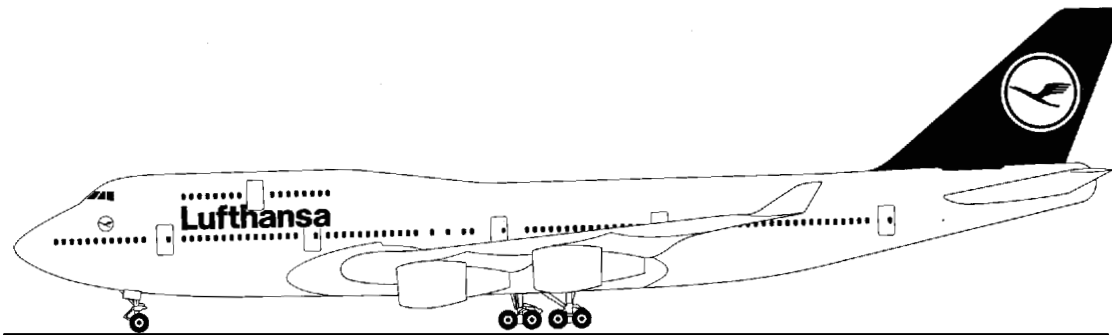




Lufthansa Technical Training

Training Manual B 747-400



ATA 34-51

VOR

ATA Spec. 104 Level 3



Lufthansa Technical Training

For training purpose and internal use only.

Copyright by Lufthansa Technical Training GmbH.

All rights reserved. No parts of this training manual may be sold or reproduced in any form without permission of:

Lufthansa Technical Training GmbH

Lufthansa Base Frankfurt

D-60546 Frankfurt/Main

Tel. +49 69 / 696 41 78

Fax +49 69 / 696 63 84

Lufthansa Base Hamburg

Weg beim Jäger 193

D-22335 Hamburg

Tel. +49 40 / 5070 24 13

Fax +49 40 / 5070 47 46

VOR



**Lufthansa
Technical Training**

B747 - 400

34-51

ATA 34-51 VOR

VOR



VOR NAVIGATION SYSTEM - INTRODUCTION

The VOR (VHF omnidirectional range) navigation system is a navigational aid that determines absolute bearing with respect to a ground station. The system receives RF signal data from the ground station and converts it into bearing data. The data is then sent to various systems for display and navigation use.



V_{HF} OMNI - DIRECTIONAL RANGE

- FLIGHT DECK INDICATIONS
- BEARING TO VOR STATION
 - COURSE DEVIATION
 - TO/FROM INDICATION
 - AUDIO SIGNAL

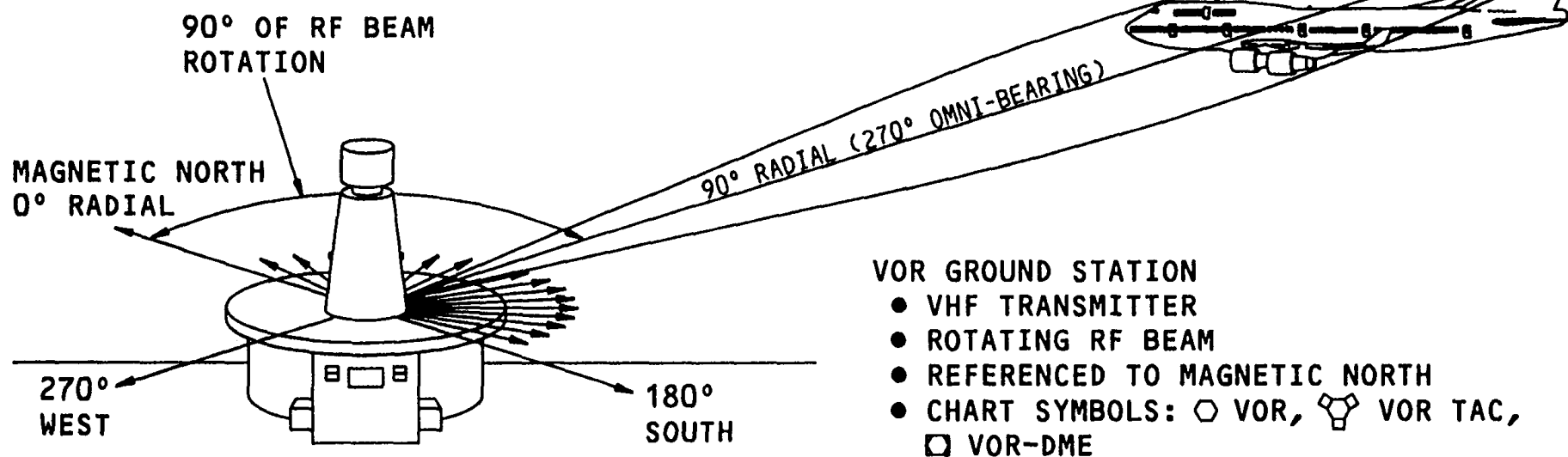


Figure 1 VOR NAVIGATION SYSTEM - INTRODUCTION

VOR



VOR NAVIGATION SYSTEM

System Description

The dual VOR system has two independent VOR receivers and a common antenna. The frequency range of the VOR system is 108.00 to 117.95 MHz.

Operation

The antenna receives signals from the ground station and sends them to the VOR receivers. The receivers use the signals to provide bearing and station identification in digital format. The receivers send the data to the EFIS/EICAS interface units (EIUs) to show on the navigation displays (NDs).

The receiver also provides an audio station identifier to the audio management unit.

Control

The VOR receivers are normally tuned automatically by the flight management computers (FMCs). The flight crew can manually tune the VORs using the control display units (CDUs). The CDUs send the signals to the FMCs. One of

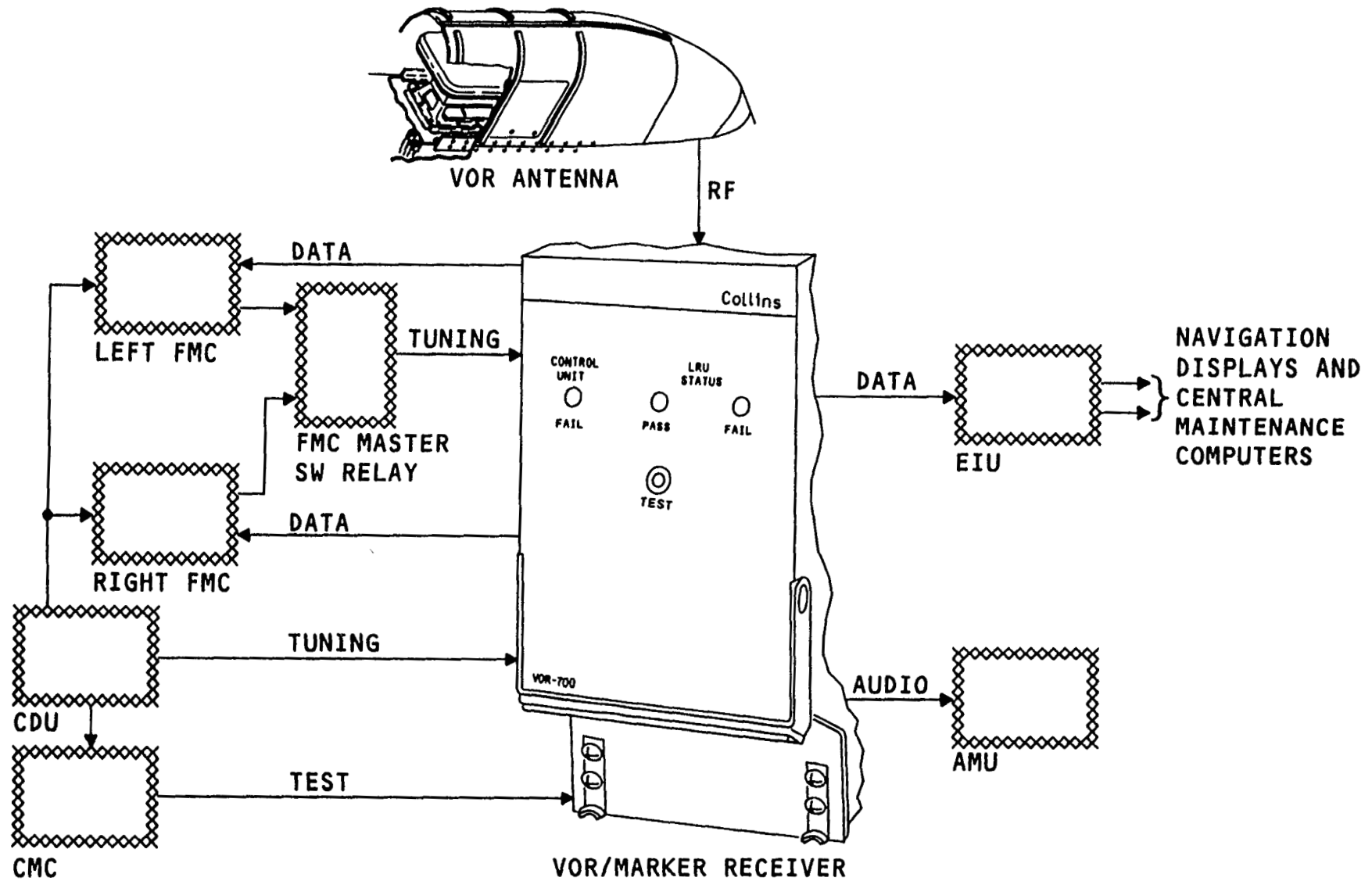
the FMCs is the master FMC. The FMC master switch relay connects the master FMC to the VOR receivers. The master FMC sends the tuning signals to the selected VOR receiver.

In the air, if the master does not operate or on the ground, if both FMCs do not operate, the onside CDU sends the VOR tuning signals directly to the onside VOR receiver.

Test and Status

Maintenance personnel set ground test and status commands on the CDUs. The CDUs send these signals to the VOR receivers through the central maintenance computers (CMCs).

The VOR receivers send status data to the CMCs through the EIUs.

**Figure 2 VOR NAVIGATION SYSTEM**



VOR

VOR NAVIGATION SYSTEM

System Description

The dual VOR system has two independent VOR receivers and a common antenna. The frequency range of the VOR system is 108.00 to 117.95 MHz.

Operation

The antenna receives signals from the ground station and sends them to the VOR receivers. The receivers use the signals to provide bearing and station identification in digital format. The receivers send the data to the EFIS/EICAS interface units (EIUs) to show on the navigation displays (NDs).

The receiver provides an audio station identifier to the audio management unit.

Control

The VOR receivers are normally tuned automatically by the flight management computers (FMCs). The flight crew can manually tune the VORs using the control display units (CDUs). The CDUs send the signals to the FMCs.

Test and Status

Maintenance personnel set ground test and status commands on the CDUs. The CDUs send these signals to the VOR receivers through the central maintenance computers (CMCs).

The VOR receivers send status data to the CMCs through the EIUs.

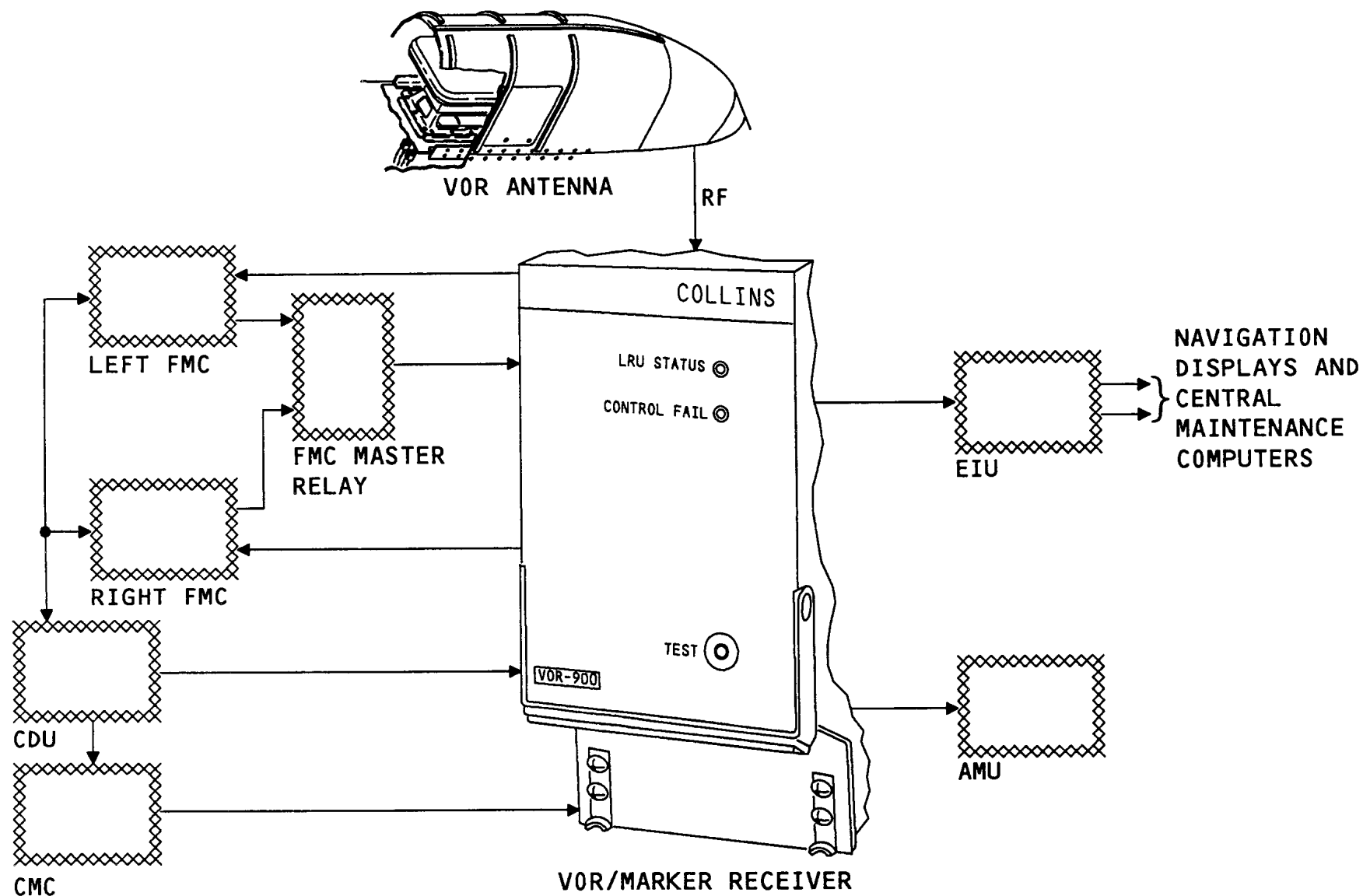


Figure 3 VOR NAVIGATION SYSTEM

VOR



VOR COMPONENT LOCATIONS - 1

The VOR navigation system components are:

- Left VOR/MKR receiver
- Right VOR/MKR receiver
- VOR antenna

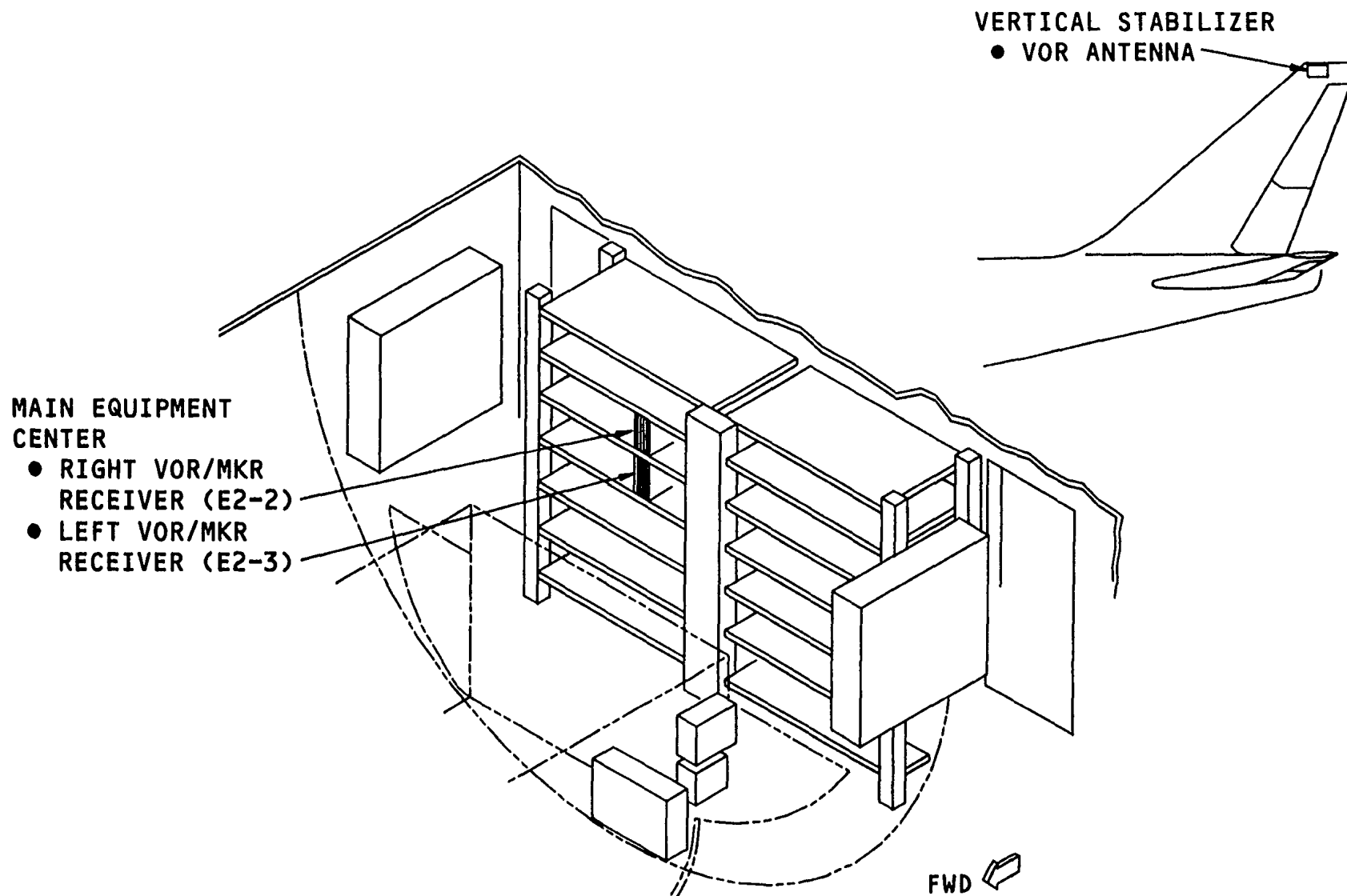


Figure 4 COMPONENT LOCATIONS - 1

VOR



COMPONENT LOCATIONS - FD

These are also VOR navigation system components:

- VOR left and right circuit breakers

The components that interface with the VOR navigation system are:

- Left CDU
- Right CDU
- Left inboard IDU
- Lower IDU
- Right inboard IDU
- Left EFIS control panel
- Right EFIS control panel
- Audio control panels

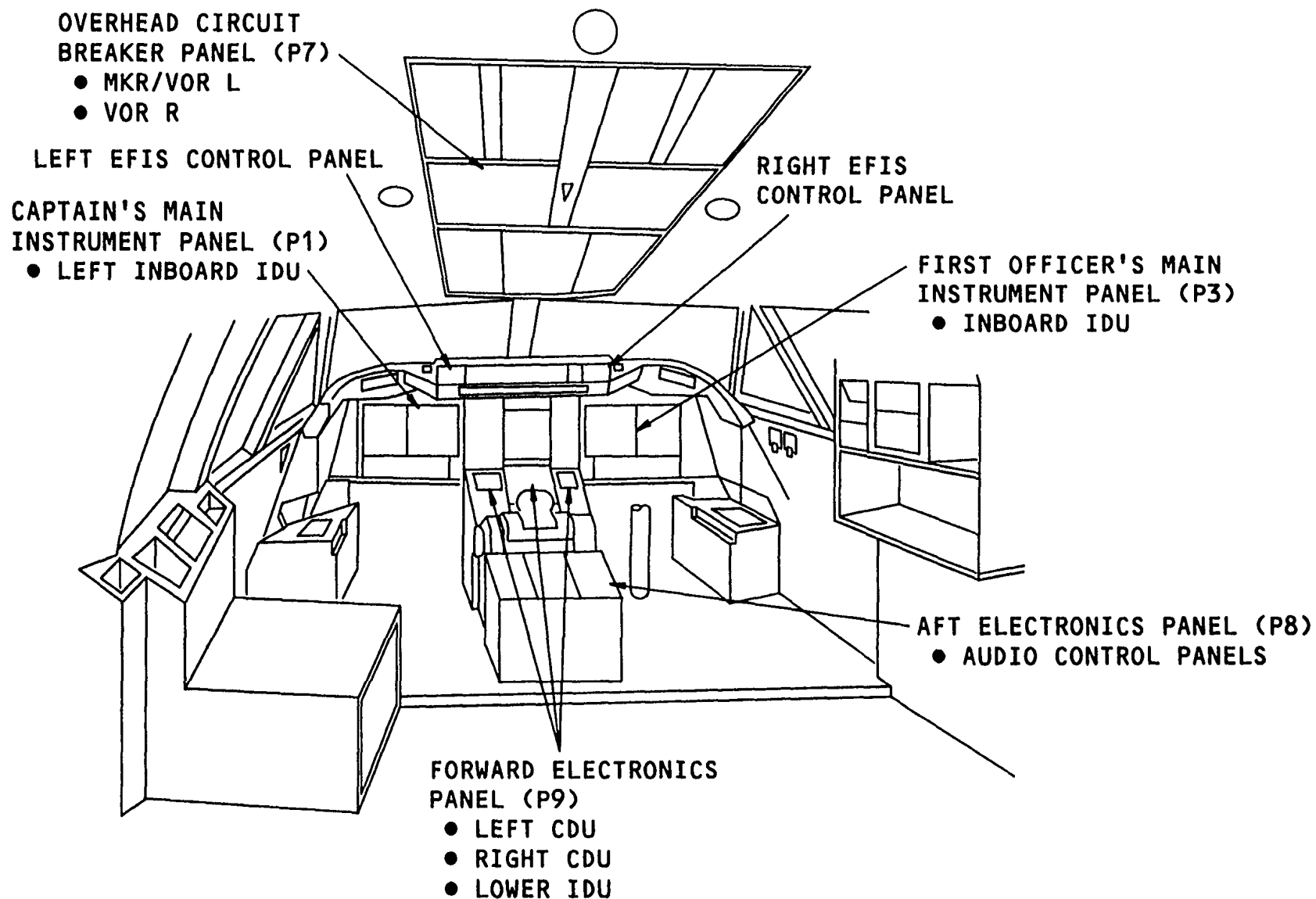


Figure 5 COMPONENT LOCATIONS - FD



THIS PAGE INTENTIONALLY LEFT BLANK

VOR



Lufthansa Technical Training

B747 - 400

005.01

34-51

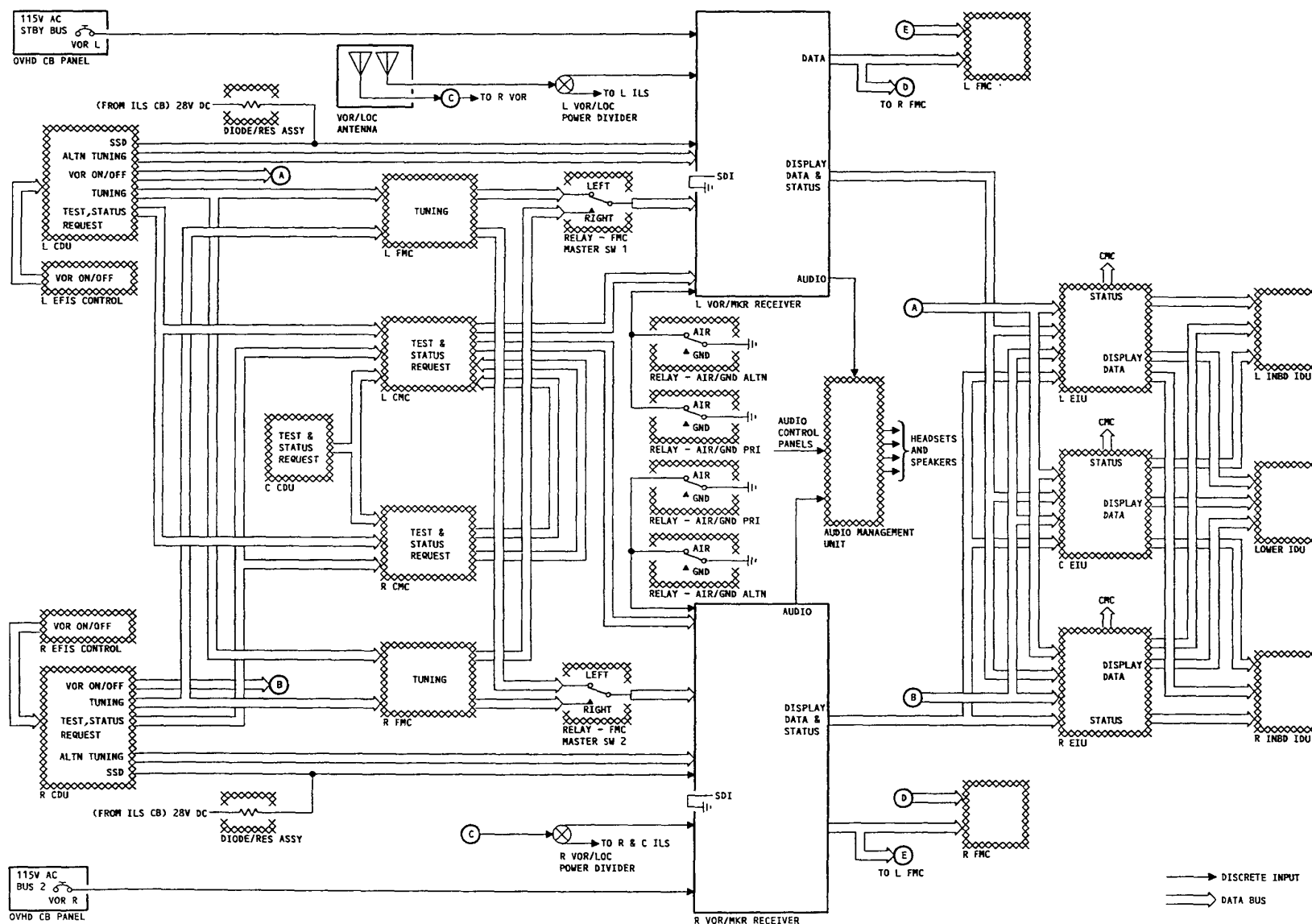


Figure 6 VOR - INTERFACE DIAGRAM

VOR



POWER AND ANTENNA INPUTS

The VOR antenna sends RF signals to the two VOR/MKR receivers.

Power for the left VOR/MKR receiver comes from the STBY bus.

Power for the right VOR/MKR receiver comes from bus 2.

VOR

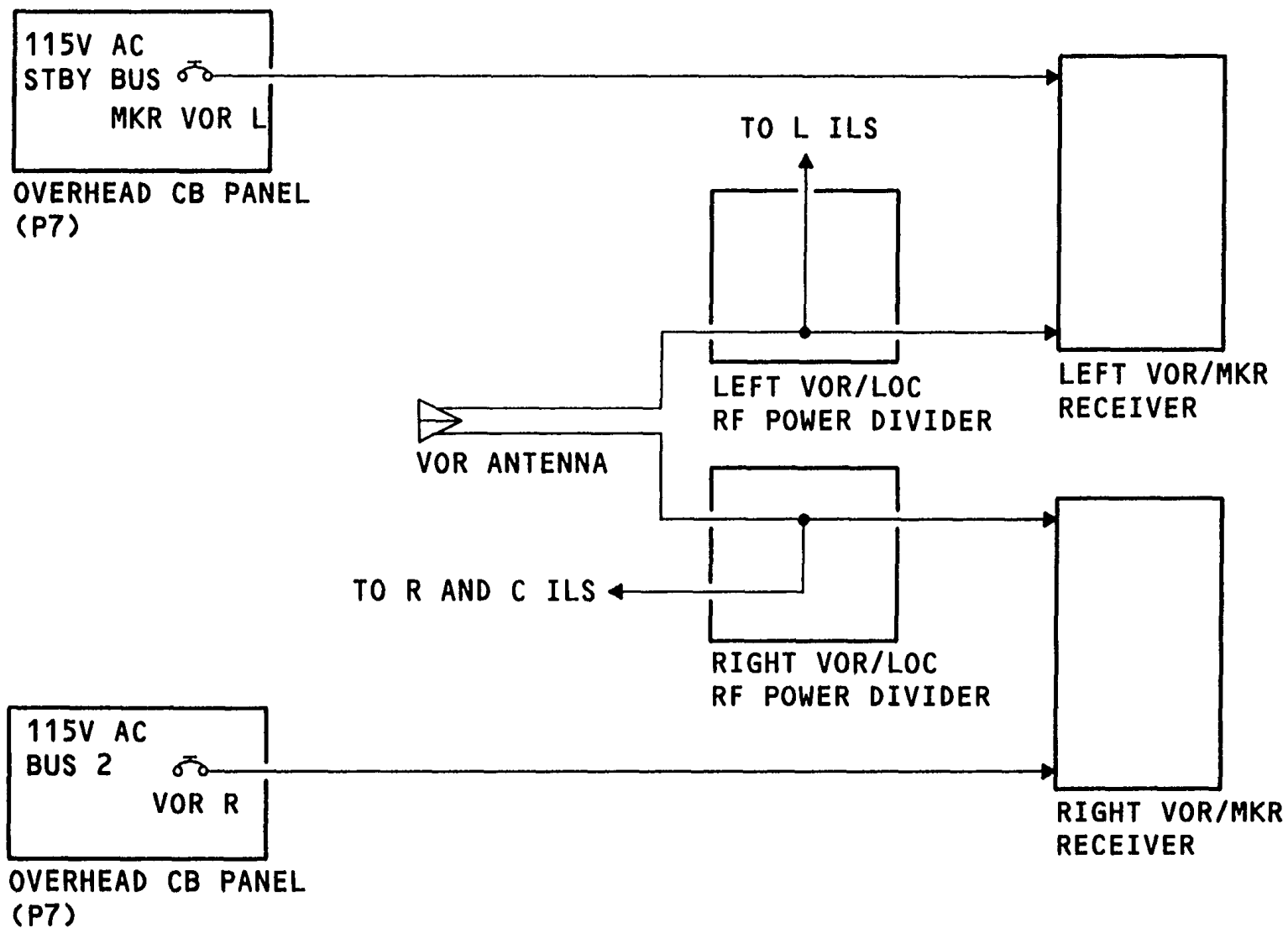


Figure 7 POWER AND ANTENNA INPUTS

VOR



TUNING INPUTS

The FMCs normally tune the two VOR/MKR receivers automatically. Manual tuning can be done by the left or right CDU if at least one FMC is operational.

If the master FMC fails, auto tuning can be continued by placing the FMC master switch to the other FMC position. This switches the FMC master relays.

On the ground, if both FMCs fail, or in the air if the master FMC fails, the left and right CDUs can be used to tune the left and right VOR/MKR receivers manually through a direct connection.

CDU tuning is supplied through port A; FMC tuning is supplied through port B.

Switching from port B to port A is performed inside the VOR/MKR receiver. It is controlled by the source select discrete (SSD) from the onside CDU.

A resistor/diode applies 28v dc as SSD bias.

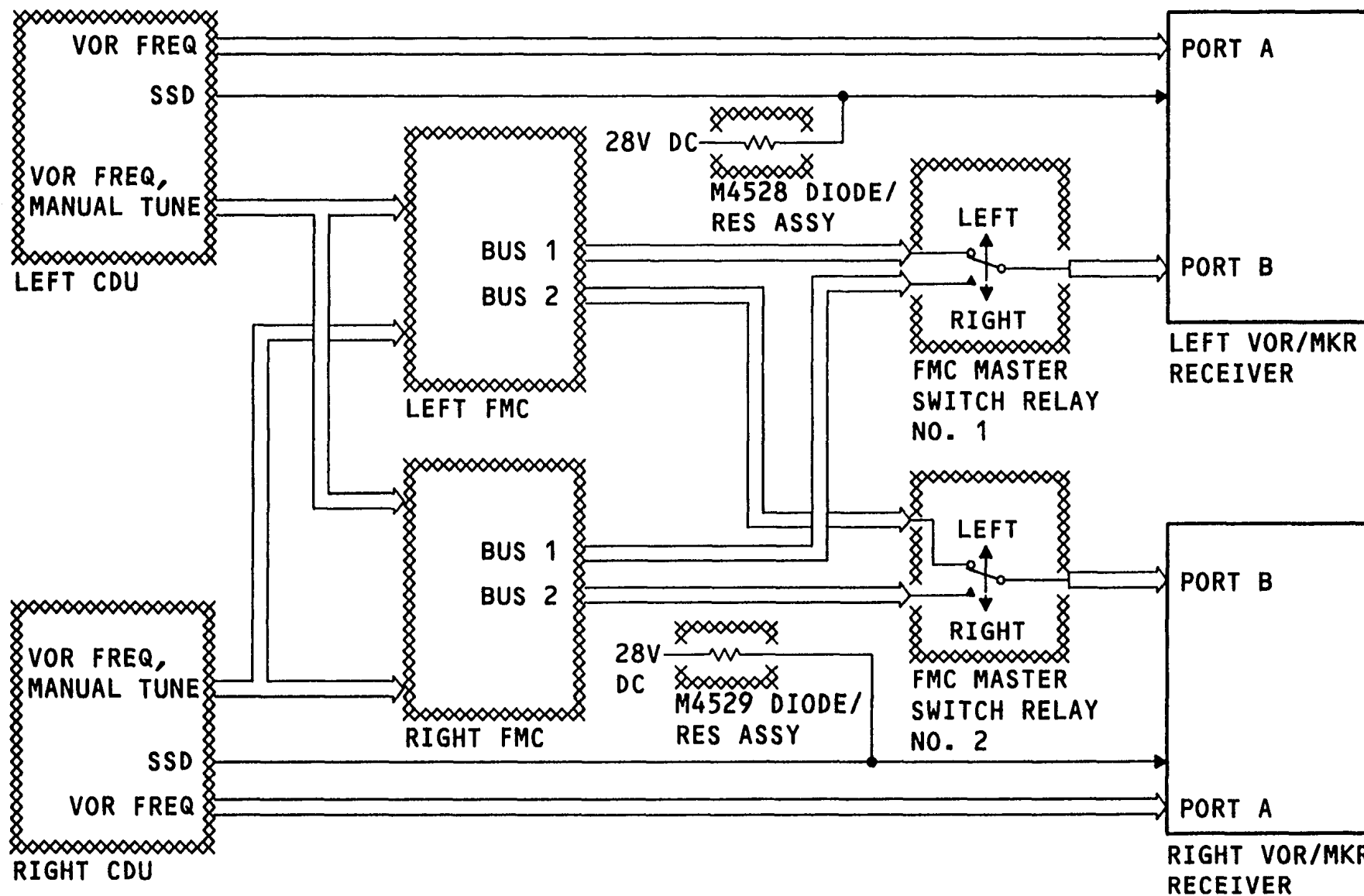


Figure 8 TUNING INPUTS

VOR



CMC INPUTS

Any one of the three CDUs can initiate tests of the VOR/MKR receivers through the CMCs.

Normally the left CMC sends a digital test discrete to initiate a test. If the CMC fails, a relay in the left CMC energizes, and sends right CMC data to the VOR/MKR receivers.

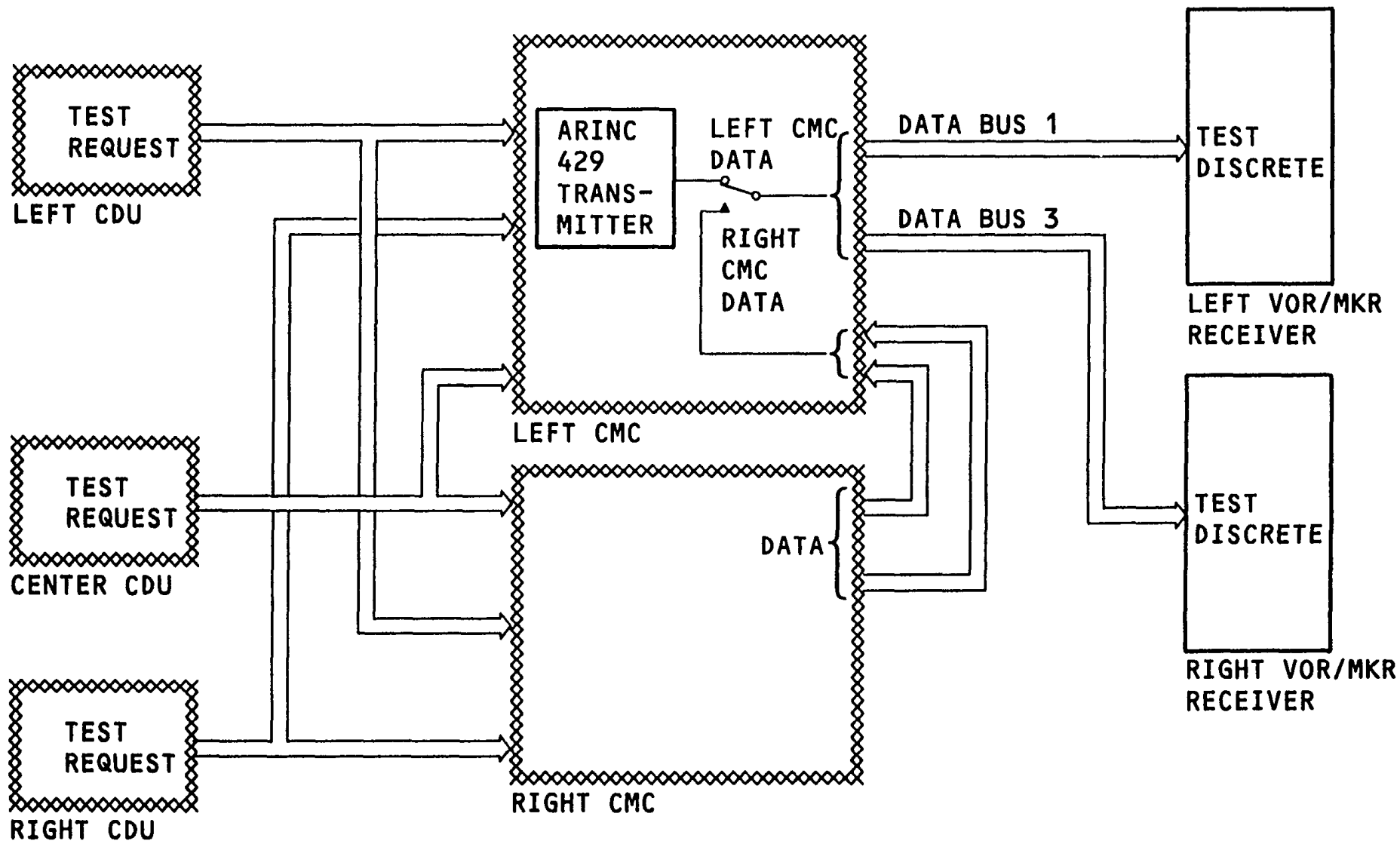


Figure 9 CMC INPUTS

VOR



OUTPUTS

The VOR receiver sends bearing data, VOR frequency, selected course, and the station identifier to the FMCs.

VOR bearing information is used in the FMCs for position updating.

The VOR receivers send VOR bearing, selected course, VOR frequency, and three letter station identifier (ID) words to the left, center, and right EIUs.

The EIUs multiplex the data and send it to the NDs.

The NDs use bearing and selected course to compute and display the to/from annunciations. The NDs also use VOR bearing and selected course to compute the VOR deviation that is shown on the NDs.

The EIUs send status to the CMCs.

VOR

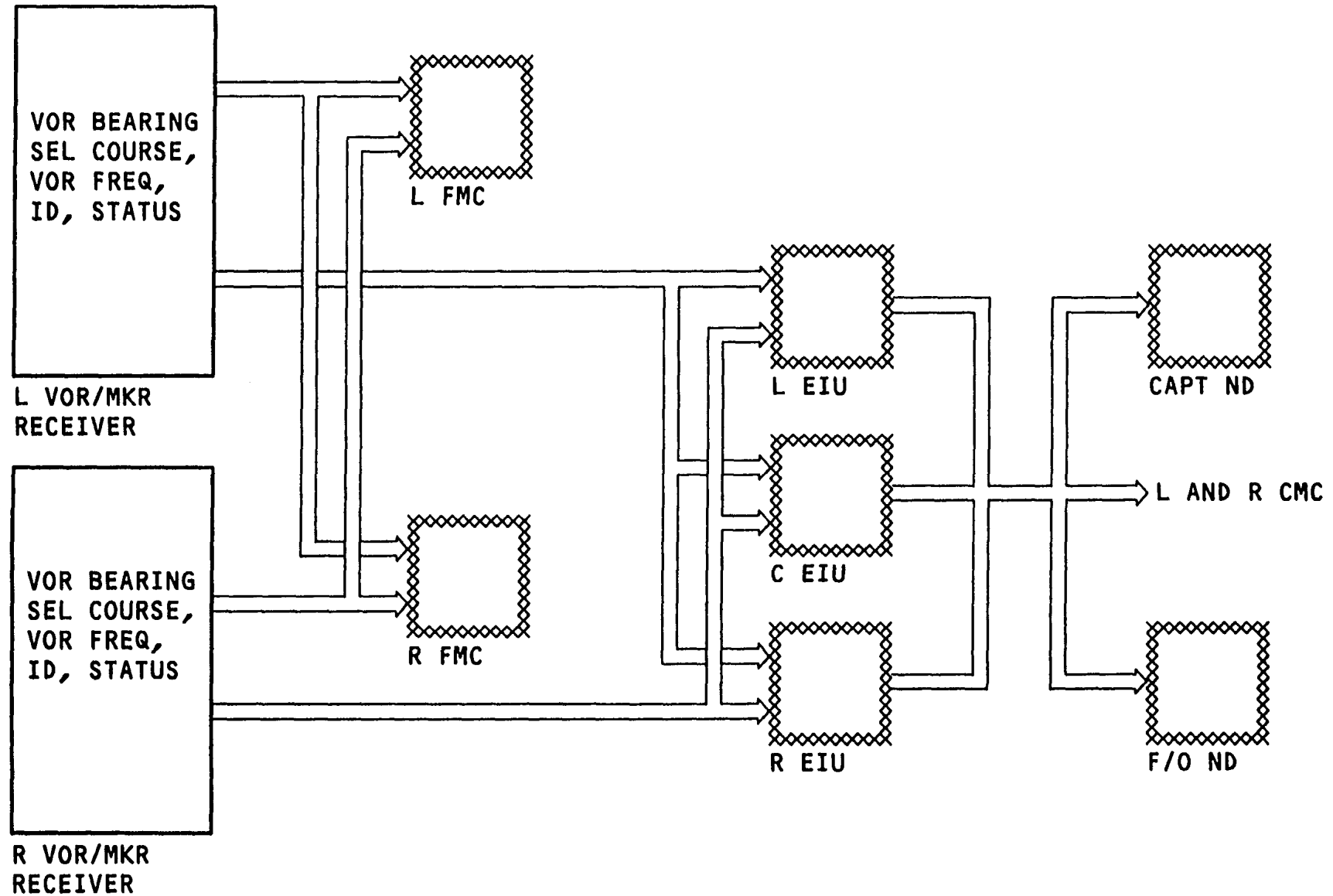


Figure 10 OUTPUTS

VOR



AUDIO OUTPUTS

Left and right VOR receiver audio signals are sent to the audio management unit and are controlled by the audio control panels. The audio signals are sent from the audio management unit to the headsets and cockpit speakers.

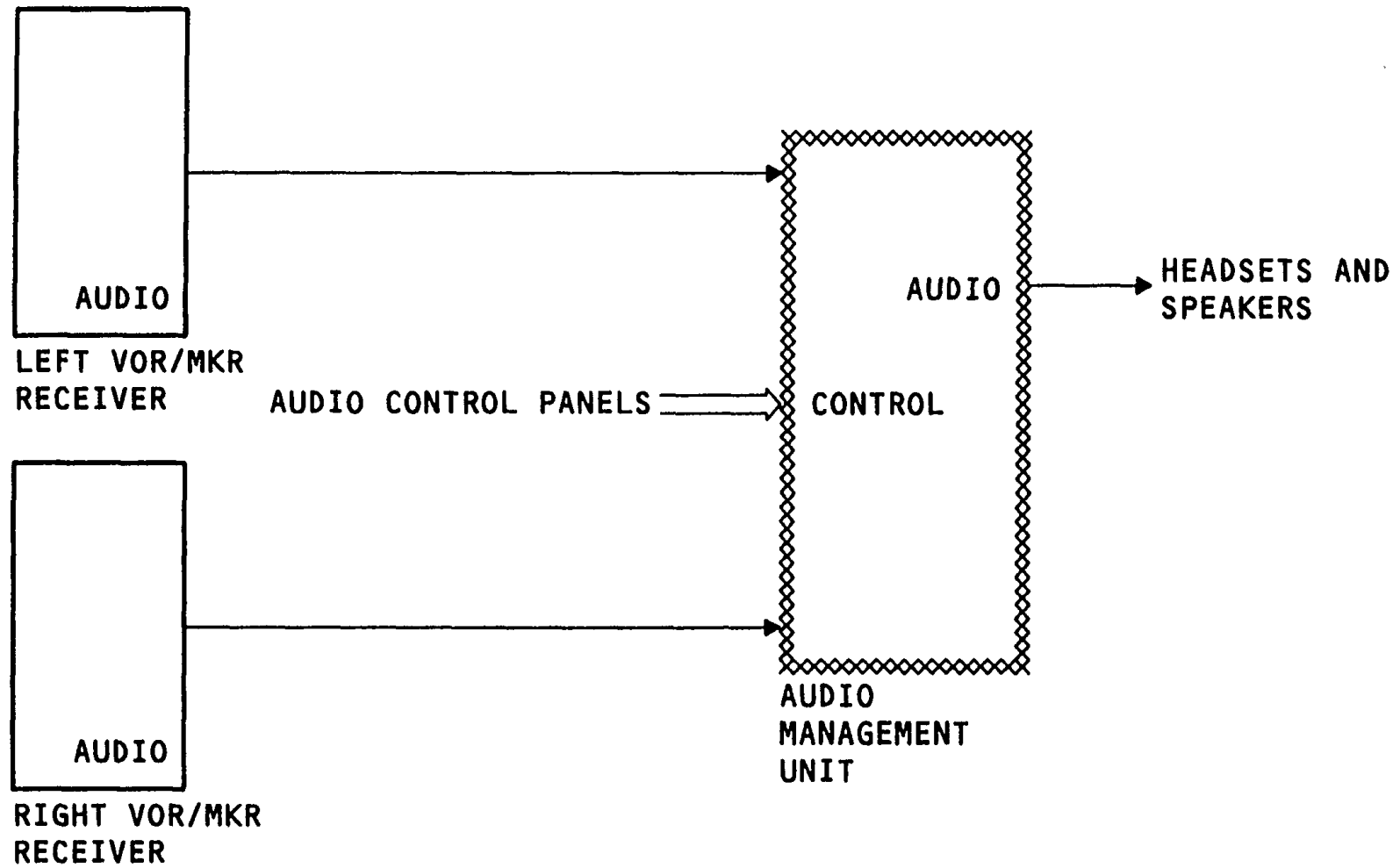


Figure 11 AUDIO OUTPUTS

VOR



ANALOG DISCRETES

Source Destination Identifier

The SDI identifies the left or right VOR system. A specified program pin identifies the left VOR receiver. A different program pin identifies the right VOR receiver.

Air/Ground Inputs

Each one of the VOR receivers gets an input from two air/ground relays in parallel.

The functions are to:

- Prevent ground tests while the airplane is in the air.
- Increment the flight leg in the nonvolatile memory of the VOR receiver if the CMC (central maintenance computer) fails.

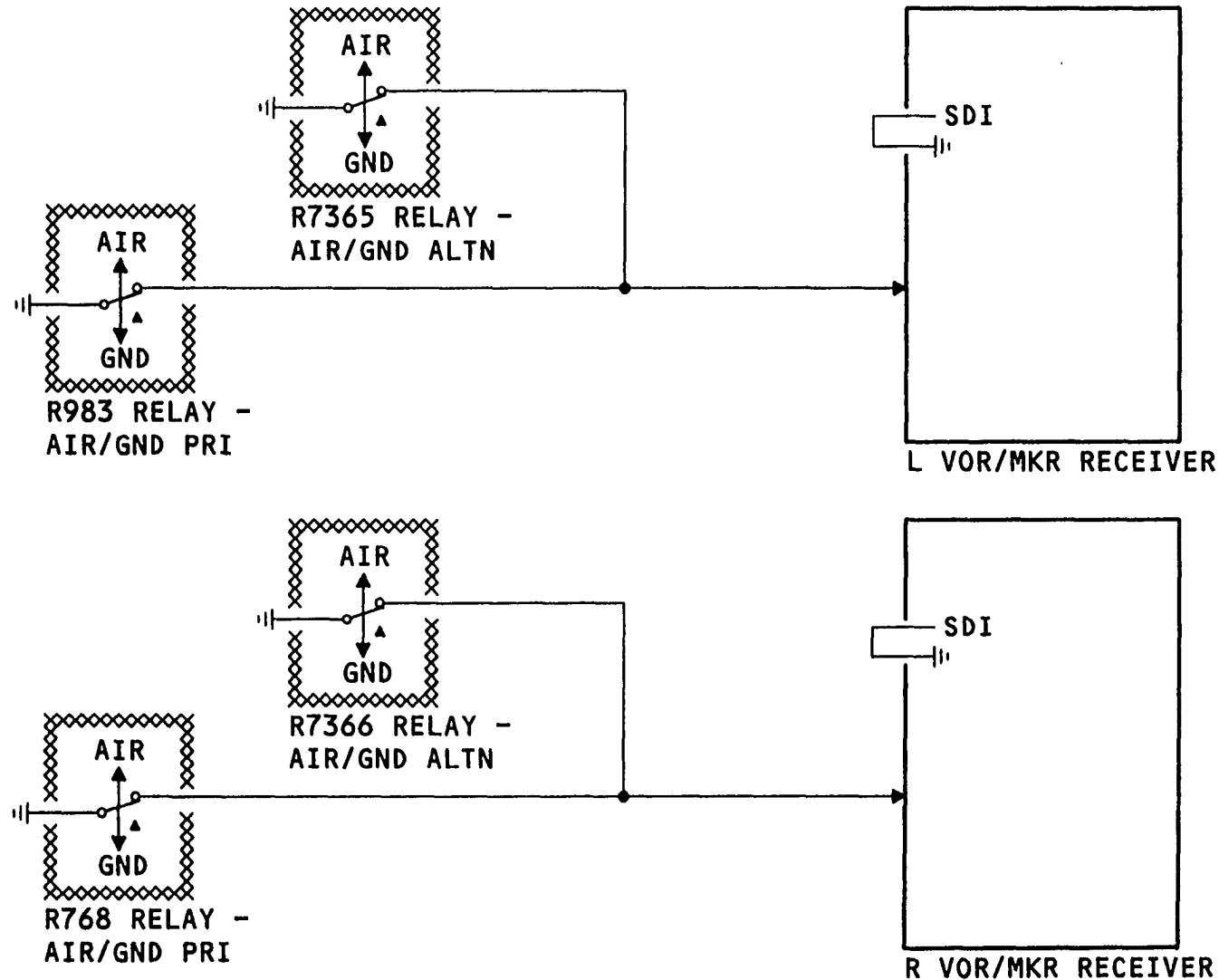


Figure 12 ANALOG DISCRETES

VOR



VOR / MKR RECEIVER

General Description

The VOR/MKR receiver gets VOR signals in the frequency range of 108.00 MHz to 117.95 MHz. Between 108.00 MHz and 112.00 MHz the frequency alternates between 50 KHz and 150 KHz (I.E. 108.00, 108.05, 108.20, 108.25, ETC.). Between 112.00 MHz and 117.95 MHz the frequency spacing is 50 KHz.

The VOR/MKR receiver sends out:

- Omni-bearing
- Selected course
- Fault information
- VOR frequency
- Audio

The VOR/MKR receiver contains a VOR receiver and marker (MKR) beacon receiver. The MKR receiver is disabled by a program pin in the right VOR/MKR receiver.

Characteristics

The VOR/MKR receiver has a non-volatile flight fault memory to record faults.

Fault memory data is available through an ATE connector at the back of the receiver.

Fault recording is prevented on the ground except during a manual self-test.

Discretes from the AIR/GND relay system determine flight legs if the CMCS fail and prevent CMC tests in the air.

Power

The VOR receiver operates on 115v ac.

Control and Monitor

The VOR receiver receives control inputs on an ARINC 429 data bus.

The front panel switch/indicators are:

- TEST switch - initiates a self-test of both the VOR and marker beacon receiver modules
- LRU STATUS FAIL LED (red) - shows a failure found in the VOR/MKR receiver
- LRU STATUS PASS LED (green) shows no failures found in the VOR/MKR receiver
- CONTROL INPUT FAIL LED (red) - shows an invalid tuning source. The source could be the FMC or the CDU

The LEDs are enabled only when the TEST switch is pushed.

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.

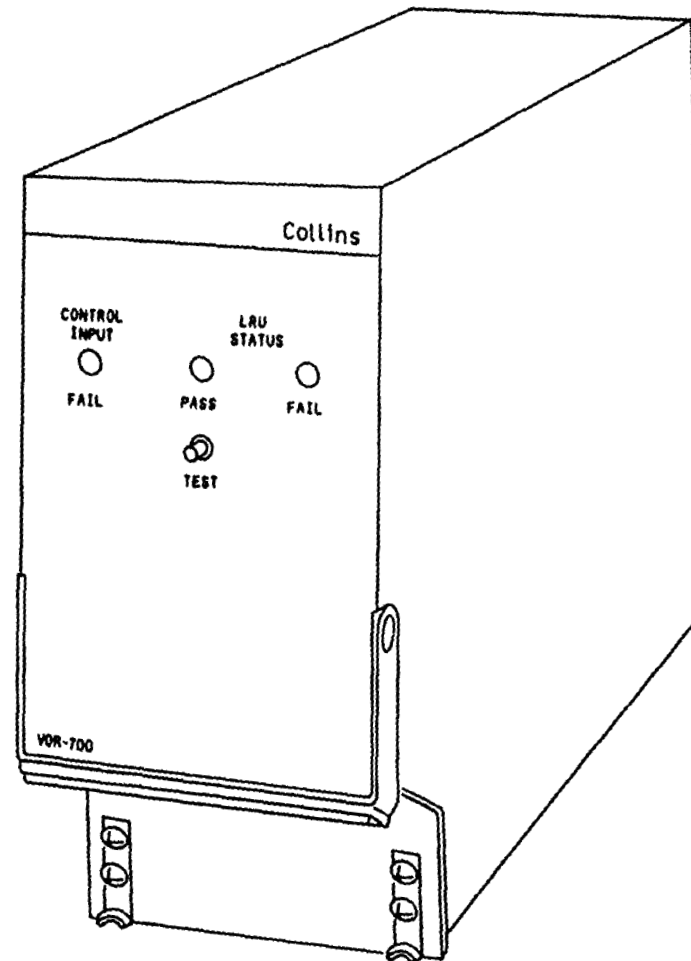


Figure 13 VOR / MKR RECEIVER (Collins VOR-700)

VOR



VOR/MKR RECEIVER

General Description

The VOR/MKR receiver gets VOR signals in the frequency range of 108.00 MHz to 117.95 MHz. Between 108.00 MHz and 112.00 MHz the frequency alternates between 50 KHz and 150 KHz (I.E. 108.00, 108.05, 108.20, 108.25, ETC.). Between 112.00 MHz and 117.95 MHz the frequency spacing is 50 KHz.

The VOR/MKR receiver sends out:

- Omni-bearing
- Selected course
- Fault information
- VOR frequency
- Audio

The VOR/MKR receiver contains a VOR receiver and marker (MKR) beacon receiver. The MKR receiver is disabled by a program pin in the right VOR/MKR receiver.

Characteristics

The VOR/MKR receiver has a non-volatile flight fault memory to record faults.

Fault memory data is available through an ATE connector at the back of the receiver.

Fault recording is prevented on the ground except during a manual self-test.

Discretes from the AIR/GND relay system determine flight legs.

Power

The VOR receiver operates on 115v ac.

Control and Monitor

The VOR receiver receives control inputs on an ARINC 429 data bus.

The front panel switch/indicators are:

- TEST switch - initiates a self-test of both the VOR and marker beacon receiver modules
- LRU STATUS LED - shows a failure found in the VOR/MKR receiver if red and shows no failure if green
- CONTROL FAIL LED - shows red for an invalid tuning source. The source could be the FMC or the CDU

The LEDs are enabled only when the TEST switch is pushed.

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.

VOR

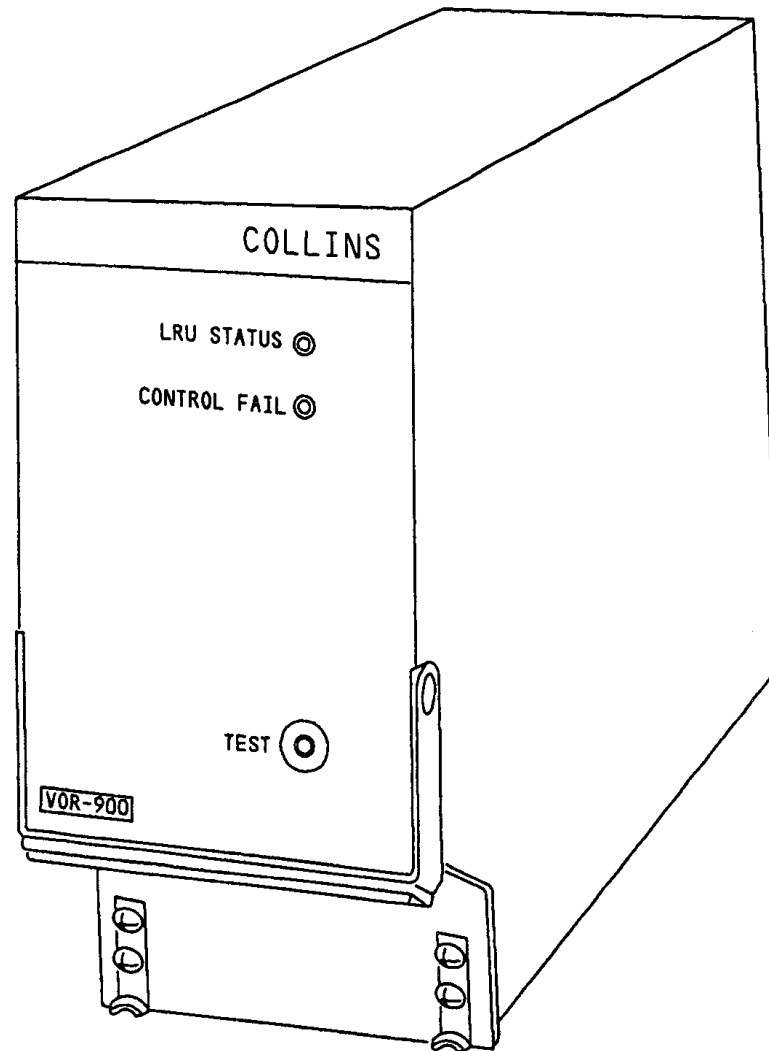


Figure 14 VOR/MKR RECEIVER (VOR-900)



VOR

VOR ANTENNA

General

The VOR antenna receives RF energy in the VHF range from 108.00 to 117.95 MHz and sends the RP to the VOR/MKR receivers.

The single VOR antenna has two outputs, one each to the left and right VOR/MKR receivers. The two outputs are isolated and matched to the coax by a balancing circuit in the antenna.

Removal/Installation

The vertical stabilizer fin tip must be removed to get access to the VOR antenna.

Remove the fourteen screws that hold the antenna to its support.

Lift and tip antenna to get access to the two coax connectors under the antenna.

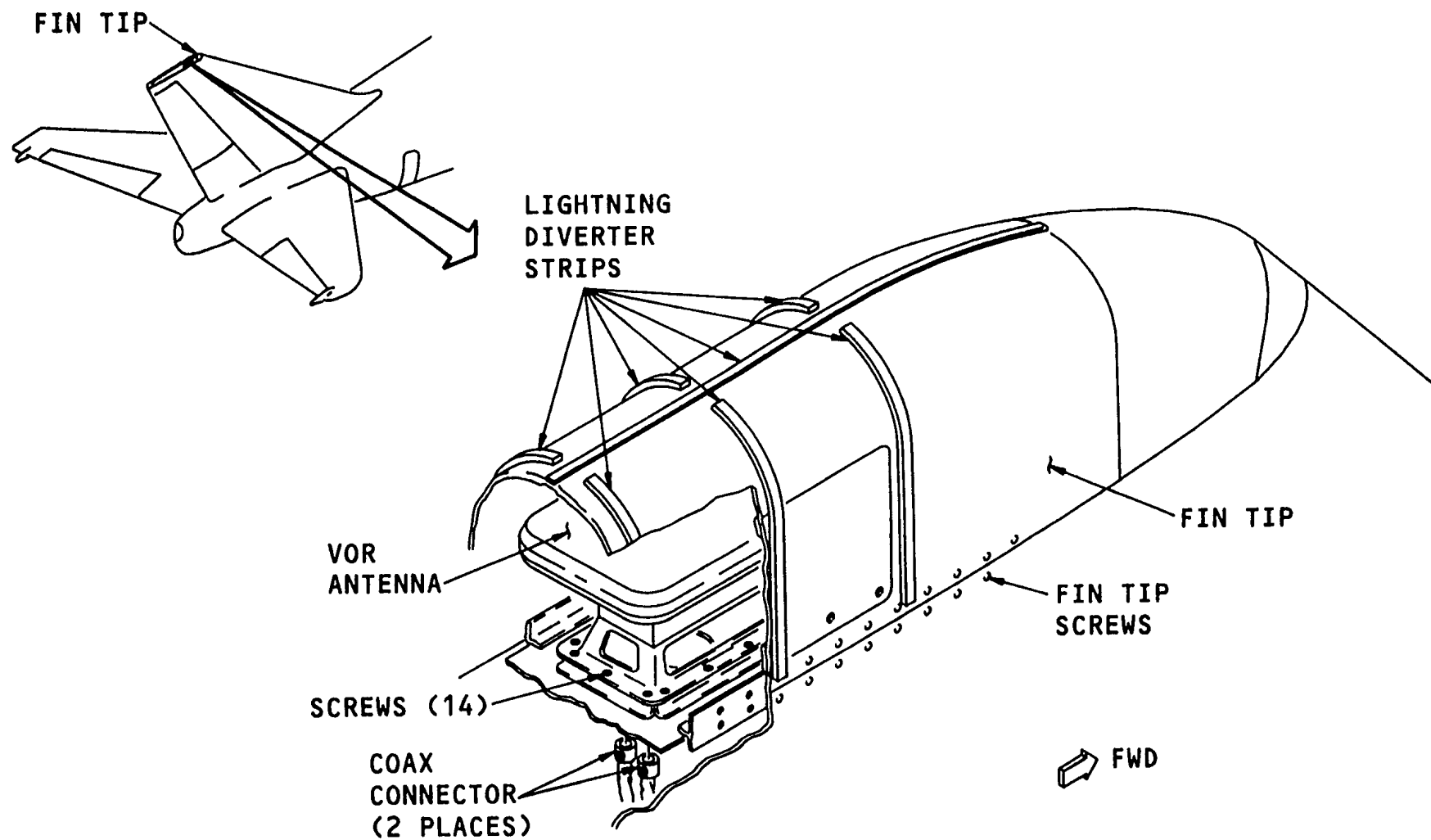


Figure 15 VOR ANTENNA



VOR

AUDIO CONTROL

The audio control panels supply input to the audio management unit. These inputs control which audio signal will be heard over the flight deck speakers and the pilots' headsets.

To hear VOR audio:

- Select left or right VOR with the VOR/ADF receiver selector switch
- Push the receiver control switch to turn on the VOR audio.
Turn the switch to adjust the volume.

The filter selector switch allows selection of V (voice) audio, R (range Morse code identification) audio, or B (both).

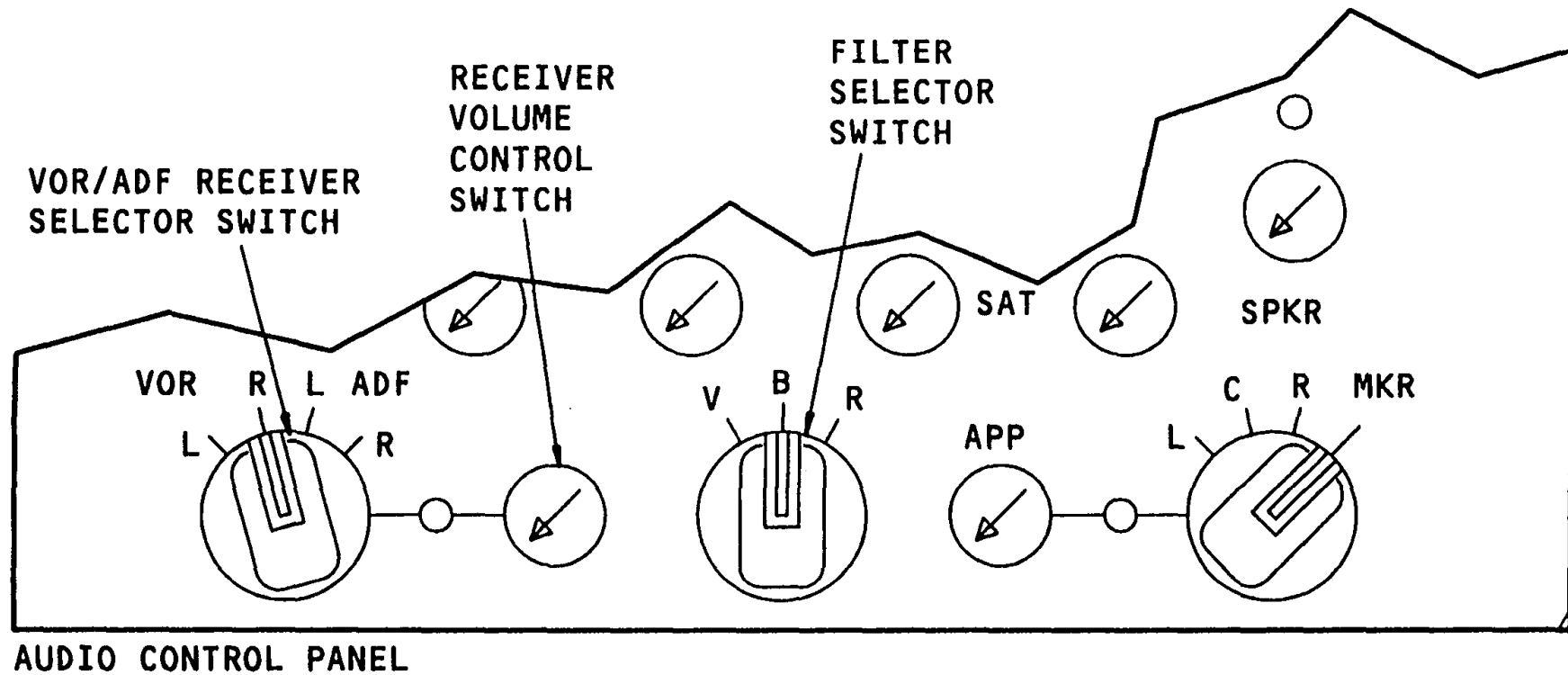


Figure 16 AUDIO CONTROL

VOR



AUTOTUNING

Normal tuning of the VOR/MKR receivers is done automatically by the FMCs. The FMC MASTER SWITCH determines which FMC autotunes the VOR receivers.

Autotuning is done as follows:

- The selected FMC autotunes the two VOR receivers.
- The left and right CDUs show the tuned frequency, for the left VOR and the right VOR on the NAV RADIO page. (The NAV RADIO page is selected by pushing the CDU NAV RAD keys.)
- Autotuning is shown on the CDU by an A (autotune), R (route) or P (procedures)

A indicates a navaid is tuned and a route or procedure navaid is not available.

Route-tuned navaids are upcoming navaids within 250 nm of the active route.

Procedure-tuned navaids are on the active leg of a published terminal area procedure.

When the VOR receivers are autotuned by the FMC, course selection is not allowed.

When the selected FMC fails, the VOR receivers remain at the last valid frequency tuned.

When the selected FMC fails, put the FMC master switch in the other FMC position to continue autotuning.

VOR

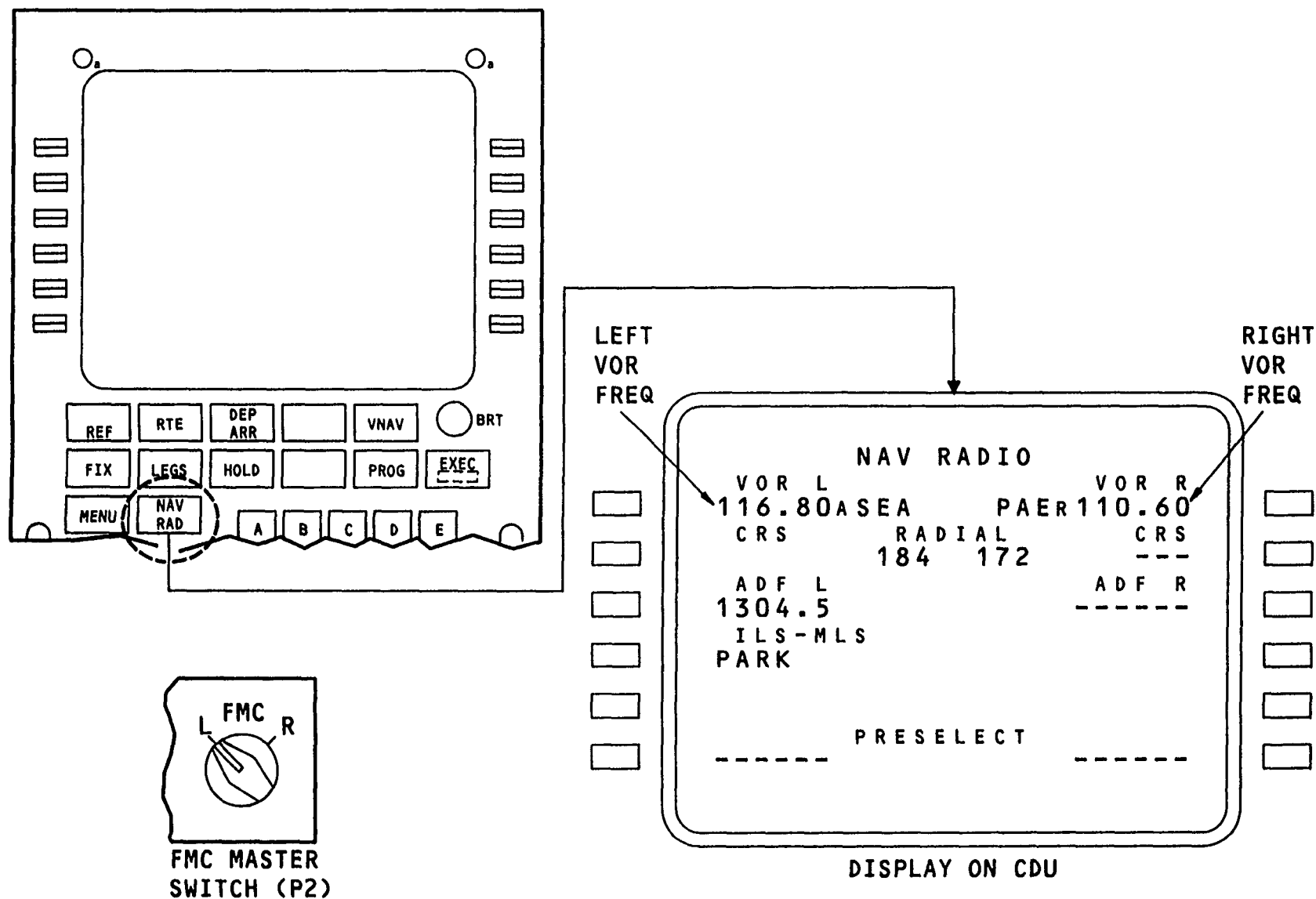


Figure 17 AUTOTUNING

VOR



MANUAL TUNING

Manual selection of a frequency on the CDU will cancel the FMC autotuning of the VOR receivers. When there is at least one valid FMC, manual tuning of the VOR receivers can be performed from either the left or the right CDU.

To manually tune the VOR receiver from the CDU, the operator must:

- Push the NAV RAD key. The CDU will show the NAV RADIO page
- Set the frequency or three-letter identifier into the scratch pad with the alpha/numeric keys
- Push the line select key next to the left or right VOR frequency display. The FMC receives the frequency or identifier from the CDU and tunes the VOR receiver. An M will show a manually-tuned frequency
- The radial displayed is the vector received from the VOR shown above in line one.

To return to autotuning the VOR receivers:

- Push the DEL key on the CDU which enters the word DELETE into the scratch pad
- Push line select key next to left or right VOR frequency display (depending on the receiver being manually tuned)

When a frequency (or an identifier) has been manually entered from the CDU, a selected course may also be entered. (This will be indicated by the display of three dashes underneath CRS.) En-

ter the course in the scratch pad and push the line select key next to the dashes.

The preselect line position may be used to store alternate VOR frequency data. By using the line select keys, the data in the preselect line position may be used to tune the VOR/MKR receiver.

VOR

Lufthansa
Technical Training

B747 - 400

016.01

34-51

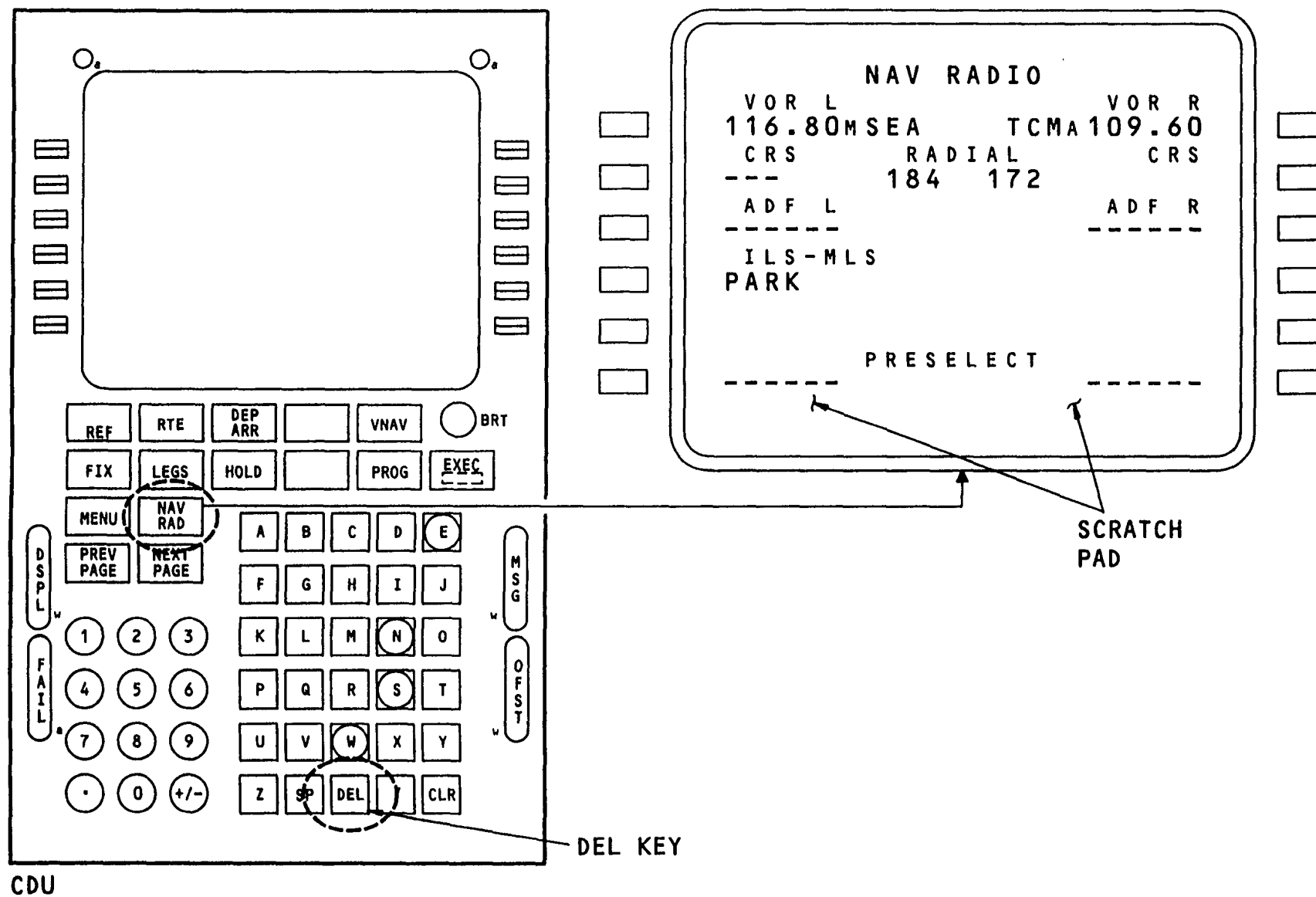


Figure 18 MANUAL TUNING

VOR



ALTERNATE TUNING

In the air if the master FMC fails or on the ground if both FMCs have failed, the left and right VOR receivers must be tuned by the onside CDUs. The steps are:

- Push the NAV RAD key (The ALTN NAV RADIO page will be shown.)
- Enter the frequency into the scratch pad.
- Line-select the frequency to the VOR frequency display line.

The selected frequency goes directly to the VOR receiver for tuning.

The preselect line position may be used to store alternate VOR frequency data. By using the line select keys, the data in the preselect position may be used to tune the onside VOR/MKR receiver.

VOR

Lufthansa
Technical Training

B747 - 400

017.01

34-51

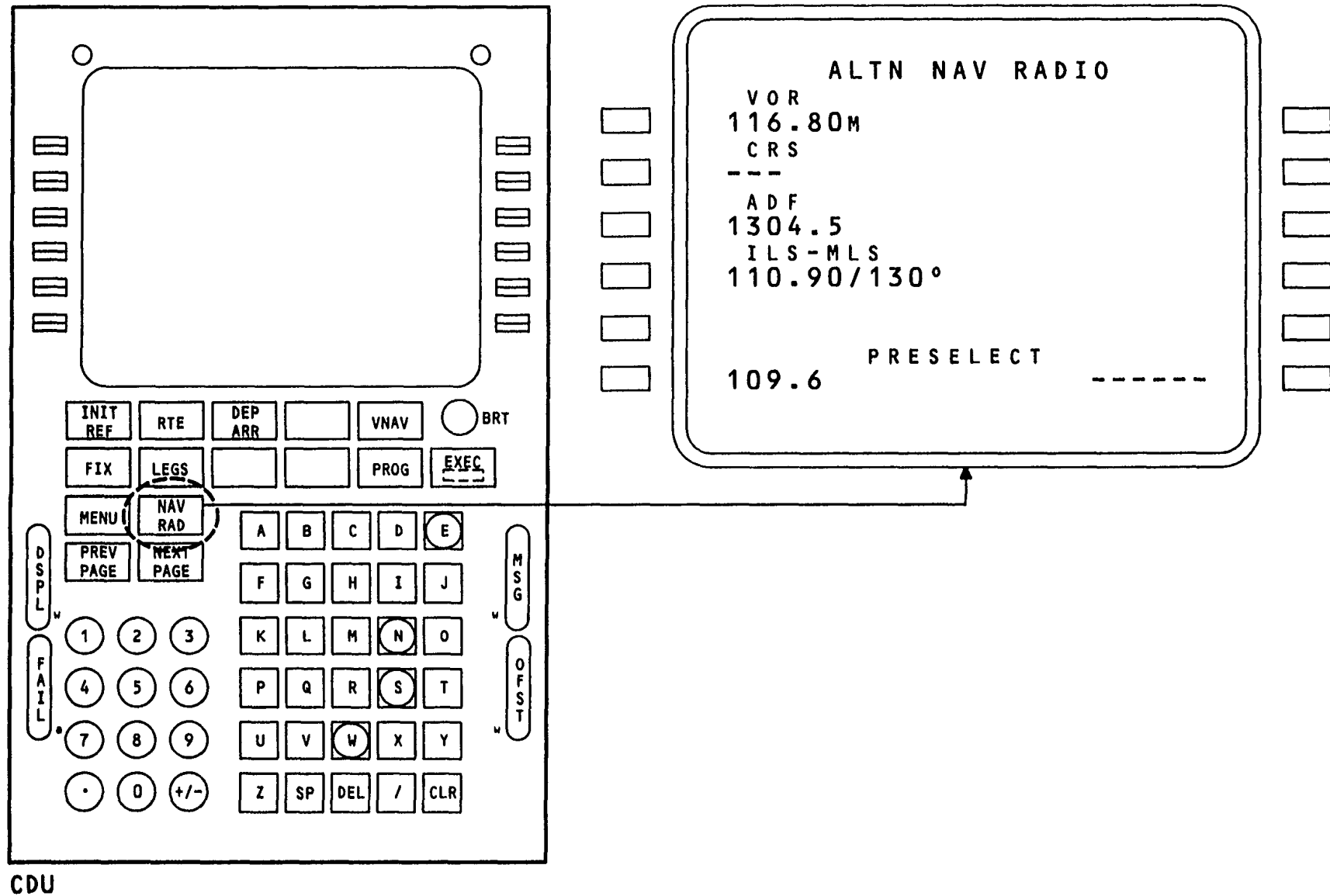


Figure 19 ALTERNATE TUNING



VOR

VOR MODE - SELECTED COURSE DISPLAYS

Selected Course and VOR Deviation

To show a selected VOR course on the ND:

- Select the VOR mode on the EFIS control panel (for a full compass rose display, press CTR on the EFIS control panel)
- Enter a course on the NAV radio page of the CDU for a route, procedure or manual tuned VOR.

The VOR deviation bar and scale show the lateral deviation from the selected course.

The ND uses selected course and the bearing to the VOR station to compute VOR deviation.

NAV Data Source

The NAV data source display shows which VOR system supplies the data. Left VOR shows on the Captains ND and right VOR shows on the First Officers ND.

To/From

The TO/FROM display shows whether the selected course will take the airplane to or from the VOR station.

VOR Frequency/Identifier

The VOR station identifier is shown on the ND. If the identifier is not available, it will be substituted by the station frequency.

VOR Raw Data

Set the raw data switches on the EFIS control panel to show the VOR stations and pointers. VOR data is green.

VOR

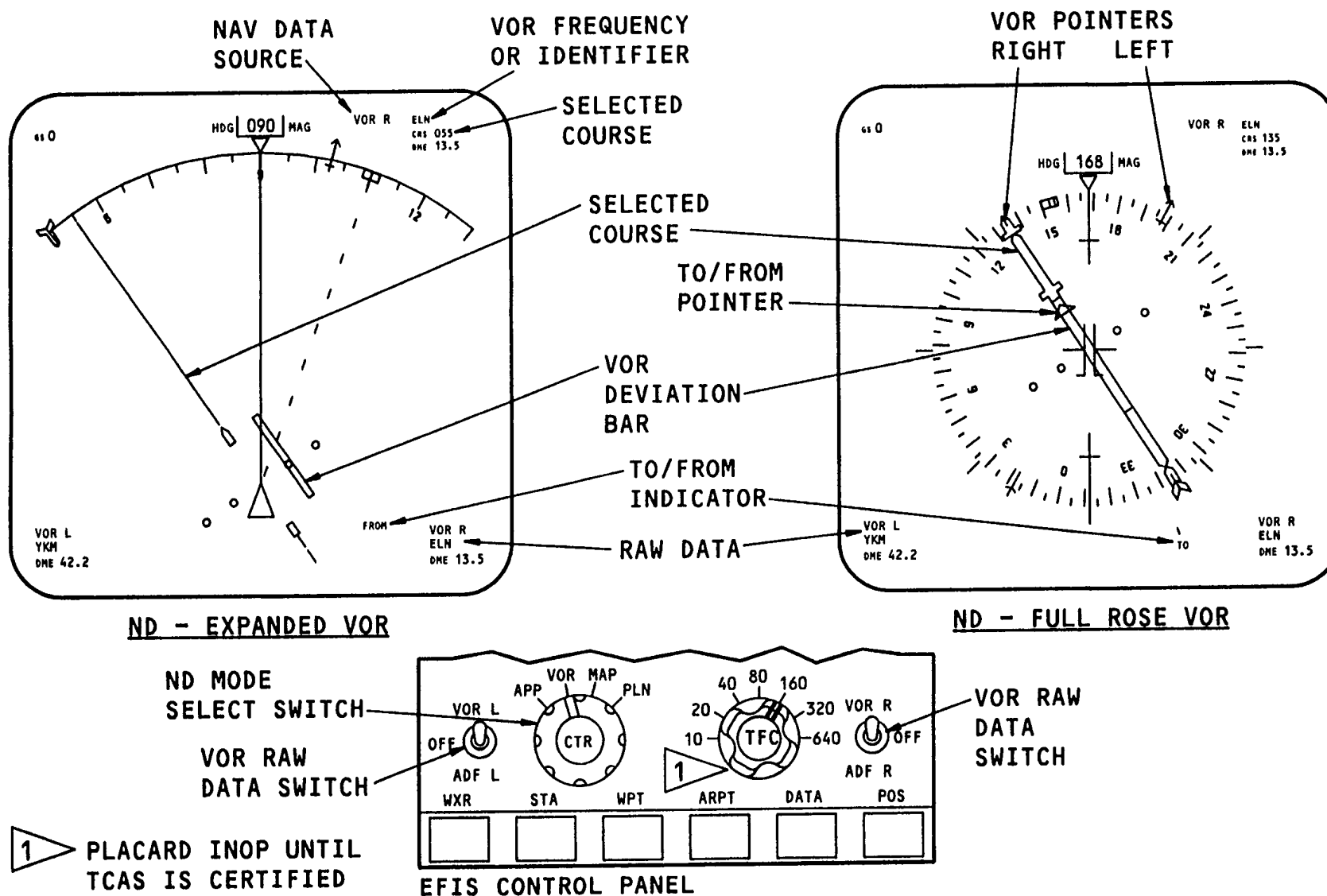


Figure 20 VOR MODE - SELECTED COURSE DISPLAYS

VOR

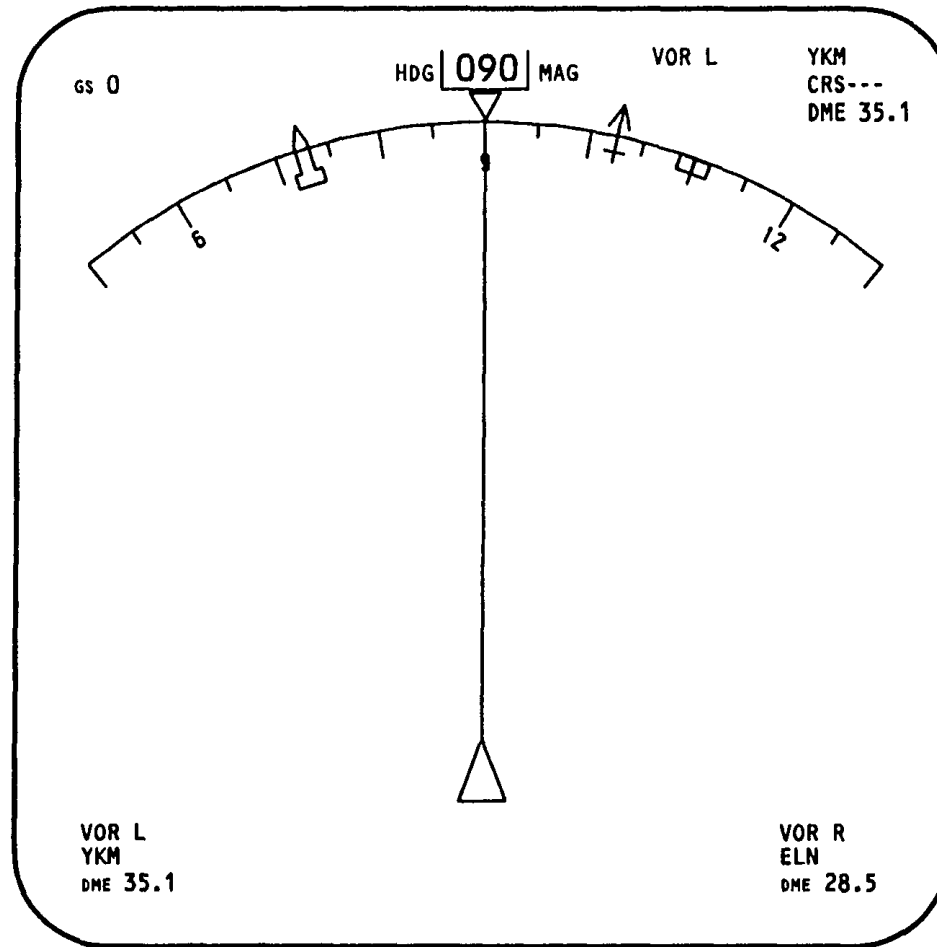


VOR MODE - NO COURSE DISPLAY

The following displays/symbols are removed with no course entered:

- VOR deviation bar
- VOR deviation scale
- Selected course pointer
- Selected course
- TO/FROM annunciation

VOR



ND - EXPANDED VOR

Figure 21 VOR MODE - NO COURSE DISPLAY



VOR

MAP MODE DISPLAYS

Nav aids

A maximum of two green colored nav aid symbols can show on the navigation display (ND).

VOR Bearing Pointers and VOR Raw Data Displays

VOR bearing pointers show when the raw data switches on the EFIS control panel are selected to the VOR position. VOR and DME data also shows in the left and right bottom corners of the ND. This VOR raw data shows with either an autotuned or manually tuned nav aid.

VOR Radials

A VOR radial is the magnetic bearing from a VOR station. VOR radials show on the map display when a VOR course is entered in the CDU. A maximum of two VOR radials will show on the ND. The radial is a green dotted line that extends for 700nm in both directions from the nav aid. The numeric bearing shows with the letter R for radial.

VOR

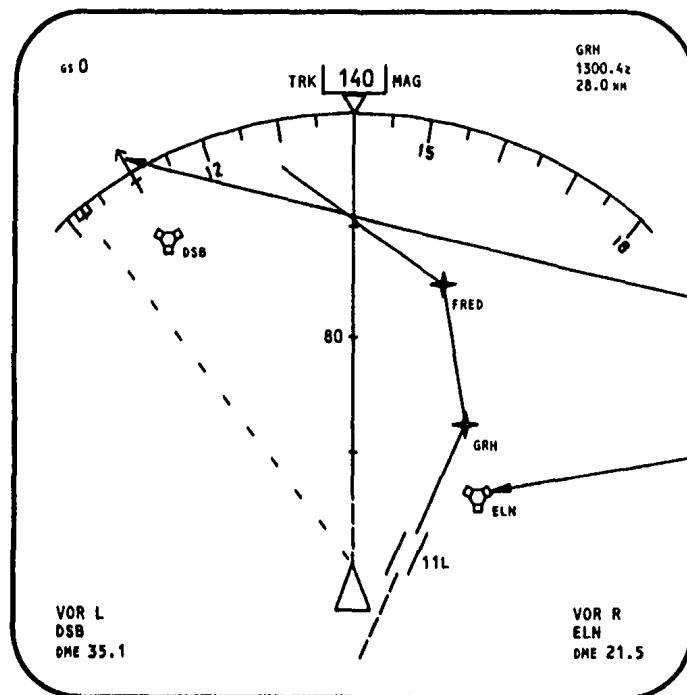


Lufthansa
Technical Training

B747 - 400

020.01

34-51



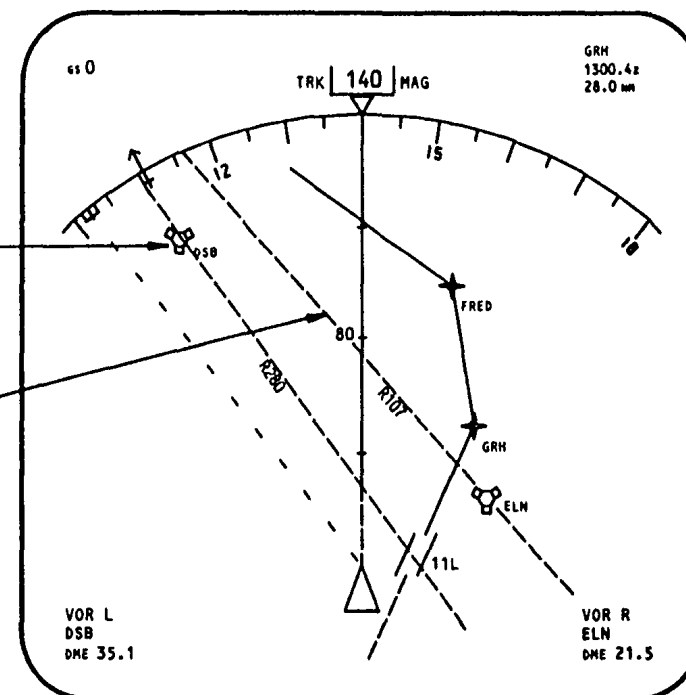
NO COURSE DISPLAY

TUNED
NAVAID

SELECTED
COURSE

VOR L
POINTER

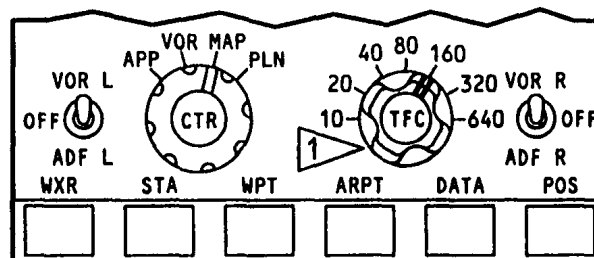
TUNED
NAVAID
NO COURSE



SELECTED COURSE DISPLAY



PLACARD INOP UNTIL
TCAS IS CERTIFIED



EFIS CONTROL PANEL

Figure 22 MAP MODE DISPLAYS

VOR



VOR BEARING NCD

VOR bearing no computed data (NCD) displays are caused by either VOR signals out-of-range, or by an antenna failure.

When an NCD VOR bearing condition exists, the ND removes the deviation bar and the TO/FROM indications.

VOR



**Lufthansa
Technical Training**

B747 - 400

021.01

34-51

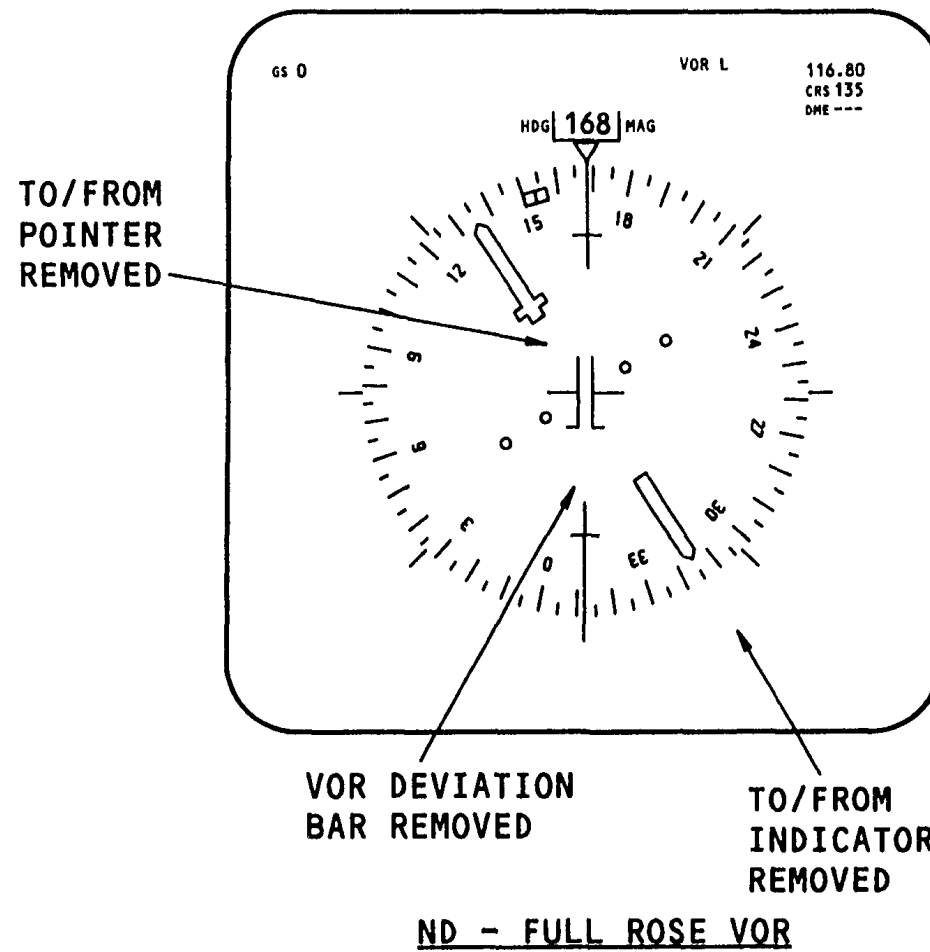
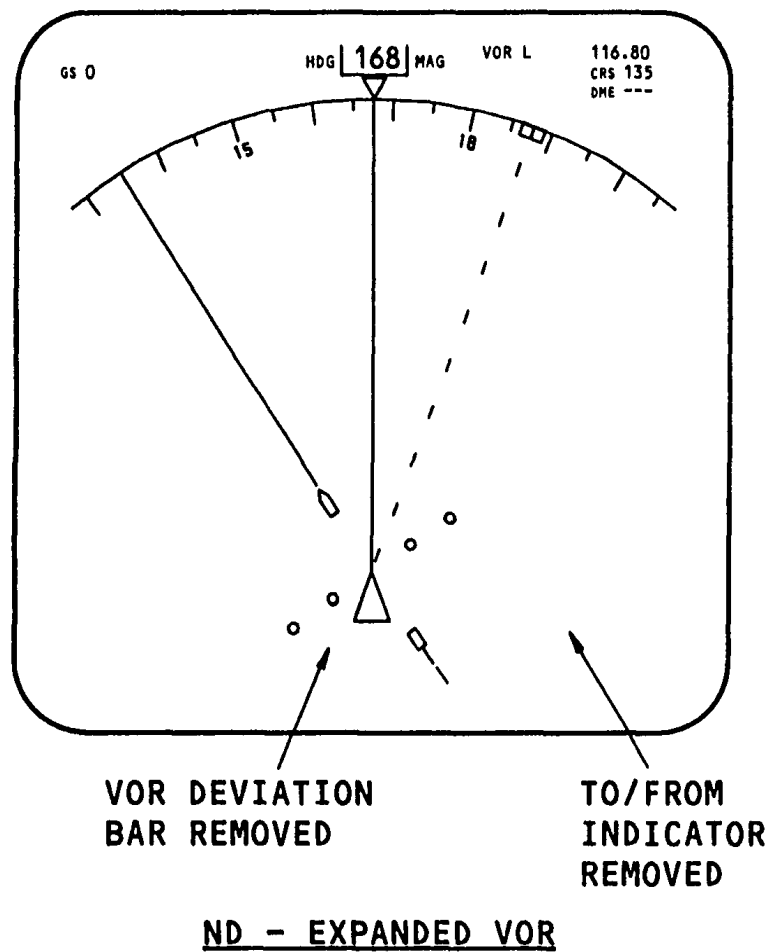


Figure 23 VOR BEARING NCD

VOR



VOR INVALID DISPLAYS

A VOR invalid condition occurs when the data from the VOR/MKR receiver is not valid.

When an invalid VOR condition exists, the VOR deviation bar and scale, the TO/FROM indications and the course pointer are removed and a VOR flag shows on the ND.

VOR

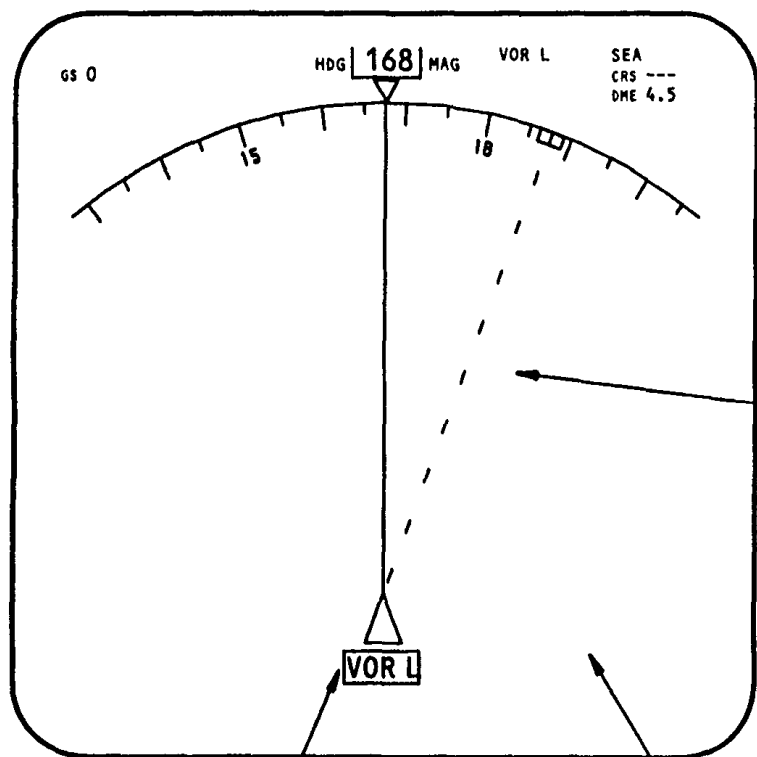


**Lufthansa
Technical Training**

B747 - 400

022.01

34-51



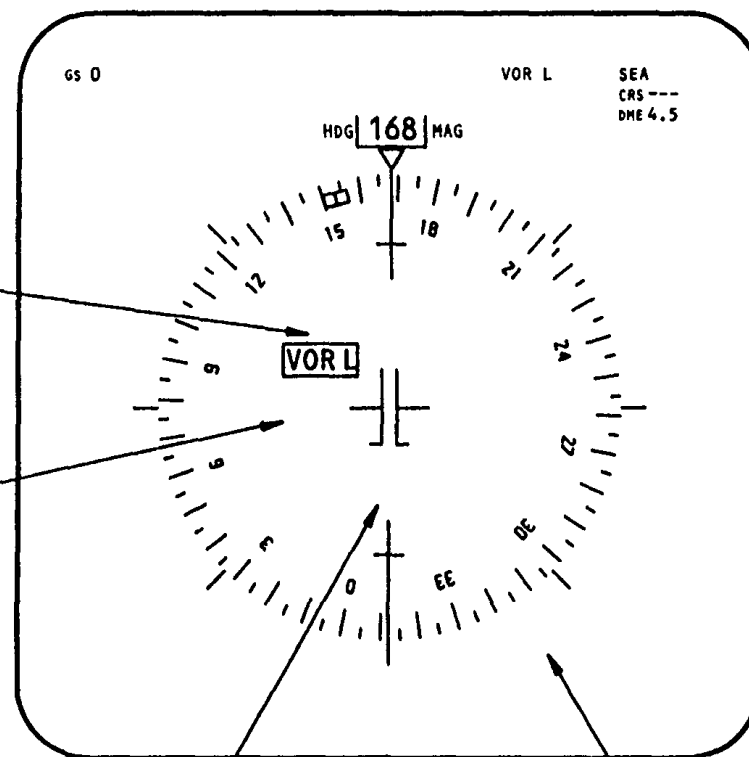
**VOR DEVIATION SCALE
AND BAR REMOVED**

**TO/FROM
INDICATOR
REMOVED**

ND - EXPANDED VOR

**TO/FROM
POINTER
REMOVED**

**COURSE
POINTER
REMOVED**



**VOR DEVIATION SCALE
AND BAR REMOVED**

**TO/FROM
INDICATOR
REMOVED**

ND - FULL ROSE

Figure 24 VOR INVALID DISPLAYS

VOR



VOR SELECTED COURSE AND FREQUENCY NCD

Selected Course

For selected course NCD:

- Selected course pointer is removed
- Selected course numbers are removed and replaced with dashes
- VOR deviation scale is removed
- VOR deviation bar is removed
- TO/FROM indications are removed

Frequency

For frequency NCD:

- TO/FROM indications are removed
- Frequency numbers are removed and are replaced with dashes

VOR



**Lufthansa
Technical Training**

B747 - 400

023.01

34-51

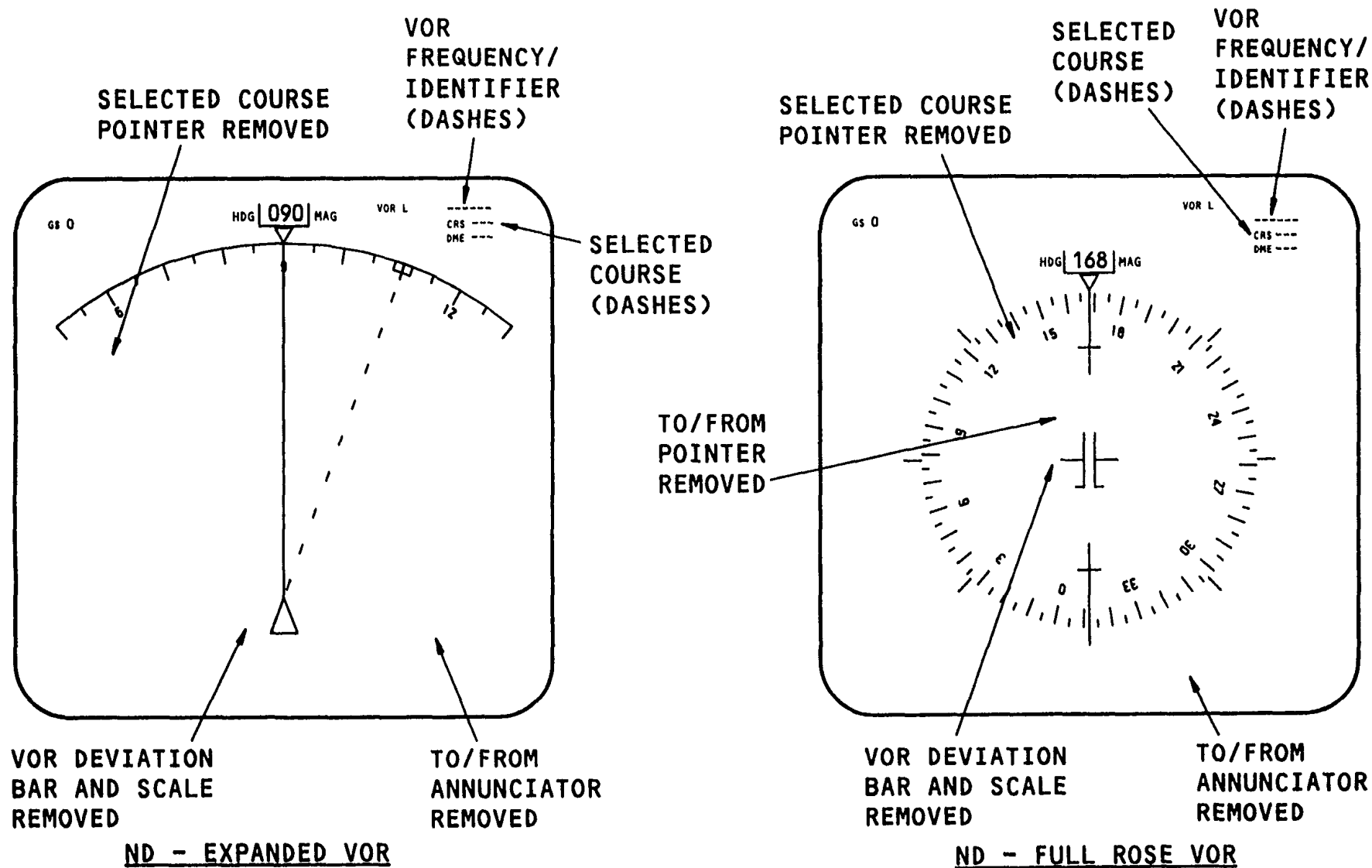


Figure 25 VOR SELECTED COURSE AND FREQUENCY NCD

VOR



SELECTED COURSE AND FREQUENCY INVALID

General

When the FMC sends an invalid selected course or frequency to the VOR, the VOR outputs an NCD course and frequency data word to the EIU. This causes the following data to be removed from the ND.

Selected Course

For selected course invalid:

- Selected course pointer is removed
- Selected course numbers are removed
- VOR deviation scale is removed
- VOR deviation bar is removed
- TO/FROM indications are removed

Frequency For frequency invalid:

- Frequency is removed
- TO/FROM indications are removed

VOR



**Lufthansa
Technical Training**

B747 - 400

024.01

34-51

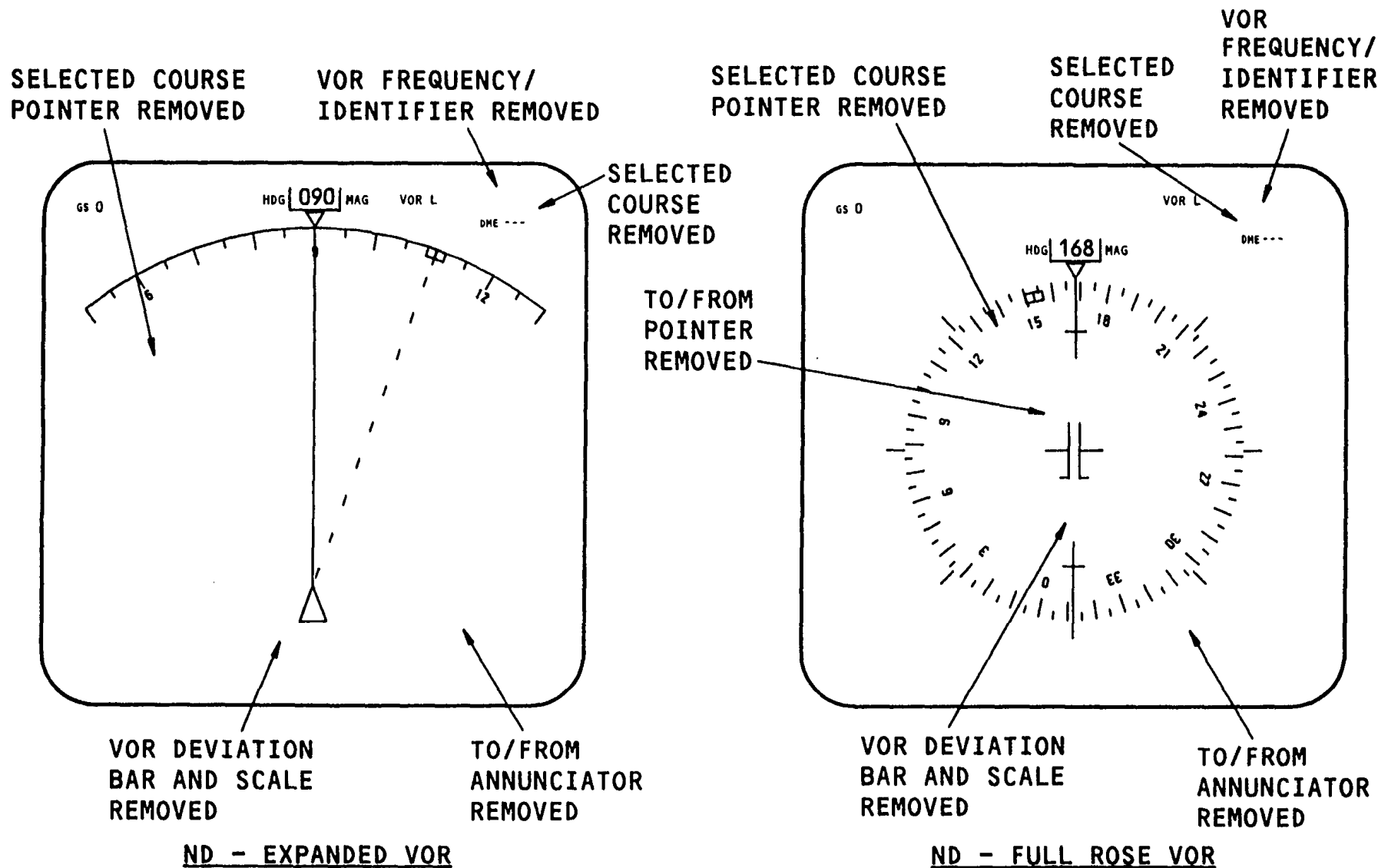


Figure 26 SELECTED COURSE AND FREQUENCY INVALID



THIS PAGE INTENTIONALLY LEFT BLANK

VOR



Lufthansa Technical Training

B747 - 400

025.01

34-51

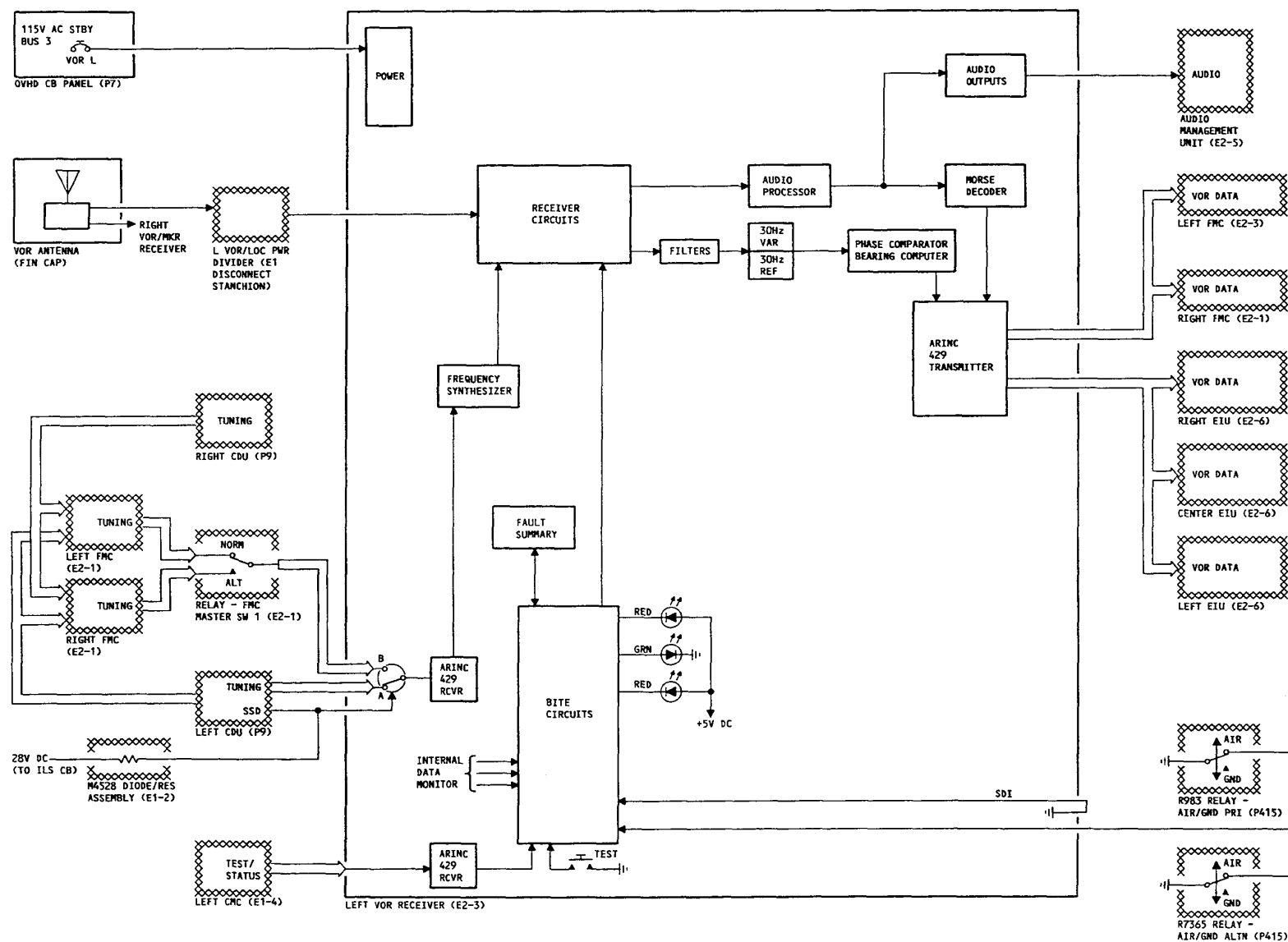


Figure 27 VOR – SCHEMATIC DIAGRAM



THIS PAGE INTENTIONALLY LEFT BLANK

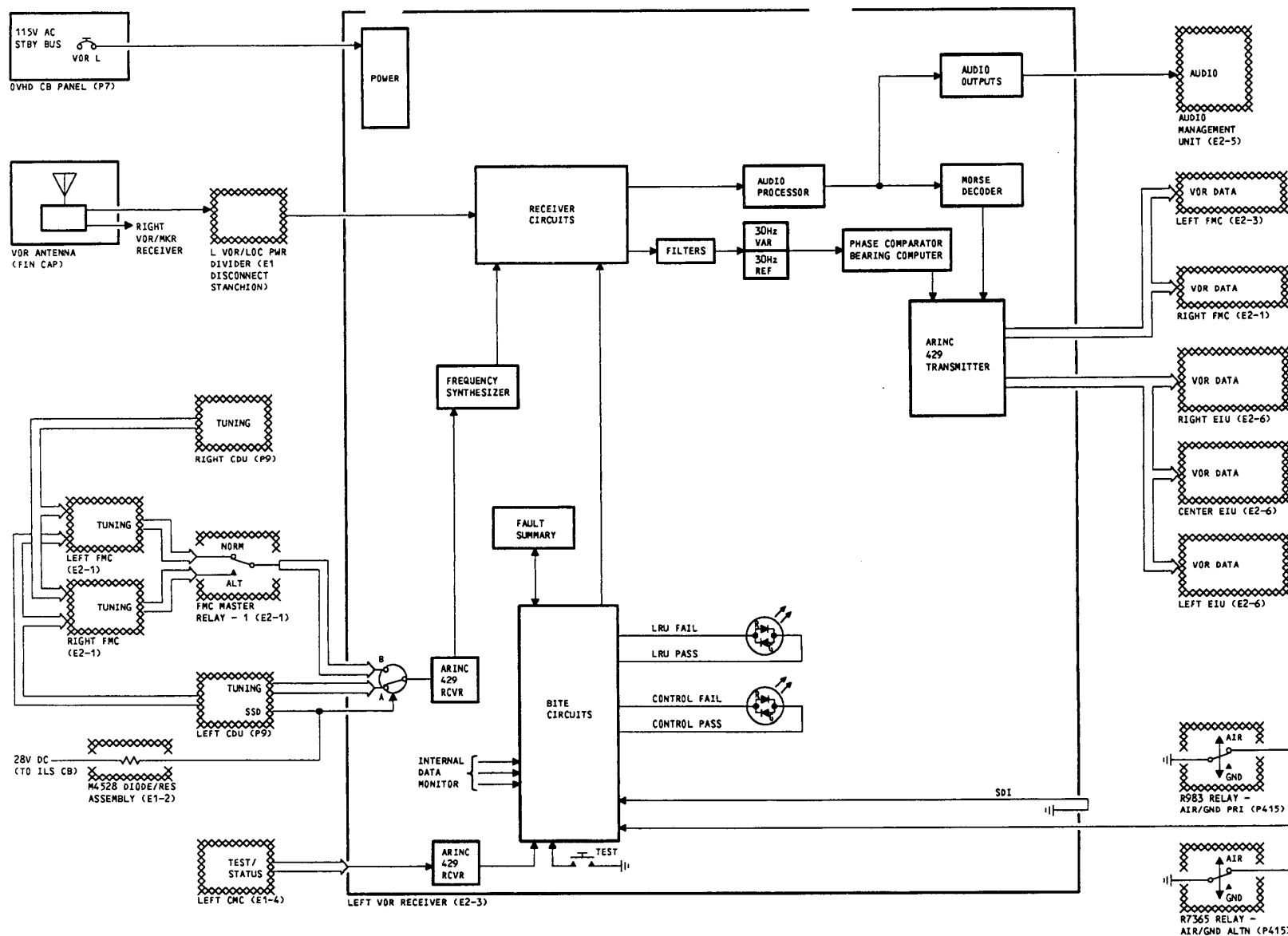


Figure 28 VOR – SCHEMATIC DIAGRAM (VOR-900)

VOR



LEFT RECEIVER TUNING

Normally, the selected FMC autotunes the VOR receiver. When the selected FMC fails, the FMC master switch must be placed in the other position to continue autotuning. In the air, if the master FMC fails or on the ground, if both FMCs fail, the CDU will send a ground discrete on the source select discrete (SSD) line. The VOR receiver will accept data directly from the left CDU.

VOR frequency data is sent from the input circuits to the frequency synthesizer circuits. The frequency synthesizer sends analog tuning voltages to the receiver circuits.

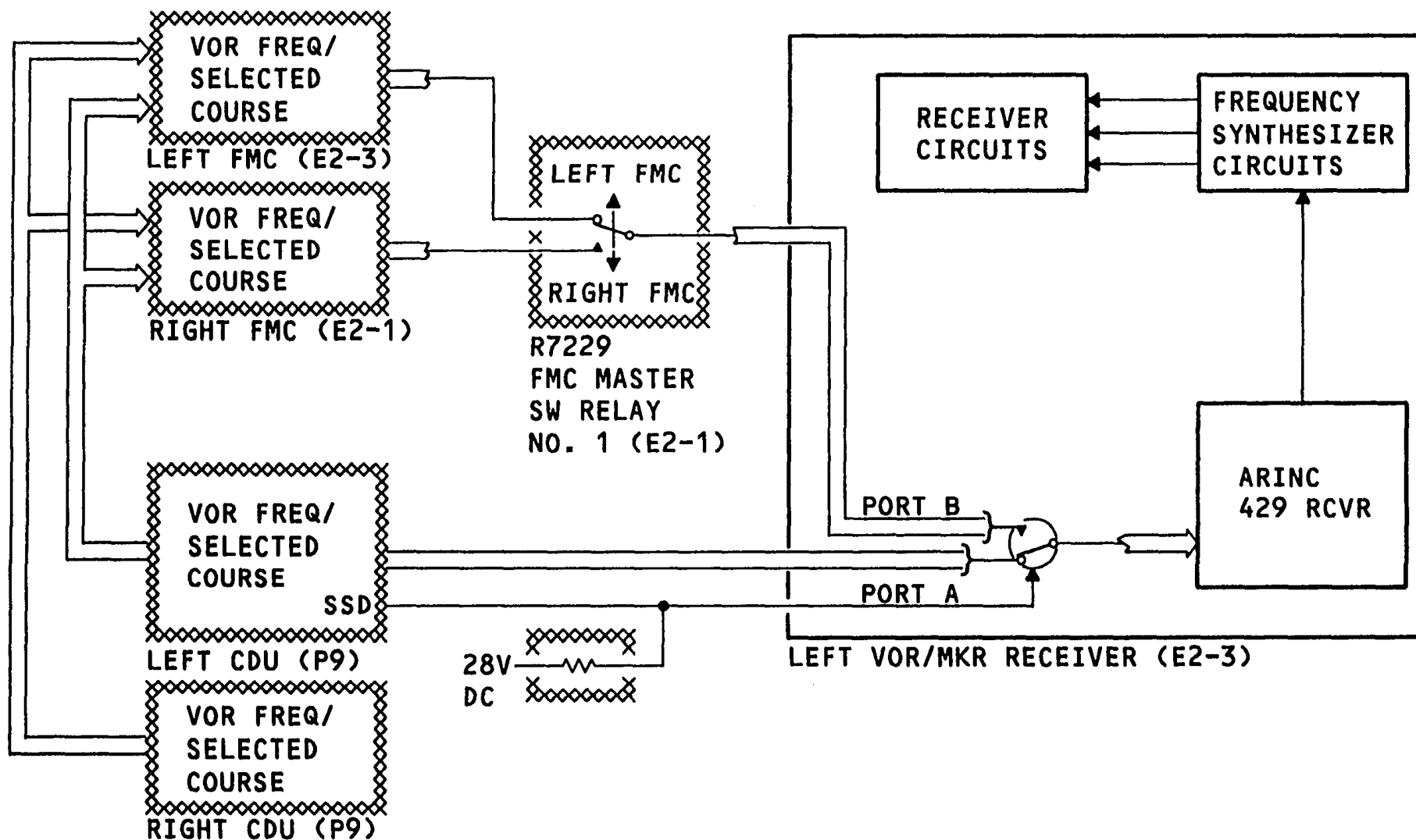


Figure 29 LEFT RECEIVER TUNING



VOR

RF SIGNAL PROCESSING

General

The receiver circuits process the RF signals from the VOR antenna, which is routed through the VOR/Localizer rf power divider. The synthesizer tunes the receiver circuits to the selected frequency.

The theory of VOR navigation includes a measurement of the phase difference between two transmitted signals. One signal is called the reference (REF) signal; the other signal is the variable (VAR) signal.

The reference signal is an rf carrier amplitude modulated with a 9960 Hz subcarrier. The subcarrier is frequency modulated +480 Hz at a 30 Hz rate.

The variable signal is an unmodulated rf carrier directional signal. It is rotated through 360 degrees at 30 rotations per second. This signal fluctuation that is received creates the same effect in the receiver's detector as a 30 Hz amplitude-modulated transmitted carrier will.

Phase Comparison

The reference 30 Hz signal and the variable 30 Hz signal are in-phase when the variable signal is aligned with the magnetic north (000) radial. An airplane on the radial receives both signals in-phase. On any other radial, the phase difference is equal to the angle of the radial from magnetic north.

Station Identifier

When the audio processor receives an audio identifier signal, it sends it to the Morse decoder. The Morse decoder changes this signal to a digital format.

The VOR data is sent to the EIUs and FMCs.

VOR

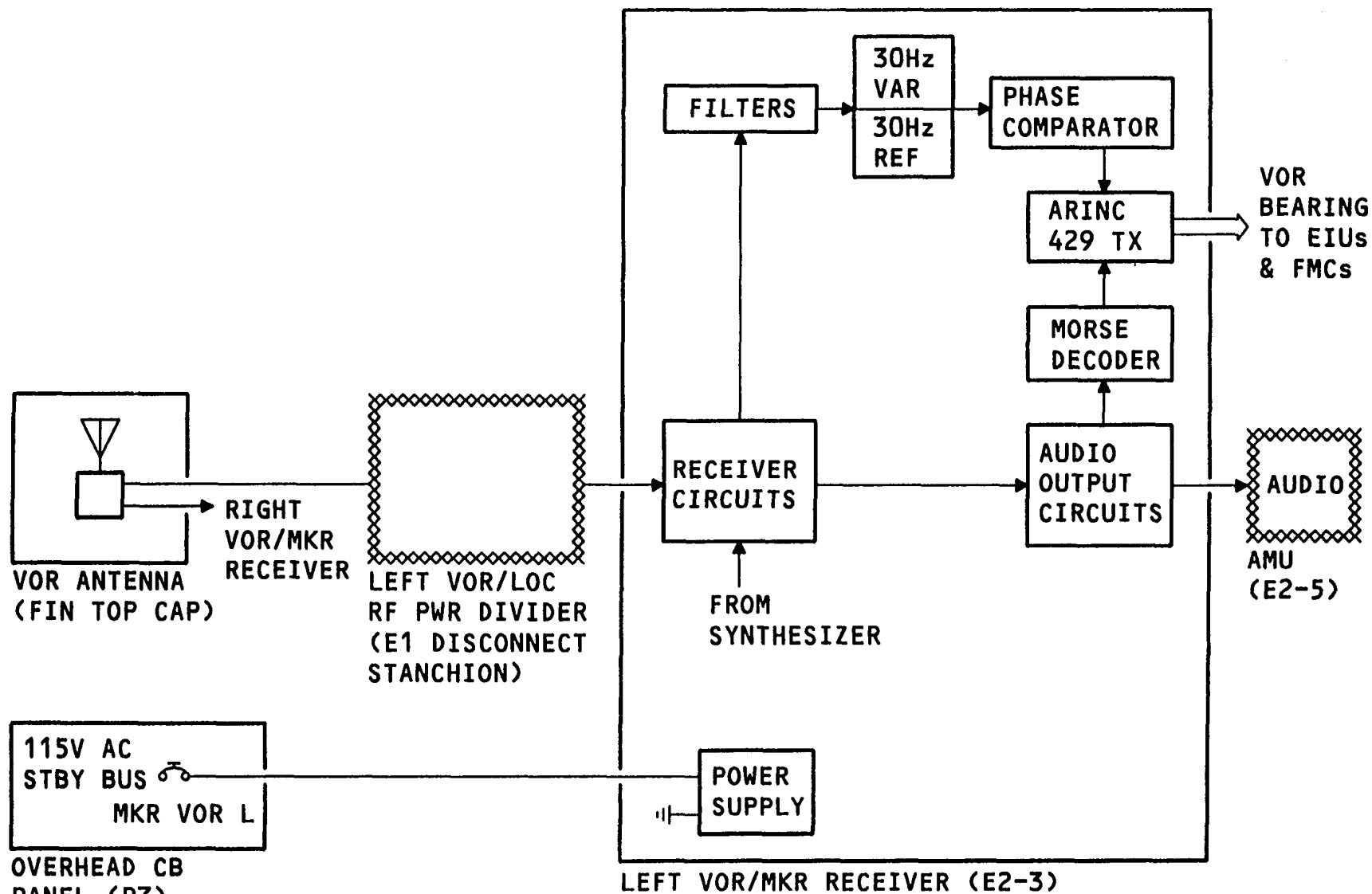


Figure 30 RF SIGNAL PROCESSING



VOR

TEST OPERATION

General

The BITE circuits monitor the VOR/MKR receiver for faults. These faults are grouped by flight legs. A flight leg is normally determined by a digital data discrete from the left CMC. This word is decoded in the processor circuits, then given to the BITE circuits. If both CMCs fail, a discrete input from the air/ground relay determines a flight leg.

VOR Navigation System Faults

Fault information can be accessed through the central maintenance computer system. Flight faults are sent to the processor circuits. Then they are sent to the CMCs through the EIUs.

VOR/MKR Receiver BITE

The BITE circuits test the operation of the VOR/MKR receiver. They also check the input data from the

FMCs and CDUs. BITE status can be checked by initiating a self-test on the front panel of the VOR/MKR receiver. The BITE test can also be done through the central maintenance computer system through the CDUs. The results of a test are shown on the CDU and on the front of the VOR/MKR receiver.

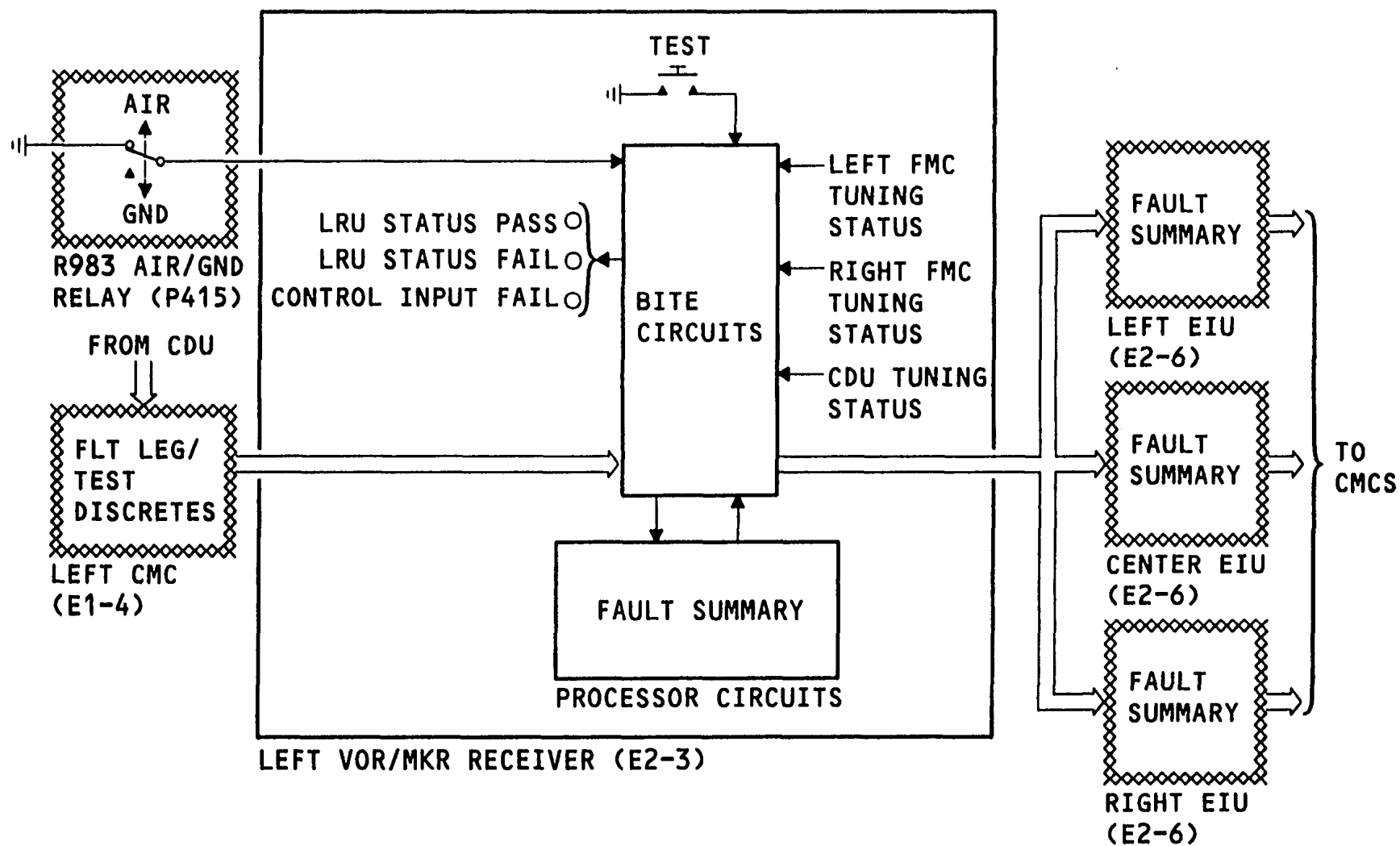


Figure 31 TEST OPERATION (VOR-700)



VOR

TEST OPERATION

General

The BITE circuits monitor the VOR/MKR receiver for faults. These faults are grouped by flight legs. A flight leg is determined by a discrete from the air/ground relay.

VOR Navigation System Faults

Fault information can be accessed through the central maintenance computer system. Flight faults are sent to the processor circuits. Then they are sent to the CMCs through the EIUs.

VOR/MKR Receiver BITE

The BITE circuits test the operation of the VOR/MKR receiver. They also check the input data from the FMCs and CDUs.

BITE status can be checked by initiating a self-test on the front panel of the VOR/MKR receiver. The BITE test can also be done through the central maintenance computer system through the CDUs. The results of a test are shown on the CDU and on the front of the VOR/MKR receiver.

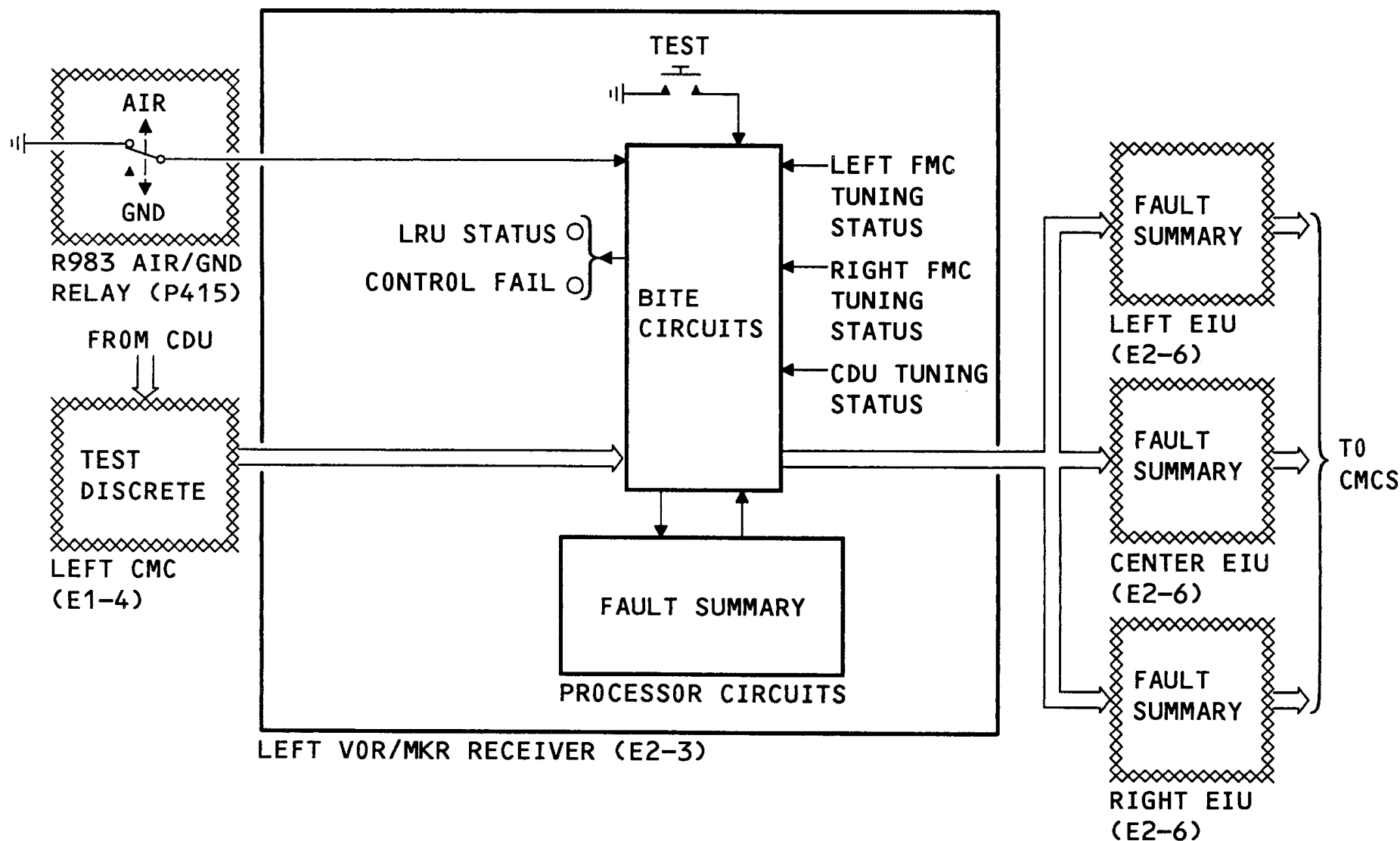


Figure 32 TEST OPERATION (VOR-900)

VOR



GROUND TEST PREPARATIONS

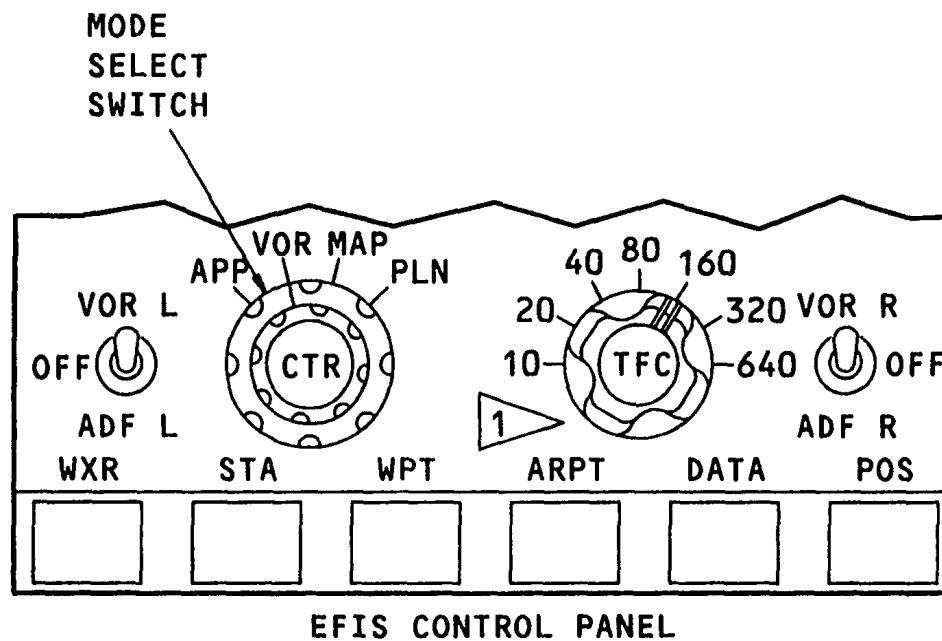
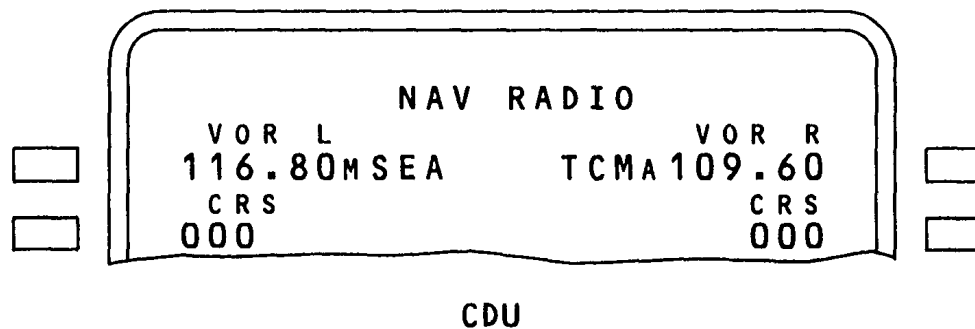
These VOR test preparations and procedures are for the left VOR navigation system. The test of the right system is done the same, with the controls and indicators for the right VOR system.

Before a test of the left system, do these steps:

- Move the mode select switch on the EFIS control panel to VOR
- Select any valid VOR frequency
- Select a course of 000 for the left system on the CDU

A VOR self-test can be performed from either front panel of the VOR/MKR receiver or from a CMC ground test page on a CDU.

VOR



1 PLACARD INOP UNTIL
TCAS IS CERTIFIED

Figure 33 GROUND TEST PREPARATIONS (VOR-700)

VOR



VOR / MKR RECEIVER SELF - TEST

To initiate the self-test push and hold the test switch on the front panel of the VOR/MKR receiver. Check the front panel of the receiver for this sequence:

- All LEDs come on for the first three seconds
- All LEDs go out for the next three seconds
- The green LRU STATUS PASS LED comes on and stays on until the end of the test (five seconds) for a valid self-test
- When there is a failure in the VOR receiver, the red LRU STATUS FAIL LED comes on
- When there is an invalid tuning source, the red CONTROL INPUT FAIL LED comes on

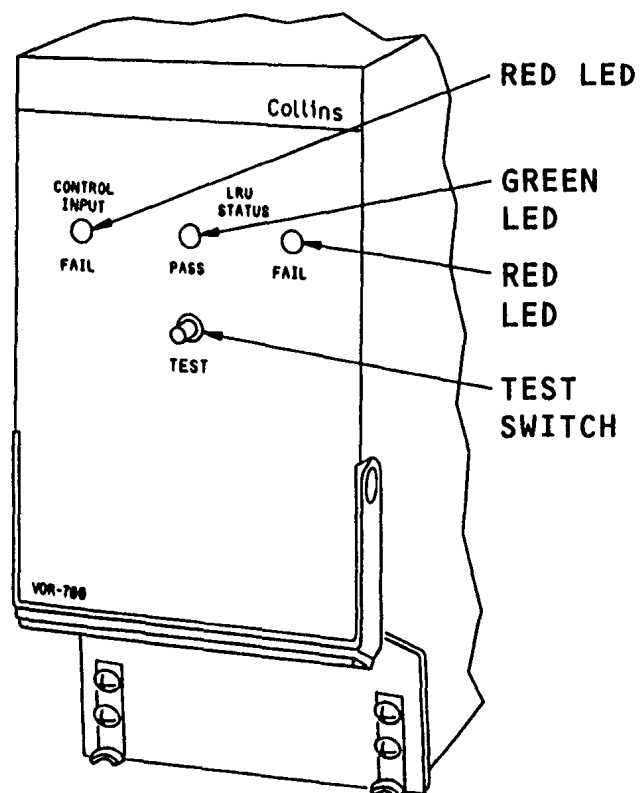
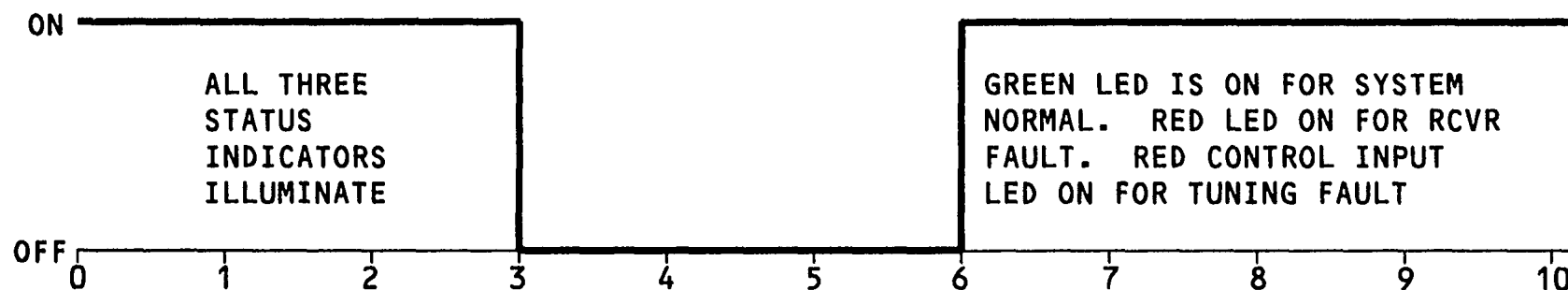


Figure 34 VOR/MKR RECEIVER SELF - TEST (VOR-700)



VOR





VOR/MKR RECEIVER SELF-TEST

To start the self-test push and release the test switch on the front panel of the VOR/MKR receiver. Check the front panel of the receiver for this sequence:

- LRU STATUS will show red for the first two seconds. It will show green for the next two seconds. It will then blank for eight seconds. Next, it will show status for thirty seconds.
- CONTROL FAIL will show red for the first four seconds, and blank for eight seconds, and status for the duration of the test.
- When there is an internal LRU fault the LRU STATUS will show red for status.
- When there is a control input fault the CONTROL FAIL LED will show red for status.

	0	1	2	3	4	12	
LRU STATUS PASS/FAIL		RED		GREEN		OFF	STATUS (30 SECONDS) 
CONTROL FAIL		RED				OFF	

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

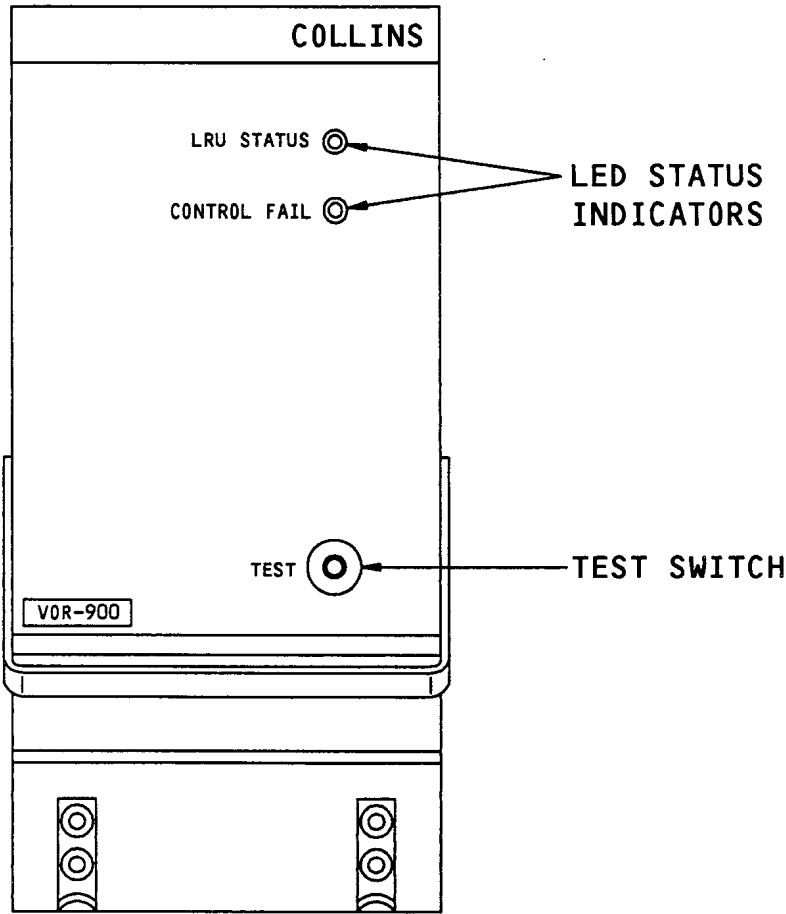


Figure 35 VOR/MKR RECEIVER SELF-TEST (VOR-900)

VOR



SELF - TEST - SEQUENCE 1

After initiating a self-test from the CDUs, these displays will show on the ND:

- VOR deviation scale and bar and TO/FROM indication removed from ND and the VOR flag displayed (VOR INVALID) for first three seconds.
- VOR deviation bar and TO/FROM indication removed from ND (VOR NCD) for the following three seconds.

VOR

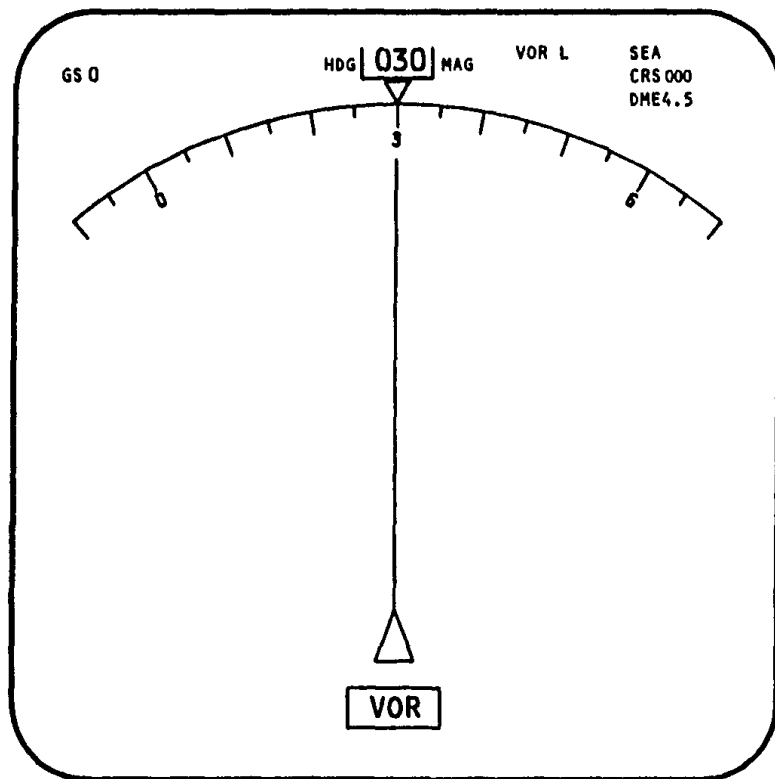


**Lufthansa
Technical Training**

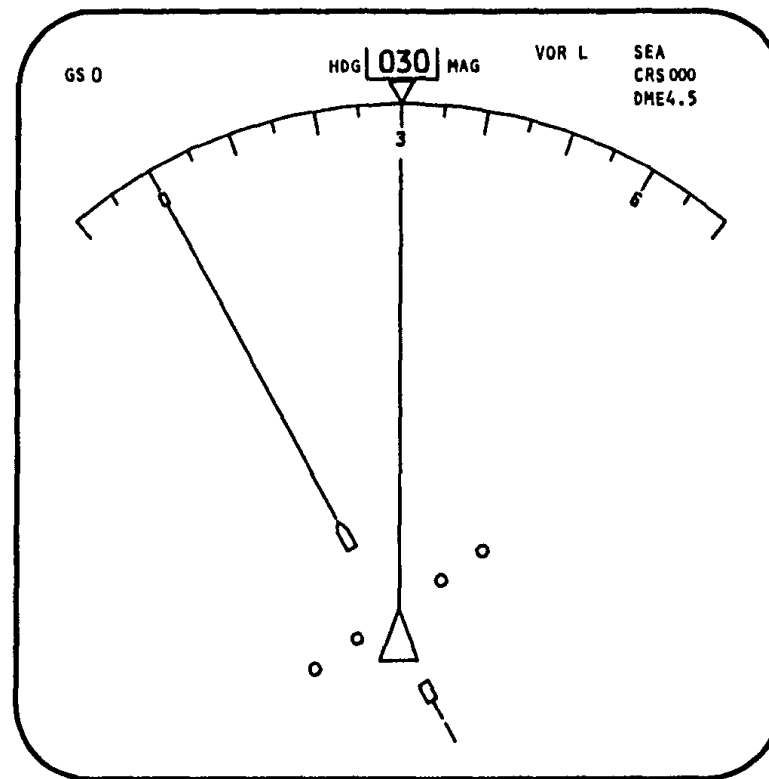
B747 - 400

031.01

34-51



**FIRST THREE SECONDS
INVALID DATA**



**FOLLOWING TWO SECONDS
NON-COMPUTED DATA**

ND - EXPANDED VOR

Figure 36 SELF - TEST - SEQUENCE 1

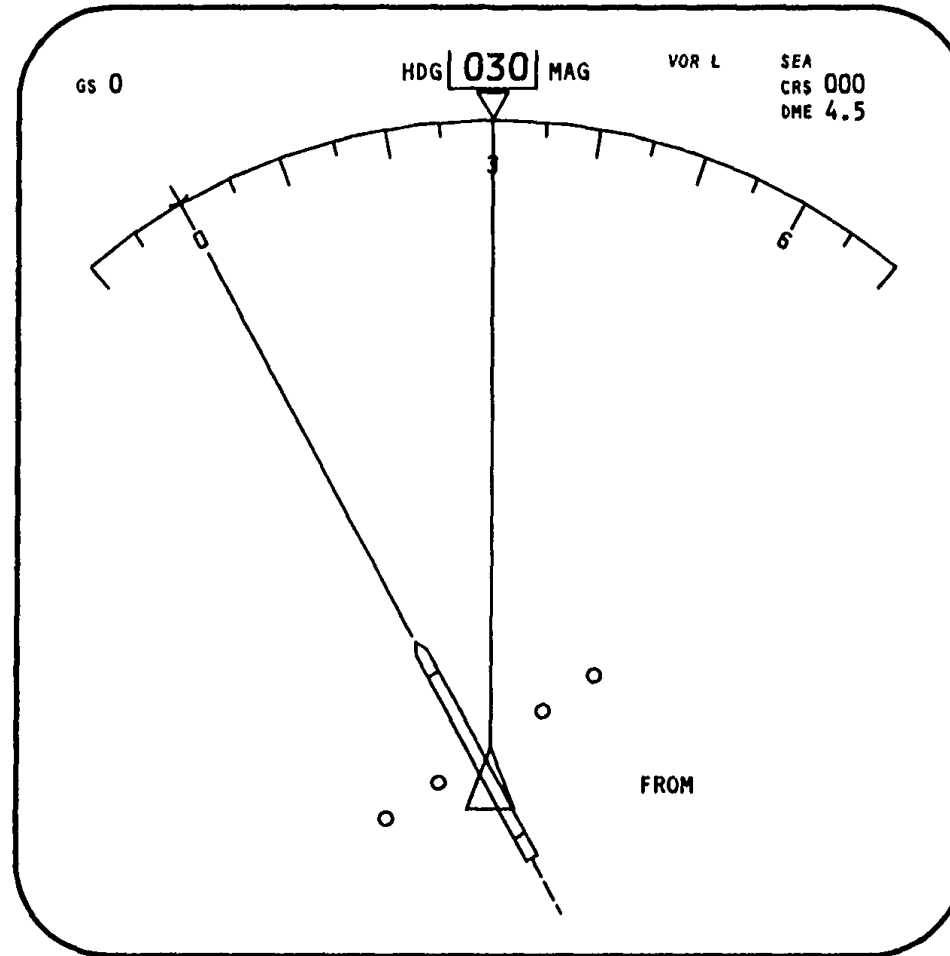
VOR**SELF - TEST - SEQUENCE 2**

After the first five seconds, these valid test displays will show on the ND:

- VOR deviation bar is in the center of ND
- TO/FROM indications show FROM on ND

Total time for the self-test is 10 seconds. After the self-test is completed, the ND continues its pre-test display.

VOR



ND - EXPANDED VOR

Figure 37 SELF - TEST - SEQUENCE 2

VOR



GROUND TEST

Ground Test

The CMC ground test menu on any CDU allows the operator to do ground tests of specific line replaceable units (LRUs). Push the line select key next to VOR - L to do a ground test of the left VOR/MKR receiver. A test preconditions screen will come up. Tune the VOR to be tested to a valid station and push the LSK start test. This test is the same as the self test that is done from the VOR/MKR receiver.

Ground Test Results

The word PASS on the same line shows a passed ground test. Failure of the ground test is shown by FAIL. Push the adjacent line select key this causes the ground test results page to be shown. This page gives more data about the test failure.

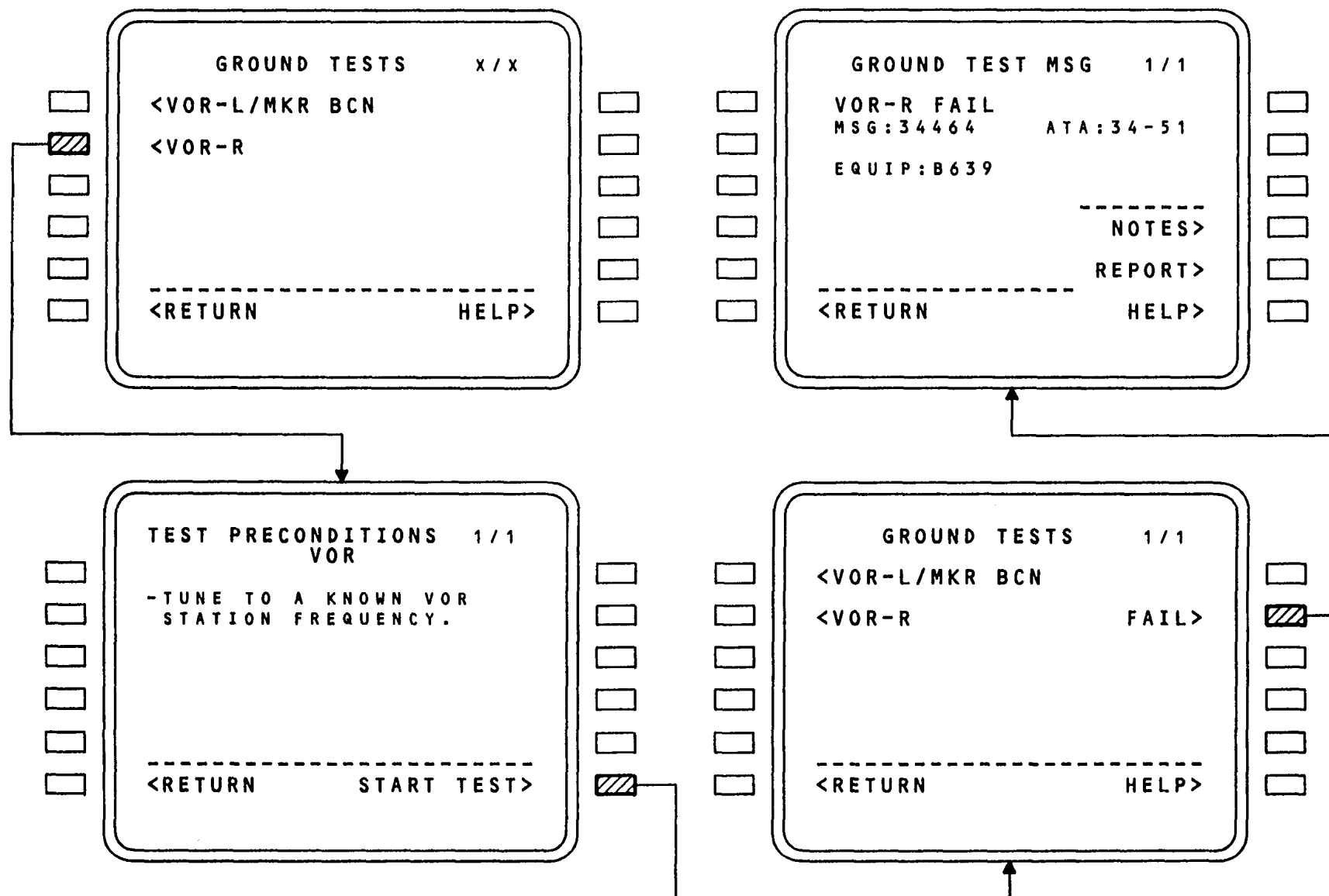


Figure 38 GROUND TEST

VOR



FLIGHT DECK EFFECTS AND CMC MESSAGES

Flight Deck Effects

A left or right VOR system failure causes VOR flags to show on the ND (navigation display) when the VOR mode is selected or the applicable raw data switch is set.

There are no EICAS messages for VOR failures.

CMC Messages

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

- CMC; VOR-X bus fail (ARINC 429 CMC to VOR receiver bus failure)
- VOR-X: EIU bus failure (ARINC 429 VOR to EIU bus failure)
- VOR-X: No test response (the VOR-X receiver failed to respond after a CMC ground test was started from the CDU)
- VOR-X: Receiver fail (VOR-X receiver failure)
- CDU: VOR-X bus fail (ARINC 429 CDU to VOR-X bus failure)
- FMC: VOR-X bus fail (ARINC 429 CDU to VOR-X bus failure)
- VOR-X-FMC-X bus fail (ARINC 429 VOR to FMC bus failure)
- VOR-X fail (FMC-X) (VOR failure sensed by the FMC)

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

VOR-X to FMC bus failures or VOR-X FAIL failures can be correlated to the VOR flag FDEs.

VOR

Lufthansa
Technical Training

B747 - 400

034.01

34-51

FLIGHT DECK EFFECT

VOR-X

TYPE

EFIS (ND) FLAG

DESCRIPTION

LEFT OR RIGHT VOR FAILURE

CMC MESSAGES

CMC ~ VOR-X BUS FAIL
VOR-X ~ EIU BUS FAIL
VOR-X - NO TEST RESPONSE
VOR-X - RECEIVER FAILURE
CDU-X ~ VOR-X BUS FAILURE
FMC-X ~ VOR-X BUS FAILURE
VOR-X ~ FMC-X BUS FAIL
VOR-X FAIL (FMC-X)



X = L (LEFT) OR R (RIGHT)

Figure 39 FLIGHT DECK EFFECTS AND CMC MESSAGES

TABLE OF CONTENTS

ATA 34-51 VOR	1	SELF - TEST - SEQUENCE 2	74
VOR NAVIGATION SYSTEM - INTRODUCTION	2	GROUND TEST	76
VOR NAVIGATION SYSTEM	4	FLIGHT DECK EFFECTS AND CMC MESSAGES	78
VOR NAVIGATION SYSTEM	6		
VOR COMPONENT LOCATIONS - 1	8		
COMPONENT LOCATIONS - FD	10		
POWER AND ANTENNA INPUTS	14		
TUNING INPUTS	16		
CMC INPUTS	18		
OUTPUTS	20		
AUDIO OUTPUTS	22		
ANALOG DISCRETES	24		
VOR / MKR RECEIVER	26		
VOR/MKR RECEIVER	28		
VOR ANTENNA	30		
AUDIO CONTROL	32		
AUTOTUNING	34		
MANUAL TUNING	36		
ALTERNATE TUNING	38		
VOR MODE - SELECTED COURSE DISPLAYS	40		
VOR MODE - NO COURSE DISPLAY	42		
MAP MODE DISPLAYS	44		
VOR BEARING NCD	46		
VOR INVALID DISPLAYS	48		
VOR SELECTED COURSE AND FREQUENCY NCD	50		
SELECTED COURSE AND FREQUENCY INVALID	52		
LEFT RECEIVER TUNING	58		
RF SIGNAL PROCESSING	60		
TEST OPERATION	62		
TEST OPERATION	64		
GROUND TEST PREPARATIONS	66		
VOR / MKR RECEIVER SELF - TEST	68		
VOR/MKR RECEIVER SELF-TEST	70		
SELF - TEST - SEQUENCE 1	72		

TABLE OF FIGURES

Figure 1	VOR NAVIGATION SYSTEM - INTRODUCTION	3	Figure 31	SELF - TEST - SEQUENCE 1	73
Figure 2	VOR NAVIGATION SYSTEM	5	Figure 32	SELF - TEST - SEQUENCE 2	75
Figure 3	VOR NAVIGATION SYSTEM	7	Figure 33	GROUND TEST	77
Figure 3	COMPONENT LOCATIONS - 1	9	Figure 34	FLIGHT DECK EFFECTS AND CMC MESSAGES ...	79
Figure 4	COMPONENT LOCATIONS - FD	11			
Figure 5	VOR – INTERFACE DIAGRAM	13			
Figure 6	POWER AND ANTENNA INPUTS	15			
Figure 7	TUNING INPUTS	17			
Figure 8	CMC INPUTS	19			
Figure 9	OUTPUTS	21			
Figure 10	AUDIO OUTPUTS	23			
Figure 11	ANALOG DISCRETES	25			
Figure 12	VOR / MKR RECEIVER (Collins VOR-700)	27			
Figure 14	VOR/MKR RECEIVER	29			
Figure 13	VOR ANTENNA	31			
Figure 14	AUDIO CONTROL	33			
Figure 15	AUTOTUNING	35			
Figure 16	MANUAL TUNING	37			
Figure 17	ALTERNATE TUNING	39			
Figure 18	VOR MODE - SELECTED COURSE DISPLAYS	41			
Figure 19	VOR MODE - NO COURSE DISPLAY	43			
Figure 20	MAP MODE DISPLAYS	45			
Figure 21	VOR BEARING NCD	47			
Figure 22	VOR INVALID DISPLAYS	49			
Figure 23	VOR SELECTED COURSE AND FREQUENCY NCD .	51			
Figure 24	SELECTED COURSE AND FREQUENCY INVALID ..	53			
Figure 25	VOR – SCHEMATIC DIAGRAM	55			
Figure 1	VOR – SCHEMATIC DIAGRAM	57			
Figure 26	LEFT RECEIVER TUNING	59			
Figure 30	RF SIGNAL PROCESSING	61			
Figure 31	TEST OPERATION	63			
Figure 1	TEST OPERATION	65			
Figure 33	GROUND TEST PREPARATIONS	67			
Figure 34	VOR/MKR RECEIVER SELF - TEST	69			
Figure 1	VOR/MKR RECEIVER SELF-TEST	71			

