back across the berthing pin, installing the leftmost pip pin, and re-torquing the EVA hex.

If a pip pin failure were to occur and the BAR could not be disengaged from the HST berthing pin, the EVA hex can be back-driven to overcome the locking pellet in the bolt. The bolt will disengage from the barrel nut, thereby allowing the arms of the BAR to separate. The arms can then be secured away from the berthing pin.

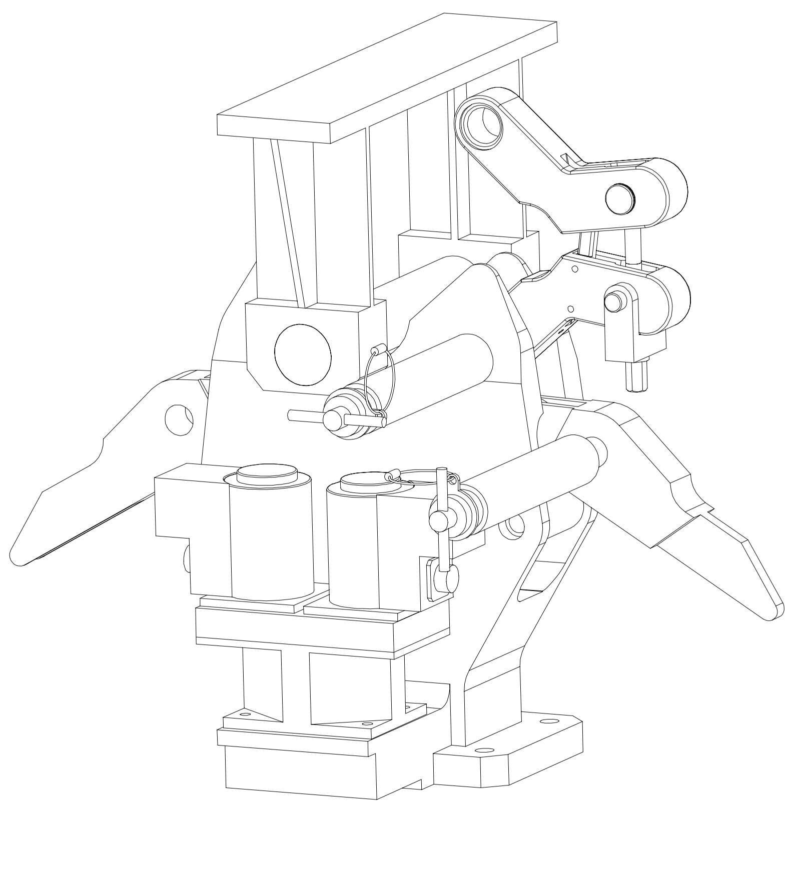


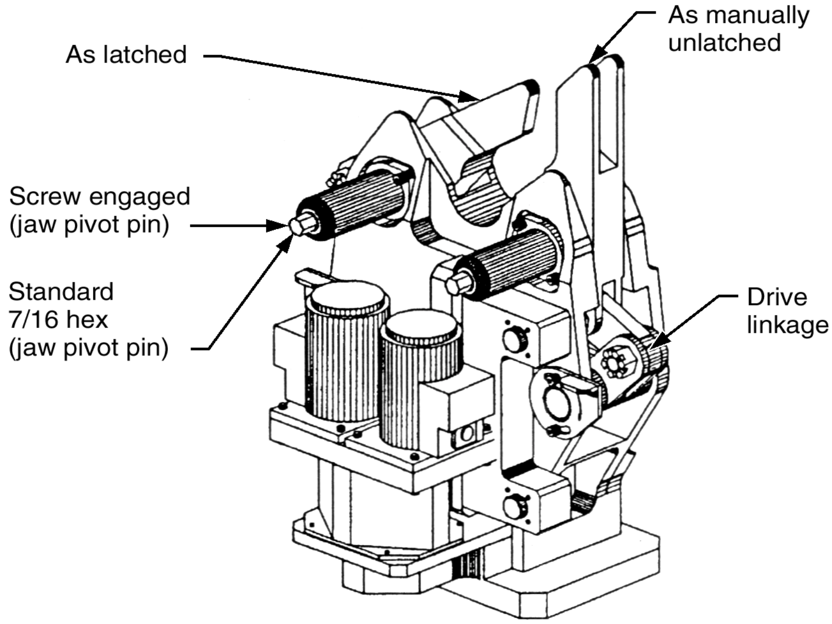
Figure 2-7. Over-night configuration

In the open position, the latch jaw is capable of supporting the HST berthing pin impact load of 1,450 lb (design limit). The design yield load is 2,900 lb. Current analysis estimates the berthing load will be less than 300 lb, assuming the RMS is operated at 0.05 fps. In the closed position, the latch can support a 9,000-lb load in all radial directions. The design limit load is 9,000 lb, and the design yield load is 18,000 lb. In the event of an operational/mechanical failure, the berthing latches have EVA override capabilities for disengagement. AFD monitors are provided to indicate latched (closed) and released (open) positions for the berthing latches.

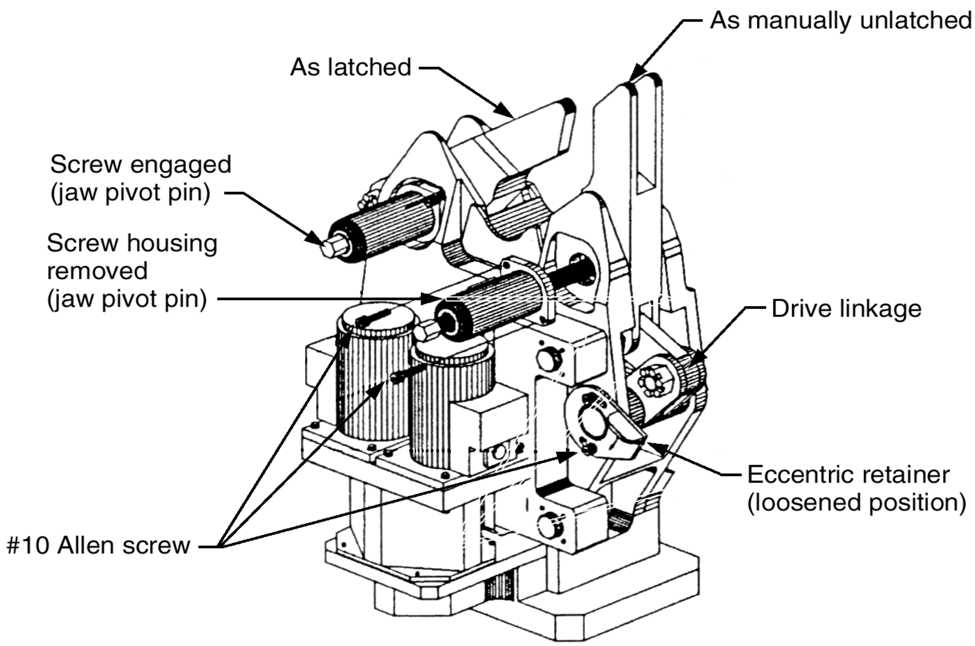
There are two EVA override provisions to operate the berthing latches from the closed position in the event of a total CDU failure. These EVA overrides consider only HST release and do not provide a means for berthing. The override provisions are as follows:

a. Primary override - Two jaw pivot pins are located on the upper left and right corners of the berthing latches (Figure 2-8). These pins can be withdrawn with an EVA standard ratchet wrench with a 7/16-in socket, which allows the upper retention jaws to rotate freely to enable the release of the HST. The EVA override does not provide the means for securing the latches, even in reverse order.

b. Secondary - Should disengagement of the berthing jaw pivot pins fail to release the HST, a secondary EVA override can be used to release the retention jaw’s links within the berthing latch (Figure 2-8). On the berthing latch, there is a eccentric retainer that preadjusts the preload setting on the drive linkage. The preload is released by loosening the upper and lower noncaptive fasteners with a no. 10 Allen tool and pressing down on the lever. This allows the jaw pivot pins to be retracted or the screw housing to be removed after removal of the no. 10 Allen captive mounting screws.



Berthing Latch Primary Override



Berthing Latch Secondary EVA Override

usa_001948_333.tif

Figure 2-8. Berthing latch primary and secondary override

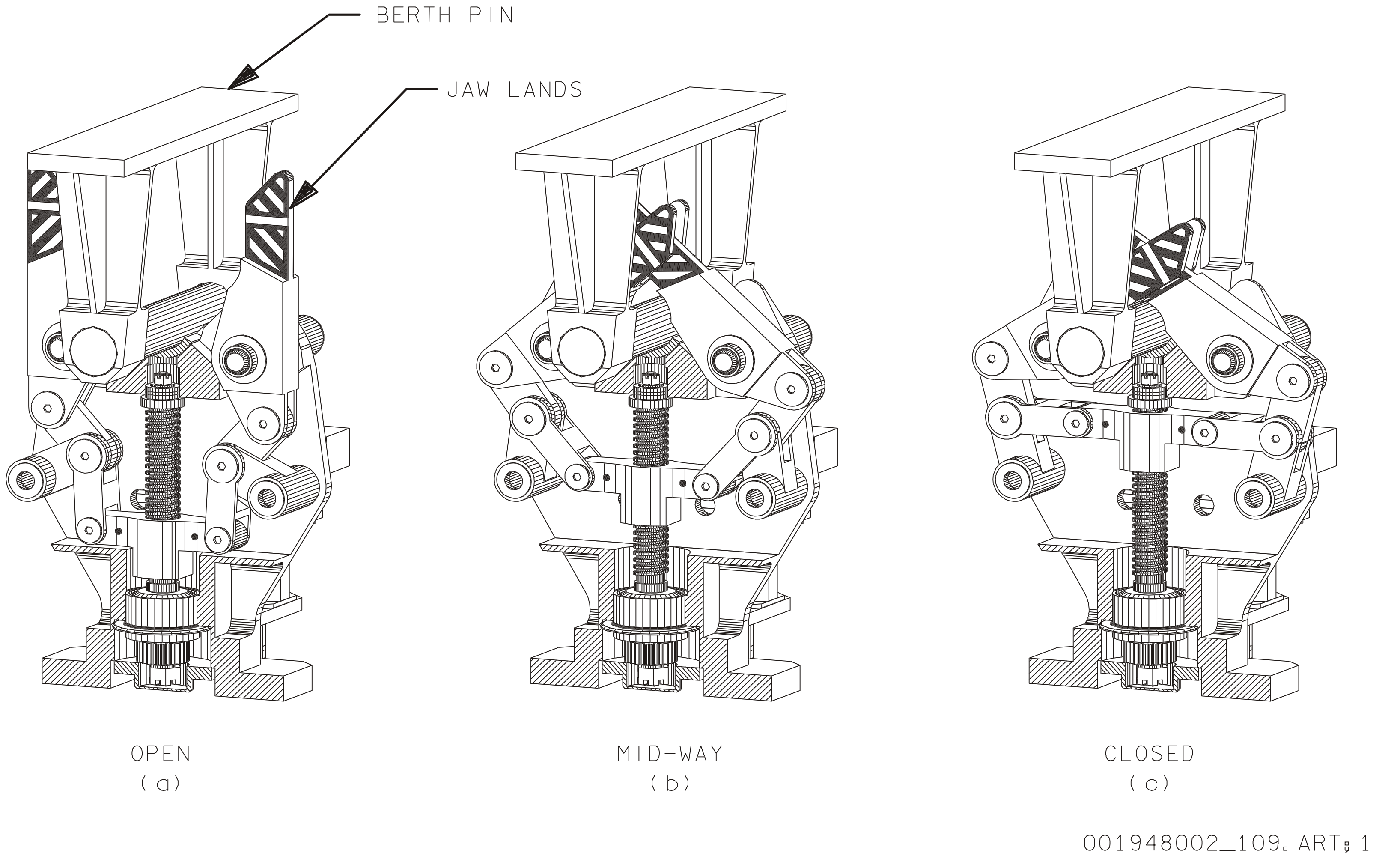


Figure 2-9. Berthing latch operation overview

Umbilical Actuators (Mechanical)

Two different types of umbilical mechanisms are available on the BAPS for the SM (Figure 2-2). The main UA is used to remotely mate and demate the FSS main umbilical to the connector on the HST aft bulkhead, as shown in Drawing 2.3. The other mechanism is the backup UDM used in the event of a failure of the main umbilical actuator. The backup UDM is manually connected and remotely released. AFD monitors are provided to indicate latched (mated) or released (demated) positions for the umbilical mechanisms.

The main UA mechanism is a translation drive with a 4.5-inch stroke that mates or demates the spacecraft umbilical connector. A toggle linkage that is slightly over dead center in both the unmated and mated positions provides the translation stroke. This mechanism is capable of developing up to 400 lb of axial force during mating and demating operations. It takes 8 seconds for the main UA to mate/demate to the connector. Measurements on existing connectors have shown required axial connector engagement loads to be less than 200 lb.

The main override is used if the actuator mechanism jams. The entire UA mechanism can be retracted; the mechanism is mounted on a movable adapter plate on the BAPS ring. The retraction is accomplished by turning the umbilical translator override screw counterclockwise. A standard ratchet wrench with a 7/16-inch socket attached is used to drive the screw. By turning the umbilical translator override screw, the mechanism is pulled away from the spacecraft, demating the umbilical connectors.

The secondary override releases the umbilical from the sill plate by removing the retainer plate screw subassembly. To remove the retainer plate, two no. 10 Allen captive retainer screws are released, which allows the carriage assembly and the translator screw to move freely and the umbilical to be manually disengaged (Drawing 2.3).

In the event of an irrecoverable failure of the main UA mechanism and/or connector, the FSS backup umbilical can be used as an alternate power feed for the HST, as shown in Figure 2-10. The FSS backup umbilical disconnect mechanism is also located on the BAPS. An EVA is required to mate the two FSS backup umbilical connectors, J107 and J108, with the HST Deploy/Return (D/R) connectors, P107 and P108. The HST D/R connectors are positioned on the HST aft bulkhead (Figure 2-11) and are tethered to the HST Emergency Umbilical Retract Mechanism (EURM). When the EURM is in the "ratchet" position, the couplings can be demated and the connectors pulled out of their cradles approximately 12 inches (Figure 2-12). The HST P107/J107 coupling is first demated, and connector P107 is mated to FSS umbilical connector J107. Subsequently, the HST P108/J108 coupling is demated, and connector P108 is mated to FSS umbilical connector J108 (Figure 2-13). Disconnection is performed remotely by the orbiter crew, utilizing the split backshells. The UDM is operated from the AFD to disconnect the FSS J107 and J108 connectors from the HST P107 and P108 umbilical connectors, respectively. The HST P107 and P108 connectors have spring-loaded backshells that are forced open and off the FSS J107/J108 connectors when the UDM is activated. The HST-mounted EURM houses a spring-loaded lanyard that is attached to the HST D/R connectors. This mechanism is automatically operated once the FSS umbilical disconnect mechanism disengages the P107/J107, P108/J108 connections. The lanyard retracts the HST connectors and holds them in the cradle of the retract mechanism via a pulling force of 6.0 to 8.0 lb.

If the backup umbilical mechanism fails, the crew can demate the connectors by overriding the release connectors from the backup umbilical interface by turning the release hex-stud of the umbilical counterclockwise. First, disengage the motor from the drive shaft. By turning the second hex-stud, the UDM connector plate raises, lifting the HST connectors (P107 and P108) until they are free of the UDM. The HST EURM then pulls the connectors away from the UDM and retains them in the EURM cradle in tension, as described previously.

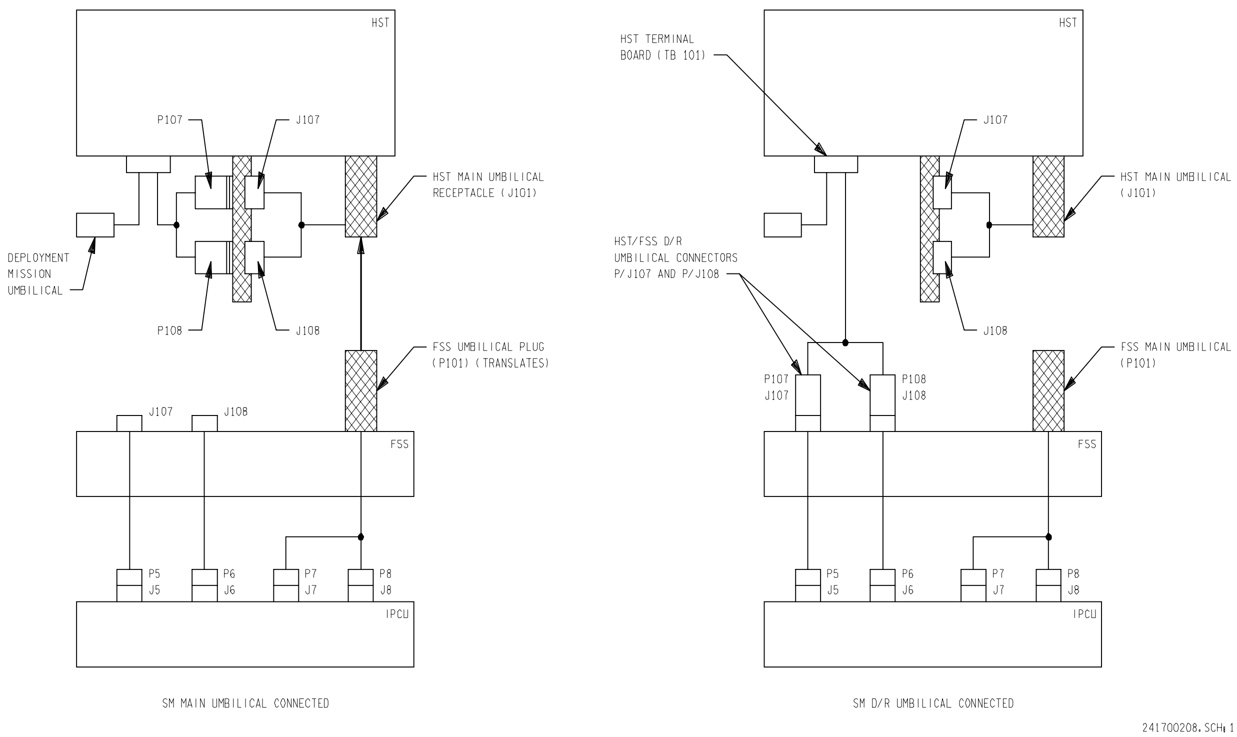


Figure 2-10. FSS main and backup umbilical connections

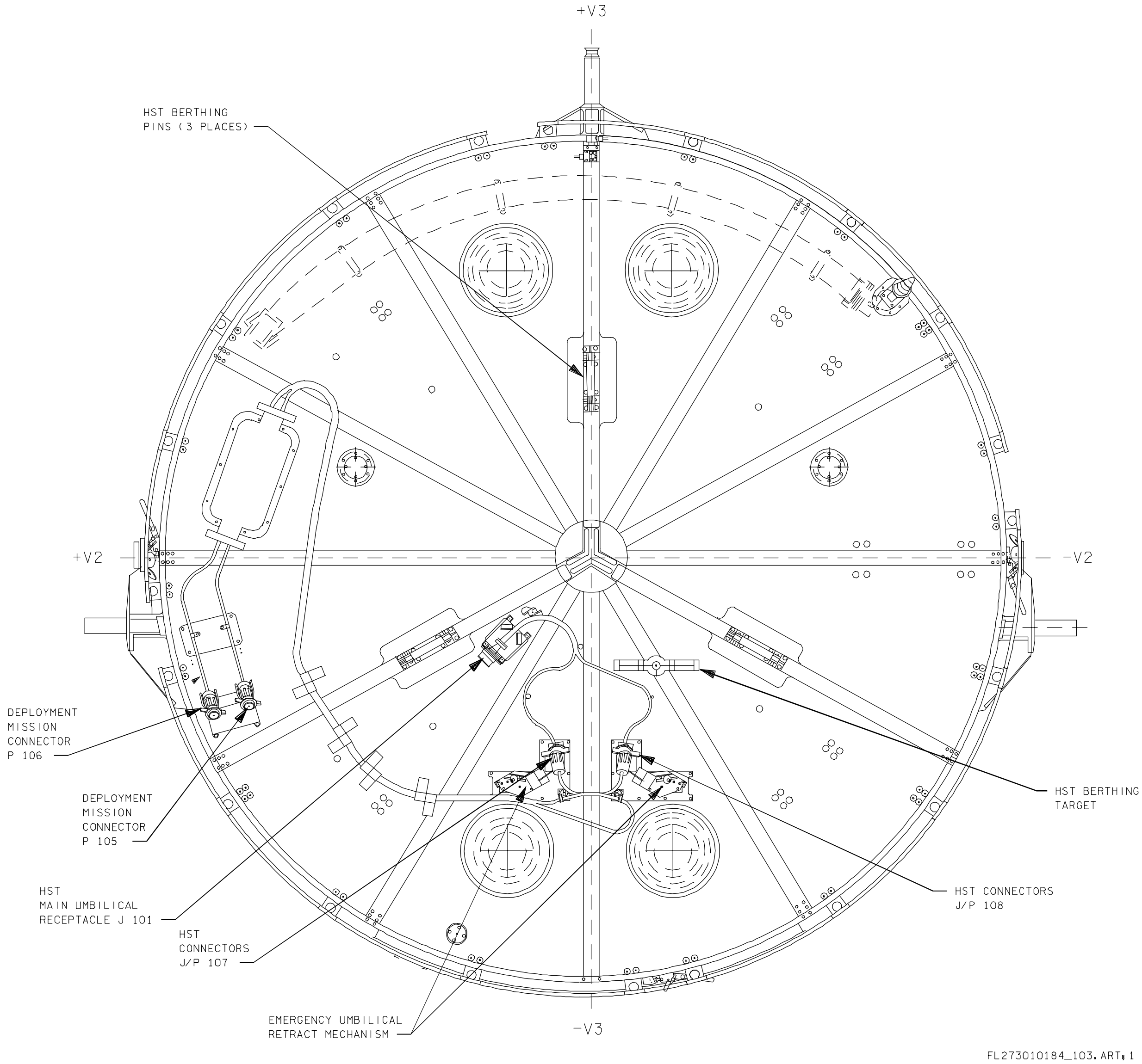


Figure 2-11. HST aft bulkhead umbilical connection locations

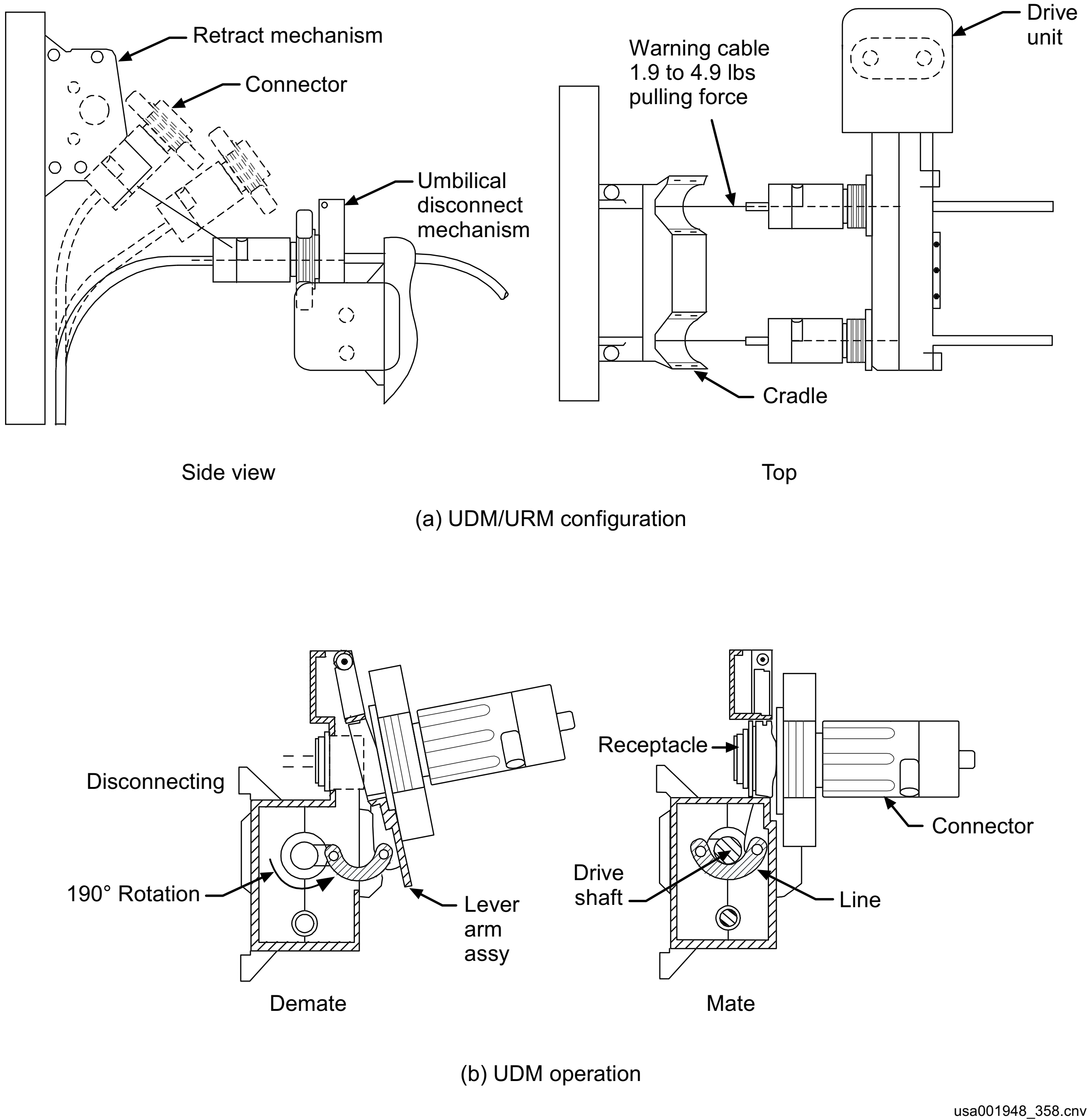
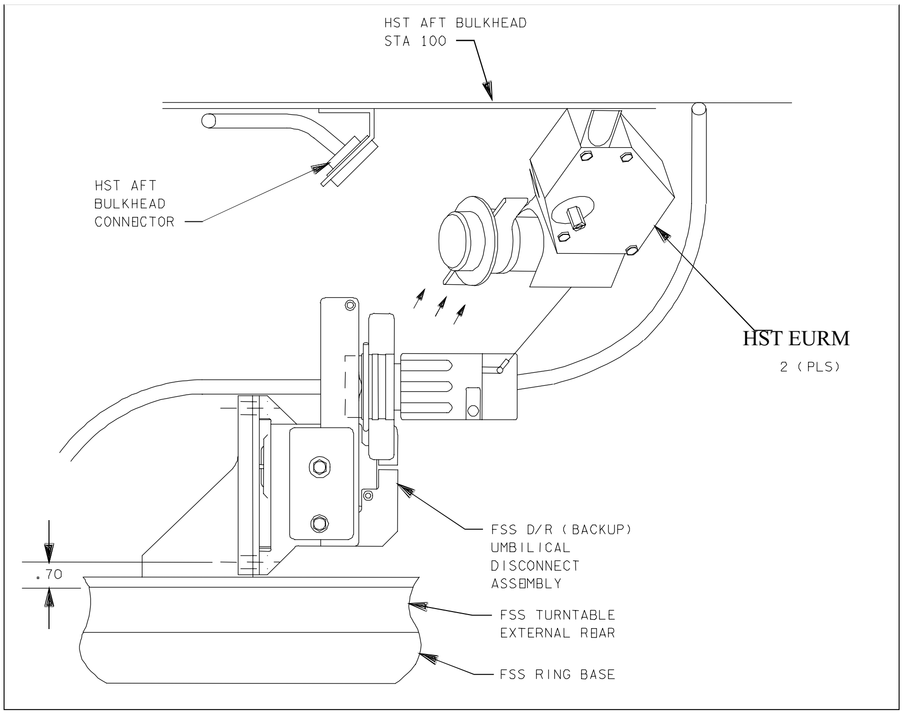
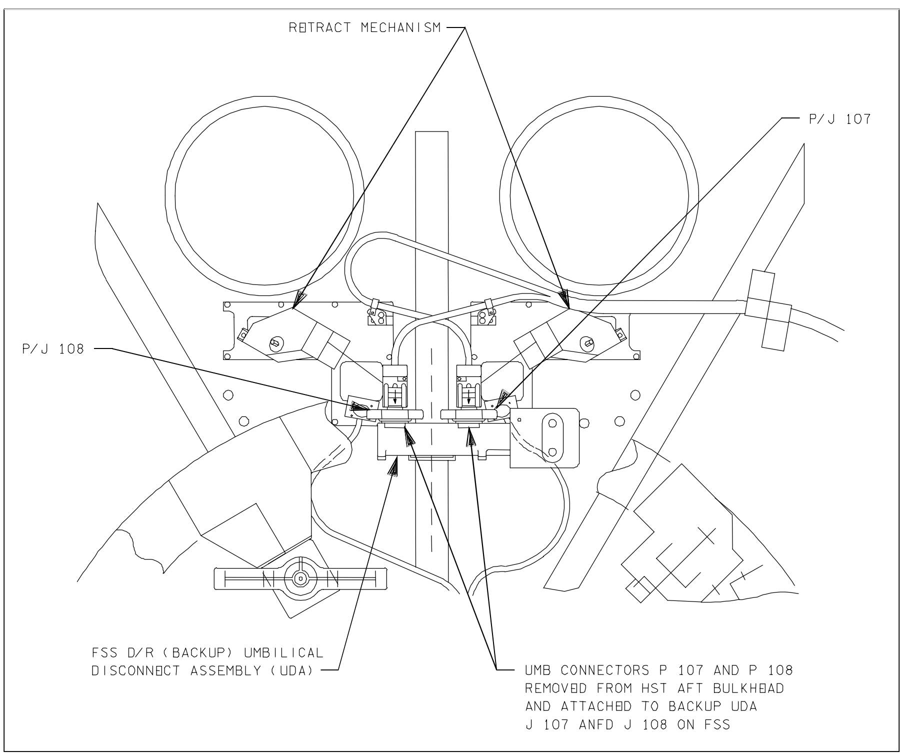


Figure 2-12. Backup umbilical retraction mechanism



SERVICING MISSION
HST UMBILICALS CONNECTED TO THE UMBILICAL DISCONNECT
ASSEMBLY MOUNTED ON THE FSS BAPS



SERVICING MISSION HST BACKUP UMBILICALS CONNECTED TO THE
FSS DEPLOY/RETURN (D/R) UMBILICAL DISCONNECT ASSEMBLY

FL273010185_103.ART;1

Figure 2-13. Backup umbilical mated to HST

BAPS Pivoter (Mechanical)

The pivoter moves the BAPS platform from the 0° (vertical or stowed) to the 90° (horizontal or berthing) position or any position in between. The pivoter is driven by a dual-torque CDU through a compound planetary gearbox, as shown in Drawing 2.3. However, the high torque is not nominally planned for use and will never be used to take the platform to the 90 degree position. Output torque to the pivot shaft (90,000 in-lb) has been sized to move the HST and react to the loads induced by firing the orbiter primary reaction control thrusters with the HST attached in the berthed position. Primary Reaction Control System (PRCS) jet firings are constrained for SM-3B (see Flight Rules for details). Impact loads induced by the RMS berthing the HST at 0.05 fps are less than the reaction control thruster loading condition and, therefore, are within the design criteria. The pivoter moves the BAPS platform 90 degrees in 1428 seconds. The expected pivot times are shown in Table 2-4. AFD monitors are provided to indicate latched (horizontal) or released (vertical) positions for the BAPS pivoter assembly.

To override the pivoter mechanism in the event of pivoter CDU failure, a small EVA override gear located in the upper left corner of the pivoter mechanism is rotated clockwise or counterclockwise to pivot the BAPS platform up or down, respectively. The EVA override can only be used when the HST is not berthed. The EVA crewmember would use an Essex wrench, 3/8-inch drive ratchet fitted with a 7/16-inch socket, to back out one bolt from each of the two pivoter-to-FSS platform captive turnbuckles. This action allows the pivoter mechanism to rotate the platform, however the HST cannot be on the BAPS. An open end 7/16-inch ratchet wrench is then used to turn a pinion hex interface located at the center of the small EVA gear. In the event of a pivoter failure, the BAPS post must be installed to provide stability. Figure 2-19 shows the BAPS pivoter and EVA override. The BAPS post is discussed later in this section.

If rapid safing is required, the minimum pivot angle with respect to the orbiter Z0 axis is 45° for the PLB Envelope, and 43.8 for the BAPS Support Post Latching. To meet the requirements for minimum pivot angle, one of the berthing latches must be aligned with the fixed visual targets on the BAPS. The worst-case situation for rapid safing occurs when any berthing latch is directly opposite of the fixed visual target. This corresponds to the berthing configuration of the rotator. If it is required to close the PLB doors in this configuration without rotating, the minimum pivot angle for clearance is 5.5°, without the BSP installed.

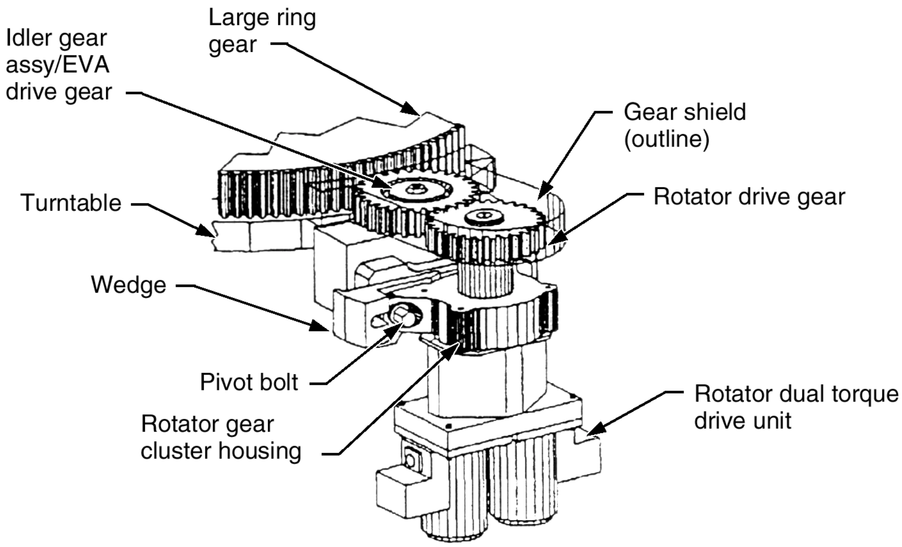
BAPS Rotator (Mechanical)

This mechanism rotates the BAPS platform (and the HST, if attached) about the BAPS/HST centerline. The rotator has a range of ±175° from its null position, as shown in Drawing 2.2. There is a 10° zone of exclusion (295°to 305° in HST coordinates) that is protected by hardstops. Rotation can be accomplished at any pivot position during unattached operations. During attached operations, refer to Figure 2-15.

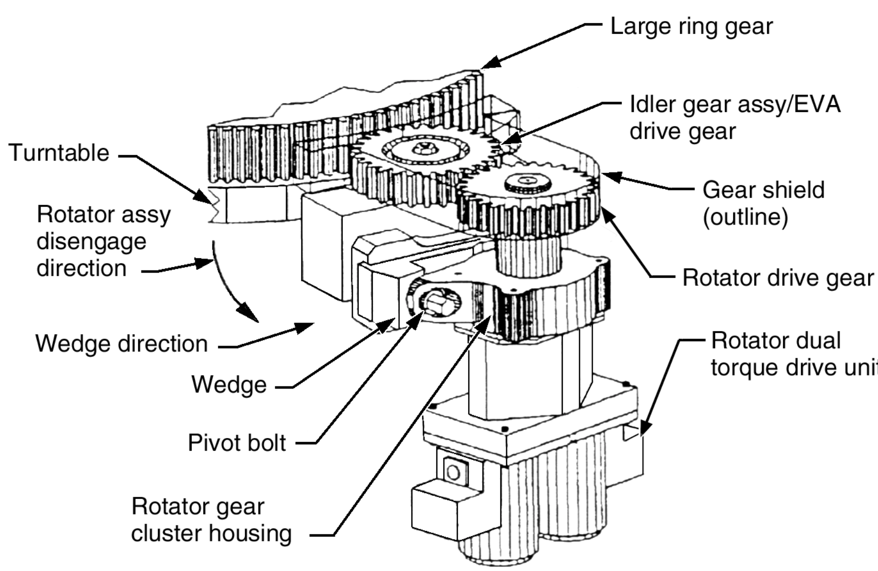
The BAPS platform has a movable ring gear that supports the HST, berthing latches, umbilical mechanisms, and the CCTV camera. The rotating ring of the BAPS is connected to the fixed ring by a ring bearing. Rotation is accomplished via an integral gear that is driven by a dual-torque CDU attached to the main fixed ring, as shown in Figure 2-14. This CDU is wired only for high torque. Once power is supplied to the CDU, the drive speed is reached nearly instantaneously. The external portion of the ring bearing has integral gear teeth that are in contact with the rotator idler gear. This rotator/gear design allows the rotator to move the rotating ring either clockwise or counterclockwise through its full range potential. The rotator CDU performance can accomplish 180° rotation in 731 seconds. The expected rotation times are shown in Table 2-3. The electrical harness service loop is stored in a cable drum suspended by radial arms inboard of the rotating and fixed ring section. This cable drum has fixed and rotating portions to allow the winding and unwinding of the cable as the platform rotates. The arrangement of the fixed and movable rings allows the mechanisms and umbilical connection to be used in any rotated position of the platform. Talkbacks on panel A6U are provided to indicate latched (counterclockwise) or released (clockwise) positions for the BAPS rotator assembly if the travel limit microswitches are reached. Additional telemetry is available on SPEC 212.

In the event of a CDU failure, an EVA override is available for the rotator. Disengaging the CDU and driving the idler gear counterclockwise with a standard ratchet wrench and 7/16-inch socket enable the override. To override this mechanism, the astronaut loosens the CDU pivot bolt, slides a wedge, which is integral to the mechanism, between the housing, and retightens the bolt. This frees the ring gear from the CDU and permits it to be driven manually through the idler gear, as shown in Figure 2-14 (see Flight Rules for recommended speed). The CDU must be reengaged to prevent free movement of the rotator. During reengagement, the EVA crewmember verifies gear tooth alignment via the sight hole in the top of the gear shield. No secondary EVA overrides are provided.

Due to the HST SAs, BAPS rotation constraints are documented to prevent inadvertent contact between the HST and the orbiter structure. Figure 2-15, Figure 2-16, and Figure 2-17 describe these constraints when the BAPS is at the 90° position. Figure 2-18 describes the allowable SA slew angles when the HST is at the +V2 Fwd position. With the BAPS at the 90° position, there are no rotation constraints once the SA2s have been fully retracted or the SA3s have been installed and are at the 0° position.



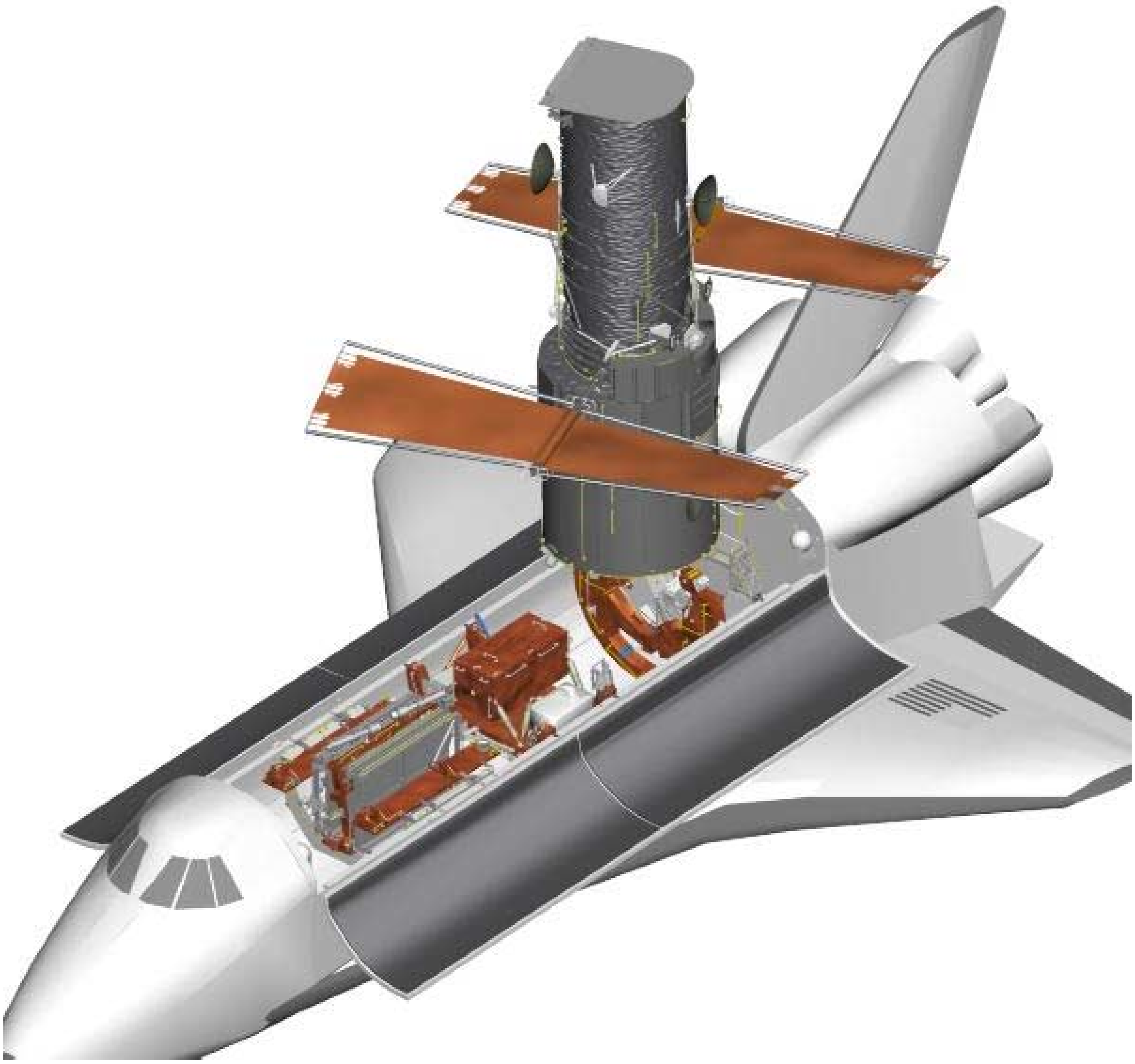
Rotator Primary Drive Configuration



Rotator Primary EVA Override Disengaged

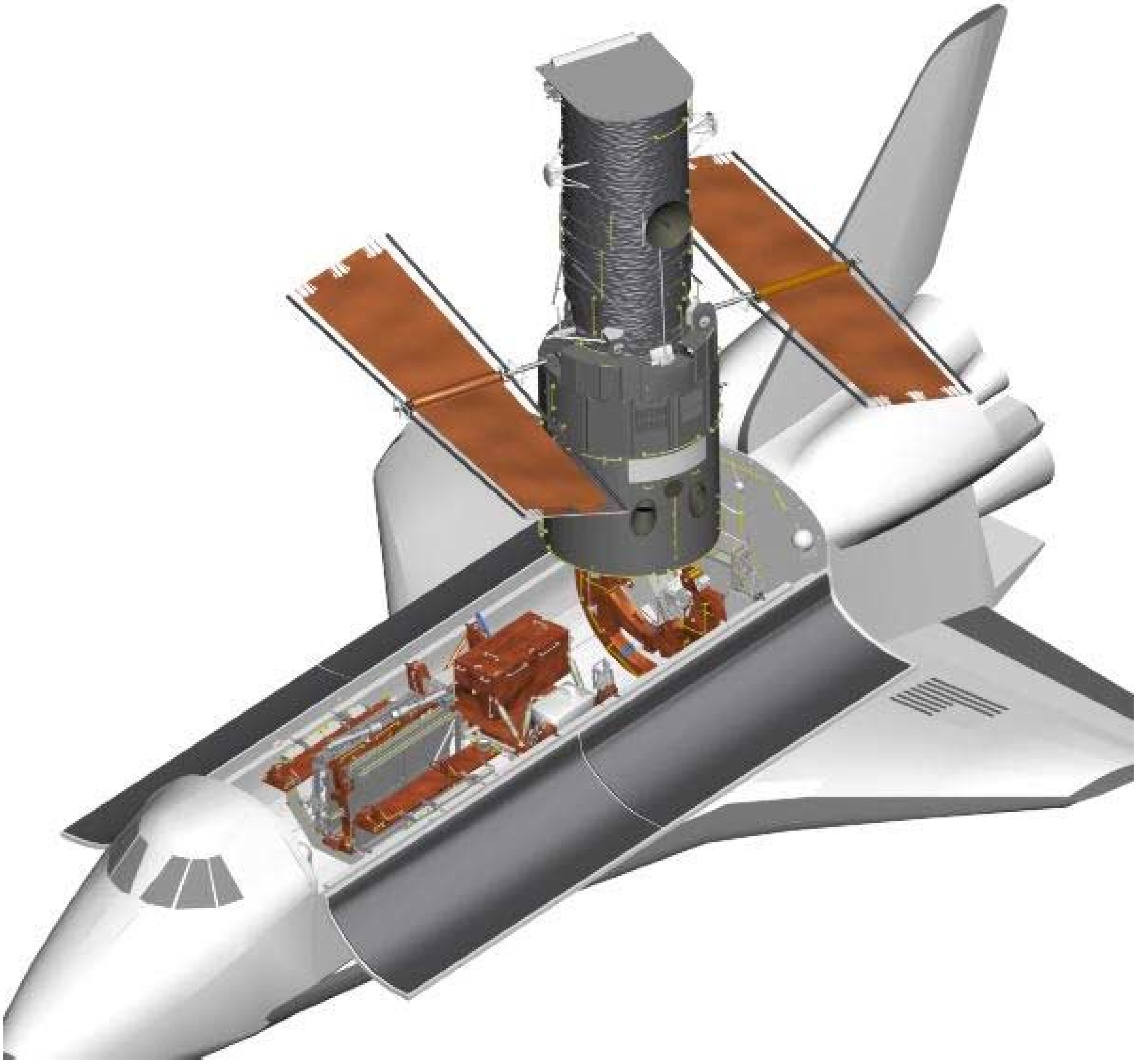
usa_001948_342.tif

Figure 2-14. BAPS rotator primary drive and EVA override



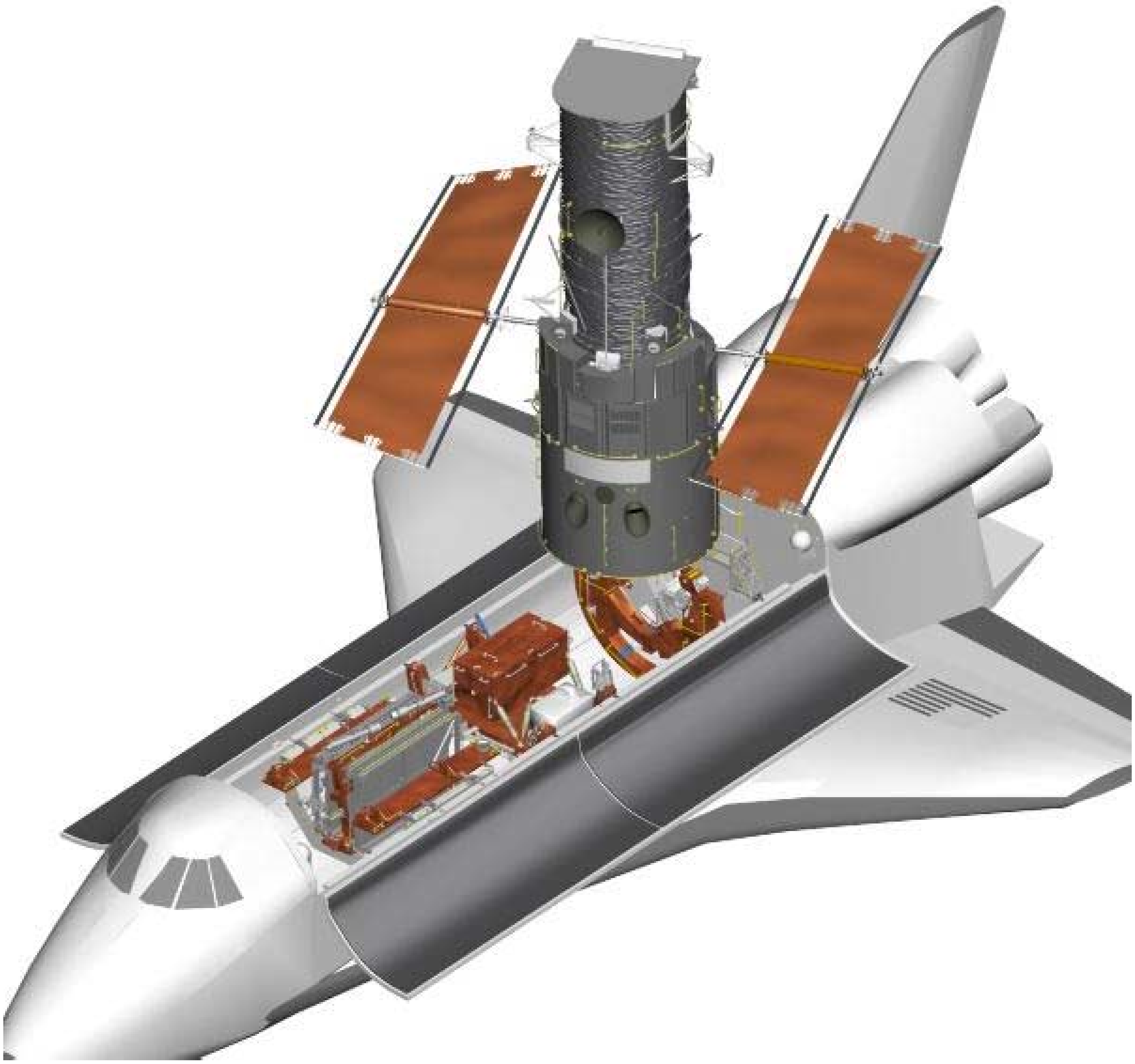
FSS ROTATED TO 70 DEG. FWD

Figure 2-15. Allowable range of FSS rotation from -V2 FWD with SA-IIs at 0° (±20°)



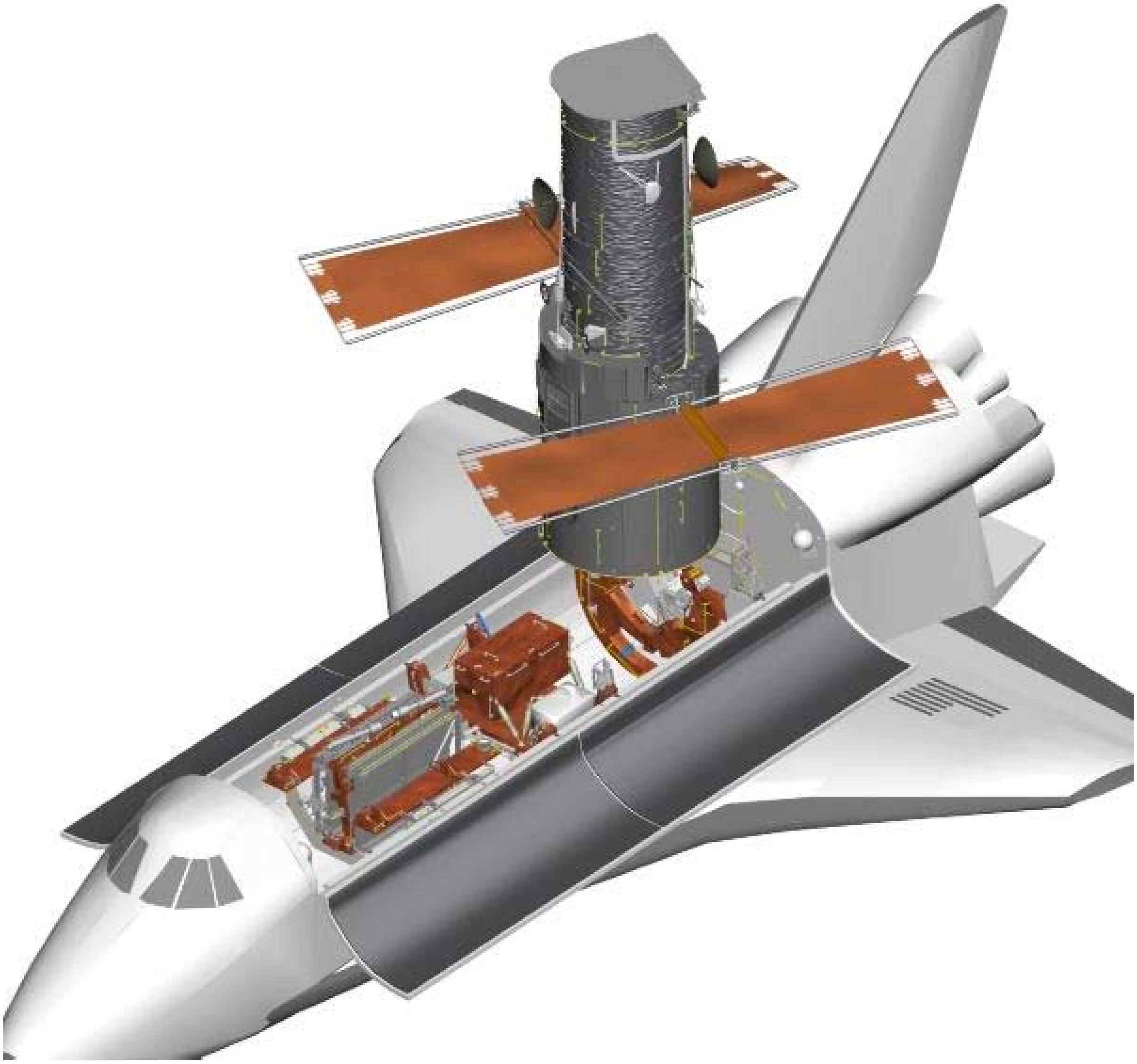
FSS ROTATED TO 110 DEG. FWD

Figure 2-15. Allowable range of FSS rotation from -V2 FWD with SA-IIs at 0° (±20°) (concluded)



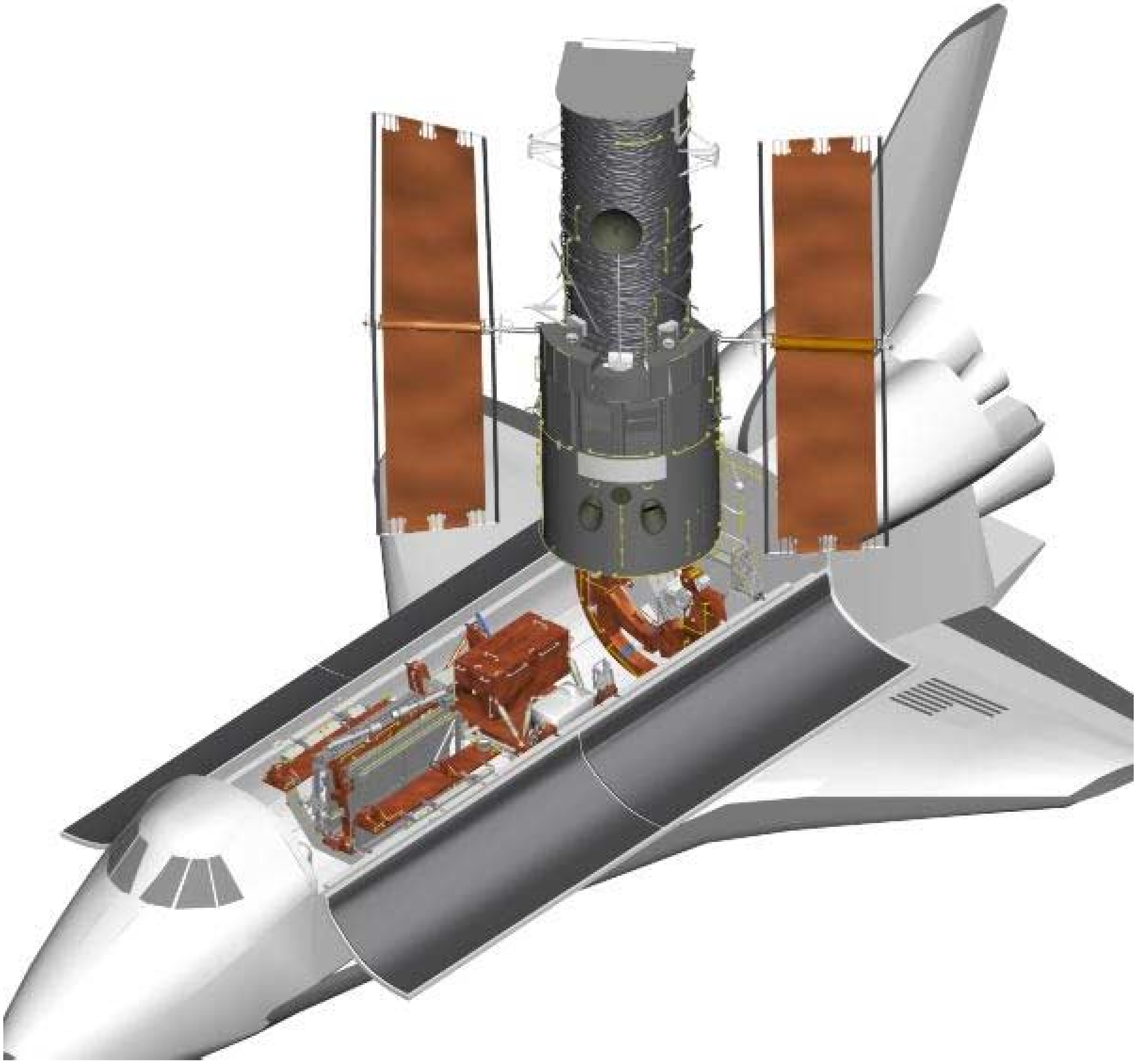
FSS ROTATED TO 155 DEG. FWD

Figure 2-16. Allowable range of FSS rotation from -V3 FWD with SA-IIs at 0° (±25°)



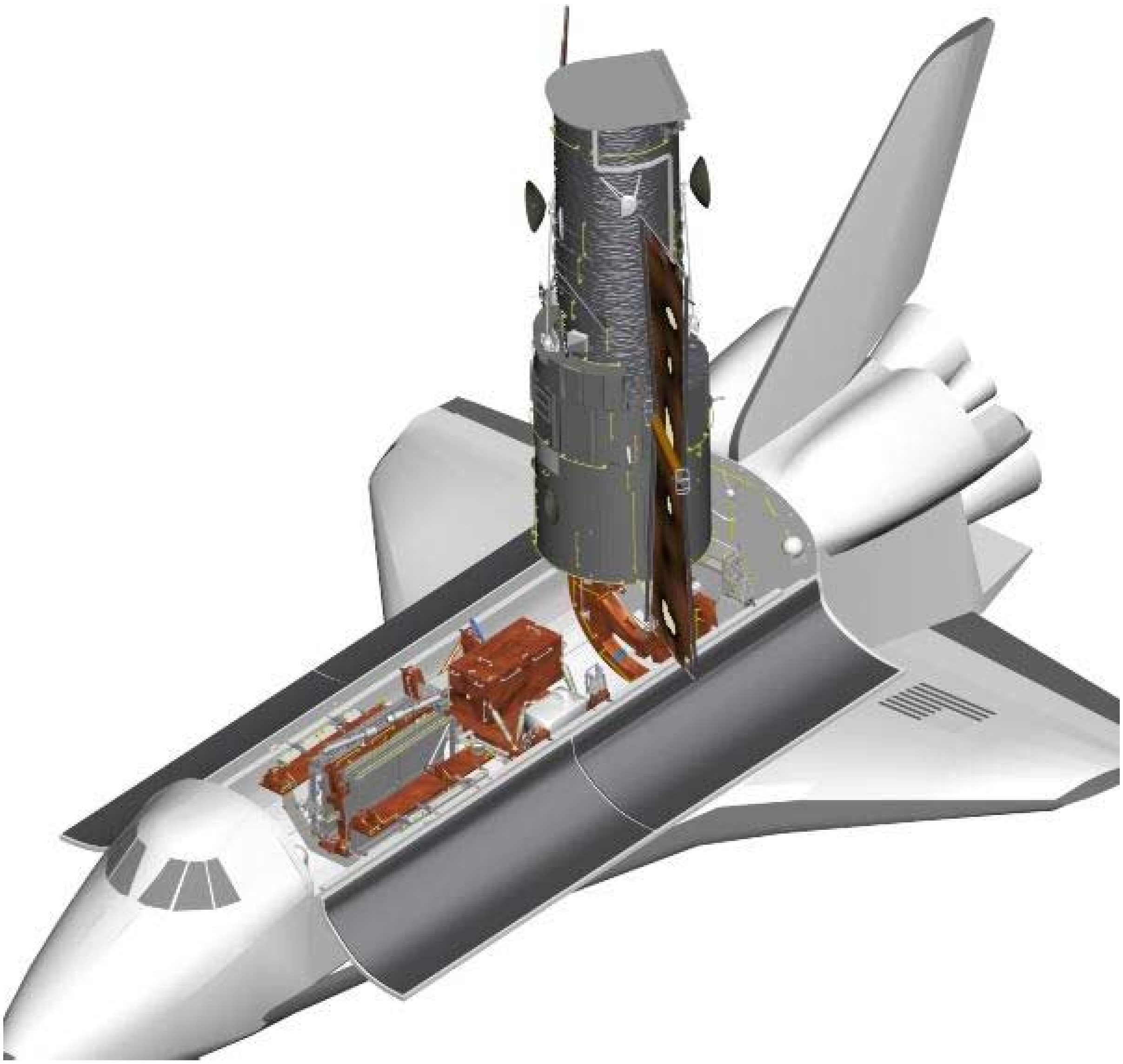
FSS ROTATED TO 205 DEG. FWD

Figure 2-16. Allowable range of FSS rotation from -V3 FWD with SA-IIs at 0° (±25°) (concluded)



FSS ROTATED TO 145 DEG. FWD

Figure 2-17. Allowable range of FSS rotation from -V3 FWD with SA-IIs at 90° (±35°)



FSS ROTATED TO 215 DEG. FWD

Figure 2-17. Allowable range of FSS rotation from -V3 FWD with SA-IIs at 90° (±35°) (concluded)

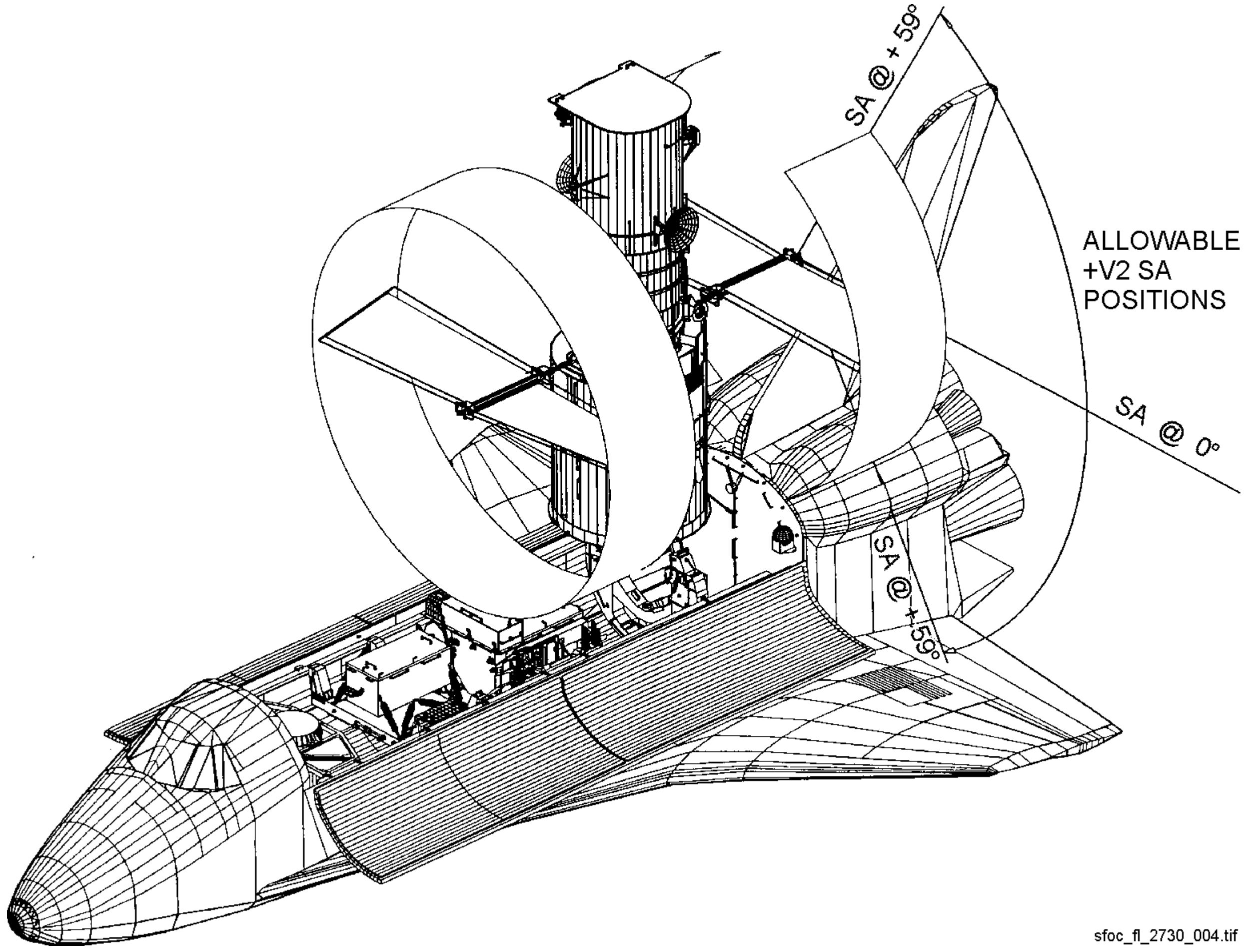


Figure 2-18. Allowable SA-IIs positions with HST at +V2 FWD

Table 2-3. FSS rotator position changes time correlation

Position To→ From↓	B (-V3) HST 180°	-V2 HST 90°	HST 225°	+V2 HST 270°	(+V3) HST 0°	HST 330°	HST 30°	HST 305°
B (-V3) HST 180°		06:05 LAT	03:03 REL	06:05 REL	12:11 LAT	14:13 LAT	10:09 LAT	15:54 LAT
-V2 HST 90°	06:05 REL		09:08 REL	12:11 REL	06:05 LAT	08:07 LAT	04:04 LAT	09:48 LAT
HST 225°	03:03 LAT	09:08 LAT		03:03 REL	15:12 LAT	17:14 LAT	13:11 LAT	18:55 LAT
+V2 HST 270°	06:05 LAT	12:11 LAT	03:03 LAT		18:16 LAT	20:18 LAT	16:14 LAT	21:59 LAT
(+V3) HST 0°	12:11 REL	06:05 REL	15:12 REL	18:16 REL		02:02 LAT	02:02 REL	03:43 LAT
HST 330°	14:13 REL	08:07 REL	17:14 REL	20:18 REL	02:02 REL		04:04 REL	01:41 LAT
HST 30°	10:09 REL	04:04 REL	13:11 REL	16:14 REL	02:02 LAT	04:04 LAT		05:45 LAT
HST 305°	15:54 REL	09:48 REL	18:55 REL	21:59 REL	03:43 REL	01:41 REL	05:45 REL	

Times based on 14.78 deg/min actual run time during previous missions
Duration shown is in MM:SS
Position shown is rotator label and/or HST station facing forward
LAT indicates counterclockwise rotation
REL indicates clockwise rotation

Table 2-4. FSS pivoter position changes time correlation

Position To→ From↓	0°	43.8°	75°	85°	90°
0°		11:35 LAT	19:50 LAT	22:29 LAT	23:48 LAT
43.8°	11:35 REL		8:15 LAT	10:54 LAT	12:13 LAT
75°	19:50 REL	8:15 REL		2:39 LAT	3:58 LAT
85°	22:29 REL	10:54 REL	2:39 REL		1:19 LAT
90°	23:48 REL	12:13 REL	3:58 REL	1:19 REL	

Times based on 3.78 deg/min actual run time during previous missions
Duration shown is in MM:SS
Position shown is pivoter protractor reading
LAT indicates movement towards horizontal position
REL indicates movement towards vertical position

BAPS Translator (Mechanical)

The translator mechanism is designed to permit linear (forward and aft) movement of the BAPS, as shown in Figure 2-20. The translator mechanism is capable of providing a linear translation of 3.5 inches in 336 seconds (±1.75 in. from the launch position) in the FSS X-Z plane for any pivoted position. A small CDU is located aft of the main support ring. The CDU drives a gear box with two output shafts extending in the +Y and -Y coordinates. AFD monitors are provided to indicate latched (aft) or released (forward) positions for the translator mechanism. The BAPS translator is not planned to be used during SM-3B.

BAPS Downlock Launch/Landing (Mechanical)

The BAPS downlock (launch/landing) mechanism, shown in Drawing 2.3, secures the BAPS to the FSS cradle A structure to prevent the pivoter mechanism from carrying BAPS inertial loads during ascent and entry. The mechanism trunnion pin is attached to the BAPS platform ring housing with four EVA tethered bolts. The latch attaches to the cradle structure through an intermediate adapter. The pin clamping action is achieved by a segmented collet mounted in an extendable/retractable cylinder that is driven by the CDU through an acme-threaded screw. When the centerline of the downlock pin is within 0.75 inches of the cylinder centerline, the collet system is driven forward over the downlock pin. As the collet system engages the pin, the cylinder and pin self-align. The cylinder then continues to extend, surrounding the pin and collet. The time required for the launch/landing downlock mechanism to secure the BAPS to the FSS cradle A structure is 24 seconds. The BAPS preferred entry condition is with the launch and landing lock engaged around the BAPS downlock pin; it is not mandatory for entry. No loads are transferred through the launch/landing downlock mechanism gear train; BAPS loads are transferred from the collet through the cylinder to the cradle/mechanism mounting interface. As a protection against overloading the mechanism gear train, a torque limiter is located between the CDU and the rear gear assembly. AFD monitors are provided to indicate latched (locked) or released (unlocked) positions for the launch/landing downlock mechanism. The SM-3B landing configuration is baselined with the BSP installed and secured in the 43.8° position. If the BSP is not installed for entry, the BAPS must be pivoted to below 5.5° for landing. When the BAPS is pivoted above 5.5°, the berthing latches violate the PLBD thermal dynamic 90-inch envelope with the rotator in the berthing configuration. Pivoting to 0° and engaging the downlock are not required as long as the pivoter has not been disengaged; however, pivoting to 0° and engaging the downlock is preferred. With the BAPS Support Post (BSP) installed, the pivoter mechanism can support landing loads when pivoted above 20°, but cannot without the BSP.

An EVA override is used in the event of a CDU failure in the locked position. The assembly holding down the downlock pin onto the BAPS platform is connected with four tethered 7/16-inch drive hex bolts shown in Figure 2-21. A standard ratchet wrench with a 7/16-inch socket attached is used to remove the bolts. The downlock pin will stay in the launch and landing lock assembly, allowing the platform to be pivoted. Once the BAPS platform is clear of the mechanism, the pin can be removed and tethered to the astronaut. The pivoter gear train is capable of withstanding the BAPS inertial loads during orbiter entry, so no EVA activity is required for orbiter landing. If rapid safing is required, the minimum pivot angle without the BSP is 5.5° for closure of the orbiter payload bay doors.

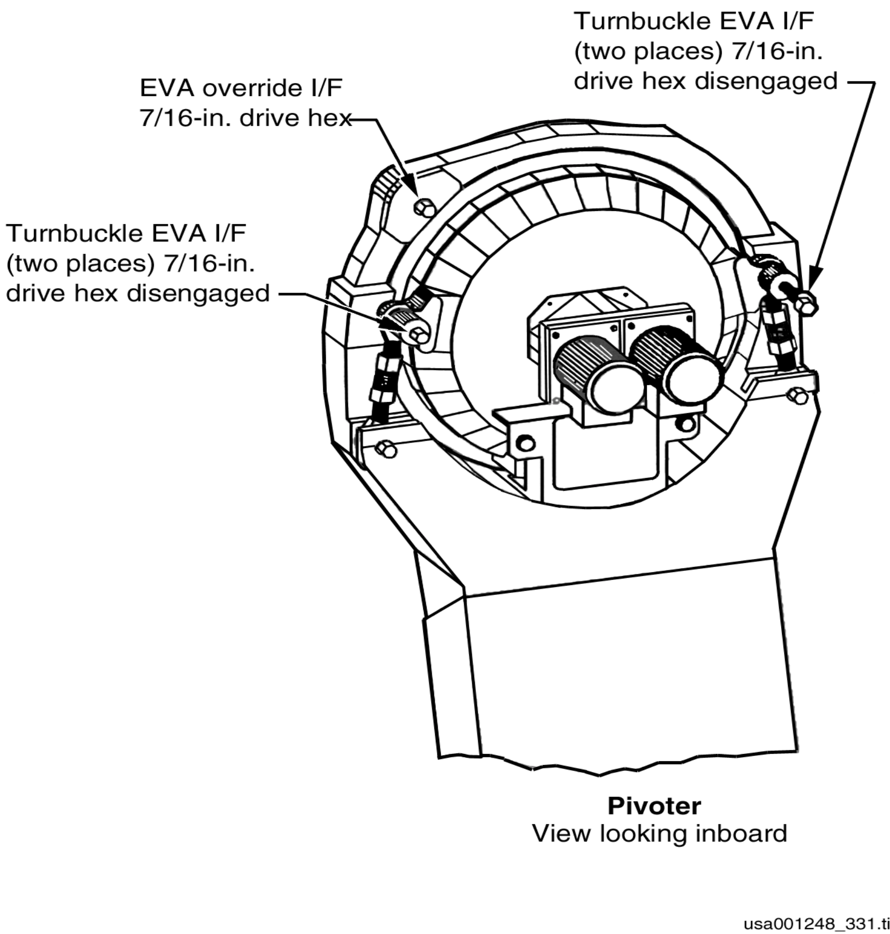


Figure 2-19. BAPS pivoter

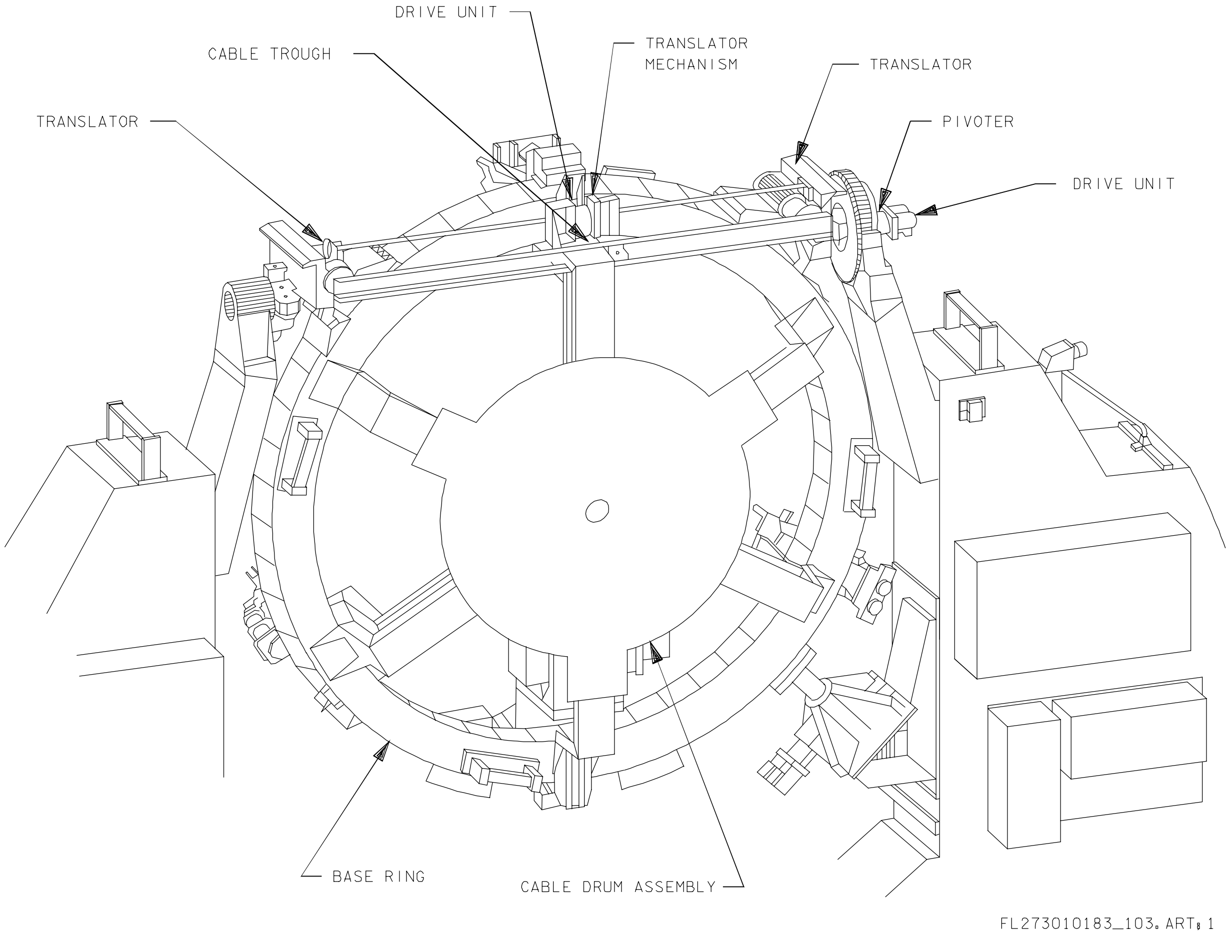
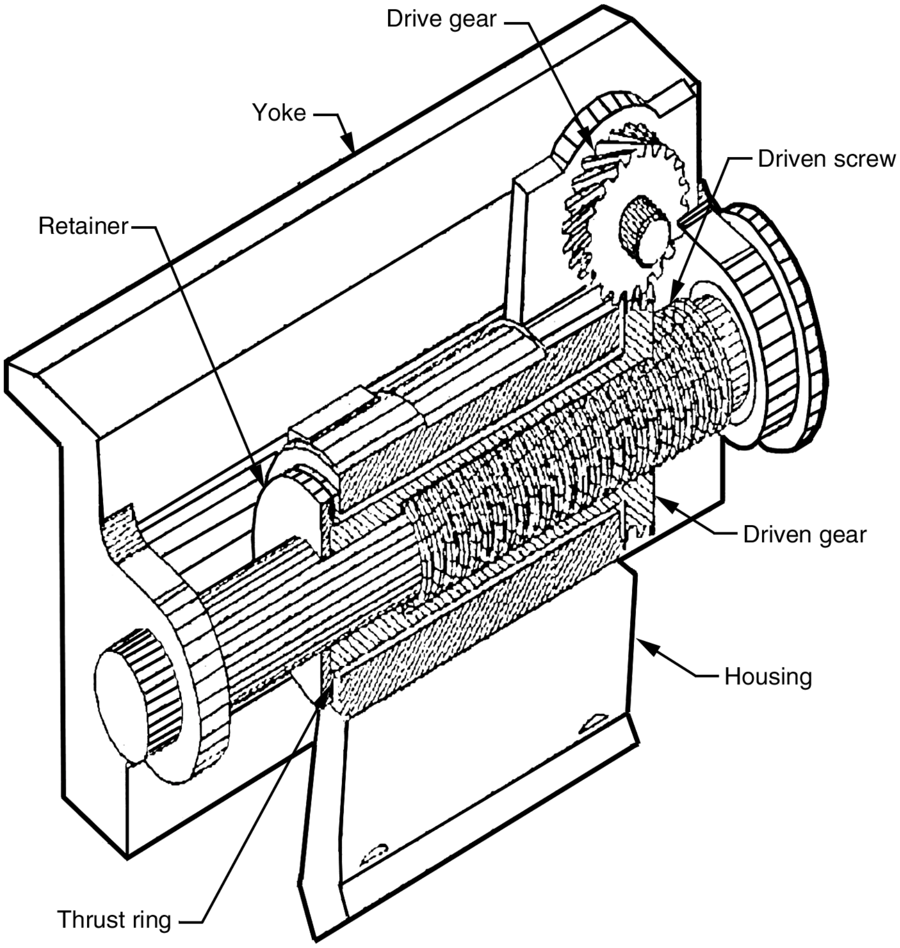


Figure 2-20. BAPS translator configuration



b. Detail

usa001948_339.tif

Figure 2-20. BAPS translator configuration (concluded)

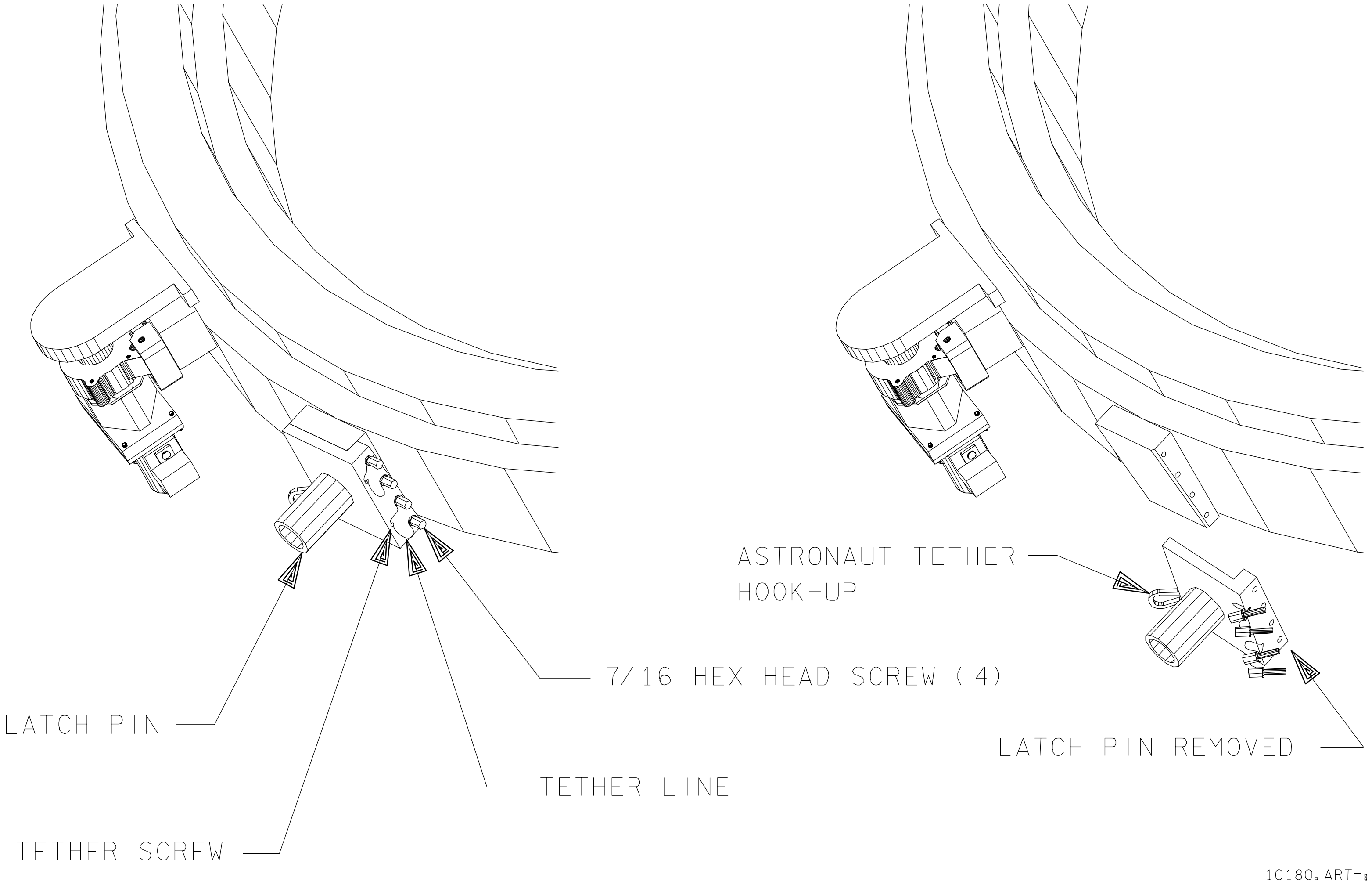


Figure 2-21. BAPS launch/landing lock primary EVA override

BAPS Support Post

The BAPS Support Post (BSP) provides support to the BAPS ring during HST EVA servicing operations, reboost operations, and landing, stiffening the BAPS, improving the berthed dynamics of HST, and off-loading the BAPS pivoter mechanism. Construction of the Post is illustrated in Figure 2-23. It is a two-piece telescoping tube capable of extending from a retracted position of 66.30 inches (43.8° BAPS pivoter angle) to a fully extended position of 119.30 inches (90° BAPS pivoter angle). Hardstops in the BSP prevent extension or retraction beyond these limits, and the Post can be locked in either of these two positions to provide the additional support and load path for the BAPS. In the fully extended position (90° BAPS pivoter angle) the BSP position is locked or fixed by inserting the center pip pins into aligning holes in the inner and outer tubes. In the retracted position (43.8° BAPS pivoter angle), the BSP is locked into position by a latch mechanism that engages automatically as the post enters the fully retracted position.

The latch mechanism is a semi-automatic device. It latches automatically when the post is fully retracted, but is commanded from the AFD to disengage and unlatch. A small CDU is used to actuate the latch to commanded positions. The latch can also be operated manually by EVA. Figure 2-22 shows the BSP latch mechanism.

BSP Operations

The BSP is operated using a combination of EVA manual activities and remote AFD operations. The BSP is launched in its stowed position, fully retracted and latched, on the lower structure of the FSS, as shown in Drawing 2.1. The EVA crew installs the BSP into its operating position on-orbit. In this position, the Post is attached between the FSS latch beam and BAPS ring by the EVA crew with a pip-pinned clevis at each end of the post. The Post’s clevis interfaces are shown in Figure 2-23.

Once installed the Post is free to extend or retract (within the limits of its travel) as the BAPS pivots up or down. Note, that with the BSP installed, the BAPS can only be pivoted down to 43.8°, and adherence to the rotational constraints on the BAPS for PLBD closure is required. These rotational constraints are discussed in the “BAPS Pivoter (Mechanical)” section.

When the BAPS is pivoted up fully (90°), the BSP is fully extended to its hardstop. The EVA crew can fix the Post in this position by inserting the two center pip pins into aligning holes on the inner and outer BSP tubes. Fixed in this manner, the post helps support the BAPS ring, improving the dynamic response of HST to EVA loads and helping to reduce loads on the pivoter. Note that the pip pins must be removed before pivoting the BAPS down, and, for safety reasons, the BSP should be left unpinned at end of each EVA.

The pip pin holes are designed to line up when the BSP is fully extended to its hardstop. Two standard size pip pins of 0.500 inch diameter are tethered and stored on the CDU bracket on the outer tube for easy accessibility. Should the crew have trouble inserting the standard pip pins, two smaller pip pins are also flown and stowed in the pip pin bracket. These undersized pip pins have a 0.470-inch outer diameter. Since optimum dynamic response and load transfer is achieved with the standard pip pins, these should be used if possible.

With the BSP installed the BAPS can only be pivoted down to 43.8°. In this position the BSP is fully retracted to its hardstop and the latch mechanism automatically engages if in the “Set” or ready-to-latch position. Figure 2-24 illustrates the operation of the latching tabs in the mechanism. They are spring loaded to engage the hooks. Once the latch is engaged, the post can extend only when an AFD crewmember commands the latch to release or the EVA crewmember manually releases the latch mechanism.

The BSP provides several indications of its state to the AFD. It indicates if the Post is retracted and if the latch tabs are engaged or disengaged. Figure 2-24 shows the function of these microswitches. Microswitches are also provided to show the position of the CDU driven mechanism and to control the CDU. These microswitches are shown in Figure 2-25. They provide an indication if the mechanism is in the “Set” (ready-to-latch), released, or latch assist position. Table 2-5 provides a summary of how the microswitches indicate the status of the CDU driven mechanism.

BSP back-ups and overrides

The BSP has a number of back-up and override features to retain as much functionality as possible and assure access to a safe configuration in the event of a failure or contingency. Back-up and override features are listed below.

1. In addition to being driven by a CDU, the BSP latch mechanism can also be released from the retracted position manually by EVA. The EVA override handle is shown in Figure 2-22 and Figure 2-23. Rotating the handle counter clockwise while holding the outer BSP tube stationary will release the lock tabs from under the hooks. This feature is used nominally during the initial EVA installation of the Post. Once installed this feature can also be used to manually release the latch in the event of a CDU or mechanism power system failure. Once the BSP is installed on the FSS, the EVA override pip pin (shown in Figure 2-23) must be removed before the EVA override handle can be rotated. The override pip pin can also be used to lock the override handle in the rotated or release position. In this position the tabs are not able to rotate under the hooks and automatic latching is inhibited.

2. Should the BSP latch mechanism fail to latch when the Post is retracted (43.8°), the Post can be fixed in this position using the same two center pip pins that are used to fix the Post in the extended (90°) position. The crew would need to insert these pins during EVA. As noted in the “BSP Operations” section, in addition to the standard (0.500 inch diameter) pip pins, undersize (0.470 inch diameter) pip pins are provided should the crew encounter difficulty inserting the pins.

3. Should the tab locks fail to engage the hooks in the latch mechanism, the CDU can be commanded to drive the tabs under the hooks. This operation is called “latch assist,” and the physical features that support his mode are shown in Figures 2-22 and 2-25 and Table 2-5. Note that the configuration of the latch must be well

understood before using this feature. Use of this feature in the wrong circumstances could damage or jam latch compromising the integrity of the Post and rendering it useless for future operations.

4. Should the CDU driven mechanism fail in either the “release” or “latch assist” positions, the entire mechanism can be manually disengaged from the tab locks, recovering the automatic latching and manual release functions of the BSP. The mounted configuration of the CDU driven mechanism is shown in Figure 2-23. This override is shown in Figure 2-23. Also shown in Figure 2-23 is the CDU with actuator lever. This CDU is mounted on a flat plate connected to the BSP outer tube. There are four captive screws on the bottom of the flat plate that hold the CDU to the plate. The EVA crewmember loosens these four screws, which allow the CDU to be lowered and the EVA override spacer to be inserted between the CDU and the plate. Then the screws can be tightened, securing the CDU. The EVA override spacer is thick enough that the actuator lever is below the breech lock tabs and the tabs are, thus, left below the tab locks; and the tabs are free to rotate.

5. When in the fully extended (90°) or retracted (43.8°) positions, the BSP can be under considerable preload. In the extended position the BSP could be under tensile preload of up to 411 pounds with the pivoter in low torque mode and 1590 pounds with the pivoter in high torque mode. In the retracted position BSP can be under compressive preloads of similar magnitude. Should the pivoter fail in either of these two positions, these preloads may hinder operation of the EVA overrides, especially release of the pivoter turnbuckles or removal of the center or end BSP pip pins. The preload release bracket, shown in Figure 2-26, is provided to release the preload on the BSP. It is located at the BSP interface with the FSS latch beam. Rotating the EVA bolt counterclockwise extends the bracket up to 1.5 inches and relieves tensile preloads on the BSP. Rotating the EVA bolt clockwise retracts the bracket up to 1.0 inches and relieves compressive preloads on the BSP.

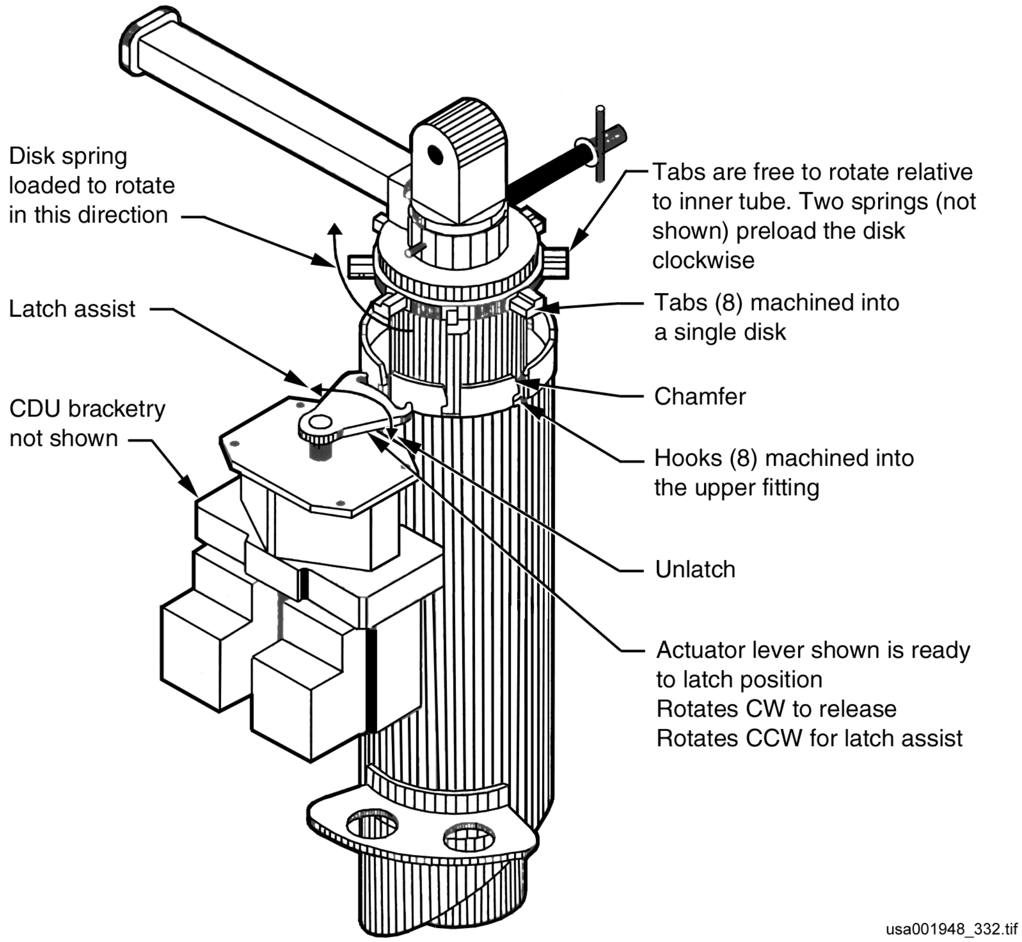


Figure 2-22. BSP mechanism

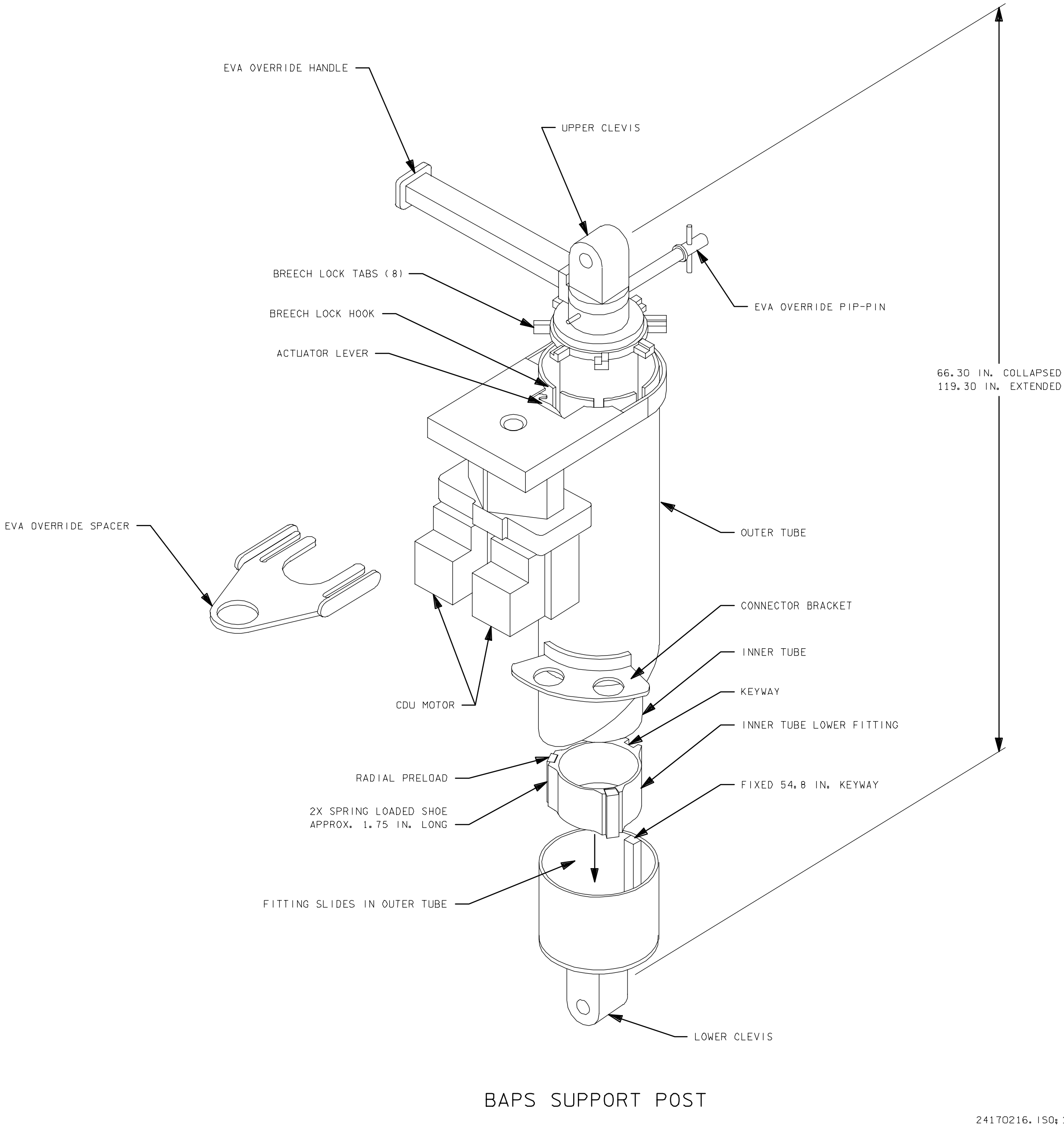


Figure 2-23. BSP structure

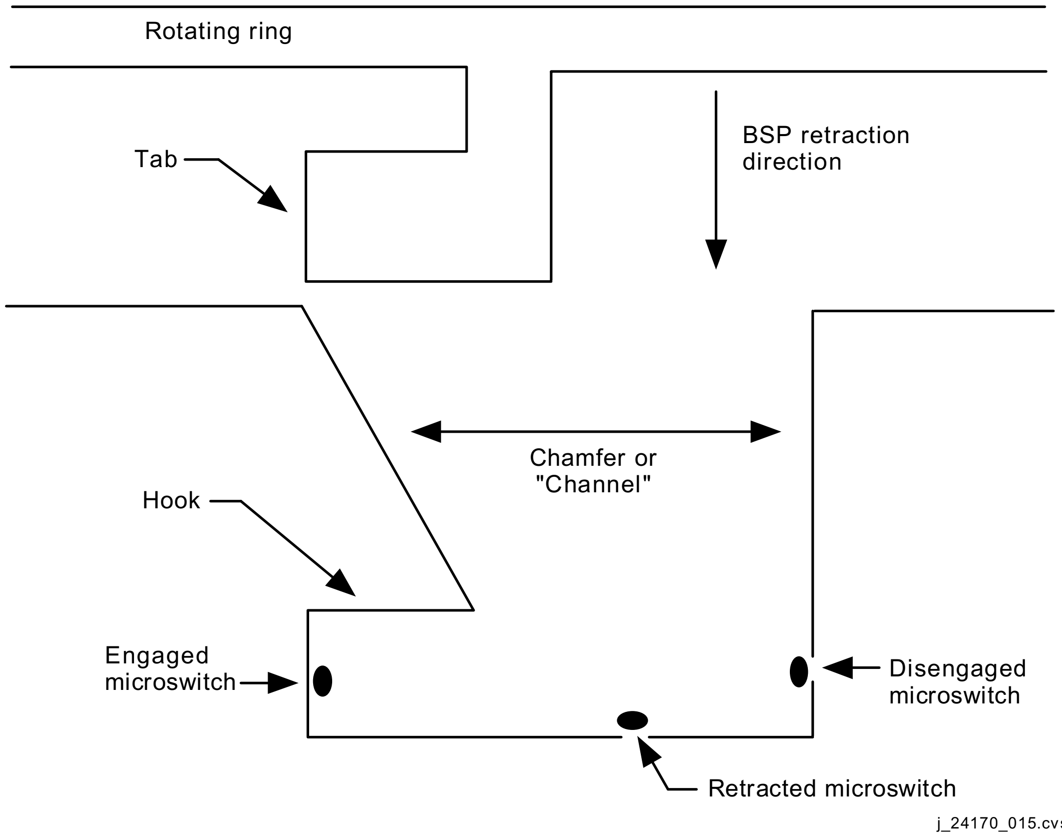


Figure 2-24. BSP breech lock mechanism

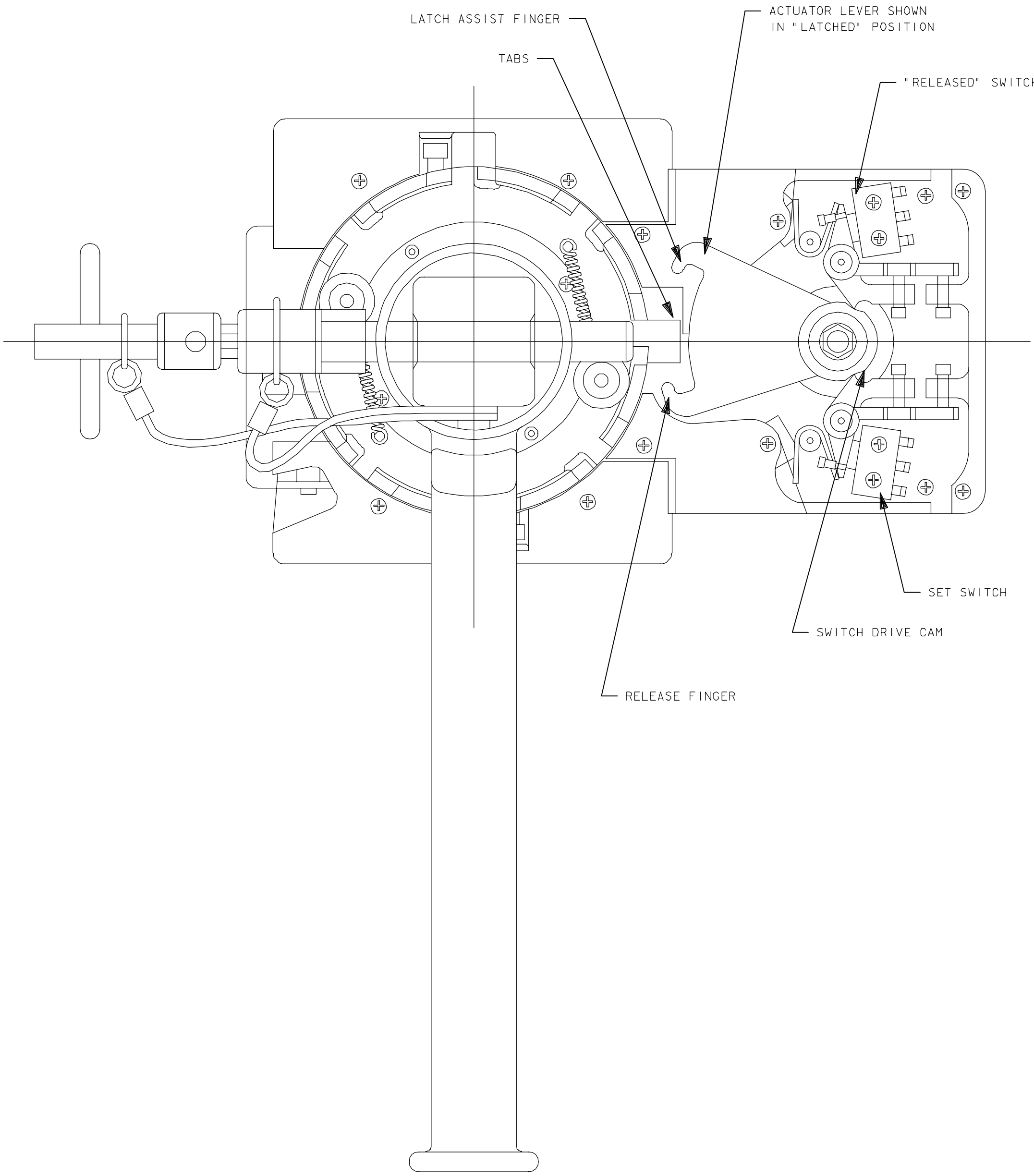


Figure 2-25. BSP actuator lever

Table 2-5. Summary of latched and released microswitch positions

Actuator lever position	Set microswitch	Released microswitch
Released	Open	Closed
Set	Closed	Open
Latch assist	Closed	Closed

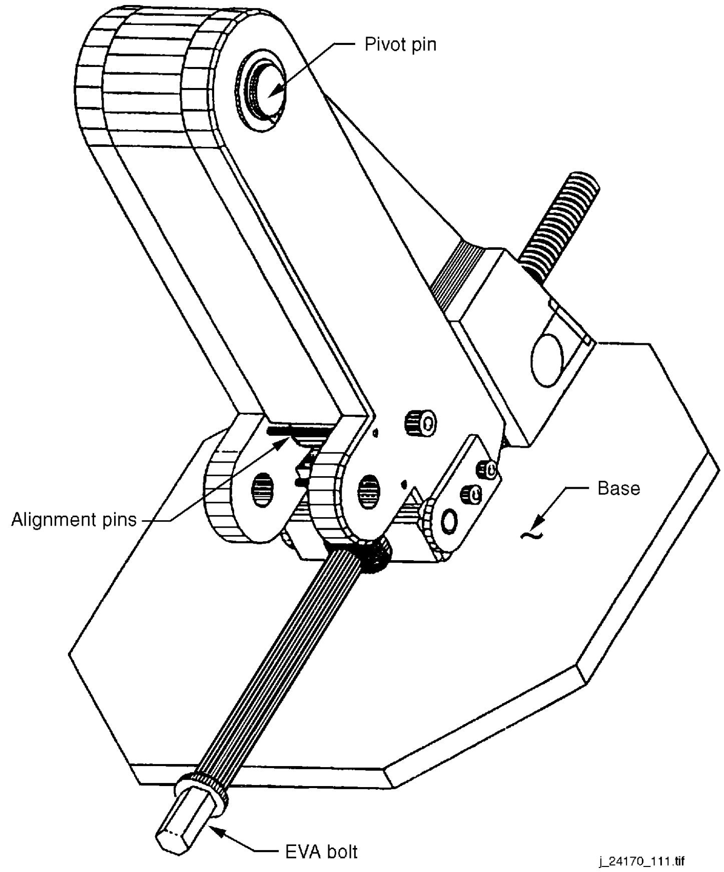


Figure 2-26. Preload release bracket

2.2 FSS ELECTRICAL POWER SUBSYSTEM

The orbiter interfaces to the FSS electrical power subsystem are shown in Drawing 1.3, and the FSS electrical power subsystem is shown in Drawings 2.4-1 and 2.4-2. The FSS provides all necessary power interfaces to electrically support the HST at retrieval and during on-orbit activities. The FSS electrical system uses redundant orbiter +28 V DC for internal power, survival heater power, and for conversion to HST external power. FSS thermostatic loads vary from 100 to approximately 400 watts with periodic peaks in the 700- to 800-watt range, depending on hardware temperatures. The FSS heaters do not normally turn on during servicing missions. See Drawing 2.1 for locations of individual components. The orbiter +28 V DC power distribution that provides power to the FSS EPDSUs is shown in Drawing 1.3 up to the payload primary bus, and the power interfaces from there to the Electrical Power Distribution System Units (EPDSUs) are shown in Drawings 2.4-1 and 2.4-2. The FSS electrical power system consists of the following subsystems:

a. Two EPDSUs

b. Port Power Conditioning Unit (PPCU) and Starboard Power Conditioning Unit (SPCU)

c. J-box

d. IPCU

2.2.1 Enhanced Power Distribution and Switching Units

Orbiter +28 V DC power distribution to the payload primary bus is shown in Drawing 1.3. The EPDSUs receive power from the payload primary bus and provide distribution, switching, current monitoring, and fault isolation of that power for the remainder of the FSS avionics. Drawings 2.4-1 and 2.4-2 show the internal components of the EPDSUs.

The modular EPDSU is specifically designed to distribute standard orbiter power to smaller gauge systems. The specific function of the EPDSU is to distribute controlled, fused power to the systems in the FSS. The EPDSU contains ten Power Control Modules, which provide downstream power. Each Power Control Module has up to three integral Solid State Power Controllers (SSPCs) that are controlled by an ON/OFF Control Logic circuit. The ON/OFF Control Logic is controlled via an SSP on Panel L12 or FMDM control. The SSP or FMDM command energizes the ON/OFF Control Logic circuit, which in turn sends a signal to the SSPC. Once activated, the SSPC allows power to pass through the Power module to downstream end items. See Table 2-7 for a list of which items in the FSS are powered by which EPDSU. The EPDSU measures the currents of the services it provides and provides the information to both FMDMs. In addition, the EPDSU contains a thermistor circuit to monitor temperatures in the avionics and electrical boxes. The EPDSU contains redundant 18 V DC regulators that provide the bias for the avionics and electrical equipment boxes thermistor circuitry. The regulator is powered from the same EPDSU circuit as the FMDM.

Table 2-6. FSS Power Services

	Side 1	Side 2
EPDSU	20 W	20 W
FMDM	30 W	30 W
AMSB	5 W	5 W
HTR A/B*	430 W / 430 W	200 W / 335 W
DPC	1920 W (6 DPC’s @ 320)	1920 W (6 DPC’s @ 320)
CCTV	25 W	--
CCTV HTR	20 W	--
TOTAL	2450 W	2175 W / 2310 W

* Primary FSS Heaters are A1 and A2, Redundant heaters are B1 and B2.

2.2.2 Power Conditioning Units

Each PCU houses six DPCs. The FSS has two units, the Starboard PCU (SPCU) and the Port PCU (PPCU). The DPCs are isolated, regulated, and current-limited power supplies. Each power supply is limited to approximately 350 watts. These isolated power supplies provide operating power to the HST during on-orbit servicing. Each DPC requires a minimum input voltage of 22 V DC to function properly. Both units are represented in Drawing 2.4-1. Each PCU measures 28- by 16- by 7.25 inches. The orbiter SM GPC (via the FMDM) or the SSP can control the DPCs. The FMDM has the capability to control individual DPCs, a function which will be utilized for the first time on SM-3B. The DPC power outputs are sent to the J-box. Total DPC power output versus current for the 12 DPC set, based on ground test data, is shown in Figure 2-27. Actual test data points are shown along with a curve-fit approximation. Also shown in Figure 2-27 is an estimated power profile of the SSE and HST for the SM-2 ground test data.

Table 2-7. FSS Power Allocation at 32V

Control	Module	Power Rating (amps)	Function
EPDSU 1			
S12 (UP)	MOD 1, s1	20	FSS 1A Heaters – PPCU A, FMDM A, EPDSU 1 A, AMSB A
S10	MOD 1, s2	15	FSS FMDM A Power
FMDM	MOD 1, s3	7	AMSB A Power
FMDM, S3, S4	MOD 2, s1	20	DPC 1 Power
FMDM	MOD 2, s2	15	FSS CCTV Power
FMDM, S3, S4	MOD 2, s3	7	DPC 1 Control Signal
FMDM, S3, S4	MOD 3, s1	20	DPC 2 Power
S8	MOD 3, s2	15	FSS CCTV Heater Power
FMDM, S3, S4	MOD 3, s3	7	DPC 2 Control Signal
FMDM, S3, S4	MOD 4, s1	20	DPC 3 Power
FMDM, S3, S4	MOD 4, s3	7	DPC 3 Control Signal
FMDM, S3, S4	MOD 5, s1	20	DPC 4 Power
FMDM, S3, S4	MOD 5, s3	7	DPC 4 Control Signal
FMDM, S3, S4	MOD 6, s1	20	DPC 5 Power
FMDM, S3, S4	MOD 6, s3	7	DPC 5 Control Signal
FMDM, S3, S4	MOD 7, s1	20	DPC 6 Power
FMDM, S3, S4	MOD 7, s3	7	DPC 6 Control Signal
S12 (DN)	MOD 10, s1	20	FSS 1B Heaters – PPCU B, FMDM B, EPDSU 1 B, AMSB B
EPDSU 2			
S12 (UP)	MOD 1, s1	20	FSS 2B Heaters – SPCU A, IPCU B, EPDSU 2 B
S10	MOD 1, s2	15	FSS FMDM B Power
FMDM	MOD 1, s3	7	AMSB B Power
FMDM, S3, S4	MOD 2, s1	20	DPC 7 Power
FMDM, S3, S4	MOD 2, s3	7	DPC 7 Control Signal
FMDM, S3, S4	MOD 3, s1	20	DPC 8 Power
FMDM, S3, S4	MOD 3, s3	7	DPC 8 Control Signal
FMDM, S3, S4	MOD 4, s1	20	DPC 9 Power
FMDM, S3, S4	MOD 4, s3	7	DPC 9 Control Signal

Table 2-7. FSS Power Allocation at 32V (concluded)

Control	Module	Power Rating (amps)	Function
EPDSU 2			
FMDM, S3, S4	MOD 5, s1	20	DPC 10 Power
FMDM, S3, S4	MOD 5, s3	7	DPC 10 Control Signal
FMDM, S3, S4	MOD 6, s1	20	DPC 11 Power
FMDM, S3, S4	MOD 6, s3	7	DPC 11 Control Signal
FMDM, S3, S4	MOD 7, s1	20	DPC 12 Power
FMDM, S3, S4	MOD 7, s3	7	DPC 12 Control Signal
S12 (DN)	MOD 10, s1	20	FSS 2A Heaters – SPCU B, IPCU A, EPDSU 2 A

Port Power Conditioning Unit

The PPCU contains DPCs 1 to 6, which derive power from EPDSU 1. Data provided to the FMDMs from the PPCU include PPCU temperature and DPC output voltage readings for each of the DPCs, however DPC input current data is provided from the EPDSU 1. PPCU heaters are powered from EPDSU 1 and are controlled as part of the FSS heaters. The PPCU is detailed in Drawing 2.4-1.

Starboard Power Conditioning Unit

The SPCU contains DPCs 7 to 12, which derive power from EPDSU 2. Data provided to the FMDMs from the SPCU include SPCU temperature and DPC voltage readings for each of the DPCs, however DPC input current data is provided from the EPDSU 2. SPCU heaters are powered from EPDSU 2 and are part of the survival heater circuitry. The SPCU is detailed in Drawing 2.4-2.

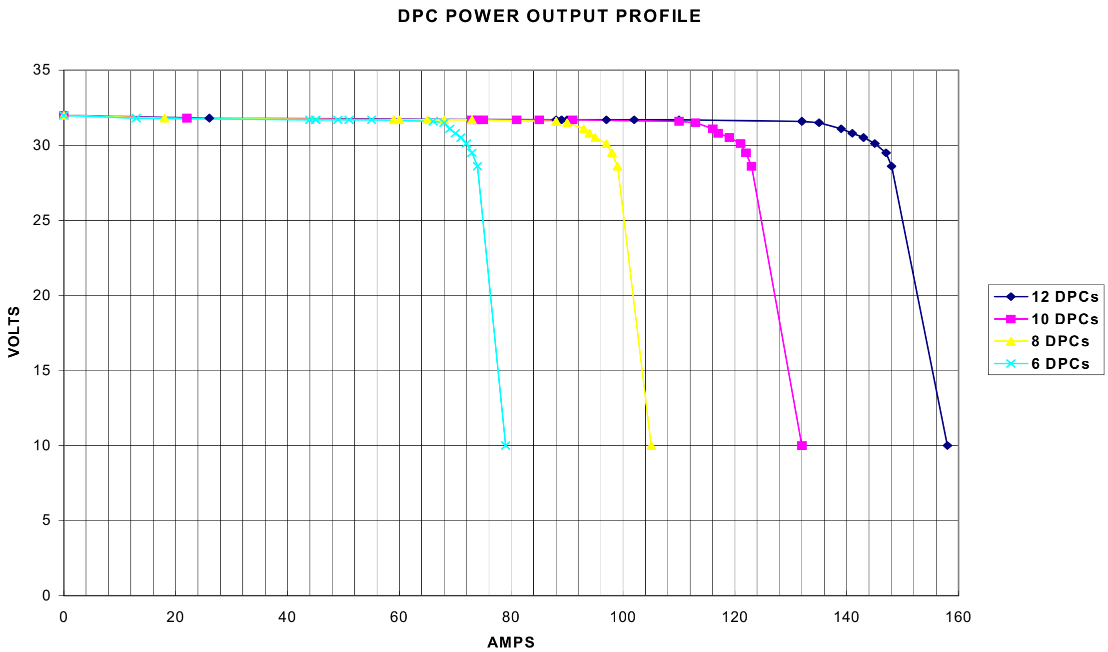


Figure 2-27. DPC power output

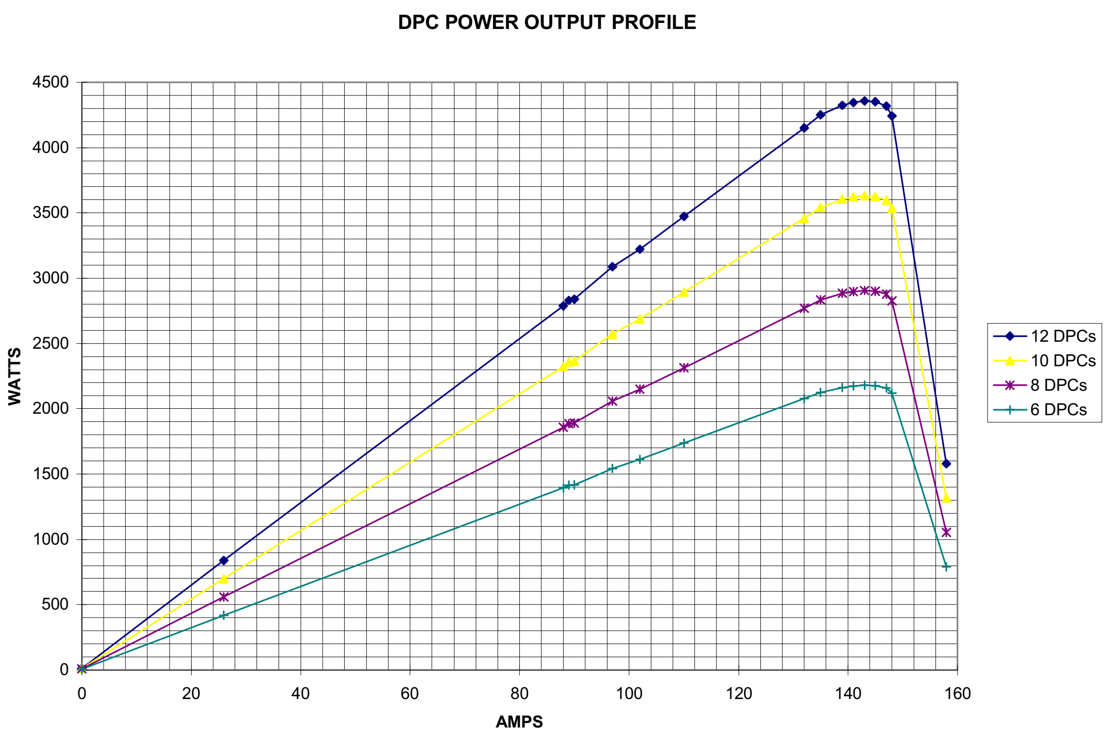


Figure 2-27. DPC power output (concluded)

2.2.3 Junction Box

The J-box buses the 34.7-V power output of each DPC and provides fuse protection for these outputs, as shown in Drawing 2.4-1. One of the fuses is connected to J-box bus A, and one of the fuses is connected to J-box bus B, thereby providing redundant circuit interfaces to each of the buses for each of the 12 DPCs. Each of the J-box buses provides 34.7-V power to the IPCU, and each bus is redundant to the other. There are no active components or telemetry points in the J-box.

The J-box has an aluminum casing with seven connector ports. Two connectors are used as inputs from the SPCU and PPCU, and one port is used as the output to the IPCU. The remaining four ports are capped and are not used for the HST SM.

2.2.4 Interface Power Control Unit

The IPCU distributes the regulated DPC power to the HST through the FSS umbilical and powers the latch indication lights used for Science Instrument (SI) installation in the HST. The orbiter SSP or the EVA HST Astronaut Control Panel (ACP) can be used to control the IPCU as detailed in Section 6. Discrete monitors are provided to verify operation and telemetry. A detailed view of the IPCU is shown in Drawing 2.5. The power provided through the IPCU is used by the HST main (SSP S17, S21), HST essential buses (SSP S13, S14), and heaters for the RSUs (SSP S16). IPCU power can also be switched to the EVA worklight receptacles (SSP S24). The FHST shutters are powered directly from the SSP switch and CAB PL3, bypassing the IPCU (SSP S15). Note that the FHST shutter SSP talkback is driven by closure of the IPCU relay and will not be available unless the IPCU is on. An overview of IPCU interfaces is shown in Drawing 2.4-1.

2.2.5 Electrical Short Circuit Protection/Grounding

The FSS is protected against short circuits and current overloads for primary +28 V power. Control power is protected by 5-amp circuit breakers on the SSP. Additionally, a 28 V PL PRI power source to the SSP via EPDSU is protected by a 2.7 K resistor in the EPDSU. AC power is protected by three-phase, 3-amp circuit breakers on the R1 panel in the orbiter. The fusing configuration in each EPDSU is shown in Drawing 2.4-1 and 2.4-2.

The FSS is retained in the cargo bay by two passive trunnion fittings and an active keel fitting. The fittings are isolated from the orbiter structure by design (ICD-A-14009 SM, par. 10.7.4.2.2.2). The FSS structure is grounded to the orbiter via two 1/0 AWG wires at the SIPs through the EPDSU. The FSS power will be grounded to the orbiter via the power return (1/0 AWG wire).

2.2.6 FSS Power Interfaces

The power for all FSS components, except mechanism motors, is routed through the EPDSU1 and EPDSU2. Control of the EPDSU1 and EPDSU2 is accomplished via the FMDMs for AMSB selection, DPC control, and CCTV. Control of the EPDSUs for FMDM power, FSS, and CCTV heaters is achieved by switch action on the SSP. AMSB power control is enabled by correct AMSB selection and orbiter power controlled by panel A6U. The AMSB is addressed in detail in Section 2.3.2.

Refer to Table 2-7 for the specific functions powered by each FSS EPDSU. The shuttle and HST power interfaces to the FSS are overviewed in Drawing 1.4.

2.3 FSS AVIONICS

The FSS avionics provide command, data monitoring, and video interfaces to support HST servicing activities. The avionics consist of two Flexible Multiplexer/Demultiplexers (FMDM), the Advanced Mechanism Select Box (AMSB), and the Closed Circuit Television (CCTV) camera. The location of the avionic components on the FSS are shown in Drawing 2.1. The avionics receive PL PRI power from the FSS EPDSUs. The SSP and the A6U retention panel are also used to control FSS operations and monitor discrete feedbacks. These panels are discussed in section 6.

2.3.1 Flexible Multiplexer/Demultiplexer

The FMDMs are the principal components of the command and data handling system of the FSS, providing a command and telemetry interface between the SM GPC and FSS subsystems. There are two FMDMs mounted to the FSS cradle, FMDM-A and FMDM-B. Each FMDM is housed in a 13.5 by 6.5 by 7.25-inch box that weighs 20 pounds. Power dissipation is approximately 28 watts.

Each FMDM is roughly equivalent in capability to half an orbiter Multiplexer/Demultiplexer (MDM) and both are identically channeled. Telemetry parameters from FSS sensors or relay status discretes are routed to the FMDMs for onboard processing and downlink. The FMDM receives these telemetry parameters in the form of bilevel discrete and/or ±5 V analog signals. The FMDM then converts and formats the data into serial digital words and transmits the words to the SM GPC when polled for onboard display or downlink. Commands can be prestored in GPC memory and issued by item entry, or uplinked from the ground. The SM GPC will send the commands serially to the FMDM. The FMDM accepts these serial command words from the GPC and converts them to discrete outputs to the FSS end items. FSS command and telemetry interfaces are summarized in Drawings 2.4-1 and 2.4-2. The flight specific Input/Output Module (IOM) configuration for the FSS FMDMS is listed in Table 2-8 and the channelization in Table 2-9. A detailed systems brief of a FMDM is provided in Appendix A.

Table 2-8. FSS IOM configuration

IOM	Type	Usage
0	AID	Temp, Current, Voltage, Tach measurements
1	AID	Temp, Current, Voltage, Tach measurements
2	AID	Temp, Current, Voltage, Tach measurements
3	DOH	AMSB, CCTV, and DPC commands
4	DIH	DPC, IPCU, BSP, BOT/EOT statuses
5	POH	Not used
6	POH	Not used
7	DIH	Mech Select and DPC status

Table 2-9. FSS FMDM channelization

	AID CARD 00		AID CARD 01		AID CARD 02	
CH	**MSID**	**NOMENCLATURE**	**MSID**	**NOMENCLATURE**	**MSID**	**NOMENCLATURE**
0-6						
7	P34V1035V	EXT ESS BUS VOLTAGE				
8	P34T2003V	AMSB TEMP	P34C2026V	HTR 1A CURRENT	P34C2022V	FMDM B CURRENT
9					P34V2040V	EPDSU-1 BUS VOLTAGE
10	P34V1009V	EXT MAIN BUS VOLTAGE	P34T2004V	EPDSU-1 TEMP	P34C2025V	AMSB DC CURRENT
11			P34C2008V	DPC 1 CURRENT	P34C2010V	DPC 3 CURRENT
12			P34C2009V	DPC 2 CURRENT	P34C2011V	DPC 4 CURRENT
13	P34C2027V	HTR 2A CURRENT	P34C2014V	DPC 7 CURRENT	P34C2012V	DPC 5 CURRENT
14			P34C2015V	DPC 8 CURRENT	P34C2013V	DPC 6 CURRENT
15	P34C2024V	HTR 1B CURRENT	P34C2095V	CCTV HTR CURRENT	P34V2041V	EPDSU-2 VOLTAGE
16						
17					P34T2117V	STRUCTURE A TEMP
18			P34V1027V	MAIN BUS VOLTAGE		
19			P34V1026V	INT ESS BUS VOLTAGE	P34T2118V	STRUCTURE B TEMP
20	P34R2108V	PIVOTER TACH	P34R2109V	ROTATOR TACH	P34R2110V	TRANSLATOR TACH
21	P34C2111V	AMSB AC CURRENT	P34C2114V	HTR EB CURRENT		
22			P34C2115V	FMDM A CURRENT		
23	P34C2113V	EPDSU-1 TOTAL AMPS	P34C2116V	EPDSU-2 TOTAL AMPS		
24	P34C2001V	FMDM A TEMP	P34V2028V	DPC 1 VOLTAGE	P34V2034V	DPC 7 VOLTAGE
25	P34C2002V	FMDM B TEMP	P34V2029V	DPC 2 VOLTAGE	P34V2035V	DPC 8 VOLTAGE
26			P34V2030V	DPC 3 VOLTAGE	P34V2036V	DPC 9 VOLTAGE
27			P34V2031V	DPC 4 VOLTAGE	P34V2037V	DPC 10 VOLTAGE
28	P34C2016V	DPC 9 CURRENT	P34V2032V	DPC 5 VOLTAGE	P34V2038V	DPC 11 VOLTAGE
29	P34C2017V	DPC 10 CURRENT	P34V2033V	DPC 6 VOLTAGE	P34V2039V	DPC 12 VOLTAGE
30	P34C2018V	DPC 11 CURRENT	P34T2005V	PPCU TEMP	P34T2006V	SPCU TEMP
31	P34C2019V	DPC 12 CURRENT	P34V2007V	EPDSU-2 TEMP	P34T2093V	IPCU TEMP

Table 2-9. FSS FMDM channelization (continued)

	DOH CARD 03 CH 01		DOH CARD 03 CH 02	
CH	MSID	NOMENCLATURE	MSID	NOMENCLATURE
0	P34K4001U	KEEL LATCH JAW 1 SELECT *	P34K4041J	FSS CCTV ON CNTR (OFF-4042)
1	P34K4002U	KEEL LATCH JAW 2 SELECT *	P34K4050J	DPC 4 ON CNTRL (OFF-4051) **
2	P34K4003J	PIVOTER LOW TORQUE SELECT *	P34K4052J	DPC 5 ON CNTRL (OFF-4053) **
3	P34K4004J	PIVOTER SELECT *	P34K4054J	DPC 6 ON CNTRL (OFF-4055) **
4	P34K4005J	ROTATOR SELECT *	P34K4056J	DPC 2 ON CNTRL (OFF-4057) **
5	P34K4006J	TRANSLATOR SELECT *	P34K4058J	DPC 10 ON CNTRL (OFF-4059) **
6	P34K4007J	DOWNLOCK SELECT *	P34K4060J	DPC 11 ON CNTRL (OFF-4061) **
7	P34K4008J	BERTH LATCH 1 SELECT *	P34K4062J	DPC 12 ON CNTRL (OFF-4063) **
8	P34K4009J	BERTH LATCH 2 SELECT *	P34K4064J	DPC 8 ON CNTRL (OFF-4065) **
9	P34K4010J	BERTH LATCH 3 SELECT *	P34K4017J	AMSB ON CNTL (OFF-4020)
10	P34K4011J	MAIN UMBILICAL SELECT *	P34K4039J	CCTV PWR ENABLE 2 (DSBL-4040)
11	P34K4012J	B/U UMBILICAL SELECT *	P34K4039J	CCTV PWR ENABLE 1 (DSBL-4040)
12	P34K4013J	BSP SELECT *	P34K4042J	DPC 3 ON CNTRL (OFF-4025) **
13			P34K4026J	DPC 1 ON CNTRL (OFF-4027) **
14	P34K4015J	AMSB EOT/BOT OVERRIDE ENBL	P34K4028J	DPC 9 ON CNTRL (OFF-4029) **
15			P34K4030J	DPC 7 ON CNTRL (OFF-4031) **

* AMSB DESELECT (P34K4018J) will disable all AMSB mechanisms and the override

** PCU ON/OFF (P34K4032J/P34K4033J) will power on/off all 12 DPCs

Table 2-9. FSS FMDM channelization (continued)

	DIH CARD 04 CH 00		DIH CARD 04 CH 01		DIH CARD 04 CH 02	
CH	**MSID**	**NOMENCLATURE**	**MSID**	**NOMENCLATURE**	**MSID**	**NOMENCLATURE**
0	P34X2098Y	FHST SHUTTER CL STAT	P34X2073Y	FSS ALT FMDM STAT	P34X2102Y	BSP RET B STAT
1	P34X2099Y	RSU SURV HTRS STAT	P34X2119Y	DPC 4 ON/OFF STAT	P34X2103Y	BSP ENG B STAT
2	P34X2100Y	AFT WRKLT PWR-1 STAT	P34X2120Y	DPC 6 ON/OFF STAT	P34X2104Y	BSP DISENG B STAT
3	P34X2101Y	AFT WRKLT PWR-2 STAT	P34X2076Y	AMSB A PWR STAT		
4			P34X2077Y	AMSB B PWR STAT	P34X2105Y	BSP RET A STAT
5			P34X2049Y	DPC 3 ON/OFF STAT	P34X2106Y	BSP ENG A STAT
6			P34X2050Y	DPC 5 ON/OFF STAT	P34X2107Y	BSP DISENG A STAT
7			P34X2047Y	DPC 1 ON/OFF STAT		
8			P34X2048Y	DPC 2 ON/OFF STAT	P34X2087Y	AMSB PRI LAT STAT
9			P34X2082Y	FSS HTR-1 PWR STAT	P34X2088Y	AMSB SEC LAT STAT
10					P34X2089Y	AMSB PRI REL STAT
11			P34X2096Y	FSS CCTV PWR-1 STAT	P34X2090Y	AMSB SEC REL STAT
12			P34X2097Y	FSS CCTV PWR-S STAT	P34X2091Y	AMSB PRI RTL STAT
13			P34X2083Y	FSS HTR-2 PWR STAT	P34X2092Y	AMSB SEC RTL STAT
14						
15						
	DIH CARD 07 CH 00		**DIH CARD 07 CH 01**		**DIH CARD 07 CH 02**	
CH	**MSID**	**NOMENCLATURE**	**MSID**	**NOMENCLATURE**	**MSID**	**NOMENCLATURE**
0			P34X2058Y	KEEL LATCH JAW 1 STAT		
1			P34X2059Y	KEEL LATCH JAW 2 STAT		
2			P34X2060Y	PIV LOW TORQUE STAT		
3			P34X2061Y	PIVOTER SEL STAT		
4			P34X2062Y	ROTATOR SEL STAT		
5			P34X2063Y	TRANSLATOR SEL STAT		
6			P34X2064Y	DOWNLOCK SEL STAT		

Table 2-9. FSS FMDM channelization (concluded)

	DIH CARD 07 CH 00		DIH CARD 07 CH 01		DIH CARD 07 CH 02	
CH	**MSID**	**NOMENCLATURE**	**MSID**	**NOMENCLATURE**	**MSID**	**NOMENCLATURE**
7			P34X2065Y	B LATCH 1 SEL STAT		
8			P34X2066Y	B LATCH 2 SEL STAT		
9			P34X2067Y	B LATCH 3 SEL STAT		
10			P34X2068Y	MAIN UMB SEL STAT	P34X2121Y	DPC 10 ON/OFF STAT
11			P34X2069Y	B/U UMB SEL STAT	P34X2122Y	DPC 12 ON/OFF STAT
12			P34X2070Y	BSP SEL STAT	P34X2053Y	DPC 9 ON/OFF STAT
13					P34X2054Y	DPC 11 ON/OFF STAT
14			P34X2072Y	AMSB EOT/BOT O/R STAT	P34X2051Y	DPC 7 ON/OFF STAT
15					P34X2052Y	DPC 8 ON/OFF STAT

The FMDMs interface to the orbiter SM GPC is via the orbiter payload data bus through Data Bus Couplers (DBCs). FSS FMDM-A interfaces to the orbiter SM GPC via the PL 2 data bus and FMDM-B via the PL 1 data bus, as shown in Figure 2-28. As far as the SM GPC is concerned, there is only one FMDM. When the payload data buses are in primary ports, the SM GPC will talk to the FMDM that is on data bus PL 1 (FMDM B). When the crew port modes to secondary ports, the SM GPC will talk to the FMDM that is on data bus PL 2 (FMDM A). Therefore, in order to select which FMDM is active, the crew selects primary ports on the PL data buses for FMDM B and secondary ports for FMDM A. Port moding between the two FMDMs is accomplished by using the orbiter SM GPC DPS UTIL crew display (SPEC 1). Nominally, FMDM-A will be used exclusively for all operations (with the exception of SSE Activation and the AMSB-B checkout). Should a failure occur within FMDM-A or on side A of the AMSB, the alternate FMDM will be selected.

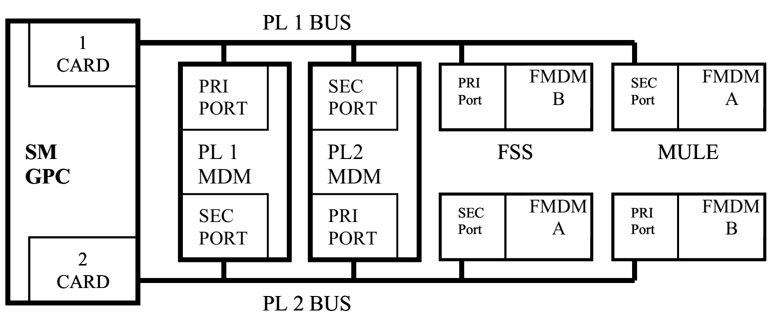


Figure 2-28. Payload data buses

For SM3B the SSE avionics complement includes two pair of FMDMs, two on the FSS (address 29) and two on the MULE (address 30). There is no MULE safety critical telemetry. For this reason, in the event of a payload data bus failure, the FSS telemetry will take precedence over the MULE telemetry during attached operations or while the FSS is not stowed for landing. Port moding will take place to manage this situation. See Section 3.3.3 for more information on the MULE FMDMs.

Orbiter DC power is supplied to each FMDM through the EPDSUs. Two dedicated switches on the SSP are used to open or close the power controllers in the EPDSU that power the FMDMs. Both FMDMs require a minimum input voltage of 24 V DC to remain on and properly function. FMDM input voltage can be monitored via the EPDSU bus voltage indications. Each FMDM controls and monitors a dedicated half of the AMSB with no cross strapping between the two sides.

Nominally, power is applied to the FMDM B prior to FSS heater activation, which occurs no less than 2 hours after PLBD opening, meeting the Flight Rule constraint of 8 hours. At powerup, or following a power transient, all outputs of the FMDM are automatically reset to zero. The FMDM contains energy storage capacitors capable of maintaining power within the FMDM for a period of 2 milliseconds.

The FSS FMDMs control power to the PPCU, SPCU, AMSB, and CCTV. They also redundantly receive status and data from both sides of the AMSB (A and B), CCTV, both EPDSUs, PPCU, and SPCU. The FSS receives data on the HST only indirectly via the status of IPCU activities, with the exception of the HST bus voltages, which are routed directly through the umbilical. With the addition of the second EPDSU for this flight, FSS heater current telemetry is redundant. A problem with the heater current telemetry was found in testing and it was determined that the currents were wired to the incorrect cards on the FSS FMDMs. The result is that the 1B current is read using the 2B MSID, the 2B current is read with the 2A MSID, and the 2A current is read with the 1B MSID. All crew procedures have been corrected so that there will be no impact to flight. There is only one telemetry parameter generated by each FMDM; the FMDM temperature. Each FMDM thermistor receives power from the power supply of the FMDM; therefore, the temperature data for an FMDM is valid only if the FMDM is powered on. The temperature reads $\leq$ -55° for an unpowered FMDM.

2.3.2 Advanced Mechanism Selection Box

The AMSB provides for the selection of 10 FSS mechanisms for operation. The CDUs are the principal means of physical movement of the FSS. The CDU mechanical operation is discussed in detail previously in Section 2.

The AMSB functionally replaces the previously used Mechanism Selection Box, but uniquely adds the AC current sensor and tachometer services.

The AMSB is controlled by the A6U panel and the SM GPC. The AMSB contains latching relays that are used to select which of the 10 FSS mechanisms are to be driven. Table 2-10 gives information on the energy usage of each mechanism.

The AMSB has an A (primary) and B (secondary) side, each of which controls one of the two independent motors for each mechanism. Each side of the AMSB is controlled by one of the two FMDMs, with FMDM-A controlling the A side and FMDM-B controlling the B side. When a mechanism is selected, the FMDM sends a command to the primary or secondary side of the AMSB to drive a relay that makes a path for the AC current to reach the motor. AC current does not flow to the motor until the PAYLOAD RETEN LAT switch is taken to either RELEASE or LATCH. This command will keep the relay closed until either the command is reset or the FMDM is turned off.

For nominal operations, only one side of the AMSB is used. It is possible, however, to select a mechanism by using one FMDM, and then select that same mechanism, using the other FMDM. This allows the use of both the A and the B motors to drive a mechanism in a contingency or time-critical situation. It should be noted that the FMDM provides data only on the AMSB current for the side which it controls. The selection of a mechanism initiates a reset/set command that causes any previously selected mechanism only on that side of the AMSB to be deselected before executing the select command for the desired mechanism.

Table 2-10. FSS AC energy usage summary (see Annex 2 Part 1)

Mechanism	CDU type	Nominal power (W)	Peak power (W)
Pivoter (low torque)	Dual torque	41.6	45.6
Rotator (low torque)	Dual torque	41.6	45.6
Translator	Small CDU	41.6	45.6
Launch/landing downlock	Large CDU	207	249
Berthing latch	Large CDU	207	249
Main umbilical (P101)	Small CDU	41.6	45.6
Backup umbilical (J107/J108)	Small CDU	41.6	45.6
BSP latch	Small CDU	41.6	45.6

Drawing 2.6 shows how the AMSB is wired into the FSS mechanisms. There are BOT and EOT indications for each mechanism that cut off power to the mechanism before it hits the hardstop. They are displayed on the A6U panel. Each A and B side of the mechanism share the BOT/EOT mechanical plunger, but each side contains its own microswitch electronics subassembly circuits. Should a mechanical failure occur within the microswitch, it would affect both AMSB A and B for the mechanism. If, however, one side of the mechanism (A/B) experiences a failure in its microswitch electronics, the alternate side (B/A) would be unaffected. It is possible for the BOT/EOT limits to be overridden via command from the FMDMs (SPEC 212), if required. Issuing the override command opens a relay, preventing the BOT/EOT status from reaching the MCA control logic.

2.3.3 FSS CCTV Camera

The command, power, and data overview for the FSS CCTV camera is shown in Drawing 2.4-1. The camera is mounted on the movable portion of the FSS BAPS, as shown in Drawing 2.2, at a radius of 21.54 inches from the spacecraft centerline (berthed) located at X_0 of 1147.2 inches. The camera is JSC supplied; however, it is an older version of the orbiter CCTV cameras. The camera will be used as an HST berthing aid, but is not considered mandatory for berthing.

The FSS CCTV camera field of view with the prism attached is 13.8°. The prism clips the standard CCTV camera field of view, which is approximately 30°. This 13.8° span produces approximately a 9.5-inch-square view of the HST berthing target when berthed.

Power to the CCTV heaters is accomplished via switch S8 on SSP 1A, and 28 V camera power is supplied from PL PRI by FMDM command from SM SPEC 211 (ITEM 3 EXEC). Once 28 V power is supplied, the camera is powered on and enters a standby mode. At this point the camera iris is closed, but overtemp data can be received via the Video Control Unit (VCU) and SPEC 76 if the camera is selected on panel A7. Camera power on/off logic is commanded by SM SPEC 211 (ITEM 5 EXEC). The camera will operate if both the 28 V power and the CCTV ON command are received.

A simplified block diagram of the CCTV camera is shown in Figure 2-29.

2.3.4 FSS Internal Command and Data Interfaces

Drawings 2.4-1 and 2.4-2 detail the FSS command and data interfaces, and Drawing 2.6 expands on AMSB control and data interfaces.

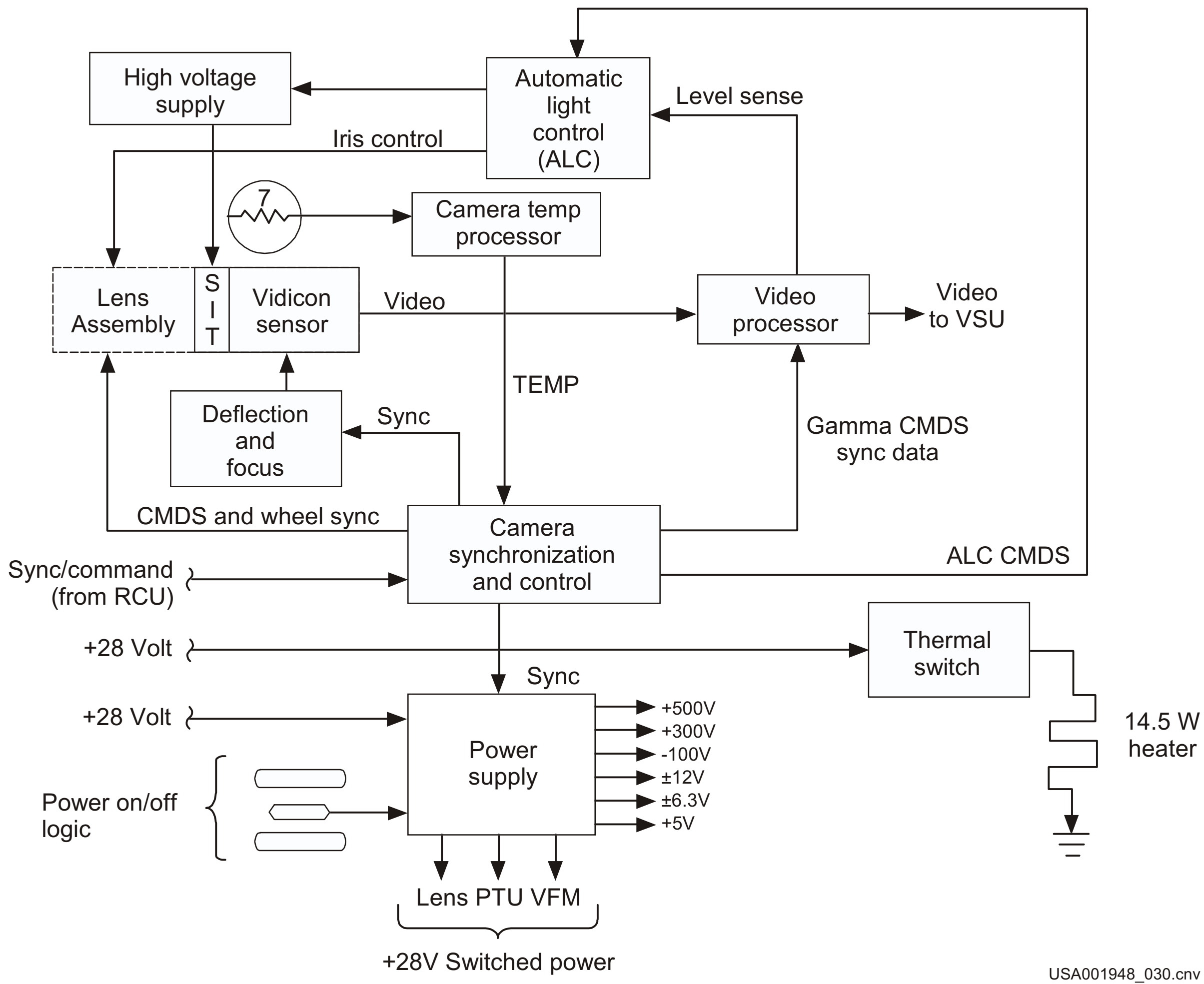


Figure 2-29. FSS CCTV camera functional block diagram

2.4 FSS THERMAL CONTROL

The FSS thermal control system provides temperature control of the FSS structure, mechanisms, avionics, and electrical equipment. The thermal design is based on passive control under worst-case hot environmental conditions, with minimal heater power required during worst-case cold conditions. The thermal analysis for the SSE is summarized in OSC memorandum 01-HEK-7023, "HST SM3B: SSE Thermal Design Analysis Summary."

Hubble servicing typically is conducted in a -ZLV, Bay-to-Earth attitude. The combination of passive and active thermal systems that allows the FSS components to remain within the temperature limits presented in Table 2-11 are as follows:

- Component: Specific payload hardware integrated into the FSS for SM-3B
- Yellow (Warning) Limit: Temperature signaling a need for close monitoring and/or corrective action
- Red (Critical) Limit: Temperature that must not be exceeded
- Transport/EVA Limit: Temperature range required before removing any stowed item from stowage compartment during an EVA; for CAT (crew aids and tools) and their stowage assemblies, it is the temperature the component must be to function during EVA

The majority of FSS avionics dissipate heat while powered on. Table 2-12 shows the nominal dissipation for each box.

Table 2-11. FSS Component temperature limits

Component**	Yellow (Warning) Limit (°C)		Red (Critical) Limit (°C)		Transport / EVA Limit (°C)
	Low	High	Low	High	n/a
SPCU*	-22	+53	-32	+63	n/a
PPCU*	-22	+53	-32	+63	n/a
IPCU*	-33	+50	-43	+60	n/a
EPDSU-2*	-20	+50	-30	+60	n/a
EPDSU-1*	-20	+50	-30	+60	n/a
AMSB*	-22	+51	-32	+61	n/a
FMDM A & B*	-3	+50	-13	+60	n/a
CCTV	0	+50	-10	+60	n/a
CDU motor housings	-60	+110	-70	+120	n/a

* Components with flight temperature sensors.

** Temperatures for all items that do not have flight temperature sensors can be determined analytically via the environment temperature sensor records and the models. SSE Thermal (GFSC) can compare monitored components to our analysis temperature predictions to create a "scale factor" which we can then use to adjust the temperature predictions of un-monitored components and determine their flight temperatures.

Table 2-12. FSS avionics nominal dissipation

Avionics Box	Nominal Dissipation (W) With HST	Nominal Dissipation (W) W/O HST
SPCU	150	0
PPCU	150	0
IPCU	14.0	0
EPDSU-1	62.12	36
EPDSU-2	62.12	36
FMDM A or B	26.6	26.6
AMSB	0	0
CCTV	--	--

2.4.1 Active Thermal Control System

The FSS active thermal control system is enabled via the FSS heater switch on the orbiter SSP. This switch extends power to the heaters on the FMDM radiator plate, AMSB, EPDSU-1, EPDSU-2, CCTV, IPCU, PPCU, and SPCU. The heaters are equipped with redundant parallel thermostats in series and redundant (A and B side) heaters that are sized to maintain the equipment within operational temperatures. Redundancy protects against both failed-on and failed-off heater conditions as well as a single bus failure. An average heater power of up to 220 watts can be required to maintain the avionics boxes above the minimum temperatures specified for each electronics box. Constraints for on-orbit attitude excursions will be implemented to ensure that the FSS structure is not subjected to thermal environments outside acceptable limits.

The following temperature parameters are available for display on the ground: AMSB, FSS Structure, FMDM A, FMDM B, SPCU, IPCU, PPCU, EPDSU-1, and EPDSU-2. The FMDM EPDSU temperature sensors measure temperatures between -55° and +124° C. The remaining temperature sensors measure temperatures between -30° and +60° C. See Table 2-13 for FSS heater characteristics.

Table 2-13. FSS heater characteristics

Heater location	Heater circuit parameters				Nom. control range (°C)	Ducer limits (*C)
	A side		B side			
	Resistance Ω	Power at 29 V (watts)	Resistance Ω	Power at 29 V (watts)		
HTR-1						
PPCU-1	7.3	115.2	7.3	115.2	-20/-10	-30/60
PPCU-2	13.3	63.2	13.3	63.2	-20/-10	-30/60
EPDSU 1	13.9	60.5	13.9	60.5	-20/-10	-55/124
FMDM	8.6	97.8	8.6	97.8	-3/+7	-55/124
AMSB	50.1	16.8	50.1	16.8	-20/-10	-30/60
HTR-2						
SPCU-1	6.9	121.9	12.9	65.2	-20/-10	-30/60
SPCU-2	12.2	68.9	n/a	--	-20/-10	-30/60
EPDSU 2	13.9	60.5	13.9	60.5	-20/-10	-55/124
IPCU	26.7	31.5	26.7	31.5	-36/-30	-30/60
CCTV	30.2	27.9	30.2	27.9	0.0/10.0	N/A

2.4.2 Passive Thermal Control System

The FSS structure is covered primarily with MLI blankets with an aluminized Kapton outer layer. The MLI blankets are redundantly grounded to the FSS structure.

The thermal blankets are made up of aluminized Kapton and Dacron mesh. The Kapton is coated with aluminum no thicker than 700 angstroms per side. The Dacron mesh used has a minimum weight of 0.44 ounces per square yard.

There are three types of blankets used for the FSS, as shown in Figure 2-30. Type A is used for the structural blankets, umbilical actuators, trunnion boxes, and FMDM. Type B is used for the BAPS ring. Type C is used in the balance of the blanket locations.

The blankets are grounded by interweaving a 0.5-inch by 0.001-inch aluminum strip between the blanket layers at an edge. The blanket and aluminum strip are then compressed together with a brass rivet. A no. 22 Teflon-coated wire is soldered to the rivet and then attached to a spacecraft ground. There are two grounds per blanket.

The thermal blankets are attached to the FSS with a rivnut, fiberglass washer, and screw. Where it is not possible to use rivnuts (such as the BAPS), a fiberglass button and snap-ring are used. If it is not possible to use either of these two methods, the blankets are attached with Velcro strips.

Passive radiators maintain the avionics boxes to a maximum temperature of 122° F (50° C) during warm nominal mission attitudes.

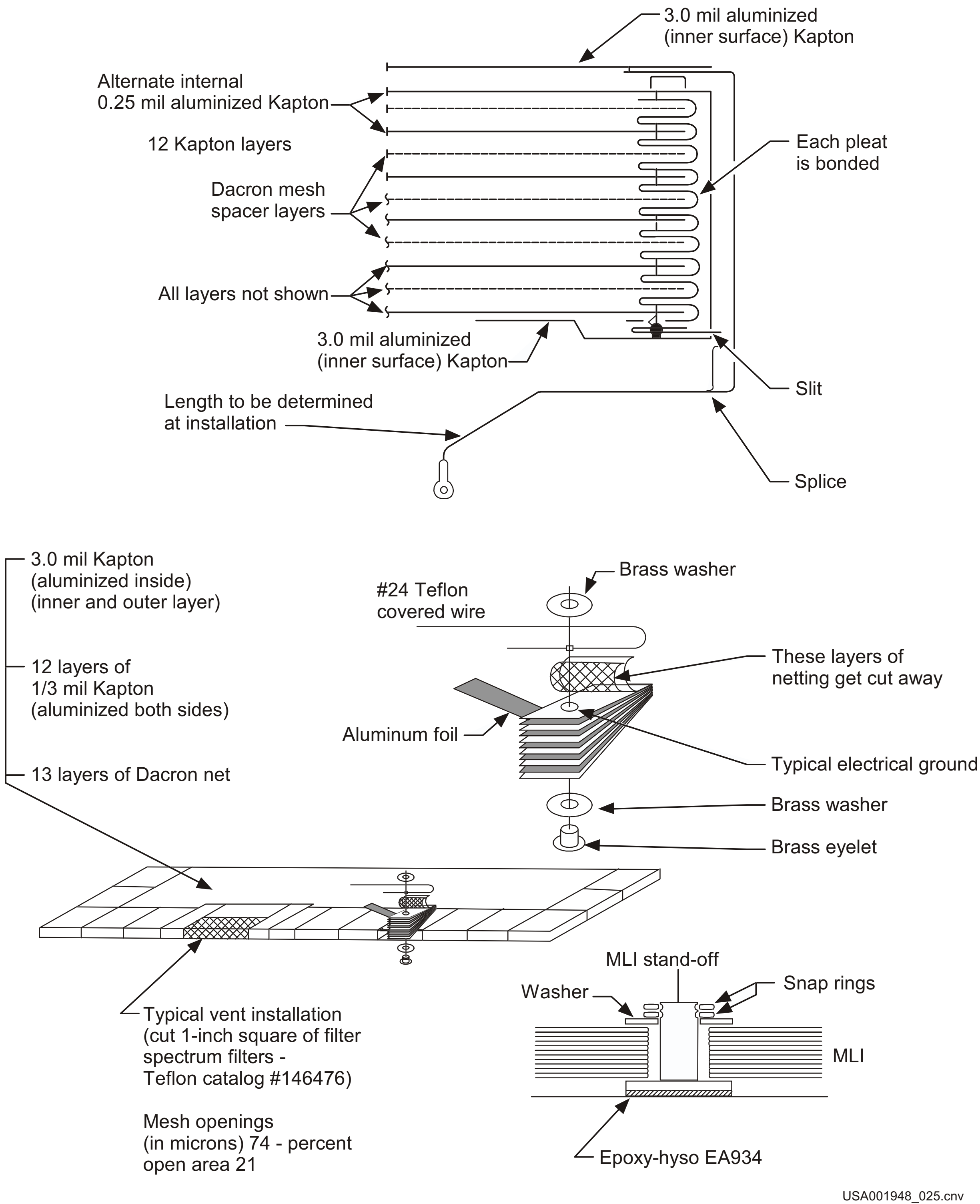


Figure 2-30. FSS blankets

All SPCU and PPCU box surfaces are used as radiators except for connector areas. The IPCU is covered with the MLI blanket except for one radiator surface. Both EPDSUs have radiator surfaces on three sides. The EPDSU located on the latch-beam has an additional forward facing radiator connected via the mounting plate. The FMDMs are covered with MLI blankets, but are also hard mounted to a radiator plate located on the latch-beam. The AMSB and the J-box are covered with MLI blankets and have no radiators since they dissipate negligible power. The BAPS structure and mechanisms are blanketed with MLI except for active mechanism areas.

With the exception of the FMDM radiator plate, all avionics are conductively coupled to the FSS structure. The FMDM radiator plate is conductively isolated from the latch-beam via G10 washers. Table 2-14 lists the FSS thermal surface properties.

Table 2-14. FSS thermal surface properties

Component	Coating	α	ε
SPCU and PPCU Radiators	White Paint, Chemglaze A276	0.26	0.87
EPDSU-1 Forward Radiator	White Paint, Chemglaze A276	0.29	0.86
	Silver Teflon Tape	0.14	0.76
EPDSU-2 Chassis Radiator	White Paint, Chemglaze A276	0.29	0.86
	Silver Teflon Tape	0.14	0.76
FMDM Radiator Plate	White Paint	0.26	0.87
Avionics Soft Covers	MLI (3 mil KAPTON outer layer)	0.45	0.78
BAPS Support Post	Blue Paint	0.60	0.87
Cradle Radiator	White Paint, Chemglaze A276	0.26	0.87
Cradle and Latch Beam	MLI (3 mil KAPTON outer layer)	0.45	0.78
FSS Radiator	White Paint, Chemglaze A276	0.26	0.87
Mechanisms Soft Covers	MLI (3 mil KAPTON outer layer)	0.45	0.78

2.5 FSS VISUAL AIDS

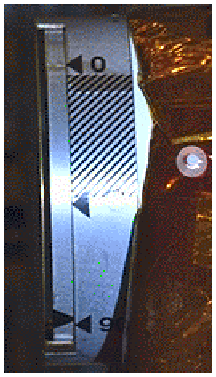
FSS visual aids/targets have been developed to provide the crew with a method of positioning the FSS and HST during both nominal and contingency operations. The targets are designed to be used in conjunction with orbiter SM GPC displays and the SSP indicators.

FSS mechanism operations are addressed in detail in Section 2.1.2

2.5.1 BAPS Pivoter Visual Aids

There are three BAPS pivoter visual aid targets mounted on the port side of the BAPS adapter arm that assist in determining the angular position of the BAPS pivoter. A rotating protractor dial with 10° incremental markings is mounted against the journal bearing of the BAPS pivoter and another dial that can be seen when facing forward and from aft (Figure 2-31).

The FSS BAPS pivoter forward and aft mounted targets include hash mark indications between the 10° and 45° ranges that would be used in a rapid safing contingency situation. An indication within the hash mark region is required to ensure that the BAPS pivoter is in a safe position to allow for PLBD closure. The minimum required pivot angle is dependent on the position of the berthing latches and can be optimized by correct FSS rotator positioning.



BAPS pivoter target view from aft

BAPS pivoter target view from port side

BAPS pivoter target view from forward

Figure 2-31. Targets on the port side of the BAPS pivoter

The FSS BAPS pivoter 0° target plane reference is parallel to the orbiter Z-axis. This position is also referred to as the launch/landing position. This target is used to verify the position of the BAPS during launch and landing preparations.

The FSS BAPS pivoter 90° target plane reference is parallel to the orbiter X-Y plane. This position is also known as the berthing position. This target is used to verify the position of the BAPS during HST berthing and deployment activities.

2.5.2 BAPS Rotator Visual Aids

There are multiple visual aids on the BAPS platform to indicate the BAPS rotator position. The targets are viewed with the BAPS platform pivoted to the berthing position (90°). The BAPS rotator fixed visual target is attached in front of the BAPS rotator hard stop located at the forward edge of the BAPS platform's fixed outer ring at the 180° position. The fixed visual target is the target without a label in Figure 2-32. All the rotating targets are mounted around the movable BAPS platform, with the exception of the B or berthing target, which is mounted against the UDM. The targets on the BAPS platform's rotating inner ring that align with the fixed visual target are shown in Table 2-15 and graphically in Figure 2-32. Two additional targets that are used to align the BAPS rotator are the HST 0° and HST 330°. The visual indications of these positions are on the HST observatory body. The alignment of these indicators with the fixed target produce the desired rotator position.

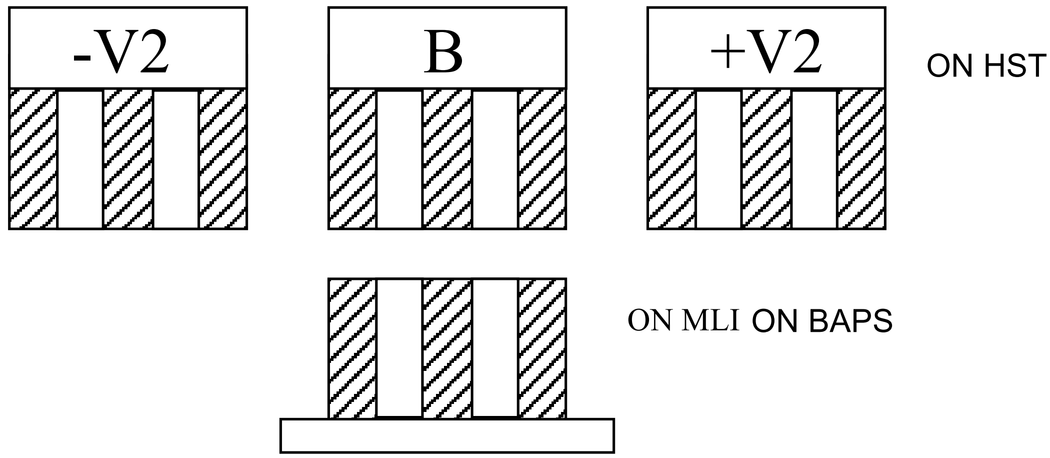


Figure 2-32. BAPS platform visual reference targets

Table 2-15. BAPS platform target locations

BAPS targets	Rotational location from fixed visual target, deg (180° reference)	HST position (FWD)
-V2	90	- V2
B	180	- V3
Fixed visual target	180	- V3
+V2	270	+ V2

2.5.3 BAPS Berthing Latches

The BAPS platform has three active capture berthing latches mounted on the perimeter of the inner ring, equally spaced in a three-point Y design (120^{o} apart). Figure 2-33 shows the BAPS platform rotated to the berthing position, and Figure 2-33 also shows the location of the berthing latches.

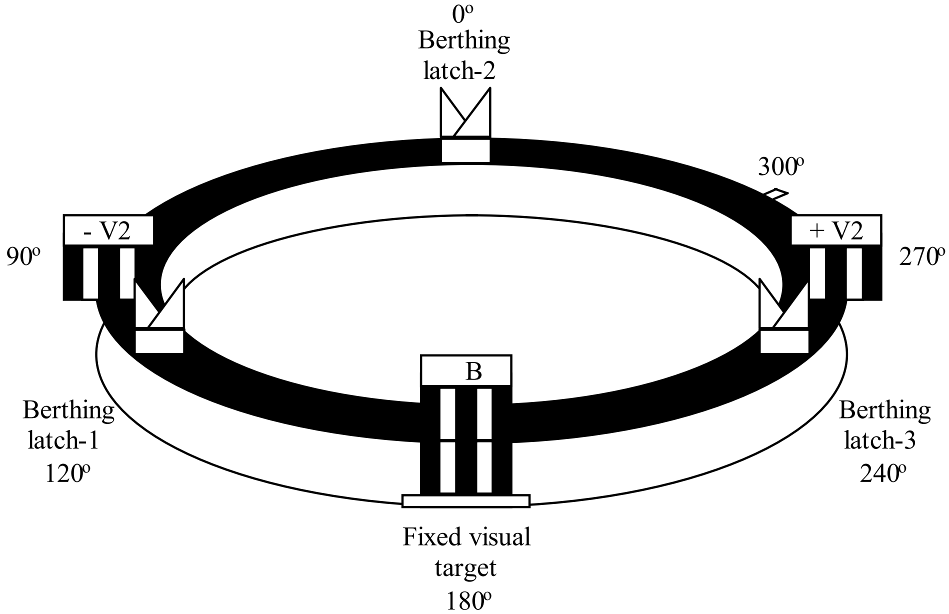


Figure 2-33. BAPS berthing latch locations and visual aids

Each BAPS berthing latch has an individual latch identification number stenciled on the latch housing and has alignment striping on the berthing latch levers to aid in the recognition of latch positions in relation to each individual HST berthing pin. The alignment striping scheme for the FSS berthing latch levers is shown in Figure 2-34. The horizontal stripes provide a visual cue for closing the latches. When the HST berthing pin is beneath the stripe, the latch will successfully retain the pin. Once the diagonal lines are even or parallel, the latches are caged. Refer to Figure 2-9 for Berthing Latch Operations.

Figure 2-34. Berthing latch levers alignment striping

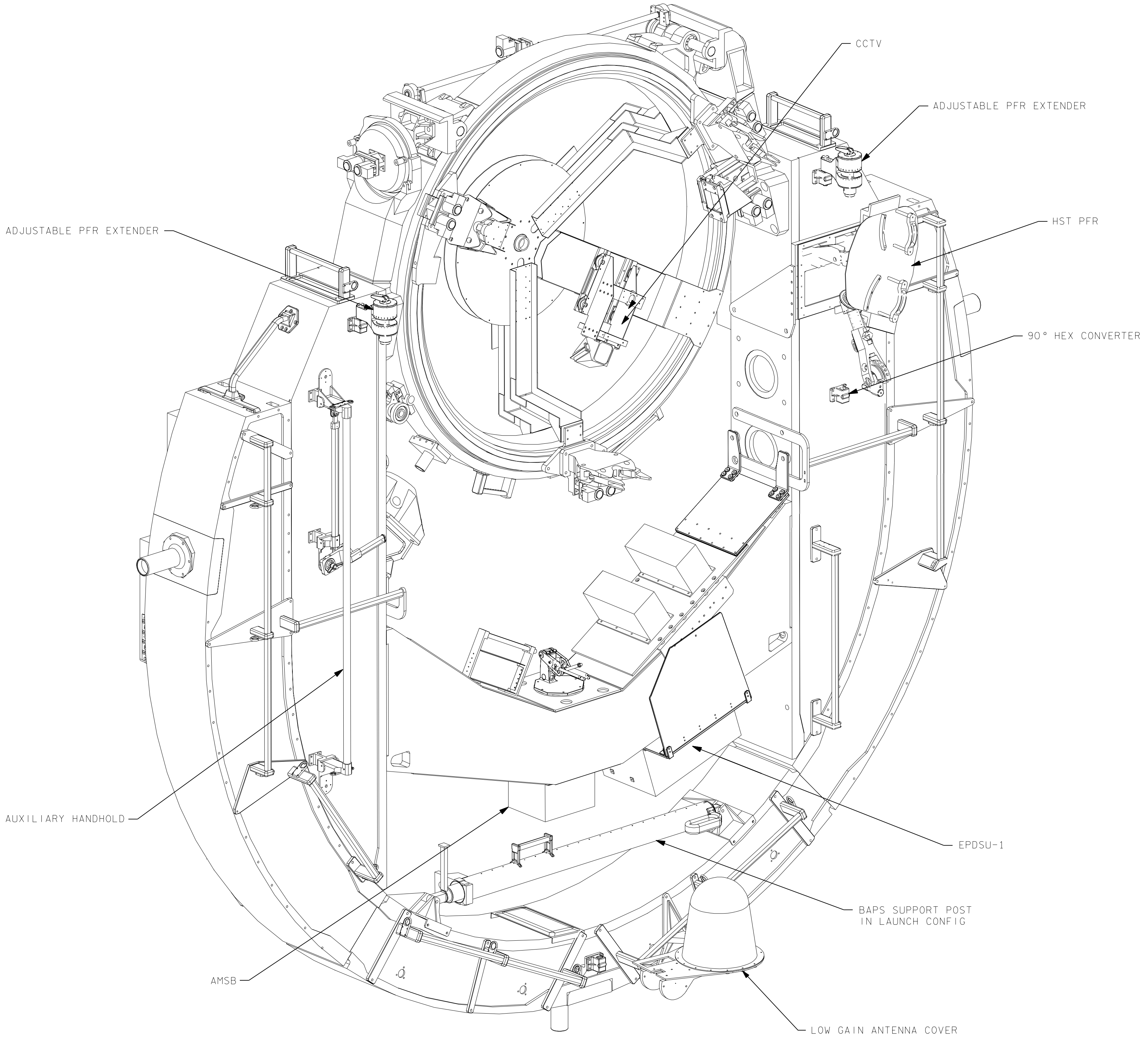
2.5.4 FSS Labels

Table 2-16 lists the decals that have been applied to the FSS and the quantity of each decal.

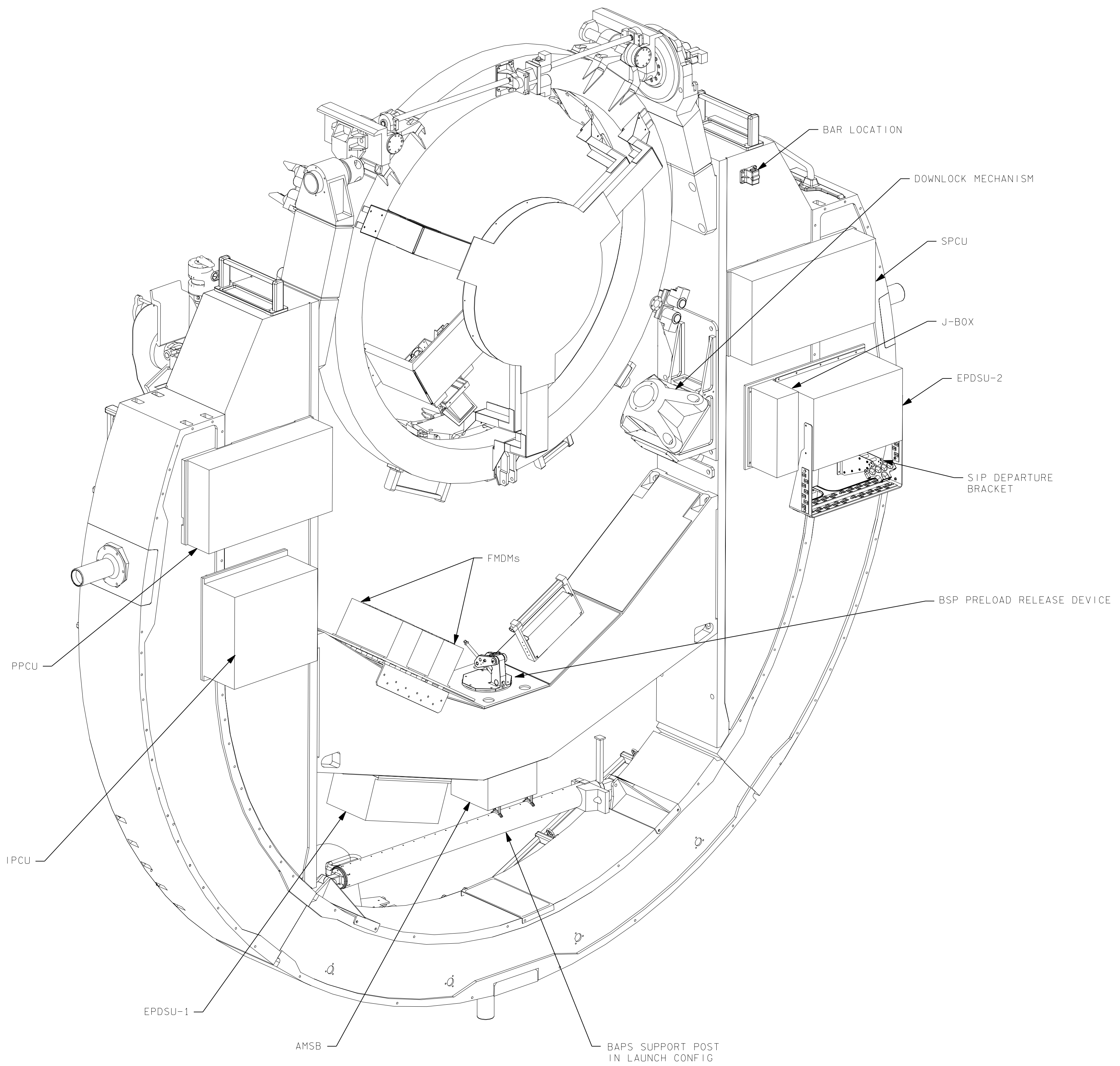
Table 2-16. FSS decals

Carrier	Location	Decal text	Qty
FSS	Berthing latch	1	1
FSS	Berthing latch	2	1
FSS	Berthing latch	3	1
FSS	PFR socket upper port	S60	1
FSS	PFR socket mid port	S61	1
FSS	PFR socket center	S62	1
FSS	PFR socket mid starboard	S63	1
FSS	PFR socket upper starboard	S64	1
FSS	PFR socket upper aft	S65	1
FSS	FMDMs	(black or silver strip)	AR
FSS	BAPS rotating target	+V2 (and alignment marks)	1
FSS	BAPS rotating target	-V2 (and alignment marks)	1
FSS	BAPS rotating target	B (and alignment marks)	1
FSS	BAPS rotating target	DF (and alignment marks)	1
FSS	BAPS fixed target	(alignment marks)	1
FSS	Pivoter target	(0° - 90° on circle)	2
FSS	Pivoter target	(rotational pointer)	2
FSS	Pivoter target	(pointer)	2
FSS	Pivoter target	(degree range from 0° - 90°)	2
FSS	Pivoter target	(degree range from 0° - 90°)	2
FSS	UDM	J1	2
FSS	UDM	08	1
FSS	UDM	07	1
FSS	Translator, fwd	(A,C,F, and pointers)	1
FSS	Translator, aft	(A,C,F, and pointers)	1
FSS	Translator	(pointer)	2

DATE: 10/16/01	NAME: MDU	VERSION: REL;4
DATE: 12/10/01	NAME: SVJ	VERSION: CHK;4
DATE: 01/24/02	NAME: MDU	VERSION: REL;5



FSS SM3B - FWD FACE



FSS SM3B - AFT FACE

1 FSS PHYS O/V

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN V. HUNTER	10/26/00		
DR		FSS PHYSICAL OVERVIEW	
ENGR R. HARVEY			
ENGR			
APP			
APP		HST SSE CSM	DWG NO 2.1
CADS		STS-109	
LTR / PCN		66 X 34	SHEET 1 OF 1

USA001948

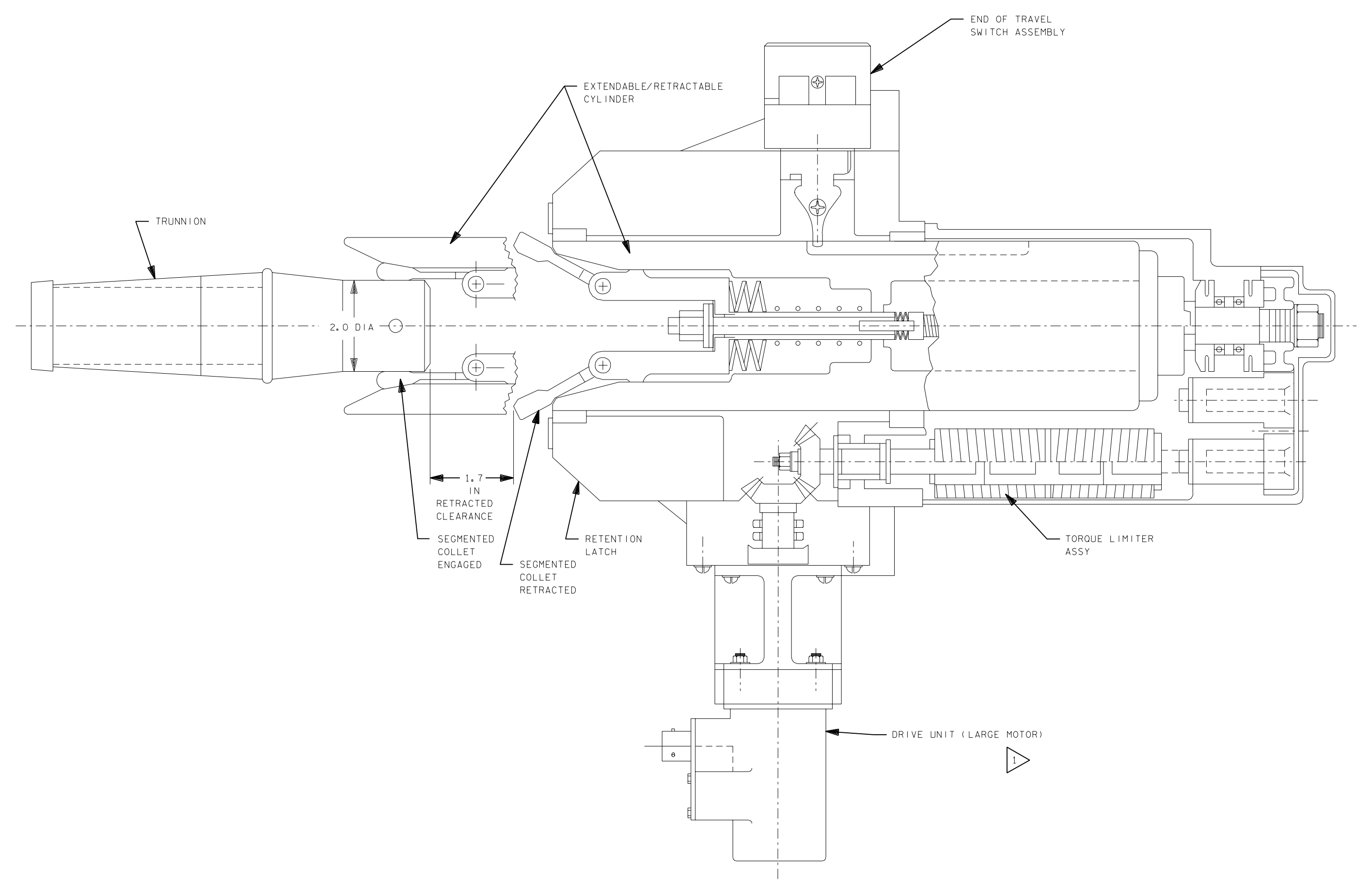
2 WHEN THE BAPS ROTATION IS IN THE NULL POSITION, IT IS AT 0°. THE BERTHING LATCH 1 IS FACING FORWARD (TOWARDS THE FRONT OF THE ORBITER)

NOTES: 1. REFERENCE GSFC DWG 2040381

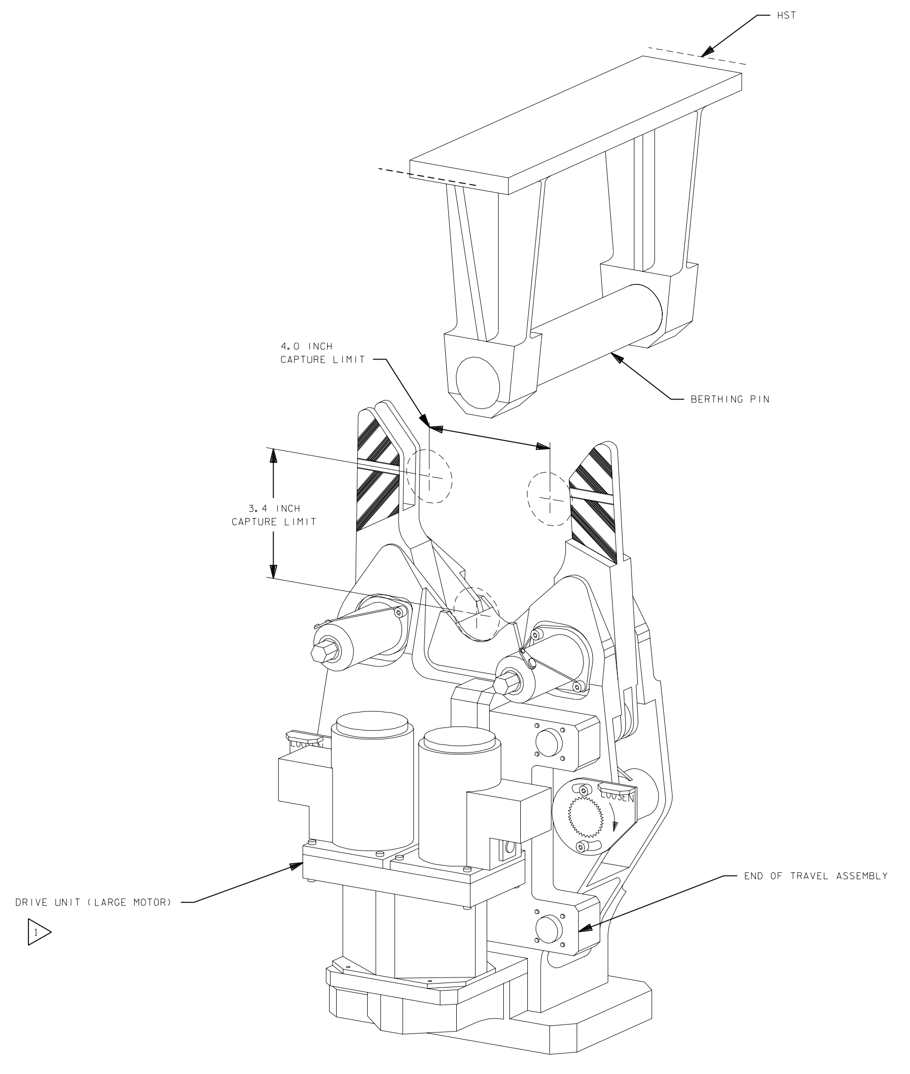
2 FSS BAPS

SIGNATURE	DATE	
DSGN M. GILLESPIE	02/18/92	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DR		FSS BERTHING AND POSITIONING SYSTEM (BAPS)
ENGR R. HARVEY		
ENGR		
APP		
APP		HST SSE CSM / DWG NO 2.2
CADS		STS-109
LTR / PCN		82.5 X 34 / SHEET 1 OF 1

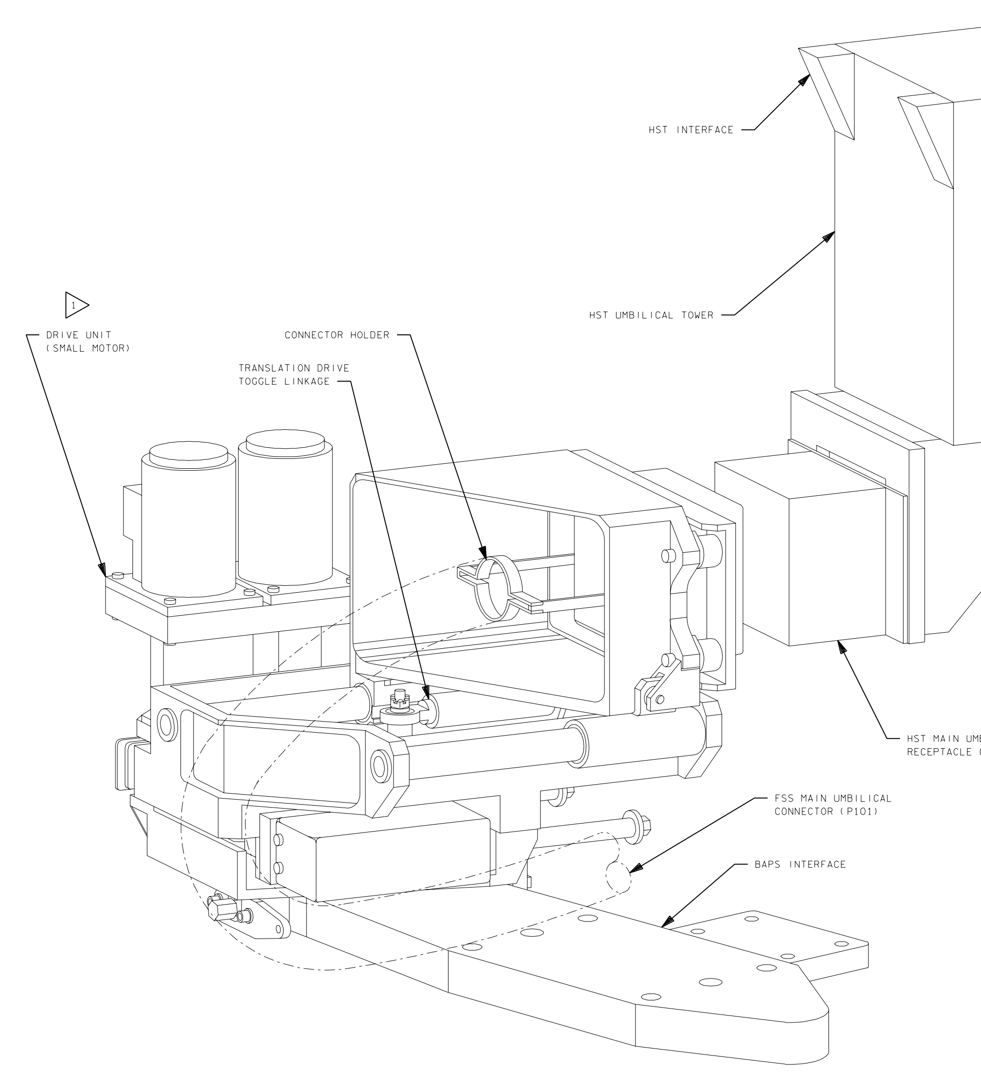
USA001948



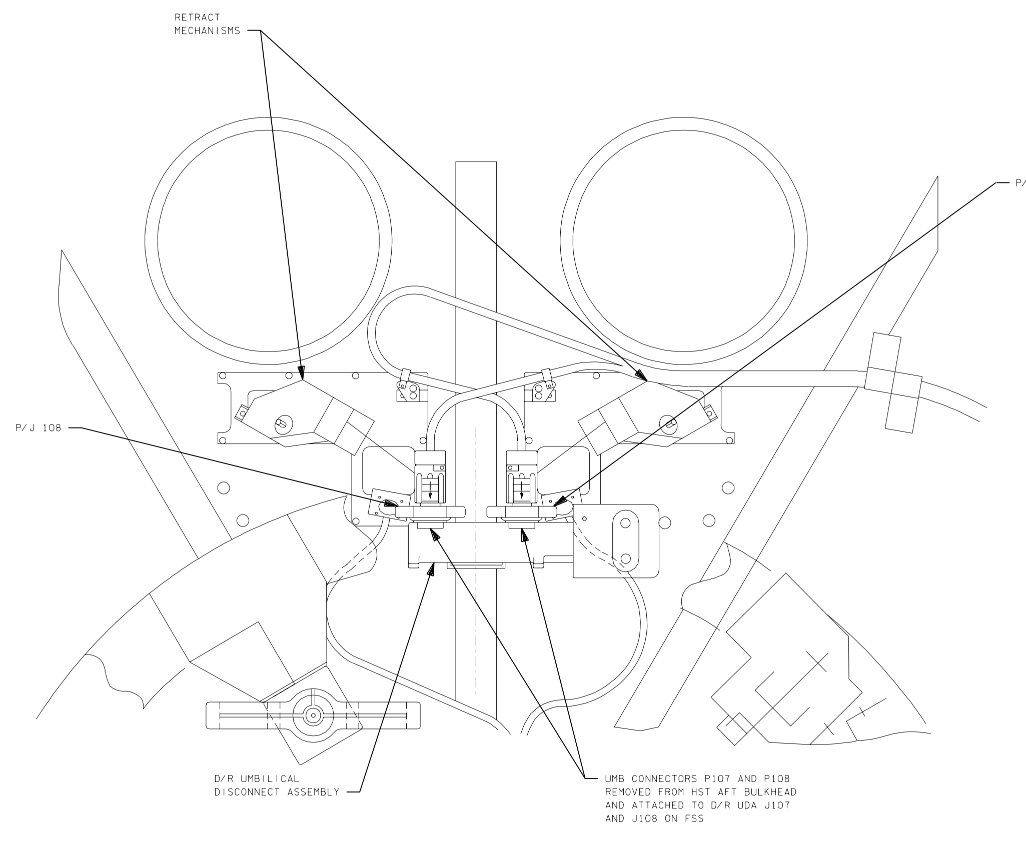
FSS PLATFORM DOWN LOCK



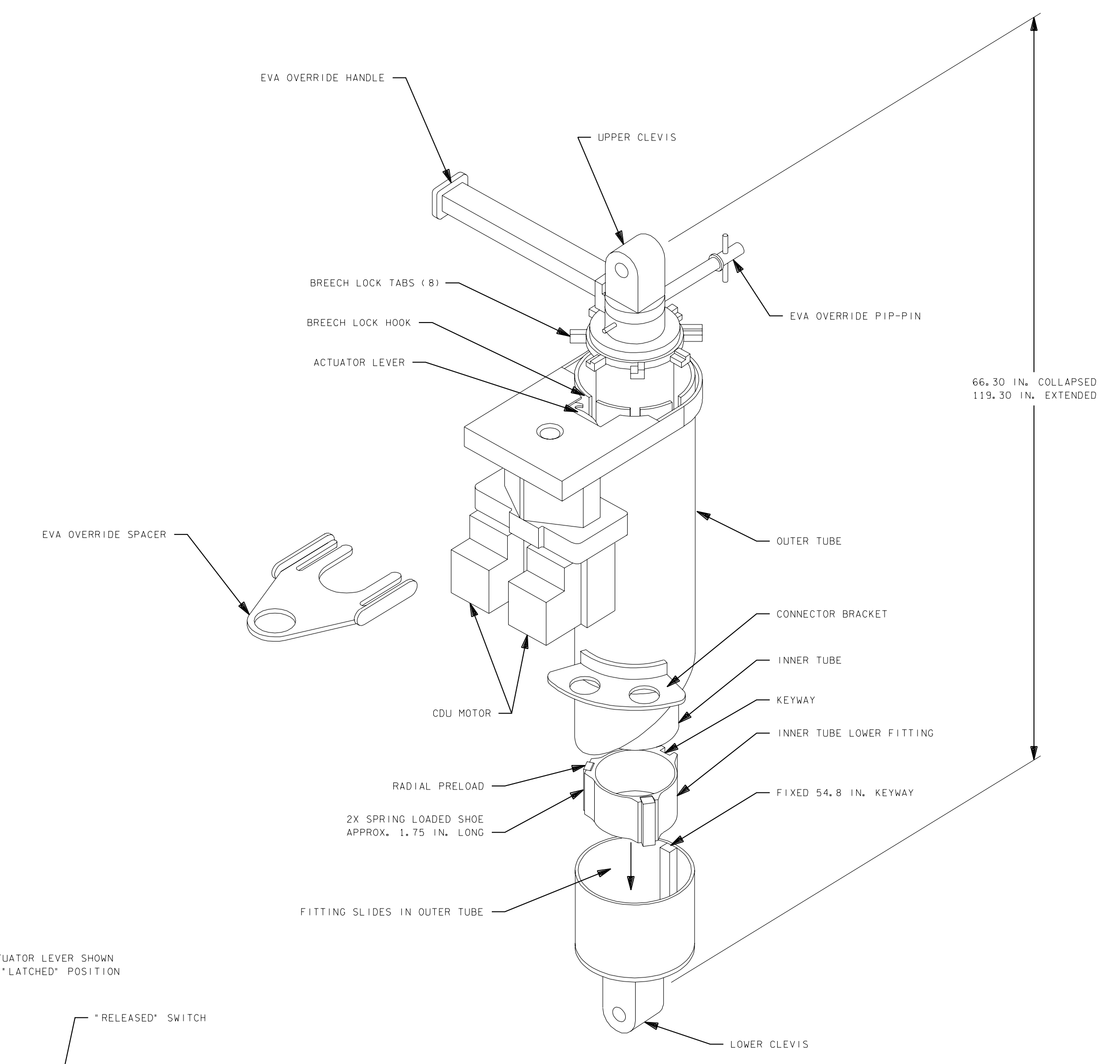
OPEN BERTHING LATCH POSITION



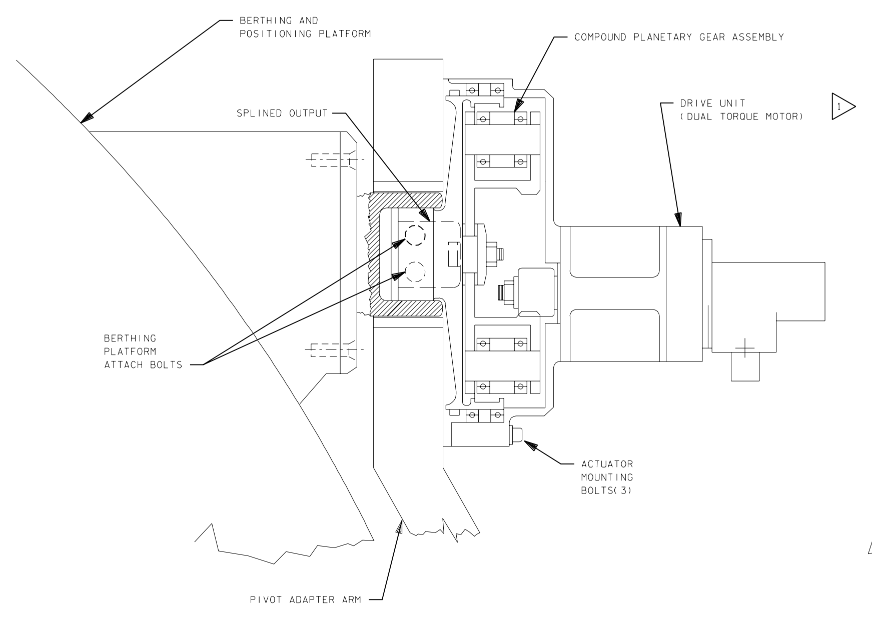
MAIN UMBILICAL

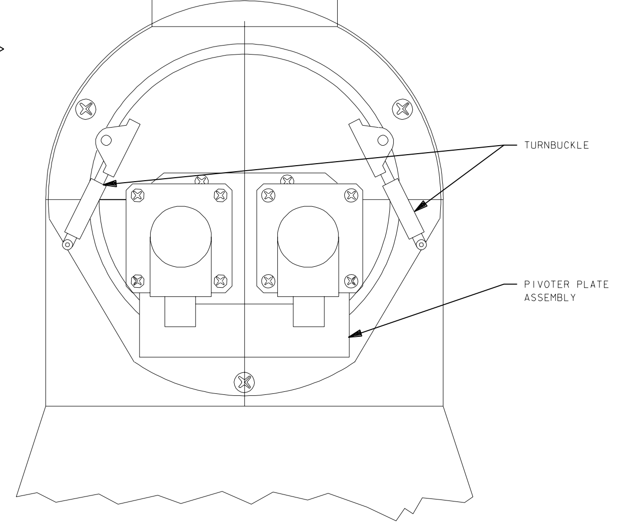


BACKUP UMBILICAL CONNECTED TO HST O/R UDA



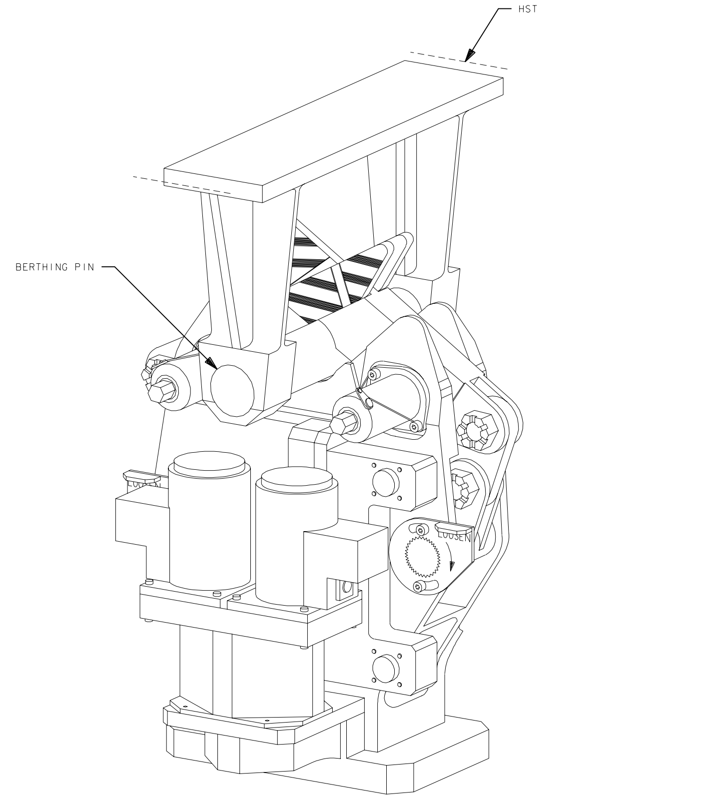
BAPS SUPPORT POST



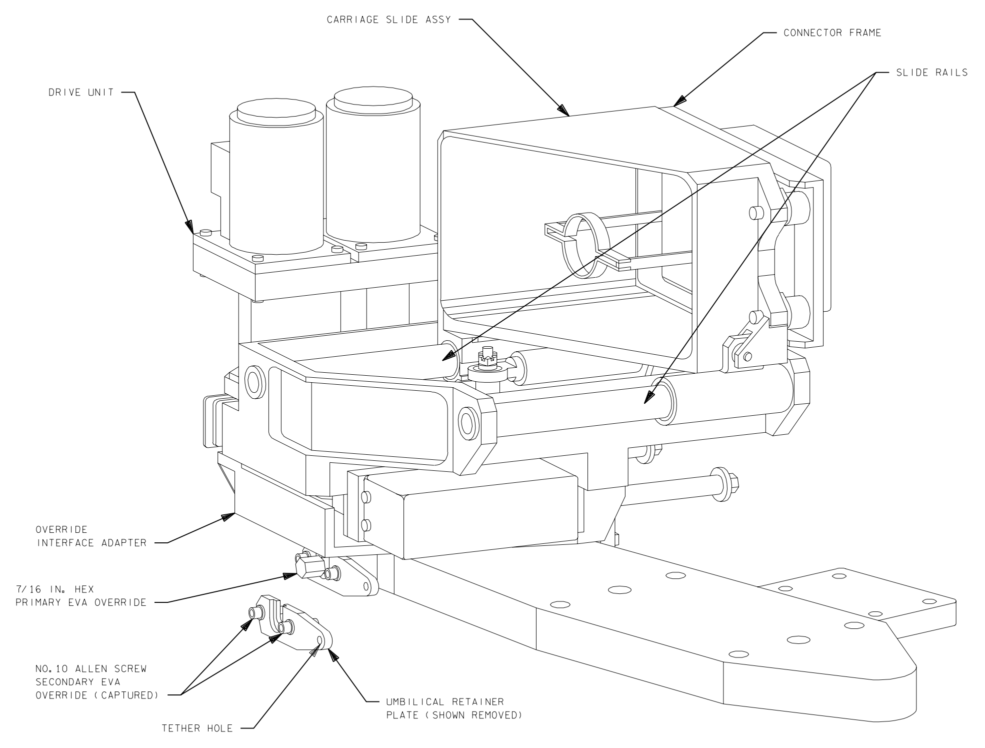


VIEW
LOOKING INBOARD

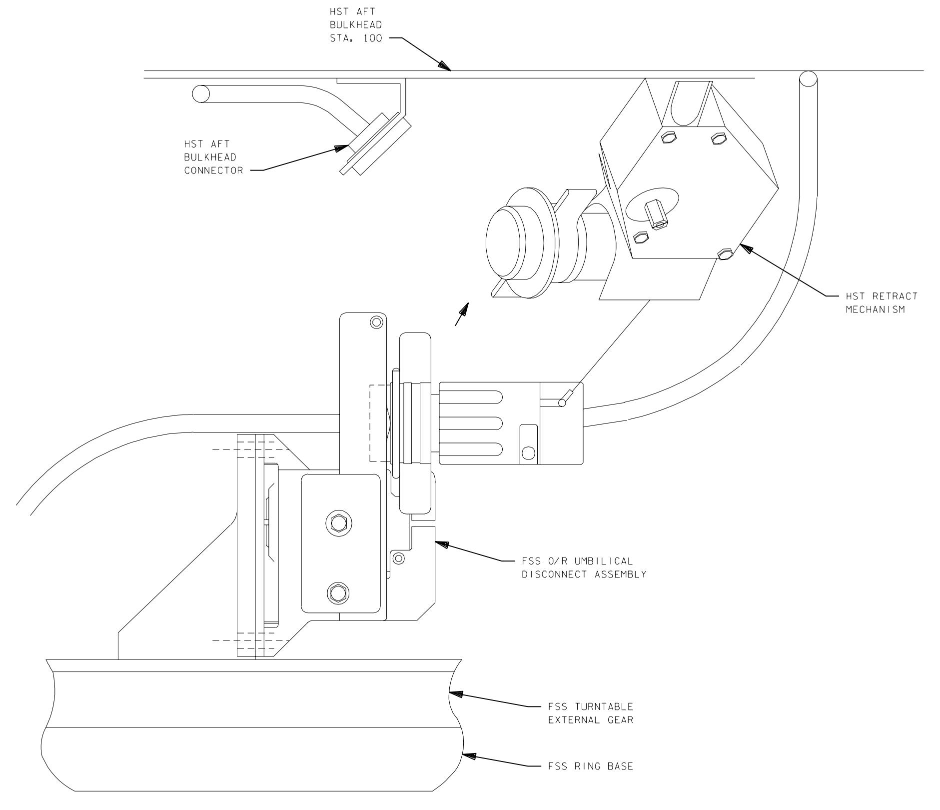
PLATFORM PIVOT ACTUATOR DETAIL



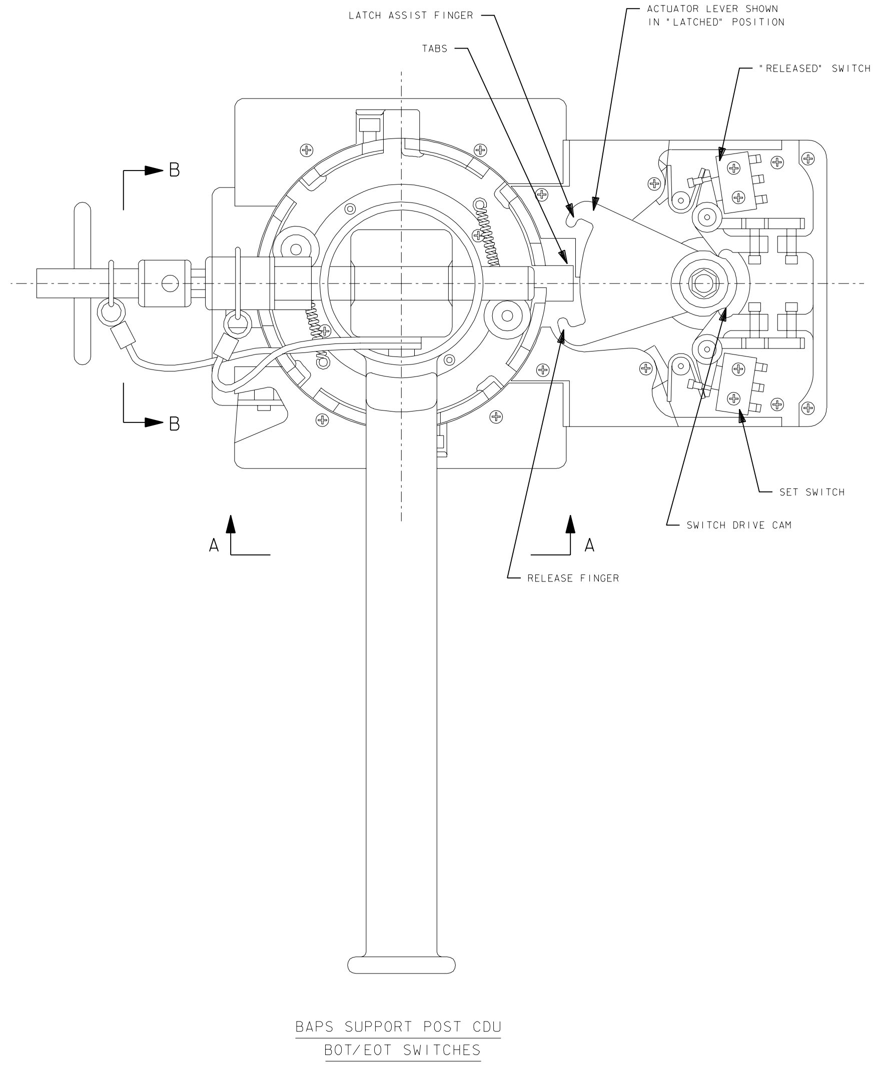
CLOSED BERTHING LATCH POSITION



MAIN UMBILICAL EVA OVERRIDE

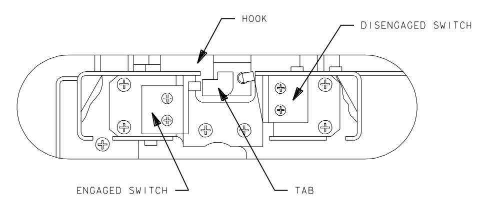


BACKUP UMBILICAL CONNECTED TO O/R UDA MOUNTED ON FSS BAPS

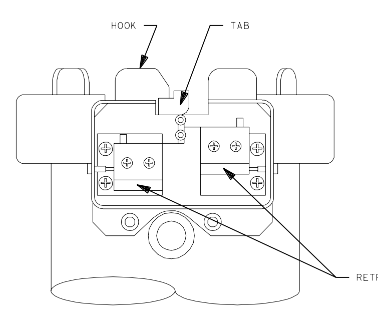


BAPS SUPPORT POST CDU BOT/EOT SWITCHES

BSP LATCHING DETAIL



VIEW A-A ENGAGED/DISENGAGED SWITCHES
(A SWITCHES SHOWN, B ON OPPOSITE SIDE)



VIEW B-B RETRACTED SWITCHES

NOTES: 1. THE CHARACTERISTICS OF THE UNITS ARE SHOWN BELOW. THE UNITS ARE REDUNDANT 115VAC, 400 HZ, 3 PHASE AC MOTORS. ALL THREE UNITS CONTAIN AN AUTOMATIC ELECTRO-MECHANICAL BRAKE SYSTEM THAT ENGAGES WHEN POWER IS REMOVED TO LOCK THE SHAFT AND PREVENT BACKDRIVING

	LARGE MOTOR	SMALL MOTOR	DUAL TORQUE
NO LOAD SPEED -OUTPUT SHAFT, 1 MOTOR	70 RPM	8 RPM	3.75 RPM
2 MOTOR	140 RPM	16 RPM	
STALL TORQUE, OUTPUT SHAFT	275 IN-LB	275 IN-LB	280/92 IN-LB
CURRENT DRAWN, NOMINAL, PER PHASE	1.1 AMPS	0.30 AMPS	0.14 AMPS

3 FSS MECH

SIGNATURE	DATE
DSGN M. MURPHY	
DR B. TEDDER	9/8/93
ENGR R. HARVEY	
ENGR	
APP	
APP	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS

FLIGHT SUPPORT SYSTEM MECHANISMS

HST SSE CSM
STS-109
DWG NO 2.3
LTR | PCN | 121 X 34 | SHEET 1 OF 1

USA001948

USA001948

USA001948

USA001948

12. FSS HTR CURRENTS WERE WIRED TO INCORRECT HTR CHANNEL ON FMDM. 2B CURRENT CAN BE READ USING 2A MSID

11. FSS HTR CURRENTS WERE WIRED TO INCORRECT HTR CHANNEL ON FMDM. 2A CURRENT CAN BE READ WITH 1B MSID

10. PL DATA BUS SHARED WITH MULE

9. SEE DRAWING 2.4-1 FOR DETAILS

8. DPC ON/OFF COMMAND (GROUND MSID)

DPC	ON MSID	OFF CMD
8	P34K4064U	P34K4065U
9	P34K4028U	P34K4029U
10	P34K4058U	P34K4059U
11	P34K4060U	P34K4061U
12	P34K4062U	P34K4063U

7. DPC CURRENT MSID

DPC	MSID
8	P34C2015V
9	P34C2016V
10	P34C2017V
11	P34C2018V
12	P34C2019V

6. DPC VOLTAGE MSID'S

DPC	MSID
8	P34V2035V
9	P34V2036V
10	P34V2037V
11	P34V2038V
12	P34V2039V

5. DPC ON/OFF MSID

DPC	MSID
8	P34X2052Y
9	P34X2053Y
10	P34X2121Y
11	P34X2054Y
12	P34X2122Y

4. ONE "PCU ON" OR "PCU OFF" CMD WILL TURN ON OR OFF ALL DPCS AT ONCE

3. FMDM A AND FMDM B TEMPS ARE READ BY BOTH FMDMS, BUT FMDM A POWER SUPPLY MUST BE TURNED ON TO CORRECTLY BIAS THERMISTOR FOR PROPER TEMPERATURE READING ON FMDM A. LIKEWISE FMDM B MUST BE ON TO MAKE FMDM B TEMP CORRECT. IF AN FMDM IS OFF THE TEMP WILL READ -55°C

2. GPC PORT ASSIGNMENTS CAN BE READ IN GNC VP SLOT 1 (HEX CODE)

BIT	DESCRIPTION
1	UNUSED
2	STRING 1
3	STRING 2
4	STRING 3
5	STRING 4
6	PL 1/2
7	NA
8	NA

1 = PRIMARY (FMDM B)
0 = SECONDARY (FMDM A)

NOMINAL HEX CODE FOR FMDM A = 7800
NOMINAL HEX CODE FOR FMDM B = 7C00

NOTES: 1. POWER MODULE ASSIGNMENT

1	FMDM B, AMSB B, FSS 2B HTR
2	DPC 7
3	DPC 8
4	DPC 9
5	DPC 10
6	DPC 11
7	DPC 12
8	NOT USED
9	NOT USED
10	FSS 2A HTR

4 FSS CMD/DATA/PWR 2

SIGNATURE	DATE	
DSGN S. WOHL	06/09/99	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DR		SPACE SUPPORT EQUIPMENT-FSS CMD/DATA/PWR
ENGR R. HARVEY		
ENGR		
APP		
APP		HST SSE CSM — DWG NO 2.4
CADS		STS-109
LTR / PCN		93.5 X 34 — SHEET 2 OF 2

NOTES:

1. ▷ EVA ACTIVITY REQUIRED TO CONNECT UDM AS SHOWN. USED IN THE CONTINGENCY CASE OF MAIN UMBILICAL J101 FAILURE
2. REFERENCE JSC-29029 HST CSM DRAWING 2.4 SHEETS 7,8,9, AND 10 FOR HST SSP SWITCH PATHS TO THE IPCU
3. ▷ FHST SHUTTERS CONTROLLED DIRECTLY BY SSP SWITCH-BYPASSES IPCU. FHST SSP TALKBACK DRIVEN BY IPCU RELAY ONLY
4. REFERENCE GSFC 1525254 REV BASIC
5. ▷ HST SERVICE UMBILICAL IS THE FSS MAIN UMB

5 IPCU

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN M. GILLESPIE	01/25/93		
DR		INTERFACE POWER CONTROL UNIT (IPCU)	
ENGR R. HARVEY			
ENGR			
APP			
APP		HST SSE CSM	DWG NO 2.5
CADS		STS-109	
LTR / PCN		126.5 X 34	SHEET 1 OF 1

USA001948

DATE: 10/16/01	NAME: MDU	VERSION: REL;1
DATE: 12/07/01	NAME: SVJ	VERSION: CHK;4
DATE: 01/24/02	NAME: MDU	VERSION: REL;2

SYSTEM 1 (S46) MECHANISM SELECTION

PAYLOAD SELECT (S37)	RETENTION LATCH SWITCH	DESCRIPTION	TLM REL	TLM LAT	DC BUS	CNTRL BUS	AC PWR	MDM
1	1 (S36)	FSS AMSB-A SYSTEM	V54X8111E	V54X8113E	MNA	AB1	AC1	OA3
2	3 (S43)	RAC KEEL LATCH	V54X8231E	V54X8233E	MNA	AB1	AC1	OF4
2	4 (S44)	SAC KEEL LATCH	V54X8241E	V54X8243E	MNA	AB1	AC1	OF4
2	5 (S45)	FSS KEEL LATCH	V54X8251E	V54X8253E	MNA	AB1	AC1	OF2

SYSTEM 2 (S47) MECHANISM SELECTION

PAYLOAD SELECT (S37)	RETENTION LATCH SWITCH	DESCRIPTION	TLM REL	TLM LAT	DC BUS	CNTRL BUS	AC PWR	MDM
1	2 (S42)	FSS AMSB-B SYSTEM	V54X8122E	V54X8124E	MNB	BC1	AC2	OF2
2	3 (S43)	RAC KEEL LATCH	V54X8232E	V54X8234E	MNB	BC1	AC2	OF1
2	4 (S44)	SAC KEEL LATCH	V54X8242E	V54X8244E	MNB	BC1	AC2	OF1
2	5 (S45)	FSS KEEL LATCH	V54X8252E	V54X8254E	MNB	BC1	AC2	OF1

11 MOTOR ASSEMBLY FOR MECHANISM 13 SAME AS MECHANISMS 3-12. SWITCH ASSY FOR MECHANISM 13 BSP SWITCH ASSY (TYP)

10. REFERENCE GSFC DRAWING 1525255 LATEST REV FOR FSS
REFERENCE SSSH DRAWING 14.3 BASIC REV E-1 FOR ORBITER

9 REFERENCE DRAWING 6.1-1

8 GPC PORT ASSIGNMENTS CAN BE READ IN GNC VP SLOT 1 (HEX CODE)

BIT	DESCRIPTION
1	UNUSED
2	STRING 1
3	STRING 2
4	STRING 3
5	STRING 4
6	PL 1/2
7	NA
8	NA

1 = PRIMARY (FMDM B)
0 = SECONDARY (FMDM A)

NOMINAL HEX CODE FOR FMDM A = 7800
NOMINAL HEX CODE FOR FMDM B = 7C00

7 EACH MECHANISM CONTAINS AN END OF TRAVEL (EOT) AND BEGINNING OF TRAVEL (BOT) MICROSWITCH ASSEMBLY. EACH OF THE AMSB SIDES OF A MECHANISM (A AND B) HAVE A SEPARATE ELECTRICAL SWITCH SUBASSEMBLY, BUT THEY SHARE THE ACTUAL MICROSWITCH PLUNGER HARDWARE, SUCH THAT A FAILURE OF THE MECHANICAL MICROSWITCH WOULD AFFECT INDICATIONS SEEN ON BOTH AMSB A AND B, BUT A FAILURE OF THE A SIDE MICROSWITCH ELECTRONICS WOULD NOT AFFECT AMSB B PROVIDED THAT THE MICROSWITCH STILL FUNCTIONED MECHANICALLY

6 SELECTION UNITS 3 AND 4 BOTH POWER THE SAME MECHANISM. SELECTION UNIT 3 PROVIDES PIVOTER LO DRIVE VIA A RESISTOR IN SERIES ON EACH PHASE. MECHANISM 4 POWERS THE SAME MECHANISM WITHOUT THE RESISTORS FOR PIVOTER HI. MECHANISMS 5-13 ARE EACH POWERED BY SELECTION UNITS 5-13, RESPECTIVELY, WITHOUT RESISTORS

5 AMSB OUTPUTS 1-2 NOT USED FOR STS-109

4 READY FOR LATCH TB'S (DS2, DS3, DS4, DS12, DS13) NOT USED FOR STS-109

3 THESE CONNECTIONS WILL NOT BE USED BY THE FLIGHT SUPPORT SYSTEM ON STS-109

2 END OF TRAVEL (EOT) POSITION — LAT; IN TRAVEL POSITION; BEGINNING OF TRAVEL (BOT) POSITION — REL

ALSO SEE NOTE 1 BELOW.

NOTES: 1 THE FSS MECHANISM ASSIGNMENTS ARE AS FOLLOWS:

MECH. NO.	FUNCTION	ITEM NO. ON SSE CONTROL SPEC	DEFINITION OF BOT	DEFINITION OF EOT	SELECTION STATUS SENSE MSID (1=ENABLED)	MECHANISM SELECTION
1	N/A				N/A	
2	N/A				N/A	
3	PIVOTOR LO	11	DN	UP	P34X 2060Y	P34K4003J
4	PIVOTOR HI	10	DN	UP	P34X 2061Y	P34K4004J
5	ROTATOR	12	-175° (CW)*	+175° (CCW)*	P34X 2062Y	P34K4005J
6	TRANSLATOR	13	FORWARD	AFT	P34X 2063Y	P34K4006J
7	PLATFORM LOCK (D LOCK)	9	DISENGAGED	ENGAGED	P34X 2064Y	P34K4007J
8	CENTER (1) BERTHING LATCH	14	OPEN	CLOSED	P34X 2065Y	P34K4008J
9	STBD (2) BERTHING LATCH	15	OPEN	CLOSED	P34X 2066Y	P34K4009J
10	PORT (3) BERTHING LATCH	16	OPEN	CLOSED	P34X 2067Y	P34K4010J
11	MAIN UMBILICAL (P101)	17	RELEASED	MATED	P34X 2068Y	P34K4011J
12	UDM	18	RELEASED	MATED	P34X 2069Y	P34K4012J
13	BAPS SUPPORT POST	19	RELEASED	SET	P34X 2070Y	P34K4013J

* AS VIEWED FROM ABOVE THE PAYLOAD BAY

6 FSS MECH CNTL

SIGNATURE	DATE	
DSGN S. OREN	03/29/83	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DR		FLIGHT SUPPORT SYSTEM MECHANISM CONTROL
ENGR R. HARVEY		
ENGR		
APP		
APP		HST SSE CSM — DWG NO 2.6
CADS		STS-109
LTR / PCN		126.5 X 34 — SHEET 1 OF 1

USA001948

3.0 MULTI-USE LIGHTWEIGHT EQUIPMENT CARRIER

The MULE is a reusable flight-qualified carrier designed to transport HST ORUs and CATs to orbit and provide environmental protection for them during all phases of the mission. The shuttle provides structural, electrical, and command/telemetry interfaces to the MULE.

3.1 MULE PHYSICAL DESCRIPTION

The MULE is composed of the UASE cradle originally designed for the UARS mission on STS-48. The protective enclosures and miscellaneous equipment from the UARS mission were removed and the cradle and honeycomb equipment mounting panels were modified to accommodate equipment required for the HOST mission on STS-95. Further modifications to the cradle and honeycomb equipment mounting panels have been required on the MULE to support the SM3B mission.

3.1.1 Structural Interfaces

The MULE is attached to the orbiter in the payload bay by a single keel trunnion and two sill trunnions at X_O 1226.33. The sill latches are passive and the keel latch is active. Although the keel latch is active, it is not wired to the Payload Retention Subsystem. The keel latch is wired to a sill where Ground Support Equipment (GSE) can be attached to actuate the latch.

3.1.2 Structural Elements

The primary support cradle is an aluminum truss structure with 3 trunnions. Honeycomb panels are attached to the cradle with locking heli-coils to provide mounting locations for ORUs and stowage containers on the MULE as shown in Drawing 3.1. Three panels are on the aft side of the MULE and provide mounting locations for the ESM, SOPE, and the LOPE. The forward side of the MULE has two panels. An aluminum panel is used to mount the MULE FMDMs and the PDSU to the center-interior section of the cradle. Two panels are mounted on the interior starboard and port sections to mount EVA handrails. On top of the cradle arms, two tower assemblies have been added with an aluminum cross beam. The cross beam is composed of two flanges riveted to a web to form an I-beam. This structure is used to mount the NCS radiator.

3.1.3 NICMOS Cooling System Radiator

The NCS radiator (Figure 3-1) is attached to the tower assemblies of the MULE with four EVA interface latches and to the I-beam with three EVA interface bolts, as shown in Figure 3-2. Any five of the seven EVA interfaces are required for contingency return. The latch system for the radiator is a semi-kinematic system. The latch system (Figure 3-3 and Figure 3-4) includes one 3-axis constraint latch, one 2-axis constraint latch, two 1-axis constraint latches and three 1-axis EVA bolts (Figure 3-5). Vespel rings on each side of the radiators provide sliding surfaces for all EVA interfaces except the 3-axis constraint latch.

The 1/4-turn squeeze handle latches are used in the four corners of the radiator and provide a nominal 650 $\pm$ 50 pound preload each. EVA bolts are used in three center locations of the radiators to attach to the I-beam, and each provides a nominal 1500-pound preload on the radiator. All latches and bolts remain captive to the radiator.

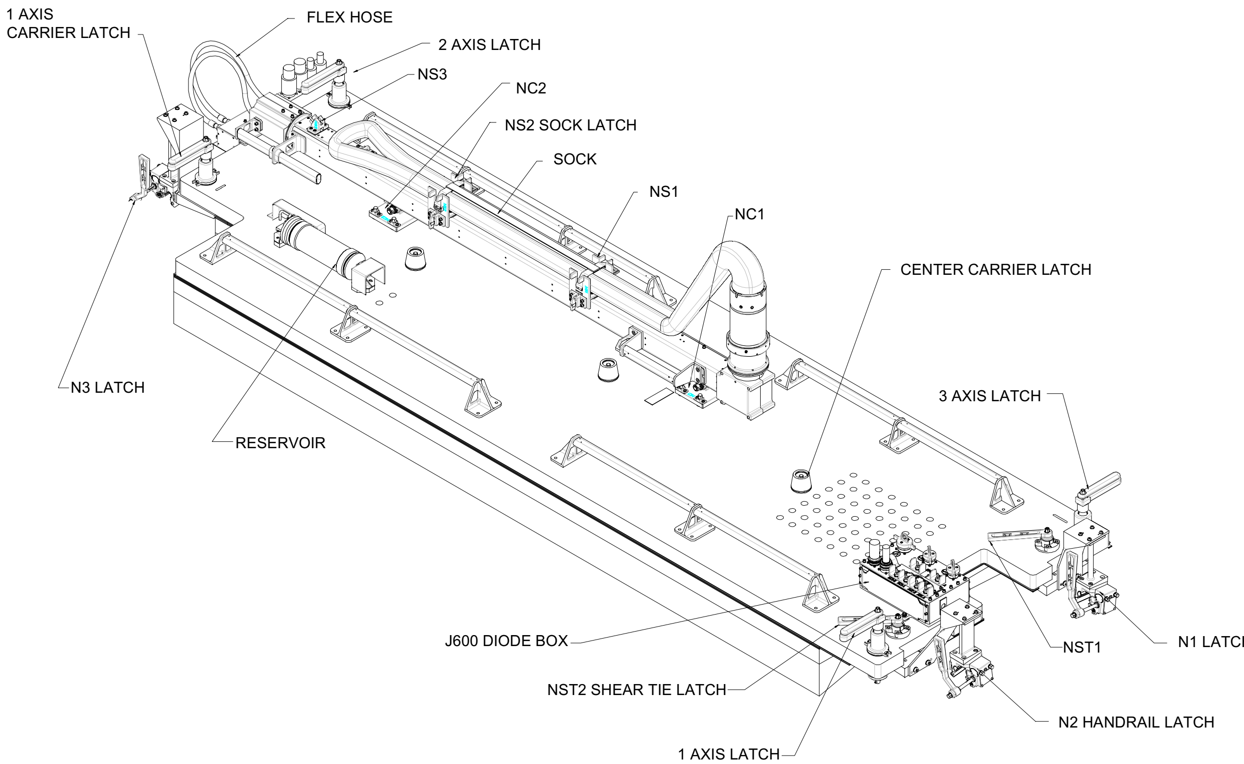


Figure 3-1. NCS radiator

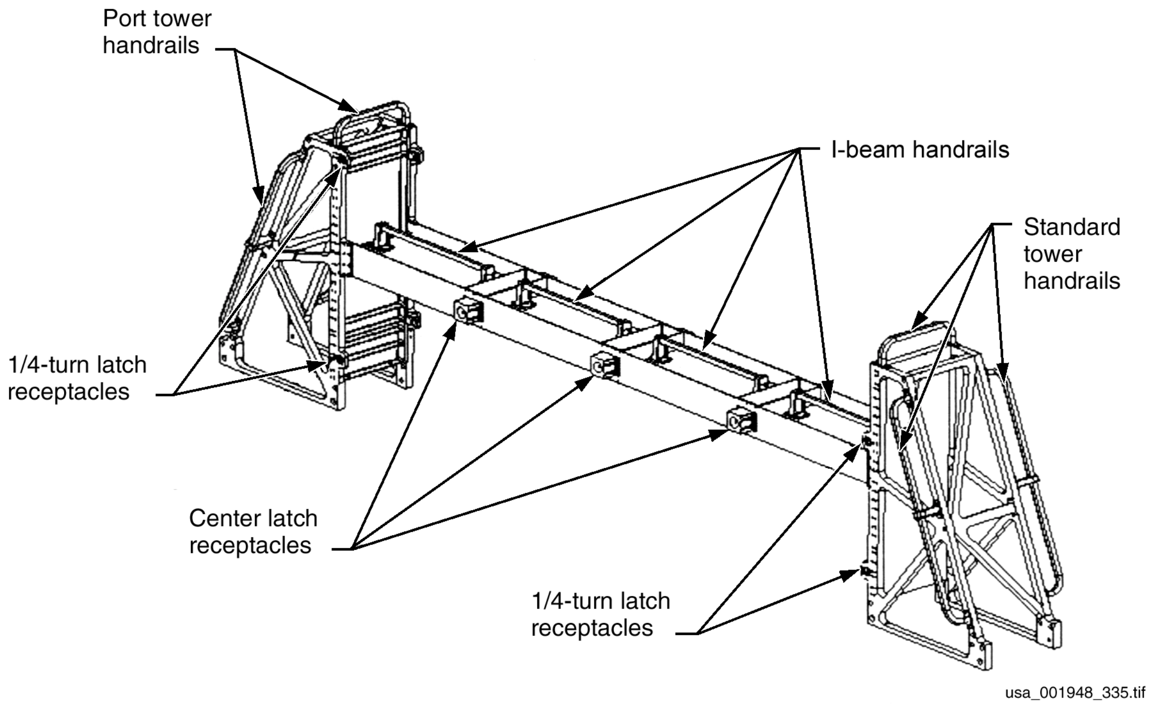


Figure 3-2. NCS radiator attachments to MULE

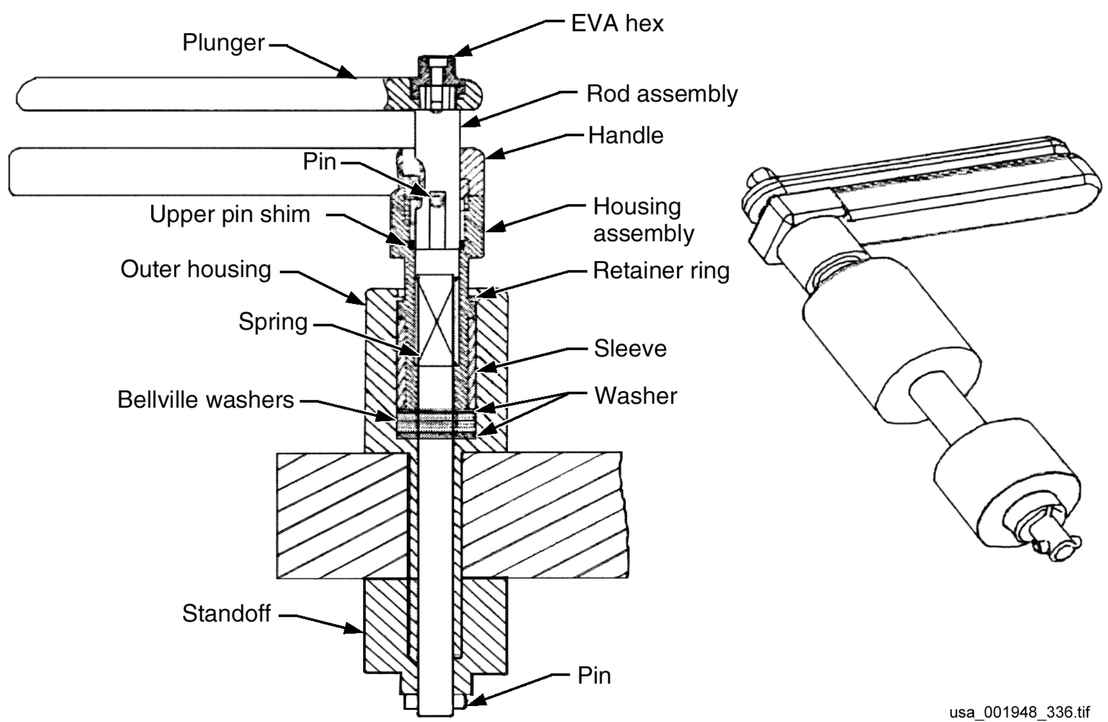


Figure 3-3. NCS radiator 3-axis constraint latch

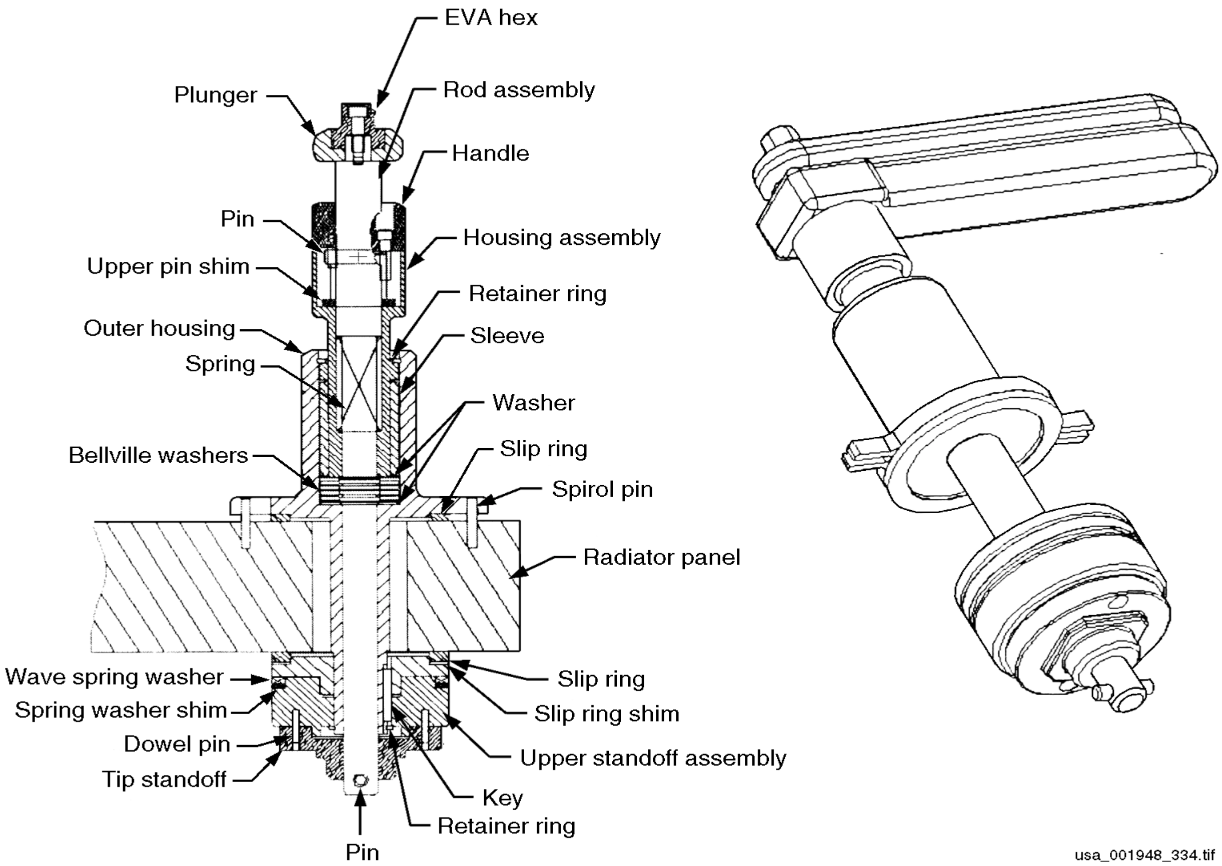


Figure 3-4. NCS radiator 1-axis and 2-axis constraint latches

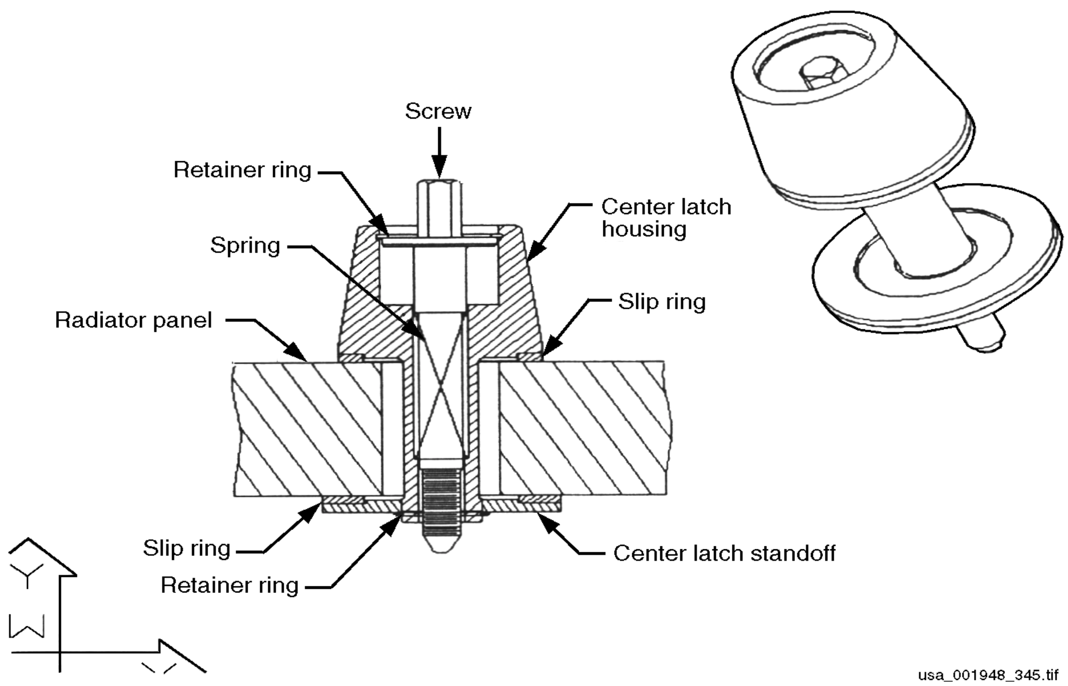


Figure 3-5. NCS radiator EVA bolt

3.1.4 Electronic Support Module

The ESM is attached to the aft-port panel of the MULE with four EVA hex bolts (refer to Figure 3-6). Two additional EVA contingency bolts are available, to be used in the event the ESM needs to be returned to the MULE and two of the nominal bolts are unusable. Any four of the bolts are required for a contingency return.

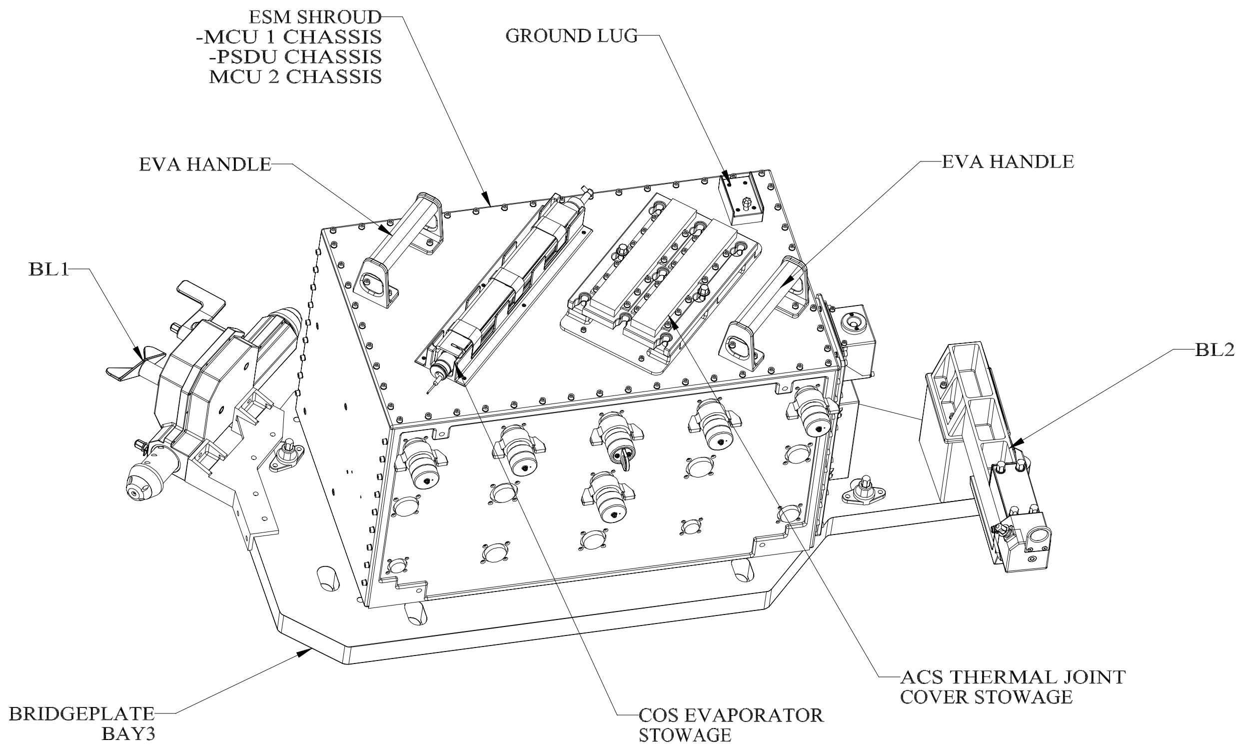


Figure 3-6. ESM configuration

3.1.5 Small ORU Protective Enclosure

The SOPE is a pallet-mounted container designed to deliver and return ORUs (refer to Figure 3-7). The SOPE is attached to the aft-center panel on the MULE with 26 bolts distributed on 11 mounting feet, but is thermally isolated with the use of 1/8-inch G-10 thermal spacers. These bolts are not an EVA interface. The SOPE is composed primarily of custom-machined aluminum plates, riveted together using standard aluminum angle sections. The enclosure (including the lid, latches, hinges, and dividers) weighs 270 pounds. Three vents are provided to ensure structural integrity during cargo bay pressurization/depressurization. The vents are unobstructed by the Transport Modules (TMs) or other internal stowage.

The SOPE has two hinges that allow the lid to open 100 degrees before hitting a stop. Each hinge has a soft-dock to hold the lid open during EVA operations. Each hinge (shown in Figure 3-8) consists of two-machined aluminum sections and a stainless steel pin. The hinge pin is free to slide in the bushing that is also free to slide in both hinge sections. This design is two-fault tolerant. Additionally, four beryllium copper washers ensure a minimum of two low friction-sliding surfaces between the hinge sections. Turfram coating is used at the machined hinge sliding surfaces (with Braycote grease on the bolt and the washers) to further reduce friction and to minimize galling potential. There is no provision to remove the SOPE hinges.

The SOPE has three EVA lid latches, as shown in Figure 3-9. The latches are actuated by a T-Handle that is twisted and laid down inside a lid-mounted bathtub fitting. The bathtub fitting prevents handle rotation and a compression spring keeps the handle down for all inertia loads. To open the lid, the EVA crewmember pulls the T-Handle up out of the bathtub fitting and twists 1/4 turn to unlatch the internal pawl/pawl catch interface. Only two latches are required for landing loads. If two latches fail, the lid can be secured by installing the contingency bolt (stowed in a pouch and captive to the SOPE with a tether) farthest from the working latch. However, if the only working latch is the middle latch, both EVA contingency bolts must be used. If the T-handle latch fails to unlatch, the primary EVA override is to lay the T-handle down on the “open” side and rotate the latch 90° in manual mode to achieve additional torque by using a standard EVA 7/16-in. socket wrench. If this fails, a secondary EVA override is to back off the four captive fasteners that secure the latch to the lid, and after tethering to the latch assembly, slide the latch assembly away from the pawl catch until it lifts out of the lid.

The SOPE is divided into three bays (A, B, and C), as shown in Figure 3-10. (Note: Figure 3-10 shows the SOPE inverted from the actual MULE mounting.) The lid of the SOPE has additional pouches attached on the internal side for extra storage space. A typical patch is shown in Figure 3-11. The contents of the SOPE are detailed in Table 3-1.

Table 3-1. SOPE contents

	Bay	**Stowage pouch**
Bay A	RSU ECU	DBC cross-strap harness
Bay B	RSU PGT	PDU connector covers Battery protective cover PCU essential bus harness (T -Harness)
Bay C	Cryo port cover PCU bypass harness Multi-setting torque limiter Speed reducer/torque multiplier Right angle gear box w/socket Drop-proof tether	MLI repair kit

The Electronic Control Unit (ECU) and RSU require vibration isolation and are contained within custom designed Transport Modules (TMs). The RSU and ECU TMs shown in Figure 3-12 and Figure 3-13 are open structures that are bolted to the SOPE base and walls. The RSU TM uses open cell foam, and the ECU TM uses silicone rubber pads to provide isolation. Scaled-down versions of the basic OPE hinges and T-handle latches are implemented for the individual TM lids. Each of the TM hinges is constructed with three nested sliding surfaces that mitigate jamming of the lid while in the open condition and are two-fault tolerant. Each TM lid has a single T-handle lid that can be operated one-handed. The TM latches have EVA overrides to account for latch failure, ensuring that the ORUs can be removed.

The remaining ORUs do not require specific load attenuation. These are packed in foam, hard mounted to the SOPE walls, or contained in soft pouches as required. Each ORU is supported independently so that any item can be removed or installed at anytime.

The Cyro Port Cover (CPC), shown in Figure 3-14, is secured inside the SOPE by a bracket with a hinged cross bar and spring-loaded clip. The bracket base contains three flexures that act as a soft-dock. The CPC is secured by a cross bar, which in turn is locked in place by a spring clip. The cross bar is lined with foam to insure preloaded contact with the CPC and prevent damage to the CPC. The cross bar pivot has three sliding surfaces and is two-fault tolerant. The spring clip uses two torsion springs, only one of which is required for proper function. The spring clip pivot has three sliding surfaces and is two-fault tolerant.

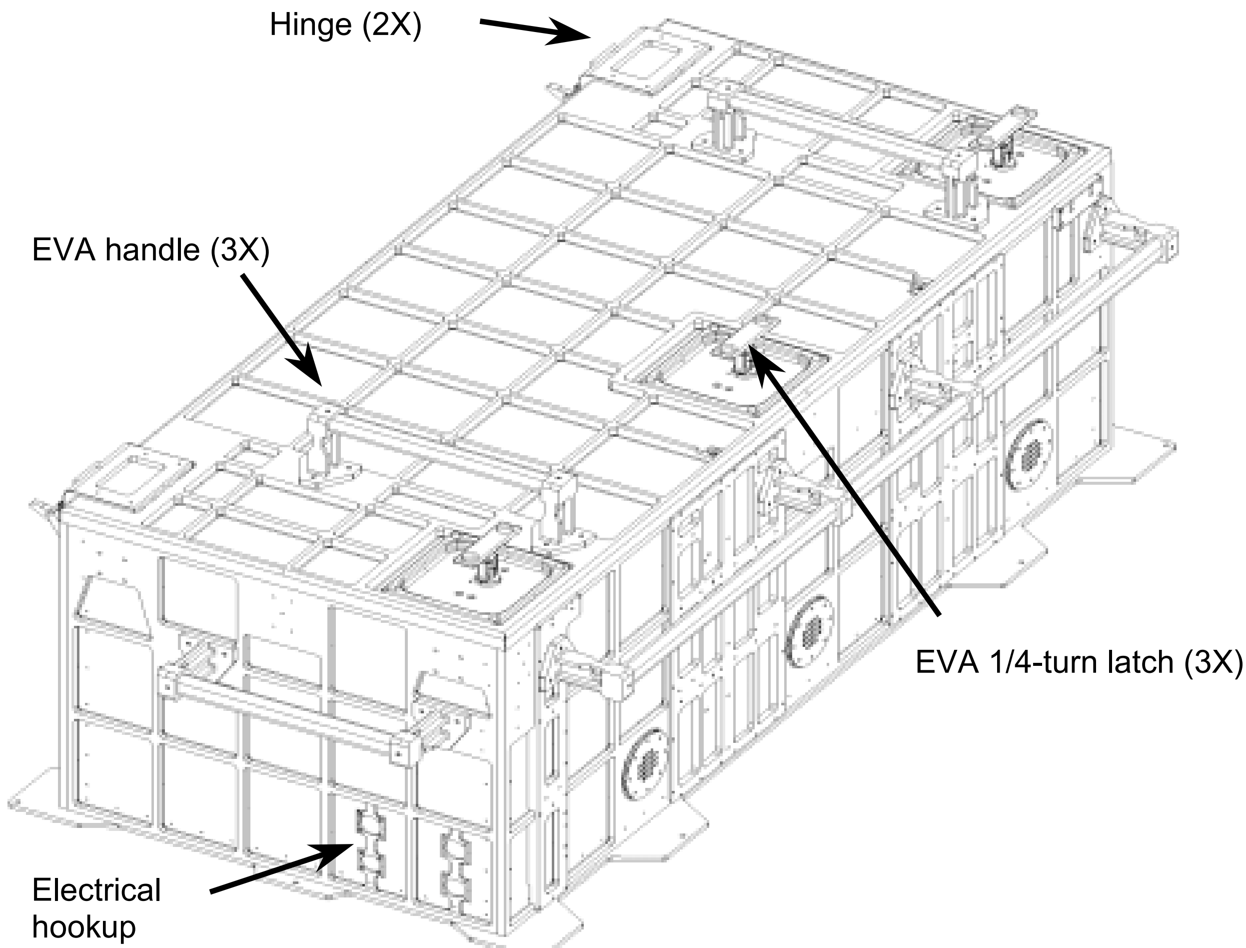


Figure 3-7. SOPE configuration

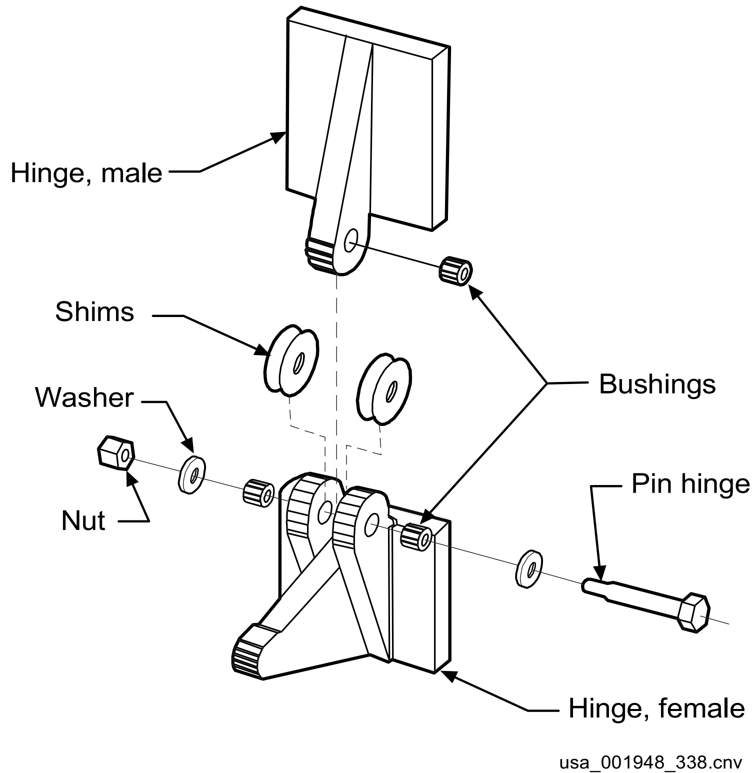


Figure 3-8. SOPE/LOPE lid hinge

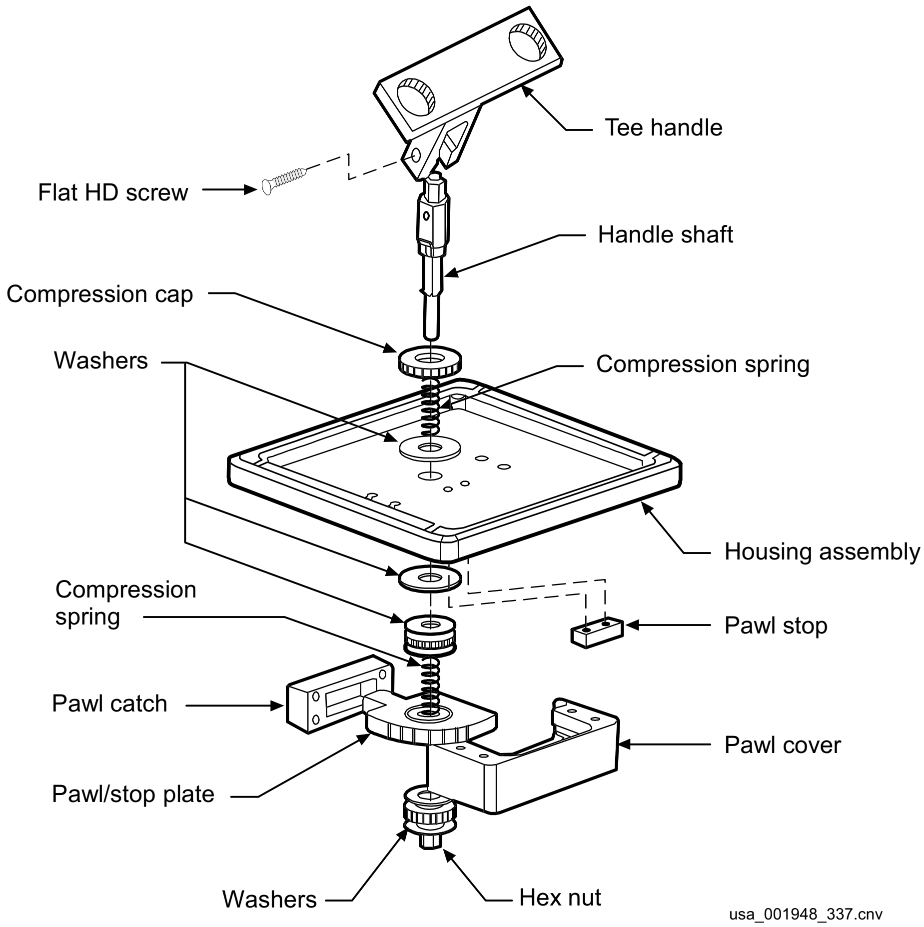


Figure 3-9. SOPE lid latch

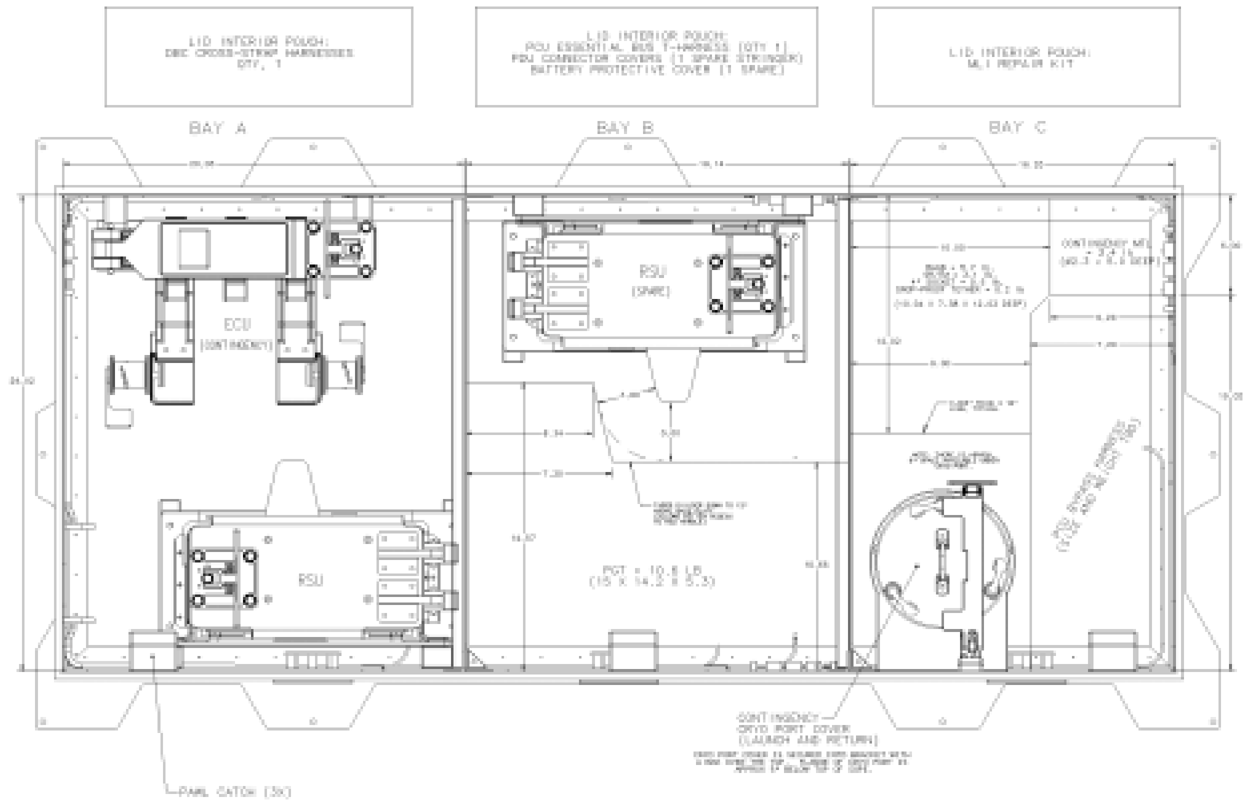


Figure 3-10. SOPE internal configuration

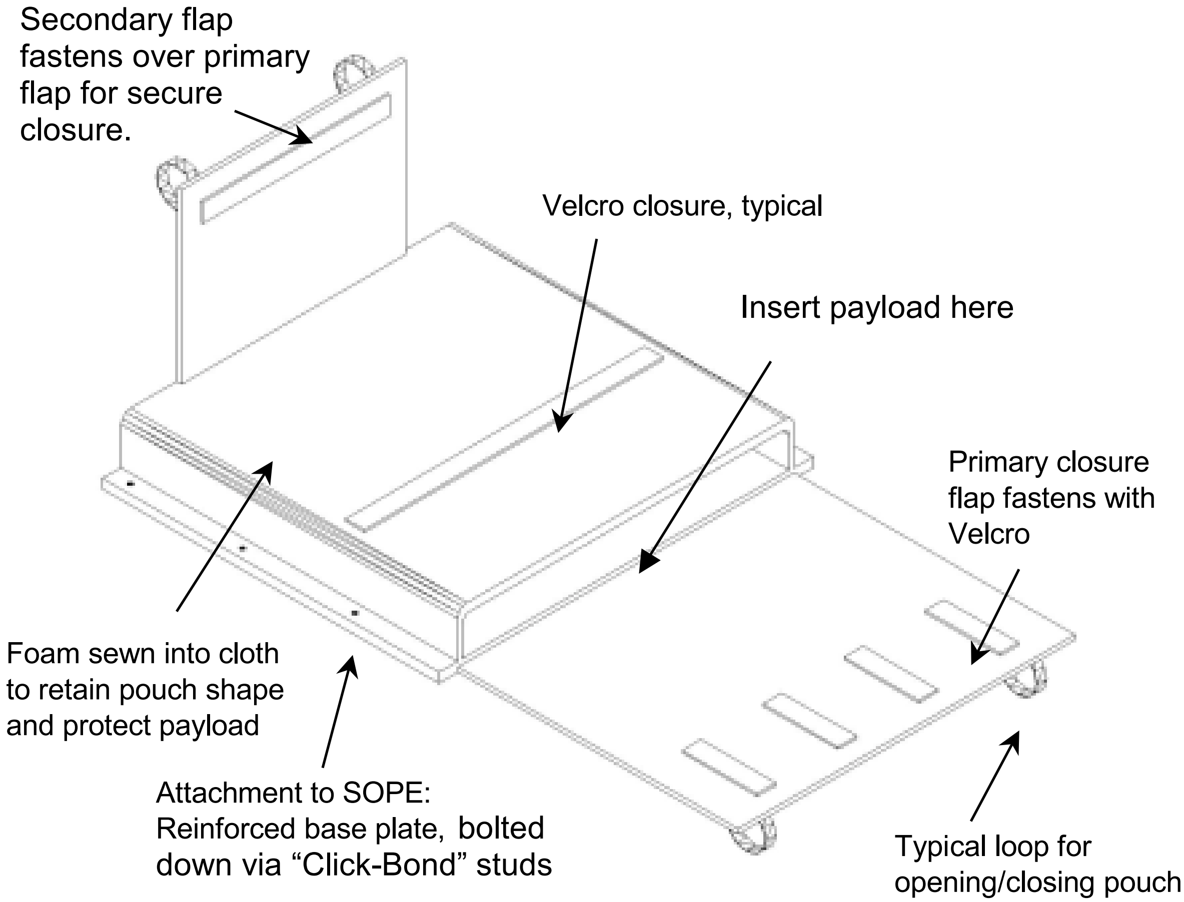


Figure 3-11. Typical pouch details

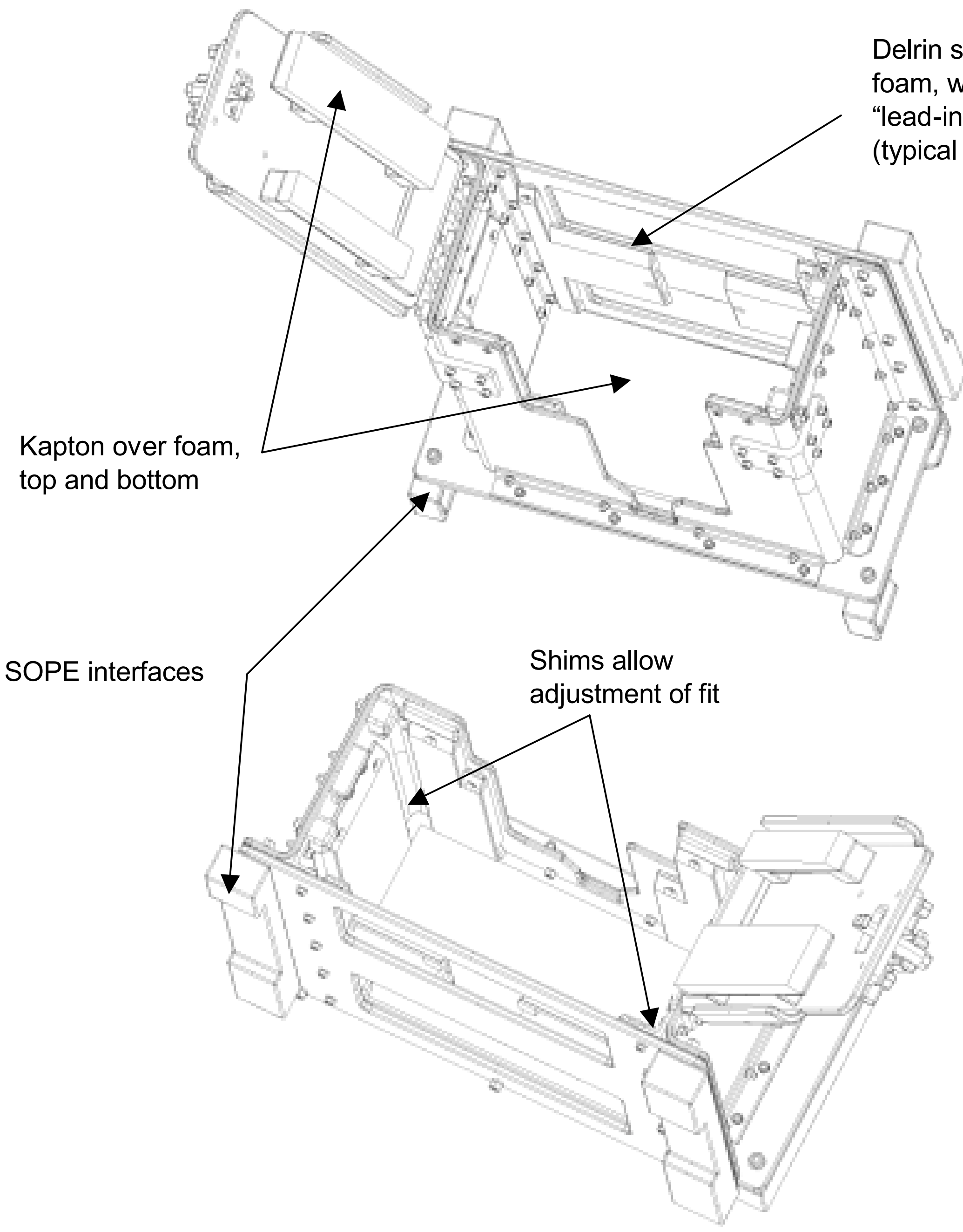


Figure 3-12. RSU transport module

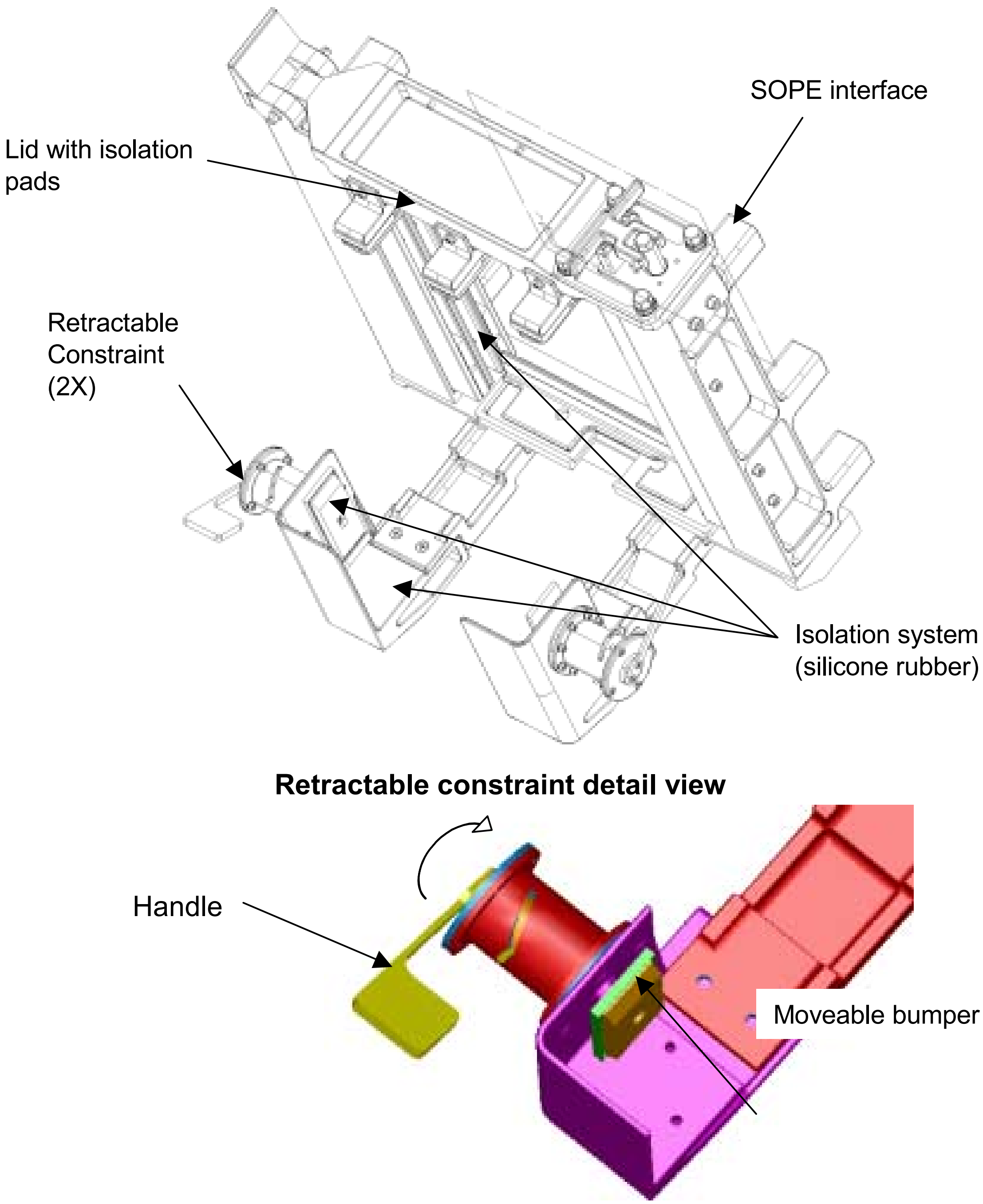


Figure 3-13. ECU transport module

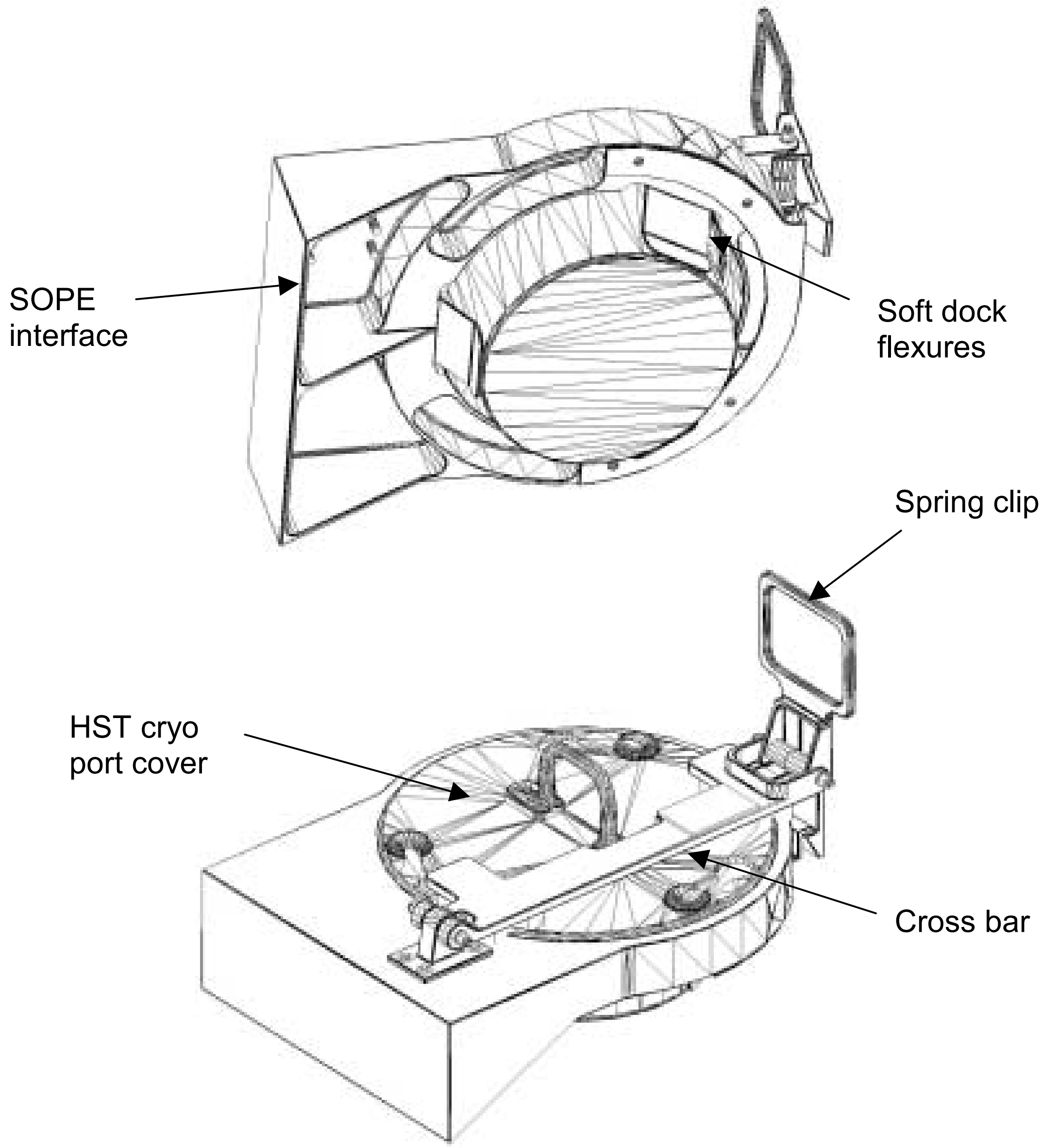


Figure 3-14. Cryo port cover bracket

3.1.6 Large ORU Protective Enclosure

The LOPE is a panel-mounted container designed to deliver and to return ORUs and/or CATs (refer to Figure 3-15). The LOPE is attached to the aft-starboard panel on the MULE with 9 bolts, but is thermally isolated with the use of 1/8-inch G-10 thermal spacers. These bolts are not an EVA interface. The LOPE is composed primarily of custom-machined aluminum plates, riveted together by using standard aluminum angle sections. The enclosure (including the lid, latches, and hinges) weighs 140 pounds. Two vents are provided to ensure structural integrity during cargo bay pressurization/ depressurization. The vents are unobstructed by the TMs or other internal stowage.

The LOPE has two hinges that allow the lid to open 120 degrees before hitting a stop. Each hinge has a soft-dock to hold the lid open during EVA operations. Each hinge (shown in Figure 3-8) consists of two-machined aluminum sections and a stainless steel pin. The hinge pin is free to rotate in the bushing that is also free to rotate in both hinge sections. This design is two-fault tolerant. Additionally, four beryllium copper washers ensure a minimum of two low friction-sliding surfaces between the hinge sections. Turfram coating is used at the machined hinge sliding surfaces (with Braycote grease on the bolt and the washers) to further reduce friction and minimize galling potential. There is no provision to remove the LOPE hinges.

The LOPE has four EVA lid latches on the side panels of the enclosure. The latches are J-hooks with a dome nut at the hook hinge point and a countersunk hex bolt that is captive to the flange (refer to Figure 3-16). Both the flange screw and the hook have 7/16 inch EVA hex heads. A PRT, PGT, or standard ratchet is used to release the latches. The bolts can be torqued to failure if required to open the LOPE. In case of a latch failure, the LOPE has 2 contingency EVA bolts. Both bolts or three latches and a bolt are sufficient for safe entry.

The internal configuration of the LOPE is shown in Figure 3-17. The contents of the LOPE are detailed in Table 3-2. Each ORU is supported independently, so any item can be removed or installed at anytime.

Table 3-2. LOPE contents

Item	Quantity
VIK jumper plugs	7
V/T signal jumper	1
Fuse modules (OTA P27A, P28A)	2
Fuse modules (OTA P25, P26)	2
Fuse plugs (P15, P16, P17)	2
PRT controller	1
PRT 6-ft umbilical	1
PRT wrench	1
RWA	1

The TMs are constructed of aluminum walls lined with foam. The foam is wrapped by thermal blanketing material and the items are secured in the TM with straps. The fuse plugs and the fuse modules are carried on a bracket in the lid of the LOPE. The bracket is populated with “dummy” receptacles, and each plug is removed/installed by demating/mating the “dummy” receptacles. VIK jumpers are carried on a caddy, and the caddy will be restrained in the lid of the LOPE using a captive deploy/lock pin.

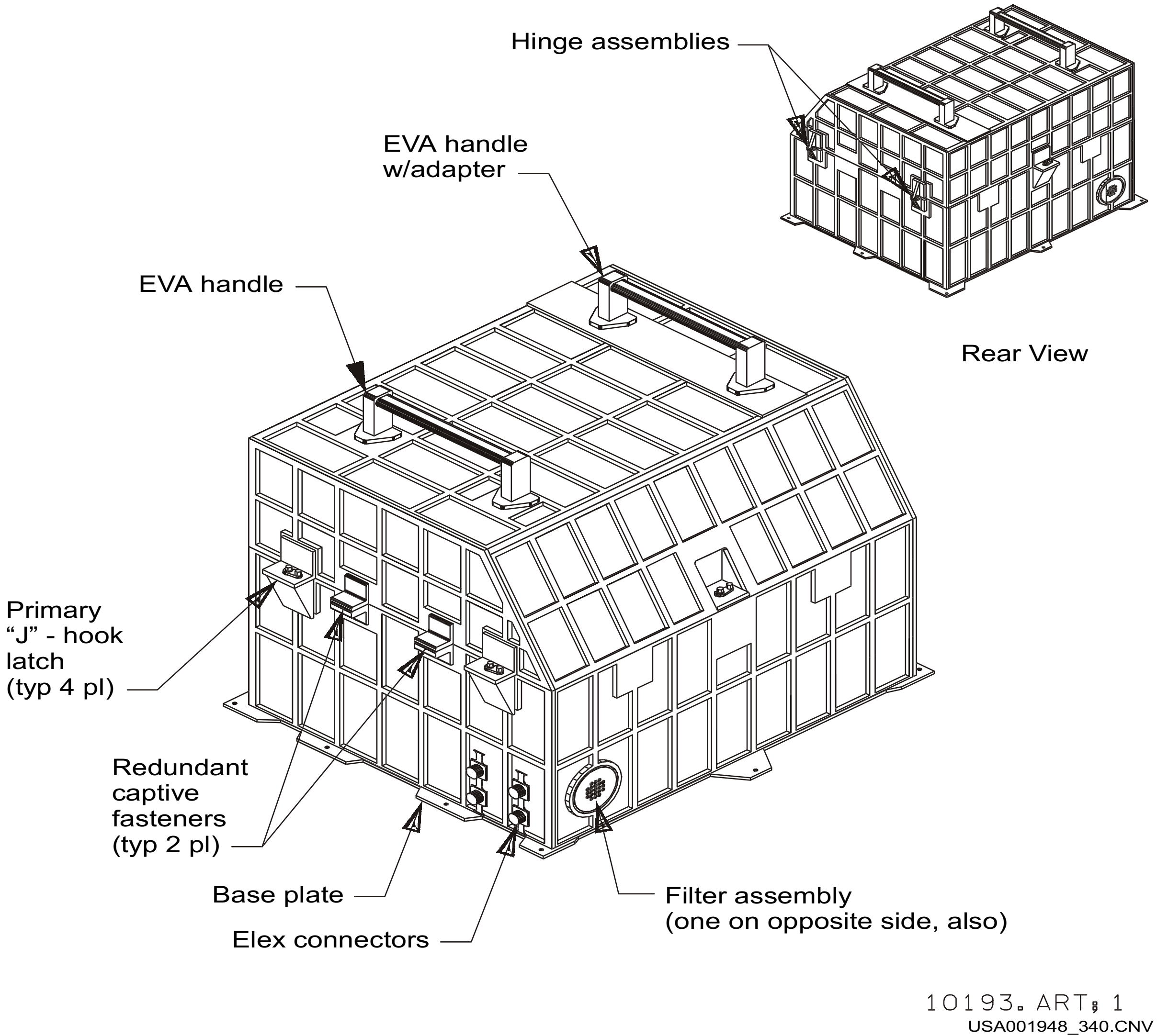


Figure 3-15. LOPE configuration

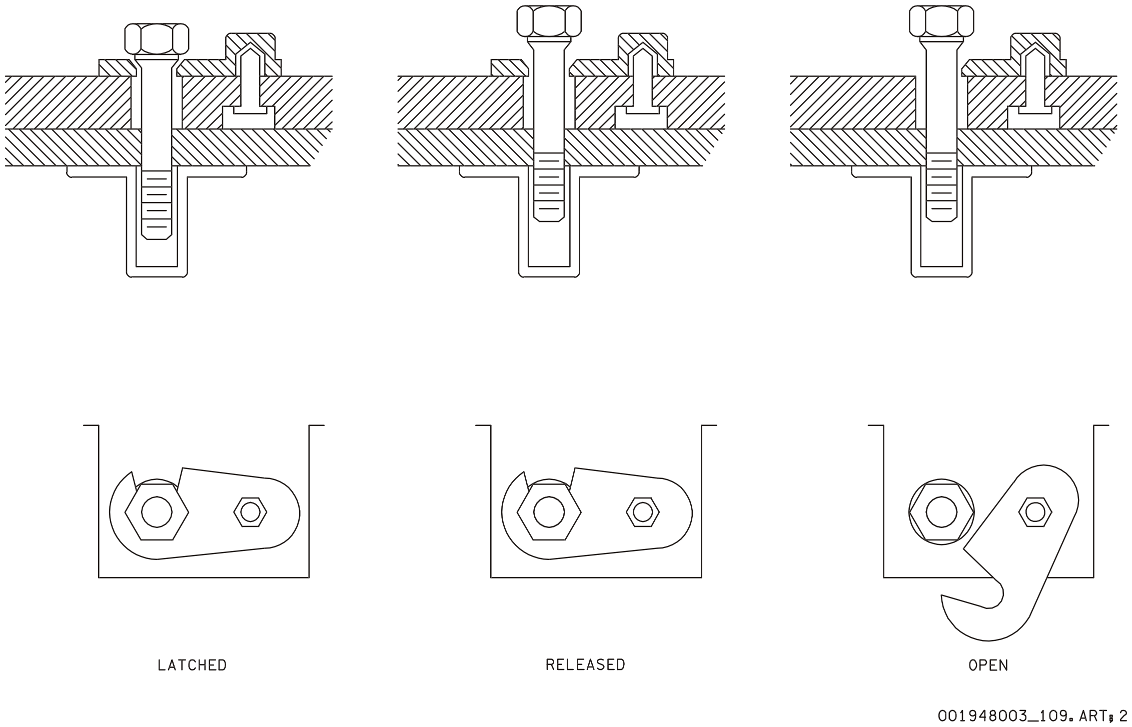


Figure 3-16. LOPE latches

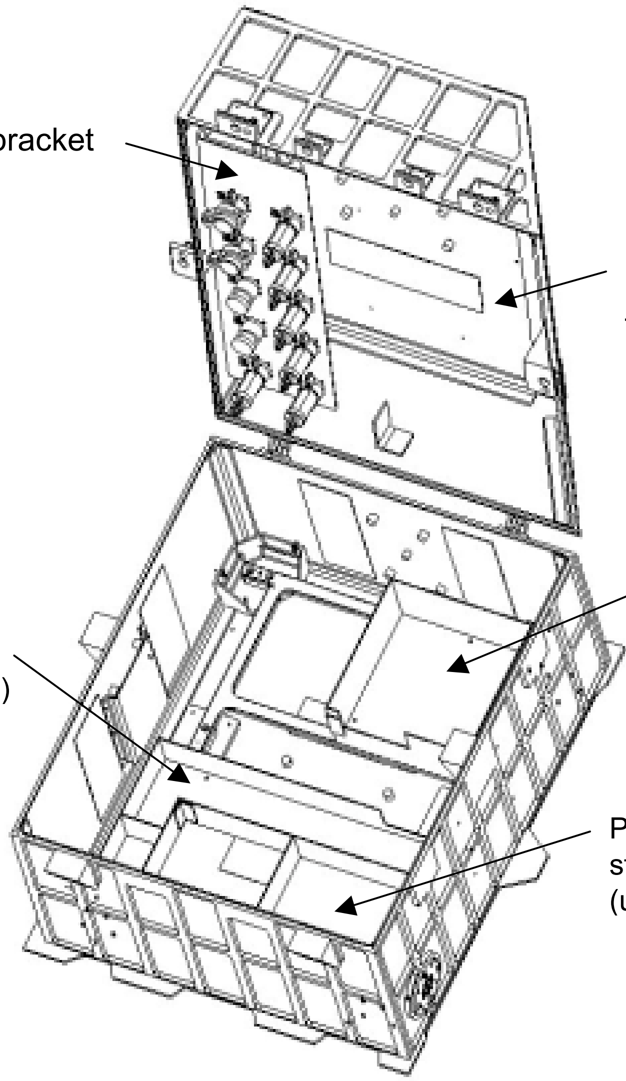


Figure 3-17. LOPE internal configuration

3.2 MULE ELECTRICAL POWER SUBSYSTEM

The MULE receives 1 of the 4 orbiter Primary Payload feeds and Payload Cabin 1 control power from the SSP. The orbiter provides +28 V dc power to the MULE PDSU. The PDSU then distributes the power to the MULE subsystems. For further details, see Drawing 3.2-1.

3.2.1 Power Distribution and Switching Unit

The PDSU receives 24-32 V, 200 amp fused dc power from the payload primary bus. The PDSU distributes 35 amp fused power to the MULE avionics and heaters via power relays. The PDSU power services have independent switching capability, 12 high-current sensors, and fault isolation. The PDSU also provides a common ground point for the MULE carrier. Drawing 3.2 shows the internal components of the PDSU and the distribution path for the power. There are no safety critical circuits for the MULE. The PDSU relays are controlled from the SSP switches. PDSU provides discrete 28 V telemetry, 18 V regulated dc power for thermistor bias, to the MULE FMDM DIL inputs. The PDSU also provides 0-5 V dc analog telemetry to the MULE FMDMs AID inputs. The PDSU measures 18- by 10- by 7.5 inches.

The PDSU provides for 17 services (only 11 of which are used for the MULE) as listed in Table 3-3.

Table 3-3. MULE power services

Service	SSP switch	PDSU relay	Relay rating	MULE assignment
1	S23	K5 K7	25 A 25 A	SOPE ZONE 1 PRIMARY HTR PWR SOPE ZONE 2 PRIMARY HTR PWR SOPE ZONE 3 PRIMARY HTR PWR
2	S24	K6 K8	25 A 25 A	SOPE ZONE 1 REDUNDANT HTR PWR SOPE ZONE 2 REDUNDANT HTR PWR SOPE ZONE 3 REDUNDANT HTR PWR
3	S19	K15	25 A	PDSU PRIMARY HTR PWR AVIONICS PLATE PRIMARY HTR PWR LOPE PRIMARY HTR PWR
4	S18	K16	25 A	PDSU REDUNDANT HTR PWR AVIONICS PLATE REDUNDANT HTR PWR LOPE REDUNDANT HTR PWR
5	S15	K9	10 A	FMDM A PWR PRIMARY THERMISTOR BIAS PWR
6	S16	K10	10 A	FMDM B PWR REDUNDANT THERMISTOR BIAS PWR
7	N/A	K19	10 A	NOT WIRED on output
8	N/A	K20	10 A	NOT WIRED on output
9	N/A	K17	25 A	NOT WIRED on output
10	N/A	K24	10 A	NOT WIRED on output
11	S20	K11	10 A	ESM ZONES 1&2 PRIMARY HTR PWR
12	S22	K12	10 A	ESM ZONES 1&2 REDUNDANT HTR PWR
13	S20	K13	10 A	ESM ZONE 3 PRIMARY HTR PWR
14	S22	K14	10 A	ESM ZONE 3 REDUNDANT HTR PWR
15	N/A	K21, K18 K22, K23	10 A 10 A	NOT WIRED on output
16	N/A	N/A	N/A	SSP PWR
17	N/A	N/A	N/A	NOT WIRED on output

The PDSU contains redundant 18 V dc regulators that provide the bias for the avionics and electrical equipment boxes thermistor circuitry. The regulator is powered from the same PDSU circuit as the FMDM.

The MULE avionics and heater power allocations are provided in Table 3-4.

Table 3-4. MULE power allocations at 32 volts

End Item	Primary	Redundant
FMDM	30 W	30 W
PDSU	20 W	20 W
SSP power	10 W	0 W

Table 3-4. MULE power allocations at 32 volts (concluded)

End Item	Primary	Redundant
Avionics/LOPE heaters	335 W	335 W
SOPE heaters	225 W	225 W
ESM heaters	175 W	175 W
Total	795 W	785W

3.3 MULE AVIONICS

3.3.1 Command Interfaces

The MULE is controlled solely from the SSP for this mission. Eight switches on the SSP are used to control the FMDM A power, FMDM B power, ESM heater A, ESM heater B, SOPE heater A, SOPE heater B, survival heater A, and survival heater B. The survival heater switches control the heater strings for the MULE avionics (PDSU and FMDMs) and the LOPE. The MULE SSP A side control power is received from the PDSU. The SSP B side control power is received from Cabin PL via CB 4. This is different from both FSS and SAC.

Spare power services are controlled via FMDM commanding, but the outputs of those relays are not connected for this mission (refer to Table 3-3).

3.3.2 Data Interfaces

Two data interfaces exist for the MULE: the serial telemetry interface via the payload data busses with the SM GPC and the discrete lines to the SSP. The MULE has an FMDM pair that collects MULE data and transmits the telemetry to the SM GPC via the payload data buses. FMDM A is on the PL 1 data bus and FMDM B is on the PL 2 data bus. Since the MULE FMDM pair is the second pair for the flight, the SM GPC will communicate with FMDM B on PL 2 when primary ports are selected and with FMDM A on PL 1 when secondary ports are selected.

Discrete signals for the power status of FMDM A, FMDM B, ESM heaters, SOPE heaters, and the survival heaters are wired to the SSP talkbacks. The FMDMs, ESM heaters, and SOPE heaters have independent talkbacks while the survival heater strings have the primary and secondary inputs OR'd together to a single talkback.

3.3.3 Flexible Multiplexer/Demultiplexer

The MULE has two FMDMs that are the principal components of its data handling system, providing the telemetry interface between the SM GPC and the MULE. The MULE FMDMs are the same type as used on the FSS; however, they have a different IOM complement. Details on the FMDM can be found in Appendix A of this CSM. This section will focus on the MULE specific wiring for these boxes. Drawing 3.2-1 illustrates how the FMDM receives telemetry from the sensors.

The two MULE FMDMs operate as a Flex pair, with the SM GPC only communicating with one FMDM at a time. To communicate with the other FMDM, the crew must do a port mode on the payload data buses. MULE FMDM A communicates with the SM

GPC via PL 1 data bus on the secondary port and FMDM B via the primary ports on the PL 2 data bus, as shown in Figure 2-28.

The FMDM is used to provide telemetry for the PDSU and MULE heaters. The SSP controls powering on the FMDMs and the heaters.

For SM3B the SSE avionics complement includes two pair of FMDMs, two on the FSS (address 29) and two on the MULE (address 30). There is no MULE safety critical telemetry. For this reason, in the event of a payload data bus failure, the FSS telemetry takes precedence over the MULE telemetry during attached operations or while the FSS is not stowed for landing. Port moding takes place to manage this situation.

3.3.4 FMDM Channelization

The IOM configuration for the MULE FMDMs is listed in Table 3-5.

Table 3-5. MULE IOM configuration

IOM	Type	Usage
0	DOL	Not used
1	AID	Voltage, current, and temperature measurement
2	DOH	Spare, not used for SM-3B
3	DOL	Not used
4	DIL	Status of heater and FMDM power state
5	Empty	Not used
6	DIL	Not used
7	SIO	Not used

Table 3-6 provides the channelization for the FMDMs.

Table 3-6. MULE FMDM channelization

IOM 1			
Channel	**FMDM A**	**FMDM B**	**MSID**
0	SOPE Prim Temp	SOPE Prim Temp	P34T8101V
1	ESM Prim Temp	ESM Prim Temp	P34T8102V
2	LOPE Prim Temp	LOPE Prim Temp	P34T8103V
3	SOPE Red Temp	SOPE Red Temp	P34T8104V
4	ESM Red Temp	ESM Red Temp	P34T8105V
5	LOPE Red Temp	LOPE Red Temp	P34T8106V
6-7	SPARE	SPARE	N/A
8	SOPE Zone 2 Prim Htr Current	SOPE Zone 2 Prim Htr Current	P34C8107V
9	SPARE	SPARE	P34C8108V
10	FMDM A Current	FMDM A Current	P34C8109V
11	ESM Zones 1&2 Prim Htr Current	ESM Zones 1&2 Red Htr Current	P34C8110V
12	ESM Zone 3 Prim Htr Current	ESM Zone 3 Red Htr Current	P34C8111V
13	SOPE Zone 1 Prim Htr Current	SOPE Zone 1 Prim Htr Current	P34C8112V
14	SOPE Zone 3 Prim Htr Current	SOPE Zone 3 Prim Htr Current	P34C8113V
15	FMDM B Current	FMDM B Current	P34C8114V
16-23	SPARE	SPARE	N/A
24	SOPE Zones 1&2 Red Htr Current	SOPE Zones 1&2 Red Htr Current	P34C8115V
25	SOPE Zone 3 Red Htr Current	SOPE Zone 3 Red Htr Current	P34C8116V
26	Survival Htr Current	Survival Htr Current	P34C8117V
27	SPARE	SPARE	P34C8118V
28	PDSU Temp	PDSU Temp	P34T8119V
29	FMDM A Temp	FMDM A Temp	P34T8120V
30	FMDM B Temp	FMDM B Temp	P34T8121V
31	PDSU Volts	PDSU Volts	P34V8122V

IOM 4			
Channel	**Bit**	**FUNCTION**	**MSID**
0	0-15	SPARE	N/A
1	0	ESM Zones 1&2 Prim Htr Status	P34X8401Y
	1	ESM Zone 3 Prim Htr Status	P34X8402Y
	2	Alt FMDM Status	P34X8403Y
	3	SPARE	N/A
	4	ESM Zones 1&2 Red Htr Status	P34X8404Y
	5	ESM Zone 3 Red Htr Status	P34X8405Y
	6	SOPE Zones 1&2 Prim Htr Status	P34X8406Y
	7	SOPE Zone 3 Prim Htr Status	P34X8407Y
	8-9	SPARE	N/A
	10	SOPE Zones 1&2 Red Htr Status	P34X8409Y
	11	SOPE Zone 3 Red Htr Status	P34X8410Y
	12	Survival Htr Status	P34X8411Y
	13-15	SPARE	N/A
2	0-15	SPARE	N/A

3.4 MULE THERMAL CONTROL

The MULE thermal control system provides temperature control of the MULE avionics, ORUs, and stowage containers. The thermal design is based on passive control under worst-case hot environmental conditions and heater control during worst-case cold conditions. The thermal analysis for STS-109 has been conducted, assuming a baseline orbital altitude of 320 n. mi. HST servicing typically is conducted in a modified –ZLV, Bay-to-Earth attitude.

The MULE provides a platform for carrying the NCC radiator panel, the ESM replacement ORU, the small ORU Protective Enclosure (SOPE), and the Large ORU Protective Enclosure (LOPE). The MULE cradle consists of a “U” shaped gridwork skeleton that is partially covered with honeycomb panels. The entire structure is covered with MLI. Three avionics boxes are mounted to an avionics radiator plate in the center of the “U” shaped cradle. The NCC radiator panel is mounted across the top of the MULE cradle.

The avionics on the MULE include two Flexible Multiplexer/Demultiplexers (FMDMs) and a Power Distribution and Switching Unit (PDSU). The boxes are hard mounted to a radiator plate so they can radiate heat to the environment. The PDSU has heaters to maintain component temperatures above cold operational limits during power-off modes, while the FMDM component temperatures are maintained via heaters on the radiator plate. All heaters are controlled with series thermostats, and heater circuits are fully redundant.

The ESM ORU is mounted to a honeycomb panel and is enclosed in an MLI soft cover on the aft port side of the MULE. The sides of the ESM MLI soft cover have inner and outer layers of 3-mil Kapton. The Kapton sides facing out of the orbiter bay are taped over with Silverized Teflon tape to reduce the applied heat load due to solar input. The removable top of the soft cover has an inner layer of 3-mil Kapton and an outer layer of Beta cloth. Heaters on the backside of the honeycomb panel maintain the ESM ORU within its temperature limits. After the ESM ORU is removed from the MULE and installed on the HST, the soft cover is not replaced, leaving the honeycomb panel exposed to space. At this time, the ESM heaters are powered off to avoid excessive heater power consumption. However, the bare honeycomb panel is still exposed to space and will act as a heat leak for the MULE cradle. To minimize the heat leak, 1/8-inch thick G-10 mounting washers are used between the panel and the cradle.

The NCC radiator, which is mounted across the top of the MULE, is thermally controlled via passive means.

The SOPE houses the RSUs and ECUs, as well as harnessing, CATs, and recovery equipment, as needed. The RSU and ECU components are supported inside the box via silicone foam. The SOPE is bolted to the MULE with 1/8-inch thick G-10 washers used for thermal isolation. Thermal control is maintained through five thermostat controlled heater circuits mounted on the four sides and bottom of the box. The heater circuits are fully redundant. The SOPE is MLI covered with a layer of 3-mil Kapton and an outer layer of Silverized Teflon.

The LOPE houses Fuse Modules and Plugs, as well as CATs. The LOPE is bolted to the MULE with 1/8-inch thick G-10 washers used for thermal isolation. Thermal control is maintained through six thermostat controlled heater circuits mounted on the four sides, top, and bottom of the box. The heater circuits are fully redundant. The LOPE is MLI covered with an inner and outer layer of 3-mil Kapton.

Table 3-7 provides the MULE subsystem temperature limits. Descriptions of the columns in the table are as follows:

- Component: specific payload hardware integrated into or stored on the MULE for SM-3B
- Yellow (Warning) Limit: temperature signaling a need for close monitoring and/or corrective action

  Avionics/Structure: Defined as 10 degrees within the critical limits

  Protective Enclosure: defined by ICD requirements for respective ORUs.
- Red (Critical) Limit: temperature that must not be exceeded

  Avionics: Qualification limit, maximum temperature seen in thermal vacuum testing

  Structure: Safety limit as defined by analysis

  Protective Enclosure: Defined by ICD requirements for respective ORUs. Reflects ORU non-operating limits

  ORU: non-operating temperature limits
- Transport/EVA Limit: temperature range required before removing any stowed item from stowage compartment during and EVA; for CAT (Crew Aids and Tools) it is the temperature that must be maintained while in use during an EVA.

Table 3-7. MULE subsystem temperature limits

Component**	Yellow Limit (°C) Low	Yellow Limit (°C) High	Red Limit (°C) Low	Red Limit (°C) High	Transport/EVA Limit (°C)
Structure					
MULE pallet	-110	+110	(°C)	+120	--
Avionics					
FMDM A&B*	-1	+50	-11	+60	--
PDSU*	-20	+50	-30	+60	--
Stowage Compartments					
ESM*	+20	+40	-40	+50	+32 to +43
SOPE*	+20	+45	+5	+60	+32 to +43
LOPE*	0	+50	+50	+71	+7 to +17
Most Restrictive ORU in each Stowage Compartment					
ESM ORU	--	--	-40	+50	+20 to +40
SOPE ORUs	--	--	+5	+60	+20 to +45
LOPE ORUs	--	--	-50	+71	0 to +50
NCC radiator	--	--	-75	+80	-75 to +80
NCC diode box	--	--	-52	+72	-52 to +72

* Components with flight temperature sensors.

** Temperatures for all items that do not have flight temperature sensors can be determined analytically via the environment temperature sensor records and the models. SSE Thermal (GSFC) can compare monitored components to our analysis temperature predictions to create a "scale factor" which can be used to adjust the temperature predictions of un-monitored components and determine their flight temperatures.

3.4.1 Active Thermal Control

The MULE heaters are located on the avionics radiator panel, the PDSU, the ESM honeycomb panel and the LOPE and SOPE walls. Although some ORUs have internal heater circuits, these are not used until after installation on the HST. Table 3-8 details the heater locations, resistance values, heater powers at 32 volts, and the thermostat set points for each circuit.

Table 3-8. MULE heater details (A and B sides are identical)

Heater location		Heaters per circuit	Resistance (Ω)	Power @ 32V (Watts)	Set points (°C)	
					Lower	Upper
Avionics radiator		2	7.0	146.3	+5	+10
PDSU		1	14.1	72.6	-20	-10
ESM	Circuit 1	2	17.4	58.9	+32	+43
	Circuit 2	2	17.4	58.9	+32	+43
	Circuit 3	2	17.4	58.9	+32	+43
SOPE	Aft	1	34.8	29.4	+32	+43
	Outboard	1	21.6	47.4	+32	+43
	Forward	1	34.8	29.4	+32	+43
	Inboard	1	18.0	56.9	+32	+43
	Bottom	1	16.3	62.8	+32	+43
LOPE	Lid	1	42.4	24.1	+7	+17
	Side wall	1	42.4	24.1	+7	+17
	Side wall	1	42.4	24.1	+7	+17
	End wall	1	42.4	24.1	+7	+17
	End wall	1	42.4	24.1	+7	+17
	Bottom	1	67.9	15.1	+7	+17

The MULE subsystem heaters have redundant sides A and B. Unlike the FSS, the MULE A and B side heaters are identical. Except during contingency failure cases, only one side is enabled at one time. All heater circuits utilize two bi-metallic thermostats in series. The redundancy and series thermostats protect against failed-on or failed-off heater conditions. Power is controlled via Standard Switch Panel (SSP) switches. Table 3-9 summarizes the MULE heater power capacities for 24 volts and 32 volts.

Table 3-9. MULE heater power summary

Component	Maximum heater power capacity (watts) @ 32 volts (1)		Minimum heater power capacity (watts) @ 24 volts (1)	
	A-Side	B-Side	A-Side	B-Side
Avionics radiator	146.3	146.3	82.3	82.3
PDSU	72.6	72.6	40.9	40.9
ESM	176.6	176.7	99.3	99.3
SOPE	226.4	226.4	127.1	127.1
LOPE	135.6	135.6	76.5	76.5

Primary and redundant telemetry thermistors are located on each heated or active component.

In addition to heaters, the avionics boxes will dissipate power during nominal operations. Table 3-10 details the MULE avionics power dissipation.

Table 3-10. MULE avionics power dissipation

Component	Power dissipation (Watts)	
	Cold case	Hot case
PDSU	20.0	20.0
FMDM A	30.0	30.0
FMDM B	--	--

3.4.2 Passive Thermal Control

The MULE also utilizes passive thermal control components. Table 3-11 details the surface thermal properties for MULE components.

Table 3-11. MULE surface thermal properties

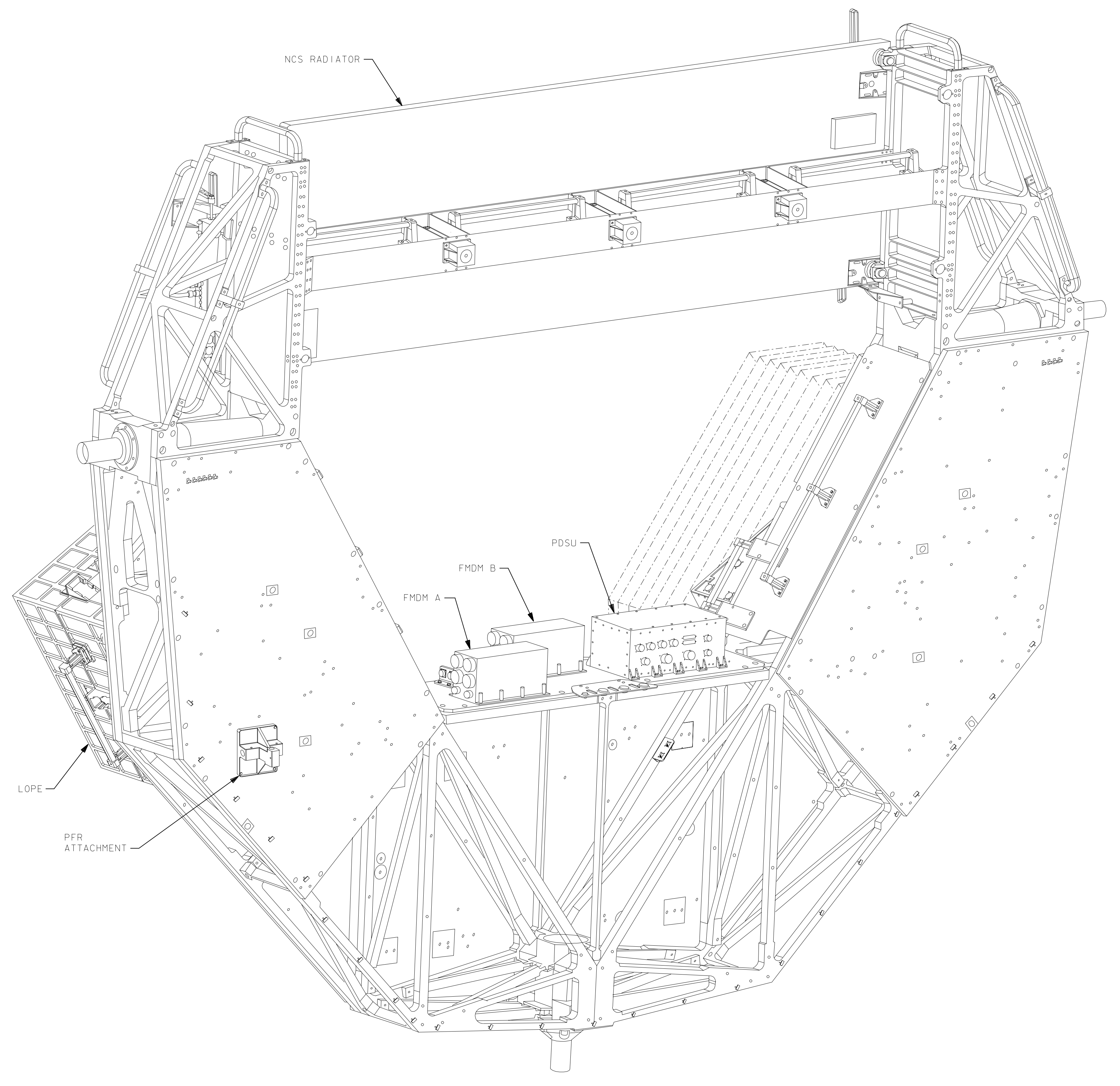
Component	Coating	α	ε
Structure	MLI (3 mil KAPTON outer layer)	0.45	0.78
Avionics Box Radiators	Silver coated Teflon tape	0.14	0.76
Avionics Radiator Plate	Silver coated Teflon tape	0.14	0.76
ESM Soft Cover Enclosure	MLI (3 mil KAPTON outer layer) MLI (Silver Teflon outer layer) MLI (Beta Cloth outer layer)	0.45 0.09 0.32	0.78 0.65 0.89
SOPE Exterior Box Hinges Latches Handrails (qty = 5) Vents	 MLI (Silver Teflon outer layer) Irridited aluminum Clear Anodize (2) Anodize, (3) Irridited aluminum Clear Anodize	 0.09 0.30 0.35 0.35 0.30 0.35	 0.65 0.10 0.84 0.84 0.10 0.84
LOPE (walls) (latches, handrails, hinges)	MLI (3 mil KAPTON outer layer) Irridited aluminum	0.45 0.30	0.78 0.10
NCC Radiator	White Chemglaze (front side) MLI (back side)	0.16 0.12	0.90 0.78

3.5 MULE VISUAL AIDS

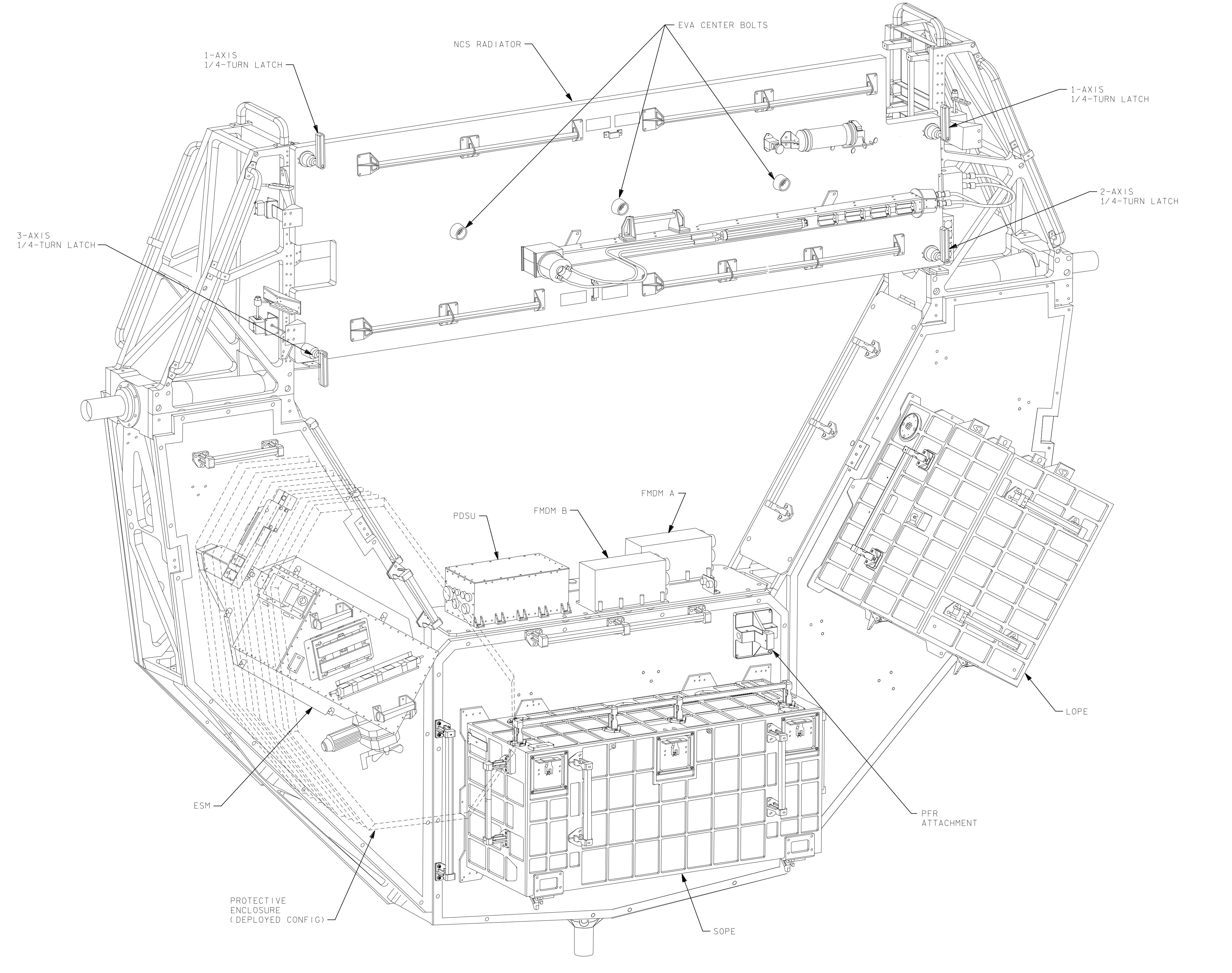
The MULE has no visual aids.

DATE: 01/24/02	NAME: MDU	VERSION: REL;6

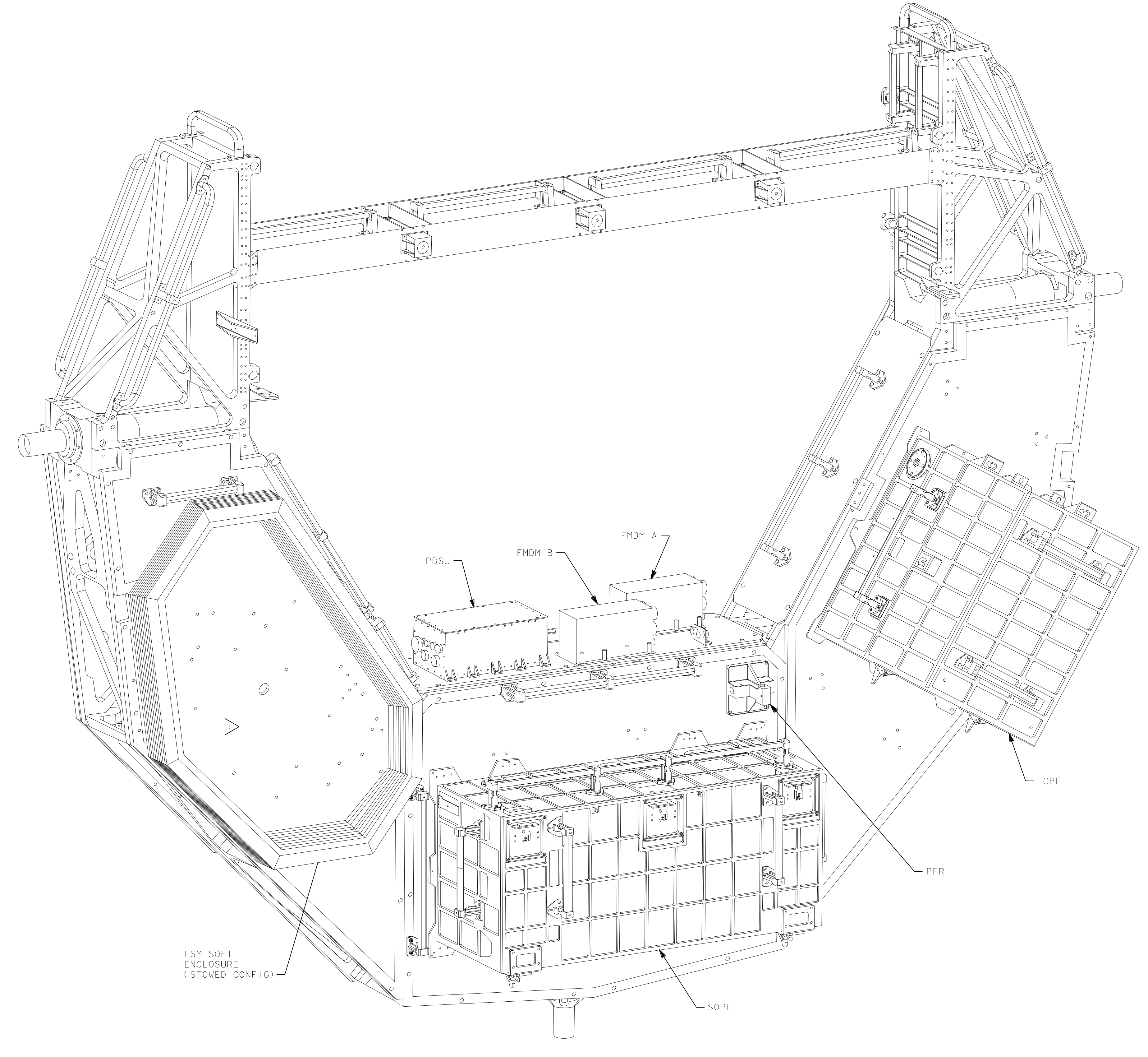
DATE: 12/07/01	NAME: VSH	VERSION: CHK;4
DATE: 01/17/02	NAME: SVJ	VERSION: REL;5
DATE: 01/24/02	NAME: MDU	VERSION: REL;6



FORWARD



AFT (LAUNCH CONFIG)



AFT (LANDING CONFIG)

1 ALL SOFT COVERS ARE SHOWN COLLAPSED IN THEIR OPEN POSITIONS, WITH THE LID NOT SHOWN FOR SIMPLICITY

1 MULE PHYS O/V

SIGNATURE	DATE	
DSGN V. HUNTER	10/3/01	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DR		MULE PHYSICAL OVERVIEW
ENGR R. HARVEY		
ENGR		
APP		
APP		HST SSE CSM — DWG NO 3.1
CADS		STS-109
LTR / PCN		104.5 X 34 — SHEET 1 OF 1

USA001948

USA001948

4 PDSU HEATER THERMOSTAT SETPOINTS: -20 C ON
-10 C OFF

FMDM HEATER THERMOSTAT SETPOINTS: +2 C ON
+10 C OFF

3 ALL HEATERS ARE MOUNTED TO INTERIOR WALLS OF BOXES

2 GPC PORT ASSIGNMENTS CAN BE READ IN GNC VP SLOT 1 (HEX CODE)

BIT	DESCRIPTION
1	UNUSED
2	STRING 1
3	STRING 2
4	STRING 3
5	STRING 4
6	PL 1/2
7	NA
8	NA

1 = PRIMARY (FMDM B)
0 = SECONDARY (FMDM A)

NOMINAL HEX CODE FOR FMDM B = 7C00
NOMINAL HEX CODE FOR FMDM A = 7800

NOTES: 1 FMDM A AND FMDM B TEMPS ARE READ BY BOTH FMDMS, BUT FMDM A POWER SUPPLY MUST BE TURNED ON TO CORRECTLY BIAS THERMISTOR FOR PROPER TEMPERATURE READING ON FMDM A. LIKEWISE FMDM B MUST BE ON TO MAKE FMDM B TEMP CORRECT. IF AN FMDM IS OFF THE TEMP WILL READ -55°C

2 MULE CMD/DATA/PWR

SIGNATURE		DATE	
DSGN	V. HUNTER	12/30/92	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DR	V. HUNTER	03/20/98	SPACE SUPPORT EQUIPMENT - MULE CMD/DATA/PWR
ENGR	T. McCRACKEN		
ENGR			
APP			
APP			HST SSE CSM — DWG NO 3.2
CADS			STS-109
LTR	PCN		126.5 X 34 — SHEET 1 OF 1

USA001948

4.0 SECOND AXIAL CARRIER

4.1 SAC PHYSICAL DESCRIPTION

The Second Axial Carrier (SAC), Drawing 4.1-1, is a reusable, reflown structure that provides transportation, load isolation, environmental control and protection for the Science Instruments (SIs), ORUs, and CATs, and tether positions to perform on-orbit servicing.

The Pallet Assembly (PA), Axial Scientific Instrument Protective Enclosure (ASIPE), ORU Plate Assembly (OPA), NOBL Transporter (NT), Under Pallet Stowage (UPS), and SAC Adapter Plate (SAP) are the principle structures of the SAC.

The secondary structures are the units carrying additional ORUs and CATs for EVAs.

4.1.1 Structural Interfaces

The SAC is located in the midsection of the payload bay and employs four orbiter PRLAs and an active keel latch as a structural retention system for the SAC trunnions (Drawing 1-1). The SAC PRLA latch locations are primary trunnions at Xo of 1017.87 inches and stabilizing trunnions at Xo of 931.33 inches. There is one keel trunnion at Xo of 1018.36 inches.

4.1.2 Pallet Assembly

The PA is the primary structure for the SAC and weighs 1820 pounds. The PA is composed of a flat pallet spanning across the cargo bay and four trunnion towers, which connect the longeron trunnions to the corners of the PA and tubular struts. Primary structural support during flight loads is supplied by the aft trunnions. Drag struts installed on the aft trunnion towers react to X-axis loads. The keel trunnion is attached to strategic intersections on the PA by three long tubular struts in a tripod arrangement. Tubular strut attachments are made using expanding bolts to eliminate structural rattle.

4.1.3 Axial SIPE

The ASIPE is composed primarily of aluminum honeycomb panels and an aluminum frame and end plates. The ASIPE weighs 567 pounds. When fully opened, a tether between a lid door handle and an ASIPE handrail can be used to restrain the lid. Each of the three ASIPE lid hinges consist of two-machined aluminum sections and a stainless steel pin. The hinge pin is free to rotate in the bushing that is also free to rotate in both hinge sections. There is no provision to remove the ASIPE hinges, shown in Figure 4-1. There are five EVA-activated latches (Figure 4-2) on the top of the ASIPE lid. Each of the five ASIPE door latches has a shear boss that must be engaged, and if a number of door latches fail, two contingency lid bolts are provided as backup. The lid can be safely secured with any three lid latches engaged.

Three latches secure the SI once it is fully seated in ASIPE. The ACS is launched in the ASIPE to replace the FOC in the HST. The FOC will return in the ASIPE. The B-latch, operated first, extends a plunger into the SI receptacle. While the B-latch is extending, the SI is seated on the A-latch and engaged over the C-latch. The A-latch constrains the SI along all three translational axes; the B-latch constrains the SI along the Y and Z axes, and the passive C-latch prevents rotation about latches A and B. Once the latches are engaged, all loads are transmitted through the three latches.

The ASIPE incorporates two diagonally opposed guide rail assemblies to maintain proper positioning of the SI during installation into the enclosure. Alignment marks on guide rails and microswitch controlled indicator lights provide visual cues during installation and removal. Indicator lights turn off to verify B-latch ready for engagement, A-latch seated, and A-latch engaged. The ASIPE safety bar is stowed on the forward face of the SAC pallet and is available for the EVA crew to secure the axially-located SI during de-orbit and landing in the event of a B-latch failure. There are also two ASIPE ground straps: one ground strap receptacle will be removed with ACS, and the other will support FOC for return to Earth.

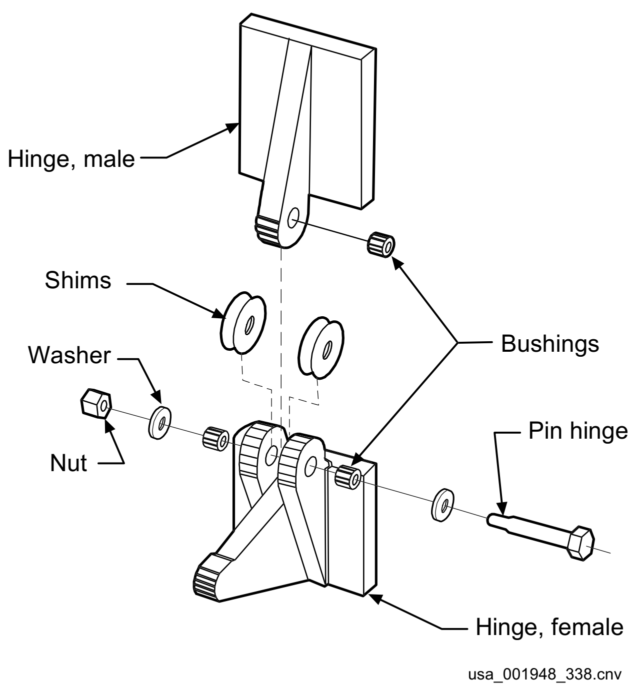


Figure 4-1. ASIPE lid hinge

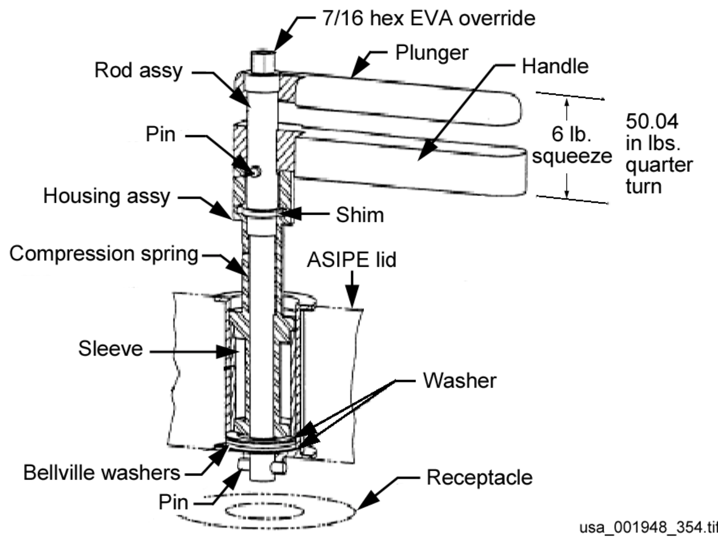


Figure 4-2. ASIPE lid latch

4.1.4 SAC Adapter Plate

The SAC Adapter Plate (SAP), Figure 4-3, is designed for stowage of the NICMOS Cryocooler (NCC) on the top-port panel of the SAC. The SAP is a 56- by 28.6- by 2.5-inch plate made from aluminum alloy hollowed out, from bottom, between structural ribs. The SAP weighs approximately 52 pounds. The SAP is attached to the SAC Pallet using eight ¼-28 bolts. The NCC attaches to the SAP using four EVA hex-head bolts. Two additional EVA contingency bolts are available for use if nominal bolts are broken and the NCC needs to be returned to Earth. The NCC is enclosed in an MLI soft cover for contamination and thermal protection. The soft enclosure has a semi-rigid Delrin rod frame with a Velcro attached lid that is sewn on one side to act as a hinge. The enclosure lid opens toward the ASIPE and is held open by Velcro against the ASIPE MLI.

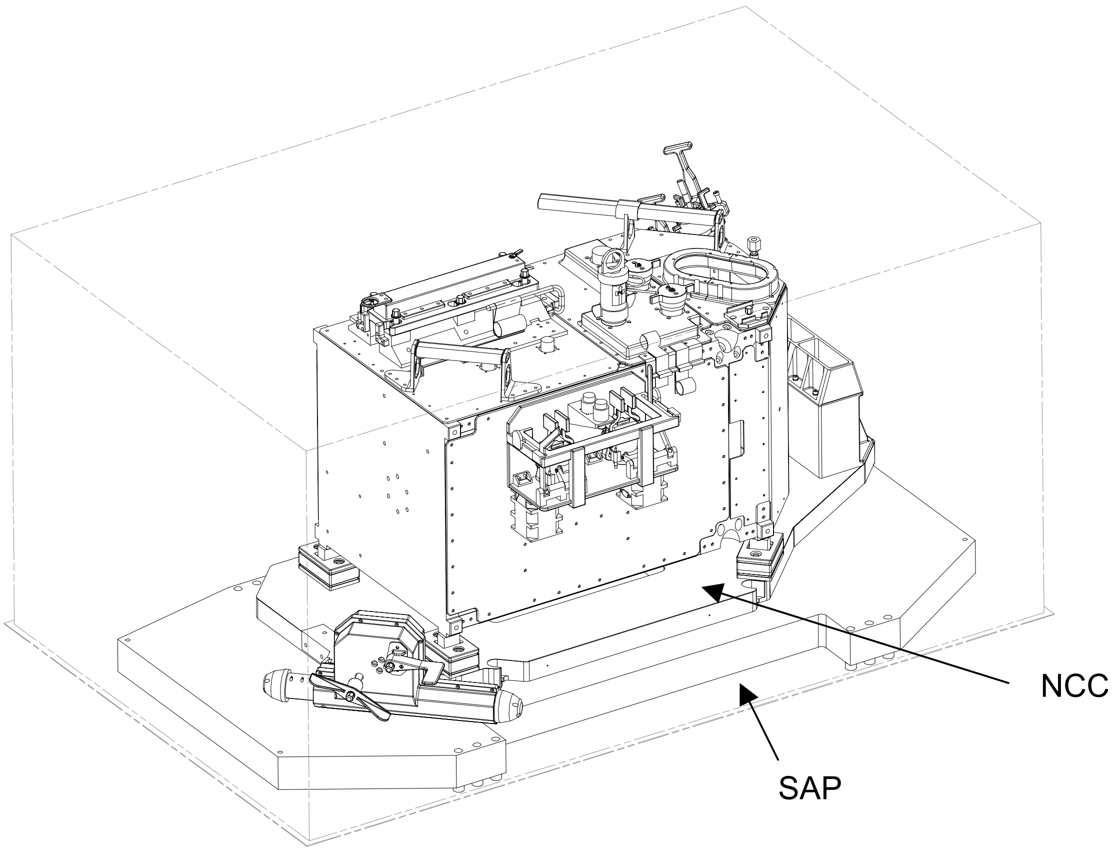


Figure 4-3. SAC Adapter Plate (SAP)

4.1.5 ORU Plate Assembly

The OPA, Figure 4-4, is designed for stowage of the HST PCU and other ORUs and CATs. The OPA is a 70- by 33- by 1.5-inch plate made from aluminum alloy hollowed out between structural ribs. The PCU interface to the OPA is similar to the HST mounting interface; the PCU will be launched with 6 of the 10 keyhole ORU Bolts engaged. The OPA uses mounting flexures (the MOPE Flexures used on SM-2) to provide structural damping and the mounting interface to the Pallet. There are 9-inch handrails located on the plate which account for the height of the PCU, and the soft cover over the PCU uses a Velcro interface with pull loops to deploy the cover. The cover opens toward the orbiter sill. The PCU Transport Handhold Stowage Assembly is mounted to the other area on the OPA and is described in Section 4.1.8.

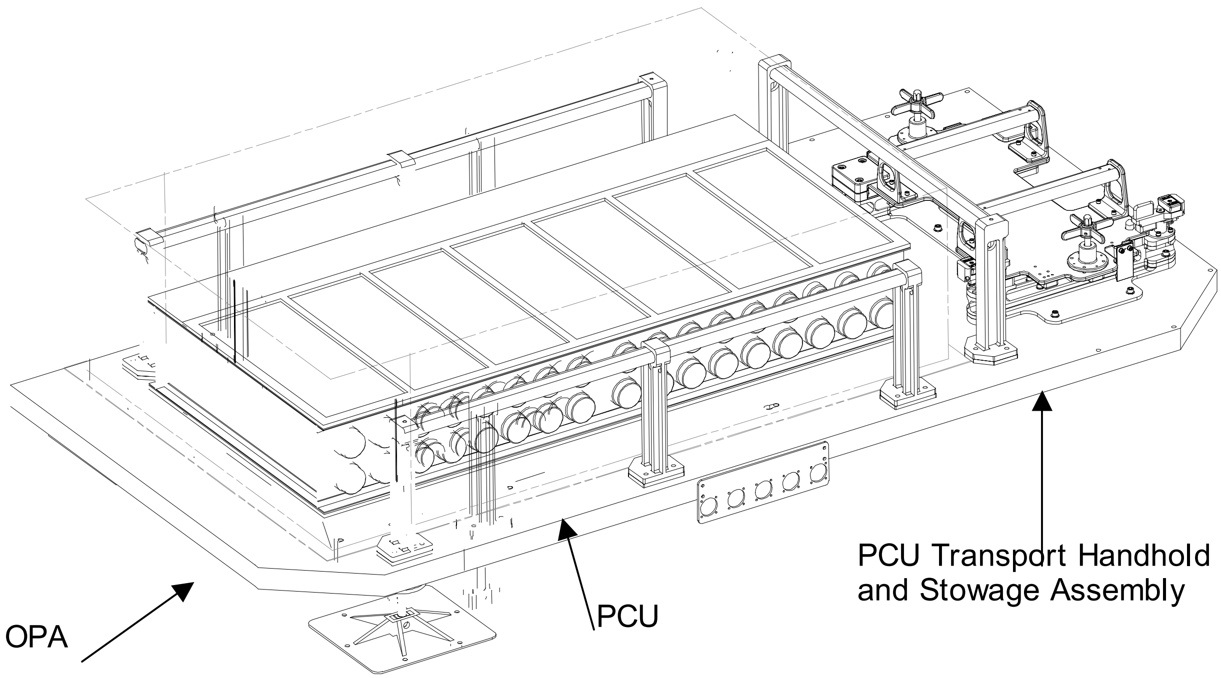


Figure 4-4. ORU plate assembly

4.1.6 NOBL Transporter

The NT, Figure 4-5, contains the sheet type NOBL pieces and associated attachment plugs that repair the HST SSM equipment bay door MLI. The NT will be stowed on the underside of the SAC pallet on the aft end. The NT weighs 150 pounds and is a mix of custom and commercial channels of aluminum beam construction. It consists of open sections with no lid or base panel and, therefore, does not require venting. The NT interface to the SAC is designed to decouple the NT from the SAC and minimize the moments into postbonded spool inserts. The NT/SAC interface hardware includes four mounting flexures that provide a seven Degree of Freedom (DOF) system. The flexures attach to the sides of the NT in four locations and to the SAC Pallet in seven locations. The NT has three one-quarter turn latches, three retractable shear pins, and three hinges. The vent plugs are stowed on the outside of the door in Kevlar reinforced Kapton pouches. The vent plugs are flown on stringers in groups of 4. Two banks of 4 vent plugs are in each pouch (8 per pouch). There are two identical pouches. The pouches are secured with a double Velcro closure and tightened down with a Kevlar strap. The strap employees a strap clamp similar to the one on the cooling system CPL restraint except it uses a hook and loop for initial engagement.

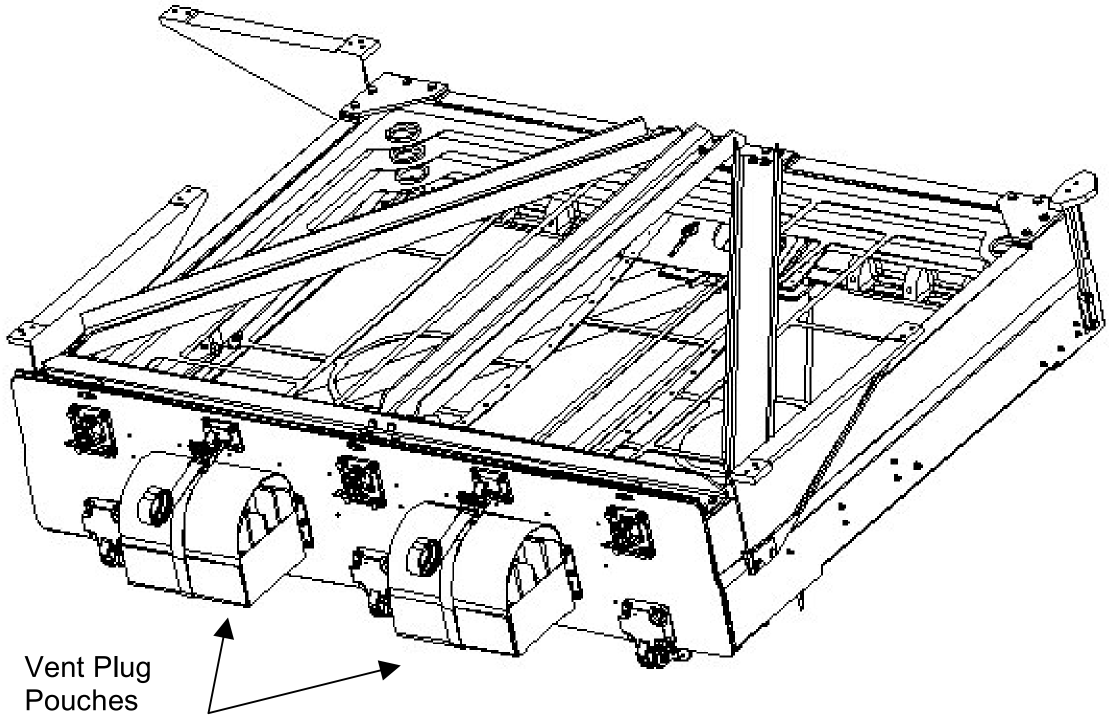


Figure 4-5. NT assembly

4.1.7 Under Pallet Stowage Assembly

The UPS Assembly, Figure 4-6, is mounted under the forward end of the Pallet to transport two Cross Aft Shroud Harnesses (CASHs), a primary and a spare. The UPS provides stowage for the two CASHs in two double slot boxes with one support bracket attached to each box and two center support brackets between the boxes. Each box has two one-quarter-turn latches and 2 retractable shear pins to secure the box lids. The center support brackets have one tensioning strap lock, identical to the NT, and one double Velcro strap each to help restrain the CASH. The UPS boxes also act as a contamination barrier for the CASH. Between the boxes there is a contamination cover over the CASH. The Velcro for the center support brackets is integral to the contamination cover, which is secured along the length by Velcro. The UPS boxes and supports are lined with foam that is covered with Teflon coated fiberglass sheets to provide a compliant, low-friction interface for the CASH.

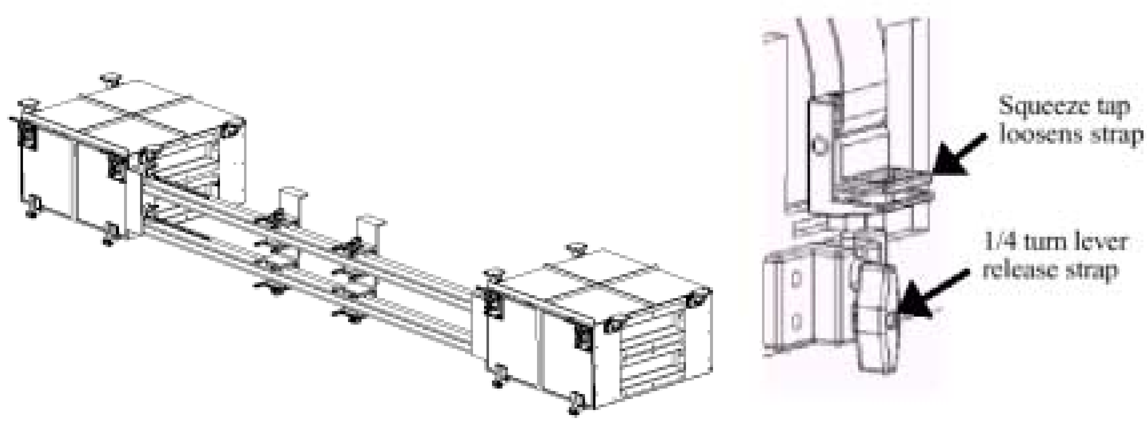


Figure 4-6. Under pallet assembly

4.1.8 PCU Transport Handhold Stowage Assembly

The PCU Transport Handhold Stowage Assembly, Figure 4-7, is an identical stowage design used on the FGS Handhold Stowage Assembly on SM2 and SM3A. The transport handhold plate slides into two Delrin guide blocks on the stowage assembly then rotates down over the two shear bosses and is locked in place by two 1-hand-actuated one-quarter-turn locking mechanisms. The mechanisms have a launch lock that must be pulled up to release and pushed down to lock. The Stowage Assembly is mounted to the OPA with 1/4-inch G-10 Fiberglass thermal spacers to thermally isolate it from the OPA.

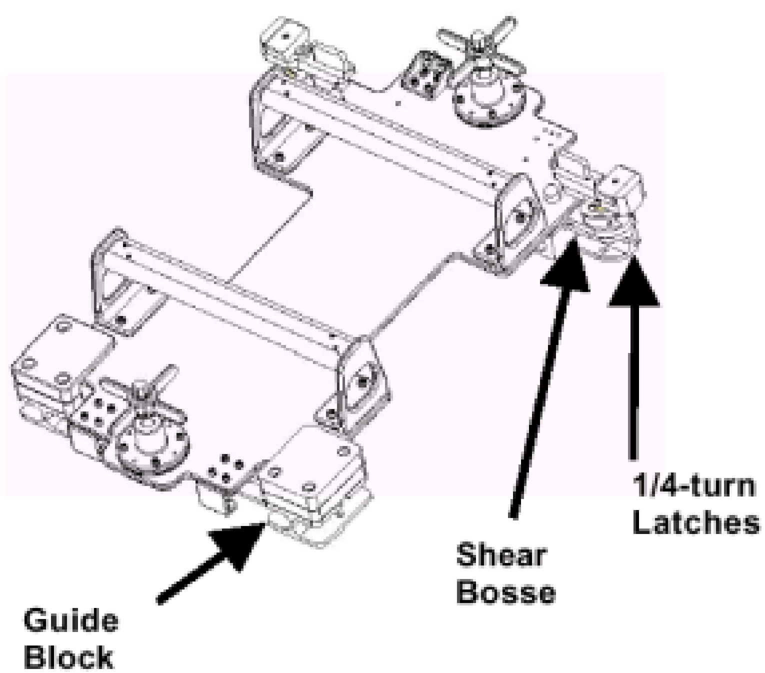


Figure 4-7. PCU transport handhold stowage assembly

4.1.9 Aft Fixture Assembly

The Aft Fixture Assembly, Figure 4-8, is attached to the aft port trunnion tower of the SAC; it flew on SM2 on the ORUC. The aft fixture is deployed on-orbit and is used to stow FOC during the ACS installation. The handrails on the FOC engage the forks of the aft fixture and the FOC is secured by a pip pin. The fixture is attached to the trunnion tower by two interface brackets mounted on the forward and aft sides of the tower. The tower support stands of the aft fixture mount to the tops of the interface brackets using two EVA contingency bolts and one shear pin each. The aft fixture is held in the stowage position using two pip pins with two hitch pins. To deploy the Aft Fixture the hitch pins and pip pins must be removed; then the upper section may be rotated about the pivot line of the tower support stands and locked into the deployed position using two push and one-quarter-turn deploy lock pins. The aft fixture may also be locked in a partially deployed position for no-RMS contingency operations. If the crew is unable to restow the fixture, the upper section can be removed and jettisoned by pulling the two pip pins that act as the hinge pins. The four EVA contingency bolts can also be removed to jettison the aft fixture, if necessary. When the Aft Fixture is in the deployed position, it is outside the 90-inch envelope and the Orbiter Cargo Bay doors cannot be closed. The interface bracket on the aft side of the trunnion tower has a mounting interface for the port Translation Aid socket.

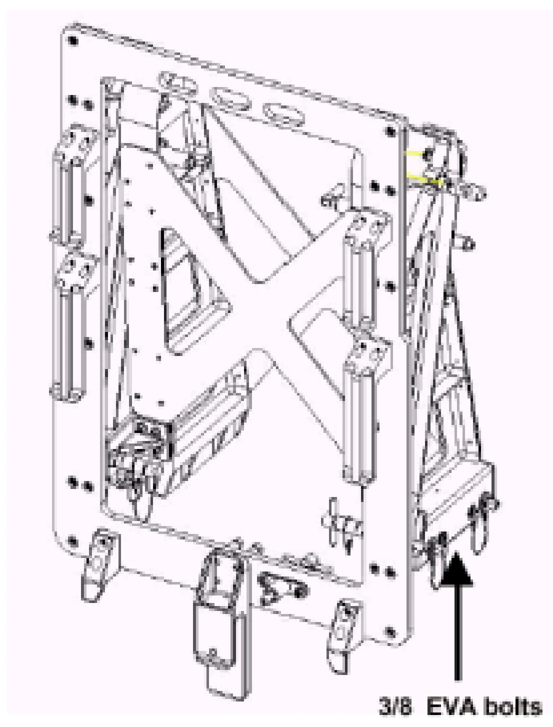
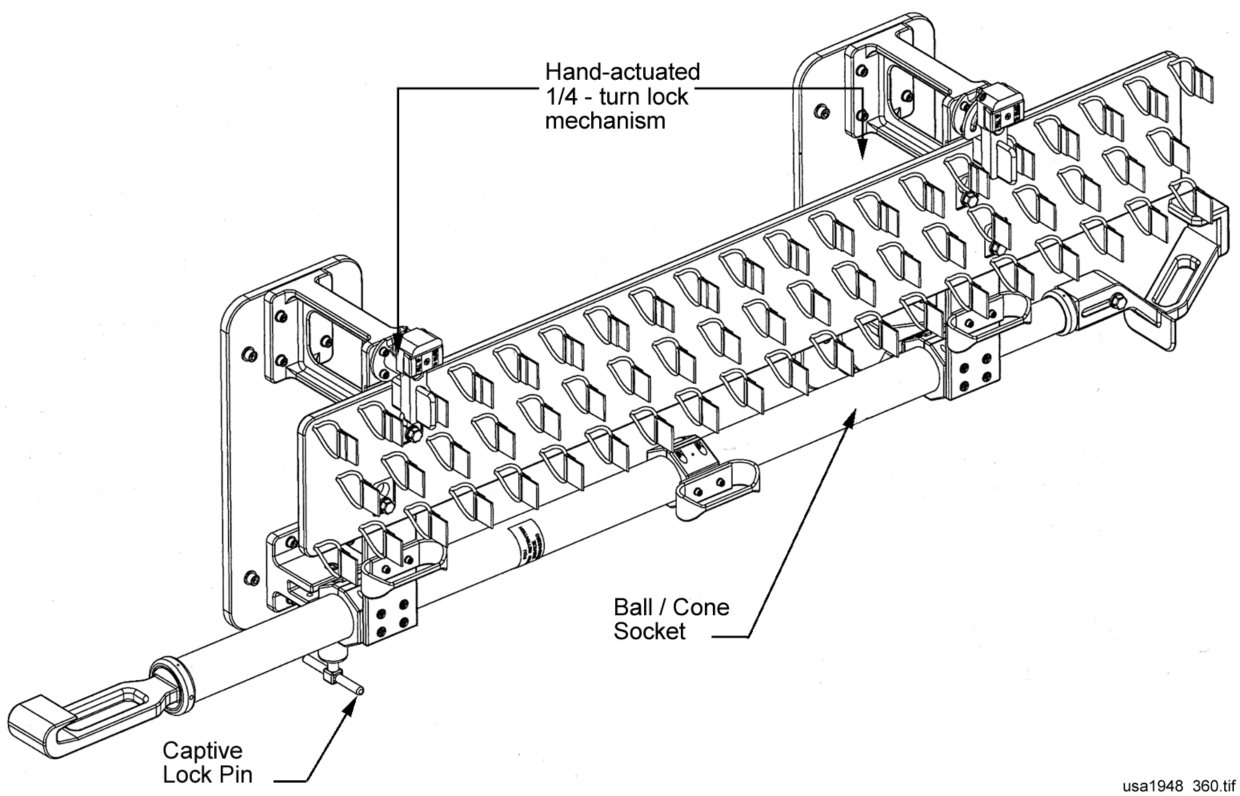


Figure 4-8. Aft fixture assembly

4.1.10 PCU Harness Retention Device Stowage Assembly

The PCU Harness Retention Device (HRD) Stowage Assembly, Figure 4-9, has two interface plates that mount to the forward face of the SAC pallet using hi-shear blind nuts in the box beam edges of the pallet honeycomb panels. The interface plates support a female clevis bracket with a captive lock pin at one end and a cone slot bracket at the other end. Each interface plate also has a support stand with a one-quarter-turn locking mechanism on each end. The captive lock pin is a push and one-quarter-turn latch that has two springs for single fault tolerance and two 7/16-inch captive EVA contingency bolts as a backup release, if required.



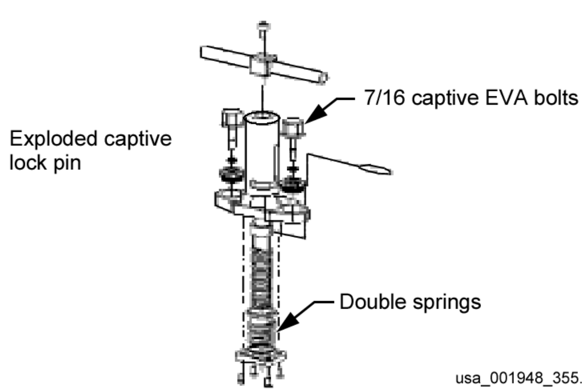


Figure 4-9. PCU harness retention device stowage assembly

4.1.11 Aft Shroud Latch Repair Kit Stowage Assembly

The Aft Shroud Latch Repair (ASLR) Kit Stowage Assembly, Figure 4-10, carries two types of clamping mechanisms designed to secure the HST aft shroud doors in the event of a door latch failure. For SM-3B, the following quantities are manifested for the aft shroud doors: Six standard door latches, Figure 4-11, and two axial handle latches, Figure 4-12. Each latch is seated between aluminum brackets and silicone foam pads and trapped in place by its own spring force and an EVA-operable slide lock mechanism. In the event of a jam in the slide lock, the entire slide lock assembly can be removed by loosening the two captive 7/16 inch hex-head fasteners securing it.

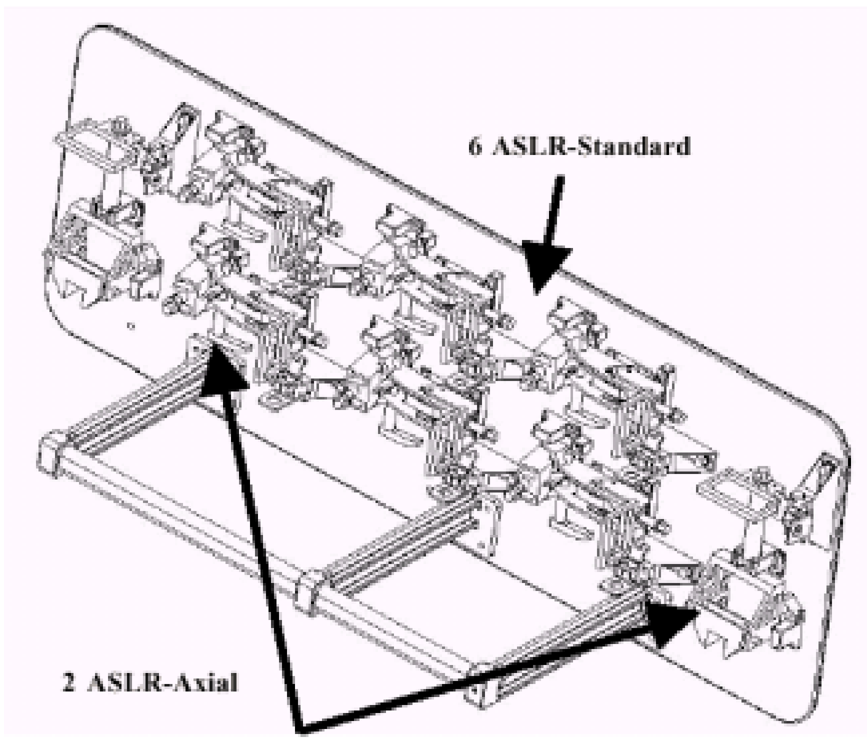


Figure 4-10. ASLR stowage assembly

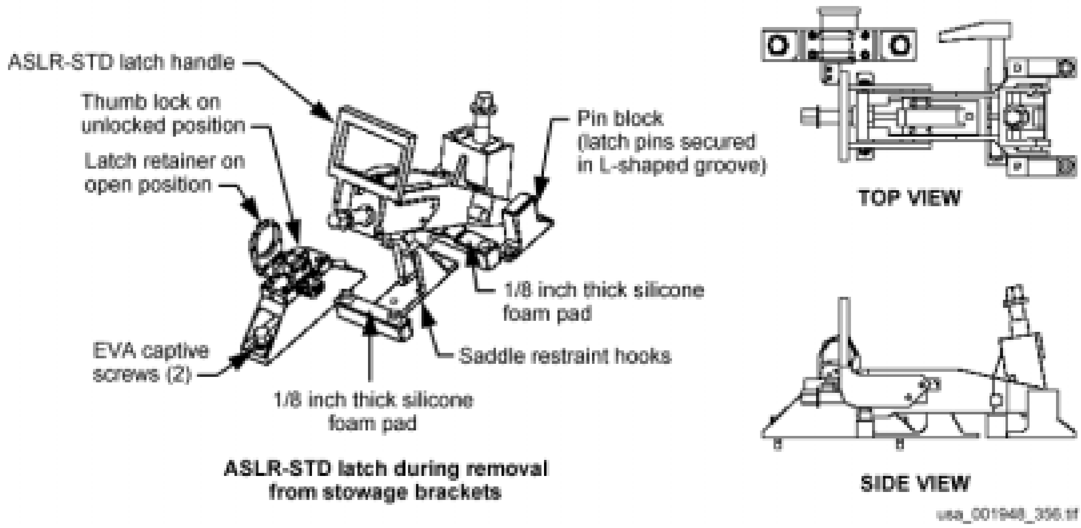


Figure 4-11. ASLR standard door latch assembly

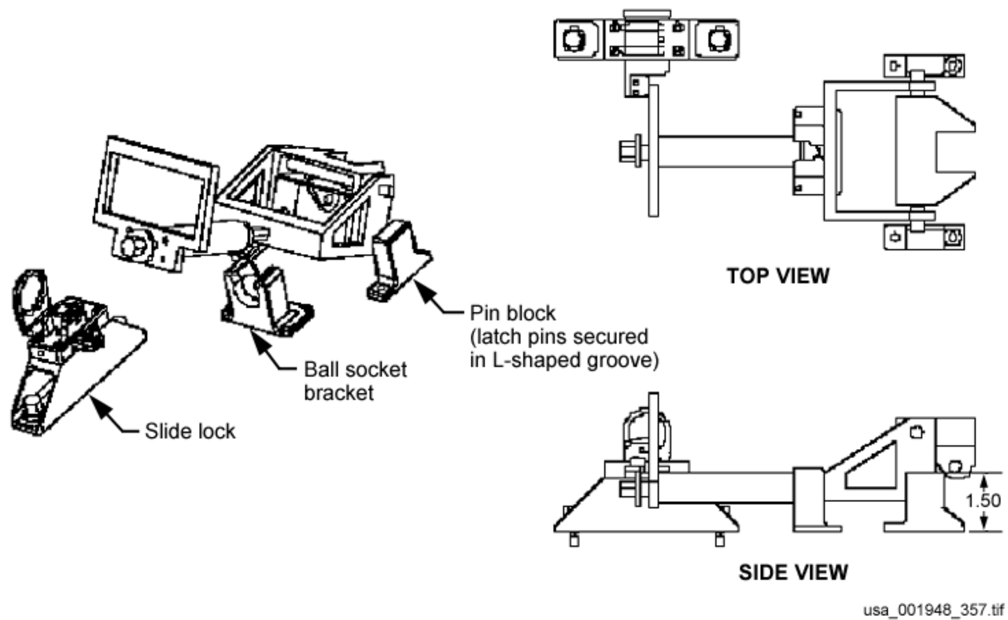


Figure 4-12. ASLR axial handle latch assembly

4.1.12 Translation Aids

There are three Translation Aids (TA) stowed on the SAC, Figure 4-13. The mini-TA is attached to the aft end of the ASIPE at the upper starboard handrail standoff location. The Mini-TA is launched stowed and is deployed on-orbit by removing a hitch pin and pip pin. Once the pip pin is released, the Mini-TA can be rotated into the deployed position and locked using the pip pin.

The port and starboard TAs are mounted to the SAC using PFR sockets with one hitch pin and one pip pin each. The port and starboard TAs will not be deployed for a nominal mission. If needed, the TAs can be deployed by hand knobs at joints A, B, and

C, and a hitch pin and pip pin release to extend the handle. The handles of the port and starboard TAs must be retracted for landing.

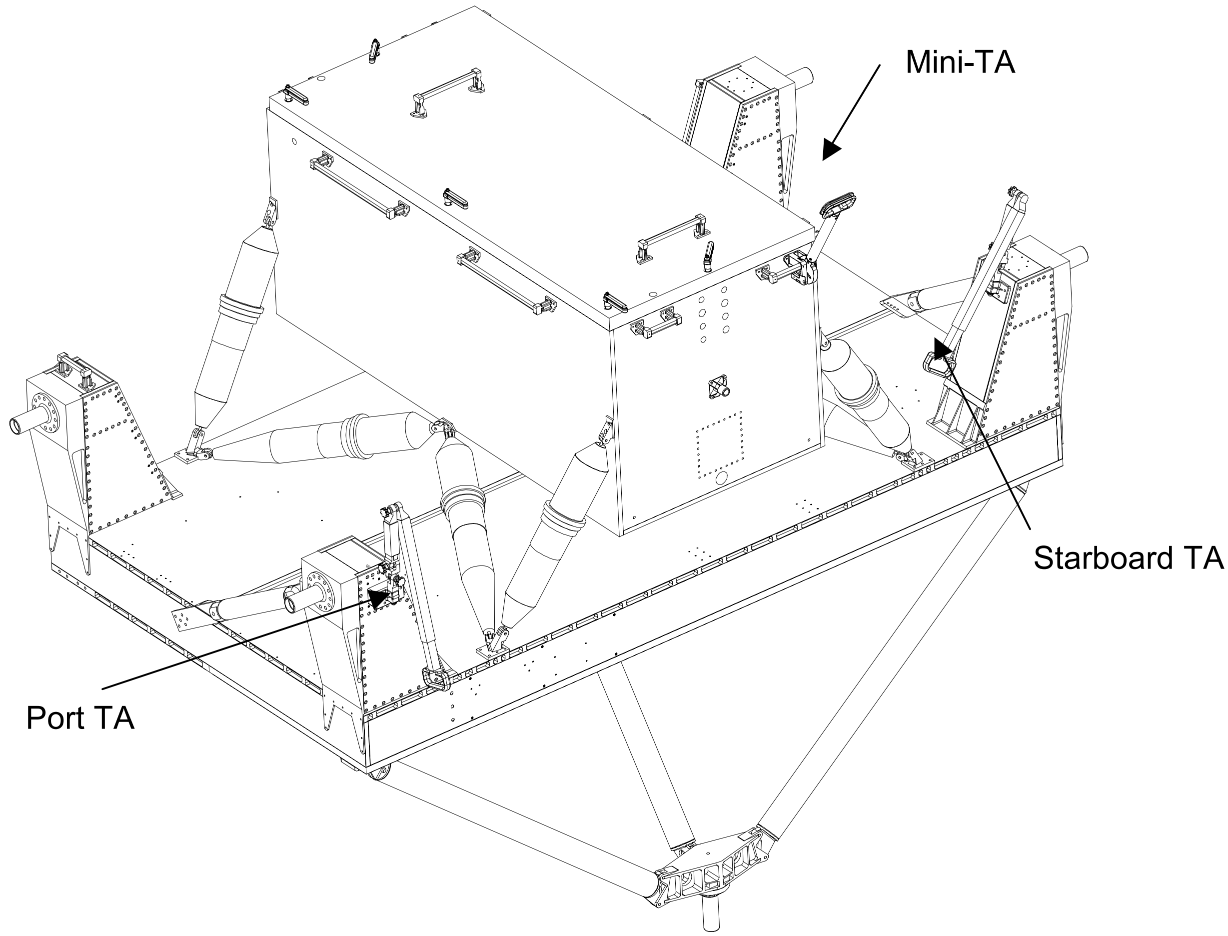


Figure 4-13. Translation aids

4.1.13 Wide Field Planetary Camera (WFPC) Thermal Cover Stowage Assembly

The WFPC Thermal Cover Stowage Assembly, Figure 4-14, is similar to the PCU transport handhold stowage assembly. Refer to Section 4.1.8 for details. The interface plate of the stowage hardware helps protect the CAT from inadvertent crew contact. The center (#1) FHST Light and Particle Shield (LPS) is an integral part of the WFPC Thermal Cover. The WFPC Thermal Cover has a removable tether that is attached to the FHST LPS #2 and #3. There is a conductive Velcro strap that attaches to the stowage interface plate and the WFPC Thermal Cover to ground the CAT during launch and landing.

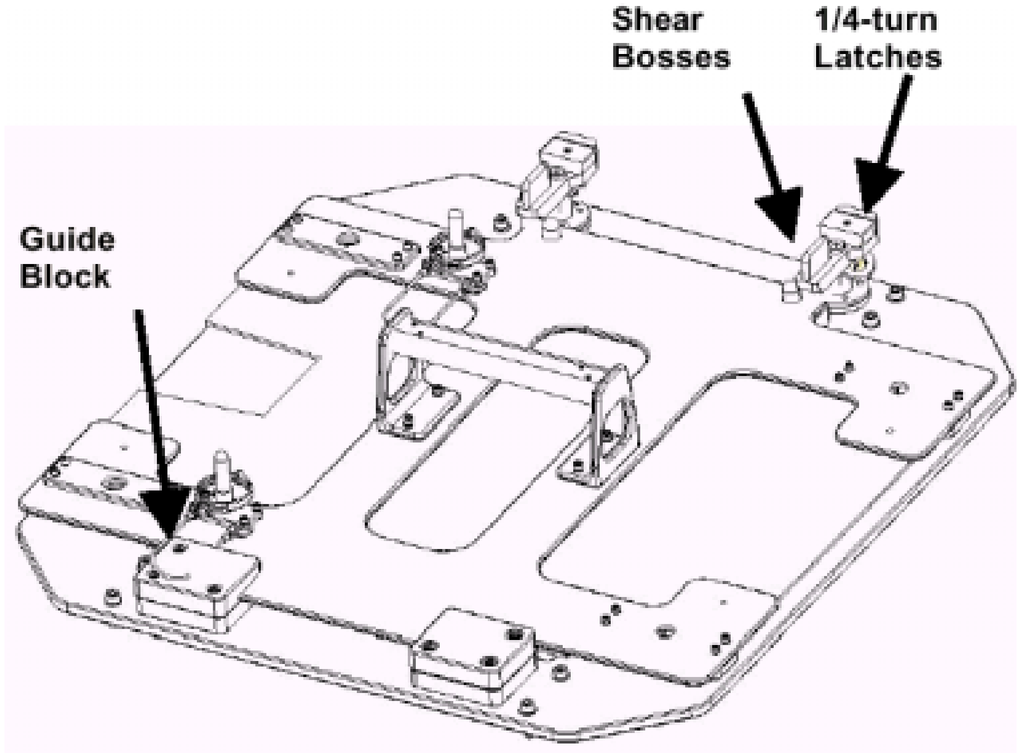


Figure 4-14. WFPC thermal cover stowage assembly

4.1.14 Exterior Stowage Pouches

The following CATs are stowed in a layered Kapton and Kevlar material pouch that is secured closed by a JSC one-quarter-turn latch and Velcro. The Stowage Pouches are located on the ASIPE and the SAC pallet as shown in Figure 4-15. The Pouch lids are held in the open position by Velcro and there is an internal Velcro strap that restrains the CAT while the EVA crewmember tethers to the CAT. The internal Velcro strap is made of conductive Velcro pouches that stow CATs that are made of MLI. Each pouch is mounted to the SAC using bolts and rivnut fasteners.

- FHST Light and Particle Shields (LPS) #2 and #3 – The FHST LPS is stowed on the forward port trunnion tower. The FHST LPS will have an integral tether that is attached to the WFPC Thermal Cover, so there is no internal strap restraining the FHST LPS in the pouch.

- Spare FHST LPS – The Spare FHST LPS stowage pouch is located on the top of the SAC Pallet under the ASIPE. The pouch has an internal strap to restrain the CAT while being tethered. The pouch is opened toward the forward end of the Pallet.

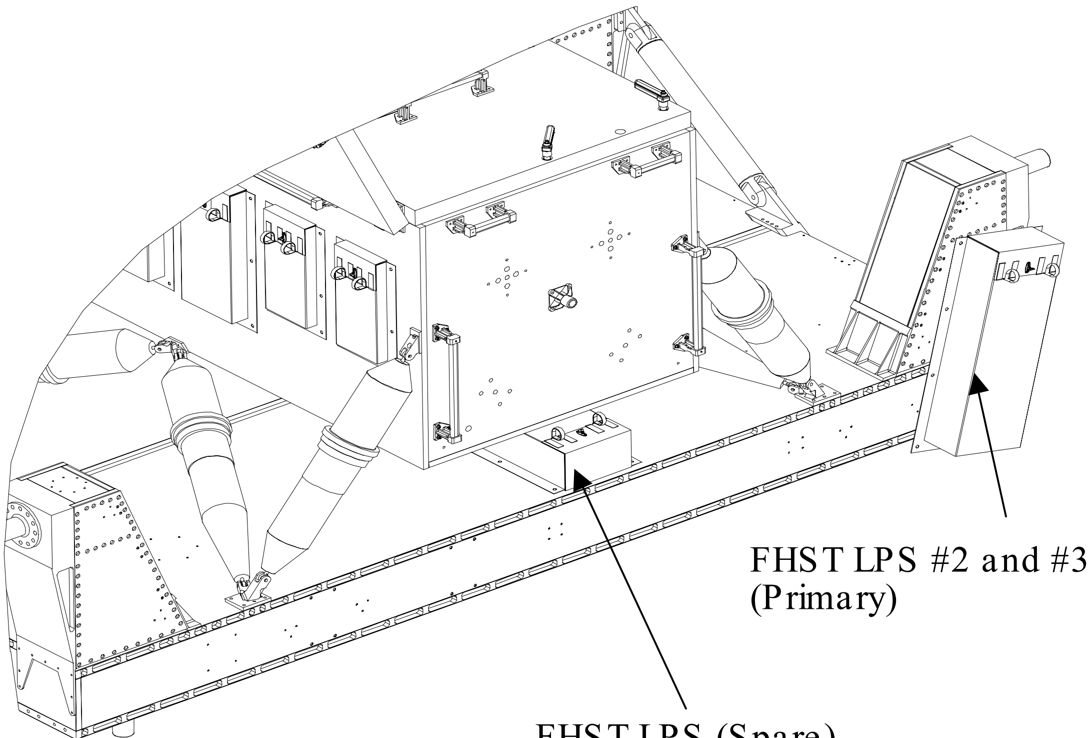


Figure 4-15. Stowage pouches on the SAC pallet

- SSM Bay Thermal Covers (Bays 5 and 10) and Diode Box Thermal Covers – Each diode box thermal cover (quantity two) is stowed attached to a SSM Bay Thermal Cover by conductive Velcro. The SSM Bay Thermal Cover Stowage Pouches are located on the top of the ASIPE (Figure 4-16). Both pouches open toward the aft end of the ASIPE. Each pouch has an internal strap made of conductive Velcro for grounding and restraining the CAT while being tethered.

- MLI Recover Bags (Bays 5 and 8) – The MLI recover bags are stowed in a double pouch that is located on the starboard side of ASIPE (aft end). The double pouch has one lid and two internal straps to secure the MLI recover bags while the crew tethers to the bags. The pouch opens toward the top of the ASIPE.

- Handrails Cover Caddies – The handrail cover caddies (quantity four) are stowed in separated stowage pouches located on the starboard side of ASIPE. Each pouch has an internal strap to restrain the CAT while being tethered. The pouches open toward the top of the ASIPE.

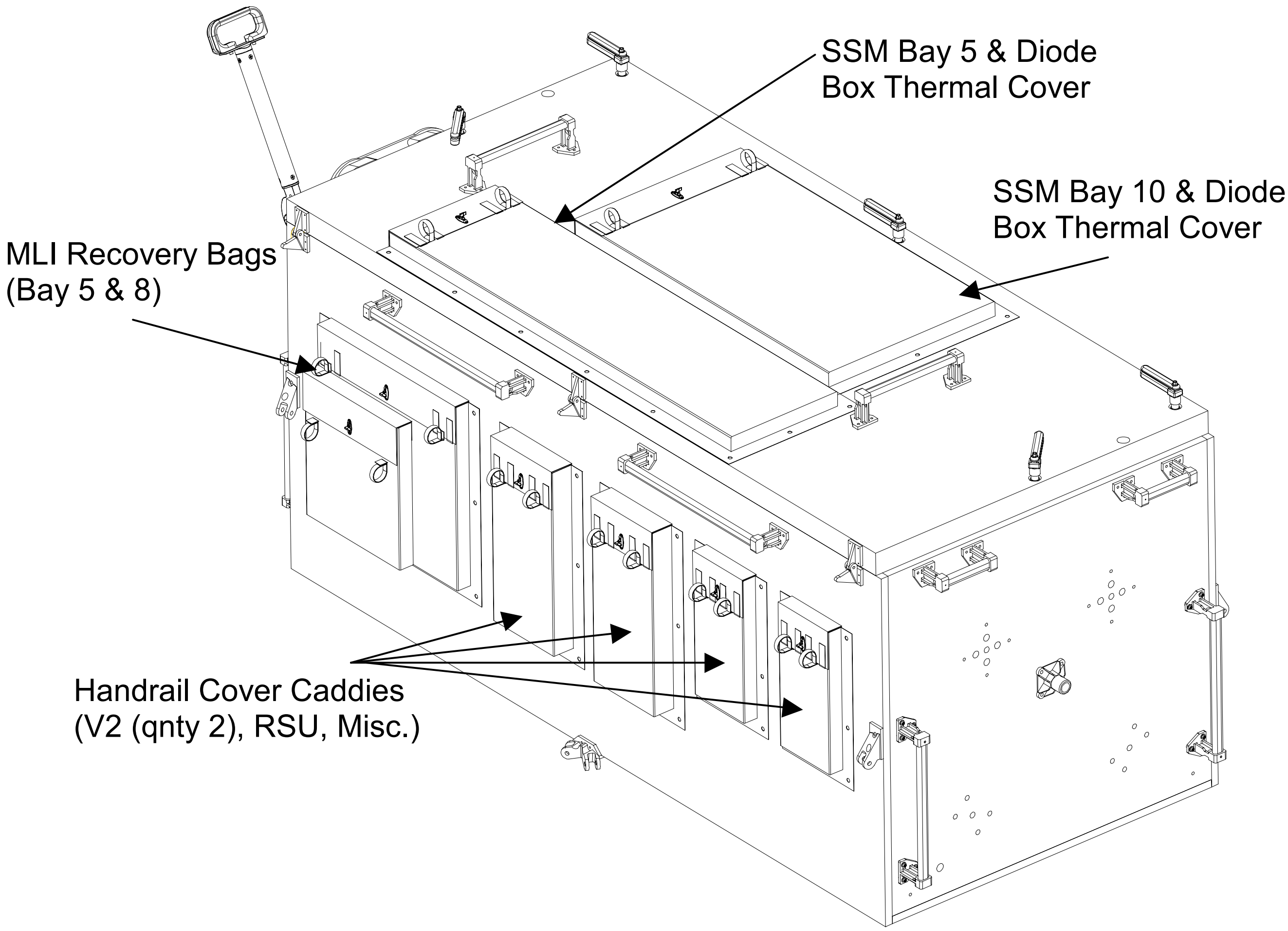


Figure 4-16. Stowage pouches on the ASIPE

4.1.15 SAC Mechanisms

The SAC Load Isolation System (LIS) is an eight-element Magnetic Strut (M-Strut) used to isolate the ASIPE from shock and vibration. Each Isolator consists of a spring and eddy-current damper acting in parallel. The stiffness of each Isolator is 800 lb/in and all eight isolators utilize common parts, except for the end cone that interfaces the pallet assembly. The overall weight of the M-Strut system is 494 pounds. The eddy current damper works by virtue of strong, permanent magnets arranged in circular patterns on inner and outer diameters of high purity copper sleeve. The outer sleeve and main shaft are structurally connected at one end of the isolator, terminating at a rod end fitting. The copper conductor is bonded to an inner sleeve that is structurally connected to the other rod end of the isolator. Thus, loads induce relative motion between the magnets and copper sleeve. This motion causes high amperage circulation electrical currents within the copper sleeve, which convert mechanical energy into heat. The permanent magnet radial arrays consist of eight magnet segments for the outer loop and six magnet segments for the inner loop. The segments are bonded between pairs of “back-irons” and nested with tube structure. The magnetic field external to the

M-Strut tubular surface has been verified to drop below tested Gauss levels, of 63 Gauss, for the EMU at a standoff distance of 1.3 inches.

4.2 SAC ELECTRICAL POWER DISTRIBUTION

The orbiter provides +28 V DC power (PL PRI) to the SAC EPDSU. The SAC EPDSU further distributes the power to the SAC Subsystems. For further details, see Drawing 4.2-1.

4.2.1 Enhanced Power Distribution and Switching Unit

The modular SAC EPDSU is designed specifically for distributing and switching standard orbiter fused power to the SAC subsystem by the way of Solid State Power Controllers (SSPCs) located on the individual SAC EPDSU modules. The power is distributed to the SAC thermostatically controlled heater system and fused regulated power for telemetry biasing. The orbiter SSP controls the SAC EPDSU SSPCs. The SAC EPDSU module circuits provide switched and distributed heater power services to the SAC subsystem and electrical equipment. The power services are shown in Table 4-1. The SAC EPDSU is designed to measure the currents of these services, and provide the information to the orbiter MDM. It also contains thermistor bias circuits used to monitor temperatures of the SAC subsystems. For further details, refer to the FSS EPDSU, Section 2.2.1.

Table 4-1. SAC power services

SSP2 switch	EPDSU SSPC	Power rating	SAC assignment
S13	4-1	20 amps	ASIPE heater A power, ASIPE indicator A power
S24 (UP)	4-3	7 amps	EPDSU Heater A power control
S14	5-1	20 amps	ASIPE heater B power, ASIPE indicator B power
S24 (DN)	5-3	7 amps	EPDSU Heater B power control
S22	6-1	20 amps	OPA heater A power
S18	6-2	15 amps	SAP heater A power
S23	7-1	20 amps	OPA heater B power
S19	7-2	15 amps	SAP heater B power

*S20 is required for B-side switches
*cb4 is required for A-side switches

Table 4-2 describes the power allocations at 32 V.

Table 4-2. SAC power allocation at 32 V

	Primary side	Redundant side
ASIPE heaters	415 W	415 W
EPDSU A heater	75 W	75 W
OPA heaters	290 W	290 W
SAP heaters	290 W	290 W
EPDSU	20 W	20 W
Total	1090 W	1090 W

4.3 SAC AVIONICS

The electrical system interfaces with the orbiter power system to provide fused, unregulated power for the thermostatically controlled heater system of the SAC and fused, regulated power for telemetry biasing. The SAC power system is controlled via aft flight deck Standard Switch Panel (SSP) functions. Output from the SAC telemetry sensors is routed to the orbiter MDM and can be viewed by both the ground and the crew.

4.3.1 Command and Data Interface

The orbiter SSP is used to control and monitor SAC hardware functions. The SM GPC receives telemetry from the SAC via the payload MDMs. Orbiter payload MDMs PF1 and PF2 interface with the SAC for latch status, temperature, heater enable status, bus current and voltage telemetry. Table 4-3 summarizes the MDM and IOM interface. The SAC command and data interfaces are given in Drawing 4.2.

Table 4-3. SAC MDM assignments

PF01 IOM 1		
Channel	**FUNCTION**	**MSID**
0	SAC Structure B Temp	P34T5213V
1	SAC Stbd Environment B Temp	P34T5214V
2	SAC OPA Mid B Temp	P34T5215V
3	SAC EPDSU B Volts	P34T5216V
4	SAC SAP Port B Temp	P34T5217V
5	SAC SAP Fwd B Temp	P34T5218V
6	ASIPE Aft Temp	P34T5219V
7	ASIPE Fwd Temp	P34T5220V
8	SAC EPDSU Temp 1	P34T5221V
9	SAC EPDSU Module 7 Current	P34C5222V
10	SAC EPDSU Module 6 Current	P34C5223V
11	SAC EPDSU Module 5 Current	P34C5224V
12	SAC EPDSU Module 4 Current	P34C5225V
13-15	SPARE	N/A

Table 4-3. SAC MDM assignments (Concluded)

PF01 IOM 11		
Channel	**FUNCTION**	**MSID**
0-1	SPARE	N/A
2	SAC ASIPE Lid A Temp	P34T6158V
3	SAC ASIPE B-Latch A Temp	P34T6159V
4-15	SPARE	N/A

PF01 IOM 13			
Channel	**Bit**	**FUNCTION**	**MSID**
0	0-15	SPARE	N/A
1	0-15	SPARE	N/A
2	0	SAC ASIPE B-Latch Not Ready Status	P34X6133Y
	1	SAC ASIPE A-Latch Not Seated Status	P34X6134Y
	2	SAC ASIPE A-Latch Not Latched Status	P34X6135Y
	3-15	SPARE	N/A

PF02 IOM 1		
Channel	**FUNCTION**	**MSID**
0	SAC Port Environment A Temp	P34T5201V
1	SAC OPA Fwd A Temp	P34T5202V
2	SAC OPA Aft A Temp	P34T5203V
3	SAC SAP Stbd A Temp	P34T5204V
4	SAC EPDSU Temp 2	P34T5205V
5	SAC EPDSU Total Current	P34C5206V
6	SAC ASIPE B-Latch B Temp	P34T5207V
7	SAC EPDSU A Volts	P34T5208V
8	SAC SAP Aft A Temp	P34T5209V
9	SAC ASIPE Stbd Temp	P34C5210V
10	SAC ASIPE Port Temp	P34C5211V
11	SAC ASIPE Lid B Temp	P34C5212V

PF02 IOM 5			
Channel	**Bit**	**FUNCTION**	**MSID**
0	0-15	SPARE	N/A
1	0-7	SPARE	N/A
	8	SAC ASIPE Htr A Pwr Status	P34X5226Y
	9	SPARE	N/A
	10	SAC EPDSU Htr A Pwr Status	P34X5228Y
	11	SAC ASIPE Htr B Pwr Status	P34X5229Y
	12	SPARE	N/A
	13	SAC EPDSU Htr B Pwr Status	P34X5231Y
	14	SAC OPA Htr A Pwr Status	P34X5232Y
	15	SAC SAP Htr A Pwr Satus	P34X5233Y
2	0	SPARE	N/A
	1	SAC OPA Htr B Pwr Status	P34X5235Y
	2	SAC SAP Htr B Pwr Status	P34X5236Y
	3-15	SPARE	N/A

4.4 SAC THERMAL CONTROL

The SAC Pallet incorporates both active heater control and passive thermal systems. Power service and heater margins were selected to provide single-bus adequate heater provisions at 24 V dc measured at the SIP. There are several thermally significant items integrated into or stored on the SAC: one Axial SIPE (ASIPE), one SAC Adapter Plate (SAP), and one ORU Plate Assembly (OPA); one avionics box – the Enhanced Power Distribution and Switching Unit (EPDSU), one Under Pallet Storage unit (UPS), one NOBL Transporter (NT), and several Crew Aids and Tools (CAT). Temperature requirements for individual Orbital Replacement Units (ORU) and Scientific Instruments (SI) stowed in the above enclosures can be found in ICD-97 and SI requirement documentation. Table 4-4 provides the SAC subsystem temperature limits. Descriptions of each column are as follows:

a. Component: Specific payload hardware integrated into or stored on the SAC for SM-3B

b. Yellow (Warning) Limit: Temperature signaling a need for close monitoring and/or corrective action

   1. Avionics/ Structure: Defined as 10 degrees within the critical limits

   2. Stowage Compartment: Defined by ICD requirements for ORUs operating limits or within 10 degrees of critical limits for compartments that will have heaters disabled after ORU is removed.

   3. ORU: N/A

   4. CAT: Defined as 10 degrees within critical limits

c. Red (Critical) Limit: Temperature that must not be exceeded

   1. Structure: Safety limit as defined by analysis

   2. Avionics: Qualification limit, maximum temperature seen in thermal vacuum testing

   3. Stowage Compartment: Defined by ICD requirements for ORUs. Reflects OPU non-operating limits or compartment qualification temperatures for compartments that will have heaters disable are ORU is removed.

   4. ORU: Non-operating temperature limits

   5. CAT: Non-operating temperature limits

d. Transport/EVA Limit:

1. Stowage Compartment: Temperature range required before removing stowed item from compartment. Ensures that the ORU is able to meet its respective operating temperature range for nominal installation activities

2. ORU: Temperature range to be maintained while stowed during the EVA periods

3. CAT: Operating temperature limits

Table 4-4. SAC subsystem temperature limits

Component**	**Yellow (Warning) Limit (°C)**		**Red (Critical) Limit (°C)**		**Transport/ EVA Limit (°C)**
	Low	**High**	**Low**	**High**	
SAC structure					
SAC pallet*	-110	+110	-120	+120	-
Avionics					
EPDSU*	-20	+50	-30	+60	-
Stowage compartments					
ASIPE*	-5	+35	-10	+45	+20 to +30
SAP*	-50	+50	-60	+60	+32 to +43
OPA*	-30	+61	-40	+71	+40 to +45
UPS	-90	+90	-100	+100	-25 to +60
NT structure	-90	+90	-100	+100	-25 to +60
Exposed CATs and CATs stowage equipment					
ASLR	-90	+90	-100	+100	-60 to +60
ASLR stowage	-90	+90	-100	+100	-60 to +60
ASIPE safety bar	-90	+90	-100	+100	-60 to +60
ASIPE safety bar stowage	-90	+90	-100	+100	-60 to +60
WFPC cover	-90	+90	-100	+100	-80 to +80
WFPC cover stowage	-90	+90	-100	+100	-60 to +60
PCU harness retention device	-90	+90	-100	+100	-80 to +80

Table 4-4. SAC subsystem temperature limits (Concluded)

Component**	Yellow (Warning) Limit (°C)		Red (Critical) Limit (°C)		Transport/ EVA Limit
	Low	High	Low	High	(°C)
PCU harness restraint stowage	-90	+90	-100	+100	-60 to +60
PCU transport handhold	-90	+90	-100	+105	-60 to +60
PCU handhold stowage	-90	+90	-100	+100	-60 to +60

* Components with flight temperature sensors

** Temperatures for all items that do not have flight temperature sensors can be determined analytically via the environment temperature sensor records and the models. SSE Thermal (GSFC) can compare monitored components to the analysis temperature prediction to create a "scale factor" which can be used to adjust the temperature predictions of un-monitored components and determine their flight temperatures.

4.4.1 Active Thermal Control

The ASIPE, SAP, OPA, and EPDSU have active thermal heating systems with some passive assistance. Table 4-5 and Table 4-6 detail the heater locations, resistance values, heater powers at 32 volts, and the thermostat set points for each circuit. All heater circuits utilize two bi-metallic thermostats in series, and each circuit is redundant (have A-side and B-side) and, therefore, protected against failed-on or failed-off heater conditions and a major bus failure. Power is controlled via seven SSP switches through the EPDSU.

The ASIPE is connected to the pallet via shock isolators, which provide reasonably good thermal isolation. Thermal control is maintained through five thermostat controlled heater circuits mounted on the four sides and lid of the box. The heater circuits are fully redundant. The ASIPE is fully covered with Multi Layer Insulation (MLI).

The SAP provides a thermal protective enclosure for the NCC ORU. The NCC is bolted to the SAC Adapter Plate (SAP) with 4 bolts. The SAP is in turn bolted to the SAC pallet using a combination of 1/8 inch thick G-10 and 1/2 inch thick titanium washers for isolation. Thermal control is maintained through five thermostat controlled heater circuits mounted on the underside of the SAP. The heater circuits are fully redundant. The SAP and NCC are enclosed in a 5-sided MLI soft enclosure. The four sides attach directly to the SAC pallet. The outer layer of the soft cover is Beta Cloth. The SAP heaters can be commanded off after the NCC is removed from the SAP in order to minimize power consumption.

The ORU Plate Assembly (OPA) houses the PCU. The OPA is mounted to the SAC pallet via titanium kinematic flexures previously used on the MOPE for isolation. These flexures are isolated from the pallet via 1/8 inch thick G10 washers. Thermal control is maintained through five thermostatically controlled heater circuits mounted on the underside of the OPA plate. The heater circuits are all fully redundant. The plate is MLI covered with a rectangular soft cover on the top surface of the plate with a beta cloth outer layer. The bottom of the plate is MLI covered with an inner and outer layer of 3-MIL Kapton.

The EPDSU is partially thermally isolated from the SAC pallet, due to its kinematic mounting feet and is covered with MLI on the two sides where the electrical connectors exit the box. The other three surfaces are coated with white paint and silver Teflon and left exposed as a radiator surface. Thermostatically controlled, redundant heater circuits provide thermal control.

Primary and redundant telemetry thermistors are located on each heated component as well as on the pallet. Two additional thermistors are reserved for reading environmental temperatures. SAC heaters can be monitored by way of orbiter payload MDM analog inputs for each module current (five total, one per module and EPDSU internal) and 22 channels, reporting the local temperature.

Table 4-5. SAC heater power details (A and B sides identical)

Heater Location	**Heaters Per Circuit**	**Resistance (Ω)**	**Power @ 32 V (watts)**	**Set Points (°C) Lower/ Upper**	**Ducer Limits (°C)**
ASIPE					
Top	3	10.6	96.6	23.0/29.0	
Stbd	3	8.8	116.4	23.0/29.0	
Port	3	8.8	116.4	23.0/29.0	
Fwd	1	26.1	39.2	23.0/29.0	
Aft	1	26.1	39.2	23.0/29.0	
SAP					
Circuit 1	2	18.0	56.9	32.0/43.0	
Circuit 2	2	18.0	56.9	32.0/43.0	
Circuit 3	2	18.0	56.9	32.0/43.0	
Circuit 4	2	18.0	56.9	32.0/43.0	
Circuit 5	2	18.0	56.9	32.0/43.0	

Table 4-5. SAC heater power details (A and B sides identical) (Concluded)

Heater Location	Heaters Per Circuit	Resistance (Ω)	Power @ 32 V (watts)	Set Points (°C) Lower/ Upper	Ducer Limits (°C)
OPA					
Circuit 1	2	18.0	56.9	40/45	
Circuit 2	2	18.0	56.9	40/45	
Circuit 3	2	18.0	56.9	40/45	
Circuit 4	2	18.0	56.9	40/45	
Circuit 5	2	18.0	56.9	40/45	
EPDSU	1	14.1	72.6	-20.0/-10.0	

Table 4-6. SAC heater power summary

Component	Maximum Heater Power Capacity (watts) @ 32 volts		Minimum Heater Power Capacity (watts) @ 24 volts	
	A-Side	B-Side	A-Side	B-Side
ASIPE	407.8	407.8	229.4	229.4
SAP	284.4	284.4	160.0	160.0
OPA	284.4	284.4	160.0	160.0
EPDSU	73.7	73.7	41.4	41.1

In addition to heaters, the EPDSU avionics boxes will dissipate power during nominal operations. The EPDSU dissipates 36 Watts during nominal operations. The dissipation may decrease if the SAP, OPA, or ASIPE heaters are commanded off during the mission.

4.4.2 Passive Thermal Control

All SAC elements except the latches, handrails, PFRs, ASIPE Safety Bar, PCU Transport Handle, PCU Harness Restraint Device, WFPC Thermal Cover, FHST LPS, and EPDSU radiator are covered with Multi Layer Insulation (MLI). Blankets are made of aluminized Kapton with a Dacron filler used between the inner layers; exterior layers vary, depending on individual component needs. Table 4-7 contains detailed thermal blanket information for each MLI covered component of the SAC. Thermal control finishes on the EVA handholds provide additional passive thermal protection. The external surface properties of significant SAC surfaces and components are provided in Table 4-8.

Table 4-7. SAC Thermal Blanket Summary

Component	Thermal Blanket Design
SAC Pallet	Covered with 11 layer MLI blanket. Outer layers 3-mil Kapton. Extra outer layer of 2-mil Silver Teflon added under OPA and SAP
Keel Struts	Wrapped with 11 layer MLI blanket. Each support strut and their mounting points to be individually wrapped. Outer layers 3 -mil Kapton
Trunnion Towers	Wrapped with 11 layer MLI blanket. Outer layers 3 -mil Kapton
EPDSU	Partially covered with 14 layer MLI blanket. Outer layers 3 -mil Kapton. All white paint & Silver Teflon areas exposed as radiator
ASIPE	Covered with 11 layer MLI blanket. Outer lay ers 3-mil Kapton. Inside of ASIPE Lid also blanketed
Shock Isolators	Wrapped with 11 layer MLI blanket. Outer layers 3 -mil Kapton
OPA	Plate bottom covered with 14 layer MLI blanket. Outer layers 3 -mil Kapton. Plate top and PCU Soft Cover blanket with 1 4 layers of MLI (outer layers 3 or 5 mil Kapton) and final exterior layer of Beta Cloth
SAP	Soft “Box” like 14 layer MLI blanket that attaches to SAC Pallet and encloses entire SAP and NCC. 12 inner layers, 5 -mil Kapton outer layers. Additional exterior layer of Beta cloth
NT	Structure coating is Irridite. Door is NOT blanketed. Other sides covered with 12 layer MLI blanket – outer layers of 5-mil Kapton for stiffness, addition exterior layer 2 -mil Silver Teflon on ± Z surfaces of NT
UPS	Beta Cloth Contamination Cover (8 layer MLI blanket with Beta Cloth exterior)
SSM Bay Thermal Covers	Kapton and Kevlar pouch attached to ASIPE MLI blanket (2 double pouch)
MLI Recovery Bags	Kapton and Kevlar pouch attached to ASIPE MLI blanket (1 double pouch)
Diode Box Thermal Covers	Kapton and Kevlar pouch attached to ASIPE MLI blanket (stowed with SSM Bay Thermal Covers)
Handrail Cover Caddies	Kapton and Kevlar pouch attached to ASIPE MLI blanket (4)
FHST Light and Particle Shields	Kapton and Kevlar pouch attac hed to forward port trunnion tower blanket (2 - primary and spare)

Table 4-8. SAC surface thermal properties

Component	Coating	a	e
SAC Pallet	MLI – 3 MIL Kapton outer layer	0.45	0.78
ASIPE			
Exterior box	MLI – 3 MIL Kapton outer layer	0.45	0.78
Hinges	Irridited aluminum	0.30	0.10
Latches	Irridited aluminum	0.30	0.10
Handrails	Irridited aluminum	0.30	0.10
PFR	Irridited aluminum	0.30	0.10
Vents	Clear Anodize	0.35	0.84
SAP			
SAC surface under SAP	MLI (2 mil Silver Teflon)	0.09	0.65
SAP top surface	MLI (Black Anodize)	0.78	0.80
Soft Cover	MLI (Beta Cloth outer layer)	0.32	0.89
OPA			
Top soft cover	MLI (Beta Cloth outer layer)	0.32	0.85
Bottom exterior	MLI – 3 MIL Kapton outer layer	0.45	0.78
Handrails	Chem-Film	0.49	0.10
Mounting feet	MLI	0.45	0.78
EPDSU			
Covered area (2 sides)	MLI – 3 MIL Kapton outer layer	0.45	0.78
Radiator area (3 sides)	Silver Teflon and White Paint	0.14	0.76
NT cover	MLI, 2 mil Silver Teflon	0.09	0.65
NT frame structure	Irridite (parts not covered with MLI)	0.30	0.10
UPS	Beta Cloth	0.32	0.89
ASLR	Gold Anodize	0.48	0.82
ASIPE safety bar	Irridited aluminum	0.30	0.10
WFPC cover	Clear Anodize	0.35	0.84
PCU harness restraint	Clear Anodize	0.35	0.84
PCU handhold	Clear Anodize	0.35	0.84

4.5 SAC VISUAL AIDS

Table 4-9 lists the decals that have been applied to the SAC and the quantity of each decal.

Table 4-9. SAC decals

DECAL TEXT	AMOUNT
PCU	1
PCU Harness Retention Device	1
PCU Transport Handhold	1
ASLR-Axial Handle	2
ASLR-Standard	6
NOBL Vent Plugs	2
Bay 5 NOBL	2
Bay 6 NOBL	2
Bay 7 NOBL	2
Bay 8 NOBL	2
NCC	1
CASH (primary)	1
CASH (spare)	1
Handrail Cover Caddy, V2	2
Handrail Cover Caddy, RSU	1
Handrail Cover, Misc.	1
FHST Contamination Cover (primary)	1
FHST Contamination Cover (spare)	1
WFPC Thermal Cover	1
SSM Bay 5 Thermal Cover/DBA Thermal Cover	1
SSM Bay 10 Thermal Cover/DBA Thermal Cover	1
MLI Recovery Bag Bay 5	2
MLI Recovery Bag Bay 8	2
Transport Module Latches (open, close)	7
ASIPE Lid Latches	5
Ground	4
Latch Label (WFPC,HRD) (push, pull, open, close)	as required
PFR Sockets 1,2,3,4,5	1 ea

4.5.1 ASIPE Latch Indicators

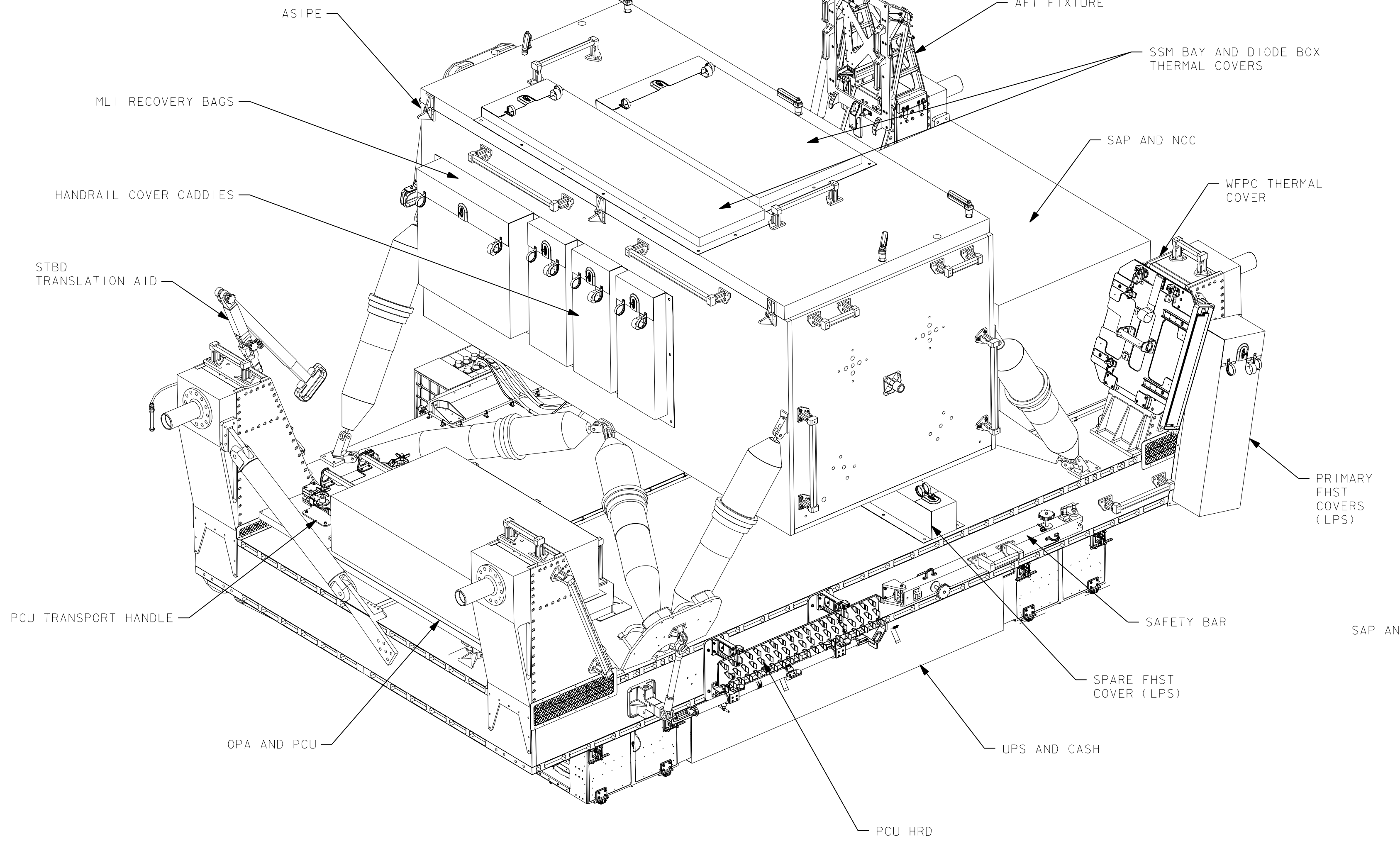
There are three (3) redundantly powered (A-side and B-side) latch indicator circuits, B-Ready, A-Seated, and A-Latched. Each circuit includes a single microswitch and redundant indicator bulbs to display critical SI latch status for the EVA crewmember and telemetry to the IVA and JSC POCC. The same modules (MOD 4 and MOD 5) that power the ASIPE power the latch indicators.

These lamps extinguish to indicate the following conditions:

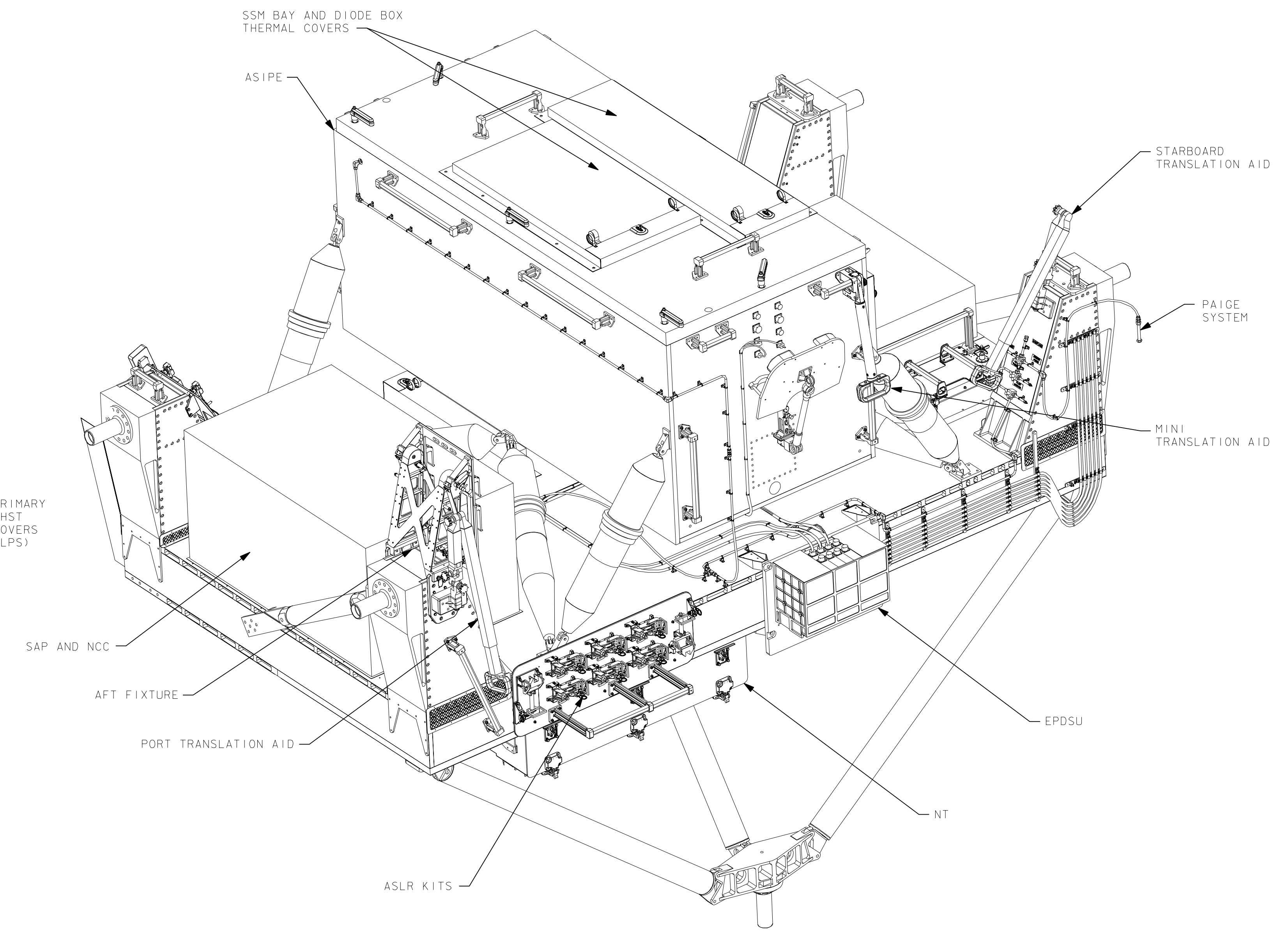
- B-READY – the SI is ready for B-Latch plunger actuation (as indicated by aft guide Rail microswitch)
- A-SEATED – A-Latch ball is seated and A-Latch is ready for engagement
- A-LATCHED – A-Latch is engaged

DATE: 01/24/02	NAME: MDU	VERSION: REL;6

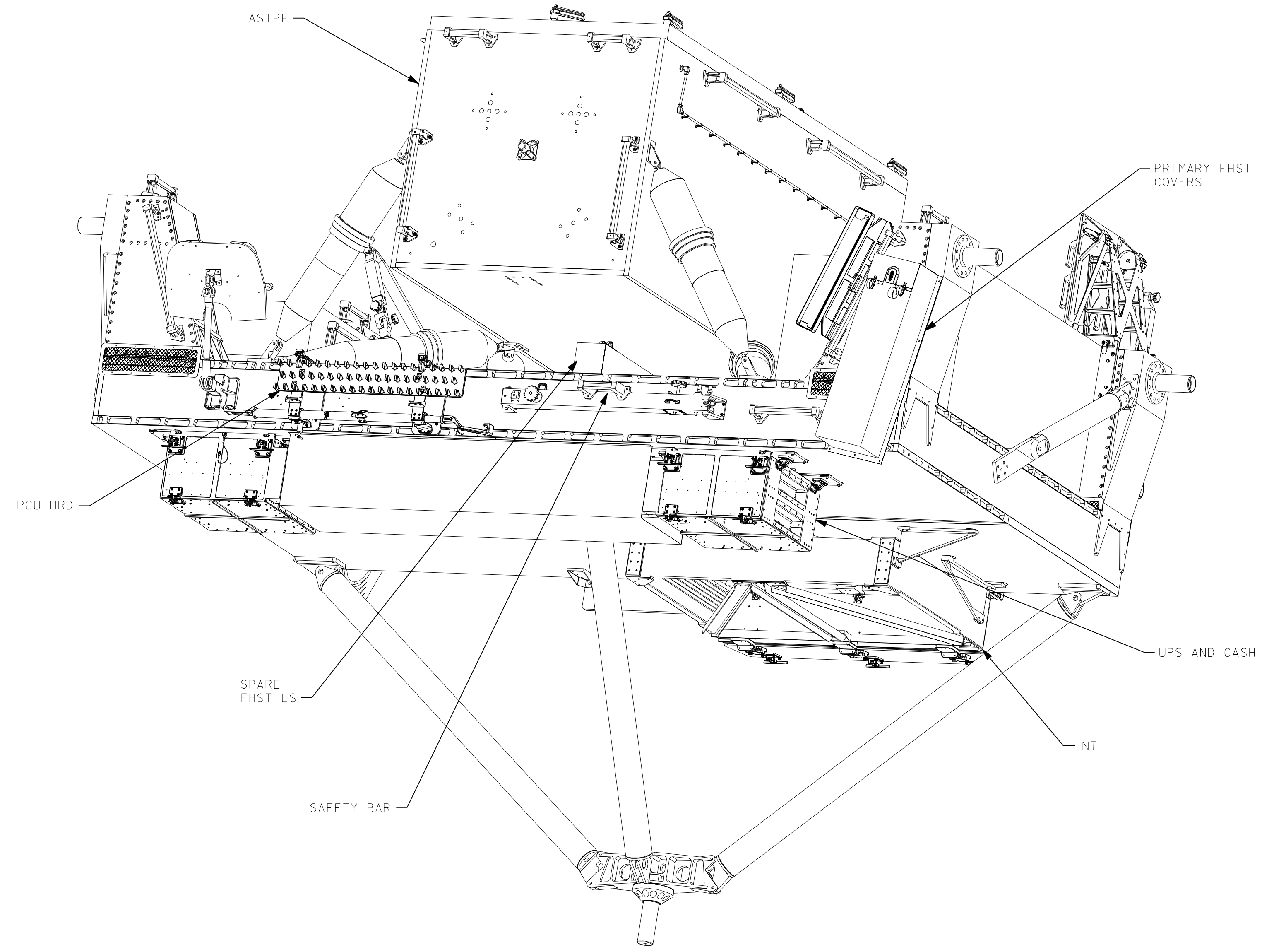
DATE: 12/07/01	NAME: VSH	VERSION: CHK;6
DATE: 01/17/02	NAME: LAM	VERSION: REL;5
DATE: 01/24/02	NAME: MDU	VERSION: REL;6



FORWARD VIEW



AFT VIEW



BOTTOM VIEW

1 SAC PHYS O/V

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN V. HUNTER	10/27/00	SAC PHYSICAL OVERVIEW	
DR			
ENGR R. HARVEY			
ENGR			
APP			
APP		HST SSE CSM	DWG NO 4.1
CADS		STS-109	
LTR	PCN	82.5 X 34	SHEET 1 OF 1

USA001948

USA001948

USA001948 USA001948

5.0 RIGID ARRAY CARRIER

5.1 RAC PHYSICAL DESCRIPTION

The Rigid Array Carrier (RAC) is designed to transport the SA3 wings to orbit and return the SA-II wings to Earth. Additionally, the RAC is used to transport ORUs and CATs to and from orbit during the HST servicing mission. The RAC has no electrical equipment and is thermally designed to be passive.

The RAC is mounted in the forward section on the orbiter payload bay. The RAC, shown in Drawing 5.1-1, uses a Spacelab Pallet (SLP) as the primary structure cradle. The SLP has been modified to add a Center Support Structure (CSS) for carrying the SA3s to HST and two shelves for the return of the SA-IIs. The weight of the SLP is 1447, and the overall weight of the RAS is approximately 5287 lbs at launch.

5.1.1 RAC Structural Elements

The SLP is the primary structure for the RAC. The structure has four longerion trunnions and one keel trunnion used to latch the RAC into the payload bay with active latches. The CSS is an aluminum I-beam truss structure that is attached to the center of the SLP (refer to Drawing 5.1-1). The SA3 Latch System on the CSS supports the SA3 wings. The CSS contains Guide Rails and a Center Chute to assist crewmembers during the removal and installation of the SA3. The Center Chute limits SA3 X-axis translation and Y-axis rotation and the Guide Rails limit SA3 Y-axis translation and Z-axis rotation.

Aluminum shelves have been added to the top of the SLP sides to support return of the SA-IIs. The shelves are unique because the clevis brackets structurally tie directly into the trunnion bathtub fittings and sill joints of the SLP, as well as being supported by struts that tie into the pallet through hard point clevis attachments. A modified SM-1 SA-II latch system with additional Forward X-Constraint (FXC) is used to support the SA-II wings. The RAC shelves accommodate associated Diode-Boxes (3), Jettison Handle, Portable Connector Trays (2), MLI Tent, spare pip pins (10), and spare SADA clamps (2). There are handrails on the shelves for translation path and removal/stowage activities.

5.1.2 Starboard Auxiliary Transport Module 1 (ATM 1)

The starboard ATM 1 is mounted to the aft starboard face of the RAC and is reflown hardware from SM3A with a slight exterior modification. ATM 1 is thermally isolated from the RAC to extend the allowable duration time in extreme temperature attitudes. This isolation allows passive thermal protection for ORUs. ATM 1 has two latches with HST heritage and one EVA contingency screw for lid closure and one EVA handrail. All mechanisms are two-fault tolerant in operation. The design of ATM 1 provides for installation/removal of the equipment by one free-floating EVA crewmember. The maximum force to remove/insert an ORU in the ATM on orbit is 10 pounds. The maximum allowable weight for ATM 1 is 150 pounds, including payload. The weight of ATM 1 is 73.9 pounds empty, 112 pounds with the SM3B payload complement. Figure 5-2 shows the ATM 1 External View.

ATM 1 is not heated. The two latches (Figure 5-5) and three hinges (Figure 5-1) are a modified design of the ORU Transport Modules for SM-2 in the COPE and SOPE. One latch is required for landing. One EVA center bolt is provided to secure ATM 1 in the event of a 2-latch failure. The hinges are designed with a soft dock to stay open 90 degrees. The hinge is a three fault tolerant design. The mechanism uses a stainless steel pin that is free to rotate with respect to brushings in the lid and fixed sections of the hinge. In addition, the beryllium-copper bushings can rotate within the holes in the hinge components.

ATM 1 will transport two P-600 harnesses, two NCC Cryo-vent inserts, and two NCC Groundstrap Assemblies. Figure 5-3 shows the ATM 1 Internal View.

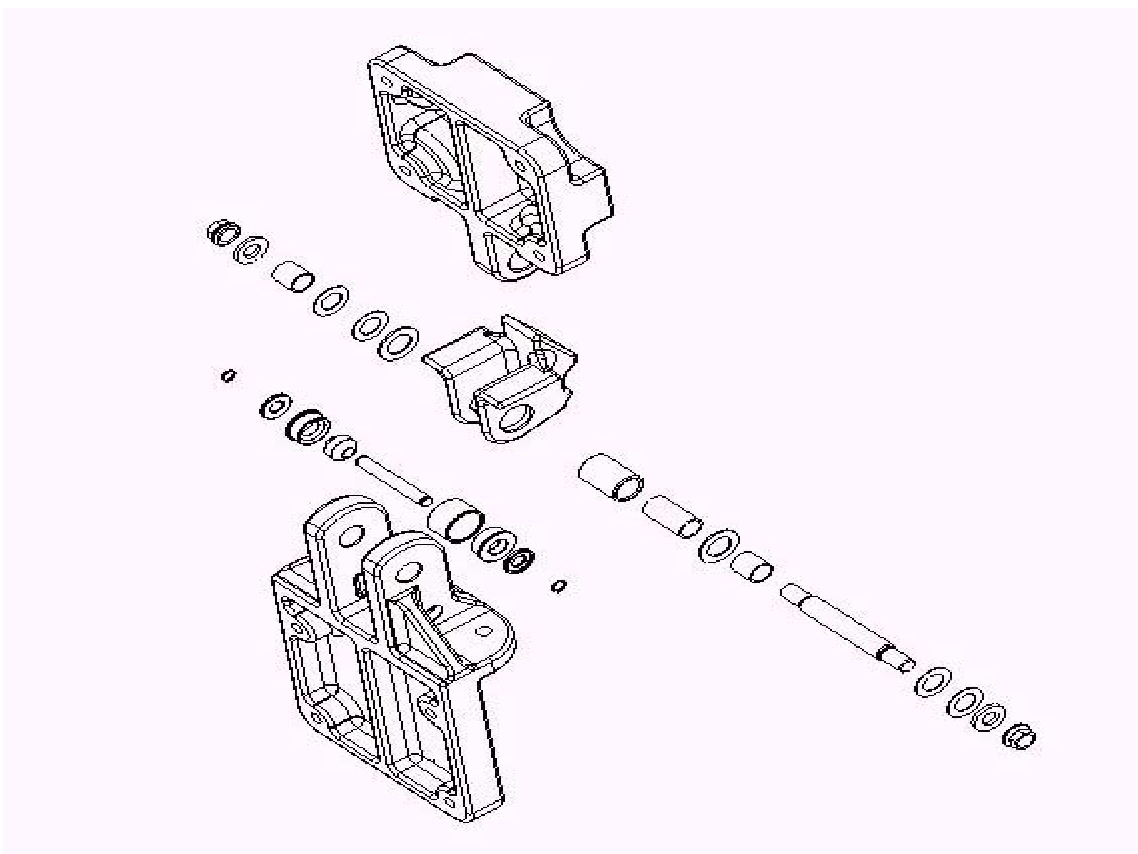


Figure 5-1. ATM hinge

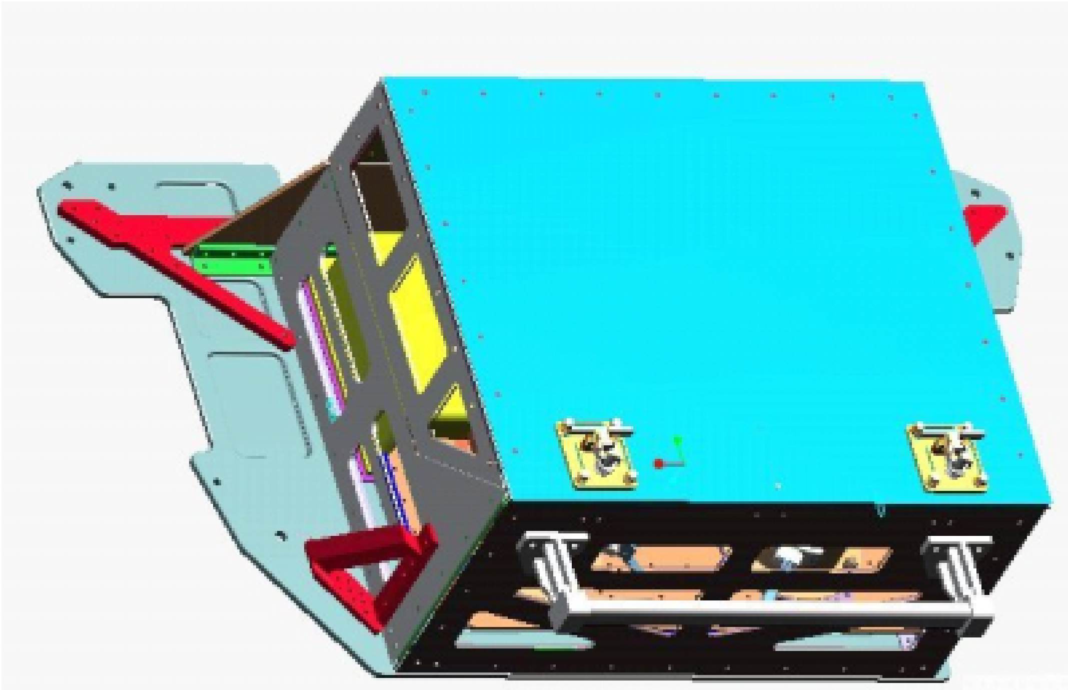


Figure 5-2. ATM 1 box design

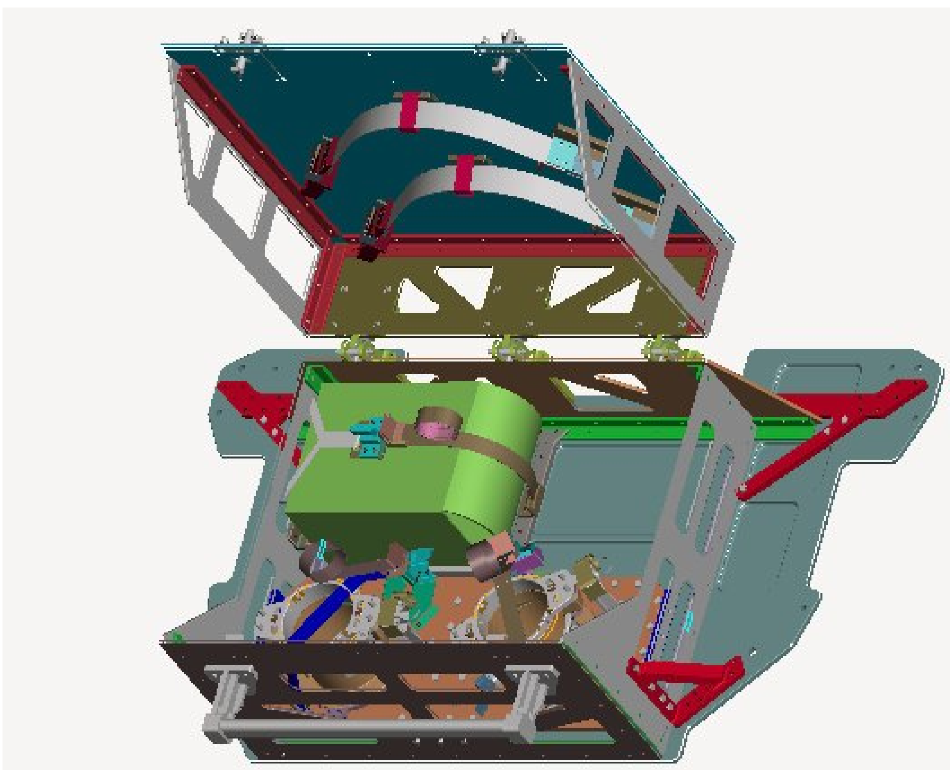


Figure 5-3. ATM 1 internal fullbox design

5.1.3 Port Auxiliary Transport Module 2 (ATM 2)

ATM 2 is attached to the port aft face of the RAC. ATM 2 weighs 82 pounds empty and the weight shall not exceed 175 pounds. ATM 2 is a honeycomb structure and is designed for heavier payloads. ATM 2 is thermally isolated from the RAC. ATM 2 has four latches, two EVA contingency screws, and one EVA handrail. Figure 5-6 shows the ATM 2 External View.

The ATM lid is secure with three hinges and four latches (Figure 5-4). The hinge and latch design are similar to those on ATM 1, but the hinge capacity was increased to accommodate higher loads due to increased payload mass and to provide a stop at 90 degrees. Two EVA bolts are provided to secure the ATM in the event of a failure of two adjacent corner latches.

ATM 2 will be used to transport the, 2 COSTAR Y-Harnesses, NICMOS Cryo-Vent Line Transport Bag, NICMOS Cryo-Vent Line, NCS Sock Transportation Bag, NCS Sock, 4 Aft Shroud Door Stop Extensions, and the DBC Cross-strap harness. Figure 5-7 shows the ATM 2 Internal View.

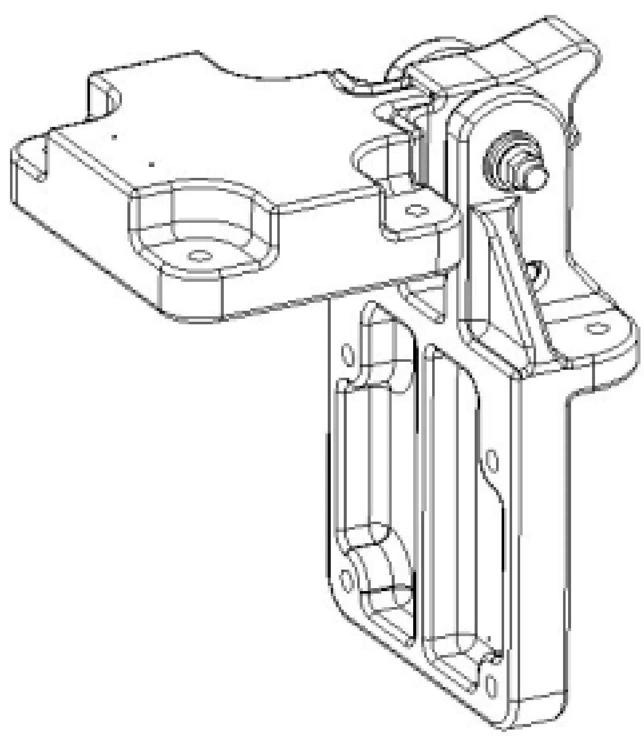


Figure 5-4. ATM hinge

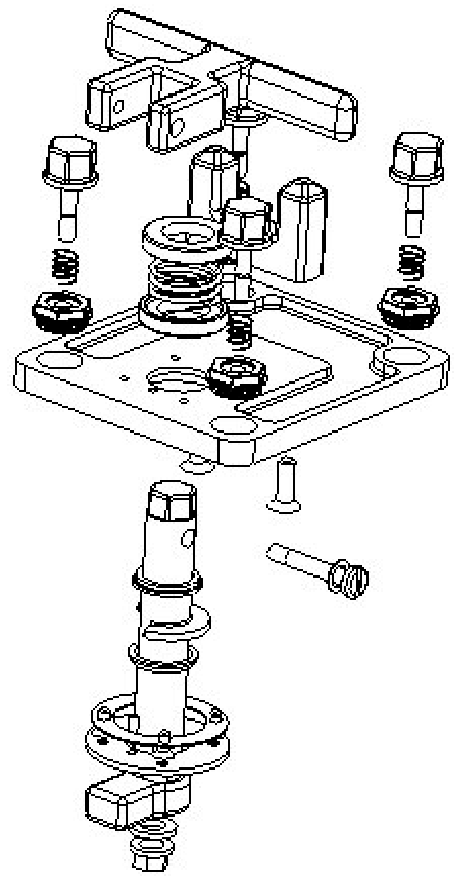


Figure 5-5. ATM latch exploded

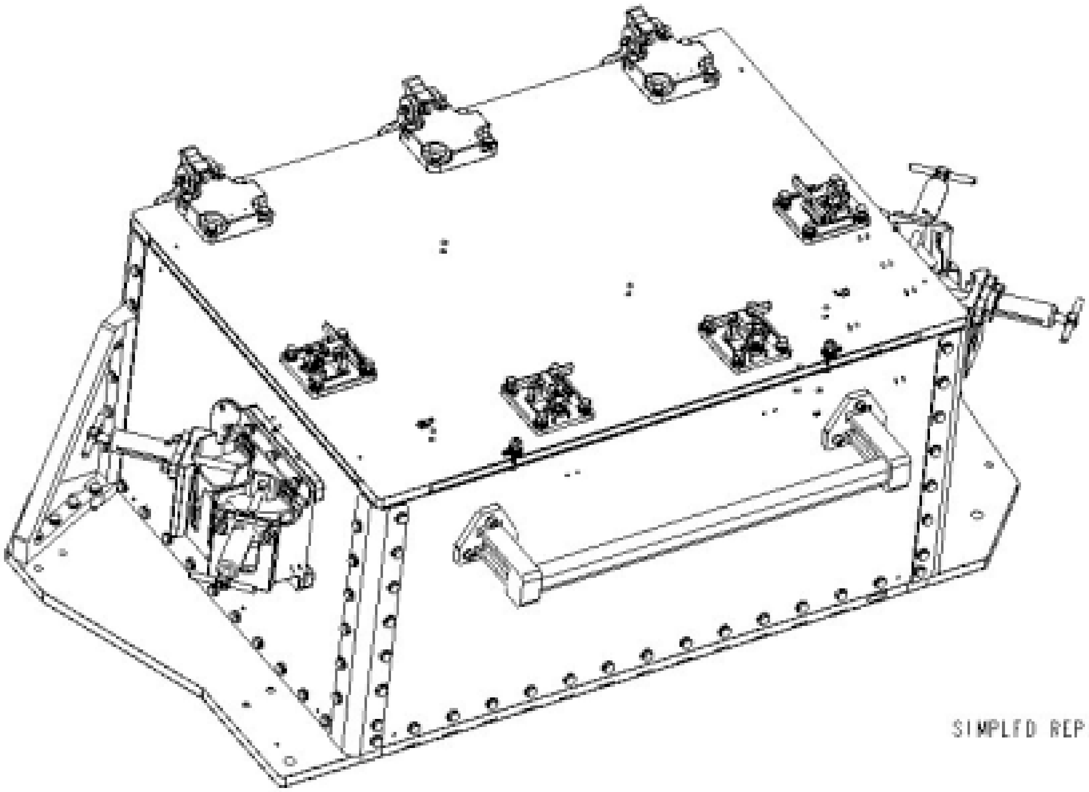


Figure 5-6. ATM 2 external box design

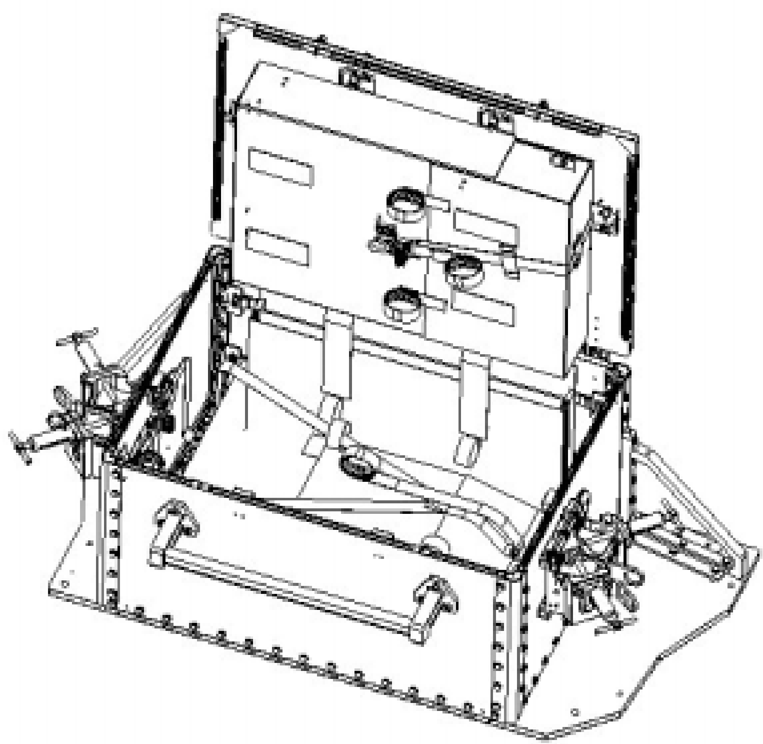


Figure 5-7. ATM 2 internal fullbox design

5.1.4 SA2 Attachments

There are SA-II Retention Mechanisms on the port and starboard shelves. There is one aft latch, one forward latch, one hinged SADA clamp and one forward x-constraint per SA-II wing. The forward and aft latches and SADA clamp are in the disengaged (open) positions for launch, eliminating the need to open the latches and SADA clamps on-orbit. A clevis attachment with a pip pin release is used at the forward and aft latches to hold the latches in the open position. There is a separate pip pin stowage hole in the bracket for return to Earth. Snubber wedges are used on the SADA Clamp Pick-Up Assembly (CPUA) to preload the clamp in the opened position to attenuate any clamp movement during launch. There is no EVA operation required to release the SADA clamp; the clamp simply slides off the Delrin wedges when it is operated to the closed position when securing the SA-II wing. The forward and aft latches each have a Schaeffer magnetic-detent stepper drive that serves as the holding portion of the mechanism. The drive is nominally operated via EVA overriding spur gear that manipulates the hold-down pawl. The pawls themselves have a separate EVA override bolt that could allow jettison of the SA2, if required.

5.1.5 SA3 Attachments

The stowed SA3s are mounted to the faces of the CSS via four EVA latches per array, plus a fifth latch for the mast. (See Drawing 5.1-1 for latch locations).

SA3 Latch 1 (Figure 5-8) is a 3-DOF reacting device, and it is nominally released last. SA3 Latch 1 is unique because the ACME drive screw is integral to the SA3. The SA3 portion of Latch 1 features a hollow, truncated, and spherically profiled fitting. This fitting interfaces with a cone fitting, which is mounted on the CSS. The cone fitting contains an ACME-threaded floating nut. The sphere/cone interface is drawn into contact via the SA3 ACME-threaded retention screw acting through a stack of disk springs to pull the ball nut. The amount of compression is calibrated to achieve the desired preload. The retention screw is EVA driven and is able to align the ball nut with simple surface contact. The SA3 integral ACME screw is lightly spring-loaded outward such that the tendency is to retract the threaded end (and protrude the hex end) in the free state. During SA3 deployment from the CSS, the hex-end has a slight tendency to come out to the free-state position once the last ACME thread is cleared from the CSS floating nut.

For a failure of Latch 1, an EVA override exists to remove the latch fitting from the SA3. There are 5 EVA-tool compatible bolts (Figure 5-9) that connect the hollow housing to the remainder of SA3. The three short bolts are captive to the housing, and the two long bolts have tether loops and are retrieved by the crew and stowed in the middeck for landing. If override is successfully exercised, the Fitting will remain attached to the CSS via the jammed ACME screw, which initiated the contingency.

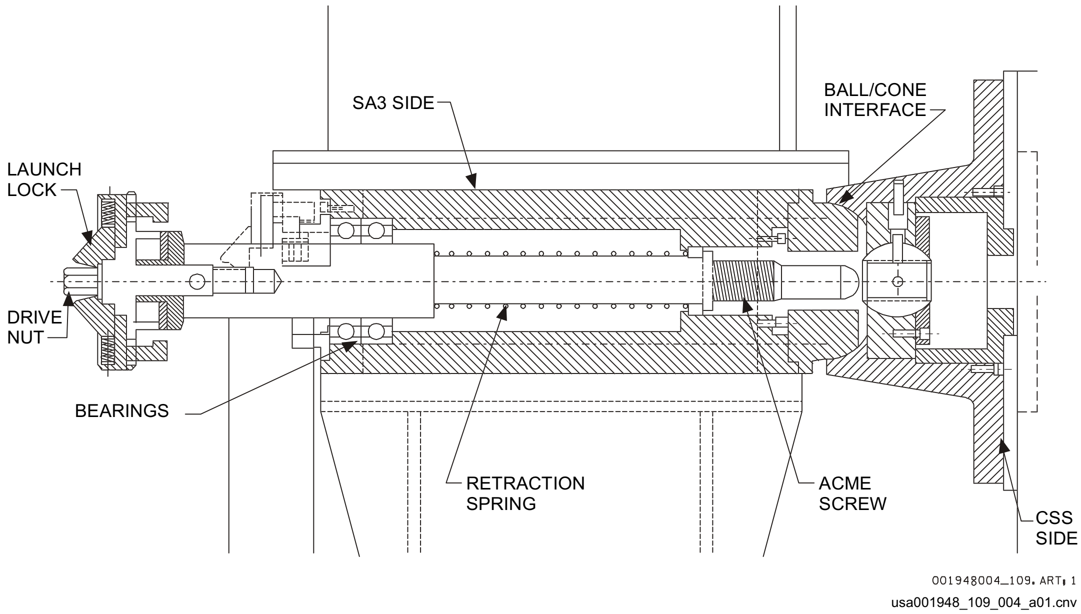


Figure 5-8. Latch 1 details

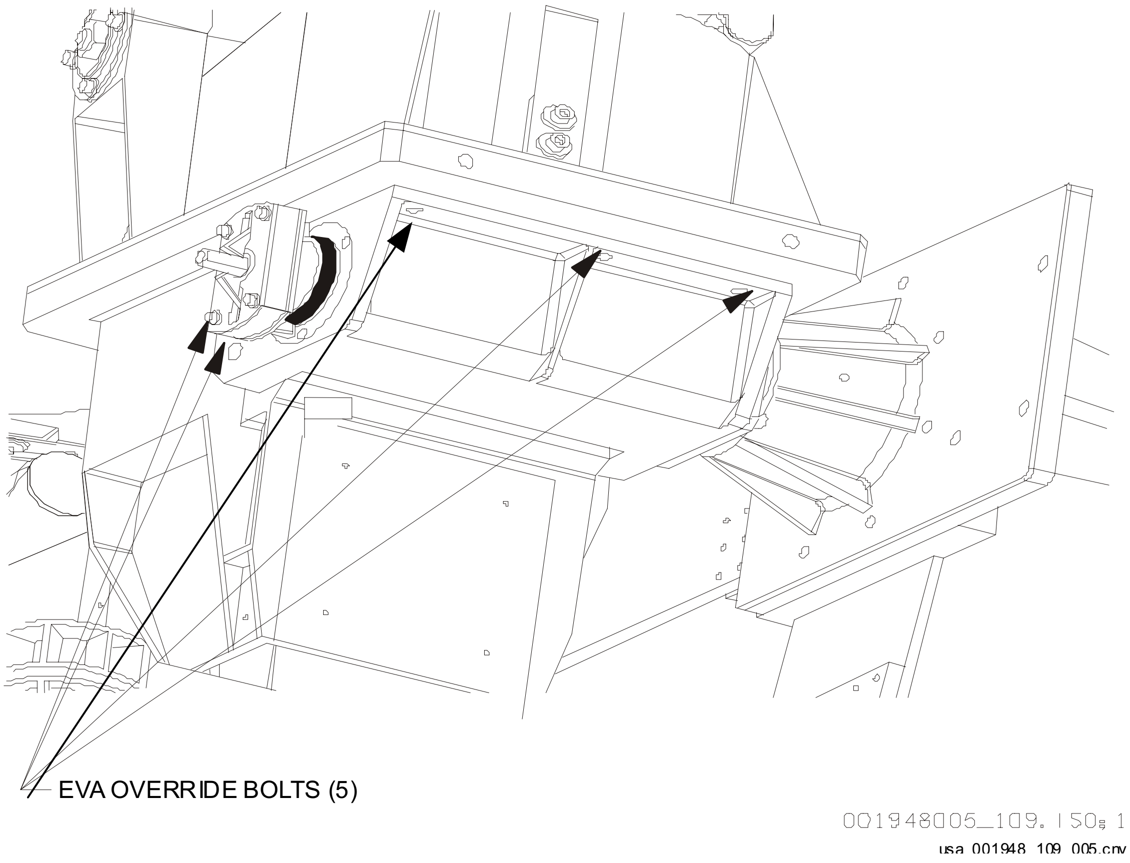


Figure 5-9. Latch 1 override bolts

SA3 Latch 4 (Figure 5-10) is nominally released third or first. Latch 4 is a 1-DOF reacting device that resembles a bench vise with the addition of a floating central

Spacer/Slider, which rides on three integral bushings that slide along the drive rod and two parallel slider shafts. The SA3 has two integral, spaced tangs that are dimensioned to slip between four spherical pads, two on the Spacer/Slider and two outside pads located on the vise proper. Sliding of the SA3 integral tangs provides the dimensional tolerance for the thermal variations, which may exist if attempting to re-install an SA3 after it has experienced thermal soak conditions associated with transfer to and from HST.

In the event that Latch 4 jams, an EVA override exists. The outboard spherical pad connects to a backing plate held to the linear stage of the vise via two EVA-tool compatible bolts. In the event that the primary action on Latch 4 is jammed, both of the override bolts (Figure 5-11) may be backed out slightly to relieve climbing force for all forward pads by effectively retracting the outer spherical pad. With the clamping force relieved, the lower set of SA3 tangs may slide free of Latch 4.

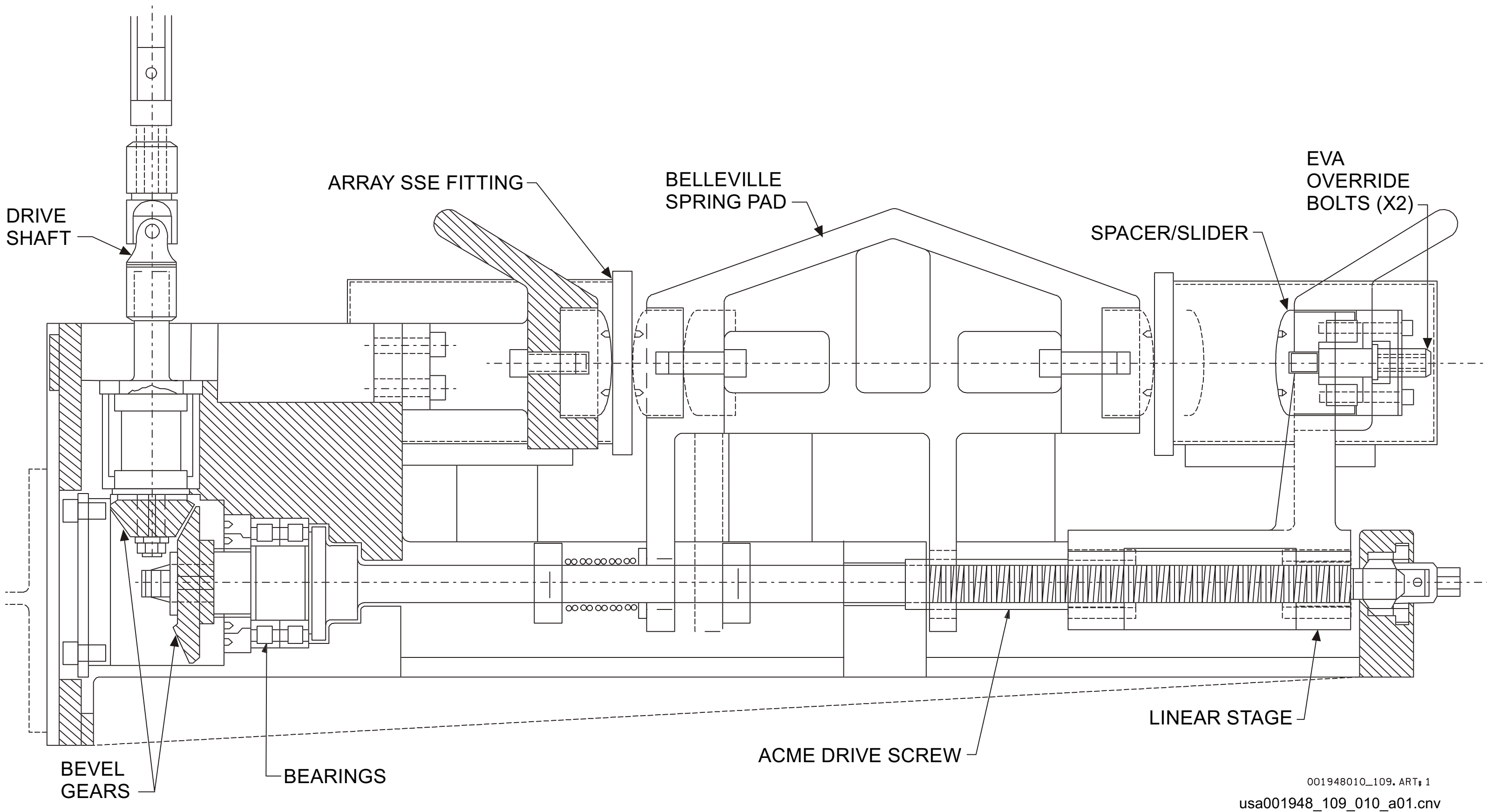


Figure 5-10. Latch 4 details

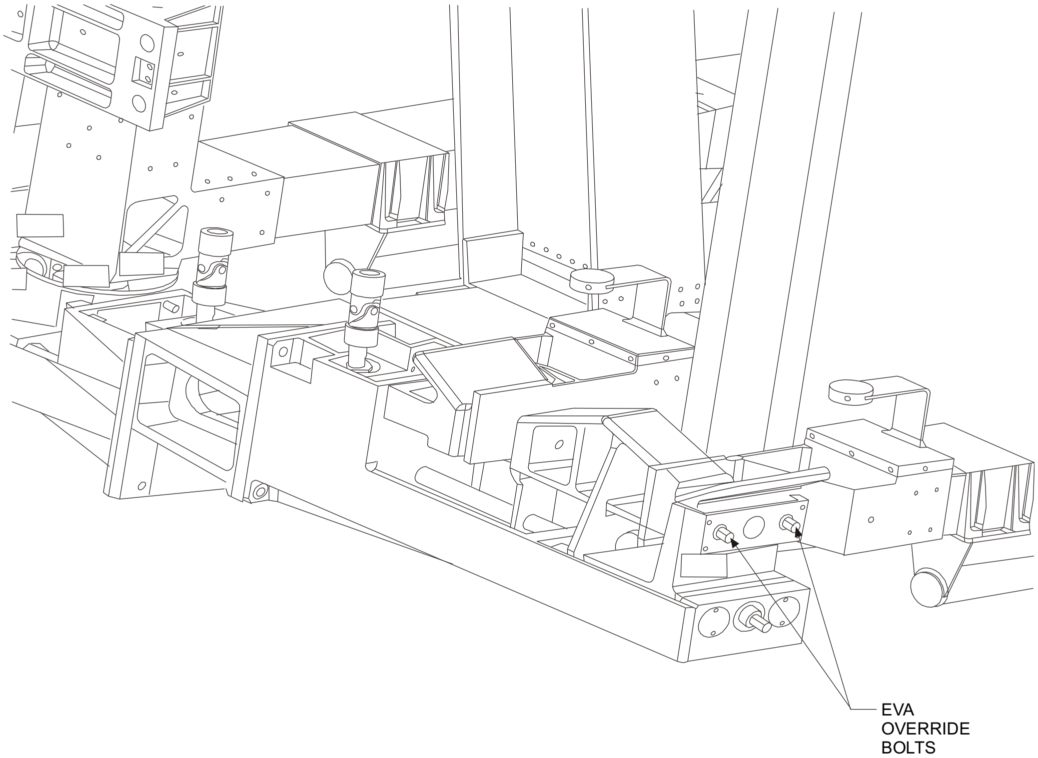


Figure 5-11. Latch 4 override bolts

SA3 Latch 2 (Figure 5-12) is nominally released fourth. SA3 Latch 2 is a 2-DOF reacting device that features an ACME screw vise driven via gearbox and shaft similar to Latch 4, except that it is a simple, single action clamp without a floating spacer in the middle. The interface surface of the SA3 presents a heel-shaped trunnion encasing a spherical ball instead of a pair of spaced tangs.

In the event that Latch 2 jams, an EVA override exists. A device that mimics the Latch 4 Backing Plate release is built into Latch 2. The reach and access situation for this override is similar to that existing for Latch 4. Figure 5-13 shows the override bolts for Latch 2.

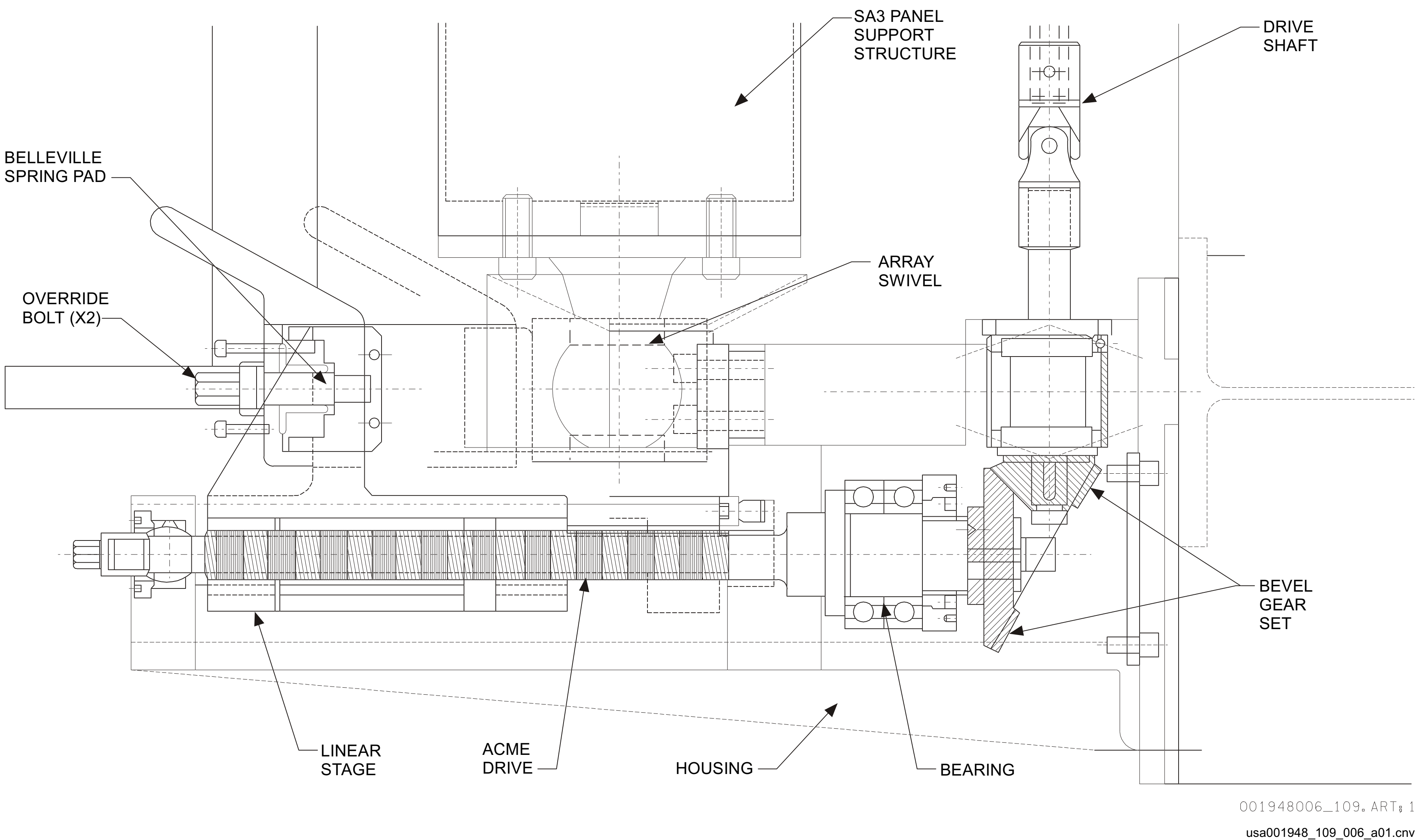


Figure 5-12. Latch 2 details

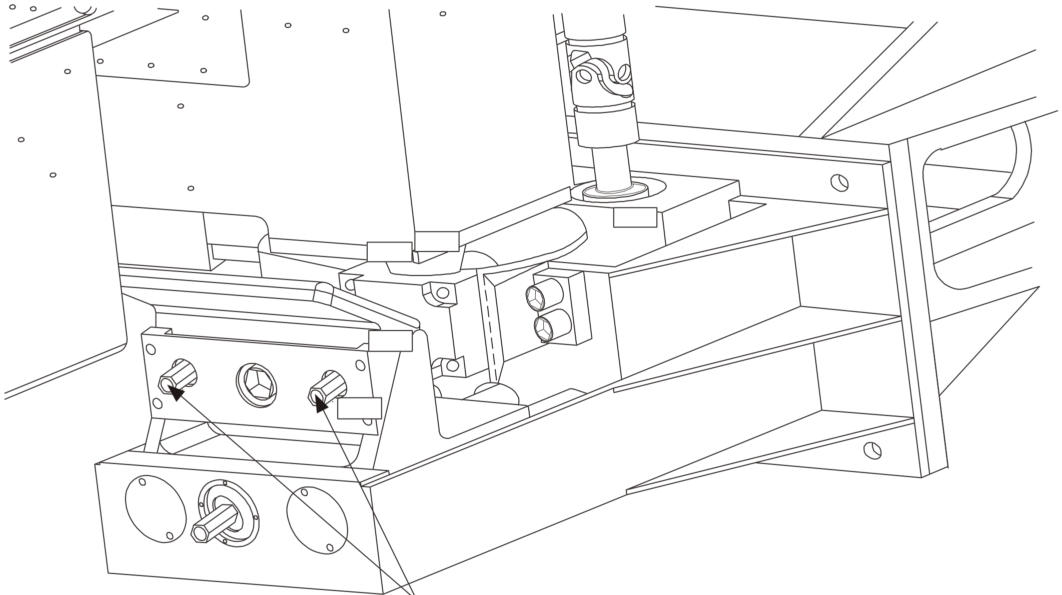


Figure 5-13. Latch 2 override bolts

SA3 Latch 3 (Figure 5-14) is nominally released first or third. Latch 3 is a 1-DOF reacting device consisting of a direct, EVA-screw actuated clamp, which is an assembly mounted to the CSS, and a pivoting clamp housing. The pivot shaft of the housing is a rotating bushing and shaft, where a jam is three fault-tolerant. The SA3 tangs are configured back-to-back and are collectively clamped by the Latch 3 pads. To bring deployed SA3 inertias within specifications, the 10-inch structural piece (the removable tang) that bridges the gap to bring the tangs together shall be removed via two EVA bolts and stowed on the RAC. The generously toleranced dovetail joint functions like a soft-dock and provides hands-off control while the EVA bolts are being managed.

In the event that Latch 3 jams, an override exists. A device that mimics the Latch 4 backing plate release is built into Latch 3. The SA3 removable tang, which is removed from SA3, comes off with two captive EVA-tool compatible bolts and stows nearby on the CSS (one bolt required). Figure 5-15 shows the Latch 3 override bolts.

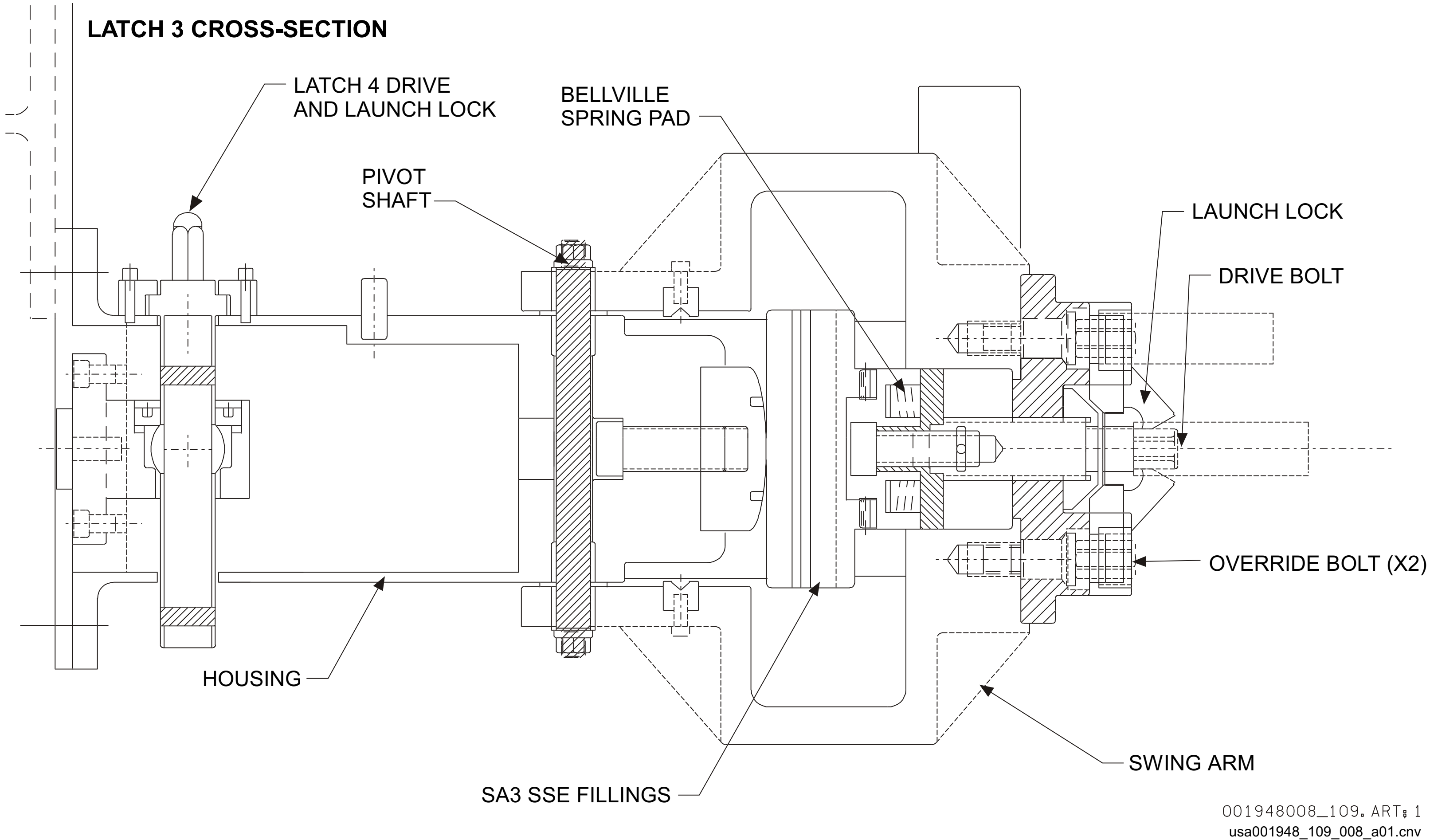


Figure 5-14. Latch 3 details

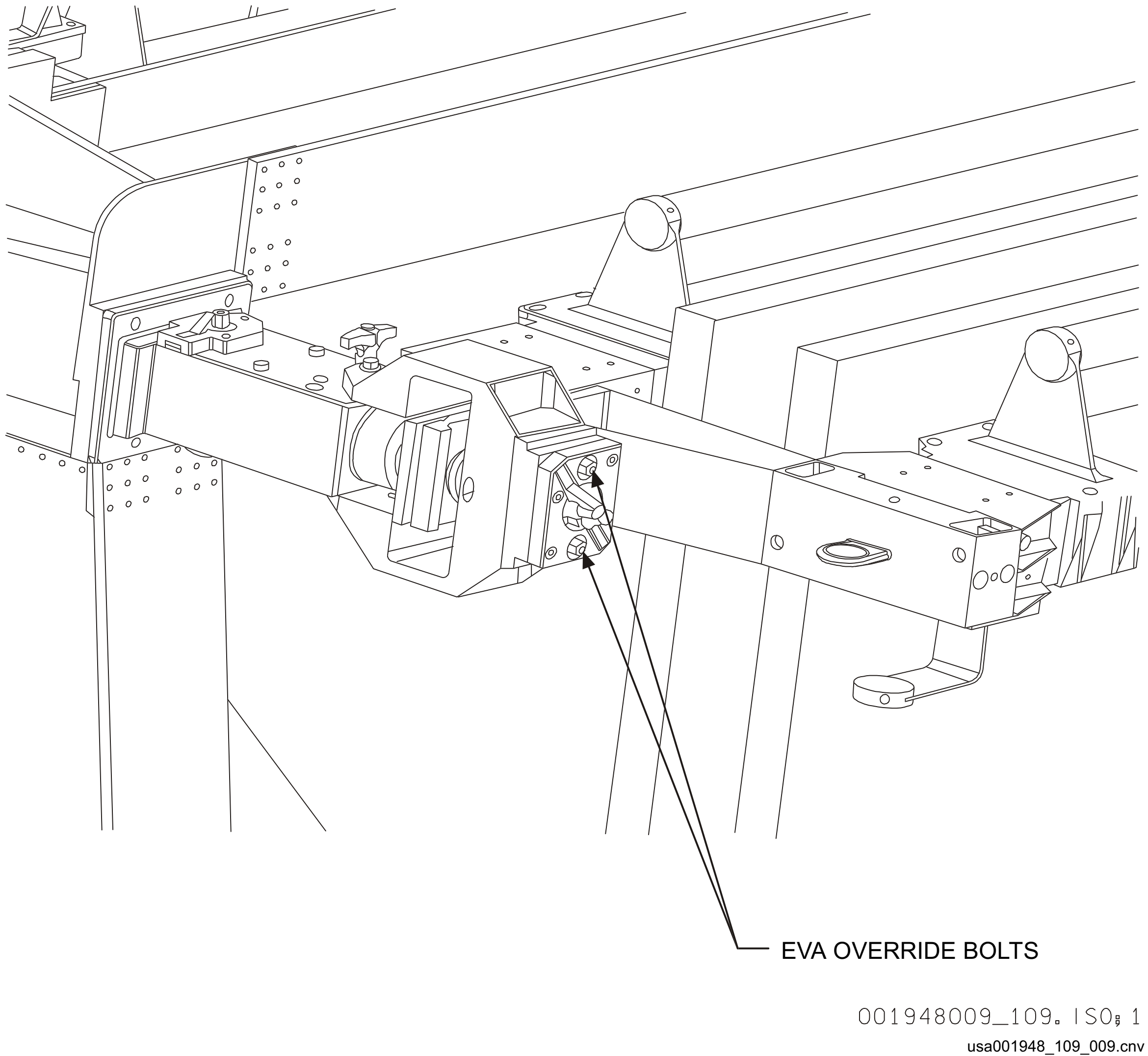


Figure 5-15. Latch 3 override bolts

SA3 Latch 5 (Figure 5-16) is centered at the top of the CSS. The function of Latch 5 is to retain the hinged "mast" portion of SA3 to the CSS. Releasing Latch 5 first allows the mast to be elevated and rigidized with two SA3-hinge fasteners in preparation for SA3 removal. When the mast is in the elevated position, it violates the PLBD envelope. The Latch-5 EVA latching bolt features a bullet-profiled lead-in tip, which would assist in the manual lead-in if the mast had to be re-installed to the CSS under anomalous conditions.

In the event that Latch 5 fails, an EVA override exists. The CSS-mounted Clevis fitting is a two-piece tower held together with a pair of EVA Override bolts, which are captive to the tower top. The override bolts (Figure 5-16) represent an interface to the mast that is independent of the primary bolt. Removal torque may be increased above nominal for both the primary and override bolts; however, these bolts feature large diameters and are likely to be beyond capabilities for bolt-breaking.

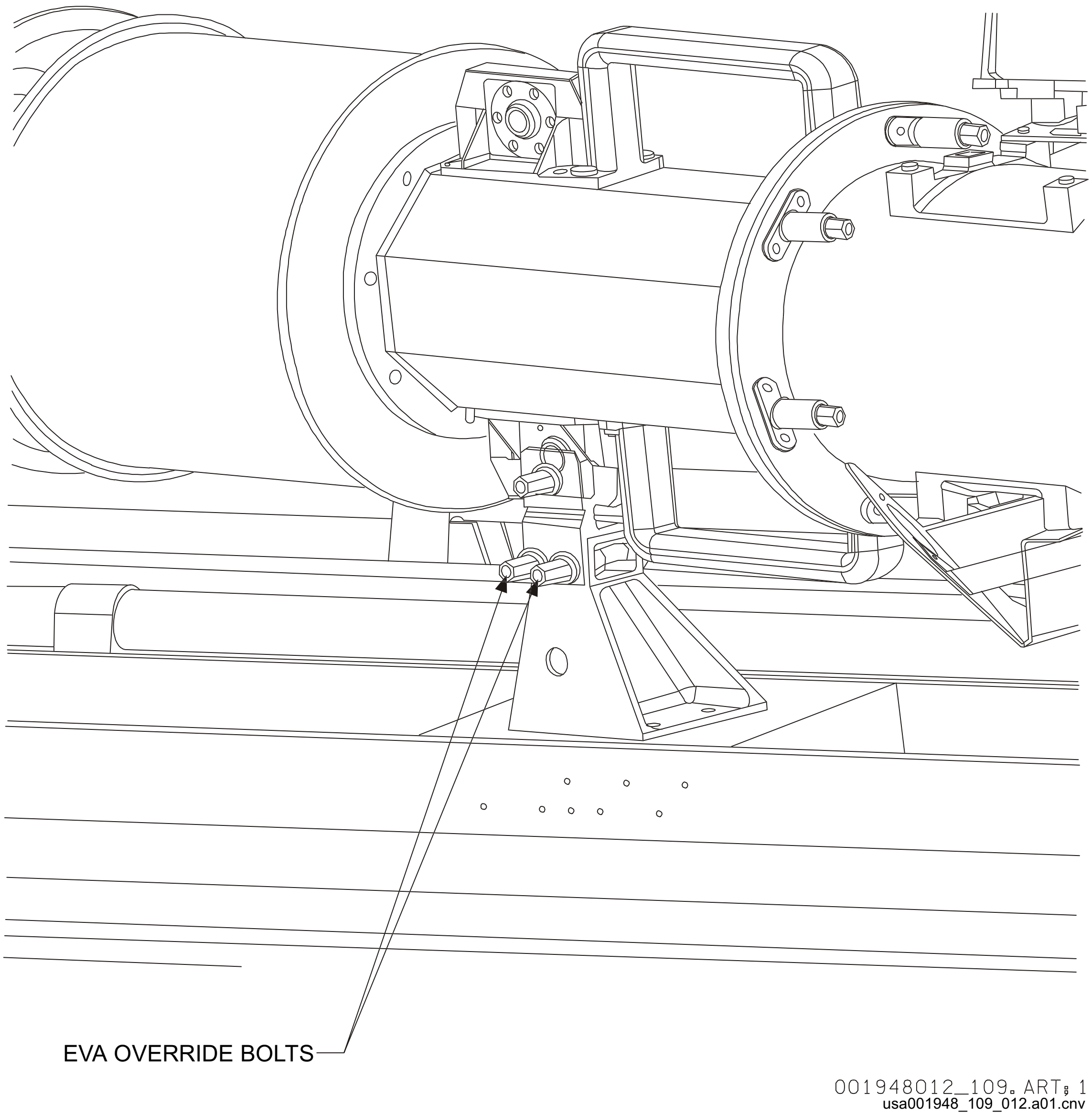
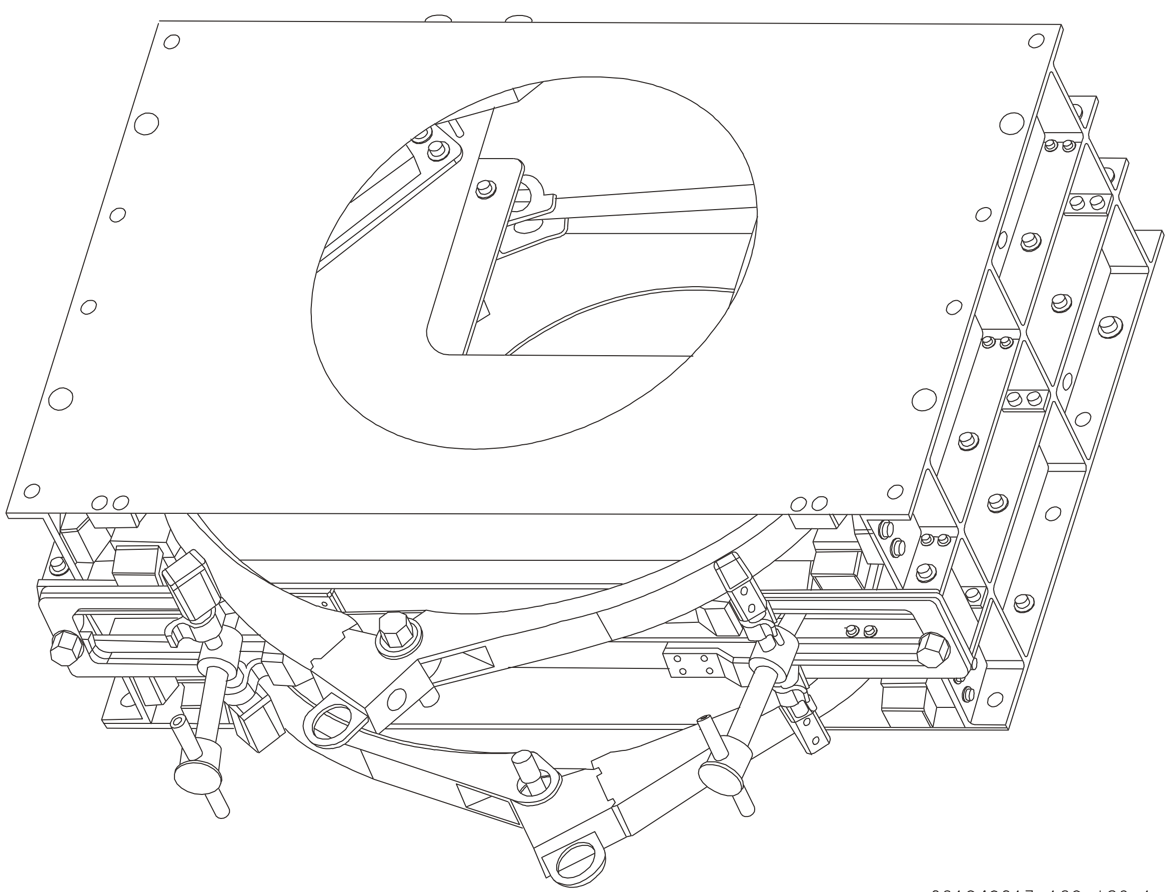


Figure 5-16. Latch 5 details and override bolts

5.1.6 Orbital Replacement Units and Crew Aids and Tools

The three Diode Box 2 Assemblies (DBA 2), Drawing 5.1-1, are located on the port and starboard shelves between the aft latch and the SADA clamp. The DBA and the DBA 2 interface contain one fixed and one retractable shear pin to account for dimensional differences due to thermal conditions in addition to four J-hook fasteners. Two DBA 2s are located on the port shelf; one DBA 2 is located on the starboard shelf. Refer to Drawing 5.1-1 for locations. Two DBA 2s are replacement units and one is a spare.

The SADA clamp stowage bracket assembly, Figure 5-17, holds the spare SADA clamps in a Poron cellular urethane foam with a Teflon impregnated fiberglass coating for a low-friction, resilient surface. The spare SADA clamps are stowed in an open position under the starboard shelf, constrained by two 2-hand actuated SADA Latching plungers that push in and slide out of latch hooks and then extend out and rotate one-quarter turn (Figure 5-18).



usa001948_109_013.cnv

Figure 5-17. SADA clamp stowage bracket assembly

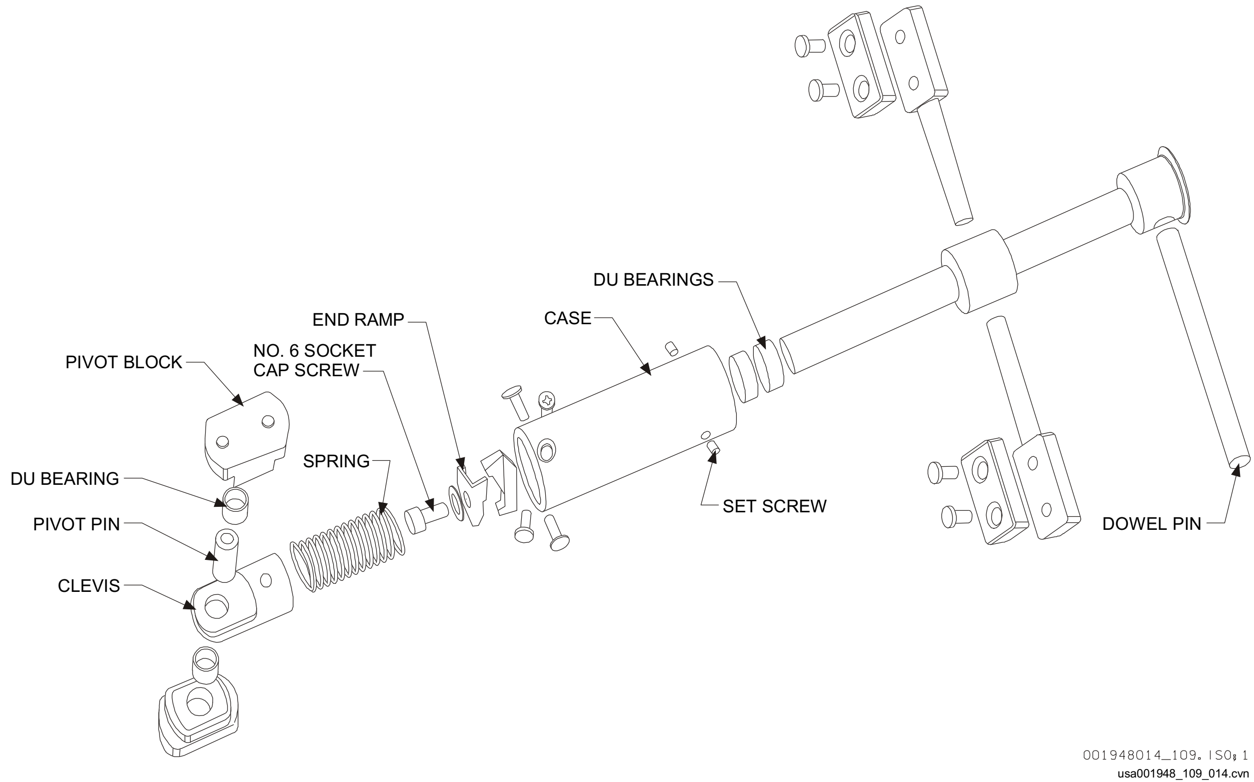


Figure 5-18. SADA plunger

The spare pip pin bracket assembly, Figure 5-19, uses pip pin holders from the SM3A ORUC spare pip pin assembly. The bracket mounts to points on the outer edge of the starboard shelf.

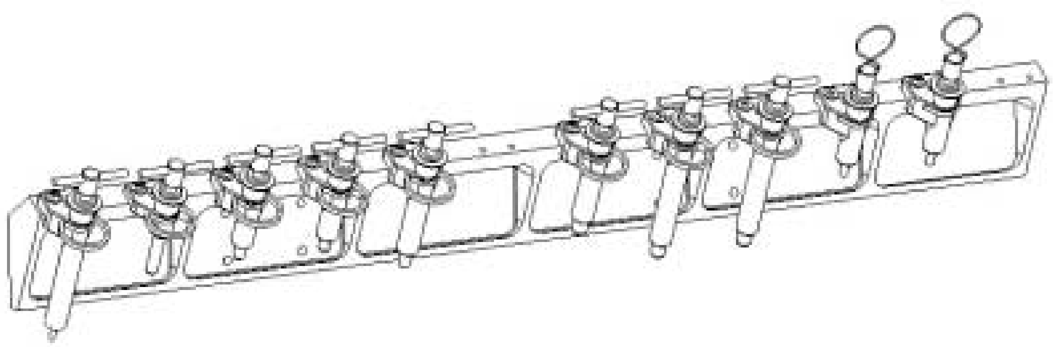


Figure 5-19. Spare pip pin bracket assembly

The SA2 FXC stows a spare pip pin, Figure 5-20, with a hitch pin as a secondary restraint (Figure 5-21). The pip pin has a tether ring for astronaut tethering. The hitch pin is tethered to the FXC bracket.

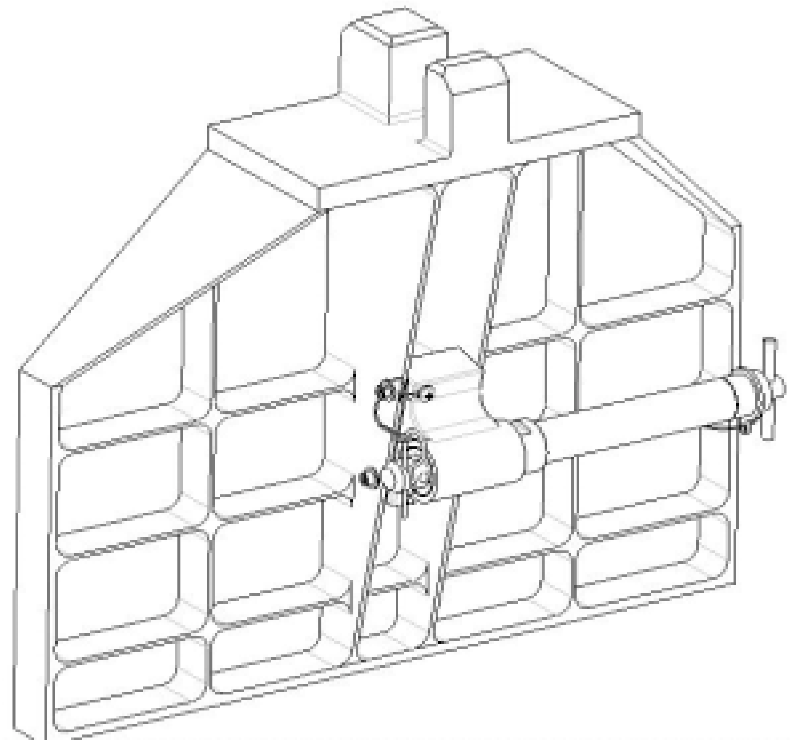


Figure 5-20. Forward x-constraint spare pip pin stowage

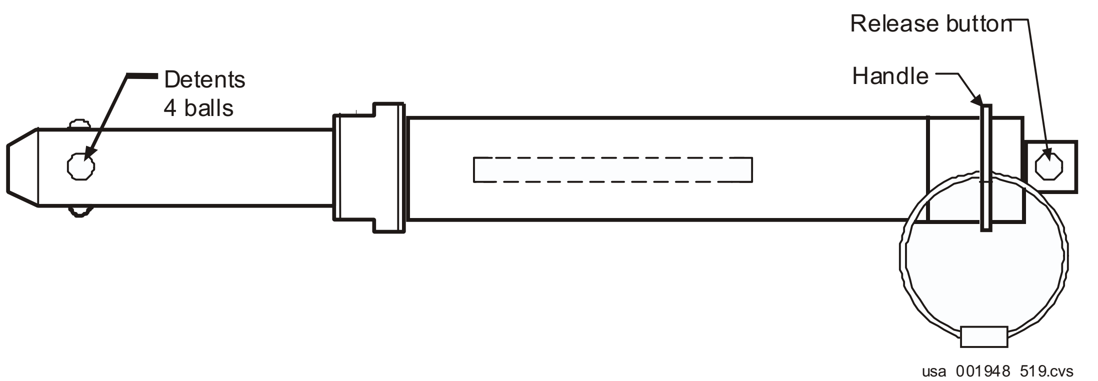


Figure 5-21. Spare pip pin

The four SA-II Bi-Stem braces are located on the starboard inner surface of the pallet cradle with four thermal shield repair kits (Figure 5-22). The Bi-Stem brace is a contingency tool used to stabilize a damaged SA2 Bi-stem. The brace provides an adjustable length stabilizer that attaches to interfaces on the inboard and outboard ends of the solar array flexible blankets. Two SA-II Bi-Stem spines are located on the underside of the port shelf. The spines are used to provide handling support to the SA2 wings.

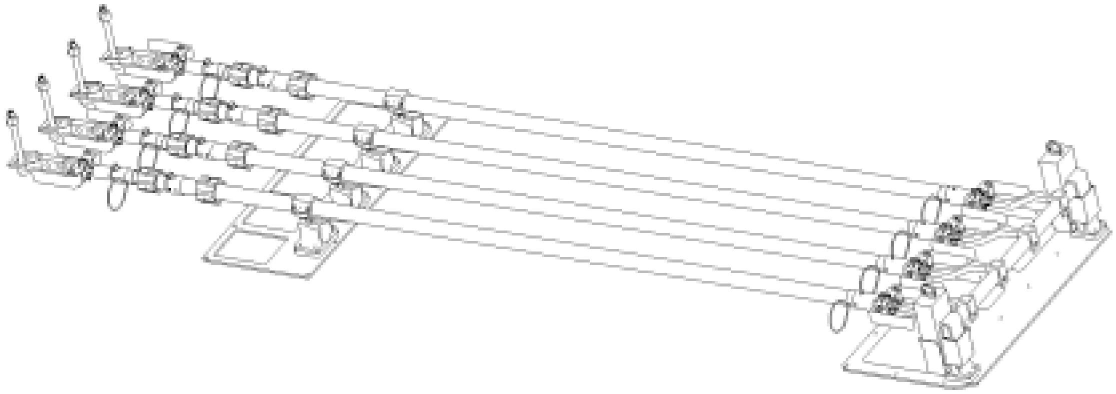


Figure 5-22. SA2 bi-stem braces with thermal shield repair kits

The primary purpose of the jettison handle, Figure 5-23, is for use in manual jettison of the aperture door. The handle interfaces with an interface receptacle mounted on the aperture door. The handle is located on the RAC port shelf.

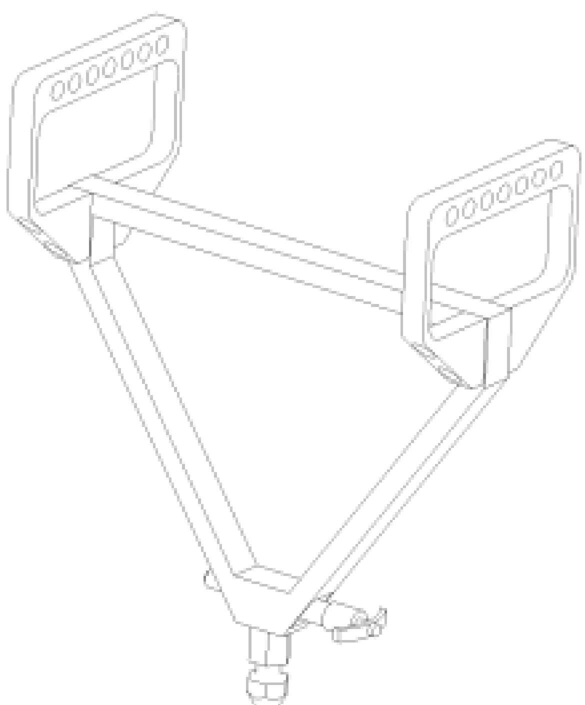


Figure 5-23. Jettison handle

5.1.7 Forward End Pouch Plate

The Forward End Pouch Plate (Figure 5-24 and Figure 5-25) will stow the PDU fuse plug caddy in one pouch and the PCU battery protective cover stringers in another pouch. Both of these interior pouches are enclosed by a soft enclosure secured with Velcro and a restraint strap. The fuse plug caddy itself has a central pouch with six stowage slots for the six fuse plugs removed during the PCU EVA. The caddy also provides an integral side pouch, which is used to stow the PDU connector covers. The PDU connector covers are installed on PDU connectors to provide electrical and physical protection during EVA. This complement of pouches is bolted to an aluminum plate, which is then mounted to the port forward face of the RAC (frame 4).

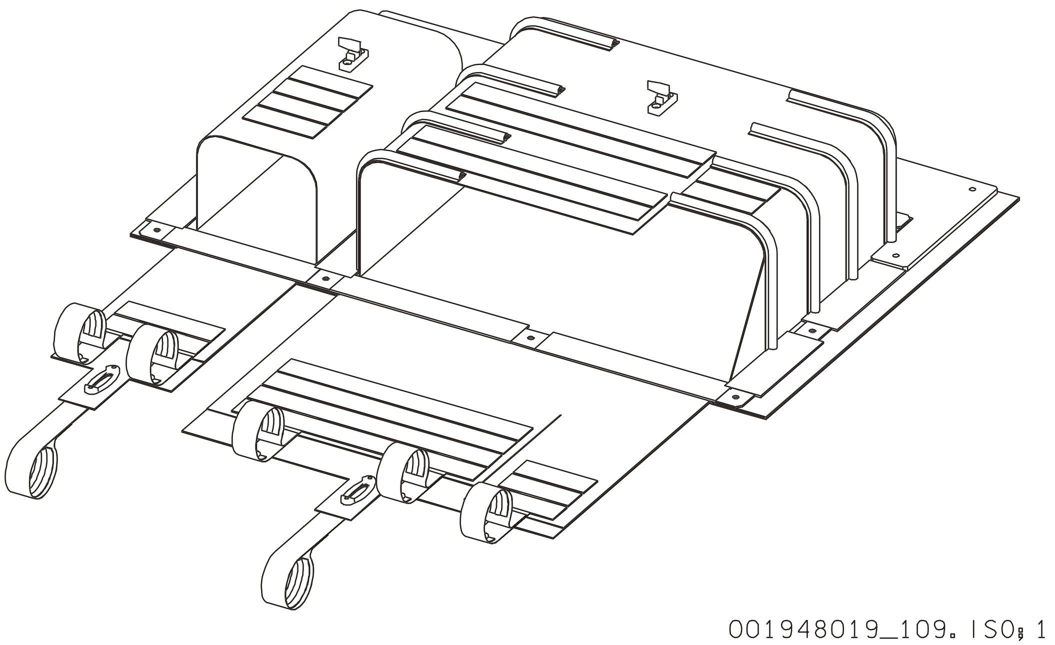


Figure 5-24. Forward end pouch plate – interior

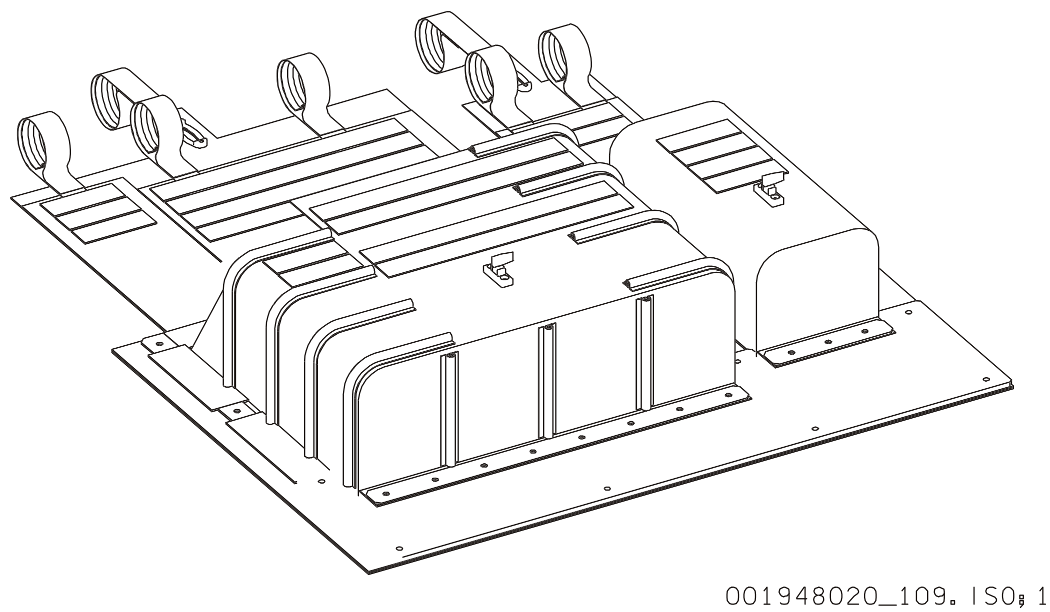


Figure 5-25. Forward end pouch plate – exterior

5.2 RAC ELECTRICAL POWER SYSTEM

There is no electrical equipment needed for the RAC.

5.3 RAC AVIONICS

There are no avionics needed for the RAC.

5.4 RAC THERMAL CONTROL

The RAC provides a platform for transporting the new SA3 solar arrays and their drive mechanisms into orbit and for bringing the old SA2 solar arrays back to Earth. The carrier also serves as a mounting surface for two Auxiliary Transport Modules (ATMs), four bistem braces, three SA3 diode boxes, a pip pin bracket, and a spare SADA clamp fixture.

The new SA3 solar arrays are supported vertically in the center of the RAC on a Center Support Structure (CSS) and are held in place with manually operated latches. The CSS is covered with MLI. The old SA2 arrays will be stowed and latched on two MLI blanketed shelves mounted on the port and starboard sides of the pallet. These shelves are also the mounting points for the SA3 Diode Boxes and the pip pin bracket. The two ATMs are mounted on the lower aft face of the pallet and are covered with MLI as well. They are thermally isolated from the pallet structure through the use of G-10 mounting washers. The Bi-Stem Braces are mounted longitudinally along the lower starboard inside face of the pallet.

The RAC uses a totally passive thermal design. The carrier has no power, heaters or telemetry.

Table 5-1 provides the RAC subsystem temperature limits. Descriptions of the columns in Table 5-1 are as follows:

- Component: Specific payload hardware integrated into or stored on the MULE for SM-3B
- Yellow (Warning) Limit: Temperature signaling a need for close monitoring and/or corrective action. Defined as 10 degrees within the critical limits for all components. Do not apply for non-operating ORUs.
- Red (Critical) Limit: temperature that must not be exceeded
- ORU/CAT/Mechanisms: Non-operating temperature limit
- Stowage Compartment: Defined by ICD requirements for ORUs. Reflects ORU non-operating limits.
- Structure: Safety limits as defined by analysis

Table 5-1. RAC subsystem temperature limits*

Component**	Yellow (Warning) Limit (°C)		Red (Critical) Limit (°C)	
	Low	High	Low	High
Structure				
Pallet Structure	-70	+75	-80	+85
Center Support Structure (CSS)	-70	+75	-80	+85
Shelves	-45	+75	-55	+85
Stowage Equipment				
ATM's	-44	+70	-54	+80
PIP Pins	-60	+70	-70	+80
BiStem Braces	-70	+105	-80	+115
SA3 Latches	-40	+60	-50	+70
SA2 Latches	-50	+50	-60	+60
ORU's				
SA3 Diode Boxes (DBA2)	--	--	-53	+90
SA3 Panels (Cell area)	--	--	-85	+105
SA3 SADM's	--	--	-54	+50
SA2 Solar Array Panels (stowed)	--	--	-105	120

* There are no flight temperature sensors on the RAC

** Temperatures for all items that do not have flight temperature sensors can be determined analytically via the environment temperature sensor records and the models. We can compare monitored components on other carriers to our analysis temperature predictions to create a "scale factor" which we can then use to adjust the temperature predictions of un-monitored components and determine their flight temperatures.

5.4.1 Active Thermal Control

The RAC uses a totally passive thermal design. The carrier has no power, heaters, or telemetry.

5.4.2 Passive Thermal Control

Table 5-2 outlines the passive thermal design approach for each major RAC element. It also provides the RAC surface thermal properties.

Table 5-2. RAC surface thermal properties

Component	Coating	α	ε
RAC Pallet	White Paint, Chemglaze A276	0.26	0.87
Center Support Structure (CSS)	MLI (3 Mil Kapton outer layer)	0.45	0.78
Shelves	MLI (3 Mil Kapton outer layer)	0.45	0.78
SA3 Diode Boxes	MLI (Beta Cloth outer layer)	0.32	0.89
Cross Brace (Shelf to CSS)	MLI (3 Mil Kapton outer layer)	0.45	0.78
SA2 Solar Arrays	Various	-	-
SA3 Solar Arrays (Front) (Back & Edge)	Solar Cell White Tedlar	0.87 0.47	0.85 0.85
SA2 Latches	MLI (3 Mil Kapton outer layer)	0.45	0.78
SA3 Latches	MLI (3 Mil Kapton outer layer) & TufRam	0.45 0.56	0.78 0.83
SA3 Solar Array Drive Mechanism (SADMs)	MLI (Silver Teflon outer layer)	0.18	0.75
BiStem Braces	Chromic Anodize	0.44	0.56
SADA Clamp Stowage Fixture	Irridited Aluminum MLI (3 Mil Kapton outer layer)	0.30 0.45	0.10 0.78
ATMs	MLI (3 Mil Kapton outer layer)	0.45	0.78
Pip pins	MLI (Beta Cloth outer layer)	0.32	0.89

5.5 RAC EXTERNAL INTERFACES

5.5.1 Payload Retention System

The payload retention system is a combination of PRLAs and bridge fittings, which secure the deployable and nondeployable payloads in the orbiter payload bay, and comprises the payload-to-orbiter interface of the Payload Deployment and Retrieval System (PDRS). The orbiter provides the RAC with a motor-driven active retention device, which allows for removal of the RAC in a contingency case. The orbiter payload retention system uses active latches installed on bridge fittings that are attached to the cargo bay frame to secure the payload to the orbiter. Normally, three or four longeron PRLAs are required per payload to react to the X-X and Z-Z flight loads; an Active Keel Actuator (AKA) may also be necessary to restrain Y loads. There are four longeron trunnions (two primary to react to X and Z loads and two stabilizing to react to Z loads) and one keel trunnion that react to Y loads on the RAC.

The two primary trunnions are pinned directly to their bridge fittings, therefore, reacting to both X and Z loads. The two stabilizing trunnions contain a spring that allows a small amount of X-X movement. The stabilizing trunnions are positioning mechanisms that retain the PRLA to its bridge fitting, which only reacts with the Z loads. A disconnect feature is designed into the PRLAs, which provides the capability to manually open and close a latch in the event of a jammed gear mechanism or dual motor failure. Rotating a PRLA EVA drive with a 7/16 inch EVA ratchet towards the latch split-bearing causes a shear pin inside the latch assembly break. Continued rotation in the same direction causes the PRLA gearbox shaft to disengage from the gearbox and dual motor input, allowing manual operation of the latch.

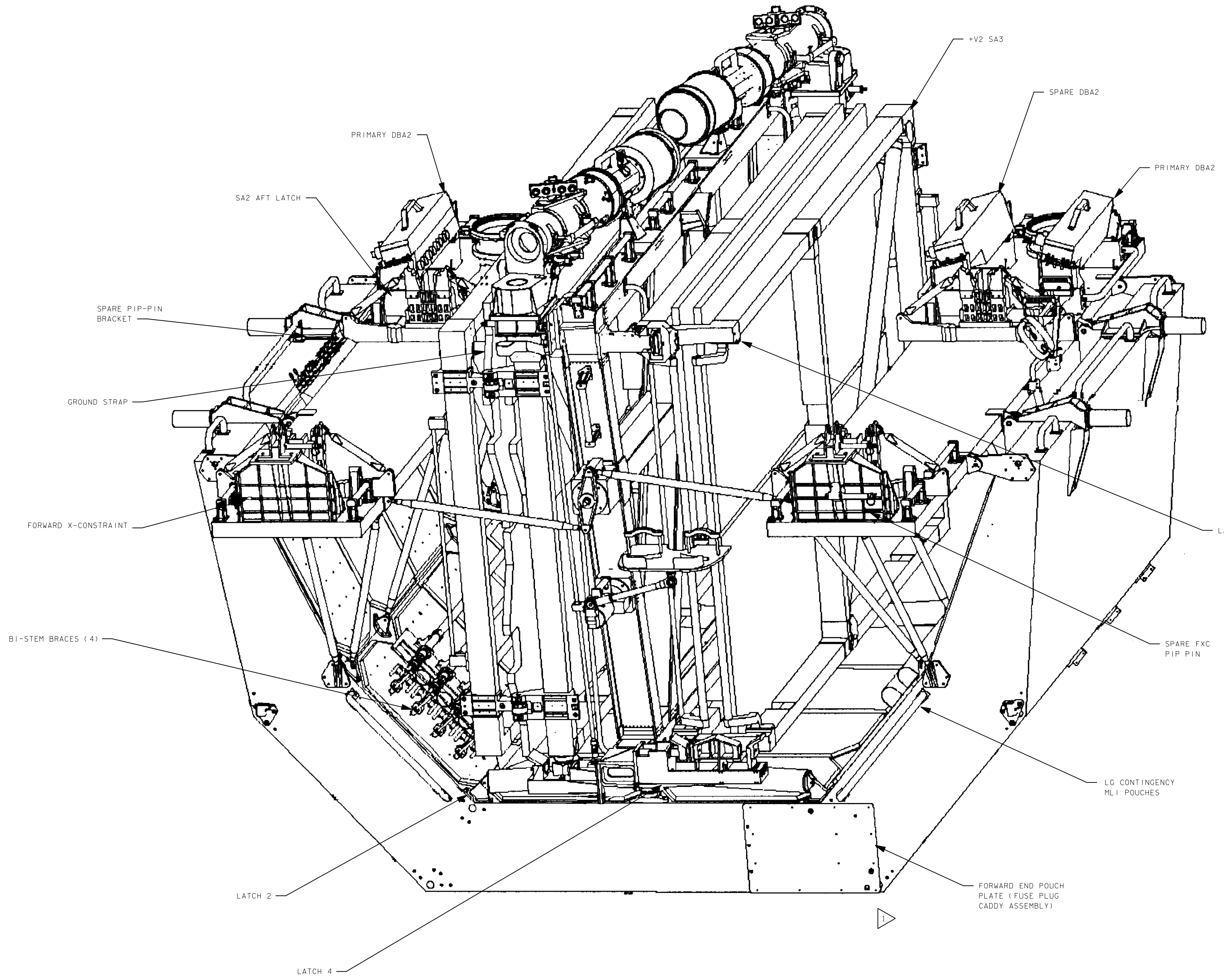
A positive overcenter locking device and positive open and close indications are provided whether the latch is operated manually or with the AC motors. This device consists of a ball, riding in a race on a bellcrank, and two ball seats that limit mechanism movement in either the open or closed position. Although the locking device is incorporated into the PRLA to maintain position at either end of full stroke, the PRLA is structurally locked only when the mechanism is in its latched and overcenter position. Since there is considerable freeplay in the released position, the PRLAs should always be configured to their latched position for launch and entry to preclude mechanism damage and accelerated wear.

The AKA is the Y-direction load-carrying latch. The RAC contains one keel trunnion at orbiter position X=825.13-inch. The AKA acts as a centering device. The AKA is controlled by the same panel A6U switches and talkbacks as the PRLAs, but has no physical EVA accessibility or EVA release/latch feature. The AKA is designed for a latch limit load of 73.7K lbs in the Y-direction, and it is designed to handle payloads of up to 65,000 lb.

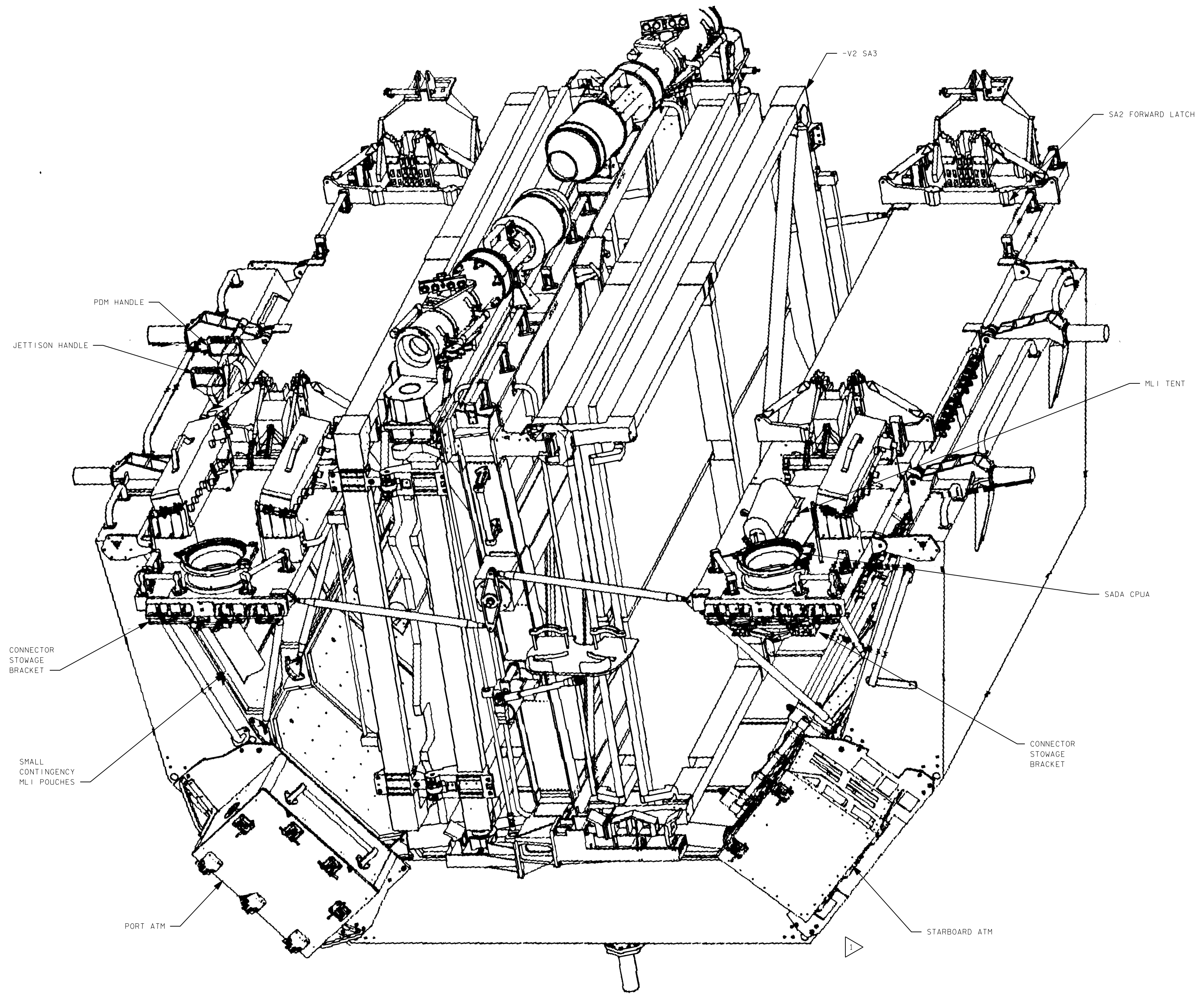
The switches and talkbacks located on Display and Control panel A6U provide onboard monitoring and control of opening or closing the active latches to secure or release payload trunnions. Dual motors drive the longeron latches and each latch has two microswitches to indicate latch and two microswitches to indicate release. The latch/release switch on the D&C panel can activate a number of latches, depending upon how they are wired together prior to launch. The latch/release talkback on the D&C panel requires at least one switch indication of either latch or release from each latch that is tied together in order to make the talkback operate. The keel latch has two microswitches to indicate whether the latch is open or closed. There is also a microswitch that senses when the keel latch is closed with a trunnion in position. Either of these switches can operate the talkback on the D&C panel.

DATE: 01/24/02	NAME: MDU	VERSION: REL;6

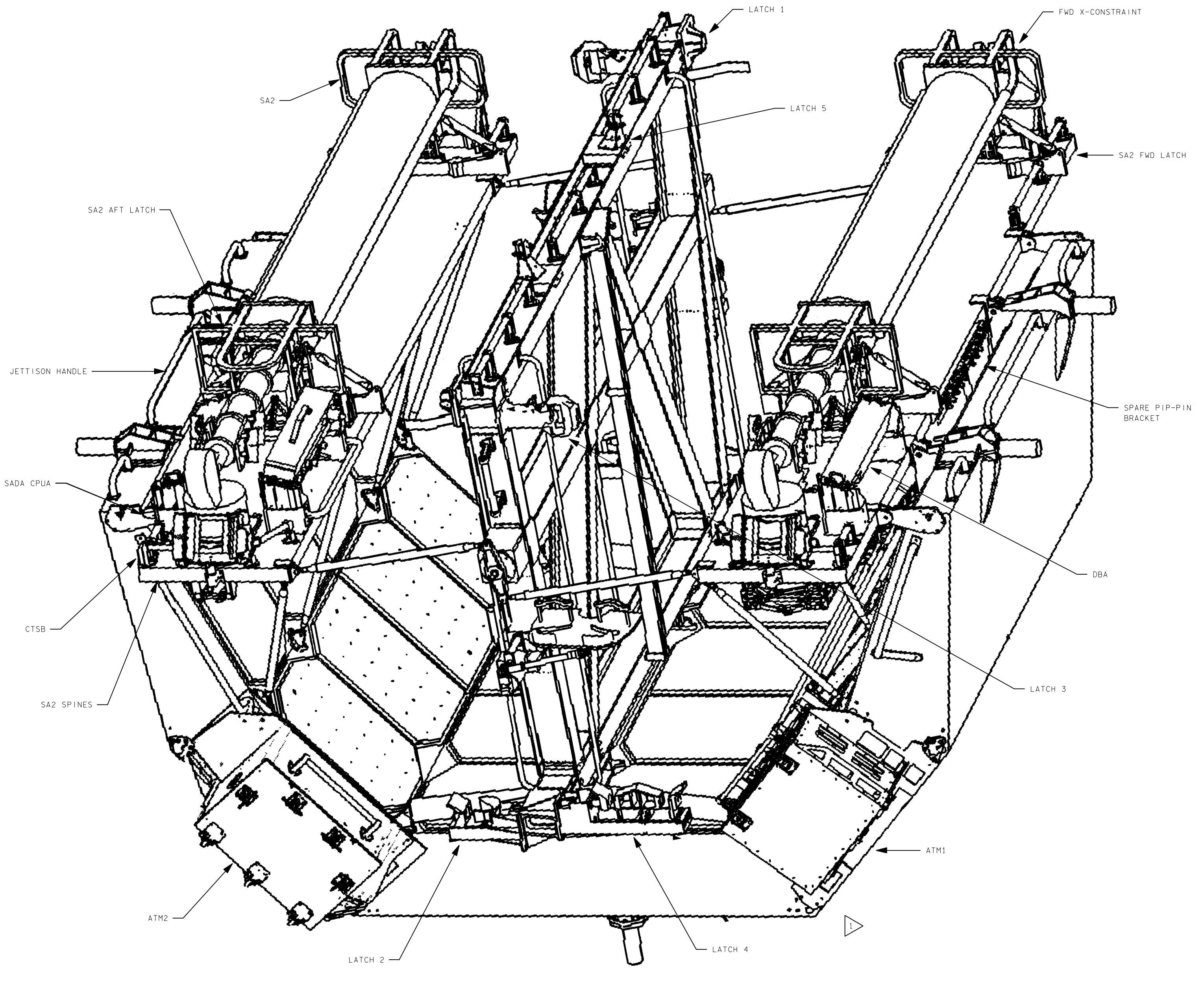
DATE: 10/16/01	NAME: MDU	VERSION: REL;4
DATE: 01/17/02	NAME: SVJ	VERSION: REL;5
DATE: 01/24/02	NAME: MDU	VERSION: REL;6



FORWARD VIEW LAUNCH



AFT VIEW LAUNCH



AFT VIEW LANDING

NOTES: 1 MLI COVERS NOT SHOWN FOR CLARITY

1 RAC PHYS O/V

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN V. HUNTER	11/3/00	RAC PHYSICAL OVERVIEW	
DR			
ENGR R. HARVEY			
ENGR			
APP			
APP		HST SSE CSM	DWG NO 5.1
CADS		STS-109	
LTR / PCN		93.5 X 34	SHEET 1 OF 1

USA001948

USA001948

2 SA-II LATCH O/V

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN V. HUNTER	12/19/01	SA-II LATCH OVERVIEW	
DR			
ENGR T. McCRACKEN			
ENGR			
APP			
APP		HST SSE CSM	DWG NO 5.2
CADS		STS-109	
LTR / PCN		126.5 X 34	SHEET 1 OF 1

USA001948

6.0 DISPLAYS AND CONTROLS

The SSE payload can be controlled via crew switch throws, SPEC item entries, and ground command. Telemetry is available to the crew via switch talkbacks and telemetry displayed on SPEC pages. The MCC flight controllers have a number of displays to view the health and status of the SSE. This section provides information on the panels the crew uses to control and monitor SSE operations, the SPEC pages used to control and monitor SSE operations, and the ground displays the MCC flight control team uses to monitor SSE health and status.

6.1 ORBITER PANELS

This section details the panels that the crew uses to control and monitor the SSE: The Standard Switch Panel (SSP) and the Payload Retention Latch control panel (A6U).

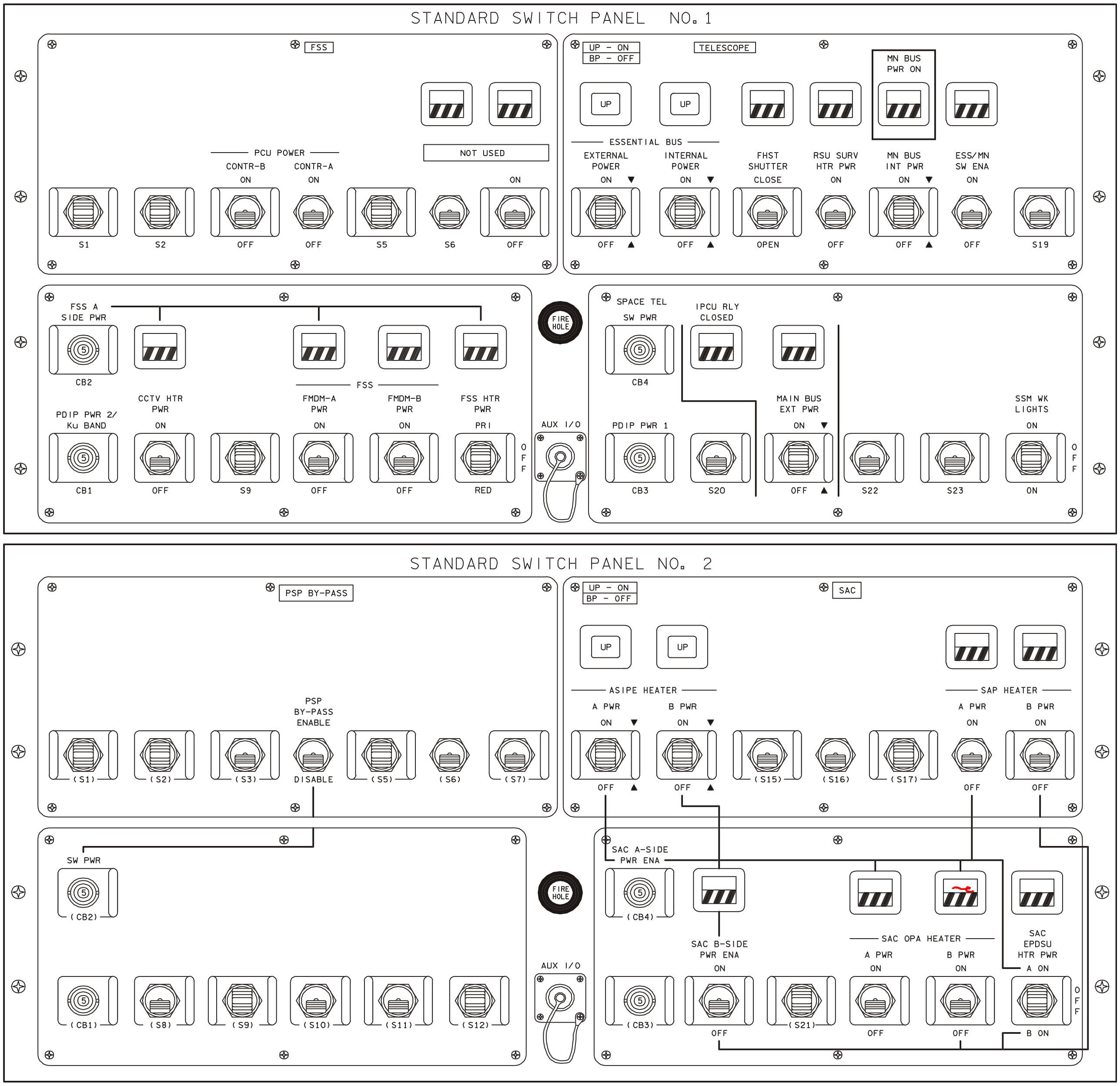
6.1.1 Standard Switch Panels

The HST uses three SSPs for controlling and monitoring the telescope, SSE, and associated support equipment. Table 6-1 details the SSP locations and functional allocations. Figures 6-1 and 6-2 show the layout of the SSPs.

Table 6-1. SSP functions per panel

	B (left)	**A (right)**
SSP 1 (L12U)	FSS	HST
SSP 2 (L12L)	PSP-Bypass	SAC
SSP 3 (L11U)	Keel Cam	MULE

A description of the FSS switches is provided in Table 6-2. The HST, PSP-Bypass, and Keel Camera switch functions are not discussed in this CSM; details on the HST can be found in the HST CSM, JSC-29029. The SAC switch descriptions are provided in Table 6-3, and the MULE switch descriptions are provided in Table 6-4. Details on SSP wiring for all 3 panels are provided in Drawings 6.1-1 to 6.1-4.



001948017_109.PNL;1

Figure 6-1. SSP1 and SSP2 (L12) layout

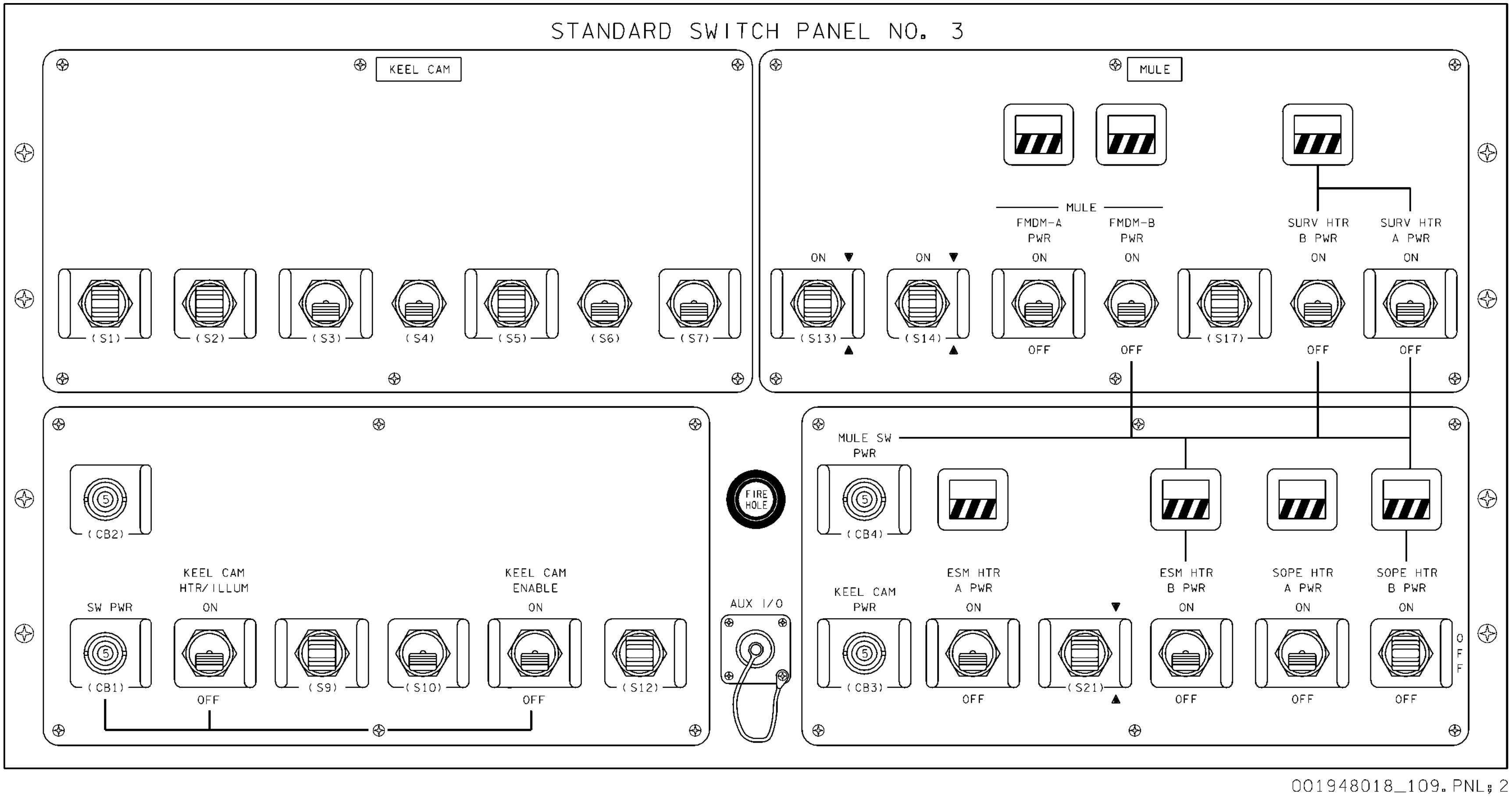


Figure 6-2. SSP3 (L11U) layout

Table 6-2. SSP 1 switch panel functions

Item	Type device	Function	Usage
PCU Power Control–B Switch (S3 – SSP 1)	Toggle switch, 2-position Double Pole, Single throw (DPST)	ON (UP) – Enables the B hardline control signal to EPDSU-1 and EPDSU-2, providing power to the PCUs OFF (DOWN) - Disables the B control signal to EPDSU-1 and EPDSU-2, removing power to the PCUs	Not normally used. PCUs will normally be controlled via FMDM <u>NOTE</u>: The power on/off indication is observed on telemetry
PCU Power Control–A Switch (S4 – SSP 1)	Toggle switch, 2-position DPST	ON (UP) - Enables the A hardline control signal to EPDSU-1 and EPDSU-2, providing power to the PCUs OFF (DOWN) – Disables the A control signal to EPDSU-1 and EPDSU-2, removing power to the PCUs. Disables the B control signal to the EPDSU-2, removing power to the SPCU DPCs	Not normally used. PCUs will normally be controlled via FMDM <u>NOTE</u>: The power on/off indication is observed on telemetry
FSS A SIDE PWR Circuit breaker (CB2 – SSP 1)	Circuit breaker	OUT - Open IN - Closed FSS B side power is hardwired Note: FSS B side power is hardwired	Closed during SSE activation 5-amp circuit breaker which routes orbiter power to S4, S6, S8, S10, and S12 (UP)

Table 6-2. SSP 1 switch panel functions (continued)

Item	Type device	Function	Usage
CCTV HTR PWR Switch (S8 - SSP 1)	Toggle switch, 2-position DPST	ON (UP) - Enables EPDSU-1 power to the CCTV heater circuits. This allows thermostatic control of the CCTV heaters OFF (DOWN) - Disables EPDSU-1 power to CCTV heater circuits	Turned on during SSE activation (no later than 8 hr after PLBD opening) Turned off during SSE deactivation (no earlier than 1 hr prior to reentry)
CCTV HTR PWR Status Indicator (DS8 – SSP 1)	Display indicator, 2-position	ON - gray OFF - bp	Status indicator
FSS FMDM-A PWR Switch (S10 – SSP 1)	Toggle switch, 2-position DPST	ON (UP) - Enables EPDSU-1 power to FMDM-A OFF (DOWN) - Disables EPDSU-1 power to FMDM-A	Turned on during SSE check-out for continuous control and monitoring of FSS Turned off during FSS deactivation
FSS FMDM-A PWR Status Indicator (DS10 - SSP 1)	Display indicator, 2–position	ON – gray OFF – bp	Status indicator
FSS FMDM-B PWR Switch (S11 - SSP 1)	Toggle switch, 2-position DPST	ON (UP) - Enables EPDSU-2 power to FMDM-B OFF (DOWN) - Disables EPDSU-2 power to FMDM-B	Turned on during SSE activation for initial control and monitoring of FSS. FMDM-B is a redundant unit and will only be used during initial FSS activation and check-out and in the event of a failure on the A-side avionics or used in contingencies in conjunction with the A-side for dual FMDM mechanism operations Turned off during completion of SSE checkout

Table 6-2. SSP 1 switch panel functions (concluded)

Item	Type device	Function	Usage
FSS FMDM-B PWR Status Indicator (DS11 - SSP 1)	Display indicator, 2-position	ON - gray OFF - bp	Status indicator
FSS HTR PWR Switch (S12 - SSP 1)	Toggle switch, 3-position DPDT	PRI (UP) - Enables EPDSU-1 and EPDSU-2 power to primary FSS heater circuits. This allows thermostatic control of primary FSS heaters OFF (CENTER) - Disables EPDSU-1 and EPDSU-2 power from FSS primary heater and redundant heater circuits RED (DOWN) - Enables EPDSU-1 and EPDSU-2 power to redundant FSS heater circuits. This allows thermostatic control of redundant FSS heaters	Turned on during SSE activation (no later than 2 hr after PLBD opening) Turned off during SSE deactivation (no earlier than 1 hr prior to reentry) Redundant FSS heaters may be activated in the event of a failure in the primary FSS heaters
FSS HTR PWR Status Indicator (DS12 - SSP 1)	Display indicator, 2-position	ON (PRI or RED) – gray OFF - bp	Status indicator

Table 6-3. SSP 2 switch panel functions

Item	Type device	Function	Usage
PSP BY-PASS SW PWR Circuit breaker (CB2 - SSP2)	Circuit breaker (5 Amps)	OUT - Open IN - Closed, provides power to PSP BY-PASS selector switch	On orbit, as required
PSP BY-PASS Switch (S4 - SSP2)	Toggle switch, 2-position DPST	ENABLE (UP) - Allows PDI data flow (DOD mode). Provides unique orbiter PI/PSP/PDI command/data configuration for HST only DISABLE (DOWN) - Inhibits PDI data flow (PSP Mode)	On orbit, as required
ASIPE HTR-A PWR Switch (S13 – SSP 2)	Toggle switch, 3-position DPDT momentary (should be held for approximately 2 sec)	ON (momentary UP) - Provides a latching signal to the SAC EPDSU. This applies power for the thermostatic control of ASIPE A heaters Center Position - Normal OFF (momentary DOWN) - Disables the EPDSU power from the thermostatically controlled ASIPE A heaters	Turned on during SSE activation Normal switch position when not in use Turned off during SSE deactivation
ASIPE HTR-A PWR Status Indicator (DS13 - SSP 2)	Display indicator 3-position	ON - UP OFF - BP DN indicator not used for HST	Status Indicator

Table 6-3. SSP 2 switch panel functions (continued)

Item	Type device	Function	Usage
ASIPE HTR-B PWR Switch (S14 - SSP 2)	Toggle switch, 3-position DPDT momentary (should be held for approximately 2 sec)	ON (momentary UP) - Provides a latching signal to the SAC EPDSU. This applies power for the thermostatic control of ASIPE B heaters Center Position - Normal OFF (momentary DOWN) - Disables the EPDSU power from the thermostatically controlled ASIPE B heaters	Redundant ASIPE heaters may be activated in the event of a failure in the A side heaters Normal switch position when not in use
ASIPE HTR-B PWR Status Indicator (DS14 - SSP 2)	Display indicator 3-position	ON - UP OFF - BP DN indicator not used for HST	Status Indicator
SAP HTR-A PWR Switch (S18 - SSP 2)	Toggle switch, 2-position DPDT	ON (UP) - Enables the SAC EPDSU. This applies power for the thermostatic control of the SAP A heaters OFF (DOWN) - Disables the EPDSU power from the thermostatically controlled SAP A heaters	Redundant SAP heaters may be activated in the event of a failure in the B side heaters
SAP HTR-A PWR Status Indicator (DS18 - SSP 2)	Display indicator 2-position	ON - GRAY OFF - BP	Status Indicator
SAP HTR-B PWR Switch (S19 - SSP 2)	Toggle switch, 2-position DPDT	ON (UP) - Enables the SAC EPDSU. This applies power for the thermostatic control of the SAP B heaters OFF (DOWN) - Disables the EPDSU power from the thermostatically controlled SAP B heaters	Turned on during SSE activation Turned off after NCC installation

Table 6-3. SSP 2 switch panel functions (continued)

Item	Type device	Function	Usage
SAP HTR-B PWR Status Indicator (DS19 - SSP 2)	Display indicator 2-position	ON - GRAY OFF - BP	Status Indicator
SAC A-SIDE PWR ENA Circuit breaker (CB4 - SSP 2)	Circuit breaker (5 Amps)	OUT - Open IN - Closed	Closed during SSE activation. 5-amp circuit breaker that routes orbiter power to S13, S18, S22, S24 (UP)
SAC B-SIDE PWR ENA Switch (S20 – SSP 2)	Toggle switch, 2-position DPDT	ON (UP) – Provides fused orbiter power from the EPDSU to SSP switches S14, S19, S23, and S24 (DN) for control of SAC B side circuits OFF (DOWN) – Removes orbiter power from B side circuits	Turned on during SSE activation Turned off during SSE deactivation
OPA HTR-A PWR Switch (S22 – SSP 2)	Toggle switch, 2-position DPDT	ON (UP) – Enables the SAC EPDSU. This applies power for the thermostatic control of the OPA A heaters OFF (DOWN) – Disables the power EPDSU from the thermostatically controlled OPA A heaters	Turned on during SSE activation Turned off after PCU-R successful Functional Test (FT)
OPA HTR-A PWR Status Indicator (DS22 – SSP 2)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator

Table 6-3. SSP 2 switch panel functions (concluded)

Item	Type device	Function	Usage
OPA HTR-B PWR Switch (S23 – SSP 2)	Toggle switch, 2-position DPDT	ON (UP) – Enables the SAC EPDSU. This applies power for the thermostatic control of the OPA B heaters OFF (DOWN) – Disables the EPDSU power from the thermostatically controlled OPA B heaters	Redundant OPA heaters may be activated in the event of a failure in the A side heaters
OPA HTR-B PWR Status Indicator (DS23 – SSP 2)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator
SAC EPDSU HTR PWR Switch (S24 – SSP 2)	Toggle switch, 3-position DPDT center off	ON (UP) – Enables the SAC EPDSU. This applies power for the thermostatic control of the EPDSU A side heaters OFF (CENTER) – Removes power from the thermostatically controlled SAC EPDSU A and B side heaters ON (DOWN) – Enables the EPDSU. This applies power for the thermostatic control of the EPDSU B side heaters	Turned on during SSE activation Turned off during SSE deactivation Redundant SAC EPDSU heaters may be activated in the event of a failure in the A side heaters
SAC EPDSU HTR Status Indicator (DS24 – SSP 2)	Display indicator, 2-position	ON A or B side – GRAY OFF - BP	Status Indicator

Table 6-4. SSP 3 switch panel function

Item	Type device	Function	Usage
MULE FMDM-A PWR Switch (S15 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to FMDM-A, A-side thermistor biases, and PDSU current sensors OFF (DOWN) – Disables the PDSU to remove power from FMDM-A, A-side thermistor biases, and PDSU current sensors	Turned on during SSE checkout for monitoring of the MULE Turned off during SSE deactivation
MULE FMDM-A PWR Status Indicator (DS15 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator
MULE FMDM-B PWR Switch (S16 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to FMDM-B, B-side thermistor biases, and PDSU current sensors OFF (DOWN) – Disables the PDSU power from FMDM-B, B-side thermistor biases, and PDSU current sensors	Turned on during SSE activation for initial monitoring of MULE. FMDM-B is a redundant unit and will only be used during initial MULE activation and checkout, and in the event of a failure on the A-side avionics Turned off during completion of SSE checkout
MULE FMDM-B PWR Status Indicator (DS16 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator

Table 6-4. SSP 3 switch panel function (continued)

Item	Type device	Function	Usage
SURV HTR B PWR Switch (S18 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to the B-side heaters: PDSU, LOPE, and avionics radiator plate OFF (DOWN) – Disables the PDSU power to the B-side heaters: PDSU, LOPE, and avionics radiator plate	Turned on during SSE activation Turned off during SSE checkout
SURV HTR PWR Status Indicator (DS18 – SSP 3)	Display indicator 2-position	ON A or B side – GRAY OFF – BP	Status Indicator
SURV HTR A PWR Switch (S19 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to the A-side heaters: PDSU, LOPE, and avionics radiator plate OFF (DOWN) – Disables the PDSU power to the A-side heaters: PDSU, LOPE, and avionics radiator plate	Turned on during SSE checkout Turned off during SSE deactivation
MULE SW PWR Circuit Breaker (CB4 – SSP 3)	Circuit breaker	OUT – Open IN - Closed	Closed during SSE activation. 5-amp circuit breaker that routes orbiter power to S16, S18, S22, S24
ESM HTR A PWR Switch (S20 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to ESM A-side heaters OFF (DOWN) – Disables the PDSU power from ESM A-side heaters	Turned on during SSE checkout Turned off after ESM installation on HST
ESM HTR A PWR Status Indicator (DS20 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator

Table 6-4. SSP 3 switch panel function (concluded)

Item	Type device	Function	Usage
ESM HTR B PWR Switch (S22 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to ESM B-side heaters OFF (DOWN) – Disables the PDSU power from ESM B-side heaters	Turned on during SSE activation Turned off during SSE checkout
ESM HTR B PWR Status Indicator (DS22 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator
SOPE HTR A PWR Switch (S23 – SSP 3)	Toggle switch, 2-position DPDT	ON (UP) – Enables the PDSU power to SOPE A-side heaters OFF (DOWN) – Disables the PDSU power from SOPE A-side heaters	Turned on during SSE checkout Turned off during SSE deactivation
SOPE HTR A PWR Status Indicator (DS23 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator
SOPE HTR B PWR Switch (S24 – SSP 3)	Toggle switch, 3-position DPDT center off	ON (UP) – Enables the PDSU power to SOPE B-side heaters OFF (CENER) – Disables the PDSU power from SOPE B-side heaters (DOWN) – not wired	Turned on during SSE activation Turned off during SSE checkout
SOPE HTR B PWR Status Indicator (DS24 – SSP 3)	Display indicator 2-position	ON – GRAY OFF – BP	Status Indicator

6.1.2 Payload Retention Latch Panel (A6U)

The orbiter panel A6U shown in Figure 6-3 is the crew interface to the payload retention latch system. The payload retention latch system supplies 115 V, 400 Hz three-phase AC power and +28 V DC power to the payload bay and receives talkback (tb) indications from the payload bay. Panel A6U can be used to control payload retention latches or the SSE mechanisms, as outlined in Section 6.1.2.1.

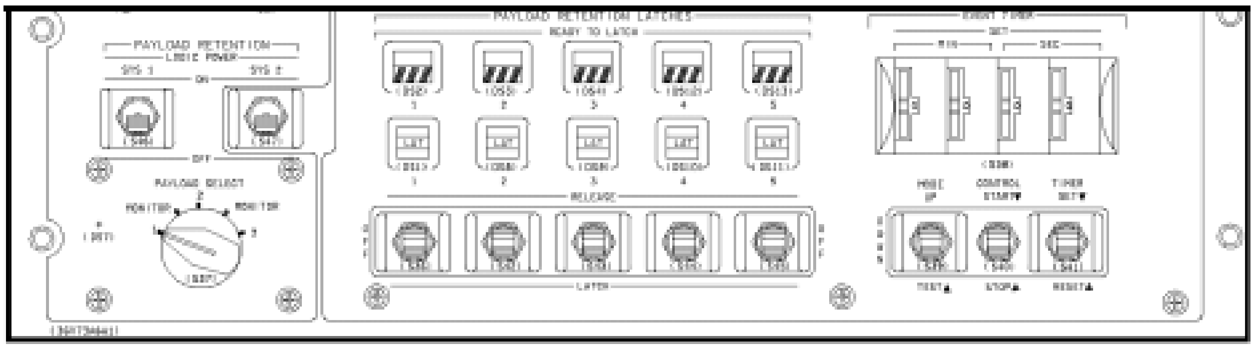


Figure 6-3. Payload retention latch panel (A6U)

Panel A6U can be used to operate a latch/mechanism with one motor or two functionally redundant motors. (A latch/mechanism refers to a system that has two redundant motors.) The retention latch assembly has redundant systems that control these redundant motors. The functional relationship of each of the components in the system is shown in Drawing 2.6 for the SSE mechanisms and SSSH Drawing 14.3-1 for the RAC active trunnion retention latches.

The major components of the retention latch system are shown in Drawing 2.6. LOGIC POWER is used to activate either system 1, 2, or both. The Mid-Motor Control Assemblies (MMCAs) house relays supply three-phase AC power to the latches in the payload bay. The patch panels connect cables from the MMCAs with cables from the electrical connectors in the payload bay. The electrical connectors in the payload bay are where latches/mechanisms plug into the orbiter for power.

Only system 1 drives the talkbacks on panel A6U. System 1 consists of LOGIC POWER 1, relays in MMCA 1, the three starboard patch panels, and one of the redundant motors in the latches/mechanisms in the payload bay. System 2 consists of LOGIC POWER 2, relays in MMCA 3, the port panel, and other redundant motors in the payload bay.

6.1.2.1 Panel A6U Controls

A description of the latch controls on panel A6U is given below, along with a description of the onboard display available to monitor the system.

The PAYLOAD SELECT switch is a five-position rotary switch that selects a group of latches/mechanisms to be controlled by the RETENTION LATCH switches (see Drawing 2.6). The five positions are PAYLOAD SELECT 1, 2, and 3, and two MONITOR positions. When the PAYLOAD SELECT switch is in either of the two

MONITOR positions, the status of all mechanisms can be monitored on the payload retention display, SPEC 097 (Figure 6-4). All talkbacks on panel A6U indicate barberpole when the PAYLOAD SELECT (PL SEL) switch is in either MONITOR position.

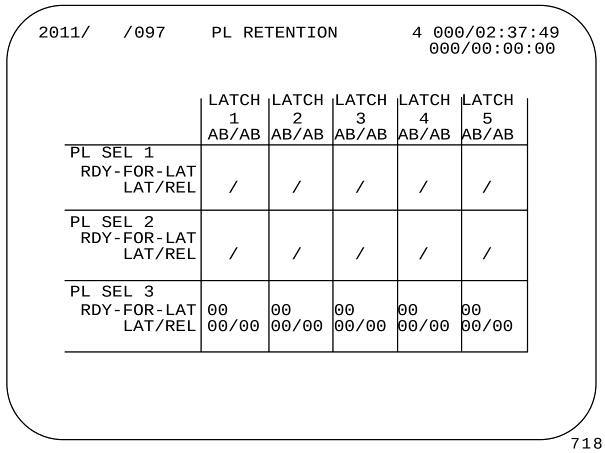


Figure 6-4. Orbiter payload retention display (SPEC SM097)

Additional information on AMSB status can be found on the PL RETENTION display (SPEC 097). This display presents the status of a selected AMSB mechanism in the LATCH 1/PL SEL 1 and LATCH 2/PL SEL 1 boxes and does not use FMDM status data. The ready for latch indications will always be 00 because the AMSB does not support that function. The status of the AMSB A will be displayed on the A side of latch 1 and the status of AMSB B will be shown on the B side of latch 2. If no mechanism is selected on either AMSB A or B, both the latch and release status for that AMSB will show 0. It should be noted that the rotator, pivoter, and translator are not expected to reach the end of travel or beginning of travel positions during the servicing mission and, therefore, the status of these two mechanisms will probably be shown as zeros in both the LAT/REL column of this display when they are selected. Once the BSP is installed, the pivoter is not expected to reach BOT/EOT microswitches.

6.1.2.1.1 RETENTION LATCH Switches

The five three-position RETENTION LATCH switches are latching toggle switches. The three positions are RELEASE, OFF, and LATCH.

6.1.2.1.2 Talkbacks

The 10 talkbacks on panel A6U are responsive only to switches in system 1. Each mechanism driven by a RETENTION LATCH switch has two talkbacks associated with it, a RELEASE/LATCH indication and a READY FOR LATCH indication. The RELEASE/LATCH talkbacks indicate LAT when a mechanism is at the end of travel, indicate REL when a mechanism is at the beginning of travel, and indicate barberpole when a mechanism is in transit. The READY FOR LATCH talkbacks are not active for the SSE mechanisms, but will function for the RAC trunnion latches. The talkbacks, like the RETENTION LATCH switches, work in conjunction with the PAYLOAD SELECT rotary switch. If the PAYLOAD SELECT switch is in MONITOR, the talkbacks indicate barberpole. The status of all mechanisms can be monitored on SPEC 097.

6.1.2.1.3 Logic Power Switches

The payload retention LOGIC POWER SYSTEM 1 switch providesMain A (MNA) power to retention drive system 1 to drive relays in MMCA 1. The relays connect three-phase AC power to the motors in the payload bay controlled by system 1. The LOGIC POWER SYSTEM 2 switch provides Main B (MNB) power to retention drive system 2 for driving relays in MMCA 3 that connect three-phase AC power to the motors controlled by system 2.

The LOGIC POWER also supplies +28 V DC indicator power to mechanisms in the payload bay. This indicator power activates end-of-travel switches in the mechanisms. LOGIC POWER 1 provides MNA indicator (MNA IND) power to system 1 motors; LOGIC POWER 2 provides MNB indicator (MNB IND) power to the motors controlled by system 2.

6.1.2.2 Payload Retention Latch System Components

The components of the payload retention latch system, other than panel A6U, are described in the following paragraphs.

6.1.2.2.1 Mid-Motor Control Assemblies

Each MMCA has a release and a latch AND gate relay for each of the five retention latch switches on the three numeric PAYLOAD SELECT positions. When an AND gate receives a high voltage signal (or a “1”) from the RETENTION LATCH switch and a low voltage signal (or a “0”) from the beginning- or end-of-travel switch in the mechanism, the AND gate passes power to the relay coil, which closes relay contacts that connect three-phase AC power with the mechanisms in the payload bay. Power from AC1 Payload Bay Mechanical Mid-Motor Controller 1 (PBM MMC1) is routed through MMCA1; power from AC2 PBM MMC3 is routed though MMCA 3.

The MMCAs also route +28 V DC indicator power (IND PWR) from LOGIC POWER to activate beginning- and end-of-travel position. When this occurs, the beginning- and end-of-travel switch in the mechanisms sends a high voltage signal (or a “1”) back to the AND gate in the MMCA; power is removed from the relay coil, which, in turn, opens the relay contacts which connect three-phase AC power with the mechanisms. Thus, power will be removed from the mechanisms.

Each MMCA OP status parameter represents the status of a serial chain of relay contacts. The payload retention contacts are one of four contacts in the relays in the MMCAs that connect three-phase AC power with the mechanisms in the payload bay. Refer to SSSH Drawing 2.4-2, to see the rest of the contacts in the serial chains that affect these parameters.

These status indications are available in the operational instrumentation downlink. The bilevel parameters indicate the status of a relay chain by transitioning between a “1” and a "0". The release and latch relay contacts are embedded in a serial chain, with relay contacts from other orbiter systems. Therefore, the opening of any one of the contacts will change the reading of the MMCA OP status parameter if all the other contacts in the chain are closed. Also, if one relay opens while another relay in the chain is already open, its transition will be undetectable in the status parameter. Furthermore, if any relay fails to open, the status parameter from the serial chain it is in will be useless. These factors must be understood when using these parameters on console.

When the latches are to be activated by the crew, the status parameters should be monitored on the ground. It should first be verified that no other contact in the serial chain with the payload latch contact will be opened at the same time as the payload latch contact. The status parameters should be monitored in conjunction with monitoring the AC bus currents that drive the motors in the mechanisms. What the MMCA status indicator actually indicates is that the relay that connects AC power with the payload retention latch is closed. A jump in the AC bus currents supplying power to the mechanism indicates that power has reached the motors in the mechanism. The MSID numbers corresponding to the AC bus currents that should be monitored are listed below.

For system 1:		AC1
	phase A	V76C1540A
	phase B	V76C1541A
	phase C	V76C1542A
For system 2:		AC2
	phase A	V76C1640A
	phase B	V76C1641A
	phase C	V76C1642A

The MCA status indications for system 1 are enabled by the following switch:

panel MA73C:A S2 - MCA LOGIC MNB MID 3

The MCA status indications for system 2 are enabled by either of the following switches:

panel MA73C:B S8 - MCA LOGIC MNB MID 3
panel MA73C:B S3 - MCA LOGIC MNB MID 3

6.1.2.2.2 Patch Panel

The payload bay contains two identical patch panels, one on the starboard side and one on the port side. The panels are located at X_0 = 807. Each panel has 12 left sill, 12 right sill, and 5 keel position connections.

The payload retention latch system is adapted for specific flight requirements at the patch panel. Cables leaving the MMCAs become the plugs in the patch panel. The plugs connect with receptacles in the patch panel that are wired to particular electrical connectors in the payload bay.

6.2 ORBITER SSE RELATED DISPLAYS

Two SM SPEC pages are used to control and monitor the SSE. SM 211 SSE OVERVIEW is used to control the systems for the FSS, MULE, and SAC. The RAC is unpowered and, therefore, has no telemetry associated with it. SM 212 SSE MECHANISMS is used to control and monitor the FSS mechanism operations. The layout of SM 211 is shown in Figure 6-5 and a description is provided in Table 6-5. The SM 212 is shown in Figure 6-6 and a description is provided in Table 6-6.

The status parameter field for all parameters is blank for normal operations or displays and M for missing data. For analog parameters, this field will also display an H or L for off-scale data. An up or down arrow is displayed when an analog parameter exceeds either an upper or lower limit. The symbols driven in the status field of the parameter have the following display priority from highest to lowest (M, H, L,↑, ↓). All symbols driven in the parameters status column will be displayed four times normal intensity.

Several feedback indications on this display are provided by BITE test 4 measurements acquired by the SM GPC upon execution of the MDM discrete commands. These measurements provide the output status only of the commanded FMDM discrete output card and should not be confused with an end-item feedback status. Proper indications based on BITE test 4 feedbacks simply verify that the command was successfully received and output by the FMDM but give no insight into the end-item status.

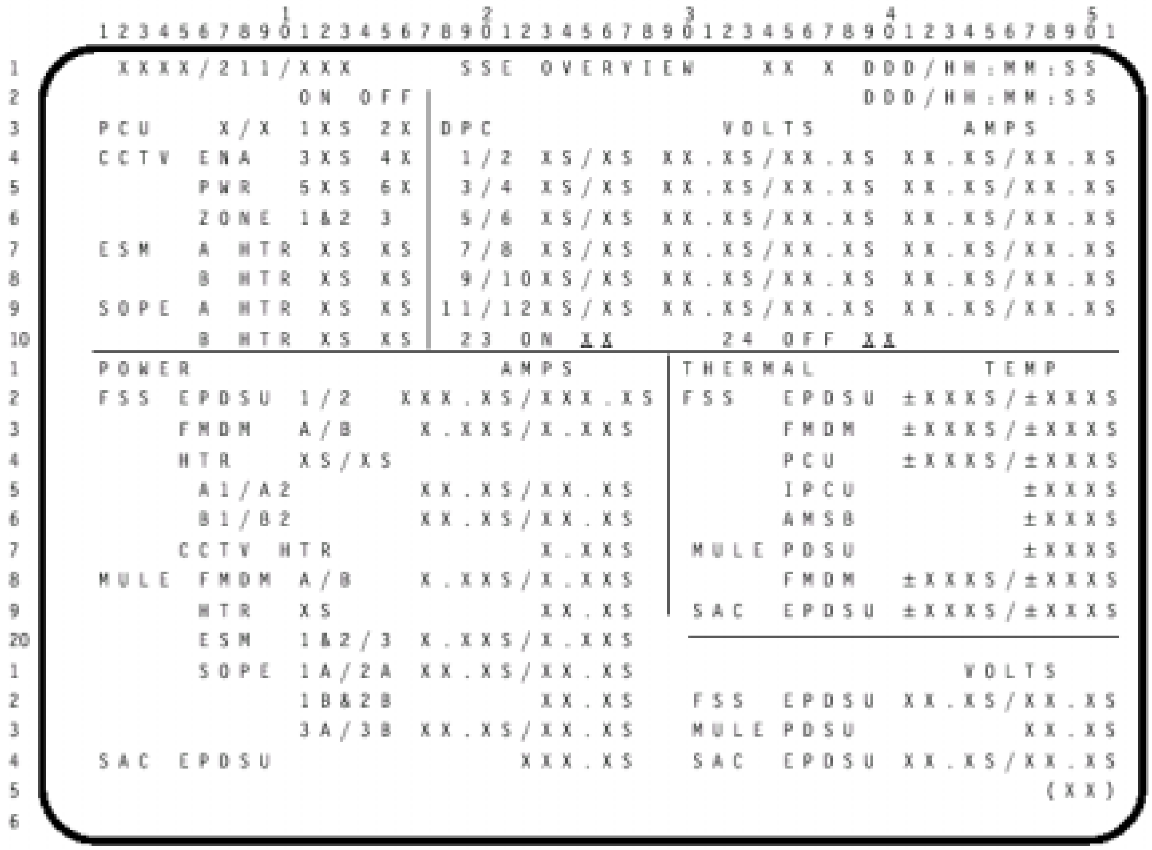


Figure 6-5. SSE displays 211

Table 6-5. Parameter characteristics: SM 211 SSE overview

CRT name	MSID	Units	Display range	Status indicators				
				M	H	L	↑	↓
PCU (P)	P34K4024Y/ P34K4026Y/ P34K4050Y/ P34K4052Y/ P34K4054Y/ P34K4056Y	event	blank, P, '*'					
(S)	P34K4028Y/ P34K4030Y/ P34K4058Y/ P34K4060Y/ P34K4062Y/ P34K4064Y	event	blank, S, '*'					

Table 6-5. Parameter characteristics: SM 211 SSE overview (continued)

CRT name	MSID	Units	Display range	Status indicators				
PCU ON	P34K4024Y/ P34K4026Y/ P34K4028Y/ P34K4030Y/ P34K4052Y/ P34K4060Y	event	blank or '*'	M				
OFF	P34K4024Y/ P34K4026Y/ P34K4028Y/ P34K4030Y/ P34K4052Y/ P34K4060Y	event	blank or '*'					
CCTV ENA ON	P34X2096Y/ P34X2097Y	event	'*', 1, 2, blank	M				
OFF	P34X2096Y/ P34X2097Y	event	'*', 1, 2, blank					
PWR ON	P34X4041Y	event	blank or '*'	M				
OFF	P34X4041Y	event	'*' or blank					
ESM A HTR ZONE 1&2	P34X8401Y	event	blank or '*'	M				
3	P34X8402Y	event	blank or '*'	M				
B HTR ZONE 1&2	P34X8404Y	event	blank or '*'	M				
3	P34X8405Y	event	blank or '*'	M				
SOPE A HTR ZONE 1&2	P34X8406Y	event	blank or '*'	M				
3	P34X8407Y	event	blank or '*'	M				
B HTR ZONE 1&2	P34X8409Y	event	blank or '*'	M				
3	P34X8411Y	event	blank or '*'	M				
DPC 1	P34X2047Y	event	blank or '*'	M				
2	P34X2048Y	event	blank or '*'	M				
1 VOLTS	P34V2028V	volts	0.0 to 40.0	M	H	L		
2 VOLTS	P34V2029V	volts	0.0 to 40.0	M	H	L		
1 AMPS	P34C2008V	amps	0.0 to 20.0	M	H	L	↑	
2 AMPS	P34C2009V	amps	0.0 to 20.0	M	H	L	↑	
3	P34X2049Y	event	blank or '*'	M				
4	P34X2119Y	event	blank or '*'	M				
3 VOLTS	P34V2030V	volts	0.0 to 40.0	M	H	L		
4 VOLTS	P34V2031V	volts	0.0 to 40.0	M	H	L		
3 AMPS	P34C2010V	amps	0.0 to 20.0	M	H	L	↑	
4 AMPS	P34C2011V	amps	0.0 to 20.0	M	H	L	↑	
5	P34X2050Y	event	blank or '*'	M				
6	P34X2120Y	event	blank or '*'	M				

Table 6-5. Parameter characteristics: SM 211 SSE overview (continued)

CRT name	MSID	Units	Display range	Status indicators				
5 VOLTS	P34V2032V	volts	0.0 to 40.0	M	H	L		
6 VOLTS	P34V2033V	volts	0.0 to 40.0	M	H	L		
5 AMPS	P34C2012V	amps	0.0 to 20.0	M	H	L	↑	
6 AMPS	P34C2013V	amps	0.0 to 20.0	M	H	L	↑	
7	P34X2051Y	event	blank or '*'	M				
8	P34X2052Y	event	blank or '*'	M				
7 VOLTS	P34V2034V	volts	0.0 to 40.0	M	H	L		
8 VOLTS	P34V2035V	volts	0.0 to 40.0	M	H	L		
7 AMPS	P34C2014V	amps	0.0 to 20.0	M	H	L	↑	
8 AMPS	P34C2015V	amps	0.0 to 20.0	M	H	L	↑	
9	P34X2053Y	event	blank or '*'	M				
10	P34X2121Y	event	blank or '*'	M				
9 VOLTS	P34V2036V	volts	0.0 to 40.0	M	H	L		
10 VOLTS	P34V2037V	volts	0.0 to 40.0	M	H	L		
9 AMPS	P34C2016V	amps	0.0 to 20.0	M	H	L	↑	
10 AMPS	P34C2017V	amps	0.0 to 20.0	M	H	L	↑	
11	P34X2054Y	event	blank or '*'	M				
12	P34X2122Y	event	blank or '*'	M				
11 VOLTS	P34V2038V	volts	0.0 to 40.0	M	H	L		
12 VOLTS	P34V2039V	volts	0.0 to 40.0	M	H	L		
11 AMPS	P34C2018V	amps	0.0 to 20.0	M	H	L	↑	
12 AMPS	P34C2019V	amps	0.0 to 20.0	M	H	L	↑	
DPC ON	P93J0100C	echo fb of item entry						
DPC OFF	P93J0101C	echo fb of item entry						
POWER:								
FSS EPDSU 1 AMPS	P34C2113V	amps	-0.3 to 150.0	M	H	L		
2 AMPS	P34C2116V	amps	-0.6 to 150.0	M	H	L		
FMDM A AMPS	P34C2115V	amps	0.0 to 5.0	M	H	L		
B AMPS	P34C2022V	amps	0.0 to 5.0	M	H	L		
HTR (1)	P34X2082Y	event	blank or '1'	M				
(2)	P34X2083Y	event	blank or '2'	M				
A1 AMPS	P34C2026V	amps	0.0 to 20.0	M	H	L	↑	
A2 AMPS	P34C2027V	amps	0.0 to 20.0	M	H	L	↑	
B1 AMPS	P34C2024V	amps	0.0 to 20.0	M	H	L	↑	
B2 AMPS	P34C2114V	amps	0.0 to 20.0	M	H	L	↑	
CCTV HTR AMPS	P34C2095V	amps	0.0 to 5.0	M	H	L		
MULE FMDM A AMPS	P34C8109V	amps	0.0 to 5.0	M	H	L		

Table 6-5. Parameter characteristics: SM 211 SSE overview (concluded)

CRT name	MSID	Units	Display range	Status indicators				
B AMPS	P34C8114V	amps	0.0 to 5.0	M	H	L		
HTR	P34X8411Y	event	blank or '*'	M				
HTR AMPS	P34C8117V	amps	0.0 to 20.0	M	H	L	↑	
ESM 1&2 AMPS	P34C8110V	amps	0.0 to 5.0	M	H	L	↑	
3 AMPS	P34C8111V	amps	0.0 to 5.0	M	H	L	↑	
SOPE 1A AMPS	P34C8112V	amps	0.0 to 20.0	M	H	L	↑	
2A AMPS	P34C8107V	amps	0.0 to 20.0	M	H	L	↑	
1B&2B AMPS	P34C8115V	amps	0.0 to 20.0	M	H	L	↑	
3A AMPS	P34C8113V	amps	0.0 to 20.0	M	H	L	↑	
3B AMPS	P34C8116V	amps	0.0 to 20.0	M	H	L	↑	
SAC EPDSU AMPS	P34C5206V	amps	-1.2 to 150.0	M	H	L	↑	
THERMAL:								
FSS EPDSU (1) TEMP	P34T2004V	deg C	-30 to 60	M	H	L		
(2) TEMP	P34T2007V	deg C	-30 to 60	M	H	L		
FMDM (A) TEMP	P34T2001V	deg C	-55 to 120	M	H	L		
(B) TEMP	P34T2002V	deg C	-55 to 120	M	H	L		
PCU (P) TEMP	P34T2005V	deg C	-30 to 60	M	H	L		
(S) TEMP	P34T2006V	deg C	-30 to 60	M	H	L		
IPCU TEMP	P34T2093V	deg C	-30 to 60	M	H	L		
AMSB TEMP	P34T2003V	deg C	-30 to 60	M	H	L		
MULE PDSU TEMP	P34T8119V	deg C	-30 to 60	M	H	L		
FMDM (A) TEMP	P34T8120V	deg C	-55 to 120	M	H	L		
(B) TEMP	P34T8121V	deg C	-55 to 120	M	H	L		
SAC EPDSU TEMP (1)	P34T5221V	deg C	-30 to 60	M	H	L		
(2)	P34T5205V	deg C	-30 to 60	M	H	L		
FSS EPDSU (1) VOLTS	P34V2040V	volts	0.0 to 40.0	M	H	L		
(2) VOLTS	P34V2041V	volts	0.0 to 40.0	M	H	L		
MULE PDSU VOLTS	P34V8122V	volts	0.0 to 40.0	M	H	L		
SAC EPDSU VOLTS (1)	P34V5208V	volts	0.0 to 40.0	M	H	L		
SAC EPDSU VOLTS (2)	P34V5216V	volts	0.0 to 40.0	M	H	L		

ITEM ENTRY CHARACTERISTICS AND SUMMARY: SM 211 SSE OVERVIEW

ITEM 1, 2: Items 1 and 2 will set and reset, respectively, twelve FMDM discrete outputs to command the twelve FSS DPCs on and off. Due to GPC limitations, the feedback for these commands are only based on command response from the 6 odd numbered DPCs. The feedback for item 3 ON indicates a blank when all DPCs are commanded off (based on the BITE test 4 feedback) and an "*" when any of the DPCs are commanded on. The item 4 OFF status is blank as long as any FMDM DPC ON discrete output is set, and indicates an "*" when all are reset.

ITEM 3, 4, 5, 6: Items 3 through 6 provide power control over the CCTV camera mounted on the FSS BAPS platform. Two power relays in series feed power to the CCTV camera by execution of item 3, whose status will nominally indicate an "*" when both relays indicate they are closed. If either relay remains open, a "1" or "2" is displayed for the item 3 ON status toindicate the closed relay, while the item 4 OFF status shows the corresponding open relay number. When commanded off with an item 4, the item 4 OFF status indicates an "*" upon both relays achieving an open condition. The camera iris is commanded open upon execution of an item 5, whose ON status shows an "*" driven by the setting of the corresponding FMDM discrete output (BITE test 4 feedback). This same FMDM BITE status is used for the item 6 OFF status, which is blank when the camera is commanded on (iris open) and an "*" when the camera is powered off (iris closed).

DPC: Provides status and control of each of the 12 DPCs. The ouput voltage for the 12 DPCs is displayed, each with a range of 0 to 40 V DC. Also, the input current for the 12 DPCs is displayed, each with a range of 0 to 20 amperes. DPCs are commanded as follows:

ITEM 23, 24: The DPCs can be commanded individually by sending indexed commands as follows:

ON ITEM 23+	OFF ITEM 24+	DPC
1	71	1
2	72	2
3	73	3
4	74	4
5	75	5
6	76	6
7	77	7
8	78	8
9	79	9
10	80	10
11	81	11
12	82	12

The corresponding number of the index command sent appears to the right of 23 ON or 24 OFF.

POWER: SSE power distribution telemetry is provided from the FSS, MULE, and SAC. The FSS EPDSU 1/2 voltages, MULE PDSU voltage, and the SAC EPDSU A and B voltages provide insight into orbiter provided voltage at the interface to the FSS, MULE, and SAC. The current for active boxes and heaters on the SSE is provided. These currents include the 2 FSS FMDMs, the 4 heater current circuits on the FSS (along with status indications), the FSS CCTV heater circuit, the MULE FMDM A/B currents, the MULE survival heater circuit (along with status indication), the 2 ESM heater circuit currents, and the 5 SOPE heater circuit currents. Status indications for the ESM and SOPE heaters is displayed in the top left corner of the display. The current for the SAC EPDSU is provided.

THERMAL: The heaters on the FSS, MULE, and SAC are controlled from the standard switch panels. Power for the FSS and MULE circuits was discussed in the POWER section, and no telemetry is available for the SAC heater circuits. Box temperatures are provided to verify each is within operating limits prior to its use.

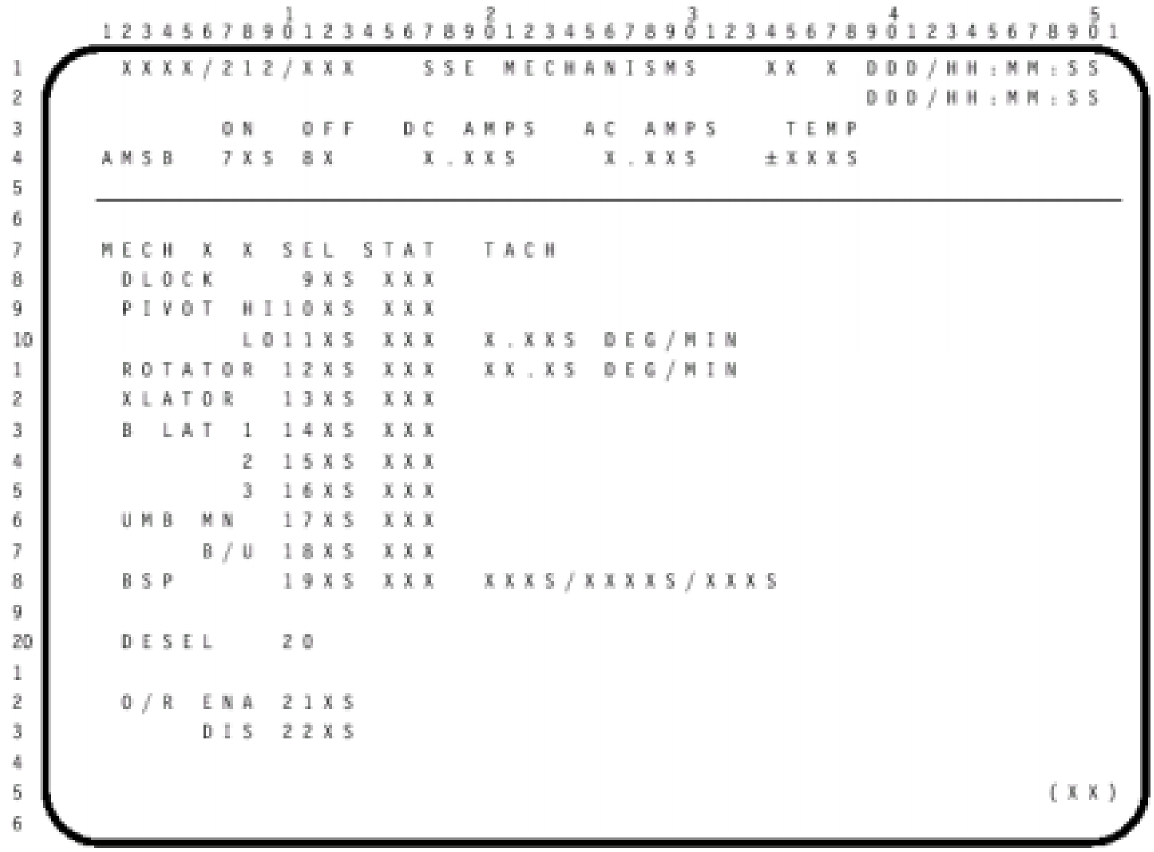


Figure 6-6. SEE display 212

Table 6-6. Parameter characteristics: SM 212 SSE mechanisms

CRT name	MSID	Units	Display range	Status indicators				
				M	H	L	↑	↓
AMSB ON	P34X2076Y/ P34X2077Y	event	A, B, blank, or '*'	M				
OFF	P34X2076Y/ P34X2077Y	event	A, B, blank, or '*'					
DC AMPS	P34C2025V	amps	-1.0 to 5.0	M	H	L	↑	↓
AC AMPS	P34C2111V	amps	0.0 to 5.0	M	H	L	↑	
TEMP	P34T2003V	deg C	-30 to 60	M	H	L		
MECH (A)	V54X8111E/ V54X8113E/ V54S8400E/ V54S8402E	event	A, A flash, blank					
(B)	V54X8122E/ V54X8124E/ V54S8400E/ V54S8402E	event	B, B flash, blank					

Table 6-6. Parameter characteristics: SM 212 SSE mechanisms (continued)

CRT name	MSID	Units	Display range	Status indicators				
DLOCK SEL	P34X2064Y	event	blank or '*'	M				↓
STAT	P34X2064Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, DIS, ENG, '*', blank					
PIVOT HI SEL	P34X2061Y	event	blank or '*'	M				↓
STAT	P34X2061Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, DN, UP, '*', blank					
PIVOT LO SEL	P34X2060Y	event	blank or '*'	M				↓
STAT	P34X2060Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, DN, UP, '*', blank					
TACH	P34R2108V	deg/min	0.0 to 5.3	M	H	L		↓
ROTATOR SEL	P34X2062Y	event	blank or '*'	M				↓
STAT	P34X2062Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, CCW, CW, '*', blank					
TACH	P34R2109V	deg/min	0.0 to 18.0	M	H	L		↓
XLATOR SEL	P34X2063Y	event	blank or '*'	M				↓
STAT	P34X2063Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, FWD, AFT, '*', blank					
B LAT 1 SEL	P34X2065Y	event	blank or '*'	M				↓
STAT	P34X2065Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, OP, CL, '*', blank					
2 SEL	P34X2066Y	event	blank or '*'	M				↓

Table 6-6. Parameter characteristics: SM 212 SSE mechanisms (concluded)

CRT name	MSID	Units	Display range	Status indicators				
STAT	P34X2066Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, OP, CL, ‘*’, blank					
3 SEL	P34X2067Y	event	blank or ‘*’	M				↓
STAT	P34X2067Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, OP, CL, ‘*’, blank					
UMB MN SEL	P34X2068Y	event	blank or ‘*’	M				
STAT	P34X2068Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, REL, MAT, ‘*’, blank					
B/U SEL	P34X2069Y	event	blank or ‘*’	M				
STAT	P34X2069Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, REL, MAT, ‘*’, blank					
BSP SEL	P34X2070Y	event	blank or ‘*’	M				
STAT	P34X2070Y/ P34X2087Y/ P34X2088Y/ P34X2089Y/ P34X2090Y	event	RDY, REL SET, L/A, ‘*’, blank					
(RET)	P34X2102Y/ P34X2105Y	event	RET A, RET B, RET *, blank	M				
(ENG)	P34X2103Y/ P34X2106Y	event	ENG A, ENG B, ENG *, blank	M				
(DIS)	P34X2104Y/ P34X2107Y	event	DIS A, DIS B, DIS *, blank	M				
O/R ENA	P34X2072Y	event	‘*’ or blank	M				
DIS	P34X2072Y	event	blank or ‘*’	M				

ITEM ENTRY CHARACTERISTICS AND SUMMARY: SM 212 SSE MECHANISMS

ITEM 7,8: Item numbers 7 and 8 provide power ON/OFF control over the FSS AMSB. When both AMSBs are off, the item 7 ON status is blank and the item 8 OFF status shows an "*". When only AMSB A is on, the item 7 ON status indicates "A" and the item 8 OFF status indicates "B". When only AMSB B is ON, the item 7 ON status will indicate "B" and the item 8 OFF status will indicate "A". Under a contingency scenario where both sides of the FSS system are being used simultaneously with both AMSBs powered on, the item 7 ON status will show an "*", and the Item 8 OFF status is blank. When commanded on, the DC current to the commanded AMSB is displayed. When a mechanism is operated, the AC current being drawn by the motor is displayed. The temperature of the AMSB is also displayed.

MECH: Two parameter fields adjacent to MECH text callout provide payload retention system feedback related to A6U circuits controlling FSS mechanism operations. The left-hand field shows a flashing 'A' whenever the A6U panel switch 1 is taken out of the OFF position. A steady 'A' is driven whenever system 1 latch 1 LATCHED or RELEASED feedbacks indicate high. The right-hand field will show a flashing 'B' whenever A6U panel switch 2 is taken out of OFF position. A steady 'B' is driven whenever system 2 latch 2 LATCHED or RELEASED feedbacks indicate high. During nominal A-side(B-side) operations B(A) field should be blank. Under failure conditions, a steady B(A) can be displayed while controlling on the A-side(B-side) if B-side(A-side) AMSB mechanism select relay is failed closed and that mechanism is at its beginning or end of travel.

ITEM 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20: Items 9 through 19 are used to select FSS mechanisms. When a mechanism is selected, an "*" is driven to the corresponding item number and the mechanism status is displayed in an adjacent field under the STAT heading. Item 20 deselects the last mechanism selected.

Note: The previously selected mechanism is deselected when a new mechanism is selected. The STAT field for each mechanism will indicate as follows:

Mechanism	REL(BOT)	Mid-travel	LAT(EOT)
Downlock (DLOCK)	DIS	RDY	ENG
PIVOT HI/LO	DN	RDY	UP
ROTATOR	CW	RDY	CCW
Translator (XLATOR)	FWD	RDY	AFT
Berthing latch (BLAT 1/2/3)	OP	RDY	CL
Main umbilical (UMB MN)	REL	RDY	MAT
Backup umbilical (UMB B/U)	REL	RDY	MAT
BAPS support post (BSP)	REL	*	SET

In the event of an error condition where both the beginning and end of travel microswitches of the selected mechanism indicate high, the STAT field shows "*", except for the BSP, which displays "L/A" if the BOT and EOT are indicated for the same microswitch indicative of the Latch Assist mode.

The status of the BSP retracted A and B switches is provided. When only switch A is retracted, "RETA" is displayed. When only switch B is retracted, "RETB" is displayed. When both switches A and B are retracted, "RET*" is displayed. When neither switch A or B is retracted, a blank is displayed. The next two fields below indicate the status of the BSP engaged A and B switches and the BSP disengaged A and B switches. They are handled in the same manner as the above BSP retracted A and B switches, except their feedbacks are "ENGA", "ENGB", "ENG*", and "DISA", "DISB", "DIS*", respectively.

ITEM 21,22: Items 21 and 22 provide the ability to override (O/R) limit switch cutoff of the selected mechanism in the event of microswitch failures or if the need arises to drive the selected mechanism to the mechanical limit (stall). The O/R ENA/DIS status is a direct feedback from the AMSB override relay. An "*" is driven next to the appropriated item number to indicate enabled or disabled.

6.3 MCC SSE DISPLAYS

This section documents the telemetry used to drive the ground displays. Each SSE display is shown with an associated table. The table lists the parameter name from the display, the MSID, the units, and the telemetry range. Also, if the field displays text, the text is displayed in the field display column. Six displays are used by the MCC flight control team: SSE Systems (Figure 6-7 and Table 6-7), SSE Mechanical (Figure 6-8 and Table 6-8), SSE Power (Figure 6-9 and Table 6-9), SSE FMDM (Figure 6-10 and Table 6-10), SM 211 Emulation (Figure 6-11 and Table 6-11), and SM 212 Emulation (Figure 6-12 and Table 6-12).

6.3.1 SSE Systems Display Description

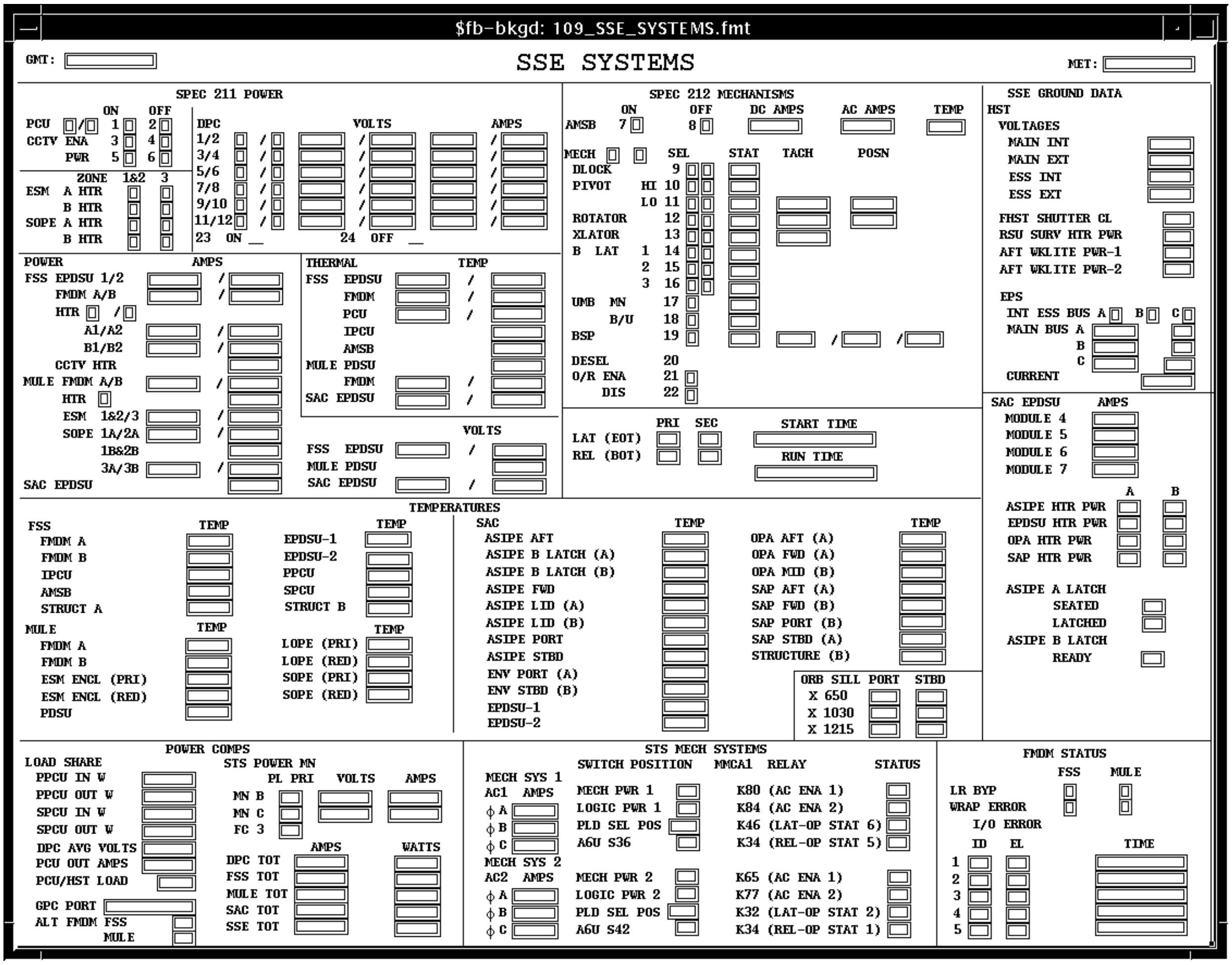


Figure 6-7. SSE systems display

Table 6-7. SSE systems description

BACKGROUND	MSID	TEXT	SRC
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
SPEC 211 POWER			
PCU P/ (not annotated)	SSEOVR001	0 = blank, 1 = ‘*’, 2 = ‘P’	UCB
	Indicates power status based on command registry (not end item) of DPCs in the PPCU. If all DPCs are off, then field is blank. If all DPCs are on, then field is P. An * will be displayed for all other conditions. Refer to the SPEC 211 writeup from a description of the comp.		
PCU /S (not annotated)	SSEOVR002	0 = blank, 1 = ‘*’, 2 = ‘S’	UCB
	Indicates power status based on command registry (not end item) of DPCs in the SPCU. If all DPCs are off, then field is blank. If all DPCs are on, then field is S. An * will be displayed for all other conditions. Refer to the SPEC 211 writeup from a description of the comp.		
PCU ON	SSEOVR003	0 = blank, 1 = ‘*’	UCB
	Provides response to crew commanding all DPCs on. Since GPC software limits proper response from all the DPCs, only the indication from the odd DPCs is used. A single odd DPC indication will cause the PCU ON indication. Refer to the SPEC 211 writeup from a description of the comp.		
PCU OFF	SSEOVR003	0 = ‘*’, 1 = blank	UCB
	Provides response to crew commanding all DPCs off. Since GPC software limits proper response from all the DPCs, only the indication from the odd DPCs is used. All odd DPCs must indicate off for the PCU OFF indication. Refer to the SPEC 211 writeup from a description of the comp.		
CCTV ENA ON	SSEPWR015	0 = blank, 1 = ‘1’, 2 = ‘2’, 3 = ‘*’	UCB
	Indicates power status (on) of the FSS CCTV camera power module. Refer to the SSE POWER writeup from a description of the comp.		
CCTV ENA OFF	SSEPWR015	0 = ‘*’, 1 =’2’, 2 = ‘1’, 3 = blank	UCB
	Indicates power status (off) of the FSS CCTV camera power module. Refer to the SSE POWER writeup from a description of the comp.		
CCTV PWR ON	P34K4041Y	0 = blank, 1 = ‘*’	PTM
	Indicates power status (on) of the FSS CCTV camera. Once the CCTV camera power module is enabled, it must be commanded ("on") to provide power to the rest of the CCTV camera so that the camera will function.		
CCTV PWR OFF	P34K4041Y	0 = ‘*’, 1 = blank	PTM
	Indicates power status (off) of the FSS CCTV camera. Note: the CCTV power module may still be enabled/on.		
ESM ZONE 1&2 A HTR	P34X8401Y	0=blank, 1=’*’	PTM
	FMDM pick-off downstream of PDSU relay.		
ESM ZONE 3 A HTR	P34X8402Y	0=blank, 1=’*’	PTM
	FMDM pick-off downstream of PDSU relay.		
ESM ZONE 1&2 B HTR	P34X8404Y	0=blank, 1=’*’	PTM
	FMDM pick-off downstream of PDSU relay.		
ESM ZONE 3 B HTR	P34X8405Y	0=blank, 1=’*’	PTM
	FMDM pick-off downstream of PDSU relay.		

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
SOPE ZONE 1&2 A HTR	P34X8406Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay.			
SOPE ZONE 3 A HTR	P34X8407Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay.			
SOPE ZONE 1&2 B HTR	P34X8409Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay.			
SOPE ZONE 3 B HTR	P34X8410Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay.			
DPC			
DPC 1 DPC 2	P34X2047Y P34X2048Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
FMDM pick-off on MOD control SSPC output.			
DPC 1 VOLTS DPC 2 VOLTS	P34V2028V P34V2029V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.			
DPC 1 AMPS DPC 2 AMPS	P34C2008V P34C2009V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Sensor is located in DPC prior to the SSPCs.			
DPC 3 DPC 4	P34X2049Y P34X2119Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
FMDM pick-off on MOD control SSPC output.			
DPC 3 VOLTS DPC 4 VOLTS	P34V2030V P34V2031V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.			
DPC 3 AMPS DPC 4 AMPS	P34C2010V P34C2011V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Sensor is located in DPC prior to the SSPCs.			
DPC 5 DPC 6	P34X2050Y P34X2120Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
FMDM pick-off on MOD control SSPC output.			
DPC 5 VOLTS DPC 6 VOLTS	P34V2032V P34V2033V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.			
DPC 5 AMPS DPC 6 AMPS	P34C2012V P34C2013V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Sensor is located in DPC prior to the SSPCs.			
DPC 7 DPC 8	P34X2051Y P34X2052Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
FMDM pick-off on MOD control SSPC output.			
DPC 7 VOLTS DPC 8 VOLTS	P34V2034V P34V2035V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.			
DPC 7 AMPS DPC 8 AMPS	P34C2014V P34C2015V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Sensor is located in DPC prior to the SSPCs.			

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
DPC 9 DPC 10	P34X2053Y P34X2121Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
FMDM pick-off on MOD control SSPC output.			
DPC 9 VOLTS DPC 10 VOLTS	P34V2036V P34V2037V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.			
DPC 9 AMPS DPC 10 AMPS	P34C2016V P34C2017V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Sensor is located in DPC prior to the SSPCs.			
DPC 11 DPC 12	P34X2054Y P34X2122Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
FMDM pick-off on MOD control SSPC output.			
DPC 11 VOLTS DPC 12 VOLTS	P34V2038V P34V2039V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.			
DPC 11 AMPS DPC 12 AMPS	P34C2018V P34C2019V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Sensor is located in DPC prior to the SSPCs.			
DPC ON	P93J0100C	data in not downlinked	---
DPC OFF	P93J0101C	data is not downlinked	---
POWER			
FSS EPDSU 1 AMPS 2 AMPS	P34C2113V P34C2116V	-0.30 to 150.00 amps -0.60 to 150.00 amps	PTM PTM
Indicates EPDSU 1 and 2 current draw. Nominal current draw is TBS amps.			
FSS FMDM A AMPS B AMPS	P34C2115V P34C2022V	0.00 to 5.00 amps 0.00 to 5.00 amps	PTM PTM
FSS HTR	P34X2082Y P34X2083Y	0 = blank, 1 = '1' 0 = blank, 1 = '2'	PTM PTM
FMDM pick-off on PDSU relay power output line.			
FSS HTR A1 AMPS A2 AMPS	P34C2026V P34C2027V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Indicates FSS primary Heaters A1 and A2 current draw. Nominal current draw is TBS amps.			
FSS HTR B1 AMPS B2 AMPS	P34C2024V P34C2114V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Indicates FSS Redundant Heaters B1 and B2 current draw. Nominal current draw is TBS amps.			
FSS CCTV HTR AMPS	P34C2095V	0.00 to 5.00 amps	PTM
Indicates FSS CCTV Heaters current draw. Nominal current draw is TBS amps.			
MULE FMDM A AMPS B AMPS	P34C8109V P34C8114V	0.00 to 5.00 amps 0.00 to 5.00 amps	PTM PTM
Indicates Mule FMDM A and B current draw. Nominal current draw is TBS amps.			

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
MULE HTR	P34X8411Y	0 = blank, 1 = '*'	PTM
FMDM pick-off on PDSU relay power output line.			
MULE HTR AMPS	P34C8117V	0.0 to 20.0 amps	PTM
Indicates Mule Heater current draw. Nominal current draw is TBS amps.			
MULE ESM 1&2 AMPS 3 AMPS	P34C8110V P34C8111V	0.00 to 5.00 amps 0.00 to 5.00 amps	PTM PTM
Indicates Mule Heater current draw. Nominal current draw is TBS amps.			
MULE SOPE 1A AMPS 2A AMPS	P34C8112V P34C8107V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Indicates SOPE primary Heaters zone 1 and 2 current draw. Nominal current draw is TBS amps.			
MULE SOPE 1B & 2B AMPS	P34C8115V	0.0 to 20.0 amps	PTM
Indicates SOPE redundant Heaters zone 1 and 2 current draw. Nominal current draw is TBS amps.			
MULE SOPE 3A AMPS 3B AMPS	P34C8113V P34C8116V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Indicates SOPE primary and redundant Heaters zone 3 current draw. Nominal current draw is TBS amps.			
SAC EPDSU AMPS	P34C5206V	-1.2 to +150.0 amps	PTM
Indicates SAC EPDSU current draw. Nominal current draw is TBS amps.			
FSS EPDSU 1 VOLTS 2 VOLTS	P34V2040V P34V2041V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Indicates FSS EPDSU 1 and 2 voltage. Nominal voltage is TBS amps.			
MULE PDSU VOLTS	P34V8122V	0.0 to 40.0 volts	PTM
Indicates Mule PDSU voltage. Nominal voltage is TBS amps.			
SAC EPDSU A VOLTS B VOLTS	P34V5208V P34V5216V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Indicates SAC EPDSU A and B voltage. Nominal voltage is TBS amps.			
THERMAL			
FSS EPDSU 1 TEMP 2 TEMP	P34T2004V P34T2007V	-30 to +60 deg C -30 to +60 deg C	PTM PTM
Indicates FSS Enhanced Power Distribution and Switching Unit (EPDSU) 1 and 2 temperature. Nominal temperature limits are -20 deg C to 50 deg C.			
FSS FMDM A TEMP B TEMP	P34T2001V P34T2002V	-55 to +120 deg C -55 to +120 deg C	PTM PTM
Indicates FSS Flex Multiplexer/Demultiplexer (FMDM) A and B temperature. Operational temperature limits are –3 deg C to 55 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off.			
FSS PCU P TEMP S TEMP	P34T2005V P34T2006V	-30 to +60 deg C -30 to +60 deg C	PTM PTM
Indicates Port and Starboard Power Conditioning Unit (PPCU) temperature. Nominal control range is –20 to 50 deg C.			

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
FSS IPCU TEMP	P34T2093V	-30 to +60 deg C	PTM
Indicates Interface Power Control Unit (IPCU) temperature. Nominal operatio nal limits are –37 deg C to 50 deg C.			
FSS AMSB TEMP	P34T2003V	-30 to +60 deg C	PTM
Indicates Mechanism Select Box (AMSB) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C.			
MULE PDSU TEMP	P34T8119V	-30 to +60 deg C	PTM
Indicates Power Distribution and Switching Unit (PDSU) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C.			
MULE FMDM A TEMP B TEMP	P34T8120V P34T8121V	-55 to 120 deg C -55 to 120 deg C	PTM PTM
Indicates Flex Multiplexer/Demultiplexer A and B (FMDM) temperatures. Operational temperature limits are –3 deg C to 55 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off.			
SAC EPDSU 1 TEMP 2 TEMP	P34T5221V P34T5205V	-30 to +60 deg C -30 to +60 deg C	PTM PTM
Indicates Enhanced Power Distribution and Switching Unit (EPDSU) temperature. Nominal operational temperature limits are –20 deg c to 50 deg C.			
SPEC 212 MECHANISMS			
AMSB ON	SSECON015	0 = blank, 1 = ‘A’, 2 = ‘B’, 3 = ‘*’	UCB
Indicates power status (on) for the A or B sides of the Advanced Mechanism Select Box (AMSB). Refer to the SPEC 212 writeup from a description of the comp.			
AMSB OFF	SSECON015	0 = ‘*’, 1 = ‘B’, 2 = ‘A’, 3 = blank	UCB
Indicates power status (off) for the A or B sides of the Advanced Mechanism Select Box (AMSB). Refer to the SPEC 212 writeup from a description of the comp.			
AMSB DC AMPS	P34C2025V	-1.00 to 5.00 amps	PTM
AMSB AC AMPS	P34C2111V	0.00 to 5.00 amps	PTM
AMSB TEMP	P34T2003V	-30 to +60 deg C	PTM
Indicates Advance Mechansim Select Box (AMSB) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C.			
MECH (left field) (right field)	W54X8111E W54X8122E	0 = blank, 1 = ‘A’, 2 = ‘A’ (red) 0 = blank, 1 = ‘B’, 2 = ‘B’ (red)	UCB UCB
Indicates payload retention system feedback related to the A6U circuits controlling the FSS mechanism operations. An ‘A’ or ‘B’ indicates that either an EOT or BOT switch indicates high, but the payload retention switch is not commanding the motor to drive. A red ‘A’ or ‘B’ (flashing on crew spec) indicates that the payload retention switch 1 or 2 is in the REL/LAT position, and both EOT and BOT switches are not indicating high.			

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
DLOCK SEL	P34X2064Y	0 = blank, 1 = '*'	PTM
	W34X2064Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON009	blank, 'RDY', 'DIS', 'ENG', '*'	UCB
	Indicates the status of the feedbacks for the translator mechanism. The field is only displayed when the translator is selected in the AMSB. A 'DIS' indicates at lea st 1 of the 2 release feedbacks is high, 'ENG' indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a descripti on of the comps.		
PIVOT HI SEL	P34X2061Y	0 = blank, 1 = '*'	PTM
	W34X2061Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON006	blank, 'RDY', 'DN', 'UP', '*'	UCB
	Indicates that the PIVOT HI mechanism has been selected (mechanism 4). The pivoter drive motor will pivot the BAPS ring using high torque. Drive times for both the high torque and low torque setting are the same. Indicates the status of the feedbacks for the pivot high torque mechanism. The field is only displayed when the high torque pivoter is sel ected in the AMSB. A DN indicates at least 1 of the 2 release feedbacks is high, UP indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps.		
PIVOT LO SEL	P34X2060Y	0 = blank, 1 = '*'	PTM
	W34X2060Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON005	blank, 'RDY', 'DN', 'UP', '*'	UCB
	Indicates that the PIVOT LO mechanism has been selected (mecha nism 3). The pivoter drive motor will pivot the BAPS ring using low torque. Drive times for both the high torque and low torque setting are the same. Indicates the status of the feedbacks for the pivot low torque mechanism. The field is only displayed when the low torque pivoter is selected in the AMSB. A DN indicates at least 1 of the 2 release feedbacks is high, UP indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both rel ease and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps.		
PIVOT LO TACH	P34R2108V	0.00 to 9.99 deg/min	PTM
	Indicates the rotation speed of the pivoter. Sensor is on motor shaft but is calibrated for output shaft speed (therefore for dual motor ops, you will still see the same speed, although the mechanism will actually being going twice as fast).		
PIVOT LO POSN	SSEMECH85	-5 to 99 deg	PTM
	Integrates the position of the pivoter based on tach speed. Comp does not function correctly for dual motor ops.		

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
ROTATOR SEL	P34X2062Y	0 = blank, 1 = '*'	PTM
	W34X2062Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON007	blank, 'RDY', 'CW', 'CCW', '*'	UCB
	Indicates that the ROTATOR mechanism has been selected (mechanism 5). Indicates the status of the feedbacks for the rotator mechanism. The field is only displayed when the rotator is selected in the AMSB. A CW indicates at least 1 of the 2 release feedbacks is high, CCW indicates at least 1 of the 2 latch feedbacks is high, RDY no feedba cks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps.		
ROTATOR TACH	P34R2109V	0.0 to 99.9 deg/min	PTM
	Indicates the rotation speed of the rotater. Se nsor is on motor shaft but is calibrated for output shaft speed (therefore for dual motor ops, you will still see the same speed, although the mechanism will actually being going twice as fast).		
ROTATOR POSN	SSEMECH86	-360 to 360 deg	PTM
	Integrates the position of the pivoter based on tach speed. Comp does not function correctly for dual motor ops.		
XLATOR SEL	P34X2063Y	0 = blank, 1 = '*'	PTM
	W34X2063Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON008	blank, 'RDY', 'FWD', 'AFT', '*'	UCB
	Indicates that the TRANLATOR mechanism has been selected (mechanism 6). Indicates the status of the feedbacks for the translator mechanism. The field is only displayed when the translator is selected in the AMSB. A FWD indicates at least 1 of the 2 release feedbacks is high, AFT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps.		
XLATOR TACH	P34R2110V	0.00 to 9.99 in/min	PTM
	Indicates the linear speed of the translator. Sensor is on motor shaft but is calibrated for output shaft speed (therefore for dual motor ops, you will still see the same speed, although the mechanism will actually being going twice as fast).		
B LAT 1 SEL	P34X2065Y	0 = blank, 1 = '*'	PTM
	W34X2065Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON010	blank, 'RDY', 'OP', 'CL', '*'	UCB
	Indicates that the center berthing latch (1) has been selected. Berthing latch 1 may also be referred to as mechanism 8. Indicates the status of the feedbacks for the berthing latch 1 mechanism. The field is only displayed when the berthing latch 1 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at l east 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps.		

Table 6-7. SSE systems description (continued)

<table>
<tr><th>BACKGROUND</th><th>MSID</th><th>TEXT</th><th>SRC</th></tr>
<tr><td>B LAT 2 SEL</td><td>P34X2066Y</td><td>0 = blank, 1 = '*'</td><td>PTM</td></tr>
<tr><td></td><td>W34X2066Y</td><td>0 = blank, 1 = 'V' (red)</td><td>UCB</td></tr>
<tr><td>STAT</td><td>SSECON011</td><td>blank, 'RDY', 'OP', 'CL', '*'</td><td>UCB</td></tr>
<tr><td></td><td colspan="3">Indicates that the starboard berthing latch (2) has been selected. Berthing latch 2 may also be referred to as mechanism 9.
Indicates the status of the feedbacks for the berthing latch 2 mechanism. The field is only displayed when the berthing latch 2 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps.</td></tr>
<tr><td>B LAT 3 SEL</td><td>P34X2067Y</td><td>0 = blank, 1 = '*'</td><td>PTM</td></tr>
<tr><td></td><td>W34X2067Y</td><td>0 = blank, 1 = 'V' (red)</td><td>UCB</td></tr>
<tr><td>STAT</td><td>SSECON012</td><td>blank, 'RDY', 'OP', 'CL', '*'</td><td>UCB</td></tr>
<tr><td></td><td colspan="3">Indicates that the port berthing latch (3) has been selected. Berthing latch 3 may also be referred to as mechanism 10.
Indicates the status of the feedbacks for the berthing latch 3 mechanism. The field is only displayed when the berthing latch 3 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps.</td></tr>
<tr><td>UMB MN SEL</td><td>P34X2068Y</td><td>0 = blank, 1 = '*'</td><td>PTM</td></tr>
<tr><td>STAT</td><td>SSECON013</td><td>blank, 'RDY', 'REL', 'MAT', '*'</td><td>UCB</td></tr>
<tr><td></td><td colspan="3">Indicates that the main umbilical has been selected. The main umbilical may also be referred to as mechanism 11.
Indicates the status of the feedbacks for the main umbilical mechanism. The field is only displayed when the main umbilical is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, MAT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks. Refer to the SPEC 212 writeup from a description of the comps.</td></tr>
<tr><td>UMB B/U SEL</td><td>P34X2069Y</td><td>0 = blank, 1 = '*'</td><td>PTM</td></tr>
<tr><td>STAT</td><td>SSECON014</td><td>blank, 'RDY', 'REL', 'MAT', '*'</td><td>UCB</td></tr>
<tr><td></td><td colspan="3">Indicates that the back up umbilical has been selected. Indicates the status of the feedbacks for the backup umbilical mechanism. The field is only displayed when the ba ckup umbilical is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, MAT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and lat ch feedbacks. Refer to the SPEC 212 writeup from a description of the comp.</td></tr>
</table>

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
BSP SEL	P34X2070Y	0 = blank, 1 = '*'	PTM
STAT	SSECON021	blank, 'RDY', 'REL', 'SET', 'L/A', '*'	UCB
	Indicates that the BAPS Support Post (BSP) has been selected. The BSP may also be referred to as mechanism 13. Indicates the status of the feedbacks for the BAPS support post mechanism. The field is only displayed when the BAPS support post is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, SET indicates at least 1 of the 2 latch feedbacks is high, L/A indicates that both the latch and release feedbacks for 1 of the 2 sides is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, release and latch feedbacks from different sides. Refer to the SPEC 212 writeup from a description of the comp.		
BSP (left field)	SSECON022	blank, 'RETA', 'RETB', 'RET*'	UCB
(middle field)	SSECON023	blank, 'ENGA', 'ENGB', 'ENG*'	UCB
(right field)	SSECON024	blank, 'DISA', 'DISB', 'DIS*'	UCB
	Indicates whether the BSP is retracted, engaged, or disengaged. Refer to the SPEC 212 writeup from a description of the comps.		
O/R ENA	P34X2072Y	0 = '*', 1 = blank	PTM
	Indicates if override of BOT/EOT microswitches is active. Override will prevent the microswitches from cutting off the motor and the motor will drive to a stall condition against the hardstops.		
O/R DIS	P34X2072Y	0 = blank, 1 = '*'	PTM
	Indicates if override is disabled, which is the normal condition.		
LAT (EOT) PRI	P34X2087Y	0 = 'NO', 1 = 'YES'	PTM
	TBS.		
LAT (EOT) SEC	P34X2088Y	0 = 'NO', 1 = 'YES'	PTM
	TBS.		
REL (BOT) PRI	P34X2089Y	0 = 'NO', 1 = 'YES'	PTM
	TBS.		
REL (BOT) SEC	P34X2090Y	0 = 'NO', 1 = 'YES'	PTM
	TBS.		
START TIME	CETSTART0	ddd/hh:mm:ss	UCB
	Indicates mechanism start time.		
ELAPSED RUN TIME	CECHRUNTM	ddd/hh:mm:ss	UCB
	Indicates mechanism elapsed run time.		
SSE GROUND DATA			
HST VOLTAGES MAIN INT	P34V1027V	0.0 to 40.0 volts	PTM
	Internal Main Bus Voltage measured at the FSS Umbilical. Part of OI downlink.		
HST VOLTAGES MAIN EXT	P34V1009V	0.0 to 40.0 volts	PTM
	External Main Bus Voltage measured at the FSS Umbilical. Part of OI downlink.		
HST VOLTAGES ESS INT	P34V1026V	0.0 to 40.0 volts	PTM
	Internal Essential Bus Voltage measured at the FSS Umbilical. Part of O I downlink.		
HST VOLTAGES ESS EXT	P34V1035V	0.0 to 40.0 volts	PTM
	External Essential Bus Voltage measured at the FSS Umbilical. Part of OI downlink.		
FHST SHUTTER CL	P34X2098Y	0 = 'DSBL', 1 = 'ENBL'	PTM

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
TBS.			
RSU SURV HTR PWR	P34X2099Y	0 = 'DSBL', 1 = 'ENBL'	PTM
TBS.			
AFT WKLITE PWR-1	P34X2100Y	0 = 'DSBL', 1 = 'ENBL'	PTM
TBS.			
AFT WKLITE PWR-2	P34X2101Y	0 = 'DSBL', 1 = 'ENBL'	PTM
TBS.			
EPS INT ESS BUS A	P34X3085E	0 = blank, 1 = '*'	PPM
Indicates that HST Diode bus A is connected to the HST Essential Bus			
EPS INT ESS BUS B	P34X3086E	0 = blank, 1 = '*'	PPM
Indicates that HST Diode bus B is connected to the HST Essential Bus			
EPS INT ESS BUS C	P34X3087E	0 = blank, 1 = '*'	PPM
Indicates that HST Diode bus C is connected to the HST Essential Bus			
EPS MAIN BUS A V	P34V3061A	-0.3 to 35.7	PPM
Indicates the voltage level of HST Main Bus A			
EPS MAIN BUS A	MBAXSWSTAT	See comps	UCB
Indicates that HST Diode Bus A is connected to HST Main Bus A. Refer to the SPEC 210 writeup from a description of the comp.			
EPS MAIN BUS B V	P34V3062A	-0.3 to 35.7	PPM
Indicates the voltage level of HST Main Bus B			
EPS MAIN BUS B	MBBXSWSTAT	See comps	UCB
Indicates that HST Diode Bus B is connected to HST Main Bus B. Refer to the SPEC 210 writeup from a description of the comp.			
EPS MAIN BUS C V	P34V3063A	-0.3 to 35.7	PPM
Indicates the voltage level of HST Main Bus C			
EPS MAIN BUS C	HSTSPEC010	See comps	UCB
Indicates that HST Diode Bus C is connected to HST Main Bus C. Refer to the SPEC 210 writeup from a description of the comp.			
EPS CURRENT	P34C3060A	-2 to 151 amps	PPM
Indicates the total sum current being passed by HST Main Buses A, B, and C			
SAC EPDSU MODULE 4 AMPS	P34C5225V	0.0 to 40.0 amps	PTM
Indicates the current draw for EPDSU module 4.			
SAC EPDSU MODULE 5 AMPS	P34C5224V	0.0 to 40.0 amps	PTM
Indicates the current draw for EPDSU module 5.			
SAC EPDSU MODULE 6 AMPS	P34C5223V	0.0 to 40.0 amps	PTM
Indicates the current draw for EPDSU module 6.			
SAC EPDSU MODULE 7 AMPS	P34C5222V	0.0 to 40.0 amps	PTM
Indicates the current draw for EPDSU module 7.			
ASIPE HTR PWR A	P34X5226Y	0 = 'ON', 1 = 'OFF'	PTM
ASIPE HTR PWR B	P34X5229Y	0 = 'ON', 1 = 'OFF'	PTM

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
EPDSU HTR PWR A	P34X5228Y	0 = 'ON', 1 = 'OFF'	PTM
EPDSU HTR PWR B	P34X5231Y	0 = 'ON', 1 = 'OFF'	PTM
OPA HTR PWR A	P34X5232Y	0 = 'ON', 1 = 'OFF'	PTM
OPA HTR PWR B	P34X5235Y	0 = 'ON', 1 = 'OFF'	PTM
SAP HTR PWR A	P34X5233Y	0 = 'ON', 1 = 'OFF'	PTM
SAP HTR PWR B	P34X5236Y	0 = 'ON', 1 = 'OFF'	PTM
ASIPE A LATCH SEATED	P34X6134Y	0 = 'NO', 1 = 'YES'	PTM
TBS.			
ASIPE A LATCH LATCHED	P34X6135Y	0 = 'NO', 1 = 'YES'	PTM
TBS.			
ASIPE B LATCH READY	P34X6133Y	0 = 'NO', 1 = 'YES'	PTM
TBS.			
TEMPERATURES			
FSS FMDM A	P34T2001V	-55.0 to 120.0 deg C	PTM
Indicates Flex Multiplexer/Demultiplexer (FMDM) A temperature. Operational temperature limits are 55 deg C to - 3 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off.			
FSS FMDM B	P34T2002V	-55.0 to 120.0 deg C	PTM
Indicates Flex Multiplexer/Demultiplexer (FMDM) B temperature. Operational temperature limits are 55 deg C to - 3 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off.			
FSS IPCU	P34T2093V	60 to -30 deg C	PTM
Indicates Interface Power Control Unit (IPCU) temperature. Nominal operational limits are 50 deg C to -37 deg C.			
FSS AMSB	P34T2003V	60 to -30 deg C	PTM
Indicates Mechanism Select Box (AMSB) temperature. Nominal operational temperature limits are 50 deg C to -20 deg C.			
FSS STRUTURE A	P34T2117V	60 to -30 deg C	PTM
Indicates Power Regulator Junction Unit A-side temperature. Nominal control range is -20 to -10 deg C.			
FSS EPDSU 1	P34T2004V	60 to -30 deg C	PTM
Indicates Power Distribution and Switching Unit (PDSU) temperature. Nominal operational temperature limits are 50 deg C to -20 deg C.			
FSS EPDSU 2	P34T2007V	60 to -30 deg C	PTM
Indicates Enhanced Power Distribution and Switching Unit (EPDSU) temperature. Nominal operational temperature limits are 50 deg C to -20 deg C.			

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
FSS PPCU	P34T2005V	60 to -30 deg C	PTM
	Indicates Port Power Conditioning Unit (PPCU) temperature. Nominal operational limits are 50 deg C to -20 deg C.		
FSS SPCU	P34T2006V	60 to -30 deg C	PTM
	Indicates Starboard Power Conditioning Unit (SPCU) temperature. Nominal operational limits are 50 deg C to -20 deg C.		
FSS STRUCTURE B	P34T2118V	60 to -30 deg C	PTM
	Indicates Power Regulator Junction Unit B-side temperature. Nominal control range is -20 to -10 deg C.		
MULE FMDM A	P34T8120V	-55.0 to 120.0 deg C	PTM
MULE FMDM B	P34T8121V	-55.0 to 120.0 deg C	PTM
MULE ESM ENCL(PRI)	P34T8102V	-60.0 to 80.0 deg C	PTM
MULE ESM ENCL(SEC)	P34T8105V	-60.0 to 80.0 deg C	PTM
MULE PDSU	P34T8119V	-30.0 to 60.0 deg C	PTM
MULE LOPE (PRI)	P34T8103V	-60.0 to 80.0 deg C	PTM
MULE LOPE (SEC)	P34T8106V	-60.0 to 80.0 deg C	PTM
MULE SOPE (PRI)	P34T8101V	-60.0 to 80.0 deg C	PTM
MULE SOPE (SEC)	P34T8104V	-60.0 to 80.0 deg C	PTM
SAC ASIPE AFT	P34T5219V	-60.0 to 80.0 deg C	PTM
SAC ASIPE B LATCH (A)	P34T6159V	-60.0 to 80.0 deg C	PTM
SAC ASIPE B LATCH (B)	P34T5207V	-60.0 to 80.0 deg C	PTM
SAC ASIPE FWD	P34T5220V	-60.0 to 80.0 deg C	PTM
SAC ASIPE LID(A)	P34T6158V	-60.0 to 80.0 deg C	PTM
SAC ASIPE LID(B)	P34T5212V	-60.0 to 80.0 deg C	PTM
SAC ASIPE PORT	P34T5211V	-60.0 to 80.0 deg C	PTM

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
SAC ASIPE STBD	P34T5210V	-60.0 to 80.0 deg C	PTM
SAC ENV PORT (A)	P34T5201V	-60.0 to 80.0 deg C	PTM
SAC ENV STBD (B)	P34T5214V	-60.0 to 80.0 deg C	PTM
SAC EPDSU-1	P34T5221V	-30.0 to 60.0 deg C	PTM
SAC EPDSU-2	P34T5205V	-30.0 to 60.0 deg C	PTM
SAC OPA AFT(A)	P34T5203V	-60.0 to 80.0 deg C	PTM
SAC OPA FWD(A)	P34T5202V	-60.0 to 80.0 deg C	PTM
SAC OPA MID(B)	P34T5215V	-60.0 to 80.0 deg C	PTM
SAC SAP AFT(A)	P34T5209V	-60.0 to 80.0 deg C	PTM
SAC SAP FWD(B)	P34T5218V	-60.0 to 80.0 deg C	PTM
SAC SAP PORT(B)	P34T5217V	-60.0 to 80.0 deg C	PTM
SAC SAP STBD(A)	P34T5204V	-60.0 to 80.0 deg C	PTM
SAC STRUCTURE(B)	P34T5213V	-60.0 to 80.0 deg C	PTM
SILL PORT X650	V34T1114A	-200 to 450 deg F	PTM
SILL STBD X650	V34T1120A	-200 to 450 deg F	PTM
SILL PORT X1030	V34T1116A	-200 to 450 deg F	PTM
SILL STBD X1030	V34T1122A	-200 to 450 deg F	PTM
SILL PORT X1215	V34T1118A	-200 to 450 deg F	PTM
SILL STBD X1215	V34T1124A	-200 to 450 deg F	PTM

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
POWER COMPS			
PPCU IN W	W34E2040D	0.0 to 4800.0 watts	UCB
TBS.			
PPCU OUT W	W34E2140D	0.0 to 4800.0 watts	UCB
TBS.			
SPCU IN W	W34E2041D	0.0 to 4800.0 watts	UCB
TBS.			
SPCU OUT W	W34E2141D	0.0 to 4800.0 watts	UCB
TBS.			
DPC AVG VOLT	W34V2020D	0.0 to 40.0 volts	UCB
TBS.			
PCU OUT AMPS	W34C2020D	0.0 to 50.0 amps	UCB
TBS.			
PCU/HST LOAD	W34U2000D	0.00 to 1.00 percent/100	UCB
TBS.			
GPC PORT	W92X5500CK	0 = 'SEC(FLEX A'S)', 1 = 'PRI(FLEX B'S)'	UCB
Norminally GNC VP Slot 1 contains information on the port moding for the data buses. The status of the PL Buses is located in bit 6 (bit 1 being msb), this comp generates a discrete MSID from the VP slot 1 telemetry (V92X5500CX).			
ALT FMDM FSS	P34X2073Y	0 = 'OFF', 1 = 'ON'	PTM
Status indication if alternate FMDM is powered on.			
ALT FMDM MULE	P34X8403Y	0 = 'OFF', 1 = 'ON'	PTM
Status indication if alternate FMDM is powered on.			
MN B PL PRI	V76X2833E	0 = 'OFF', 1 = 'ON'	PTM
Indicates that Main B bus is connected to payload primary bus.			
MN B VOLTS	V76V0200A	0.0 40.0 volts	PTM
Indicates Main B bus voltage.			
MN B AMPS	V45C0201A	0.0 to 999 .0 amps	PTM
Indicates current drawn by MN B bus from Fuel Cell 2. Measured on Fuel Cell ground leg.			
MN C PL PRI	V76X2838E	0 = 'OFF', 1 = 'ON'	PTM
Indicates that Main C bus is connected to payload primary bus.			
MN C VOLTS	V76V0300A	0.0 40.0 volts	PTM
Indicates Main C bus voltage.			
MN C AMPS	V45C0301A	0.0 to 999 .0 amps	PTM
Indicates current drawn by MN C bus from Fuel Cell 3. Measured on Fuel Cell ground leg.			
FC 3 PL PRI	V76X2843E	0 = 'OFF', 1 = 'ON'	PTM
Indicates that Fuel Cell 3 is connected to payload primary bus.			
DPC TOT AMPS	SSESYS001	0.0 to 999.9 amps	UCB
Comp calculates total current draw of DPCs.			
DPC TOT WATTS	SSESYS002	0 to 9999 watts	UCB
Comp calculates total power draw of DPCs.			

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
FSS TOT AMPS	SSESYS003	0.0 to 999.9 amps	UCB
	Comp calculates total current draw of FSS.		
FSS TOT WATTS	SSESYS004	0 to 9999 watts	UCB
	Comp calculates total power draw of FSS.		
MULE TOT AMPS	SSESYS005	0.0 to 999.9 amps	UCB
	Comp calculates total current draw of MULE.		
MULE TOT WATTS	SSESYS006	0 to 9999 watts	UCB
	Comp calculates total power draw of MULE.		
SAC TOT AMPS	P34C5206V	0.0 to 999.9 amps	PTM
	Comp calculates total current draw of SAC.		
SAC TOT WATTS	SSESYS008	0 to 9999 watts	UCB
	Comp calculates total power draw of SAC.		
SSE TOT AMPS	SSESYS009	0.0 to 9999.9 amps	UCB
	Comp calculates total current draw of SSE.		
SSE TOT WATTS	SSESYS010	0 to 9999 watts	UCB
	Comp calculates total power draw of SSE.		
STS MECH SYSTEM 1			
AC1 PHASE A AMPS	V76C1540A	0.0 to 20.0 amps	PTM
	AC1 phase A current. All FSS mechanisms are driven by 3 -phase motors.		
AC1 PHASE B AMPS	V76C1541A	0.0 to 20.0 amps	PTM
	AC1 phase B current. All FSS mechanisms are driven by 3 -phase motors.		
AC1 PHASE C AMPS	V76C1542A	0.0 to 20.0 amps	PTM
	AC1 phase C current. All FSS mechanisms are driven by 3 -phase motors.		
MECH PWR 1	V76S2875E	0 = ‘OFF’, 1 = ‘ON’ (yellow)	PTM
	Indicates whether the PL BAY MECH PWR switch (PNL R13A2, S1) is in the on or o ff position. This switch provides down stream power to PAYLOAD 1 CONTROL logic which closes both the K80 and K84 relays.		
LOGIC PWR 1	V54S8424E	0 = ‘OFF’, 1 = ‘ON’ (yellow)	PTM
	Indicates whether LOGIC POWER has been supplied to the control/driver in the PAYLOAD 1 CONTROL logic.		
PLD SEL POS	PWRSELECT	blank, ‘PL1’, ‘PL2’, ‘PL3’, ‘MON’	UCB
	Indicates the position of the payload retention system rotary select switch on the A6U panel. Refer to PAYLOAD SUPPORT writeup for a description of the comp.		
A6U S36	SSEMECH25	0 = ‘MID’ 1 = ‘LAT’ (yellow) 2 = ‘REL’ (yellow) 3 =‘ERR’ (red)	UCB
	Indicates the position of the PAYLOAD RETENTION LATCH switch (S36). The crew uses this switch to control FSS mechanisms. For example, if mechanism 3 (PIVOT LO) was selecte d via the SM GPC, the crew would take the PAYLOAD RETENTION LATCH switch to either LAT or REL to command the BAPS to pivot up or down. Refer to SSE MECH writeup for a description of the comp.		

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
K80 (AC ENA 1) STATUS	V76X2161E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
		Indicates the status of one of three main relays in the PAYLOAD 1 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K84 and K34 or K46 are the other relays that must be closed to prov ide downstream 3-phase power.	
K84 (AC ENA 2) STATUS	V76X2162E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
		Indicates the status of one of three main relays in the PAYLOAD 1 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K80 and K34 or K46 are the other relays that must be closed to provide downstream 3-phase power.	
K46 (LAT-OP STAT 6) STATUS	V76X2216E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
		Indicates the status of one of three main relays in the PAYL OAD 1 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K80 and K84 are the other relays that must be closed to provide downstream 3-phase power.	
K34 (REL-OP STAT 5) STATUS	V76X2215E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
		Indicates the status of one of three main relays in the PAYLOAD 1 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K80 and K84 are the other relays that must b e closed to provide downstream 3-phase power.	
STS MECH SYSTEM 2			
AC2 PHASE A AMPS	V76C1640A	0.0 to 20.0 amps	PTM
		AC2 phase A current. All FSS mechanisms are driven by 3-phase motors.	
AC2 PHASE B AMPS	V76C1641A	0.0 to 20.0 amps	PTM
		AC2 phase B current. All FSS mechanisms are driven by 3-phase motors.	
AC2 PHASE C AMPS	V76C1642A	0.0 to 20.0 amps	PTM
		AC2 phase C current. All FSS mechanisms are driven by 3-phase motors.	
MECH PWR 2	V76S2878E	0 = 'OFF', 1 = 'ON' (yellow)	PTM
		Indicates whether the PL BAY MECH PWR switch (PNL R13A2, S2) is in the on or off position. This switch provides down stream power to PAYLOAD 2 CONTROL logic which closes both the K65 and K77 relays.	
LOGIC PWR 2	V54S8425E	0 = 'OFF', 1 = 'ON' (yellow)	PTM
		Indicates whether LOGIC POWER has been supplied to the control/driver in the PAYLOAD 2 CONTROL logic.	
PLD SEL POS	PWRSELECT	blank, 'PL1', 'PL2', 'PL3', 'MON'	UCB
		Indicates the position of the payload retention system rotary select switch on the A6U panel. Refer to PAYLOAD SUPPORT writeup for a description of the comp.	

Table 6-7. SSE systems description (continued)

BACKGROUND	MSID	TEXT	SRC
A6U S42	SSEMECH28	0 = 'MID' 1 = 'LAT' (yellow) 2 = 'REL' (yellow) 3 ='ERR' (red)	UCB
	Indicates the position of the PAYLOAD RETENTION LATCH (S42) switch. The crew uses this switch to control FSS mechanisms. For example, if mechanism 3 (PIVOT LO) was selected via the SM GPC, the crew would take the PAYLOAD RETENTION LATCH switch to either LAT or REL to command the BAPS to pivot up or down. Refer to SSE MECH writeup for a description of the comp.		
K65 (AC ENA 1) STATUS	V76X2183E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
	Indicates the status of one of three main relays in the PAYLOAD 2 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K77 and K34 or K32 are the other relays that must be closed to provide downstream 3-phase power.		
K77 (AC ENA 2) STATUS	V76X2184E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
	Indicates the status of one of three main relays in the PAYLOAD 2 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K65 and K34 or K32 are the other relays that must be closed to provide downstream 3-phase power.		
K32 (LAT-OP STAT 2) STATUS	V76X2232E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
	Indicates the status of one of three main relays in the PAYLOAD 2 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K65 and K77 are the other relays that must be closed to provide downstream 3-phase power.		
K34 (REL-OP STAT 1) STATUS	V76X2231E	0 = 'ENA' (yellow), 1 = 'DIS'	PTM
	Indicates the status of one of three main relays in the PAYLOAD 2 CONTROL LOGIC that are required to be closed (ENA) in order to provide 3-phase power to downstream FSS mechanisms. K65 and K77 are the other relays that must be closed to provide downstream 3-phase power.		
FMDM STATUS			
FSS LR BYP MULE LR BYP	V92X0343X V92X0345X	0 = blank, 1 ='*' (red) 0 = blank, 1 ='*' (red)	PTM PTM
	A Low-Rate Bypass indicates that an error occurred (on two consecutive transactions to the same element) during the SM read cycles and that specific element has been bypassed. This would indicate that the SM is no longer receiving telemetry from 1 or more cards. The I/O Error ID and EL will indentify the suspect card. The telemetry from the suspect card will be static.		
FSS WRAP ERR MULE WRAP ERR	V92X0342X V92X0344X	0 = blank, 1 ='*' (red) 0 = blank, 1 ='*' (red)	PTM PTM

Table 6-7. SSE systems description (concluded)

BACKGROUND	MSID	TEXT	SRC
A WRAP Error indicates an error with FMDM communciation and all read transactions have been bypassed. The FMDM telemetry will be static and is not valid.			
I/O ERROR ID 1	V92J4326CX	00 to 99 decimal	PTM
I/O ERROR ID 2	V92J4403CX	00 to 99 decimal	PTM
I/O ERROR ID 3	V92J4480CX	00 to 99 decimal	PTM
I/O ERROR ID 4	V92J4553CX	00 to 99 decimal	PTM
I/O ERROR ID 5	V92J4623CX	00 to 99 decimal	PTM
The Transaction Identifier identifies the unique device or transaction corresponding to the failed I/O transfer. The following ID's are of interest to payload operations: 51 = PL Hi rate read, 52 = PL Lo rate read, 53 = FSS FMDM read, and 54 = MULE FMDM read.			
I/O ERROR EL 1	V92J4325CX	000 to 999 decimal	PTM
I/O ERROR EL 2	V92J4402CX	000 to 999 decimal	PTM
I/O ERROR EL 3	V92J4479CX	000 to 999 decimal	PTM
I/O ERROR EL 4	V92J4552CX	000 to 999 decimal	PTM
I/O ERROR EL 5	V92J4622CX	000 to 999 decimal	PTM
The Element number indenfies the specific card bypassed for the specified transaction ID . The following EL's are applicable for STS-109:			
I/O ERROR TIME 1	V92M4389PX	ddd/hh:mm:ss	PTM
I/O ERROR TIME 2	V92M4467PX	ddd/hh:mm:ss	PTM
I/O ERROR TIME 3	V92M4544PX	ddd/hh:mm:ss	PTM
I/O ERROR TIME 4	V92M4617PX	ddd/hh:mm:ss	PTM
I/O ERROR TIME 5	V92M4697PX	ddd/hh:mm:ss	PTM
The time is the onboard generated time of when the SM GPC detected the error. The downlink value is in hours.			

COMPS:

CETSTART0 – Calculates start time of mechanism motion, based on the Mid MCA OPS Stats.

Use Comp from STS-103, Dan can you send me the info.

CECHRUNTM – Calculates run time of a mechanism based on the Mid MCA OPS Stats.

Use Comp from STS-103, Dan can you send me the info.

W34E2040D/W34E2041D – Calculates power into PCUs.

TEMP1 = P34C2008V + P34C2009V + P34C2010V + P 34C2011V +P34C2012V + P34C2013V
TEMP2 = P34C2014V + P34C2015V + P34C2016V + P34C2017V +P34C2018V + P34C2019V
W34E2040D = P34V2040V * TEMP1
W34E2041D = P34V2041V * TEMP2

W34E2140D/W34E2141D – Calculates power out of PCUs. Uses a disspation loss of 25 watts and and efficiency of 0.88.

W34E2140D = (W34E2040D – 25) * 0.88
W34E2141D = (W34E2041D – 25) * 0.88

W34V2020D – Calculates average voltage of DPCs.

W34V2020D = (P34V2028V + P34V2029V + P34V2030V + P34V2031V + P34V2032V + P34V2033V + P34V2034V + P34V2035V + P34V2036V + P34V2037V + P34V2038V + P34V2039V)/12

W34C2020D – Calculates total current output by the PCU's for use by the HST after accounting for line loses.

```
if (P34V2020D > 0.0) then
        W34C2020D = (W34E2141D + W34E2140D) / W34V2020D
else
        W34C2020D = 0.0
```

W34U2000D – Calculates total fraction of power that the SSE is supplying ot HST.

```
if (P34C3060A > 0.0)
        W34U2000D = W34C2020D / P34C3060A
else
        W34U2000D = 0.0
```

SSESYS001/SSESYS002 – Calculates current and power draw of DPCs.

SSESYS001 = TEMP1 + TEMP2
SSESYS002 = (TEMP1 * P34V2040V) + (TEMP2 * P34V2041V)

SSESYS003/SSESYS004 – Calculates current and power draw of FSS.

SSESYS003 = P34C2113V + P34C2116V
SSESYS004 = (P34C2113V * P34V2040V) + (P34C2116V * P34V2041V)

SSESYS005/SSESYS006 – Calculates current and power draw of MULE.

SSESYS005 = P34C8107V + P34C8109V +P34C8110V + P34C8111V + P34C8112V + P34C8113V + P34C8114V + P34C8115V + P34C8116V + P34C8117V
SSESYS006 = SSESYS005 * P34V8122V

SSESYS008 – Calculates power draw of SAC.

SSESYS008 = P34C5206V * P34V5208V

SSESYS009/SSESYS010 – Calculates current and power draw of SSE.

SSESYS009 = SSESYS003 + SSESYS005 + P34C5206V
SSESYS010 = SSESYS004 + SSESYS006 + SSESYS008

6.3.2 SSE Mechanical Display Description

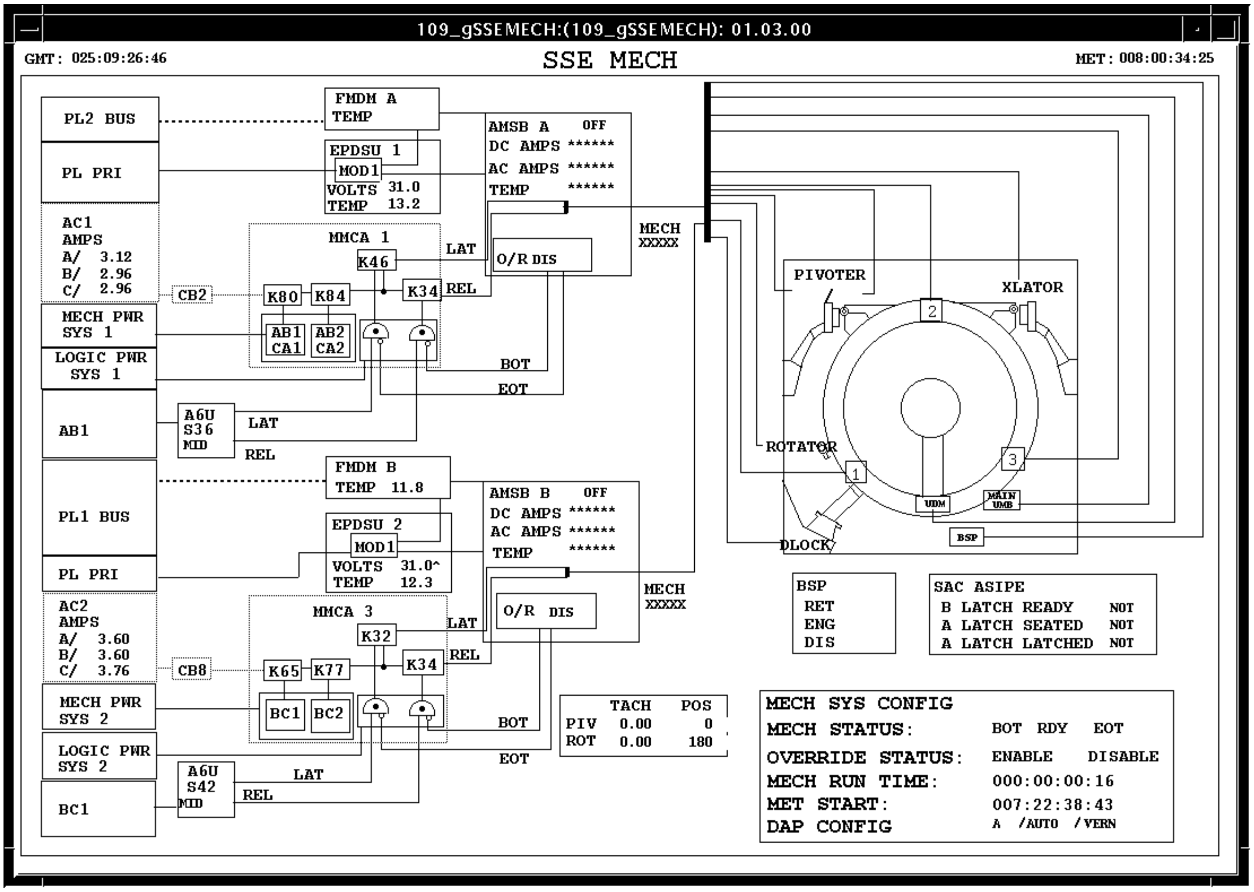


Figure 6-8. SSE mechanical display

Table 6-8. SSE mechanical description

NOMENCLATURE	MSID	FIELD	SRC	DESCRIPTION
MET	M50Q0030HP	ddd/hh:mm:ss	N/A	
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A	
Mechanism Side A (top left of display)				
PL2 box/text + lines to FMDM A	W92X5500CK	0 = green,1 = gray	UCB	Indicates that SM GPC communication is active on the secondary ports (PL2 to FMDM A). Refer to SSE FMDM section for a description of the comp.
FMDM A box/text + line from MOD1 + MOD1 box/text	P34T2001V	<-50 = gray, >50 = red, else green	PTM	Indicates power state of FMDM A, based on temperature. Red indication used for over temp condition.
FMDM A TEMP	P34T2001V	-55.0 to 120.0 deg C	PTM	FMDM A temperature, when powered off temperature will read -55.0 deg C.
PL PRI box/text + line to EPDSU 1	SSEPWR006C	0 = gray, 1 = green	PTM	Indicates that PL PRI is receiving power from at least one orbiter power feed. EPDSU 1 will receive power when PL PRI is on. Refer to SSE POWER display description for information on the comp.
EPDSU 1 box/text	P34V2040V	<24 = gray, >32 = red, else green	PTM	Indicates status of power from payload primary to EPDSU-1 based on EPDSU-1 bus voltage.
EPDSU 1 VOLTS	P34V2040V	0.0 to 40.0 volts	PTM	EPDSU 1 voltage.
EPDSU 1 TEMP	P34T2004V	-55.0 to 124.0 deg C	PTM	EPDSU 1 temperature.
AC1 box/text + line + CB2 box/text + line + MMCA 1 box/text	SSEMECH05	1 = gray 2 = red 3 = yellow 4 = green	UCB	Comp determines status of AC phase input statuses. If all 3 phases are ON, line will be green, 2 phases will be displayed in yellow, 1 phase will be displayed in red, and all phases off will be gray.
AC1 AMPS A	V76C1540A	0.0 to 20.0 amps	PTM	AC1 phase A current.
AC1 AMPS B	V76C1541A	0.0 to 20.0 amps	PTM	AC1 phase B current.
AC1 AMPS C	V76C1542A	0.0 to 20.0 amps	PTM	AC1 phase C current.
MECH PWR SYS 1 box/text + line + box around AB1/CA1 & AB2/CA2	V76S2875E	0 = gray, 1 = green	PTM	Indicates mechanical power has been applied to system 1, based on switch status.
LOGIC PWR SYS 1 box/text + line + box around logic gates	V54S8424E	0 = gray, 1 = green	PTM	Indicates logic power has been applied to system 1, based on switch status.

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE / DESCRIPTION	MSID	FIELD	SRC
AB1 box/text + line + A6U S36 box/text	V76V0120A	>24..0 = green, else gray	PTM
Indicates control AB1 power is active.			
AB1 CA1 box/text + line to K80 box	SSEMECH31	0 = green, 1 = gray, 2 = red	UCB
Indicates the status of power to K80. For power to be available, mech power 1 must be on and at least 1 of the 2 control buses showing nominal voltage. If both voltages are over 32 volts, the line will be red.			
AB2 CA2 box/text + line to K84 box	SSEMECH32	0 = green, 1 = gray, 2 = red	UCB
Indicates the status of power to K84. For power to be available, mech power 1 must be on and at least 1 of the 2 control buses showing nominal voltage. If both voltages are over 32 volts, the line will be red.			
K80 box + line to K84	SSEMECH33	1 = gray, 4 = green	UCB
Indicates power is available to K80, AC1 power is on, and AC1 PBM/PBD power is enabled. Note that the PBM & PBD statuses are OR'd together, so that the activation of either relay will indicate the two buses are enabled.			
K84 box + lines to K46 and K34	SSEMECH34	1 = gray, 4 = green	UCB
Indicates power is available to K84 and AC1 PBM/PBD power is enabled and ON. Note that the PBM & PBD statuses are OR'd together, so that the activation of either relay will indicate the two buses are ON.			
A6U S36	SSEMECH25	0 = 'MID' 1 = 'LAT' 2 = 'REL' 3 = 'ERR' (red)	UCB
Status of S36 switch on A6U, ERR indicates both latch and release indications are present.			
Lat line and word 'LAT' out of A6U S36 to logic gate	V54S8402E	0 = gray, 1 = green	PTM
Indicates the crew has toggled the switch to LATCH.			
Rel line and word 'REL' out of A6U S36 to logic gate	V54S8400E	0 = gray, 1 = green	PTM
Indicates the crew has toggled the switch to RELEASE.			
AMSB A EOT line to logic gate in MMCA 1 + logic gate inverter + 'EOT' text	SSEMECH38	1 = gray, 3 = green	UCB
Indicates that the mechanism has tripped the EOT microswitch (latch side of logic), note power to AMSB must be on for indication.			
AMSB A BOT line to logic gate in MMCA 1 + logic gate inverter + 'BOT' text	SSEMECH39	1 = gray, 3 = green	UCB
Indicates that the mechanism has tripped the BOT microswitch (release side of logic), note power to AMSB must be on for indication.			
Lat logic gate + line to K46 box in MMCA 1	SSEMECH40	0 = green, 1 = gray	UCB
Indicates that latch position has been selected on switch and EOT has not been reached, or that the limit switch override is active.			

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE	MSID	FIELD	SRC
DESCRIPTION			
Rel logic gate + line to K34 box in MMCA 1	SSEMECH41	0 = green, 1 = gray	UCB
Indicates that release position has been selected on switch and BOT has not been reached, or that the limit switch override is active.			
MMCA 1 K46 box + line into AMSB A to the bus + LAT text	SSEMECH42	default = gray, 4 = green	UCB
Indicates when system is driving a mechanism in the latch direction (Side A). Comp verifies power is available, command has been sent, and EOT has not been reached.			
MMCA 1 K34 box + line into AMSB A to the bus + REL text	SSEMECH43	default = gray, 4 = green	UCB
Indicates when system is driving a mechanism in the release direction (Side A). Comp verifies power is available, command has been sent, and BOT has not been reached.			
AMSB A box + text in AMSB A + line from MOD1 + line from FMDM A	P34X2076Y	0 = gray, 1 = green	PTM
Indicates AMSB A has been powered, based on AMSB A power status.			
AMSB A	P34X2076Y	0 = 'OFF', 1 = 'ON'	PTM
Indicates that AMSB A has been commanded on.			
AMSB A DC AMPS	SSEMECH45	-1.00 to 5.00 amps	UCB
Indicates the direct current draw of AMSB A. If AMSB A is off, current will read *** ***			
AMSB A AC AMPS	SSEMECH44	0.00 to 5.00 amps	UCB
Indicates the alternating current draw of AMSB A. If AMSB A is off, current will read ******			
AMSB A TEMP	SSEMECH46	-30.0 to 60.0	UCB
Indicates temperature of AMSB A. If AMSB A is off, tempature wi ll read ******			
AMSB A O/R text (ENA/DIS) and O/R box	SSEMECH37	Text: 1 = 'ENA' (yellow), 0 = 'DIS' Box: 1 = yellow, 0 = white	UCB
Indicates status of AMSB O/R, will be yellow if AMSB is powered and override is enabled.			
AMSB A interior bus + line to large bus	SSEMECH97	default = gray, 4 = green, 5 = yellow	UCB
Indicates when mechanism has been selected and power has been provided to the mechanism from AMSB A. If AMSB A on and any mechanism is selected but the latch or release has not been commanded, then the line will show yellow indicating the mechanism will drive when the command is issued. The lines will turn green when the command is issued.			
AMSB A MECH	SSEMECH95	'XXXX ' or 'DRIVE' or 'SEL '	UCB
Indicates when a mechanism is being driven or is just selected by AMSB A. Note that if a latch or release command is received when no mechanism is selected then you will receive a drive status but the lines from the AMSB will remain gray.			
Mechanism Side B (bottom left of display)			
PL1 box/text + lines to FMDM B	W92X5500CK	0 = gray, 1 = green	UCB
Indicates the SM GPC coomunication is active on the primary ports (PL1 to FMDM B). Refer to SSE FMDM section for a description of the comp.			

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE / DESCRIPTION	MSID	FIELD	SRC
FMDM B box/text + line from MOD1 + MOD1 box/text	P34T2002V	<-50 = gray, >50 = red, else green	PTM
Indicates status of FMDM B, based on temperature.			
FMDM B TEMP	P34T2002V	-55.0 to 120.0 deg C	PTM
FMDM B temperature, when powered off temperature will read -55.0 deg C.			
PL PRI box/text + line to EPDSU 2	SSEPWR006C	0 = gray, 1 = green	PTM
Indicates that at least one orbiter power feed is connected to PL PRI. Refer to SSE POWER section for a description of the comp.			
EPDSU 2 box/text	P34V2041V	<24 = gray, >32 = red, else green	PTM
Indicates status of power from payload primary to EPDSU-2 based on EPDSU-2 bus voltage.			
EPDSU 2 VOLTS	P34V2041V	0.0 to 40.0 volts	PTM
Indicates voltage from EPDSU 2.			
EPDSU 2 TEMPERATURE	P34T2007V	-55.0 to 124.0 deg C	PTM
Indicates temperature of EPDSU 2.			
AC2 box/text + line + CB8 box/text + line + MMCA 3 box/text	SSEMECH14	1 = gray 2 = red 3 = yellow 4 = green	UCB
Comp determines status of AC phase input statuses. If all 3 phases are ON, line will be green, 2 phases will be displayed in yellow, 1 phase will be displayed in red, and all phases off will be gray.			
AC2 AMPS A	V76C1640A	0.0 to 20.0 amps	PTM
AC2 phase A current.			
AC2 AMPS B	V76C1641A	0.0 to 20.0 amps	PTM
AC2 phase B current.			
AC2 AMPS C	V76C1642A	0.0 to 20.0 amps	PTM
AC2 phase C current.			
MECH PWR SYS 2 box/text + line + box around BC1 & BC2	V76S2878E	0 = gray, 1 = green	PTM
Indicates mechanical power has been applied to system 2, based on switch status.			
LOGIC PWR SYS 2 box/text + line + box around logic gates	V54S8425E	0 = gray, 1 = green	PTM
Indicates logic power has been applied to system 2, based on switch status.			
BC1 box/text/ + line + A6U S42 box/text	V76V0220A	>24.0 = green, else gray	PTM
Indicates control BC1 power is active.			
BC1 box/text + line to K65 box	SSEMECH35	0 = green, 1 = gray, 2 = red	UCB
Indicates the status of power to K65. For power to be available, mech power 2 must be on and control bus showing nominal voltage. If voltage is over 32 volts, the line will be red.			
BC2 box/text + line to K77 box	SSEMECH36	0 = green, 1 = gray, 2 = red	UCB
Indicates the status of power to K77. For power to be available, mech power 2 must be on and control bus showing nominal voltage. If voltage is over 32 volts, the line will be red.			

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE / DESCRIPTION	MSID	FIELD	SRC
K65 box + line to K77	SSEMECH68	1 = gray, 4 = green	UCB
Indicates power is available to K65, AC2 power is ON, and AC1 PBM power is enabled.			
K77 box + lines to K32 and K34	SSEMECH69	1 = gray, 4 = green	UCB
Indicates power is available to K77 and AC2 PBM power is enabled and ON.			
A6U S42	SSEMECH28	0 = 'MID' 1 = 'LAT' 2 = 'REL' 3 = 'ERR' (red)	UCB
Status of S36 switch on A6U, ERR indicates both latch and release indications are present.			
Lat line and word 'LAT' out of A6U S42 to logic gate	V54S8406E	0 = gray, 1 = green	PTM
Indicates the crew has toggled the switch to LATCH.			
Rel line and word 'REL' out of A6U S42 to logic gate	V54S8404E	0 = gray, 1 = green	PTM
Indicates the crew has toggled the switch to RELEASE.			
AMSB B EOT line to logic gate in MMCA 3 + logic gate inverter + 'EOT' text	SSEMECH72	1 = gray, 3 = green	UCB
Indicates that the mechanism has tripped the EOT microswitch (latch side of logic), note power to AMSB must be on for indication.			
AMSB B BOT line to logic gate in MMCA 3 + logic gate inverter + 'BOT' text	SSEMECH73	1 = gray, 3 = green	UCB
Indicates that the mechanism has tripped the BOT microswitch (release side of logic), note power to AMSB must be on for indication.			
Lat logic gate + line to K32 box in MMCA 3	SSEMECH74	0 = green, 1 = gray	UCB
Indicates that latch position has been selected on switch and EOT has not been reached, or that the limit switch override is active.			
Rel logic gate + line to K34 box in MMCA 3	SSEMECH75	0 = green, 1 = gray	UCB
Indicates that latch position has been selected on switch and BOT has not been reached, or that the limit switch override is active.			
MMCA 1 K32 box + line into AMSB B to the bus + LAT text	SSEMECH76	1 = gray, 4 = green	UCB
Indicates when system is driving a mechanism in the latch direction (side B). Comp verifies power is available, command has been sent, and EOT has not been reached.			
MMCA 3 K34 box + linto into AMSB B to the bus + REL text	SSEMECH77	1 = gray, 4 = green	UCB
Indicates when system is driving a mechanism in the release direction (side B). Comp verifies power is available, command has been sent, and BOT has not been reached.			
AMSB B box + text in AMSB B + line from MOD1 + line from FMDM B	P34X2077Y	0 = gray, 1 = green	PTM
Indicates when AMSB B has been powered.			

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE / DESCRIPTION	MSID	FIELD	SRC
AMSB B	P34X2077Y	0 = ‘OFF’, 1 = ‘ON’	PTM
Indicates that AMSB B has been commanded on.			
AMSB B DC AMPS	SSEMECH78	-1.00 to 5.00 amps	UCB
Indicates the direct current draw of AMSB B. If AMSB B is off, current will read ******.			
AMSB B AC AMPS	SSEMECH81	0.00 to 5.00 amps	UCB
Indicates the alternating current draw of AMSB B. If AMSB B is off, current will read ******.			
AMSB B TEMP	SSEMECH79	-30.0 to 60.0	UCB
Indicates temperature of AMSB B. If AMSB B is off, tempature will read ******			
AMSB B O/R text (ENA/DIS) and O/R box	SSEMECH71	Text: 1 = ‘ENA’ (yellow), 0 = ‘DIS’ Box: 1 = yellow, 0 = white	UCB
Indicates status of AMSB O/R, will be yellow if AMSB is powered and override is enabled.			
AMSB B interior bus + line to large bus	SSEMECH99	default = gray, 4 = green, 5 = yellow	UCB
Indicates when mechanism has been selected and power has been provided to the mechanism from AMSB B. If AMSB B on and any mechanism is selected but the latch or release has not been commanded, then the line will show yellow indicating the mechanism will drive when the command is issued. The lines will turn green when the command is issued.			
AMSB B MECH	SSEMECH96	‘XXXX ‘ or ‘DRIVE’ or ‘SEL ‘	UCB
Indicates when a mechanism is being driven or is just selected by AMSB B. Note that if a latch or release command is received when no mechanism is selected then you will receive a drive status but the lines from the AMSB will remain gray.			
Command Mechanism Elements (right side of display)			
PIV TACH	P34R2108V	0.0 to 5.30 deg/min	PTM
From CDU motor, for dual motor operations, tach will not increase since it is measured at the motor shaft, not the output shaft.			
PIV POS	SSEMECH85	-5 to 99 deg	UCB
Based on comp that integrates position based on tach when pivoter is active and A6U switch position. In LAT position, tach is added; in REL position, tach is subtracted.			
ROT TACH	P34R2109V	0.0 to 18.0 deg/min	PTM
From CDU motor, for dual motor operations, tach will not increase since it is measured at the motor shaft, not the output shaft.			
ROT POS	SSEMECH86	-360 to 360 deg	UCB
Based on comp that integrates position based on tach when pivoter is active and A6U switch position. In LAT position, tach is added; in REL position, tach is subtracted.			
Large mechanism bus	SSEMECH06	default = gray, 4 = green, 5 = yellow	UCB
Yellow indicates a mechanism is selected and green indicates power is flowing			
DLOCK text + lines from bus	SSEMECH47	default = gray, 4 = green, 5 = yellow	UCB
Indicates when DLOCK is selected (yelow) and active (green).			

Table 6-8. SSE mechanical description (continued)

NOMENCLATURE / DESCRIPTION	MSID	FIELD	SRC
PIVOTER text + HI text + lines from bus	SSEMECH48	Lines: default = gray, 4 = green, 5 = yellow HI/LOW: default = blank, 4 & 5 = 'HI' (white)	UCB
Indicates when PIVOTER HI is selected (yellow) and active (green)			
PIVOTER text + LOW text + lines from bus	SSEMECH49	Lines: default = gray, 4 = green, 5 = yellow HI/LOW: default = blank, 4 & 5 = 'LOW' (white)	UCB
Indicates when PIVOTER LOW is selected (yellow) and active (green).			
ROTATOR text + lines from bus	SSEMECH50	default = gray, 4 = green, 5 = yellow	UCB
Indicates when ROTATOR is selected (yellow) a nd active (green).			
XLATOR text + lines from bus	SSEMECH51	default = gray, 4 = green, 5 = yellow	UCB
Indicates when XLATOR is selected (yellow) and active (green).			
Berth latch 1 box/text + lines from bus	SSEMECH52	default = gray, 4 = green, 5 = yellow	UCB
Indicates when Berthing Latch 1 is selected (yellow) and active (green).			
Berth latch 2 box/text + lines from bus	SSEMECH53	default = gray, 4 = green, 5 = yellow	UCB
Indicates when Berthing Latch 2 is selected (yellow) and active (green).			
Berth latch 3 box/text + lines from bus	SSEMECH54	default = gray, 4 = green, 5 = yellow	UCB
Indicates when Berthing Latch 3 is selected (yellow) and active (green).			
MAIN UMB box/text + lines from bus	SSEMECH55	default = gray, 4 = green, 5 = yellow	UCB
Indicates when Main Umbilical is selected (yellow) and active (green).			
UDM box/text + lines from bus	SSEMECH56	default = gray, 4 = green, 5 = yellow	UCB
Indicates when Backup Umbilical is selected (yellow) and active (green).			
BSP box/text + lines from bus	SSEMECH80	default = gray, 4 = green, 5 = yellow	UCB
Indicates when BAPS Support Post is selected (yellow) and active (green).			
BSP RET ENG DIS	SSECON022 SSECON023 SSECON024	blank, RETA, RETB, RET* blank, ENGA, ENGB, ENG* blank, DISA, DISB, DIS*	UCB UCB UCB
Indicates whether the BSP is retracted, engaged, or disengaged. Refer to SPEC 212 SSE Mechanisms section for a description of the comp.			
SAC ASIPE			
B LATCH READY	P34X6133Y	0 = 'NOT', 1 = 'RDY'	PTM
Indicates when the ASIPE B latch is ready for engagem ent.			
A LACTH SEATED	P34X6134Y	0 = ' NOT', 1 = 'SEAT'	PTM
Indicates when the ASIPE A latch is seated.			
A LATCH LATCHED	P34X6135Y	0 = ' NOT', 1 = 'LTCH'	PTM
Indicates when the ASIPE A latch is latched.			

Table 6-8. SSE mechanical description (concluded)

NOMENCLATURE / DESCRIPTION	MSID	FIELD	SRC
MECH SYS CONFIG TEXT	SSEMECH94	0 = blank, 1 = A , 2 = B, 3 = DM (red)	UCB
Indicates the configuration of the mech system (i.e. which AMSB is being used or if dual mechanisms are being operated).			
MECH STATUS 'BOT' text	SSEMECH61	default = gray, 0 = green, 2 = red	UCB
Indicates if the BOT has been reached, red is used if both BOT and EOT are indicated.			
MECH STATUS 'RDY' text	SSEMECH63	default = gray, 0 = green	UCB
Indicates if the mechanism is ready to be operated.			
MECH STATUS 'EOT' text	SSEMECH62	default = gray, 0 = green, 2 = red	UCB
Indicates if the EOT has been reached, red is used if both BOT and EOT are indicated.			
OVERRIDE STATUS 'ENABLE' text	P34X2072Y	0 = green, 1 = gray	PTM
Indicates if the mechanism override is enabled.			
OVERRIDE STATUS 'DISABLE' text	P34X2072Y	0 = gray, 1 = green	PTM
Indicates if the mechanism override is disabled.			
MECH RUN TIME	CECHRUNTM	mm:ss	UCB
MET START TIME	CETSTART0	ddd:hh:mm:ss	UCB
SELECT (not annotated)	DAPSELECT= V72X2807X V72X2808X	 0 = blank, 1 = 'A' 0 = blank, 1 = 'B'	UCB PTM PTM
Displays the current load for which the DAP is configured, A or B.			
MODE (not annotated)	DAPMODEXX= V72X2850X V72X2849X V72X2868X V72X2897X	 0 = blank, 1 = 'AUTO' 0 = blank, 1 = 'INRT' 0 = blank, 1 = 'LVLH' 0 = blank, 1 = 'FREE'	UCB PTM PTM PTM PTM
Indicates the current mode configuration of the DAP: auto, inertial, local vertical local horizontal, or free drift..			
RCS (not annotated)	DAPJETSLCT= V72X2855X V72X2856X V72X2896X	 0 = blank, 1 = 'PRIM' 0 = blank, 1 = 'VERN' 0 = blank, 1 = 'ALT'	UCB PTM PTM PTM
Displays which mode of RCS jets is selected: primary, vernier, or alternate.			

COMPS:

CECHRUNTM - ELAPSED RUN TIME - This comp calculates the run time of a mechanism based on the Mid MCA OPS statuses.

CETSTART0 - START TIME - This comp calculates the start time of a mechanism base on the Mid MCA OPS statuses.

SSEMECH05 – Used to provide color indication of status of AC1 Bus, off (1=gray), 1 phase on (2=red), 2 phases on (3=yellow), 3 phases on (4=green).

MSID									
V76X1537E	AC BUS 1 PH A INPUT ON	0	0	0	0	1	1	1	1
V76X1538E	AC BUS 1 PH B INPUT ON	0	0	1	1	0	0	1	1
V76X1539E	AC BUS 1 PH C INPUT ON	0	1	0	1	0	1	0	1
	SSEMECH05 =	1	2	2	3	2	3	3	4

SSEMECH06 – Used to provide color for the mechanism bus, if either side has a mechanism driving, it will be green. If either side has a mechanism selected, but the other side is not driving, then it will be yellow.

```
if (SSEMECH97 = 4 or SSEMECH99 = 4) then
        SSEMECH06 = 4
else if (SSEMECH97 = 5 or SSEMECH99 = 5) then
        SSEMECH06 = 5
else
        SSEMECH06 = 1
```

SSEMECH14 – Used to provide color indication of status of AC2 Bus, off (1=gray), 1 phase on (2=red), 2 phases on (3=yellow), 3 phases on (4=green).

MSID									
V76X1637E	AC BUS 2 PH A INPUT ON	0	0	0	0	1	1	1	1
V76X1638E	AC BUS 2 PH B INPUT ON	0	0	1	1	0	0	1	1
V76X1639E	AC BUS 2 PH C INPUT ON	0	1	0	1	0	1	0	1
	SSEMECH14 =	1	2	2	3	2	3	3	4

SSEMECH25 - A6U S36 - This comp identifies the position of switch 1 of the payload retention system on panel A6U.

MSID	NOMENCLATURE				
V54S8400E	PL LAT 1 REL CMD	0	0	1	1
V54S8402E	PL LAT 1 LAT CMD	0	1	0	1
	SSEMECH25 =	0	1	2	3

SSEMECH28 - A6U S42 - This comp identifies the position of switch 2 of the payload retention system on panel A6U.

MSID	NOMENCLATURE				
V54S8404E	PL LAT 2 REL CMD	0	0	1	1
V54S8406E	PL LAT 2 LAT CMD	0	1	0	1
	SSEMECH28 =	0	1	2	3

SSEMECH31 - Indicates the power status of relay K80 in MMCA 1.

```
if V76S2875E = 1 then
        if (V76V0120A >= 24.0 and V76V0120A <= 32.0) then SSEMECH31 = 0
        else if (V76V0320A >= 24.0 and V76V0320A <= 32.0) then SSEMECH31 = 0
        else if (V76V0120A < 24.0 and V76V0320A < 24.0) then SSEMECH31 = 1
        else if (V76V0120A > 32.0 and V76V0320A > 32.0) the n SSEMECH31 = 2
        else SSEMECH31=2
else SSEMECH31 = 1
```

SSEMECH32 - Indicates the power status of relay K84 in MMCA 1.

```
if V76S2875E = 1 then
        if (V76V0121A >= 24.0 and V76V0121A <= 32.0) then SSEMECH32 = 0
        else if (V76V0321A >= 24.0 and V76V0321A <= 32. 0) then SSEMECH32 = 0
        else if (V76V0121A < 24.0 and V76V0321A < 24.0) then SSEMECH32 = 1
        else if (V76V0121A > 32.0 and V76V0321A > 32.0) then SSEMECH32 = 2
        else SSEMECH32=2
else SSEMECH32 = 1
```

SSEMECH33 - Indicates MID MCA 1 PBD/PBM power bus is enabled is zero and all required power is on.

```
if ((SSEMECH05 = 3 or SSEMECH05 = 4) and SSEMECH31 = 0
   and V76X2161E = 0) then
        SSEMECH33 = 4
else SSEMECH33 = 1
```

SSEMECH34 - Indicates MID MCA 1 PBD/PBM power bus is enabled and on, and all required power is on.

```
if (SSEMECH32 = 0 and SSEMECH33 = 4 and V76X2162E = 0)
  then
        SSEMECH34 = 4
else SSEMECH34 = 1
```

SSEMECH35 - Indicates the power status of K65 in MMCA 3.

```
if (V76S2878E = 1) then
        if (V76V0220A < 24.0) then SSEMECH35 = 1
        else if (V76V0220A > 32.0) then SSEMECH35 = 2
        else SSEMECH35=0
else SSEMECH35 = 1
```

SSEMECH36 - Indicates the power status of K77 in MMCA 3.

```
if (V76S2878E = 1) then
        if (V76V0221A < 24.0) then SSEMECH36 = 1
        else if (V76V0221A > 32.0) then SSEMECH36 = 2
        else SSEMECH36=0
else SSEMECH36 = 1
```

SSEMECH37 - Indicates status of AMSB A override.

```
if (P34X2076Y = 1 and P34X2072Y = 0) then SSEMECH37 = 1
        else SSEMECH37 = 0
```

SSEMECH38 - Indicates that the AMSB A mechanism has tripped the EOT microswitch (latch).

```
if (P34X2076Y = 1 and P34X2087Y = 1) then SSEMECH38 = 3
        else SSEMECH38 = 1
```

SSEMECH39 - Indicates that the AMSB A mechanism has tripped the BOT microswitch (release).

```
if (P34X2076Y = 1 and P34X2089Y = 1) then SSEMECH39 = 3
        else SSEMECH39 = 1
```

SSEMECH40 - Indicates that latch position has been selected on switch and EOT has not been reached.

```
if (V54S8402E = 1 and SSEMECH38 = 1) then SSEMECH40 = 0
        else SSEMECH40 = 1
```

SSEMECH41 - Indicates that release position has been selected on switch and BOT has not been reached.

```
if (V54S8400E = 1 and SSEMECH39 = 1) then SSEMECH41 = 0
        else SSEMECH41 = 1
```

SSEMECH42 - Indicates when system is driving a mechanism in the latch direction.

```
if (SSEMECH34 = 4 and SSEMECH40 = 0) then SSEMECH42 = 4
        else SSEMECH42 = 1
```

SSEMECH43 - Indicates when system is driving a mechanism in the release direction.

```
if (SSEMECH34 = 4 and SSEMECH41 = 0) then SSEMECH43 = 4
        else SSEMECH43 = 1
```

SSEMECH44/SSEMECH45/SSEMECH46 – AMSB A and B use the same telemetry MSID's therefore this comp verifies AMSB A active before display data, otherwise the data will be displayed as overflow indicating that AMSB A is off

```
if (P34X2076Y = 1) then
        SSEMECH44 = P34C2111V
        SSEMECH45 = P34C2025V
        SSEMECH46 = P34T2003V
else
        SSEMECH44 = 999999
        SSEMECH45 = 999999
        SSEMECH46 = 999999
```

SSEMECH47 - Indicates when pivoter lock has been selected and whether the mechanism is being driven.

```
SSEMECH47 = 1
if (P34X2076Y = 1 and P34X2064Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH47 = 5
        else SSEMECH47 = 4
if (P34X2077Y = 1 and P34X2064Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH47 = 5
        else SSEMECH47 =4
```

SSEMECH48 - Indicates when pivoter high has been selected and whether the mechanism is being driven.

```
SSEMECH48 = 1
if (P34X2076Y = 1 and P34X2061Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH48 = 5
        else SSEMECH48 = 4
if (P34X2077Y = 1 and P34X2061Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH48 = 5
        else SSEMECH48 =4
```

SSEMECH49 - Indicates when pivoter low has been selected and whether the mechanism is being driven.

```
SSEMECH49 = 1
if (P34X2076Y = 1 and P34X2060Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH49 = 5
        else SSEMECH49 = 4
if (P34X2077Y = 1 and P34X2060Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH49 = 5
        else SSEMECH49 =4
```

SSEMECH50 - Indicates when rotator has been selected and whether the mechanism is being driven.

```
SSEMECH50 = 1
if (P34X2076Y = 1 and P34X2062Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH50 = 5
        else SSEMECH50 = 4
if (P34X2077Y = 1 and P34X2062Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH50 = 5
        else SSEMECH50 =4
```

SSEMECH51 - Indicates when translator has been selected and whether the me chanism is being driven.

```
SSEMECH51 = 1
if (P34X2076Y = 1 and P34X2063Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH51 = 5
        else SSEMECH51 = 4
if (P34X2077Y = 1 and P34X2063Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH51 = 5
        else SSEMECH51 =4
```

SSEMECH52 - Indicates when berthing latch 1 has been selected and whether the mechanism is being driven.

```
SSEMECH52 = 1
if (P34X2076Y = 1 and P34X2065Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH52 = 5
        else SSEMECH52 = 4
if (P34X2077Y = 1 and P34X2065Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH52 = 5
        else SSEMECH52 =4
```

SSEMECH53 - Indicates when berthing latch 2 has been selected and whether the mechanism is being driven.

```
SSEMECH53 = 1
if (P34X2076Y = 1 and P34X2066Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH53 = 5
        else SSEMECH53 = 4
if (P34X2077Y = 1 and P34X2066Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH53 = 5
        else SSEMECH53 =4
```

SSEMECH54 - Indicates when berthing latch 3 has been selected and whether the mechanism is being driven.

```
SSEMECH54 = 1
if (P34X2076Y = 1 and P34X2067Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH54 = 5
        else SSEMECH54 = 4
if (P34X2077Y = 1 and P34X2067Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH54 = 5
        else SSEMECH54 =4
```

SSEMECH55 - Indicates when main umbilical has been selected and whether the mechanism is being driven.

```
SSEMECH55 = 1
if (P34X2076Y = 1 and P34X2068Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH55 = 5
        else SSEMECH55 = 4
if (P34X2077Y = 1 and P34X2068Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH55 = 5
        else SSEMECH55 =4
```

SSEMECH56 - Indicates when backup umbilical has been selected and whether the mechanism is being driven.

```
SSEMECH56 = 1
if (P34X2076Y = 1 and P34X2069Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH56 = 5
        else SSEMECH56 = 4
if (P34X2077Y = 1 and P34X2069Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH56 = 5
        else SSEMECH56 =4
```

SSEMECH61/SSEMECH62 - Indicates if the BOT/EOT has been reached.

MSID	NOMENCLATURE				
P34X2087Y	MSB PRI LATCHED STATUS	0	0	1	1
P34X2089Y	MSB PRI RELEASE STATUS	0	1	0	1
	SSEMECH61 =	1	0	1	2
	SSEMECH62 =	1	1	0	2

SSEMECH63 - Indicates if the mechanism is ready to be operated.

```
if (SSMECH61 = 1 and SSEMECH62 = 1) then
if (SSEMECH47 = 4 or SSEMECH48 = 4 or SSEMECH49 = 4 or SSEMECH50 = 4
      or SSEMECH51 = 4 or SSEMECH52 = 4 or SSEMECH53 = 4 or SSEMECH54 = 4
      or SSEMECH55 = 4 or SSEMECH56 = 4) then
          SSEMECH63 = 0
    else if (SSEMECH47 = 5 or SSEMECH48 = 5 or SSEMECH49 = 5 or
      SSEMECH50 = 5 or SSEMECH51 = 5 or SSEMECH52 = 5 or SSEMECH53 = 5
      or SSEMECH54 = 5 or SSEMECH55 = 5 or SSEMECH56 = 5) then
          SSEMECH63 = 0
    else
          SSEMECH63 = 1
```

SSEMECH68 - Indicates MID MCA 3 PBM power bus is enabled is zero and all required power is on.

```
if ((SSEMECH14 = 3 or SSEMECH14 = 4) and
  SSEMECH35 = 0 and V76X2183E = 0) then
      SSEMECH68 = 4
else SSEMECH68 = 1
```

SSEMECH69 - Indicates MID MCA 3 PBM power bus is enabled and on, and all required power is on.

```
if (SSEMECH68 = 4 and V76X2184E = 0) then
      SSEMECH69 = 4
else SSEMECH69 = 1
```

SSEMECH71 - Indicates status of AMSB B override.

```
if (P34X2077Y = 1 and P34X2072Y = 0) then SSEMECH71 = 1
        else SSEMECH71 = 0
```

SSEMECH72 - Indicates that the AMSB B mechanism has tripped the EOT microswitch (latch).

```
if (P34X2077Y = 1 and P34X2087Y = 1) then SSEMECH72 = 3
        else SSEMECH72 = 1
```

SSEMECH73 - Indicates that the AMSB B mechanism has tripped the BOT microswitch (release).

```
if (P34X2077Y = 1 and P34X2089Y = 1) then SSEMECH73 = 3
        else SSEMECH73 = 1
```

SSEMECH74 - Indicates that latch position has been selected on switch and EOT has not been reached (side B).

```
if (V54S8406E = 1 and SSEMECH72 = 1) then SSEMECH74 = 0
        else SSEMECH74 = 1
```

SSEMECH75 - Indicates that release position has been selected on switch and BOT has not been reached (side B).

```
if (V54S8404E = 1 and SSEMECH73 = 1) then SSEMECH75 = 0
        else SSEMECH75 = 1
```

SSEMECH76 - Indicates when system is driving a mechanism in the latch direction (side B).

```
if (SSEMECH69 = 4 and SSEMECH74 = 0) then SSEMECH76 = 4
        else SSEMECH76 = 1
```

SSEMECH77 - Indicates when system is driving a mechanism in the release dire ction (side B).

```
if (SSEMECH69 = 4 and SSEMECH75 = 0) then SSEMECH77 = 4
        else SSEMECH77 = 1
```

SSEMECH78/SSEMECH79/SSEMECH81 – AMSB A and B use the same telemetry MSID's therefore this comp verifies AMSB B active before display data, otherwise the data will be displayed as overflow indicating that AMSB B is off

```
if (P34X2077Y = 1) then
        SSEMECH81 = P34C2111V
        SSEMECH78 = P34C2025V
        SSEMECH79 = P34T2003V
else
        SSEMECH81 = 999999
        SSEMECH79 = 999999
        SSEMECH78 = 999999
```

SSEMECH80 - Indicates when berthing support post has been selected and whether the mechanism is being driven.

```
SSEMECH80 = 1
if (P34X2076Y = 1 and P34X2070Y = 1) then
        if (SSEMECH42 = 1 and SSEMECH43 = 1) then
                SSEMECH80 = 5
        else SSEMECH80 = 4
if (P34X2077Y = 1 and P34X2070Y = 1) then
        if (SSEMECH76 = 1 and SSEMECH77 = 1) then
                SSEMECH80 = 5
        else SSEMECH80 =4
```

SSEMECH85 - Indicates position of pivoter by integrating the tach speed when the pivoter is active.

```
Initially set SSEMECH85 = 0.0

if SSEMECH49 = 4 then

        if (SSEMECH42 = 4) then SSEMECH85 = SSEMECH85 + (P34R2108V / 60)
        if (SSEMECH43 = 4) then SSEMECH85 = SSEMECH85 – (P34R2108V / 60)
        if (SSEMECH76 = 4) then SSEMECH85 = SSEMECH85 + (P34R2108V / 60)
        if (SSEMECH77 = 4) then SSEMECH85 = SSEMECH85 – (P34R2108V / 60)
```

SSEMECH86 - Indicates position of rotator by integrating the tach speed when the rotator is active.

```
Initially set SSEMECH86 = 180.0

if SSEMECH50 = 4 then
        if (SSEMECH42 = 4) then SSEMECH86 = SSEMECH86 - (P34R2108V / 60)
        if (SSEMECH43 = 4) then SSEMECH86 = SSEMECH86 + (P34R2108V / 60)
        if (SSEMECH76 = 4) then SSEMECH86 = SSEMECH86 - (P34R2108V / 60)
        if (SSEMECH77 = 4) then SSEMECH86 = SSEMECH86 + (P34R2108V / 60)
```

SSEMECH94 - Indicates power status for MSB A and MSB B.

MSID	NOMENCLATURE				
P34X2076Y	MSB-A POWER STATUS	0	0	1	1
P34X2077Y	MSB-B POWER STATUS	0	1	0	1
	SSEMECH94 =	0	2	1	3

SSEMECH95/SSEMECH97 - Indicates status of MSB A.

```
SSEMECH95 = 'XXXX '
SSEMECH97 = 1
if (P34X2076Y =1) then
  if  (SSEMECH42 = 4 or SSEMECH43 = 4) then
      SSEMECH95 = 'DRIVE'
      SSEMECH97 = 1
  if (SSEMECH47 = 4 or SSEMECH48 = 4 or SSEMECH49 = 4 or SSEMECH50 = 4
  or SSEMECH51 = 4 or SSEMECH52 = 4 or SSEMECH53 = 4 or SSEMECH54 = 4
  or SSEMECH55 = 4 or SSEMECH56 = 4 or SSEMECH80 = 4) then
      SSEMECH95 = 'DRIVE'
      SSEMECH97 = 4
  else if (SSEMECH47 = 5 or SSEMECH48 = 5 or SSEMECH49 = 5
  or SSEMECH50 = 5 or SSEMECH51 = 5 or SSEMECH52 = 5
  or SSEMECH53 = 5 or SSEMECH54 = 5 or SSEMECH55 = 5
  or SSEMECH56 = 5 or SSEMECH80 = 5) then
      SSEMECH95 = 'SEL  '
      SSEMECH97 = 5
```

SSEMECH96/SSEMECH99 - Indicates status of MSB B.

```
SSEMECH96 = 'XXXX '
SSEMECH99 = 1
if (P34X2077Y =1) then
  if  (SSEMECH76 = 4 or SSEMECH77 = 4) then
      SSEMECH96 = 'DRIVE'
      SSEMECH99 = 1
  if (SSEMECH47 = 4 or SSEMECH48 = 4 or SSEMECH49 = 4 or SSEMECH50  = 4
  or SSEMECH51 = 4 or SSEMECH52 = 4 or SSEMECH53 = 4 or SSEMECH54 = 4
  or SSEMECH55 = 4 or SSEMECH56 = 4 or SSEMECH80 = 4) then
      SSEMECH96 = 'DRIVE'
      SSEMECH99 = 4
  else if (SSEMECH47 = 5 or SSEMECH48 = 5 or SSEMECH49 = 5
  or SSEMECH50 = 5 or SSEMECH51 = 5 or SSEMECH52 = 5
  or SSEMECH53 = 5 or SSEMECH54 = 5 or SSEMECH55 = 5
  or SSEMECH56 = 5 or SSEMECH80 = 5) then
      SSEMECH96 = 'SEL  '
      SSEMECH99 = 5
```

6.3.3 SSE Power Display Description

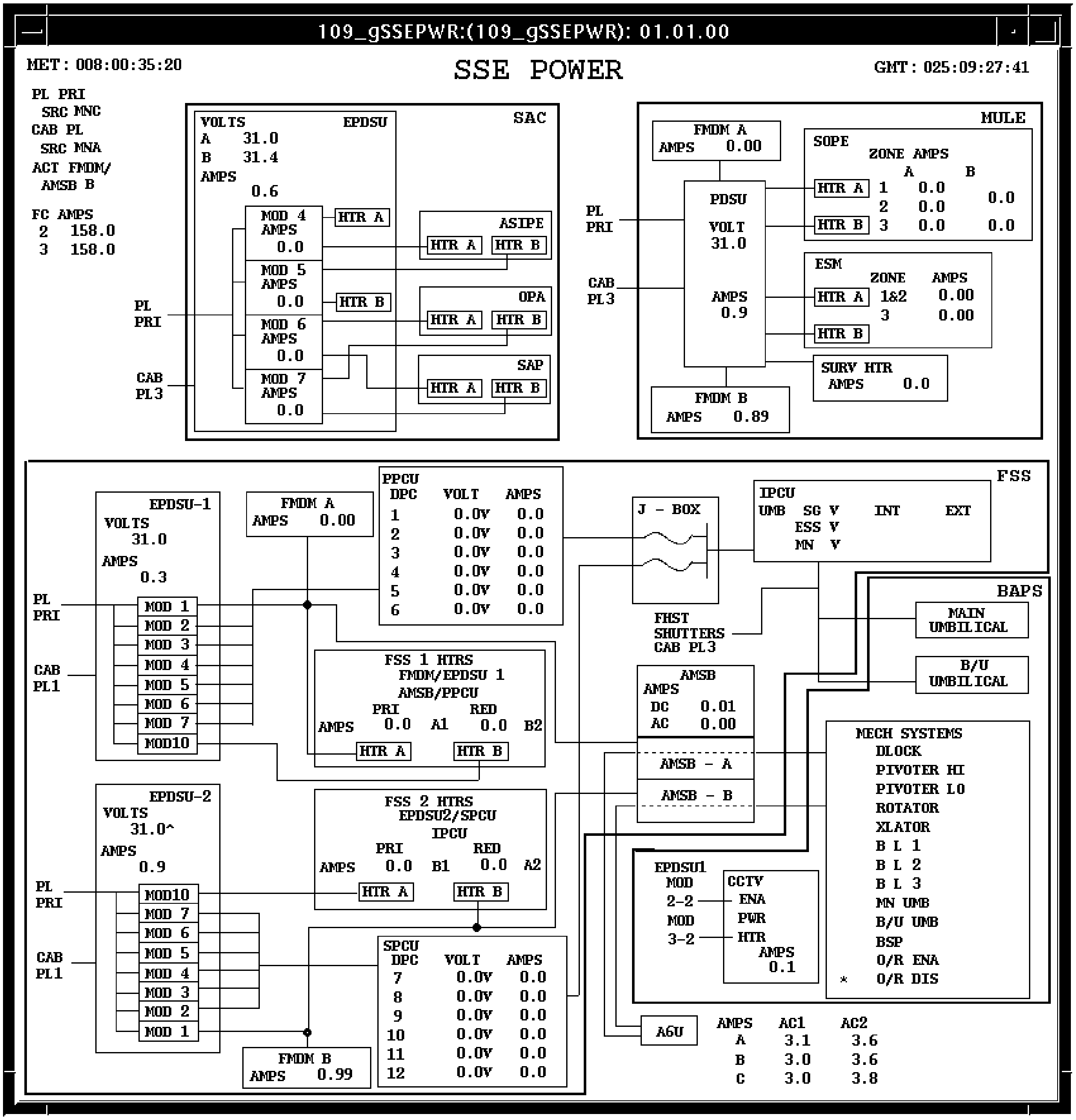


Figure 6-9. SSE power display

Table 6-9. SSE power description

NOMENCLATURE / DESCRIPTION9	MSID	FIELD	SRC
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
PL PRI SRC	SSEPWR006	see comps	UCB
Indicates the source of PL PRI. Display options are OFF, MNB, MNC, FC3, or TIE. TIE indicates 2 or 3 of the sources are tied to the PL PRI bus.			
CAB PL SRC	SSEPWR007	see comps	UCB
Indicates the source of the CABIN PL buses. Display options are OFF, MNA, MNB, or ERR. ERR indicates a switch problem as telemetry is indicating both MNA and MNB are feeding the buses which is physically not possible with the switch.			
ACT FMDM/AMSB	W92X5500CK	0 = ‘A’, 1 = ‘B’	UCB
Indicates which set of FMDMs and AMSB are active, either A or B. Ref er to FMDM display write-up for information on this comp.			
FC AMPS 2	V45C0201A	0.0 to 500.0 amps	PTM
Current produced from fuel cell 2.			
FC AMPS 3	V45C0301A	0.0 to 500.0 amps	PTM
Current produced from fuel cell 3.			
SAC			
PL PRI text + lines to MODs	SSEPWR006C	0 = gray, 1 = green	UCB
Shows flow of PL PRI power when PL PRI is activated from any source.			
CAB PL3 text + line EPDSU	SSEPWR007C	0 = gray, 1 = green	UCB
Shows flow of CAB PL3 input power to the EPDSU when CAB PL is activated.			
EPDSU VOLTS A	P34V5208V	0.0 to 40.0 volts	PTM
Sensor location TBD.			
EPDSU VOLTS B	P34V5216V	0.0 to 40.0 volts	PTM
Sensor location TBD.			
EPDSU AMPS	P34C5206V	-1.2 to 150.0 amps	PTM
Sensor on PL PRI power feed input to the EPDSU.			
MOD4 AMPS	P34C5225V	0.0 to 40.0 amps	PTM
Sensor on power feed input to the module.			
MOD5 AMPS	P34C5224V	0.0 to 40.0 amps	PTM
Sensor on power feed input to the module.			
MOD6 AMPS	P34C5223V	0.0 to 40.0 amps	PTM
Sensor on power feed input to the module.			
MOD7 AMPS	P34C5222V	0.0 to 40.0 amps	PTM
Sensor on power feed input to the module.			

Table 6-9. SSE power description (continued)

NOMENCLATURE / DESCRIPTION9	MSID	FIELD	SRC
EPDSU HTR A box + line to MOD4	P34X5228Y	0 = green, 1 = gray	PTM
EPDSU HTR B box + line to MOD5	P34X5231Y	0 = green, 1 = gray	PTM
ASIPE HTR A box + line to MOD4	P34X5226Y	0 = green, 1 = gray	PTM
ASIPE HTR B box + line to MOD5	P34X5229Y	0 = green, 1 = gray	PTM
OPA HTR A box + line to MOD6	P34X5232Y	0 = green, 1 = gray	PTM
OPA HTR B box + line to MOD7	P34X5235Y	0 = green, 1 = gray	PTM
SAP HTR A box + line to MOD6	P34X5233Y	0 = green, 1 = gray	PTM
SAP HTR B box + line to MOD7	P34X5236Y	0 = green, 1 = gray	PTM
MULE			
PL PRI text + line to PDSU	SSEPWR006C	0 = gray, 1 = green	UCB
Shows flow of PL PRI power when PL PRI is activated from any source.			
CAB PL3 text + line PDSU	SSEPWR007C	0 = gray, 1 = green	UCB
Shows flow of CAB PL3 input power to the PDSU when CAB PL is activated.			
FMDM A box + line to PDSU	SSEPWR001	0 = gray, 1 = green	UCB
Based on FMDM temp, ON when temp > -50.			
FMDM A AMPS	P34C8109V	0.00 to 5.00 amps	PTM
Sensor upstream of PDSU relay.			
PDSU VOLT	P34V8122V	0.0 to 40.0 volts	PTM
Sensor located on Bus B in the PDSU.			
PDSU AMPS	SSEPWR005	0.0 to 999.0 amps	UCB
Sum of power draw through PDSU for all MULE loads			
FMDM B box + line to PDSU	SSEPWR002	0 = gray, 1 = green	UCB
Based on FMDM temp, ON when temp > -50.			
FMDM B AMPS	P34C8114V	0.00 to 5.00 amps	PTM
Sensor upstream of PDSU relay.			
SOPE HTR A box + line to PDSU	SSEPWR016	0 = gray, 1 = green	UCB
Indicates if either the A heater or B heater is active.			
SOPE HTR B box + line to PDSU	SSEPWR017	0 = gray, 1 = green	UCB
Indicates if either the A heater or B heater is active.			
SOPE ZONE 1 AMPS A	P34C8112V	0.0 to 20.0 amps	PTM
Sensor upstream of PDSU relay.			

Table 6-9. SSE power description (continued)

NOMENCLATURE / DESCRIPTION9	MSID	FIELD	SRC
SOPE ZONE 2 AMPS A	P34C8107V	0.0 to 20.0 amps	PTM
Sensor upstream of PDSU relay.			
SOPE ZONE 3 AMPS A	P34C8113V	0.0 to 20.0 amps	PTM
Sensor upstream of PDSU relay.			
SOPE ZONE 1&2 AMPS B	P34C8115V	0.0 to 20.0 amps	PTM
Sensor upstream of PDSU relay.			
SOPE ZONE 3 AMPS B	P34C8116V	0.0 to 20.0 amps	PTM
Sensor upstream of PDSU relay.			
ESM HTR A box + line to PDSU	SSEPWR018	0 = gray, 1 = green	UCB
Indicates if either the A heater or B heater is active.			
ESM HTR B box + line to PDSU	SSEPWR019	0 = gray, 1 = green	UCB
Indicates if either the A heater or B heater is active.			
ESM ZONE 1&2 AMPS	P34C8110V	0.00 to 5.00 amps	PTM
Sensor upstream of PDSU relay.			
ESM ZONE 3 AMPS	P34C8111V	0.00 to 5.00 amps	PTM
Sensor upstream of PDSU relay.			
SURV HTR box + line to PDSU	P34X8411Y	0 = gray, 1 = green	PTM
Indicates if either the A heater or B heater is active. Relay output signals are wired together before input to the FMDM.			
SURV HTR AMPS	P34C8117V	0.0 to 20.0 amps	PTM
Tbd - will this sensor give you the sum of both relays, or does it only display the higher of the two currents. Need to add some detail to drawing 3.3-2 zone P-6			
FSS			
PL PRI text + line to EPDSU-1 MODs	SSEPWR006C	0 = gray, 1 = green	UCB
Shows flow of PL PRI power when PL PRI is activated from any source.			
CAB PL1 text + line EPDSU-1	SSEPWR007C	0 = gray, 1 = green	UCB
Shows flow of CAB PL1 input power to EPDSU-1 when CAB PL is activated.			
EPDSU-1 VOLTS	P34V2040V	0.0 to 40.0 volts	PTM
Sensor on SSPC1-2.			
EPDSU-1 AMPS	P34C2113V	0.0 to 999.0 amps	UCB
Sum of power draw through EPDSU-1 for PPCU, HTR 1A, HTR 1B, FMDM A, AMSB DC A, and CCTV HTR loads. Note CCTV camera power has no current monitor but draws power from EPDSU-1. AMSB current is included in only the EPDSU-1 AMPS calculation, is there a better way to do this?			
FMDM A box + line to MOD1 output line at the dot	SSEPWR003	0 = gray, 1 = green	UCB
Based on FMDM temp, ON when temp > -50.			
FMDM A AMPS	P34C2115V	0.00 to 5.00 amps	PTM
Sensor is located in MOD prior to SSPC.			

Table 6-9. SSE power description (concluded)

NOMENCLATURE / DESCRIPTION9	MSID	FIELD	SRC
FSS 1 HTR box	P34X2082Y	0 = gray, 1 = green	PTM
Indicates if either the A heater or B heater is active. Relay output signals are wired together before input to the FMDM.			
FSS 1 HTR A AMPS	P34C2026V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
FSS 1 HTR B AMPS	P34C2114V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC. MSID is labeled as FSS HEATER 2B CURRENT, but actually provides current for 1B heater.			
AMSB A box + line to MOD1 output line at the dot	P34X2076Y	0 = gray, 1 = green	PTM
AMSB DC AMPS	P34C2025V	-1.00 to 5.00 amps	PTM
AMSB AC AMPS	P34C2111V	0.00 to 5.00 amps	PTM
PPCU box + common line to EPDSU-1 + lines into J-BOX (including fuse) up to the bus	SSEPWR012	0 = gray, 1 = green	UCB
Indicates if any of the 6 DPCs in the PPCU are on.			
line from MOD2 to common line + MOD2 box	P34X2047Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
line from MOD3 to common line + MOD3 box	P34X2048Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
line from MOD4 to common line + MOD4 box	P34X2049Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
line from MOD5 to common line + MOD5 box	P34X2119Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
line from MOD6 to common line + MOD6 box	P34X2050Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
line from MOD7 to common line + MOD7 box	P34X2120Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
DPC 1	P34X2047Y	0 = blank, 1 = ‘*’	PTM
FMDM pickoff on MOD control SSPC output.			
DPC 2	P34X2048Y	0 = blank, 1 = ‘*’	PTM
FMDM pickoff on MOD control SSPC output.			

Table 6-9. SSE power description (continued)

NOMENCLATURE / DESCRIPTION9	MSID	FIELD	SRC
DPC 3	P34X2049Y	0 = blank, 1 = '*'	PTM
FMDM pickoff on MOD control SSPC output.			
DPC 4	P34X2119Y	0 = blank, 1 = '*'	PTM
FMDM pickoff on MOD control SSPC output.			
DPC 5	P34X2050Y	0 = blank, 1 = '*'	PTM
FMDM pickoff on MOD control SSPC output.			
DPC 6	P34X2120Y	0 = blank, 1 = '*'	PTM
FMDM pickoff on MOD control SSPC output.			
DPC 1 VOLT	P34V2028V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts.			
DPC 2 VOLT	P34V2029V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts.			
DPC 3 VOLT	P34V2030V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts.			
DPC 4 VOLT	P34V2031V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts.			
DPC 5 VOLT	P34V2032V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts.			
DPC 6 VOLT	P34V2033V	0.0 to 40.0 volts	PTM
Sensor is located in DPC down stream of the output filter. Nominal voltage is 34.7 volts.			
DPC 1 AMPS	P34C2008V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
DPC 2 AMPS	P34C2009V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
DPC 3 AMPS	P34C2010V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
DPC 4 AMPS	P34C2011V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
DPC 5 AMPS	P34C2012V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
DPC 6 AMPS	P34C2013V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
PL PRI text + line to EPDSU-2 MODs	SSEPWR006C	0 = gray, 1 = green	UCB
Shows flow of PL PRI power when PL PRI is activated from any source.			
CAB PL1 text + line EPDSU-2	SSEPWR007C	0 = gray, 1 = green	UCB
Shows flow of CAB PL1 input power to EPDSU-2 when CAB PL is activated.			
EPDSU-2 VOLTS	P34V2041V	0.0 to 40.0 volts	PTM
Sensor on SSPC1-2.			
EPDSU-2 AMPS	P34C2116V	0.0 to 999.0 amps	UCB
Sum of power draw through EPDSU-2 for SPCU, HTR 2A, HTR 2B, FMDM B.			

Table 6-9. SSE power description (continued)

NOMENCLATURE / DESCRIPTION9	MSID	FIELD	SRC
FMDM B box + line to MOD1 output line at the dot	SSEPWR004	0 = gray, 1 = green	UCB
Based on FMDM temp, ON when temp > -50.			
FMDM B AMPS	P34C2022V	0.00 to 5.00 amps	PTM
Sensor is located in MOD prior to SSPC.			
FSS 2 HTR box	P34X2083Y	0 = gray, 1 = green	PTM
Indicates if either the A heater or B heater is active. Relay output signals are wi red together before input to the FMDM.			
FSS 2 HTR A AMPS	P34C2024V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC. MSID is labeled as FSS HEATER 1B CURRENT, but actually provides current for 2A heater.			
FSS 2 HTR B AMPS	P34C2027V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC. MSID is labeled as FSS HEATER 2A CURRENT, but actually provides current for 2B heater.			
AMSB B box + line to MOD1 output line at the dot	P34X2077Y	0 = gray, 1 = green	PTM
SPCU box + common line to EPDSU-2 + lines into J-BOX (including fuse) up to the bus	SSEPWR013	0 = gray, 1 = green	UCB
Indicates if any of the 6 DPCs in the SPCU are on.			
line from MOD2 to common line + MOD2 box	P34X2051Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
line from MOD3 to common line + MOD3 box	P34X2052Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
line from MOD4 to common line + MOD4 box	P34X2053Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
line from MOD5 to common line + MOD5 box	P34X2121Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
line from MOD6 to common line + MOD6 box	P34X2054Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
line from MOD7 to common line + MOD7 box	P34X2122Y	0 = gray, 1 = green	PTM
FMDM pickoff after EPDSU MOD.			
DPC 7	P34X2051Y	0 = blank, 1 = ‘*’	PTM
FMDM pickoff after EPDSU MOD.			

Table 6-9. SSE power description (continued)

NOMENCLATURE DESCRIPTION9	MSID	FIELD	SRC
DPC 8	P34X2052Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD.			
DPC 9	P34X2053Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD.			
DPC 10	P34X2121Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD.			
DPC 11	P34X2054Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD.			
DPC 12	P34X2122Y	0 = blank, 1 = '*'	PTM
FMDM pickoff after EPDSU MOD.			
DPC 7 VOLT	P34V2034V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC.			
DPC 8 VOLT	P34V2035V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC.			
DPC 9 VOLT	P34V2036V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC.			
DPC 10 VOLT	P34V2037V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC.			
DPC 11 VOLT	P34V2038V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC.			
DPC 12 VOLT	P34V2039V	0.0 to 40.0 volts	PTM
Sensor is located in DPC after the output filter. Nominal voltage is 34.7 volts per DPC.			
DPC 7 AMPS	P34C2014V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
DPC 8 AMPS	P34C2015V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
DPC 9 AMPS	P34C2016V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
DPC 10 AMPS	P34C2017V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
DPC 11 AMPS	P34C2018V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
DPC 12 AMPS	P34C2019V	0.0 to 20.0 amps	PTM
Sensor is located in MOD prior to SSPC.			
J-BOX box/bus + line to IPCU + IPCU box + lines to UMBILICALS + MAIN UMBILICAL box + B/U UMBILICAL box	SSEPWR014	0 = gray, 1 = green	UCB
Indicates at least 1 DPCs is on and providing power to the umbilicals.			
UMB INT ESS V	P34V1026V	0.0 to 40.0 volts	PTM
TBS			
UMB INT MN V	P34V1027V	0.0 to 40.0 volts	PTM
TBS			

Table 6-9. SSE power description (continued)

NOMENCLATURE / DESCRIPTION9	MSID	FIELD	SRC
UMB EXT ESS V	P34V1035V	0.0 to 40.0 volts	PTM
TBS			
UMB EXT MN V	P34V1009V	0.0 to 40.0 volts	PTM
TBS			
FHST SHUTTERS CAB PL3 text + line to IPCU/UMBICAL line	SSEPWR007C	0 = gray, 1 = green	UCB
Indicates CAB PL3 power is available for the SSP switch to close the FHST Shutters.			
BAPS			
DLOCK	P34X2064Y	0 = blank, 1 = '*'	PTM
Indicates that the downlock mechanism has been selected in the active MSB.			
PIVOTER HI	P34X2061Y	0 = blank, 1 = '*'	PTM
Indicates that the high rate pivoter mechanism has been selected in the active MSB.			
PIVOTER LOW	P34X2060Y	0 = blank, 1 = '*'	PTM
Indicates that the low rate pivoter mechanism has been selected in the active MSB.			
ROTATOR	P34X2062Y	0 = blank, 1 = '*'	PTM
Indicates that the rotator mechanism has been selected in the active MSB.			
TRANSLATOR	P34X2063Y	0 = blank, 1 = '*'	PTM
Indicates that the translator mechanism has been selected in the active MSB.			
B L 1	P34X2065Y	0 = blank, 1 = '*'	PTM
Indicates that the berth latch 1 mechanism has been selected in the active MSB.			
B L 2	P34X2066Y	0 = blank, 1 = '*'	PTM
Indicates that the berth latch 2 mechanism has been selected in the active MSB.			
B L 3	P34X2067Y	0 = blank, 1 = '*'	PTM
Indicates that the berth latch 3 mechanism has been selected in the active MSB.			
MN UMB	P34X2068Y	0 = blank, 1 = '*'	PTM
Indicates that the main umbilical mechanism has been selected in the active MSB.			
B/U UMB	P34X2069Y	0 = blank, 1 = '*'	PTM
Indicates that the backup umbilical mechanism has been selected in the active MSB.			
BSP	P34X2070Y	0 = blank, 1 = '*'	PTM
Indicates that the BAPS support post mechanism has been selected in the active MSB.			
O/R ENA	P34X2072Y	0 = '*', 1 = blank	PTM
Indicates that the mechanism override is enabled.			
O/R DIS	P34X2072Y	0 = blank, 1 = '*'	PTM
Indicates that the mechanism override is disabled.			
CCTV box + line to MOD2-2	SSEPWR015	0 = gray, 1, 2, 3 = green	UCB
CCTV ENA	SSEPWR015	0 = blank, 1 = '1'(yellow), 2 = '2' (yellow), 3 = '*'	UCB
CCTV PWR	P34K4041Y	0 = blank, 1 = '*'	PTM
Telemetry from FDMD command registry, this is not an end-item command response.			
CCTV HTR AMPS	P34C2095V	0.00 to 5.00 amps	PTM
Sensor is located in MOD prior to SSPC.			

Table 6-9. SSE power description (concluded)

NOMENCLATURE / DESCRIPTION9	MSID	FIELD	SRC
A6U box	SSEPWR010C	0 = gray, 1 = green	UCB
Indicates if either logic power system 1 or 2 is powered.			
Line from A6U through MSB A to MECH SYSTEMS	SSEPWR010	0 = green, 1 = gray	UCB
Indicates if system 1 is driving a mechanism in either the latch or release direction.			
Line from A6U through MSB B to MECH SYSTEMS	SSEPWR011	0 = green, 1 = gray	UCB
Indicates if system 2 is driving a mechanism in either the latch or release direction.			
AC1 AMPS A B C	V76C1540A V76C1541A V76C1542A	0.0 to 20.0 amps 0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM PTM
AC1 current for phases A, B and C.			
AC2 AMPS A B C	V76C1640A V76C1641A V76C1642A	0.0 to 20.0 amps 0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM PTM
AC2 current for phases A, B and C.			

COMPS:

SSEPWR001 – Determines power state of MULE FMDM A based on its temperature.

```
if P34T8120V > -50 then
        SSEPWR001 = 1
else
        SSEPWR001 = 0
```

SSEPWR002 – Determines power state of MULE FMDM B based on its te mperature.

```
if P34T8121V > -50 then
        SSEPWR002 = 1
else
        SSEPWR002 = 0
```

SSEPWR003 – Determines power state of FSS FMDM A based on its temperature.

```
if P34T2001V > -50 then
        SSEPWR003 = 1
else
        SSEPWR003 = 0
```

SSEPWR004 – Determines power state of FSS F MDM B based on its temperature.

```
if P34T2002V > -50 then
        SSEPWR004 = 1
else
        SSEPWR004 = 0
```

SSEPWR005 – Sum of power draw through PDSU for all MULE loads.

SSEPWR005 = P34C8107V + P34C8109V + P34C8110V + P34C8111V + P34C8112V + P34C8113V + P34C8114V + P34C8115V + P34C8116V + P34C8117V

SSEPWR006/SSEPWR006C - Indicates source of power for payload primary bus.

```
if (V76X2833E =1 and V76X2838E = 0 and V76X2843E =0) then
        SSEPWR006 = ‘MNB’
        SSEPWR006C = 1
else if (V76X2833E =0 and V76X2838E = 1 and V76X2843E  =0) then
        SSEPWR006 = ‘MNC’
        SSEPWR006C = 1
else if (V76X2833E =0 and V76X2838E = 0 and V76X2843E =1) then
        SSEPWR006 = ‘FC3’
        SSEPWR006C = 1
else if (V76X2833E =0 and V76X2838E = 0 and V76X2843E =0) then
        SSEPWR006 = ‘OFF’
        SSEPWR006C = 0
else
        SSEPWR006 = ‘TIE’
        SSEPWR006C = 1
```

SSEPWR007/SSEPWR007C - Indicates source of power for cabin payload buses.

```
if (V76S2851E = 1 and V76S2853E = 0) then
        SSEPWR007 = ‘MNA’
        SSEPWR007C = 1
if (V76S2851E = 0 and V76S2853E = 1) then
        SSEPWR007 = ‘MNB’
        SSEPWR007C = 1
if (V76S2851E = 0 and V76S2853E = 0) then
        SSEPWR007 = ‘OFF’
        SSEPWR007C = 0
else
        SSEPWR007 = ‘ERR’
        SSEPWR007C = 1
```

SSEPWR008 – Sum of power draw through EPDSU-1.

SSEPWR003 = P34C2008V + P34C2009V + P34C2010V + P34C2011V + P34C2012V + P34C2013V + P34C2024V + P34C2025V + P34C2026V +P34C2095V + P34C2115V

SSEPWR009 – Sum of power draw through EPDSU-2.

SSEPWR003 = P34C2014V + P34C2015V + P34C2016V + P34C2017V + P34C2018V + P34C2019V + P34C2022V + P34C2027V + P34C2114V

SSEPWR010 - Indicates if mechanism system 1 (A6U switch 1 to AMSB A) is being operated.

```
if (SSEMECH42 = 4 or SSEMECH 43 = 4) then
        SSEPWR010 = 0
else
        SSEPWR010 = 1
```

SSEPWR010C - Indicates if either logic power system is powered.

```
if (V54S8424E = 1 or V54X8425E = 1) then
        SSEPWR010C = 1
else
        SSEPWR010C = 0
```

SSEPWR011 - Indicates if mechanism system 2 (A6U switch 2 to AMSB B) is being operated.

```
if (SSEMECH76 = 4 or SSEMECH77 = 4) then
        SSEPWR011 = 0
else
        SSEPWR011 = 1
```

SSEPWR012 – Determines if any of the PPCU DPCs are on.

```
if (P34X2047Y = 1 or P34X2048Y = 1 or P34X2049Y = 1 or P34X2050Y = 1 or
P34X2119Y = 1 or P34X2120Y = 1) then
        SSEPWR012 = 1
else
        SSEPWR012 = 0
```

SSEPWR013 – Determines if any of the SPCU DPCs are on.

```
if (P34X2051Y = 1 or P34X2052Y = 1 or P34X2053Y = 1 or P34X2054Y = 1 or
P34X2121Y = 1 or P34X2122Y = 1) then
        SSEPWR013 = 1
else
        SSEPWR013 = 0
```

SSEPWR014 – Determines if any of the DPCs are on.

```
if (SSEPWR012 = 1 or SSEPWR013 = 1) then
        SSEPWR014 = 1
else
        SSEPWR014 = 0
```

SSEPWR015 – Determines if both CCTV power statuses are enabled.

```
if (P34X2096Y = 1 and P34X2097Y = 1) then
        SSEPWR015 = 3
if (P34X2096Y = 0 and P34X2097Y = 1) then
        SSEPWR015 = 2
if (P34X2096Y = 1 and P34X2097Y = 0) then
        SSEPWR015 = 1
else
        SSEPWR015 = 0
```

SSEPWR016 – Determines if both sets of SOPE A heaters have activated.

```
if (P34X8406Y = 1 and P34X8407Y = 1) then
        SSEPWR016 = 1
else
        SSEPWR016 = 0
```

SSEPWR017 – Determines if both sets of SOPE B heaters have activated.

```
if (P34X8409Y = 1 and P34X8410Y = 1) then
        SSEPWR017 = 1
else
        SSEPWR017 = 0
```

SSEPWR018 – Determines if both sets of ESM A heaters have activated.

```
if (P34X8401Y = 1 and P34X8402Y = 1) then
        SSEPWR018 = 1
else
        SSEPWR018 = 0
```

SSEPWR019 – Determines if both sets of ESM B heaters have activated.

```
if (P34X8404Y = 1 and P34X8405Y = 1) then
        SSEPWR019 = 1
else
        SSEPWR019 = 0
```

6.3.4 SSE FMDM Display Description

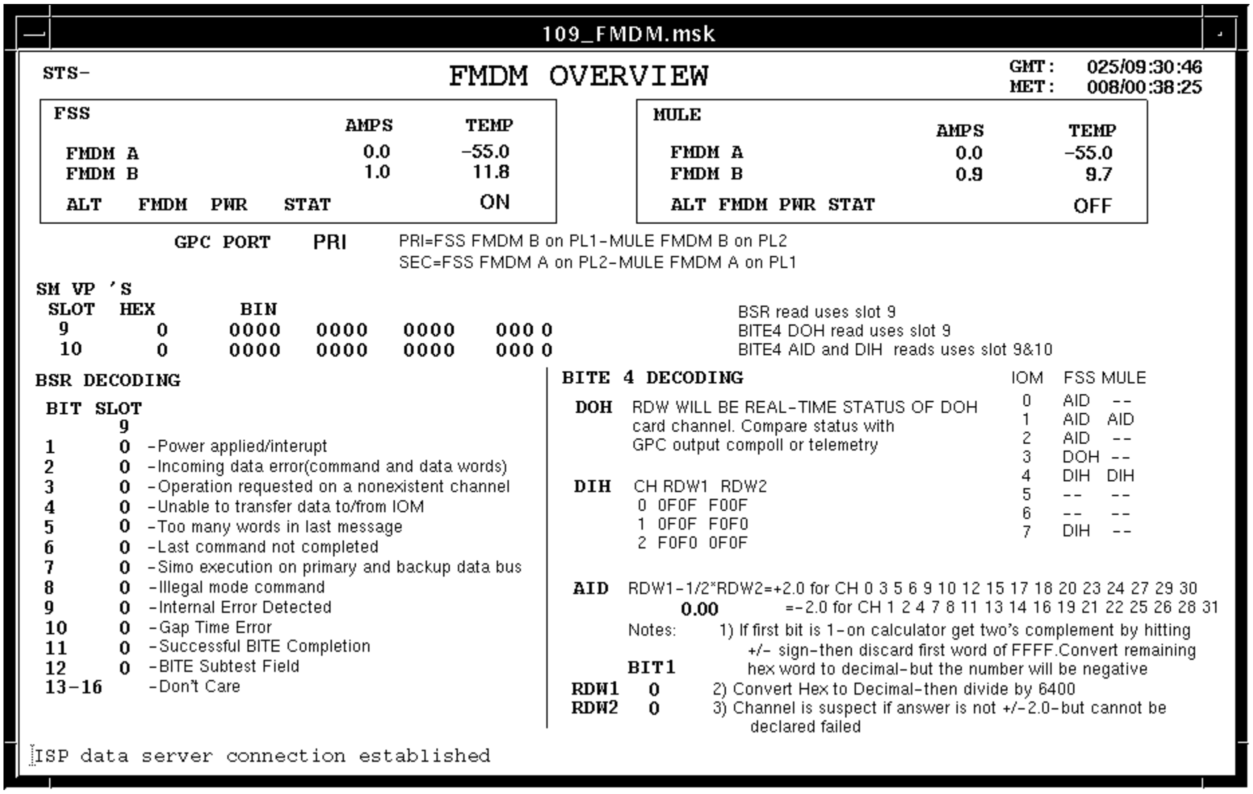


Figure 6-10. SSE FMDM display

Table 6-10. SM 211 emulation description

NOMENCLATURE / DESCRIPTION	MSID	FIELD	SRC
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
FSS FMDM A AMPS	P34C2115V	0.0 to 5.0 amps	PTM
Sensor is inline on power feed to EPDSU-1 MOD 1-2 SSPC.			
FSS FMDM A TEMP	P34T2001V	-55 to 120 deg C	PTM
Operational temperature limits are TBD. FSS FMDM radiator heater setpoints are TBD. A temperature indication of ~ -55 deg C indicates that the FMDM is off.			
FSS FMDM B AMPS	P34C2022V	0.0 to 5.0 amps	PTM
Sensor is inline on power feed to EPDSU-2 MOD 1-2 SSPC.			
FSS FMDM B TEMP	P34T2002V	-55 to 120 deg C	PTM
Operational temperature limits are TBD. FSS FMDM radiator heater setpoints are TBD. A temperature indication of ~ -55 deg C indicates that the FMDM is off.			
FSS ALT FMDM PWR STAT	P34X2073Y	0 = 'OFF', 1 = 'ON'	PTM
Wired downstream of SSPC that powers the alternate FMDM.			
MULE FMDM A AMPS	P34C8109V	0.0 to 5.0 amps	PTM
Sensor is inline on power feed to PDSU relay.			
MULE FMDM A TEMP	P34T8120V	-55 to 120 deg C	PTM
Operational temperature limits are TBD. MULE FMDM radiator heater setpoints are +2 deg C ON and +10 deg C OFF. A temperature indication of ~ -55 deg C indicates that the FMDM is off.			
MULE FMDM B AMPS	P34C8114V	0.0 to 5.0 amps	PTM
Sensor is inline on power feed to PDSU relay.			
MULE FMDM B TEMP	P34T8121V	-55 to 120 deg C	PTM
Operational temperature limits are TBD. MULE FMDM radiator heater setpoints are +2 deg C ON and +10 deg C OFF. A temperature indication of ~ -55 deg C indicates that the FMDM is off.			
MULE ALT FMDM PWR STAT	P34X8403Y	0 = 'OFF', 1 = 'ON'	PTM
Wired downstream of PDSU relay that powers the alternate FMDM.			
GPC PORT	W92X5500CK	0 = 'SEC', 1 = 'PRI'	UCB
Norminally GNC VP Slot 1 contains information on the port moding for the data buses. T he status of the PL Buses is located in bit 6 (bit 1 being msb), this comp generates a discrete MSID from the VP slot 1 telemetry (V92X5500CX).			
SM VP'S SLOT 9 HEX	V92U5516CY	0000 to FFFF hex	PTM
VP slot is used for downlinking BSR and BITE4 read telemetry to troubleshoot MDM problems.			
SM VP'S SLOT 9 BIN	W92X5516CP through W92X5516CA	0 or 1	UCB
Comps used to generate 16 descretes from the VP slot 9 telemetry			

Table 6-10. SM 211 emulation description (concluded)

NOMENCLATURE / DESCRIPTION	MSID	FIELD	SRC
SM VP'S SLOT 10 HEX	V92U5518CY	0000 to FFFF hex	PTM
VP slot is used for downlinking BITE4 read telemetry to troubleshoot MDM problems.			
SM VP'S SLOT 10 BIN	W92X5518CP through W92X5518CA	0 or 1	UCB
Comps used to generate 16 descretes from the VP slot 10 telemetry			
BSR DECODING SLOT 9	W92X5516CP through W92X5516CE	0 or 1	UCB
Same information displayed in SM VP'S SLOT 9 BIN fields, but with information to interpret a BSR read.			
BITE4 DECODING AID	FMDMBITE4	-99.00 to +99.00	UCB
Comp to calculate telemetry from BITE4 AID card read.			
BITE4 DECODING AID BIT 1	W92X5516CP W92X5518CP	0 or 1 0 or 1	UCB
For a BITE4 AID card read, if the first bit is zero, then the value is negative, and the two's complement must be used to calculate the decimal conversion.			

COMPS:

W92X5516C/W92X5518C - Calculates discrete MSID's from VP hex telemetry.

V92U5516CY	Comp MSID	V92U5518CY	Comp MSID
X (msb)	W92X5516CP	X (msb)	W92X5518CP
X	W92X5516CO	X	W92X5518CO
X	W92X5516CN	X	W92X5518CN
X	W92X5516CM	X	W92X5518CM
X	W92X5516CL	X	W92X5518CL
X	W92X5516CK	X	W92X5518CK
X	W92X5516CJ	X	W92X5518CJ
X	W92X5516CI	X	W92X5518CI
X	W92X5516CH	X	W92X5518CH
X	W92X5516CG	X	W92X5518CG
X	W92X5516CF	X	W92X5518CF
X	W92X5516CE	X	W92X5518CE
X	W92X5516CD	X	W92X5518CD
X	W92X5516CC	X	W92X5518CC
X	W92X5516CB	X	W92X5518CB
X (lsb)	W92X5516CA	X (lsb)	W92X5518CA

FMDMBITE4 – Calculates error checking factor from BITE4 read.

Conv1 = hex to decimal conversion (V92U5516CY)
Conv2 = hex to decimal conversion (V92U5518CY)
FMDMBITE4 = Conv1/6400 – Conv2/12800

Note: the first bit is a sign bit, if it is a 1, have to do two's complement conversion, decimal value should be made negative.

6.3.5 SM 211 Emulation Display Description

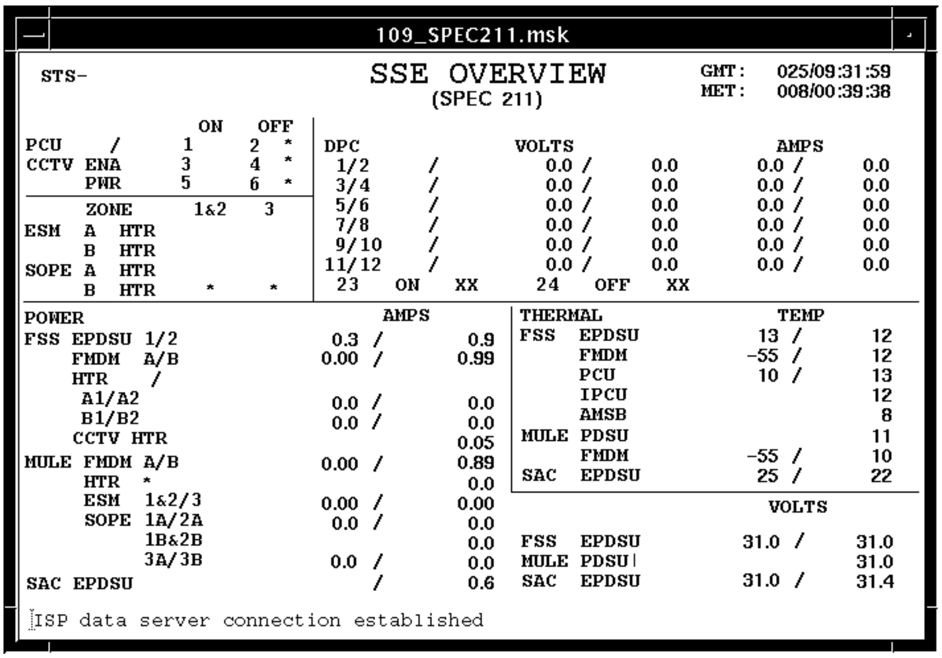


Figure 6-11. SM 211 emulation display

Table 6-11. SM 21 emulation description

BACKGROUND	MSID	TEXT	SRC
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
PCU P/ (not annotated)	SSEOVR001	0 = blank, 1 = '*', 2 = 'P'	UCB
	Indicates power status based on command registry (not end item) of DPCs in the PPCU. If all DPCs are off, then field is blank. If all DPCs are on, then field is P. An * will be displayed for all other conditions.		
PCU /S (not annotated)	SSEOVR002	0 = blank, 1 = '*', 2 = 'S'	UCB
	Indicates power status based on command registry (not end item) of DPCs in the SPCU. If all DPCs are off, then field is blank. If all DPCs are on, then field is S. An * will be displayed for all other conditions.		
PCU ON	SSEOVR003	0 = blank, 1 = '*'	UCB
	Provides response to crew commanding all DPCs on. Since GPC software limits proper response from all the DPCs, only the indication from the odd DPCs is used. A single odd DPC indication will cause the PCU ON indication.		
PCU OFF	SSEOVR003	0 = '*', 1 = blank	UCB
	Provides response to crew commanding all DPCs off. Since GPC software limits proper response from all the DPCs, only the indication from the odd DPCs i s used. All odd DPCs must indicate off for the PCU OFF indication.		
CCTV ENA ON	SSEPWR015	0 = blank, 1 = '1', 2 = '2', 3 = '*'	UCB
	Indicates power status (on) of the FSS CCTV camera power module. Refer to the SSE POWER writeup from a description of the comp.		
CCTV ENA OFF	SSEPWR015	0 = '*', 1 ='2', 2 = '1', 3 = blank	UCB
	Indicates power status (off) of the FSS CCTV camera power module. Refer to the SSE POWER writeup from a description of the comp.		
CCTV PWR ON	P34K4041Y	0 = blank, 1 = '*'	PTM
	Indicates power status (on) of the FSS CCTV camera. Once the CCTV camera power module is enabled, it must be commanded ("on") to provide power to the rest of the CCTV camera so that the camera will function.		
CCTV PWR OFF	P34K4041Y	0 = '*', 1 = blank	PTM
	Indicates power status (off) of the FSS CCTV camera. Note: the CCTV power module may still be enabled/on.		
ESM ZONE 1&2 A HTR	P34X8401Y	0=blank, 1='*'	PTM
	FMDM pick-off downstream of PDSU relay.		
ESM ZONE 3 A HTR	P34X8402Y	0=blank, 1='*'	PTM
	FMDM pick-off downstream of PDSU relay.		
ESM ZONE 1&2 B HTR	P34X8404Y	0=blank, 1='*'	PTM
	FMDM pick-off downstream of PDSU relay.		
ESM ZONE 3 B HTR	P34X8405Y	0=blank, 1='*'	PTM
	FMDM pick-off downstream of PDSU relay.		
SOPE ZONE 1&2 A HTR	P34X8406Y	0=blank, 1='*'	PTM
	FMDM pick-off downstream of PDSU relay.		

Table 6-11. SM 21 emulation description (continued)

BACKGROUND	MSID	TEXT	SRC
SOPE ZONE 3 A HTR	P34X8407Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay.			
SOPE ZONE 1&2 B HTR	P34X8409Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay.			
SOPE ZONE 3 B HTR	P34X8410Y	0=blank, 1='*'	PTM
FMDM pick-off downstream of PDSU relay.			
DPC			
DPC 1 DPC 2	P34X2047Y P34X2048Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
FMDM pick-off on MOD control SSPC output.			
DPC 1 VOLTS DPC 2 VOLTS	P34V2028V P34V2029V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.			
DPC 1 AMPS DPC 2 AMPS	P34C2008V P34C2009V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Sensor is located in DPC prior to the SSPCs.			
DPC 3 DPC 4	P34X2049Y P34X2119Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
FMDM pick-off on MOD control SSPC output.			
DPC 3 VOLTS DPC 4 VOLTS	P34V2030V P34V2031V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.			
DPC 3 AMPS DPC 4 AMPS	P34C2010V P34C2011V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Sensor is located in DPC prior to the SSPCs.			
DPC 5 DPC 6	P34X2050Y P34X2120Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
FMDM pick-off on MOD control SSPC output.			
DPC 5 VOLTS DPC 6 VOLTS	P34V2032V P34V2033V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.			
DPC 5 AMPS DPC 6 AMPS	P34C2012V P34C2013V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Sensor is located in DPC prior to the SSPCs.			
DPC 7 DPC 8	P34X2051Y P34X2052Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
FMDM pick-off on MOD control SSPC output.			
DPC 7 VOLTS DPC 8 VOLTS	P34V2034V P34V2035V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.			
DPC 7 AMPS DPC 8 AMPS	P34C2014V P34C2015V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
Sensor is located in DPC prior to the SSPCs.			

Table 6-11. SM 21 emulation description (continued)

BACKGROUND	MSID	TEXT	SRC
DPC 9 DPC 10	P34X2053Y P34X2121Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
	FMDM pick-off on MOD control SSPC output.		
DPC 9 VOLTS DPC 10 VOLTS	P34V2036V P34V2037V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
	Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.		
DPC 9 AMPS DPC 10 AMPS	P34C2016V P34C2017V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
	Sensor is located in DPC prior to the SSPCs.		
DPC 11 DPC 12	P34X2054Y P34X2122Y	0=blank, 1='*' 0=blank, 1='*'	PTM PTM
	FMDM pick-off on MOD control SSPC output.		
DPC 11 VOLTS DPC 12 VOLTS	P34V2038V P34V2039V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
	Sensor is located in DPC downstream of the output filter. Nominal voltage is 34.7 volts.		
DPC 11 AMPS DPC 12 AMPS	P34C2018V P34C2019V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
	Sensor is located in DPC prior to the SSPCs.		
DPC ON	P93J0100C	data in not downlinked	---
DPC OFF	P93J0101C	data is not downlinked	---
POWER			
FSS EPDSU 1 AMPS 2 AMPS	P34C2113V P34C2116V	-0.30 to 150.00 amps -0.60 to 150.00 amps	PTM PTM
	Indicates EPDSU 1 and 2 current draw. Nominal current draw is TBS amps.		
FSS FMDM A AMPS B AMPS	P34C2115V P34C2022V	0.00 to 5.00 amps 0.00 to 5.00 amps	PTM PTM
FSS HTR	P34X2082Y P34X2083Y	0 = blank, 1 = '1*' 0 = blank, 1 = '2*'	PTM PTM
	FMDM pick-off on PDSU relay power output line.		
FSS HTR A1 AMPS A2 AMPS	P34C2026V P34C2027V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
	Indicates FSS primary Heaters A1 and A2 current draw. Nominal current draw is TBS amps.		
FSS HTR B1 AMPS B2 AMPS	P34C2024V P34C2114V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
	Indicates FSS Redundant Heaters B1 and B2 current draw. Nominal current draw is TBS amps.		
FSS CCTV HTR AMPS	P34C2095V	0.00 to 5.00 amps	PTM
	Indicates FSS CCTV Heaters current draw. Nominal current draw is TBS amps.		

Table 6-11. SM 21 emulation description (continued)

BACKGROUND	MSID	TEXT	SRC
MULE FMDM A AMPS B AMPS	P34C8109V P34C8114V	0.00 to 5.00 amps 0.00 to 5.00 amps	PTM PTM
	Indicates Mule FMDM A and B current draw. Nominal current draw is TBS amps.		
MULE HTR	P34X8411Y	0 = blank, 1 = '*'	PTM
	FMDM pick-off on PDSU relay power output line.		
MULE HTR AMPS	P34C8117V	0.0 to 20.0 amps	PTM
	Indicates Mule Heater current draw. Nominal current draw is TBS amps.		
MULE ESM 1&2 AMPS 3 AMPS	P34C8110V P34C8111V	0.00 to 5.00 amps 0.00 to 5.00 amps	PTM PTM
	Indicates Mule Heater current draw. Nominal current draw is TBS amps.		
MULE SOPE 1A AMPS 2A AMPS	P34C8112V P34C8107V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
	Indicates SOPE primary Heaters zone 1 and 2 current draw. Nominal current draw is TBS amps.		
MULE SOPE 1B & 2B AMPS	P34C8115V	0.0 to 20.0 amps	PTM
	Indicates SOPE redundant Heaters zone 1 and 2 current draw. Nominal current draw is TBS amps.		
MULE SOPE 3A AMPS 3B AMPS	P34C8113V P34C8116V	0.0 to 20.0 amps 0.0 to 20.0 amps	PTM PTM
	Indicates SOPE primary and redundant Heaters zone 3 curr ent draw. Nominal current draw is TBS amps.		
SAC EPDSU AMPS	P34C5206V	-1.2 to 150.0 amps	PTM
	Indicates SAC EPDSU current draw. Nominal current draw is TBS amps.		
FSS EPDSU 1 VOLTS 2 VOLTS	P34V2040V P34V2041V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
	Indicates FSS EPDSU 1 and 2 voltage. Nominal voltage is TBS amps.		
MULE PDSU VOLTS	P34V8122V	0.0 to 40.0 volts	PTM
	Indicates Mule PDSU voltage. Nominal voltage is TBS amps.		
SAC EPDSU A VOLTS B VOLTS	P34V5208V P34V5216V	0.0 to 40.0 volts 0.0 to 40.0 volts	PTM PTM
	Indicates SAC EPDSU A and B voltage. Nominal voltage is TBS amps.		
THERMAL			
FSS EPDSU 1 TEMP 2 TEMP	P34T2004V P34T2007V	-30 to 60 deg C -30 to 60 deg C	PTM PTM
	Indicates FSS Enhanced Power Distribution and Switching Unit (EPDSU) 1 and 2 temperature. Nominal temperature limits are -20 deg C to 50 deg C.		

Table 6-11. SM 21 emulation description (concluded)

BACKGROUND	MSID	TEXT	SRC
FSS FMDM A TEMP B TEMP	P34T2001V P34T2002V	-55 to 120 deg C -55 to 120 deg C	PTM PTM
	Indicates FSS Flex Multiplexer/Demultiplexer (FMDM) A and B temperature. Operational temperature limits are –3 deg C to 55 deg C. A temperature indication of ~ -55 deg C indicates that the FMDM is off.		
FSS PCU P TEMP S TEMP	P34T2005V P34T2006V	-30 to 60 deg C -30 to 60 deg C	PTM PTM
	Indicates Port and Starboard Power Conditioning Unit (PPCU) temperature. Nominal control range is –20 to 50 deg C.		
FSS IPCU TEMP	P34T2093V	-30 to 60 deg C	PTM
	Indicates Interface Power Control Unit (IPCU) temperature. Nominal operational limits are –37 deg C to 50 deg C.		
FSS AMSB TEMP	P34T2003V	-30 to 60 deg C	PTM
	Indicates Mechanism Select Box (AMSB) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C.		
MULE PDSU TEMP	P34T8119V	-30 to 60 deg C	PTM
	Indicates Power Distribution and Switching Unit (PDSU) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C.		
MULE FMDM A TEMP B TEMP	P34T8120V P34T8121V	-55 to 120 deg C -55 to 120 deg C	PTM PTM
	Indicates Flex Multiplexer/Demultiplexer A and B (FMDM) temperatures. Operational temperature limits are –3 deg C to 55 deg C. A temperature indicati on of ~ -55 deg C indicates that the FMDM is off.		
SAC EPDSU 1 TEMP 2 TEMP	P34T5221V P34T5205V	-30 to 60 deg C -30 to 60 deg C	PTM PTM
	Indicates Enhanced Power Distribution and Switching Unit (EPDSU) temperature. Nominal operational temperature limits are –20 deg c to 50 deg C.		

COMPS:

SSEOVR001 – Determines power status of the PPCU DPCs.

```
if (P34K4024Y = 1 and P34K4026Y = 1 and P34K4050Y = 1 and P34K4052Y = 1 and
P34K4054Y = 1 and P34K4056Y = 1) then
        SSEOVR001 = 2
if (P34K4024Y = 0 and P34K4026Y = 0 and P34K4050Y = 0 and P34K4052Y = 0 and
P34K4054Y = 0 and P34K4056Y = 0) then
        SSEOVR001 = 0
else
        SSEOVR001 = 1
```

SSEOVR002 – Determines power status of the SPCU DPCs.

if (P34K4028Y = 1 and P34K4030Y = 1 and P34K4058Y = 1 an d P34K4060Y = 1 and P34K4062Y = 1 and P34K4064Y = 1) then
SSEOVR002 = 2
if (P34K4028Y = 0 and P34K4030Y = 0 and P34K4058Y = 0 and P34K4060Y = 0 and P34K4062Y = 0 and P34K4064Y = 0) then
SSEOVR002 = 0
else
SSEOVR002 = 1

SSEOVR003 – Determines power status of the PPCU DPCs.

if (P34K4024Y = 0 and P34K4026Y = 0 and P34K4028Y = 0 and P34K4030Y = 0 and P34K4052Y = 0 and P34K4060Y = 0) then
SSEOVR003 = 0
else
SSEOVR003 = 1

6.3.6 SM 212 Emulation Display Description

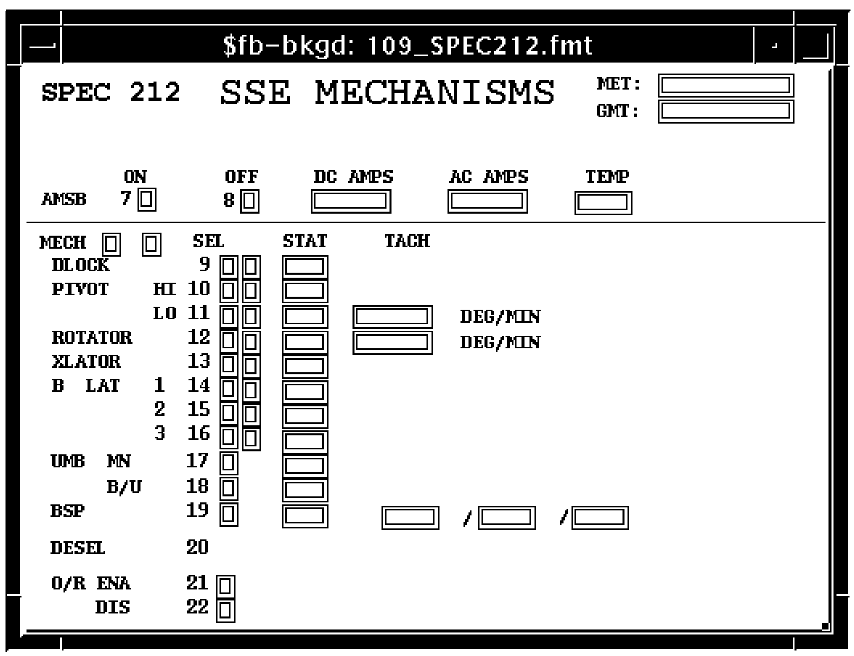


Figure 6-12. SM 212 emulation display

Table 6-12. SM 212 emulation description

BACKGROUND	MSID	TEXT	SRC
GMT	M50Q0027HP	ddd/hh:mm:ss	N/A
MET	M50Q0030HP	ddd/hh:mm:ss	N/A
AMSB ON	SSECON015	0 = blank, 1 = ‘A’, 2 = ‘B’, 3 = ‘*’	UCB
	Indicates power status (on) for the A or B sides of the Advanced Mechanism Select Box (AMSB).		
AMSB OFF	SSECON015	0 = ‘*’, 1 = ‘B’, 2 = ‘A’, 3 = blank	UCB
	Indicates power status (off) for the A or B sides of the Advan ced Mechanism Select Box (AMSB).		
AMSB DC AMPS	P34C2025V	-1.00 to 5.00 amps	PTM
AMSB AC AMPS	P34C2111V	0.00 to 5.00 amps	PTM
AMSB TEMP	P34T2003V	-30 to +60 deg C	PTM
	Indicates Advance Mechansim Select Box (AMSB) temperature. Nominal operational temperature limits are –20 deg C to 50 deg C.		
MECH (left field) (right field)	W54X8111E W54X8122E	see comps see comps	UCB UCB
	Indicates payload retention system 1 feedback related to the A6U circuits controlling the FSS mechanism operations. A backlig hted ‘A’ (flashing on the crew spec) indicates that the mechanism is being driven based on the A6U switch 1 being placed in the REL/LAT position.		
DLOCK SEL STAT	P34X2064Y W34X2064Y SSECON009	0 = blank, 1 = ‘*’ 0 = blank, 1 = ‘V’ (red) see comps	PTM UCB UCB
	Indicates the status of the feedbacks for the translator mechanism. The field is only displayed when the translator is selected in the AMSB. A 'DIS' indicates at least 1 of the 2 release feedbacks is high, 'ENG' indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks.		
PIVOT HI SEL STAT	P34X2061Y W34X2061Y SSECON006	0 = blank, 1 = ‘*’ 0 = blank, 1 = ‘V’ (red) see comps	PTM UCB UCB
	Indicates that the PIVOT HI mechanism has been selected (mechanism 4). The pivoter drive motor will pivot the BAPS ring using high torque. Drive times for both the high torque and low torque setting are the same. Indicates the status of the feedbacks for the pivo t high torque mechanism. The field is only displayed when the high torque pivoter is selected in the AMSB. A DN indicates at least 1 of the 2 release feedbacks is high, UP indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks.		

Table 6-12. SM 212 emulation description (continued)

BACKGROUND	MSID	TEXT	SRC
PIVOT LO SEL	P34X2060Y	0 = blank, 1 = '*'	PTM
	W34X2060Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON005	see comps	UCB
	Indicates that the PIVOT LO mechanism has been selected (mechanism 3). The pivoter drive motor will pivot the BAPS ring using low torque. Drive times for both the high torque and low torque setting are the same. Indicates the status of the feedbacks for the pivot low torque mechanism. The field is only displayed when the low torque pivoter is selected in the AMSB. A DN indicates at least 1 of the 2 release feedbacks is high, UP indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks.		
PIVOT LO TACH	P34R2108V	0.00 to 9.99 deg/min	PTM
	Indicates the rotation speed of the pivoter. Sensor is on motor shaft but is calibrated for output shaft speed (therefore for dual motor ops, you will still see the same speed, although the mechanism will actually being going twice as fast).		
ROTATOR SEL	P34X2062Y	0 = blank, 1 = '*'	PTM
	W34X2062Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON007	see comps	UCB
	Indicates that the ROTATOR mechanism has been selected (mechanism 5). Indicates the status of the feedbacks for the rotator mechanism. The field is only displayed when the rotator is selected in the AMSB. A CW indicates at least 1 of the 2 release feedbacks is high, CCW indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks.		
ROTATOR TACH	P34R2109V	0.0 to 99.9 deg/min	PTM
	Indicates the rotation speed of the rotater. Sensor is on motor shaft but is calibrated for output shaft speed (therefore for dual motor ops, you will still see the same speed, although the mechanism will actually being going twice as fast).		
XLATOR SEL	P34X2063Y	0 = blank, 1 = '*'	PTM
	W34X2063Y	0 = blank, 1 = 'V' (red)	UCB
STAT	SSECON008	see comps	UCB
	Indicates that the TRANLATOR mechanism has been selected (mechanism 6). Indicates the status of the feedbacks for the translato r mechanism. The field is only displayed when the translator is selected in the AMSB. A FWD indicates at least 1 of the 2 release feedbacks is high, AFT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks.		

Table 6-12. SM 212 emulation description (continued)

B LAT 1 SEL	P34X2065Y W34X2065Y	0 = blank, 1 = '*' 0 = blank, 1 = 'V' (red)	PTM UCB
STAT	SSECON010	see comps	UCB
	Indicates that the center berthing latch (1) has been selected. Berthing latch 1 may also be referred to as mechanism 8. Indicates the status of the feedbacks for the berthing latch 1 mechanism. The field is only displayed when the berthing latch 1 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks.		
B LAT 2 SEL	P34X2066Y W34X2066Y	0 = blank, 1 = '*' 0 = blank, 1 = 'V' (red)	PTM UCB
STAT	SSECON011	see comps	UCB
	Indicates that the starboard berthing latch (2) has been selected. Berthing latch 2 may also be referred to as mechanism 9. Indicates the status of the feedbacks for the berthing latch 2 mechanism. The field is only displayed when the berthing latch 2 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch fe edbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks.		
B LAT 3 SEL	P34X2067Y W34X2067Y	0 = blank, 1 = '*' 0 = blank, 1 = 'V' (red)	PTM UCB
STAT	SSECON012	see comps	UCB
	Indicates that the port berthing latch (3) has been selected. Berthing latch 3 may also be referred to as mechanism 10. Indicates the status of the feedbacks for the berthing latch 3 mechanism. The field is only displayed when the berthing latch 3 is selected in the AMSB. A OP indicates at least 1 of the 2 release feedbacks is high, CL indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks.		
UMB MN SEL	P34X2068Y	0 = blank, 1 = '*'	PTM
STAT	SSECON013	see comps	UCB
	Indicates that the main umbilical has been selected. The main umbilical may also be referred to as mechanism 11. Indicates the status of the feedbacks for the main umbilical mechanism. The field i s only displayed when the main umbilical is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, MAT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condi tion, both release and latch feedbacks.		

Table 6-12. SM 212 emulation description (concluded)

UMB B/U SEL STAT	P34X2069Y SSECON014	0 = blank, 1 = '*' see comps	PTM UCB
Indicates that the back up umbilical has been selected. Indicates the status of the feedbacks for the backup umbilical mechanism. The field is only displayed when the backup umbilical is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, MAT indicates at least 1 of the 2 latch feedbacks is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, both release and latch feedbacks.			
BSP SEL STAT	P34X2070Y SSECON021	0 = blank, 1 = '*' see comps	PTM UCB
Indicates that the BAPS Support Post (BSP) has been selected. The BSP may also be referred to as mechanism 13. Indicates the status of the feedbacks for the BAPS support post mechanism. The field is only displayed when the BAPS support post is selected in the AMSB. A REL indicates at least 1 of the 2 release feedbacks is high, SET indicates at least 1 of the 2 latch feedbacks is high, L/A indicates that both the latch and release feedbacks for 1 of the 2 sides is high, RDY no feedbacks are high, and a bug indicates an off nominal condition, release and latch feedbacks from different sides.			
BSP (left field) (middle field) (right field)	SSECON022 SSECON023 SSECON024	see comps see comps see comps	UCB UCB UCB
Indicates whether the BSP is retracted, engaged, or disengaged.			
O/R ENA	P34X2072Y	0 = '*', 1 = blank	PTM
Indicates if override of BOT/EOT microswitches is active. Override will prevent the microswitches from cutting off the motor and the motor will drive to a stall condition against the hardstops.			
O/R DIS	P34X2072Y	0 = blank, 1 = '*'	PTM
Indicates if override is disabled, normal condition.			

COMPS:

SSECON015 - This comp indicates the power status for both sides of the AMSB.

MSB-A PWR STATUS P34X2076Y	0	1	0	1
MSB-B PWR STATUS P34X2077Y	0	0	1	1
SSECON015 =	0	1	2	3

W54X8111E - MECH A - This comp provides payload retention system 1 feedback related to the A6U circuits controlling the FSS mechanism operations. An ‘A’ is displayed when the mechanism rel or lat feedback indicates high. A backlighted ‘A’ (flashing on the crew spec) indicates that the mechanism is being driven based on the A6U switch 1 being placed in the REL/LAT position.

P/L 1 SEL 1A REL V54X8111E	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
P/L 1 SEL 1A LAT V54X8113E	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
PL LAT 1 REL CMD V54S8400E	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
PL LAT 1 LAT CMD V54S8402E	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
W54X8111E =	0	1	1	0	2	2	2	0	2	2	2	0	0	0	0	0
Display =		A	A		A	A	A		A	A	A					

W54X8122E - MECH B - This comp provides payload retention system 2 feedback relate d to the A6U circuits controlling the FSS mechanism operations. An ‘B’ is displayed when the mechanism rel or lat feedback indicates high. A backlighted ‘B’ (flashing on the crew spec) indicates that the mechanism is being driven based on the A6U switch 2 being placed in the REL/LAT position.

P/L 1 SEL 2B REL V54X8122E	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
P/L 1 SEL 2B LAT V54X8124E	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
PL LAT 2 REL CMD V54S8404E	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
PL LAT 2 LAT CMD V54S8406E	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
W54X8122E =	0	1	1	0	2	2	2	0	2	2	2	0	0	0	0	0
Display =		B	B		B	B	B		B	B	B					

W34X2060Y - PIVOT LOW FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

```
if ((P34X2060Y = 1) and (P34X2061Y = 1 or P34X2062Y = 1 or P34X2063Y = 1 or
    P34X2064Y = 1 or P34X2065Y = 1 or P34X2066Y = 1 or P34X2067Y = 1 or
    P34X2068Y = 1)) then
        W34X2060Y = 1
else
        W34X2060Y = 0
```

SSECON005 - PIVOT LO STAT indications.

PIVOT LO SEL P34X2060Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	DEFAULT
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON005=	RDY	DN	DN	DN	UP	*	*	*	UP	*	*	*	UP	*	*	*	blank

W34X2061Y - PIVOT HI FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

```
if ((P34X2061Y = 1) and (P34X2062Y = 1 or P34X2063Y = 1 or P34X2064Y = 1 or
    P34X2065Y = 1 or P34X2066Y = 1 or P34X2067Y = 1 or P34X2068Y = 1)) then
        W34X2061Y = 1
else
        W34X2061Y = 0
```

SSECON006 - PIVOT HI STAT indications.

PIVOT HI SEL P34X2061Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	DEFAULT
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON006=	RDY	DN	DN	DN	UP	*	*	*	UP	*	*	*	UP	*	*	*	blank

W34X2062Y - ROTATOR FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

```
if ((P34X2062Y = 1) and (P34X2063Y = 1 or P34X2064Y = 1 or P34X2065Y = 1 or
    P34X2066Y = 1 or P34X2067Y = 1 or P34X2068Y = 1)) then
        W34X2062Y = 1
else
        W34X2062Y = 0
```

SSECON007 - ROTATOR STAT indications.

ROTATOR SEL P34X2061Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	DEFAULT
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON007=	RDY	CW	CW	CW	CCW	*	*	*	CCW	*	*	*	CCW	*	*	*	blank

W34X2063Y - XLATOR FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

```
if ((P34X2063Y = 1) and (P34X2064Y = 1 or P34X2065Y = 1 or P34X2066Y = 1 or
    P34X2067Y = 1 or P34X2068Y = 1)) then
        W34X2063Y = 1
else
        W34X2063Y = 0
```

SSECON008 - XLATOR STAT indications.

XLATOR SEL P34X2061Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	DEFAULT
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON008=	RDY	FWD	FWD	FWD	AFT	*	*	*	AFT	*	*	*	AFT	*	*	*	blank

W34X2064Y - DLOCK FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

```
if ((P34X2064Y = 1) and (P34X2065Y = 1 or P34X2066Y = 1 or P34X2067Y = 1 or
    P34X2068Y = 1)) then
        W34X2064Y = 1
else
        W34X2064Y = 0
```

SSECON009 - DLOCK STAT indications.

DLOCK SEL P34X2061Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	DEFAULT
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON009=	RDY	DIS	DIS	DIS	ENG	*	*	*	ENG	*	*	*	ENG	*	*	*	blank

W34X2065Y - B LAT 1 FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

```
if ((P34X2065Y = 1) and (P34X2066Y = 1 or P34X2067Y = 1 or P34X2068Y = 1)) then
        W34X2065Y = 1
else
        W34X2065Y = 0
```

SSECON010 - B LATCH 1 STAT indications.

B LAT 1 SEL P34X2065Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	DEFAULT
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON010=	RDY	OP	OP	OP	CL	*	*	*	CL	*	*	*	CL	*	*	*	blank

W34X2066Y - B LAT 2 FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

```
if ((P34X2066Y = 1) and (P34X2067Y = 1 or P34X2068Y = 1)) then
        W34X2066Y = 1
else
        W34X2066Y = 0
```

SSECON011 - B LATCH 2 STAT indications.

B LAT 2 SEL P34X2066Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	DEFAULT
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON011	RDY	OP	OP	OP	CL	*	*	*	CL	*	*	*	CL	*	*	*	blank

W34X2067Y - B LAT 3 FDA - This comp identifies when multiple mechanisms are selected that should not be operated in unison.

```
if (P34X2067Y = 1 and P34X2068Y = 1) then
        W34X2067Y = 1
else
        W34X2067Y = 0
```

SSECON012 - B LATCH 3 STAT indications.

B LAT 3 SEL P34X2067Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	DEFAULT
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON012	RDY	OP	OP	OP	CL	*	*	*	CL	*	*	*	CL	*	*	*	blank

SSECON013 - UMB MN STAT indications.

UMB MN SEL P34X2068Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	D E F A U L T
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON013=	RDY	REL	REL	REL	MAT	*	*	*	MAT	*	*	*	MAT	*	*	*	blank

SSECON014 - UMB B/U STAT indications.

UMB B/U SEL P34X2069Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	D E F A U L T
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON013=	RDY	REL	REL	REL	MAT	*	*	*	MAT	*	*	*	MAT	*	*	*	blank

SSECON021 - BSP STAT indications.

BSP SEL P34X2070Y	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	D E F A U L T
MSB PRI(A) LAT P34X2087Y	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	
MSB SEC(B) LAT P34X2088Y	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1	
MSB PRI(A) REL P34X2089Y	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1	
MSB SEC(B) REL P34X2090Y	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	
SSECON021=	RDY	REL	REL	REL	SET	L/A	*	*	SET	*	L/A	*	SET	*	*	L/A	blank

SSECON022 - This comp indicates the status of the BSP retracted switches.

BSP RET A P34X2105Y	0	1	0	1
BSP RET B P34X2102Y	0	0	1	1
SSECON022 =	blank	RETA	RETB	RET*

SSECON023 - This comp indicates the status of the BSP engaged switches.

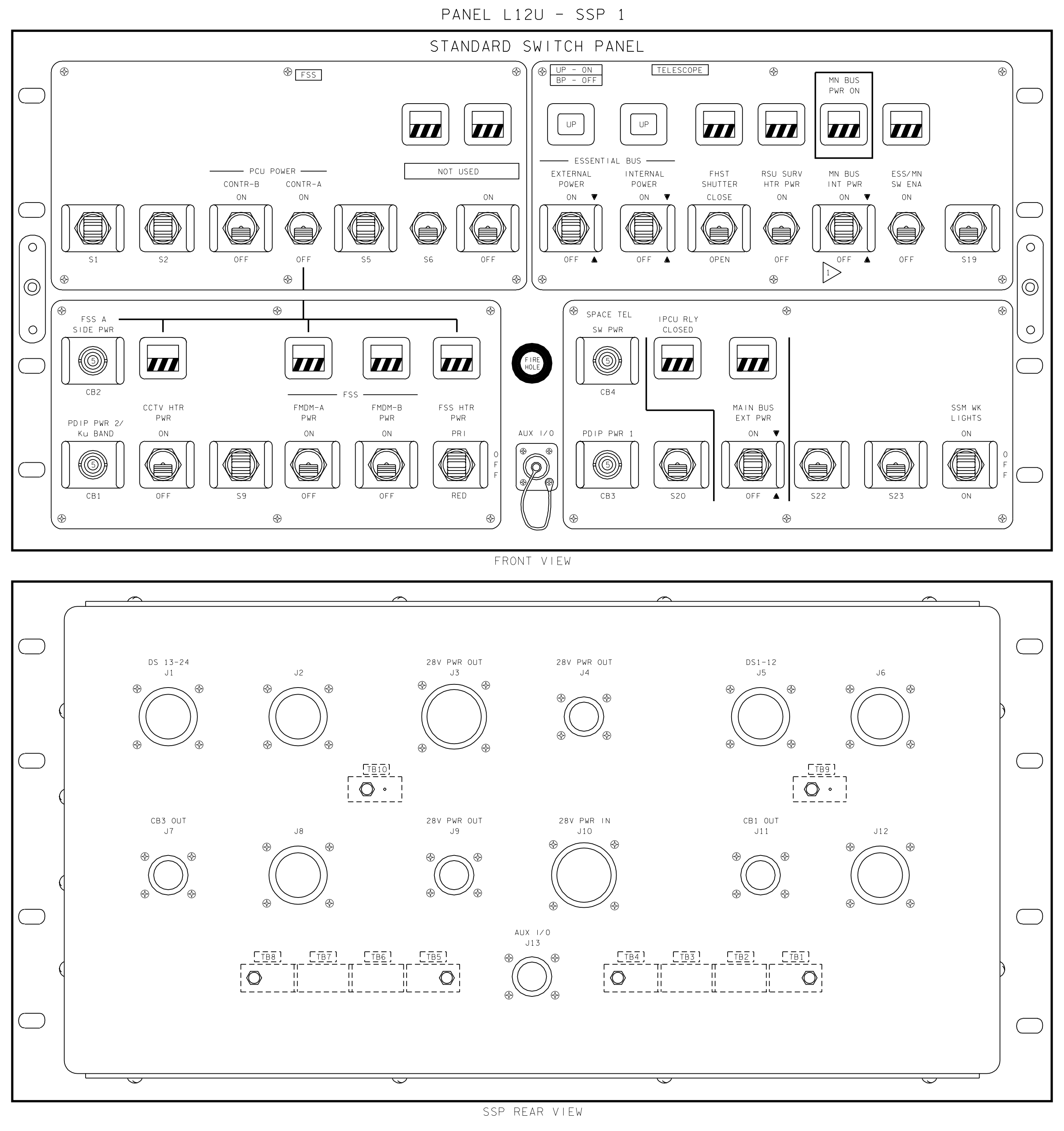
BSP ENG A P34X2106Y	0	1	0	1
BSP ENG B P34X2103Y	0	0	1	1
SSECON023 =	blank	ENGA	ENGB	ENG*

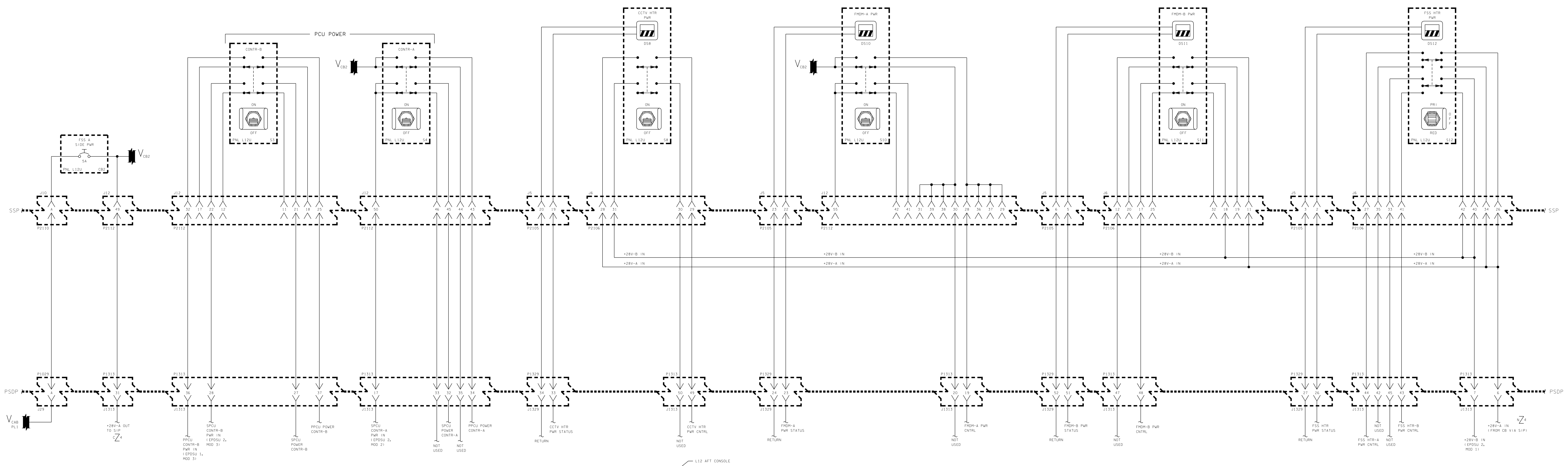
SSECON024 - This comp indicates the status of the BSP disengaged switches.

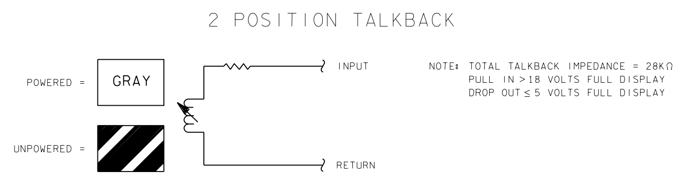
BSP DIS A P34X2107Y	0	1	0	1
BSP DIS B P34X2104Y	0	0	1	1
SSECON024 =	blank	DISA	DISB	DIS*

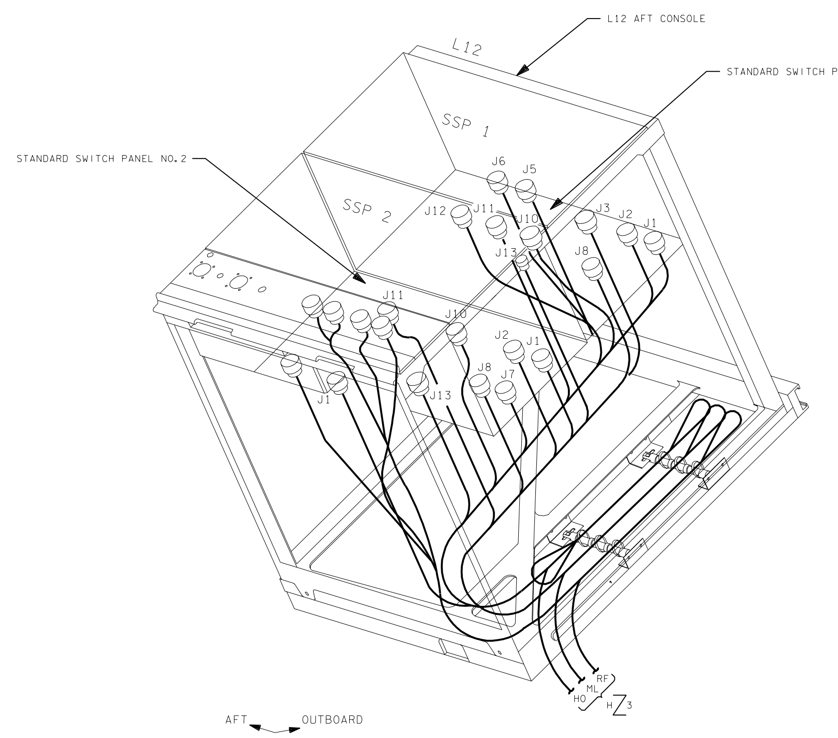
DATE: 01/24/02	NAME: MDU	VERSION: REL.6

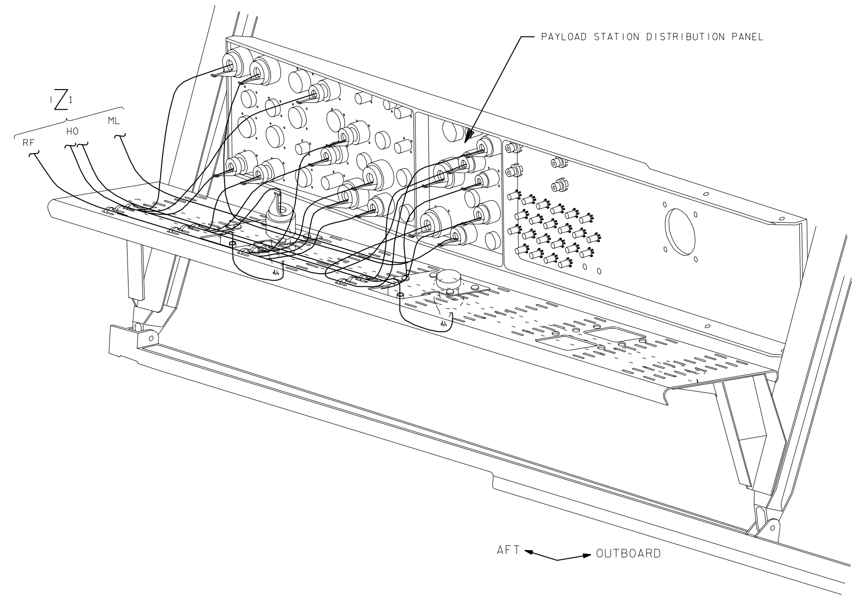
DATE: 12/07/01	NAME: VSH	VERSION: CHK.5
DATE: 01/17/02	NAME: LAM	VERSION: REL.5
DATE: 01/24/02	NAME: MDU	VERSION: REL.6











3. REFERENCE VS72-200186

2. COMPONENT DESIGNATORS (E.G. S9) ARE SHOWN FOR REFERENCE ONLY AND ONLY THOSE FOR UNUSED SWITCHES AND CIRCUIT BREAKER WILL APPEAR ON THE ACTUAL PANEL OVERLAY

NOTES: 1 MN BUS INT PWR SWITCH IS SWITCHGUARD PROTECTED

1 FSS SSP

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN M. GILLESPIE	1/28/93		
DR		FSS STANDARD SWITCH PANEL	
ENGR T. McCRACKEN			
ENGR			
APP			
APP		HST SSE CSM	DWG NO 6.1
CADS		STS-109	
LTR	PCN	104.5 X 34	SHEET 1 OF 4

USA001948

PANEL L12U - SSP 1
STANDARD SWITCH PANEL NO.1
FRONT VIEW
SSP REAR VIEW
ESSENTIAL BUS
3 POSITION TALKBACK
2 POSITION TALKBACK
NOTES: 1 HST UNIQUE HARNESS
2 DS17 INDICATES GRAY WHEN MAIN BUS IS POWERED, REGARDLESS OF SOURCE
1 HST SSP 2
SIGNATURE
DATE
DSGN B. TEDDER, JR. 4/24/86
DR
ENGR T. McCRACKEN
ENGR
APP
APP
CADS
LTR
PCN
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
HST STANDARD SWITCH PANEL
HST SSE CSM
STS-109
126.5 X 34
DWG NO 6.1
SHEET 2 OF 4
USA001948

3. B-SIDE POWER IS FROM PL PRI BUS. SWITCHES DO NOT REQUIRE PNL CB PWR

2. REFERENCE VS72-200153 SHEET 13

NOTES: 1. COMPONENT DESIGNATORS (E.G. S9) ARE SHOWN FOR REFERENCE ONLY AND ONLY THOSE FOR UNUSED SWITCHES AND CIRCUIT BREAKER WILL APPEAR ON THE ACTUAL PANEL OVERLAY

1 MULE/KEEL CMR SSP 3

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS	
DSGN B. BOWEN	04/22/96		
DR		MULE/KEEL CAMERA STANDARD SWITCH PANEL	
ENGR T. MCCRACKEN			
ENGR			
APP			
APP		HST SSE CSM	DWG NO 6.1
CADS		STS-109	
LTR / PCN		126.5 X 34	SHEET 3 OF 4

USA001948

USA001948

3. B-SIDE POWER IS FROM PL PRI BUS. SWITCHES DO NOT REQUIRE PNL CB PWR

2. REFERENCE VS72-200153 SHEET 13

NOTES: 1. COMPONENT DESIGNATORS (E.G. S9) ARE SHOWN FOR REFERENCE ONLY AND ONLY THOSE FOR UNUSED SWITCHES AND CIRCUIT BREAKER WILL APPEAR ON THE ACTUAL PANEL OVERLAY

1 SAC/PSP BY-PASS SSP 4

SIGNATURE	DATE	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION LYNDON B. JOHNSON SPACE CENTER HOUSTON, TEXAS
DSGN B. BOWEN	04/22/96	
DR		SECONDARY AXIAL CARRIER/PSP BY-PASS STANDARD SWITCH PANEL
ENGR M. DIBENEDETTO		
ENGR		
APP		
APP		HST SSE CSM — DWG NO 6.1
CADS		STS-109
LTR / PCN		126.5 X 34 — SHEET 4 OF 4

7.0 SSE OPERATIONAL CONSTRAINTS AND PREVIOUS ANOMALIES

The following section is designed to allow the console operator quick access to any operational constraints and information on any previous anomalies. This will allow for better judgment realtime.

7.1 OPERATIONAL CONSTRAINTS

Operational constraints for STS-109 will consist of both software-controlled items and things that the flight controllers must be aware of during the mission. These constraints are in place to ensure safe mission operations.

7.1.1 SA-IIs deployed

The following are the FSS rotational constraints due to structural interference with the orbiter:

a. Solar arrays at 0° and the FSS at 90°, rotations of ±25° from ±V3 forward are acceptable

b. Solar arrays at 0° and the FSS at 90°, rotations of ±20° from ±V2 forward are acceptable

c. Solar Arrays at 90° and the FSS at 90°, rotations of ±35° from ±V3 forward are acceptable

d. For FSS at 75°, the Table 7-1 and Table 7-2 show the constraints for the solar array positioning

Table 7-1. SA-II allowable positions based on SADE-1 Telemetry

	ALLOWABLE SA-II POSITION (DEGREES)	
FSS ROTATOR RANGE (DEGREES) WHEN FSS PIVOTED TO 75 DEGREES	MIN/NOMINAL/MAX +V2 WING	MIN/NOMINAL/MAX -V2 WING
90 - 360 - 305	-40 / 0 / +6	-40 / 0 / +6
295 - 270	-40 / 0 / +6	-40 / 0 / +6
90 - 180 - 270	-6 / 0 / +40	-6 / 0 / +40
305 - 360 - 90 - 180 - 270 - 295	-6 / 0 / +6	-6 / 0 / +6

Table 7-2. SA-II allowable positions based on SADE-2 Telemetry

	ALLOWABLE SA-II POSITION (DEGREES)	
FSS ROTATOR RANGE (DEGREES) WHEN FSS PIVOTED TO 75 DEGREES	MIN/NOMINAL/MAX +V2 WING	MIN/NOMINAL/MAX -V2 WING
90 - 360 - 305	-42 / -2 / +4	-38 / +2 / +8
296 - 270	-42 / -2 / +4	-38 / +2 / +8
90 - 180 - 270	-8 / -2 / +38	-4 / +2 / +42
305 - 360 - 90 - 180 - 270 - 295	-8 / -2 / +4	-4 / +2 / +8

A FSS BAPS rotation or pivot must be followed with a 4 minute wait period before the next rotate or pivot to allow the solar motion to dampen.

The FSS BAPS pivoter will not nominally be operated while the rotator is within ±45° of the ±V2 forward position, due to the 2 inch screening criteria for SA-II bistem tip deflections.

Nominal BAPS pivoter operations are constrained to 90° to 75° with the solar array positions constrained to 0° (±3.5 deg) due to predicted tip displacements in excess of 2 inches.

7.1.2 SA3s deployed

The following are the FSS rotational constraints due to structural interference with the orbiter:

For the solar arrays at 0° and the FSS at 90°, there are no clearance issues.

For the solar arrays at 90° and the FSS at 90°, rotations of ±78° from ±V3 forward are allowed.

For the FSS at 75°, there are no clearance issues.

Table 7-3 shows the allowable FSS rotations with the SA3s deployed.

FSS rotational constraints due to structural interference with the orbiter are shown in Table 7-3.

Table 7-3. Allowable FSS rotations for SA3

FSS PIVOT/NOMINAL ROTATE	SA3 ACTUAL POSITION (DEGREES)	FSS ROTATE RANGE (DEGREES)
90 / 180 FWD	-3.5 / 0/ +3.5	NO CLEARANCE CONCERNS
90 / 360 FWD	-3.5 / 0/ +3.5	NO CLEARANCE CONCERNS
90 / 90 FWD	-3.5 / 0/ +3.5	NO CLEARANCE CONCERNS
90 / 270 FWD	-3.5 / 0/ +3.5	NO CLEARANCE CONCERNS
90 / 180 FWD	+86.5 / +90/ +93.5	102 - 258
90 / 360 FWD	+86.5 / +90/ +93.5	305 - 78

7.1.3 FSS Mechanisms

For the FSS Mechanisms, the following constraints apply:

a. Any mechanism operation will be immediately halted for an SM ALERT, in order to prevent the driving of two mechanisms at one time. This is the only software controlled operational constraint.

b. The BAPS shall not be pivoted up from 43.8° with the BSP latched or the center pip-pins installed.

c. The BAPS shall not be pivoted down from 90° with the BSP center pip-pins installed

d. No mechanism shall be powered longer than 30 seconds after movement has stopped:

    1. The rotator and pivoter have tachometer telemetry available via SPEC 212, and an FDA will alert the crew of a stalled rotator or pivoter

    2. For all others or if a tachometer fails, motion is verified via visual observation.

e. The pivoter will not be operated nominally in high torque mode without full concurrence of the SSE Team.

7.2 PREVIOUS ANOMALIES

This section describes all previous SSE anomalies and the outcome of the situation. This section also details the preflight hardware problems and resolutions.

7.2.1 STS-31

During the Deploy mission, STS-31, no SSE Anomalies were seen.

7.2.2 STS-61

During the first Servicing Mission, STS-61, the Radial Science Instrument Protective Enclosure (RSIPE) A Latch lights did not function during the removal of the Wide Field Planetary Camera (WFPC). There was no impact, as the ground telemetry verified the Latched/Unlatched status. The WFPC-I was successfully removed and WFPC-II was successfully installed in the RSIPE, with ground telemetry verifying the A Latch Seated Status.

Also during STS-61, DPC 5 hard failed during transfer of HST to external power. The DPC voltage dropped from 31.5v to 0.2 v, and the current was less than 0.3 Amps. DPC 5 never picked up the Telescope load. The mission was continued with nominal operations without DPC 5, as mission requirements were only for 8 of 12 DPCs.

7.2.3 STS-82

During STS-82, the second Servicing Mission, the HST Customer expressed concern that the retracted Translation Aids (TAs) would interfere with payload bay door closure if not fully retracted and stowed. During EVA 5 on Flight Day 8, the EVA crew positioned the TAs within the Payload Bay Door Envelope.

7.2.4 STS-103

On STS-103, Servicing Mission 3A, the SSE equipment saw temperatures above the Flight Rule limits on the COPE Lid. This was due to excessive sunlight on the lid. The resolution was to maneuver the Shuttle to a benign attitude.

Also during STS-103, the Rate Sensing Unit (RSU)-2 that was replaced during the Servicing Mission did not fully seat back into its Transport Module (TM). A partially exposed RSU-2 prevented closure of the TM lid. This violated a flight rule. The crew revisited the TM, made additional attempts to fully seat RSU-2 inside the TM, and was successful in reseating the RSU in the TM. The TM lid was latched, meeting the safe-to-land criteria.

7.2.5 STS-109

During the STS-109, SM 3B, preflight testing, three anomalies were found.

7.2.5.1 FSS TVAC

The pivoter on the FSS successfully completed 4 cycles of system level Thermal Vacuum (TVAC) testing. The BAPS post exhibited higher than normal retraction force during post TVAC manual retraction. The BAPS post was re-worked and 2 additional FSS system level TVAC cycles were conducted to qualify the post for flight. The pivoter CDU stalled unexpectedly while pivoting up during FSS/BAPS post TVAC testing. The CDU stalled 4° short of reaching the 90° position during the second (final) cold cycle. The BAPS post was removed, and the pivoter operated nominally. Initially conclude the post was the problem. The pivoter

CDU rate and current draw were erratic while pivoting down, without the post. The investigation included the BAPS post, the pivoter CDU, the Electrical Ground Support Equipment (EGSE), the Mechanical GSE (MGSE), the pivoter journal bearings and interfaces, the pivoter mechanism, the ground operations and test setup, and contamination. Verification of test data, setup, procedures and documentation eliminated the EGSE and the MGSE setup. Contamination was evaluated during all phases of inspection.

The BAPS post was eliminated from the investigation due to reoccurrence of stall conditions at ambient, without the post installed. The post was re-inspected, and re-tested and was approved for flight.

The CDU was replaced with a flight spare, and the pivoter repeated erratic behavior, with the post, during ambient testing. The flight CDU was sent back to the manufacturer to repeat Acceptance Testing. The flight CDU was re-installed onto the pivoter and is acceptable for flight.

The pivoter tower bushing and the journal bushing were inspected and both were nominal; however, the dry film coating on the thrust plates was found to be worn. The abrasions were buffed out and the thrust plates were replaced. These abrasions were insufficient to provide the force required to stall the CDU.

The pivoter was sent to the manufacturer for complete inspection, with no obvious damage to the components or debris found. Minor spalling was discovered on one of the planet gears; however, gears were acceptable for flight. The hardware was reassembled and retested in an attempt to recreate the anomaly. During ambient testing 5.5 pivot cycles were successfully performed in clean room testing and 5.5 cycles were completed successfully in TVAC testing. Anomaly could not be repeated and all data was nominal. The following parts were replaced as risk mitigation: ball bearings between housing and output gear, both pinion gear bearings, all idler gear bearings, and the planet gear spindles. The thrust needle bearing was fully inspected and found to be in good condition.

Pivoter was retested with a new test stand fixture, and functioned properly. The FSS underwent requalification testing in TVAC. Refurbished pivoter with new test fixture was tested in the TVAC 24 times, 12 with BAPS post, 12 without BAPS post. The anomaly was determined to be a product of the non-realistic 1-G loads that will not be present in 0-G on-orbit environment.

7.2.5.2 TVAC BSP

The BAPS post would not retract during the manual retraction following the post TVAC Comprehensive Performance Test (CPT). The post jammed in the extended position, with a required retraction force of 12 lbs (twice the expected). The post was disassembled and 2 bearing pellets appeared to be slightly worn. The pellets were determined to be burnished, but the wear patterns were not unusual. Modeling indicated that the wear was great enough the pellets would catch on the internal edge of the outer tube and cause the post to stall. Spare flight quality pellets (with ramps machined into one end) were installed to prevent binding. The post was rebuilt and tested and now operates as well as, if not better than, before. Post was manually extended and retracted 3 times with no anomalies observed.

7.2.5.3 FSS FMDM Wiring

During the SM 3B, STS-109, preflight assembly of the FSS, the Heater current wiring was incorrectly connected to the FMDMs. This forces the flight controller to look at different telemetry. Namely for the 1B Heater current, the 2B MSID must be used; for the 2B heater current, the 2A MSID must be used; and for the 2A heater current, the 1B MSID must be used.

APPENDIX A
ACRONYM LIST

A/D	Analog-to-Digital
AC	Alternating Current
ACP	Astronaut Control Panel
ACS	Advanced Camera for Surveys
ACTR 5	Actuator 5
AFD	Aft Flight Deck
AID	Analog Input Differential
AKA	Active Keel Actuator
ALC	Automatic Light Control
AMSB	Advanced Mechanism Selection Box
APE	Auxiliary PFR Extender
ASIPE	Axial Science Instrument Protective Enclosure
ASLR	Aft Shroud Latch Repair
ATM	Auxiliary Transport Module
BAPS	Berthing and Positioning System
BAR	Berthing Assist and Restraint
BITE	Built-In Test Equipment
BOT	Beginning of Travel
BSP	BAPS Support Post
BSR	BITE Status Register
BTU	Bus Terminal Unit
CAB	Cabin
CASH	Cross Aft Shroud Harness
CAT	Crew Aids and Tools
CCTV	Closed Circuit Television
CDU	Common Drive Unit
CEP	Containment Environmental Package
CNTL	Control
COPE	Contingency ORU Protective Enclosure
CPC	Cyro Port Cover
CPT	Comprehensive Performance Test
CPUA	Clamp Pickup Assembly
CRES	Corrosion-Resistant Steel
CSM	Cargo Systems Manual
CSS	Center Support Structure
DBA	Diode Box Assembly
DBC	Data Bus Coupler
	Diode Box Controller
DC	Direct Current
DI/DO	Discrete Input/Discrete Output

DIH	Discrete Input High
DIL	Discrete Input Low
DOF	Degree of Freedom
DOH	Discrete Output High
DOL	Discrete Output Low
DPC	Direct Power Converter
DPST	Double Pole, Single Throw
D/R	Deploy/Return
ECU	Electronic Control Unit
EGSE	Electrical Ground Support Equipment
EMU	Extravehicular Mobility Unit
ENA	Enable
EOT	End of Travel
EPDSU	Enhanced Power Distribution and Switching Unit
EPDU	Electrical Power Distribution Unit
ESM	Electronic Support Module
ESS	Essential
EURM	Emergency Umbilical Retract Mechanism
EVA	Extra-Vehicular Activity
EXT	External
FD	Flight Day
FDA	Fault Detection/ Annunciation
FGS	Fine Guidance Sensor
FHST	Fixed Head Star Tracker
FMDM	Flexible Multiplexer/Demultiplexer
FOC	Faint Object Camera
FSS	Flight Support Structure
FWD	Forward
FXC	Forward X-Constraint
GPC	General Purpose Computer
GSE	Groundt Support Equipment
GSFC	Goddard Space Flight Center
HOST	Hubble On-Orbit Space Test
HPGSCA	HST Payload General Support Computer Assembly
HRD	Harness Restraint Device
HST	Hubble Space Telescope
HTR	Heater
I/F	Interface
I/O	Input/Output
ICD	Interface Control Document
IND	Indicator
IOM	Input/Output Module

IPCU	Interface Power Control Unit
IVA	Intravehicular Activity
J-BOX	Junction Box
JSC	Johnson Space Center
L/A	Latch Assist
LAT	Latch
LIS	Load Isolation System
LOPE	Large ORU Protective Enclosure
LPS	Light and Particle Shield
LRU	Line Replaceable Unit
MCA	Motor Control Assembly
MCC	Mission Control Center
MDI	Magnetically Damped Isolator
MDM	Multiplexer Demultiplexer
MET	Mission Elapsed Time
MGSE	Mechanical Ground Support Equipment
MIA	Multiplexer Interface Adapter
MLI	Multilayer Insulation
MMC	Mid-Motor Controller
MMCA	Mid Motor Control Assembly
MNA	Main A
MNB	Main B
MOD	Mission Operations Directorate
MOPE	Multi-Mission ORU Protective Enclosure
MSID	Measurement Stimulus Identification
M-STRUT	magnetic strut
MULE	Multi-Use Lightweight Equipment
NASA	National Aeronautics and Space Administration
NBL	Neutral Buoyancy Lab
NCC	NICMOS CryoCooler
NCS	NICMOS Cooling System
NICMOS	Near Infrared Camera and Multi-Object Spectrometer
NOBL	New Outer Blanket Layer
NRZ-L	Non-Return-to-Zero Level
NSTS	National Space Transportation System
NT	NOBL Transport System Transporter
OPA	ORU Plate Assembly
ORB	Orbiter
ORU	Orbital Replacement Unit
ORUC	Orbit Replacement Unit Carrier

PA	Pallet Assembly
PBM	Payload Bay Mechanical
PCM	Pulse-Code Modulation
PCN	Page Change Notice
PCU	Power Control Unit
	Power Conditioning Unit
PDI	Payload Data Interleaver
PDIP	Payload Data Interface Panel
PDRS	Payload Deployment and Retrieval System
PDSU	Power Distribution and Switching Unit
PE	Protective Enclosure
PFR	Portable Foot Restraint
PGT	Pistol Grip Tool
PI	Payload Interrogator
PL	Payload
PLB	Payload Bay
PLBD	Payload Bay Door
POH	Pulse Output High
PPCU	Port Power Conditioning Unit
PRB	Preload Release Bracket
PRCS	Primary Reaction Control System
PRLA	Payload Retention Latch Actuator
PROM	Programmable Read-Only Memory
PRT	Power Ratchet Tool
PSP	Payload Signal Processor
PWR	Power
RAC	Rigid Array Carrier
REL	Released
RF	Radio Frequency
RL	Retention Latch
RMS	Remote Manipulator System
RSIPE	Radial Science Instrument Protective Enclosure
RSU	Rate Sensing Unit
RWA	Reaction Wheel Assembly
SA	Solar Array
SAC	Second Axial Carrier
SADA	Solar Array Drive Adapter
SADM	Solar Array Drive Mechanism
SAP	SAC Adaptor Plate
SCU	Sequence Control Unit
SI	Science Instrument
SIP	Standard Interface Panel
SLP	SpaceLab Pallet

SM	Servicing Mission
	Systems Management
SMEL	Servicing Mission Equipment List
SOPE	Small ORU Protective Enclosure
SORU	Small Orbital Replaceable Unit
SPCU	Starboard Power Conditioning Unit
SSE	Space Support Equipment
SSP	Standard Switch Panel
SSPC	Solid State Power Controller
SSSH	Space Shuttle Systems Handbook
STBD	Starboard
STOCC	Space Telescope Operations Control Center
STS	Space Transportation System
SURV	Survival
TA	Translation Aid
tb	talkback
TM	Transport Module
TVAC	Thermal Vacuum
UA	Umbilical Actuator
UARS	Upper Atmospheric Research Satellite
UASE	UARS Airborne Structure Equipment
UDM	Umbilical Disconnect Mechanism
UPS	Under Pallet Storage
USA	United Space Alliance
VCU	Video Control Unit
VIK	Voltage Improvement Kit
WFPC	Wide Field Planetary Camera
WRKLT	Worklight

APPENDIX B
FMDM SYSTEM DESCRIPTION

B.1 FNMDM COMPONENTS

The principal elements of the FMDM, as shown in Drawing 2.4-1, Drawing 2.4-2 or Drawing 3.2, include the Multiplexer Interface Adapter (MIA), Sequence Control Unit (SCU), Analog-to-Digital (A/D) converter, and the Input/Output Modules (IOMs).

The MIA is a bidirectional communication link between the SM GPC and the FMDM, which encodes and decodes the data between the payload data bus and the SCU. The MIA operates as a half-duplex transmitter or receiver, so receiving and transmitting functions are performed over a single data bus (see Figure B-1).

The GPC communicates with the FMDM using 28-bit words formatted as shown in Figure B-2. The first three bits of each word comprise the sync code. Upon receipt of a valid sync code from the data bus, the MIA begins to decode the remainder of the word from a Manchester II format to a Non-Return-to-Zero Level (NRZ-L).

Following decoding, each bit is then shipped sequentially to the SCU. The SCU uses the information contained in the next 25 bits to control the operations of the MIA, as well as the other FMDM components. Following decoding, the MIA generates error flags in response to detected errors in parity, errors in the number of bit counts, or invalid Manchester codes. The presence of any one of these error flags will cause the FMDM to stop processing and discard the rest of the data.

In the transmit mode, the MIA receives the data from the SCU, generates the sync code, encodes the data to a Manchester II format, and transmits the data over the payload data bus. It should be noted that for the MIA to enter the transmit mode, the appropriate command word must be received and decoded, instructing the SCU to configure the MIA to transmit. The GPC software is programmed to issue the requests to read the FMDM status and parameters at regular intervals and is referred to as GPC polling.

The SCU is the heart of the FMDM. The SCU controls the flow of data between the payload data bus and the IOMs and all the internal operations of the FMDM and provides internal timing. The SCU receives serial NRZ-L 25-bit messages from the MIA and converts the message into control signals for the operations of the IOMs, the MIA, and the A/D converter. Similarly, the SCU accepts information from the IOMs or the A/D converter and formats the data into serial response data words for transmission through the MIA to the GPC. All SCU operations are controlled by microprograms stored in the control store memory, which is a 512-word by 50-bit Programmable Read-Only Memory (PROM) within the SCU. These microprograms are selected and executed by the appropriate fields in the command word (Figure B-2).

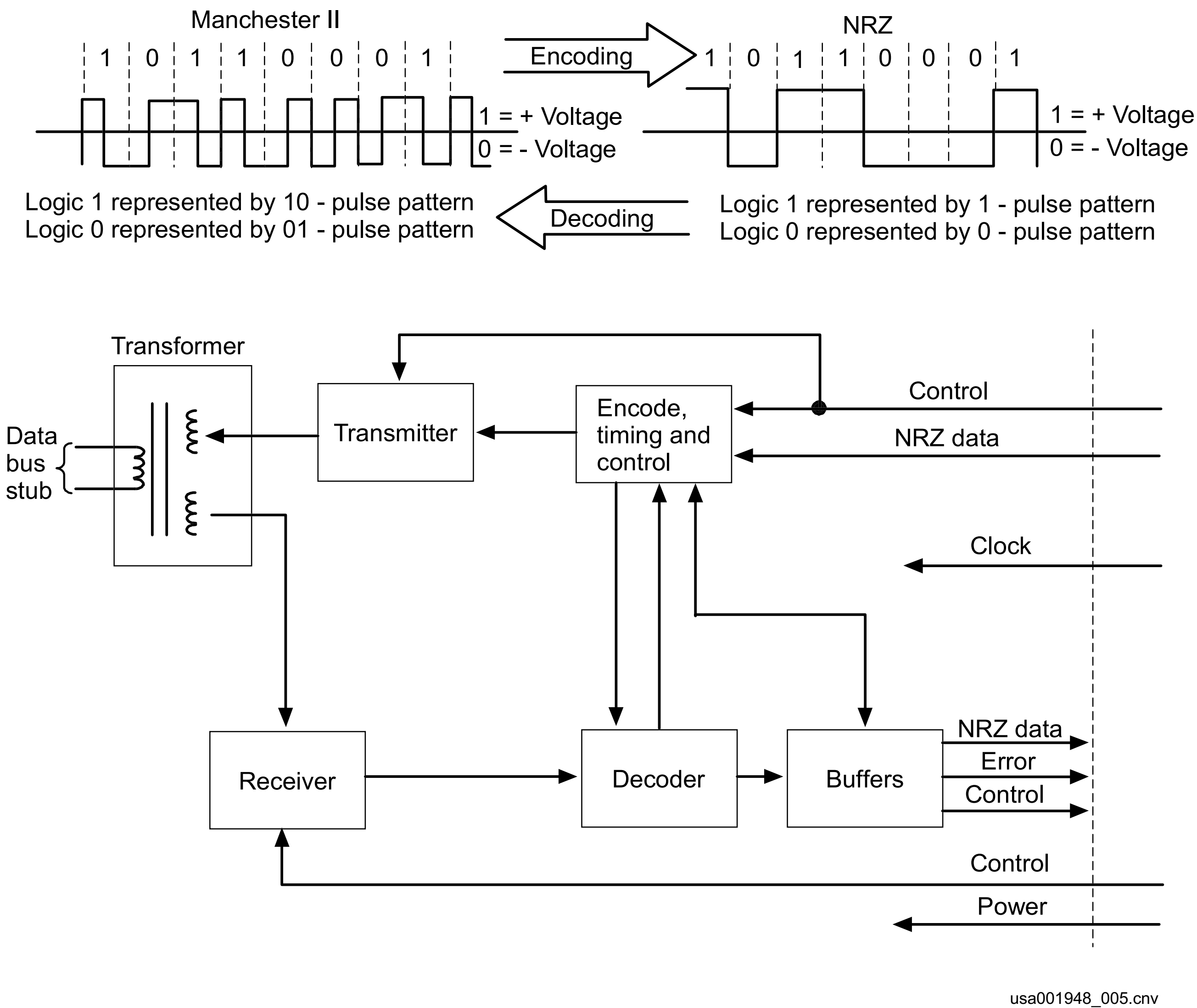


Figure B-1. FMDM MIA functional diagram

After the MIA receives a sync code, it begins decoding each bit and routing it serially to the SCU. The SCU first checks the 5-bit address code by comparing it to the hardwired pattern. If the bit patterns do not match, the SCU commands the MIA to halt its decoding, and no further processing of the data will occur until the next sync code is detected. If the address is correct and no errors are detected by the MIA, the SCU reads the control field and addresses to properly configure the FMDM for operation.

The A/D converter transforms analog input signals received by the IOMs from the SSE into digital form and transmits the converted data to the SCU. The A/D converter accepts input signals in the range of +5.11 to -5.12 V dc. This input voltage is then represented by a 10-bit digital word that is sent to the SCU, where it is formatted and transmitted to the MIA. An example of an analog measurement is the input from a temperature sensor on the SSE.

COMMAND WORD FORMAT: DIRECT MODE

CMD SYNC	MDM ADDRESS	S	MODE CONTROL	IOM ADDRESS	INITIAL CHANNEL	NUMBER OF WORDS	P
1 3	4 8	9					

MODE CONTROL = 0100 - RECEIVE COMMAND DATA
0101 - TRANSMIT RESPONSE DATA

COMMAND WORD FORMAT: INDIRECT MODE

CMD SYNC	MDM ADDRESS	S	MODE CONTROL	PROM SEQUENCE START ADDRESS	NUMBER OF PROM INSTR	P
1 3	4 8	9				

MODE CONTROL = 0010 - EXECUTE THE NUMBER OF PROM INSTRUCTIONS
BEGINNING AT PROM START ADDRESS

COMMAND DATA WORD FORMAT

DATA SYNC	MDM ADDRESS	DATA	CHECK	P
1 3	4 8	9		

RESPONSE DATA WORD FORMAT

DATA SYNC	MDM ADDRESS	DATA	S	E	V	P
1 3	4 8	9				

MDM ADDRESS = 11101
S= 1 - NOMINAL OPERATION
0 - IOM OUTPUTS HAVE BEEN RESET TO 0 DUE TO A POWER TRANSIENT
E= 0 - NOMINAL OPERATION
1 - ERROR ON SERIAL INPUT
V= 1 - NOMINAL OPERATION
0 - MDM DATA SUSPECT - INTERROGATE BITE STATUS REGISTER
P= PARITY BIT (ODD)

Figure B-2. FMDM data word format

The IOMs deliver or receive signals from the FMDM interface connectors. The FMDM can have a mixture of analog input IOMs, discrete output IOMs, discrete input IOMs, and pulsed output IOMs. The pulsed output IOMs are not used during this SM. The flight specific configuration is defined in the avionics sections for the various carriers. The description of the various IOM types follows.

a. Discrete Output High (DOH) – The DOH module groups its discrete output into three channels, each with 16 bits per channel. The high-level voltage is 28 V and the low is 0 V.

b. Discrete Input High (DIH) – The DIH module groups its discrete input into three channels, each with 16 bits per channel. The voltage levels are 28 V and 0 V.

c. Pulse Output High (POH) (not used) – The POH module outputs a 28 V, 20- to 30-millisecond pulse. The module is configured with three 16-bit channels.

d. Analog Input Differential (AID) – The AID module will accept up to 32 pairs of analog values with a range between -5.12 V and +5.11 V.

The only change in using FMDM-A or FMDM-B from the orbiter side will be the data bus. Therefore, the GPC does not differentiate which FMDM is active; it only differentiates the data bus with which it is communicating.

The FMDMs are commanded over the payload data bus by the SM GPC. The data transfer occurs in the form of two types of serial 28-bit words, command words, and command data words. The command words are retained by the SCU for internal mode control and initialization. The command data words are gated to an IOM for transmission to the SSE subsystems in the form of discretes DOH.

The various SSE telemetry is converted and formatted by the FMDM into 28-bit words for retransmission to the GPC. These words are referred to as response data words and consist of either one A/D converted 10-bit signal or 16 individual discrete signals. Response data words are transmitted by the FMDM upon GPC request. GPC polling typically occurs once per second.

B.1.1 FMDM Error Indications

The FMDMs do not generate any telemetry concerning their own status (the only telemetry parameters originating from the FMDMs are temperatures).

There are three fault indications that can alert the Mission Control Center (MCC) to possible FMDM problems and their corrections. A BCE BYPASS message usually indicates a failure of a specific card or channel. The card(s) lost may be determined by examining Measurement Stimulus Identifications (MSIDs). An Input/Output (I/O) ERROR FLEX message usually indicates a failed MIA in transmit, receive, or both. An I/O PL2 (PL1) message, in addition to an I/O ERROR FLEX message, usually indicates a PL2 (PL1) data bus problem at the GPC.

B.1.1.1 FMDM BITE Status Register

The SCU performs extensive real-time tests during FMDM input and output operations. The results of these tests are to set a bit in the Built-In Test Equipment (BITE) Status Register (BSR) if an error is detected. However, the ground will know of this error only if the BSR read command is executed from the MCC. Once the command is executed, the BSR is read, downlinked, and reset. The MCC workstation FMDM overview display, covered in Section 6, shows the explanation of the bit function, the primary conditions that cause the bit to be set, and the SCU reaction to the condition.

The uplink command, built by DPS, specifies a known operational code that informs the GPC to find the known BSR command stored in memory and to send the command to the FMDM. The mode control field 1010 is to send the BITE status register and reset the BSR (see Table B-1). If the SCU BITE test is requested, the mode control field would be 0100; for the A/D BITE test, the mode control field would be 0101; for the power supply BITE test, the mode control field would be 0110; and for the IOM BITE (BITE test 4), the mode control field would be 0111.

The FMDM response data word data portion is placed in the FMDM overview display. The FMDM display reflects the error seen in the FMDM by showing a bit set high in the corresponding field. An explanation of each of the error indications is shown in Table B-1.

The uplink command, which is built by DPS SUPPORT, is a 48-bit command with the following configuration:

Bits 1-3	-	Vehicle ID (where OV-105 is 101)
Bits 4-7	-	Major function (SM is 1000)
Bits 8-14	-	OP code for each load type (0101100 is OP code for MDM BITE data read)
Bit 15	-	Set to 1 if first command word
Bit 16	-	Set to 1 if last command word
Bits 17-20	-	4-bit binary code identifying the I/O module for BITE 4 (0-15)
Bits 21-25	-	3-fill bits (0) and a 2-bit binary code identifying the channel for BITE 4 (0-2)
Bits 26-32	-	MDM number, 7-bit binary code to address particular MDM (FLX1-BCE 10-0001101, FLX2-BCE 11-0001110)
Bit 33	-	Transfer count (0 - for BSR, for BITE 4 output card -0, input card -1)
Bits 33-44	-	All logical 0s
Bits 45-48	-	Variable parameter ID, range from 0 - 10 in decimal

Table B-1. BSR read table

BSR	Function	Set primary condition	SCU action to condition if internally generated
1	Power applied/interrupt	1. Power up 2. Power down	Bit 25 of two response words cleared if responding at time of occurrence. IOMs are reset. If power up, SCU powerup BITE must be successfully completed prior to MIA receiver enable
2	Incoming data error	1. Command or data word received with valid FMDM address and a. Nonvalid Manchester b. Bit count error c. Bad parity 2. Expected data word received with a. Nonvalid FMDM address b. Nonvalid Manchester c. Bit count error d. Bad parity e. Incorrect check pattern	
3	Operation requested on a nonexistent channel	Nonexistent channel addressed	Continue processing data. During FMDM response, the V-bit reflects this condition on a word-by-word basis
4	Unable to transfer data to/from IOM	IOM not responsive to SCU command	Continue processing data. During FMDM response, the V-bit reflects this condition on a word-by-word basis
5	Too many words in last message	More words received in a message than specified by the command word	Ignore extra data and await receipt of a new command
6	Last command not completed	New command recognized before previous command was completed	Respond to new command if FMDM is addressed and terminate operation on previous command
7	Simultaneous execution on primary and backup data bus	Both SCUs operating simultaneously	Stop processing data until receipt of a new command

Table B-1. BSR read table (concluded)

BSR	Function	Set primary condition	SCU action to condition if internally generated
8	Illegal mode commanded	Illegal or ambiguous mode has been commanded • Spare mode • Data received with no command • RCV and RSP mixed during sequence execution • Conflict between mode commanded and module class • Addressed module classed as "not present" or "spare"	Stop processing data until receipt of a new command
9	Internal error detected	The SCU has detected an internal error • Sequence memory parity • Internal FMDM buses	Stop processing data until receipt of new command or continue processing data with the V-bit reflecting the condition in the return data words
10	Gap time error	Message receive gap time outside acceptable limits (gap <4 microseconds or gap >11) microseconds	Stop processing data until receipt of a new command
11	Successful BITE completion	Commanded SCU, A/D, or power supply BITE executed successfully	Test terminated upon successful completion or failure detected. No further processing until receipt of a new command
12 - 16	BITE subtest field	Indicates progression through SCU or power supply BITE tests	Indicates last subtest completed

B.1.1.2 BITE Test 4

The FMDM BITE test 4 can be performed on any IOM card (DCIN, DOL, DOH, DIL, DIH); however, the test is most useful to the ground on the discrete output cards since the discrete inputs and DCIN (AID) are seen nominally via telemetry. The BITE 4 is seen on the FMDM display and shows the pattern sent to the Discrete Input/Discrete Output (DI/DO) module and the response back from the module.

In the DIH BITE test, two separate tests are run via an SCU microcode sequence, BITE 1 and BITE 2. For BITE 1, the IOM generates a sample data word ("true"), consisting of alternating zeros and ones. For BITE 2, or BITE complement, the IOM generates a sample data word, consisting of the opposite combination of zeros and ones. These results are returned in the 32-bit data word seen on the FMDM overview display. A different pattern is used for each of the three channels and provides added benefit for validating the DIH module channel addressing logic. The appropriate response words can be seen in Table B-2. Each DIH card has three separate channels and the test is commanded independently for each channel.

Table B-2. BITE response words for DIH

Channel number	BITE 1 (true) response word in hexidecimal	BITE 2 (complement) response word in hexidecimal	Binary pattern
0	0FF0		0000111111110000
0		F00F	1111000000001111
1	0F0F		0000111100001111
1		F0F0	1111000011110000
2	F0F0		1111000011110000
2		0F0F	0000111100001111

The DOH BITE (BITE test 4) tells the current output (active/inactive state) of the 16 discrete output lines. The actual discrete output for the entire channel is sent back to the GPC in one MDM response word. Therefore, the nominal value of the desired bilevel discrete (or discretes) must be known. The data is downlisted in hex, where the most significant bit is zero. For STS-109, DOH card 3, channels 1 and 2 are used for commands.

The DCIN (AID) BITE test generates two return words for a given channel on an IOM card, the BITE response and the channel input response. The BITE response is generated by scaling the input voltage in half and adding a reference voltage (either +2 V or -2 V, depending on which channel it is) to the scaled voltage. This word is downlinked directly to the FMDM overview display. The second word returned is the input response of the channel. Table B-3 lists which channels get +2 V added to them and which channels get -2 V added.

Table B-3. AID BITE reference voltage table

Ch 0 = +2 V	Ch 7 = -2 V	Ch 14 = -2 V	Ch 21 = -2 V	Ch 28 = -2 V
Ch 1 = -2 V	Ch 8 = -2 V	Ch 15 = +2 V	Ch 22 = -2 V	Ch 29 = +2 V
Ch 2 = -2 V	Ch 9 = +2 V	Ch 16 = -2 V	Ch 23 = +2 V	Ch 30 = +2 V
Ch 3 = +2 V	Ch 10 = +2 V	Ch 17 = +2 V	Ch 24 = +2 V	Ch 31 = -2 V
Ch 4 = -2 V	Ch 11 = -2 V	Ch 18 = +2 V	Ch 25 = -2 V	
Ch 5 = +2 V	Ch 12 = +2 V	Ch 19 = -2 V	Ch 26 = -2 V	
Ch 6 = +2 V	Ch 13 = -2 V	Ch 20 = +2 V	Ch 27 = +2 V	

Both response words are downlisted in hexidecimal. To determine if the IOM card is functional, the BITE voltage must be calculated. To calculate the BITE voltage, the hexidecimal data must be converted into decimal. The decimal value must be divided by 64 to obtain the Pulse-Code Modulation (PCM) count. The PCM count is multiplied by 10 mV, since each PCM count is 10 mV. The BITE voltage is then calculated by subtracting one-half of the response word 2's voltage from response word 1's voltage.

As an example, consider a test of FMDM card 0, channel 2. Because it is channel 2, the BITE voltage added to one-half of the input voltage will be -2 V. For this example, assume that word 1 is 0C80 and word 2 is 7D00. Word 1 converts to 3200 in decimal and word 2 converts to 32000 in decimal. By dividing each decimal value by 64, word 1 is 50 PCM counts and word 2 is 500 PCM counts. By multiplying the PCM counts by 10 mV, we find that word 1 is 0.5 V and word 2 is 5.0 V. Therefore, by subtracting one-half of word 2's voltage from word 1's voltage, the BITE voltage is -2.0 V. In this example, FMDM card 0, channel 2 is working correctly.

B.1.1.3 SCU BITE Test

The SCU BITE test performs the following:

a. FMDM receiver addressing is checked to verify response to only 1 of 32 possible MDM addresses.

b. Microprogram control store cyclic checking is verified by executing a microsequence with an incorrect cyclic check.

c. All SCU counters are loaded and tested against one another by monitoring for the presence of simultaneous overflow (underflow).

d. Command data word SEV pattern detection capability is tested through generation of invalid SEV patterns and verification that an error can be detected.

e. SCU PROM odd parity detection capability is tested by forcing bad parity.

f. The SCU register file is checked for both read/write errors and addressing errors.

g. With firmware, the following BSR bits are set to logical "1" in various subsets: BSR bits 2, 3, 4, 5, 6, 8, 9, and 10.

h. SCU OUT bus, SCU IN bus, and IOM reply lines are verified by the SCU communicating with each IOM and monitoring the IOM reply lines. The SCU checks that the IOMs will not respond to invalid check bits on the SCU OUT bus.

The SCU BITE test has no response word; thus, it is necessary to read the BSR for the response to the SCU BITE. If the test is successful, bit 11 is set in the BSR to a logical 1. If the SCU BITE is unsuccessful, bit 11 will be 0. Figure B-3 shows which bits will be set in the SCU BSR, depending on the errors found. The numbers represent the logical 1's and the "-'s" represent 0's.

SCU BITE — After requesting SCU BITE, 1.04 milliseconds must transpire before interrogating the BSR for test results.

No response to request for BSR:

1. Fatal cyclic check error
or 2. Cyclic comparator failure
or 3. FMDM receiver address comparator failure
or 4. Counter(s) failure
   a. Number of words
   b. Number of instructions
   c. State control timer

Response to request for BSR:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
–	–	3	–	5	6	–	8	–	–	–	–	–	–	–	16	Output of sequence memory parity always indicates odd parity.
–	–	3	4	5	6	–	8	–	–	–	–	–	–	–	16	Command Data Word check pattern checker recognizes bad check pattern as good.
–	–	3	4	5	6	–	8	9	–	–	–	–	–	–	16	Command Data Word check pattern checker does not recognize good check pattern.
–	–	3	4	5	6	–	8	–	–	–	–	–	–	15	–	Sequence memory parity tree failure
–	2	3	4	5	6	–	8	9	10	–	–	–	–	15	16	Register file failure a. Read write error b. Addressing error
–	2	3	4	5	6	–	8	9	10	–	–	–	–	–	–	Module interface test: 1. Addressed module responds to bad check bits or 2. Addressed module reply line always asserted or 3. Addressed module not powered If SCU BITE is repeated without cycling FMDM power, bits 3 and 4 will not be set if the addressed module reply line is always asserted or if the addressed module is not powered (2 and 3 above).
–	2	3	4	5	6	7	8	8	10	11	12	–	–	15	16	Successful SCU BITE completion.

(Bits 10–16 of the module interface test row:) BITE TEST FIELD ≥4 — Binary address of module being addressed ignoring bit 12 (numbered 0 →15)

Figure B-3. BSR during SCU BITE

APPENDIX C
CONFIGURATION CONTROL

C.1 INTRODUCTION

C.1.1 Purpose

The purpose of this appendix is to delineate configuration control procedures for the CSM. This will ensure the proper coordination of changes and provide a record of proposed changes, rationale, and disposition.

C.2 CONFIGURATION CONTROL PROCEDURE

C.2.1 Submission of Changes

Proposed changes are solicited from any individual or any organization having a valid input. Changes should be submitted to the CSM book manager at mail code DO52, NASA/Johnson Space Center, Houston, Texas 77058.

Individuals desiring to submit a change should complete all applicable items on the Change Request Form (Figure C-1). This form should be typed or neatly printed. Additional pages may be used if the space provided is not adequate. The original completed form should then be forwarded to the CSM book manager.

C.2.1.1 Disposition of Changes

The CSM book manager will obtain formal concurrence and comments from the necessary personnel, including customer representatives. All proposed modifications to the CR will be coordinated with all necessary personnel prior to disposition.

Upon obtaining the required concurrences, the CSM book manager will present the proposed change to the appropriate section head for final disposition.

A copy of all dispositioned CRs will be retained by the CSM book manager for future reference. A courtesy copy of all approved CRs will be sent to ZC01/J. Woodall, EV12/D. Sykes, and MS3/F. W. Parker.

C.3 CSM REVISIONS/CPNs

C.3.1 Development

The CSM book manager will compile all approved changes and any typographical errors and incorporate them into a revision or CPN to the document.

Pen and ink changes may be used to correct typographical errors if there are no other changes on the page concerned.

C.3.2 Approval

Any revisions/CPNs to the document will be approved by the appropriate section head. Revisions/CPNs to the final versions will also be approved by the manager of the Space Shuttle Systems Integration Office.

C.3.3 Publication

Revisions/CPNs will be made on an as-required basis. Revisions/CPNs will be printed and distributed to the standard distribution list.

NASA - JOHNSON SPACE CENTER
CHANGE REQUEST FORM

NUMBER:__________

SECTION(S) AFFECTED:

WAS:

IS:

RATIONALE FOR CHANGE:

ORIGINATOR	CONCURRENCE
NAME ____________	LEAD PAYLOAD OFFICER ____ DATE
ORGANIZATION ____________	
TELEPHONE ____________	CUSTOMER REPRESENTATIVE ____ DATE
BOOK MANAGER	☐ APPROVED ☐ DISAPPROVED
NAME ____________ DATE	☐ APPROVE WITH CHANGES
RECOMMENDATION: ____________	
INCORPORATED: ____________ DATE	SECTION HEAD ____ DATE

Figure C-1. Change Request Form