

## Space Flight Operations Contract

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# Audio/UHF Training Manual AUD/UHF 21002

March 17, 2006

**Final Version**

**This document has been reviewed and updated.  
No subsequent updates to this document are anticipated or required  
due to the approaching shuttle program closure.**

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**Audio/UHF Training Manual  
AUD/UHF 21002**

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## PREFACE

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This material is for training purposes only and should not be used as a source of operational data. All numerical data, display, and checklist references are intended only as examples. To determine any prerequisites before using this document, consult the applicable Certification Plan. For shuttle manuals, consult the Flight Operations Support Personnel Training Guide (Blue Book) or the Crew Training Catalog. For Space Station manuals, consult the appropriate Space Station Certification Training Guide or Training Administration Management System (TAMS). The applicable training package should be studied before attending any classroom session or lesson for which this is a prerequisite.

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## 1.0 INTRODUCTION

The goal of this series of training manuals is to prepare the reader to perform onboard procedures associated with the Space Shuttle Communications (COMM) system. Figure 1-1 is a simplified diagram of the various COMM subsystems and interfaces of the orbiter. Each block in the figure represents a training manual that is dedicated to that particular subsystem.

The space shuttle COMM system is more than a link for the transfer of voice. The orbiter COMM system also accommodates the transfer of telemetry, commands, and documents. Onboard the orbiter, the transfer of this information takes place through Hardline (HL) and/or Radio Frequency (RF) links. HL refers to the transfer of information through wires connecting the COMM devices; RF is the transfer of information via a radio signal.

The COMM system of the orbiter consists of three main RF ground links, which are Space Tracking and Data Network (STDN), Space Ground Link System (SGLS), and Tracking and Data Relay Satellite System (TDRSS). Figure 1-1 illustrates all three systems. The STDN and SGLS sites support COMM via S-band Phase Modulation (S-Bd PM), and S-band Frequency Modulation (S-Bd FM). The STDN sites also support COMM via Ultrahigh Frequency (UHF). The STDN sites are owned by the National Aeronautics and Space Administration (NASA), and SGLS sites are owned by the military. TDRSS supports the Ku-band (Ku-Bd) and S-Bd PM COMM systems.

The S-Bd PM system is an Uplink/Downlink (UL/DL) source; telemetry and commands are sent and received through this system via TDRSS or STDN/SGLS sites. The S-Bd FM system is a downlink (only) RF link to a ground site. The S-Bd FM system allows the downlink of payload data, orbiter data, or TV signals.

The "S-band COMM/IN" block in Figure 1-1 represents the S-Bd PM system, Network Signal Processor (NSP), instrumentation, recorders, and S-Bd FM system and their interfaces. The operation of these systems is discussed in the S-band COMM 21002 Training Manual.

The Ku-band system is another path through which the crew achieves two-way COMM with the Mission Control Center (MCC). In contrast to S-band PM and FM, the Ku-band system does not have STDN or SGLS site coverage. The Ku-band system has more channels (three) and a greater data capacity with which to downlink Closed-Circuit Television (CCTV), payload data, and other telemetry. Ku-band is limited to on-orbit operations and the TDRSS. The Ku-band system is also used as a radar system during rendezvous and proximity operations. The KU OPS 21002 Training Manual covers operations and limitations of the system.

There are two UHF systems on the orbiter. The UHF SPLX system provides two-way communication with a ground site. The system is used as backup to the S-band PM for voice communications during ascent and entry. The other UHF system, the Space to Space Orbiter Radio (SSOR), provides COMM between the Extravehicular Activity

(EVA) astronauts, the orbiter, and the International Space Station (ISS). The audio system is the main source for the transfer of voice, Caution and Warning (C&W), and Tactical Air Navigation (TACAN) tones/alarms onboard the orbiter and to the MCC, ISS, Spacehab, and EVA astronauts. Both the audio and UHF Simplex system are explained in this Audio/UHF 21002 Training Manual. The SSOR is fully explained in the Extravehicular Activities Space-to-Space Communication System Training Workbook (EVA SSCS 21002).

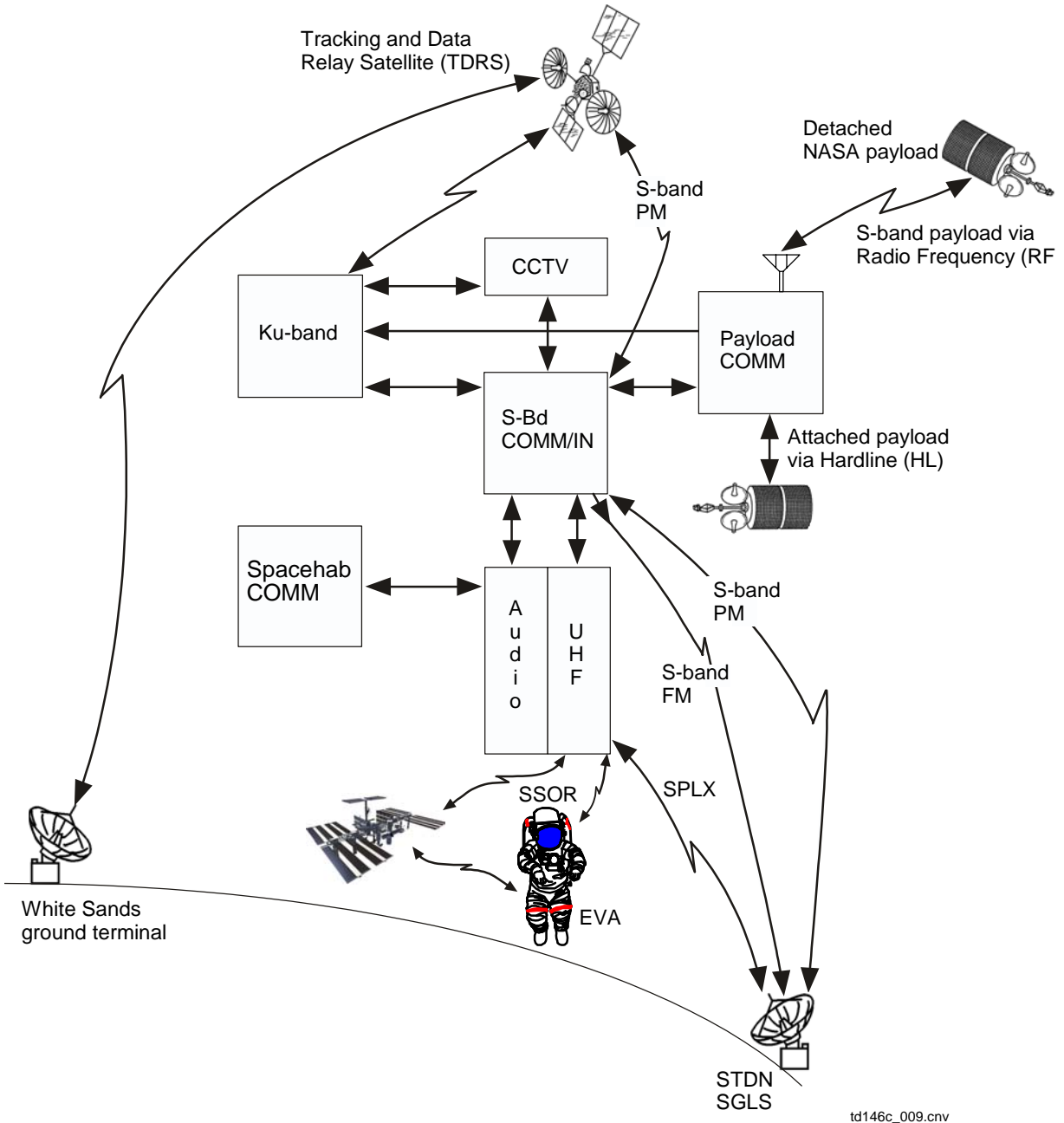


Figure 1-1. Space shuttle communication system

Communications (telemetry and commands) to payloads is achieved through the S-band Payload (S-Bd P/L) system for a detached (RF) or attached (HL) payload. Further information on the P/L COMM system is found in the P/L COMM 21002 Training Manual.

The CCTV system is used to record crew activities during payload, rendezvous, and EVA operations, to provide views to crewmembers during ISS assembly tasks, and to downlink television (recorded or live). The system is explained in the CCTV OPS 21002 Training Manual.

## **2.0 AUDIO DISTRIBUTION SYSTEM**

### **2.1 OBJECTIVES**

After reading this section, the student will

- a. Understand the operation of the orbiter Audio Distribution System (ADS)
- b. Know the number of voice loops available in the orbiter and how they are used
- c. Know how the voice loops are connected to the orbiter RF links
- d. Know how the audio crew stations of the mission specialists and the pilot affect voice communications with MCC
- e. Know how the C&W and TACAN audio tones are connected to the orbiter audio system
- f. Know the differences between UHF SIMPLEX (SPLX) and SSOR operations

### **2.2 OVERVIEW**

The ADS (Figure 2-1) provides the onboard crew with voice communications to each other and to MCC through headsets, microphones, and speakers. For communication with MCC, the ADS is connected to three RF links (S-band, Ku-band, and UHF SPLX). For communication with EVA and ISS, the ADS is connected to another RF system, the SSOR. Finally, for communication with the docked ISS, hardline connections are provided between the ADS and ISS Audio system (through the X connectors on the shuttle's ODS and ISS' PMA).

The UHF Simplex transceiver is used only for voice communication; it is treated in this training manual as part of the ADS. The other UHF system, the SSOR, is used for voice, command, and data transmission between the orbiter and the ISS.

In addition, Caution and Warning (C&W) tones are routed through the ADS to alert the crew of onboard equipment or environmental problems.

TACAN tones are routed through the ADS to the Commander (CDR) and Pilot (PLT) for monitoring during the landing sequence. These are Morse code tones which identify the landing site.

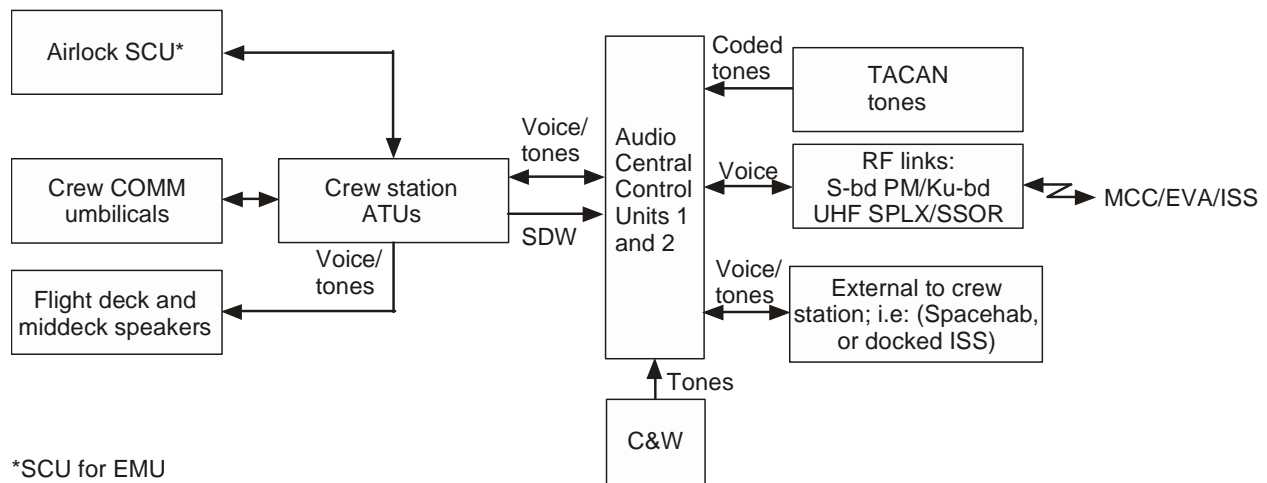
The Audio Central Control Unit (ACCU) is the heart of the ADS. Primary and secondary ACCU circuits are housed in a single Line Replaceable Unit (LRU). The crew may select primary (ACCU 1) or secondary (ACCU 2) with a power switch mounted on console Panel C3 between the CDR and PLT. Connected to the ACCU are six Audio Terminal Units (ATUs), each of which terminates in a Crew Communications Umbilical (CCU). The CCU provides the crew with a place to connect headsets, microphones, and other devices to the ADS.

Voice and tone signals are controlled by the ACCU, and are routed to and from the CCU and to speakers. In addition, for EVA astronauts inside the airlock, voice and tones are routed to the Extravehicular Mobility Unit (EMU) through the Service and Cooling Umbilical (SCU). Internal configuration and microphone keying in the ACCU are controlled by a Serial Data Word (SDW) from each ATU. The ATU control panels are located at six COMM stations throughout the crew compartment (four on the flight deck, one in the middeck, one in the airlock). In this training manual, the ATU control panel will be called the ATU.

Other connections to the ACCU extend the ADS to provide audio communication for areas external to the orbiter crew compartment, such as the Spacehab and ISS.

The ADS is manually controlled. There is no ADS telemetry; therefore, MCC does not have insight into or control of the configuration of the ADS.

The UHF SPLX system is also manually controlled, but some telemetry on this system is monitored in MCC.

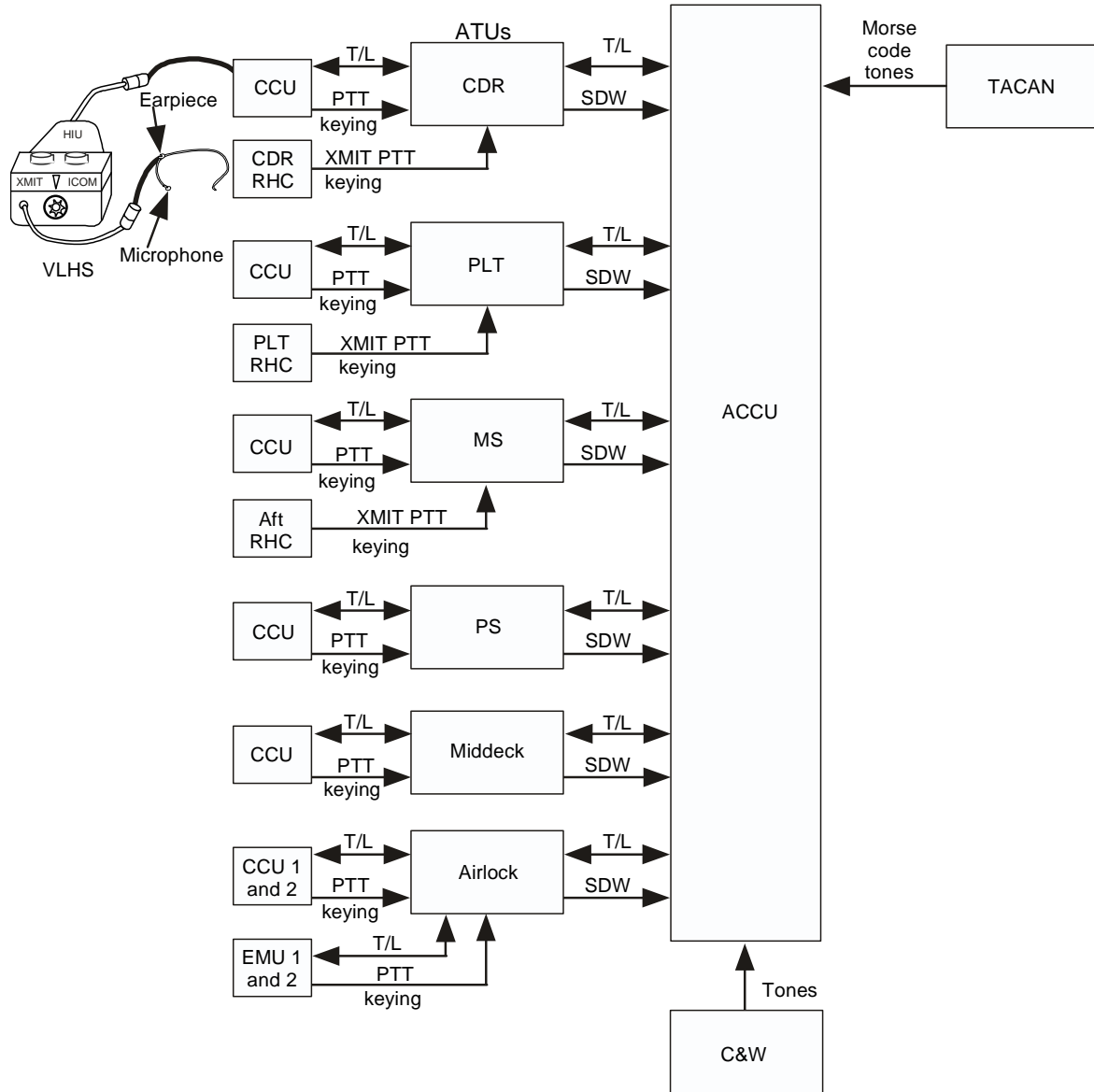


**Figure 2-1. Audio distribution system**

## 2.3 OPERATIONAL DESCRIPTION

### 2.3.1 ACCU/ATUs

Figure 2-2 illustrates the crew compartment ATU/CCU terminals and ACCU connections.



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Figure 2-2. Audio terminal units

There are six ATUs:

- a. Commander (CDR)
- b. Pilot (PLT)
- c. Mission Station (MS)
- d. Payload Station (PS)
- e. Middeck (MD)
- f. Airlock (AL)

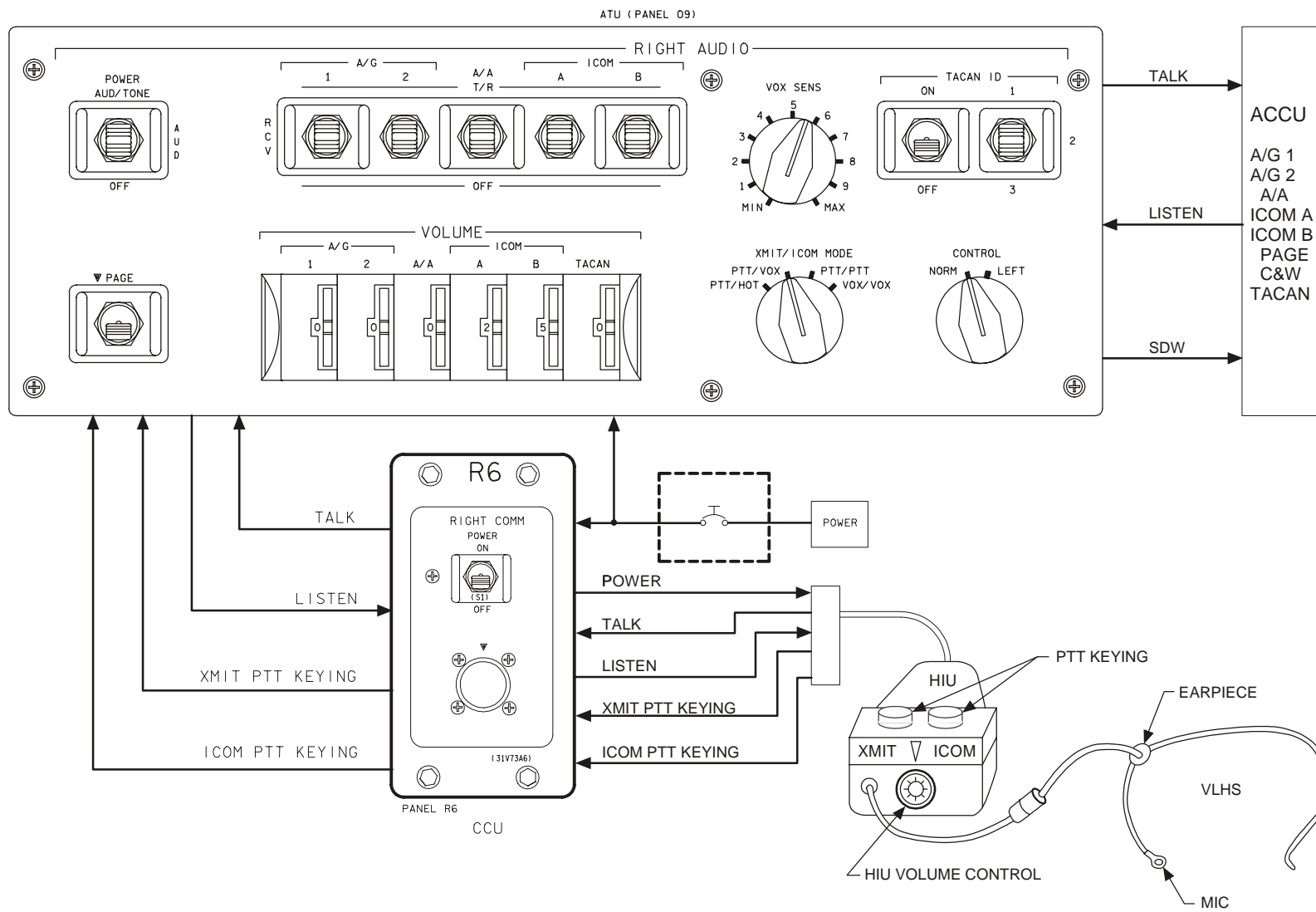
There is one CCU for every ATU (except for the Airlock ATU). Each CCU is designed to accommodate connections to various audio devices. Figure 2-3 illustrates a Very Lightweight Headset (VLHS) connection to the CDR station through a Headset Interface Unit (HIU).

The airlock ATU is unique because it has two CCU connections parallel to the two EMU suit connections.

Figure 2-3 illustrates a typical ATU/CCU/VLHS combination. The example in this illustration represents the PLT ATU. Note the TACAN Identification (ID) switches. Use this illustration for the text through page 2-12.

The VLHS is connected to the CCU through an HIU. The CCU is connected to the ATU by a power line, a TALK line, a LISTEN line, and two Push-to-Talk (PTT) KEYING lines. The HIU provides five lines: a TALK line microphone signal amplification, a LISTEN line audio volume control for the headset earpiece, two PTT keying lines, and a power line. The electrical power line for the HIU microphone amplifier is provided through the switch on the CCU. When the HIU amplifier is powered on, the microphone audio signal is routed through the HIU and ATU to the ACCU on the TALK line. Audio from the ACCU is routed to the headset earpiece through the ATU, CCU, and HIU on the LISTEN line. No power from the CCU is required to hear the LISTEN audio (the CCU switch does not need to be ON to LISTEN).

If the CCU microphone power is ON, audio on the TALK line is present in the ATU on the way to the ACCU. When PTT keying occurs, TALK audio is returned to the headset on the LISTEN line as a "sidetone". This lets the user know the ATU is working, much the same way one knows a telephone is working when they can hear themselves talking in their own receiver. It is important to remember that the sidetone originates in the ATU, not the ACCU. The same PTT keying signals are sent on to the ACCU as bits in the SDW line along with loop selection and volume control.



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Figure 2-3. Typical crew station interface diagram



The ACCU contains circuitry for eight separate audio loops.

- |                                  |         |            |
|----------------------------------|---------|------------|
| a. Air-to-Ground 1               | (A/G 1) | VOICE loop |
| b. Air-to-Ground 2               | (A/G 2) | VOICE loop |
| c. Air-to-Air                    | (A/A)   | VOICE loop |
| d. Intercomm A                   | (ICOMA) | VOICE loop |
| e. Intercomm B                   | (ICOMB) | VOICE loop |
| f. Paging                        | (PAGE)  | VOICE loop |
| g. Caution and Warning           | (C&W)   | TONE loop  |
| h. TACAN (CDR and PLT ATUs only) |         | TONE loop  |

## 2.4 LOOP USAGE

A/G 1 and A/G 2 provide orbiter-to-MCC communications via S-band PM and Ku-band systems. A/G 1 is also used for orbiter-to-EVA and ISS crew communications via SSOR, and for orbiter-to-docked ISS communications during docked operations. A/G 2 is a backup to A/G 1 during ascent and entry operations, A/G 2 is also used for voice communications separate from A/G 1; i.e., payload specialists or private conversations with family or flight surgeons, during orbit operations.

The ISS also has two loops for communications to the ISS MCC, dubbed Space-to-Ground 1 and 2 (S/G 1 and S/G 2). During operations involving ISS, A/G 1 and S/G 1 are used as the "Big Loop". The Big Loop connects the orbiter, ISS, shuttle MCC, and ISS MCC. This is achieved by the connection of A/G1 on the shuttle to Space-to-Ground 1 (S/G 1) on the ISS, using either the SSOR (during rendezvous or EVA) or the docked audio connections (during docked operations).

A/A provides orbiter/MCC another backup voice communications loop during ascent and entry, via the UHF Simplex system.

ICOMA and ICOMB provide intercommunications within the orbiter and extended habitat, such as the Spacehab or docked ISS.

The PAGE loop provides a way to call all audio stations, no matter what other loops are active on the other ATUs. PAGE is extended to the SSOR system, for use during EVA and ISS operations.

Crew may access these loops by configuring switches on an ATU. Switch throws are coded onto the SDW, and sent to the ACCU. The ACCU responds to the ATU selections by decoding the data on the SDW.

The SDW contains three types of information.

- a. Loop selection
- b. Individual loop volume control
- c. Microphone keying

## **2.5 SERIAL DATA WORD**

Figure 2-4 illustrates the 128-bit (numbered 0 to 127) SDW. As previously stated, the ACCU configuration is controlled through a separate SDW from each ATU. Examples are as follows:

- a. Bit 28 is activated and deactivated by the POWER switch on the associated ATU.
- b. Bit 28 = 1 configures the ACCU to provide C&W TONES to the associated ATU.
- c. Bit 28 = 0 removes the tones.

BIT	FUNCTION	
0	FRAME SYNC	
1		
2		
3		
4		
5		
6		
7		
8	VOX	
9	SPARES	
10		
11		
12		
13		
14		
15		
16	A/G 1	AUDIO CENTER SSOR UHF
17	A/G 2	
18	A/A	
19	SPARES	
20		
21	PAGE- UHF (EVA)	
22	SPARES	
23		
24	VOX	
25	PTT/ICOM	
26	PTT/A/G XMIT	
27	A/G VOX	ENABLE
28	AUD C&W	
29	A/G 2	
30	A/A	
31	PAGE	
32	ICOMA VOLUME	
33		
34		
35	ICOMB VOLUME	
36		
37		
38		
39	VOX	
40	ENABLE	
41		ICOMA
42		ICOMB
43	A/G 1	

BIT	FUNCTION	
44	A/G 1 VOLUME	
45		
46		
47	A/G 1 VOLUME	
48		
49		
50		
51	A/A VOLUME	
52		
53		
54	VOX	
55		
56		
57		NAV 1
58	NAV 2	TACAN TONE SELECT
59	NAV 3	
60	TACAN TONE VOLUME	
61		
62		
63		
64	RECORD CHAN 1	AUDIO CENTER OPS RCDR VOICE SELECT
65		
66		
67		
68	RECORD CHAN 2	
69	NSP 1	A/G 1 SELECT
70		
71	NSP 2	
72	VOX	
73	NSP 1	A/G 2 SELECT
74	NSP 2	
75	SPARES	
76		
77		
78		
79		
80		
81	SPLX UHF	
82	SPARES	
83		
84	ICOMA	P/L BAY ENA
85	ICOMB	
86	SPARES	
87		

BIT	FUNCTION	
88	VOX	
89		
90		
91		
92		
93		
94		
95	AUDIO CENTER SPACELAB ON	
96		A/G 1
97		A/G 2
98		A/A
99		ICOMA
100	ICOMB	
101	PAGE	
102	TONE	
103	SPARE	
104	VOX	
105		
106		
107		
108		
109		
110		
111	AUDIO CENTER DOCKING RING ON	
112		A/G 1
113		A/G 2
114		A/A
115		ICOMA
116	ICOMB	
117	PAGE	
118	TONE	
119	SPARE	
120	VOX	
121		
122		
123		
124	DEAD TIME	
125		
126		
127		

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Figure 2-4. Serial Data Word

The ACCU processes the unshaded bits from each ATU. The ACCU processes the shaded bits only from the MS and PLT ATUs.

## 2.6 LOOP SELECTION

Refer to Figure 2-3.

If the POWER switch is set to the OFF position, the ATU is disabled and all of the bits in the SDW are zeros. No loops can be selected, and there is no sidetone to the CCU/headset. The same is true if the illustrated circuit breaker (cb) has been opened. With the cb open, power is removed from the CCU HIU headset microphone amplifier as well as the ATU.

If the cb is closed and the POWER switch is in the AUD position, all functions on the ATU, except the C/W tones, are activated. If AUD/TONE is selected, the C&W loop in the ACCU is also activated, and C&W tones are audible at the CCU/headset when they occur.

If Receive (RCV) is selected on the A/G 1 switch, the A/G 1 loop in the ACCU is configured in such a way that the LISTEN line, but not the TALK line, is activated to the CCU/headset. Any transmission from other sources on the A/G 1 loop will be heard on the headset connected to the ATU. The crewmember will not be able to talk on A/G 1.

If Transmit/Receive (T/R) is selected on the A/G 1 switch, the LISTEN line from the user's ATU is connected to the A/G 1 loop in the ACCU. When the microphone is keyed, the ACCU connects the TALK line to the A/G 1 loop in the ACCU. Again, the loop selection and the keying are activated in the selected ACCU through the SDW.

A/G 2, A/A, ICOMA, and ICOMB operation is the same as that of A/G 1.

The PAGE loop is keyed by holding the PAGE switch in the UP position. This action keys the PAGE loop in the ACCU, enabling you to transmit to the LISTEN line of all active ATU/CCU terminals. When the SSOR system is being used for EVA or rendezvous operations, the PAGE loop is also transmitted to the ISS and EVA crewmembers.

Note: EVA crewmembers cannot respond on the PAGE loop.

The TACAN loop is activated by selecting TACAN ID - ON. The Morse code ID for the selected TACAN station is then heard on that ATU's LISTEN line. Only the CDR and PLT ATUs in the orbiter ADS have this capability.

## 2.7 INDIVIDUAL LOOP VOLUME

Overall volume of the LISTEN line to your headset earpiece is controlled by the HIU volume rotary control. Individual volume for each active loop is controlled by VOLUME thumbwheel settings (0 to 9). They are used to set up an appropriate balance of volume between loops; i.e., the volume of a prime loop, like A/G 1, may be set higher than the other loops. Note that “0” volume does not turn off that loop, “0” volume is simply one step lower in volume than volume “1”. The PAGE and C&W loops have no individual volume control on the ATU. The PAGE loop has no crew-accessible volume controls; the C&W volume, which is set from other panels in the crew compartment, is discussed later.

## 2.8 MICROPHONE KEYING

The ATU provides two types of keying.

- PTT
- Voice-Operated-Transmit (VOX)

You select the keying type with the ATU XMIT/ICOM MODE switch. Either type of keying is identified in the ACCU through the SDW. Activation of any type of keying initiates the transmission to loops in the T/R mode.

## 2.9 PTT

The HIU has two PTT pushbuttons. Pressing either one keys the sidetone circuit in the ATU. Pressing the Transmit (XMIT) button on the HIU keys A/G 1, A/G 2, A/A, ICOMA, and ICOMB if their switches are in T/R. The ICOM button keys only ICOMA and ICOMB, again only if their switches are in T/R.

The orbiter is provided with three Rotational Hand Controllers (RHCs), one at the CDR's position, one at the PLT's position, and one at the aft flight deck position. See figures in [Section 3](#). Each has a PTT “trigger” switch that functions as a XMIT PTT for each associated ATU. The aft RHC “trigger” XMIT PTT switch is connected to the MS ATU; the CDR RHC switch is connected to the CDR ATU; and the PLT RHC switch is connected to the PLT ATU.

The PAGE loop is PTT-keyed through the PAGE switch on each ATU, which keys only the PAGE loop.

HOT keying stands for HOT MICROPHONE (or HOT MIC, pronounced “hot mike”). HOT MIC is accomplished by forcing the PTT bit ON in the SDW. The PTT/HOT position on the XMIT/ICOM MODE switch provides this condition on the ICOM loops. Also, inadvertently holding a PTT switch down will create a hot mic.

## 2.10 VOX

VOX keying is activated by positioning the XMIT/ICOM MODE switch to the PTT/VOX or VOX/VOX position. A VOX circuit in the ATU is designed to respond to audio signals on the microphone TALK line. Adjusting the VOX SENSITIVITY (SEN) sets the threshold at which the microphone audio level “keys” the ATU VOX circuit. Adjustments to the VOX SEN rotary are made such that VOX keying occurs when the crewmember speaks in a normal tone; but lower level audio, such as breathing or ambient noise, will not key the VOX circuit.

In the PTT/VOX mode, only ICOMA and ICOMB are VOX-keyed. A/G 1, A/G 2, and A/A are keyed by the XMIT PTT button on the HIU. In the VOX/VOX mode, A/G 1, A/G 2, A/A, ICOMA, and ICOMB are all VOX-keyed.

Sidetone is activated when a VOX key occurs in the ATU, even if no loops are in RCV or T/R.

## 2.11 CONTROL SWITCH

The CONTROL switch is the only ATU function that does not control the ACCU through the SDW (Figure 2-5).

The TALK, LISTEN, and PTT keying lines from the CCU/headset terminal are routed directly to the CONTROL switch. If the control switch is set to NORMAL, these lines are routed to the associated ATU audio circuitry. Any mode of keying in the ATU activates the sidetone circuit and causes the TALK audio to return to the headset on the LISTEN line. The ACCU also responds to the key by transmitting the same audio to other stations on the active loops.

The CONTROL switch is set to ALTERNATE, the TALK, LISTEN, and PTT lines are diverted to the alternate ATU. In this configuration, both users are connected to the same ATU and can communicate with each other through the common sidetone circuit. Microphone keying and audio routing to the ACCU are also common to both users.

Power through the CCU to the HIU microphone amplifier is not included in the ALTERNATE crossover connections. If, therefore, CCU power has been lost, the crewmember is able to listen but not talk through the ALTERNATE ATU.

A CONTROL switch is associated with four ATUs in the orbiter. The ATUs are

- a. CDR
- b. PLT
- c. MS
- d. AIRLOCK

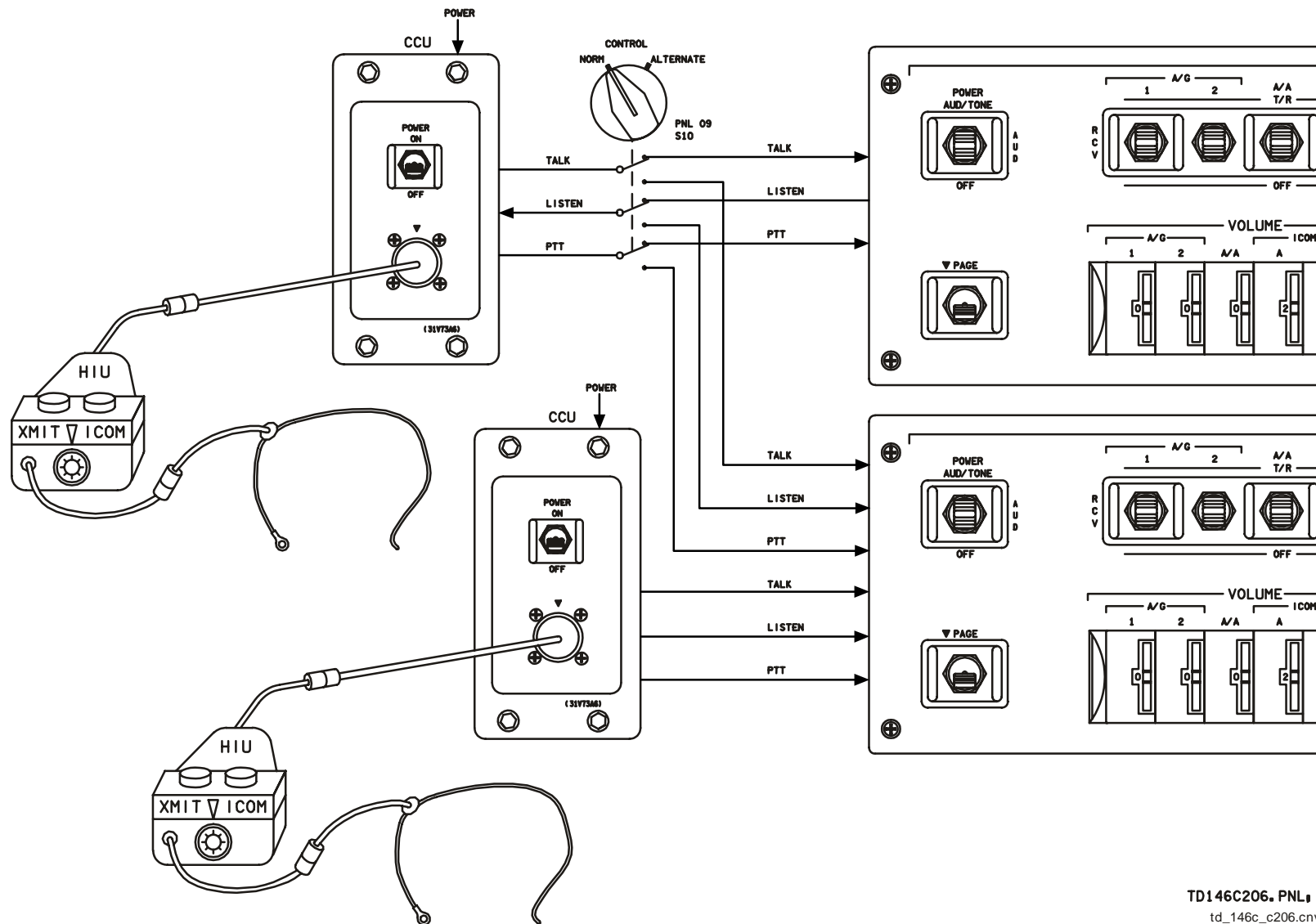


Figure 2-5. CONTROL switch configuration

TD146C206. PNL 1  
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The following table illustrates the normal/alternate relationship for each CONTROL switch:

<u>Normal</u>	<u>Alternate</u>
CDR	PLT (Panel O9)
PLT	CDR (Panel O5)
MS	PS (Panel L9)

### 2.11.1 Speaker Units

Figure 2-6 is an expansion of Figure 2-2. Included are two onboard Speaker Units (SUs), one on the flight deck and one on the MD. Both SUs are subject to the configuration of the connected ATU. The flight deck speaker is connected to the MS ATU; the middeck speaker is connected to the MD ATU. The audio to each SU is the same as the LISTEN line audio to the associated ATU.

Figure 2-7 illustrates the SU front panel configuration, which includes two speakers and a KEY light indicator. The top speaker responds only to the Klaxon and siren tones coming directly from the C&W circuitry (see Figure 2-11). The Klaxon tone occurs when the orbiter cabin air pressure rate of change exceeds a predetermined value. The siren is activated by smoke in the cabin.

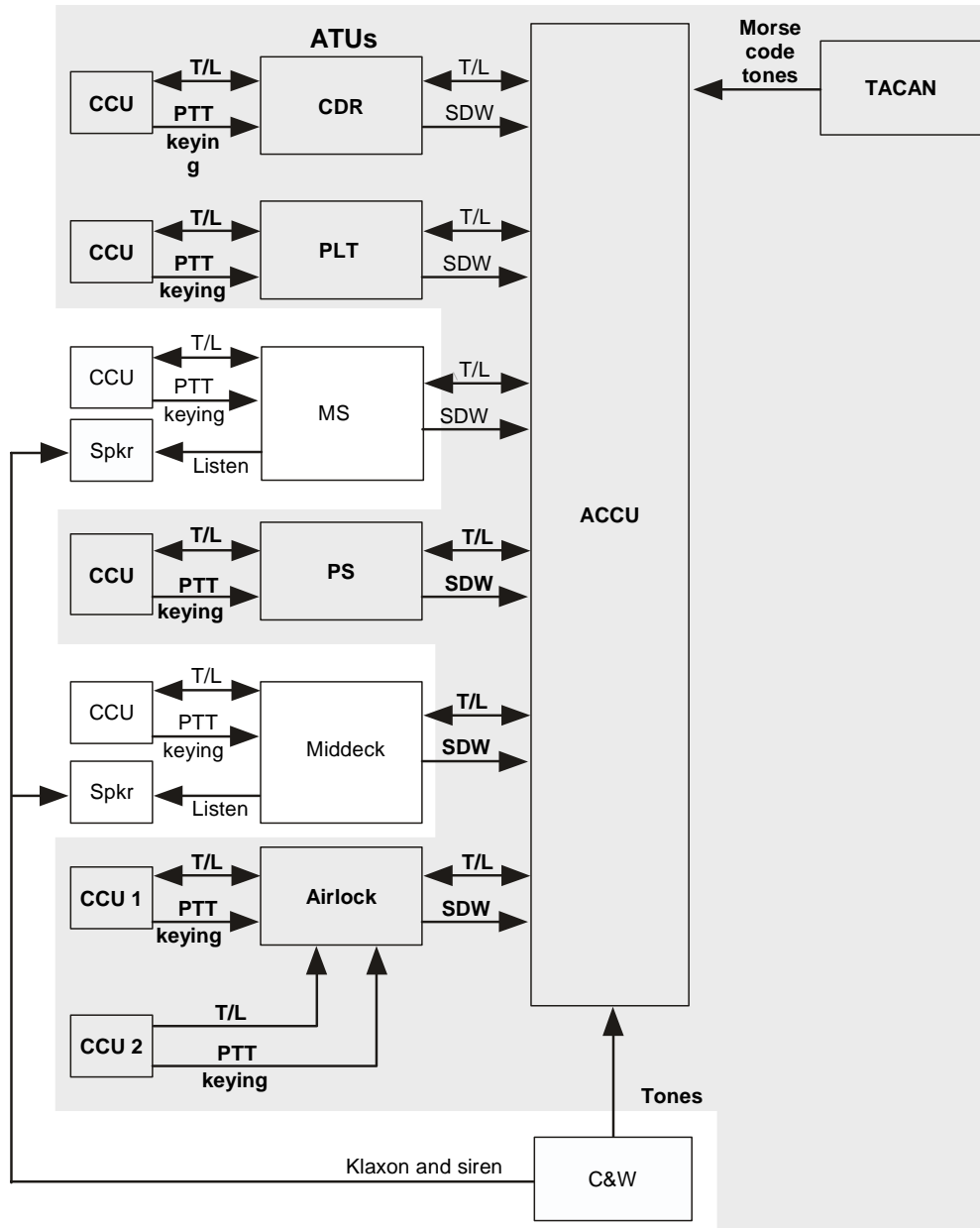
The bottom speaker responds to voice and tones from the attached ATU.

When a Klaxon or siren tone occurs, the bottom speaker is muted; therefore, no voice or tones will be heard from the bottom speaker until the tone is cleared.

The KEY indicator illuminates when any mode of keying (i.e., PTT, VOX, or PAGE) occurs only at the associated ATU (MS ATU key for flight deck speaker, middeck ATU key for the middeck speaker). When the KEY indicator is illuminated, the bottom speaker is muted. The top speaker is never muted.

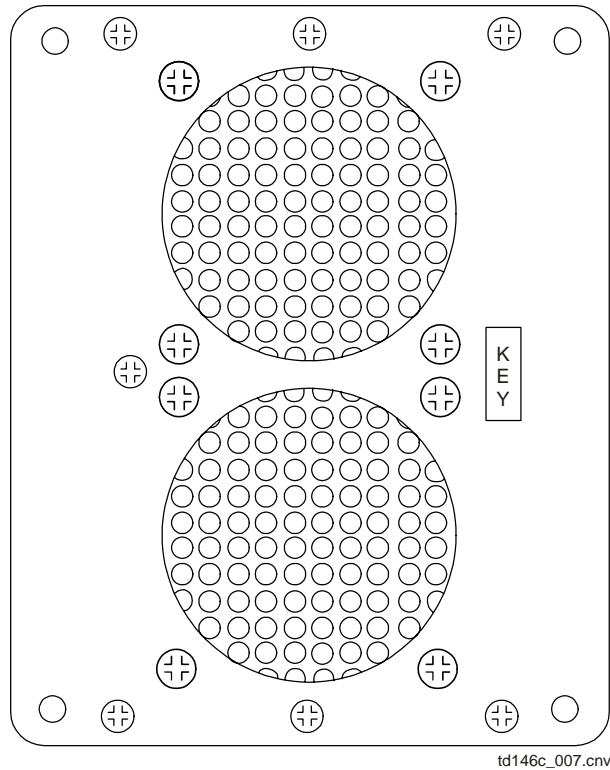
Note: Flight deck keying does not mute the middeck speaker nor does middeck keying mute the flight deck speaker; therefore, audio hardware plugged into a flight deck ATU should not be keyed in the middeck area, nor should middeck audio hardware be keyed on the flight deck. Feedback squealing tones will result.





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Figure 2-6. Audio terminal units – speaker units



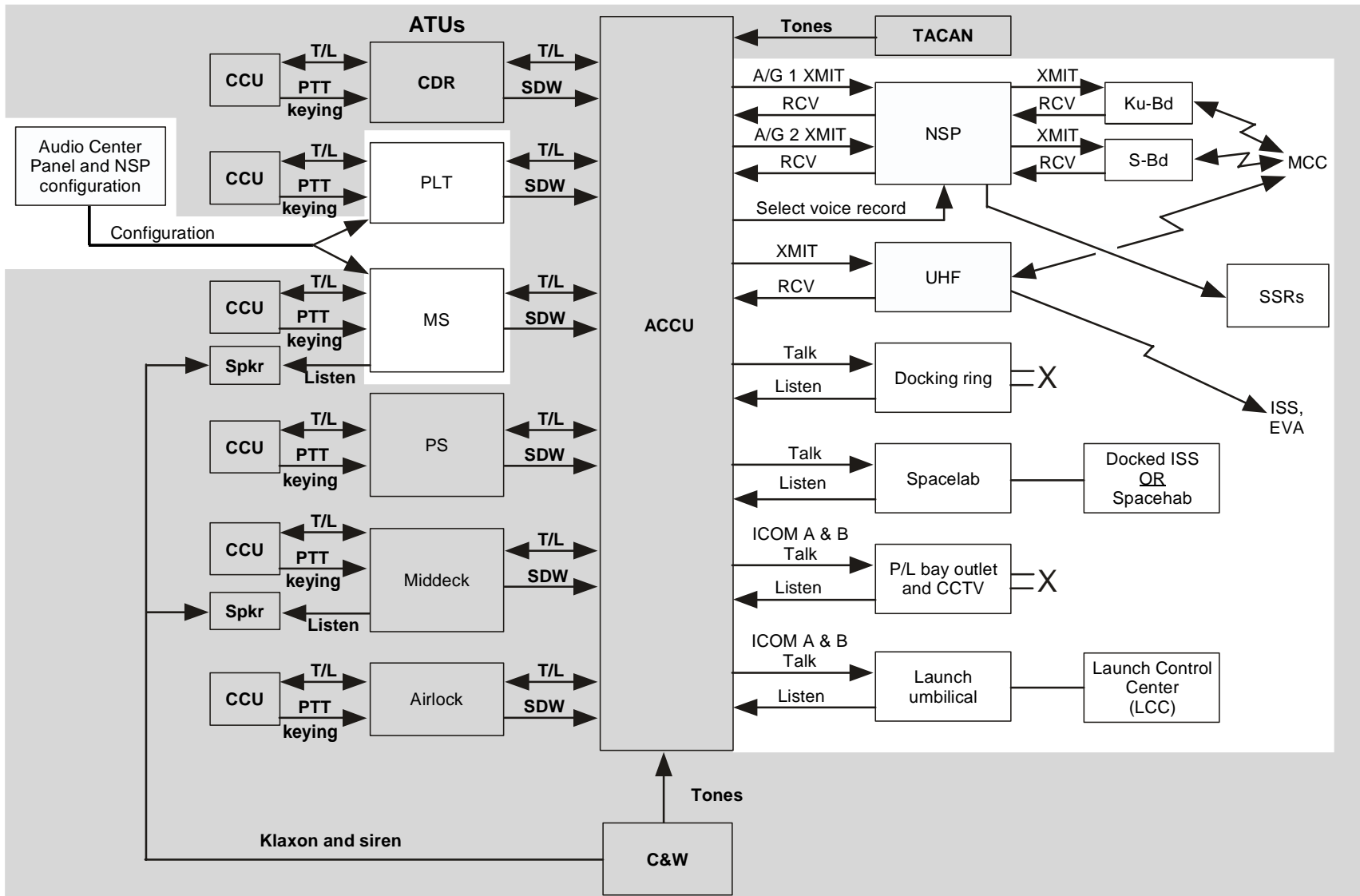
**Figure 2-7. SU front panel configuration**

### 2.11.2 Other Audio Connections

Figure 2-8 has been further expanded to include other TALK/LISTEN connections to the ACCU. Listed below is a summary of these connections.

- a. A/G 1 and A/G 2 to the NSP
- b. Selected voice loops routed to the NSP for the SSRs (Solid State Recorders)
- c. A/G 1, A/G 2, A/A to the SSOR
- d. ACCU loops routed to the Spacelab module or docked ISS.
- e. A/A routed to the UHF Simplex system
- f. ICOMA and ICOMB routed to the orbiter umbilical

The first connection listed (A/G 1 and A/G 2 to the NSP) is controlled by the Ground Command Interface Logic (GCIL) NSP settings, and is nominally always connected. The next three connections listed are controlled by functions on the orbiter aft Panel A1R. The UHF Simplex system is always connected to the A/A loop when the UHF Simplex system is powered ON. Lastly, the umbilical connections are always present in the ACCU but are terminated at the umbilical at launch Time Zero (T-0).



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Figure 2-8. ATUs with other TALK/LISTEN connections

The portions of Panel A1 that are connected to ADS are

- AUDIO CENTER PANEL (Panel A1R, Figure 2-9)
- NETWORK SIGNAL PROCESSOR (Panel A1L, Figure 2-10)

### 2.11.3 Panel A1R (The “Audio Center Panel”)

Figure 2-9 illustrates orbiter aft station Panel A1R (also called the Audio Center Panel).

The two “VOICE RECORD SELECT” rotaries send ACCU loops to the onboard recorders. The ACCU connects the selected loops to the active NSP, where they are digitized and sent with Pulse-Code Modulation Master Unit (PCMMU) telemetry to be recorded on the SSRs. SSR1 is housed in Mass Memory Unit 1 (MMU1), SSR2 is housed in MMU2. References to SSR1 and SSR2 in most comm procedures and panels will be labeled MMU1 and MMU2.

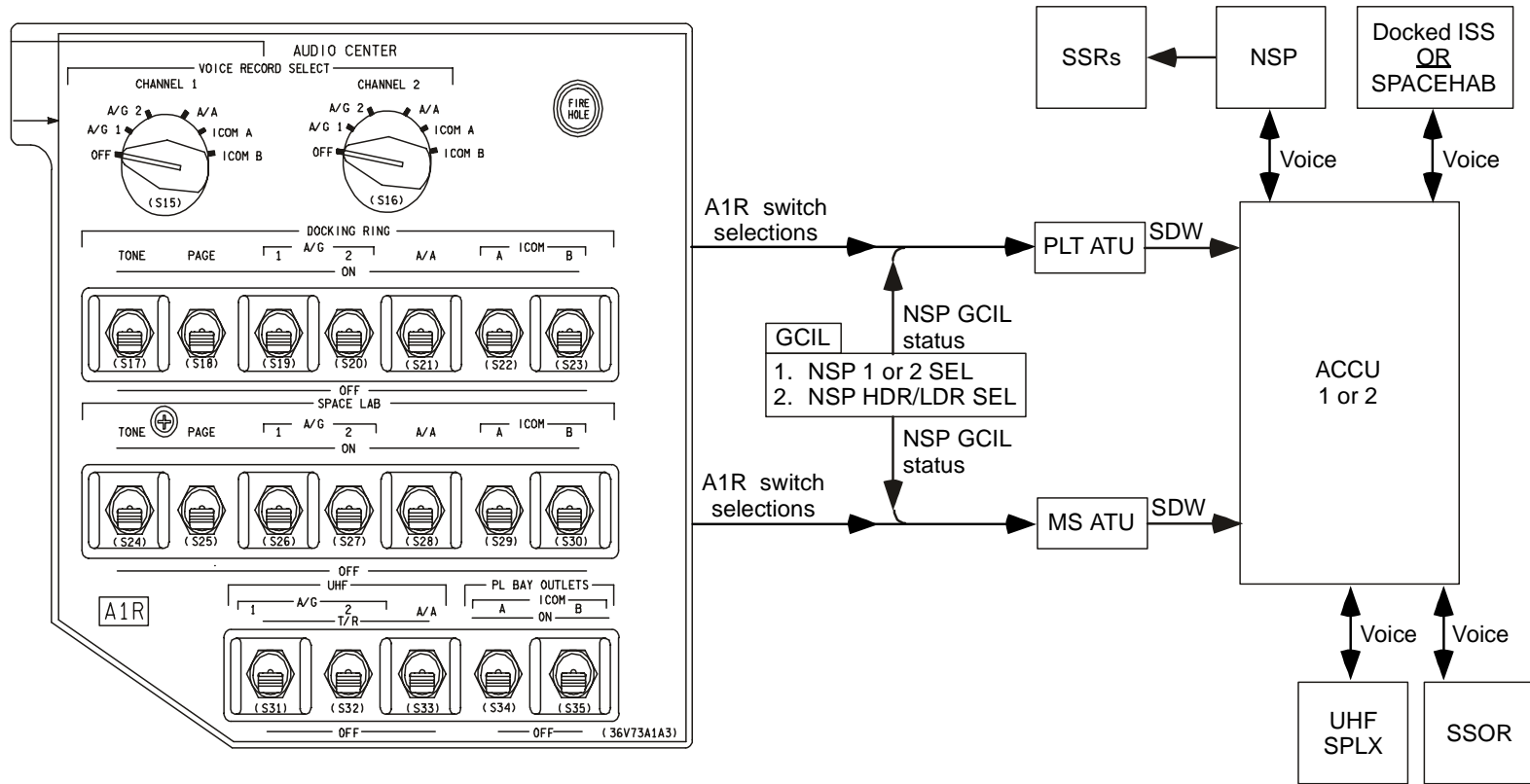
The “SPACELAB” switches connect ACCU loops to the docked ISS audio loops for all ISS flights. Only four loops are physically connected across the Orbiter Docking System (ODS) X-connectors and to the ISS Audio system: A/G1, A/A, ICOMA and PAGE. Therefore the SPACELAB TONE, A/G2, and ICOMB switches for ISS flights are non-functional. For non-ISS flights, these loops can be connected to a Spacehab audio system, if Spacehab is flown in the payload bay. For ISS flights with a Spacehab in the payload bay, the Spacehab audio system will be non-functional, and the SPACELAB switches will be used for docked ISS audio.

The “UHF” switches are used to connect ACCU loops to the SSOR. Typically, only A/G1 is turned ON during rendezvous and EVA activities. These switches are not used at all for the UHF Simplex system; UHF Simplex is connected to the A/A loop in the ACCU whenever the UHF Simplex system is powered ON.

The “DOCKING RING” and “PL BAY OUTLETS” switches are currently non-functional during flight.

As previously stated, the ACCU configuration is controlled by bit changes in the SDW from each ATU. The Panel A1R functions do not have a direct SDW input to the ACCU. As illustrated in Figure 2-9, configuration information from Panel A1R is routed redundantly through the PLT and MS ATUs, and is part of the SDW for both.

If both PLT and MS ATUs are OFF, the switch selections of the A1R Panel are not sent to the ACCU. One of these two ATUs must ON at all times. If both ATUs are OFF, UL/DL voice to MCC through the NSP and UHF SPLX are lost, as well as voice to ISS and EVA through the SSOR, and voice to ISS or Spacehab through the SPACELAB switches.



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Figure 2-9. Panel A1R

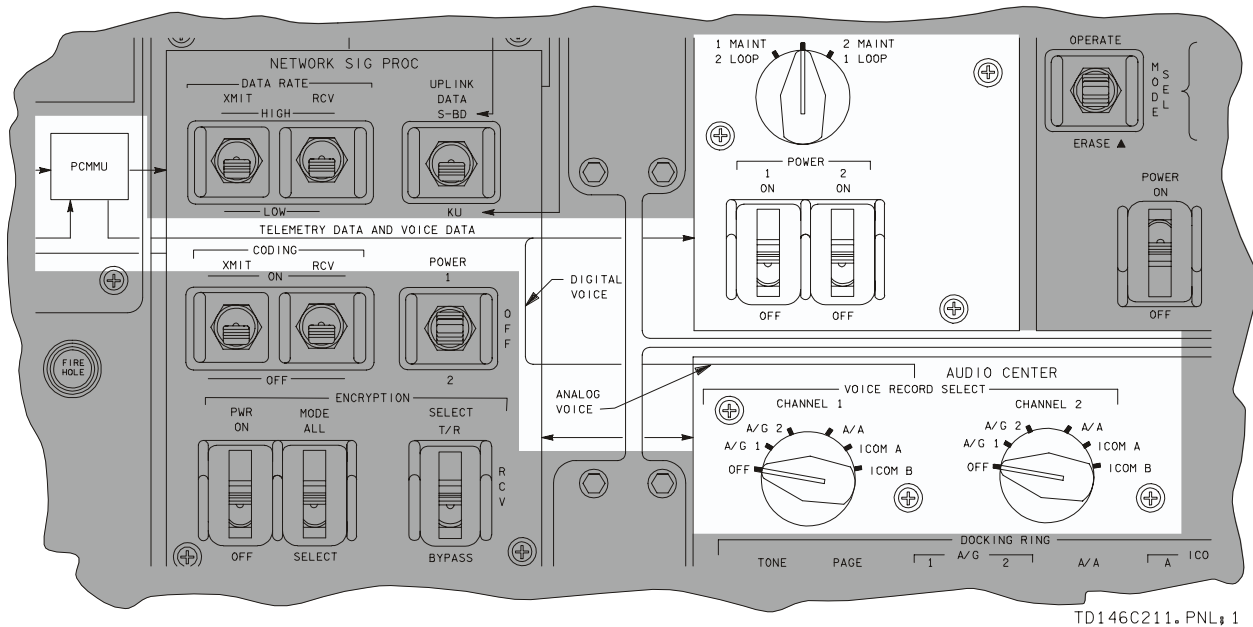


Figure 2-10. VOICE RECORD SELECT switches

## 2.12 NETWORK SIGNAL PROCESSOR

The orbiter NSP provides the data and voice interface between the orbiter and MCC through the S-band and Ku-band RF links. The downlink to MCC carries telemetry and digitized voice. The uplink from MCC carries commands and digitized voice.

There are two NSPs. Typically, NSP 2 is prime, with NSP 1 as backup. The operating NSP processes data and voice at one of two data rates for MCC support. They are identified as High Data Rate (HDR) and Low Data Rate (LDR) modes. Nominally, HDR is always used during flight.

The HDR/LDR and active NSP select functions are visible on the NETWORK SIG PROC portion of Panel A1R under the DATA RATE and POWER labels (Figure 2-11). These functions either may be commanded from MCC or may be controlled from the illustrated switches. The status of these functions is monitored by MCC through PCMMU telemetry.

A/G1 in the ACCU is nominally always connected to the active NSP, to allow communications with MCC. The ACCU processes and routes analog voice, but the NSP processes digital data for uplink/downlink to MCC. Therefore digital-to-analog / analog-to-digital conversion takes place in the NSP. When the NSP is moded to HDR for both uplink and downlink, A/G 2 is connected between the selected ACCU and the active NSP on a set of TALK/LISTEN lines separate from A/G 1. When the active NSP is moded to LDR, either uplink or downlink, A/G 2 (both uplink and downlink) is removed from the NSP and only A/G 1 remains.

The ACCU must respond to the data rate and active NSP selections for proper routing of the analog A/G 1 and A/G 2. The data rate and NSP selection information is routed to the ACCU through the PLT and MS SDW line along with the Panel A1R configuration data. Again the PLT or the MS ATU must be active to provide the SDW for these functions. (See SDW bits 70, 71, 73, and 74 in Figure 2-4). Therefore, as stated earlier, if the MS and PLT ATUs are both powered OFF, AG1 and AG2 voice to MCC through the NSP will not function. The NSP connects to the S-band PM and Ku-band RF systems for communications with MCC.

If the NETWORK SIG PROC ENCRYPTION MODE switch (Figure 2-10) is in the SELECT position, the NSP is considered to be in the NASA mode. The information that is routed to the Solid State Recorders is HDR telemetry and digitized voice. Digitized voice is selected on the AUDIO CENTER VOICE RECORD SELECT switches on Panel A1R (The Audio Center Panel). The NSP can be moded to process the PCMMU-only data to the recorders and reject the voice. This is an MCC command function only. There are no crew controls of the SSRs.

If the ENCRYPTION MODE switch is selected to ALL, the NSP is considered to be in the Department of Defense (DoD) mode, and NSP downlink data and voice (A/G1 and A/G2 when in HDR; A/G 1 when in LDR) are continuously routed to the recorders. In this mode, the selections made on the VOICE RECORD SELECT switches on panel AIR VOICE RECORD selections are ignored. This mode is currently not used.

### 2.12.1 Caution and Warning Tones

Four C&W tones are distributed in the ADS.

KLAXON	2500 Hz mixed with a 250-Hz tone; activated by an out-of-limits change in cabin air pressure.
SIREN	Varying 666- to 1470-Hz tone; activated by smoke in the cabin.
C&W	Alternating 375- to 1000-Hz tone; activated by hardware- or software-detected out-of-limits conditions. Accompanied by illumination of a MASTER ALARM (red) indicator.
SM ALERT	512-Hz tone; activated by computer inputs. Accompanied by illumination of an SM ALERT (blue) indicator.

The C&W system provides redundant sources for all four tones. Figure 2-11 illustrates the distribution of the two sources in the ADS.

Tones follow four general paths: all four tones to the ACCU (for reception at each of the six ATUs), to the SLEEP STATION, to the middeck bottom speaker mixer, and Klaxon/Siren to the top speaker of both the FD and MD speaker.

All four tones from each source are routed to the ACCUs through screwdriver volume controls on the C&W Panel (R13U). There is no further volume control until the tones pass to the HIU or the speaker volume controls. Both A and B sources are routed to both ACCUs. Logic in the active ACCU determines which redundant source is used. The combined ACCU output of tones and voice is routed to the LISTEN line of all headsets and speakers through the associated ATU. The power switch of the ATU must be in AUD/TONE mode to hear the tones.

All four tones are routed to the middeck SLEEP STATION headset connector from C&W LOGIC B. No voice is routed to this station. An HIU may be connected to monitor tones. Originally envisioned to be used by one crewmember, who would be awakened by tones during a sleep period (when the speakers are off), crewmembers typically opt to simply leave a speaker ON during sleep.

All four tones also bypass the ACCU and go to the middeck speaker unit mixer. Without this bypass, if the ACCU failed (for example, during a sleep period), the crew would not be able to talk to MCC nor hear C&W or SM Alert tones (Klaxon and Siren would still be heard on the upper speaker, see next paragraph). This is potentially a dangerous situation, should an onboard problem occur requiring the crew's attention. Therefore all four C&W tones can bypass the ACCU and go to the middeck ATU bottom speaker. These bypassed tones are mixed with the usual Middeck ATU LISTEN line (audio & tones from the ACCU) when the TONES switch on the Middeck ATU is in the "ACCU/BYPASS" position. When the TONES switch is in the "ACCU" position, the bypassed tones will not be mixed with the Middeck ATU LISTEN line. Nominally, this switch is in ACCU/BYPASS for the entire flight.

The KLAXON and SIREN tones are singled out in the C&W LOGIC and are routed directly to the top speaker of the flight deck and middeck speaker units. The flight deck is driven by LOGIC A and the middeck by LOGIC B outputs. There is no volume control for this source.



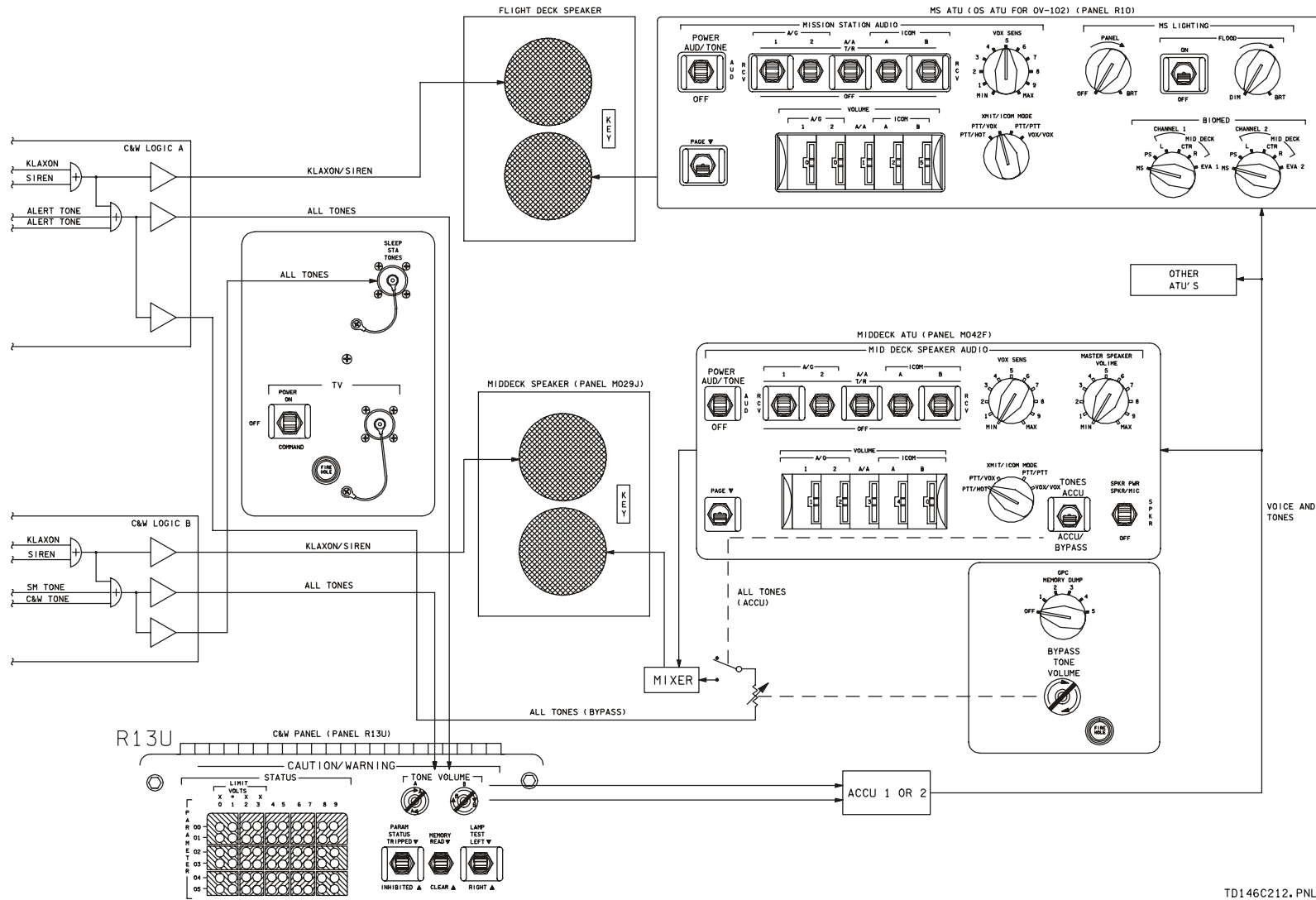


Figure 2-11. C&W tone distribution

TD146C212, PNL 2

### **2.12.2 UHF SPLX and SSOR**

The UHF SPLX and SSOR transceivers (XCVRs) reside in avionics bay 3A. The UHF SPLX XCVR is used as a backup voice RF link to MCC during ascent and entry. The SSOR is used as a voice, command, and telemetry link to the ISS and EVA crewmembers.

The UHF switches on Panel O6 control both the UHF SPLX system and the SSOR. (See Figure 2-12).

The UHF SPLX XCVR (Figure 3-9) is called the EVA/ATC XCVR in other documents, such as the In-Flight Maintenance (IFM) book. It was used for EVA communications before the SSOR was flown on STS-96. ATC stands for Air Traffic Control, which still properly defines its usage.

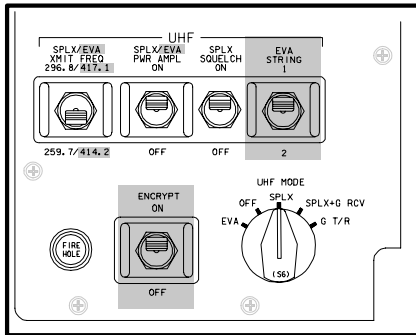
MCC monitors the status and configuration of the UHF XCVR and SSOR through the PCMMU telemetry data.

### **2.12.3 UHF SIMPLEX (SPLX)**

The UHF SPLX XCVR is used as a backup to the S-band PM RF system for voice COMM with MCC during ascent and entry. It may be used on orbit but is normally powered OFF. Figure 2-12 represents the ascent and entry configuration. COMM is limited to STDN ground sites that support UHF, such as Merritt Island (MILA), Florida. The Malfunction Procedures book lists the sites which currently support UHF Simplex communications.

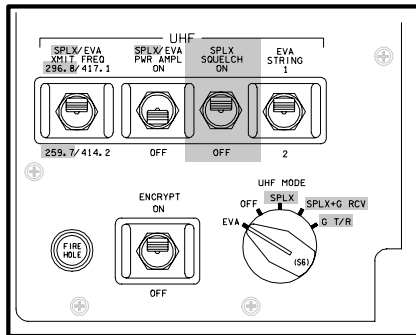
Figure 2-13 illustrates the relationship between frequency bands within the radio frequency spectrum. UHF is defined as frequencies between 200 and 3000 MHz. The orbiter uses frequencies in the 200-MHz range (for UHF SPLX) and 400-MHz range (for SSOR).

### UHF SPLX Switches



- When mode switch in SPLX, SPLX+G RCVR, or GT/R:
  - UHF SPLX XCVR is ON
  - SSOR is OFF
- XMIT FREQ (259.7 and 298.6), PWR AMPL, and squelch switches are functional
- EVA STRING and ENCRYPT switches are non-functional

### SSOR Switches



- When mode switch in EVA,
  - UHF SPLX XCVR is OFF
  - SSOR is ON
- XMIT FREQ (414.2 and 417.1), PWR AMPL, EVA STRING, and ENCRYPT switches are functional
- Squelch switch is non-functional

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**Figure 2-12. UHF O6 Panel, SIMPLEX mode**

Transoceanic Abort Landing (TAL) sites relay UHF SPLX COMM to MCC through the International Marine Satellite (INMARSAT) system. UHF guard (243.0 MHz) is available at most U.S. landing fields, and is used by the crew for East Coast Abort Landings (ECALs).

The prime UHF XCVR antenna is mounted on the bottom of the orbiter and is protected by the heat shield (see Figure 3-9).

Figure 2-12 illustrates the UHF Panel O6 in the prime SIMPLEX mode. In this mode, the UHF XCVR can transmit and receive on one of two frequencies.

- 259.7 MHz (prime)
- 296.8 MHz (alternate frequency)

The selection is made with the XMIT FREQ switch.

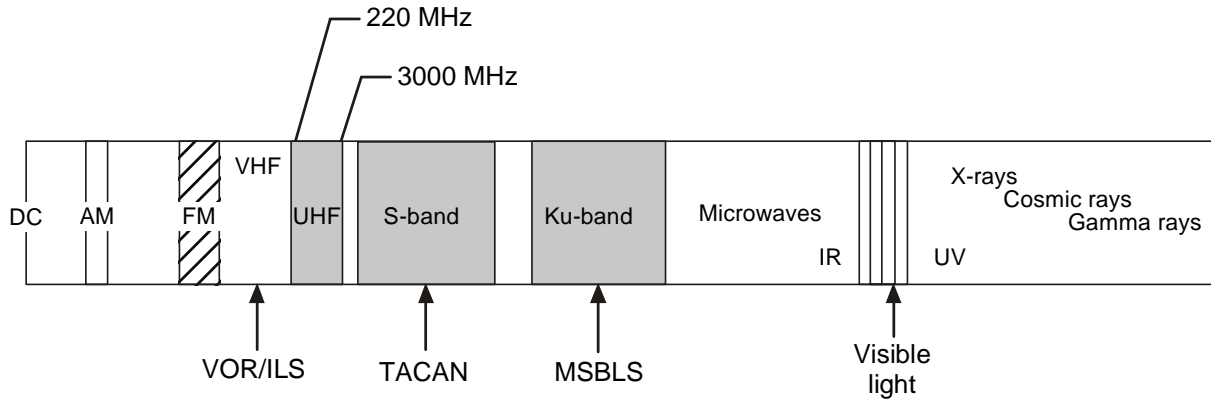
The UHF SPLX system is always in SIMPLEX mode, which means that transmission and reception are on the same frequency; therefore, the crew cannot TALK and LISTEN at the same time.

Table 2-1 illustrates the frequency combinations for the three SPLX modes available. The guard channel also operates as a simplex system.

**Table 2-1. UHF SPLX frequency modes**

		Orbiter transceiver operational modes			
		OFF	SIMPLEX	SIMPLEX + G RCV	G T/R
X M I T  f r e q u e n c y	2 9 6 - 8	OFF	296.8 MHz T/R voice	296.8 MHz T/R voice  243.0 MHz RCV voice	243.0 MHz T/R voice
	2 5 9 - 7	OFF	259.7 MHz T/R voice	259.7 MHz T/R voice  243.0 MHz RCV voice	243.0 MHz T/R voice

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Orbiter frequencies		
UHF SPLX	243.0	MHz
	259.7	MHz
	296.8	MHz
SSOR	414.2	MHz
	417.1	MHz
S-band PM TRANSMIT	2217.5	MHz
	2287.5	MHz
RECEIVE	2041.9	MHz
	2106.4	MHz
S-band PAYLOAD	1763.721 - 2300.875	MHz
S-band FM	2250.0	MHz
Ku-band TRANSMIT	13.775	GHz
RECEIVE	15.0034	GHz

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**Figure 2-13. Radio frequency spectrum chart**

The power output in the SIMPLEX mode is normally 10 watts. The UHF SPLX XCVR output is routed through a power amplifier to achieve the 10-watt output. If necessary, power amplifier can be bypassed by selecting OFF with the Panel O6 SPLX PWR AMPL switch. The transmitted output is then reduced to 0.25 watts.

The receiver is provided with a squelch circuit to reduce background interference. The SQUELCH switch on Panel O6 is normally ON, but can be selected to OFF if the incoming UHF signal is weak or unreadable.

If a crewmember XMIT keys the microphone from the ATU, audio on the A/A loop is routed to the UHF XCVR. The KEY signal follows the SDW path to the ACCU, which routes a signal to the Transmit (TX) KEY line and keys the transmitter.

During SIMPLEX operation, the A/A loop on the ATU must be positioned to T/R for the XMIT KEY to reach the UHF XCVR.

If UHF SPLX + G REC is selected on Panel O6, a 243.0-MHz receiver is added to the SIMPLEX configuration, and transmissions from all ground locations can be heard on the GUARD channel. The GUARD frequency is an internationally accepted emergency channel.

Selecting G T/R on the UHF MODE switch enables transmit and receive on the GUARD channel frequency in the SIMPLEX mode. All other frequencies are disabled.

#### 2.12.4 EVA (SSOR)

Extravehicular Communication (EVC) is facilitated through the orbiter SSOR UHF system. The SSOR is a separate system from the 200-MHz SPLX system. The SSOR configuration is controlled from orbiter Panel O6.

The SSOR transmits and receives on the same frequency (414.2 MHz prime, or 417.1 MHz backup) but provides duplex operation by incorporating Time Division Multiplexing (TDM) for up to five separate users. Figure 2-16 illustrates the orbiter, ISS, and two EVA users. TDM slots may be used as indicated in the illustration. All the UHF radios are the same, the different acronyms identifies the user:

- a. Space-to-Space Orbiter Radio (SSOR): on the shuttle
- b. Space-to-Space Space Station Radio (SSSR): on the ISS
- c. Space-to-Space EVA Radio (SSER): in the backpack of each EMU

Together these radios make up the Space-to-Space Communications System (SSCS). The distance indicators represent the maximum distances for each type user combination. Operationally, low power is always used (~0.25 watts) since high power exceeds National Telecommunications and Information Administration (NTIA) spectrum certification limits. The system automatically assigns slots as users are added or removed. The SSOR has two antennas: one in the payload bay and one in the airlock. The airlock antenna provides an RF link to the suit during pre-EVA checkout. The [RF power output specifications follow in Table 2-2.](#)

**Table 2-2. SSOR RF Power Output**

	Low Power	High Power
Payload Bay Antenna	0.2 to 0.7 W	2 to 14 W
Airlock Antenna	0.0001 to 0.0005 W	0.002 to 0.01 W

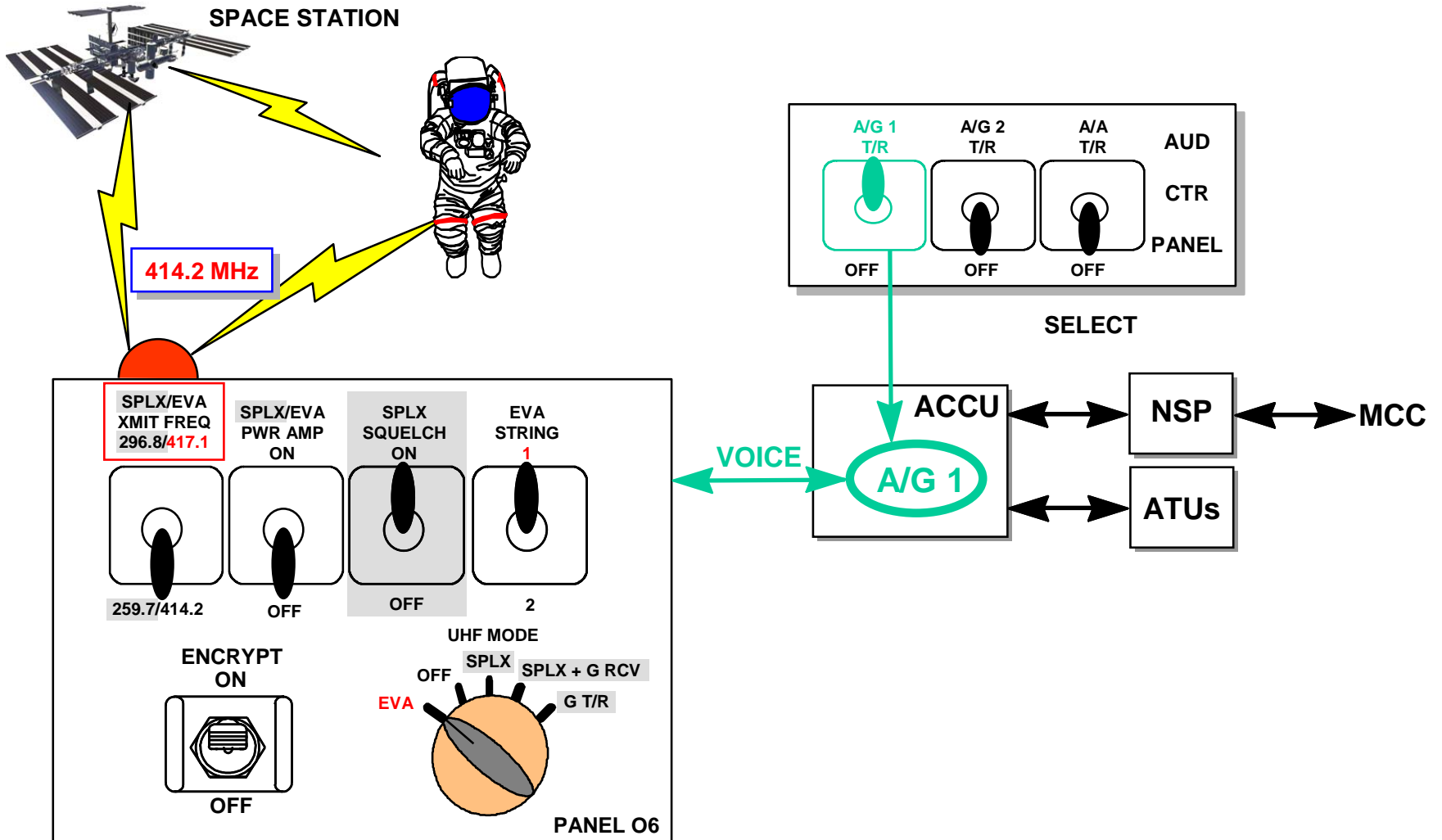
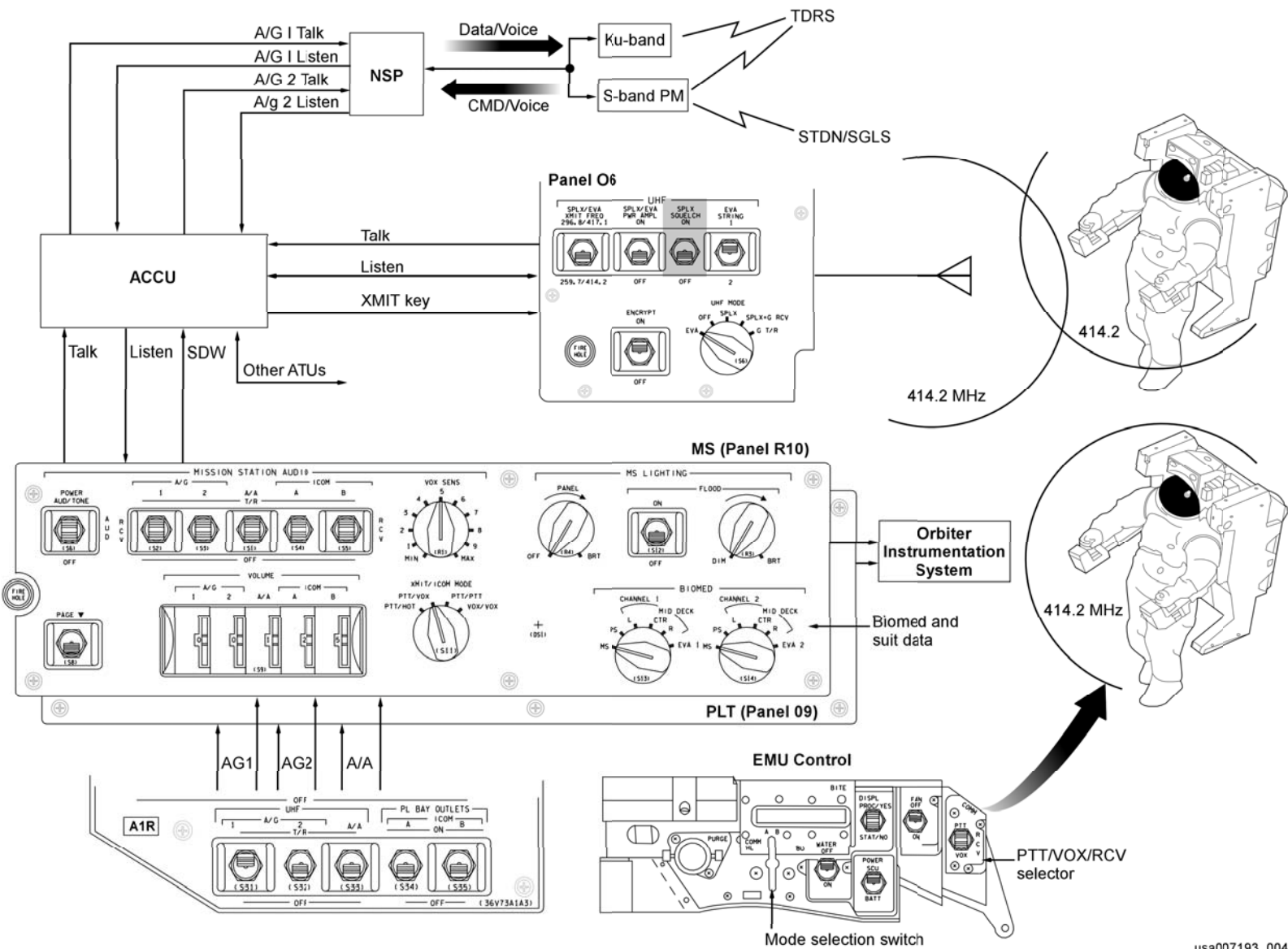


Figure 2-14. EVA configuration

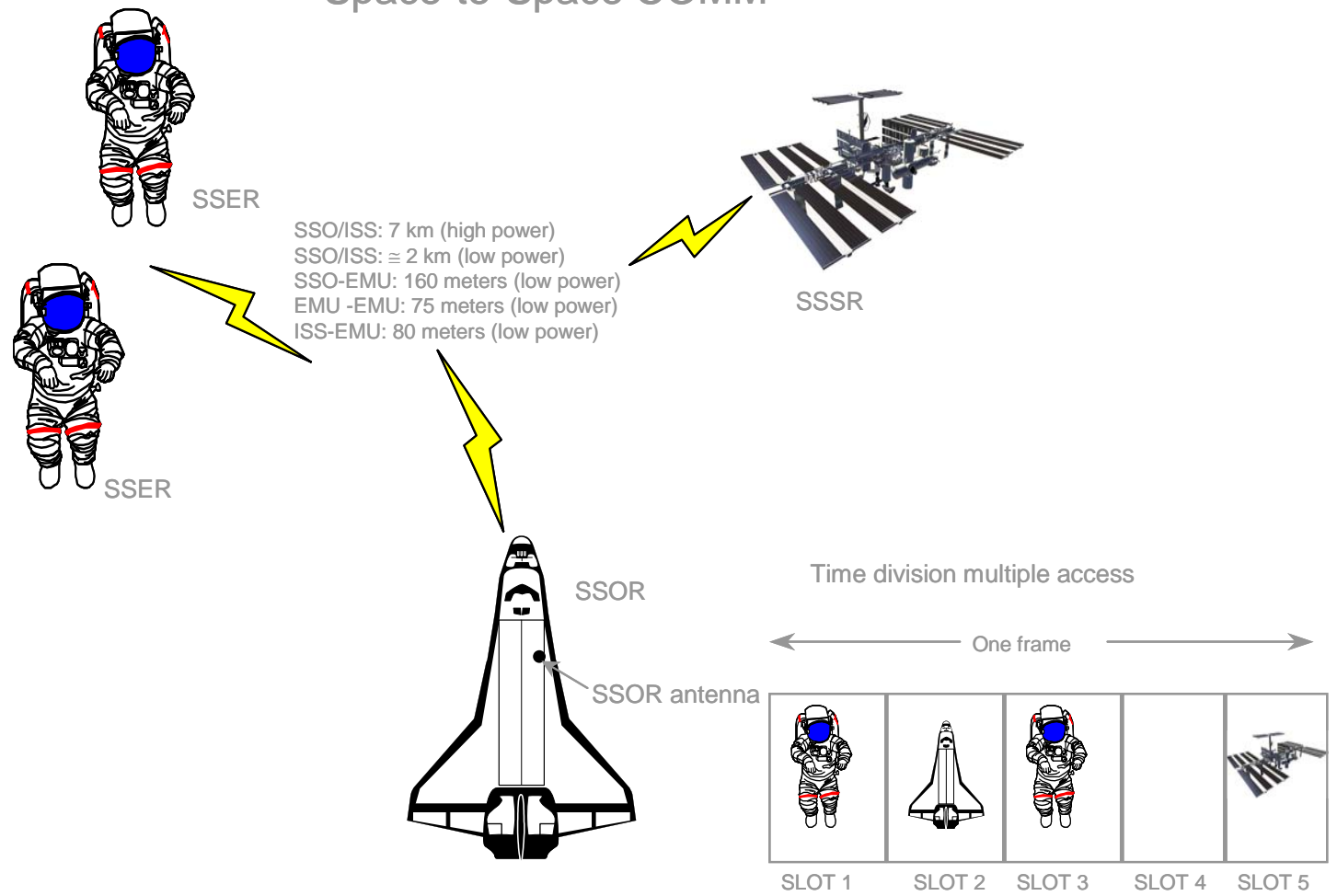


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Figure 2-15. SSCS users



# Space-to-Space COMM



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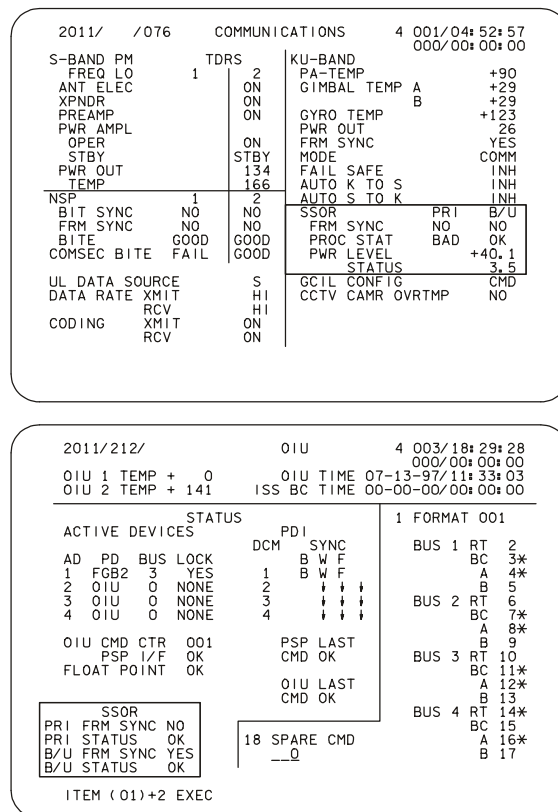
Figure 2-16. Time division multiplexing

### 2.12.5 MCC-to-EVA COMM

The UHF A/G 1 and A/G 2 selections on Panel A1R have been provided to enable MCC to listen and talk to the EVA crewmembers. Selecting UHF A/G 1 T/R on Panel A1R connects A/G 1 in the ACCU to the SSOR. MCC always has access to A/G 1 in the ACCU through the S-Bd PM or Ku-band systems, and may communicate with the EVA crew through this loop. The orbiter crew also communicates with the EVA crewmembers and CAPCOM through the same configurations. With appropriate selections, A/G 2 may also be used in the same way. The A/A T/R switch selection on Panel A1R connects the SSOR to the A/A loop. This connection allows communications between the orbiter and EVA crew without MCC hearing on A/G1 or A/G2.

### 2.12.6 SSOR Status

Status of the SSOR is displayed on orbiter Cathode Ray Tube (CRT) displays COMMUNICATIONS SPEC 76 and Orbiter Interface Unit (OIU) SPEC 212. Figure 2-17 illustrates the backup (B/U) SSOR, **SSOR 2** activated.



TD1460217. CRT: 2

**Figure 2-17. COMMUNICATIONS SPEC 76  
and OIU SPEC 212**

## 2.13 QUESTIONS

**Note:** There may be more than one correct answer per question.

1. Choose three of the five lines that connect the headset to a CCU.
  - (a) TALK, LISTEN, and VOX
  - (b) TALK, LISTEN, and POWER
  - (c) TALK, LISTEN, and SDW
2. Choose the three lines that connect the ATU to the ACCU.
  - (a) TALK, LISTEN, and PTT
  - (b) TALK, LISTEN, and VOX
  - (c) TALK, LISTEN, and POWER
  - (d) TALK, LISTEN, and SDW
3. True or **False**. Loop selection in the ACCU is accomplished by the interpretation of the code in a serial data word.
4. Which of the following loops have individual thumbwheel volume controls?
  - (a) A/G 1
  - (b) C&W tones
  - (c) PAGING
  - (d) TACAN
5. True or **False**. The PAGE loop is keyed by pressing the HIU ICOM pushbutton.
6. The PAGE loop is routed to which UHF systems?
  - (a) UHF SPLX
  - (b) SSOR
  - (c) both

7. The VOX SENSITIVITY control is used to adjust the
  - (a) Headset listen volume
  - (b) Speaker volume
  - (c) Microphone keying level
  - (d) PAGE loop VOX keying
8. The ATU CONTROL switch allows you to
  - (a) Select loops
  - (b) Select microphone keying modes
  - (c) Work around an ATU failure
  - (d) Control headset volume
9. ICOMA and ICOMB loops may be keyed by using the
  - (a) HIU XMIT pushbutton
  - (b) HIU ICOM pushbutton
  - (c) VOX keying method
10. True or **False**. The A/G voice loops are routed to the NSP for voice communications with MCC. |
11. True or **False**. MCC cannot tell which ACCU is active through telemetry. |
12. Headset sidetone originates in the
  - (a) ATU
  - (b) ACCU
  - (c) HIU
  - (d) MHA
13. The top speaker on the SU responds to
  - (a) Voice only
  - (b) All C&W tones
  - (c) Voice and C&W tones
  - (d) Klaxon and siren only

14. True or **False**. The bottom SU speaker is muted when the KEY indicator is lit.
15. A/G 2 cannot be used for MCC voice communications if
  - (a) The PLT ATU has A/G 2 selected to OFF
  - (b) The MS ATU power switch is selected to OFF
  - (c) UHF is OFF
  - (d) The NSP is moded to low data rate
16. A/G 1 and A/G 2 downlink audio are lost if
  - (a) The PLT and the MS ATUs are powered OFF simultaneously
  - (b) The PS and the MS ATUs are powered OFF simultaneously
  - (c) The MS ATU only is powered OFF
  - (d) The PLT ATU only is powered OFF
17. Two audio loops may be routed to the Solid State Recorders from the NSP. The selection of these two loops is made on the
  - (a) **Audio Center Panel**
  - (b) **NSP Panel**
  - (c) **Solid State Recorders Panel**
  - (d) **S-Bd FM Panel**
18. True or **False**. The purpose of the UHF A/G 1 switch on the AUDIO CENTER Panel is to provide a way for the MCC to communicate with EVA personnel.
19. All four C&W tones are routed to
  - (a) The docked ISS
  - (b) The headsets
  - (c) The NSP
  - (d) The UHF system for EVA operations

20. All four C&W tones which bypass the ACCU are routed to
- (a) All headsets
  - (b) The flight deck SU
  - (c) Sleep station
  - (d) The middeck SU
21. UHF SPLX transmissions may be routed to MCC through
- (a) The TDRSS
  - (b) Selected STDN ground sites
  - (c) The ISS audio and RF systems
  - (d) INMARSAT relay at a TAL site
22. The SPLX UHF antenna is mounted
- (a) On the top of the orbiter crew compartment
  - (b) In the cargo bay
  - (c) On the tip of the vertical fin
  - (d) On the bottom of the orbiter
23. The SSOR antenna is mounted
- (a) On top of the orbiter crew compartment
  - (b) In the cargo bay
  - (c) On the tie of the vertical fin
  - (d) On the bottom of the orbiter
24. In the SIMPLEX mode, the UHF system normally transmits at
- (a) 10 watts
  - (b) 0.25 watts
  - (c) 30 watts
  - (d) 25 watts

25. True or **False**. The A/A loop on an ATU must be positioned to T/R for the HIU XMIT KEY to reach the UHF XCVR. |

**Note:** See Pages B-1 and B-2 for answers to these questions.

### 3.0 FUNCTIONAL LOCATION

The ADS panels, switches, cb's, and electronic circuits are scattered throughout the orbiter. In some cases, the common association of the different parts is not obvious. Figure 3-1 shows the commander's COMM station.

### 3.1 OBJECTIVE

After studying this section, the student will understand the relationship of the panels and controls associated with each orbiter audio crew station

### 3.2 COMMANDER COMM STATION

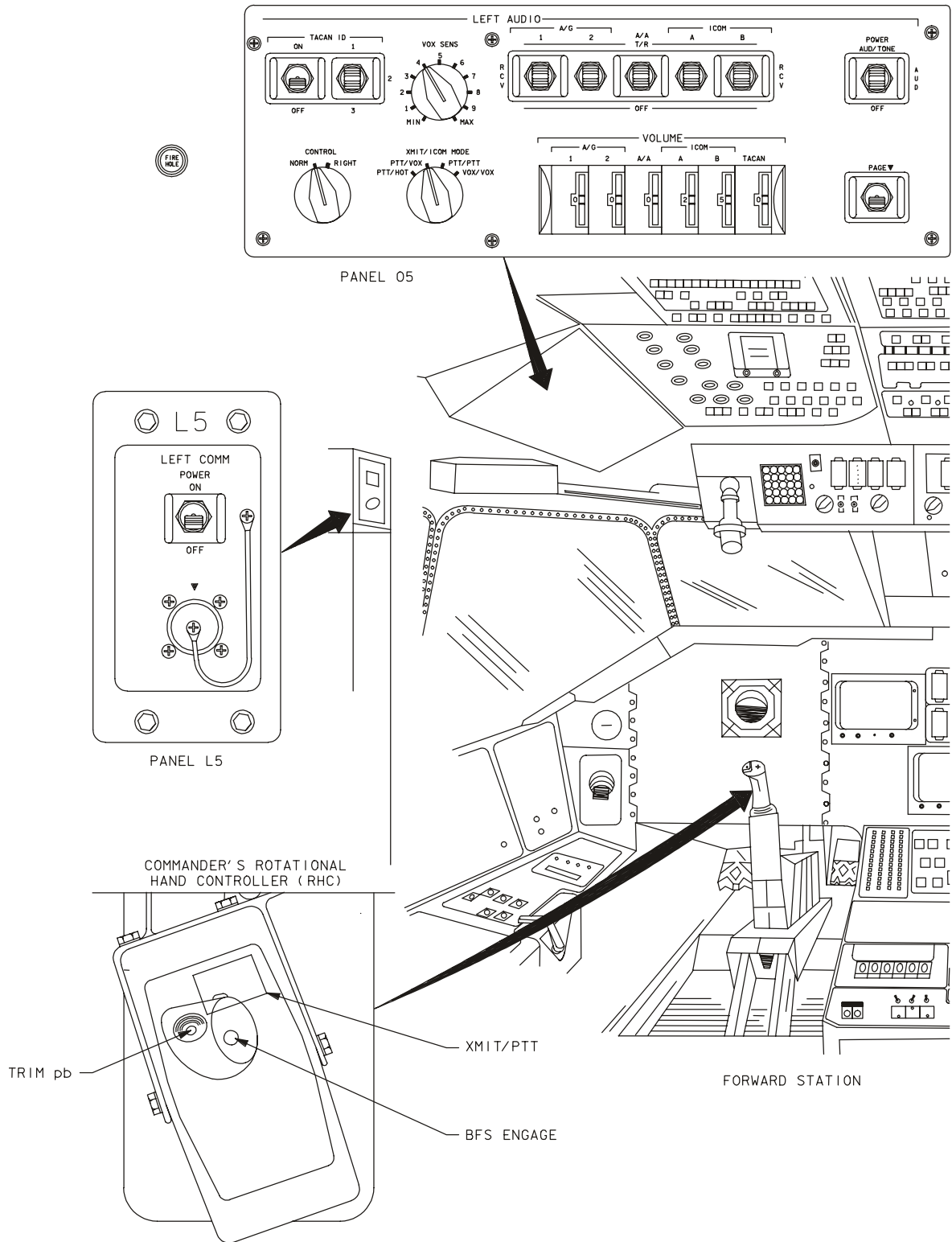
Figure 3-1 illustrates the location of panels and controls associated with the commander's COMM station.

The AUDIO LEFT cb on aft station Panel R14 controls ESS 1BC bus power to the forward left station AUDIO POWER switch on [Panel O5](#) and the left COMM POWER switch on [Panel L5](#).

The commander's RHC is provided with a XMIT PTT pushbutton for microphone keying on the A/G, A/A, and ICOM voice loops.

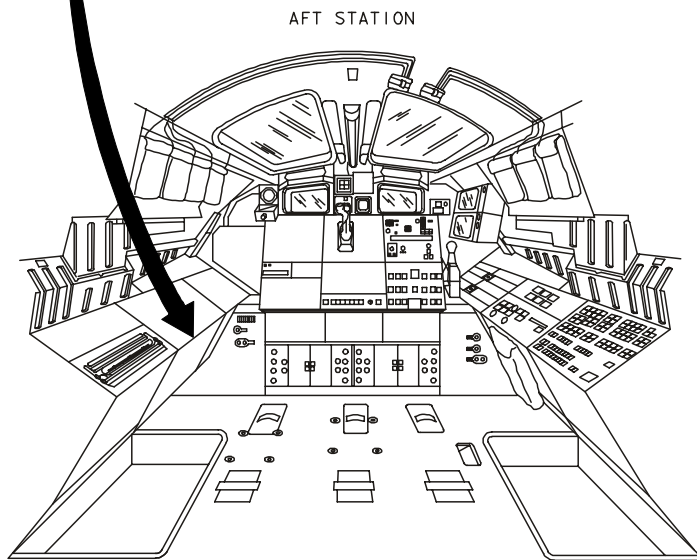
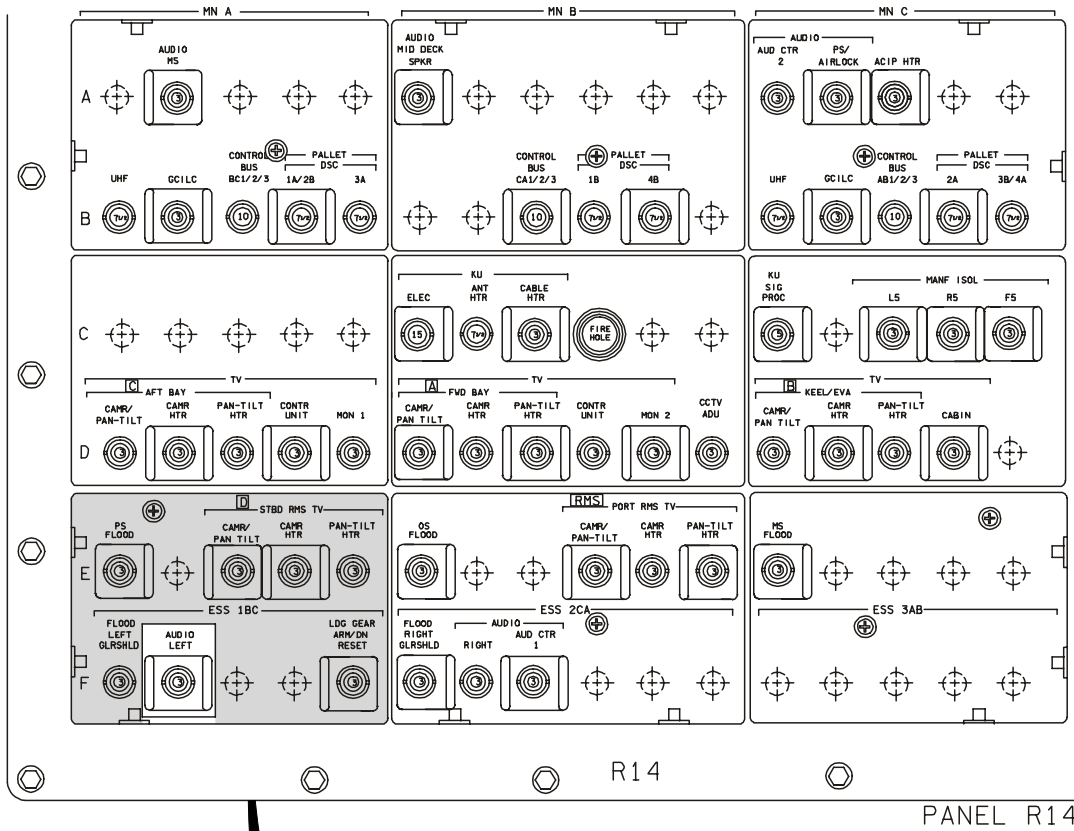
- The CONTROL switch is used to switch the commander's headset to the pilot's ATU.





TD146C31A, PNL 1

**Figure 3-1. Commander's COMM station**



usa007193\_007

**Figure 3-1. Commander's COMM station (concluded)**

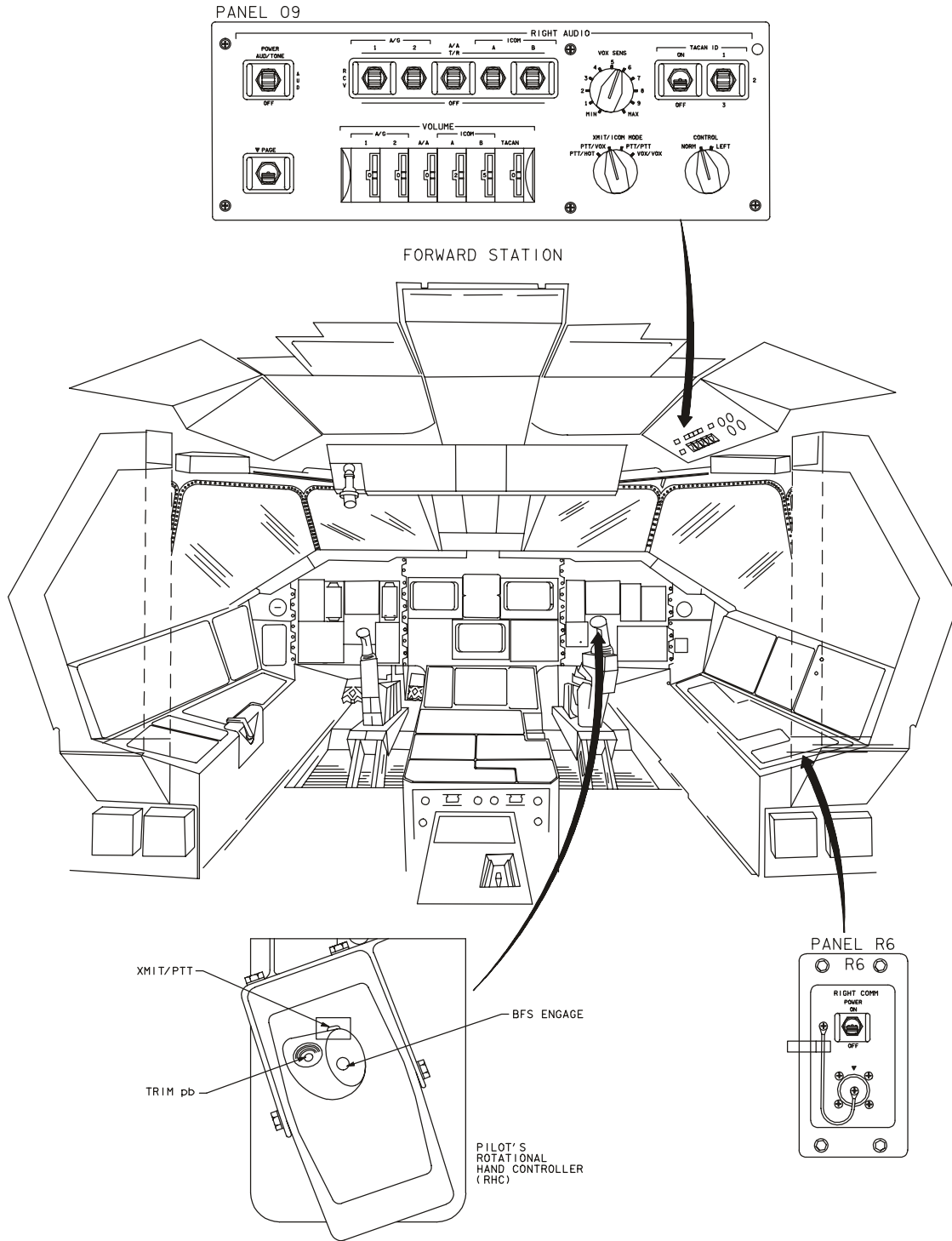
### 3.3 PILOT COMM STATION

Figure 3-2 illustrates the location of panels and controls associated with the pilot's COMM station.

The AUDIO RIGHT cb on aft station Panel R14 controls ESS 2CA bus power to the forward right station AUDIO POWER switch on Panel O9 and the right COMM POWER switch on [Panel L5](#).

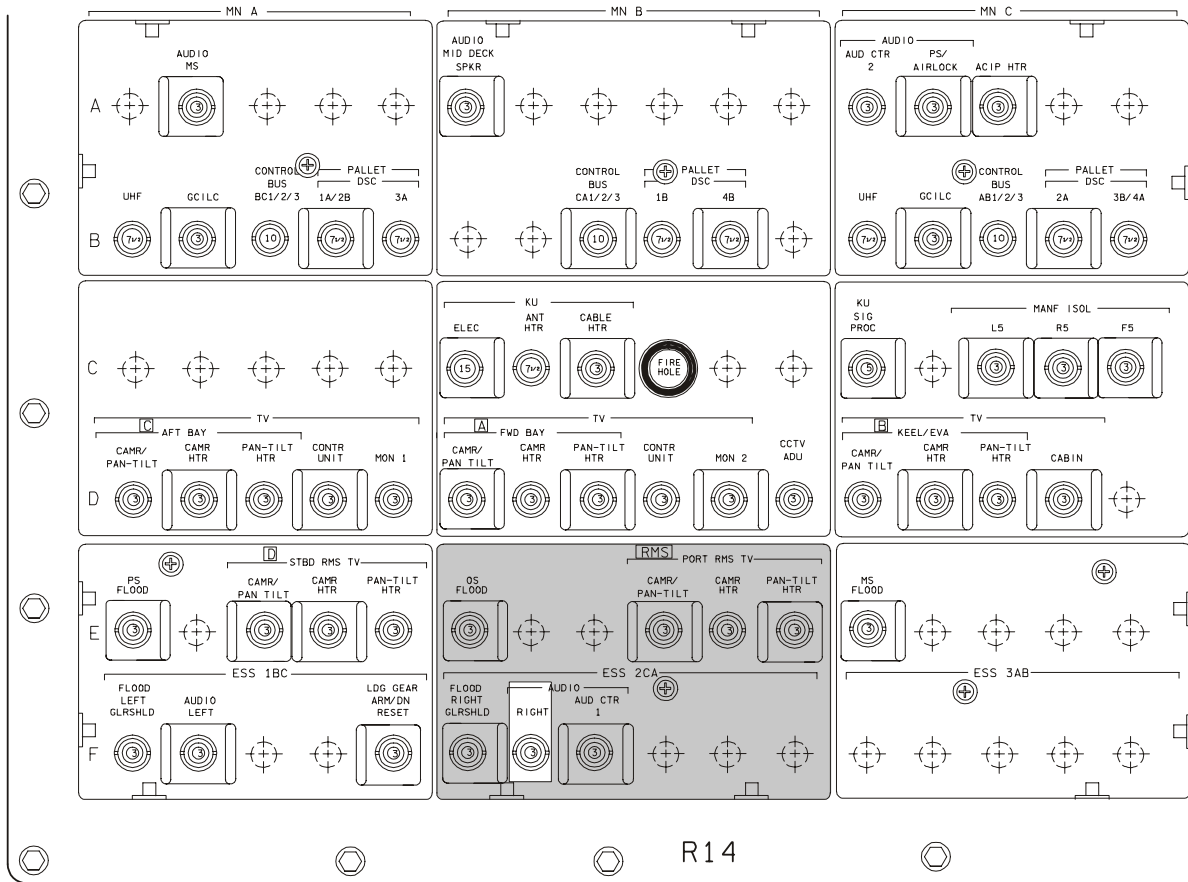
The pilot's RHC is provided with a XMIT PTT pushbutton for microphone keying on the A/G, A/A, and ICOM voice loops.

The CONTROL switch is used to switch the pilot's headset to the commander's ATU.

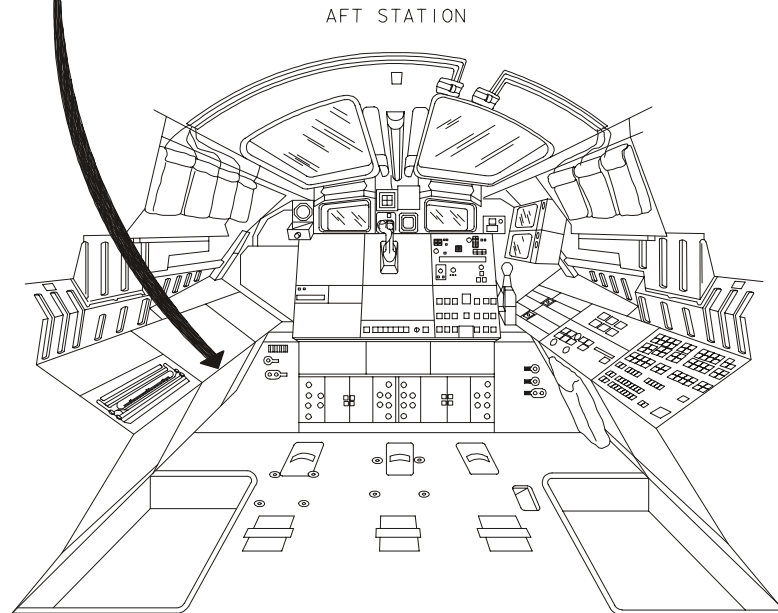


TD146C32A, PNL: 1

Figure 3-2. Pilot's COMM station



PANEL R14



TD146C32B, PNL § 1  
TD146C\_032b.cns

Figure 3-2. Pilot's COMM station (concluded)

### 3.4 MISSION STATION

Figure 3-3 illustrates the location of all panels and controls associated with the mission station.

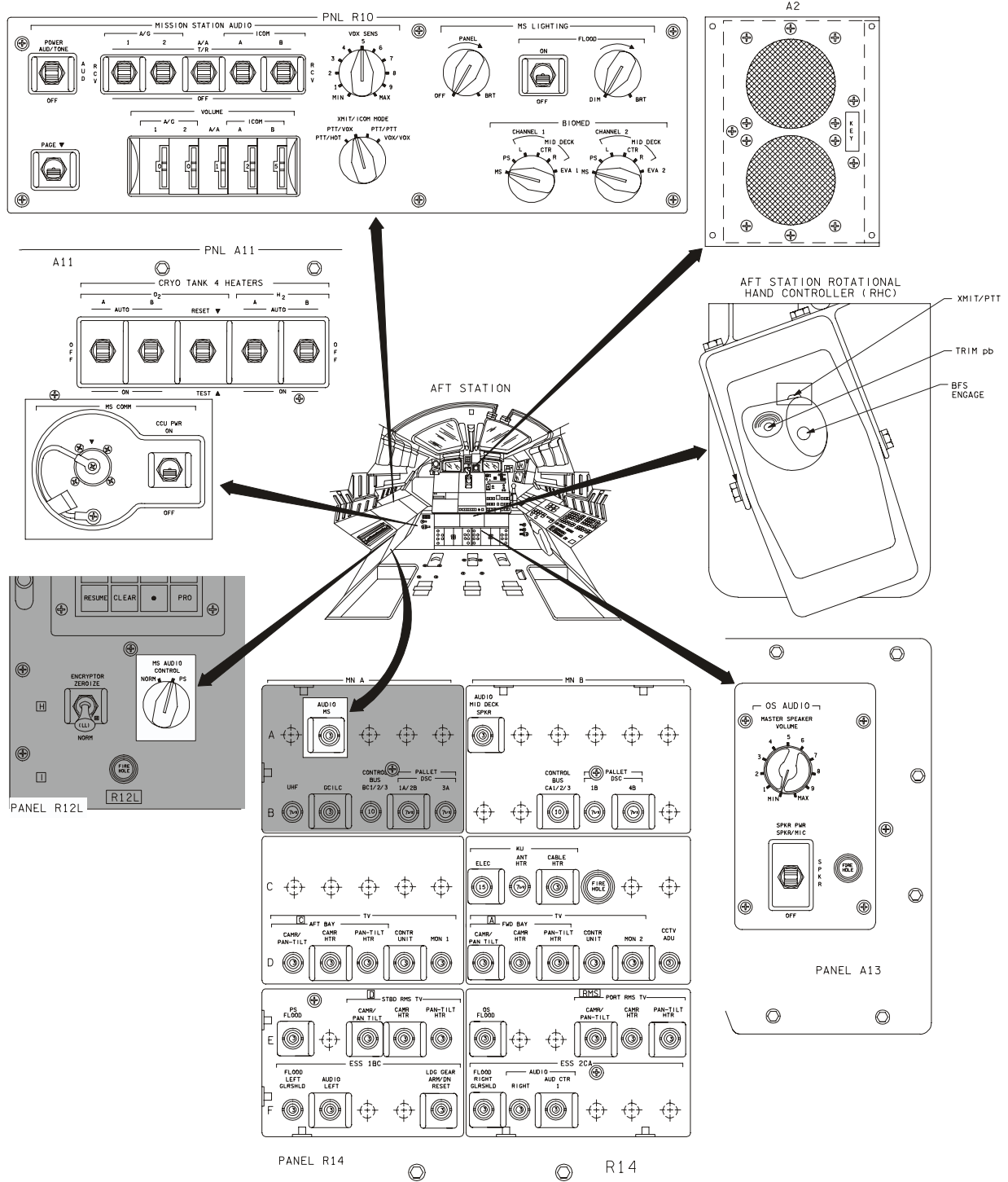
The MS cb on aft station Panel R14 controls MNA bus power to the mission station, Panel R10, the MS COMM CCU POWER switch on Panel A11, and the SPKR PWR switch on Panel A13.

The aft station RHC is provided with a XMIT PTT pushbutton for microphone keying on the A/G, A/A, and ICOM voice loops through the mission station.

Panel R12L is provided with an MS AUDIO CONTROL switch to route the MS COMM receptacle on Panel A11 and the RHC PTT pushbutton wiring to the payload station panel in case the mission station fails. CCU PWR is not included in this wiring.

Power and volume control for the aft station speaker is provided on Panel A13. The speaker wiring is routed to the MS audio panel circuitry and does not switch to the payload station panel when the MS AUDIO CONTROL switch is set to PS.

Selection of the EVA 1 and EVA 2 biomedical (biomed) data from the SSOR is made on the biomed section of the mission station panel.



TD146C303, PNL 1

Figure 3-3. Mission station

### **3.5 PAYLOAD STATION**

Figure 3-4 illustrates the location of all panels and controls associated with the payload station.

The PS/AIRLOCK cb on aft station Panel R14 controls MNC bus power to the PS COMM Panel L9 and the PS COMM CCU PWR switch on Panel A15. This cb also controls power to the AIRLOCK COMM station (Figure 3-6).

The PS serves as a backup to the MS and to airlock CCU 1.

Typically, the PAYLOAD STATION is used on orbit for connection to the Digital Television (DTV) recorders.



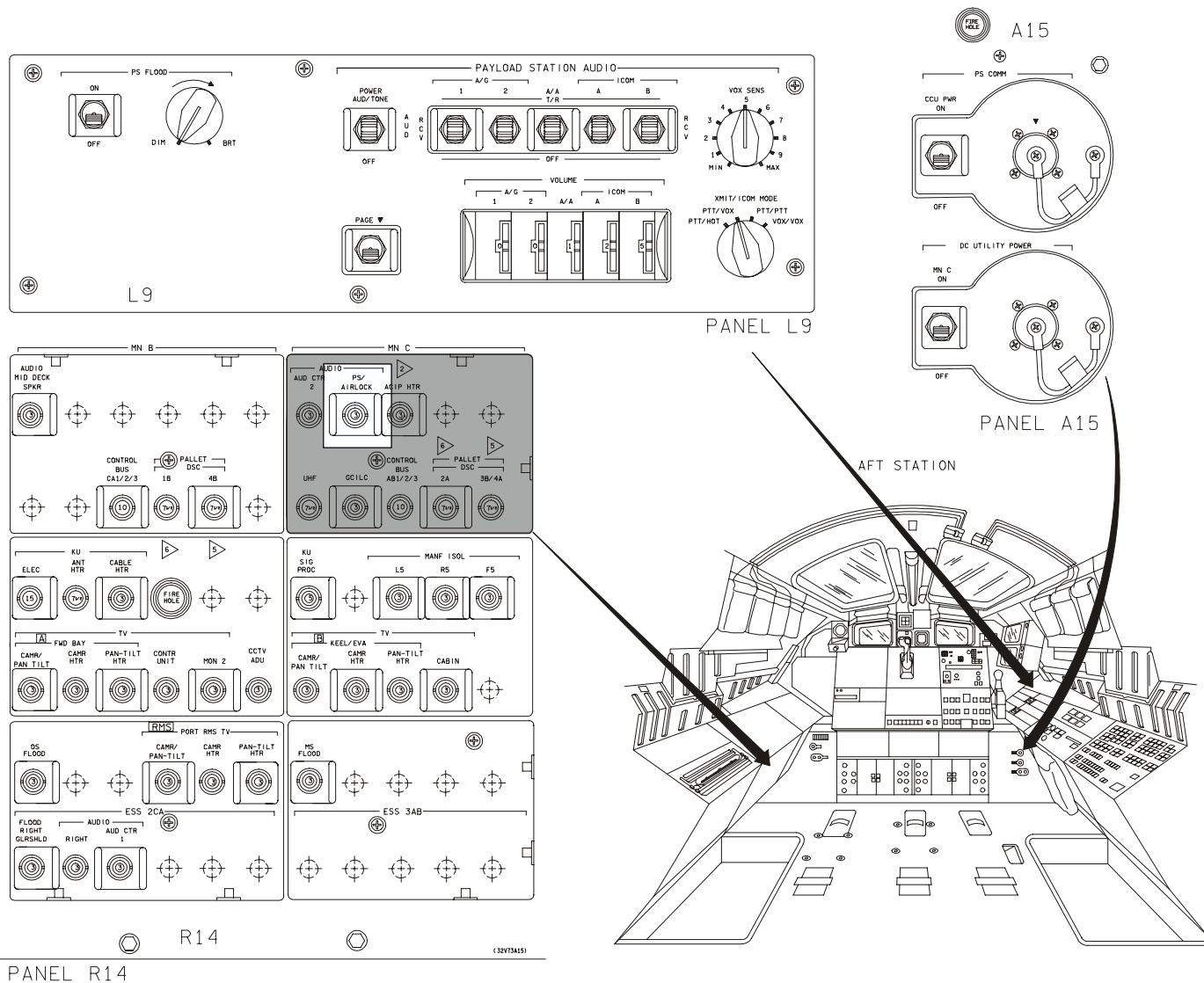


Figure 3-4. Payload station

### 3.6 MIDDECK STATION

Figure 3-5 illustrates the location of all the panels and controls associated with the middeck COMM crew station. All panels except the cb panel are mounted on the middeck ceiling.

The AUDIO MIDDECK SPKR cb on aft station Panel R14 controls MNB bus power for the MIDDECK SPEAKER AUDIO ATU, the SPKR PWR switch on Panel MO42F, and the MID DECK COMM CCU PWR switch on Panel MO39M. The ATU and the speaker POWER and the SPKR PWR switches are in series; therefore, the ATU and the speaker POWER switch must be on for the speaker to work.

Included in this configuration is the SU on Panel MO29J. The top speaker on the SU responds to Klaxon and siren tones directly from the C&W system. The bottom speaker responds to voice and C&W tones from ATU Panel MO42F. Volume and power controls for the SU are on the MO42F ATU.

A volume control, BYPASS TONE VOLUME, is provided on Panel MO42F to adjust the volume of the C&W tones applied to the bottom speaker through a mixer, bypassing the ACCU tones from the middeck ATU. These tones may be eliminated from the speaker by positioning the TONES switch to ACCU. If this switch is in the ACCU/BYPASS position, the ACCU BYPASS tones are added to the ACCU tones from the ATU.

Note: If MNB power is removed from the ATU, the bottom speaker on the SU will be unpowered, and the BYPASS tones will be lost. Klaxon and Siren, however, will still annunciate on the top speaker.

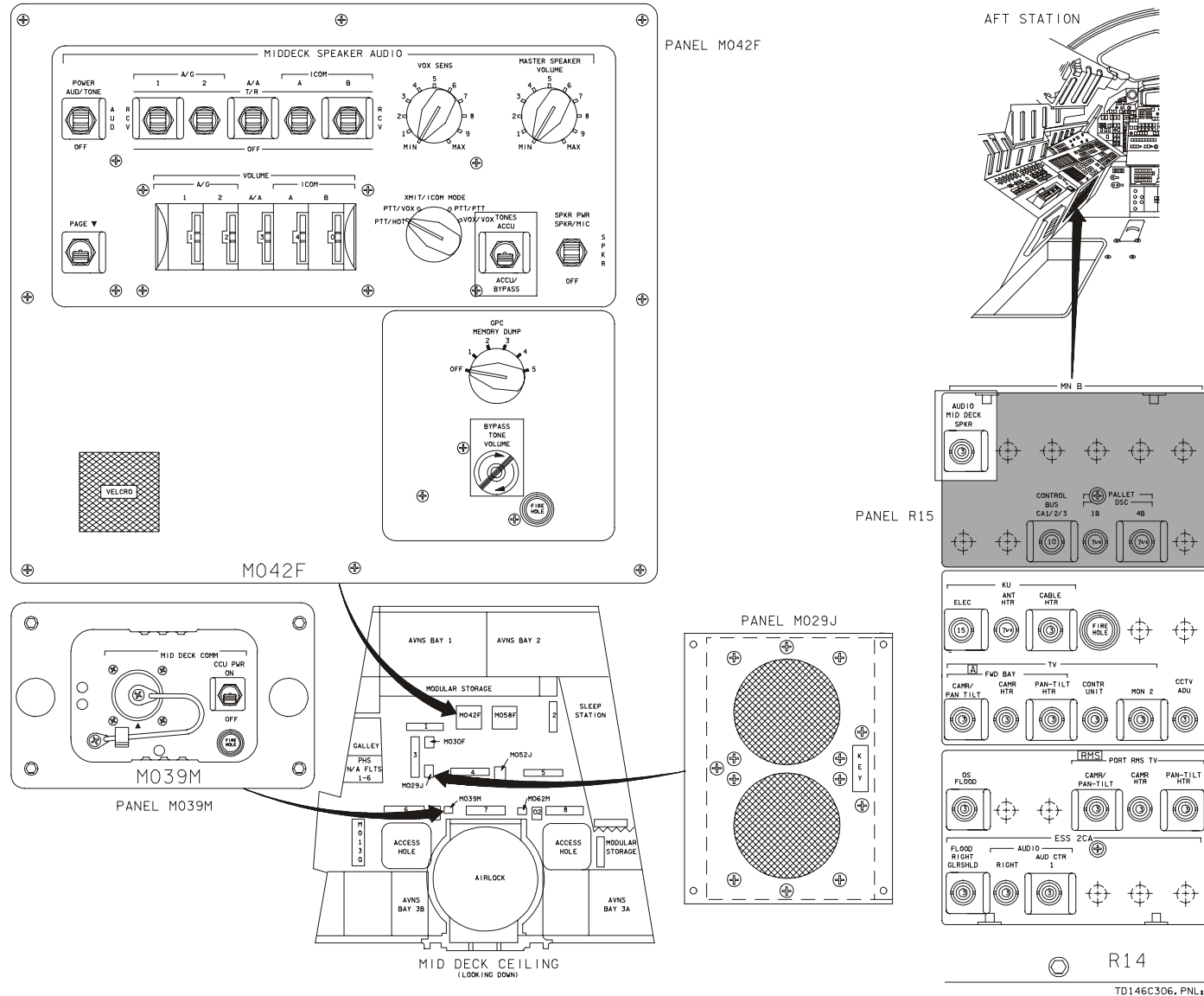


Figure 3-5. Middeck COMM crew station

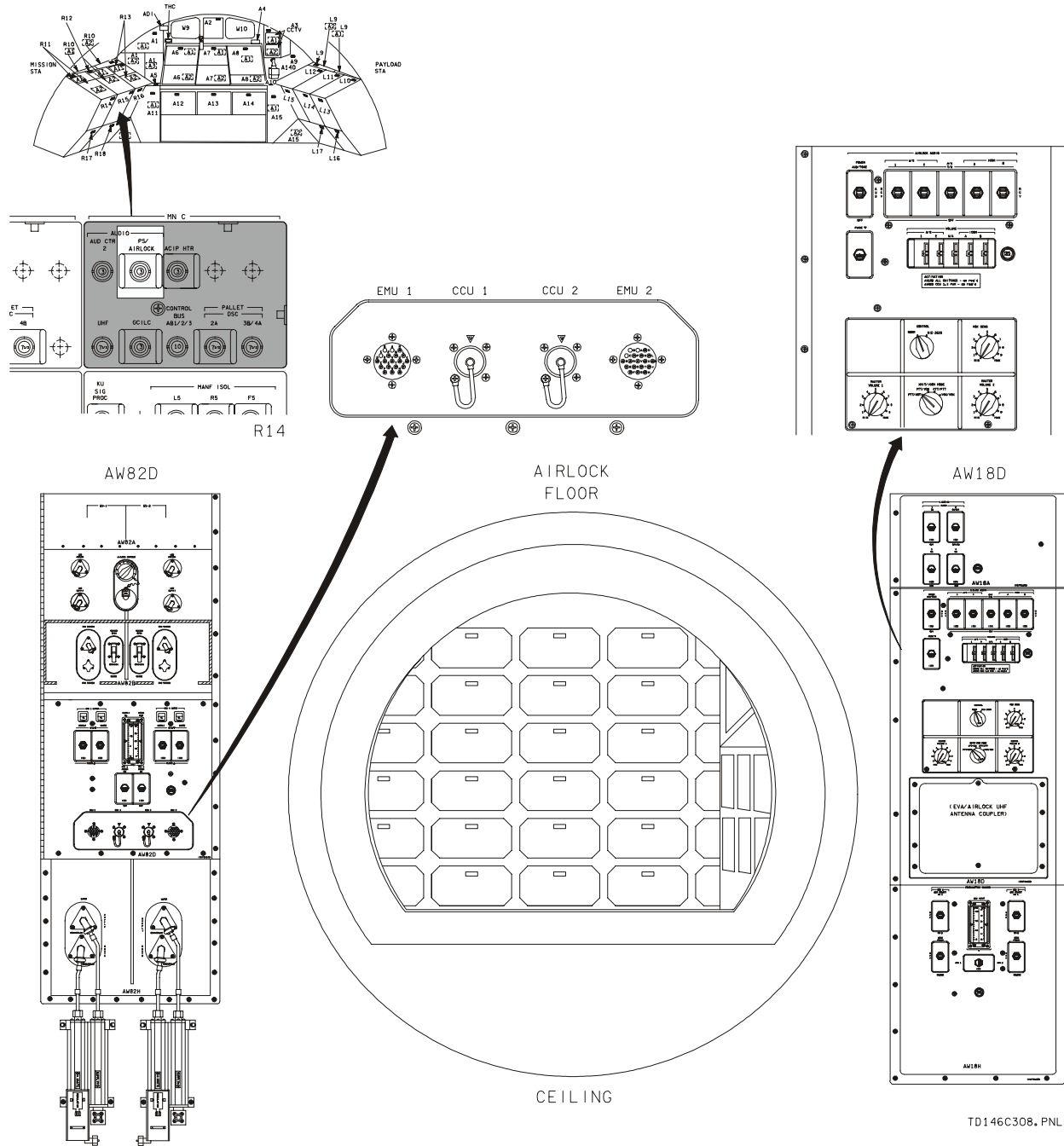
### 3.7 AIRLOCK STATION

Figure 3-6 illustrates the location of panels and controls associated with the airlock audio crew station. The panels are located on each side of the airlock door and are inverted, with the tops of the panels toward the orbiter floor.

Power for the ATU/CCU audio crew station is routed through the AUDIO PS/AIRLOCK cb on Panel R14. Unlike the other ATU/CCU audio crew stations, the airlock station has two CCUs. The TALK, LISTEN, and PTT lines of both CCU 1 and CCU 2 are parallel to each other in the ATU. In addition, the EMU 1 and EMU 2 connections have TALK, LISTEN, and PTT lines that are parallel to the CCU lines. The EMU connections are used for pre-EVA checkout. The audio lines in this connector become active when the MODE SELECTOR switch on the EMU control panel is in the HL position.

The CONTROL switch on Panel AW18D enables the crew to switch the CCU and EMU connectors on AW82D to middeck and PS audio panels if the airlock ATU fails.

- a. CCU 1 and EMU 1 to PS (flight deck Panel L9)
- b. CCU 2 and EMU 2 to middeck (middeck Panel MO42F)



TD146C308, PNL 1

**Figure 3-6. Airlock COMM crew station**

### **3.8 AUDIO CENTRAL CONTROL UNIT**

Figure 3-7 illustrates the location of the ACCU and associated controls.

The AUD CTR 1 cb located on aft station Panel R14 controls ESS 2CA bus power to the AUDIO CENTER 1 switch position on forward station Panel C3. The AUDIO CENTER 1 position of the switch routes ESS 2CA bus power to the ACCU primary circuitry.

The AUD CTR 2 cb controls MNC bus power to the ACCU secondary circuitry through the AUDIO CENTER 2 position of the Panel C3 switch.

The ACCU is located in middeck avionics bay 1. Both primary (1) and secondary (2) circuits are contained in the single ACCU Line Replaceable Unit (LRU).

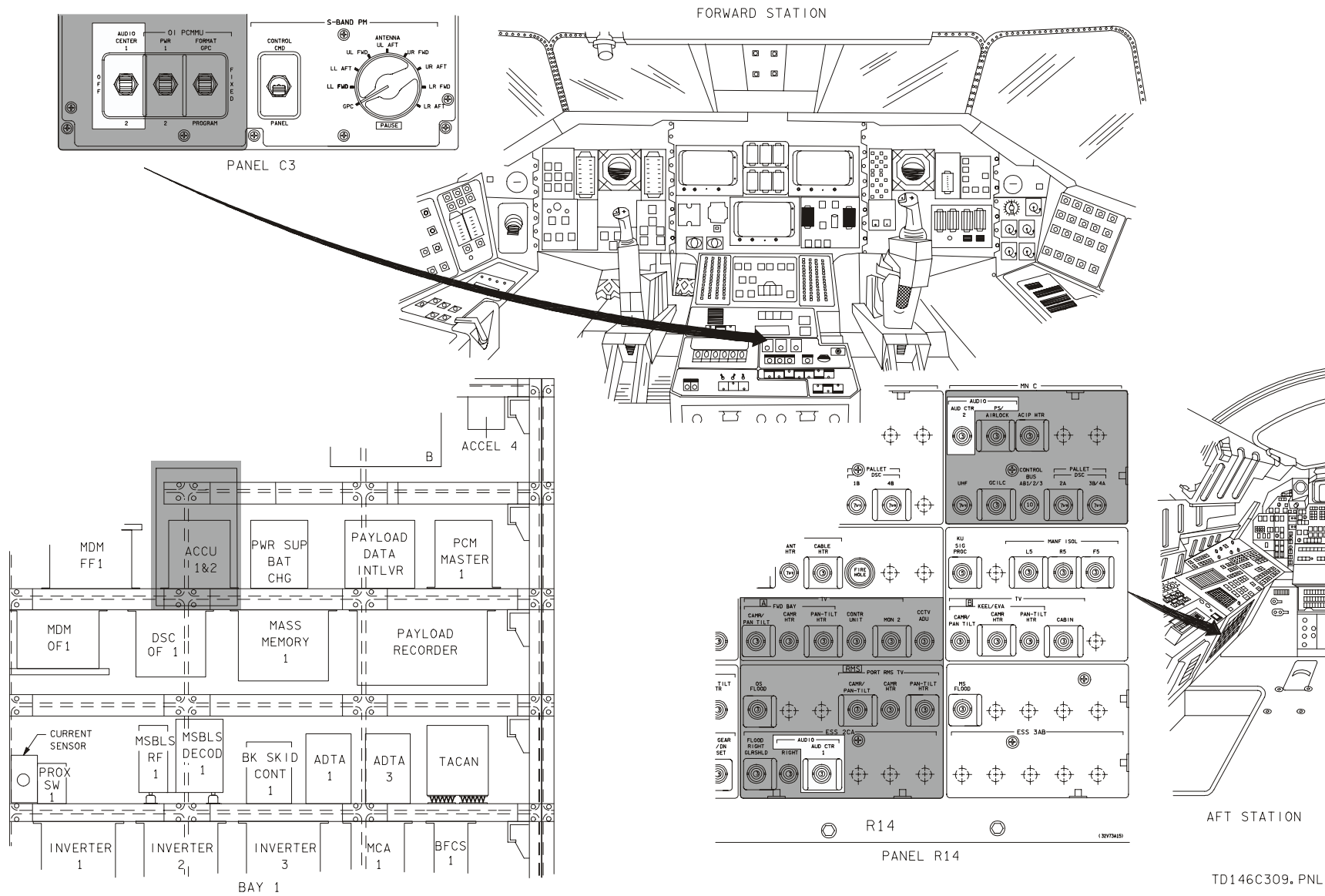
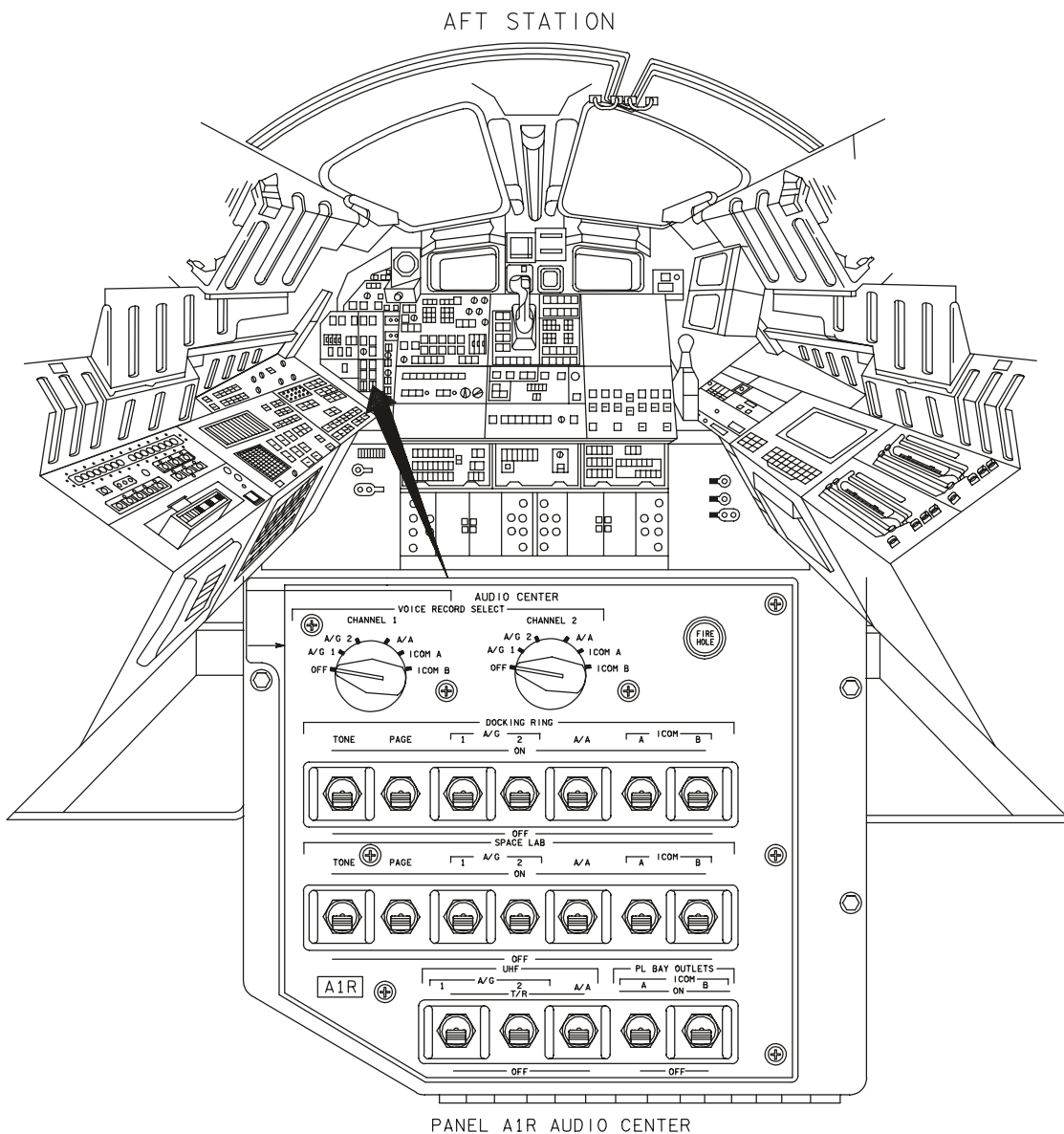


Figure 3-7. Audio central control unit

### 3.9 AUDIO CENTER PANEL

Figure 3-8 illustrates the audio center controls located on aft station Panel A1R, which provides switches to select the following:

- a. Voice audio for the Solid State Recorders
- b. Voice loops for docked ISS or Spacehab (through the SPACELAB switches)
- c. Voice routing for ISS and EVA comm via SSOR (through the UHF switches)
- d. The DOCKING RING and PL BAY OUTLETS switches are non-functional for flight.



**Figure 3-8. Audio Center Panel**

TD146C310. PNL 1



### **3.10 UHF TRANSCEIVER**

The two orbiter UHF transceiver systems are the UHF SPLX transceiver and the SSOR.

#### **3.10.1 UHF SPLX Transceiver**

Figure 3-9 illustrates the location of panel and controls for the SPLX UHF system. Included is the location of the UHF transceiver (EVA ATC XCVR) LRU.

The UHF cb's on aft station Panel R14, Row A, control MAIN A (MN A) bus and MNC bus power to the SPLX UHF transceiver. Loss of the MNA power source causes loss of the UHF power amplifier. The UHF power transmission is reduced from 10 to 0.25 watts. MNC power is a backup to MNA for low power operations.

The UHF controls located on overhead Panel O6 in the forward station control the UHF modes.

The external UHF antenna is located under the heat shield on the bottom of the orbiter forward section. A second UHF antenna, located in the AW18D airlock panel, is used only with the SSOR.

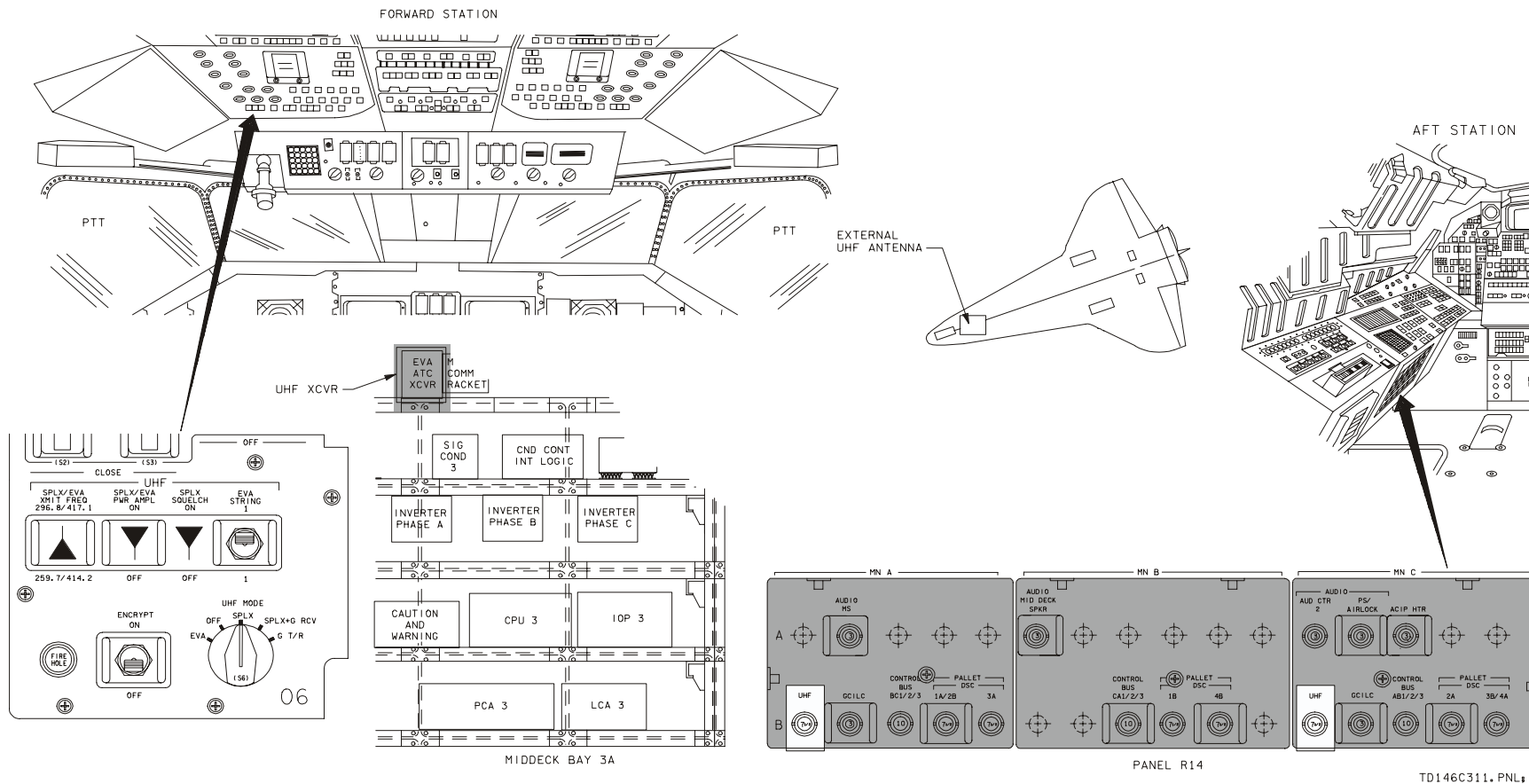


Figure 3-9. SPLX UHF transceiver controls

### 3.10.2 SSOR

Figure 3-10 illustrates the location of panels and controls for the SSOR UHF systems. The LRU for SSOR is located in avionics bay 3A, second shelf from the bottom.

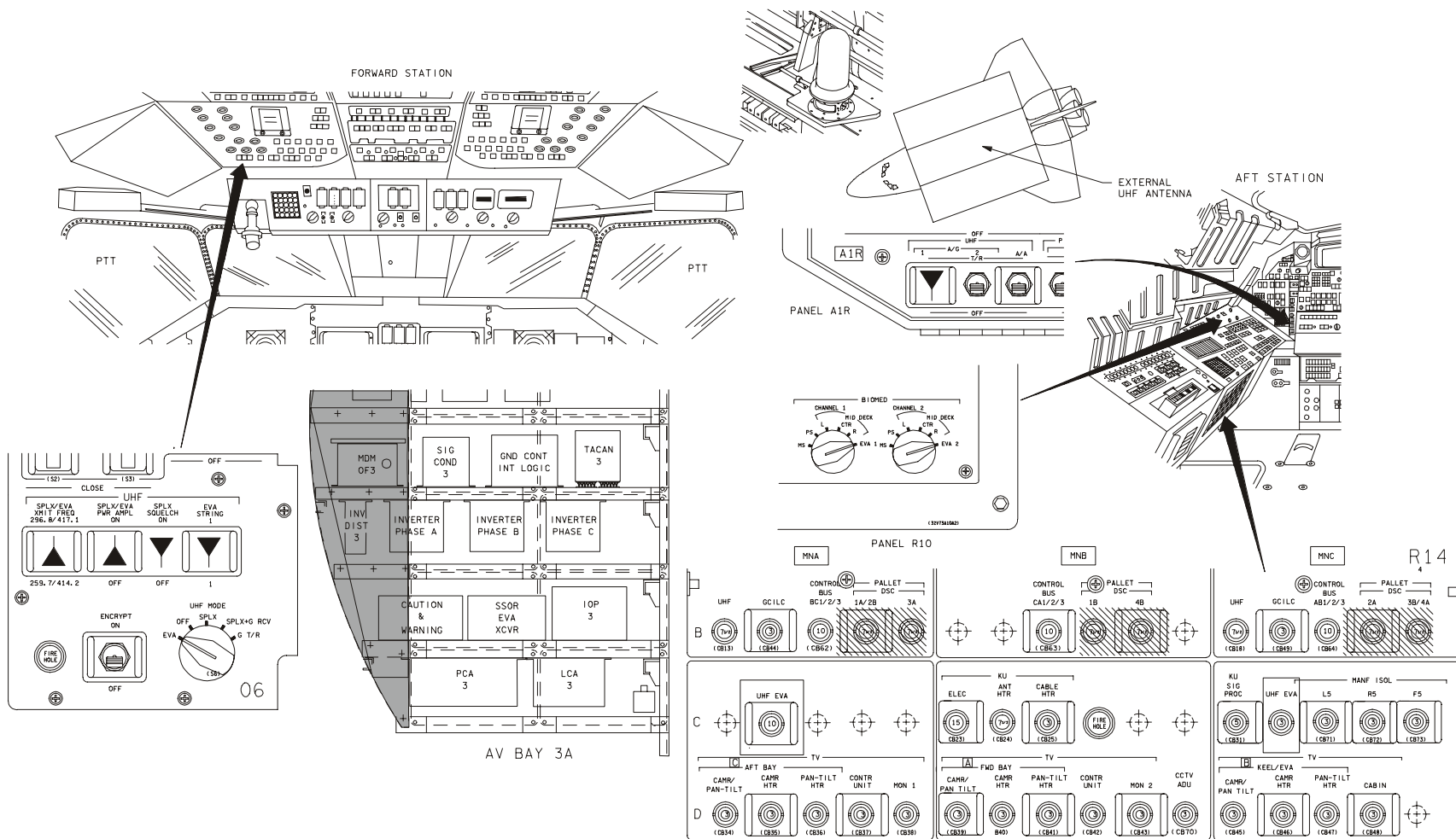
The SSOR cb's are located on Panel R14, Row C. Either cb will supply power to the SSOR. MNA and MNC are the power sources for the SSOR.

The SSOR systems share the O6 control panel with the SPLX system. The O6 Panel in Figure 3-10 is illustrated with SSOR 414.2 MHz selected for system 1 with the PWR AMPL OFF. This is a typical SSOR configuration.

The prime SSOR antenna is in the cargo bay on the starboard sill longeron near the Ku-band antenna. In addition, a secondary antenna is mounted in the air lock for EVA checkout operation (Figure 3-11).

The A1R AUDIO CENTER Panel provides crew control for SSOR connections to the ACCU A/G 1, A/G 2, and A/A loops. The illustration shows the A/G 1 loop connected to SSOR. This is a typical configuration for EVA operations.

Biomed/suit data are routed to the MS ATU Panel (R10) BIOMED switches. Selecting EVA 1 and EVA 2 routes this data to the orbiter instrumentation system. The SSOR is capable of processing voice and data for four EVA crewmembers. However, there are the only two inputs to the instrumentation system for this data.



TD146C312, PNL 1  
TD146c\_312.cv5

Figure 3-10. SSOR controls

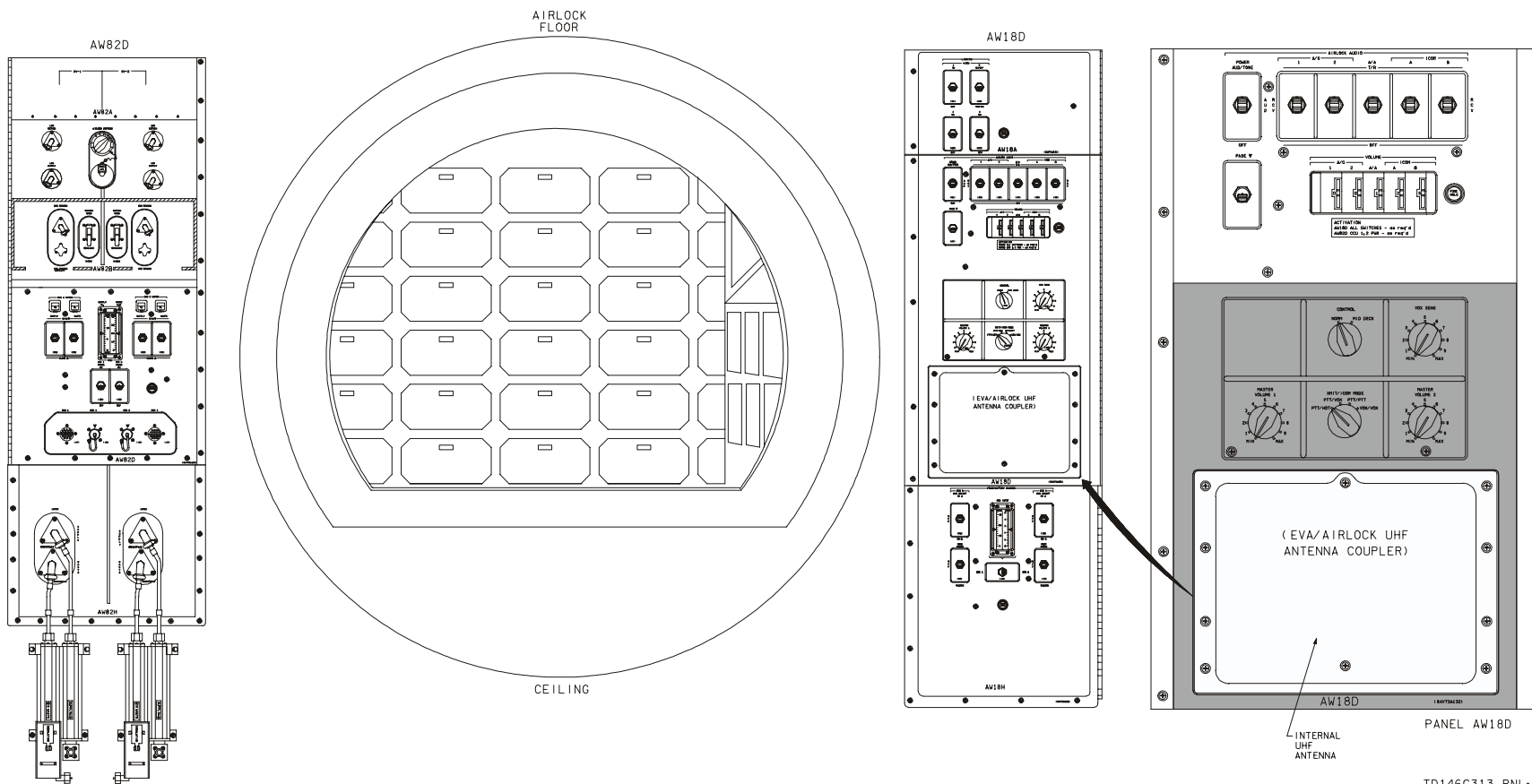
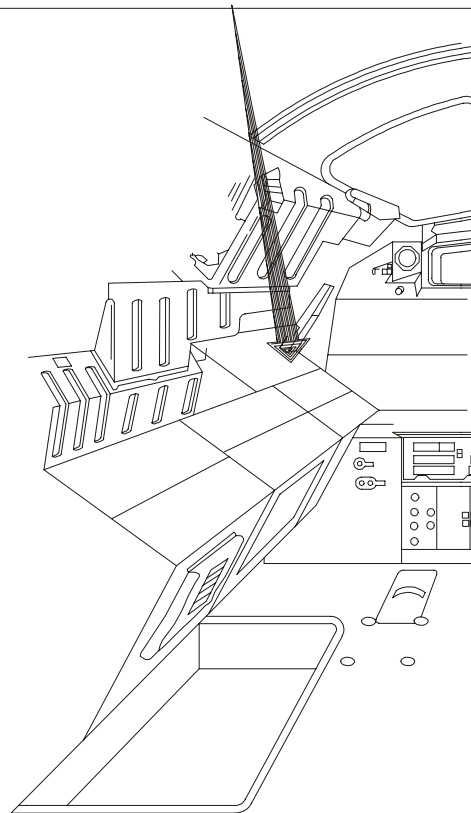
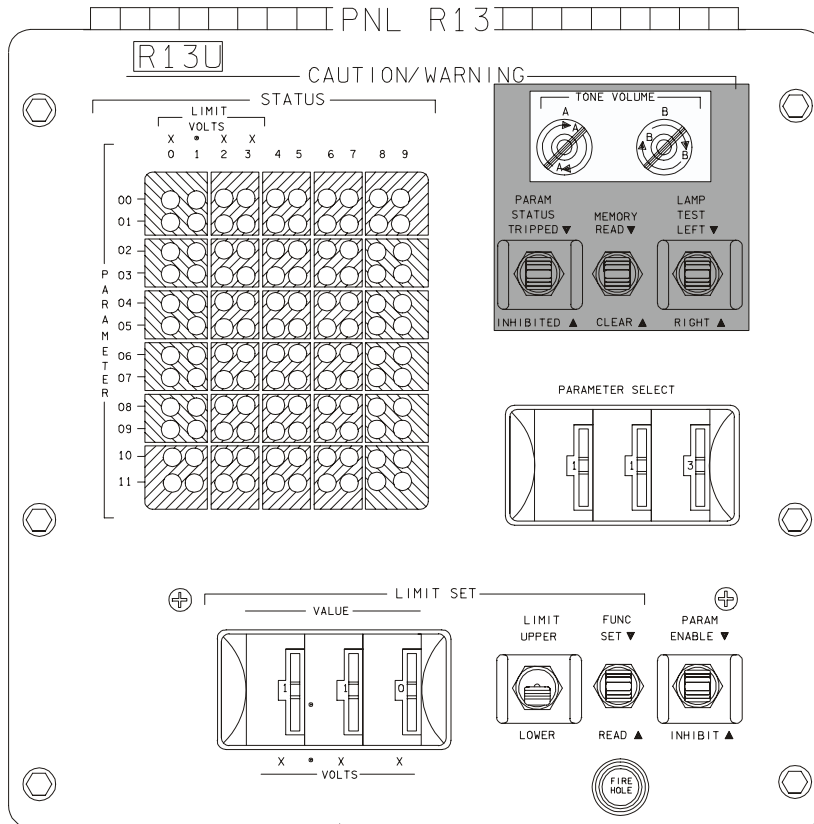


Figure 3-11. Internal SSOR antenna location

TD146C313, PNL 1

### **3.11 CAUTION/WARNING TONE VOLUME**

Figure 3-12 illustrates the location of the volume controls for C&W audio tones. The outputs of both controls are routed to both ACCU1 and ACCU2 C&W select circuits. The volume of these tones (as well as all other audio) can be controlled on the HIU and speaker volume control.



TD146C314, PNL 1

**Figure 3-12. C&W tone volume control**

### **3.12 SLEEP STATION**

Figure 3-13 illustrates the sleep station C&W receptacle. The sleep station tones receptacle is located on Panel MO58F on the middeck ceiling. The connector is designed for use with any crew headset. The receptacle is wired directly to the C&W system and has no volume or disabling control. If volume control is desired, an HIU should be included in the headset configuration.



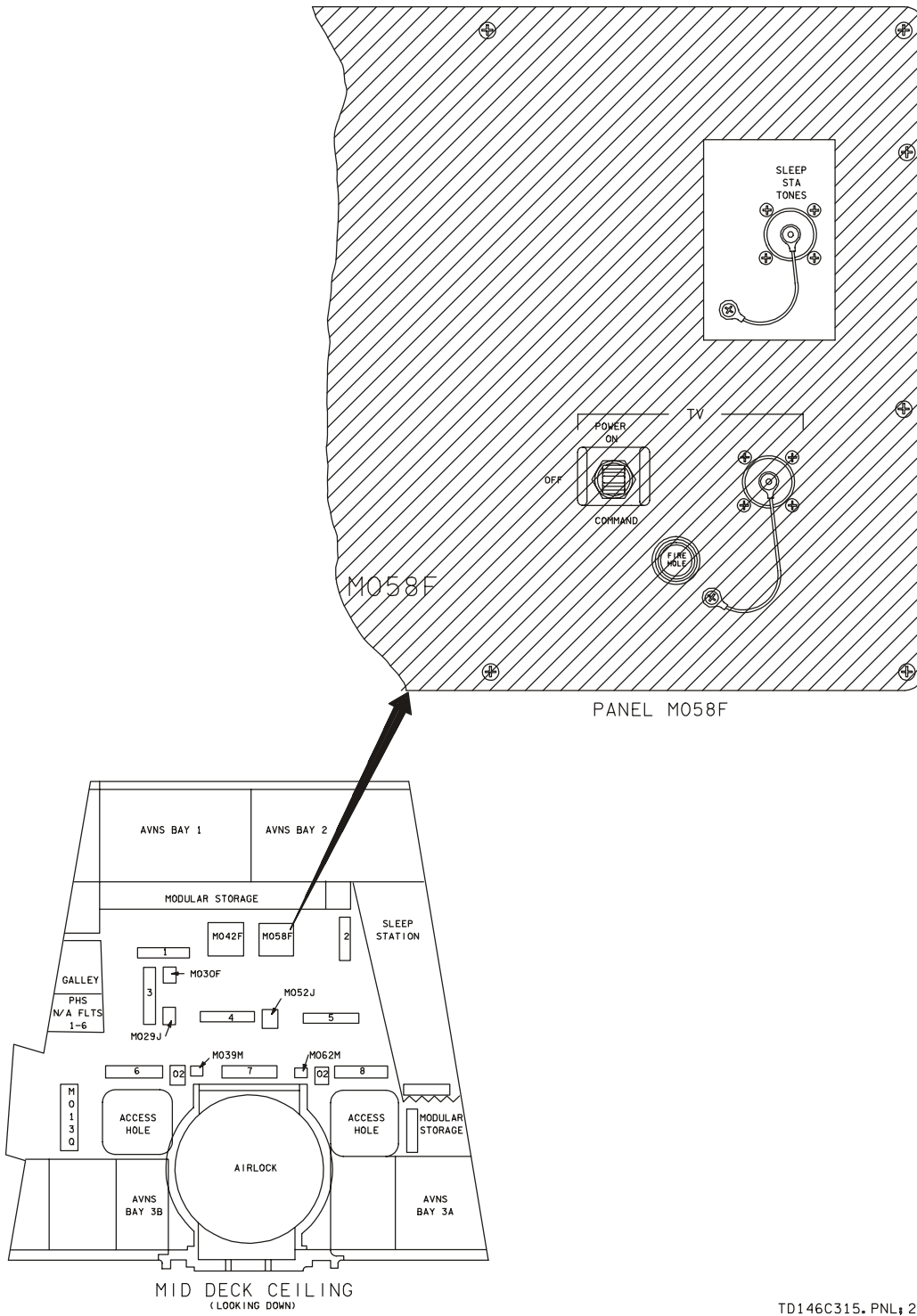


Figure 3-13. Sleep station receptacle

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## Questions

**Note:** You may refer to the associated drawings to answer these questions.

1. The flight deck SU is connected to the
  - (a) CDR ATU
  - (b) MS ATU
  - (c) PS ATU
  - (d) PLT ATU
  
2. The PLT ATU and the associated CCU are powered from **Panel R14**
  - (a) AUDIO LEFT circuit breaker
  - (b) AUDIO RIGHT circuit breaker
  - (c) AUD CTR 1 circuit breaker
  - (d) ESS bus 1BC
  
3. The aft station RHC is connected to
  - (a) PS ATU
  - (b) MD ATU
  - (c) PLT ATU
  - (d) MS ATU
  
4. True or **False**. The AIRLOCK ATU and the PS ATU are powered by the same circuit breaker.
  
5. The AUDIO CENTER Panel is on
  - (a) Panel C3
  - (b) Panel A1R
  - (c) Panel A15
  - (d) The middeck ATU

6. ACCU 1 and 2 are mounted in
  - (a) Different avionics bays
  - (b) The flight deck
  - (c) Avionics bay 1
  - (d) Avionics bay 3
7. C&W volume controls are mounted on panel
  - (a) R13
  - (b) R10
  - (c) O9
  - (d) O5
8. The UHF SPLX XCVR is mounted
  - (a) On the bottom of the orbiter
  - (b) In avionics bay 1
  - (c) On the flight deck
  - (d) In avionics bay 3A
9. The SLEEP STATION tones connector is mounted
  - (a) In the cargo bay
  - (b) At the PLT's audio crew station
  - (c) In the airlock
  - (d) On the middeck ceiling

Note: See page B-3 for answers to these questions.

## APPENDIX A ACRONYMS AND ABBREVIATIONS

A/A	Air-to-Air
A/G	Air-to-Ground
ACCU	Audio Central Control Unit
ADS	Audio Distribution System
AIU	Audio Interface Unit
AL	Airlock
ASP	Astronaut Support Personnel
ATC	Air Traffic Control
ATU	Audio Terminal Unit
AUD	audio
B/U	Backup
BPSMU	Battery Powered Speaker Microphone Unit
BIOMED	Biomedical
C&W	Caution and Warning
CAPCOM	Capsule Communicator
cb	circuit breaker
CCA	Communication Carrier Assembly
CCTV	Closed-Circuit Television
CCU	Crew Communications Umbilical
CDR	Commander
COMM	Communications
CRT / IDP	Cathode Ray Tube / Integrated Display Processor
CRU	Crew Remote Unit
CTR	Center
DL	Downlink
DTV	Digital Television
DoD	Department of Defense
ECAL	East Coast Abort Landing
EMU	Extravehicular Mobility Unit
ESS	Essential
EVA	Extravehicular Activity
EVC	Extravehicular Communication
FM	Frequency Modulation
G REC	Guard Receive
GCIL	Ground Command Interface Logic
GT/R	Guard Transmit/Receive

HHM	Handheld Microphone
HIU	Headset Interface Unit
HL	Hardline
ICOM	Intercommunications
ICOM A	Intercom A
ICOM B	Intercom B
ID	Identification
IDS	Integrated Documentation Support
IFM	In-Flight Maintenance
INCO	Instrumentation and Communication Officer
INMARSAT	International Marine Satellite
ISS	International Space Station
JSC	Johnson Space Center
Ku-Bd	Ku-band
KU OPS	Ku Operations
LDR	Low Data Rate
LES	Launch/Entry Suit
LRU	Line Replaceable Unit
MCC	Mission Control Center
MD	Middeck
MHA	Multiple Headset Adapter
MHz	megahertz
mic	microphone
MILA	Merritt Island
MIN	minimum
MMU	Mass Memory Unit
MNA	Main Bus A
MNB	Main Bus B
MNC	Main Bus C
MOD	Mission Operations Directorate
MS	Mission Station
NASA	National Aeronautics and Space Administration
NSP	Network Signal Processor
ODS	Orbiter Docking System
OPS	Operations
OIU	Orbiter Interface Unit
P/L	Payload
PAGE	Paging
PCMMU	Pulse Code Modulation Master Unit

PGSC	Portable General Support Computer
PLT	Pilot
PM	Phase Modulation
PROC	Processor
PS	Payload Station
PTT	Push-to-Talk
PWR	Power
PWR AMPL	Power Amplifier
RCV	Receive
RF	Radio Frequency
RHC	Rotational Hand Controller
S/G	Space-to-Ground
S-Bd Fm	S-band Frequency Modulation
S-Bd P/L	S-band Payload
S-Bd PM	S-band Phase Modulation
SCU	Service and Cooling Umbilical
SDW	Serial Data Word
SEN	Sensitivity
SGLS	Space Ground Link System
SIG	Signal
SPKR	Speaker
SPLX	SIMPLEX
SSCS	Space-to-Space Communication System
SSER	Space-to-Space EVA Radio
SSOR	Space-to-Space Orbiter Radio
SSSR	Space-to-Space Station Radio
SSR	Solid State Recorder
STDN	Space Tracking and Data Network
SU	Speaker Unit
T-0	Time Zero
T/R	Transmit/Receive
TACAN	Tactical Air Navigation
TAL	Transoceanic Abort Landing
TAMS	Training Administration Management System
TDM	Time Division Multiplexing
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
TV	Television
TX KEY	Transmit Key
UHF	Ultrahigh Frequency
UL	Uplink

VLHS	Very Lightweight Headset
VOX	Voice-Operated Transmit
WCCS	Wireless Crew Communications System
XMIT	Transmit
XCVR	Transceiver



## APPENDIX B ANSWERS

### Answers to Section 2

1. b. TALK, LISTEN, and POWER are three of the five lines that connect the headset to a CCU.
2. d. TALK, LISTEN, and SDW are the three lines that connect the ATU to the ACCU.
3. True Loop selection in the ACCU is accomplished by the interpretation of the code in a serial data word.
4. a and d The A/G 1 and TACAN loops have individual thumbwheel volume controls.
5. False The PAGE loop is keyed by using the PAGE momentary switch on the ATU.
6. b. The PAGE loop in the ACCU is routed only to the SSOR. The UHF SPLX system connects only to the A/A loop in the ACCU.
7. c. The VOX SENSITIVITY control is used to adjust the microphone keying level.
8. c. The ATU CONTROL switch allows you to work around an ATU failure.
9. a, b, c. The ICOM loops are keyed by all three methods.
10. True. Both A/G loops are routed to the operating NSP for communications with MCC via the S-band PM or Ku-band systems.
11. True. MCC cannot tell which ACCU is active through telemetry.
12. a. When microphone keying occurs, TALK audio returns to the headset on the LISTEN line as a sidetone.
13. d. The top speaker on the SU responds to Klaxon and siren only.
14. True The bottom SU speaker is muted when the KEY indicator is lit.
15. d. A/G 2 is removed for the operating NSP when the NSP is moded to low data rate.
16. a. A/G downlink audio are lost if the PLT and the MS ATUs are powered OFF simultaneously.

17. a. Two audio loops may be routed to the solid state recorders (SSRs) from the NSP. The selection of these two loops is made on the AUDIO CENTER Panel.
18. True. The purpose of the UHF A/G 1 switch on the Audio Center Panel is to provide a way for the MCC to communicate with EVA personnel.
19. True. All four C&W tones are routed to the headsets.
20. d. Bypass C&W tones are routed to the middeck SU.
21. b and d UHF transmissions may be routed to MCC through selected STDN ground sites and through INMARSAT relay at a TAL site.
22. d. The UHF XCVR antenna is mounted on the bottom of the orbiter.
23. b. The SSOR UHF antenna is mounted in the forward bay area on the starboard side.
24. a. In the SIMPLEX mode, the UHF system normally transmits at 10 watts.
25. True. The A/A loop must be selected to T/R at your ATU for the UHF XCVR to key by the HIU XMIT pushbutton.

**Answers to Section 3**

1. a. The flight deck SU is connected to the MS ATU.
2. b. The PLT ATU and the associated CCU are powered from Panel R14 AUDIO RIGHT circuit breaker.
3. d. The aft station RHC is connected to MS ATU.
4. True. The airlock and the PS ATUs are powered by the same circuit breaker on R14.
5. b. The Audio Center Panel is on Panel A1R.
6. c. ACCU 1 and 2 are mounted in avionics bay 1.
7. a. C&W volume controls are mounted on Panel R13U.
8. d. The UHF XCVR is mounted in avionics bay 3A.
9. d. The SLEEP STATION tones connector is mounted on the middeck ceiling.

## **APPENDIX C LOOSE COMM GEAR**

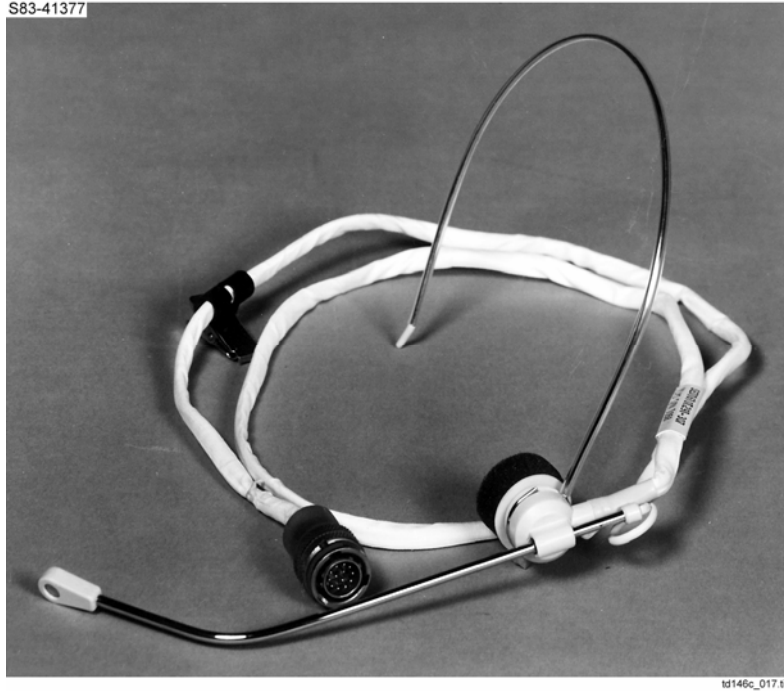
Listed below are the audio devices that can be attached to the ADS through a CCU connector. The devices are illustrated in this appendix.

1. Very Lightweight Headset (VLHS) / Headset Interface Unit (HIU)
2. Launch/Entry Suit (LES) helmet
3. Hardline handheld microphone
4. Multiple Headset Adapter (MHA)
5. Wireless Crew Communications System (WCCS)
6. Wireless handheld microphone
7. COMM Carrier Assembly (CCA)
8. Intercommunication (ICOM) recorder
9. Battery Powered Speaker Microphone Unit (BPSMU)

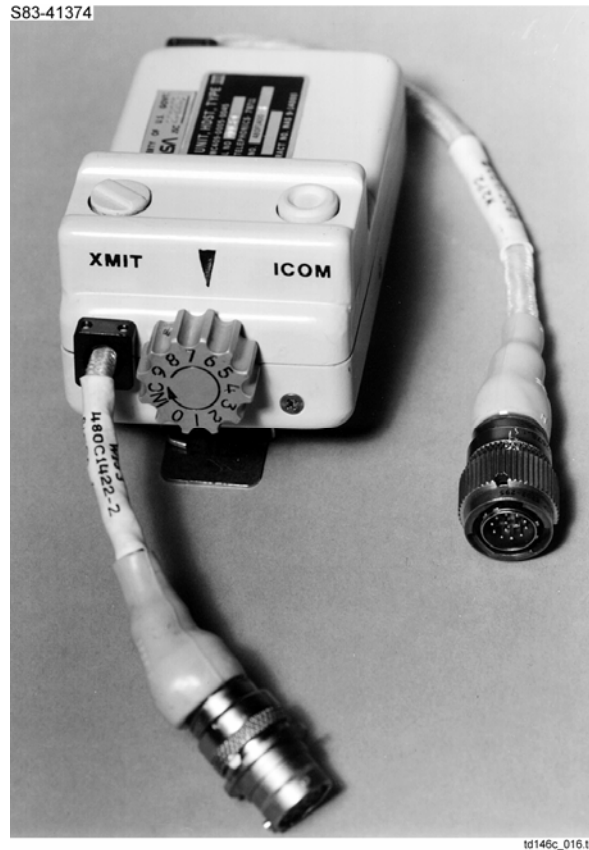
A short description is given with each illustration.

### **C.1 VERY LIGHTWEIGHT HEADSET/HEADSET INTERFACE UNIT**

The VLHS is used in combination with an HIU (Figures C-1 and C-2). Without the HIU, LISTEN audio to the headset earpiece has no volume control, and the microphone has no power or amplification to produce the TALK audio. The HIU also is provided with pushbuttons for PTT keying. The XMIT pushbutton provides A/G and A/A loop keying for transmission external to the orbiter (MCC/EVA). The ACCU also responds to the XMIT pushbutton by keying the active ICOM loops. The ICOM pushbutton keys only the active ICOM loops. Extension cables of 4, 14 and 40 feet may be attached to the HIU to extend the user's reach from the CCU. The VLHS/HIU combination is used during on-orbit operations. The HIU is used with the LES/helmet/CCA combinations for launch and entry operations.



**Figure C-1. Very lightweight headset**



**Figure C-2. Headset interface unit**

## C.2 LAUNCH AND ENTRY SUIT HELMET

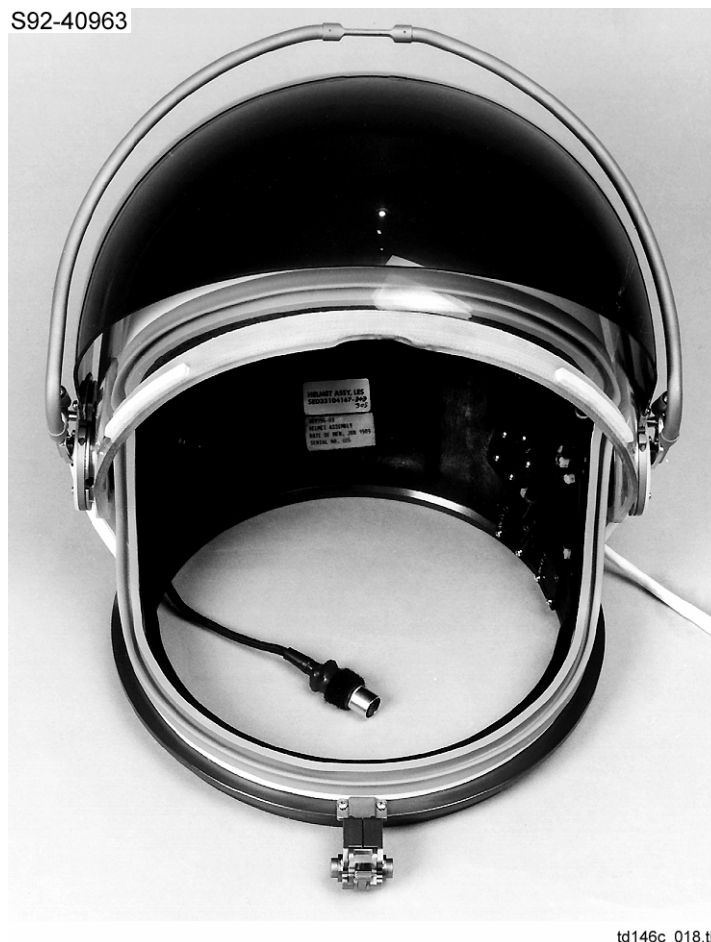
The LES helmet (Figure C-3) is used with an HIU and is connected to an ATU/CCU audio crew station during launch.

Internally, there is a connection for the Communications Carrier Assembly (CCA). The CCA provides two earpieces and two microphones (Figure C-4). Earpiece volume control and microphone keying are provided by the HIU.

A set of pressure sensitive switches inside the helmet monitors the oxygen flow into the helmet. If oxygen flow is sensed, the microphones are muted. Oxygen flow occurs when

1. The user is inhaling
2. The seal around the visor or the neck of the helmet is not complete

The purpose of the muting is to eliminate oxygen flow noise when the crewmember is inhaling.



**Figure C-3. Launch and entry suit helmet**

### C.3 HANDHELD MICROPHONE (HHM)

A handheld microphone (Figure C-4) is basically an HIU with no LISTEN line connections. An amplifier in the microphone box, powered from the CCU, provides amplification for the microphone TALK audio. The pushbuttons are for PTT keying. The XMIT pushbutton is for A/G and A/A keying plus the active ICOM loops. The ICOM pushbutton is for ICOM loops only.

The handheld microphone is normally used on orbit with the MS/OS and/or middeck ATU/CCU audio crew stations. The HHM has a 7-foot cable and extension cables of 4, 14 and 40 feet can be added to it. When a handheld microphone is used, listening is accomplished through the flight deck and middeck speakers.

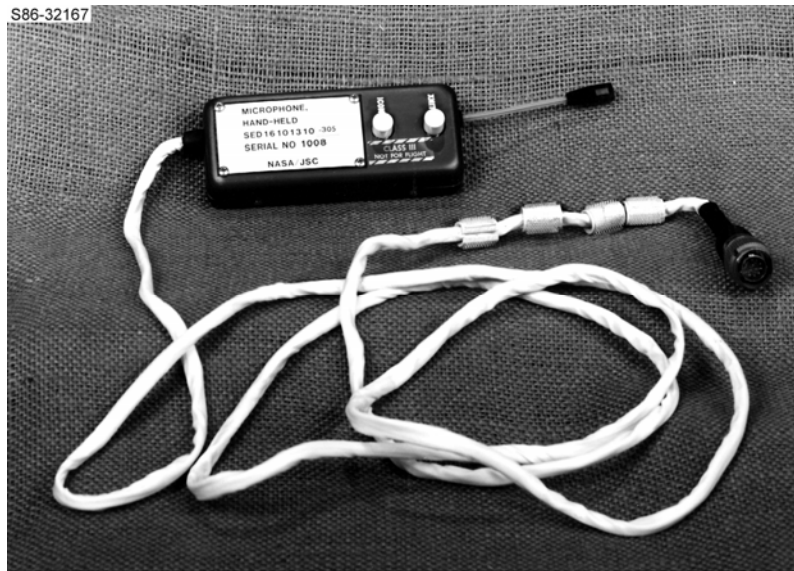


Figure C-4. Handheld microphone

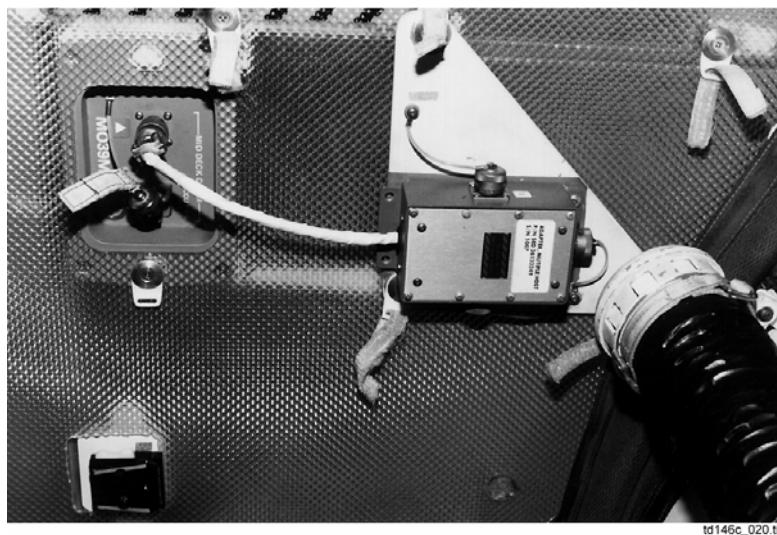


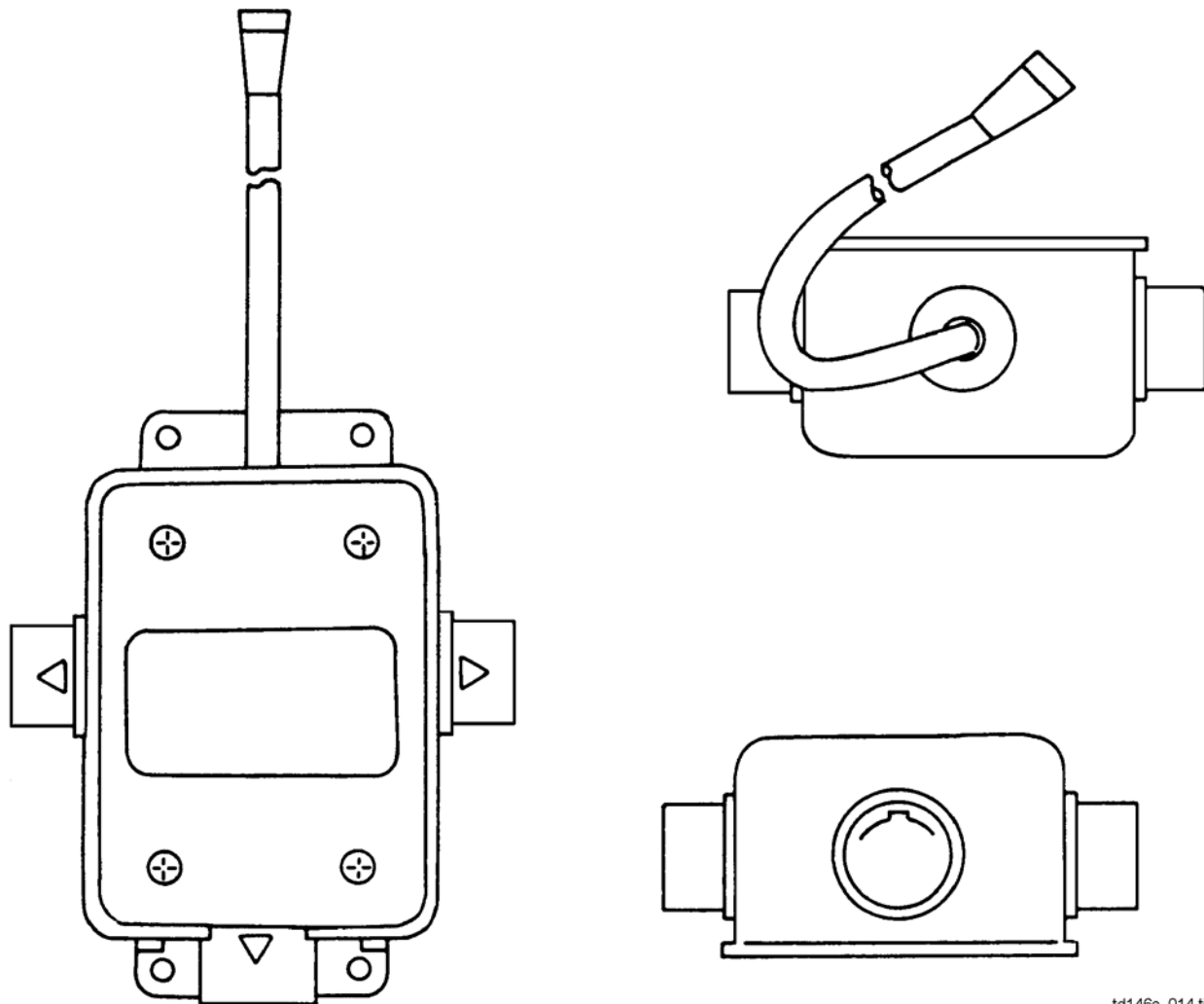
Figure C-5. Multiple headset adapter installed on middeck ceiling

#### C.4 MULTIPLE HEADSET ADAPTER (MHA)

The MHA provides a way to connect up to three hardware devices to a single ATU/CCU crew station.

The pigtail port at one end of the MHA connects to the CCU. Figure C-5 illustrates the MHA connected to the middeck ATU/CCU. It is important to remember that because the microphone keying takes place in the ATU, the keying is common to all microphones attached to the MHA. Figure C-6 shows the three port locations.

During ascent and entry, the flight deck backseat crewmembers are connected to the MS ATU/CCU crew station through an MHA. Middeck crewmembers are connected to the middeck ATU/CCU.



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Figure C-6. MHA port locations



## C.5 WIRELESS CREW COMMUNICATIONS SYSTEM (WCCS)

The WCCS (Figure C-7) has two parts, each with attachments and controls.

1. Audio Interface Unit (AIU), or wall unit
2. Crew Remote Unit (CRU), or leg unit

The AIU is attached to a wall bracket and is connected to a crew station ATU/CCU through an umbilical for power and audio. By appropriate selections on the SELECT MODE switch, the AIU can be moded to work with one or both of the two available RF channels. The HARDLINE ONLY (HL) selection enables the side port on the AIU, to which a standard VLHS/HIU, handheld microphone, or other hardline device can be connected.

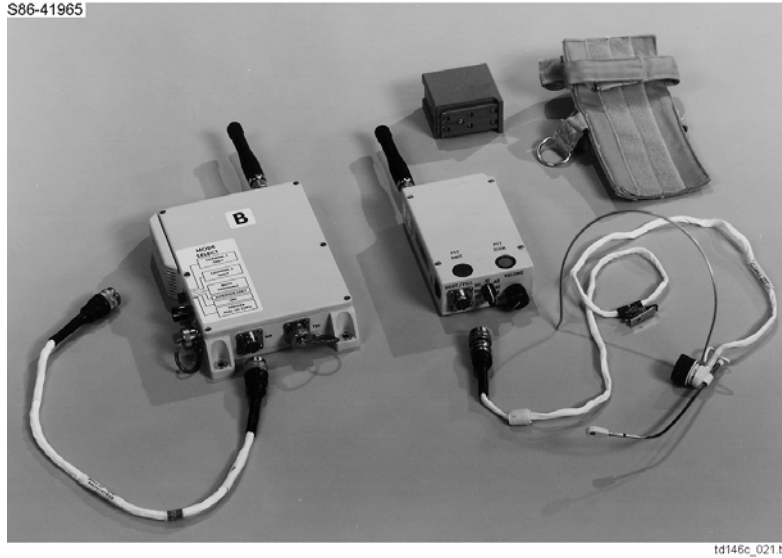
The CRU has a CCU-type connection (CCU/HIU) to accommodate a VLHS. Like an HIU, it is provided with a PTT XMIT and ICOM pushbutton and a LISTEN VOLUME control. The CRU is powered by a replaceable lithium battery that provides 35 to 40 hours of support.

The CRU can be moded to work with either of the two RF channels of any AIU. Each AIU has a letter designation, A, B, C, D, or E. The selection B1 on the CRU means that your CRU will work with RF channel 1 of AIU B. For Spacelab operation, an AIU and the associated CRUs are programmed to operate at frequencies designated "D" or "E." The link between the CRU and AIU is through the detachable antennas on each unit.

All the RF channels can be encrypted for security, with the provision to zeroize the encryption if necessary. The FILL label identifies the ports through which the encryption coding may be loaded. This is not a crew function.

A holder is provided to facilitate strapping the CRU to the user's leg. In training, a chest strap and holster are used instead of the leg strap used during a flight. The leg strap does not work well in a one-g environment.

Figure C-8 illustrates a CRU configured for wireless handheld microphone operation and may be used in place of the hardline handheld microphone (Figure C-4). Because there is no earpiece associated with this configuration, the user cannot tell when the battery is becoming weak. The battery must be changed on a scheduled basis.



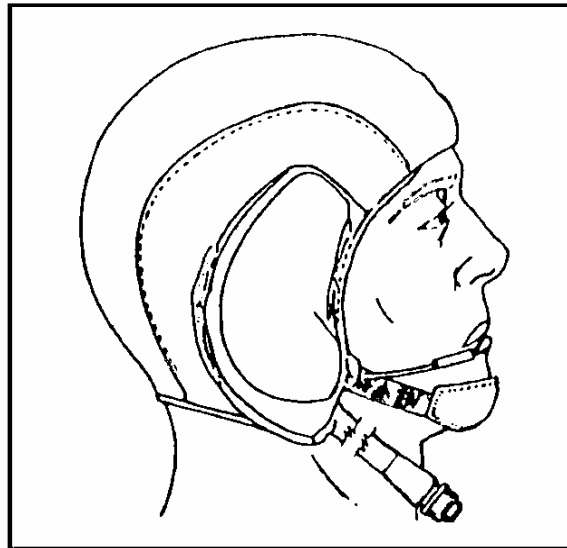
**Figure C-7. Wireless crew communications system**



**Figure C-8. Wireless handheld microphone**

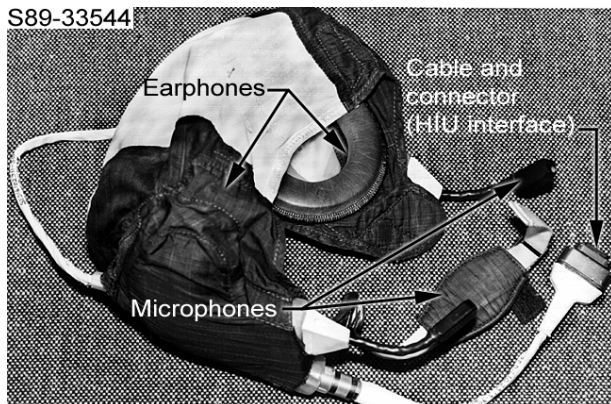
## C.6 COMM CARRIER ASSEMBLY

Figure C-9 illustrates the two different types of CCA helmets used with the orbiter audio system. One type of CCA is used with the EVA helmet; the other is used with the LES helmet (Figure C-3). They are not interchangeable. The top figure with the EVA CCA donned illustrates the cap as it is worn by a crewmember. The LES helmet CCA is donned similarly. When used with the EVA suit, the CCA connects with the UHF system for RF comm or the SCU for hardline comm through the airlock ATU for pre-EVA checkout.



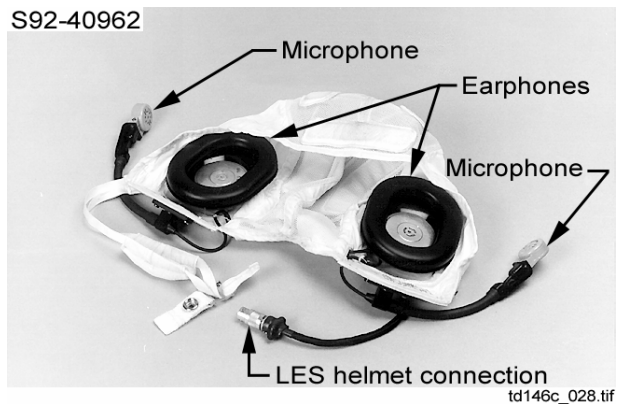
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**EVA CCA donned**



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**EVA CCA**



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**LES helmet CCA**

**Figure C-9. Communications carrier assembly**

## **C.7 ICOM RECORDER**

The ICOM RECORDER is used during ascent and entry to record ADS audio and ambient crew compartment noise. A specially designed cable/harness has been provided to facilitate connection between the recorder and the ADS plus a standard microphone (Figure C-10).

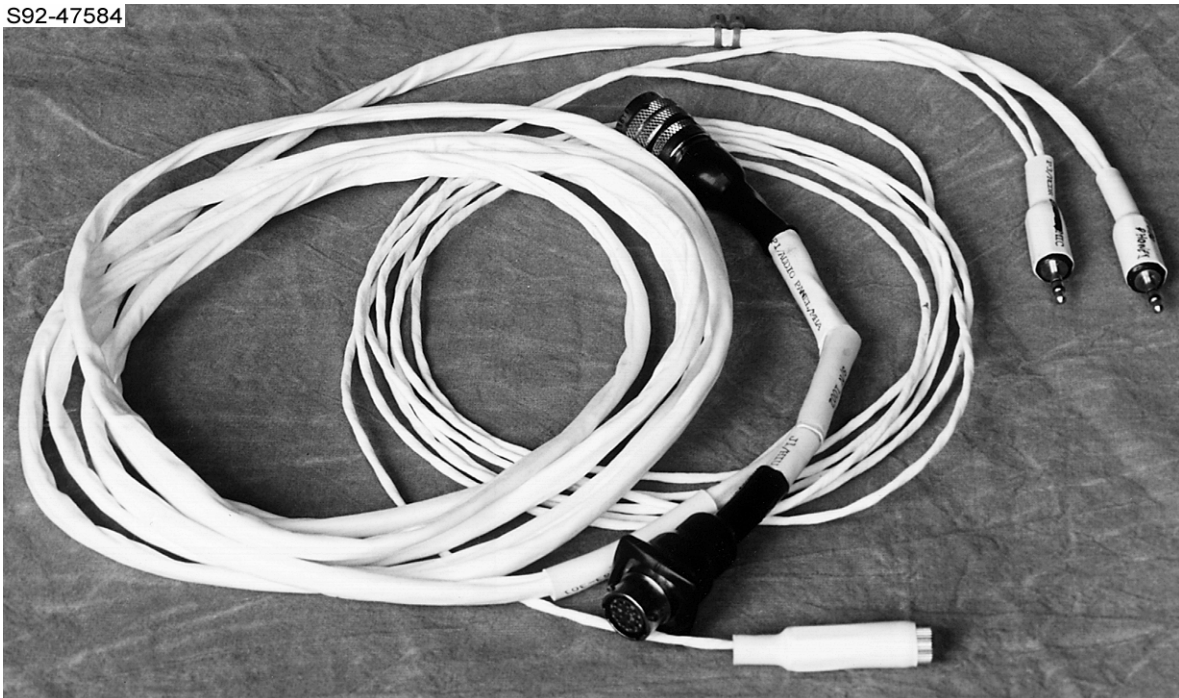
During ascent and entry the recorder is mounted as illustrated in Figure C-11. This configuration is set up, prelaunch, by Astronaut Support Personnel (ASP).

The crewmember seated behind the PLT activates the standard microphone and the recorder just before launch. The same configuration is set up for entry by a crewmember using an Orbit Operations Checklist procedure.

The recorder cable (Figure C-12) is designed to route ADS audio from the MS CCU to the MICROPHONE connection on the ICOM RECORDER. The MHA provides connections to the MS CCU for the ICOM RECORDER cable and two MS crewmembers. The STANDARD MICROPHONE audio is also routed to the ICOM RECORDER MICROPHONE connection through the cable harness. The STANDARD MICROPHONE audio and the ADS audio are each routed to a separate stereo track in the recorder. The PLT CONNECT pigtail has been added to provide a spare connection for the pilot's headset in case the PLT comm station fails during ascent or entry.

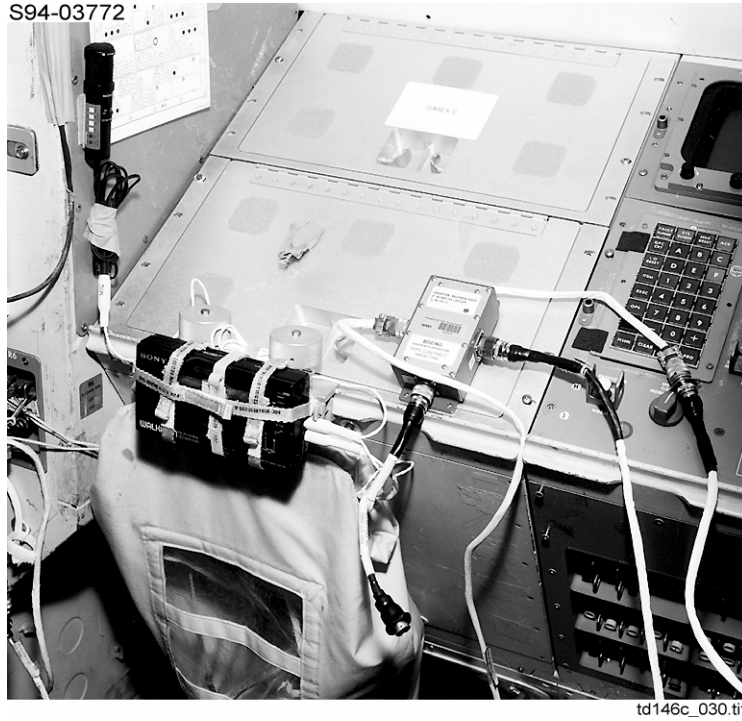
The ICOM RECORDER cable may be used to play back both stereo tracks to the ADS through the HEADSET connection.

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**Figure C-10. ICOM cable**



**Figure C-11. ICOM recorder configuration**

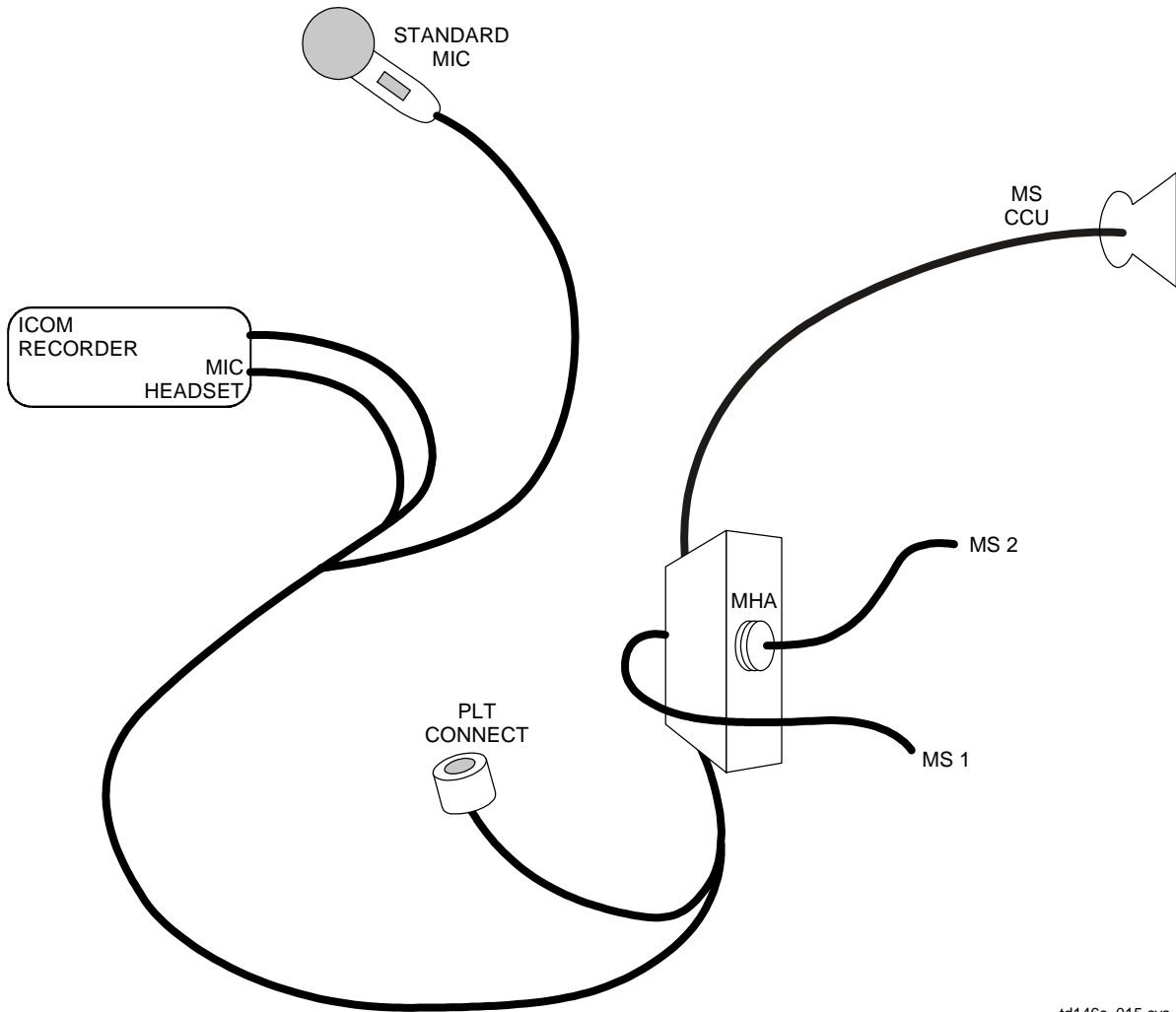


Figure C-12. Recorder cable

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## **C.8 BATTERY POWERED SPEAKER MICROPHONE UNIT (BPSMU)**

The BPSMU was originally built for MIR missions so that shuttle C&W tones could be heard while all shuttle crew members were on MIR. With a microphone, speaker, and well over 100 feet of cable, the BPSMU allowed shuttle crewmembers to access the orbiter audio system from inside the MIR. The BPSMU has a similar use onboard ISS, allowing easy access to the orbiter audio system. The BPSMU has an integral 8-ft cable and for additional cabling a 4-ft and a 42-ft cable is required, along with a BPSMU/ODS adapter for the Airlock CCU1 and CCU2 ports. However, other extension cables of 22, 35 and 44 feet can be used between the 4 and 42 foot cables.

The BPSMU's microphone amplifier is powered by two 9-V batteries, not the CCU power switch as for most other audio hardware. The CCU power therefore need not be on when using a BPSMU. Several spare batteries are flown, as the expected battery life span is 7-10 days. The BPSMU speaker does not use battery power as it is driven only by the audio signal on the LISTEN line. The Speaker has a volume rotary.

During ISS operations, a BPSMU is also typically connected to the CDR ATU using a 1-foot BPSMU to CCU adapter cable, and a HHM is connected to the MS ATU (which uses the flight deck speaker). The MS ATU/HHM/FD speaker is then configured for A/G1 (BIG LOOP) communications, and the CDR ATU/BPSMU microphone and speaker are configured for A/G2 (Shuttle-only) communications. This allows for a physical separation between the two loops, simplifying crew comm operations.

The BPSMU can never be used with a MHA, due to circuitry incompatibilities. Additionally, there are other BPSMU cables that have both audio and video capability. These are used based upon specific flight requirements and details can be found in the Photo/TV Checklist.





**Figure C-13. Battery Powered Speaker Microphone Unit (BPSMU)**