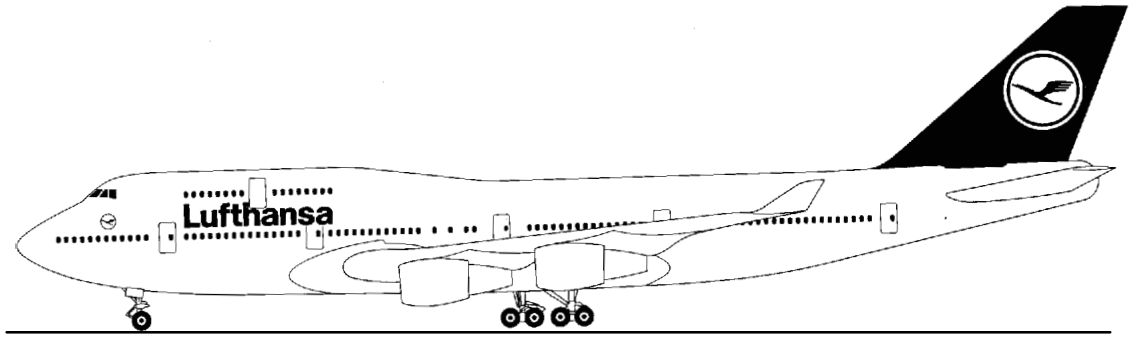
Lufthansa Technical Training

Training Manual B 747-400



ATA 34-31
ILS

ATA Spec. 104 Level 3

Book No:

Lufthansa
Technical Training GmbH
Lufthansa Base

Issue: Nov 2001
For Training Purposes Only

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ATA 34-31 INSTRUMENT LANDING SYSTEM

INSTRUMENT LANDING SYSTEM INTRODUCTION

Purpose

The multi mode receiver (MMR) contains these functions:

- Instrument landing system (ILS) function
- Global positioning system (GPS) function
- Microwave landing system (MLS) function.

The ILS function gives precise lateral and vertical position data necessary for approach to put the airplane on the runway. The system uses signals from a glideslope ground station and a localizer ground station.

The glideslope ground station transmits signals to give the airplane a descent path to the touchdown point on the runway. The localizer ground station transmits signals to give the airplane lateral guidance to the runway centerline.

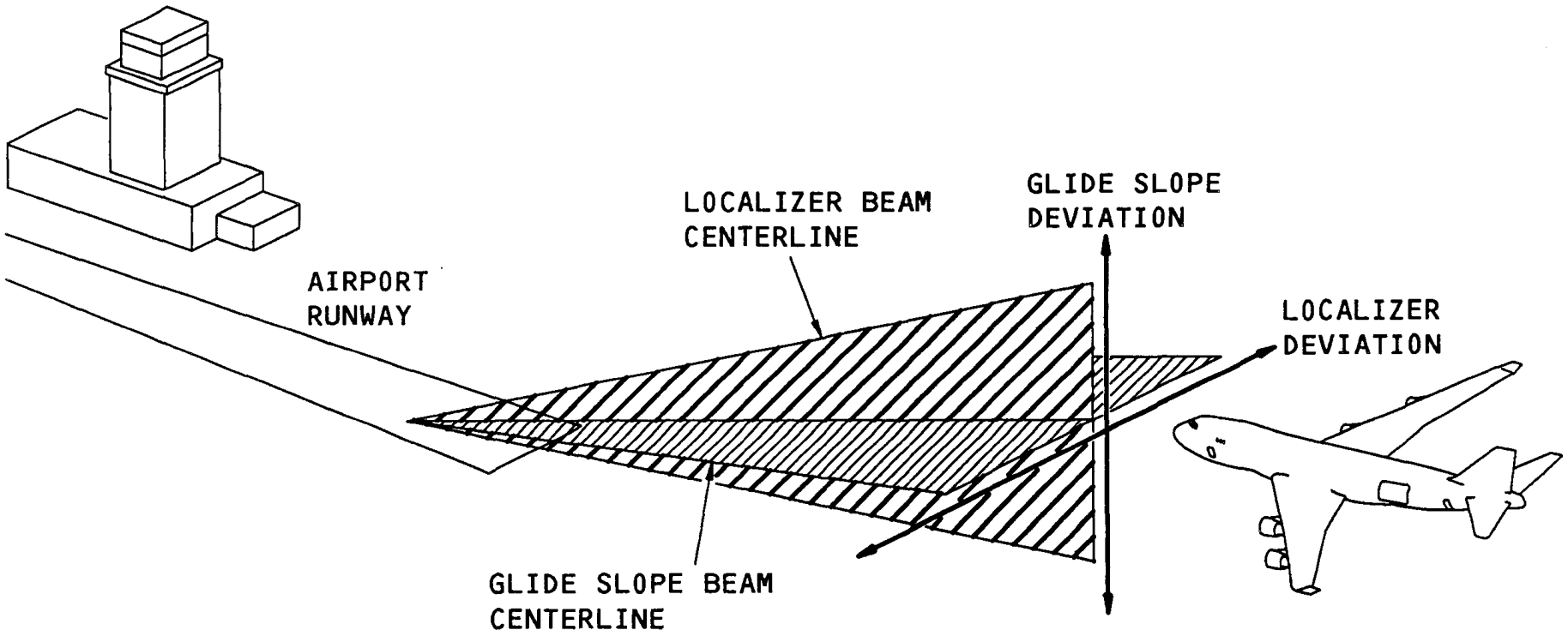

Figure 1 INSTRUMENT LANDING SYSTEM INTRODUCTION

INSTRUMENT LANDING SYSTEM

General

The instrument landing system (ILS) has three multi mode receivers (MMR) that contain the ILS functions. The ILS function in the MMRs use inputs from these antennas:

- VOR/LOC antenna
- Localizer antenna
- Glideslope antenna.

Description

The ILS calculates vertical deviation from the GIS beam and horizontal deviation from the LOC beam. Interfacing systems use the computed data from the ILS to aid in the precision landing of the airplane.

The master flight management computer (FMC), automatically tunes the ILS receivers. Use the control display unit (CDU) to manually tune the ILS receivers.

The central maintenance computer (CMC) performs an ILS ground test when started on the CDU.

The VOR/LOC antenna and the localizer antenna send localizer signals to the ILS receivers. The glideslope antenna sends glideslope signals to the ILS receivers. The ILS receiver gets antenna inputs through the GIS antenna switch relay and the VOR/LOC antenna switch.

The ILS receivers send ILS data to these systems:

- IDS
- GPWS
- FMC'S
- FCC's
- DMU.

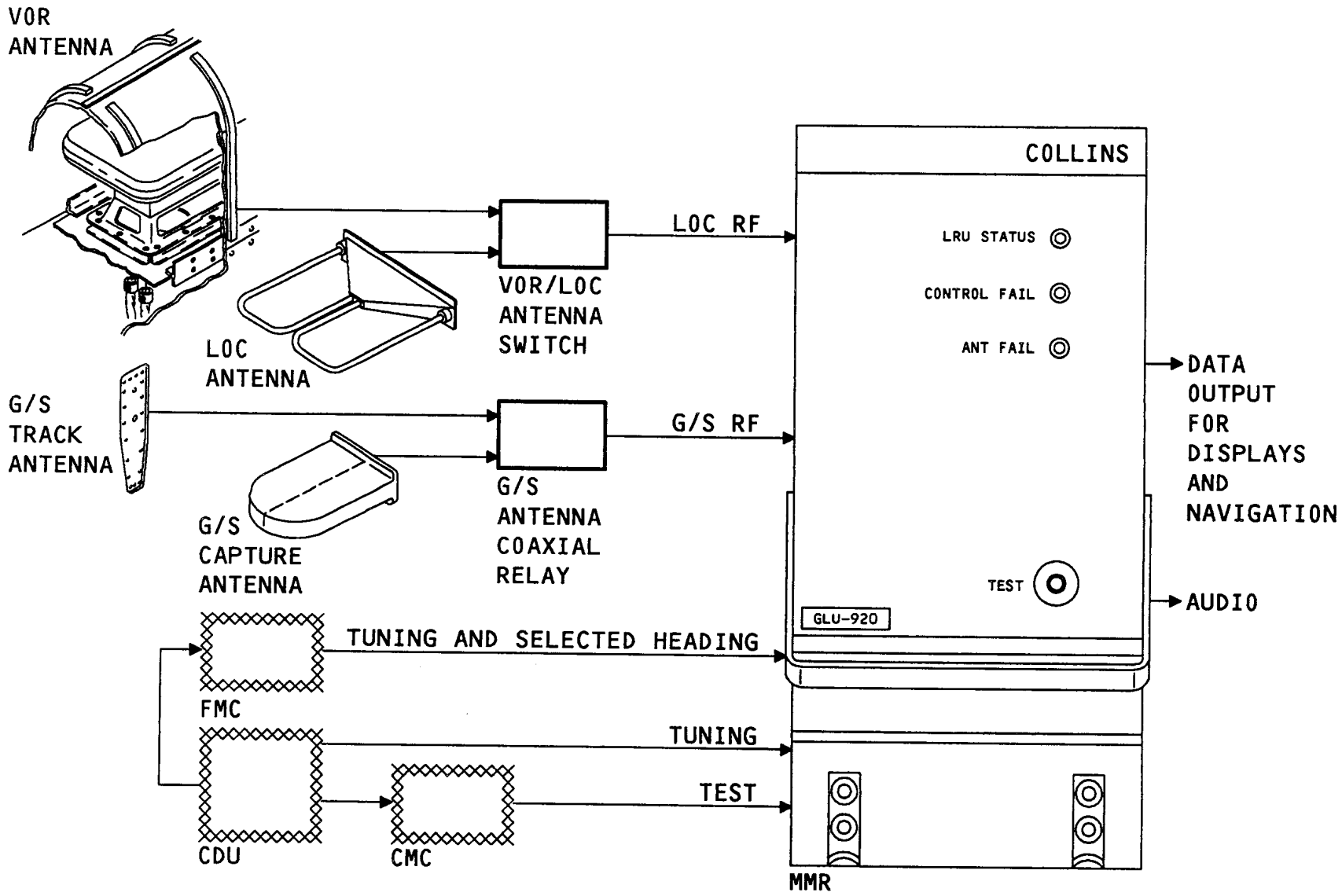

Figure 2 INSTRUMENT LANDING SYSTEM

COMPONENT LOCATIONS - FD

These are the flight deck components:

- Left, center and right MMR circuit breakers
- Left, center and right ILS antenna switching circuit breakers.

These are the ILS display components in the flight deck:

- Pilots' IDUs.

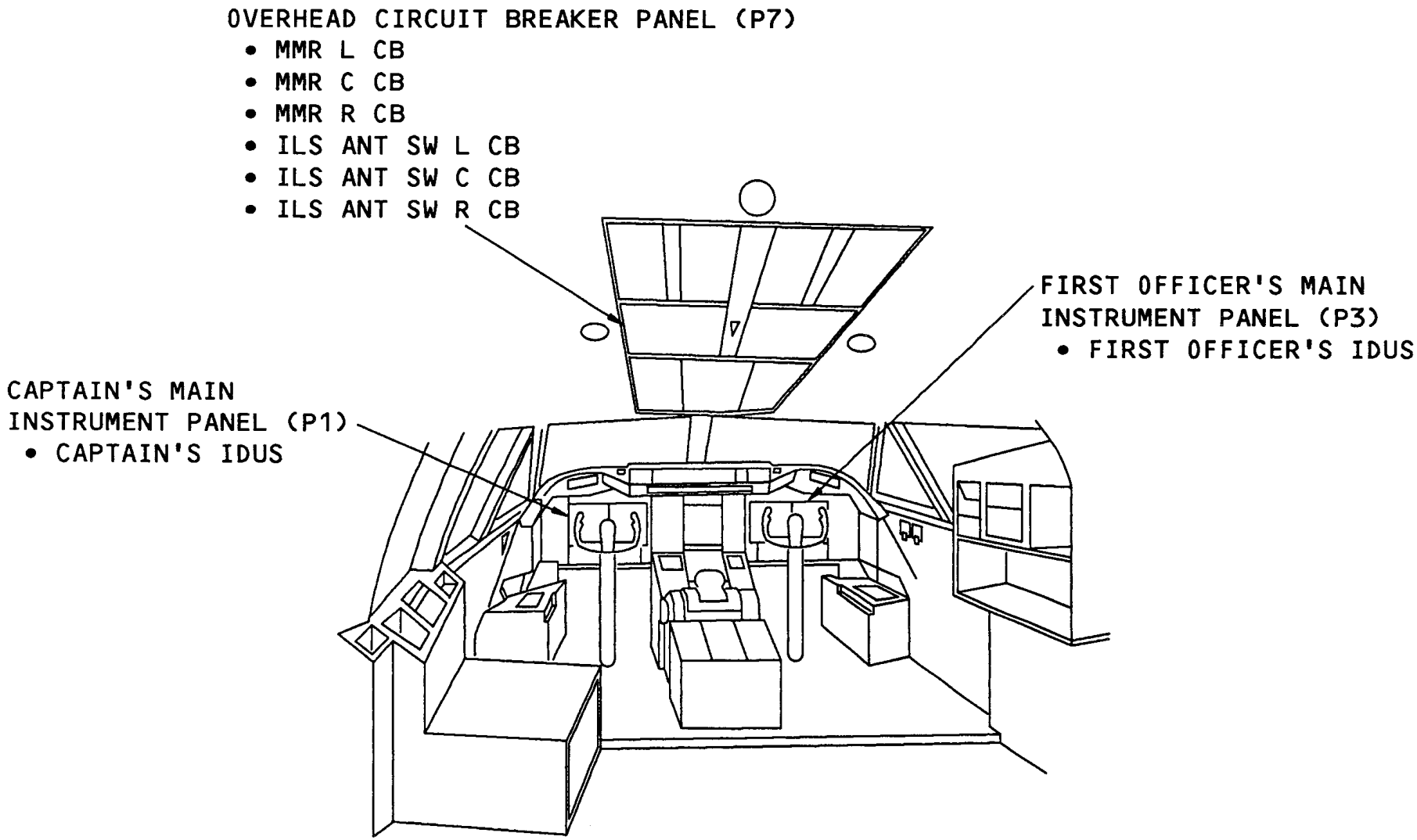

Figure 3 COMPONENT LOCATIONS - FD

COMPONENT LOCATIONS - MEC

These ILS components are in the main equipment center:

- Left, center and right Multi Mode receivers (MMR)
- Left, center and right VOR/LOC antenna switches
- eft VOR/LOC rf power divider
- Right VOR/LOC rf power divider
- Right and center localizer rf power divider
- Left, center and right glide slope antenna coaxial relays.

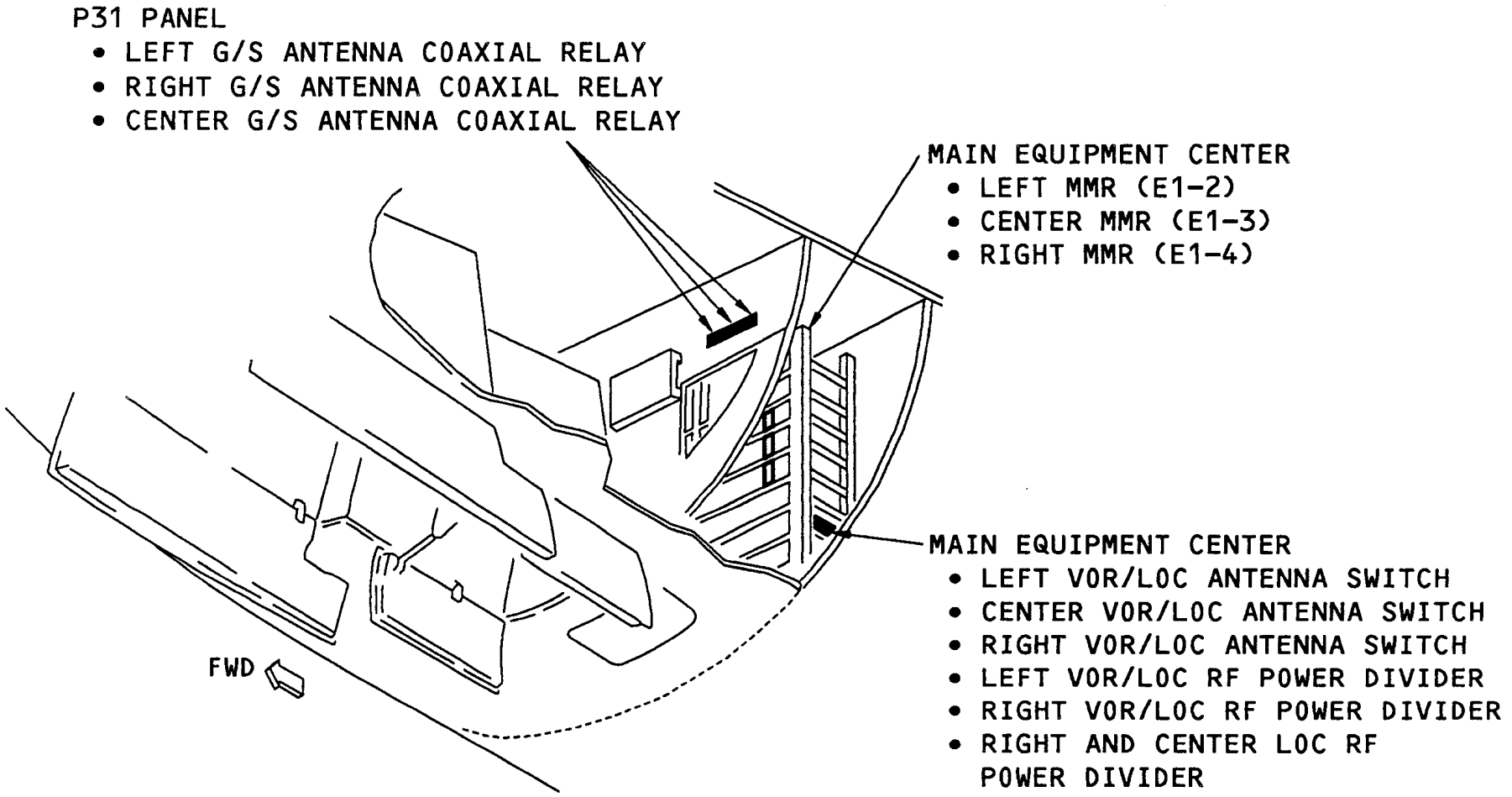

Figure 4 COMPONENT LOCATIONS - MEC

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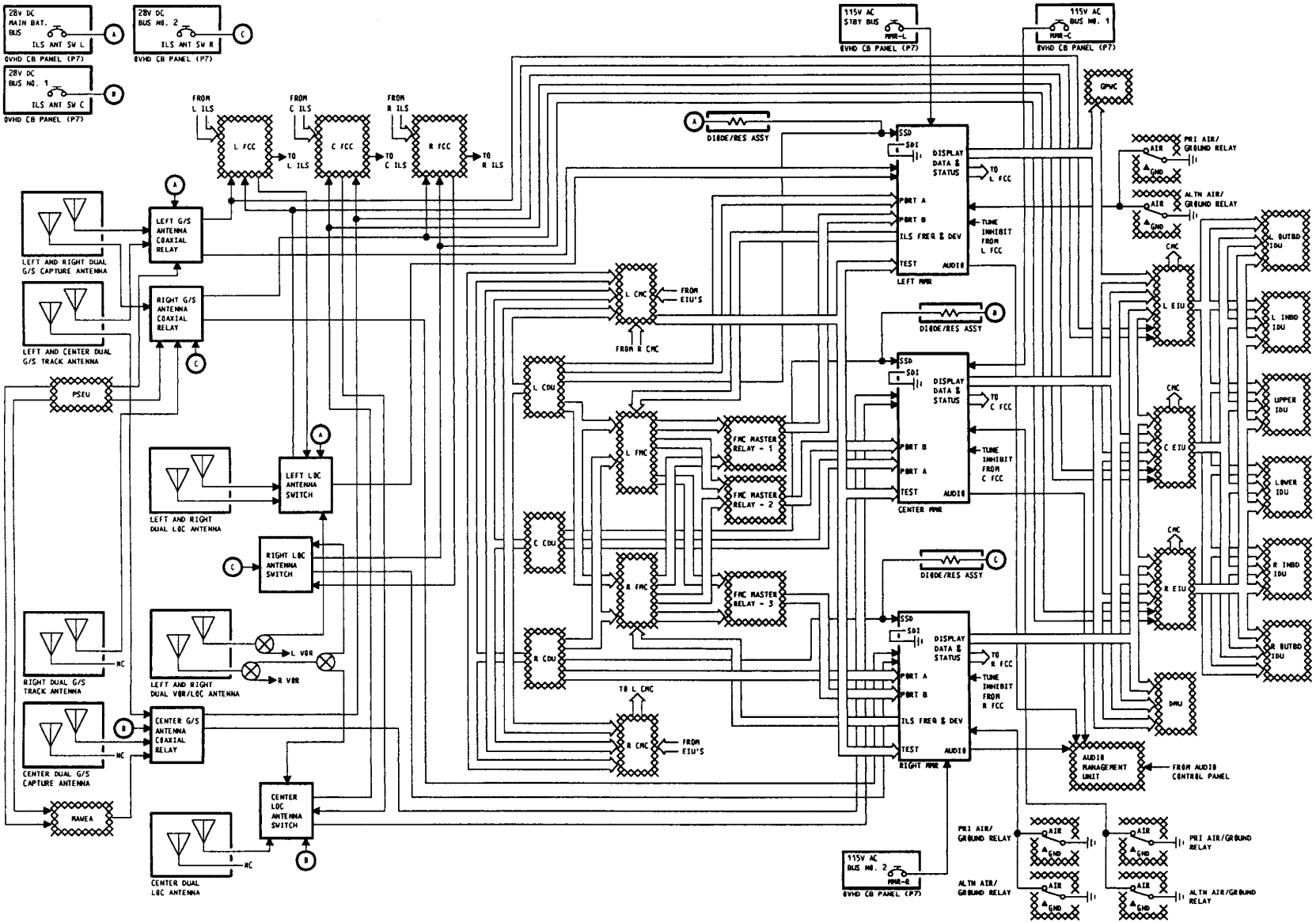

Figure 5 ILS – INTERFACE DIAGRAM

POWER INPUTS

The multi mode receivers get 115 volts ac through the circuit breakers from three separate ac buses. The glide slope (GIS) and VOR/LOC antenna switching relays get unswitched 28 volts dc through the circuit breakers from three separate dc buses.

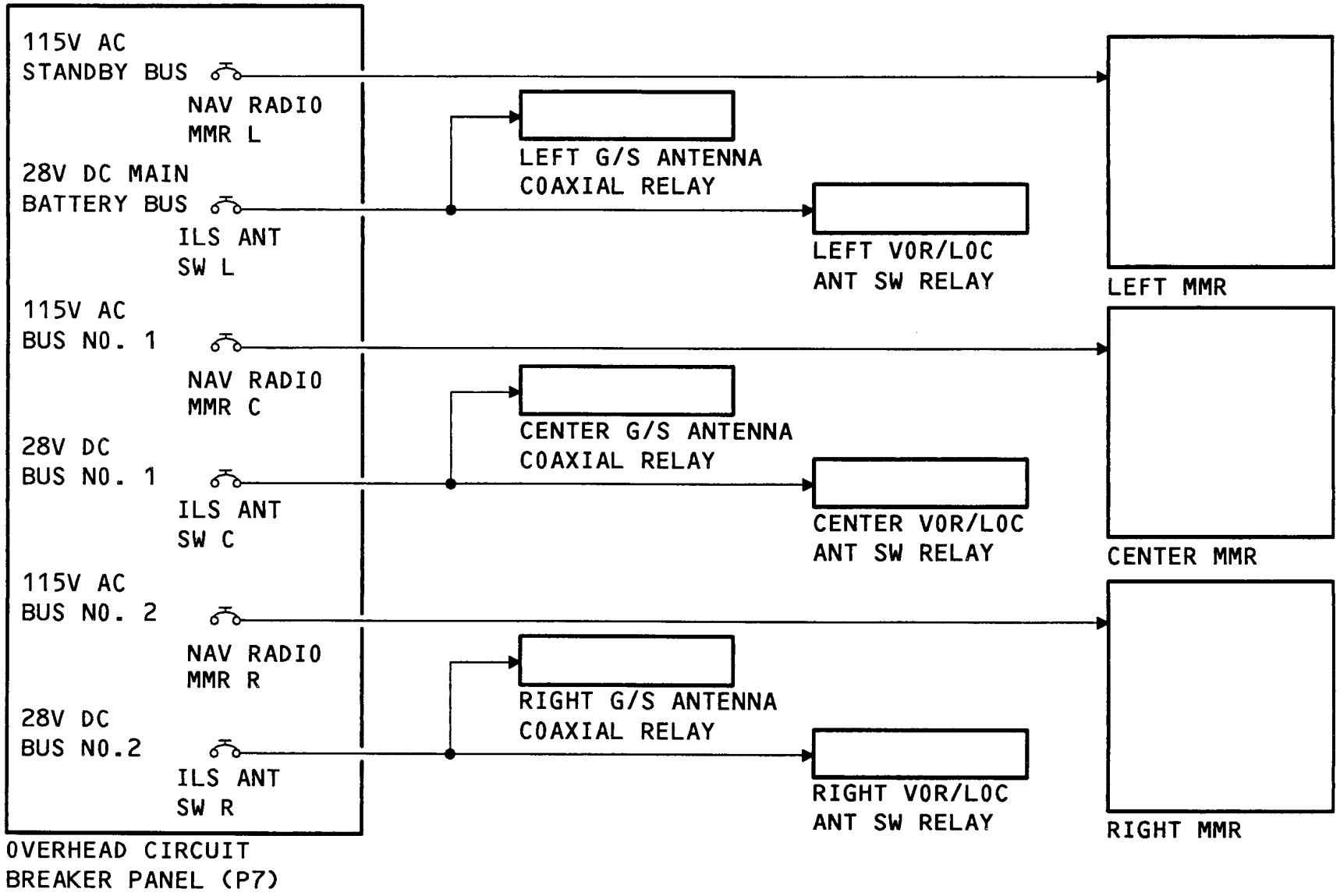

Figure 6 POWER INPUTS

LOCALIZER ANTENNA INPUTS

Each MMR gets localizer rf signals from one of two different antennas. When not in approach, the MMR gets localizer rf from the VOR/LOC antenna on the vertical fin. During approach, it gets signals from the localizer antenna located in the nose radome.

When the airplane is on the ground, or if the FCC is in the approach (APP), or localizer (LOC) mode, an FCC discrete commands the localizer rf input to the MMR to switch to the LOC capture antennas in the nose radome.

A discrete that shows the VOR/LOC antenna switch relay position goes to the EIUs and to the FCCs.

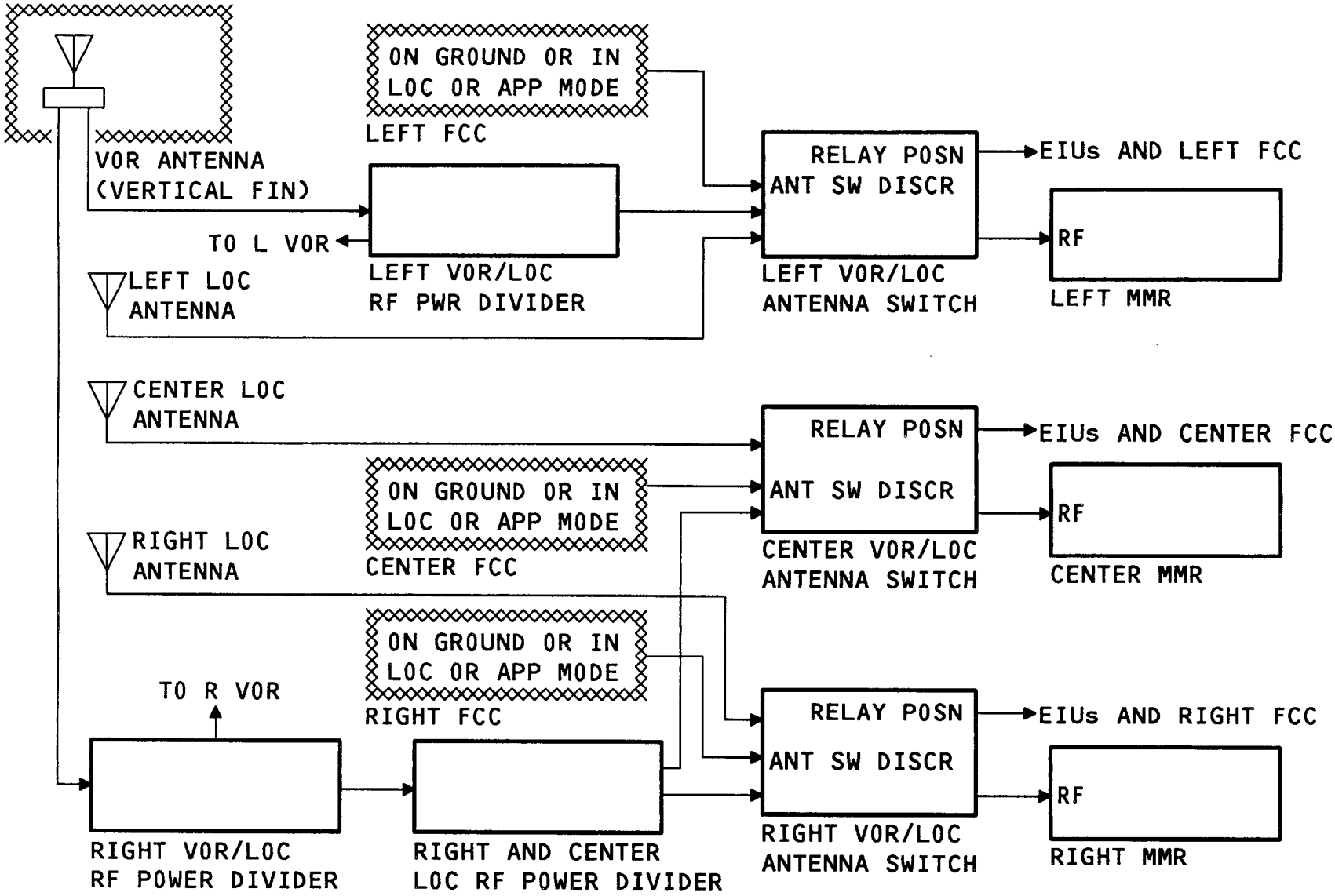

Figure 7 LOCALIZER ANTENNA INPUTS

GLIDE SLOPE ANTENNA INPUTS

Each MMR gets glide slope rf signals from one of two different antennas. With the landing gear up, the rf signals come from the GIS capture antennas on the nose section forward bulkhead. With the landing gear down, glide slope rf signals come from the track antennas in the aft nose wheel well landing gear doors.

The proximity switch electronics unit (PSEU) and modularized avionics warning electronics assembly (MAWEA) send signals to change the position of the GIS antenna switching relays. The left G/S antenna relay is switched by the primary PSEU processor card and the right is switched by the alternate PSEU processor card. The center GIS antenna relay is switched by either the primary or the alternate PSEU processor card thru an output logic circuit in the MAWEA.

A discrete that shows the GIS antenna switch relay position goes to the EIUs and the respective FCC.

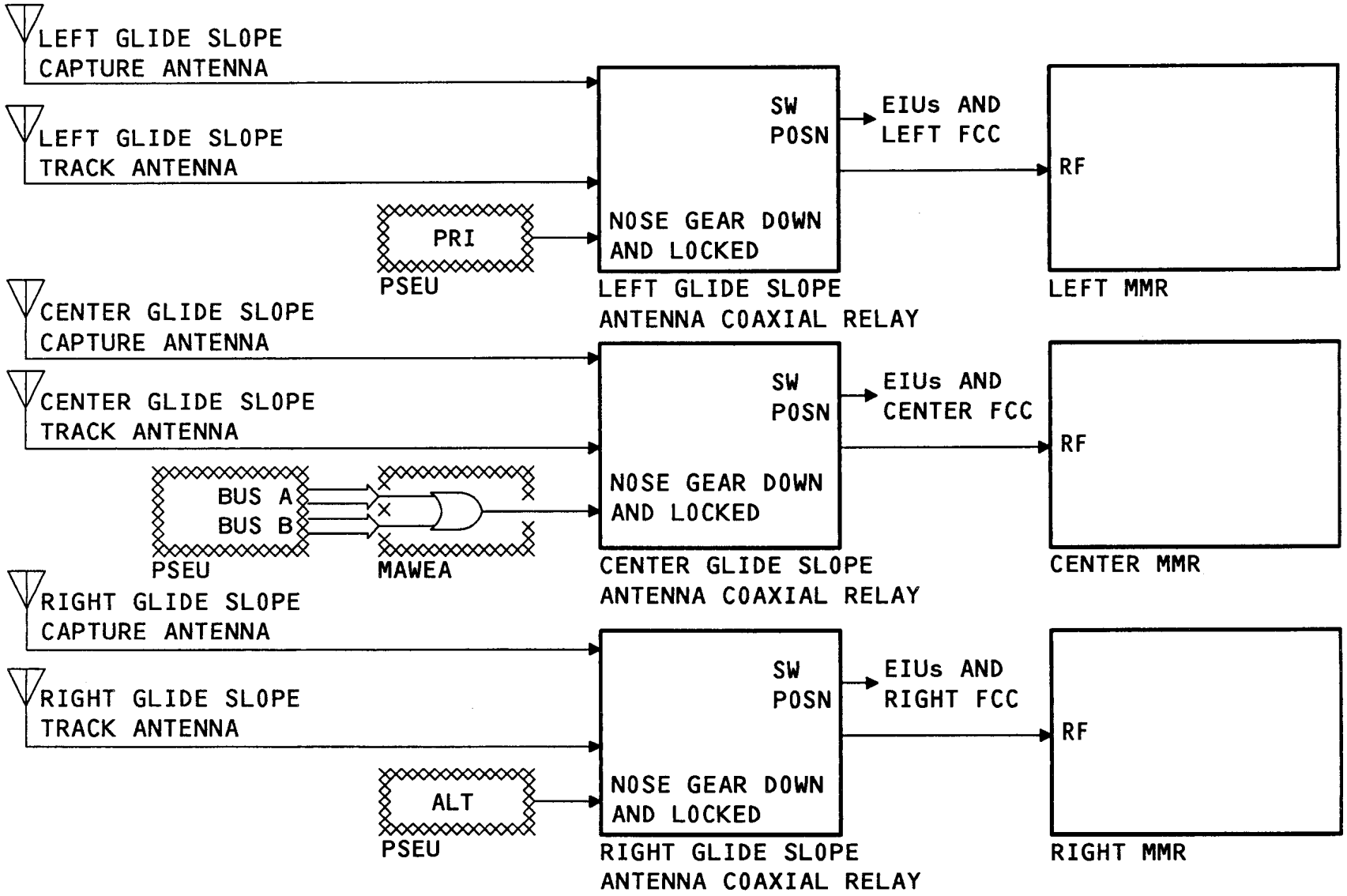

Figure 8 GLIDE SLOPE ANTENNA INPUTS

TUNING INPUTS

Tuning Input Ports

There are two tuning input ports on the MMR. Port B, is the primary port for automatic and manual tuning data sent from the selected FMC. Port A is the port for alternate tuning data sent directly from the onside CDU.

A source select discrete (SSD) from the onside CDU controls the port switching inside the MMR.

Autotuning

The master FMC (selected by the FMC master switch) tunes all three MMRs automatically if an ILS equipped runway is part of the active flight plan.

When the master FMC fails, the MMRs remain tuned to the last valid frequency. Use the FMC master switch to select the other FMC, and autotuning continues.

Manual Tuning

Use the left or right CDU to manually tune all three MMRs when the master FMC is operational.

Alternate Tuning

If the master FMC fails in the air or if both FMCs fail on the ground, alternate tuning is done. Enter a frequency and runway course into the L, C and R CDUs, each CDU directly tunes the onside MMR.

Tune/Test Inhibit

A tune/test inhibit from the onside FCC is sent to the MMR. It inhibits tuning or the test of the MMR during these times:

- Autopilot engaged and GIS or LOC capture has occurred, or
- Below 500 ft RA and GIS or LOC capture has occurred for F/D only approach, or,
- On ground, LOC valid, airplane heading within 45 degrees of the LOC front course, and ground speed greater than 40 knots.

ILS Tuning Summary

Autotuning: Master FMC sends tuning inputs to all MMRs.

Manual Tuning: Use left or right CDUs to enter ILS tuning input. The master FMC sends this tuning input to all MMRs.

Alternate Tuning: Use the onside CDU (left, center, or right) to send tuning inputs directly to the onside MMR (left, center, or right).

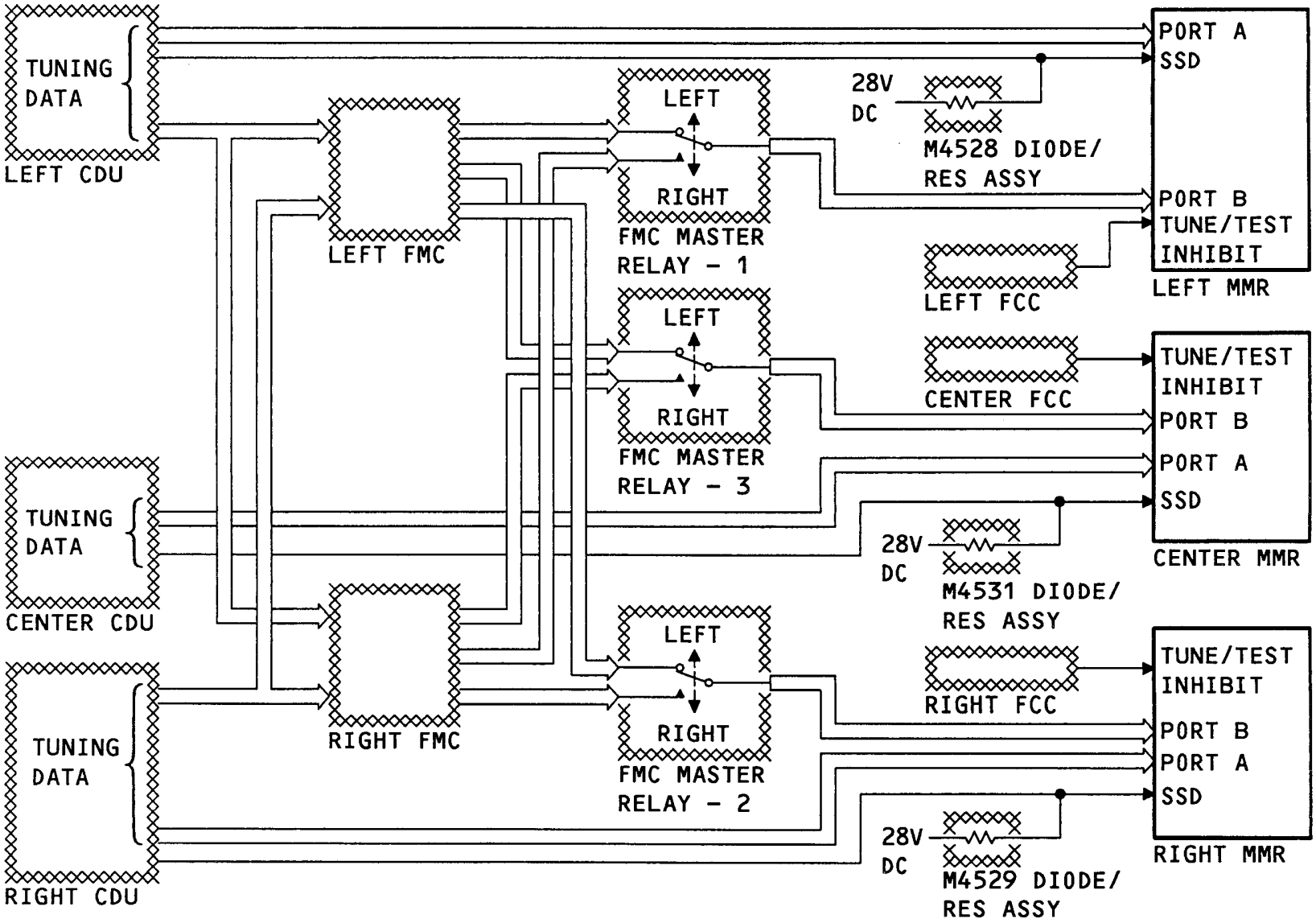

Figure 9 TUNING INPUTS

CMC INPUTS

Any one of the three CDUs can request fault information and initiate tests of the MMRs through the CMCs.

Normally, the left CMC performs these functions. If the left CMC fails, control of these functions is supplied by the right CMC automatically. The right CMC output to the MMRs is through a set of contacts in the left CMC.

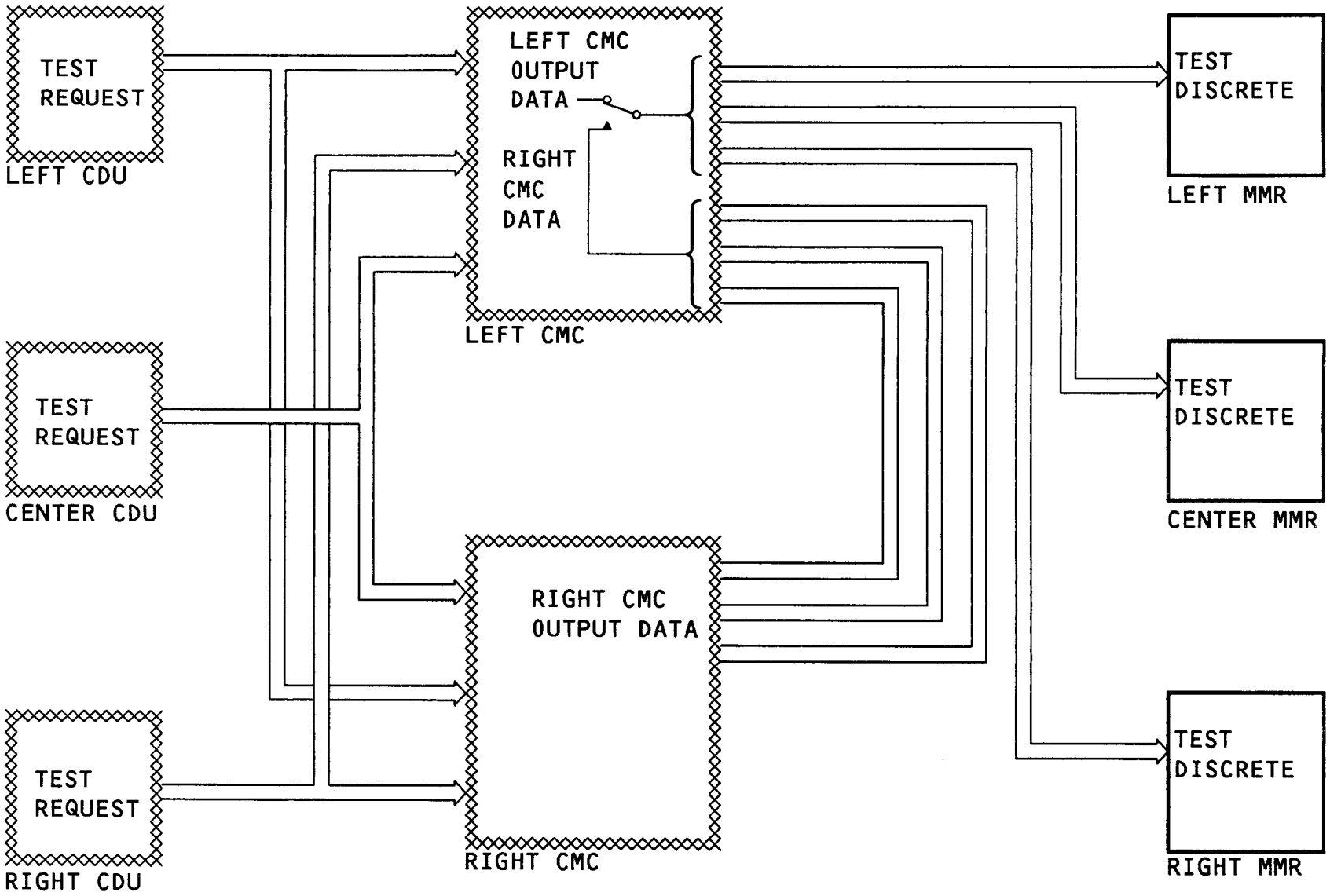

Figure 10 CMC INPUTS

AUDIO OUTPUTS

The MMRs send ILS audio identification tones to the audio management unit and are heard through the flight deck speakers and headsets.

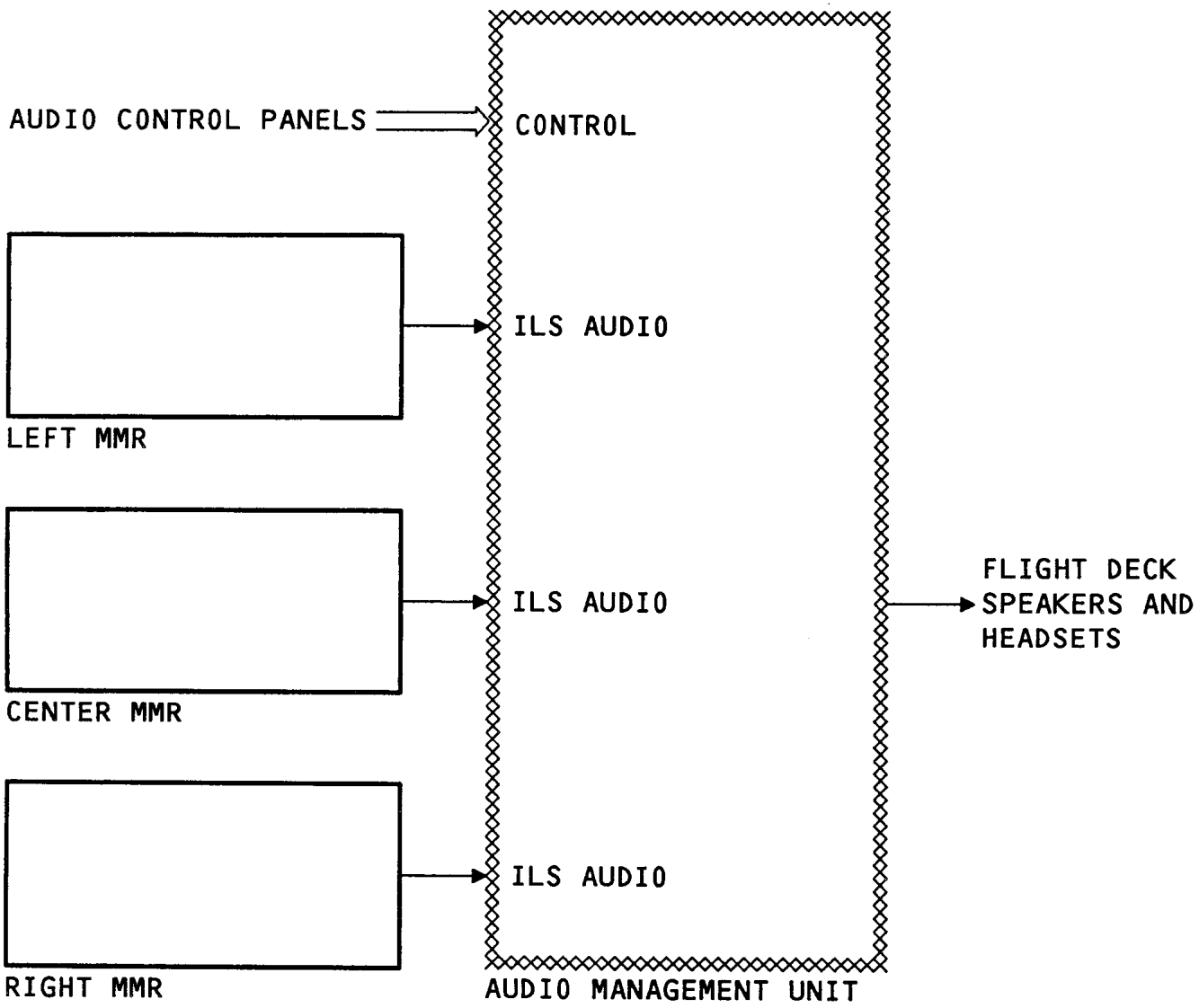

Figure 11 AUDIO OUTPUTS

RECEIVER BUS OUTPUTS

Each MMR has two ILS look alike output data buses which show display data and status. One data bus goes to the onside flight control computer (FCC). The other data bus goes to the onside FMC, DMU, and the EIUs. Only the left MMR sends ILS data to the GPWC.

The FCCs use ILS data to guide the airplane onto the runway.

The FMC uses onside ILS data to update the navigation position.

The GPWC uses left ILS data to give warnings if the plane is below the glide slope by a certain amount. The GPWC may also use ILS data to change the way some GPWC modes operate.

The DMU records the ILS data for airline use.

The EIUs get ILS data, sends it to the IDUs to show LOC and GIS deviation on the PFDs and NDs.

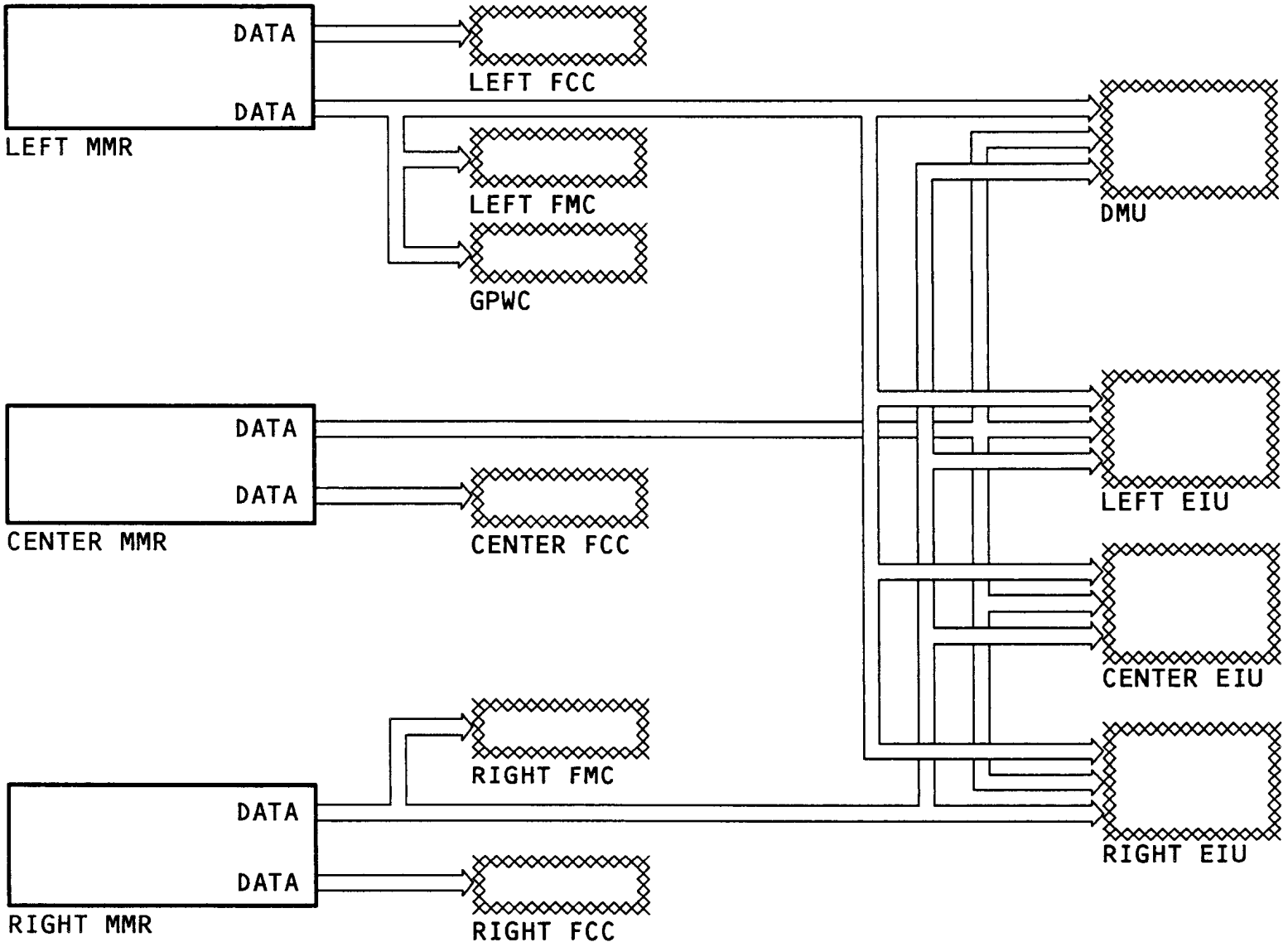

Figure 12 RECEIVER BUS OUTPUTS

DATA OUTPUTS TO DISPLAYS

The MMRs send localizer and glide slope deviation data, ILS frequency, station identifier and the selected runway course on a data bus to the left, center, and right EIUs.

The EIUs multiplex the data and send the localizer and glide slope data to the navigation displays (NDs) and the primary flight displays (PFDs).

The PFDs and NDs show:

- The ILS frequency or station identifier
- The localizer deviation
- The glide slope deviation
- The selected runway course

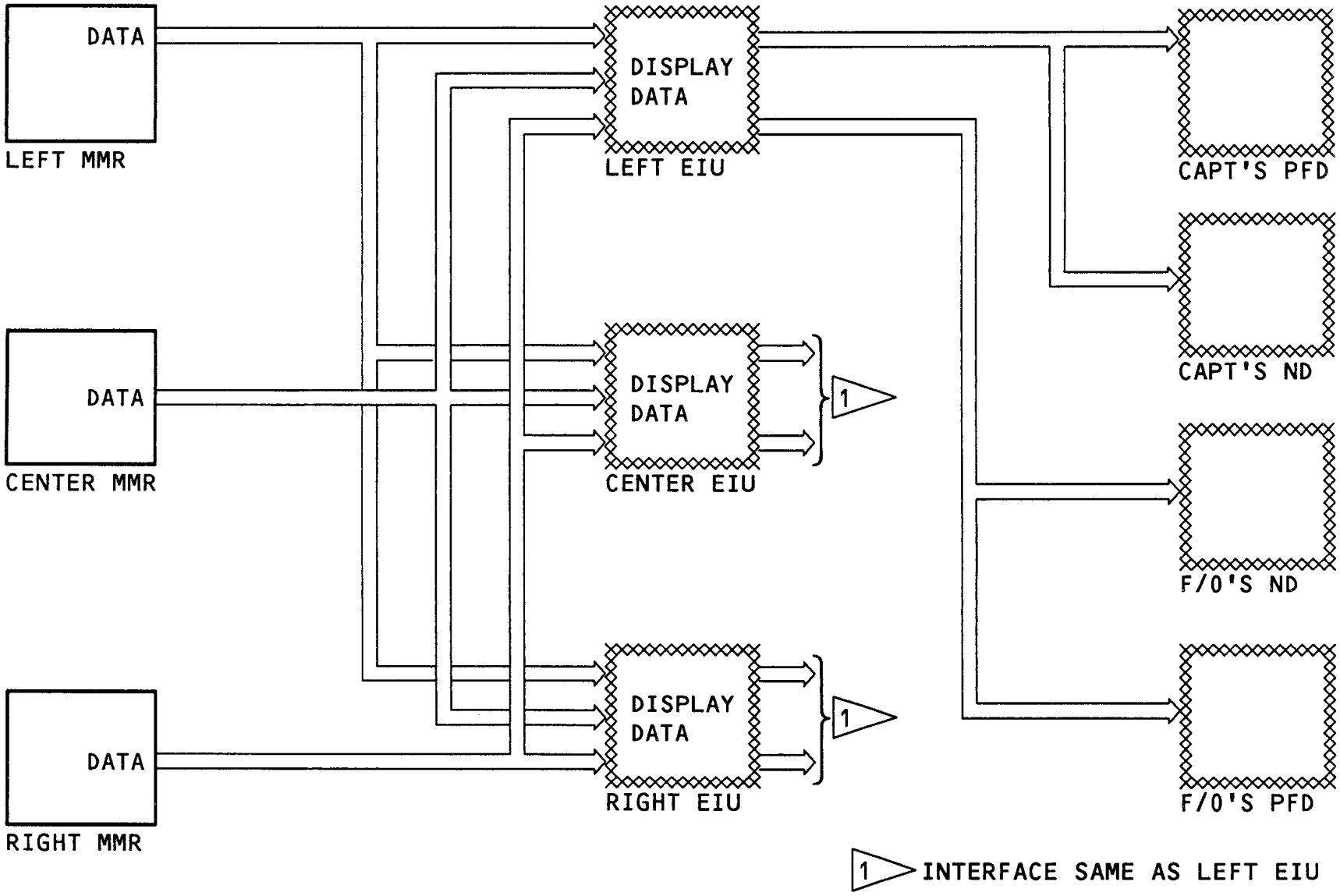

Figure 13 DATA OUTPUTS TO DISPLAYS

DISCRETE INTERFACE

FCC Analog Tune/Test Inhibit

The left FCC sends an analog tune/test inhibit discrete to the left MMR to inhibit tuning and self-test during an approach.

Air/Ground Relay

A discrete from the air/ground relay ensures that the MMR records fault data when the airplane is in the air. The air/ground relay increments flight segments for in-the-air fault recording.

Source Destination Identifier (SDI)

The SDI identifies the left, center or right ILS receiver. This SDI information is used by the MMR when the output data words are formatted.

Analog Relay Position Discrete

The left GIS antenna coaxial relay and the left VOR/LOC antenna switching relay send analog discretes to show the relay switch position to the left FCC and all three EIUs.

An EICAS message shows when a relay switch position fails to change when commanded.

The MMRs get the tune/test inhibit from the onside FCC.

The center and right MMRs operate the same as the left MMR.

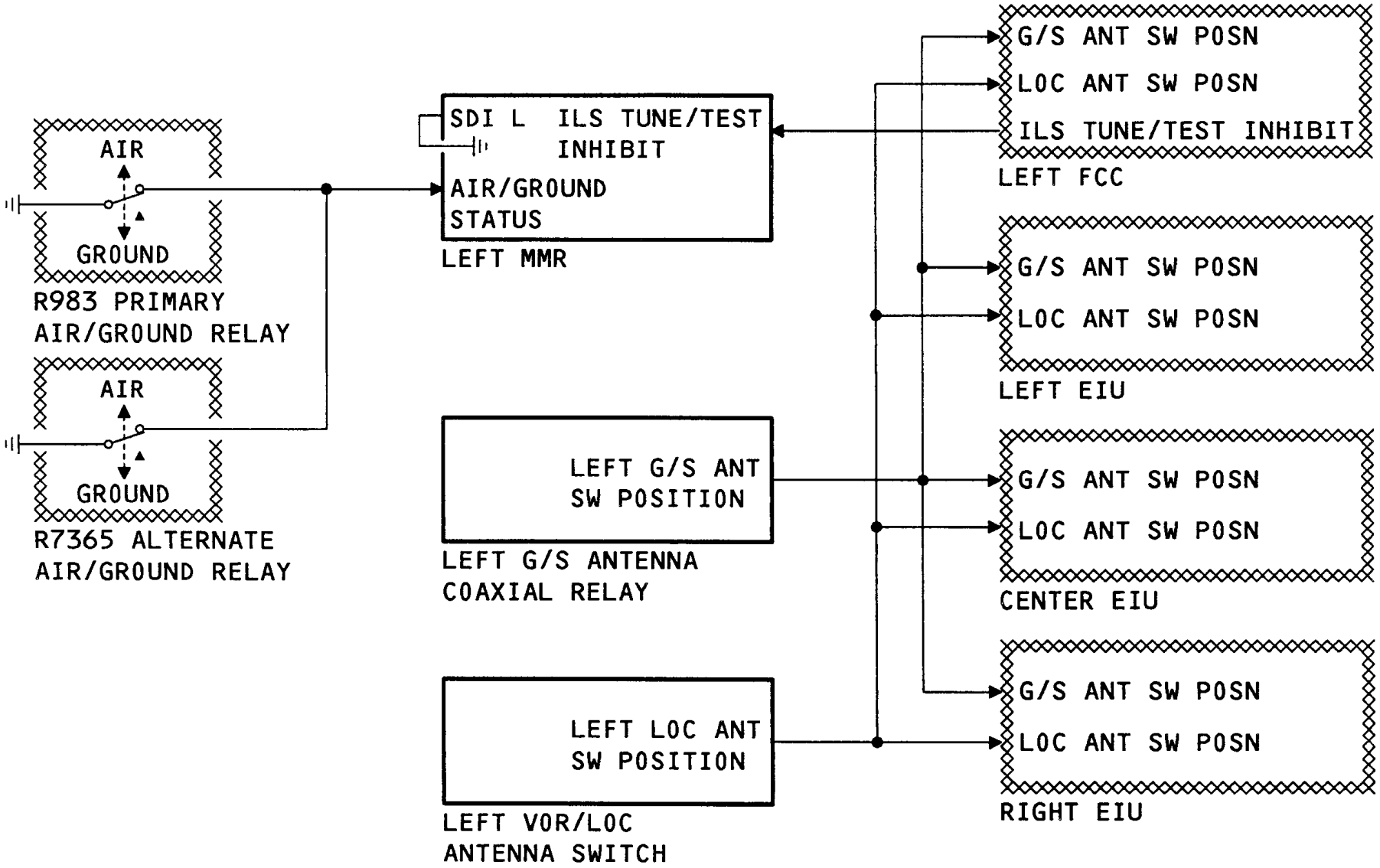

Figure 14 DISCRETE INTERFACE

ILS RECEIVER

General Description

The ILS section of the multi mode receiver (MMR) contains a localizer receiver, a glide slope receiver and control circuits. The localizer receiver gets localizer signals within the frequency range of 108.10 MHz to 111.95 MHz with 50 KHz and 150 KHz channel spacing. The glide slope receiver gets glide slope signals within the frequency range of 329.15 MHz to 335.00 MHz with 150 KHz channel spacing.

The MMR sends to the user systems ILS audio signals and data for ILS station identification, data for ILS frequency and localizer and glide slope deviation.

Flight-Fault Monitoring

The MMR has a non-volatile flight-fault memory.

The discrete from the air/gnd relay system is used to determine flight legs.

The discrete from the air/ground relay inhibits fault recording into the flight fault memory when on the ground except during self-test.

Power

The MMR operates on 115v ac.

Control and Monitor

The MMR receives control inputs on an ARINC 429 data bus.

These are the front panel switch/indicators:

- TEST switch - starts a self-test of the MMR
- LRU STATUS LED - shows a failure found in the MMR 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
- ANT FAIL - reserved for future use.

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.

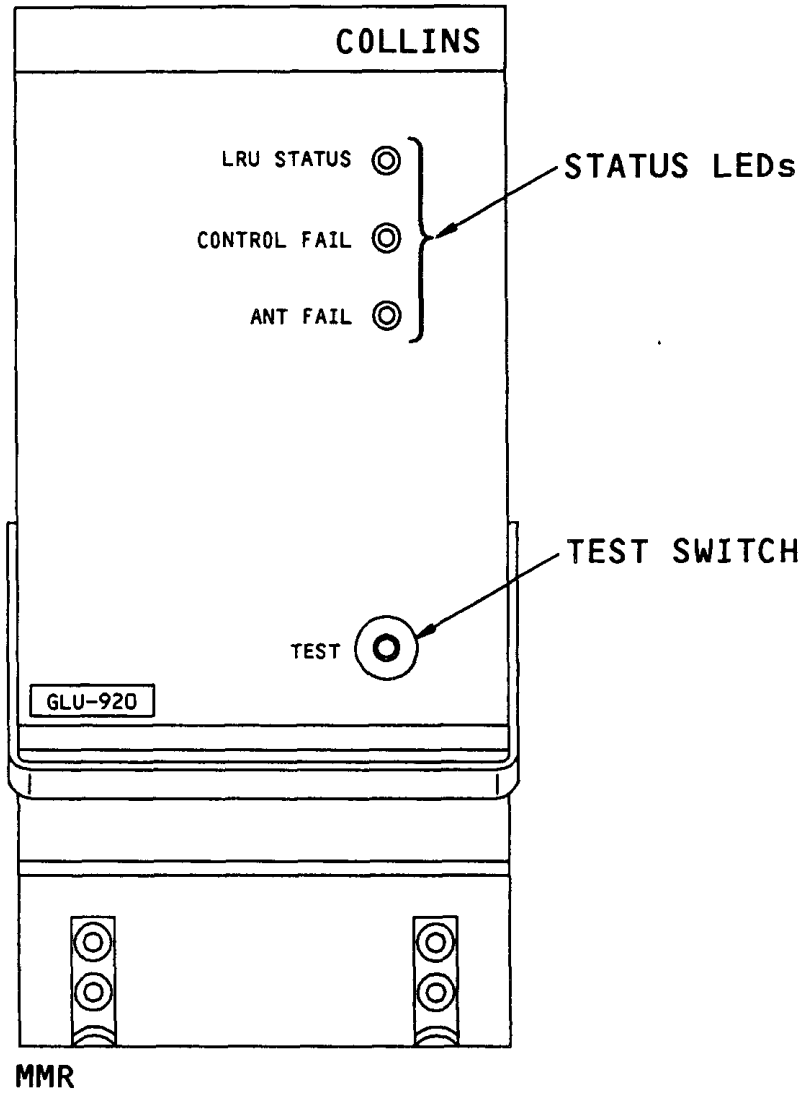

Figure 15 ILS RECEIVER

AUDIO CONTROL PANEL CONTROLS

Purpose

The audio control panel (ACP) controls the audio management unit (AMU). The AMU sends the ILS audio to the flight deck speakers and pilots, headsets.

Controls

Use the approach receiver selector switch on the ACP to select the ILS audio from any one of the multi mode receivers. Turn the receiver control switch to adjust the audio volume level.

The audio sent to the AMU goes through a voice/range filter. Use the filter selector switch to select the desired ILS audio.

In the voice (V) position, audio frequencies except the VOR, LOC, NDB and DME identification code audio are sent through the AMU. The pilots hear voice audio without identification code audio interference.

In the range (R) position, VOR, LOC, NDB and DME identification code audio frequencies are sent through the AMU.

The pilots hear the identification code audio without voice audio interference.

In the both (B) position, all audio frequencies are sent through the AMU. The pilots hear the identification code audio and voice audio at the same time.

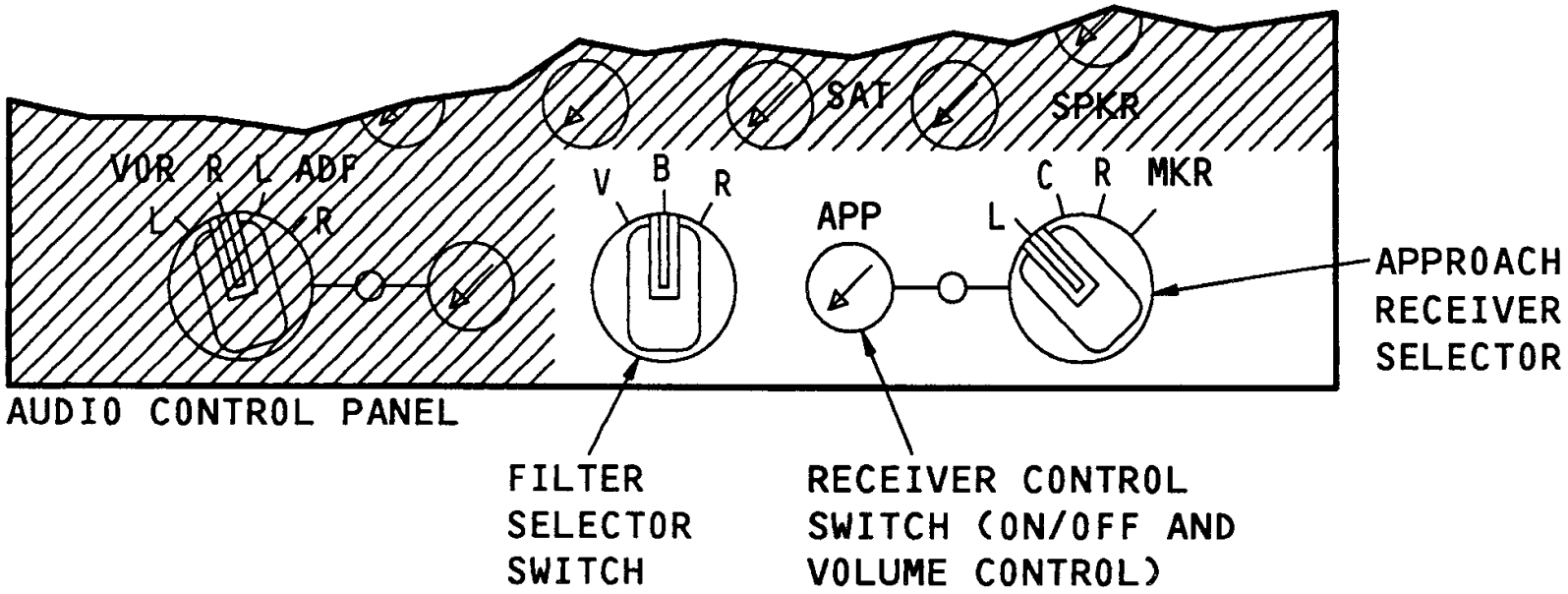

Figure 16 AUDIO CONTROL PANEL CONTROLS

AUTOTUNING CONTROL

Tuning of the ILS frequency in the multi mode receivers (MMR) is done automatically by the master FMC when an ILS runway is part of the active flight plan. PARK shows on the left side of the CDUs when the MMRs are not tuned.

The ILS autotune frequency shows followed by PARK in small font when:

- The airplane is within 200 nm of the top of descent, or
- More than halfway along the active route.

The FMC autotunes the MMRs and the ILS frequency shows in large font with PARK removed when:

- within 50 nm of top of descent, or
- Within 150 nm direct distance to the runway threshold (whichever is greater), or
- When active in descent mode

If the master FMC fails, the MMRs remain tuned to the last valid ILS frequency. To continue, to autotune,

select the other FMC with the FMC master switch.

Autotune is not done during these times:

- On the ground
- Less than 10 minutes after ground-to-air transition.

In departure or go-around, only manual tuning is possible.

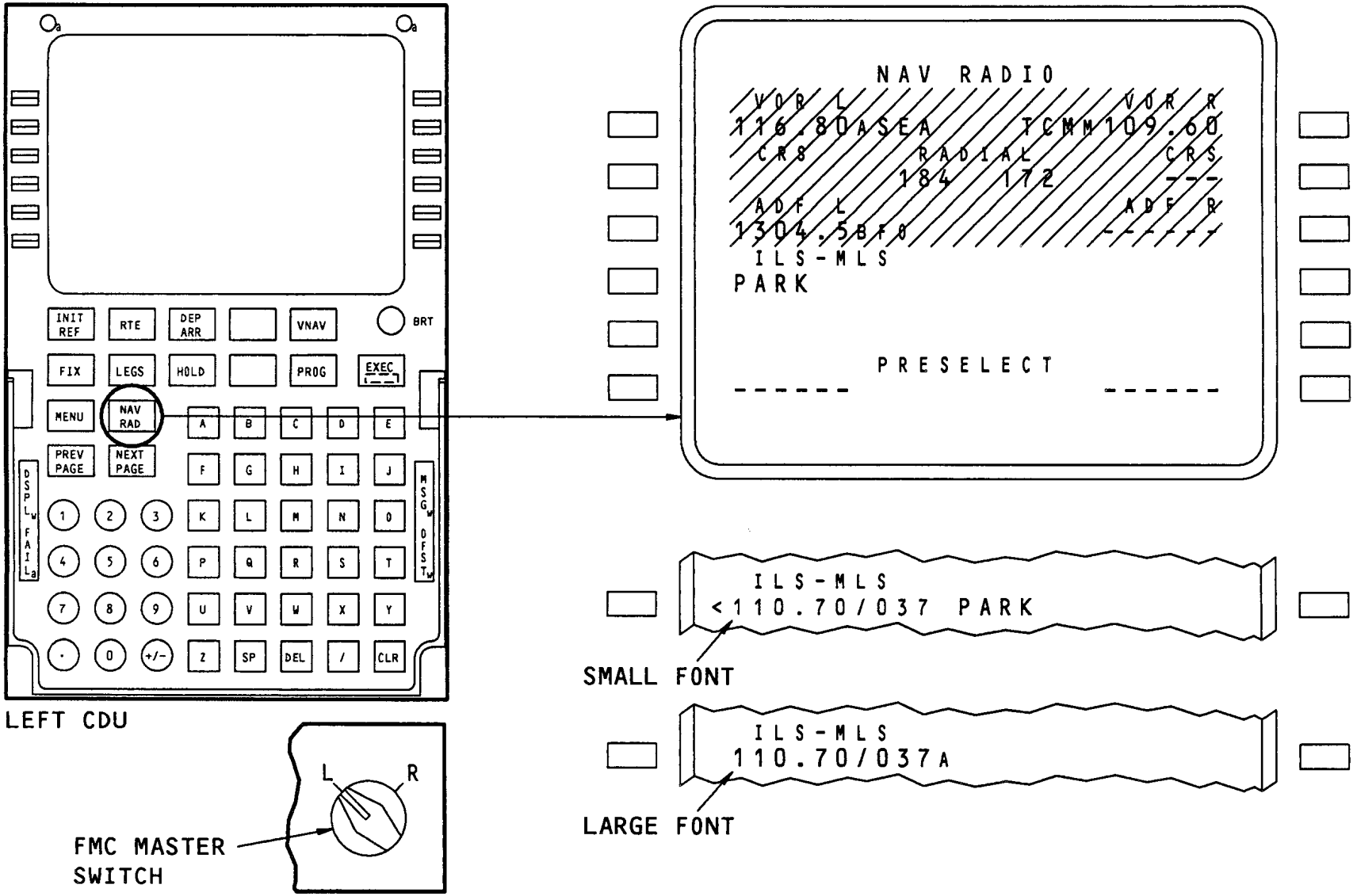

Figure 17 AUTOTUNING CONTROL

MANUAL TUNING CONTROL

Manual Tuning

Manual selection of an ILS frequency on the left or right CDU overrides the autotuning of the ILS in the multi mode receivers by the master FMC.

Use these steps to manually tune the MMRs:

- Push the NAV RAD key on the CDU to show the NAV RADIO page.
- Use the alpha/numeric keys, enter the desired ILS frequency and runway heading into the scratch pad.
- Push the line select key next to the ILS frequency display.

Both FMCs get the ILS frequency and runway heading from the CDU, and the master FMC tunes the ILS receivers. The manually tuned frequency shows on the CDU's ILS frequency display in large font numbers, and a M shows manual tuning.

Pre-Select

The pre-select function stores additional tuning data on the NAV RADIO page. Enter the tuning data into a pre-select line. To tune, push the key next to the pre-select line to enter the tuning data into the scratch pad, then line select the data into the proper position.

Delete

The CDU delete function clears the preselect line and the prompt dashes appear. It is also used to return to autotuning after manual tuning is done.

To return to autotuning or clear the preselect line:

- Push the DEL, this enters the word DELETE into the scratch pad.
- Push the line selector key next to the ILS frequency shown on the CDU.

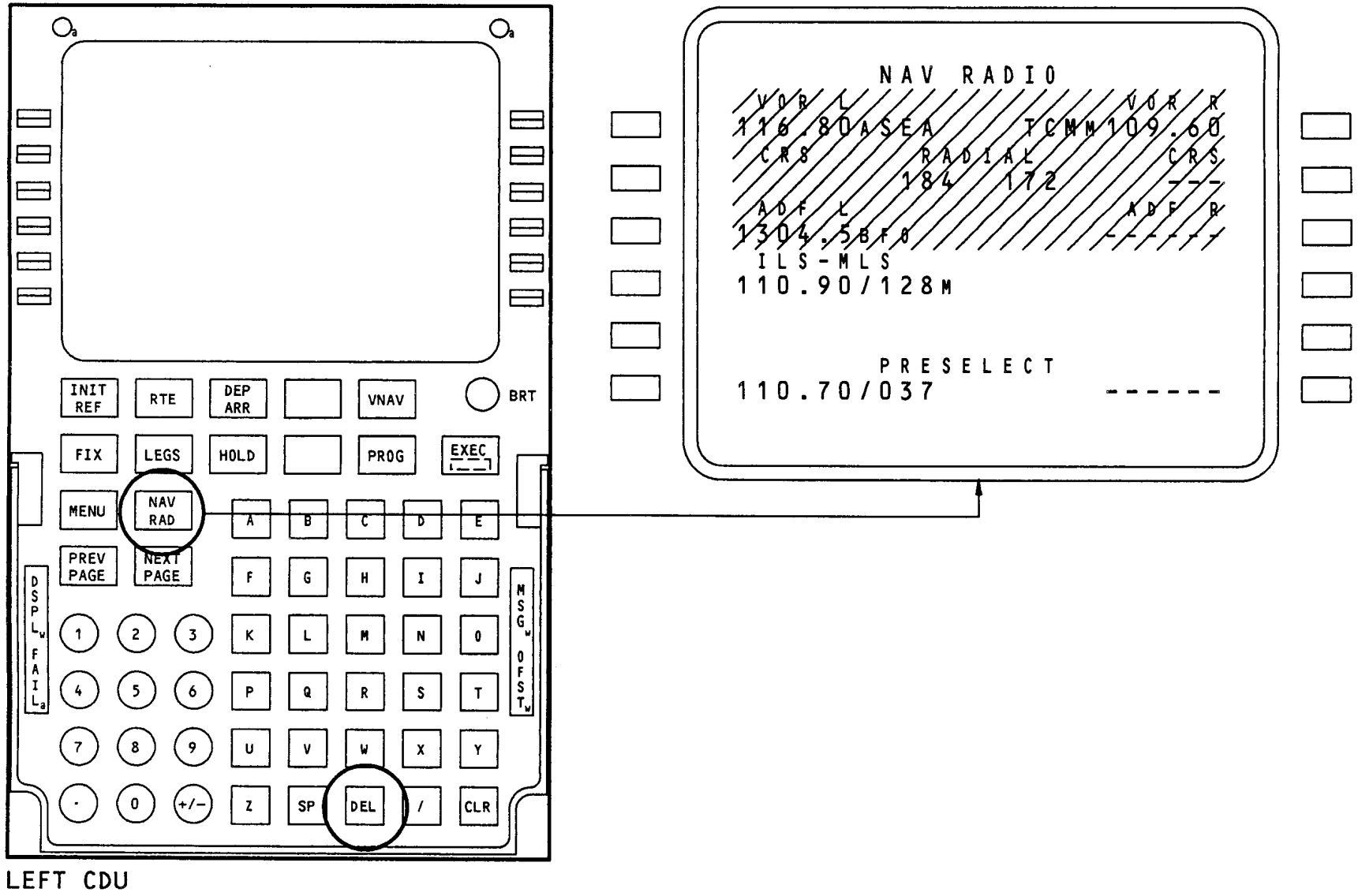

Figure 18 MANUAL TUNING CONTROL

ALTERNATE TUNING CONTROL

If the master FMC fails in the air or both FMCs fail on the ground, the L, C and R MMRs are tuned directly by their onside CDU.

Do these steps to alternately tune:

- Push the NAV RAD key on the CDU, the ALTN NAV RADIO page shows.
- Enter the ILS frequency and runway course into the scratch pad.
- Select the frequency from the scratch pad.

The selected frequency goes directly to the ILS in the onside MMR.

Use the delete and pre-select functions as previously defined.

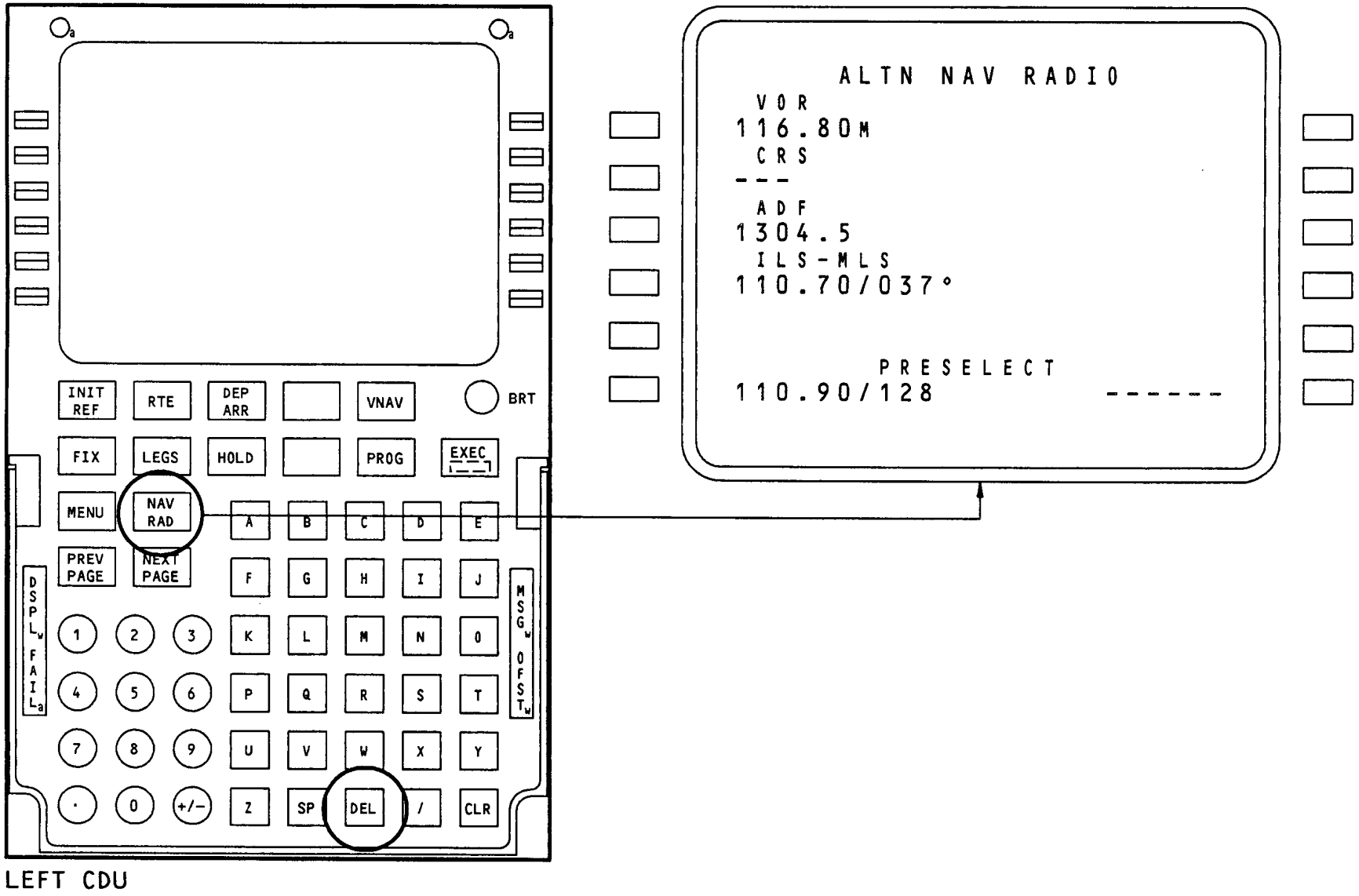

Figure 19 ALTERNATE TUNING CONTROL

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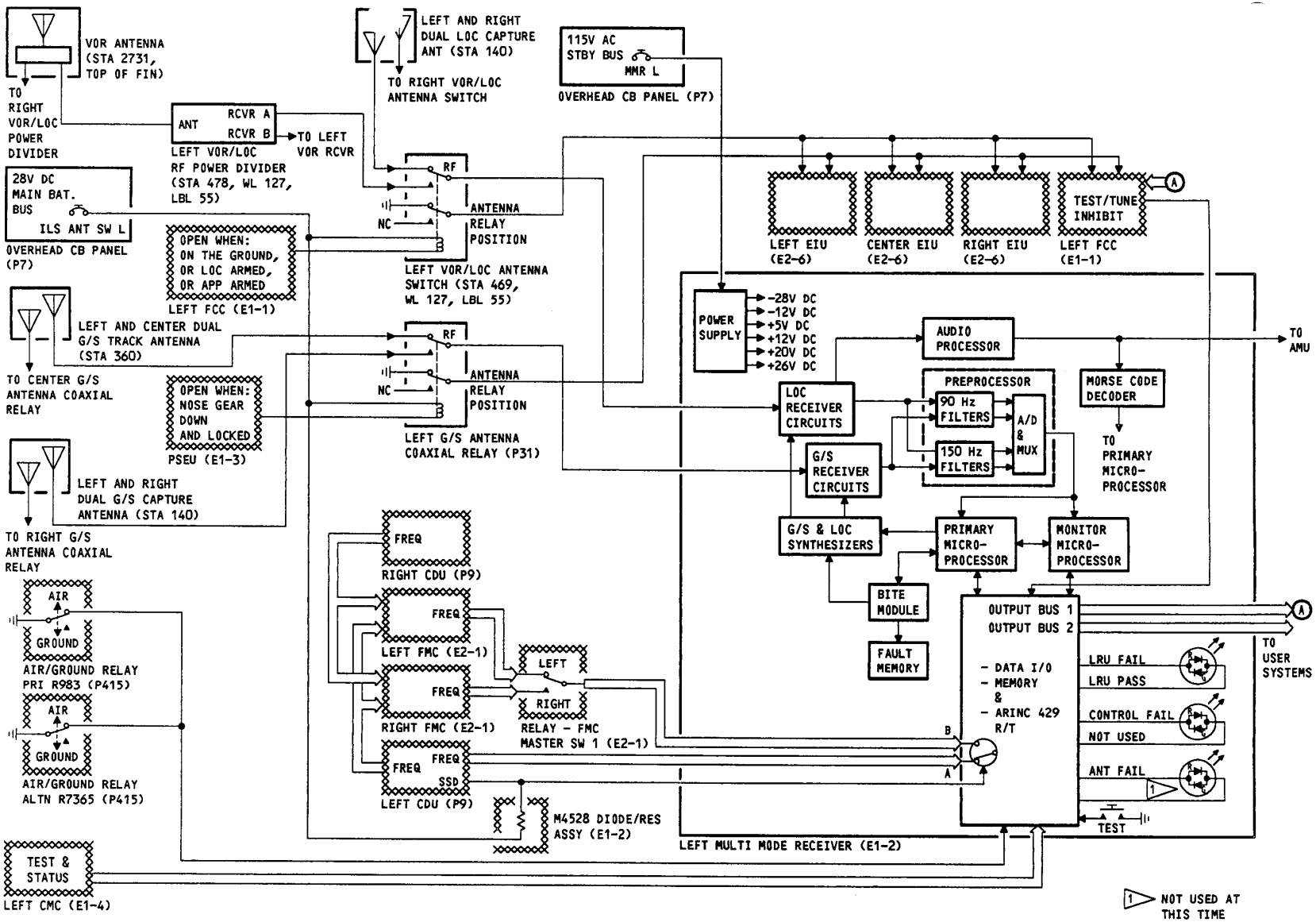

Figure 20 ILS – SCHEMATIC DIAGRAM

LOCALIZER ANTENNA SWITCH OPERATION

The localizer antenna input to the MMR comes from these locations:

- The dual LOC antennas on the nose section forward bulkhead
- The VOR/LOC antenna on the top of the vertical fin.

When the airplane is on the ground, or the FCC has localizer (LOC) or approach (APP) mode armed, the switch relaxes and the LOC antenna on the nose section forward bulkhead gives input to the MMR.

When the airplane is in the air and the FCC does not have LOC or APP mode armed, the VOR/LOC antenna switch energizes, and the VOR/LOC antenna gives input to the MMR.

The onside antenna relay position analog discrete, indicates to the onside FCC and all three EIUs the current antenna switch position.

When the antenna switch position fails to change, an EICAS status message shows.

When two or more antennas switch positions fail to change, an EICAS caution message shows.

The LOC antenna switch gets 28 volts dc power through a dedicated circuit breaker.

The RF power divider, divides one antenna input into two RF outputs.

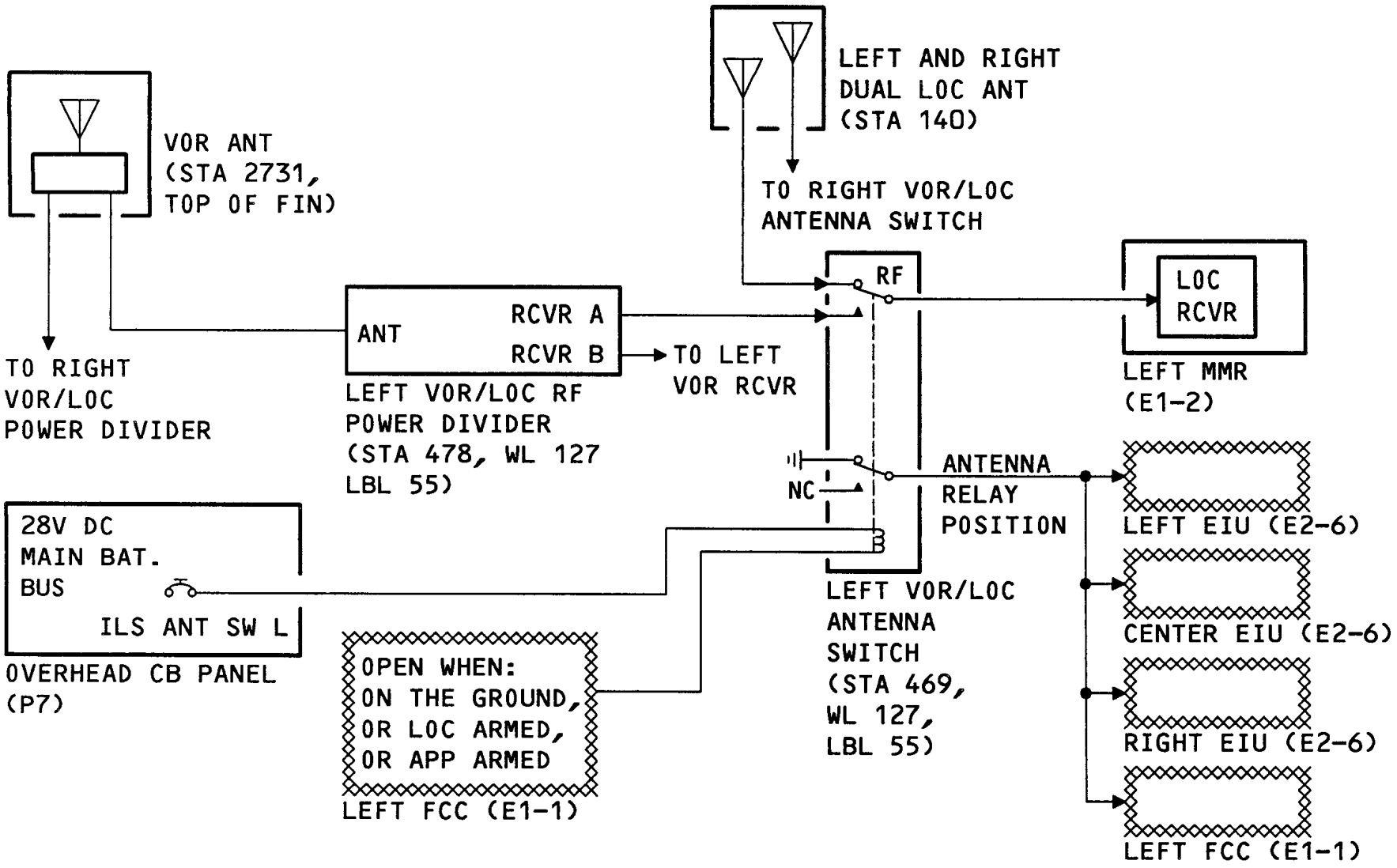

Figure 21 LOCALIZER ANTENNA SWITCH OPERATION

GLIDE SLOPE ANTENNA COAXIAL RELAY OPERATION

The glide slope antenna input to the MMR comes from these locations:

- The dual track antenna on the forward edge of the aft nose wheel well doors
- The dual GIS capture antenna on the nose section forward bulkhead.

When the nose wheel well landing gear is down and locked, the relay is relaxed; and the GIS track antenna gives input to the MMR.

When the nose wheel landing gear is not down and locked, the GIS antenna switch relays energize; and the G/S capture antenna gives the input to the MMR.

The onside antenna relay position analog discrete tells the onside FCC and all three EIUs the current antenna switch position.

If the antenna switch position fails to change, an EICAS status message shows.

If two or more antennas switch positions fail to change, EICAS shows a caution message.

The GIS antenna switch relay gets 28 volts dc power through a dedicated circuit breaker.

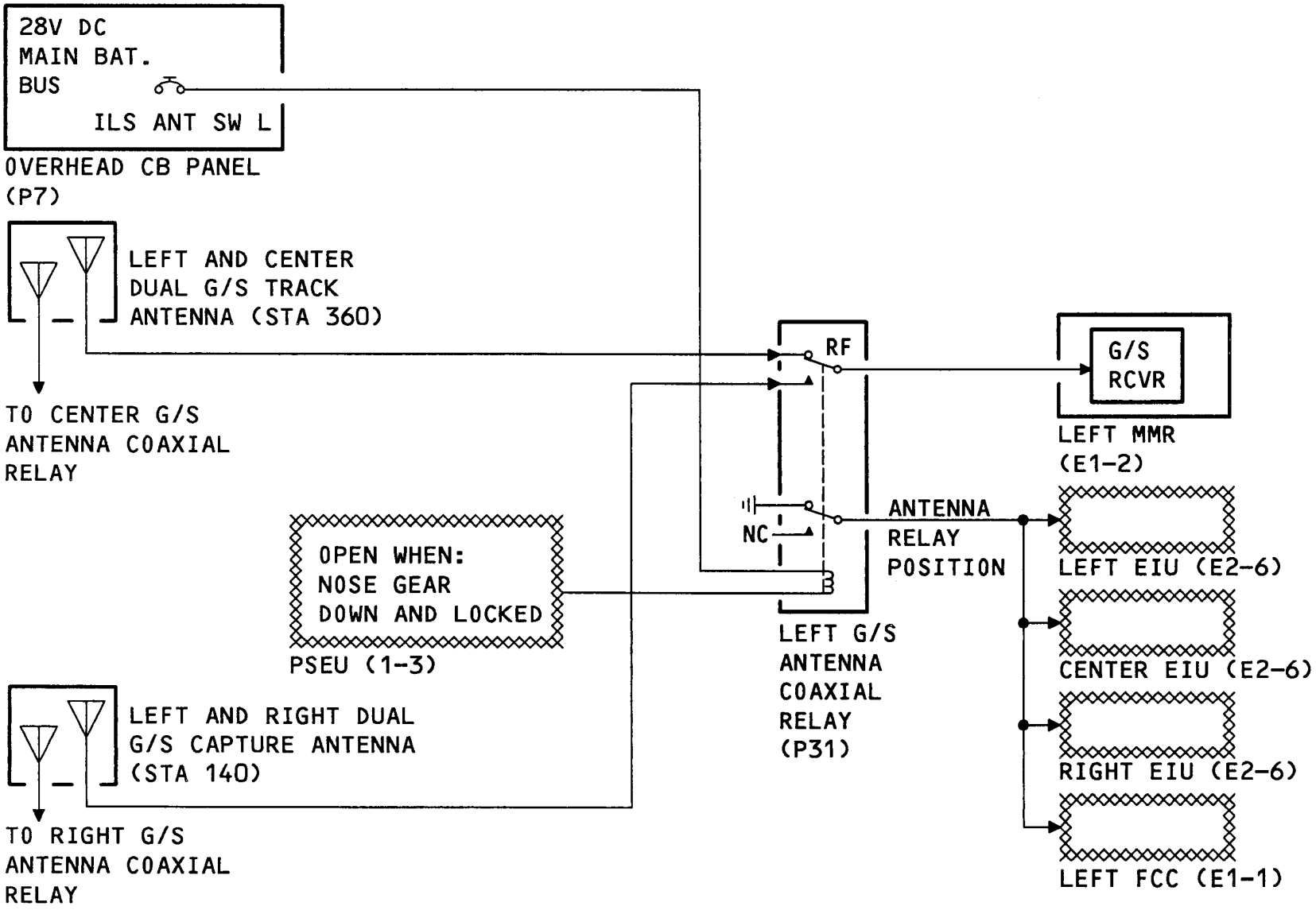

Figure 22 GS ANTENNA COAXIAL RELAY OPERATION

RECEIVER TUNING / SIGNAL PROCESSING

Tuning

The MMR is tuned:

- Automatically by the master FMC
- Manually by CDU entries through the selected FMC
- Alternately by direct tuning from the onside CDU

If the selected FMC fails, select the other FMC with the FMC master switch.

If the selected FMC fails in the air or both FMCs fail on the ground, the onside CDU supplies a source select discrete (SSD). The SSD causes the tuning input ports in the MMR to change from port B to port A, and direct tuning comes from the onside CDU.

Signal Processing

The receiver gets 115 volts ac from its dedicated circuit breaker. The receiver's power supply changes the 115 volts ac into voltages necessary for receiver operation.

The data input/output (1/0) sends a tuning frequency word from the tuning source to the primary microprocessor.

The primary microprocessor sends tuning data to the frequency synthesizers which tune the localizer and glide slope receiver circuits.

Detected localizer signals go to the audio processor and the preprocessor. The detected glide slope signals go to the preprocessor.

The audio processor prepares the ILS audio for use by the AMU and the Morse code decoder.

The Morse code decoder, processes the LOC audio input signals and makes the station Morse code identifier into digital format. This digital identifier goes to the FMCs for confirmation and to the EIUs to show the ILS identification on the PFDs and NDs.

Signal Processing

The preprocessor contains the 90 Hz and 150 Hz filters which detect the modulated localizer and glide slope signals. The modulation signals are digitized in an analog to digital (A/D) converter. The digital data is sent to the primary and monitor microprocessors where ILS deviation data values are computed. The computed deviation data from the monitor and primary microprocessors are compared. If the signals are the same, the computed deviations are sent to the data 1/0, converted to ARINC 429 format, and sent to the user systems. If the comparison fails, the deviation data is set invalid or NCD, formatted and sent to the user systems.

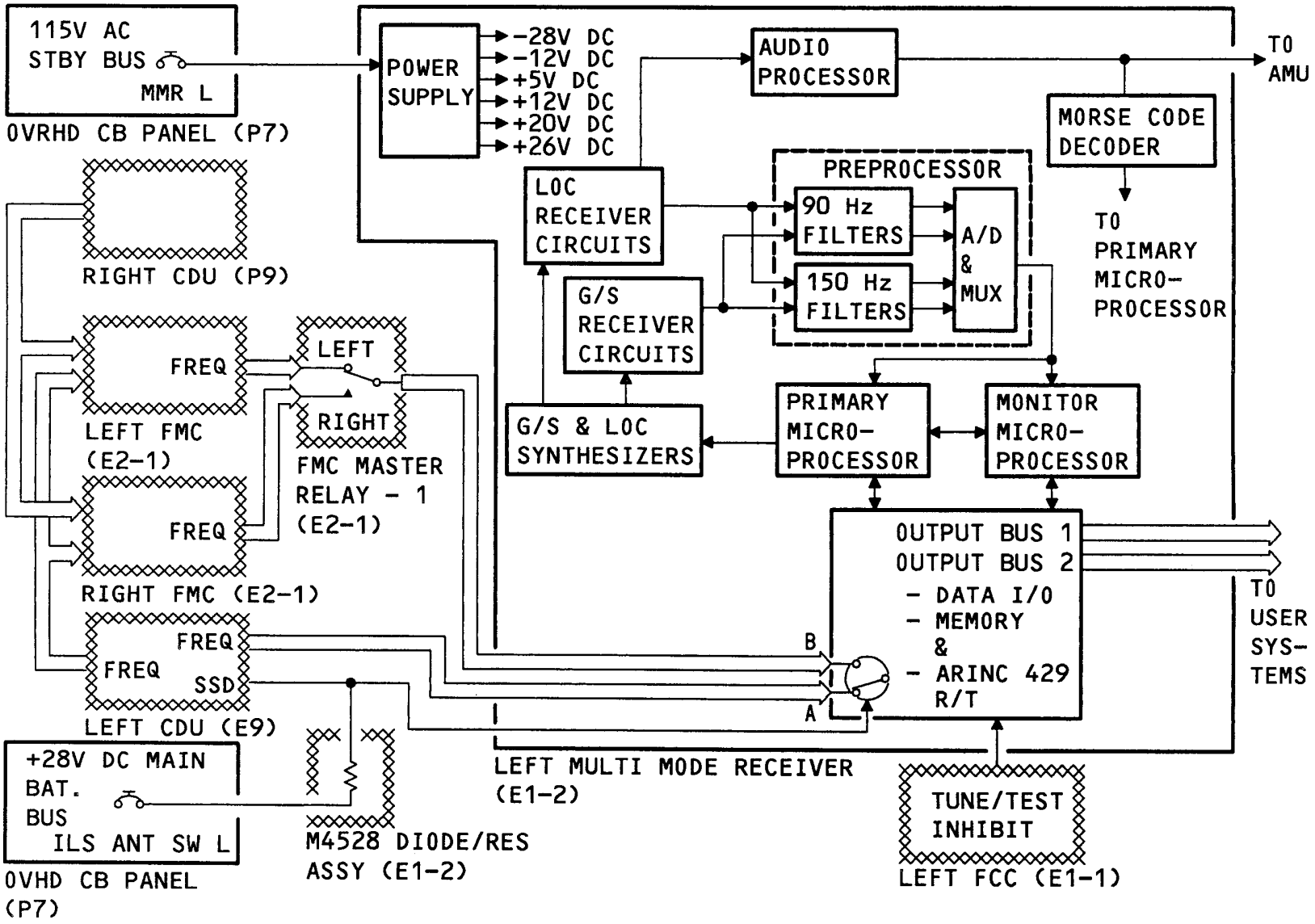

Figure 23 RECEIVER TUNING/SIGNAL PROCESSING

ILS-TEST OPERATION

Self-T est and Ground Test

There are two places an ILS test is started from:

- The self-test switch on the MMR front panel
- The ground test page from the CDU.

During a ground test, the CDU sends the test command to the MMR through the CMC. Both tests are the same and give the same results.

If the airplane is in the air, an input from the air/ground relay inhibits the ground test command.

An FCC discrete inhibits tuning and selftest when:

- Autopilot engaged and GIS or LOC capture has occurred, or
- Below 500 ft RA and GIS or LOC capture has occurred for F/D only approach, or
- On ground, LOC valid, airplane heading within 45 degrees of LOC

front course, and ground speed greater than 40 knots.

Test Command

The test command goes to the primary microprocessor from data 1/0, then it is sent to the built-in test equipment (BITE) module. A test sequence of the MMR LED status indicators occurs.

Test Signal Flo

The BITE sends 90 Hz and 150 Hz modulated test signals to the synthesizers, then from the synthesizer, to the localizer and glide slope receivers.

The output of the LOC and GIS receivers is tested by both microprocessors for system performance and to confirm normal system operation.

The up-left and down-right test operations are performed as a result of the 90 Hz and 150 Hz modulation test signals made by the BITE.

Fault Memory

The BITE module gets status information of the internal circuits and the tuning data from the FMC or the CDU. It records it by flight legs in the non-volatile fault memory. A discrete input from the air/ground relays increment fault memory.

Status Data

The BITE module continuously sends real-time status data through the microprocessors and data 1/0 to the user systems.

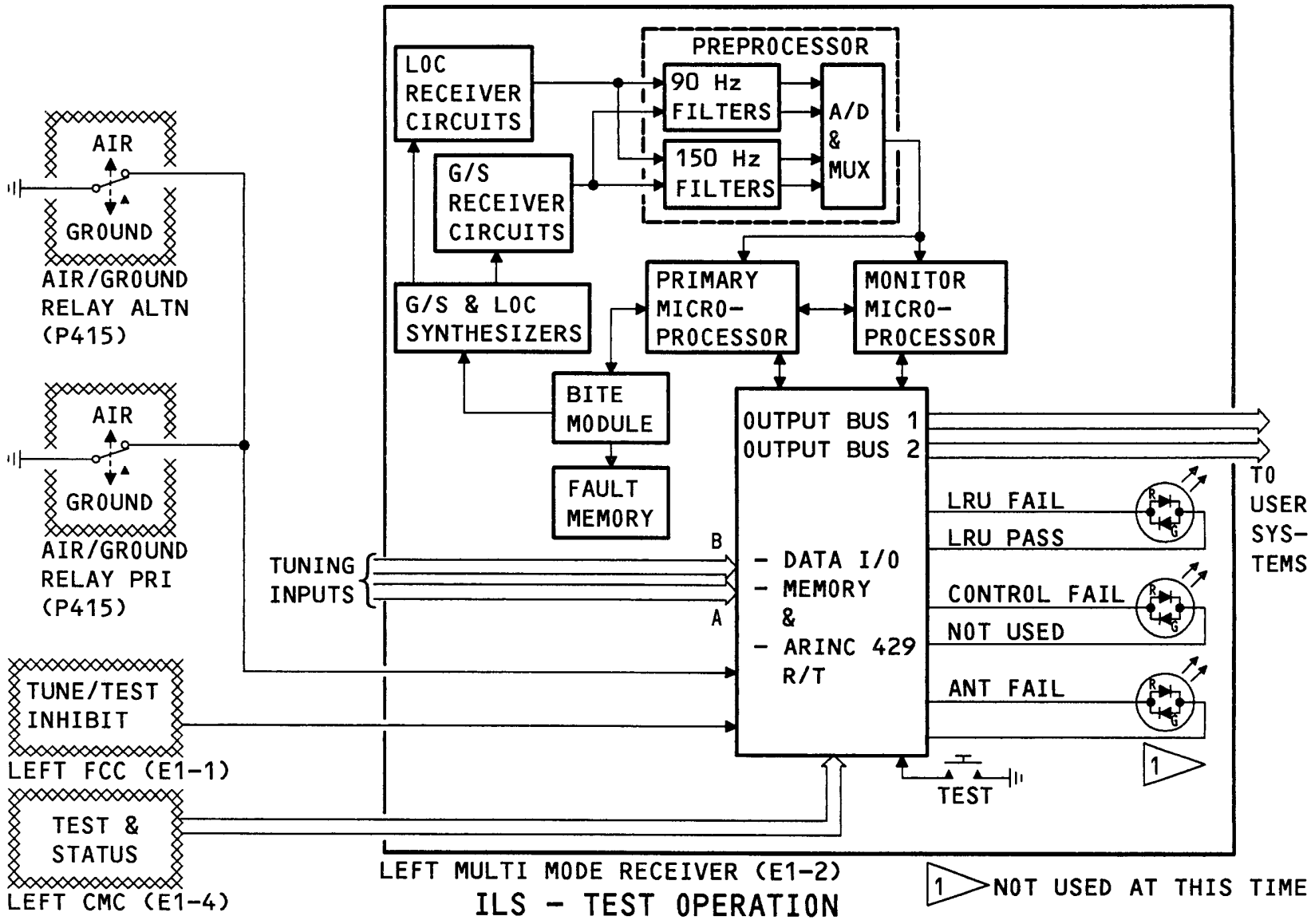

Figure 24 TEST OPERATION

RECEIVER FRONT PANEL SELF TEST

Test

When you push the test switch, the MMR does a check of the internal operation and its interface with other airplane systems. The test takes approximately 36 seconds. This is the test sequence that shows on the LED status indicators during the test:

- 0 to 2 seconds; the LRU STATUS and the CONTROL FAIL LEDs are red
- 2 to 4 seconds; the LRU STATUS LED is green and the CONTROL FAIL LED is red
- 4 to 6 seconds; all LEDS go off
- 6 to 36 seconds; test status shows.

The LRU STATUS segment shows red when there is an internal failure in the MMR. Green shows that the MMR is operating normally.

The CONTROL FAIL segment shows red when an interface to the MMR has a failure. Green shows that all the interfaces to the MMR are normal.

The ANT FAIL LED is not used at this time.

Display Unit Annunciations

The flight deck display units show test sequences 1, 2, 3, and 4 during the front panel self-test.

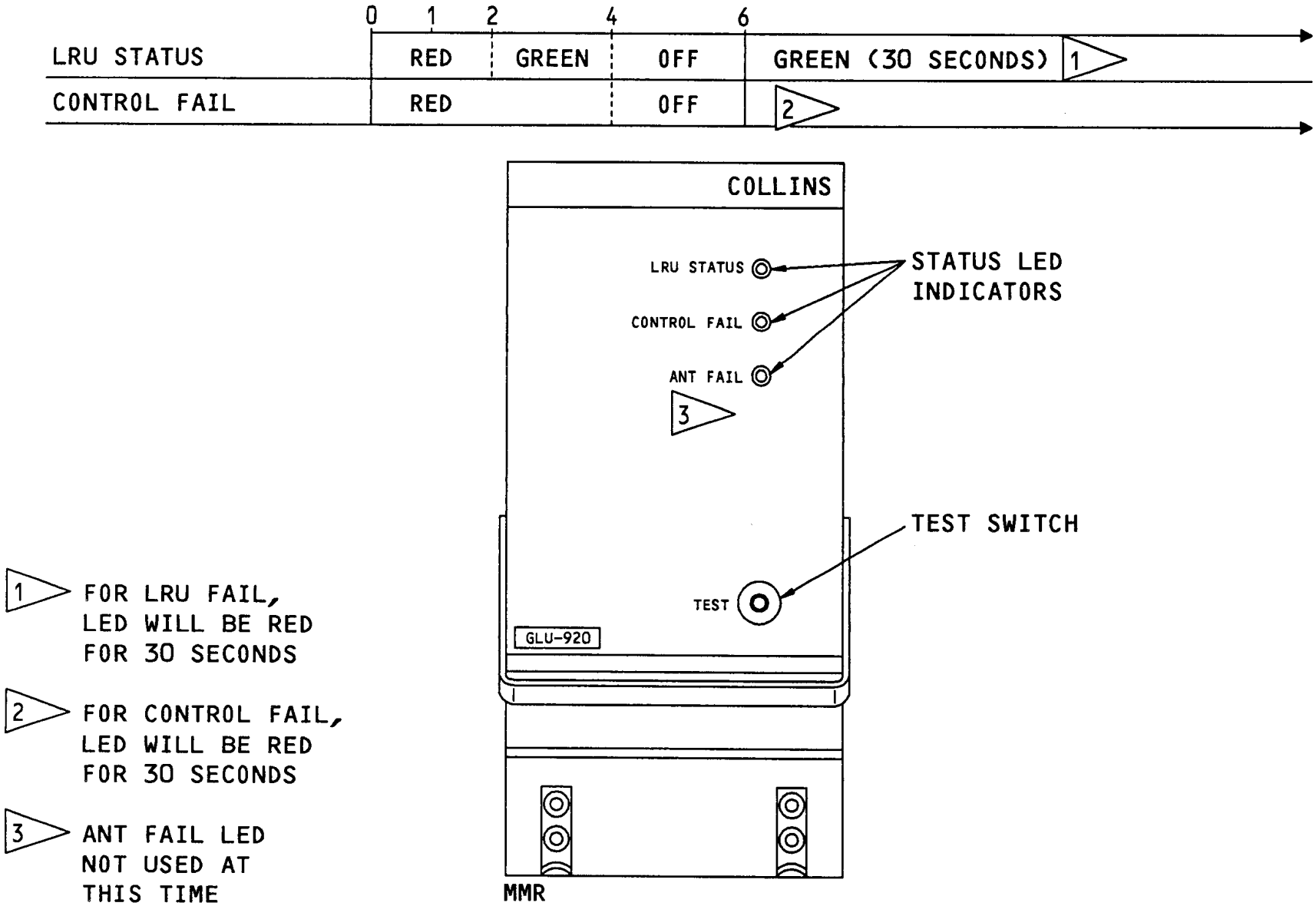

Figure 25 RECEIVER FRONT PANEL SELF TEST

FLIGHT DECK EFFECTS

Flight Deck Effects (FDEs)

ILS FDEs are defined as EICAS status and caution messages.

Some left, center or right ILS failures cause ILS status and caution messages to show on the EICAS.

These messages are ILS FDEs:

- ILS ANTENNA
- >SNGL SOURCE ILS
- GIS ANTENNA X
- LOC ANTENNA X
- ILS LEFT
- ILS CENTER
- ILS RIGHT.

When a FDE appears, some CMC messages may be correlated to the FDE.

If only one ILS is operational, any failure causes ILS flags to show on the PFDs and NDs. A LOC flag, a GIS flag, or both show when the last ILS fails.

NOTE: X = LEFT (L), RIGHT (R) OR CENTER (C).

FLIGHT DECK EFFECTS	TYPE	DESCRIPTION
ILS ANTENNA	CAUTION MESSAGE	TWO OR MORE LOC ANT SWITCHES OR G/S ANT COAXIAL RELAYS FAIL TO CHANGE POSITIONS WHEN COMMANDED
>SNGL SOURCE ILS	CAUTION MESSAGE	BOTH PILOTS PFD/ND ON SAME G/S SOURCE OR LOC SOURCE
G/S ANTENNA X 	STATUS MESSAGE	G/S ANTENNA X COAXIAL RELAY FAILED TO CHANGE POSITIONS WHEN COMMANDED
LOC ANTENNA X	STATUS MESSAGE	LOC ANTENNA X SWITCH FAILED TO CHANGE POSITIONS WHEN COMMANDED
ILS LEFT	STATUS MESSAGE	LEFT ILS FAILURE
ILS CENTER	STATUS MESSAGE	CENTER ILS FAILURE
ILS RIGHT	STATUS MESSAGE	RIGHT ILS FAILURE

PFD AND ND FLAGS	TYPE	DESCRIPTION
G/S	EFIS (PFD AND ND) FLAG	ILS G/S SOURCE FAILURE
LOC	EFIS (PFD AND ND) FLAG	ILS LOC SOURCE FAILURE

 X = L (LEFT), R (RIGHT) OR C (CENTER)

Figure 26 FLIGHT DECK EFFECTS

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