



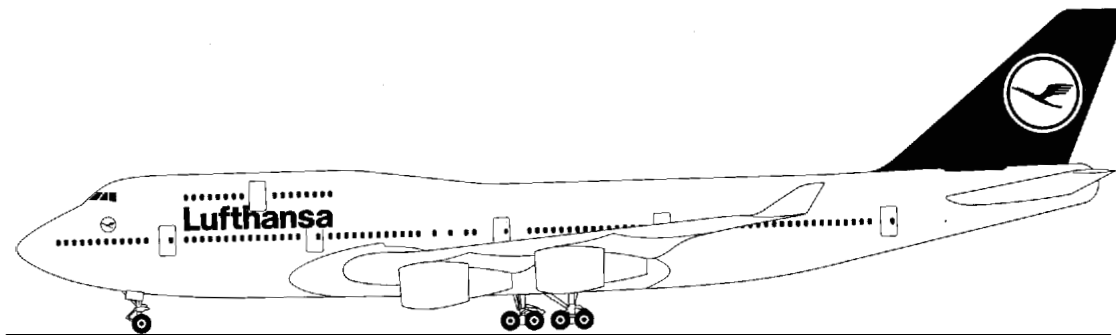
Lufthansa Technical Training

Training Manual B 747-400

ATA 34-55

DME

ATA Spec. 104 Level 3



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Lufthansa
Technical Training GmbH
Lufthansa Base

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DME



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DME



DME SYSTEM - INTRODUCTION

General

A dual distance measuring equipment (DME) System is installed which provides the pilots and Subsystems with slant range (line-of-sight) distance between the airplane and a ground station. The System also supplies an audio station identifier.

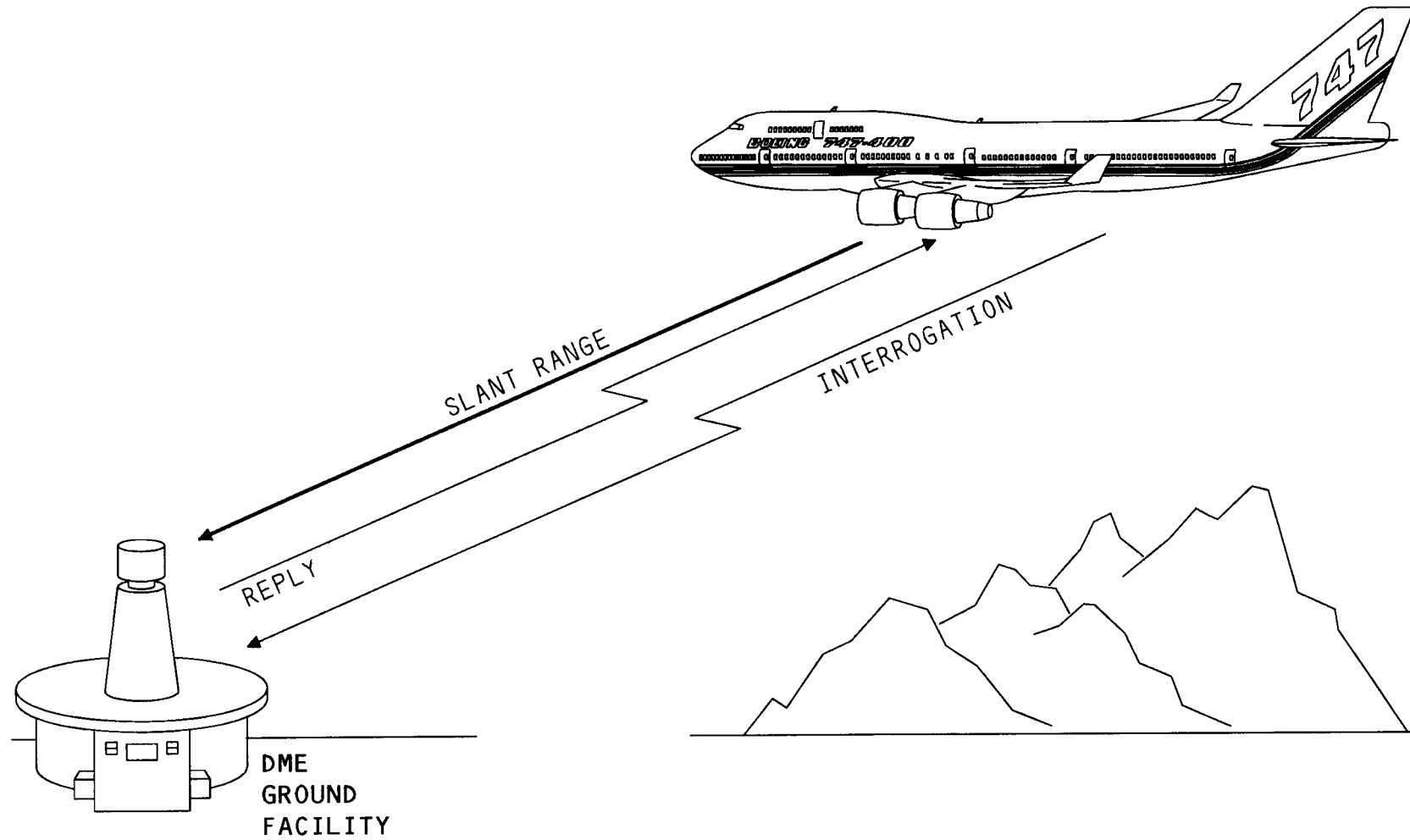


Figure 1 DME INTRODUCTION

**DME****DME - SYSTEM****General**

The purpose of the distance measuring equipment (DME) system is to measure the slant distance from the airplane to selected DME ground stations. The DME system computes slant distance using the time a signal takes to go from the airplane to a ground station and back. The DME interrogators transmit DME rf interrogations through the antennas to the ground stations. The interrogator receives the ground returns through the same antennas.

DME Tuning

DME tuning is automatic or manual. The FMCS do automatic tuning, and the CDUs do manual tuning.

DME Interfaces DME Outputs go to:

- The EFIS/EICAS interface units (EIUs)
- The FMCS
- The audio management unit (AMU) - The air traffic control (ATC) - TCAS
- The central maintenance computer (CMC) commands a DME ground test.

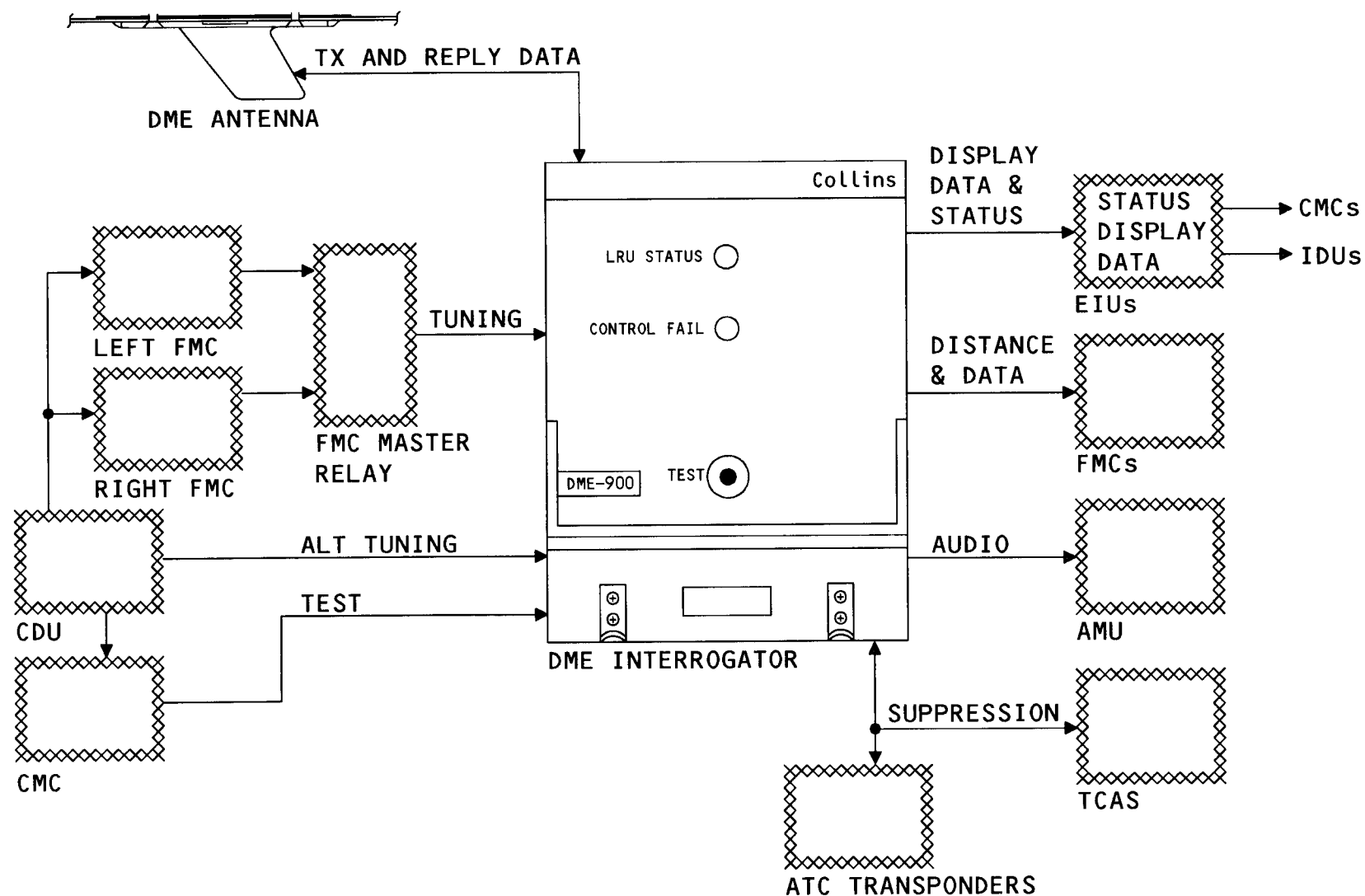


Figure 2 DME SYSTEM

DME



COMPONENT LOCATIONS - FLIGHT DECK

The following DME System components are located in the flight deck:

- Left DME circuit breaker
- Right DME circuit breaker.

The following components of interfacing systems are located in the flight deck:

- Left outboard integrated display unit (IDU)
- Left inboard IDU
- Right outboard IDU
- Right inboard IDU.

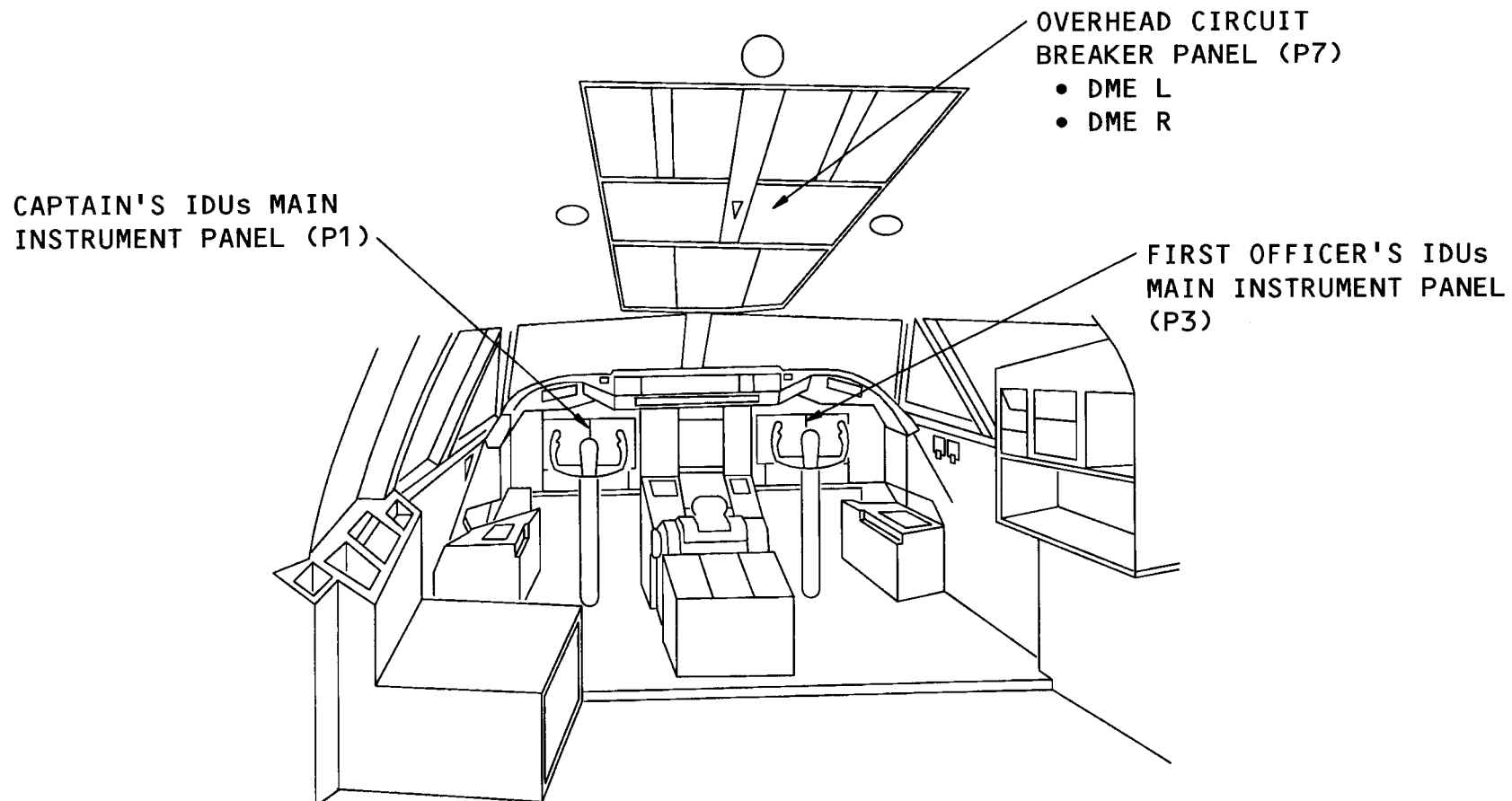


Figure 3 COMPONENT LOCATION - FLIGHT DECK

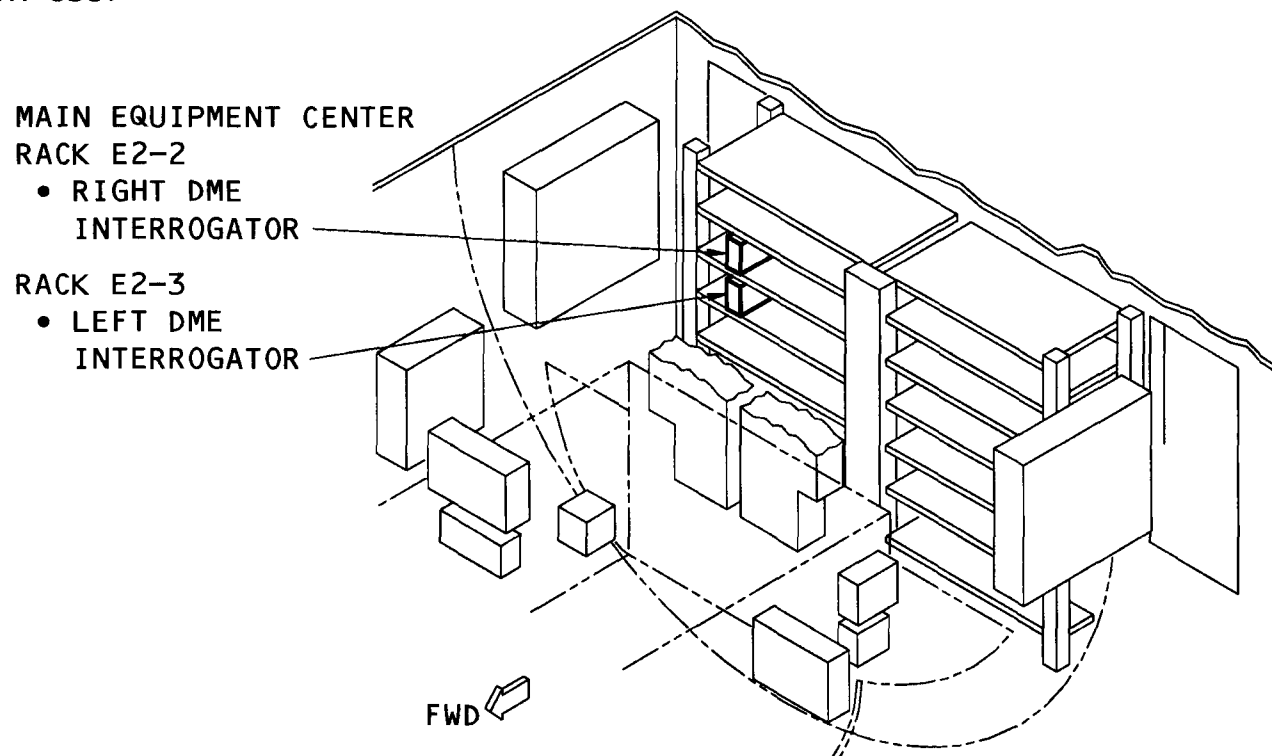
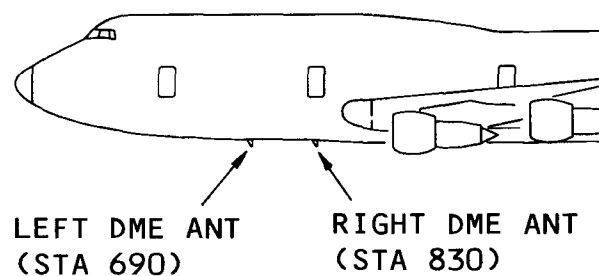
DME



COMPONENT LOCATIONS

The following components are located in the main equipment center and on the exterior of the airplane:

- Left DME interrogator
- Right DME interrogator
- Left DME antenna
- Right DME antenna

DME**Figure 4 COMPONENT LOCATION MEC**

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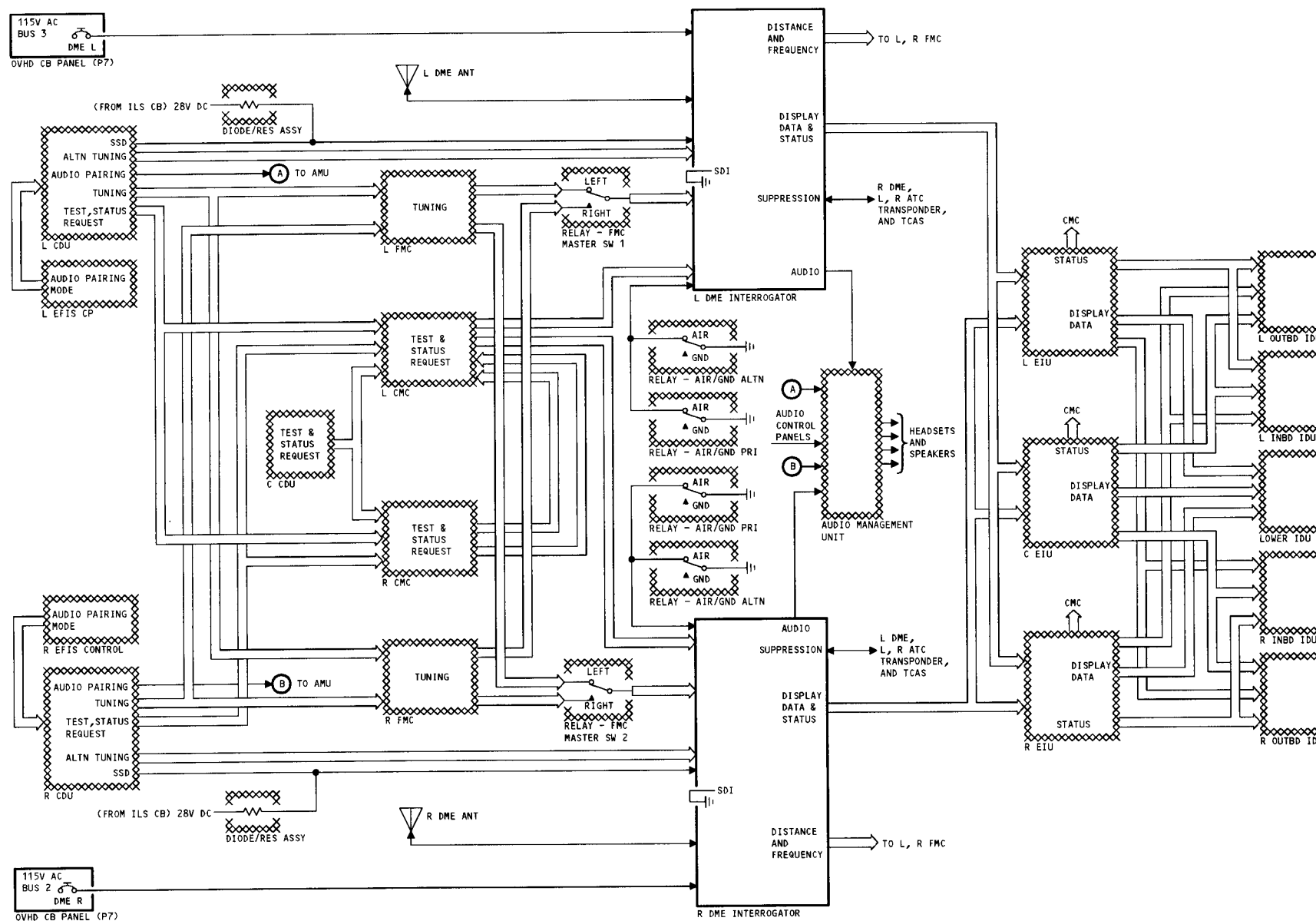


Figure 5 DME INTERFACE DIAGRAM



DME

POWER AND DATA

Each DME interrogator receives 115v ac from its circuit breaker.

DME Distance Computation

The DME interrogator sends interrogation pulse-pairs to the DME antenna. The DME antenna sends them to the ground station. The ground station sends them back to the airplane after a 50-microsecond delay. The same DME antenna receives the returns and sends them to the DME interrogator.

The DME interrogator computes the slant distance from the round-trip time of the pulse pairs.

DME Data Display

The DME interrogators send the computed DME distance and the DME identifier to the EFIS/EICAS interface units (EIUs) for display on the navigation displays (NDs) and the primary flight displays (PFDs).

DME data is always paired with the onside VOR data and/or the instrument landing system (ILS) data.

FMC Interface

The FMCs use DME data for position update. In normal operation, the left FMC uses left DME data and the right FMC uses right DME data. If a DME fails, the FMCs will use the offside DME data.

DME

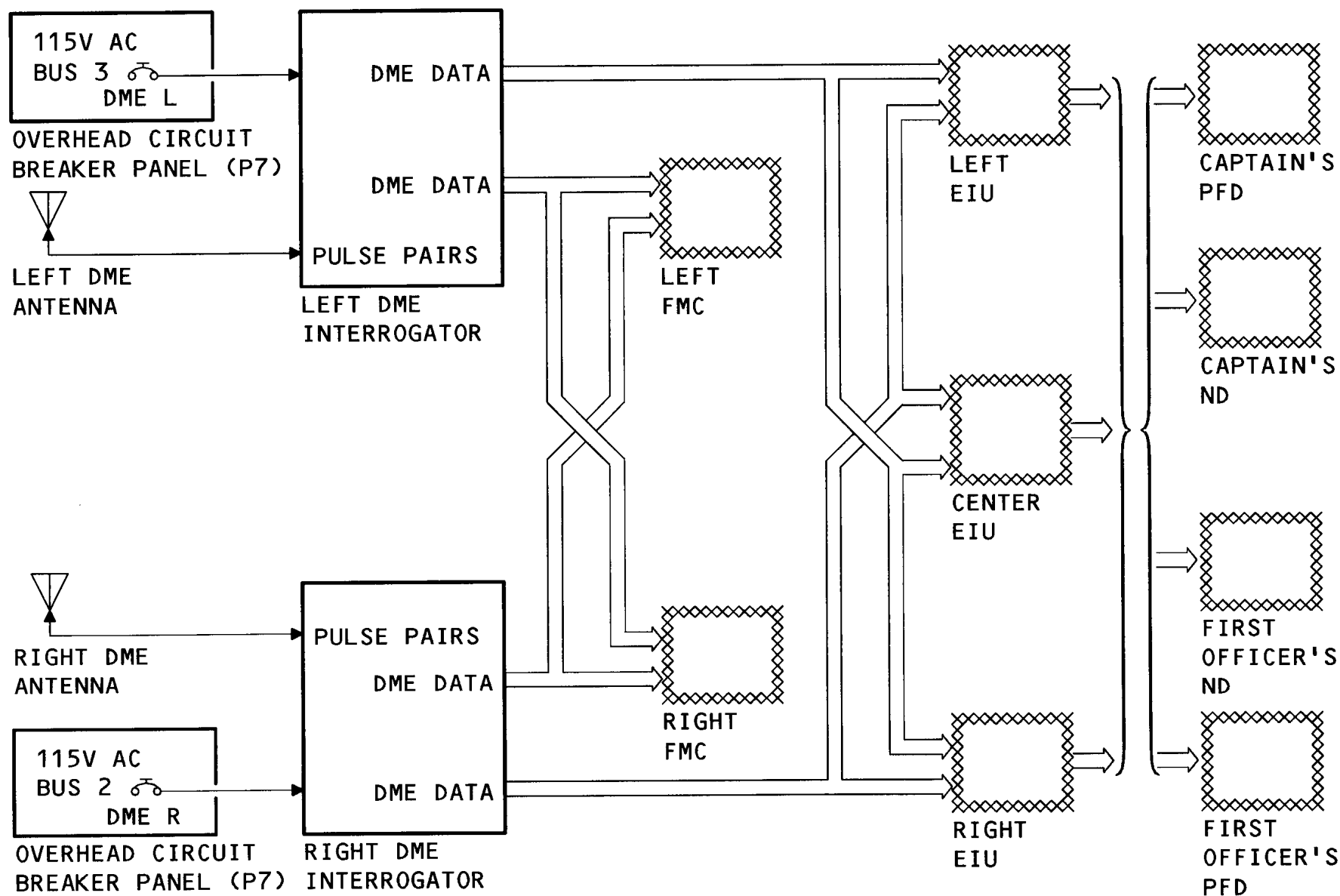


Figure 6 POWER AND DATA



DME

TUNING

General

Tuning is automatic or manual. Automatic tuning is done by the FMCs. Manual tuning is done from the CDU through an FMC or directly from the CDU.

Automatic Tuning

The master FMC provides automatic tuning data to port B of both DME interrogators. The master FMC is determined by the FMC master switch.

Manual Tuning

Manually selected frequencies come to the DME interrogator on port B through the master FMC.

Alternate Tuning

If the master FMC has failed in the air or if both FMCs have failed on the ground, the frequencies come directly from the CDUs through port A.

The source-select discrete (SSD) from the CDU determines if tuning data is used from port A or port B in the DME interrogator.

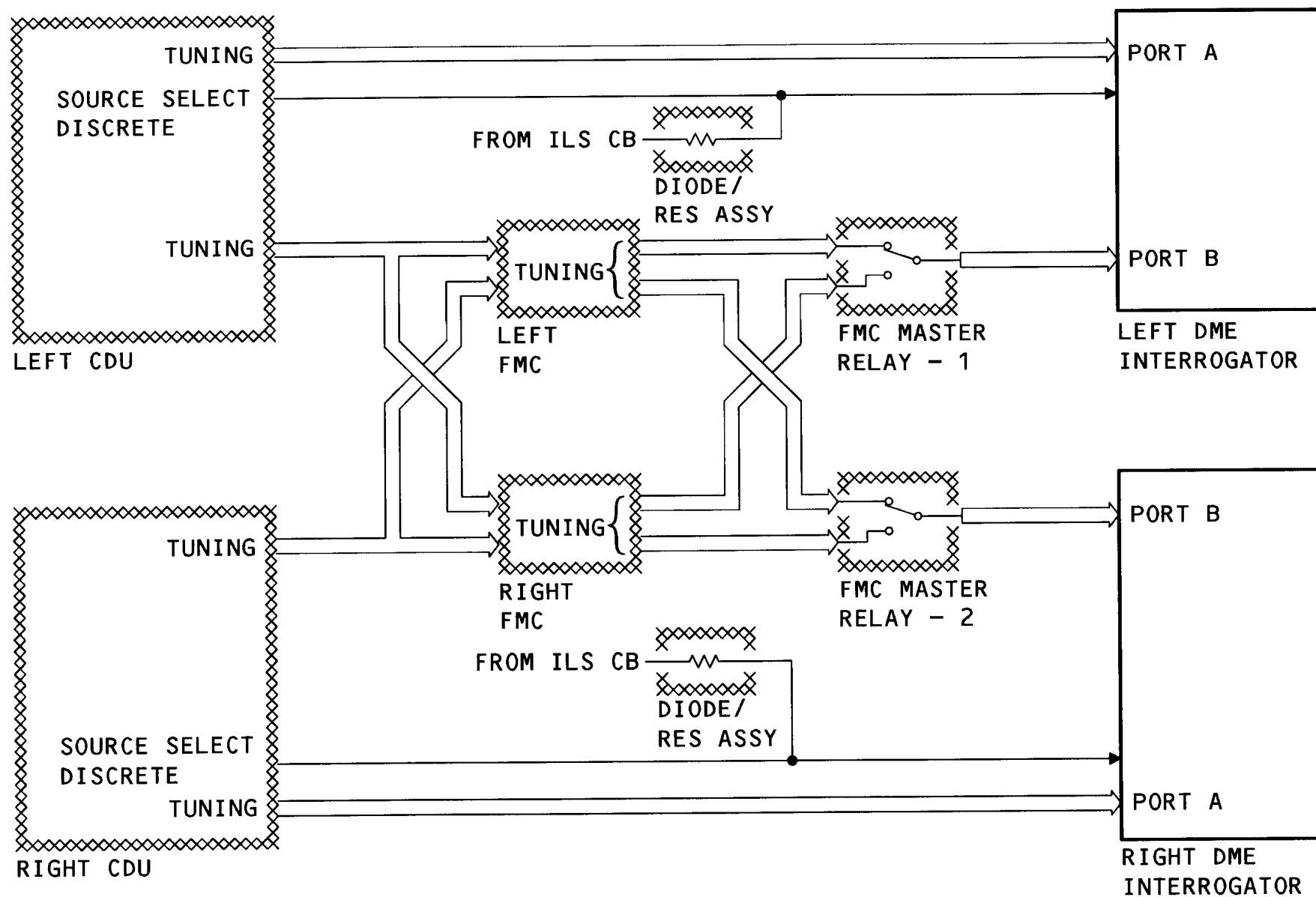


Figure 7 TUNING

DME



AUDIO

When tuned to a station, the DME interrogator sends the audio identifier of the station to the audio management unit (AMU). The AMU sends the audio to the headsets and the cockpit speakers. An audio pairing discrete from the onside CDU allows pairing of this identifier with either a VOR audio identifier or an ILS audio identifier. If the EFIS approach mode is selected, the DME audio is paired with an ILS audio identifier. In all other EFIS modes the DME audio is paired with a VOR audio identifier.

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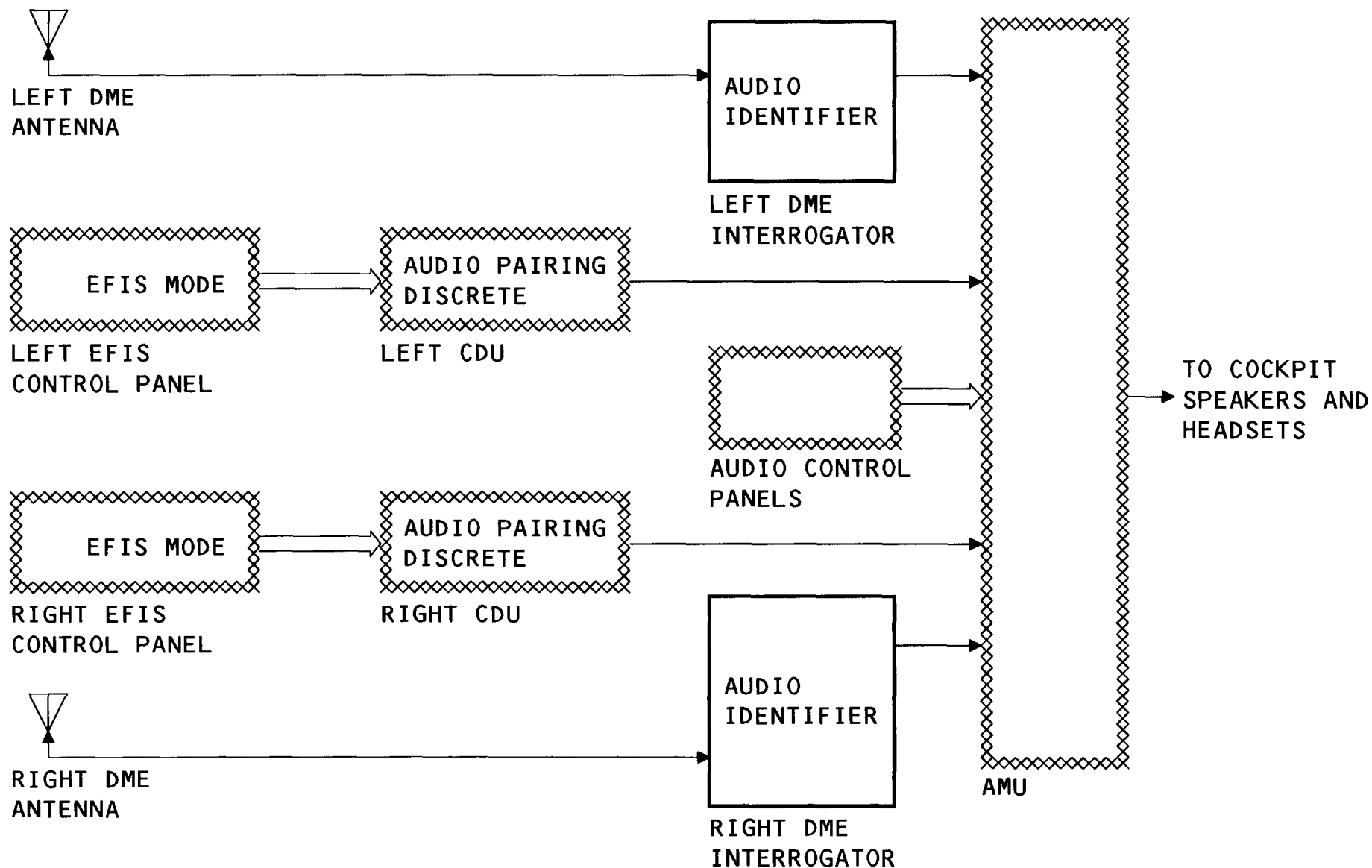


Figure 8 AUDIO

DME



SUPPRESSION

The DME system, the ATC system, and the TCAS system operate in the Same frequency band.

When either DME interrogator, ATC transponder, or TCAS interrogator transmits, it sends a suppression pulse to the other units. This suppression pulse inhibits reception in the other units, to prevent damage to the receiver circuits.

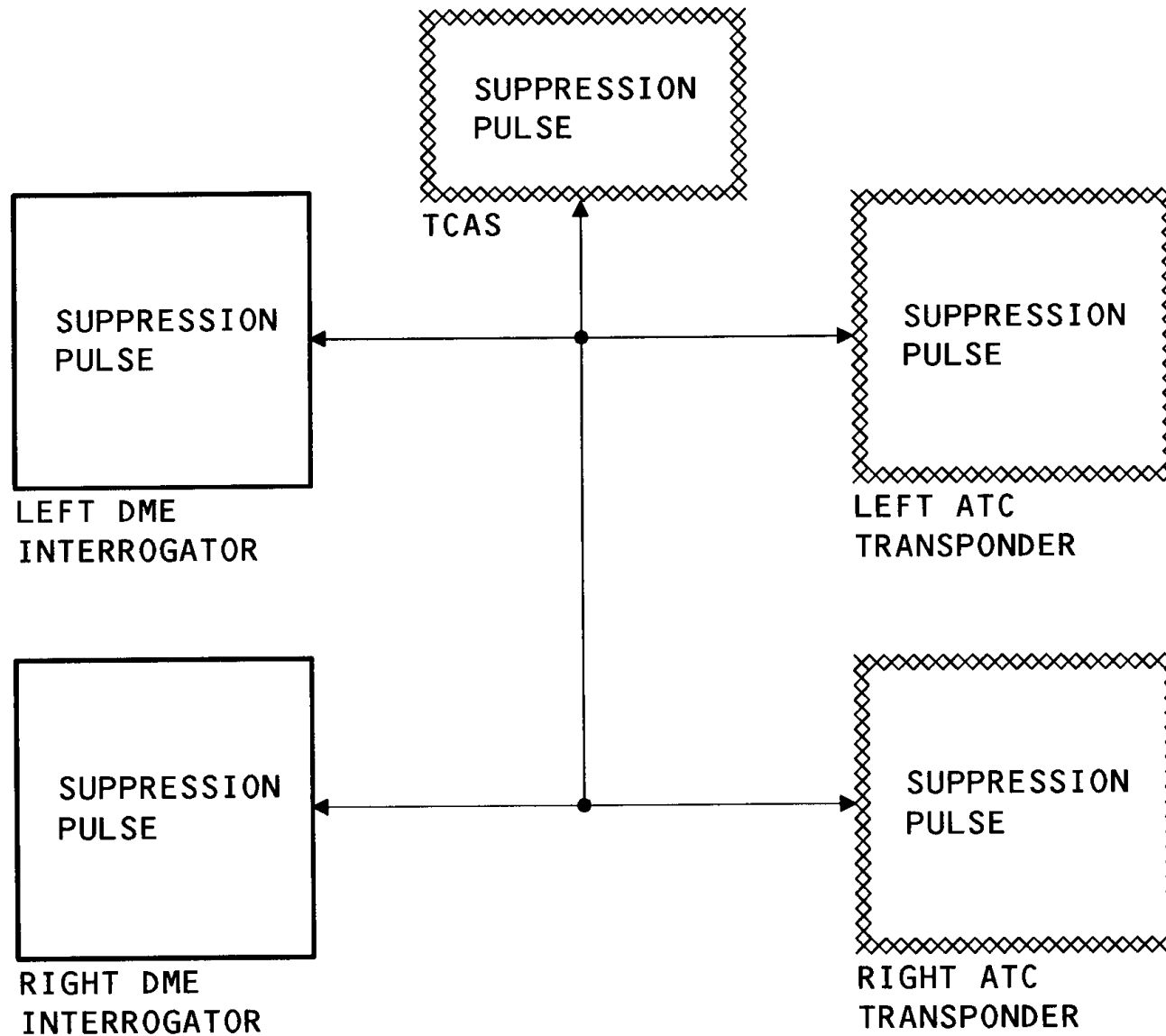


Figure 9 SUPPRESSION

DME



TEST AND STATUS

CMC Function

The CMCs request ground tests and receive status data. When the left CMC fails, the right CMC performs the CMC functions.

Ground Test

The active CMC initiates a ground test of the selected DME when any one of the three CDUs requests it. The DMEs send the test results to the CMCs through the EFIS/EICAS interface units (EIUs). The CMCs send the ground test results to the CDUs for display.

Status Information

The DME interrogators continuously send their status information to the CMCs through the EIUs.

Flight Legs

For the DME interrogator nonvolatile memory fault recording, the air/ground relays define flight legs.

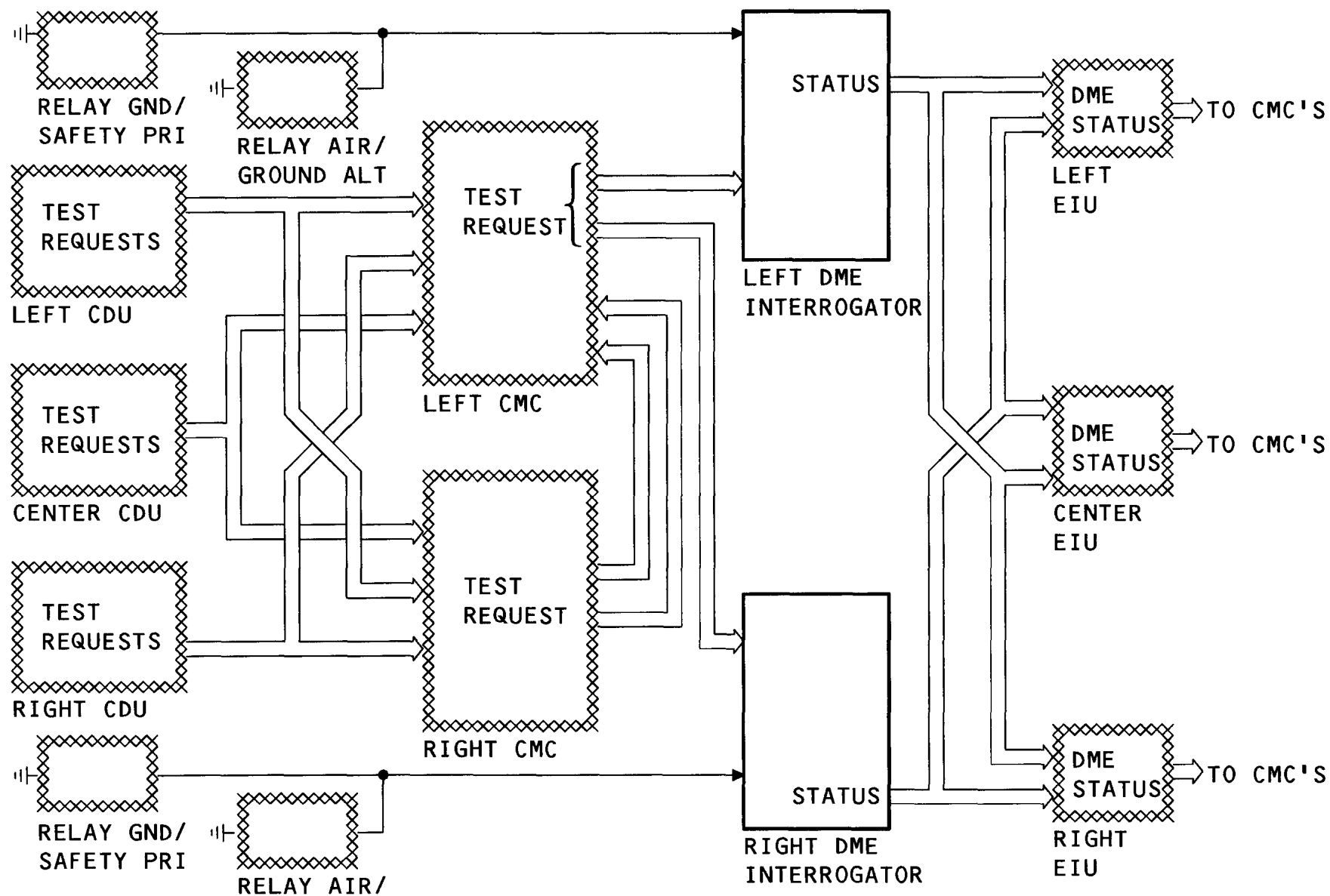


Figure 10 TEST AND STATUS



DME

DME INTERROGATOR

Purpose

The purpose of the DME interrogator is to:

- Interrogate DME stations - Receive the replies
- Compute distances up to 320 nm
- Send computed distances and audio identifiers to user systems

Frequencies

The DME interrogator uses these frequencies in the L band:

- Transmit: 1025 to 1150 MHz - Receive: 962 to 1215 MHz

The DME is tuned with a paired VOR or ILS frequency from the FMCs or the CDUs.

These DME tuning frequencies are in the VHF band:

- Paired VOR or ILS frequencies: 108.00 to 117.95 MHz
- Unpaired frequencies: 133.30 to 135.95 MHz

Front Panel

The front panel of the DME interrogator has these features:

- A self-test switch
- LED status indicators

The status indicators come on only when a test is started by the self-test switch.

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.

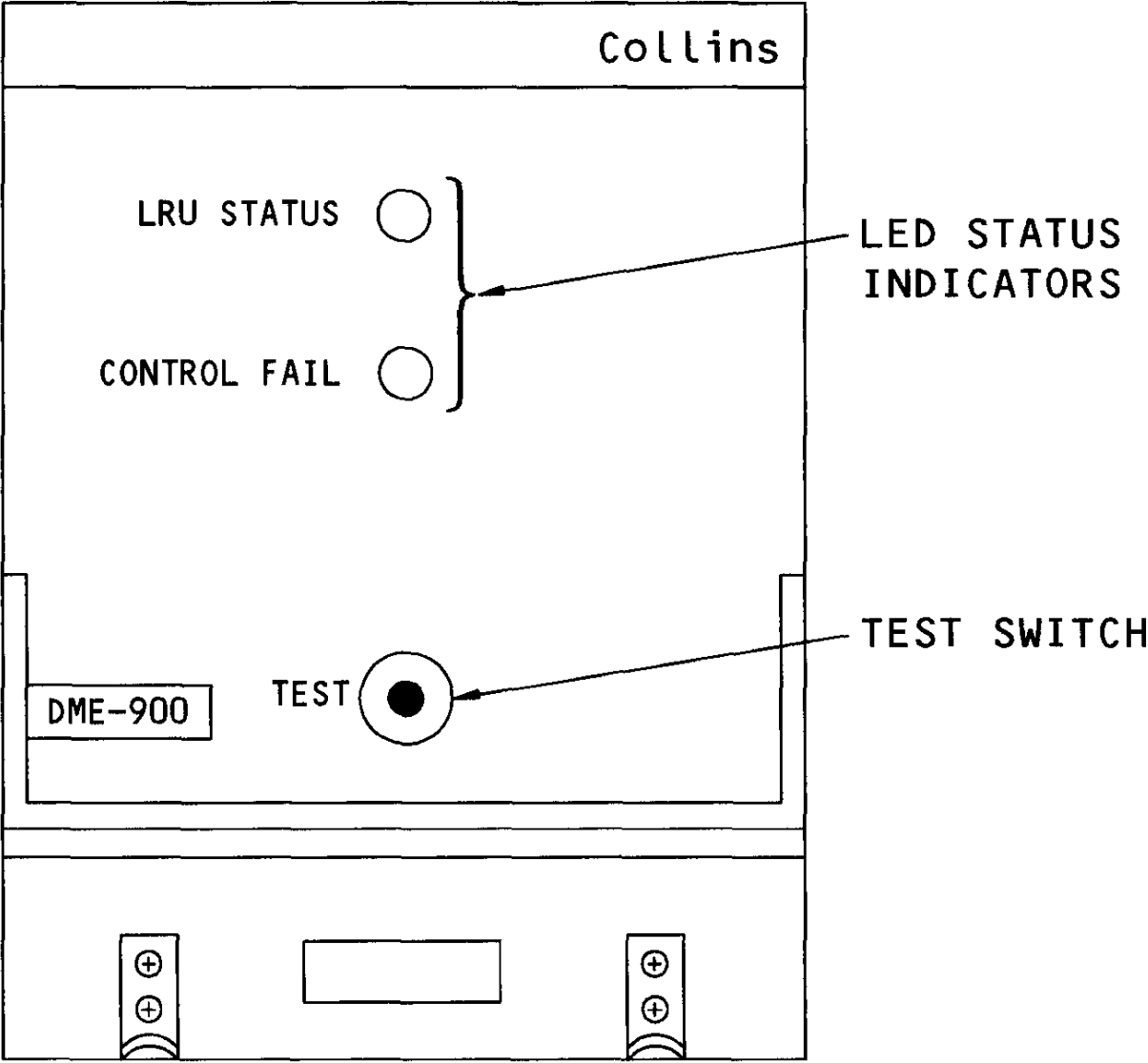


Figure 11 DME INTEROGATOR (COLLINS DME-900)



DME

DME ANTENNA

General

The DME L-band blade antenna transmits the interrogator output signals and receives the ground station reply signals.

Moisture Guard

A moisture guard keeps moisture from the antenna/connector interface. It is a standpipe/sleeve assembly that is riveted to the fuselage skin.

DME Antenna/ATC Antenna Commonality

The DME antennas and the ATC antennas have the same part number and can be interchanged with each other.

DME Antenna Removal

WARNING: EXTRA FORCE ON ANTENNA BASE MAY BE REQUIRED TO BREAK WEATHERPROOFING SEAL. TO PREVENT DAMAGE TO AIRPLANE SKIN OR ELECTRICAL CABLE AT ANTENNA BASE, CAREFULLY PRY AROUND THE ANTENNA WITH SEALANT REMOVAL TOOL.

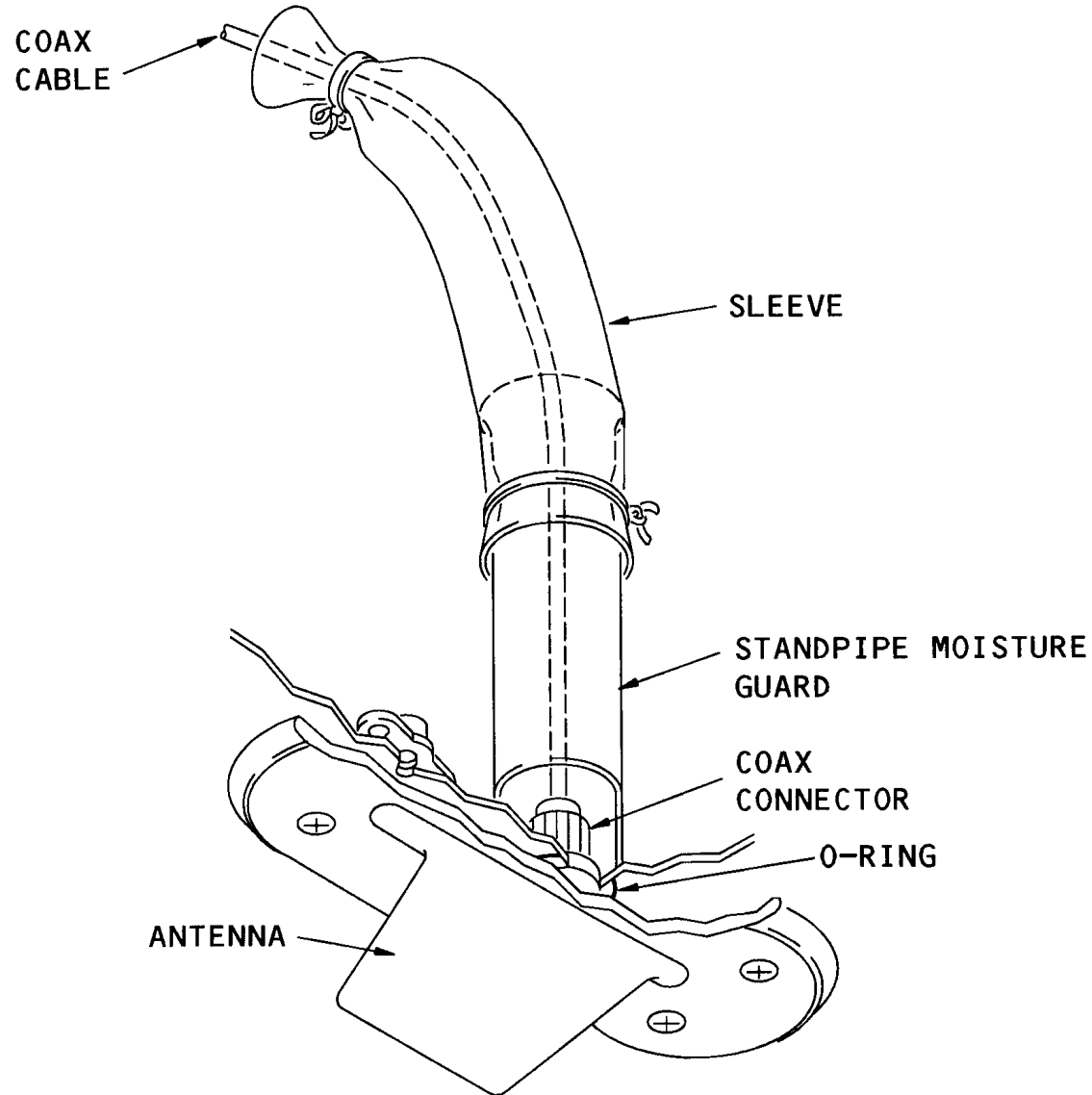


Figure 12 ANTENNA

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CDU TUNING DISPLAY

General

The CDU's NAV RADIO page functions are to:

- - Display tuning information for the Nav radios
- - Manually tune the navigation radios

The master FMC tunes the DME interrogators. In autotune, the FMC selects the stations and sends the tuning commands to both DME interrogators.

In manual tune, commands start in either CDU. The CDU sends these commands to both FMCs. The master FMC tunes both DME interrogators.

NAV RADIO Page

The NAV RADIO page Shows navigation radio tuning data. To Show this page, push the NAV RAD key an the CDU.

VOR Tuning Display

The VOR/DME frequency and identifier are shown an the CDU. The letters A, M, R, or P identify the tuning mode. If an autotuned DME Station has no VOR station paired with it, the frequency, mode, and identifier are replaced with six dashes.

To tune a station manually, enter its frequency or identifier an the line below VOR L for the left VOR, or VOR R for the right VOR.

When the delete function of the CDU is applied to a manually tuned VOR/DME, the tuning returns to the autotune mode.

DME Channel Allocation

The VOR or ILS frequency causes the DME to automatically select a ground station. There are 200 DME channels paired with the VHF NAV frequencies. The other 52 channels are unpaired and normally used for Military TACAN facilities. The DME receive frequency is 63 mHz above or below the transmit frequency.

FMC - Controlled Tuning

The DME interrogators scan 252 channels and calculate distance information for all channels in the DME range. The master FMC requests distance information from one to five stations (channels). Channels one and two are reserved for autotuned stations used for navigation updating. Channels three and four are used for:

- Manually tuned stations (M)
- Route tuned stations (R)
- Procedure tuned stations (P)
- Other autotuned stations the FMC desires to use for updating or for check against channels one and two

Channel five is used for DME stations paired with the ILS station used an approach.

ILS/DME Tuning

Under certain conditions, the master FMC autotunes channels of both DME interrogators to an ILS/DME frequency. ILS/DME tuning is independent of VOR/DME tuning.

Manual selection of a different station overrides the autotuned station.

An annunciation of A for autotuning, or M for manual tuning appears after the ILS runway heading.

When the delete function of the CDU is applied to a manually tuned ILS/DME, it causes the tuning to return to the autotune mode.

**DME****ILS/DME Tuning Data Display**

The ILS/DME tuning data on the ILS/MLS line Shows as follows:

- PARK Shows when the airplane is not within 200 nmi of the top-of-descent and is not past the halfway point of the active route (whichever is closer to the destination).
- A caret followed by the ILS frequency, selected runway heading, and the word PARK when there is an active flight plan, and the airplane is within 200 nmi of the top of descent or past the halfway point of the active route (whichever is closer to the destination). The active FMC does not tune ILS or DME at this point.
- ILS frequency and selected runway heading. An A Shows after the runway heading to announce autotune. An ILS autotune occurs when the airplane is within 50 nm of top of descent or when within 150 nm direct distance to the runway (whichever distance is greater), or when active in descent mode.

Pre-Select

This function provides easy access storage to allow entries on this page. To preselect a station, enter the tuning data into the respective preselect line position. To tune, line select the information into the proper line position. The CDU delete function clears the preselect line and the prompt dashes appear.

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DME CHANNEL NUMBER	TX DME A TO G (MHz)	RX DME G TO A (MHz)	VHF (MHz)
37X	1061	998	110.00
37Y	1061	1124	110.05
38X	1062	999	110.10
38Y	1062	1125	110.15

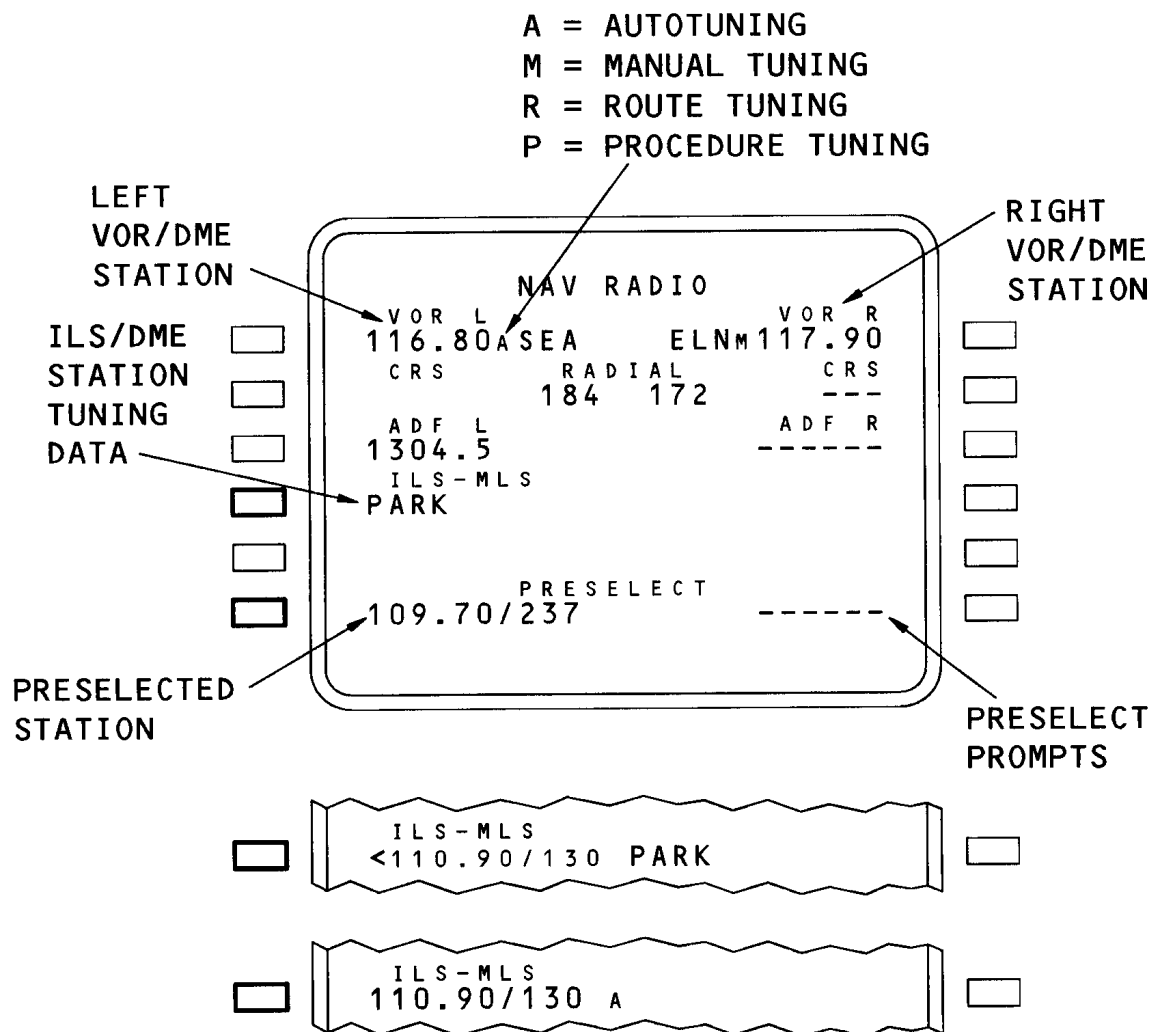
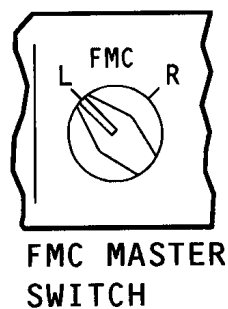
DME INTERROGATOR LOOKUP TABLE
(PARTIAL)

Figure 13 CDU TUNING DISPLAY

DME



ALTERNATE CDU TUNING

General

The purpose of alternate CDU tuning is to allow manual navigation radio tuning when both FMCs have failed on the ground or the master FMC has failed airborne.

Tuning

The manual tuning commands start in the left and right CDUs. From the CDUs, the tuning commands go to the onside DME interrogators.

ALTN NAV RADIO Page

On the CDUs, the ALTN NAV RADIO page is used to enter the tuning data. To show this page, push the NAV RAD key on the CDU. The NAV RAD key causes the ALTN NAV RADIO page to be shown in place of the NAV RADIO page.

VOR/DME Tuning

For VOR/DME tuning, enter the frequency of the VOR/DME station. The VOR/DME will remain tuned to the last

FMC-supplied frequency until a new frequency is entered. The letter M shows manual tuning.

ILS/DME Tuning

For ILS/DME tuning, enter the frequency and course of the ILS/DME station. The ILS/DME will remain tuned to the last FMC-supplied frequency until a new frequency is entered. The display will show PARK if no ILS station was tuned.

Pre-Select

This function provides storage to allow entries on this page. To pre-select a station, enter the tuning data into the respective pre-select line position. To tune, line select the information into the proper line position. The CDU delete-function clears the pre-select line and the prompt dashes appear again.

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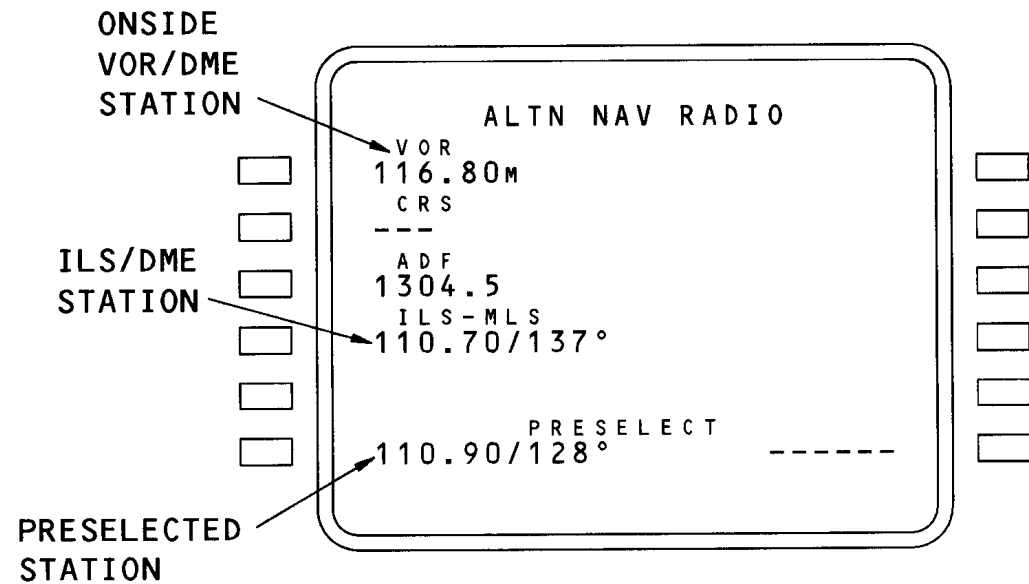
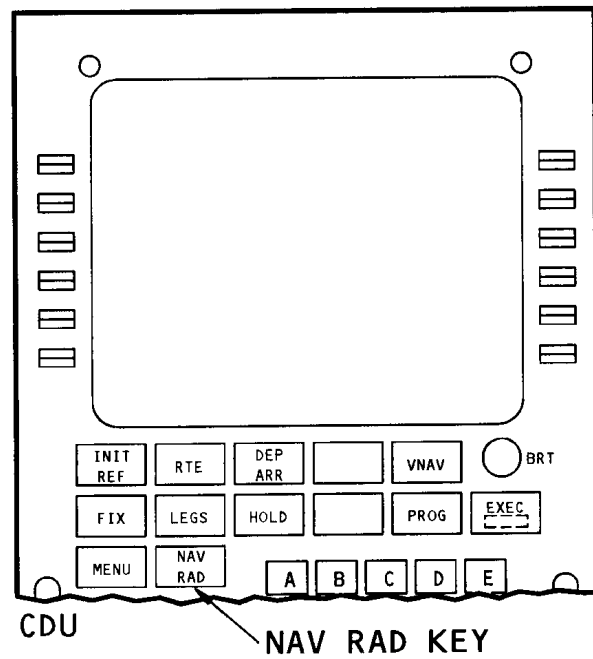
**NOTE: ONSIDE TUNING ONLY**

Figure 14 ALTERNATE CDU TUNING

DME



AUDIO CONTROL

The DME audio identifier is transmitted over the flight interphone system, and is paired with a VOR or an ILS audio identifier.

EFIS mode selection determines the pairing. In approach mode, the DME audio identifier is paired with an ILS audio identifier. If not in the approach mode, the DME audio identifier is paired with a VOR identifier.

To hear a VOR/DME-paired identifier, use the associated left or right VOR receiver controls. To hear an ILS/DME-paired identifier, use the associated left or right approach receiver controls. The center ILS audio identifier is never paired with a DME audio identifier.

The DME identifier is heard at 1350 Hz following every third or fourth ILS/VOR identifier (heard at 1020 Hz).

The filter selector must be in range (R), or both (B) to hear DME audio.

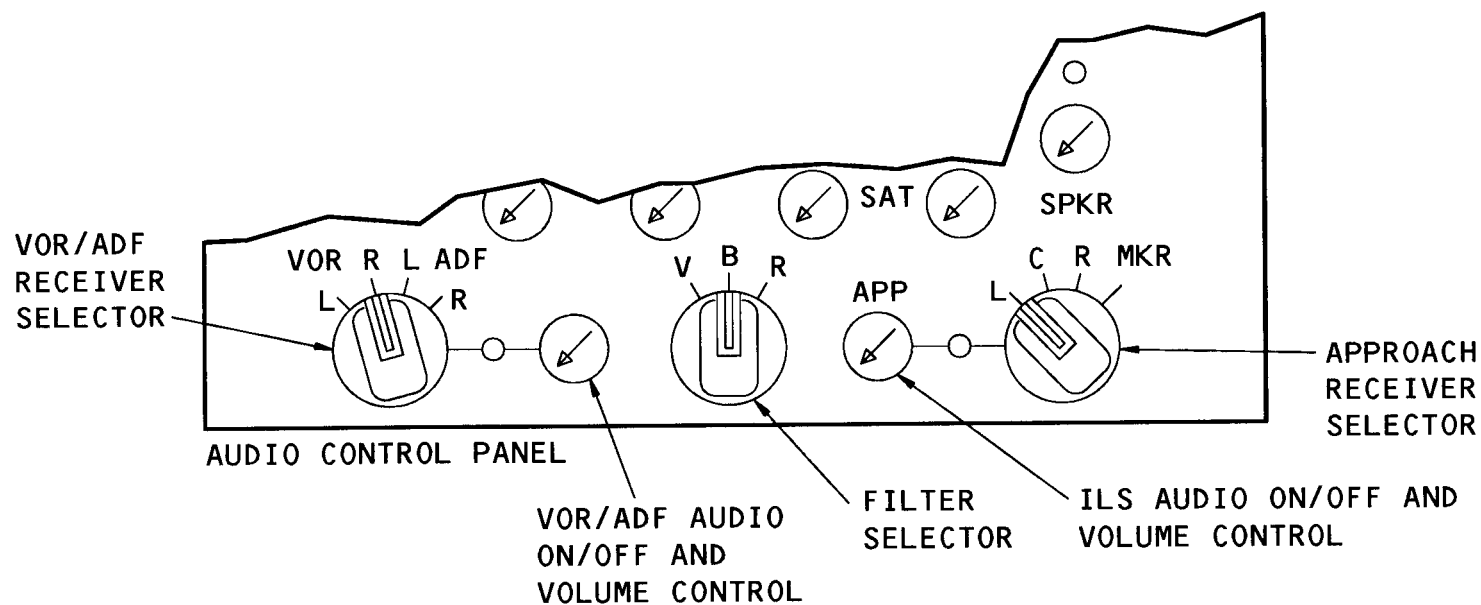


Figure 15 AUDIO CONTROL



DME

DME - PFD DISPLAY

General

The Primary Flight Display (PFD) Shows the ILS DME distance when:

- The onside DME is tuned to a paired ILS frequency.
- The onside DME distance is valid.

The left PFD Shows left DME data. The right PFD Shows right DME data.

Distance Display

For DME distances less than 99.95 nm, the distance is shown in tenths of an nm. For DME distances of 100 nm or greater, the distance is shown to the nearest nm.

NCD and Invalid Displays

Dashes replace digits when the DME distance is no computed data (NCD). A blank for the DME distance display Shows there is DME data that is invalid.

DME



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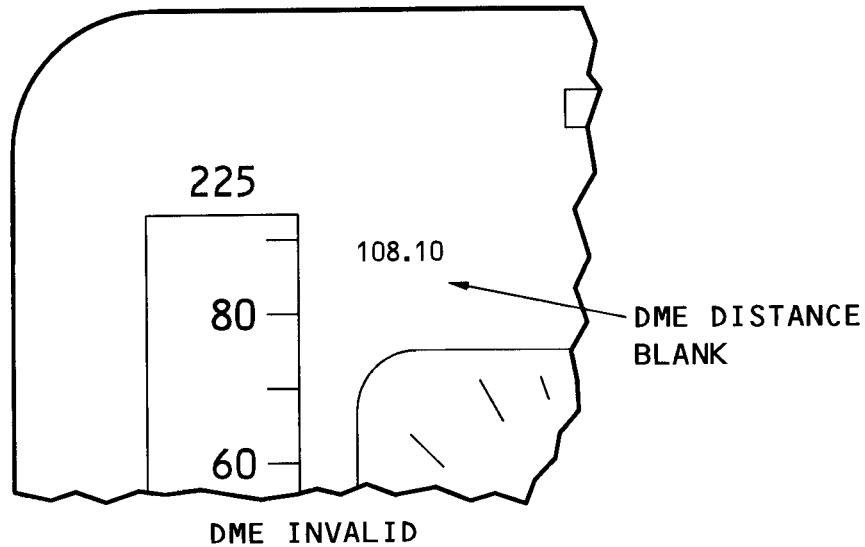
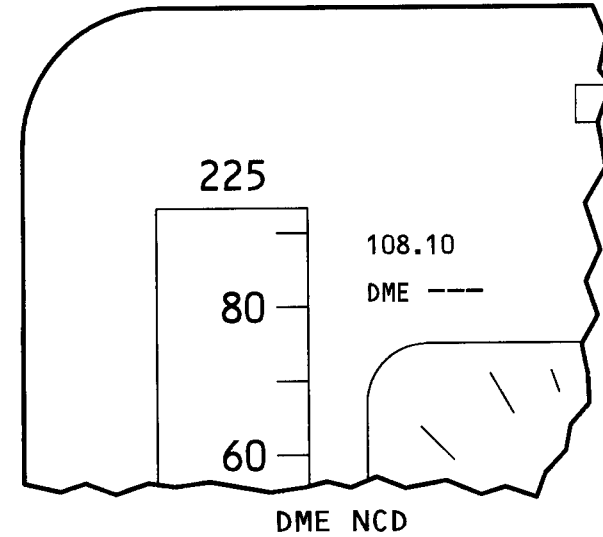
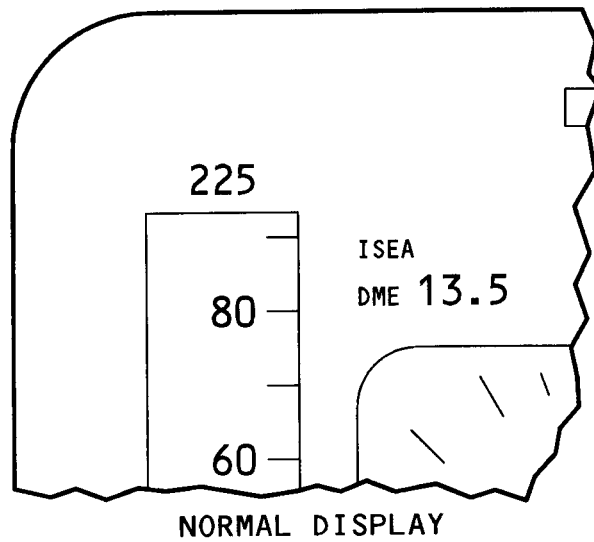


Figure 16 PFD DISPLAY

DME



ND MAP MODE DISPLAY

General

With the map mode selected on the EFIS control panel mode selector and the raw data switches Set to VOR, the ND Shows left and right VOR/DME stations when:

- The DME is tuned to a paired VOR frequency.
- The DME distance is valid.

Distance Display

For DME distances less than 99.95 nm the distance is shown in tenths of an nm. For DME distances of 100 nm or greater, the distance shown is to the nearest nm.

NCD and Invalid Displays

Dashes replace digits when the DME distance is NCD. A DME fail flag Shows when DME data is invalid.

Non-Normal Displays

DME station identifiers and distance can be shown in small font in the event of VOR failures only.

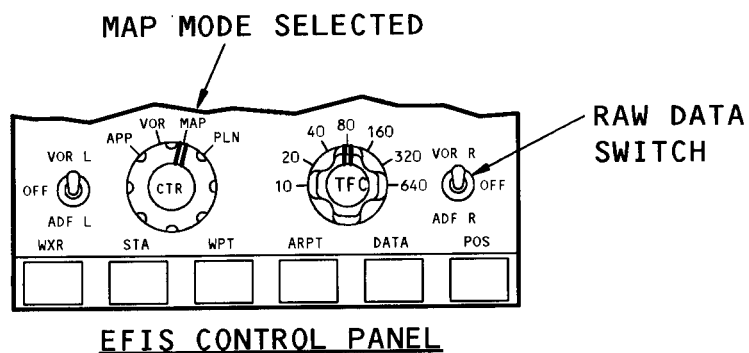
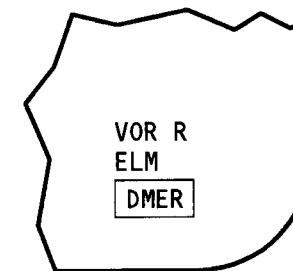
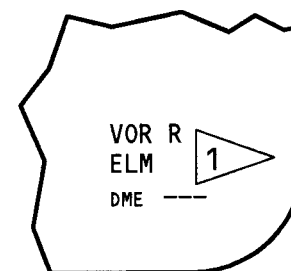
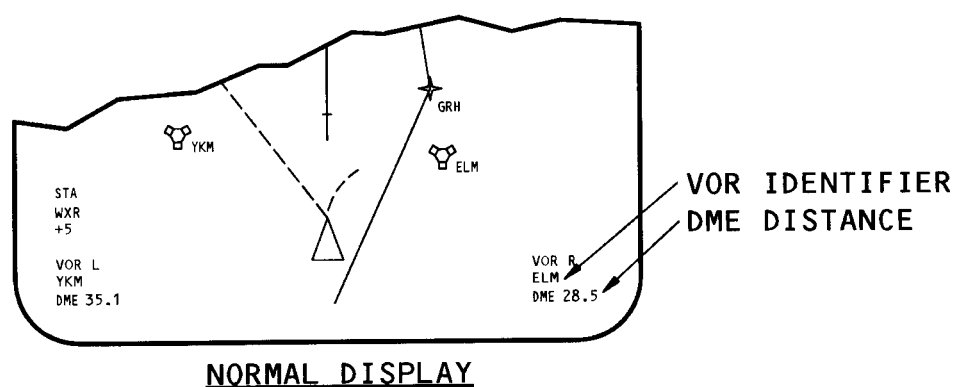
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**NON-NORMAL IDENTIFIER DISPLAYS**

- VOR ID FAILED - SHOW DME ID IN SMALL FONT
- DME ID FAILED - SHOW VOR FREQ
- VOR FREQ FAILED - SHOW DME FREQ IN SMALL FONT
- IF ALL FAILED - BLANK

NOTE: IN CENTER MAP MODE
THE DISPLAY IS THE SAME.

Figure 17 ND MAP MODE DISPLAY



DME

ND VOR MODE DISPLAY

General

With VOR selected on the EFIS control panel mode selector and the raw data switches Set to VOR, the ND shows VOR/DME stations in full rose VOR or in expanded VOR modes. It shows DME distance when the onside DME is tuned to a paired VOR frequency, and the onside DME distance is valid.

The left ND shows left DME distance. The right ND shows right DME distance. For the left and right corner information DME data is always paired with the onside VOR.

Distance Display

For DME distances less than 99.95 nm the distance is shown in tenths of an nm. For DME distances of 100 nm or greater, the distance shown is to the nearest nm.

NCD and Invalid Displays

Dashes take the place of digits, when the DME distance is NCD. A fail flag shows when DME data is invalid.

Non-Normal Displays

DME Station identifiers and distance can be shown in small font in the event of VOR failures.

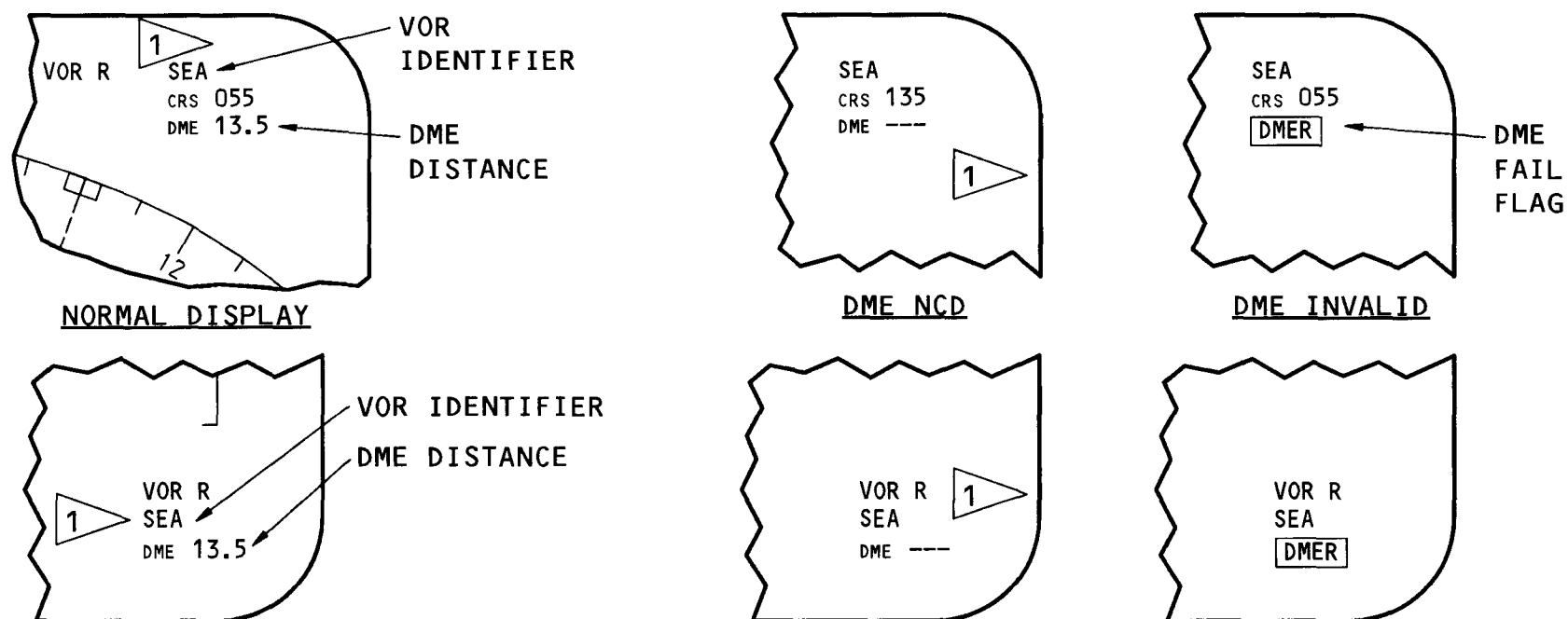
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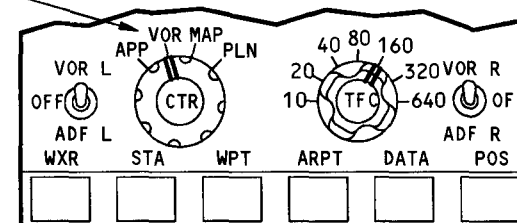
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**NON-NORMAL DISPLAYS**

- VOR ID FAILED - SHOW DME ID IN SMALL FONT
- DME ID FAILED - SHOW VOR FREQ
- VOR FREQ FAILED - SHOW DME FREQ IN SMALL FONT
- DME FREQ FAILED - FAIL FLAG

VOR MODE
SELECTED**EFIS CONTROL PANEL****Figure 18 ND VOR MODE DISPLAY**



DME

ND APPROACH MODE DISPLAY

General

With approach selected on the EFIS control panel mode selector, the ND shows ILS/DME stations in full rose approach or in expanded approach modes.

It shows DME distance when:

- The onside DME is tuned to an ILS frequency.
- The onside DME distance is valid.

The left ND shows left DME distance. The right ND shows right DME distance.

Distance Display

For DME distances less than 99.95 nm the distance is shown in tenths of an nm. For DME distances of 100 nm or greater, the distance is to the nearest one nm.

NCD and Invalid Displays

Dashes replace digits when the DME distance is NCD. A fail flag shows when DME data is invalid.

Raw Data

Raw data is available in the approach mode also.

DME

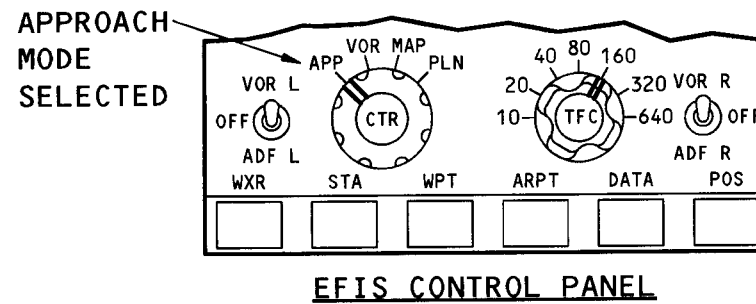
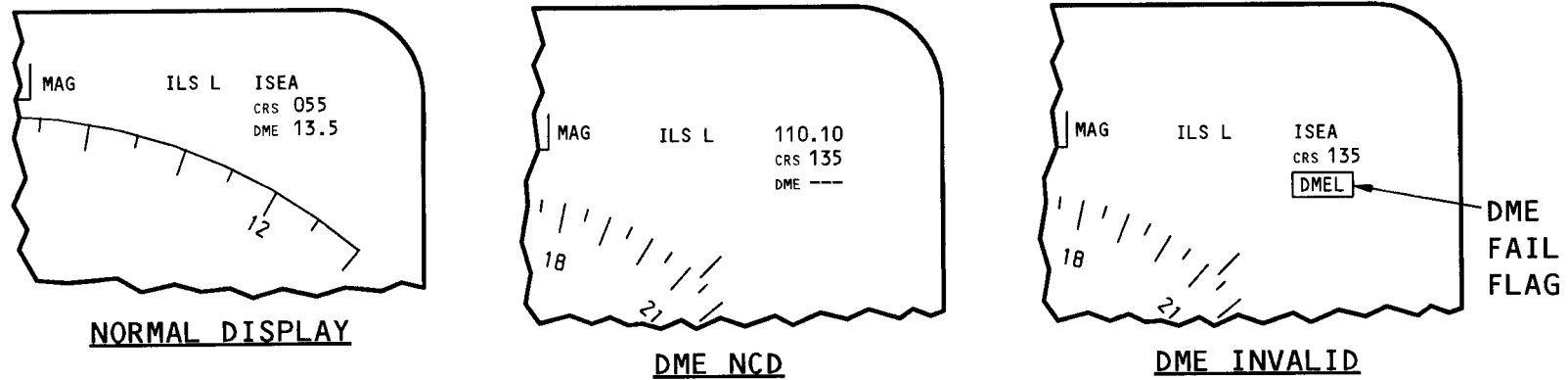


Figure 19 ND APPROACH MODE DISPLAY

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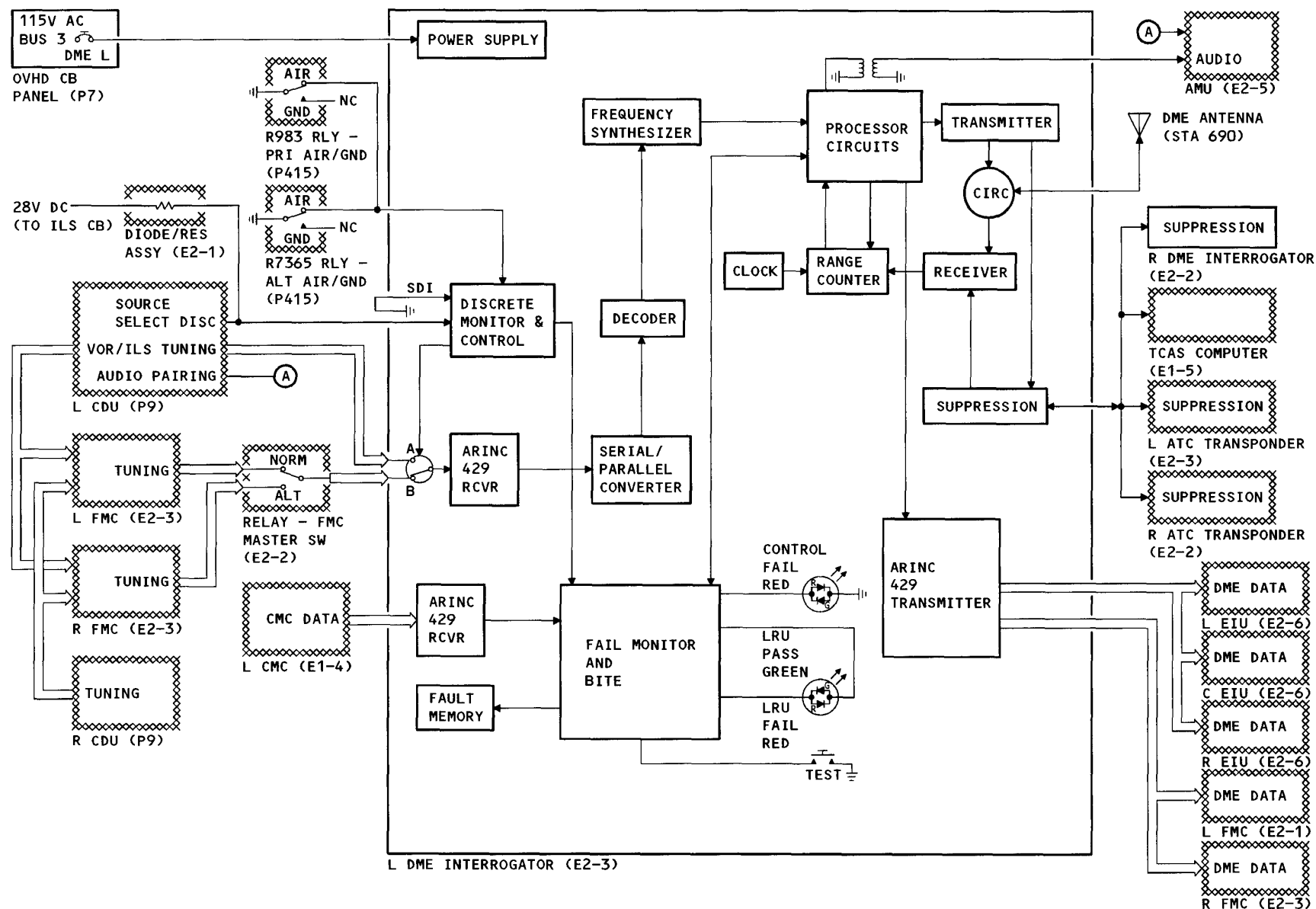


Figure 20 DME SCHEMATIC DIAGRAM

DME



OPERATION

Frequency Sources

The DME interrogator receives tuning data at input ports A or B. The tuning data from the FMCs is received through port B. The tuning data from the CDUs is received through port A.

Frequency Source Selection

Frequencies entered at the CDUs go either directly, or through the FMCs to the DME interrogator. The tuning data that comes from the FMCs is either an FMC-selected autotune frequency or a frequency that is manually selected at the CDUs.

A tuning source discrete from the CDUs determines whether the DME interrogator will use port A or port B input. Port B is the normal port. Port A is used if the master FMC fails in the air or both FMCs fail on the ground.

Bias for the SSD is provided by 28V DC from the ILS CB through a diode/resistor network.

Master FMC

The tuning frequencies that enter the DME interrogator at input port B come from the master FMC. The FMC master switch determines which FMC is the master.

DME Distance Computation

In the DME interrogator, the frequency is changed to parallel and sent to the frequency synthesizer.

A processor controls the format of the interrogations sent to the ground station by the transmitter. It also sends a signal to the range counter which records the time of the transmission. The transmitter sends the interrogations through the circulator to the antenna. The circulator isolates the transmitter from the receiver.

The antenna receives the return signals and sends them through the circulator and the receiver to the range counter. With a clock input, the range counter determines the time between transmission and reception. This time is the basis for the DME distance computation.

The processor sends the computed DME distance to the FMCs and the EIUs.

Identifier

The processor separates the DME station audio identifier from the received returns and sends it through an output transformer to the audio management unit (AMU). The frequency of the DME identifier is 1350 Hz.

The processor also decodes the DME station identifier and transmits the resulting station identifier in digital format to the FMCs for station confirmation and to the EIUs for display.

Suppression

A suppression network connects both DME interrogators, both ATC transponders, and TCAS. When one of these units transmits, a pulse from this unit inhibits its reception in the other units.

Program Pins

Program pins (SDI) determine whether the DME interrogator is a left or a right unit.

Air Ground Relay

An input from the air/ground relays inhibits test in the air and provides a way to count flight legs.

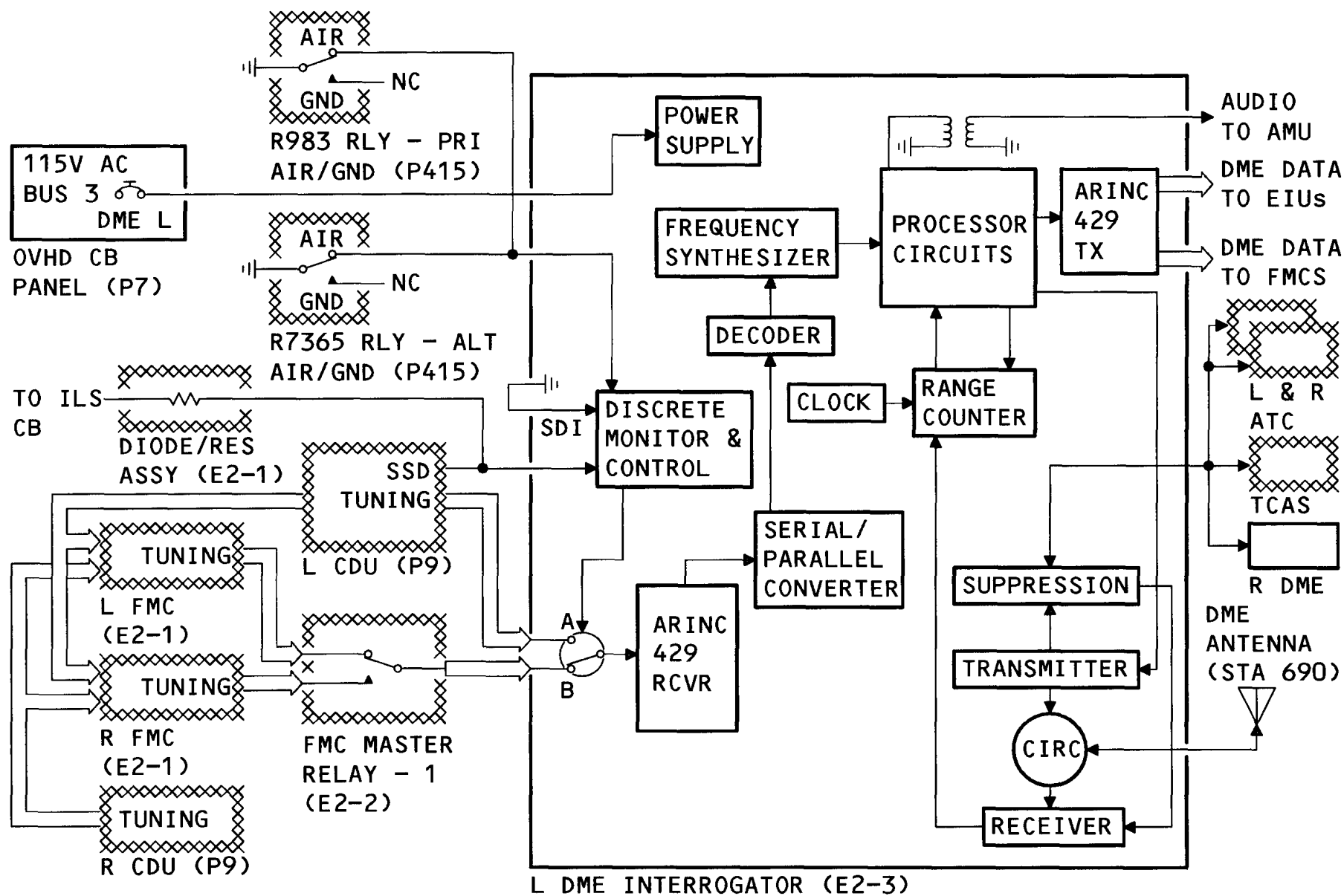


Figure 21 OPERATION



DME

BITE AND TEST

BITE

The DME BITE circuit:

- Does periodic DME interrogator tests
- Monitors internal circuits and records faults in nonvolatile fault memory
- Receives ground test requests from the CMC and performs the ground test
- Receives self-test requests from the front panel self-test switch and performs the self-test
- Sends status information through the processor to the EFIS/EICAS interface units (EIUs) for display on the NDs and the PFDs and to the CMCs to be recorded
- Receives a discrete from the air/ground relays which inhibits self-test during flight.

The processor controls the operation of the BITE circuit.

Nonvolatile Fault Memory

The nonvolatile fault memory records system faults by flight legs. The air/ground relays determine each new flight leg.

Ground Test

A request from a CDU through the active CMC starts a ground test. After the test request is received, the BITE circuit checks the operation of the unit. The processor transmits the test results to the CMCs through the EIUs. Normally, it is the left CMC that sends the test requests to the DME interrogators. If the left CMC fails, it is the right CMC that sends the test requests. The data from the right CMC passes through a set of contacts in the left CMC to the DME interrogators.

Self-Test

The TEST switch on the front panel of the DME interrogator is used to initiate a self-test. The BITE circuit:

- Performs the self-test
- Controls the self-test sequence of the LED status indicators
- Sends self-test ND and PFD display commands through the processor to the EIUs

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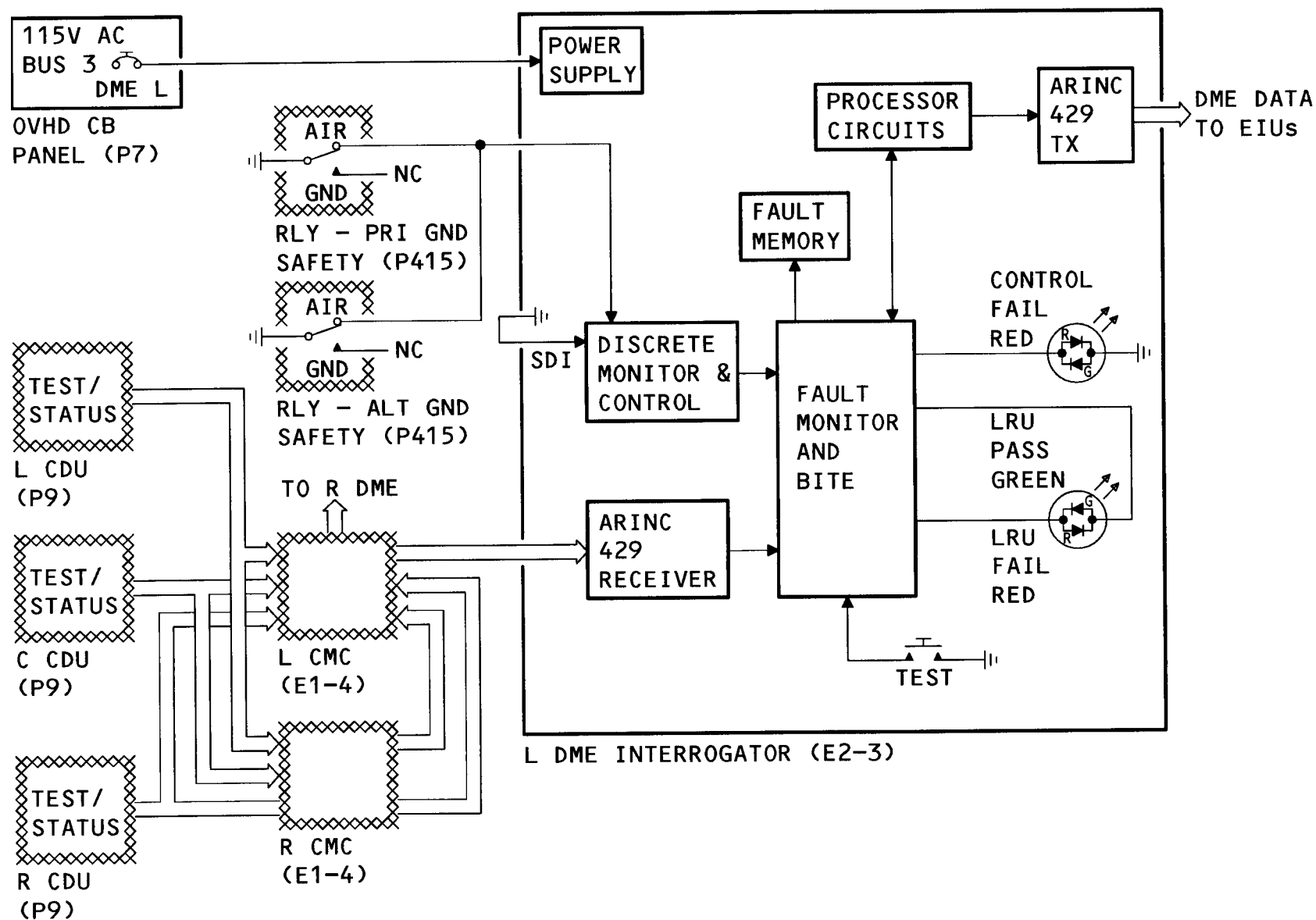


Figure 22 BITE AND TEST



DME

SELF - TEST

Self-Test

To start a DME self-test push and release the TEST switch on the DME interrogator.

Front Panel Displays

The LED status indicators go through this sequence:

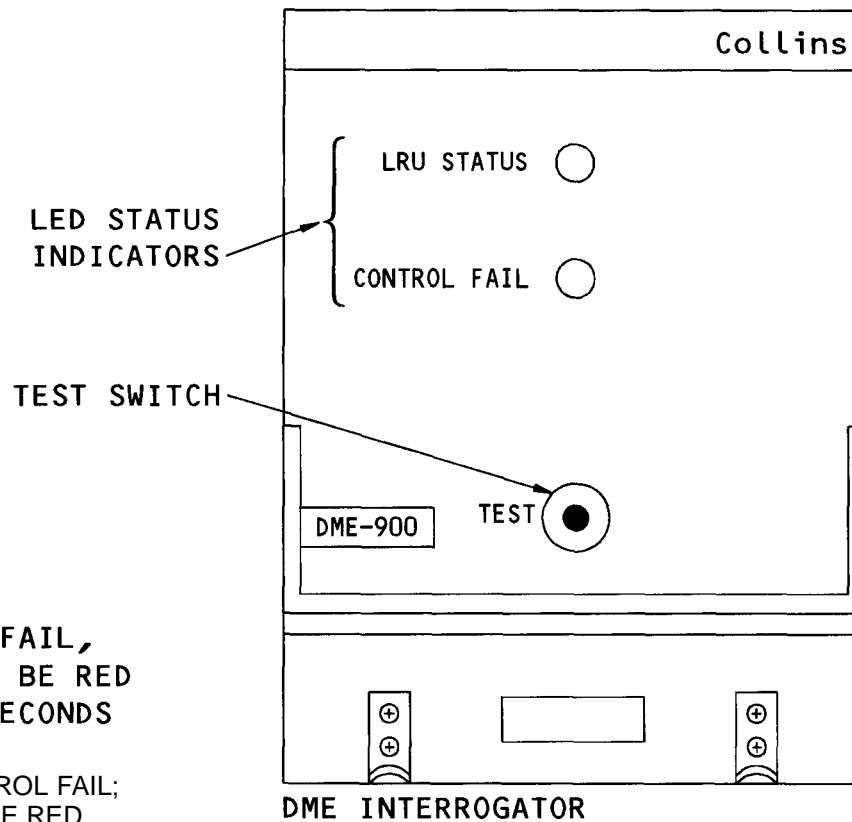
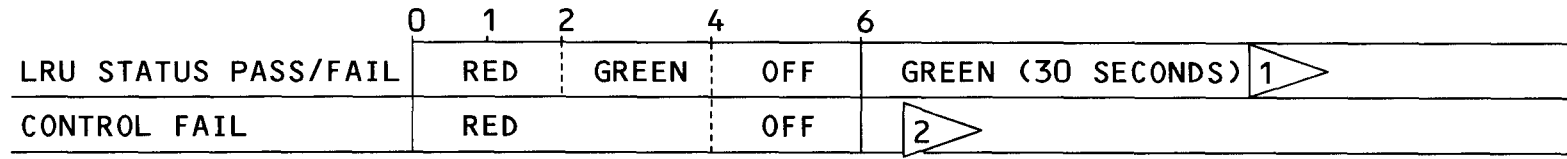
- Both indicators come on red for two seconds.
- LRU status comes on green for two seconds; CONTROL FAIL continues to Show red.
- Both indicators go off for two seconds.
- The indicators Show status for 30 seconds.

The red CONTROL FAIL LED Shows when the tuning source is invalid.

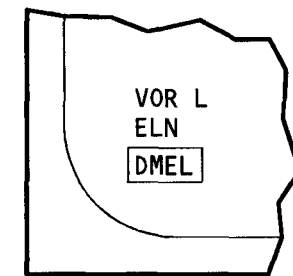
The LRU STATUS LED Shows interrogator test results. The LRU STATUS LED Shows green for a good test or it Shows red for a test failure.

PFD or ND Display Sequence

The DME distance displays on the PFD's go blank and the DME fail flag Shows on the ND's for the two seconds that both indicators are off.



- 1 FOR LRU FAIL,
LED WILL BE RED
FOR 30 SECONDS
- 2 FOR CONTROL FAIL;
LED WILL BE RED
FOR 30 SECONDS



DME FLAG

ND DISPLAY SEQUENCE

Figure 23 SELF-TEST

DME



GROUND TEST

Ground tests start from either CDU by selecting DME L or DME R on the CMC ground tests menu page.

At the end of the ground test, the test results will show on the GROUND TEST MENU. To get more data about a failure, push the line-select key next to FALL. The GROUND TEST MSG page will show more data.

DME

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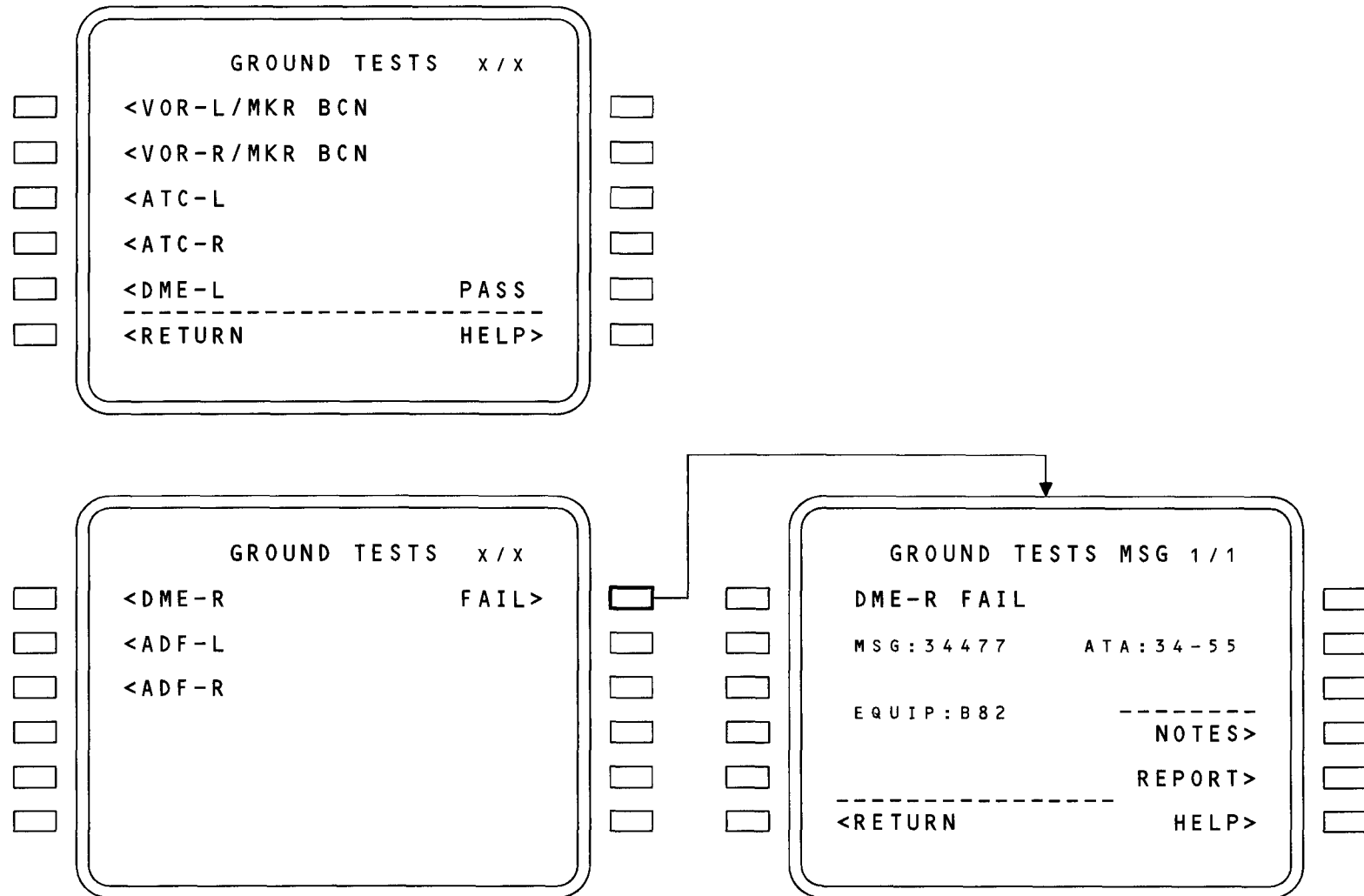


Figure 24 GROUND TEST

DME

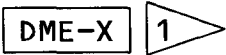


FLIGHT DECK EFFECTS

Flight Deck Effects

A left or right DME system failure causes DME flags to show on the navigation display (ND) and a status message to show on the auxiliary EICAS display.

FLIGHT DECK EFFECT



DME LEFT
DME RIGHT

TYPE

EFIS (ND) FLAG
STATUS MESSAGE
STATUS MESSAGE

DESCRIPTION

LEFT OR RIGHT DME FAILURE
LEFT DME FAILURE
RIGHT DME FAILURE

 X = L (LEFT) OR R (RIGHT)

Figure 25 FLIGHT DECK EFFECTS

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