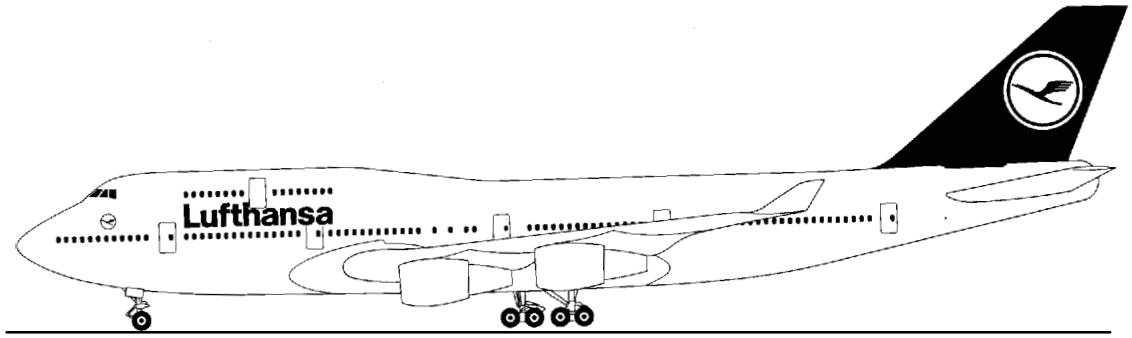
Lufthansa Technical Training

Training Manual B 747-400



ATA 23-11 HF SYSTEM

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ATA 23-1 1 HF SYSTEM

HF COMMUNICATION SYSTEM - INTRODUCTION

The HF system is a long-range air-to ground and air-to-air voice communication system.

The HF system operates between 2 MHz and 29.999 MHz. The HF system operation relies on ground wave propagation and sky wave propagation. Ground wave propagation is used for short range communication. Sky wave propagation relies on refraction in an ionized layer and the earth's surface to achieve long range communication. Sky wave propagation distances are dependent on frequency, time of day and airplane altitude. Areas between ground bounces are known as Skip.

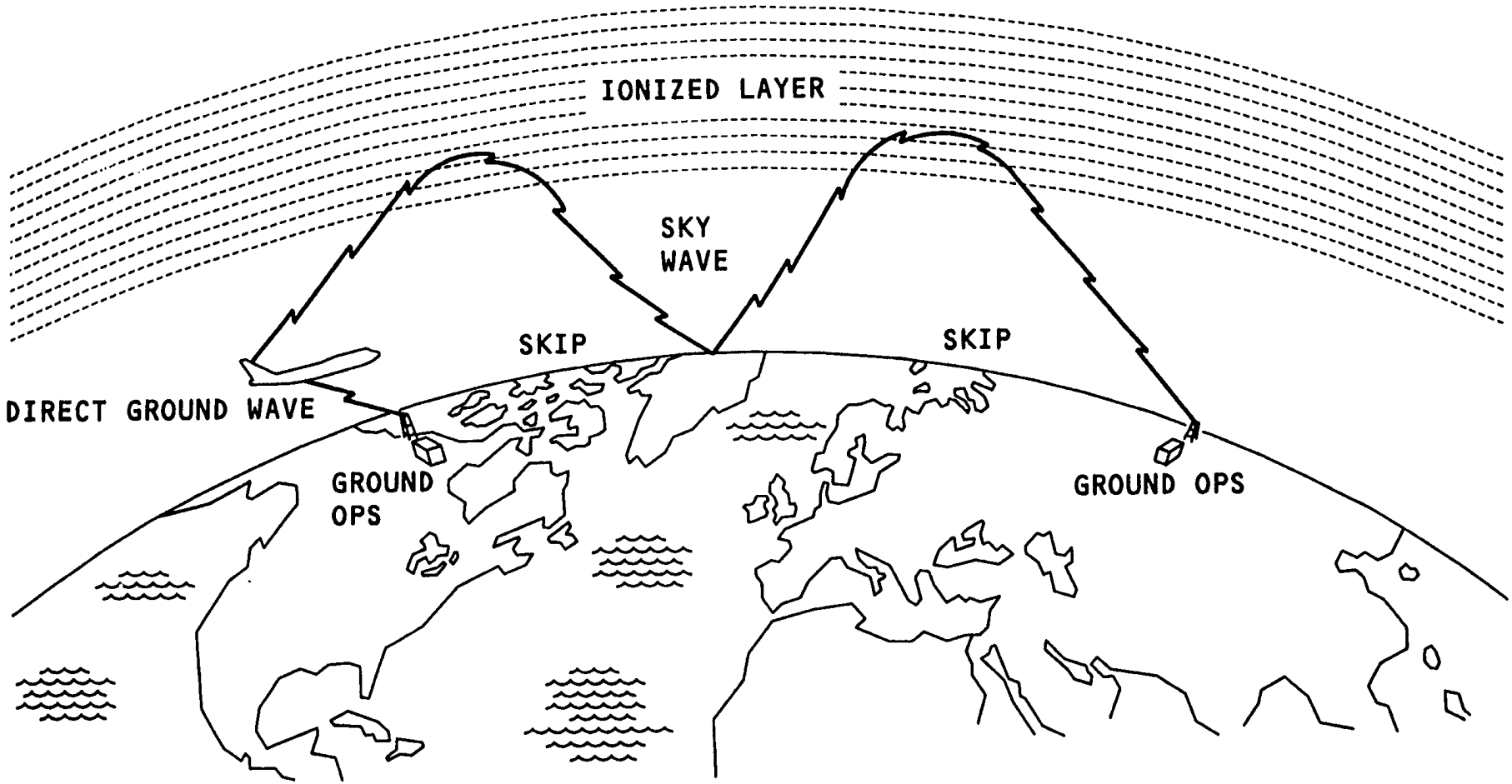

Figure 1 HF COMMUNICATION SYSTEM - INTRODUCTION

HF SYSTEM

General Description

The HF communication systems operate in the HF aeronautical communication band which ranges from 2.000 to 29.999 MHz.

An HF communication system has:

- A common HF antenna. The antenna radiates and receives RF signals in the HF range
- An antenna coupler. The antenna coupler matches the impedance of the antenna and transmission line to the output of the transceiver at the selected frequency.
- An HF transceiver. The receiver/transmitter operates in the AM or upper side band (USB) mode.

The HF communication system interfaces with:

- The radio communication panels (RCPs). The RCPs send tuning data and mode information to the HF transceiver.
- The audio management unit (AMU). Microphone audio and PTT discretes are sent to the transceiver through the AMU. Receiver audio is sent from the transceiver to the speakers and headsets through the AMU.
- The SELCAL decoder. The SELCAL decoder initiates an alert when a call is received for that airplane.
- The digital flight data acquisition card (DFDAC) in the MAWEA. It receives the microphone PTT signal for input to the flight recorder.
- The central maintenance computer system (CMCS) interfaces with the HF transceiver and the radio communication panels to monitor HF system faults.
- The air/ground relay. The transceiver uses air/ground logic to define flight legs for its internal fault memory.

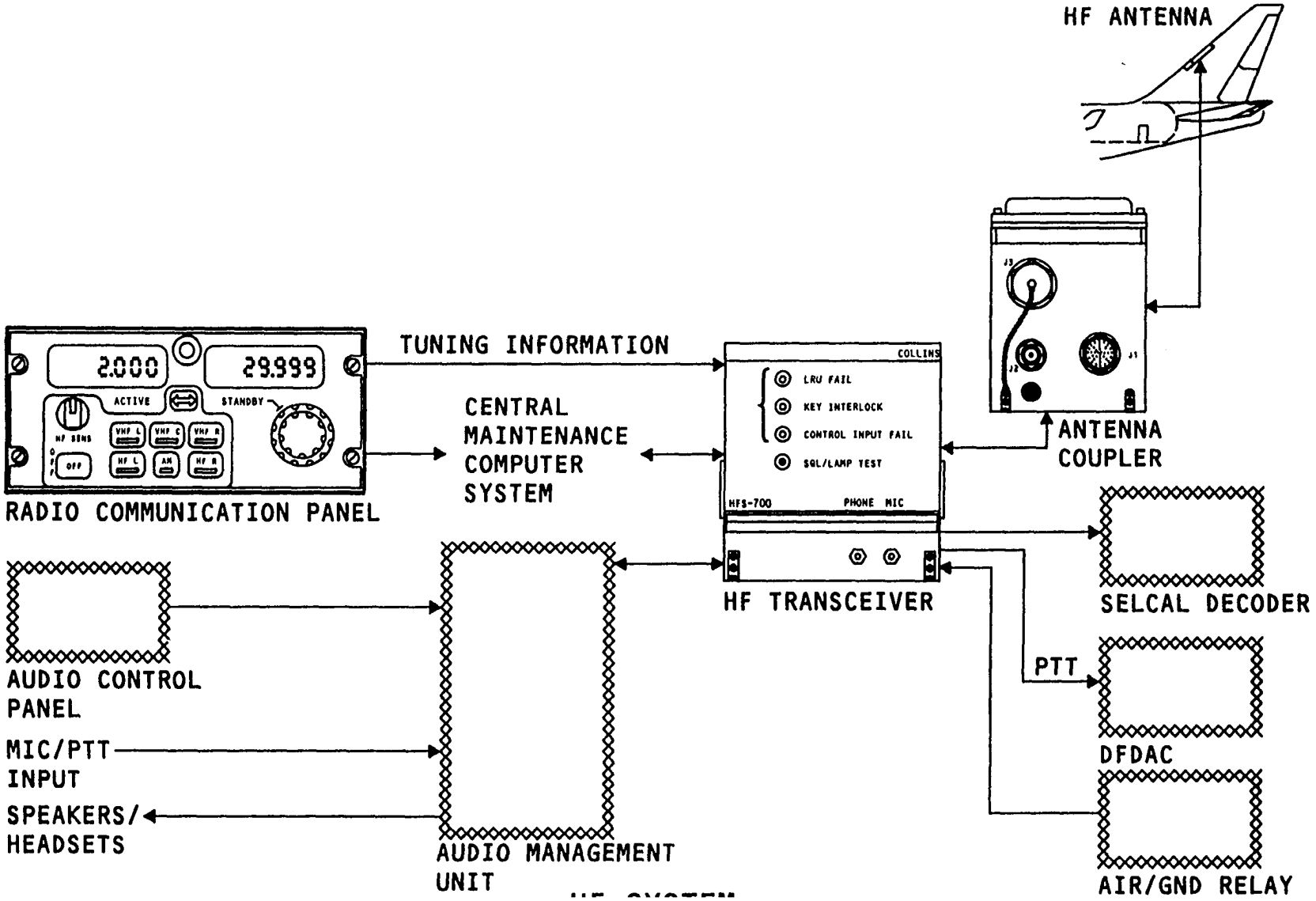

Figure 2 HF SYSTEM

COMPONENT LOCATIONS

The HF systems components are:

- HF transceivers
- Antenna couplers
- HF antenna
- HF circuit breakers
- Radio Communication panels (RCPs)
- Coupler switching panel

The audio control panels (ACPs) interface with the HF System.

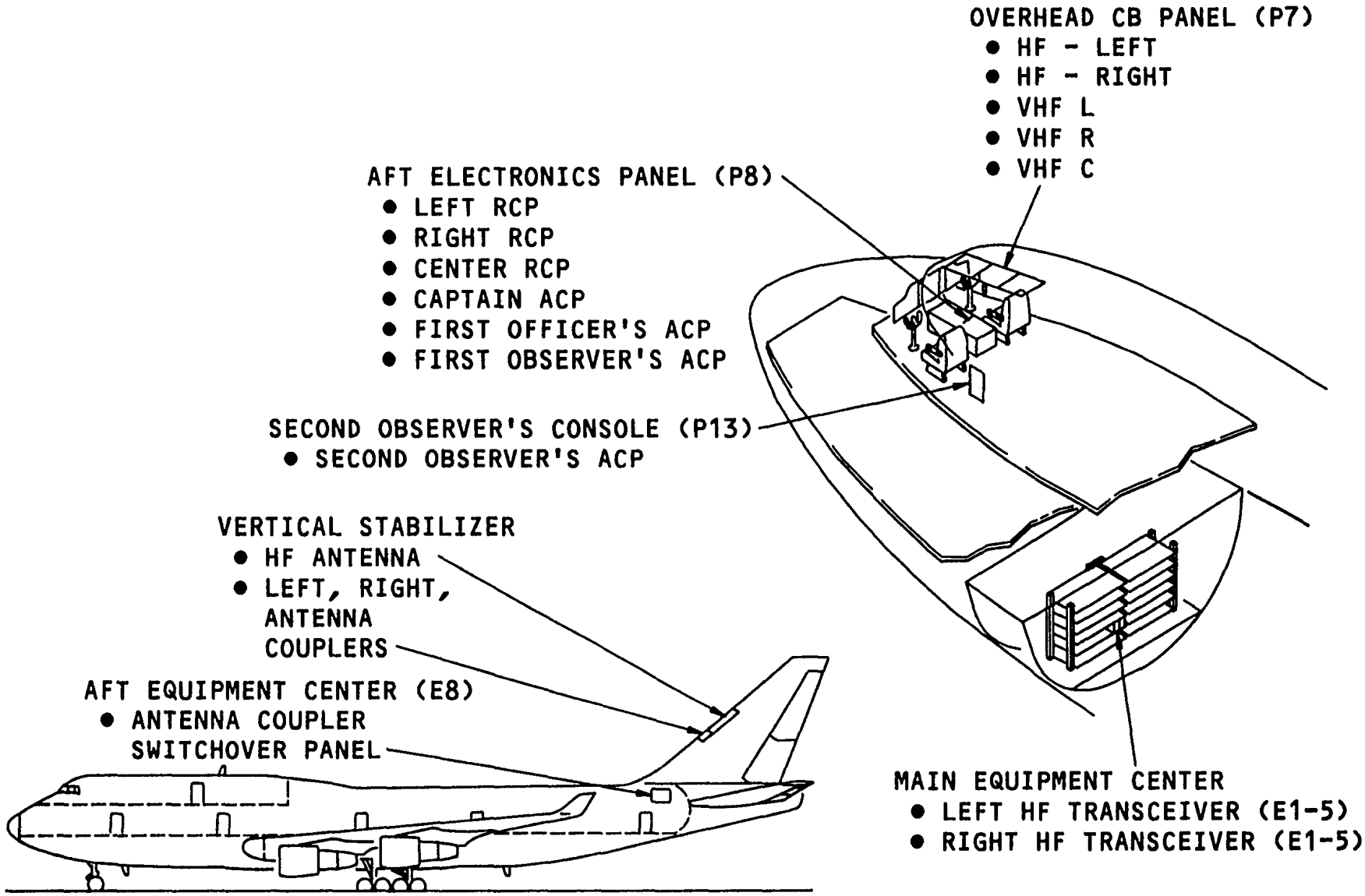

Figure 3 COMPONENT LOCATIONS

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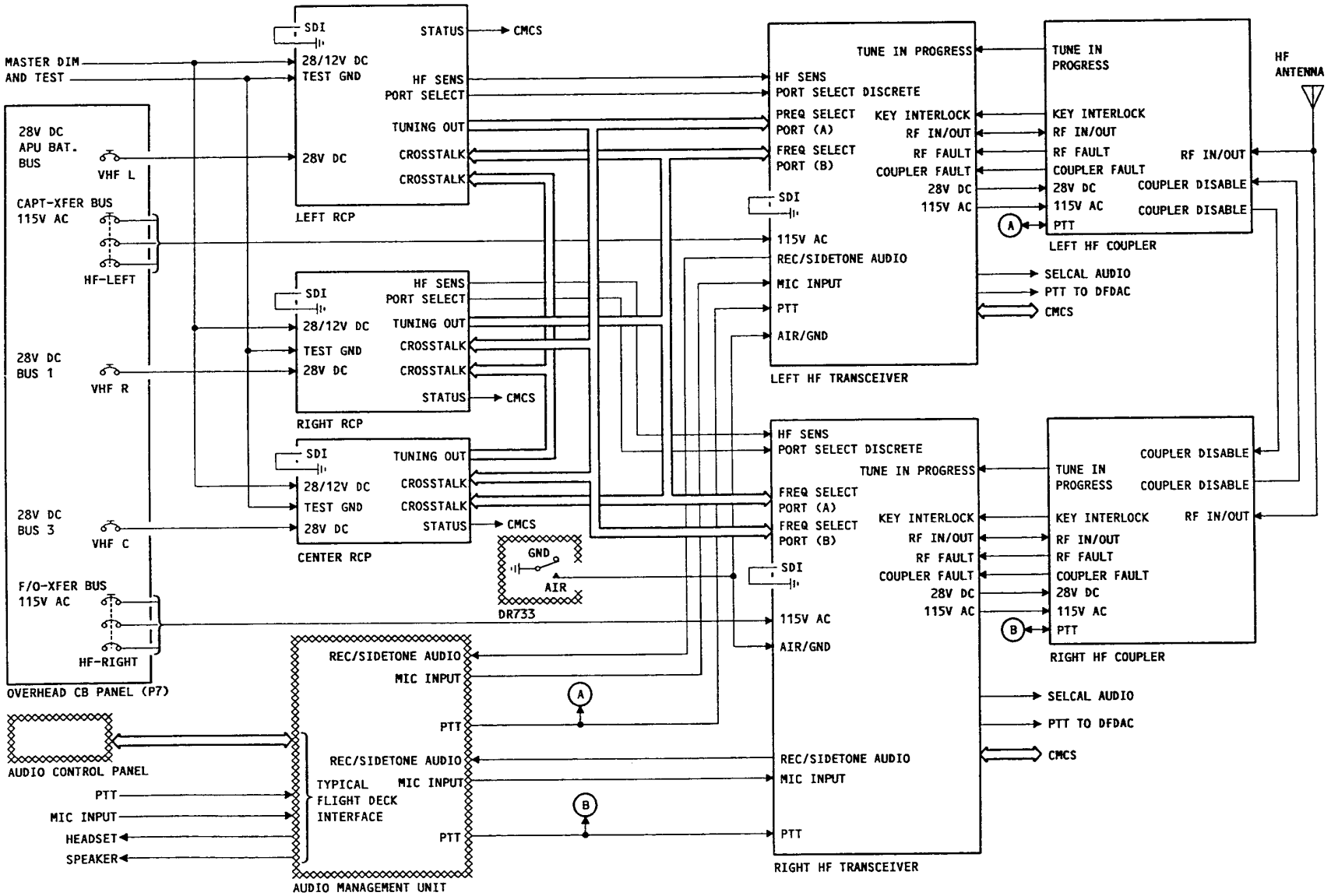

Figure 4 HF–INTERFACE DIAGRAM

INPUT POWER

The 115 volt ac captain's transfer bus supplies 3-phase power to the left HF transceiver.

The left HF transceiver supplies 115 volt ac single-phase power and 28 volt dc to the left antenna coupler.

The 115 volt ac first officer's transfer bus supplies 3-phase power to the right HF transceiver.

The right HF transceiver supplies 115 volt ac single-phase power and 28 volt dc to the right antenna coupler.

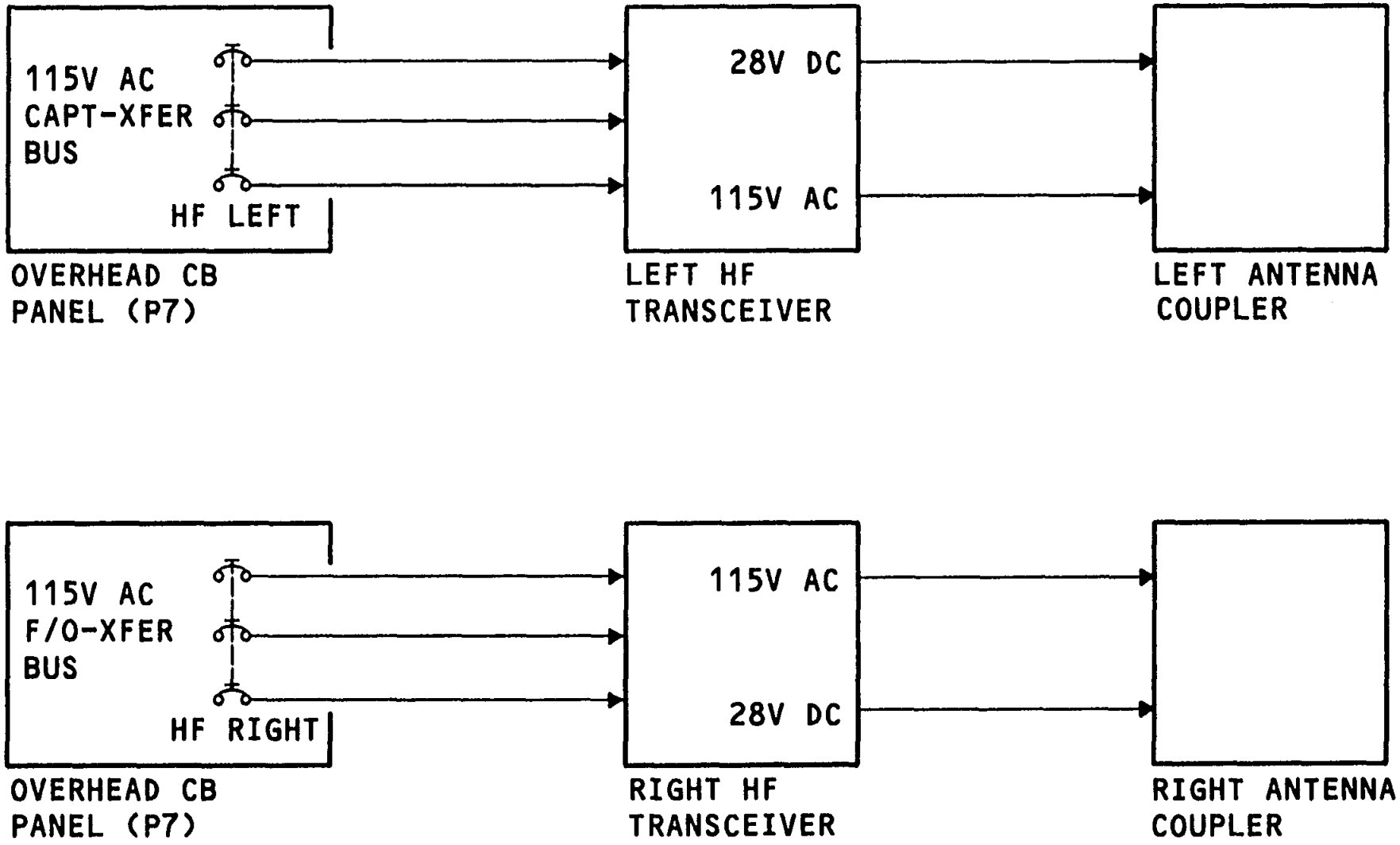

Figure 5 INPUT POWER

RCP INPUT POWER

The 28v dc APU battery bus supplies power to the left radio communication panel (RCP).

The 28v dc bus 1 supplies power to the right RCP.

The 28v dc bus 3 supplies power to the center RCP.

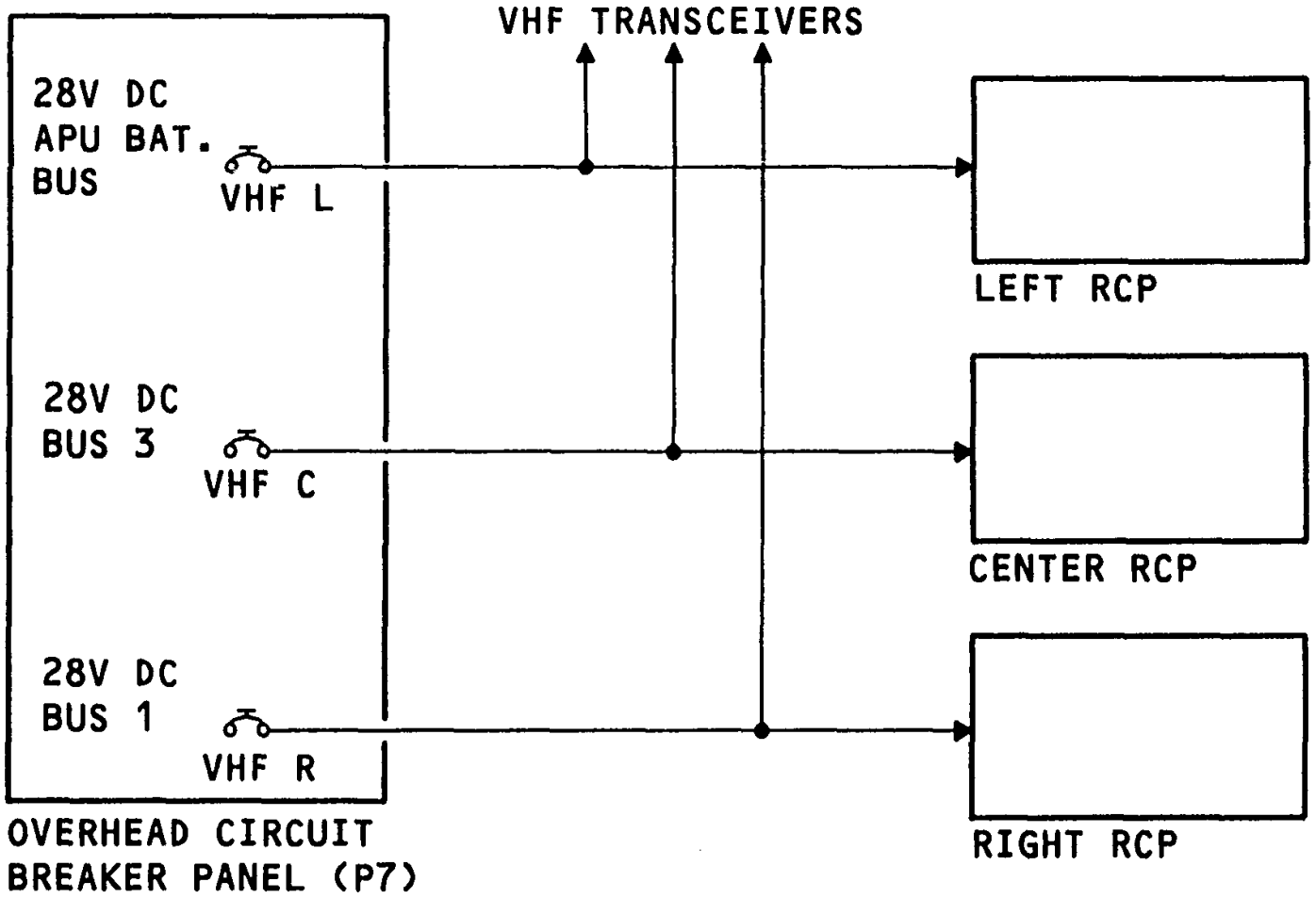

Figure 6 RCP INPUT POWER

TUNING

General Description

The HF transceivers get tuning data from three identical radio communication panels (RCPs). Any RCP can tune any communication radio.

Each RCP monitors the tuning frequency information from the other RCPs. This is done through the crosstalk buses. All three RCPs keep the same frequency and modulation mode data for both HF transceivers. New data from any RCP updates the data in all the RCPs.

The tuning and mode data is transmitted to the HF transceivers and transmitted to the HF transceivers and other RCPs through ARINC 429 buses.

Port Select Discrete

Each HF transceiver has two tuning frequency input ports. The ports are port A and port B. The transceiver uses the port select discrete to decide which tuning input port to use. The normal active port is port A. Port A is used when the port select discrete input is grounded. Port B is used when the port select discrete is open. The

left transceiver port select discrete is connected to the left RCP. The right transceiver port select discrete is connected to the right RCP.

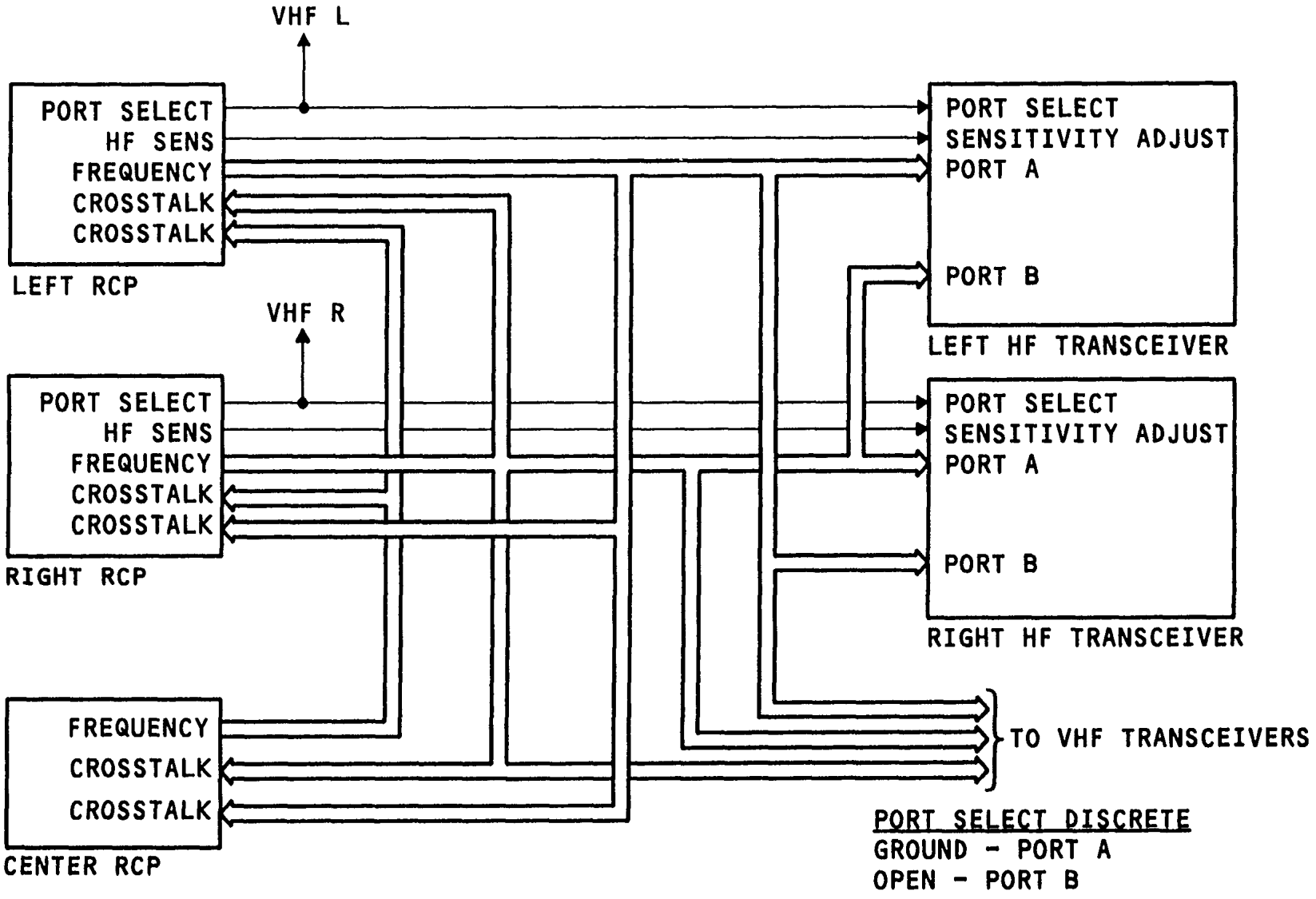

Figure 7 TUNING

RECEIVE / TRANSMIT

Signal Flow - Transmission

Mic audio and PTT signals are sent to the transceiver through the Audio Management Unit (AMU). The transceiver changes the mic audio to an RF signal and sends it to the coupler when there is a key interlock discrete from the coupler. The coupler tunes itself to match the impedance of the transmitter to the antenna at the selected transmit frequency. During the tune mode, the coupler sends a tune-in-progress discrete to the transceiver. The output of the coupler goes to the antenna. The RF signal radiates into the air from the antenna. Audio sidetone goes back to the AMU from the transceiver as receiver audio.

The left and right HF systems share a common antenna. During transmission, a discrete goes from the active coupler to disable the other coupler.

Signal Flow - Reception

The RF signals received by the antenna are sent through the coupler to the transceiver. The transceiver changes the RF signals to audio. The audio goes to the AMU.

System Interfaces

Select transmitter, receiver audio and audio level from the audio control panels (ACP's).

The SELCAL decoder monitors all received audio. It alerts the flight crew when it detects a call to the airplane.

The digital flight data acquisition card (DFDAC) monitors the PTT signal for the flight recorder.

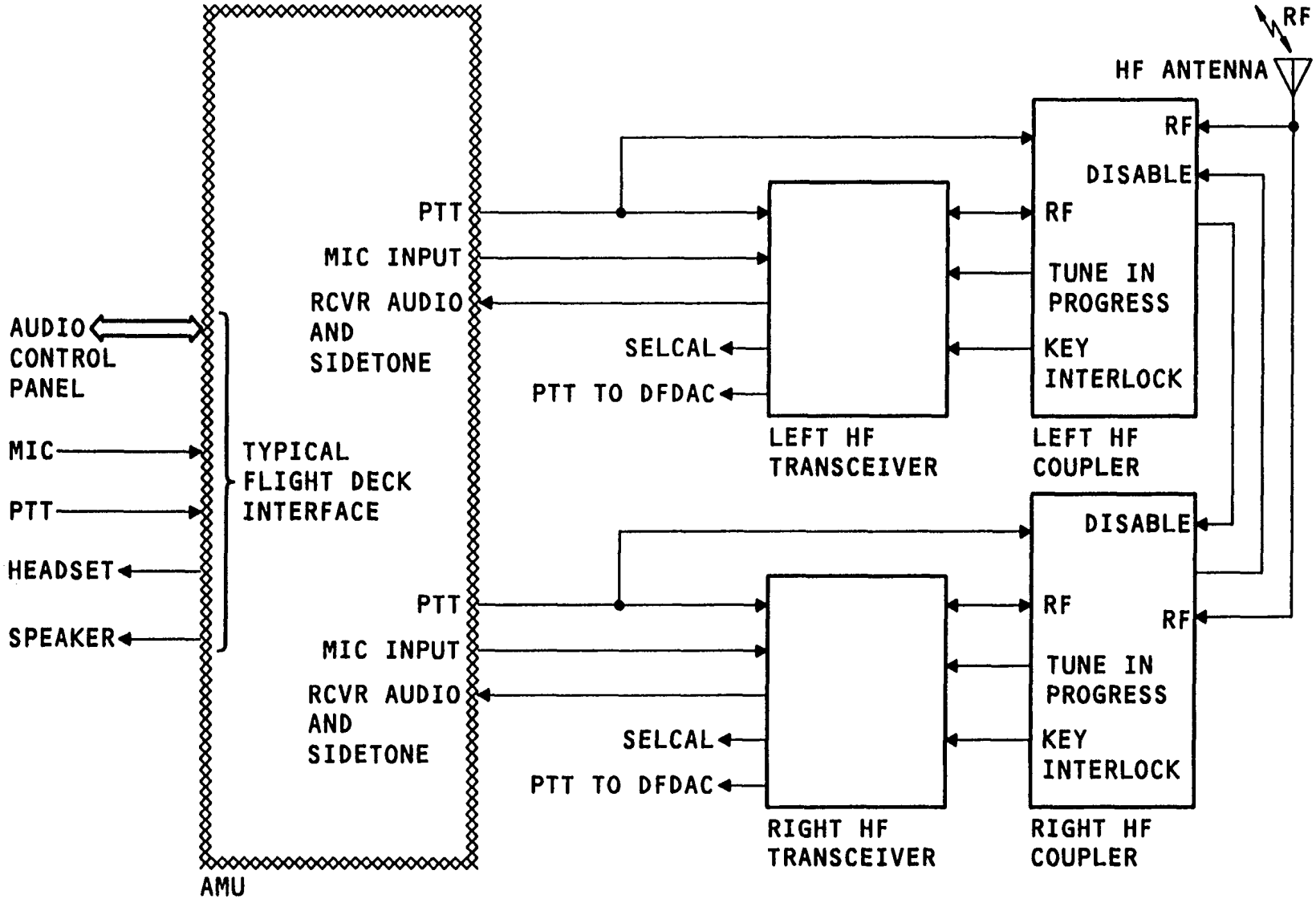

Figure 8 RECEIVE / TRANSMIT

CMCS INTERFACES

RCP Interfaces

The radio communication panels (RCPs) send a discrete to the central maintenance computer system (CMCS). The CMCs monitor the discrete to determine if an internal failure exits.

Transceiver Interfaces

The antenna coupler sends real-time fault status to the transceiver. The HF transceivers send real-time fault status to the CMCs. The HP transceivers also send ground test data to the CMCs over ARINC 429 data buses. The left CMC sends ground test commands to the HF transceivers over separate ARINC 429 data buses.

The air/ground relay sends a discrete to the transceiver.

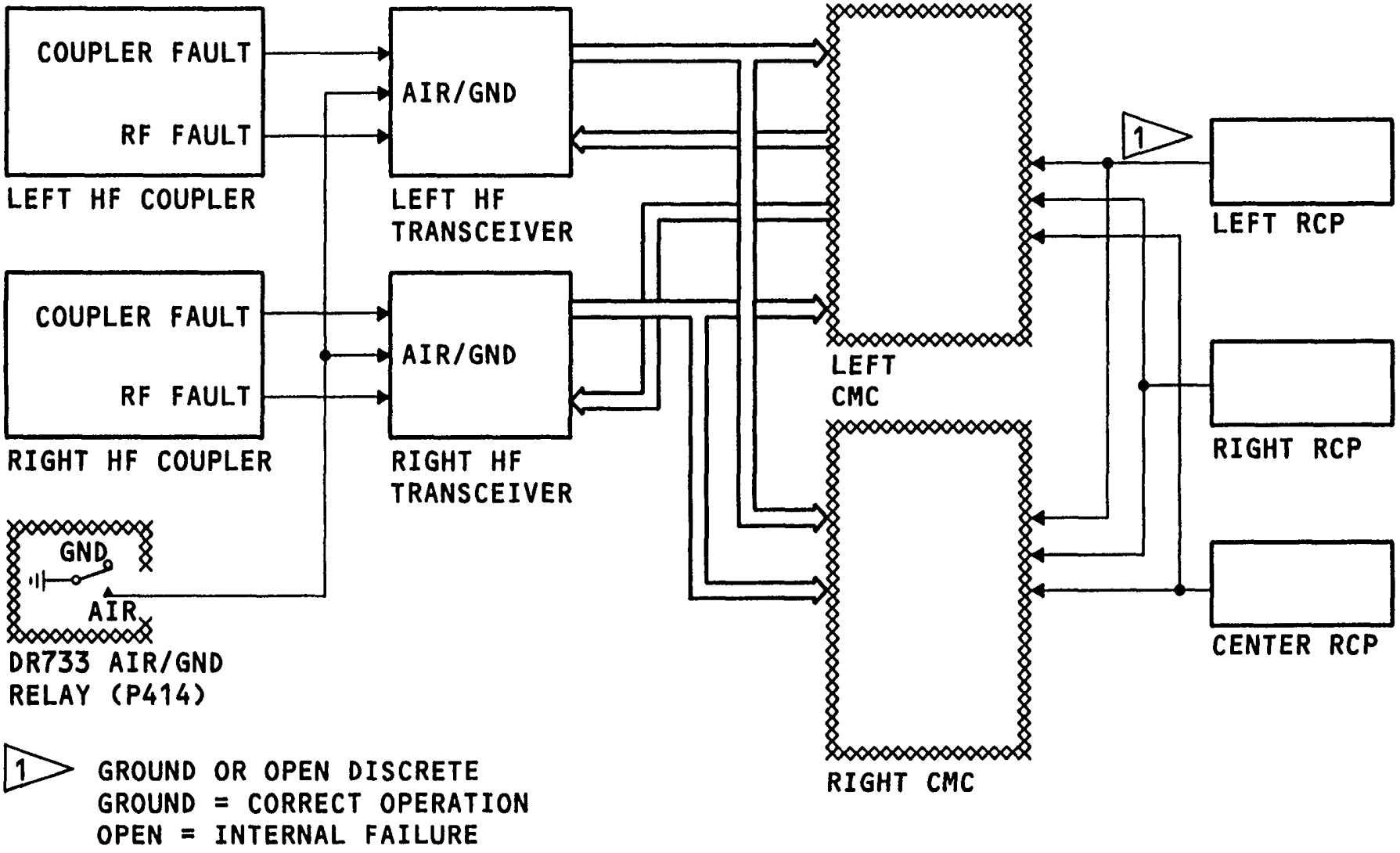

Figure 9 CMCS INTERFACES

HF TRANSCEIVER

General Description

The HF transceiver operates in the AM or upper sideband modes. A receiver/transmitter detects the voice audio from the carrier during reception, and modulates the carrier with voice audio during transmission. An internal blower motor insures adequate cooling of the transmitter.

Characteristics

The HF transceiver has:

- 1 KHz channel spacing
- A frequency range of 2.000-29.999 MHz
- Maximum RF output power of 400 watts peak envelope power (USB), 125 watts (AM)

Controls and Indications

There are three LED indicators on the transceiver front panel. They are the:

- LRU FAIL indicator
- KEY INTERLOCK indicator
- CONTROL INPUT FAIL indicator

These indicators come on when failures occur.

When you push the SQL/LAMP test pushbutton switch the LRU FAIL, KEY INTERLOCK, and CONTROL INPUT FAIL indicators come on. This switch also causes the receiver sensitivity to go to the maximum level.

The phone and mic jacks provide connection points for a headphone and microphone. This allows operation of the HF transceiver from the main equipment center to assist in troubleshooting.

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.

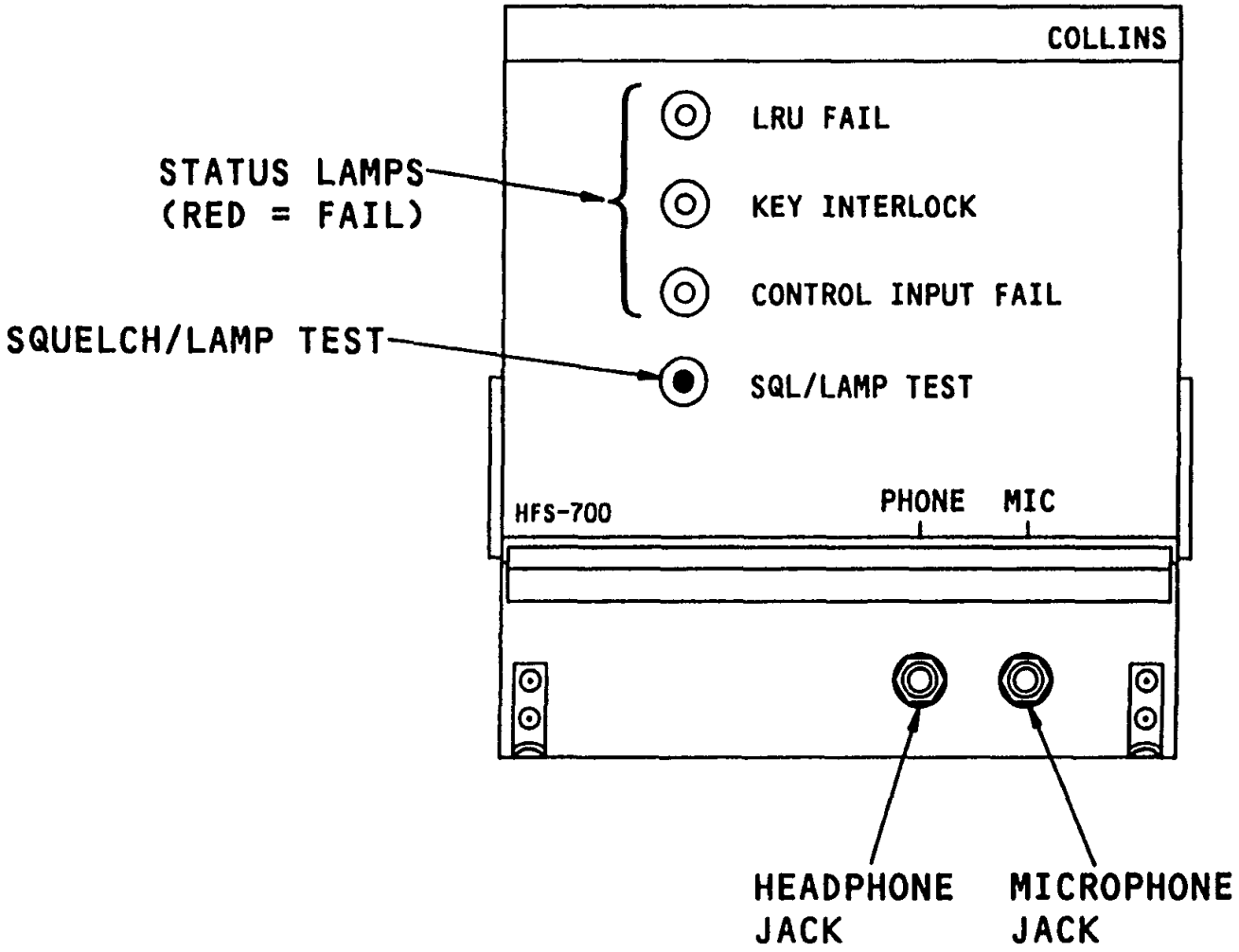

Figure 10 HF TRANSCEIVER (COLLINS HFS-700)

ANTENNA COUPLER

Purpose

The antenna coupler matches the impedance of the antenna and feedline with the output impedance of the transceiver at the selected frequency. This results in a VSWR of less than 1.3:1.

General Description

The antenna coupler is a sealed, pressurized unit which weighs 17 pounds. A feedline connects each coupler to the antenna, while a coaxial cable connects each coupler to its transceiver.

There are connectors on the coupler for:

- Control interface
- Coaxial cable
- Automatic test equipment
- Antenna feedline

The coupler consists of tuning elements and control circuits. The coupler constantly monitors the rf

transmissions to automatically adjust the tuning elements. Typical tuning time is 2 to 7 seconds.

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.

The antenna coupler is pressurized with dry air or nitrogen at 5 to 7 psig.

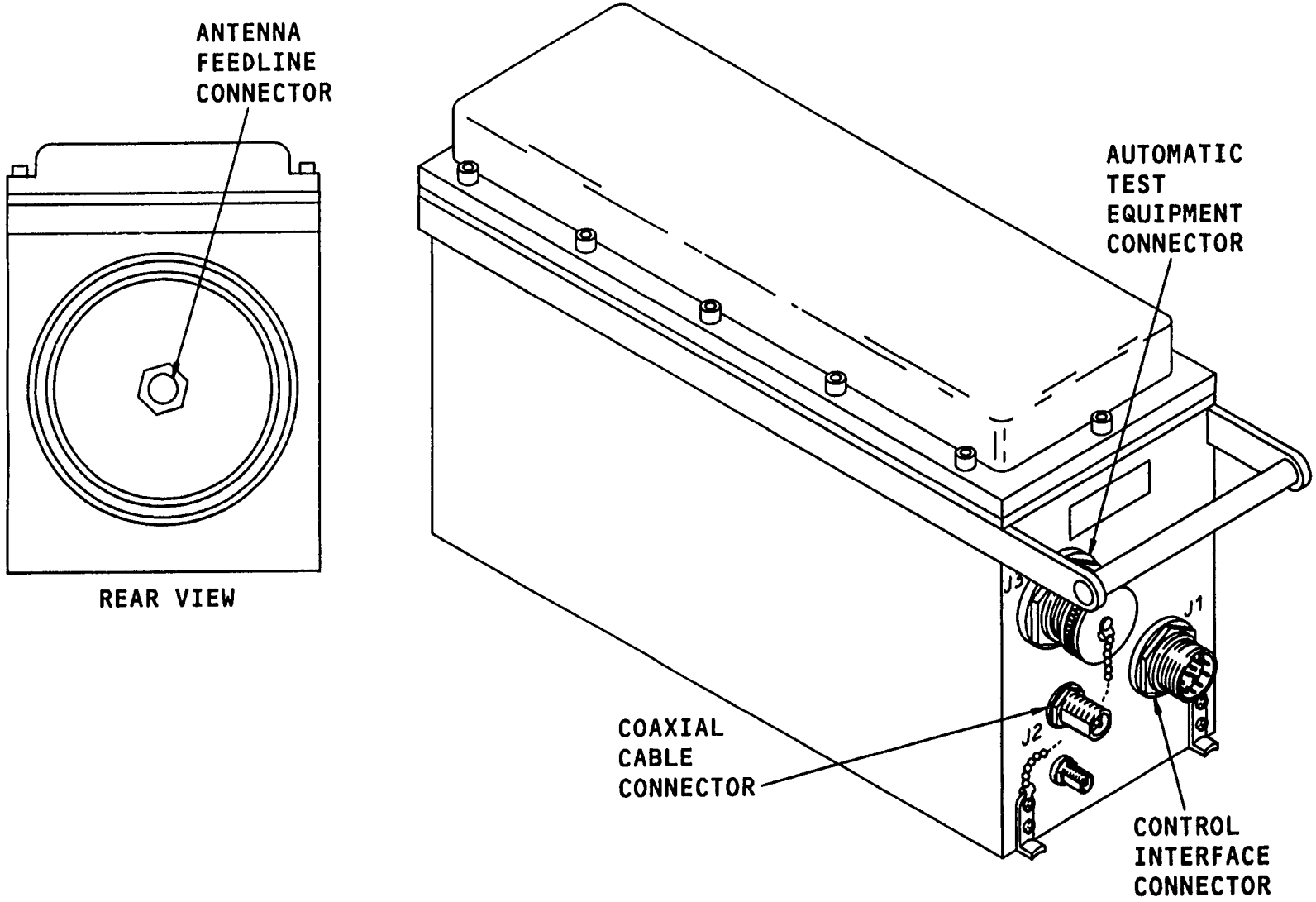

Figure 11 HF - ANTENNA COUPLER (ananlog)

ANTENNA COUPLER (DIGITAL)

Purpose

The antenna coupler matches the impedance of the antenna and feedline with the output impedance of the transceiver at the selected frequency. This results in a VSWR of less than 1.3:1.

General Description

The antenna coupler is a sealed, pressurized unit. It weighs 15.7 pounds. The antenna RF connector connects the coupler to the antenna. The RF coaxial connector connects each coupler to its transceiver.

These connectors are on the coupler:

- Control interface
- Antenna RF connector
- J2 RF coaxial connector.

The antenna coupler is pressurized with dry air or nitrogen.

Functional Description

The coupler has tuning elements and control circuits. The coupler constantly monitors the rf transmissions to automatically adjust the tuning elements. Typical tuning time is 2 to 7 seconds.

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.

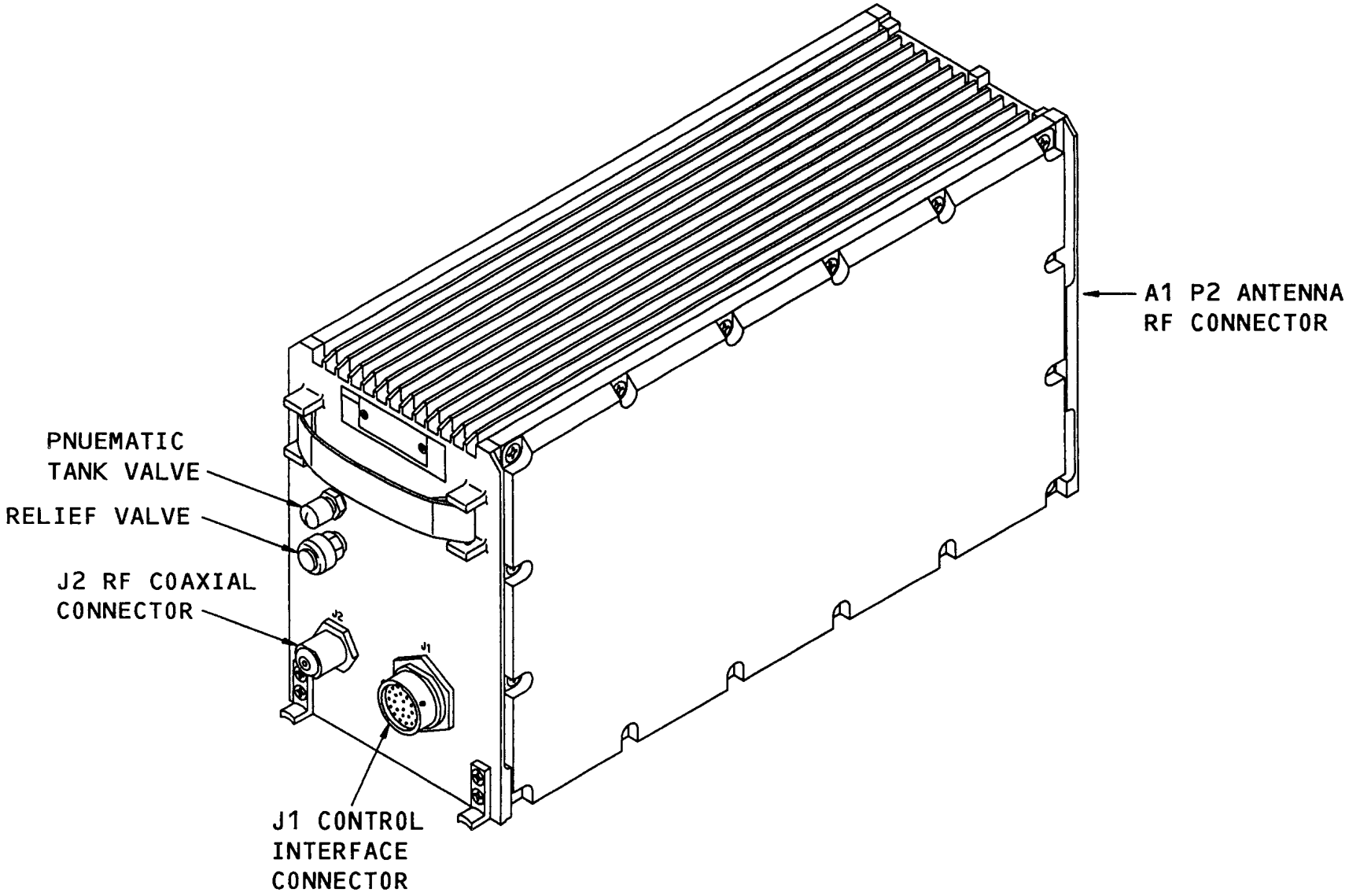

Figure 12 HF - ANTENNA COUPLER

ANTENNA COUPLER INSTALLATION

Location and Access

The two antenna couplers are located in the leading edge of the vertical stabilizer, at the base of the HF antenna. An access panel is provided for the antenna couplers. An access door is also provided for the feed line connection at the antenna.

Installation

The antenna couplers are each secured with two knurled knobs.

Each coupler has a wire bundle and coaxial cable connected to the front panel.

WARNING: ENSURE THAT POWER IS DISCONNECTED FROM BOTH HF SYSTEMS BEFORE OPENING ANTENNA COUPLER ACCESS PANEL. INADVERTENT HF TRANSMISSION CAN CAUSE AN ELECTRICAL SHOCK INJURIOUS TO PERSONNEL.

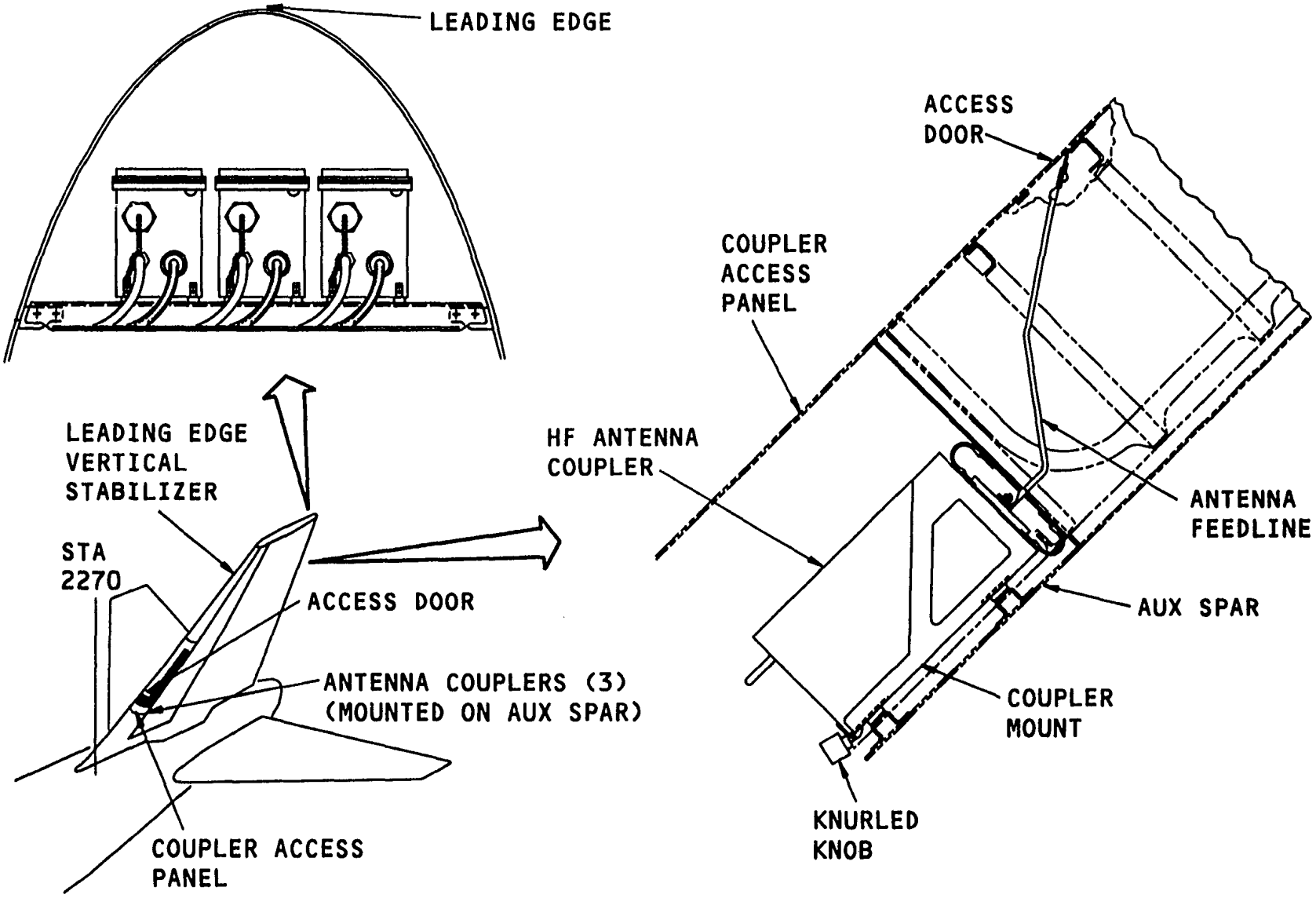

Figure 13 ANTENNA COUPLER INSTALLATION

ANTENNA COUPLER SWITCHOVER PANEL

Description

The center antenna coupler is not normally connected to an HF transceiver. It does however have a wire bundle and coaxial cable connecting it to the antenna coupler switchover panel. This wiring allows the operator to use the center antenna coupler as a cold spare. The center antenna coupler is used in place of the left or right unit, by connecting a wire bundle and coaxial cable to the capped connectors.

Location and Access

The antenna coupler switchover panel is located in the aft equipment center, on the forward side of the E-8 equipment rack. Access to this panel is through the overhead crew rest area.

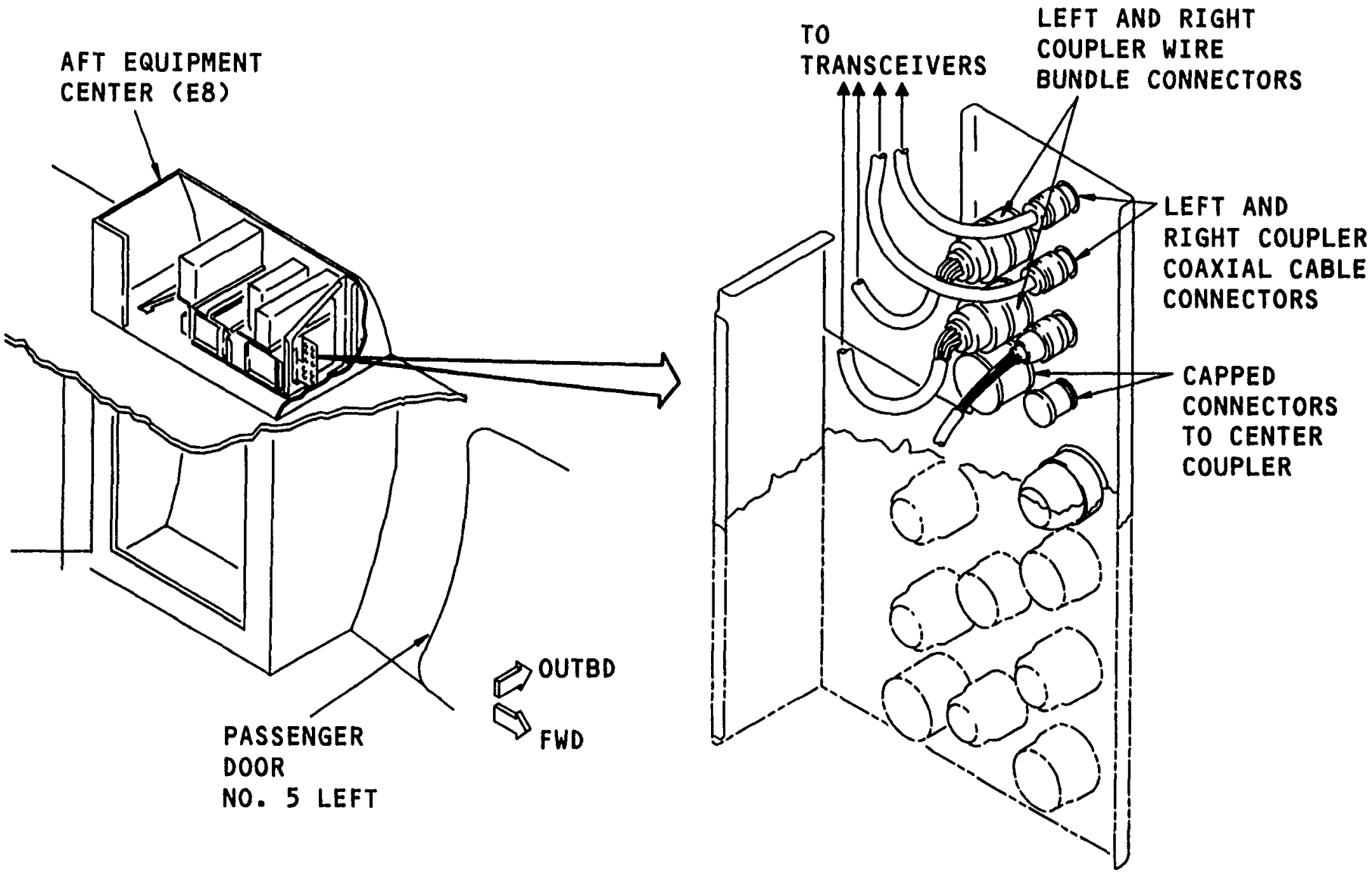

Figure 14 ANTENNA COUPLER SWITCHOVER PANEL

HF ANTENNA

Purpose

The HF antenna radiates and receives RF signals in the HF range.

General Description

The antenna is a flush-mounted shunt-fed slot type, approximately 9 feet long. The antenna driven element is surrounded by the inverted U-shaped insulative port on of the leading edge structure. This antenna dielectric portion is constructed of fiberglass. The fiberglass section is covered with a rain erosion coating.

Location and Access

The HF antenna is a section of the leading edge of the vertical stabilizer. The antenna has an access door for the feedline connection to the antenna driven element. The other end of the feedline connects to the coupler.

WARNING: DO NOT OPERATE HF COMMUNICATIONS SYSTEM DURING REFUELING. HAZARDS TO PERSONNEL AND EQUIPMENT EXIST DURING HF TRANSMISSIONS.

WARNING: ENSURE THAT POWER IS IS DISCONNECTED FROM BOTH HF SYSTEMS BEFORE OPENING ANTENNA COUPLER ACCESS PANEL. INADVERTENT HF TRANSMISSION CAN CAUSE AN ELECTRICAL SHOCK INJURIOUS TO PERSONNEL.

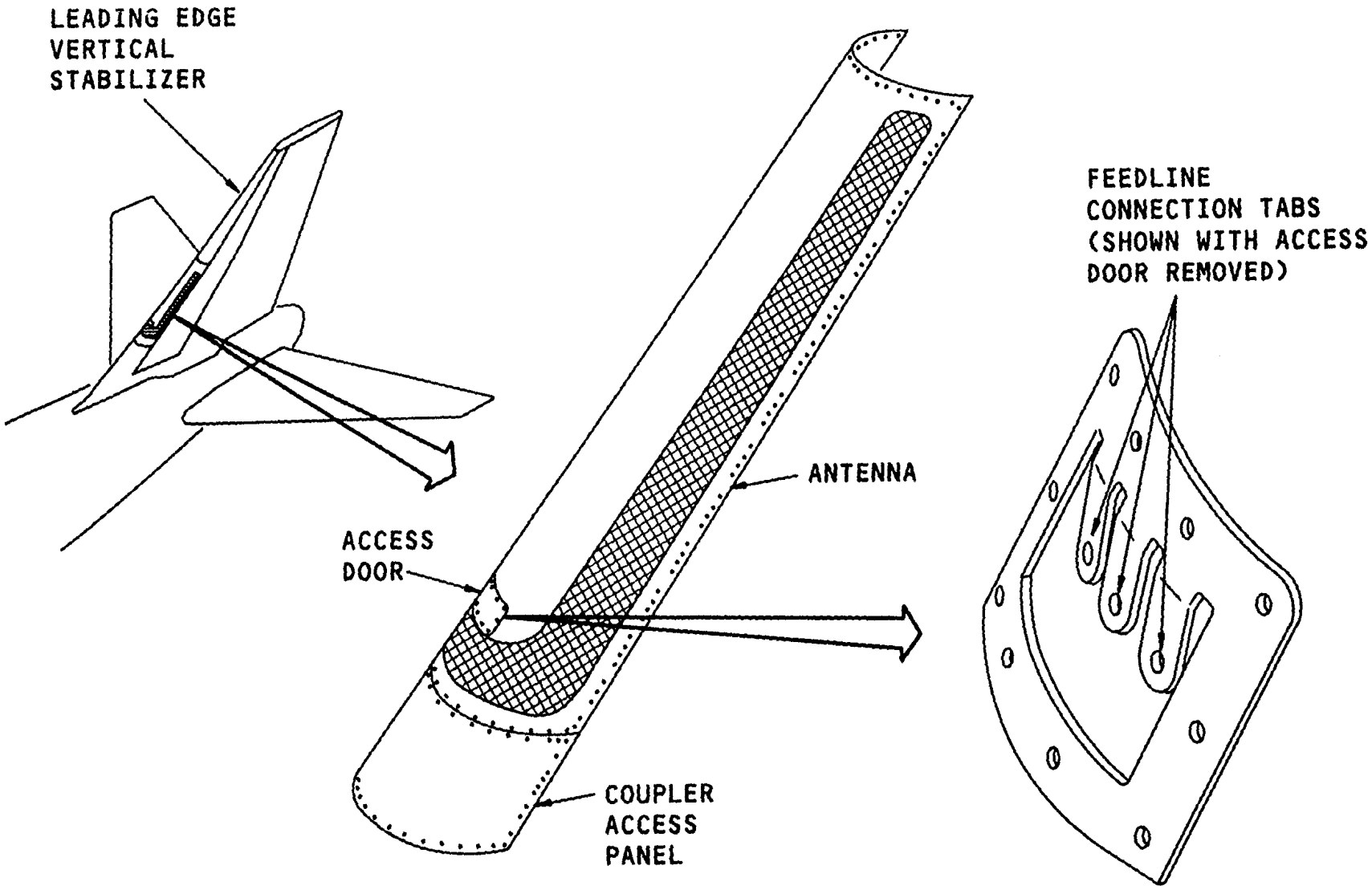

Figure 15 HF ANTENNA

RADIO COMMUNICATION PANEL

Purpose

The Radio Communication Panel (RCP) sends tuning and mode information to the HF transceivers. It allows selection of the active and standby frequencies for each transceiver.

Control and Indications

Push the OFF switch (momentary) to stop the operation of the RCP. It shows white in an off condition.

The frequency selector rotary knobs set the standby frequency. The outer knob controls the 1st, 2nd and 3rd digits (10 MHz, 1 MHz, and 100 kHz). The increments are in 100 kHz steps. The inner knob controls the 4th and 5th digits (10 and 1 kHz). The increments are in 1 kHz steps.

The frequency can only be set in the standby frequency window.

The momentary transfer switch exchanges the active and standby frequencies when it is pushed.

The momentary radio selector switches select a transceiver. When selected, the radio selector switch light bar shows white. Only one HF radio is selected at a time.

The terms on-side and off-side describe the relative positions of two components. The left RCP and left HF transceiver are on-side. The left RCP and right HF transceiver are off-side.

If an RCP is set to an off-side radio, two off-side control lights come on. When the:

- Left RCP is set to the right HF, the left and right RCP off-side control lights come on.
- Right RCP is set to the left HF, the right and left RCP off-side control lights come on.
- Center RCP is set to the left HF, the center and left RCP off-side control lights come on.
- Center RCP is set to the right HF, the center and right RCP off-side control lights come on.

The momentary AM switch selects between AM and USB modulation modes for the selected transceiver. When AM modes is selected, the AM mode switch light bar shows white. The AM mode switch shows white on its on-side HF transceiver is selected while in Am mode. When USB mode is selected the light bar is off.

The active frequency indicator is an LCD display. It shows the frequency being used for transmission and reception by the selected transceiver.

The standby frequency indicator is an LCD display. It shows the standby frequency for the selected transceiver.

The HF SENS rotary knob sets the RF sensitivity level of the on-side HF transceiver:

- Left RCP sets left HF
- Right RCP sets right HF
- Center RCP HF SENS knob is not connected to a transceiver

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.

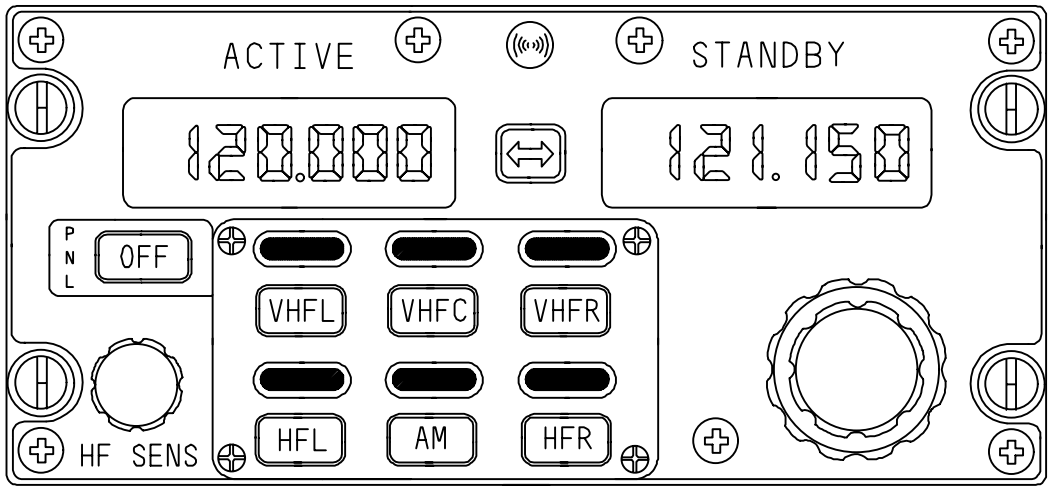

Figure 16 RADIO COMMUNICATION PANEL (GABLES)

AUDIO CONTROL PANEL

General Description

The Audio Control Panel (ACP) supplies transmitter selection, receiver selection and volume control for the left or right HF transceiver.

NOTE: THE OPERATOR CAN TRANSMIT ON ONLY ONE HF SYSTEM AT A TIME, BUT CAN LISTEN TO BOTH HF SYSTEMS AT THE SAME TIME.

Control and Indications

The receiver control switches are push-on/push-off, rotate-for-volume controls. They select the audio from the HF systems for the headset and speakers. When a receiver control is pushed on, the receive light above the control shows green.

The cockpit speaker control adjusts the volume of the speaker.

The transmit switches are electronically interlocked, which permits only one switch selection at a time. When selected, a transmit switch connects the microphone to one of the HF systems.

The mic light shows white to indicate the selected system. The selected system receiver audio is automatically adjusted to the level set on the ACP. The receiver control light is independent of the transmit switch selection.

The PTT switch on the ACP keys the selected transceiver when selected to R/T.

CAUTION: STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REF 20-41-02/01). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCHARGE.

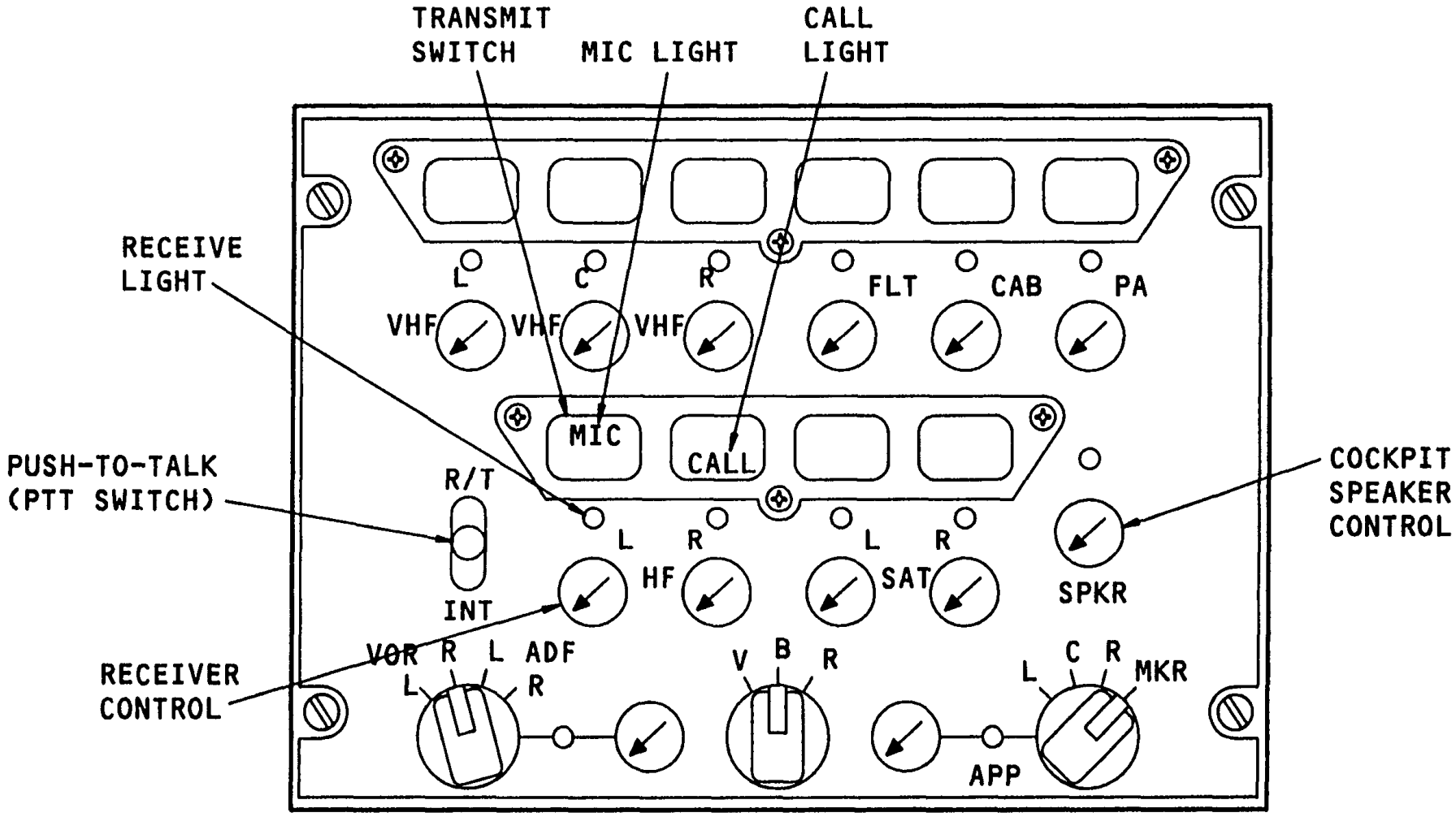

Figure 17 AUDIO CONTROL PANEL

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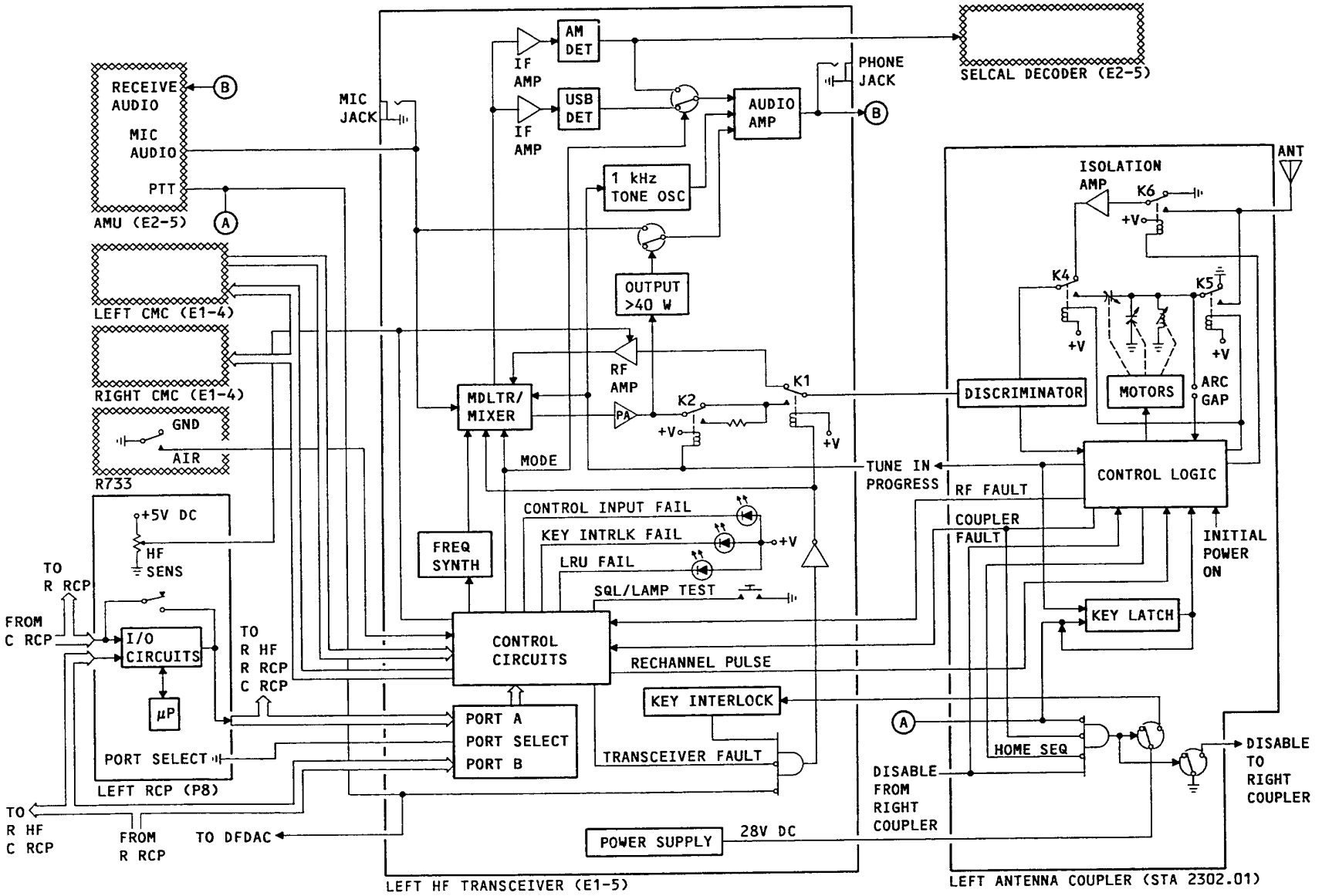


Figure 18 HF SCHEMATIC DIAGRAM (analog coupler)

Figure 19

RCP Switching (cont.)

When the center RCP is off, it switches the right RCP crosstalk input to its output bus.

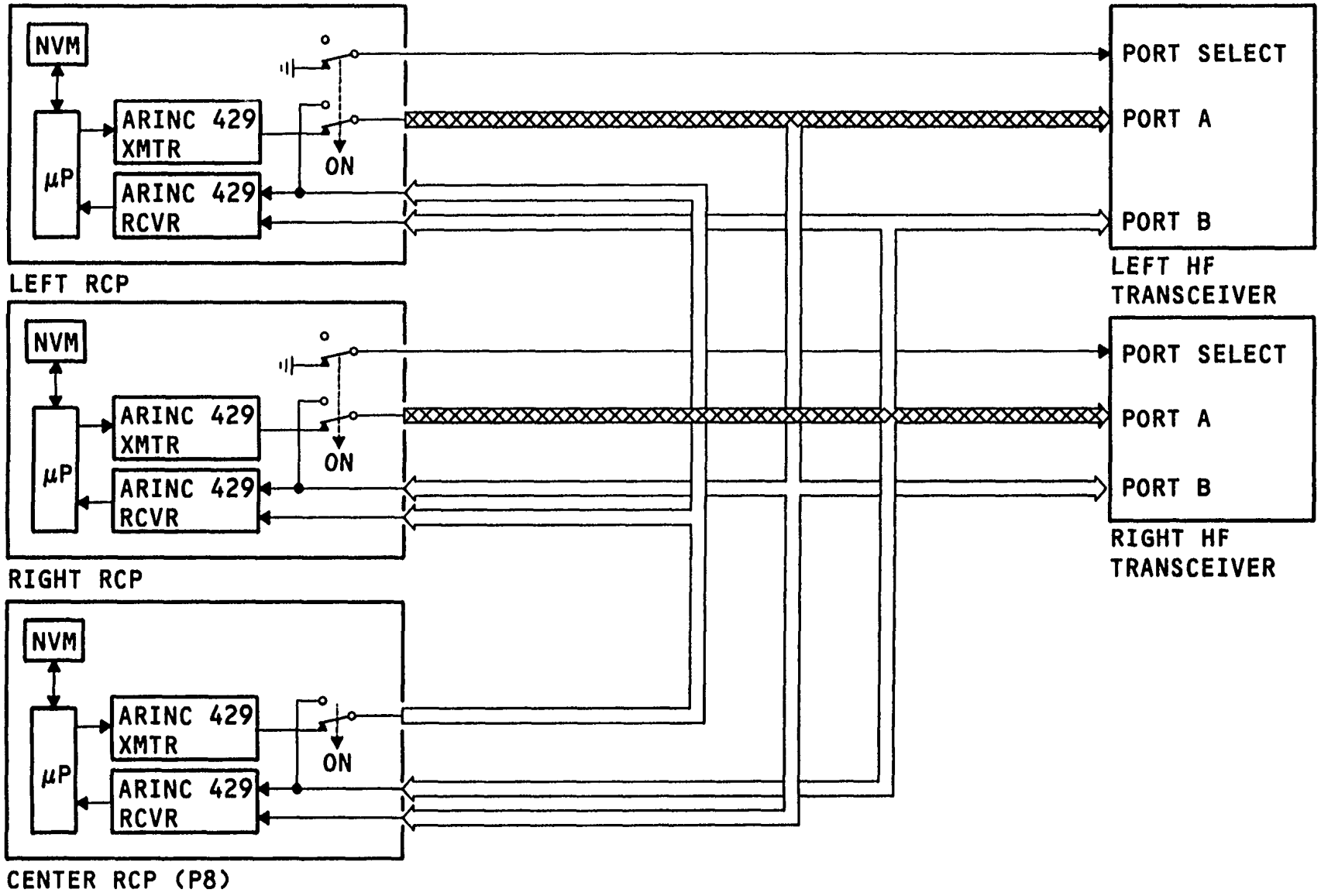


Figure 20 HF – TUNING – NORMAL

TUNING - LEFT RCP OFF

The fault status of the radio communication panels (RCPs) is constantly monitored by internal BITE circuits. When the left RCPs internal BITE circuit finds a failure, the message ”FAIL” shows in the active frequency display window of the RCP. If the left RCP fails, turn off the RCP with the OFF switch. The ”FAIL” message in the active frequency window of the left RCP stays on after you turn off the RCP.

When the RCP is off:

- The left RCP OFF switch shows white.
- The left RCP active frequency indicator continues to show ”FAIL”.
- The port select discrete for the left HF transceiver goes to an open condition.

With the left RCP off, the left HF transceiver uses the tuning and mode data received through Port B. The right RCP sends tuning and mode data to Port B of the left HF transceiver.

Because the right and the center RCPs continue to get data from each other, either of these RCPs can tune either of the transceivers.

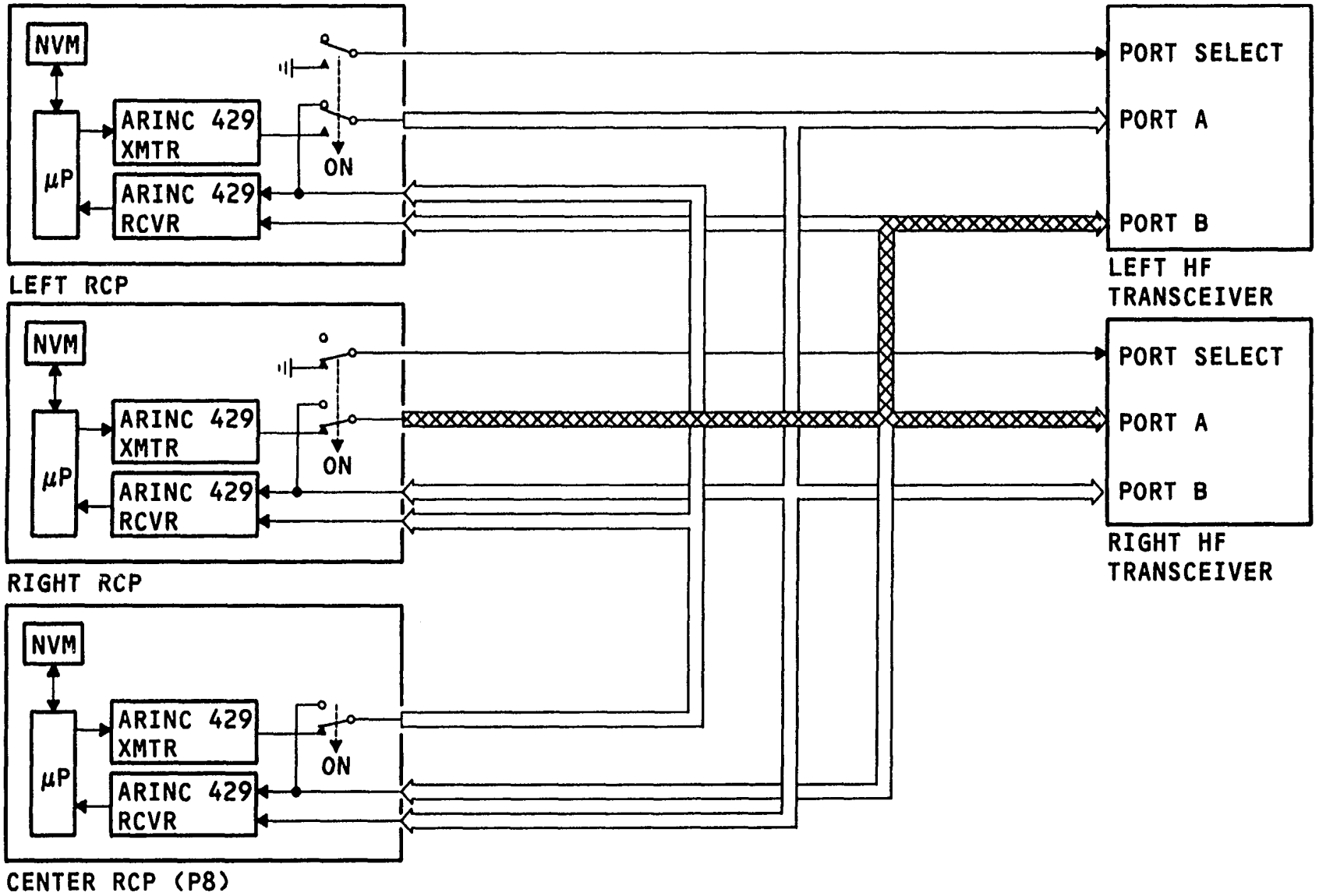


Figure 21 TUNING - LEFT RCP OFF

TUNING - LEFT AND CENTER RCPS OFF

The fault status of the radio communication panels (RCPs) is constantly monitored by internal BITE circuits. When the left and center RCPs internal BITE circuits find a failure, the active frequency display window of the left and center RCPs shows the message ”FAIL”. If the left and center RCPs fail, turn off the RCPs with the left and center RCPs OFF switches. The ”FAIL” message in the active frequency window of the left and center RCPs stay on after you turn off the RCPs.

When the left and center RCPs are off:

- The left and center RCP OFF switch shows white.
- The left and center RCP active frequency indicator continues to show ”FAIL”.
- The port select discrete for the left HF transceiver goes to an open condition.

With the left and center RCPs off, the left HF transceiver uses the tuning and mode data received through Port B. The right RCP sends tuning and mode data to Port B of the left HF transceiver.

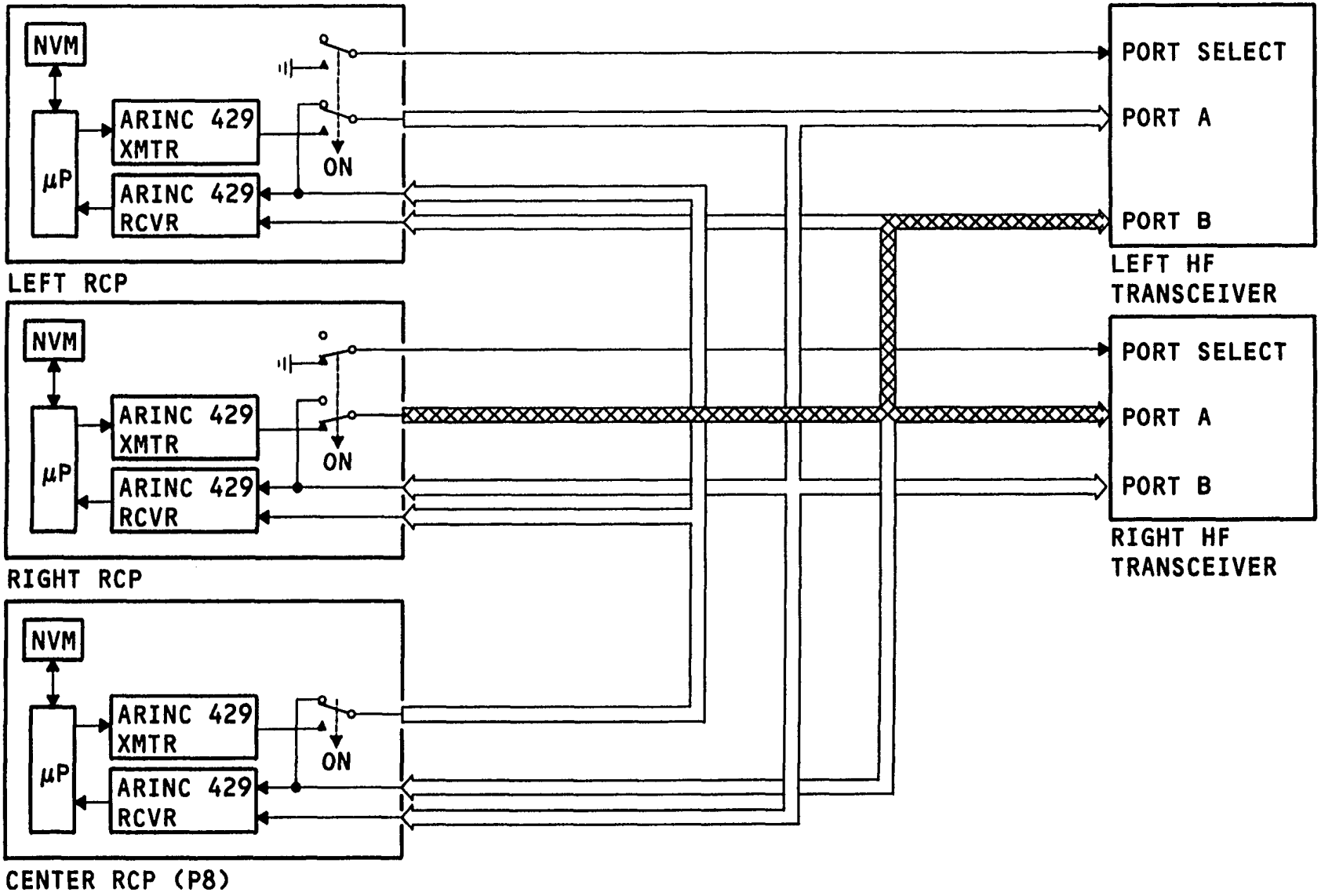


Figure 22 HF - TUNING - LEFT AND CENTER RCPs OFF

TUNING - RIGHT RCP OFF

The fault status of the radio communication panels (RCPs) is constantly monitored by internal BITE circuits. When the right RCPs internal BITE circuit finds a failure, the message ”FAIL” shows in the active frequency display window of the RCP. If the right RCP fails, turn off the RCP with the OFF switch. The ”FAIL” message in the active frequency window of the right RCP stays on after you turn off the RCP.

When the right RCP is off:

- The right RCP OFF switch shows white.
- The right RCP active frequency indicator continues to show ”FAIL”.
- The port select discrete for the right HF transceiver goes to an open condition.

With the right RCP off, the right HF transceiver uses the tuning and mode data received through Port B. The left RCP sends tuning and mode data to Port B of the right HF transceiver.

Because the left and the center RCPs continue to get data from each other, either of these RCPs can tune either of the transceivers.

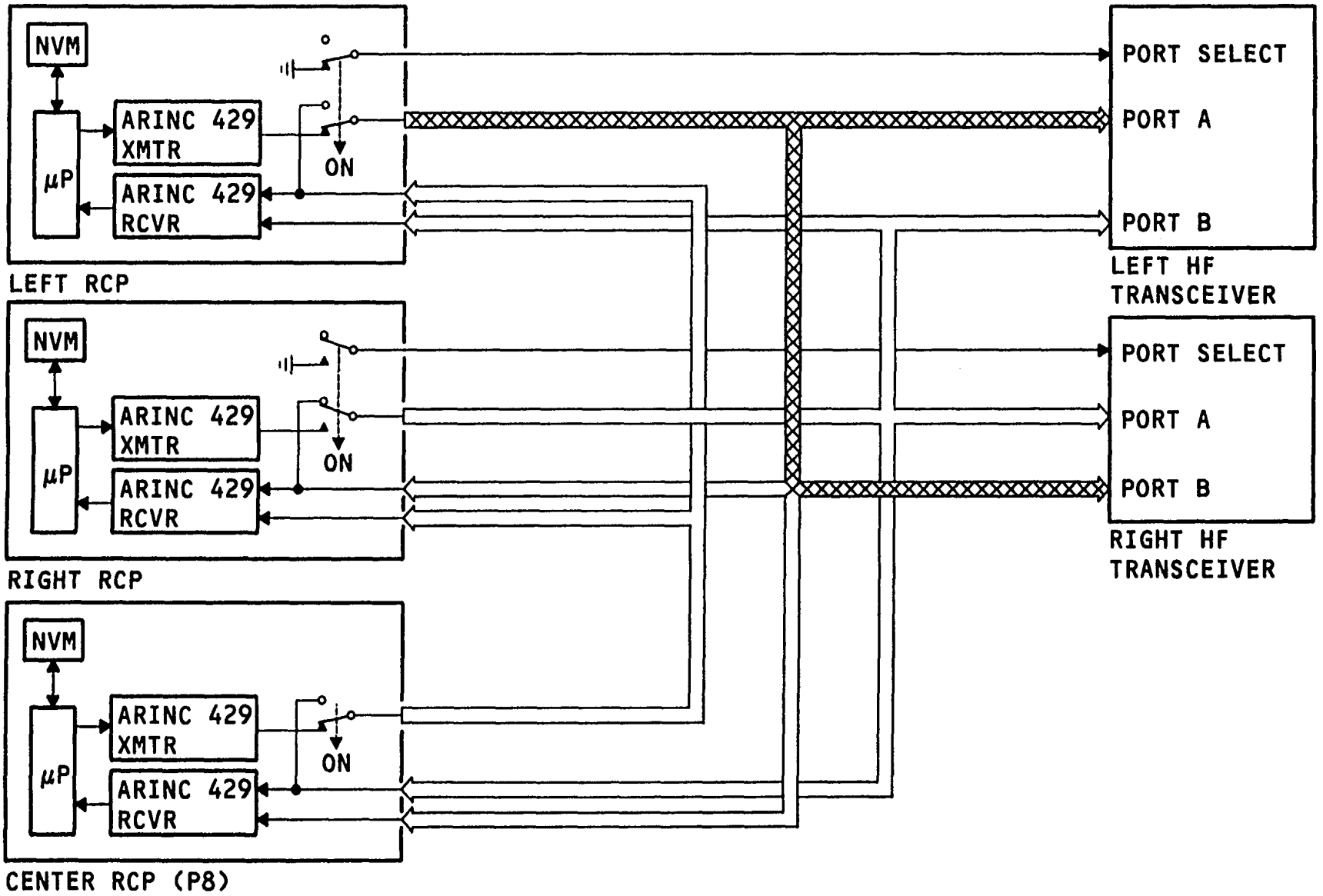


Figure 23 TUNING - RIGHT RCP OFF

TUNING - RIGHT AND CENTER RCPS OFF

The fault status of the radio communication panels (RCPs) is constantly monitored by internal BITE circuits. When the right and center RCPs internal BITE circuits find a failure, the active frequency display window of the right and center RCPs show the message ”FAIL”. If the right and center RCPs fail, turn off the RCPs with the right and center RCPs OFF switches. The ”FAIL” message in the active frequency window of the right and center RCPs stay on after you turn off the RCPs.

When the right and center RCPs are off:

- The right and center RCP OFF switch shows white.
- The right and center RCP active frequency indicator continues to show ”FAIL”.
- The port select discrete for the right HF transceiver goes to an open condition.

With the right and center RCPs off, the right HF transceiver uses the tuning and mode data received through Port B. The left RCP sends tuning and mode data to Port B of the right HF transceiver.

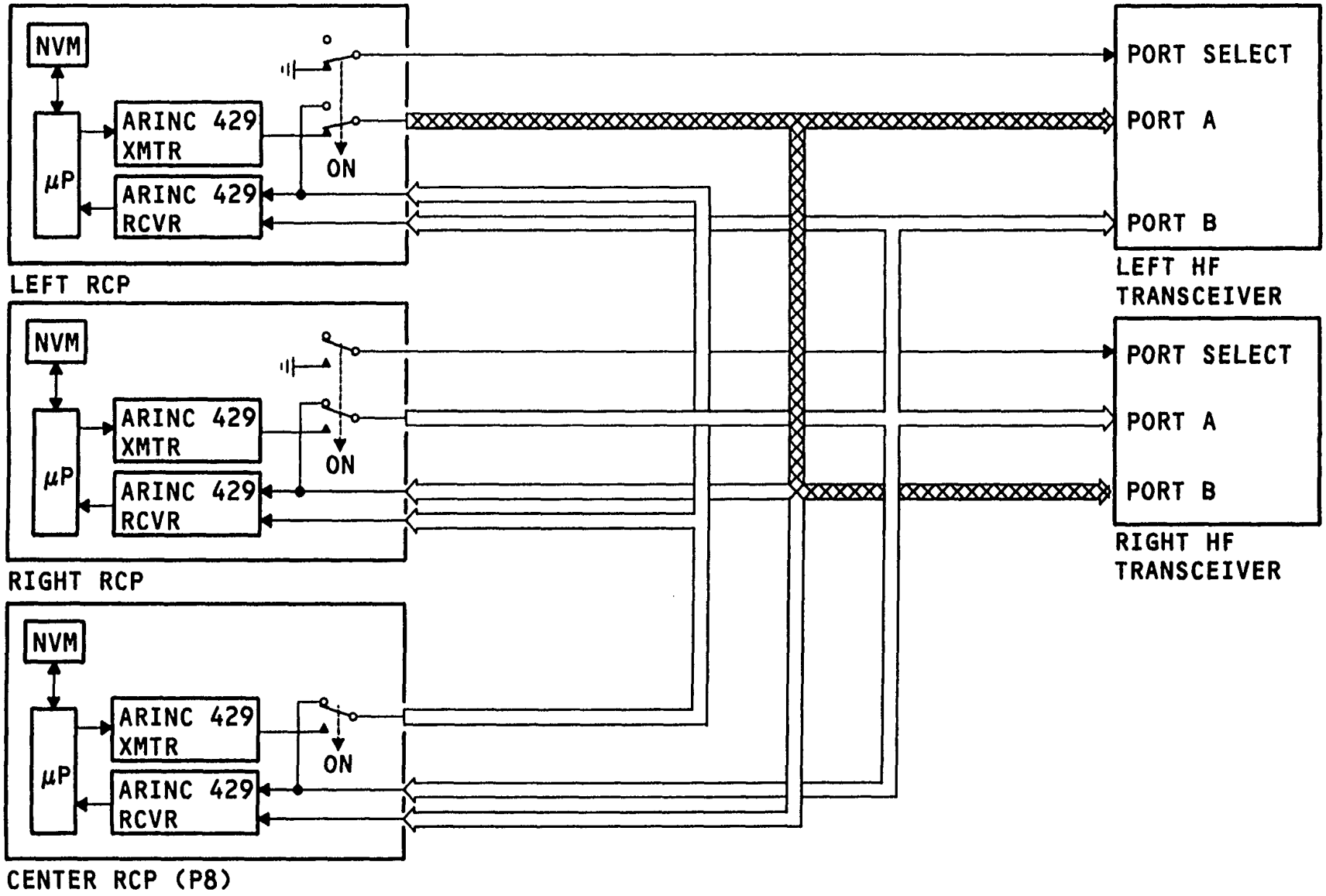


Figure 24 TUNING - RIGHT AND CENTER RCPs OFF

TUNING - LEFT AND RIGHT RCPS OFF

The fault status of the radio communication panels (RCPs) is constantly monitored by internal BITE circuits. When the left and right RCPs internal BITE circuits find a failure, the active frequency display window of the left and right RCPs show the message ”FAIL”. If the left and right RCPs fail, turn off the RCPs with the left and right RCPs OFF switches. The ”FAIL” message in the active frequency window of the left and right RCPs stay on after you turn off the RCPs.

When the left and right RCPs are off:

- The left and right RCP OFF switch shows white.
- The left and right RCP active frequency indicator continues to show ”FAIL”.
- The port select discrete for the left and right HF transceiver goes to an open condition.

With the left and right RCPs off, the left and right HF transceivers use the tuning and mode data received through the port B of each transceiver. The center RCP sends tuning and mode data to the:

- Left transceiver through the left and right RCPs.
- Right transceiver through a relay in the left RCP.

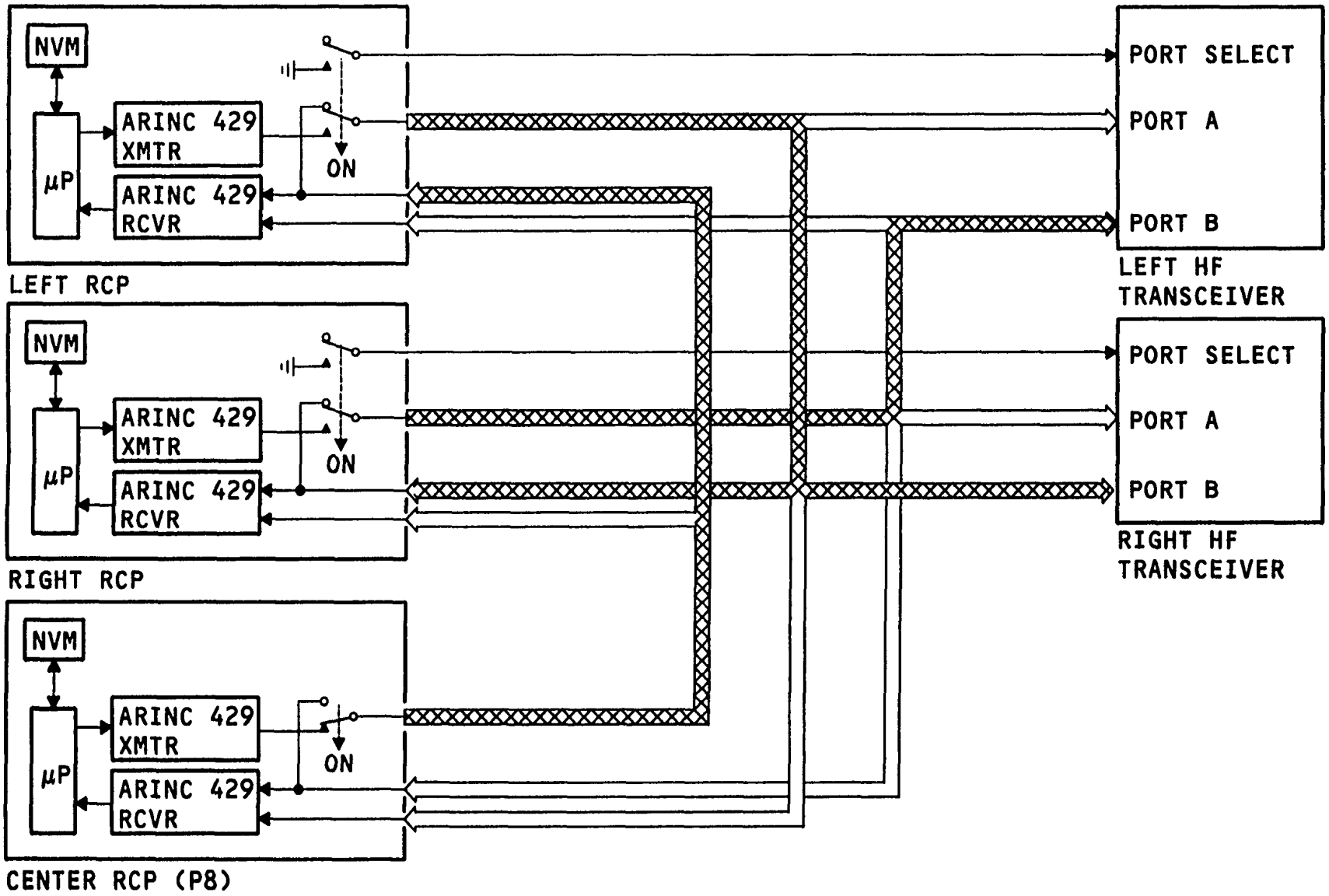


Figure 25 TUNING - LEFT AND RIGHT RCPs OFF

OPERATIONAL SEQUENCE

Home Sequence

When power turns on or when a radio communication panel (RCP) sends a new frequency, the tuning elements in the coupler begin the home sequence. During the home sequence, the tuning elements must move to the home position within 15 seconds. If they do not, the coupler FAULT will cause a KEY INTERLOCK indication on the transceiver when it is keyed. This prevents the transceiver from transmitting.

Receive/Standby

The HF system automatically enters the receive/standby mode when the tuning elements reach the home position. In this mode, the HF system receives on the selected frequency.

LM

A PTT to the HF system causes the coupler to position the tuning elements for the selected frequency. The coupler must tune within 15 seconds. If it does not, a coupler fault will cause a KEY INTERLOCK indication on the

transceiver. During the tune sequence the transceiver sends a 1 kHz tone as HF receiver audio.

Receive/Operate

The HF system automatically enters the operate mode when tuning is complete. In this mode, the HF system receives on the selected frequency. When you select a new frequency (re-channel) the system returns to the home sequence.

Transmit

When the HF system is in the receive/operate mode, a PTT will make the system go to the transmit mode. In the transmit mode:

- Full RF power is generated and applied to the antenna
- If RF arcing occurs, the KEY INTERLOCK light comes on
- If the coupler fails to tune due to low power from the transceiver, the LRU FAIL light comes on

When the PTT is removed, the HF system returns to the receive/operate mode.

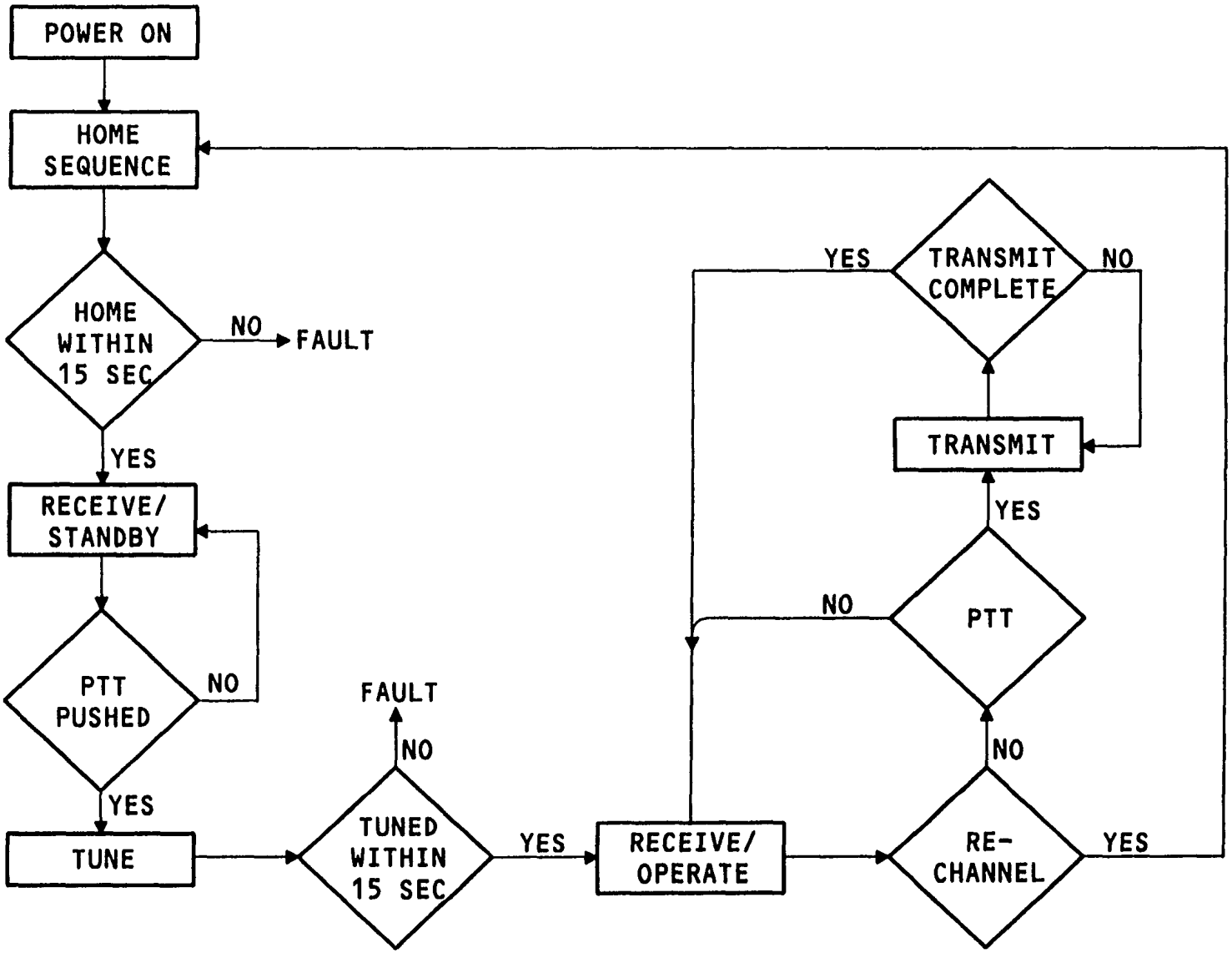


Figure 26 OPERATIONAL SEQUENCE

HOME / RECEIVE SCHEMATIC

General Description

The home sequence and receive/standby modes are described. The left HF system is shown. The right HF system is similar.

Home Sequence Mode

The HF transceiver gets tuning and modulation mode (AM or USB) data from a microprocessor in the radio communication panel (RCP). The transceiver's control circuits decode the data. When the RCP sends a change in frequency, the control circuits send a rechannel pulse to the control logic in the antenna coupler. This causes the coupler to enter the home sequence mode. The home sequence is also entered when power is initially applied.

During the home sequence, the control logic:

- tells the motors to move the two variable capacitors and the variable inductor (tuning elements) to the home position.
- energizes relay K6.
- de-energizes relays K4 and K5.

The home position is the starting point for the tuning elements when there is a change in frequency.

The control logic energizes K6 so that the HF system can receive during the home sequence. When the tuning elements reach the home position, the hF system is in the receive/standby mode.

Receive/Standby Mode

During the receive/standby mode, relays K1, K4 and K5 stay de-energized. Relay K6 stays energized. The received RF signal passes through the isolation amplifier in the coupler. The RF signal then goes through the discriminator unaffected. It then goes to the transceiver where it is amplified by the RF amplifier. The HF SENS control on the RCP sets the sensitivity of the RF amplifier.

The mixer/filters then process the RF signal to produce an intermediate frequency (IF) signal. The IF amplifiers then amplify the signal. The AM detector and the USB detector receive the IF signal from the IF amplifiers. The detectors detect the audio from the signal. Audio from the AM detector goes to the SELCAL decoder and to a solid state switch. Audio from the USB detector also goes to this switch. The mode output from the control circuits selects audio detected by either the AM detector or the USB detector. The selected audio goes through an audio amplifier to:

- The audio management unit.
- A phone jack on the transceiver front panel.

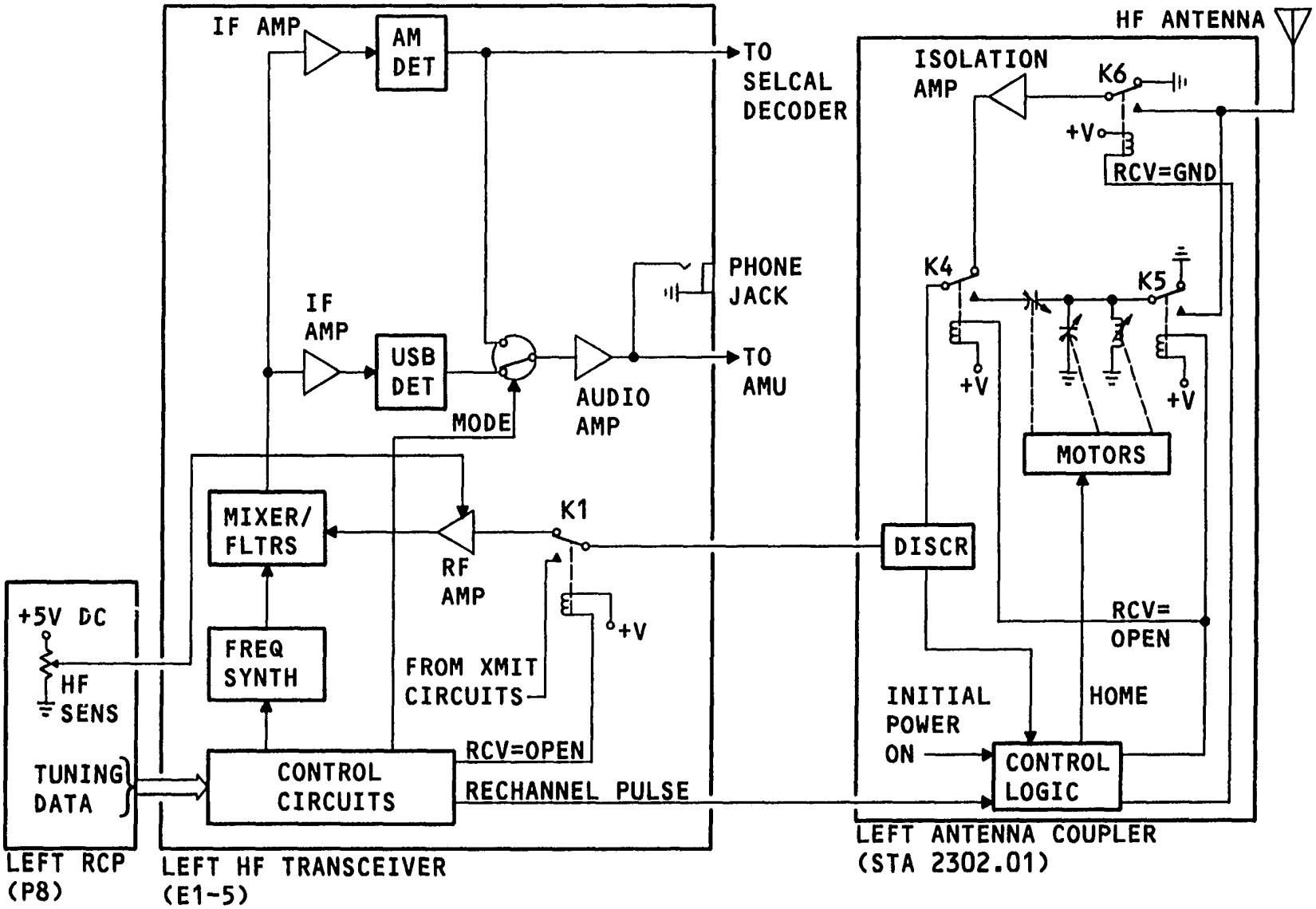


Figure 27 HOME / RECEIVE SCHEMATIC (analog Coupler)

Figure 28

TUNE SCHEMATIC

General Description

The left HF system is shown. The right HF system operates in a similar way.

Tune Mode Initiation

When a ground is on the disable discrete from the right antenna coupler, the left coupler cannot enter the tune mode. The ground on the disable discrete also causes relays K4, K5 and K6 to open. This disconnects the left coupler from the antenna while the right coupler is in the tune or transmit modes.

When in the receive/standby mode, a PTT to the control logic in the coupler puts it into the tune mode. During this mode, the control logic energizes relays K4 and K5, and de-energizes relay K6. This puts a ground on the input to the isolation amplifier and connects the tuning elements in-line between the discriminator and the antenna.

The control logic in the coupler (which includes the AND gate shown) turns on a switch to send a ground output to disable the right HF coupler; it turns on another switch to send a 28 volt dc key interlock signal back to the left HF transceiver. The control logic turns on these switches only if:

- There is a ground on the PTT line.
- There is no disable from the right coupler.
- The control logic is not in the home sequence.
- There are no coupler faults.

The control logic puts a ground on the tune-in-progress line when the coupler is in the tune mode. This ground causes the key latch to keep the PTT line grounded until tuning is complete. The grounded tune-in-progress line also goes to the transceiver.

The ground on the tune-in-progress line energizes K2 in the transceiver. It also makes an oscillator come on, which sends a 1 kHz tone (through an amplifier) to the front panel phone jack and to the audio management unit.

This tone tells the operator that the system is in the tune mode.

Tune Mode

The control circuits in the transceiver (which include the AND gate) energize K1 and tell the modulator to send a carrier from the frequency synthesizer if:

- There is a ground on the PTT line.
- There is no transceiver fault.
- There is a key interlock signal from the coupler.

The grounded tune-in-progress line tells the modulator not to modulate the carrier with audio. Thus, the modulator sends out only a carrier during the tune mode. The carrier goes through a power amplifier to relay K2. Since relay K2 is energized in the tune mode, the output from the power amplifier goes through the resistor. The resistor reduces the power load on the amplifier to 75 watts.

Since K1 is energized, the carrier signal goes to the discriminator in the coupler. Since K4 and K5 are energized in the tune mode, the RF carrier goes through the tuning elements to the antenna.

The discriminator samples the RF signal that goes through it and sends analog signals to the control logic. These signals are related to the standing wave ratio and other transmission line parameters. The control logic uses these signals from the discriminator to match the impedance of the transceiver to the impedance of the antenna at the selected frequency. To match the impedances, the control logic tells the motors to move the tuning elements. The control logic continues the tune mode until it matches the impedances. When the impedances are matched, the control logic opens the tune-in-progress discrete. Thus, the tune mode ends.

When the tune mode ends, the HF system begins the receive/operate mode. Relays K1 K21 K4 and K5 are de-energized. Relay K6 energizes. Now the HF system is ready to transmit when a PTT occurs. If the tune mode does not end within 15 seconds, the control logic sets a coupler fault.

Key Event Output

A ground discrete goes to the digital flight data acquisition card (DFDAC) while there is a PTT.

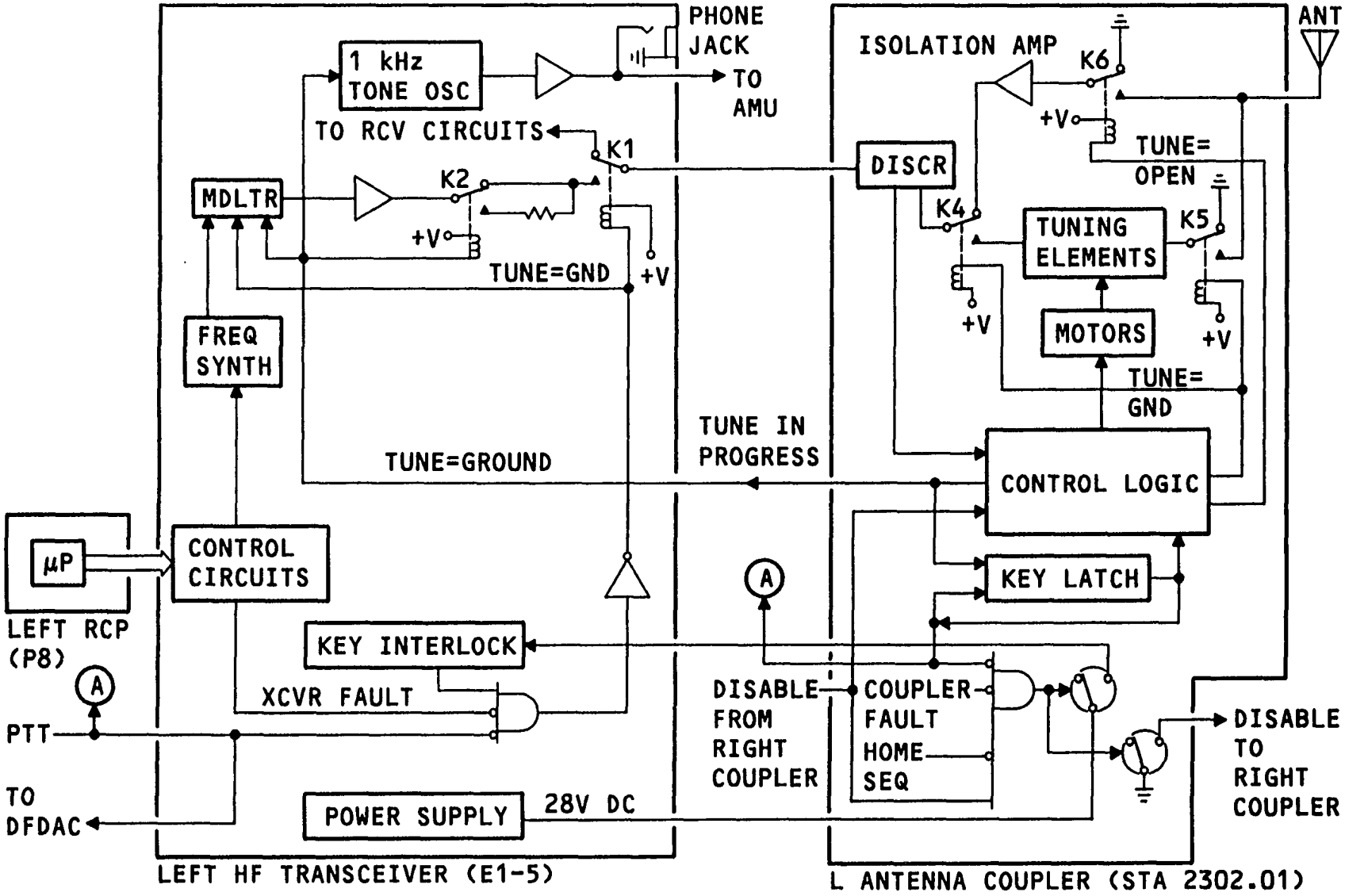


Figure 29 TUNE SCHEMATIC (analog Coupler)

Figure 30

TRANSMIT SCHEMATIC

General Description

The left HF system is shown. The right HF system operates in a similar way.

Transmit Mode

When in the receive/operate mode, a PTT to the control logic in the coupler puts it into the transmit mode. During this mode, the control logic energizes relays K4 and K5, and de-energizes relay K6. This puts a ground on the input to the isolation amplifier and connects the tuning elements in-line between the discriminator and the antenna.

The control logic in the coupler (which includes the AND gate shown) turns on a switch to send a ground output to disable the right HF coupler; it turns on another switch to send a 28 volt dc key interlock signal back to the left HF transceiver. The control logic turns on these switches only if:

- There is a ground on the PTT line.
- There is no disable from the right coupler.
- The control logic is not in the home sequence.
- There are no coupler faults.

The control logic puts an open on the tune-in-progress line when the coupler is in the transmit mode. This open discrete goes to the transceiver, where it de-energizes K2.

The control circuits in the transceiver (which include the AND gate) will energize K1 and tell the modulator to send a carrier if:

- There is a ground on the PTT line.
- There is no transceiver fault.
- There is a key interlock signal from the coupler.

The modulator modulates the carrier from the frequency synthesizer with mic audio. The RF signal goes through a power amplifier to relay K2. Since relay K2 is de-energized in the transmit mode, and since K1 is energized, the RF signal goes to the discriminator in the coupler. Since K4 and K5 are energized in the transmit mode, the RF signal goes through the tuning elements to the antenna. The antenna radiates the RP signal.

Sidetone

If the output from the PA is greater than 40 watts, a switch connects the microphone audio to the audio amplifier. The amplified audio goes to the audio Jack and to the audio management unit for sidetone.

Fault Monitoring

The antenna coupler sends two discretes to the transceiver for fault monitoring. The control logic puts a ground on the coupler fault discrete

when it finds a coupler fault. A coupler fault occurs when;

- The control logic finds a tuning fault.
- The arc gap detects arcing.

The control logic puts a ground on the RP fault discrete when it finds that there is low power through the coupler during the transmit mode. The transceiver uses these discretes for its continuous fault reports to the central maintenance computer system (CMCS). The control circuits use the air/ground logic from relay R733 to define flight legs far its internal fault memory.

Key Event Output

A ground discrete goes to the digital flight data acquisition card (DFDAC) while there is a PTT.

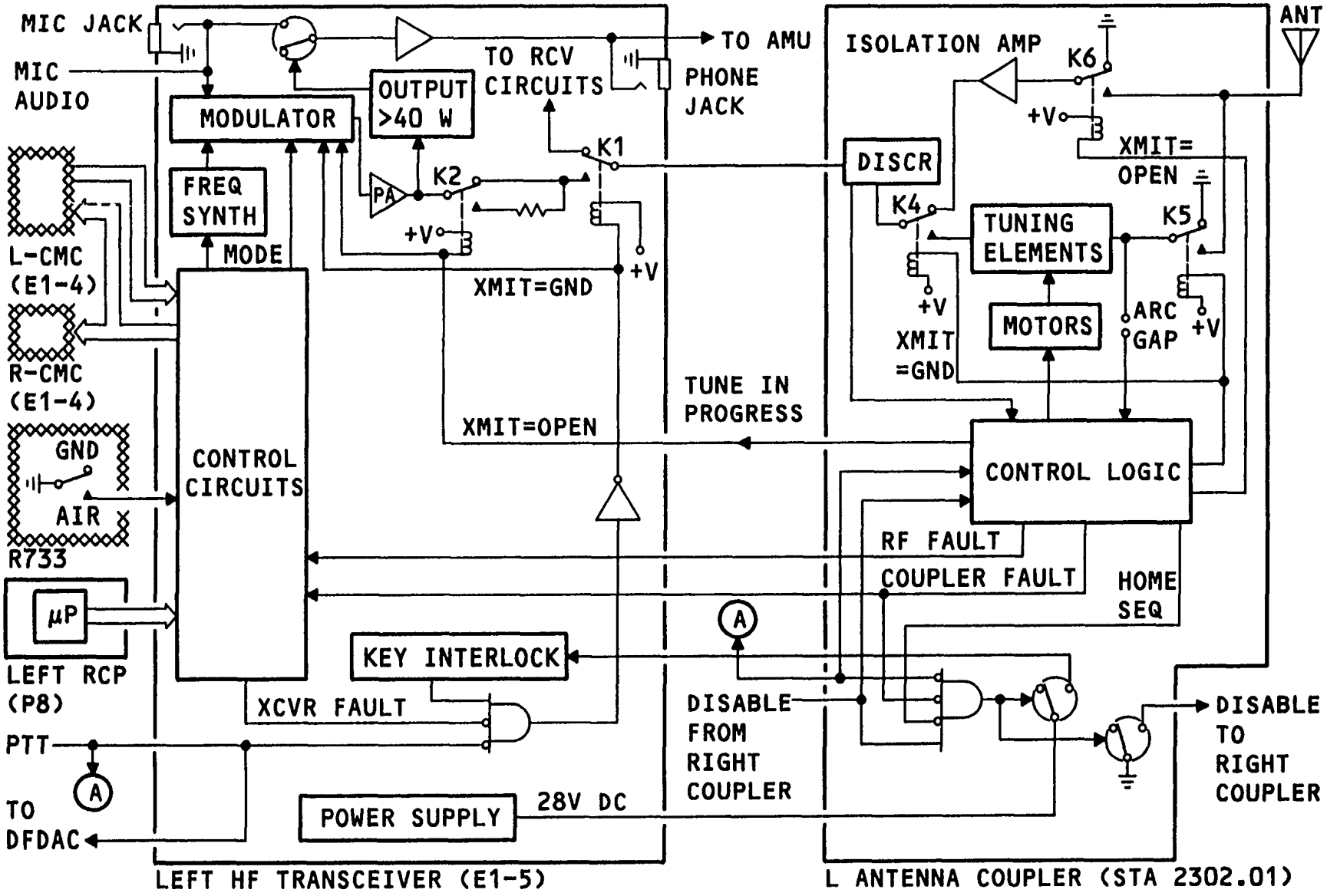


Figure 31 TRANSMIT SCHEMATIC (analog Coupler)

TUNE FUNCTIONAL DESCRIPTION

General

The left and right HF systems are the same. This example shows the left system.

The tune sequence begins after the home sequence is complete.

Tune Mode Initiation

Select the HF communication frequency on a radio communication panel (RCP) and key the mic. The PTT signal from the mic starts the tune mode. The same signal goes to the control cirucits in the transceiver and the control logic circuits in the antenna coupler.

The coupler control logic circuits energize the RF network relays to get an antenna match.

The coupler control logic sends a disable discrete to the right HF coupler and sends a key interlock signal to the left HF transceiver.

The control logic circuits can start tuning only in these conditions:

- There is a ground on the PTT line
- There is no disable from the right coupler
- There are no coupler faults.

Tune Mode Operation

The coupler control logic sends a tune-in-progress discrete to the transceiver when the coupler is in tune mode. The logic latches the PTT discrete to ground until the tuning is complete.

The tune-in-progress discrete goes to the transceiver RF circuits. The RF circuits send an audio tone to the front panel phone jack and to the audio management unit. This tone tells the operator that the system is in the tune mode.

The control circuits in the transceiver energize relay K1 and tell the RF circuits to send a carrier in these conditions:

- There is a PTT signal
- There is no transceiver fault
- There is a key interlock signal from the coupler.

In the tune mode, the RF carrier contains no audio. The RF carrier goes to the coupler. The RF carrier goes through the discriminator to the tuning elements and to the antenna.

The coupler gets antenna balance by energizing and de-energizing the RF network relays. This switches different value capacitors and inductors in and out of circuit.

The control logic circuits check the memory for fast tone data. If fast tone data for the selected data is available, the logic set these relays first.

During tuning, the discriminator samples the RF carrier and sends data to the coupler control logic circuits. The control logic circuits use the data from the discriminator to generate controls for the tuning circuits. The tune mode continues until the impedance of the transceiver and the antenna are balanced for the selected frequency. When the impedance balances, the control logic circuits remove these signals:

- The tune-in-progress discrete
- The ground on the PTT discrete
- The 28v dc key interlock signal.

The control logic stores tune data in memory for fast tune.

Tuning is complete.

If the tune mode does not end within 7 seconds, the coupler control logic sends a coupler fault and stops the key interlock signal to the transceiver.

Operate mode (Receive)

When the tune mode ends, the HF system begins the operate (receive) mode. Relays K1 and K2 in the transceiver de-energize. Now the HF system is ready to transmit when it receives a PTT signal.

Key Event Output

The PTT discrete goes to these systems:

- Digital flight data acquisition card (DFDAC)
- EFIS/EICAS interface units (EIU)
- Aircraft condition and monitoring system (ACMS).

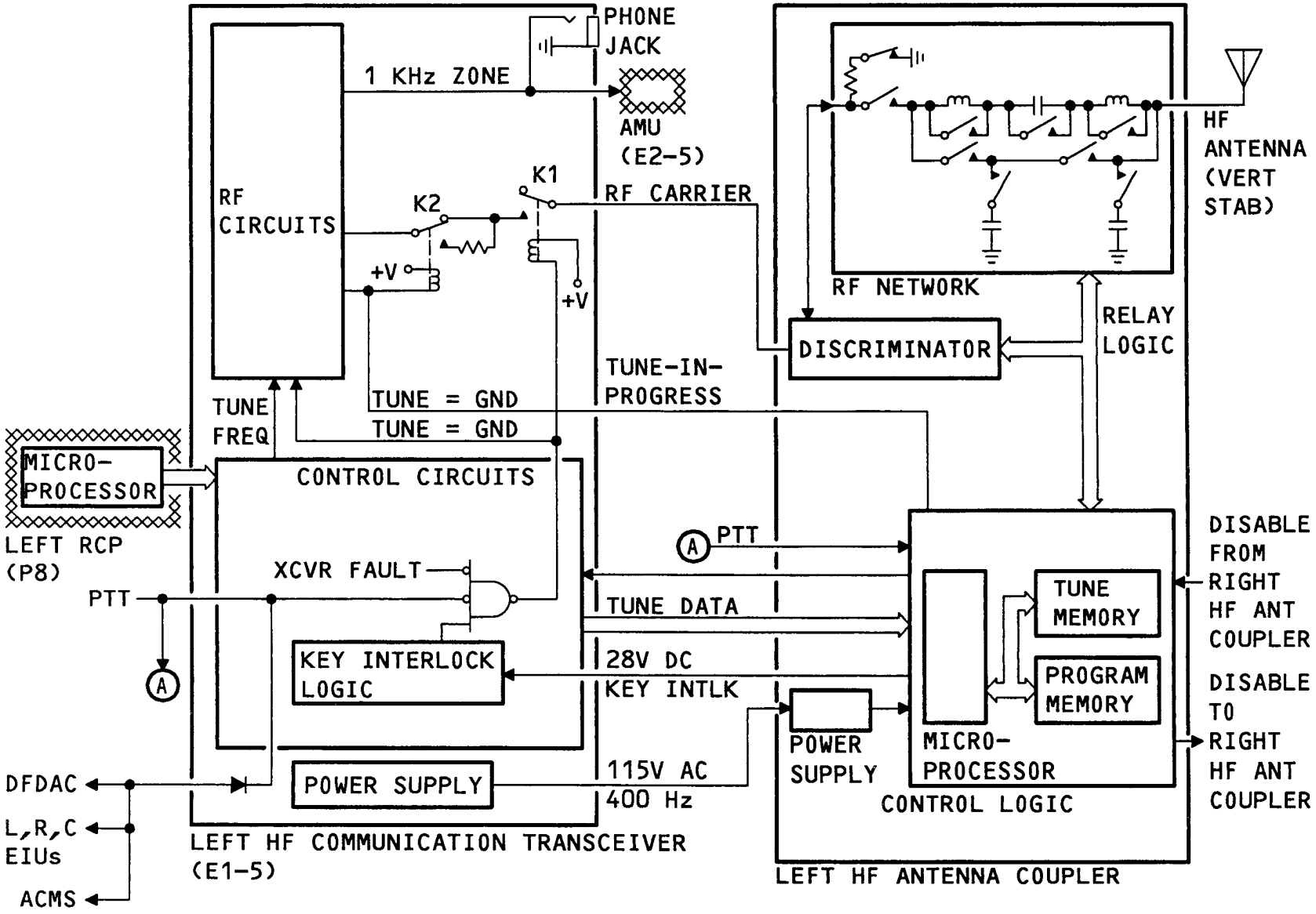


Figure 32 TUNE FUNCTIONAL DESCRIPTION

SELF TEST

General Description The HF transceiver's built in test equipment (BITE) runs continuously. For certain tests, the transmitter must operate to determine the unit's status. LED status indicators come on when a test finds a failure. The transceiver front panel has a switch to start a squelch/lamp test.

Fault Indications

The HF transceiver front panel has these indications of failure:

- LRU FAIL
- KEY INTERLOCK
- CONTROL INPUT FAIL

The red LRU FAIL LED comes on for these failures:

- Low internal power supply output voltage
- Frequency synthesizer failure
- Low transmitter output power when keyed in AM mode

The red KEY INTERLOCK LED comes on for these failures when the transceiver is keyed:

- Excessive antenna coupler tuning time
- Arcing during transmission

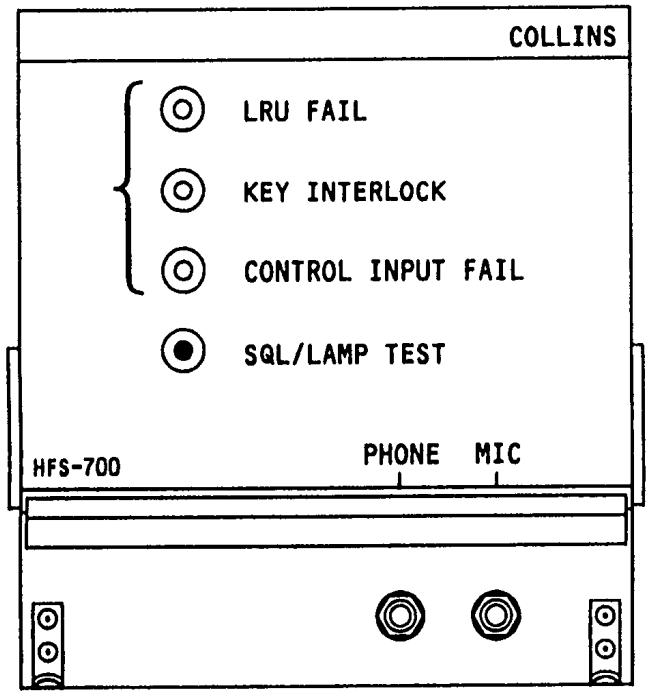
The HF transceiver is disabled when the KEY INTERLOCK LED is on.

The red CONTROL INPUT FAIL LED comes on when the tuning data from the RCP in use is not valid.

Squelch/Lamp Test

Pressing the SQL/LAMP TEST pushbutton switch causes these indications:

- All three LED status indicators come on
- RF sensitivity goes to the maximum level



SQL/LAMP TEST - ALL LED'S COME ON AND SENSITIVITY GOES TO MAXIMUM LEVEL

FRONT PANEL FAULT INDICATIONS

LRU FAIL	- LOW INTERNAL POWER SUPPLY VOLTAGE
	FREQUENCY SYNTHESIZER FAILURE
	LOW TRANSMITTER OUTPUT POWER WHEN KEYED IN AM MODE
KEY INTERLOCK (WHEN KEYED)	- TUNING SEQUENCE FAILURE
	ARCING DURING TRANSMISSION
CONTROL INPUT FAIL	- TUNING DATA FROM RCP IS NOT VALID

Figure 33 SELF TEST (COLLINS HFS-700)

GROUND TEST

To do an HF system test, select HF from the ground test menu. A TEST PRE-CONDITION page shows. This page gives additional information about the test. Use the START TEST key to start the test.

If the test passes, the CDU shows the word PASS. If the test fails, the CDU shows the word FAIL. Push the line select key next to the word FAIL to show the failed test message page. The ground test message page shows details relating to the failure.

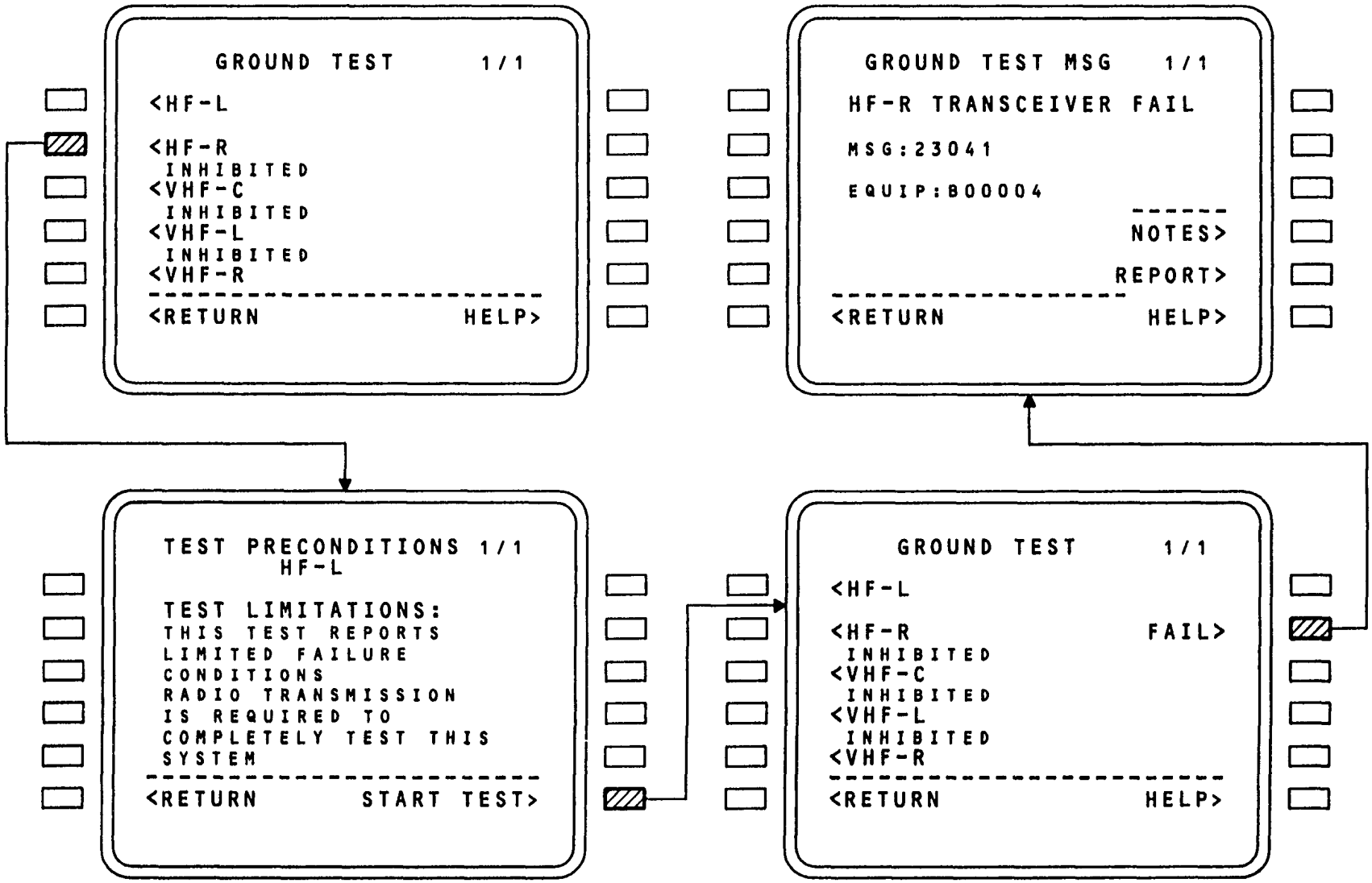


Figure 34 GROUND TEST

CMC MESSAGES

CMC Messages

The different types of CMC messages displayed for the HF system are:

- CMC--HF-X BUS FAIL (The ARINC 429 bus from the central maintenance computer to the HF-X transceiver has failed.)
- HF-X--CMC BUS FAIL (The ARINC 429 bus from the HF-X transceiver to the central maintenance computer has failed.)
- HF-X NO TEST RESPONSE (The HF-X transceiver failed to respond after a CMC ground test was started from the control display unit.)
- HF-X TRANSCEIVER FAIL (HF-X transceiver failure)
- HF-X INPUT PORT A BUS FAIL (The transceiver is not receiving valid frequency tuning information in port A)
- HF-X INPUT PORT B BUS FAIL (The transceiver is not receiving valid frequency tuning information in port B)
- X RADIO COMMUNICATION PANEL FAIL (The X radio communication panel is sending an open BITE discrete to the CMC)
- HF-X COUPLER FAIL (The transceiver gets a coupler fault discrete from the hf coupler.)

NOTE: X = L (LEFT), R (RIGHT)

CMC MESSAGES

CMC ≈ HF-X BUS FAIL
HF-X ≈ CMC BUS FAIL
HF-X NO TEST RESPONSE
HF-X TRANSCEIVER FAIL
HF-X INPUT PORT A BUS FAIL
HF-X INPUT PORT B BUS FAIL
X RADIO COMMUNICATION PANEL FAIL
HF-X COUPLER FAIL

1

1 X = L(LEFT), R(RIGHT)

Figure 35 CMC MESSAGES

23-61 STATIC DISCHARGER

STATIC DISCHARGER

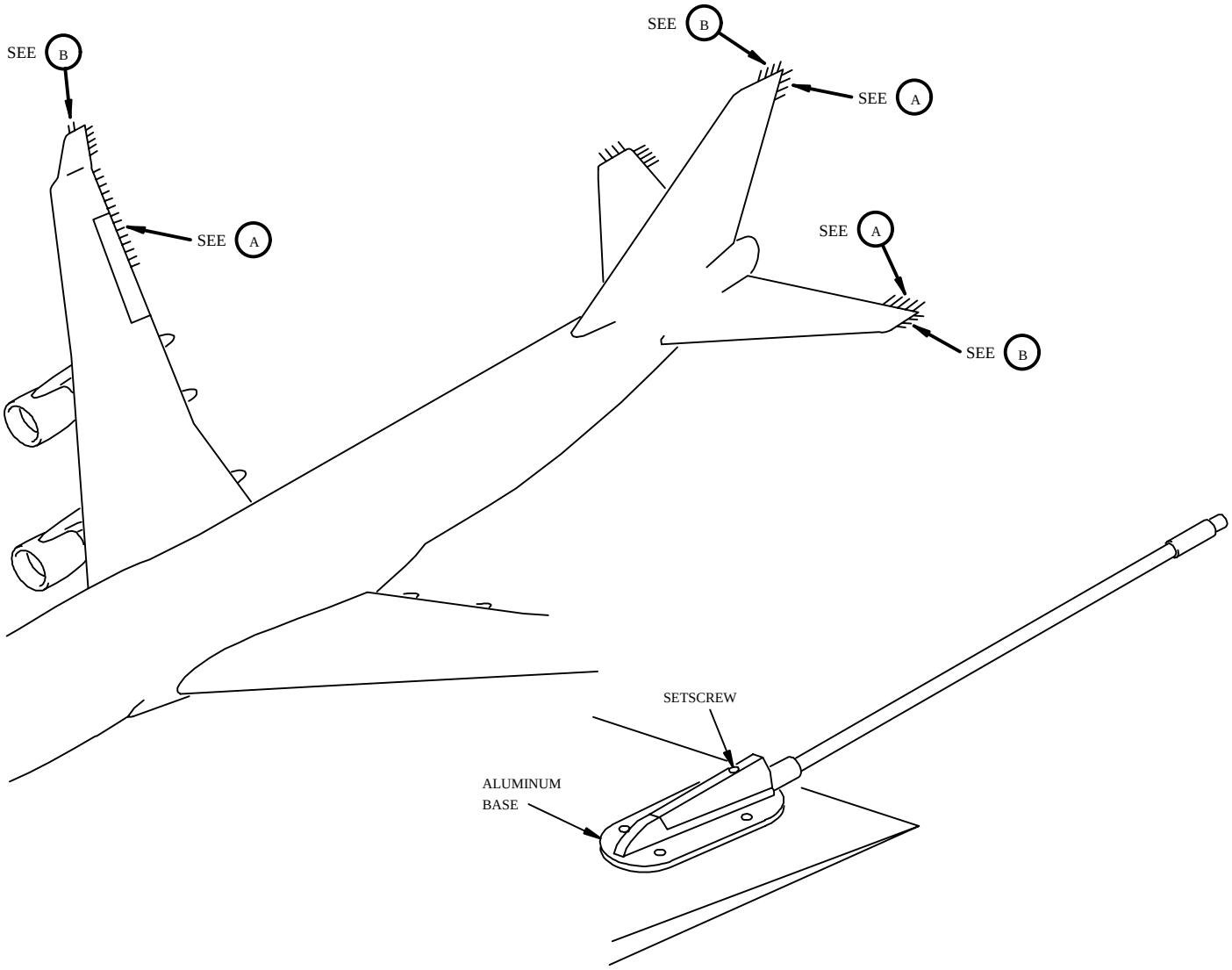
General

Static dischargers are installed on the airplane to reduce radio receiver interference. This interference is caused by a corona discharge emitted from the airplane surfaces as a result of precipitation static and engine charging. Precipitation static results from an electric charge accumulated by the airplane striking charged air and moisture particles. Static usually discharges at the wing and tail extremities and is coupled into the radio receiver antennas. The static dischargers are designed to discharge the static at points which are a critical length away from the wing and tail extremities where there is little or no coupling of the static into the radio receiver antennas.

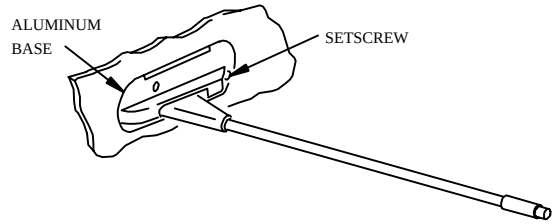
Location

The dischargers that are installed along the trailing edges of the wing and tail surfaces consist of a carbon block mounted near the end of a slender rod. The rod has controlled resistive characteristics and is attached to a metal base. The base is fastened and bonded to the trailing edge surfaces. The wingtip dischargers are smaller but have the same general construction and are attached in the same manner.

The vertical fin has four tip dischargers and four trailing edge dischargers. Each horizontal stabilizer has four tip dischargers and five trailing edge dischargers. Each wingtip has two tip dischargers and 19 trailing edge dischargers.



TRAILING EDGE
SURFACE INSTALLATION
(EXAMPLE)



STABILIZER TIP, WING TIP
AND FIN CAP INSTALLATION
(EXAMPLE)

B

Figure 36 STATIC DISCHARGER LOCATION

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