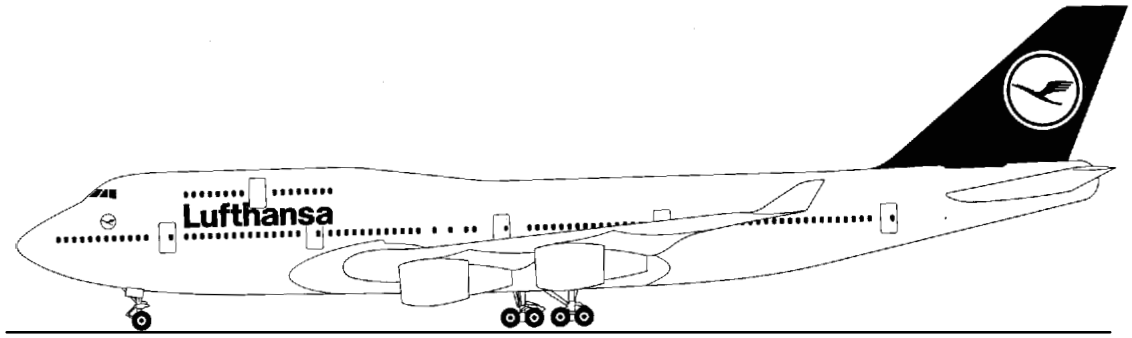
Lufthansa Technical Training

Training Manual B 747-400



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ATA 23-25 SATELLIT COMMUNICATION

SATCOM SYSTEM INTRODUCTION

The satellite communications (SATCOM) system is a long range data and voice communications system. SATCOM is much less susceptible to atmospheric interference than VHF communications systems.

SATCOM uses satellites in geosynchronous orbit as relay stations between the airplane earth stations (AES) and ground earth stations (GES). The GES use telephone lines or microwave links to complete the communication link between the airplane and the selected GES.

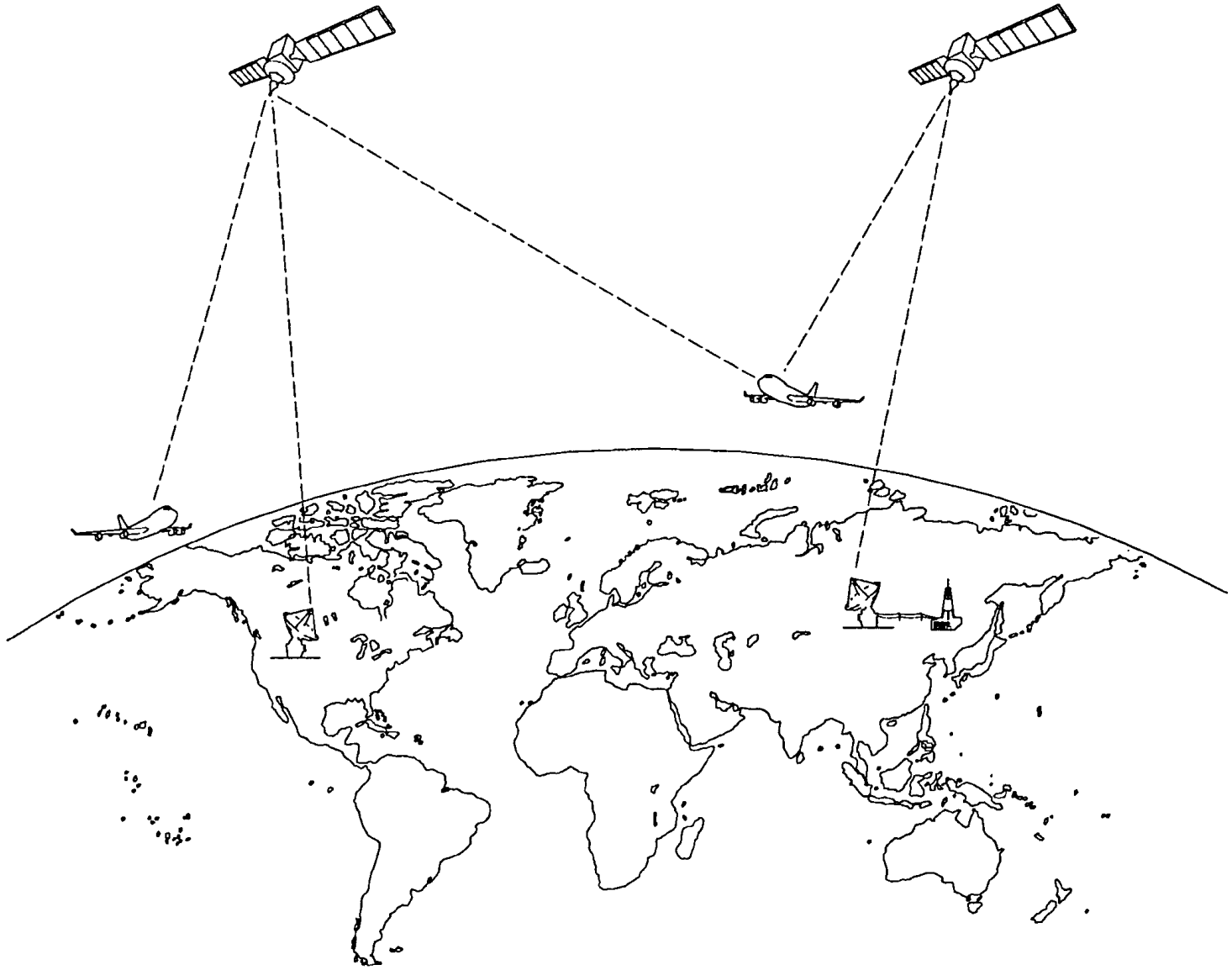


Figure 1 SATCOM SYSTEM INTRODUCTION

SATCOM SYSTEM

General

The SATCOM system has two separate high gain systems with six channels for both data and voice communications.

The SATCOM system uses the L-band frequencies. The L-band frequencies are:

- 1530 to 1559 MHz for receive.
- 1626.5 to 1660.5 MHz for transmit.

The SATCOM system components are the:

- Satellite data units (SDU)
- Radio frequency units (RFU)
- Attenuators
- High power amplifiers (HPA)
- Low noise amplifier/diplexers (LNA/DIPs)
- Beam steering units (BSU)
- Antennas.

The SATCOM system interfaces with the:

- Left, right and center control display units (CDU).
- Airborne data loader (ADL).
- Flight interphone system audio management unit (AMU)
- Modularized avionics warning electronics assembly (MAWEA).
- ARINC communications addressing and reporting system (ACARS).
- Cabin telecommunication unit (CTU)
- Cabin passenger management unit (CPMU).
- FAX unit
- Inertial reference units (IRU).
- Central maintenance computer system (CMCS).
- SATCOM maintenance panel.

Control

The flight crew use the CDUs to interface with the SATCOM system. The CDUs send the control data to the SDU.

The SDU:

- Controls system operation.
- Has software that defines system protocol and operation.
- Contains a satellite position and frequency data base.

Transmit Operation

During transmit the SDU:

- Gets voice signals from the cabin telecom unit or flight interphone system.
- Gets data signals from ACARS or the FAX unit.
- Digitizes voice and data signals.
- Converts up to three channels of digital voice and data signals to RF signals and sends the RF signals to the RFU.
- Gets navigation data from the IRU.
- Converts the navigation data to steering data, and sends the steering data to the BSU.

The RFU also converts up to three channels of digital voice and data signals to RF signals. The RFU sends the RF signals to the HPAs. The RF splitter output to the high gain HPA goes through an attenuator.

The HPAs amplify the RF and send the amplified RF signals to the LNA/DIPs. The diplexer allows the antenna to transmit and receive at the same time. The low noise amplifier increases the received RF signal from the antenna.

The BSU decodes the ARINC 429 steering data from the SDU. The BSU sends control signals to the high gain antenna to radiate the transmit RF signal in a specific direction.

Receive Operation

During receive, the antennas get RF signals from the satellite.

The antennas send the RF to the LNA/DIPs.

The low noise amplifier in the LNA/DIPs amplify the RF and send the amplified RF to the RFU.

The RFU and the SDU convert the received RF signal into digital voice or data channels. The SDU decodes the digital data and sends the voice or data to the applicable system.

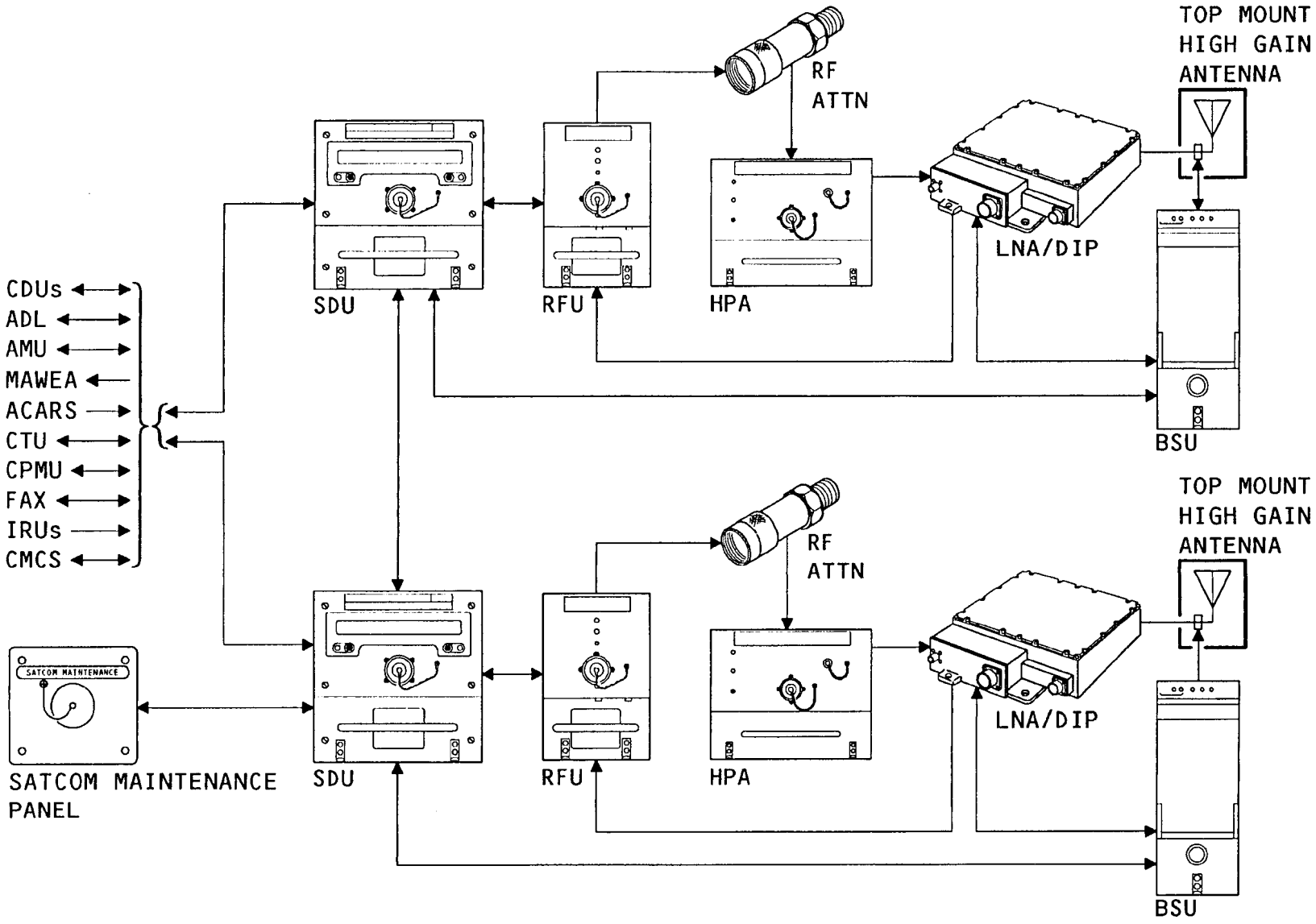


Figure 2 SATCOM SYSTEM

SATCOM - COMPONENT LOCATIONS - FLIGHT DECK

The SATCOM components and interfacing components located in the flight deck are:

- Control display units (CDU)
- Audio control panels (ACP)
- SATCOM-L circuit breaker
- SATCOM HGA-L circuit breaker
- SATCOM-R circuit breaker
- SATCOM HGA-R circuit breaker
- SATCOM maintenance panel
- Airborne data loader (ADL)
- ADL control panel

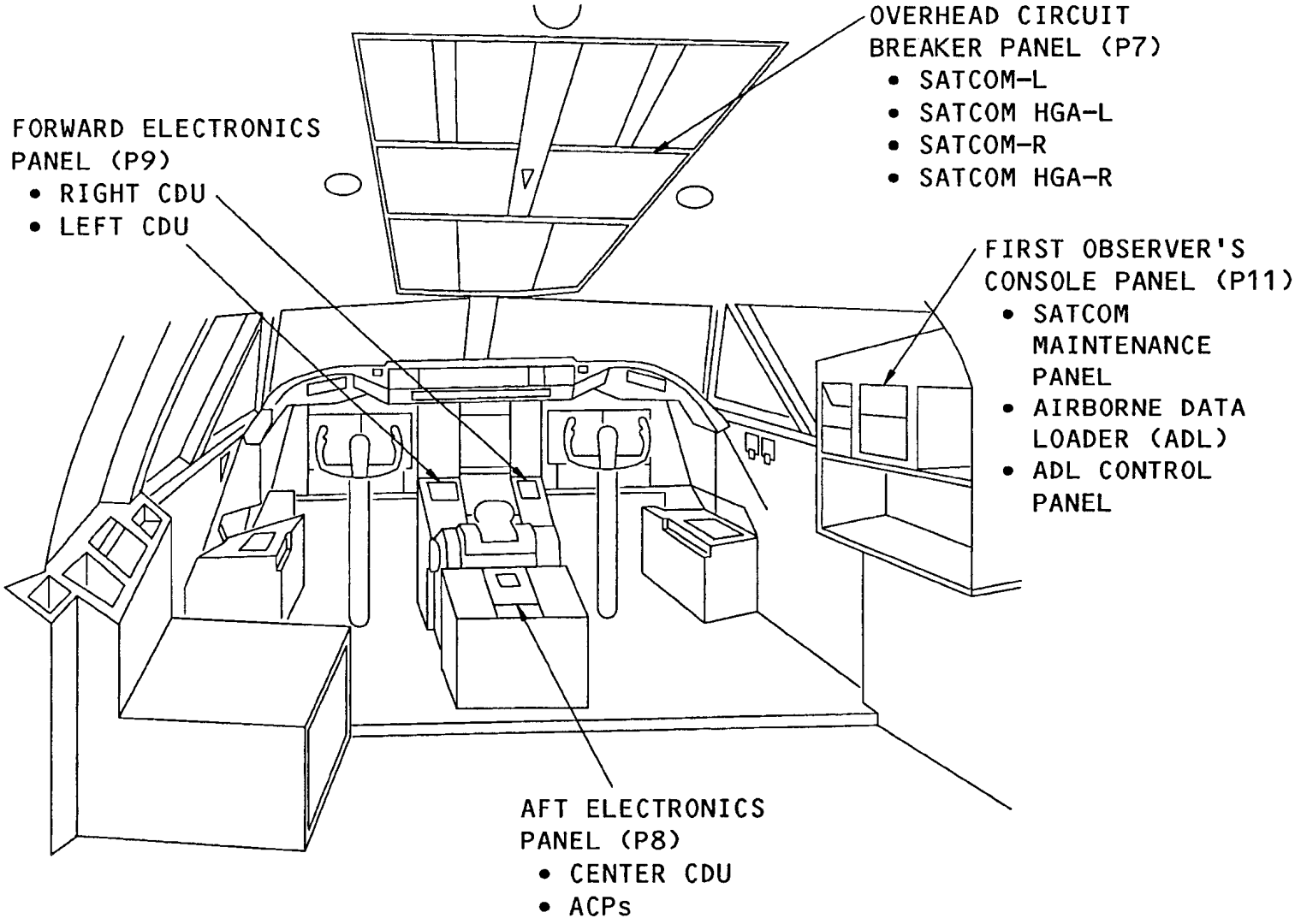
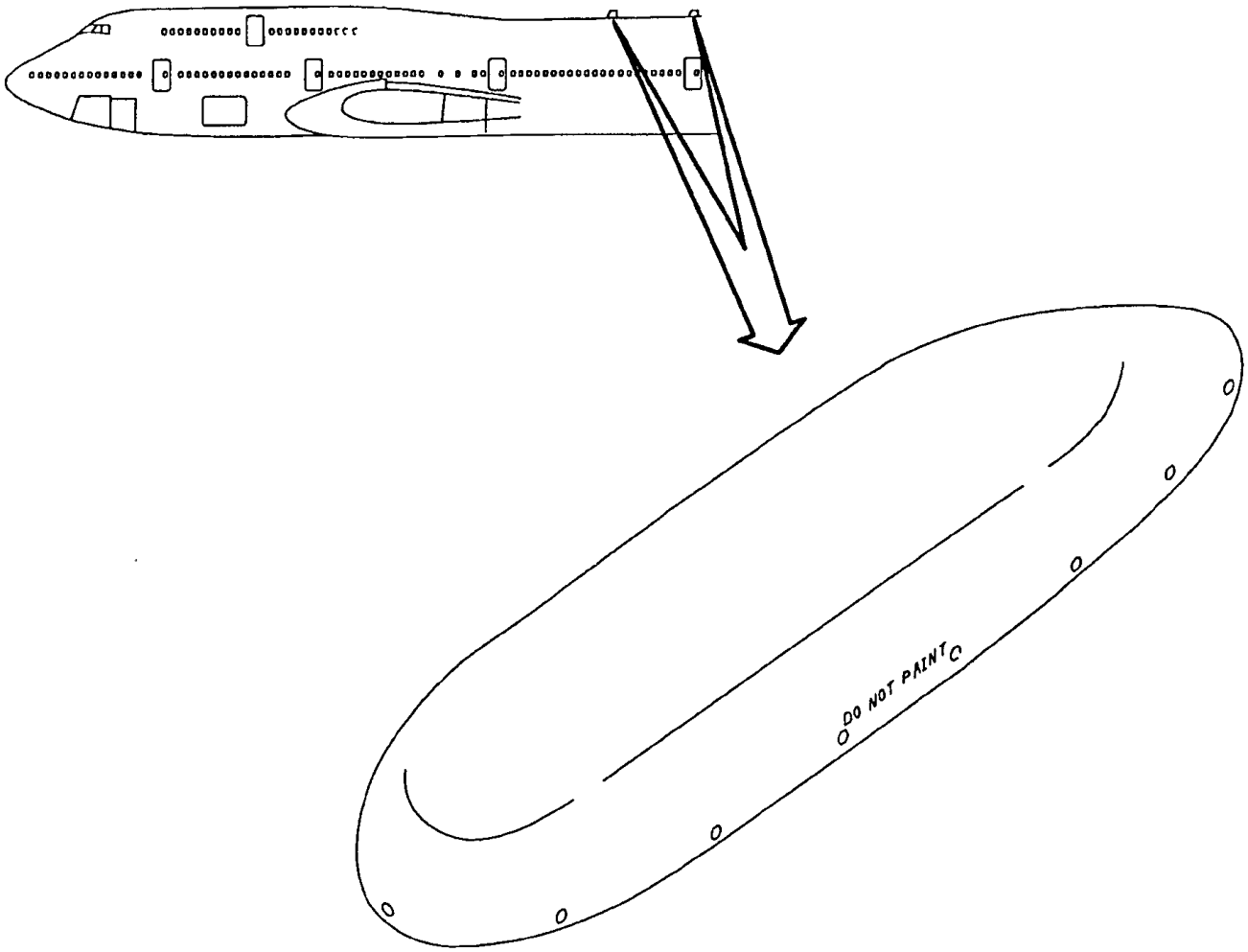


Figure 3 COMPONENT LOCATIONS - FLIGHT DECK

ANTENNA LOCATIONS

The antennas are at the top cumline:

- STA 1570
- STA 1650



HIGH GAIN ANTENNA

Figure 4 ANTENNA LOCATIONS

COMPONENT LOCATIONS PASSENGER CABIN

The E42 rack is at STA 1620, WL 320, LBL 50. The SATCOM components on the E42 rack are the left:

- Satellite data unit (SDU)
- Radio frequency unit (RFU)
- High power amplifier (HPA)
- Beam steering unit (BSU)

The E59 rack is at STA 1470, WL 323, LBL 52. The SATCOM components on the E59 rack are the right:

- SDU
- RFU
- HDA
- BSU

The attenuators are on the rear of the E42 racks.

Disconnect panels are at the forward end of E42 and E59 racks. The coding receptacles are on the front of the panels.

The LNA/DIPs are located at STA 1650. Access is through the ceiling panels.

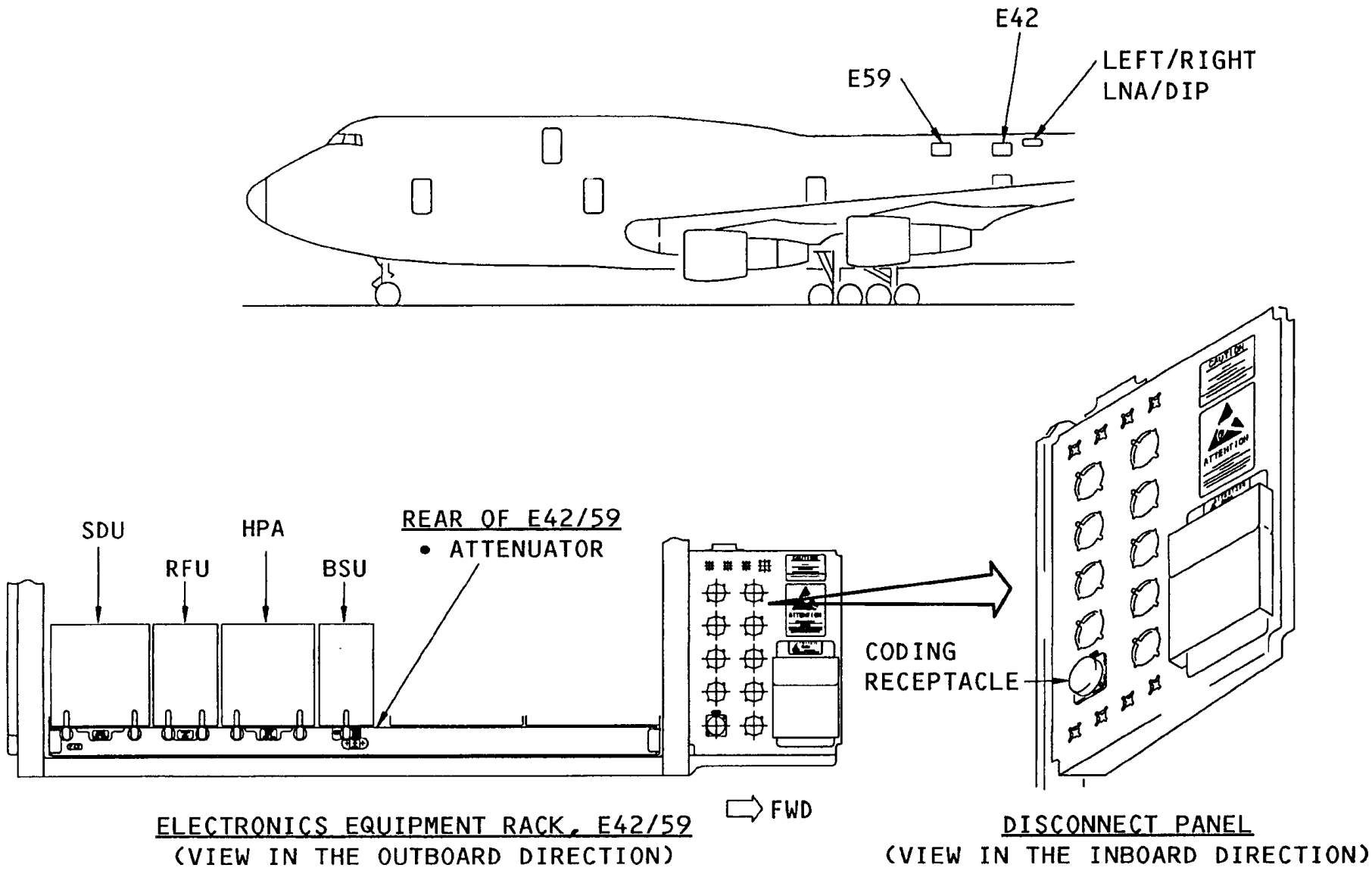


Figure 5 COMPONENT LOCATIONS PASSENGER CABIN

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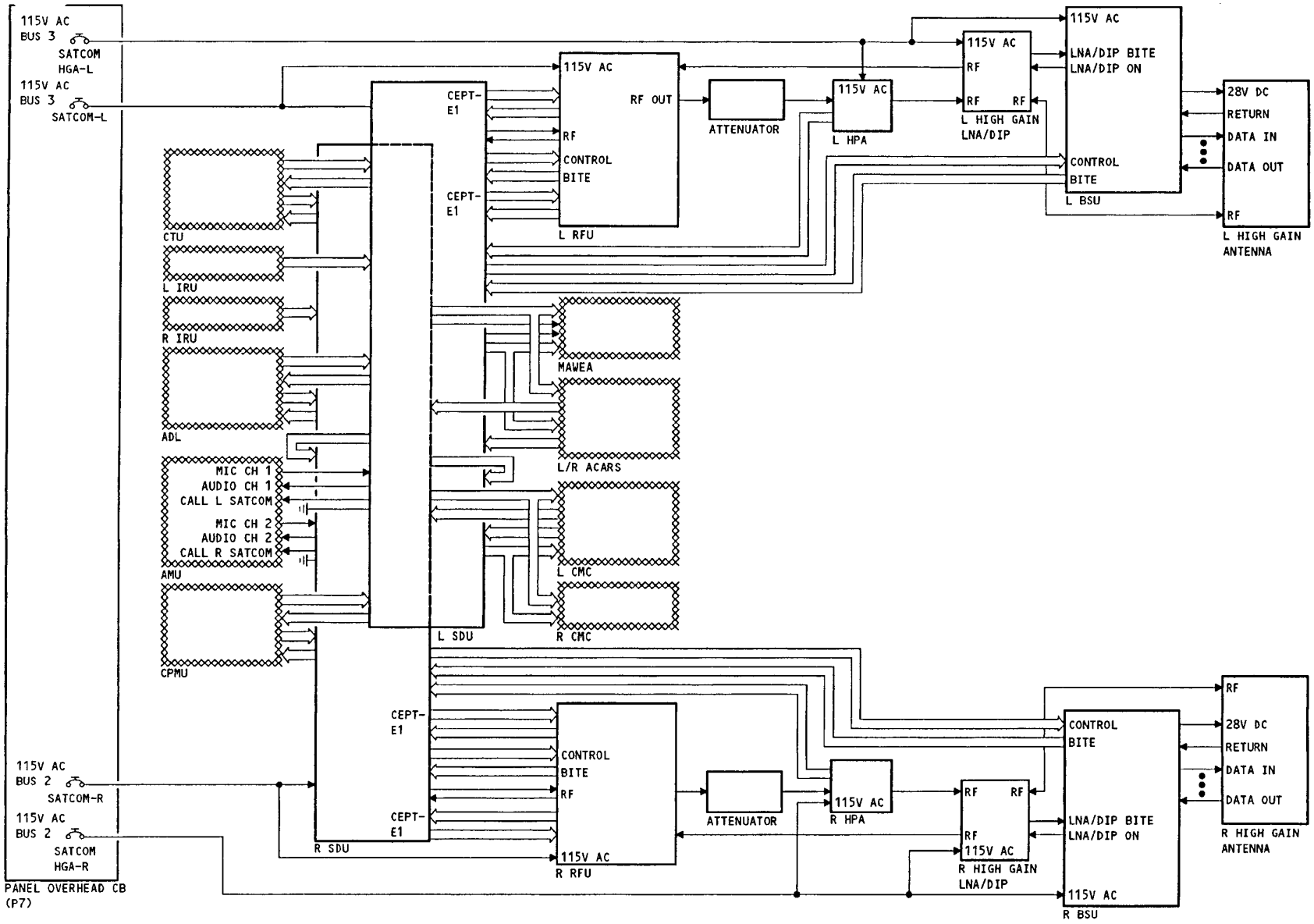


Figure 6 SATCOM – INTERFACE DIAGRAM

POWER

AC bus 3 supplies 115v ac to the:

- SATCOM-L circuit breaker
- SATCOM HGA-L circuit breaker

The SATCOM-L circuit breaker sends power to the:

- Left satellite data unit (SDU)
- Left radio frequency unit (RFU).

The SATCOM HGA-L circuit breaker sends power to the:

- Left high power amplifier (HPA)
- Left beam steering unit (BSU).

AC bus 2 supplies 115v ac to the:

- SATCOM-R circuit breaker
- SATCOM HGA-R circuit breaker

The SATCOM-R circuit breaker sends power to the:

- Right SDU
- Right RFU.

The SATCOM HGA-R circuit breaker sends power to the:

- Right HPA
- Right BSU.

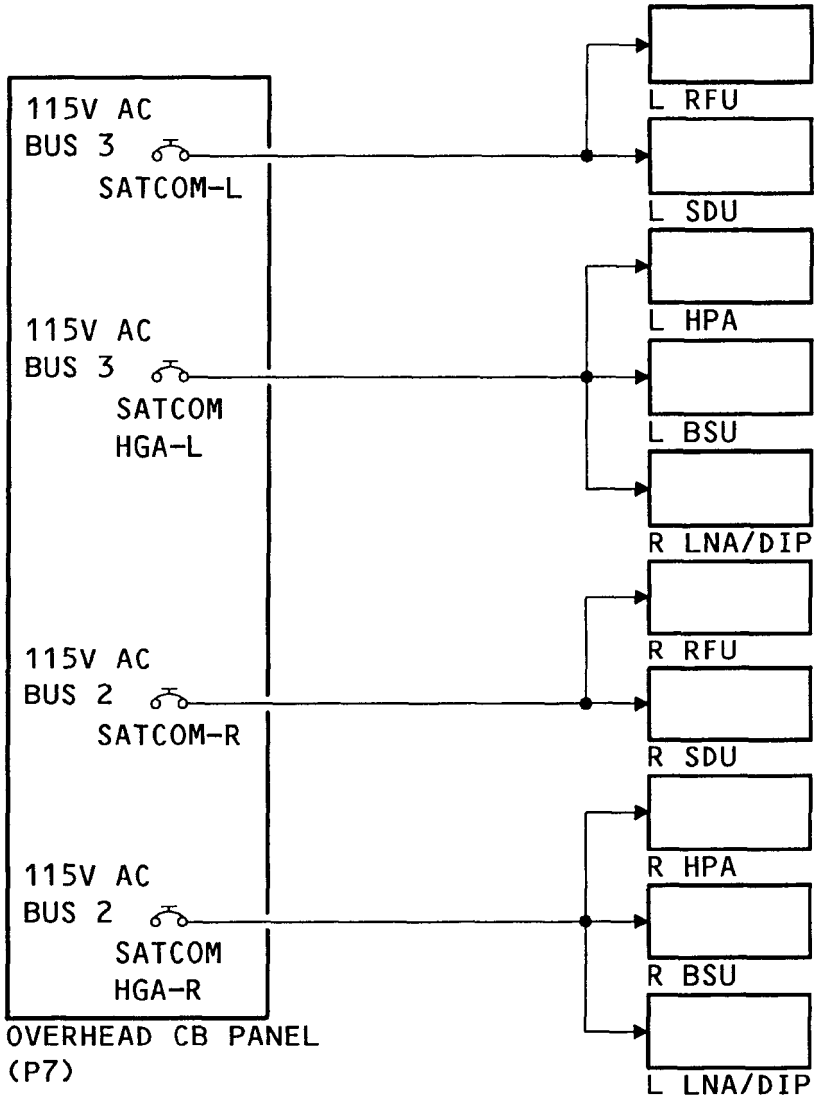


Figure 7 POWER

SDU INTERFACE

The left satellite data unit (SDU) is shown.

The IRU interface sends attitude and position data for the high gain antenna system. The left IRU sends data to the left SDU. The right IRU sends data to the right SDU.

The ADL loads system software and accepts download message data to a pre-formatted disk. The ADL interfaces with both SDUs.

The AMU sends mic audio and selection. Receive audio and call indications are from the SDU. The AMU interfaces with both SDUs.

The CTU sends up to five channels of digital voice/data messages. The CPMU sends control signals for cabin communications. The CTU and CPMU interface with both SDUs.

The CMCS stores system fault data and starts system ground test. CMCS interfaces with both SDUs.

The ACARS MU is a data channel interface. ACARS formats the transmit messages. The received messages are

decoded and stored in the ACARS MUs. Both the left and right ACARS MUS interface with both SDUs.

The MAWEA sounds a chime when a call is received, and processes SATCOM EICAS messages. MAWEA interfaces with both SDUs.

The CDUs are the flight crew interface with the SATCOM system. Use the CDUs to configure the system, initiate log on and start a ground test. All CDUs interface with both SDUs.

The SATCOM maintenance panel provides a connection for a maintenance terminal.

The SATCOM coding receptacle gets the airplane identification and functional options.

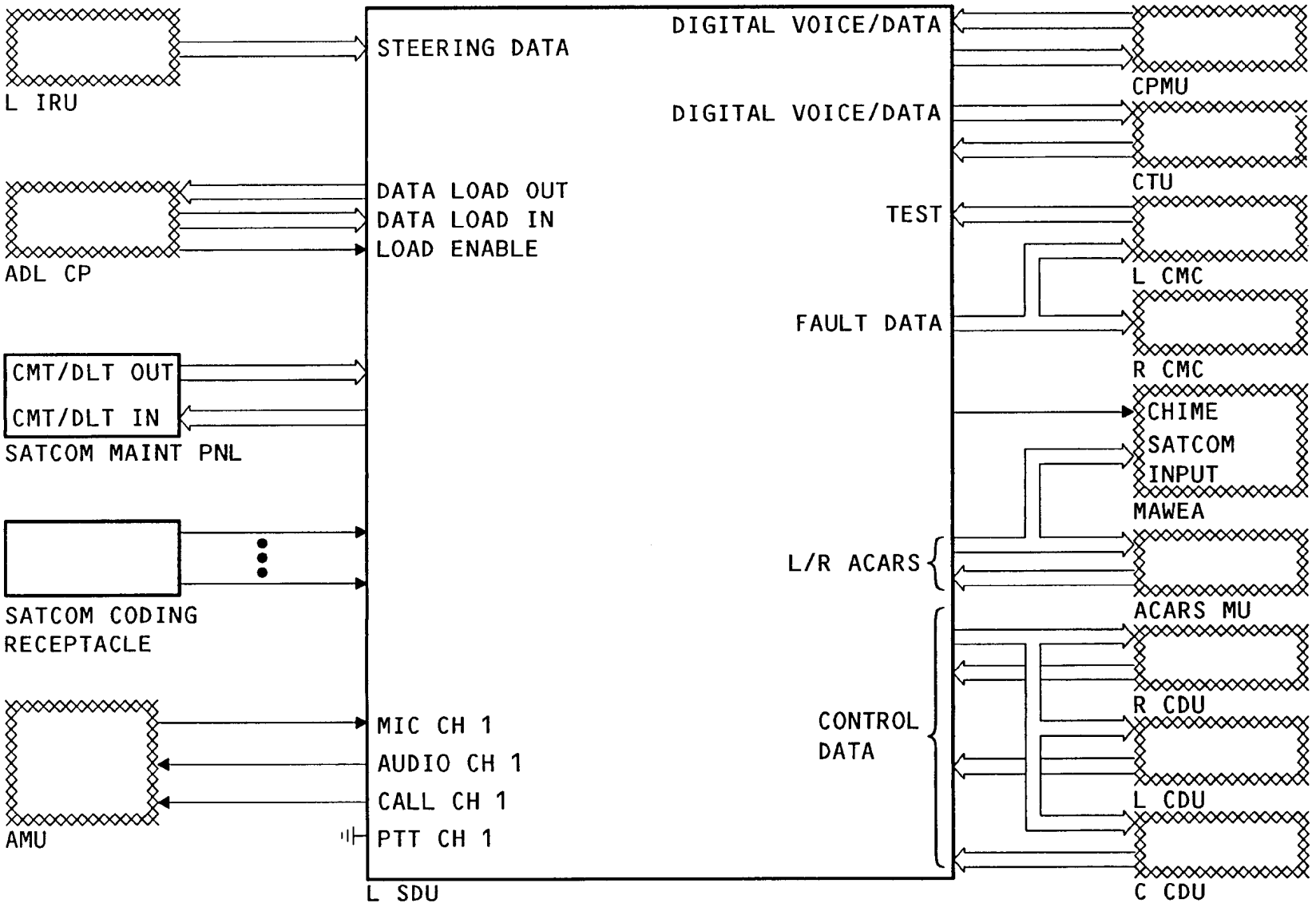


Figure 8 SDU INTERFACE

HIGH GAIN SYSTEM INTERFACE

General

Both SATCOM systems operate the same. The left and right SDUs have a crosstalk bus.

Transmit

The satellite data unit (SDU) converts analog audio and digital data to an RF signal. The SDU sends the digital voice and data, and RF signal to the radio frequency unit (RFU).

The RFU converts digital voice and data to RF and sends the RF signal to the high power amplifier (HPA).

The RF from the high gain HPA goes to the low noise amplifier/diplexer (LNA/DIP). The LNA/DIP sends the RF to the antenna.

The BSU sends data and power to the antenna. The BSU gets steering data from the SDU to electronically scan the antenna for the best RF link. The antenna sends the RF to a satellite.

Receive

During **receive, the high gain antenna gets RF** signals from a satellite. The high gain antenna sends the RF signals to the LNA/DIP.

The RF signals go to the low noise amplifier section of the LNA/DIP. The LNA/DIP amplifies the RF signal and sends to the RFU.

The RFU and SDU convert the RF to digital voice or data. The RFU sends the digital voice/data and RF signals to the SDU.

The SDU converts the signals to analog audio or digital data.

BITE

The satellite data unit (SDU) gets built in test equipment (BITE) data from the:

- RFU
- BSU
- LNA/DIP
- Antenna
- HPA.

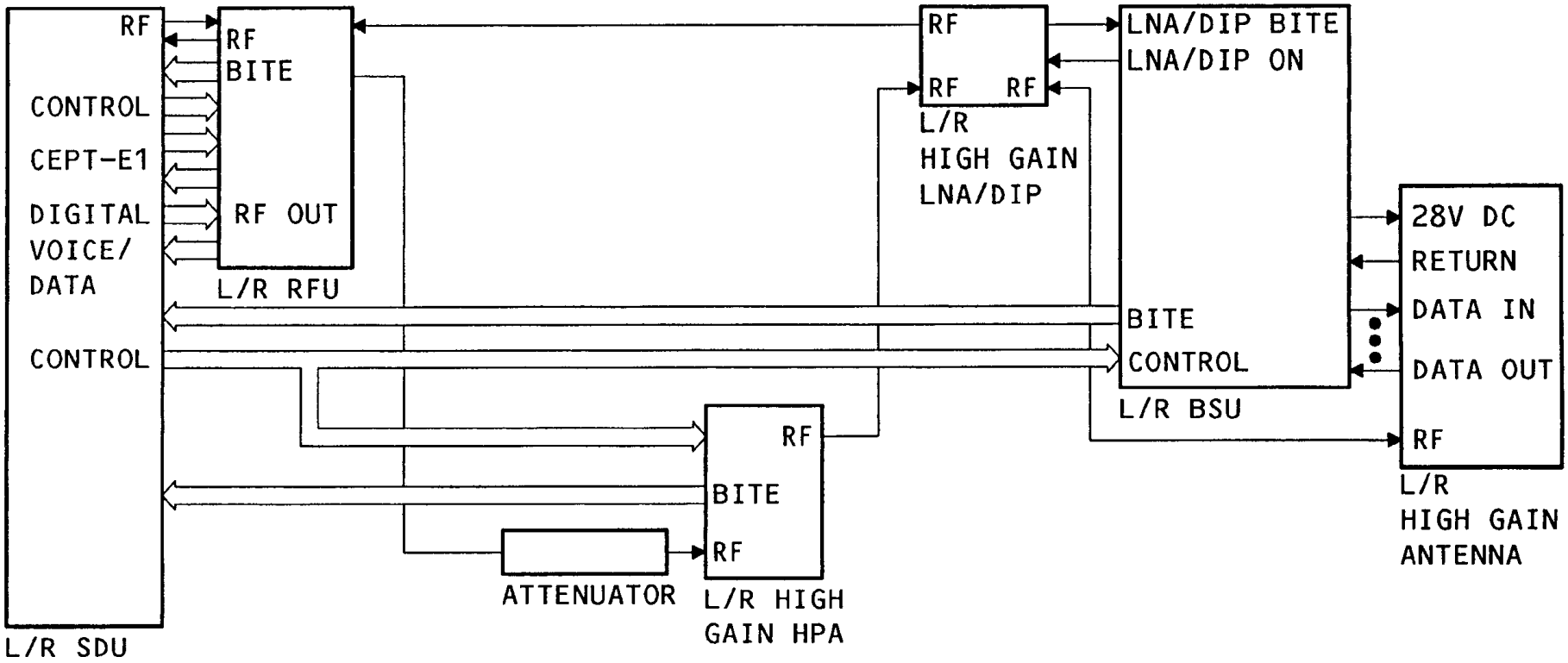


Figure 9 HIGH GAIN SYSTEM INTERFACE

SATELLITE DATA UNIT

Purpose

The satellite data unit (SDU) is the system interface and controller for the SATCOM system. It contains system operation software. The SDU also contains position and frequency data for each satellite.

Physical Description

The SDU is a 6 MCU LRU and weights 24 pounds. It has these front panel controls and indicators:

- SDU FAIL - shows red if the SDU has a failure
- SDU TEST switch - push this switch to start a test of the SDU
- System status display - shows data related to the pass or fail status of SATCOM LRUs
- CM/SCROLL - push this button to scroll through messages on the system status display
- SYSTEM LRU-FAIL - Shows red if any other SATCOM LRU has a failure.

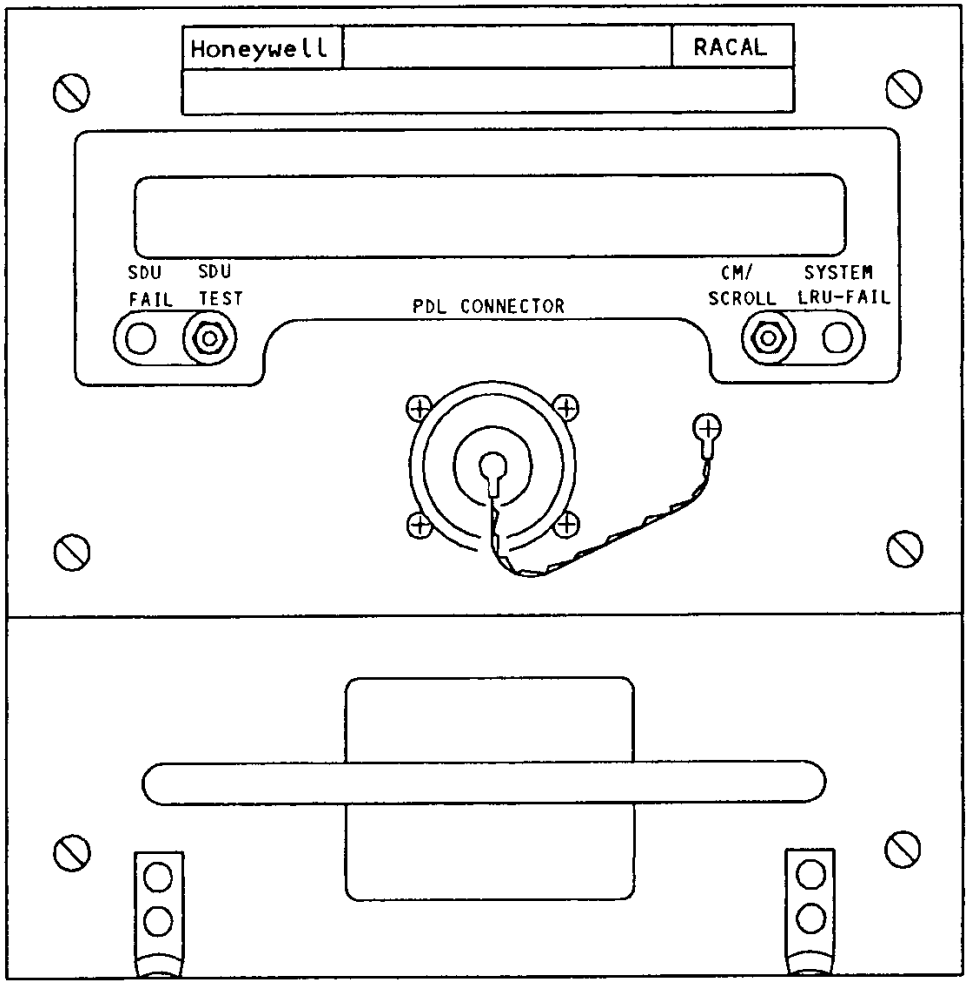


Figure 10 SATELLITE DATA UNIT

RADIO FREQUENCY UNIT

General Description

The RFU gets digital voice or data from the SDU. The RFU converts the channel data into an L-band RF signal.

The RFU combines the L-band RF signal with the RF from the SDU, and sends the combined RF to the high power amplifier (HPA).

The RFU gets amplified L-band signals from the low noise amplifier/diplexer (LNA/DIP) and sends them to the SDU. The RFU converts RF into digital voice or data, and sends them to the SDU.

Controls and Indications

The RFU has a front panel momentary action PUSH TO TEST switch.

Push the PUSH TO TEST switch to start a self test of the RFU'.

The front panel displays on the RFU are the:

- Green PASS light emitting diode (LED)
- Red FAIL LED

The green PASS LED comes on for 30 +/5 seconds at the end of an RFU BITE test when no faults are detected.

The red FAIL LED is on:

- For 30 +/- 5 seconds at the end of an RFU BITE test when the BITE detects a fault.
- Continuously if continuous monitoring detects a fault.

CAUTION: STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REF 20-41-02/201). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCHARGE.

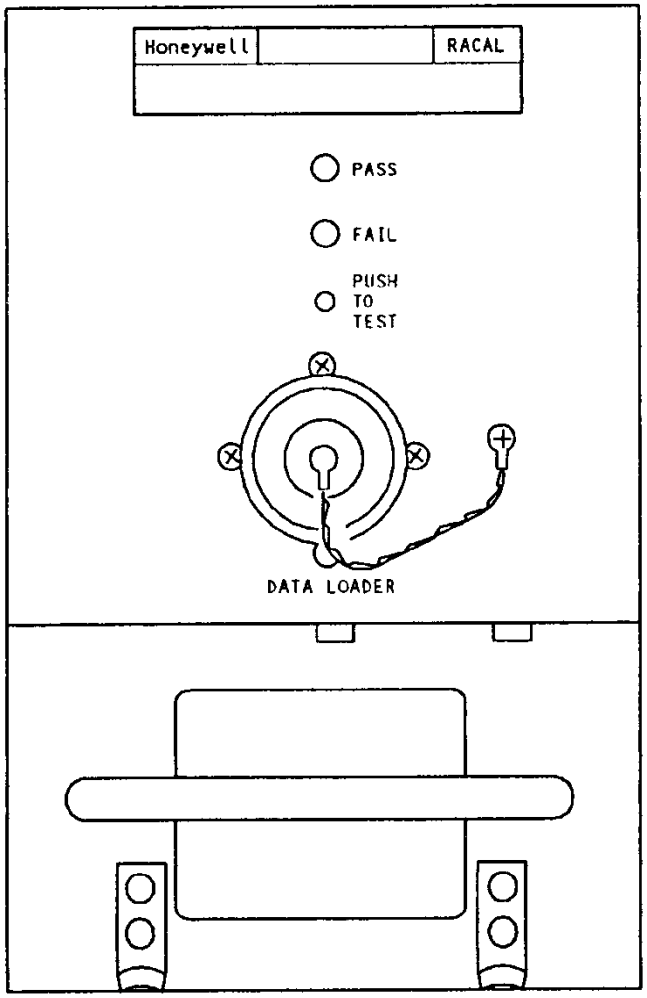


Figure 11 RADIO FREQUENCY UNIT

ATTENUATOR AND MAINTENANCE PANEL

Attenuator

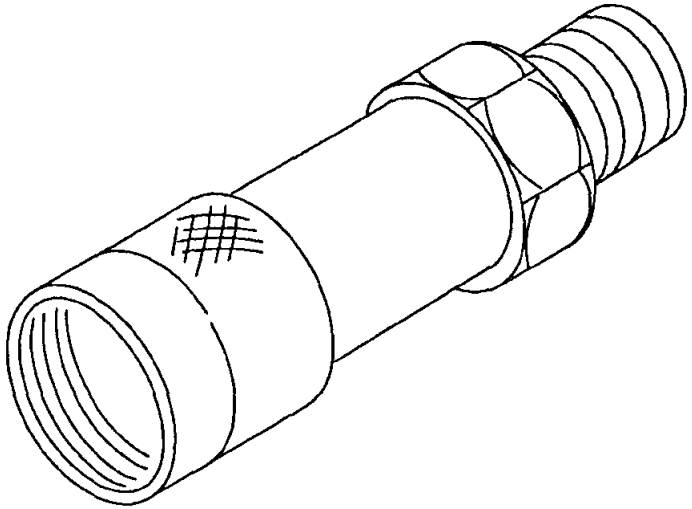
The attenuator adjusts the radio frequency signal level to make the output from the RFU compatible to the input level needed for the HPA.

The attenuator has these properties:

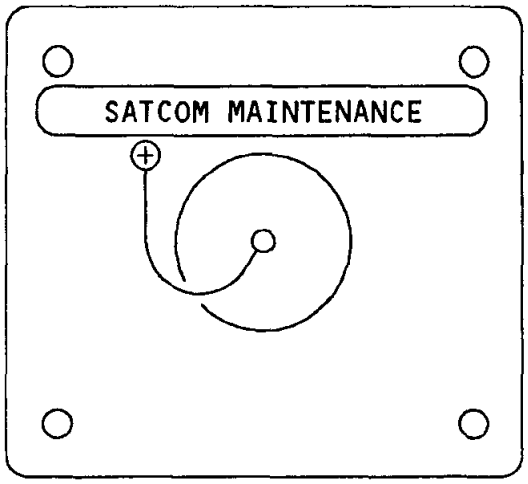
- Length - 2 inches
- Diameter - .5 inches
- Weight - 1.3 ounces.
- 20 DB attenation

Maintenance Panel

The SATCOM maintenance panel provides a connection to the SDU. A commissioning and maintenance terminal uses this connection to run tests and log faults and data from the system.



ATTENUATOR



MAINTENANCE PANEL

Figure 12 ATTENUATOR AND MAINTENANCE PANEL

HIGH GAIN SYSTEM - HIGH POWER AMPLIFIER

General Description

The high gain system high power amplifier (HPA) interfaces with the:

- Satellite data unit (SDU)
- Radio frequency unit (RFU)
- High gain low noise amplifier/diplexer (LNA/DIPs).

Characteristics

The HPA has:

- An output power level of 80 watts maximum
- A frequency range of 1626.5 - 1660.5 MHz.

Controls and Indications

The HPA has a front panel momentary action PUSH TO TEST push button switch.

Push the PUSH TO TEST switch to start a self test of the HPA.

The front panel indications on the HPA are the:

- Green PASS light emitting diode (LED)
- Red FAIL LED

The green PAS LED comes on for 30 +/- 5 seconds at the end of an HPA BITE test when no faults are detected.

The red FAIL LED is on:

- For 30 +/- 5 seconds at the end of an HPA BITE test when the BITE detects a fault.
- Continuous if monitoring detects a fault.

CAUTION: STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REF 20-41-02/201). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCH

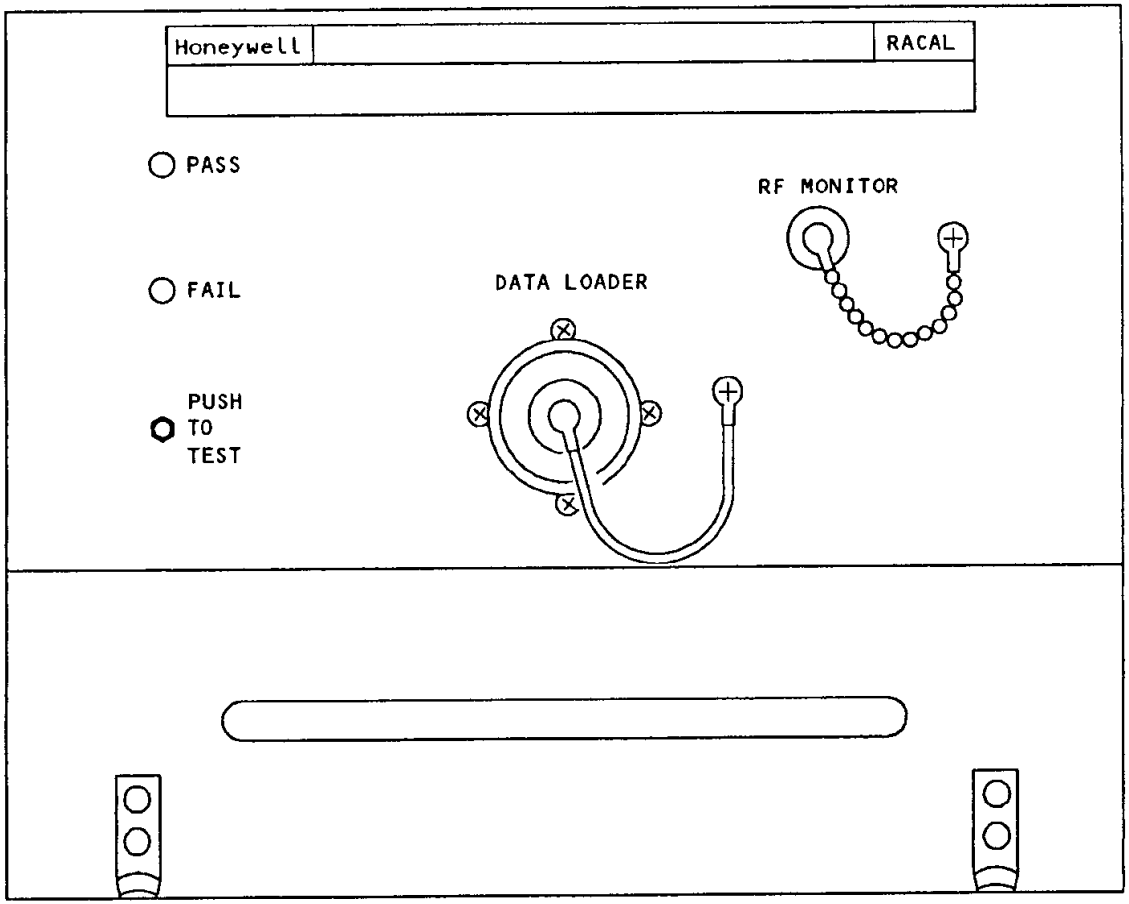


Figure 13 HIGH GAIN SYSTEM - HIGH POWER AMPLIFIER

HIGH GAIN SYSTEM - LNA/DIPLEXER

General Description

The high gain system low noise amplifier/diplexer (LNA/DIP) interfaces with the:

- RF combiner
- High gain system, beam steering unit (BSU).

The LNA/DIP couples transmit and receive signals to the BSU. It isolates the high power transmit signal from the high sensitivity receiver. The LNA amplifies the very low level signal from the satellite to usable levels for the RFU.

The diplexer allows the antenna to transmit and receive at the same time.

Controls and Indicators

There are no controls or indicators on the LNA/DIP.

CAUTION: STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REF 20-41-02/201). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCHARGE.

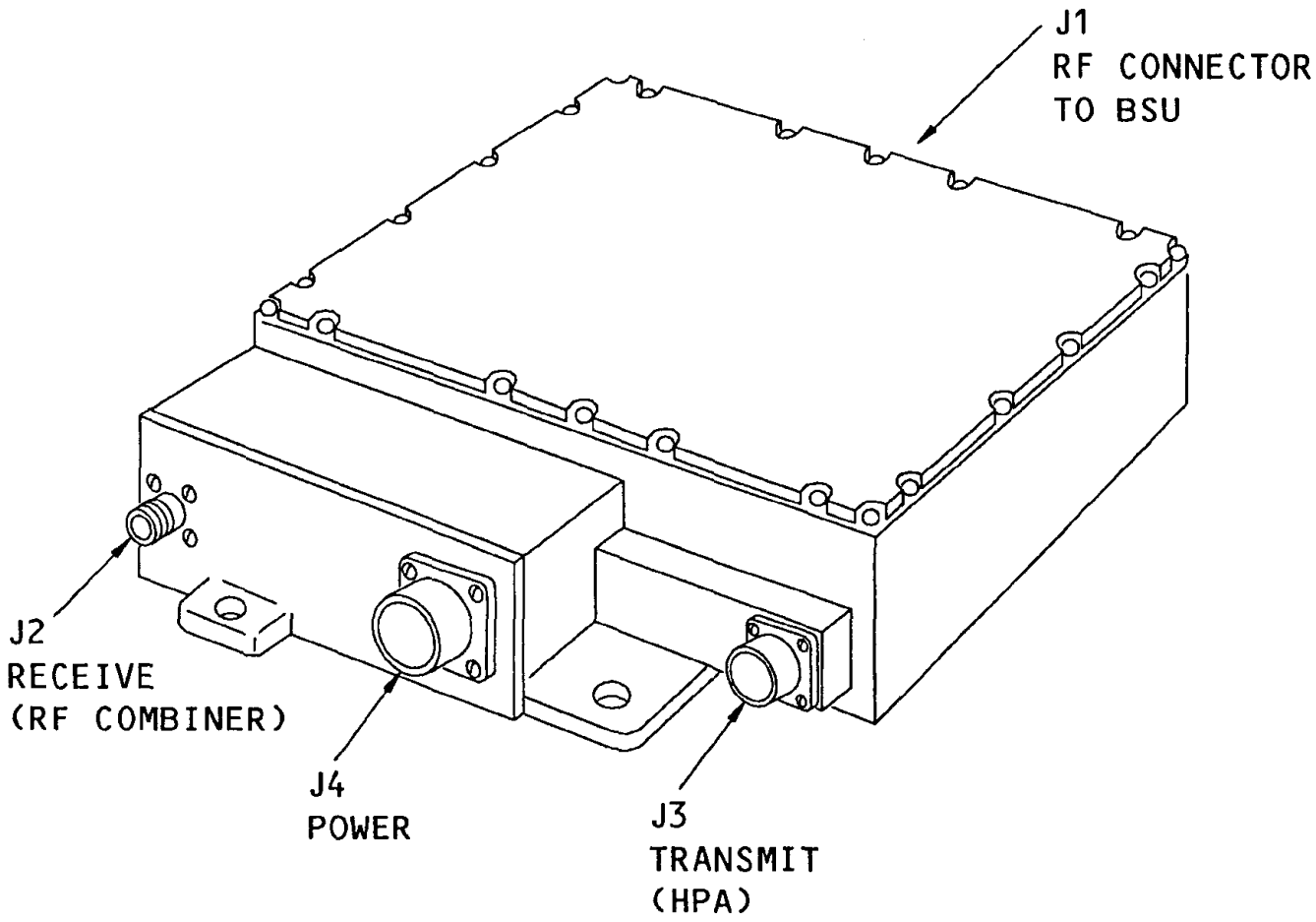


Figure 14 HIGH GAIN SYSTEM - LNA/DIPLEXER

HIGH GAIN SYSTEM - BEAM STEERING UNIT

General Description

The high gain beam steering unit (BSU), interfaces with the:

- High gain system low noise amplifier/diplexer (LNA/DIP).
- Satellite data unit (SDU)
- High gain antenna (HGA)

Characteristics

The BSU gets beam steering commands from the SDU. The BSU sends the beam steering commands to the antenna.

Controls and Indications

The BSU has a front panel momentary action TEST switch. Push the TEST switch to start a self test of the BSU.

The front panel indications on the BSU are the:

- Red BSU, HGA, and LNA/DIP fail indicators
- Green power (PWR) applied indicator
- Red PWR power supply failure indicator

CAUTION: STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REF 20-41-02/201). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCHARGE.

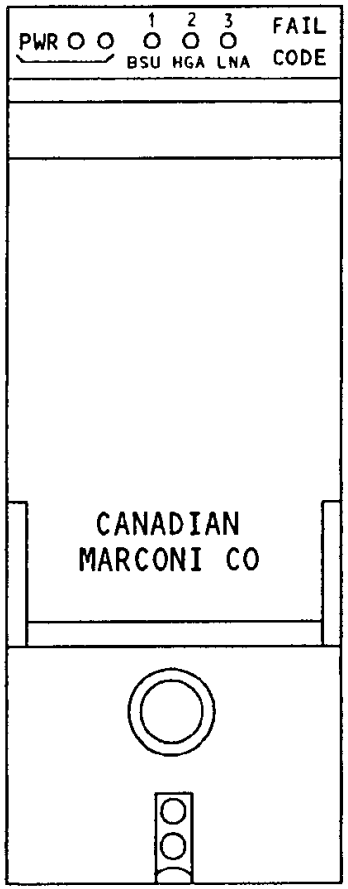


Figure 15 HIGH GAIN SYSTEM - BEAM STEERING UNIT

HIGH GAIN SYSTEM - ANTENNA

General Description

The high gain system antenna is for high speed data and voice communication. The antenna elements are protected by a bubble-shaped aerodynamic radome. The antenna is full-duplex capable.

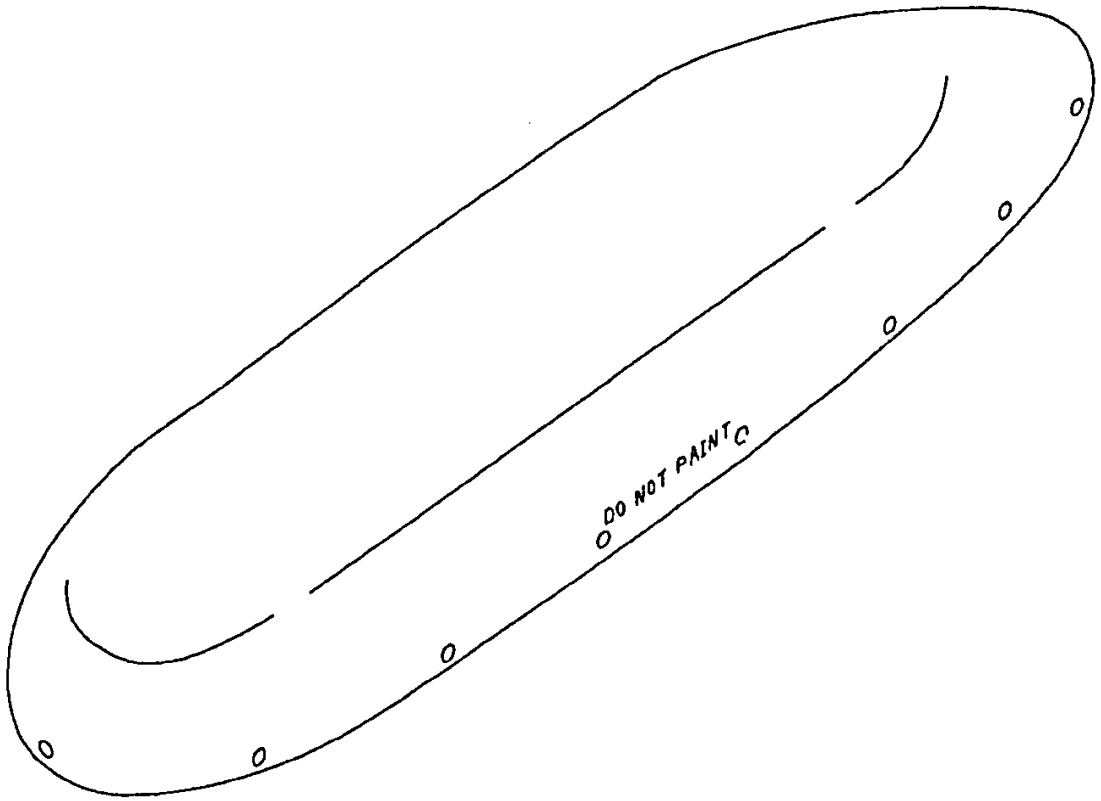


Figure 16 HIGH GAIN SYSTEM - ANTENNA

LOW GAIN ANTENNA

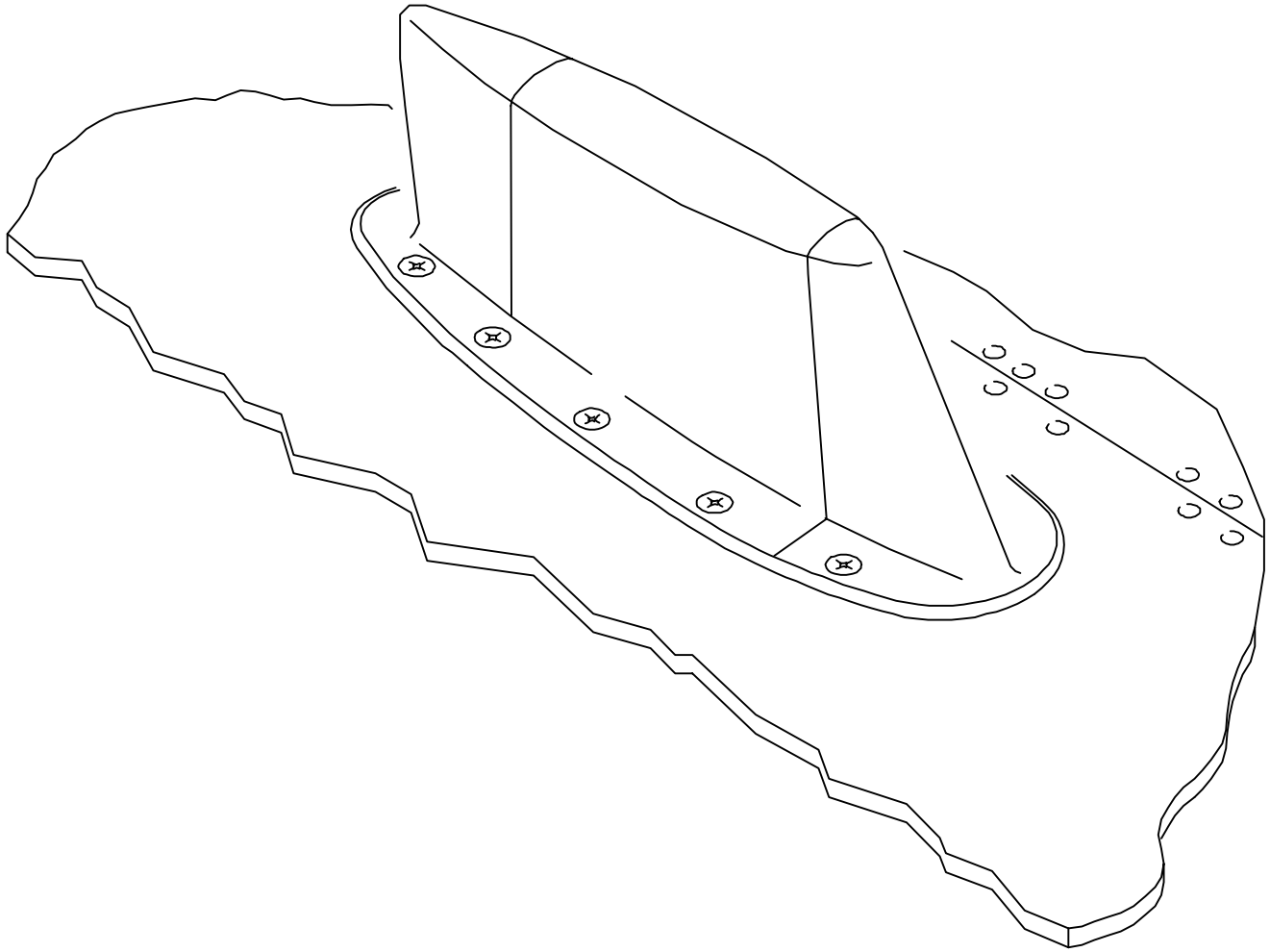


Figure 17 LOW GAIN ANTENNA

CONTROL DISPLAY UNIT

General

The CDU contains these items:

- Keyboard for data entry or display selection
- Cathode ray tube to show data
- Eight bit microprocessor to control the operation of the CDU

The primary control interface to the CDU is the keyboard. There are four types of keys:

- Function keys
- Mode key
- Line select keys
- Alpha-numeric keys

only keys relating to SATCOM are discussed.

Function and Mode Keys

The function keys are:

- NEXT PAGE: used to look at the next page among many pages
- Previous page (PREV PAGE): used to look at the last among many pages

The MENU mode key selects the CDU MENU.

Line Select Keys

The line select keys (1L - 6L and 1R 6R) are used to insert data from the scratch pad, to put data into the scratch pad or to select a function.

Alpha-numeric Keys

The alpha-numeric keys provide the means to enter data. In addition to the letters and numbers, there are these keys:

- Slash (/) key
- Change sign (+/-) key
- Delete (DEL) key
- Clear (CLR) key
- Space (SP) key

The CLR key is used to clear (remove data from) all or part of the scratch pad. The DEL key enters the word DELETE in the scratch pad. A line select key then deletes (removes) the selected field.

Display Format

There are 14 lines of data available. Each line is 24 characters long. The top line is always the title of the page or function, the page number and the number of pages in that function. The bottom line is for the scratch pad. The scratch pad is for data entry or transfer and for messages to show.

SATCOM MAIN MENU

The CDUs are the primary crew interface with SATCOM. To use SATCOM, push the CDU MENU key. This shows the CDU MENU on the display. Push the line select key next to the SATCOM prompt, to show the SATCOM MAIN MENU. The SATCOM MAIN MENU page gives access to the different SATCOM functions and shows the voice channel status.

The SATCOM main menu shows:

- The name selected for call on channel 1 or 2.
- Call controls
- SATCOM directory access
- Access to SATCOM submenus.

For each channel, SATCOM shows these items:

- Channel status
- Call connection commands
- Call disconnect commands
- The call destination name chosen from the directory.

SATCOM Submenu

The submenu shows the current log-on status of SATCOM. It also has selections to let you control the

log-on and log-off. other selections let you see the status of each channel and check the configuration of LRUs.

SATCOM Directory

The SATCOM directory pages show the labels for each phone number in the directory.

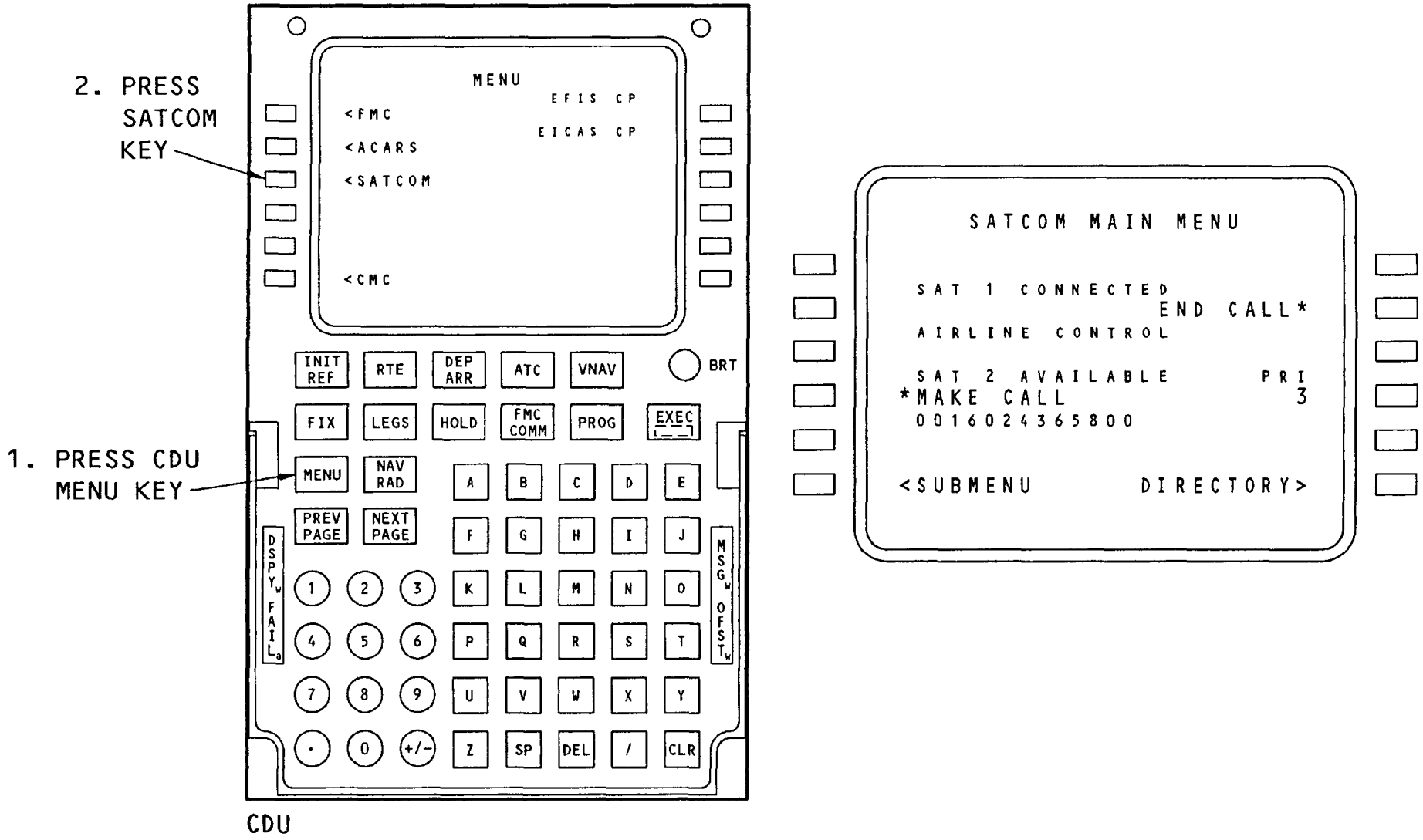


Figure 18 CONTROL DISPLAY UNIT

SATCOM - LOG ON

General

To use the SATCOM system, the airplane must log-on to a communication service company.

Automatic Log-On

An automatic log-on occurs when the system powers up. The SATCOM system uses satellite frequencies in memory to find a satellite transmit signal. When the SATCOM system finds an active frequency from the satellite, it locks on to it. The system then uses the satellite as a relay to log-on to a ground station.

After the airplane logs on, the log-on data goes to all ground station networks so that any of the ground station can locate a specified airplane SATCOM system.

Manual Log-On

Push the SATCOM prompt on the CDU menu to show the SATCOM main menu. Push the

line select key (LSK) adjacent to SUBMENU. The submenu shows the log-on state and allows access to the log-on, status, and maintenance screens.

On the SATCOM submenu, push the LSK adjacent to LOG-ON. This shows the logon screen for the SATCOM system.

The SATCOM log-on screen shows these:

- The log-on state
- The ground earth station (GES) logged on to
- The satellite in use.

If the system is logged off, select the LSK adjacent to *AUTO LOG-ON to make the system automatically log-on to a satellite and GES. You may also push the LSK adjacent to GES-SEL to show a list of ground earth stations. From this screen, you may select a GES and log-on.

An airplane can only log-on to one ground station at a time. However, the airplane does not have to get all communication services from that ground station. The airplane may use other links with other ground stations. A typical multi-ground station operation permits an airplane to do these functions:

- Keep data links with the airplane operations base
- Talk to an air traffic control (ATC) center through the log-on ground station
- Operate passenger communications through different ground station.

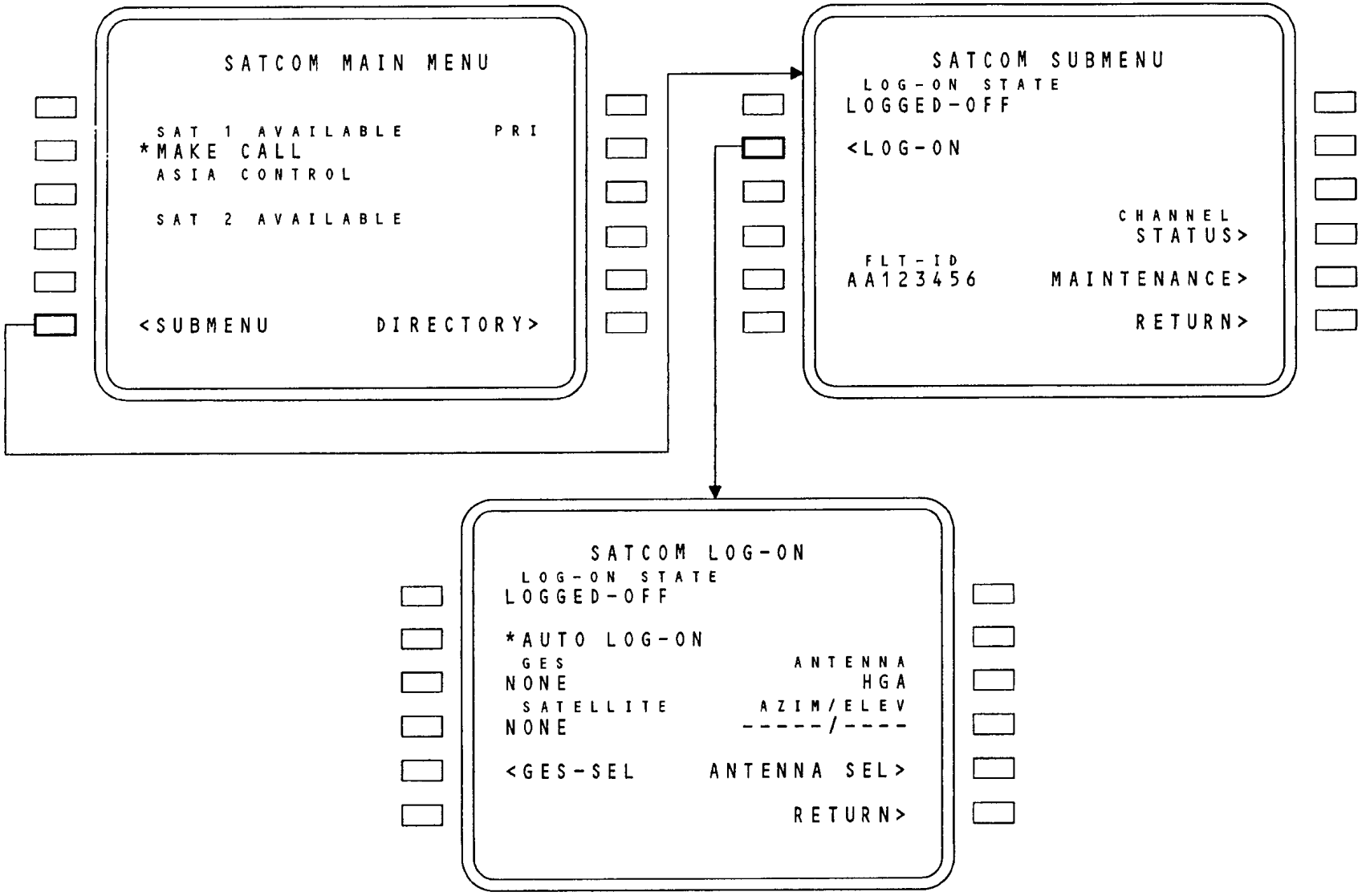


Figure 19 SATCOM - LOG ON

VOICE OPERATION

General

The flight crew uses the control display units (CDUs) and audio control panels (ACPs) to control the voice mode of the SATCOM system.

Outgoing Calls

Push a SATCOM transmit switch on the ACP. Adjust the volume with the related SAT receiver volume control.

Push the MENU key on the CDU and then push the line select key (LSK) adjacent to SATCOM. The SATCOM MAIN MENU shows on the CDU.

Push the LSK adjacent to DIRECTORY to show the categories of numbers (1 through 4). Push the adjacent LSK to show the list of numbers in the category. Push the LSK next to the name you want to call. The SATCOM system automatically starts the call and returns to the SATCOM MAIN MENU. When the call is made, the related SAT CALL light comes on and you hear the ringback tone in the headset.

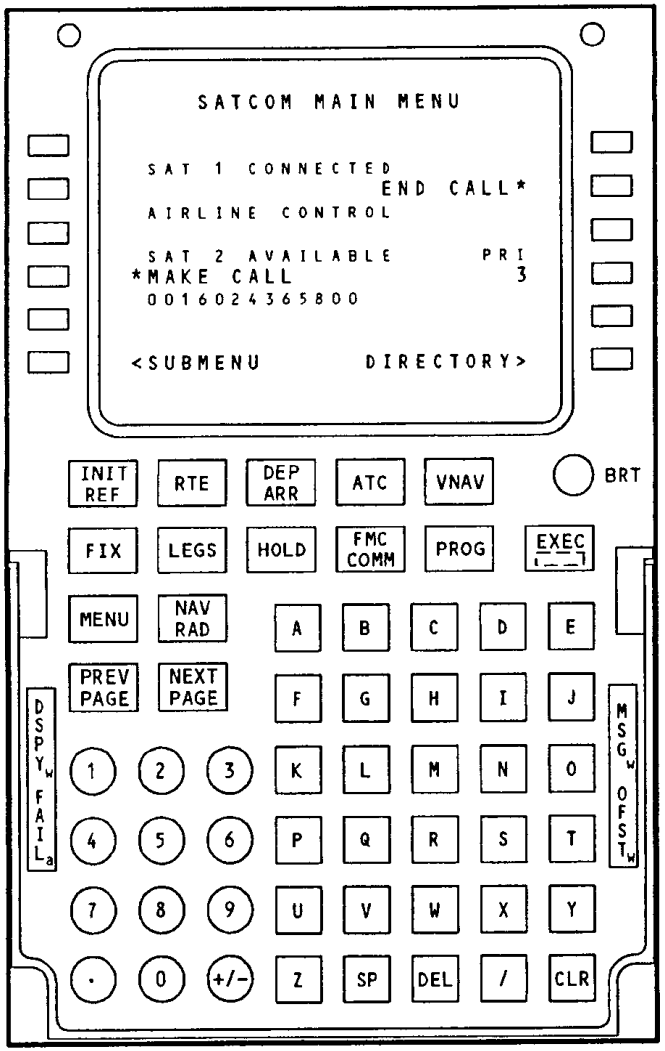
When the called party answers, you can push any PTT switch and speak into the microphone. You do not need to release the MIC/interphone switch to listen. When you finish the call, push the LSK adjacent to END CALL from the SATCOM-MAIN MENU.

Incoming Calls

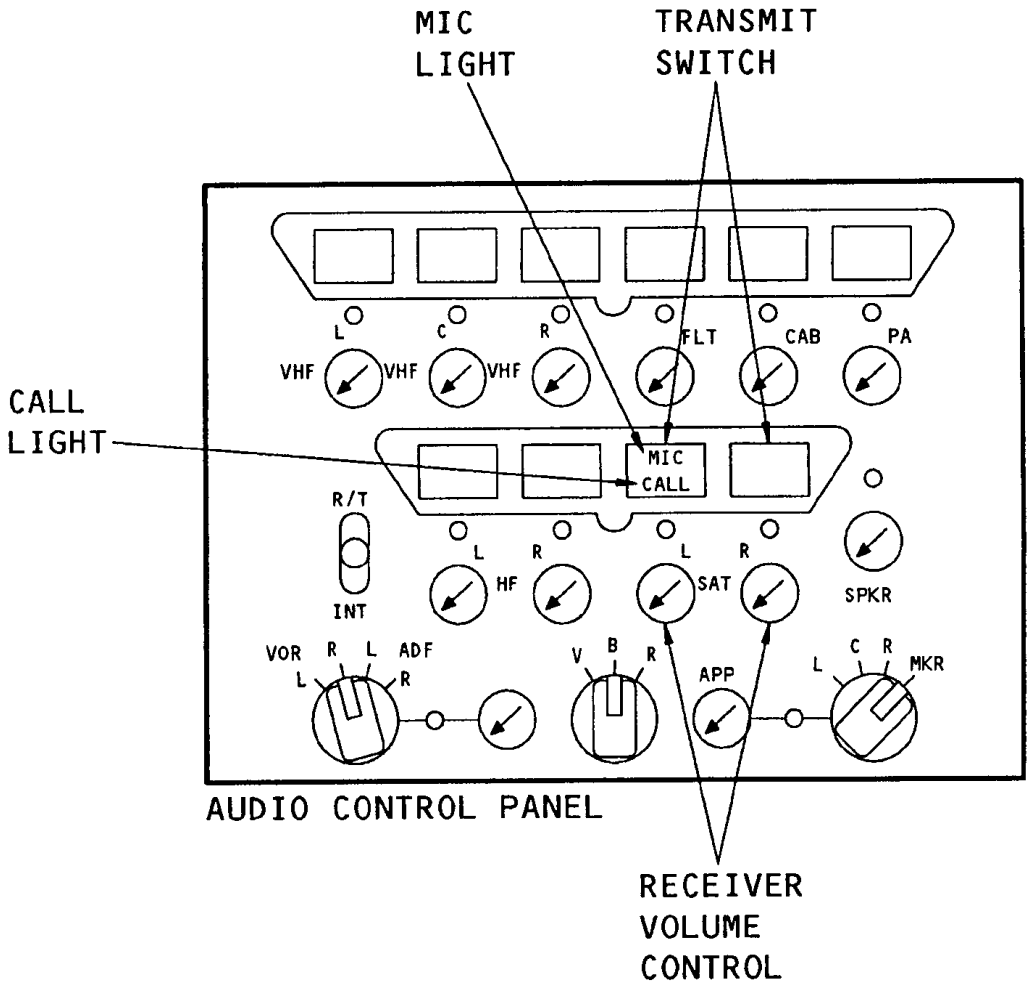
When the airplane receives a call, a chime sounds and the call light shows on the ACP. To answer the call, push the related transmit switch on the ACP.

On the ACP, adjust the volume with the receiver volume control. The call light remains on until the flight crew ends the SATCOM call.

Use the CDU to end the call. Push the LSK adjacent to END CALL.



CONTROL DISPLAY UNIT



AUDIO CONTROL PANEL

Figure 20 VOICE OPERATION

SATCOM - SYSTEM NETWORK

General

SATCOM is a long range data and voice communications system. It uses a network of satellites and ground stations. The SATCOM network is made up of three segments. They are the:

- Satellites
- Aircraft earth stations (AES)
- Ground earth stations (GES)

The satellites are in geo-synchronous orbits and are the two-way relay between the AES and GES. Uplink signals are sent to the satellite and downlink signals are sent from the satellite.

The satellite is transparent to the users. It converts C-Band frequency signals from the GES to L-Band frequency signals and relays them to the AES.

The AES equipment processes signals in the L-band frequencies from 1530 MHz to 1660.5 MHz.

The GES synchronizes the SATCOM system and coordinates transmissions. The GES

transmits and receives on C-band frequencies from 4 GHz to 6 GHz. The network allows the AES to communicate with any other user on the network.

Operation

Typically a user logs onto a GES at the beginning of each flight. Log-ons may be renewed during flight if a substantial interruption of communications has occurred. New log-ons are also needed when a satellite or GES hands off the AES to another station. An AES may only log-on to one GES at a time, but may establish separate links for other communication.

When first powered the AES scans a stored set of frequencies from 1530 MHz to 1559 MHz to locate and lock on to a satellite. The AES measures the doppler shift of the GES signal and calculates the error correction necessary to prevent doppler induced errors. once locked onto a satellite, the AES logson with a GES. Log-on information is shared throughout the network, so any of the ground stations can communicate with the AES.

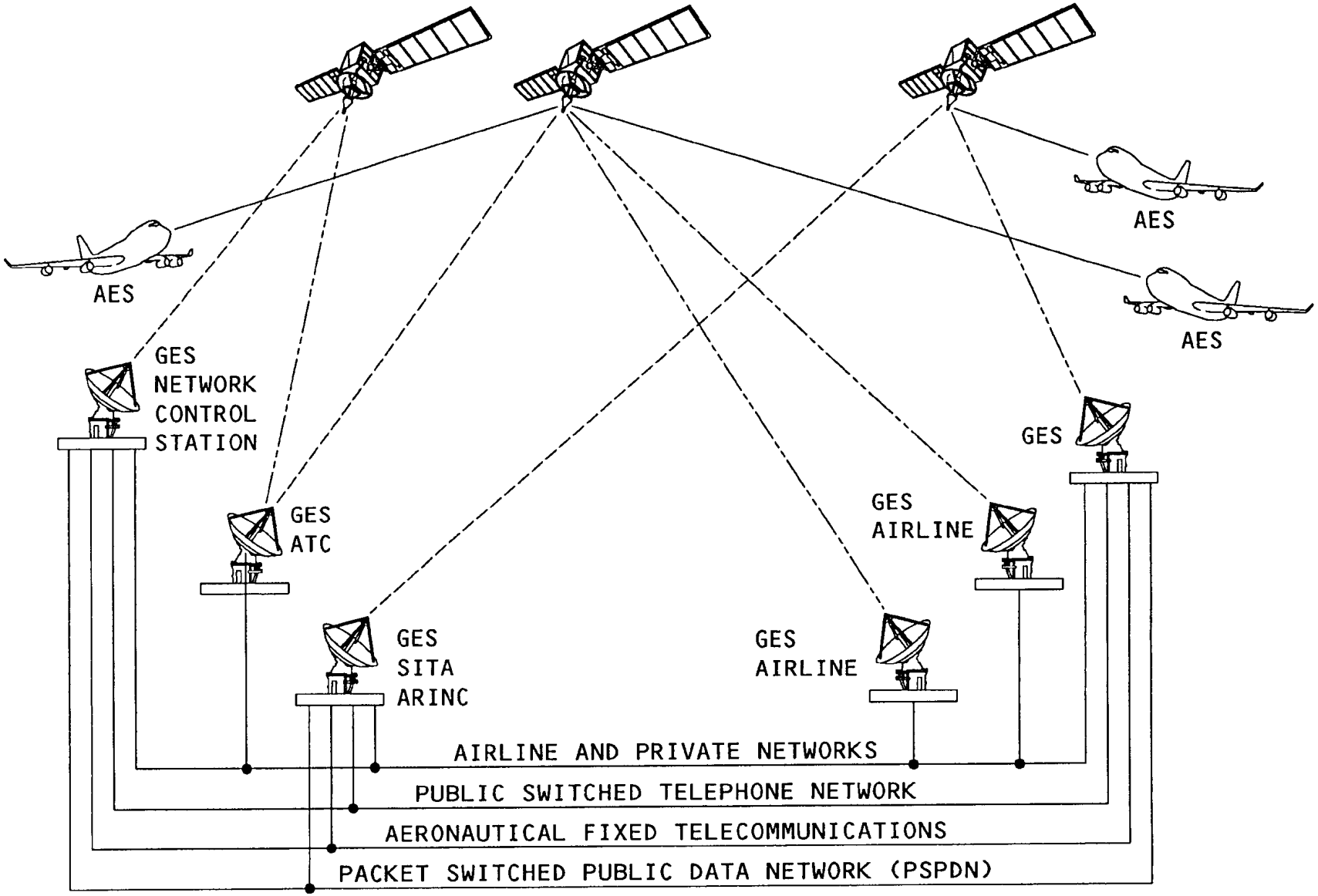


Figure 21 SATCOM - SYSTEM NETWORK

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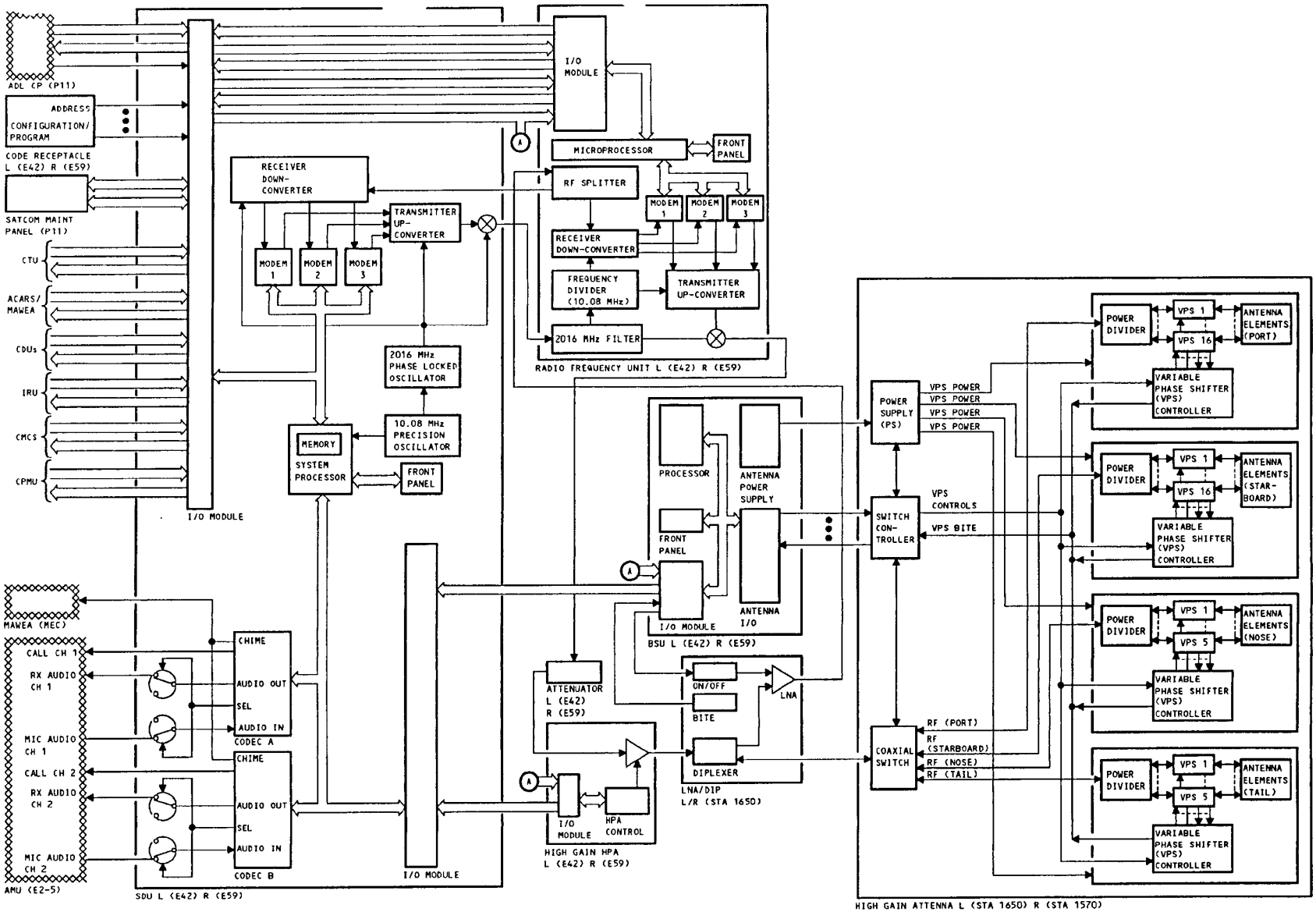

Figure 22 SATCOM – SCHEMATIC DIAGRAM

SATELLITE DATA UNIT SCHEMATIC

General Description

The satellite data unit (SDU) is the system interface and controller for the airplane SATCOM system. It contains system operation programs. The SDU has these components:

- Receiver down-converter
- Transmitter up-converter
- Three modulator/demodulators (modems)
- Input/output (1/0) module
- Audio interface
- System processor
- 2016 MHz phase locked oscillator
- 10.08 MHz precision oscillator
- Front panel.

The SDU supplies as many as three voice/data channels. It also connects to the radio frequency unit (RFU). The RFU can supply three more voice/data channels.

Receiver Down-Converter

The receiver down-converter gets radio frequency (RF) signals from the RFU.

It changes the RF data to as many as three channels of intermediate frequencies (IF) and sends them to the modems.

Transmitters UD-Converter

The transmitter up-converter gets as many as three channels of IF signals from the modems. It uses an input from the 2016 MHz oscillator to change the IF signals to RF. The SDU mixes the RF output with a 2016 MHz reference signal and sends it to the RFU.

Modems

The modems demodulate the intermediate frequency signals from the down-converter. They change the inputs to digital and send them to the system processor. They also get digital data from the system processor, change it to IF and send it to the transmitter up-converter.

In-Put/Output Module

The 1/0 module controls the interface between SATCOM components and other systems. The 1/0 module has the following interfaces:

- The airborne data loader (ADL) can transfer the SATCOM operational program and owner requirements table. The ADL can also accept downloads of event reports.
- The control display units (CDUs) are the flight crew interface to the SATCOM system.
- The left Inertial Reference unit (IRU) sends attitude and position data for high gain antenna control.
- The ARINC Communication addressing and reporting system (ACARS) uses SATCOM to send and receive messages, usually when out of range of VHF facilities.
- The cabin telecommunications unit (CTU) and cabin passenger management unit (CPMU) send and receive passenger voice and data.
- The FAX unit provides passenger facsimile service.
- The audio management unit (AMU) sends two microphone audio signals. The AMU gets receive audio and call indication.
- The radio frequency unit (RFU) gets control and digital voice/data. The RFU sends status and digital voice/data.
- Crosstalk with the right SDU.

Audio Interface

The audio interface connects the SDU to the audio management unit (AMU). It changes analog audio from the AMU to digital data for the SDU. It also changes the digital SDU data to analog voice signals for the AMU. The same process is used for the FAX audio signals.

System Processor

The system processor controls all operations of the satellite data unit and operates the complete SATCOM system. It sends call light signals to the AMU. The memory keeps data for:

- System operation
- Satellite identification
- Ground station identification
- Channel frequencies.

You use switch inputs from the front panel to make the processor start a test of the SDU. The processor sends display data to the front panel to show the status of the test.

2016 MHz Phase Locked Oscillator

The 2016 MHz oscillator gets its input from a 10.08 MHz precision oscillator. The 2016 MHz goes to the converters to change the input and output frequencies. It also gets mixed with the RF output for the RFU to use as a reference.

10.08 MHz Precision oscillator

The SATCOM system uses this oscillator as a precise reference for the modulation of the RF signals. The SDU also uses it as its base reference frequency for the processor.

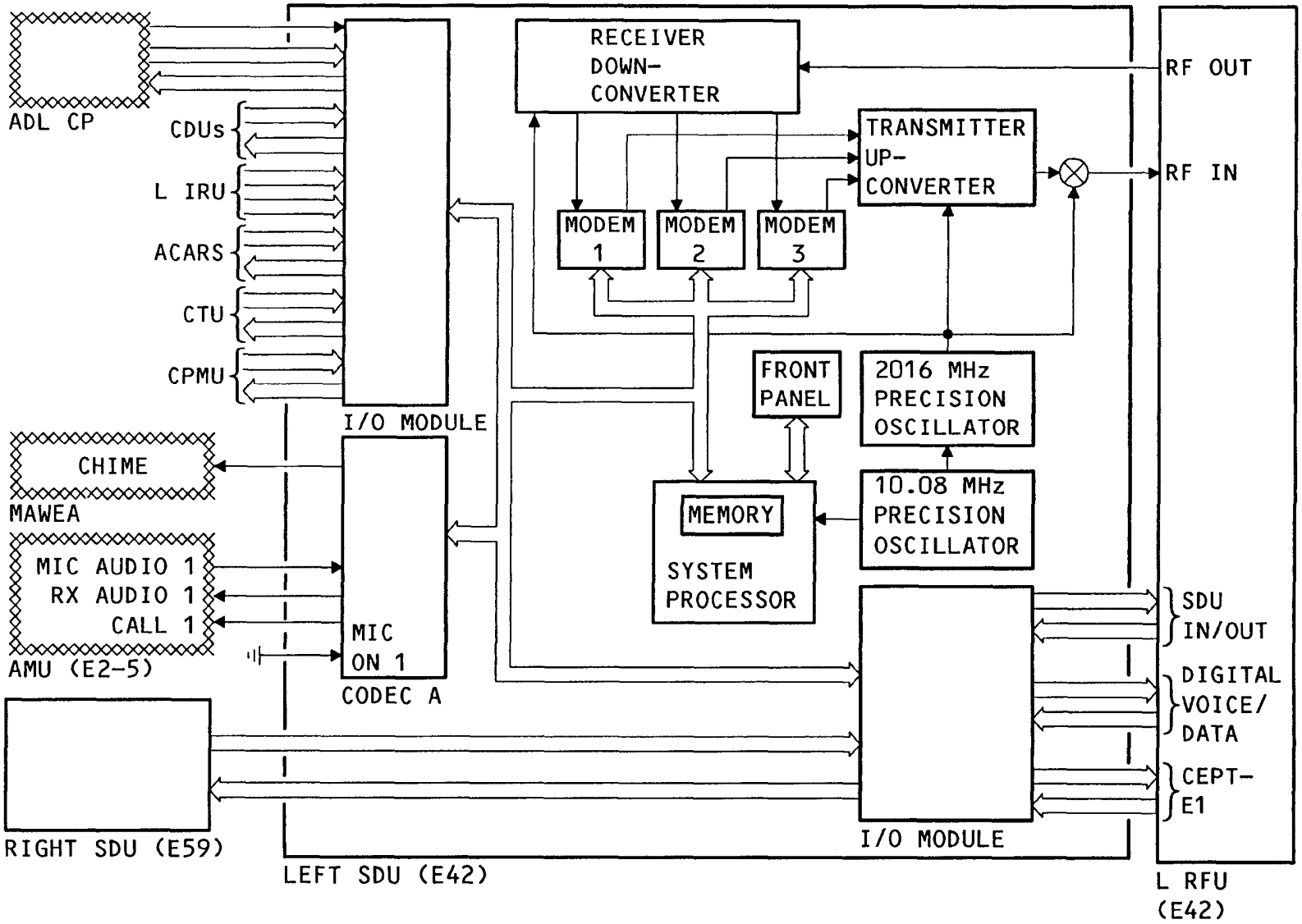

Figure 23 SATELLITE DATA UNIT SCHEMATIC

RADIO FREQUENCY UNIT SCHEMATIC

General

The radio frequency unit (RFU) changes digital audio from the cabin telecommunications unit (CTU) and satellite data unit (SDU) to radio frequency (RF) signals. The RFU has three voice/data channels. If the passenger telephone system needs to use more than three channels, the RFU passes the RF to the SDU. The SDU supplies three additional channels.

The RFU has these parts:

- 2016 MHz filter
- Frequency divider
- Transmitter up-converter
- Receiver down-converter
- RF splitter
- Three modulator/demodulators (modems)
- ARINC 429 interface
- Conference Europeenne des Administrations des Postes et des Telecommunications (CEPT) interface -microprocessor - Front panel.

Transmit Operations

The RFU gets transmitted RF signals from the SDU. A filter sends the 2016 MHz reference frequency to a divider to make the 10.08 MHz base reference frequency for the RFU. It uses the 10.08 MHz reference frequency for transmit and receive operations.

The 2016 MHz filter sends the RF input to a mixer in the RFU.

The RFU gets digital passenger telephone data on the CEPT interface. It may also get digital audio from the SDU.

The microprocessor sends the digital data to the modems. If all three modems are in use and the RFU needs another channel, it sends digital audio/data to the SDU for it to change to RF.

Each modem changes the digital data from the microprocessor to an intermediate frequency (IF) and sends it to the transmitter up-converter.

The transmitter up-converter changes the IF signals from the modems to RF and sends them to the mixer.

The mixer gets the RF outputs from the SDU and the transmitter up-converter and puts them on one RF output. The mixer output goes to the RF attenuator and then to the high power amplifier.

Receive Operations

The RFU gets received RF inputs from an antenna system through the RF combiner. An RF splitter sends the inputs signals to the receiver down-converter. It also sends the RF to the SDU if the system needs to use more than three SATCOM channels.

The receiver down-converter changes as many as three channels of RF signals to intermediate frequencies and sends them to the modems.

Each modems changes its IF input to digital data and sends it to the microprocessor.

The microprocessor uses part of the data from the modem to find where the data needs to go. It sends CEPT data to the passenger telephone system and digital audio/data to the SDU for the flight deck.

Control Signals

The RFU gets signals from the SDU through the ARINC 429 interface. The signals from the SDU control the RFU operations. The SDU may also send BITE commands to the RFU during system test. The RFU sends BITE data and status to the SDU.

The microprocessor may get a test signal from the front panel switch. This starts a test of only the RFU. The microprocessor sends status signals to the front panel lights.

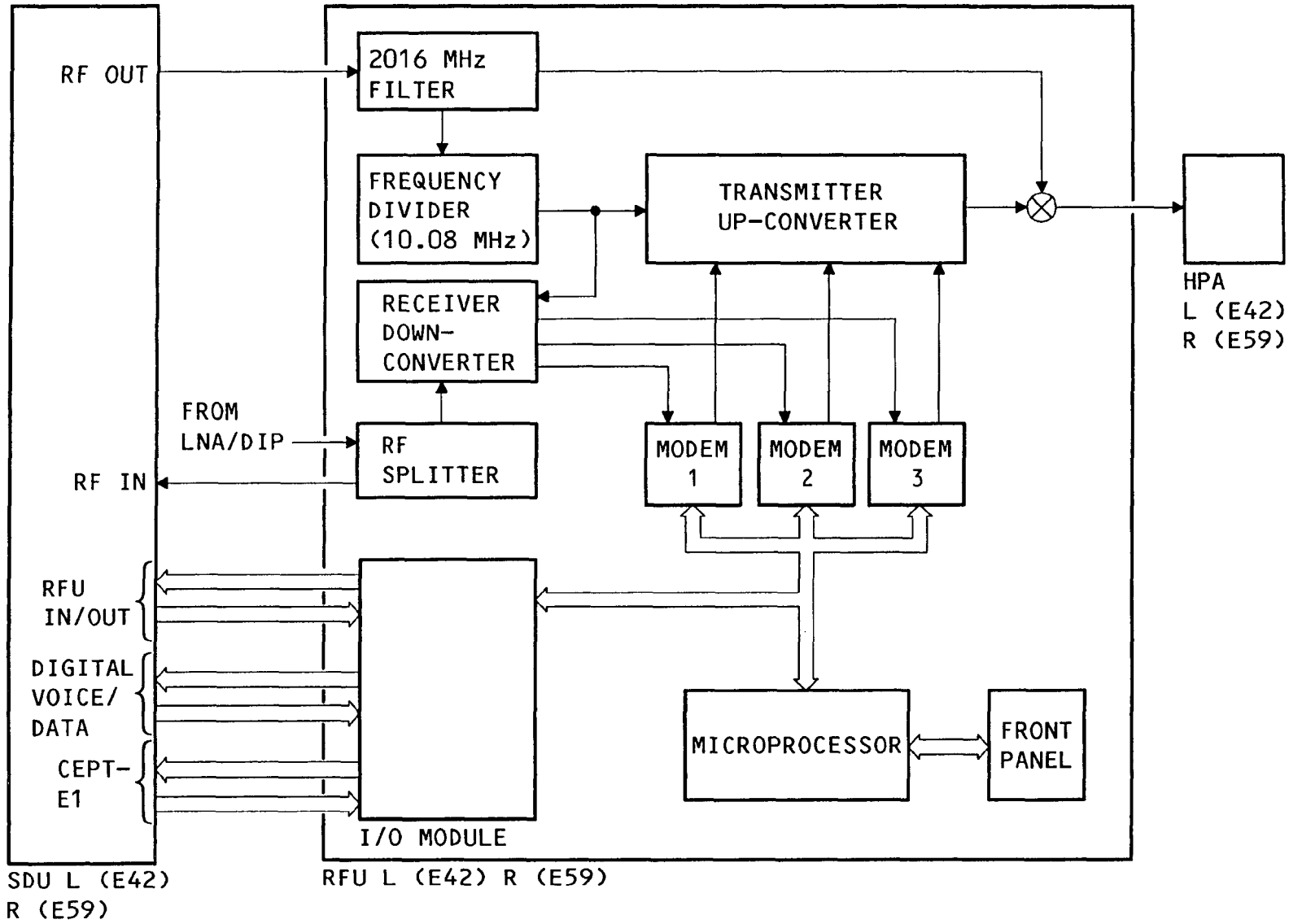

Figure 24 RADIO FREQUENCY UNIT SCHEMATIC

HIGH GAIN SYSTEM SCHEMATIC

General Description

The purpose of the SATCOM high gain system is to amplify the low level multiplexed, phase shift modulated RF to a level suitable for transmit over the phased array high gain antenna.

Transmit

The high gain system gets the multiplexed phase shift modulated RF from the RFU and sends it to the high gain HPA. The high gain HPA is controlled by a high speed ARINC 429 bus from the SDU. It amplifies the RF to a nominal 80 watts and sends it to the low noise amplifier/diplexer (LNA/DIP).

The LNA/DIP is the device that allows simultaneous transmit and receive. The transmit RF is sent through the RF diplexer to the antenna. The RF diplexer is a passive device that routes the transmit RF through the LNA/DIP.

The BSU and high gain antenna function together. The antenna has a nominal gain of 12 db. The BSU is controlled

by a high speed ARINC 429 bus from the SDU. The SDU uses IRU information to determine steering data to send to the antenna. The transmit RF from the LNA/DIP goes directly to the high gain antenna. The BSU processor sends an antenna steering control to the antenna switch controller. The antenna power supply sends 28v dc to the variable phase shifters in the antenna. The variable phase shifters get RF from the coaxial switch, through power dividers. The switch controller sends commands to the variable phase shifters for beam steering. BITE status is sent to the BSU for fault reporting.

Receive

The receive RF from the high gain antenna elements is combined in the power dividers and coaxial switch.

The receive RF signal goes from the antenna to the high gain LNA/DIP.

The low noise amplifier (LNA) is turned on or off by the SDU through the BSU. The receive RF is sent through the diplexer to the LNA. The LNA amplifies the receive RF and sends it through the combiner to the RFU.

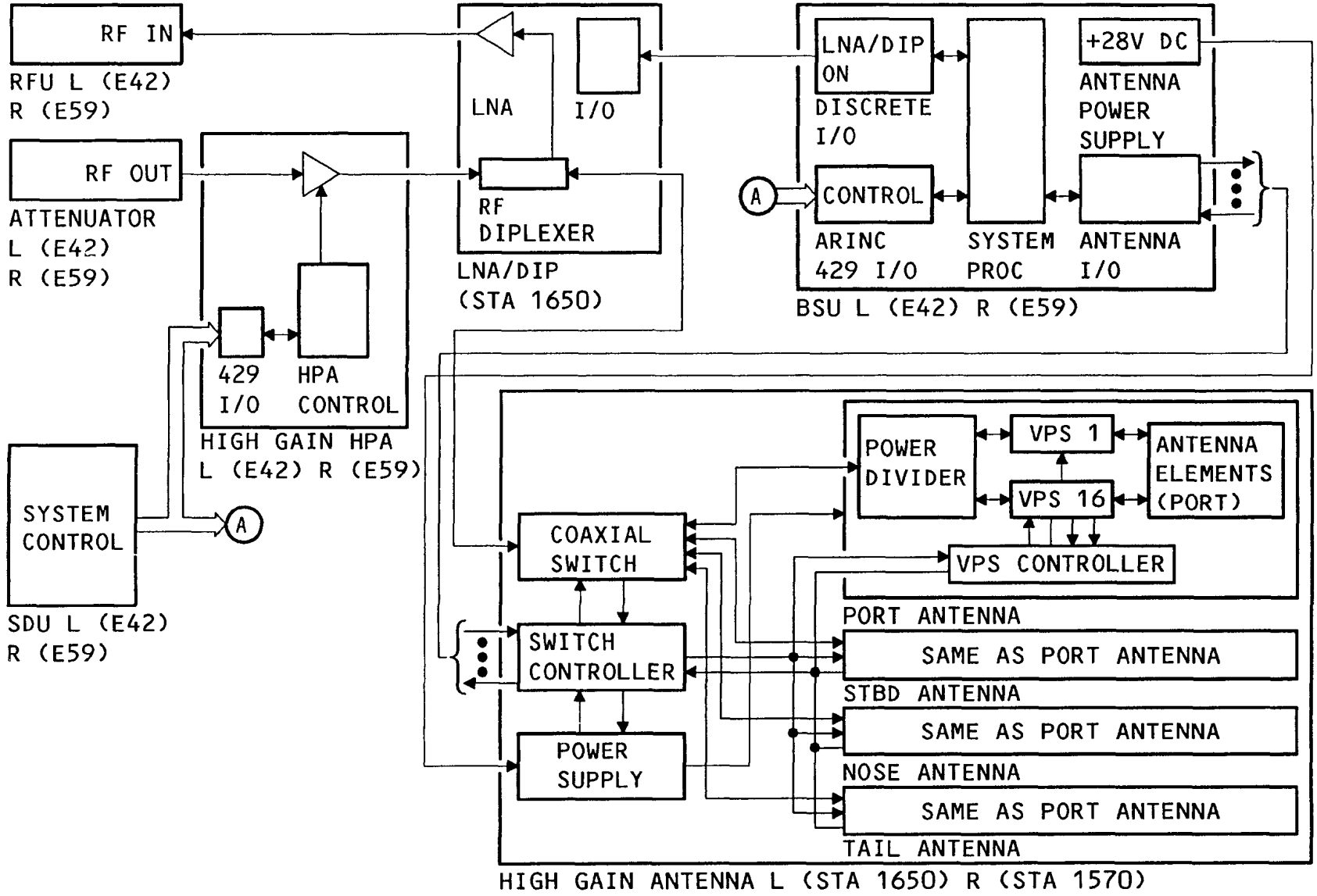

Figure 25 HIGH GAIN SYSTEM SCHEMATIC

BITE SCHEMATIC

General Description

The SATCOM system built in test equipment (BITE) does these tests:

- Power on self test
- Manual self test
- Continuous monitoring
- CMCS ground test

Power On Self Test

The power on self test is done after each cold start up. Power interruption for more than 10 seconds causes a cold start up. The test is a series of BITE tests for the individual LRUs. The test puts the LRUs in a known state. After the satellite data unit (SDU) completes its own test, it commands a system wide function test for the radio frequency unit (RFU), high power amplifier (HPA), beam steering unit (BSU) and antenna. The SDU processes the test results from these LRUs and the LNA/DIP. If the LRU does not respond to the self test command and the ARINC 429 bus activity is normal, the SDU reports the LRU failed. If the bus activity is not normal, then the SDU reports a bus failure. The results of the power on self test show on the SDU display and are reported to the central maintenance computer system (CMCS).

Manual Self Test

The manual self test is the same as a power on self test except it is started manually.

CMCS Ground Test

The CMCS ground test is the same as a manual self test except it is started from the CMC ground test menu from the CDU.

Continuous Monitoring BITE

Continuous monitoring BITE circuitry does not interfere with normal system operation, but does show any failed condition. The LRU failure shows as a red FAIL LED on the SDU front panel display. All failures are reported to the CMCS.

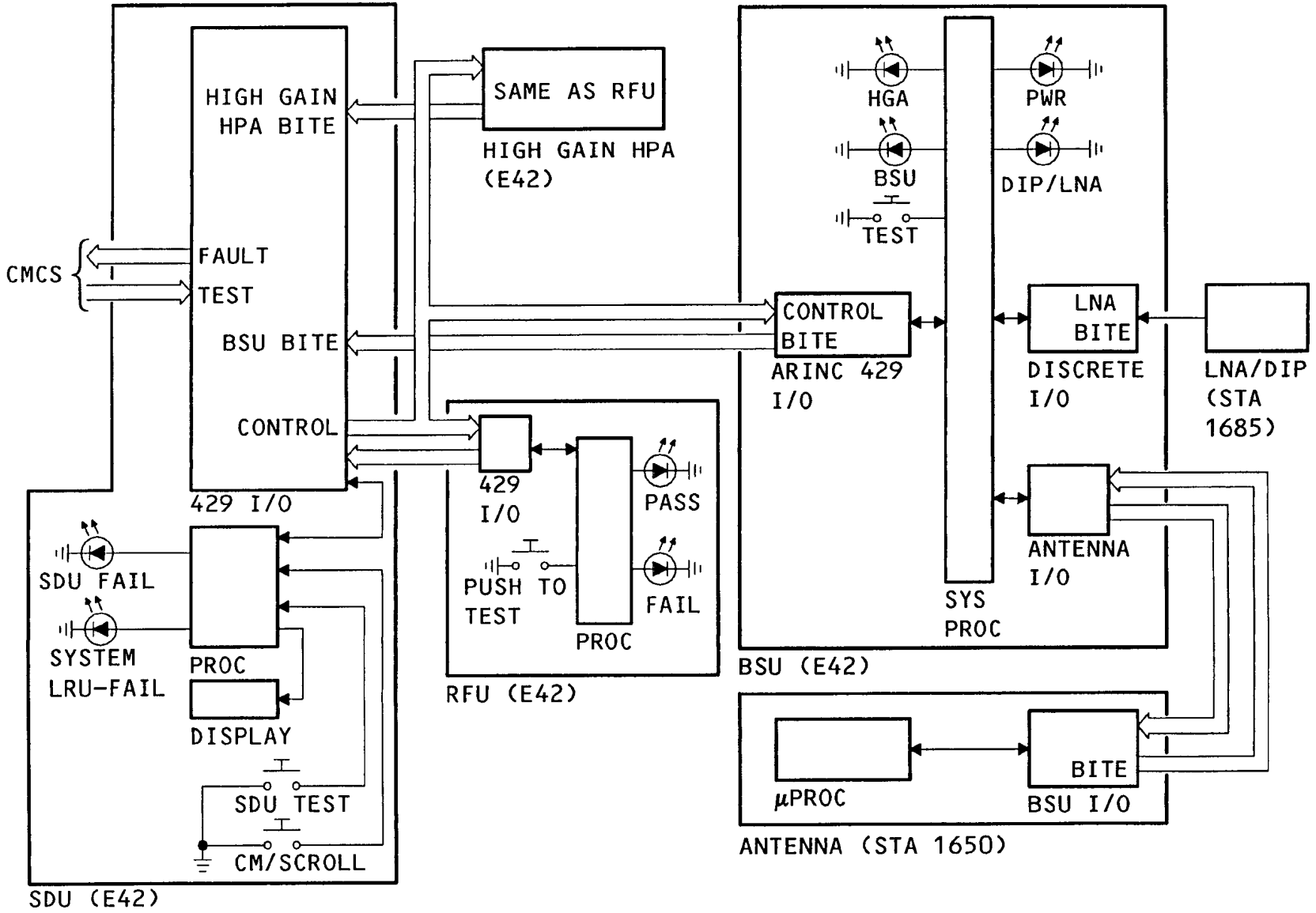

Figure 26 BITE SCHEMATIC

SATCOM - SELF TEST

Push the related LRU front panel self test switch for approximately one second to start a manual self test. If the switch is pushed while a test is in progress, the switch is ignored.

The self test results for the radio frequency unit (RFU) or high power amplifier (HPA) are the:

- lGreen LED on the front panel comes on for 30 + 5 seconds for no test failures.
- Red LED on the front panel comes on for 30 + 5 seconds if a failure occurs.

The self test results for the beam steering unit (BSU) is the BSU red indicator does not come on.

The system self test results for the SDU are LRU pass/fail indications, inactive bus indications and software confirmation numbers as follows:

- Both the red SDU FAILURE and SYSTEM LRU FAILURE LEDs on the front panel come on together.

The red SYSTEM LRU FAILURE LED comes on alone if the SDU passes, but there are inactive buses or any other LRU reports a failure.

Both LEDs turn off if all LRUs pass and the display reads SYSTEM PASS for 30 + 5 seconds and blanks unless the CM/SCROLL switch is pushed.

Push the front panel CM/SCROLL switch to scroll the display through multiple LRU fail indications, inactive bus indications and software confirmation numbers. These indications are stepped through one at a time each time the CM/SCROLL switch is pushed.

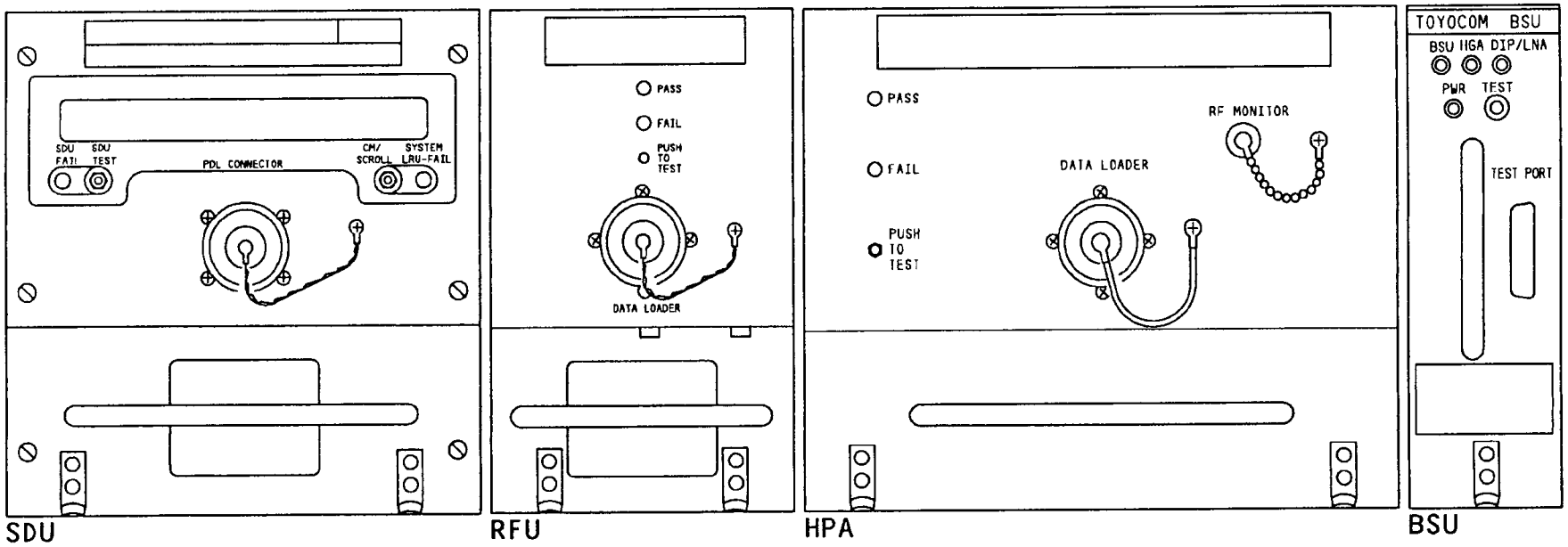

Figure 27 SATCOM - SELF TEST

SATCOM - CDU SELF TEST

General

The control display units (CDUs) can be used to start a test of the SATCOM system. The system will log off during the test, and will log on when the test is complete (automatic mode). other SATCOM tests are:

- Central maintenance computer system (CMCS) ground test; this test is the same as the CDU test.
- Front panel BITE; if run from the SDU, the test is the same as the CDU test. If run from another SATCOM LRU, only that LRU is tested.
- RF link test; this test involves the operator placing a call to test end to end system performance.

CDU Self Test

To start the CDU test, select the SATCOM MAIN MENU from the CDU menu. Select SUBMENU, and then MAINTENANCE to show the SATCOM TEST function. Push the line select key (LSK) next to

TEST to start the test. After 30 seconds the results of the test will show. Push RETURN repeatedly to go back to the SATCOM MAIN MENU.

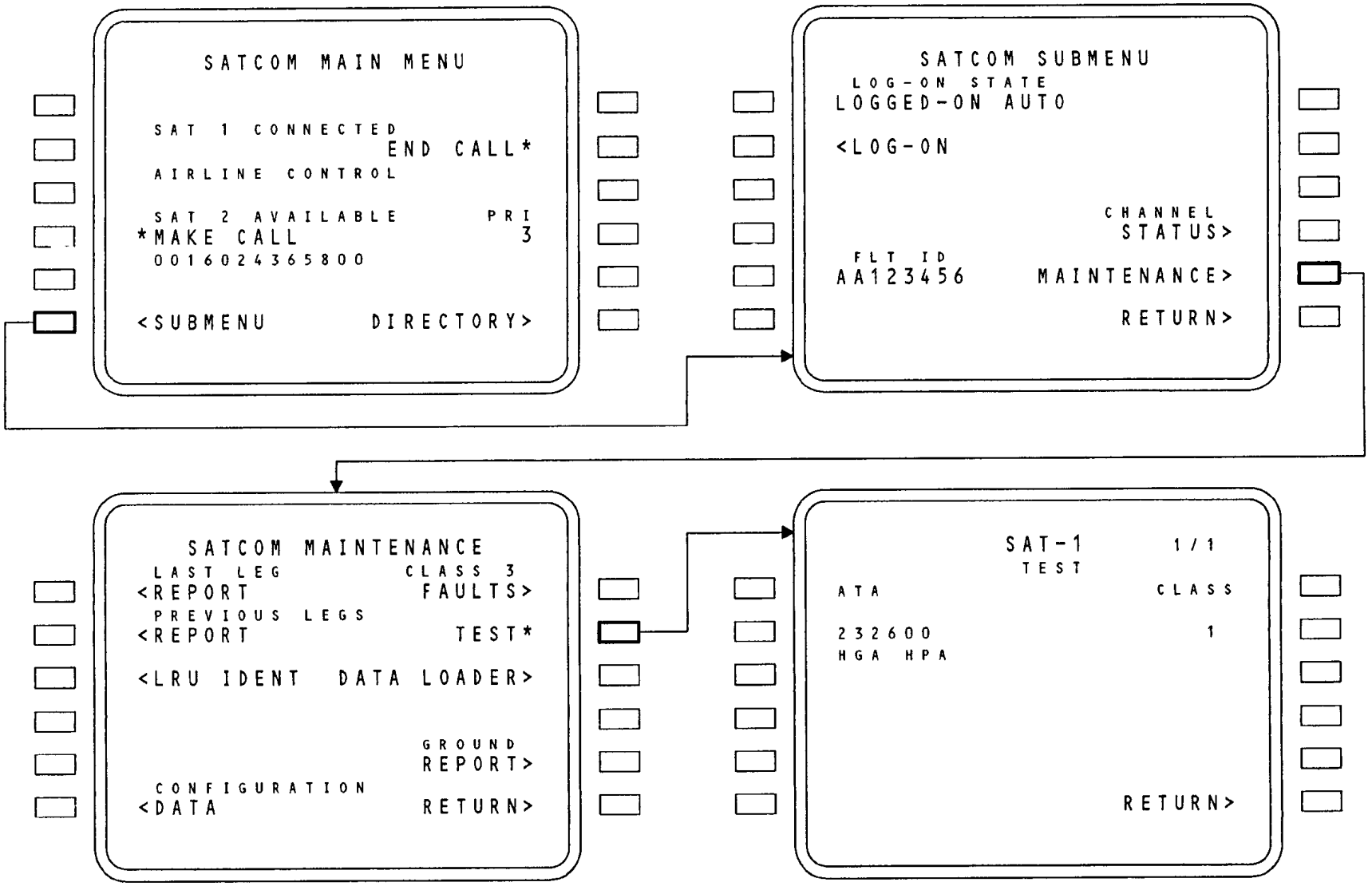

Figure 28 SATCOM - CDU SELF TEST

GROUND TEST

The central maintenance computer (CMC) SATCOM ground test tests the SATCOM system AES equipment when selected through the control display unit (CDU).

To start a SATCOM test, push the line select key (LSK) next to SATCOM. During the test IN PROGRESS shows above SATCOM.

PASS shows if the test passses and FAIL shows if the test fails.

The ground test message page shows the faults related to failed SATCOM AES equipment.

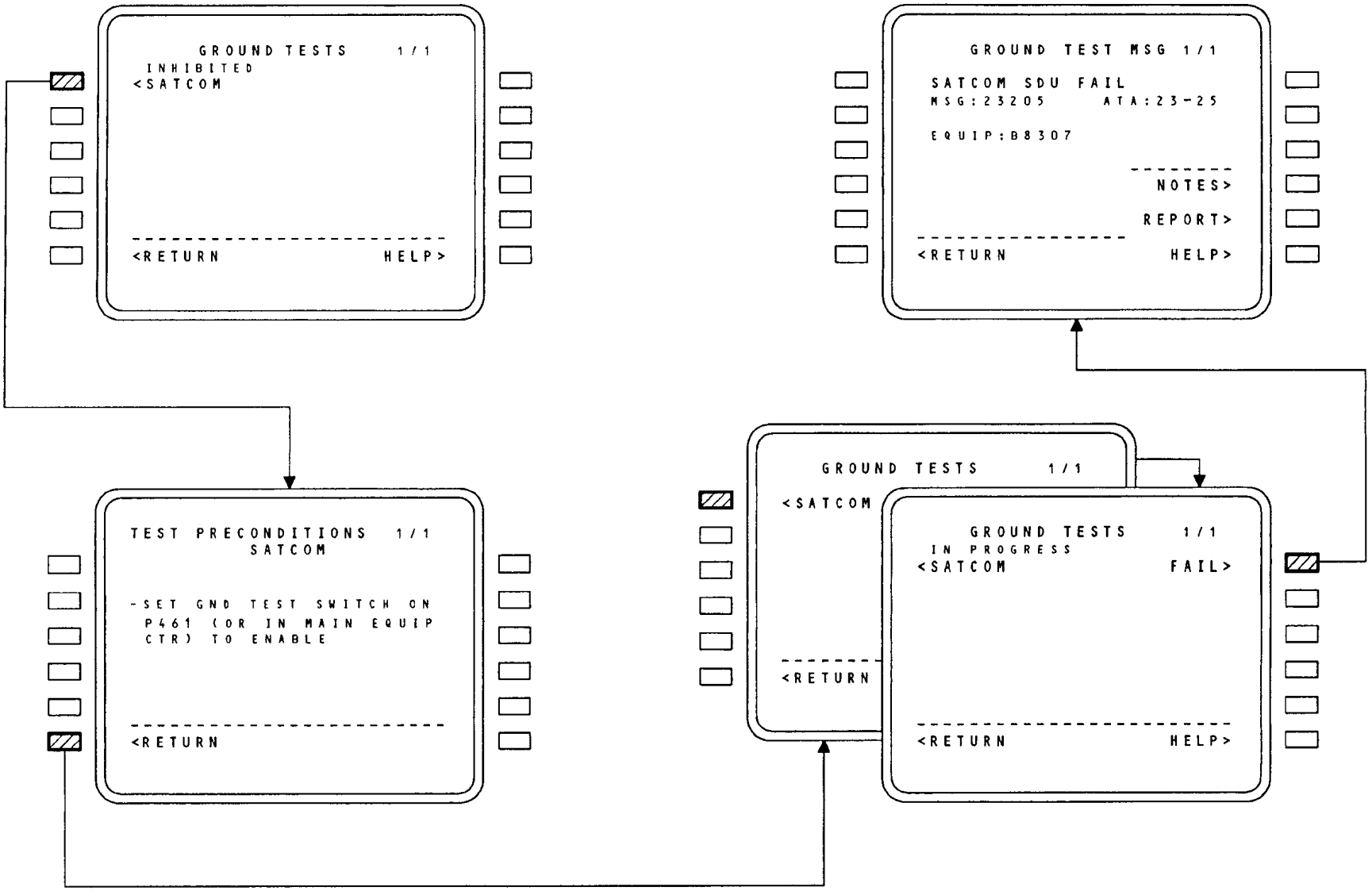

Figure 29 GROUND TEST

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