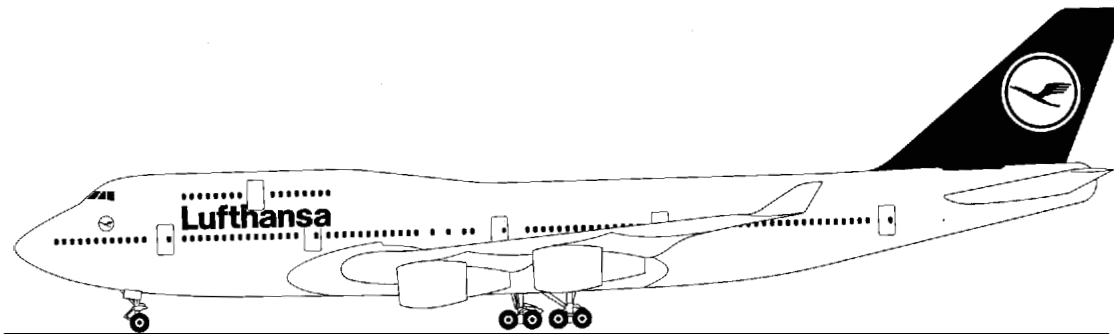




Lufthansa Technical Training

Training Manual B 747-400

ATA 34-43 WEATHER RADAR ATA Spec. 104 Level 3





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ATA 34-43 WEATHER RADAR SYSTEM

WEATHER RADAR



INTRODUCTION

Purpose

The weather radar (WXR) system provides:

- Visual indications of weather conditions
- A display of significant land contours

Method

The WXR system transmits radio frequency (rf) pulses in a 180 degree sector forward of the airplane path. Precipitation or terrain contours reflect the pulses back to the airplane.

Display

The WXR returns show in various colors on CRTs located in the flight deck of the airplane.

In the case of precipitation, the amplitude of these returns depends on the intensity of the precipitation.

This enables the WXR to show areas of various weather conditions on a cathode ray tube (CRT) display.

In the case of returns from the ground, their amplitude depends on the characteristics of the ground surface and enables the WXR to define the shape of ground surface contours.

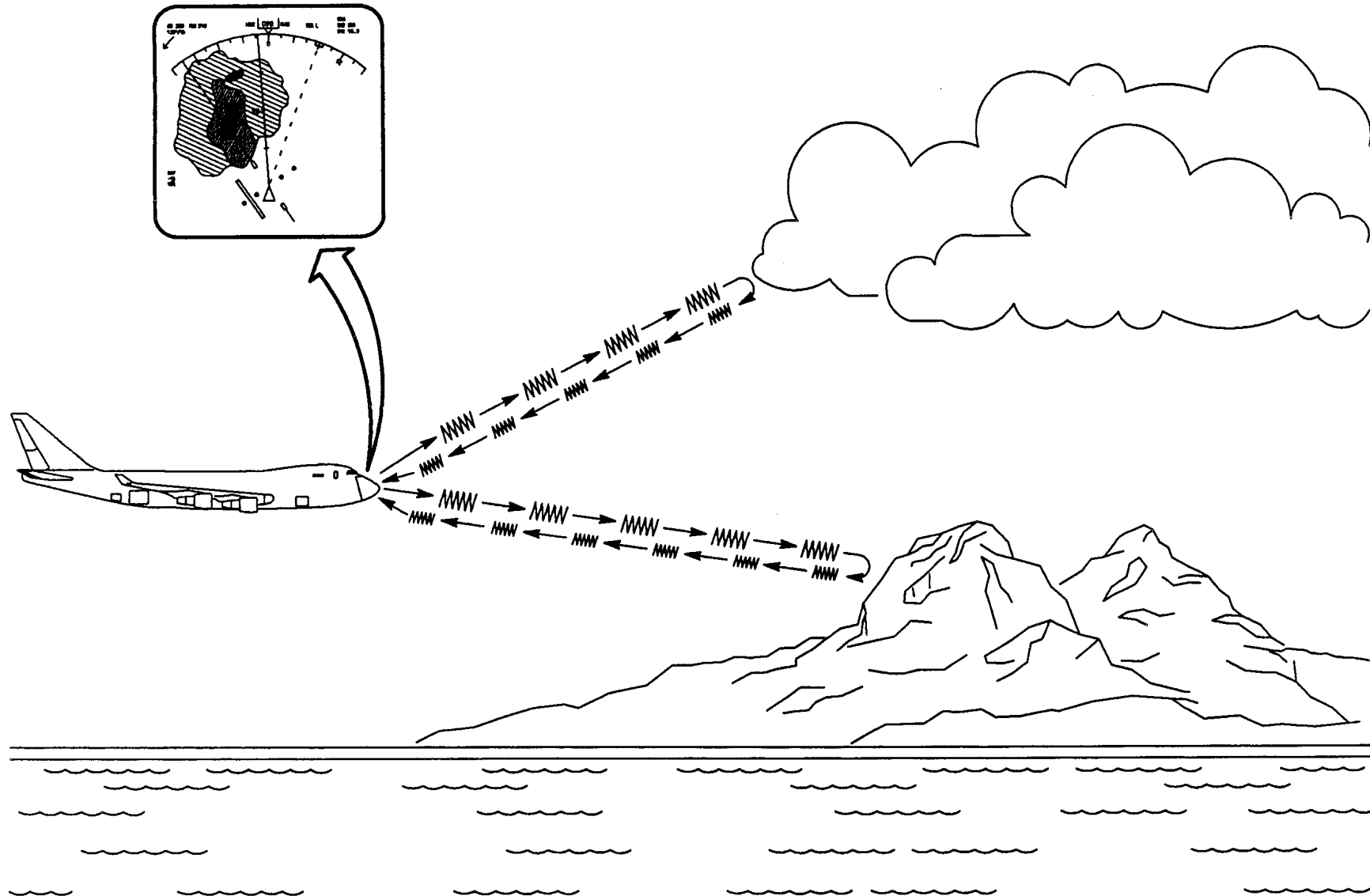


Figure 1 INTRODUCTION

WEATHER RADAR



WEATHER RADAR SYSTEM

Receiver/Transmitter (R/T)

The central component of the weather radar (WXR) system is the weather radar receiver/transmitter (R/T). The system uses dual R/Ts with only one R/T in operation at a time. The WXR R/T:

- Produces X-band rf pulses
- Transmits rf pulses
- Processes received rf returns
- Supplies WXR display

Control

These units provide WXR system control:

- WXR control panel (WXR CP)
- Left and right EFIS control panels (L and R EFIS CPs)
- Left and right control display units (L and R CDUs)

Antenna

The WXR antenna radiates the rf pulses and receives the rf returns. The R/T receives inertial reference unit pitch and roll data for antenna stabilization.

Display

WXR data shows on these display units:

- Left and right navigation displays
(L and R NDs)

Status and Test

The WXR R/T continually sends status data to the left and right central maintenance computers (L and R CMCs) to record in memory and show on the WXR displays or CDUs. A WXR ground test is available from any CDU.

WEATHER RADAR

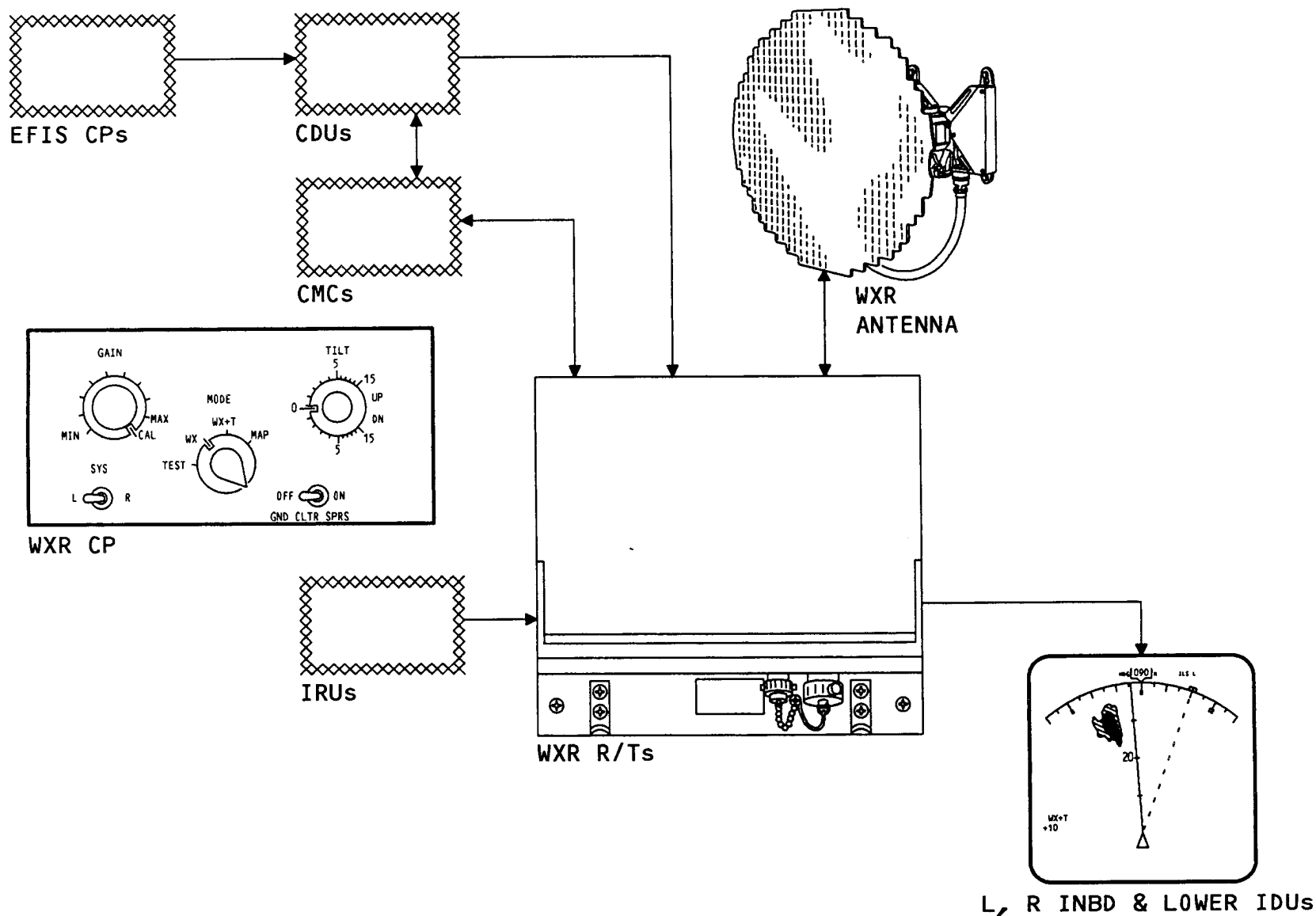


Figure 2 WEATHER RADAR SYSTEM

WEATHER RADAR



COMPONENT LOCATIONS - FLIGHT DECK

WXR System Components

These are components of the WXR system:

- WXR control panel
- Left WXR R/T circuit breaker
- Right WXR R/T circuit breaker.

Interfacing System Components

These components interface with the WXR system:

- Left EFIS control panel
- Right EFIS control panel
- Left inboard IDU
- Right inboard IDU.

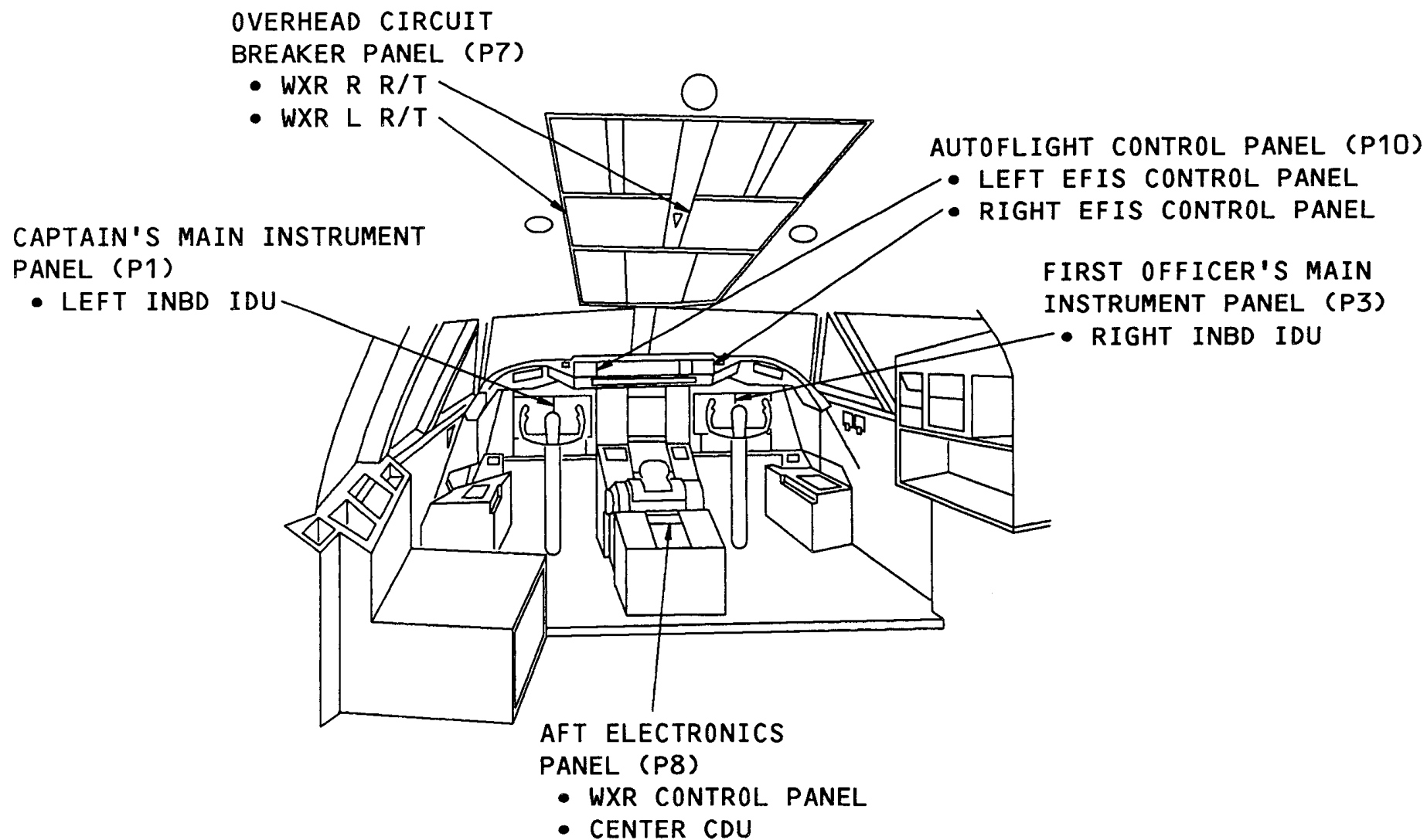


Figure 3 COMPONENT LOCATIONS - FLIGHT DECK



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WEATHER RADAR



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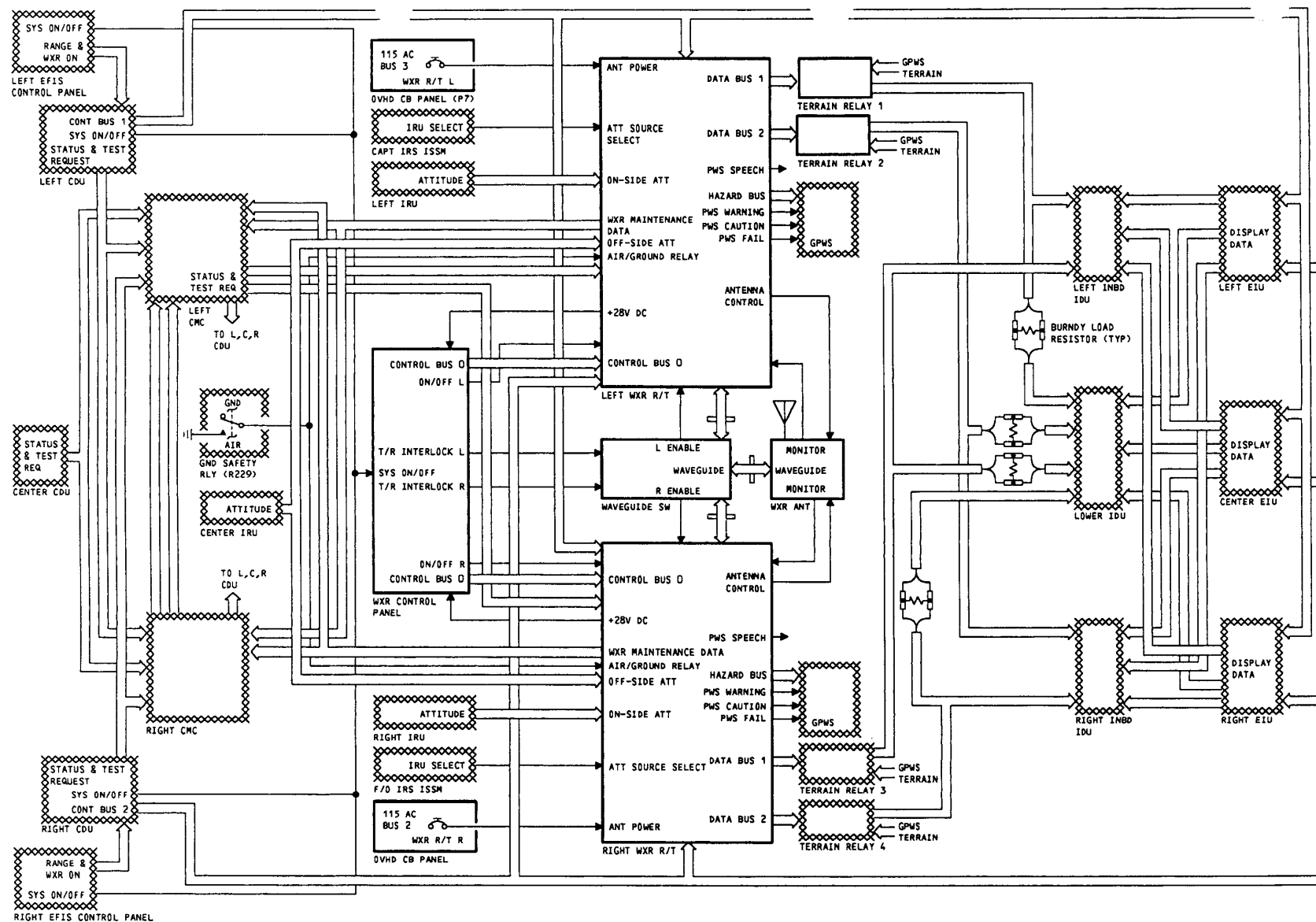


Figure 4 WXR INTERFACE DIAGRAM

WEATHER RADAR



WXR - POWER

The left and the right WXR R/Ts get power from their individual circuit breakers.

The WXR control panel and the WXR antenna get power from the operating WXR R/T.

WEATHER RADAR

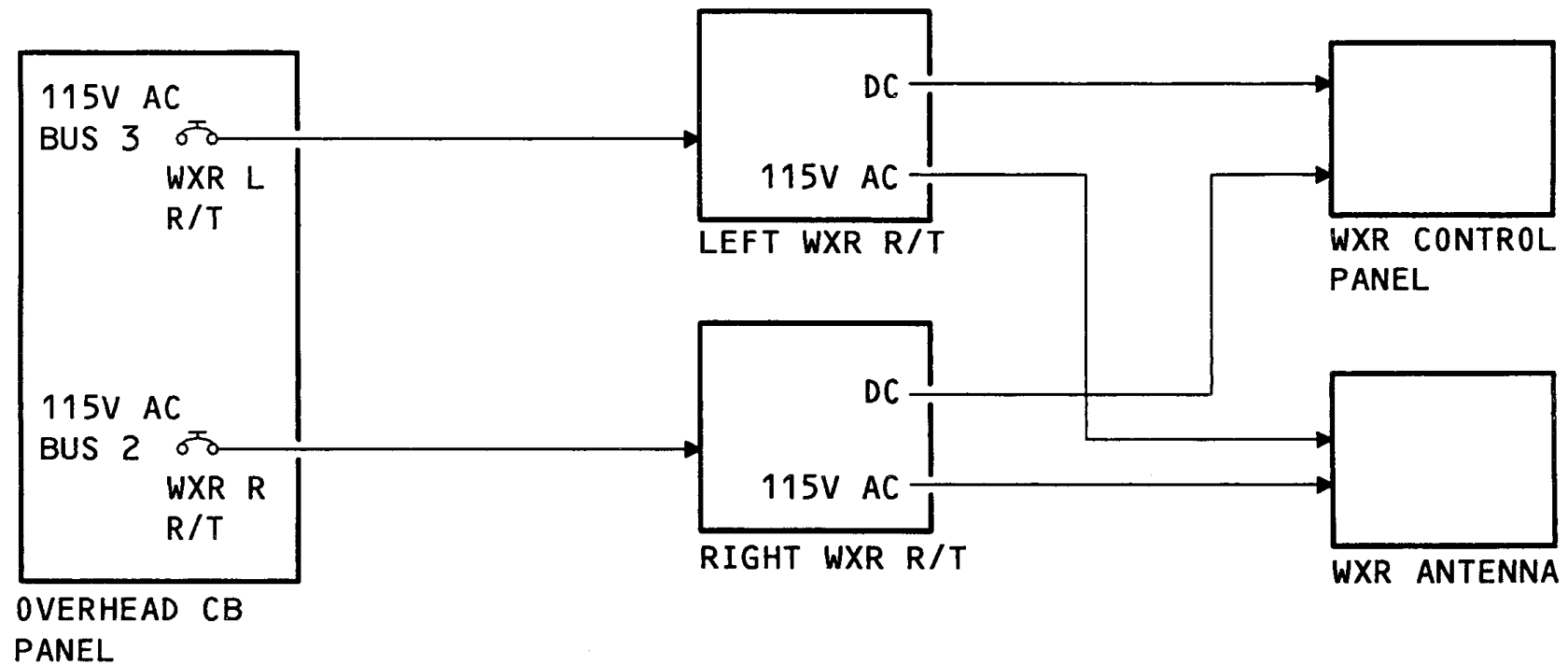


Figure 5 WXR - POWER

WEATHER RADAR



WXR - SYSTEM TURN-ON

Left/Right WXR System Selection

The left/right system selector on the WXR control panel (WXR CP) sends the respective ground-level discrete T/R INTLK L or R to the waveguide switch. The waveguide switch connects the antenna to the selected R/T. It also sends the ground-level discrete R/T ENABLE to the selected R/T and enables it.

WXR R/T Turn-on

The ground-level discretes ON/OFF LEFT and RIGHT from the WXR CP turn on the selected L or R R/T. The discrete originates in the L and/or R EFIS CP, or from the left or right CDU as the SYSTEM ONIOFF discrete.

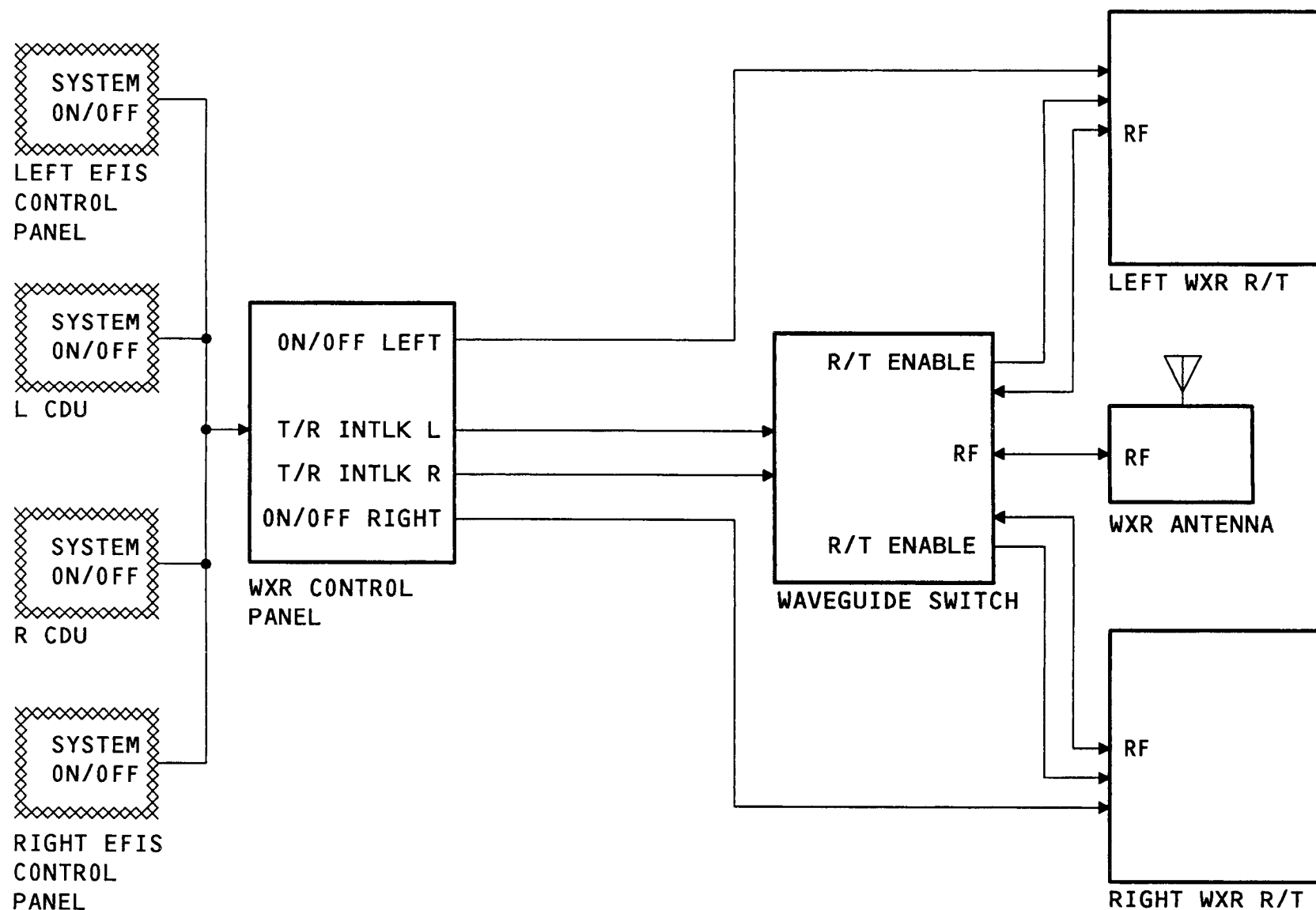


Figure 6 WXR - SYSTEM TURN-ON

WEATHER RADAR



CONTROL AND DISPLAY

System Control

The WXR control panel provides system control on control buses 0. These buses transmit mode, tilt and gain data to the R/Ts.

ND Range and Display Control

The EFIS control panels provide ND range and on/off display control through the onside CDU. If the EFIS control panel fails, the on-side CDU continues to provide this operational function through control bus 1 for the left CDU and control bus 2 for the right CDU.

WXR Output Data and Display

The WXR R/Ts process and send WXR video according to the range selected on the onside EFIS control panel. The operating R/T sends the WXR display video to the GPWC TERRAIN SELECT RELAYS. These relays send WXR video to the ND unless a higher priority terrain alert is generated by the GPWC or manually selected. The WXR pushbutton enable switch on the EFIS control panels turns on the WXR display of the onside ND. If a terrain display shows on the ND, WXR arms the ND to show WXR data when the terrain display no longer shows. The NDs normally show WXR video on the inboard IDUs. The lower IDU is a backup for the captain or first officer's ND.

Status Display

The NDs also show WXR system status and fault annunciations in the same EFIS modes that they show WXR video.

Data-Bus Types

Data buses 1 and 2 are ARINC 453 buses. All other data buses are ARINC 429 buses. A burny load resistor across the two wires of each data bus to the lower IDU helps to prevent spoking of the WXR video display.

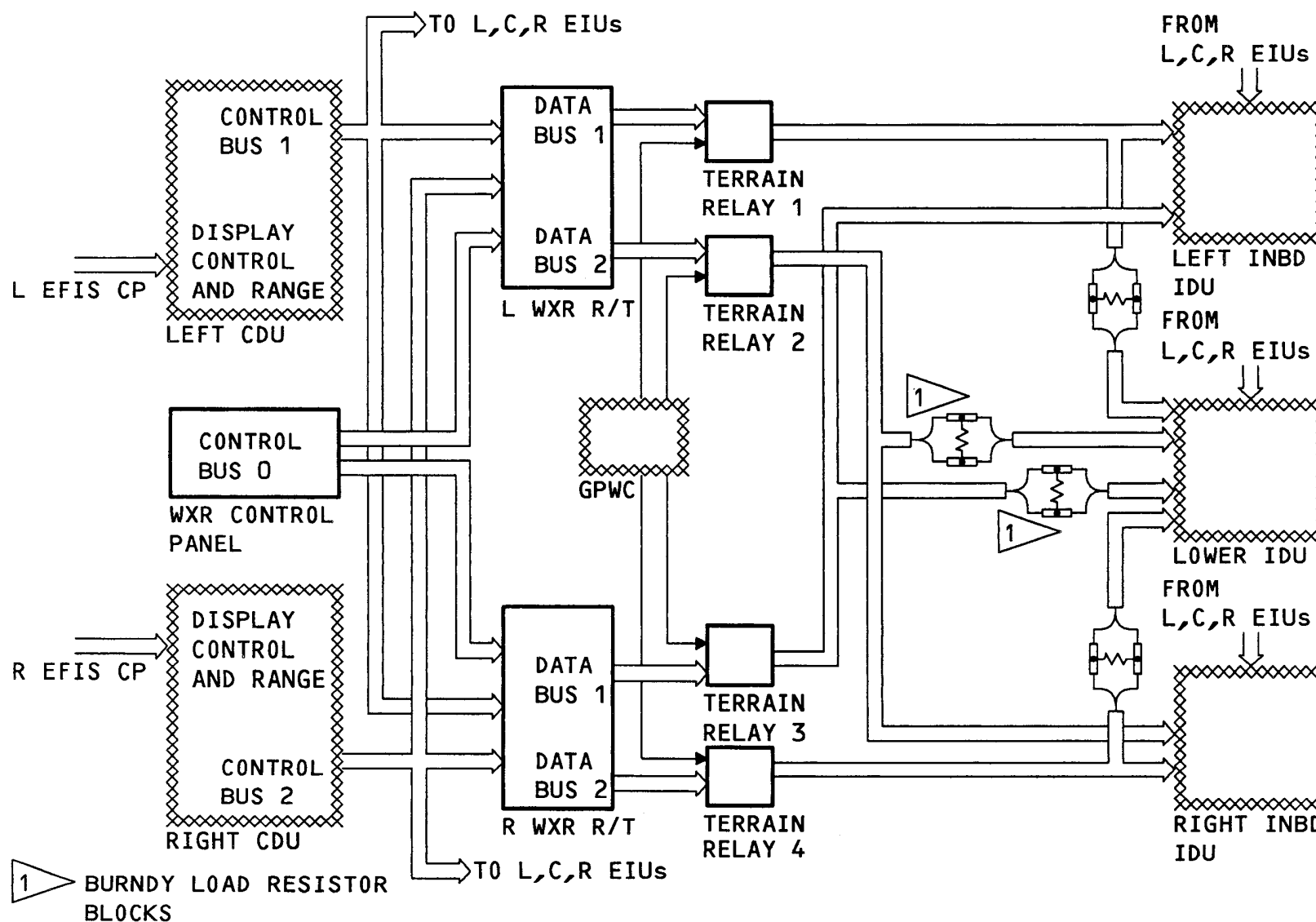


Figure 7 CONTROL AND DISPLAY

WEATHER RADAR



ANTENNA CONTROL

Antenna Control

The selected R/T sends antenna control and stabilization signals. The waveguide switch connects the selected R/T to the antenna.

The WXR control panel sends manual tilt on control bus 0.

Antenna Position Monitoring

The R/T gets feedback from the antenna for present scan and elevation positions.

Attitude Sources

The onside inertial reference units (IRUs) normally send airplane attitude data for antenna stabilization. The IRS instrument source select switches send manual onside or center IRU selection discretes to the R/T.

Signal Types

Antenna control signals are analog signals.

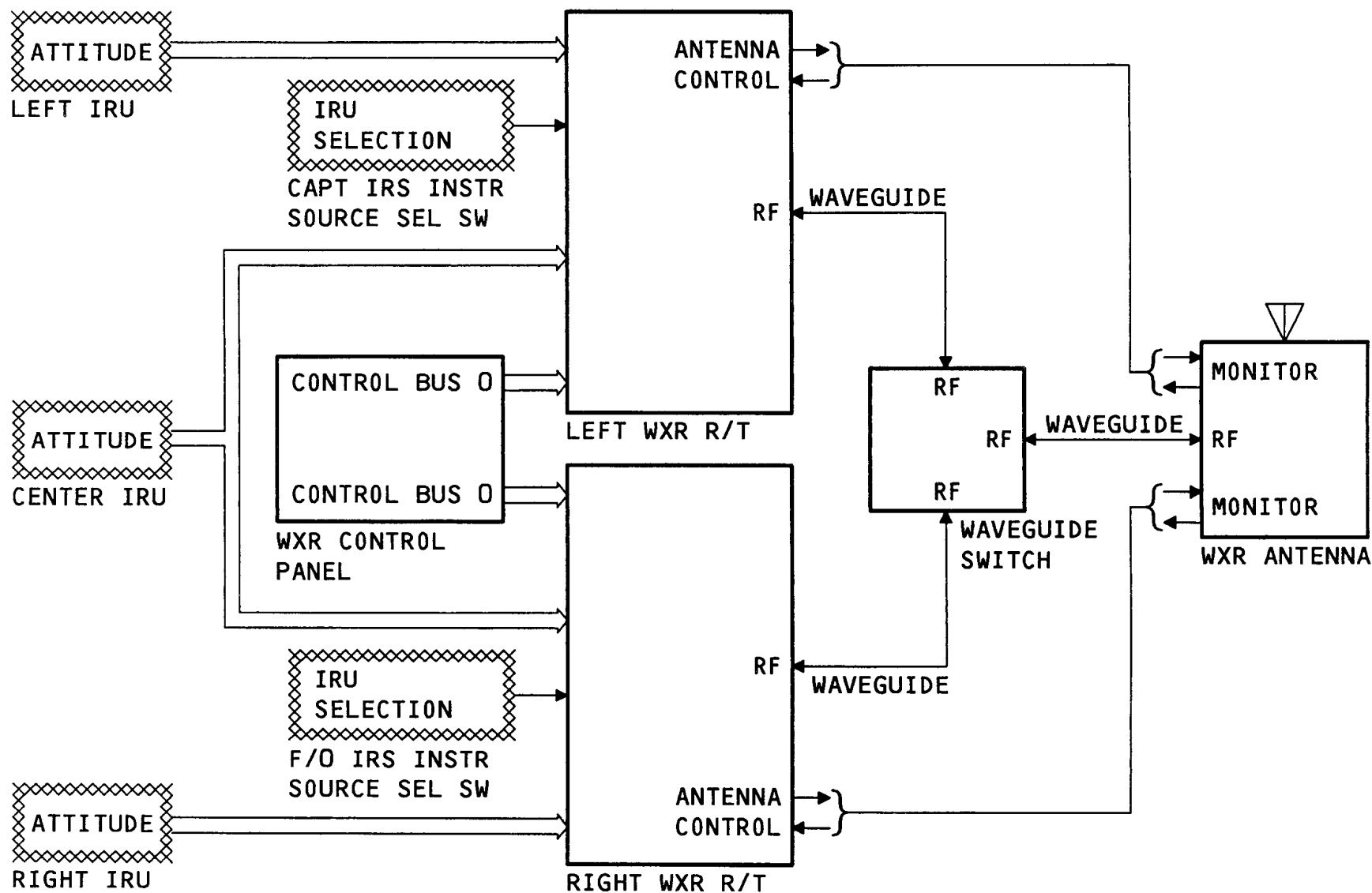


Figure 8 ANTENNA CONTROL

WEATHER RADAR



MAINTENANCE INTERFACES

Central Maintenance Computer Functions

The functions of the central maintenance computer (CMC) are:

- Transmit ground test commands received from the CDUs to the R/Ts
- Transmit WXR status information to the CDUs when requested.

Normally, the left CMC is the active CMC. When the left CMC fails, the right CMC becomes the active CMC.

WXR R/T Fault Memory

The R/Ts record faults in NVM by flight legs. An input from the ON/OFF switch defines each flight leg.

System Status Data

The CMCs continually get WXR system maintenance data from the R/Ts. They store it in memory to show on the CDUs.

Ground Test

When started from any CDU, the CMCs send a ground test command to the R/T in operation. The R/T sends test results back to the CMCs to show on the CDUs.

Air/Ground

The air/ground relay inhibits ground tests in the air.

WEATHER RADAR

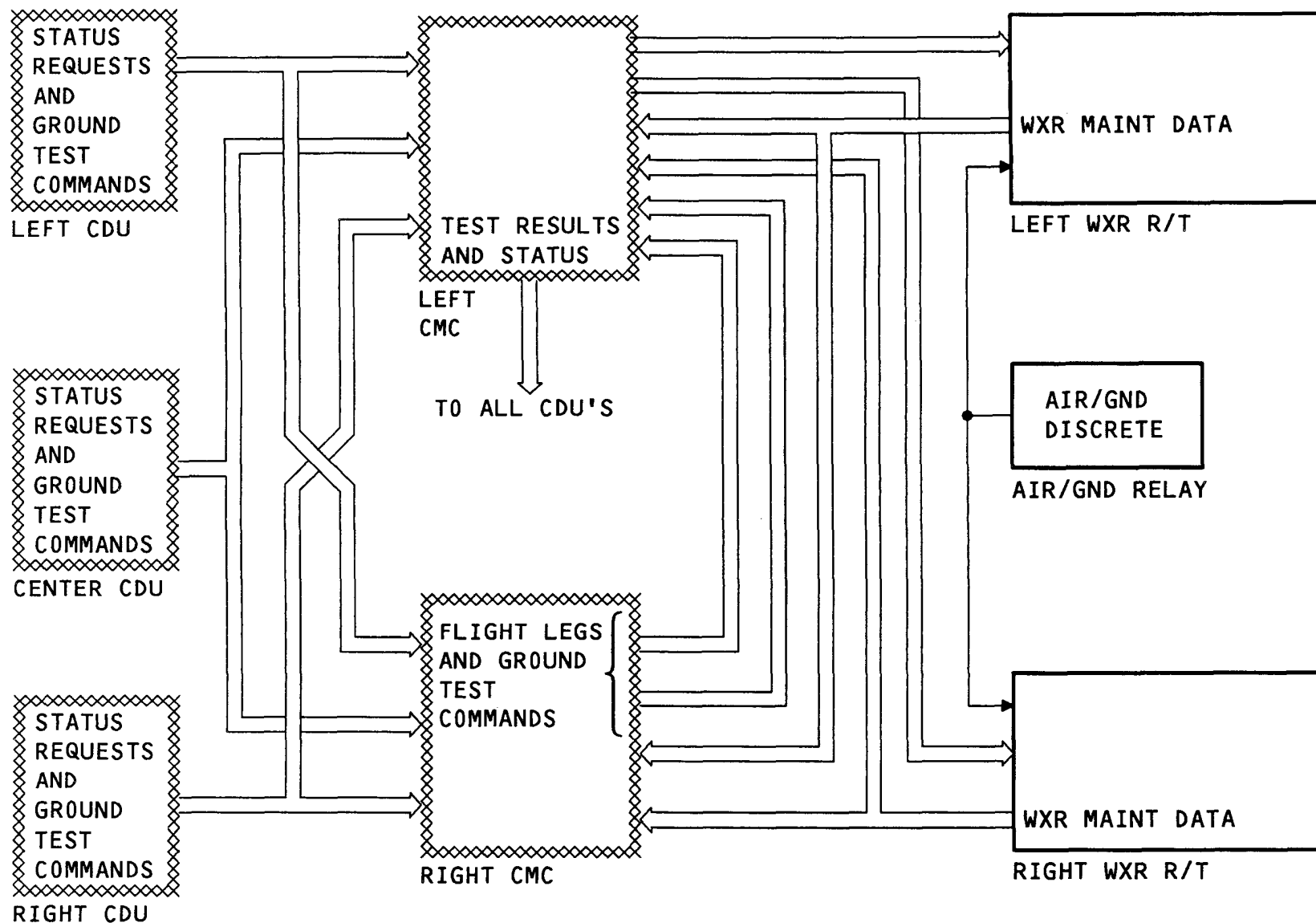


Figure 9 MAINTENANCE INTERFACES

WEATHER RADAR



WXR - CONTROL PANEL

Purpose

The WXR control panel provides WXR system control.

Left or Right RZT Selection

Only one R/T can operate at any one time. Separate pushbutton switches labeled L R/T and R R/T allow selection. A mechanical interlock prevents the selection of both R/Ts.

Dual Operation

The control panel selects control functions independently for the left and right side. The R/T uses the left selections for operation control, signal processing and display update on the left ND during the left-to-right antenna sweep.

During TEST, both sides are used.

Mode Selectors

The mode pushbutton selectors are:

- WX (Enables precipitation detection)
- WX+T (Enables precipitation and turbulence detection. For selected ranges less than 50 nm precipitation and turbulence functions are enabled. For selected ranges of greater than 50 =, only precipitation operates)
- MAP (Enables ground mapping)

Tilt and Gain Control

Two sets of concentric knobs control manual tilt and receiver gain, one set for each side.

The outer knob of each set selects manual tilt from 15 degrees up to 15 degrees down. The left tilt selector sets the tilt for the left-to-right sweep. The right tilt selector sets the tilt for the right-to-left sweep.

The inner knob MAP GAIN of each set selects preset or manual gain in the map mode. It has 10 detented positions. The most clockwise position automatically presets the gain to a calibrated value. Counterclockwise rotation of the knob first selects maximum gain, after which it reduces the gain in 2 db steps to a minimum value. The minimum value corresponds to the preset calibrated gain.

In WX, WX+T, and TEST modes, the R/T uses only preset calibrated gain independently from MAP GAIN knob settings.

Ground Clutter Suppression

The GCS pushbutton reduces the intensity of ground clutter in the WX mode.

Transfer Functions

The transfer pushbutton TFR causes the R/T to use the same mode, tilt, and gain as the other side.

The selection of the transfer function on both sides puts the R/T in the standby mode. The antenna scan stops, rf transmissions stop, and the system annunciates an R/T failure.

Pushbutton Interlock

A mechanical interlock between the pushbuttons TFR, WX, WX+T, and MAP on each side prevents the selection of more than one mode at a time. The selection of one pushbutton causes any other pushbutton to pop out.

WEATHER RADAR

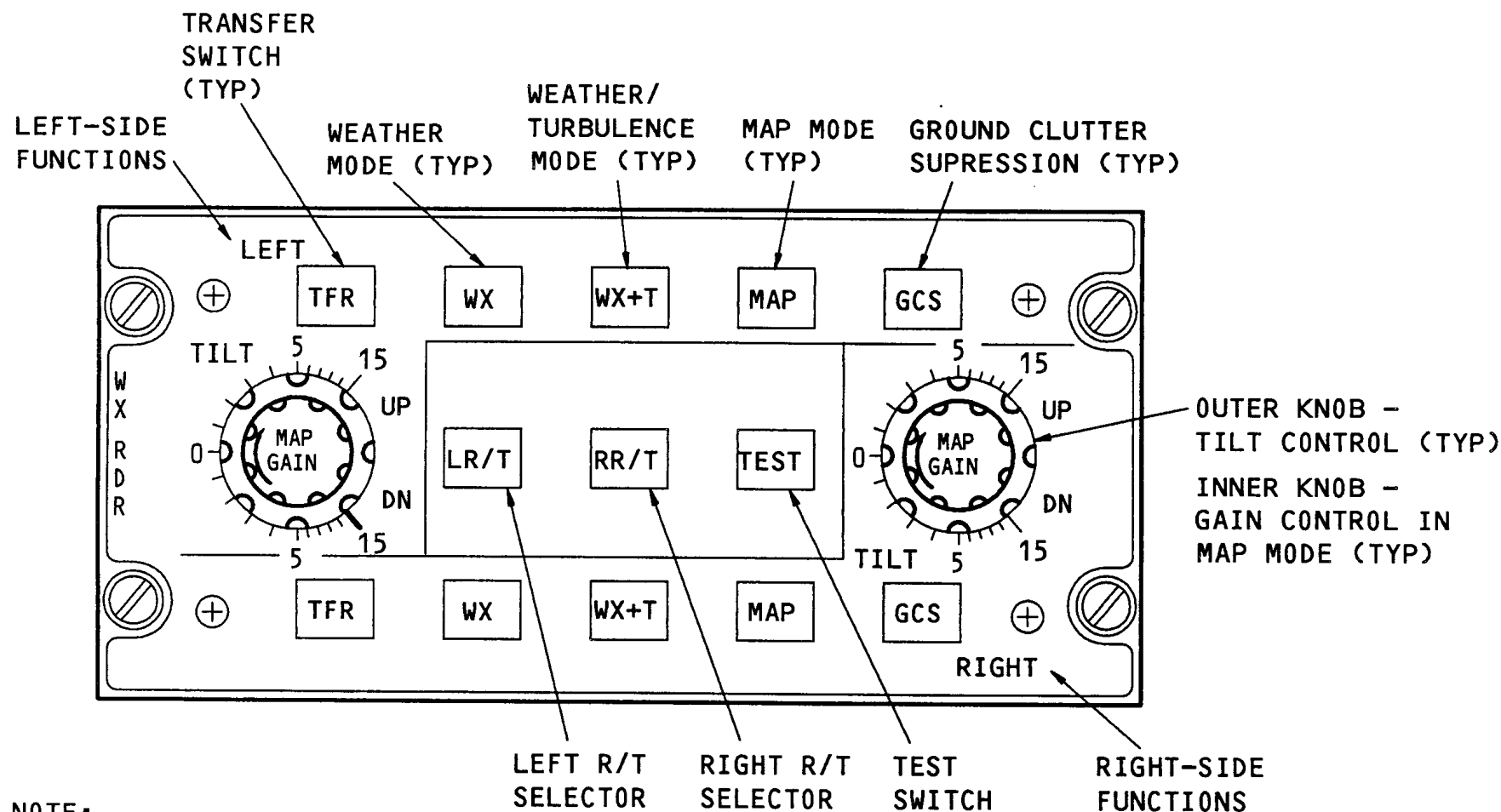


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**NOTE:**

MECHANICAL INTERLOCKS PREVENT THE SELECTION OF MORE THAN ONE R/T (L R/T OR R R/T), AND OF MORE THAN ONE MODE (WX, WX+T, MAP, OR TFR) ON THE SAME SIDE.

Figure 10 WXR - CONTROL PANEL

WEATHER RADAR



WXR - RECEIVER/TRANSMITTER

Purpose

The purpose of the WXR R/T is to:

- Generate and transmit rf pulses
- Process return signals
- Generate display data
- Transmit display data to the display units
- Generate test pattern for display units
- Provide antenna stabilization
- Monitor and test system operation
- Transmit and record status info and test results

Characteristics

These are the characteristics of the WXR R/T:

- Output power: 125 w. peak; approximately 600 mw average,
- Weight: 27 lb (12.2 kg)
- Cooling: forced air

Front Panel

An ATE test connector provides test points to monitor system operation during bench tests.

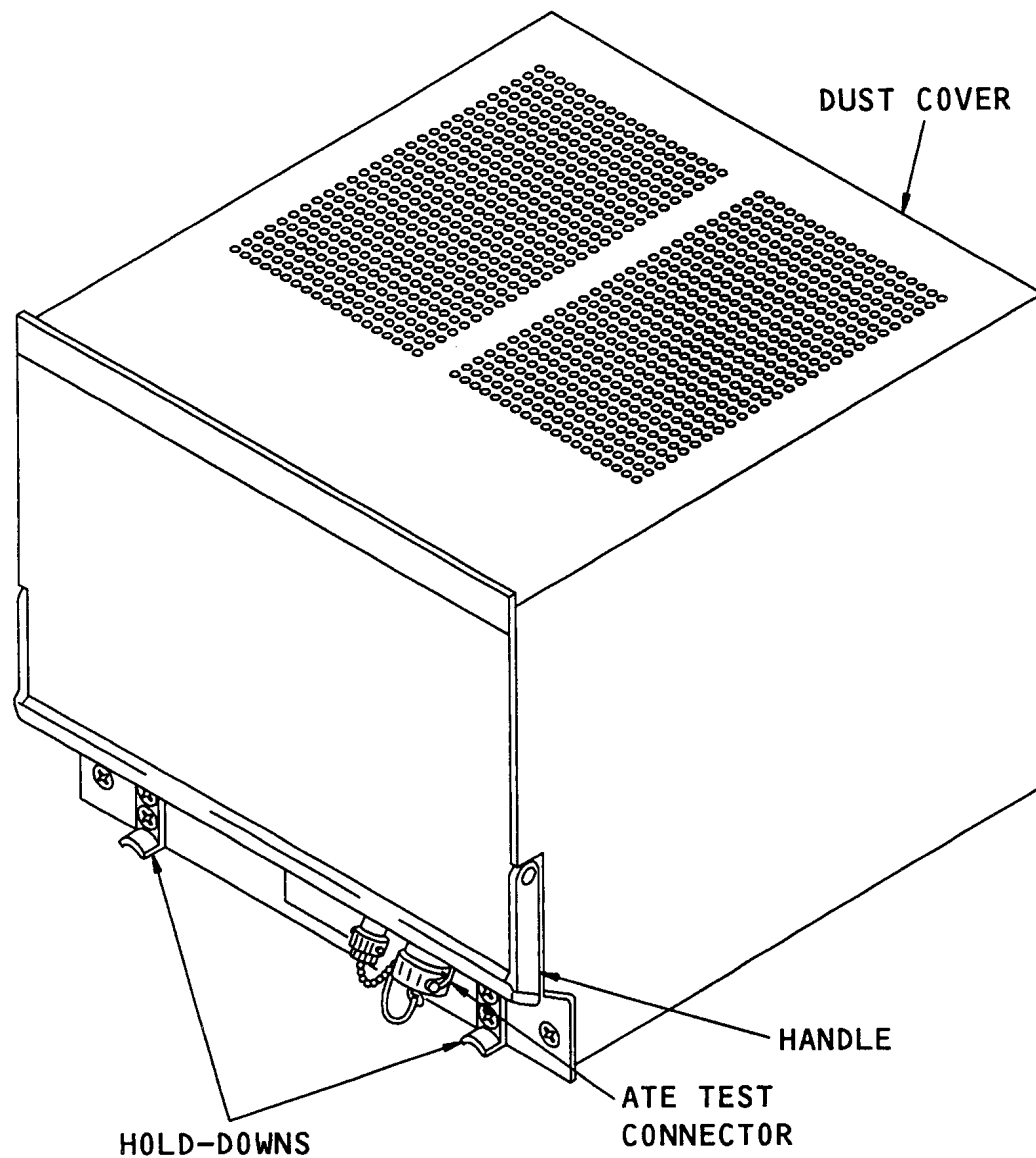


Figure 11 WXR - RECEIVER/TRANSMITTER

WEATHER RADAR



WXR - ANTENNA 1

Antenna Functions

The WXR antenna does these functions:

- Radiates rf energy sent out from the WXR R/T
- Receives the reflected rf energy and sends it back to the R/T
- Scans the flat plate 90 degrees left and right of centerline

Characteristics

The characteristics of the WXR antenna are:

- Flat plate width: 28 inches
- Flat plate weight: 6 lbs (2.7 kg)
- Mounting pedestal weight: 25 lbs (11.5 kg)
- Scan rate (15 looks-per-minute)

Bea

The flat plate is an array of individual radiation slots. The radiation from each of these slots, combined, make a pencil beam 3.6 degrees high and 3.5 degrees wide.

Antenna Stabilization

The antenna receives stabilization command from the operation R/T. The stabilization range is +40 degrees, including +15 degrees manual tilt.

Warnings and Cautions

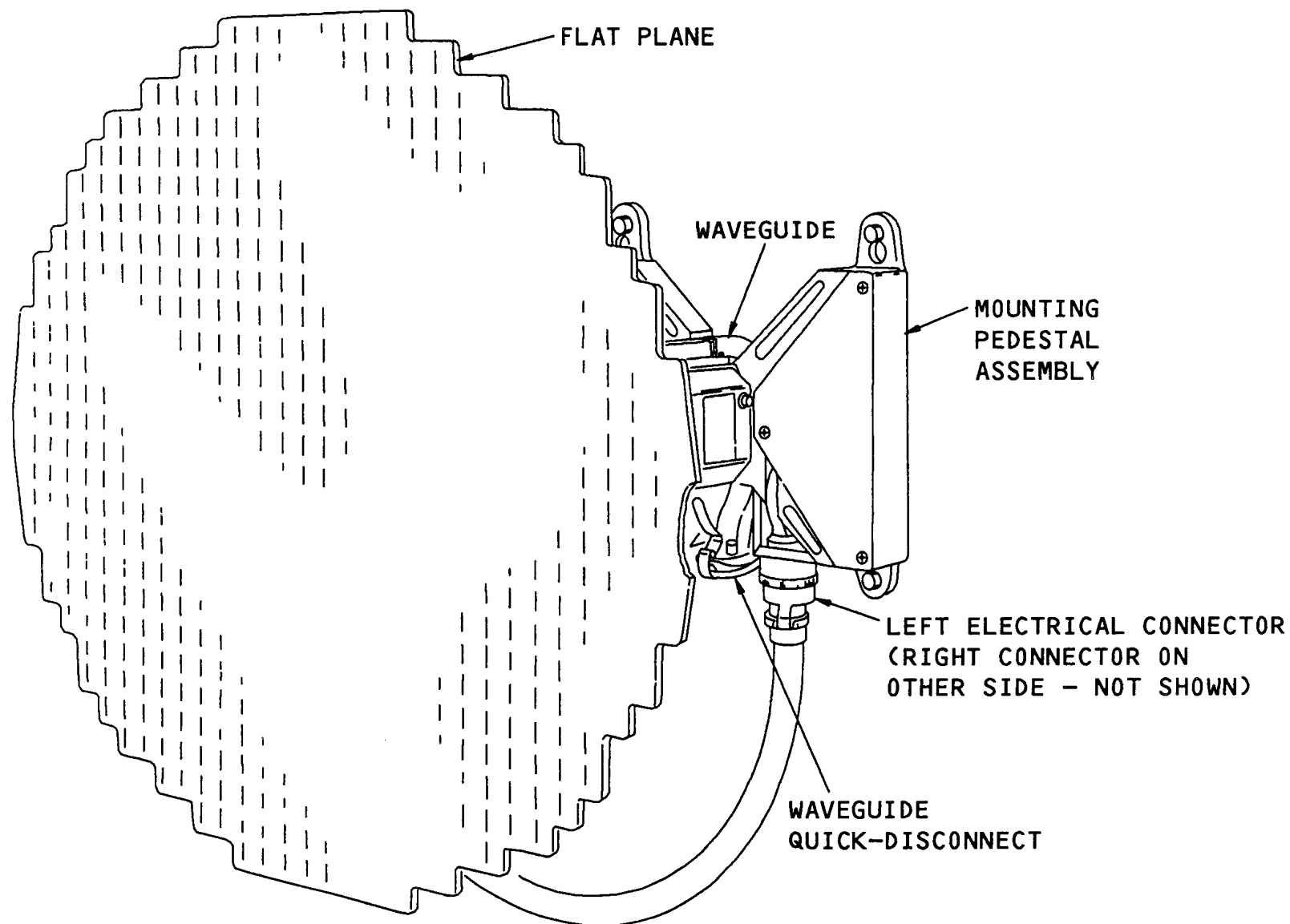
WARNING: WARNING: DURING AN ANTENNA REMOVAL USE TWO PERSONS AND A SAFELY INSTALLED PLATFORM. THE ANTENNA WEIGHS APPROXIMATELY 25 POUNDS.

CAUTION: WHEN THE WEATHER RADAR ANTENNA OR AN ANTENNA ASSEMBLY IS REMOVED OR INSTALLED BE CAREFUL TO CONTROL THE WORK STAND AND EQUIPMENT. ACCIDENTAL CONTACT OF THE WORK STAND OR OTHER EQUIPMENT COULD DAMAGE THE LOCALIZER ANTENNA OR OTHER RADOME EQUIPMENT. DO NOT USE THE LOCALIZER ANTENNA AS A FOOTREST OR SUPPORT. DAMAGE TO THE LOCALIZER ANTENNA WILL RESULT.

WEATHER RADAR

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34-43**Figure 12 WXR - ANTENNA 1**

WEATHER RADAR



WXR - ANTENNA 2

RF Energy Transmission

RF pulses go from the R/T to the flat plate through the scan and elevation rotary joints. The waveguide connection with the antenna is by means of a quick disconnect clamp. A mica pressure window at the waveguide input prevents waveguide pressure from escaping.

Power and Control

The antenna pedestal mount has two sets of power supplies and electronics. One set drives the flat plate when the left R/T is selected. The other set drives the flat plate when the right R/T is selected. The mount also has two electrical connectors. One connector goes to the left R/T. The other connector goes to the right R/T.

Antenna Movement

A 26 volt dc stepper motor gives scan movement. A second motor gives elevation movement. Both get power from the selected R/T.

Antenna Position Monitors

Two zero position monitors and two incremental monitors send position feedback to the selected R/T. One set of monitors send scan position feedback data and the other set sends elevation position feedback data.

Scan and Elevation Disable Switches

A scan disable toggle switch and an elevation disable toggle switch behind the left cover plate disable the scan or the elevation movement during maintenance procedures. The switches do not disable rf transmissions.

Scan and Elevation Angle Dials

A scan angle dial on the scan zero dial shows the scan angle value. An elevation angle dial on the elevation zero monitor shows the elevation angle value.

Elevation Torque Spring

A torque spring inside the antenna pedestal (not shown) counter balances the weight of the flat plate. After removal of the flat plate, the torque spring drives the elevation drive into the upper position.

Planar Array Removal/Installation

Observe these warnings and cautions during the removal and installation of the flat plate:

WARNING: DURING ANTENNA PEDESTAL REMOVAL USE TWO PERSONS AND A SAFELY INSTALLED PLATFORM. THE ANTENNA PEDESTAL WEIGHS APPROXIMATELY 20 POUNDS.

WARNING: DURING ANTENNA FLAT PLATE REMOVAL USE TWO PERSONS AND A SAFELY INSTALLED PLATFORM. THE ANTENNA FLAT PLATE WEIGHS APPROXIMATELY 5 POUNDS.

WEATHER RADAR



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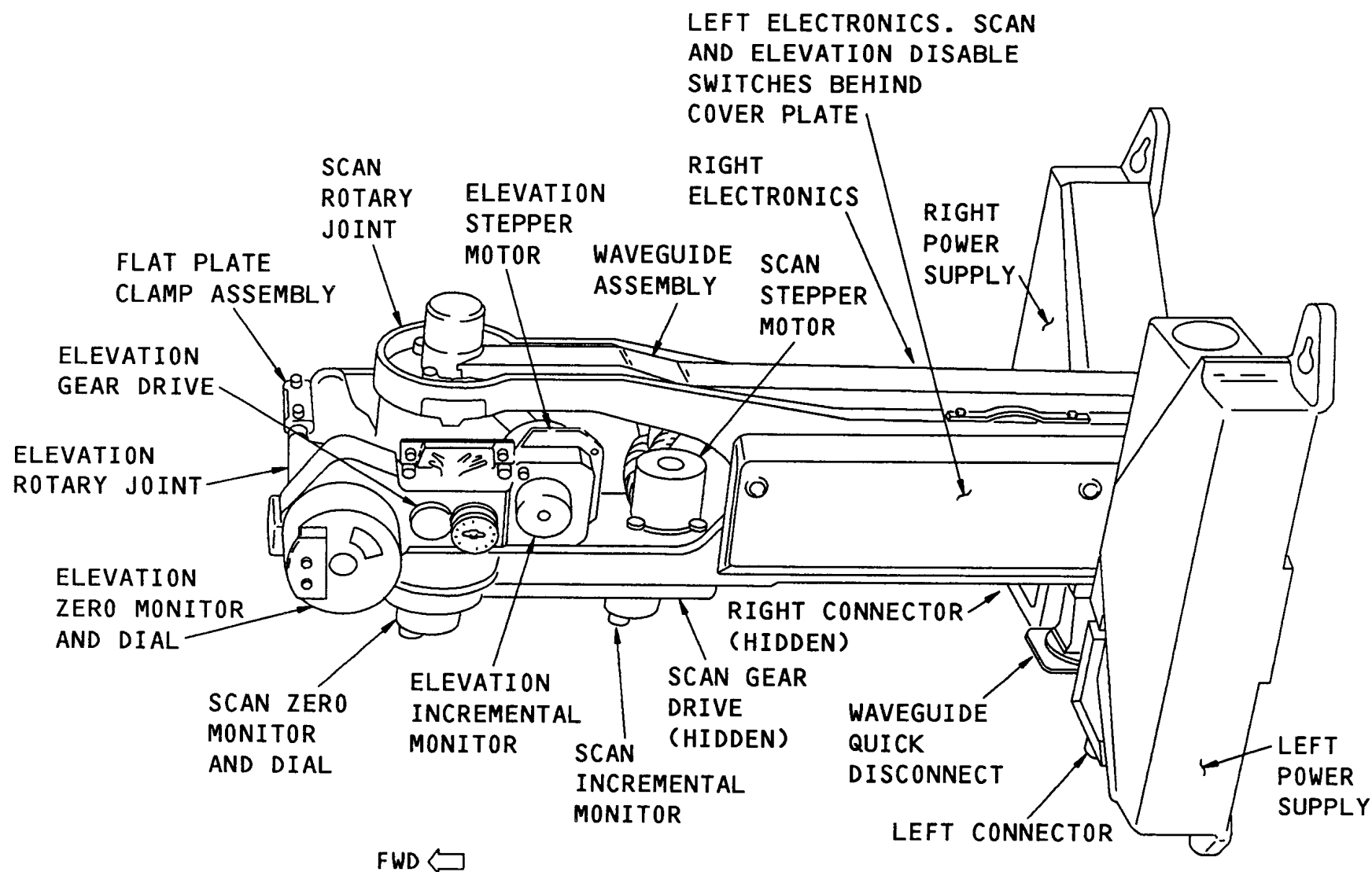


Figure 13 WXR - ANTENNA 2

WEATHER RADAR



EFIS CONTROL PANEL

Purpose

The EFIS control panels provide on/off selection of the WXR R/Ts and select the WXR display on the NDs.

WXR Switch

The WXR switch turns on the selected WXR R/T and enables the WXR display on the onside NDs.

TERR Switch

The terrain switch causes the enhanced ground proximity warning system to show the terrain awareness and alerting display (TAAD) on the onside ND. TAAD always overrides and replaces the WXR display.

EFIS Modes

The NDs show WXR data in these modes:

- Expanded APP (approach) mode
- Expanded VOR mode
- Expanded MAP mode
- CTR MAP mode

Range

MAP modes show range at all times. Radio navigation modes (VOR and APP) show range only when WXR is ON. For a range of 640 nm selected on the EFIS control panel, the WXR R/T operates at 320 nm.

For a selected range of 640 nm, weather displays are shown up to a distance of 320 nm on the NDs.

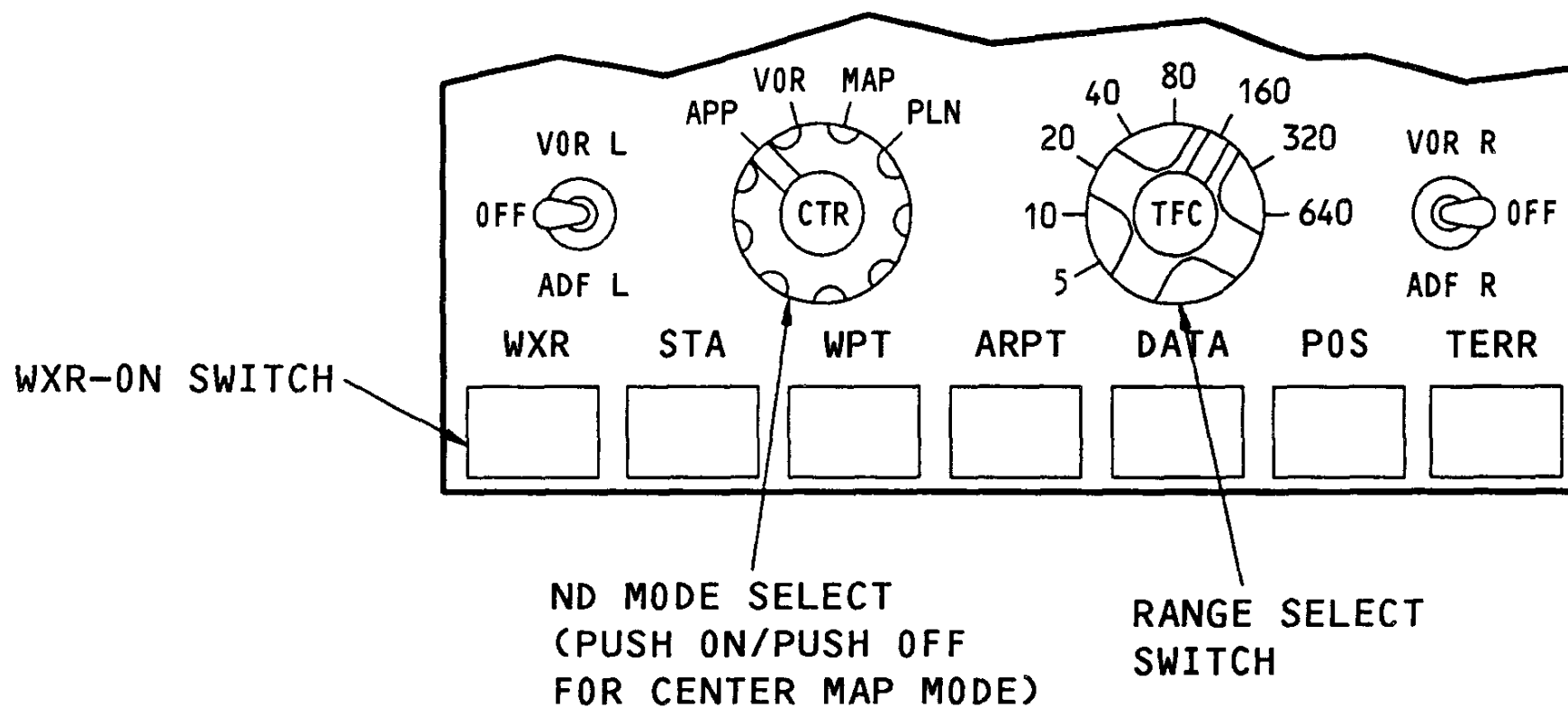


Figure 14 EFIS CONTROL PANEL

WEATHER RADAR



CDU SELECTIONS

Purpose

The control display unit (CDU) provides back-up WXR controls for the EFIS control panel.

Description

A failure of the EFIS control panel enables the CDU display controls.

To get the EFIS CONTROL page:

- Push the MENU key on the CDU. The MENU page comes on.
- On the MENU page, line select EFIS CP. The EFIS CONTROL page comes on. If the EFIS control panel is not disabled, the EFIS CONTROL page cannot be called up.

Select the EFIS modes and range on the EFIS CONTROL page.

To get the EFIS OPTIONS page, line select OPTIONS on the EFIS CONTROL page. To enable the WXR displays on the NDs, line select WXR on the EFIS OPTIONS page.

To return to the EFIS CONTROL page, line select CONTROL on the EFIS OPTIONS page.

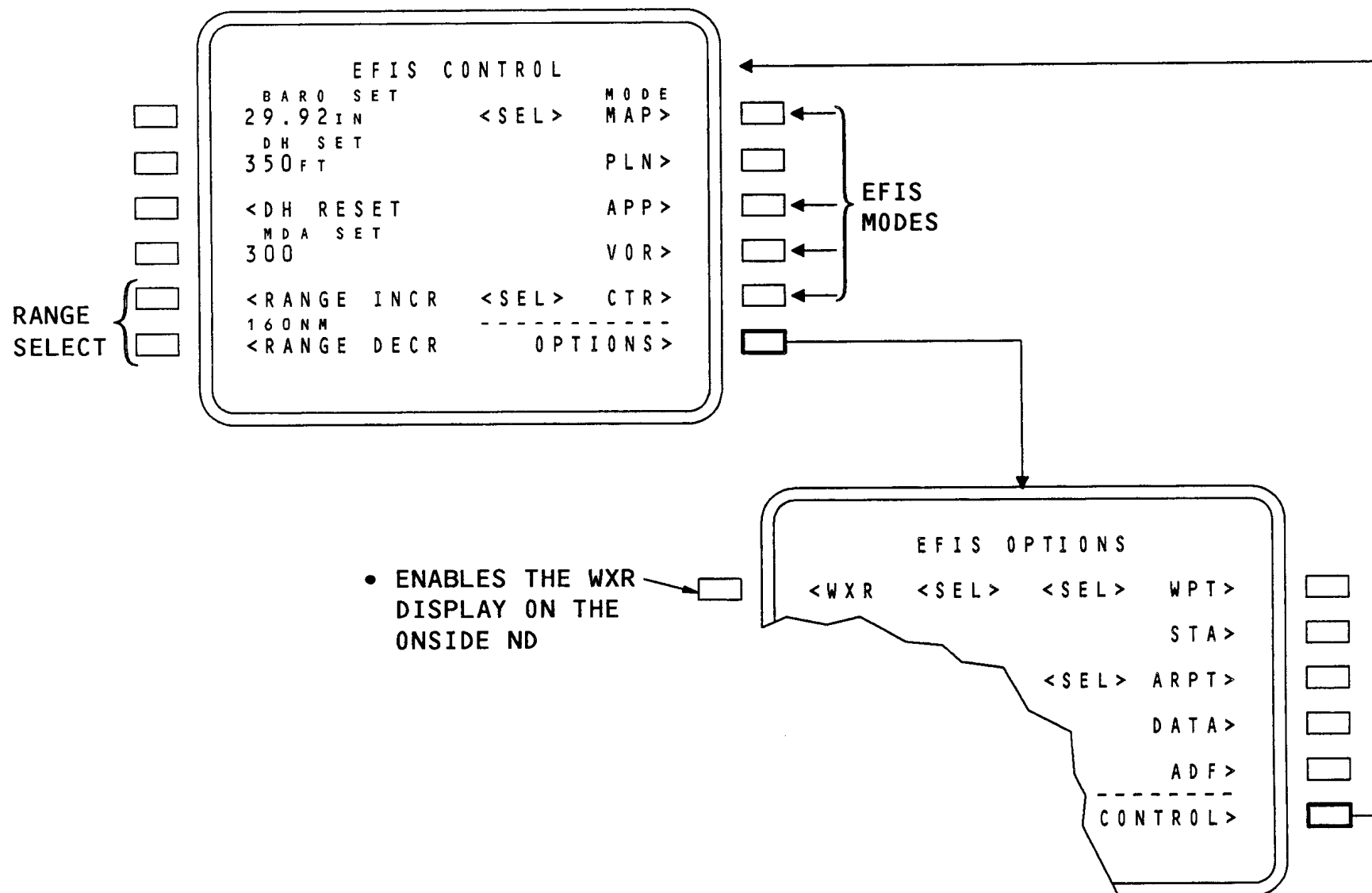


Figure 15 CDU SELECTIONS

WEATHER RADAR



ATTITUDE INPUT SWITCHING

The IRS source selector switches select the outside or the center IRUs. The IRUs are attitude data sources for the R/Ts.

With the captain's IRS source selector switch in the L (left) position, the left IRU provides attitude information to the left WXR R/T. With the captain's IRS source selector switch in the C (center) or R (right) position, the center IRU provides attitude data to the left WXR R/T.

The first officer's IRS source selector switch controls the attitude inputs into the right WXR R/T. The right IRU provides attitude data with the source selector switch in the R (right) position. When the switch is in the L (left) or C (center) position, the center IRU is the attitude data source.

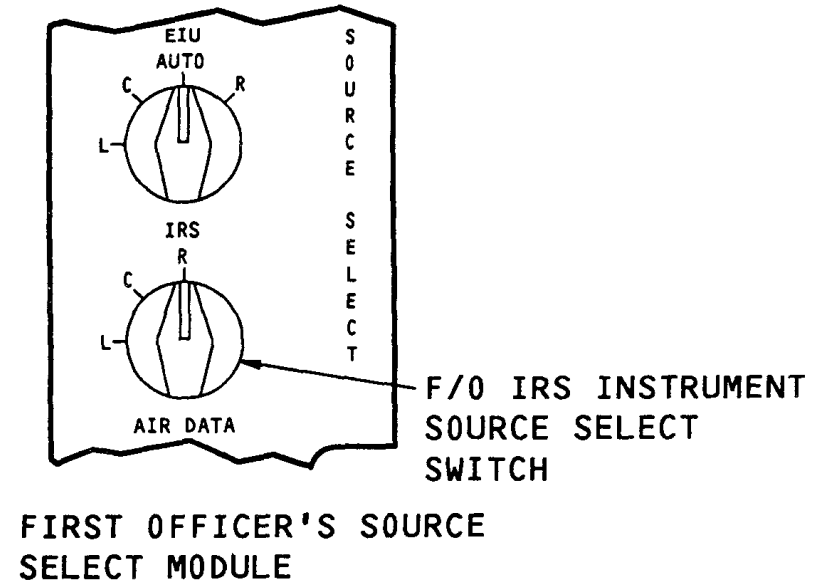
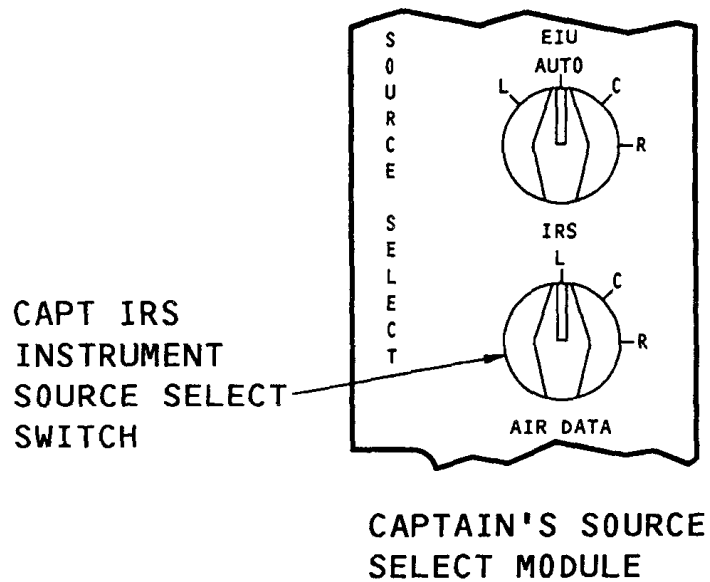


Figure 16 ATTITUDE INPUT SWITCHING

WEATHER RADAR



WXR - ND DISPLAYS

EFIS MODES

The ND shows WXR system data in the expanded approach mode, expanded VOR mode, and the center and expanded MAP modes.

WXR Data

The WXR system shows radar returns, WXR mode, manual tilt, and manual gain selection on the NDs. The display of radar returns is by raster. The display of all other functions is by stroke.

The WXR system can detect and show turbulence only for selected ranges less than 50 nm. For selected ranges greater than 50 nm, the WXR does not detect and show turbulence returns. The message in this case is WX instead of WX+T.

WXR Messages

The ND shows WXR messages on three lines:

- On line 1 (WXR mode)
- On line 2 (manual tilt value)
- On line 3 (manual gain selection)

All messages are cyan.

The WXR mode messages are:

- WXR (weather mode)
- MAP (ground map mode)
- WX+T (weather + turbulence mode)
- TEST (test mode)

The tilt display shows manual tilt set on the WXR control panel. The range is +15 degrees to -15 degrees.

The message VAR indicates that variable gain is selected. The absence of the VAR message shows that calibrated (preset) gain is in use.

Color Code

The color code for WXR returns is:

- Green for light returns
- Yellow for medium returns
- Red for heavy returns
- Magenta for turbulence

WXR Display Update

The update of the WXR display is by antenna sweep. As the display on one unit updates, the displays on the other units are stationary.

The sequence that the WXR displays are updated is:

- Left ND on the left to right sweep
- Right ND on the right to left sweep

WEATHER RADAR

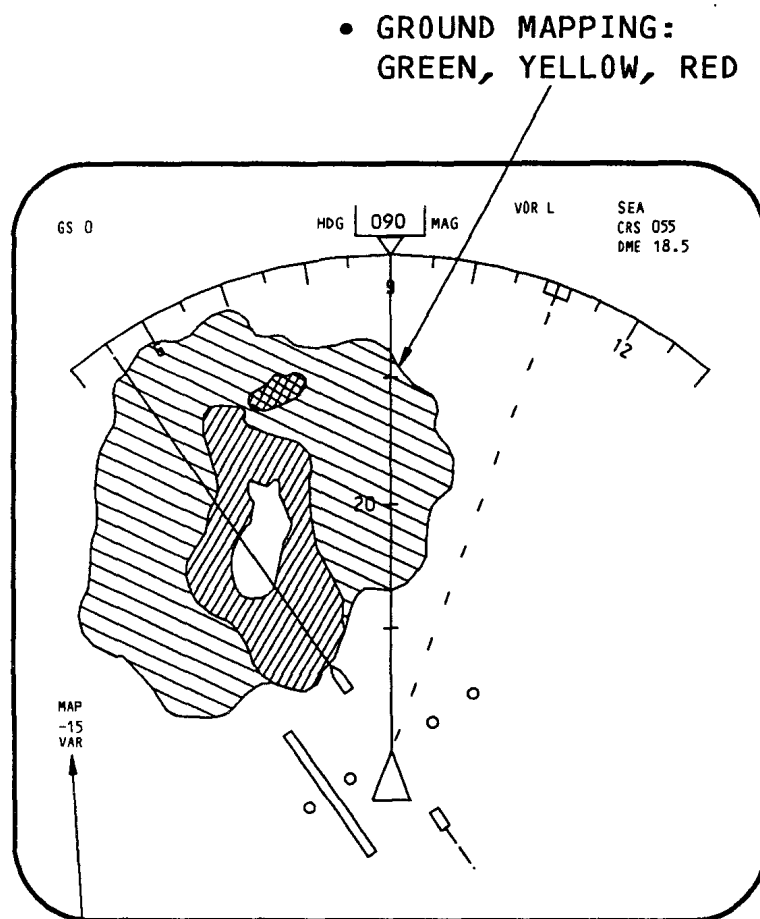


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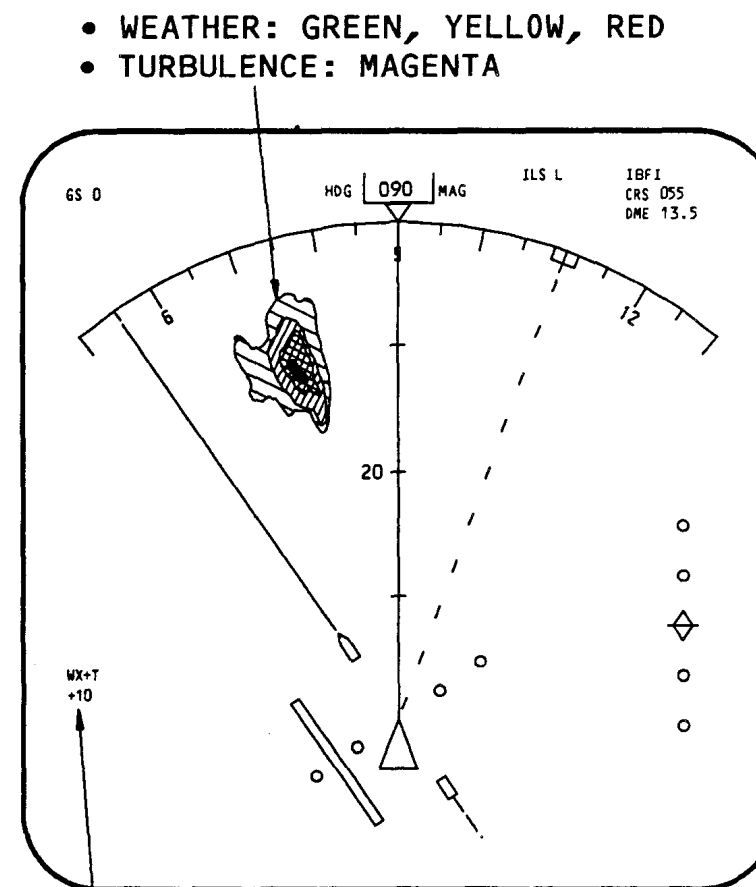
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- GROUND MAPPING:
GREEN, YELLOW, RED
- MAP MODE (CYAN)
- MAN. TILT 15° DOWN (CYAN)
- MANUAL GAIN

EXPANDED VOR MODE SHOWN



- WEATHER: GREEN, YELLOW, RED
- TURBULENCE: MAGENTA
- WEATHER PLUS TURBULENCE MODE (CYAN)
- MAN. TILT 10° UP (CYAN)
- GAIN INDICATION BLANK FOR
PRESET GAIN

EXPANDED APPROACH MODE SHOWN

Figure 17 ND DISPLAYS

WEATHER RADAR



PREDICTIVE WINDSHEAR

General Description

Weather radar with predictive windshear (PWS) detects windshear ahead of the airplane. PWS uses doppler radar returns, inertial data and air data windshear. If PWS detects a windshear condition, it alerts the flight crew with visual and aural annunciations.

System On/Off - Takeoff

PWS turns on automatically when the airplane is on the ground and one of these conditions exists:

- Engine 2 or 3 reaches takeoff thrust
- The flight crew pushes the WXR button on an EFIS control panel or control display unit (CDU).

The WXR button on the EFIS CP does not turn off the PWS if the engines are at takeoff thrust. PWS turns off automatically when the airplane climbs above 2300 feet radio altitude.

System On/Off - Approach

PWS turns on automatically when the airplane descends below 2300 feet radio altitude. PWS turns off automatically when one of these conditions exists:

- The airplane lands
- The airplane climbs above 2300 feet radio altitude.

If PWS is on and WXR is not selected on the EFIS CP or the CDU, all antenna sweeps search for windshear. If WXR is selected, the antenna uses one sweep to search for windshear and the other sweep to search for normal weather returns. PWS operation does not affect the WXR mode or range selected by the flight crew.

PWS Display

If PWS detects windshear, it makes a windshear symbol on the ND. The symbol is red and black bars. Yellow bars go from the edges of the symbol to the compass rose. The yellow bars help the crew to see the PWS symbol.

The ND mode selector must be in a correct mode for the windshear data to show. ND modes that show windshear data are:

- Expanded APP
- Expanded VOR
- Expanded MAP
- Centered MAP.

Windshear data does not show above 1500 feet radio altitude.

PWS Automatic Display Function

If PWS detects a windshear threat, weather data automatically displays on both NDs. Weather data automatically displays if these conditions exist:

- PWS detects a windshear threat
- Airplane altitude is less than 1500 feet
- WXR is not selected on either EFIS CP or CDU
- The ND mode selector is in a correct mode.

PWS Fail

These EICAS messages display for a PWS failure:

- Status message
- WINDSHEAR PRED
- Advisory message
- WINDSHEAR SYS.

There are no ND messages for a PWS failure.

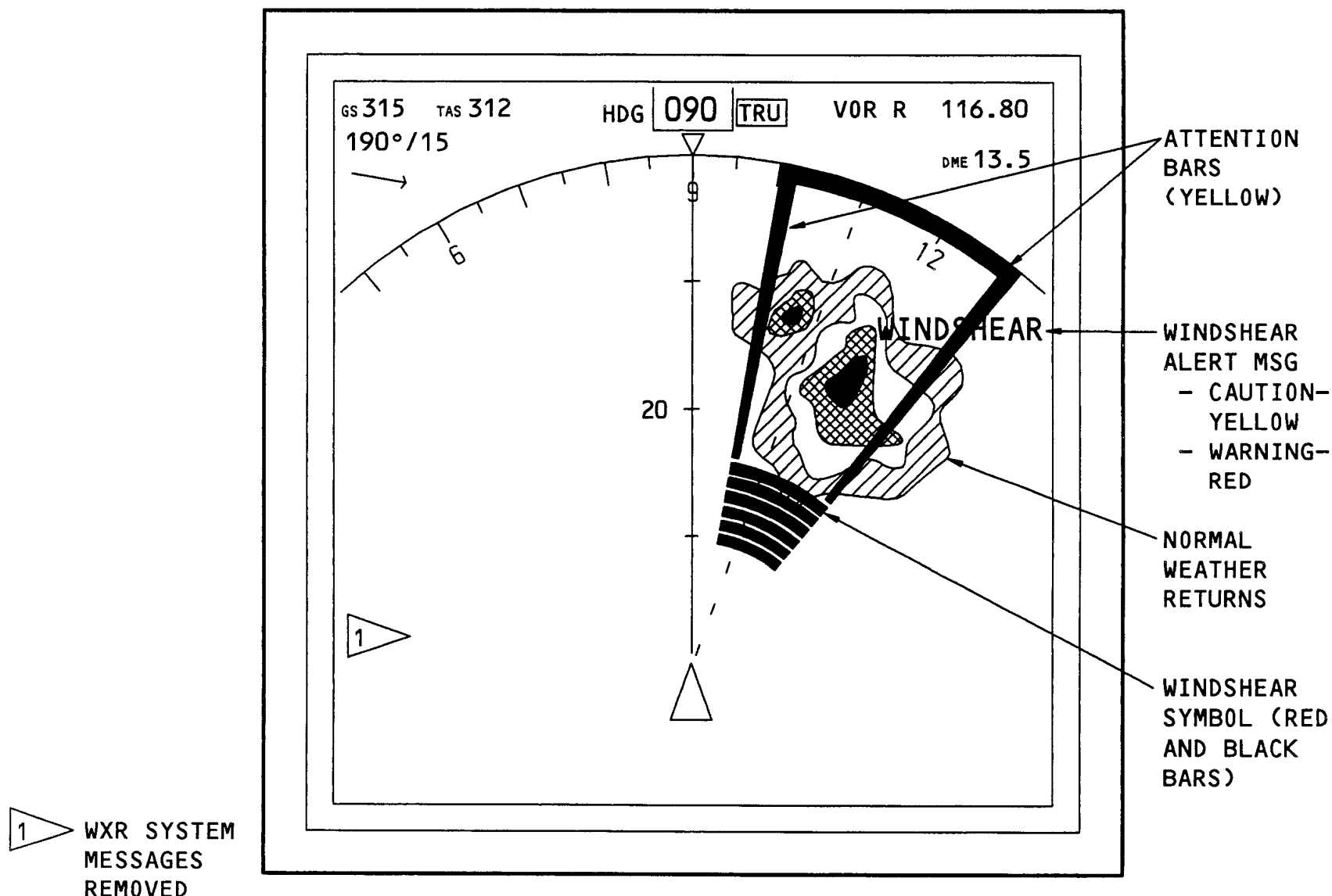


Figure 18 PREDICTIVE WINDSHEAR INDICATION

WEATHER RADAR



PREDICTIVE WINDSHEAR ALERTS

General Description

If PWS detects a windshear threat, it makes an alert. The alert may be a warning or a caution. The alert the crew receives depends upon these conditions:

- Position of the windshear relative to airplane heading
- Distance to the windshear
- Airplane flight phase - takeoff or approach.

PWS Warning Area - Takeoff

In takeoff, PWS gives a warning if it detects a windshear threat in this area:

- Less than .25 nm on either side of the airplane projected magnetic heading
- More than .5 nm but less than 3 nm ahead of the airplane.

PWS Warning Area - Approach

In approach, PWS gives a warning if it detects a windshear threat in this area:

- Less than .25 nm on either side of the airplane projected magnetic heading
- More than .5 nm but less than 1.5 nm ahead of the airplane.

PWS inhibits new windshear warnings in takeoff and approach if both these conditions exist:

- Airspeed greater than 100 knots
- Less than 50 feet radio altitude.

PWS Caution Area

PWS gives a caution if it detects a windshear threat in this area:

- Within 25 degrees on either side of the airplane projected magnetic heading
- More than .5 nm but less than 3 nm ahead of the airplane
- Not in the PWS warning area.

PWS inhibits new windshear cautions in takeoff and approach if both these conditions exist:

- Airspeed greater than 80 knots
- Less than 400 feet radio altitude.

All PWS alerts are inhibited above 1200 feet radio altitude.

PWS Warning

A PWS warning has these visual and aural annunciations:

- A red WINDSHEAR message on the PFD
- A red WINDSHEAR message on the ND
- A windshear symbol on the ND
- Master warning lights on
- Aural voice - WINDSHEAR AHEAD, WINDSHEAR AHEAD (takeoff)

On approach, the aural annunciation is GO AROUND, WINDSHEAR AHEAD.

PWS Caution

A PWS caution has these visual and aural annunciations:

- An amber WINDSHEAR message on the ND
- A windshear symbol on the ND
- Aural annunciation - MONITOR RADAR DISPLAY.

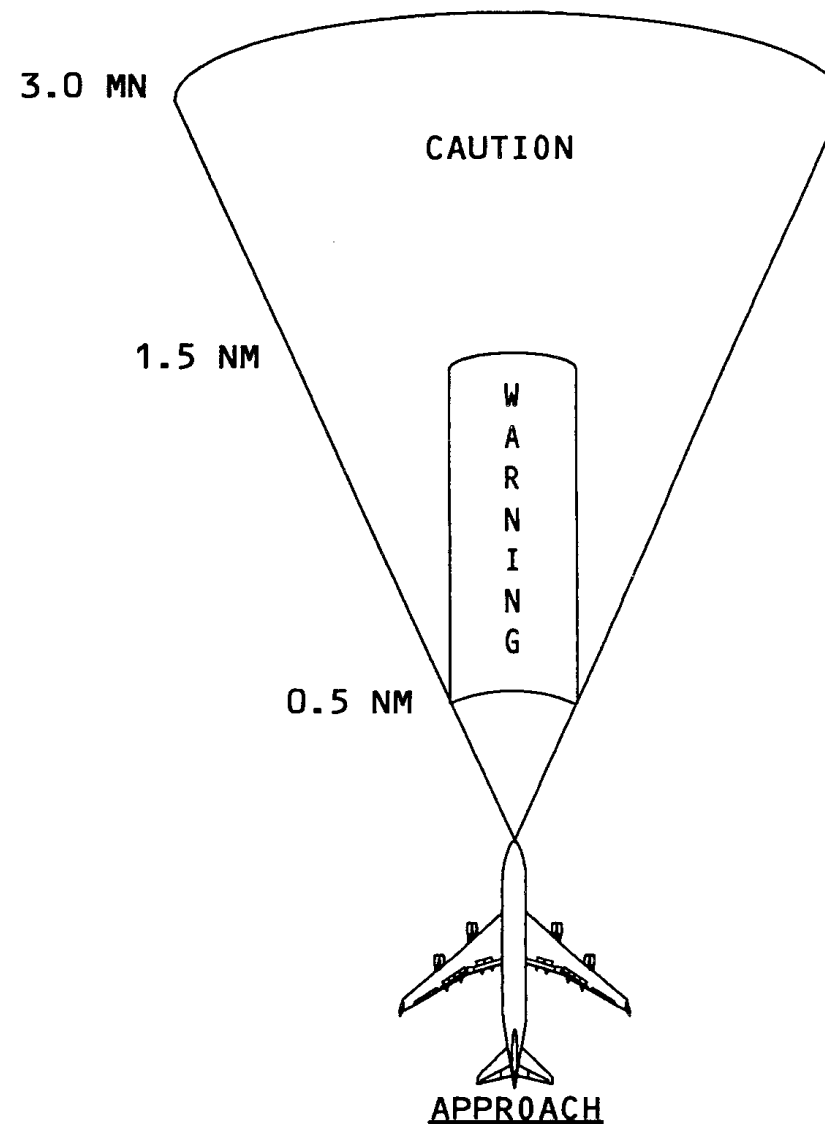
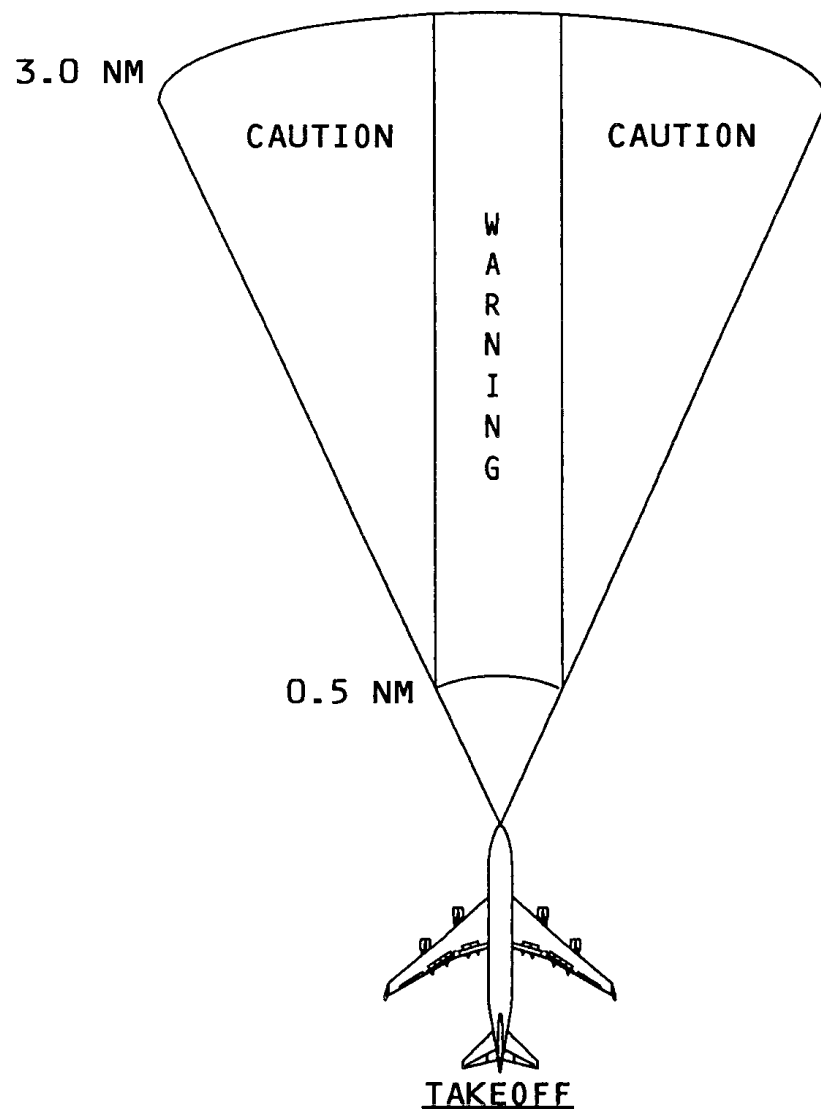


Figure 19 PREDICTIVE WINDSHEAR ALERTS

WEATHER RADAR



WINDSHEAR OPERATION

General

The predictive windshear (PWS) WXR provides alerts to the flight crew of potential windshear in the airplane flight path.

The PWS operational profile is shown in the graphic.

WEATHER RADAR

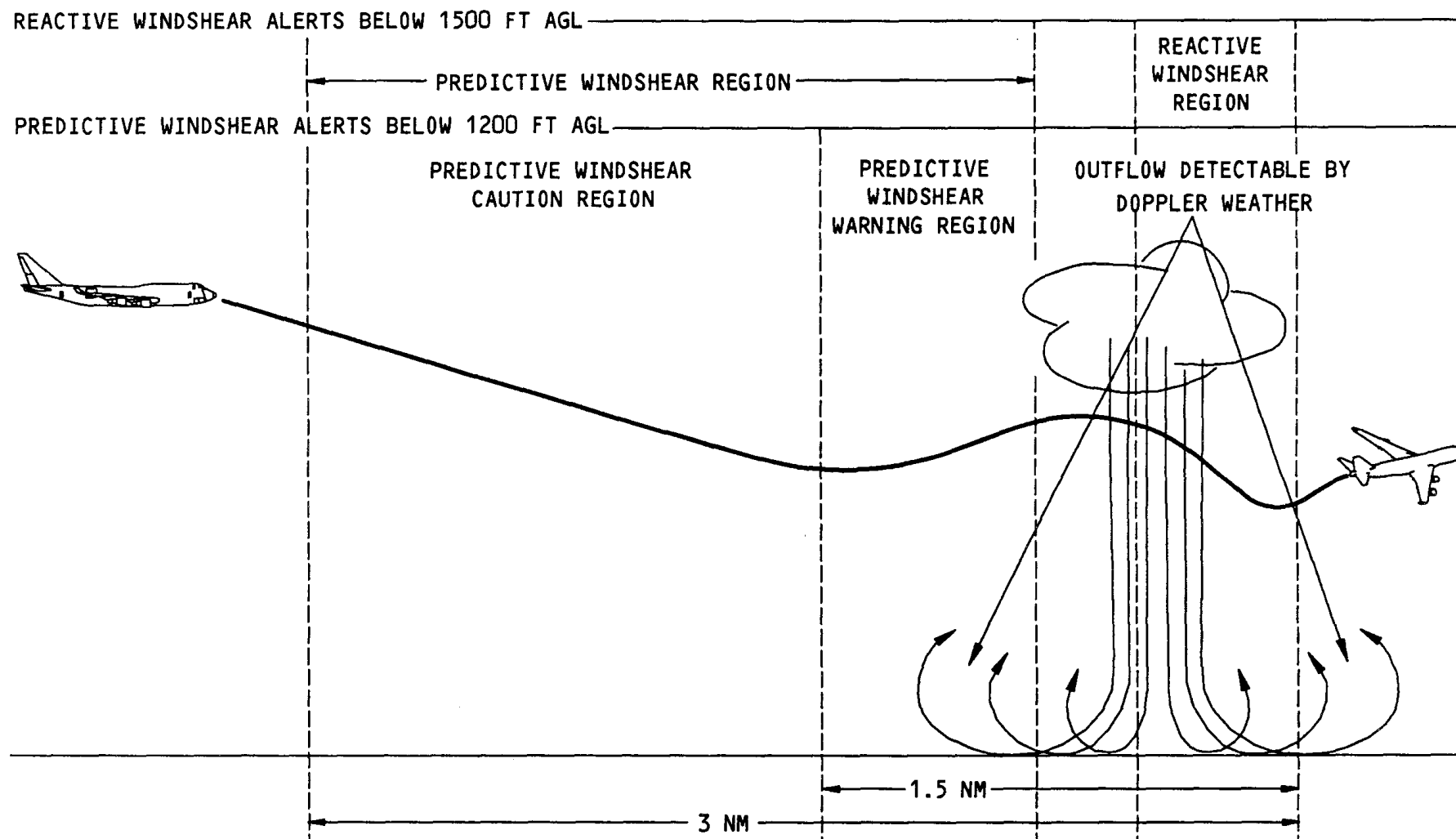


Figure 20 WINDSHEAR OPERATION

WEATHER RADAR

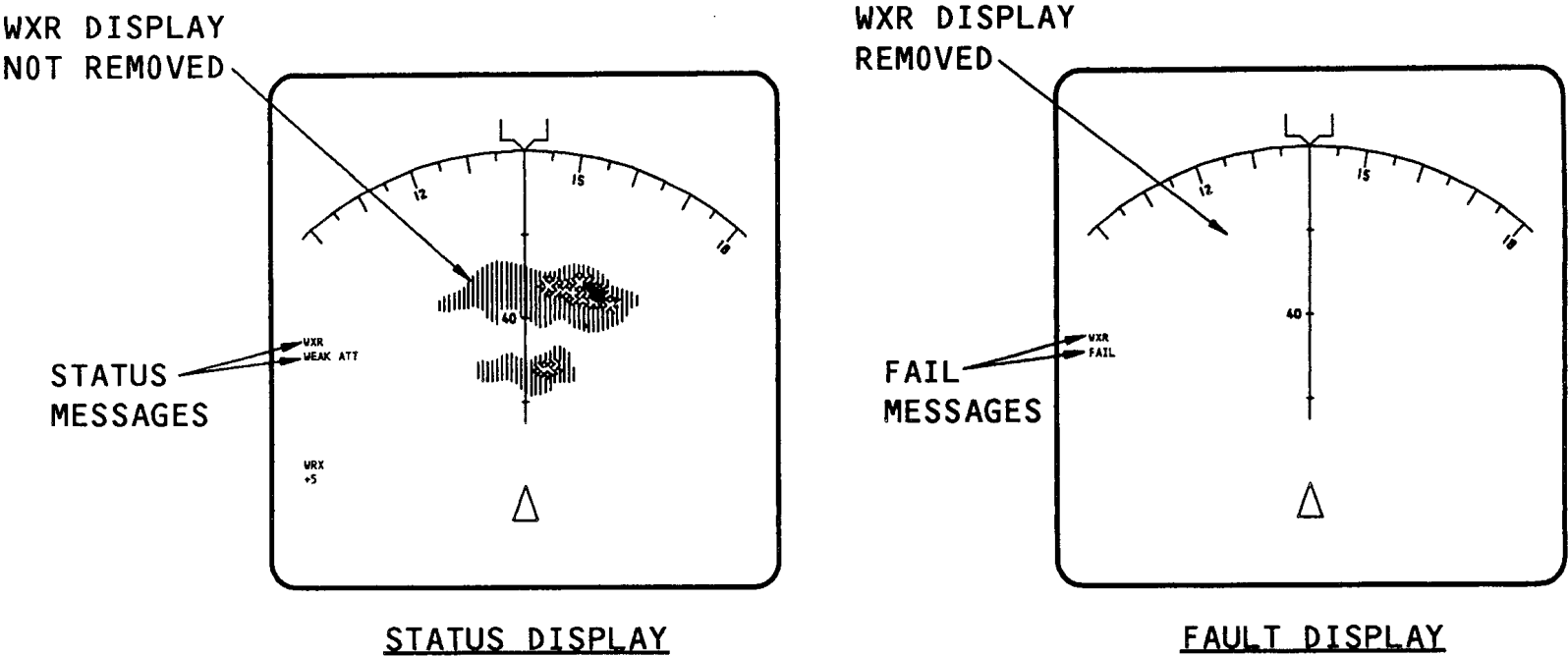


ND FAULT MESSAGES

General

The WXR show messages on the left side of the ND. These are the message types:

- Status messages
- Fail messages.



STATUS/FAIL MESSAGES (YELLOW)		MEANING OF THE MESSAGES	WXR DATA DISPLAY	ORDER OF PRIORITY OF MESSAGE
WXR	WEAK	CALIBRATION FAULT	DISPLAYED	FIRST PRIORTY
WXR	ATT	ATTITUDE INPUT FAULT	DISPLAYED	SECOND PRIORTY
WXR FAIL	RT	RECEIVER/TRANSMITTER FAULT	REMOVED	WXR WEAK AND ATT MESSAGE INHIBITED
WXR FAIL	CON	CONTROL FAULT	REMOVED	
WXR FAIL	ANT	ANTENNA FAULT	REMOVED	

Figure 21 ND FAULT MESSAGES

WEATHER RADAR



ND RANGE DISAGREE

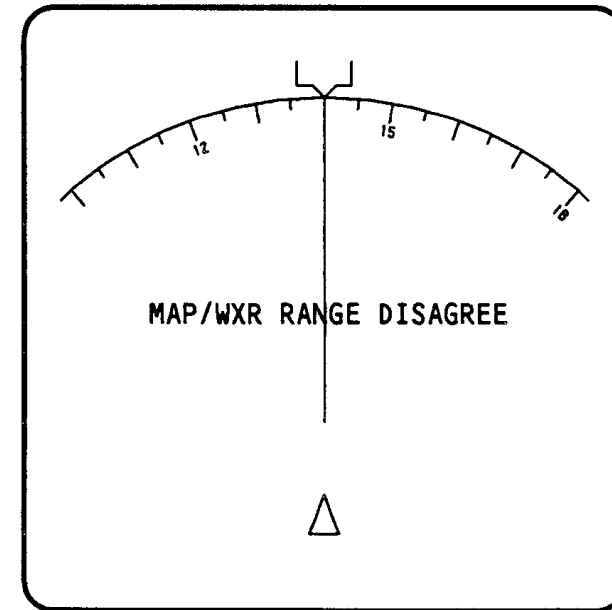
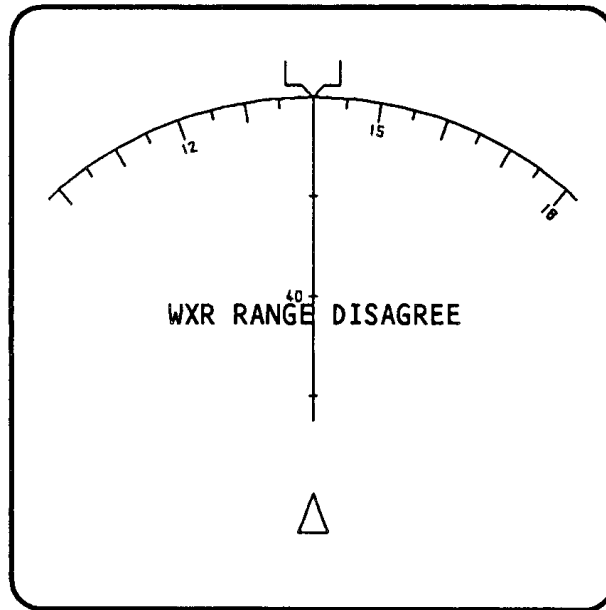
The IDUs compare the EFIS control panel, the WXR R/T, and the FMC ranges. A difference between any of these ranges causes a yellow range disagreement message.

Two range disagreement messages are possible:

- WXR RANGE DISAGREE
- MAP/WXR RANGE DISAGREE

During a range disagreement:

- No radar returns show
- The mode, tilt and gain messages show
- The range marks show.



MESSAGE	COLOR	WXR DATA DISPLAY	CONDITION	EFIS MODE
WXR RANGE DISAGREE	YELLOW	REMOVED	WXR XMTR OR FMC RANGE DISAGREES WITH EFIS CP SELECTED RANGE	EXP APPR, EXP VOR EXP MAP, CTR MAP
MAP/WXR RANGE DISAGREE	YELLOW	REMOVED	WXR XMTR RANGE AND FMC RANGE BOTH DISAGREE WITH EFIS CP SELECTED RANGE	EXP MAP, CTR MAP

Figure 22 ND RANGE DISAGREE

WEATHER RADAR



IDU OVERHEAT

First-Level Overheat

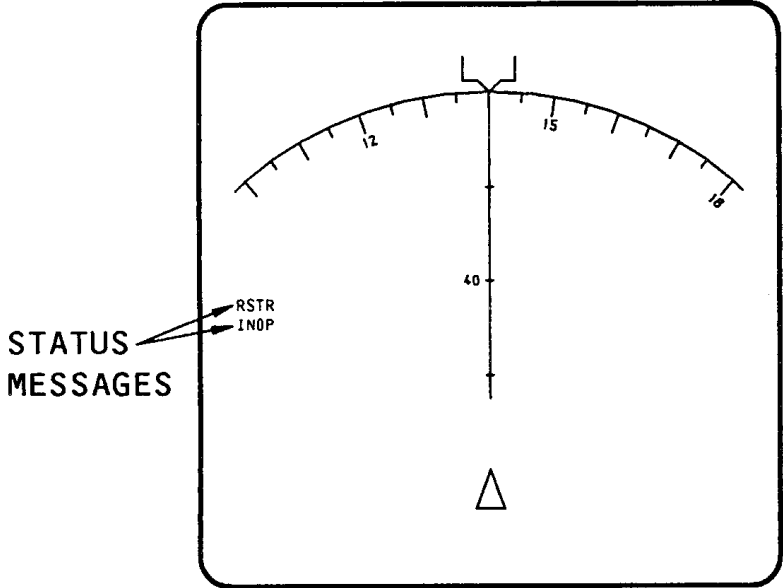
A first-level overheat removes all WXR displays 30 seconds after it is detected in the IDU but shows the yellow RSTR INOP message immediately. This message inhibits the display of any other WXR fault message.

Second-Level Overheat

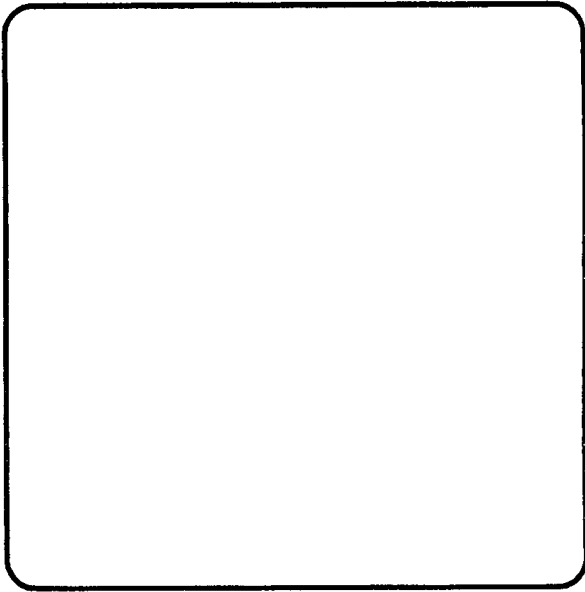
A second-level overheat makes the IDU display blank.

Display Return

The display returns to the previous conditions when the temperature falls 17 degrees below the respective shutoff level.



FIRST LEVEL OVERHEAT DISPLAY



SECOND LEVEL OVERHEAT DISPLAY

STATUS/FAIL MESSAGES (YELLOW)		MEANING OF THE MESSAGES	WXR DATA DISPLAY	ORDER OF PRIORITY OF MESSAGE
RSTR	INOP	ND TEMP ABOVE 1ST THRESHOLD (105°C)	REMOVED AFTER 30 SEC	ALL OTHER WXR MESSAGES INHIBITED
BLANK	BLANK	ND TEMP ABOVE 2ND THRESHOLD (120°C)	ENTIRE ND DISPLAY OFF	

Figure 23 IDU OVERHEAT



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WEATHER RADAR



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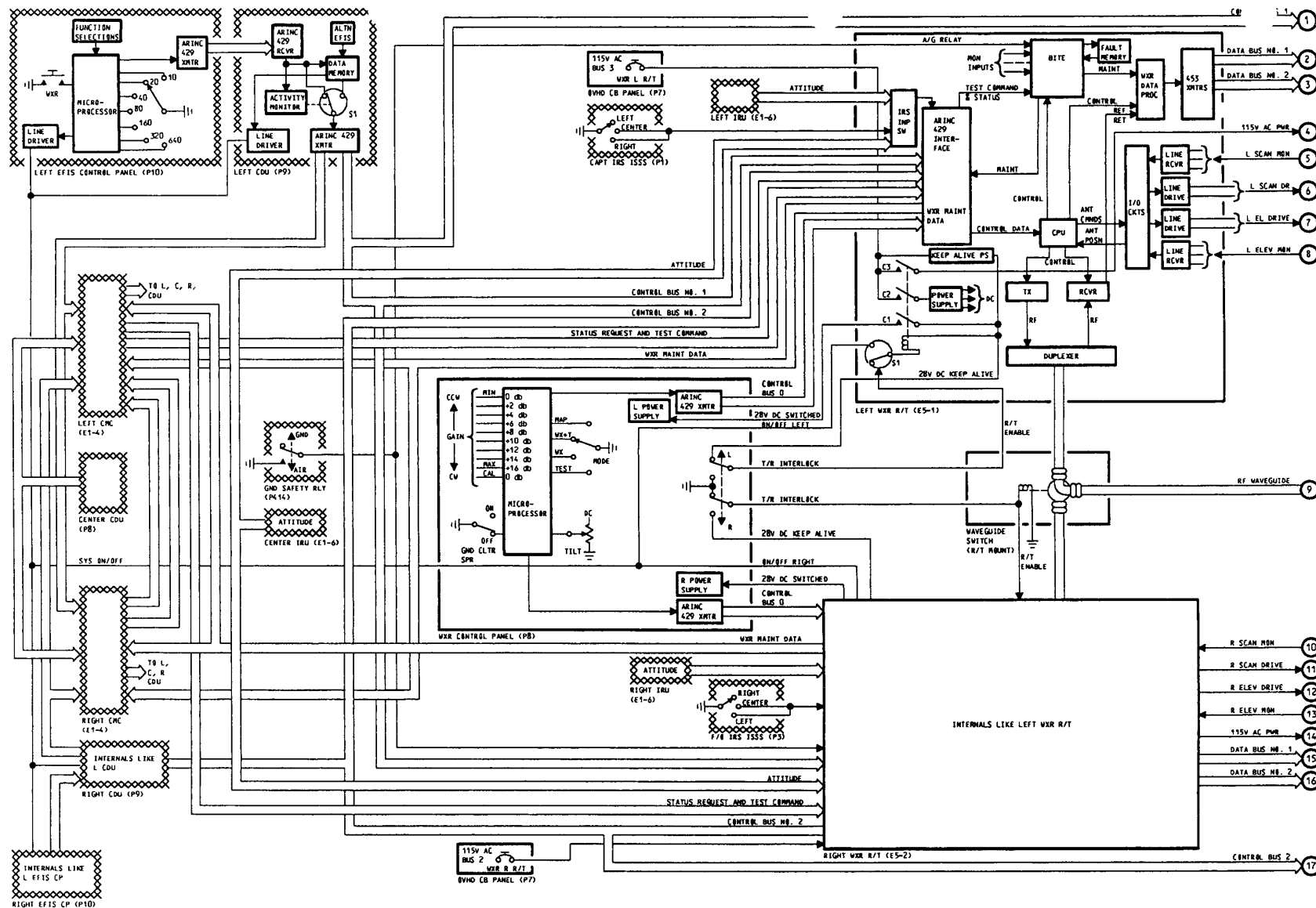


Figure 24 WXR SCHEMATIC - 1

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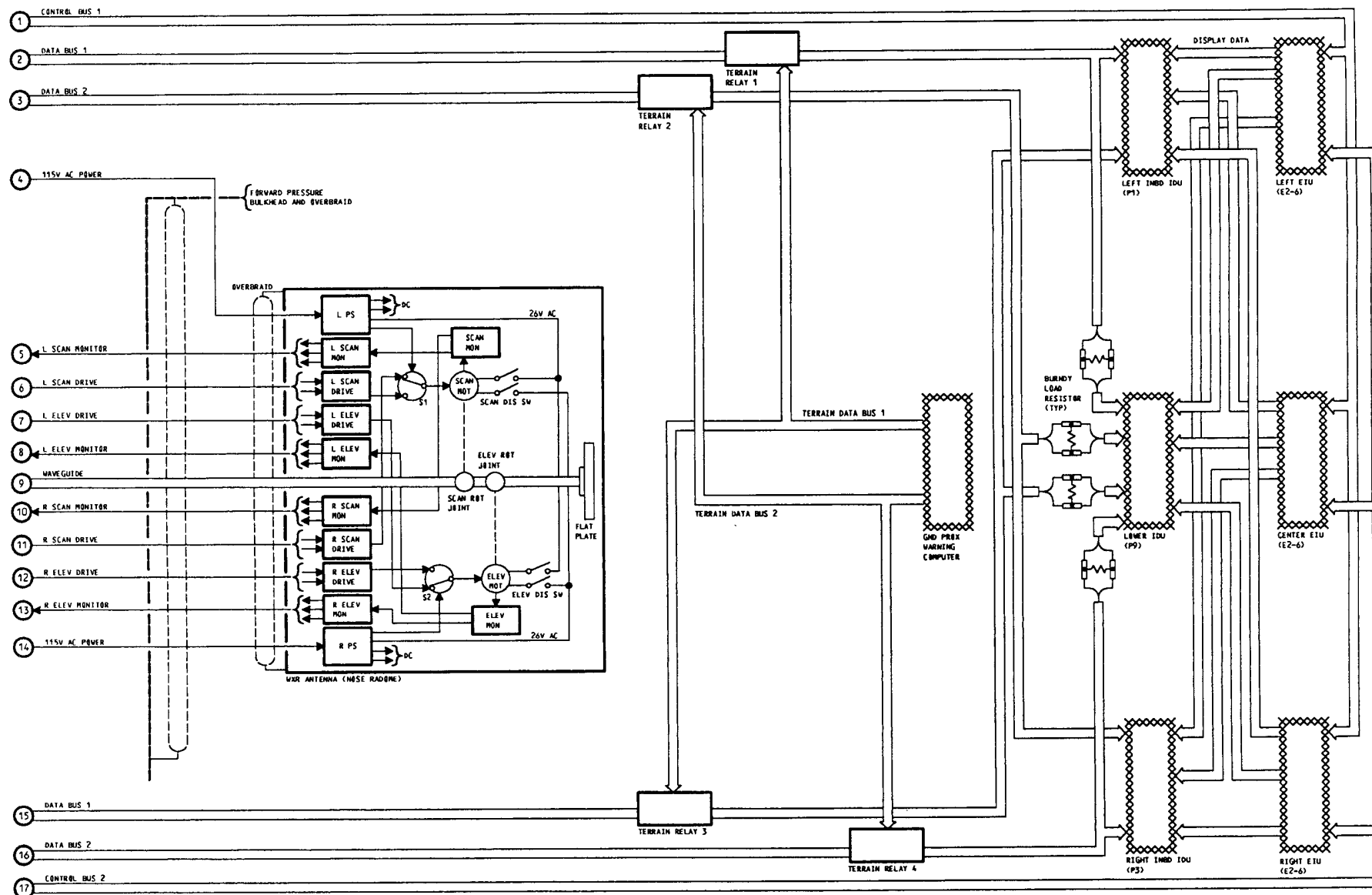


Figure 25 WXR SCHEMATIC -2

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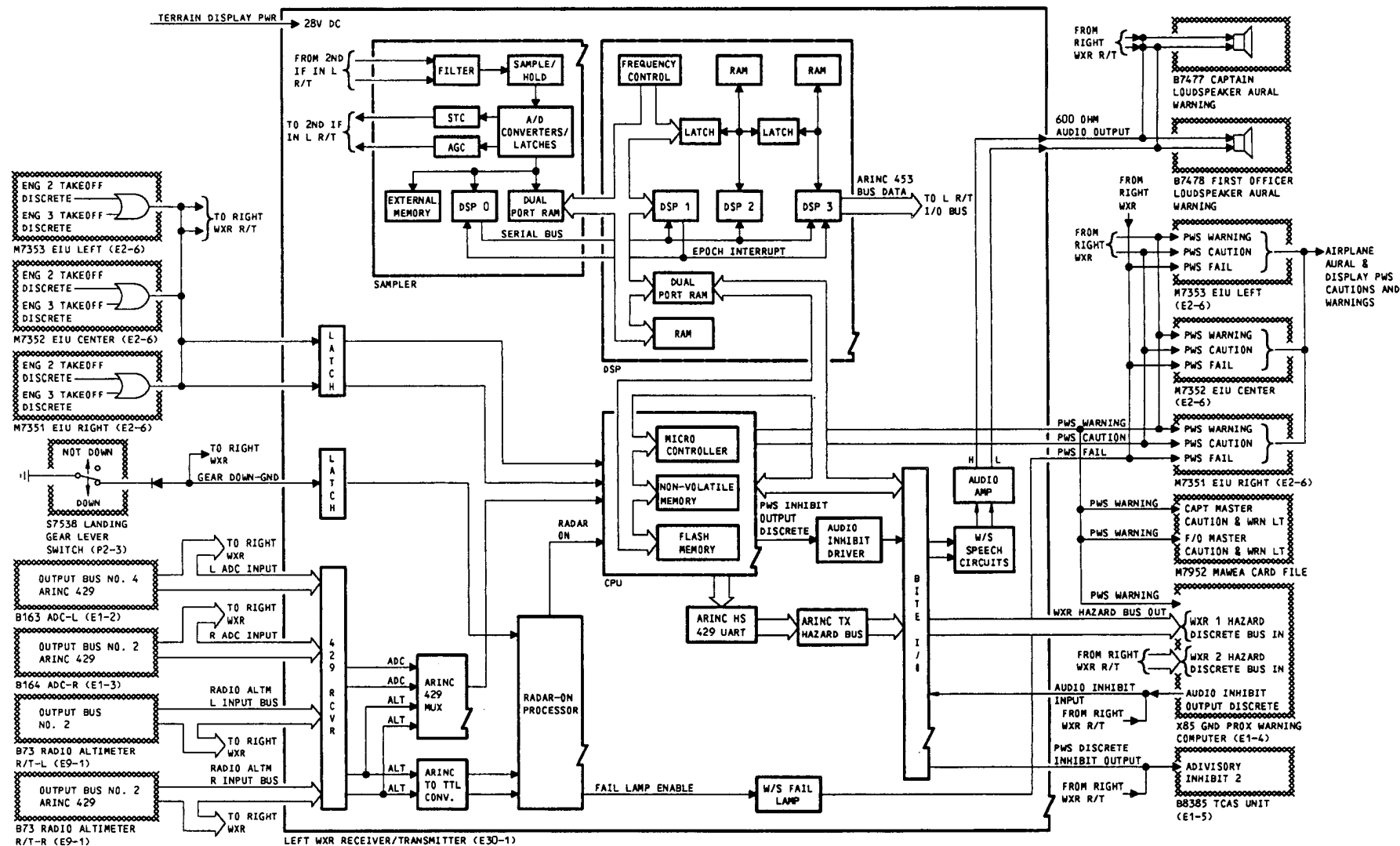


Figure 26 WXR SCHEMATIC - 3

WEATHER RADAR



WXR - SYSTEM ON/OFF

System Turn-On

The WXR switch on the L EFIS CP turns on the selected L or R WXR R/T and enables the WXR display on the left ND.

The WXR switch on the R EFIS CP turns on the selected L or R WXR R/T and enables the WXR display on the right ND.

The line select key next to WXR on the EFIS OPTIONS page on the left CDU turns on the selected L or R WXR R/T and enables the WXR display on the left ND.

The line select key next to WXR on the EFIS OPTIONS page on the right CDU turns on the selected L or R WXR R/T and enables the WXR display on the right ND.

Keep-Alive Power

A KEEP-ALIVE power supply in each R/T provides 28v dc power for system turn-on.

Power goes to:

- The L/R SYS selector in the WXR CP
- The coil R1 in the R/T which closes C1, C2 and C3
- The respective L (or R) PS in the WXR CP through C1

The KEEP-ALIVE power supply sends 28v dc continuously as long as it gets power from its L (R) WXR R/T circuit breaker.

R/T Turn-On

The L/R SYS selector in the WXR CP sends the 28v dc analog discrete R/T ENABLE to the respective L or R WXR R/T through the waveguide switch. (See next graphic WXR R/T INTERLOCK). This discrete closes S1. Push the WXR switch on either EFIS CP, or line select key next to WXR on either CDU EFIS OPTIONS page to send a ground-level discrete ON/OFF LEFT or RIGHT to the respective R/T. This provides a return for the 28v dc from the KEEP-ALIVE power supply through S1 and R1.

R1 energizes and closes contacts C1 C2 and C3.

C1 sends 28v dc KEEP-ALIVE power to the respective L or R power supply in the WXR CP.

C2 sends 115v ac power to the power supply in the L (or R) R/T.

C3 sends 115v ac power to the antenna.

System ON/OFF Discrete

The momentary WXR switch on the EFIS CP supplies the ground-level SYSTEM ON/OFF discrete. From the switch, the discrete goes to the microprocessor. The microprocessor latches the discrete and sends it to the line driver (LN DR). The LN DR sends it to the WXR CP. From the WXR CP it goes to the respective L or R R/T as ON/OFF LEFT or RIGHT.

A second push of the switch turns the discrete off. When the EFIS CP fails, the LN DR sends out an open. However, if the failure goes away, the LN DR output returns to the state it was in prior to the failure.

The CDU line driver and memory operate the same as the EFIS control panel.

WEATHER RADAR

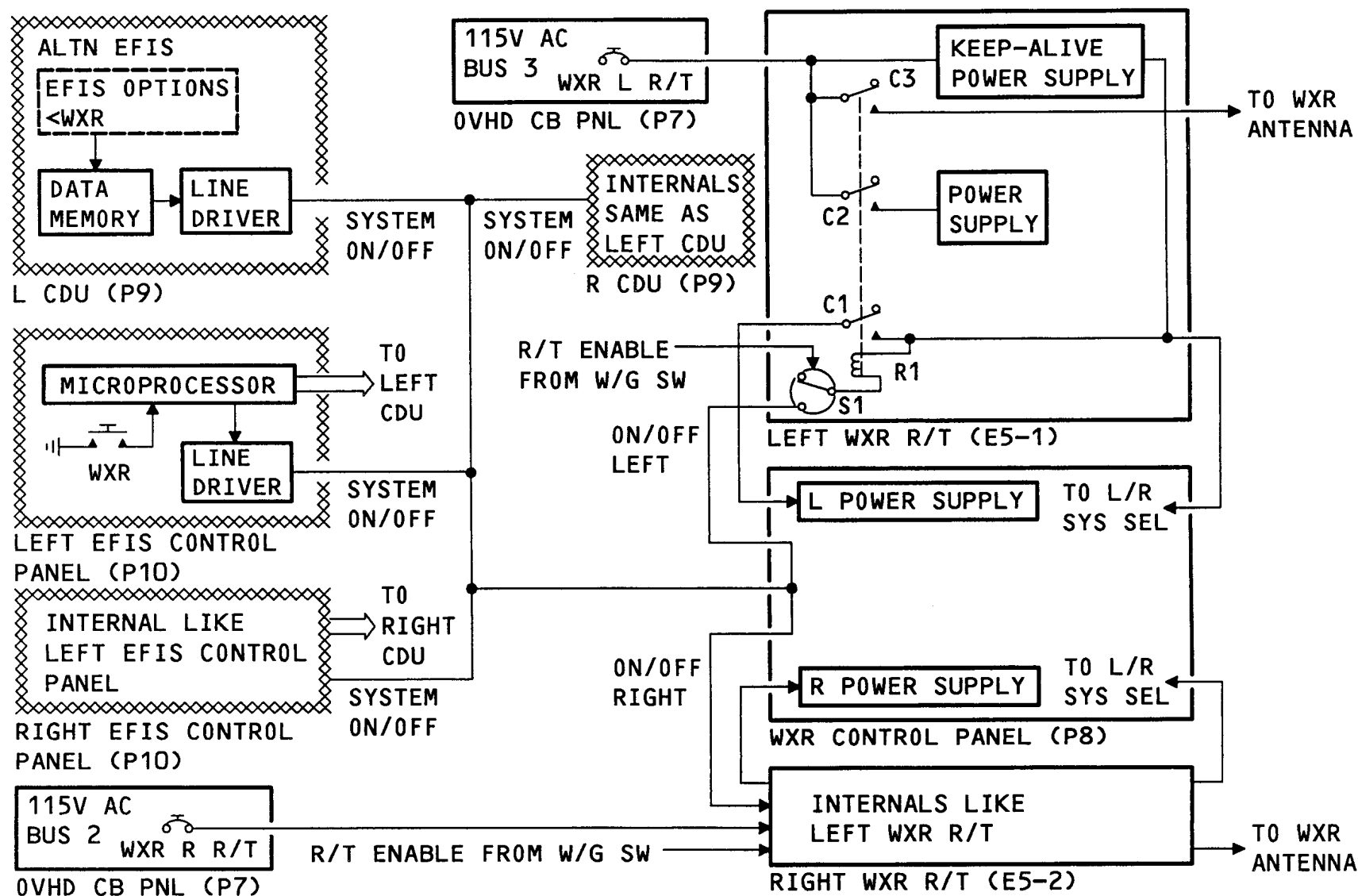


Figure 27 WXR - SYSTEM ON/OFF

WEATHER RADAR



R/T INTERLOCK

The L/R system selector in the WXR CP sends the 28 volts dc LEFT (or RIGHT) ENABLE from the L(R) KEEP-ALIVE power supply to S1 in the respective L(R) R/T. This causes S1 to close. When the ON/OFF LEFT (RIGHT) signal from the WXR CP goes to a ground level, RI energizes and closes C1 C2 and C3.

The waveguide switch is spring-loaded to the left position. This connects the WXR antenna to the left R/T. With the L/R SYS selector switch on the WXR CP in the right position, 28 volts dc from the right R/T energizes the waveguide switch coil. This connects the antenna to the right R/T.

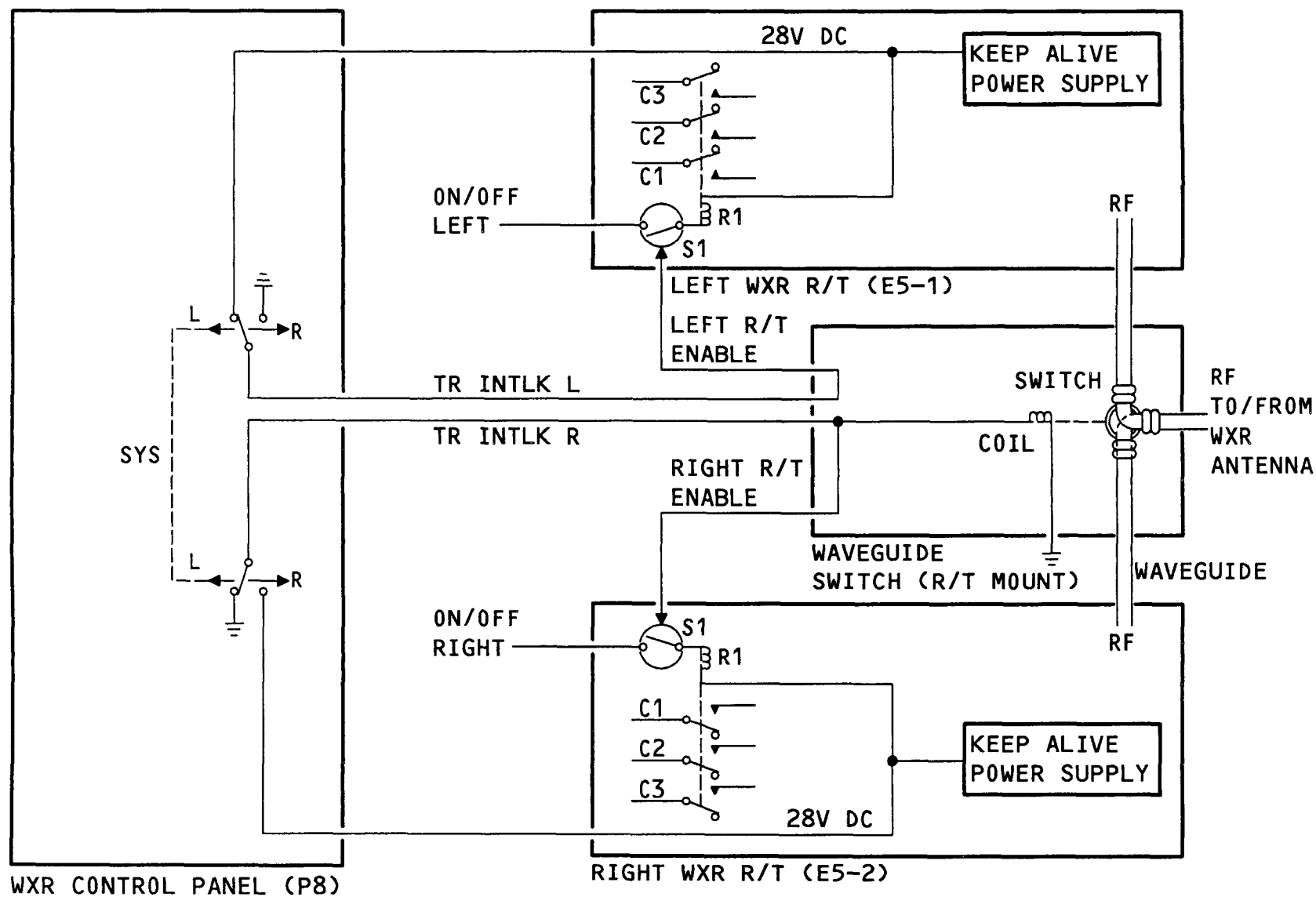


Figure 28 R/T INTERLOCK

WEATHER RADAR



R/T DATA

Overview

The selected L or R WXR R/T generates rf pulses and transmits them over the waveguide to the antenna. The antenna sends the pulses into space, gets the returns back and sends them to the R/T. The R/T determines the reflectivity levels of the targets at various distances and sends the data out on buses 1 and 2 to the respective display units.

Control

The central processing unit (CPU) in the R/T controls the operation of the R/T. It gets, through the ARINC 429 interface circuits:

- Left range selection on control bus 1 from the left EFIS CP
- Right range selection on control bus 2 from the right EFIS CP
- System control data on control bus 0 from the WXR CP
- Test commands from the left CMC

The CPU sends timing, control and operational commands to the internal circuits of the R/T.

RF Patterns

The transmitter generates a transmission pattern based on the selected range. The transmitter varies the pulse width and pulse repetition frequency (PRF). The system is capable of operation with two different ranges selected. This is done by the antenna sweep. During the first antenna sweep from left-to-right, the transmission pattern is based on the range from the left EFIS CP. During the right-to-left sweep the pattern is based on the range from the right EFIS CP. If both range selections are the same, the transmission pattern will be the same.

RF Transmission

The rf pulses travel from the transmitter to the antenna flat plate through the duplexer, the waveguide switch and the scan and elevation rotary joints.

The duplexer connects the antenna to the transmitter during rf transmission and to the receiver during the reception of rf returns.

The waveguide switch connects the antenna to the selected R/T.

The scan and elevation rotary joints allow continuous transmission during antenna scan and elevation movements.

RF Returns

From the antenna, the reflected returns travel through the rotary joint, through the waveguide switch, through the duplexer and on to the receiver circuits. The receiver circuits process the returns and send them to the WXR data processor. This processor generates the display data based on the detected rate of rainfall.

Display Data Transmission

The WXR data processor compiles WXR data and status (MAINT) information from the BITE circuits into ARINC 453 format. The data is sent to the display units in two different data words on data buses 1 and 2.

Data bus 1 sends a data word to the left ND based on the left EFIS CP/CDU range. Data bus 2 sends a data word to the right ND based on the right EFIS CP/CDU range.

Data word transmission on buses 1 and 2 is in synchronization with antenna sweep. As a result, when the WXR data is updated on one bus, it is stationary on the other bus.

BITE Operation

The BITE module:

- Monitors the operation of the system
- Starts automatic and commanded tests
- Transmits maintenance (MAINT) data for CMC use
- Transmits status (MAINT) data for the display units

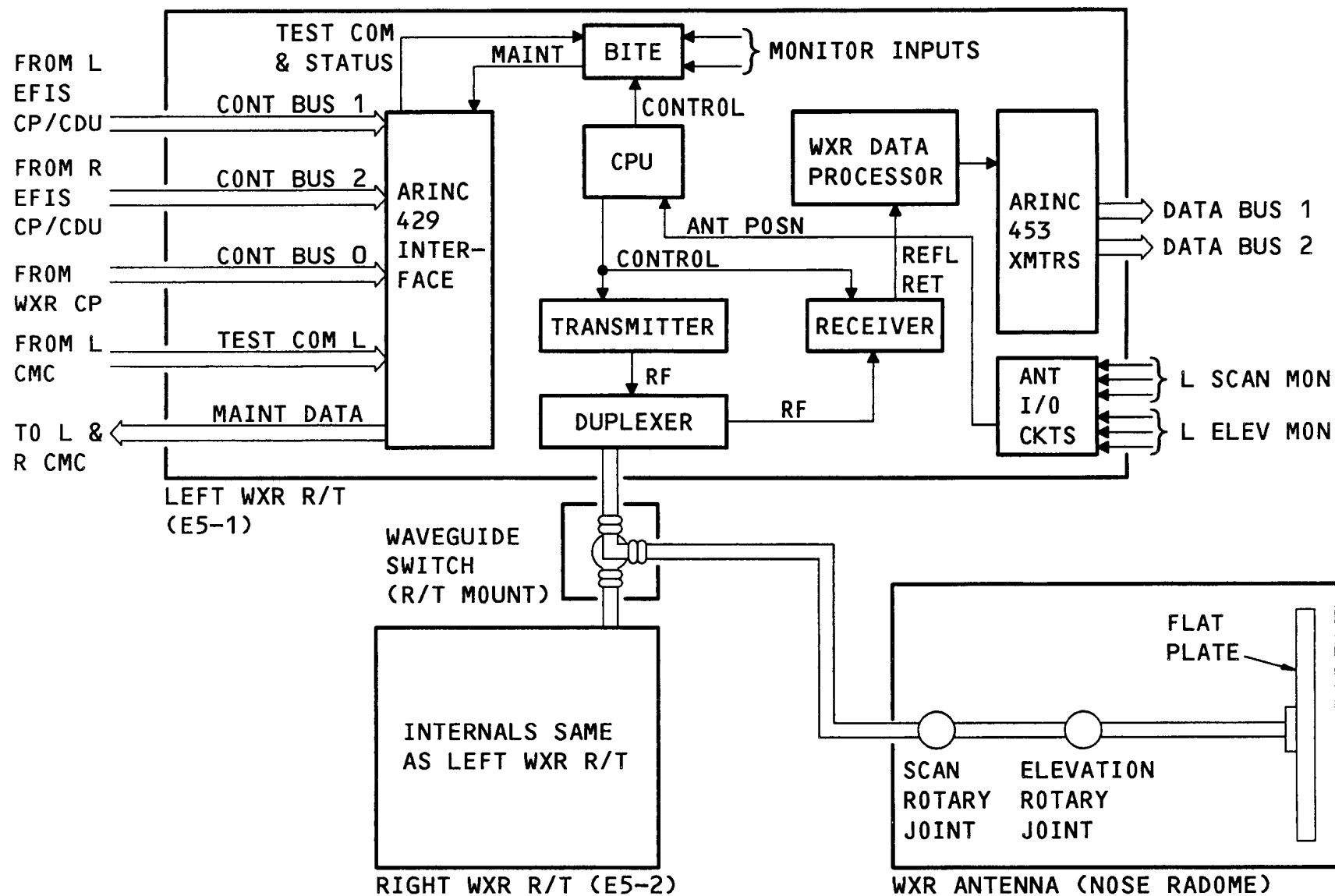


Figure 29 R/T DATA

WEATHER RADAR



EFIS CP/CDU DATA 1

Control Buses 1 and 2

Data from the EFIS CPs/CDUs comes on control buses 1 and 2. Control bus 1 data comes from the L EFIS CP/CDU. Control bus 2 data comes from the R EFIS CP/CDU. Both buses go to both WXR R/Ts and all three EIUs.

In the R/Ts, control bus 1 supplies data for the data bus 1 output. Control bus 2 supplies data for the data bus 2 output.

Control Bus 1 and 2 Data

The primary source of control bus 1 (2) data is the L (R) EFIS CP. This data includes:

- EFIS mode to the EIUs from the function selection (FUNCT. SEL.) inputs. The onside ND displays this mode.
- Range for the operating WXR R/T and the EIUs, for display on the onside ND.
- A WXR DATA SELECT bit that enables the display of WXR data on the onside ND.

CDU Operation

The onside CDU receives the data from the EFIS CP and sends it out on control bus 1 (2) through switch S1. The memory (MEM) also records this data.

When the EFIS CP fails, the activity monitor (ACT MON) causes S1 to connect the memory to the control bus 1 output. Thus control bus 1 continues to carry the EFIS CP selections. To make new selections, use the alternate function selection pages of the CDU (EFIS CONTROL and EFIS OPTIONS).

Bus Standards

The control buses are ARINC 429 buses. The data buses are ARINC 453 buses.

WEATHER RADAR



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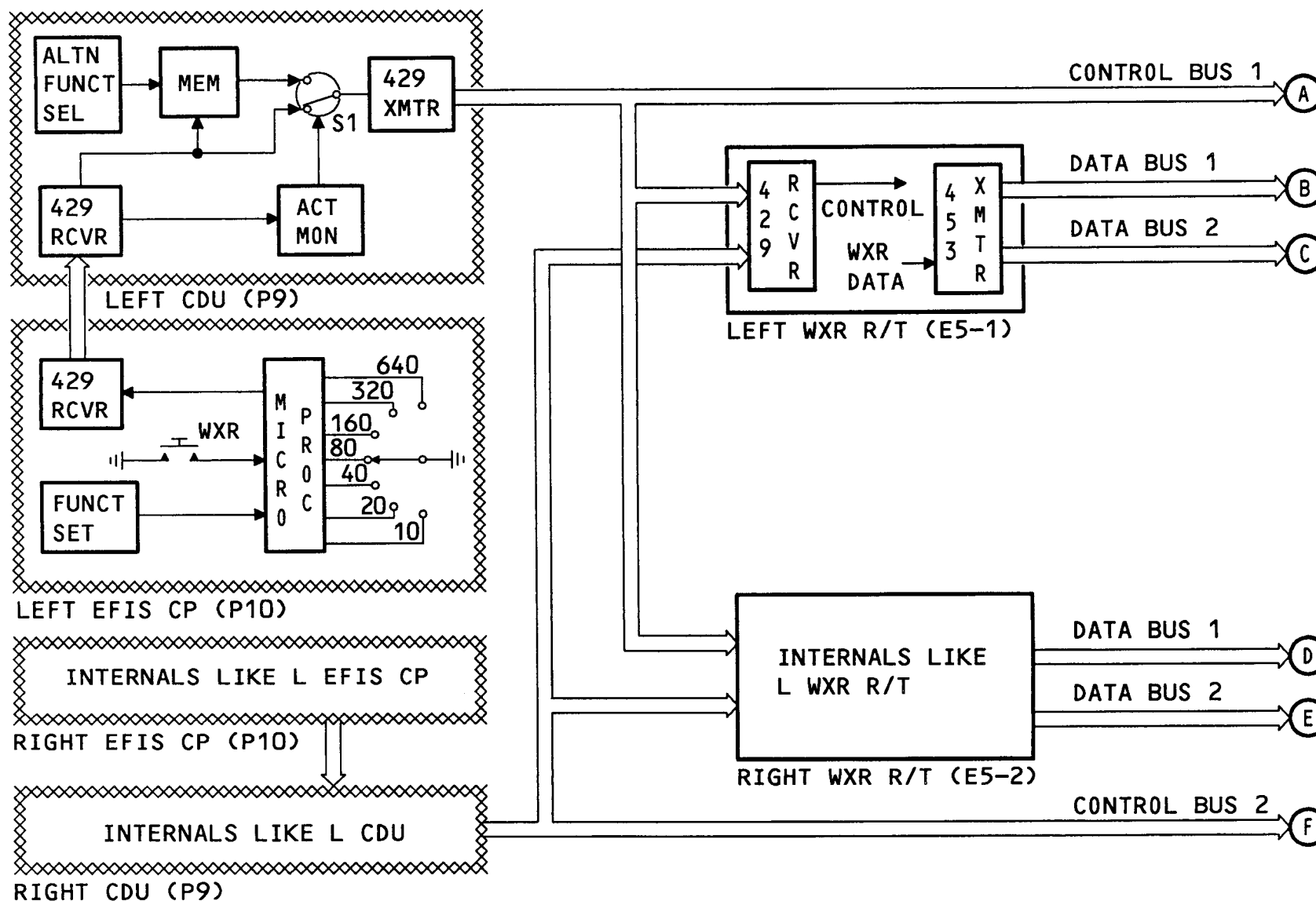


Figure 30 EFIS CP/CDU DATA 1

WEATHER RADAR



EFIS CP/CDU DATA 2

Control Buses 1 and 2

Both control bus 1 and control bus 2 feed into the L, C, and R EIUs. In either EIU, control bus 1 provides display data for the left ND. Control bus 2 provides display for the right ND.

Data Buses 1 and 2

WXR data from the operating WXR R/T goes to the ground proximity warning system (GPWS) terrain select relays. These relays allow either WXR display data or GPWS terrain display data to go to the IDUs. Relay position is controlled by logic in the GPWC or is manually selected by the flight crew.

The NDs display WXR data. Normally, the outside inboard IDU shows the NAV display. The lower IDU is a backup display.

Burndv Load Resistors

A burndv load resistor connects both wires of each data bus. The purpose of these resistors is to prevent spoking of the WXR display.

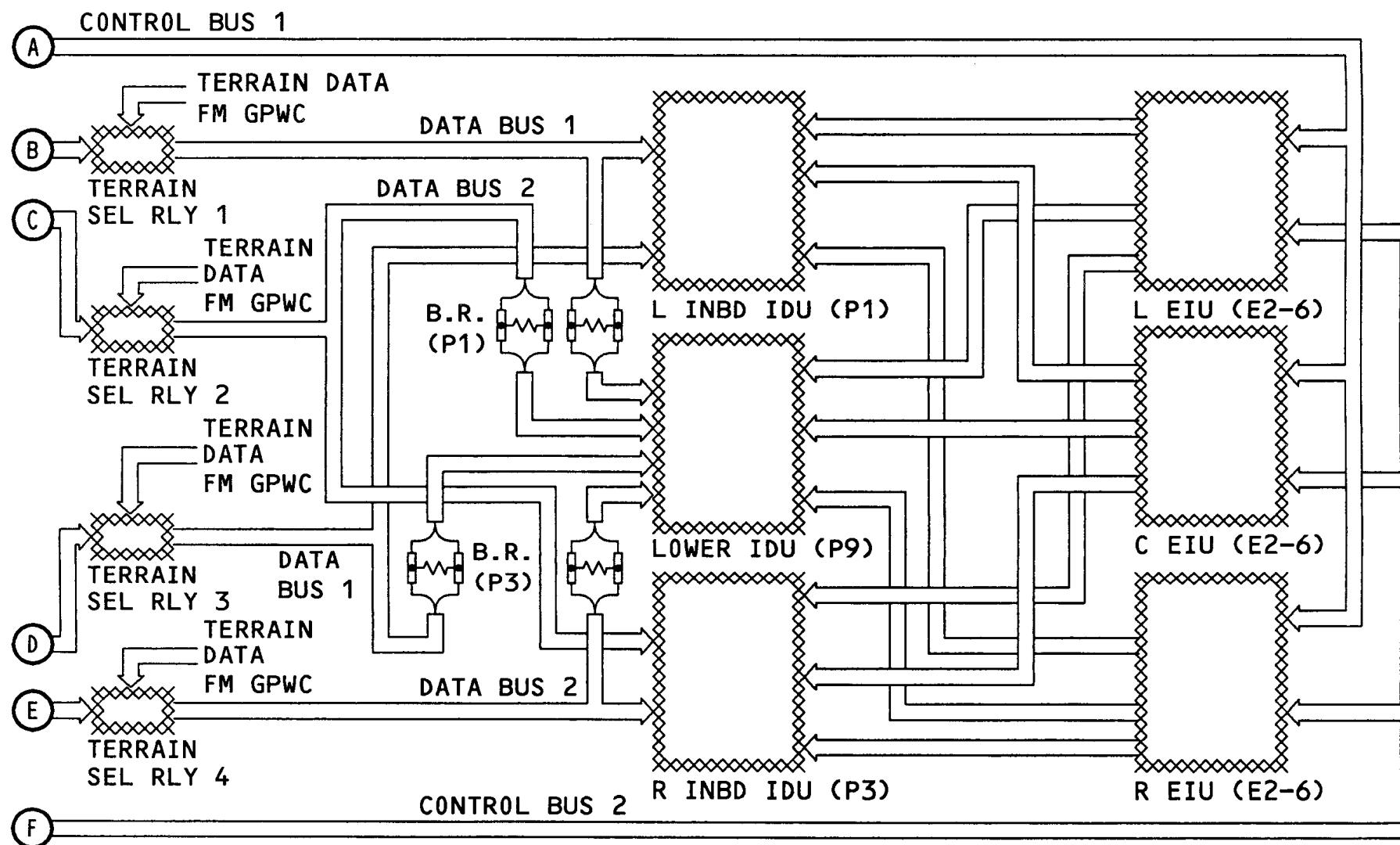


Figure 31 EFIS CP/CDU DATA 2

WEATHER RADAR



WXR CP DATA

The WXR CP sends control signals for the WXR system on control bus 0. The following parameters are included:

- WXR mode (MAP, WX, WX+T, TEST)
- Gain (in the detented CW CAL position, gain is at preset calibrated level. Out of detent, gain is manually adjustable in all modes except TEST)
- Manual tilt (adjustable between +15 degrees and -15 degrees)
- Ground Clutter Suppression (GND CLTR SPRS)

Control bus 0 is in ARINC 429 format.

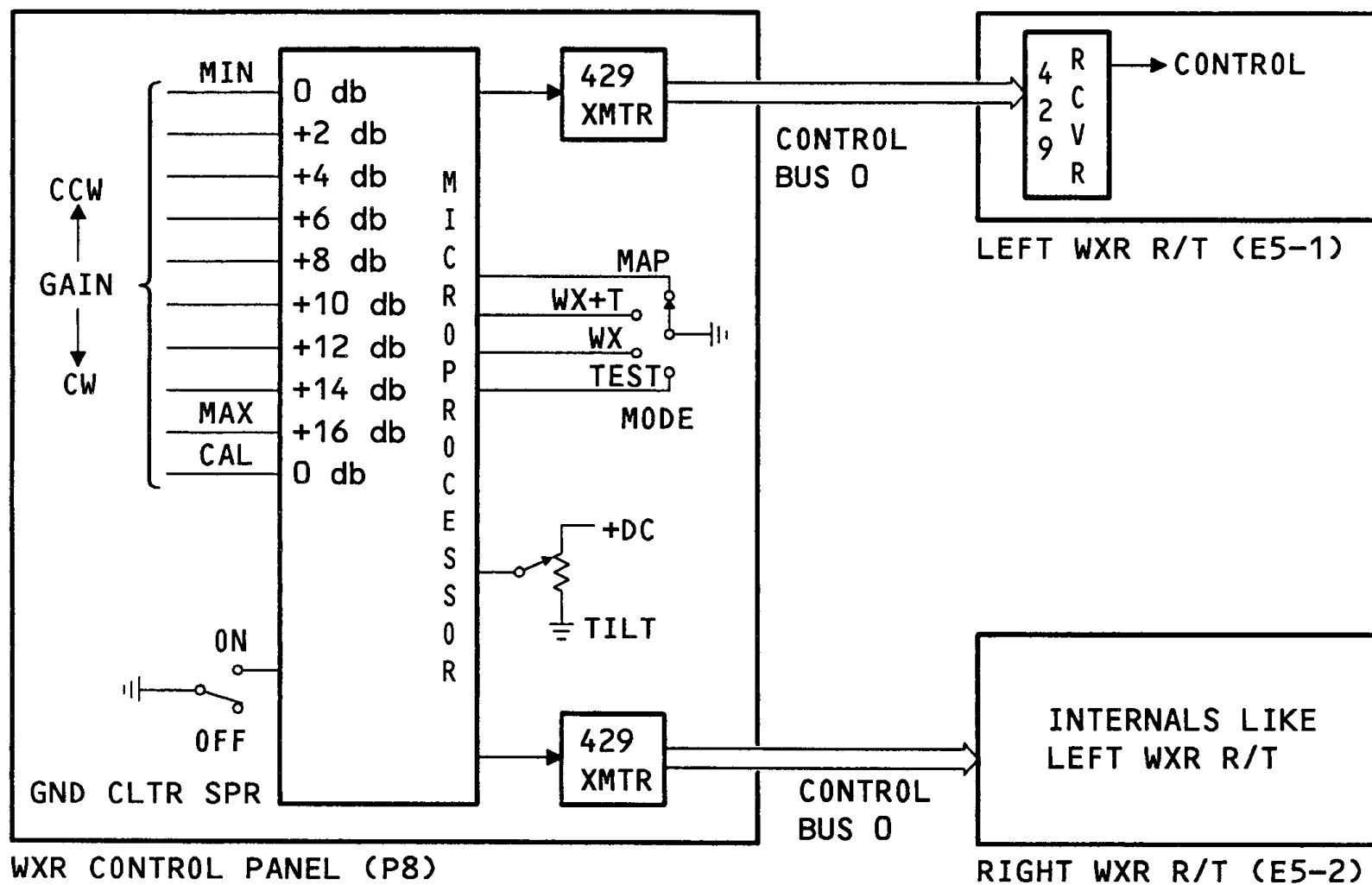


Figure 32 WXR CP DATA

WEATHER RADAR



WXR - ANTENNA CONTROL

Antenna Control

The central processing unit (CPU) in the selected R/T controls and monitors antenna operation.

The WXR CP provides antenna tilt.

Antenna Stabilization

The R/T uses attitude inputs from the IRS for antenna stabilization. The normal attitude source is the onside IRU. The alternate source is the center IRU. The onside IRS source select switch (IRS SSS) selects the alternate source.

The CPU uses the IRS inputs to compute and command scan and elevation movements for antenna scan and stabilization.

Antenna Drive

The antenna uses one bi-directional scan stepper motor (SCAN MTR) and one bidirectional elevation stepper motor (EL MTR) for stabilization. The selected R/T drives the motors. Switch S1 connects the left or right scan drive (L or R SCAN DR) to the scan motor. Switch S2 connects the left or right elevation drive (L or R EL DR) to the elevation motor.

The scan motor movement drives the scan rotary joint (SCAN ROT JOINT). The elevation motor movement drives the elevation rotary joint (EL ROT JOINT).

Left/Right System Operation

The antenna has two sets of electronics and two power supplies. With the left R/T selected, it powers the left power supply (L PS) and the left set of electronics. Right side operation is similar.

The power supplies use 115 volts ac input power and provide 26 volts dc motor power. They also provide other internal dc voltages.

Position Feedback

Two zero and two incremental monitors send scan motor position information and elevation motor position information to the R/T. The zero monitors sense the zero position. The incremental monitors count the number of steps the motors move from the center position.

Monitor transmitters (L and R SCAN MON and L and R EL MON) send antenna position feedback data to the R/Ts.

Antenna Position Integrity

The CPU compares the actual antenna position with the commanded position. If there is a difference, the CPU declares a failure.

Disable Switches

A scan disable switch (SCAN DIS SW) disables the scan motor during maintenance work. An elevation disable switch (EL DIS SW) disables the elevation motor. An open disable switch does not stop rf transmissions from the antenna.

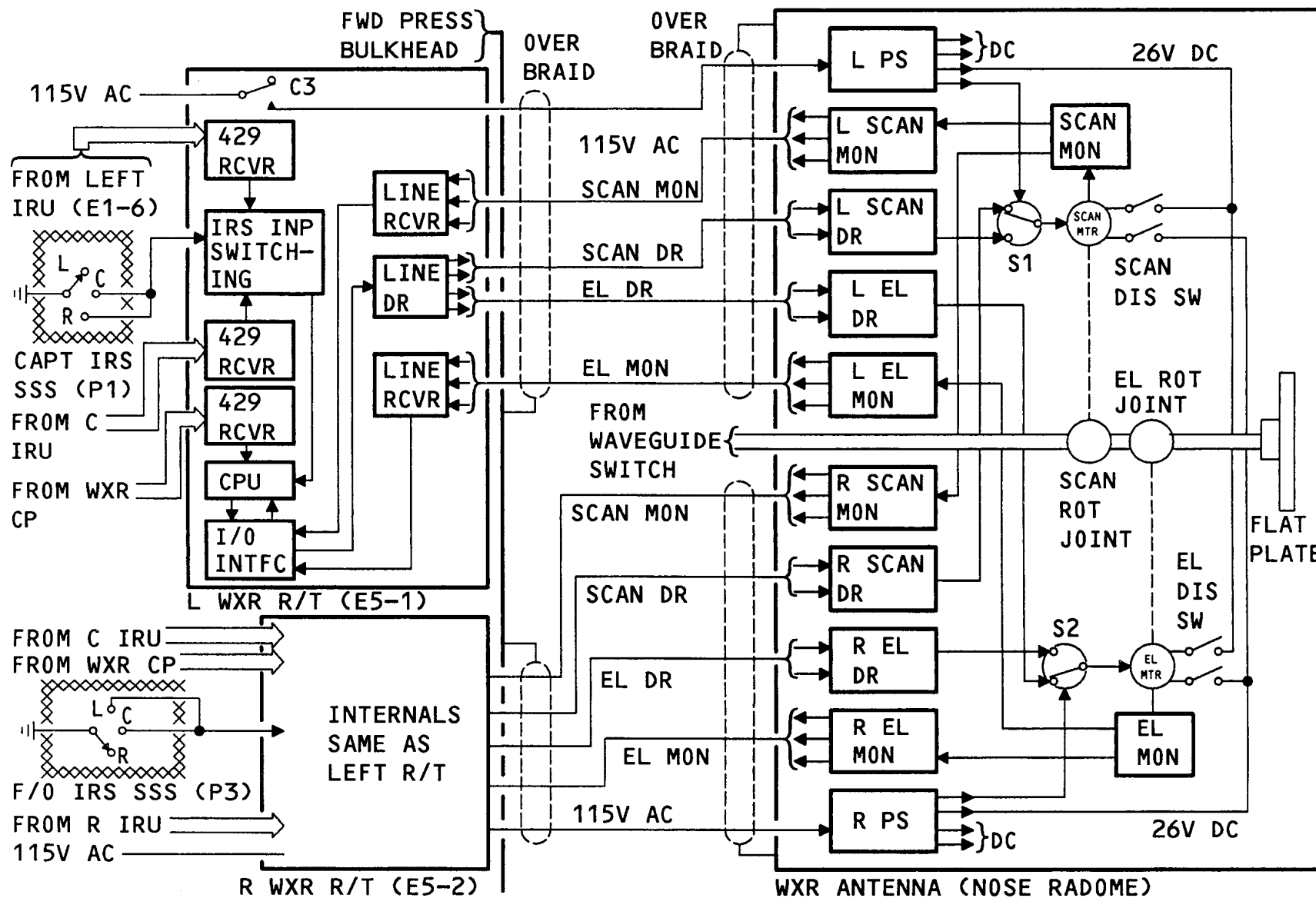


Figure 33 WXR - ANTENNA CONTROL

WEATHER RADAR



BITE OPERATION

General Operation

The WXR R/T central processing unit (CPU) controls the operation of the BITE module. The BITE module:

- Gets status information from the interface components
- Gets internally monitored data
- Does a self-test when it gets a test command from the WXR CP or a CDU through a CMC
- Generates a test pattern and sends it on data buses 1 and 2 to the display units
- Records faults in non-volatile fault memory
- Sends maintenance data to the WXR data processor
- Sends maintenance data on buses 1 and 2 to the display units
- Continuously sends maintenance data to the CMCs

Internal Input Monitoring

The functions monitored by BITE are:

- Overtemperature from the power supply
- Control bus 1 and 2 inputs
- Attitude from the selected IRU
- Antenna scan and elevation position integrity from the CPU

Right R/T operation is similar.

CDU/CMC Interface

The BITE module continuously sends status data to the CMCs. The CMCs record and send this data on demand to the CDUs for display.

The R/T runs a ground test when it gets a CDU/CMC test command. It sends the test results to the CMCs to record in memory and to show on the CDU.

The air/ground relay inhibits ground tests in the air.

Fault Memory

A non-volatile fault memory records up to 63 faults by flight legs. An input from the on/off circuit defines the beginning and the end of the flight leg.

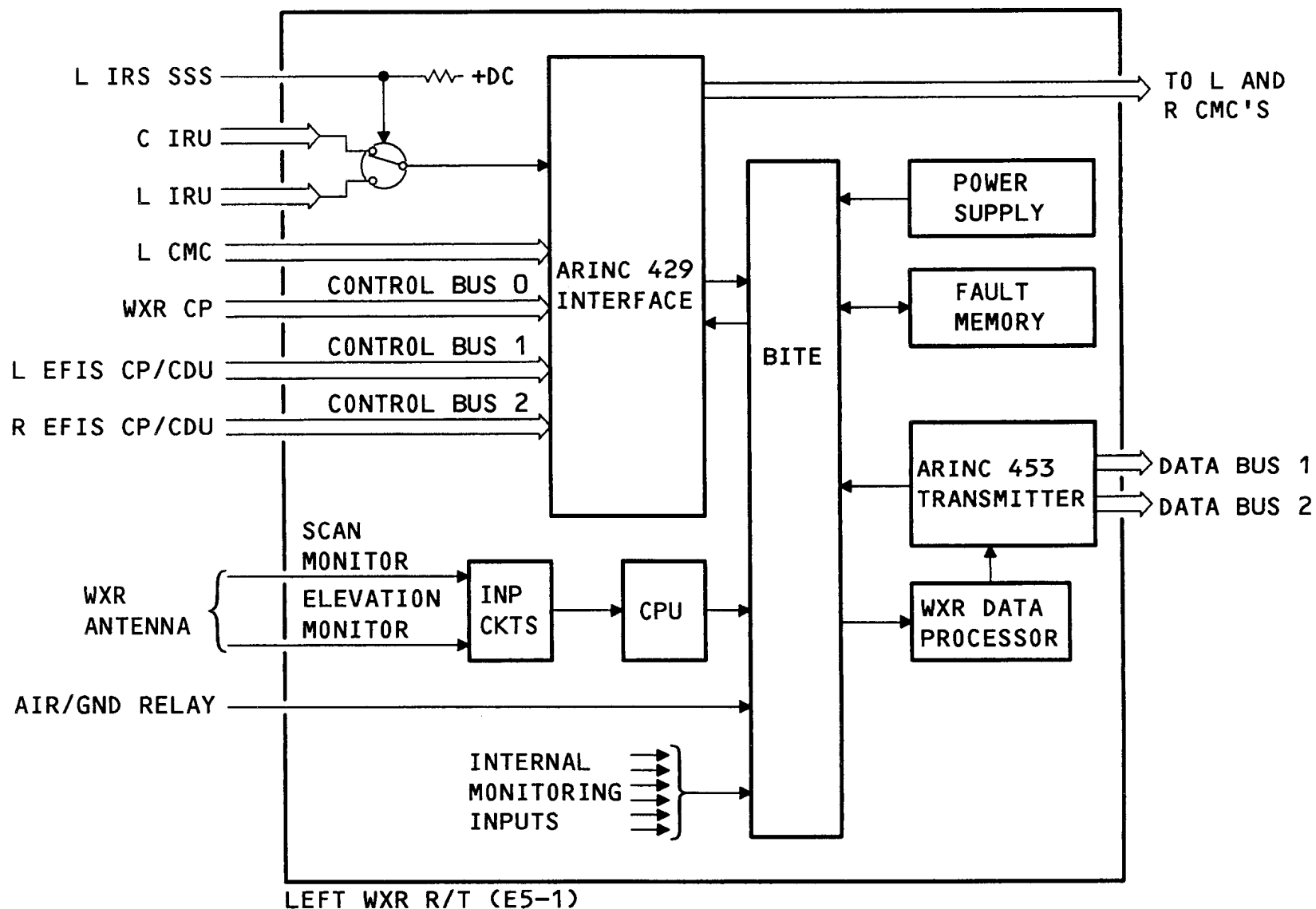


Figure 34 BITE OPERATION

WEATHER RADAR



FLIGHT DECK SELF-TEST - ND

The weather radar (WXR) system transmits some pulses to let BITE monitor for correct operation. Do not do a test of the WXR system in a hanger. Make sure the nose of the airplane points away from buildings and other aircraft or large metal objects.

Test Preparation

WARNING: DO NOT OPERATE THE WEATHER RADAR WHILE FUEL IS ADDED OR REMOVED FROM THE AIRPLANE. DO NOT TRANSMIT RF ENERGY WHILE FUEL IS ADDED OR REMOVED IN AN AREA 300 FEET OR LESS FROM THE ANTENNA. THIS CAN CAUSE AN EXPLOSION.

WARNING: MAKE SURE NO PERSONS ARE IN THE AREA 15 FEET OR LESS FROM THE ANTENNA WHEN IT TRANSMITS RF ENERGY. RF ENERGY CAN CAUSE INJURIES TO PERSONS.

Use an EFIS control panel or a CDU to:

- Select an ND mode that can show the

WXR display

- Apply power to the selected RT

Test Start

When you select TEST on the WXR control panel, the WXR self-test starts.

Test Operation

These visual and aural annunciations show for a normal test:

- WXR test pattern and cyan WXR TEST message show on the ND
- Amber WINDSHEAR message on ND
- Aural message - MONITOR WINDSHEAR DISPLAY
- Red WINDSHEAR message on ND and PFD
- Aural message - WINDSHEAR AHEAD, WINDSHEAR AHEAD
- MASTER WARNING LIGHTS ON
- EICAS status messages WINDSHEAR PRED
- EICAS advisory message WINDSHEAR SYS.

The WXR TEST pattern shows until you select another mode on the WXR panel or EFIS control panel.

The TEST pattern shows without any alert annunciations if either of these conditions exist:

- PWS is on
- Airplane is in the air.

The PWS symbol always shows in the TEST pattern. If PWS detects a real windshear threat while in TEST mode, the test stops. PWS then shows the actual display data and alert annunciations.

Test Pass

For a valid self-test, you must see and hear all visual annunciations.

Test Fail

For a self-test that fails, these are the indications:

- For some faults, the WXR test pattern does not show
- WXR or PWS shows in amber on alert message line one
- FAIL shows in amber on alert message line two
- A fail message shows for the WXR system failure.

The windshear symbol shows on the ND, even if PWS fails self-test.

WEATHER RADAR

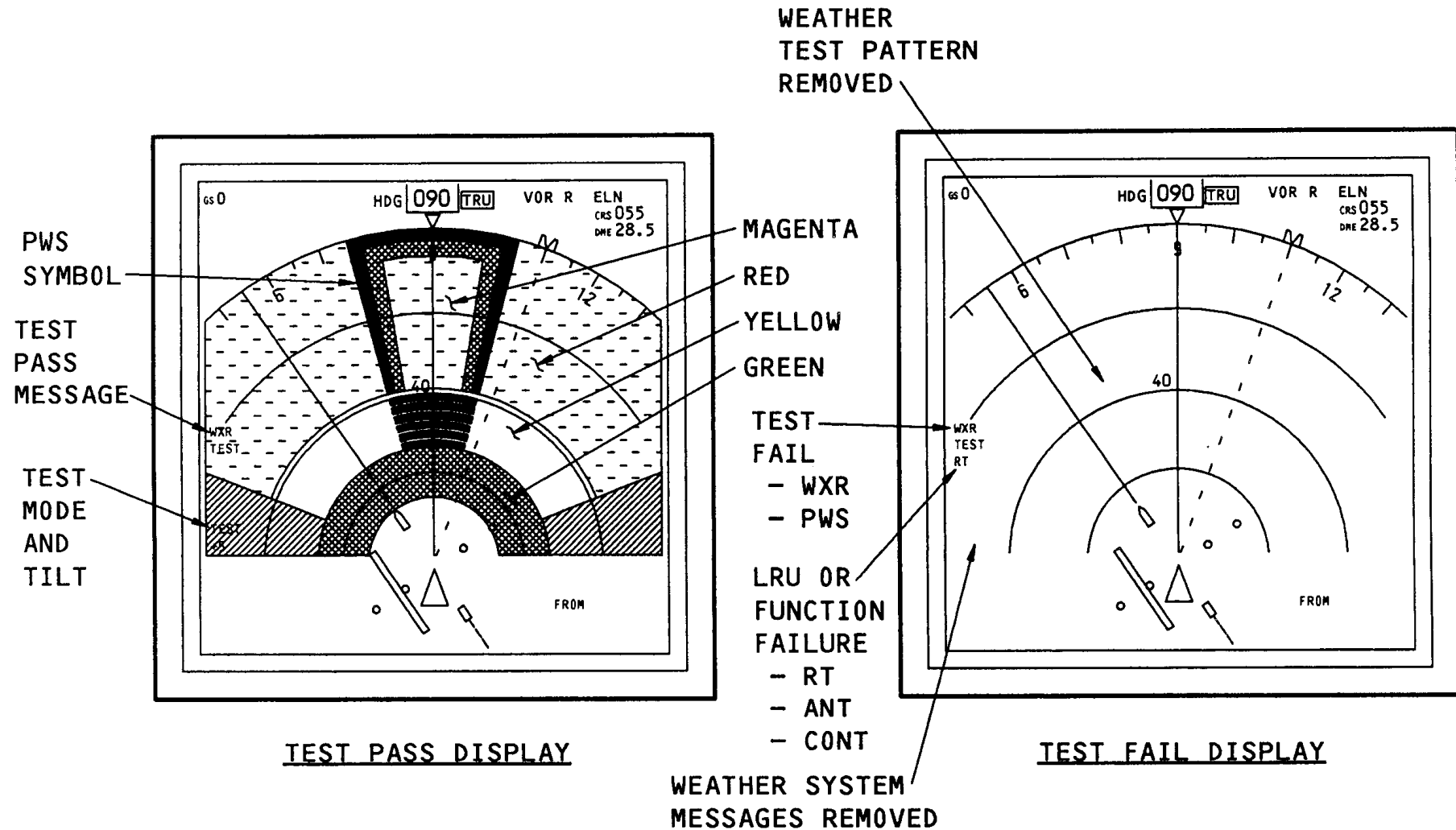


Figure 35 FLIGHT DECK SELF-TEST - ND

WEATHER RADAR



GROUND TEST-1

General

To start a weather radar ground test:

- Select the CMC GROUND TEST menu. (chapter 34 Navigation Radios)
- Push the WXR-L LSK (Note that INHIBITED shows above WXR-L, and WXR-R).
- The ENABLE TEST screen shows on the CDU.

The ENABLE TEST screen lists the conditions that must be satisfied to start the WXR-L test. These conditions are:

- AIRPLANE ON THE GROUND
- SET SYS SWITCH ON WXR CONTROL PANEL TO L
- PUSH WXR SWITCH ON EFIS CONTROL PANEL

After these conditions are satisfied, push the RETURN LSK.

NOTE: WXR-R TEST IS EQUIVALENT TO THE WXR-L TEST.

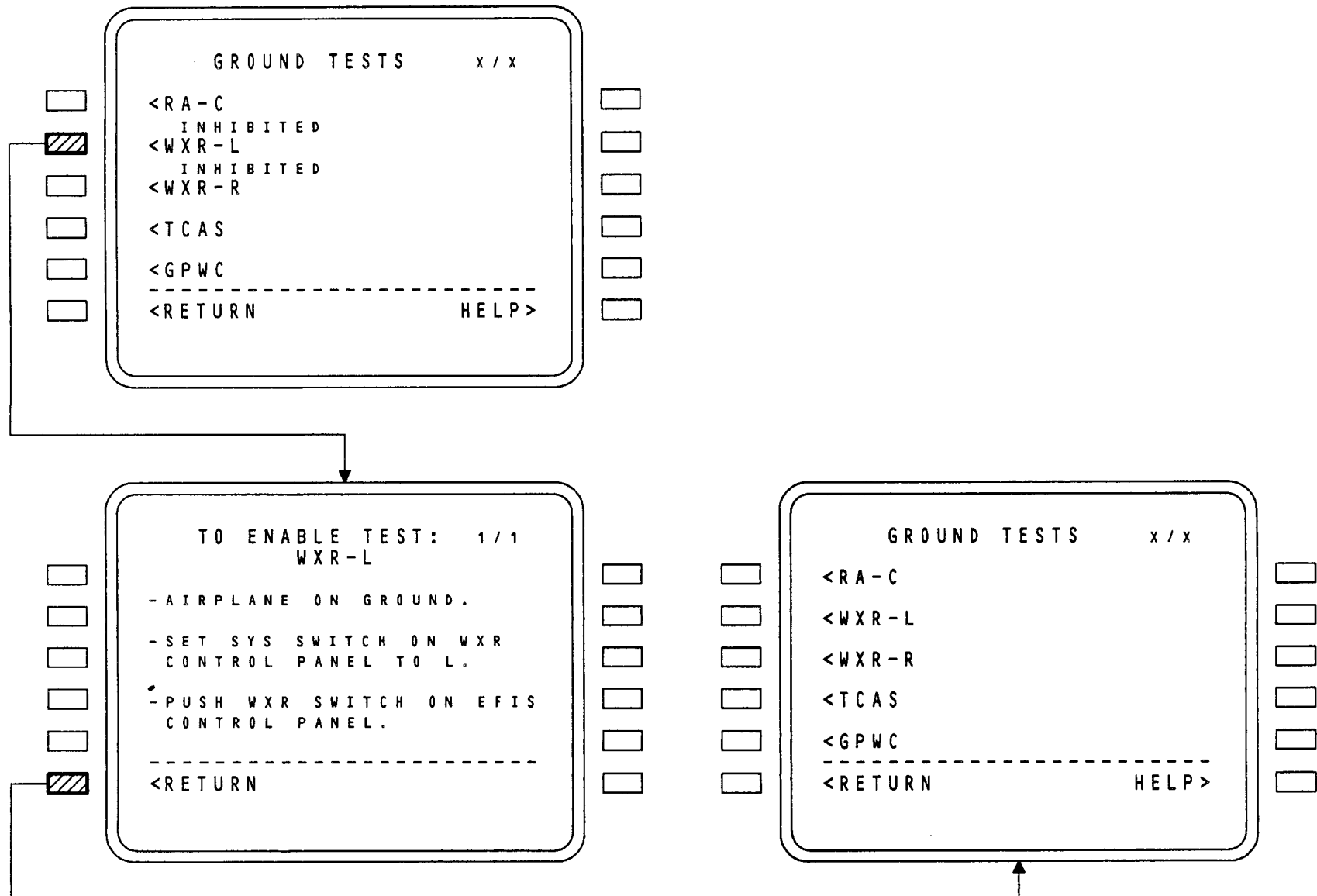


Figure 36 GROUND TEST-1

WEATHER RADAR



GROUND TEST - 2

Ground Tests

Show the CMC GROUND TEST menu (chapter 34 Navigation Radios). Then:

- Push the WXR-L (or -R) LSK
- Observe TEST PRECONDITIONS pages
- Push START TEST LSK.

Ground Tests Results

Upon completion of a ground test using the CDU, the word PASS will appear on the same line if there are no detected faults. The word FAIL shows a failure of the ground test.

NOTE: WXR-R TEST IS EQUIVALENT TO WXR-L TEST.

WEATHER RADAR

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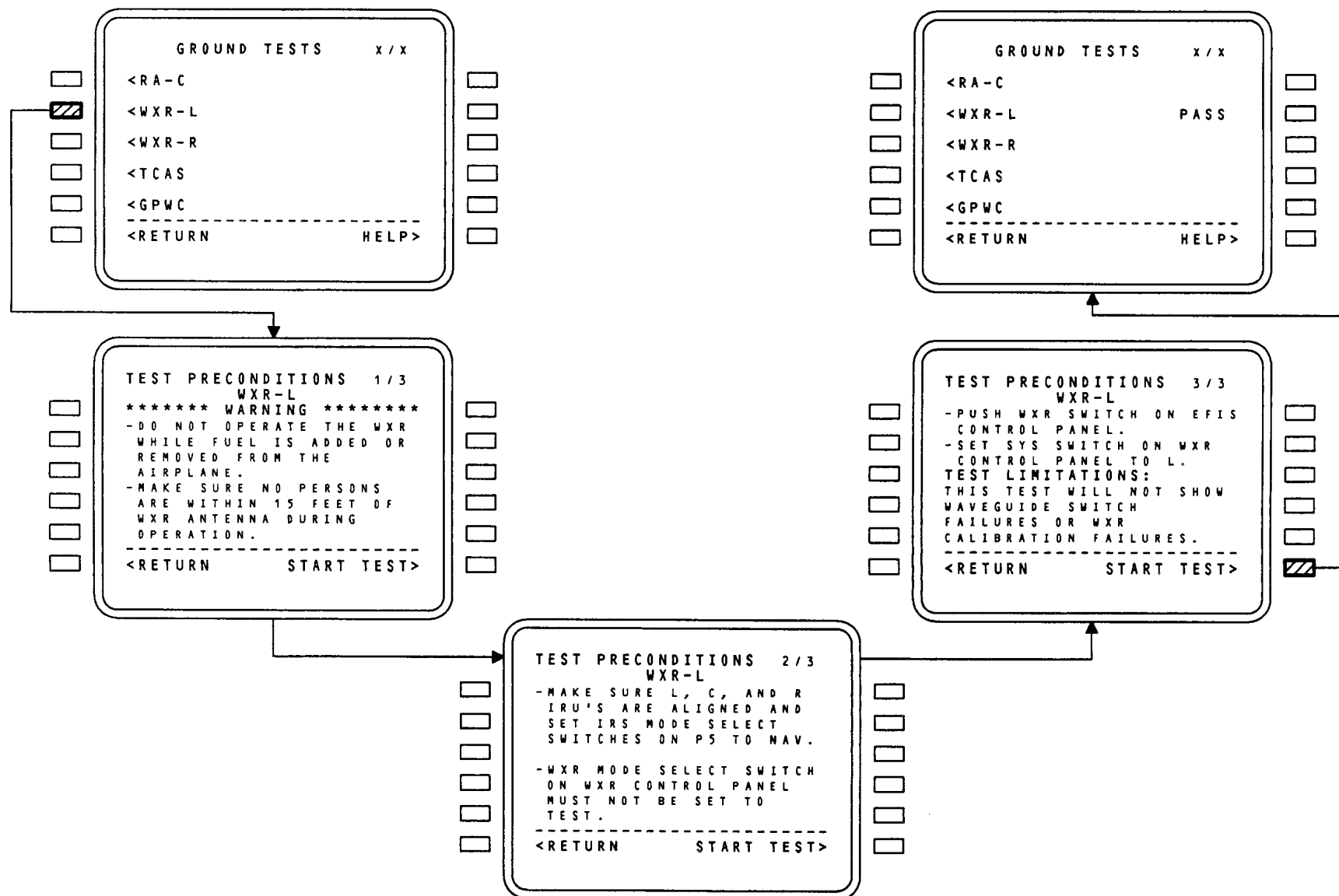


Figure 37 GROUND TEST - 2

WEATHER RADAR



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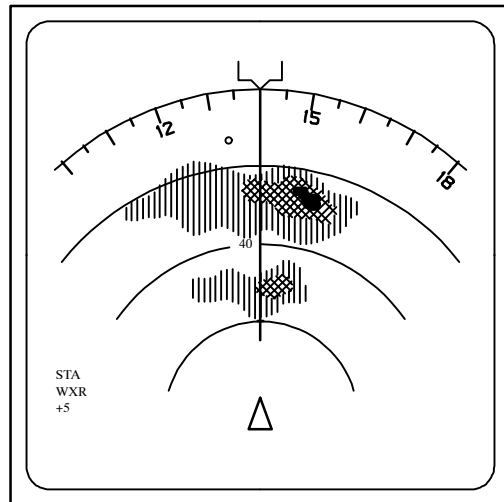


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NAVIGATION DISPLAY AND
AUXILIARY EICAS DISPLAY

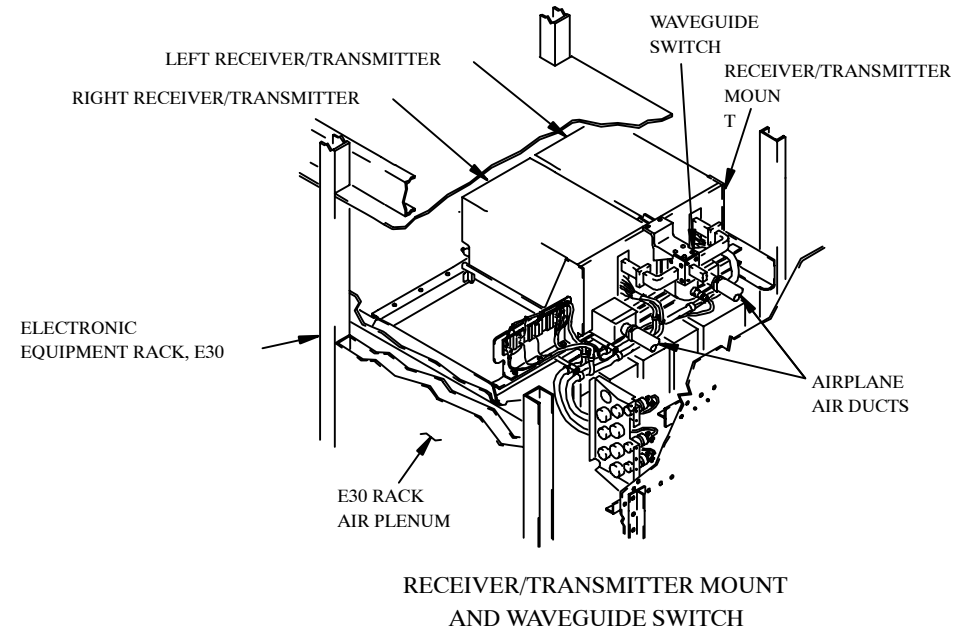


Figure 38



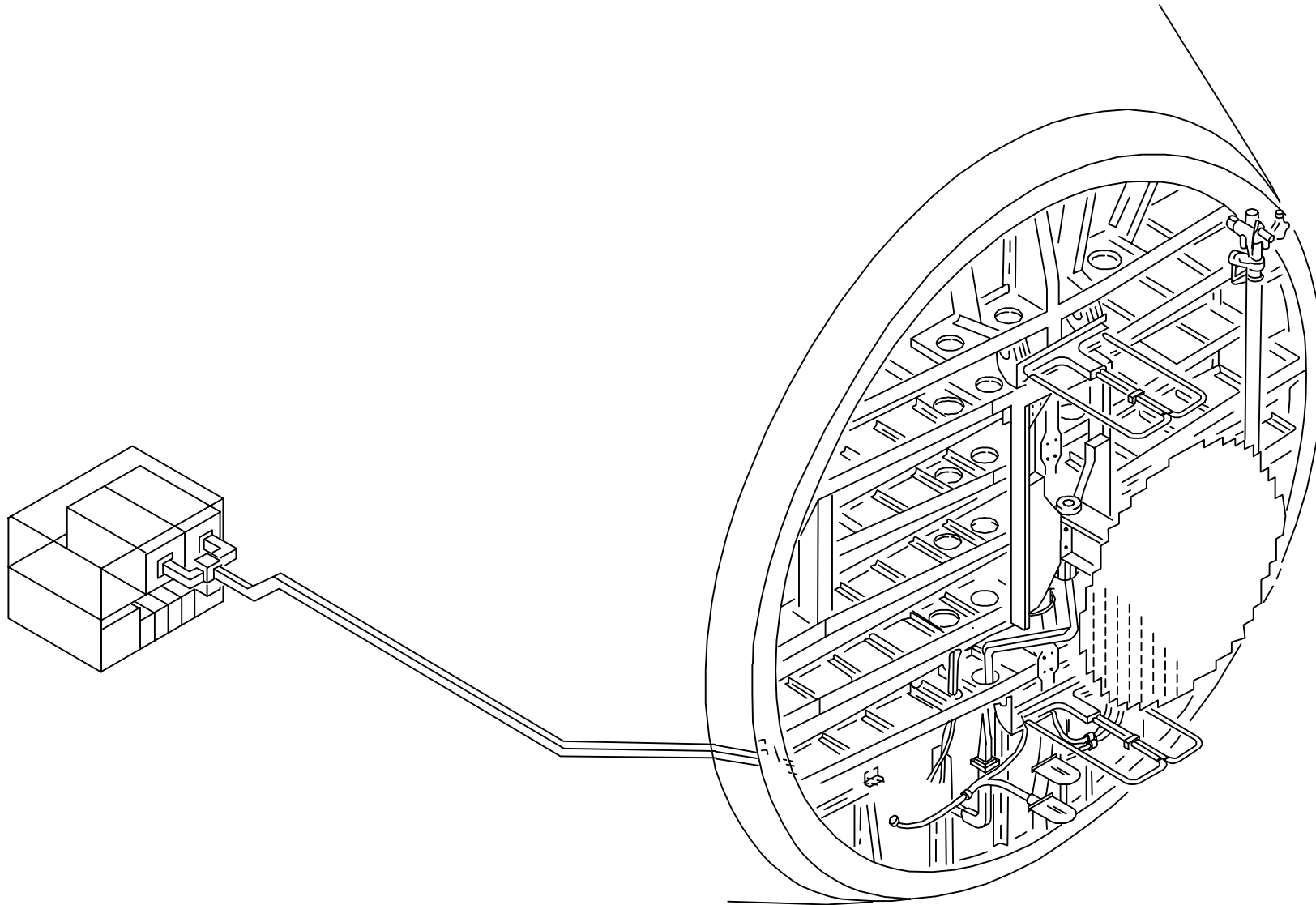


Figure 39 COMPONENT LOCATIONS - NOSE RADOM

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