TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34-10 NAVIGATION (ATA 34)

LEVEL 3

TABLE OF CONTENTS

TABLE OF FIGURES

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–11. STATIC / TOTAL AIR PRESSURE SYSTEM(ATA 34–11)

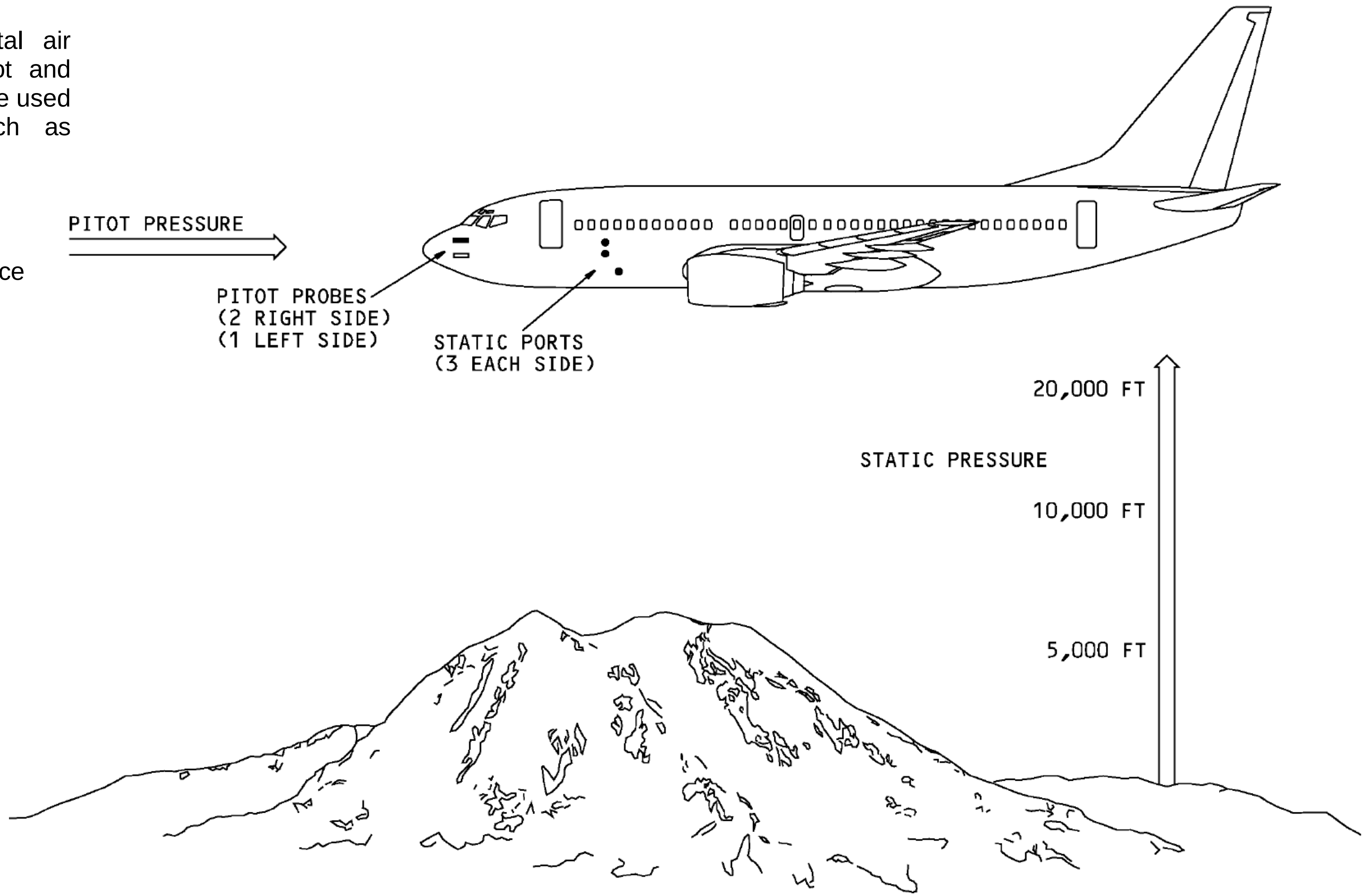
LEVEL 3

INTRODUCTION

The purpose of the static and total air pressure system is to measure pitot and static air pressure. These pressures are used to calculate flight parameters such as airspeed and altitude.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- ADM - air data module
- altn - alternate
- ARINC - Aeronautical Radio Incorporated
- aux - auxiliary
- capt - captain
- ft - feet
- F/O - first officer
- fwd - forward
- L - left
- R – right



STATIC AND TOTAL AIR PRESSURE SYSTEM

GENERAL DESCRIPTION

General

The static and total air pressure system gets air pressure inputs from three pitot probes and six static ports on the airplane fuselage.

These are the two types of air pressure:

- Static air pressure is the ambient air pressure around the airplane
- Pitot air pressure is the air pressure on the pitot probe tube as a result of the forward motion of the airplane.

The static and total air pressure system has these components:

- Three pitot probes
- Six static ports
- Five drain fittings.

Flexible and hard pneumatic tubing are used to connect the pitot-static components.

The system drains are used to remove condensation in the pitot-static lines.

PrimaryStaticandTotalAirPressureSystem

The two primary pitot probes connect to two pitot air data modules (ADMs). Two pairs of the primary static ports connect to two static ADMs.

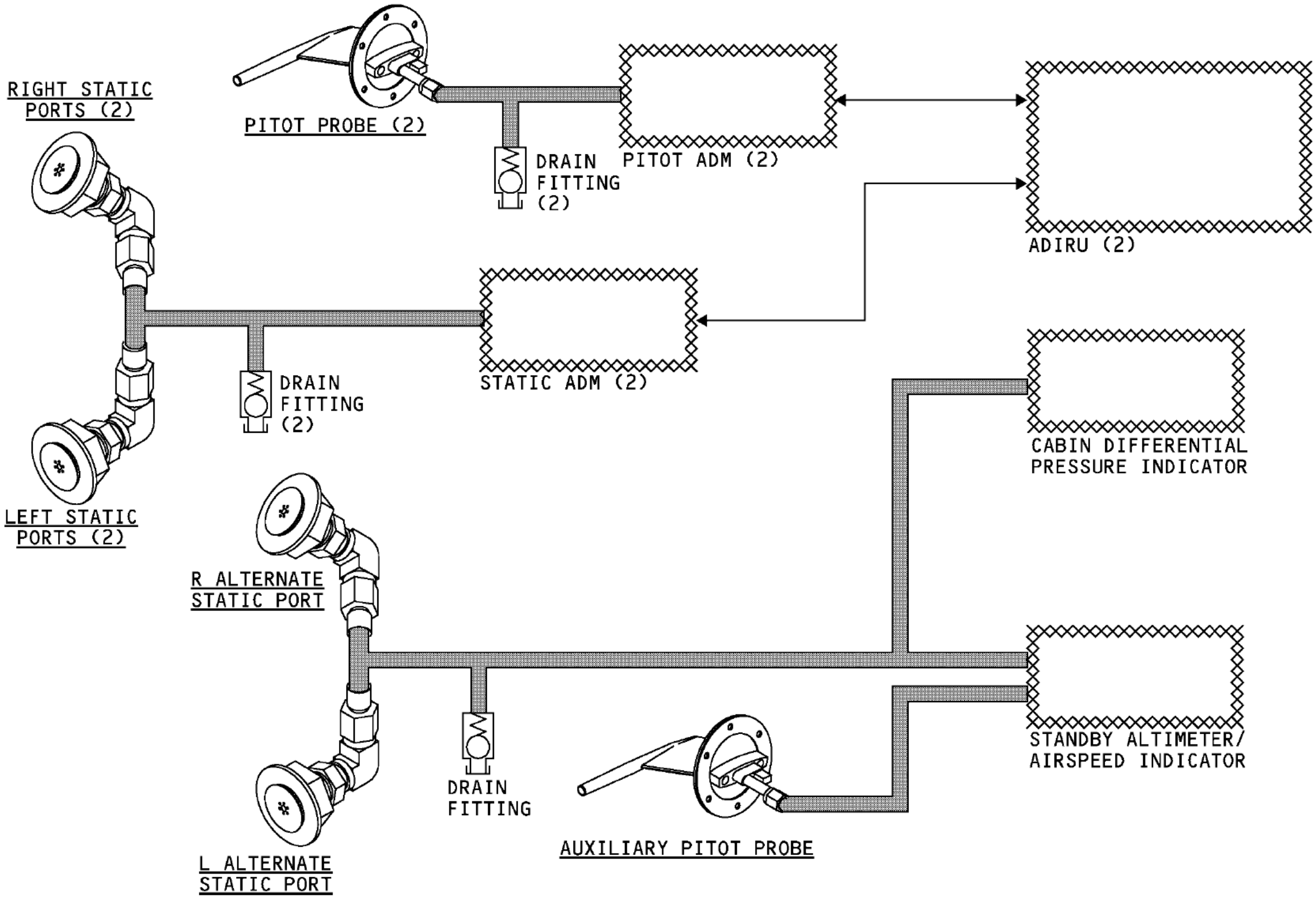
The ADMs change the air pressures to electrical signals and send them to the air data inertial reference units (ADIRUs) on ARINC 429 data buses. The ADIRUs use the signals to calculate flight parameters such as airspeed and altitude.

Each pitot line and each static line has a drain fitting.

AlternateStaticandTotalAirPressureSystem

The auxiliary pitot probe connects to the standby altimeter/airspeed indicator. The alternate static ports connect to the standby altimeter/airspeed indicator and to the cabin differential pressure indicator.

The standby static line has a drain fitting

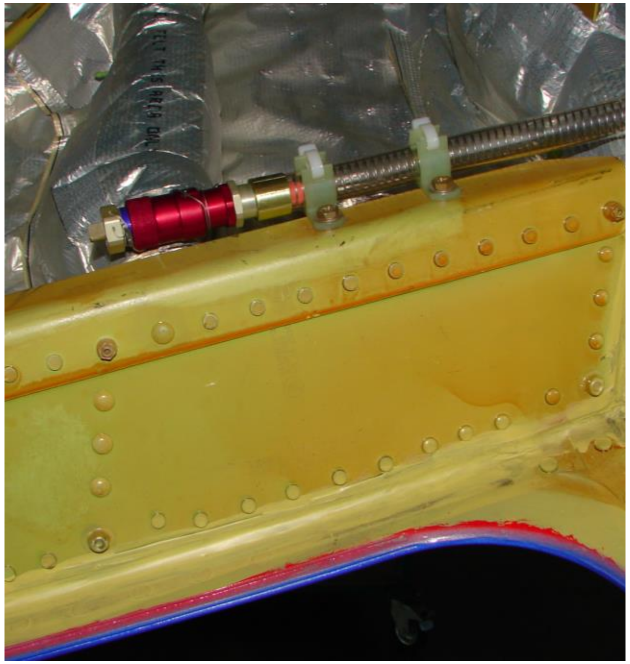


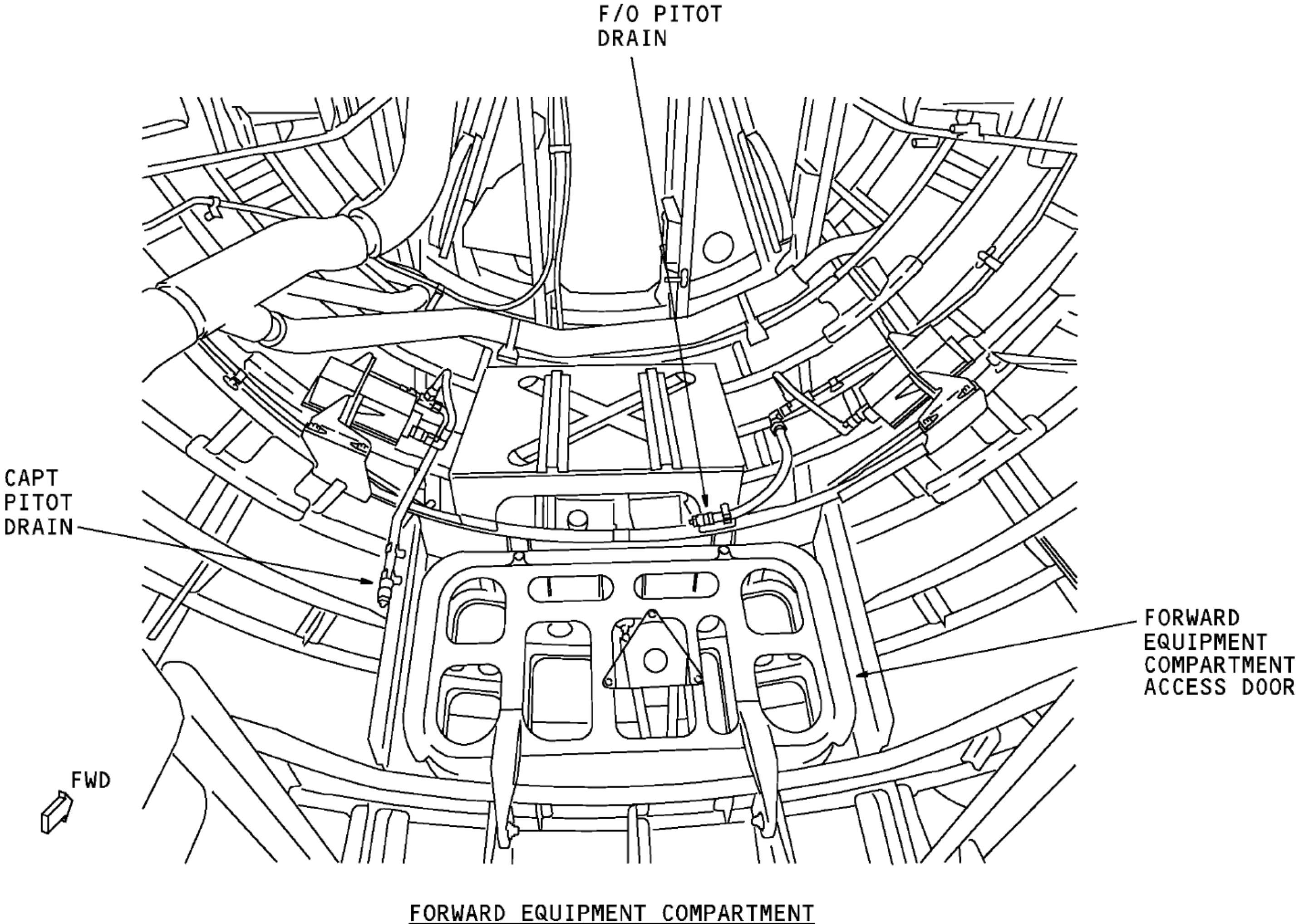
STATIC AND TOTAL AIR PRESSURE SYSTEM – GENERAL

COMPONENT LOCATION 1

Primary Pitot Drain Fittings

The drain fittings for the captain and first officer pitot lines are in the forward equipment compartment adjacent to the compartment access door.





PRIMARY PITOT DRAINS - LOCATION

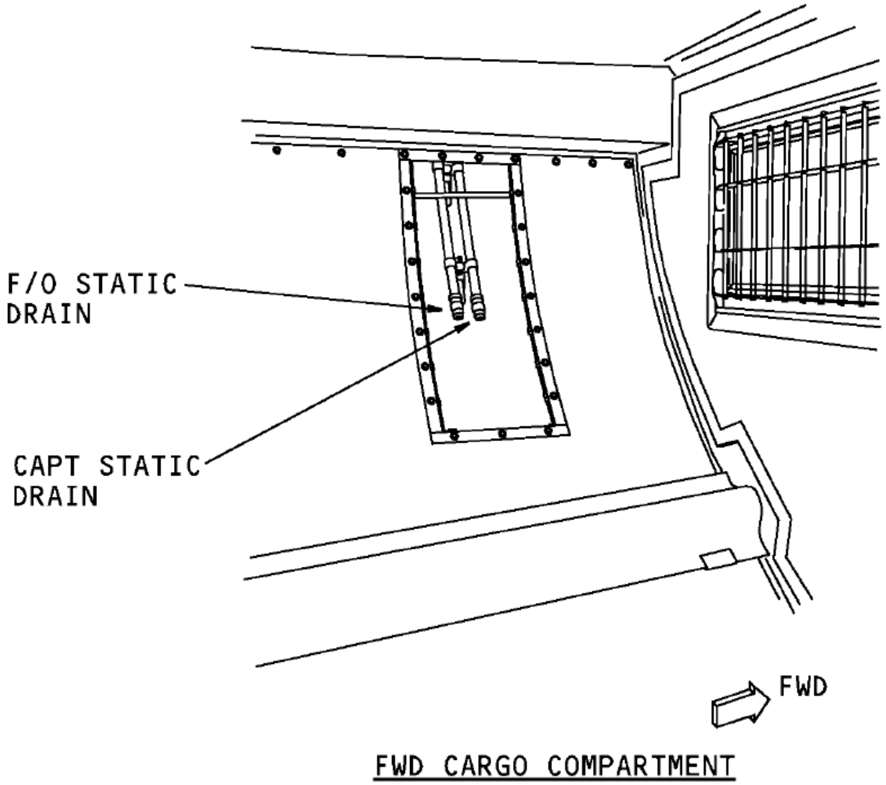
COMPONENT LOCATION 2

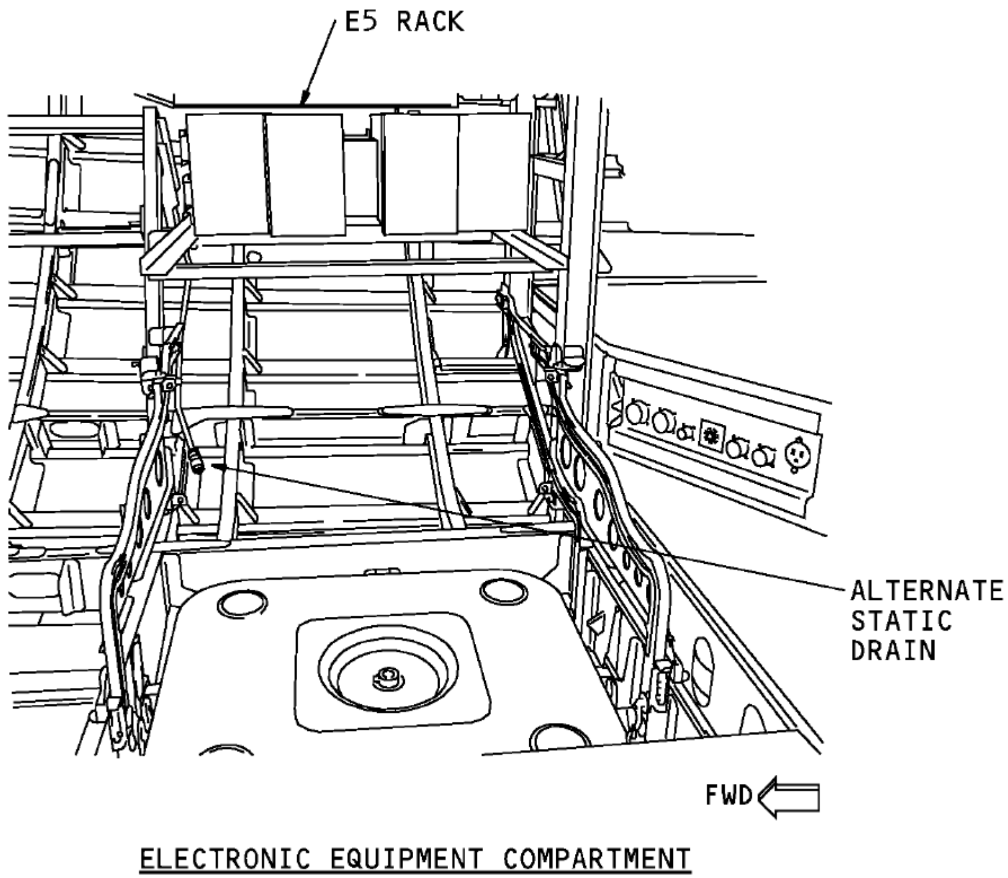
PrimaryStaticDrainFittings

The drain fittings in the captain and first officer static lines are in the forward cargo compartment along the left side of the airplane. You must remove an access panel to get to the drain fittings.

AlternateStaticDrainFitting

The drain fitting in the alternate static line is in the electronic equipment compartment below the E-5 rack.





STATIC DRAINS - LOCATION

COMPONENT LOCATION 3

Pitot Probe Location

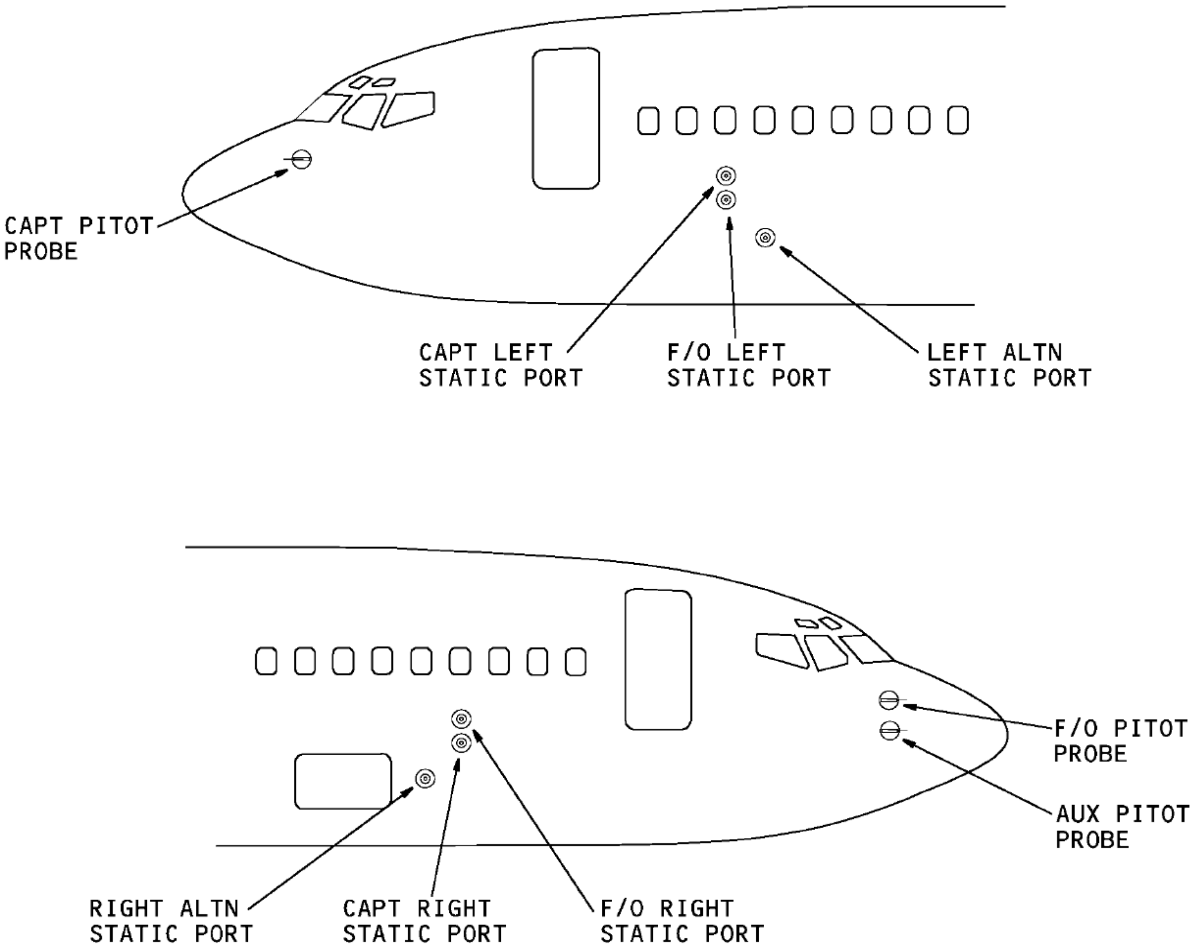
The airplane has three pitot probes. The captain pitot probe is on the left side of the airplane. The first officer and the auxiliary pitot probes are on the right side of the airplane.

Static Port Location

The airplane has six static ports. There is a captain, first officer, and an alternate static port on each side of the airplane.

AlternateStaticPortsLocation

The airplane has two alternate static ports. There is one port on each side of the airplane.



PITOT AND STATIC PORTS - LOCATION

THIS PAGE IS INTENTIONALLY LEFT BLANK

INTERFACE

ARINC 429 Data

These items send air pressure through pneumatic lines to the ADMs:

- Captain pitot probe
- First officer pitot probe
- Captain static ports
- First officer static ports.

The length of the pressure lines and the number of connectors are a minimum. The left and right static ports are connected together. This gives an average ambient air pressure to the ADMs.

Pressure Lines

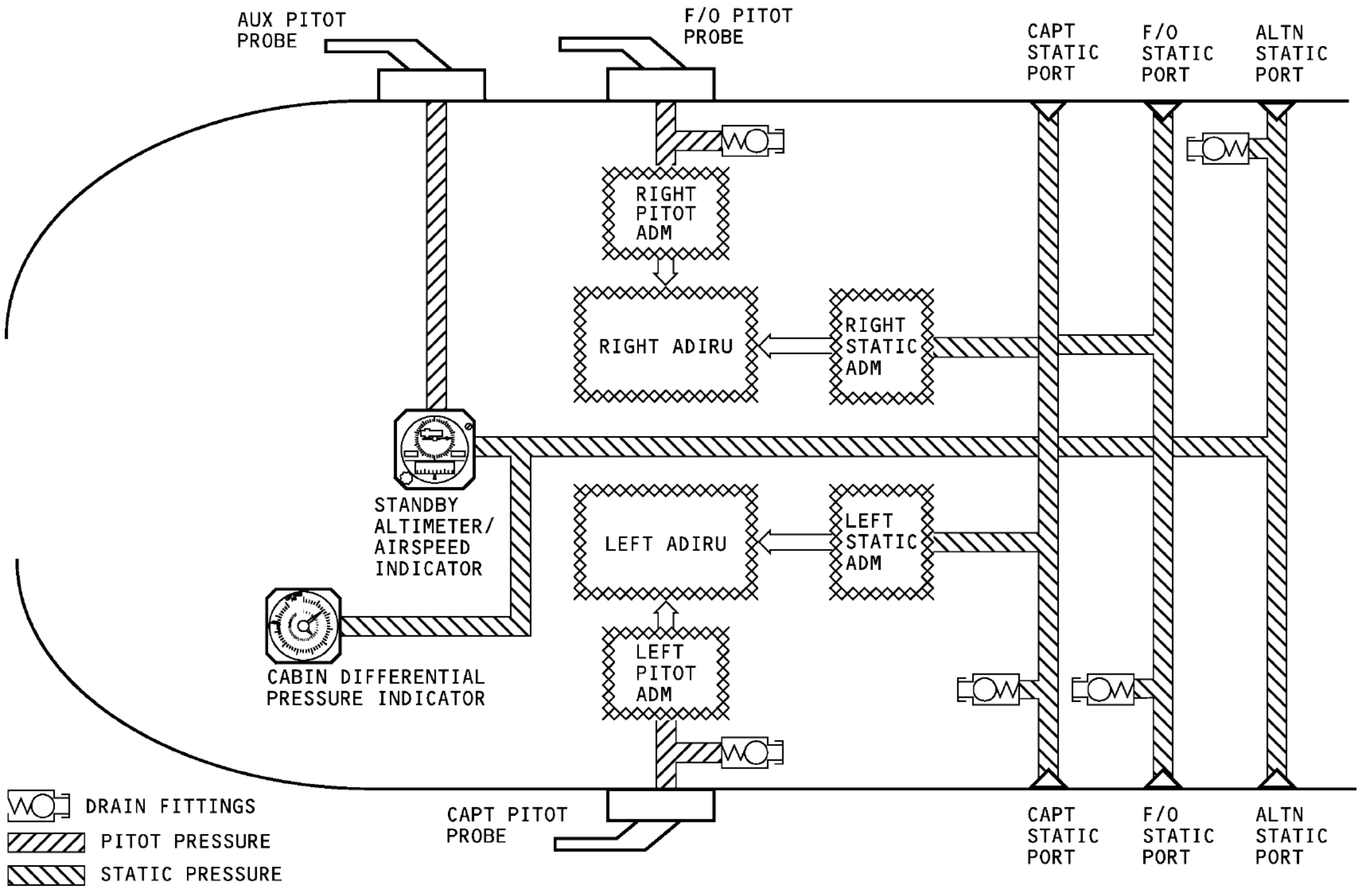
The pressure lines from the auxiliary pitot probe and the alternate static ports go to the standby altimeter/airspeed indicator. The pressure lines from the alternate static ports also go to the cabin differential pressure indicator.

The alternate static ports are connected together to give average ambient pressure.

Drain Fittings

Each static line has a drain fitting. The captain and first officer pitot lines also have drain fittings.

The auxiliary pitot line does not have a drain fitting. The probe is at the lowest part of the line so moisture can drain from the probe.


AUX PITOT PROBE
F/O PITOT PROBE
CAPT STATIC PORT
F/O STATIC PORT
ALTN STATIC PORT
RIGHT PITOT ADM
RIGHT ADIRU
RIGHT STATIC ADM
STANDBY ALTIMETER/ AIRSPEED INDICATOR
LEFT ADIRU
LEFT STATIC ADM
LEFT PITOT ADM
CABIN DIFFERENTIAL PRESSURE INDICATOR
DRAIN FITTINGS
PITOT PRESSURE
STATIC PRESSURE
CAPT PITOT PROBE
CAPT STATIC PORT
F/O STATIC PORT
ALTN STATIC PORT

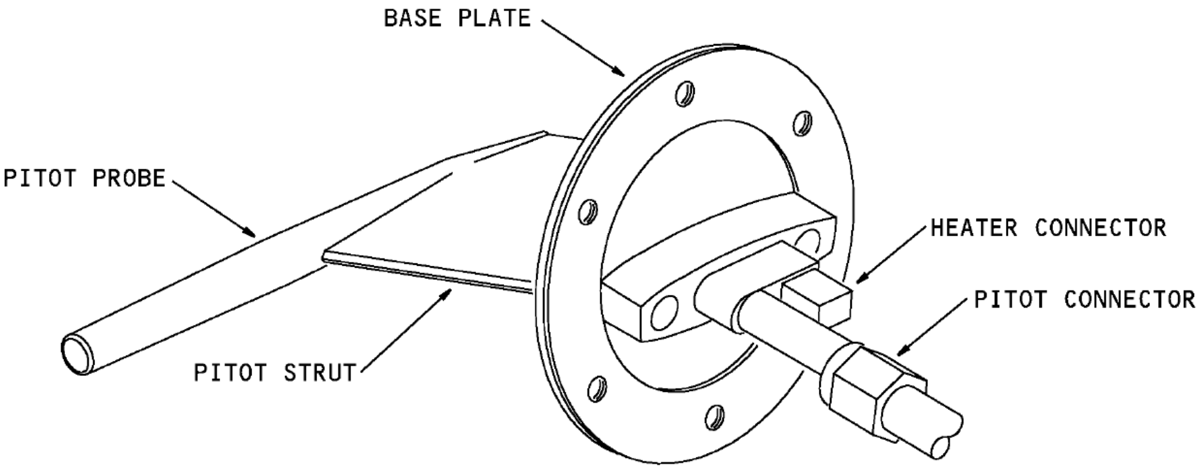
INTERFACE

PITOT PROBE

Physical Description

The pitot probe measures pitot air pressure.

The pitot probe port points forward to measure pitot pressure. A strut moves the probe several inches from the airplane skin to decrease airflow turbulence effects. A base plate contains the electrical and pressure connectors. A gasket is between the probe base and the airplane structure to form a pressure seal.
An anti-icing heater is in the probe to prevent ice. The heater is attached to the electrical connector in the base plate.



PITOT PROBE

STATIC PORT

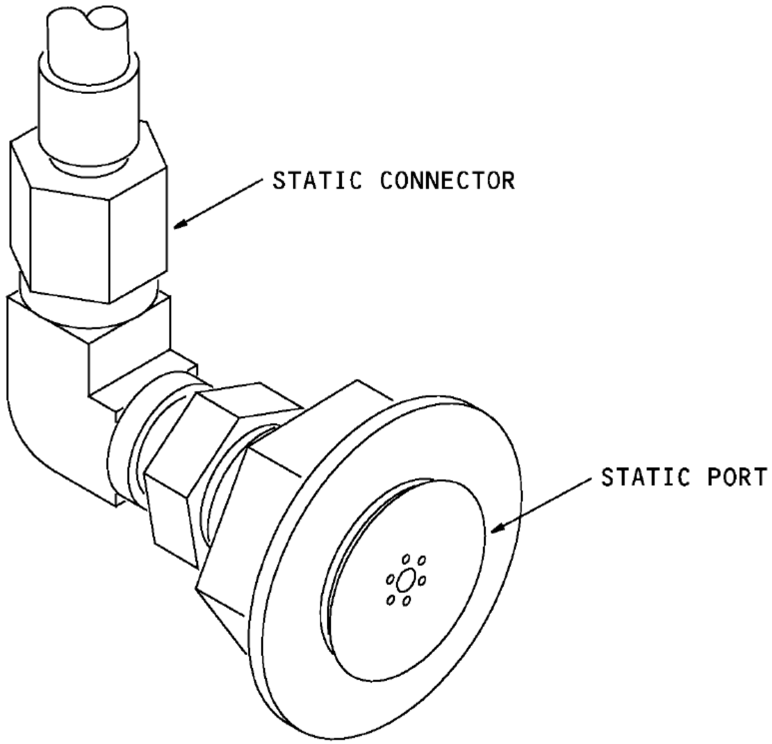
Physical Description

The static ports measure static (ambient) air pressure.

The static ports are flush-mounted on the fuselage skin. There is a circle around the port with a caution note.

The static ports do not have anti-icing heaters.

Caution: DO NOT PLUG OR DEFORM HOLES. INDICATED AREAS MUST BE SMOOTH AND CLEAN.



STATIC PORT

STATIC PORT INSPECTION (Training information port)

Damages of the Static ports and skin in the area where the Static probes installed is most strongly affect for the accuracy of altitude measurement systems; automatic altitude control system and altitude alert system. These systems are critical for the RVSM capability of aircraft. Damages can restrict RVSM capability of aircraft. So, this area called Critical zone area and required more attention during inspection.

Regular inspections help reduce the risk of lowering the accuracy of the static pressure measurement.

Static port inspection

This procedure contains these tasks:

- A detailed inspection of the static ports and the skin surface near the port
- A special detailed inspection of the static ports and the skin surface near the port.

Static Port - Detailed Inspection

Visually examine the static port for damage.
Visually examine the holes in the port for contamination. If there is a problem with a primary or alternate static port, replace the port.

Visually examine the surface of the airplane skin in a three inch radius around the port: Make sure that the surface of the skin is not rough. If the skin is rough, refer to the Structural Repair Manual (SRM 51-10-01).

If the detailed inspection of the static port is not satisfactory, do the Static Port - Special Detailed Inspection ref AMM 34-11-02.

RVSM CRITICAL AREA

STATIC PORT - SPECIAL DETAILED INSPECTION

Inspection procedure for the Primary Static Ports requires visually examination the primary static port and holes for damage and skin inspection:

Visually examine the primary static port for damage and make sure that the depth of any scratches on the port are less than 0.010 inch (0.254 mm).
Visually examine the holes in the port for contamination. If there is a problem with a primary static port, replace the port.

Measure the step height of the primary static ports and nake sure the primary static port step height is 0.000 to +0.003 inch (0.076 mm) above the skin

- ➢ If the step height is too low, then replace the port.
- ➢ If the step height is too high, then decrease the port step height (SRM 51-10-03

Note: The step height is the distance between the surface of the skin and the primary static ports.

Visually examine the airplane skin surface in a three inch radius around the static port.

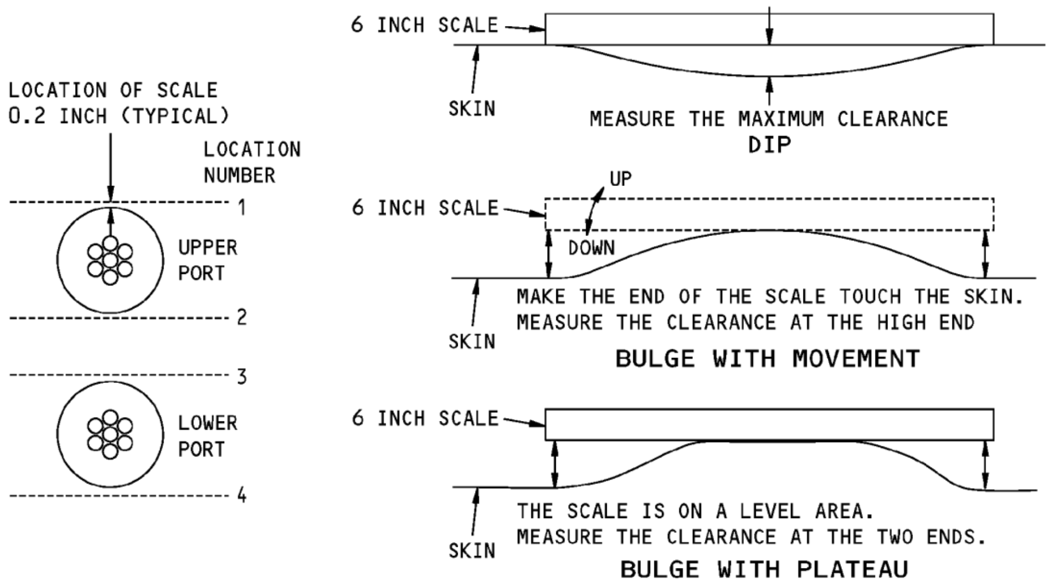
- ➢ Make sure the surface of the skin is not rough.
- ➢ If the skin is rough, refer to the Structural Repair Manual 51-10-01.

Find the surface waviness of the airplane skin in the area of each primary static port:

- ➢ Find the primary static ports on each side of the airplane.
- ➢ Measure the skin waviness in an approximate 3 inch (76.20 mm) area around each primary static port.

1) Align the center of a metal 6-inch scale with the center of the static port.
2) Measure horizontally.

- ➢ Examine the area for a dip or bulge condition.
- ➢ Measure and record the waviness.



LEFT SIDE								
	LOCATION	DIP	BULGE WITH MOVEMENT			BULGE WITH PLATEAU		
		MAXIMUM	FORWARD	AFT	MAXIMUM	FORWARD	AFT	MAXIMUM
UPPER PORT	1	-0.010						
	2	-0.004						
	WAVINESS	-0.007						
LOWER PORT	3		0.008	0.000	0.008			
	4		0.020	0.010	0.020			
	WAVINESS				0.007			
RIGHT SIDE								
	LOCATION	DIP	BULGE WITH MOVEMENT			BULGE WITH PLATEAU		
		MAXIMUM	FORWARD	AFT	MAXIMUM	FORWARD	AFT	MAXIMUM
UPPER PORT	1	-0.010						
	2	-0.000						
	WAVINESS	-0.005						
LOWER PORT	3					0.008	0.000	0.008
	4					0.020	0.010	0.020
	WAVINESS							0.014

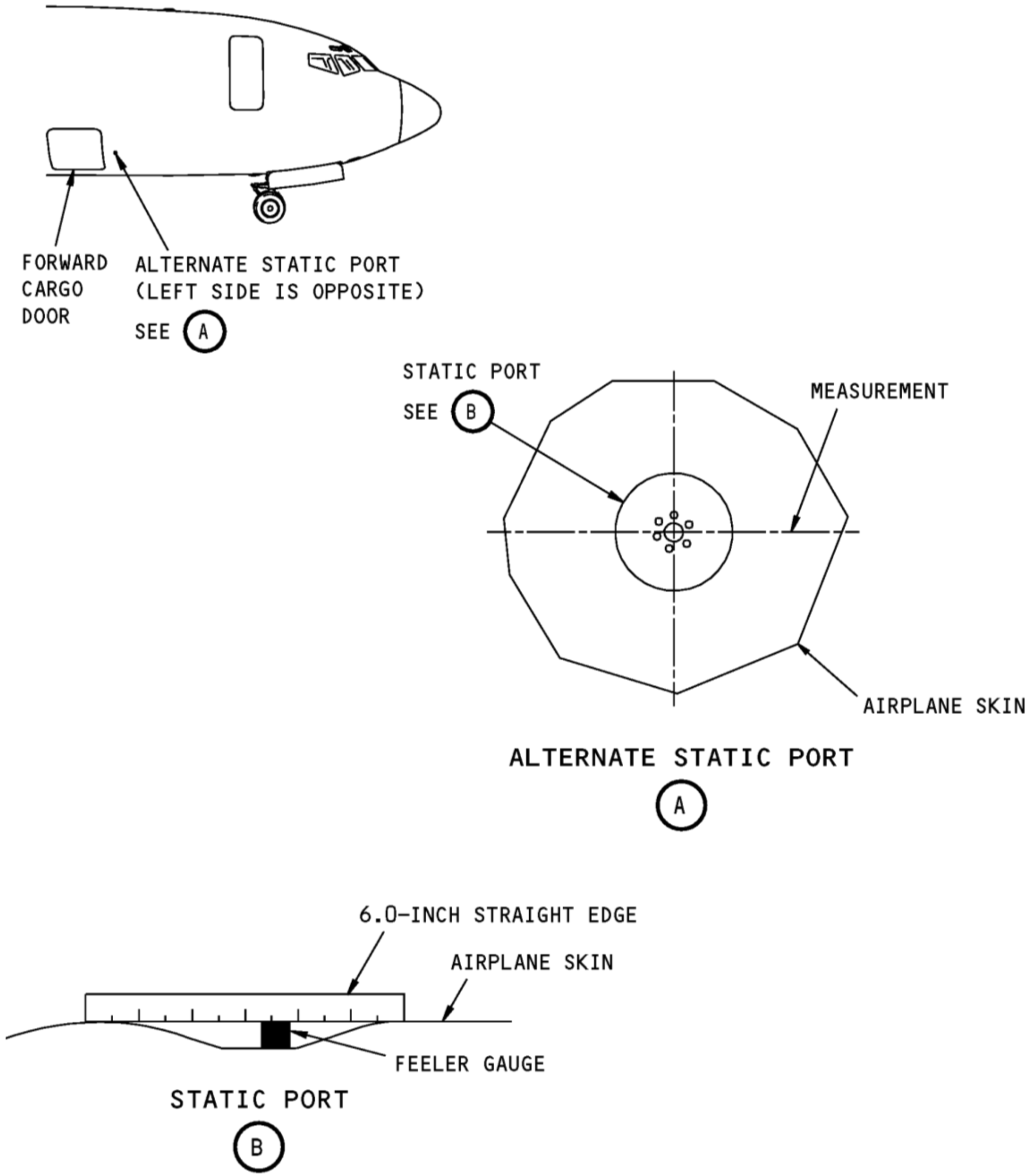
STATIC PORT INSPECTION

Skin Condition Description

Dip : The skin touches the two ends of the scale but not the middle part of the scale.
Bulge: The skin touches the middle part of the scale but not at the ends of the scale.

There are two types of bulges:

- Bulge with Movement: The 6-inch scale can easily move up or down on the bulge.
- Bulge with Plateau: The 6-inch scale is on a level area of the bulge and is resistant to up and down movement



STATIC PORT INSPECTION – SKIN CONDITION

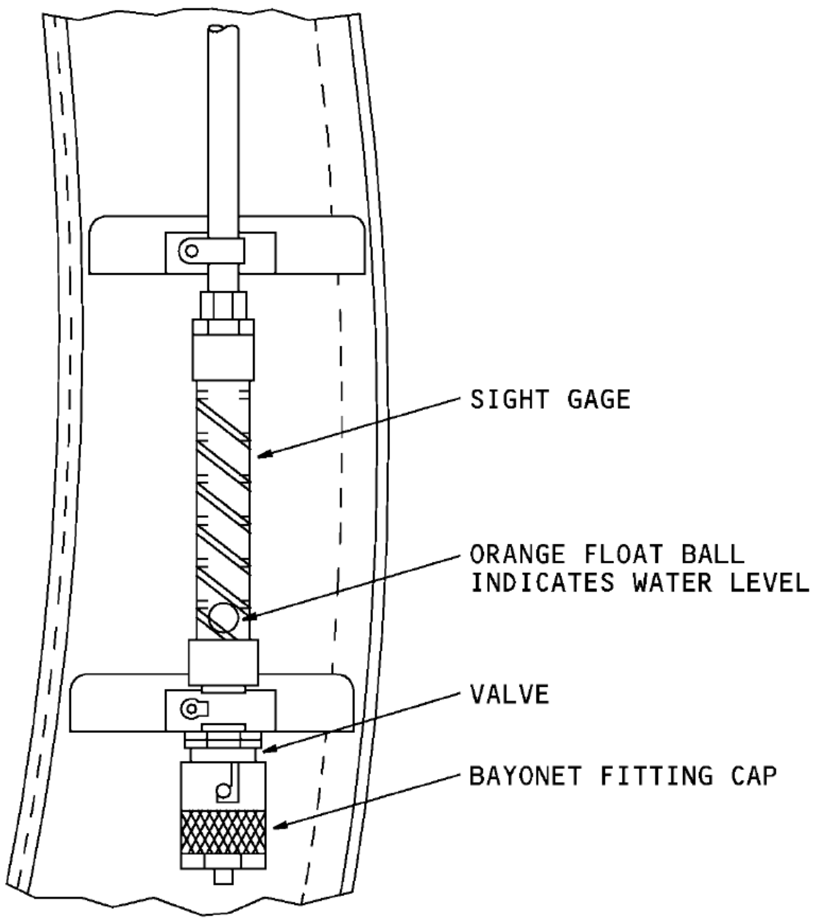
DRAIN FITTING

Physical Description

The system drains remove condensation that collects in the pitot-static lines. The drain fittings have a reinforced transparent section of tubing with an orange float. This forms a sight gauge to show the level of fluid that collects in the sump.

Operation

The lower part of the drain contains a valve covered by a bayonet cap. To drain the pitot-static line, remove the cap and insert the valve depressor on the cap into the valve. The liquid in the sump drains by gravity when you push the valve.



DRAIN FITTING

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–13 AIR DATA INSTRUMENTS (ATA34-13)

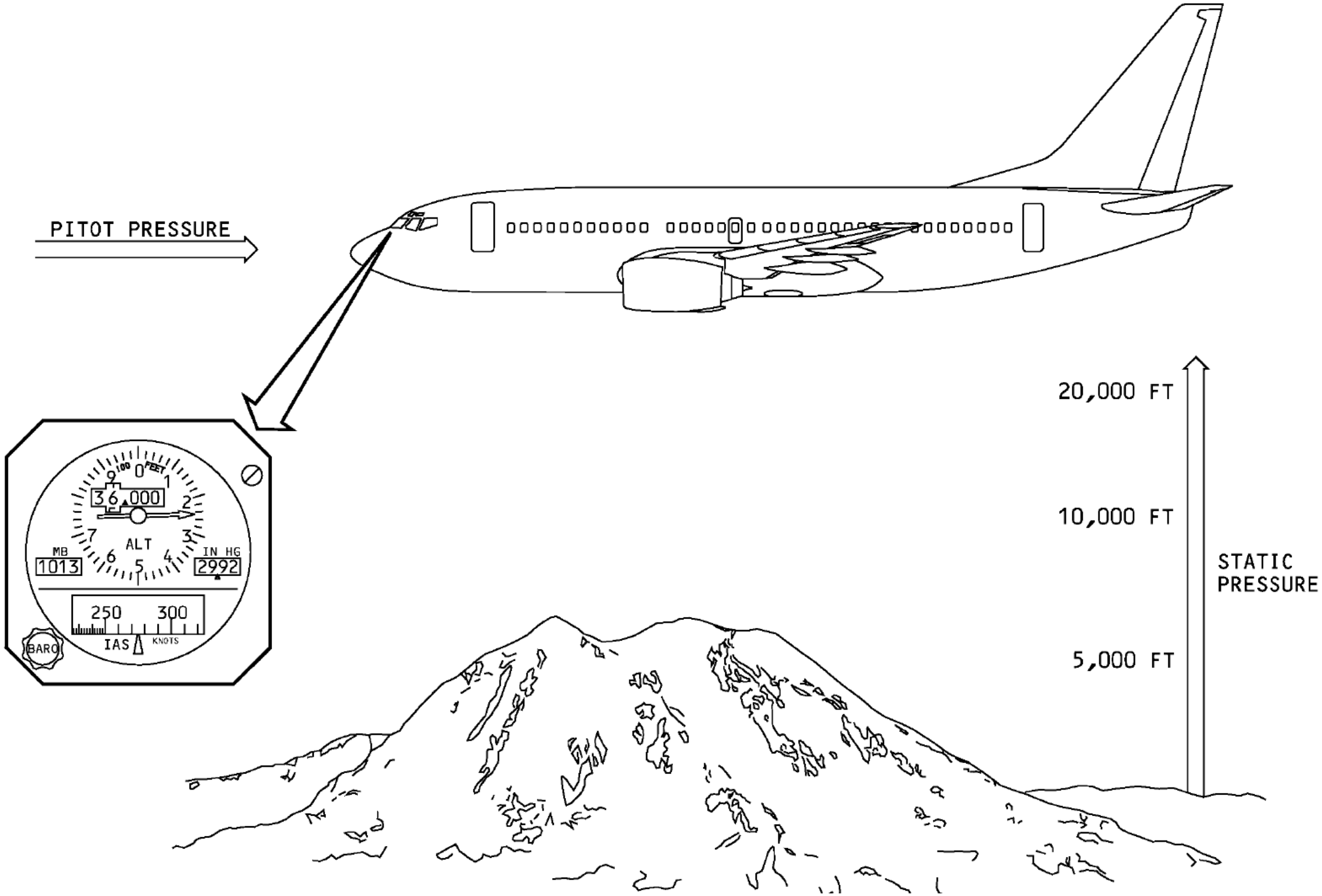
LEVEL 3

INTRODUCTION

The air data instruments supply the crew with standby indications of the airplane altitude and indicated airspeed (IAS).

Abbreviations and Acronyms

- alt - altitude
- BARO - barometric
- G/T - gear train
- IAS - indicated airspeed
- IN HG - inches of mercury
- MB – millibars



AIR DATA INSTRUMENTS

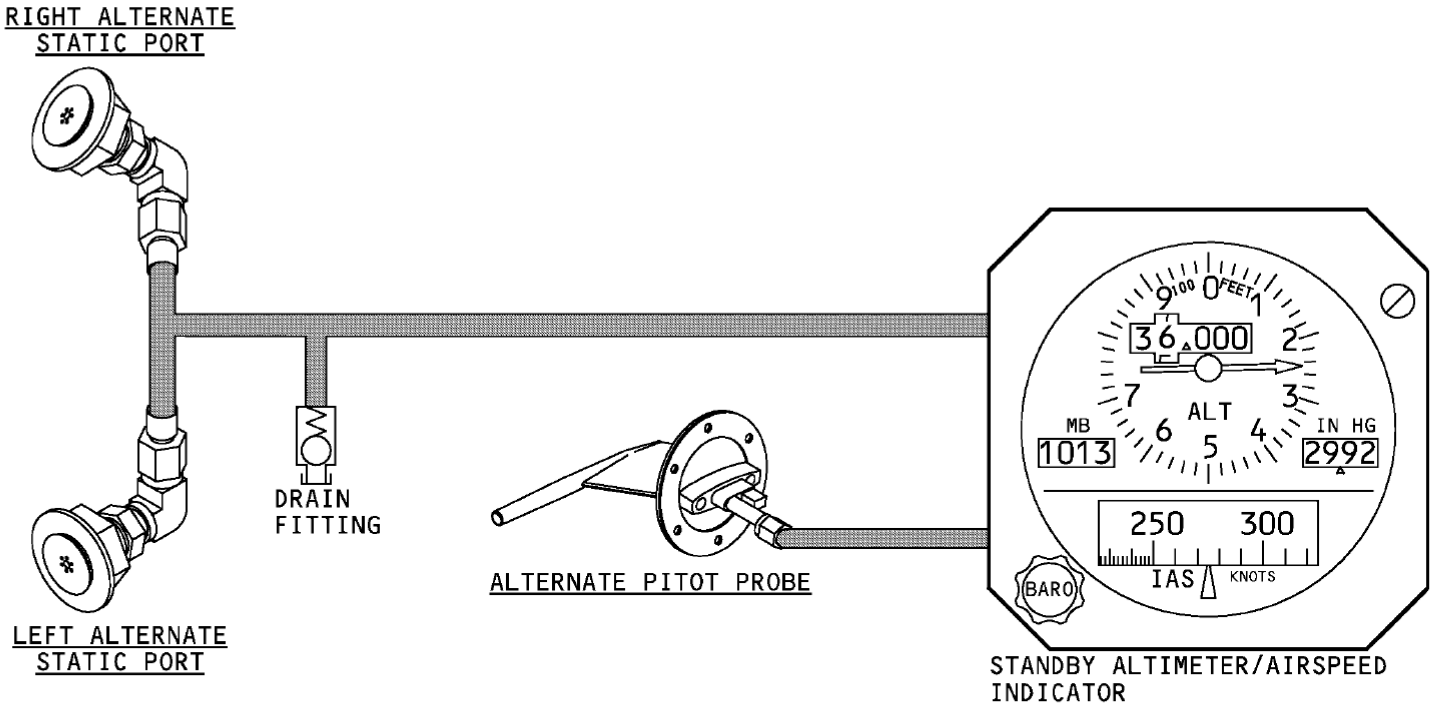
GENERAL DESCRIPTION

General

The standby altimeter/airspeed indicator is two flight instruments in one component.

One instrument is a pneumatic altimeter. It gets static air pressure from the alternate static ports and shows barometric altitude.

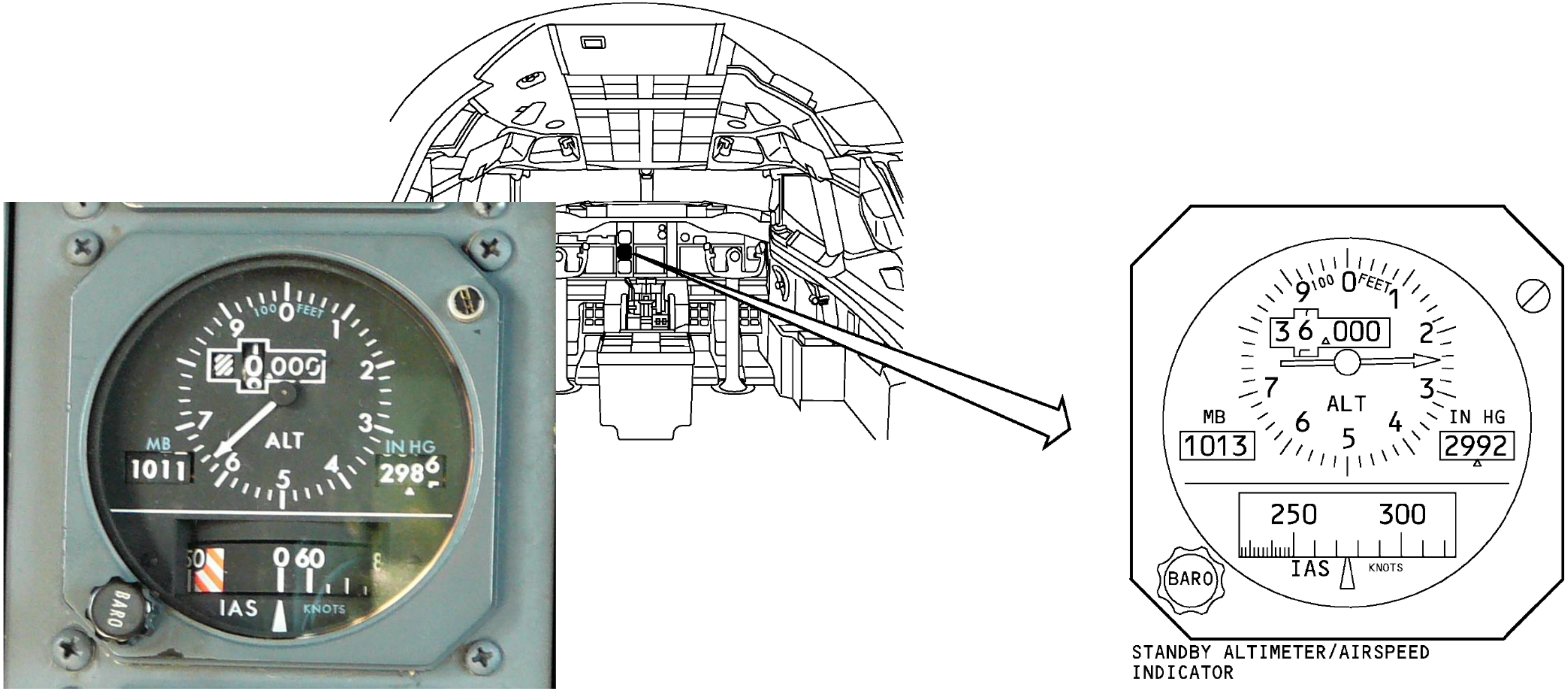
The other instrument is a pneumatic airspeed indicator. This indicator gets pitot air pressure from the alternate pitot probe and static air pressure from the alternate static ports to show the indicated air speed.



AIR DATA INSTRUMENTS - GENERAL

COMPONENT LOCATION

The standby altimeter/airspeed indicator is in the flight compartment on the P2 Central instrument panel.



STANDBY ALTIMETER/AIRSPEED INDICATOR - LOCATION

STANDBY ALTIMETER/AIRSPEED INDICATOR

The standby altimeter/airspeed indicator shows air data information such as barometric altitude and indicated airspeed. The standby altimeter/airspeed indicator receives pitot pressure from the alternate pitot probe. It also receives static pressure from the alternate static ports.

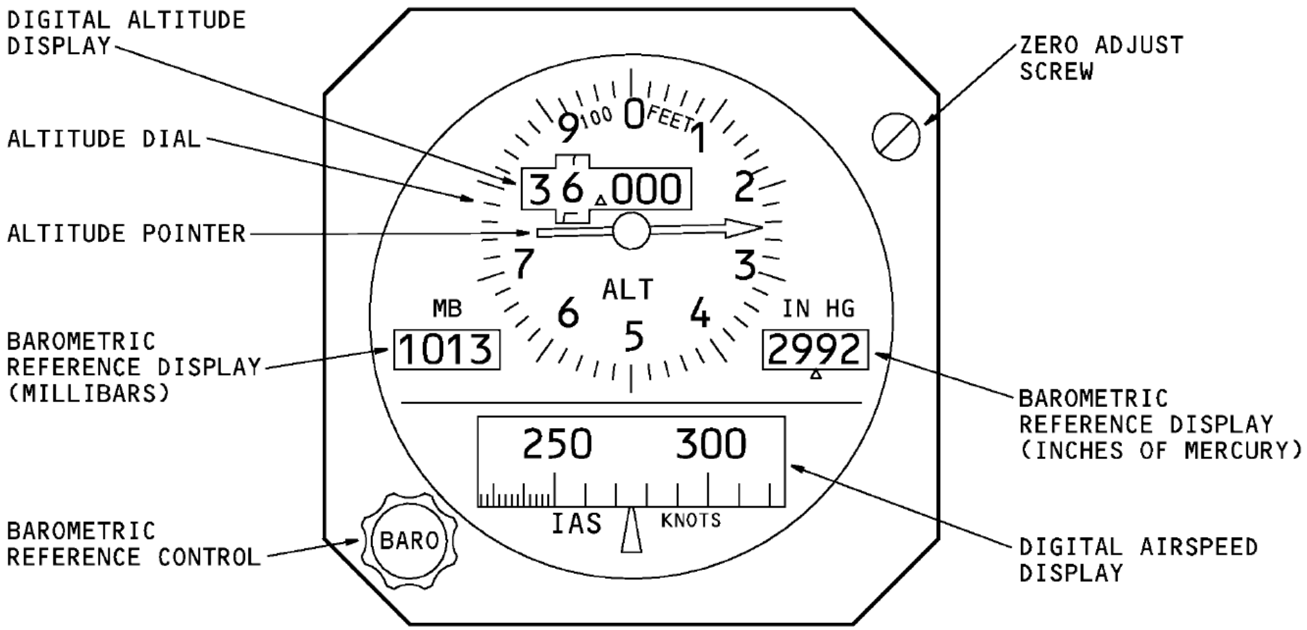
Operation

The digital altitude display shows barometric altitude from -1000 to 50000 feet in thousands of feet. The altitude dial and pointer show altitude in 20 foot increments. One turn of the pointer is equal to 1000 feet.

Barometric pressure reference in inches of mercury (in Hg) and millibars (mb) shows on the indicator. Rotate the barometric reference control knob to set the barometric pressure reference. It is adjustable from 745 to 1049.5 mb and from 22.00 to 30.99 in Hg.

The zero adjust screw lets you adjust the altitude without changing the barometric reference settings.

The digital airspeed display shows airspeed from 60 to 450 knots. A drum, graduated in knots, shows the indicated airspeed.



STANDBY ALTIMETER/AIRSPEED INDICATOR

INTERFACE

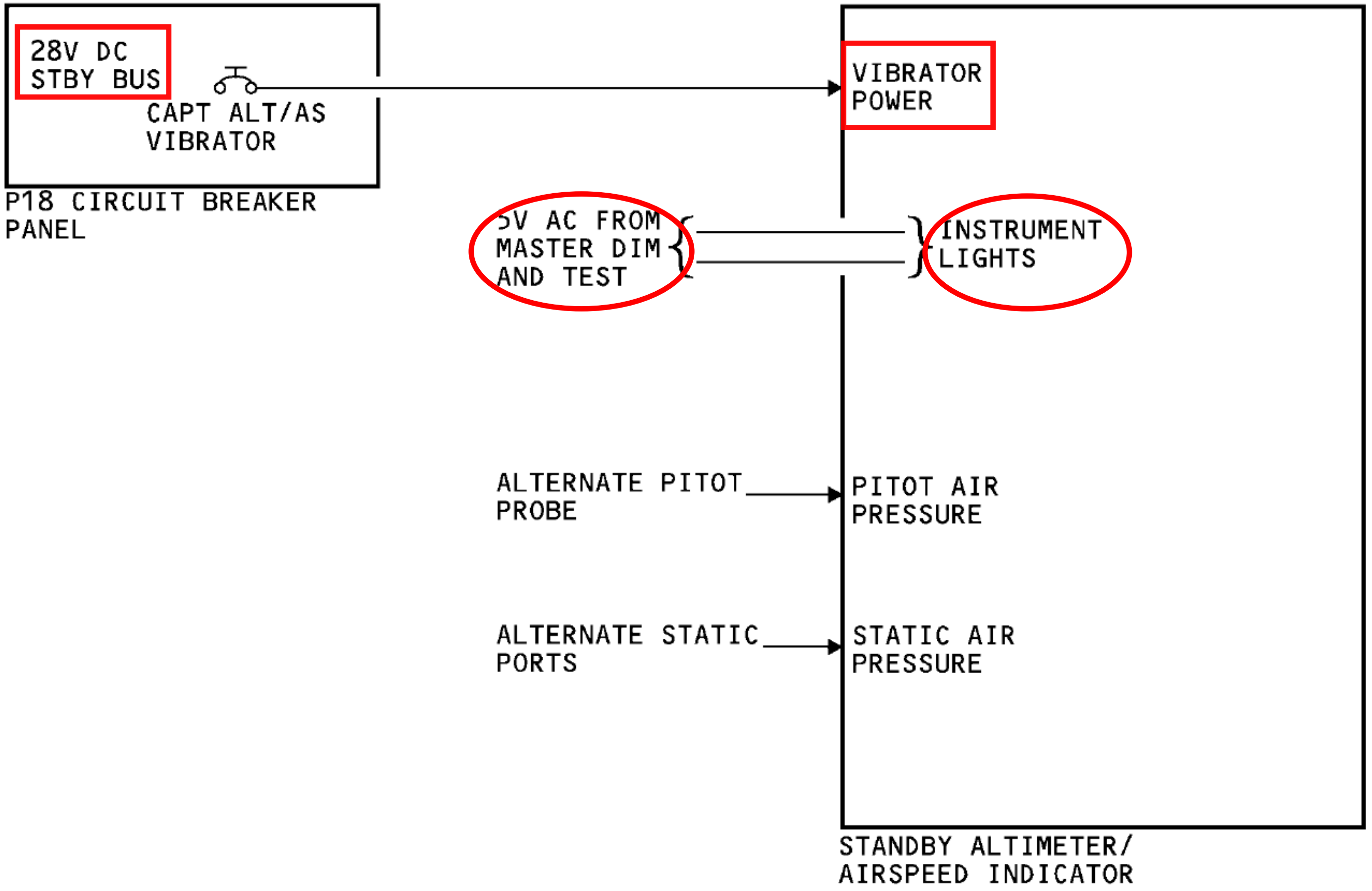
Power

The vibrator in the standby altimeter/airspeed indicator gets 28v dc from the dc standby bus, through the CAPT ALT/AS VIBRATOR circuit breaker.

The indicator gets 5v ac for the internal instrument lights from the master dim and test circuit.

Pitot-Static Interface

The alternate pitot probe sends pitot air pressure to the standby altimeter/airspeed indicator. The alternate static ports send static air pressure to the indicator.



INTERFACE

FUNCTIONAL DESCRIPTION

The standby altimeter/airspeed indicator consists of these two pneumatic instruments:

- Standby altimeter
- Standby airspeed indicator.

Standby Altimeter

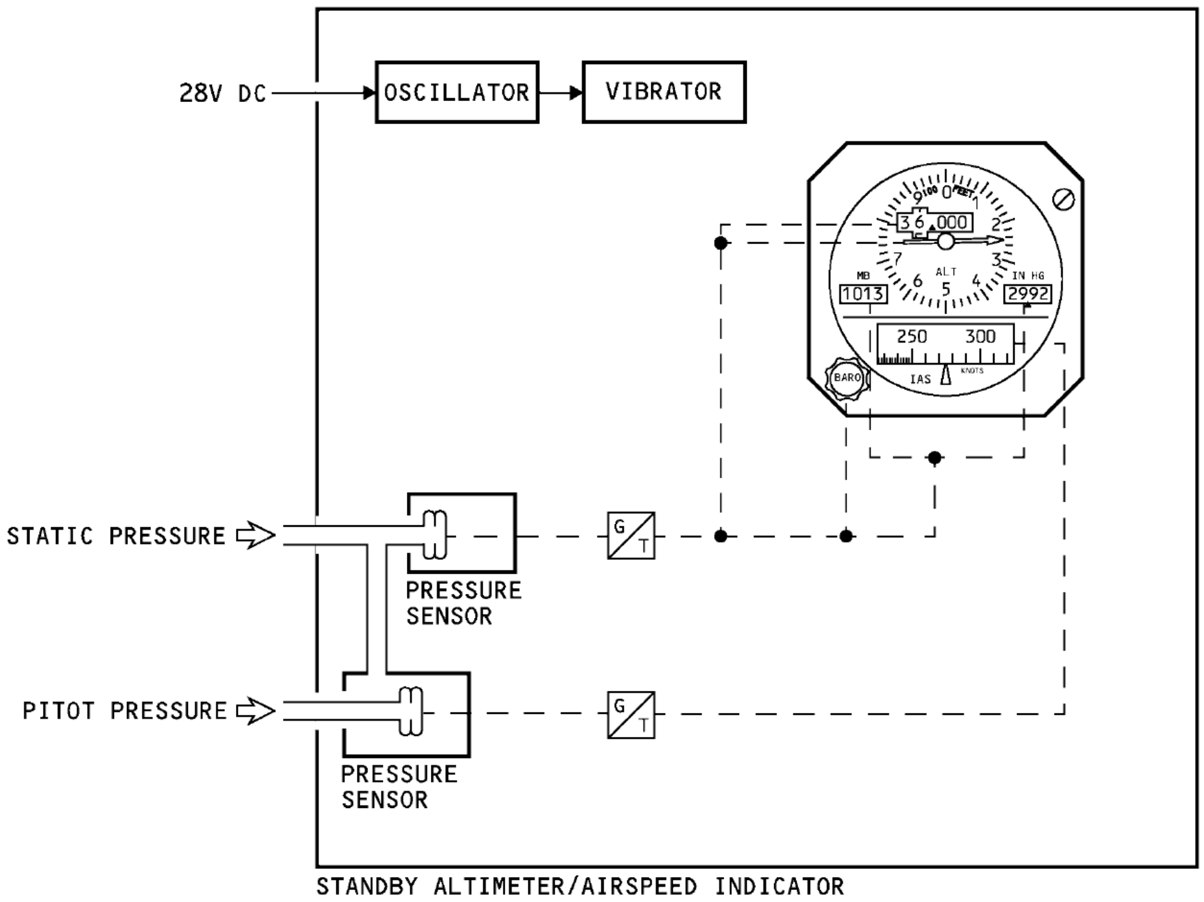
A vibrator is on the instrument frame to reduce friction errors in the mechanical linkage and to improve indicator response. The vibrator receives 28 volts dc power from the 28v dc standby bus.

The standby altimeter gets static pressure from the two alternate static ports. The pressure sensor moves in response to the static pressure change. The sensor drives the altitude gear train which connects mechanically to the altitude counter and pointer.

Rotating the BARO set knob on the front panel corrects for local changes in barometric pressure.

Standby Airspeed Indicator

The indicator mechanism has two pressure ports. One port is for static pressure and the other port is for pitot pressure. The pressure sensor expands and contracts with changes in the pitot-static pressure. The movement is transmitted to a counter to indicate airspeed.



STANDBY ALTIMETER/AIRSPEED INDICATOR – FUNCTIONAL DIAGRAM

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–16. OVERSPEED WARNING (ATA34-16)

LEVEL 3

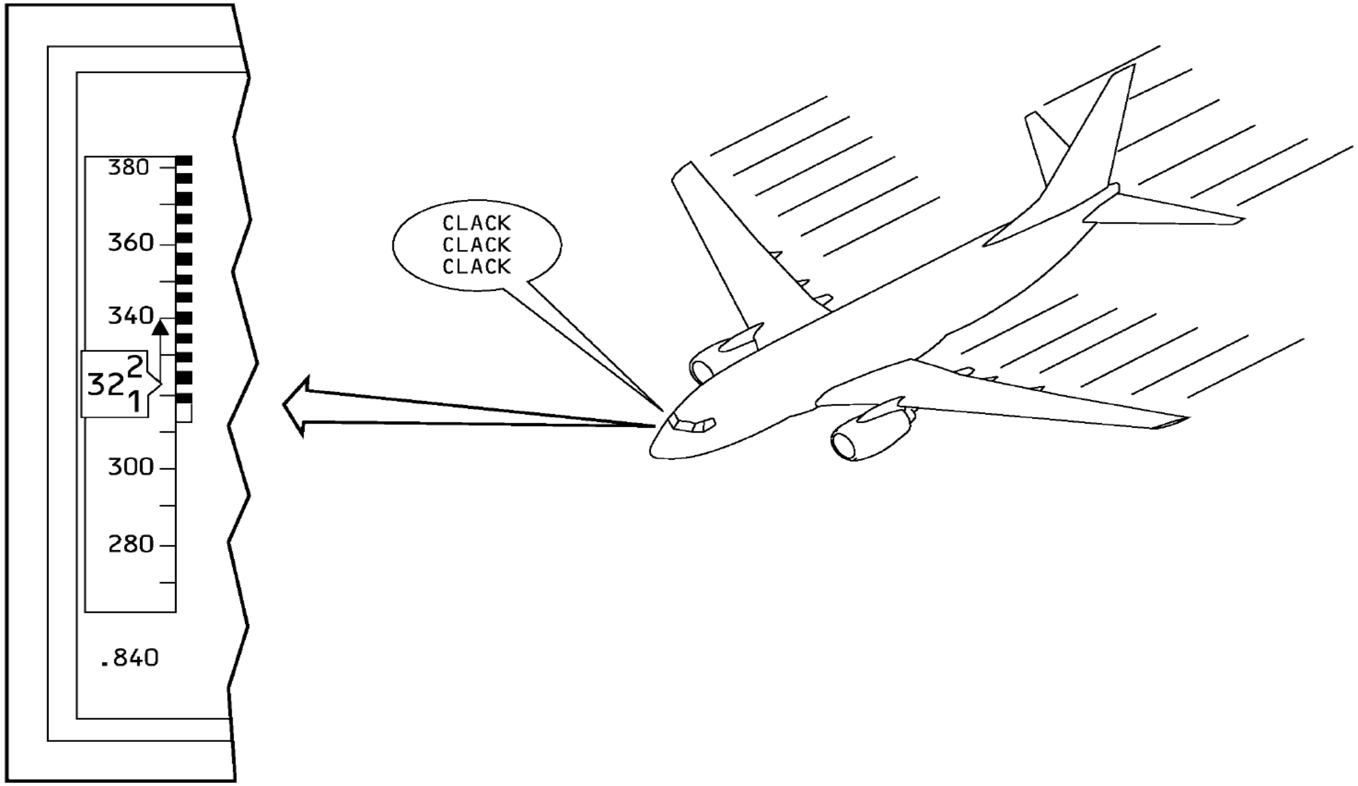
INTRODUCTION

The 737 has an airspeed and a mach limit to protect the airframe. The mach airspeed warning system gives an aural warning that tells the flight crew when the airspeed is more than the mach or airspeed limit.

The airplane maximum operating limit speed (VMO) is 340 kts when the airplane is at or below an altitude of 25,968 ft. Above this altitude, the airplane is limited by mach number. The maximum operating mach (MMO) is 0.82.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- ADM - air data module
- CAPT - captain
- FO - first officer
- MMO - maximum operating mach
- VMO - maximum operating limit speed
- kts – knots



OVERSPEED WARNING

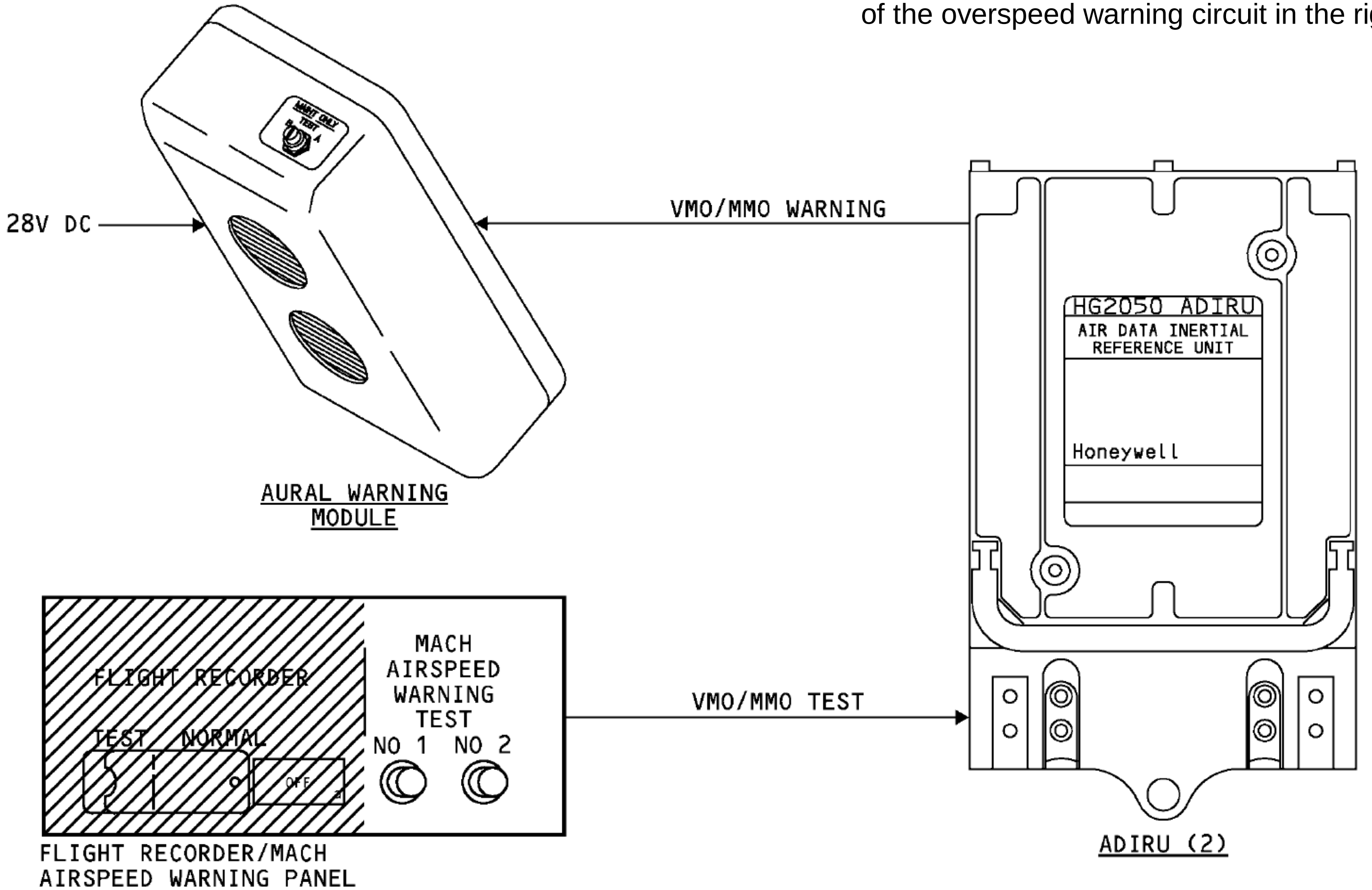
GENERAL DESCRIPTION

VMO/MMO Overspeed Warning

The mach airspeed warning system gets the overspeed warning signal from an ADIRU. The signal means that the airspeed is more than the maximum operating limit speed (VMO) or the maximum operating mach (MMO). This signal turns on the clacker sound in the aural warning module.

Test

The mach airspeed warning system has a mach airspeed warning test switch. It is part of the flight recorder/mach airspeed warning panel. Push one of the two mach airspeed warning test switches to start the clacker sound in the aural warning module. Test switch No. 1 does a test of the overspeed warning circuit in the left ADIRU. Test switch No. 2 does a test of the overspeed warning circuit in the right ADIRU.

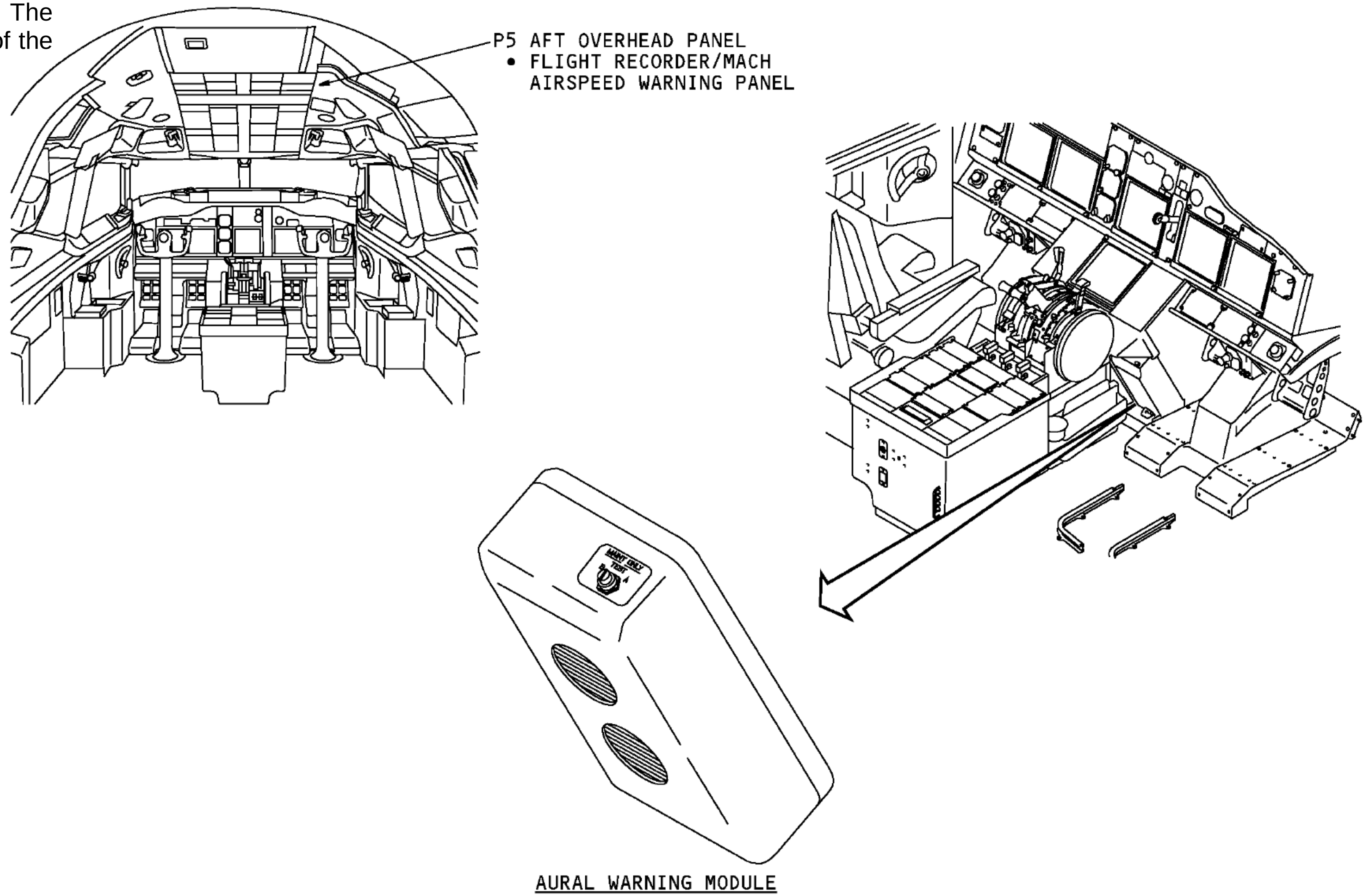


GENERAL

COMPONENT LOCATION

Aural warning module

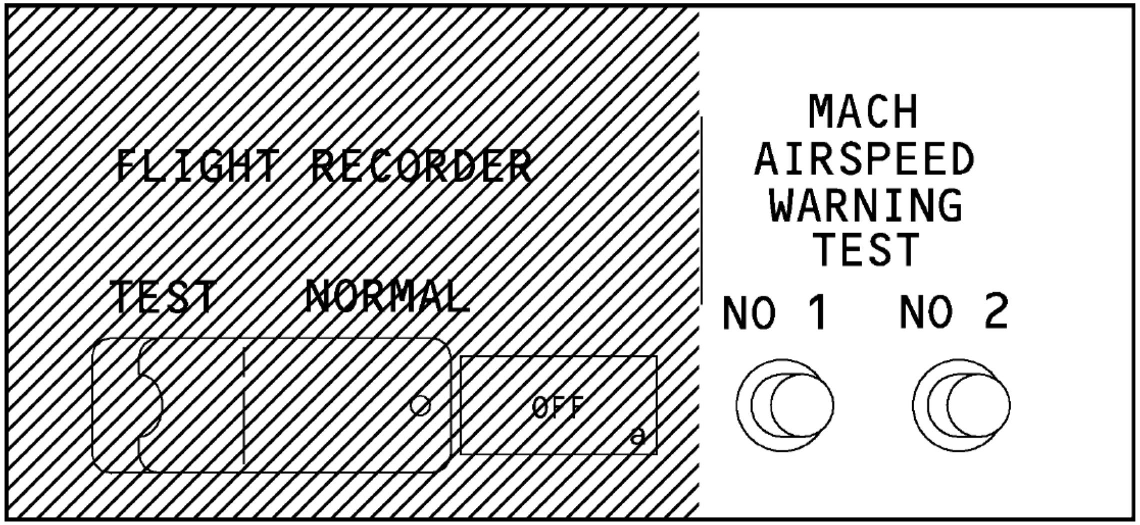
The flight recorder/mach airspeed warning panel is on the aft overhead pane P5l. The aural warning module is on the bottom of the forward electronics panel



COMPONENT LOCATION – AURAL WARNING BOX

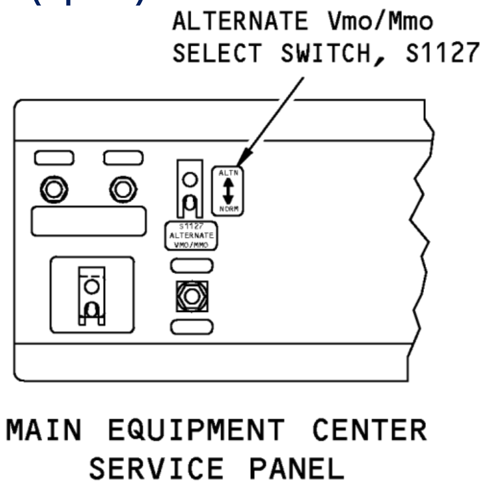
Mach airspeed warning test switches

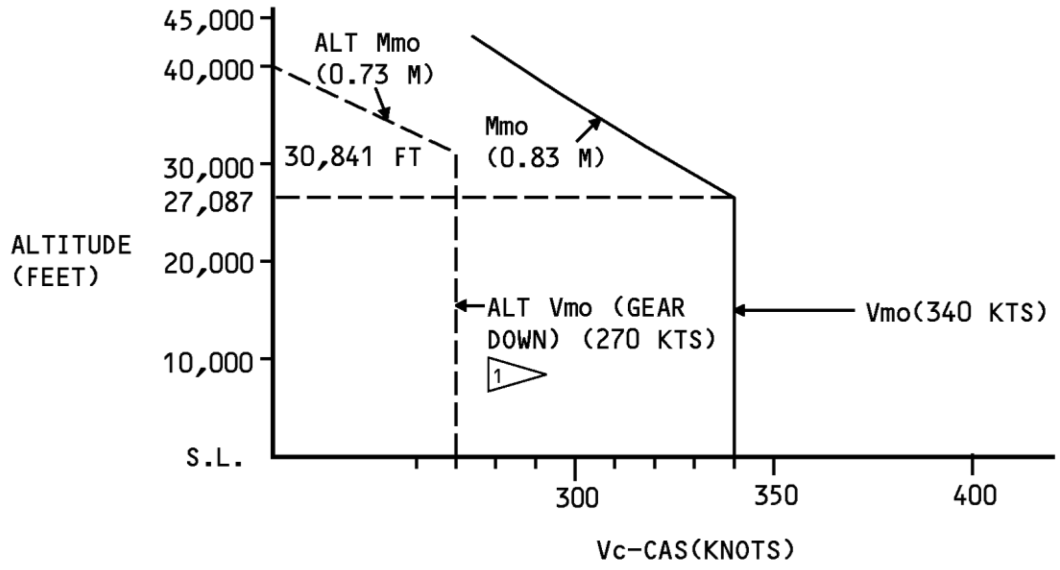
There are two mach airspeed warning test switches. They are momentary push switches. When you push the test switch, a ground discrete goes to the air data inertial reference unit (ADIRU).



COMPONENT LOCATION - TEST SWITCHES

ALTERNATE VMO/MMO SWTICH (Option)





The ALTERNATE VMO/MMO get the signal from the ALTERNATE VMO/MMO SWITCH(Gear Down Dispatch Switch).
The ALTERNATE VMO/MMO switch input is provided to the ADIRU. When the switch is pushed up to the ALTERNATE position, the ADIRU adjusts the Vmo/Mmo curve to compensate for a flight with the landing gear down.

The ALTERNATE VMO/ MMO is located in the E/E bay on the Main Equipment Center Service Panel.

NORMAL Vmo/Mmo OVERSPEED DISCRETE ACTUATION POINTS
Vc≥341 ± 0.25 KNOTS
Mc≥0.823 ± 0.0005 MACH

ALTERNATE Vmo/Mmo OVERSPEED SWITCH ACTUATION POINTS
Vc ≥ 271.0 ± 0.25 KNOTS
Mc ≥ 0.742 ± 0.0005 MACH

Vmo = MAX OPERATING AIRSPEED
Vc = COMPUTED AIRSPEED OUTPUT, OF ACTUATION POINT, KNOTS
Mc = MACH NUMBER OUTPUT OF ACTUATION POINT
Mmo = MAX OPERATING MACH

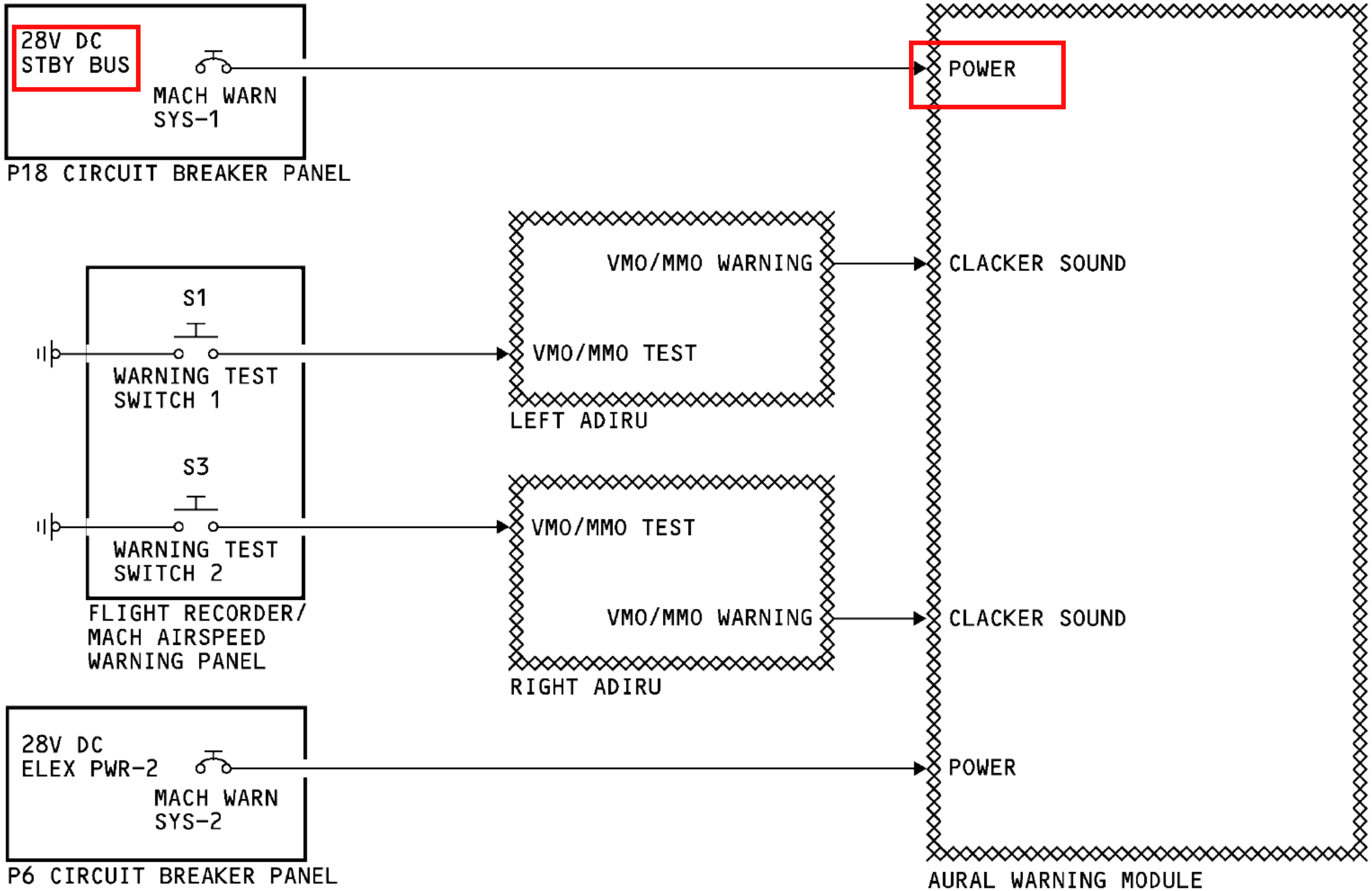
1315904 S0000229618_V2

ALTERNATE VMO/MMO SWTICH

INTERFACE

28v dc power goes to the aural warning module.
When you push the test switch, a ground discrete goes to the air data inertial reference unit (ADIRU).

The ADIRU sends an overspeed signal to the aural warning module. The aural warning module makes the clacker sound. Test switch 1 goes to the left ADIRU and test switch 2 goes to the right ADIRU.



INTERFACE

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34-20. NAVIGATION (ATA 34)

LEVEL 3

THIS PAGE IS INTENTIONALLY LEFT BLANK

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34 – 21. AIR DATA INERTIAL REFERENCE SYSTEM(ATA 34 – 21)

LEVEL 3

ADIRS - INTRODUCTION

Purpose

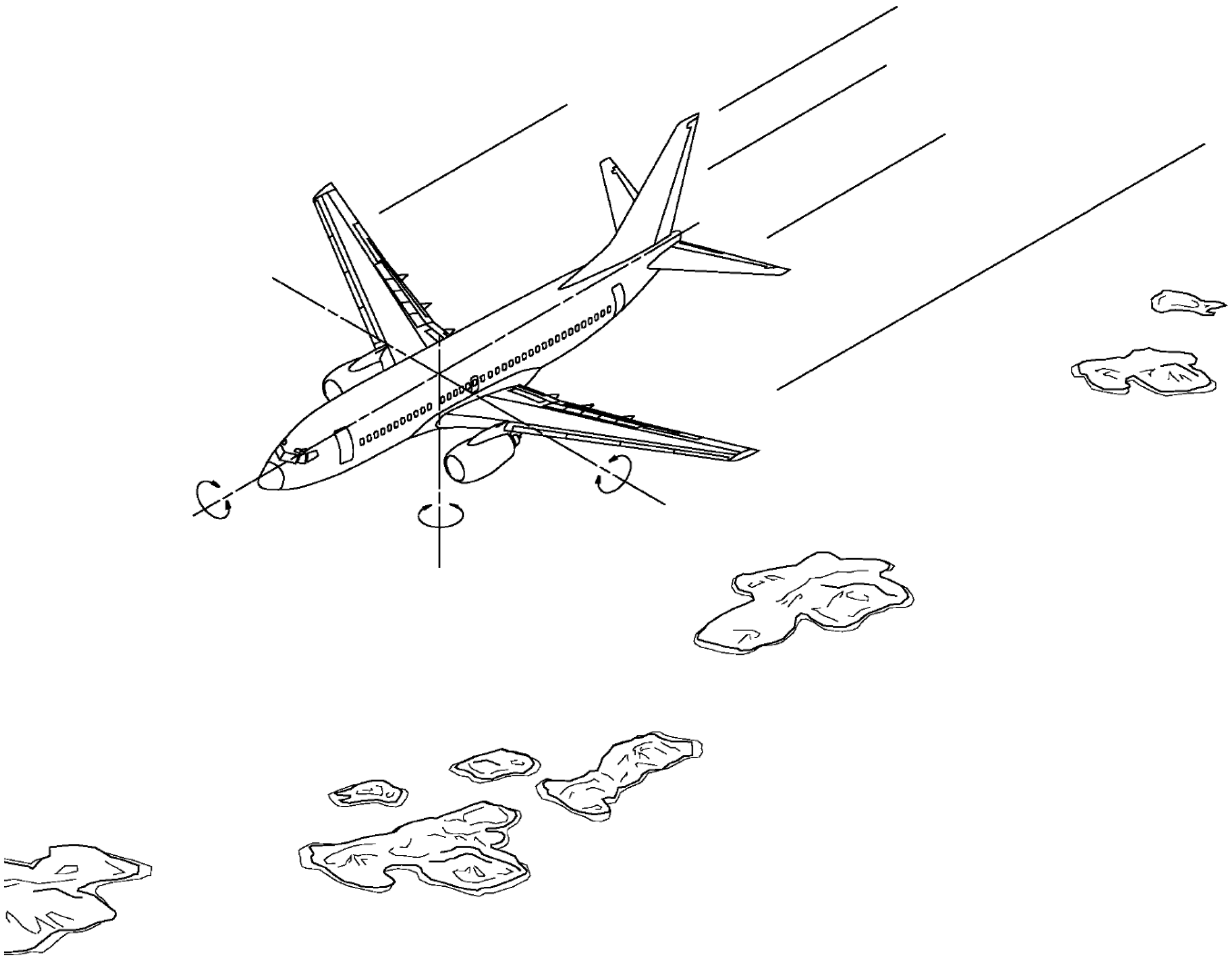
The air data inertial reference system (ADIRS) has two primary functions:

- Air data reference (ADR)
- Inertial reference (IR).

The ADR function calculates airspeed and barometric altitude.

The IR function calculates this data:

- Attitude
- Present position
- Groundspeed
- Heading.



AIR DATA INERTIAL REFERENCE SYSTEM - INTRODUCTION

ADIRS - GENERAL DESCRIPTION

General

The air data inertial reference system (ADIRS) supplies these type of data to the aircrew and to the airplane systems:

- Altitude
- Airspeed
- Temperature
- Heading
- Attitude
- Present position.

The ADIRS has these components:

- Air data modules (ADMs) (4)
- Total air temperature (TAT) probe
- Angle of attack (AOA) sensors (2)
- Inertial system display unit (ISDU)
- Mode select unit (MSU)
- Air data inertial reference unit (ADIRU) (2)
- IRS master caution unit.

Functional Description

The TAT probe measures the outside air temperature. It changes the temperature value to an electrical signal. The electrical signal goes to the ADIRUs.

The AOA sensors measure and convert angle of attack to electrical signals. The electrical signals go to the ADIRUs.

The ISDU supplies initial position and heading data to the ADIRUs.

It also supplies this data to the flight crew:

- Present position
- Heading
- Navigation
- Performance
- Status.

The MSU gives mode selection data to the ADIRUs. It also shows system operational and fault status to the flight crew.

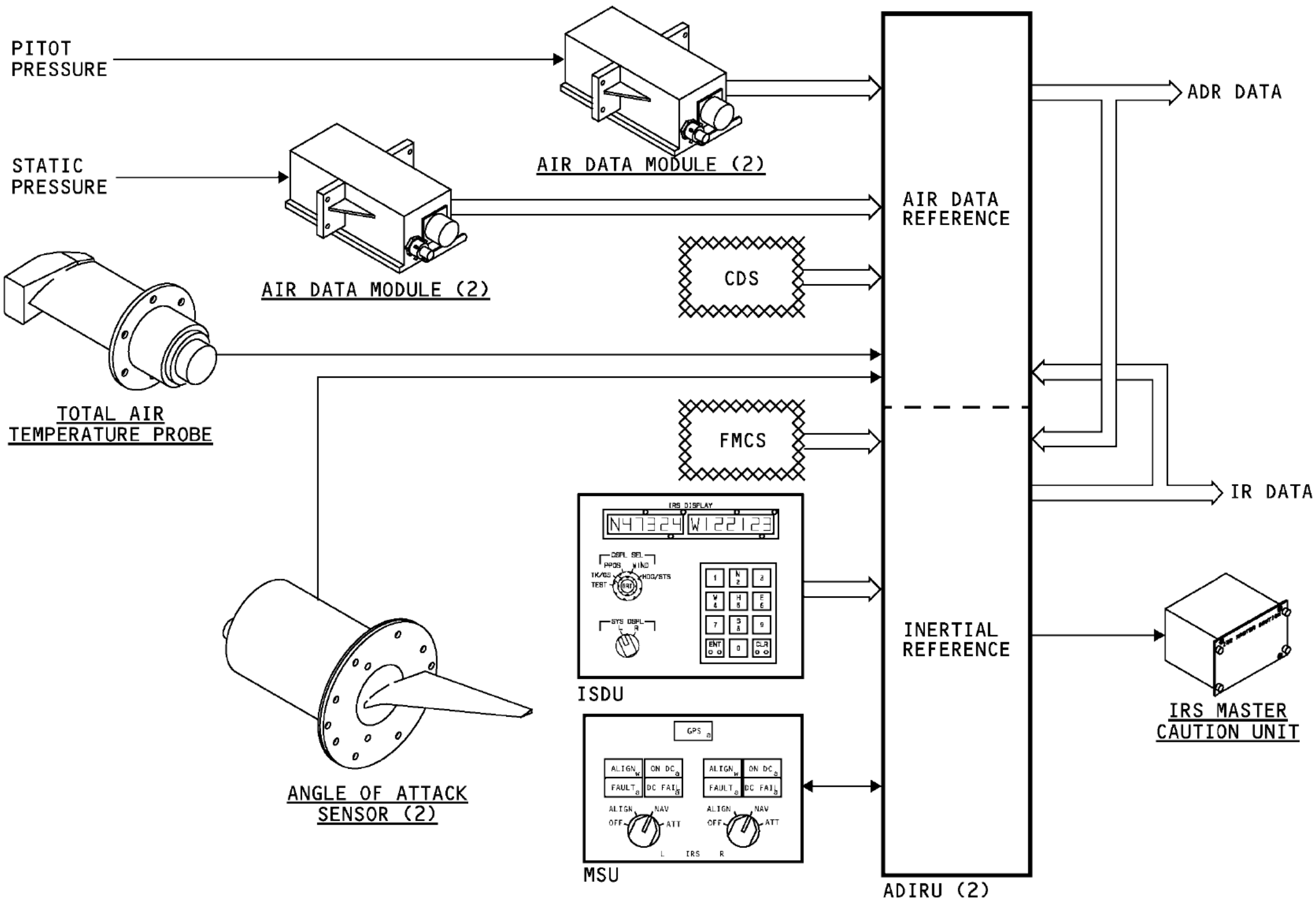
The two ADIRUs calculate and send air data and inertial reference information on ARINC 429 data buses. Each ADIRU has two parts. One part is the air data reference (ADR) part. The other is the inertial reference (IR) part.

The ADIRUs use these inputs to calculate air data:

- Pitot pressure
- Static pressure
- Total air temperature
- Angle of attack
- Common display system (CDS) barometric correction
- IR data.

Each ADIRU uses three accelerometers and three laser gyros to calculate inertial reference (IR) data. Initial present position information goes to the ADIRUs from the ISDU, or the flight management computer system (FMCS).

The IRS master caution unit sends fail discretes to the flight compartment master caution system.



GENERAL DESCRIPTION

COMPONENT LOCATION 1

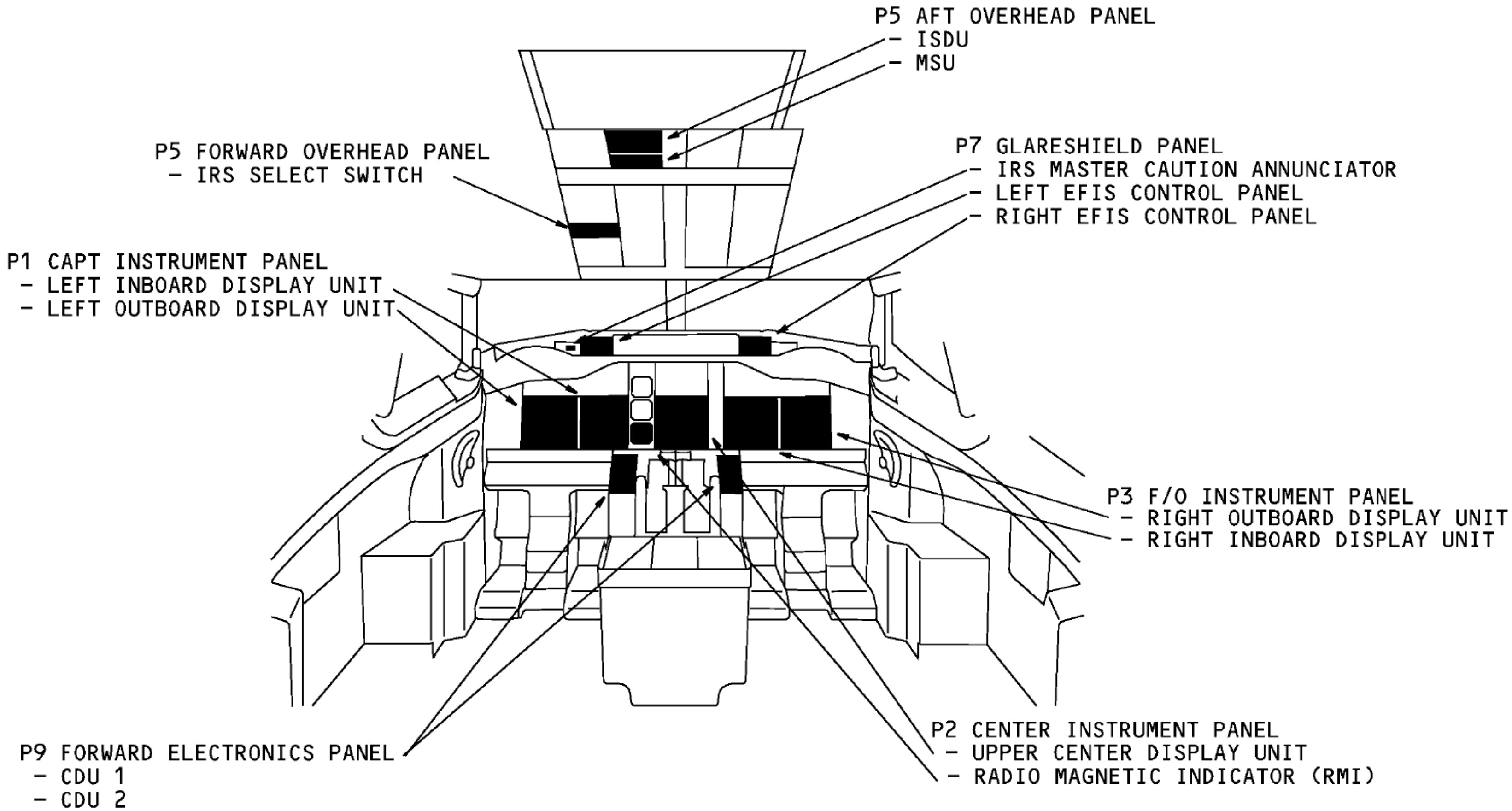
Flight compartment

These are the ADIRS components in the flight compartment:

- Inertial system display unit (ISDU)
- Mode select unit (MSU)
- IRS master caution annunciator.

These are the components in the flight compartment that have an interface with the ADIRS:

- Left inboard and outboard display units
- Right inboard and outboard display units
- Upper center display unit
- IRS select switch
- Control display unit (CDU) 1 and 2
- Radio magnetic indicator (RMI)
- Left and right EFIS control panels.

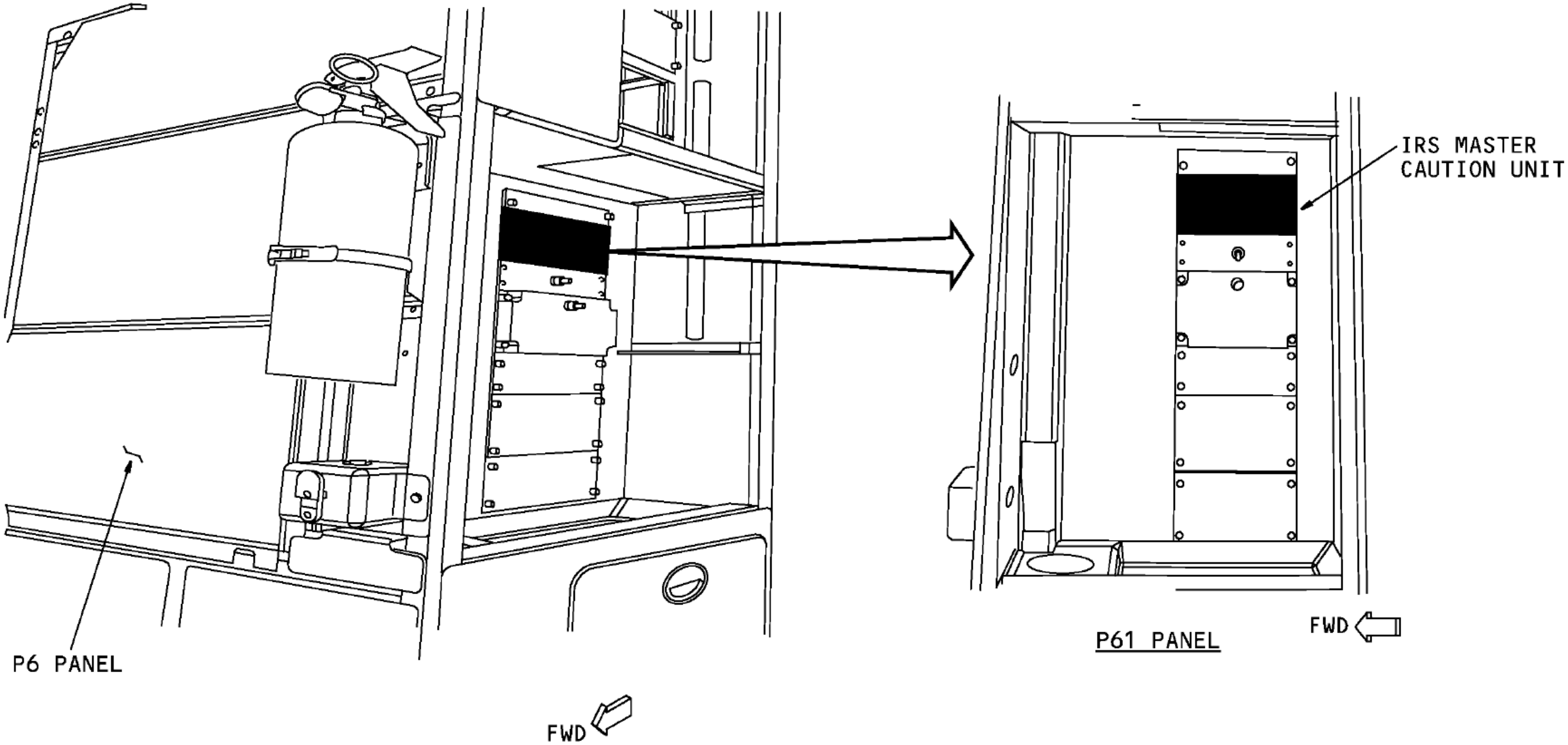


COMPONENT LOCATION – FLIGHT COMPARTMENT

COMPONENT LOCATION 2

IRS master caution unit

THE IRS master caution unit is in the flight compartment on the P61 panel.



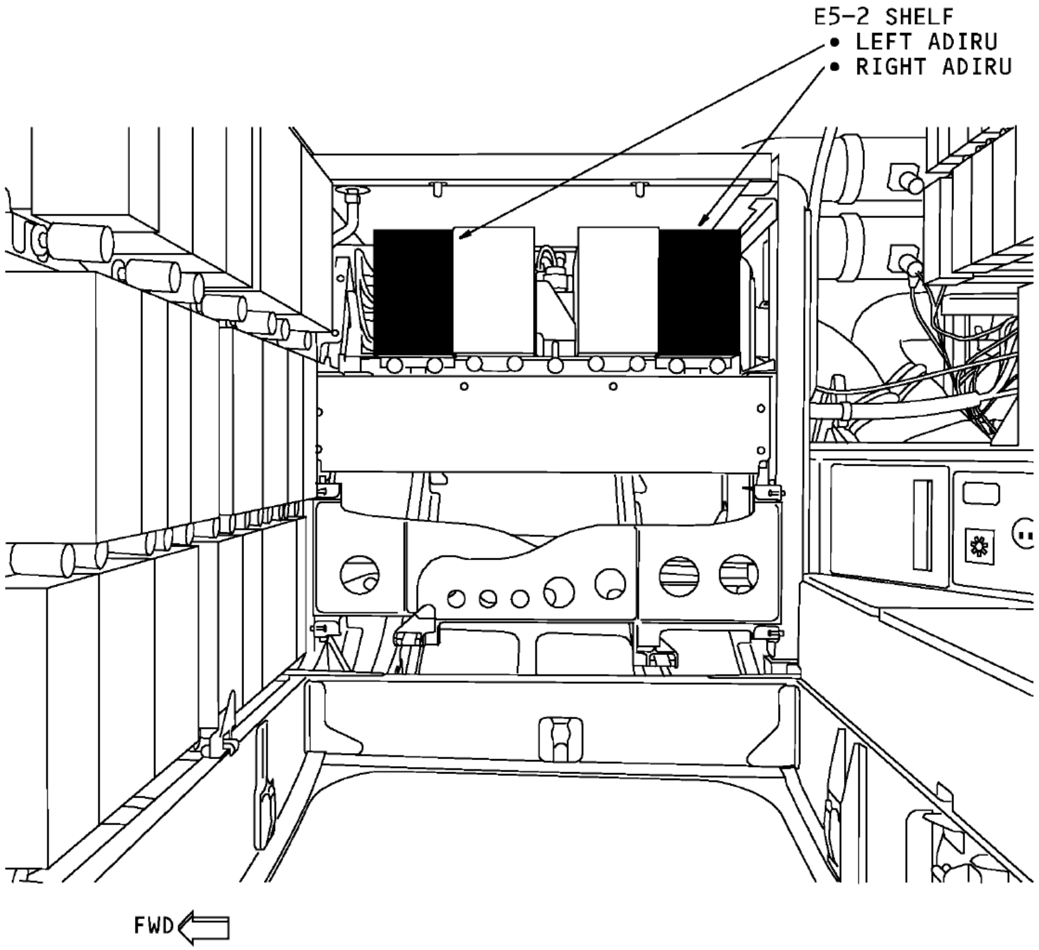
COMPONENT LOCATION – IRS MASTER CAUTION UNIT

COMPONENT LOCATION 3

EE compartment

These are the ADIRS components in the electronic equipment (EE) compartment:

- ➢ Left air data inertial reference unit (ADIRU)
- ➢ Right ADIRU.

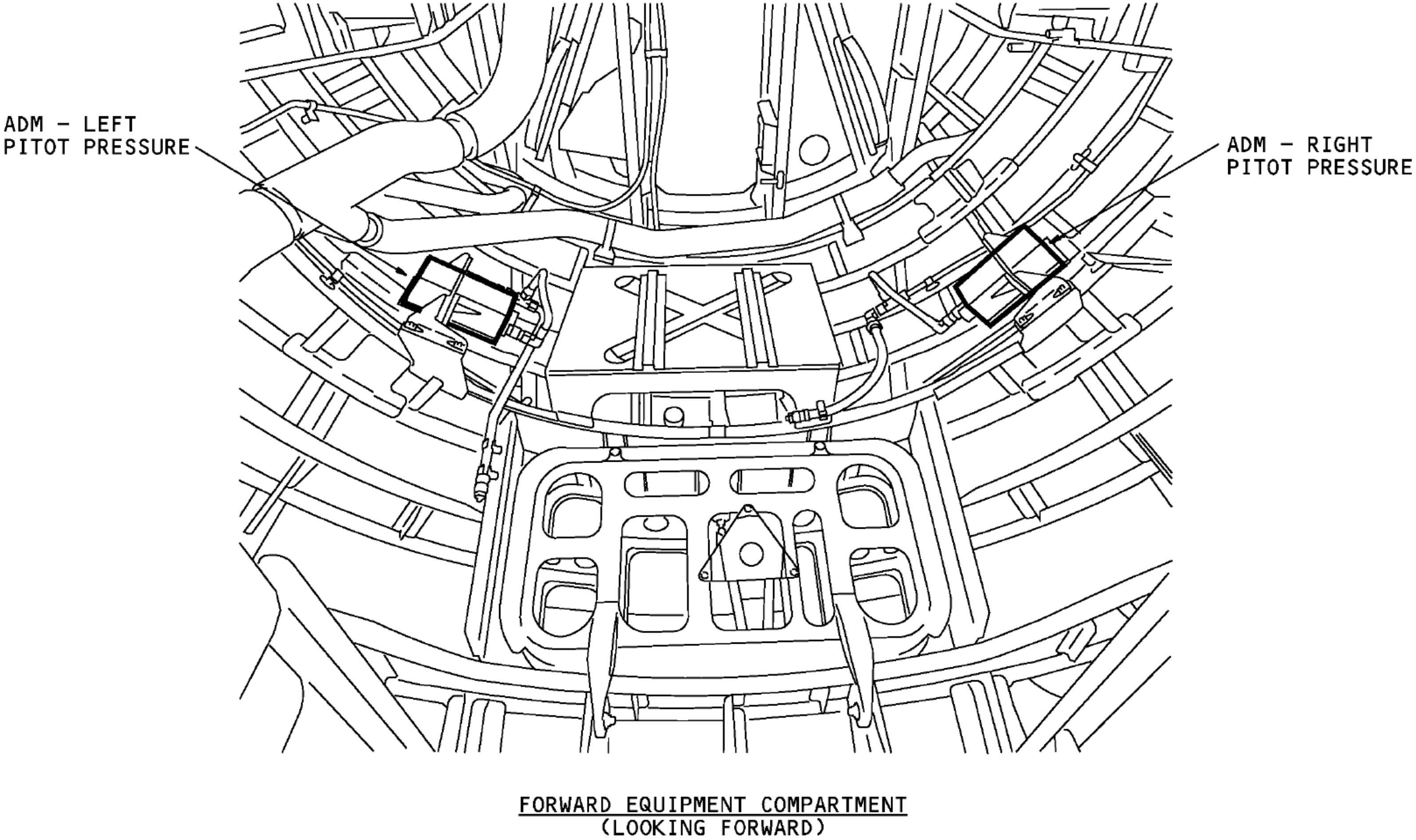


COMPONENT LOCATION – EE COMPARTMENT

COMPONENT LOCATION 4

Pitot air data modules

The pitot pressure air data modules (ADM) are in the forward equipment compartment.

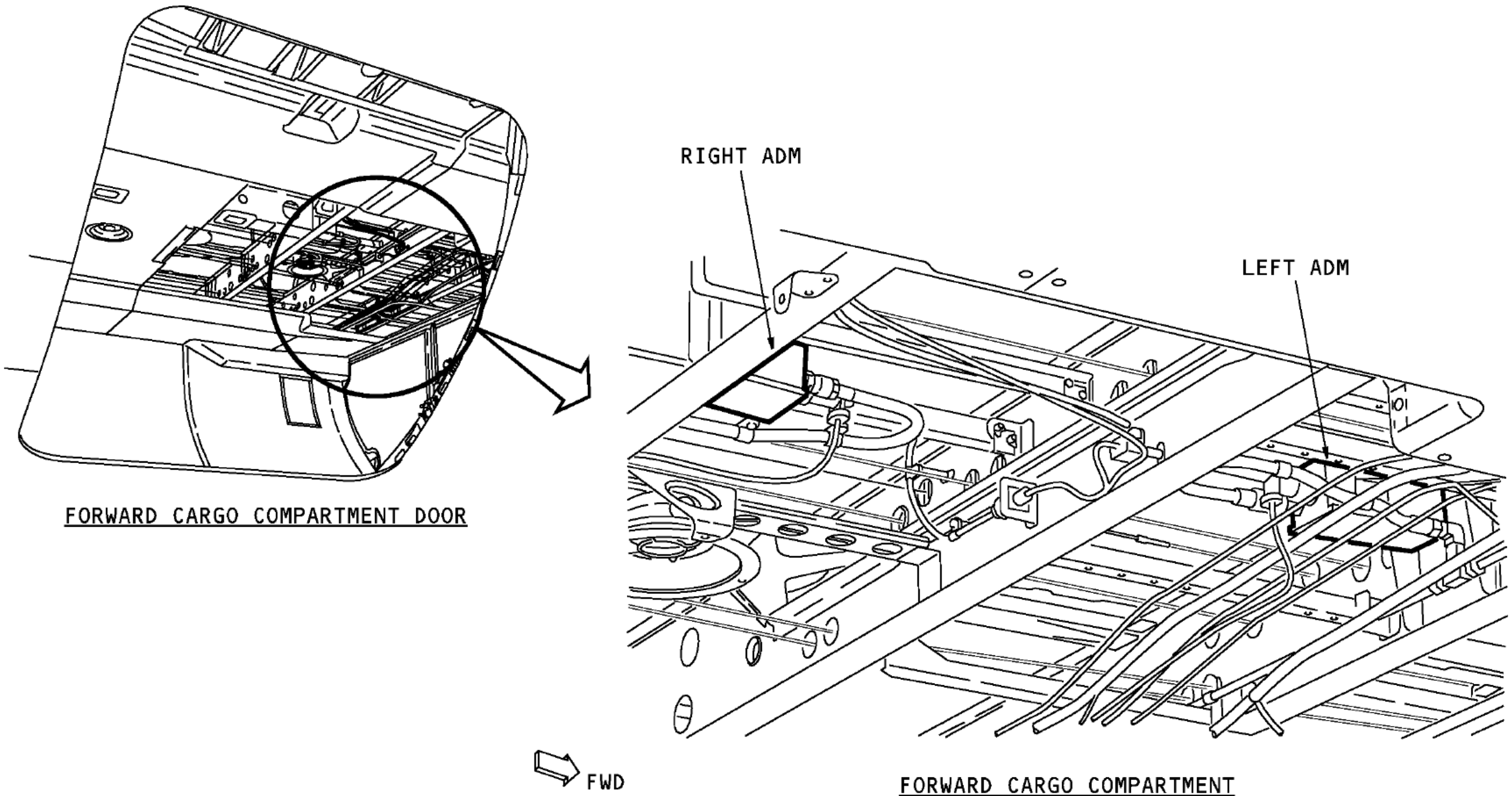


COMPONENT LOCATION – PITOT AIR DATA MODULES

COMPONENT LOCATION 5

Static air data modules

The static pressure ADMs are in the forward cargo compartment, above the ceiling panels.

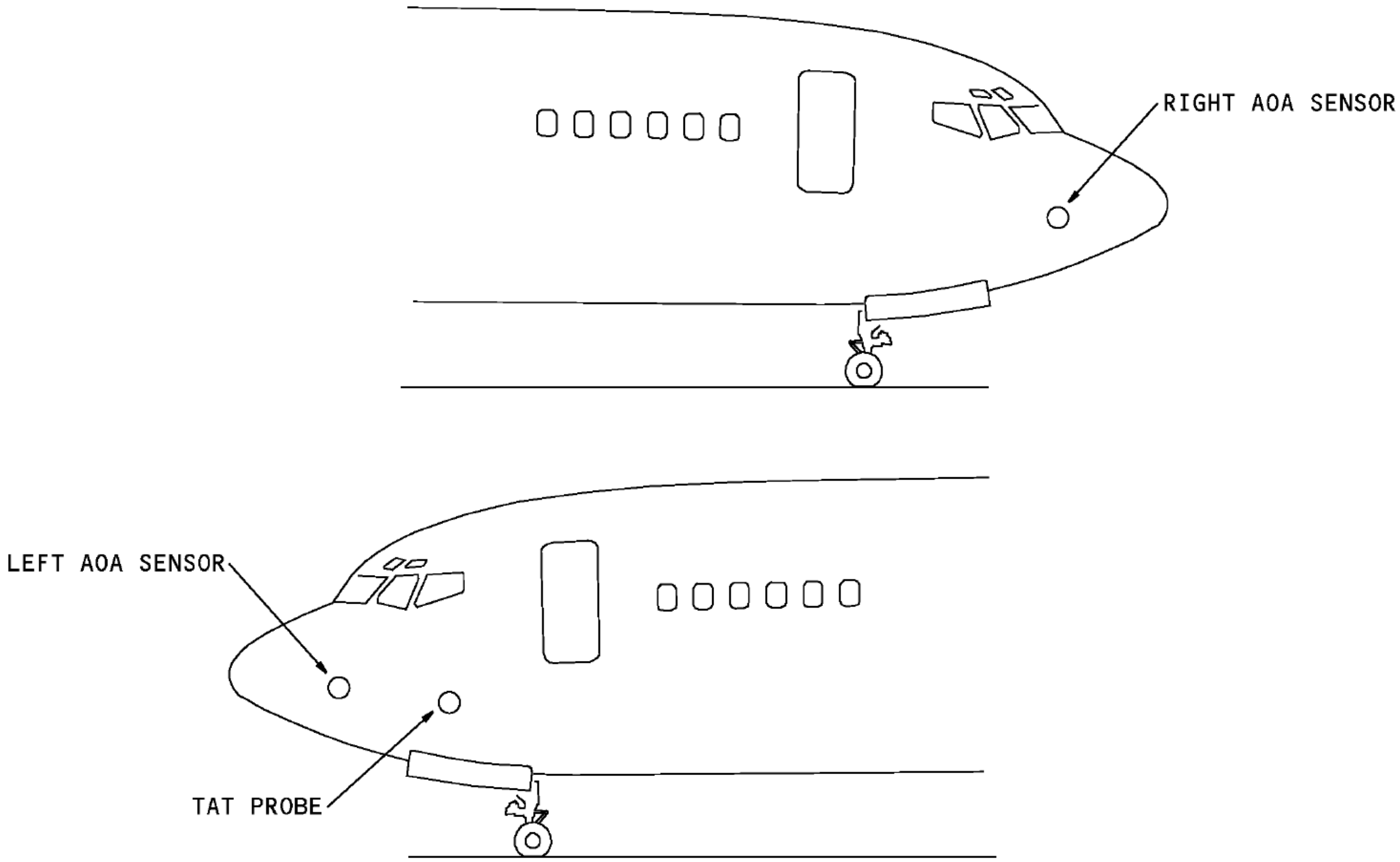


COMPONENT LOCATION – ATATIC AIR DATA MODULES

COMPONENT LOCATION 5

AOA sensors and TAT probe

The angle of attack (AOA) sensors are on both sides of the fuselage. The total air temperature (TAT) probe is on the left side.



COMPONENT LOCATION – AOA SENSORS AND TAT PROBE

ADIRS - POWER

ADIRU

The ADIRU operates with 115v ac or 28v dc. 115v ac is the normal power source.

Each ADIRU has a separate ac and dc power source.

The left ADIRU gets power from these buses:

- 115v ac stby bus
- 28v dc sw hot battery bus.

The right ADIRU gets power from these buses:

- 115v ac xfr bus 2
- 28v dc sw hot battery bus.

AC Reference Voltage

The 28v ac stby bus supplies a servo reference voltage to the left ADIRU and to the left angle of attack (AOA) sensor. The 28v ac xfr bus 2 supplies servo reference voltage to the right ADIRU and to the right AOA sensor.

Integrated Flight Systems Accessory Unit

The integrated flight systems accessory unit (IFSAU) gets ac power from the 115v ac xfr bus 2. DC power comes from the 28v dc sw hot bat bus. The IFSAU uses these inputs to control power going to the right ADIRU and to supply power to the crew call horn when the ADIRUs operate with dc power on the ground.

Air Data Modules

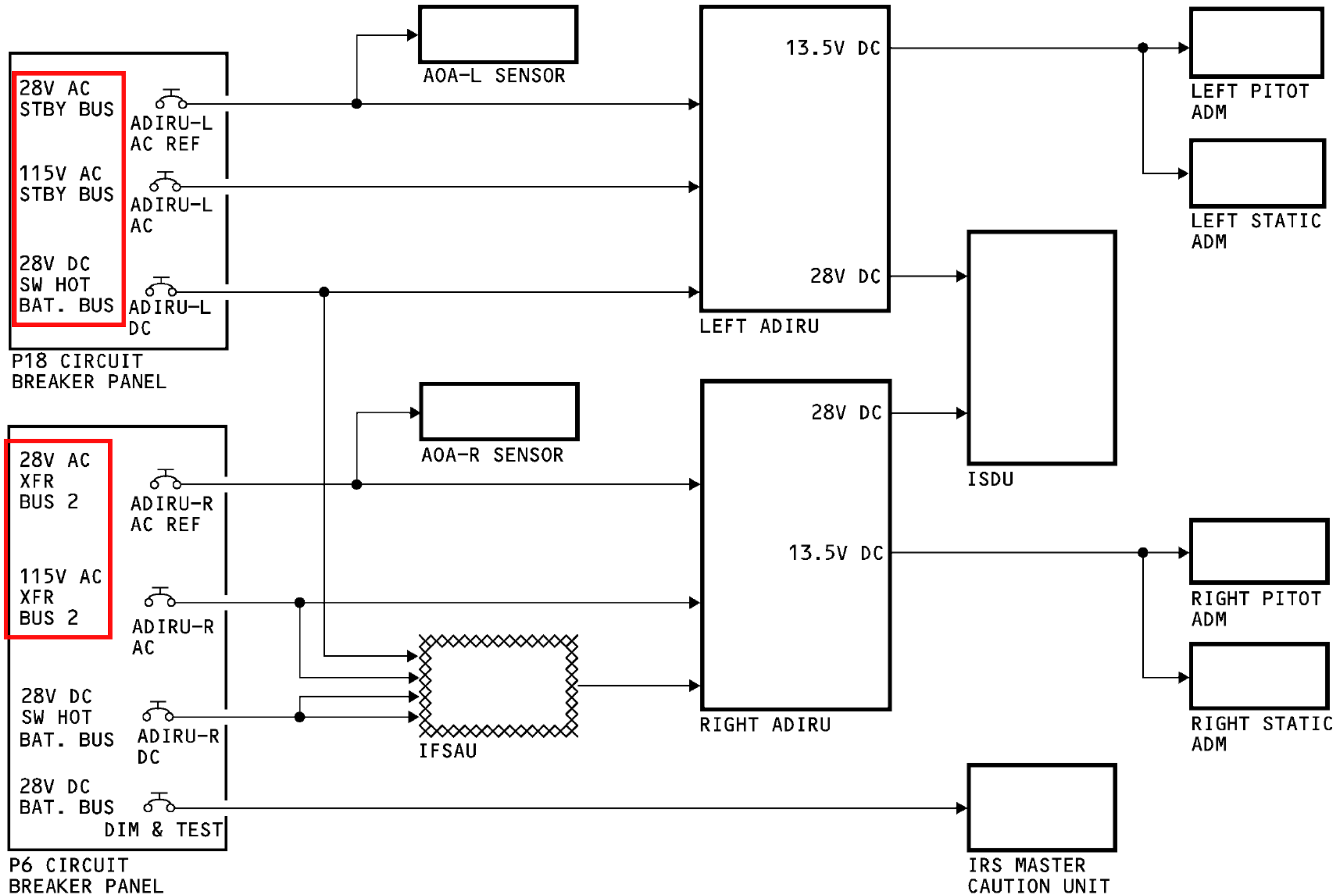
The left ADIRU supplies 13.5v dc to the left pitot ADM and to the left static ADM.
The right ADIRU supplies 13.5v dc to the right ADMs.

Inertial System Display Unit

The inertial system display unit (ISDU) gets 28v dc from the left and the right ADIRU.

IRS Master Caution Unit

The IRS master caution unit gets power from the 28v dc bat bus.


28V AC
STBY BUS
ADIRU-L
AC REF
115V AC
STBY BUS
ADIRU-L
AC
28V DC
SW HOT
BAT. BUS
ADIRU-L
DC
P18 CIRCUIT
BREAKER PANEL
AOA-L SENSOR
13.5V DC
28V DC
LEFT ADIRU
LEFT PITOT
ADM
LEFT STATIC
ADM
ISDU
AOA-R SENSOR
28V AC
XFR
BUS 2
ADIRU-R
AC REF
115V AC
XFR
BUS 2
ADIRU-R
AC
28V DC
SW HOT
BAT. BUS
ADIRU-R
DC
28V DC
BAT. BUS
DIM & TEST
P6 CIRCUIT
BREAKER PANEL
IFSAU
28V DC
13.5V DC
RIGHT ADIRU
RIGHT PITOT
ADM
RIGHT STATIC
ADM
IRS MASTER
CAUTION UNIT

ADIRS - POWER

DC POWER OPERATION

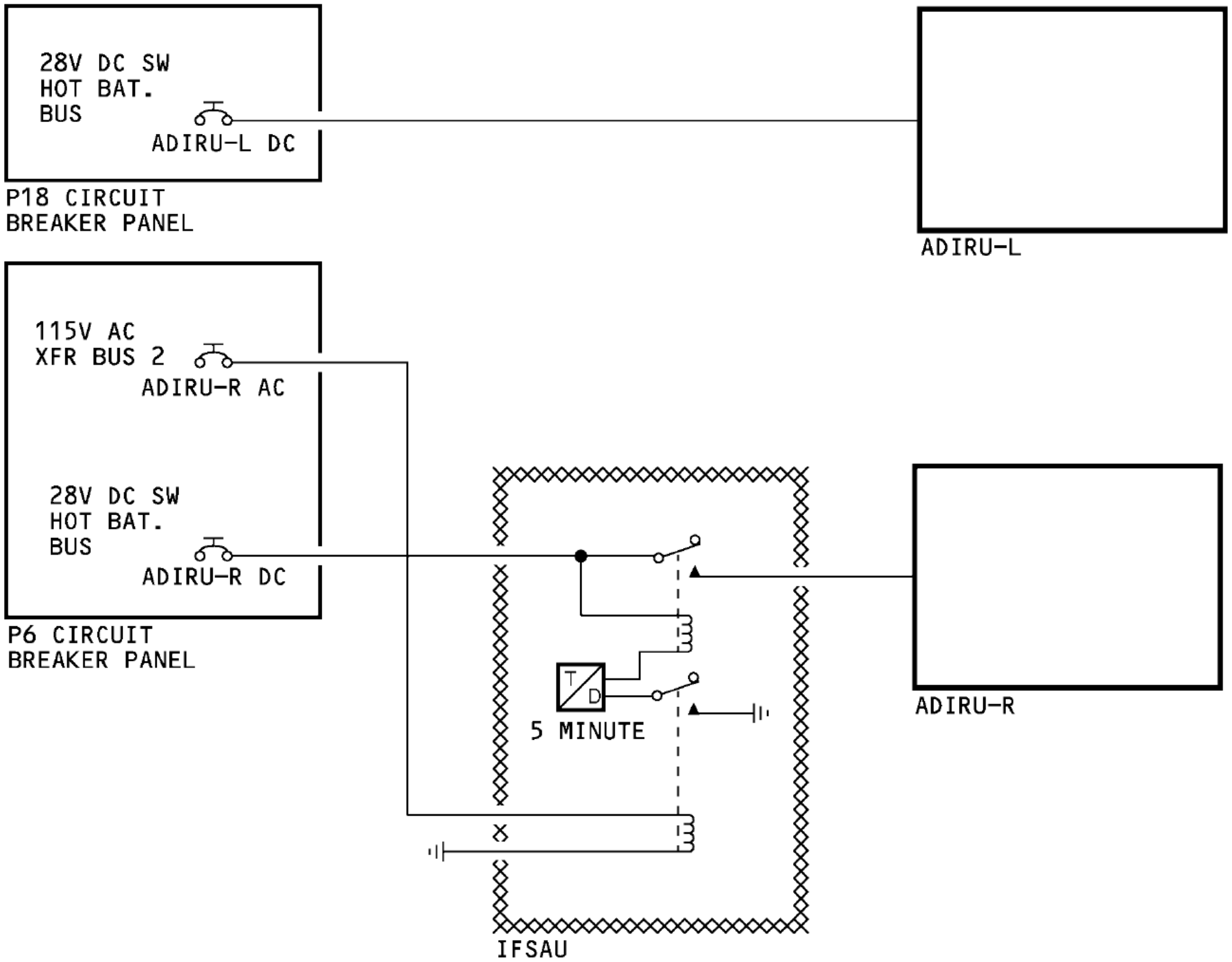
The ADIRUs operates with AC or DC power. AC power is the normal power source. If the AC power source is not available, DC power from the airplane battery will supply power to the ADIRUs.

Left ADIRU DC Operation

When AC power is not available, the left ADIRU will operate on DC power from the 28v dc sw hot battery bus. The left ADIRU will continue to operate on DC power until the battery power is less than 18v dc.

Right ADIRU DC Operation

DC power to the right ADIRU goes through a time delay circuit in the integrated flight systems accessory unit (IFSAU). When AC power is not available, a 5 minute time delay keeps the DC power relay energized, and the right ADIRU operates on DC power. After 5 minutes continuous operation on DC power, the time delay circuit deenergizes the relay and DC power to the right ADIRU is removed. This feature allows the airplane battery to drain at a slower rate.



DC POWER OPERATION

NO COOLING AND ON DC WARNING

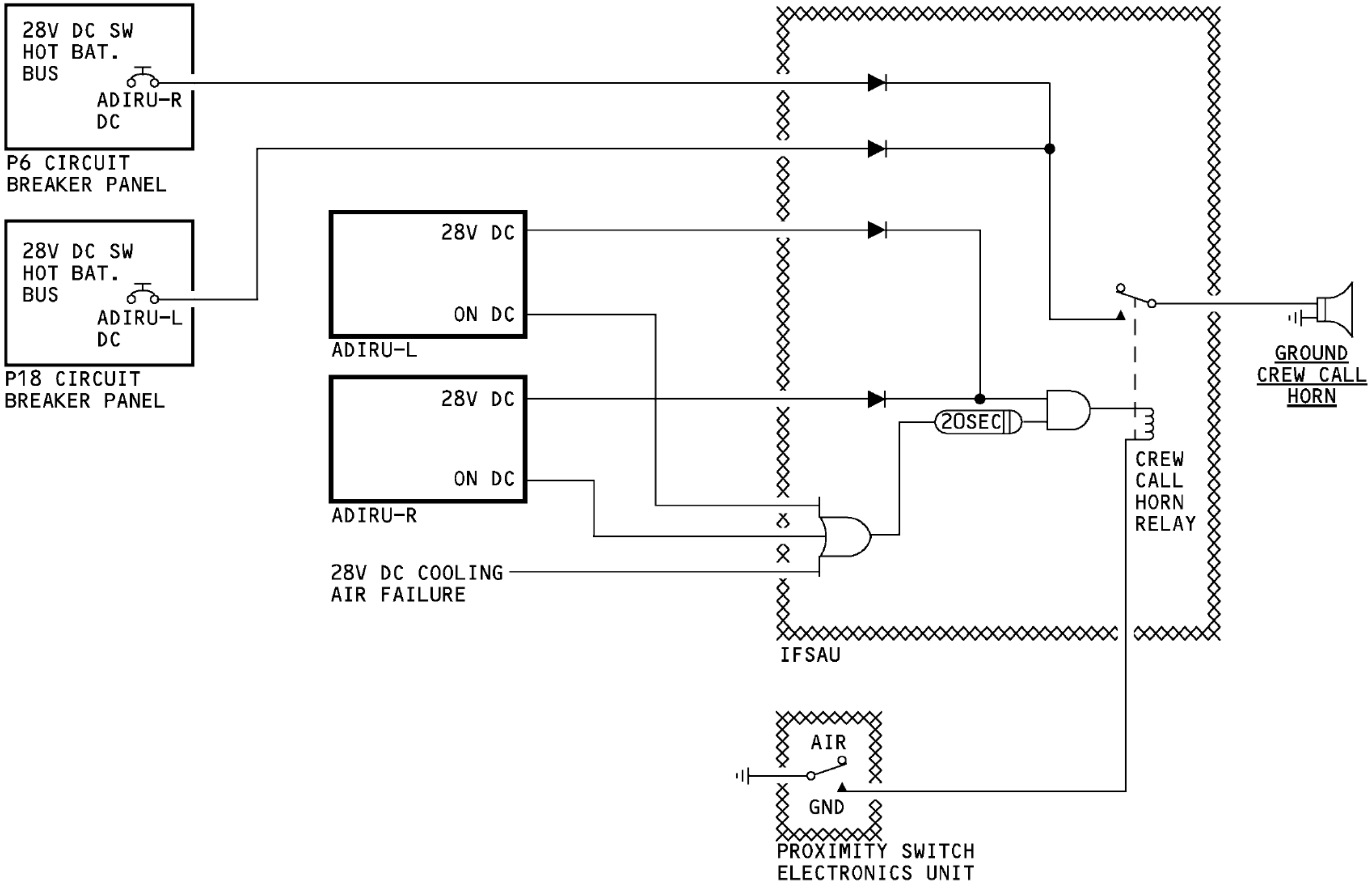
The integrated flight systems accessory unit (IFSAU) contains a circuit which causes the ground crew call horn to tell maintenance personnel of unsafe ADIRU operation. This occurs when the airplane is on the ground and the ADIRUs are on dc power or when the equipment cooling system fails.

ADIRU DC Power Operation

The ADIRUs send 28v dc to the AND logic circuit in the IFSAU. When an ADIRU senses that it is on dc power, it sends an ON DC discrete to the IFSAU. The discrete goes through a 20 second delay to the AND gate logic. After twenty seconds of dc operation, the AND gate supplies power to the crew call horn relay. The relay energizes when the air/gnd relay is in the gnd position. The energized crew call relay closes the relay switch, and 28v dc power causes the horn to operate.

Equipment Cooling Failure

Two equipment cooling sensors monitor the cooling air flow to the ADIRUs. A low flow relay in the sensor will close when the cooling air flow fails. The closed relay lets 28v dc go to the IFSAU. The 28v dc discrete goes through a 20 second delay to the AND gate logic. After twenty seconds, the AND gate supplies power to the crew call horn relay. The relay energizes when the air/gnd relay is in the gnd position. The energized crew call horn relay closes the relay switch, and 28v dc power causes the horn to operate.



NO COOLING AND ON DC WARNING

CONTROL AND WARNING

These are the units that interface to supply control and warning data to the pilots:

- ISDU
- MSU
- IRS master caution unit.

ISDU Interface

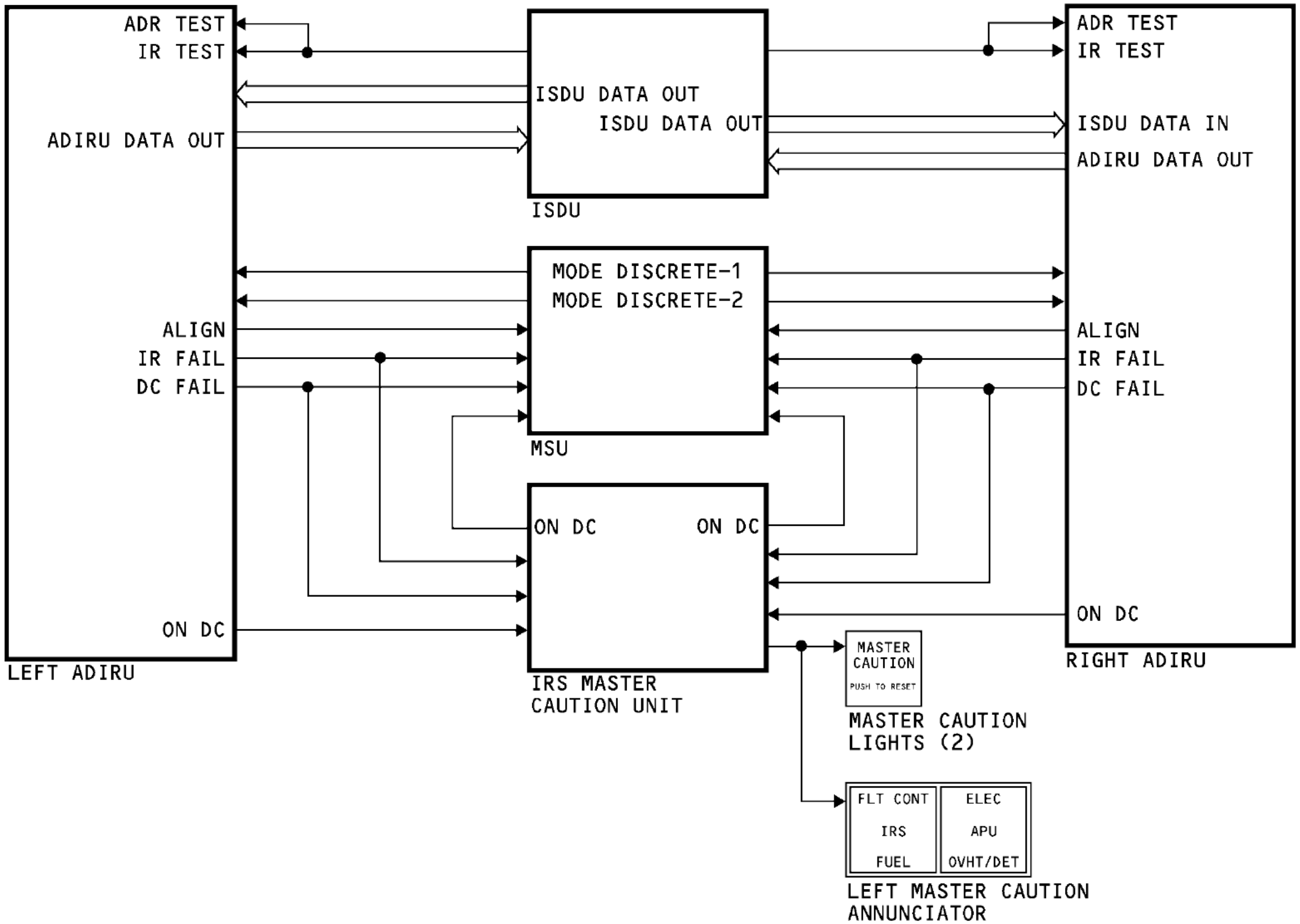
The ISDU supplies both ADIRUs with test discretes, heading data, and present position data. The ADIRUs supply IR data and fault data to the ISDU.

MSU Interface

The MSU supplies mode discretes to the ADIRUs. The ADIRUs supply align and fail discretes to the MSU. The MSU also receives an ON DC discrete from the ADIRUs. The ON DC discrete goes through the IRS master caution unit.

IRS Master Caution Unit Interface

The IRS master caution unit receives fail and ON DC discretes from the ADIRUs. The IRS master caution unit supplies discrete outputs to the MSU and to the master caution lights and annunciators.



CONTROL AND WARNING

THIS PAGE IS INTENTIONALLY LEFT BLANK

ADIRS SIGNALS
SYSTEM INPUTS

General

Each ADIRU receives inputs from these on-side components:

- AOA sensor
- Pitot ADM
- Static ADM.

The AOA sensor gives angle of attack information to the ADIRU. The ADIRU uses angle of attack to modify pitot and static values.

The pitot ADM gives the ADIRU total air pressure information. This is used to calculate airspeed and mach number.

The static ADM gives the ADIRU static air pressure information. This is used to calculate altitude and airspeed.

These components supply data to both ADIRUs:

- TAT probe
- DEU 1 and DEU 2
- Window and pitot heat module
- Inertial system display unit (ISDU)
- FMC 1 and FMC 2.

The TAT probe gives total air temperature to the ADIRUs. The ADIRUs use TAT to modify altitude and airspeed calculations.

DEU 1 and DEU 2 give barometric correction to the ADIRUs. The ADIRUs use barometric correction to calculate corrected barometric altitude.

The window and pitot heat module sends a discrete signal to the ADIRUs when anti ice heat is on. The ADIRUs modify the input values of these components when anti ice heat is on:

- AOA sensor
- Pitot probe
- TAT probe.

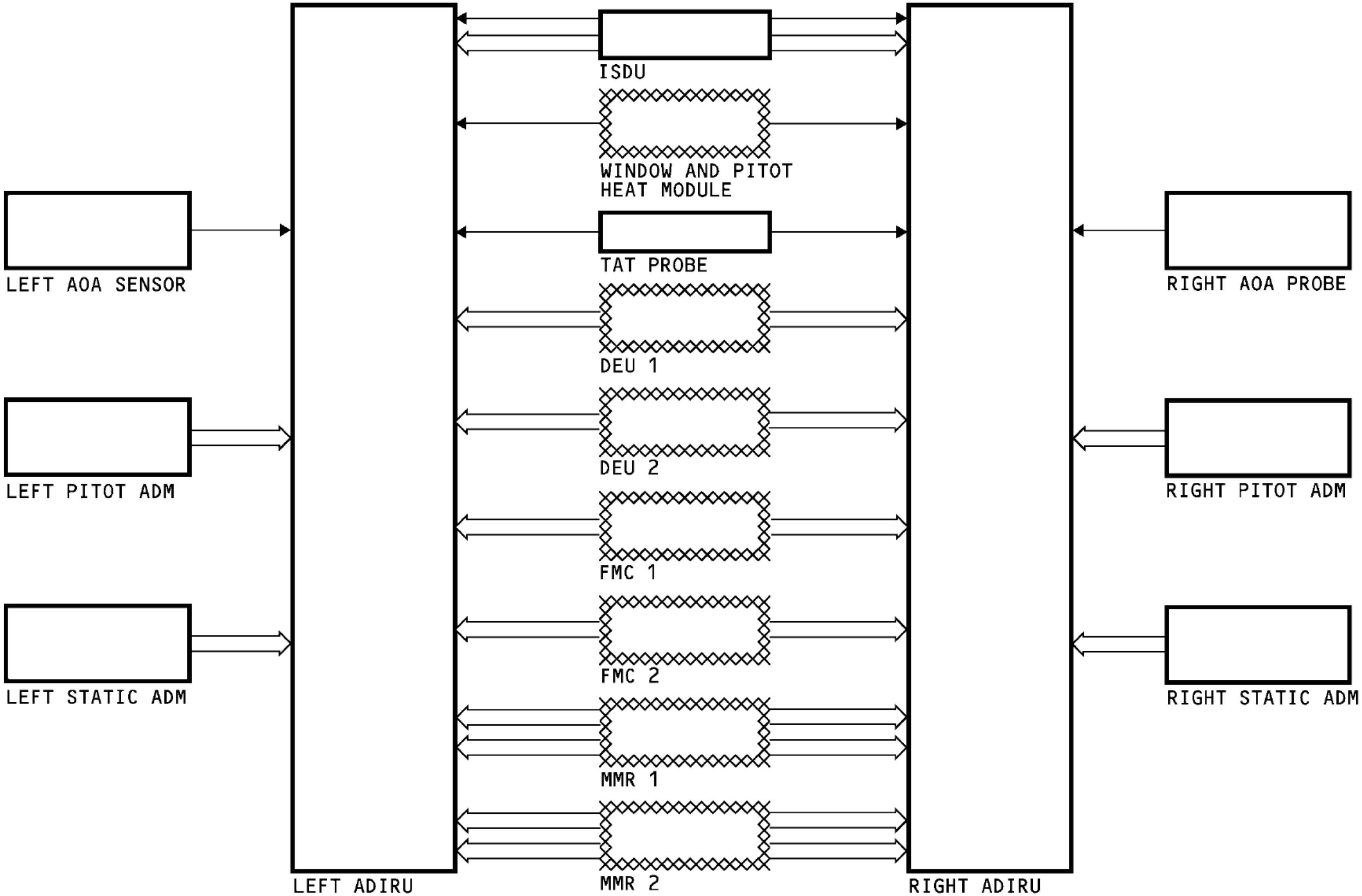
The ISDU gives initial present position data and heading data to the ADIRUs. The ADIRUs use present position data during the align mode. Heading data is used during the attitude mode.

The FMC gives the ADIRUs this information:

- Present position
- Heading
- BITE command.

The ADIRUs use present position in the align mode. Heading data is used in the attitude mode. The BITE command starts the ADIRU Bite tests.

Multi-mode receiver 1 (MMR 1) and MMR 2 have data buses to the ADIRUs. The MMRs do not supply any data to the ADIRUs. The data buses are for future use to send global positioning system (GPS) information.



SYSTEM INPUTS

LEFT INERTIAL REFERENCE DIGITAL OUTPUTS

The left ADIRU supplies inertial reference (IR) data to many systems and components. IR data goes out on ARINC 429 data buses. The data on each bus is the same. One data bus goes from the IR section of the ADIRU to the air data reference (ADR) section.

These are the components and systems that receive IR data from the left ADIRU:

- Display electronics unit (DEU) 1 and 2
- Radio magnetic indicator (RMI)
- Multi mode receiver (MMR) 1 and MMR 2
- Stall management yaw damper (SMYD) 1 and 2
- Flight control computer (FCC) A and B
- Ground proximity warning computer (GPWC)
- Weather radar receiver transmitter (WXR R/T)
- TCAS computer
- Integrated flight systems accessory unit (IFSAU)
- Inertial system display unit (ISDU)
- Anti skid autobrake control unit (AACU)
- Autothrottle (A/T) computer
- Flight management computer (FMC) 1 and 2.

DEU
The DEUs use IR data from the ADIRUs to show information on the display units.

RMI
The RMI uses magnetic heading data to control the position of its compass card.

MMR
The MMRs use present position and inertial altitude for GPS calculations.

SMYD
SMYD 1 uses IR data to calculate stall management and yaw damper values. SMYD 2 uses IR data to calculate yaw damper values.

DFCS
The flight control computers (FCC) use IR data for autoflight calculations.

GPWS
The GPWC uses IR data to calculate unsafe conditions.

WXR R/T
The WXR R/T uses data for weather condition calculations and antenna stabilization.

TCAS
This IR data goes to the TCAS computer:

- Pitch attitude rate
- Roll attitude rate
- Magnetic heading.

TCAS does not use this data at this time.

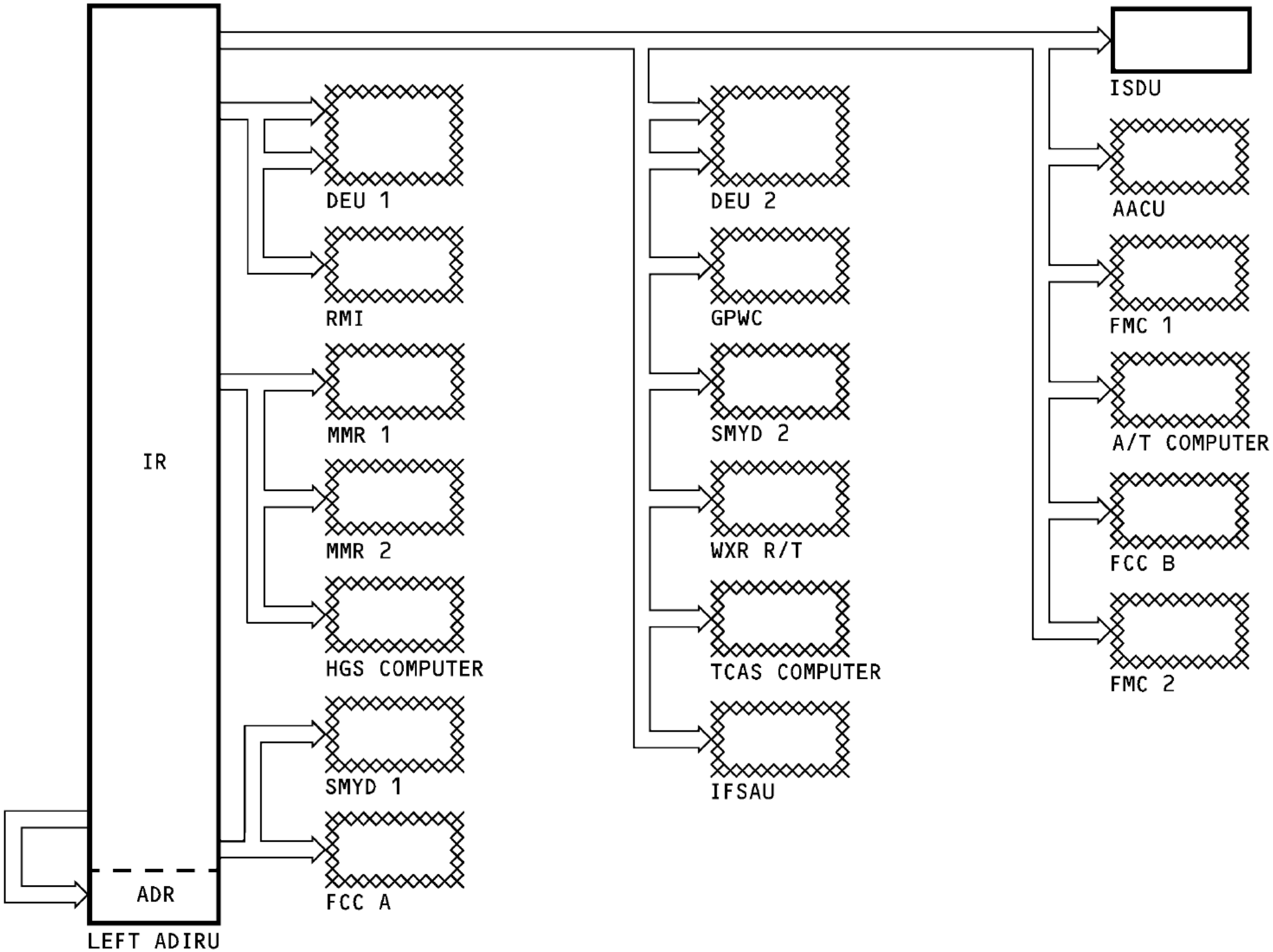
IFSAU
The integrated flight systems accessory unit receives all IR data and sends it to the flight data acquisition unit for recording.

ISDU
The inertial system display unit receives IR data to show on the IRS display.

AACU
The anti-skid auto-brake control unit (AACU) uses IR data for auto-brake calculations.

A/T Computer
The A/T computer uses data for throttle command calculations.

FMCS
The FMCS uses this data for performance and navigation calculations.



LEFT INERTIAL REFERENCE DIGITAL OUTPUTS

RIGHT INERTIAL REFERENCE DIGITAL OUTPUTS

The right ADIRU supplies inertial reference (IR) data to many systems and components. IR data goes out on ARINC 429 data buses. The data on each bus is the same. One data bus goes from the IR part of the ADIRU to the air data reference (ADR) part.

These are the components and systems that receive IR data from the right ADIRU:

- Display electronics unit (DEU) 1 and 2
- Radio magnetic indicator (RMI)
- Multi-mode receiver (MMR)1 and 2
- Stall management yaw damper (SMYD) 1 and 2
- Flight control computer (FCC) A and B
- Weather radar receiver transmitter (WXR R/T)
- Integrated flight systems accessory unit (IFSAU)
- Inertial system display unit (ISDU)
- Antiskid autobrake control unit (AACU)
- Autothrottle (A/T) computer
- Flight management computer (FMC) 1 and 2.

DEU
The DEUs use IR data from the ADIRU to show information on the display units.

RMI
The RMI uses magnetic heading data to position its compass card.

MMR
The MMRs use present position and inertial altitude for GPS calculations.

SMYDs
SMYD 1 uses IR data to calculate yaw damper values.
SMYD 2 uses IR data to calculate stall management and yaw damper values.

DFCS
The flight control computers (FCC) use IR data for autoflight calculations.

WXR R/T
The WXR R/T uses data for weather condition calculations and antenna stabilization.

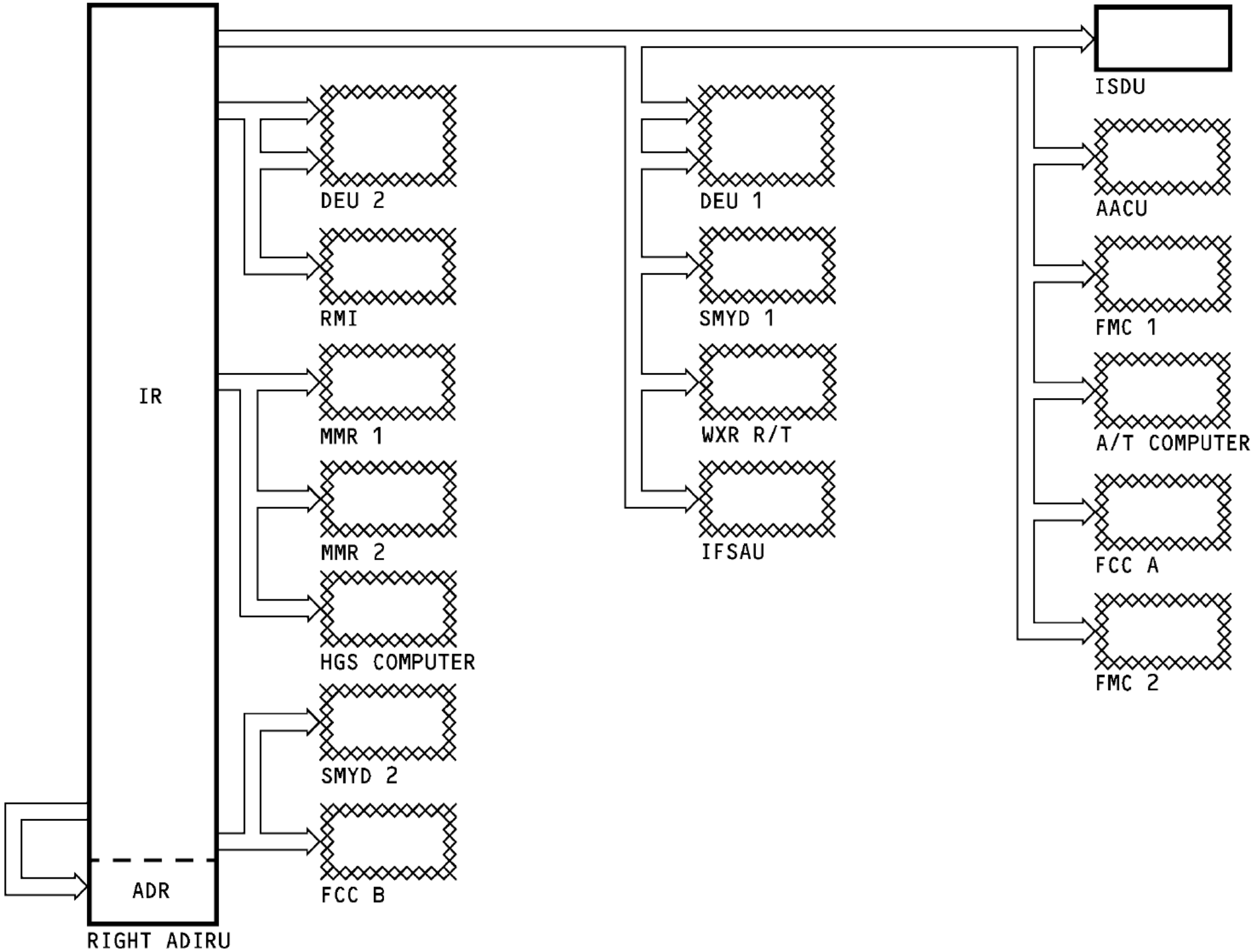
IFSAU
The integrated flight systems accessory unit receives all IR data and sends it to the flight data acquisition unit for recording.

ISDU
The inertial system display unit (ISDU) receives IR data to show on the IRS display.

AACU
The anti-skid auto-brake control unit (AACU) uses IR data for auto-brake calculations.

A/T Computer
The A/T computer uses data for throttle command calculations.

FMCS
The FMCS uses data for performance and navigation calculations.



RIGHT INERTIAL REFERENCE DIGITAL OUTPUTS

LEFT AIR DATA DIGITAL OUTPUTS

The left ADIRU supplies air data reference (ADR) data to many systems and components. ADR data is on ARINC 429 data buses. The data on each bus is the same. One data bus goes from the ADR section of the ADIRU to the IR section.

These components and systems receive ADR data from the left ADIRU:

- Auto-throttle (A/T) computer
- Display electronics unit (DEU) 1 and 2
- Flight control computer (FCC) A
- Flight data acquisition unit (FDAU)
- Air traffic control (ATC) 1 and 2
- Flap/slat electronics unit (FSEU)
- Ground proximity warning computer (GPWC)
- Stall management yaw damper (SMYD) 1
- Cabin pressure controller 1 and 2
- Weather radar receiver transmitter (WXR R/T)
- Flight management computer (FMC) 1 and 2.

A/T Computer
The ADIRU sends ADR data to the A/T computer for throttle command calculations.

DEU
The DEU uses data for display information and sends it on to other systems such as the electronic engine control (EEC).

FCC A
FCC A uses information for automatic flight control mode calculations.

FDAU
The ADIRU sends all ADR data to the flight data acquisition unit (FDAU). The FDAU selects and formats this data and then sends it to the digital flight data recorder (DFDR) to be recorded.

ATC Transponders
The ADIRU sends uncorrected baro altitude data to the ATC transponders for altitude reporting.

FSEU
The ADIRU sends computed airspeed to the flap slat electronics unit (FSEU) for flap load relief calculations and as part of its uncommanded motion detection logic.

GPWC
The GPWC uses data to detect unsafe flight conditions.

SMYD 1
The SMYD 1 uses this data for stall management and yaw damper calculations.

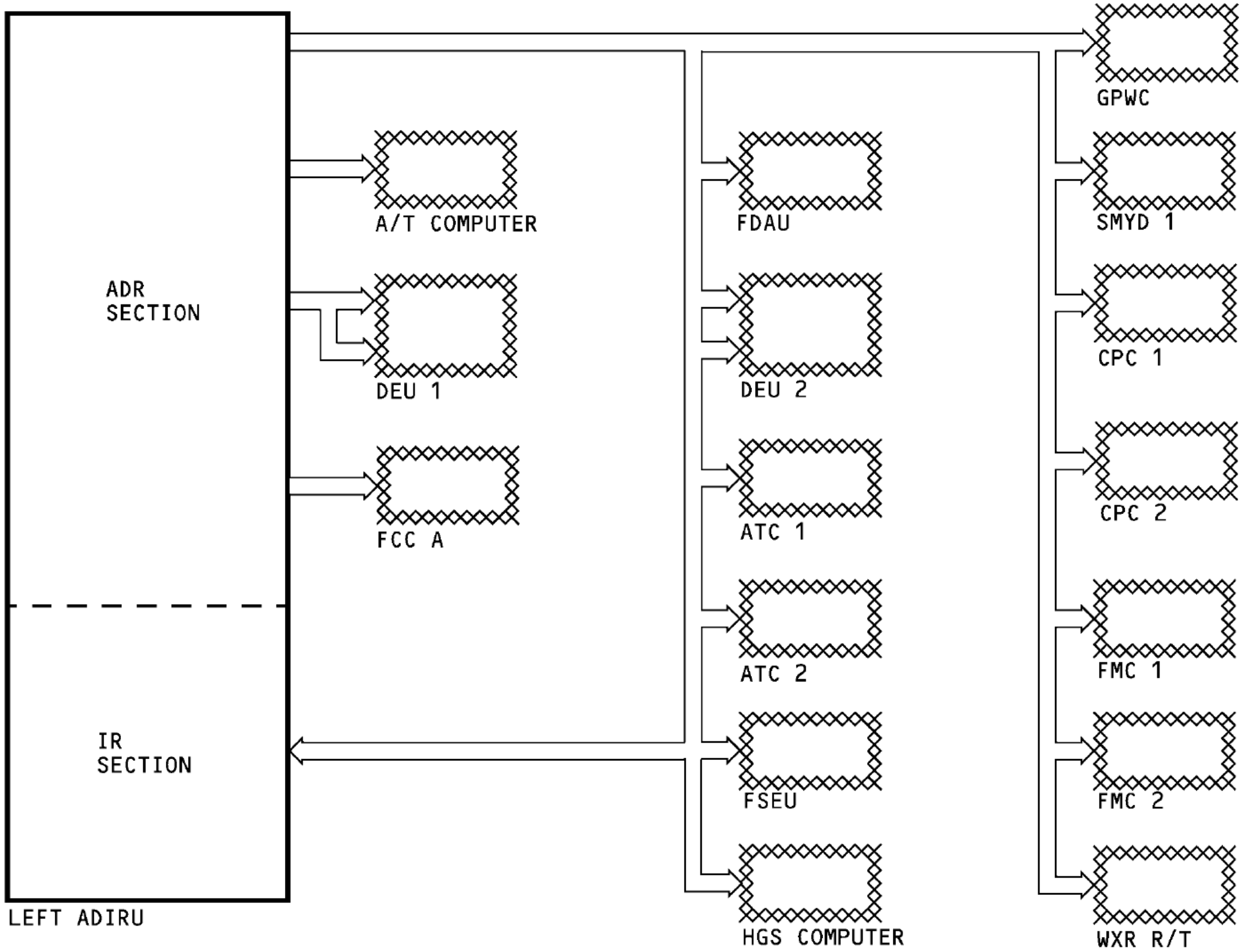
CPC
The ADIRU sends ADR data to cabin pressure controller (CPC) 1 and 2 to calculate pressurization values.

WXR R/T
The ADIRU sends true airspeed data to the WXR R/T for predictive windshear calculations.

FMCS
The ADIRU sends this ADR data to the FMCS:

- Computed airspeed
- True airspeed
- Mach
- Corrected baro altitude
- Uncorrected baro altitude
- Total air temperature
- Static air temperature.

The FMCS uses this data for performance calculations.



LEFT AIR DATA DIGITAL OUTPUTS

RIGHT AIR DATA OUTPUTS

The right ADIRU supplies air data reference (ADR) data to many systems and components. ADR data is on ARINC 429 data buses. The data on each bus is the same. One data bus goes from the ADR section of the ADIRU to the IR section.

These components and systems receive ADR data from the right ADIRU:

- Autothrottle (A/T) computer
- Display electronics unit (DEU) 1 and 2
- Flight control computer (FCC) B
- Air traffic control (ATC) 1 and 2
- Stall management yaw damper (SMYD) 2
- Cabin pressure controller 1 and 2
- Weather radar receiver transmitter (WXR R/T)
- Flight management computer (FMC) 1 and 2.

A/T Computer

The ADIRU sends ADR data to the A/T computer for throttle command calculations.

DEU

The DEUs use data for display information and sends it on to other systems such as the electronic engine control (EEC).

FCC B

FCC B uses information for automatic flight control mode calculations.

ATC Transponders

The ADIRU sends uncorrected baro altitude data to the ATC transponders for altitude reporting.

SMYD 2

The SMYD 2 uses data for stall management and yaw damper calculations.

CPC

The ADIRU sends this ADR data to cabin pressure controller (CPC) 1 and 2 to calculate pressurization values.

WXR R/T

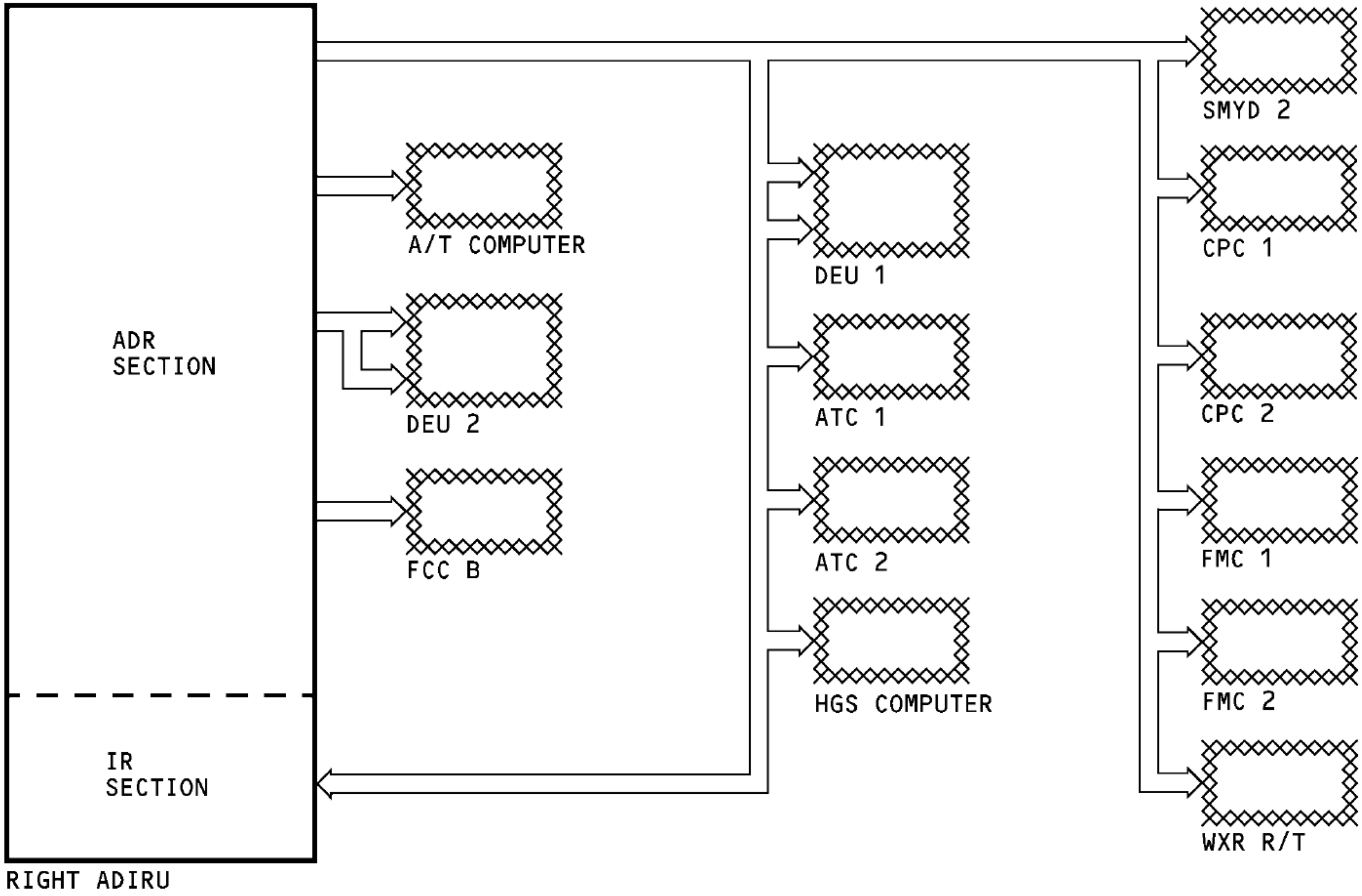
The ADIRU sends true airspeed data to the WXR R/T for predictive windshear calculations.

FMCS

The ADIRU sends this ADR data to the FMCS:

- Computed airspeed
- True airspeed
- Mach
- Corrected baro altitude
- Uncorrected baro altitude
- Total air temperature
- Static air temperature.

The FMCS uses this data for performance and guidance calculations.



RIGHT AIR DATA OUTPUTS

INERTIAL REFERENCE (IR) SIGNAL SWITCHING

General

The IRS transfer switch on the instrument switching module selects the ADIRU to supply inertial reference (IR) data to components and systems. The IRS transfer switch does not affect air data reference (ADR) signals.

IRS Transfer Switch

The IRS transfer switch is a three-position switch.

These are the three positions:

- Normal
- Both on L
- Both on R.

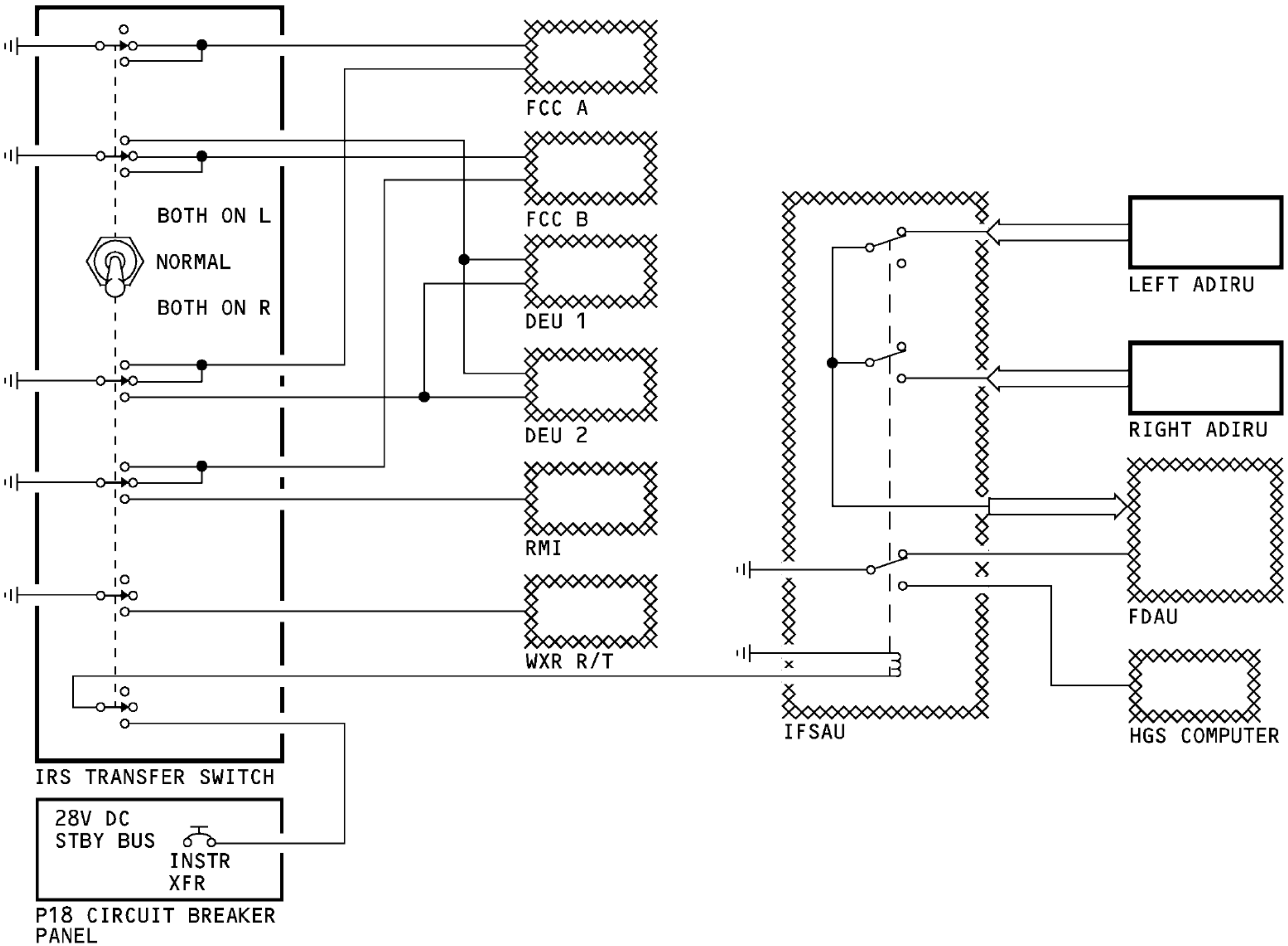
The normal position sends discrete signals that tell the components to use their usual source of IR data.

The BOTH ON L and BOTH ON R switch positions tell the components to use only left IR data or only right IR data.

The CDS display electronics units (DEUs) cause the INSTR SWITCH message to show on the display units when the IRS transfer switch is in the BOTH ON L or BOTH ON R position.

IFSAU Relay

The position of a relay in the integrated flight systems accessory unit (IFSAU) sets the source of IR data to the flight data acquisition unit (FDAU). The usual source of IR data is the left ADIRU. Set the IRS transfer switch to BOTH ON R to energize the relay in the IFSAU. The energized relay sets the IR data source to the right ADIRU.



INERTIAL REFERENCE SIGNAL SWITCHING

ADIRS COMPONENTS
AIR DATA INERTIAL REFERENCE UNIT

General

The air data inertial reference unit (ADIRU) has two functions:

- Air data reference (ADR) calculations
- Inertial reference (IR) calculations.

and has three parts:

- Power supply
- Air data
- Inertial reference.

These are the physical properties of the ADIRU:

- Length - 15.12 inches
- Width - 4.88 inches
- Height - 7.64 inches
- Weight - 28 pounds
- Power - 69 watts AC, 64 watts DC steady state.

Power Supply

The power supply is the only part of the ADIRU used by both the ADR function and the IR function. The power supply receives 115v ac and 28v dc from the airplane buses and supplies operating voltages to the ADR and IR.

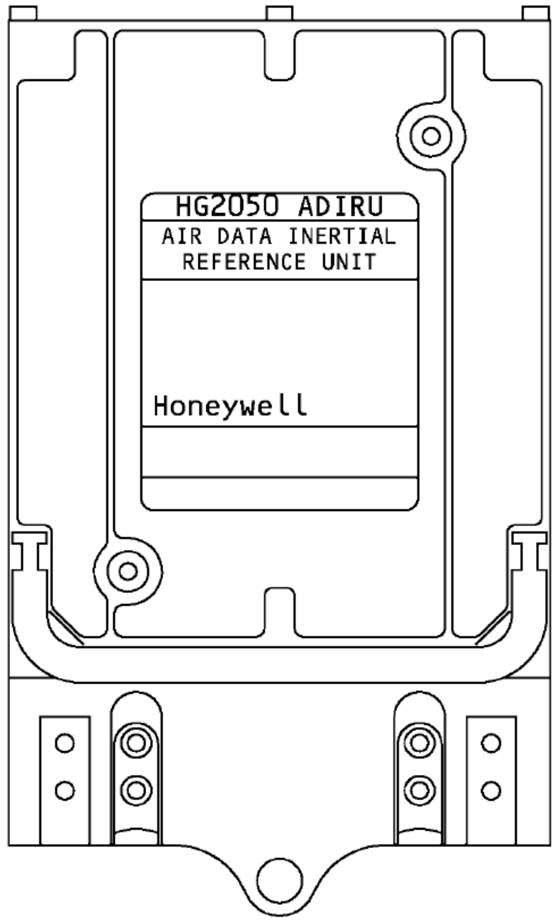
Air Data Reference

The ADR function receives digital inputs of pitot and static pressure from the air data modules and temperature inputs from the total air temperature probe. It uses these inputs to calculate the air data parameters. It also receives analog inputs from the AOA vane for error correction.

Inertial Reference

The inertial reference function has three accelerometers and three laser gyros which sense motion and angular movements.
The IR function uses these sensor signals to calculate these and other parameters:

- Airplane attitude
- Heading
- Acceleration
- Position.



AIR DATA INERTIAL REFERENCE UNIT

INERTIAL SYSTEM DISPLAY UNIT

Purpose

The inertial system display unit (ISDU) has an interface with the ADIRUs. You can send digital data to the ADIRUs and show digital information and maintenance information from the ADIRUs.

These are the properties of the ISDU:

- Height - 4.5 inches
- Width - 5.75 inches
- Depth - 5.25 inches
- Weight - 3.7 pounds
- Power - 11 watts steady state.

Features

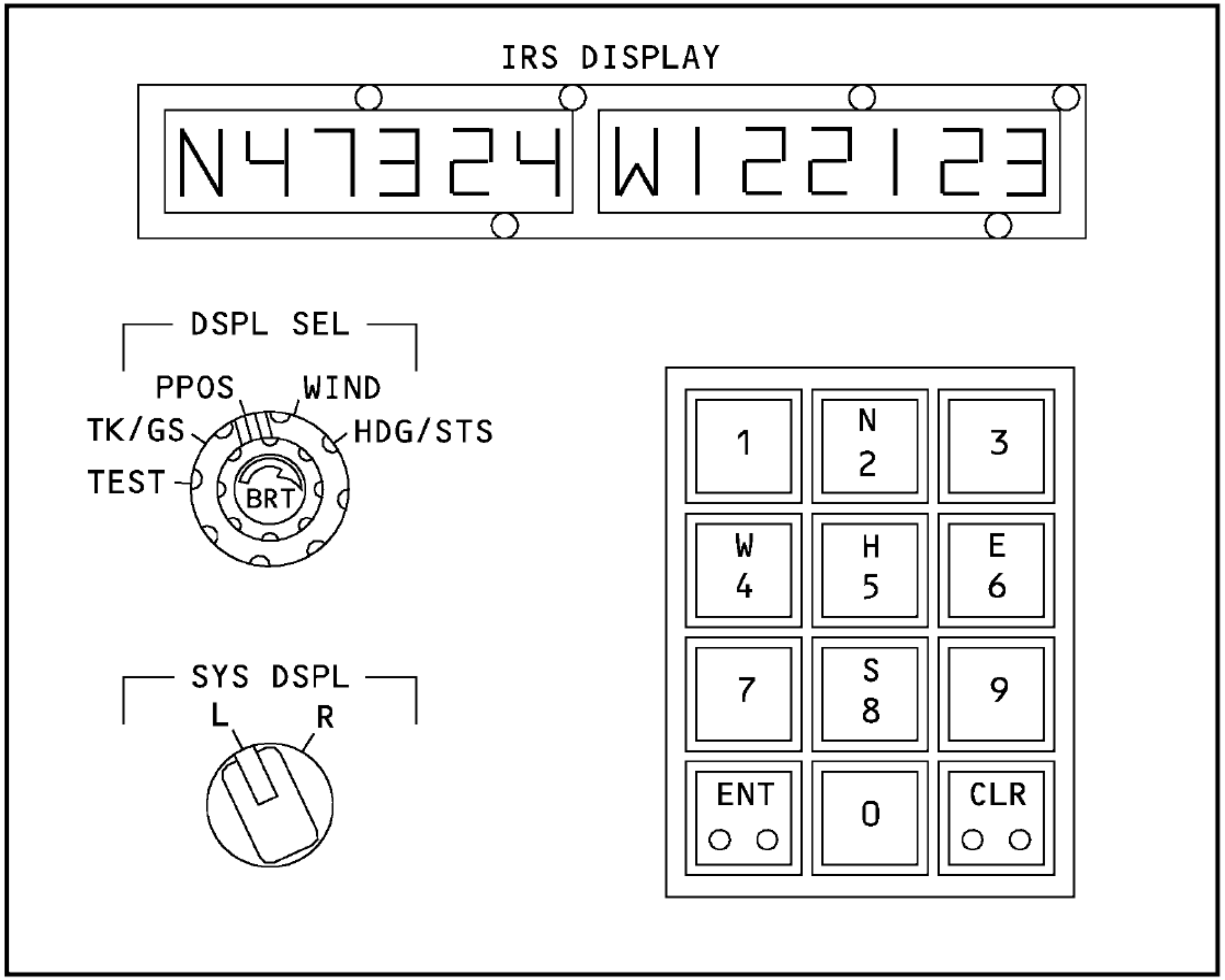
Use the keyboard on the front panel to enter latitude, longitude, and heading data.
The SYS DSPL switch selects left or right ADIRU data to show on the IRS display. The IRS display is a 13-character display that can show numbers and the letters N, S, E, and W. The characters are incandescent filaments. Each character is line replaceable.

The DSPL SEL switch selects the data to show from the ADIRU.

The DSPL SEL switch has these positions:

- TEST
- TK/GS (track/ground speed)
- PPOS (present position)
- WIND (wind speed/wind direction)
- HDG/STS (heading/status).

A BRT control is on the center of the DSPL SEL switch. Use the BRT control to adjust the brightness of the ISDU display and back lights.



INERTIAL SYSTEM DISPLAY UNIT

MODE SELECT UNIT

The mode select unit (MSU) sends IR mode selection instructions to the ADIRUs. It also gives visual indications of ADIRS operation and failures.

Caution: SOME SWITCHES MUST BE PULLED AND THEN TURNED.
IF YOU TRY TO TURN THESE SWITCHES BEFORE YOU PULL THEM, YOU CAN DAMAGE THE SWITCH.

The MSU has two mode selectors. One for the left ADIRU, and one for the right ADIRU. Each mode selector has four positions.

These are the four positions:

- OFF. Causes the ADIRU not to operate
- ALIGN. Causes the ADIRU to start the alignment process
- NAV. Causes the ADIRU to enter the navigation mode after a successful alignment
- ATT. Causes the ADIRU to enter the attitude mode.

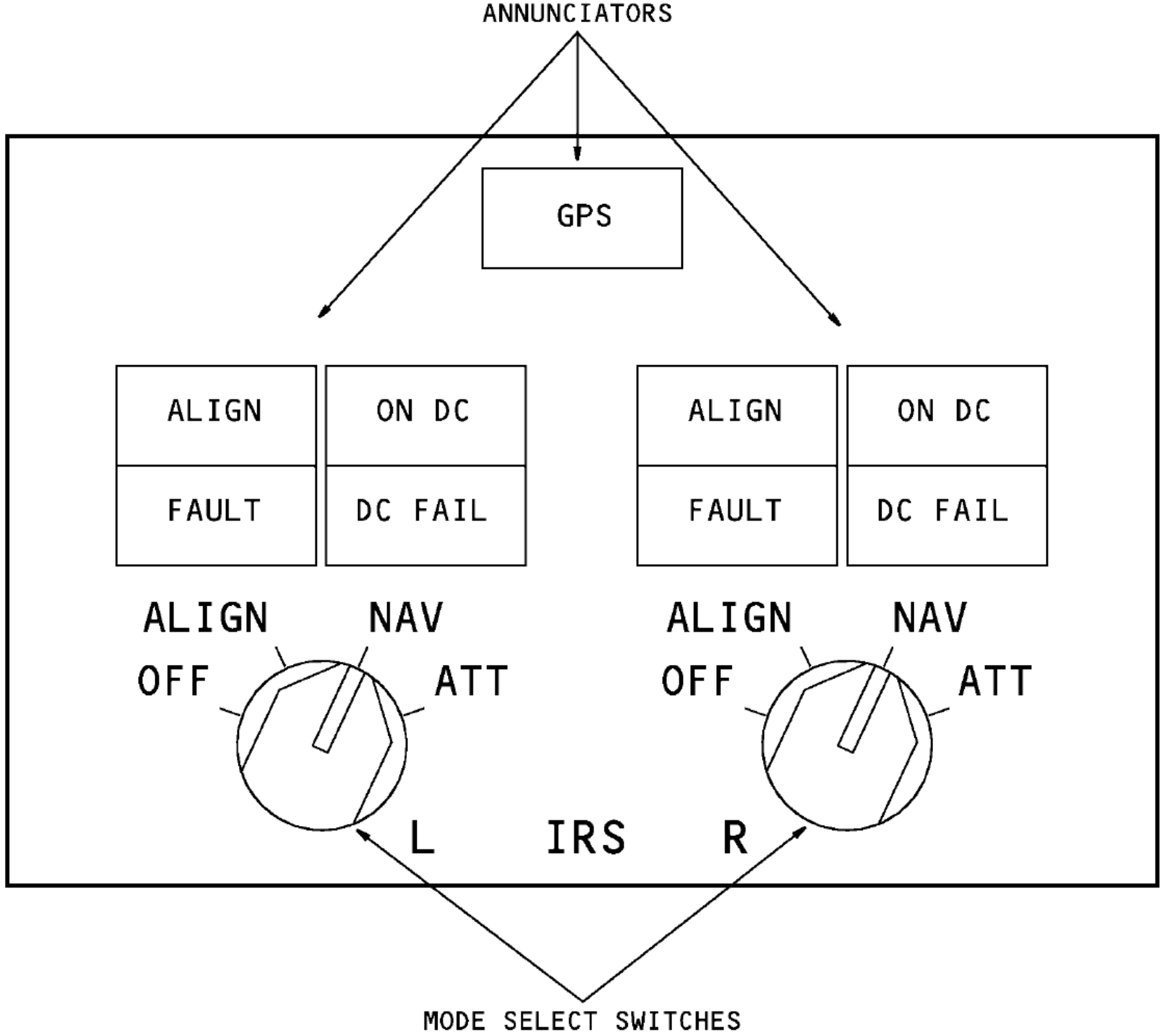
The mode selectors have a feature to decrease the risk that the flight crew will accidentally put the ADIRU in a mode that will disable its operation. When the selector is in the NAV position, the operator must pull the knob to put it in the ATT mode. When the selector is in the ALIGN position, the operator must pull the knob to put the selector in the OFF position. All other position changes do not require the operator to pull the knob.

The MSU has two sets of annunciators. One set is for the left ADIRU and one set is for the right ADIRU.

Each set has these annunciators:

- ALIGN. A white annunciator that comes on steady during ADIRU alignment. The annunciator will flash when the ADIRU needs information.
- ON DC. An amber annunciator that comes on steady when the ADIRU is on the 28v dc power source.
- FAULT. An amber annunciator that comes on steady when the IR function of the ADIRU fails.
- DC FAIL. An amber annunciator that comes on steady when the DC power source is less than 18v dc.

An amber GPS annunciator on MSU indicates a failure of an installed global positioning system.



MODE SELECT UNIT

IRS MASTER CAUTION UNIT

Purpose

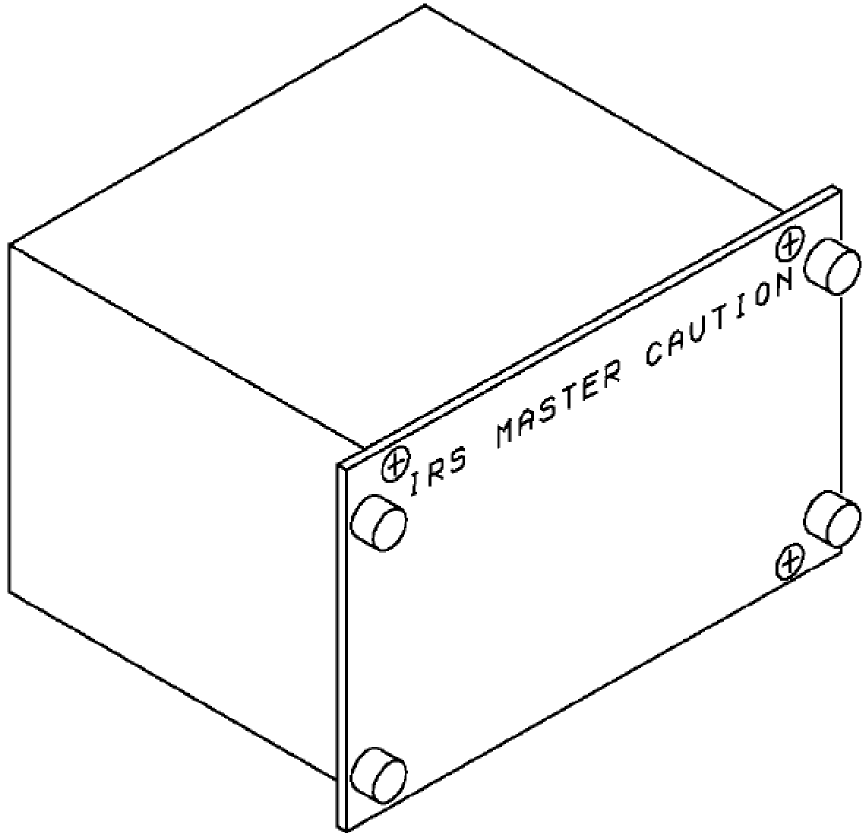
The IRS master caution unit monitors the ADIRS for unsatisfactory conditions. It controls the IRS light on the master caution annunciator and it supplies discrete signals to the master caution lights.

Physical Properties

The IRS master caution unit contains circuit cards.

The cards do these functions:

- Monitors ON DC, IR FAULT, and DC FAIL logic from the ADIRUs
- Monitors GPS status
- Controls the IRS light on the master caution annunciator.



IRS MASTER CAUTION UNIT

AIR DATA MODULE

General

The ADIRS has four air data modules (ADMs).

One ADM is for each of these components:

- Captain's pitot probe
- Captain's static port
- First officer's pitot probe
- First officer's static port.

Purpose

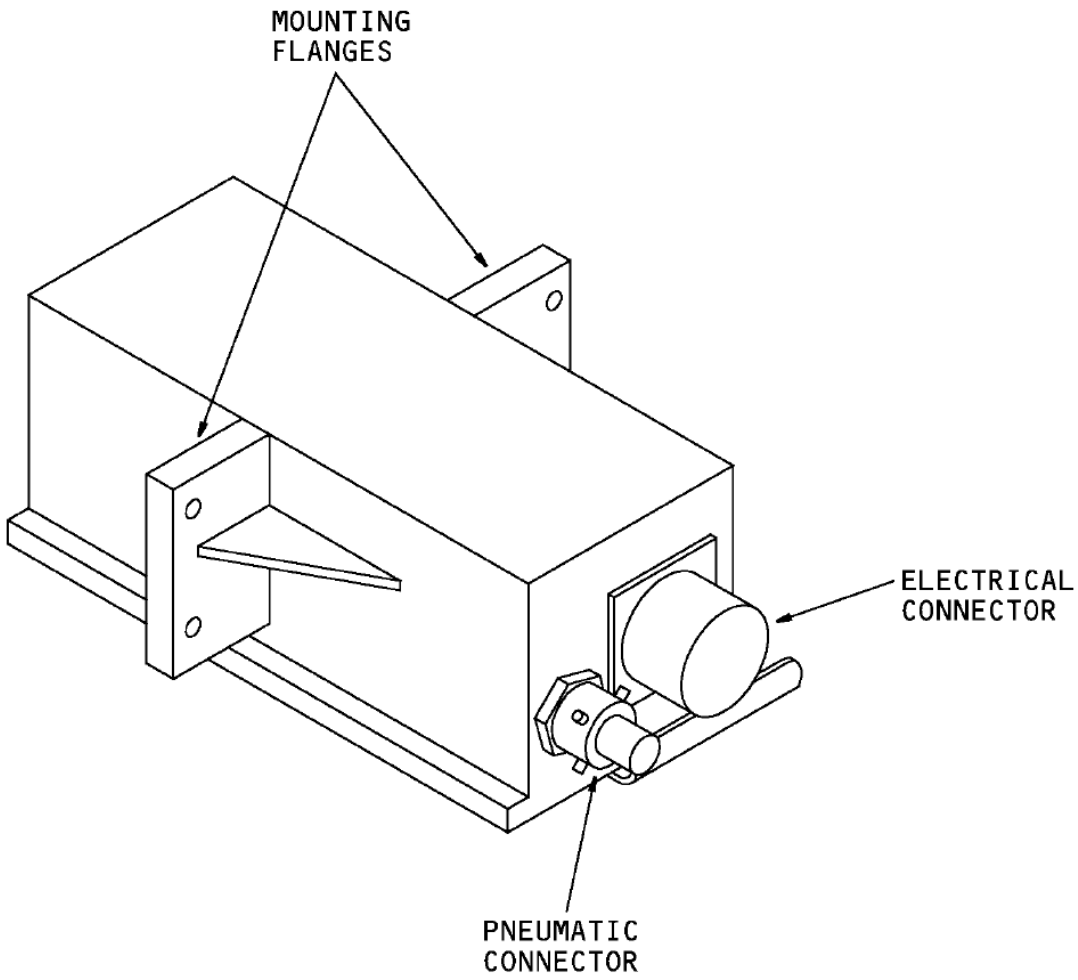
The ADM measures air pressure and changes the measured value to ARINC 429 data. The ADM transmits the data to the ADIRU.

Physical Properties

The ADM has these dimensions:

- Height - 2.5 in (6.35 cm)
- Width - 3 in (7.62 cm)
- Length - 6 in (15.24 cm).

The ADM mounts to the airframe with the two flanges on the sides of the unit. The ADM weighs less than 2 pounds. It does not need to be cooled. The ADMs are interchangeable.



AIR DATA MODULE

ANGLE OF ATTACK SENSOR

General

The angle of attack (AOA) sensor measures the direction of airflow relative to the fuselage.

These are the physical properties of the AOA sensor:

- Length - 7.5 inches (19 cm)
- Diameter - 3.2 inches (8.1 cm)
- Weight - 2.5 pounds (1.1 kg).

Resolvers

There are two resolvers in each AOA sensor.

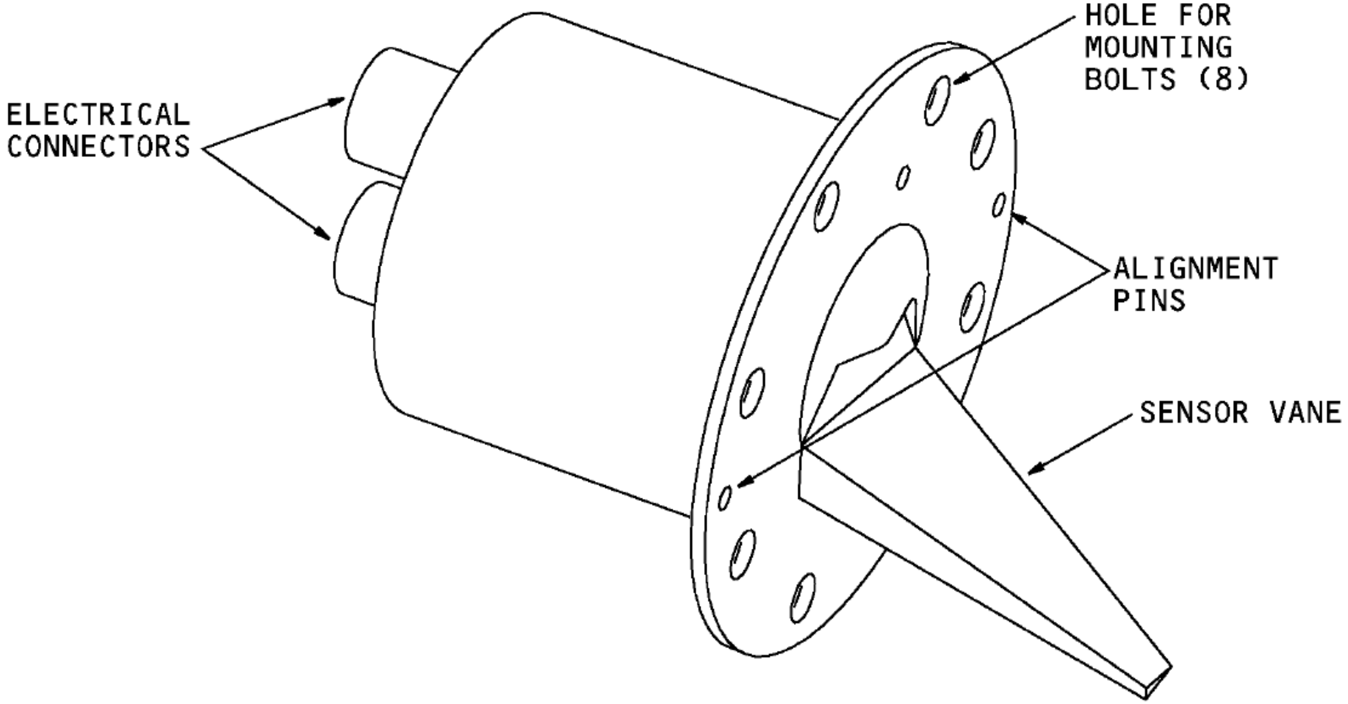
The AOA data from the two resolvers in the left AOA sensor go to the left ADIRU and to the stall management yaw damper (SMYD) 1. The AOA data from the two resolvers in the right AOA sensor goes to the right ADIRU and to the SMYD 2.

Electrical Connector

The angle of attack sensor has two electrical connectors. One connector receives heater power and supplies resolver 1 data to the SMYD. The other connector supplies resolver 2 data to the ADIRU.

Training Information Point

You install the AOA sensor from the outside of the airplane.
There are two alignment pins on the AOA sensor. Make sure the pins fit in their holes when you install the AOA sensor.



ANGLE OF ATTACK SENSOR

TOTAL AIR TEMPERATURE PROBE

General

The total air temperature (TAT) probe measures the air temperature outside the airplane. An opening in the front of the sensor lets air flow through and around the sensing elements and exit through ports in the rear of the probe.

Sensing Elements

There are two sense elements in the TAT probe. Each sense element is a resistive element. The value of resistance changes when the temperature of the air flow across the element changes.

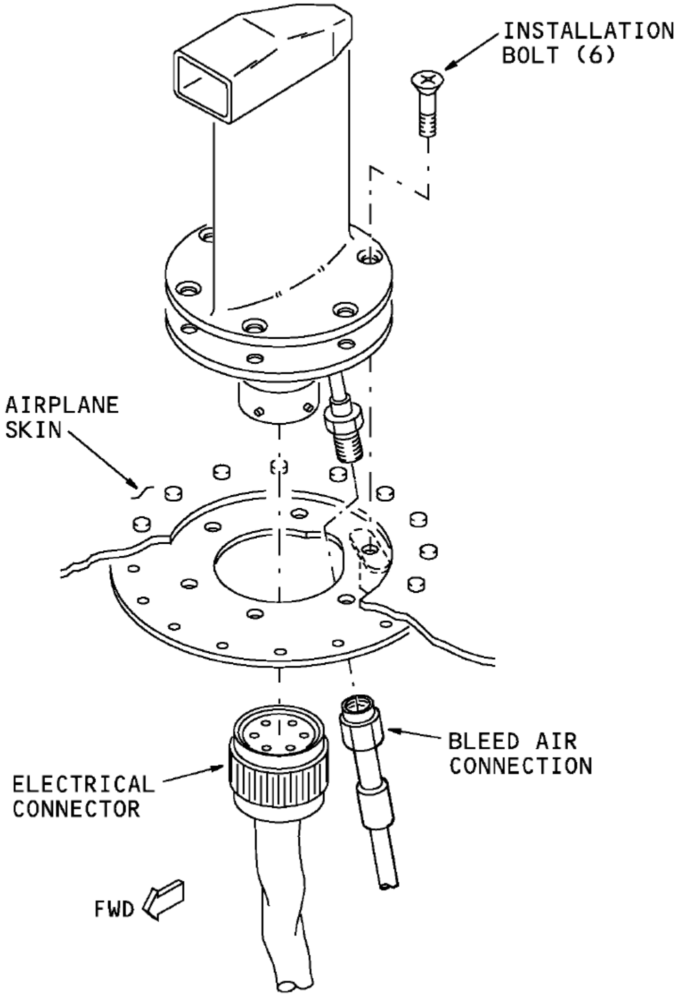
Bleed Air

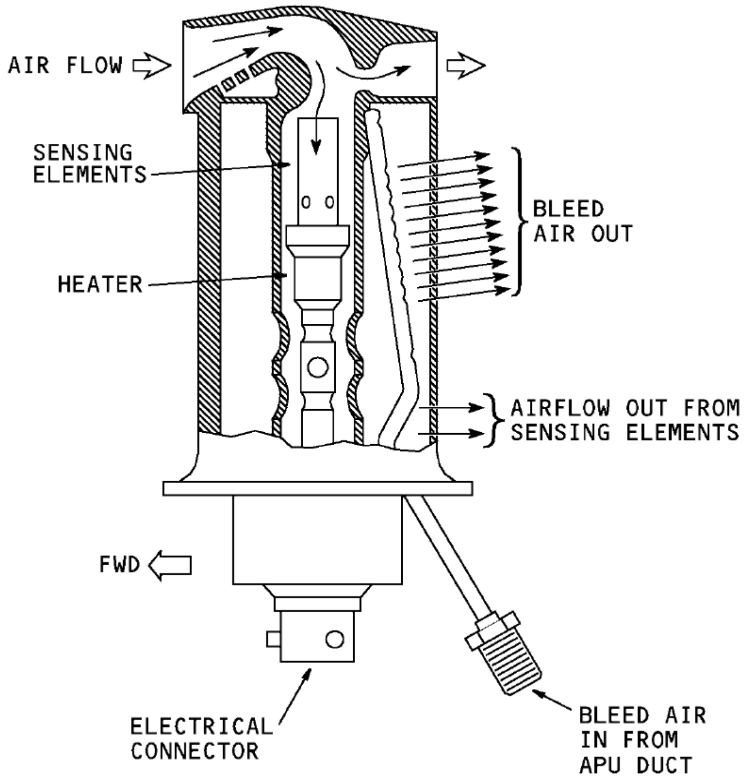
The TAT probe gets bleed air from the APU duct in the keel beam. See the bleed air chapter for more information. (CHAPTER 36)

Bleed air into the probe makes a negative pressure inside the probe. The negative pressure pulls outside air across the sensing elements. This permits accurate temperature measurement when the airplane is on the ground or moving at low speed.

Electrical Connector

The analog connection to the ADIRUs and to the heater power connection comes through the electrical connector. The heater in the TAT probe prevents ice.





TOTAL AIR TEMPERATURE PROBE

ADIRS - IR GENERAL THEORY 1

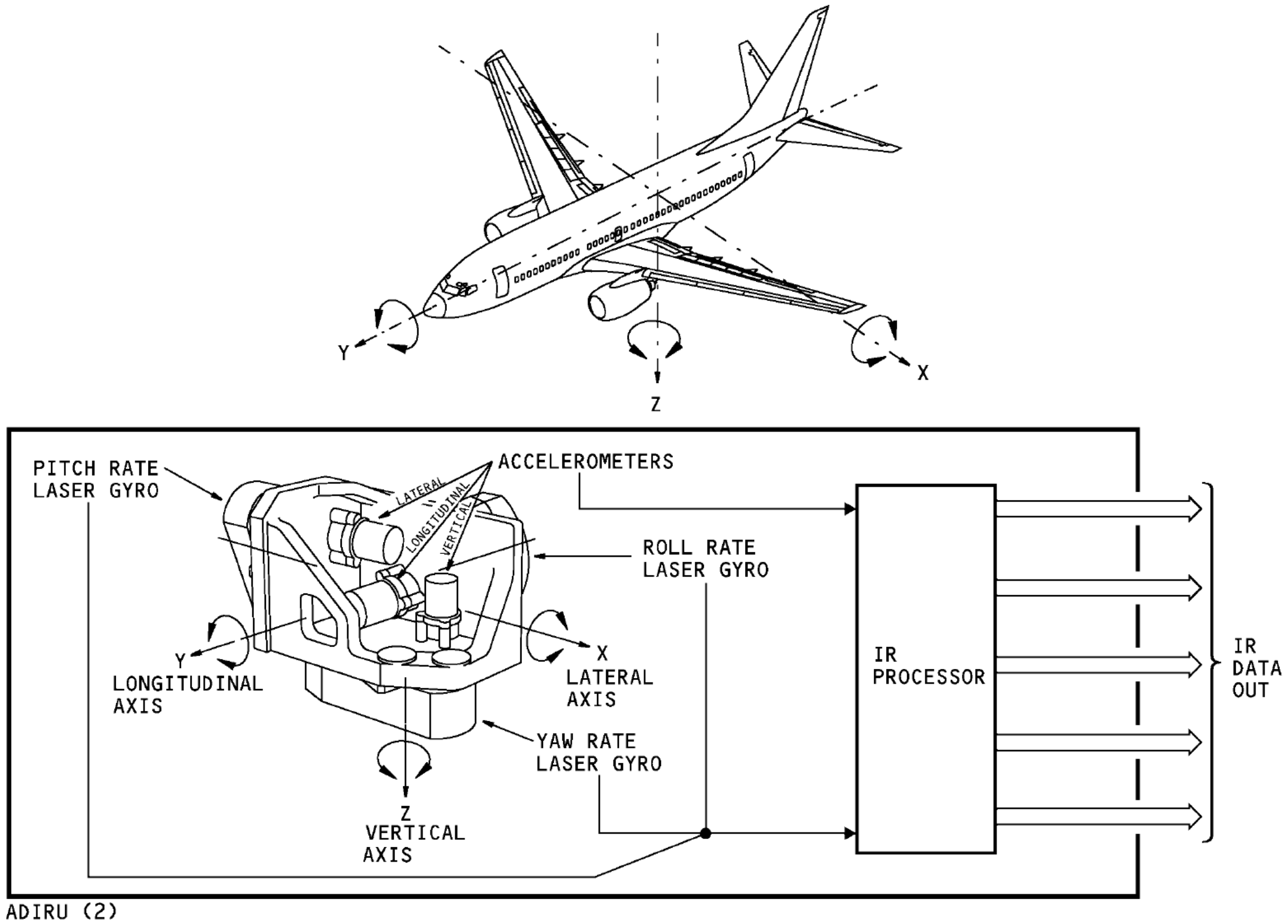
General

The inertial reference function of the ADIRU supplies heading and attitude information. The ADIRU calculates this information with accelerometer and laser gyro sensed data.

The ADIRU has three accelerometers and three laser gyros. The accelerometer orientation in the ADIRU is on the x, y, and z axes of the airplane. This orientation allows the ADIRU to sense accelerations in each of the three axes. The three laser gyros sense pitch, roll, and yaw rotation around the x, y, and z axes.

The accelerometers and laser gyros are in a strap-down configuration. This means that their orientation is on the x, y, and z axes of the airplane and they move with the airplane when it moves around or along the axes.

The IR processor in the ADIRU uses the sensor signals to calculate IR data.



ADIRS – IR GENERAL THEORY 1

IR GENERAL THEORY 2

General

The ADIRU uses three accelerometers to sense motion along the x, y, and z axes. Each accelerometer senses acceleration along one axis. The accelerometer can sense very large and very small accelerations along this axis.

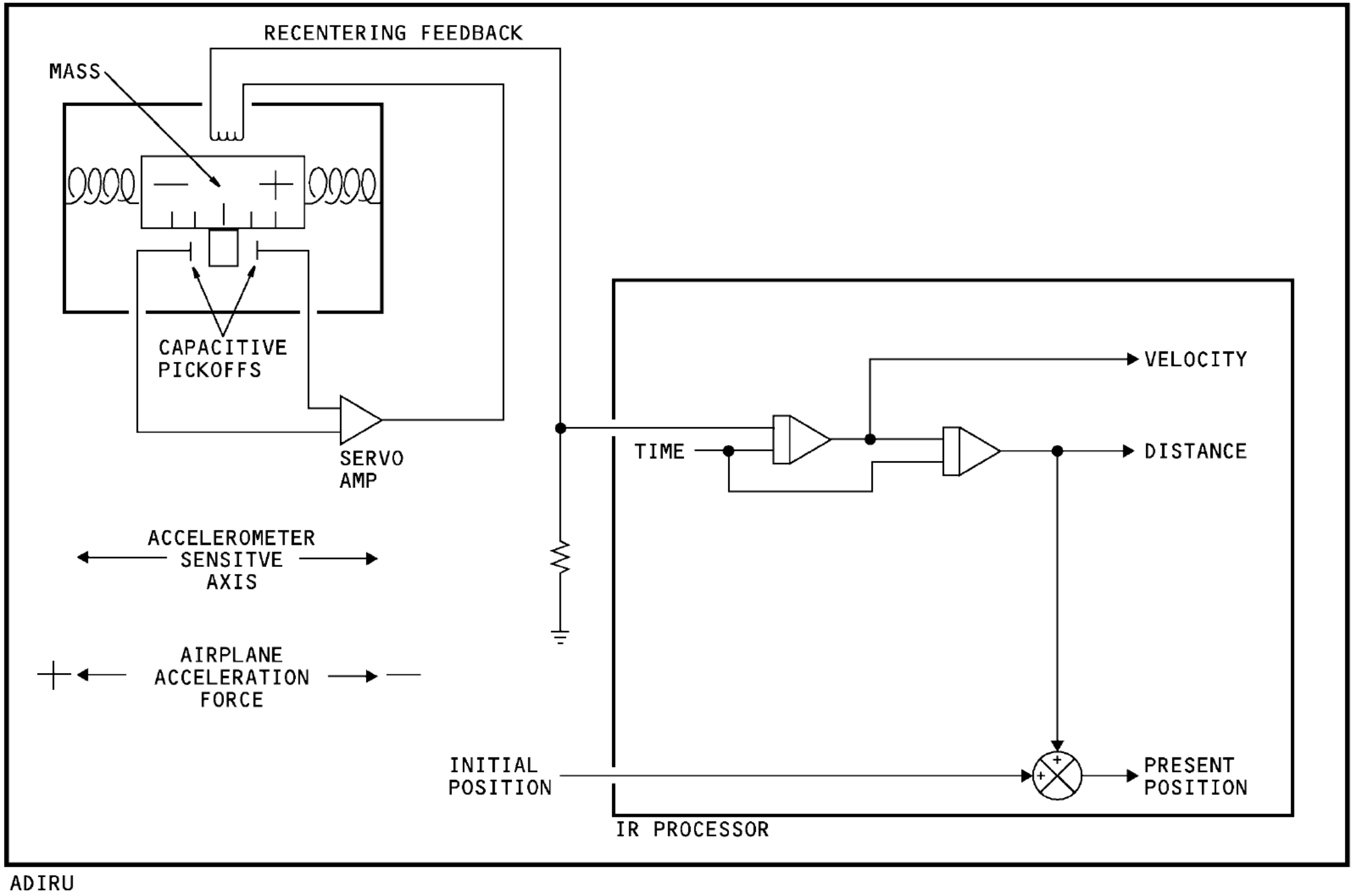
Each accelerometer measures acceleration along a different axis than the other two accelerometers.

Operation

The accelerometer is a mass centered in an outer case by two springs. When the airplane accelerates, the mass moves from the center and makes an electrical signal through the pickoffs. An amplifier then amplifies this signal and sends it to the recentering coil which moves the mass back to center. The amount of the signal necessary to keep the mass centered is proportional to airplane acceleration.

The IR processor integrates the feedback signal with time to calculate velocity and then integrates the calculated velocity with time to calculate distance flown.

The IR processor then adds distance flown to the initial position to calculate present position.



IR GENERAL THEORY 2

THIS PAGE IS INTENTIONALLY LEFT BLANK

IR GENERAL THEORY 3

General

Each gyro is a triangular shaped, helium-neon laser that creates two light beams. One light beam travels in the clockwise direction. The other light beam travels in the counter-clockwise direction.

Laser Beam Generation

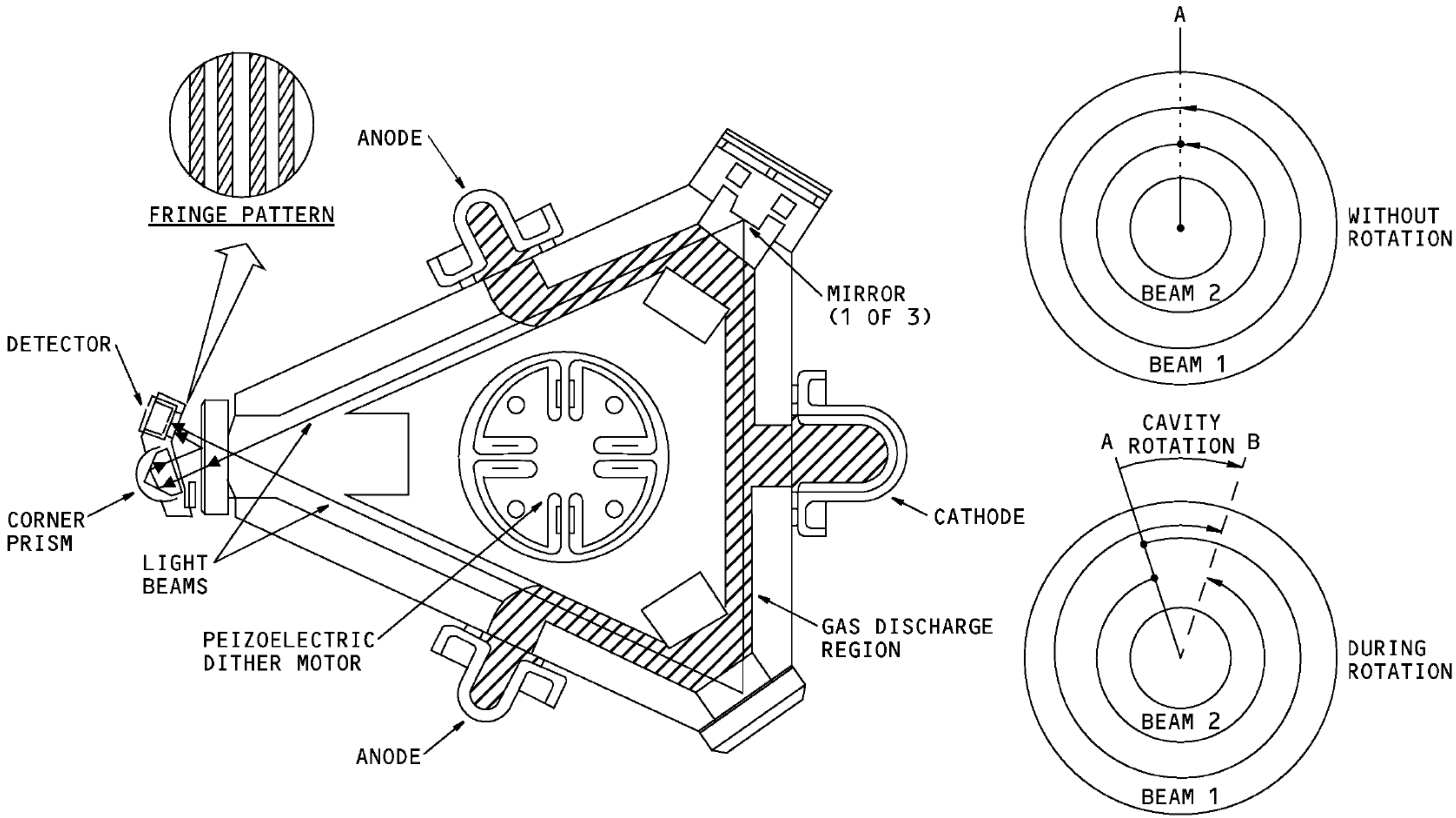
Light beam production, or lasing, occurs when a high voltage discharge between the anodes and the cathode causes ionization of a low pressure mixture of helium-neon gas in the gas discharge region of the gyro. The ionized particles in the gas discharge region begin to glow creating light. Mirrors in each corner of the triangle reflect this light around the triangle creating the clockwise and counter-clockwise light beams. One of the corners of the gyro contains a partially silvered mirror and a corner prism which lets the two light beams mix together to form a fringe pattern on the detector.

Operation

While the gyro is stationary, the fringe pattern is also stationary because the frequencies of both light beams are the same. When the gyro turns around the axis perpendicular to the lasing plane, the two light beam phases become slightly different. The phase of the two light beams are different during the turn because of the rotation rate. The difference in light beam phase causes the fringe pattern to move left or right depending on the direction of gyro movement. Photo diodes in the detector change the fringe pattern movement into a signal that is equal to the rotation rate of the gyro.
The measured rotation rate is integrated with time to calculate the attitude of the airplane.

Dither Motor

During low gyro rotation rates the two light beams can get coupled together in a condition called laser lock-in. To prevent a loss of information at low rotation rates, a piezoelectric-electric dither motor vibrates the gyro assembly through the lock in region. The gyro sensed signals that are caused by these vibrations, are de-coupled from the gyro output to prevent errors during operation.



IR GENERAL THEORY 3

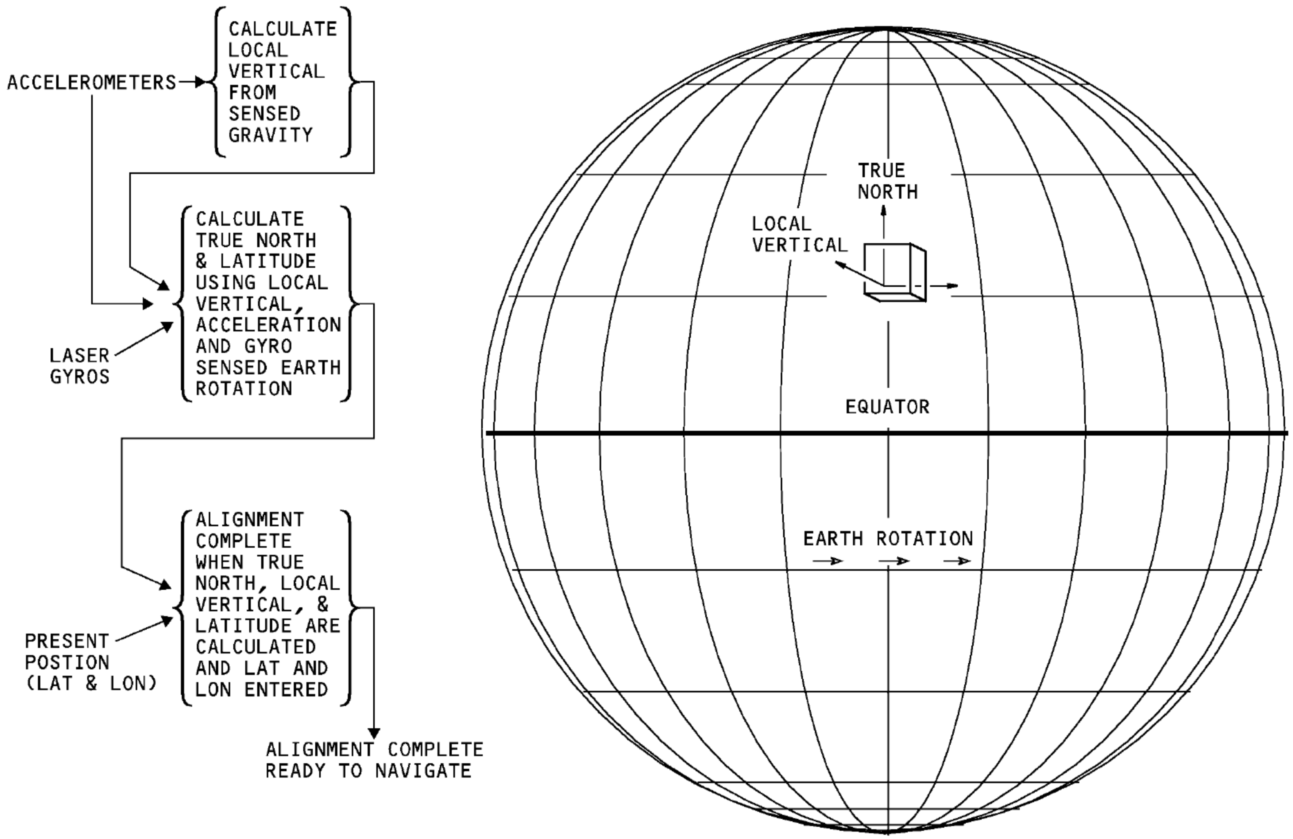
IR GENERAL THEORY 4

Alignment

The ADIRU uses accelerometers and gyros to sense the earth rotation rate and gravity. Earth rate and gravity are then used to calculate:

- Local vertical
- True north
- Present position latitude.

After the ADIRU has measured these values and present position (latitude and longitude) is entered, the ADIRU completes its alignment to true north and is then ready to navigate. ADIRS alignment time will vary based on local attitude.



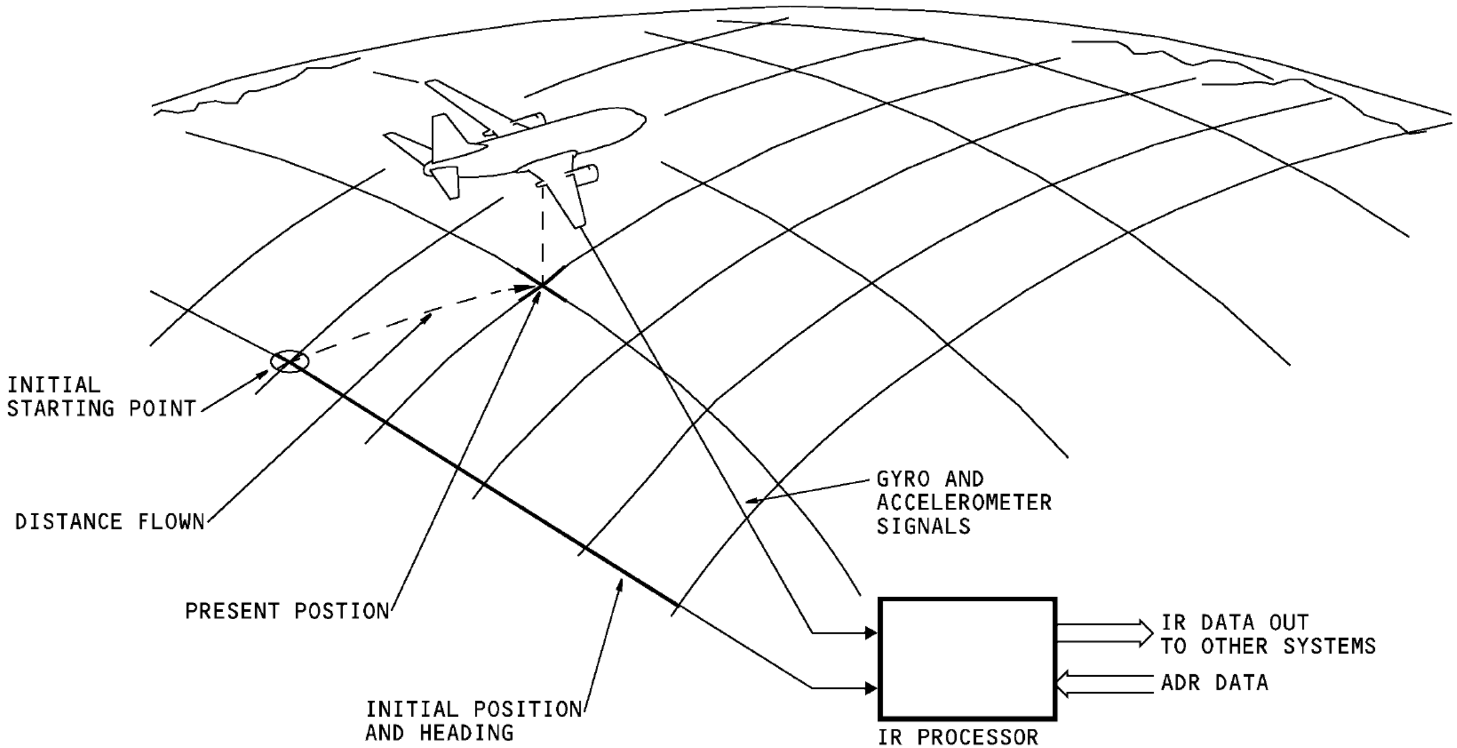
ADIRS – IR GENERAL THEORY 4

IR GENERAL THEORY 5

General

In the navigation mode, the IR processor uses the initial starting point and gyro and accelerometer values to calculate attitude, heading, velocity, and distance flown. The IR processor continuously updates this data over time to calculate present position and all other IR data values.

The IR processor also gets data from the ADR section of the ADIRU. The IR processor uses this input to calculate some of its IR data values.



IR GENERAL THEORY 5

ADIRS - ADIRU FUNCTIONAL DESCRIPTION

General

The ADIRU has these three parts:

- Power supply
- Inertial reference (IR)
- Air data reference (ADR).

Power Supply

The power supply receives 115v ac and 28v dc. The ADIRU operates with either power source. The power supply gives power to the ADR and the IR. Power also goes to the ISDU and to the ADMs.

The power supply monitor sends BITE data to the IR section.

The power supply monitors for these conditions:

- AC power failure
- DC power failure.

Inertial Reference

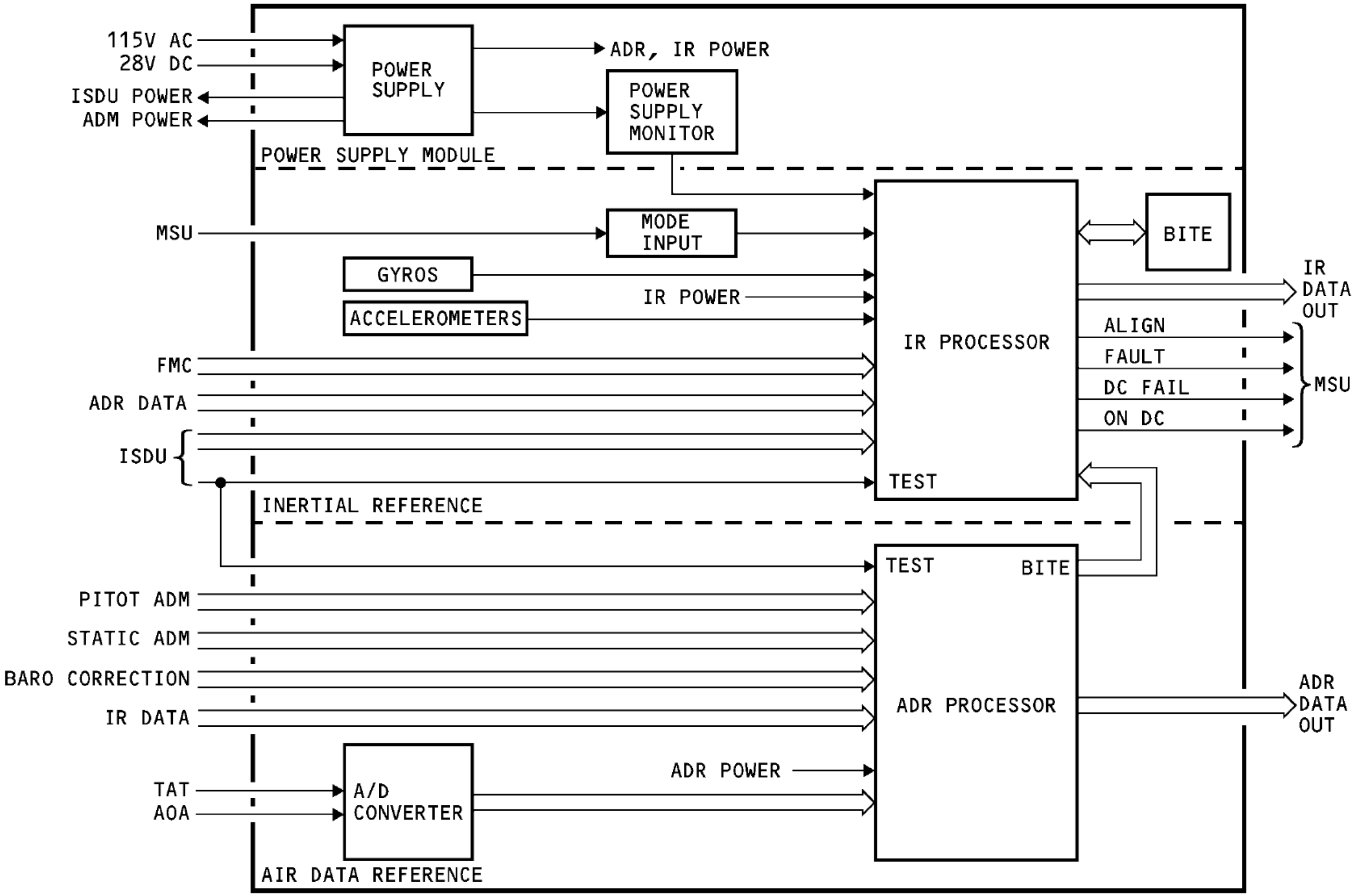
The ISDU or the FMC supplies bite commands and initial position data to the IR processor. The mode of operation comes from the MSU. The gyros and accelerometers supply movement data to the IR processor. The ADR data bus gives altitude, altitude rate, and true airspeed to the IR processor. The IR uses this ADR data as part of its inertial altitude, vertical speed and wind calculations.

The IR processor calculates these IR data values:

- Pitch
- Roll
- Yaw
- Latitude
- Longitude
- True heading
- Magnetic heading
- Inertial velocity vectors
- Linear accelerations
- Angular rates
- Track angle
- Wind speed and direction
- Inertial altitude
- Vertical speed and acceleration
- Ground speed
- Drift angle
- Flight path angle and acceleration.

The IR data goes out on ARINC 429 data buses.

The IR processor sets the ALIGN discrete during the alignment mode



ADIRU FUNCTIONAL DESCRIPTION

Air Data Reference

Static and pitot air pressure come from the air data modules (ADMs). Barometric correction comes from the common display system (CDS).

The ISDU or the IR data bus supplies bite commands to the ADR processor. The IR data bus also gives pitch, roll, vertical speed, and acceleration to the ADR processor. The ADR uses this IR data to calculate thrust and ground effect compensation values. The ADR then uses the calculated thrust and ground effect compensation values as part of its static source error correction calculation.

Total air temperature (TAT) and angle of attack (AOA) data is converted from analog data to digital data by the A/D converter before the data is received by the ADR processor.

The ADR processor calculates these values:

- Altitude
- Baro-corrected altitude
- Altitude rate
- Computed airspeed
- Maximum allowable airspeed
- Mach
- True airspeed
- Static air temperature
- Total air temperature
- Impact pressure
- Static pressure
- Total pressure.

The ADR data goes out on ARINC 429 data buses.

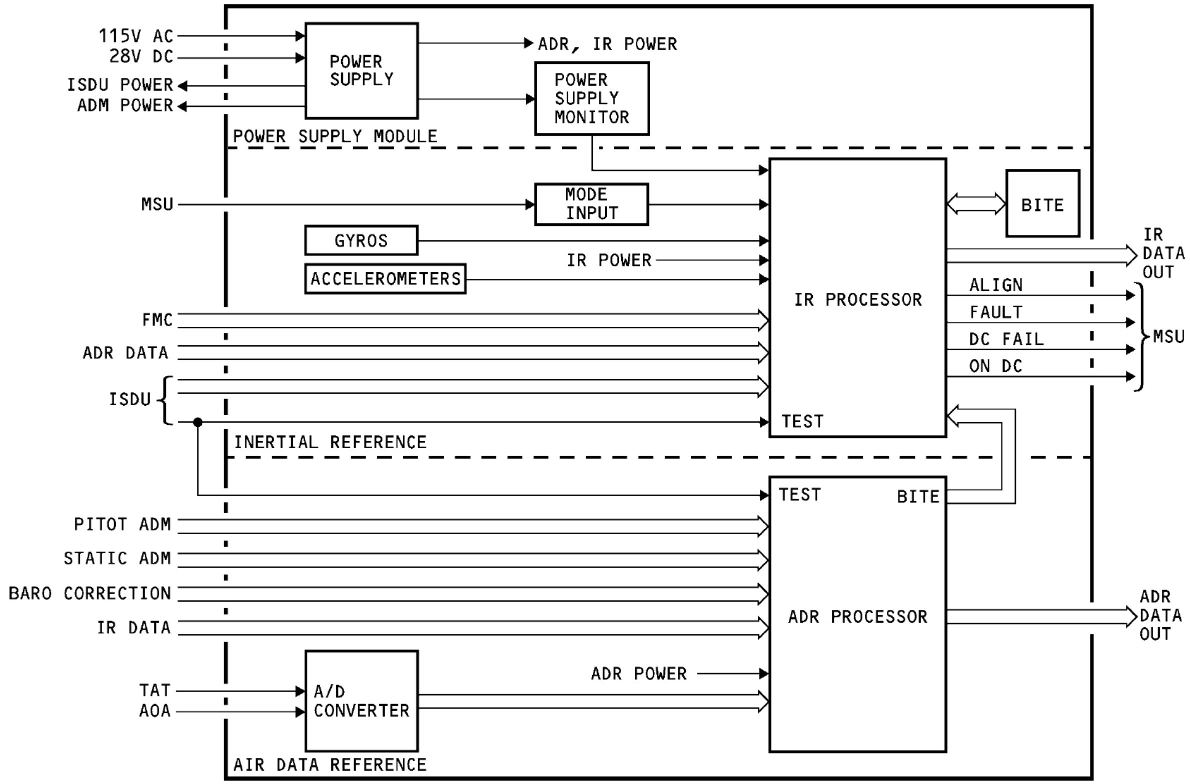
BITE

The IR processor monitors and reports BITE. Detected faults from the ADR or power supply go to the IR processor for processing and storage. The IR processor sends fault data and status data out on ARINC 429 data buses.

IR faults cause the IR processor to set the FAULT discrete.

Power supply faults cause the IR processor to set the DC FAIL or the ON DC discretes.

Alignment problems cause the IR processor to set the ALIGN discrete to an intermittent flash.



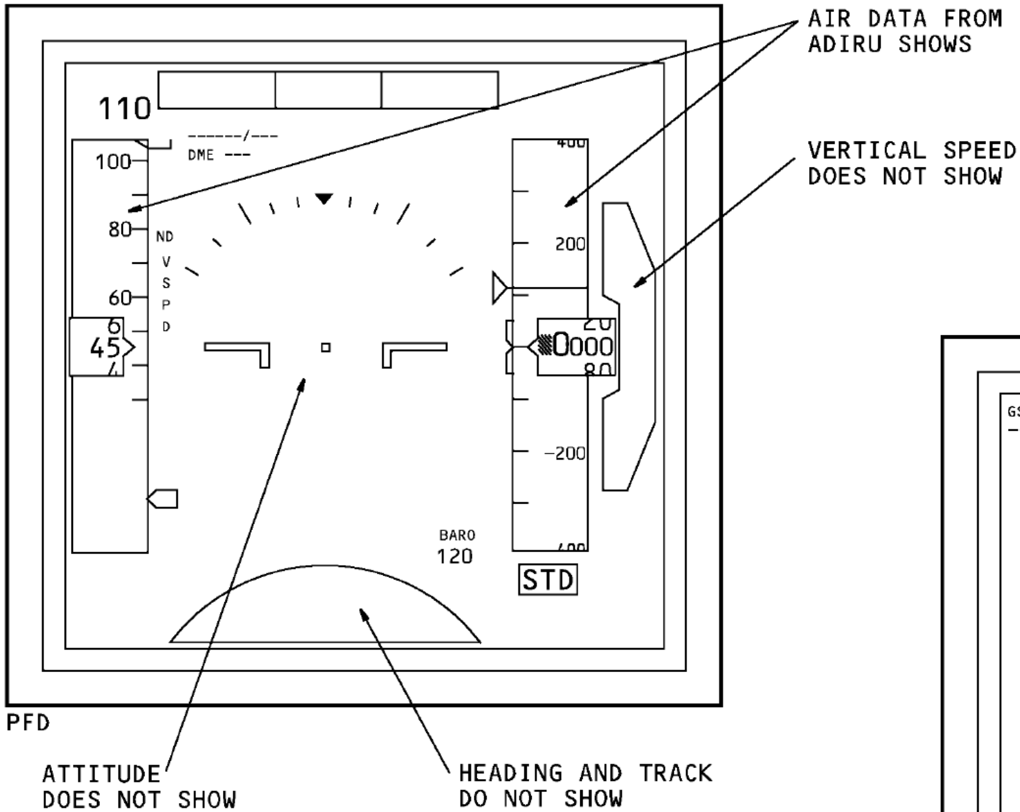
ADIRS INDICATION
PFD AND ND INDICATIONS DURING ALIGNMENT

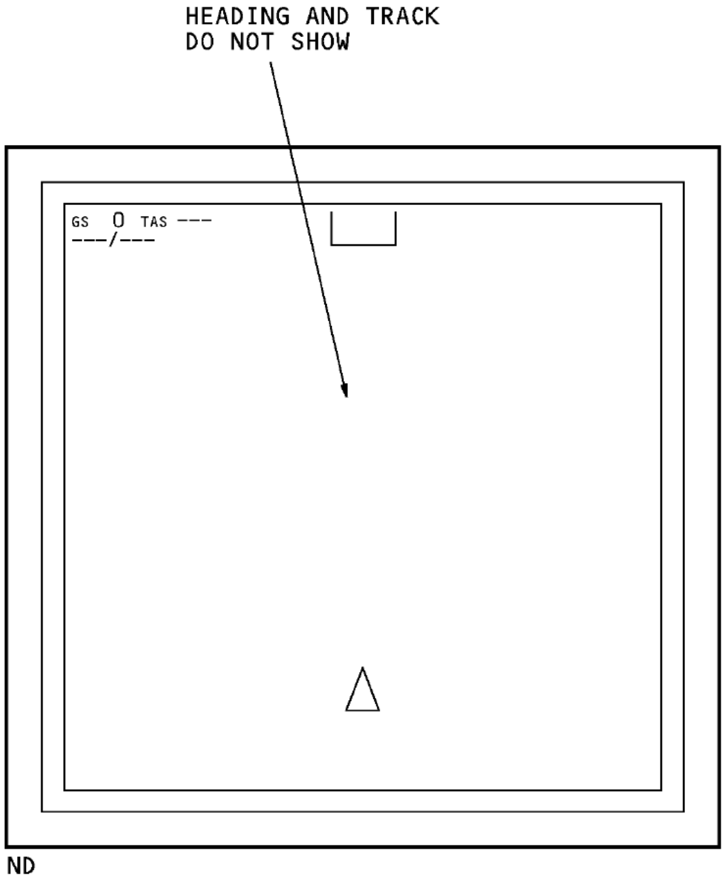
These are the indications on the CDS when the ADIRU is in the align mode:

The PFD shows no computed data (NCD) indications for attitude, heading, and track data

- The PFD shows NCD indication for vertical speed
- The ND shows NCD indications for track and heading data.

Air data from the ADIRU is not affected by the inertial reference (IR) mode of operation. The PFD shows air data information on the speed tape and altitude tape.





PFD AND ND INDICATIONS DURING ALIGNMENT

PFD AND ND INDICATIONS AFTER ALIGNMENT

General

When the ADIRU alignment is complete and the ADIRU is in the NAV mode, the PFD and ND show ADIRU inertial reference (IR) data. The PFD shows this data:

- Horizon and sky/ground shading
- Pitch scale
- Bank (roll) pointer
- Slip/skid indicator
- Heading pointer
- Track line
- Flight path vector
- Selected heading
- Mag/Tru annunciation
- Vertical speed scale. The ND shows this data:
- Heading or track
- Magnetic or true annunciation
- Track/heading scale
- Selected heading
- Ground speed
- Track line.

In flight, the ND also shows this data:

- True airspeed
- Wind speed
- Wind direction.

Display Source Priority

Track and ground speed data comes from the FMC and the ADIRS. The data that shows on the CDS is normally FMC track and FMC ground speed. If the FMC fails, the CDS shows ADIRS track and ground speed.

True Airspeed and Wind Speed and Direction

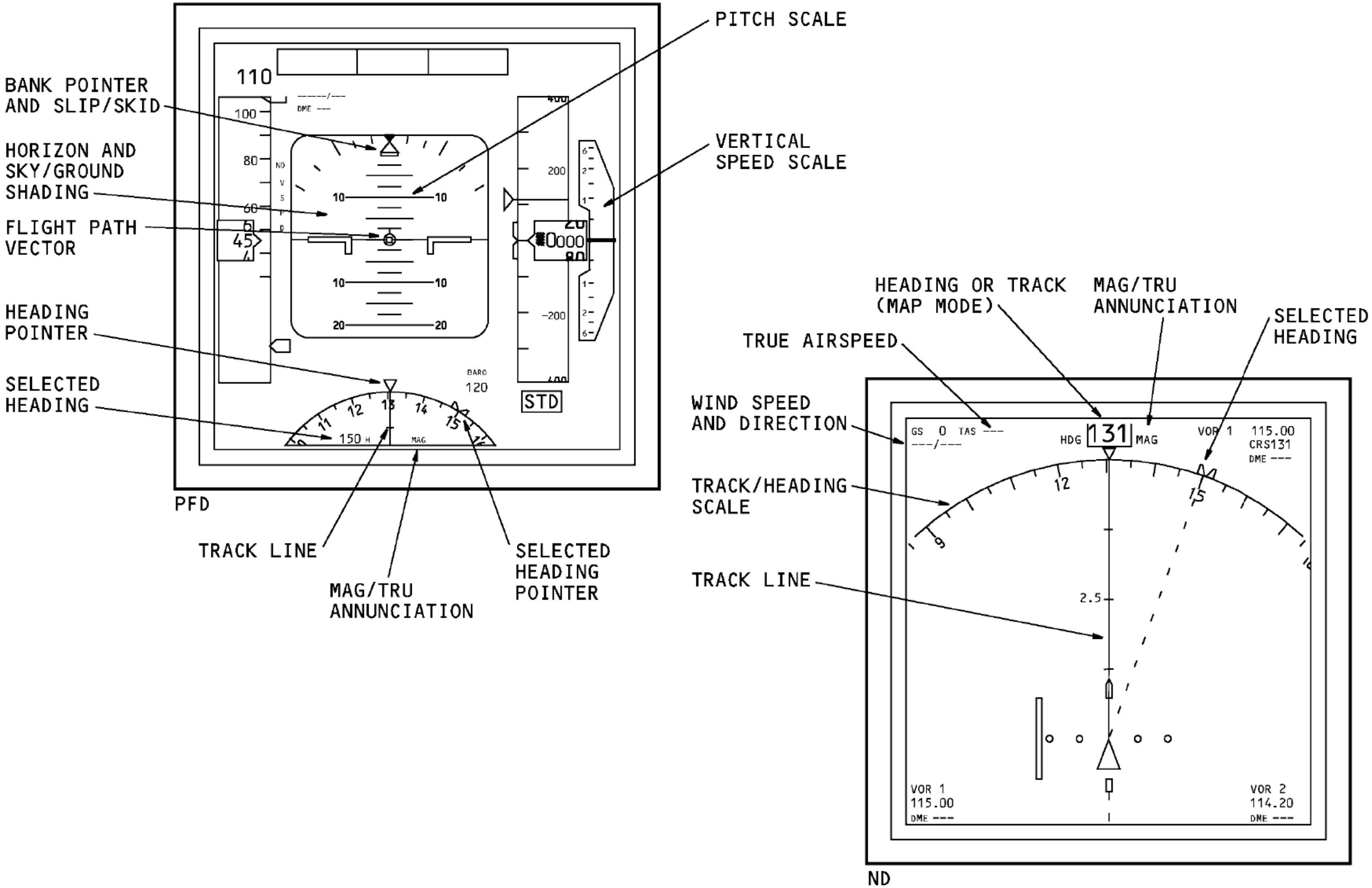
True airspeed does not show on the ND until TAS is more than 100 kts. The normal display when TAS is 100 kts or less is three dashes. This is the NCD indication.
Wind speed and direction does not show until TAS is more than 100 kts. When TAS is 100 kts or less, wind speed and direction is blank.

Flight Path Vector

The flight path vector (FPV) shows on the PFD when you make a selection on the EFIS control panel. The flight path vector symbol shows the motion of the airplane relative to the horizon and the airplane heading. The FPV moves perpendicular to the horizon to show flight path angle and moves parallel to the horizon to show drift angle. On the ground, the flight path vector is centered on the horizon line.

Heading or Track Up Display

The ND reference is airplane heading in the VOR and APP modes. The ND reference is airplane track in the MAP and Plan modes.



PFD AND ND INDICATIONS AFTER ALIGNMENT

PFD AND ND INVALID ADIRS DATA

General

Failure flags show on the PFD and ND for invalid inertial reference (IR) or invalid air data reference (ADR) conditions.

The PFD shows these flags for invalid ADIRS data:

- ATT for invalid attitude data
- ALT for invalid baro altitude data
- FPV for invalid flight path vector data
- HDG for invalid heading data
- SPD for invalid airspeed data
- VERT for invalid vertical speed data.

The ND shows the HDG flag for invalid heading data in the VOR and APP modes. The TRK flag will show in the MAP mode or PLAN mode.

Attitude Flag

When attitude data from the ADIRU is invalid, the PFD shows the ATT flag.

The PFD does not show these values:

- Horizon line
- Sky/ground shading
- Bank pointer
- Slip/skid indicator
- Pitch scale.

Altitude Flag

The ALT flag shows on the PFD for invalid altitude data from the ADIRU. The PFD does not show the altitude tape.

Flight Path Vector Flag

The FPV flag will show on the PFD when attitude data from the ADIRU is invalid. The PFD does not show the flight path vector.

Heading/Track Flag

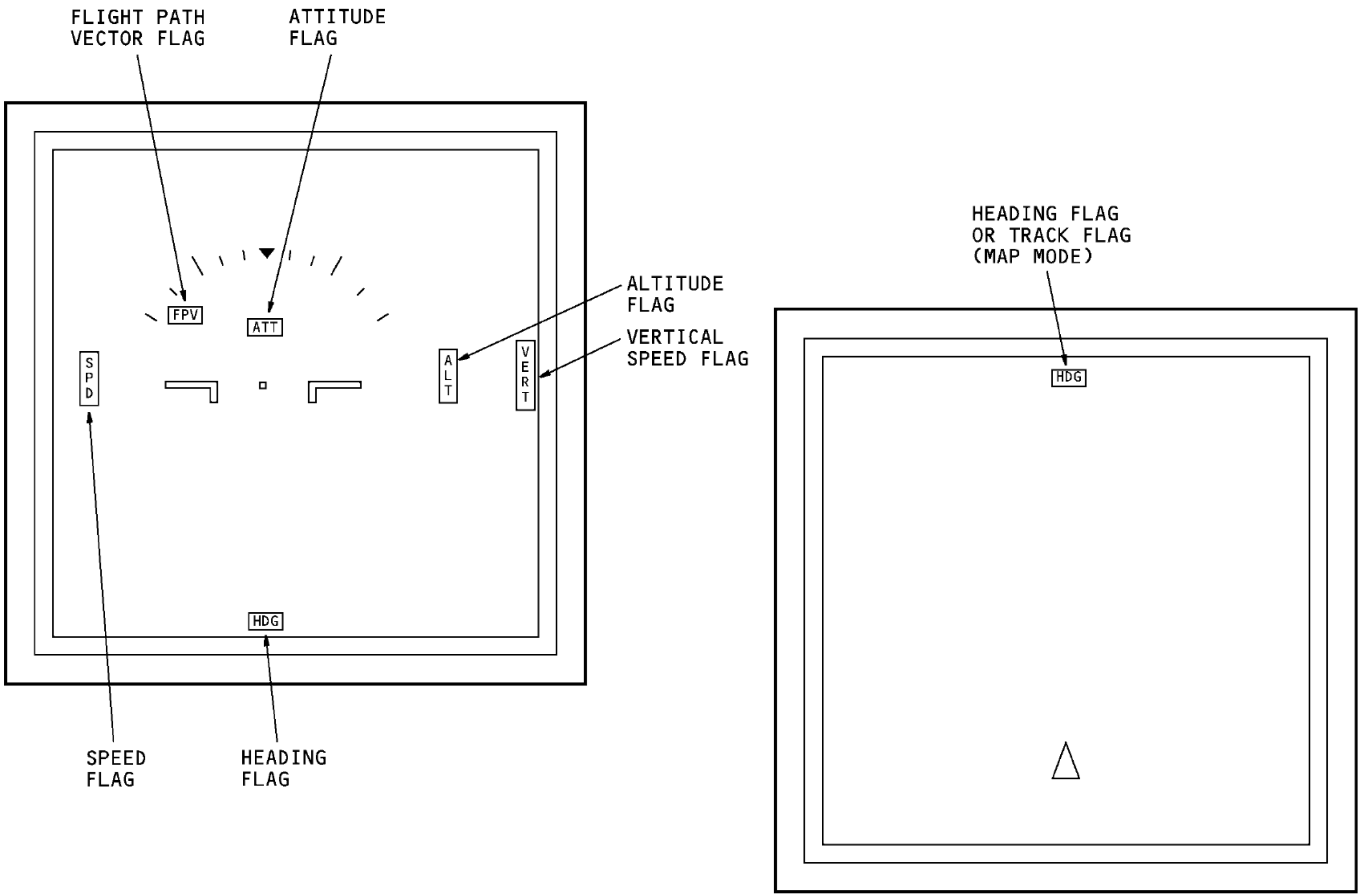
The HDG flag shows on the PFD, and the HDG or TRK flag shows on the ND when the ADIRU heading data is invalid. Heading and track data do not show.

Speed Flag

The SPD flag shows on the PFD when ADIRS airspeed data is invalid. The Speed tape does not show on the PFD.

Vertical Speed Flag

The VERT flag shows on the PFD when ADIRS vertical speed data is invalid. The vertical speed scale and pointer do not show on the PFD.



PFD AND ND INVALID ADIRS DATA

BAROMETRIC CORRECTION INDICATION

General

Barometric correction adjusts the barometric altitude value that shows on the altimeter indication. This adjusts for changes in barometric pressure.

Barometric Correction Controls

The barometric correction controls are on the EFIS control panels. The controls select and set barometric correction reference, values, and displays.

These are the barometric controls:

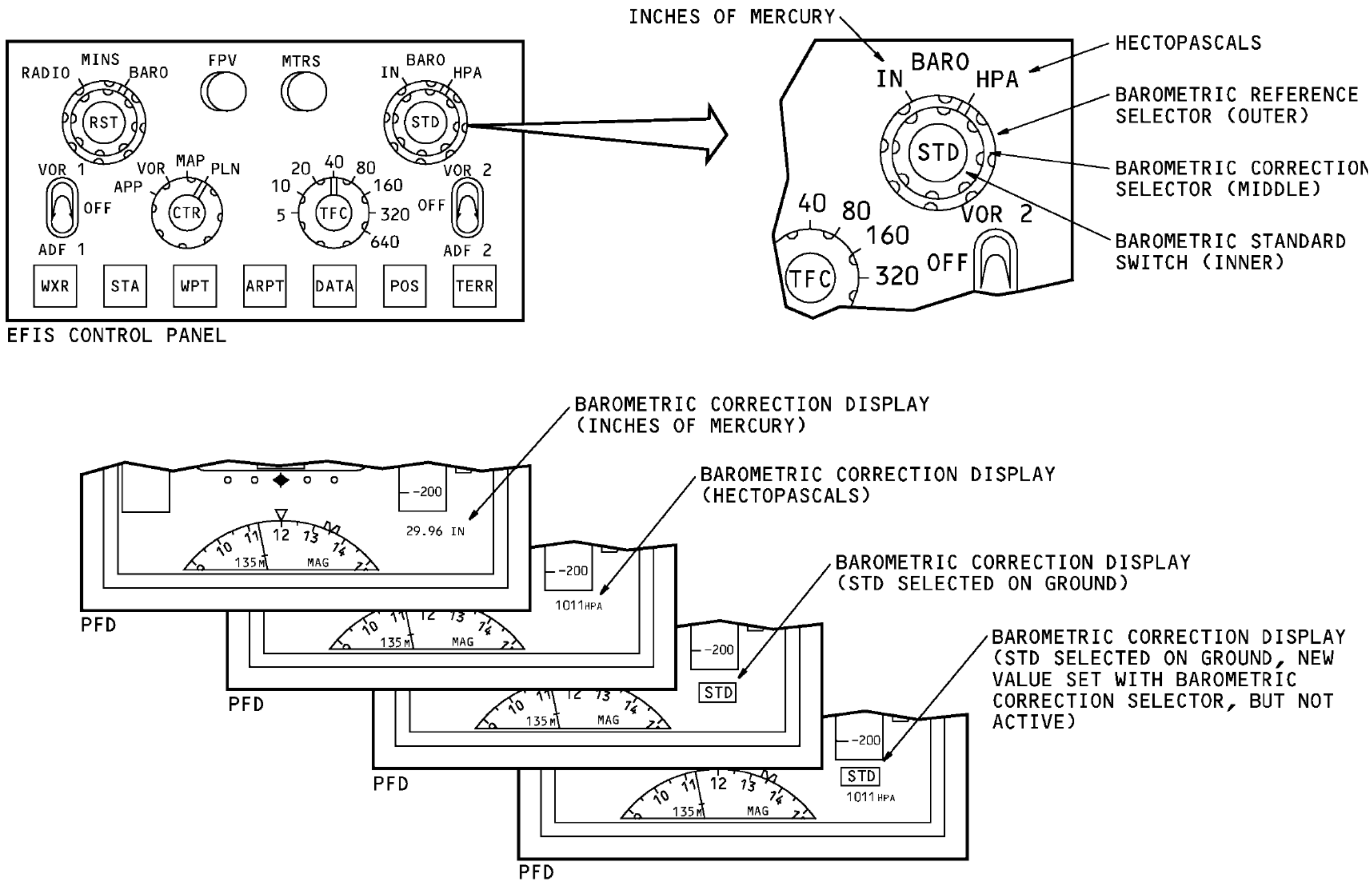
- Barometric reference selector - selects inches of mercury (IN) or hectopascals (HPA) as the barometric reference
- Barometric correction selector - sets the value of barometric correction
- Barometric standard (STD) switch - push the switch to set the barometric standard to 29.92 in Hg, 1013 hPa.

Barometric Correction Display

Barometric correction shows on the PFD below the altitude tape. The barometric correction shows in Hg or hPa. The EFIS control panel barometric reference selector determines the format that shows.

Push the STD switch to show standard barometric correction.
When the barometric altitude of the airplane is at or below the FMC transition altitude plus 300 feet, a yellow boxed STD replaces the standard barometric correction value.

When you set a new barometric correction value and STD is active, the new value will show below the STD value. Push the STD switch to remove the STD value and make the new value active.

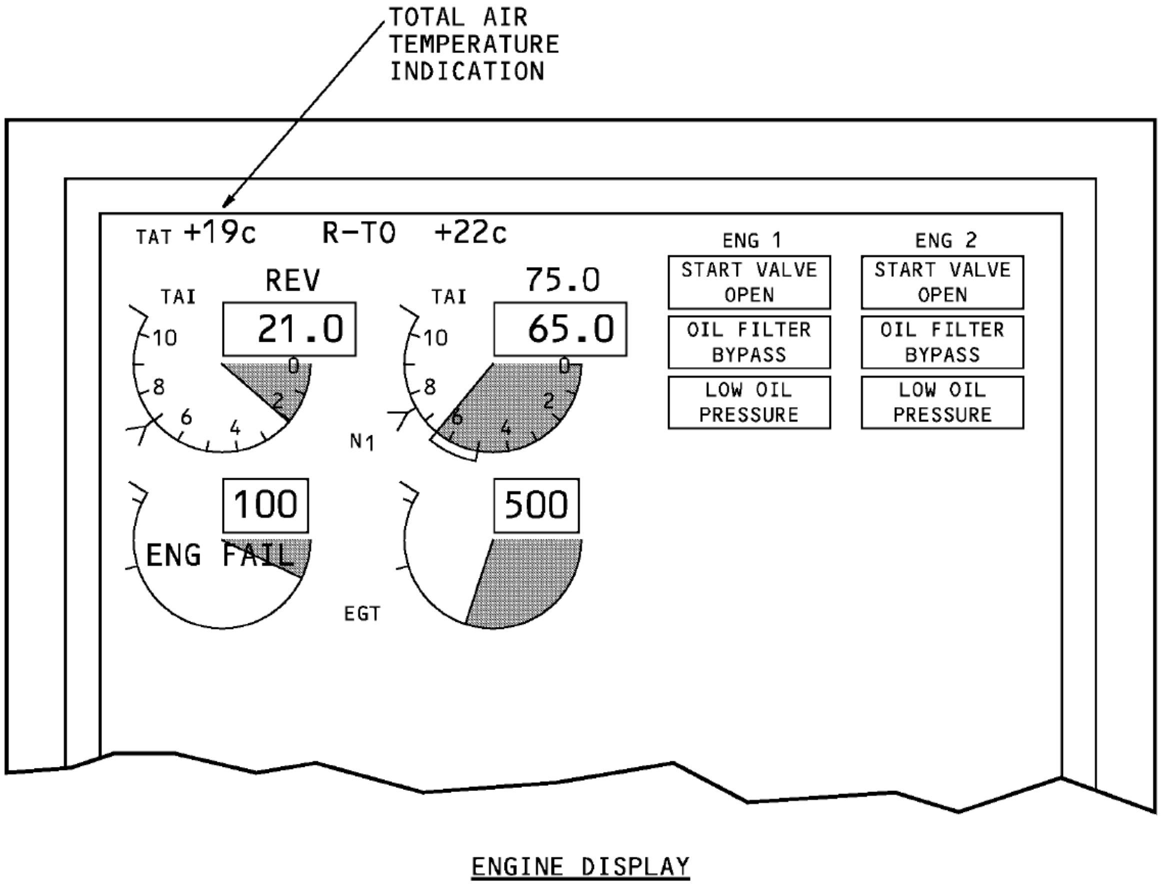


BAROMETRIC CORRECTION INDICATION

TAT INDICATION

General

Total air temperature (TAT) from the ADIRUs shows on the top of the engine display. The TAT value that shows is from the left ADIRU. When the left ADIRU TAT is invalid, the right ADIRU TAT value shows. TAT goes out of view when the data from both ADIRUs is invalid.



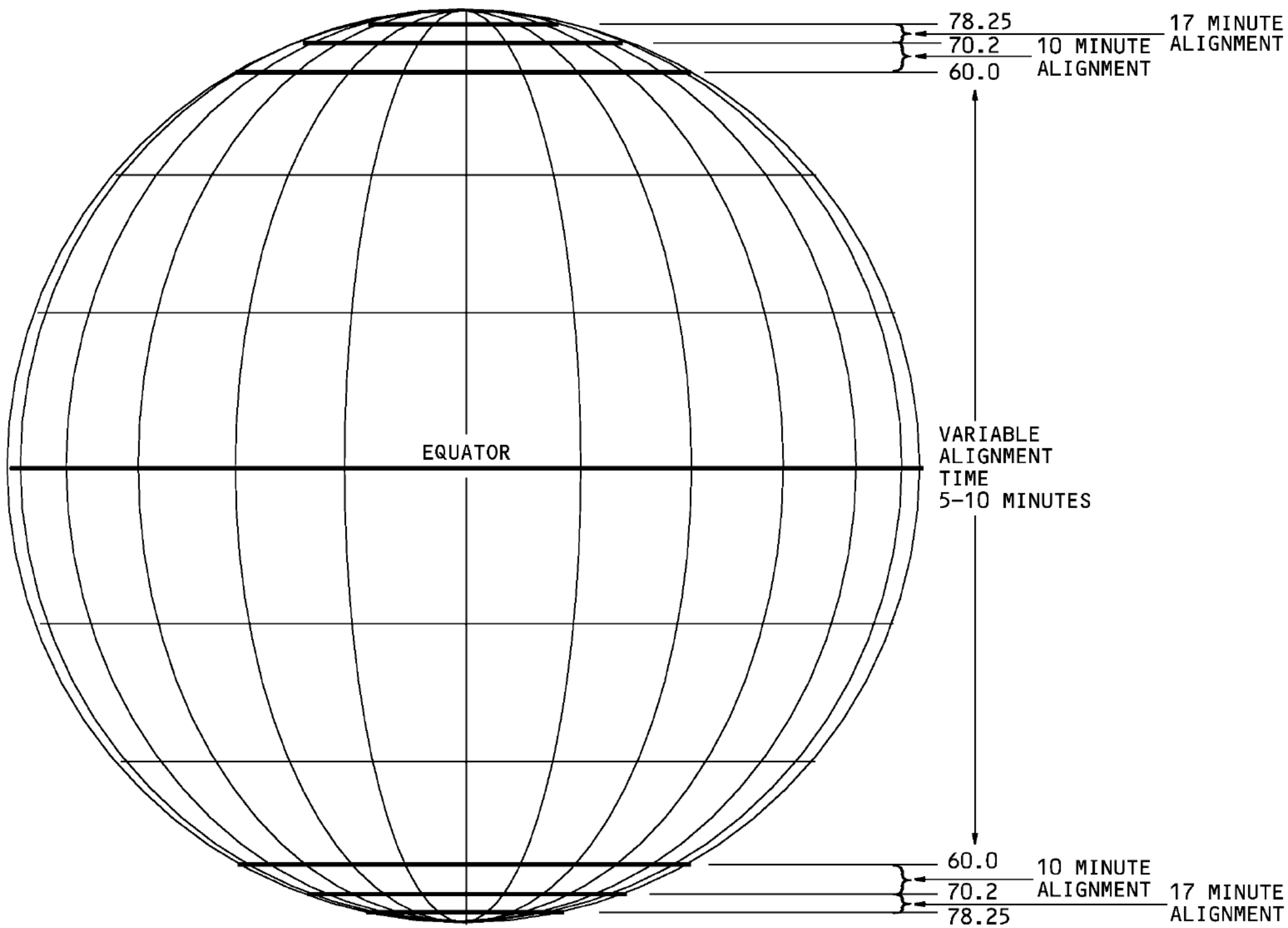
TAT INDICATION

THIS PAGE IS INTENTIONALLY LEFT BLANK

ADIRS - ALIGNMENT PROCEDURE

The ADIRS alignment time will change between a minimum of 5 minutes at the equator to 17 minutes maximum at 78.25 degrees, north or south latitudes.

The alignment time will not be more than 10 minutes if the present position latitude is between 60.0 degrees north or south. The alignment time is fixed at 10 minutes between latitudes of 60.0 and 70.2 degrees north or south. The alignment time is fixed at 17 minutes between latitudes of 70.2 and 78.25 degrees north or south.



ADIRS – ALIGNMENT PROCEDURE

Alignment Mode

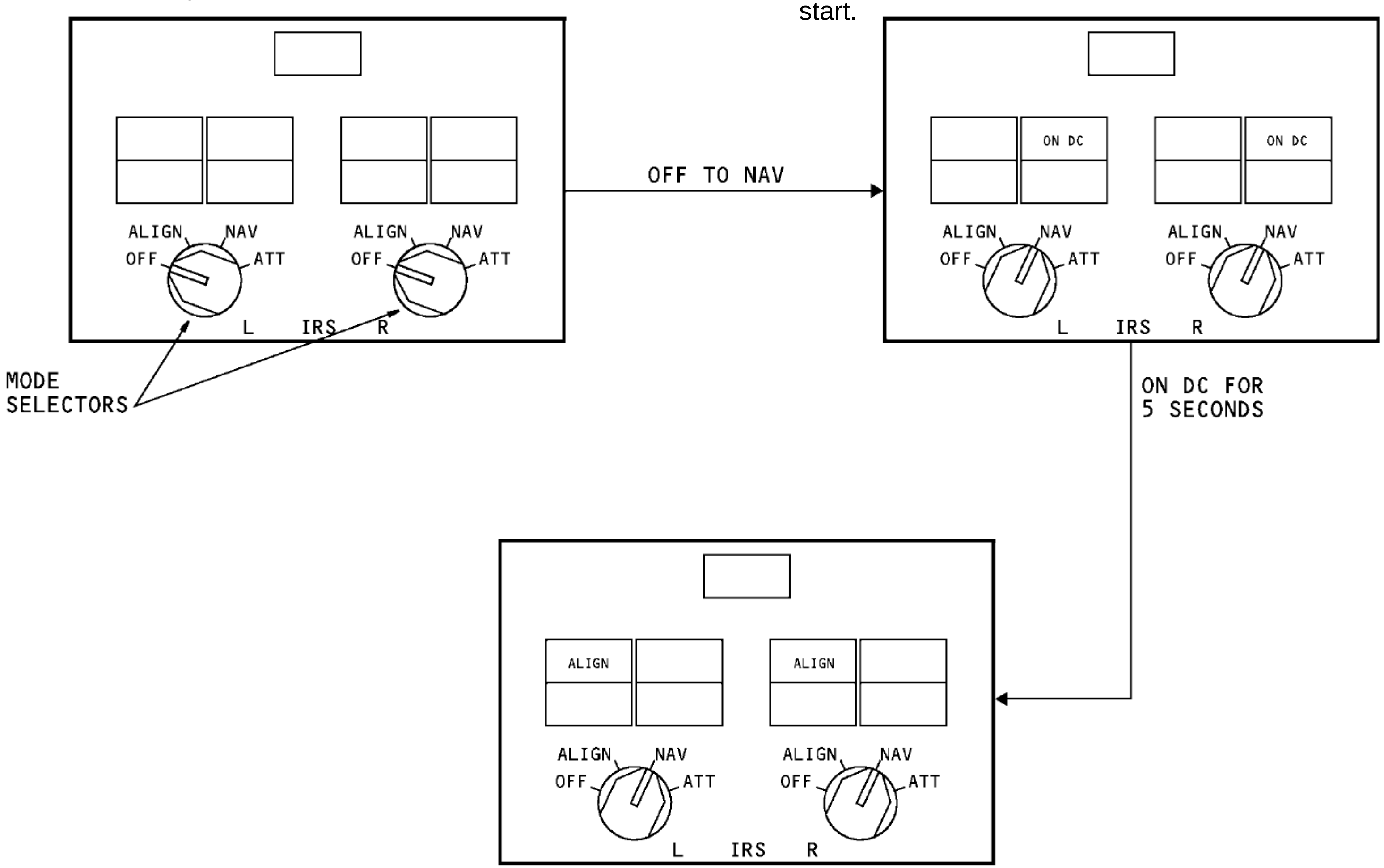
Caution: SOME SWITCHES MUST BE PULLED AND THEN TURNED. IF YOU TRY TO TURN THESE SWITCHES BEFORE YOU PULL THEM, YOU CAN DAMAGE THE SWITCH.

Use the mode selector on the MSU to start the ADIRU alignment. Move the selector from OFF to NAV. The left selector controls the left ADIRU and the right selector controls the right ADIRU.

The ON DC light comes on for 5 seconds. During this time, the ADIRU does a check of its dc power source. After 5 seconds, the ON DC light goes off and the ALIGN light comes on. The ADIRU is now in the alignment mode.

Training Information Point

If the ADIRU detects airplane movement during the alignment mode, the alignment process will stop. After the motion stops, a new alignment will start.

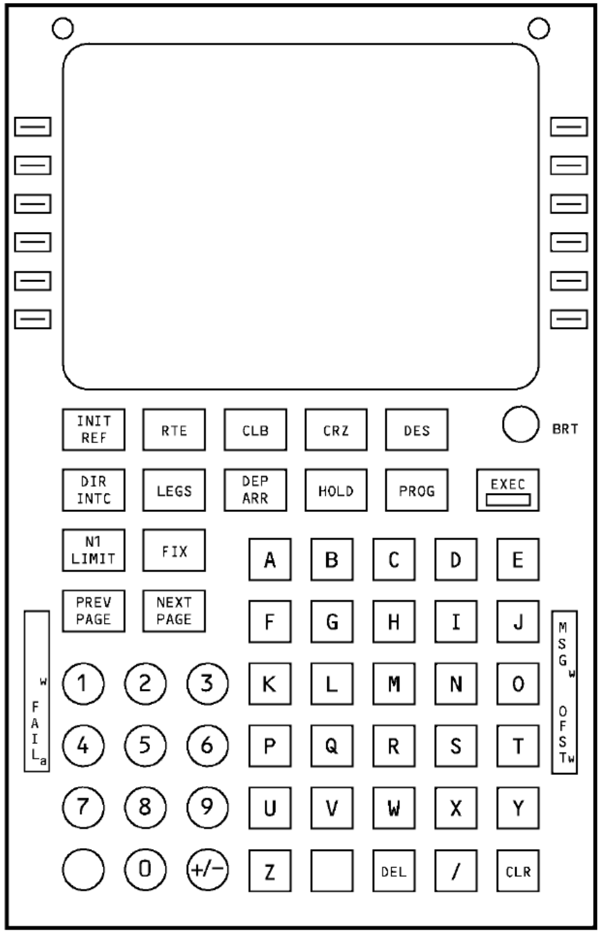


ALIGNMENT MODE

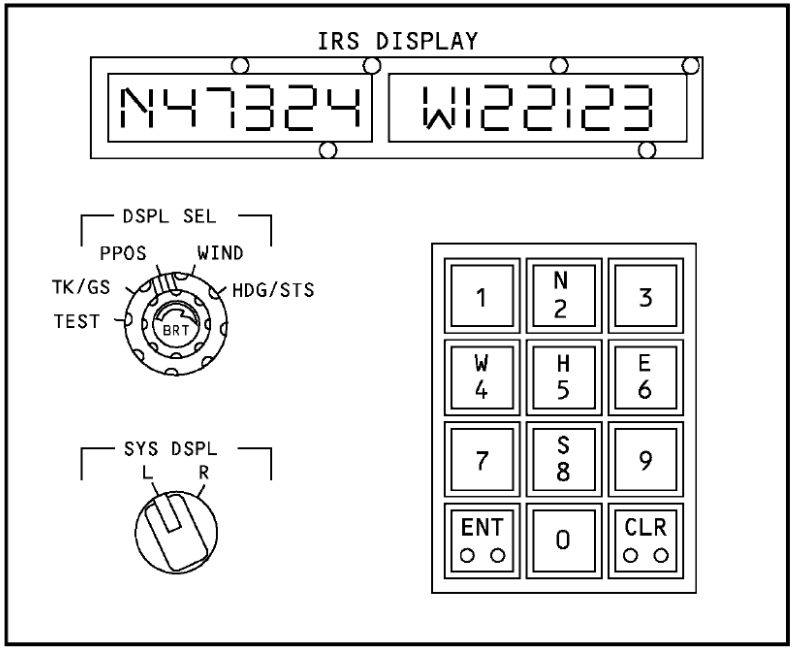
PRESENT POSITION ENTRY

You must enter present position data for the ADIRU during alignment. The ADIRU calculates present position latitude but it cannot calculate present position longitude. The ADIRU uses your entry for latitude and longitude. The ADIRU compares your latitude entry to its calculated value to make sure its calculation of latitude is correct.

You can use the ISDU or the FMC CDU to enter present position data. When both ADIRUs are in alignment mode, you only need to enter the data one time. The data goes to both ADIRUs. If you make a wrong entry, you can enter the data again. The ADIRUs use the last data entry that you make.



FMCS CDU



ISDU

PRESENT POSITION ENTRY

CDU Present Position Entry

ADIRS present position can be set using the FMC CDU. Push the INIT/REF key on the CDU to show the position initialization (POS INIT) page.

From this page, there are these three procedures that you can use to enter present position for the ADIRUs:

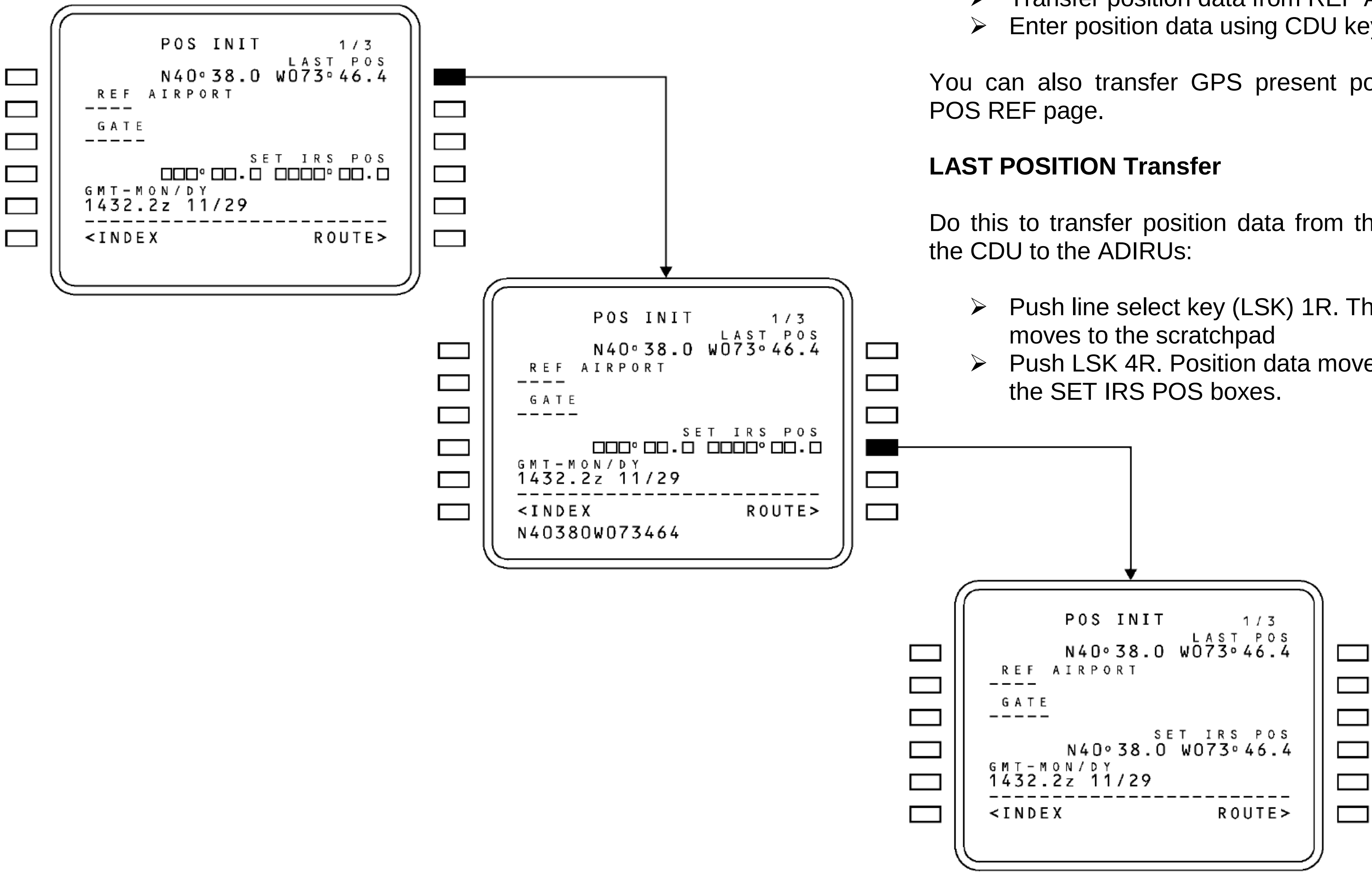
- Transfer position data from LAST POS line
- Transfer position data from REF AIRPORT line
- Enter position data using CDU keyboard.

You can also transfer GPS present position from the CDU POS REF page.

LAST POSITION Transfer

Do this to transfer position data from the LAST POS line on the CDU to the ADIRUs:

- Push line select key (LSK) 1R. The position data moves to the scratchpad
- Push LSK 4R. Position data moves from scratchpad to the SET IRS POS boxes.



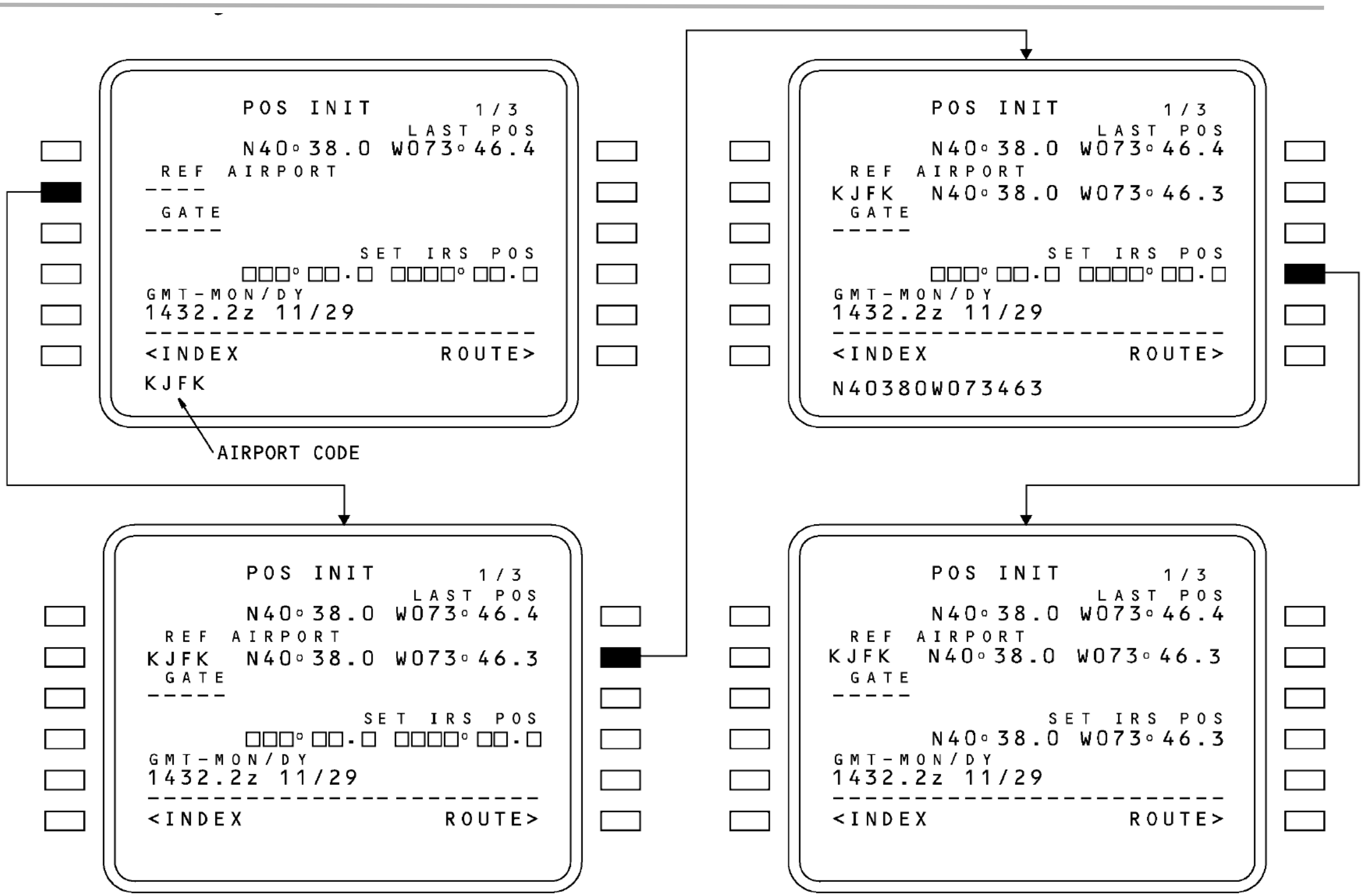
LAST POSITION ENTRY

Reference airport position entry

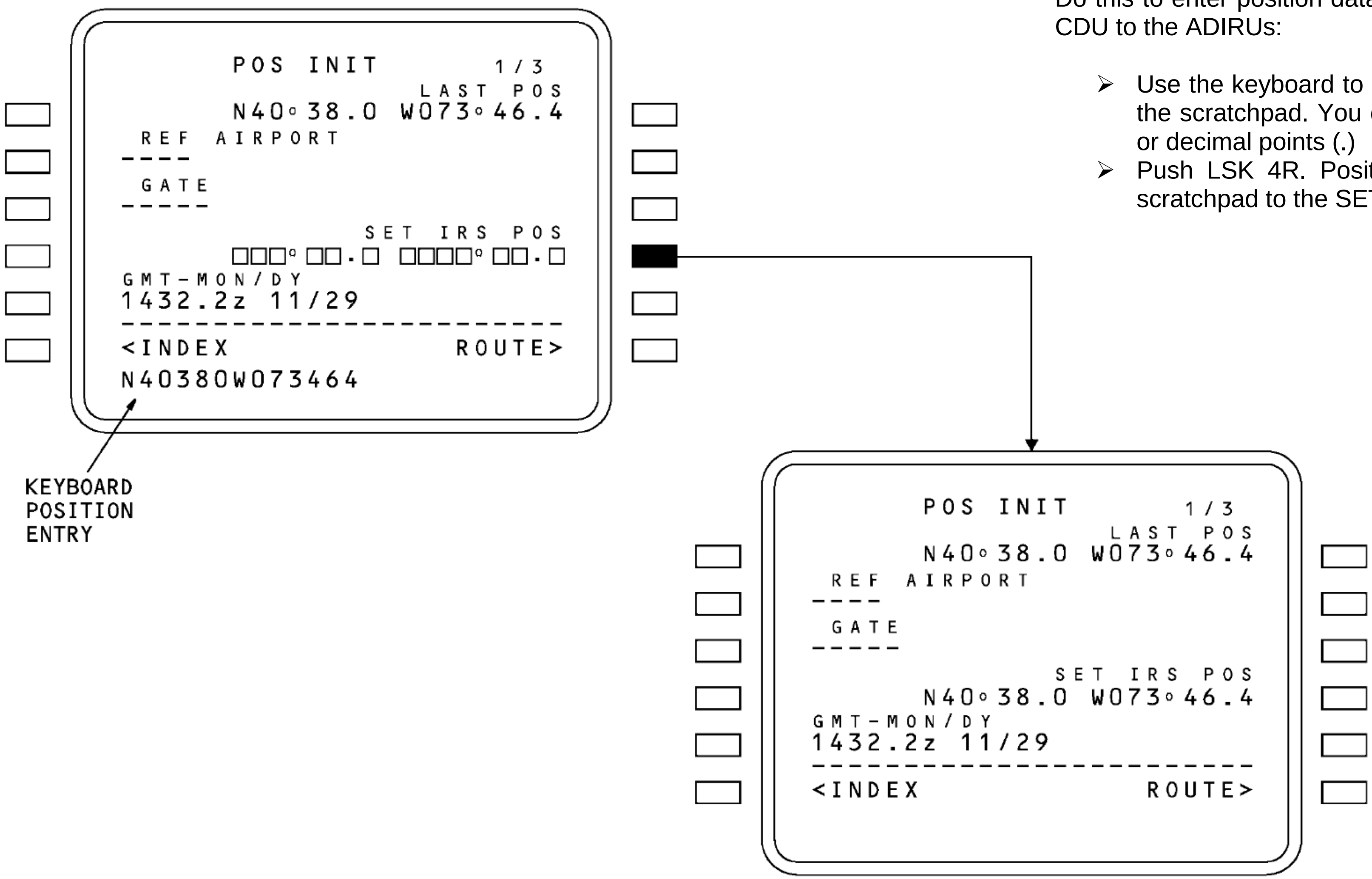
Do this to transfer position data from the REF AIRPORT line on the CDU to the ADIRUs:

- Use the CDU keyboard to enter the airport code in the scratchpad.
- Push LSK 2L. The airport code moves to REF AIRPORT and airport position data shows.
- Push line select key (LSK) 2R. The position data moves to the scratchpad.
- Push LSK 4R. The position data moves from the scratchpad to the SET IRS POS boxes.

> Note: Some reference airports also have the position of gates. Enter the gate number in the scratchpad after you push LSK 2L. Push LSK 3L and the gate position will show. This position may be used as present position.



REFERENCE AIRPORT POSITION ENTRY



CDU Keyboard present position entry

Do this to enter position data from the keyboard on the CDU to the ADIRUs:

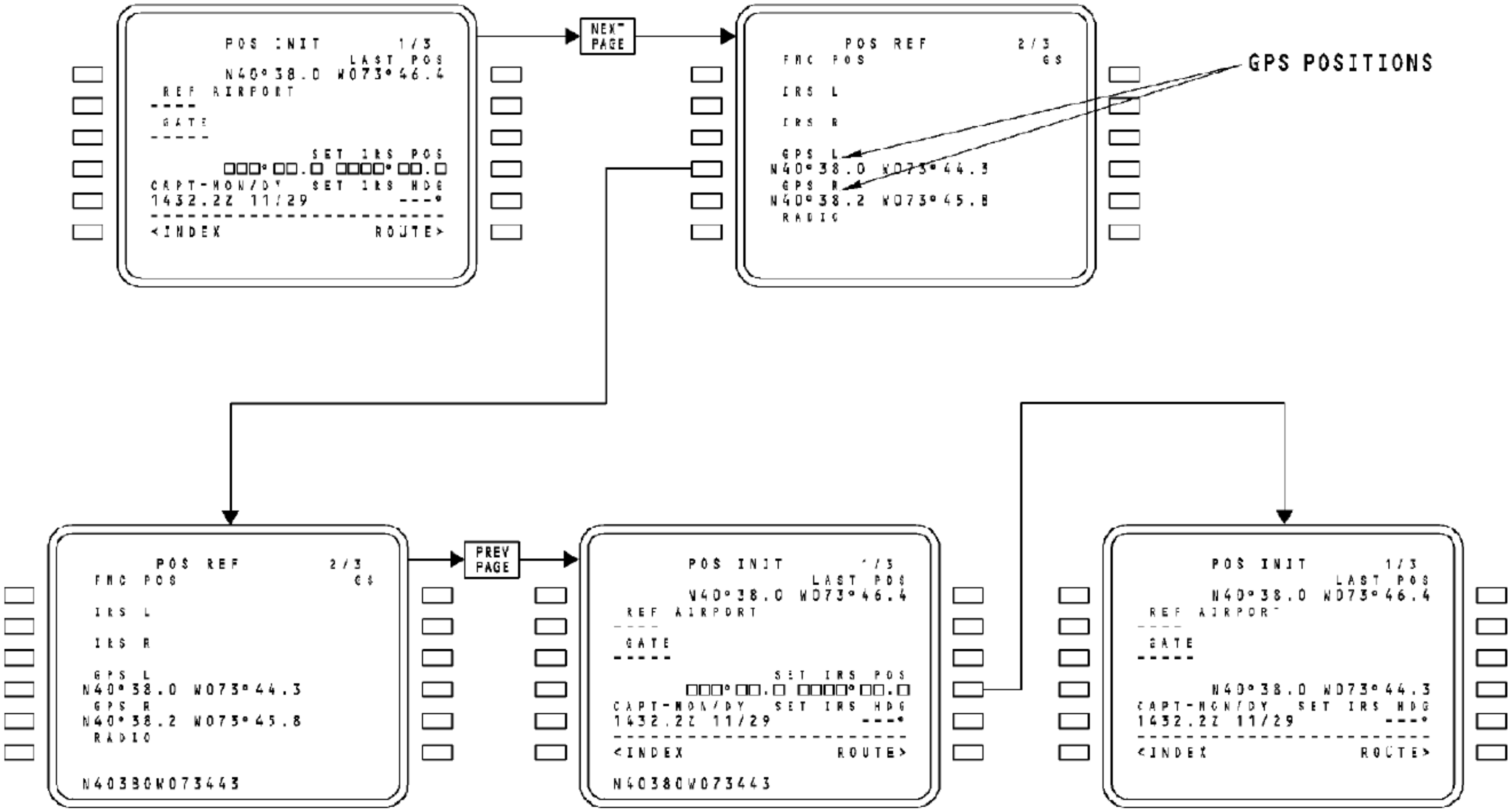
- Use the keyboard to enter the position data into the scratchpad. You do not need to use spaces or decimal points (.)
- Push LSK 4R. Position data moves from the scratchpad to the SET IRS POS boxes.

PRESENT POSITION ENTRY THROUGH CDU

GPS Position Transfer

Do this to transfer GPS position data from the POS REF page on the CDU to the ADIRUs:

- Push the NEXT PAGE key on the CDU. The INIT REF page changes to the POS REF page.
- Push LSK 4L, or LSK 5L. The GPS L or GPS R position data moves to the scratchpad.
- Push the PREV PAGE key on the CDU. The POS REF page changes to the INIT REF page. The GPS position data stays in the scratchpad.
- Push LSK 4R. The GPS position data moves from the scratchpad to the SET IRS POS boxes.



PRESENT POSITION ENTRY

ISDU Present Position Entry

You can use the ISDU keyboard to enter present position data for the ADIRUs. The display selector (DSPL SEL) can not be in TEST. You can enter latitude or longitude first.

Latitude Entry

Push the N2 or S8 key to enter latitude. The letter N or S shows in the left IRS DISPLAY and the light on the ENT key comes on. Push the keys to enter the latitude data. When you push each key, the number appears at the far right of the left IRS DISPLAY. Numbers entered before will shift one space to the left. Push the ENT key to send the data to the ADIRUs. The light on the ENT key goes off. If the display selector is in a position other than PPOS, the IRS DISPLAY will change to the information that showed before you started the position entry.

Longitude Entry

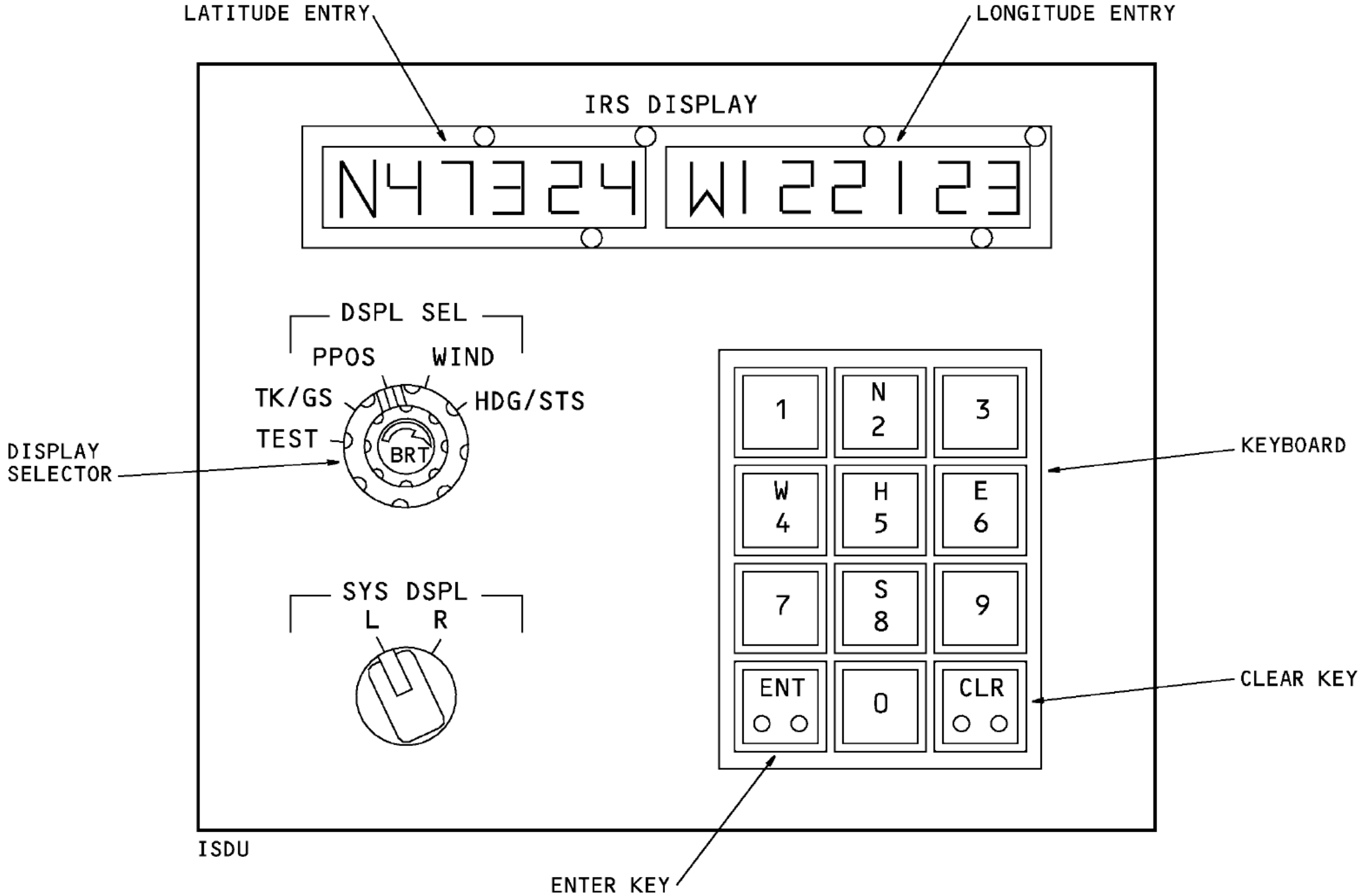
The longitude entry is similar to the latitude entry. Push the W4 or E6 key to enter longitude. The longitude data will show in the right IRS DISPLAY.

Invalid Position Entry

These keyboard entries cause the CLR key light to come on when you push the ENT key:

- Latitude greater than 90 degrees
- Longitude greater than 180 degrees
- Minute value greater than 59.9.

Push the CLR key to clear the invalid position entry.

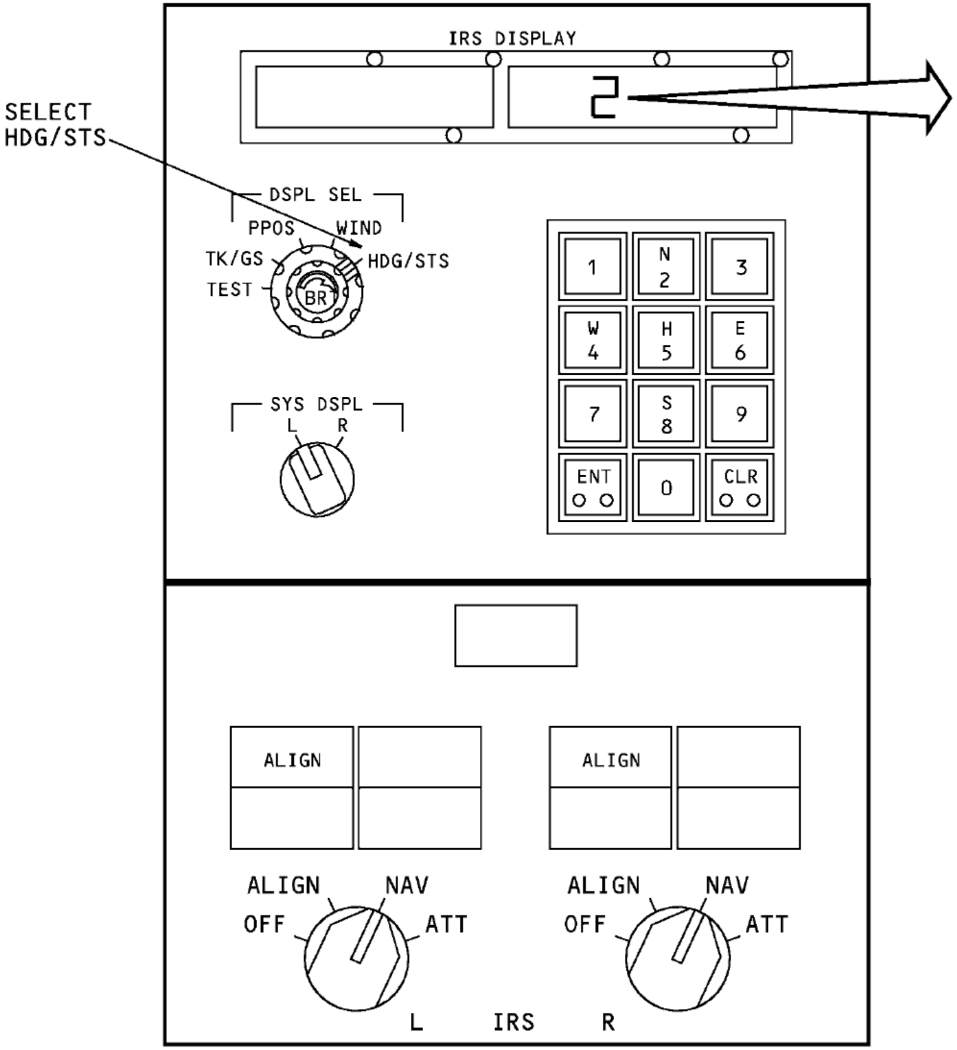


PRESENT POSITION ENTRY FROM ISDU

ALIGNMENT TIME

You can see the time remaining to alignment on the ISDU. Set the DSPL SEL switch to the HDG/STS position. The right IRS DISPLAY shows the time in minutes until the ADIRU is aligned. For 17 minute alignments, 15 shows in the right IRS DISPLAY for the first three minutes. After three minutes, the display counts down to zero.

The ADIRU goes to the navigation mode at the end of the alignment time if the mode select switch is in the NAV position and present position has been entered.



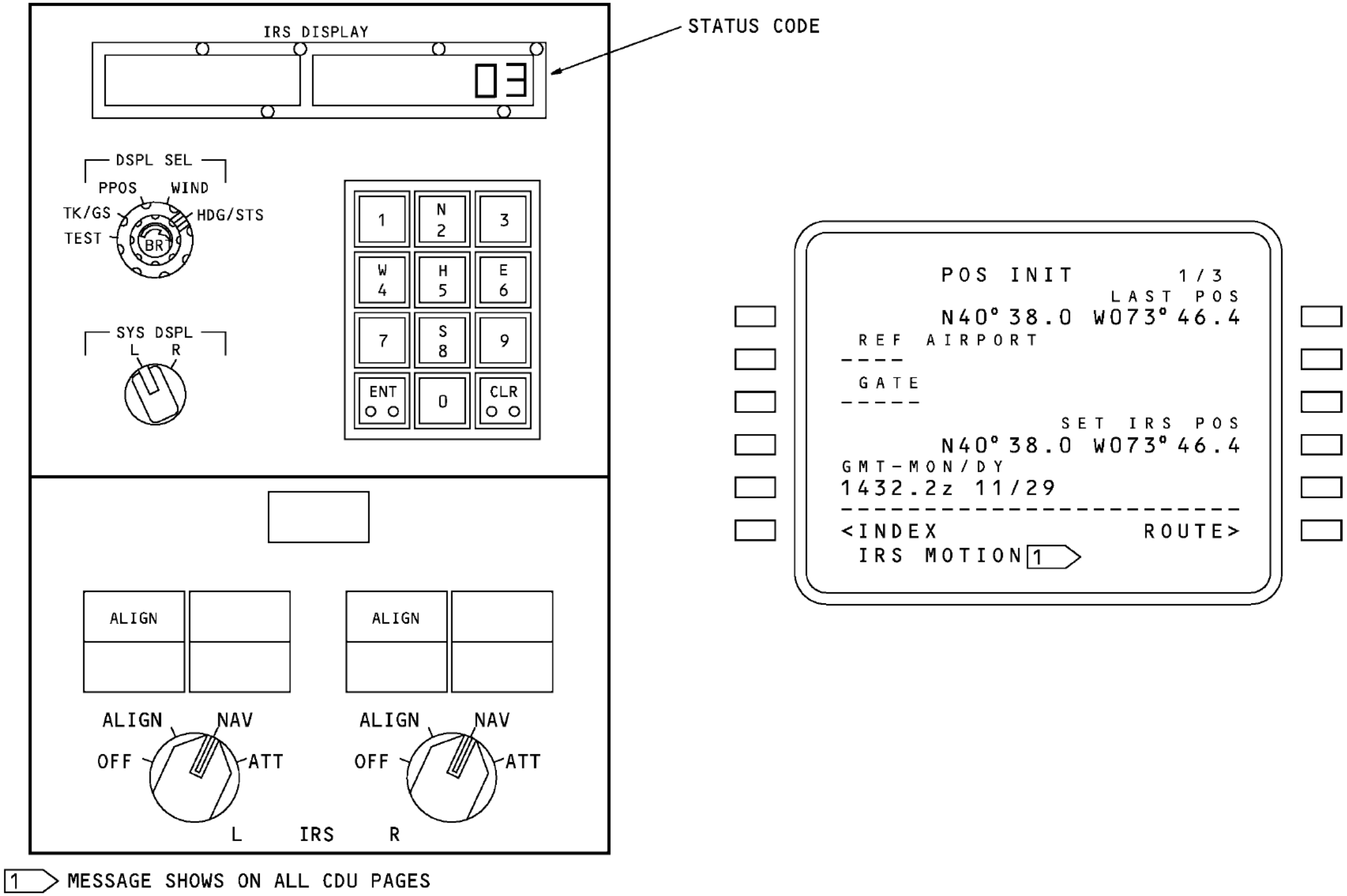
MINUTES REMAINING	SHOW NUMBER
17	15
16	15
15	15
14	14
13	13
12	12
11	11
10	10
9	9
8	8
7	7
6	6
5	5
4	4
3	3
2	2
1	1
0	0

ALIGNMENT TIME

IRS MOTION

When the ADIRUs are in the alignment mode and the ADIRUs detect airplane movement, the alignment mode stops. A status code 3 shows on the ISDU and IRS MOTION shows on the CDU scratchpad. After 30 seconds, the ADIRUs do a check for airplane motion. When the motion stops, the ADIRUs start new alignments. When the new alignment starts, the status code 3 goes out of view. You push the CLR key on the CDU to remove the IRS MOTION message from the CDU scratchpad.

Note: The display selector must be in the HDG/STS position to see the status code 3.



IRS MOTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

POSITION DIFFERENCE DURING ALIGNMENT

> Note: The ADIRU does not calculate longitude. The ADIRU will not detect an incorrect longitude entry after alignment is complete.

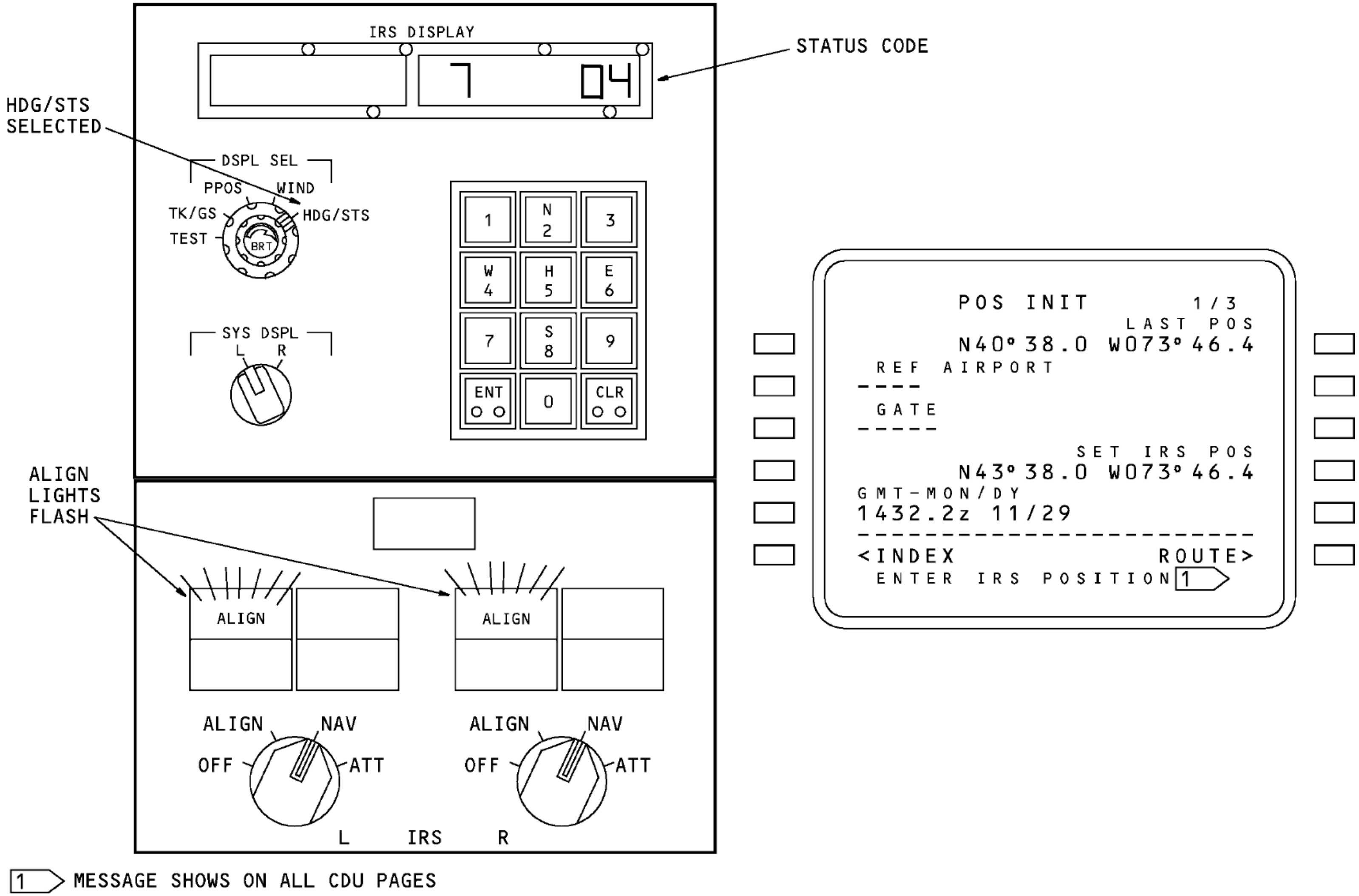
The ADIRU keeps a record of its last position. You must enter position data during the alignment mode.

When you enter position data that is more than 1 degree different than the recorded latitude or 1 degree different than the recorded longitude, these things occur:

- ALIGN light flashes
- Status code 4 shows on ISDU
- ENTER IRS POSITION shows on CDU.

Enter the same position data again to cause these to occur:

- Align light on (no flash)
- Status code 4 goes out of view
- ENTER IRS POSITION goes out of view.



POSITION DIFFERENCE DURING ALIGNMENT

POSITION DIFFERENCE AFTER ALIGNMENT

At the end of the alignment period, if the ADIRU calculated latitude is different than the latitude you entered, you will see these conditions:

- ALIGN light flash
- SET IRS POSITION shows on CDU
- Alignment time shows 0 on ISDU
- Status code out of view on ISDU.

If you enter the same latitude again, you will see these conditions:

- ALIGN light on
- FAULT light on
- SET IRS POSITION on CDU goes out of view
- Alignment time shows 0 on ISDU
- Status code 2 shows on ISDU.

One of these will cause a latitude difference:

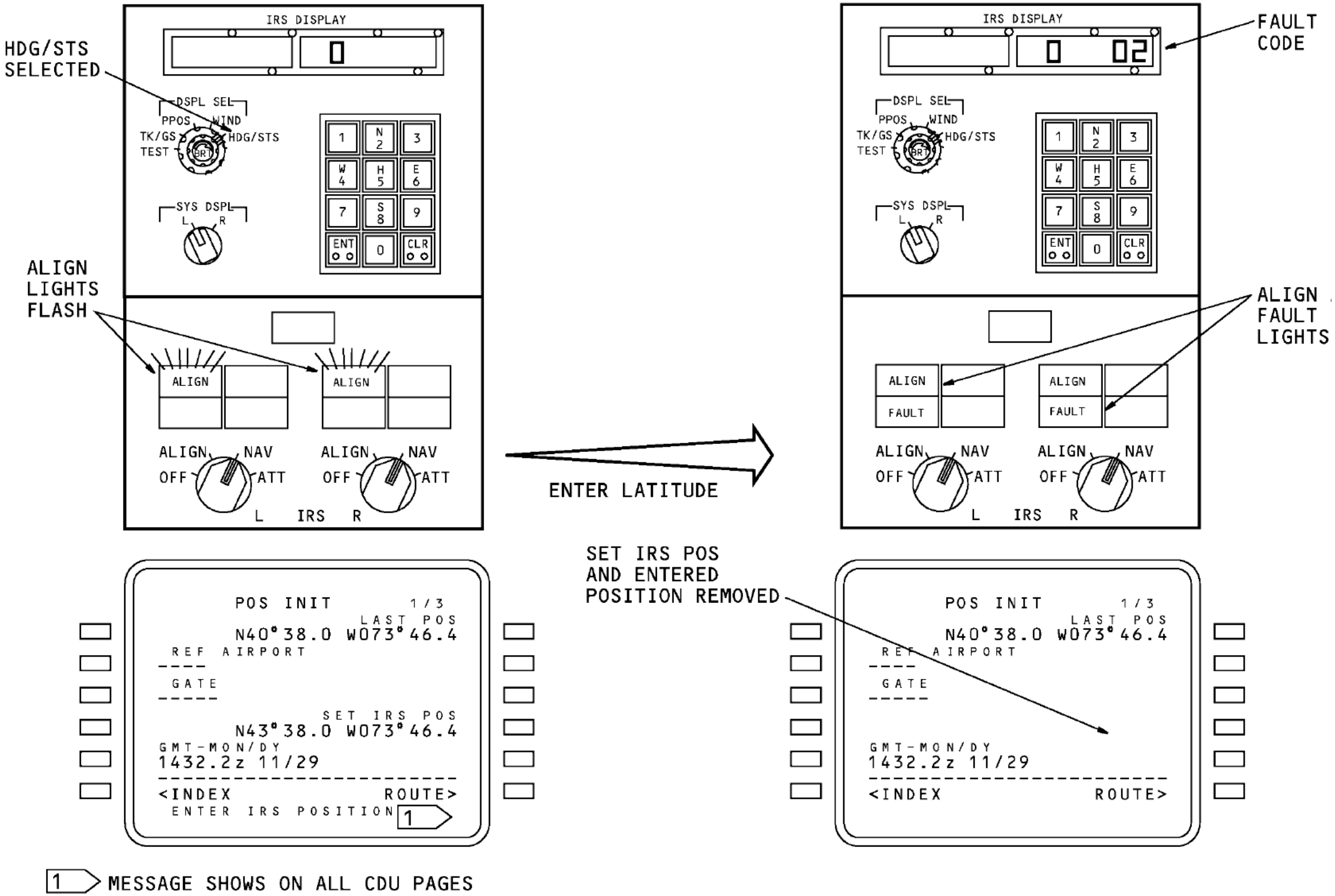
- ADIRU calculated latitude error
- Latitude entry error.

ADIRU Calculated Latitude Error

A calculated latitude error usually will occur in one ADIRU. If the position difference is in one ADIRU, start a new alignment. If the new alignment has a position difference, refer to troubleshooting procedures in part two of the maintenance manual.

Latitude Entry Error

A latitude entry error gives the wrong latitude to both ADIRUs. If the position difference is in the left and right ADIRU, correct position can be entered without starting a new alignment.



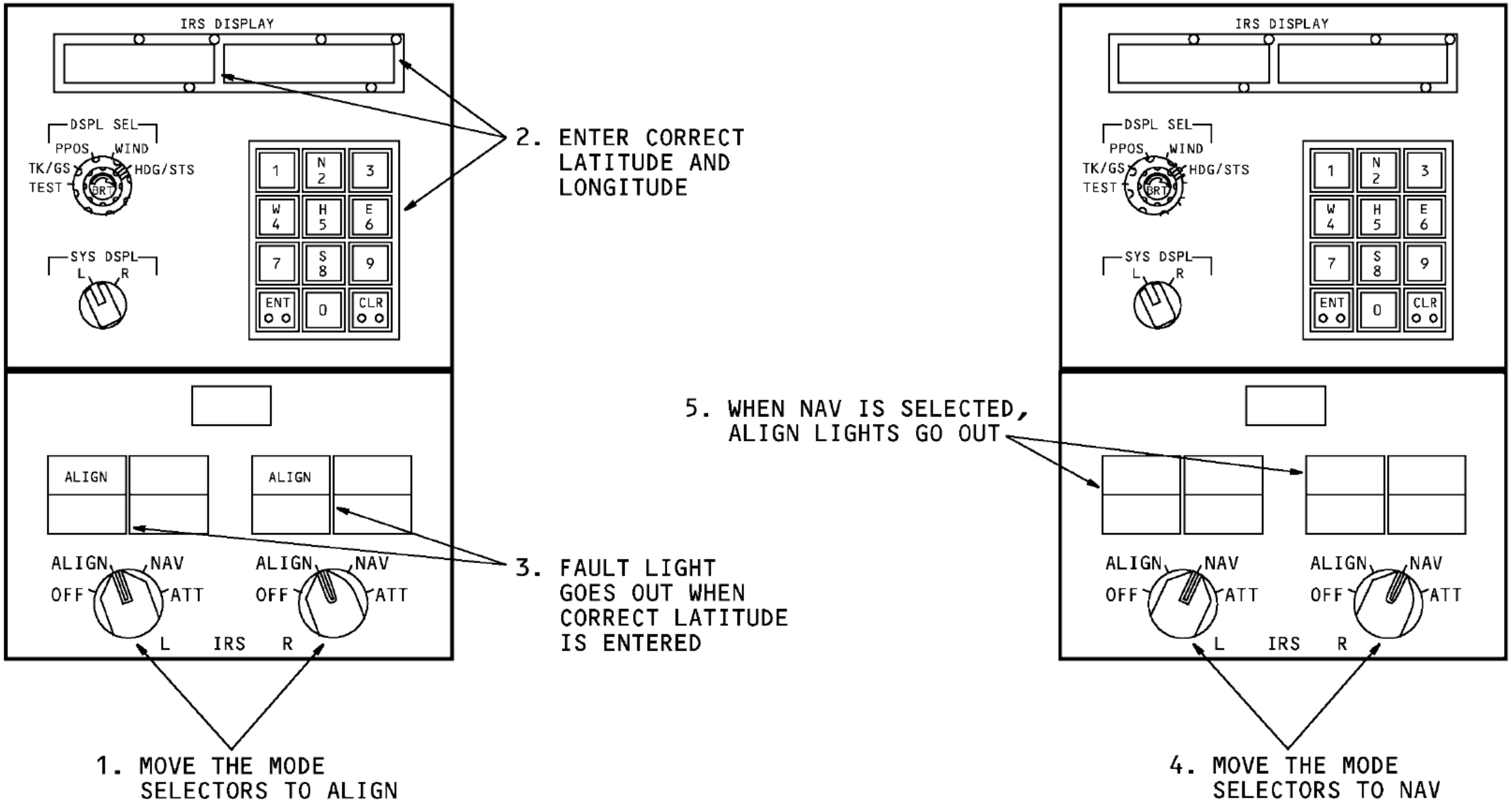
POSITION DIFFERENCE AFTER ALIGNMENT

Correct Position Entry

Move the mode selector on the MSU to ALIGN. Use the keyboard on the ISDU to enter the correct latitude and longitude. The FAULT light goes off when the correct latitude is entered.

Move the mode selector to NAV. The ALIGN lights go out and the ADIRUs enter navigation mode.

If the ADIRUs do not enter the navigation mode, start a new alignment. Refer to the fault isolation manual (FIM) section 34-21 for troubleshooting procedures.



CORRECT POSITION ENTRY

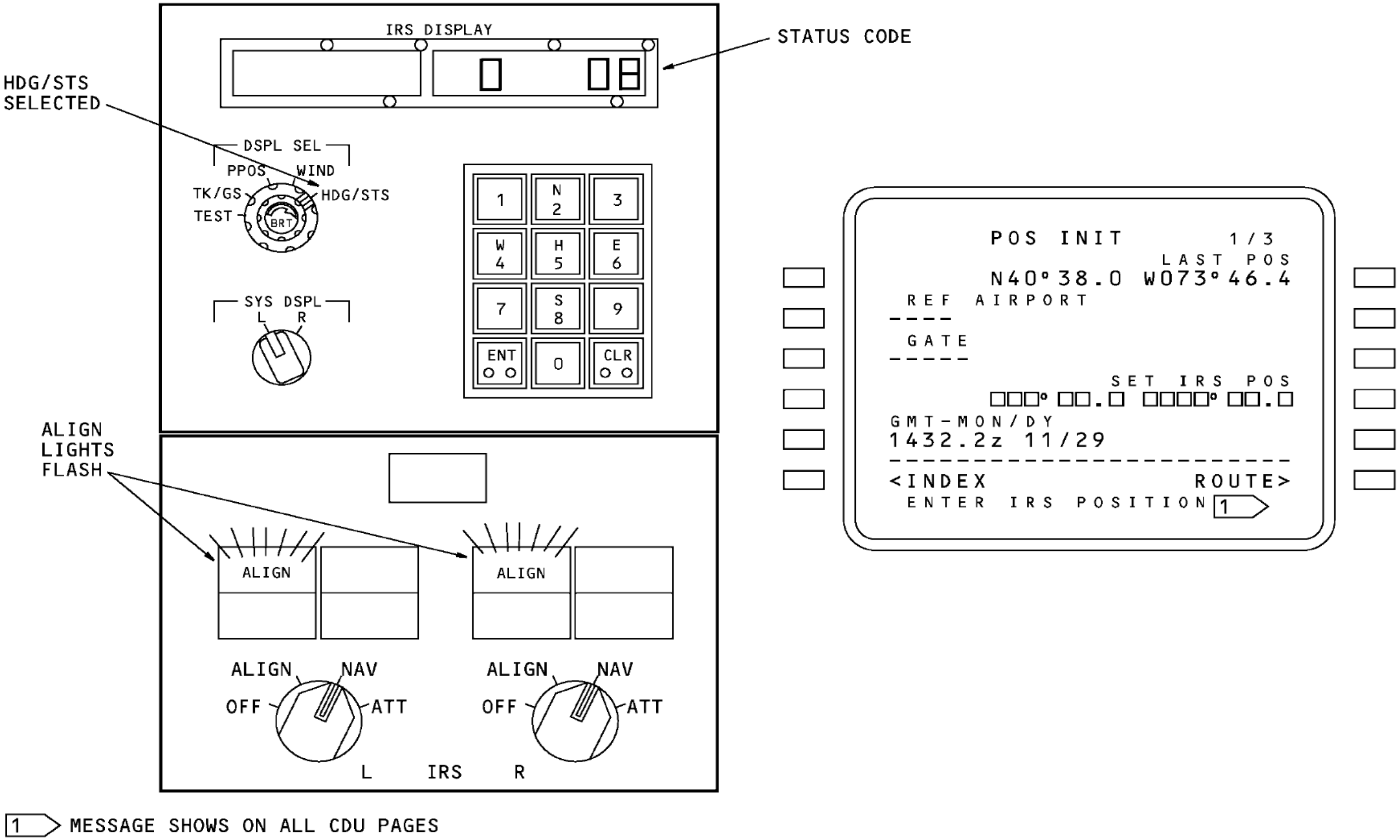
NO PRESENT POSITION ENTRY

You must enter present position during the alignment period. If the alignment period ends and present position has not been entered, these conditions show:

- ALIGN light flashes
- Status code 8 shows on ISDU
- ENTER IRS POSITION shows on CDU.

Use the CDU or the ISDU to enter present position.
When you enter present position these conditions show:

- ALIGN light goes off
- Status code 8 goes out of view
- ENTER IRS POSITION goes out of view.



NO PRESENT POSITION ENTRY

ADIRS - ATTITUDE MODE

General

Use the attitude (ATT) mode when you only need pitch and roll data, or when the navigation function of the ADIRU fails. You can select the attitude mode on the ground or in the air.

Attitude Mode Selection

Move the mode selector to ATT to select the attitude mode. The ADIRU goes to the attitude mode 2 seconds after the mode is selected. The two second delay prevents accidental selection of the mode.

Attitude Alignment

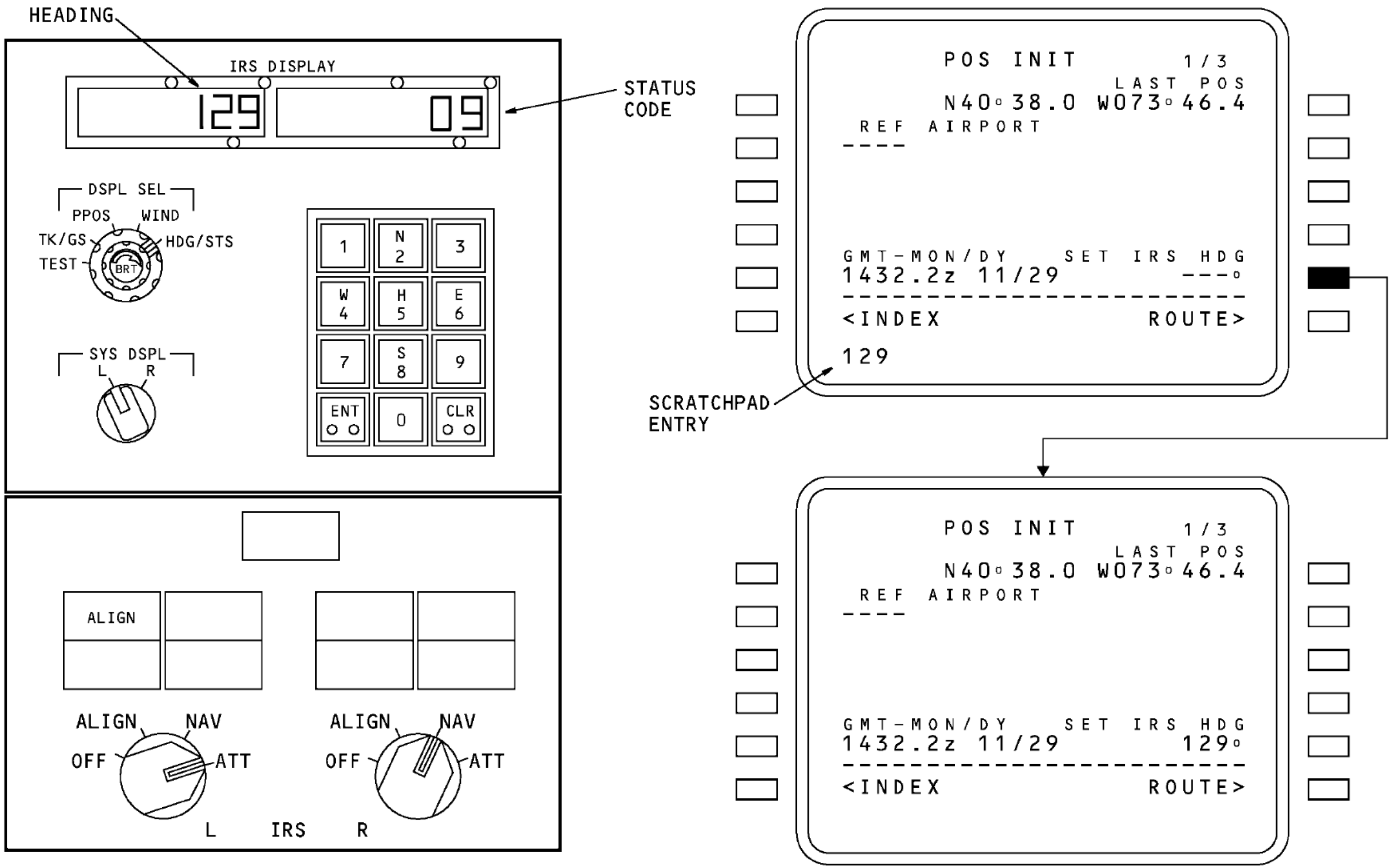
When you select the attitude mode, the ALIGN light comes on for 30 seconds. During this time, the ADIRU calibrates to 0 degrees in pitch and roll. If the airplane is in the air, the pilot must keep the airplane straight and level and not accelerate until the ALIGN light goes off.

Heading Entry

The ADIRU uses manual heading in the ATT mode. Status code 9 shows on the ISDU until you enter magnetic heading. Enter magnetic heading with the ISDU or CDU.

On the ISDU, push the H5 key and the number keys. Heading shows on the IRS DISPLAY. Push the ENT key to enter the heading in the ADIRU.

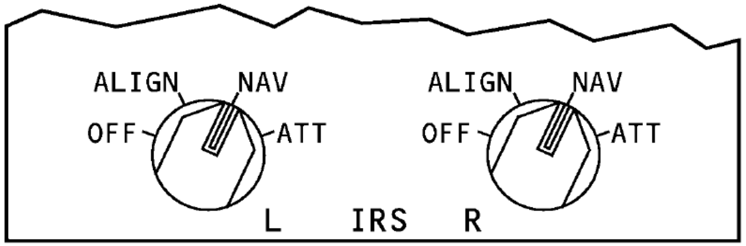
On the CDU, enter the three digit heading value in the scratchpad. Use the line select key (LSK) 5R to enter the heading in the ADIRU. The heading shows on the CDU.



ADIRS – ATTITUDE MODE

INERTIAL REFERENCE MODES

The chart shows the mode sequences of the MSU mode selector.



MODE SELECT SWITCH SEQUENCE	RESULT
OFF TO ALIGN (AIRPLANE NOT MOVING)	ADIRU GOES TO ALIGNMENT MODE. ALIGN LIGHT COMES ON.
OFF TO NAV (AIRPLANE NOT MOVING)	ADIRU GOES TO ALIGNMENT MODE. ADIRU AUTOMATICALLY GOES TO NAV MODE AT END OF ALIGNMENT PERIOD IF PRESENT POSITION IS ENTERED.
NAV TO ALIGN TO NAV (AIRPLANE NOT MOVING)	ADIRU VELOCITY SET TO 0. RESET LEVEL. ALIGN LIGHT COMES ON FOR 30 SECONDS.
NAV TO ALIGN (AIRPLANE NOT MOVING)	SETS VELOCITY TO 0. RESETS LEVEL AND HEADING. ALIGN LIGHT COMES ON.
OFF, ALIGN, OR NAV TO ATT	ADIRU GOES TO ATTITUDE MODE AFTER 2 SECONDS. ALIGN LIGHT COMES ON FOR 30 SECONDS. HEADING CAN BE ENTERED.
ATT TO NAV OR ALIGN	ADIRU IN ATTITUDE MODE UNTIL SWITCH IS MOVED TO OFF.
ATT TO OFF	ALIGN LIGHT COMES ON FOR 30 SECONDS. AFTER 30 SECONDS, ADIRU GOES OFF.
NAV OR ALIGN TO OFF	ALIGN LIGHT COMES ON FOR 30 SECONDS. FAULTS AND POSITION DATA STORED IN MEMORY. AFTER 30 SECONDS, ADIRU GOES OFF.

ADIRS – IR MODES

ADIRS MAINTENANCE CODES

ADIRS maintenance codes show on the IRS DISPLAY of the ISDU. Some codes give the condition of ADIRS components and signals. Some codes give instructions.

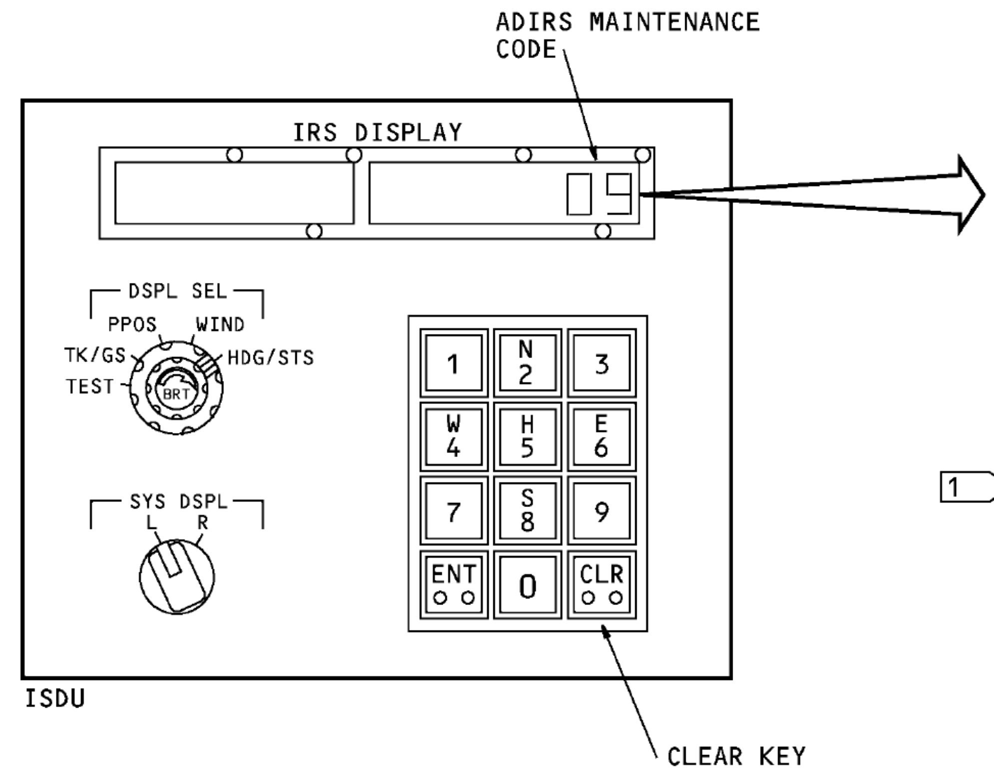
Two or more codes cause the ISDU CLR key light to come on. Push the CLR key to show the codes in sequence.

The ADIRS maintenance codes come from the ADIRUs. Put the SYS DSPL selector in the L position to see codes from left ADIRU. The right shows codes from the right ADIRU.

> Note: Maintenance codes 26 and 36 are not used.

CDU Display Pages

You can see the list of ADIRS maintenance codes on the CDU. The list is a part of the ADIRS BITE.



	CODE TABLE	
	01	ISDU FAIL
	02	IR FAILURE
	03	EXCESSIVE MOTION
	04	ALIGN FAULT
	07	ADR DATA INVLD
	08	ENTER PPOS
	09	ENTER HEADING
	10	ISDU POWER LOSS
	18	NO ADR DATA
	19	IR PROG PIN INVLD
	20	ADR FAIL
	21	ADR PROG PIN INVLD
	22	TAT PROBE SIGNAL FAIL
	23	AOA SIGNAL FAIL
	24	NO AOA REF SIGNAL
1	26	NO BARO 3 REF SIGNAL
	27	NO PITOT ADM DATA
	28	NO STATIC ADM DATA
	29	NO BARO 1 DATA
	30	NO BARO 2 DATA
	31	NO IR DATA
	32	PITOT ADM DATA INVLD
	33	STATIC ADM DATA INVLD
	34	BARO 1 DATA INVLD
	35	BARO 2 DATA INVLD
1	36	BARO 3 SIGNAL FAIL
	37	IR DATA INVLD
	38	AIR/GND LOGIC INVLD

1 NOT USED

ADIRS MAINTENANCE CODES

ADIRS BITE
CDU ADIRS BITE PAGES - ADIRS BITE MAIN MENU
(TRAINING INFORMATION POINT)

General

The ADIRS has maintenance information that you can get access to through the flight management computer control display unit (CDU).

To see the maintenance information, select ADIRS on line select key (LSK) 4L from the MAINT BITE INDEX. This shows the ADIRS BITE page.

On the ADIRS BITE page, select either ADIRS L on LSK 1L or ADIRS R on LSK 2L. This shows the ADIRS BITE main menu for the left ADIRU or the right ADIRU.

ADIRS BITE Main Menu

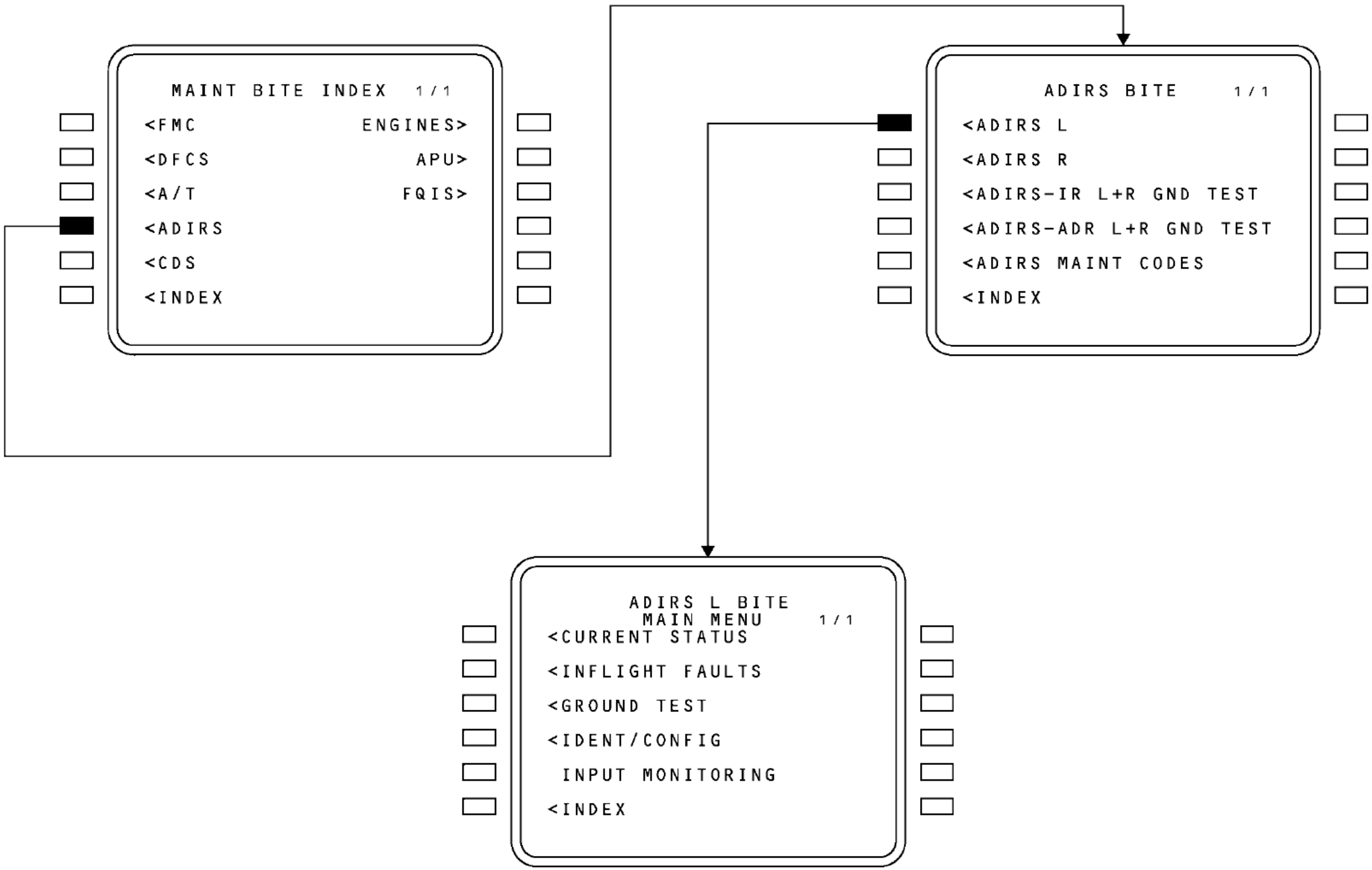
There are four maintenance procedures that you can select through the ADIRS BITE main menu.

These are the selections:

- Current status
- Inflight faults
- Ground test
- Ident/config.

To show the current status, select LSK 1L. To show the inflight faults, select LSK 2L. To operate a ground test, select LSK 3L.
To show the identification and configuration information, select LSK 4L.
The input monitoring line is not active.

Select LSK 6l to return to the ADIRS BITE page.



CDU ADIRS BITE PAGES – ADIRS BITE MAIN MENU

CURRENT STATUS

General

To show the current status, select CURRENT STATUS on line select key (LSK) 1L from the ADIRS L BITE MAIN MENU. This shows the CURRENT FAULTS page.

It shows active faults detected by the ADIRU. If there are no active faults detected by the ADIRU, the message page NO CURRENT FAULTS shows.

CURRENT FAULTS Page

Three faults show on a page. The number of current faults pages show on the top right. To show the next current faults page, select the NEXT PAGE key on the FMC CDU keypad.

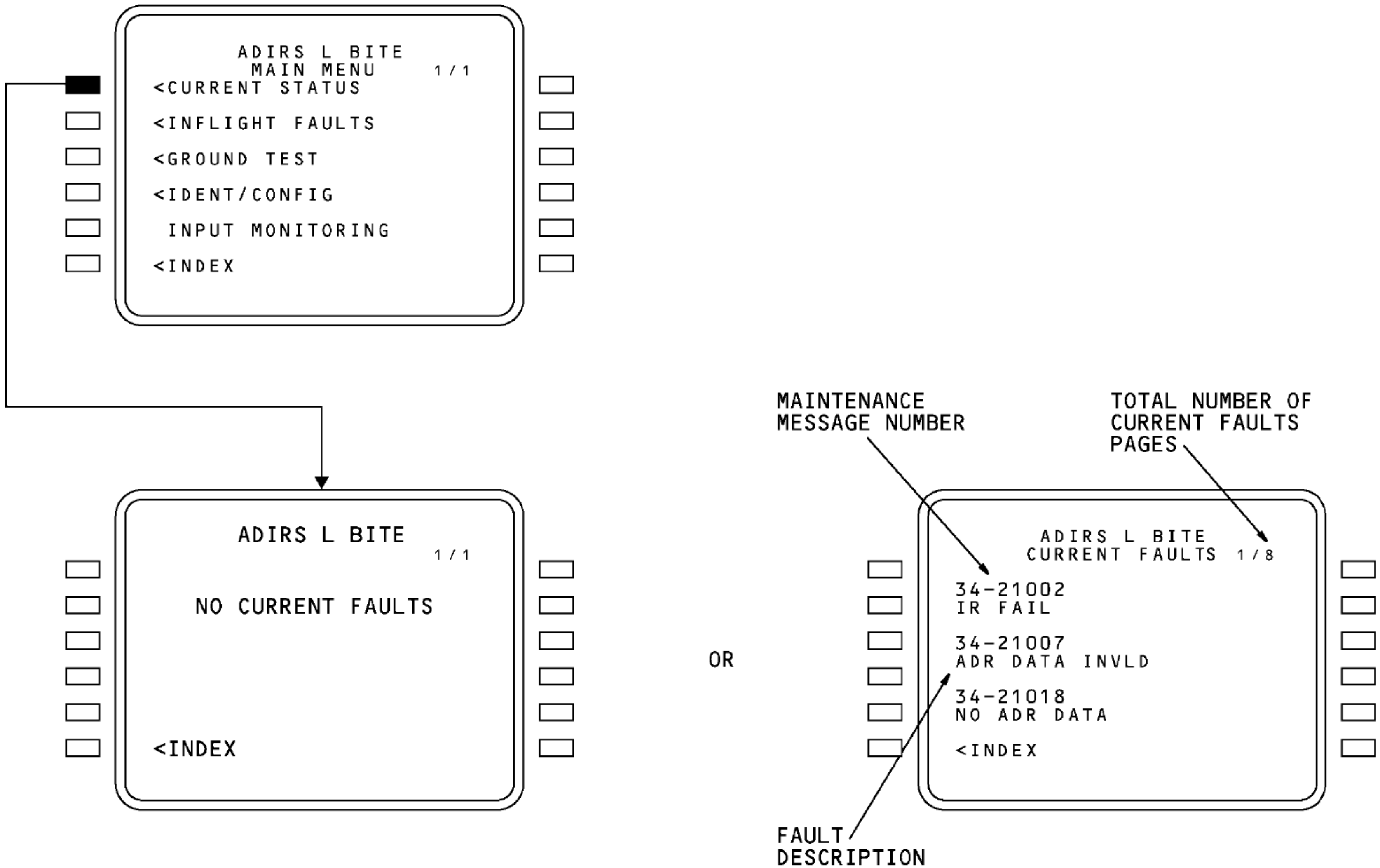
The faults show in the order that the ADIRU detects the faults. If the ADIRU detects a new fault while current faults show, the new fault shows after the last detected fault.

This information shows for a fault:

- Maintenance message number
- Fault description.

The maintenance message number is a number assigned to the fault. You can use the maintenance message number index in the fault isolation manual (FIM) to find the correct fault isolation procedure to fix the fault.

The fault description is a short description of the fault.



CURRENT STATUS

INFLIGHT FAULTS

General

To show the inflight faults, select INFLIGHT FAULTS on line select key (LSK) 2L from the ADIRS L BITE MAIN MENU. This shows the INFLIGHT FAULTS MENU page.

The ADIRU stores faults for up to 9 flight legs. The ADIRU can store up to 26 faults for each flight leg.

A new flight leg starts when the airplane takes off. The flight leg ends when the airplane lands. If a fault occurs on the ground, the ADIRU stores the fault as a current fault. If the fault exists when a new flight leg starts, the ADIRU stores the fault in the new flight leg.

INFLIGHT FAULTS MENU Page

The INFLIGHT FAULTS MENU page shows a list of the flight legs that have faults in the ADIRU memory. The number of inflight faults for the flight leg shows below the flight leg number.

To show the faults for a flight leg, select the LSK next to the flight leg. This shows the first three faults in that flight leg. Leg 01 is the most current flight leg.

LEG XX FAULTS Page

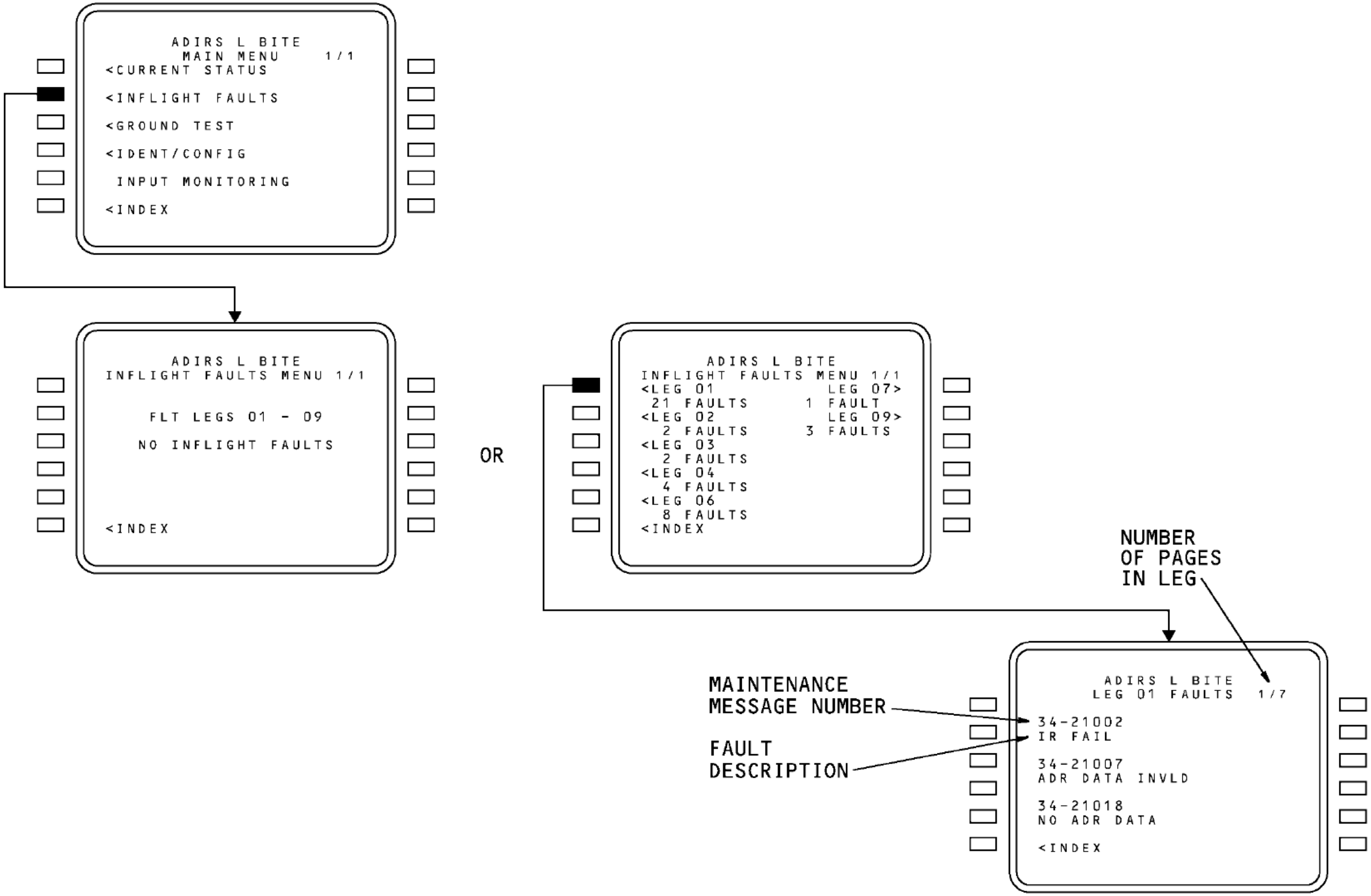
Up to three faults show on a page. If the fault leg has more than three faults, the additional faults show on additional pages for the flight leg. The number of pages shows on the top of the page.

This information shows for a single fault:

- Maintenance message number
- Fault description.

The maintenance message number is a number assigned to this fault. You can use the maintenance message number index in the fault isolation manual (FIM) to find the correct fault isolation procedure to fix the fault.

The fault description is a short description of the fault.



INFLIGHT FAULTS

THIS PAGE IS INTENTIONALLY LEFT BLANK

GROUND TEST MENU

To operate a ground test, select line select key (LSK) 3L, GROUND TEST from the ADIRS BITE MAIN MENU. This shows the GROUND TEST page.

GROUND TEST Page

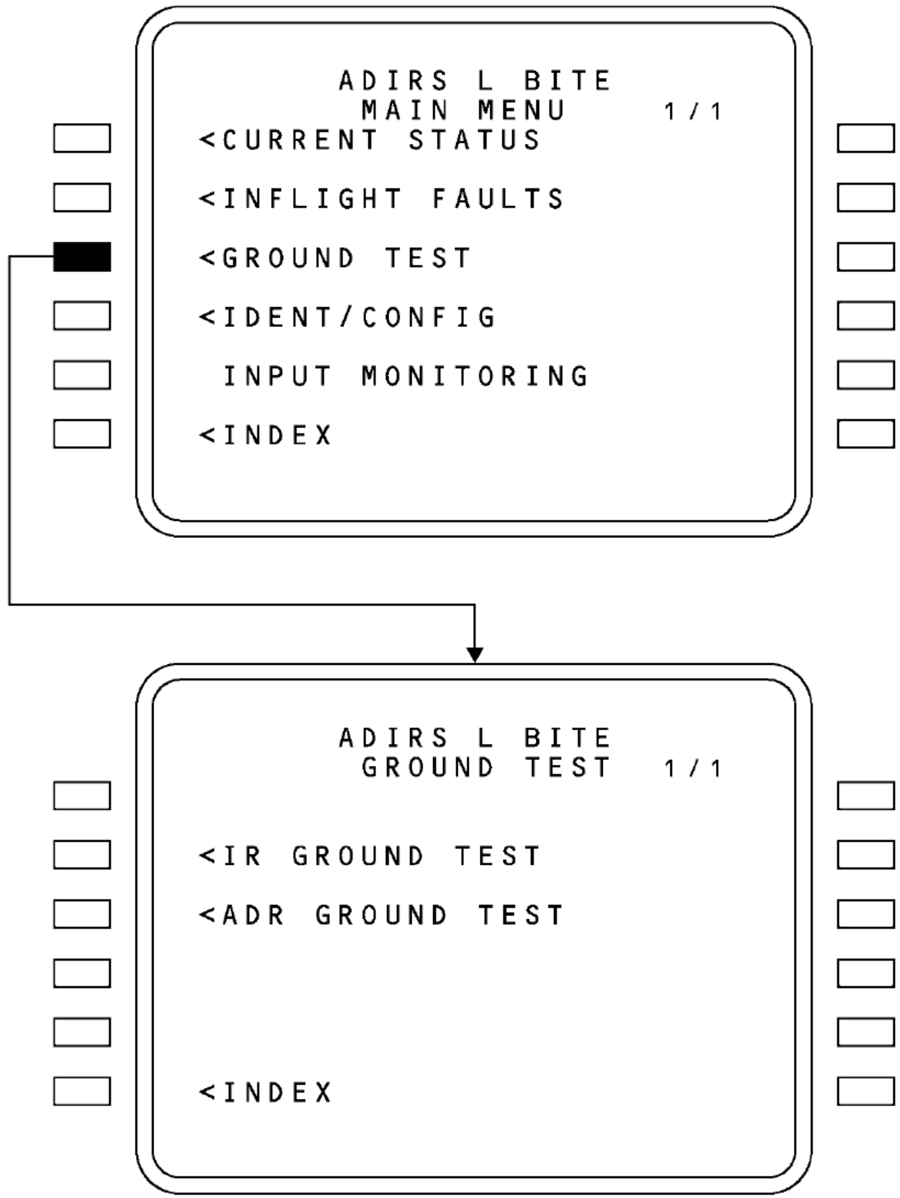
The GROUND TEST page shows a list of the ground tests you can operate.

These are the ground tests:

- IR ground test
- ADR ground test.

To operate the IR ground test, select LSK 2L.

To operate the ADR ground test, select LSK 3L.



GROUND TEST MENU

IR GROUND TEST

General

To operate the IR GROUND TEST, select line select key (LSK) 2L. ADIRS X BITE IR GROUND TEST page shows.

IR GROUND TEST Pages

The IR GROUND TEST pages show information about the self test. There are three IR GROUND TEST pages.

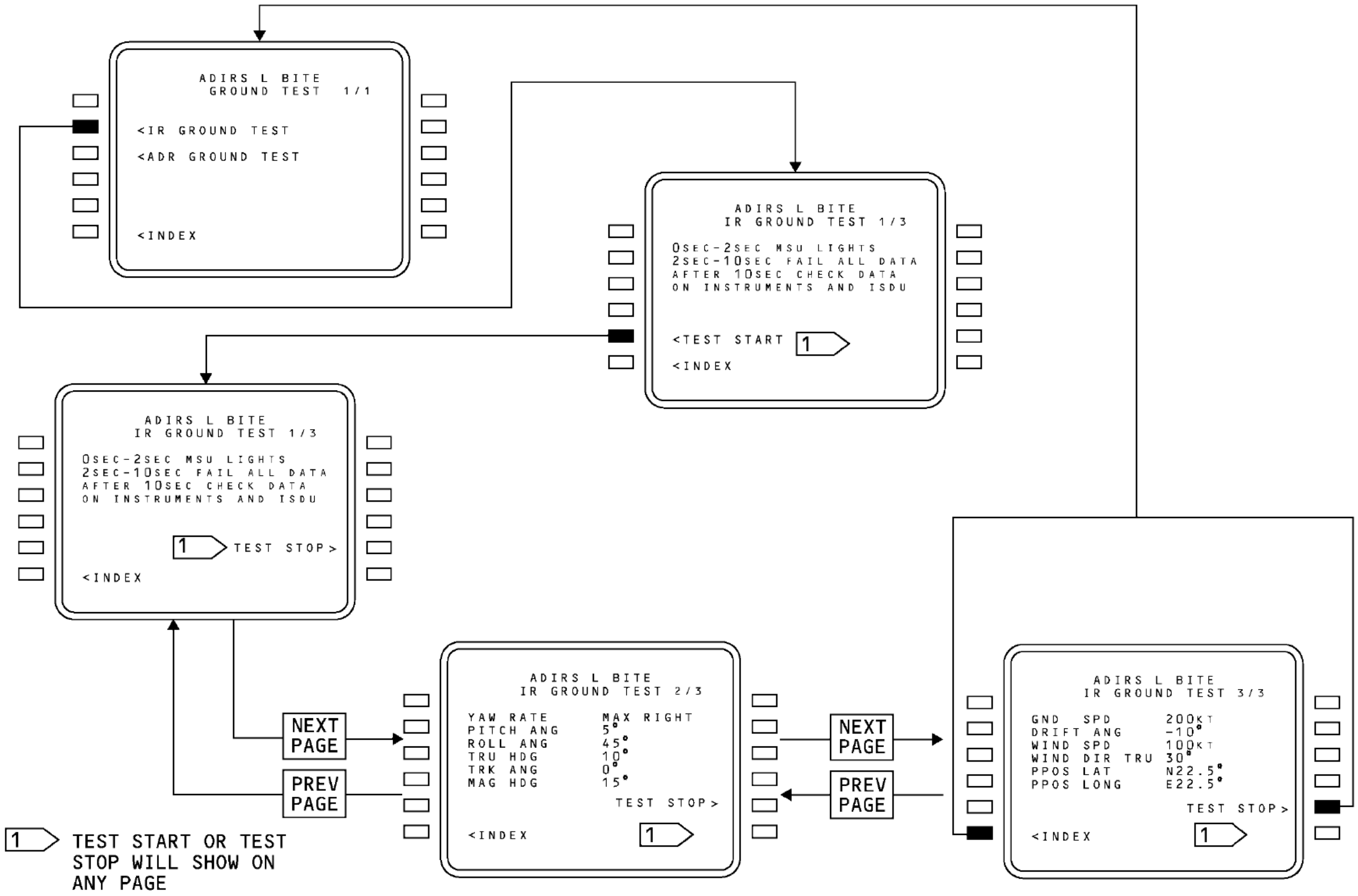
The IR GROUND TEST pages do not show test data when the self test runs. The IR GROUND TEST pages only show test values that you verify during the test.

Page 1 gives a description of the test. Page 2 and page 3 show the test values for the IR ground test. Verify the values on the flight compartment instruments. To move between pages 1, 2, and 3, use the NEXT PAGE and PREV PAGE keys on the CDU.

You can start the IR ground test from page 1, 2 or 3. Push LSK 5L to start the test. LSK 5L is next to the START TEST prompt.

When the IR ground test starts, the TEST START prompt goes out of view. The TEST STOP prompt shows. The IR ground test continues until you select TEST STOP or INDEX. TEST STOPS show on page 1, page 2 and page 3. INDEX shows on page 1, 2 and 3. Push LSK 5R or 6L to stop the test and return to the GROUND TEST menu.

The IR ground test will not operate if the ground speed is more than 20 knots, or IR is in the attitude mode. TEST INOP shows on all IR GROUND TEST pages, and TEST START goes out of view.



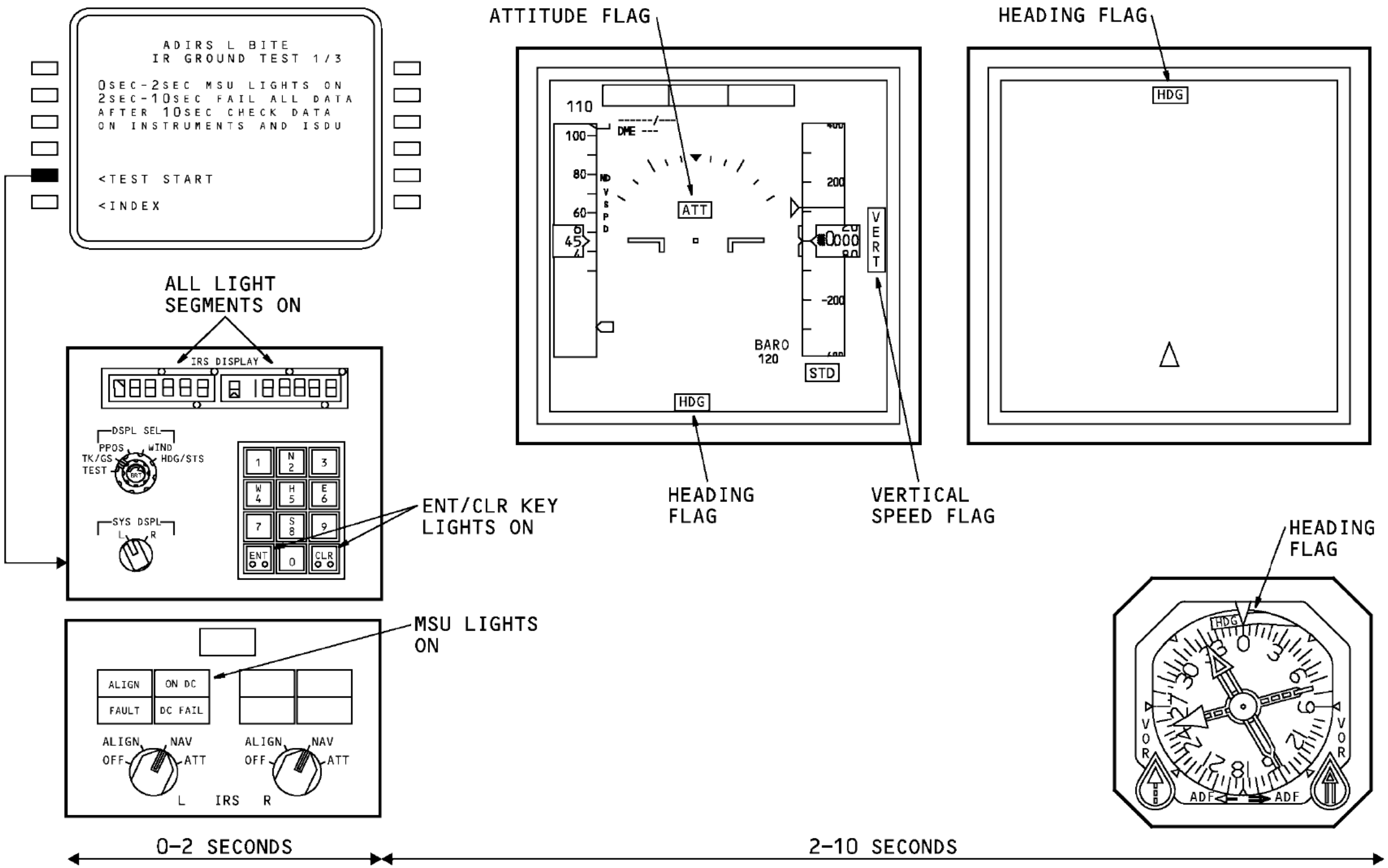
IR GROUND TEST

IR GROUND TEST RESULTS

Push LSK 5L to start the IR ground test. Test values show in the flight compartment.

0-2 Seconds
When the test starts, all the lights on the MSU and ISDU come on for 2 seconds.

2-10 Seconds
Between 2 and 10 seconds, all IR data fails. Components and displays that use IR data show failure flags and failure conditions.



IR GROUND TEST RESULTS 1

10 Seconds To End of Test

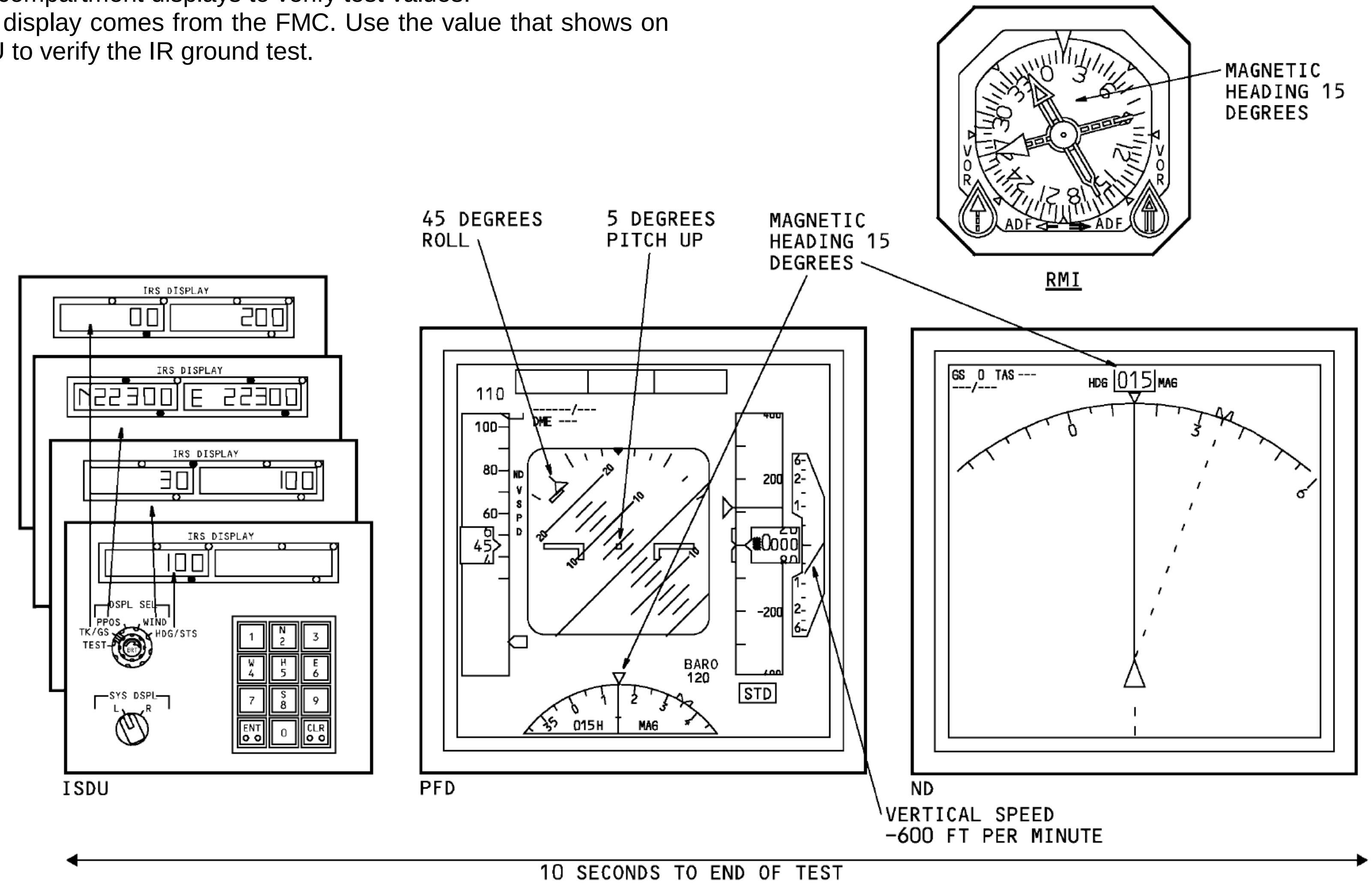
Ten seconds after the IR ground test starts, the ADIRU sends test values on its data buses. The test values show on the page 2 and 3 of the IR GROUND TEST.

Look at the flight compartment displays to verify test values.

data on the NAV display comes from the FMC. Use the value that shows on the ISDU to verify the IR ground test.

YAW RATE MAX RIGHT can not be verified. It does not show on flight compartment displays.

> Note: When you start the IR ground test from the CDU, ground speed and track



IR GROUND TEST RESULTS 2

ADR GROUND TEST

To operate the ADR GROUND TEST, push line select key (LSK) 3L. ADIRS X BITE ADR GROUND TEST page shows.

ADR GROUND TEST Pages

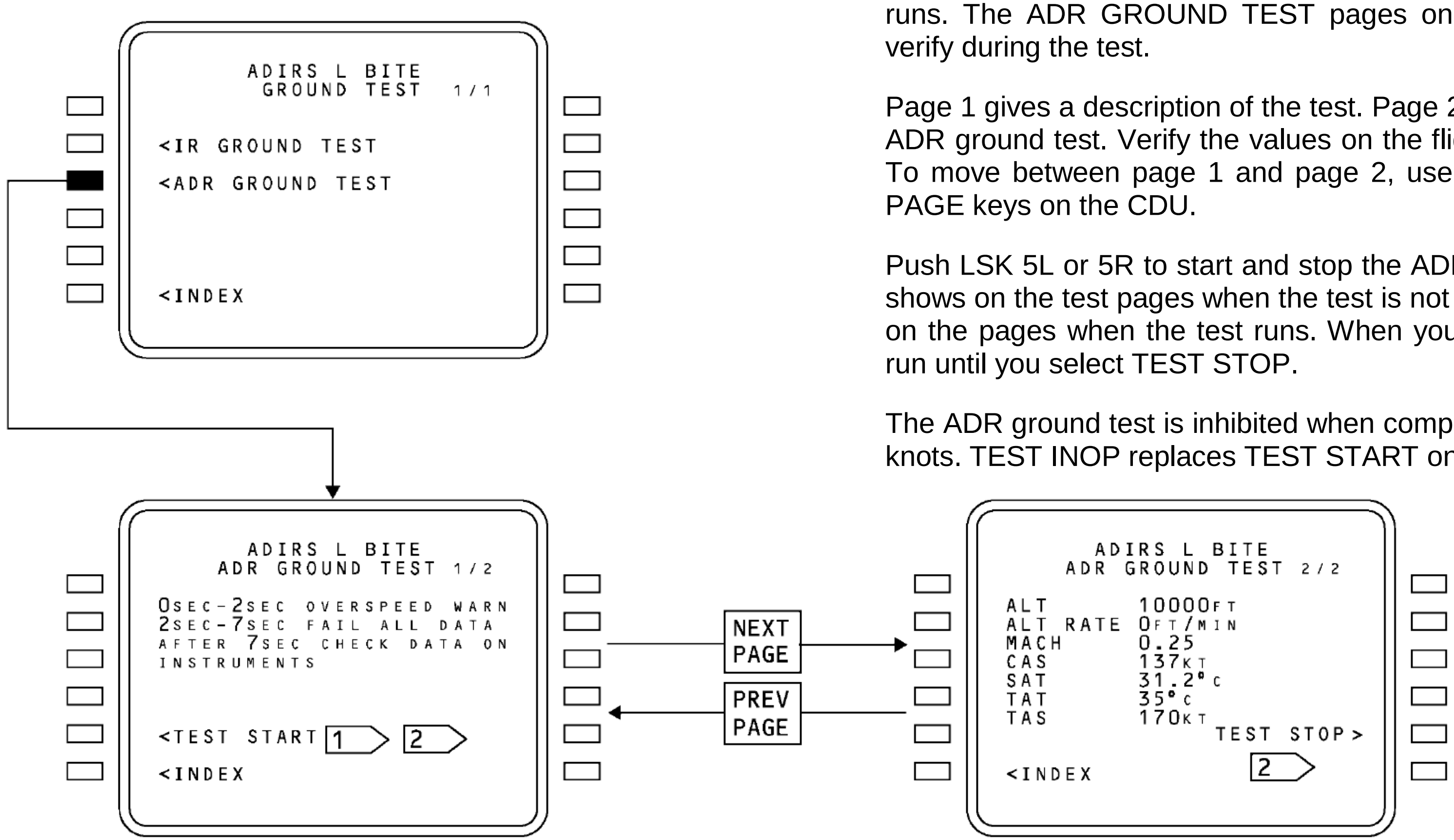
The ADR GROUND TEST pages show information about the self test. There are two ADR GROUND TEST pages.

The ADR GROUND TEST pages do not show test data when the self test runs. The ADR GROUND TEST pages only show test values that you verify during the test.

Page 1 gives a description of the test. Page 2 shows the test values for the ADR ground test. Verify the values on the flight compartment instruments. To move between page 1 and page 2, use the NEXT PAGE and PREV PAGE keys on the CDU.

Push LSK 5L or 5R to start and stop the ADR ground test. <TEST START shows on the test pages when the test is not running. TEST STOP> shows on the pages when the test runs. When you start the test, it continues to run until you select TEST STOP.

The ADR ground test is inhibited when computed airspeed is more than 30 knots. TEST INOP replaces TEST START on the ground test pages.



1 IF THE ADIRU INHIBITS THE GROUND TEST, TEST INOP REPLACES TEST START.

2 TEST START OR TEST STOP SHOW ON BOTH GROUND TEST PAGES.

ADR GROUND TEST

ADR GROUND TEST RESULTS

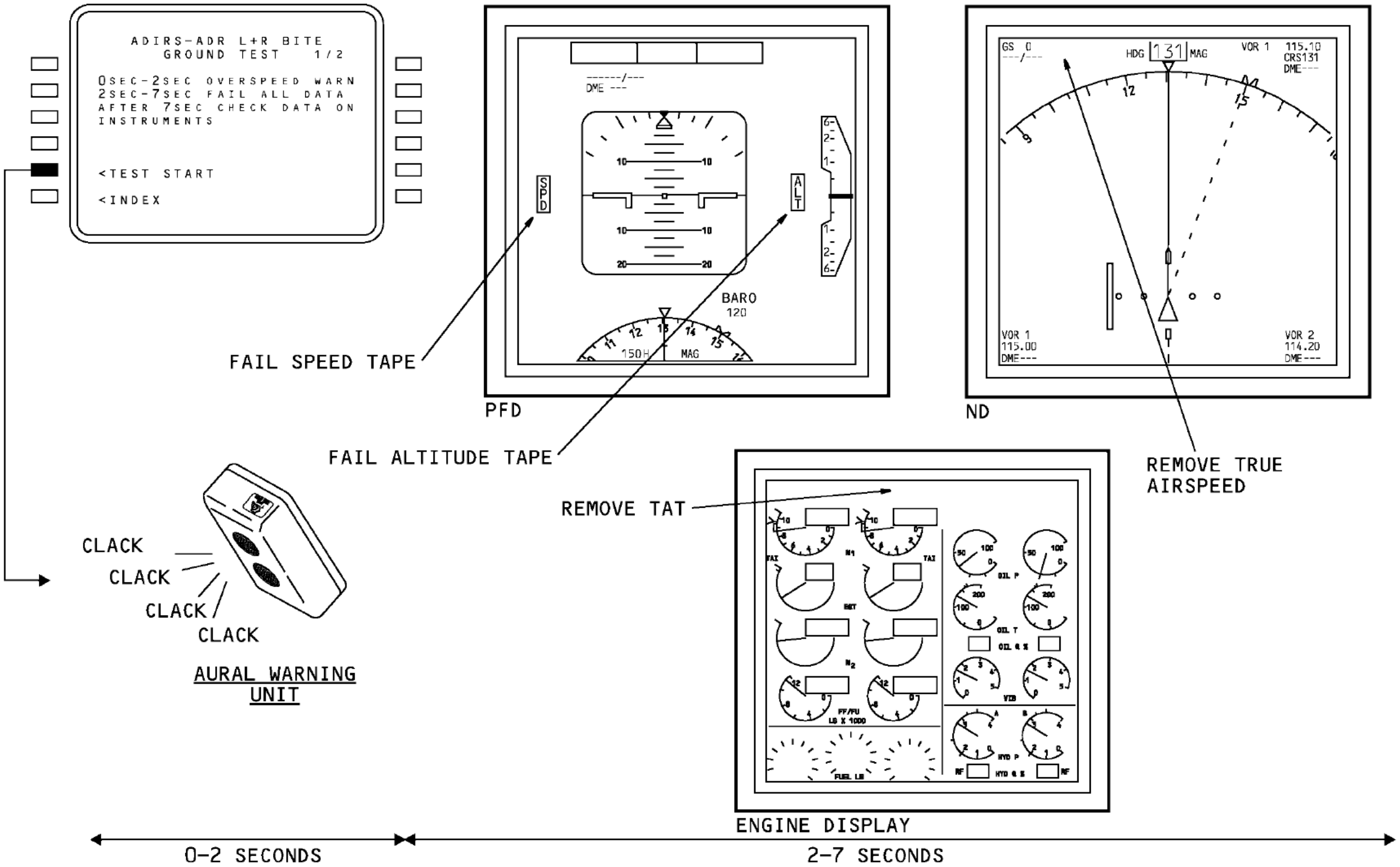
Push LSK 5L to start the ADR ground test. Test values show in the flight compartment.

0-2 Seconds

When the test starts, you hear the overspeed warning for 2 seconds.

2-7 Seconds

Between 2 and 7 seconds, all ADR data fails. Components and displays that use ADR data show failure flags and failure conditions.



ADR DROUND TEST RESULTS 1

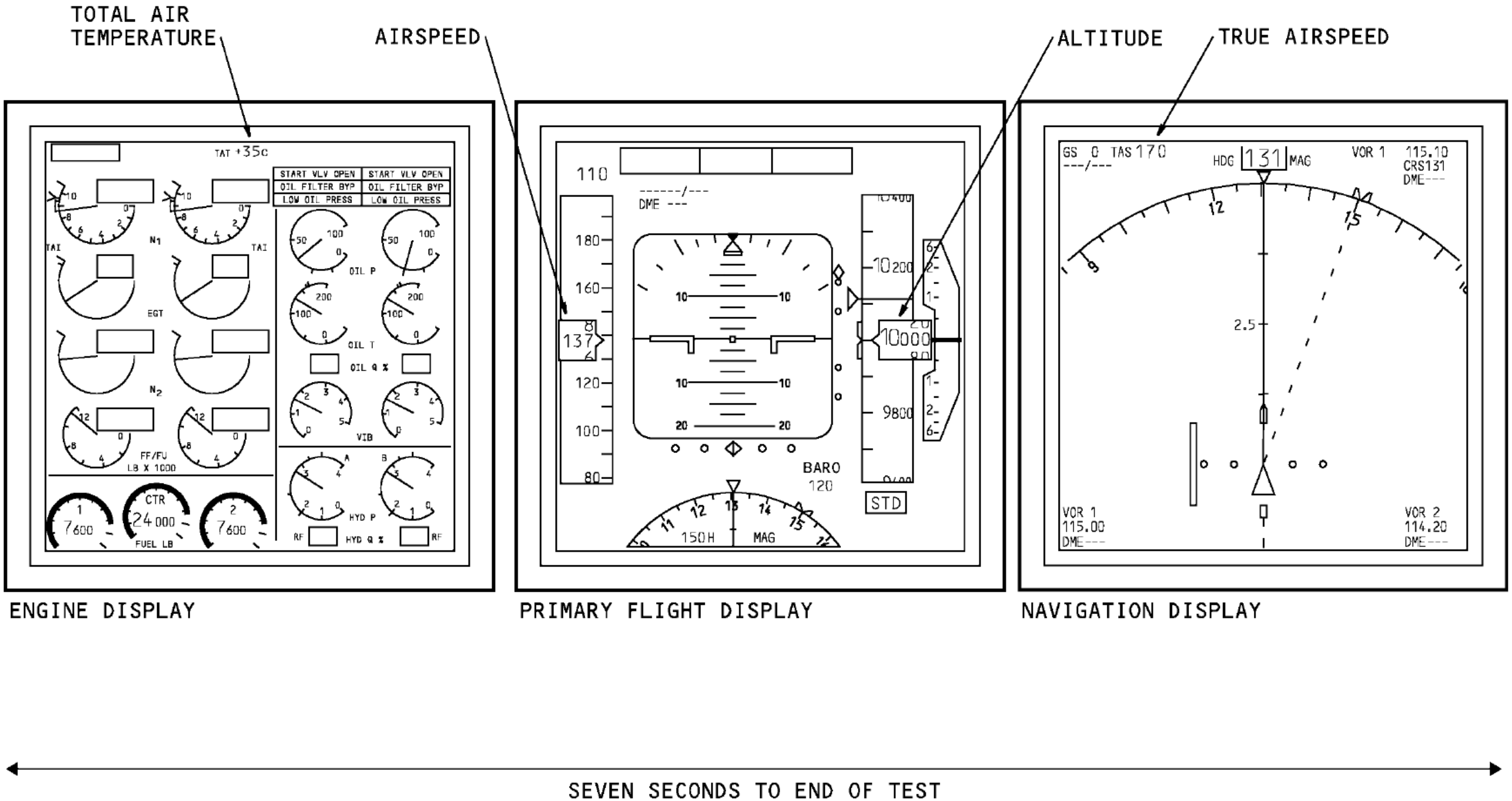
Seven Seconds To End of Test

Seven seconds after the ADR ground test starts, the ADIRU sends test values on its data buses. The test values show on page 2 of the ADR GROUND TEST. Not all test values on page 2 show in the flight compartment.

These are the values that you can see:

- ALT; 10000 FT
- Airspeed; 137 KT
- TAT; 35C
- TAS; 170 KT.

Look at flight compartment displays to verify test values.



ADR GROUND TEST RESULTS 2

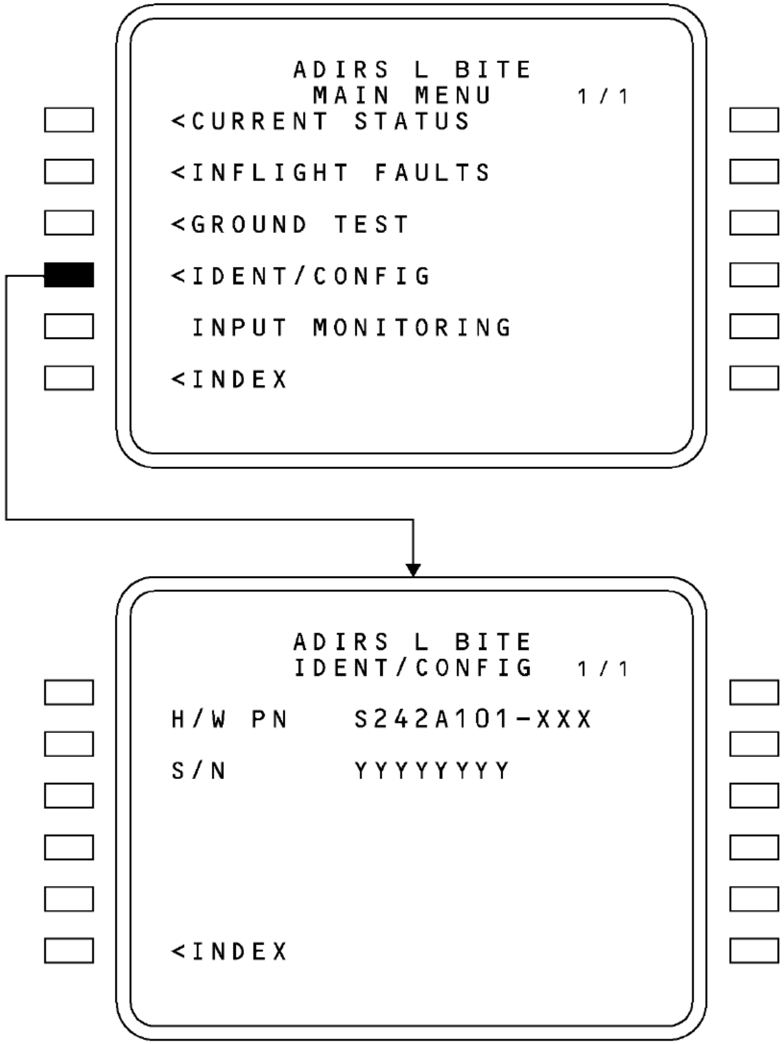
IDENT / CONFIG

To show the configuration information, select IDENT/CONFIG on line select key (LSK) 4L from the ADIRS X BITE MAIN MENU. This shows the IDENT/CONFIG page.

IDENT/CONFIG Page

The IDENT/CONFIG page shows this information:

- ADIRU hardware part number
- Serial number.



IDENT/CONFIG

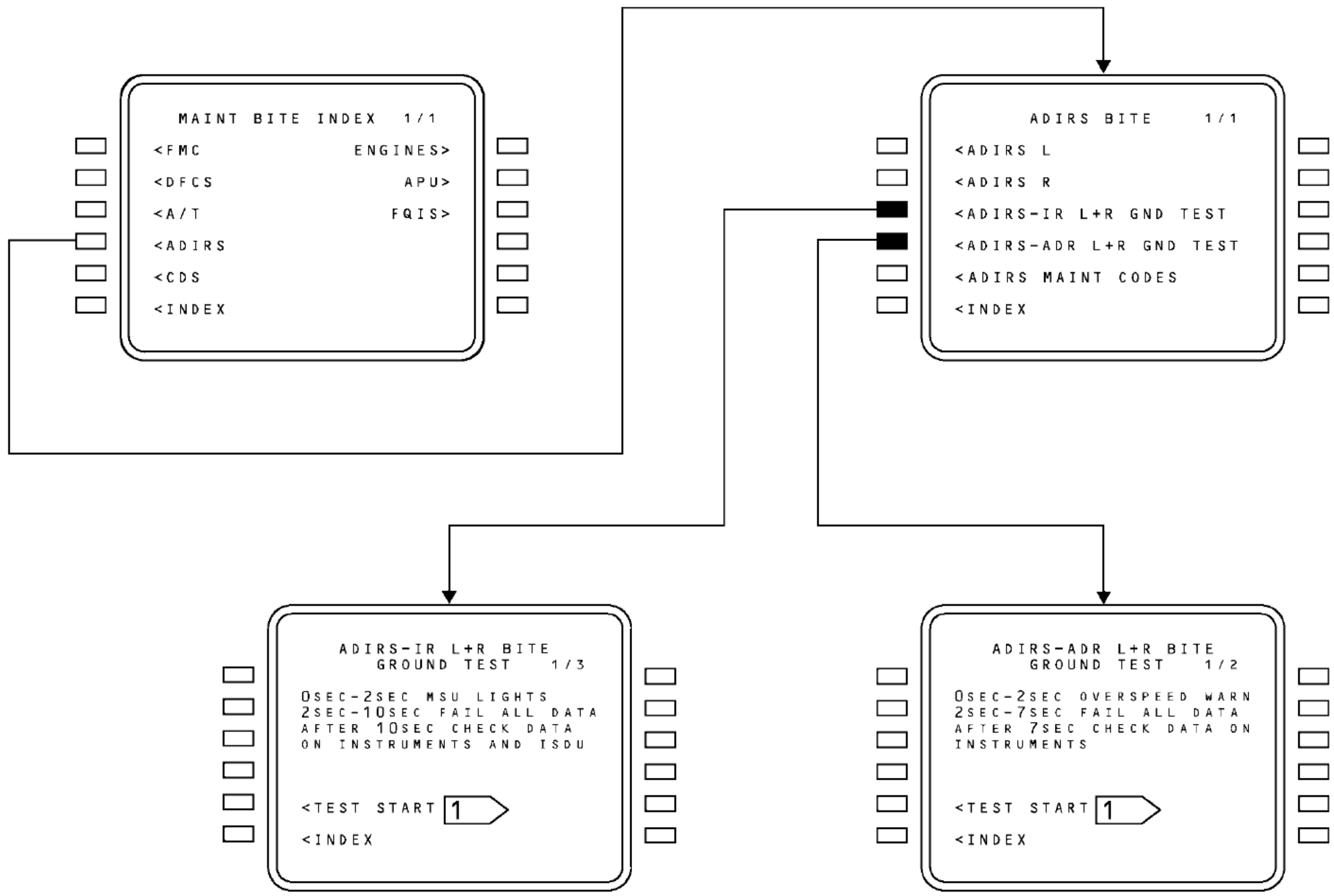
THIS PAGE IS INTENTIONALLY LEFT BLANK

ADIRS L + R GND TEST

The ADIRS-IR L+ R GROUND TEST and the ADIRS-ADR L+R GROUND TEST are similar to the IR and ADR ground tests. The only difference is that the L + R ground tests allow you to test both ADIRUs at the same time.

To access the L + R ground tests, select ADIRS on line select key (LSK) 4L from the MAINT BITE INDEX. This shows the ADIRS BITE page.

On the ADIRS BITE page select either ADIRS-IR L+R GND TEST on LSK 3L or ADIRS-ADR L+R GND TEST on LSK 4L.



1 IF ADIRU INHIBITS GROUND TEST, TEST INOP REPLACES TEST START

ADIRS L + R GND TEST

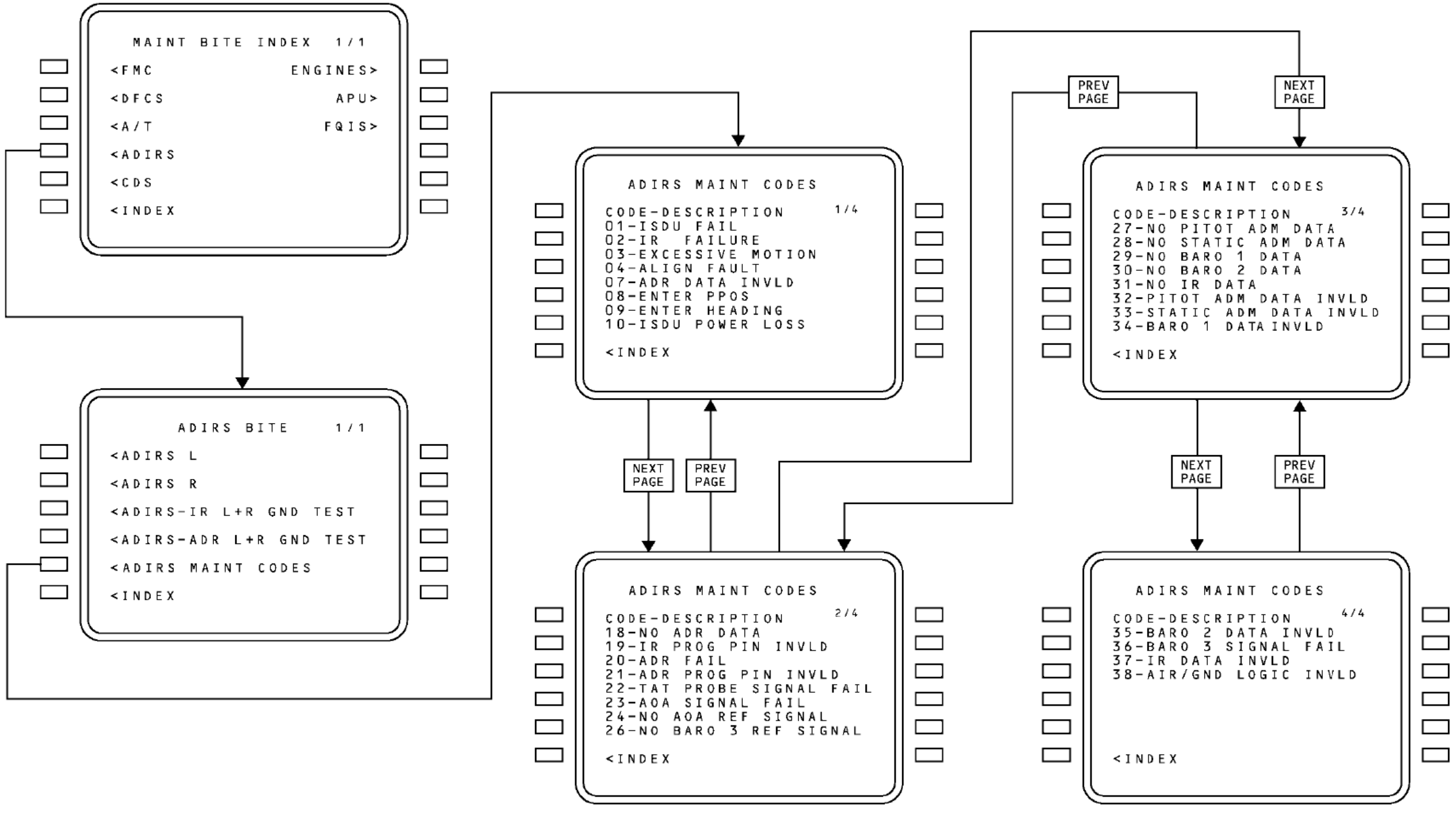
CDU ADIRS BITE PAGES - ADIRS MAINTENANCE CODES

General

These pages have the description of the ADIRS maintenance codes that can show on the ISDU. Forty codes are permitted, but not all codes are in use. Only the codes in use show on the CDU.

To show the ADIRS maintenance codes, push LSK 5L on the ADIRS BITE page. Page 1 of the ADIRS MAINT CODES pages shows.

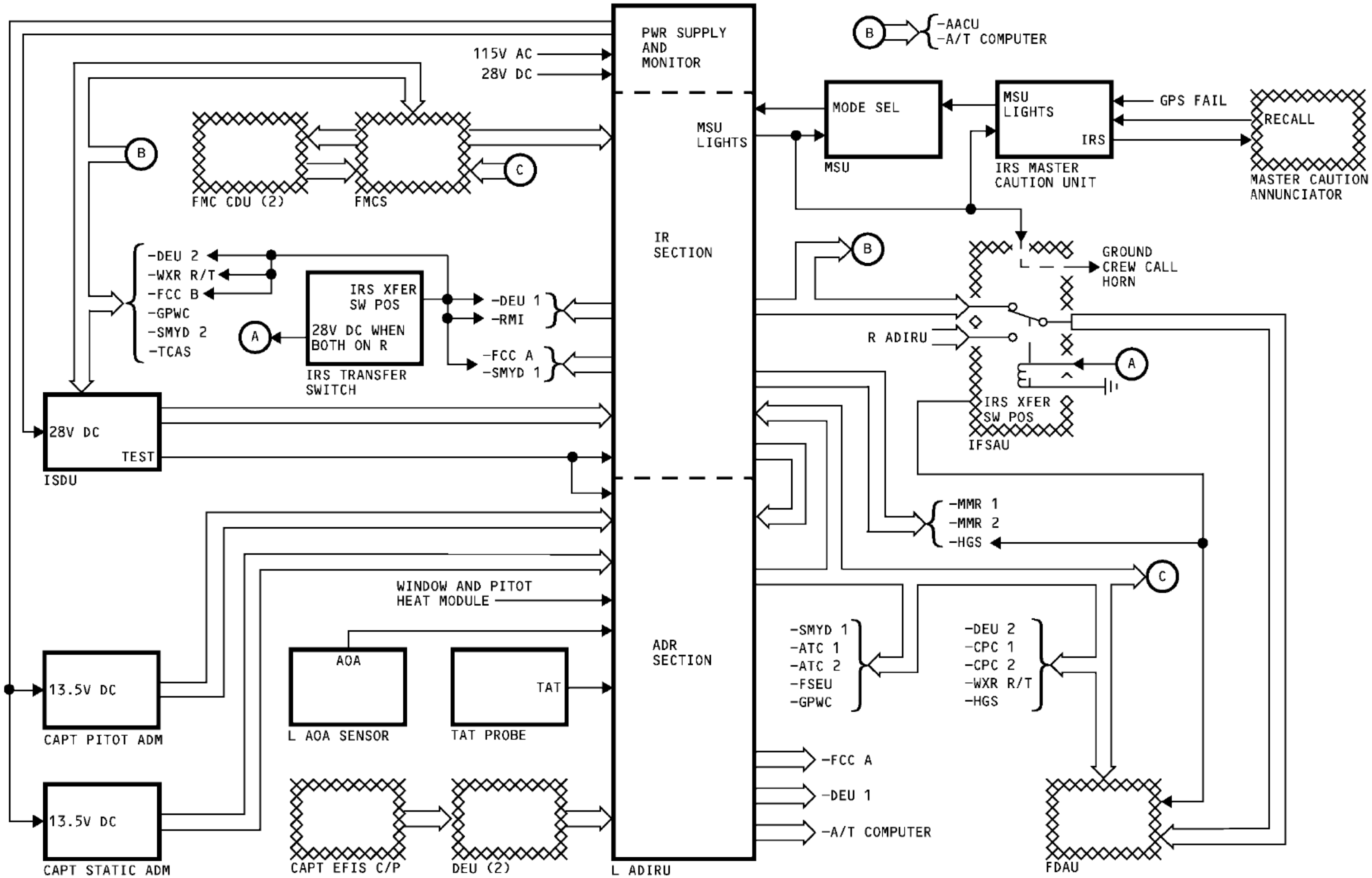
Use the NEXT PAGE and PREV PAGE keys on the CDU to move between the ADIRS MAINT CODES pages.



ADIRS MAINTENANCE CODES

ADIRS - SYSTEM SUMMARY 1

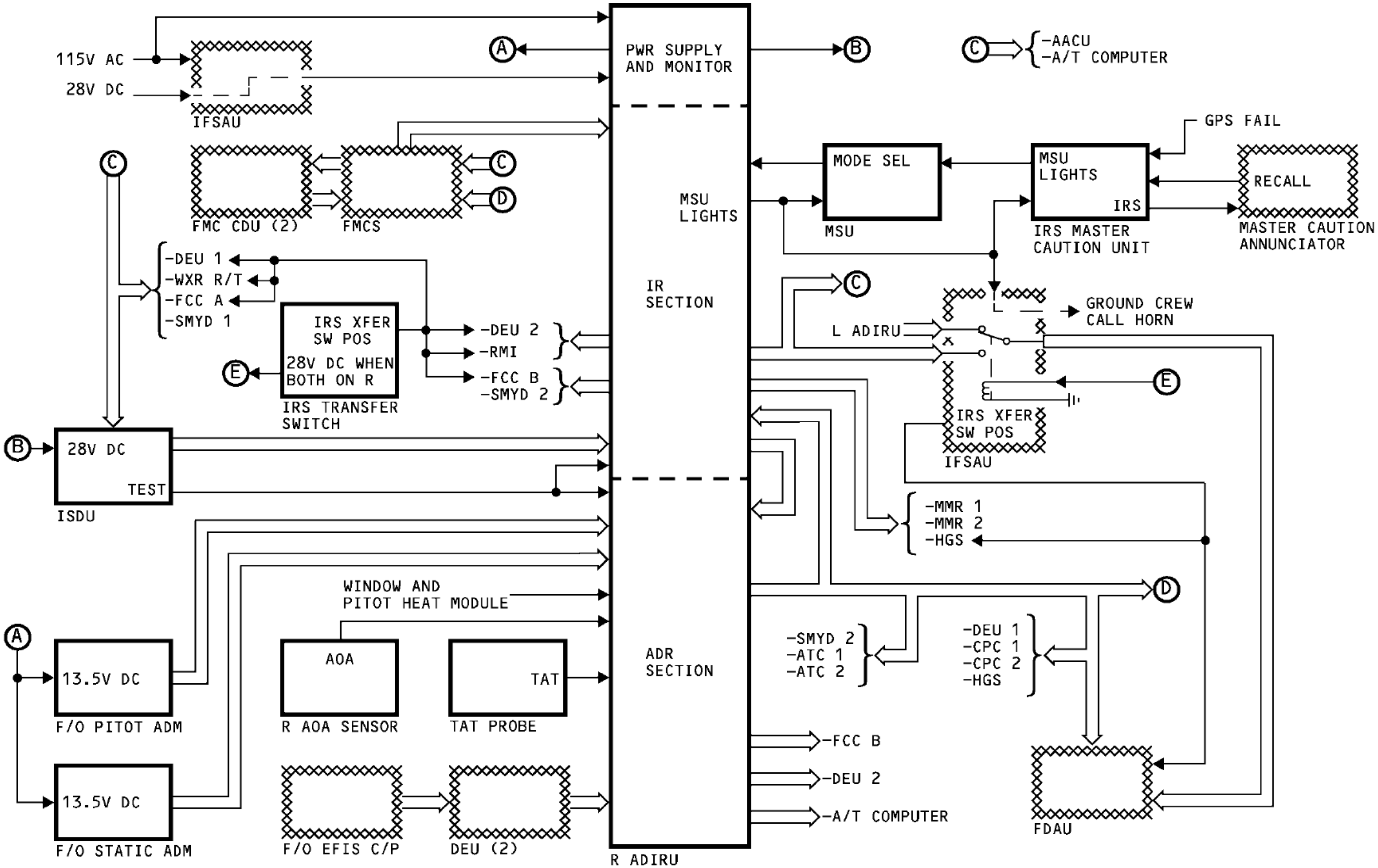
General



ADIRS – SYSTEM SUMMARY 1

ADIRS - SYSTEM SUMMARY 2

General



ADIRS – SYSTEM SUMMARY 2

THIS PAGE IS INTENTIONALLY LEFT BLANK

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34 – 23. STANDBY MAGNETIC COMPASS

(ATA 34 – 23)

LEVEL 3

STANDBY MAGNETIC COMPASS

Purpose

The standby magnetic compass is a backup magnetic heading reference.

Location

The standby magnetic compass is below the P5 forward overhead panel.

Power

The standby magnetic compass has a 5v ac light bulb. A lamp access cover permits replacement of the bulb.

Characteristics

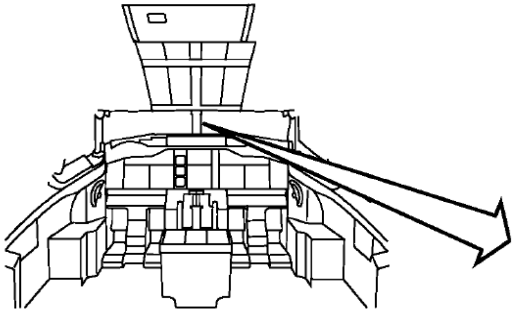
The standby magnetic compass has a circular heading indicator card. The card floats in a case filled with liquid. The liquid does not permit the card to move quickly.
There are two magnets in the standby magnetic compass. The magnets are parallel to each other, and they are in the horizontal plane. The magnets align the compass with the magnetic flux lines of the earth.

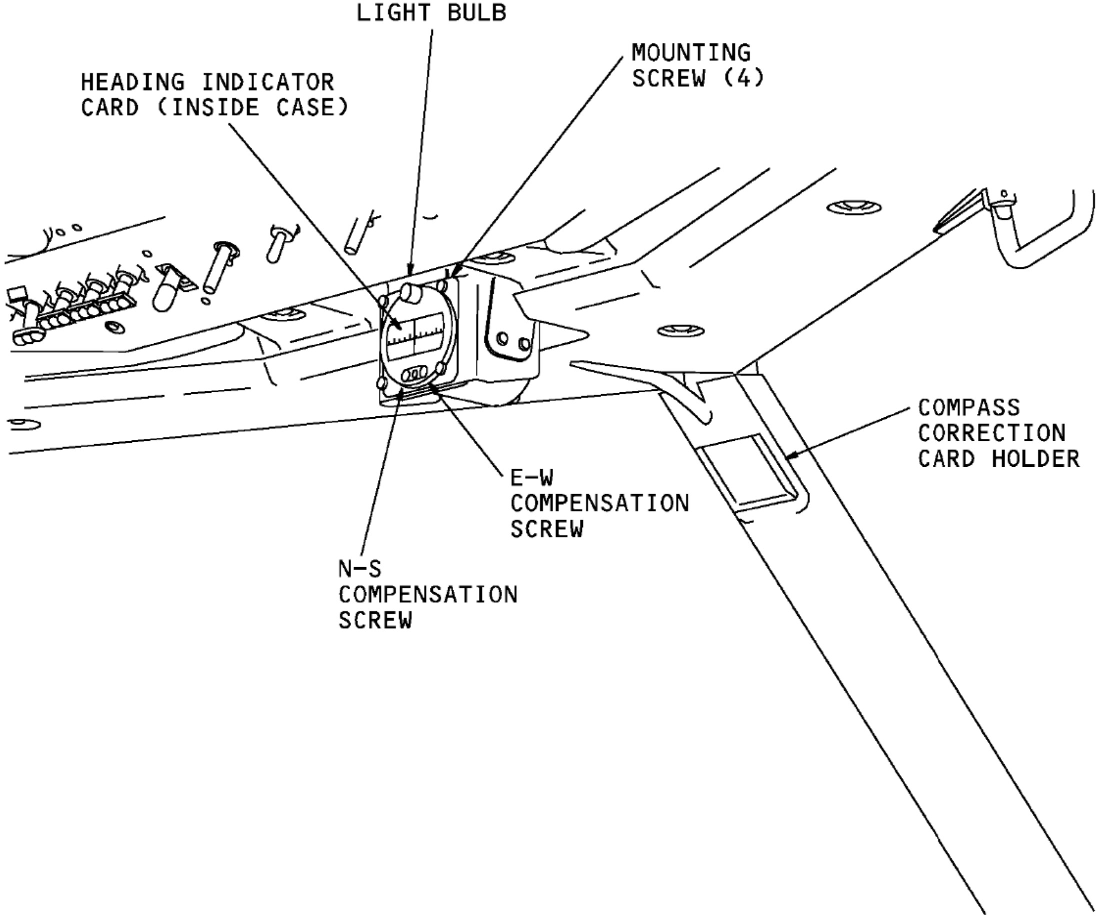
Adjustment

The standby magnetic compass has N-S (north-south) and E-W (east-west) compensation screws. These screws change the position of the magnets.
Use the compensation screws to correct for magnetic deviation. Use only non- magnetic tools to turn the compensation screws.
There is a compass correction card near the compass. Use this card to write small errors that the compensation screws cannot remove.

Training Information Point

Four screws hold the standby magnetic compass in place. Use only non-magnetic tools and screws to remove and install the standby magnetic compass.
You must do a compass swing after you replace the standby magnetic compass.





STANDBY MAGNETIC COMPASS

THIS PAGE IS INTENTIONALLY LEFT BLANK

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34 – 24. STANDBY ATTITUDE REFERENCE SYSTEM(ATA 34 – 24)

LEVEL 3

STANDBY ATTITUDE REFERENCE SYSTEM (Optional1) - INTRODUCTION

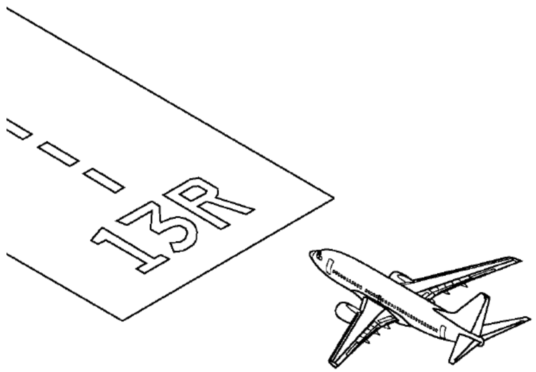
The standby attitude reference system is a backup system. It gives the pilots indications of airplane attitude in pitch and roll. The standby attitude reference system also shows instrument landing system (ILS) localizer and glideslope deviation.

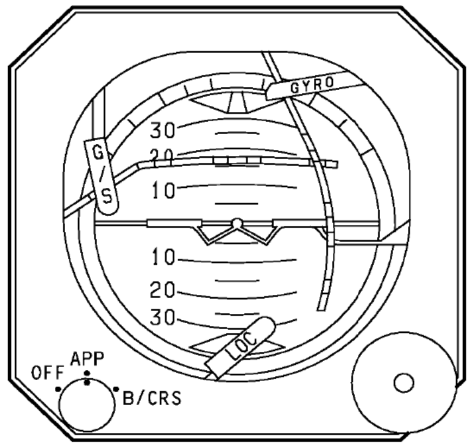
General

The standby attitude reference system operates independently of the air data inertial reference system.

Abbreviations and Acronyms

- AC - alternating current
- APP - approach
- ARINC - Aeronautical Radio, Inc.
- B/CRS - back course
- DC - direct current
- G/S - glideslope
- ILS - instrument landing system
- LOC - localizer
- NCD - no computed data
- V – volts



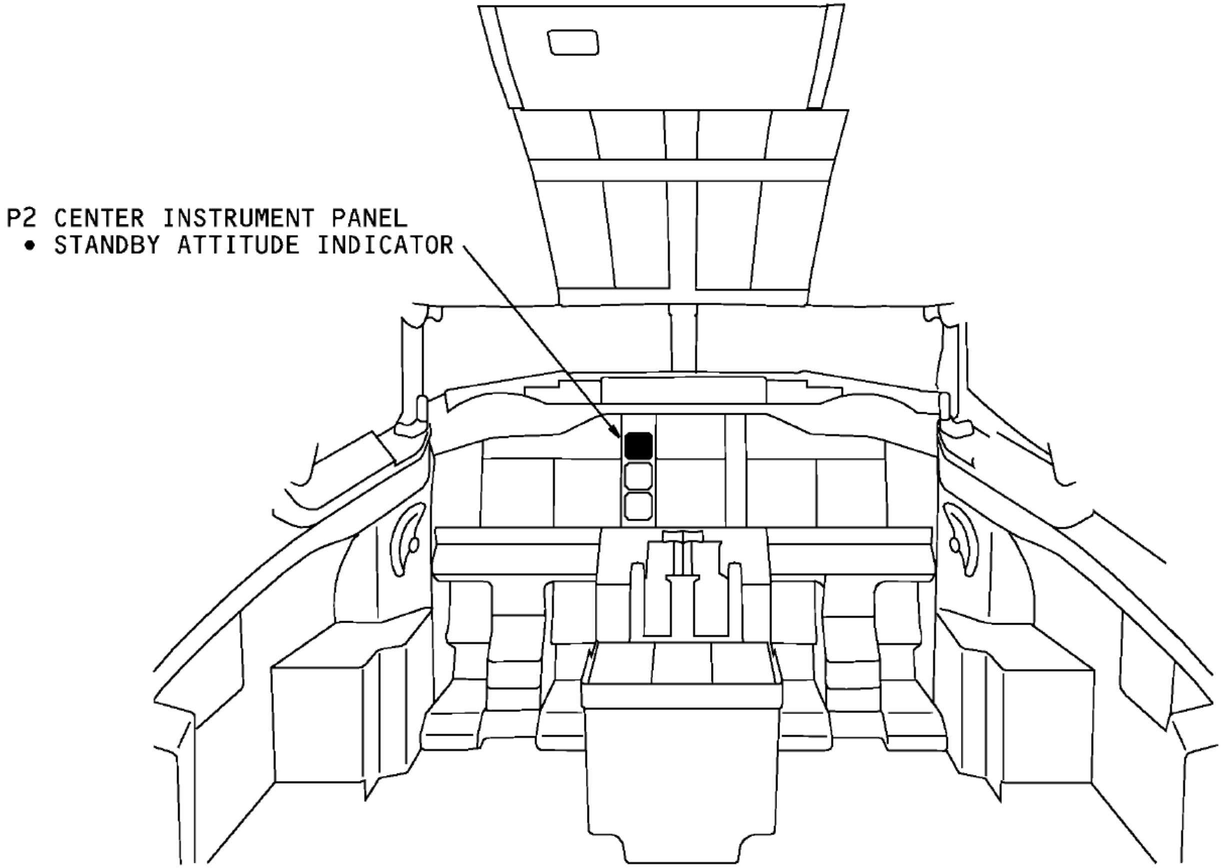


STANDBY ATTITUDE REFERENCE SYSTEM - INTRODUCTION

COMPONENT LOCATION

General

The standby attitude indicator is on the P2 center instrument panel.



COMPONENT LOCATION

STANDBY ATTITUDE INDICATOR

General

The standby attitude indicator has a gyro-stabilized ball that shows horizon position to the pilots. A roll scale is on the top of the indicator case. The roll indication shows with marks at 0, 10, 20, 30, and 60 degrees.

A pitch scale is on the face of the attitude ball. The pitch angle shows with marks at each five degree increment. Numerals show at each ten degree increment. The fixed airplane symbol is on the case of the indicator and does not move.

Control

The standby attitude indicator gyro will align to vertical in these two ways:

- In the automatic mode, application of power causes the gyro to align to vertical at a rate of three degrees per minute
- In the manual mode, let the gyro spin for thirty seconds. After thirty seconds, pull the cage knob. The cage knob aligns the gyro to vertical and makes the attitude ball stable at zero degrees pitch and roll.

The approach mode selector has these positions:

- Off - no ILS data on indicator
- APP - ILS localizer and glideslope data shows
- B/CRS - back course ILS localizer data shows.

Indications

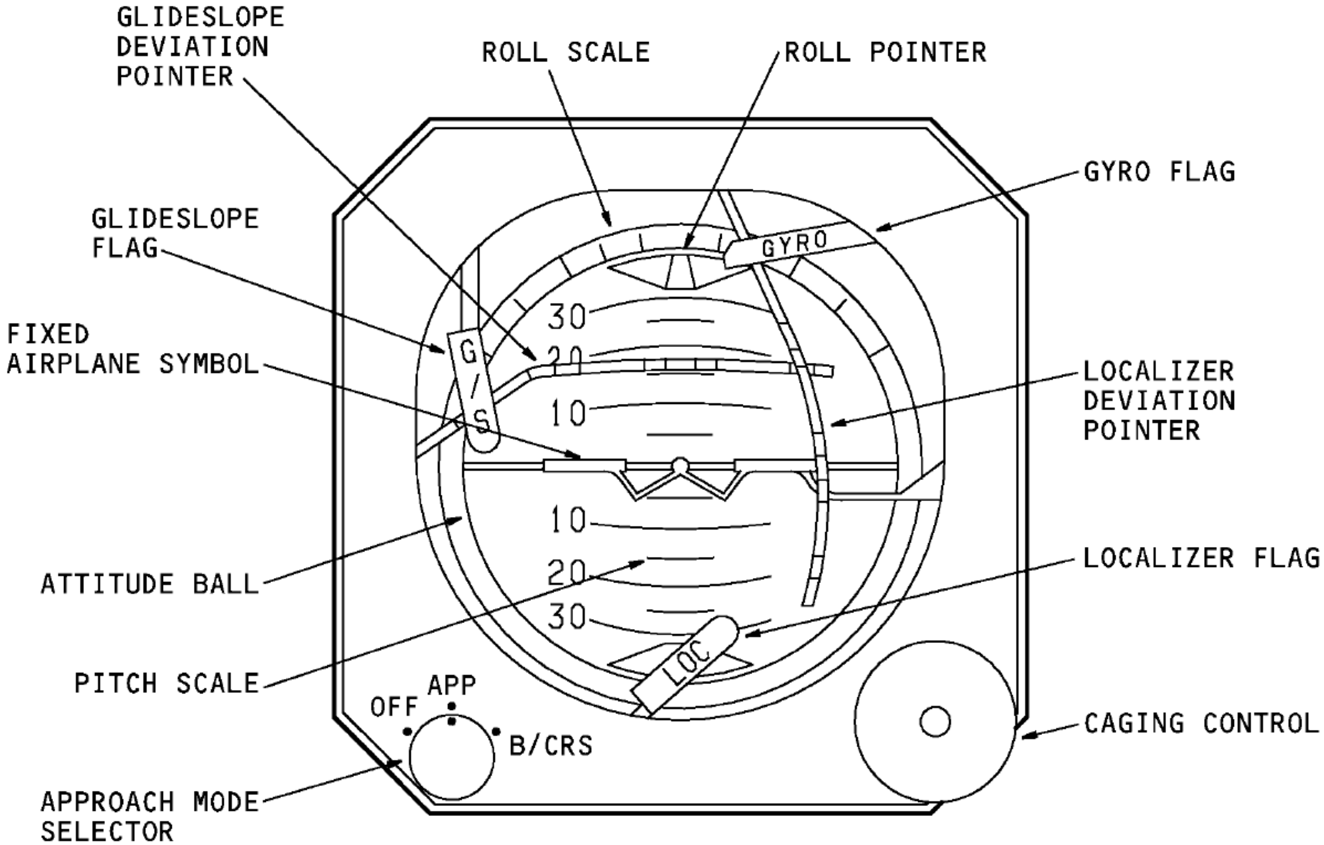
The normal ILS indications are the glideslope and localizer deviation pointers in view and the LOC flag and G/S flag out of view.
When the ILS data is no computed data (NCD), the related deviation pointer goes out of view.

When the indicator receives incorrect ILS data, the related deviation pointer goes out of view and you can see the failure flag.

When you select B/CRS, the localizer deviation pointer reverses polarity for the approach display. The glideslope deviation pointer is NCD and is not in view during B/CRS approaches.

Training Information Point

It is necessary to remove power from the standby attitude indicator nine minutes before you remove the indicator. This will give the gyro time to stop spinning.



STANDBY ATTITUDE INDICATOR

THIS PAGE IS INTENTIONALLY LEFT BLANK

INTERFACE

General

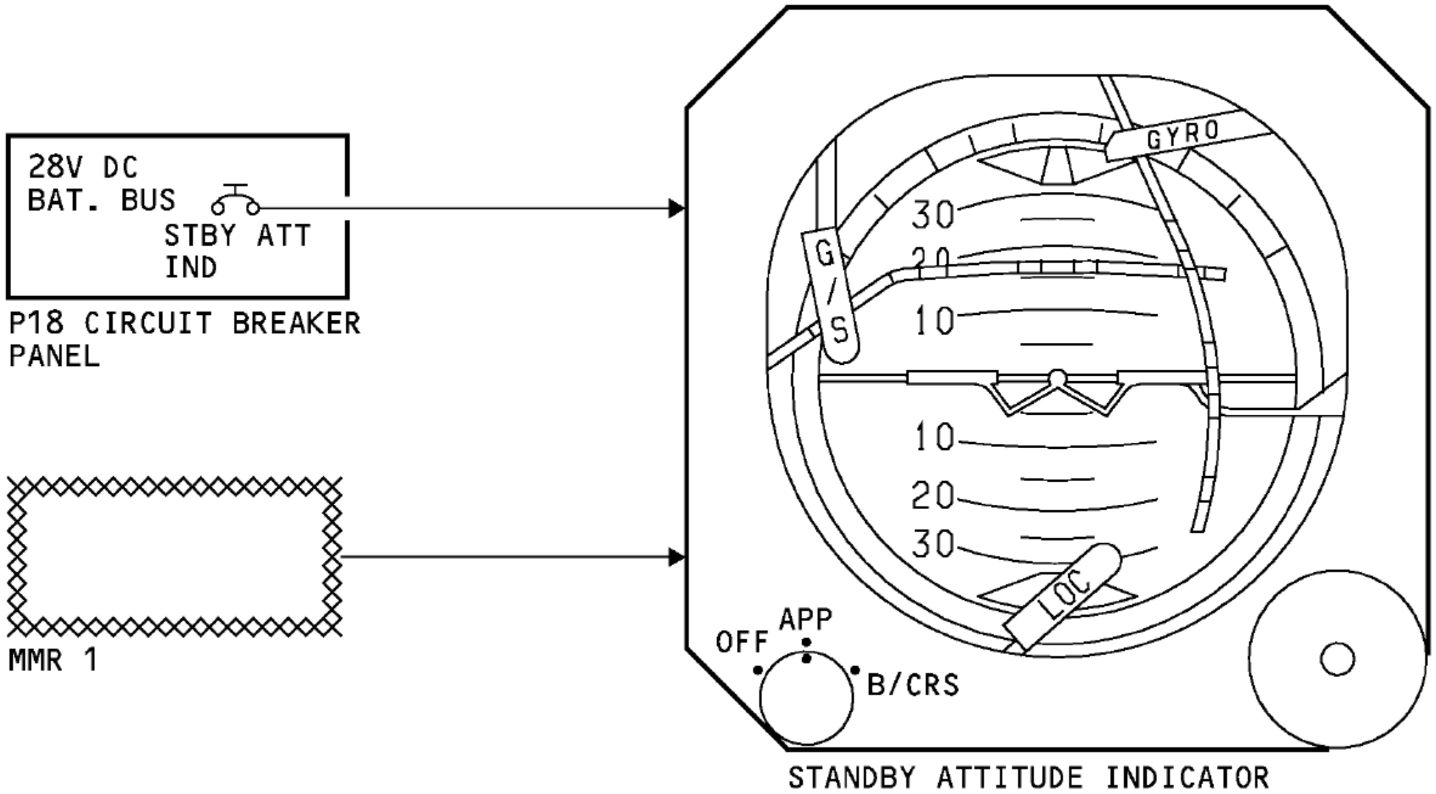
The standby attitude reference system is an alternate source of airplane pitch and roll attitude information.

The standby attitude reference system can also show instrument landing system (ILS) localizer and glideslope deviation. ILS data is from multi mode receiver (MMR) 1.

The failure flags on the standby attitude indicator tell the flight crew if there is an ILS or indicator failure.

Power

28v dc from the battery bus supplies power for the standby attitude reference system.



INTERFACE

FUNCTIONAL DESCRIPTION

General

The standby attitude indicator uses a gyro stabilized attitude ball to show airplane attitude.
The gyro starts to operate when you apply power. The gyro normally aligns to vertical at a rate of three degrees per minute. You can pull the cage knob to align the gyro to vertical in a few seconds.
The standby attitude indicator uses inputs from ILS receiver 1 to supply a backup glideslope and localizer display.

Power

The static inverter/power supply gives 115v ac to the gyro motor. A gyro current monitor circuit causes the gyro flag to come into view when gyro power is not there or is incorrect. The static inverter/power supply also gives dc voltages for circuit functions.

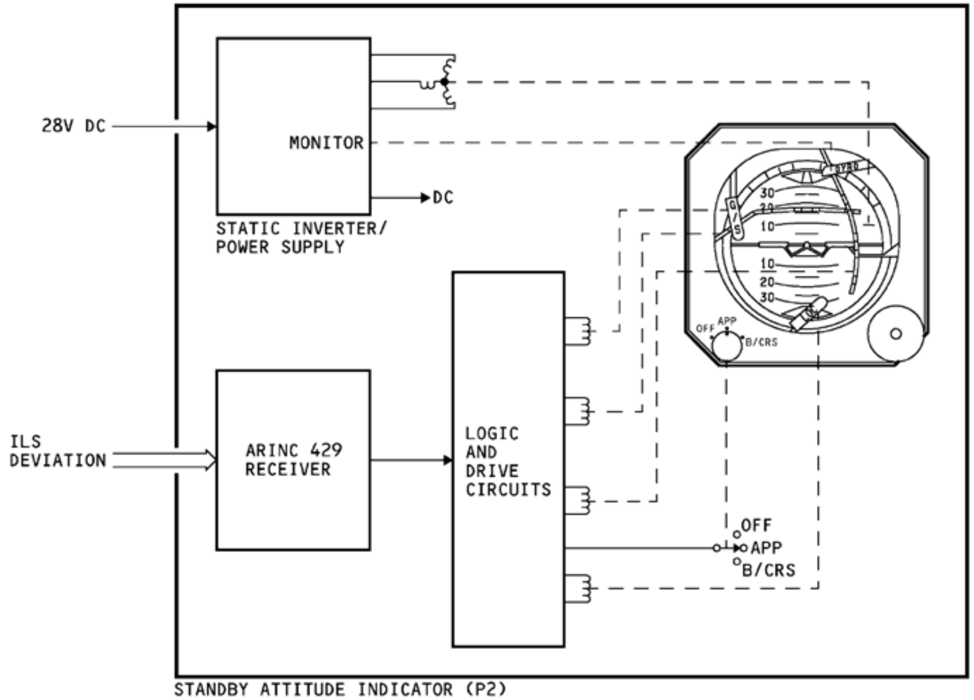
ILS Operation

ILS deviation data goes to the ARINC 429 receiver. The ARINC 429 receiver sends the data to the logic and drive circuits. These circuits control the localizer deviation pointer and the failure flag. They also control the glideslope deviation pointer and failure flag.
An ILS mode select discrete and the approach mode selector position sets theILS mode and validity.

When you select the OFF mode or when an NCD or incorrect data signal is present, the deviation pointers go out of view.
When you select the APP mode and the ILS data is correct, the localizer and glideslope deviation pointers show ILS deviation.
When you select the B/CRS mode, the localizer deviation pointer signal reverses, and the glideslope deviation pointer goes out of view.

ILS Failure Flags

The ILS failure flags are normally out of view. When ILS data is incorrect, the G/S flag, the LOC flag, or both flags will come into view.



FUNCTIONAL DIAGRAM

STANDBY ATTITUDE REFERENCE SYSTEM - ILS SELF-TEST

General

There are no special tests for the standby attitude reference system. You do a check of the approach display with an ILS receiver 1 self-test.

Start the ILS self-test from the test switch on the navigation control panel. You can also start it from the test switch on the ILS receiver 1. The approach mode selector must be in the APP position.

There are four display sequences that occur on the standby attitude indicator during the ILS self-test:

- Invalid data
- No computed data (NCD)
- Data correct - up/left
- Data correct - down/right.

The length of the self test sequence is 14 seconds.

Invalid Data Display

Invalid data is the first display in the self-test sequence.

It shows on the standby attitude indicator for three seconds.

Invalid data causes these indications:

- LOC flag comes into view
- G/S flag comes into view
- Deviation pointers go out of view.

NCD Display

NCD is the second display in the self-test sequence. It shows on the standby attitude indicator for two seconds.

NCD causes these indications:

- LOC flag goes out of view
- G/S flag goes out of view
- Deviation pointers go out of view.

Data Correct - Up/Left Display

Data correct - up/left is the third display in the self-test sequence. It shows for three seconds on the standby attitude indicator.

Data correct - up/left causes these indications:

- LOC flag goes out of view
- G/S flag goes out of view
- Localizer pointer shows one dot of left deviation
- Glideslope pointer shows one dot of up deviation.

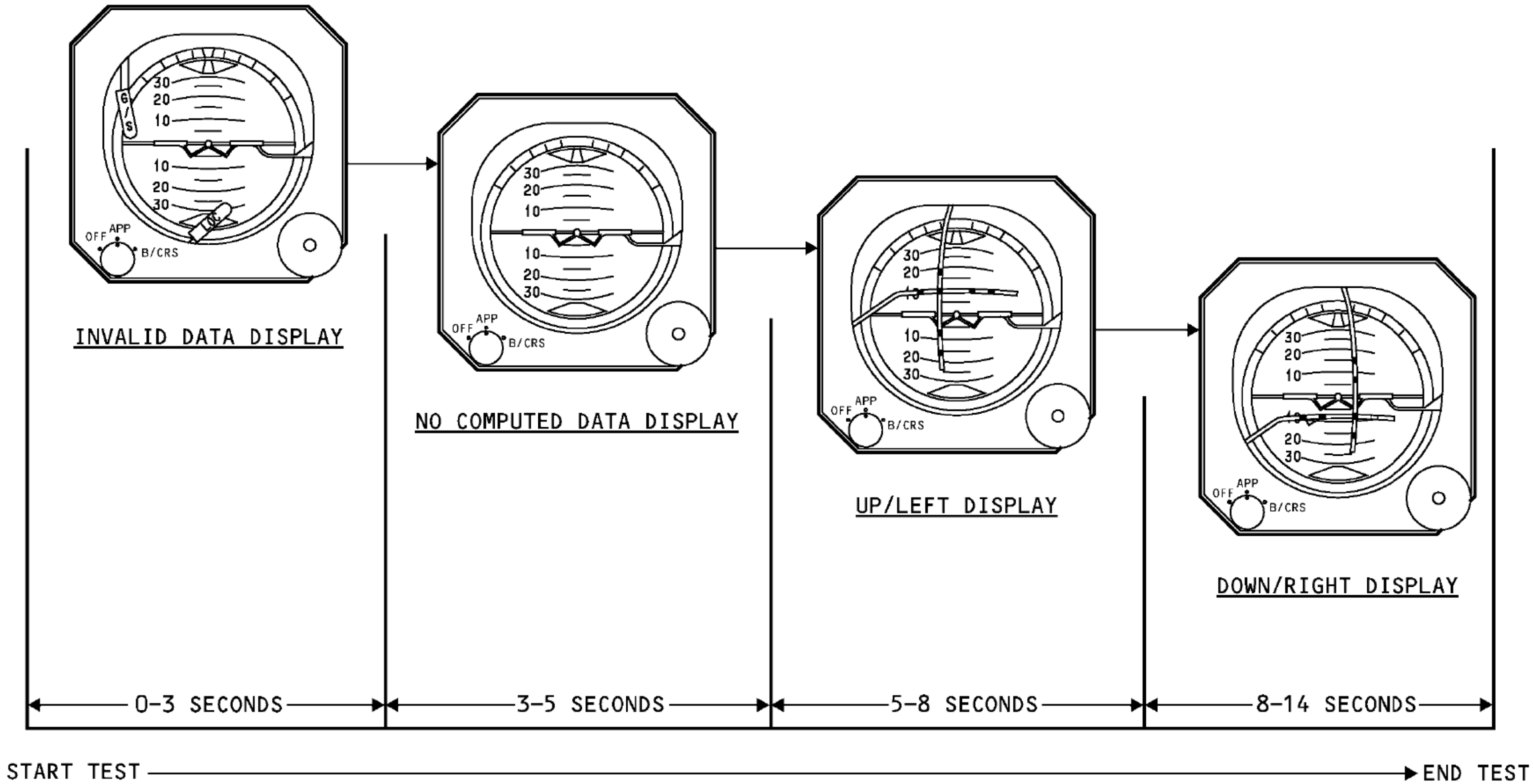
Data Correct - Down/Right Display

Data correct - down/right is the forth display in the self-test sequence. It shows for six seconds on the standby attitude indicator.

Data correct - down/right causes these indications:

- LOC flag goes out of view
- G/S flag goes out of view
- Localizer pointer shows one dot of right deviation
- Glideslope pointer shows one dot of down deviation.

The approach display goes back to normal indications at the end of the self-test sequence.



STANDBY ATTITUDE REFERENCE SYSTEM-ILS SELF-TEST

STANDBY ATTITUDE REFERENCE SYSTEM (Optional2) - STANDBY ATTITUDE REFERENCE SYSTEM – ISFD - INTRODUCTION

General

The standby attitude reference system consists of an integrated standby flight display (ISFD) and an ISFD dedicated battery system.

The ISFD shows this standby data:

- Attitude
- Airspeed
- Altitude.

The ISFD can also show heading (program pin selection) from the air data inertial reference system (ADIRS).

The display is a color liquid crystal display (LCD).

Power

Airplane power goes through the ISFD dedicated battery system to the ISFD.

The battery bus provides the 28v dc power.

The battery switch on the electrical meters, battery, and galley power module controls the power to the ISFD.

When the battery switch is on, the battery/charger sends power to the ISFD.

The battery bus supplies power to the ISFD through the battery/charger.

The battery bus also charges a battery in the battery/charger.

If there is not sufficient power on the battery bus to operate the ISFD, the battery in the battery/charger supplies power to the ISFD.

When the battery switch is off, the battery/charger removes power to the ISFD.

Attitude

Pitch and roll attitude come from the inertial sensors in the ISFD.

Pitch and roll attitude show as an attitude ball in the center of the display.

Altitude and Airspeed

The ISFD is a pneumatic altimeter and airspeed indicator.

The ISFD gets static pressure from the alternate static ports and pitot pressure from the alternate pitot probe.

The ISFD uses pitot and static pressure to show indicated airspeed (IAS). IAS shows on the airspeed tape on the left side of the display.

The ISFD uses static pressure to show barometric altitude. Barometric altitude shows on the altitude tape on the right side of the display.

The ISFD can also show the barometric altitude in meters in a digital format on the bottom of the display (program pin selection).

Heading

The air data inertial reference system (ADIRS) provides heading to the ISFD from the left air data inertial reference unit (ADIRU).

Heading shows on the compass rose on the bottom of the display (program pin selection).

Localizer and Glideslope Deviation

The standby attitude reference system also shows information from the instrument landing system (ILS) or (GLS).

When you select the approach (APP) mode on the ISFD, the localizer deviation scale shows on the bottom of the attitude ball and the glideslope deviation scale shows on the right side of the attitude ball.

Push the approach mode switch (APP) two times to select the back course mode.

When you select the back course (BCRS) mode on the ISFD, the localizer deviation scale shows on the bottom of the attitude ball.

The ISFD also moves the localizer deviation pointer to the opposite side of the scale.

The glideslope deviation scale does not show.

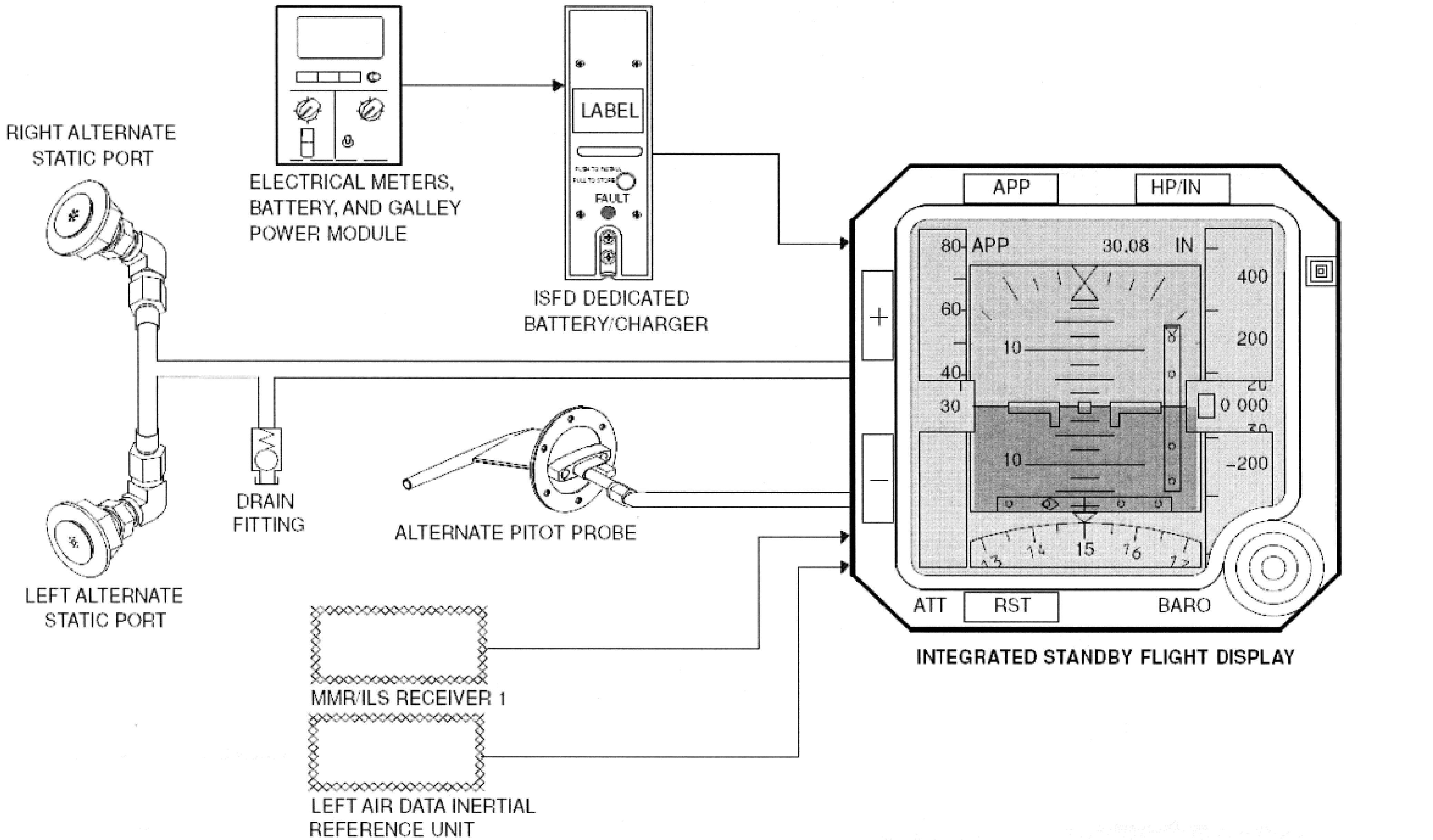
Multi−mode receiver (MMR) 1 sends localizer and glideslope deviation to the ISFD.

Air Data Inertial Reference Unit

The ADIRU sends inertial reference data to the ISFD.

The ISFD shows heading on the bottom of the display (program pin selection).

The ISFD uses ground speed to sense when the airplane is on the ground.



ISFD – GENERAL DESCRIPTION

ISFD – COMPONENT LOCATION

General

The components for the standby attitude reference system are in the flight compartment and the electronic equipment compartment.

Flight Compartment

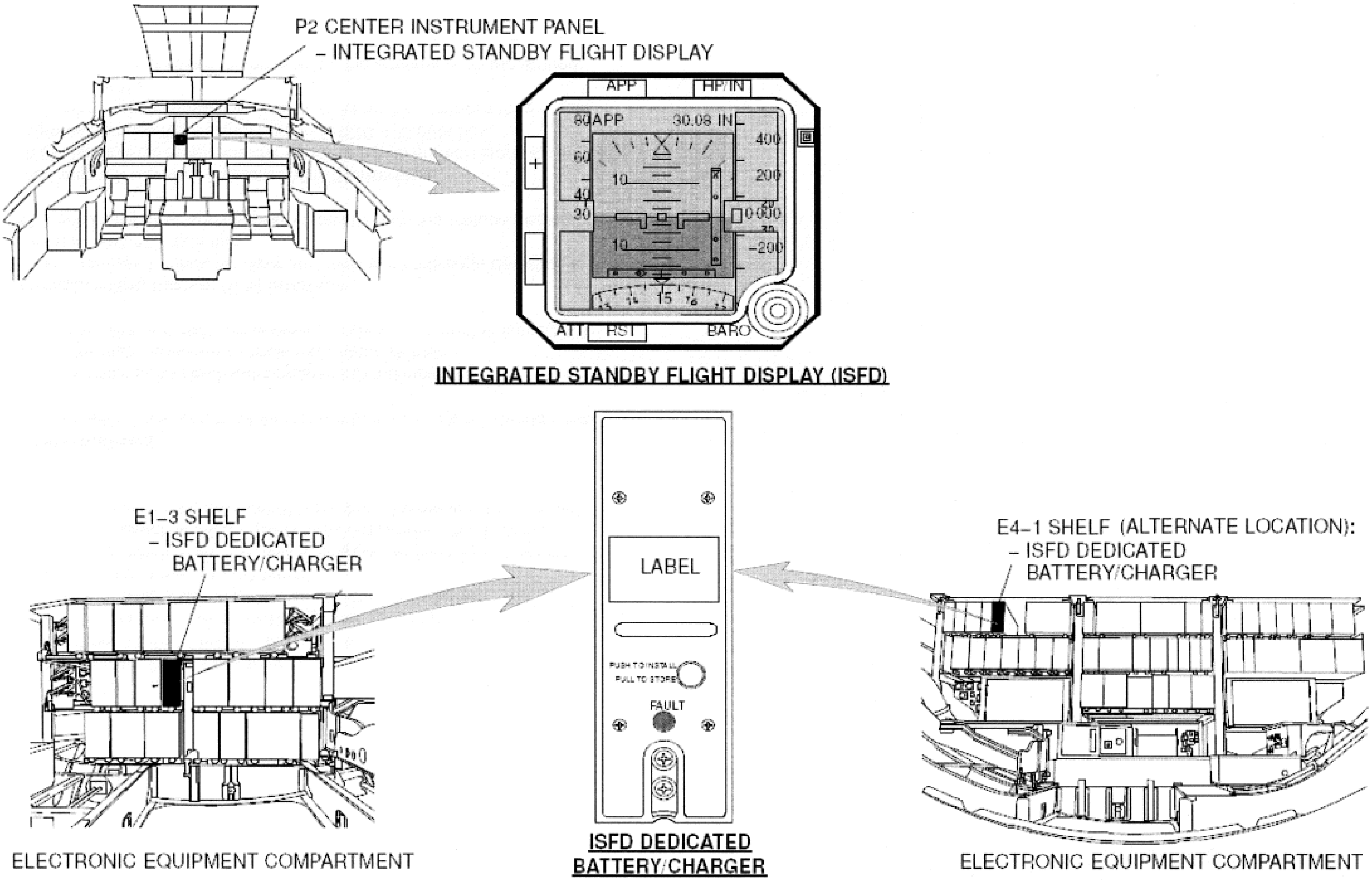
The integrated standby flight display (ISFD) is on the P2 center instrument panel.

Electronic Equipment Compartment

The ISFD dedicated battery system is in the electronic equipment compartment on the E1 rack, shelf E1−3.

Alternate location:

The ISFD dedicated battery system is in the electronic equipment compartment on the E4 rack, shelf E4−1.



ISDF – COMPONENT LOCATION

INTERFACE

Power

The integrated standby flight display (ISFD) gets 28v dc from the ISFD dedicated battery/charger.
The ISFD dedicated battery system gets 28v dc from the battery bus.
The battery/charger sends the 28v dc power to the ISFD.
The battery/charger also uses the 28v dc power to charge its internal battery.
A signal from the battery switch on the electrical meters, battery, and galley power module goes to the battery/charger.
When the battery switch is on, the battery/charger supplies 28v dc power to the ISFD.
When the battery switch is off, the ISFD does not receive 28v dc power.
The ISFD gets 5v ac for the front panel lights from the master dim and test circuit.

Pitot−Static Interface

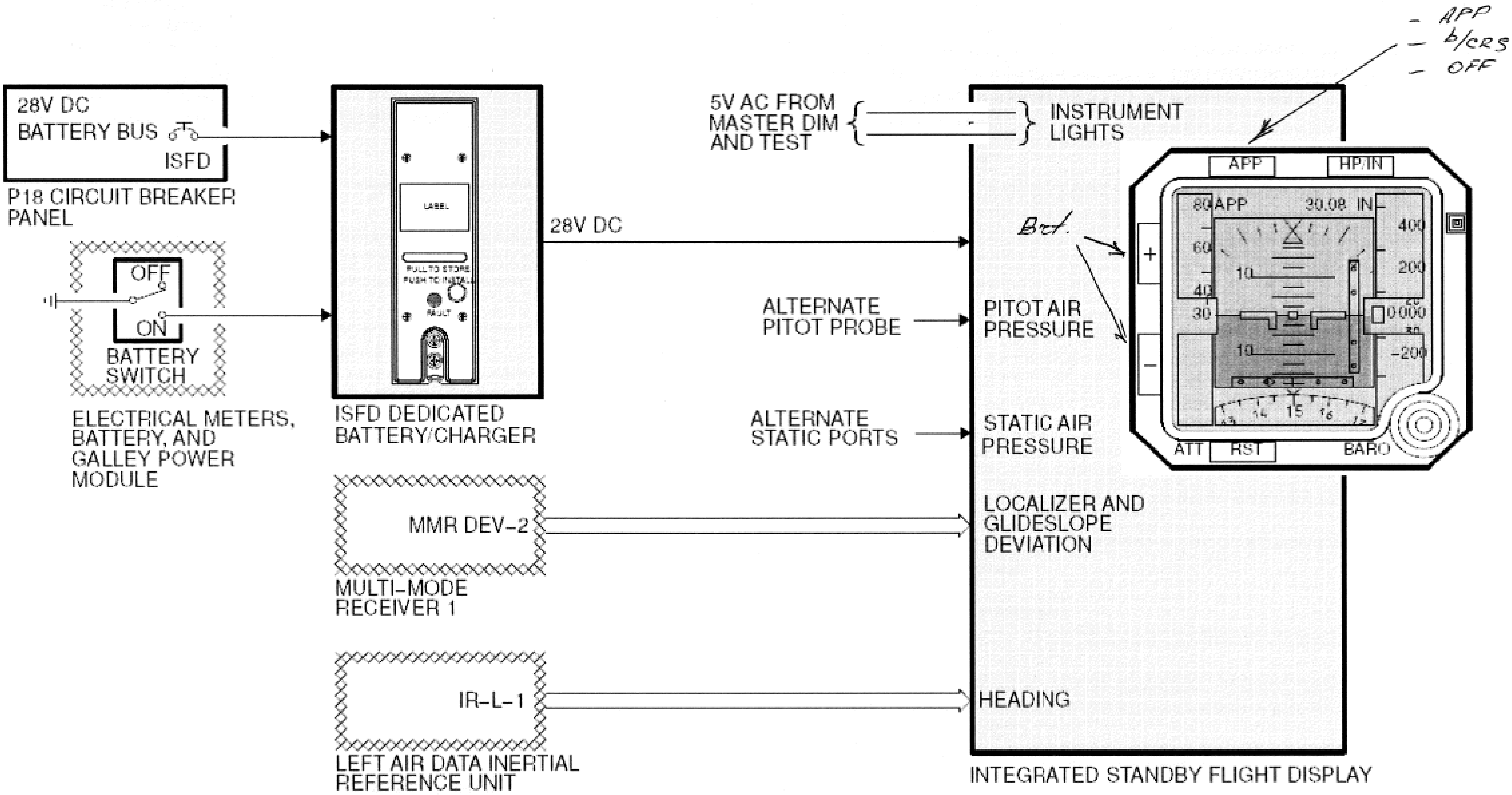
The alternate pitot probe sends pitot pressure to the integrated standby flight display.
The alternate static ports send static pressure to the indicator.
The ISFD uses static pressure to show barometric altitude.
The ISFD uses pitot and static air pressure to show indicated airspeed (IAS).

Instrument Landing System (ILS) Interface

Multi−mode receiver 1 sends localizer deviation and glideslope deviation to the ISFD on an ARINC 429 data bus.
The ISFD shows localizer and glideslope deviation on the attitude display.

Air Data Inertial Reference System (ADIRS) Interface

The left air data inertial reference unit (ADIRU) sends inertial reference data to the integrated standby flight display on an ARINC 429 data bus.
The ISFD uses magnetic heading data to show on the compass rose on the bottom of the display.
The ISFD uses ground speed to sense when the airplane is on the ground.


- APP
- b/CRS
- OFF
28V DC
BATTERY BUS
ISFD
P18 CIRCUIT BREAKER PANEL
OFF
ON
BATTERY SWITCH
ELECTRICAL METERS, BATTERY, AND GALLEY POWER MODULE
LABEL
PULL TO STORE
PUSH TO INSTALL
FAULT
ISFD DEDICATED BATTERY/CHARGER
28V DC
5V AC FROM MASTER DIM AND TEST
INSTRUMENT LIGHTS
ALTERNATE PITOT PROBE
PITOT AIR PRESSURE
ALTERNATE STATIC PORTS
STATIC AIR PRESSURE
MMR DEV-2
MULTI-MODE RECEIVER 1
LOCALIZER AND GLIDESLOPE DEVIATION
IR-L-1
LEFT AIR DATA INERTIAL REFERENCE UNIT
HEADING
Brt.
APP
HP/IN
80 APP
30.08 IN
400
200
0 000
-200
60
40
30
10
+
-
15
ATT
RST
BARO
INTEGRATED STANDBY FLIGHT DISPLAY

INTERFACES

INTEGRATED STANDBY FLIGHT DISPLAY (ISFD)

General

The integrated standby flight display (ISFD) provides the flight crew a single integrated display of these parameters:

- Pitch and roll attitude
- Indicated airspeed
- Altitude
- Metric altitude (program pin selection)
- Heading (program pin selection)
- Localizer and glideslope deviation.

The ISFD is a single unit which has these components:

- Color liquid crystal display
- Solid state rate sensors
- Accelerometers
- Pitot and static air pressure sensors.

The ISFD calculates attitude, altitude, and airspeed internally.

The ISFD receives heading data from the air data inertial reference unit (ADIRU). The heading display is selected by program pin.

The ISFD receives localizer and glideslope deviation data from the multi−mode receiver (MMR).

The ISFD has three connectors at the rear of the unit. One electrical connector supplies the wiring interface for all electrical power and interface signals. Two pnuematic connectors are for the pitot air pressure and the static air pressure inputs to the ISFD.

The ISFD is passively cooled. Forced air cooling is not necessary.

Controls

The ISFD has these controls on the front of the display:

- Display brightness switches (+, −)
- Approach mode switch (APP)
- Barometric reference switch (HP/IN)
- Barometric control (BARO)
- Standard select switch
- Attitude reset switch (ATT RST).

- Display Brightness Switches (+, −)

Use the display brightness switches to adjust the intensity of the display manually. Push the + switch to increase the intensity. Push the − switch to decrease the ntensity.

The ISFD uses the light sensor on the front of the display to control the intensity of the display automatically.

Approach Mode Switch (APP)

The approach mode switch controls the display of the localizer and glideslope deviation.

When the ISFD comes on, the ISFD shows no localizer scale and no glideslope scale. Push the APP mode switch once to make the front course approach mode come on. The ISFD shows the localizer and the glideslope deviation scales.

Push the APP mode switch a second time to make the back course approach mode come on. The ISFD shows only the localizer scale. The ISFD also moves the localizer deviation pointer to the opposite side of the scale.

Push the APP mode switch a third time to make the approach mode displays go off.

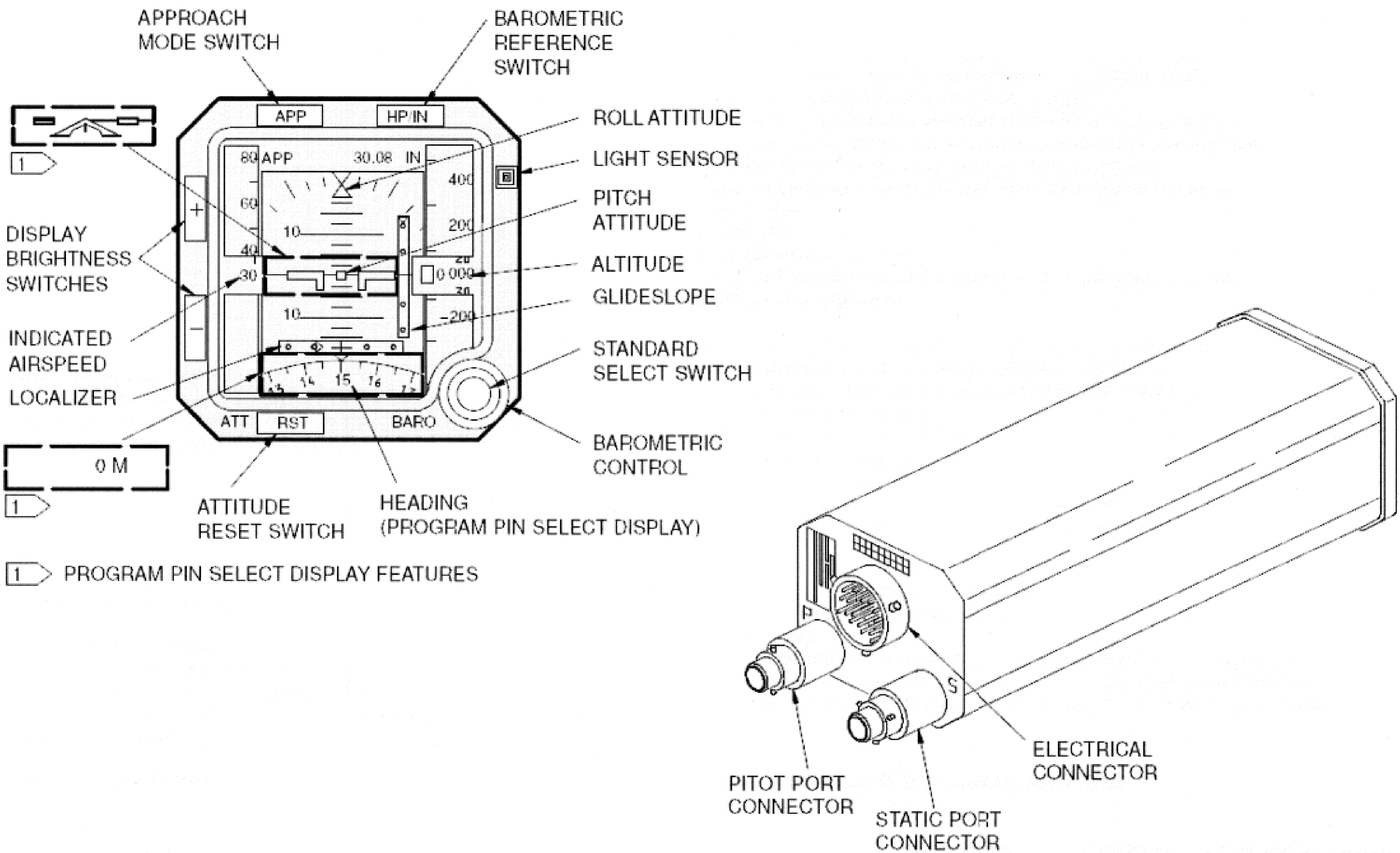
Barometric Reference Switch (HP/IN)

The barometric reference switch controls the units for the barometric correction. The barometric correction shows in units of hectopascals or inches of mercury. Push the switch to change the reference between hectopascals and inches of mercury. The display shows HP for hectopascals (hPa) and IN for inches of mercury (in Hg).

Barometric Control (BARO)

The barometric control is a rotary knob and a push−button switch.

Turn the control to set the barometric correction. The barometric correction shows on the top right side of the display in units of hectopascals (hPa) or inches of mercury (in Hg). The range of the barometric correction is 22.00 to 32.48 in Hg (745 to 1100 hPa).



DISPLAY UNIT

(continued from previous page)

Standard Select Switch
Push the standard select switch in the center of the BARO control to set the standard barometric correction of 29.92 in Hg (1013 hPa). The ISFD shows STD in place of the barometric correction. Push the switch again to set the barometric correction manually.

Attitude Reset Switch (ATT RST)
The attitude reset switch controls the alignment of the attitude display manually.

Built−in Test Equipment
The ISFD has built−in test equipment (BITE) which monitors inputs to the ISFD and internal circuits.

The ISFD can show BITE data on the display.
When the airplane is on the ground, push the approach (APP) mode switch and the barometric reference switch (HP/IN) for 2 seconds.
The display shows a BITE menu.

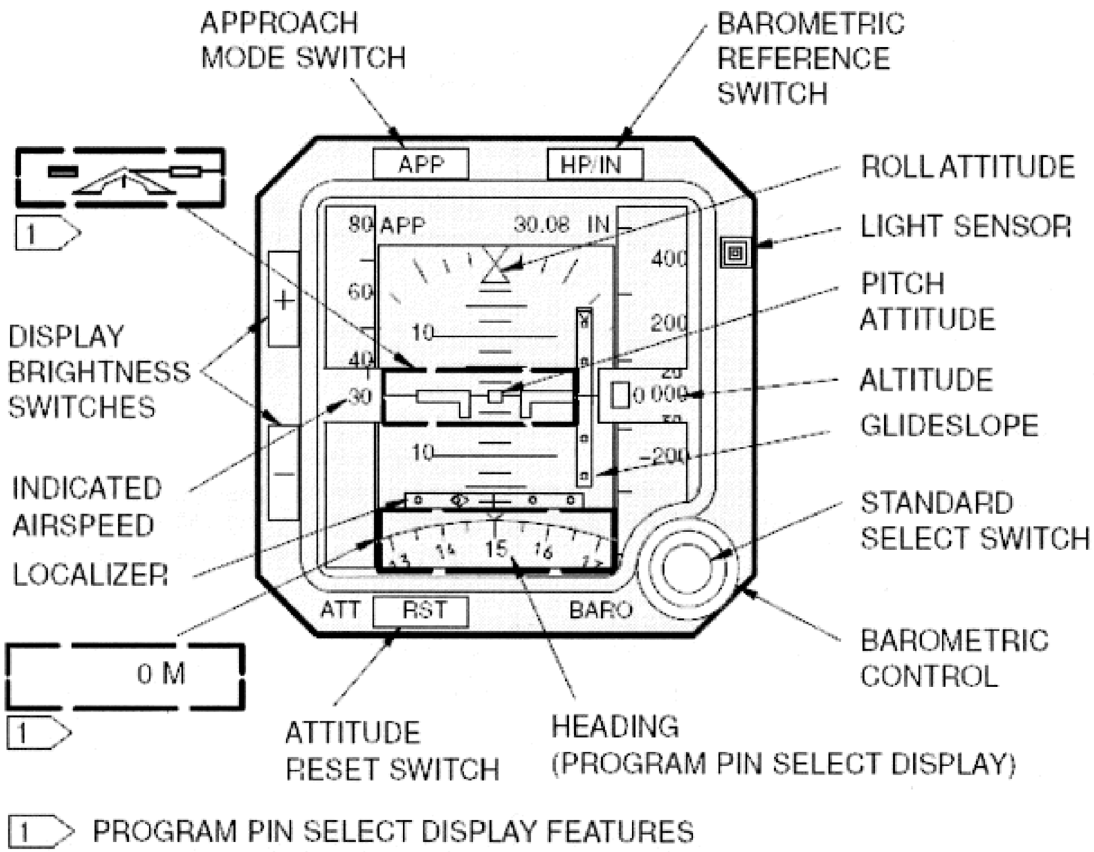
DEDICATED BATTERY / CHARGER

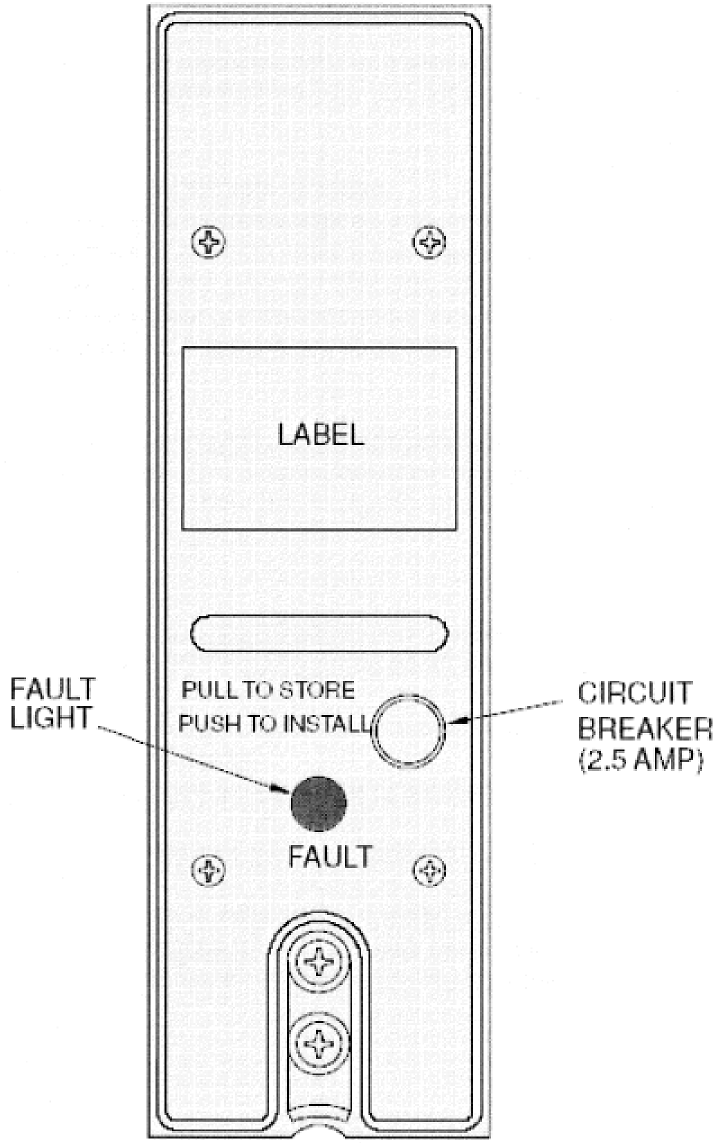
General
The integrated standby flight display (ISFD) dedicated battery system provides power to the ISFD when the power from the airplane battery bus is not available.
The battery/charger is a single unit which has a battery pack and battery charger circuits.
The battery pack in the battery/charger contains 11 lead−acid cells which are bonded together and covered in a sleeve.

Operation
The charger circuits in the battery/charger keep the battery pack charged while there is electrical power on the airplane battery bus.
The battery/charger also uses the power from the airplane battery bus to supply power to the ISFD.
If the airplane battery bus goes off, the battery pack can provide 28v dc power to the ISFD for 150 minutes.
When the battery switch in the flight compartment is set to OFF, the battery/charger removes the battery pack from the circuit.
This causes no power to go to the ISFD and the ISFD goes off.

Controls and Indication
The battery/charger has these components on the front of the unit:
- Circuit breaker (2.5 amp)
- Fault light.
- Fault Light

If there are failures in the battery/charger, the fault light comes on.
The fault light comes on if one of these conditions occur:
- Operating temperature is more than the maximum or less than the minimum. The maximum operating temperature is 180F (83C). The minimum operating temperature is 5F (−15C).
- Battery charger circuits do not give the correct output voltage.
- Voltage levels of the cells in the battery pack are not equal.





ISFD DEDICATED BATTERY CHARGER

DEDICATED BATTERY CHARGER

FUNCTIONAL DESCRIPTION

General

The components of the standby attitude reference system are the integrated standby flight display (ISFD) and the dedicated battery system.

The ISFD shows these parameters from alternate sources:

- Attitude
- Airspeed
- Altitude.

The ISFD also shows these parameters from other sources on the airplane:

- Magnetic heading from the air data inertial reference system (ADIRS)
- Localizer deviation from the instrument landing system (ILS) or global landing system (GLS).

Glideslope deviation from the ILS or GLS.

The battery/charger uses airplane power to charge an internal battery and to supply power to the ISFD. If airplane power is not available, the battery/charger uses its battery to supply power to the ISFD.

Power

The battery bus supplies 28v dc power to the battery/charger. The 28v dc power goes through a diode and a 2.5 amp circuit breaker in the battery/charger to the ISFD.

NOTE: The 2.5 amp circuit breaker is on the front face of the battery/charger.

The battery bus also supplies 28v dc power to charge the battery in the battery/charger.

The monitors and switch logic in the battery/charger measures the input voltage from the input power.

When the voltage on the input power goes to less than 20v dc, the monitors and switch logic closes the switch that connects the battery to the output circuitry of the battery/charger.

This lets the battery in the battery/charger supply power to the ISFD.

The battery in the battery/charger is a pack of 11 lead-acid cells. The battery pack can supply power to the ISFD for a maximum of 150 minutes.

Program Pins

The program pins tell the ISFD the airplane model and the optional parameters.

The program pins that identify the airplane model set these parameters:

- Tilt angle - To correct the attitude as a function of the angle of the main instrument panel
- Static source error correction - To correct the static pressure as a function of the Mach number
- Air data aiding - To correct the attitude as a function of airspeed.
- Other program pins identify display options.

The ISFD uses one program pin, called the parity pin, to make sure the airplane model and optional functions are correct.

The sum of all the program pins and the parity pin must be an even number.

If the sum is odd, there is a fault and the ISFD shows the message PROGRAM PIN ERROR.

ARINC 429 Interfaces

The ISFD receives data from these components on ARINC 429 data buses:

- Multi-mode receiver (MMR) number 1 - localizer deviation and glideslope deviation
- Left air data inertial reference unit (ADIRU) - magnetic heading.

Pneumatic Inputs

There are two pneumatic sensors in the ISFD that sense pitot and static pressures.

One sensor receives pitot pressure from the alternate pitot probe.

The other sensor receives static pressure from the alternate static ports.

Pitot and static pressure data goes to the data control and system processing.

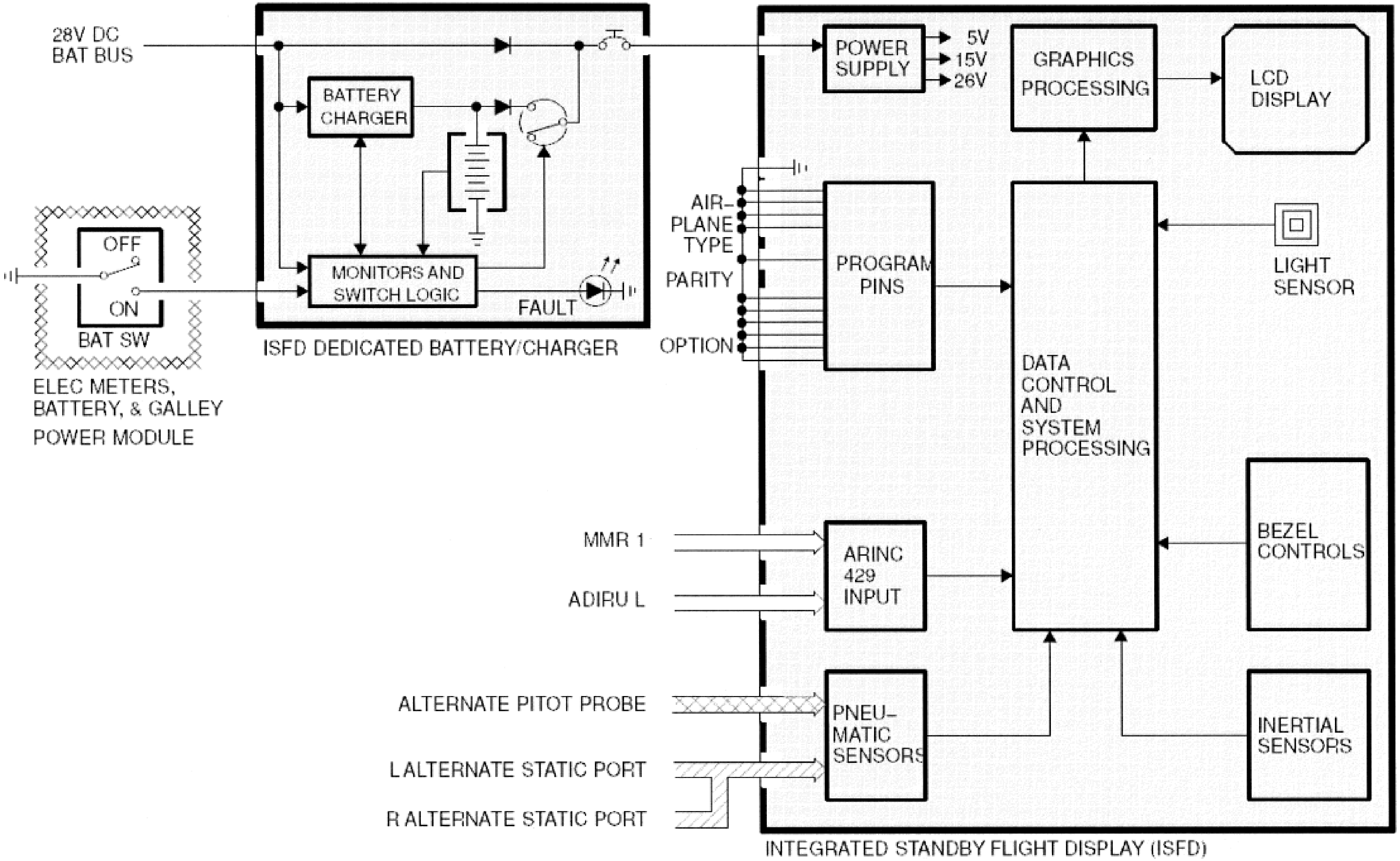
The processor uses static pressure to calculate altitude and airspeed.

The processor uses pitot pressure to calculate airspeed.

Inertial Sensors

The ISFD has inertial sensors that sense angular rate and linear acceleration.

The ISFD uses the inertial sensors to calculate pitch and roll attitude.



FUNCTIONAL DIAGRAM

The angular rate data comes from solid−state quartz rate sensors. Rotational movement about the sensor axis gives a DC voltage that is in proportion to the angular rate.
The linear acceleration data comes from silicon accelerometers.
Each accelerometer has a single silicon crystal.
Gravity and acceleration forces change the capacitance of the crystal.
The accelerometer gives a DC voltage that is in proportion to the acceleration.

Bezel Controls
The front face of the ISFD has five push−buttons and one rotary knob to control the operation.
There is one light sensor on the bezel. The ISFD uses the light sensor to control the intensity of the display as the ambient light changes.

Data Control and System Processing
All inputs and controls go to the data control and system processing section of the ISFD. The processor does these functions:

- Calculates airspeed and altitude from the pressure sensor signals
- Calculates pitch and roll attitude from the inertial sensor signals
- Changes calculated data to graphics data for the graphics processing
- Controls brightness
- Changes the display in response to inputs from the bezel controls.
- Graphics Processing and Display

The graphics processor does these functions:

- Calculates graphic data for each parameter from the system processor
- Controls the liquid crystal display (LCD) matrix drivers Refreshes the display.

The display has a color active matrix LCD and a back−lighting box.
The back−lighting box has these components:

- Three fluorescent tubes
- Reflector
- Diffuser.

THIS PAGE IS INTENTIONALLY LEFT BLANK

POWER UP DISPLAYS

Power-Up Display

The ISFD shows flags when you first apply power to it.
For the first 15 seconds, the display shows these flags:

- ATT - attitude flag
- SPD - airspeed flag
- ALT - altitude flag.

The airspeed and altitude functions in the ISFD complete the initialization after 15 seconds.
After 15 seconds, the display removes the SPD and ALT flags and shows the altitude and airspeed.
The attitude function in the ISFD completes the initialization after 90 seconds.
After 90 seconds, the dipslay removes the ATT flag and shows the pitch and roll attitude.

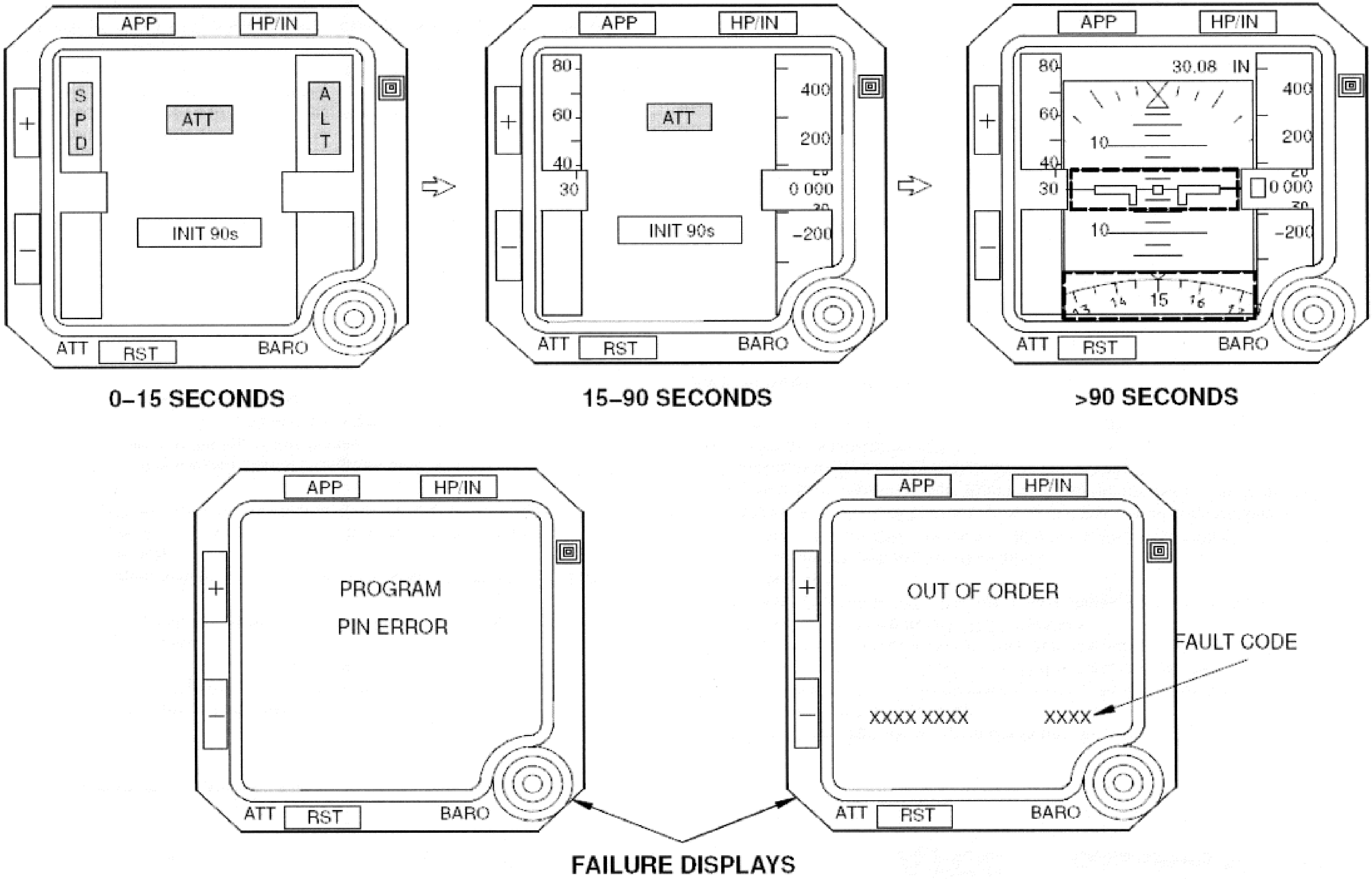
Failure Displays

If there are failures in the ISFD, the display shows failure messages when you apply power to it.
The display shows PROGRAM PIN ERROR if either one of these conditions occur:

- Parity for the program pins is odd.
- Program pins sense an airplane type or option combination that is not valid.

NOTE: The ISFD uses one program pin, called the parity pin, to make sure the airplane model and optional functions are correct. The sum of all the program pins and the parity pin must be an even number. If the sum is odd, there is a fault.

The display shows OUT OF ORDER if the ISFD has a fault.
The display also shows a fault code.
The bench technicians use the fault code to troubleshoot failures inside the ISFD.



POWER UP AND FAILURE DISPLAYS

OPERATION – ATTITUDE

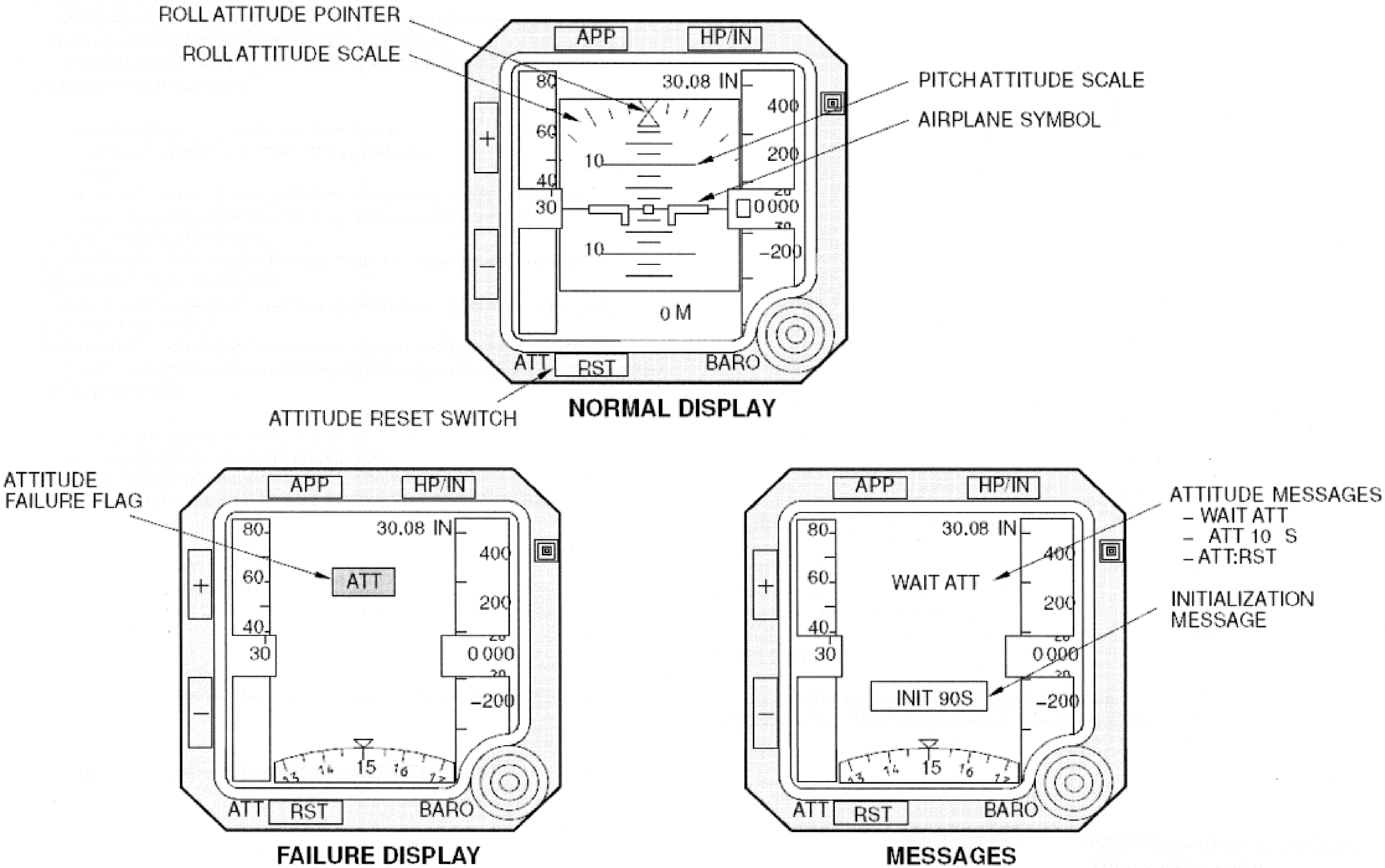
Normal Display
The ISFD shows pitch and roll attitude.
The ISFD goes through alignment when it first receives power.
90 seconds after the ISFD receives power, the pitch and roll attitude scales and pointer show on the display.
The pitch attitude scale shows as horizontal markers from the top to the bottom of the display.
There are 2.5 degrees between each marker. The airplane symbol is fixed at the center of the display.
The pitch attitude scale moves up or down as the pitch angle changes.
When the pitch attitude scale shows pitch attitude more than 30 degrees, large red arrowheads show.
The arrowheads point in the direction of 0 degrees pitch attitude.
The roll attitude scale is at the top of the display.
The markers are at 0, 10, 20, 30, 45 and 60 degrees of bank angle.
The resolution of the display is 0.25 degree for pitch and 0.5 degree for roll.

Failure Display
If the ISFD finds a failure of the attitude function, the display shows the attitude (ATT) flag.
The ISFD removes the pitch and roll scales and pointers.

Messages
The ISFD shows these messages on the attitude display:
- INIT 90s (initialize for 90 seconds)
- WAIT ATT (wait attitude)
- ATT 10s (attitude 10 seconds)
- ATT:RST (attitude reset).

The initialization 90 seconds (INIT 90s) message shows during power−up.
The ISFD takes 90 seconds to align the pitch and roll attitude during power−up.
When the attitude alignment is complete, the ISFD shows the pitch and roll attitude scales and pointer.
The wait attitude (WAIT ATT) message shows when the inertial sensors sense the angular rate or the acceleration is more than the maximum.
The maximum angular rate is 100 degrees per second.
The maximum acceleration is 3.2g.
When the angular rate and acceleration go less than the maximum, the ISFD removes the message and shows the attitude scales and pointer.
If the angular rate or acceleration is more than the maximum for more than 10 seconds, the ISFD shows the ATT:RST message.
The attitude 10 seconds (ATT 10s) messages shows after you push the attitude reset switch.
The ISFD aligns the attitude for 10 seconds.
After 10 seconds, the ISFD shows the attitudes scales and pointer.
The attitude reset (ATT:RST) message shows if the inertial sensors sense angular rate or acceleration more than the maximum for more than 10 seconds.
The maximum angular rate is 100 degrees per second.
The maximum acceleration is 3.2g.
Push the attitude reset switch to make the ISFD begin an attitude alignment.

Attitude Reset Switch (ATT RST)
Use the attitude reset switch to make the ISFD reset the attitude.
Do this if there is an error between the ISFD attitude and the real airplane attitude, or if the ATT:RST message shows.
Push the attitude reset switch for a minimum of 2 seconds to start the attitude reset.
The ISFD shows the message, ATT 10s. After 10 seconds, the message goes off and the attitude scales and pointer show.



ATTITUDE DISPLAYS

AIRSPEED AND ALTITUDE

General
The ISFD uses pneumatic inputs from alternate pitot and static ports to calculate indicated airspeed and altitude.

Indicated Airspeed
The airspeed tape shows on the left side of the display. Indicated airspeed shows in a digital display box with rolling digits.
The range of the indicated airspeed is 30 to 520 knots.

Altitude
The altitude tape shows on the right side of the display. Altitude shows in a digital display box with rolling digits.
The range of the altitude is −2,000 to 50,000 feet.
The resolution of the altitude display is 10 feet.

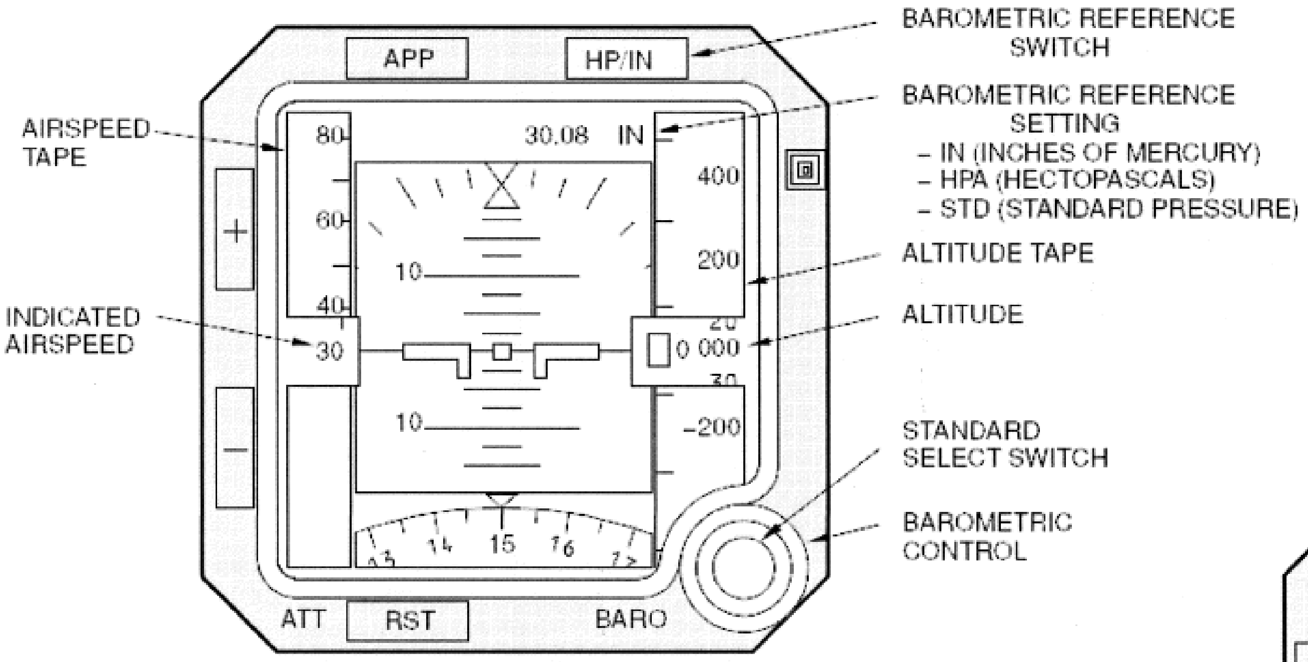
Barometric Reference
The ISFD shows the barometric reference setting on the top right side of the display.
Use the barometric control and the barometric reference switch to control the barometric reference setting.
Rotate the barometric control to change the barometric reference setting and set the barometric corrected altitude.
The ISFD shows the barometric reference setting in units of hectopascals (hPa) or inches of mercury (in Hg).
The ISFD shows HPA for hectopascals or IN for inches of mercury.
Use the barometric reference switch to change the units of the barometric reference setting.
- Push the switch to change the units from HPA to IN.
- Push the switch again to change the units to HPA.

Standard Barometric Pressure
Use the standard select switch in the center of the barometric control to set the standard barometric pressure (29.92 in Hg or 1013 hPa).
- Push the standard select switch to change the barometric reference setting to the standard barometric pressure.

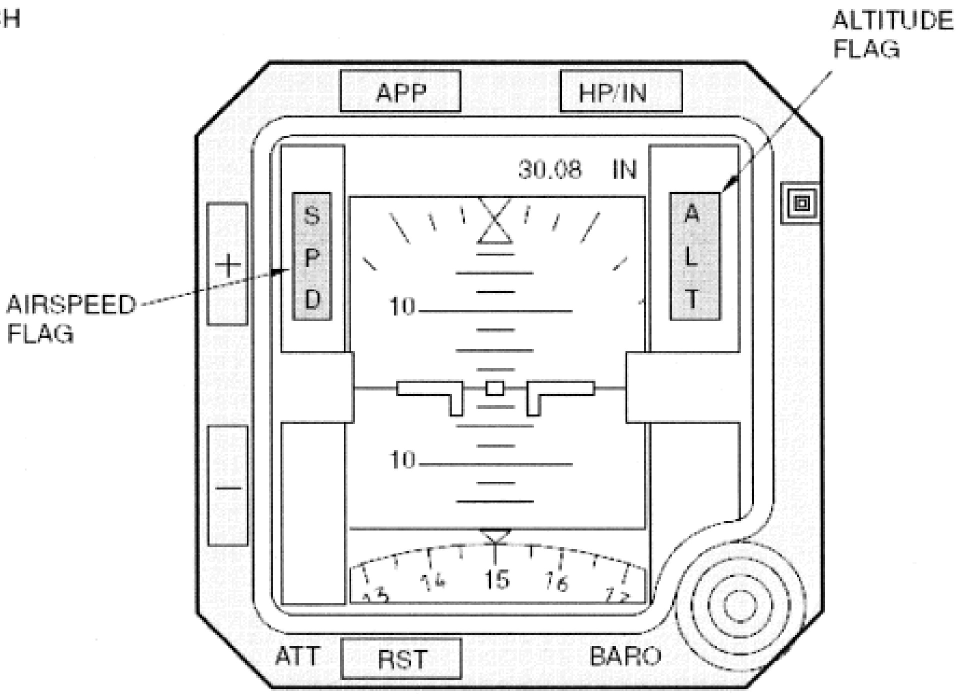
The display shows STD for the barometric reference setting.
- Push the switch again to remove the standard setting.

This lets you manually set the barometric reference.

Failure Displays
If the ISFD can not calculate the indicated airspeed, the airspeed tape and the indicated airspeed displays go off.
The display shows the airspeed flag (SPD).
If the ISFD can not calculate the altitude, the altitude tape and the altitude displays go off.
The display shows the altitude flag (ALT).



NORMAL DISPLAY



FAILURE DISPLAYS

ALTITUDE AND AIRSPEED DISPLAYS

OPERATION – HEADING

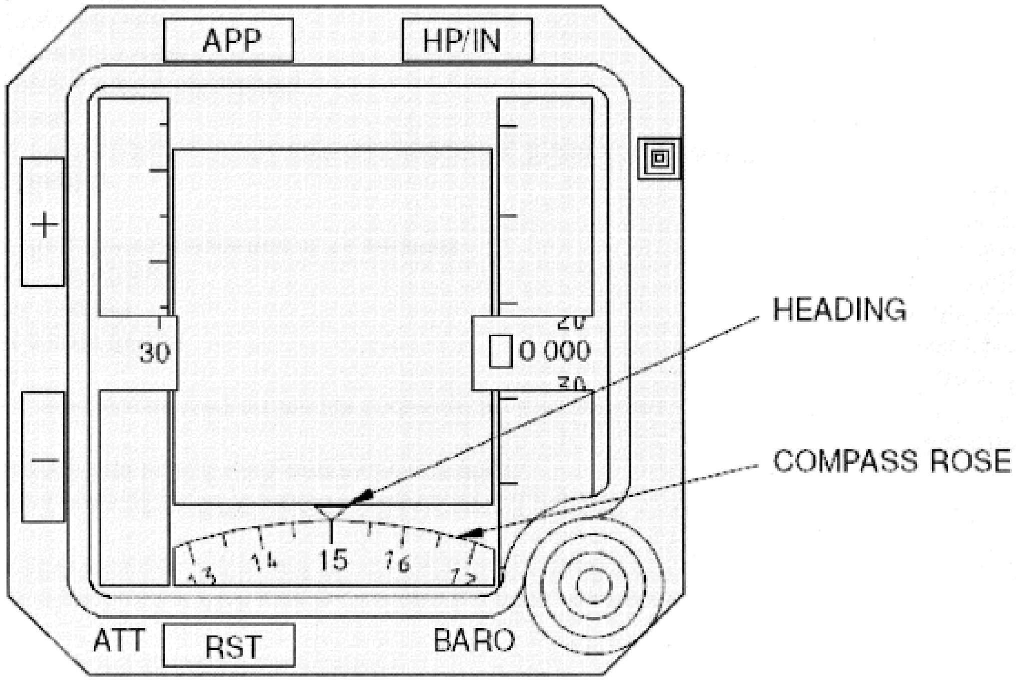
General

The integrated standby flight display (ISFD) receives magnetic heading data from the air data inertial reference system (ADIRS).
The ISFD shows the magnetic heading on a compass rose at the bottom of the display.
The range of the heading is from 0 to 360 degrees.
The display resolution for heading is 1 degree.

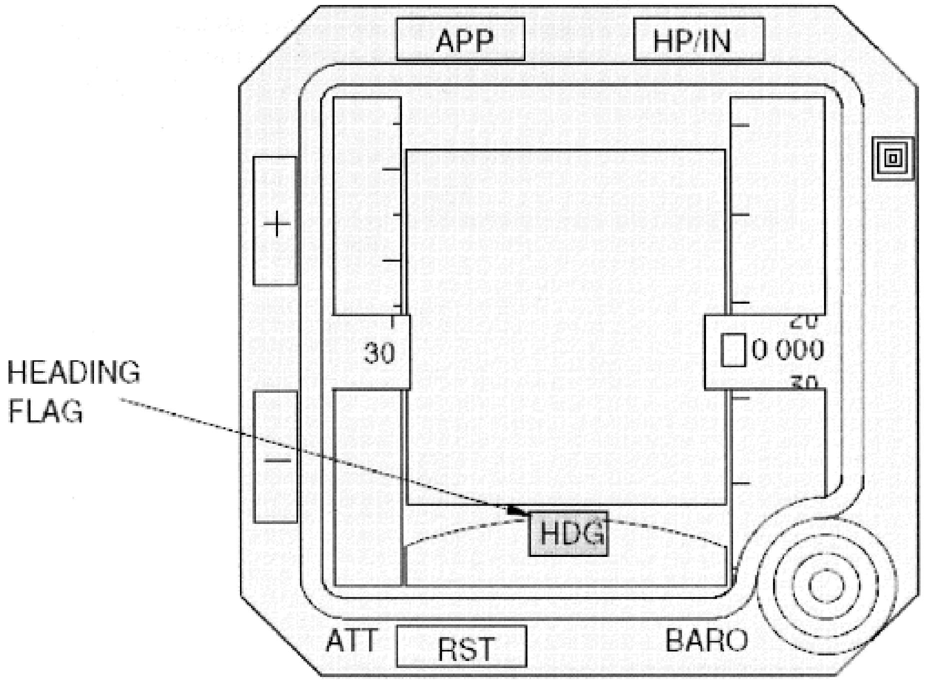
Failure Display

The ISFD shows the heading flag (HDG) and removes the compass rose if one of these conditions occurs:

- ISFD does not receive the magnetic heading data (ARINC 429 label 320) from the air data inertial reference unit (ADIRU)
- Magnetic heading data is no computed data (NCD)
- Magnetic heading data word has a failure warning (FAIL WARN).



NORMAL DISPLAY



FAILURE DISPLAY

HEADING DISPLAYS

OPERATION – APPROACH

General

There are no special ILS tests for the integrated standby flight display (ISFD). You do a check of the approach display with a multi−mode receiver (MMR) 1 self−test.
Start the ILS self−test from the test switch on the navigation control panel. You can also start it from the test switch on MMR 1.

- Push the APP switch on the ISFD so that the APP annunciation shows on the display.

NOTE: The ISFD does not show ILS or GLS data at power−up. The first push of the APP switch shows normal ILS or GLS indications and the APP annunciation.

NOTE: The next push of the APP switch removes the glideslope scale, shows the localizer scale, and shows the BCRS annunciation.

NOTE: The next push of the APP switch removes all ILS or GLS indications and no ILS GLS annunciations show.

These is the display sequences on the ISFD during the ILS self−test:

- Invalid data
- No computed data (NCD)
- Data correct − up/left
- Data correct − down/right.

The length of the self−test sequence is 14 seconds.

Invalid Data Display

Invalid data is the first display in the self−test sequence. It shows on the ISFD for three seconds.
Invalid data causes these indications:

- LOC flag comes into view
- G/S flag comes into view
- Deviation scales go out of view
- Deviation pointers go out of view.

NCD Display

NCD is the second display in the self−test sequence.
It shows on the ISFD for two seconds.
NCD causes these indications:

- LOC flag goes out of view
- G/S flag goes out of view
- Deviation scales come into view
- Deviation pointers stay out of view.

Data Correct − Up/Left Display

Data correct − up/left is the third display in the self−test sequence.
It shows for three seconds on the ISFD.
Data correct − up/left causes these indications:

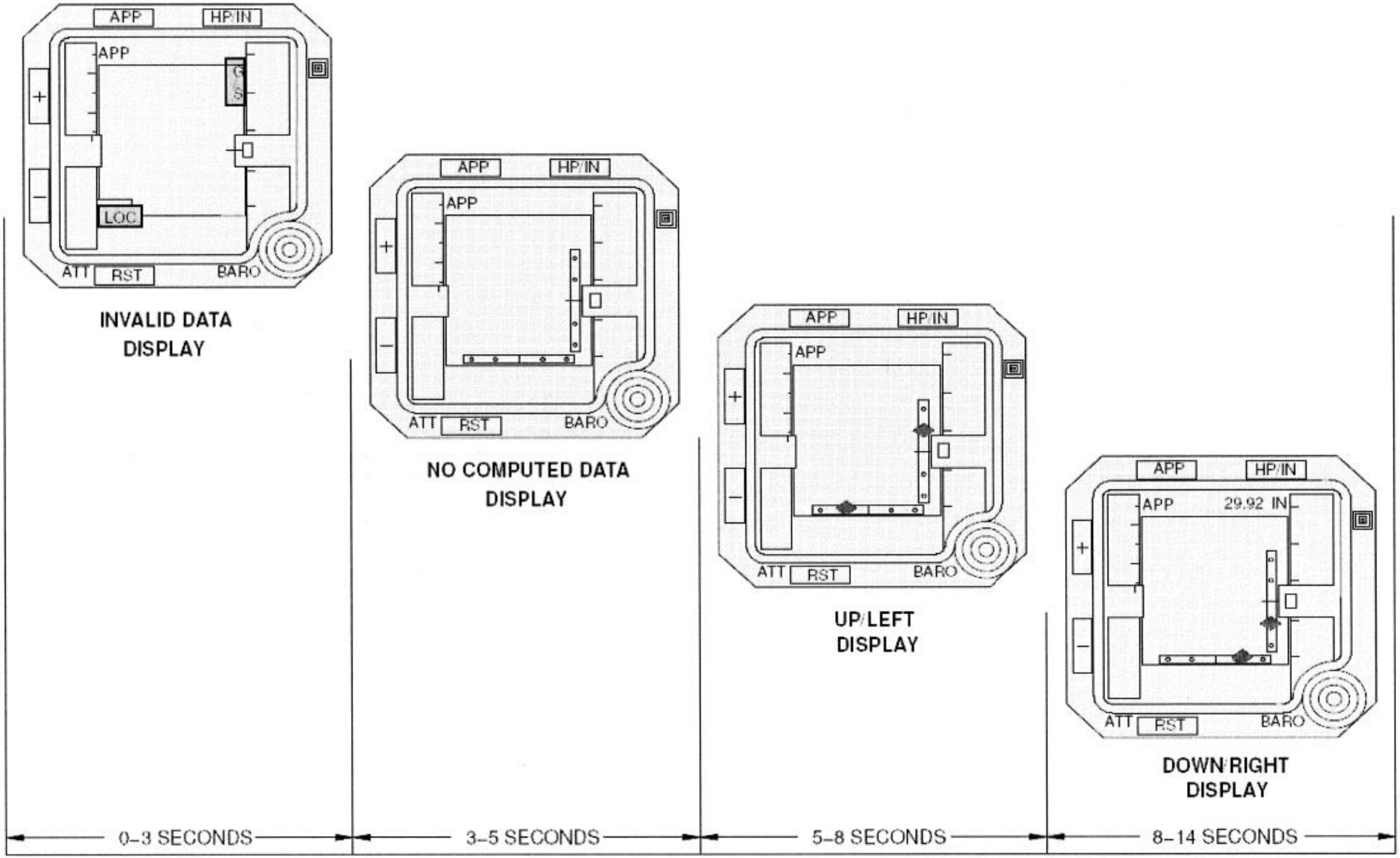
- LOC flag stays out of view
- G/S flag stays out of view
- Localizer pointer shows one dot of left deviation
- Glideslope pointer shows one dot of up deviation.

Data Correct − Down/Right Display

Data correct − down/right is the forth display in the self−test sequence.
It shows for six seconds on the ISFD.
Data correct − down/right causes these indications:

- LOC flag stays out of view
- G/S flag stays out of view
- Localizer pointer shows one dot of right deviation
- Glideslope pointer shows one dot of down deviation.

The approach display goes back to normal indications at the end of the self−test sequence.



APPROACH DISPLAYS

BITE MENU
(TRAINING INFORMATION POINT)

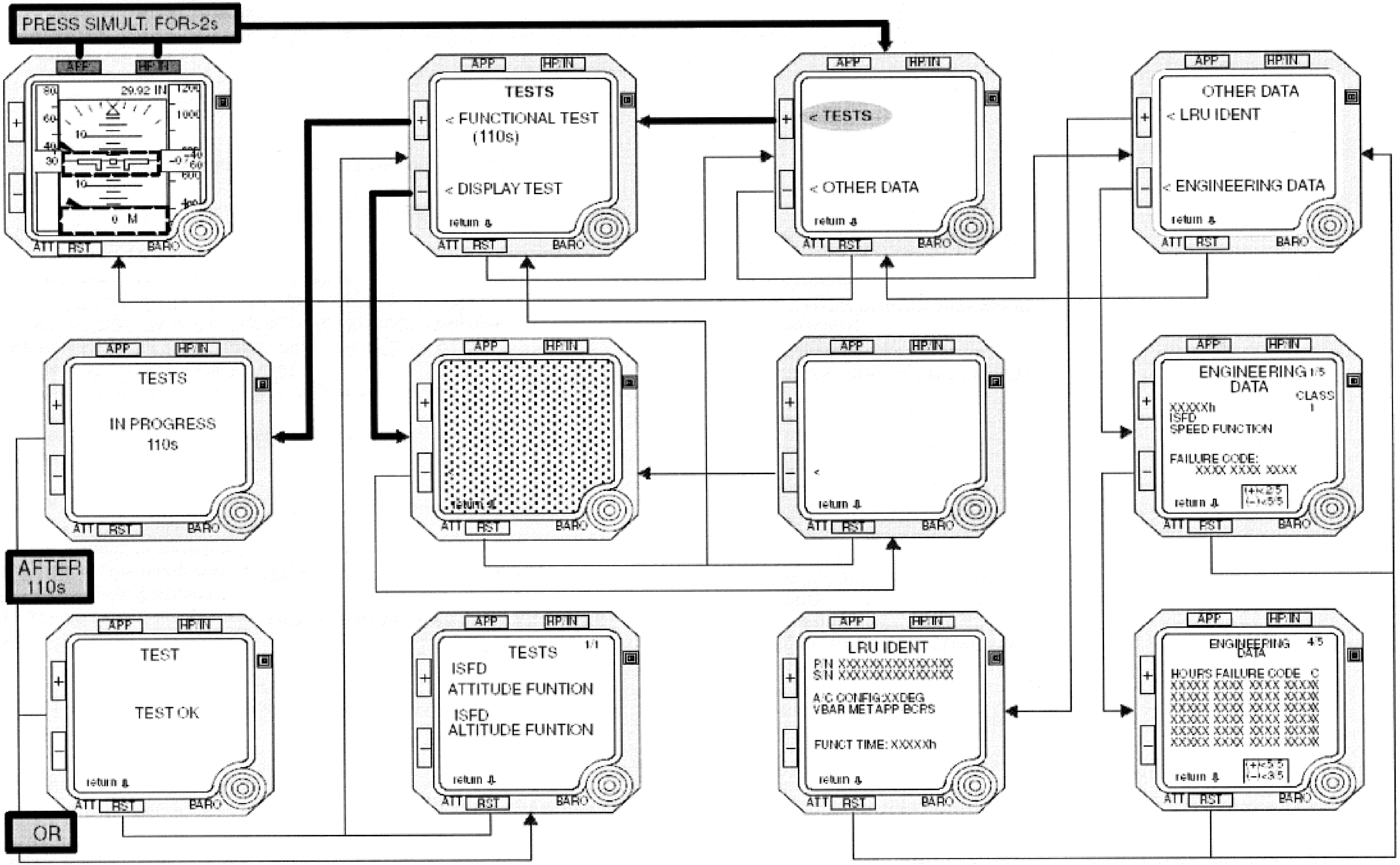
General

The ISFD has internal BITE that lets you monitor and do tests.
To show the BITE displays, the airplane must be on the ground and the ISFD power−up complete.

NOTE: The ISFD uses internal calculations of computed air speed or, as a backup, ADIRU ground speed to determine the on ground condition. The threshold speed is 100 kts.

ISFD Tests

To start the BITE, simultaneously push and hold the APP and the HP/IN switches for at least two seconds.
After two seconds, the TESTS and OTHER DATA page shows.
From this BITE page you can go the other BITE pages or return to the normal display operation.


PRESS SIMULT. FOR>2s
APP
HP/IN
ATT
RST
BARO
TESTS
< FUNCTIONAL TEST
(110s)
< DISPLAY TEST
return
< TESTS
< OTHER DATA
OTHER DATA
< LRU IDENT
< ENGINEERING DATA
TESTS
IN PROGRESS
110s
AFTER
110s
ENGINEERING 1/5
DATA
CLASS
XXXXXh
ISFD
SPEED FUNCTION
FAILURE CODE:
XXXX XXXX XXXX
TEST
TEST OK
OR
TESTS 1/1
ISFD
ATTITUDE FUNTION
ISFD
ALTITUDE FUNTION
LRU IDENT
P/N XXXXXXXXXXXXXX
S/N XXXXXXXXXXXXXX
A/C CONFIG:XXDEG
VBAR MET APP BCRS
FUNCT TIME: XXXXXh
ENGINEERING 4/5
DATA
HOURS FAILURE CODE C

BITE MENU

BITE – FUNCTIONAL TEST

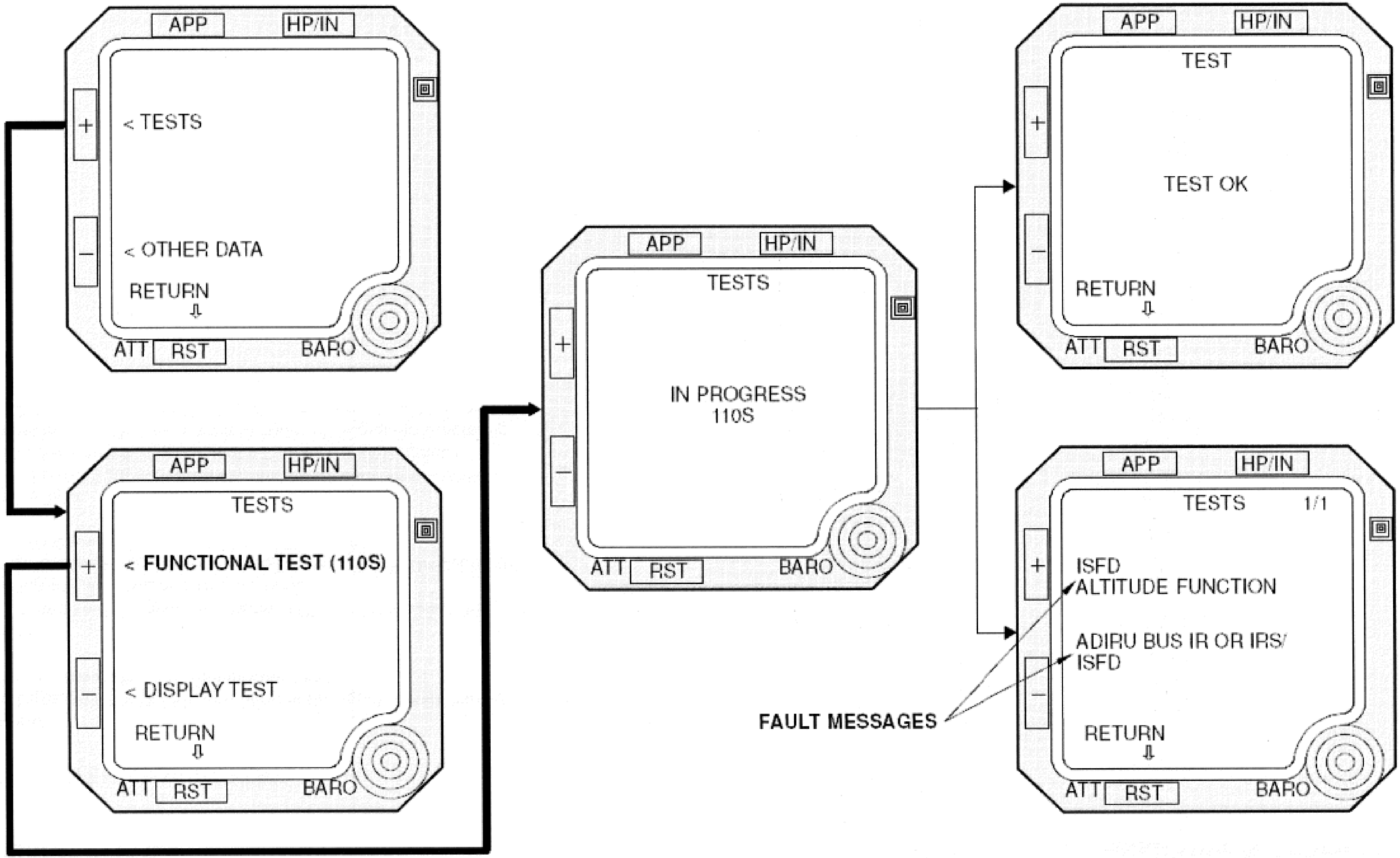
General
The functional test checks the operation of the integrated standby flight display (ISFD) and the input signals to the ISFD.

Access
Push and hold the approach mode (APP) and the barometric reference setting (HP/IN) switches for 2 seconds.
The ISFD shows the menu with TESTS and OTHER DATA prompts.
- Push the + switch to show the TESTS menu.
- Push the + switch to start the functional test.

The display shows the TEST page with the IN PROGRESS 110s message.

Functional Test
The functional test checks the internal operation of the ISFD. It also checks the input signals to the ISFD.
For example, the test checks the program pins and the ARINC 429 input from the air data inertial reference unit (ADIRU).
The test lasts for about 110 seconds. When the ISFD completes the test, the display shows TEST OK or the display shows the fault messages.
When the TEST OK shows, all circuits are operating correctly.
When a fault message shows, there is a failure.

Fault Messages
At the end of the functional test, the ISFD BITE shows fault messages if there are faults.
The table below shows the possible fault messages and the flight deck effects.
- Flight Deck Effect
  - Fault Message
  - Internal or External
  - OUT OF ORDER
  - ISFD
  - Internal
  - PROGRAM PIN ERROR
  - WRG: MODE DISCRETE/ ISFD
  - External
  - PROGRAM PIN ERROR
  - WRG: PARITY PIN-PROG/ ISFD
  - External
  - ATT
  - ISFD ATTITUDE_FUNCTION
  - Internal
  - SPD
  - ISFD SPEED_FUNCTION___
  - Internal
  - ALT
  - ISFD ALTITUDE_FUNCTION
  - Internal
  - G/S and/or LOC
  - ILS OR MMR/ ISFD
  - External
  - HDG
  - ADIRU BUS IR OR IRS/ ISFD
  - External
  - no effect
  - POWER SUPPLY INTERRUPT
  - External
  - no effect
  - WRG TEST DISCRETE/ ISFD
  - External



BITE FUNCTIONAL TEST

BITE – DISPLAY TEST

General

The display test checks the operation of the liquid crystal display (LCD) matrix in the integrated standby flight display (ISFD).

Access

- Push and hold the approach mode (APP) and the barometric reference setting (HP/IN) switches for 2 seconds.

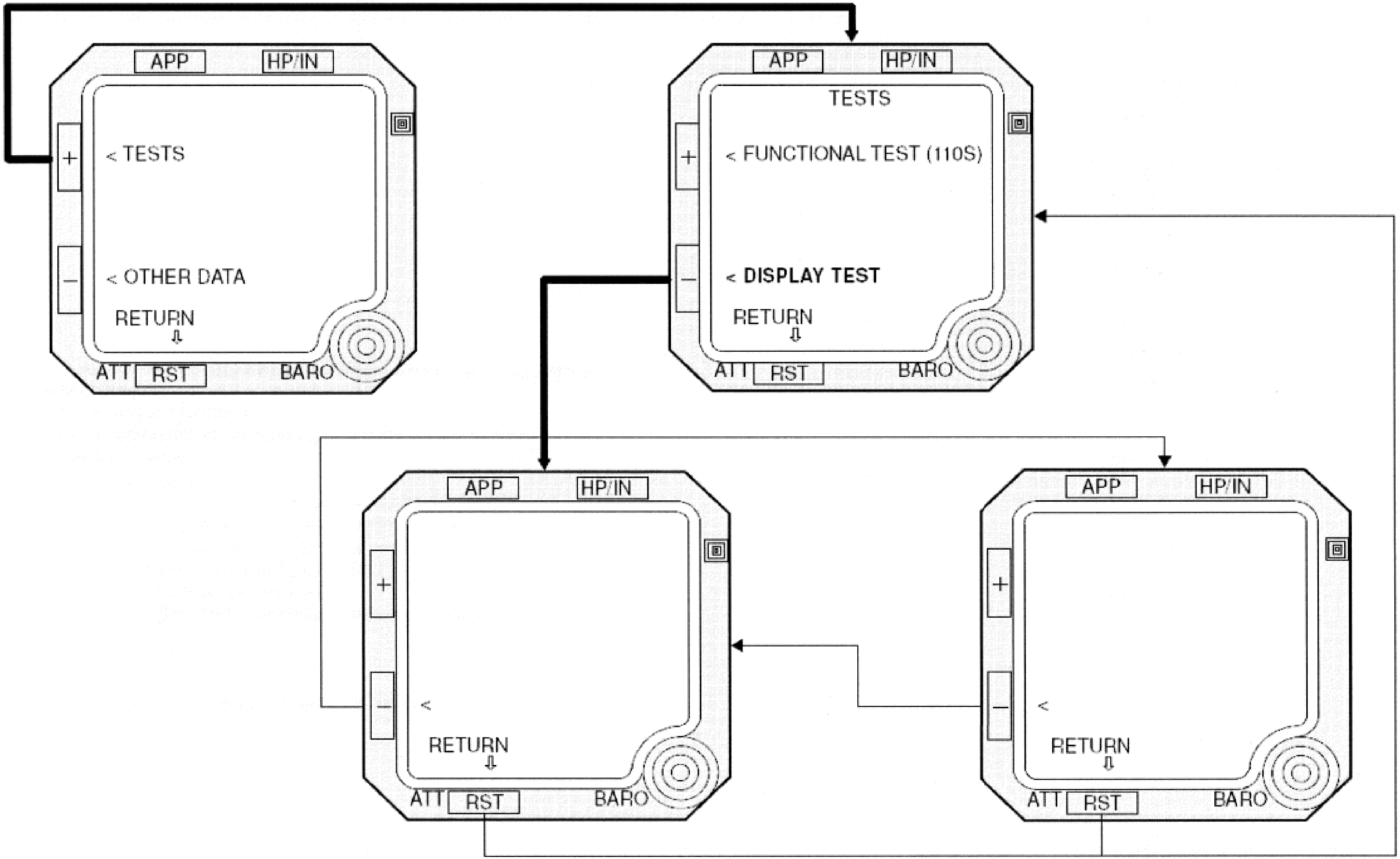
The ISFD shows the menu with TESTS and OTHER DATA prompts.

- Push the + switch to show the TESTS menu.

Display Test

When the ISFD starts the display test, the display shows white.

- Push the − switch again to make the display show black.
- Continue to push the − switch to show white and black screens.
- Push the attitude reset (RST) switch to return to the tests menu.



BITE DISPLAY TEST

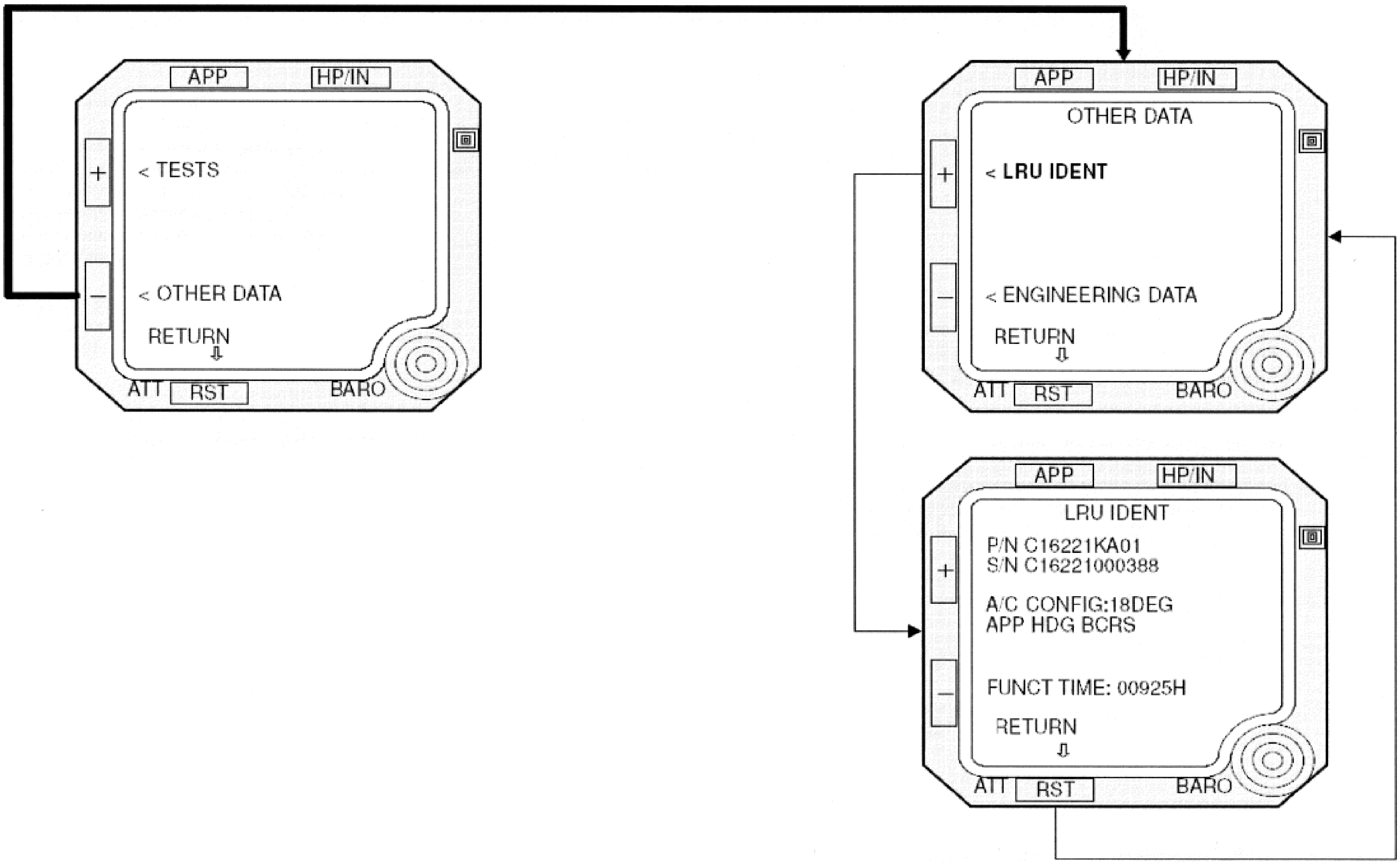
BITE – LRU IDENT

General

The LRU IDENT (line−replaceable−unit identification) page lets you see identification data for the ISFD.

Access

- Push and hold the approach mode (APP) and the barometric reference setting (HP/IN) switches for two seconds.
  - The ISFD shows the menu with TESTS and OTHER DATA prompts.
- Push the − switch to show the OTHER DATA menu.
- Push the + switch to show the LRU IDENT page.
  The LRU ident page shows these parameters about the ISFD:
  - Hardware part number
  - Software part number
  - Airplane configuration which shows the tilt angle for the airplane model
  - Options set by the program pins
  - Time in operation.
- Push the attitude reset (RST) switch to return to the OTHER DATA menu.



BITE LRU IDENT

ALT FLAG ON ISFD – FAULT ISOLATION

NOTE: The following is taken from the FIM / MM.
It **must not** be considered as a procedure for repair!!

Description
The ALT flag shows on the integrated standby flight display when the altitude data is invalid.

Possible Causes
- Integrated standby flight display, N226.
- Alternate pitot system.
- Alternate static system.

Circuit Breakers
This is the primary circuit breaker related to the fault:
- CAPT Electrical System Panel, P18-2
- Row Col. Number Name D 8 (C01551) ISFD

Related Data
- (SSM 34-24-15).
- (WDM 34-24-15).

Initial Evaluation
Make sure that this circuit breaker is closed:
- CAPT Electrical System Panel, P18-2
- Row Col Number Name D 8 (C01551) ISFD
  - If the ALT flag does not show on the integrated standby flight display, **then there was an intermittent fault.**
  - If the ALT flag shows on the integrated standby flight display, then do the Fault Isolation Procedure below.

Fault Isolation Procedure
Replace the integrated standby flight display, N226.
These are the tasks:
- Integrated Standby Flight Display Removal, AMM TASK 34-24-02-XXX,
- Integrated Standby Flight Display Installation, AMM TASK 34-24-02-XXX.
  - If the installation task for the integrated standby flight display is satisfactory and the ALT flag does not show, **then you corrected the fault.**
  - If the ALT flag shows on the integrated standby flight display, then continue.

Do a leak test of the alternate pitot and static systems:
- Do this task: Alternate Pitot System Leak Test, AMM TASK 34-11-00-XXX.
- Do this task: Alternate Static System Low-range Leak Test, AMM TASK 34-11-00-XXX.
  - If the alternate pitot or alternate static system has a leak, then do these steps:
    - Repair the leak.

Do this task:
- Integrated Standby Flight Display - System Test, AMM TASK 34-24-02-XXX.
- If the operational test is satisfactory and the ALT flag does not show on the integrated standby flight display, then you corrected the fault.

737-6/7/8/9 Hapag-Lloyd Flug Observed / Cabin Fault List

Begin typing text:

Integrated standby flight display

- IMBAL message shows in fuel quantity indication (flight compartment)
- INCORRECT DISK INSERTED message shows on CDU during FMC software load
- Indicator light - does not come on correctly
- Indicator light - does not go off
- Insects - detected on airplane
- Integrated standby flight display - ALT flag shows
- Integrated standby flight display - ATT flag shows
- Integrated standby flight display - attitude display disagrees with primary display, no flag shows
- Integrated standby flight display - display blank
- Integrated standby flight display - G/S flag shows
- Integrated standby flight display - HDG flag shows
- Integrated standby flight display - LOC flag shows
- Integrated standby flight display - OUT OF ORDER flag shows
- Integrated standby flight display - PROGRAM PIN ERROR flag shows
- Integrated standby flight display - SPD flag shows
- Integrated standby flight display - WAIT ATT flag shows
- Interphone, flight - does not operate - all stations
- Interphone, flight - does not operate - captain's

FAULT ISOLATION (FIM)

INSTALLATION AND TEST

NOTE: The following is taken from the FIM / MM.
It must not be considered as a procedure for repair!!

Installation Procedure

Make sure that this circuit breaker is open:

- Front of the ISFD Dedicated Battery System, M2100, E1-3:
  - DBC Output Breaker
- Front of the ISFD Dedicated Battery System, M2100, E4-1:
  - DBC Output Breaker

CAUTION: DO NOT TOUCH THE CONNECTOR PINS OR OTHER CONDUCTORS ON THE INTEGRATED STANDBY FLIGHT DISPLAY.
IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE INTEGRATED STANDBY FLIGHT DISPLAY.

Install the integrated standby flight display:

CAUTION: MAKE SURE THAT THE PITOT-STATIC SYSTEM IS AT AMBIENT PRESSURE BEFORE YOU CONNECT THE PITOT HOSE AND THE STATIC HOSE TO THE DISPLAY.
IF THE PITOT-STATIC SYSTEM IS NOT AT AMBIENT PRESSURE, DAMAGE TO THE DISPLAY CAN OCCUR.

- Connect the pitot hose [5] and static hose to the display.
- Do a visual inspection to make sure the pitot-static system hose

connections and quick-disconnect fittings are locked in the sealed position.
Make sure that the actuation ring of the quick-disconnect fitting is fully engaged on the lock pins, and make sure that you see the colored lock ring indicator that shows a correct connection of the quick-disconnect fitting.

- Install the display into the instrument panel.
- Do the ISFD installation test.

Installation Test

CAUTION: AIRPLANES WITH ISFD S231A120-1;
DO NOT MOVE THE AIRPLANE WHILE THE ISFD SHOWS THE YELLOW "ATT" AND "INIT90S" MESSAGES.
IF YOU MOVE THE AIRPLANE DURING THE ISFD SYSTEM POWER-UP AND INITIALIZATION ALIGNMENT, THE ISFD MAY DISPLAY INCORRECT ATTITUDE INFORMATION WITH NO ATT FLAG OR MESSAGE.

Close this circuit breaker and remove the DO-NOT-CLOSE tag:

- Front of the ISFD Dedicated Battery System, M2100, E1-3:
  - DBC Output Breaker
- Front of the ISFD Dedicated Battery System, M2100, E4-1:
  - DBC Output Breaker

Close this circuit breaker and remove the DO-NOT-CLOSE tag:

- Front of the ISFD Dedicated Battery System, M2100, E1-3:
  - DBC Output Breaker

Make sure that the display shows the following flags in approximately 15 seconds after power up:

- SPD flag
- ATT flag
- ALT flag
- INIT 90S flag.

Make sure the following flags and indications show in approximately 15 to 90 seconds after power up:

- ATT flag
- INIT 90S flag
- Airspeed indication with no SPD flag
- Altitude indication with no ALT flag.

Make sure the following is displayed on the ISFD after approximately 90 seconds:

- Attitude (normal) display with the following indications with no flags:
  - Fixed aircraft symbol
  - Roll scale

(CONTINUED FROM PREVIOUS PAGE)

- Roll index
- Pitch scale.

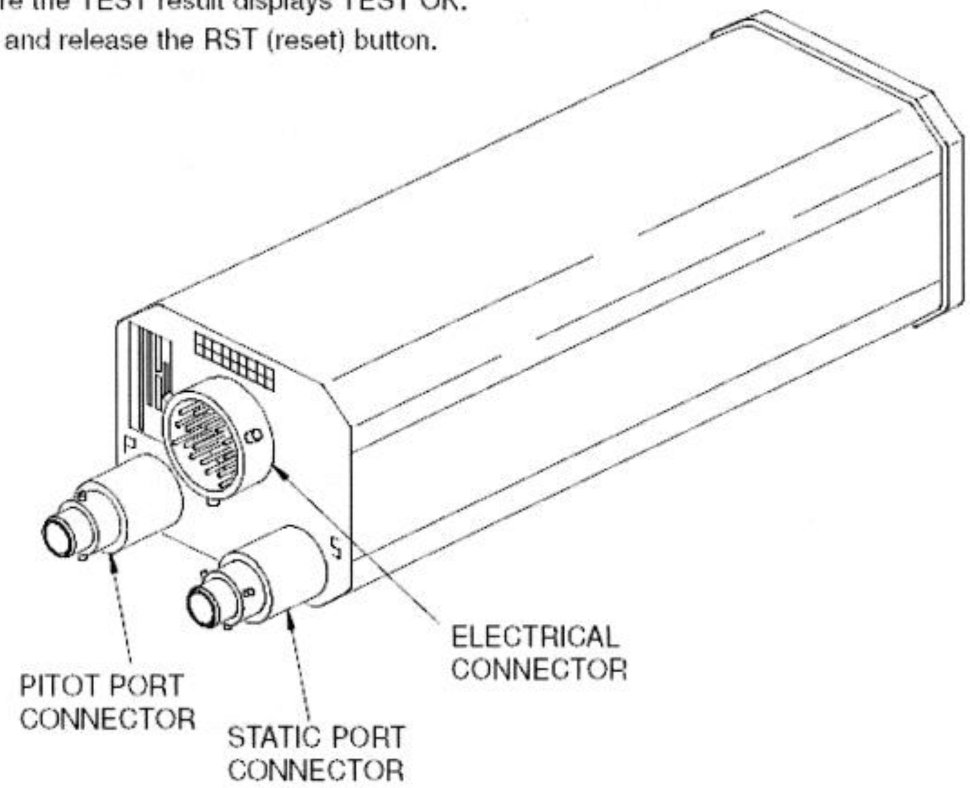
NOTE: To restart the initialization, push and release the ATT RST button on the face of the ISFD.

- Push APP and HP/IN, on the face of the ISFD, for approximately two seconds.
- Push the + select key next to <TESTS.
- Push the select key next to <FUNCTIONAL TEST (110s).

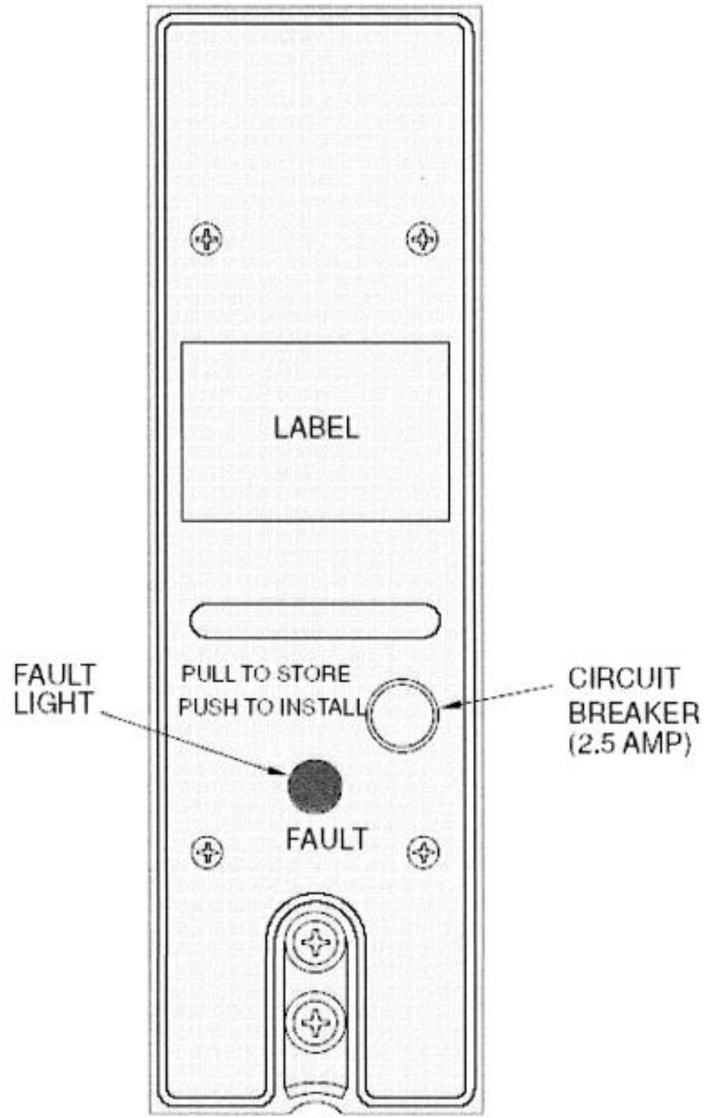
NOTE: The TEST screen will display IN PROGRESS 110s.

Make sure the TEST result displays TEST OK.

- Push and release the RST (reset) button.



INTEGRATED STANDBY FLIGHT DISPLAY (IFSD)



ISFD DEDICATED BATTERY CHARGER

INSTALLATION AND TEST

BITE ENGINEERING DATA

General

The ENGINEERING DATA page lets you see information about faults.

Access

- Push and hold the approach mode (APP) and the barometric reference setting (HP/IN) switches for two seconds.

The ISFD shows the menu with TESTS and OTHER DATA prompts.

- Push the − switch to show the OTHER DATA menu.
- Push the − switch to show the ENGINEERING DATA page.

The engineering data page shows these parameters about failures:

- Time of failure
- Class (1, 2, or 3)
- Fault message
- Failure code.

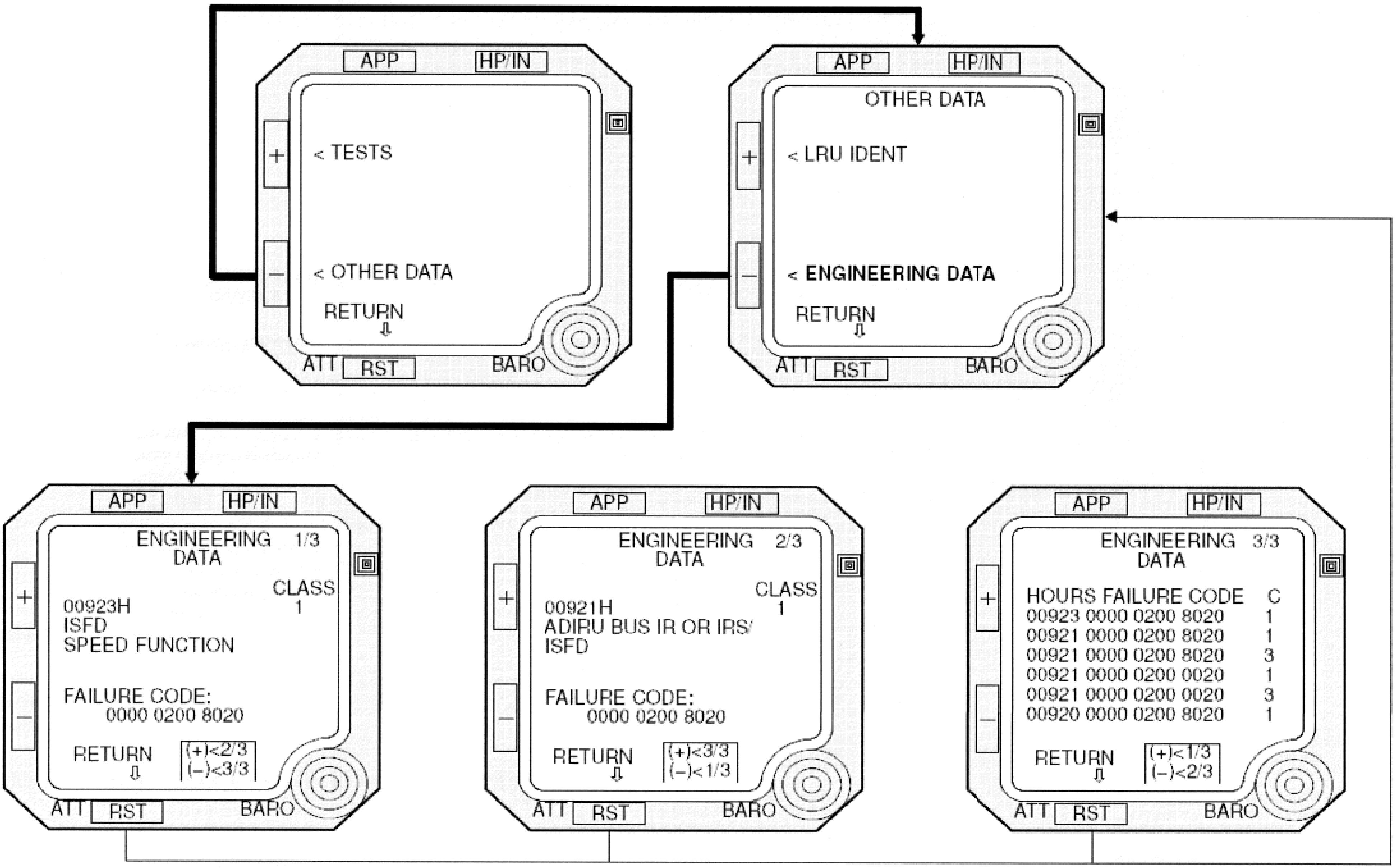
The ISFD shows 1, 2, or 3 pages of engineering data which show the fault message and failure code. These pages show one fault per page.

The ISFD shows 1 or 2 pages of engineering data which show a list of the time of failure, the failure code, and the class of the failure.

These are the classes of failures:

- Class 1 − A failure which has a flight deck effect and must be reported.
- Class 2 − A failure which is less important than a class 1 failure.
- Class 3 − A failure which has no flight deck effect and has no effect on the operation of the airplane systems.

- Push the attitude reset (RST) switch to return to the OTHER DATA menu.



BITE ENGINEERING DATA

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34 – 25. RADIO MAGNETIC INDICATOR (ATA 34 – 22)

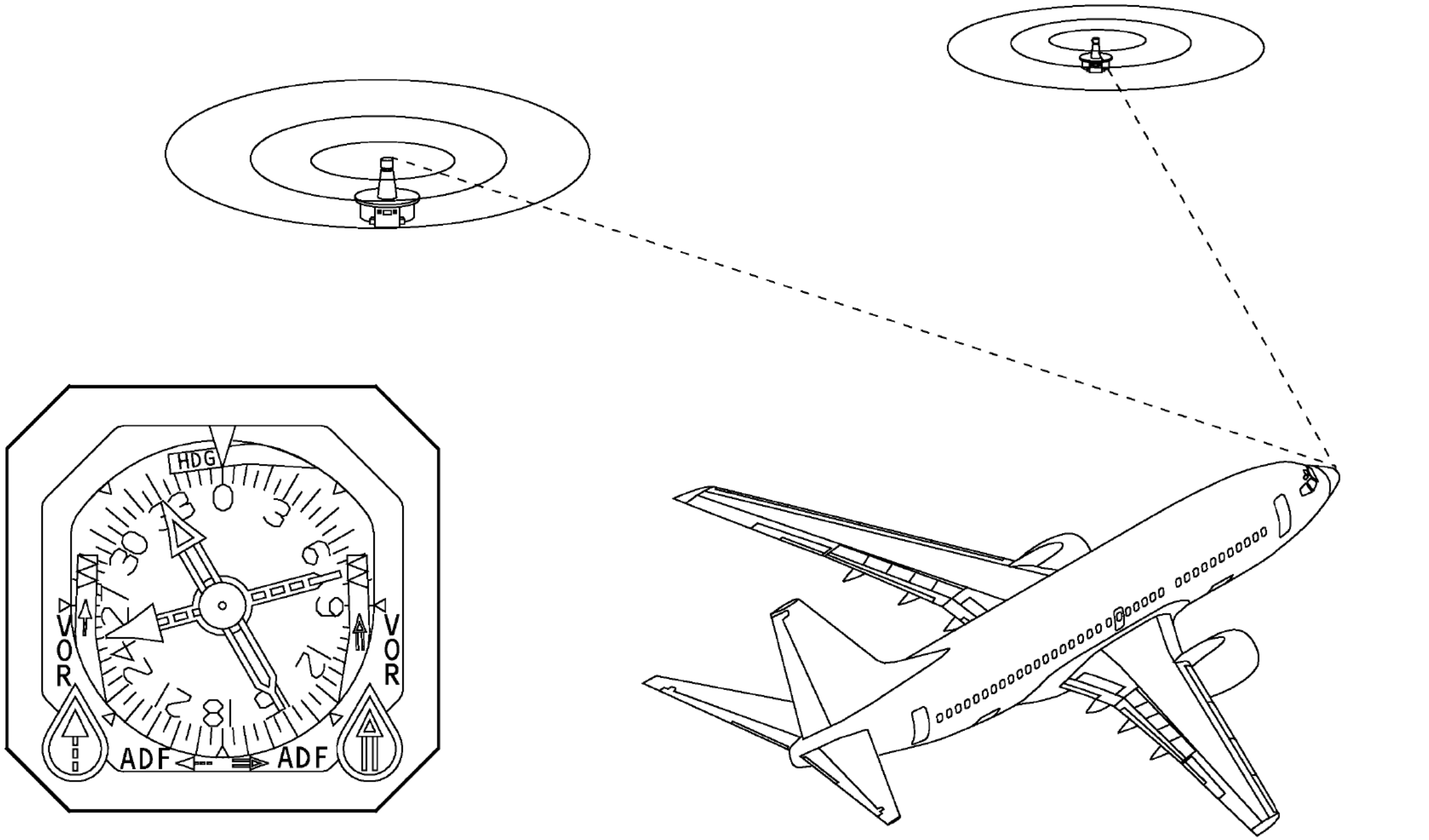
LEVEL 3

RADIO MAGNETIC INDICATOR - INTRODUCTION

The radio magnetic indicator is a standby instrument. Its purpose is to show relative bearing to VOR and ADF stations. It also shows airplane magnetic heading.

Abbreviations and Acronyms

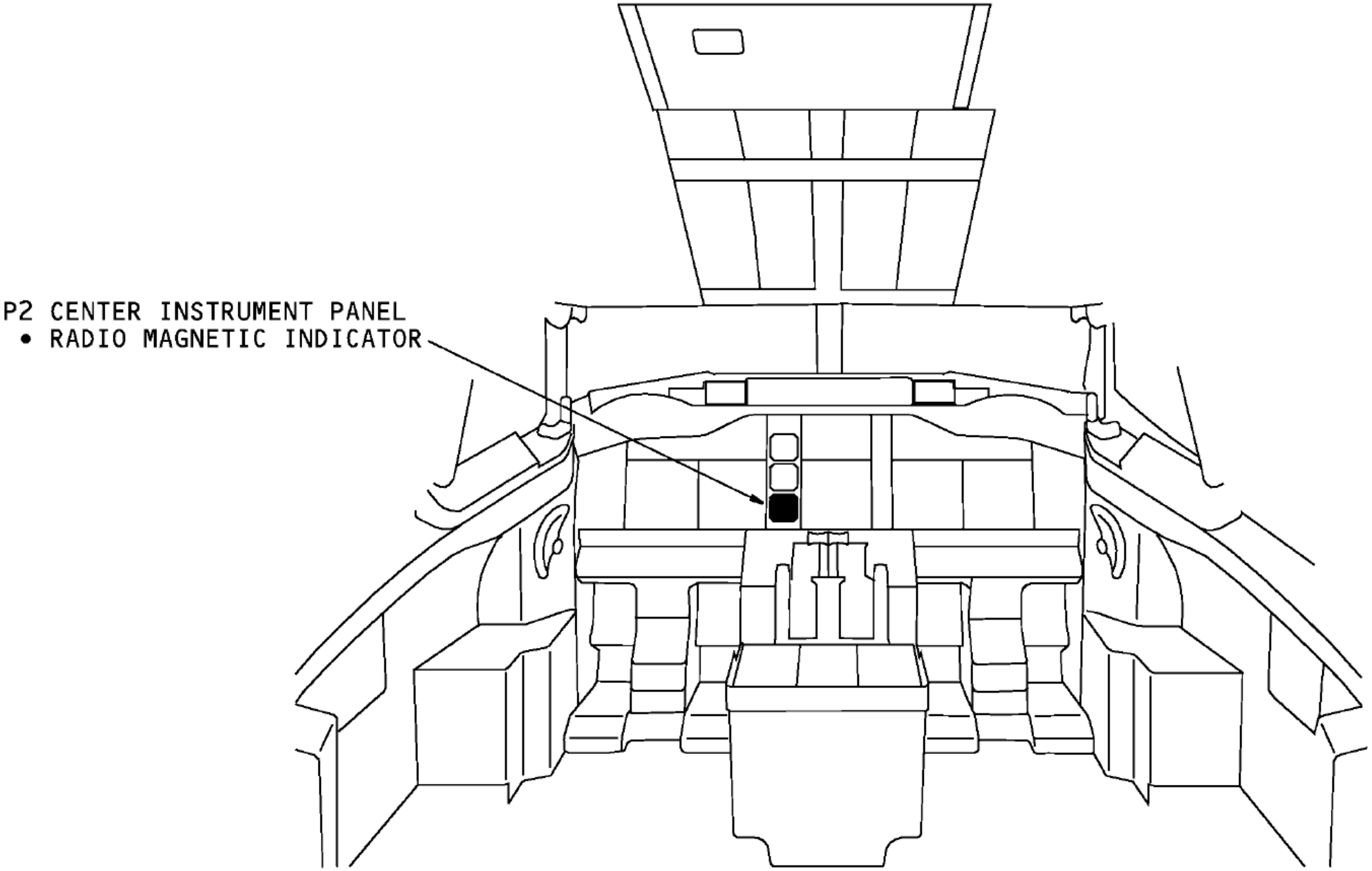
- ac - alternating current
- ADF - attitude direction finder
- ADIRS - air data inertial reference system
- ADIRU - air data inertial reference unit
- ARINC - Aeronautical Radio, Inc.
- cm - centimeter
- HDG - heading
- IRS - inertial reference system
- kg - kilogram
- L - left
- MB - marker beacon
- R - right
- RMI - radio magnetic indicator
- v - volts
- VHF - very high frequency
- VOR - VHF omnidirectional range



RADIO MAGNETIC INDICATOR - INTRODUCTION

COMPONENT LOCATION

The RMI is in the flight compartment on the P2 center instrument panel.



COMPONENT LOCATION

GENERAL DESCRIPTION

Purpose

The radio magnetic indicator (RMI) is a standby instrument. It shows heading and bearing information.

Physical Properties

These are the physical properties of the RMI:

- Height - 3.26 in (8.28 cm)
- Width - 3.26 in (8.28 cm)
- length - 10 in (25.4 cm)
- Weight - 4.83 lb (2.2 kg).

Controls and Indicators

The RMI has two controls. They are the ADF/VOR 1, and ADF/VOR 2 bearing pointer selectors. Turn the selector to select ADF or VOR bearing inputs to control the position of bearing pointer 1 or 2.

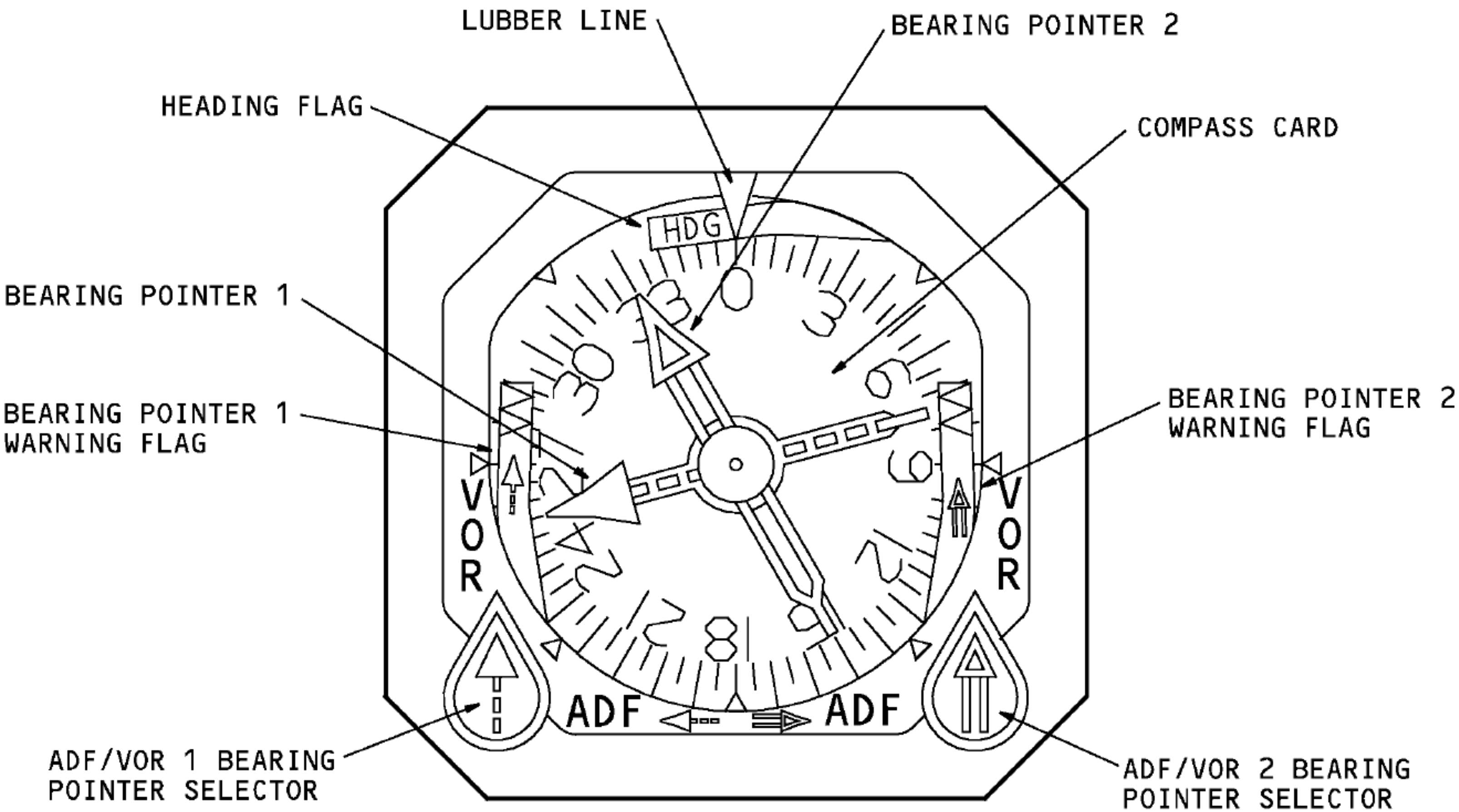
The RMI has these indicators:

- Lubber line; a fixed heading reference
- Compass card; shows ADIRS heading with reference to the lubber line
- Bearing pointers (2); shows ADF or VOR bearing relative to the compass card.

Failure Flags

The RMI has these three failure flags:

- Heading flag; shows when heading input fails
- Bearing pointer 1 warning flag; shows when ADF 1 or VOR 1 bearing input fails or is NCD
- Bearing pointer 2 warning flag; shows when ADF 2 or VOR 2 bearing input fails or is NCD.



RMI – RADIO MAGNETIC INDICATOR

RMI – INTERFACE

Heading Input

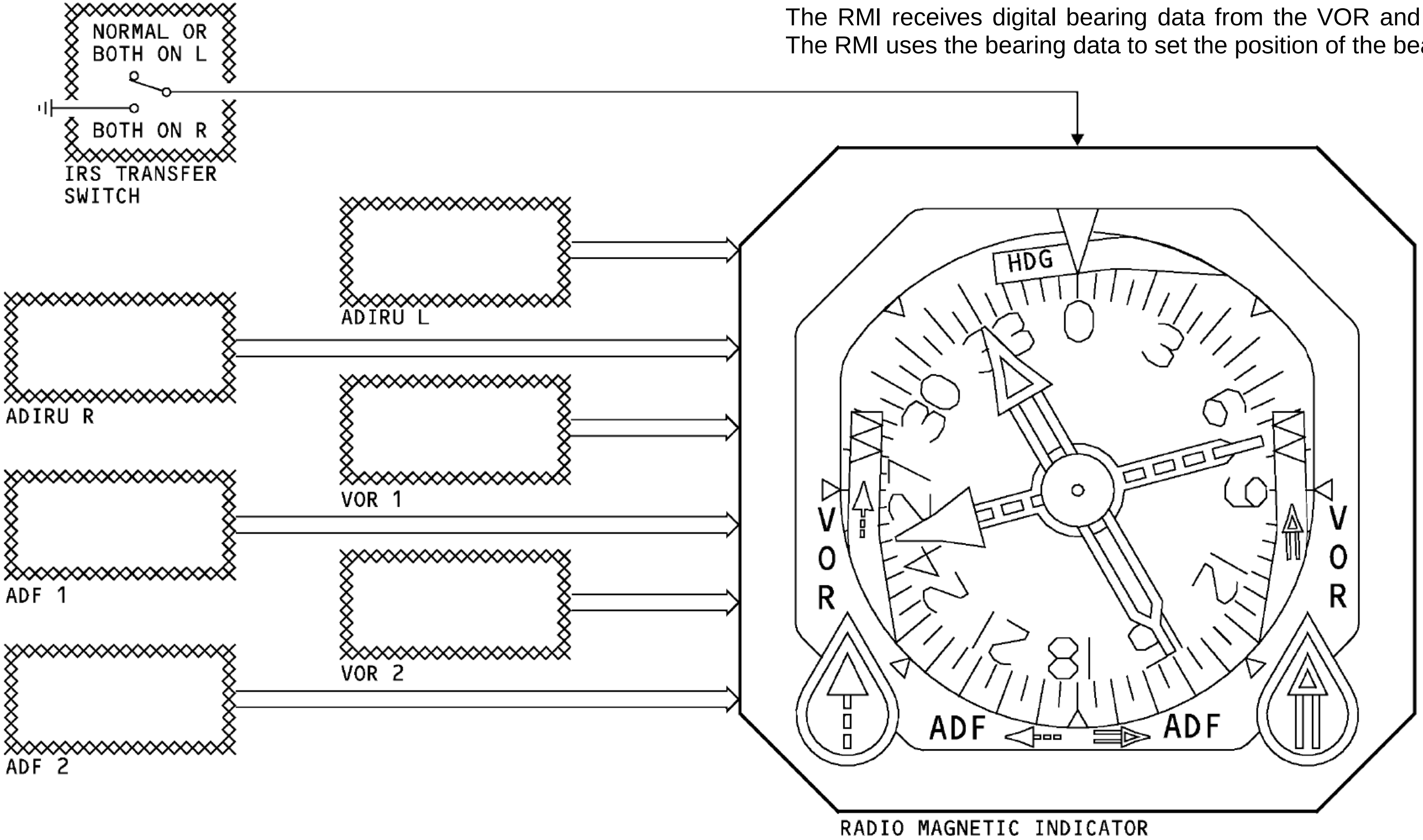
The RMI receives digital heading data from the air data inertial reference units (ADIRUs). The heading data sets the compass card to the magnetic heading of the airplane.

IRS Transfer Switch Input

The RMI uses the heading data from the left ADIRU with the IRS transfer switch in the normal or both on left position. Move the switch to the both on right position to use heading data from the right ADIRU.

VOR/ADF Bearing

The RMI receives digital bearing data from the VOR and ADF receivers. The RMI uses the bearing data to set the position of the bearing pointers.



RMI - INTERFACE

FUNCTIONAL DESCRIPTION

Power

The radio magnetic indicator (RMI) receives 115v ac from the 115v ac standby bus. The power goes through the RMI circuit breaker on the P18 panel.

Heading Input

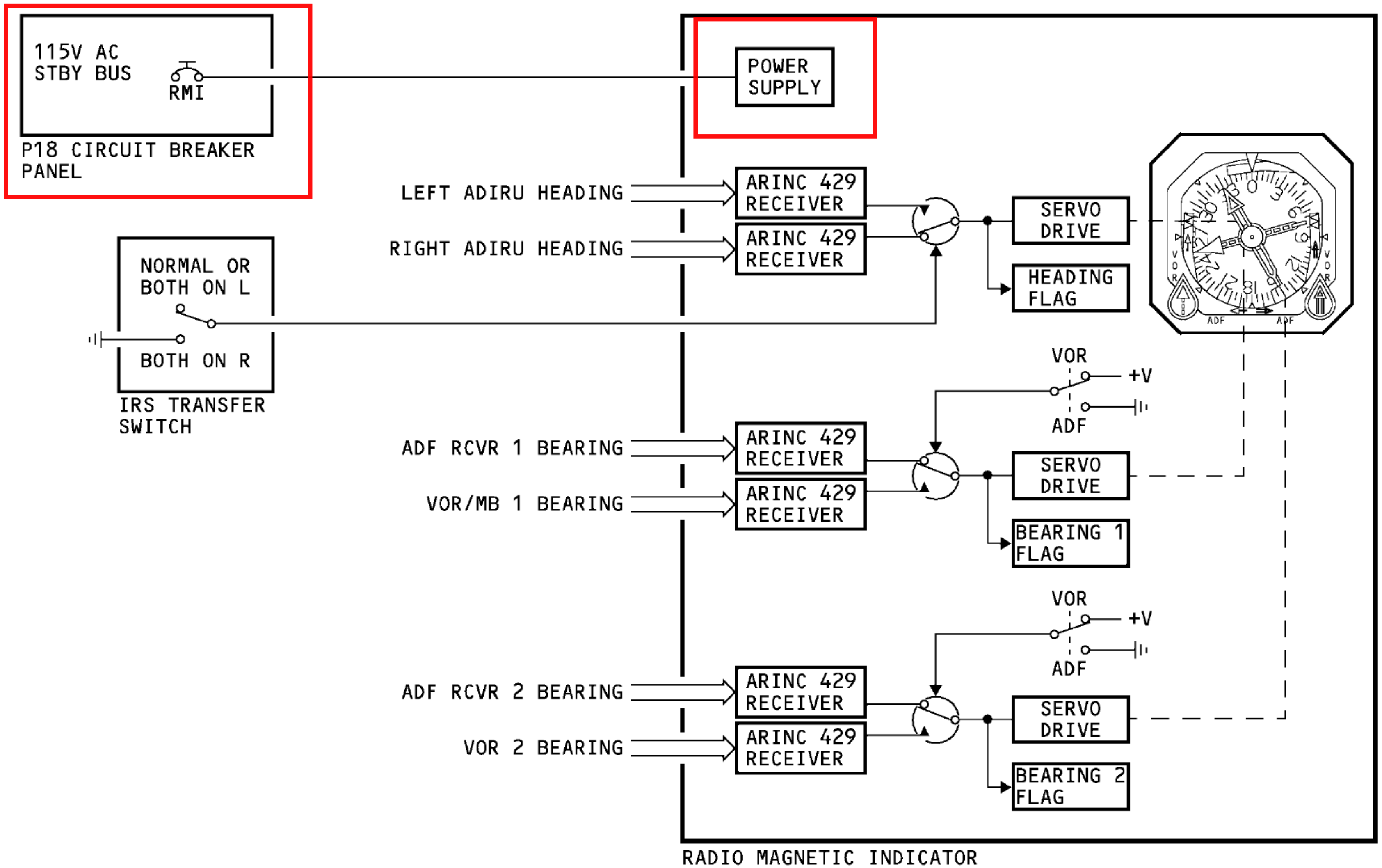
The RMI receives digital heading data from the air data inertial reference units (ADIRU). The heading data sets the compass card to the magnetic heading of the airplane.

The RMI uses heading data from one ADIRU. The position of the IRS transfer switch selects the ADIRU that gives data to the RMI. Put the switch in NORMAL or BOTH ON L for the left ADIRU to give data to the RMI. Put the switch in BOTH ON R for the right ADIRU to give data to the RMI.

VOR/ADF Bearing

The RMI receives digital bearing data from the VOR and ADF receivers. The RMI uses the bearing data to set the position of the bearing pointers.

Each bearing pointer can show VOR bearing or ADF bearing. Use the VOR/ADF bearing pointer selector to select VOR or ADF data.



FUNCTIONAL DESCRIPTION

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34-30. NAVIGATION (ATA 34)

LEVEL 3

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–31. INSTRUMENT LANDING SYSTEM (ATA 34–31)

LEVEL 3

INSTRUMENT LANDING SYSTEM (ILS) - INTRODUCTION

Purpose

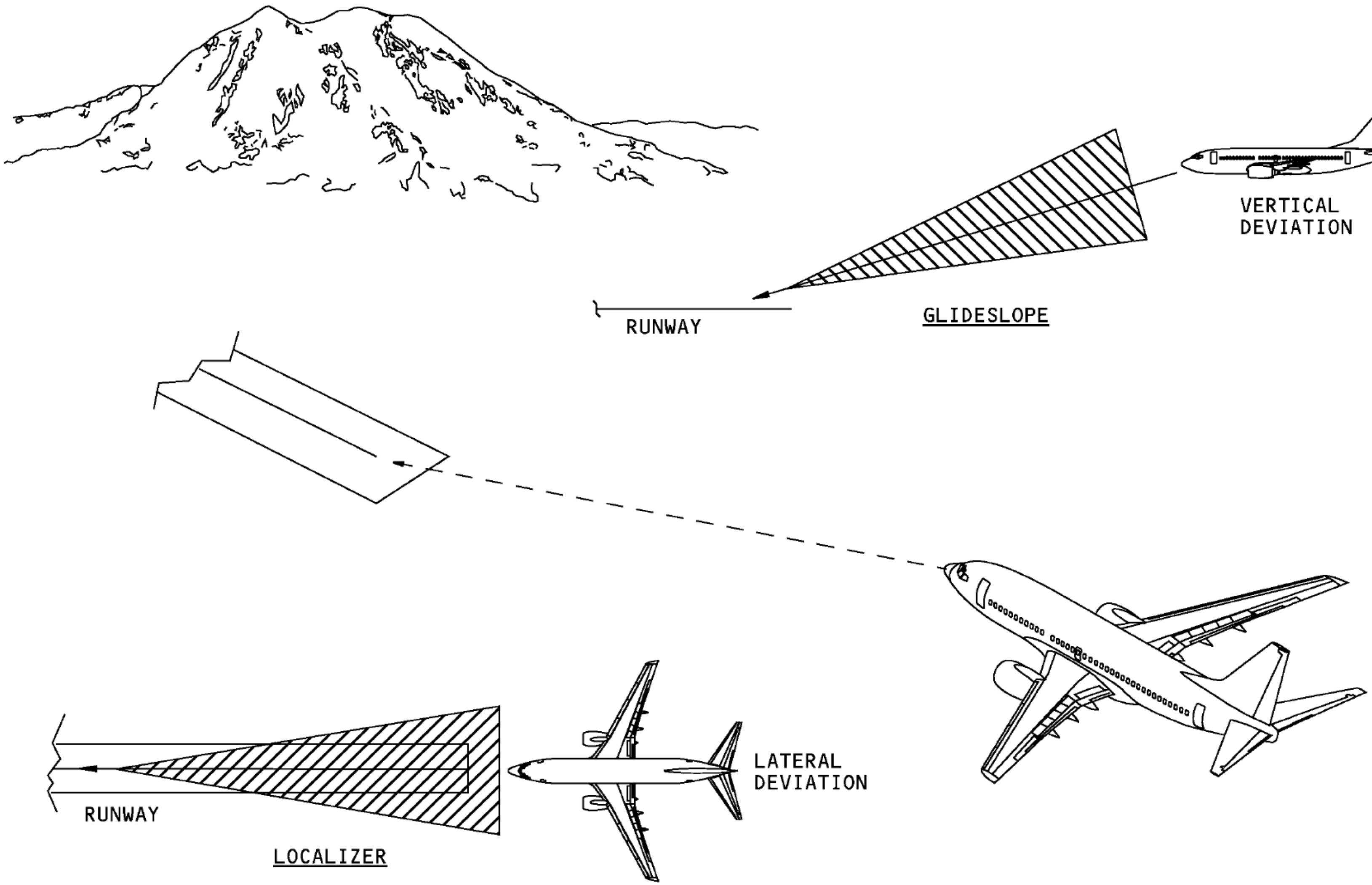
The multi-mode receiver (MMR) contains the instrument landing system and the global positioning system functions. This section only covers the instrument landing system function.

The instrument landing system (ILS) provides lateral and vertical position data necessary to put the airplane on the runway for approach. 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.

Abbreviations and Acronyms

- AC - alternating current
- ACP - audio control panel
- alt - alternate
- altn - alternate
- app - approach
- ARINC - Aeronautical Radio, Inc.
- BITE - built-in test equipment
- BL - buttock line
- CAPT - captain
- DC - direct current
- DEU - display electronics unit
- DME - distance measurement equipment
-
-
- EFIS - electronic flight instrument system
- F/O - first officer
- FCC - flight control computer
- FDAU - flight data acquisition unit
- FMC - flight management computer
- freq - frequency
- fwd - forward
- grd - ground
- ILS - instrument landing system
- LCD - liquid crystal display
- LED - light emitting diode
- LRU - line replaceable unit
- maint - maintenance
- MHz - megahertz
- MMR - multi-mode receiver
- MKR - marker beacon
- NAV - navigation
- NCD - no computed data
- ND - navigation display
- norm - normal
- rcvr - receiver
- RDMI - radio distance magnetic indication
- REU - remote electronics unit
- RF - radio frequency
- spkr - speaker
- sta - station
- tfr - transfer
- V - volts
- xfr - transfer
- xmtr - transmitter



INSTRUMENT LANDING SYSTEM(ILS) - INTRODUCTION

GENERAL DESCRIPTION

General

The instrument landing system (ILS) has two multi-mode receivers (MMRs) that contain the ILS function.

The ILS function in the MMRs receive inputs from these antennas:

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

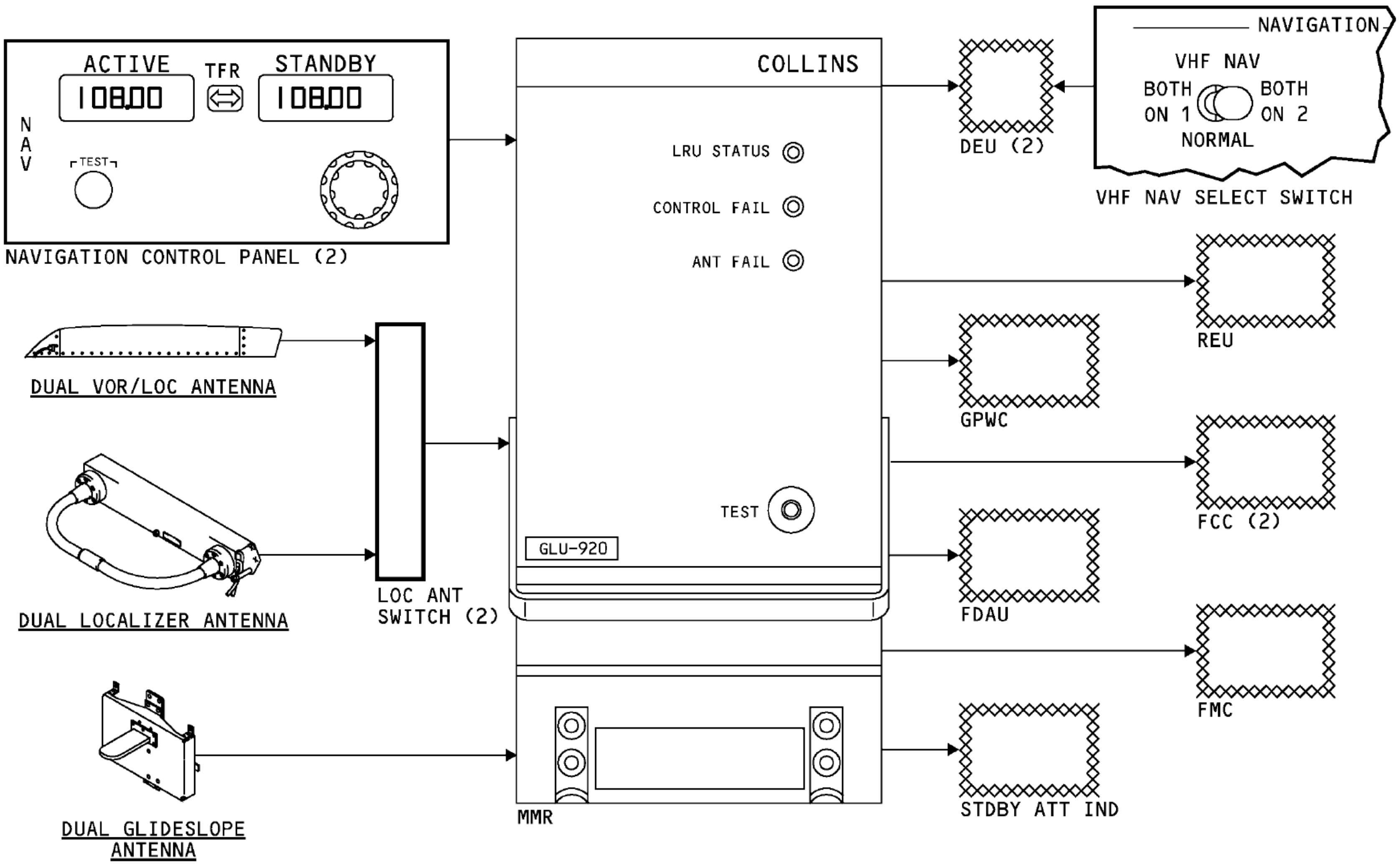
Description

The receivers get manual tune inputs from the navigation (NAV) control panels.

The VOR/LOC antenna and the localizer antenna send localizer signals through the localizer antenna switches to the MMRs. The localizer antenna switches select the VOR/LOC antenna or the localizer antenna as the source of RF input to the MMR. The glideslope antenna sends glideslope signals to the multi mode receivers.

The multi-mode receivers send ILS deviation data to these LRUs:

- DEUs
- REU
- GPWC
- FCC
- FDAU
- FMC
- Standby attitude indicator.



GENERAL DESCRIPTION

ILS - COMPONENT LOCATION

Flight compartment

These flight compartment components have an interface with the ILS system:

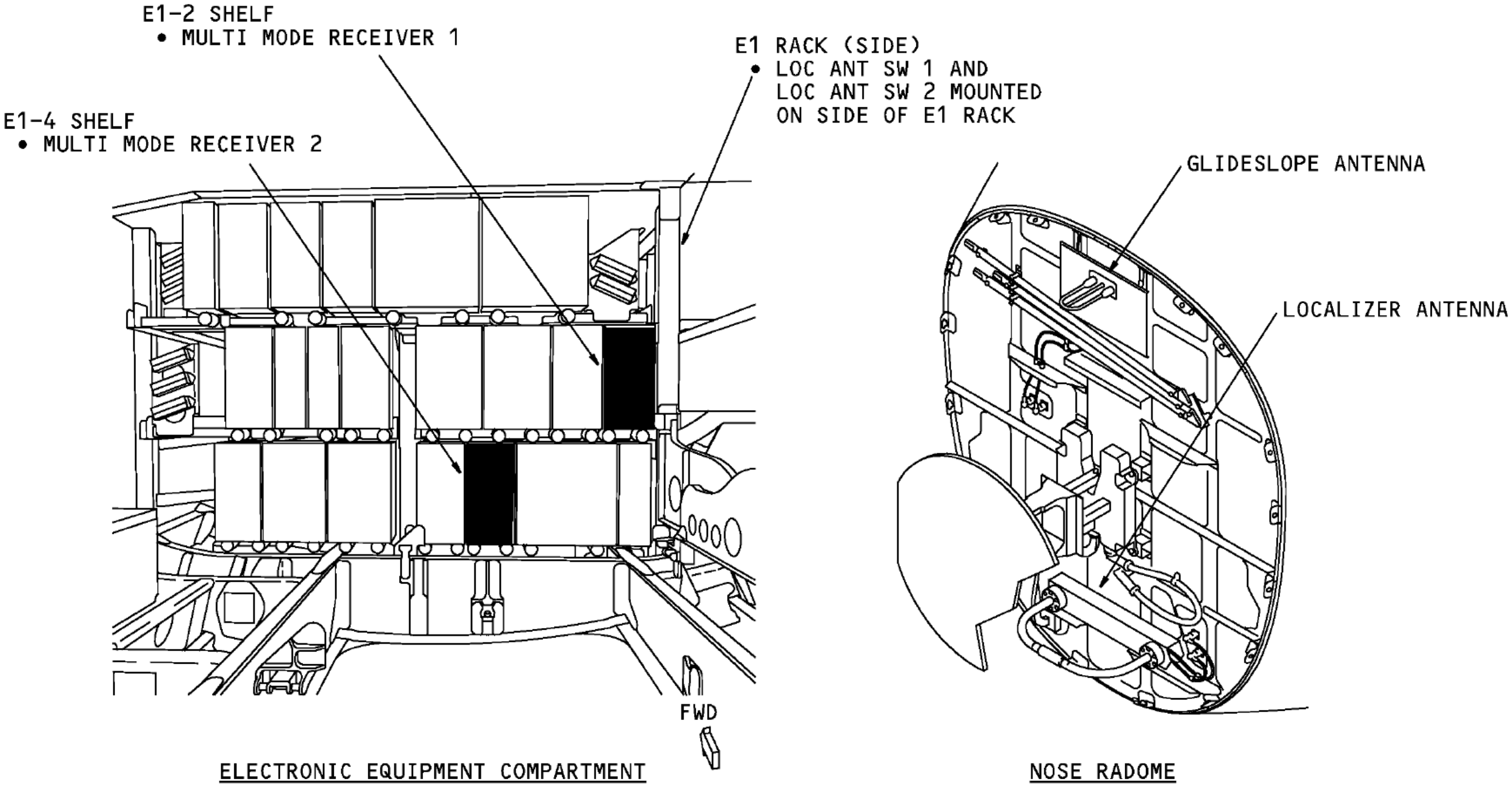
- VHF NAV select switch
- Capt secondary and primary EFIS displays
- Left and right EFIS control panels
- F/O secondary and primary EFIS displays
- Capt and F/O NAV control panels
- Capt and F/O audio control panels.

Electronic Equipment Compartment

The multi-mode receivers (MMRs) are in the electronic equipment compartment. MMR 1 is on the E1-2 shelf. MMR 2 is on the E1-4 shelf. The LOC antenna switches are on the side of the E1 rack.

Nose Radome

The glideslope and localizer antennas are in the nose radome. The glideslope antenna is above the weather radar antenna. The localizer antenna is below the weather radar antenna.



COMPONENT LOCATION

ILS –INTERFACES

POWER INTERFACES

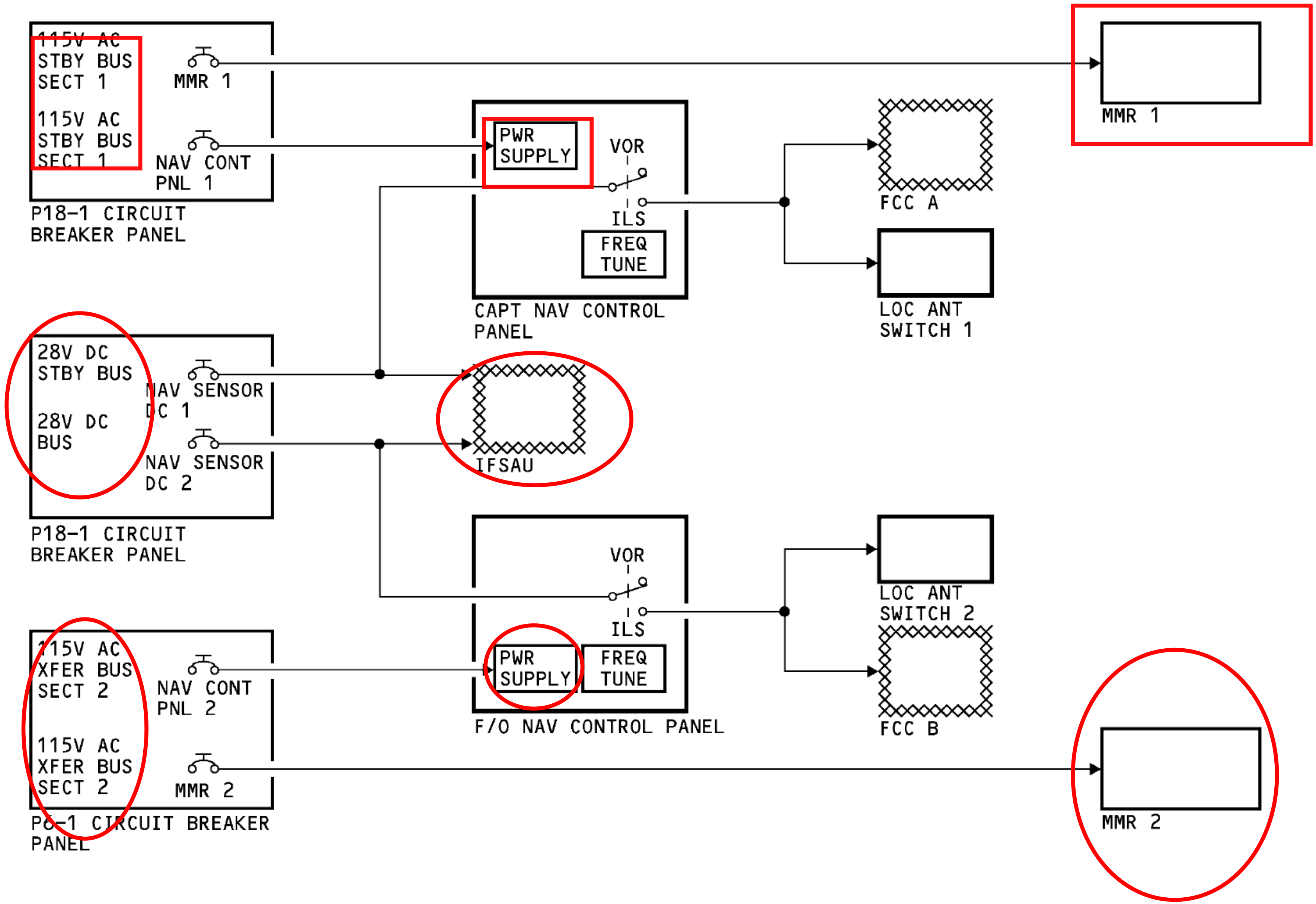
Power Inputs

The P18-1 circuit breaker panel contains the MMR 1 and NAV CONT PNL 1 circuit breakers. The circuit breakers receive 115v ac from the 115v ac standby bus section 1. The circuit breakers supply power to the multi mode receiver 1 and the captain's NAV control panel.

The P18-1 circuit breaker panel also contains the NAV SENSOR DC 1 and NAV SENSOR DC 2 circuit breakers. The circuit breakers receive 28v dc from the 28v dc standby bus and the 28v dc bus. The circuit breakers send 28v dc to the NAV control panels and to the integrated flight system accessory unit (IFSAU). For the ILS, The IFSAU contains circuits that supply a discrete signal to the LOC antenna switches for operation. The IFSAU uses the 28v dc from the NAV control panel and a discrete signal from the FCC to set the logic to send a discrete signal to operate the LOC antenna switches.

The P6-1 circuit breaker panel contains the NAV CONT PNL 2 and the MMR 2 circuit breakers. The circuit breakers receive 115v ac from the 115v ac transfer bus section 2. The circuit breakers supply power to the first officer's NAV control panel and the multi mode receiver 2.

When you tune an ILS frequency on the NAV control panels, 28v dc goes to the on-side FCC and LOC antenna switch. The FCC's use the 28v dc for mode selection. The LOC antenna switches use the 28v dc for operation.



POWER INTERFACES

DIGITAL INTERFACE

General

These are the components that have a digital interface with the multi-mode receivers:

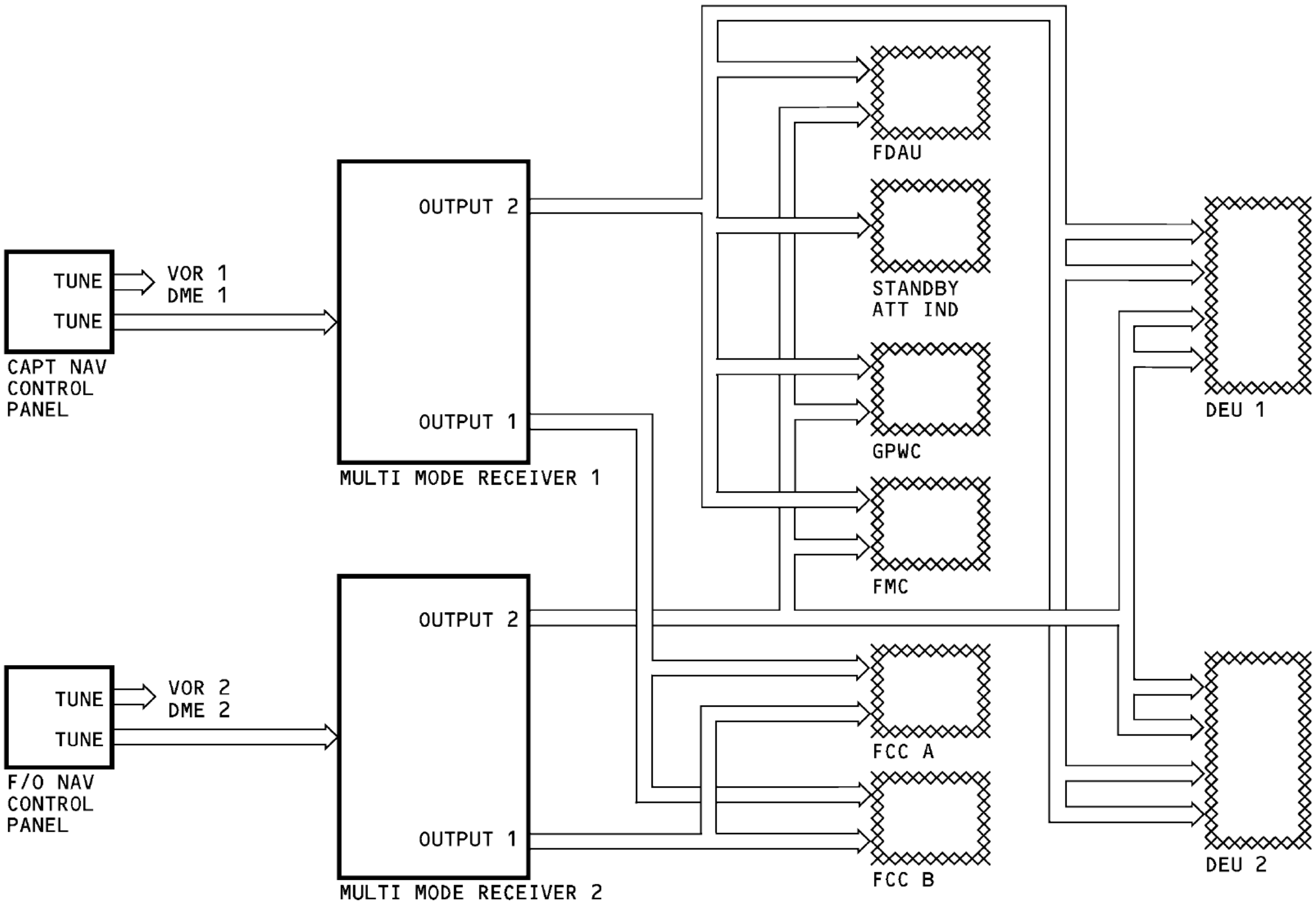
- Captain and first officer NAV control panels
- Flight data acquisition unit (FDAU)
- Standby attitude indicator
- Ground proximity warning computer (GPWC)
- Flight management computer (FMC) 1 and 2
- Display electronics units (DEU)
- FCC A and FCC B.

Digital Inputs

The NAV control panels supply frequency tune inputs to the multi-mode receivers. The NAV control panels also send tune inputs to the VOR and DME systems on a separate data bus.

Digital Outputs

Each MMR has two output data buses. Output data bus 1 goes to the FCCs. Output data bus 2 goes to many components.
The FDAU receives ILS data and status of the MMR receivers. The FDAU processes the data for the flight data recorder.
The standby attitude indicator uses localizer and glideslope deviations for the ILS deviation bar operation. Only MMR 1 sends ILS data to the standby attitude indicator.
The GPWC receives glideslope data from both ILS receivers for mode 5 (below glideslope) warnings.
FMC 1 and FMC 2 receive ILS data and receiver status from the two MMRs. The FMCS uses the ILS data for position update calculations.
The FCCs use ILS data to calculate airplane steering commands for the digital flight control system (DFCS) autopilot and flight director modes.
The DEU 1 receives two inputs from MMR 1 and two inputs from MMR 2. DEU 2 also receives two inputs from MMR 1 and two inputs from MMR 2. The CDS uses the ILS data to calculate the localizer deviation and glideslope deviation displays.



DIGITAL INTERFACE

FREQUENCY TRANSFER AND INSTRUMENT SWITCHING

General

The frequency transfer switch on the NAV control panel and the VHF NAV transfer switch on the navigation/displays source select panel have interface with the FCCs and DEUs.

Frequency Transfer Switch

The frequency transfer switch on the NAV control panel permits the crew to transfer the frequency from the standby display window on the NAV control panel, to the active display window.

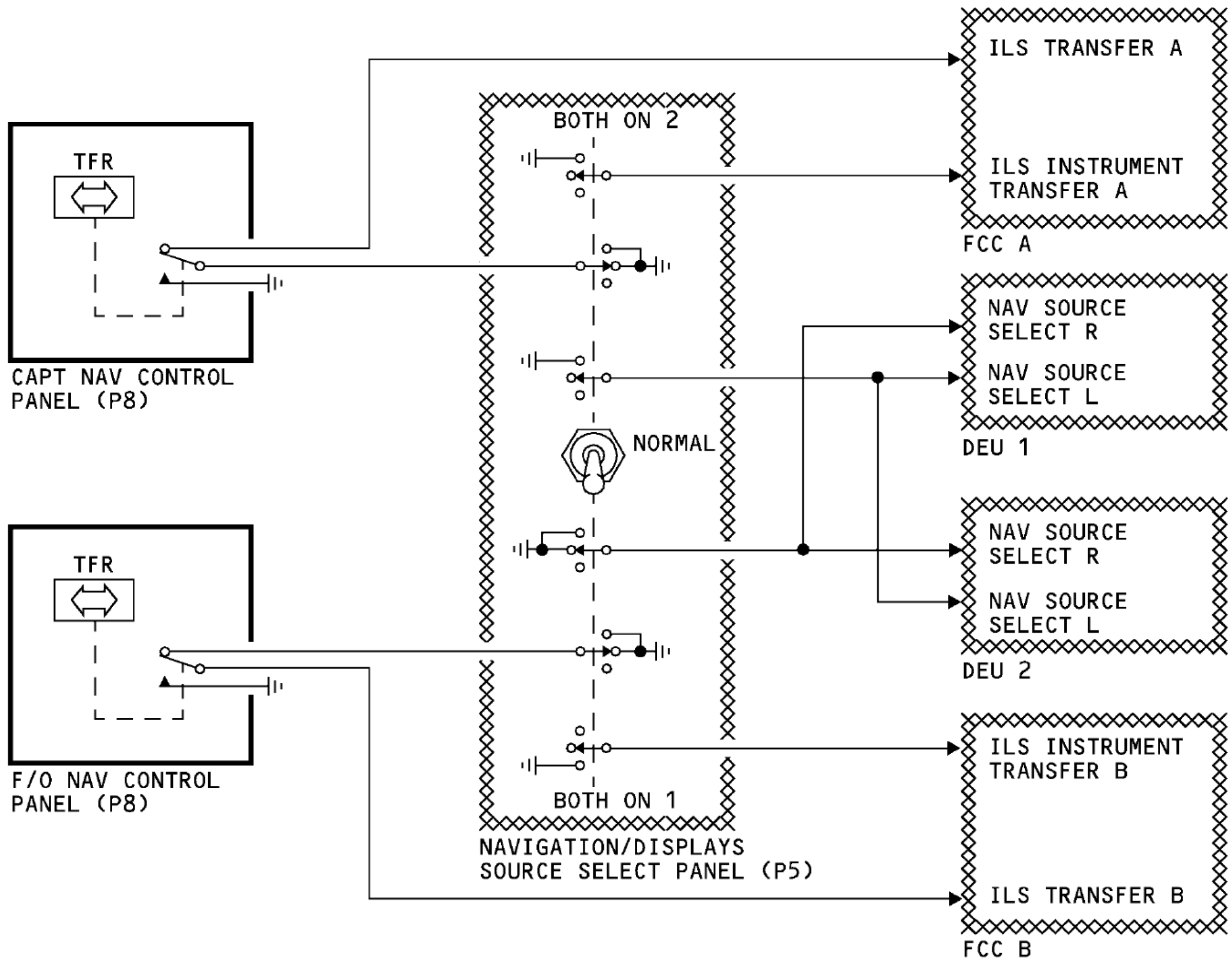
The transfer switch is a momentary action switch. When you push the switch, it changes the discrete level to the FCCs. The discrete tells the FCC when there is an ILS frequency change.

Navigation/Displays Source Select Panel

The VHF NAV switch on the navigation/displays source select panel is a three position switch. The positions are; BOTH ON 1, NORMAL, and BOTH ON 2. This switch changes the source of the data that the DEUs use for the ILS displays.

In the NORMAL position, MMR 1 supplies data for the captain displays and MMR 2 supplies data for the first officer displays. When you select BOTH ON 1, the DEUs use MMR 1 as the source for the captains displays and first officers displays. When you select BOTH ON 2, MMR 2 is the source for the captains displays and first officers displays.

Discrete signals also go to the flight control computers (FCCs) to signal that the switch is not in the normal position.



FREQUENCY TRANSFER AND INSTRUMENT SWITCHING

ANTENNA INTERFACE

General

The multi-mode receivers (MMRs) get RF inputs from these antennas:

- VOR/LOC antenna on the vertical stabilizer
- Localizer antenna in the nose radome
- Glideslope antenna in the nose radome.

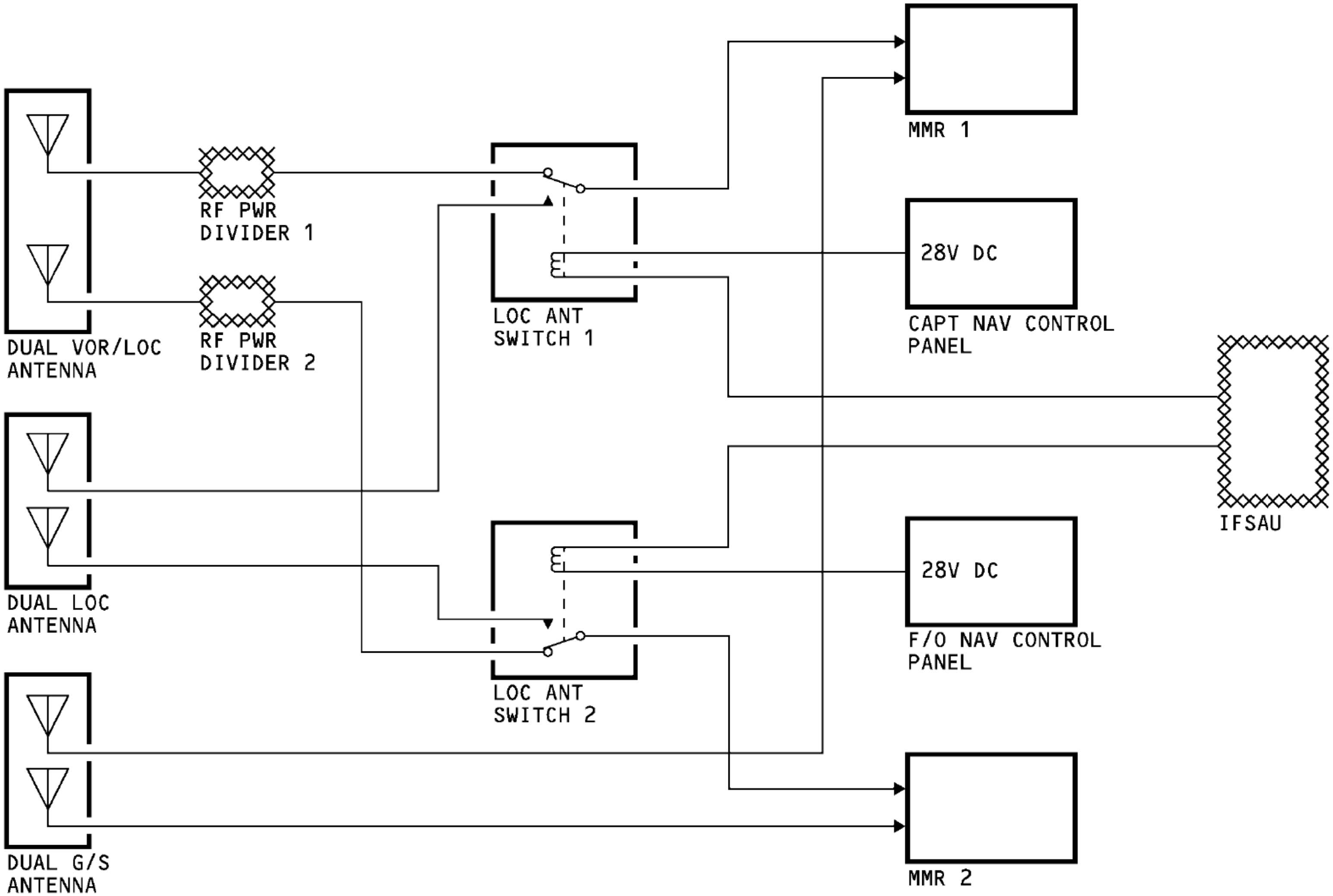
The VOR/LOC antenna RF inputs go through the power dividers then to the localizer (LOC) antenna (ANT) switches.

The localizer antenna RF inputs go directly to the LOC ANT switches. The antenna switches select the VOR/LOC antenna or localizer antenna as the source of the localizer RF signal input to the MMRs.

The glideslope antenna inputs do not go through the antenna switches. Glideslope antenna RF inputs go directly to the MMRs.

When you tune an ILS frequency on the navigation (NAV) control panels, they send 28v dc to the LOC antenna switches. The LOC ANT switches use 28v dc from the NAV control panels and a discrete signal from the integrated flight system accessory unit (IFSAU) for operation.

The IFSAU sends the discrete when it receives a discrete from the Flight Control Computers (FCCs). The FCCs send the discrete when you select the approach (APP) or localizer (LOC) mode on the DFCS mode control panel.



ANTENNA INTERFACE

ANALOG INTERFACES

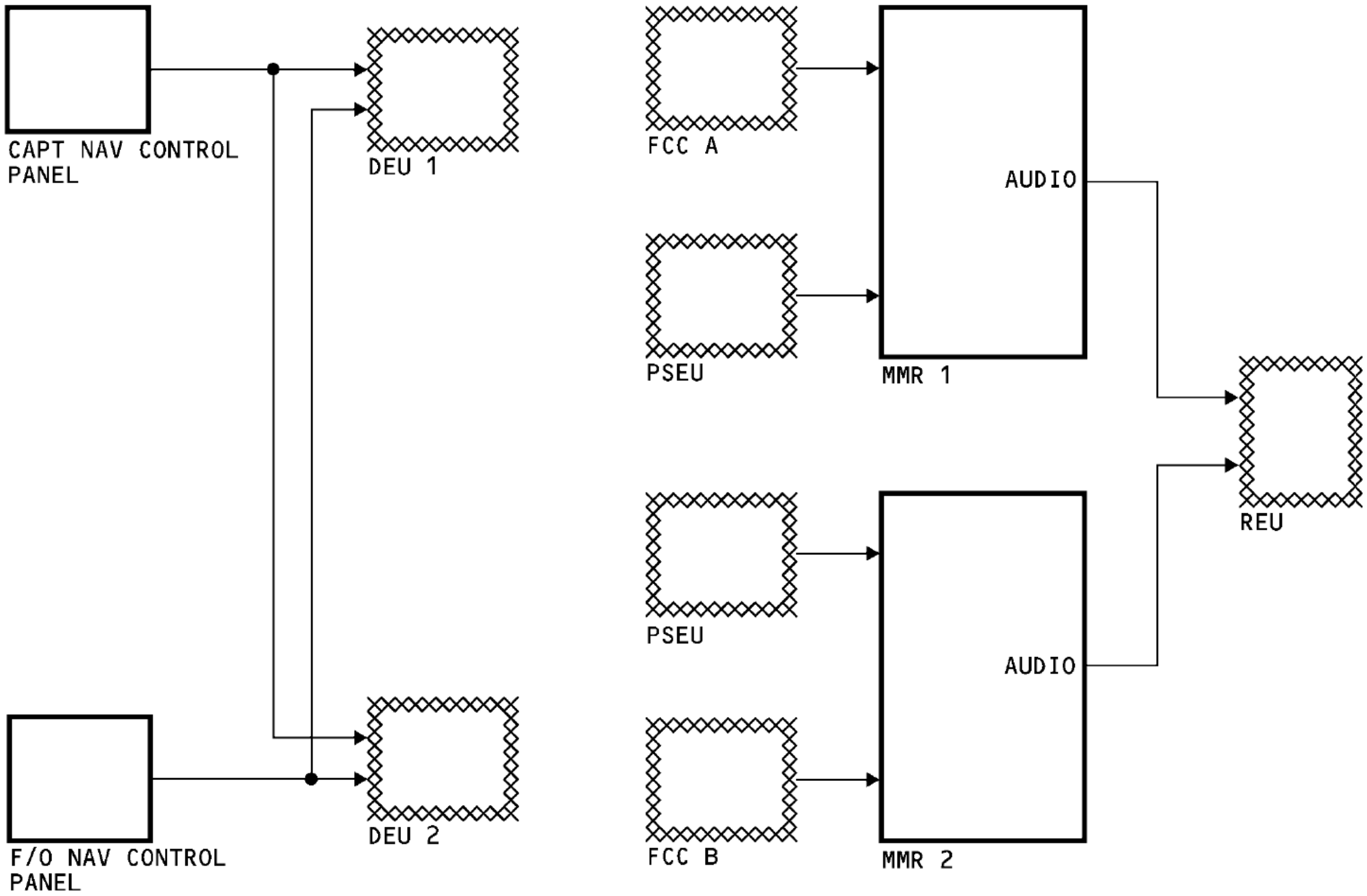
General

When you tune an ILS frequency on the NAV control panels, discrete signals go to the DEUs to tell if the frequency is an ILS or VOR frequency. Each NAV control panel sends the discrete signal to the DEU 1 and DEU 2.

The FCCs send an ILS tune inhibit to the ILS function of the MMRs during the approach (APP) mode of operation. The ILS receiver will not accept another tune frequency during this mode.

The PSEU sends air/ground discrete signals to the MMRs to set the flight leg count in the internal memory, and also inhibit test in the air.

The MMRs send ILS ground station audio to the REU. The REU sends the audio to the flight compartment.



ANALOG INTERFACES

ILS – COMPONENTS

MULTI MODE RECEIVER (MMR)

Purpose

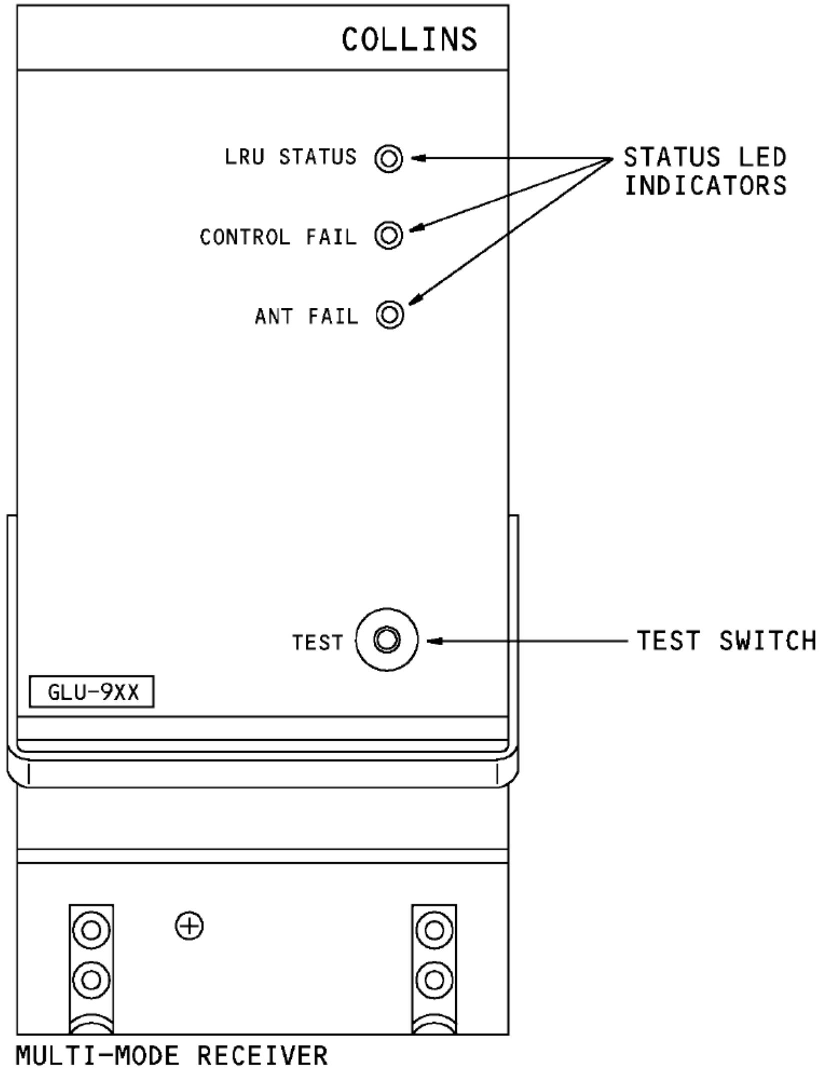
The multi-mode receiver contains an ILS receiver and a global positioning system (GPS) sensor unit. The ILS receiver function supplies localizer and glideslope deviation to different airplane systems. The GPS sensor unit supplies position data and time to the flight management computer system (FMCS).

Description

The MMR is a standard ARINC 600 3 MCU unit with dimensions 3.75 x 7.75 x 14.6 inches. The receiver weighs 10 pounds and uses 115v ac 400 Hz power for operation.

Test and Indication

There are status LED indicators and a test switch on the front of the multi mode receiver. The test switch starts a functional test of the receiver. The LED status indicators show test results.



MULTI MODE RECEIVER

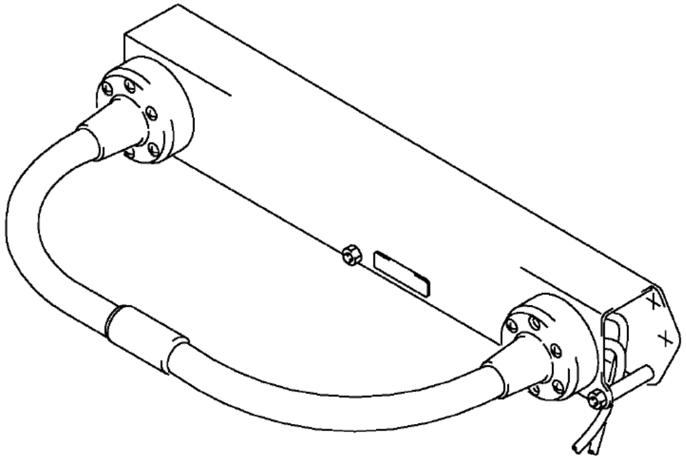
ANTENNAS

Localizer Antenna

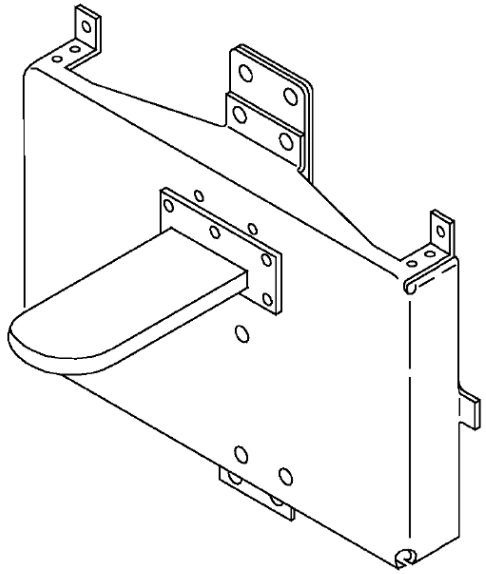
The localizer antenna has two elements. One element supplies RF inputs to ILS receiver 1 and one element supplies RF inputs to ILS receiver 2. The localizer antenna receives frequencies from 108.1 MHz to 111.95 MHz at odd tenth intervals.

Glideslope Antenna

The glideslope antenna also has two elements. One element supplies RF signal inputs to MMR 1 and one element supplies RF signal inputs to MMR 2. The glideslope antenna receives frequencies from 328.6 MHz to 335.4 MHz.



LOCALIZER ANTENNA



GLIDESLOPE ANTENNA

ANTENNAS

NAVIGATION CONTROL PANEL

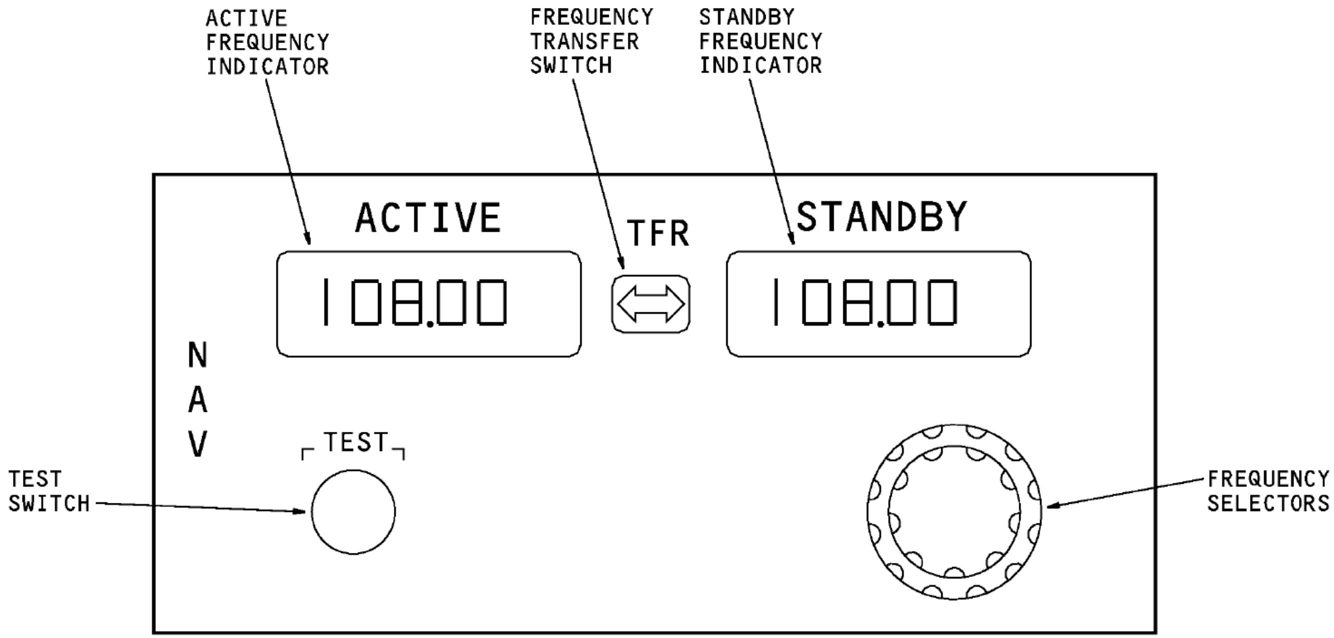
The navigation (NAV) control panels supply frequency control and test signals to the DME, the MMR, and the VOR navigation radios.

Operation

The NAV control panels have an active frequency indicator and a standby frequency indicator. The frequency that shows in the active frequency indicator is the frequency the navigation radios use for operation. The standby frequency indicator shows the next frequency you will use.
The frequency transfer switch is a momentary action switch. It transfers the frequency in the standby frequency indicator to the active frequency indicator. When you push the switch, the frequency in the active frequency indicator transfers to the standby frequency indicator.
The frequency selectors are continuous rotary selectors. There is an inner selector and an outer selector. The outer selector sets the tens and ones numbers. The inner selector sets the tenth and one hundredth numbers. The frequency selectors only change the numbers in the standby frequency indicator.
At power up, the frequency displays show the last frequency entry before power down.
The NAV control panel continuous BITE function monitors the operation. The NAV control panel shows FAIL in the active and the standby frequency indicators when there is a control panel failure.
An internal monitor in the NAV control panel monitors the 28v dc input. If the monitor does not see the 28v dc, it shows the message BLANK in the active and the standby frequency indicators.

Test

When you push the NAV control panel test switch, a test command goes out on the data bus. If a VOR frequency is active, the VOR receiver starts a self test. If an ILS frequency is active, the MMR receiver starts a self test. If a DME frequency is paired with the VOR or ILS frequency, the DME interrogator starts a self test at the same time.
When you do a test of the master dim and test system, the NAV control panel shows 188.88. The display shows for two seconds on, then one second off until the test is complete.



NAVIGATION CONTROL PANEL

FUNCTIONAL DESCRIPTION

Power Interface

The NAV control panel uses 115v ac power for operation. It also uses 28v dc for an internal monitor. The NAV control panel uses 5v ac from the master dim and test for panel lights.

ARINC 429 Interfaces

Frequency tune inputs and test commands from the NAV control panel go to the MMR on an ARINC 429 bus.

When you tune an ILS frequency, the frequency tune circuits operate switches in the NAV control panel that send these discrete signals:

- Open discrete to the REU
- Ground discrete to the DEUs
- 28v dc to the FCCs
- 28v dc to the LOC antenna switches.

Discrete Interfaces

The REU uses the open discrete to select ILS audio. The DEUs use the ground discrete to set the ILS displays. The NAV control panel sends the 28v dc to the FCCs when an ILS frequency is active. It also sends 28v dc to the LOC antenna switches when an ILS frequency is active for switch operation.

The on-side FCC supplies a discrete during an AFDS approach mode. The discrete causes the MMR to not accept any frequency changes. The discrete also goes to the NAV control panel. When the discrete is set, It prevents any frequency change to the output data word that goes to the MMR. The MMR uses the air/ground discrete for flight leg count.

RF Interfaces

RF signals from the VOR/LOC antenna or localizer antenna in the nose radome, go to the localizer receiver circuits in the MMR. RF signals from the glideslope antenna in the nose radome go to the glideslope receiver circuits in the MMR.

Receiver Functional Description

All inputs to the receiver go through a high intensity radiated frequency (HIRF) filter. This filter provides protection to internal circuits.

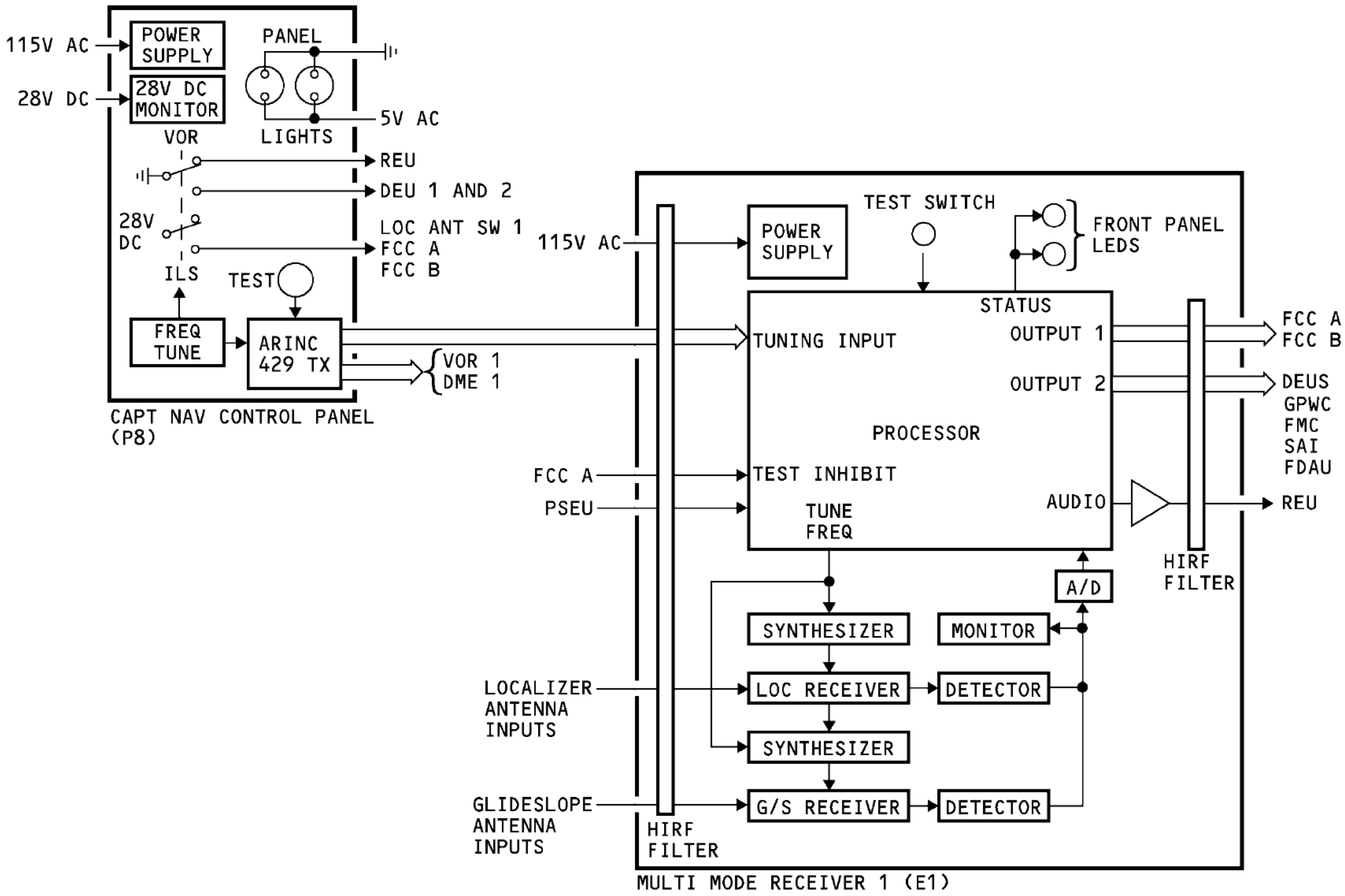
Tune inputs from the NAV control panel go to the main processor. The processor sends the tune frequency to the frequency synthesizer circuits. The frequency synthesizer circuits tune the localizer receiver and glideslope receiver.

The receiver circuits send the RF signal inputs from the antennas to the main processor. The processor computes localizer deviation and glideslope deviation.

ILS data goes out on two ARINC 429 buses. Output 1 goes to FCC A and FCC B. Output 2 goes to these LRUs:

- FDAU
- Standby attitude indicator
- GPWC
- FMC
- DEUs.

The A/D function of the receiver converts the audio from the localizer ground station from an analog to a digital format. The audio then goes to the main processor. The main processor sends the audio to the REU. The processor also detects any Morse code station identifier and sends it out on the data buses. When there is a station identifier on the data bus, the DEUs replace the frequency display with the four letter station identifier.



FUNCTIONAL DESCRIPTION

CONTROLS

EFIS Controls

To show ILS data on the captain's and F/O's displays, set the mode selector on the EFIS control panel to the APP position.

DFCS Controls

The digital flight control system (DFCS) mode control panel (MCP) supplies runway heading data to the display electronics unit (DEU) for ILS displays. You use the DFCS MCP course selector to set the course for approach.

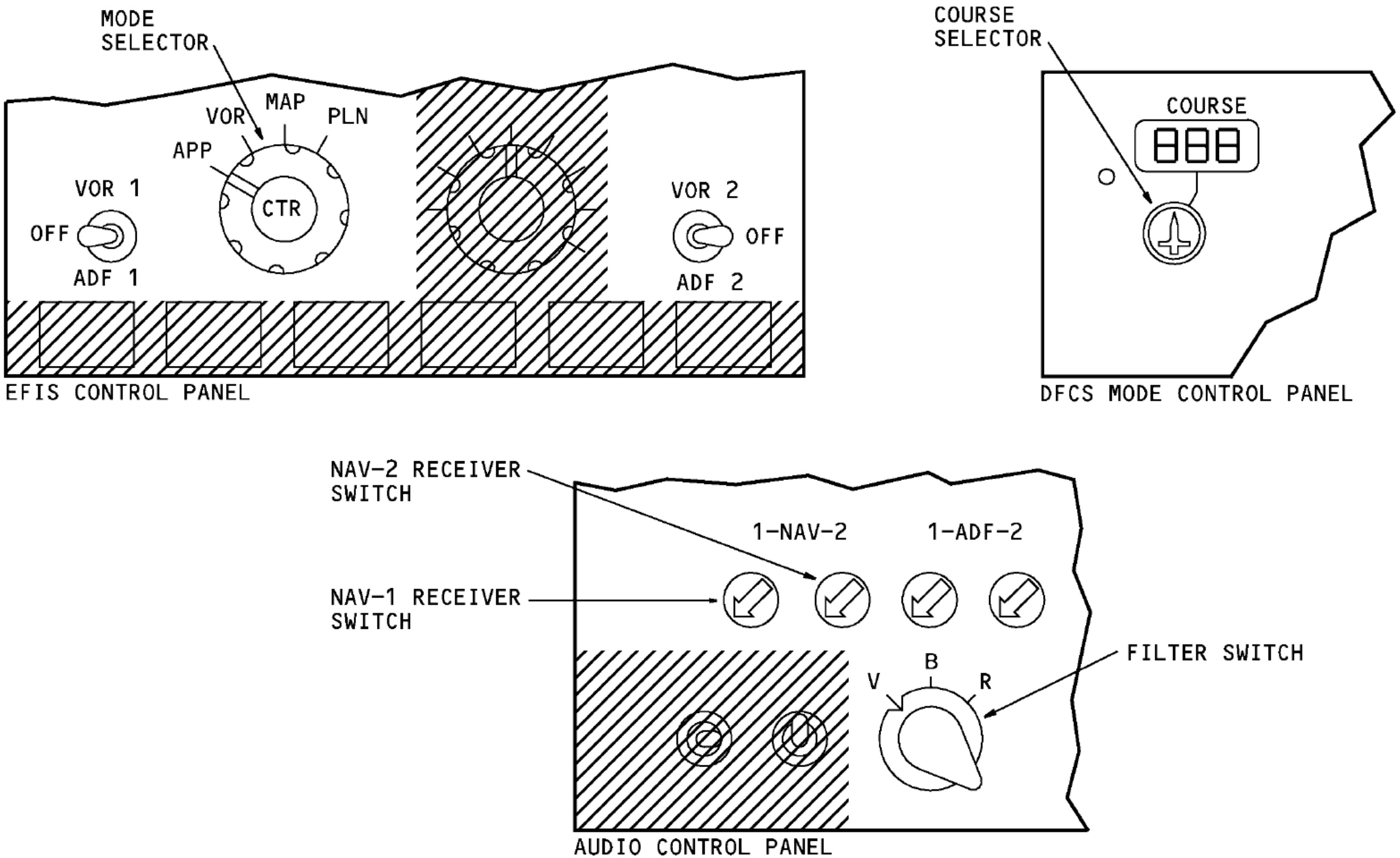
The DEU uses the course input and ILS deviation to calculate the airplane's deviation from the runway centerline. The DEUs compare the course input to the airplane's track to calculate if this is a back course approach. If the course input and airplane track are different by more than 90 degrees, the DEUs show back course ILS displays.

Audio Control Panel Controls

The audio control panels (ACPs) lets the crew listen to ILS station audio or the Morse code station identifier.

You use the ACP receiver switches to select the ILS audio you want to listen to. The NAV 1 receiver switch selects the MMR 1 audio and the NAV 2 receiver switch selects the MMR 2 audio.

The filter switch lets you listen to only voice audio in the voice (V) position. The range (R) position lets you listen to the station Morse code identifier. With selector in the both (B) position you can listen to both the voice audio and the Morse code station identifier.


MODE
SELECTOR
MAP
VOR
PLN
APP
CTR
VOR 1
OFF
ADF 1
VOR 2
OFF
ADF 2
EFIS CONTROL PANEL
COURSE
SELECTOR
COURSE
888
DFCS MODE CONTROL PANEL
NAV-2 RECEIVER
SWITCH
1-NAV-2
1-ADF-2
NAV-1 RECEIVER
SWITCH
FILTER SWITCH
B
V
R
AUDIO CONTROL PANEL

CONTROLS

THIS PAGE IS INTENTIONALLY LEFT BLANK

ILS – DISPLAYS

STANDBY ATTITUDE INDICATOR

The standby attitude indicator gives the crew an alternate attitude indication source. The indicator also provides ILS data. You use the approach selector on the indicator to show ILS data.

The approach selector has these positions:

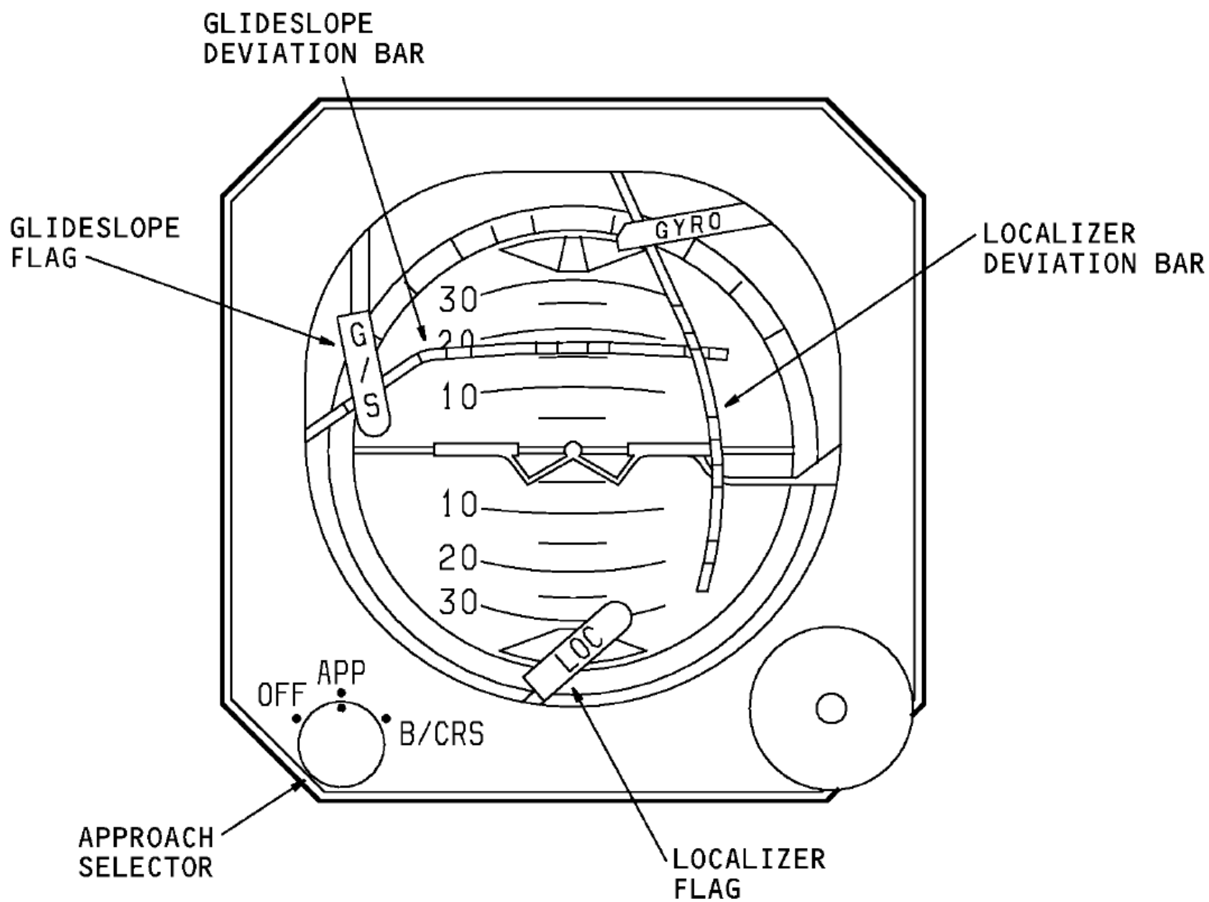
- Off - no ILS data on indicator
- APP - ILS localizer and glideslope data shows
- B/CRS - back course ILS localizer data shows.

Indications

When the selector is in the OFF position, the localizer and glideslope deviation bars do not show. When the selector is in the APP position, the localizer and glideslope deviation bars show. When you select B/CRS, the localizer deviation bar reverses polarity for the approach display and the glideslope deviation bar goes out of view.

When the indicator receives invalid ILS data, the localizer or glideslope deviation bars go out of view and the glideslope flag or localizer flag shows.

When the ILS data is no computed data (NCD) for localizer or glideslope data, the related deviation bar goes out of view.



ILS DISPLAYS - STANDBY ATTITUDE INDICATOR

ADI DISPLAYS

General

To show ILS displays on the ADI you must tune a valid ILS frequency on the NAV control panel and select it to the active display window.

Normal Display

The localizer deviation pointer and scale show at the bottom of the attitude display. The scale is a standard four dot scale. One dot equals 1 degree of deviation. The deviation indication shows deviation to the left or right of the runway centerline. The localizer scale shows in white and the localizer pointer shows in magenta.

The localizer scale can show the standard display or the expanded scale. A two-dot expanded scale can replace the four-dot scale. For the expanded scale, each dot equals 0.5 degrees of deviation. The white expanded scale goes to amber and flashes when the autopilot sends an ILS deviation warning.

The expanded scale shows for these conditions:

- LOC deviation is less than 5/8 dot
- LOC or APP mode is engaged
- ILS course and the airplane track are within 5 degrees of each other
- An autopilot is in CMD.

The glideslope deviation pointer and scale show to the right of the attitude display. The scale is a standard four-dot scale. One dot equals 0.35 degrees of deviation. The pointer gives fly-to commands to intercept the glideslope beam. The glideslope scale shows in white and the glideslope pointer shows in magenta. There is no expanded scale for glideslope deviation.

During back course conditions, the localizer deviation pointer operates opposite to the normal localizer display movement and the glideslope deviation pointer goes out of view. The DEUs use the course input from the DFCS MCP and compares it to the airplanes track to calculate a back course condition. If the course input and airplane track are different by more than 90 degrees, the DEUs show back course displays.

The ILS station frequency and course show above and to the right of the ADI. If the ILS ground station transmits a Morse coded station identifier, the stations letter identifier replaces the numeric frequency display when the receiver captures the signal.

Rising Runway (POST SB option)

The rising runway shows when there is a LOC signal capture and the radio altitude is below 2500 feet. The symbol goes out of view above 2500 feet. The rising runway symbol is green with a magenta stem.

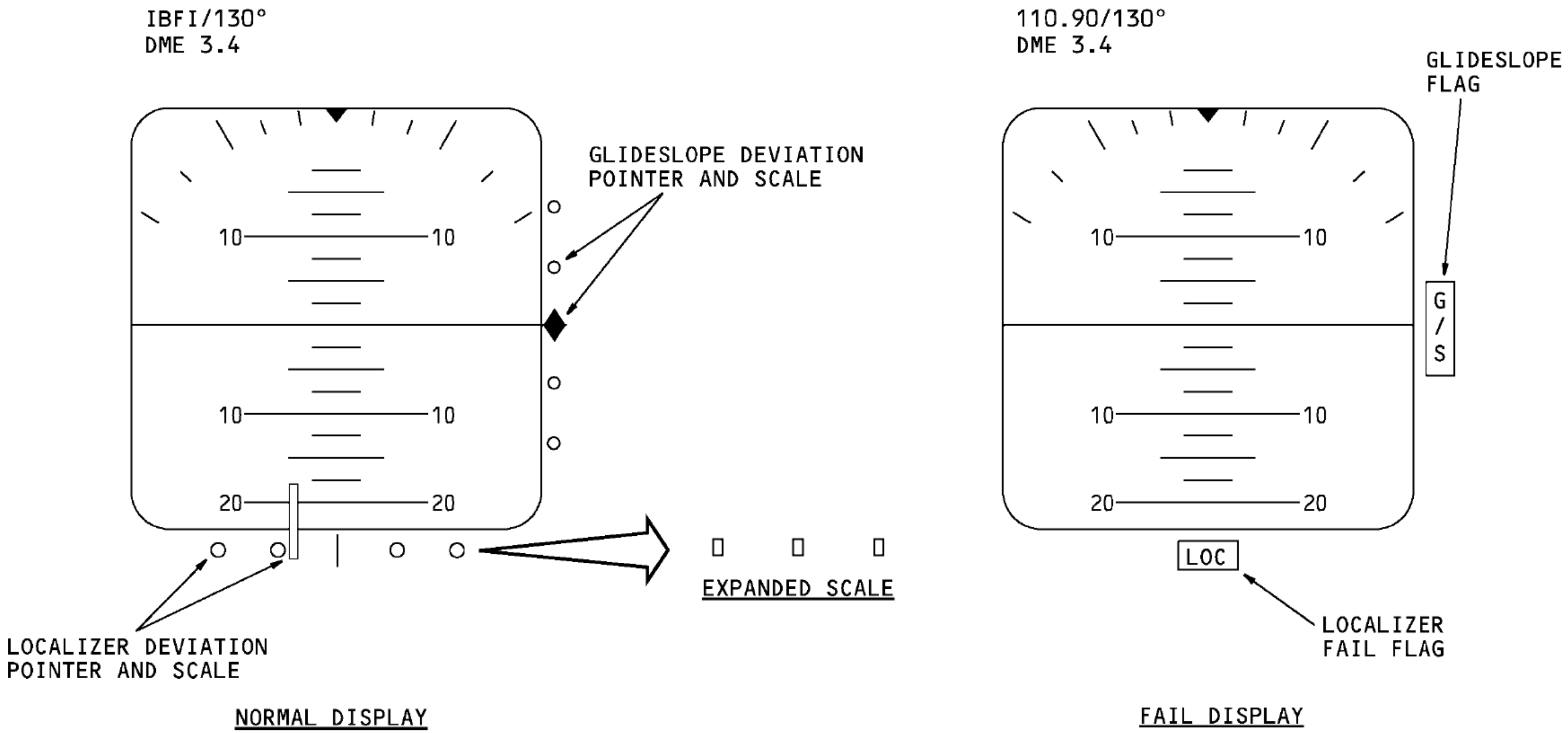
The rising runway symbol represents the radio altitude above the runway. It moves laterally with the localizer deviation pointer to show localizer deviation. The symbol starts to move when the radio altitude is 200 feet. It touches the airplane symbol when the radio altitude is 0 or at touchdown.

NCD Display

When the ILS data goes to an NCD condition, the CDS shows the localizer and glideslope scales and removes the pointers.

Fail Display

The amber LOC flag replaces the localizer deviation pointer and scale when the localizer receiver function has a failure. The amber G/S flag replaces the glideslope deviation pointer and scale when the glideslope receiver function has a failure.



ILS DISPLAYS - ADI DISPLAYS

NAVIGATION EXPANDED DISPLAY

General

To show ILS displays on the CDS, set the EFIS control panel mode selector to the APP position. You must also tune a valid ILS frequency on the NAV control panel.

Normal Display

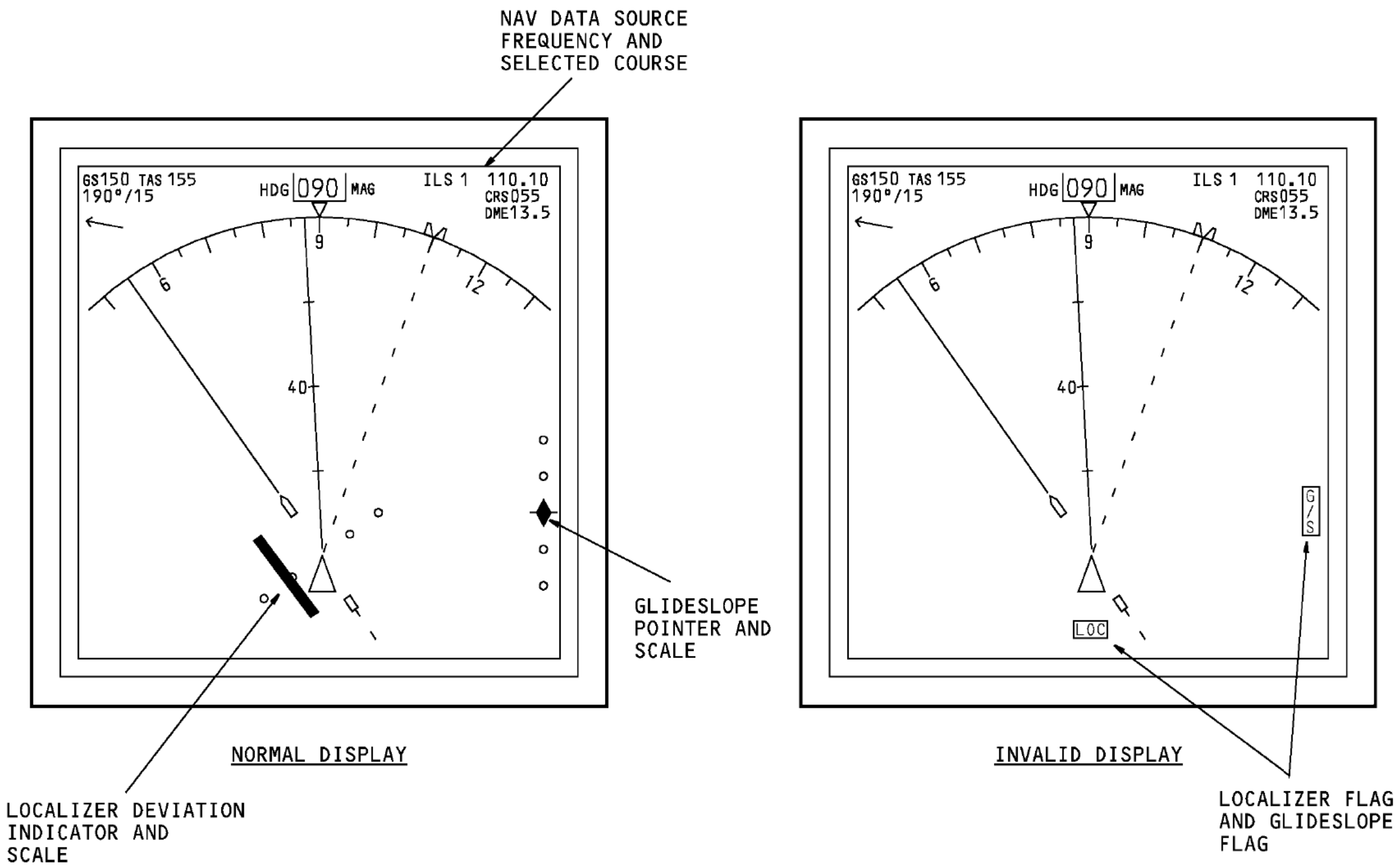
The glideslope deviation pointer and scale show at the right of the NAV display. The glideslope deviation pointer is magenta and the scale is white.
The glideslope scale is the standard four dot scale where each dot equals 0.35 degrees of deviation. The glideslope deviation pointer gives fly-to signals to intercept the glideslope beam.
The course pointer points to the number that you set on the DFCS MCP. For ILS, you use the DFCS MCP course selector to enter the ILS course (airport runway heading).
The localizer deviation indicator and scale shows at the bottom of the NAV display. The localizer scale is white and the localizer deviation indicator is magenta.
The deviation scale is the standard four dot scale. One dot is equal to 1 degree of deviation. The localizer deviation indicator shows the deviation to the left or right of the runway centerline.
The NAV data source is white at the bottom left corner of the HSI display. The display shows the source of the data for the ILS displays.
The ILS frequency is green at the bottom right corner of the HSI display. For NCD ILS frequency data, dashes replace the frequency display.

NCD Display

When the ILS data goes to an NCD condition, the CDS shows the localizer and glideslope scales and removes the pointers.

Fail Display

For invalid ILS data, the CDS replaces the localizer deviation scale and indicator with the amber LOC flag when the localizer receiver fails. The amber G/S flag replaces the glideslope deviation scale and pointer when the glideslope receiver fails.



ILS DISPLAYS – NAVIGATION EXPANDED DISPLAY

NAVIGATION CENTERED DISPLAY

General

To show the centered ILS NAV display, push the CTR switch on the EFIS control panel mode selector switch.

Normal Displays

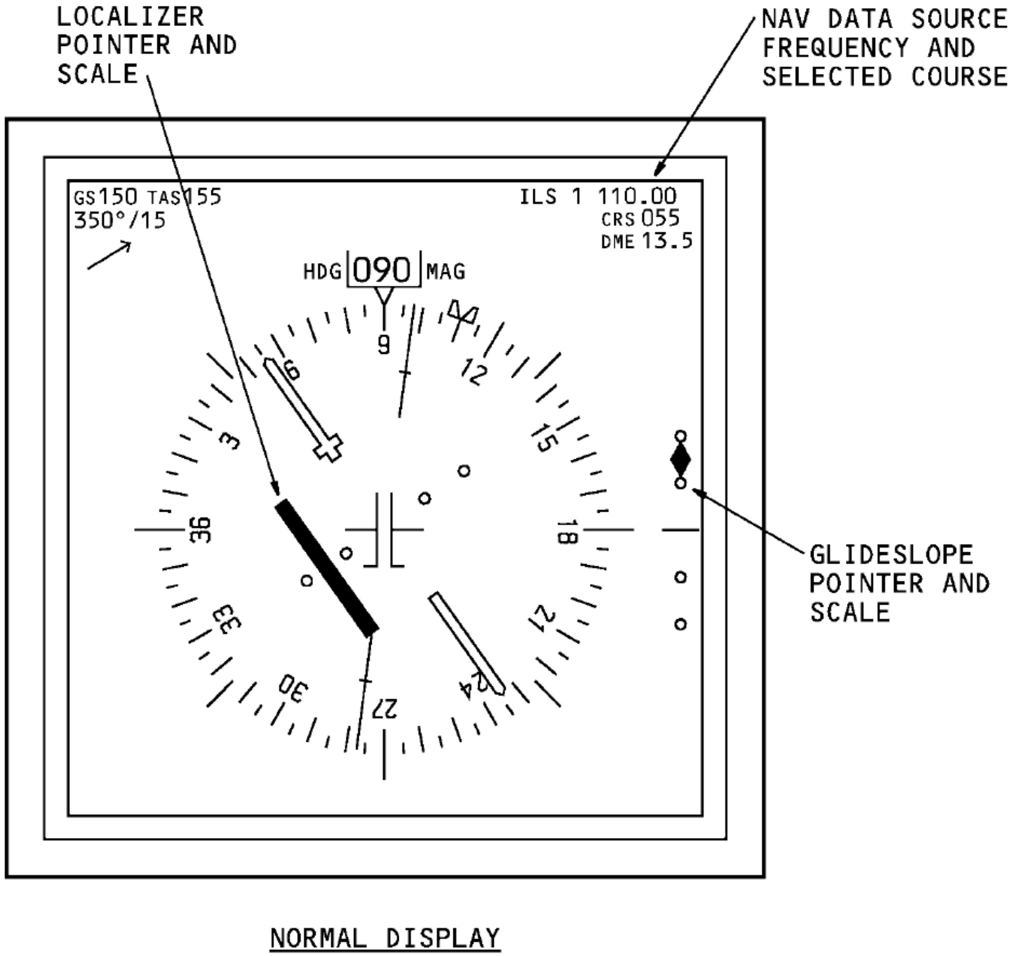
The glideslope deviation pointer and scale show to the right of the HSI display. The glideslope pointer is magenta and the scale is white.
The glideslope scale is the standard four dot scale. Each dot equals 0.35 degrees of deviation. The pointer gives fly-to commands to intercept the glideslope beam.
The course pointer points to the number that you set on the DFCS MCP. For ILS, you use the DFCS MCP course selector to enter the ILS course (airport runway heading).
The localizer deviation indicator and scale show in the center of the HSI compass card. The localizer deviation indicator is magenta and the scale is white.
The localizer scale is the standard four dot scale. Each dot is equal to 1 degree of deviation. The deviation indicator shows the deviation to the left or the right of the runway centerline.
The NAV data source is white at the bottom left corner of the NAV display. The display shows the source of data for the ILS displays.
The ILS frequency is green at the bottom left corner of the NAV display. For NCD ILS frequency data, dashes replace the frequency display.

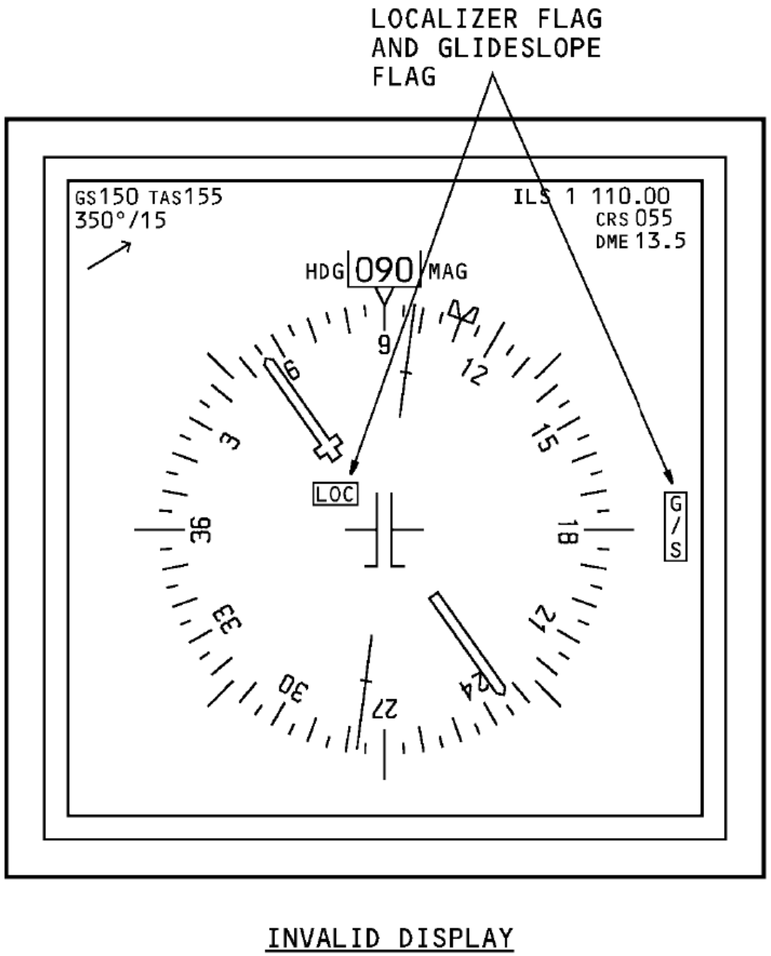
NCD Display

For an ILS NCD condition, the CDS displays the localizer and glideslope scales and removes the deviation bar and glideslope pointer.

Fail Display

For invalid ILS data, the CDS replaces the localizer scale and deviation indicator with the amber LOC flag when the localizer receiver fails. The amber G/S flag replaces the glideslope scale and pointer when the glideslope receiver fails.





ILS DISPLAYS – NAVIGATION CENTERED DISPLAY

ILS - SELF-TEST

You use the NAV control panels to do an ILS test from the flight compartment. The captain NAV control panel does a test of MMR 1 and the first officer NAV control panel does a test of MMR 2.

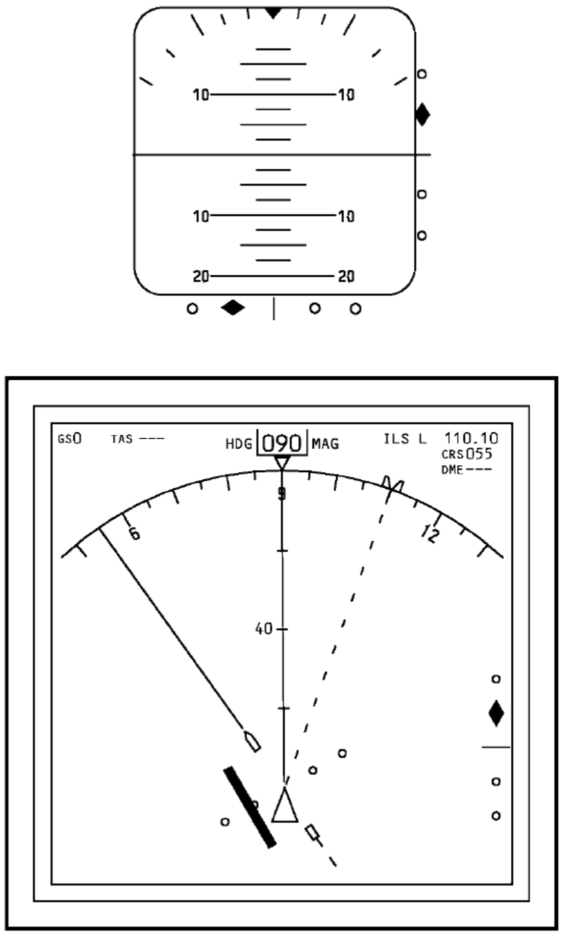
You need to set these controls to do an ILS test:

- ➢ Enter a valid ILS frequency into the active frequency display window on the NAV control panel
- ➢ Set a course on the DFCS mode control panel that is within 90 degrees of the airplane heading
- ➢ Push the test switch on the NAV control panel.

To see the ILS test on the NAV display, you must select the approach (APP) mode on the EFIS control panel mode selector.

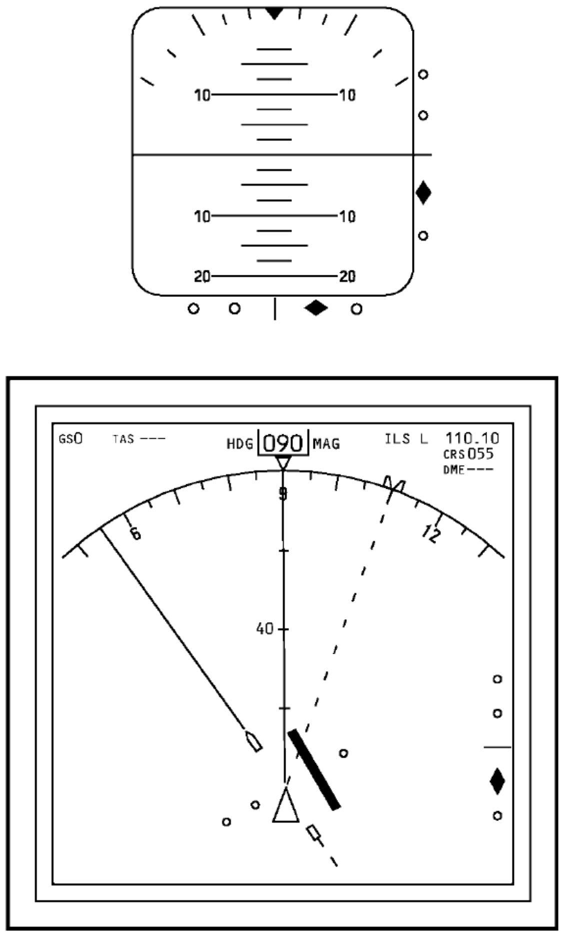
This is the display sequence that shows on the CDS during the ILS test:

- ➢ For the first 3 seconds, one dot left of localizer deviation and one dot up of glideslope deviation
- ➢ For the next 3 seconds, one dot right of localizer deviation and one dot down of glideslope deviation
- ➢ Displays return to normal indications.



FIRST 3 SECONDS OF TEST

LOCALIZER = ONE DOT LEFT DISPLAY
GLIDESLOPE = ONE DOT UP DISPLAY



NEXT 3 SECONDS OF TEST

LOCALIZER = ONE DOT RIGHT DISPLAY
GLIDESLOPE = ONE DOT DOWN DISPLAY

ILS – SELF-TEST

THIS PAGE IS INTENTIONALLY LEFT BLANK

ILS - BITE

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.

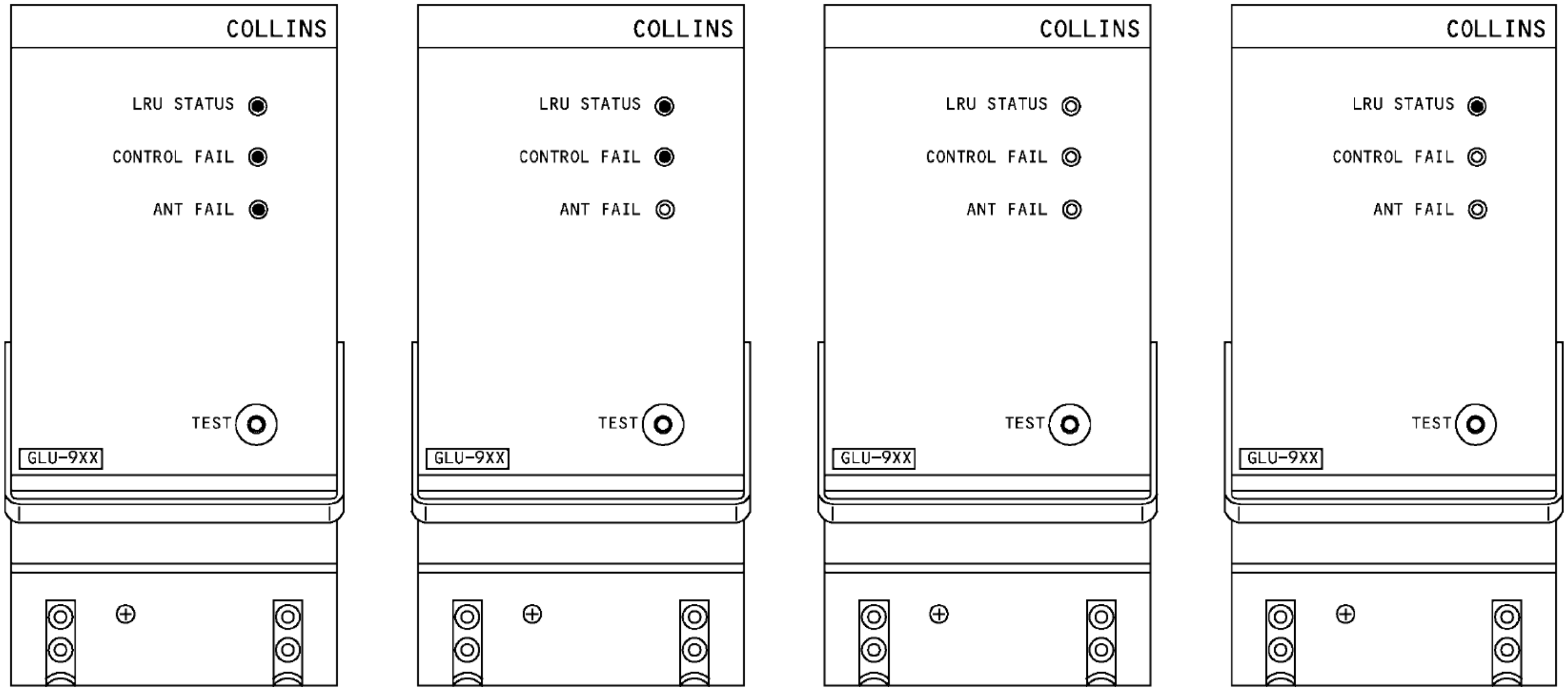
This is the test sequence that shows on the LED status indicators during the test:

- **0 to 2 seconds** - the LRU STATUS, the CONTROL FAIL, and the ANT FAIL LEDs come on 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.

Note: The ANT FAIL LED is not used at this time.



0-2 SECONDS

THE LRU STATUS, CONTROL FAIL, AND ANT FAIL LEDS COME ON. (THE ANT FAIL LED COMES ON FOR THE LAMP TEST ONLY AND WILL REMAIN OFF FOR THE REST OF THE TEST)

2-4 SECONDS

THE LRU STATUS IS GREEN AND THE ANT FAIL IS RED

4-6 SECONDS

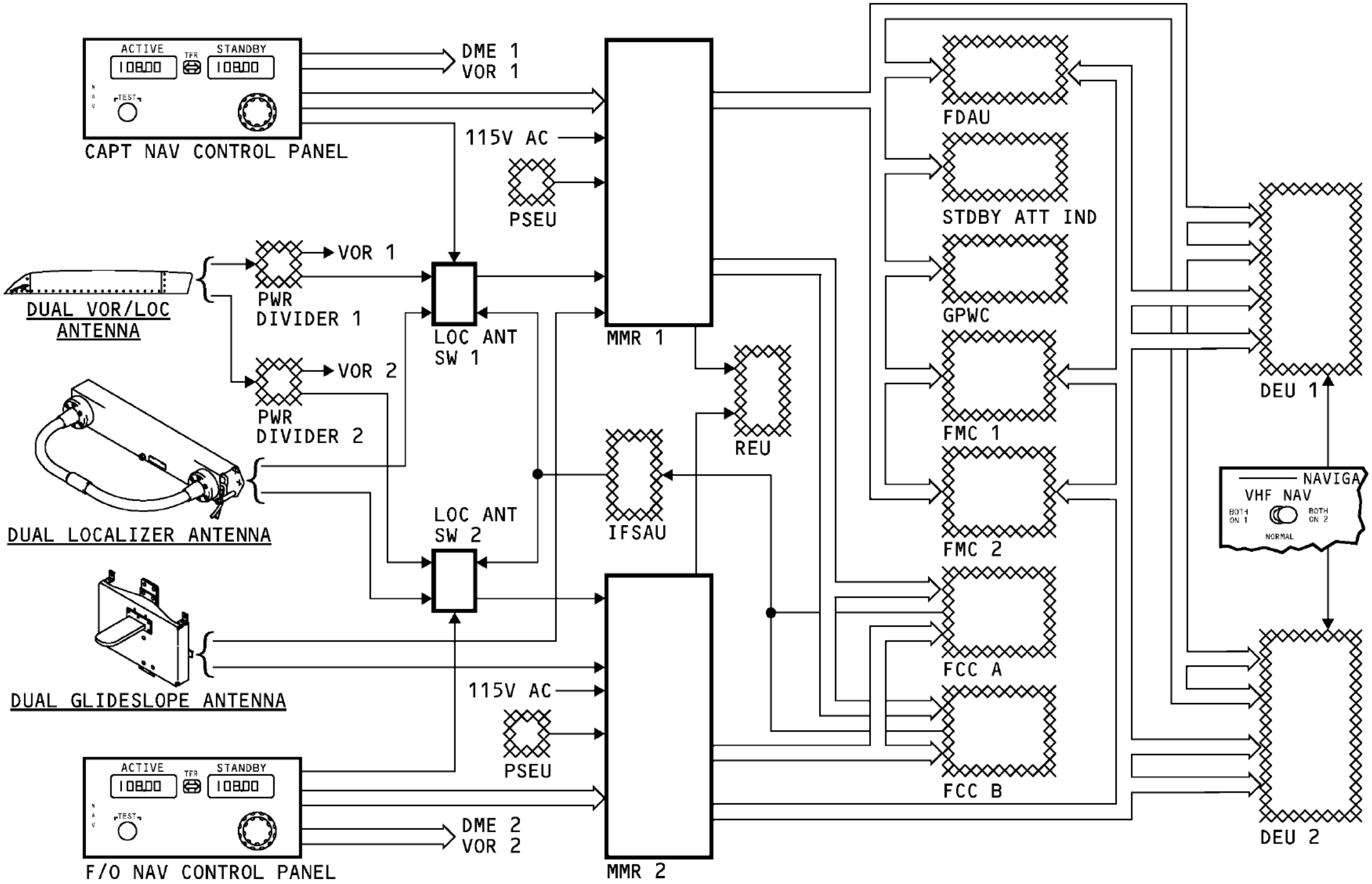
THE LEDS GO OFF

4-6 SECONDS

THE TEST STATUS SHOWS

ILS – BITE

SYSTEM SUMMARY



SYSTEM SUMMARY

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–32. MARKER BEACON SYSTEM (ATA 34–32)

LEVEL 3

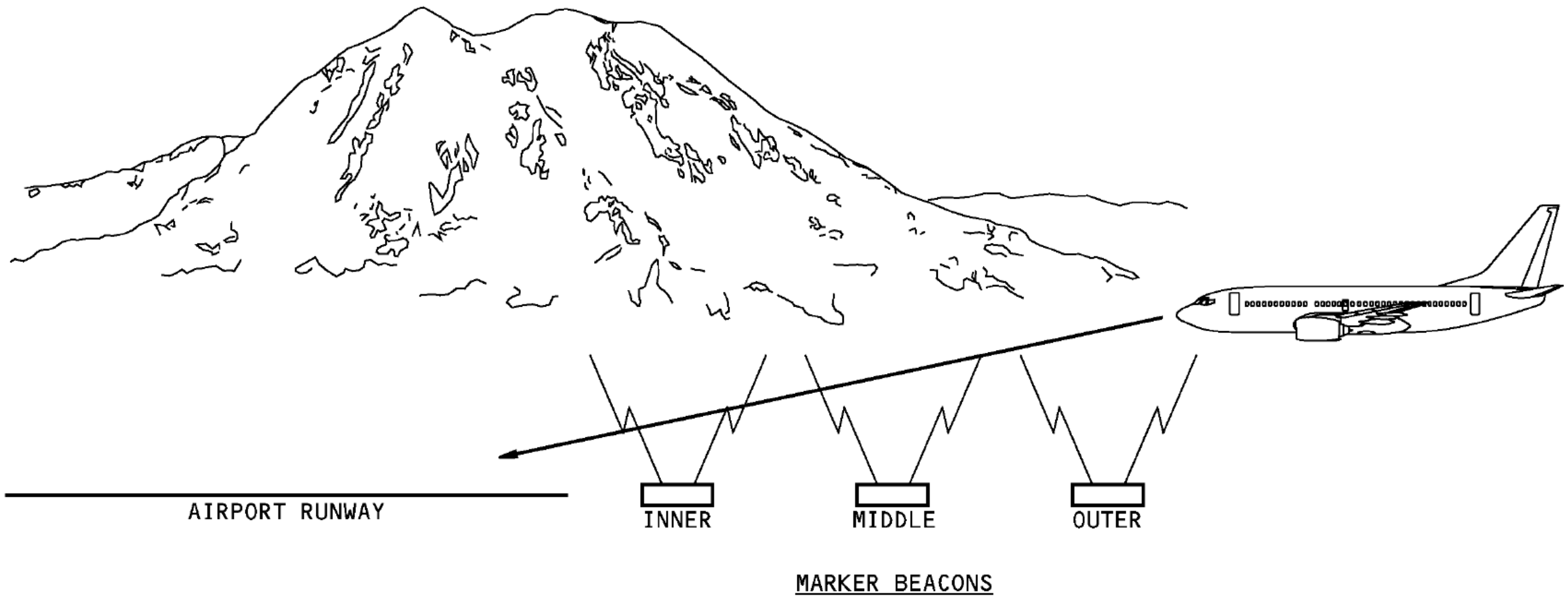
MARKER BEACON SYSTEM - INTRODUCTION

General

The marker beacon system supplies visual and aural indications when the airplane flies over airport runway marker beacon transmitters.

Abbreviations and Acronyms

- A/P - autopilot
- AC - alternating current
- ACP - audio control panel
- ALT - alternate
- AMP - amplifier
- B - both
- BITE - built-in test equipment
- CDS - common display system
- DEU - display electronics unit
- DME - distance measuring equipment
- FDAU - flight data acquisition unit
- DU - display unit
- EFIS - electronic flight instrument system
- FT - functional test
- GND - ground
- Hz - hertz
- I/C - intercom
- ILS - instrument landing system
- IM - inner marker
- I/O - input/output
- LCD - liquid crystal display
- LED - light emitting diode
- LRU - line replaceable unit
- MAINT - maintenance
- MB - marker beacon
- MHz - mega hertz
- MM - middle marker
- NAV - navigation
- NC - not connected
- ND - navigation display
- NORM - normal
- NVM - non-volatile memory
- OM - outer marker
- R - range
- REU - remote electronics unit
- RF - radio frequency
- R/T - receive/transmit
- RCVR - receiver
- STA - station
- TFR - transfer
- V - voice
- V - volt
- VHF - very high frequency
- VOR - vhf omnidirectional ranging



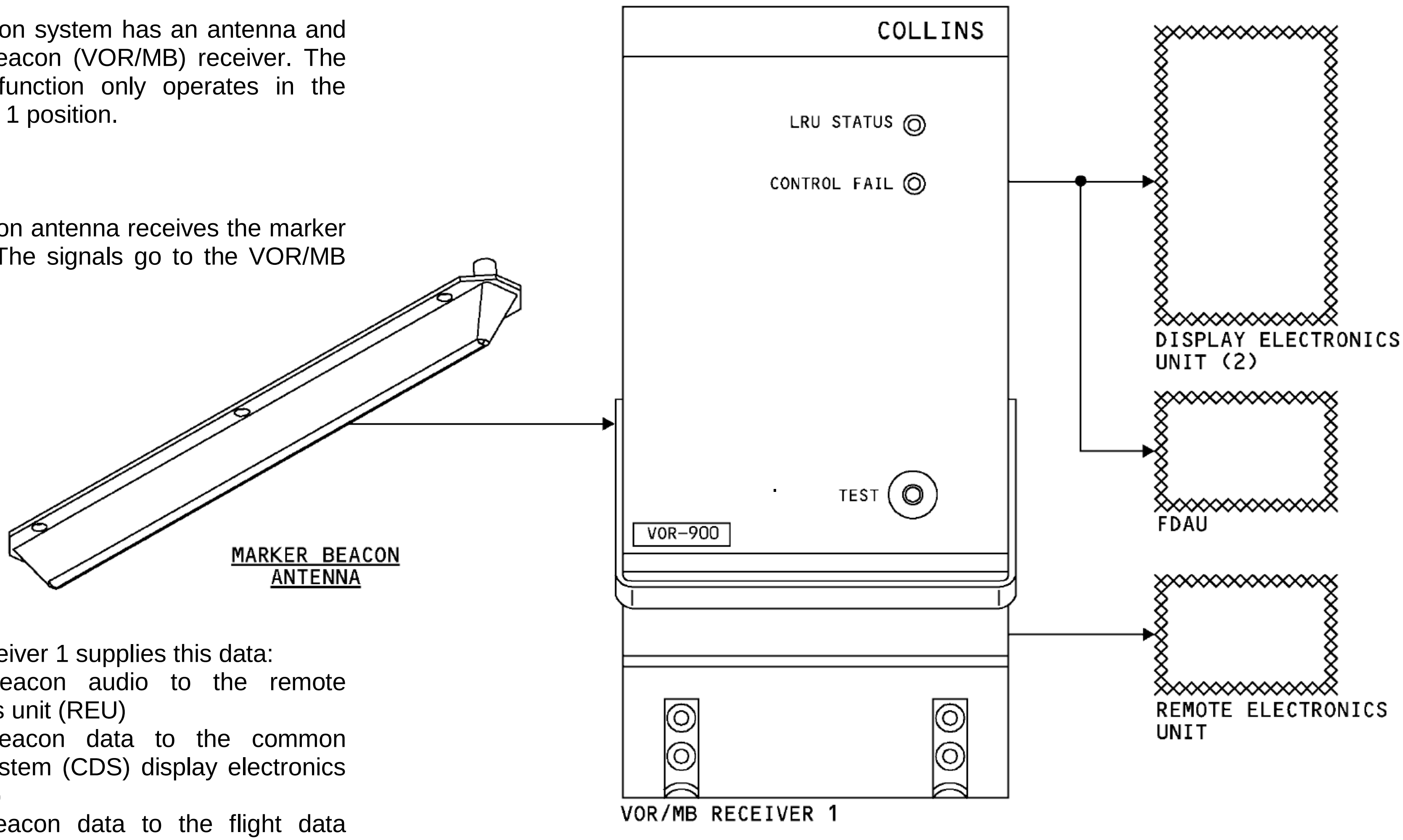
MARKER BEACON SYSTEM - INTRODUCTION

GENERAL DESCRIPTION

The marker beacon system has an antenna and a VOR/marker beacon (VOR/MB) receiver. The marker beacon function only operates in the VOR/MB receiver 1 position.

Operation

The marker beacon antenna receives the marker beacon signals. The signals go to the VOR/MB receiver 1.



The VOR/MB receiver 1 supplies this data:

- Marker beacon audio to the remote electronics unit (REU)
- Marker beacon data to the common display system (CDS) display electronics unit (DEU)
- Marker beacon data to the flight data acquisition unit (FDAU).

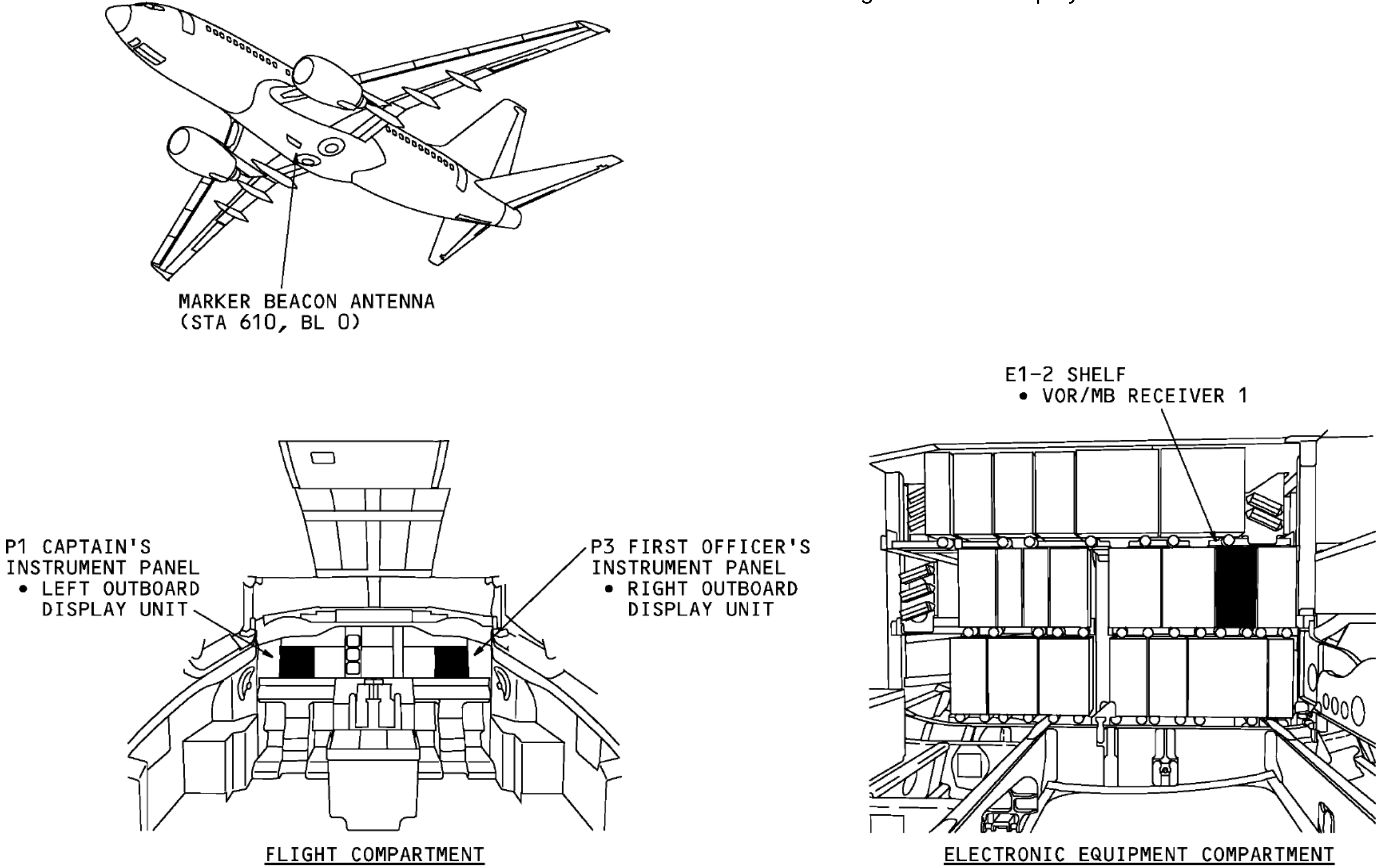
The displays show marker beacon data

COMPONENTS LOCATION

The marker beacon antenna is on the bottom of the fuselage.
The VOR/MB receiver 1 is in the electronic equipment compartment E1-2.

The marker beacon data shows on these display units:

- Left outboard display unit
- right outboard display unit.



COMPONENTS LOCATION

INTERFACES

Power

The VOR/marker beacon (VOR/MB) receiver 1 uses 115v ac power from the standby bus.

Antenna Interface

The marker beacon antenna sends radio frequency (RF) signals to the VOR/MB receiver 1.

PSEU

The proximity switch electronics unit (PSEU) supplies an air/ground discrete signal to the VOR/MB receiver 1.

The VOR/MB receiver uses this signal for these functions:

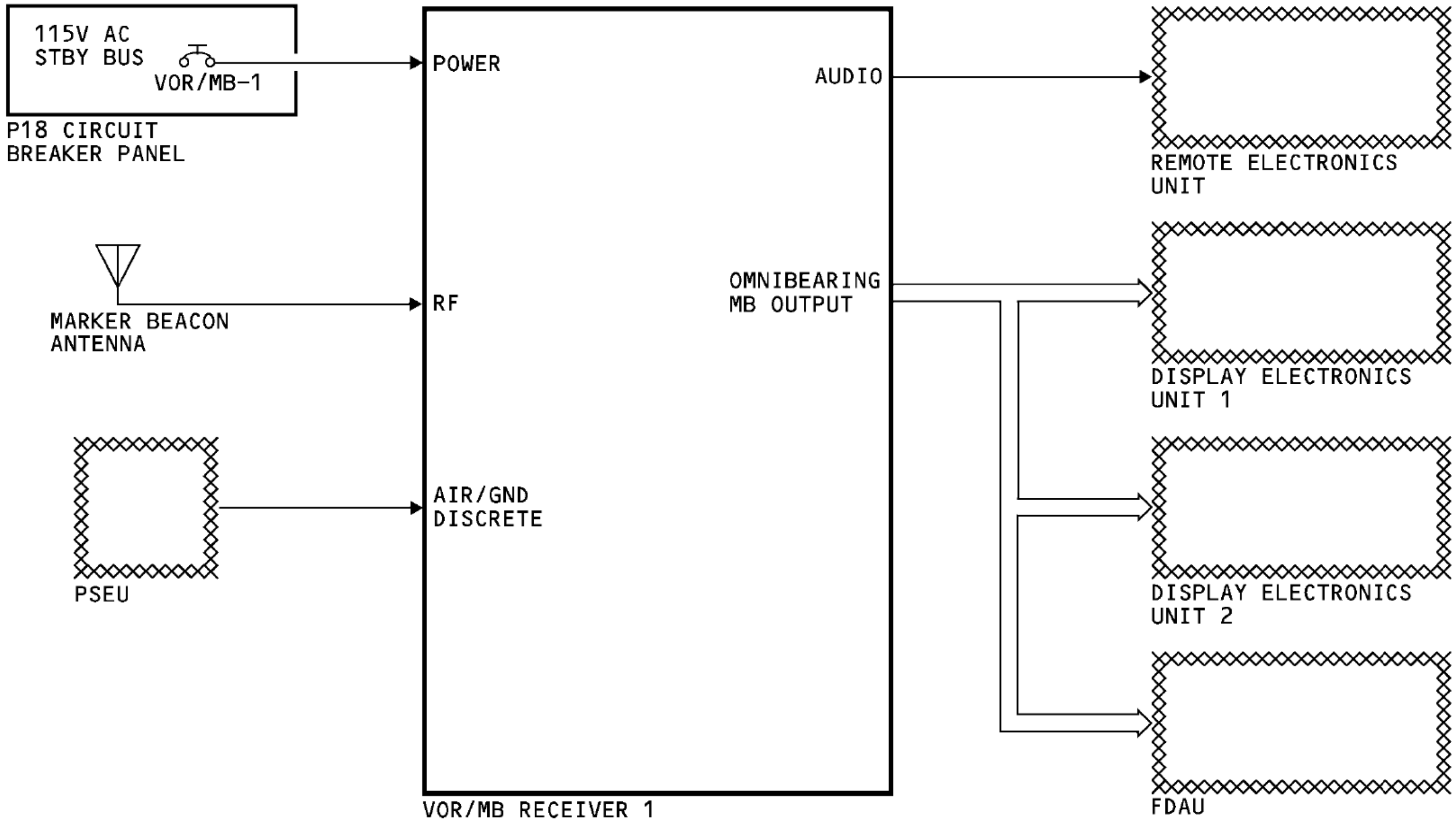
- Prevent a test in the air
- Count flight legs.

Audio Interface

The VOR/MB receiver 1 sends marker beacon audio to the remote electronics unit (REU). The REU supplies marker beacon audio to the flight compartment.

Marker Beacon Data

The VOR/MB receiver 1 supplies marker beacon data to the 1 and 2 common display system (CDS) display electronics units (DEU). The receiver also supplies marker beacon data to the FDAU.


115V AC
STBY BUS
VOR/MB-1
P18 CIRCUIT
BREAKER PANEL
MARKER BEACON
ANTENNA
PSEU
POWER
RF
AIR/GND
DISCRETE
AUDIO
OMNIBEARING
MB OUTPUT
VOR/MB RECEIVER 1
REMOTE ELECTRONICS
UNIT
DISPLAY ELECTRONICS
UNIT 1
DISPLAY ELECTRONICS
UNIT 2
FDAU

INTERFACES

VOR/MARKER BEACON RECEIVER

General

The VOR/marker beacon (VOR/MB) receiver has these two parts:

- VOR receiver
- Marker beacon receiver.

The marker beacon system operates in the VOR/MB receiver 1 position. The marker beacon receiver receives 75 MHz signals.

Test and Indications

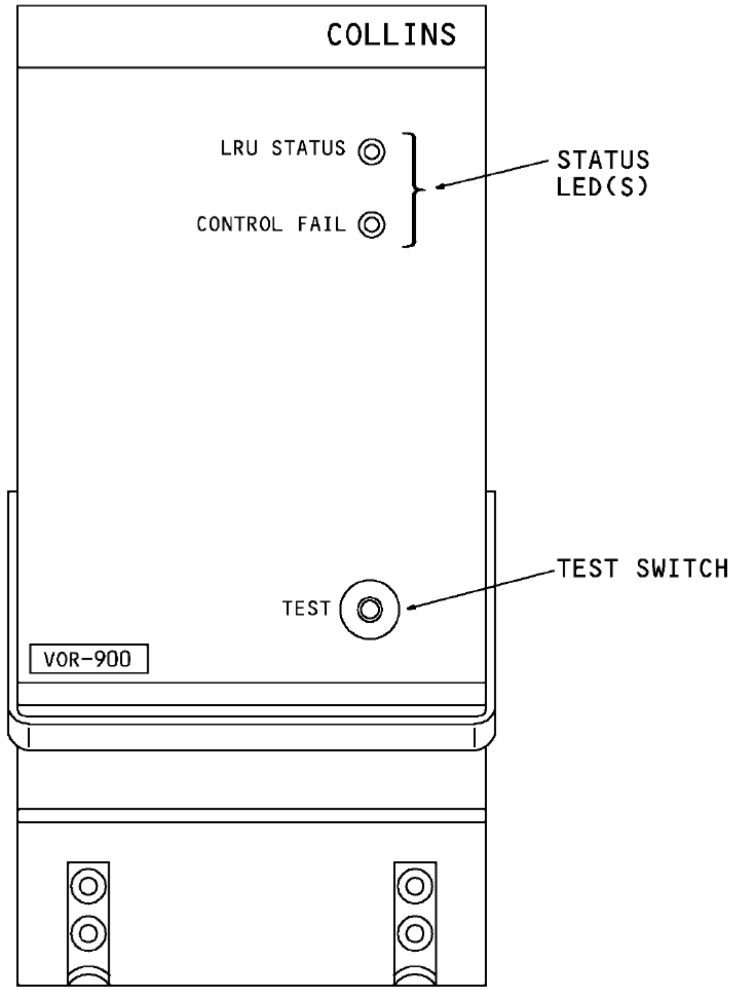
You do a test of the these VOR/MB receiver 1 functions at the same time:

- VOR function
- MB function.

There is a test switch and two light emitting diodes (LEDs) on the front panel of the VOR/MB receiver.

Flight Fault Memory

The VOR/MB receiver has a nonvolatile flight fault memory. Only shop personnel can read the memory.

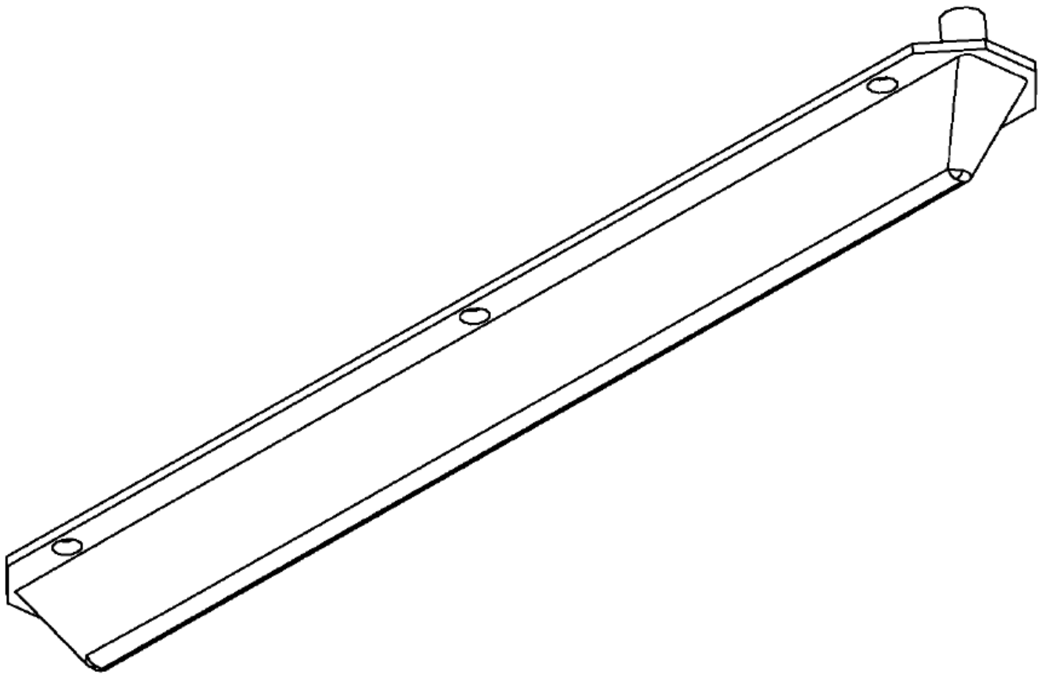


VOR/MARKER BEACON RECEIVER

MARKER BEACON ANTENNA

The marker beacon antenna receives signals from marker beacon ground stations.

Six screws hold the antenna to the fuselage.



MARKER BEACON ANTENNA

DISPLAYS AND AUDIO OUTPUTS

General

When the airplane goes above a marker beacon transmitter, marker beacon data shows on the upper left of the captain primary EFIS display and the upper right of the first officer primary EFIS display.

If you want to hear marker beacon audio, you select the marker beacon audio on the audio control panel (ACP).

Display Types

OM shows when the airplane goes above the outer marker. The OM letters are cyan.

MM shows when the airplane goes above the middle marker. The MM letters are yellow.

IM shows when the airplane goes above the inner marker, back course marker, or an airways marker. The letters IM are white.

NCD/Fail Display

If marker beacon data fails or is no computed data (NCD), the display does not show.

Audio General

The ACP supplies control signals to the remote electronics unit (REU). The REU uses the control signals to select the audio that goes to the flight interphone speakers and headsets.

Use the ACP to listen to marker beacon audio.

Audio Operation

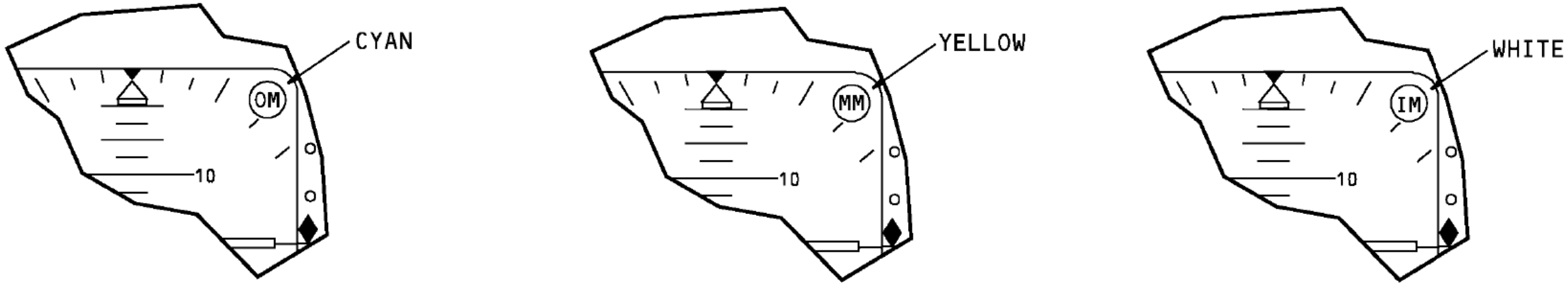
You make these ACP selections to listen to marker beacon audio:

- Push the marker beacon receiver volume control to make the marker beacon audio come on
- Turn the marker beacon receiver volume control to change the volume level.

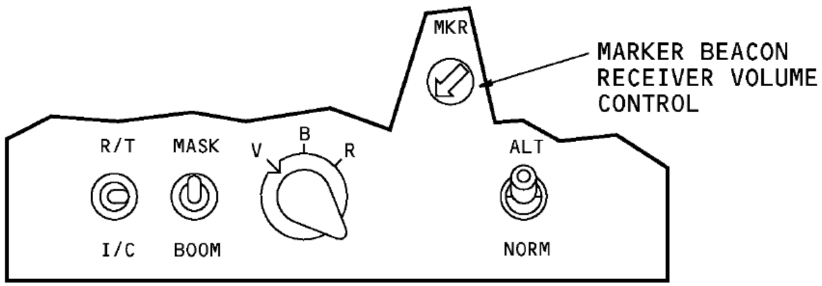
Audio Outputs

These are the marker beacon audio outputs:

- Outer marker (OM) is 400 Hz, continuous dashes (- - - -)
- Middle marker (MM) is 1300 Hz, alternate dots and dashes (-.-.-.-.-)
- Inner marker (IM) is 3000 Hz, continuous dots (......)
- Back course marker is 3000 Hz, continuous paired dots (.. .. .. ..)
- Airways marker is 3000 Hz with the Morse code. identifier for that station.



MARKER BEACON
DISPLAYS (PFD)



AUDIO CONTROL PANEL

MARKER BEACON AUDIO OUTPUTS

DISPLAYS AND AUDIO OUTPUTS

FUNCTIONAL DESCRIPTION

Marker Beacon Signal

The marker beacon antenna receives the 75 MHz signal and sends it to a 75 MHz filter in the VOR/marker beacon (VOR/MB) receiver 1. This filter tunes and rejects unwanted signals. The output goes to a radio frequency (RF) amplifier. A detector receives the amplifier output and sends the demodulated signal to three bandpass filters.
The bandpass filters are at 400 Hz, 1300 Hz, and 3000 Hz. The filters send the signals to an audio amplifier and to an input/output (I/O) card. The audio amplifier sends audio tones to the REU. The I/O card sends data to the DEU and the flight data acquisition unit (FDAU).
The DEU shows marker beacon data on the primary EFIS display.

Monitor and Test

The test switch starts a test of the VOR/MB receiver. The built-in test equipment (BITE) circuits do a test of the VOR/MB receiver. The test results show on the common display, light emitting diodes (LEDs), and through the flight interphone speakers and headsets.

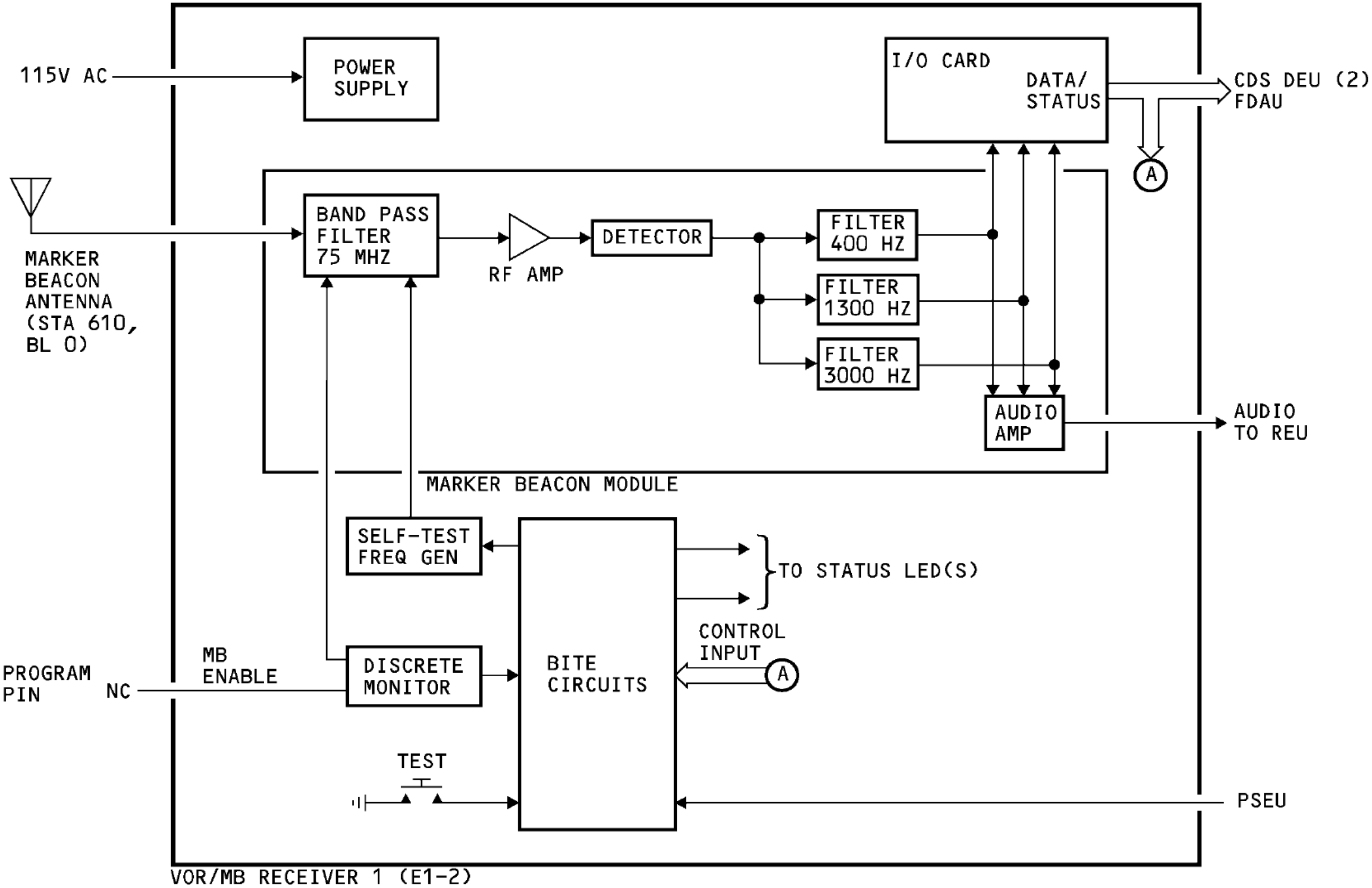
During the test, a self-test frequency generator gives a 75 MHz RF signal that has 400 Hz, 1300 Hz, and 3000 Hz audio signals. The bandpass filters find the audio signals and send them to the audio amplifier. The audio amplifier sends the audio signals to the REU. The REU sends the audio signals to the flight interphone speakers and headsets in the flight deck.

The BITE circuits monitor the condition of the output data of the VOR/MB receiver.

PSEU

The VOR/MB receiver gets an air/ground discrete signal from the proximity switch electronics unit (PSEU). The VOR/MB receiver uses this signal to prevent a test in the air.

An internal nonvolatile fault memory (NVM) in the BITE circuits use the air/ground discrete signal. The NVM uses this signal to calculate flight legs.



FUNCTIONAL DESCRIPTION

MARKER BEACON SYSTEM – SELF-TEST

You do a remote test of the navigation receivers with the navigation control panel.

The navigation control panel does a test of these receivers:

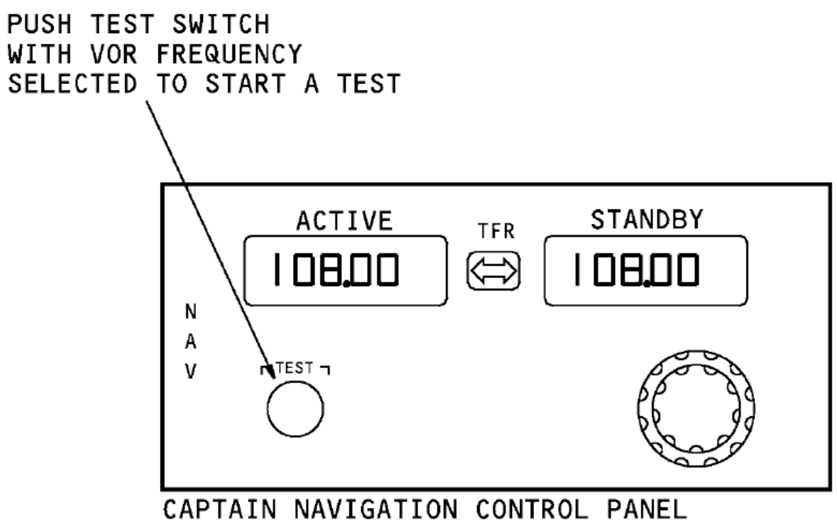
- VOR/MB receiver
- ILS receiver.

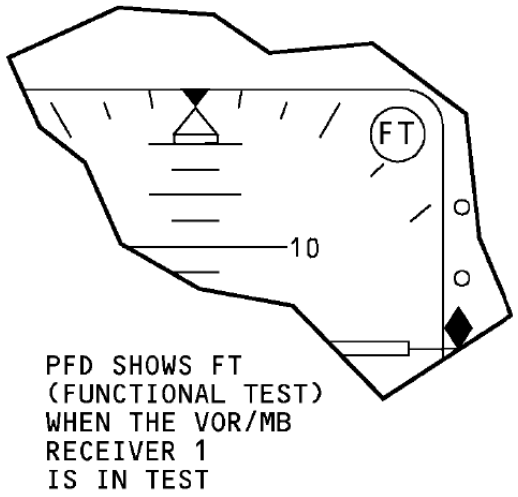
When you do a test of the marker beacon system, you do a test of the VOR/MB receiver 1 at the same time.

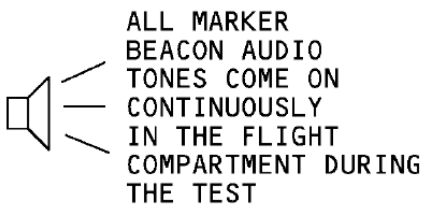
Operation

To do a test of the VOR/MB receiver 1, select a VOR frequency and push the test switch on the front panel of the navigation control panel. FT shows for common display system indications.

You must select marker beacon audio on at least one of the ACPs to hear the audio tones. All the marker beacon audio tones come on in the flight compartment when you do the test. The audio tones come on continuously and you hear the outer, middle, and inner at the same time.







SELF- TEST

THIS PAGE IS INTENTIONALLY LEFT BLANK

BITE

General

When you do a test of the marker beacon system, you test the VOR receiver 1 at the same time.

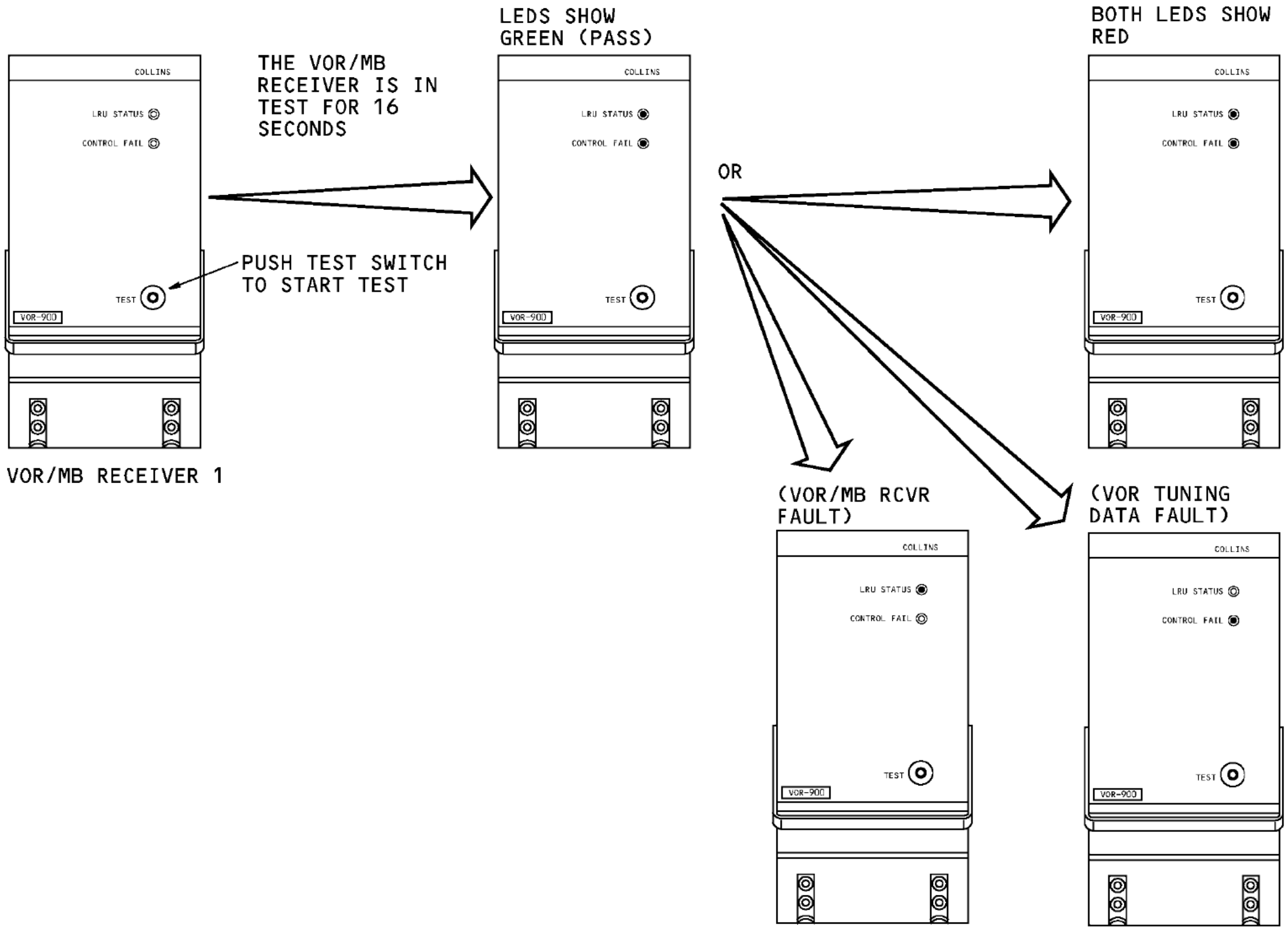
Operation

When you push the test switch, the receiver does a check of the internal receiver operation and the interface with the NAV control panel. The test takes 48 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 12 seconds - the LRU status and the control fail LEDs go off
- 12 to 42 seconds - test status shows.

The LRU status LED indicator shows green for an LRU test pass condition or red for an LRU test fail condition. The control fail LED shows red if there is no tune input from the NAV control panel or if the signal is invalid.


THE VOR/MB RECEIVER IS IN TEST FOR 16 SECONDS
LEDS SHOW GREEN (PASS)
BOTH LEDS SHOW RED
OR
PUSH TEST SWITCH TO START TEST
VOR/MB RECEIVER 1
(VOR/MB RCVR FAULT)
(VOR TUNING DATA FAULT)
COLLINS
LRU STATUS
CONTROL FAIL
TEST
VOR-900

BITE

THIS PAGE IS INTENTIONALLY LEFT BLANK

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–35. VOR SYSTEM (ATA 34–51)

LEVEL 3

VHF OMNIDIRECTIONAL RANGING (VOR) SYSTEM - INTRODUCTION

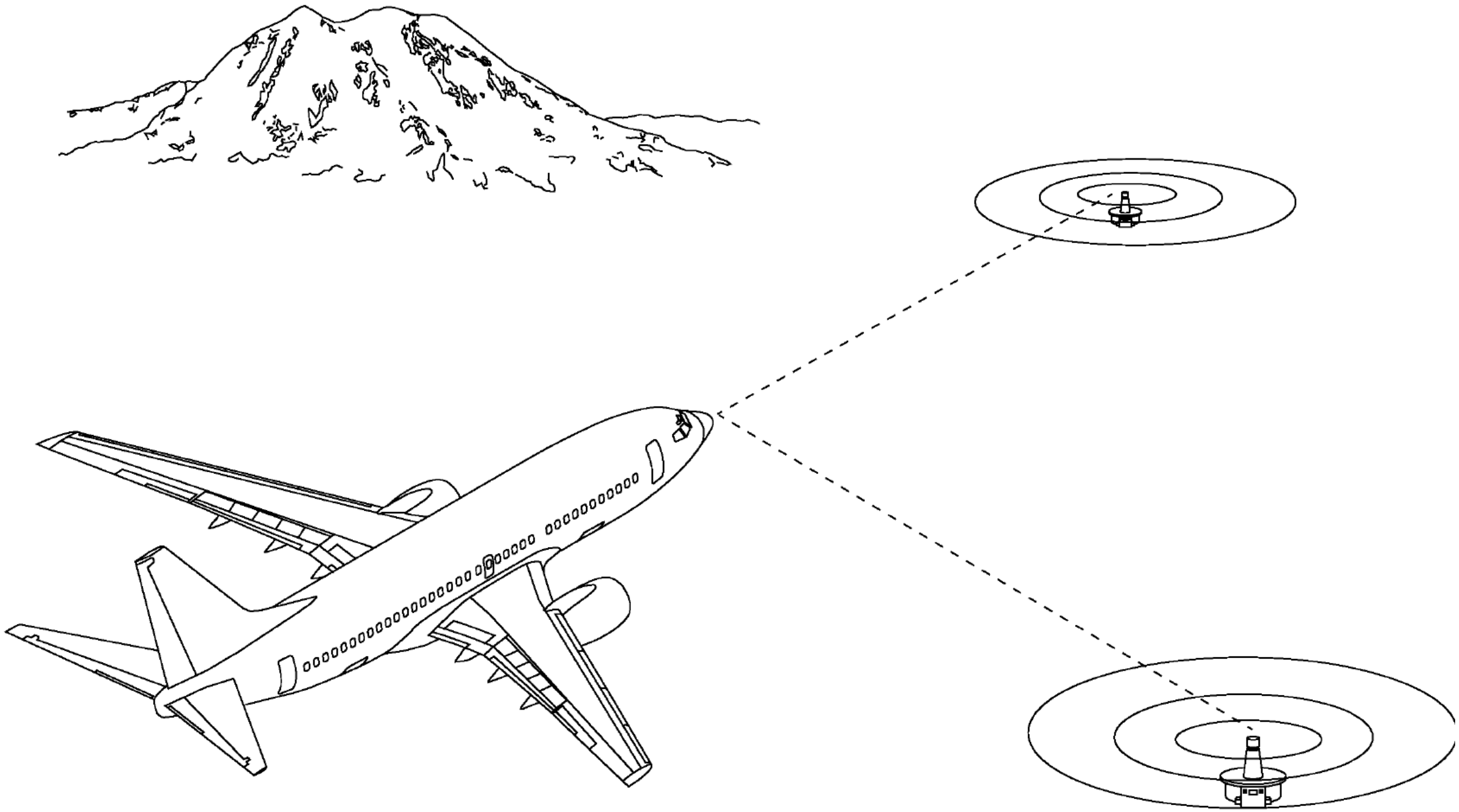
Purpose

The VHF omnidirectional ranging (VOR) system is a navigation aid that gives magnetic bearing data from a VOR ground station to the airplane.

The VOR ground stations transmit signals that give magnetic radial information from 000 degrees to 359 degrees. All VOR stations reference the 000 degree to magnetic north.

Abbreviations and Acronyms

- ACP - audio control panel
- DEU - display electronic unit
- DFCS - digital flight control system
- DME - distance measurement equipment
- EFIS - electronic flight instrument system
- FCC - flight control computer
- FDAU - flight data acquisition unit
- FMC - flight management computer
- HSI - horizontal situation indicator
- ILS - instrument landing system
- LCD - liquid crystal display
- MCP - mode control panel
- NAV - navigation
- NCD - no computed data
- PWR - power
- RDMI - radio direction magnetic indicator
- REU - remote electronic unit
- RF - radio frequency
- RMI - radio magnetic indicator
- VOR - VHF omnidirectional ranging.



VHF OMNIDIRECTIONAL RANGING (VOR) SYSTEM - INTRODUCTION

GENERAL DESCRIPTION

General

The VOR system has two VOR/marker beacon (VOR/MB) receivers. The receivers have VOR and marker beacon functions. This section covers only the VOR operation of the VOR/MB receivers.

Description

The navigation (NAV) control panels give manual tune inputs to the VOR/MB receivers. There are two NAV control panels, one for the captain and one for the first officer.

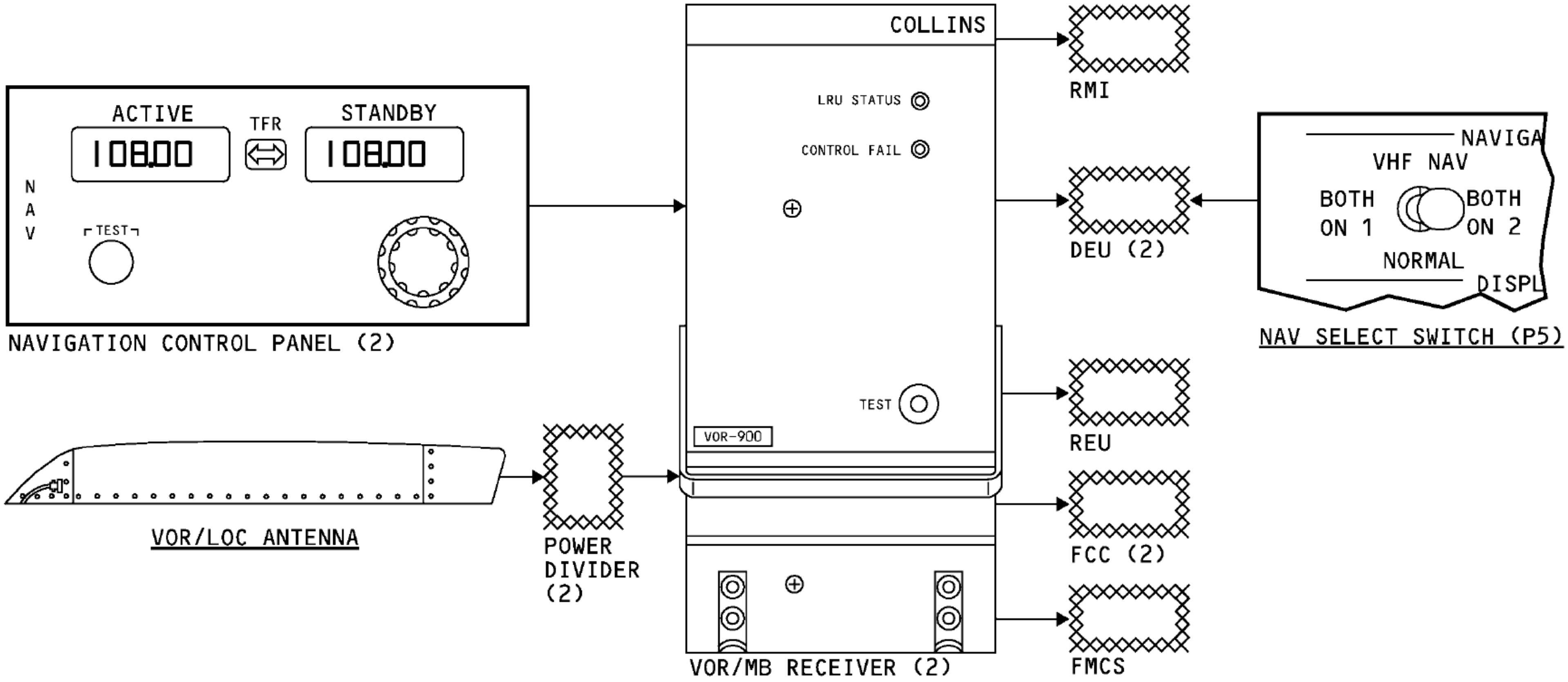
RF signals from the VOR/LOC antenna go through power dividers, then to the VOR/MB receivers. The VOR/MB receivers use the RF signals to calculate station bearing and decode the Morse code station identifier signal and station audio.

The receivers send VOR bearing to the remote magnetic indicator (RMI). You can select the RMI bearing pointers to show VOR or ADF station bearing with the RMI bearing pointer selectors.

The receivers send VOR bearing data to the display electronic units (DEU) for display. The NAV select switch lets the crew select VOR/MB receiver 1 or VOR/MB receiver 2 as the source for the captain and first officer displays.

The receivers send station audio and Morse code station identifier signals to the remote electronic unit (REU).

The receiver sends VOR bearing data to the FCCs for the DFCS VOR/LOC mode of operation. The bearing data also goes to the FMCS as a radio navigation aid for present position calculations.



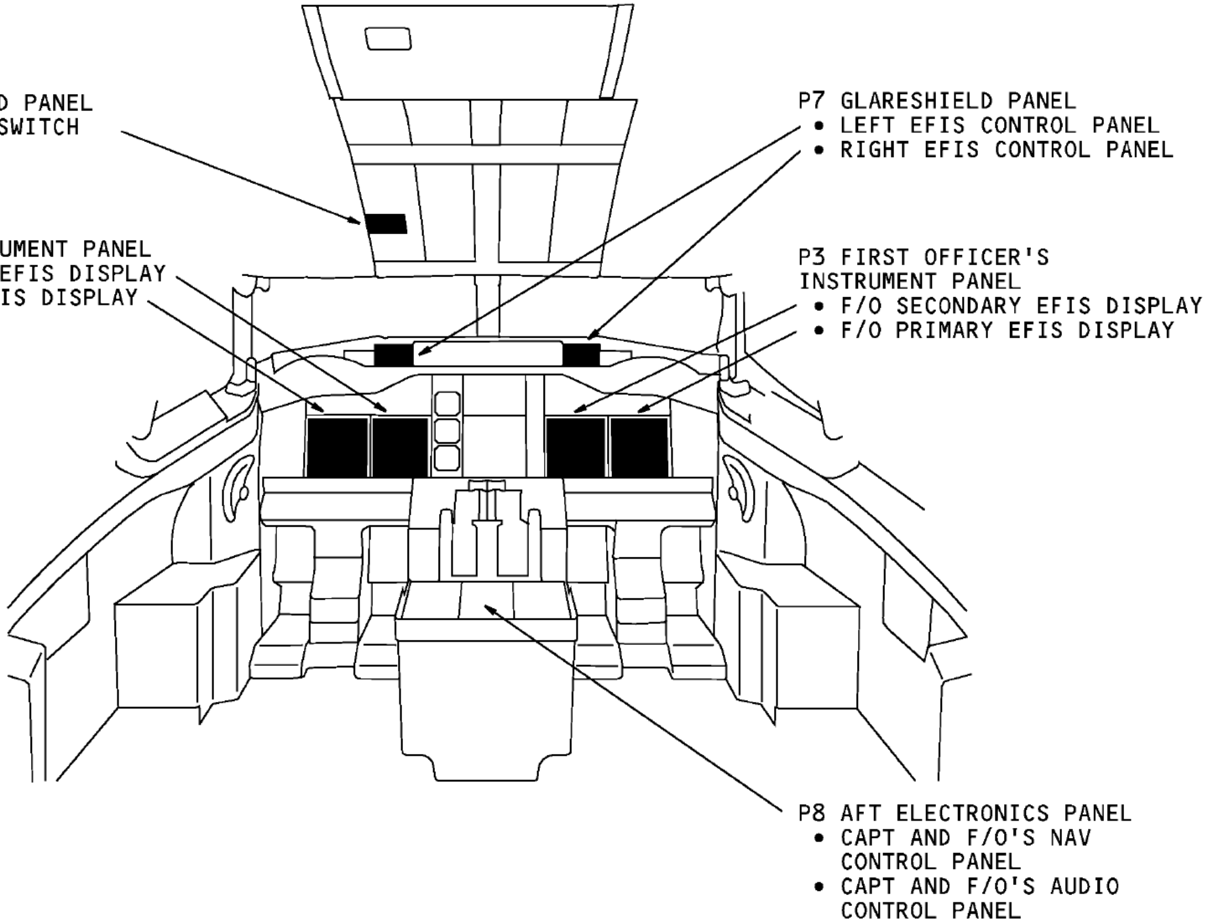
GENERAL DESCRIPTION

VOR SYSTEM - COMPONENT LOCATION

Flight compartment

These are the components in the flight compartment that interface with the VOR system:

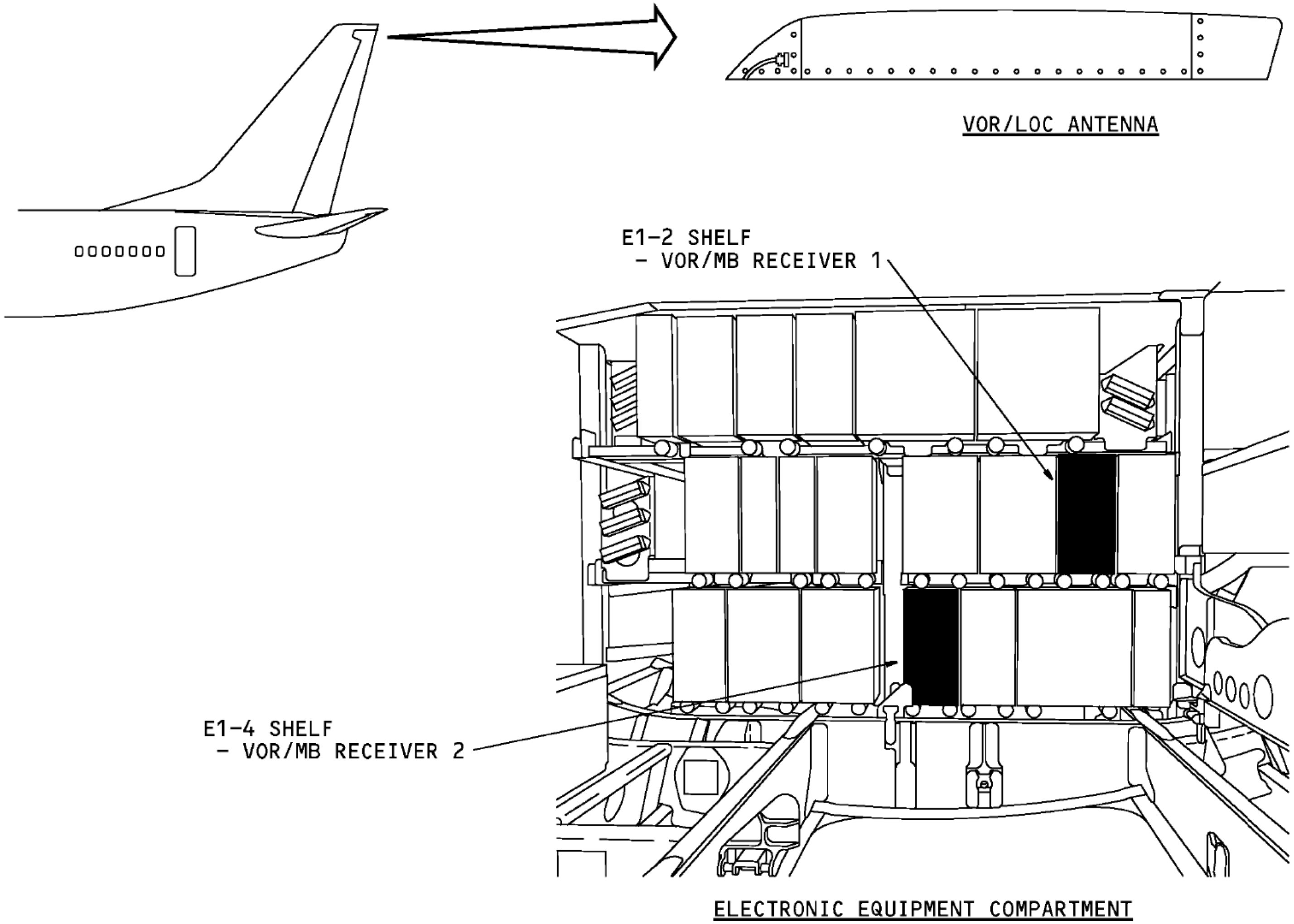
- Captain's primary and secondary EFIS displays
- Left and right EFIS control panels
- First officer's primary and secondary EFIS displays
- Captain's and first officer's NAV control panel
- Captain's and first officer's audio control panel
- VHF NAV transfer switch.



VOR SYSTEM COMPONENT LOCATION - FLIGHT COMPARTMENT

VOR/LOC antenna and electronic equipment compartment

The VOR/LOC antenna is at the top of the vertical stabilizer.
VOR/MB receiver 1 is on the E1-2 shelf and VOR/MB receiver 2 is on the E1-4 shelf.



VOR/LOC ANTENNA AND ELECTRONIC EQUIPMENT COMPARTMENT

VOR SYSTEM – INTERFACES

POWER AND ANALOG INTERFACE

General

These are the components that have power and analog interface with the VOR system:

- Circuit breakers
- VOR antenna
- Navigation control panels
- Card files
- Remote electronics unit.

Circuit breakers

The VOR circuit breakers supply 115v ac power for receiver operation. VOR/MB receiver 1 gets power from the ac standby bus, section 1 and VOR/MB receiver 2 gets power from the ac transfer bus 2, section 2.

The NAV control panel circuit breakers supply 115v ac for control panel operation. The captain control panel gets power from the ac standby bus and the first officer control panel gets power from the ac transfer bus 2.

The NAV control panels receive 28v dc for control panel monitor operation and for the ILS 28v dc ILS tuned output when you tune an ILS frequency. The captain control panel receives 28v dc from the 28v dc standby bus, NAV sensor DC-1 circuit breaker. The first officer control panel receives 28v dc from the 28v dc bus 2, NAV sensor DC-2 circuit breaker.

VOR/ILS Antenna

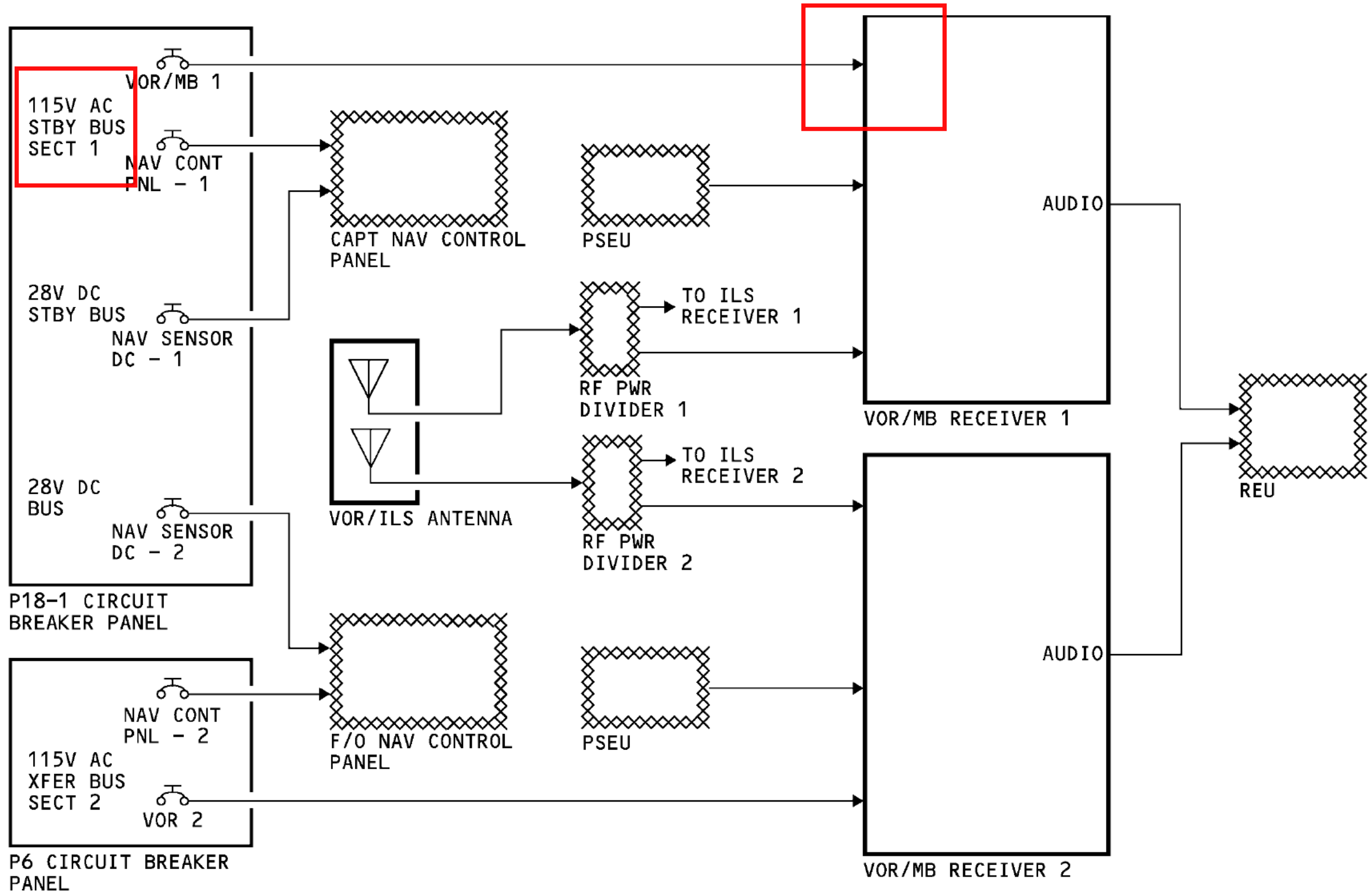
The VOR/ILS antenna sends RF signals through the RF power divider 1 and RF power divider 2, to the VOR/MB receivers.

PSEU

The VOR /MB receivers get air/ground inputs from the proximity switch electronics unit (PSEU). The receiver uses the inputs to set the flight leg count for internal memory, and also inhibit test in the air.

REU

The remote electronics unit (REU) receives Morse code station identifier signals and station audio from the VOR/MB receivers and supplies them to the flight interphone speakers and headsets.



POWER AND ANALOG INTERFACE

DIGITAL INTERFACE

General

All digital interfaces are on ARINC 429 data buses.

These are the components that have digital interface with the VOR/MB receivers:

- Captain and first officer NAV control panel
- Flight data acquisition unit (FDAU)
- Radio magnetic indicator (RMI)
- Flight management computers (FMC 1, FMC 2)
- Flight control computer (FCC) A
- FCC B
- Display electronics unit (DEU) 1
- DEU 2.

NAV Control Panel

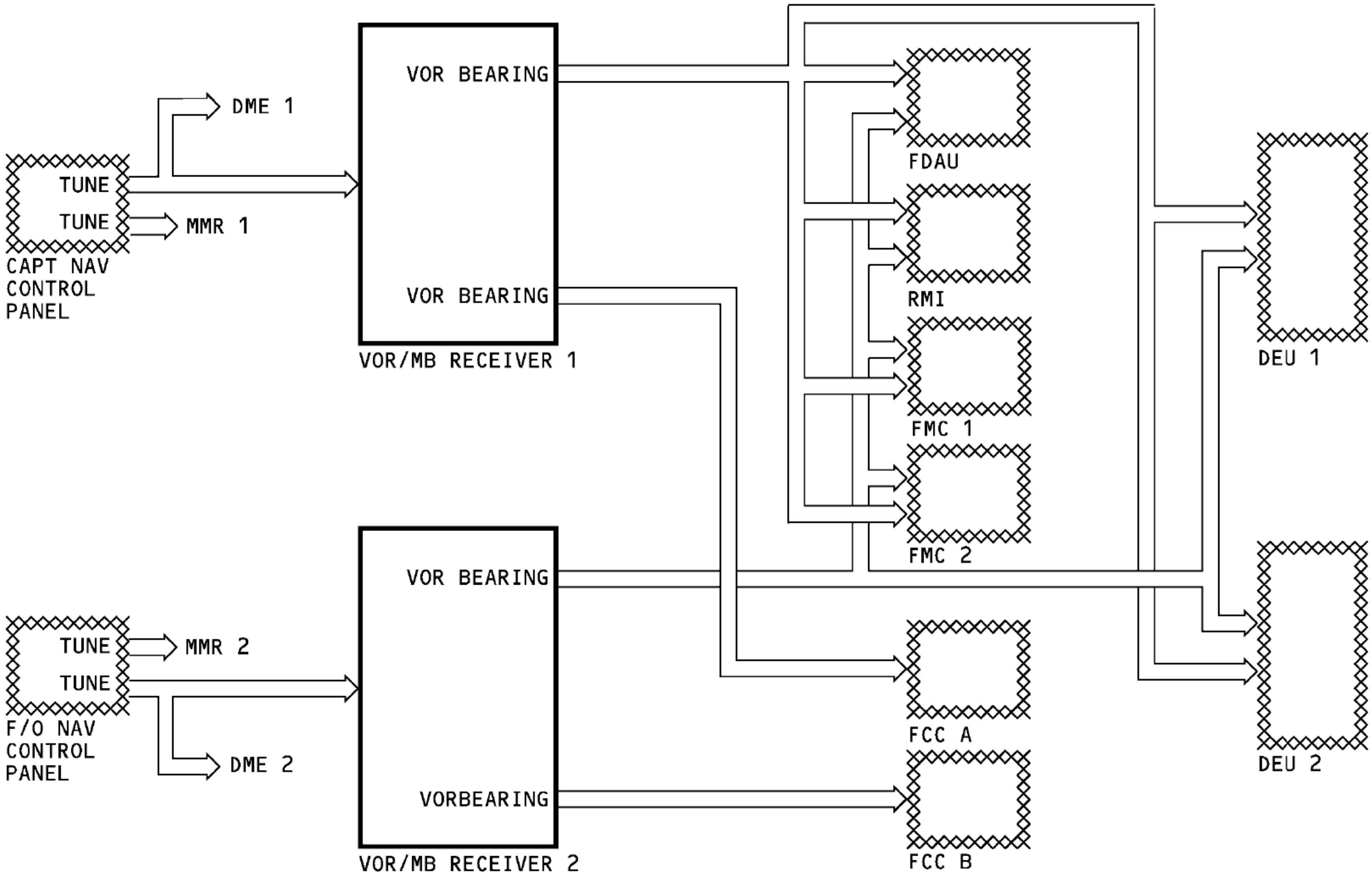
The captain and first officer NAV control panels send manual tune and test command inputs to the VOR/MB receivers. The NAV control panels send tune inputs and test commands out on two data buses. One data bus goes to the multi mode receivers (MMR) and one data bus goes to both the VOR receiver and the DME interrogators.

VOR/MB Output

The VOR/MB receivers each have two output buses. One output bus from each receiver goes to the on-side FCC. VOR/MB receiver 1 supplies VOR data and status to FCC A. VOR/MB receiver 2 supplies VOR data and status to FCC B. The FCCs use the data for the autopilot VOR mode of operation.

The other output bus of each receiver sends VOR data and status to these components:

- FDAU for data to record by the digital flight data recorder
- RMI for bearing pointer displays
- FMC 1 and FMC 2 for position update calculations
- DEUs for VOR displays.



DIGITAL INTERFACE

FREQUENCY TRANSFER AND INSTRUMENT SWITCHING

Frequency Transfer Switch

The frequency transfer switch on the NAV control panel transfers the frequency in the standby window display, to the active window display.

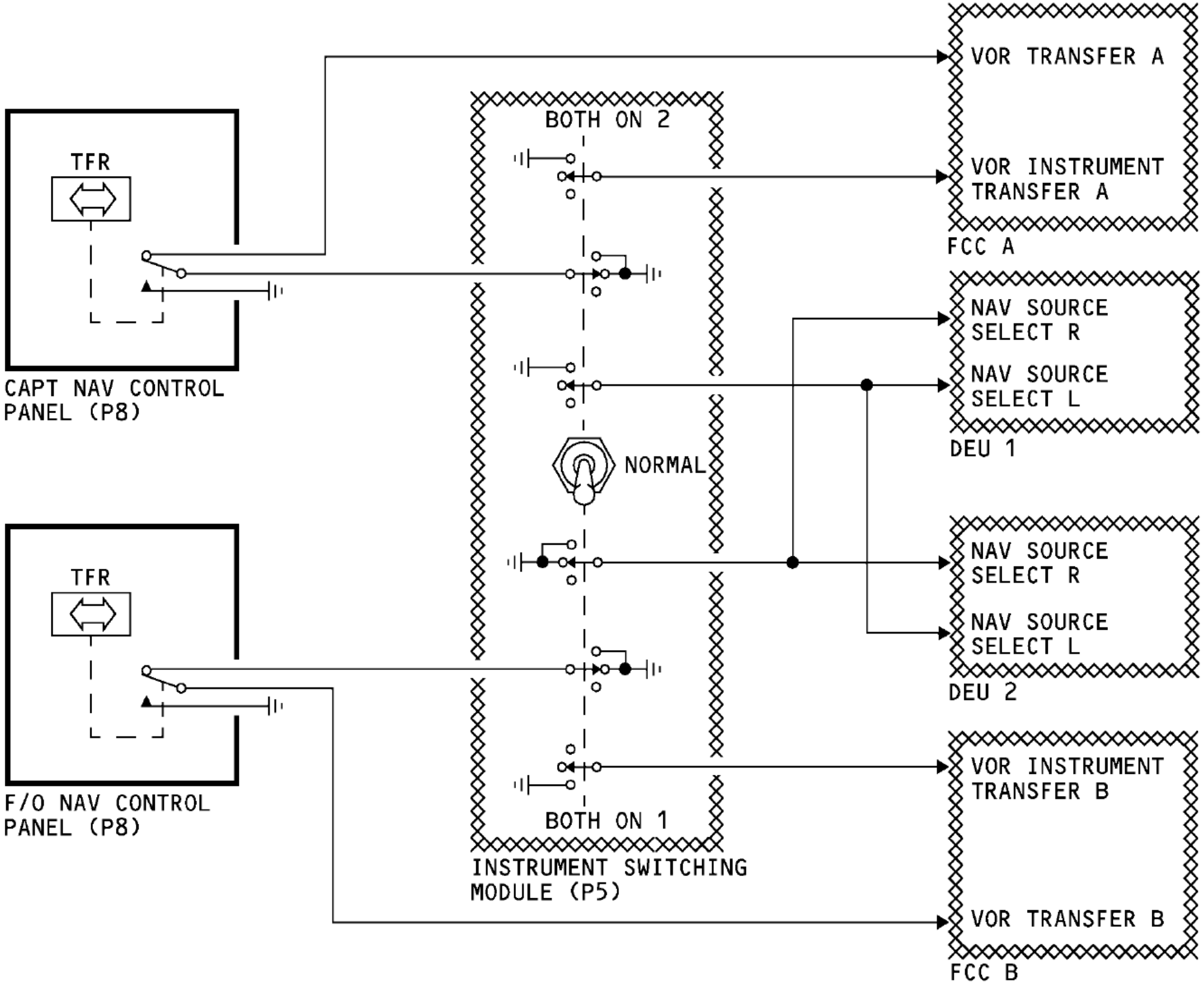
The transfer switch also provides a discrete to the FCCs. The FCCs use the discrete to disengage the autopilot when the autopilot system is in the VOR mode and the crew changes the VOR frequency.

Instrument Switching Module

The instrument switching module on the P5 overhead panel provides discretes to the display electronics unit (DEU) for display switching when you move the switch to the both on 1 or both on 2 position.

With the switch in the both on 1 position, the DEU's use VOR data from VOR/MB receiver 1 for display. With the switch in the both on 2 position the DEU's use VOR data from VOR/MB receiver 2 for display.

The instrument switching module also sends discretes to the FCC when you move the switch out of the normal position.



FREQUENCY TRANSFER AND INSTRUMENT SWITCHING

VOR SYSTEM – COMPONENTS

VOR/MB RECEIVER

General

The VOR/marker beacon (VOR/MB) receiver contains the VOR receiver function and the marker beacon function. The VOR/MB receiver supplies magnetic bearing data from a VOR ground station.

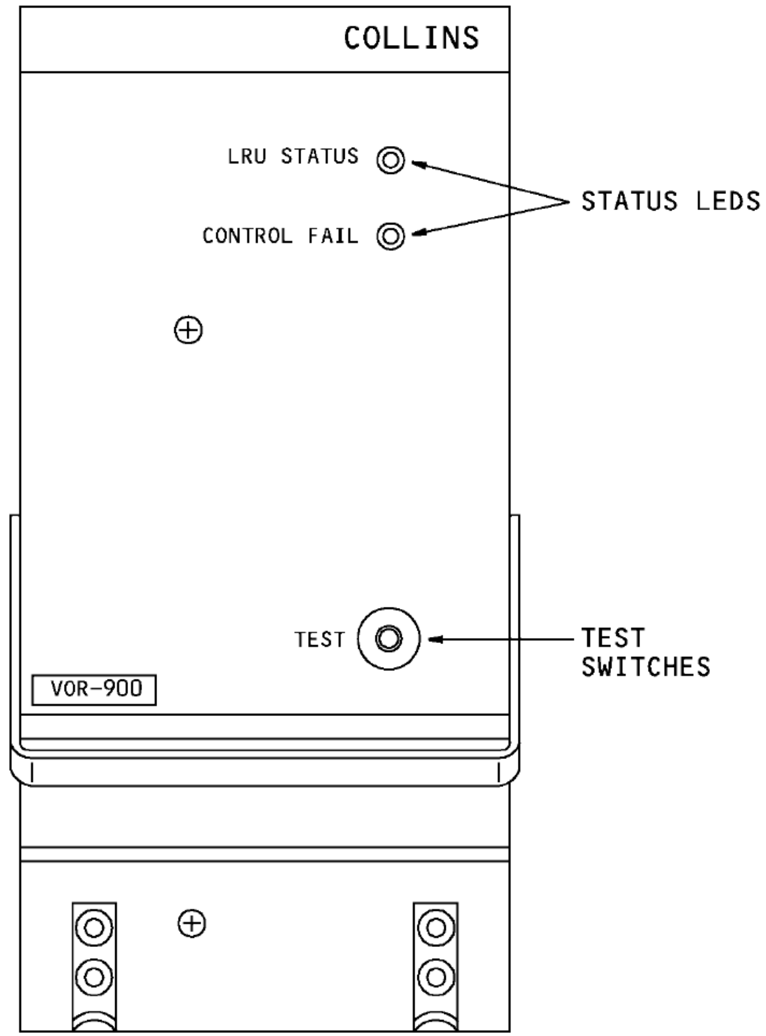
Description

The VOR/MB receiver is a standard ARINC 3 MCU unit with dimensions approximately 3.74"x 7.87"x 14.76". The receiver weighs 9 pounds and uses 115v ac 400 Hz power for operation.

Test and Indication

There are two light emitting diodes (LEDs) and a test switch on the front of the VOR/MB receiver. The LEDs show receiver test status when you do a test of the VOR/MB receiver. The red control fail LED shows the status of the tune inputs. The green or red LRU status LED shows the status of the receiver test.

You can do a test of the VOR/MB receiver from the NAV control panel or from the test switch on the VOR/MB receiver front panel. When you do a test of the VOR function of the left VOR/MB receiver, you do a test of the VOR function and the marker beacon function at the same time.

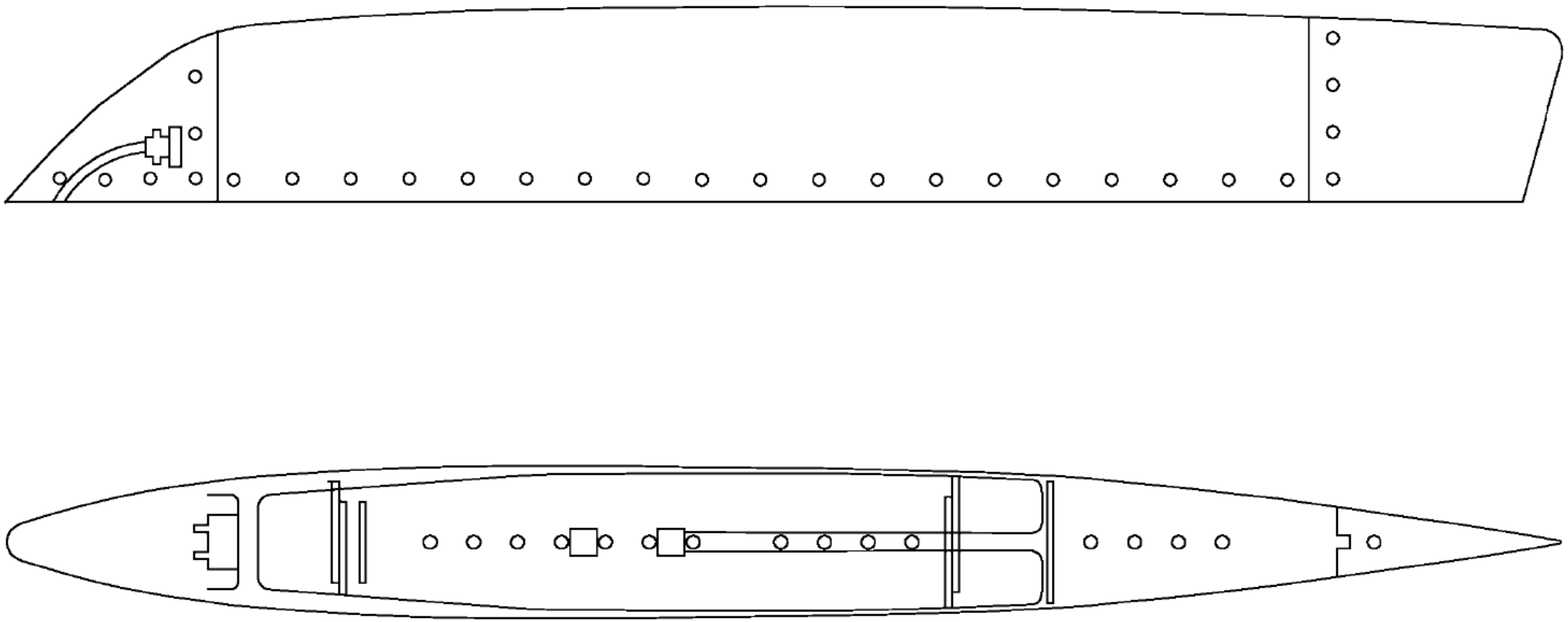


VOR/MB RECEIVER

THIS PAGE IS INTENTIONALLY LEFT BLANK

ANTENNA

The VOR/LOC antenna is on the top of the vertical stabilizer. The VOR antenna receives RF signals in the frequency range of 108 MHz to 117.95 MHz. The antenna receives VOR and localizer frequencies. The VOR/LOC antenna sends VOR signals to both VOR/MB receivers.



ANTENNA

NAVIGATION CONTROL PANEL

General

The navigation (NAV) control panel supplies frequency inputs and test commands to the DME, ILS, and VOR navigation radios.

Operation

The NAV control panel has an active frequency display window and a standby frequency display window. The frequency that shows in the active frequency display window is the frequency that the navigation radios use for operation. The standby frequency display window shows the next frequency you want to use.

The transfer switch is a momentary action switch that transfers the frequency in the standby frequency display window to the active frequency display window. When you push the switch, the frequency that is in the active frequency display window transfers to the standby frequency display window.

The frequency select control is a continuous rotary knob. There is an inner knob and an outer knob. The outer knob sets the tens and ones digits. The inner knob sets the tenths and one hundredths digits.

At power up, the frequency displays show the last frequency entry before power down.

The NAV control panel continuous bite monitors control panel operation. The NAV control panel shows FAIL in the active and standby frequency display windows when there is a failure.

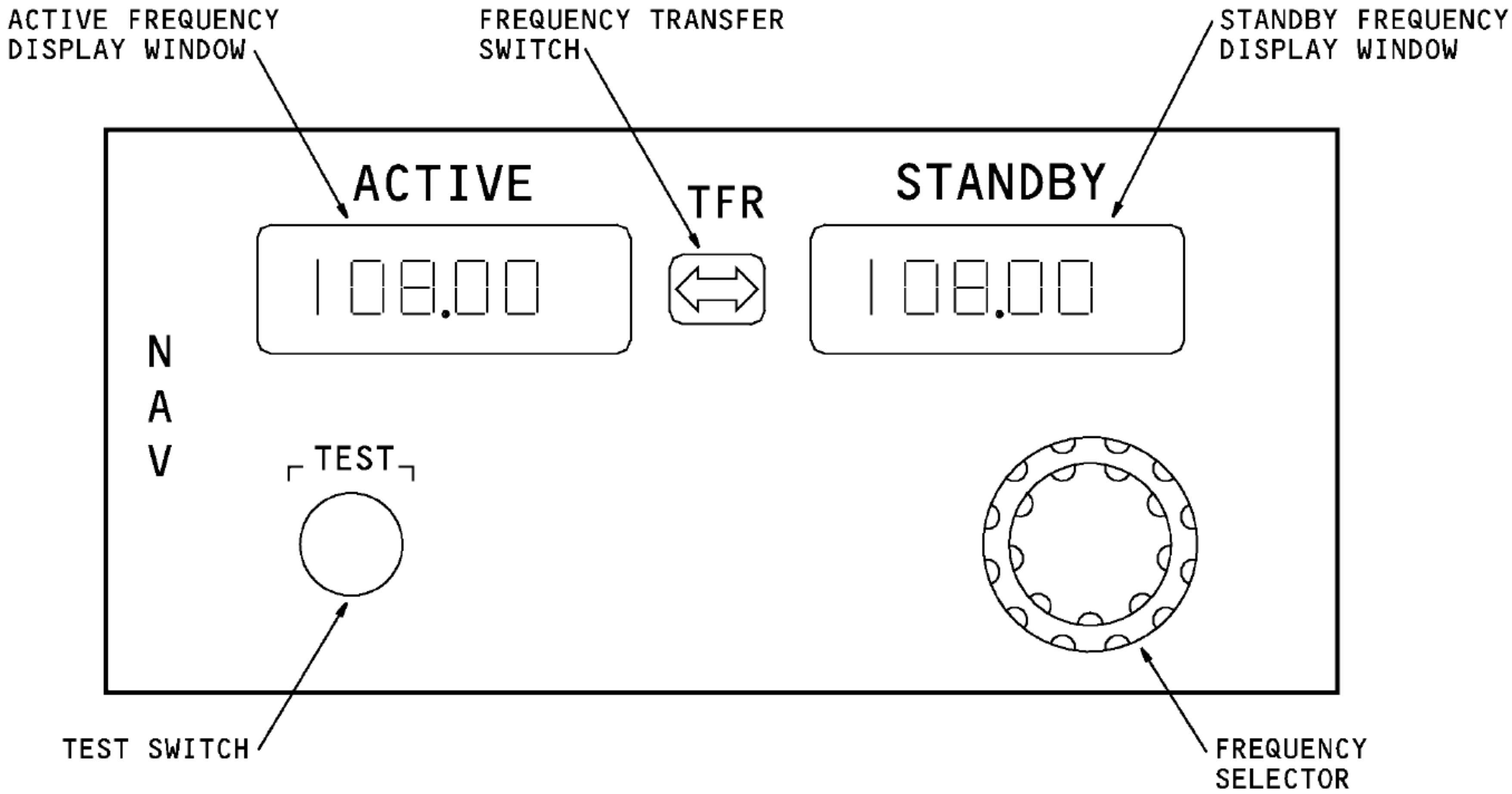
An internal monitor in the NAV control panel monitors the 28v dc input. If the monitor does not see the 28v dc input, it will show the message BLANK in both the active and standby frequency display windows.

When you set a VOR frequency in the range of 108 MHz to 117.95 MHz, the NAV control panel sends the frequency to the VOR/MB receivers and DME interrogators. The control panel sets the data word to the ILS receivers to NCD.

Test

When you push the NAV control panel test switch, a test command goes out to the VOR/MB receiver, ILS receiver, and DME interrogator. If a VOR frequency shows in the active frequency window, the test command goes to only the VOR/MB receiver. IF an ILS frequency shows in the active frequency window, the control panel sends a test command to only the ILS receiver. If there is a DME frequency that is paired with the VOR or ILS frequency, a test command also goes to the DME interrogators.

When you do a test of the master dim and test system, the NAV control panel shows 188.88. The display shows for two seconds on then one second off until the test is complete.



NAVIGATION CONTROL PANEL

VOR SYSTEM - FUNCTIONAL DESCRIPTION

General

The receiver contains VOR and marker beacon functions. This section only covers the VOR function.

Operation

Frequency tune inputs from the NAV control panel go to an ARINC 429 receiver in the VOR/MB receiver, then to the processor. The processor sends the tune inputs to the frequency synthesizer to tune the receiver circuits.

The control panel sends a discrete to the REU when you tune a VOR frequency. The REU uses the discrete to select VOR audio inputs.

When you tune a VOR frequency, the control panel also sends a discrete to the DEUs. The DEUs use the discrete to display VOR or ILS as the frequency data source on the lower left corner of the captain and first officer NAV displays.

The processor sends fault data to the memory card. Only shop personnel can read the memory card contents.

The air/ground discrete input from the PSEU inhibits a VOR test when the airplane is in the air. The receiver also uses the discrete for flight leg count.

RF input signals from the VOR/ILS antenna go through the power divider then to the receiver circuits in the VOR/MB receiver. The receiver circuits send audio and Morse code station identifier signals from the ground station to the audio processor.

The audio processor sends the audio and Morse code station identifier signal to the audio output circuits then to the remote electronics unit.

The Morse decoder circuit decodes the station identifier and puts it in digital format then sends it to the ARINC 429 transmitter. The display electronic units (DEU 1 & 2), receive the Morse code identifier signals but do not use it.

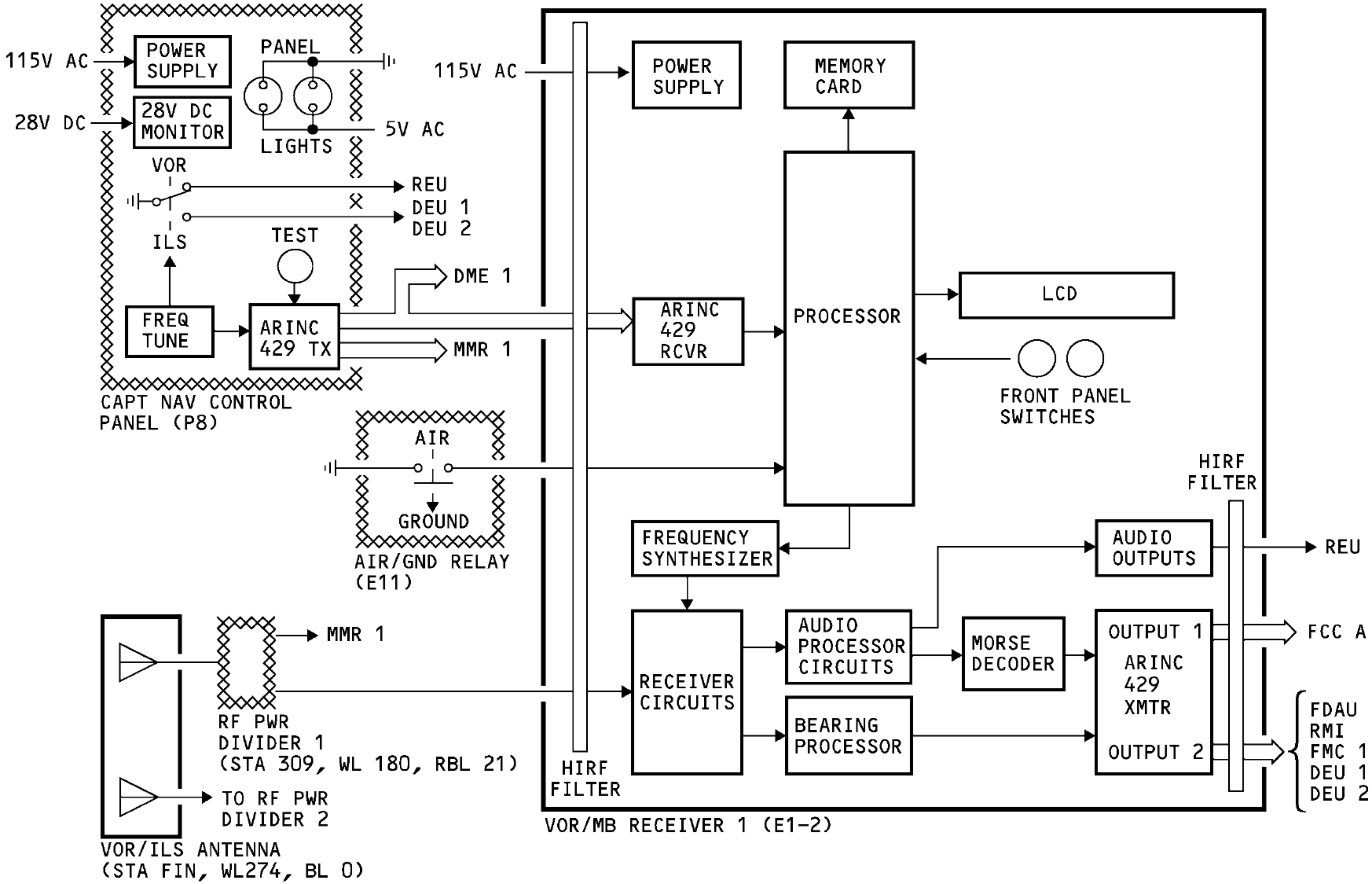
The VOR/MB VOR receiver circuits send the antenna inputs to the bearing processor which calculates the VOR station bearing. Data from the bearing processor goes to the ARINC 429 transmitter. The VOR/MB receiver transmits VOR bearing and receiver status on two output buses.

Output bus 1 goes to the onside FCC. Output bus 2 goes to these components:

- Flight data acquisition unit (FDAU)
- Radio magnetic indicator (RMI)
- Flight management computers (FMC)
- Display electronic units (DEU).

Test

When you push the test switch on the NAV control panel, a test command goes to the receiver when a VOR frequency is the active frequency. When the processor receives a test command, it monitors the VOR/MB receiver operation and control input status. Test results show on the status LEDs when you do a test from the front panel switches.



FUNCTIONAL DIAGRAM

VOR SYSTEM - CONTROLS

EFIS Controls

To show VOR displays on the captain's and F/O's secondary EFIS display, set the mode selector on the EFIS control panel to the VOR position.

VOR data shows when the mode selector is in the VOR position and a valid VOR frequency is active on the NAV control panels.

The VOR/ADF switches make the RDMI bearing pointers show either VOR or ADF station bearing. In the OFF position, the bearing pointers go out of view.

DFCS Controls

The digital flight control system (DFCS) mode control panel (MCP) supplies course data to the display electronics unit (DEU) for VOR displays. You use the DFCS MCP course select control to enter a course for the VOR station.

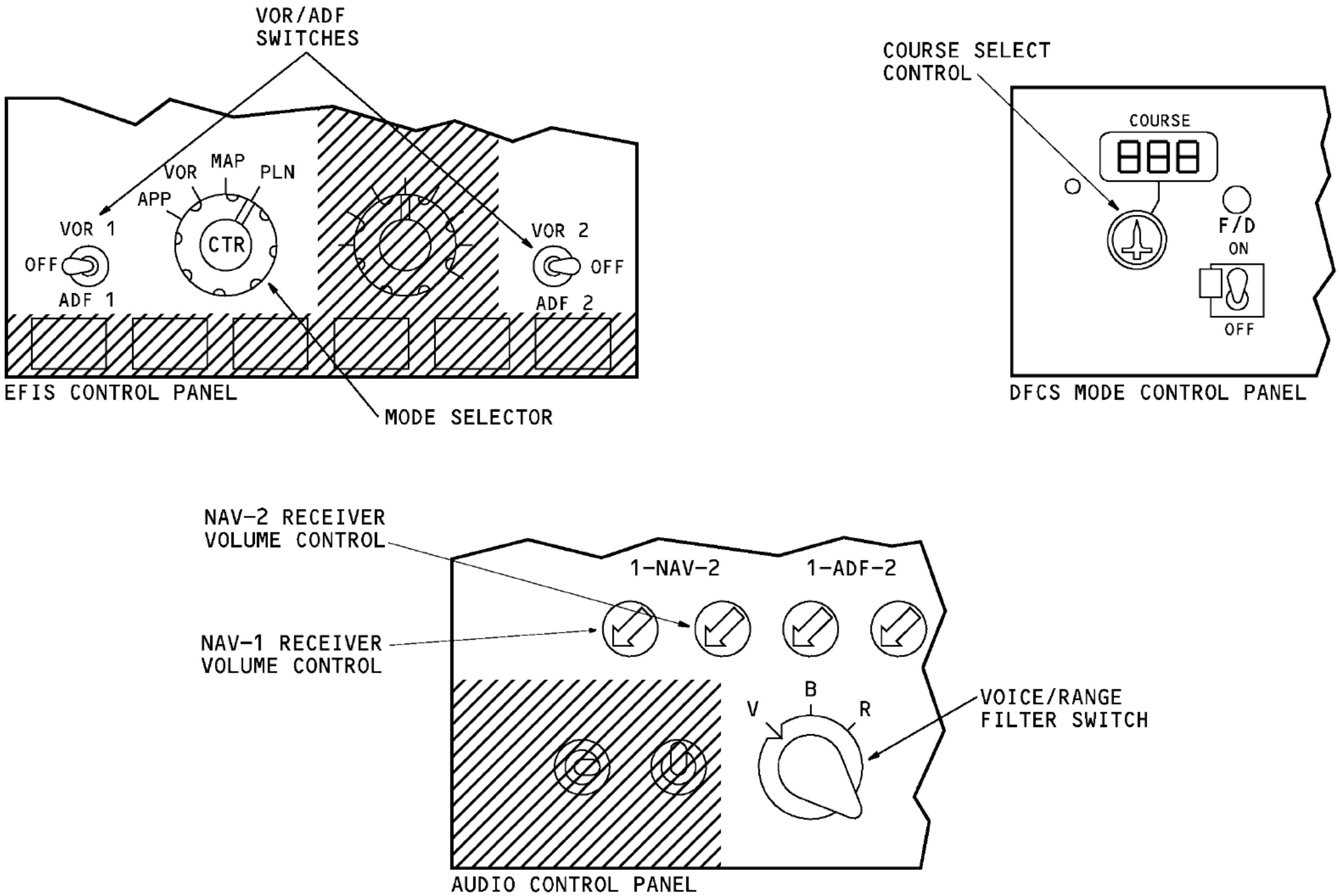
The DEU uses the course input and VOR bearing data from the VOR/MB receiver to calculate the airplane deviation from the VOR course.

Audio Control Panel Controls

The audio control panels (ACP) permit the crew to listen to VOR station audio or the Morse code station identifier.

You use the ACP volume control switches to select the VOR/MB system you want to listen to. The NAV 1 volume control selects the VOR/MB receiver 1 audio and the NAV 2 volume control selects VOR/MB receiver 2 audio.

The voice/range selector permits you to listen to only voice audio in the voice (V) position. The range (R) position permits you to listen to the station Morse code identifier. With the selector in the both (B) position, you can listen to both the voice audio and the Morse code station identifier.



VOR SYSTEM - CONTROLS

VOR SYSTEM - DISPLAYS

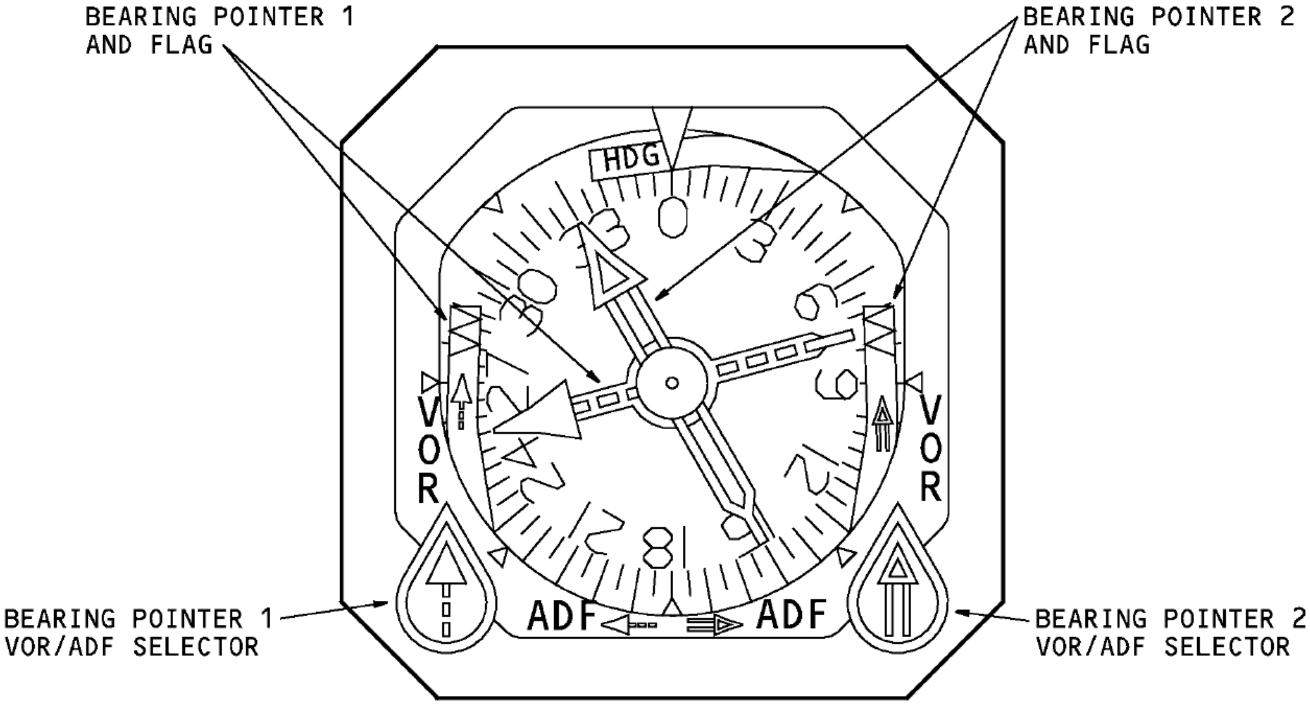
RADIO MAGNETIC INDICATOR

The radio magnetic indicator (RMI) shows bearing data to a VOR or ADF station with reference to the airplane magnetic heading.

The RMI has two bearing pointers. There is a fail flag for bearing pointer 1, and a fail flag for bearing pointer 2. The bearing pointer 1 and flag 1 show bearing and status from the VOR/MB receiver 1 or ADF receiver 1. The bearing pointer 2 and flag 2 show bearing and status from the VOR/MB receiver 2 or ADF receiver 2.

Set the bearing pointer VOR/ADF selectors to VOR to show VOR bearing on bearing pointers 1 and 2.

With the VOR/ADF selectors in the VOR position, the fail flags show for invalid data from the VOR/MB receivers.



VOR SYSTEM DISPLAYS – RADIO MAGNETIC INDICATOR

EFIS NORMAL DISPLAYS

General

VOR data shows on the captain and first officer displays. To show VOR displays, you must select the VOR mode on the EFIS control panels and enter a valid VOR frequency on the NAV control panels.

Deviation Bar and Scale

The VOR deviation bar shows in magenta. The DEUs use VOR bearing from the VOR/MB receivers and course inputs from the DFCS mode control panel to calculate VOR deviation.

The scale is the standard four dot scale. One dot equals five degrees of deviation.

The DEUs remove the deviation bar for NCD deviation inputs from the VOR/MB receivers.

Selected Course Pointer

The course select control on the DFCS mode control panel sets the position of the selected course pointer.

TO/FROM Pointer and Indicator

The TO/FROM pointer is a small white triangle that shows as part of the selected course pointer. The TO/FROM pointer shows on the centered VOR display only.

The TO/FROM indicator shows at the bottom right corner of both the centered and expanded VOR displays. The DEUs use VOR bearing from the VOR/MB receivers and course inputs from the DFCS MCP to calculate TO/FROM pointer and indicator displays.

The TO indication shows when you enter a course on the DFCS MCP that takes you to the VOR station. The FROM indication shows when you enter a course that takes you away from the VOR station.

The DEUs remove the TO/FROM pointer and indicators for NCD and invalid displays.

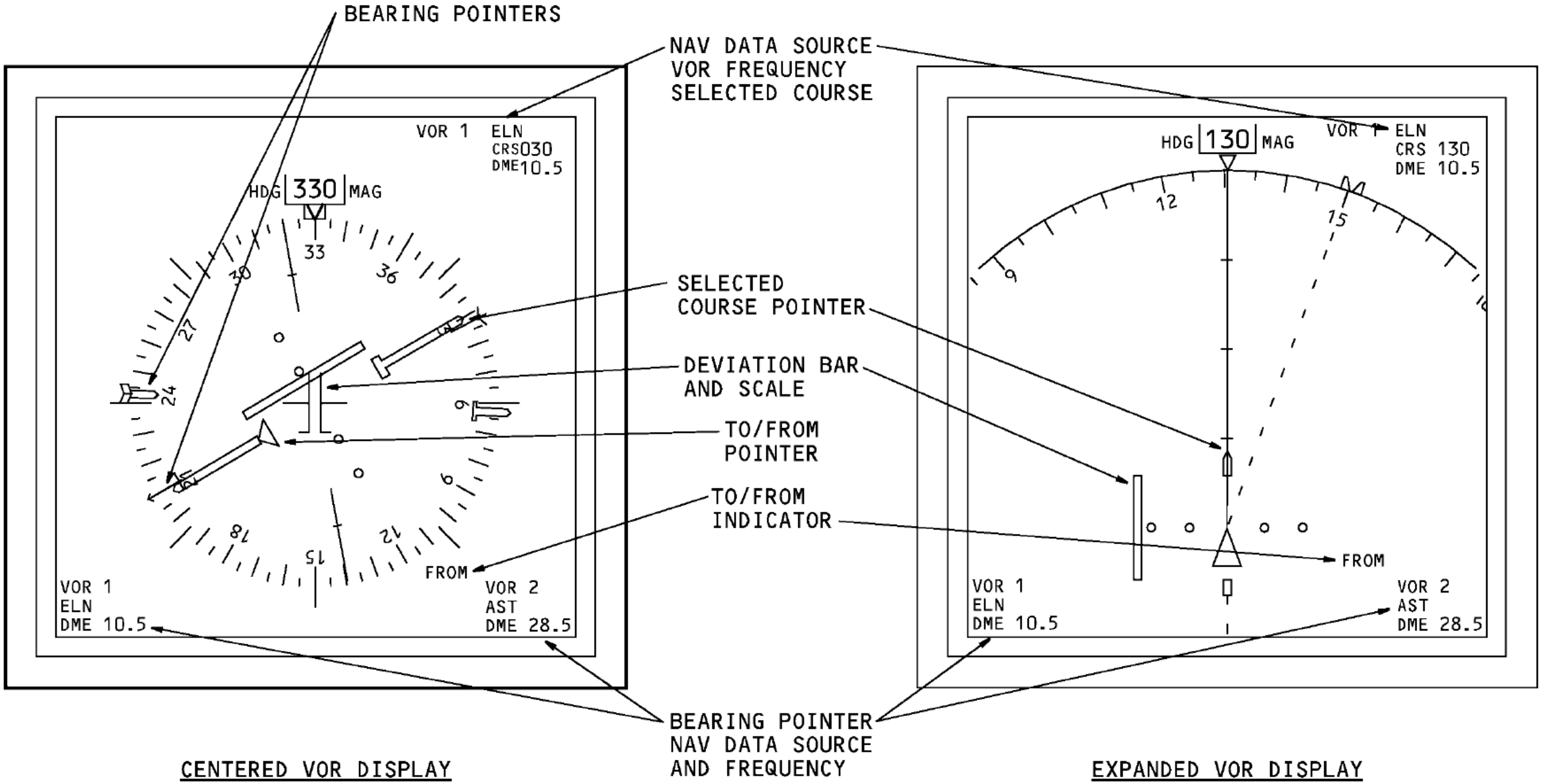
NAV Data Source

The DEUs show the source of the data for the NAV displays in the bottom left corner. The normal source for the captain NAV display is the VOR/MB receiver 1 and the normal source for the first officer is the VOR/MB receiver 2.

VOR Frequency

The VOR frequency display at the bottom right corner comes from the NAV control panel. The frequency from the NAV control panel goes through the VOR/MB receivers, then to the DEUs for display. The frequency shows in green.

The DEUs change the VOR frequency to dashes for NCD inputs from the VOR/MB receivers.



EFIS NORMAL DISPLAYS

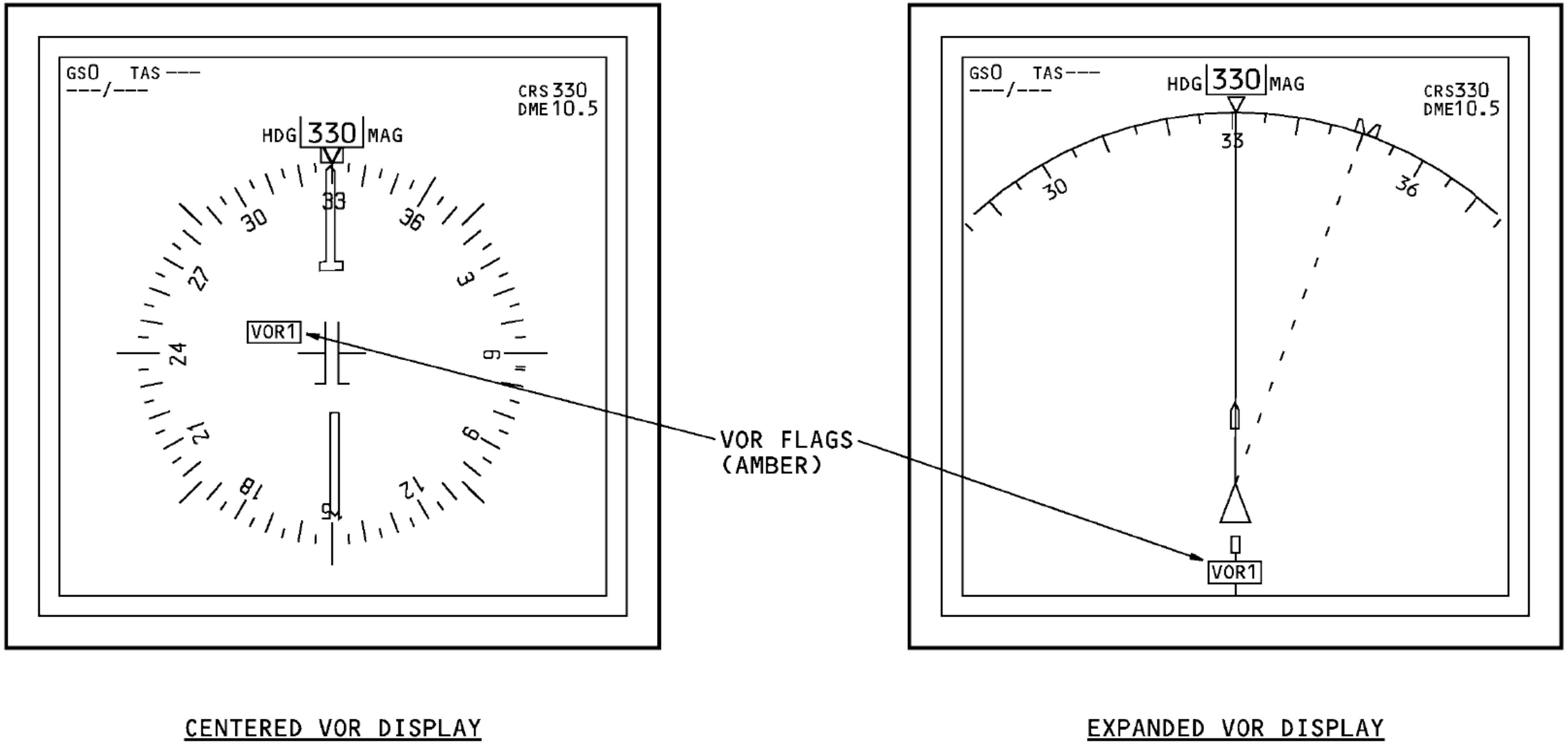
EFIS INVALID DISPLAYS

Invalid Display

The DEUs remove these displays for invalid VOR/MB receiver inputs:

- Deviation bar and scale
- TO/FROM pointer and indicator
- VOR frequency
- Bearing pointers.

The DEUs show the amber VOR flags on both the centered and expanded VOR displays for VOR/MB receiver failures.



EFIS INVALID DISPLAYS

VOR SYSTEM - SELF TEST

You can do a test of the VOR/MB receivers from the flight compartment with the NAV control panels. The captain's NAV control panel does a test of VOR/MB receiver 1 and the first officer's NAV control panel does a test of VOR/MB receiver 2.

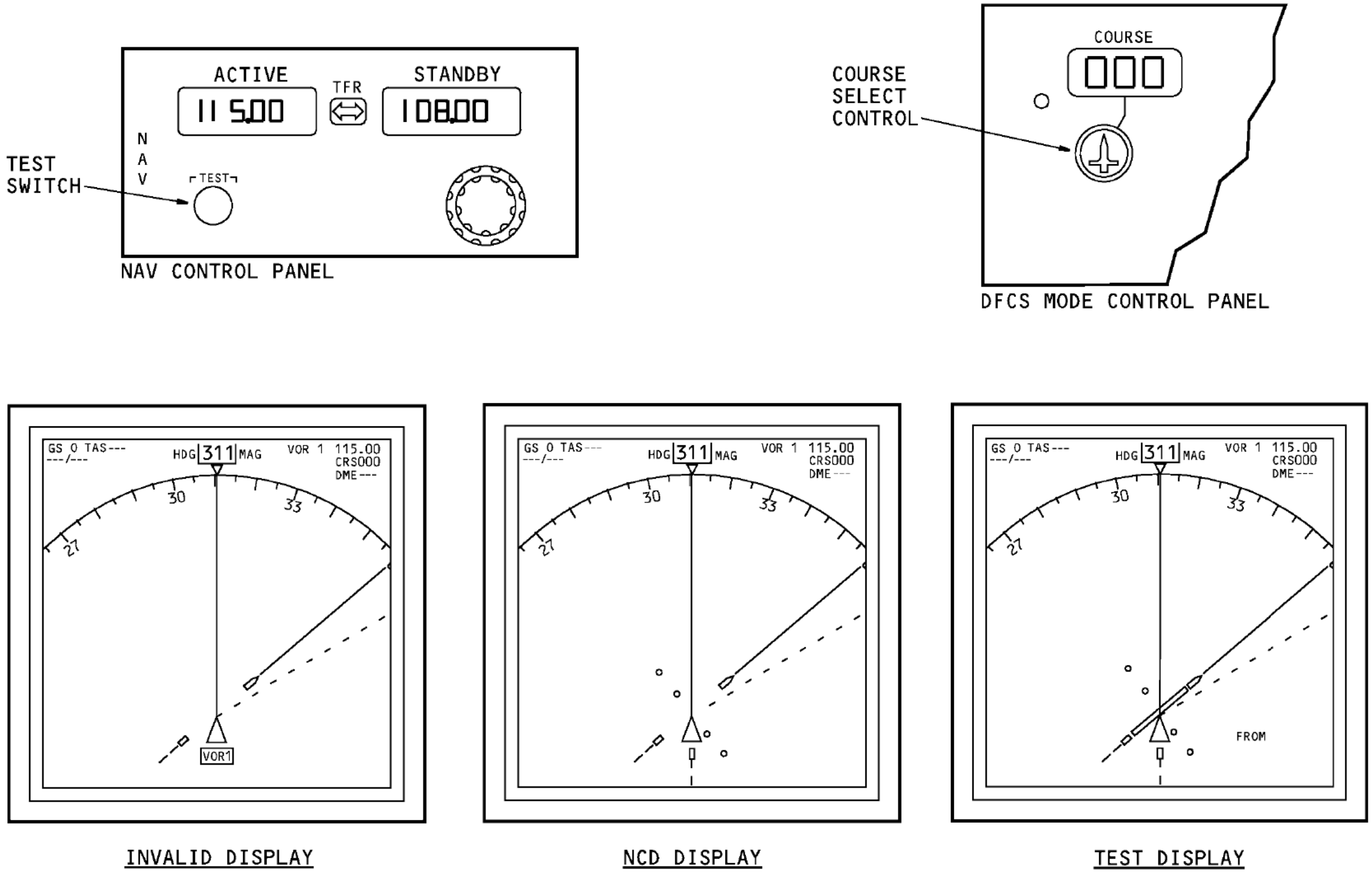
You need to set these controls to do a test of the VOR/MB receivers:

- Enter a valid VOR frequency into the active frequency display window on the NAV control panel
- Set a selected course of 000 on the DFCS mode control panel
- Set the mode selector on the EFIS control panel to the VOR position
- Push the test switch on the NAV control panel.

This is the flight compartment display sequence that shows during the VOR test:

- Invalid display (VOR flag)
- NCD display (deviation bar out of view)
- Test display (deviation bar centered).

During the test, the RMI bearing pointers and EFIS RDMI bearing pointers go to the 180 degree position.



VOR SYSTEM – SELF TEST

THIS PAGE IS INTENTIONALLY LEFT BLANK

BITE

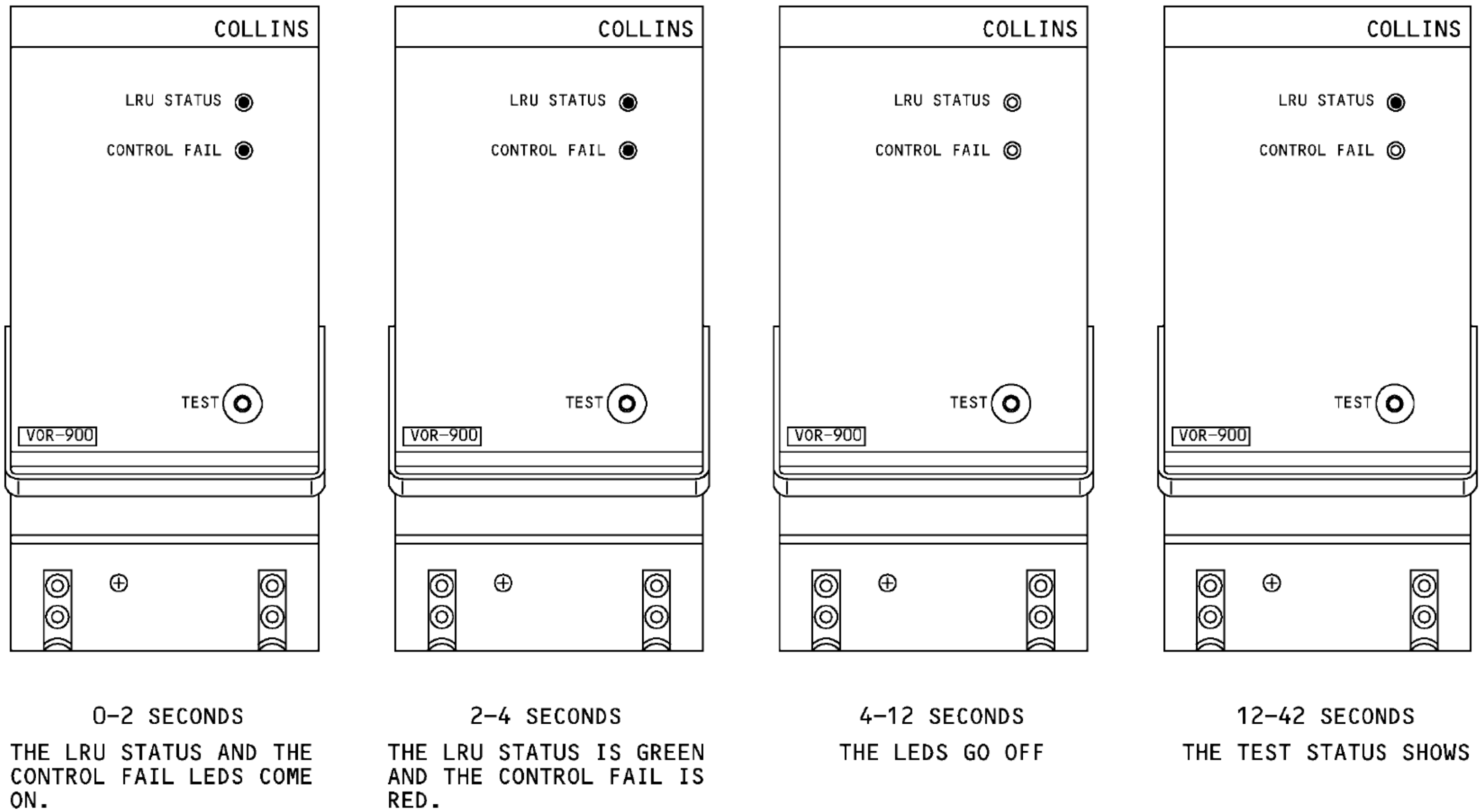
Push the test switch on the front panel to start a test of the VOR receiver. The test results show on the LED status indicators. There are two status LEDs. The LRU status LED can be red or green. The control fail LED is only red.

When you push the test switch, the receiver does a check of the internal receiver operation and its interface with the NAV control panel. The test takes 48 seconds.

This is the test sequence that shows on the LED status indicators during the test:

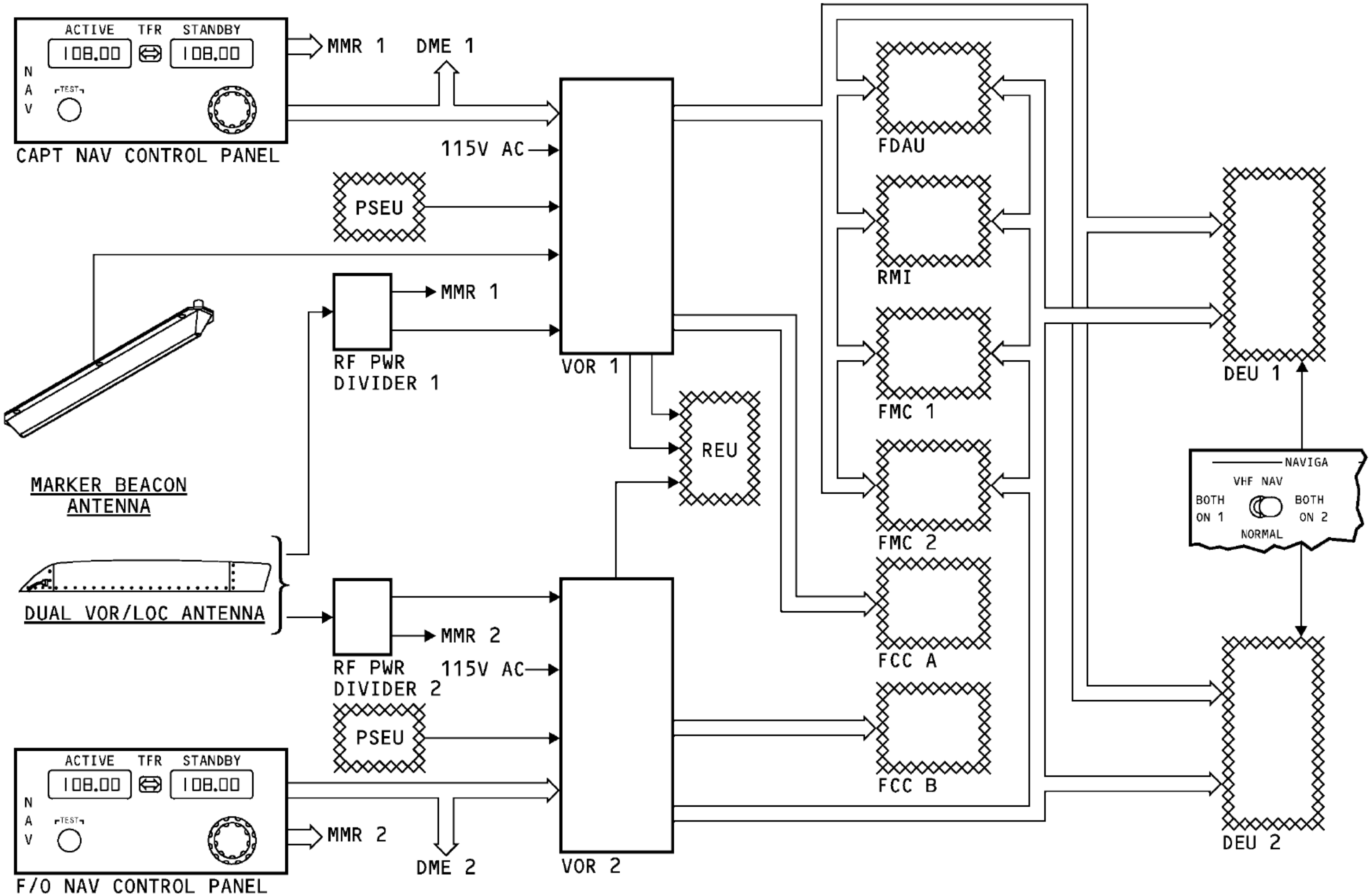
- **0 to 2 seconds** - the LRU status and the control fail LEDs are red
- **2 to 4 seconds** - the LRU status LED is green and the control fail LED is red
- **4 to 12 seconds** - the LRU status and the control fail LEDs go off
- **12 to 42 seconds** - test status shows.

The LRU status LED indicator shows green for an LRU test pass condition or red for an LRU test fail condition. The control fail LED shows red if there is no tuning input from the NAV control panel or if the signal is invalid.



BITE

SYSTEM SUMMARY



SYSTEM SUMMARY

THIS PAGE IS INTENTIONALLY LEFT BLANK

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–37. DISTANCE MEASURING EQUIPMENT SYSTEM (ATA 34–55)

LEVEL 3

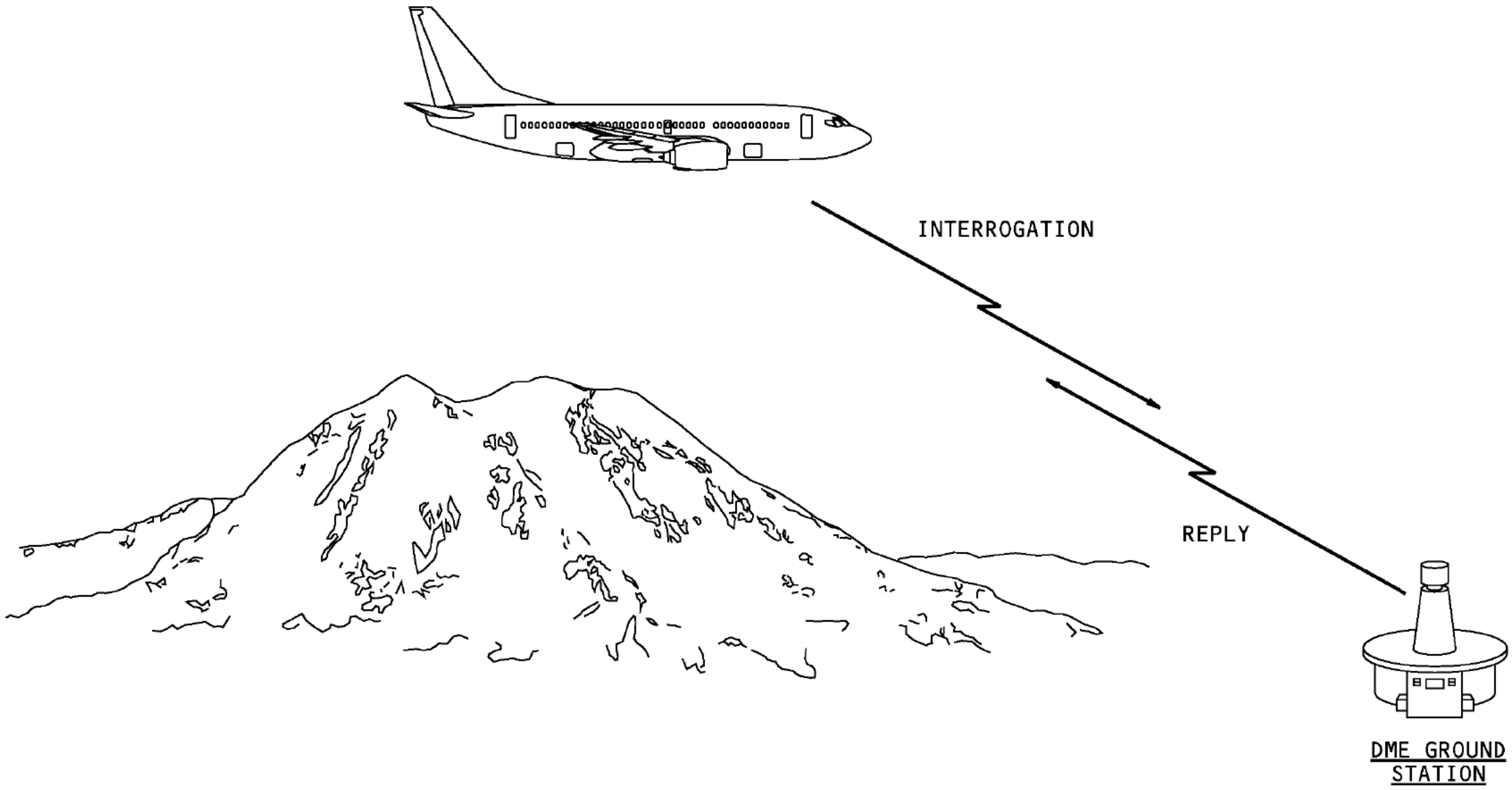
DISTANCE MEASURING EQUIPMENT(DME) - INTRODUCTION

Purpose

The distance measuring equipment (DME) system supplies slant range (line of sight) distance measurement between the airplane and the ground station.

Abbreviations and Acronyms

- AC - alternating current
- ACP - audio control panel
- ADF - automatic direction finder
- alt - alternate
- altn - alternate
- app - approach
- ARINC - Aeronautical Radio, Inc.
- ATC - air traffic control
- ATE - automatic test equipment
- auto - automatic
- B - both
- BITE - built-in test equipment
- BL - buttock line
- CAPT - captain
- CDU - control display unit
- circ - circulator
- CPU - central (control) processing unit
- DC - direct current
- DEU - display electronics unit
- DME - distance measurement equipment
- EFIS - electronic flight instrument system
- F/O - first officer
- FCC - flight control computer
- FDAU - flight data acquisition unit
- FMC - flight management computer
- FMCS - flight management computer system
- freq - frequency
- fwd - forward
- grd - ground
- I/C - intercom
- ILS - instrument landing system
- LCD - liquid crystal display
- LED - light emitting diode
- LRU - line replaceable unit
- maint - maintenance
- MHz - megahertz
- MKR - marker beacon
- nav - navigation
- NCD - no computed data
- ND - navigation display
- NORM - normal
- R - range
- rcvr - receiver
- RDMI - radio distance magnetic indication
- REU - remote electronics unit
- RF - radio frequency
- rly - relay
- R/T - receive/transmit
- spkr - speaker
- sta - station
- TCAS - traffic alert and collision avoidance system
- TFR - transfer
- TX - transmitter
- V - voice
- V - volts
- VHF - very high frequency
- xfr - transfer
- xmtr - transmitter
- xpndr - transponder



DISTANCE MEASURING EQUIPMENT - INTRODUCTION

GENERAL DESCRIPTION

General

The DME system has two DME interrogators and two antennas.

Description

The interrogators get manual tune inputs and flight management computer system (FMCS) autotune inputs from the navigation control panel. If the NAV control panel tune inputs fail, the interrogators get autotune inputs directly from the FMC.
The DME system sends data to the display electronics units to show on the primary EFIS displays.

The DME system sends data to these units:

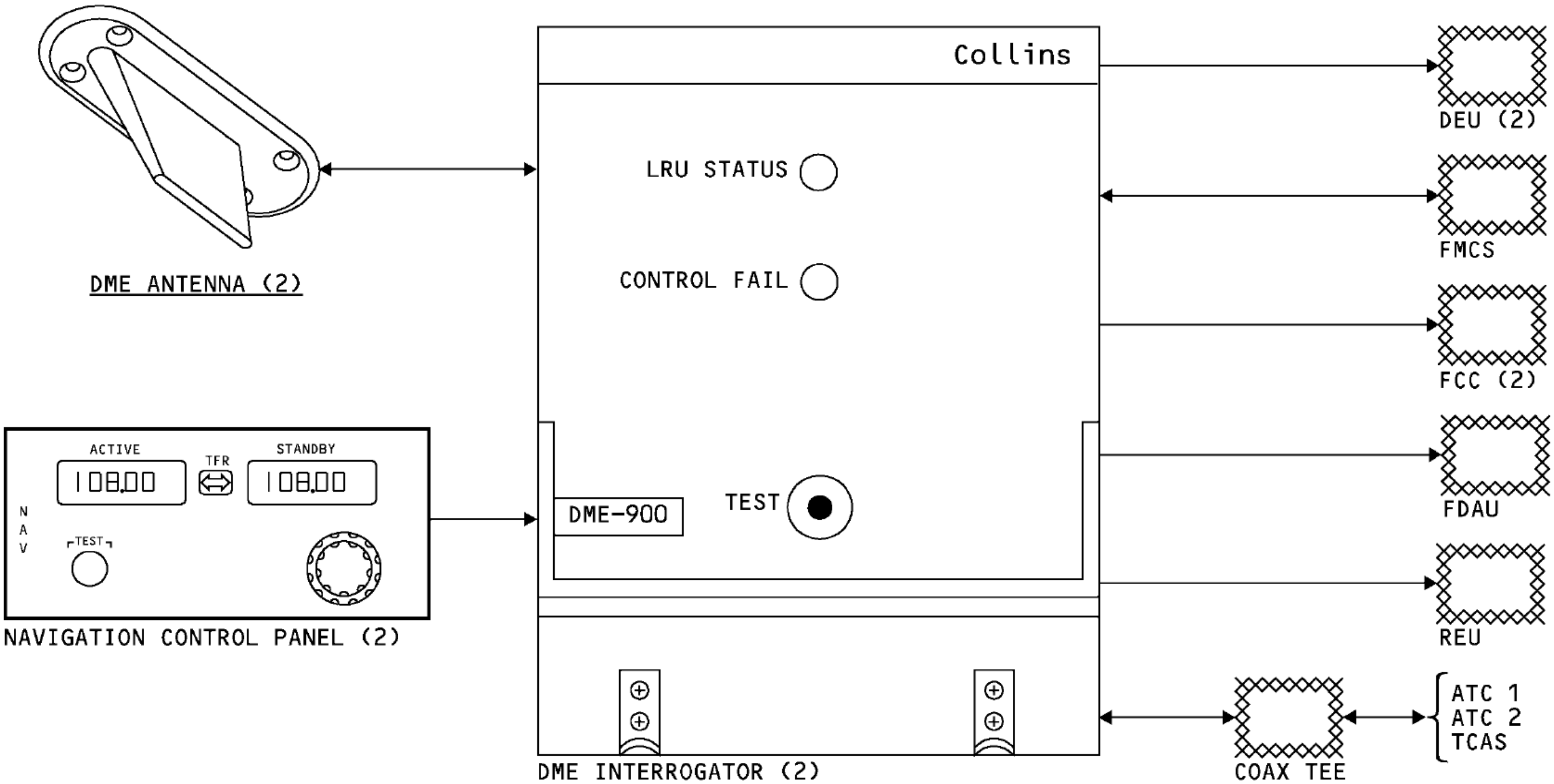
- Flight control computers (FCC)
- Flight management computer System (FMCS)
- Flight data acquisition unit (FDAU)
- Remote Electronics Unit (REU).

The FCCs use DME data as an input to calculate the VOR capture point in the autopilot VOR mode. The DME data is also used in the VOR mode to find when over station is sensed (OSS) for the VOR ground station.
The FMCS uses DME data to calculate FMC position updates.
The flight data acquisition unit receives DME data, formats it, and sends it to the flight data recorder.
The REU receives audio from the DME station and sends it to the flight deck headsets and speakers.

The DME system sends and receives a suppression pulse between these units:

- DME
- ATCs
- TCAS.

The DME interrogator receives the station audio identifiers and sends them to the remote electronics unit (REU).



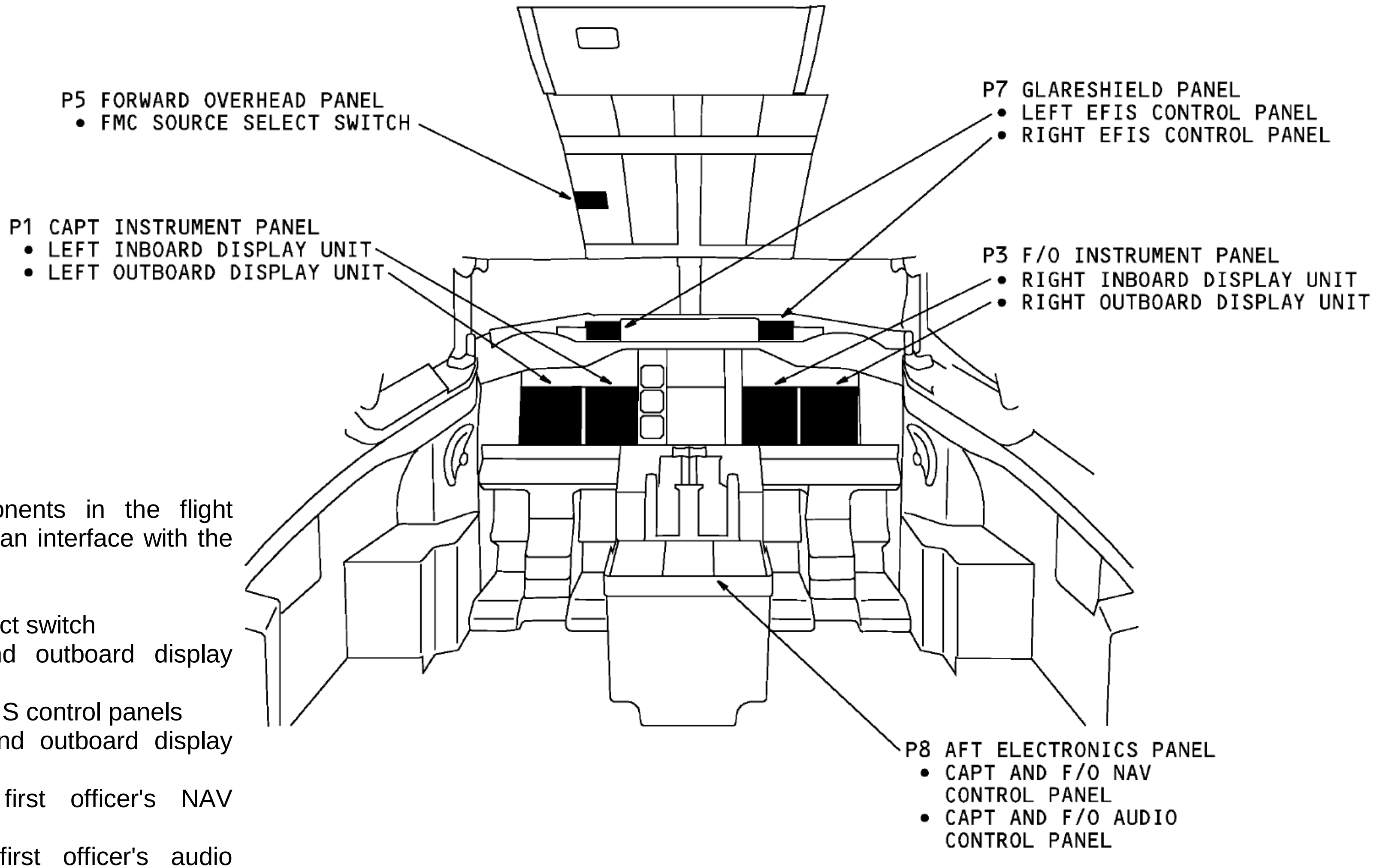
GENERAL DESCRIPTION

DME SYSTEM - COMPONENT LOCATION

Flight compartment

These are the components in the flight compartment that have an interface with the DME system:

- FMC source select switch
- Left inboard and outboard display units
- Left and right EFIS control panels
- Right inboard and outboard display units
- Captain's and first officer's NAV control panel
- Captain's and first officer's audio control panel.



COMPONENT LOCATION – FLIGHT COMPARTMENT

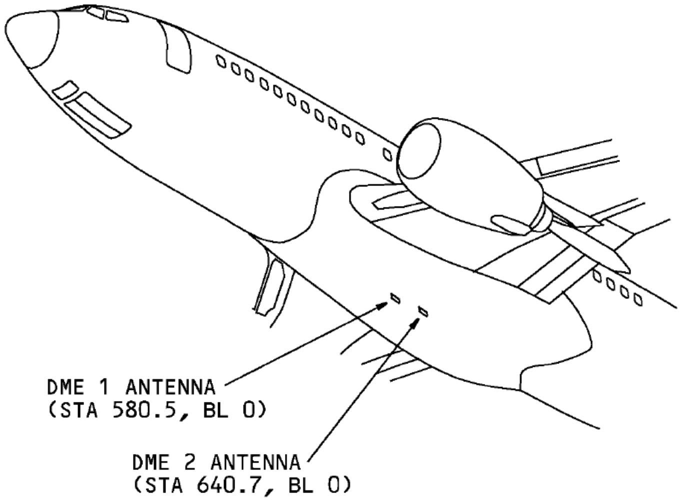
Eelectronic equipment compartment and antennas

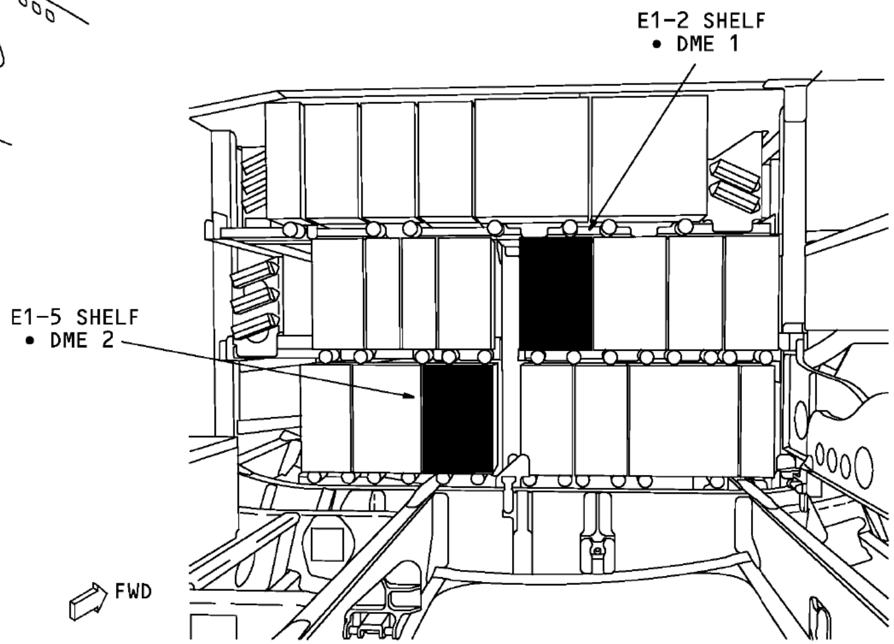
These components are in the electronics equipment compartment:

- DME 1 interrogator
- DME 2 interrogator.

These components are on the exterior of the airplane:

- DME 1 antenna
- DME 2 antenna.





ELECTRONIC EQUIPMENT COMPARTMENT

ELECTRONIC EQUIPMENT COMPARTMENT AND ANTENNAS

DME SYSTEM – NTERFACES

ARINC 429 INTERFACE

Navigation Control Panel

The navigation control panels supply a manual tune frequency input to the DME interrogator. They also send four auto tune frequency inputs from the Flight Management Computer (FMC).

The control panels send tune and test data on two output data buses. One output data bus goes to the MMR receiver and one output data bus goes to both the DME interrogator and VOR receiver.

DME Outputs

Each DME interrogator has two output buses. One output bus supplies data to the on-side flight control computer (FCC). DME 1 sends data to FCC A and DME 2 sends data to FCC B.

The other Output bus supplies data to these units:

- Flight management computer system (FMCS).
- Display electronics units 1 and 2
- Flight data acquisition unit (FDAU).

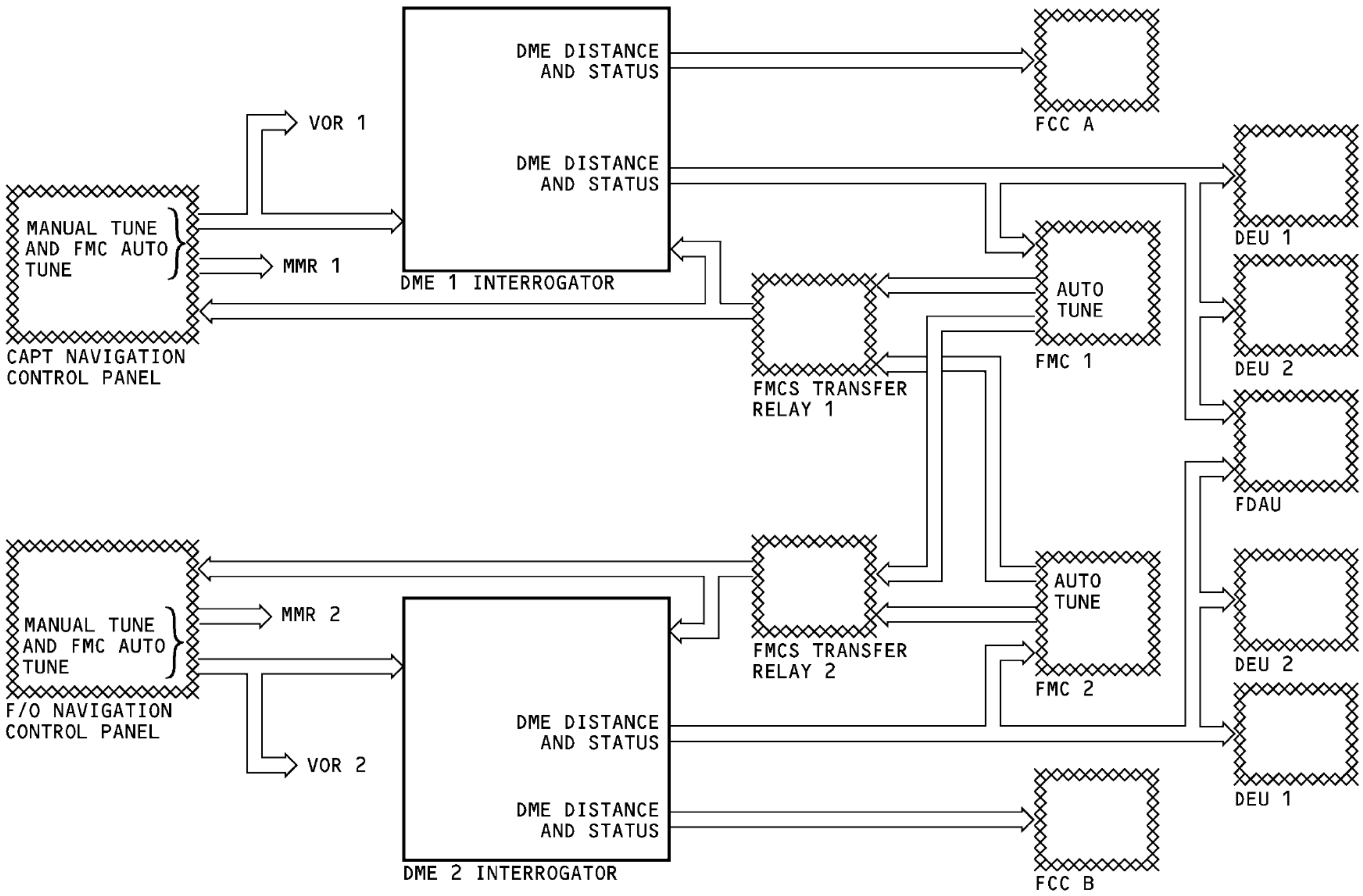
The FMCS uses DME distance to calculate position updates.

The DEUs use DME distance for displays.

The FDAU receives DME distance and formats it for the flight data recorder.

Flight Management Computer

The FMC supplies auto tune commands through the navigation control panel to the DME interrogator. If the navigation control panel has a failure, the DME gets auto tune signals directly from the FMC.



ARINC 429 INTERFACES

POWER, ANTENNA, ANALOG, AND DISCRETE INTERFACE

Power Interface

Each DME interrogator receives 115v ac from the DME circuit breakers.

DME Antenna Interface

The DME antennas transmit and receive DME signals. The antennas transmit signals to the ground stations. They then receive the reply signals from the DME ground station and send them to the interrogator.

Source Select Discrete

The source select discrete controls the ARINC 429 receive ports in the DME interrogator. With the source select open, the DME interrogator gets manual and auto tune commands from the navigation control panel. If the navigation control panel has a failure, the source select discrete goes to ground. The DME then gets auto tune signals directly from the FMC.

PSEU

The proximity switch electronics unit (PSEU), supplies an air/ground discrete inputs to the DME interrogators to set flight leg count. The air/ground discrete also goes to the navigation control panels to inhibit test commands in the air.

Default Scan Inhibit Discrete

The default scan inhibit discrete locks the DME interrogator so it can not make a scan of all the DME frequencies. It tunes to five channels controlled by the navigation control panel and the flight management computer.

DME/ATC/TCAS Suppression

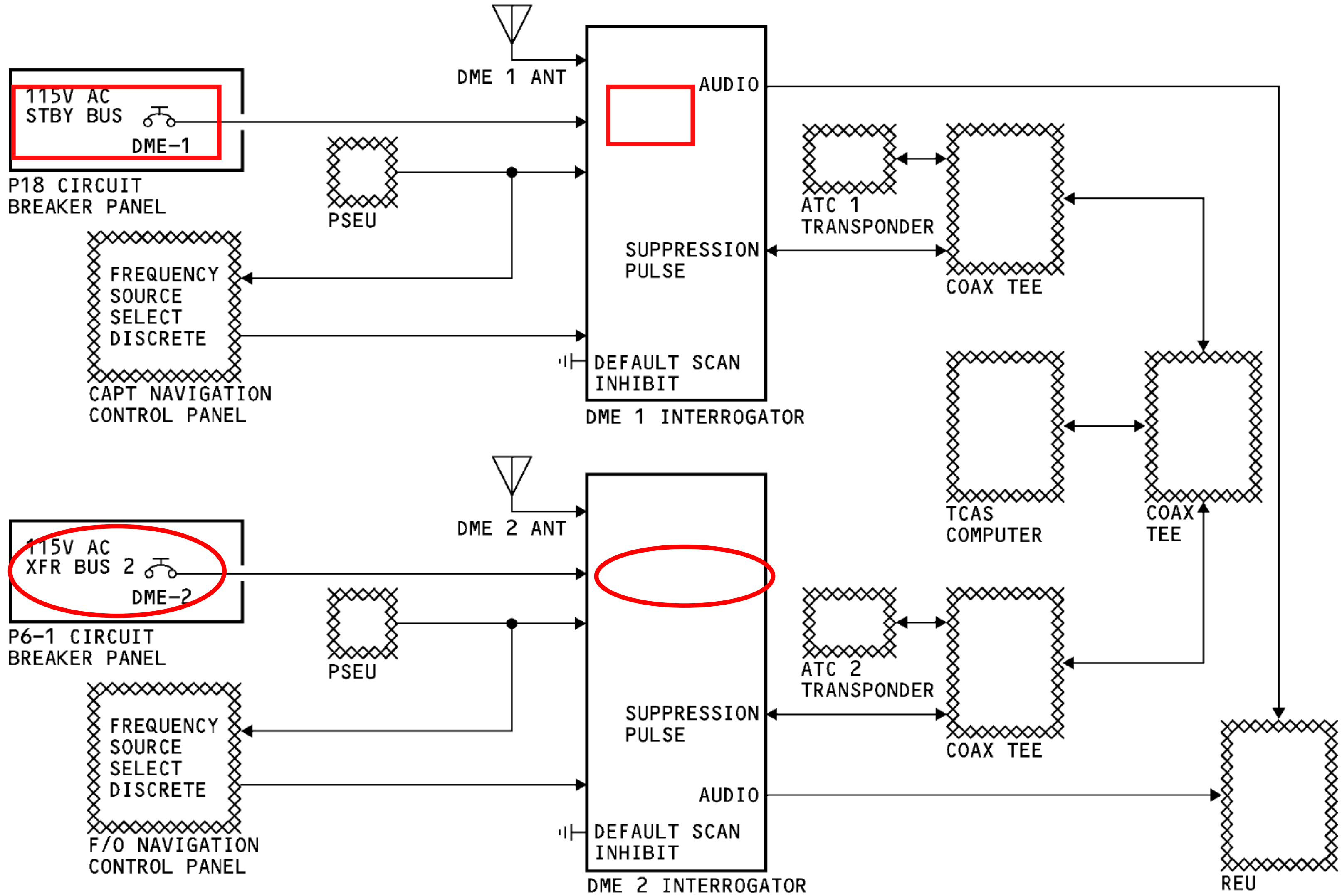
These systems operate in the same frequency band:

- DME
- Air traffic control (ATC)
- Traffic alert and collision avoidance system (TCAS).

When a DME interrogator, an ATC transponder, or the TCAS computer transmits, it sends a suppression pulse through the suppression lines. This pulse stops the reception of the other four units. This prevents damage to the receiver circuits of the other LRUs.

DME Audio

The DME interrogator sends the DME station audio identifier to the remote electronics unit (REU). The audio goes to the headsets and the flight interphone speakers.



POWER, ANTENNA, ANALOG, AND DISCRETE INTERFACE

DME SYSTEM – COMPONENTS

INTERROGATOR

General

The DME interrogator tunes to 252 channels and calculates distance information for all the channels in the DME range. There are 200 DME channels for the VHF NAV frequencies. The other 52 channels are for military TACAN functions. The DME receive frequency is 63 MHz above or below the transmit frequency.

Purpose

These are the purposes of the DME interrogator:

- Interrogate DME stations
- Receive the station replies
- Receive audio identifiers
- Calculate slant range distances.

Frequencies

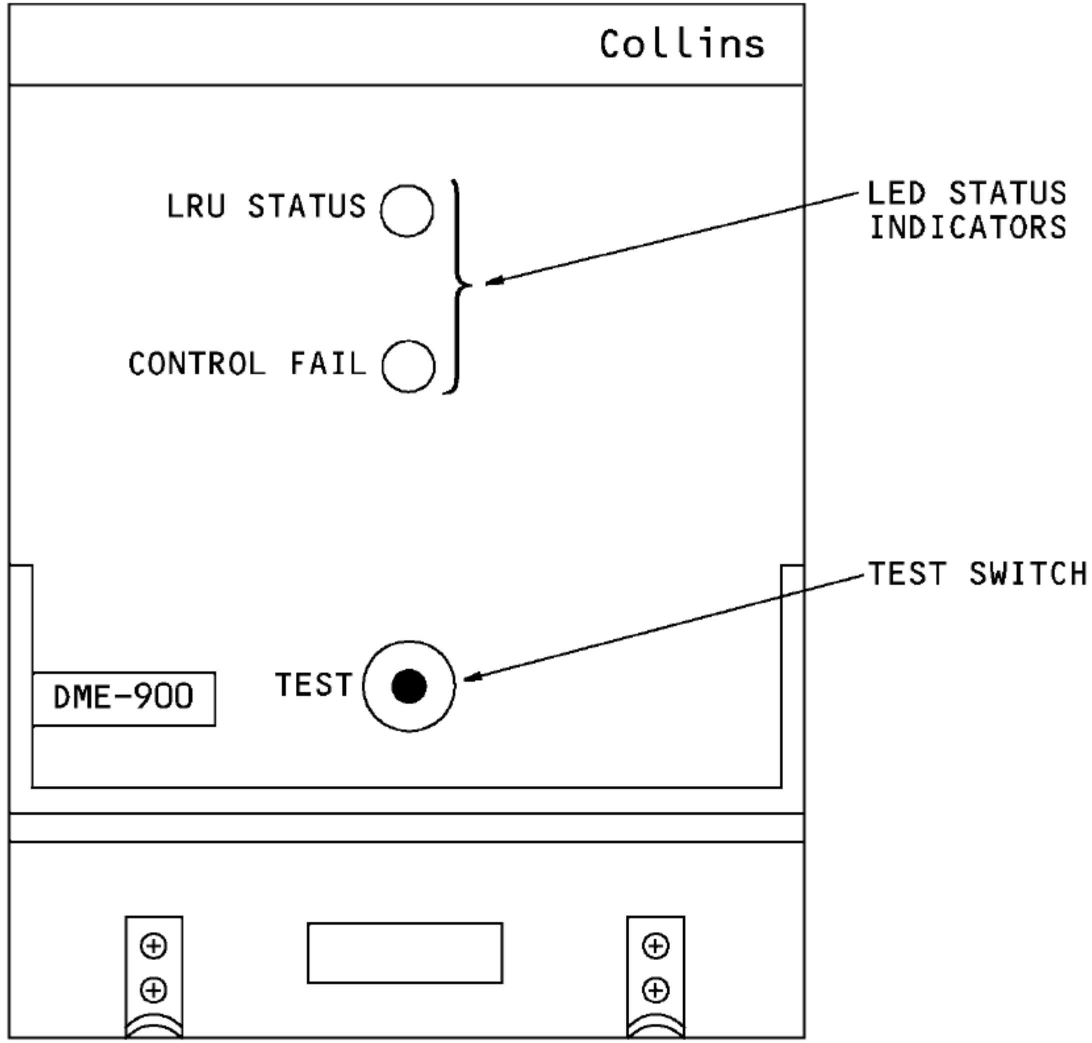
These DME tuning frequencies are in the VHF band:

- 108.00 to 117.95 MHz for DME stations with VOR or ILS
- 133.30 to 135.95 MHz for DME only stations.

Front Panel

The front panel of the DME interrogator has these features:

- LED status indicators
- A self test switch.



INTERPROGATOR

ANTENNA

General

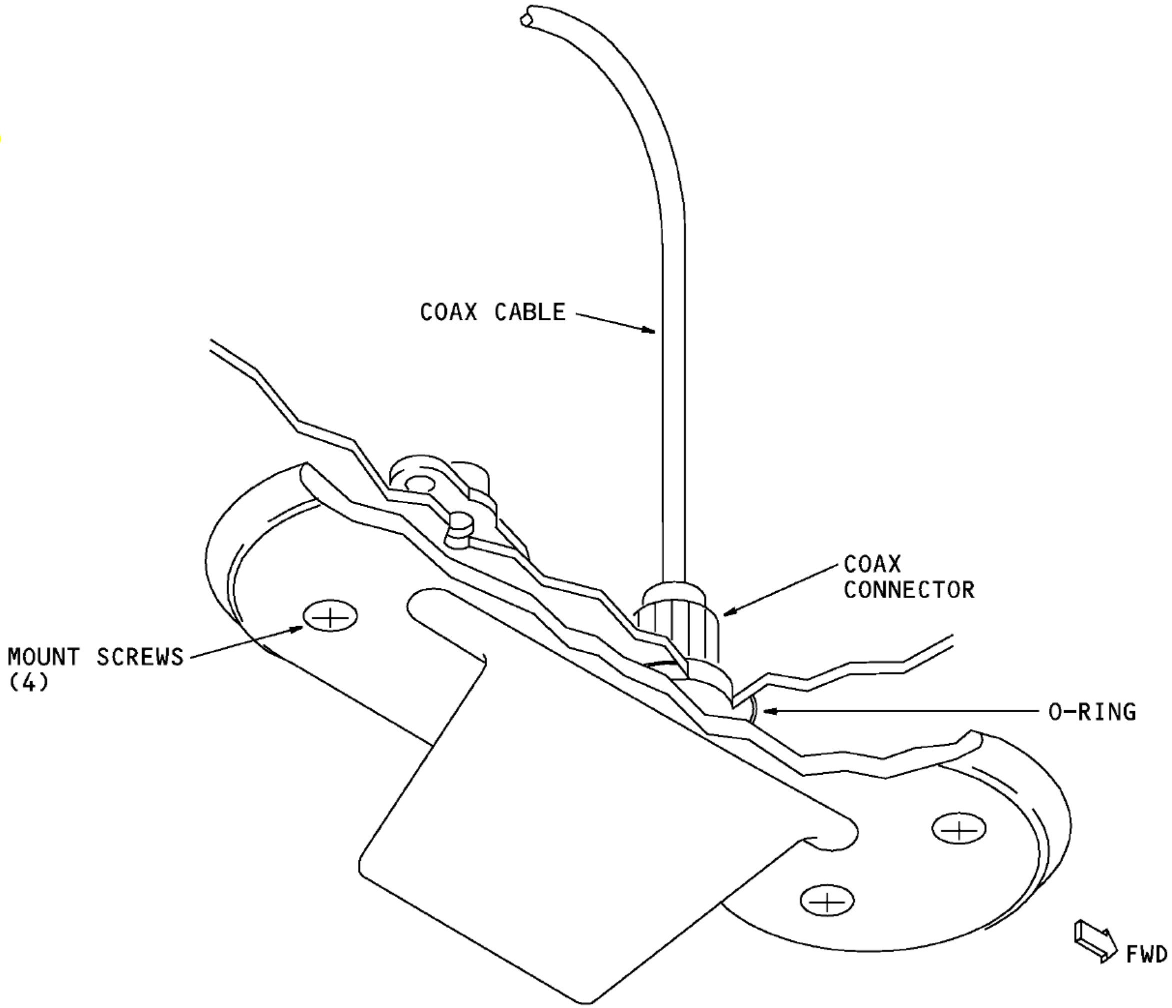
The L-band DME antenna transmits the interrogator output signal and receives the ground station reply and identification signals.

Physical Description

The antenna has an o-ring moisture seal and attaches to the airplane with four screws. The DME and the ATC antennas are the same and are interchangeable.

Training Information Point

Extra force on the antenna may be necessary to break the weatherproofing seal. To prevent damage to aircraft skin or electrical cable at the antenna base, carefully pry around the antenna with a sealant removal tool.



ANTENNA

NAVIGATION CONTROL PANEL

General

The navigation (NAV) control panels supply frequency inputs and test commands to these navigation radios:

- DME
- ILS
- VOR.

When you put a paired VOR or ILS frequency into the navigation control panel, it also goes to the DME interrogator. The DME tunes a DME frequency in the range of 108MHz to 117.95MHZ.

Set the frequency on the navigation control panel for these audio outputs:

- VOR and DME station identification
- ILS and DME station identification.

Operation

The NAV control panels have an active frequency display window and a standby frequency display window. The frequency that shows in the active frequency display window is the frequency that the navigation radios use for operation. The standby frequency display window shows the next frequency you will use.

The transfer switch is a momentary action switch. It transfers the frequency in the standby frequency display window to the active frequency display window. When you push the switch, the frequency that is in the active frequency display window transfers to the standby frequency display window.

The frequency select control is a continuous rotary knob. There is an inner knob and an outer knob. The outer knob sets the tens and ones. The inner knob sets the tenth and one hundredth numbers.
At power up, the frequency displays show the last frequency entry before power down.

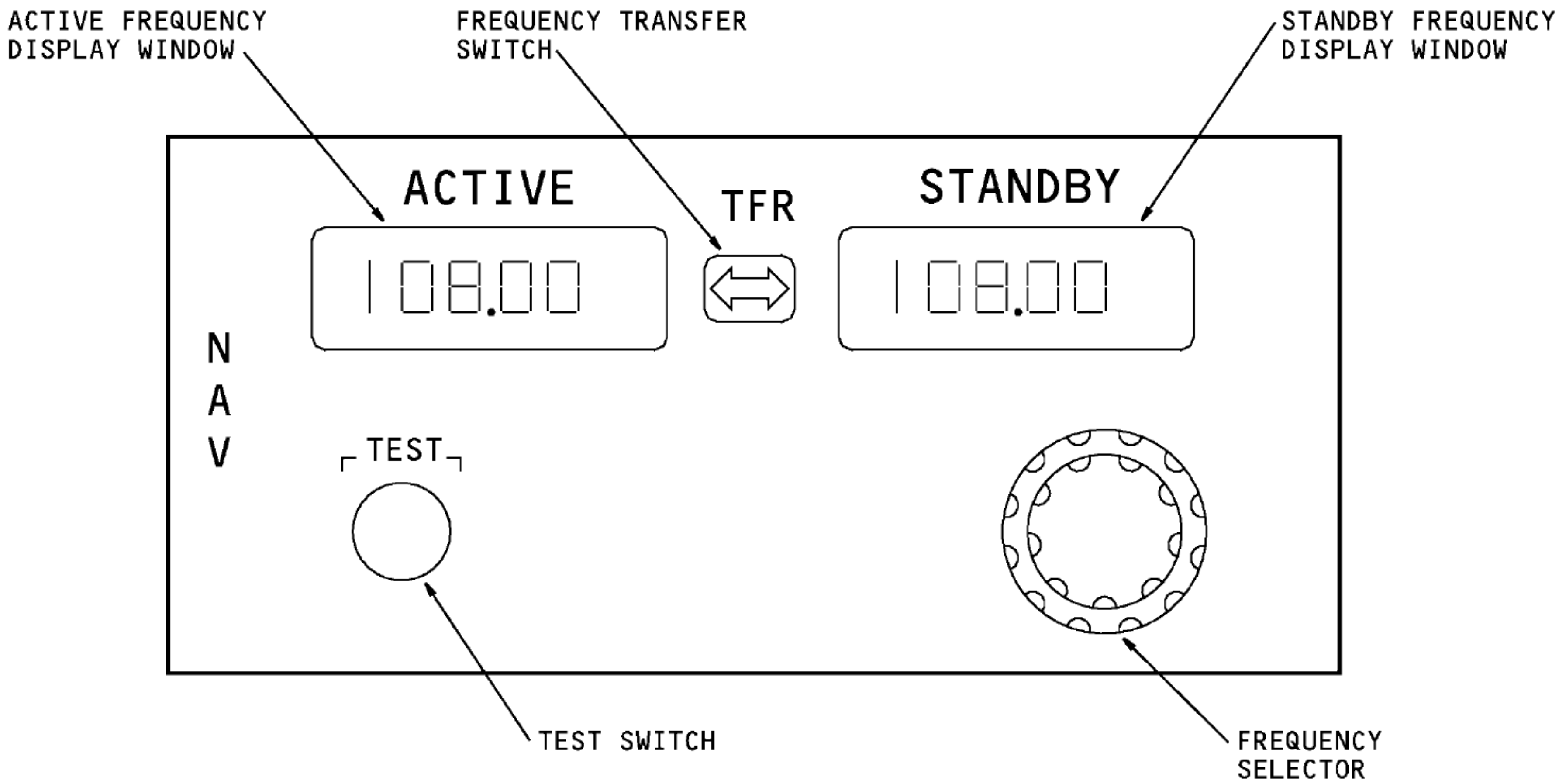
The NAV control panel continuous BITE function monitors the operation. The NAV control panel shows FAIL in the active and the standby frequency display windows when there is a failure.

The monitor in the NAV control panel monitors the 28v dc input. If the monitor does not get the 28v dc, the frequency display windows are blank.

Test

When you push the test switch, the NAV control panel sends a test command out on it's output bus. If a VOR frequency shows in the active frequency window, the test command goes to the VOR receiver. IF an ILS frequency shows in the active frequency window, the control panel sends a test command to the ILS receivers. If there is a DME frequency that is paired with the VOR or ILS frequency, a test command also goes to the DME interrogators.

When you do a test of the master dim and test system, the NAV control panel shows 188.88. The display shows for two seconds on then one second off until the test is complete.

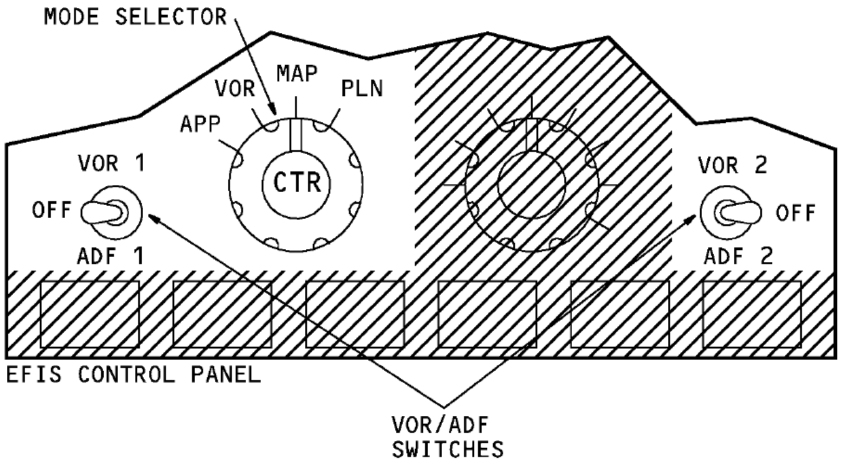


NAVIGATION CONTROL PANEL

OPERATION - CONTROLS

The audio control panels (ACP) permit the crew to hear the DME station identification signals. The identification signals are 1350 Hz.

The EFIS control Panel mode selector switch selects the NAV display modes that show DME distance.



EFIS Controls

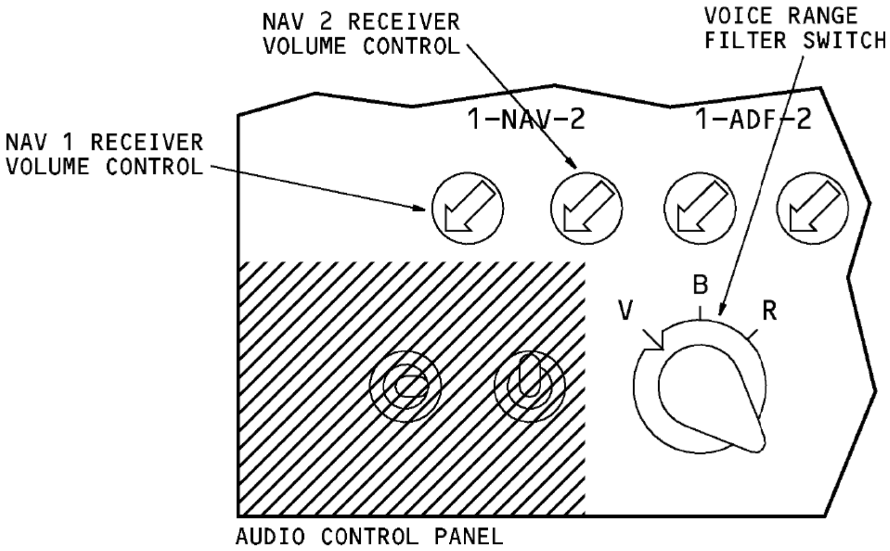
The EFIS control panel mode selector switch must be in the VOR or APP positions to show DME distance on the top left of the ND.

Audio Controls

Set these controls on the audio control panel to listen to DME audio:

- Push ON the NAV receiver volume control (NAV 1 for DME 1 and NAV 2 for DME 2)
- Select B (both) or R (range) on the voice range filter switch
- Set the NAV receiver volume control.

The voice/range selector permits you to hear DME audio. You will hear the DME audio when the voice/range selector is in the R or B position.



OPERATION - CONTROLS

THIS PAGE IS INTENTIONALLY LEFT BLANK

DME SYSTEM - DISPLAYS

Normal RDMI Display

The radio distance magnetic indication (RDMI) on the captain's primary electronic flight instrument (EFIS) display shows DME distance. The first officer's RDMI on the secondary EFIS shows the DME distance.

The RDMI show DME 1 distance above the DME1 legend on the left side and DME 2 distance on the right side above the DME2 legend.

The DME distance display shows in white letters and numbers.

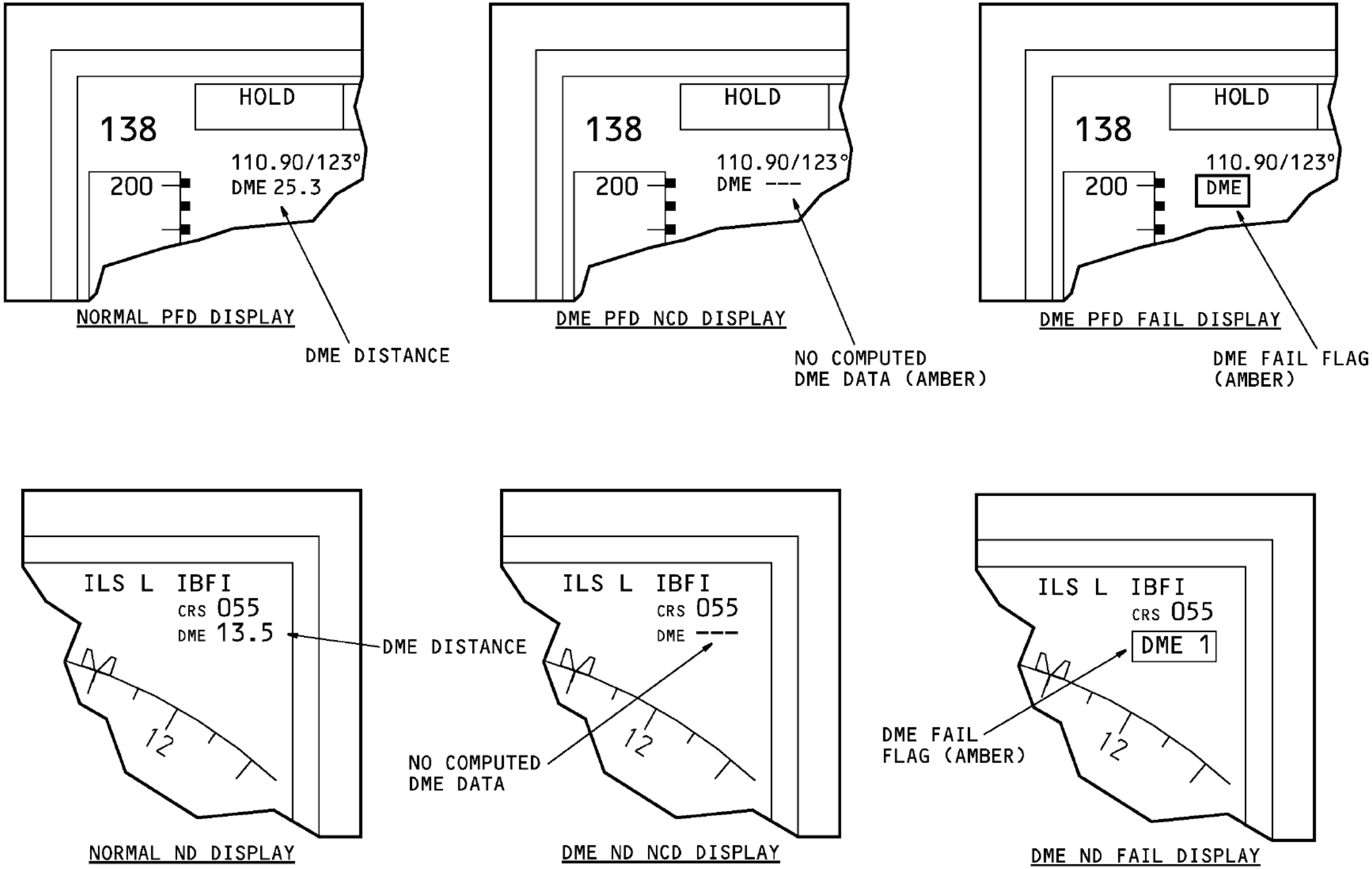
Normal ND display

The DME distance shows on the top left corner of these ND displays:

- Expanded and centered VOR
- Expanded and centered ILS.

DME NCD and Fail Displays

White dashes replace the DME distance when the DME distance data is no computed data (NCD). If the DME has a failure, the DME amber flag replaces the DME distance.



DME SYSTEM - DISPLAYS

DME SYSTEM - FUNCTIONAL DESCRIPTION

Normal Tune Input

The navigation control panel is the normal source for tune inputs. The flight management computer (FMC) sends up to four channels of auto tune signals to the navigation control panel. The navigation control panel adds one manual channel and sends five tune channels to the DME interrogator.

Alternate Tune Input

If the navigation control panel has a failure, the FMC sends auto signals directly to the DME interrogator.

Discrete Inputs

When the navigation control panel has a failure, it grounds a source select discrete to the DME central processing unit (CPU). The CPU changes the input from the navigation control panel to the FMC.

The proximity switch electronics unit (PSEU)supplies an air/ground discrete to prevent a DME test when the aircraft is in the air. The discrete also supplies flight leg data.

Operation

The CPU uses tune inputs to tune the frequency synthesizer. The CPU give a signal to the transmitter to send interrogation pulses. The transmit pulses go through a circulator then to the DME antenna.

The transmitter sends a signal to the suppression circuits.

During a transmission, the suppression circuit in the DME 1 interrogator sends a suppression pulse to these units:

- DME 2 interrogator
- ATC 1 and 2 transponders (XPNDR)
- TCAS computer.

The suppression pulse stops receiver operation in the other LRUs to prevent damage to internal circuits.

Receive

The circulator sends the RF pulse pairs it receives from the antenna to the receiver. The receiver sends the pulse pair to the CPU. The CPU calculates the slant range distance. It uses the time it takes to transmit pulse pairs and get a reply from the ground station. When another L-band system transmits, a suppression pulse stops the receiver operation.

Interrogator Output

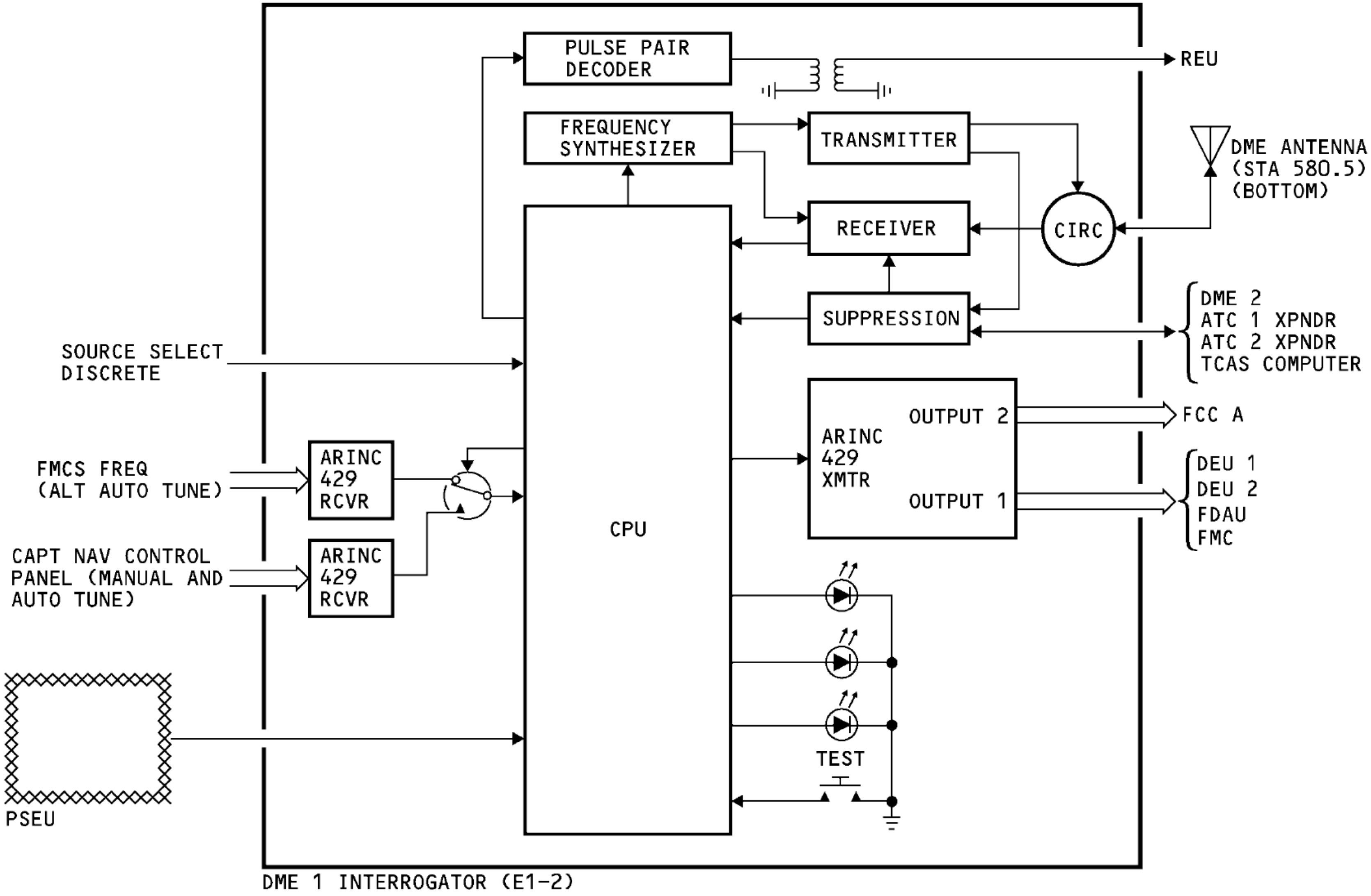
After the CPU calculates slant range distance, the CPU sends it to two ARINC 429 transmitters. One ARINC 429 transmitter sends the range data to the DEUs for the flight deck displays and to other systems. A second ARINC 429 transmitter sends range data to the flight control computer. The CPU sends the pulse pairs to the pulse pair decoder. The decoder sends the DME audio to the REU.

Bite Module

The built-in test equipment (BITE) in the CPU monitors the circuits in the DME interrogator for faults. The fault memory in the DME keeps the number of faults per flight. Shop personnel can read the fault memory contents.

Test

The CPU does a test of the interrogator when it receives a test command from the navigation control panel. You can also push the test switch on the front panel of the interrogator. The LEDs on the front panel of the interrogator do not show during the navigation control panel test.



DME SYSTEM – FUNCTIONAL DESCRIPTION

DME SYSTEM - BITE

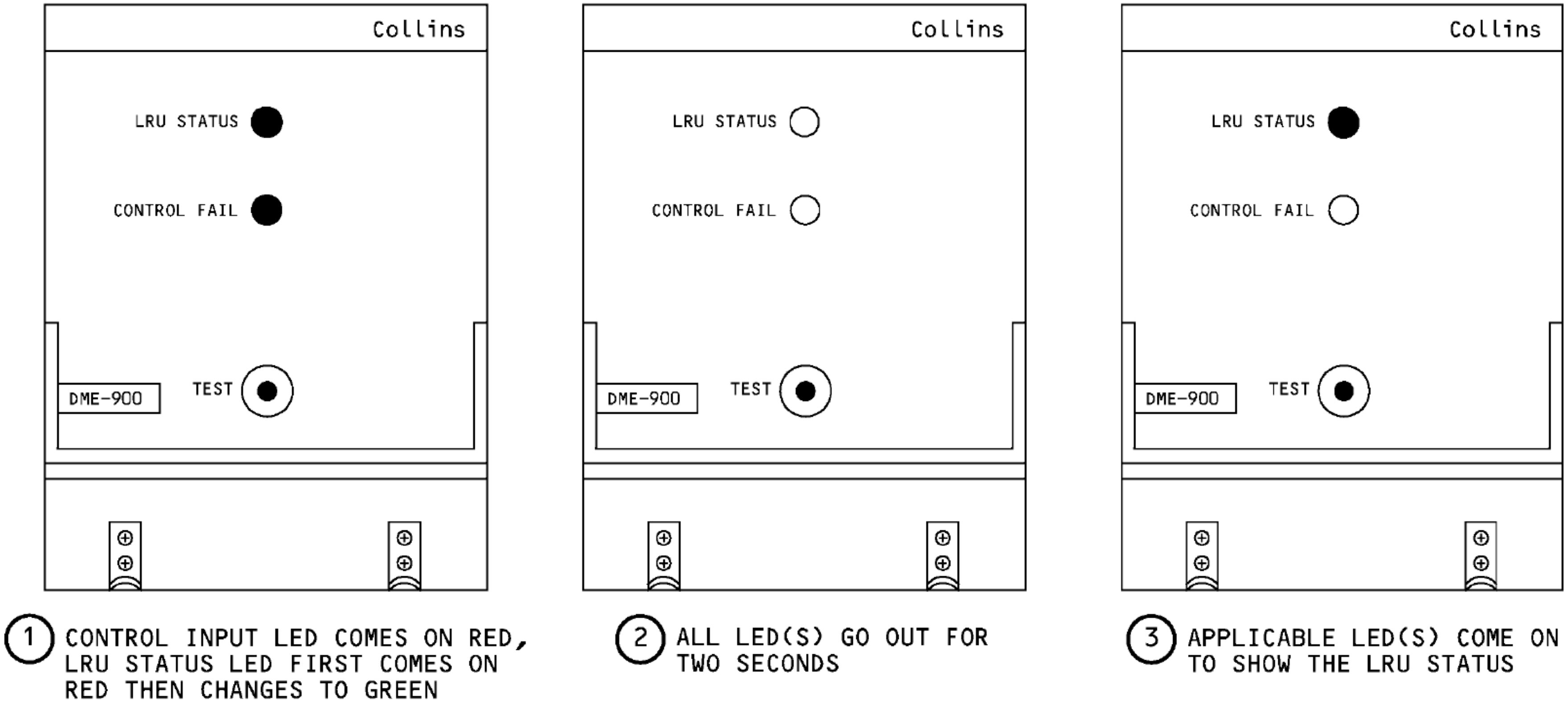
Self Test
Push the test switch on the DME interrogator to start a DME self-test.

Front Panel Displays
The LED status indicators go through this sequence:

- The LRU status and control fail LEDs come on red for two seconds.
- The LRU status LED changes to green.
- All LEDs go off for two seconds.
- The applicable LEDs come on to show the LRU status.

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

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



BITE

TEST DISPLAY

General

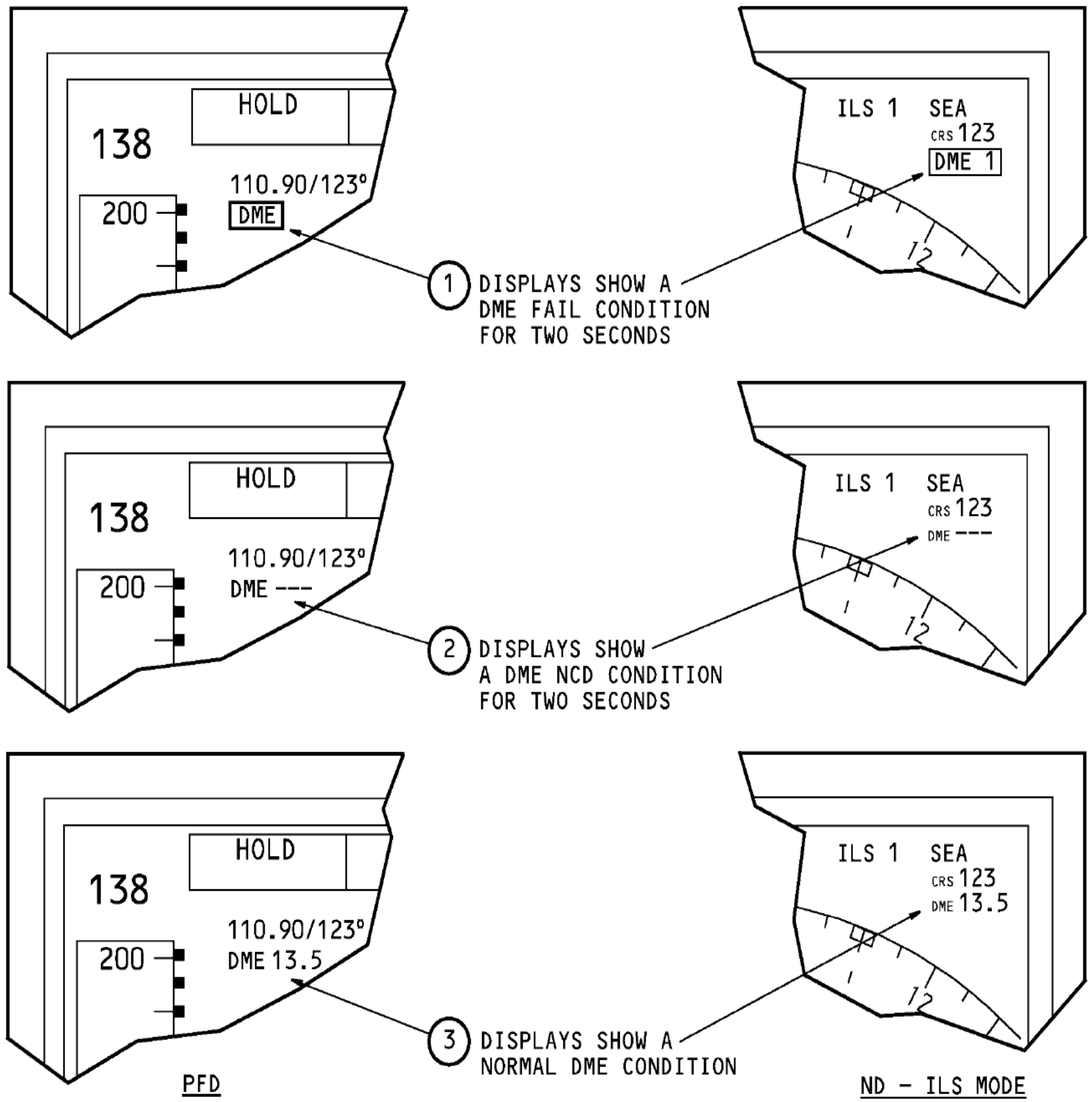
During a ground test or a self test, the display units show these indications:

- ➢ The DME fail condition for two seconds
- ➢ The DME NCD condition for the next two seconds
- ➢ The DME normal condition to end the test.

The DME normal condition is the distance that shows before the test starts.

NOTE:
THE GRAPHIC SHOWS A TEST DISPLAY OF DME INTERROGATOR 1 ON THE CAPTAIN PFD AND ND WITH THE APP MODE SELECTED ON THE EFIS CONTROL PANEL.
THE TEST IS THE SAME FOR DME INTERROGATOR 2 ON THE FIRST OFFICER DISPLAYS.

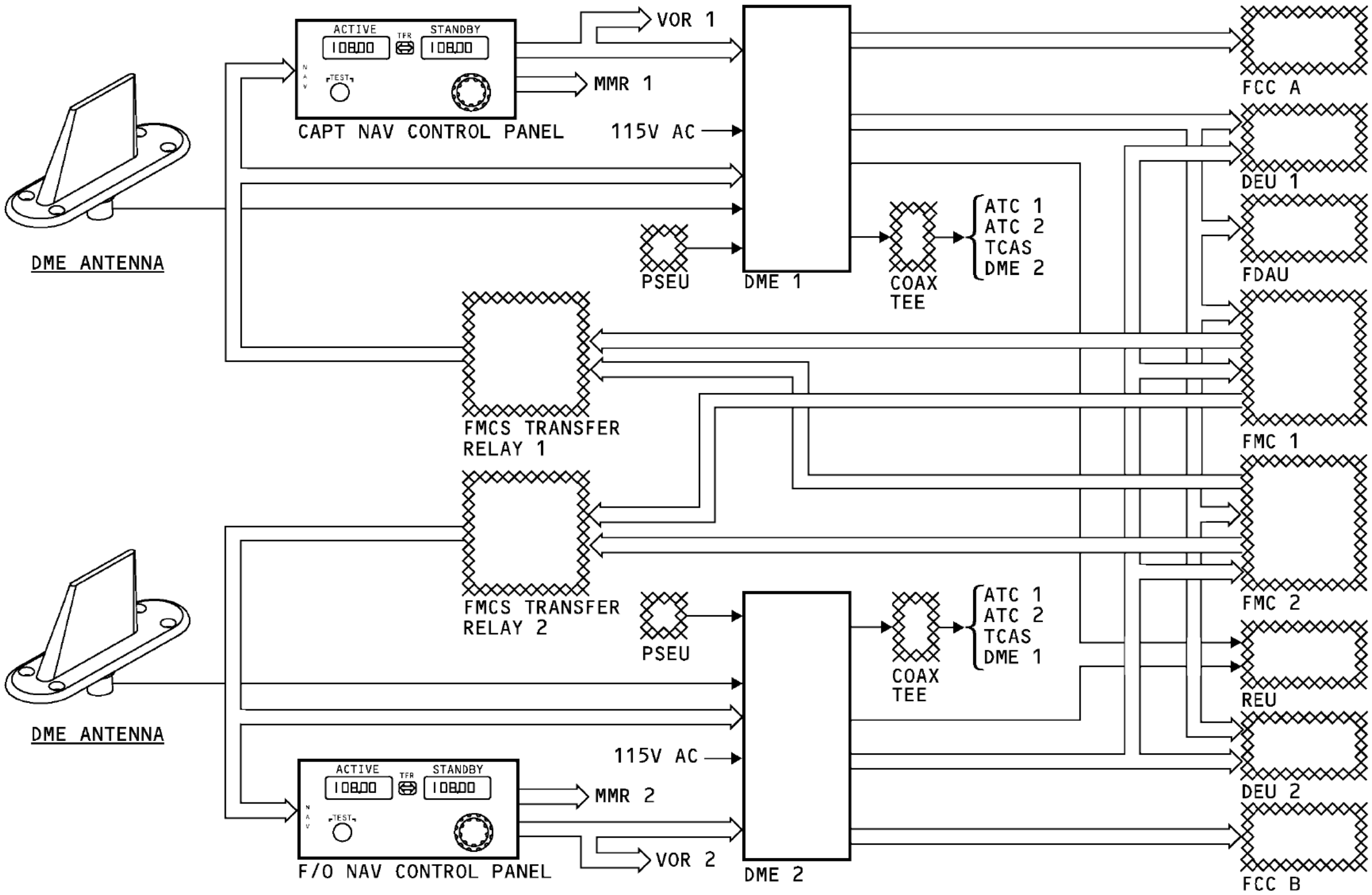
YOU CAN ALSO SEE THE DME TEST ON THE ND IN THE VOR DISPLAY MODE.



TEST DISPLAY

DME SYSTEM - SYSTEM SUMMARY

General



SYSTEM SUMMARY

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–38. GLOBAL POSITIONING SYSTEM (ATA 34–58)

LEVEL 3

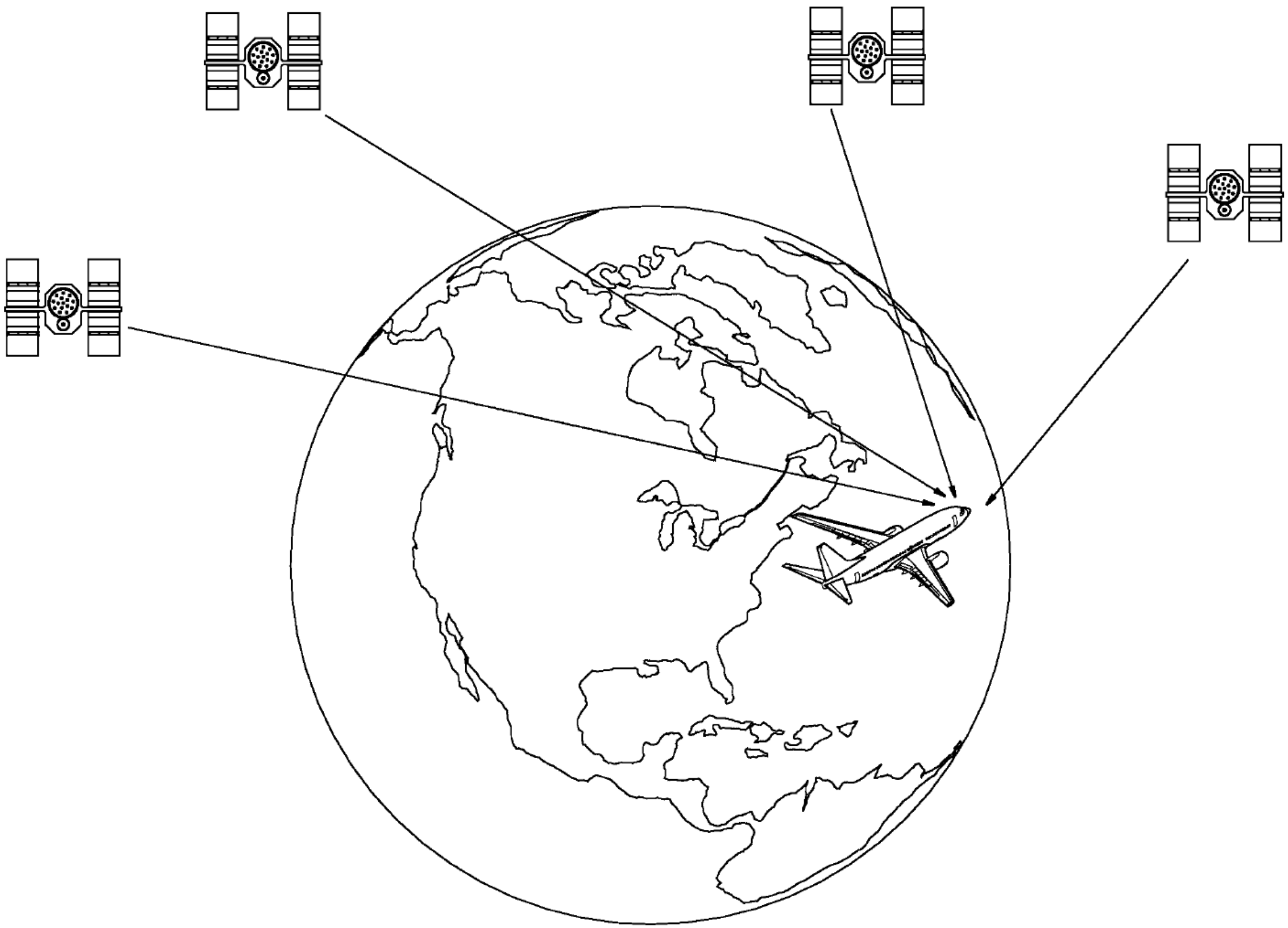
GLOBAL POSITIONING SYSTEM (GPS) - INTRODUCTION

Purpose

The global positioning system (GPS) uses navigation satellites to supply airplane position to airplane systems and to the flight crew.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- AMP - amplifier
- APU - auxiliary power unit
- ARINC - Aeronautical Radio, Inc.
- ATT - attitude
- A/D - analog to digital
- BITE - built-in test equipment
- CDU - control display unit
- CONV - convertor
- dc - direct current
- DET - detection
- D/A - digital to analog
- ELEC - electrical
- flt - flight
- FMC - flight management computer
- GP - general purpose
- GPS - global positioning system
- HEX - hexadecimal
- IRS - inertial reference system
- L - left
- LBL - left buttock line
- MMR - multi mode receiver
- nav - navigation
- NCD - no computed data
- NVM - non volatile memory
- ovht – overheat
-
- pos - position
- PPS - precision positioning service
- R - right
- RAIM - receiver autonomous integrity monitor
- RBL - right buttock line
- rcvr - receiver
- RF - radio frequency
- SAT - satellite
- SCR - silicon controlled rectifier
- SPS - standard positioning service
- SS - single shot
- sta - station
- UTC - universal time (coordinated)
- tBIAS - clock bias
- V - volts
- WL - water line



GLOBAL POSITIONING SYSTEM - INTRODUCTION

GENERAL DESCRIPTION

General

The global positioning system (GPS) calculates this data:

- Latitude
- Longitude
- Altitude
- Accurate time
- Ground speed.

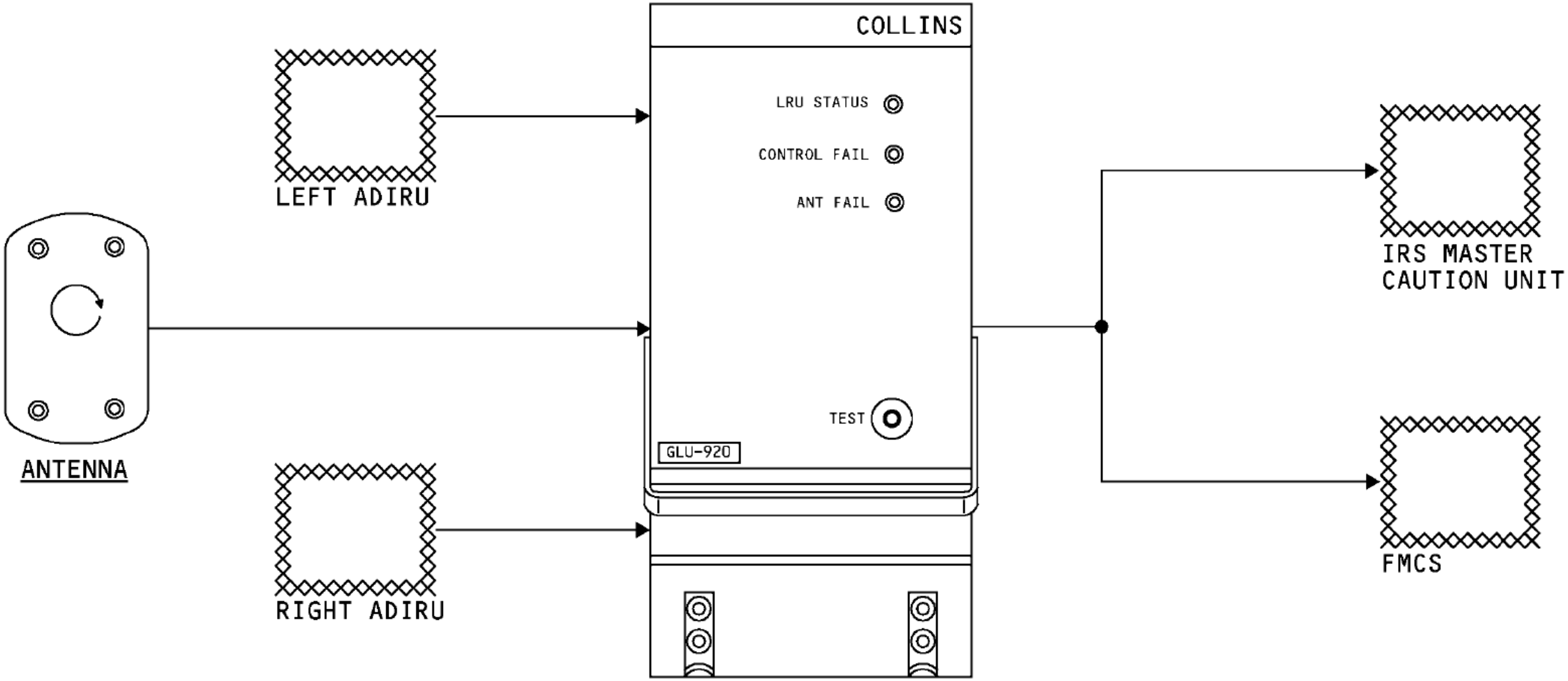
There are two GPS systems. Antenna 1 receives satellite signals and sends them to multi mode receiver (MMR) 1. Antenna 2 connects to MMR 2. The MMRs calculate the airplane position and accurate time. This data goes to the flight management computer system (FMCS) and the IRS master caution unit. The FMCS uses GPS or navigation radio position with inertial reference data to calculate the airplane position.

The ADIRU sends position data to the MMRs.

The IRS master caution unit gets GPS data from both MMRs. It causes the GPS fail light on the IRS mode select unit to come on when the two units have a failure or if one unit fails and the master caution annunciator is pushed.

The ground proximity warning computer gets GPS position and velocity data from the MMRs.

The clock gets GPS time and date from the MMRs.



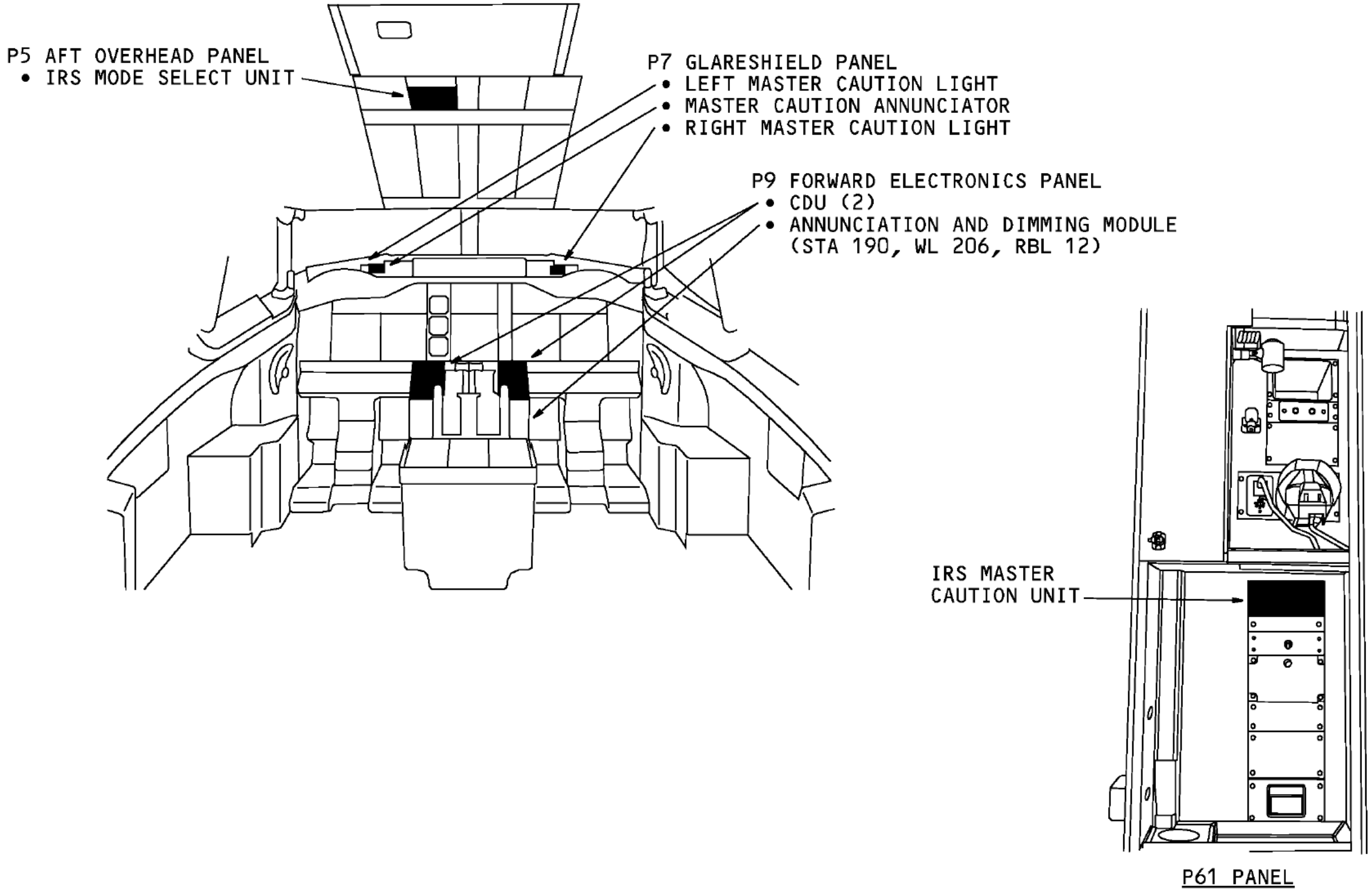
GENERAL DESCRIPTION

GPS - COMPONENT LOCATION

Flight compartment

These are the components in the flight compartment that have a relation to the GPS:

- Control display units
- Master caution annunciator
- Master caution lights
- IRS master caution unit
- Annunciation and dimming module
- IRS mode select unit.

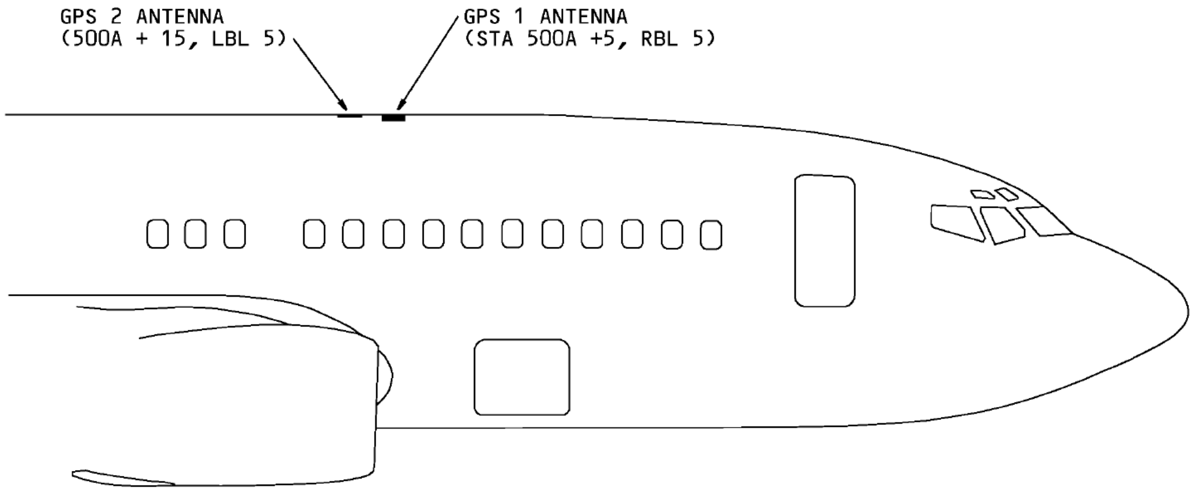


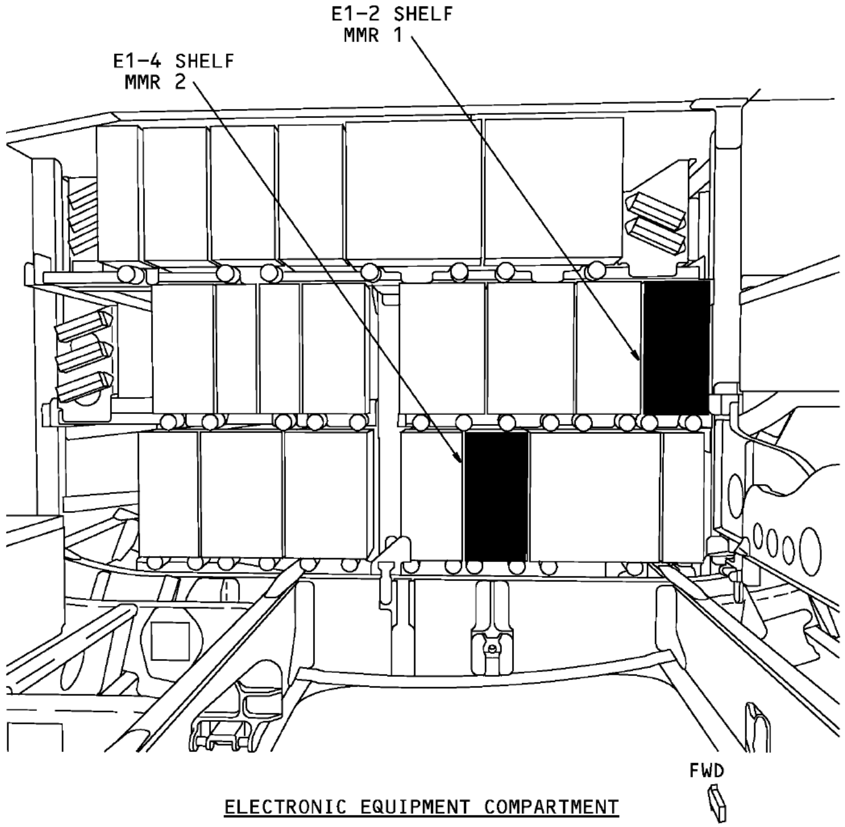
GPS COMPONENT LOCATION - FLIGHT COMPARTMENT

Antenas and EE compartment

The GPS antennas are on the top of the fuselage.

GPS sensor units are in the multi mode receivers (MMR). The MMRs are in the electronic equipment compartment. MMR 1 is on the E1-2 shelf. MMR 2 is on the E1-4 shelf.





ANTENNAS AND EE COMPARTMENT

INTERFACES

Power and Antenna Interface

Each multi-mode receiver (MMR) has a circuit breaker. The 115v ac buses supply power to the MMRs.

Each MMR receives a radio frequency (RF) signal from a GPS antenna.

ADIRU Data Buses

The MMRs get inertial reference data from the ADIRUs. Each MMR receives IR data from its onside ADIRU and the offside ADIRU. During normal operation, MMR 1 uses L ADIRU data and MMR 2 uses R ADIRU data. If there is a loss of data from an ADIRU, the MMR will use the data from the offside ADIRU.

The MMRs use this data for system initialization and to help system operation during periods of low satellite coverage.

MMR Data Output Bus

The MMR sends out this data:

- GPS latitude
- GPS latitude Fine
- GPS longitude
- GPS longitude fine
- Clock time and date
- GPS status
- Horizontal figure of merit
- Horizontal integrity limit.

The MMR sends the data to these units:

- FMC 1
- FMC 2
- Clocks, captain and first officer
- Ground proximity warning computer (GPWC)
- IRS master caution unit.

Flight Management Computer (FMC)

The MMRs send these GPS parameters to the FMC:

- Latitude
- Longitude
- Time
- Horizontal figure of merit
- Horizontal integrity limit.

The FMC uses the data for FMC position update and actual navigation performance (ANP) calculation.

Clock

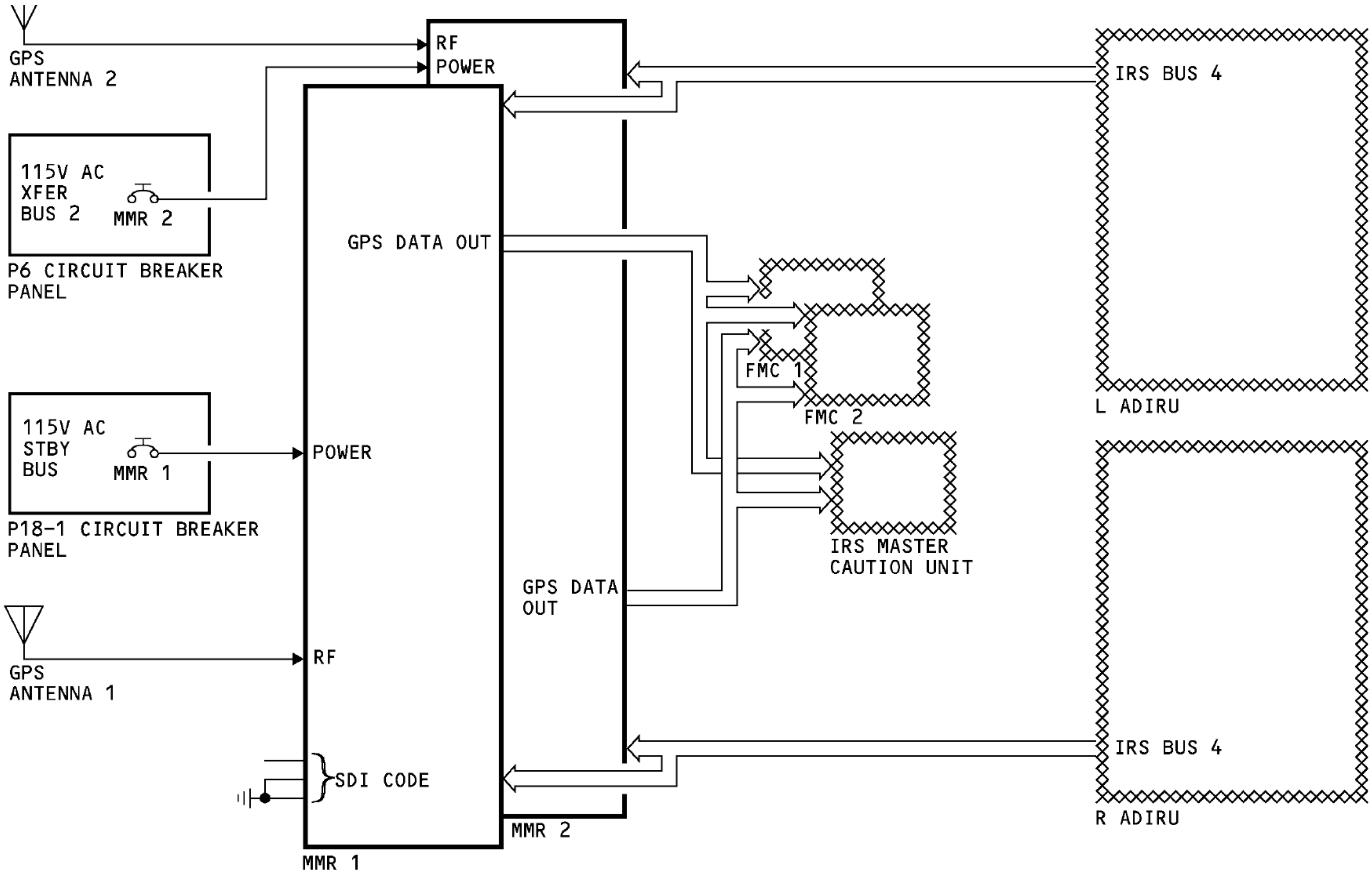
The clock uses GPS time and date.

IRS Master Caution Unit

The IRS master caution unit monitors data from the MMRs.

SDI Program Pins

Three program pins tell the MMR if it is number 1 or 2.


GPS
ANTENNA 2
RF
POWER
IRS BUS 4
115V AC
XFER
BUS 2
MMR 2
P6 CIRCUIT BREAKER
PANEL
GPS DATA OUT
FMC 1
FMC 2
L ADIRU
115V AC
STBY
BUS
MMR 1
POWER
IRS MASTER
CAUTION UNIT
P18-1 CIRCUIT BREAKER
PANEL
GPS DATA
OUT
GPS
ANTENNA 1
RF
IRS BUS 4
SDI CODE
MMR 2
R ADIRU
MMR 1

INTERFACES

GPS – COMPONENTS

RECEIVER

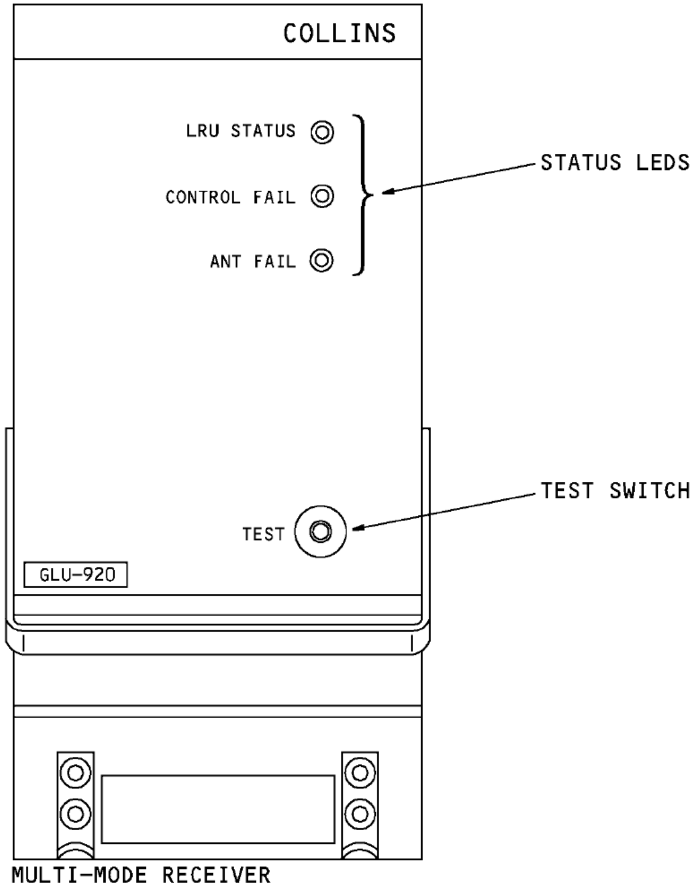
The multi-mode receiver (MMR) contains the GPS receiver. The GPS receiver receives navigation satellite signals to calculate GPS data.

The MMR is a standard ARINC 600 3 MCU unit 3.6 inches wide, 7.9 inches high, and 14.6 inches long. It has passive cooling. The MMR weighs 10 pounds and uses 115v ac, 400Hz power for operation.

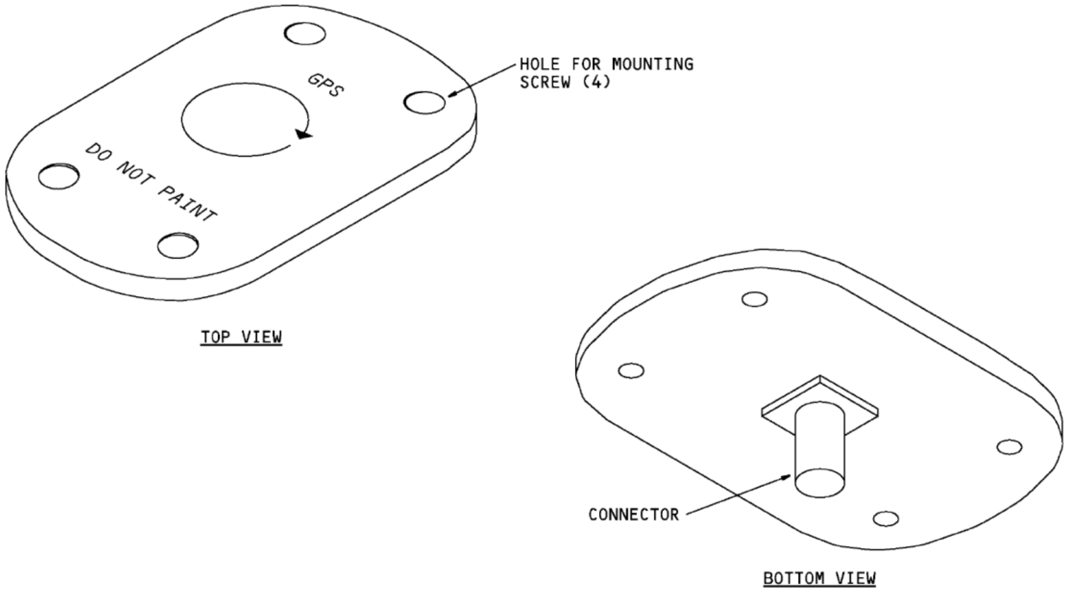
ANTENNAS

The GPS antennas receive L-band frequency signals (1575.42 MHz) and sends them to the multi mode receivers (MMR).

Each antenna contains an integrated preamplifier to increase the signal level to the MMR. The antenna preamplifiers use 12v dc which comes from the power supply in the MMR.



MULTI MODE RECEIVER



GPS ANTENNAS

THIS PAGE IS INTENTIONALLY LEFT BLANK

THEORY OF OPERATION

GPS Segments

The GPS has these three segments:

- Satellite
- User
- Control.

Satellite Segment

The satellite segment is a group of satellites that orbit 10,900 nautical miles above the earth. Each satellite makes an orbit once every 12 hours. There are 21 operational satellites and 3 spares.

The satellites continuously transmit radio signals with navigation data, range code, and the exact time.

User Segment

The user segment is the GPS receiver unit on the airplane. It receives the satellite signals. The GPS uses the satellite data to calculate the airplane position.

Control Segment

The control segment has control and monitor stations on earth that continuously monitor and track the satellites.

The control segment does these things:

- Monitor and correct satellite orbits and clocks
- Calculate and format a satellite navigation message. This message has up-to-date descriptions of the satellites future positions, and a collection of the latest data on all GPS satellites
- Update the satellite navigation message regularly.

The control segment has one master control station and five monitor stations. Three of the monitor stations are also upload stations.

The master control station is in Colorado Springs, USA. The master control station is the operational center of the GPS. The master control station controls all operations in the control segment. The master control station has an atomic clock, this clock is the reference for the GPS.

The monitor stations track the satellites 24 hours a day. The master control station remotely controls the monitor stations through on-line connections. The monitor stations are in these locations:

- Ascension island
- Colorado Springs
- Diego Garcia island
- Hawaii
- Kwajalein island.

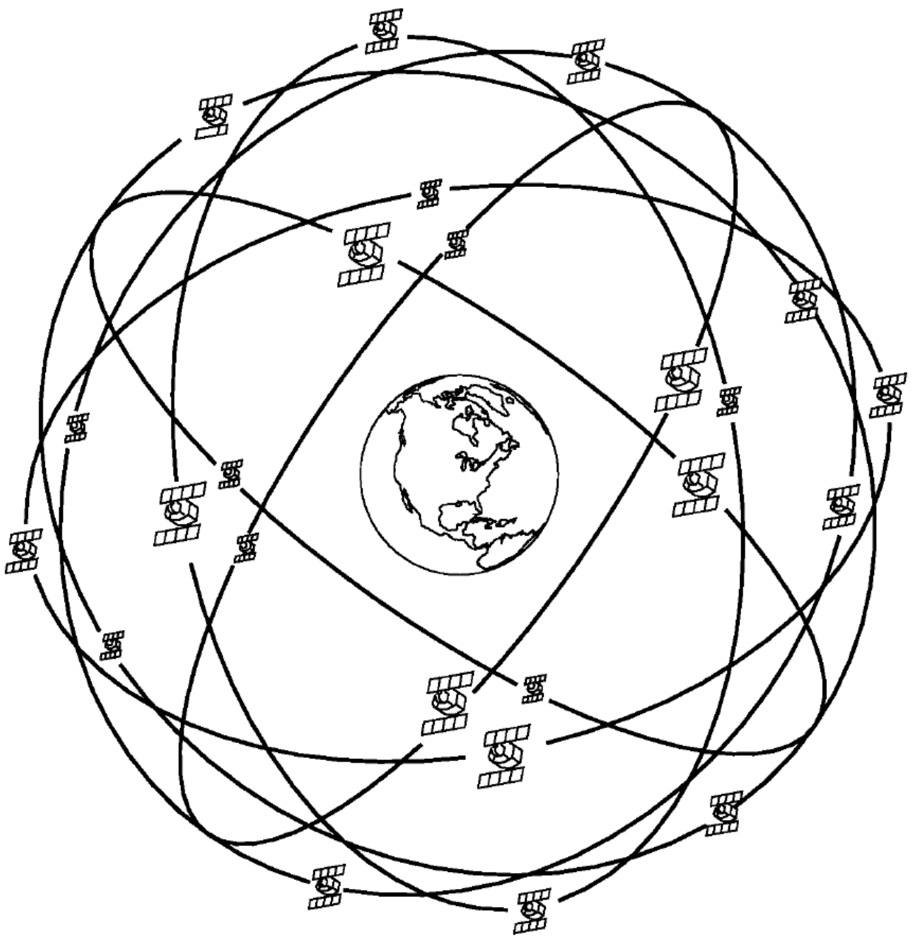
The monitor stations receive the same information from the satellites that the GPS receiver unit in the airplane receives.

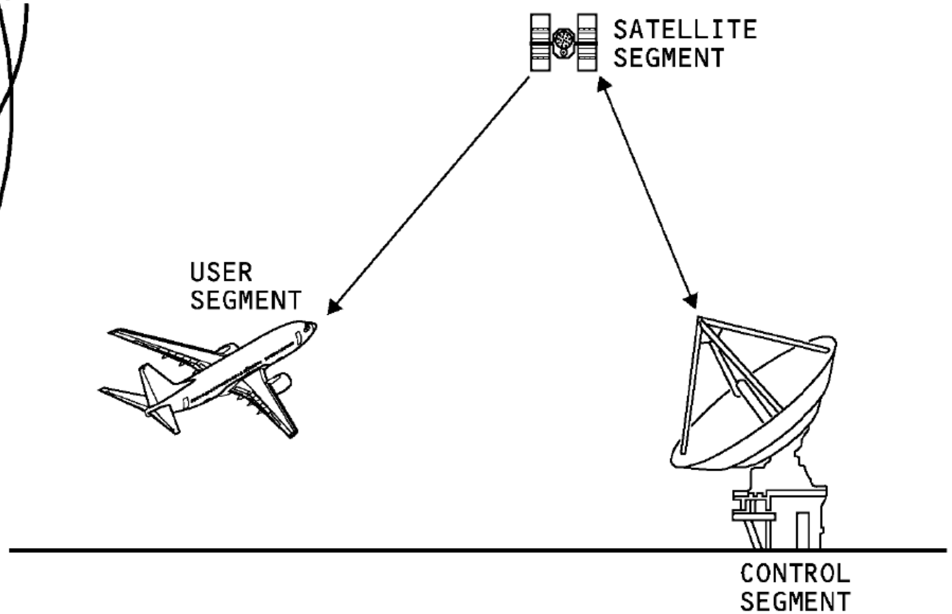
The monitor stations do these things:

- Record the accuracy of the satellite clocks
- Collect and relay to the control station meteorologic data such as barometric pressure, temperature, and dew point. The master control station uses this data to calculate the tropospheric signal delay
- Continuously measure the ranges to all visible satellites. The master control station uses this data to calculate and predict the satellites orbits.

The master control station uses the upload stations to send this data:

- Orbit correction commands to the satellites. The satellites use control rockets to correct their orbits
- The navigation message to the satellites.





THEORY OF OPERATION - 1

THEORY OF OPERATION (Continue)

Ranging

The GPS receivers use the principle of ranging to measure the distance between the receiver and the satellites. The receiver always has the location of the satellites in their orbits in memory.

The receiver measures the time it takes for a radio signal to go from a satelite to the airplane. Since the receiver knows the location of the satellite and that the radio signal travels at the speed of light, it can calculate the distance to the satellite.

The receiver uses one way ranging. The receiver must know exactly at what time the satellite sent the radio signal. The receiver compares the satellite signal to a signal that the receiver makes at the same time as the satellite. The difference between the two signals (t) is the time the satellite signal took to get to the receiver.

Each satellite has an atomic clock to keep accurate time. All the satellites have precisely the same time. The receiver in the airplane has an internal clock but it is not atomic. It is not as accurate. Thus, it is not possible for the receiver to have precisely the same time as the satellite.

The receiver assumes that its internal clock is off by some clock bias (tBIAS). This tBIAS is an unknown that the receiver must calculate. The tBIAS is the difference between the receiver time and GPS time.

To calculate the airplane position (latitude, longitude, and altitude) and the tBIAS, the receiver must know the position of at least four satellites. The receiver then measures the distances to all the satellites at the same time.

It then solves for these four unknowns with four range equations:

- Latitude
- Longitude
- Altitude
- tBIAS.

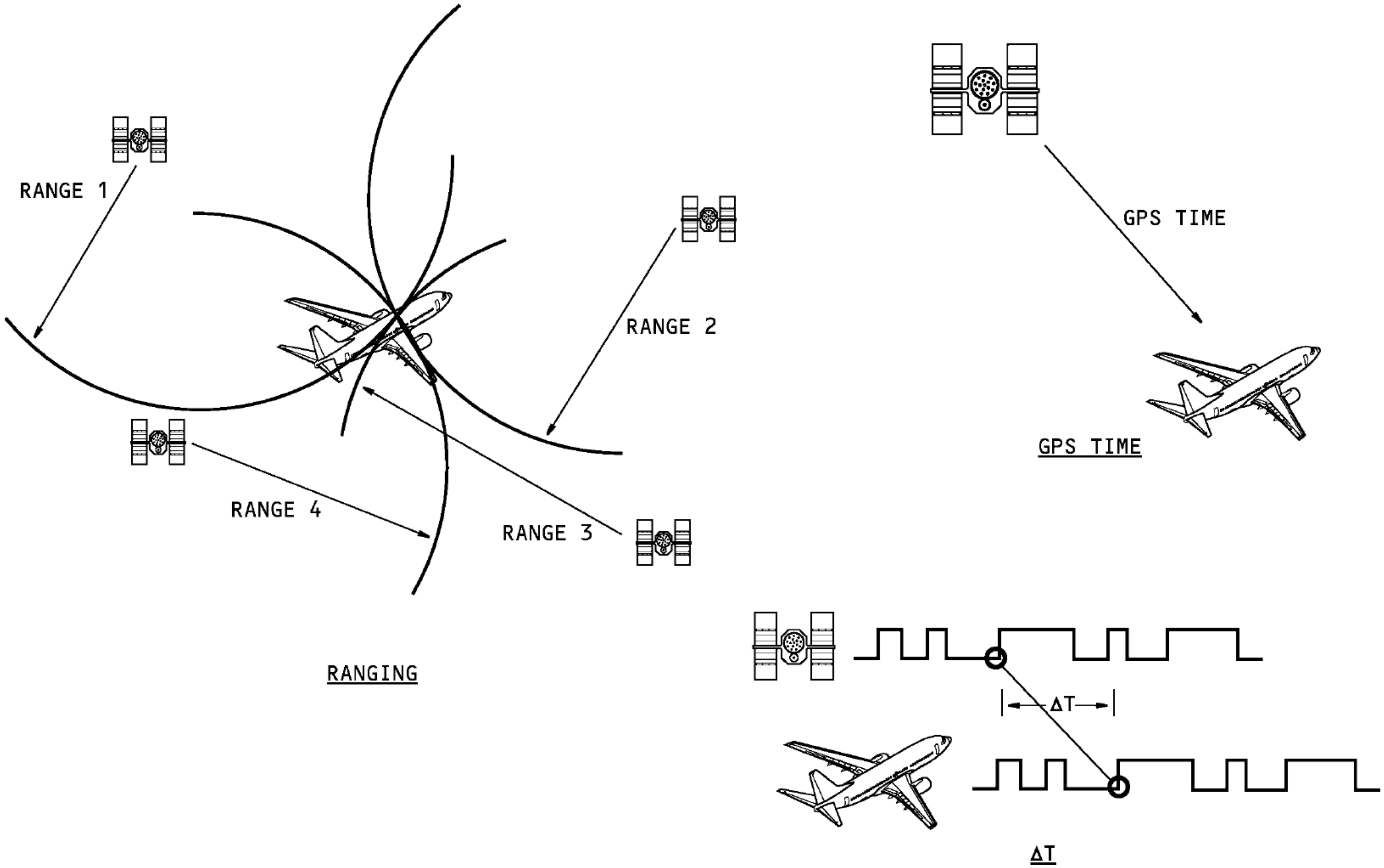
GPS Time

All the satellites synchronize to universal time (coordinated) (UTC). The satellites transmit this time to the receiver. The accuracy of the satellite UTC is approximately 100 nanoseconds. The receiver transmits UTC on an ARINC 429 format. The receiver also transmits a very accurate time mark once per second.

GPS Accuracy

Civilian users have access to standard positioning service (SPS). SPS has an accuracy of 15 - 25 meters for 95% of the position fixes. ~~For security reasons, the American Department of Defense intentionally degrades the accuracy for civilian users to 100 meters for 95% of the fixes.~~

Military users have access to precision positioning service (PPS). PPS has an accuracy of 18 meters or less for 95% of the fixes.



THEORY OF OPERATION - 2

THEORY OF OPERATION (Continue)

GPS Modes of Operation

The GPS operates in these modes:

- Acquisition mode
- Navigation mode
- Altitude aided mode
- Aided mode.

Acquisition Mode

The GPS looks for and locks on to the satellite signals. The GPS must find at least 4 satellites before it starts to calculate GPS data. The GPS gets data from the air data inertial reference system (ADIRS).

The GPS uses this data from air data inertial reference unit (ADIRU) when it is in the acquisition mode:

- Present position
- Altitude.

The GPS uses this data and its internal database to calculate which satellites are available at the present airplane position. The GPS takes less time to get to the navigation mode with this data.

If the ADIRU data is not available, the GPS can still acquire satellites signals. It takes longer to acquire the satellite signals because it has to look for all the satellites. When the GPS finds the satellites, it calculates which ones it can use.

The GPS takes approximately 75 seconds to acquire the satellite signals when the ADIRU data is available. The GPS takes approximately 4 minutes (maximum of 10 minutes) to acquire the satellites when the ADIRU data is not available.

Navigation Mode

The GPS enters the navigation mode after it acquires and locks on to at least 4 satellites. When the GPS is in the navigation mode, it calculates GPS data.

Altitude Aided Mode

With four satellites available, the GPS stores the difference between the ADIRU inertial altitude and the GPS altitude.

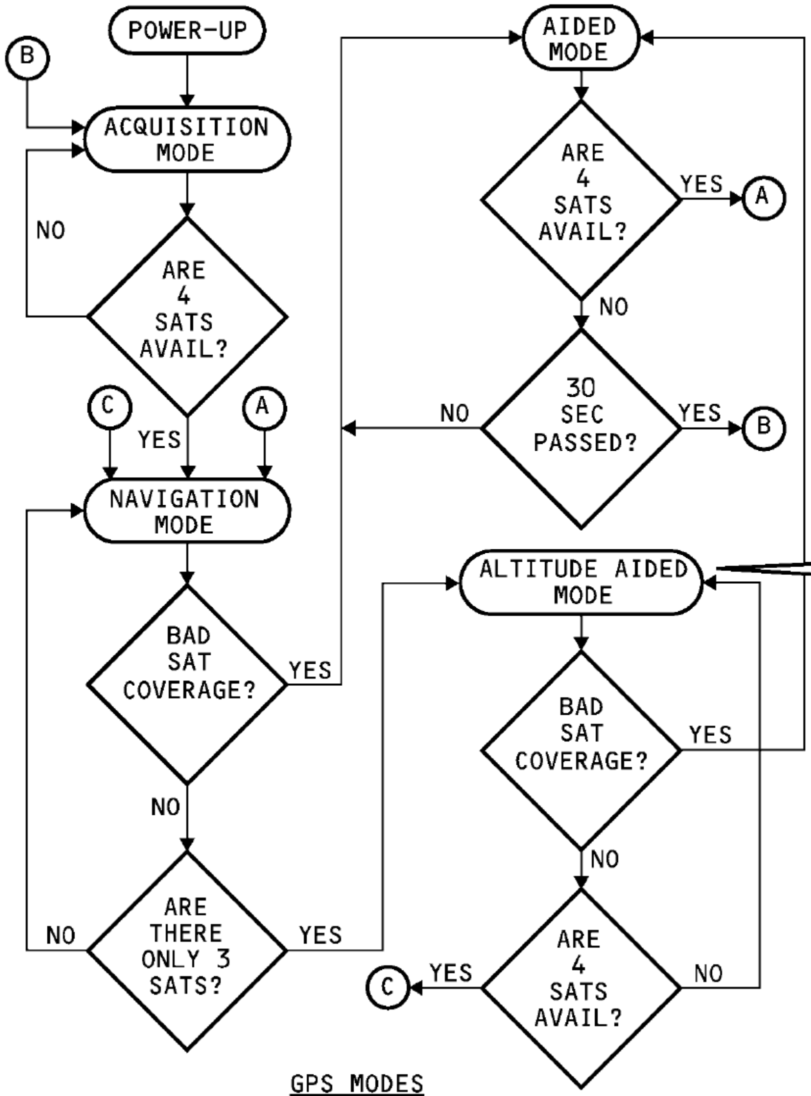
The GPS stores the difference between inertial and GPS altitude so that it can estimate the GPS altitude when only three satellites are available.

In the altitude aided mode, the GPS sums the airplane altitude from the ADIRU and the length of the earth radius as the fourth range.

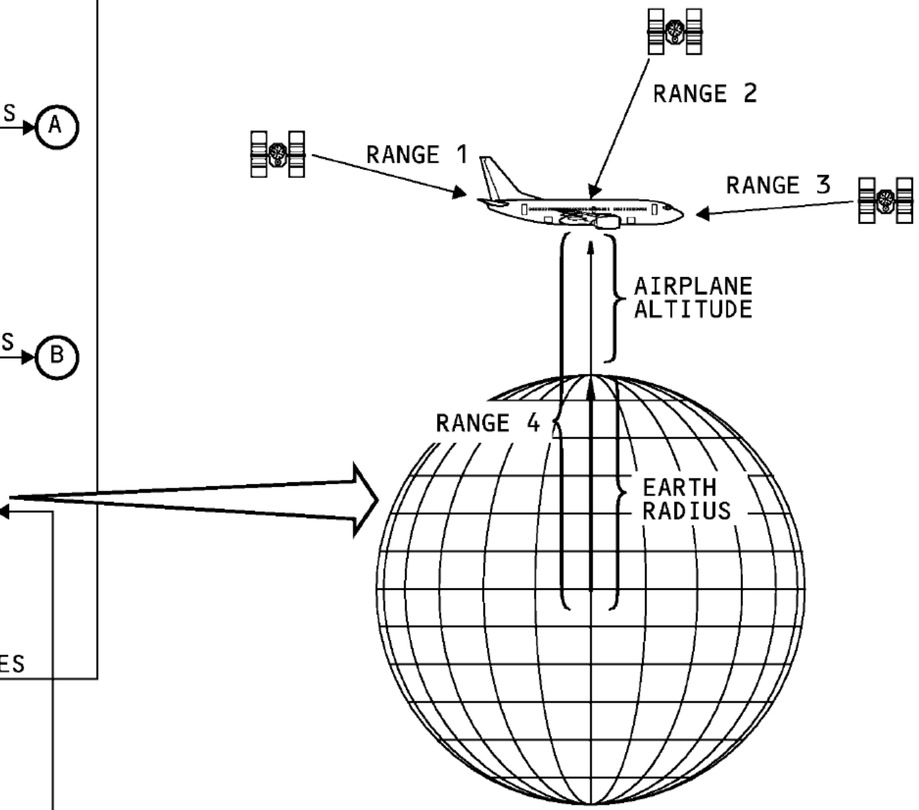
The GPS enters the altitude aided mode only after these three conditions are true:

- The GPS was in the navigation mode
- There are only 3 satellites available with good geometry for position fixes
- The GPS stored the difference between inertial and GPS altitude in memory.

The GPS starts normal operation again when a fourth satellite comes into view.



GPS MODES



ALTITUDE AIDED MODE

THEORY OF OPERATION - 3

THEORY OF OPERATION (Continue)

Aided Mode

The GPS enters the aided mode during short periods (less than 30 seconds) of bad satellite coverage. An example of bad satellite coverage is where at least four satellites are available but the airplane banks and loses satellite reception.

In the aided mode, the GPS receives inertial altitude, track angle, and ground speed from the ADIRU. The GPS uses the ADIRU data to go back quickly to the navigation mode when there is good satellite coverage again. The GPS output is NCD in this mode.

If the GPS cannot track any satellites for 30 seconds or more, the GPS goes to the acquisition mode.

GPS Frequencies

The satellites transmit to the GPS in the airplane on the L1 (1575.42 MHz) and L2 (1227.6 MHz) frequencies. The satellites downlink satellite status data to the monitor stations on 1783.74 MHz.

The upload stations send information to the satellites on 2227.5 MHz.

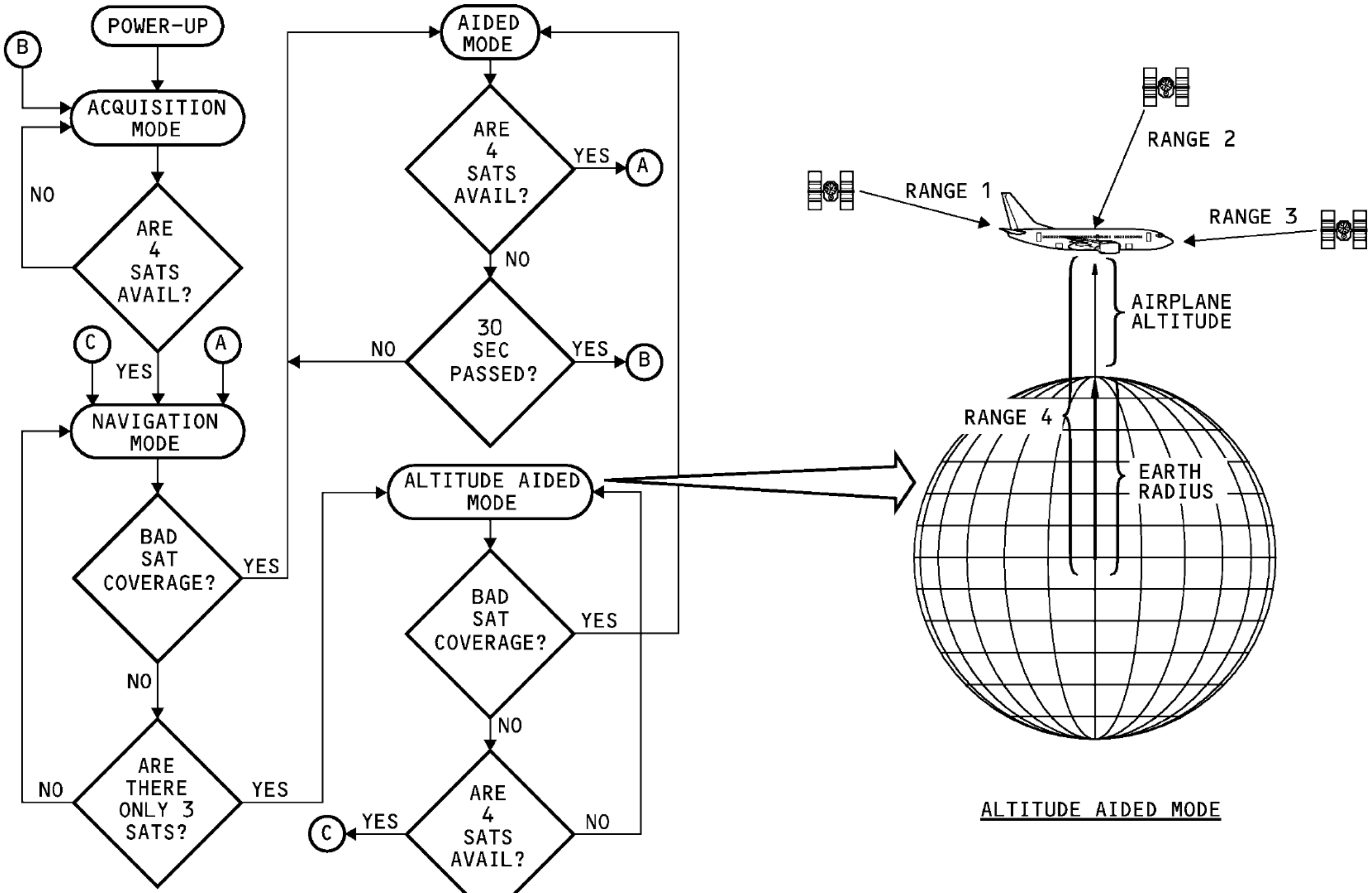
Autonomous Integrity Limit

The GPS has a receiver autonomous integrity monitor (RAIM) function. The RAIM monitors the status of the satellites that the GPS uses for calculations. The output of the RAIM function is an estimate of the GPS position error. The autonomous integrity monitor value goes to the FMC. The FMC uses the autonomous integrity monitor to determine if it can use GPS data for navigation.

Values Calculated by the GPS

These are some of the values that the GPS calculates:

- Latitude
- Longitude
- Altitude
- Universal time (coordinated) (UTC)
- Date
- North/south velocity
- East/west velocity
- Vertical velocity
- Track angle
- Autonomous integrity limit
- Satellite position
- GPS status.



GPS MODES

ALTITUDE AIDED MODE

THEORY OF OPERATION - 3

FUNCTIONAL DESCRIPTION

Power

The power supply makes various dc voltages from the 115v ac input to the multi-mode receiver (MMR).

Satellite Signal Processing

The GPS antenna first amplifies the satellite signals and then sends them to the MMR. The low noise amplifier (LNA) in the MMR receives and amplifies the satellite signals from the GPS antenna. The receiver detects the satellite signal and sends it to an analog to digital converter (A/D). The A/D sends the digitized signal to the microprocessor. The microprocessor calculates the airplane position and other GPS data.

The GPS data goes to these units:

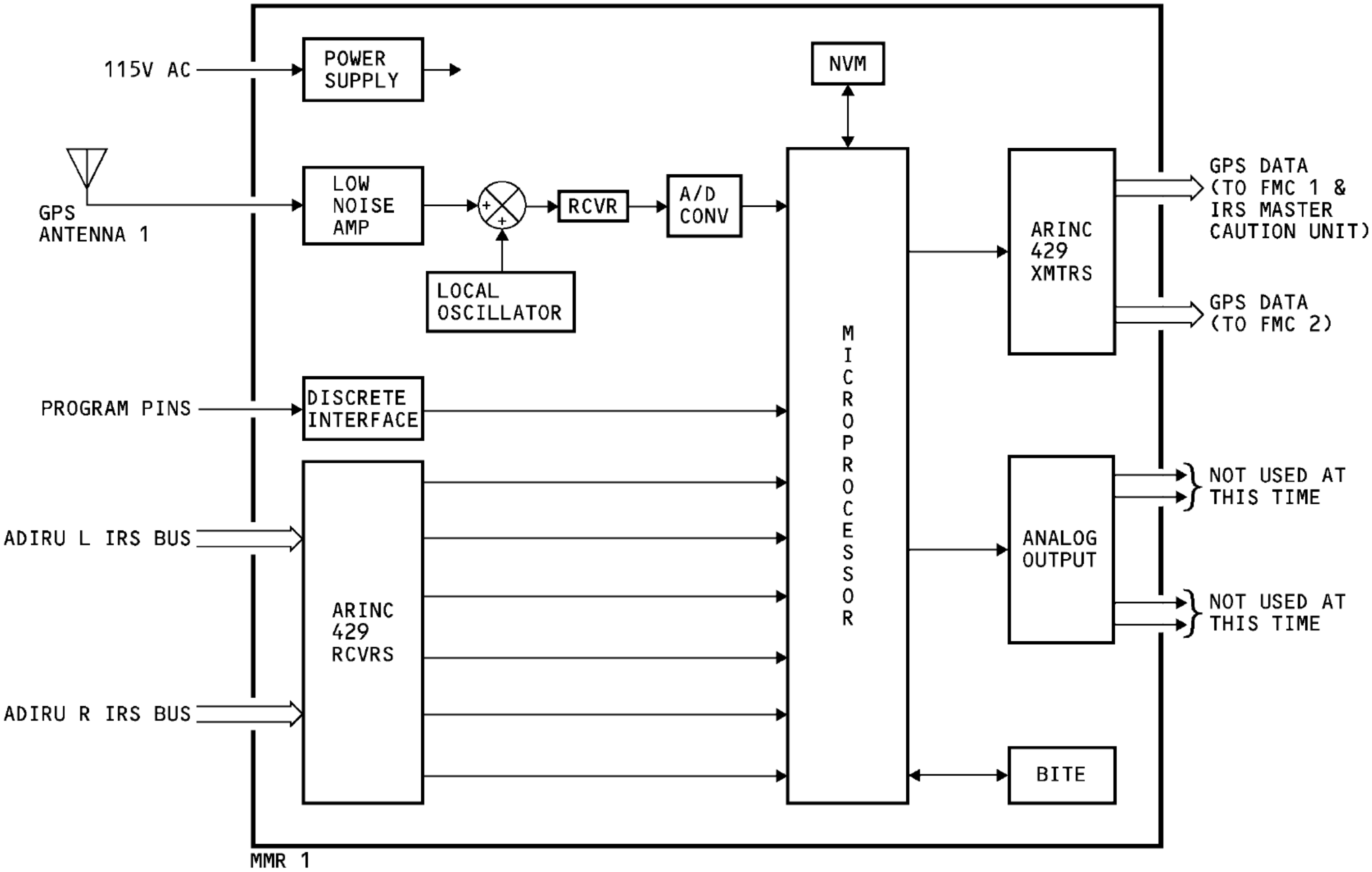
- Ground proximity warning computer (GPWC)
- Clocks
- Flight management computers (FMC 1 and 2).

The IRS master caution unit receives digital fault data from GPS systems 1 and 2.

Inputs

The ADIRU sends inertial reference data on output bus 4 for initialization. The MMR uses this data in the aided and altitude aided modes.

The program pins tell position to the MMR. This is used for the source destination identifier (SDI) code in ARINC 429 data.



FUNCTIONAL DIAGRAM

GPS FAULT MONITORING - FUNCTIONAL DESCRIPTION

One GPS Failure

If there is one GPS failure, there is no annunciation until you push the system status annunciator panel assembly (recall).

When you push the annunciator panel, these annunciations show:

- GPS light on the IRS mode select unit
- IRS light on the system status annunciator
- Left and right master caution lights.

A/C PRE SB 737-34-1461

When you release the annunciator panel assembly, the GPS light goes out but the IRS light and master caution lights stay on. Push either the left or right master caution light (reset) to reset all the annunciations.

A/C POST SB 737-34-1461

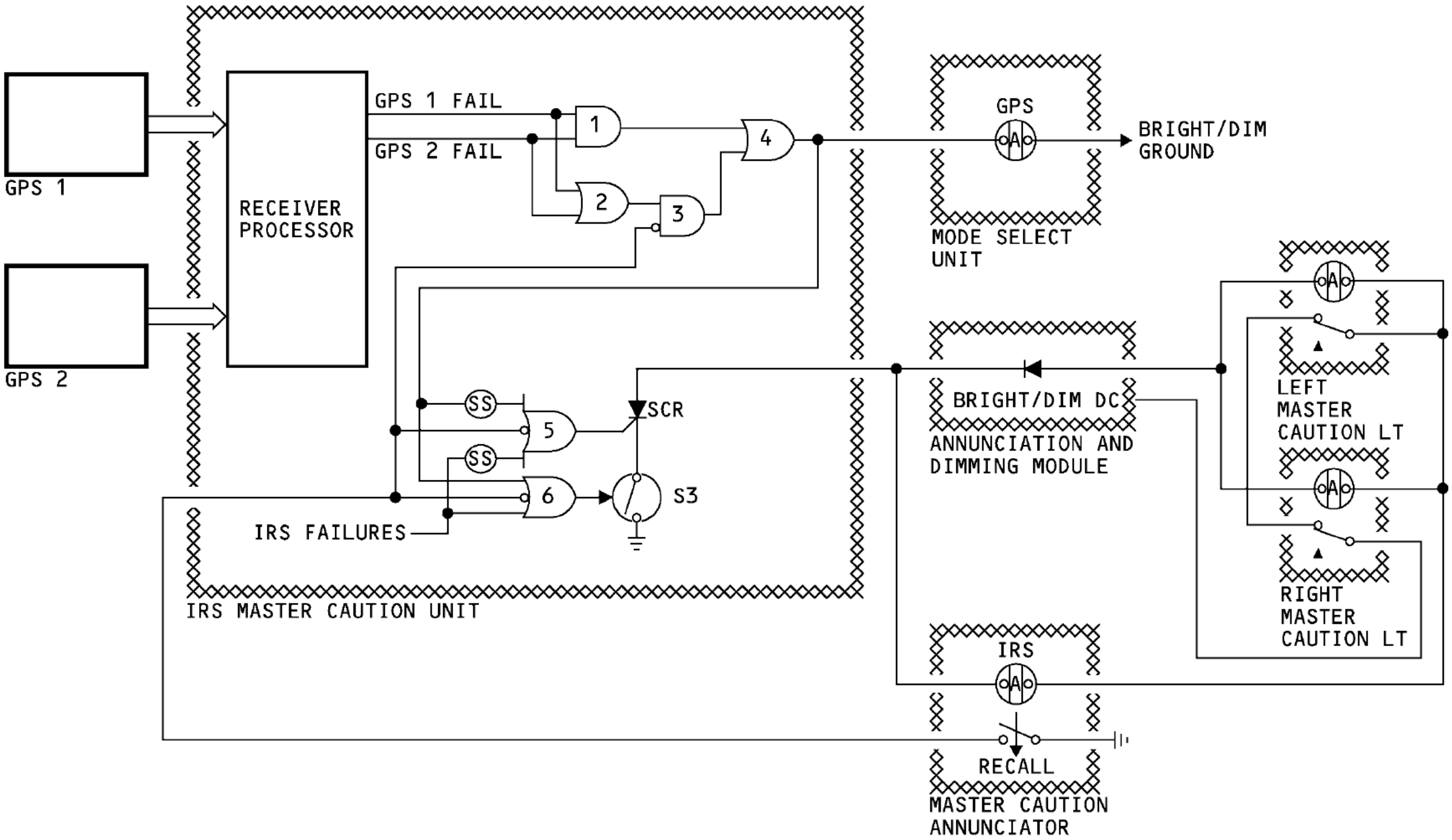
When you release the annunciator panel assembly, all the annunciations stay on until you reset by a push of either the left or right master caution light (reset).

Two GPS Failures

If both GPS systems have a failure, these annunciations show:

- GPS light on the IRS mode select unit
- IRS light on the system status annunciator
- Left and right master caution lights.

When you push and release either the left or right master caution light, the IRS light and master caution lights go out but the GPS light stays on.



GPS FAULT MONITORING

GPS - DISPLAYS

CDU

General

GPS data shows on the control display unit (CDU). The position pages show this data.

These are the three position pages:

- Position initialization (1/3)
- Position reference (2/3)
- Position shift (3/3).

You use the next and previous key to see all three position pages.

These are the pages that show GPS data:

- Position reference (POS REF)
- Position shift (POS SHIFT).

POS REF Page

The POS REF page shows GPS L (1) and R (2) positions.

POS SHIFT Page

The POS SHIFT page shows the GPS position from the flight management computer (FMC) position.

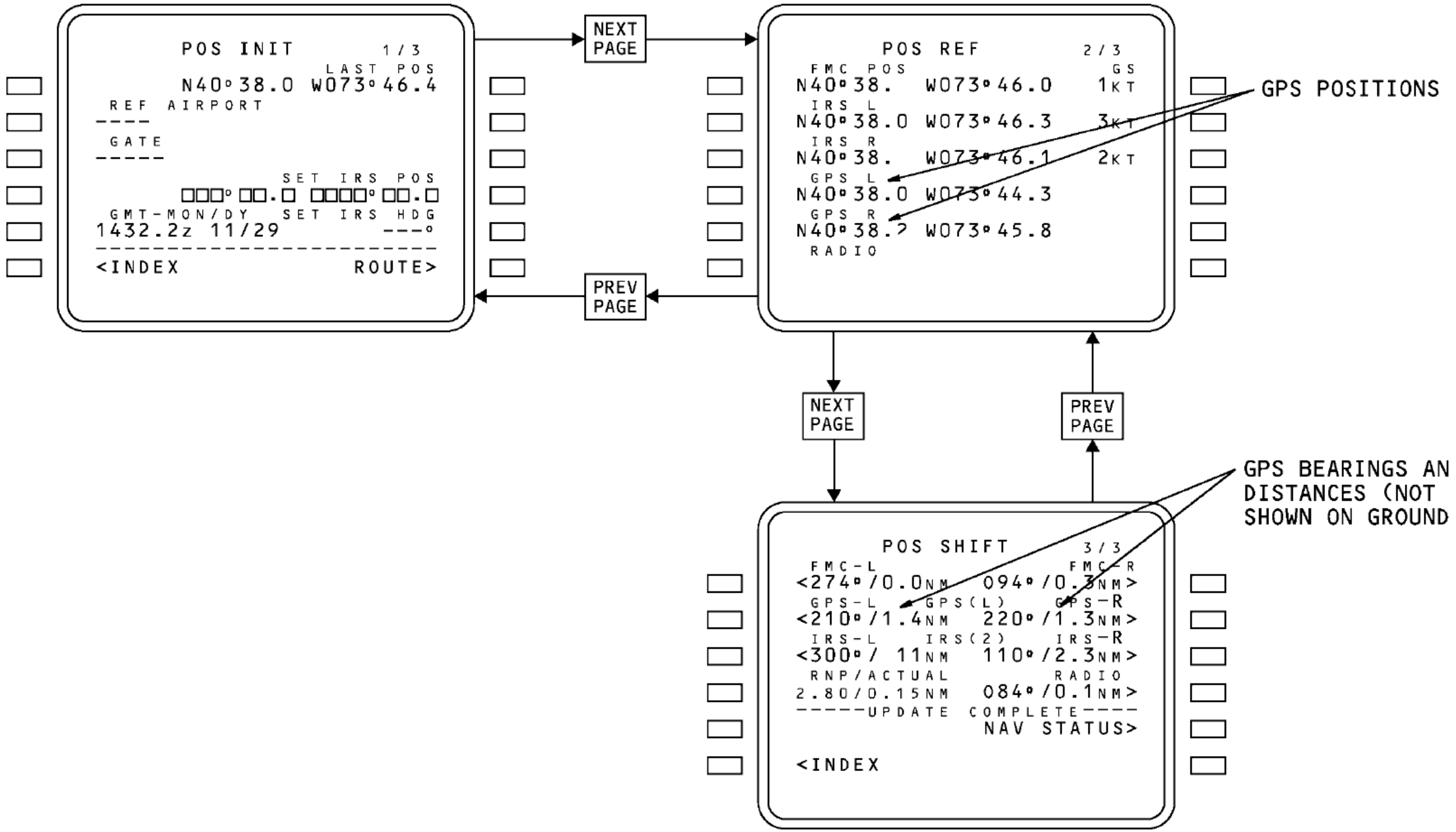
The GPS position shows in these two parts divided by a slash (/):

- Bearing of the GPS position from the FMC position
- Distance of the GPS position from the FMC position in nautical miles (NM).

Training Information Point

For all CDU displays that show GPS data, the displays refer to GPS 1 as GPS L and GPS 2 as GPS R.

The POS SHIFT page does not show information in the data fields when the airplane is on the ground.



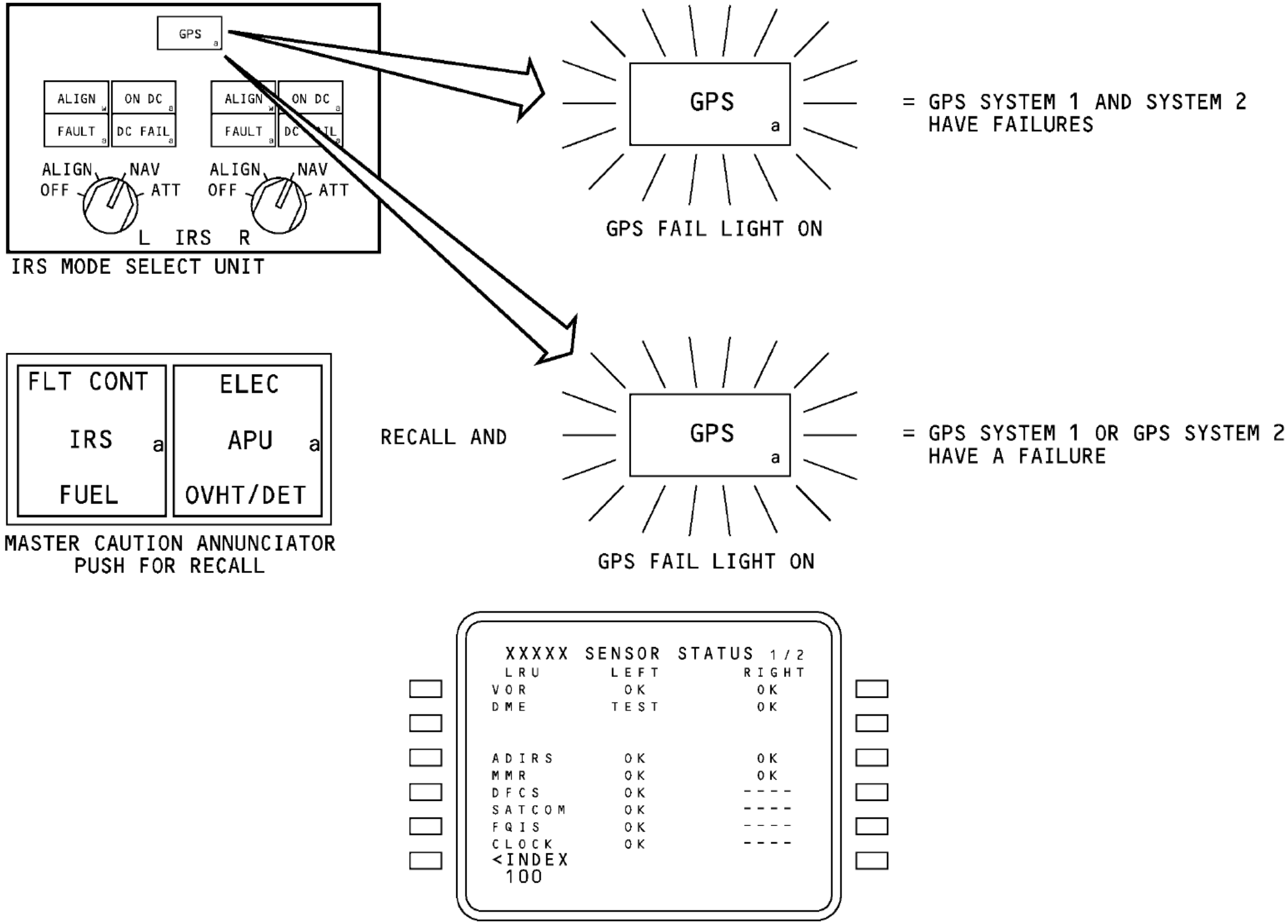
GPS DISPLAYS - CDU

GPS FAULT DISPLAYS (TRAINING INFORMATION POINT)

The GPS has continuous monitor BITE.

These are the three ways to detect GPS failures:

- When both GPS system 1 and GPS system 2 have failures, the GPS fail light comes on.
  PRE SB 737-34-1461
- When you push/hold a master caution annunciator and a GPS system has a failure, the GPS fail light comes on.
  POST SB 737-34-1461
- When you push a master caution annunciator and a GPS system has a failure, the GPS fail light comes on.
- The FMC SENSOR STATUS page shows MMR failures. The FMC SENSOR DATA page shows the internal failure in the MMR.



GPS FAULT DISPLAYS

GPS DATA FROM FMCS BITE (TRAINING INFORMATION POINT)

These are the two pages that show GPS maintenance data:

- FMCS SENSOR STATUS page
- FMCS SENSOR DATA page.

FMCS SENSOR STATUS Page

The FMCS SENSOR STATUS page shows the status of the GPS systems. It shows OK for systems that are valid and FAIL for a GPS system that has failed.

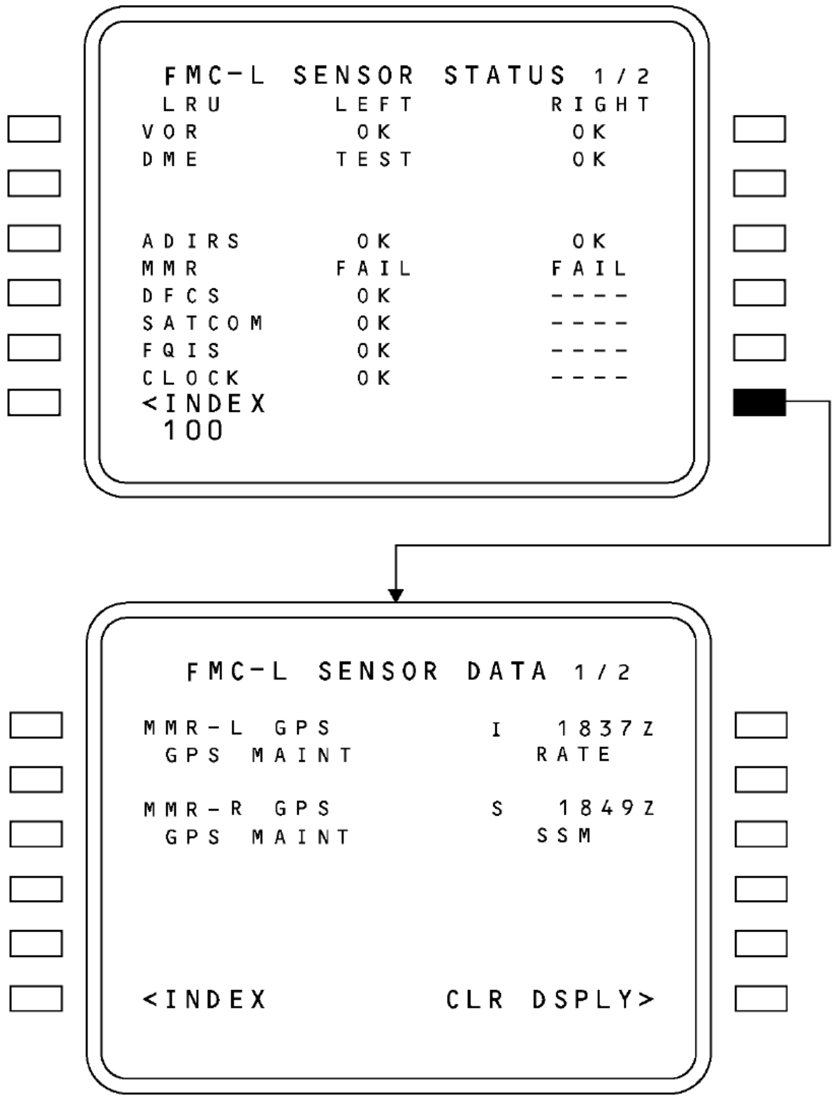
To get access to the engineering data for the failures, type 100 in to the scratch pad and select line select key 6 right (LSK 6R).

FMCS SENSOR DATA Page

When GPS L (1) or GPS R (2) has a failure, the engineering data will show. If both GPS systems are valid, no engineering data for the GPS systems will show on this page.

This is the data that will show:

- System code
- Label code
- Fault state
- Failure time
- Monitor code.



GPS DATA ON CDU

GPS - MMR BITE

When you push the test switch, the MMR does a check of the internal operation and its interface with the GPS antenna. The test takes approximately 36 seconds.

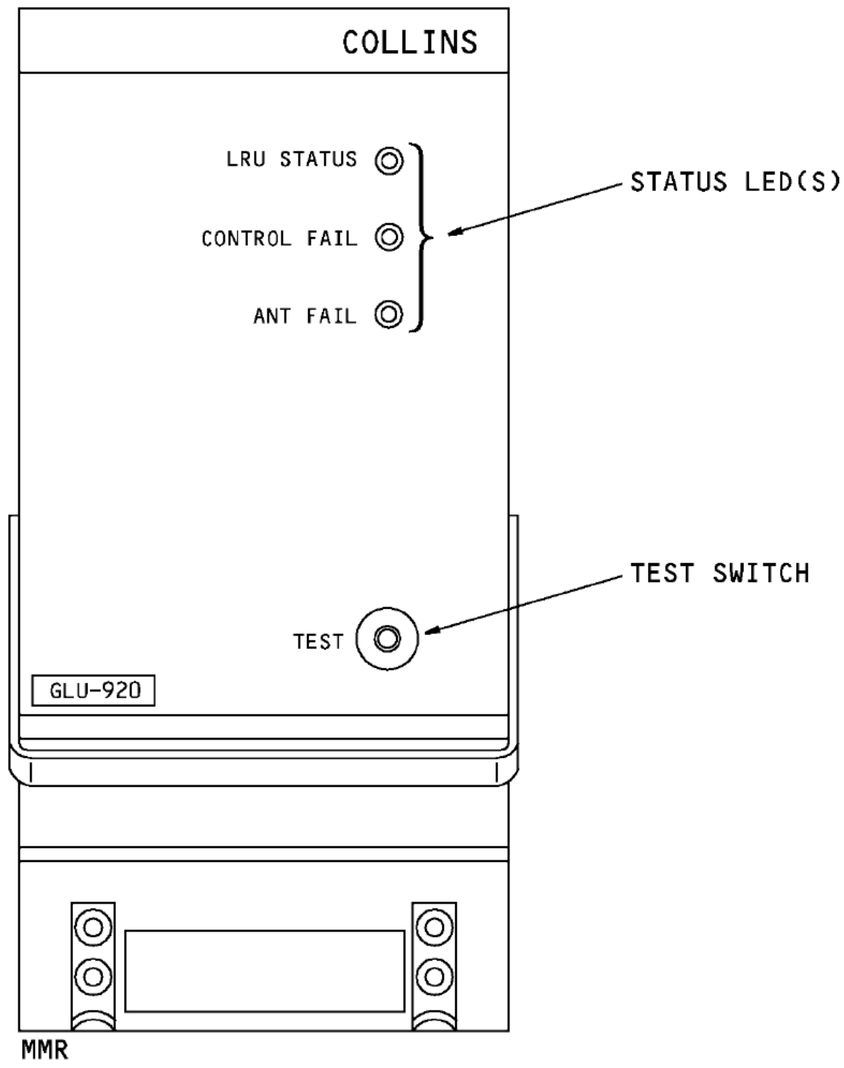
This is the test sequence that shows on the status LEDs during the test:

- **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.

Note: The ANT FAIL LED is not used at this time.

The LRU STATUS LED shows red when there is an internal failure in the MMR. A green LED shows that the MMR is normal.

The CONTROL FAIL LED shows red when an interface to the MMR has a failure.



BITE

THIS PAGE IS INTENTIONALLY LEFT BLANK

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34-40 NAVIGATION (ATA 34)

LEVEL 3

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–41. RADIO ALTIMETER SYSTEM (ATA 34–33)

LEVEL 3

RADIO ALTIMETER SYSTEM - INTRODUCTION

General

The radio altimeter (RA) system measures the vertical distance from the airplane to the ground. The radio altitude shows in the flight compartment on the display units (DU). The radio altitude is computed with the receiver transmitter unit by comparing the transmitted signal to the received signal. The R/T unit transmits a radio signal then receives the reflected RF signal back from the ground to determine the altitude of the aircraft. The R/T sends computed altitude data out on two ARINC 429 data buses to user systems on the aircraft.

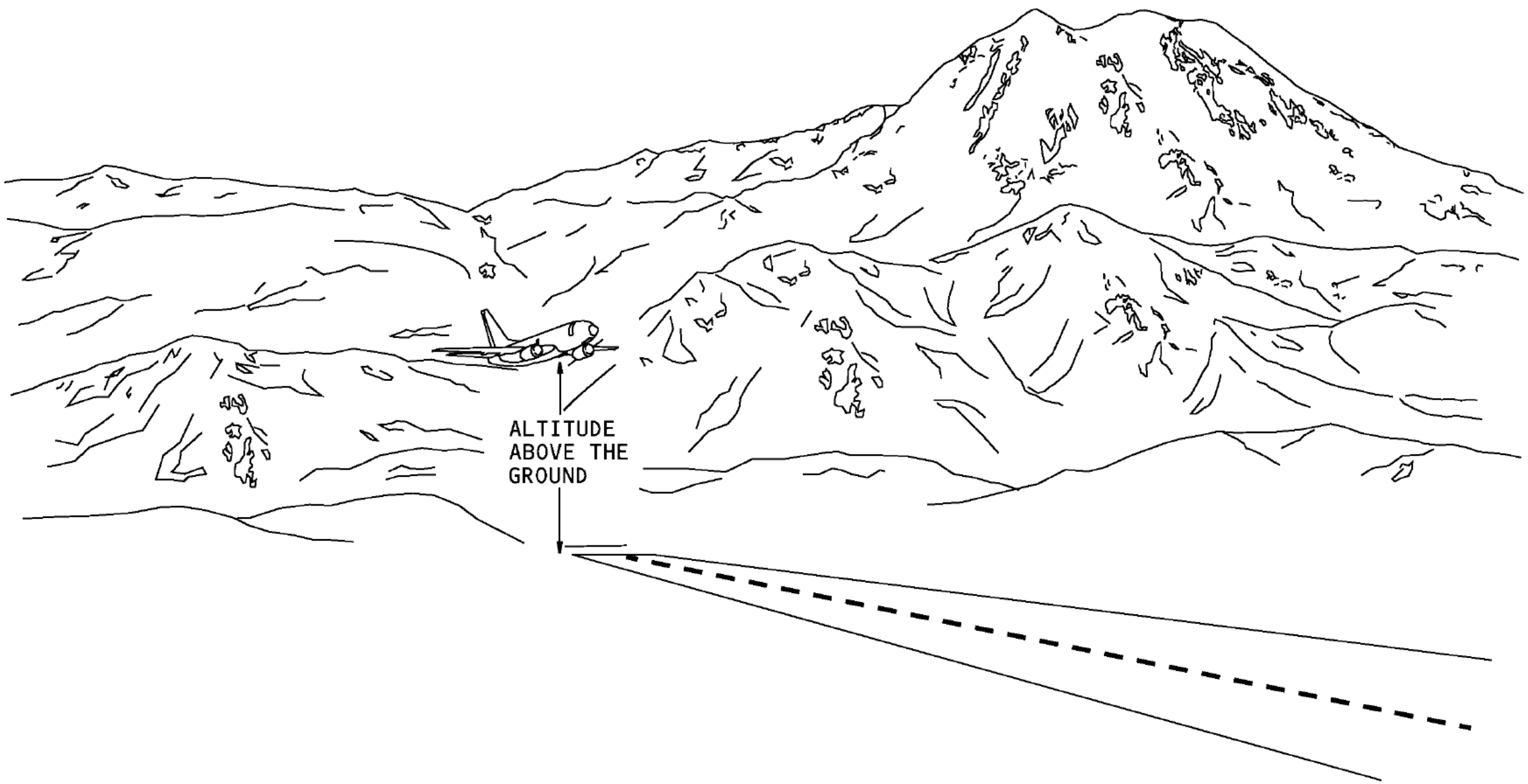
The flight crew and other airplane systems use the altitude data during low altitude flight, approach, and landing.

The system has a range of -12 to 2500 feet.

An adjustable radio minimums alert operates with the radio altitude system and is independently selectable from 0 to 999 feet on the captains and first officers EFIS control panels. The radio minimums altitude selection is compared and processed in the display electronics units (DEUs) with the existing radio altitude value output from the radio altitude R/T. When the airplane descends to the selected radio minimums altitude a flashing radio minimums alert is displayed on the applicable DU.

Abbreviations and Acronyms

- AID - aircraft installed delay
- altm - altimeter
- ant - antenna
- ARINC - Aeronautical Radio, Inc.
- BITE - built-in test equipment
- CDS - common display system
- conn - connector
- CP - control panel
- CW - continuous wave
- DEU - display electronics unit
- DH - decision height
- DME - distance measuring equipment
- DU - display unit
- EFIS - electronic flight instrument system
- FCC - flight control computer
- FDAU - flight data acquisition unit
- FM - frequency modulation
- F/O - first officer
- freq - frequency
- GPWC - ground proximity warning computer
- ILS - instrument landing system
- LCD - liquid crystal display
- LED - light emitting diode
- LRU - line replaceable unit
- MDA - minimum descent altitude
- mins - minimums
- PFD - primary flight display
- P/N - part number
- RA - radio altimeter
- RA - radio altitude
- rec - receiver
- RF - radio frequency
- rst - reset
- R/T - receiver transmitter
- S/W - software
- sys - system
- T - time
- TCAS - traffic alert and collision avoidance system
- VCO - voltage controlled oscillator
- WXR - weather radar
- xmit - transmit



RADIO ALTIMETER SYSTEM - INTRODUCTION

GENERAL DESCRIPTION

The radio altimeter system has two receiver/transmitters (R/Ts). Each R/T has a transmit and a receive antenna. The radio altimeter R/T makes a frequency modulated continuous wave RF signal that is sent to the ground and reflected back to the airplane. The time that it takes for the signal to travel from the transmit circuit of the R/T to the receive circuit of the R/T is changed into absolute altitude. The number one system altitude shows on the captain display and the number two system shows on the first officer display.

The altitude data and signal validity is sent on two ARINC 429 data buses.

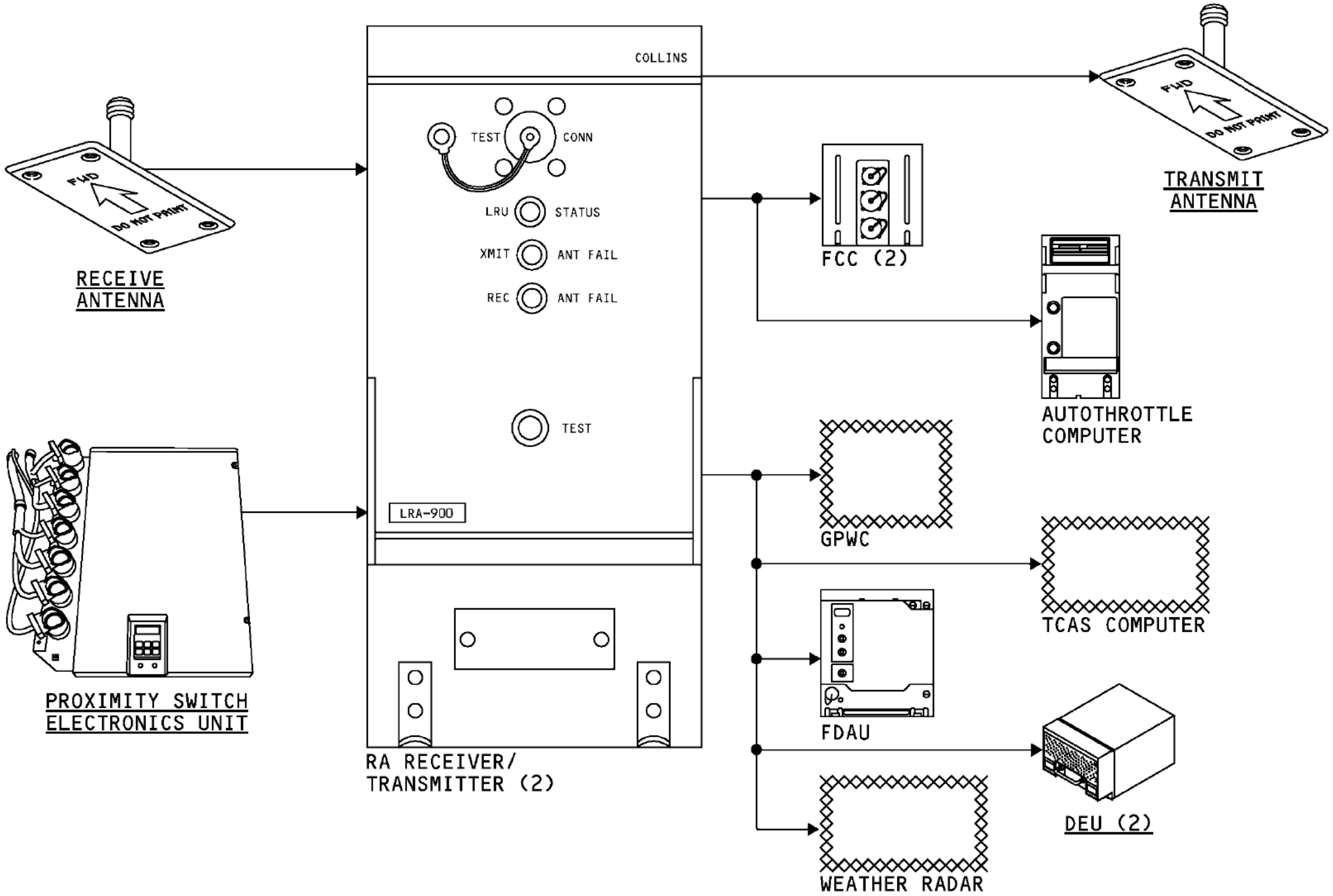
ARINC 429 data bus 1 sends data to these components:

- Flight control computers (FCC)
- Autothrottle computer.

ARINC 429 data bus 2 sends data to these components:

- Ground proximity warning computer (GPWC)
- Traffic alert and collision avoidance system (TCAS) computer
- Flight data acquisition unit (FDAU)
- Weather Radar (WXR)
- Common display system (CDS) display electronic units (DEU).

The receiver/transmitters get discrete inputs from the proximity switch electronics unit (PSEU) used to count flight legs for fault recording.



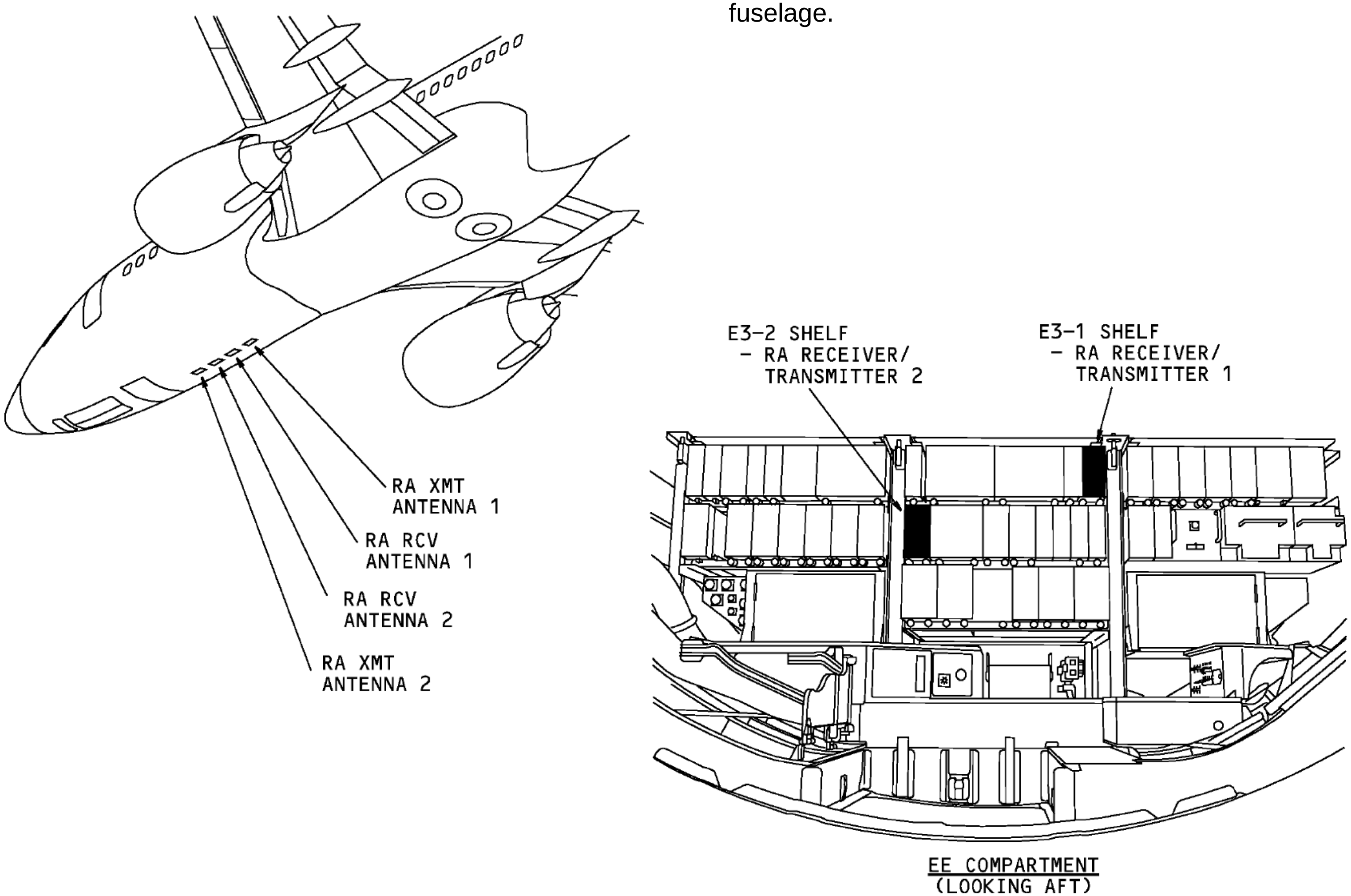
GENERAL DESCRIPTION

RA SYSTEM - COMPONENTS LOCATION

Antennas and EE compartment

The RA receiver/transmitters are on the E3 rack in the electronic equipment (EE) compartment.

The RA antennas are on the bottom of the fuselage.

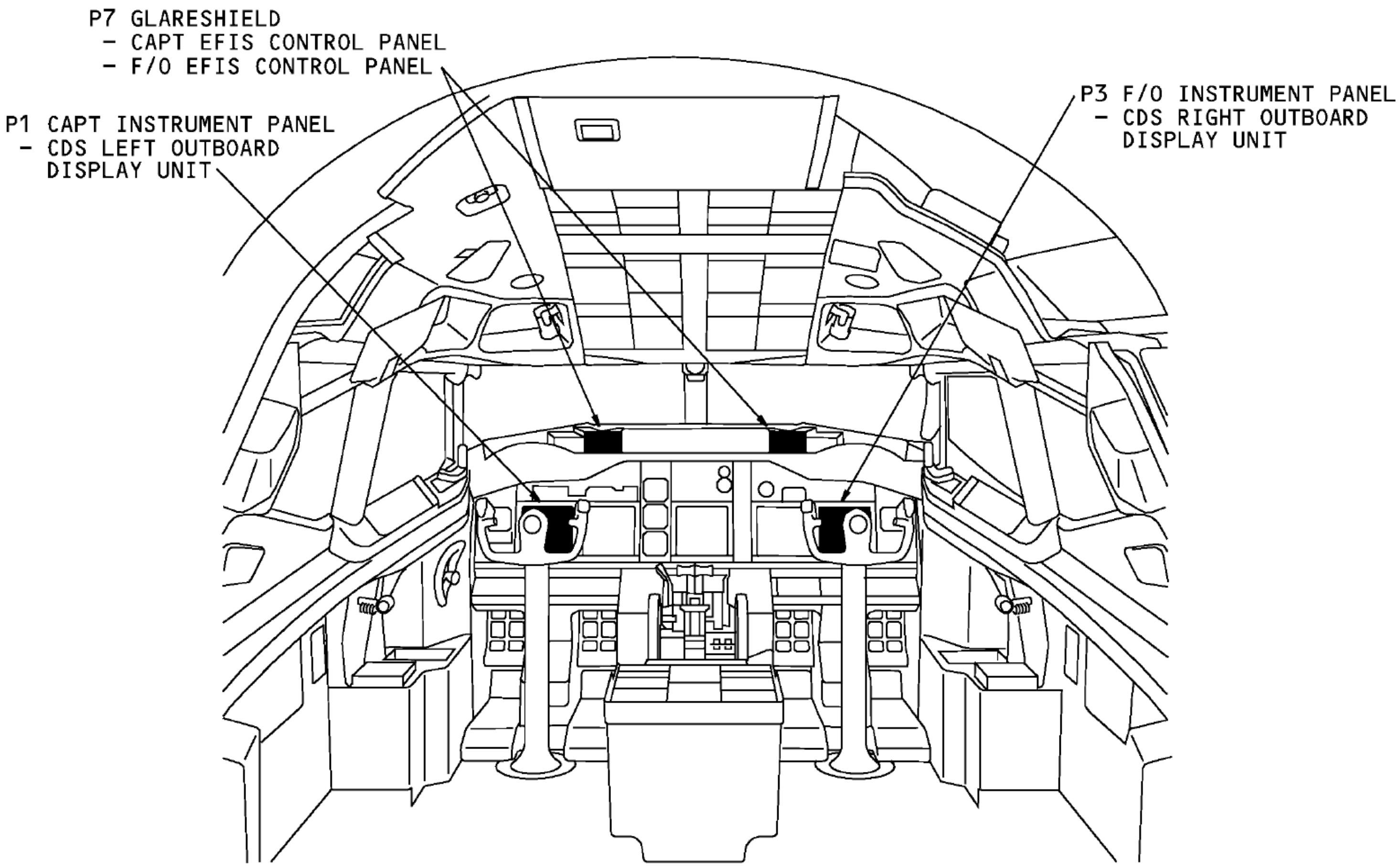


COMPONENTS LOCATION - 1

Flight deck

These are the components in the flight compartment that interface with the RA system:

- Left and right EFIS control panels
- Common display system (CDS) display units (DU).



COMPONENTS LOCATION - 2

THIS PAGE IS INTENTIONALLY LEFT BLANK

RA SYSTEM – INTERFACES

POWER, ANTENNA, AND DISCRETE INPUTS

Power

Power for the RA receiver/transmitter 1 is 115v ac from xfer bus 1. RA receiver/transmitter 2 receives 115v ac from xfer bus 2.

Antenna Interfaces

The transmit antenna sends radio frequency (RF) signals to the ground. The receive antenna sends reflected RF signals to the receiver circuits of the RA receiver/transmitter.

Flight Control Computer Discrete

The flight control computers (FCC) supply a test inhibit signal to the RA receiver/transmitter. This signal prevents an RA test when ILS mode is selected.

PSEU

The RA receiver/transmitter keeps internal and external faults in a nonvolatile fault memory. The RA receiver/transmitter keeps these faults by flight segments. The RA identifies the faults as airborne faults or ground faults. The proximity switch electronics unit (PSEU) gives the air/ground condition.

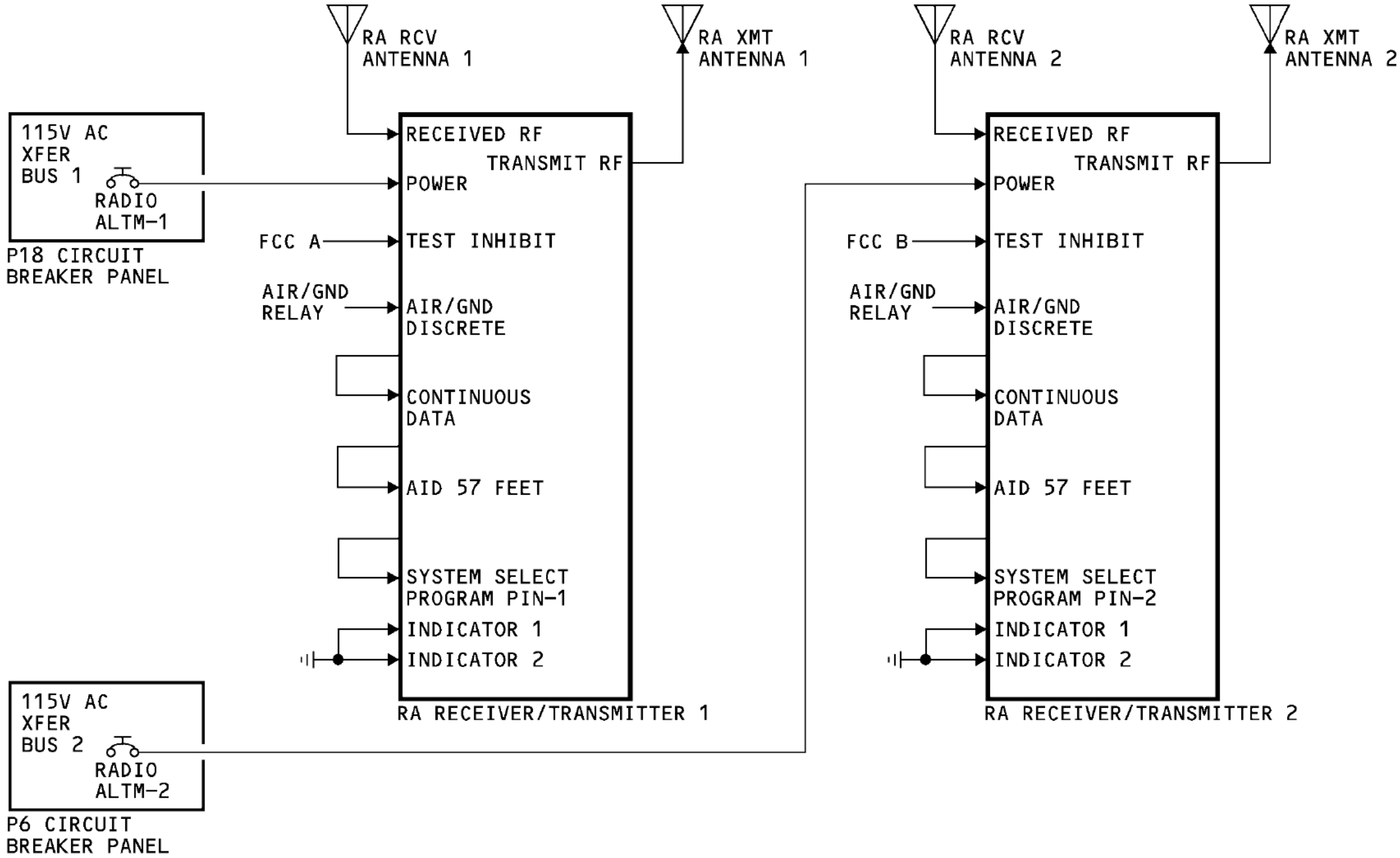
Input Program Pins

These are the radio altimeter program pins:

- Continuous data. When grounded, lets continuous altitude data be transmitted to user systems
- Aircraft installed delay (AID) of 57 feet. This lets the RA system compensate the altitude calculation for antenna cable length and distance of the RA system antennas from the ground at touchdown
- System select. Used to identify which system.

Indicator Discrete

The indicator discrete supplies the status of flight compartment radio altitude indicators. This system does not use radio altitude indicators.



POWER, ANTENNA, AND DISCRETE INPUTS

DATA BUS OUTPUTS, DECISION HEIGHT INTERFACE

General

The RA system supplies radio altitude (RA) data to these components:

- FCC A and the FCC B
- Autothrottle computer
- Display electronics unit (DEU) 1 and the DEU 2
- Weather radar R/T
- GPWC
- FDAU
- TCAS computer.

RA Receiver/Transmitter Outputs

Each FCC uses radio altitude from its on-side RA receiver/transmitter. The FCCs use radio altitude in the approach control and low altitude flight calculations.

The autothrottle uses radio altitude in the TO/GA calculations and autothrottle flare calculations.

The DEUs use radio altitude data to calculate the type of radio altitude display and the radio altitude value to show on the display units.

The weather radar R/T uses radio altitude to turn on or off the predictive windshear function and to enable/disable display and alert functions.

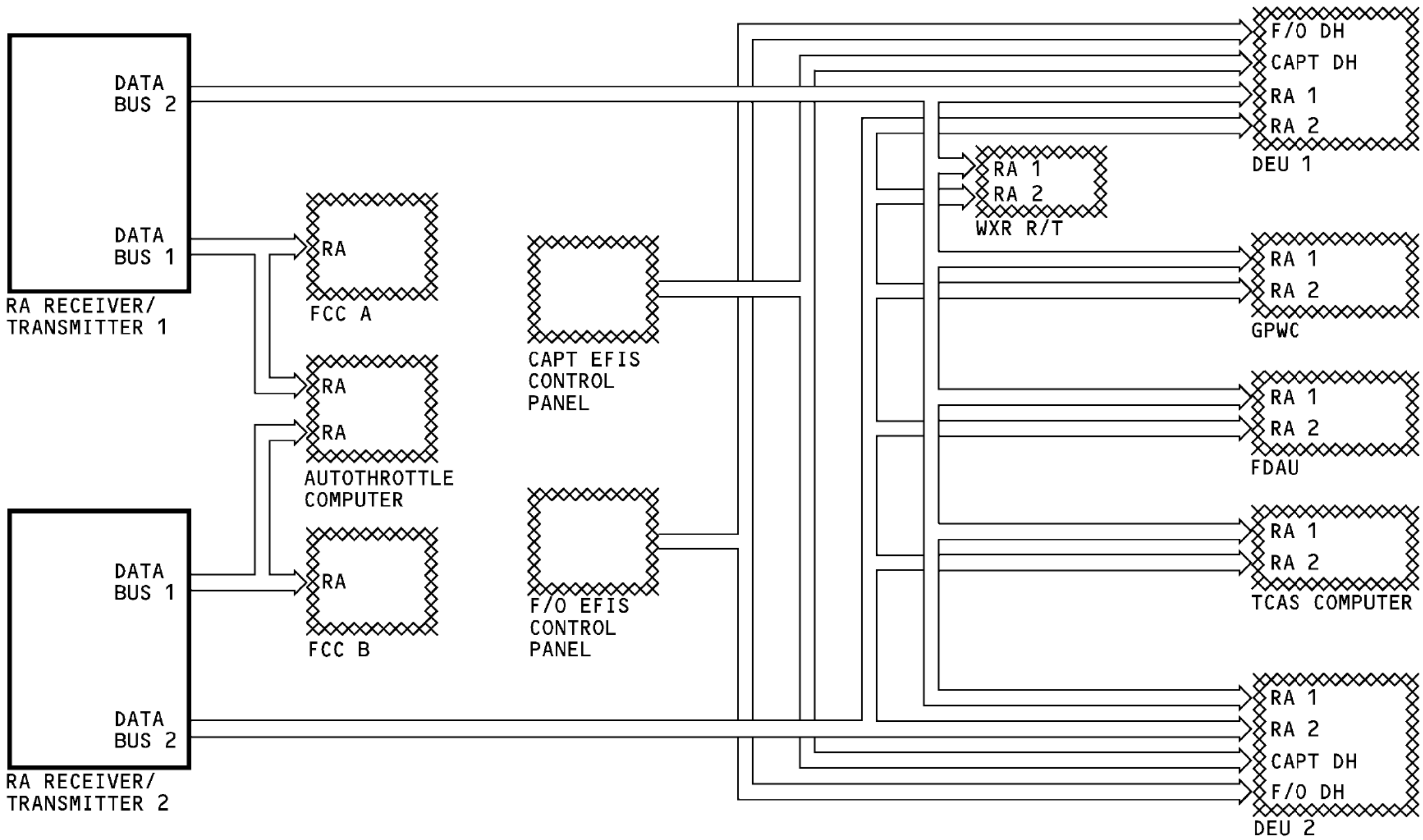
The GPWC uses radio altitude in its ground proximity alert and warning logic calculations.

The FDAU records radio altitude values.

The TCAS computer uses radio altitude to set the sensitivity levels for intruder advisory calculations and to find if an intruder aircraft is on the ground.

EFIS Control Panel Interface

The EFIS control panels supply radio minimums values to the DEUs. The DEUs use radio minimums and radio altitude to calculate radio minimums alerts that show on the display units.



DATA BUS OUTPUTS, DECISION HEIGHT INTERFACE

RA SYSTEM – COMPONENTS

RA RECEIVER/TRANSMITTER

Purpose

The RA receiver/transmitter calculates radio altitude.

The RA receiver/transmitter has a non-volatile memory which stores fault information from the last 63 flights. It can store up to 13 faults per flight. Only shop personnel read the non-volatile memory information.

Description

These are the operation limits of the receiver/transmitter:

- Frequency = 4235 MHz to 4365 MHz
- Transmit power = 500 mw nominal
- Operating range = -12 to 2500 feet.

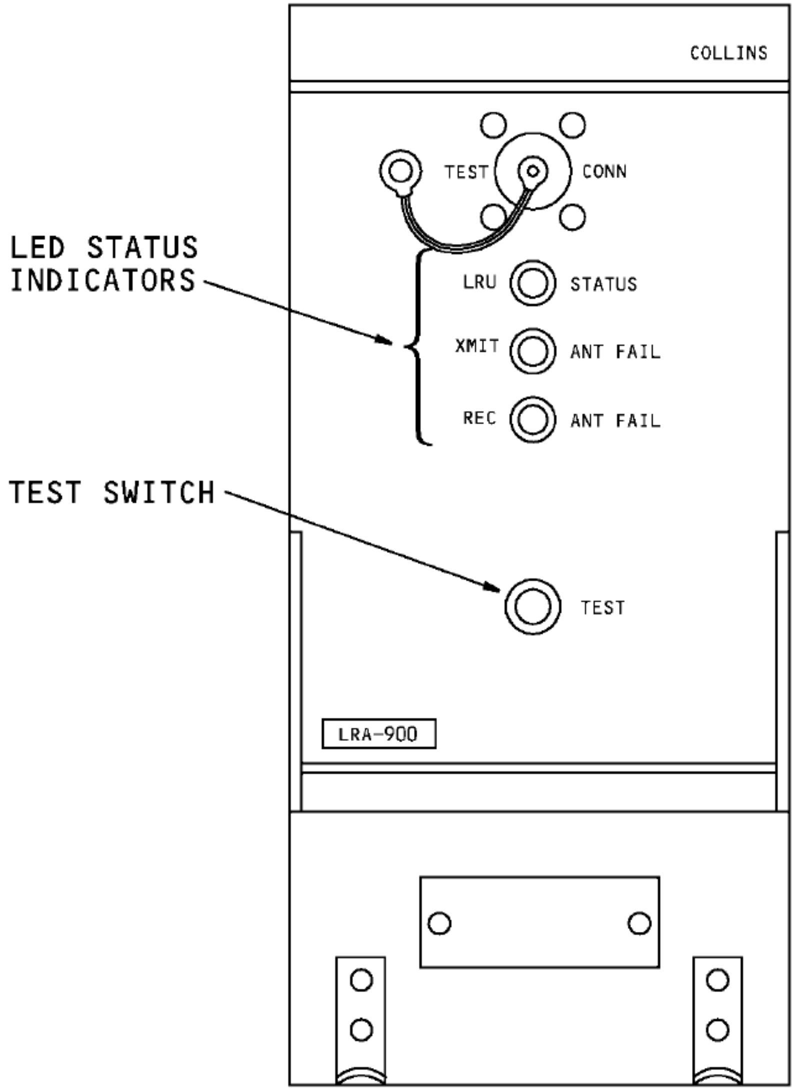
A test connector on the front panel connects test equipment for shop tests.

Operation

These are the three LED status indicators on the front panel:

- Red or green LRU STATUS LED shows the receiver/transmitter operational status. It comes on green when the receiver/transmitter is OK. It comes on red when the receiver/transmitter has a fault
- Red XMIT ANT FAIL LED shows a transmission antenna or coax cable fault
- Red REC ANT FAIL LED shows a receive antenna or coax cable fault.

You push the test switch to start a self-test.



RA RECEIVER/TRANSMITTER

RA ANTENNA

Purpose

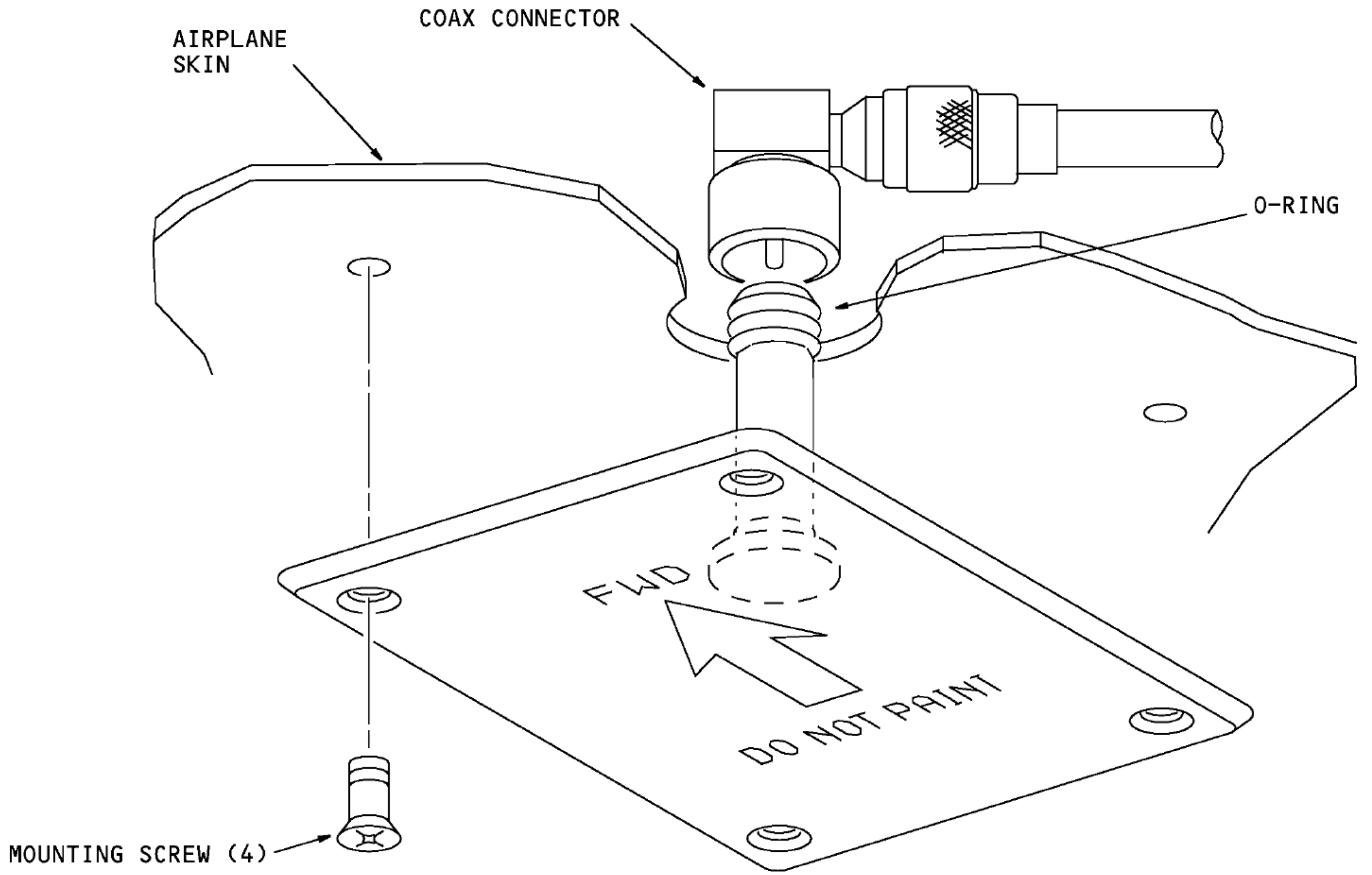
The RA system uses four antennas that transmit and receive RF signals. Each RA receiver/transmitter has a transmit and receive antenna. The transmit and receive antennas are the same and interchangeable.

Physical Description

Four screws attach each antenna to the bottom of the fuselage. There is an O- ring seal in a groove around the coax connector. The O-ring seal gives moisture protection. The radiation side of the antenna has red markings "FWD" and "DO NOT PAINT".

Training Information Point

Do not paint the radiation surface or the back plate of the antenna. Paint does not permit the antenna to send or receive RF signals.



RA ANTENNA

OPERATION AND CONTROL

EFIS Control Panel

The EFIS control panel controls the radio minimums value and resets the radio minimums alert display to a normal display. The radio minimums shows on the captain and first officer display units. The left EFIS control panel controls the captain display units. The right EFIS control panel controls the first officer display units.

The minimums controls have these three controls:

- A two-position rotary switch (minimums reference selector)
- A spring loaded rotary switch (minimums altitude selector)
- A radio minimums reset (RST) switch.

You use the radio position on the minimums reference selector to set the radio minimums.

To set a radio minimums value, use the rotary switch to adjust the value between -1 feet and +999 feet.

Push the radio minimums reset (RST) switch to set the radio minimums alert display back to normal.

Display Unit

The display unit (DU) shows radio altitude and radio minimums values. The flight crew uses this data during an approach and a landing.

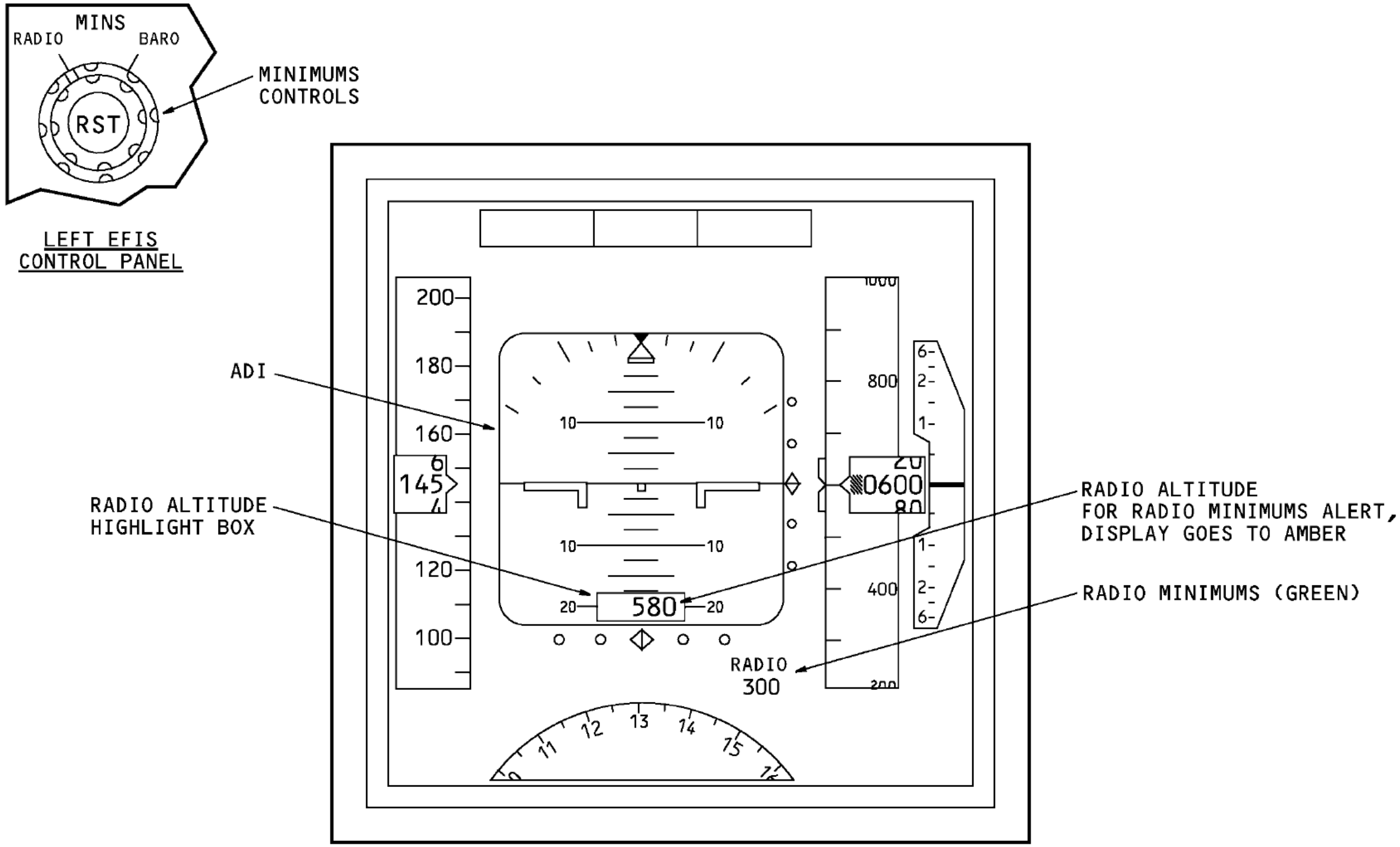
Radio altitude shows in white for airplane altitude between -12 and 2500 feet.

This is when the radio altitude values update:

- Two foot increments from -12 to 100 feet
- Ten foot increments from 100 to 500 feet
- Twenty foot increments from 500 to 2500 feet. The radio altitude does not show above 2500 feet.

The white radio altitude shows as a digital display on the DU for altitudes between -12 and 2500 feet. For altitudes between 0 and 1000 feet, a round dial shows around the digital display. The dial has increments of 100 feet. As the radio altitude increases or decreases, the display adds or removes the perimeter of the dial. A green radio minimums bug moves around the dial and shows the value selected from the EFIS control panel radio mins altitude selector.

The green radio minimums display shows above the digital radio altitude display when the airplane is on the ground or when radio altitude is more than 1000 feet. If the radio minimums value is selected to a value less than zero feet, the display is removed.


MINS
RADIO
BARO
RST
MINIMUMS CONTROLS
LEFT EFIS CONTROL PANEL
ADI
RADIO ALTITUDE HIGHLIGHT BOX
RADIO ALTITUDE FOR RADIO MINIMUMS ALERT, DISPLAY GOES TO AMBER
RADIO MINIMUMS (GREEN)
200
180
160
145
120
100
10
20
580
800
0600
400
RADIO
300
11
12
13
14
15

RA DISPLAY

OPERATION AND CONTROL
(Continue)

Radio Minimums Alert

A radio minimums alert occurs when the radio altitude of the aircraft is the same as the selected radio mins altitude value from the EFIS control panel. The radio minimums alerts occur separately between the captain and first officer displays.

Also, the radio altitude dial changes from white to amber and goes on and off for three seconds and the decision height bug changes from green to amber and goes on and off for three seconds.

After three seconds, the display continues to show amber until it is set back to normal.

Each of these procedures sets the radio minimums alert back to normal:

- Push the reset (RST) switch on the EFIS control panel
- The airplane climbs to 75 feet above the radio minimums value
- The airplane lands.

When radio minimums is set to normal, the radio altitude and the radio altitude dial go back to white, and the radio minimums bug goes back to green.

RA Data NCD

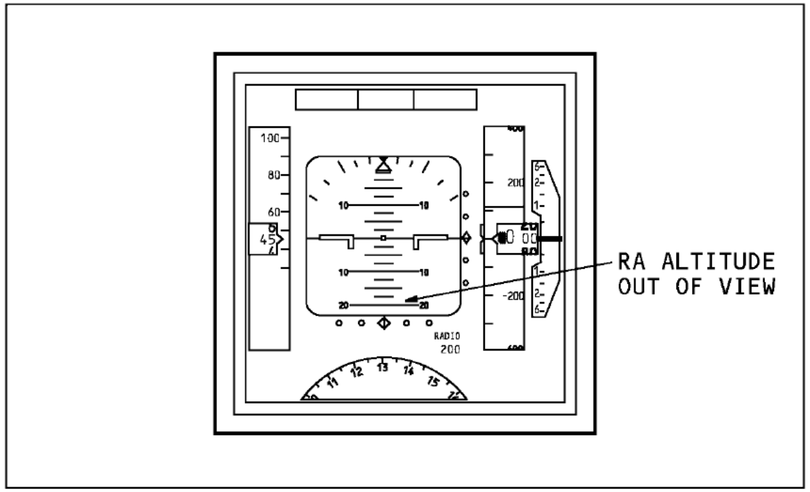
RA data NCD causes the RA display and rising runway symbol to be removed. The NCD occurs when the return RA signals are too weak or the radio altitude is more than 2500 feet. Also, the rising runway will not show when the ILS is not captured.

RA Data Invalid

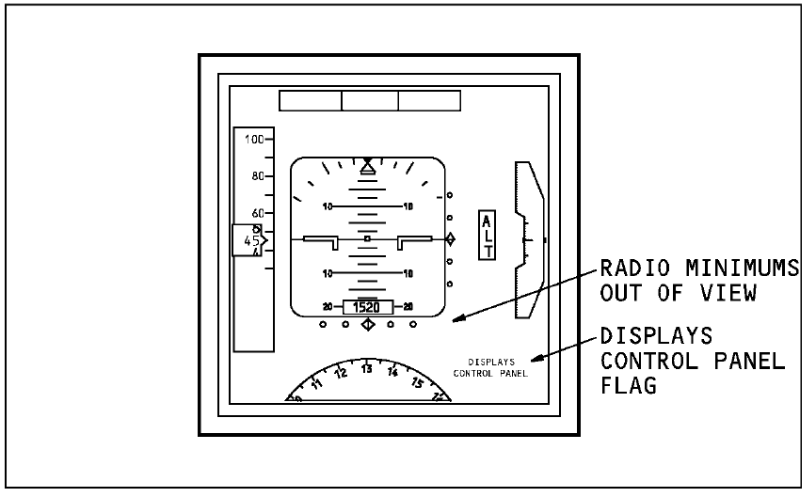
Invalid RA data causes a amber RA flag to show in the radio altitude position.
Invalid RA also causes the rising runway symbol to be removed. The invalid data occurs when the RA receiver/transmitter finds a failure in the RA system.

Radio Minimums Data Invalid

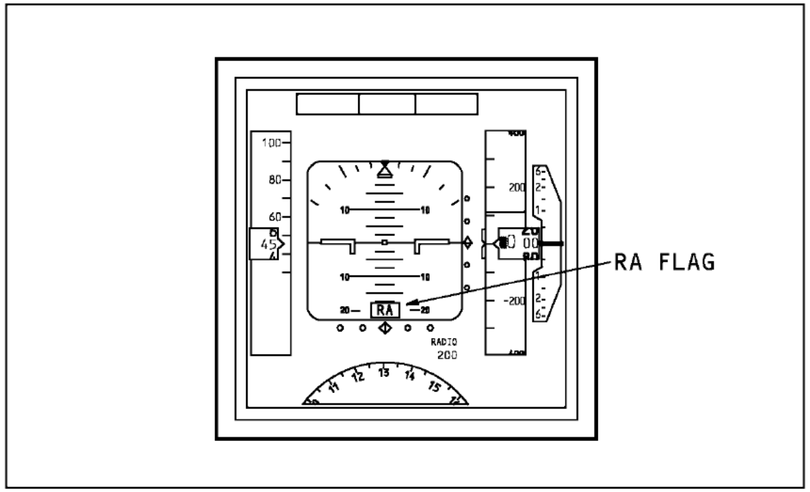
Invalid EFIS control panel data on the ground or above 1000 feet causes the amber displays control panel flag to show and the letters RADIO and the radio minimums value to go out of view. Between 0 and 1000 feet, the amber controls display panel flag shows and the radio minimums bug is removed.



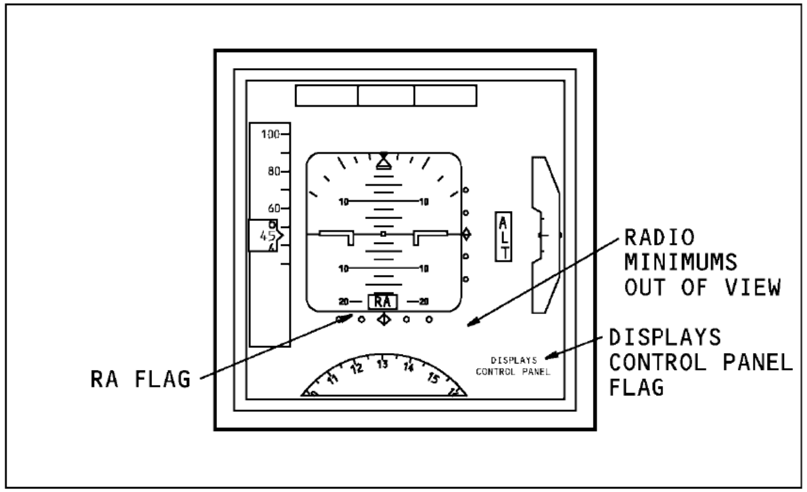
RA DATA NCD



RADIO MINIMUMS DATA INVALID



RA DATA INVALID



RA INVALID AND RADIO MINIMUMS INVALID

RA DATA INVALID DISPLAY

FUNCTIONAL DESCRIPTION

The radio altimeter transmits a frequency modulated/continuous wave (FM/CW) signal through the transmit antenna. This signal is a CW carrier that scans linearly from 4,235 to 4,365 MHz 145 times a second.

Transmit and Receive

The ground causes a reflection of the transmit signal. The receive antenna receives the signal. The RF processor mixes the transmit and receive signals to make a difference frequency. The difference frequency is in proportion to the time it takes the signal to go to the ground and come back. The main processor changes the difference frequency to radio altitude. The radio altitude goes out on two ARINC 429 data buses.

The two buses supply radio altitude and status information to these components:

- FCC A or FCC B
- Autothrottle computer
- DEU 1 and DEU 2
- GPWC
- TCAS computer
- FDAU.

Input Program Pins

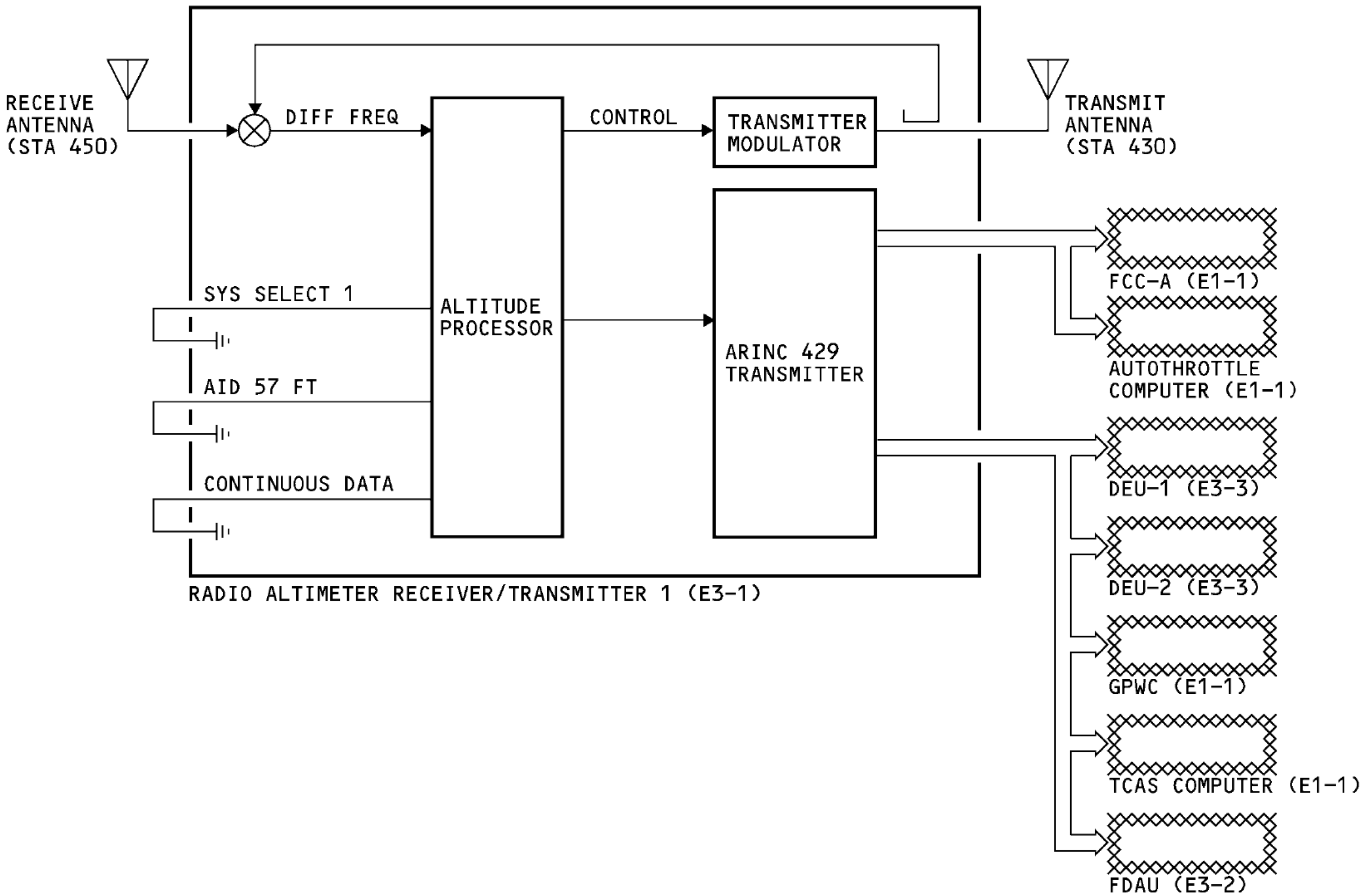
The system select program pin input sets the system modulation rate and system identification. The modulation rate for the RA 1 system is 145Hz, the RA 2 system is 155Hz.

The aircraft installation delay (AID) program pin is grounded to the 57 feet selection. This calibrates the system so that the radio altitude is 0 feet at touchdown.

It makes an allowance for these conditions:

- Length of the antenna cables
- Fuselage to ground distance
- Flare angle.

When grounded, the continuous data program pin selects non-interrupted RA data output at all times.



FUNCTIONAL DIAGRAM

FAULT DETECTION

BITE Module

The built-in test equipment (BITE) module monitors the circuits in the RA receiver/transmitter for faults. The flight fault memory stores the number of faults for each flight leg. Shop personnel use the automatic test equipment (ATE) connector to read the fault memory contents.

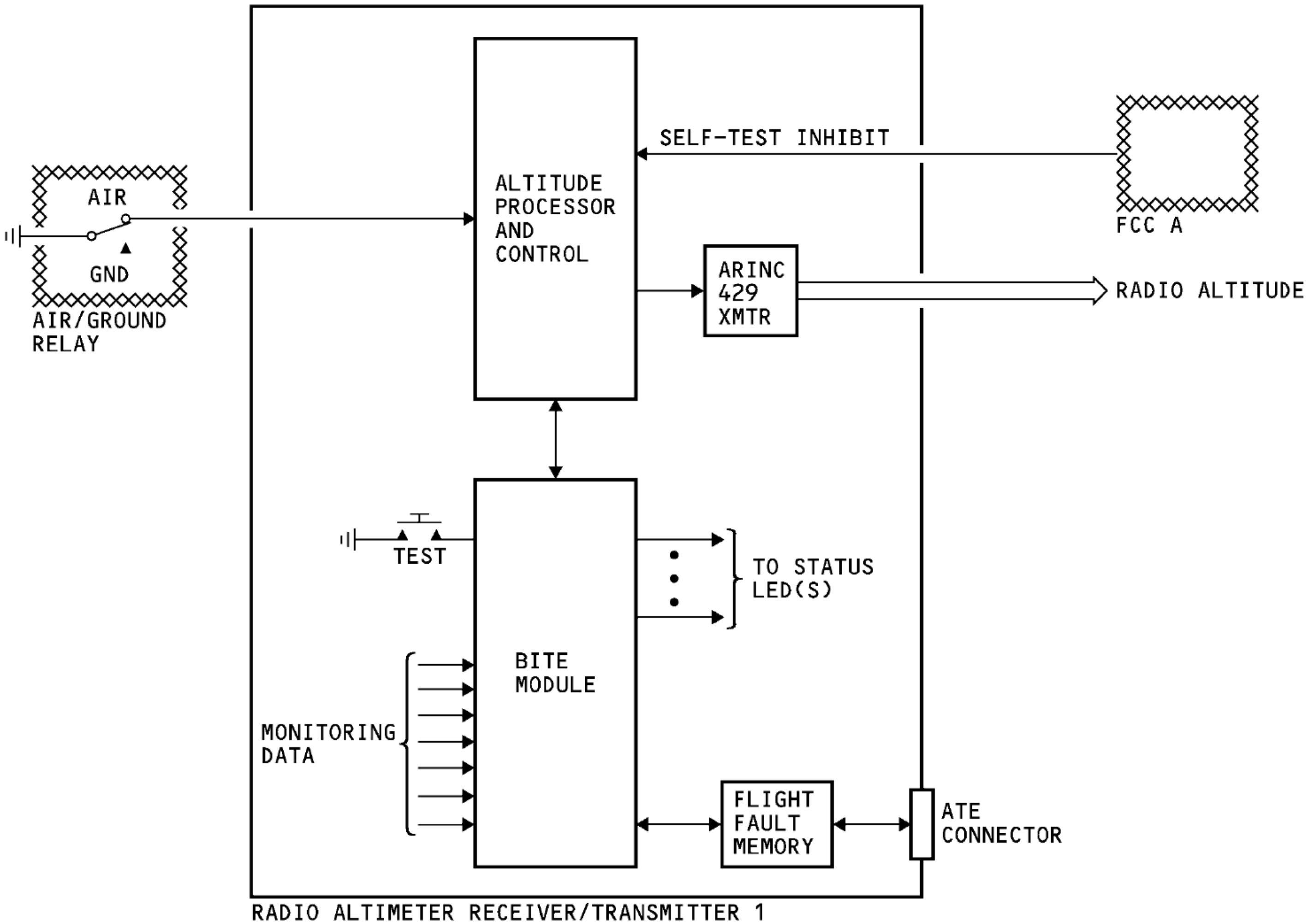
Test

A test switch on the front of the RA receiver/transmitter starts an RA self-test. LEDs show the results of the self-test.

The self-tests do a check of these:

- Receiver/transmitter internal status
- ARINC 429 output transmitters status
- Antennas and coaxial cables.

The flight control computers (FCCs) supply a test inhibit signal to the receiver/transmitters. This prevents an RA test when the FCC is in the approach mode.



FAULT DETECTION

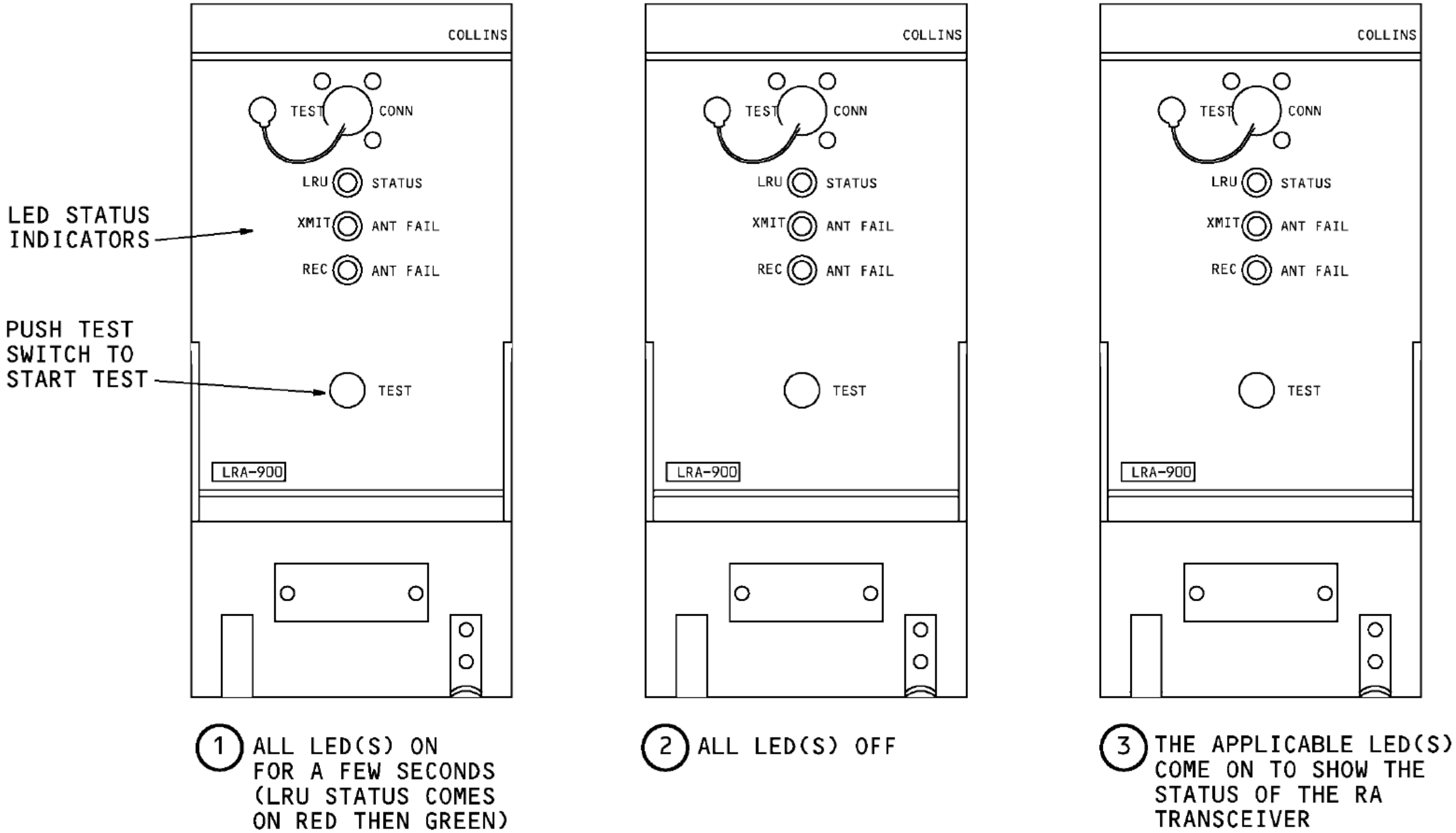
BITE

The front panel BITE test only operates when the airplane is on the ground.

Momentarily push the test switch on the front of the RA receiver/transmitter to start a self test.

Monitor the front panel for these results:

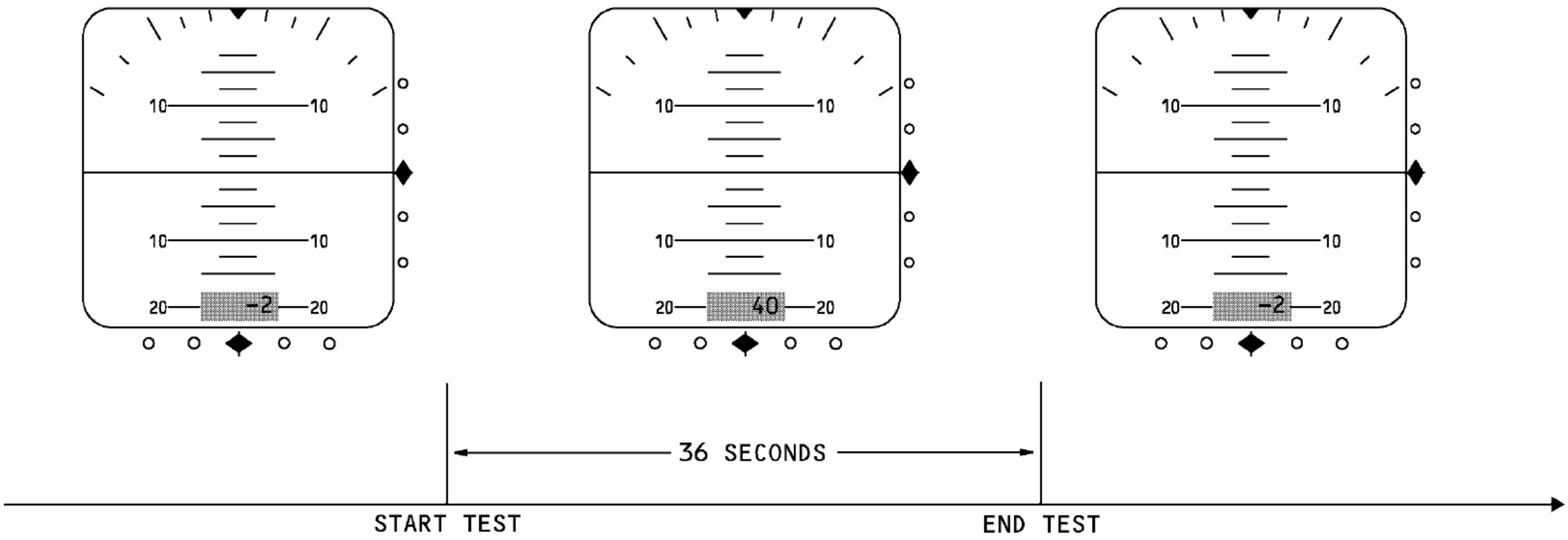
- **0 seconds** - all front panel LEDs come on red
- **2 seconds** - LRU STATUS LED changes to green
- **4 seconds** - all front panel LEDs go off
- **6 seconds** - applicable LEDs come on to show a normal (green) or fault (red) condition
- **36 seconds** - Front panel LEDs go off.



BITE

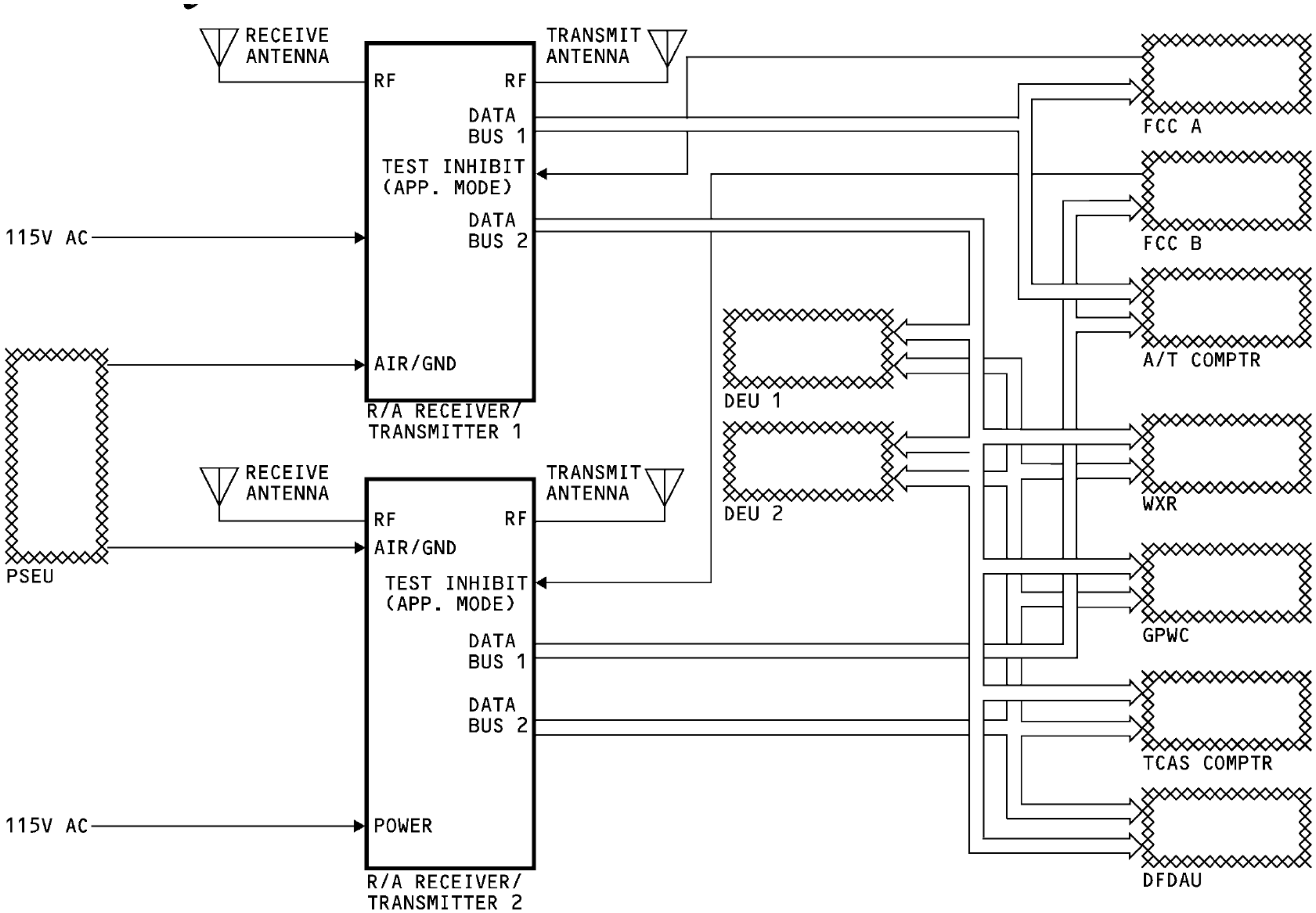
FLIGHT COMPARTMENT BITE DISPLAY

The front panel BITE test causes the RA receiver/transmitter to send a test altitude to the flight compartment display units. The test altitude is 40 feet. The test altitude shows during the full test. The altitude display goes back to normal when the test is complete.



RA BITE DISPLAY

RA SYSTEM - SYSTEM SUMMARY



SYSTEM SUMMARY

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–43. WEATHER RADAR SYSTEM (ATA 34–43)

LEVEL 3

WEATHER RADAR SYSTEM - INTRODUCTION

The weather radar (WXR) system supplies these visual indications:

- Weather conditions
- Windshear events
- Land contours.

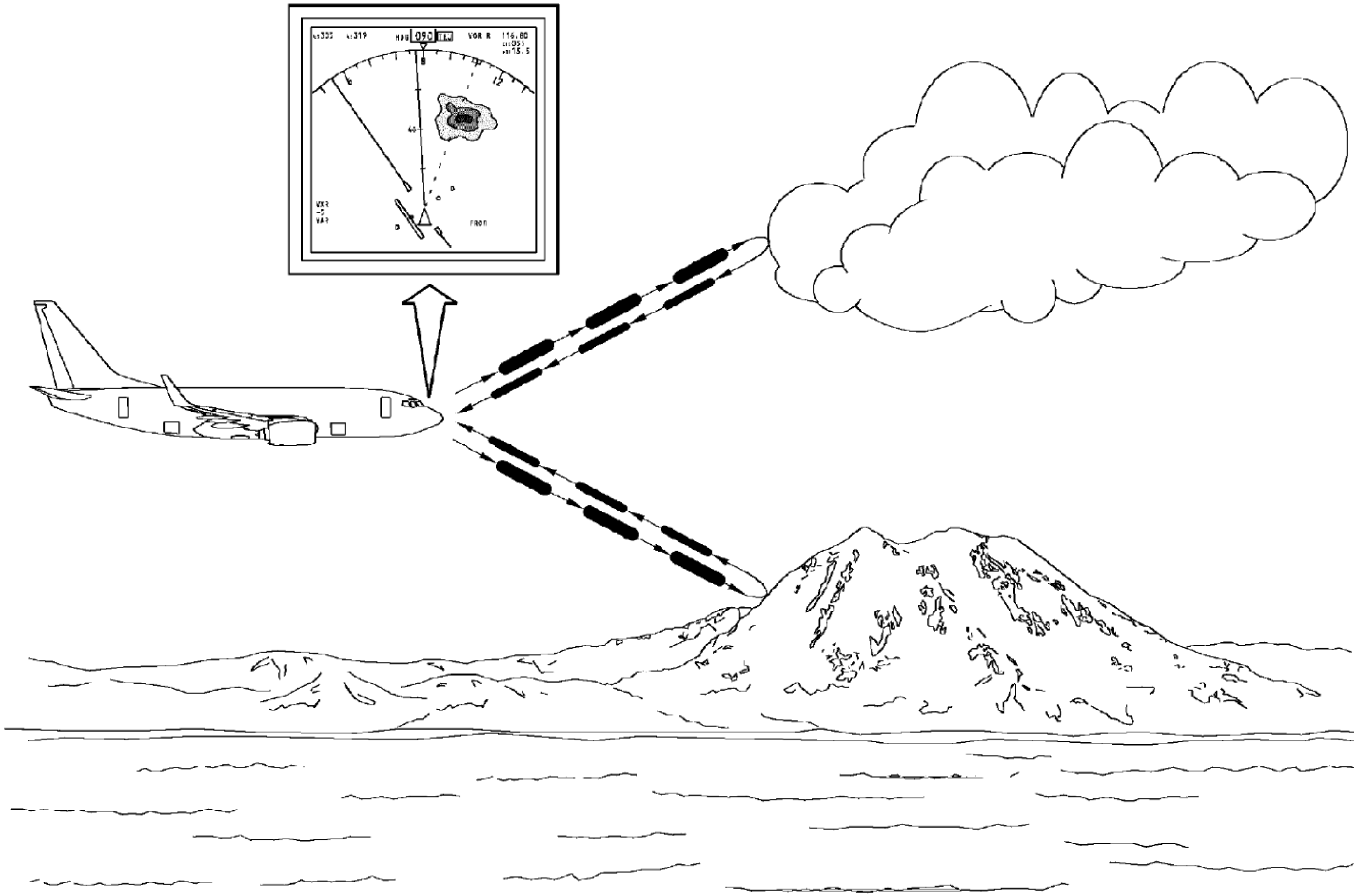
Description

WXR operates on the same principle as an echo. The WXR system transmits radio frequency (RF) pulses in a 180 degree area forward of the airplane.
Objects reflect the pulses back to the receiver. The receiver processes the return signal to show weather, terrain, and windshear events.

Display

The WXR returns show in four different colors on the navigation displays (ND). Colors of the indications give the crew information about the intensity of the returns.

The predictive wind shear (PWS) cautions and warnings show in amber and red on the ND and PFD displays. Also, there are aural alerts for PWS cautions and warnings.



WEATHER RADAR SYSTEM - INTRODUCTION

GENERAL DESCRIPTION

Control

These components supply weather radar (WXR) system control:

- Left and right EFIS control panels
- Weather radar control panel.

System Inputs

These components supply signals to the WXR transceiver for predictive windshear:

- Air data inertial reference system sends air data for the PWS function
- Radio altimeters send altitude to enable or disable PWS during takeoff and approach
- Autothrottle switch packs enable PWS during takeoff
- Landing gear lever switch sends a landing gear down discrete to enable PWS during approach
- An air/ground relay sends an air/ground discrete for flight leg counting.

System Outputs

The weather radar transceiver sends these signals out for predictive windshear:

- PWS video to the WXR/TERR relays
- PWS warnings or cautions to the GPWS to prioritize any callouts
- Audio inhibit to TCAS when there is a PWS warning
- Audio to the REU for PWS.

Display

WXR data shows on the navigation displays (NDs). The weather data from the WXR receiver/transmitter (R/T) goes to the weather radar/terrain (WXR/TERR) relays.

The ground proximity warning computer (GPWC) controls and switches the relays. If TERR is selected on the EFIS control panel or there is a Terrain Awareness/Terrain Clearance Floor warning from the GPWC, then the EGPWS terrain data shows on the navigation display (ND). If TERR is not selected and there are no EGPWS warnings, WXR data shows on the ND.

Antenna

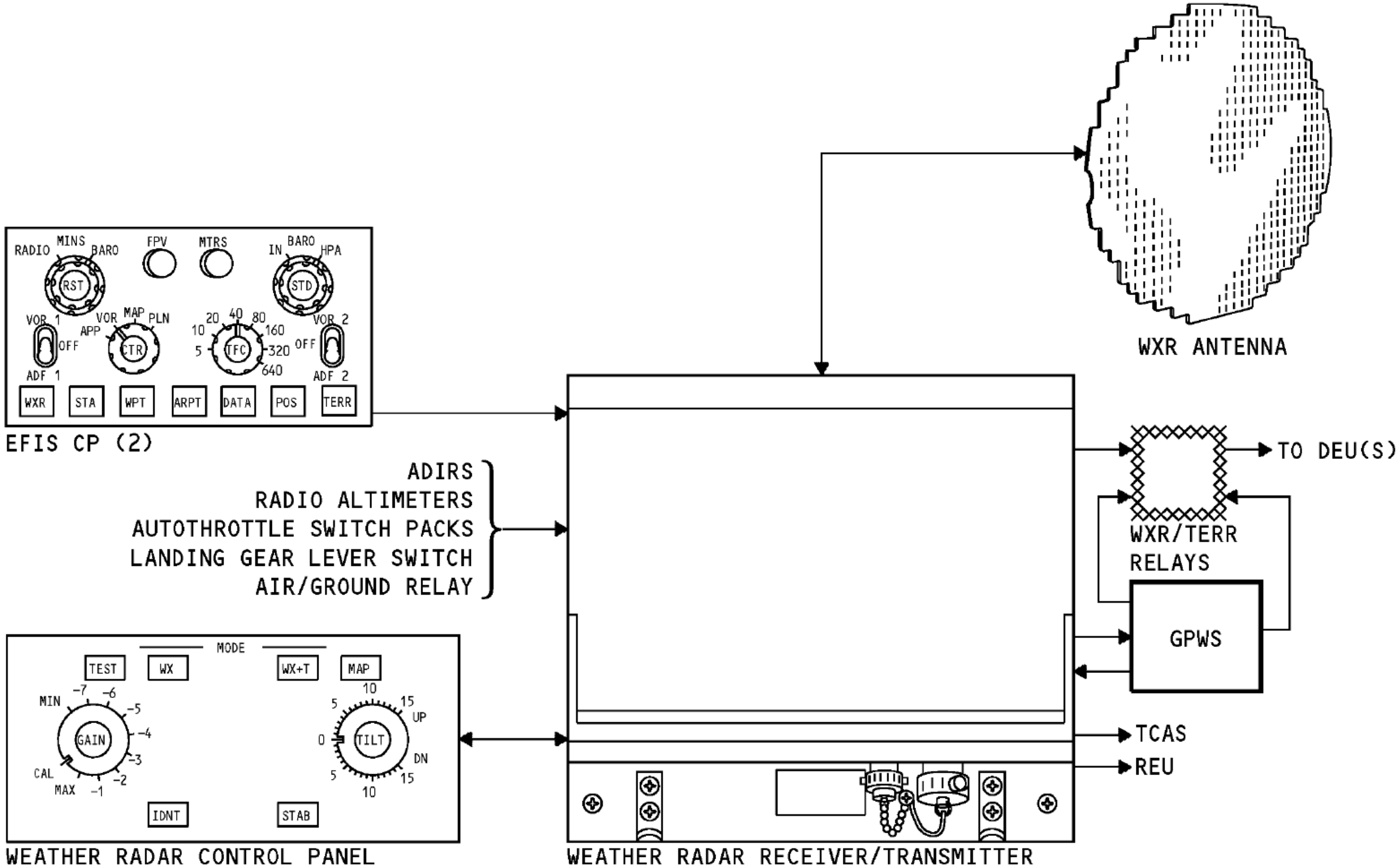
The WXR antenna sends the RF pulses and receives the RF returns. The R/T gets air data inertial reference unit (ADIRU) pitch and roll data for antenna stabilization.

Receiver/Transmitter (R/T)

The primary component of the WXR system is the weather radar R/T.

The WXR R/T does these functions:

- Transmits RF pulses
- Processes the RF returns
- Detects windshear events and sends warnings and cautions to the flight crew
- Supplies the WXR display data.



GENERAL DESCRIPTION

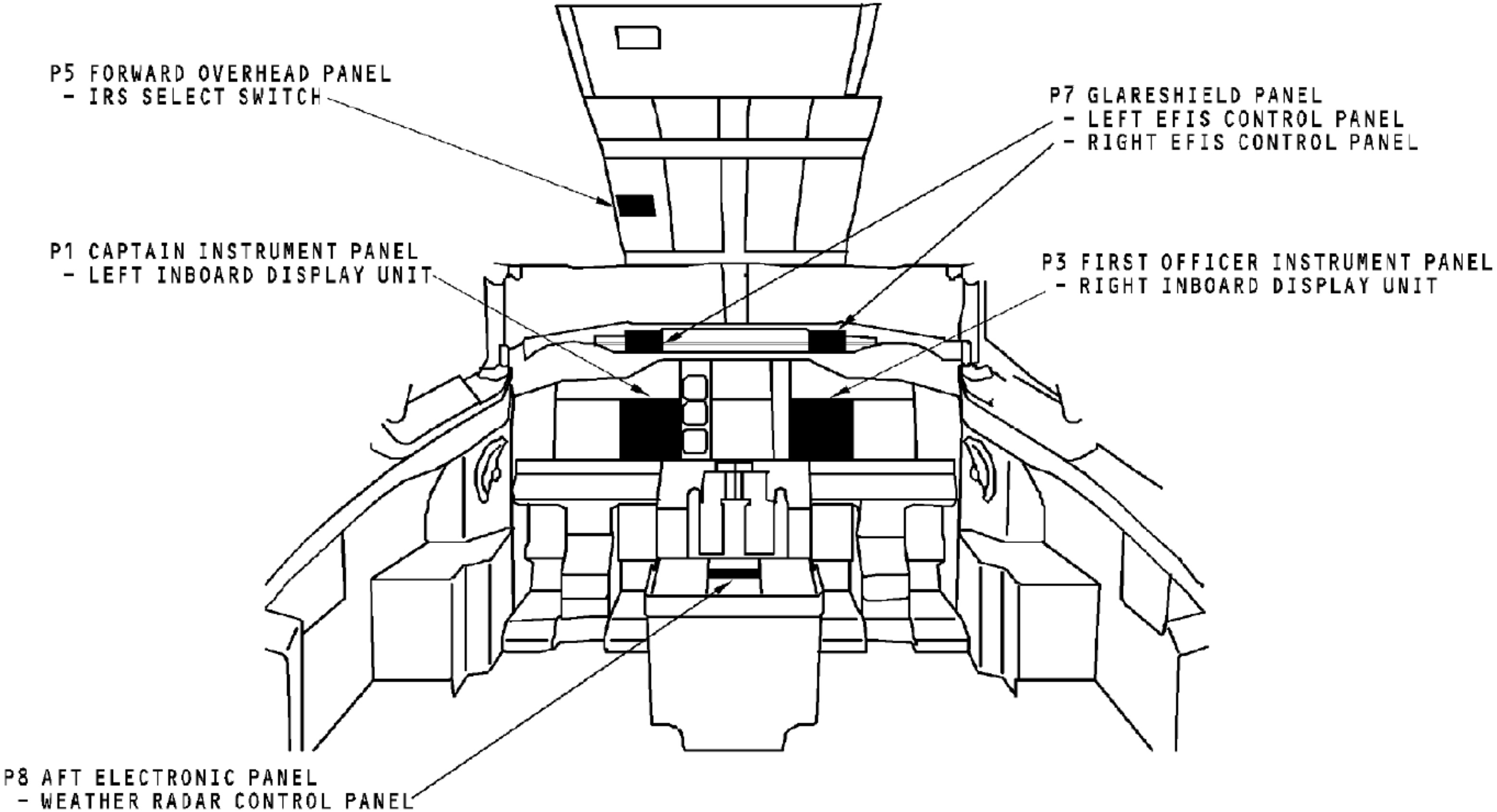
WXR SYSTEM - COMPONENTS LOCATION

Flight compartment

The weather radar control panel is on the P8 aft electronic panel in the flight compartment.

These are the flight compartment components that have an interface with the WXR system:

- Left EFIS control panel (P7)
- Right EFIS control panel (P7)
- Left inboard display unit (P1)
- Right inboard display unit (P3)
- IRS select switch on the navigation/displays source select panel (P5).



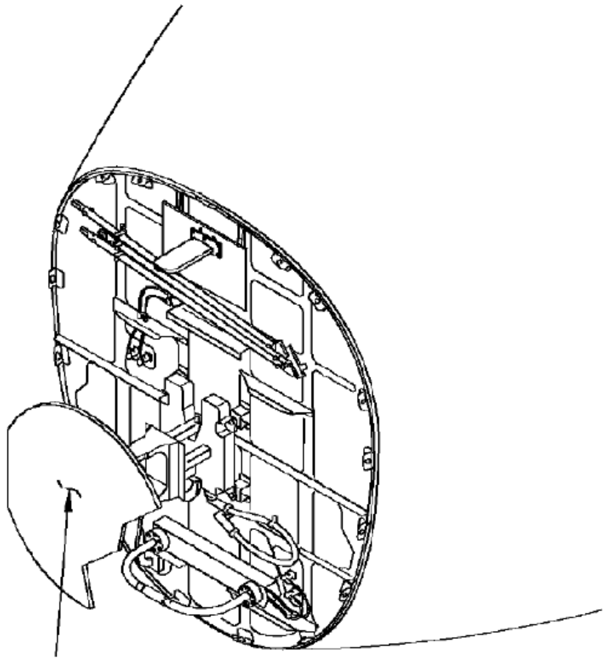
COMPONENTS LOCATION – FLICHT COMPARTMENT

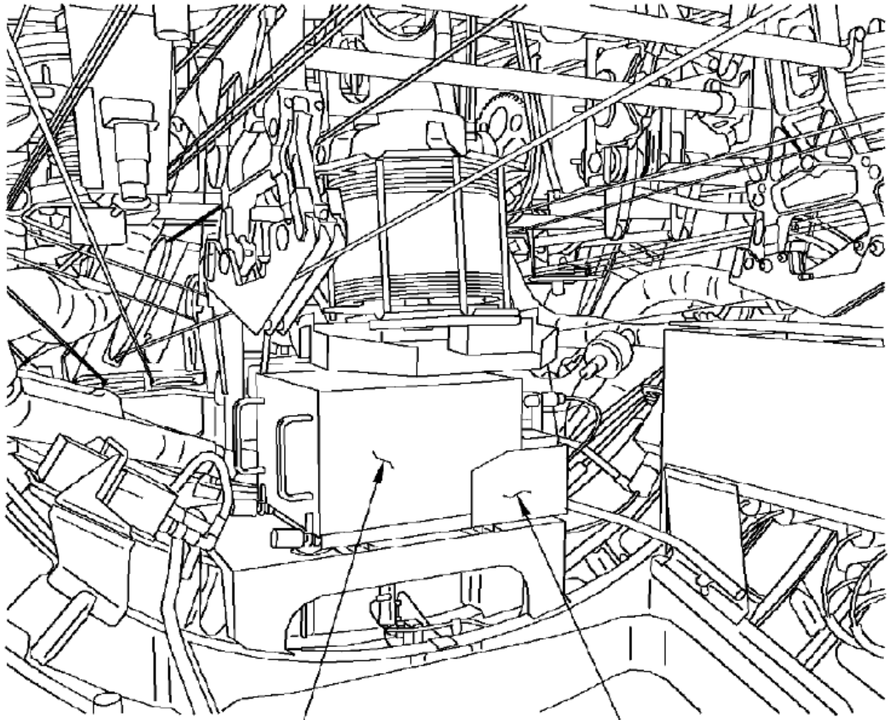
Forward equipment compartment and nose radome

Caution: WHEN REMOVING OR INSTALLING THE WEATHER RADAR R/T, CARE SHOULD BE TAKEN TO AVOID DAMAGE TO THE CAPTAIN PITOT AIR DATA MODULE FLEXIBLE HOSE.

The WXR antenna is on the forward bulkhead behind the nose radome.
These are the WXR system components in the forward equipment compartment:

- WXR R/T
- WXR R/T mount.





FORWARD EQUIPMENT COMPARTMENT AND NOSE RADOME

WXR SYSTEM - INTERFACES

POWER AND ANALOG

System Power and ON/OFF

The WXR receiver transmitter (R/T) gets 115v ac through the WXR RT circuit breaker from the 115v ac XFR BUS 2 (P6 circuit breaker panel). The WXR R/T circuit breaker also sends 115v ac to the WXR R/T mount for fan operation.

The left and right EFIS control panels (CP) send the ON/OFF data to display electronics unit (DEU) 1 and DEU 2. The DEUs make sure the navigation display is in a mode that can show WXR data. If the navigation display is in a correct mode, the DEUs send an ON/OFF discrete to the WXR control panel.

The ON/OFF discrete goes through the WXR control panel to the WXR R/T. This discrete lets the WXR R/T operate.

When the WXR R/T gets the ON signal, it sends 28v dc to the power supply in the WXR control panel and 115v ac to the WXR R/T power supply.

The WXR R/T sends a 28v dc power interlock to the WXR control panel. The control panel sends the 28v dc interlock back to the WXR R/T as R/T ENABLE.

The WXR antenna gets 115v ac from the WXR R/T.

The WXR RT mount gets 115v ac from XFR bus 2 for fan test power. This permits an operational test of the fan when the RT is not installed.

Discretes

The GPWS sends an inhibit discrete to the PWS. The discrete inhibits PWS aural alerts if the GPWS alerts are a higher priority.
The PWS aural alert will stop when a higher GPWS alert is received.

The landing gear lever sends a landing gear down discrete to enable PWS during an approach.

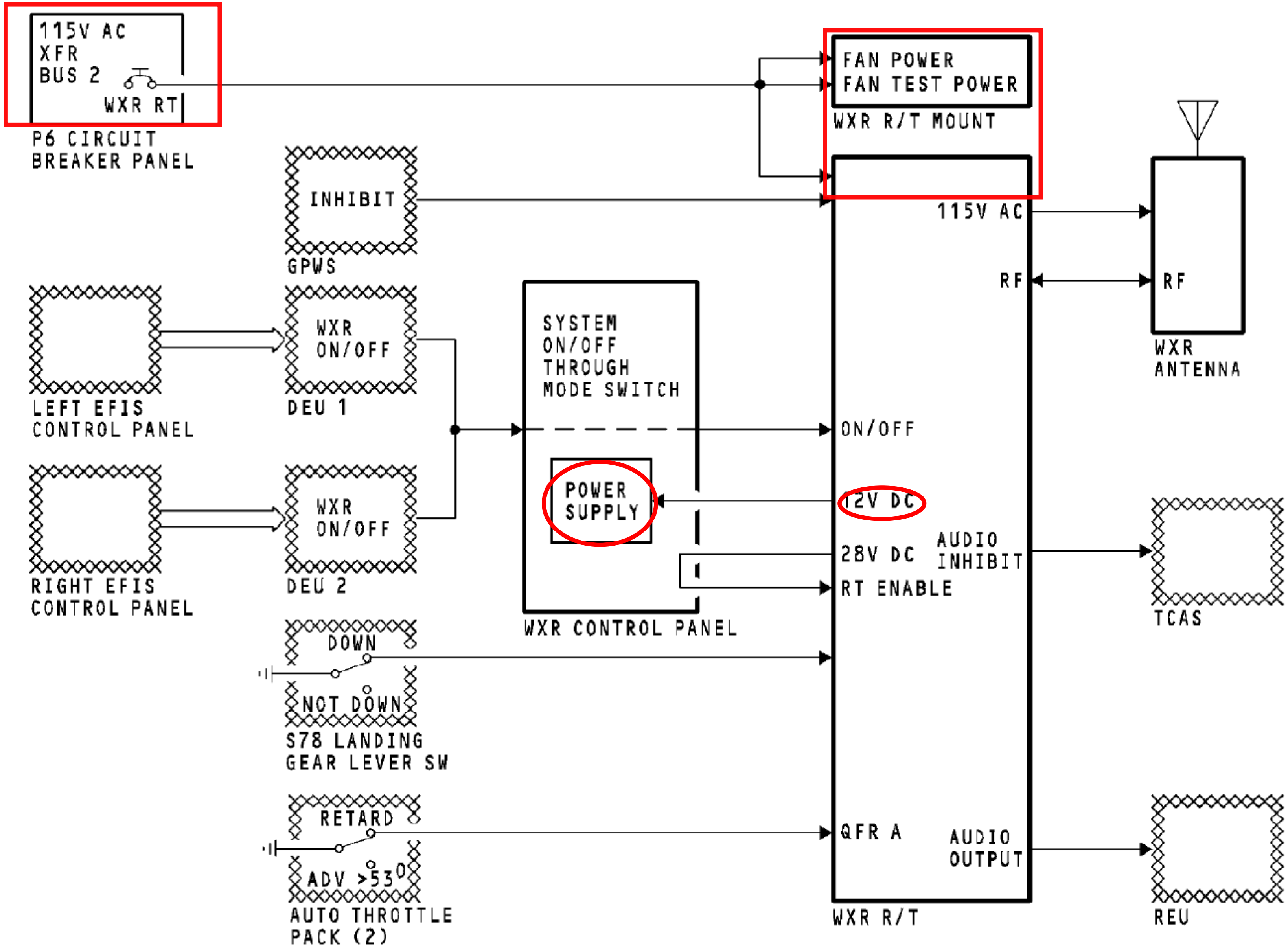
Another air/ground relay discrete goes to the WXR control panel. This discrete causes the WXR control panel to select the TEST mode when the airplane is on the ground and power is first applied to the WXR system.

The left and right auto throttle switch packs send discretes (QFR A) to enable the PWS function. When the throttles move through 53 degrees and the aircraft is below 2300 feet RA, the radar turns on.

The audio inhibit discrete goes to the TCAS. The TCAS uses this discrete to downgrade all RAs to TAs and inhibit all aural alerts.

RF Transmission and Reception

Transmit radio frequency (RF) goes from the R/T through the waveguide to the weather radar antenna. The receive RF goes from the antenna through the waveguide to the R/T.



POWER AND ANALOG INTERFACES

CONTROL AND DISPLAY INTERFACE

Digital Inputs

The WXR R/T receives data from these systems:

- Air data inertial reference system (ADIRS)
- Radio altimeter (RA) system
- Common display system (CDS).

Air Data Inertial Reference System

The ADIRS sends this inertial reference (IR) data to the WXR R/T on a high-speed ARINC 429 data bus:

- Pitch angle
- Roll angle
- Ground speed
- True heading
- Magnetic heading
- Drift angle
- Discretes.

The WXR R/T uses the IR data for windshear calculation, sensitivity time control (STC), and stabilization.

The ADIRS sends baro altitude (corrected and uncorrected) and true and computed airspeed to the WXR R/T on a low-speed ARINC 429 data bus.

The WXR R/T uses altitude and airspeed data for windshear calculation. The WXR R/T also uses altitude data for sensitivity time control calculations.

Radio Altimeter System

The radio altimeters send radio altitude on a low-speed ARINC 429 data bus to the WXR R/T for the predictive windshear (PWS) function. The PWS uses this data to turn PWS on and off and to enable/disable display and alert functions.

Common Display System

The EFIS control panels send range data and the WXR on/off discrete to the display electronic units (DEUs) on an ARINC 429 data bus.

The DEUs send range data from the EFIS control panel to the WXR R/T on ARINC 429 data buses. The DEUs send the WXR on/off discrete to the WXR control panel on a discrete wire.

Control Inputs

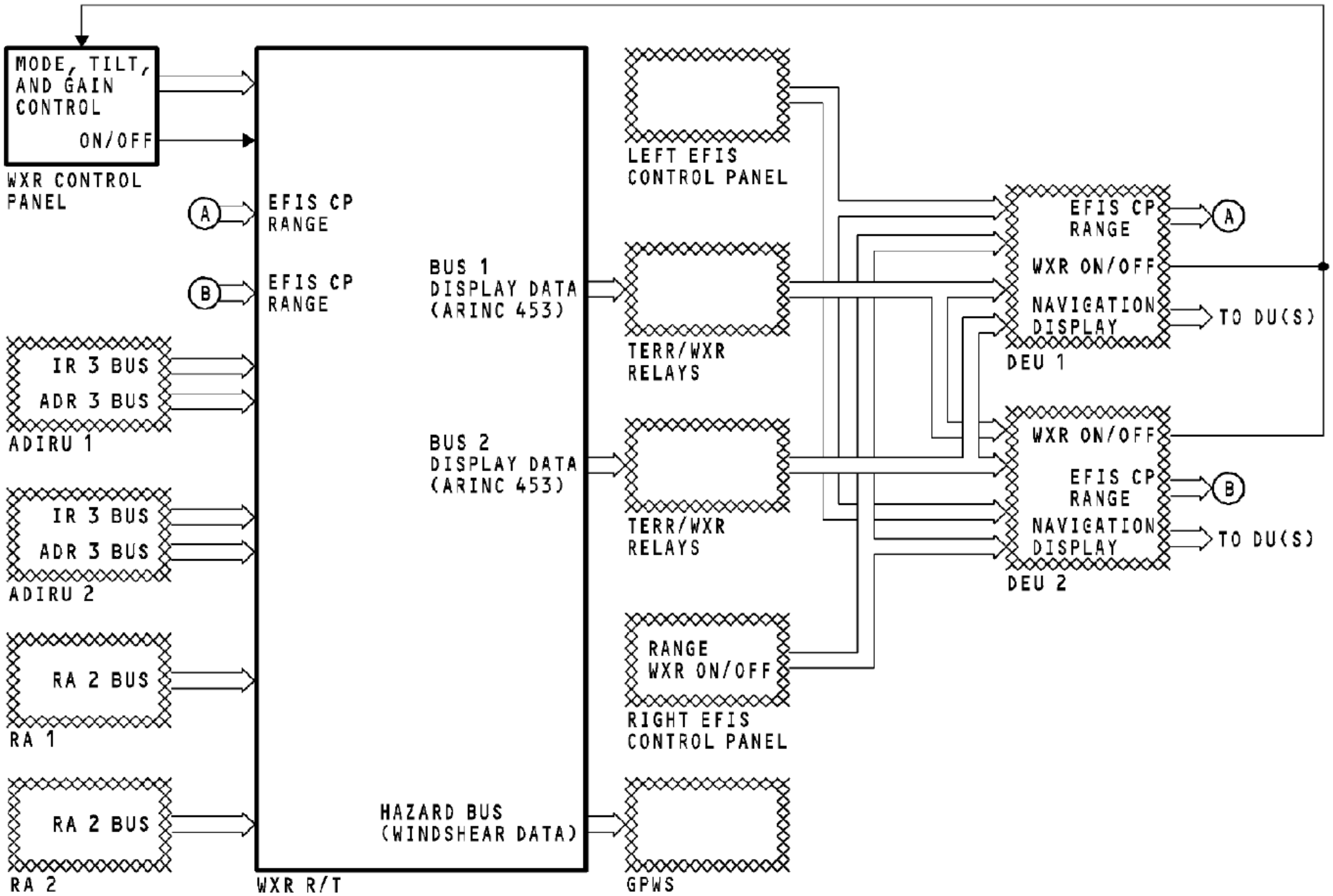
The WXR control panel supplies this data to the WXR R/T:

- Transmit mode
- Tilt
- Gain control
- On/off discrete.

WXR Output Data and Display

The WXR R/T sends display data on an ARINC 453 data bus to the terrain weather relays. The display data goes from the terrain weather relays to the DEUs to show on the navigation displays. The terrain/weather radar relays are controlled by the ground proximity warning computer (GPWC).

The WXR R/T sends windshear alert data on an ARINC 708A hazard bus to the ground proximity warning system (GPWS). The GPWS uses this data to prioritize alert callouts. If a higher GPWS alert exists, the GPWC switches the terrain weather relays and terrain data is shown on the NDs.



CONTROL AND DISPLAY INTERFACE

PWS INTERFACES

General Description

The predictive windshear (PWS) part of the weather radar (WXR) system interfaces with other airplane systems and components.

Air Data Inertial Reference System

The air data inertial reference system (ADIRS) sends this data to PWS:

- Attitude Data
- Heading data
- Air data.

Ground Proximity Warning Computer

PWS sends windshear alert data to the ground proximity warning computer (GPWC) on the ARINC 708A hazard bus. The GPWC uses this data to prioritizes alerts. If there is a higher priority alert, the GPWC sends an inhibit discrete to the WXR. This discrete inhibits the PWS alert output.

Landing Gear Control Lever Module

The landing gear control lever module sends an analog discrete to PWS. PWS uses this discrete in its takeoff/approach alert logic.

Radio Altimeter

The radio altimeter (RA) provides radio altitude data to PWS. PWS uses radio altitude data to do these functions:

- Turn PWS on and off
- Enable/disable display and alert functions.

Remote Electronic Unit

The WXR sends the PWS aural alerts to the remote electronic unit (REU).

Autothrottle Microswitch Pack

The left and right autothrottle microswitch packs send a discrete to the PWS. The PWS uses this discrete to determine the throttle lever position for the automatic turn on.

Display Electronic Unit

The WXR sends the following discretes to the display electronic units:

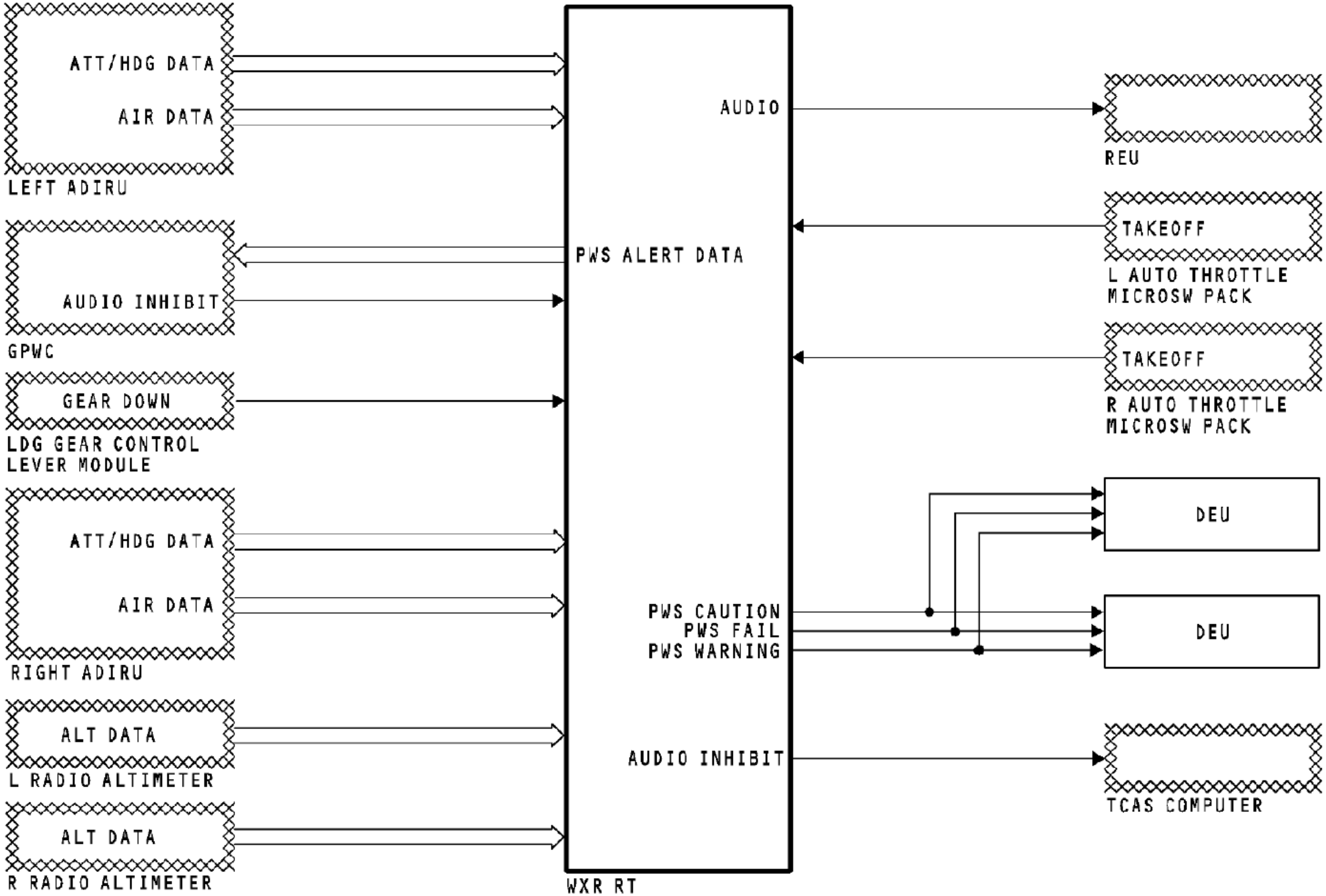
- PWS warning
- PWS caution
- PWS fail.

Traffic Alert and Collision Avoidance System

WXR sends an inhibit discrete to the traffic alert and collision avoidance system (TCAS) computer when there is a PWS alert.

This discrete does these functions:

- Changes resolution advisories (RAs) to traffic advisories (TAs)
- Inhibits all TCAS audio alerts.



PWS INTERFACES

ANTENNA CONTROL INTERFACE

Antenna Tilt

The WXR panel supplies antenna tilt control signals to the WXR R/T.

Attitude Sources

The WXR R/T uses ADIRU attitude data to stabilize the antenna.

The left ADIRU signals connect to the on-side attitude input of the WXR R/T. The right ADIRU signals connect to the off-side attitude input of the WXR R/T.

Attitude Source Select Discrete

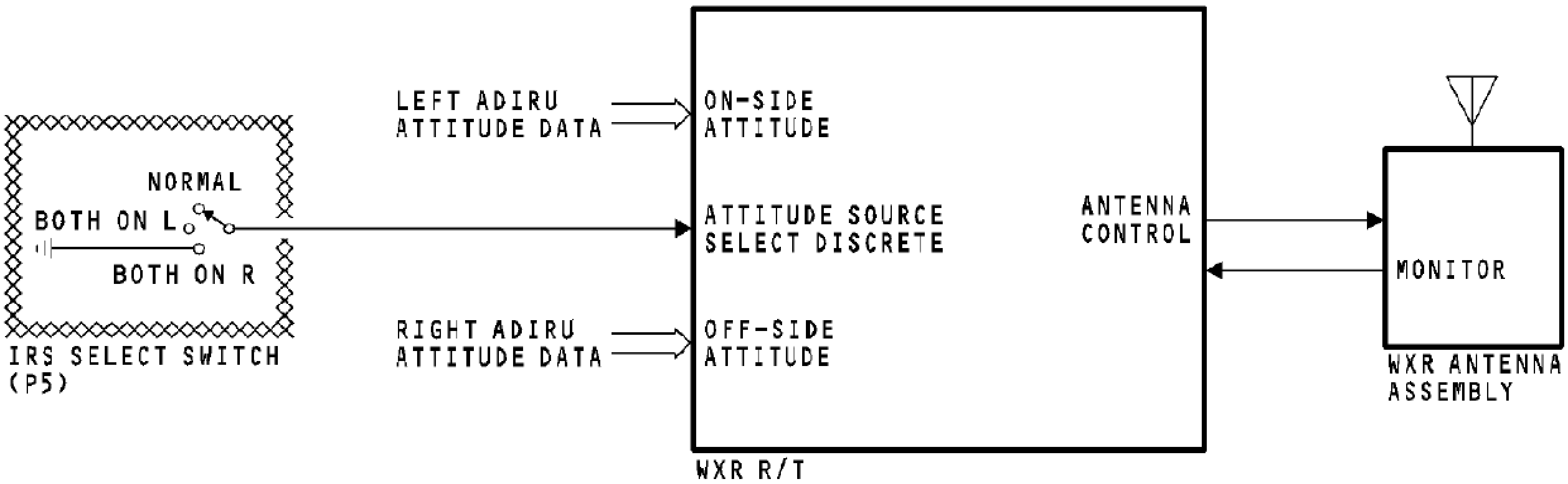
Use the IRS select switch to choose the ADIRU source to the WXR R/T. Set the switch to NORMAL or BOTH ON L to use the left ADIRU input. Set the switch to BOTH ON R to use the right ADIRU input.

WXR R/T Antenna Control

The WXR R/T sends signals to the WXR antenna assembly to control it and make it stable.

Antenna Position Monitoring

The WXR antenna sends antenna position data to the WXR R/T for scan and elevation feedback.



ANTENNA CONTROL INTERFACE

WXR SYSTEM – COMPONENTS

CONTROL PANEL

The weather radar (WXR) control panel has these functions:

- Mode selection
- Tilt control
- Gain control.

Mode Selector

The captain and first officer can show separate weather radar displays.

The control panel has these mode switches:

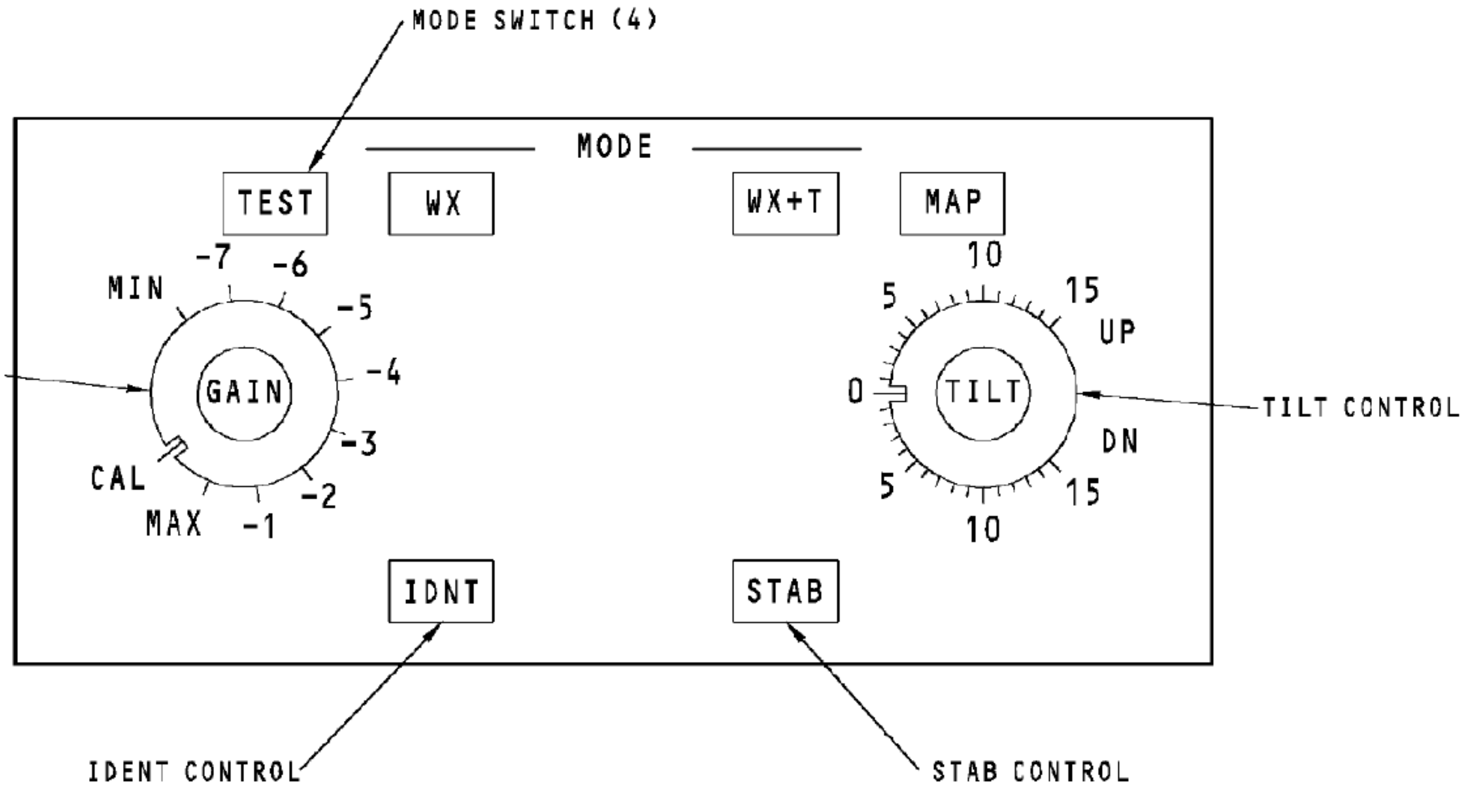
- TEST - starts a self-test of the R/T and shows the test results on the NDs
- WX - R/T shows the weather data on the NDs
- WX+T - R/T shows weather and turbulence data on the NDs. The turbulence range is up to a maximum of 40 nautical miles (NM). If a range more than 40 NM is set on the EFIS control panel, the NDs show weather data only .
- MAP - R/T shows ground and terrain features on the NDs
- IDNT - starts ground clutter suppression

Tilt Control

The tilt control adjusts the antenna tilt angle from +15 degrees to -15 degrees.

Gain Control

The gain controls adjust the gain for the WXR R/T signal returns. The switches have 10 detented positions. Turn the switch full clockwise for the CAL position. In the CAL position, the gain is set to a calibrated level by the R/T.



CONTROL PANEL

WXR RECEIVER/TRANSMITTER

Purpose

These are the functions of the WXR receiver/transmitter (R/T):

- Make and transmit RF pulses
- Process RF return signals
- Make display data
- Send display data to the DEUs
- Supply antenna stabilization
- Monitor and do system operation test
- Send fault status and test data to the DEUs
- Make WXR display test patterns show on the display units.

The WXR R/T provides these displays to the DEUs:

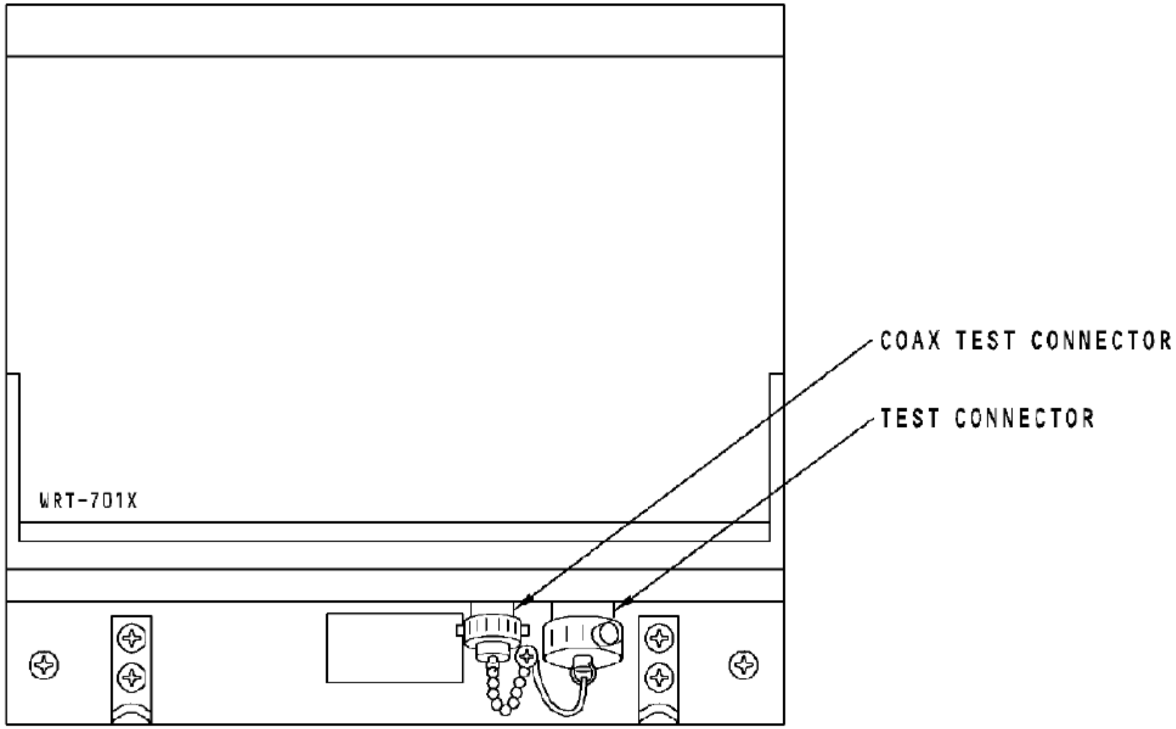
- Test
- Weather
- Map (ground mapping).

Physical Description

The WXR R/T weighs 31.5 lbs. Forced air from the WXR R/T mount cools the WXR R/T.

The front panel of the R/T has these items:

- Coax test connector
- Test connector.



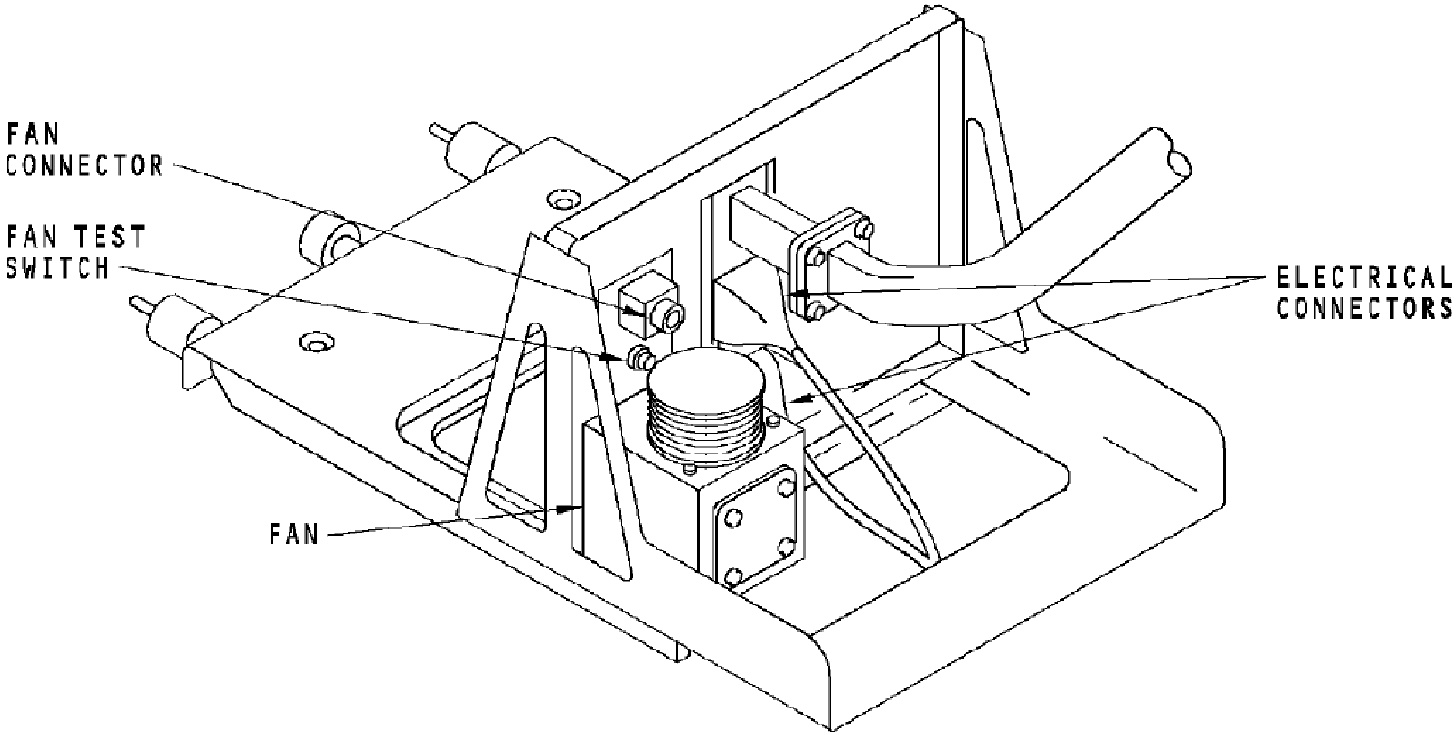
RECEIVER/TRANSMITTER

RECREIVER/T RANSMITTER MOUNT

The WXR R/T mount:

- Holds the R/T
- Connects the R/T to the airplane wiring
- Connects the R/T to the waveguide
- Supplies cooling air to the R/T.

The test switch does a test of the fan.



R/T MOUNT

ANTENNA

Antenna Assembly

These are the parts of the antenna:

- Flat plate antenna
- Antenna pedestal.

Flat Plate Antenna

The flat plate antenna transmits and receives RF pulses.

The flat plate antenna is an array of radiation slots. The RF pulses radiate from each of the slots. The antenna makes a beam 5.4 degrees high and 5.4 degrees wide. The antenna weighs 6 lb (2.7 kg). It is 23 inches wide.

Antenna Pedestal

The antenna pedestal contains these items:

- Scan motors
- Antenna position monitors
- Elevation and scan disable switches.

There is a horizontal scan motor to move the antenna +/- 90 degrees from the airplane centerline. There is also an elevation scan motor to move the antenna +/- 40 degrees up or down. This value includes manual tilt selection from the WXR control panel.

There is a zero position monitor and an incremental monitor for each motor. These monitors send antenna horizontal scan and elevation scan position data to the WXR R/T. There are elevation and azimuth scales that permit a visual measurement of the tilt and scan angles.

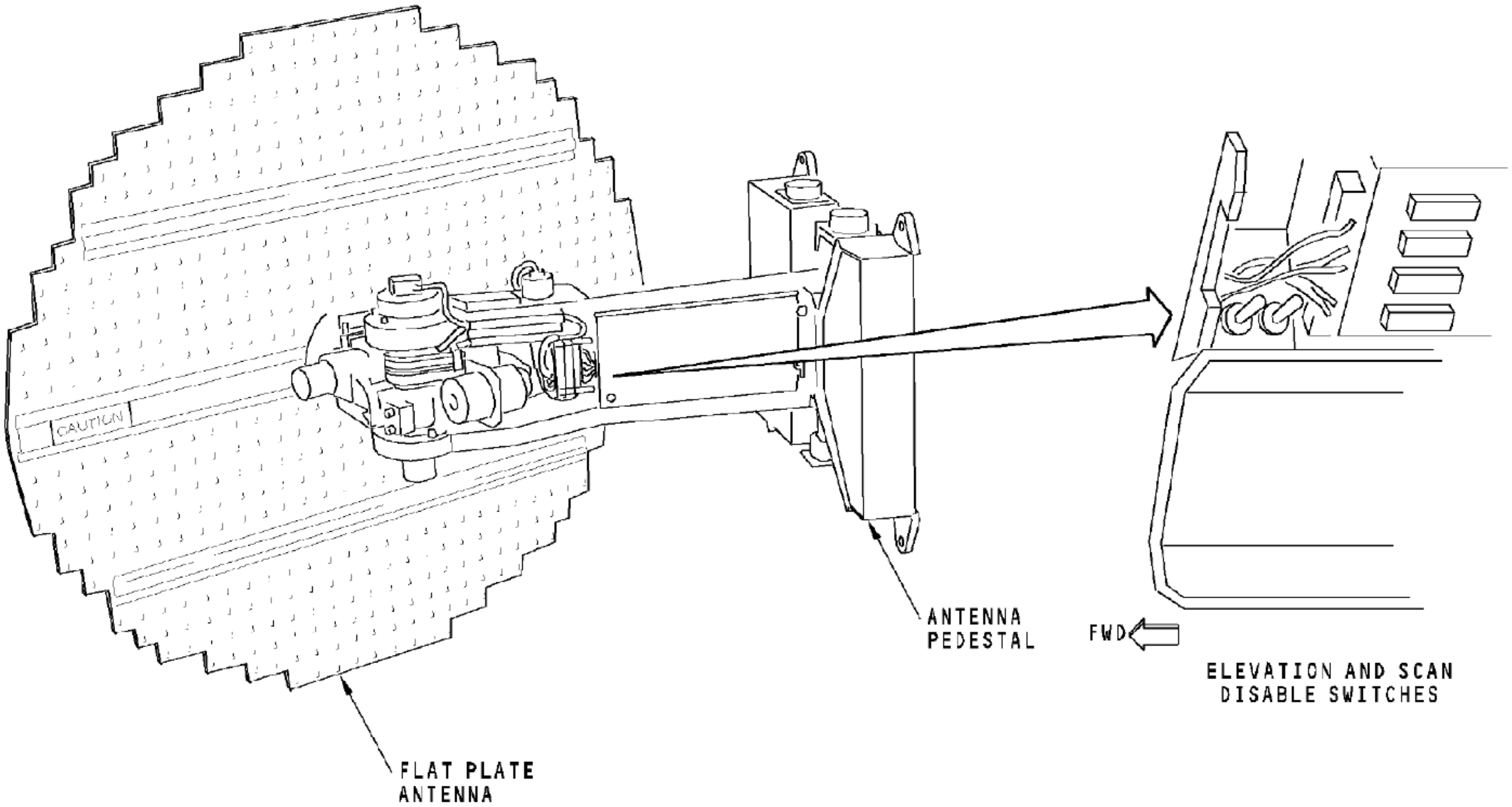
There are elevation and scan disable switches on the antenna pedestal. They remove power to the scan and elevation motors. Use these switches to prevent movement of the antenna during maintenance. The switches do not stop RF transmissions from the WXR R/T.

A torque spring in the antenna pedestal balances the weight of the antenna. When you remove the antenna, the torque spring moves the elevation drive to the upper position.

Training Information Point

Use the elevation and scan disable switches for safety to make sure that the antenna does not move while you work on or around it.

Warning: DO NOT OPEN THE NOSE RADOME IF THE WIND IS MORE THAN 15 KNOTS. IF YOU OPEN THE RADOME IN A WIND, THE RADOME CAN MOVE QUICKLY. THIS CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.


CAUTION
ANTENNA
PEDESTAL
FWD
ELEVATION AND SCAN
DISABLE SWITCHES
FLAT PLATE
ANTENNA

ANTENNA

EFIS CONTROL PANEL

These are the functions of the EFIS control panel (CP) for WXR control:

- Supplies the on and off control of the WXR R/T
- Enables the navigation displays (ND) to show WXR data
- Supplies the selection of different ND modes
- Supplies the selection of different ranges for WXR data to show on the NDs.

WXR Map Switch

These are the things that occur when you push the WXR map switch:

- The WXR R/T starts to operate
- The WXR data shows on the on-side ND.

To stop the operation of the WXR R/T, the WXR map switches on both EFIS control panels must be off.

Mode Selector

Use the mode selector switch to select an ND mode.

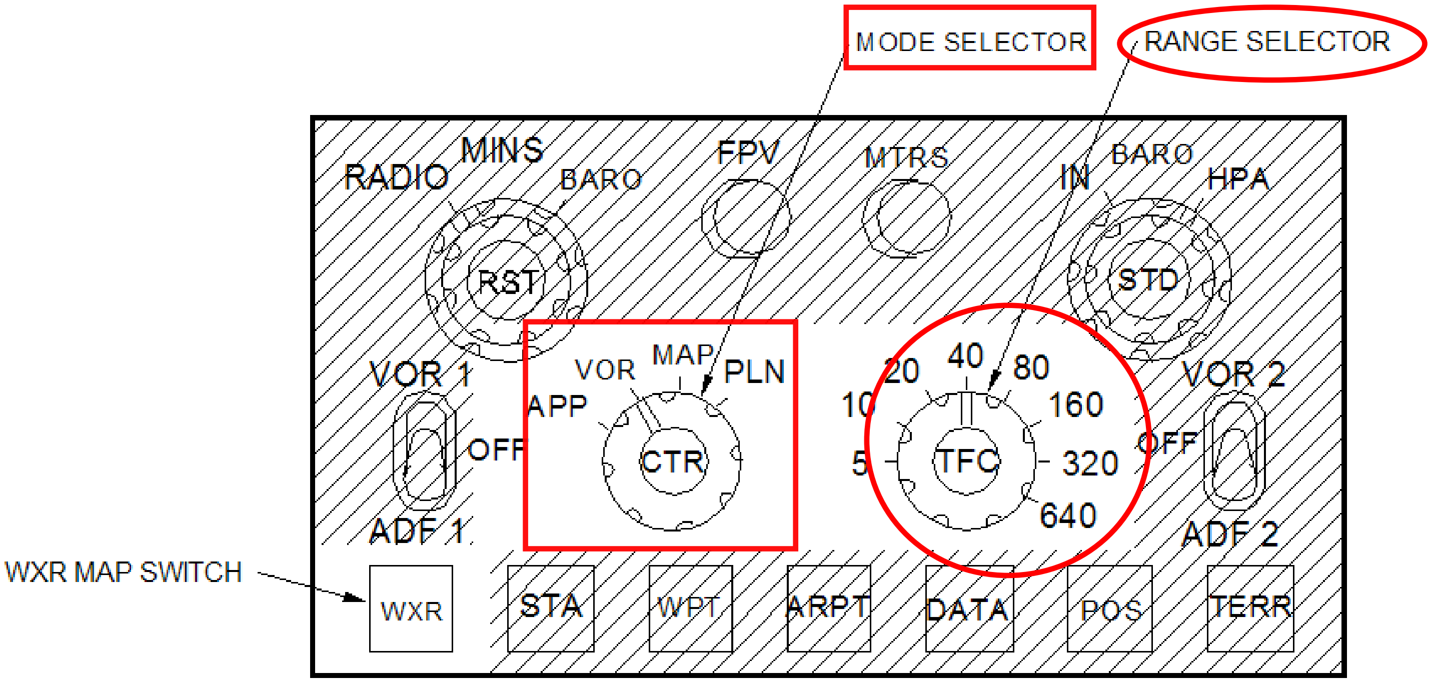
A WXR display can show in these ND modes:

- Expanded APP (approach) mode
- Expanded VOR mode
- Expanded MAP mode
- Centered MAP mode.

Range Selector

The EFIS control panel range selector has eight positions. The range selections are 5, 10, 20, 40, 80, 160, 320, and 640 nautical miles (NM). With the 640 NM range selection, the 640 NM range shows on the ND. But the WXR R/T only shows weather displays out to a maximum range of 320 NM.

The weather/turbulence mode shows turbulence data up to a maximum range of 40 nautical miles (NM). If a range more than 40 NM is set on the EFIS control panel, the NDs show weather data only.



EFIS CONTROL PANEL

THIS PAGE IS INTENTIONALLY LEFT BLANK

WXR SYSTEM - DISPLAYS

NORMAL DISPLAYS

Display Modes

The navigation display (ND) shows WXR system data in these modes:

- Expanded approach
- Expanded VOR
- Center MAP
- Expanded MAP.

WXR System Display Data

The ND shows these displays:

- WXR data
- WXR system messages
- WXR alert messages.

WXR Displays

The WXR data on the ND shows the weather or the terrain in front of the airplane. Colors show the strength of the RF return signals from the weather or the terrain.

These are the four colors for the WXR displays:

- Green - light weather
- Yellow - medium weather
- Red - heavy weather
- Magenta - turbulence.

The WXR system calculates and shows turbulence only to 40 NM.

WXR System Messages

This weather radar data shows on three lines in the bottom left of the navigation display:

- Mode
- Antenna tilt
- Gain.

Line 1 shows mode.

Mode shows this data:

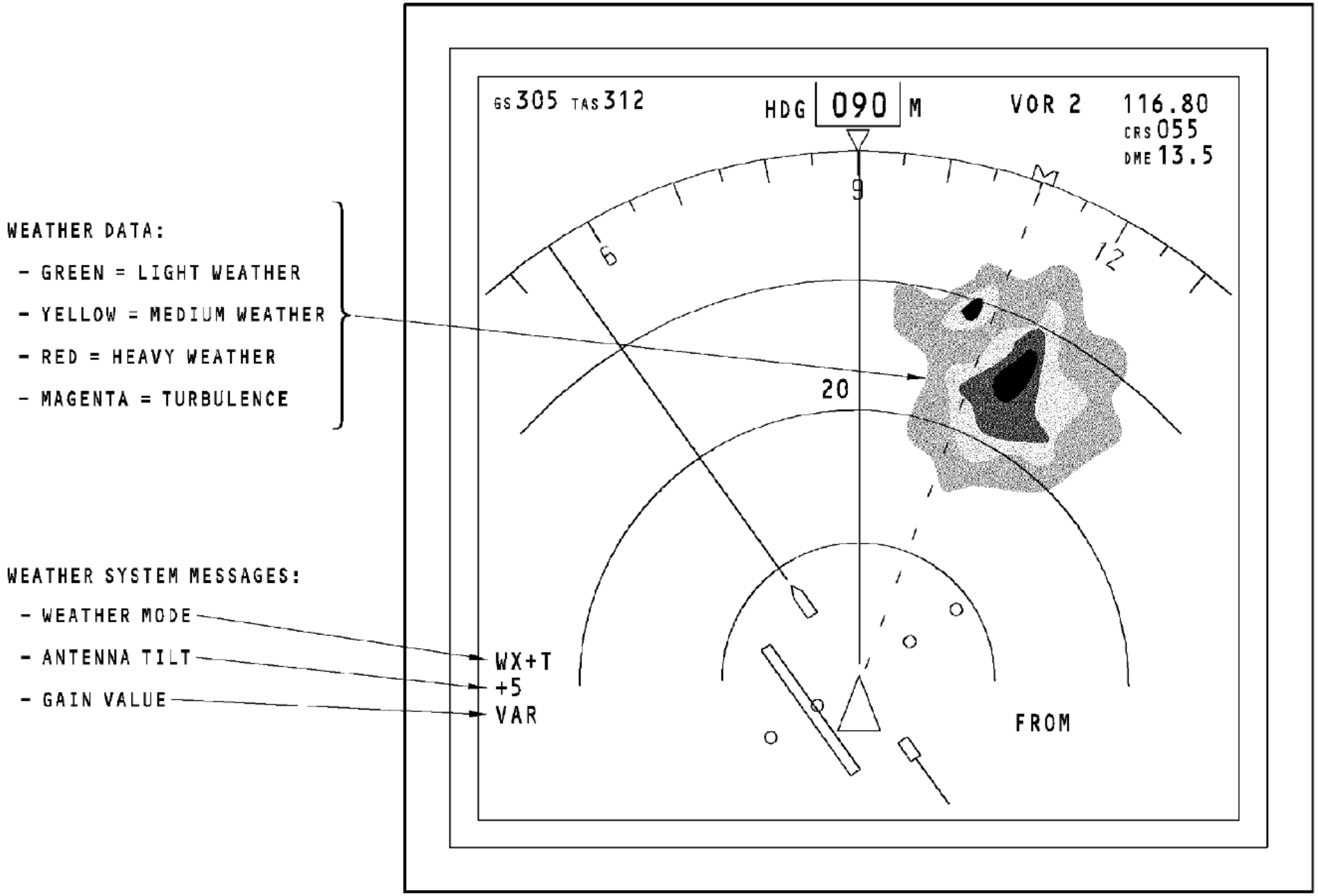
- WXR
- MAP
- WX+T
- TEST.

Line 2 shows the antenna tilt value set on the WXR panel. Antenna tilt shows 0.0 to + 15 or - 15 degrees.

Line 3 shows gain.
Gain shows this data:

- VAR - R/T has gain set by gain switch
- Blank - normal operation (gain switch in AUTO).

All WXR system messages show cyan.



WXR SYSTEM DISPLAYS – NORMAL DISPLAY

PWS OPERATION

General Description

If the 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

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

- Less than 0.25 NM on either side of the airplane projected magnetic heading
- More than 0.5 NM but less than 3 NM ahead of the airplane.

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

- Less than 0.25 NM on either side of the airplane projected magnetic heading
- More than 0.5 NM but less than 1.5 NM ahead of the airplane.

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

- Airspeed more 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 0.5 NM but less than 3 NM ahead of the airplane
- Not in the PWS warning area.

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

- Airspeed more than 80 knots
- Less than 400 feet radio altitude

All PWS alerts are inhibited above 1200 feet radio altitude.

PWS Warning - Flight Deck Effects

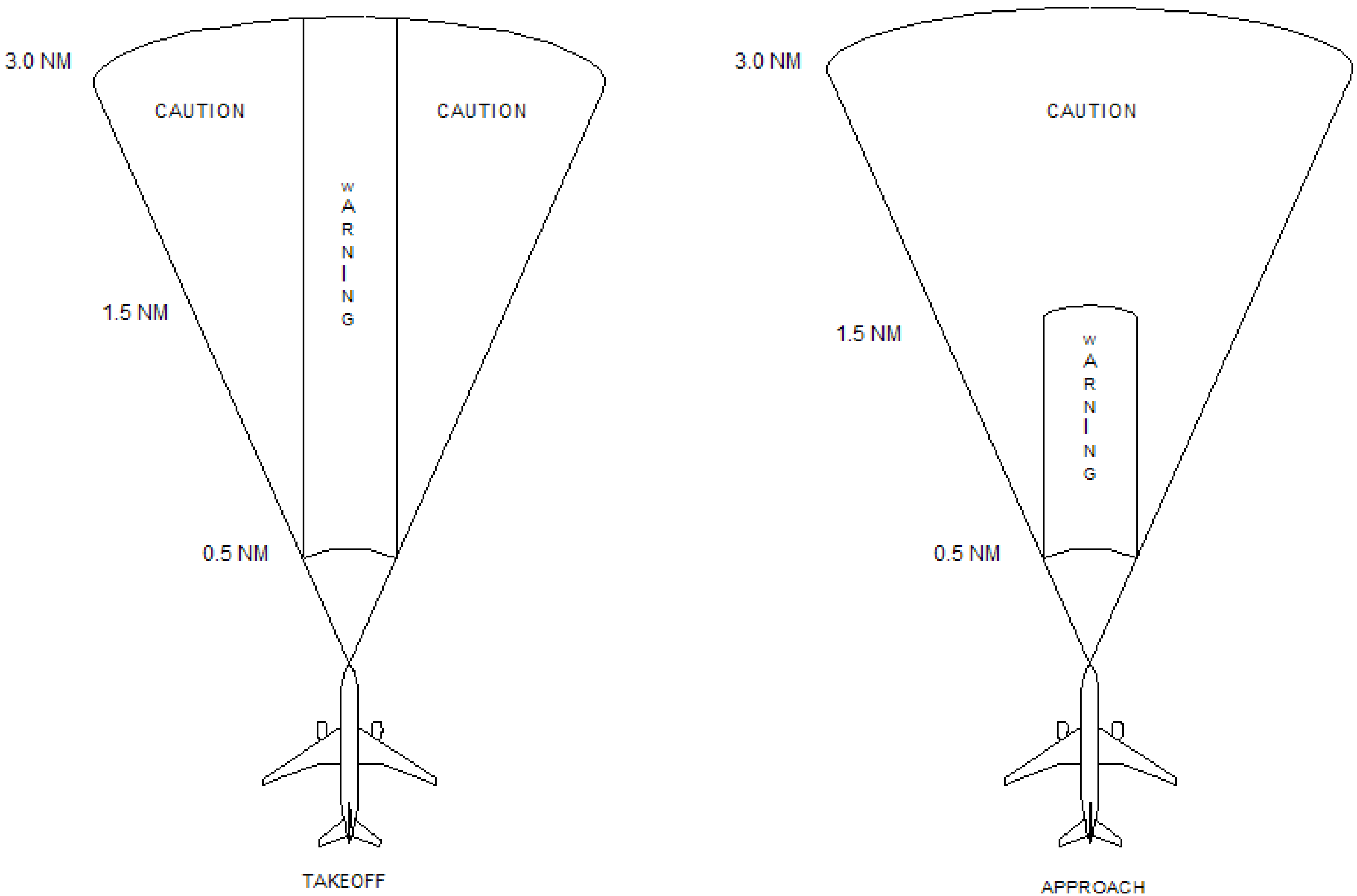
A PWS warning has these visual and aural annunciations:

- Red WINDSHEAR message on the PFD
- Red WINDSHEAR message on the ND
- Aural annunciation - WINDSHEAR AHEAD, WINDSHEAR AHEAD (takeoff)
- Aural annunciation - GO AROUND, WINDSHEAR AHEAD (approach).

PWS Caution - Flight Deck Effects

A PWS caution has theses visual and aural annunciations:

- Amber WINDSHEAR message on the ND
- Windshear symbol on the ND
- Aural annunciation - MONITOR RADAR DISPLAY.



PWS OPERATION

PWS DISPLAY

General Description

Weather radar with predictive windshear (PWS) detects windshear ahead of the airplane.

PWS uses this data to detect windshear:

- Doppler radar returns
- Inertial data
- Air data.

If PWS detects a windshear condition, it alerts the flight crew with visual and aural annunciations.

System On/Off - Takeoff

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

- Throttles move through 53 degrees
- Flight crew pushes the WXR button on an EFIS control panel.

The WXR button on the EFIS CP does not turn off the PWS if the throttle levers are above 53 degrees. 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 when one of these conditions occur:

- Airplane lands
- Airplane climbs above 2300 feet radio altitude.

If PWS is on and WXR is not selected on the EFIS CP, 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.

These are the ND modes that show windshear data:

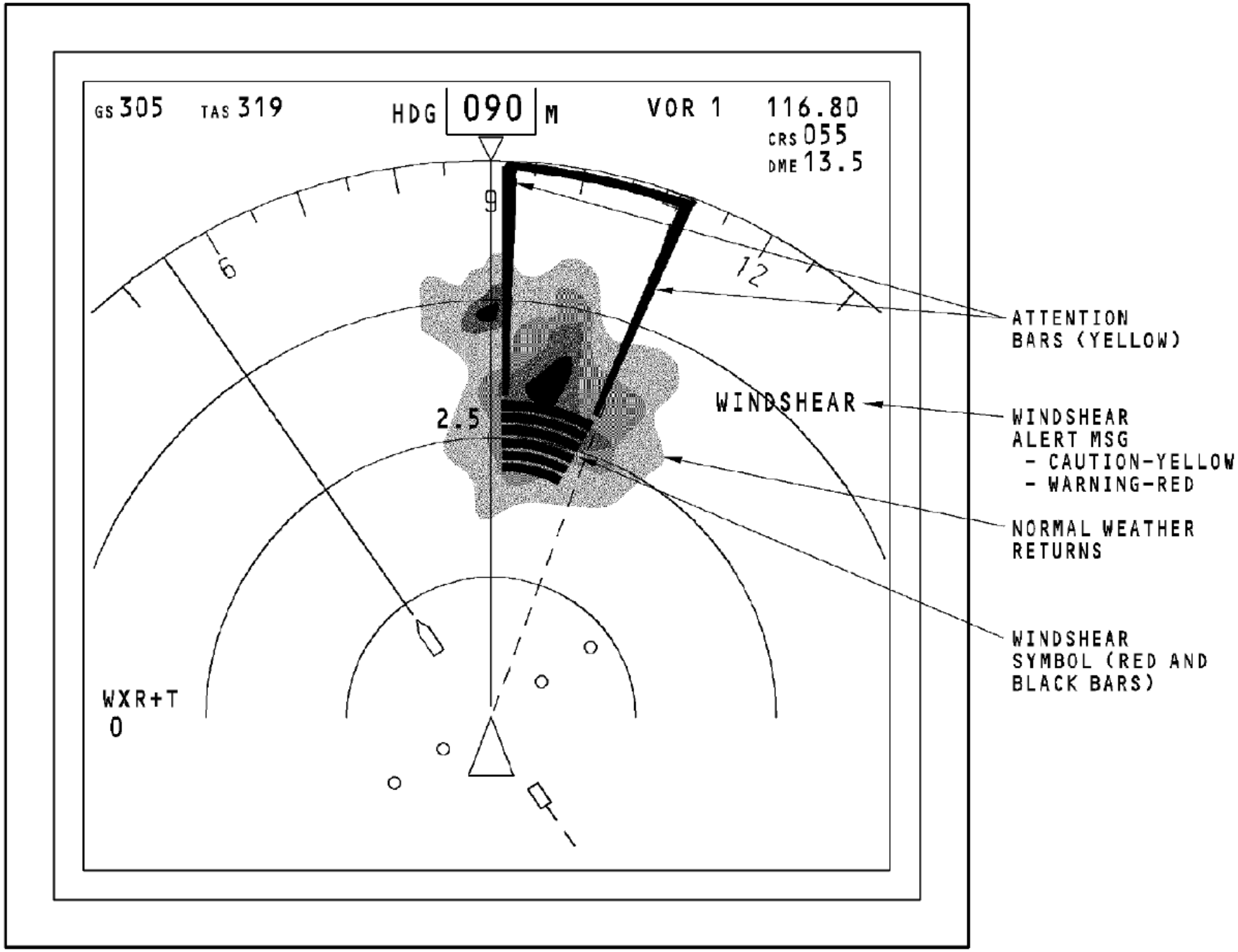
- Expanded APP
- Expanded VOR
- Expanded MAP
- Centered MAP.

PWS cautions or warnings are inhibited above 1200 feet radio altitude. New PWS cautions are inhibited between 80 knots computed airspeed on the ground and 400 feet radio altitude.

New PWS warnings are inhibited between 100 knots computed airspeed and 50 feet radio altitude.

These inhibits apply to both takeoff and approach modes.

> Note: These inhibits do not remove a PWS caution or warning that already exists.


GS 305
TAS 319
HDG 090 M
VOR 1
116.80
CRS 055
DME 13.5
6
9
12
2.5
WINDSHEAR
WXR+T
0
ATTENTION
BARS (YELLOW)
WINDSHEAR
ALERT MSG
- CAUTION-YELLOW
- WARNING-RED
NORMAL WEATHER
RETURNS
WINDSHEAR
SYMBOL (RED AND
BLACK BARS)

PWS DISPLAY

PREDICTIVE WARNING DISPLAY (Continue)

Sweep Patterns

The antenna sweep is the same for takeoff and approach PWS modes. The PWS changes the sweep when PWS is active. Both WXR and PWS sweeps decrease to -60 to +60 degrees.

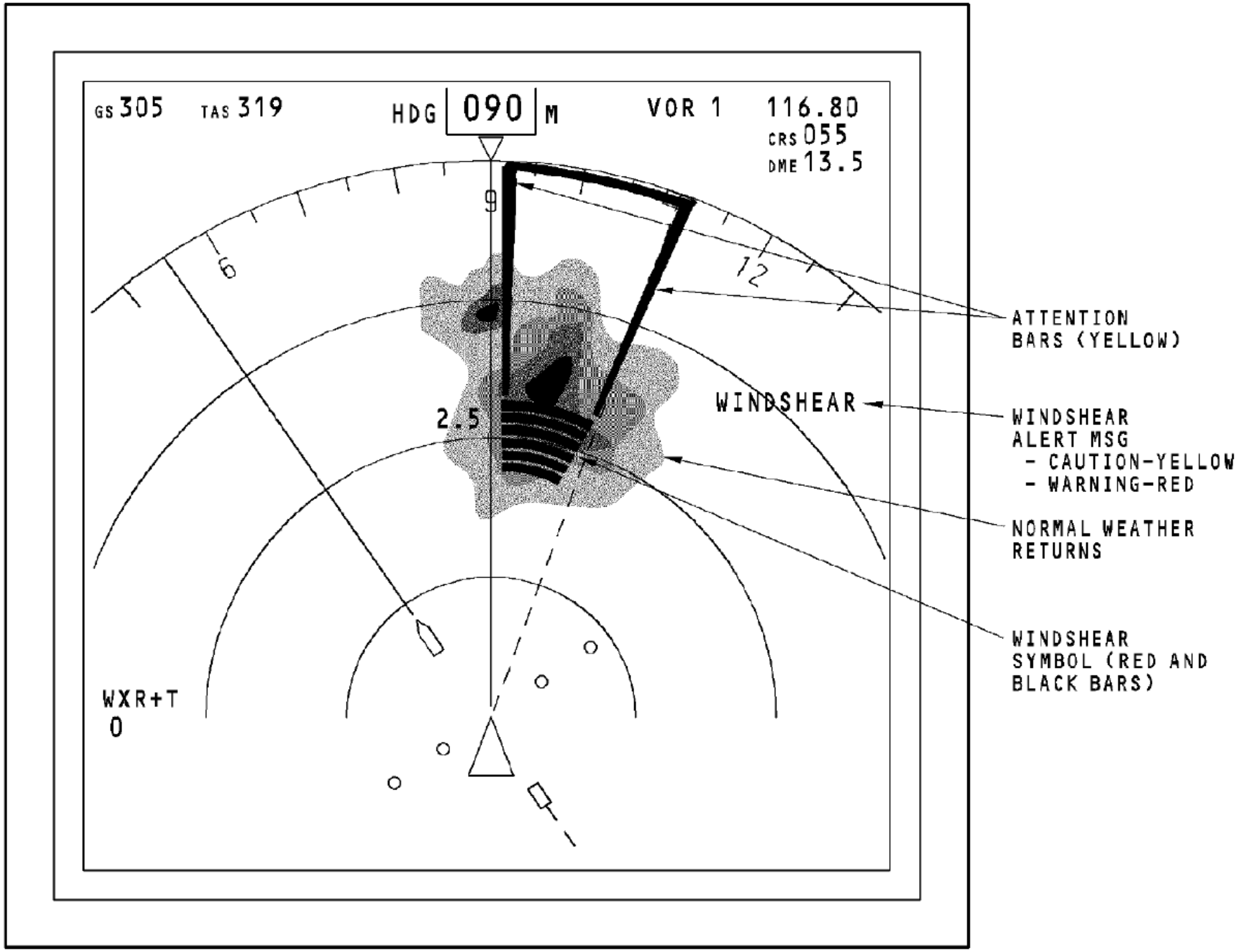
PWS and WXR Sweep Pattern

Position	Dir	Radar Sweep	Paint Sweep	Angle (Degrees)	Time
Sweep 1	L-R	Capt WXR data updated	Capt WXR + icon painted	-60 to +60	3
Sweep 2	R-L	Both PWS data updated	None	+60 to -60	3
Sweep 3	L-R	F/O WXR data updated	F/O WXR + icon painted	-60 to +60	3
Sweep 4	R-L	Both PWS data updated	None	+60 to -60	3

The sweep pattern may go to a PWS only mode during takeoff and approach when WXR is not selected and PWS is automatically activated. The scan is -60 to +60 degrees.

PWS Sweep Pattern

Position	Dir	Radar Sweep	Paint	Angle	Time
Sweep	L-R	None	None	N/A	3
Sweep 2	R-L	Both PWS data updated	None	+60 to -60	3
Sweep	L-R	None	None	N/A	3
Sweep 4	R-L	Both PWS data updated	None	+60 to -60	3


GS 305
TAS 319
HDG 090 M
VOR 1
116.80
CRS 055
DME 13.5
9
6
12
2.5
WINDSHEAR
WXR+T
0
ATTENTION
BARS (YELLOW)
WINDSHEAR
ALERT MSG
- CAUTION-YELLOW
- WARNING-RED
NORMAL WEATHER
RETURNS
WINDSHEAR
SYMBOL (RED AND
BLACK BARS)

PWS DISPLAY

FAILURE DISPLAYS

WXR System Alert Messages and Display

Alert messages show on the ND when the R/T processes data that is not satisfactory. The WXR display will continue to show with an alert message.
Only one alert message shows on the ND. When the R/T processes unsatisfactory data from more than one source only the highest priority message shows.

These are the alert messages and priority from highest to lowest:

- WXR WEAK shows for an R/T gain calibration failure
- WXR ATT shows when the selected attitude input fails
- WXR STAB shows when stabilization is off.

The alert messages show on these alert lines:

- Line 1 shows WXR in amber
- Line 2 shows WEAK, ATT, or STAB in amber.

WXR System Fail Messages and Displaymessage on the ND.

A failure of these components causes a WXR failure:

- R/T
- WXR control panel
- WXR antenna.

A WXR failure causes these conditions:

- WXR FAIL message shows on ND
- Mode, tilt, and gain messages go out of view
- WXR display goes out of view.

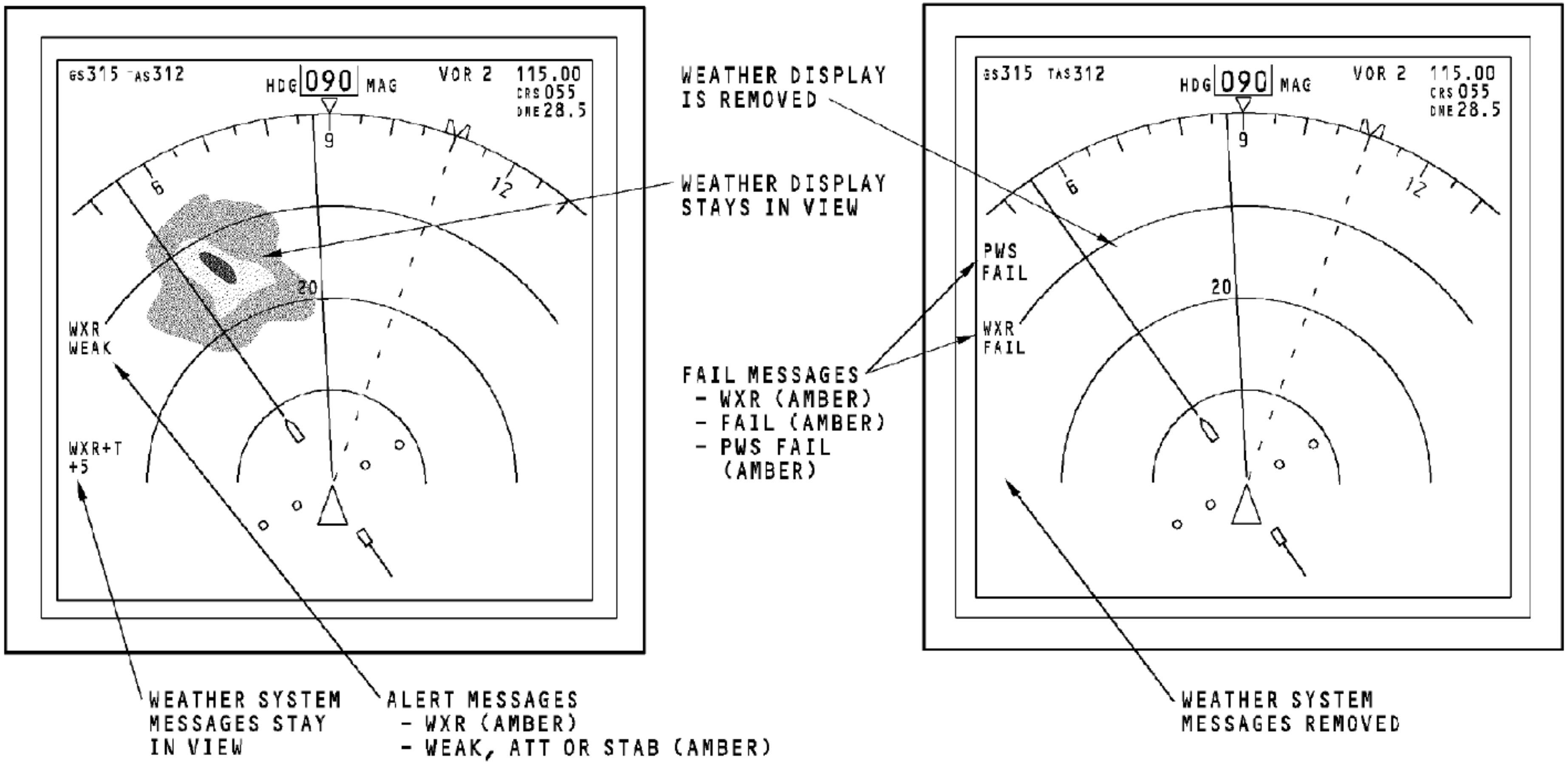
The fail message shows on these alert lines:

- Line 1 shows WXR in amber
- Line 2 shows FAIL in amber.

A failure of these components will cause a PWS failure:

- Loss of any RA
- Loss of ADR data
- Loss of IR data
- Scan and tilt antenna faults
- Internal WXR system faults
- Loss of CAS and TAS.

A failure of the predictive windshear causes an amber PWS FAIL.



WXR SYSTEM ALERT MESSAGES AND DISPLAY

WXR SYSTEM FAIL MESSAGES AND DISPLAY

FAILURE DISPLAYS

ND RANGE DISAGREEMENT

The DEUs compare the ND ranges from these components:

- EFIS CP
- WXR R/T
- Flight management computer (FMC).

A difference between any of these ranges causes an amber range disagreement message on alert line 3.

These WXR range disagreement messages are possible:

- WXR RANGE DISAGREE; shows when there is a difference between the EFIS CP range and the WXR R/T range
- MAP/WXR RANGE DISAGREE; shows when there is a difference between the EFIS CP range, the WXR R/T range, and the FMC range.

MAP/WXR RANGE DISAGREE will show in these modes:

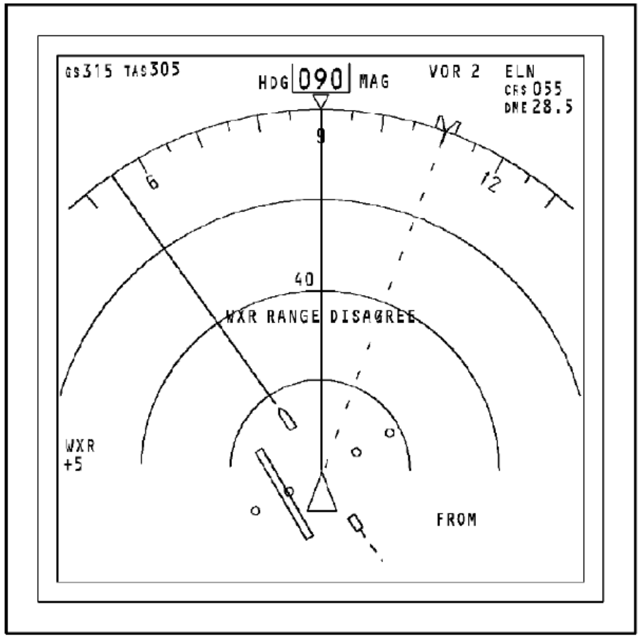
- Expanded map
- Centered map.

This happens during a range disagreement:

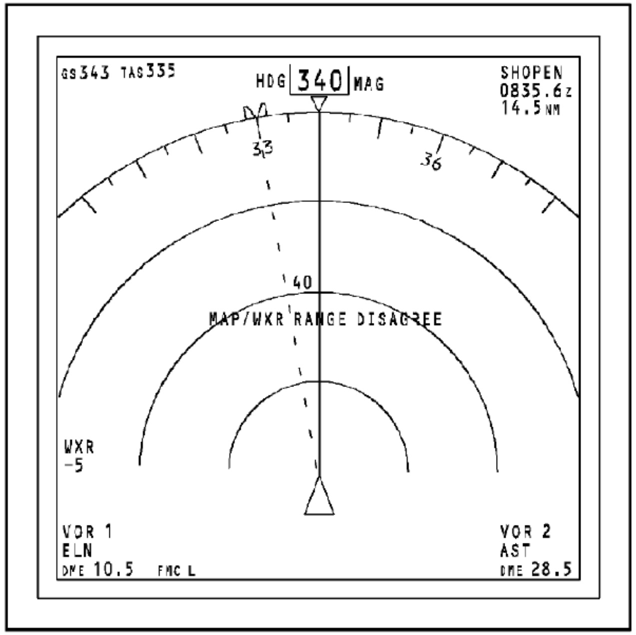
- WXR display goes out of view
- mode, tilt, and gain messages show
- FMC range shows.

WXR RANGE DISAGREE will show in these modes:

- Expanded approach
- Expanded VOR
- Expanded map
- Centered map.



MODES:
- EXPANDED APPROACH
- EXPANDED VOR
- EXPANDED MAP
- CENTERED MAP



MODES:
- EXPANDED MAP
- CENTERED MAP

ND RANGE DISAGREEMENT

THIS PAGE IS INTENTIONALLY LEFT BLANK

WXR SYSTEM - SYSTEM SELECT AND SYSTEM ON/OFF

System Select

The receiver transmitter (R/T) gets 115v ac from XFR bus 2. The keep alive power supply makes unregulated and regulated 28v dc. The unregulated 28v dc power goes to the power relay in the R/T and also provides the interlock (INTRLK) signal through the WXR control panel to switch S1. S1 is held closed.

System On

To make the WXR system operate, push the WXR switch on one of the EFIS control panels.

When you push the WXR switch, the on-side display electronics unit (DEU) supplies a ground through the WXR control panel. The ground then goes through switch S1 of the R/T. This ground lets the unregulated 28v dc power from the power supply energize the relay to close switches S2 and S3. The keep- alive power supply sends regulated 28v dc power through switch S2 to energize the WXR CP power supply.

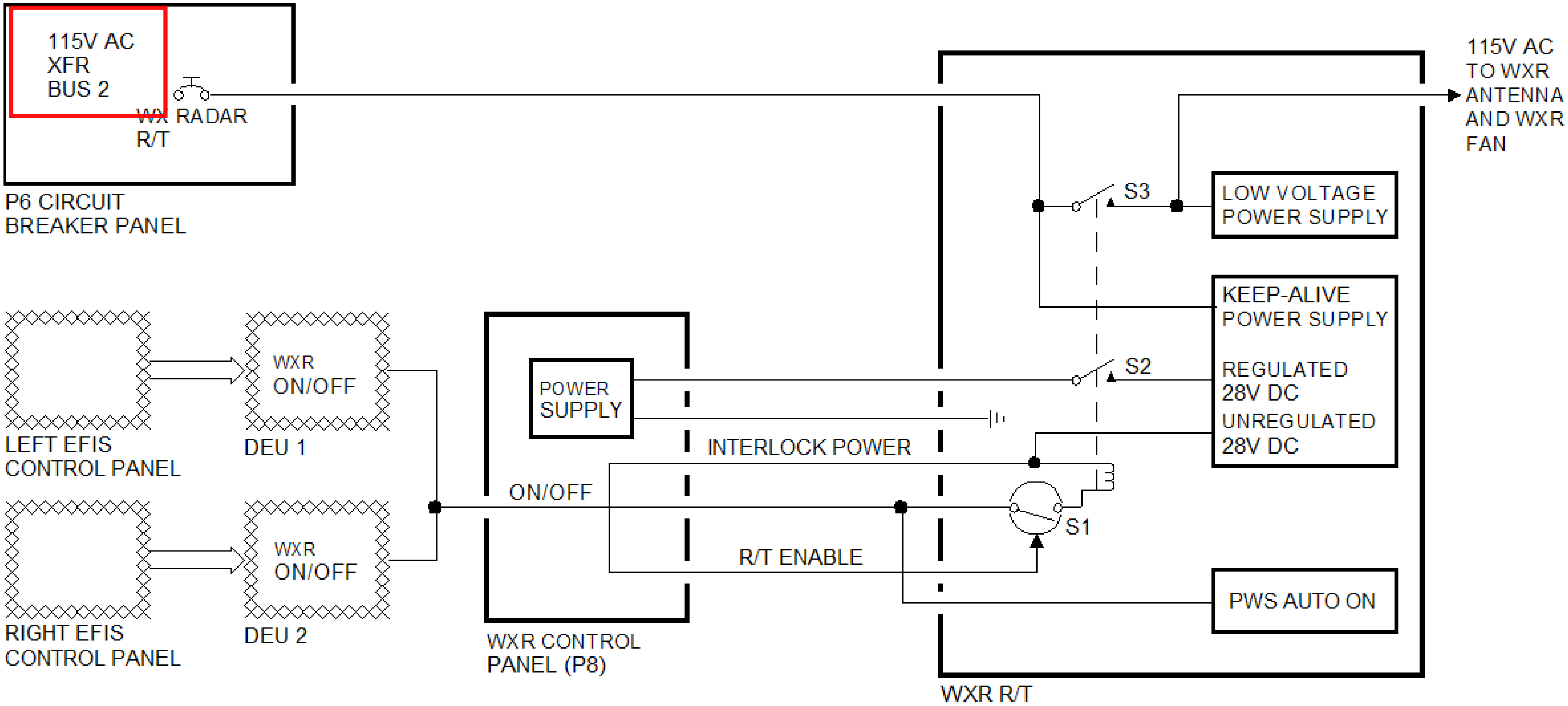
The 115v ac goes through switch S3 to energize these things:

- R/T low voltage power supply
- WXR antenna drive
- WXR cooling fan.

Certain conditions cause the predictive windshear (PWS) function to turn the WXR system on automatically. When this happens, the ground signal comes from the PWS card in the R/T instead of the DEUs.

System Off

To make the WXR system go OFF, push the WXR switch on the EFIS control panel to OFF. This removes the ON discrete from the DEU. If more than one WXR switch is on, push all of the switches to OFF.



SYSTEM SELECT AND SYSTEM ON/OFF

WXR R/T FUNCTIONAL DESCRIPTION

General

The WXR R/T makes RF pulses and sends them to the antenna. The antenna transmits pulses and receives the return signals and sends them to the WXR R/T. The R/T processes the return signals to make display data that shows on the NDs. The WXR data on the ND shows the weather patterns in front of the airplane.

The WXR R/T also comes on automatically during take off and approach to detect windshear events in front of the airplane. If a windshear event is detected, the WXR sends cautions or warnings to the flight compartment.

Control Inputs

The EFIS control panel (EFIS CP) sends the WXR system ON/OFF discrete on a digital bus to the display electronics unit (DEU). The DEU sends a discrete to the WXR R/T to turn ON the weather radar. The discrete goes through the WXR control panel to ensure the panel is in the airplane. The DEUs only send the ON discrete if the navigation display is in the correct mode. The EFIS CP sends range data to the WXR R/T.

The WXR control panel sends control data on a bus to the WXR R/T.

The WXR CP sends these signals:

- Gain
- Tilt
- Mode of operation.

Predictive Windshear Inputs

These are the inputs to the WXR R/T for predictive windshear (PWS):

- Ground proximity warning system inhibit discrete
- Auto throttle 1 switch pack throttle position discrete
- Auto throttle 2 switch pack throttle position discrete
- Radio altimeter 1 and 2.

The GPWS determines the priority for the aural warnings and cautions to the flight compartment. If the PWS CPU finds there is a windshear condition, the WXR R/T sends the warning or caution to the GPWS.

The auto throttle packs determine the position of the throttles. When the airplane is on the ground and either throttle is moved more than 53 degrees, the PWS comes on automatically.

The PWS CPU uses the radio altimeter input to turn the PWS on or off. When the airplane goes below 2300 feet radio altitude on approach, the PWS is turned on. When the altitude goes above 2300 feet during takeoff, the PWS is turned off.

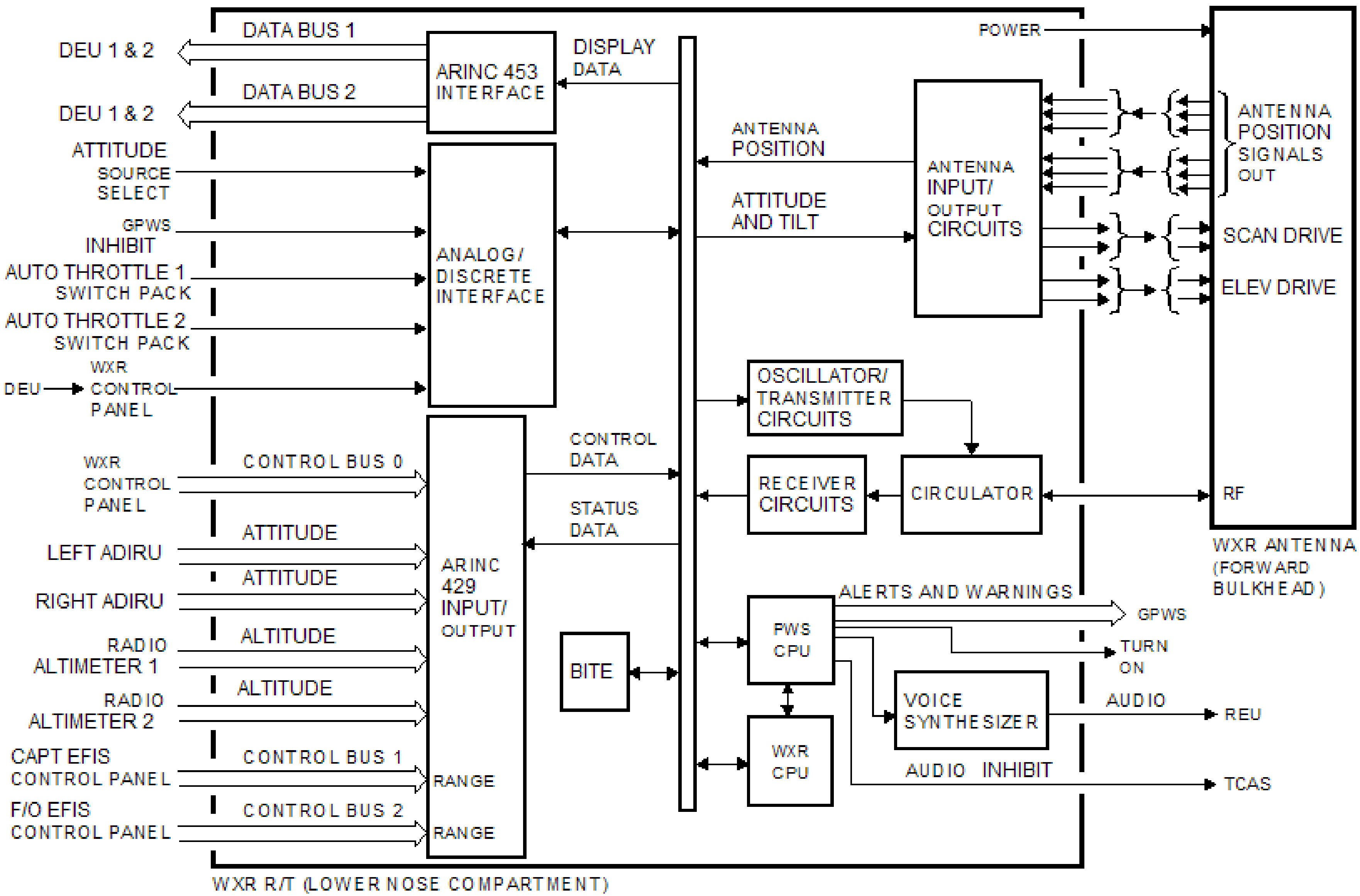
Antenna Control

The WXR R/T gets attitude data for antenna stabilization from the ADIRUs. When the IRS select switch on the navigation/displays source select panel is in NORMAL or BOTH ON L, the R/T uses the left ADIRU for stabilization. You put the IRS select switch to BOTH ON R to change to the right ADIRU stabilization data. The IRS select switch sends a ground discrete to the WXR R/T.

WXR Central Processor Unit

The WXR central processor unit (CPU) uses the control data to control the operation of the R/T and the antenna drive. The CPU sends range, gain and mode control signals to the transmitter circuits.

Also, the WXR CPU makes the scan and elevation signals from the ADIRU attitude data. It sends these signals to the antenna for antenna stabilization. The WXR CPU also gets antenna position signals from the antenna assembly.



WXR R/T FUNCTIONAL DIAGRAM

WXR R/T FUNCTIONAL DESCRIPTION (Continue)

Predictive Windshear Central Processor Unit

The PWS CPU uses inputs from these systems to turn on the WXR PWS function:

- Auto throttle switch packs
- Radio altimeters.

The PWS CPU controls the antenna scan and pulse repetition frequency of the transmitter to detect windshear events directly in front of the airplane. The area is limited to a very small range because of the high pulse repetition frequency.

When the PWS CPU detects a windshear, it sends the warning or caution to the GPWS. The GPWS has the priority logic for warnings and cautions. If there is no higher priority warning or caution, the PWS CPU sends the windshear display to the DEUs and sends the aural signal to the REU. Also, the PWS CPU sends an aural inhibit to the TCAS computer to inhibit any aural signals from TCAS.

Oscillator/Transmitter Circuits

The oscillator/transmitter circuit makes RF pulse patterns and sends them out through the WXR antenna.

RF Transmit

The RF pulses go from the transmitter circuits through the circulator. The circulator connects the antenna to the transmitter during RF transmission. It also connects the antenna to the receiver circuits to get the return RF pulses. From the circulator, the RF goes to the WXR antenna.

RF Receive

The antenna receives the RF return signals. Then the RF goes through the circulator to the receiver circuits. The receiver circuits process the return signals and send them to the CPU. The CPU uses the strength of the RF return signals to calculate the intensity of the precipitation and to make the WXR display data.

When the PWS is on, the return signals may also contain windshear information. The PWS CPU processes the windshear returns and makes the aural signals and display signals.

WXR Display Data

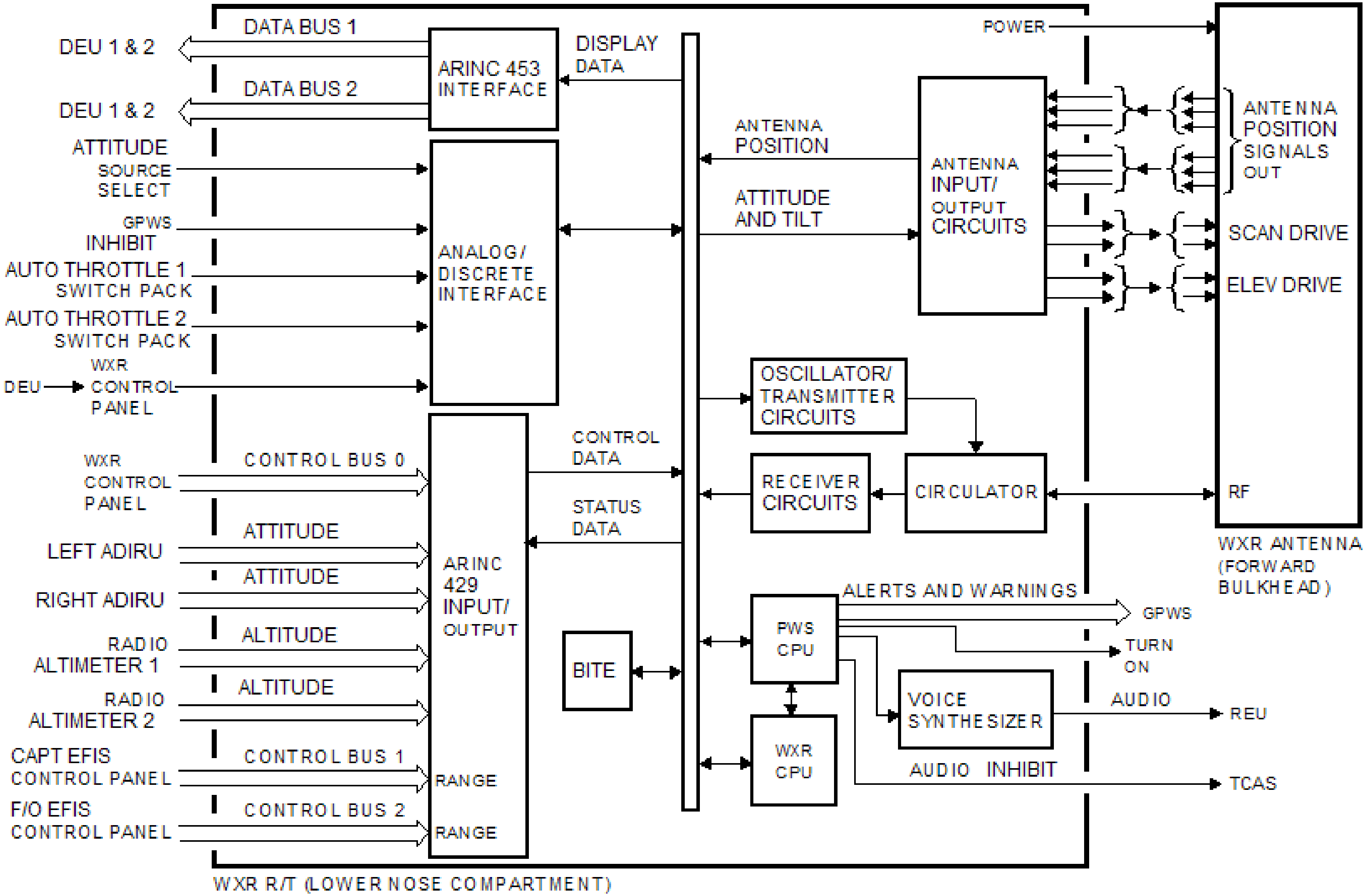
The CPU puts this data into the ARINC 453 format:

- WXR display data
- Range processed
- System mode
- Status data.

The CPU sends the output data to the ARINC 453 transmitters. The 453 transmitters send the data on the high speed ARINC 453 DATA BUS 1 and DATA BUS 2 to the DEUs.

System Status Data

The BITE module continuously gets system status data. The system status and the faults show on the ND alert lines.



WXR R/T FUNCTIONAL DIAGRAM

ANTENNA FUNCTIONAL DESCRIPTION

Antenna Control

The CPU in the WXR R/T controls and monitors the antenna operation.

Antenna Stabilization

The WXR R/T uses attitude inputs from the ADIRU for antenna stabilization. The CPU uses the attitude inputs to calculate and control the scan and elevation movements. It sends the scan and elevation drive signals to the antenna.

Antenna Operation

The antenna power supply gets 115v ac from the WXR R/T. The antenna power supply sends 26v dc power to the antenna motor driver. The motor driver sends 26v dc power to the scan and elevation stepper motors. The motor driver also sends power to the antenna position monitors.

Antenna Drive

The antenna has one scan motor and one elevation motor. The scan motor drives a gear train which moves the antenna horizontally. It moves the antenna | 90 degrees from the centerline of the airplane. The elevation motor drives a gear train which moves the antenna vertically. It moves the antenna up and down |40 degrees. This elevation range includes |15 degrees for the manual tilt.

Antenna Position Feedback

There are two zero and two incremental monitors in the antenna assembly. Each stepper motor has one zero monitor and one incremental monitor. The zero monitors read the zero or center position of the stepper motor. The incremental monitors count the number of steps the motor moves from the center position. The monitors send antenna position data to the WXR R/T.

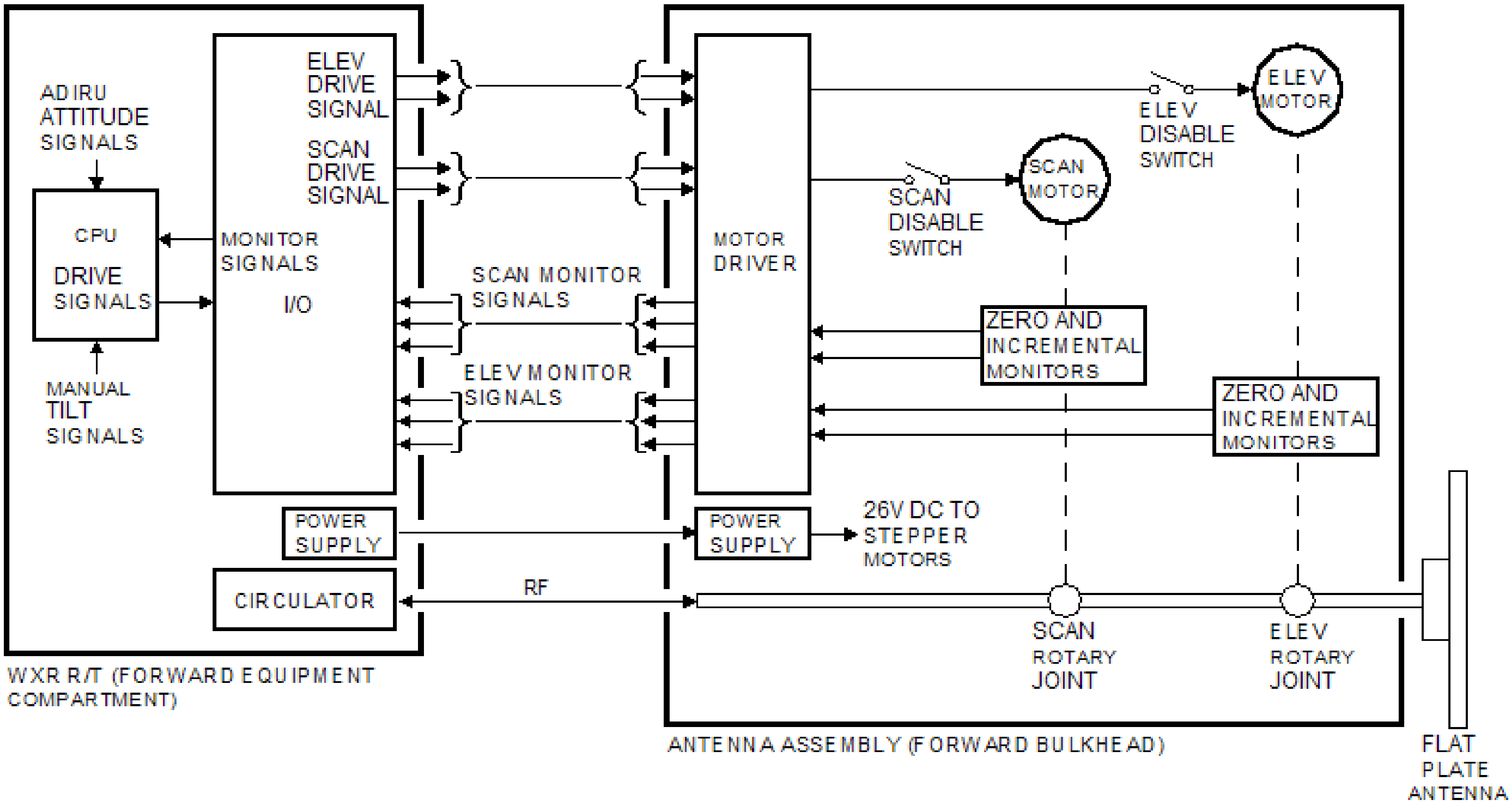
Antenna Position Compare

The WXR R/T CPU uses the position information from the monitors to compare the actual antenna position with the desired antenna position. When the two are not the same, the WXR R/T sets the antenna fault.

Disable Switches

The disable switches are on the antenna pedestal. The scan disable switch disconnects the scan motor from the motor drive. The elevation disable switch disconnects the elevation motor from the motor drive. Because the motors disconnect from the motor drives, the antenna does not move.

Caution: AN OPEN DISABLE SWITCH DOES NOT STOP RF TRANSMISSION FROM THE ANTENNA.



ANTENNA FUNCTIONAL DIAGRAM

WXR R/T BITE - FUNCTIONAL DESCRIPTION

The CPU in the WXR R/T controls the operation of the BITE module.

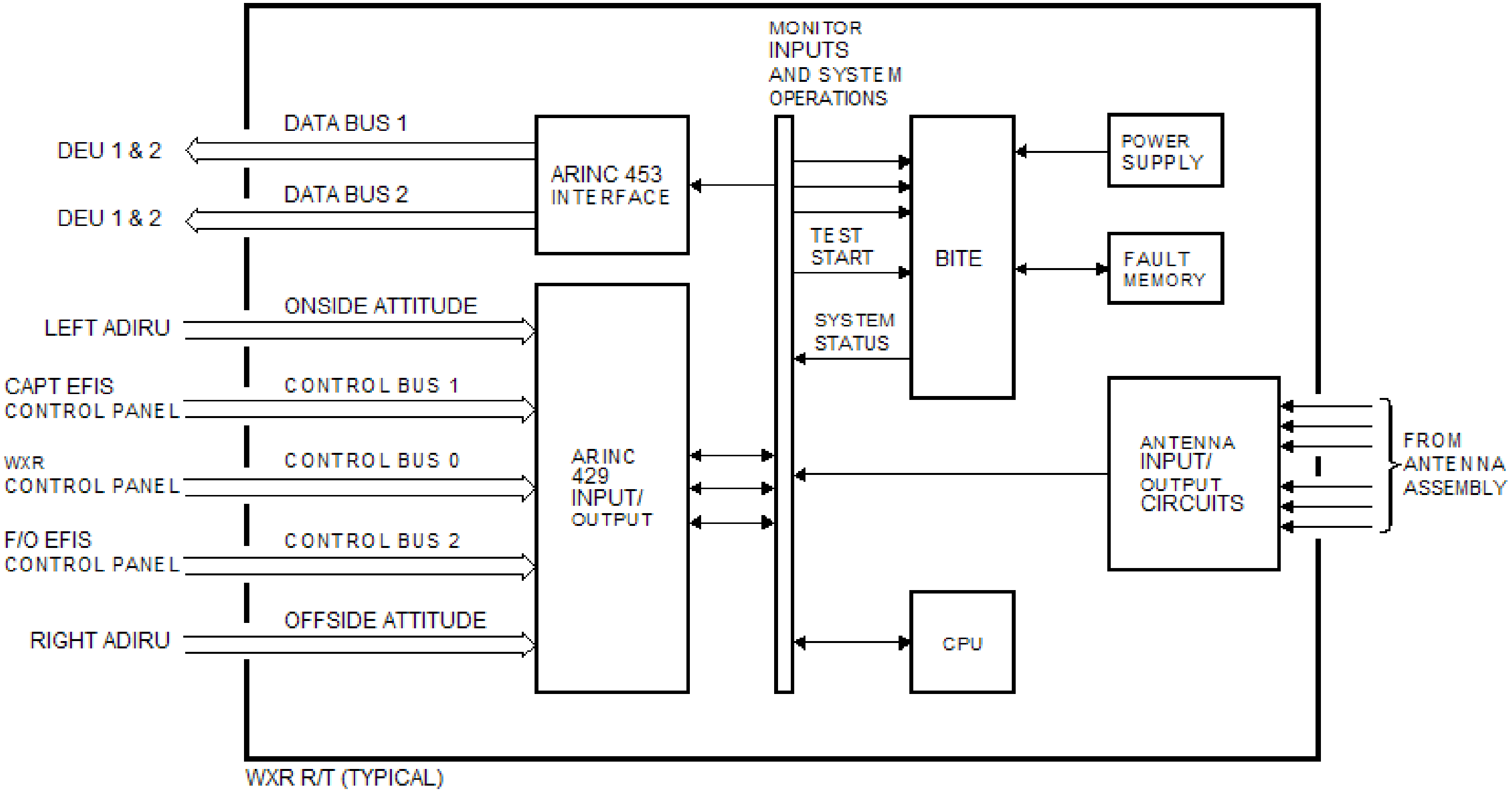
These are the functions of the BITE module:

- Gets status information from the interface components
- Gets internally monitored data
- Does a self-test when it gets a command from the WXR CP
- Sends a test pattern to the DEUs to show on the ND
- Sends system status data to the DEUs to show on the ND.

Internal Input Monitoring

The BITE monitors these things:

- Over temperature from the power supply
- Control and range from the WXR panel on control bus 0
- Range inputs from the EFIS control panels on control bus 1 and 2
- Antenna scan and elevation position from the CPU.



WXR R/T BITE - FUNCTIONAL DIAGRAM

THIS PAGE IS INTENTIONALLY LEFT BLANK

WXR SELF-TEST - START

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 IN FRONT OF THE ANTENNA. THIS CAN CAUSE AN EXPLOSION.

Warning: MAKE SURE NO PERSONS ARE IN THE AREA 50 FEET OR LESS FROM THE ANTENNA WHEN IT TRANSMITS RF ENERGY. RF ENERGY CAN CAUSE INJURIES TO PERSONS.

Caution: MAKE SURE NO LARGE METALLIC OBJECTS ARE CLOSER THAN 300 FEET FOR THE 180-DEGREE AREA IN FRONT OF THE AIRPLANE WHEN THE RADAR OPERATES. LARGE METAL OBJECTS CAN INCLUDE HANGARS, TRUCKS, OR OTHER AIRPLANES. DAMAGE TO THE TRANSCEIVER COULD OCCUR IF OBJECTS ARE IN THIS AREA. THIS DOES NOT APPLY WHEN THE WEATHER RADAR OPERATES IN THE TEST MODE.

Test Preparation

On the WXR control panel, select these functions:

- Set the mode selector to the TEST position.
- Set the tilt control to 0 degrees.
- Set the gain control to the Auto position.

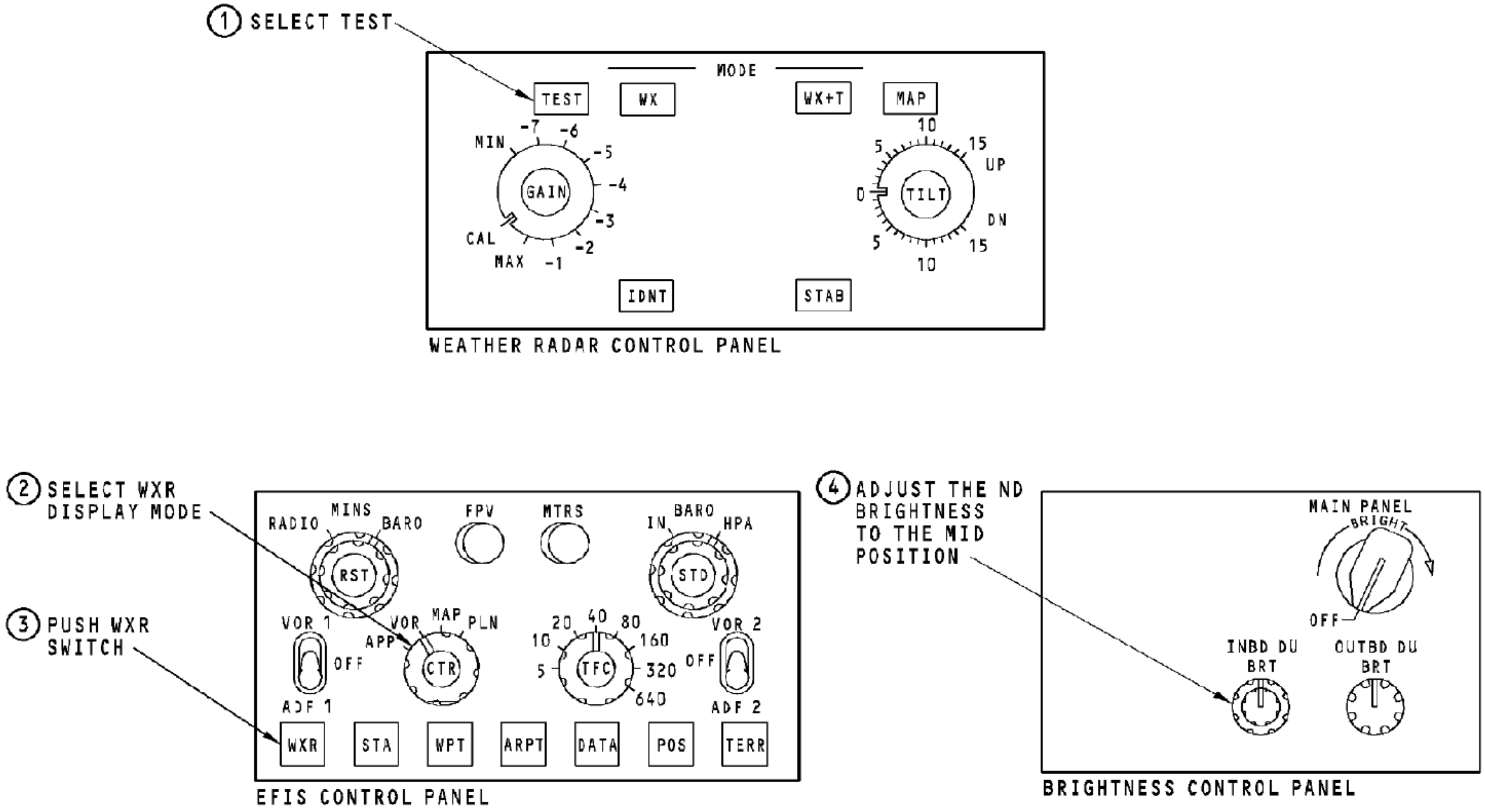
On the EFIS control panel, select these functions:

- Set the range selector to the 40 NM position.
- Set the mode selector to the correct ND mode (expanded APP, expanded VOR, expanded MAP or centered MAP).

Also, adjust the inner ND brightness control to the middle position.

Test Start

Push the WXR switch on the EFIS control panel to apply power to the WXR R/T.



SELF-TEST START

SELF-TEST

Training Information Point

During a test, the weather radar (WXR) system transmits a few pulses to let the BITE monitor the 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

On the WXR control panel, select these functions:

- Set the mode selector to the TEST position (Option 2)
- Set the mode selector to the WXR position
- Set the tilt control to 0 degrees
- Set the gain control to the AUTO position. On the EFIS control panel, select these functions:
- Set the range selector to 40 NM
- Set the mode selector to the correct ND mode (expanded APP, expanded VOR, expanded MAP or centered MAP).

Also, adjust the inner ND brightness control to the middle position.

Test Start

Push the WXR switch on the EFIS control panel to apply power to the WXR R/T.

(Option 2)

On the EFIS control panel, push the WXR switch to apply power to the WXR R/T. On the WXR control panel, set the mode selector to the TEST position to start the test.

Note: (Option 2) If the WXR mode selector is in the TEST position before you apply power to the WXR R/T, you must set the mode selector to another mode and then set the mode selector to TEST to start the test.

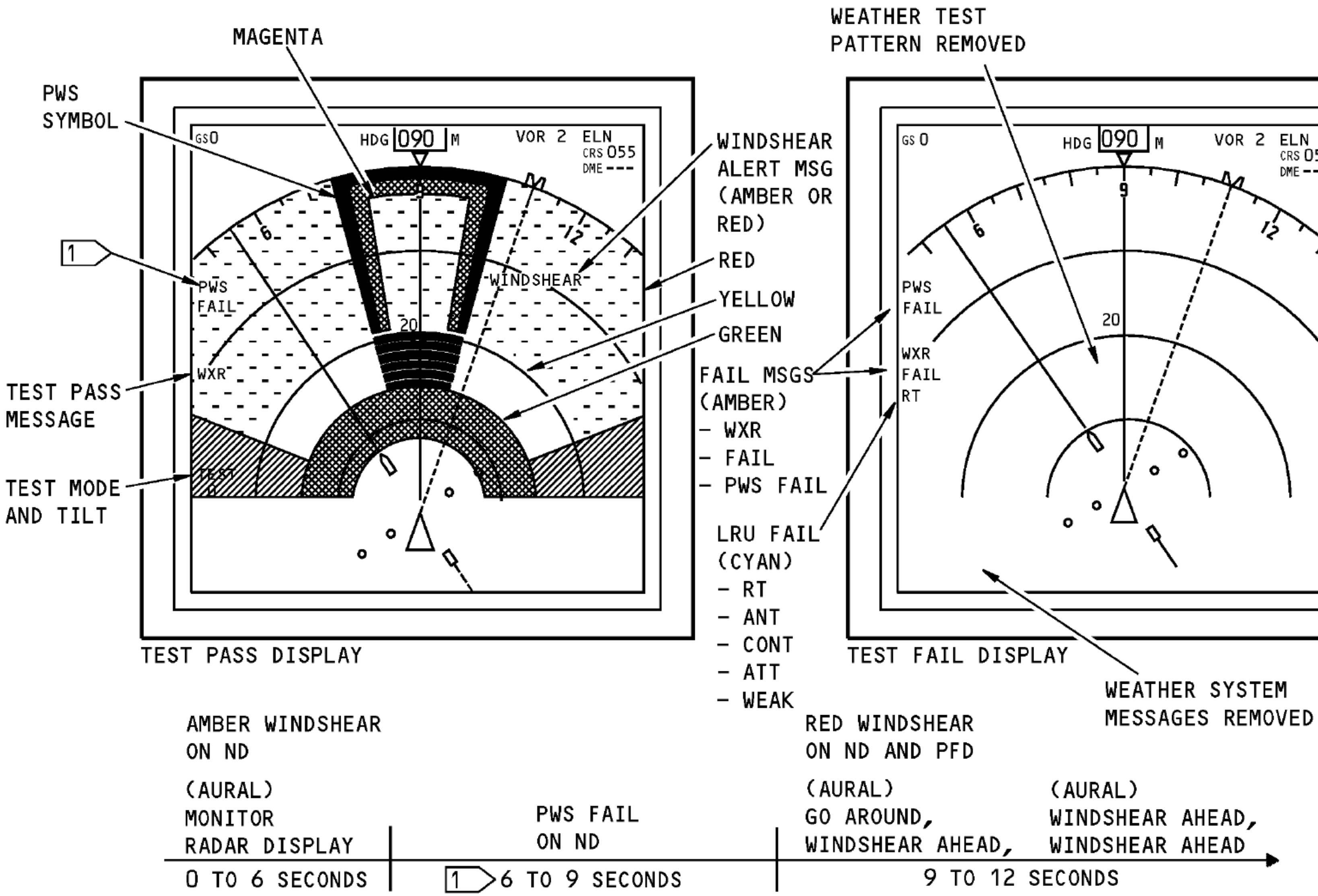
Test Operation

During the test, these things happen:

- R/T transmits a few pulses to let the BITE monitor for correct operation
- R/T makes a test pattern and sends it to the DEU to show on the NDs
- R/T sends test messages and mode, gain, and tilt information to the DEUs to show on the NDs
- WXR test pattern shows on ND.

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

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


MAGENTA
PWS SYMBOL
WINDSHEAR ALERT MSG (AMBER OR RED)
RED
YELLOW
GREEN
FAIL MSGS (AMBER)
- WXR
- FAIL
- PWS FAIL
LRU FAIL (CYAN)
- RT
- ANT
- CONT
- ATT
- WEAK
TEST PASS MESSAGE
TEST MODE AND TILT
WEATHER TEST PATTERN REMOVED
WEATHER SYSTEM MESSAGES REMOVED
TEST PASS DISPLAY
TEST FAIL DISPLAY
GS 0
HDG 090 M
VOR 2 ELN
CRS 055
DME ---
PWS FAIL
WXR
WINDSHEAR
TEST
WXR FAIL RT
AMBER WINDSHEAR ON ND
RED WINDSHEAR ON ND AND PFD
(AURAL) MONITOR RADAR DISPLAY
PWS FAIL ON ND
(AURAL) GO AROUND, WINDSHEAR AHEAD,
(AURAL) WINDSHEAR AHEAD, WINDSHEAR AHEAD
0 TO 6 SECONDS
1 6 TO 9 SECONDS
9 TO 12 SECONDS

SELF-TEST

SELF-TEST
(Continue)

Test Pass

For a valid WXR self-test, CDS shows these displays:

- WXR test pattern
- Amber WINDSHEAR message on ND
- Aural message - MONITOR RADAR DISPLAY
- Red WINDSHEAR message on ND and ADI
- Aural message - GO AROUND, WINDSHEAR AHEAD, (pause) WINDSHEAR AHEAD, WINDSHEAR AHEAD
- WXR on alert message line one
- TEST on alert message line two.

Test Fail

For a test that fails, these are the indications on the ND:

- WXR test pattern does not show
- WXR shows on alert message on line one
- FAIL shows on alert message on line two
- Line three shows all of the failures.

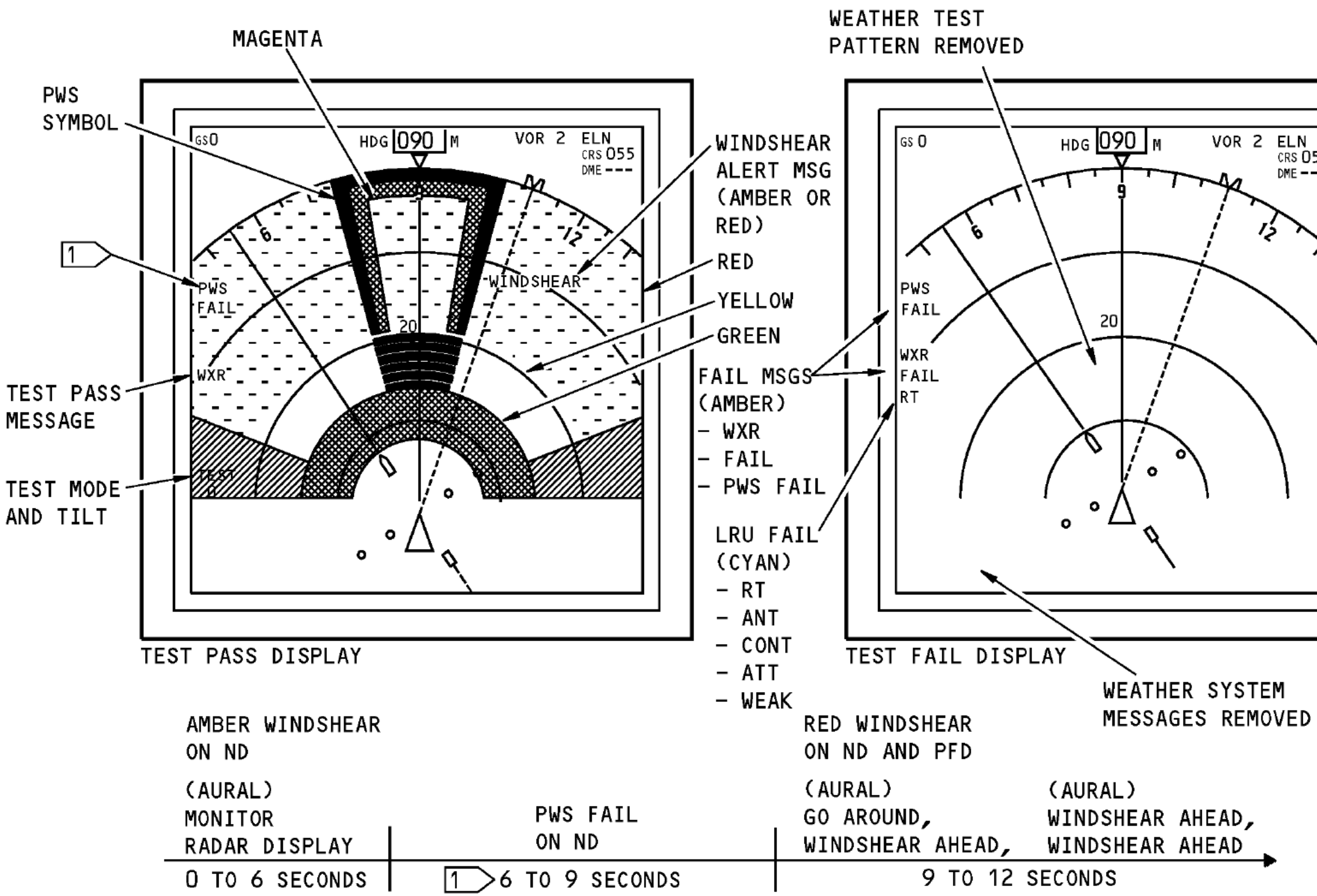
These are the messages that can show on line three:

- R/T - receiver/transmitter fault
- ANT - antenna fault
- CONT - control panel fault
- ATT - attitude input fault
- WEAK - calibration fault.

There is no Aural output from WXR if the test fails.

Training Information Point

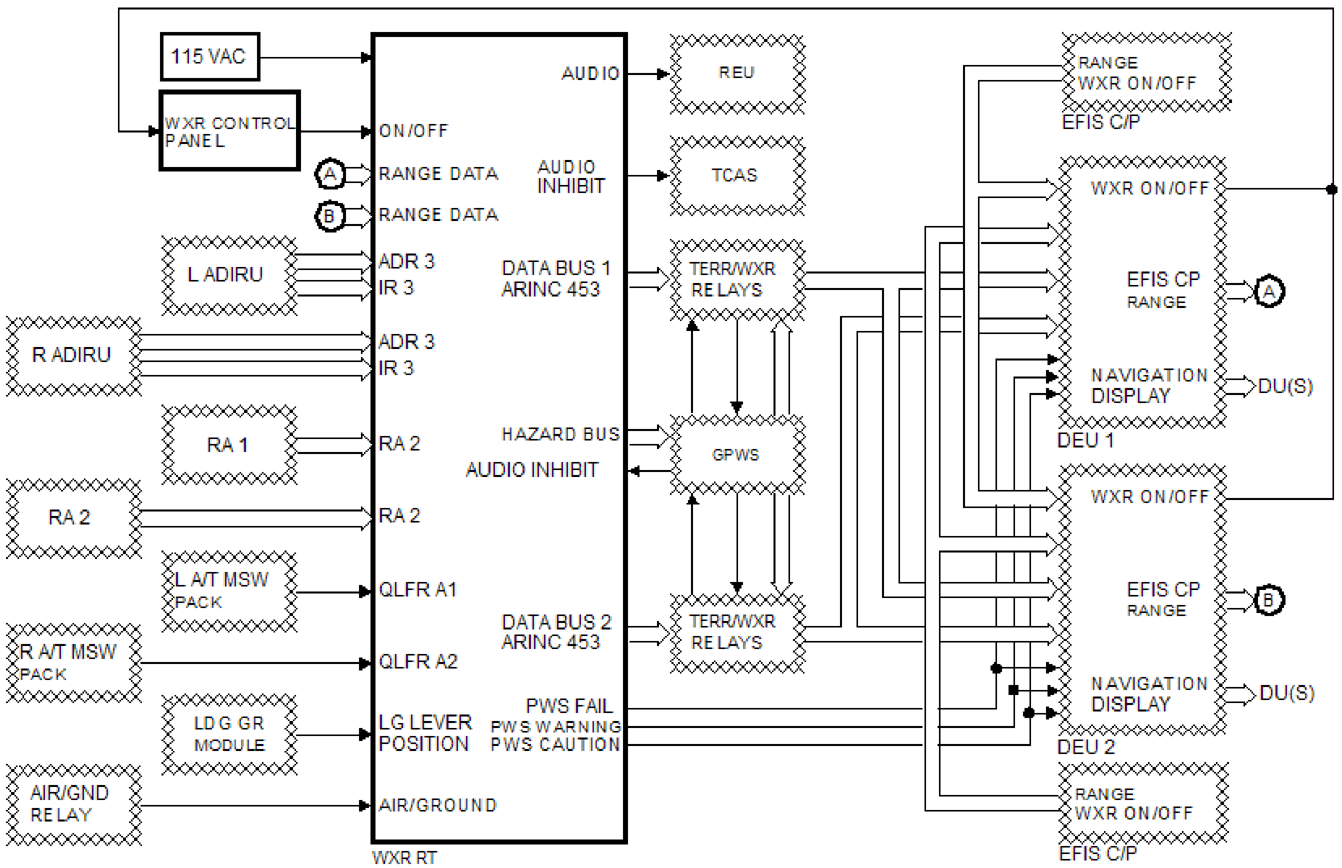
There are bite instructions to do a manual test of the weather radar in the CDS DEU BITE menu. This test is WXR INTERFACE TEST and shows three pages of instructions. This test is for the CDS/WXR interface.


MAGENTA
PWS SYMBOL
1
TEST PASS MESSAGE
TEST MODE AND TILT
GS0
HDG 090 M
VOR 2 ELN
CRS 055
DME ---
PWS FAIL
WXR
WINDSHEAR
20
6
12
TEST
TEST PASS DISPLAY
WINDSHEAR ALERT MSG (AMBER OR RED)
RED
YELLOW
GREEN
FAIL MSGS (AMBER)
- WXR
- FAIL
- PWS FAIL
LRU FAIL (CYAN)
- RT
- ANT
- CONT
- ATT
- WEAK
WEATHER TEST PATTERN REMOVED
WXR FAIL RT
TEST FAIL DISPLAY
WEATHER SYSTEM MESSAGES REMOVED
AMBER WINDSHEAR ON ND
(AURAL) MONITOR RADAR DISPLAY
0 TO 6 SECONDS
PWS FAIL ON ND
1 6 TO 9 SECONDS
RED WINDSHEAR ON ND AND PFD
(AURAL) GO AROUND, WINDSHEAR AHEAD,
(AURAL) WINDSHEAR AHEAD, WINDSHEAR AHEAD
9 TO 12 SECONDS

SELF-TEST

WXR SYSTEM - SYSTEM SUMMARY

General



SYSTEM SUMMARY

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–46. GROUND PROXIMITY WARNING SYSTEM (ATA 34–46)

LEVEL 3

GROUND PROXIMITY WARNING SYSTEM - INTRODUCTION

Purpose

The ground proximity warning system (GPWS) alerts the flight crew of an unsafe condition when the airplane is near the terrain. It also supplies a warning for windshear conditions.

The GPWS uses global positioning system (GPS)and loadable software data bases to give the flight crew improved terrain awareness. This is done by the display of detailed terrain information for the area around the aircraft. The GPWS also warns the flight crew of an early descent.

Description

The GPWS uses aural messages, lights, and displays to give alerts in the flight compartment.

GPWS Modes

These are the GPWS modes:

- Mode 1 - Large descent rates
- Mode 2 - Too much of a closure rate when approaching terrain that is rising
- Mode 3 - Too much altitude loss during climbout (at takeoff or in go around) when the airplane is not in the landing configuration
- Mode 4 - Not enough terrain clearance
- Mode 5 - Too much deviation below the glideslope
- Mode 6 - Aural callouts when the airplane descends through selected radio altitudes
- Mode 7 - Warning for windshear conditions.
- Terrain clearance floor - early descent on approach
- Terrain awareness - display of terrain around the airplane.

Abbreviations and Acronyms

- FPM - feet per minute
- FPS - feet per second
- GND PROX - ground proximity
- GPS - global positioning system
- GPWC - ground proximity warning computer
- GPWM - ground proximity warning module
- GPWS - ground proximity warning system
- G/S - glideslope
- ILS - instrument landing system
- inop - inoperative
- IVS - inertial vertical speed
- ovrd - override
- pos - position
- PSEU - proximity switch electronic unit
- PWS - predictive windshear
- RA - radio altitude
- REU - remote electronics unit
- sec - second
- sw - switch
- sys - system
- TA - terrain awareness
- TCAS - traffic alert and collision avoidance system
- TCF - terrain clearance floor
- TERR - terrain
- WXR - weather radar system
- vert - vertical
- xfr - transfer
- xmtr - transmitter

GROUND PROXIMITY WARNING SYSTEM - INTRODUCTION

GENERAL DESCRIPTION

General Description

The GPWS gives the pilots aural and visual warnings of unsafe conditions. The warnings continue until the pilots correct the condition. The system operates when the airplane is less than 2450 feet above the ground.

The enhanced GPWS function contains a worldwide terrain data base. The GPWC compares airplane position and track with this data base to find if there is a warning condition. This is the terrain awareness (TA) function.

The enhanced GPWS also contains an airport data base. This data base contains terrain information for all hard surface runways that are more than 3500 feet or longer. The GPWC compares airplane position and runway location to find if there is a warning condition. This is the terrain clearance floor (TCF) function.

The GPWS uses inputs from these units to calculate warning conditions:

- Ground proximity warning module (GPWM)
- Radio altimeter (RA)
- Air data inertial reference system (ADIRS)
- Stall management yaw dampers (SMYDs)
- Multi-mode receivers (MMRs)
- Flight management computer system (FMCS)
- DFCS MCP
- Weather radar (WXR)
- Display electronics units (DEUs).

GPWS visual warnings show on the common display system (CDS) display units, the below glideslope annunciators, and the GPWM.

GPWS aural warnings go through the remote electronics unit to the pilots headsets and flight deck speakers.

The GPWS sends inhibit signals to the TCAS and weather radar systems when GPWS calculates cautions and warnings.

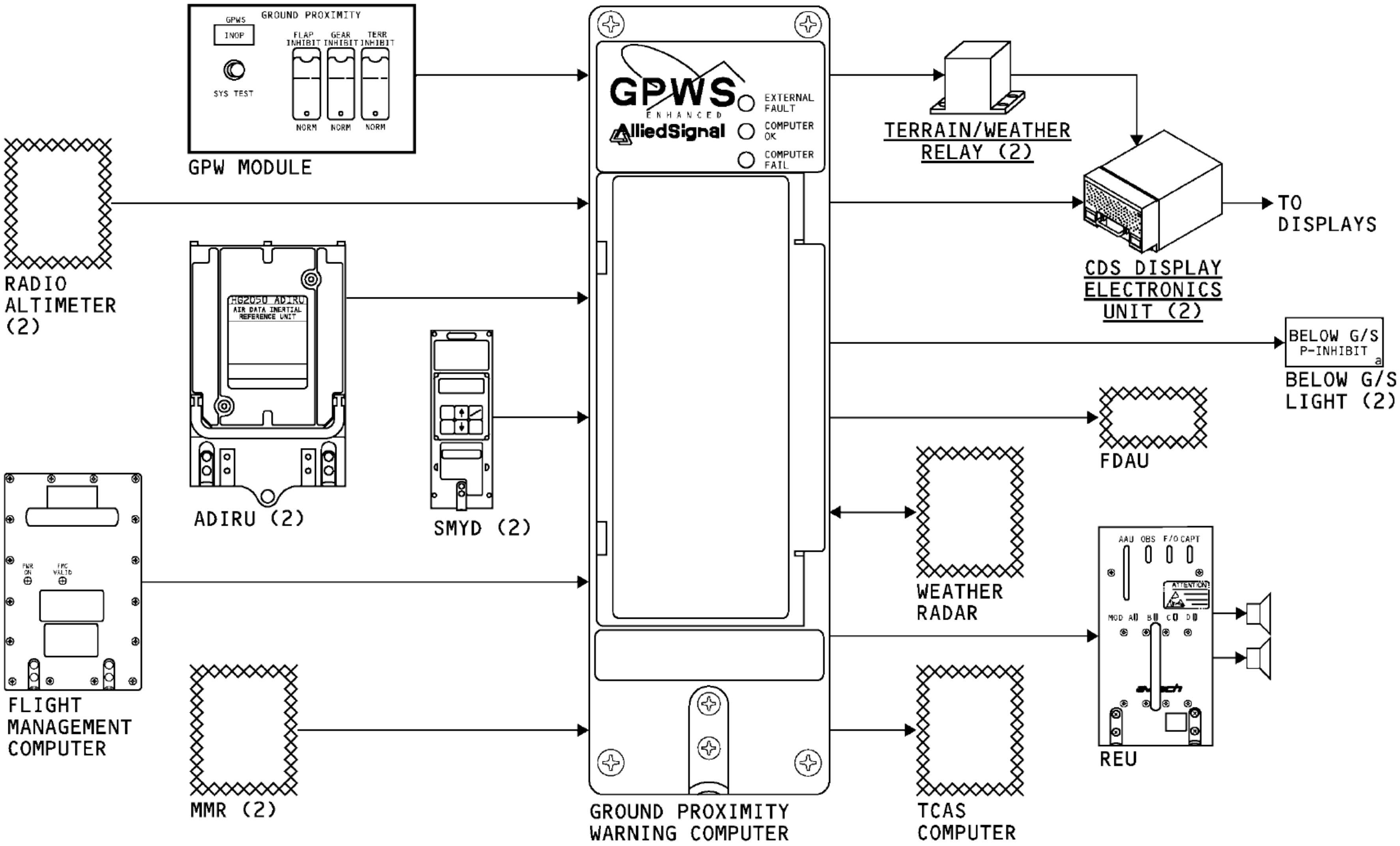
The GPWS shows terrain that is forward of the airplane. This information goes to the terrain/weather relays and then to the DEUs for display. Alerts to the flight crew of an early descent during a landing go directly to the DEUs for display.

Visual indications show on these:

- Captain and first officer primary EFIS displays
- Captain and first officer navigation displays
- Captain and first officer glideslope inhibit switches
- GPWM.

GPWS cautions and warnings go to the flight data acquisition unit (FDAU).

Aural messages go to the remote electronics unit (REU).



GENERAL DESCRIPTION

GPWS - COMPONENTS LOCATION

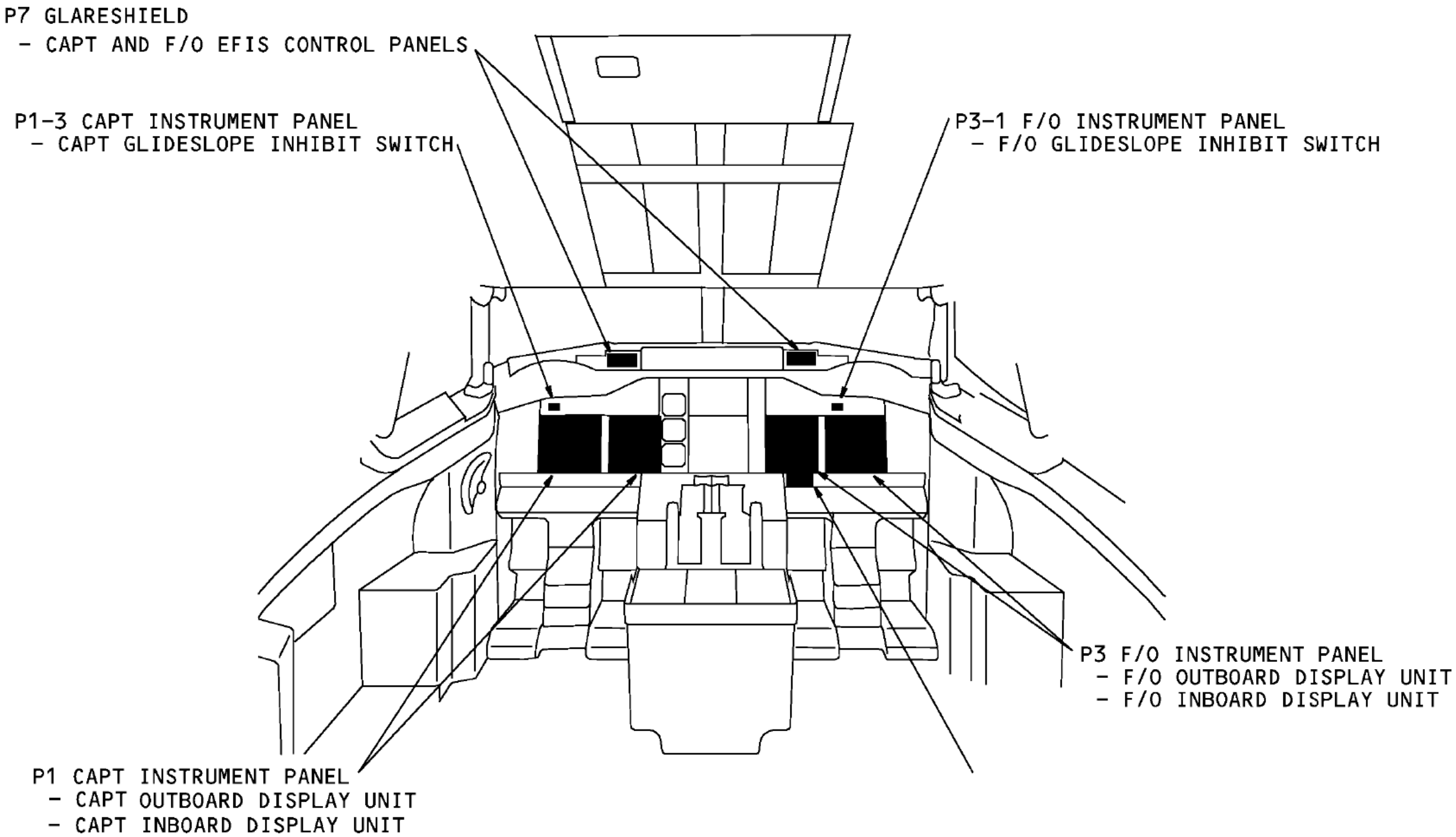
Flight Compartment Locations

These are the GPWS components in the flight compartment:

- Capt and F/O glideslope inhibit switch
- Ground proximity warning module.

These are the components in the flight compartment that interface with the GPWS:

- Capt and F/O display units
- Capt and F/O EFIS control panels.



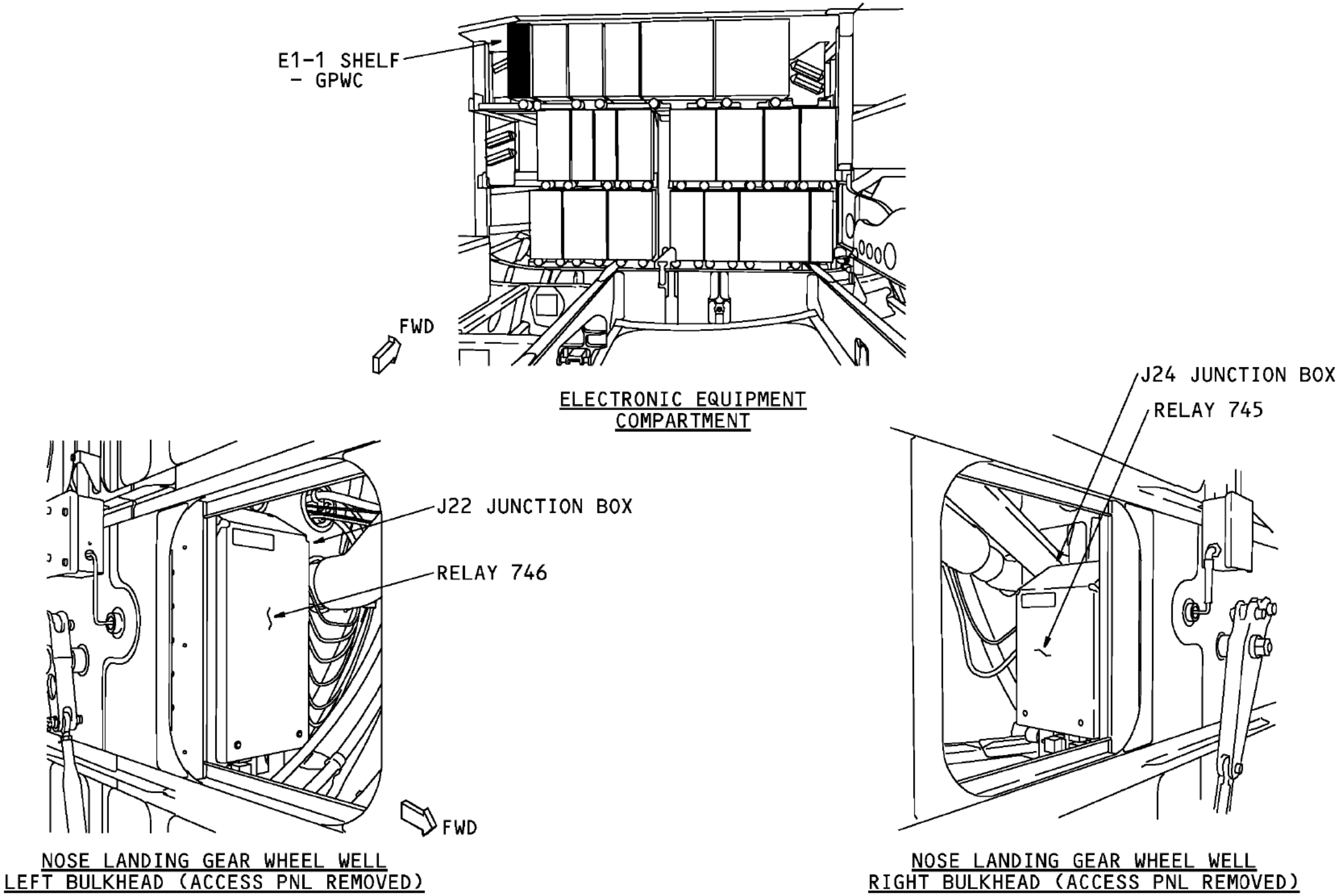
GPWS –COMPONENTS LOCATION 1

EE Compartment Locations

The ground proximity warning computer (GPWC) and the GPWS program switch module are on the electronic equipment compartment on the E1-1 shelf.

The terrain weather relay 745 is in the J24 box. The J24 box is in the nose wheel well on the right side and behind the forward access panel.

The terrain weather relay 746 is in the J22 electrical junction box. The J22 box is in the nose wheel well on the left side and behind the forward access panel.



COMPONENTS LOCATION - 2

GPWS - INTERFACES

POWER AND ANALOG

The ground proximity warning computer (GPWC) receives 115v ac from the GND PROX WARN circuit breaker on the P18 circuit breaker panel.

The terrain weather relays receive 28v dc from the TERRAIN DISPLAY circuit breaker on the P18 circuit breaker panel.

The GPWC provides a ground discrete (terrain select) to energize the terrain weather relays. This discrete energizes the TERR/WXR relays to connect the GPWC to the DEUs so that terrain data shows on the navigation displays.

The terrain select discrete can be set manually with the TERR switch on the EFIS control panel or automatically by the pop up function. The pop up function lets terrain data show automatically on the navigation displays when there is a terrain awareness caution or warning. This function only occurs when both of the navigation displays are not currently showing terrain data.

When the terrain weather relays energize, they send 28v dc to the GPWC relay monitors to show relay position.

Gear position from the landing gear lever switch module on P2-3 goes to the gear inhibit switch in the ground proximity warning module (GPWM). The GPWM sends the landing gear position discrete to the GPWC. The gear inhibit switch in the inhibit position sends a discrete to the GPWC that simulates the landing gear in the extended position.

GPWC uses gear position for Mode 2, Mode 3, Mode 4, Mode 5.

When the flap inhibit switch on the GPWM is in the inhibit position, a flap inhibit discrete signal goes to the GPWC. This simulates a flaps landing position in the GPWC.

The GPWM terrain inhibit discrete prevents the enhanced function of the GPWS. The discrete does not affect the operation of modes 1 thru 7. These items are inhibited:

- Terrain cautions
- Terrain warnings
- Terrain displays
- Terrain aural messages.

The GPWM also sends a test discrete signal to the GPWC. The GPWC uses the test discrete to start a self-test of the GPWS.

The GPWC sends a GPWC INOP discrete to the GPW control module to turn on the amber INOP light.

The PSEU sends air/ground discrete data to the GPWC for in-air logic.This logic is used in these modes:

- Mode 2
- Mode 3
- Mode 4
- Inhibit BITE in air
- Flight leg counting.

The GPWC sends an inhibit discrete to the TCAS computer when the GPWC has a higher priority alert. This discrete inhibits the TCAS aural messages and downgrades TCAS resolution advisories (RAs) to traffic alerts (TAs).

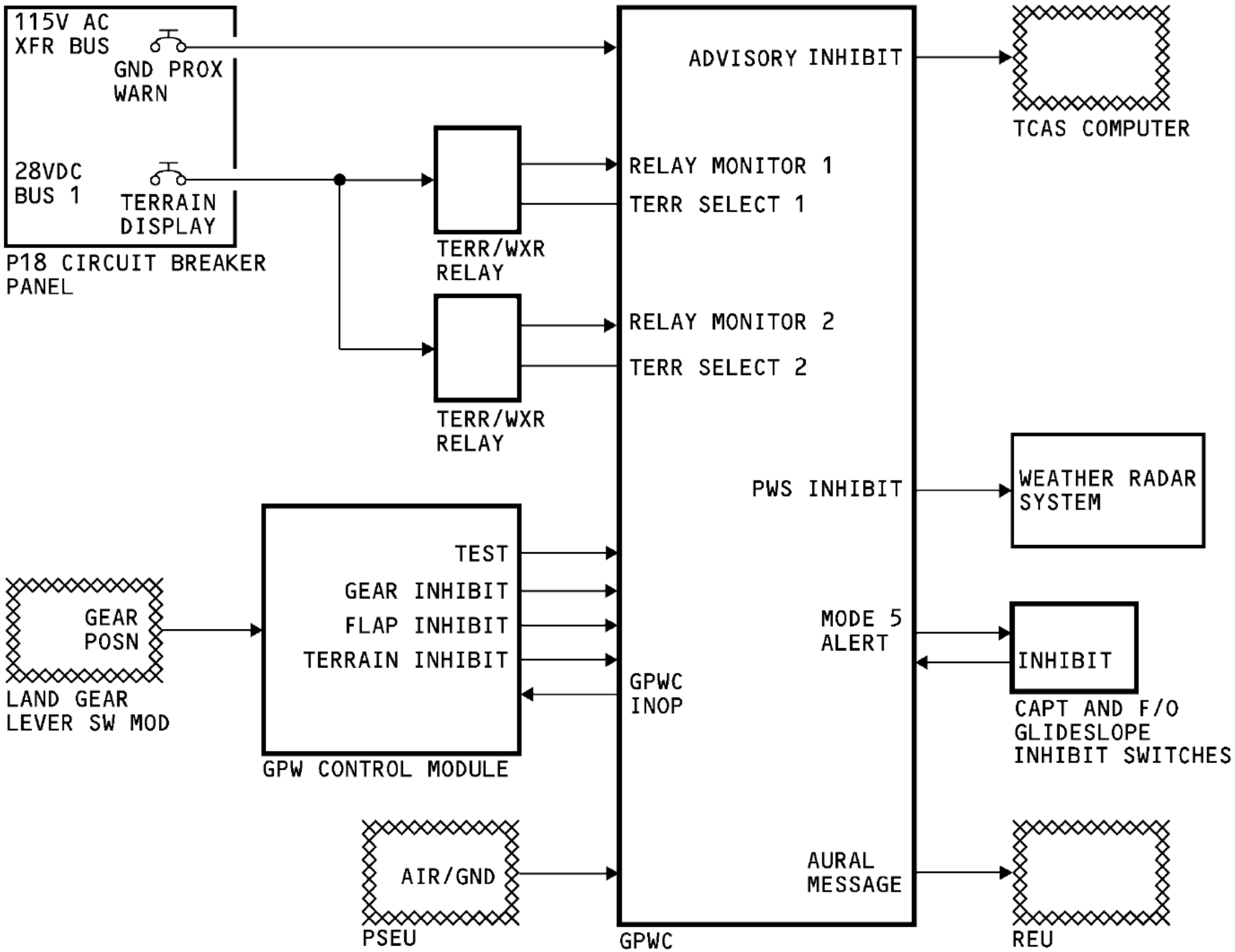
GPWC aural messages have a higher priority than the TCAS aural messages with the exception of mode 6 aural messages. Mode 6 aural messages can occur at the same time as TCAS aural messages.

The GPWC also sends a predictive windshear inhibit discrete to the weather radar receiver transmitter when the GPWC has a higher priority alert. This discrete inhibits the PWS aural messages.

The GPWC sends discretes to the captain and first officer glideslope inhibit switches. The lights come on for GPWC mode 5 alerts. When you push the light assemblies, a discrete goes to the GPWC to turn off the lights and stop the aural warnings.

GPWS alert and warning aural messages go to the remote electronics unit (REU). The REU sends the aural messages to the flight compartment.

The program switch module supplies program pin selections to the GPWC.



POWER AND ANALOG INTERFACES

DIGITAL INTERFACES

The GPWC interfaces with other airplane systems on ARINC 429 data buses.

These systems have digital interfaces with the GPWC:

- Left and right air data inertial reference units
- Radio altimeter 1 and 2
- Multi mode receivers 1 and 2
- Flight management computer 1 and 2
- DFCS mode control panel
- Stall management yaw damper 1 and 2
- Weather radar (WXR)
- Display electronics unit (DEU) 1 and 2
- Terrain/weather relays
- Flight data acquisition unit (FDAU).

Air Data Inertial Reference Unit

The left and right ADIRU ADR buses send this data to the GPWC:

- Computed airspeed
- True airspeed
- Barometric altitude rate
- Uncorrected altitude
- Barometric altitude.

This air data is used to determine cautions and warnings for GPWS modes 1, 2, 3, 4, and 7. The GPWC uses the data from from the left ADIRU. If the left ADIRU data is invalid, it uses data from the right ADIRU.

The left and right ADIRU IR bus sends these inputs to the GPWC:

- Latitude
- Longitude
- Inertial altitude
- Inertial vertical speed
- Track angle magnetic
- Pitch attitude
- Roll attitude
- Body longitudinal acceleration
- Body normal acceleration
- Inertial vertical acceleration
- Pitch rate
- Ground speed
- True track
- True heading
- IR mode.

This IR data is used to determine cautions and warnings for GPWS modes 1, 2, 3, 7, terrain clearance floor (TCF), and terrain awareness (TA). The GPWC uses the data from from the left ADIRU. If the left ADIRU data is invalid, it uses data from the right ADIRU.

Radio Altimeter Receiver-Transmitter

The radio altimeters (RA) send radio altitude data to the GPWC. This data is used in modes 1 to 7 and TCF. The GPWC uses the data from from RA 1. If RA 1 data is invalid, it uses data from RA 2.

Instrument Landing System

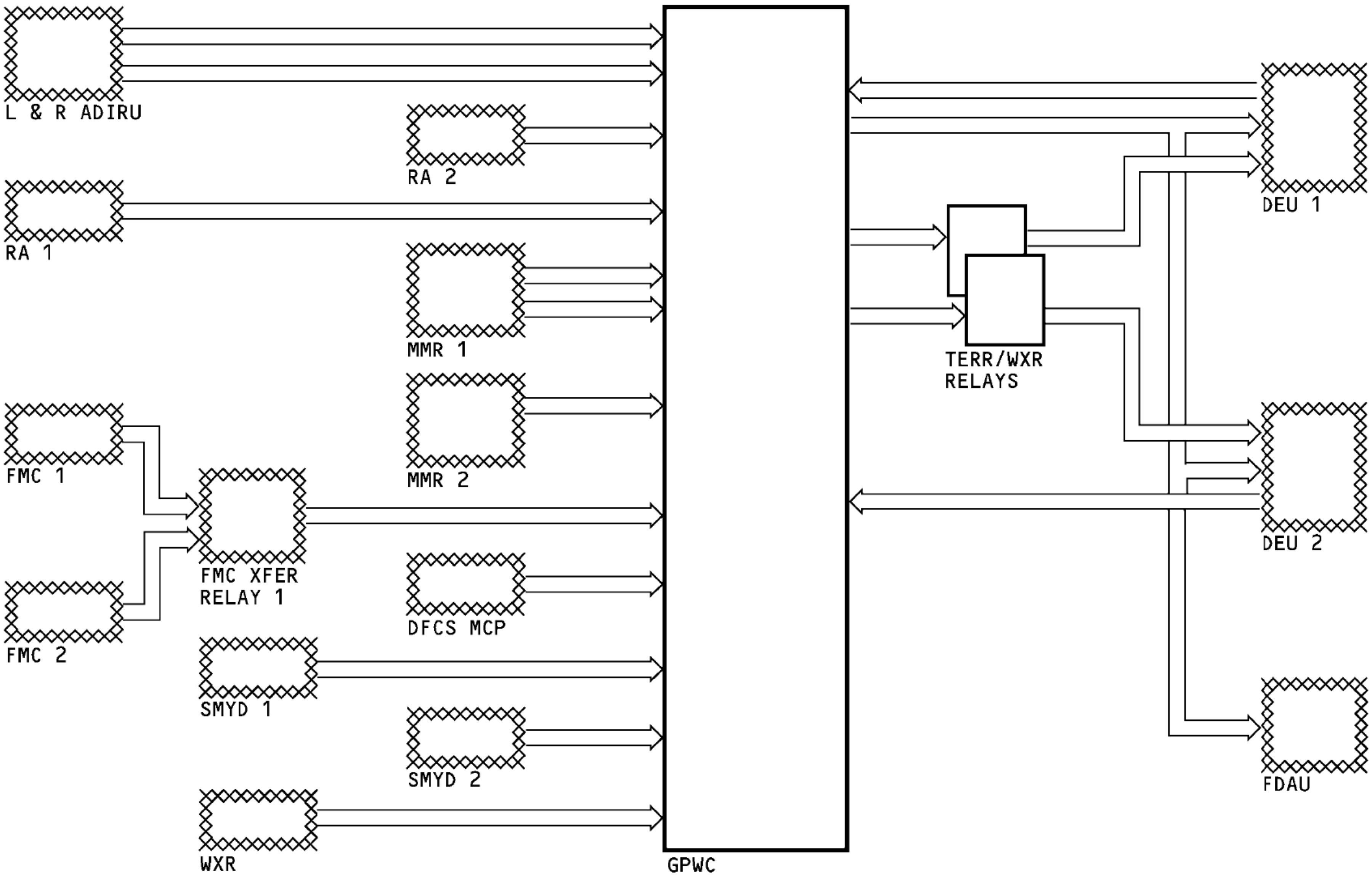
POST SB 737-34-1616
The ILS receiver in both MMRs send localizer and glideslope deviation data to the GPWC. Localizer deviation data is used in the envelope modulation function. Glideslope deviation data is used in mode 5 and the envelope modulation function. The GPWC uses the ILS data from from MMR 1. If MMR 1 data is invalid, it uses ILS data from MMR 2.

Stall Management Yaw Damper

The stall management yaw dampers (SMYD) send this data to the GPWC:

- Indicated angle of attack (AOA)
- Corrected AOA
- Stick shaker AOA
- Flap position
- Minimum operating speed.

The inputs from the SMYD are used primarily in wind shear calculations.



DIGITAL INTERFACE

DIGITAL INTERFACES (Continue.)

Global Position System

The GPS in the MMRs sends this data to the GPWC:

- Latitude (coarse)
- Longitude (coarse)
- Latitude (fine)
- Longitude (fine)
- Ground speed
- True track.
- Altitude
- Vertical velocity
- Horizontal dilution of precision (HDOP)
- Vertical dilution of precision (VDOP)
- Horizontal figure of merit (HFOM)
- Vertical figure of merit (VFOM)
- Date
- Time (UTC)
- Horizontal integrity limit (HIL)
- Sensor status.

The GPWC uses the GPS data from from MMR 1. If MMR 1 data is invalid, it uses GPS data from MMR 2.
Latitude and longitude (coarse and fine) information gives airplane position for the TCF and TA functions.
Ground speed, true track, altitude, and vertical velocity are used in the TA function.
Horizontal dilution of precision, vertical dilution of precision, horizontal figure of merit, and vertical figure of merit data is used for airplane position accuracy calculations.
Date and time information is used in the fault monitor process, which labels each fault with the date and time of occurrence.
The horizontal integrity limit is used to determine the current integrity limit and GPS non-isolatable satellite failures.
Sensor status lets the GPWC monitor the status of the GPS receiver IN THE MMR.

Flight Management Computer System

The primary FMC sends latitude, longitude, and magnetic track data to the GPWC. The GPWC uses this data in the envelope modulation function. If the FMC input is invalid, the GPWC uses latitude, longitude and magnetic track data from the ADIRS.

DFCS MCP

The digital flight control system (DFCS) mode control panel (MCP) sends selected course data to the GPWC. This data is used in mode 5 and the envelope modulation function.

DEUs

The display electronic units (DEUs) send Range, Terrain select, Radio minimums and Baro minimums from the EFIS control panels to the GPWC:

Weather Radar Receiver-Transmitter

The weather radar RT sends predictive windshear caution and warning data to the GPWC. The GPWC contains aural prioritization logic that uses this data to determine which system cautions and warnings to inhibit. The GPWS, TCAS, and PWS systems are prioritized by the GPWC.

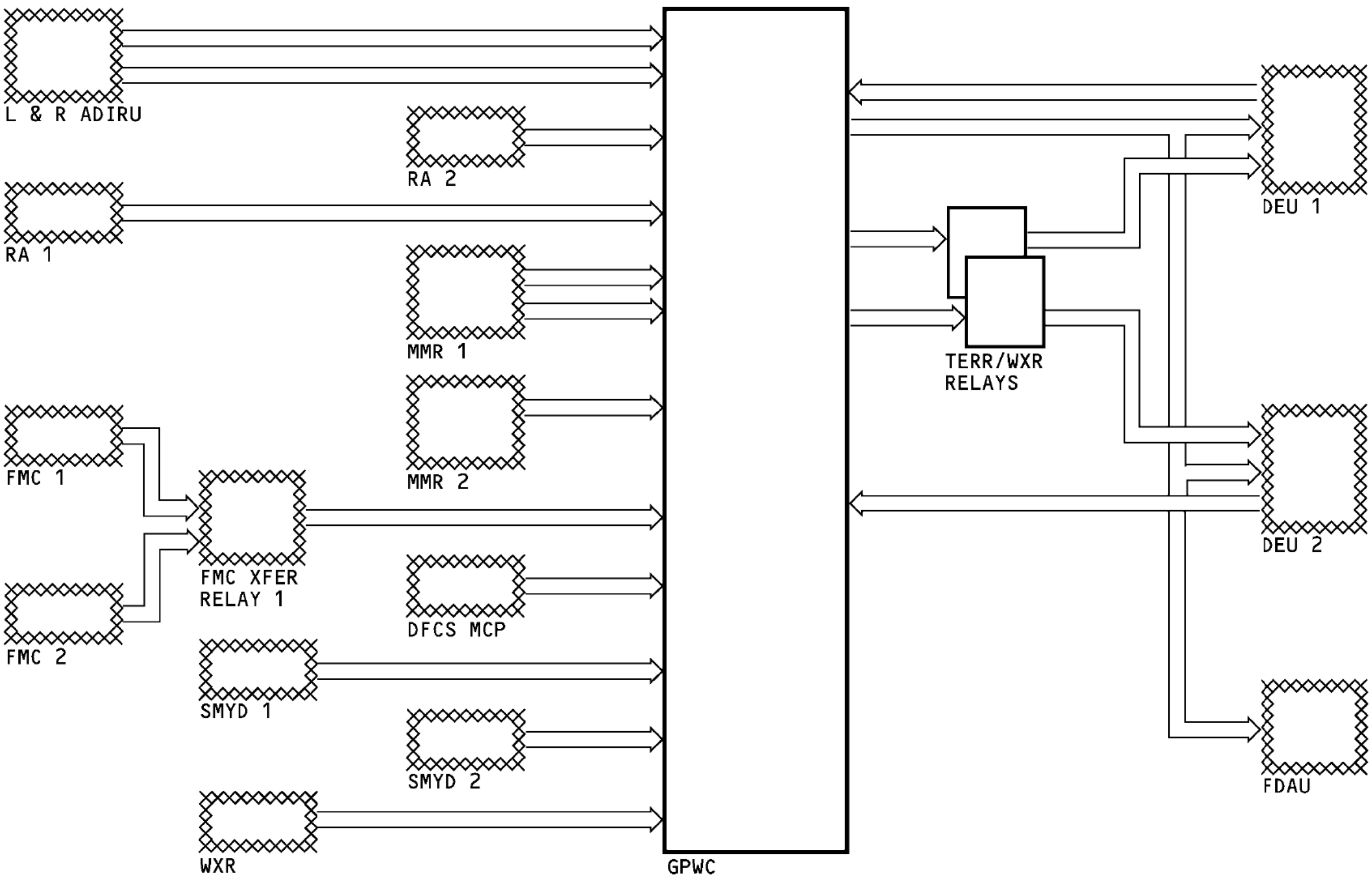
GPWC Outputs

The GPWC sends system status, caution, and warning data on an ARINC 429 data bus to the DEUs. The DEUs show system status, caution, and warning annunciations on the captain and first officer EFIS primary and navigation displays.

The GPWC sends caution, warning, and status discretes to the flight data acquisition unit (FDAU). The FDAU sends the GPWC data to the flight data recorder.

The GPWC sends terrain display data on an ARINC 453 data bus to the terrain weather relays. The display data then goes from the terrain weather relays to the DEUs to show on the navigation displays.

The terrain data is sent when TERR is selected on the EFIS control panel or automatically for the pop-up mode. The pop-up mode occurs when a terrain caution or warning is calculated and the captain and the first officer navigation displays are not selected to show terrain data



DIGITAL INTERFACES

TERRAIN/WEATHER RELAY INTERFACE

Purpose

The ground proximity warning computer (GPWC) and the weather radar (WXR) receiver-transmitter send display data that shows on the navigational displays (NDs). Two terrain weather select relays control which data shows on each ND.

Relay Power

The terrain weather select relays get 28v dc from the terrain display circuit breaker on the P18 circuit breaker panel.

Digital Relay Interfaces

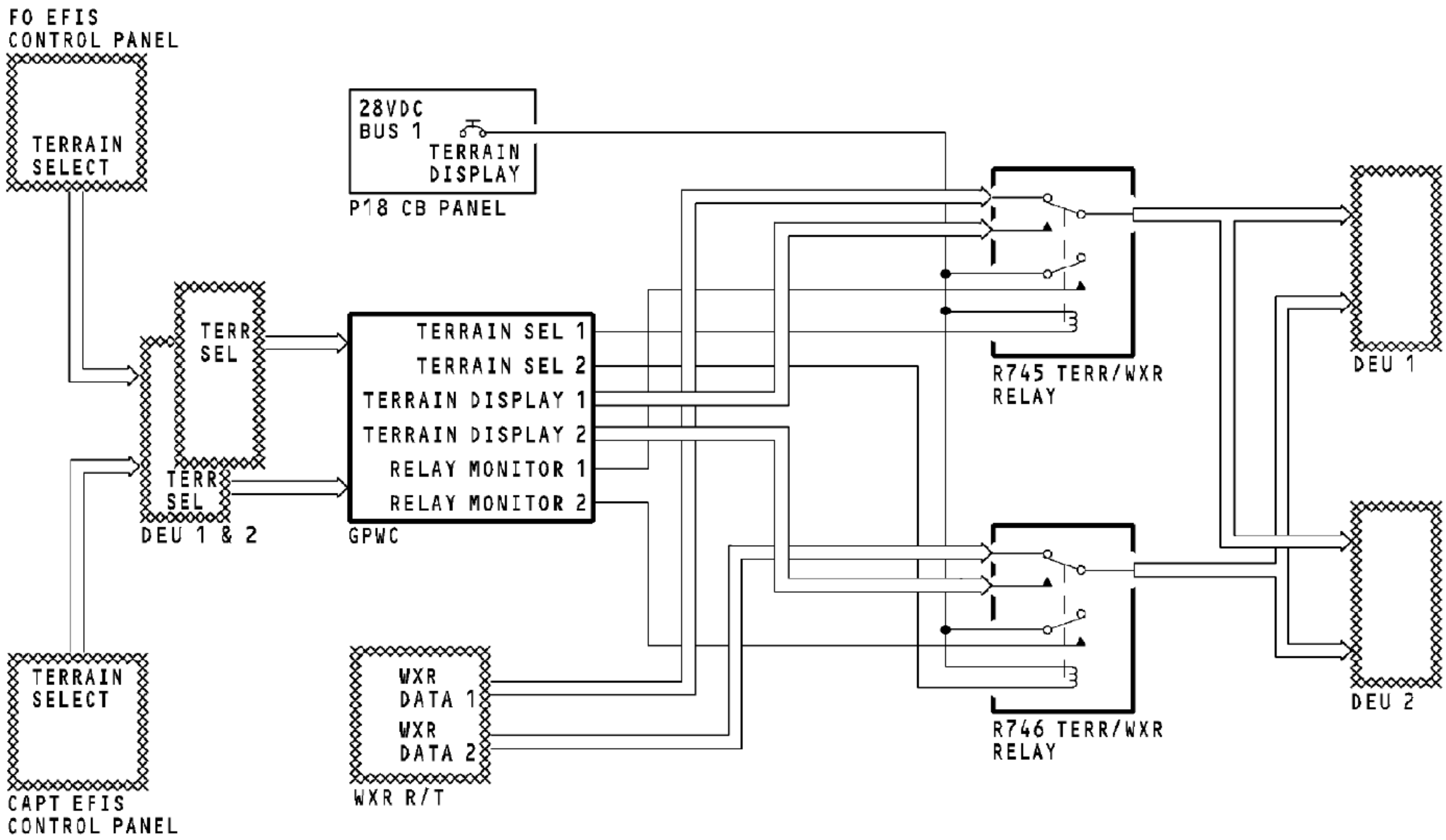
The GPWC and WXR send data to both terrain weather select relays on ARINC 453 data buses.
The terrain weather select relays send data to the display electronics units on ARINC 453 data buses. The display electronics units shows the data on the NDs.

Relay Control

When you push the WXR switch on the EFIS control panel, the normal relay position lets the weather radar data show on the NDs. When you push the TERR switch on either EFIS control panel (CP), the on side DEU sends a discrete to the GPWC. When the GPWC receives the DEU discrete, it sends a terrain select ground discrete signal to energize the relay. This lets the terrain data connect to the DEUs for display on the NDs. When you push the TERR switch again, the relay deenergizes. The relay now connects the WXR to the DEUs.

Relay Monitor

The terrain weather select relays send a signal to the GPWC when it energizes. The GPWC uses these inputs to identify which position the relays are in. When the relays are in the normal position, the GPWC monitor senses no voltage.
When the relays are in the energized position, the GPWC monitor senses 28v dc.



TERRAIN/WEATHER RELAY INTERFACE

GPWS – COMPONENTS

GROUND PROXIMITY WARNING COMPUTER

The ground proximity warning computer (GPWC) compares the airplanes flight profile, flap and gear position, and terrain clearance to find if there is a warning condition.

Description

The GPWC is the main component of the GPWS. The computer front panel contains three LEDs that show internal and external failures. The front panel also contains a self-test switch. The switch provides access to six self-test modes.
The faults are annunciated through the flight deck speakers or through headphones connected to the jack below the switch.

You can update the computer operational software and terrain database with a download from a PC card that you put into the front panel PCMCIA interface slot. When you put the card in, the computer downloads data without further action. There are four status LEDs to show the progress of the memory card data transfer. A blank formatted card may be used to download GPWS fault history data.

The computer has a front panel, 15-pin, D-type portable PC test connector (RS-232) for a serial data connection to a PC compatible computer.

Physical Description

The GPWC is a standard ARINC 600, 2 MCU. The dimensions are 2.4 inches wide, 7.9 inches high, and 14.3 long. The computer weighs 7 pounds and uses 115v ac, 400 HZ single-phase power for operation.

The GPWC is cooled with air from the equipment cooling system. The cooling air for the GPWC is blow-through.

Front Panel

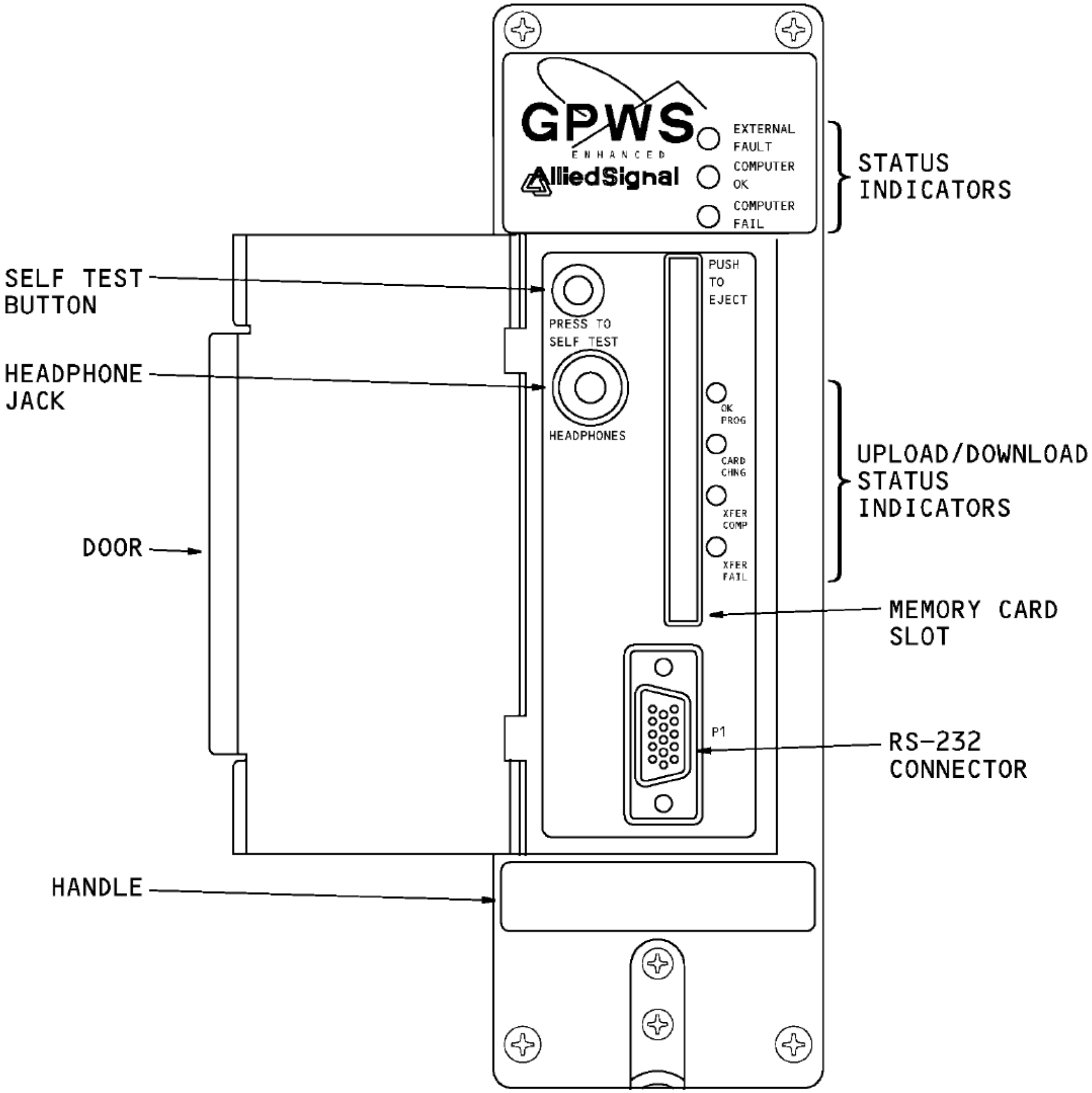
The GPWC front panel has three status LEDs and a door.

These are the three status LEDs on the front panel:

- EXTERNAL FAULT - amber LED turns on for a failure external to the GPWC
- COMPUTER OK - green LED stays on when GPWC has power and operates normally
- COMPUTER FAIL - red LED stays on when the GPWC has an internal failure.

The front panel door gives access to these:

- SELF-TEST switch - starts a test of the GPWS
- Headphone jack - lets you hear self-test audio
- Memory card slot - lets you upload software from a memory card or download fault and warning history data
- Upload/download status indicators - show conditions of the upload or download operation
- RS-232 connector - used for shop test, or for the upload/download of data with a compatible PC computer.



GROUND PROXIMITY WARNING COMPUTER

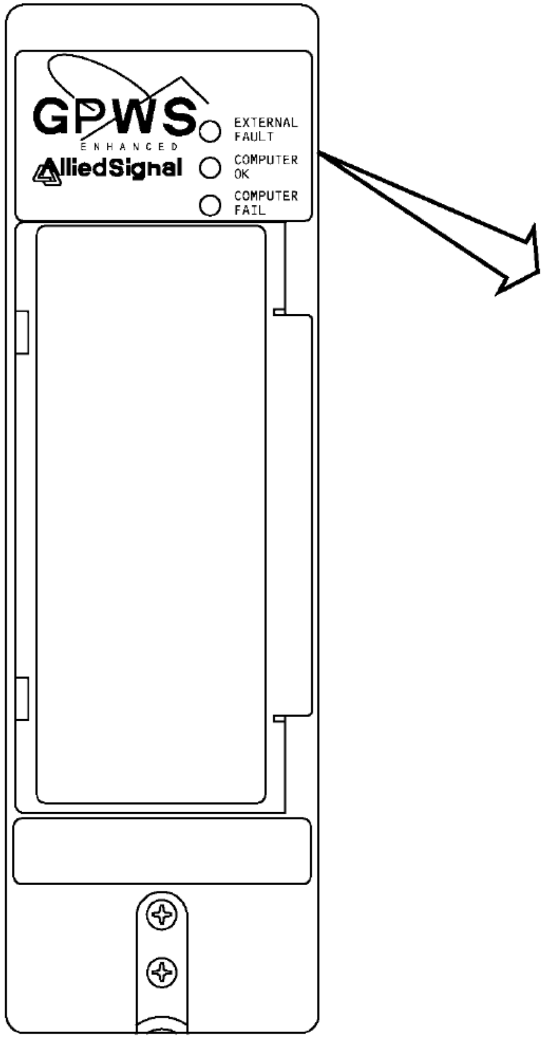
GPWC STATUS LEDS

There are three status LEDs on the front panel of the ground proximity warning computer (GPWC). The LED indicators show the status of the GPWC when power is supplied.

The LEDs turn on for these conditions:

- External fault - yellow
- Computer OK - green
- Computer fail - red.

The yellow external fault LED shows that the GPWC has detected an external interface fault. The green computer OK LED shows that the GPWC is operating with no internal faults. The red computer fail LED shows that the GPWC has an internal fault.



EXTERNAL FAULT	COMPUTER OK	COMPUTER FAIL	CONDITION
OFF	OFF	OFF	GPWC POWER OFF
OFF	OFF	RED	GPWC INTERNAL FAULT
OFF	GREEN	OFF	NORMAL OPERATION
OFF	GREEN	RED	GPWC INTERNAL FAULT
YELLOW	OFF	OFF	GPWS EXTERNAL FAULT
YELLOW	OFF	RED	BOTH GPWC INTERNAL AND GPWS EXTERNAL FAULTS
YELLOW	GREEN	OFF	GPWS EXTERNAL FAULT
YELLOW	GREEN	RED	GPWC INTERNAL FAULT

GPWC STATUS LEDS

EFIS CONTROL PANEL

The EFIS control panel lets the flight crew choose the information they want to show on the navigation displays. These controls interface with the GPWS:

- TERR Map switch
- ND mode selector
- ND range selector.

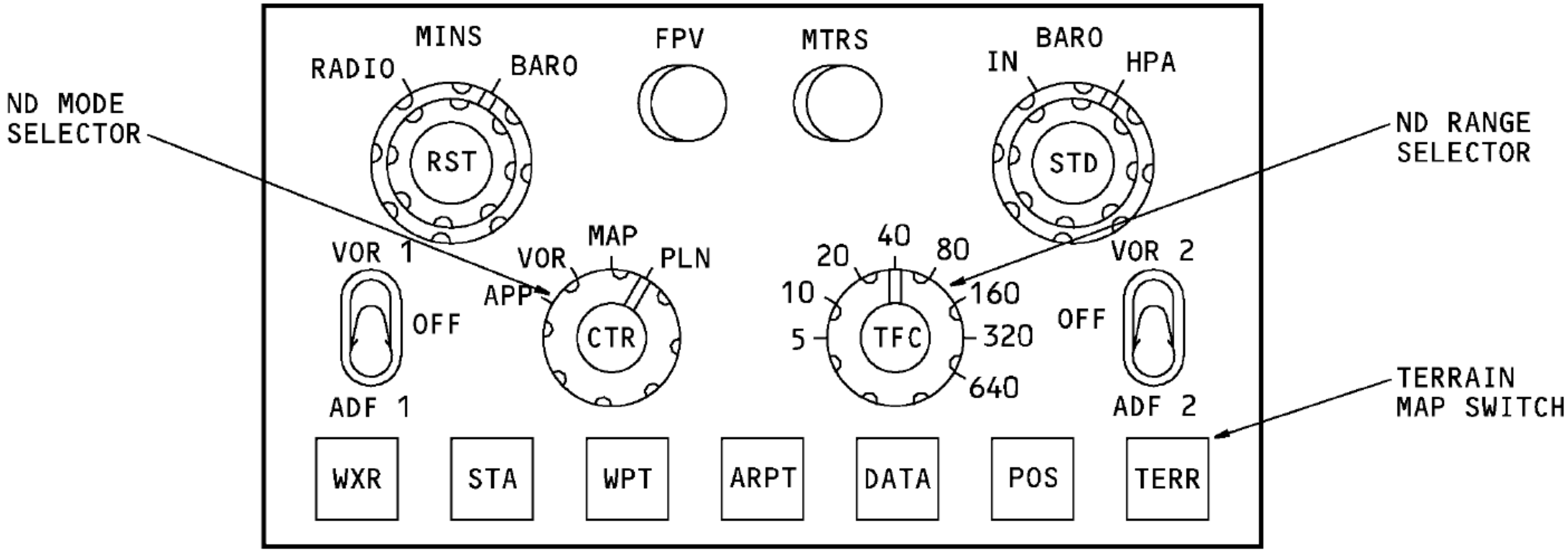
TERRMapSwitch
When you push the TERR map switch on the EFIS control panel, terrain data shows on the on-side ND. Push the TERR map switch again to remove the terrain data.

NDModeSelector
Use the ND mode selector to choose an ND mode. These are the ND modes that show terrain data:

- Expanded APP (approach) mode
- Expanded VOR mode
- Expanded MAP mode
- Centered MAP mode.

When you push the TERR map switch the terrain data arms, even if it is not in the correct mode. The terrain data shows when you change the ND selector to a correct mode. The terrain data stays armed even if you push the TERR map switch again. Push the WXR map switch to disarm the terrain data and arm the weather data.

NDRangeSelector
The EFIS control panel has an eight-position range selector. The range selections are 5,10, 20, 40, 80, 160, 320, and 640 NM. The map mode shows the range at all times. Terrain data shows only in the 5NM through 320 NM selections. When the range selector is in the 640NM range, terrain data will only show to 320NM.



EFIS CONTROL PANEL

GROUND PROXIMITY WARNING MODULE

The ground proximity warning module (GPWM) is the interface between the flight crew and the GPWS. The GPWM has an amber GPWS INOP light.

The panel also has these switches:

- Test switch
- Flap inhibit switch
- Gear inhibit switch.
- Terrain inhibit switch.

INOP light

The amber INOP light on the GPWM comes on when there is a failure of the GPWC or if there is a failure of a critical input to the GPWC. The INOP light also comes on if the GPWC can not calculate windshear conditions. During a GPWC self test, the INOP light comes on.

Test Switch

The test switch is a momentary action switch that lets you do a self-test of the GPWC from the flight compartment.

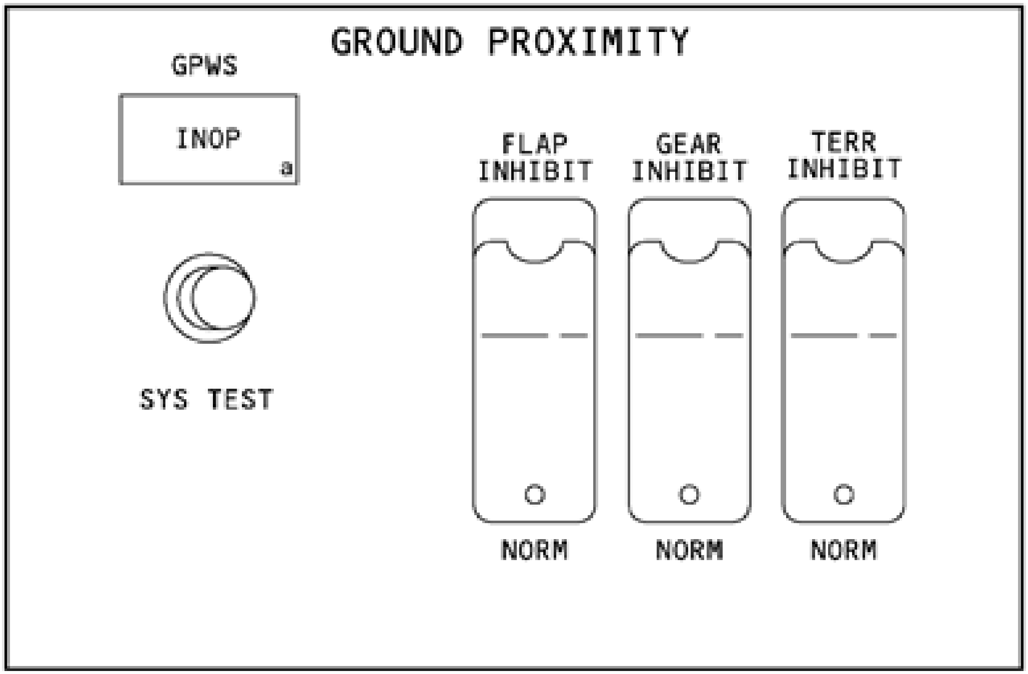
Momentarily push the test switch to start a self-test. There are six levels of self- tests that can be done from the GPWM. To make navigation of self-test levels faster, the test switch can be used to cancel self-test sequences and self-test levels. A short cancel stops a test sequence and a long cancel stops a self-test level. Push the test switch for less than two seconds for a short cancel and push the test switch for more than two seconds for a long cancel.

Inhibit Switches

The flap, gear, and terrain inhibit switches supply discrete signals to the GPWC. The flap inhibit switch simulates a flaps down condition to the GPWC. The use of this switch prevents warnings when the flight crew makes a flaps up approach. When selected, the mode 4 warning TOO LOW FLAP is inhibited.

The gear inhibit switch simulates a gear down condition to the GPWC. The use of this switch prevents warnings when the flight crew makes a gear up approach. When selected, the mode 4 warning TOO LOW GEAR is inhibited.

The terrain inhibit switch sends a discrete ground to the GPWC. The discrete ground inhibits the terrain clearance floor (TCF) function and the terrain awareness (TA) function. When the switch is in the inhibit position, TCF and TA cautions and warnings do not show on the navigation displays and are not heard over the flight deck speakers. Also, when the terrain inhibit switch is in the inhibit position, the amber TERR INHIBIT message shows on both navigation displays.



GROUND PROXIMITY WARNING MODULE

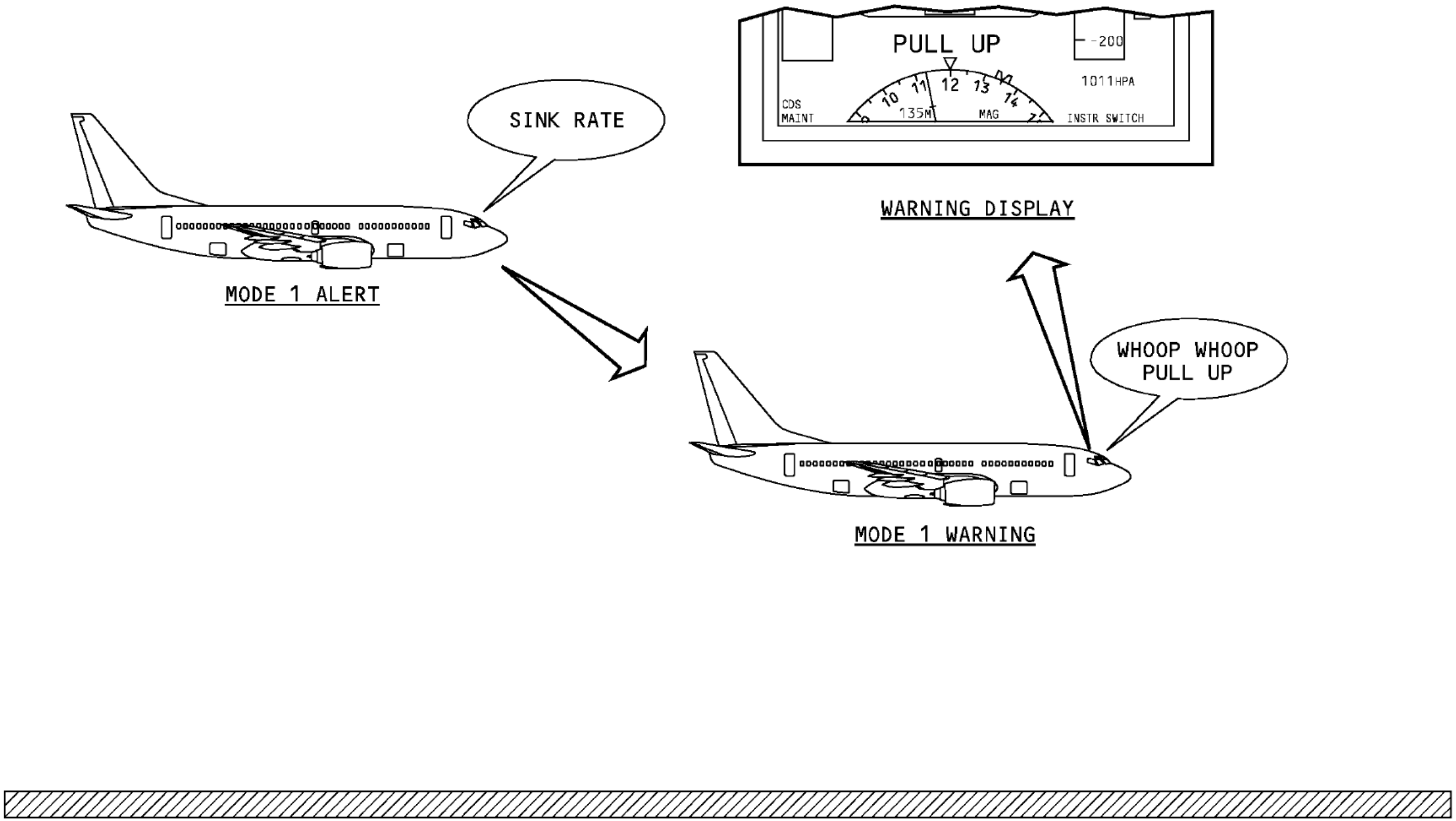
GPWS – OPERATION

MODE 1 GENERAL DESCRIPTION

Mode 1 supplies alerts and warnings for large descent rates when the airplane is near the terrain. This mode is independent of flap or gear positions.

The alert condition gives the aural message, SINK RATE and makes the PULL UP display on the attitude indication (AI). If the descent rate does not decrease, the alert condition changes to a warning condition.

The warning condition makes the red PULL UP warning on the AI and gives the aural message, WHOOP WHOOP PULL UP.



MODE 1 DESCRIPTION

MODE 1 FUNCTIONAL DESCRIPTION

Mode 1 alert conditions and warning conditions can occur between 2450 feet and 10 feet radio altitude. The type of annunciation depends on the rate of descent and the radio altitude. The first annunciation is a caution. If the rate of descent does not decrease, the annunciation changes to a warning.

The LRUs that supply inputs for mode 1 operation are the radio altimeter transceivers and the left and right ADIRUs.

The GPWC uses this data to detect mode 1 cautions and warnings:

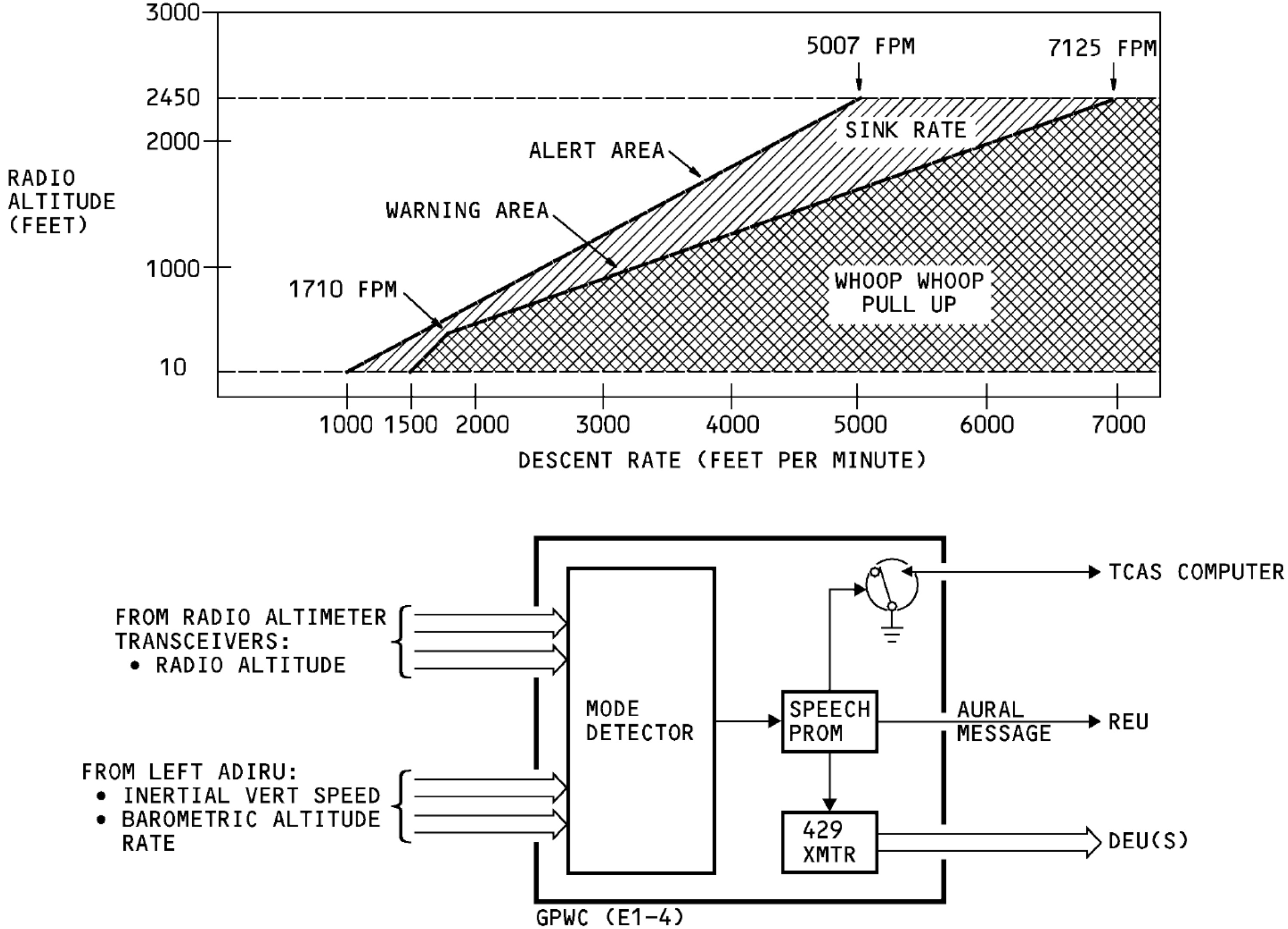
- Radio altitude
- Inertial vertical speed
- Barometric altitude rate.

The mode detector in the GPWC calculates the descent rate from the inertial vertical speed input. If it is not available, the mode detector uses an internally calculated altitude rate. If the IVS and the internally calculated rates are invalid, the barometric altitude rate from the ADIRU is used. When the GPWC uses barometric altitude rate, the lower altitude cutoff changes from 10 feet to 30 feet.

When there is a caution or warning condition, the mode detector sends a discrete to the speech prom to make the aural messages come on. The aural messages go to the remote electronics unit (REU) which sends them to the flight compartment speakers.

Caution and warning conditions cause the mode detector to send a signal on the ARINC 429 transmitter to the DEUs to show the PULL UP display.

When the GPWC gives an aural message, a discrete goes to the TCAS computer to inhibit TCAS aural messages.



MODE 1 FUNCTIONAL DIAGRAM

MODE 2A GENERAL DESCRIPTION

Mode 2 supplies alerts and warnings when the closure rate to the terrain is too large. Mode 2 has two submodes, mode 2A and mode 2B.

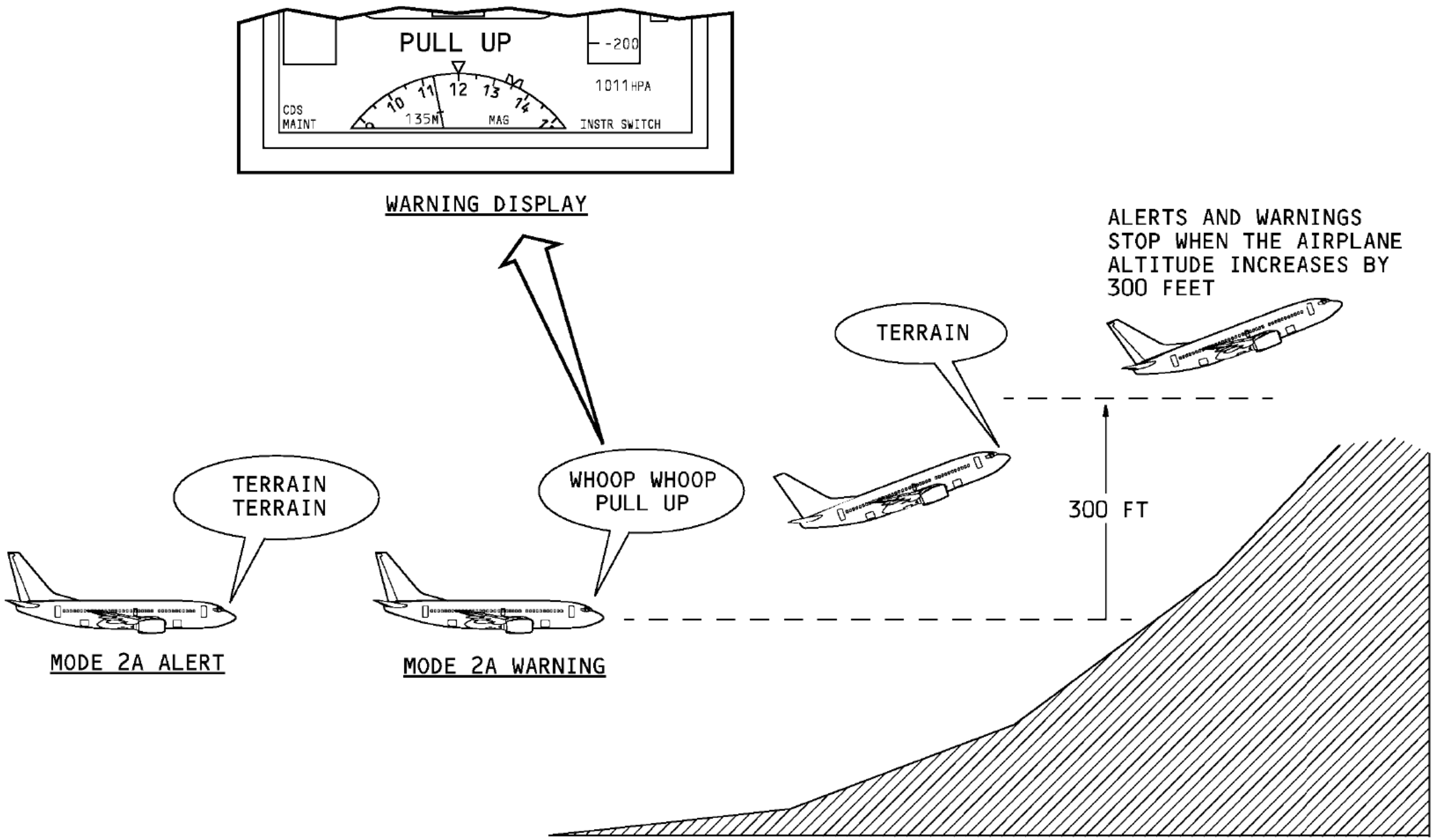
Mode 2A occurs for a large closure rate if the flaps are not in the landing configuration and glideslope deviation is more than 2 dots. Flaps 30 or more is a landing configuration. Mode 2A can have two alert levels, a caution condition or a warning condition.

If the terrain closure is too large, the GPWC gives the TERRAIN aural caution message twice and PULL UP shows on the attitude indicator (AI).

If the condition is not corrected, the caution aural message changes to the warning WHOOP WHOOP PULL UP message and PULL UP still shows on the AI.

When the mode 2A envelope is no longer active due to either a terrain drop off or a pull up maneuver by the flight crew, the altitude gain function operates. PULL UP continues to show on the AI until the altitude increases 300 feet or 45 seconds have elapsed. If there is still a terrain closure rate during this period, however, the GPWC also gives the TERRAIN aural caution message.

After a 300 feet increase in inertial altitude or the landing gear comes down, the PULL UP indications on the AI stop and the aural warnings stop.



MODE 2 A DESCRIPTION

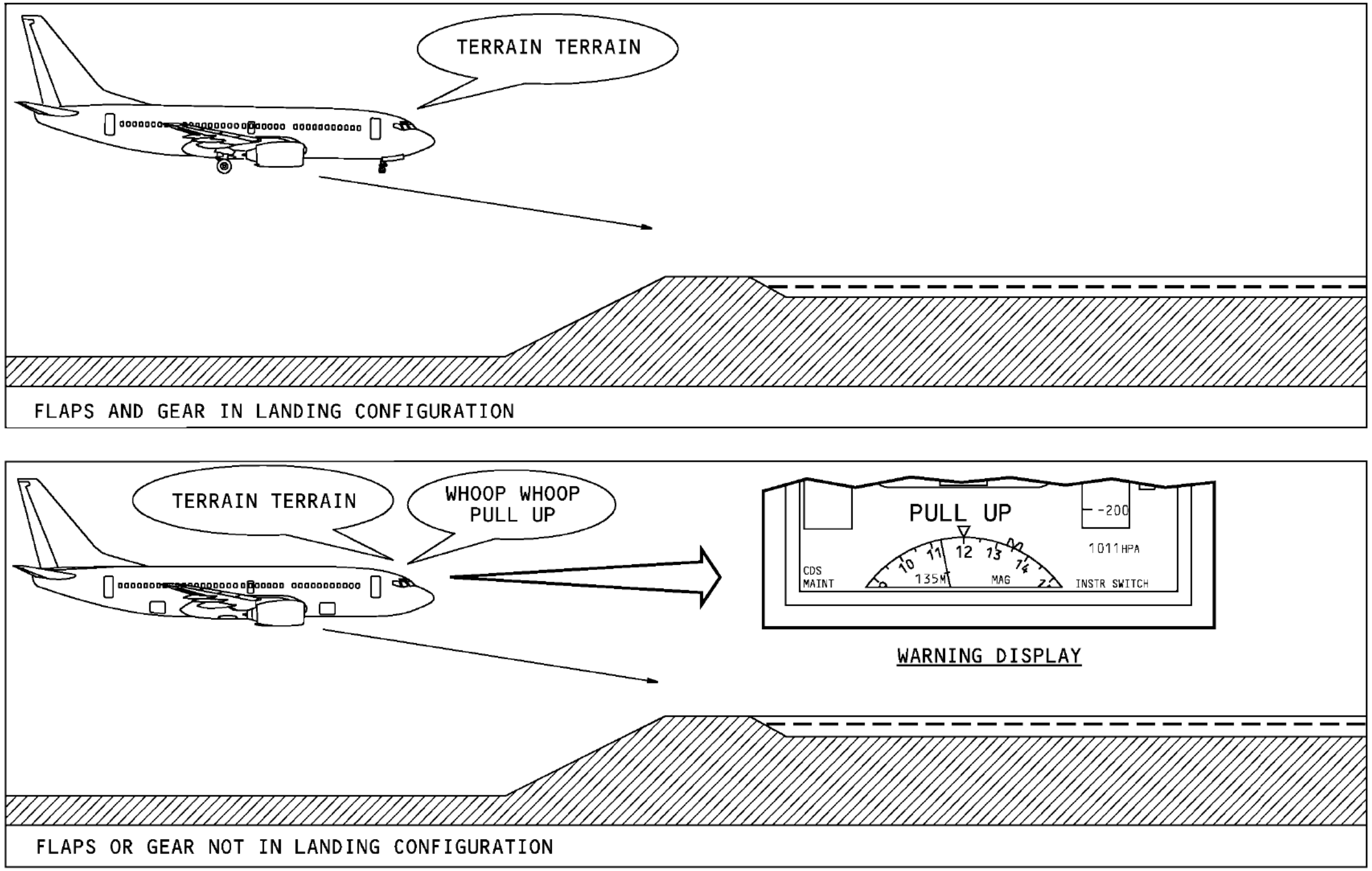
MODE 2B GENERAL DESCRIPTION

Mode 2B gives alerts for a large closure rate if the flaps are in the landing configuration (30 units or more).

Mode 2B can have a caution condition or a warning condition.

If the terrain closure is excessive, the ground proximity warning computer (GPWC) gives the TERRAIN aural caution message repeatedly. If this condition lasts for more than 1.6 seconds, the GPWC gives the WHOOP WHOOP PULL UP aural warning message and a PULL UP annunciation on the AI.

If the terrain closure is excessive and the landing gear is extended, the PULL UP aural warning message is replaced with the TERRAIN aural caution message.



MODE 2 B DESCRIPTION

MODE 2 FUNCTIONAL DESCRIPTION

Mode 2A annunciations occur between 1650 feet radio altitude and 30 feet radio altitude for airspeed less than 220 knots. The top limit increases to 2450 feet radio altitude for airspeed between 220 knots and 310 knots.

Mode 2B annunciations can occur between 789 feet radio altitude and 30 feet radio altitude. The lower limit is between 30 feet and 600 feet radio altitude. The GPWC uses flap configuration and altitude descent rate to calculate the lower limit.

These are the LRUs that supply inputs for mode 2 operation:

- Left and right radio altimeter transceivers
- Left and right ADIRUs
- GPW module
- Stall management yaw dampers (SMYDs)
- Multi-mode receiver (MMR) 1 and 2
- Proximity switch electronic unit (PSEU).

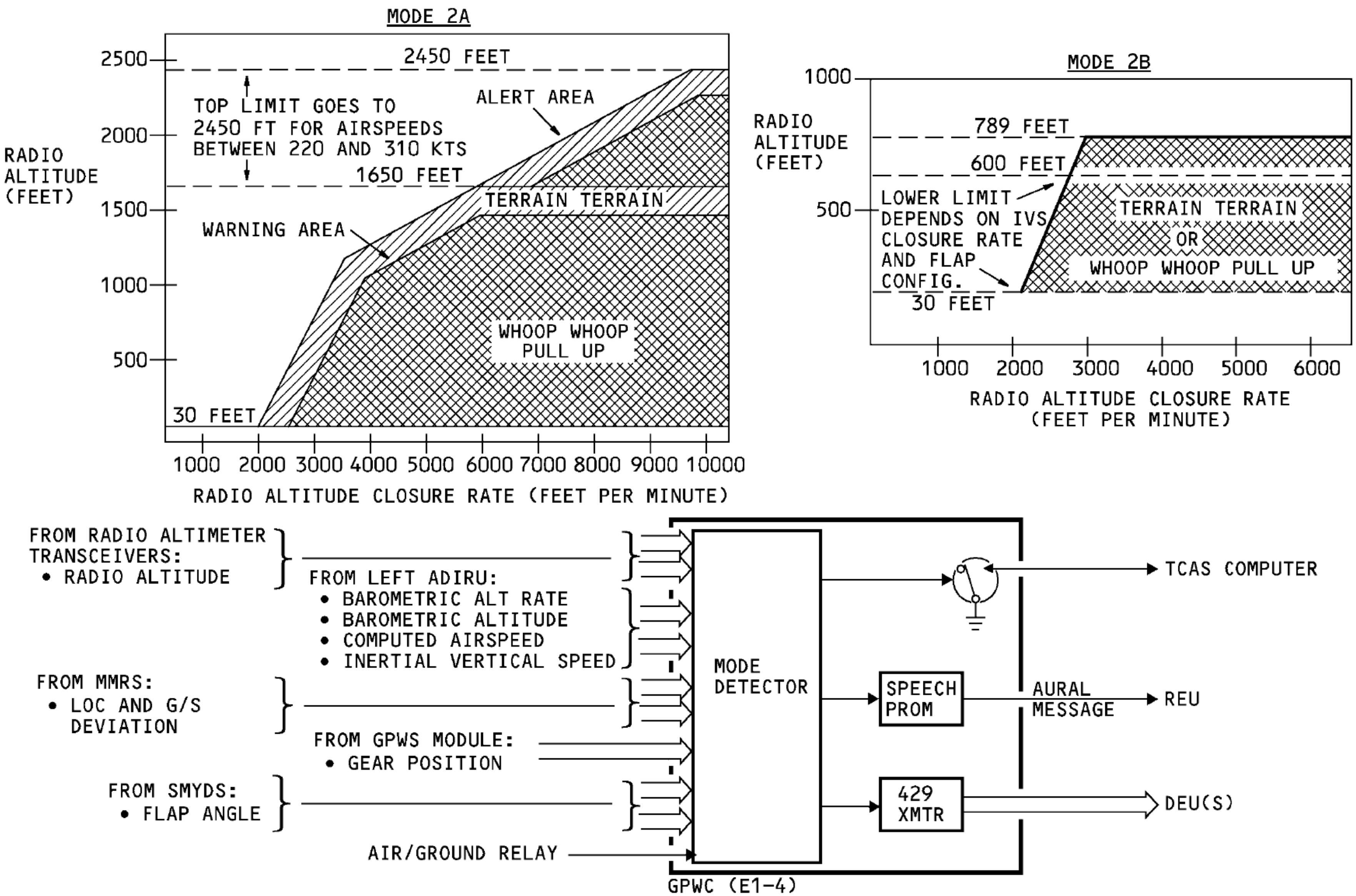
This is the data the GPWC uses to detect mode 2 alerts and warnings:

- Radio altitude
- Inertial vertical speed (IVS)
- Barometric altitude rate
- Barometric altitude
- Computed airspeed
- Flap and gear position
- Glideslope deviation
- Air/ground inputs.

When there is an alert condition or warning condition, the mode detector sends a discrete to the speech prom to make the aural messages come on. The aural messages go to the REU which sends them to the flight compartment speakers.

When there is a mode 2 warning condition, the mode detector also sends a signal on the ARINC 429 transmitter to the DEUs and the PULL UP message shows on the AI.

When the GPWC gives a mode 2 aural message, a discrete goes to the TCAS computer to inhibit TCAS resolution advisories and TCAS aural messages.



MODE 2 FUNCTIONAL DIAGRAM

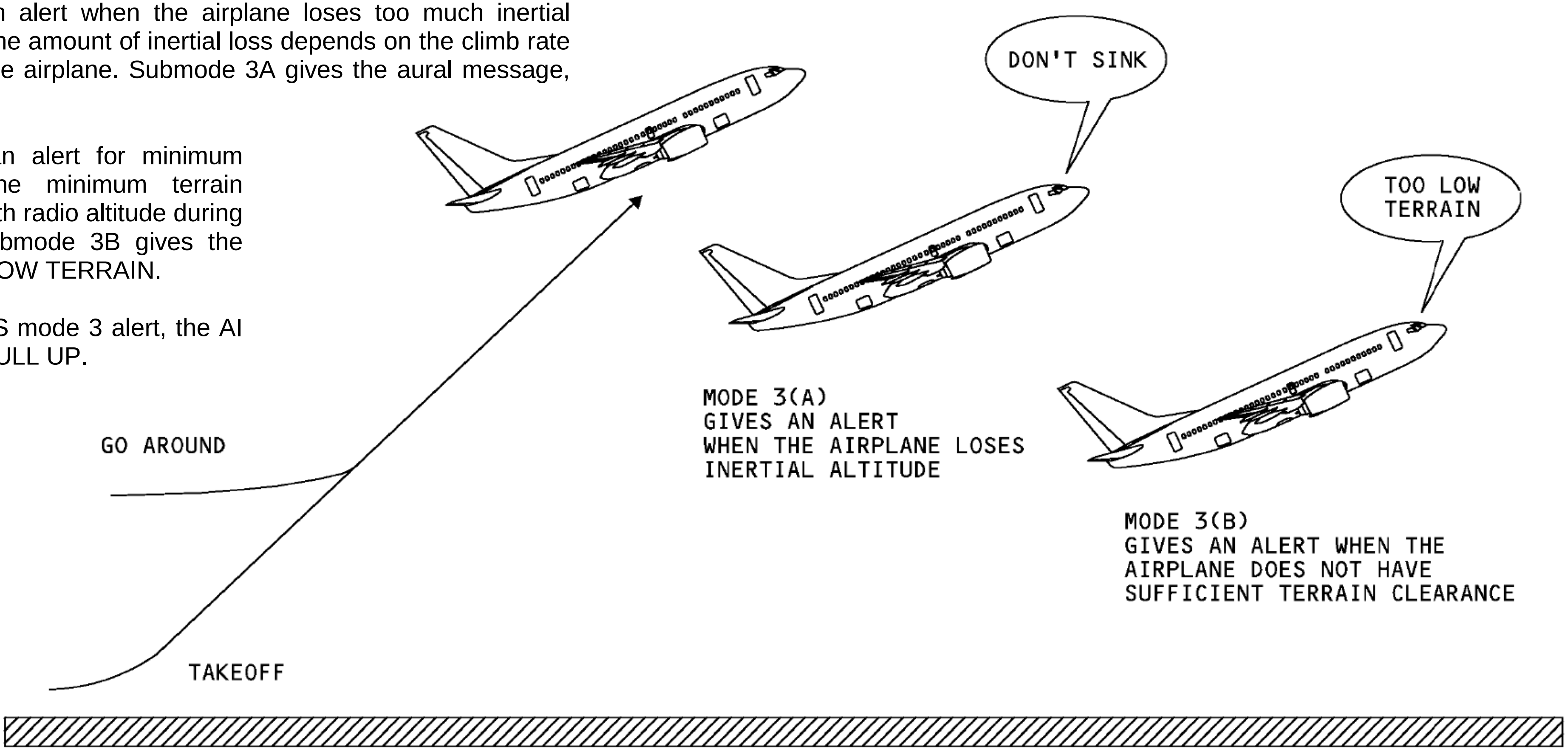
MODE 3 GENERAL DESCRIPTION

Mode 3 supplies alerts for a large altitude loss during takeoff or during a missed approach with the flaps not in the landing configuration (landing configuration for the flaps is 30 units or more) or landing gear not down. Mode 3 has two submodes (3A and 3B). After the airplane gets to 1500 feet radio altitude, Mode 3 is not armed. When Mode 3 is not armed, Mode 4 is armed.

Submode 3A gives an alert when the airplane loses too much inertial altitude after takeoff. The amount of inertial loss depends on the climb rate and radio altitude of the airplane. Submode 3A gives the aural message, DONT SINK.

Submode 3B gives an alert for minimum terrain clearance. The minimum terrain clearance increases with radio altitude during takeoff and climb. Submode 3B gives the aural message, TOO LOW TERRAIN.

When there is a GPWS mode 3 alert, the AI shows the message, PULL UP.



MODE 3 DESCRIPTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

MODE 3 FUNCTIONAL DESCRIPTION

General

Mode 3 operates when either of these conditions is true:

- Airplane climbs after going below 245 feet in landing configuration (gear down, flaps more than 30 units)
- Airplane takes off.

The Mode 3A alerts occur between 1500 feet and 30 feet. The alert conditions change with the airplane climb rate.

The Mode 3B alerts occur when the airplane altitude is lower than the altitude value the GPWC stores in a filter. The filter begins operation during climb at 150 feet and stores 75 percent of the altitude. The filter stores up to 500 feet altitude for airspeed less than 190 knots (500 feet in the filter equals an airplane altitude of 667 feet). When the airspeed goes above 250 knots, the top limit goes to 1000 feet (1000 feet in the filter equals an airplane altitude of 1333 feet). Mode 3 changes to Mode 4 when the altitude gain filter gets to the upper limits.

These are the LRUs that supply inputs for Mode 3 operation:

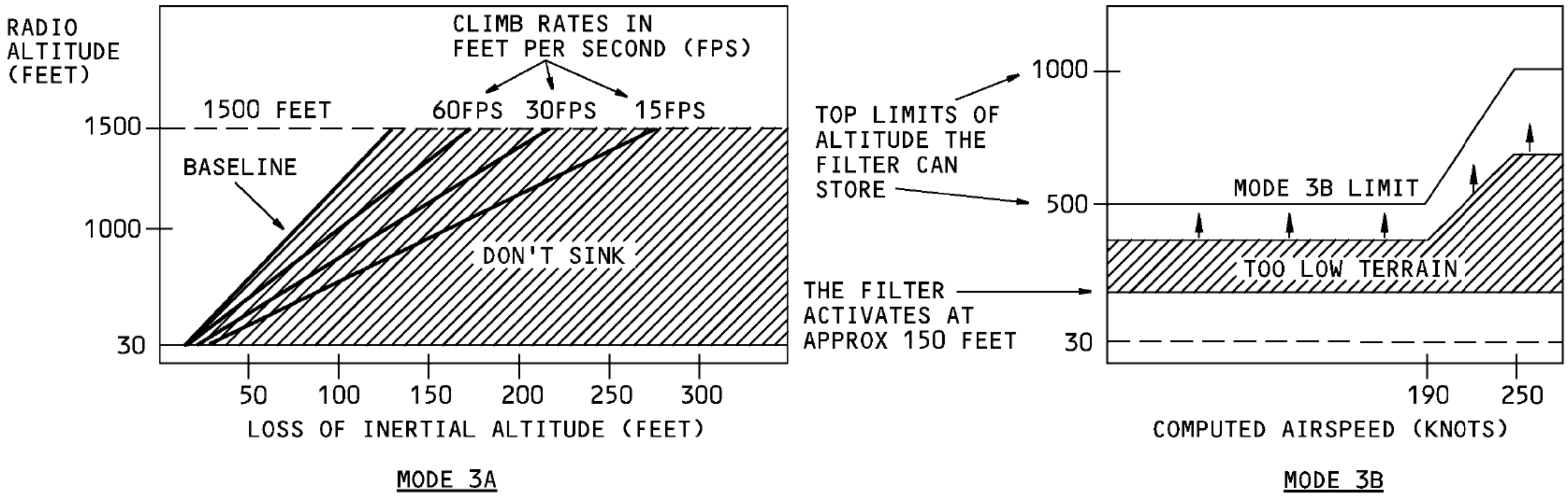
- Radio altimeter transceivers
- Left and right ADIRUs
- GPWS module
- Landing gear handle switch
- Stall management yaw damper (SMYD) 1 and 2.

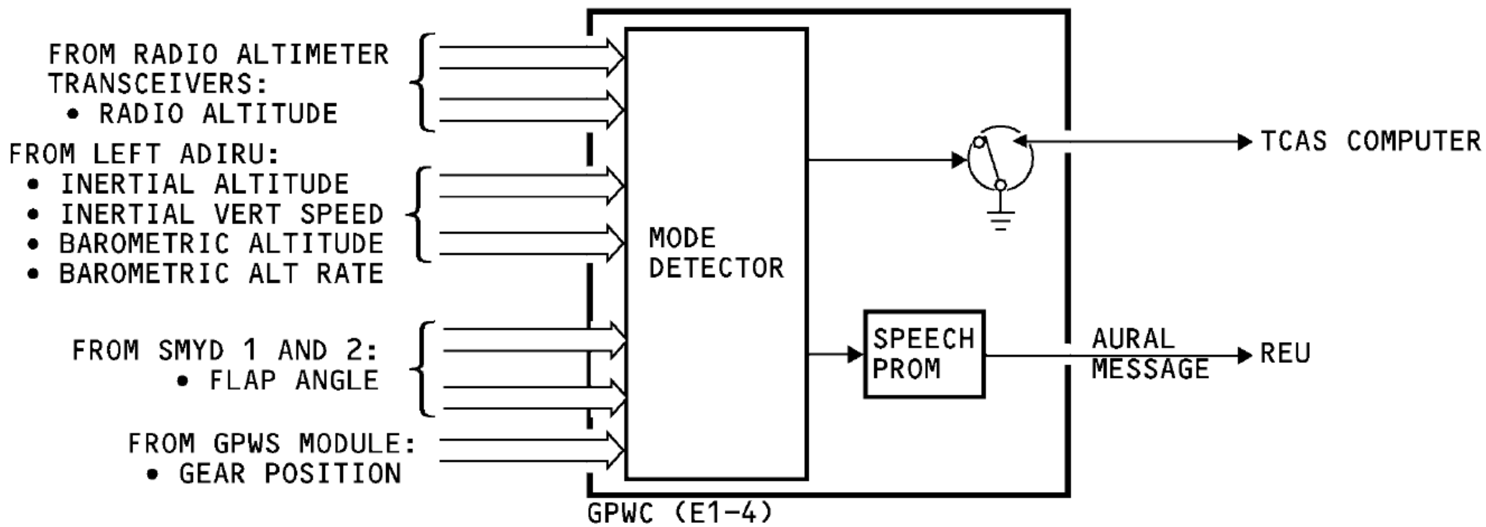
The GPWC uses this data to detect mode 3 alerts:

- Radio altitude
- Inertial altitude
- Inertial vertical speed
- Barometric altitude
- Barometric altitude rate
- Flap angle
- Gear position.

When there is a Mode 3A or Mode 3B condition, the mode detector sends a discrete to the speech PROM to make the aural messages. The aural messages go to the REU which sends them to the flight compartment speakers. Also, when there is any Mode 3 condition, the mode detector sends a discrete on an ARINC 429 data bus to the DEUs to show the warning message.

When the GPWC gives a mode 3 aural message, a discrete goes to the TCAS computer to inhibit TCAS advisories and TCAS aural messages.





MODE 3 FUNCTIONAL DIAGRAM

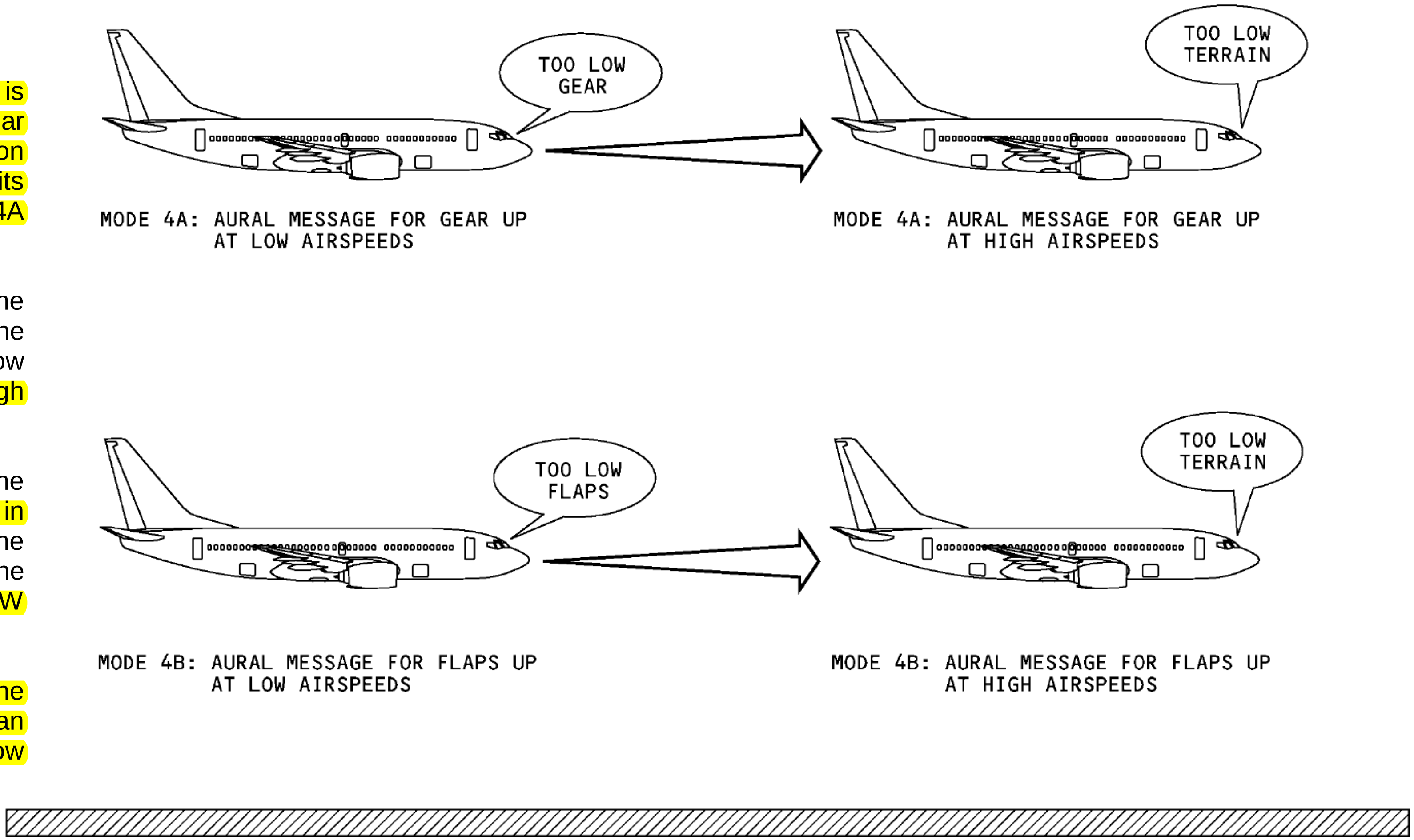
MODE 4 GENERAL DESCRIPTION

Mode 4 supplies alerts when the airplane is too close to the terrain and the landing gear or flaps are not in the landing configuration (landing configuration for the flaps is 30 units or greater). Mode 4 has two submodes (4A and 4B).

The GPWC gives a Mode 4A alert when the landing gear is not down. Mode 4A gives the aural messages TOO LOW GEAR at low airspeeds, or TOO LOW TERRAIN at high airspeeds.

The GPWC gives a Mode 4B alert when the landing gear is down and the flaps are not in landing configuration. Mode 4B gives the aural messages TOO LOW FLAPS if the airplane is at low airspeed, or TOO LOW TERRAIN at high airspeeds.

When the GPWC gives a Mode 4 alert, the mode detector also sends a discrete on an ARINC 429 data bus to the DEUs to show the PULL UP message on the ADI.



MODE 4 DESCRIPTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

MODE 4 FUNCTIONAL DESCRIPTION

General

Mode 4 alerts occur between 1000 feet and 30 feet. The altitude limits for mode 4A and mode 4B are lower at low airspeed.

The Mode 4A alert occurs if the landing gear is not down below the altitude limit. The mode 4A altitude limit is 500 feet when the airspeed is less than 190 knots and it is 1000 feet at high airspeed. The mode 4A aural message TOO LOW GEAR changes to the aural message TOO LOW TERRAIN when the airspeed is more than 190 knots.

The Mode 4B alert occurs if the landing gear is down and the flaps are not in a landing configuration below the altitude limit (landing configuration for the flaps is 30 units or more). The Mode 4B altitude limit is 245 feet when the airspeed is less than 159 knots and it is 1000 feet at high airspeed. The mode 4B aural message TOO LOW FLAPS changes to the aural message TOO LOW TERRAIN when the airspeed is more than 159 knots.

The LRUs that supply inputs for mode 4 are:

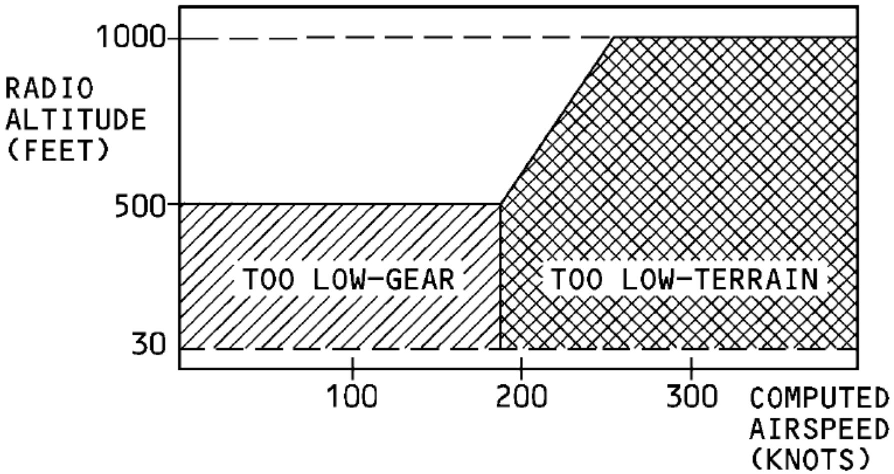
- Left and right radio altimeter transceivers
- Left ADIRU IRS and air data buses
- Stall management yaw damper computers (SMYD)
- Landing gear handle switch
- GPWS module.

The GPWC uses this data to detect mode 4 alerts:

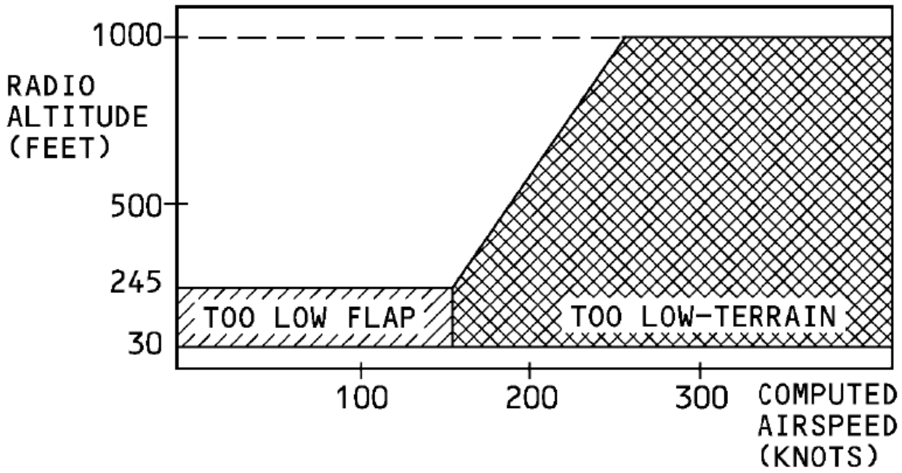
- Radio altitude
- Computed airspeed
- Flap angle
- Gear position.

When there is a Mode 4 condition, the mode detector sends a discrete to the speech PROM to make the aural message come on. The aural message goes to the REU which sends it to the flight compartment. When the GPWC gives an aural message, a discrete goes to the TCAS computer to inhibit TCAS aural messages. The mode detector also sends a discrete on an ARINC 429 data bus to the DEUs to show the PULL UP message for any Mode 4 alert condition.

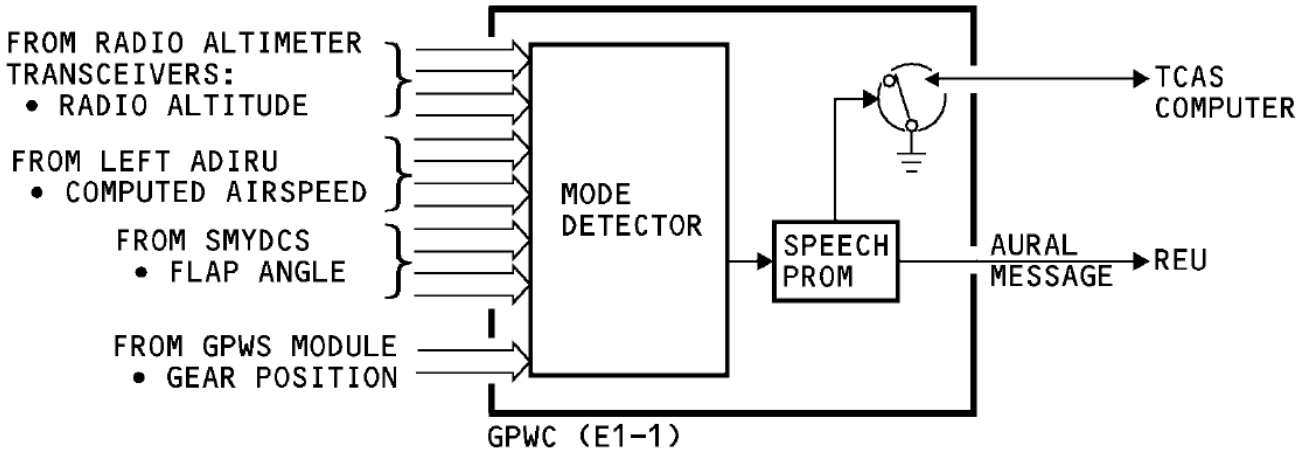
Mode 4 changes to mode 3 if the airplane goes below 245 feet in landing configuration (flaps down and gear down).



MODE 4A



MODE 4B

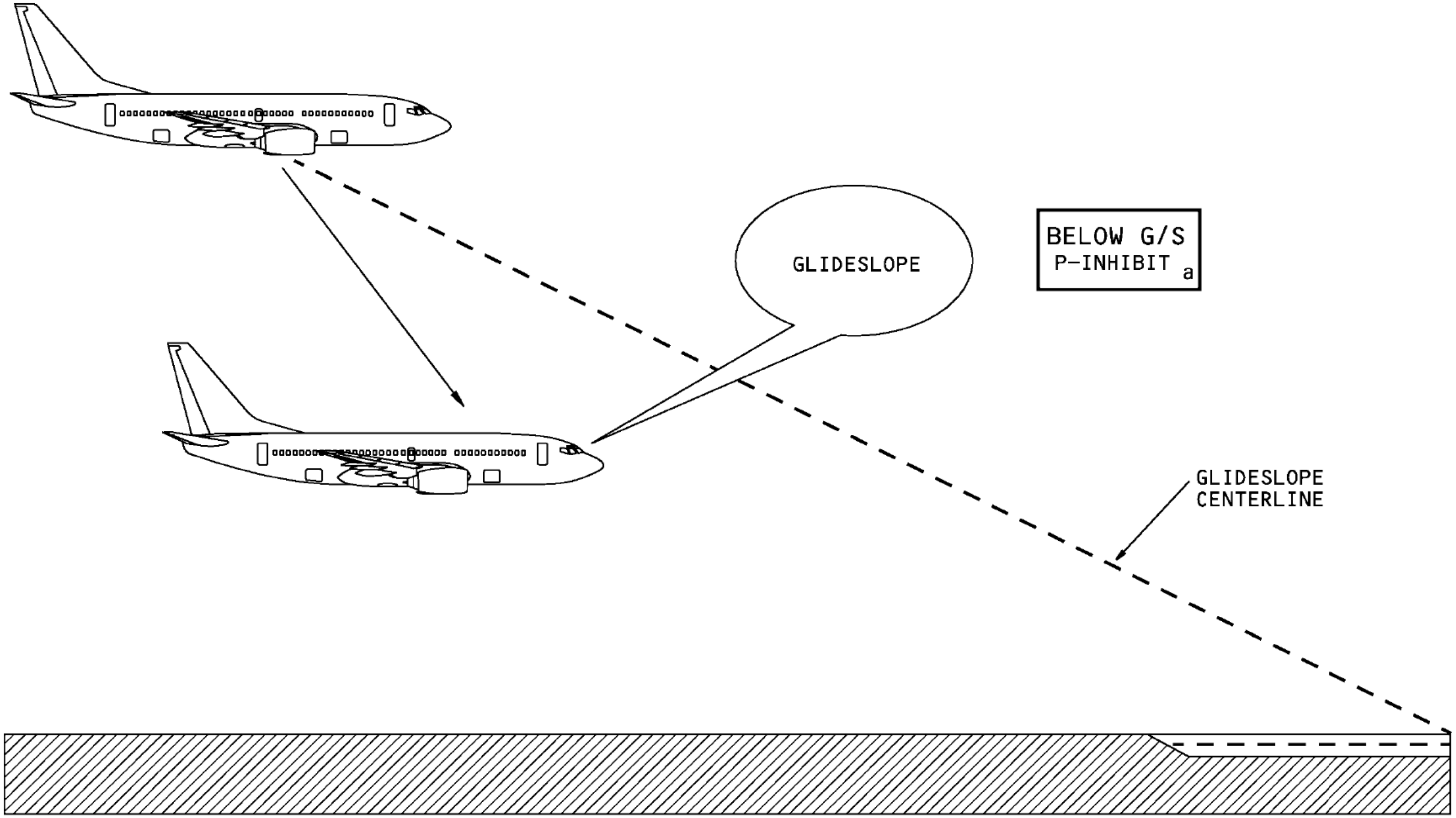


MODE 4 FUNCTIONAL DIAGRAM

MODE 5 GENERAL DESCRIPTION

The GPWC gives a mode 5 alert when the airplane goes below the glideslope during approach if the landing gear is down.

For mode 5 alerts, the GPWC gives the aural message GLIDESLOPE and the below glideslope lights come on. The volume level of the aural message increases and the message repeats faster as the terrain gets closer. You push the glideslope inhibit switch to inhibit or cancel mode 5 alerts.



MODE 5 DESCRIPTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

MODE 5 FUNCTIONAL DESCRIPTION

Mode 5 alerts can occur between 1000 and 30 feet radio altitude. The interval between aural messages depends on altitude and glideslope deviation. Low volume audio occurs below 1000 feet down to 30 feet when the deviation is more than 1.3 dots. Normal volume audio occurs below 300 feet when the deviation is more than 2 dots.

These LRUs supply inputs for mode 5 operation:

- Radio altimeter transceivers
- DFCS mode control panel
- Landing gear handle switch
- MMRs
- FMCS
- GPW module.

The GPWC uses this data to calculate mode 5 alerts:

- Radio altitude.
- Selected runway heading
- Gear position
- Magnetic track
- Localizer and glideslope deviation

When there is an alert condition, the mode detector sends a discrete to the speech prom to make the aural message. The aural message goes to the REU which sends it to the flight compartment.

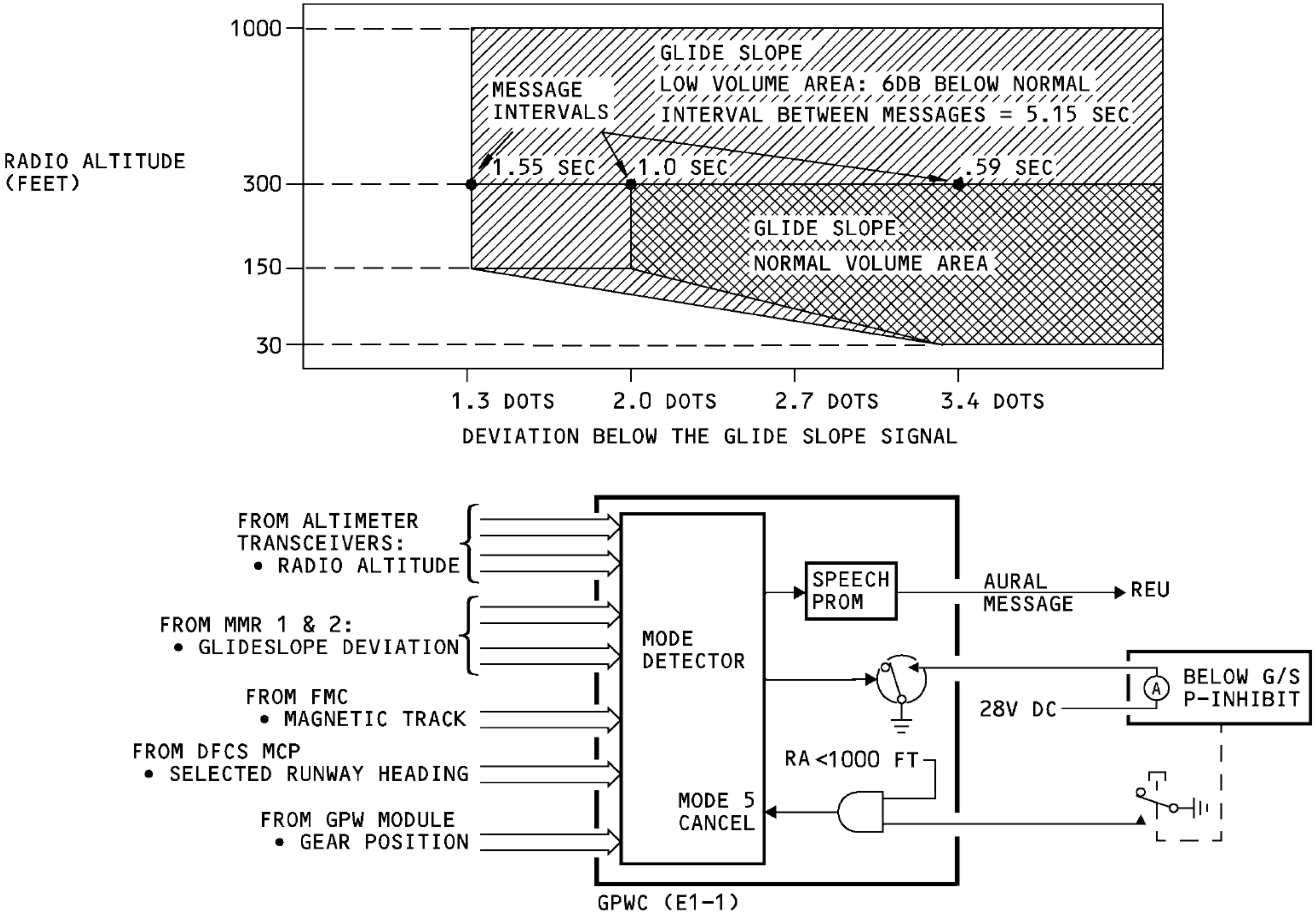
Mode 5 arms when this data is true:

- Terrain clearance is less than 1000 feet
- Landing gear is down
- Glideslope signal is valid
- Airplane is not in a back course approach
- Localizer signal is captured.

Push the ground proximity glideslope inhibit switch to inhibit or cancel mode 5 aural and visual alerts. If you push the switch before mode 5 alerts begin, you inhibit the aural message and visual annunciations. If you push the ground proximity glideslope inhibit switch during a mode 5 alert, you cancel the aural message and visual annunciations.

When you inhibit or cancel the alert, you can not activate it again unless the airplane leaves the mode 5 alert conditions or you cycle the landing gear.

When the GPWC gives an aural message, a discrete goes to the TCAS computer to inhibit TCAS advisories and aural messages.



MODE 5 FUNCTIONAL DIAGRAM

MODE 6 GENERAL DESCRIPTION

Purpose

The GPWC mode 6 supplies aural callouts when the airplane descends through set altitudes with the landing gear down.

These are the options available for mode 6:

- Altitude callouts
- Minimums callout
- Approaching minimums callout
- Bank angle (roll alert) callout.

Altitude callouts start at 2500 feet. At 2500 feet, there is an option to give the aural TWENTY FIVE HUNDRED or give the aural, RADIO ALTITUDE.

The minimums callout option gives an aural callout when the airplane descends through the decision height altitude set on the EFIS control panels.

These are the aural callouts the GPWC can give for decision height:

- MINIMUMS
- MINIMUMS, MINIMUMS
- DECISION HEIGHT.

There is also an approaching minimums option callout that tells the pilots when the airplane is near the decision height set on the EFIS control panel. The callout normally comes on when the airplane altitude is 80 feet above the decision height.

The aural callouts for this option are:

- APPROACHING MINIMUMS
- APPROACHING DECISION HEIGHT
- PLUS HUNDRED (for this callout the altitude selection is set for decision height + 100 feet).

Mode 6 bank angle callouts occur when the airplane bank angle is more than 10 degrees between 30 feet and 130 feet altitude. Above 130 feet, the callout occurs at 35 degrees, 40 degrees, and 45 degrees. The aural message is BANK ANGLE, BANK ANGLE.

Description

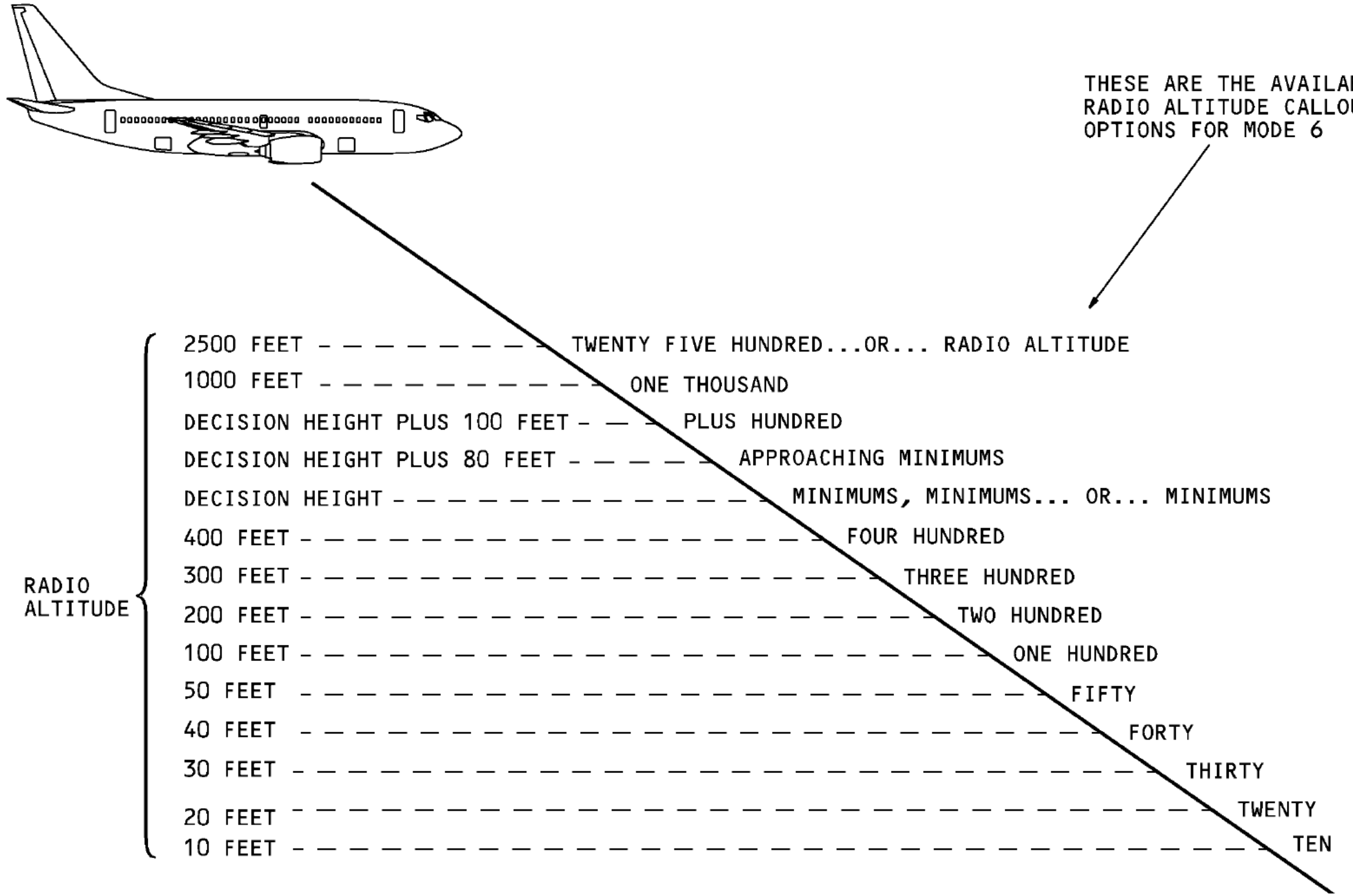
The GPWC receives inputs from these units:

- Radio altimeter transceivers
- GPWS module
- Program switch module
- left and right ADIRUs
- DEU 1 and 2.

The GPWC uses this data to calculate mode 6 alerts:

- Radio altitude
- Landing gear position
- Program pin selection
- Roll attitude
- Decision height.

Mode 6 is armed when the airplane climbs through 1000 feet radio altitude. To reset mode 6, the airplane must climb above the radio altitude where the first altitude callout occurs.



MODE 6 DESCRIPTION

MODE 7 GENERAL DESCRIPTION

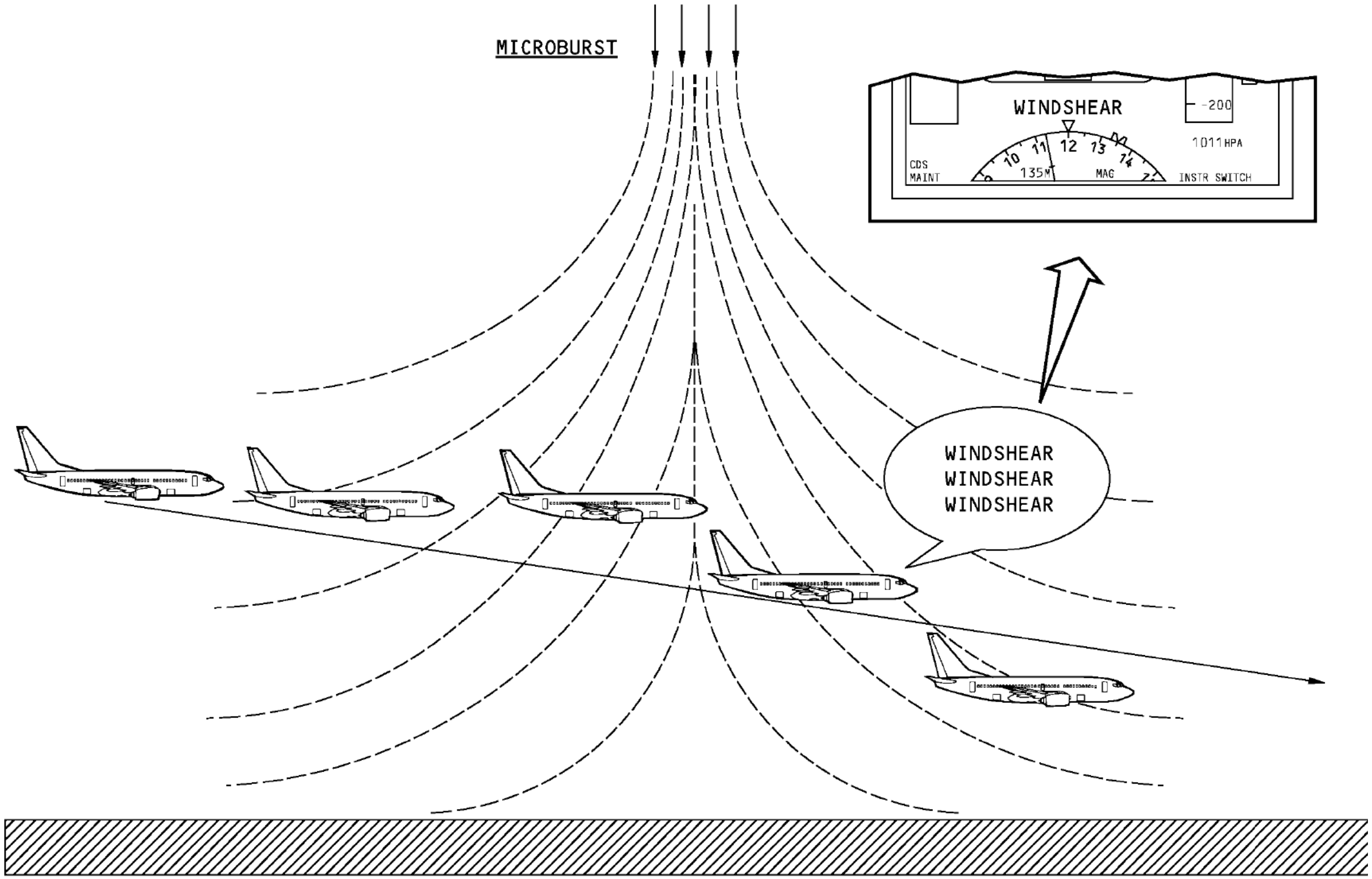
The GPWC gives mode 7 warnings when there are horizontal and vertical windshear conditions during approach or takeoff.

Windshear is the effect of large volumes of air that change direction rapidly. The most dangerous type of windshear is the microburst. When the airplane is near the terrain, a downward microburst gives the pilots very little time to react to the windshear effects.

The initial effects on an airplane when it encounters the microburst are an increase in airspeed and lift. Because of the increased lift, the airplane increases altitude.

As the airplane continues through the microburst, the effects rapidly change to a loss in airspeed and lift. The airplane altitude now rapidly decreases.

For mode 7 warnings, the GPWC gives the aural message WINDSHEAR WINDSHEAR WINDSHEAR with a siren. The GPWC sends a discrete to the DEUs to make the red WINDSHEAR message show on the EFIS displays. Mode 7 warnings have the highest priority.



MODE 7 DESCRIPTION

THIS PAGE IS INTENTIONALLY LEFT BLANK

MODE 7 FUNCTIONAL DESCRIPTION

General

These LRUs supply data for mode 7 operation:

- Radio altimeter 1 AND 2
- Left and right ADIRUs
- Stall management yaw damper 1 and 2.

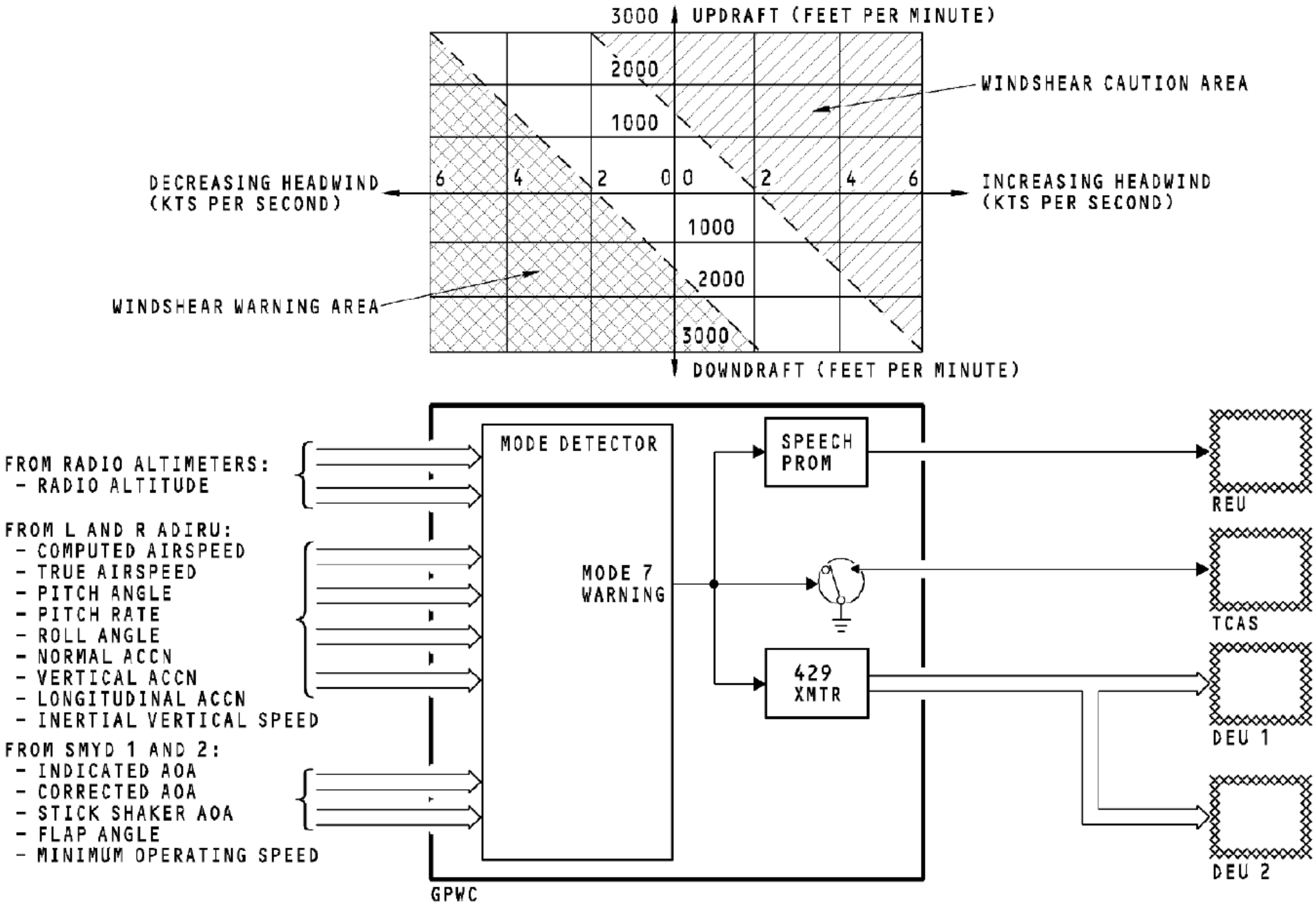
The GPWC uses this data to detect windshear:

- Radio altitude
- Inertial vertical speed
- Pitch and roll angle
- Pitch rate
- Longitudinal acceleration
- Normal acceleration
- Vertical acceleration
- Indicated angle of attack (AOA)
- Corrected AOA
- Stick shaker AOA
- Flap angle
- Minimum operating speed
- True airspeed
- Computed airspeed.

When there is an windshear condition, the mode detector sends a discrete to the speech prom to make the aural message. The aural message goes to the remote electronic unit (REU) which sends it to the flight compartment.

When the GPWC gives an aural message, a discrete goes to the TCAS computer to inhibit TCAS aural messages and downgrade TCAS resolution advisories to traffic alerts.

The mode detector also sends a discrete on the ARINC 429 data bus to the DEUs to show the WINDSHEAR message on the attitude indication (AI).



MODE 7 FUNCTIONAL DIAGRAM

ENHANCED FEATURES FUNCTIONAL DESCRIPTION

Purpose

The ground proximity warning computer compares the airplane position, flap and gear position, and terrain clearance to find if an alert or warning condition exists.

Terrain Awareness Inputs

The GPWC receives inputs from these systems for the terrain awareness function:

- GPS 1
- GPS 2
- ADIRU L
- ADIRU R
- CDS
- Landing gear switch module
- Weather Radar.

Aircraft position from the GPS 1 system is the primary input. If GPS 1 position is not valid, GPS 2 position is used. ADIRU position can be used for short periods of time when neither GPS 1 or 2 position is not valid.

Terrain Awareness Calculation

The GPWC has a world-wide terrain database in memory. The GPWC compares airplane position and track to the terrain database. If the GPWC finds there is a terrain threat, it makes an alert.

Terrain Display Output

The GPWC makes a digital map of the terrain forward of the airplane. It sends this digital map to the display electronics units (DEUs) to show on the map displays. The display uses different colored dots to show terrain altitude relative to airplane altitude.

Terrain Alert Outputs

If the GPWC finds the airplane is 60 seconds from a terrain conflict, it makes a terrain caution alert.

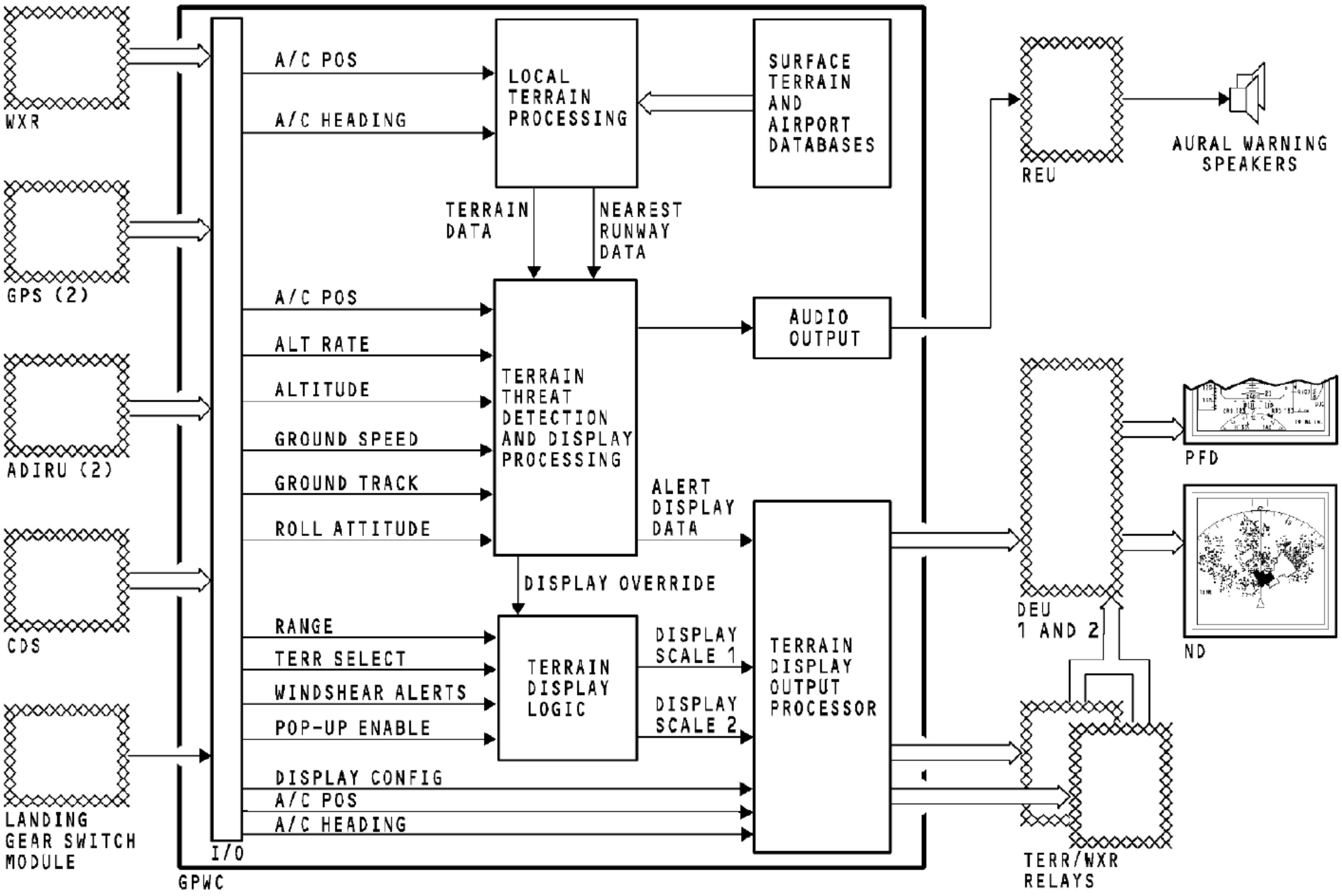
These are the caution alert indications:

- Alert aural message CAUTION TERRAIN
- Amber message, TERRAIN on the map display
- Terrain display on both map displays (pop up function)
- Threat terrain on the map display changes from dots to a solid yellow color.

If the GPWC finds the airplane is 30 seconds from a terrain conflict, it makes a terrain warning alert.

These are the warning alert indications:

- Aural message, TERRAIN, TERRAIN PULL UP
- Red PULL UP message on the ADI
- Red TERRAIN message on the map display
- Terrain display on both map displays if not selected on either one (pop up function)
- Threat terrain on the map display changes from dots to a solid red color.



ENHANCED FEATURES FUNCTIONAL DESCRIPTION

TERRAIN CLEARANCE FLOOR

Description

Terrain clearance floor (TCF) alerts the flight crew when the airplane descends too low on approach. TCF uses airplane position and a runway database to find if there is an alert condition.

Terrain Clearance Floor Inputs

The ground proximity warning system (GPWS) receives airplane data from these systems:

- Global positioning system (GPS)
- Air data inertial reference system (ADIRS)
- Radio altitude (RA) system. TCF uses this data:
- Latitude
- Longitude
- Radio altitude.

TCF uses GPS data for latitude and longitude. It uses IRS data if GPS data is not valid.

Terrain Clearance Floor Logic

The GPWC has a runway database in memory. The runway database is in the terrain database. The runway database contains the location of all hard surface runways in the world that are longer than 3,500 feet. TCF makes a terrain clearance envelope around the runway. The altitude of the envelope increases as the distance from the airport increases. GPWC compares airplane latitude, longitude, and radio altitude with TCF envelope data. If the airplane descends through the floor of the envelope, the GPWC makes an alert.

TCF makes an alert even if the airplane is in landing configuration.

The TCF function is active through the entire flight. When the aircraft is 15nm or more from a runway the floor is 700 feet AGL until the aircraft approaches another runway that meets the requirements. Then the floor decreases as shown on the graphic.

Terrain Clearance Floor Alert

If the GPWC finds that the airplane is below the TCF, it makes this caution alert:

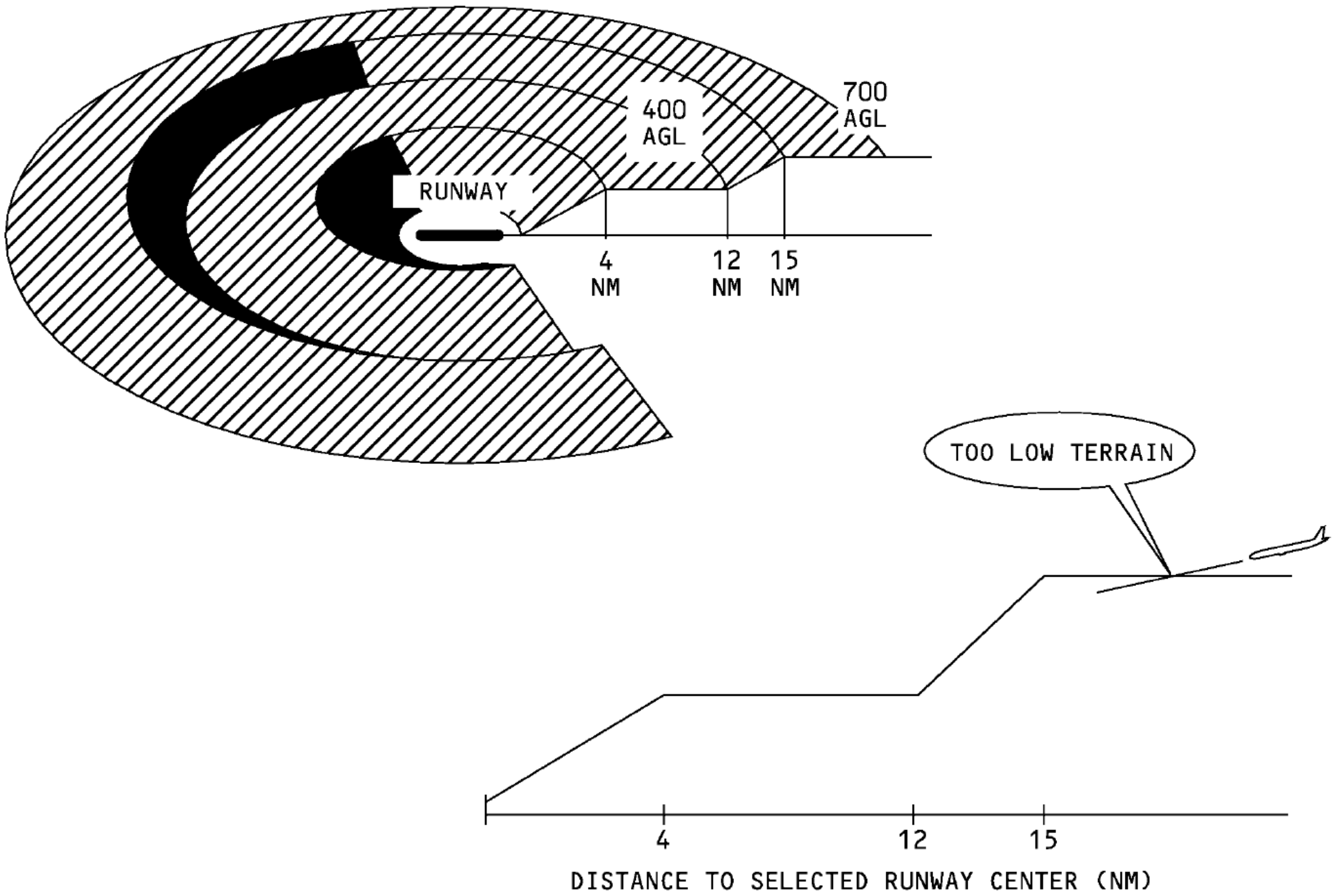
- Aural message TOO LOW TERRAIN. This message repeats for each 20 percent loss of altitude.
- Message, TERRAIN on the ND in amber.

If descent continues, these alerts happen:

- Aural message PULL UP
- Message, TERRAIN on the ND in red
- Message, PULL UP on the ADI.

The GPWC inhibits TCF alerts for any of these conditions:

- Airplane is on the ground
- Less than 20 seconds after takeoff
- Less than 30 feet radio altitude.



TERRAIN CLEARANCE FLOOR

ENVELOPE MODULATION

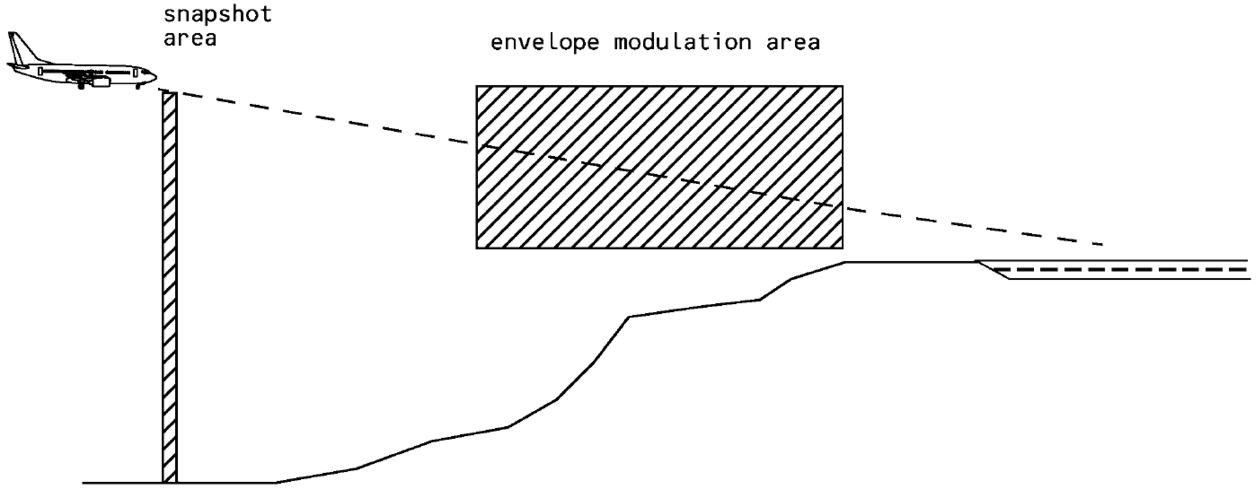
Some airports have unusual terrain clearances near the runway that cause nuisance messages by the GPWS. The most common is a mode 2 warning for an excessive closure rate due to rising terrain located at the end of a runway. Other GPWS modes affected by unusual terrain are modes 1, 4, and 5. Envelope modulation changes the different alert and warning areas to prevent alert messages that are not necessary.

The airports that need envelope modulation are in the GPWC non-volatile memory and identified by their latitude and longitude. This latitude and longitude is called a snapshot area. A snapshot area is then followed, on an approach, by the envelope modulation area. The envelope modulation area has its own latitude and longitude. When the airplane is in a snapshot area, the GPWC looks at other airplane parameters to ensure that all the required data is valid and within tolerances. Once the snapshot requirements have been verified by the GPWC, and depending on which airport the airplane is approaching, one or more of the listed GPWS modes can be modified.

- Mode 1 - to allow higher altitude descent rates
- Mode 2(A and B) - to allow higher closure rates
- Mode 4 - to allow less minimum terrain clearance
- Mode 5 - to allow GLIDE SLOPE warnings at higher altitudes.

Not all airports require the same parameters.

These are the monitored inputs: Latitude, Longitude, Radio altitude, Localizer deviation, Magnetic track, Selected runway heading, Barometric corrected altitude.



MODE	TYPE OF MODULATION	PURPOSE OF MODULATION
1	INCREASE ALLOWABLE DESCENT RATE	PERMITS GREATER BAROMETRIC DESCENT RATES WITHOUT ALERTS OR WARNINGS
2	LOWER THE ALERT/WARNING RADIO ALTITUDE LIMITS	LETS THE AIRPLANE FLY CLOSER TO THE TERRAIN WITHOUT ALERTS OR WARNINGS
3	LOWER THE ALERT/WARNING RADIO ALTITUDE LIMITS	LOWERS THE MINIMUM TERRAIN CLEARANCE FOR AIRSPEEDS ABOVE 250KTS FOR ALERTS
4	INCREASE ALERT AREA RA LIMITS REMOVE GEAR DOWN REQUIREMENTS	PERMITS MODE 5 ANNUNCIATIONS AT HIGHER ALTITUDES OR WITHOUT GEAR DOWN

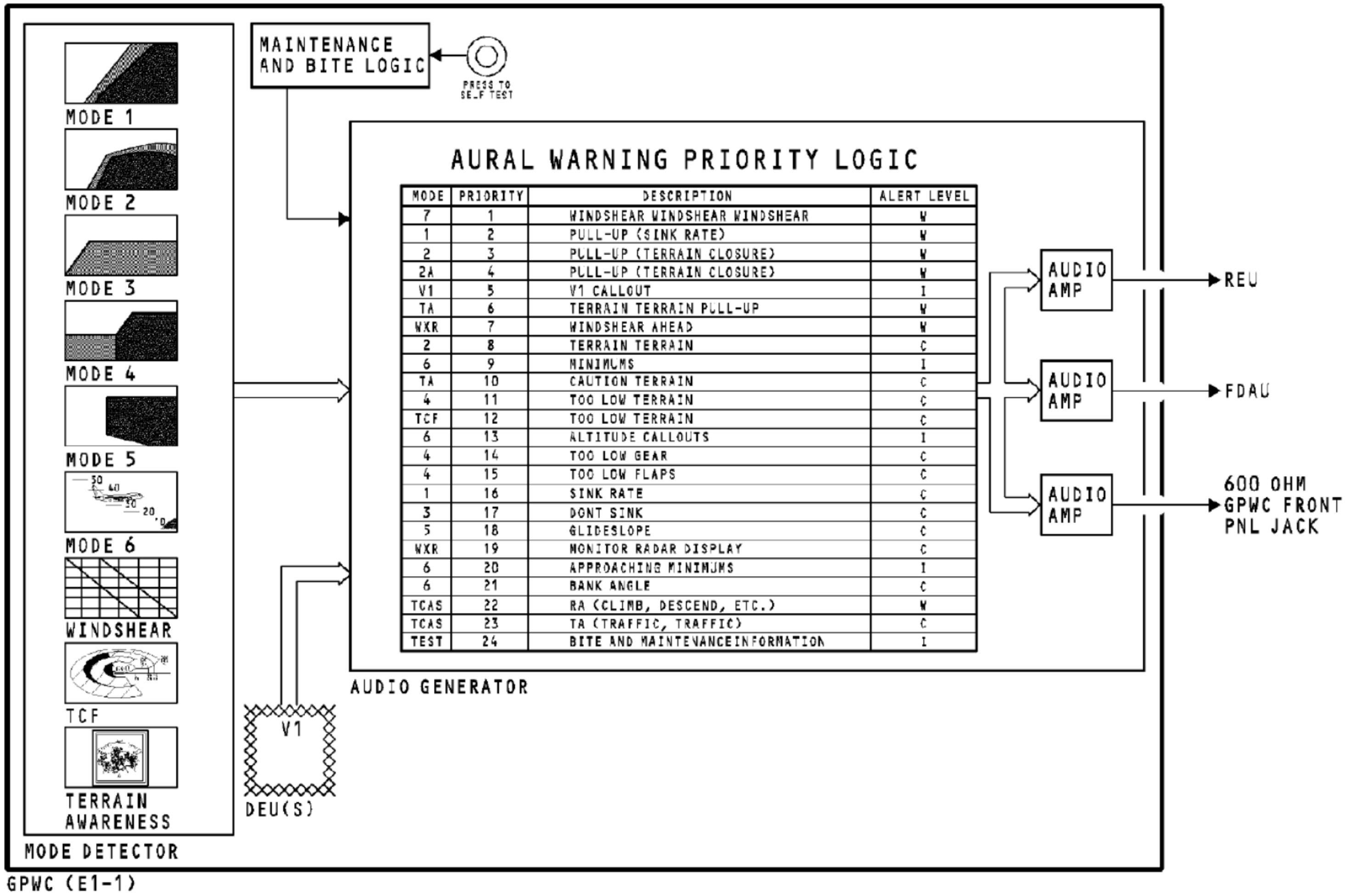
ENVELOPE MODULATION

SPEECH PROM

The speech PROM supplies aural messages for modes 1 through 7 when the mode detector detects an alert or warning condition. The speech PROM also contains optional callouts for certain radio altitudes, decision height callouts, and bank angle.

The audio generator sends only one message at a time to the audio amplifier. If more than one message discrete comes from the mode detector, the audio generator sends the message that has the highest priority. This makes sure only one message is sent at a time. From the audio amplifier, the audio goes to the remote electronics unit and on to the flight compartment speakers and headphones. Warnings and cautions also go to the flight data acquisition unit for recording. There are hundreds of words necessary for the annunciation of all the possible BITE, caution, and warning messages. The graphic shows the possible GPWS modes with the caution and warning aural messages and their priority.

The audio generator gets inputs for message requests and volume levels from the mode logic detector. The test circuit gives an input for annunciation of all BITE information.



SPEECH PROM

GPWS - DISPLAYS

CDS Warning Annunciations

The common display system (CDS) can show these two warning annunciations in the GPWS message field on the AI display:

- PULL UP (red)
- WINDSHEAR (red).

The PULL UP warning annunciation shows for mode 1, 2, 3 and 4 conditions. The WINDSHEAR warning annunciation shows for a mode 7 condition.

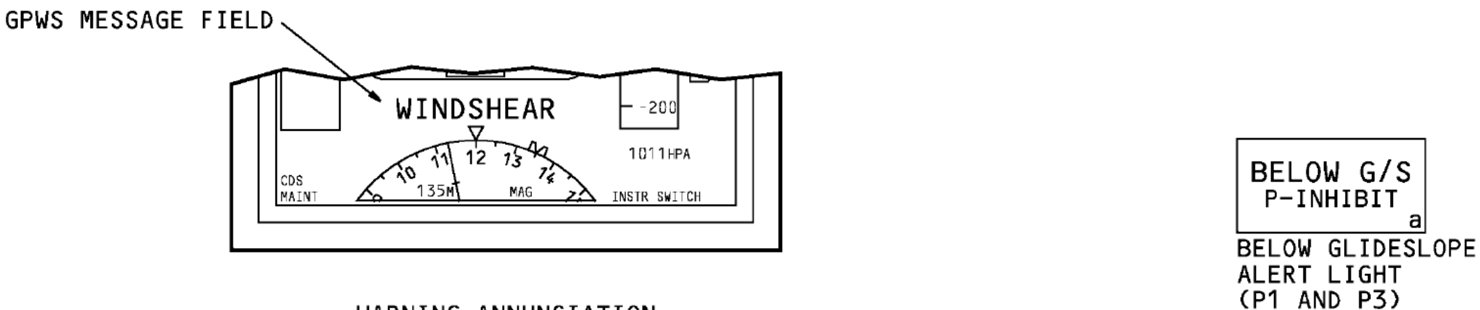
Below Glideslope Light

There are two BELOW GLIDESLOPE lights. One for the captain and one for the first officer. The lights are amber and come on for mode 5 alerts. The below the glide slope light can be pushed to stop the alert. This will also cancel the aural warning.

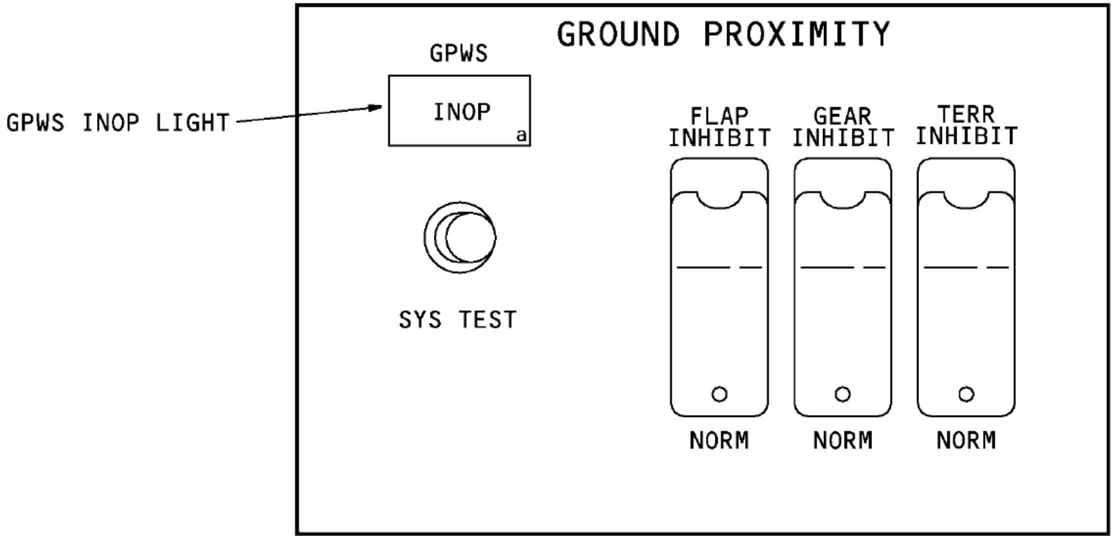
Ground Proximity INOP Light

The INOP light on the ground proximity warning module comes on for these conditions:

- GPWS inoperative
- Windshear inoperative
- System input failure
- Program pin change while airplane is in the air
- During start of the BITE test.



WARNING ANNUNCIATION



GPW MODULE (P3)

GPWS - DISPLAYS

THIS PAGE IS INTENTIONALLY LEFT BLANK

TERRAIN AWARENESS DISPLAY

Terrain Awareness Display Data

The navigation displays (NDs) show this GPWS data:

- Terrain awareness display
- GPWS system messages
- GPWS alert messages.

Terrain Awareness Display

The terrain awareness display on the NDs uses dots to show the terrain ahead of the airplane. Dot color and dot pattern density are based on the terrain altitude and airplane altitude.

These are the dot colors and patterns the terrain display uses:

- High density red - Terrain more than 2,000 feet above airplane altitude
- High density yellow - Terrain 1,000 feet to 2,000 feet above airplane altitude
- Medium density yellow - Terrain 500 feet below to 1,000 feet above airplane altitude. Gear down changes this to 500 feet below to 250 feet above
- Medium density green - Terrain 500 feet below to 1,000 feet below airplane altitude. Gear down changes this to 500 feet below to 250 feet below
- Low density green - Terrain 1,000 feet below to 2,000 feet below airplane altitude
- Black - Terrain more than 2,000 feet below airplane altitude
- Magenta - Unknown terrain.

If GPWS detects a terrain caution alert, the threat terrain changes from dots to a solid yellow color. If GPWS detects a terrain warning alert, the threat terrain changes from dots to a solid red color.

On final approach, terrain near the runway does not show.

GPWS System Messages

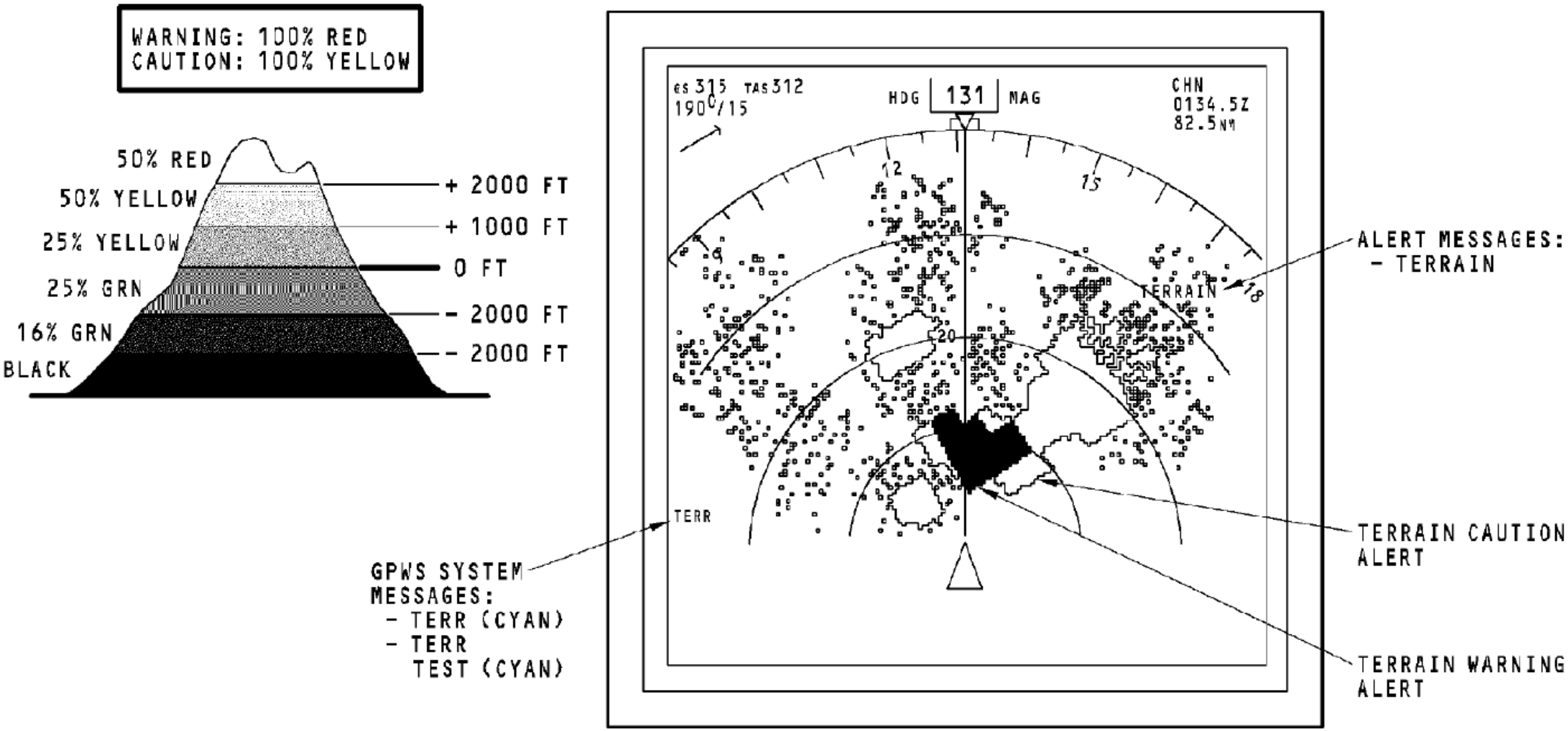
These GPWS system messages show in cyan on the left side of the ND:

- TERR shows when terrain data displays
- TERR TEST show when the GPWS is in self-test mode.

GPWS Alert Messages

These GPWS alert messages show on the right side of the ND:

- TERRAIN (red) shows when a terrain awareness warning occurs
- TERRAIN (amber) shows when a terrain awareness caution occurs.



TERRAIN AWARENESS DISPLAY

NON-NORMAL TERRAIN DISPLAYS

GPWS Non-Normal Messages

These messages show on the navigation display (ND) for GPWS non-normal conditions:

- System alert messages
- Range disagree messages.

GPWS System Alert Messages

These messages show in amber on the left side of the ND:

- TERR POS shows when airplane position data is not valid
- TERR INHIBIT shows when you push the terrain override switch on the GPW module
- TERR FAIL shows when the TCF or TA functions have failed.

Note: The TERR FAIL message shows in all display modes.

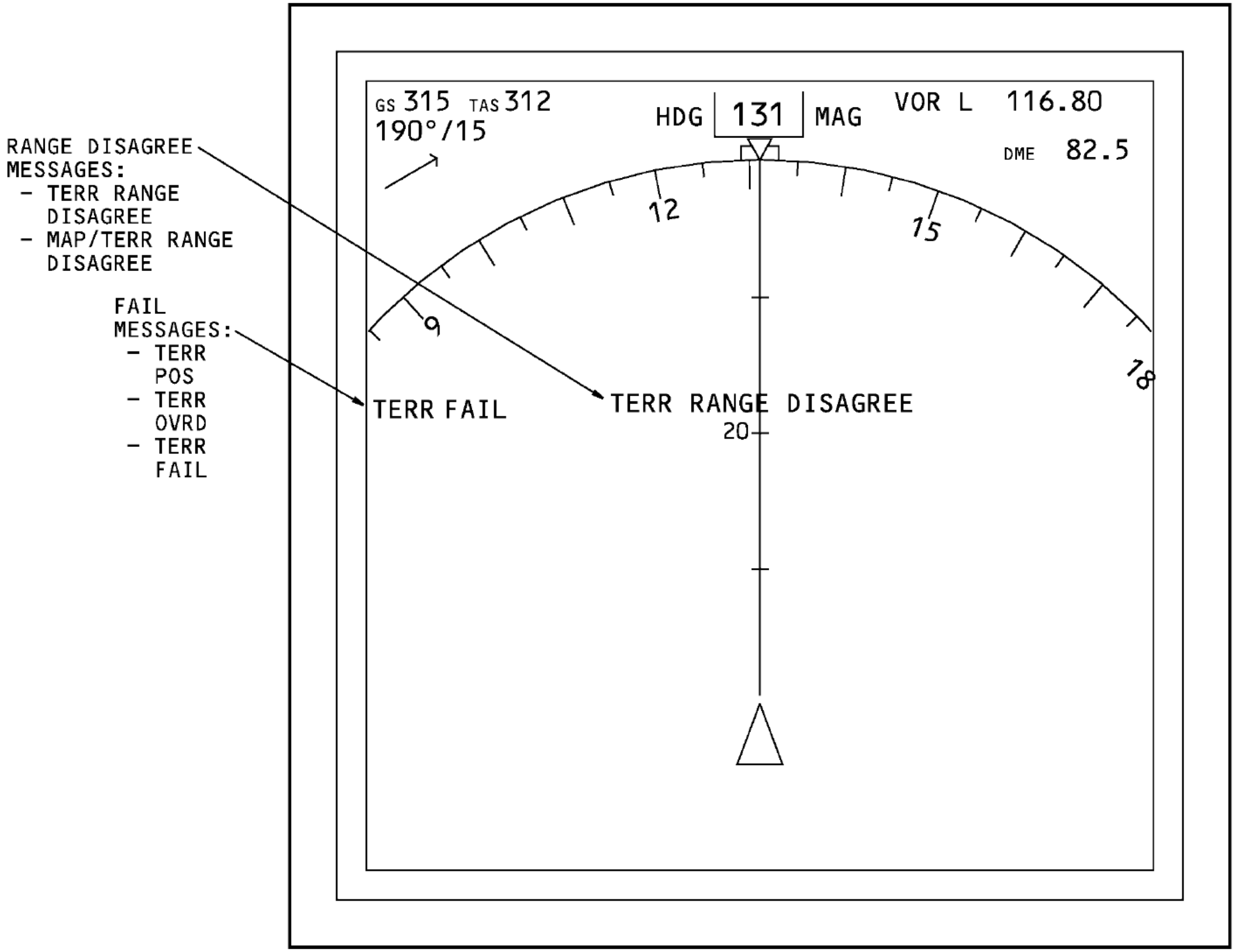
Terrain data does not show on either ND if there is a system alert message.

Range Disagree Messages

These alert messages show in amber on the ND when there is a range disagree fault:

- TERR RANGE DISAGREE shows when the GPWS range disagrees with the range selected on the on-side EFIS control panel
- MAP/TERR RANGE DISAGREE shows when the GPWS range, the on-side EFIS range, and the FMC range disagree.

Terrain data does not show on the ND if there is a range disagree message.



NON-NORMAL TERRAIN DISPLAYS

THIS PAGE IS INTENTIONALLY LEFT BLANK

GPWS TEST – LEVEL ONE SELF-TEST

The ground proximity warning system (GPWS) has six levels of self-test. Each level provides different information about the GPWS. These are the six levels of self-test:

- 1 - GO/NO-GO operational test
- 2 - Current faults
- 3 - System configuration
- 4 - Fault history
- 5 - Alert/warning history
- 6 - Discrete input test.

Level One Test Preparation
Level one is the GO/NO-GO operational test. A level one test provides visual and aural annunciations on the flight deck. There are two leve lone tests: short and long. These conditions must be true to do a level one test of the GPWS:

- Airplane on ground
- GPWS power on
- EFIS ND mode selector in correct mode (expanded APP, VOR, MAP, and centered MAP)
- TERR switch on EFIS control panel (CP) selected
- All interfacing systems installed and energized.

Level One Test Procedure
Use the test switch on the ground proximity warning module to begin a level one test.

NOTE: You can start a level one test from the front panel of the GPWC, but you cannot see the flight deck annunciations. Use the GPW module to start an operational test of the GPWS.

A level one test first does a test of these configuration conditions:

- Program pin parity
- Airplane configuration database validity
- Airplane type.

If the test finds a configuration fault, the self-test annunciates the fault and the self-test ends. If the GPWS passes the configuration test, the level one test continues.

Short Level One Test - Normal Indications
These visual and aural annunciations are for a normal level one test:

- ND system message TERR TEST shows in cyan
- Ground proximity warning light on 0.7 seconds
- Glideslope lights on 0.7 sec and aural message GLIDESLOPE
- Pull-up message below the ADI on for 0.7 sec and aural WHOOP WHOOP PULL-UP
- Windshear message below the ADI on 0.7 sec and a two tone siren followed by the aural WINDSHEAR, WINDSHEAR, WINDSHEAR
- Terrain test pattern on the ND for 12 seconds and the aural message TERRAIN, TERRAIN, PULL-UP.

Long Level One Test
To start the long level one test, push and hold the test button for 5 seconds. This will do the short level one test then continue to give voice callouts for all customer selected items.

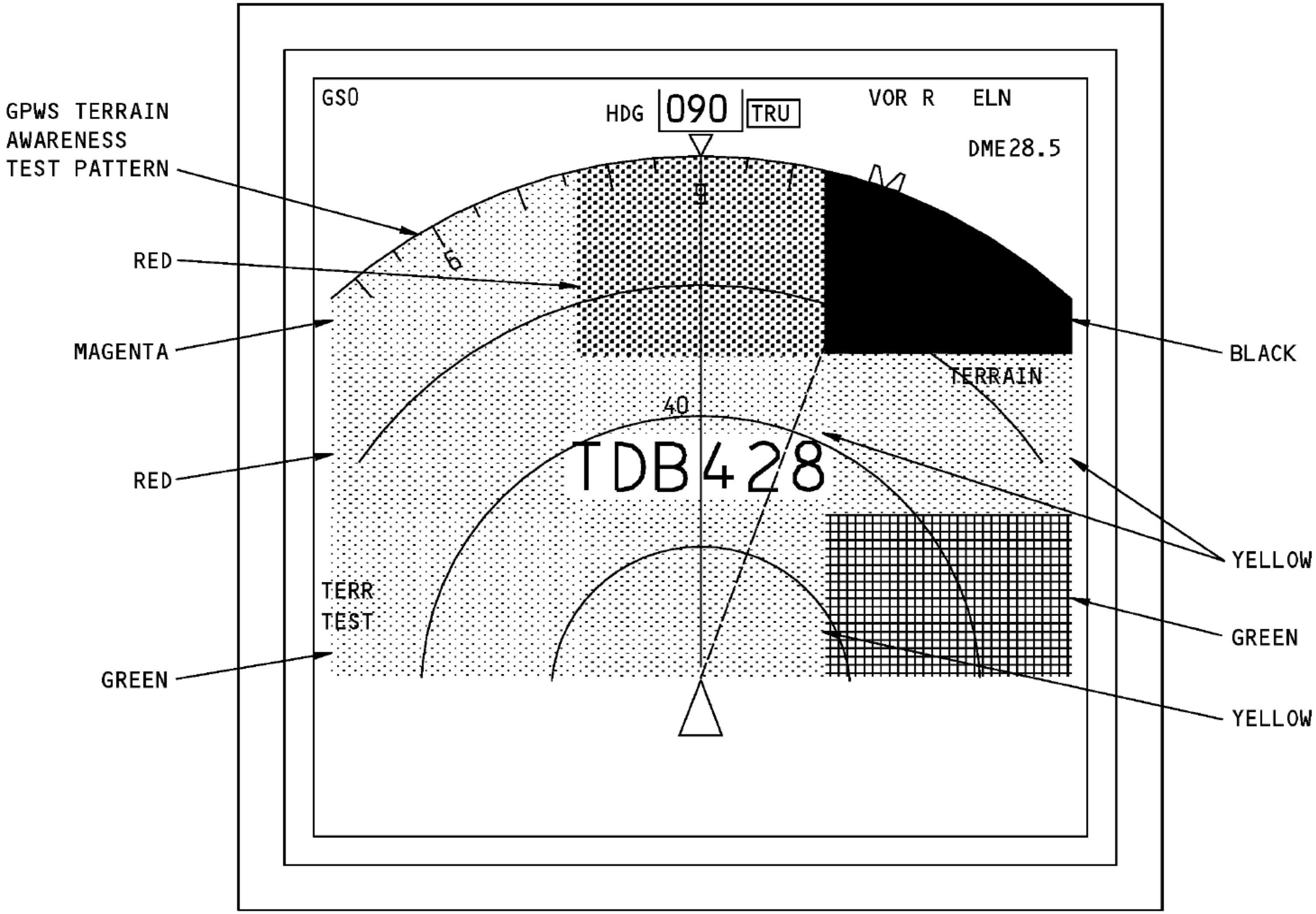
Training Information Point
1. To continue the GPWS BITE to the next level, push the test button after the GO- NO-GO (level 1) test is complete. No annunciation will instruct the operator to push the test button on the GPWM at the end of the go-no-go (level 1) test to continue with the BITE.
2. Some GPWS modes have the same annunciations. If you do not see and hear all annunciations, the test fails.

Level One Self Test - Non-Normal Indications
The GPWS level one test fails for any of these conditions:

- Terrain test pattern does not show
- TERR FAIL message on the ND stays on
- You do not see and hear all annunciations.

GPWS Mode Failures
These aural messages are for GPWS modes that do not function:

- GLIDESLOPE INOP
- GPWS INOP
- CALLOUTS INOP
- WINDSHEAR INOP



SELF-TEST – LEVEL ONE

TEST - LEVELS 2-5 BITE

The ground proximity warning computer (GPWC) has six levels of self test:

- 1 - GO/NO-GO operational test
- 2 - Current faults
- 3 - System configuration
- 4 - Fault history
- 5 - Alert/warning history
- 6 - Discrete input test.

Self-test levels 2-6 access is through the GPW module and the GPWC. When you use the GPWC, a 600 ohm headphone is necessary to listen to the test information. Plug the headphone into the jack on the front panel of the GPWC. If you do the tests from the flight deck, the information comes over the flight deck speakers.

Use the self-test button on the front panel of the GPWC or the self-test button on the GPW module to get access to levels 2-6. The self-test button has these two modes:

- Short cancel - push the button for less than two seconds
- Long cancel - push the button for more than two seconds.

Use the self-test buttons for these functions:

- Start self-test level one
- Go to the next item or flight leg within a test
- Go to the next self-test level
- End the self-test.

When test level 1 ends, there is no aural message, push the test button to continue. If you do not push the self-test button within three seconds, self-test ends. When test levels 2 through 5 end, there is an aural message PRESS TO CONTINUE. Push the self-test button to go to the next test level.

Level Two Self-test - Current Faults

A level two test begins with the aural message, CURRENT FAULTS. If there are no current faults, you hear the aural message NO FAULTS. If there are faults, the GPWC annunciates the faults one at a time. A short or long cancel ends the level two test.

Level Three Self-test - System Configuration

A level three test annunciates the GPWS configuration. A level three test begins with the aural message SYSTEM CONFIGURATION. A short cancel causes the test to go immediately to the next configuration item. A long cancel ends the level three test.

A level three test provides this information:

- GPWC part number
- GPWC modification status
- GPWC serial number
- Application software version
- Configuration software version
- Terrain database version
- Envelope modulation database version
- Boot code version
- Aircraft type
- Audio menu
- Altitude callout menu number
- Selected options.

TEST – LEVEL 2-5 BITE (Continue)

Level Four Self-test - Fault History

Level four test shows the GPWS fault history over the last ten flights.
A level four test begins with the aural message FAULT HISTORY. If there are no faults in the flight history memory, you hear the aural message NO FAULTS. If there are faults in the flight history memory, you hear the most recent faults annunciate first.

You hear the faults in this order:

- FLIGHT X (X is the most recent flight leg number)
- Internal faults for flight X
- External faults for flight X
- Go to next oldest flight leg and repeat.

A short cancel causes the test to go immediately to the next flight leg. A long cancel ends test level four.

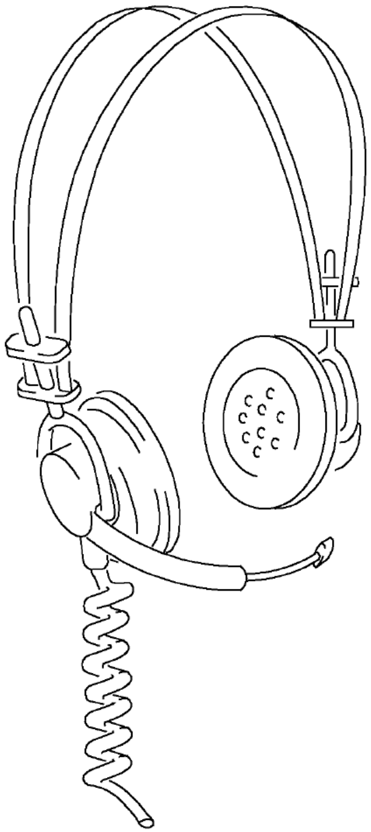
Level Five Self-test - Warning History

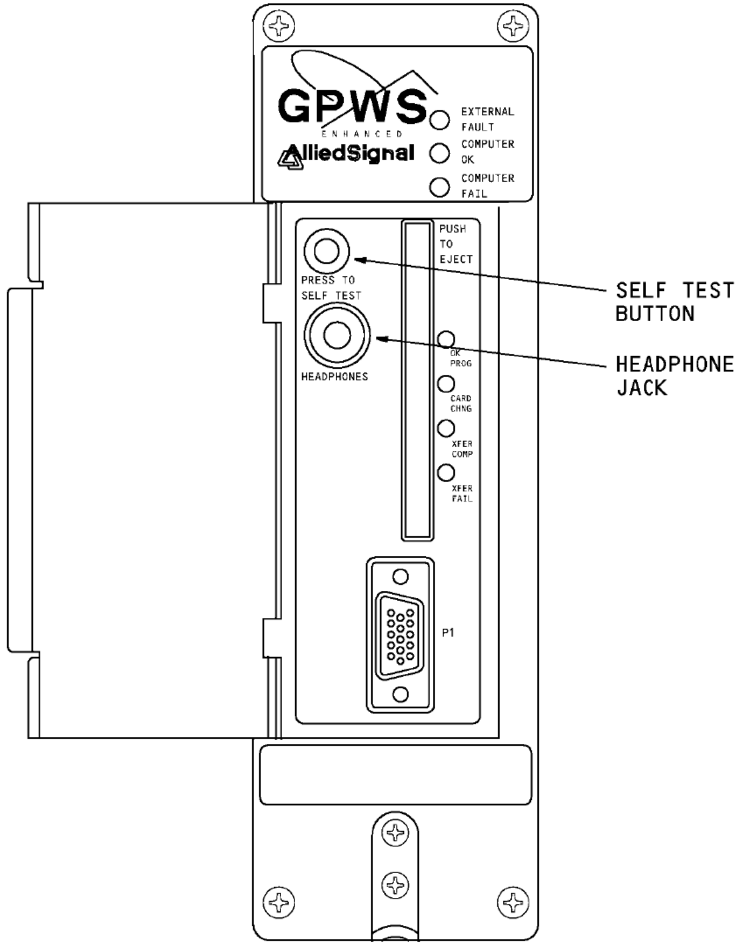
Level five test show GPWS alerts over the last ten flights.A level five test begins with the aural message WARNING HISTORY. If there are no alerts in the flight history memory, you hear the aural message NO WARNINGS. If there are alerts in the flight history memory, you hear the most recent alerts first.

You hear the alerts in this order:

- FLIGHT X (X is the most recent flight leg number)
- GPWS alerts for flight X
- Go to next oldest flight leg and repeat.

A short cancel cause the test to go immediately to the next flight leg. A long





LEVEL 2-5 BITE

SELF-TEST - LEVEL 6 BITE

General Description

The GPWC has a level six discrete input test.

The level six self-test can be done from the GPWC or the GPW module. Use a 600 ohm headphone to listen to the test information when you do the test from the GPWC. Plug the headphone into the jack on the front panel of the GPWC.

Use the self-test button on the front panel of the GPWC or the GPW module to get access to level six.

The self-test buttons have these two modes:

- Short cancel - push the button for less than two seconds
- Long cancel - push the button for more than two seconds.

Use the self-test buttons for these functions:

- Start self-test level one
- Go to the next item or flight leg within a test
- Go to the next self-test level
- End the self-test.

When test levels 2 through 5 end, the aural message PRESS TO CONTINUE shows. Push the self-test button to go to the next test level. When the level one test ends, there is no aural message. If you do not push the self-test button within three seconds, the self-test ends.

Level Six Self-test - Discrete Input Test

A level six test finds changes in discrete inputs.

The test starts with the aural message DISCRETE TEST. If the condition of a discrete input changes, you hear the new state of the discrete.

You hear the aural message DISCRETE INPUT TEST - PRESS TO CANCEL every 60 seconds. Push a short or long cancel to end the self-test.

DISCRETE INPUT	INPUT SOURCE	ANNUNCIATIONS
GEAR INHIBIT SWITCH	GPW MODULE	LANDING GEAR DOWN LANDING GEAR UP
FLAP INHIBIT SWITCH	GPW MODULE	LANDING FLAPS NOT LANDING FLAPS
GLIDESLOPE INHIBIT SWITCH	P1-3 AND P3-1	GLIDESLOPE CANCELLED GLIDESLOPE ENABLED
TERRAIN INHIBIT SWITCH	GPW MODULE	TERRAIN OFF TERRAIN ON
TERRAIN RELAY 1	LEFT EFIS TERR SWITCH	TERRAIN RELAY 1 ON TERRAIN RELAY 1 OFF
TERRAIN RELAY 2	RIGHT EFIS TERR SWITCH	TERRAIN RELAY 2 ON TERRAIN RELAY 2 OFF

LEVEL 6 DISCRETE INPUT TEST

TEST – LEVEL 6

MODE DESCRIPTION SUMMARY

This summary shows this information:

- GPWS modes
- Mode conditions
- Aural messages for each mode
- Annunciators or displays that come on.

MODES	CONDITION			AURAL MESSAGE	AI-RED MESSAGE	ND MESSAGE	GND PROX-G/S INHIBIT LIGHT
1	INITIAL ANNUNCIATION			SINK RATE...	PULL UP		
1	WARNING			PULL UP...	PULL UP		
2A	FLAPS <30 AND G/S AND LOC DEV >2 DOTS	INITIAL ANNUNCIATION		TERRAIN TERRAIN	PULL UP		
2A	FLAPS <30 AND G/S AND LOC DEV >2 DOTS	WARNING		PULL UP...	PULL UP		
2A	FLAPS <30 AND G/S AND LOC DEV >2 DOTS	ALTITUDE GAIN FUNCTION: - STARTS WHEN MODE 2 CONDITION STOPS - STOPS WHEN 300 FT OF INERTIAL ALT IS GAINED OR 45 SECS ELAPSED		TERRAIN..	PULL UP		
2B	FLAPS >30 AND G/S OR LOC DEV <2 DOTS	FLAPS AND GEAR DOWN		TERRAIN..	PULL UP		
2B	FLAPS >30 AND G/S OR LOC DEV <2 DOTS	FLAPS OR GEAR UP	INITIAL ANNUNCIATION	TERRAIN TERRAIN..	PULL UP		
2B	FLAPS >30 AND G/S OR LOC DEV <2 DOTS	FLAPS OR GEAR UP	WARNING	PULL UP..	PULL UP		
3A	FLAPS <30 OR GEAR UP (FOR ALTITUDE LOSS OF 10% TO 20%)			DON'T SINK...	PULL UP		
3B	FLAPS <30 OR GEAR UP. RA LESS THAN THRESHOLD VALUE.			TOO LOW TERRAIN..	PULL UP		
4A	GEAR UP AND FLAPS <30	AIRSPEED <190 KNOTS AND RA <500 FT		TOO LOW GEAR..	PULL UP		
4A	GEAR UP AND FLAPS <30	AIRSPEED >190 KNOTS AND RA <1000FT		TOO LOW TERRAIN..	PULL UP		
4B	GEAR DOWN AND FLAPS <30	AIRSPEED <159 KNOTS AND RA <245 FT		TOO LOW FLAPS..	PULL UP		
4B	GEAR DOWN AND FLAPS <30	AIRSPEED >159 KNOTS AND RA <100FT		TOO LOW TERRAIN..	PULL UP		
5	APPROACH AND GEAR DOWN	RA <1000 FT AND G/S DEVIATION >1.3 DOTS		GLIDE SLOPE... AT 1/2 VOLUME, FREQ PROPORTIONAL TO DEVIATION AND GROUND PROXIMITY.			X
5	APPROACH AND GEAR DOWN	RA <300 FT AND G/S DEVIATION >2.0 DOTS		GLIDE SLOPE... AT FULL VOLUME, FREQ PROPORTIONAL TO G/S DEVIATION AND GROUND PROXIMITY.			X
6	PROGRAM PIN SELECTABLE			RADIO ALTITUDE CALLOUTS AS SELECTED BY PROGRAM PINS			
7	WINDSHEAR CONDITION			SIREN, THEN WINDSHEAR, WINDSHEAR, WINDSHEAR...	WINDSHEAR		
TA	60 SEC TO THREAT TERRAIN			CAUTION, TERRAIN..		TERRAIN	
TA	30 SEC TO THREAT TERRAIN			TERRAIN, TERRAIN, PULL UP..	PULL UP	TERRAIN	
TCF & RFCF	INITIAL PENETRATION OF TCF AND AFTER EACH 20% FURTHER RA LOSS			TOO LOW TERRAIN..		TERRAIN	
TCF & RFCF	WARNING			PULL UP...	PULL UP	TERRAIN	

MODE DESCRIPTION SUMMARY

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

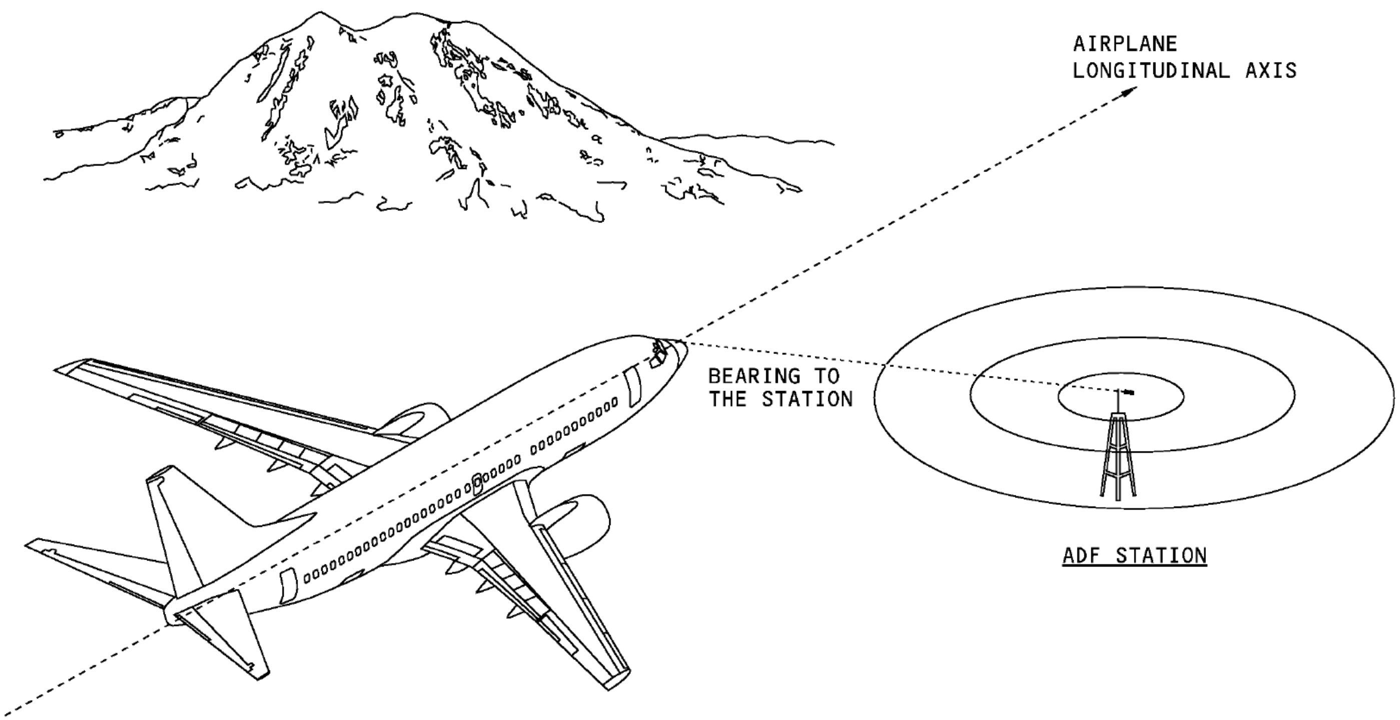
34–47. AUTOMATIC DIRECTION FINDER SYSTEM (ATA 34–57)

LEVEL 3

AUTOMATIC DIRECTION FINDER SYSTEM - INTRODUCTION

Purpose

The automatic direction finder (ADF) system is a navigation aid. The ADF receiver uses amplitude modulated (AM) signals from ground stations to calculate the bearing to the ADF station from the airplane longitudinal axis. The ADF system also receives standard AM radio broadcasts.



Abbreviations and Acronyms

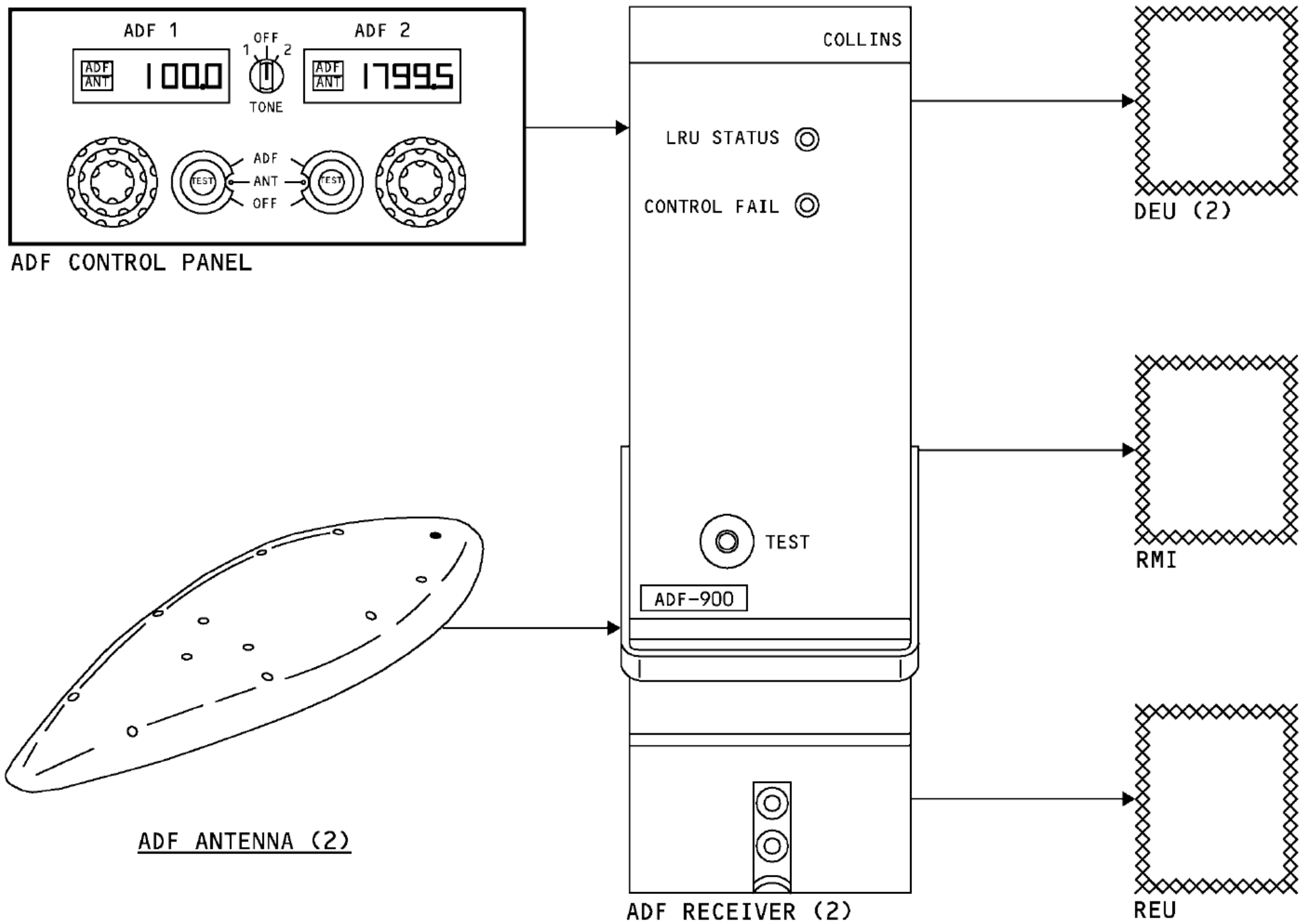
- AC - alternating current
- AM - amplitude modulated
- ACP - audio control panel
- ADF - automatic direction finder
- AM - amplitude modulation
- ant - antenna
- app - approach
- ARINC - Aeronautical Radio, Inc.
- BFO - beat frequency oscillator
- Capt - captain
- DC - direct current
- DEU - display electronics unit
- EFIS - electronic flight instrument system
- F/O - first officer
- gnd - ground
- Hz - hertz
- LCD - liquid crystal display
- LRU - line replaceable unit
- nav - navigation
- NCD - no computed data
- QEC - quadrantal error correction
- RBL - right buttock line
- RDMI - radio distance magnetic indicator
- RMI - radio magnetic indicator
- sta - station
- V - volts
- VOR - VHF omnidirectional ranging
- xmtr – transmitter

AUTOMATIC DIRECTION FINDER SYSTEM - INTRODUCTION

GENERAL DESCRIPTION

The ADF control panel supplies manual tune inputs to the ADF receivers. The ADF antenna assemblies contain the loop antennas and the sense antennas. There are two ADF antennas, one for ADF receiver 1 and one for ADF receiver 2.

The ADF receiver calculates the bearing to the ADF ground stations and sends it to the DEUs for display. The ADF bearing also goes to the radio magnetic indicator (RMI). The ADF receiver processes audio from the ground stations and sends it to the remote electronics unit (REU).



GENERAL DESCRIPTION

ADF SYSTEM - COMPONENTS LOCATION

Flight compartment

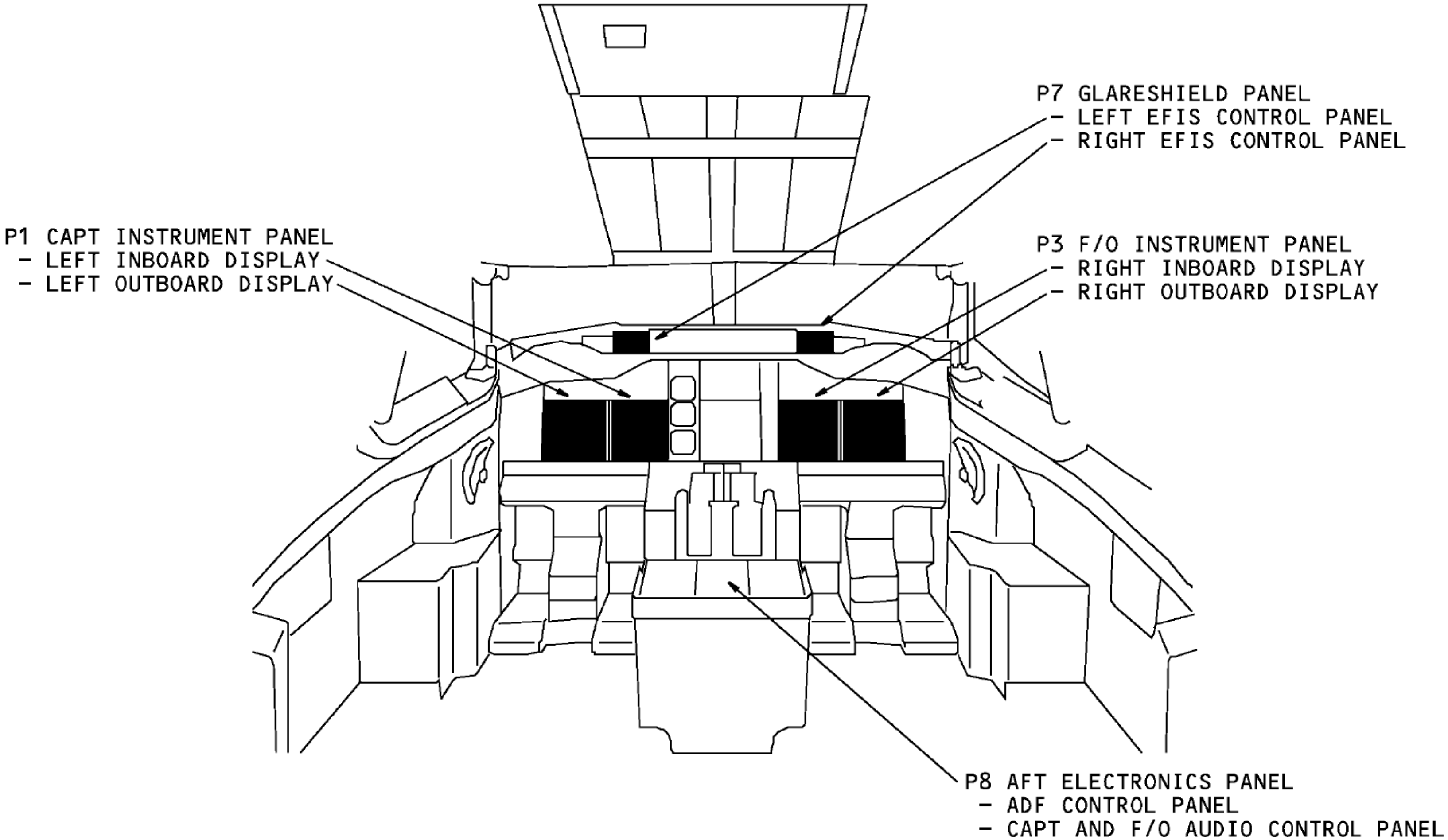
ADF System Components

The ADF control panel is on the P8 aft electronics panel.

Interface Components

These flight compartment components have an interface with the ADF system.

- Left and right EFIS control panels
- Left inboard and outboard display units
- Right inboard and outboard display units
- Capt and F/O audio control panels.



FLIGHT COMPARTMENT COMPONENTS LOCATION

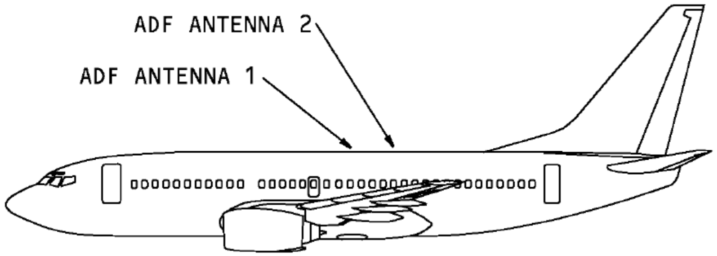
EE COMPARTMENT AND ANTENNA

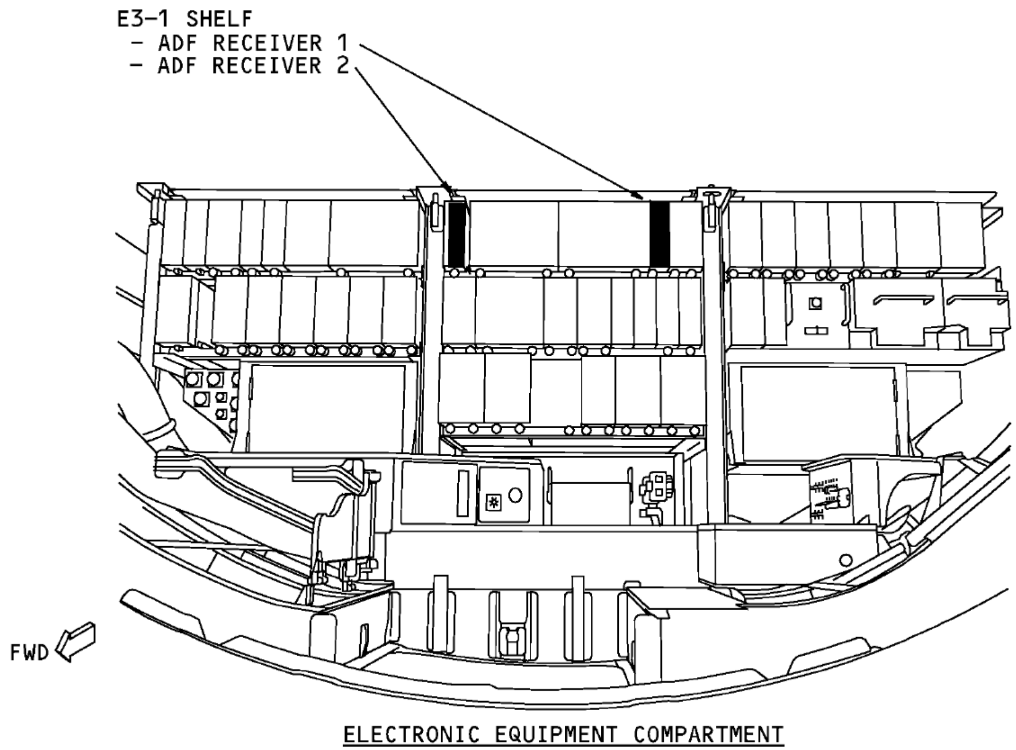
Electronic Equipment Compartment

ADF receiver 1 and ADF receiver 2 are in the electronic equipment compartment on the E3-1 shelf.

ADF Antenna

The ADF antennas are on the top of the fuselage. ADF antenna 1 is at fuselage station 694, and ADF antenna 2 is at fuselage station 727.





EE COMPARTMENT AND ANTENNA

ADF SYSTEM INTERFACES

POWER AND ANALOG

Power

115v ac power from the ADF circuit breakers go to the ADF control panel. The ADF control panel uses the 115v ac power for operation. The ADF control panel sends 115v ac power to the ADF receivers for operation. The ADF receivers send 12v dc power to the ADF antennas for operation.

PSEU

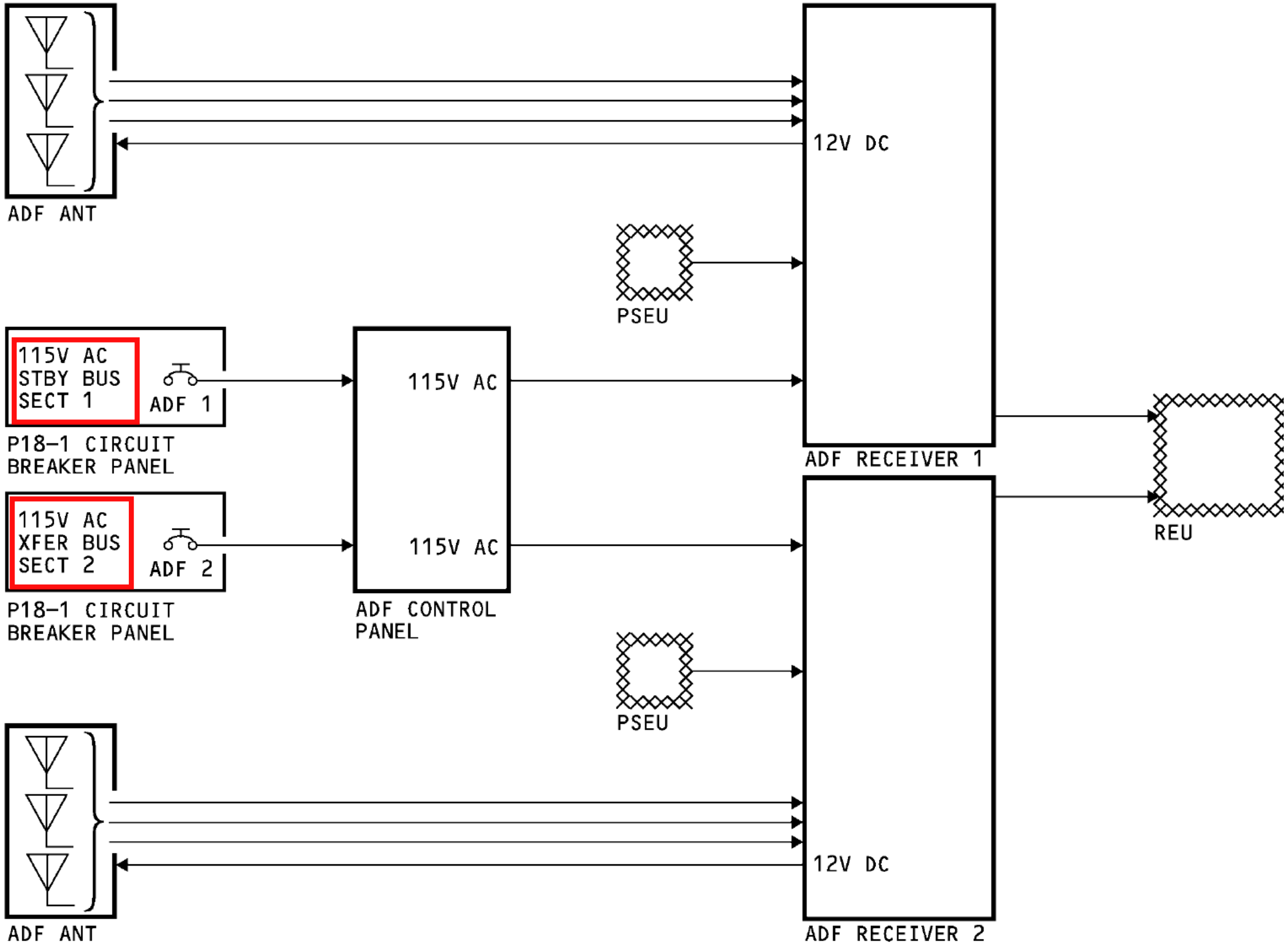
The proximity switch electronics unit (PSEU) supplies an air/ground discrete input to the ADF receiver. The ADF receiver uses the air/ground input to calculate the flight leg count for the internal memory.

ADF Antenna

The ADF antenna assembly contains the loop antennas and the sense antenna. The antenna assembly also contains signal amplifiers for the loop and the sense antenna. The loop antennas supply direction data and the sense antenna supplies station audio.

REU

The ADF receiver sends station audio to the remote electronics unit (REU). The REU sends the station audio to the flight compartment headsets and speakers.



POWER AND ANALOG INTERFACE

DIGITAL INTERFACE

The ADF receivers have an interface with the display electronics units (DEUs) and the radio magnetic indicator (RMI). The interface is on ARINC 429 data buses.

ADF Control Panel

The ADF control panel sends tune frequency inputs to the ADF receiver. The ADF control panel sends a data word that contains the ADF mode or ANT mode selection. The ADF control panel sets a bit that enables ADF receiver beat frequency oscillator (BFO) operation when you turn on the tone selector.

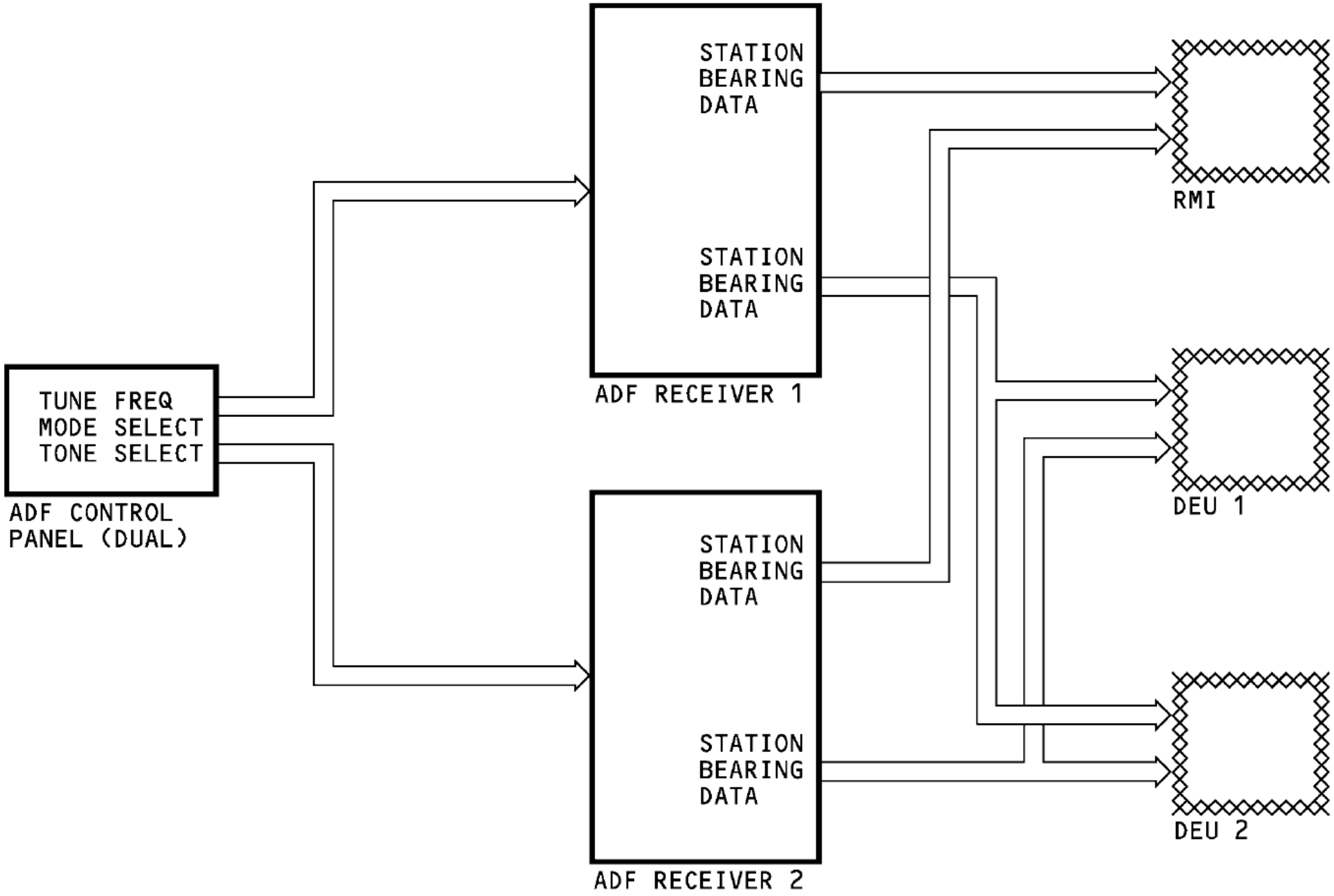
Digital Output

The ADF receiver sends this data on two output data buses:

- ADF station bearing
- Test signals
- Receiver condition.

Output data bus 1 from the ADF receiver goes to the radio magnetic indicator (RMI). The RMI uses the station bearing data to control the RMI bearing pointers.

Output data bus 2 goes to the DEUs for display.



DIGITAL INTERFACE

ADF SYSTEM –COMPONENTS

RECEIVER

Purpose

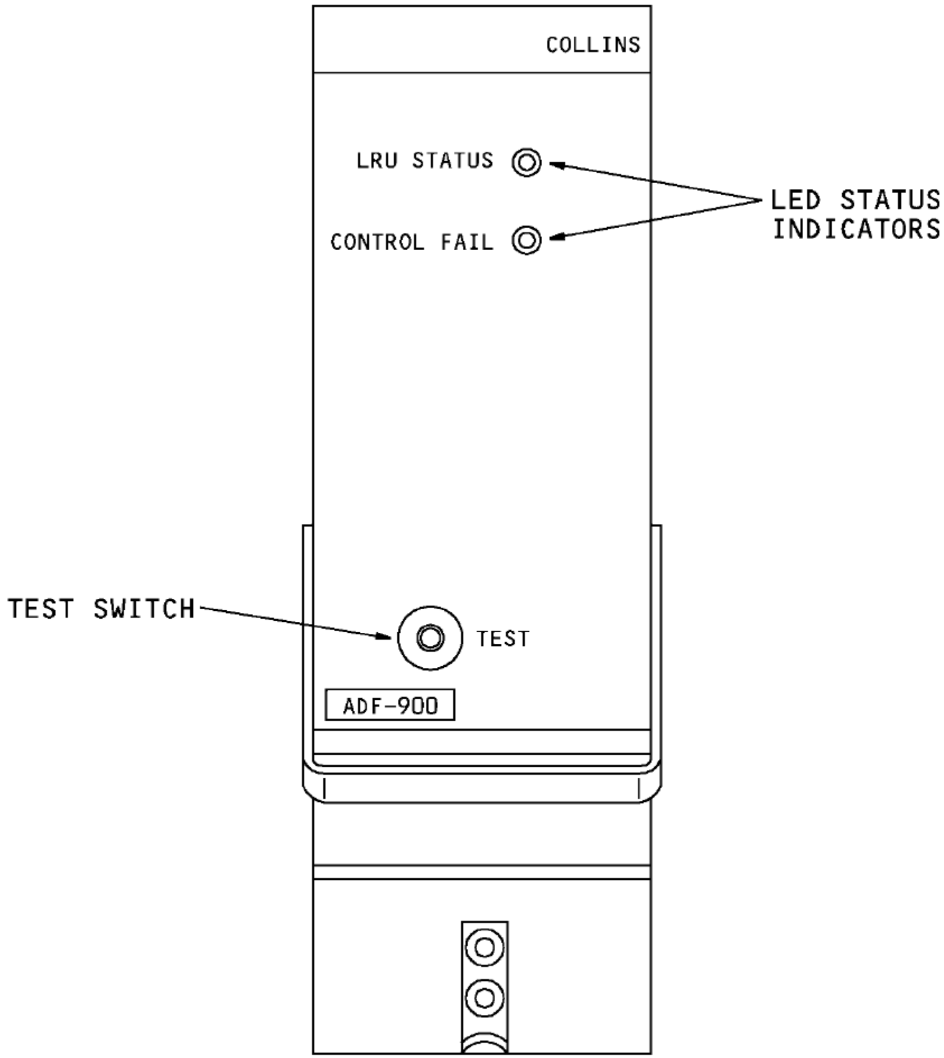
The ADF receiver calculates bearing to a station that transmits in the frequency range of 190 KHz to 1750 KHz. The receiver also receives station identifiers and AM broadcasts.

Description

The ADF receiver is a standard ARINC 600 3 MCU unit with dimensions approximately 3.7 in. x 7.9 in. x 14.8 in. The receiver weighs approximately 9 pounds and uses 115V ac 400 Hz power for operation. The receiver has a non- volatile flight fault memory. Only shop personnel can use this feature.

Test and Indication

There is a test switch on the front panel of the receiver. When you push the test switch, a self test of the receiver starts. At the end of the test, the status of the receiver and the control panel inputs show on the front panel LED status indicators.



ADF RECEIVER

ANTENNA

The ADF antenna receives electromagnetic signals from ground stations. The sense antenna receives the electrical part of the signal. The loop antenna receives the magnetic part of the ground station signal.

The antenna assembly is a one piece molded shell. The antenna attaches to the airplane with 12 bolts.

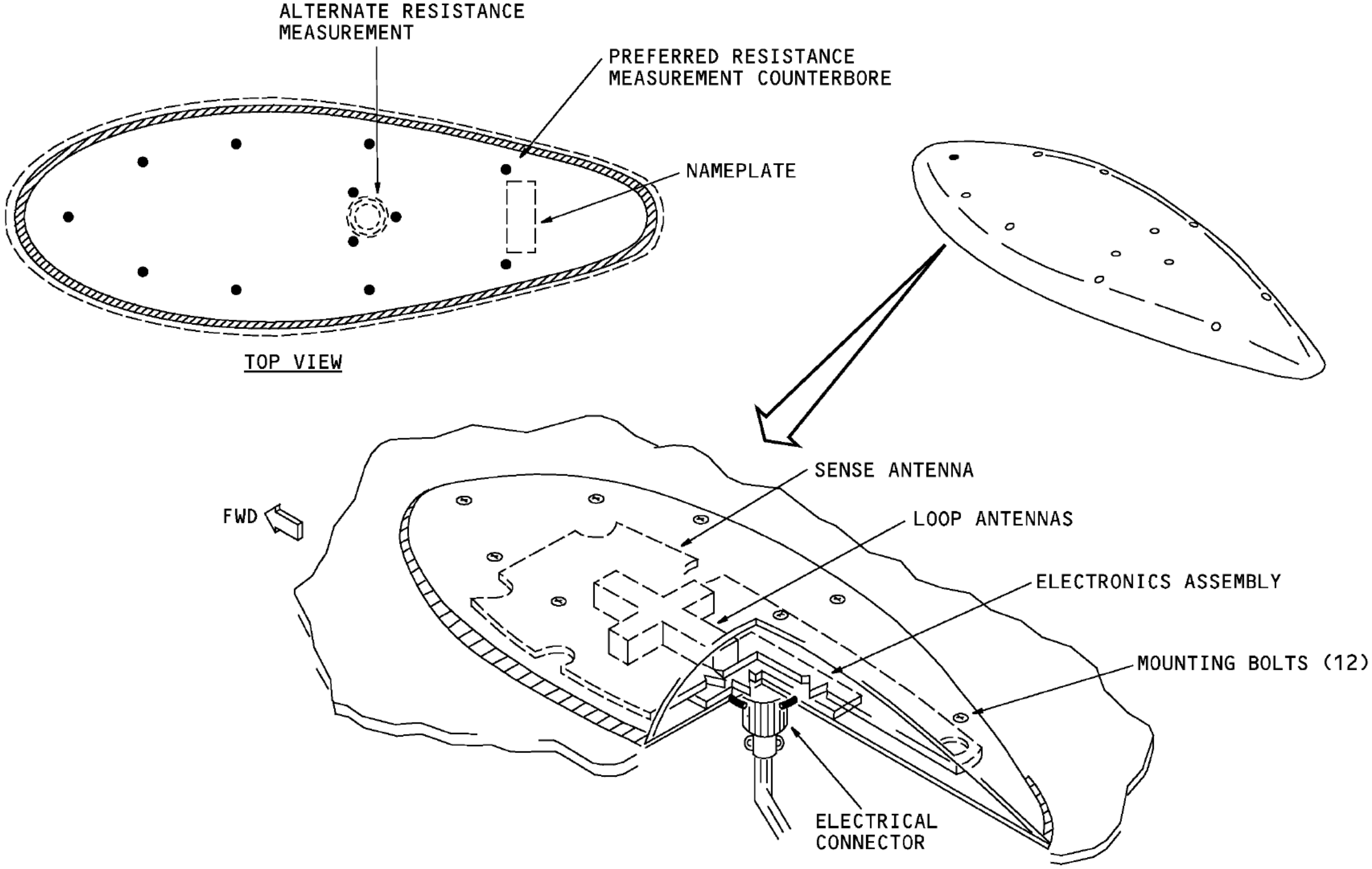
The antenna assembly contains these components:

- Loop antenna elements (2)
- Sense antenna (1)
- Electronics assembly.

The ADF antenna electronics assembly contains amplifiers for each of the antenna elements. The amplifiers receive 12v dc power from the ADF receiver.

The electrical connectors connect the antenna assembly to the ADF receiver.

The preferred resistance measurement point uses one of the mounting bolt holes counterbore. There is also an alternate resistance measurement point. The alternate measurement is done from the inside of the airplane.



ANTENNA

CONTROL PANEL

The ADF control panel supplies tune frequencies and system mode selection to the ADF receiver.

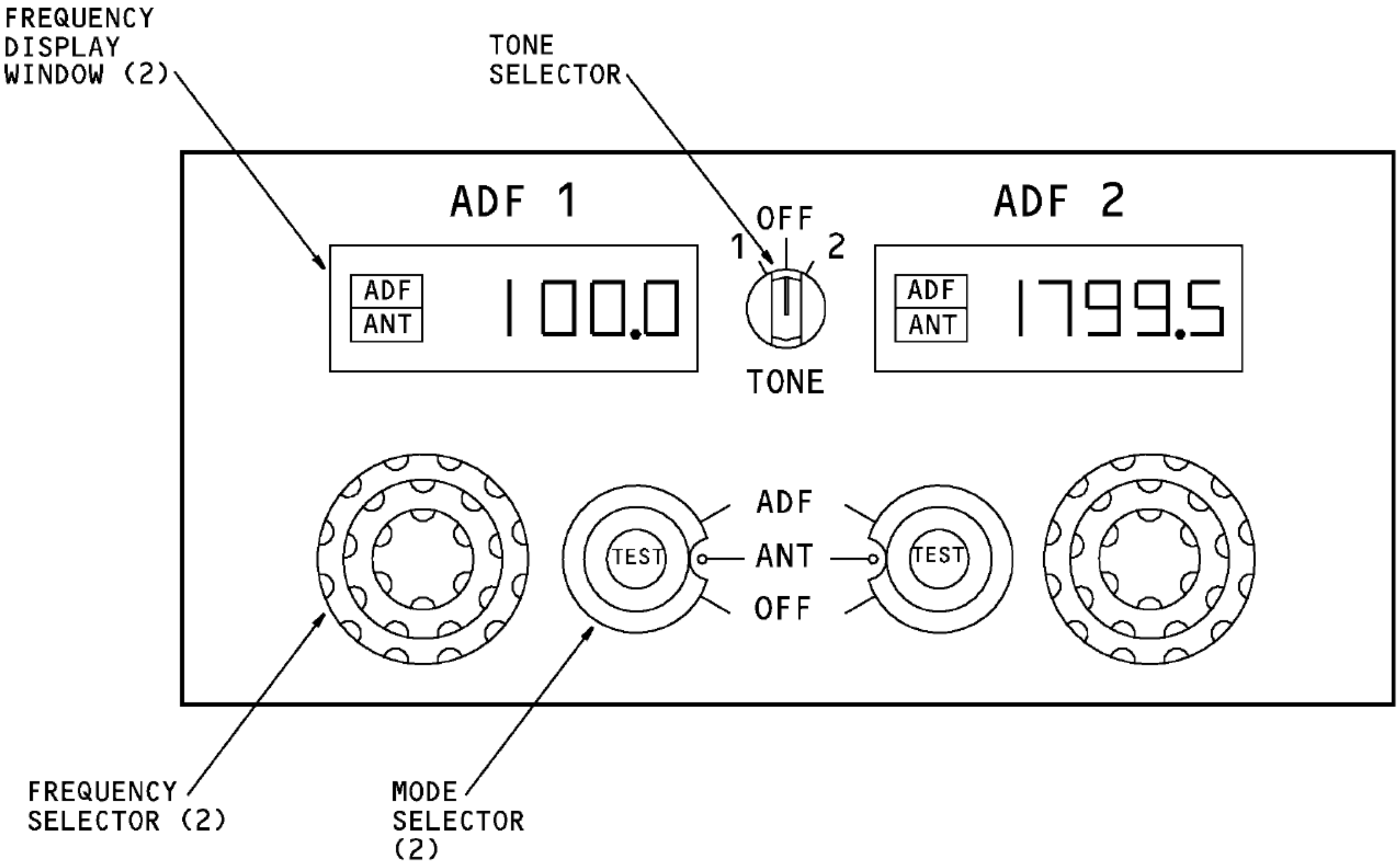
There are two frequency display windows. the windows show the frequency that you set with the frequency selectors. There are indicators in the display windows that show if the system is in the ADF mode or the antenna (ANT) mode.

The tone selector turns on the beat frequency oscillator (BFO) in the ADF receiver. There are some ADF stations that turn their transmitters on and off to transmit their Morse code station identifier. To process this type of signal, the receiver must be in the BFO mode. The selector has three positions, a position for receiver 1, receiver 2, and off.

There are two frequency selectors. Each frequency selector sets the frequency for the display window that is directly above it. The selectors each have three controls. There is an outer, middle, and inner control. The inner control sets the tenths and ones numbers. The middle control sets the tens number. The outer control sets the hundreds number.

The mode selector selects the ADF or ANT modes. In the ADF position, the receiver sends bearing data and station audio. In the ANT mode, the receiver sends only station audio.

The test switches are on the top of the ADF mode selectors. Momentarily push the push button to start a system self test.



CONTROL PANEL

THIS PAGE IS INTENTIONALLY LEFT BLANK

ADF SYSTEM - FUNCTIONAL DESCRIPTION

Antenna Inputs

The loop antenna contains two identical antenna loops (sine and cosine) that are mechanically displaced ninety degrees from each other and share a common ferrite core. The sense antenna and loop antenna sine and cosine outputs are coupled through an L- band filter and static protection circuit. The signals then go to separate but identical low noise, wide dynamic range FET input amplifiers. The antenna outputs go to the antenna modulators in the ADF receiver.

ADF Control Panel Inputs

The ADF receiver system processor receives manual tune inputs and control panel mode selections from the ADF control panel on an ARINC 429 data bus.

PSEU

The proximity switch electronics unit (PSEU) sends an air ground discrete to the system processor. The discrete sets the flight leg count for the fault memory.

Program Pin Inputs

The ADF receivers get program pin discretes from a dip switch. The bearing computer circuit uses quadrantal error correction (QEC) program pin inputs to adjust for the signal distortion caused by the airplane structure.

A discrete identifies the antenna location as a top mounted antenna.

Receiver Operation

The ADF receiver contains two major assemblies, the A4 receiver assembly and the A2 instrument assembly.

The A4 receiver assembly contains the antenna modulators, tuner section, and synthesizer.

The modulator receives the input signals from the antenna assembly. The loop antenna inputs are modulated with a 95 Hz sine and cosine reference signal produced by the system processor. The modulated loop antenna signals are then summed with the sense antenna input. This composite signal then goes to a preselector filter in the tuner section.

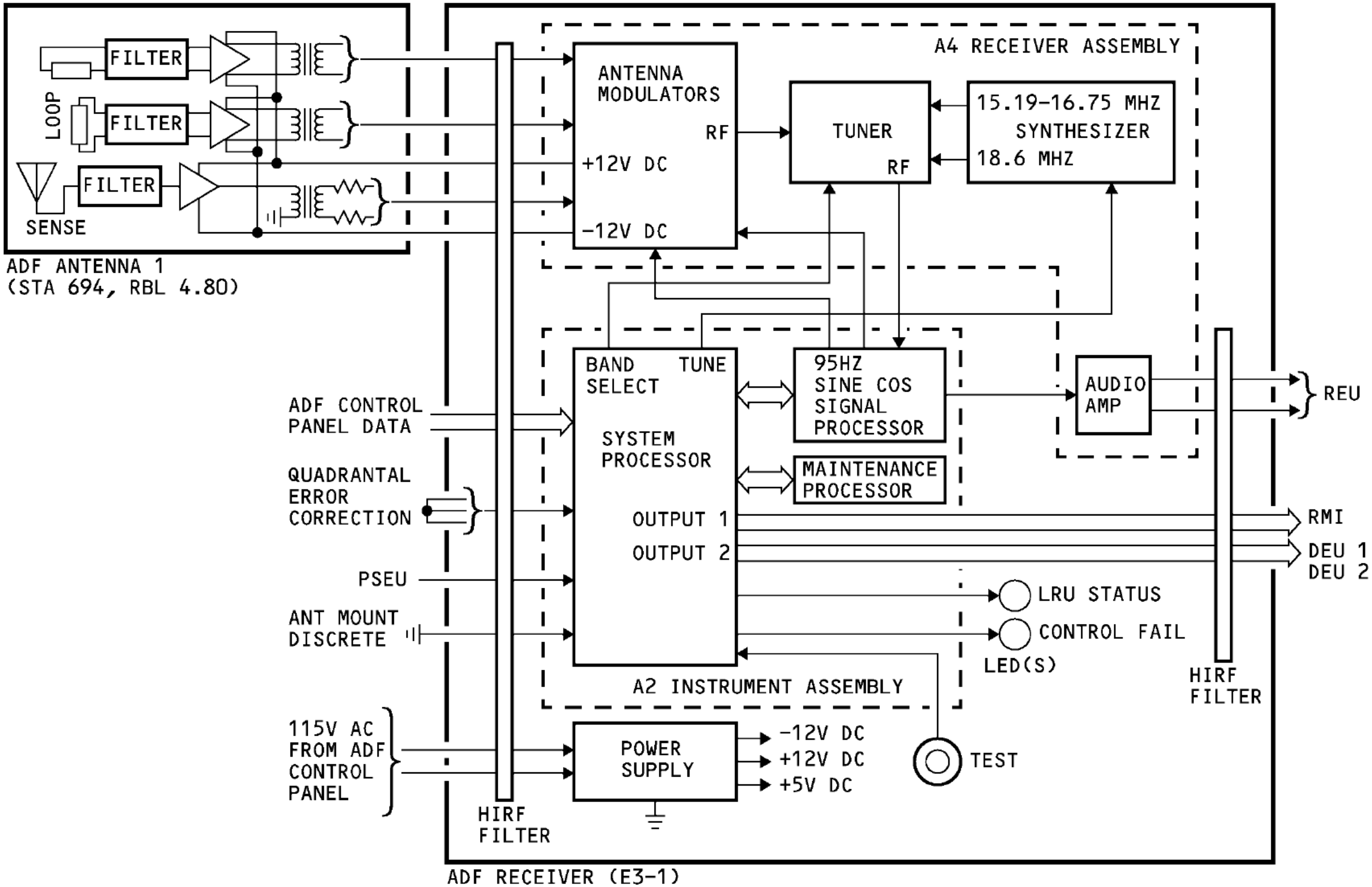
The tuner section basically contains the receiver that processes the antenna inputs. The receiver tunes the frequency range of 190 to 1799 kHz. The tuner section receives the input signals from the antenna modulators and first sends it through a preselector filter. This preselector filter is made of six diode switched bandpass filters that are tuned to a specific portion of the ADF signal band. The filter is tuned by the system processor based on ADF control panel tune selections. From the preselector the signals are mixed with 15.19 through 16.75 MHz signal and an 18.6 MHz signal from the synthesizer. The signals are also filtered through a 15 MHz and 3.6 MHz to produce an intermediate frequency that can be processed by the ADF receiver.

The synthesizer uses binary tune data from the system processor to produce the injection frequencies to the mixers in the tuner section.

The A2 assembly contains the system processor, signal processor, and the maintenance processor.

The system processor provides these functions:

- Format ADF bearing from the signal processor into an ARINC 429 bearing word
- Provide frequency tuning for the tuner section
- Perform functional test and power up tests
- Provide test results to the maintenance processor
- Transmit equipment identification and frequency data.
- Transmit station identification word and maintenance related words from the maintenance processor
- Store calibration constants in nonvolatile memory.



FUNCTIONAL DIAGRAM

FUNCTIONAL DESCRIPTION
(Continue)

The signal processor provides these functions:

- Generate sine and cosine modulation to the ADF loop antenna modulators
- Receive analog data from tuner section
- Compute relative bearing to the station
- Detect 1020 Hz and 400 Hz identifier tones
- Provide audio output.

The maintenance processor provides these functions:

- Receives data from the maintenance bus inputs, stores time, date, and aircraft configuration and processes the maintenance control word.
- Store data from system processor in NVM.
- Determines validity of input maintenance word
- Formats fault summary word and sends it to the system processor
- Transfers all CMC interactive and normal mode data to system processor
- Provide maintenance menus in the airplane when requested by the CMC
- Provide extended interactive mode support for troubleshooting data when LRU is removed from the airplane
- Monitor and decode the Morse code station identification data from the signal processor
- Format the station ident word
- Format the LRU ident message.

The signal processor receives the conditioned analog data from the tuner section and compares the signal to a 95 Hz reference signal to compute the station bearing and station identification and sends it to the system processor. The signal processor also sends audio and station identifier tones to the audio amp in the A4 receiver assembly that sends it to the REU.

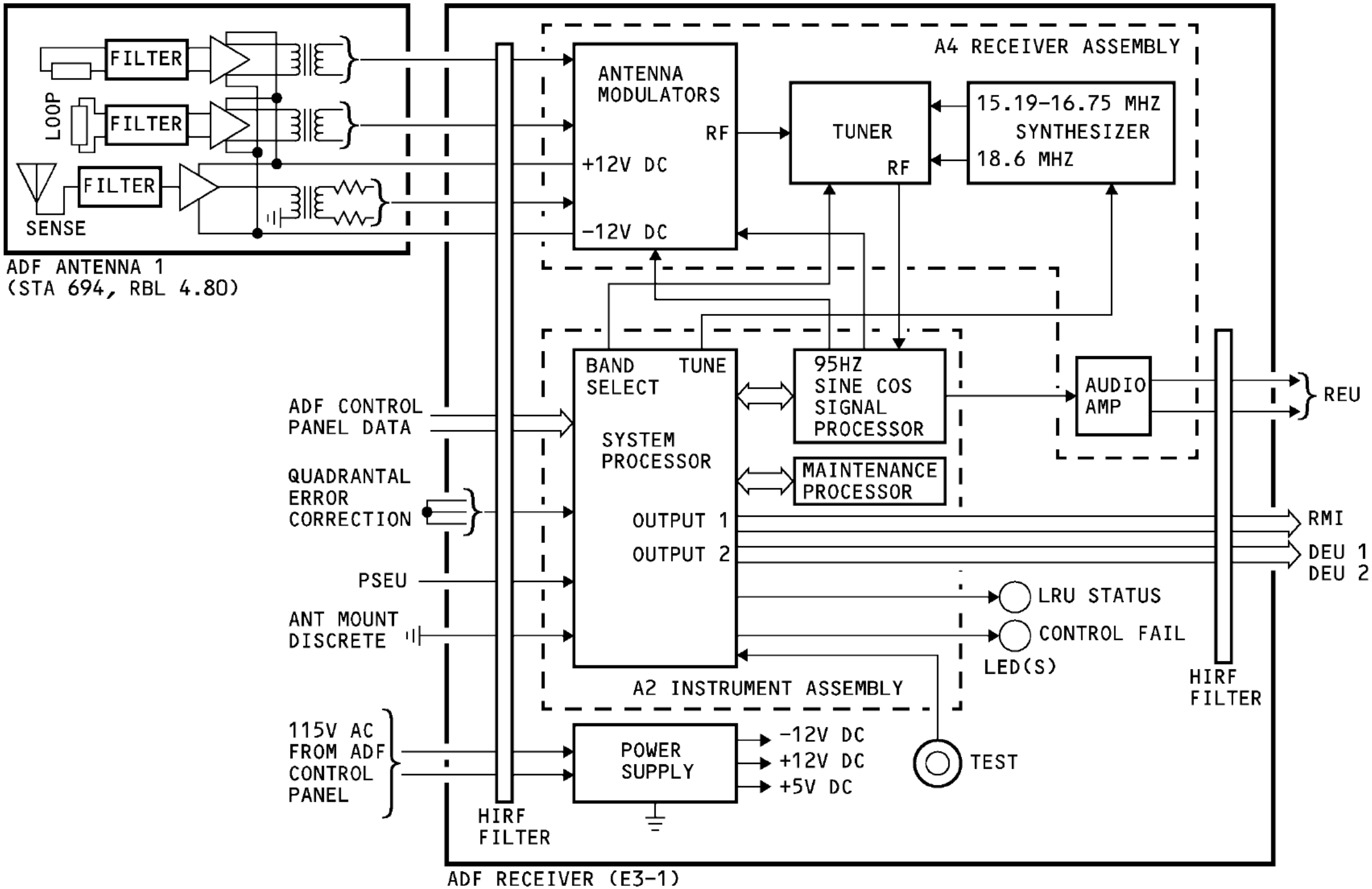
The system processor receives all data bus and discrete inputs that come into the ADF receiver. The processor uses ADF control panel tune data to tune the antenna modulators and synthesizer. It sends the QEC program pin configuration to the signal processor to compensate for QEC. It also processes the air/ground and antenna mount discrete for memory. The signal processor receives the bearing computation and detected ident codes from the signal processor, formats the bearing data word, and sends the data out on two data buses. Output 1 goes to the RMI and output 2 goes to the DEUs.

Power

The ADF receiver power supply receives 115v ac, 400 Hz power from the ADF control panel. The power supply provides -12v dc, +12v dc, and +5v dc for internal use. The modulators send the 12v dc power outputs to the ADF antenna for operation.

Test

When you push the test switch on the ADF receiver front panel, the system processor starts a test of internal functions and checks the ADF control panel data word input. The antenna modulator removes power to the antenna assembly amplifiers. This causes no RF signal inputs to the antenna modulators. A test RF signal replaces the antenna RF input and the receiver sends the signal through its internal circuits. Test results show on the front panel LED status indicators.



FUNCTIONAL DIAGRAM

CONTROLS

EFIS Control Panel

The ADF bearing data can show on the NAV display in the VOR or APP display modes. You use the mode selector on the EFIS control panel to select the display mode for the NAV displays.

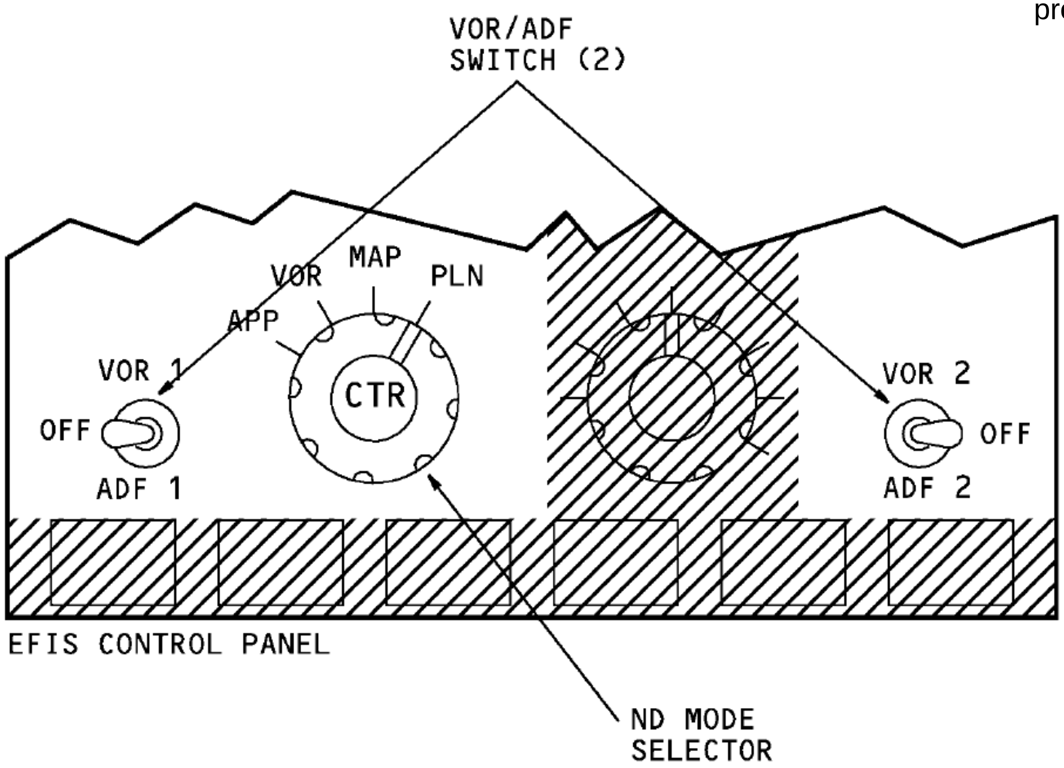
The VOR/ADF switches select the VOR system or the ADF system as the source of bearing data for the RDMI bearing pointers. To show ADF bearing, set the VOR/ADF switches to the ADF position.

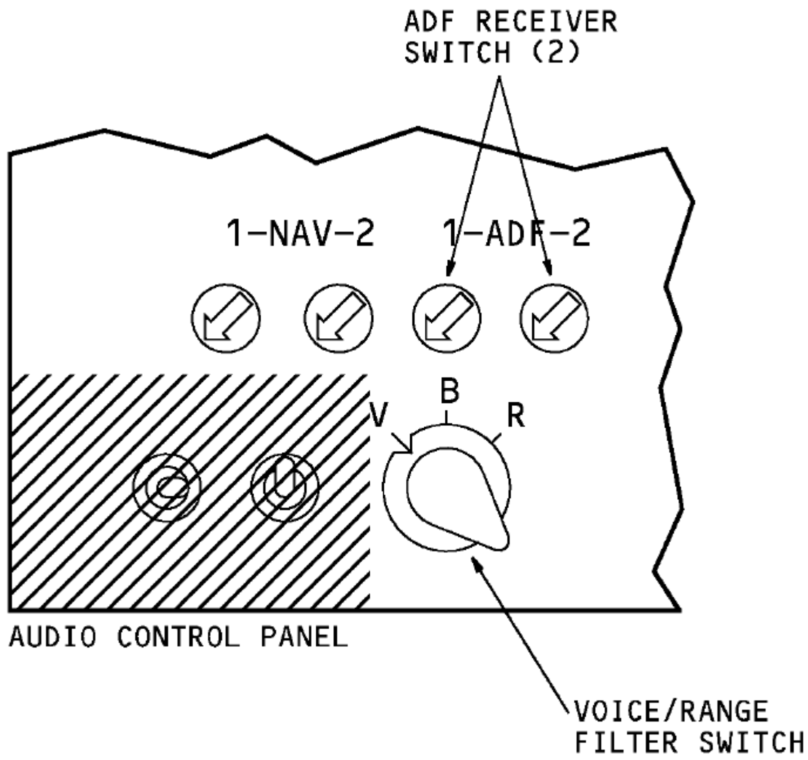
Audio Control Panel Controls

The audio control panels (ACP) let the crew listen to ADF station audio or the Morse code station identifier. You use the ACP ADF receiver switches to listen to ADF receiver audio.

The voice/range selector permits you to listen to only voice audio in the voice (V) position. The range (R) position permits you to listen to the station Morse code identifier. With the selector in the both (B) position, you can listen to both the voice audio and the Morse code station identifier.

Navigation aid stations transmit their Morse code identifier signals on a typical 1020 Hz signal. There are some ADF stations that transmit their Morse code identifier on a 400 Hz signal. The voice/range selector has no effect on these stations, the station Morse code identifier will always be present.





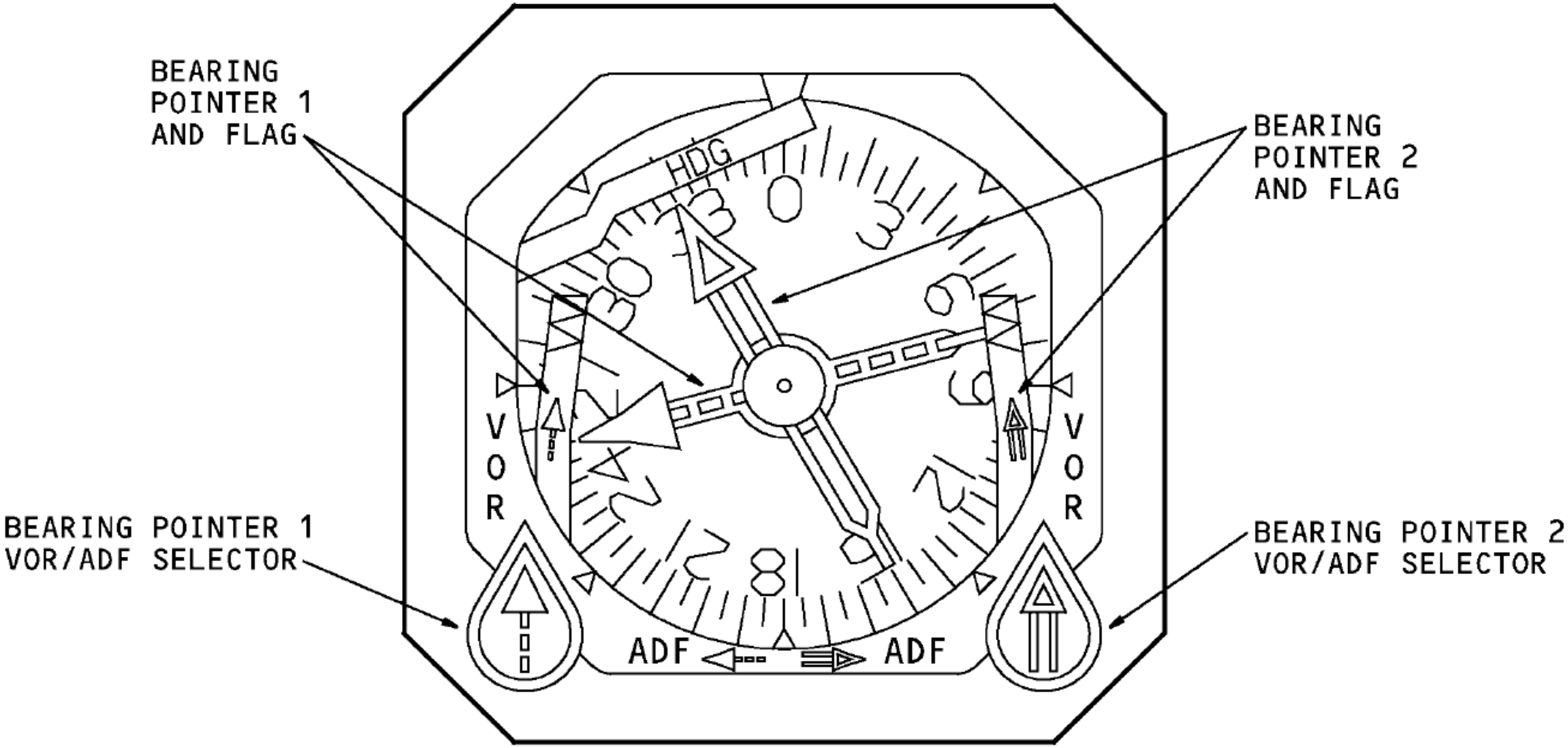
CONTROLS

ADF SYSTEM DISPLAYS

RADIO MAGNETIC INDICATOR

The radio magnetic indicator (RMI) shows bearing to a VOR or ADF station relative to the airplane magnetic heading.

The RMI has two bearing pointers. The bearing pointers can show ADF or VOR data. You use the selectors on the front of the RMI to select between VOR or ADF as the source of data. The RMI has two amber flags, one for each bearing pointer. The flags come into view if the selected data source inputs fail.



ADF DISPLAY - RADIO MAGNETIC INDICATOR

EFIS NAVIGATION DISPLAY

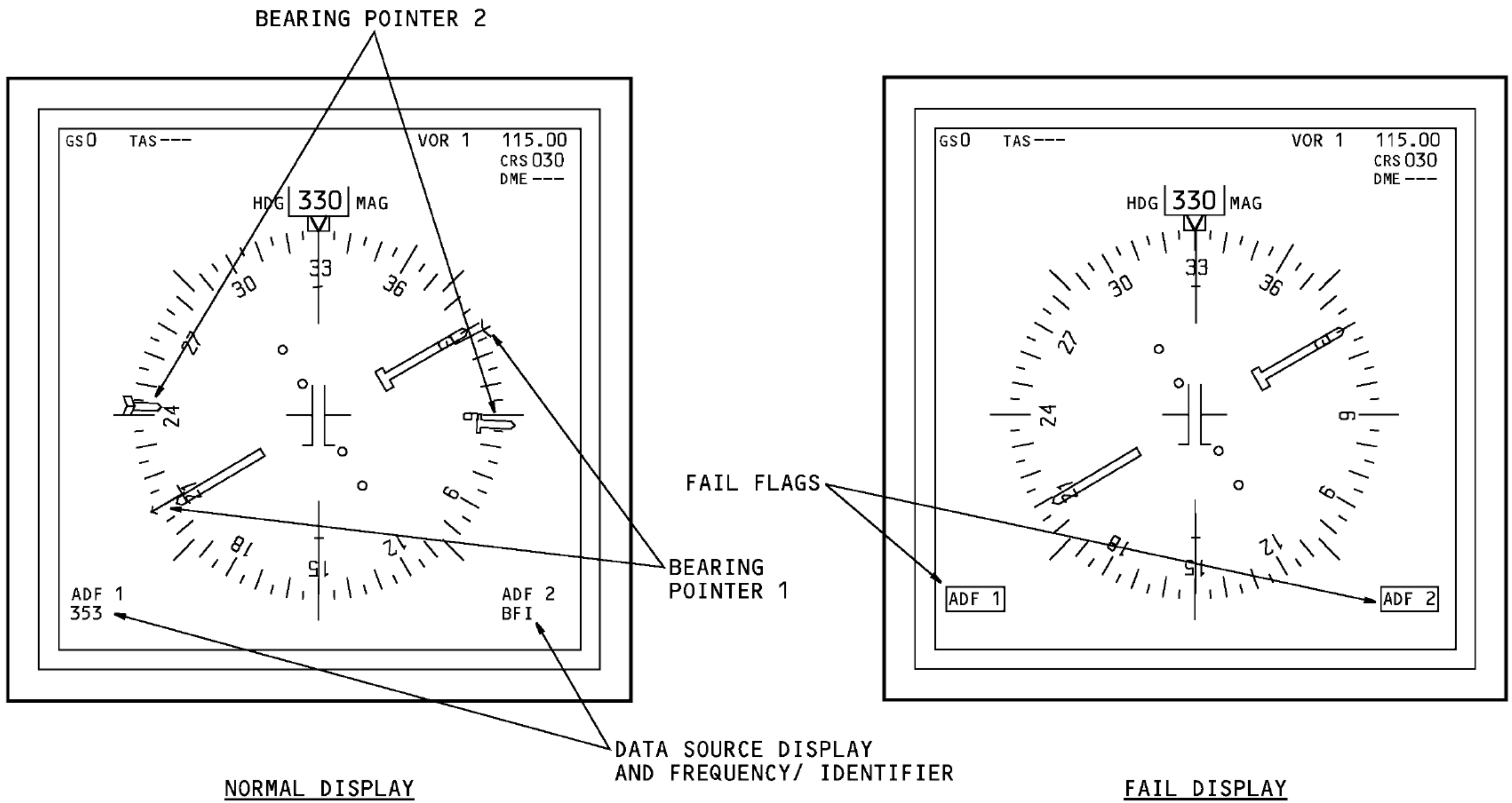
The ADF data shows on the captain and first officer NAV displays in the VOR or APP modes. The bearing pointers show in cyan around the compass rose. To show ADF bearing, set the EFIS control panel mode selector to the VOR or APP display modes. The DEUs remove the bearing pointers when the receiver data goes to an NCD condition.

The ADF data shows on the captain and first officer NAV displays in the VOR, APP, and MAP modes. The bearing pointers show in cyan around the compass rose. To show ADF bearing, set the EFIS control panel mode selector to the VOR, APP, or MAP display modes. The DEUs remove the bearing pointers when the receiver data goes to an NCD condition.

The bearing pointers show in the expanded and centered displays. The bearing pointers show on the expanded displays if the ADF bearing is in the compass rose display limit. This graphic shows the displays in the centered NAV display mode.

Invalid Display

The amber ADF fail flags show in the upper corners of the NAV displays when there is a failure of the ADF receivers. The ADF flags show in the same location for the expanded NAV display.



ADF DISPLAY – EFIS NAV DISPLAY

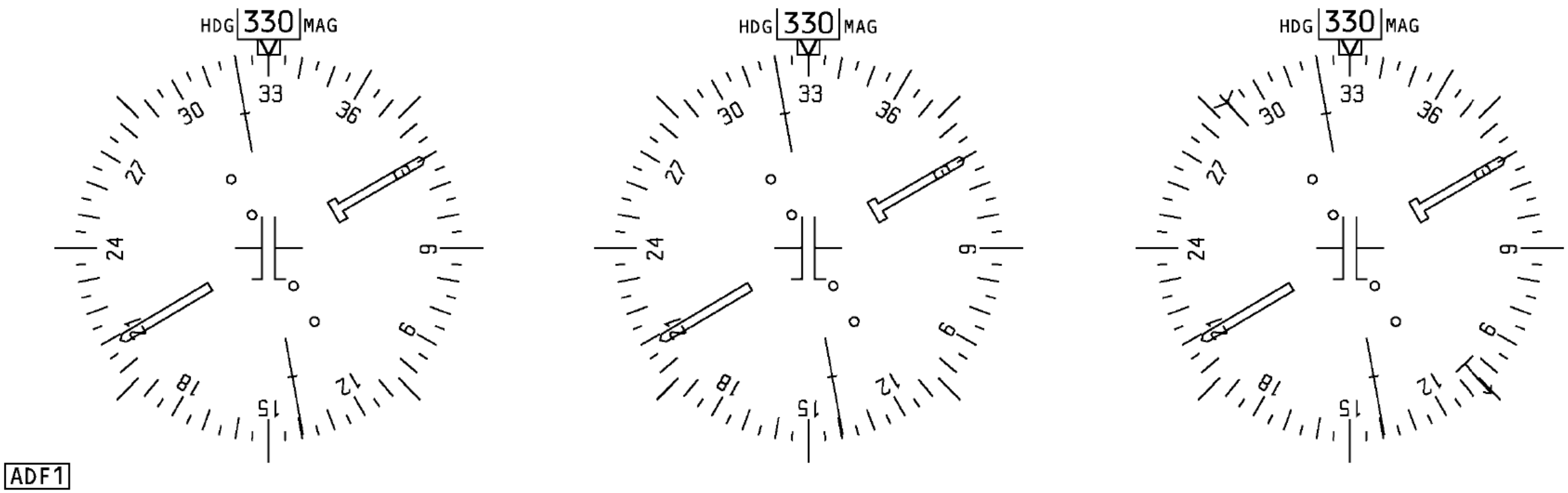
ADF SYSTEM - SELF-TEST

To see the ADF test sequence:

- select VOR or APP on the EFIS control panel mode selector.
- push the test switch on the ADF control panel mode selector knob.

Note: The graphic shows a test of ADF receiver 1. For a dual system, the test is the same for ADF receiver 2.

- **0 to 2 seconds** - the receiver output goes to a fail condition. The pointer goes out of view and the amber ADF flag shows momentarily.
- **2 to 4 seconds** - the receiver output goes to an NCD condition. During this time, the amber ADF flag goes out of view and the pointer stays out of view.
- **4 till end** - the test display shows and the pointer goes to a test position of 135 degrees from the heading lubber line until the end of test.



0 TO 2 SECONDS:

THE RECEIVER OUTPUT GOES TO A FAIL CONDITION. THE ADF DATA GOES OUT OF VIEW. THE AMBER ADF FLAG SHOWS MOMENTARILY.

2 TO 4 SECONDS:

THE RECEIVER OUTPUT GOES TO NO COMPUTED DATA (NCD) AND THE FLAG GOES OUT OF VIEW. THE ADF POINTERS STAY OUT OF VIEW.

FROM 4 SECONDS TO END OF TEST:

THE POINTERS GO TO THE TEST POSITION (APPROX. 135 DEGREES FROM THE HEADING LUBBER LINE).

ADF SYSTEM - SELF TEST

BITE

Test

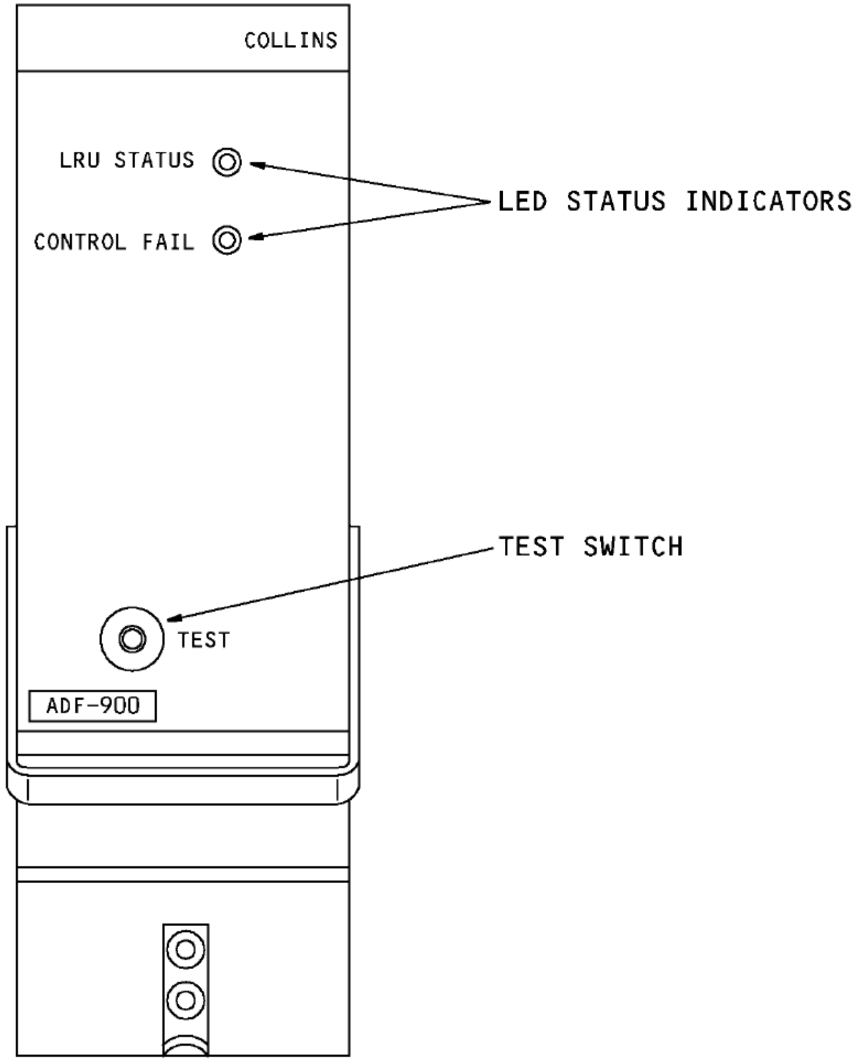
Push the test switch on the front of the ADF receiver to start the test. The test results show on the LED status indicators on the front of the receiver.

When you push the test switch, the receiver does a check of the internal receiver operation and the interface with the ADF control panel. The self test lasts 30 seconds.

This is the test sequence that shows on the LED status indicators:

- **0 to 2 seconds** - the LRU status and control fail LEDS come on red
- **2 to 4 seconds** - the LRU status LED changes to green and the control fail LED remains red
- **4 to 12 seconds** - the LRU status and control fail LEDs go off
- **12 to 42 seconds** - the test results show on the LED status indicators.

For test results, the LRU status LED comes on green if there are no LRU faults or red if any faults occur. The control fail LED stays off if the ADF control panel input signal is valid or comes on red if there is no input from the ADF control panel or if the input signal is invalid.



ADF SYSTEM BITE

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34-50 NAVIGATION (ATA 34)

LEVEL 3

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34 – 53. AIR TRAFFIC CONTROL SYSTEM (ATA 34–53)

LEVEL 3

AIR TRAFFIC CONTROL SYSTEM - INTRODUCTION

General

The air traffic control (ATC) ground stations interrogate the airborne ATC system. The ATC transponder replies to the interrogations in the form of coded information that the ground station uses.

The ATC transponder also replies to mode S interrogations from the traffic alert and collision avoidance systems (TCAS) of other airplanes or ground stations.

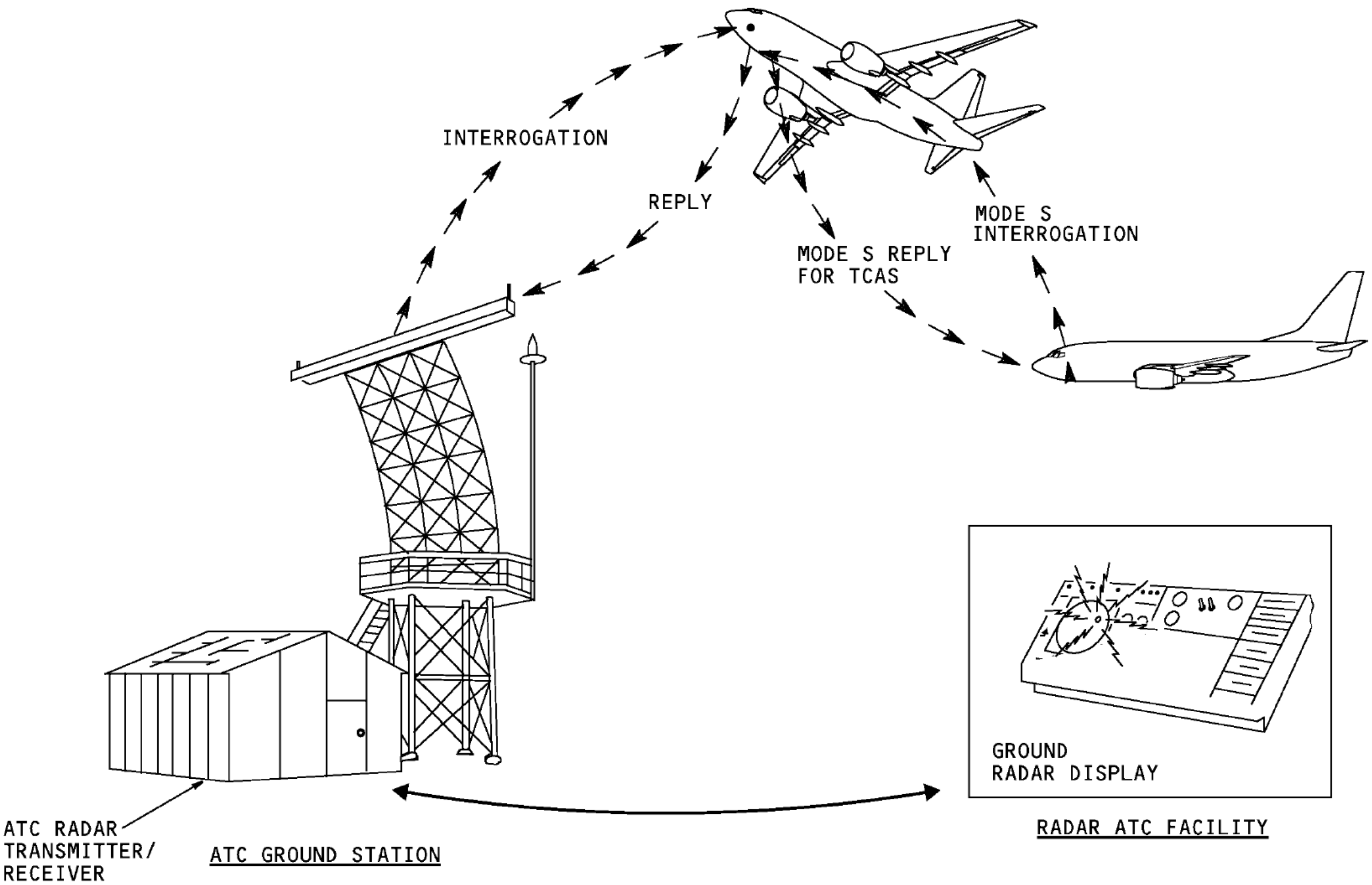
When a ground station or a TCAS computer from another airplane interrogates the ATC system, the transponder transmits a pulse-coded reply signal.

The reply signal identifies and shows the altitude of the airplane.

- Maximum airspeed
- TCAS coordinating signals
- TCAS status
- Altitude
- Mode A identity code
- Twenty-four bit address.

Abbreviations and Acronyms

- abs - absolute
- abv - above
- ADIRU - air data inertial reference unit
- AD - air data
- ADR - air data reference
- alt - altitude
- amp - amplifier
- ant - antenna
- ATC - air traffic control
- ATCRBS - air traffic control radar beacon system
- BITE - built-in test equipment
- blw - below
- bot - bottom
- coax - coaxial
- CPU - central processing unit
- DME - distance measuring equipment
- ELEX - electrical
- FL - flight level
- ID - identification
- I/O - input/output
- ident - identification
- INS - instrument
- INT - interrogator
- LED - light emitting diode
- PSR - primary surveillance radar
- RA - resolution advisory
- REL - relative
- RF - radio frequency
- rptg - reporting
- RX - receive
- SDI - source destination identifier
- SLS - side lobe suppression
- SSR - secondary surveillance radar
- SPI - special purpose identification
- stby - standby
- sw - switch
- TA - traffic advisory
- TAS - true air speed
- TCAS - traffic alert and collision avoidance system
- tpr - transponder
- TX - transmit
- XFR - transfer
- xmtr - transmitter
- xpdr - transponder
- xpndr - transponder



AIR TRAFFIC CONTROL SYSTEM - INTRODUCTION

GENERAL DESCRIPTION

General Description

These are the components of the ATC system:

- Top antenna
- Bottom antenna
- ATC coaxial switch (2)
- ATC/TCAS control panel
- ATC transponder (2).

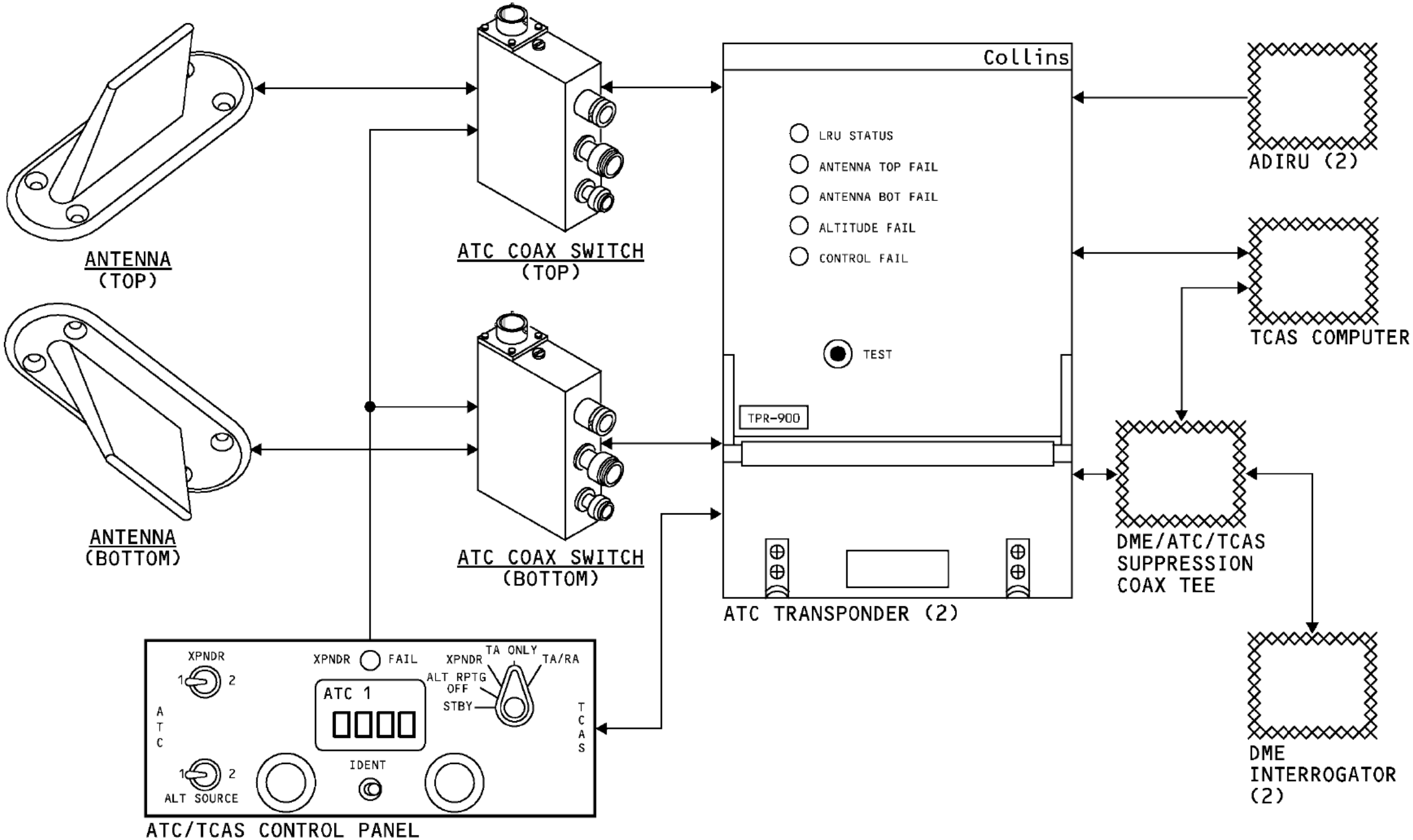
The two antennas transmit signals from the ATC transponder and send received signals to the ATC transponder. These signals go through the ATC coax switches.

The ATC/TCAS control panel sends identification and control data to the transponders. The ATC/TCAS control panel also allows selection of either transponder 1 or transponder 2.

The air data inertial reference units (ADIRUs) supply barometric altitude data to the ATC transponders.

The ATC transponders interface with the TCAS system.

The ATC transponders send and receive suppression pulses through the suppression coax tees. This prevents ATC transmissions from interfering with the DME and TCAS system operations.



GENERAL DESCRIPTION

ATC SYSTEM - COMPONENTS LOCATION

Flight Compartment

The ATC/TCAS control panel is on the P8 aft electronics panel.

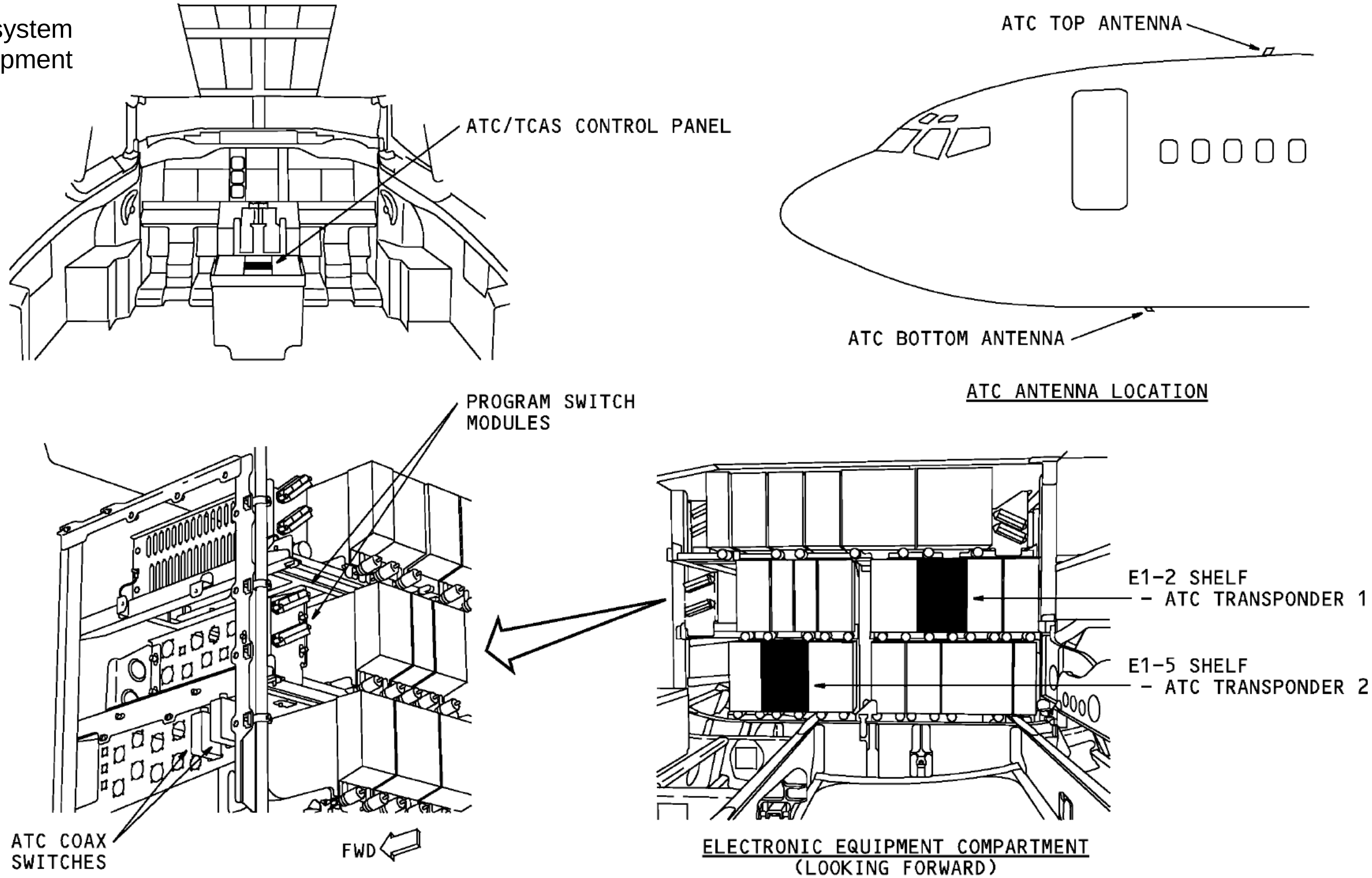
Electronic Equipment Compartment

These are the ATC transponder system components in the electronic equipment compartment:

- ATC transponder 1
- ATC transponder 2
- Program switch module (2)
- Top ATC coax switch
- Bottom ATC coax switch.

ATC Antenna Location

The ATC antennas are on the forward fuselage near the centerline. The top ATC antenna is at STA 430.25. The bottom ATC antenna is at STA 355.

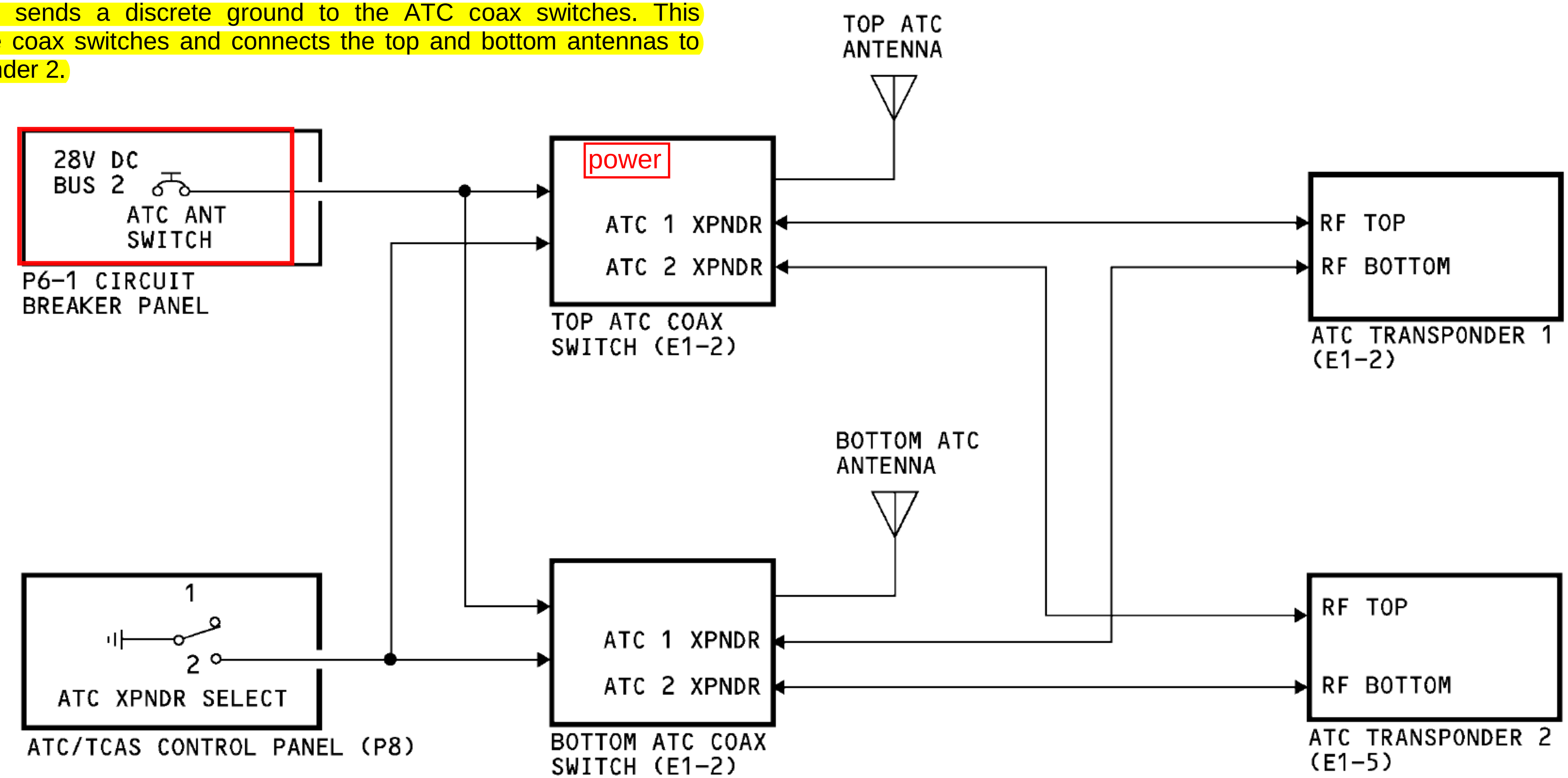


COMPONENTS LOCATION

ATC SYSTEM - INTERFACES

ANTENNA INTERFACE

The ATC coax switches get power through the ATC ANT SWITCH circuit breaker. When you select ATC transponder 1 on the ATC/TCAS control panel, the ATC coax switches do not energize and the antennas connect to ATC transponder 1. When you select ATC transponder 2, the ATC/TCAS control panel sends a discrete ground to the ATC coax switches. This energizes the coax switches and connects the top and bottom antennas to ATC transponder 2.



ANTENNA INTERFACE

POWER, IDENTITY, CONTROL, AND AIR DATA INTERFACES

Power

ATC transponder 1 gets 115v ac power from standby bus 1. ATC transponder 2 gets 115v ac power from transfer (xfr) bus 2. The ATC/TCAS control panel gets 115v ac power from both standby bus 1 and xfr bus 2.

Standby/On Discrete

The ATC/TCAS control panel sends a ground standby discrete to the transponder that is not in use.

Identity Code

The flight crew sets the four digit identity code and it shows on the ATC/TCAS control panel. Both transponders get the identity code from the ATC/TCAS control panel.

Control Data

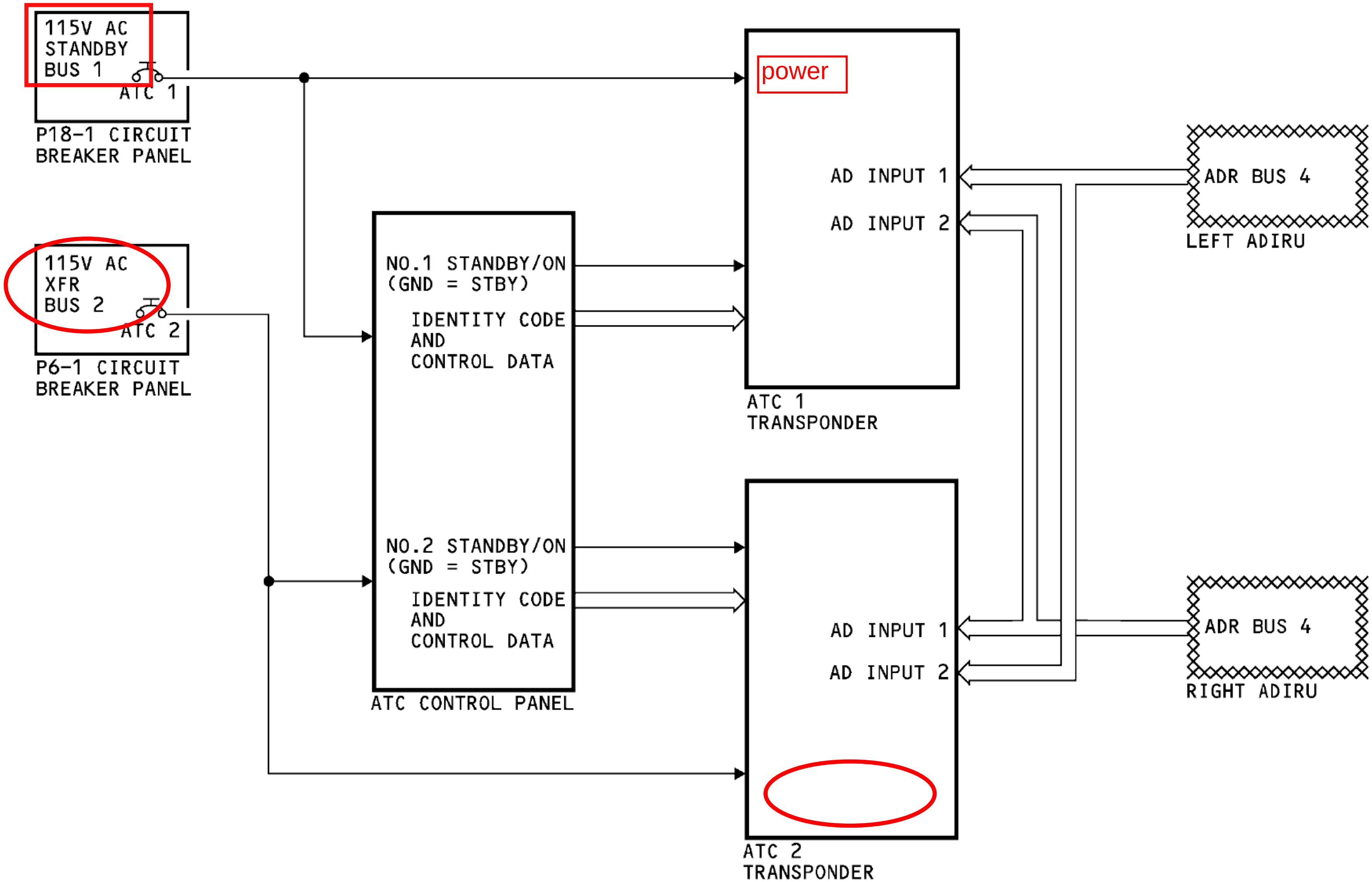
The ATC/TCAS control panel also sends control data to the transponders.

This control data does these functions:

- Permits mode C and mode S operation.
- Lets the transponder send the special position identification (SPI) pulse or airplane identification code.

Air Data

The air data inertial reference units (ADIRU) send air data to the ATC transponders.
ATC transponder 1 gets air data at AD input 1 from the left ADIRU air data reference (ADR) bus 4. The left ADIRU also supplies air data to the ATC 2 transponder from ADR bus 4.
ATC transponder 2 gets air data at AD input 1 from the right ADIRU air data reference (ADR) bus 4. The right ADIRU also supplies air data to the ATC 1 transponder from ADR bus 4.



POWER, IDENTITY, CONTROL, AND AIR DATA INTERFACES

MAINTENANCE INTERFACE

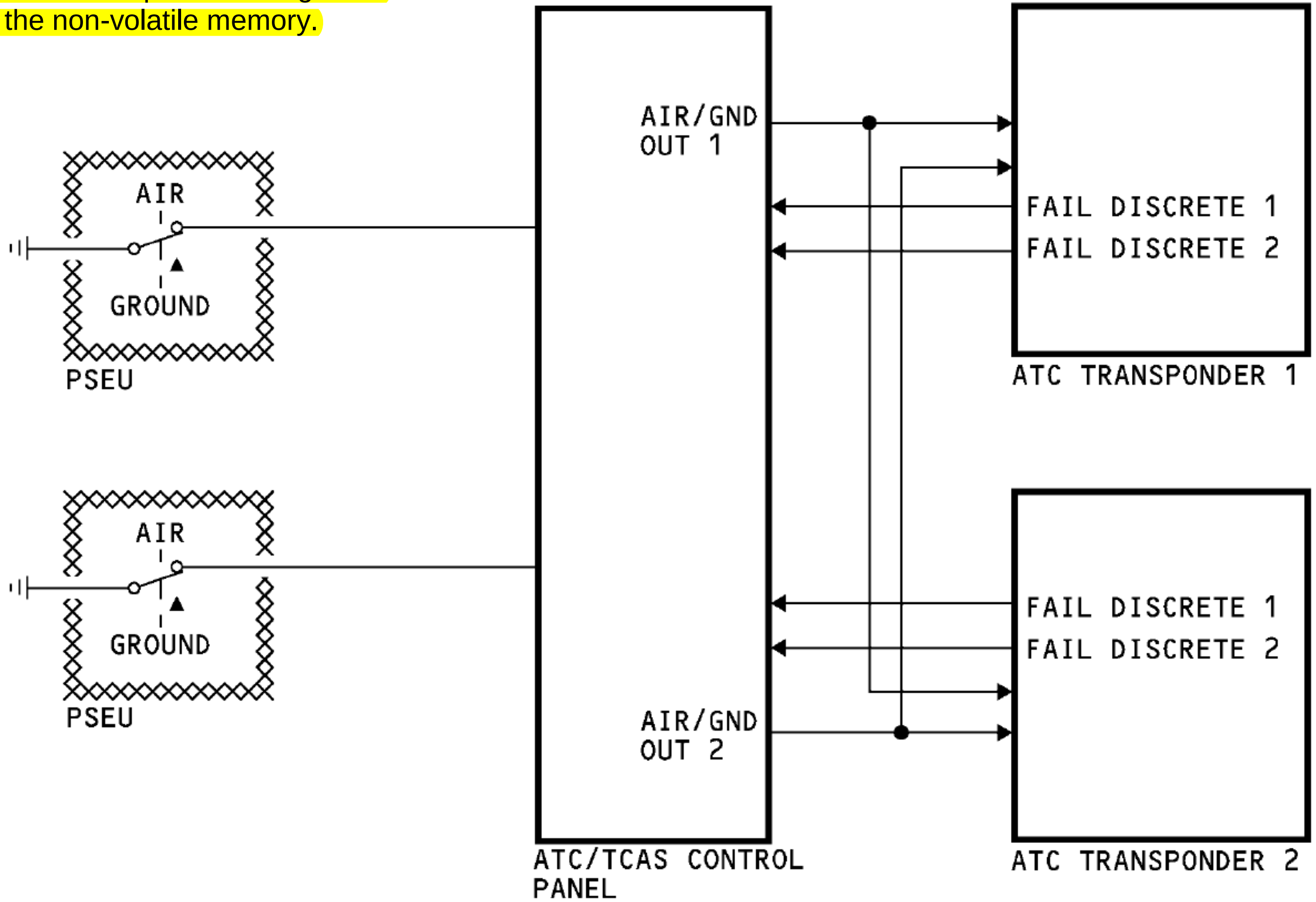
PSEU

The proximity switch electronics unit (PSEU) sends air/ground discretes through the ATC/TCAS control panel to the transponders.
These are the purposes of the air/ground discretes:

- Prevent ground tests of the ATC system in the air
- Prevent mode A and mode C replies on the ground
- Defines flight legs in the non-volatile memory.

Transponder Fail Discretes

Each transponder built-in test equipment (BITE) continually monitors the equipment for failures. If the BITE detects a failure, the transponder sends the fail discretes to the ATC/TCAS control panel.



MAINTENANCE INTERFACE

THIS PAGE IS INTENTIONALLY LEFT BLANK

TCAS INTERFACE AND PROGRAM PINS

Program Pins

Each ATC transponder has these program pins:

- Airplane mode S address
- Source destination identifier (SDI)
- Maximum true airspeed.

There are 24 airplane address program pins on each transponder. A program switch module connects to the program pins. The program switch module supplies the open and ground connections necessary to make the 24-bit unique airplane identification.

The SDI defines the transponder as the ATC 1 or ATC 2 transponder.

The maximum true airspeed pins define the maximum true airspeed for the airplane. The transponder formats and sends the maximum true airspeed to the TCAS computer.

Digital Data to TCAS

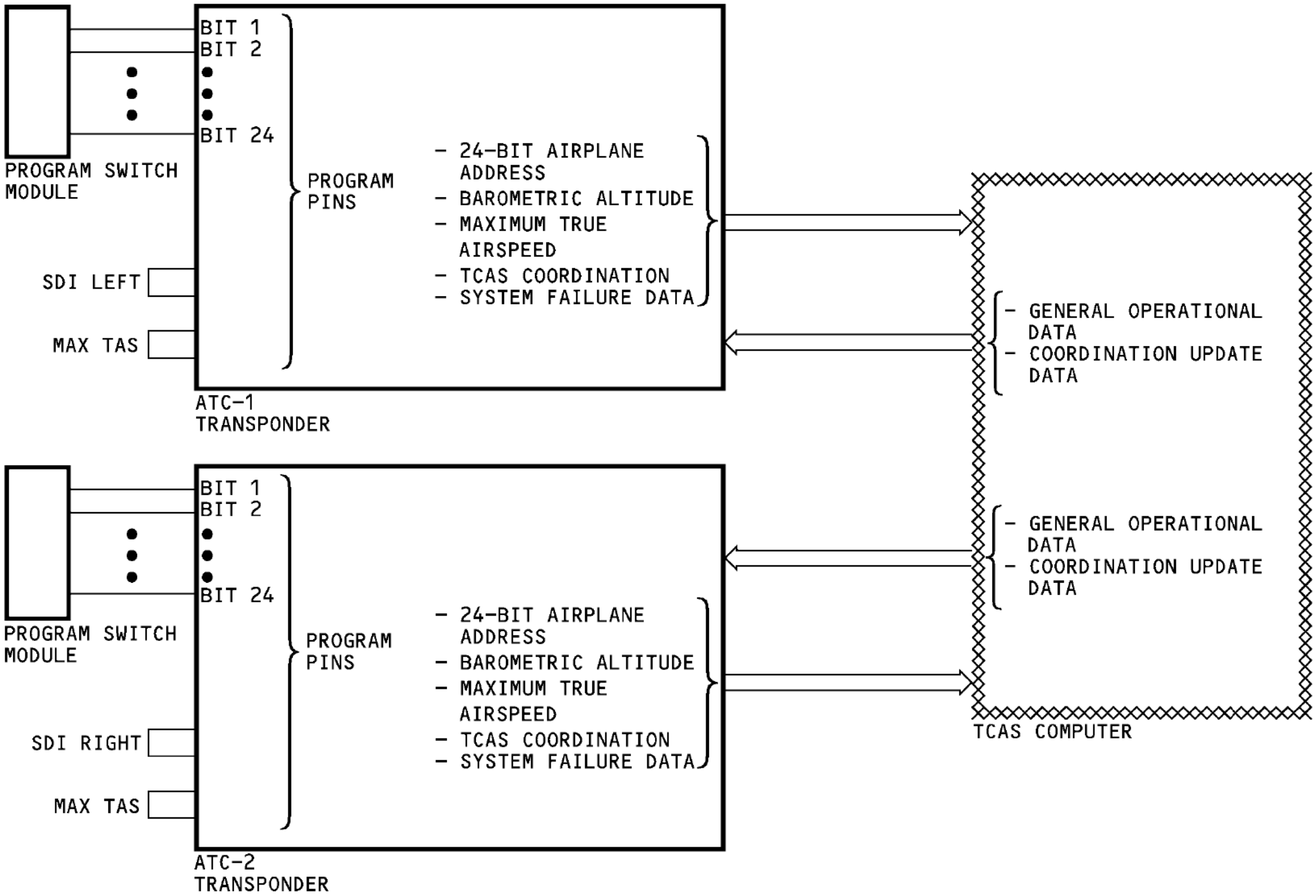
The active ATC transponder sends this data to the traffic alert and collision avoidance system (TCAS) computer:

- The 24-bit mode S airplane identification. TCAS needs the airplane mode S identification for maneuver coordination.
- Barometric altitude
- Maximum true airspeed
- TCAS coordination message data
- ATC transponder system failure data.

TCAS to Active Transponder

The TCAS computer sends this data to the active transponder:

- General TCAS operational data
- Coordination update data.



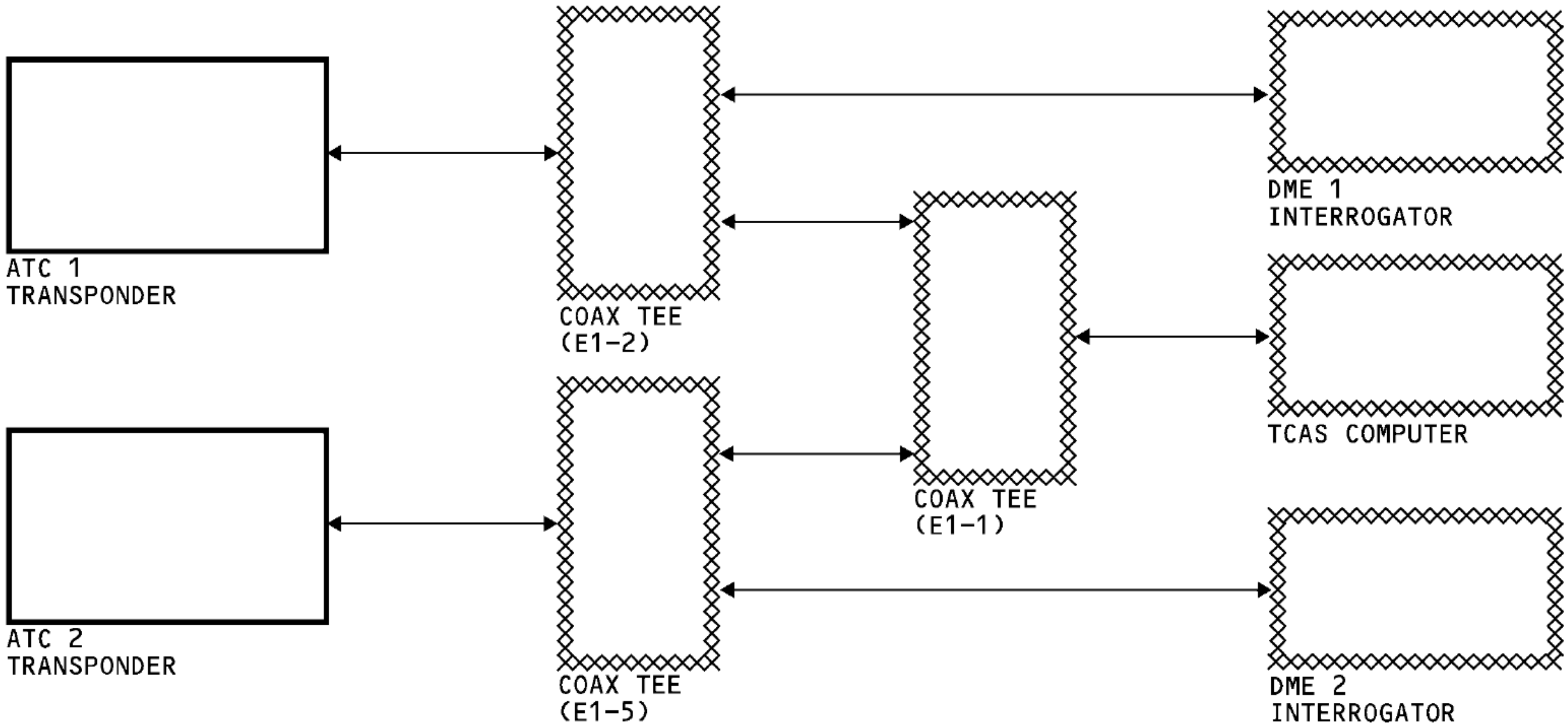
TCAS INTERFACE AND PROGRAM PINS

SUPPRESSION INTERFACE

General

The ATC transponders, TCAS, and the DME interrogators operate in the same frequency band. There is a suppression interface between these units. This prevents damage to the receiver circuits during a signal transmission. The suppression circuits also prevent responses from onboard equipment.

The first unit to transmit sends a suppression pulse to a coax tee. The coax tee divides the suppression pulse and sends it to the different units, or to a different coax tee. This suppression pulse prevents the operation of the receiver circuits in the other units.



SUPPRESSION INTERFACE

THIS PAGE IS INTENTIONALLY LEFT BLANK

ATC SYSTEM – COMPONENTS

ATC/TCAS CONTROL PANEL

The dual ATC/TCAS control panel controls the ATC transponder and the TCAS computer.

These are the ATC controls and displays on the ATC/TCAS control panel:

- Transponder select switch
- Active system display
- Transponder code selectors
- Four digit identification code
- Transponder mode selector
- IDENT switch
- Altitude source switch
- Reply selector
- Fail light.

Transponder Select Switch and Active System Display

The transponder select switch is a two-position switch used to select ATC transponder 1 or ATC transponder 2 as the active transponder. When the flight crew selects the 1 position, the control panel sends a ground standby/on discrete to transponder 2 only. Transponder 2 is in standby. Transponder 1 is active.

When the flight crew selects the 2 position, the control panel sends an open standby/on discrete to transponder 2 to make it active. A ground standby/on discrete goes to transponder 1 and an antenna transfer discrete goes to the ATC coax switches. This puts transponder 1 in standby and makes the relays connect the ATC antennas to transponder 2. The selected ATC system shows on the LCD active system display.

Identification Code Display and Selection

The flight crew uses the code selectors to set the four digits of the identification code. The four digits show on the liquid crystal display (LCD). Codes are from 0000 to 7777, with 4096 different selections.

Caution: DO NOT SELECT CODES 7500, 7600 OR 7700. THESE CODES ARE USED ONLY FOR EMERGENCIES.

Transponder Mode Selector

The transponder mode selector has several positions. These are the functions that the ATC system uses:

- STBY - Sets the active transponder to the standby mode. In the standby mode, the transponder will not reply to ATC/Mode S interrogations, BITE functions are active.
- TEST - This push button on the top of the mode selector starts an ATC transponder functional test.
- ALT RPTG OFF (altitude reporting off) - The active transponder responds to ATC interrogations. The reply does not contain an altitude report.
- XPDR (transponder) - The active transponder responds to ATC interrogations. Mode C and Mode S altitude replies contain altitude information.

IDENT Switch

When the ATC controller requests the airplane identifier, the flight crew pushes the momentary IDENT switch. The transponder adds a special position identification (SPI) pulse to the interrogation reply for the next 18 seconds.

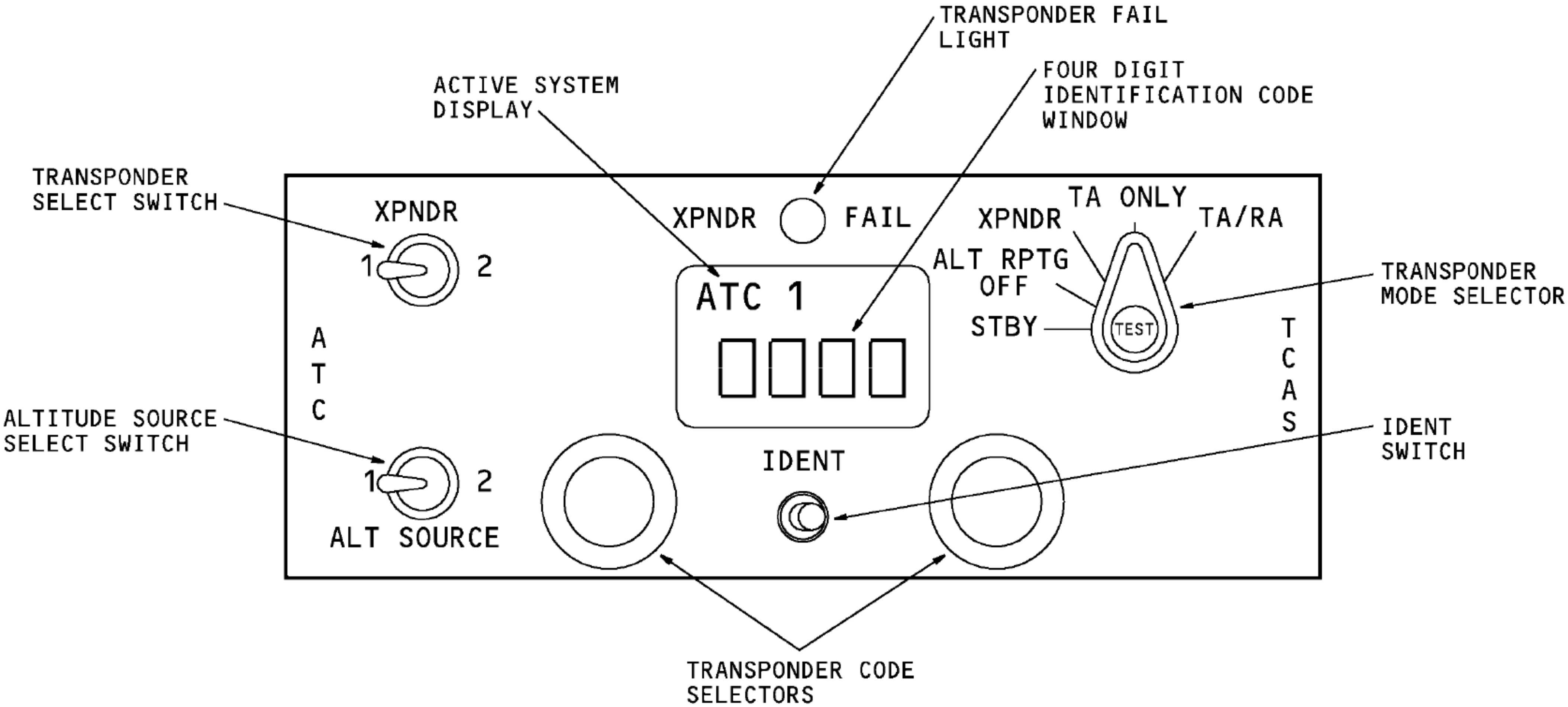
Altitude Source Switch

Use the two-position switch to set the source of altitude data for the ATC transponder. When you set the switch to the number 1 position, ADIRU 1 supplies the altitude data. When you set the switch to the number 2 position, ADIRU 2 supplies the altitude data.

XPNDR FAIL Light

The XPNDR FAIL light comes on for these conditions:

- Transponder failure
- Antenna failure
- Control data failure.
- Altitude input failure.



ATC/TCAS CONTROL PANEL

TRANSPONDER

General

The ATC ground station interrogates the ATC transponder with a pulse-coded signal at a frequency of 1030 MHz.

The transponder responds with pulse-coded signals at a frequency of 1090 MHz.

Characteristics

The transponder responds to air traffic control radar beacon system (ATCRBS) mode A and mode C interrogations. The transponder also responds to air traffic control and the TCAS computer with the mode select (mode S) format.

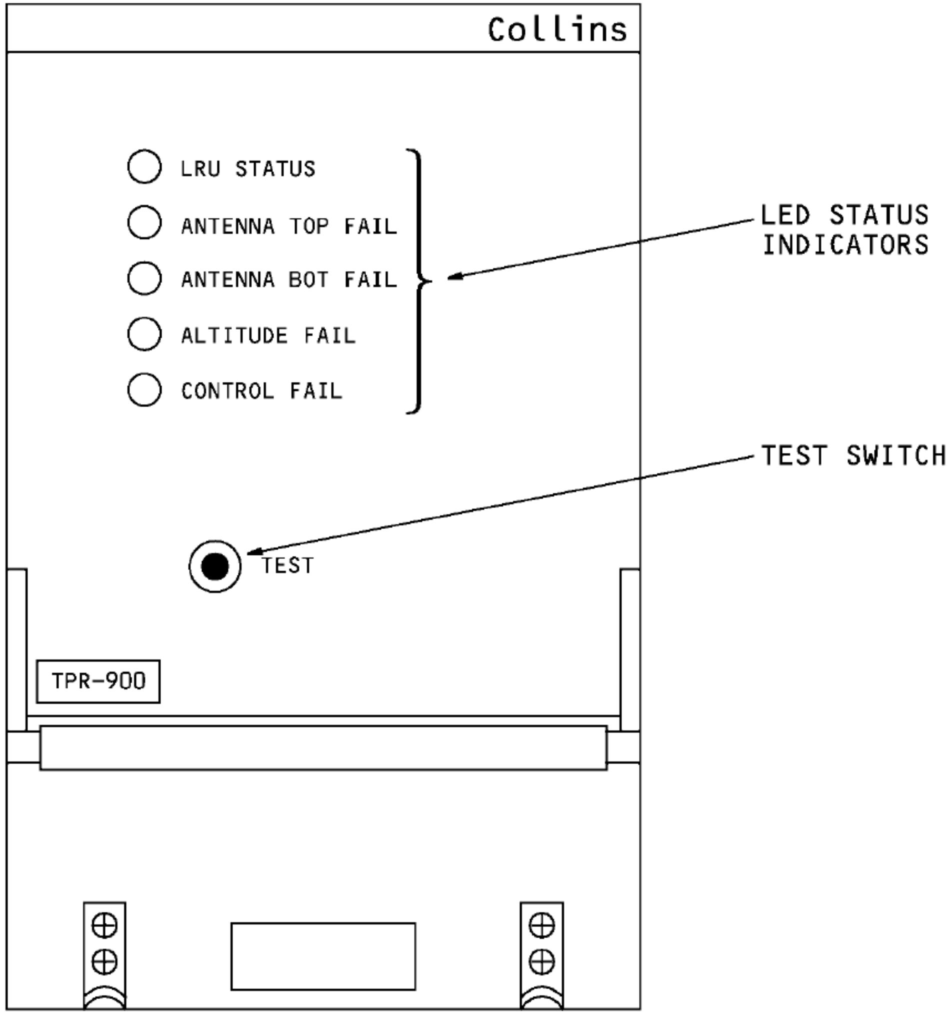
The ATC transponder has a non-volatile flight-fault memory.

Front Panel Indications

The test switch starts a self-test.

The light emitting diode (LED) status indicators on the front panel show for these conditions:

- LRU STATUS (green), if there are no LRU failures
- LRU STATUS (red), if there is an LRU failure
- ANTENNA TOP FAIL, if the top antenna fails
- ANTENNA BOT FAIL, if the bottom antenna fails
- ALTITUDE FAIL, if the altitude input from the ADIRU fails
- CONTROL FAIL, if the control panel input fails.



ATC TRANSPONDER

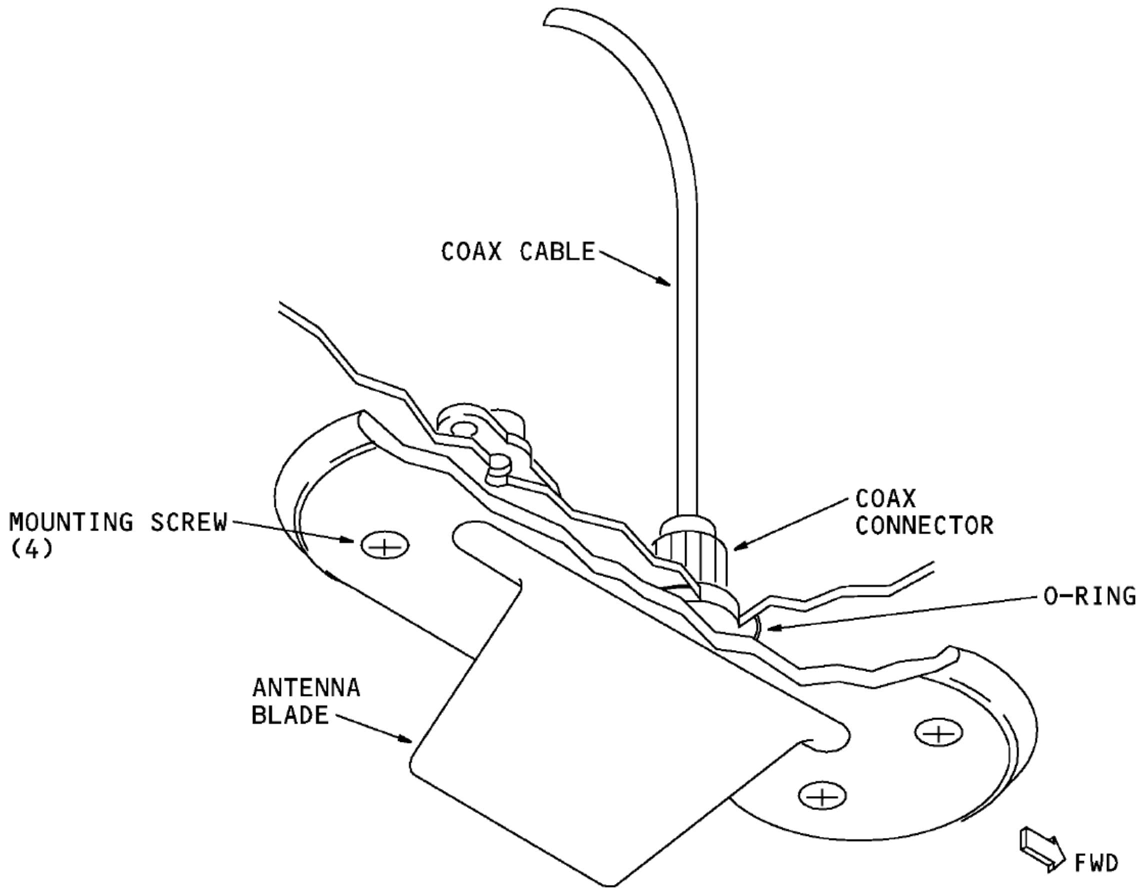
ATC ANTENNA

Purpose

The ATC L-band blade antenna receives 1030 MHZ interrogation signals from ATC ground stations and other airplanes that have TCAS. The ATC transponder transmits the reply signals through the L-band antenna.

Physical Description

The coaxial cable connector connects to the antenna. The antenna has an O-ring moisture seal and attaches to the airplane by four screws. The ATC and DME antennas are the same and are interchangeable.



ATC ANTENNA

ATC COAXIAL SWITCH

General

The ATC coax switches connect the active ATC transponder to the top and bottom ATC antennas.

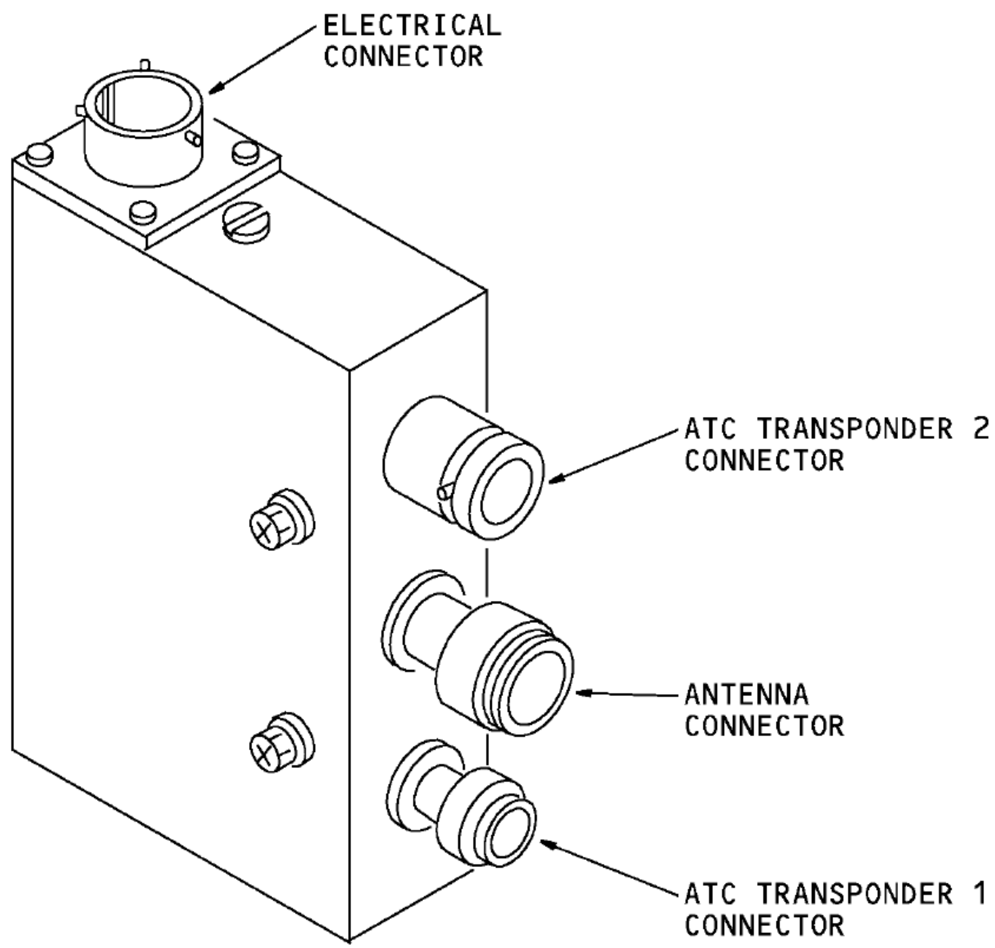
These are the electrical connector inputs:

- ATC antenna switch circuit breaker
- ATC/TCAS control panel.

The ATC coax switches supply an RF interface for the ATC system interrogation and reply signals.

These are the connectors:

- ATC transponder 1 connector
- ATC antenna connector
- ATC transponder 2 connector.



ATC COAXIAL SWITCH

THIS PAGE IS INTENTIONALLY LEFT BLANK

ATC SYSTEM - INPUTS AND CONTROL

ATC Control Panel

The ATC/TCAS control panel controls the operation of the ATC transponders.

The microprocessor in the control panel gets inputs from these:

- Code selectors
- IDENT switch
- Mode selector.

The microprocessor changes these inputs into ARINC 429 digital data. The ATC control panel sends this data on an ARINC 429 data bus to the selected transponder:

- The identity code the flight crew selects to reply to interrogations
- Digital discretes for the position of the IDENT switch
- Digital discretes for ALT RPTG OFF or XPNDR mode
- Digital discrete for TEST.

The XPNDR 1-2 switch selects one transponder for operation. The selected transponder receives an open discrete from the control panel. A ground discrete goes from the panel to the other transponder to put it in the standby mode. This discrete also goes to the ATC antenna coax switches to connect the two ATC antennas to the selected transponder.

The STBY position of the reply selector sets the selected transponder to standby mode.

Air/Ground Input

The transponder receives an air/ground discrete input from the proximity switch electronics unit (PSEU). The CPU uses the air/ground discrete to count flight segments in the fault history non-volatile memory.
In the air, the transponder will reply to all interrogations. On the ground, the transponder will not reply to mode A and mode C interrogations.

ATC Transponder Inputs

The transponder has an input/output (I/O) that has an interface with the ARINC 429 data and analog discretes from the control panel.

Control Inputs

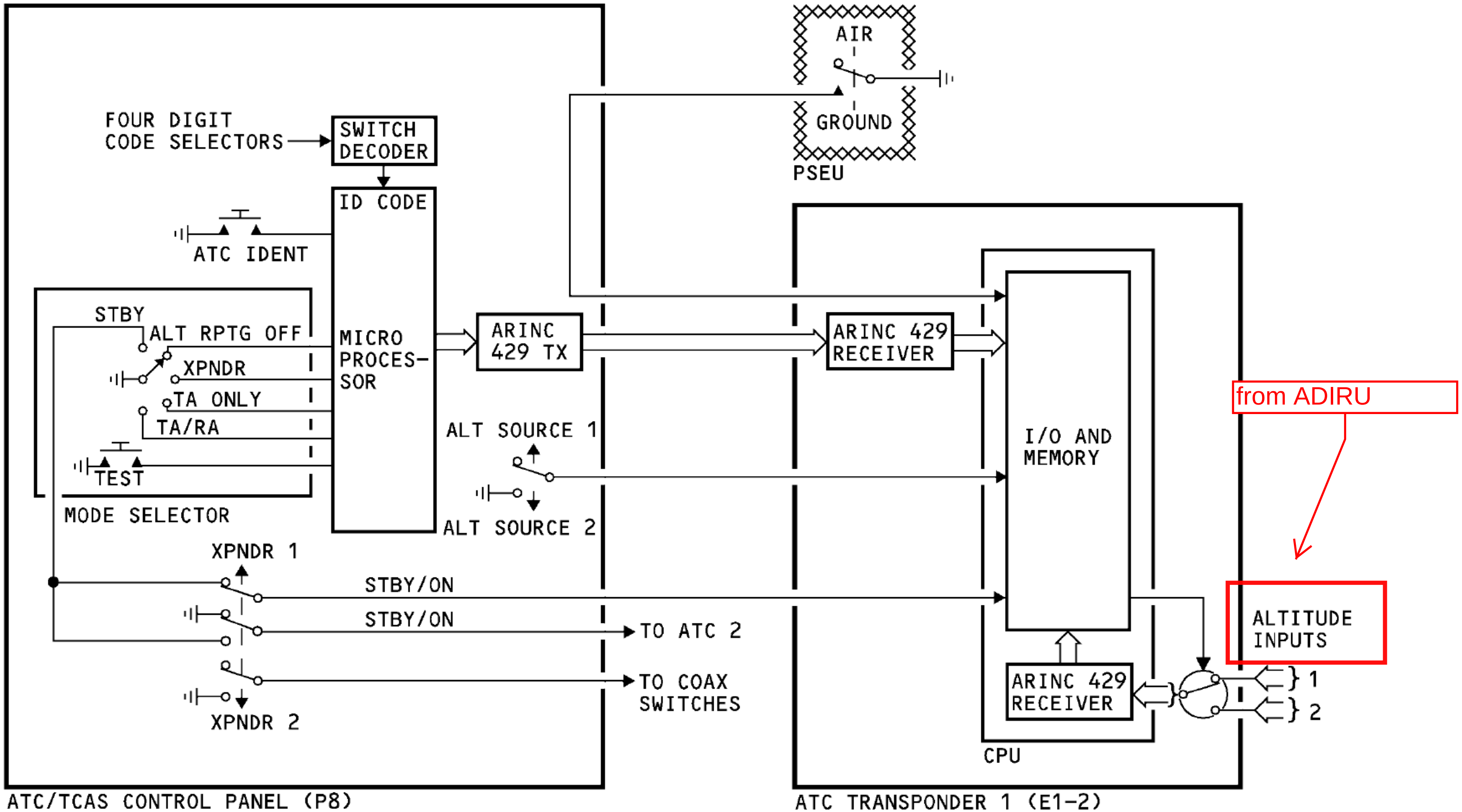
The digital data bus from the control panel has three digital discretes. One shows if the mode selector on the panel is in the ALT RPTG OFF (altitude reporting off) position. If it is, the CPU does not permit the transponder to make a mode C reply or to give altitude information in a mode S reply.

The second digital discrete from the control panel shows the position of the IDENT switch. The pilot momentarily pushes the IDENT switch at the request of the ATC ground station. When this happens, the transponder sends a special position identification (SPI) pulse at the end of every normal mode A reply. It continues for 18 seconds. The SPI causes the airplane to be highlighted on the air traffic controller's radar screen.

The third digital discrete from the control panel shows if TEST is selected. If it is, the transponder starts a functional self-test.

Altitude Inputs

The air data inertial reference units (ADIRUs) send barometric altitude to each transponder. Each transponder uses only one ADIRU altitude input. Set the altitude source switch on the control panel to 1 to use input 1, or 2 to use input 2.



ATC SYSTEM – INPUTS AND CONTROL

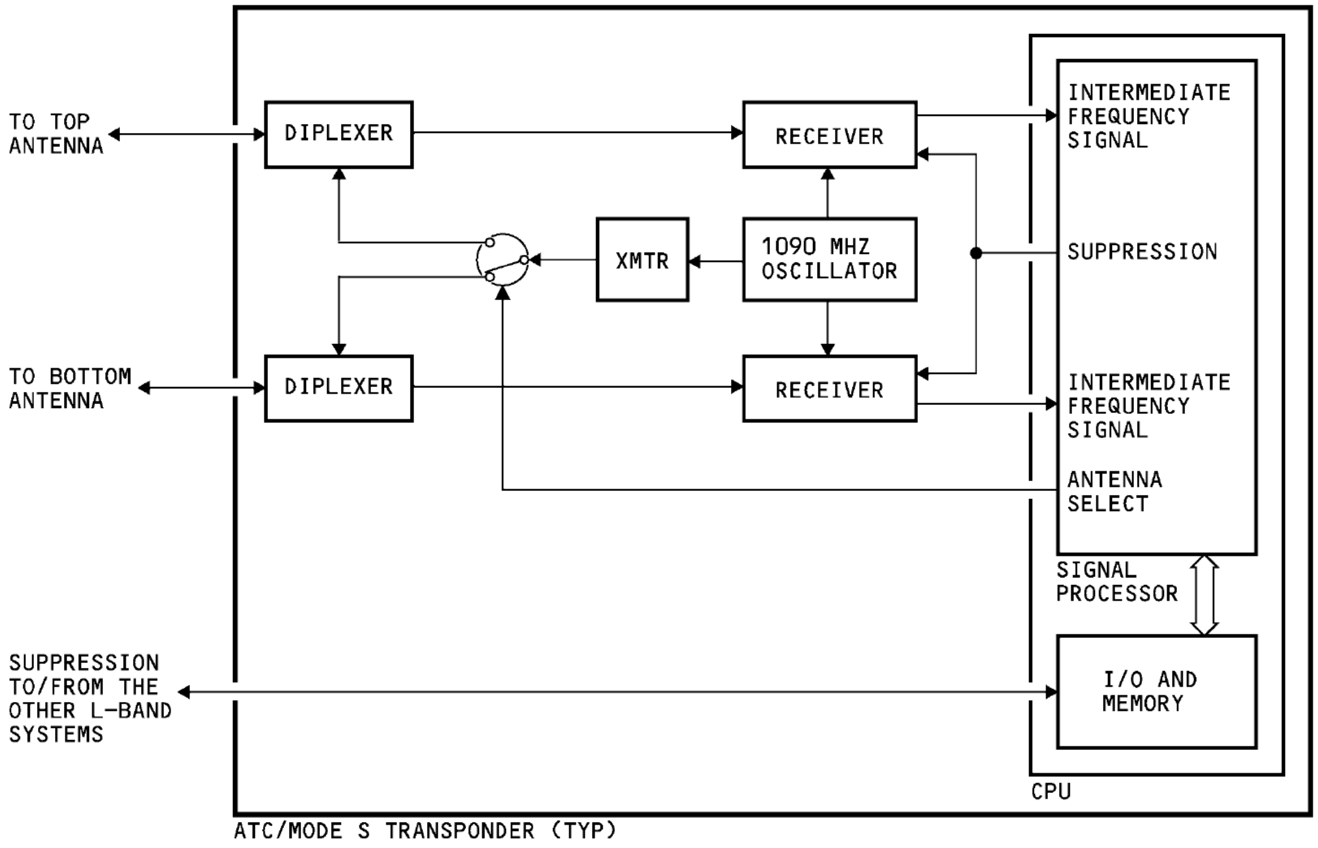
ATC TRANSPONDER RECEIVING FUNCTIONAL DESCRIPTION

General
The antennas send the interrogation signals to the transponder. The signals go through the diplexer circuits to two receivers. The 1030 MHz interrogation signal mixes with a 1090 MHz signal from the 1090 MHz oscillator. This makes an intermediate frequency signal that the signal processor uses.

Suppression
When the transponder gets a suppression pulse from another system, the signal processor circuits do not permit the receiver circuits to operate.

Antenna Select
The antenna select circuit chooses the diplexer and antenna that supplies the strongest receiver signal. The transmission of the reply signal goes through the selected diplexer and antenna.

Signal Processor
The signal processor determines if the transponder receives a valid interrogation signal. It also determines the correct reply mode; mode A, mode C, or mode S.



RECEIVING FUNCTIONAL DIAGRAM

THIS PAGE IS INTENTIONALLY LEFT BLANK

ATC TRANSPONDER TRANSMISSION FUNCTIONAL DESCRIPTION

Transmit

The central processor unit (CPU) controls the transponder to reply to a mode A, mode C, or mode S interrogation. The mode format circuits use the identity code, airplane altitude and the unique 24-bit airplane address from the memory to format the data for the reply signals.

The mode A reply contains the airplane identity code. The mode C reply contains the airplane altitude.

The mode S replies contain a unique 24-bit airplane address, identity code, altitude information, and TCAS information.

After the signal processor chooses the correct mode for the reply data, the modulator makes a reply signal in that format. The modulator uses the signal processor output to modulate a 1090 MHz carrier to make the transmission reply signal. The transmission reply signal goes to the power amplifier and then to the diplexer and to the ATC antenna.

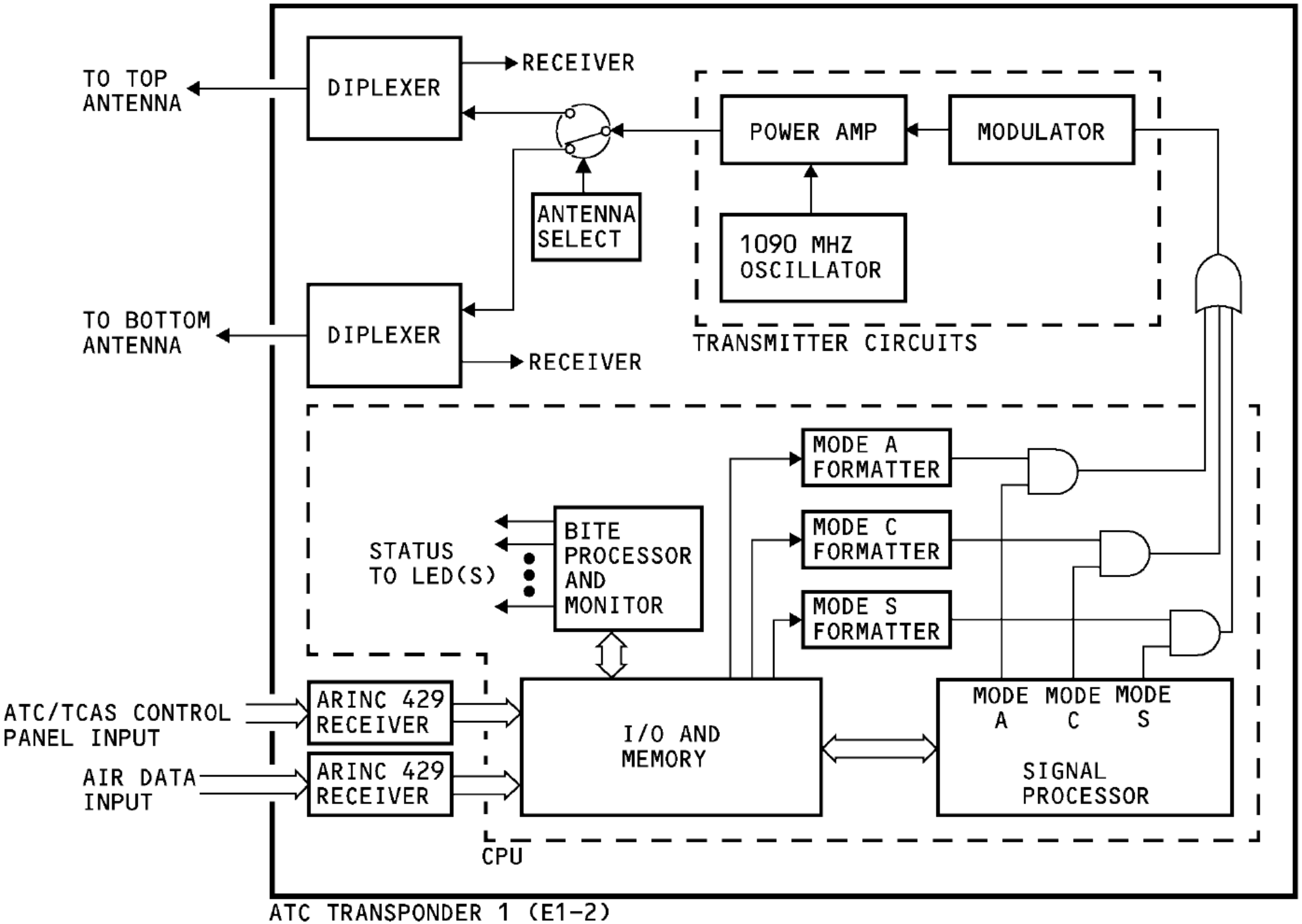
The antenna select circuit makes the transmission signal go to the antenna that receives the strongest interrogation signal.

Test

When you apply power or do a test of the ATC transponder system, the built-in test equipment (BITE) does a check of the operational status of all the internal circuits and for the correct antenna impedance. The BITE circuits identify any failures and put them into the non-volatile memory.

The LEDs on the front panel of the transponder come on to report these conditions:

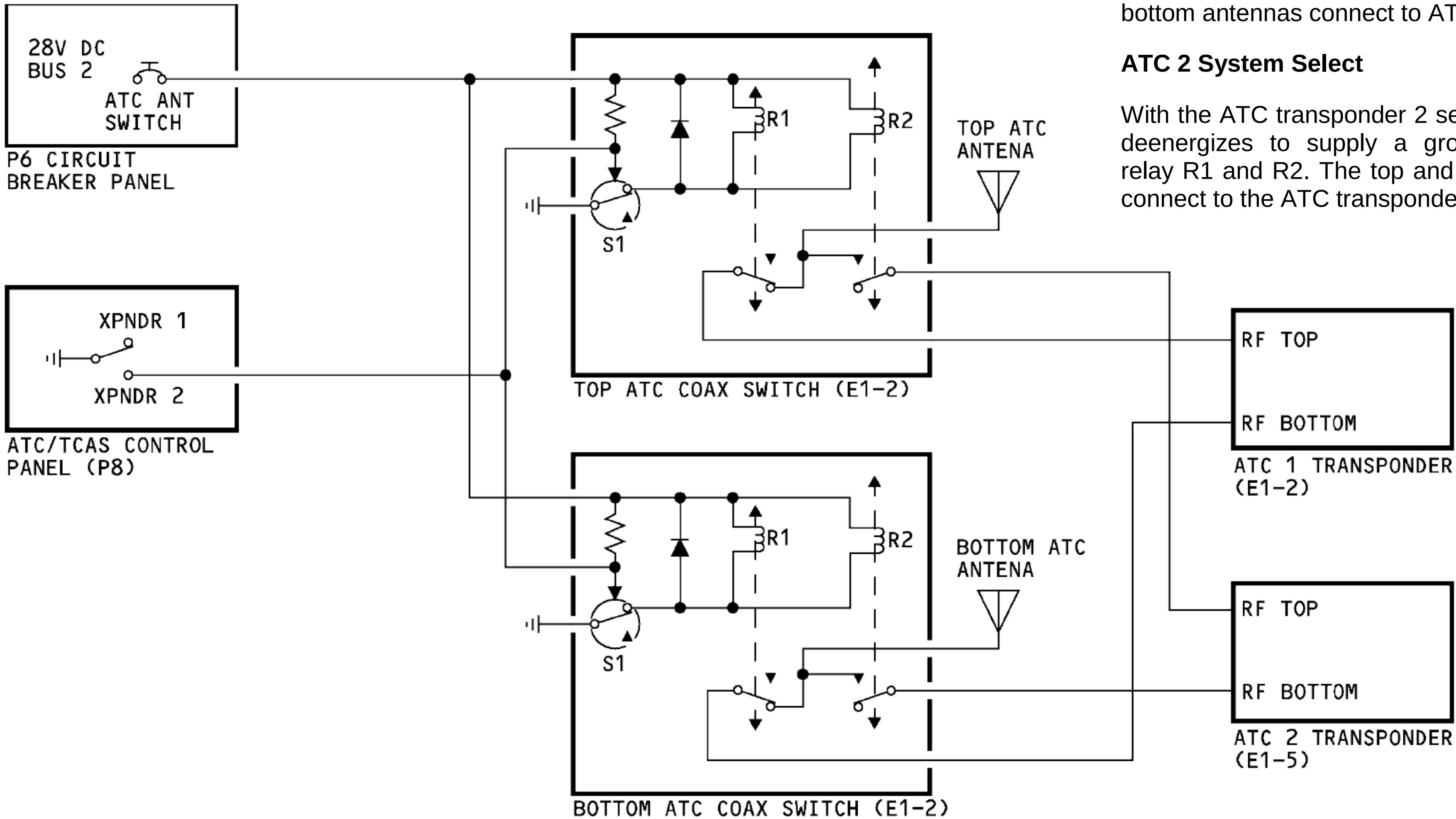
- Transponder status
- Antenna status
- Transponder control interface status
- Altitude interface status.



ATC TRANSPONDER TRANSMISSION FUNCTIONAL DIAGRAM

ANTENNA COAXIAL SWITCH CONTROL

Use the ATC/TCAS control panel to select the active ATC system. When you do this, the ATC/TCAS control panel sends a discrete open or ground to the top and bottom ATC coax switches. This connects the ATC transponder 1 or the ATC transponder 2 to the top and bottom ATC antennas.



ANTENNAL COAXIAL SWITCH CONTROL

ATC 1 System Select or Standby

When the airplane power is on and when the ATC/TCAS control panel has the ATC transponder 1 selected, the S1 switches energize. This removes the ground to relays R1 and R2. They do not energize. The top and bottom antennas connect to ATC transponder 1.

ATC 2 System Select

With the ATC transponder 2 selected, switch S1 deenergizes to supply a ground to energize relay R1 and R2. The top and bottom antennas connect to the ATC transponder 2.

THIS PAGE IS INTENTIONALLY LEFT BLANK

ATC SYSTEM - SELF TEST

General

Push the TEST switch on the front of the transponder or select TEST on the ATC/TCAS control panel to start a self-test of the ATC system.

During the test, the transponder BITE circuits do these functions:

- Normal operation test
- Memory tests
- Simulated interrogation test of the receiver circuits
- Antenna impedance test
- TCAS interface test
- Valid control and altitude inputs monitor.

Test From the Front Panel

Push and release the test switch. All front panel light emitting diode (LED) status indicators turn red for two seconds. After two seconds, the LRU STATUS turns green and the other LEDs remain red. Then all the LEDs go off for two seconds. At this time, the applicable LEDs come on to show the condition of the ATC transponder system. After 30 seconds, all LEDs go off.

These are the LED status indicators and their related conditions:

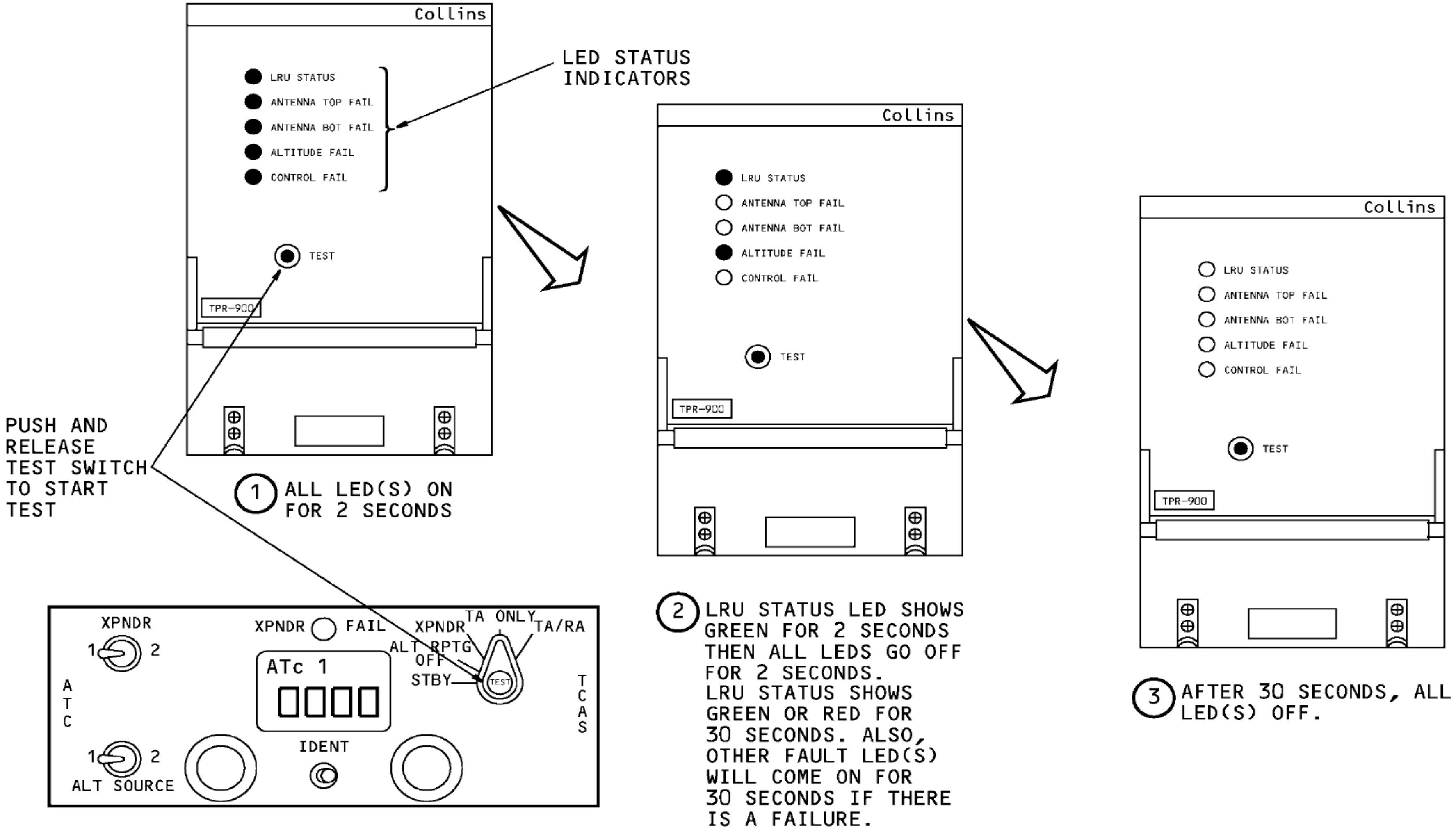
- LRU STATUS (GREEN) - no LRU failures
- LRU STATUS (RED) - LRU failure
- ANTENNA TOP FAIL - top antenna fails
- ANTENNA BOT FAIL - bottom antenna fails
- ALTITUDE FAIL - altitude input from the ADIRU fails
- CONTROL FAIL - control panel input fails.

Test From the Control Panel

Push and release the test button on the control panel to start a self-test of the ATC system. The XPNDR FAIL light comes on for three seconds and then goes off if the test is successful.

The XPNDR FAIL light stays on for any of these conditions:

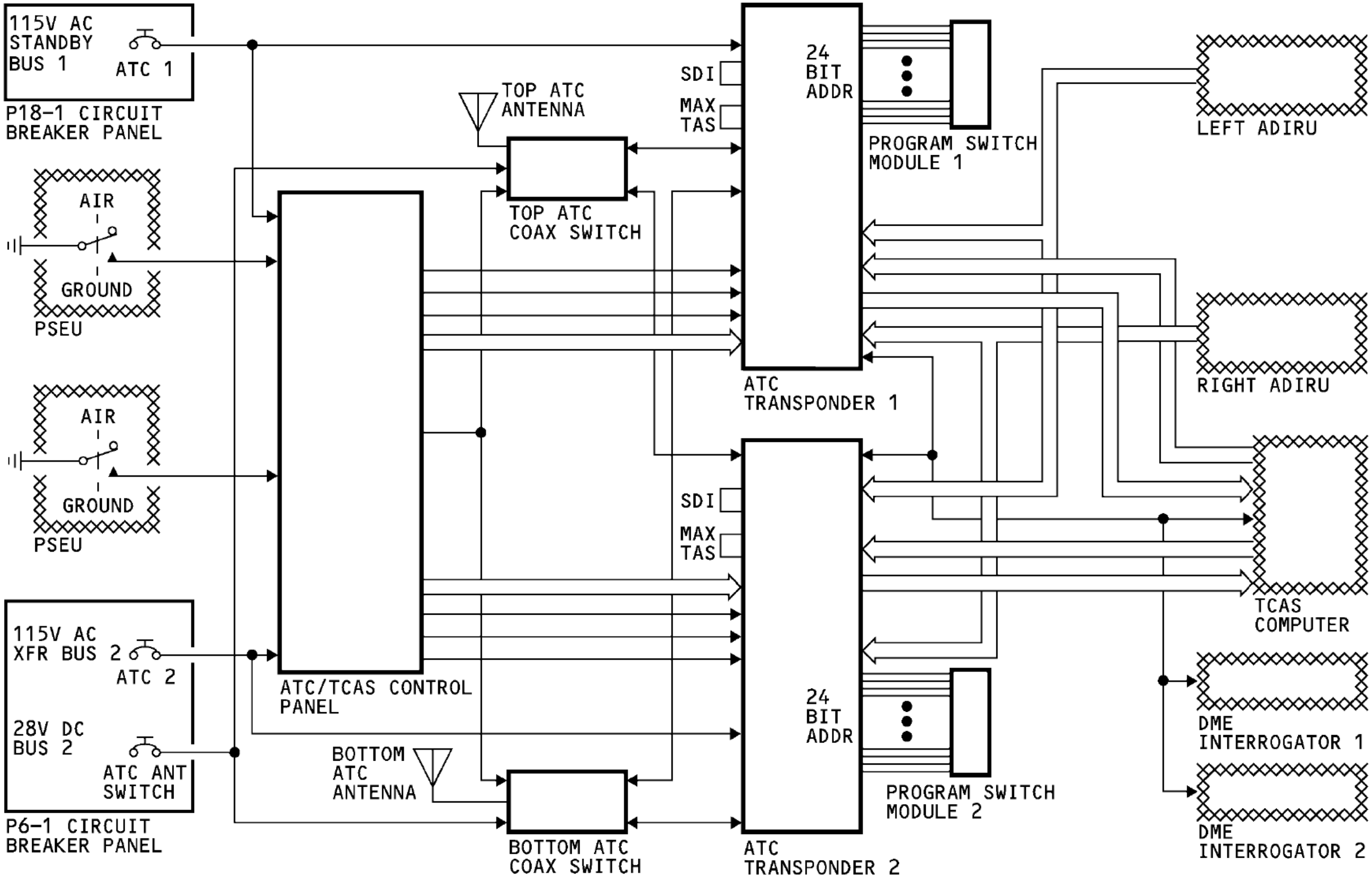
- Antenna failure
- Transponder failure
- Control data failure
- Altitude input failure.



ATC SYSTEM – SELF TEST

ATC SYSTEM - SYSTEM SUMMARY

General



SYSTEM INTERFACE

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–55. TRAFFIC ALERT and COLLISION AVOIDANCE SYSTEM (ATA 34–45)

LEVEL 3

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM - INTRODUCTION

General

The traffic alert and collision avoidance system (TCAS) helps the flight crew maintain safe air traffic separation from other ATC transponder equipped airplanes. TCAS is an airborne system and operates independently of the ground-based ATC system.

TCAS sends interrogation signals to nearby airplanes. These airplanes which are equipped with an air traffic control radar beacon system (ATCRBS) transponder or an air traffic control (ATC) mode S transponder respond to these interrogations. TCAS uses these response signals to calculate the range, relative bearing, and altitude of the responding airplane. If a responding airplane does not report altitude, TCAS cannot calculate the altitude of that airplane. Airplanes tracked by TCAS are called targets.

Using the information from the response signals and altitude of own airplane, TCAS calculates the relative movement between own airplane and the target. TCAS then calculates how close the target will be to own airplane at the closest point of approach (CPA).

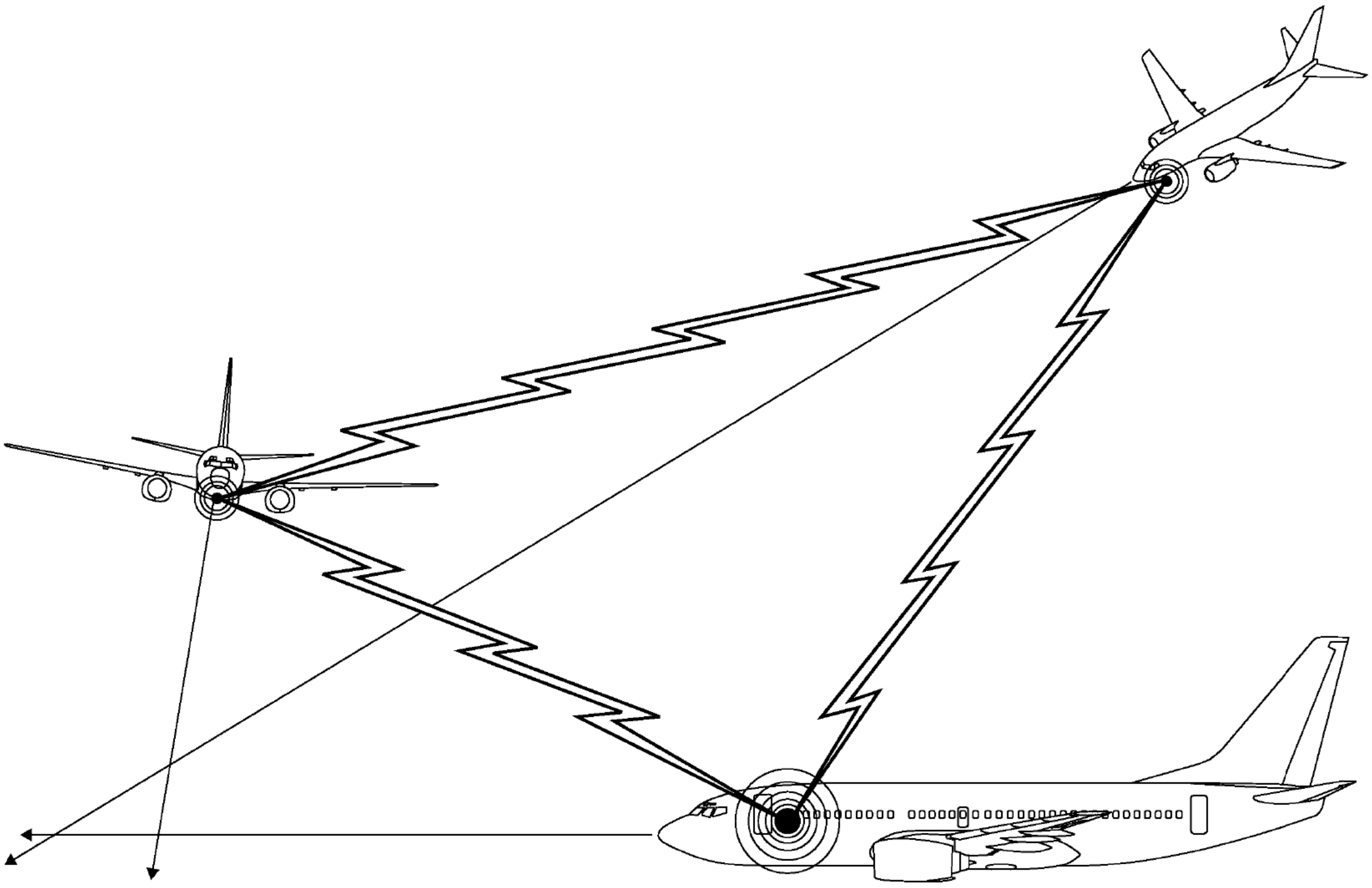
Targets are classified as one of these four types depending on the separation at CPA and the time it will take until CPA occurs:

- Other traffic
- Proximate traffic
- Intruders
- Threats.

Each type of target has a different symbol on the display.
If the separation at CPA is within certain limits, TCAS provides advisory messages to the flight crew. TCAS provides two levels of advisories to the flight crew, traffic advisory (TA) and resolution advisory (RA). The type of advisory is determined by a combination of altitude, the time to CPA, and the separation at CPA. The TA shows for relatively longer times to CPA and relatively larger separation at CPA and is for intruder targets. The RA shows for relatively shorter times to CPA and relatively smaller separation at CPA and is for threat targets.

The TA shows the range, bearing, and relative altitude (if relative altitude is known) of the intruder target. The RA also gives visual and aural commands to the flight crew to make sure there is safe vertical separation from the threat target.

TCAS also communicates with other airplanes that have TCAS to coordinate the flight movement to prevent a collision.



TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM - INTRO

GENERAL DESCRIPTION

General

The TCAS transmits to and receives signals from other airplanes to get altitude, range, and bearing data. The other airplanes report their own altitudes. The range of the other airplanes is calculated by measurement of the time between the transmission of an interrogation and the reception of a response from the other airplanes. Bearing is calculated by the use of directional antennas. TCAS uses these data and inputs from other onboard airplane systems to provide visual indications of the position of other airplanes and to provide visual and aural traffic avoidance alerts.

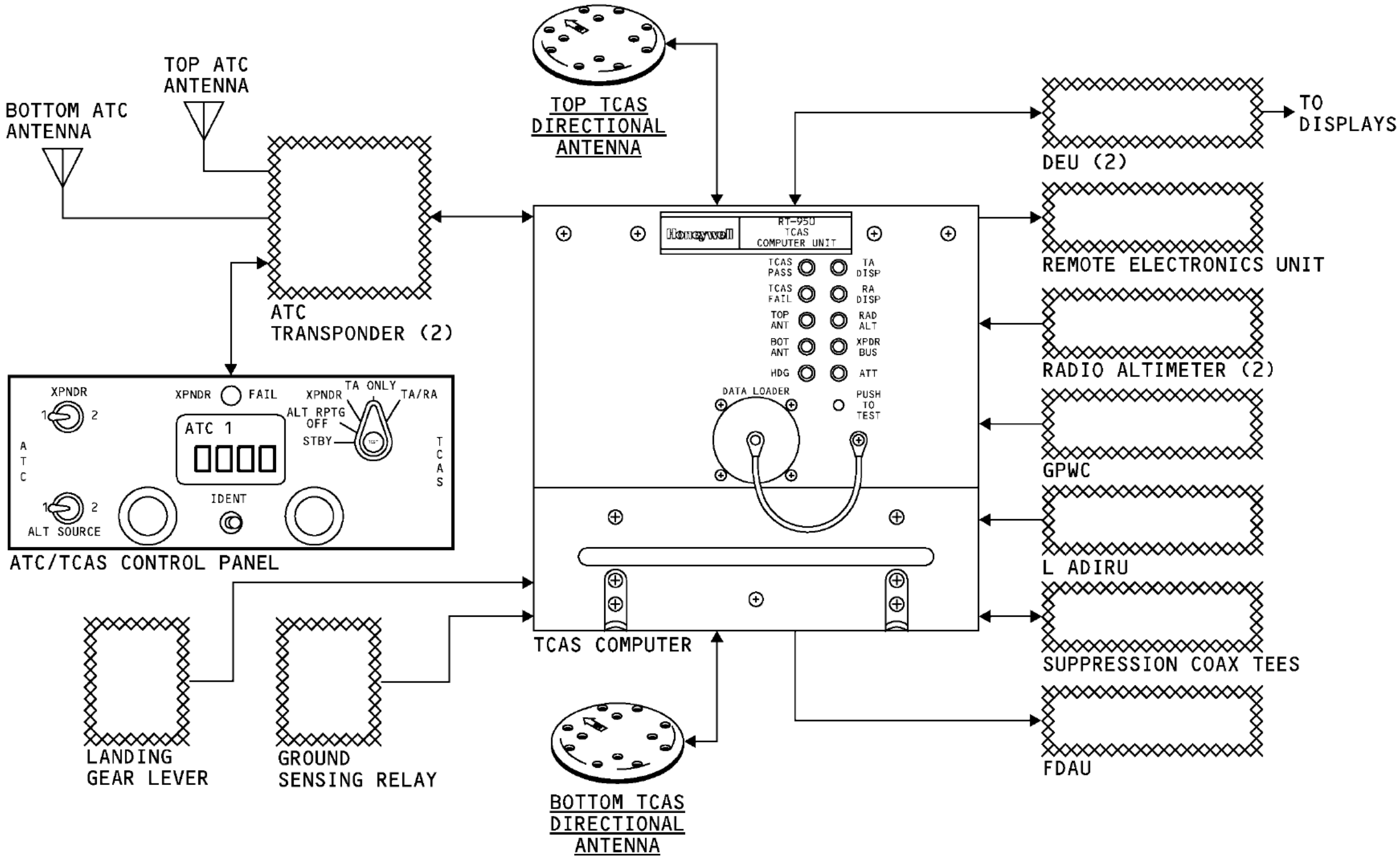
General Description

These are the TCAS components:

- TCAS directional antennas (2)
- TCAS computer
- ATC/TCAS control panel.

TCAS interfaces with these other system components:

- ATC transponders (2)
- Landing gear lever
- PSEU
- Common display system (CDS) display electronic units (DEUs) (2)
- Remote electronics unit (REU)
- Radio altimeters (2)
- Ground proximity warning computer (GPWC)
- Weather radar
- Left air data inertial reference unit (ADIRU)
- Suppression coax tees
- Flight data acquisition unit (FDAU).



GENERAL DESCRIPTION

TCAS - COMPONENTS LOCATION

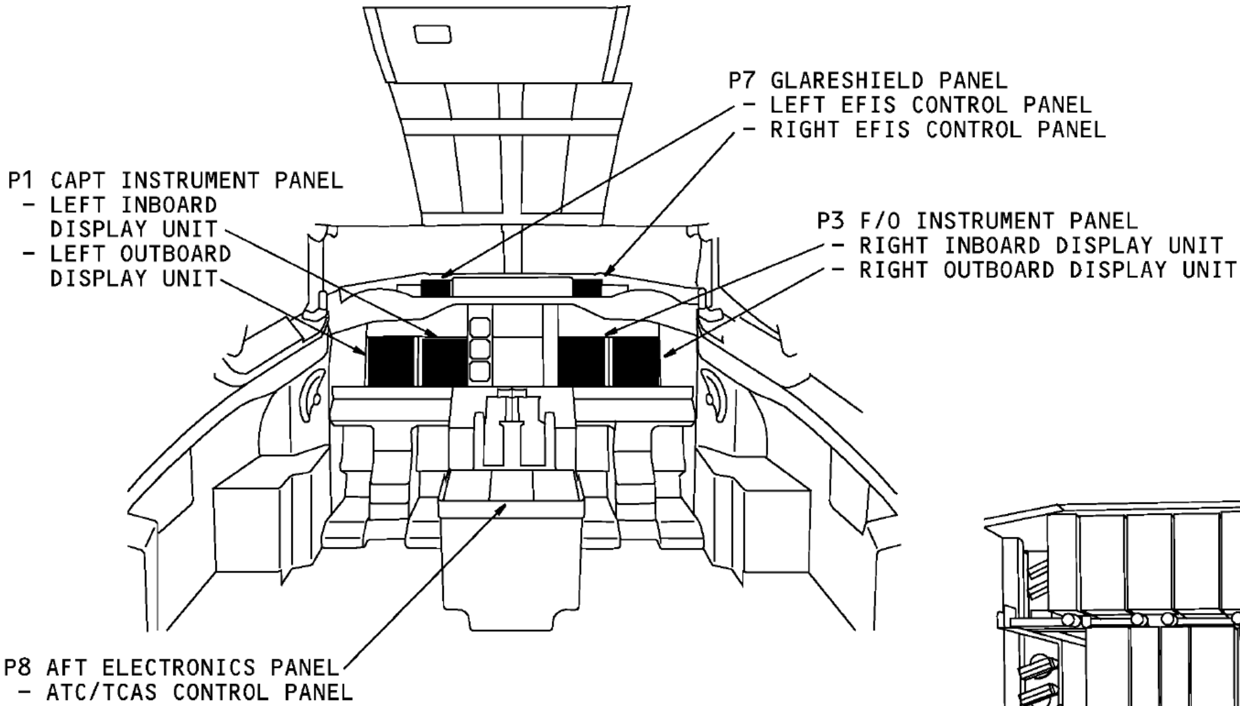
Electronic Equipment Compartment

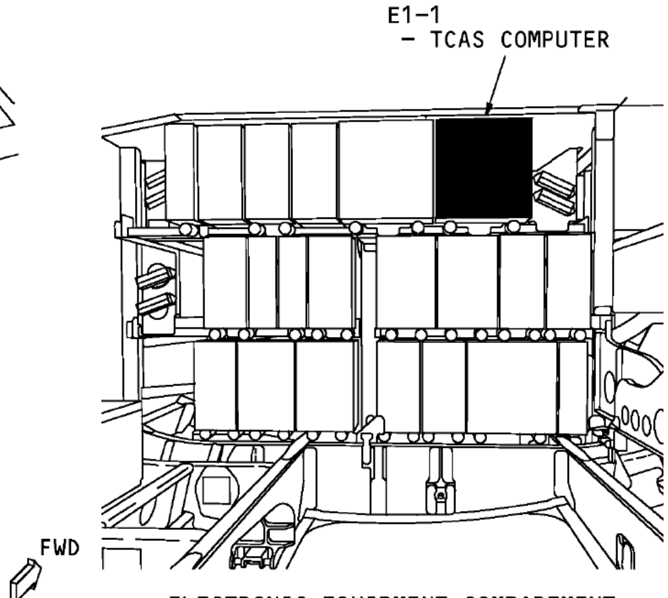
The TCAS computer is in the electronic equipment compartment.

Flight Compartment

These are the components in the flight compartment that interface with TCAS:

- Left electronic flight instrument system (EFIS) control panel
- Left outboard display unit
- Left inboard display unit
- Right EFIS control panel
- Right outboard display unit
- Right inboard display unit
- ATC/TCAS control panel.



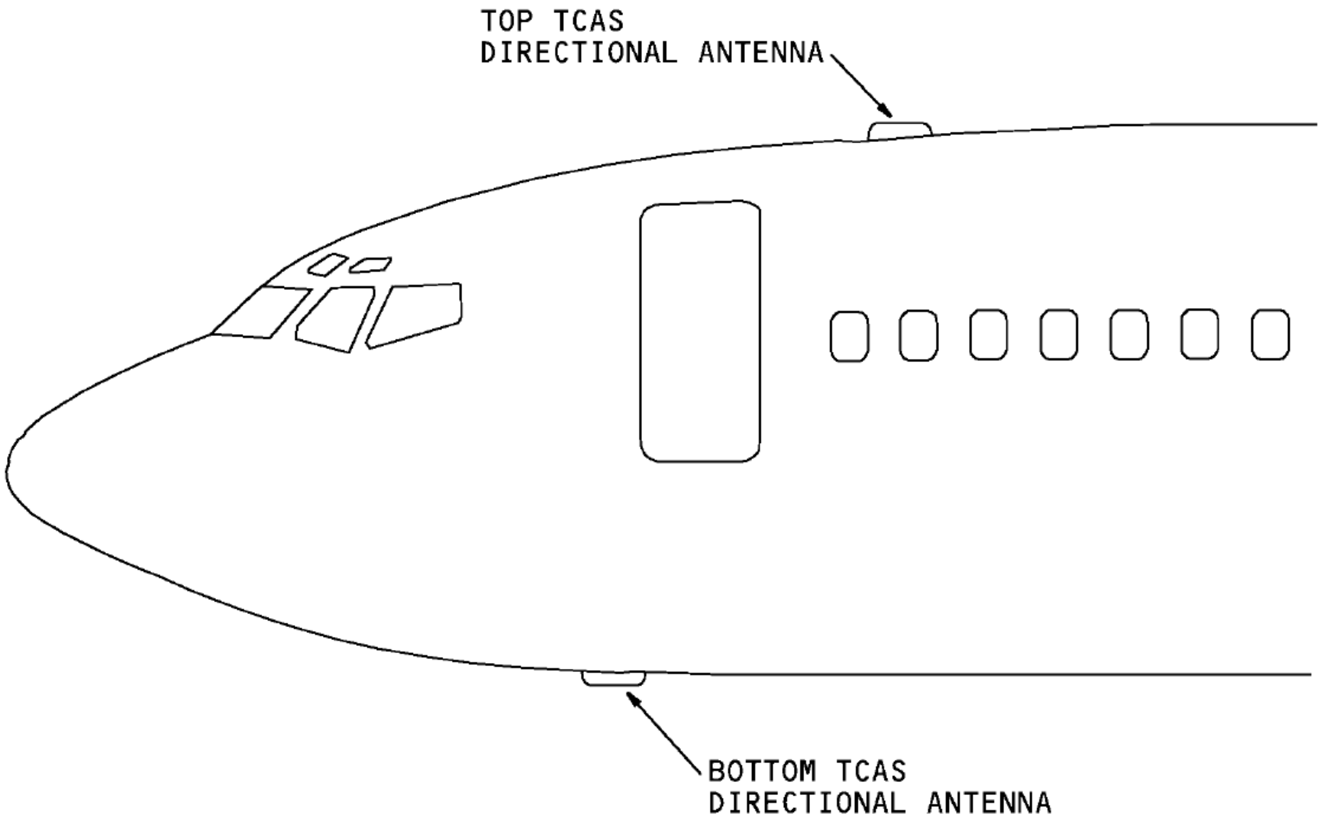


ELECTRONIC EQUIPMENT COMPARTMENT

COMPONENTS LOCATION

Antennas

The top TCAS directional antenna is at station 385 on top of the fuselage. The bottom TCAS directional antenna is at station 305 on the bottom of the fuselage.



ANTENNAS LOCATION

TCAS - INTERFACES

POWER, ANTENNAS, ANALOG, DISCRETE INTERFACES AND PROGRAM PINS

The TCAS computer has analog and discrete interfaces with these components:

- Top and bottom TCAS directional antennas
- Landing gear lever switch
- Proximity Switch Electronics Unit (PSEU)
- Ground proximity warning computer (GPWC)
- Weather radar
- DME/ATC/TCAS suppression coax tees
- Display electronic unit (DEU) 1 and 2
- Remote electronics unit (REU).

Program pins control the configuration of the TCAS computer.

Power

The TCAS computer gets 115v ac from AC transfer bus-1 through the TCAS circuit breaker on the P18 circuit breaker panel.

Antennas

There are two TCAS directional antennas. The TCAS directional antennas receive traffic airplane reply signals. They also transmit the TCAS interrogation signals.

Landing Gear Lever Switch

The discrete from the landing gear lever switch tells the TCAS computer that the landing gear is down. When the TCAS computer gets this discrete, the TCAS computer makes the bottom directional antenna become an omnidirectional antenna.

PSEU

The discrete from the PSEU supplies in-air or on-ground status to the TCAS computer. The air/ground discrete inhibits TCAS operation on the ground and inhibits tests when in the air. The air/ground discrete also controls flight leg increments in the TCAS nonvolatile memory.

GPWC - Advisory Inhibit Discretes

The GPWC sends one discrete to the TCAS computer. This discrete inhibits TCAS aural and visual warnings when the GPWC makes any voice message.

Weather Radar

The TCAS computer gets one discrete from the weather radar. This discrete inhibits all TCAS aural warnings and changes RAs to TAs when the weather radar makes a predictive windshear warning.

Suppression Input/Output

The TCAS computer gets a suppression pulse when an ATC transponder or DME interrogator transmits. When the TCAS computer transmits, it sends a suppression pulse to the ATC transponders and the DME interrogators.

DEU - Display Status

A discrete from either DEU goes to the TCAS computer when the DEU loses the ability to show TCAS displays.

When the TCAS computer gets this discrete, the TCAS computer does not do these functions:

- Send TCAS display outputs to the DEU
- Send TCAS aurals to the REU
- Transmit coordination data to traffic airplanes with TCAS.

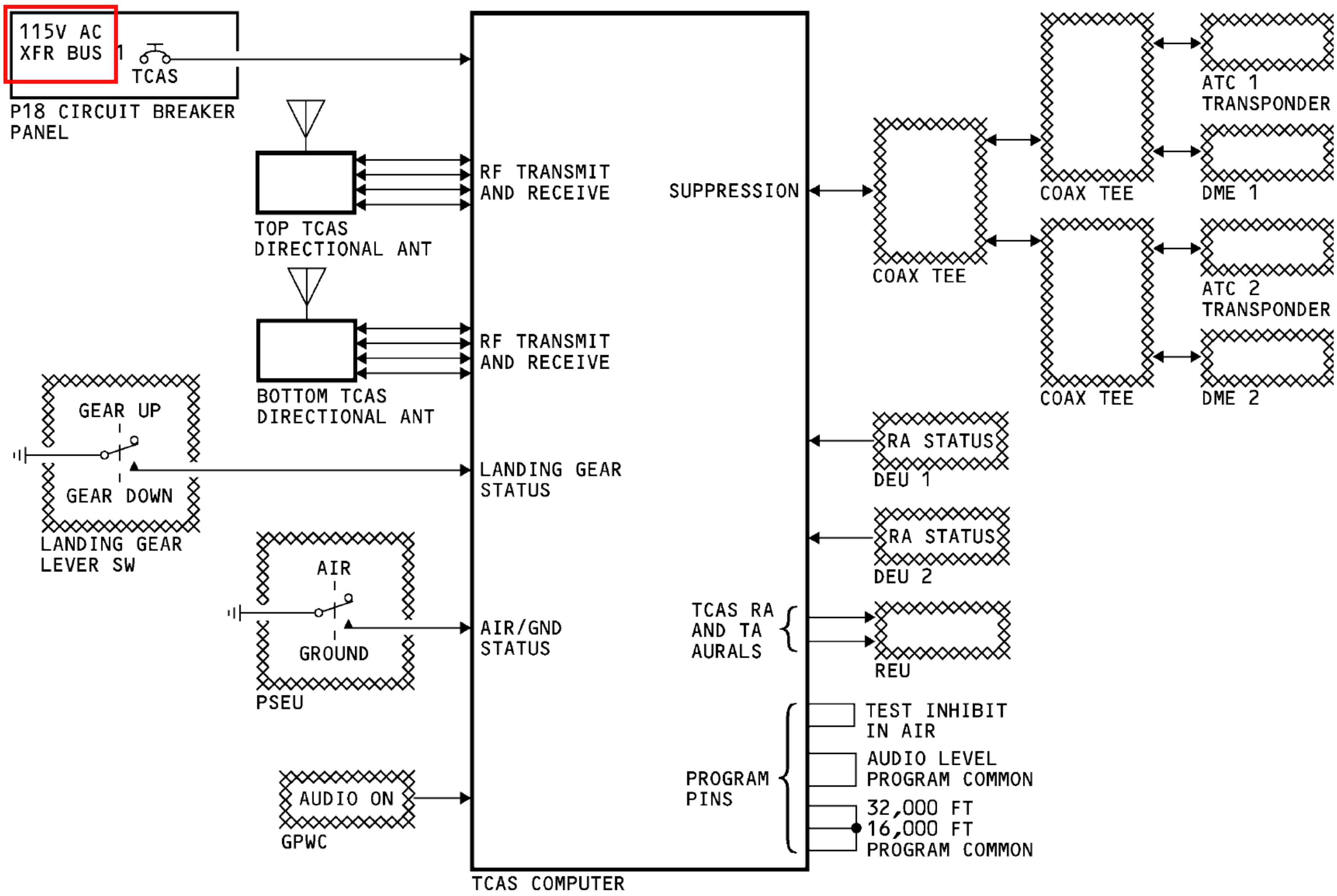
REU - TCAS Aurals - Voice Outputs

The TCAS computer sends resolution advisory (RA) and traffic advisory (TA) aural signals to the remote electronic unit (REU). The REU amplifies the RA and TA aurals. Then it sends them to the flight interphone speakers and headsets to alert the flight crew.

Program Pins

These are the functions for the program pins on the TCAS computer:

- Does not show airplanes that are on the ground when own airplane is below 1750 feet AGL
- Inhibits self-test in the air
- Controls the audio level of the voice outputs
- Sets the airplane altitude limit of 48,000 feet so TCAS does not command a climb or increase climb above this altitude.



POWER, ANTENNAS, ANALOG, DISCRETE INTERFACES AND PROGRAM PINS

DIGITAL INTERFACE

General

The TCAS computer has digital interfaces with these components:

- ATC 1 transponder
- ATC 2 transponder
- Radio altimeter 1 transceiver
- Radio altimeter 2 transceiver
- Left air data inertial reference unit (ADIRU)
- Display electronic unit 2 (DEU 2)
- Display electronic unit 1 (DEU 1)
- Flight data acquisition unit (FDAU).

ATC Transponder - Control and Coordination Data

When you select an ATC transponder, it sends this ATC control panel data to the TCAS computer:

- The TCAS mode selection (TA only or TA/RA)
- Control of the altitude limits for the TCAS display that shows on the navigation display (ND).

The TCAS computer uses this data from the ATC transponder to calculate the climb or descent to prevent a collision:

- 24-bit airplane address
- Barometric altitude
- Maximum true airspeed.

The TCAS computer sends this to the ATC transponder:

- General TCAS operational status
- Mode S coordination data.

Radio Altimeter Inputs

The TCAS computer gets radio altitude from radio altimeter 1 and 2 transceivers although only one input is necessary for TCAS operation. The data is used by the TCAS computer to calculate some sensitivity levels.

At approximately 1700 feet, the TCAS computer uses radio altitude together with barometric altitude to determine intruders that are on the ground and therefore no threat to the TCAS airplane.

At 1000 feet radio altitude, the TCAs computer inhibits resolution advisories and TA ONLY will show on the NDs.

TCAS Inputs from ADIRU

The left ADIRU supplies (for future use) these inputs to the TCAS computer:

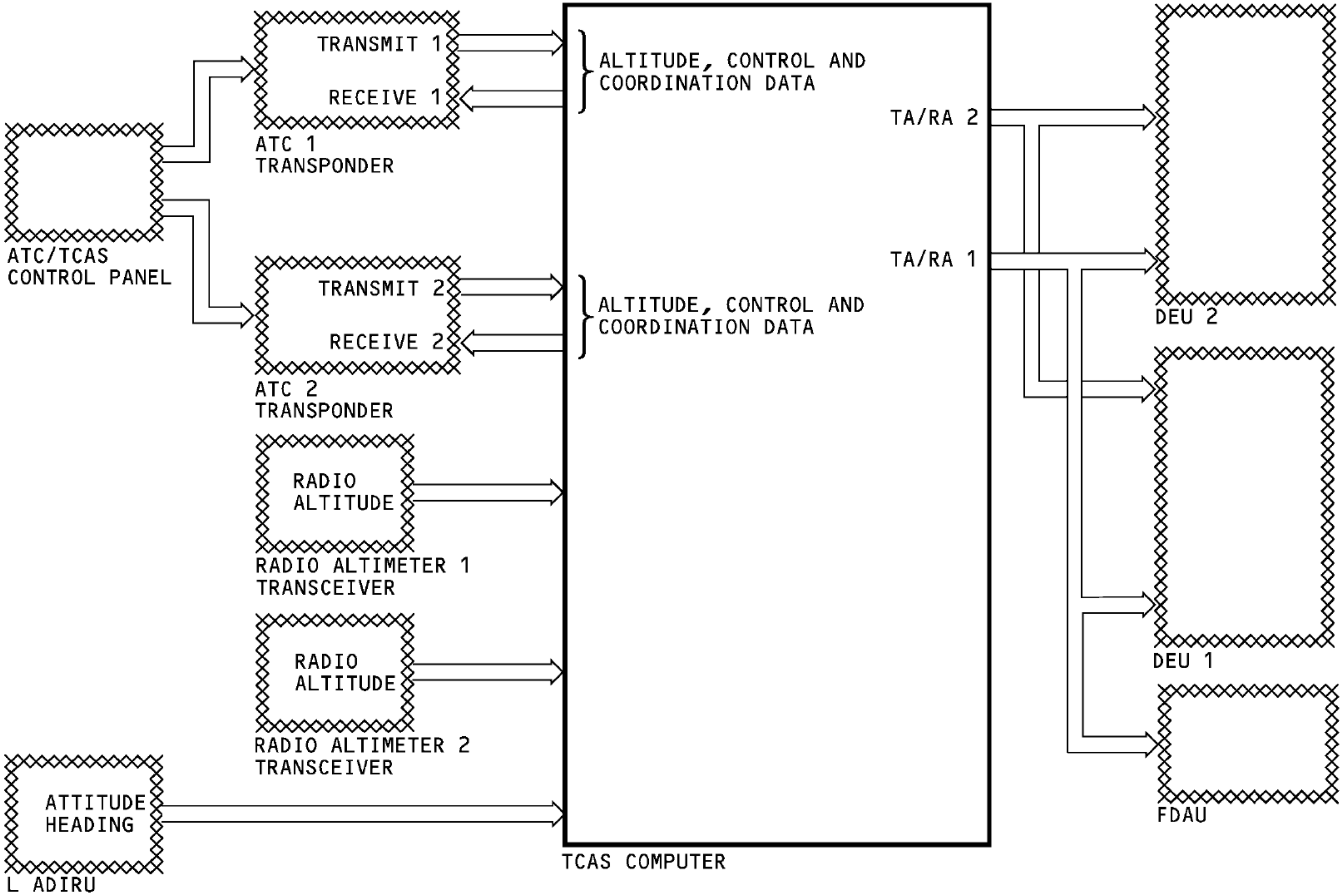
- Airplane roll attitude
- Airplane pitch attitude
- Airplane heading.

TCAS Outputs to DEUs

The TCAS computer supplies resolution advisory (RA) and traffic advisory (TA) data to the DEUs. This includes all traffic data for TCAS displays.

TCAS Outputs to the FDAU

The FDAU receives the same TCAS data that goes to the DEUs.



DIGITAL INTERFACES

TCAS – COMPONENTS

TCAS COMPUTER

Purpose

The TCAS computer is the main component of the TCAS.

It controls these functions:

- Surveillance
- Tracking
- Advisory
- Air-to-air maneuver coordination.

The TCAS computer sends signals which tell the flight crew to make one of these maneuvers:

- Keep the current flight plan
- Make flight maneuvers to prevent a possible collision with other airplanes in the area.

Physical Description

The TCAS computer is a 6 MCU size unit. It weighs 28 lbs (11.3 kg).

Functional Description

The TCAS computer transmits 1030 MHz pulse-coded interrogation signals. It receives 1090 MHz pulse-coded reply signals from intruder airplanes with an ATC transponder.

Front Panel LED Indications

These are the status light emitting diodes (LEDs):

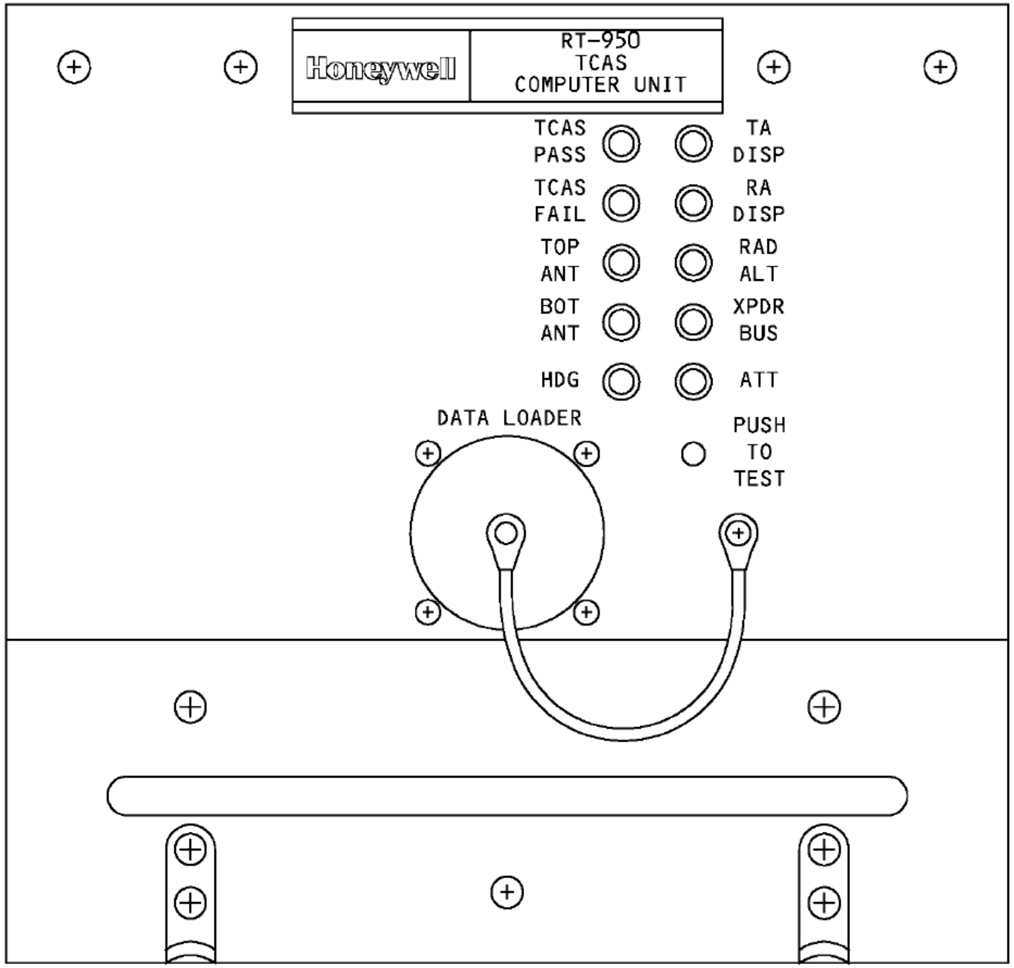
- A green PASS to show that there is no TCAS computer failure
- A red FAIL to show a TCAS computer failure
- A red XPNDR to show an ATC transponder interface failure
- A red UPPER ANT to show a top TCAS antenna failure
- A red LOWER ANT to show a bottom TCAS antenna failure
- A red RAD ALT to show no radio altitude data from the RA
- A red HDNG to show no heading data from the ADIRU
- A red R/A to show a DEU display function failure
- The red T/A does not operate.

Front Panel Self-Test

You push the test switch on the front panel to start a test of the TCAS. The LED indications come on to show system status.

Front Panel Connectors

There is one connector on the front panel. You use it to load revised software and for automated test equipment.



TCAS COMPUTER

ATC/TCAS CONTROL PANEL

The ATC/TCAS control panel controls the TCAS computer.

Function Select Switch

You use the function select switch to select one of these TCAS modes:

- TA ONLY mode. This is the TA only mode. The display of RAs is prevented.
- TA/RA mode. The displays show all targets. This is the normal mode of operation for TCAS.

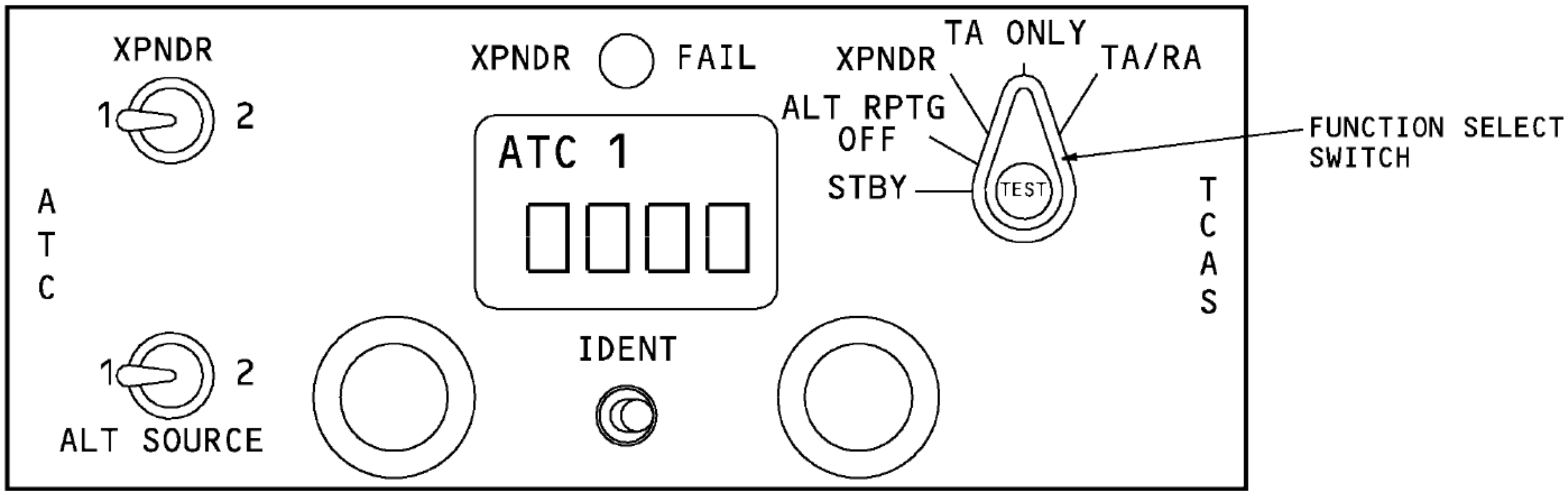
You can use the test button in the center of the switch to do a test of the ATC and TCAS systems.

Above/Normal/Below Switch (if installed)

This switch selects the relative altitude limits to show other traffic on the display. Other traffic shows as a white diamond that is not filled.

The switch has these three positions:

- ABOVE - this makes the display show other traffic that is from 2700 feet below to 7000 feet above the present airplane altitude.
- NORM - this makes the display show other traffic that is from 2700 feet below to 2700 feet above the present airplane altitude.
- BELOW - this makes the display show other traffic that is from 7000 feet below to 2700 feet above the present airplane altitude.

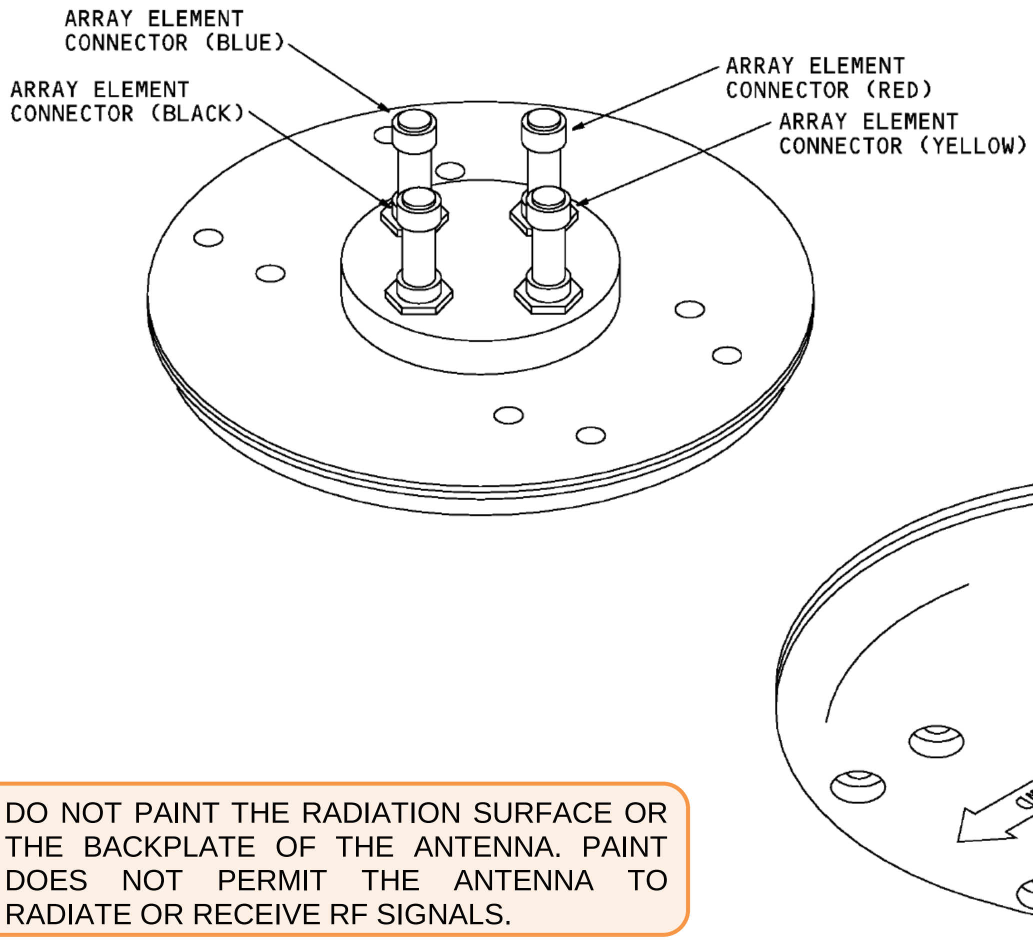


ATC/TCAS CONTROL PANEL

TCAS DIRECTIONAL ANTENNA

The TCAS uses a top and bottom directional antenna. The antennas are the same and interchangeable.

Caution: TO PREVENT DAMAGE TO THE ANTENNA CABLES, DO NOT PULL ON THEM.



Caution: DO NOT PAINT THE RADIATION SURFACE OR THE BACKPLATE OF THE ANTENNA. PAINT DOES NOT PERMIT THE ANTENNA TO RADIATE OR RECEIVE RF SIGNALS.

Physical Description

The directional antenna is a phased array antenna. There are four array elements on the antenna. Each element has a color coded connector. The TCAS computer sends transmit interrogation signals to the array elements with different phases. This makes the interrogation signal directional.

To attach the antenna cables, connect each coaxial cable with the array element connector that has the same color band.

Four screws attach the antenna to the airplane. The radiation side of the antenna shows FWD and DO NOT PAINT.

Training Information Point

An antenna connection includes the coax cable and an antenna element. The TCAS computer checks the resistance of each antenna connection at power-up. The TCAS computer reports an antenna fault when it detects that the resistance of the connection is out of range. If you do not connect the coax cable to the correct element, the TCAS computer reports an antenna fault.

TCAS DIRECTIONAL ANTENNA

TCAS - FUNCTIONAL DESCRIPTION

General

The TCAS computer transmits interrogations to and receives replies from other airplanes. Airplanes that are tracked by TCAS are called targets. The TCAS computer uses these replies and data from other airplane systems to calculate if a target is a collision threat. The TCAS computer can communicate with other airplanes that have TCAS. The two TCAS computers can use the shared data to perform coordinated maneuvers and avoid potential collisions.

The TCAS computer also gets analog and digital inputs from other airplane systems. These inputs control TCAS and provide data for TCAS to track intruders. The TCAS computer sends display data to the common display system (CDS) display electronic units (DEUs).

The TCAS computer has these circuits:

- Input/output (I/O)
- Speech Processor
- Central processing unit (CPU) and memory
- Suppression circuit
- Signal Processor
- Receiver
- Transmitter
- Beam steering and attenuator
- BITE.

I/O

The I/O circuit gets this on-board airplane systems data and send to the CPU:

- Magnetic heading data from the left ADIRU
- Coordination and control data from the ATC transponder system
- Barometric altitude from the left or right ADIRU from the active **ATC**
- Radio altitude from the radio altimeters
- Resolution advisory status from the DEUs
- Landing gear down discrete from the landing gear lever switch
- Aural inhibit discrete interface with the GPWC
- Aural inhibit discrete interface with the weather radar
- Air/ground data from the PSEU.

Program pins set these parameters in the TCAS computer:

- Altitude limits
- Aural warning volume levels
- Self test inhibits
- Standby on ground
- Intruders on ground disabled.

CPU

The CPU gets the data from the inputs of the I/O and puts it into memory. The CPU combines the input data and the data it receives from the signal processor. The CPU makes the necessary calculations for the TCAS displays and aural messages.

The CPU sends TCAS display data to the CDS DEUs.

It shows on these indicators:

- Attitude indicators (AI)
- Navigation display (ND)

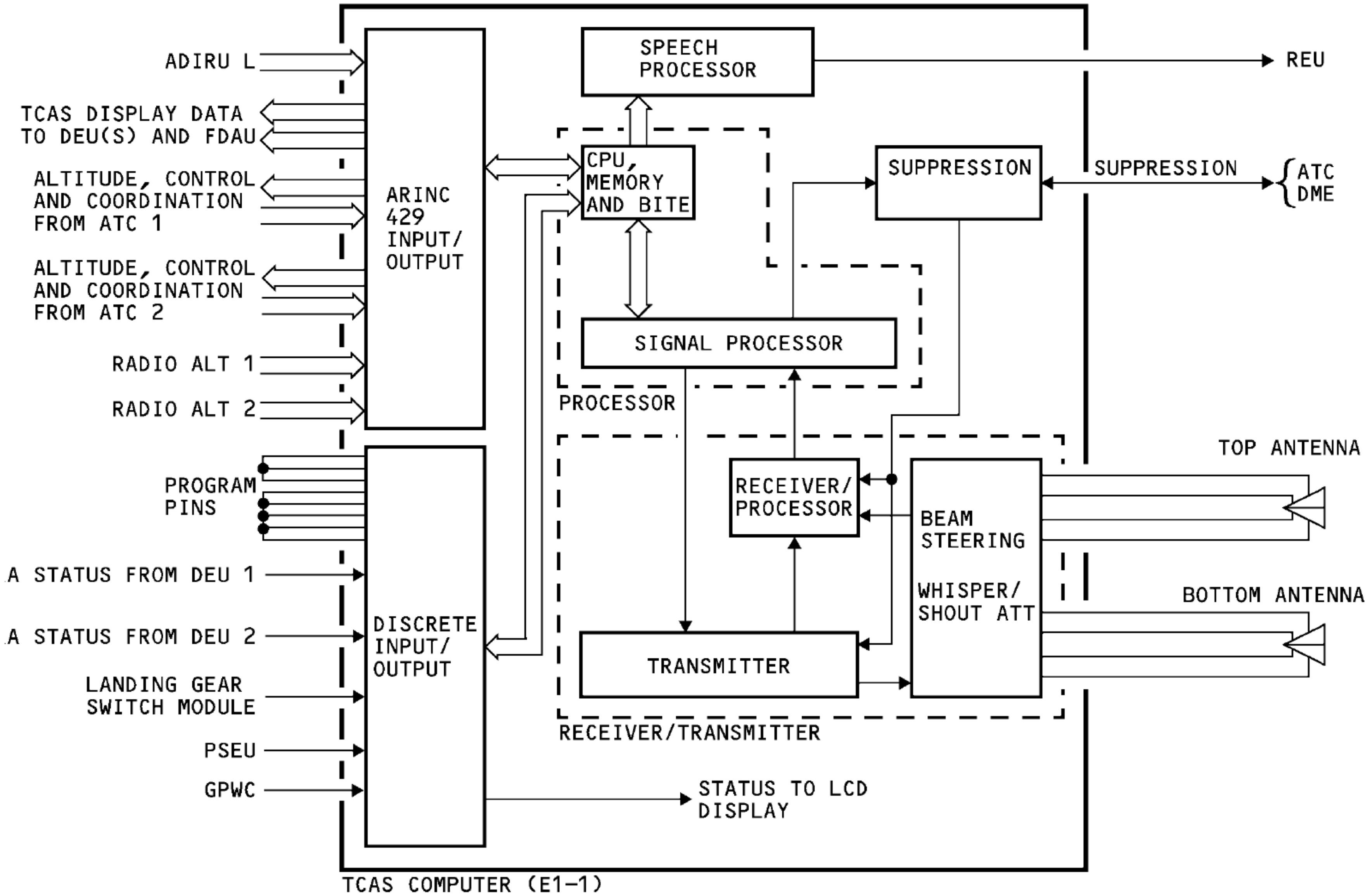
The CPU sends the display data to the flight data acquisition unit (FDAU). It also sends signals through the speech processor circuits to the REU to make TCAS aurals.

Signal Processor

The signal processor gets bearing information from the receiver/processor and changes it to digital signals.

The signal processor does these functions:

- Uses time measurement logic and the bearing information to calculate the intruder airplane range and bearing
- Detects the mode C or mode S pulses
- Controls the suppression circuit to send the suppression pulse when TCAS transmits
- Makes all signals necessary to receive and transmit mode S and ATCRBS interrogations through the receiver/transmitter circuits.



FUNCTIONAL DIAGRAM

FUNCTIONAL DESCRIPTION (Continue)

Suppression

The suppression circuit sends a suppression pulse when the TCAS computer transmits. The TCAS computer receives a suppression pulse when an onboard ATC transponder or DME interrogator system transmits. This suppression pulse stops the TCAS computer receiver and transmitter circuits.

Speech Processor

When there is a TA, RA, or during a self-test, the TCAS computer sends signals to the speech processor. The speech processor sends the aural alerts to the REU. The REU sends them to the flight compartment.

During aural annunciations the GPWC sends an analog discrete to the TCAS computer to prevent TCAS advisories.

During predictive windshear annunciations the weather radar sends an analog discrete to the TCAS computer to prevent TCAS advisories.

Receiver Processor

The receiver gets the target replies from the antennas. The receiver uses the phase of the received signals to determine the bearing of the target. The receiver sends the signal to the signal processor to calculate the range to the target. The receiver decodes the target altitude from the reply signal. The receiver also receives and decodes coordination replies from targets equipped with TCAS.

Transmitter

The transmitter has a 1030 MHz output. The transmitter gets signals from the signal processor. The transmitter sends the formatted signals to the beam steering and attenuator (ATT) circuits. The transmitter controls the beam steering circuits and whisper/shout attenuator.

Beam Steering and Attenuator Circuits

The beam steering circuits send the signals to the four antenna elements. During transmit, the beam steering circuit controls the phase relationships of the four RF outputs. The whisper/shout attenuator makes the output power smaller or larger based on the control signals from the transmitter.

During receive, the phase of the received signals is different in each element. These beam steering circuit sends the signals to the receiver.

The TCAS computer receives a discrete input from the landing gear lever switch. When the landing gear lever is down, the TCAS computer uses all four antenna elements equally for the bottom antenna. Thus, the bottom antenna operates as an omnidirectional antenna.

BITE

The TCAS computer has BITE. The BITE continuously monitors TCAS for system faults and interface faults during normal operation. Also, when you start a self- test, the BITE makes test signals and sends them to the signal processor and receiver/transmitter circuits. The BITE monitors for system faults and interface faults during the self-test.

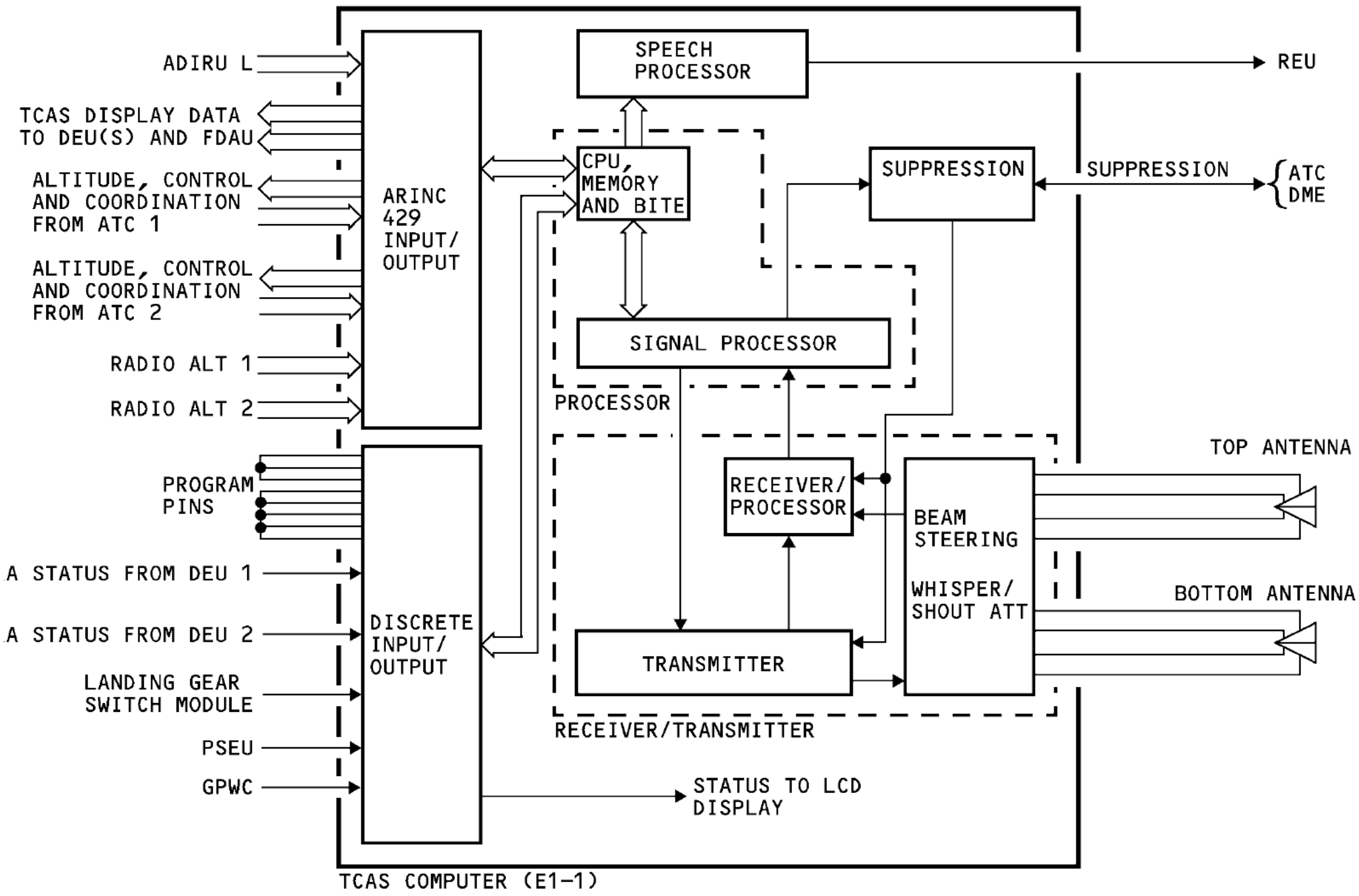
When the BITE detects a fault through the continuous fault monitor, the fault goes into the fault memory. It also goes to the I/O circuits for output to the CDS DEUs and the FDAU.

When the BITE detects a fault during a self-test, the fault data goes to the I/O and then to these systems:

- DEUs
- REU
- FDAU
- TCAS computer status LEDs if test is done from computer front panel.

Directional Antenna

The directional antenna has four elements spaced 90 degrees apart. Each element is independent of the others and has it own coaxial connector.



FUNCTIONAL DESCRIPTION

TCAS - BASIC OPERATION

General

TCAS transmits these two types of interrogation signals:
- Whisper-shout for ATCRBS transponders
- Mode S.

The TCAS finds and monitors all of the airplanes within range that have ATCRBS or mode S transponders. The TCAS operates with its mode S transponders to interrogate traffic airplanes and calculate if they are a threat. The TCAS does not track airplanes that do not have a transponder. The TCAS tracks airplanes with transponders that do not reply with mode C information. These airplanes send framing pulses in response to a mode C interrogation. The TCAS uses the framing pulse replies to give range and bearing to the target. TCAS cannot give RAs for targets that do not report altitude.

The TCAS can calculate maneuver commands to prevent possible collisions with target airplanes.

If the traffic airplane also has TCAS, the two airplanes can agree on maneuvers that give a safe distance between them.

Whisper-Shout Interrogation

The TCAS uses an ATCRBS all-call whisper-shout interrogation to look for airplanes that have an ATCRBS transponder. The whisper-shout procedure changes the strength of the interrogation pulse in many steps. This lets TCAS interrogate intruders at different ranges. Intruders that reply are put on the TCAS roll call list and TCAS monitors them.

The airplanes that are near receive the lower power (whisper) interrogations. The airplanes that are far away do not receive these low power signals so they do not respond.

The TCAS transmits a suppression pulse as the interrogation power increases.

The airplanes that are farther away receive the higher power (shout) interrogations. The airplanes that are near receive the interrogation and the suppression pulse so they do not reply.

Mode S Interrogation

Mode S transponders transmit a squitter signal once each second. The signals contain a 24-bit airplane address. The TCAS listens for mode S squitter signal transmissions from airplanes that have mode S transponders. When the TCAS receives an address, it puts that airplane on a roll call list. The TCAS then interrogates the mode S transponder of the traffic airplane with the discrete 24- bit airplane address on the roll call list.

TCAS Data Calculation

When the TCAS interrogates a target, the reply signal from the target usually contains the airplane altitude and any information requested by TCAS.

The TCAS computer uses the round-trip time of the reply signal to calculate the range and range rate of the target. It uses the direction of the reply to calculate bearing of the target.

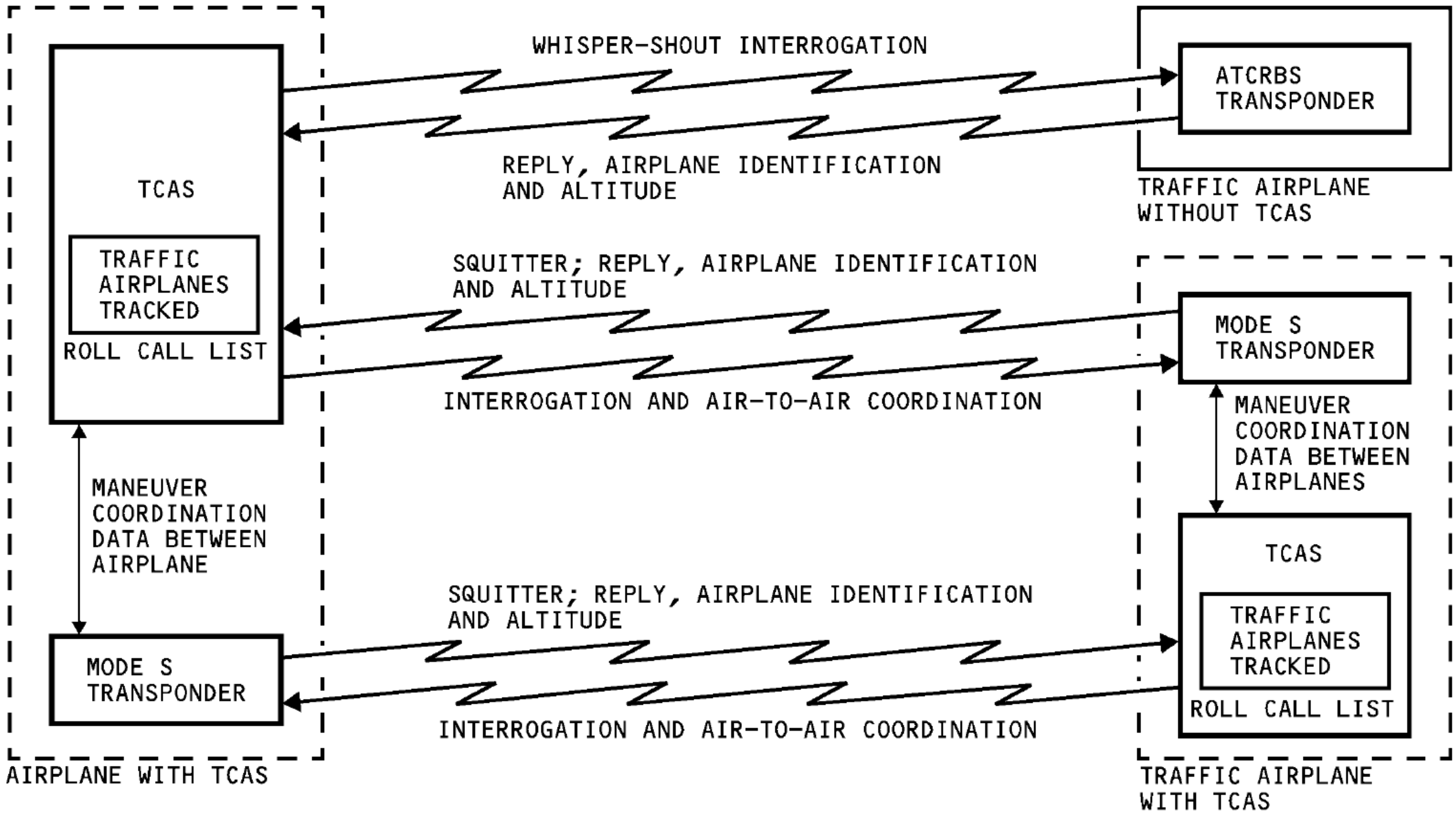
If the TCAS computer receives altitude data, it calculates these parameters of the traffic airplane:
- altitude
- altitude rate
- relative altitude.

The TCAS computer uses the target data to calculate if the target is on a possible collision or near collision course with its flight path. If it is, the TCAS computer calculates traffic coordination maneuver data. This data and the position data go to the DEUs to make the TCAS displays. If TCAS advises that a maneuver be made it also sends an aural command to the flight crew.

Air-to-Air Coordination

If the target also has TCAS, the two TCAS computers communicate with each other using the mode S transponders.

Both TCAS computers calculate an escape path if it is necessary. Both TCAS computers send the escape path to the mode S transponder in the other airplane. This sets up the air-to-air mode S data link between the airplanes.



BASIC OPERATION DIAGRAM

TCAS SURVEILLANCE AREA

General

The TCAS tracks and evaluates up to 30 airplanes that are in the surveillance area.

Airplanes in the surveillance area are put into one of these four groups:

- Resolution advisory (RA) group
- Traffic advisory (TA) group
- Proximate traffic
- Other traffic.

TCAS has a maximum surveillance area that is 8700 feet above and below your airplane. It has a range of 40 nm.

RA and TA Groups

The TCAS forms two protected areas around its own airplane. The dimensions of these protected areas change with airspeed and altitude of the TCAS airplane and the closure rate of the target.

The protected area represents the time until the target will be at the closest point of approach (CPA) to the TCAS airplane. This protected area is called the TAU area.

To calculate the TAU, the TCAS computer uses this data:

- Own airplane altitude
- Target closure rate
- Target range and altitude.

Traffic advisory TAU and resolution advisory TAU define areas around the TCAS airplane that, if penetrated by a target within the required altitude restrictions, would produce the appropriate warning from the TCAS computer.

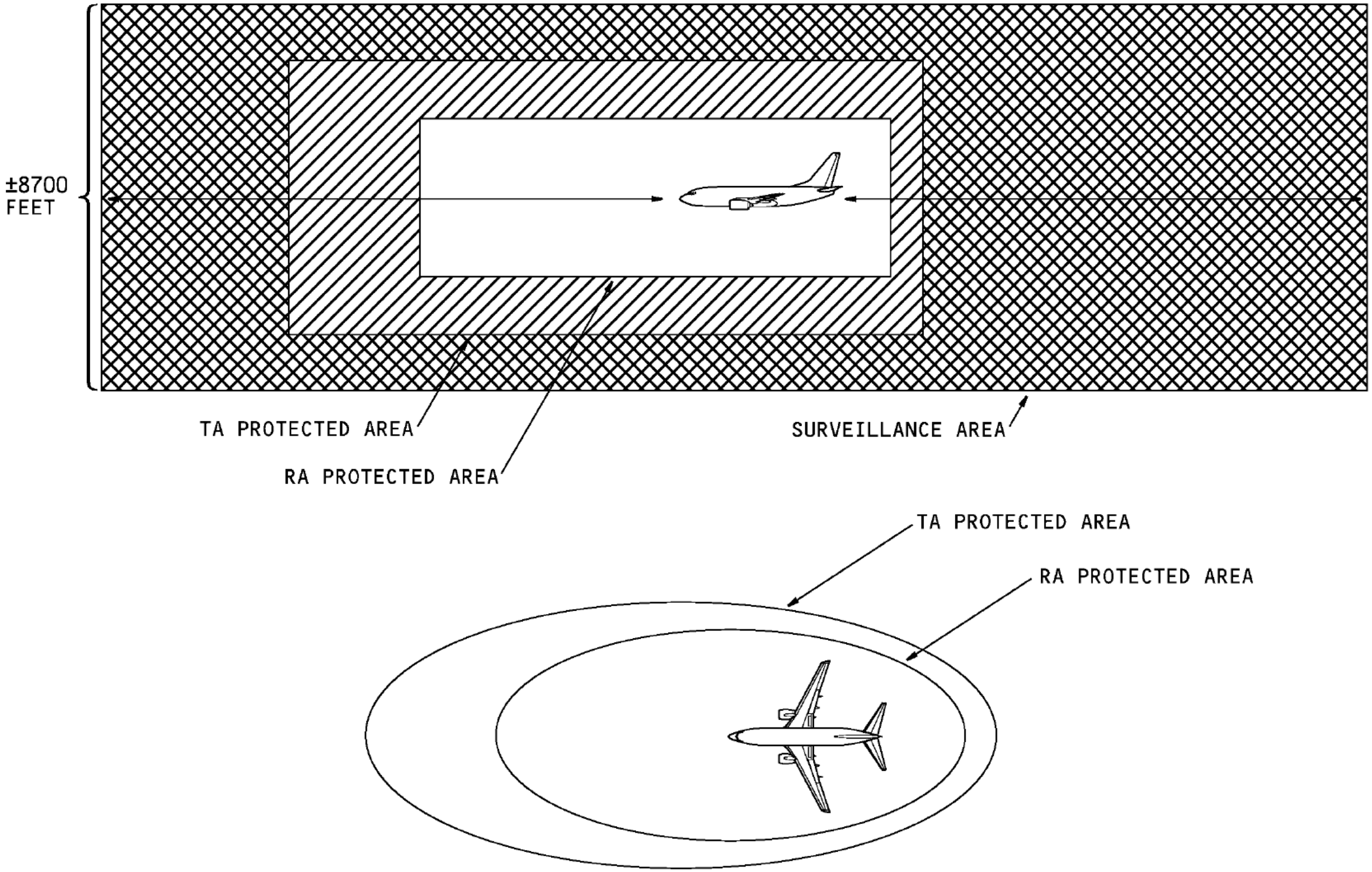
The TCAS computer uses six sensitivity levels (2-7). Level 7 is the most sensitive. At level 2, no resolution advisories may occur. Below 1000 feet, level 2 is used and above 20000 feet, level 7 is used. Sensitivity levels are set by the TCAS computer based on own airplane altitude.

The TA and RA times vary with sensitivity level. At sensitivity level 3, RA TAU is 15 seconds while at sensitivity level 7, RA TAU is 35 seconds.

Proximate Traffic and Other Traffic

Proximate traffic is an airplane with a relative altitude separation less than 1200 feet, is in a 6 nm radius of your airplane, and is not a TA or RA threat.

Other traffic is an airplane with a range more than 6 nm that is not a TA or RA threat. If the range is less than 6 nm, the relative altitude must be more than 1200 feet.



TCAS SURVEILLANCE AREA

TCAS - CONTROL AND DISPLAY

General

The EFIS control panel and the ATC control panel control the TCAS data that shows on the displays.

EFIS Control Panel

To show the TCAS data on the display, put the mode selector on the EFIS control panel in one of these modes:

- Expanded approach
- Expanded VOR
- Expanded map
- Centered map.

The range selector selects the range for the ND.
Push the TFC (traffic) switch on the range selector to let the ND show the TCAS data. When you do this, the TFC message and the TCAS symbols of any targets show on the display.

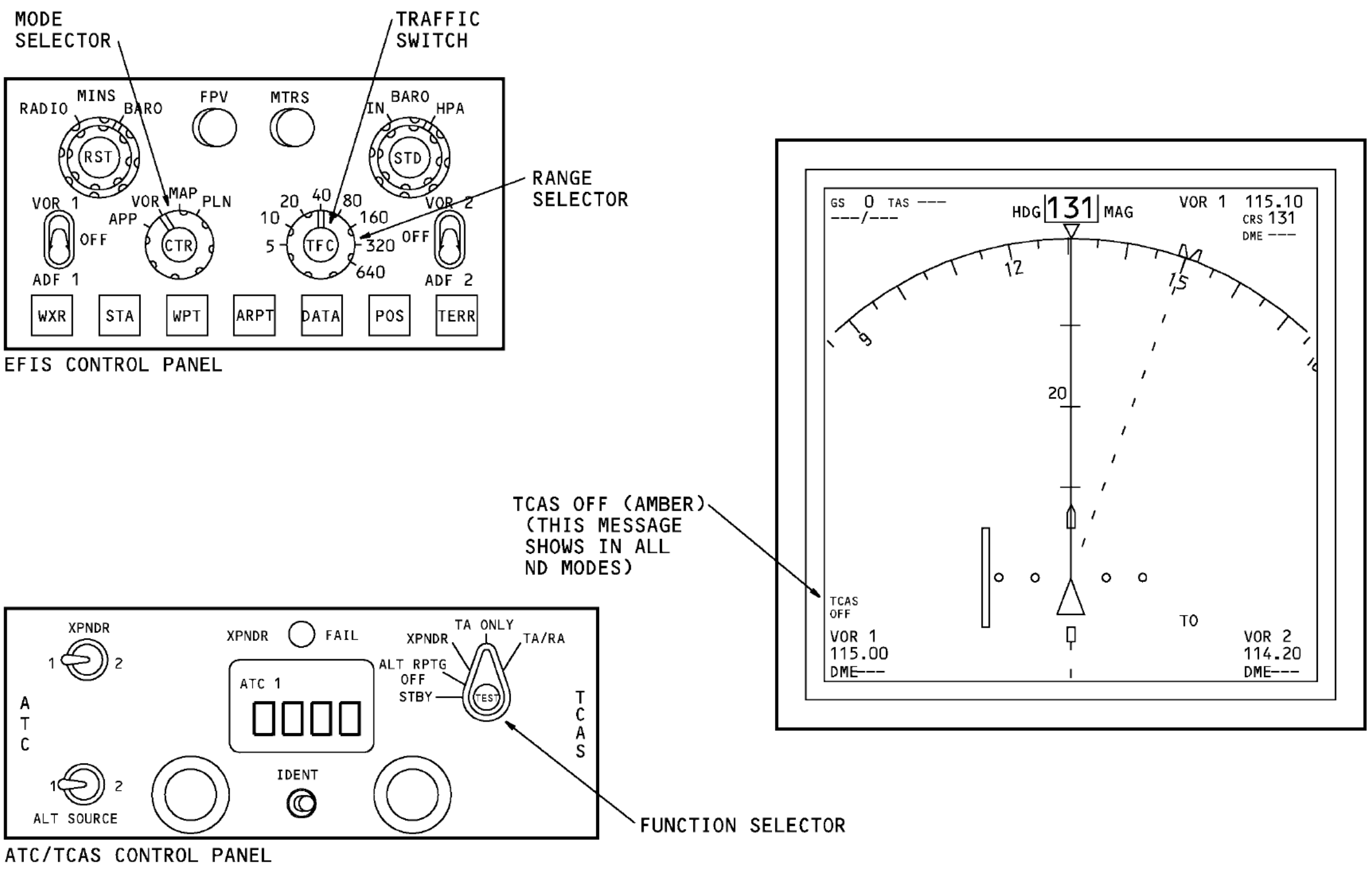
If the function selector on the ATC control panel is not in the TA or TA/RA position, the display does this:

- Shows an amber message, TCAS OFF (TCAS OFF shows in all ND modes)
- Removes all TCAS target symbols.

To remove the TCAS messages and symbols from the display, push the TFC switch again.

ATC/TCAS Control Panel

The ATC/TCAS control panel sends control data through the ATC Mode S transponder to the TCAS computer. The TCAS computer sends this data to the DEU for display.
The function selector puts the TCAS computer in the TA only or TA/RA mode. In the TA only mode, the TCAS does not supply RA traffic symbols or advisories. It also does not supply RA aural messages. The function selector can also put the TCAS computer in the test mode.
The ND shows the relative altitude of the target above or below the symbol.



CONTROL AND DISPLAY

TCAS - DISPLAYS

NAVIGATION DISPLAY

The TCAS computer puts traffic into these four groups:

- Other traffic shows as a white open diamond, and the altitude readout is white text
- Proximate traffic shows as a solid white diamond, and the altitude readout is white text
- Traffic advisory (TA) shows as a solid amber circle, and the altitude readout is amber text
- Resolution advisory (RA) shows as a solid red square and the altitude readout is red text.

Each traffic symbol has an altitude readout. A vertical motion arrow is also shown if the airplane vertical speed is greater than 500 feet per minute (fpm).

The traffic symbols show in these navigation display modes:

- Center (CTR) MAP
- Expanded (EXP) MAP
- Expanded (EXP) VOR
- Expanded (EXP) APP.

Range Data

Push the TFC switch on the EFIS control panel to show TCAS data. The range the EFIS control panel selects also shows on the ND.

Also, when you push the TFC switch, range arcs show on the ND.

Altitude Readout

Relative altitude shows in the same color as the traffic symbol on the NDs.

Altitude Separation

The TCAS computer calculates the altitude separation between own airplane and the target. It uses the barometric altitudes of the airplanes to do this. The altitude separation shows on the ND in hundreds of feet. If the traffic is above, the digits show above the traffic symbol with a plus (+) sign. If the traffic is below, the digits show below the traffic symbol with a minus (-) sign.

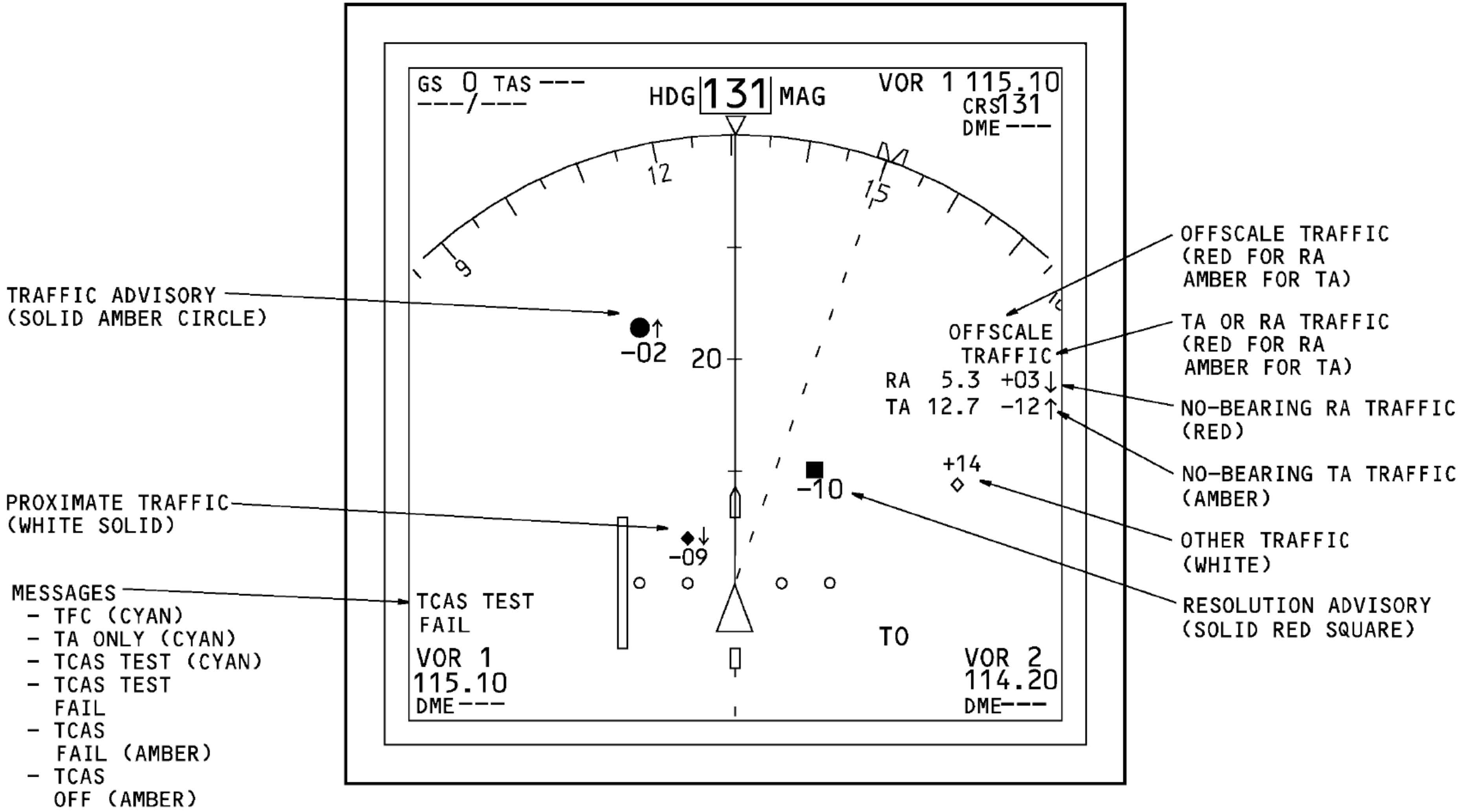
If the altitude separation is less than 100 feet, 00 shows.

If the altitude separation cannot be calculated, the altitude display does not show.

Vertical Motion Arrow

A vertical motion arrow shows on the right side of the traffic symbol. It is the same color as the traffic symbol.

The arrow points down if the traffic airplane goes down at a rate more than or equal to 500 fpm. The arrow points up if the traffic airplane is in a climb at a rate more than or equal to 500 fpm. The arrow does not show for rates less than 500 fpm.



TCAS DISPLAY – NAVIGATION DISPLAY

NAVIGATION DISPLAY
(Continue)

TCAS Messages

The ND can show these messages for TCAS:

- TFC shows in cyan in the CTR MAP and EXP MAP, VOR and APP modes. It shows the TCAS traffic display is active. The TFC switch on the EFIS control panel must be set to ON.
- TA ONLY shows in cyan and in all modes. It shows that TCAS is not calculating RAs. It shows if the TFC switch on the EFIS control panel is set to ON or OFF.
- TCAS TEST shows in cyan and in all modes. It shows that TCAS is in the test mode. It shows if the TFC switch on the EFIS control panel is set to ON or OFF.
- TCAS TEST FAIL shows on two lines when in test mode and the TCAS has a failure. TCAS and FAIL show in amber and TEST shows in cyan. It shows if the TFC switch on the EFIS control panel is set to ON or OFF.
- TCAS FAIL shows in amber and in all modes. It shows that TCAS has failed. The TFC switch on the EFIS control panel must be set to ON.
- TCAS OFF shows on two lines in amber and in all modes. It shows that the ATC mode switch is not in TA or TA/RA. It shows if the TFC switch on the EFIS control panel is set to ON or OFF.

OFFSCALE

The OFFSCALE message shows on the ND when an RA or TA is outside the current ND display area. The TFC switch on the EFIS control panel must be set to ON to show the OFFSCALE message. If an RA is outside the ND range, the OFFSCALE message shows in red. If a TA is outside the ND range, the OFFSCALE message shows in amber. If both a TA and RA are outside the ND range, the OFFSCALE message shows in red.

This message shows in these navigation display modes:

- Center (CTR) MAP
- Expanded (EXP) MAP
- Expanded (EXP) VOR
- Expanded (EXP) APP.

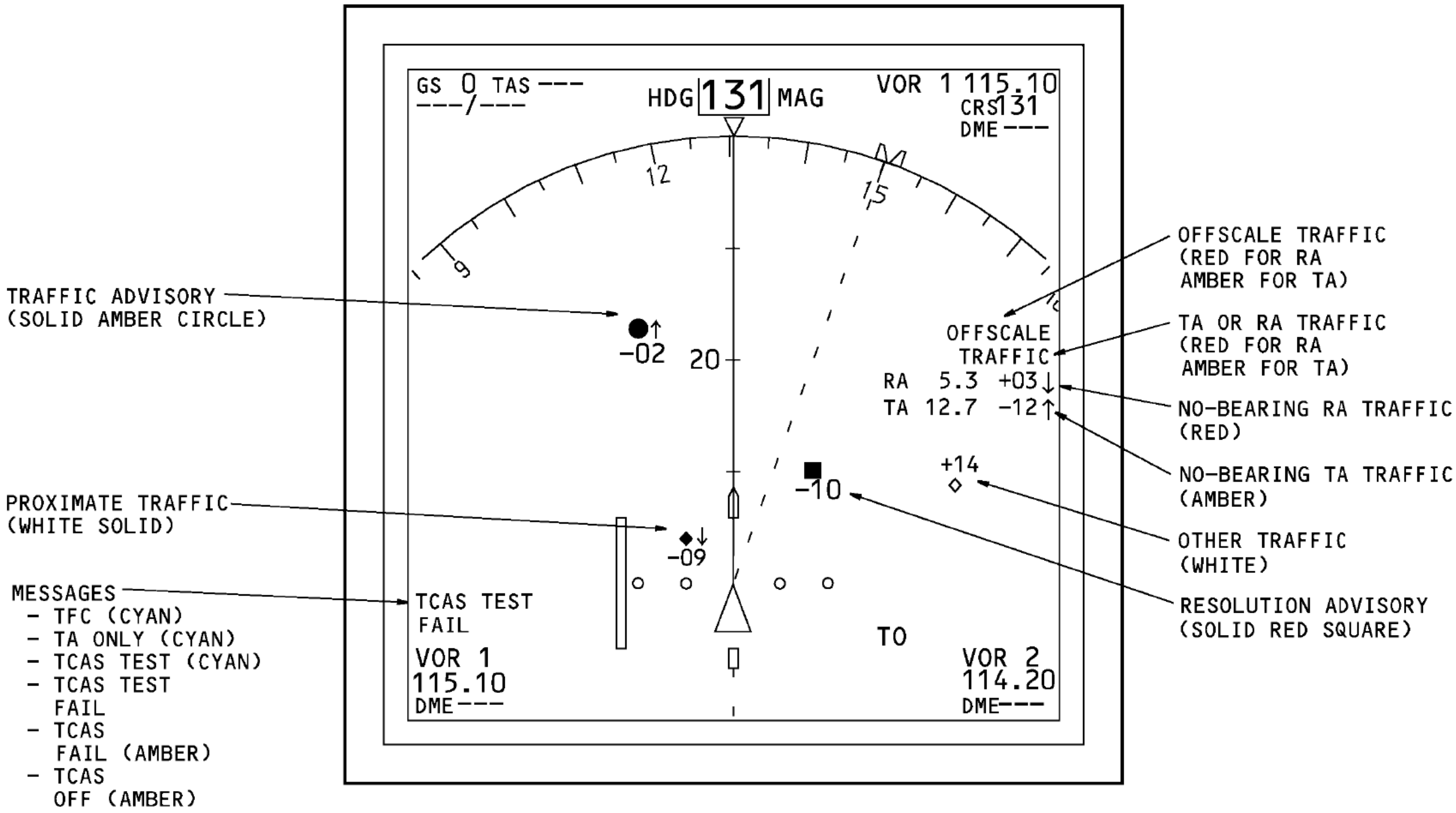
TRAFFIC

The red TRAFFIC message shows any time there is an RA. The amber TRAFFIC message shows any time there is a TA and no RA. The TRAFFIC message shows in all ND formats with the TFC switch on the EFIS control panel set to ON or OFF.

RA and TA No-Bearing Traffic

The no-bearing RA and TA messages show on the ND when TCAS loses the bearing of the RA or TA traffic. The bottom directional antenna becomes an omnidirectional antenna when the landing gear is down. When this happens, the bottom antenna cannot find the bearing of the intruder traffic. The bearing is NCD. Because of this, the no-bearing messages show on the ND.

If a TA becomes no-bearing traffic, an amber TA with the range, altitude, and vertical motion arrow shows on the ND. If an RA becomes no-bearing traffic, a red RA with the range, altitude, and vertical motion arrow shows on the ND. Only two no-bearing traffics may show.



NAVIGATION DISPLAY

ATTITUDE INDICATOR

General

These are the two types of TCAS vertical resolution advisories that can show on the attitude indicator (AI):

- TCAS RA - down advisory
- TCAS RA - up advisory.

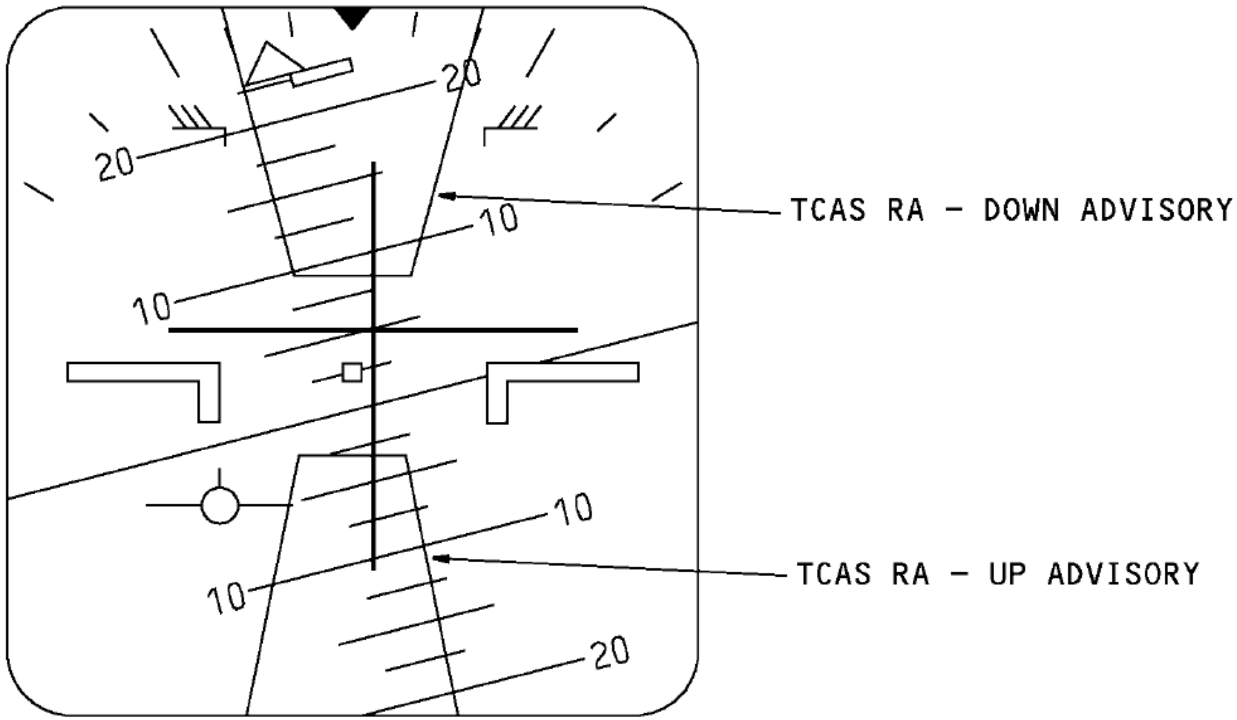
These symbols only show for an RA when:

- The function selector on the ATC control panel is in the TA/RA position
- The TCAS communicates with threat airplanes that give their altitude.

Description

The red advisories show on the attitude display. They tell the flight crew to avoid some pitch movements.

The flight crew uses the advisories to avoid a possible collision with threat airplanes.



ATTITUDE INDICATOR

THIS PAGE IS INTENTIONALLY LEFT BLANK

TCAS - AURAL MESSAGES

Aural advisory messages occur during these conditions:
- Traffic advisories (TA)
- Resolution advisories (RA)
- TCAS system tests.

Traffic Advisory Aural
When a traffic advisory occurs, the aural message TRAFFIC TRAFFIC comes on. This message tells the flight crew to monitor the display for intruder traffic.

Resolution Advisory
These are the two types of aural messages that can come on during a resolution advisory (RA):
- Preventive action RA
- Corrective action RA.

Preventive Action RA
This type of RA occurs when at the closest point of approach (CPA) the present vertical speed results in a safe altitude separation from the threat airplane. When this happens, the aural advisory comes on.

These are the aural messages for the preventive action RA:
- MONITOR VERTICAL SPEED
- MAINTAIN VERTICAL SPEED, MAINTAIN
- MAINTAIN VERTICAL SPEED, CROSSSING MAINTAIN.

The preventive action RA messages tell the flight crew to do these things:
- Maintain the flight path
- Do not fly into the area of RA pitch symbol on the ADI
- Maintain the vertical speed rate.

Corrective Action RA
This type of RA occurs when the altitude separation at the CPA is not safe.These RA aural advisories tell the flight crew to take corrective action to avoid a possible collision:
- CLIMB - CLIMB. The flight crew must climb at a rate to avoid the preventive up advisory.
- CLIMB CROSSING CLIMB - CLIMB CROSSING CLIMB. The flight crew must climb at a rate to avoid the preventive up advisory. The flight path crosses through the flight path of the threat.
- ADJUST VERTICAL SPEED - ADJUST. The flight crew must reduce the rate of climb to avoid the preventive down advisory.
- DESCEND - DESCEND. The flight crew must descend at a rate to avoid the preventive down advisories.
- DESCEND CROSSING DESCEND - DESCEND CROSSING DESCEND. The flight crew must descend at a rate to avoid the preventive down advisory. The flight path crosses through the flight path of the threat.
- ADJUST VERTICAL SPEED - ADJUST. The flight crew must reduce the rate of descent to avoid the preventive up advisory.

Increase Corrective Action RA
This type of RA tells the flight crew to increase the corrective maneuvers because of maneuver changes from the threat airplane or because the flight crew did not react quickly enough to the initial RA:

- INCREASE CLIMB - INCREASE CLIMB. This follows the CLIMB advisory. The range of advised climb rates shifts to tell the flight crew to increase the climb rate.
- INCREASE DESCENT - INCREASE DESCENT. This follows the DESCEND advisory. The range of advised descent rates shifts to tell the flight crew to increase the descent rate.
- CLIMB, CLIMB NOW - CLIMB, CLIMB NOW. This follows the DESCEND advisory. A climb is now necessary to give safe vertical separation at CPA.
- DESCEND, DESCEND NOW - DESCEND, DESCEND NOW. This follows the CLIMB advisory. A descent is now necessary to give safe vertical separation at CPA.

Clear of Conflict
When the range of the threat airplane that causes an RA increases, the aural message CLEAR OF CONFLICT comes on.

Self-Test Aural
At the completion of the self-test, the TCAS computer sends the status aural to the flight compartment. TCAS SYSTEM FAIL indicates that the TCAS computer has a failure. TCAS SYSTEM TEST FAIL indicates an input to the TCAS system has a failure.

AURAL MESSAGE	MESSAGE TYPE
TRAFFIC, TRAFFIC	TRAFFIC ADVISORY
MONITOR VERTICAL SPEED, MONITOR VERTICAL SPEED [1]	RESOLUTION ADVISORY (PREVENTATIVE ACTION)
CLIMB, CLIMB, CLIMB	RESOLUTION ADVISORY (CORRECTIVE ACTION)
DESCEND, DESCEND, DESCEND	
CLIMB, CROSSING CLIMB CLIMB, CROSSING CLIMB	
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	
REDUCE CLIMB, REDUCE CLIMB	
REDUCE DESCENT, REDUCE DESCENT	
CLIMB, CLIMB NOW CLIMB, CLIMB NOW	RESOLUTION ADVISORY (INCREASED CORRECTIVE ACTION) [2]
DESCEND, DESCEND NOW DESCEND, DESCEND NOW	
INCREASE CLIMB, INCREASE CLIMB INCREASE DESCENT, INCREASE DESCENT	
CLEAR OF CONFLICT [3]	CLEARED RESOLUTION ADVISORY
TCAS TEST	TEST START
TCAS TEST PASS	SYSTEM TEST RESULTS
TCAS TEST FAIL	

[1] MONITOR VERTICAL SPEED COMES ON ONCE IF THE RA IS DOWNGRADED FROM A CORRECTIVE ADVISORY TO A PREVENTIVE ADVISORY

[2] INCREASED CORRECTIVE ACTION RA FOLLOWS A CORRECTIVE ACTION RA

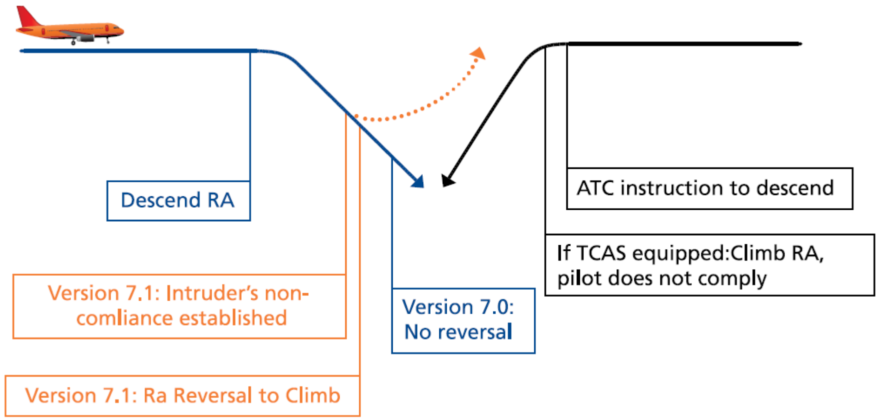
[3] OCCURS WHEN THE RANGE OF THE THREAT INCREASES TO PREVENT THREAT

AURAL MESSAGES TABLE

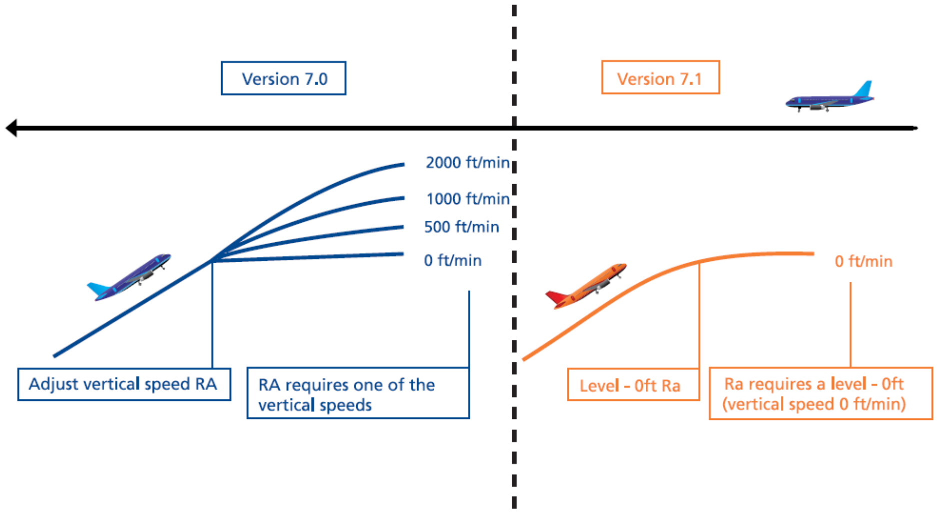
Introduction of change 7.1 software

The Traffic alert and Collision Avoidance System (TCAS) has been introduced in order to reduce the risk of mid-air collisions or near mid-air collisions between aircraft. Studies conducted for Eurocontrol, using recently recorded operational data, indicate that currently the probability of a mid-air collision in European airspace equates to one in every 3 years. When TCAS II version 7.1 is implemented that probability will reduce by a factor of 4.
EASA recently issued Safety Information Bulletin EASA SIB No: 2009-16, in which they indicated that there have been a number of instances of incorrect pilot response to TCAS Resolution Advisories (RA) due to misinterpretation of the RA aural annunciations and RA displays, which have resulted in serious incidents.
The “Adjust Vertical Speed, Adjust” resolution advisory requires the reduction of vertical speed to 2000, 1000, 500, or 0 feet/min. In the cases of incorrect responses, the pilots increased their vertical speed instead of reducing it, consequently, causing the situation to deteriorate.
Enhancements in training alone can improve the behavior of fl ight crews when an “Adjust Vertical Speed, Adjust” resolution advisory is issued, but is not suffi cient to avoid all the opposite reactions.
A second reason to update the current TCAS software is a series of mid-air encounters in which safety margins have been lost (including 2 accidents), due to the failure of the TCAS system to reverse some Resolution Advisories (RA) when a reversal is more efficient to resolve the threat of a collision.
It is expected that EASA will mandate this change 7.1 software update as an Airspace Usage Requirement per December 01/2015.
TCAS software change 7.1 improves safety by implementing the following improvements:

• The “Adjust Vertical Speed, Adjust” (AVSA) RA of TCAS software change 7.0. Several AVSA RA versions have been replaced by a single “Level-off” RA. The associated aural message is straightforward and the associated man oeuvre corresponds to the standard manoeuvre already performed in critical Situations.



• The reversal logic of TCAS software change 7.0 by detecting geometries by easing the triggering thresholds of reversal RAs in encounters in which the aircraft remain within 100 feet vertical separation to each other.
Furthermore the change adds detection of RA compliance by the own aircraft and prediction of vertical separation at the closed point of approach to detect the need of reversal RA.



TCAS - SELF-TEST

General

You can start a self-test from the ATC/TCAS control panel or from the TCAS computer front panel test switch.

During a test, TCAS test signals go to these:

- NDs
- ADIs
- Front panel of the TCAS computer.

At the end of the test, a TCAS test aural goes to the flight interphone speakers.

TCAS Self-Test Indications - ND

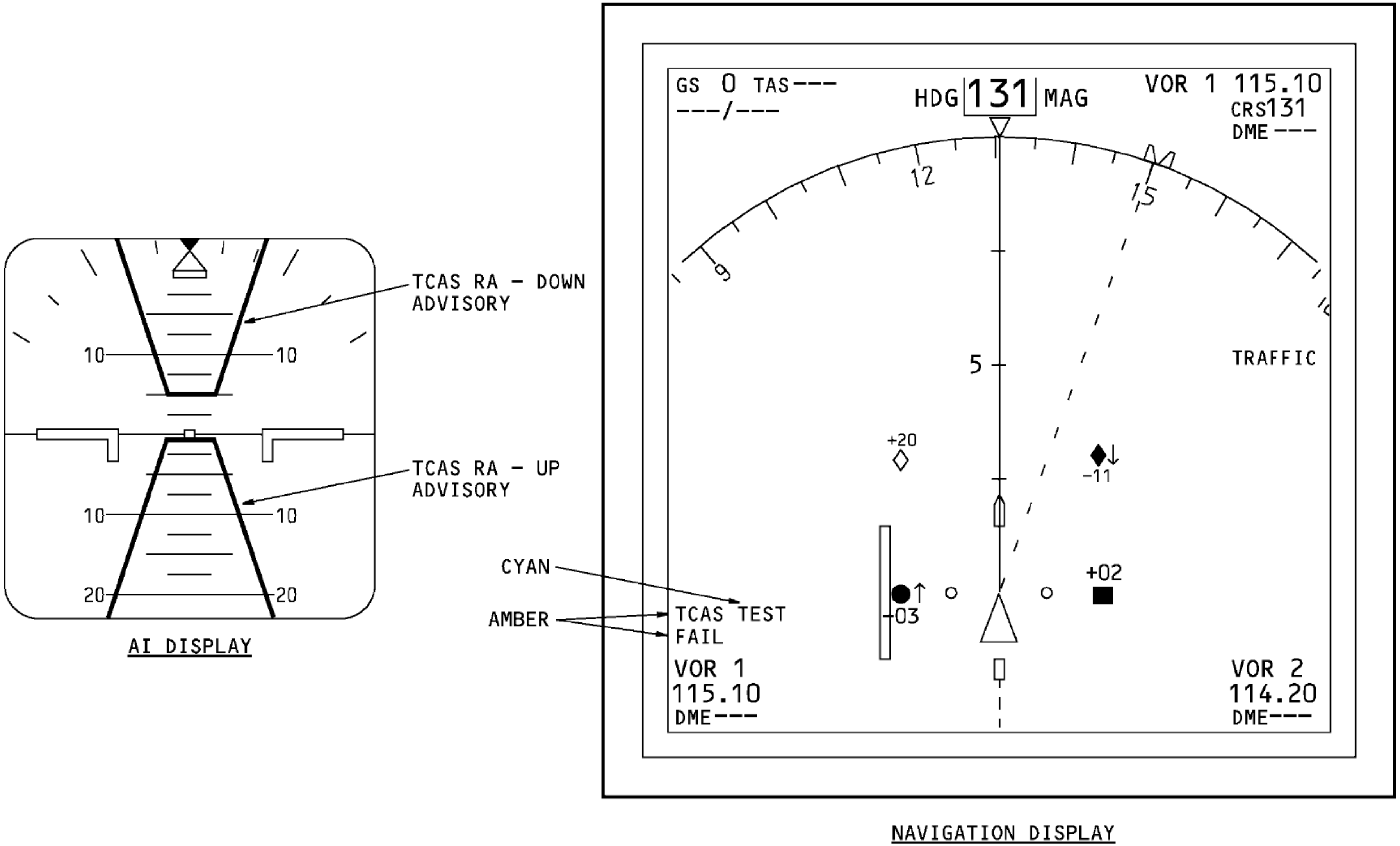
If the test passes, the ND shows this data:

- A cyan message, TCAS TEST
- A red message, TRAFFIC
- Amber TA traffic symbol at the 9:00 position, -200 feet relative altitude with an up vertical motion arrow and 2 nm from the airplane
- White other traffic symbol at the 11:00 position, +1000 feet relative altitude with no vertical motion arrow and 3.6 nm from the airplane
- White proximate traffic symbol at the 1:00 position, -1000 feet relative altitude with a down vertical motion arrow and 3.6 nm from the airplane
- Red RA traffic symbol at the 3:00 position, +200 feet relative altitude with no vertical motion arrow and 2 nm from the airplane.

If the test fails, the message TCAS TEST FAIL replaces the TCAS TEST message and no traffic shows. TCAS and FAIL shows in amber and TEST shows in cyan.

TCAS Self-Test Indications - AI

If the test passes, the AI shows the red RA up and down advisory cues.
If the test fails, the AI does not show any RA advisories.



SELF-TEST DISPLAY

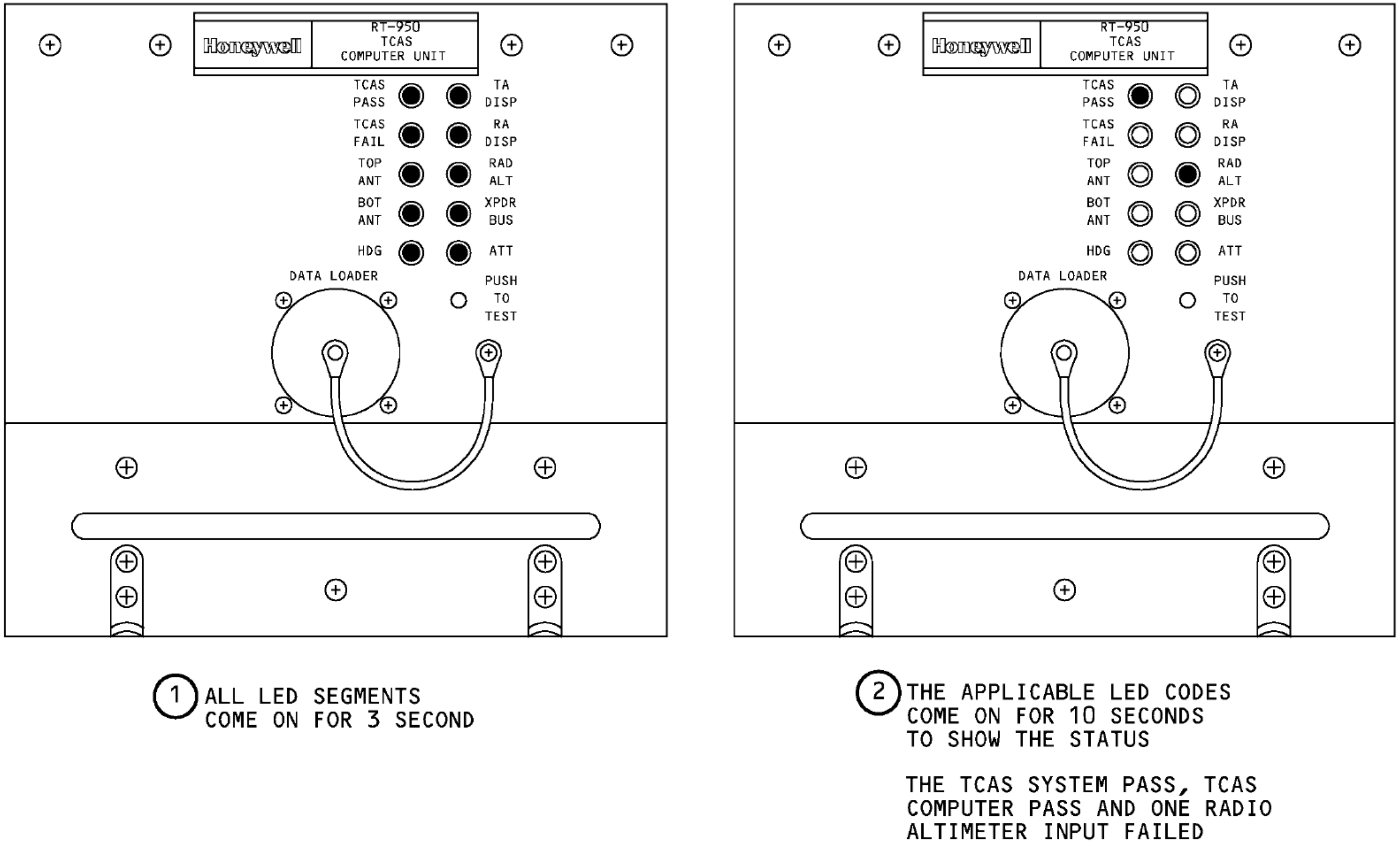
TCAS - BITE

Push and hold the test switch on the front panel for one second. This starts a self-test.

During the test, the front panel shows these indications:

- All LEDs come on for one second to do a test of the LEDs
- All LEDs go off for one second
- Applicable LED comes on to show the status of the TCAS or the TCAS interfaces.

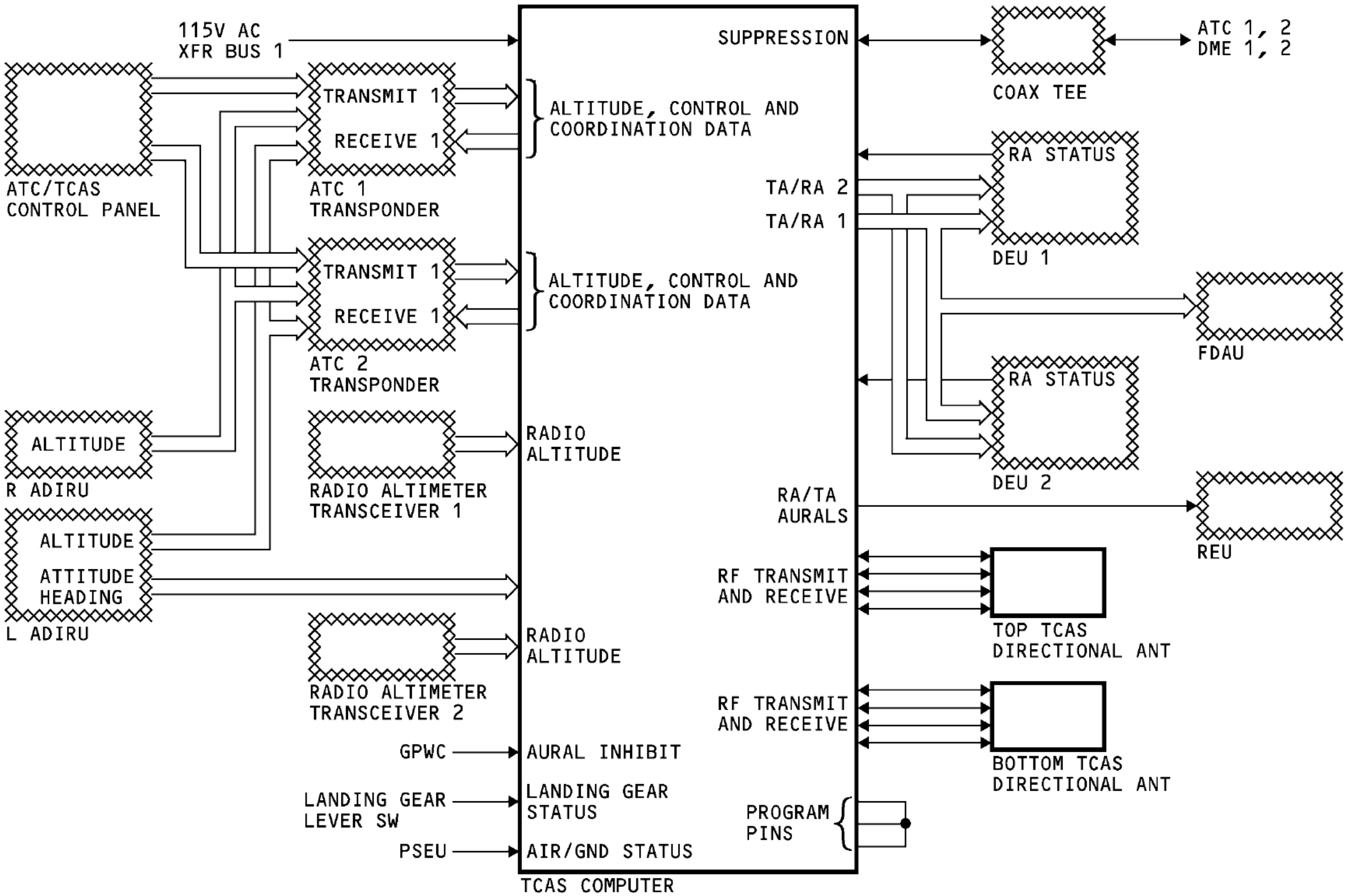
The red fail LED shows that the TCAS computer has a failure.



TCAS BITE

TCAS - SUMMARY

General



SUMMARY

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34-60. NAVIGATION (ATA 34)

LEVEL 3

TRAINING MANUAL

Boeing 737-600/700/800/900 (CFM 56) cat. B2

34–61. FLIGHT MANAGEMENT COMPUTER SYSTEM (ATA 34–61)

LEVEL 3

FLIGHT MANAGEMENT COMPUTER SYSTEM - INTRODUCTION

General

The flight crew uses the flight management computer system (FMCS) to enter route and vertical performance flight plan data for a flight.

With the flight plan and inputs from the airplane sensors, the FMCS does these functions:

- Navigation
- Performance
- Guidance.

Navigation

A navigation data base is in the FMC memory. It includes the navigation data for the area of operation. The pilot can use the navigation data base to set the entire flight plan before a flight.

The FMC calculates the airplane position during the flight. To do the calculation, it uses the inertial reference function and the radio navigation aids, if available.

The FMC can also use the global positioning system (GPS) to calculate the airplane position.

The FMC compares the calculated position with the flight plan for LNAV control. The FMC shows the calculated position and the flight plan on the navigation display.

Performance

A performance data base in the FMC contains data to model the airplane and the engines.

The flight crew puts this data in the FMC:

- Airplane gross weight
- Cruise altitude
- Cost index.

The FMC uses the data to calculate these functions:

- Economy speeds
- Best flight altitude
- Top of descent point.

The common display system (CDS) shows target speeds and altitudes.

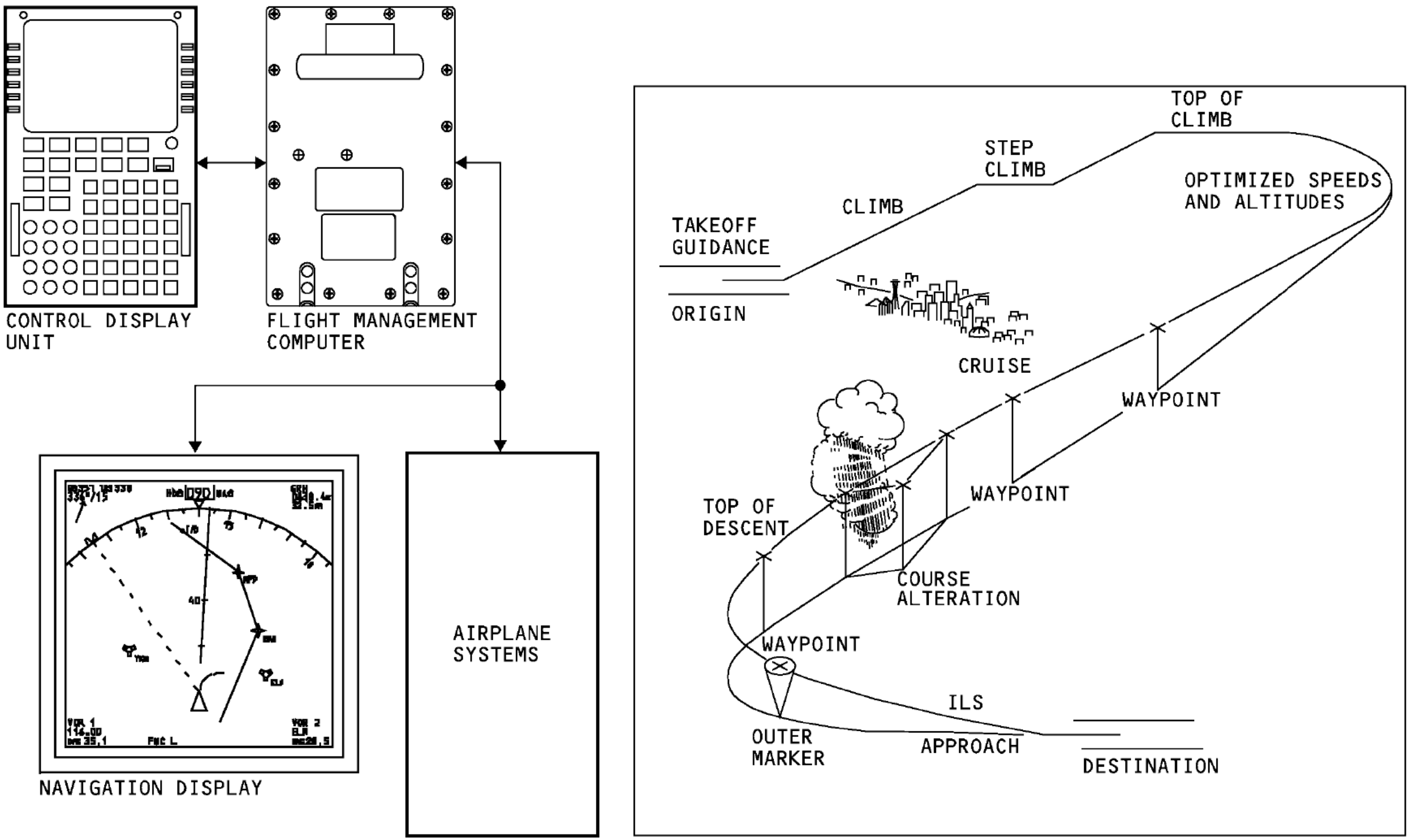
Guidance

The FMC sends commands to the digital flight control system (DFCS) and the autothrottle (A/T). The DFCS and the A/T use these signals to control the airplane in the lateral (LNAV) and vertical (VNAV) modes of flight.

Built-In Test equipment

You use the FMCS CDU to select and control BITE for these systems:

- FMCS
- Digital flight control system (DFCS)
- Autothrottle (A/T)
- Air data inertial reference unit (ADIRU)
- Common display system (CDS)
- Electronic engine controller (EEC)
- APU engine control unit (ECU)
- Fuel quantity indication system (FQIS).



FLIGHT MANAGEMENT COMPUTER SYSTEM - INTRODUCTION

GENERAL DESCRIPTION

General

The flight management computer system (FMCS) reduces flight crew workload with automatic control of the airplane navigation, performance and guidance functions. It also gives access to the BITE functions of other systems.

The main components of the FMCS are two flight management computers (FMC) which do all the FMCS calculations and two multi-purpose control display units (CDU) which provide the interface between the system and the flight crew.

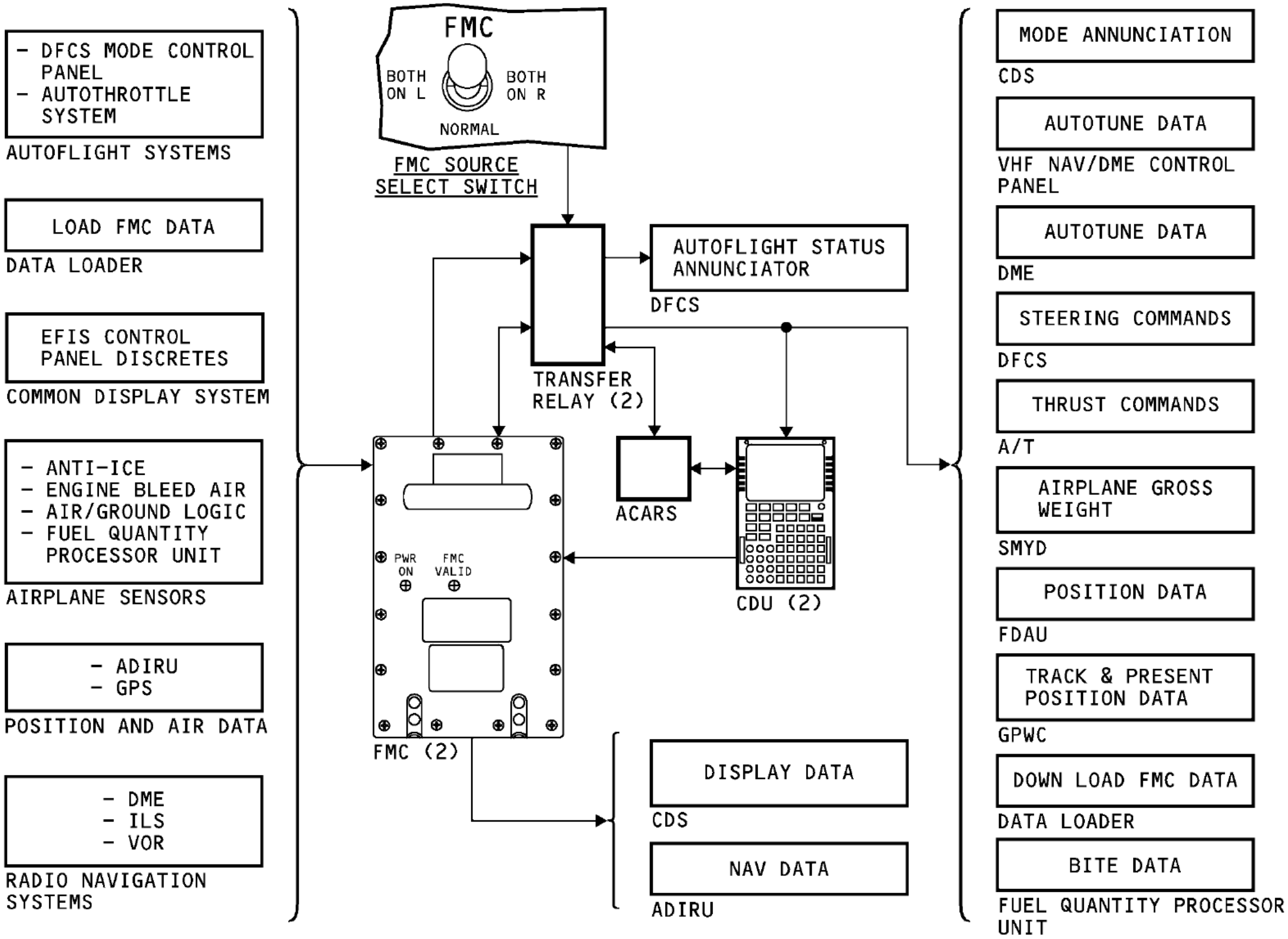
The FMCs receive data from other airplane systems to calculate navigation and performance data. This data shows on the common display system (CDS) for use by the flight crew.

The navigation and performance functions also go to the digital flight control system (DFCS) and the autothrottle (A/T) to provide automatic control of the airplane flight path in both the vertical (VNAV) and lateral (LNAV) modes. This is the guidance function of the FMC.

FMC display data goes directly to CDS and present position data goes directly to the air data inertial reference units (ADIRU). The ADIRUs use present position during the alignment.

All other data goes through two transfer relays to the user systems.

The FMC input and output data format is ARINC 429 digital data and analog discretes.



GENERAL DESCRIPTION

FMCS - COMPONENTS LOCATION

FMCS Component Locations - P9 Forward Electronics Panel

These are the FMCS components on the P9 forward electronics panel:

- MCDU 1
- MCDU 2.

FMCS Component Location - P5 FWD Overhead Panel

The FMC source select switch is on the P5-28 forward overhead panel.

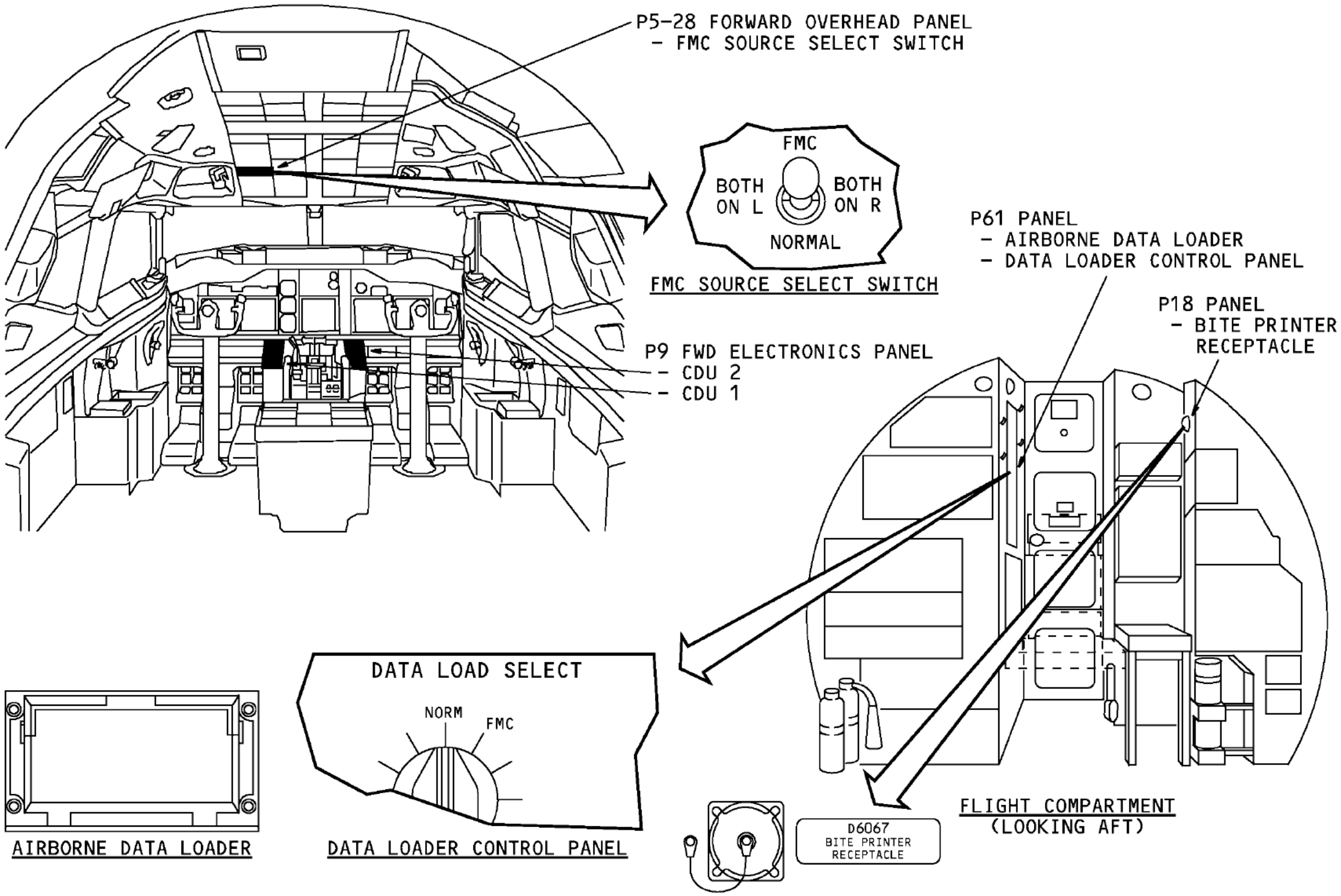
FMCS Component Locations - P61 Panel

These are the FMCS components on the P61 panel:

- Data loader control panel.
- Airborne data loader

FMCS Component Locations - P18 Panel

The BITE printer receptacle is on the P18 panel. When a portable printer is connected to this receptacle, you can print CDU and FMC data.

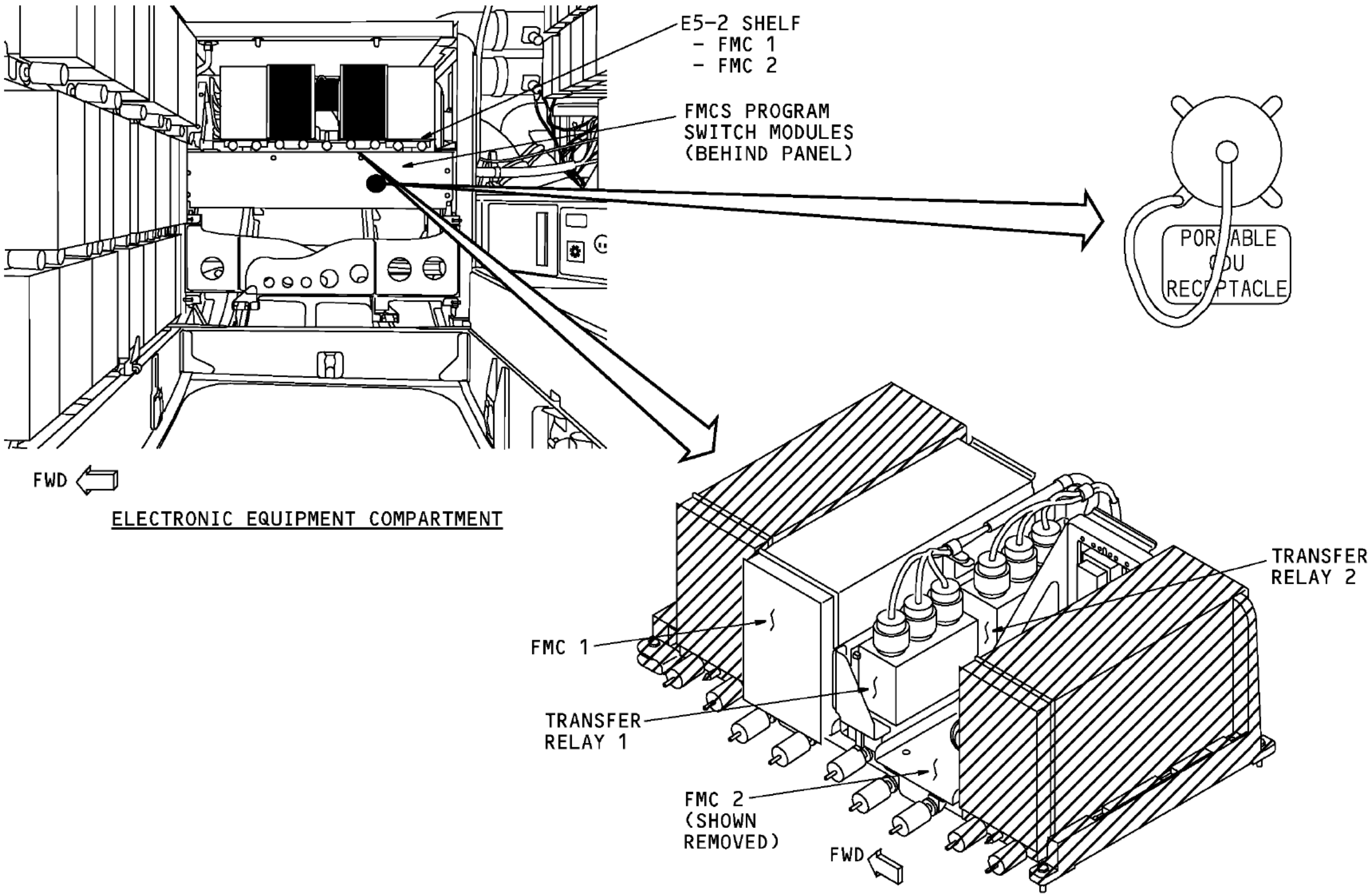


FLIGHT COMPARTMENT COMPONENTS LOCATION

Electronic Equipment compartment

These are the FMCS components on the E5-2 shelf:

- FMC 1
- FMC 2
- Portable CDU receptacle
- FMCS program switch modules
- FMCS transfer relay 1
- FMCS transfer relay 2.

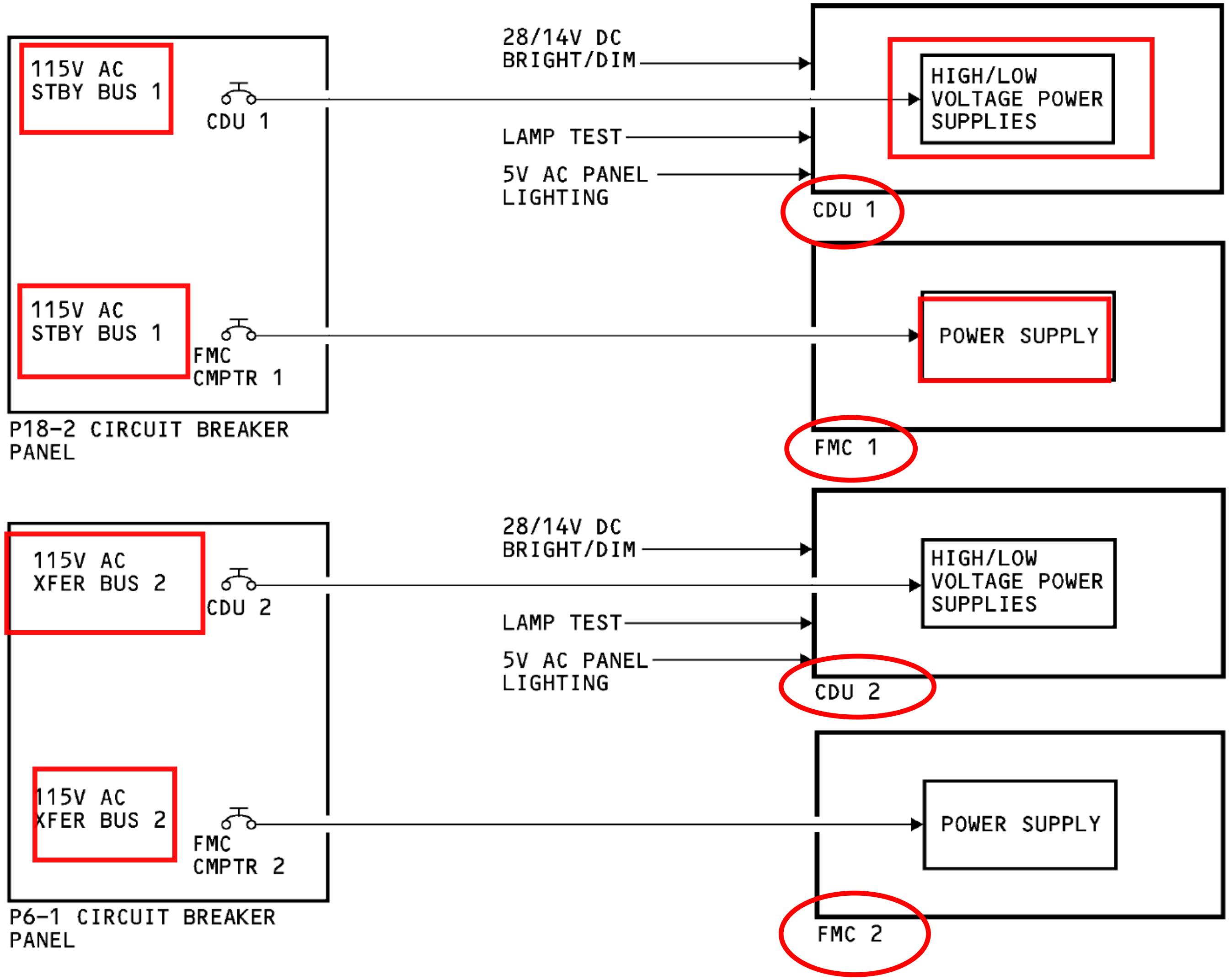


EE COMPARTMENT COMPONENTS LOCATION

FMCS - INTERFACES

FMC AND CDU POWER INTERFACE

The FMC and CDU primary power is 115v ac from the AC transfer buses 1 and 2.



FMC AND CDU POWER INTERFACE

THIS PAGE IS INTENTIONALLY LEFT BLANK

TRANSFER RELAY POWER INTERFACE

General

The transfer relays are Ledex type relays. They mechanically latch to the position you select.

The FMCS source select switch controls the FMCS transfer relays.

These are the switch positions:

- NORMAL
- BOTH ON L (both on left FMC)
- BOTH ON R (both on right FMC).

Operation

The transfer relay power is 28v dc from electronics bus 2. The FMC source select switch controls the dc power to the transfer relays.

With the FMC source select switch in the NORMAL position, both transfer relays go to the normal position and mechanically latch in that position.

When the FMC source select switch is set to the BOTH ON R position, 28v dc goes from the source select switch, through a contact on transfer relay 2, to relay 1 coil winding. Relay 1 moves to the BOTH ON R position and mechanically latches to that position. Relay 2 does not change because the BOTH ON R and NORMAL positions are the same.

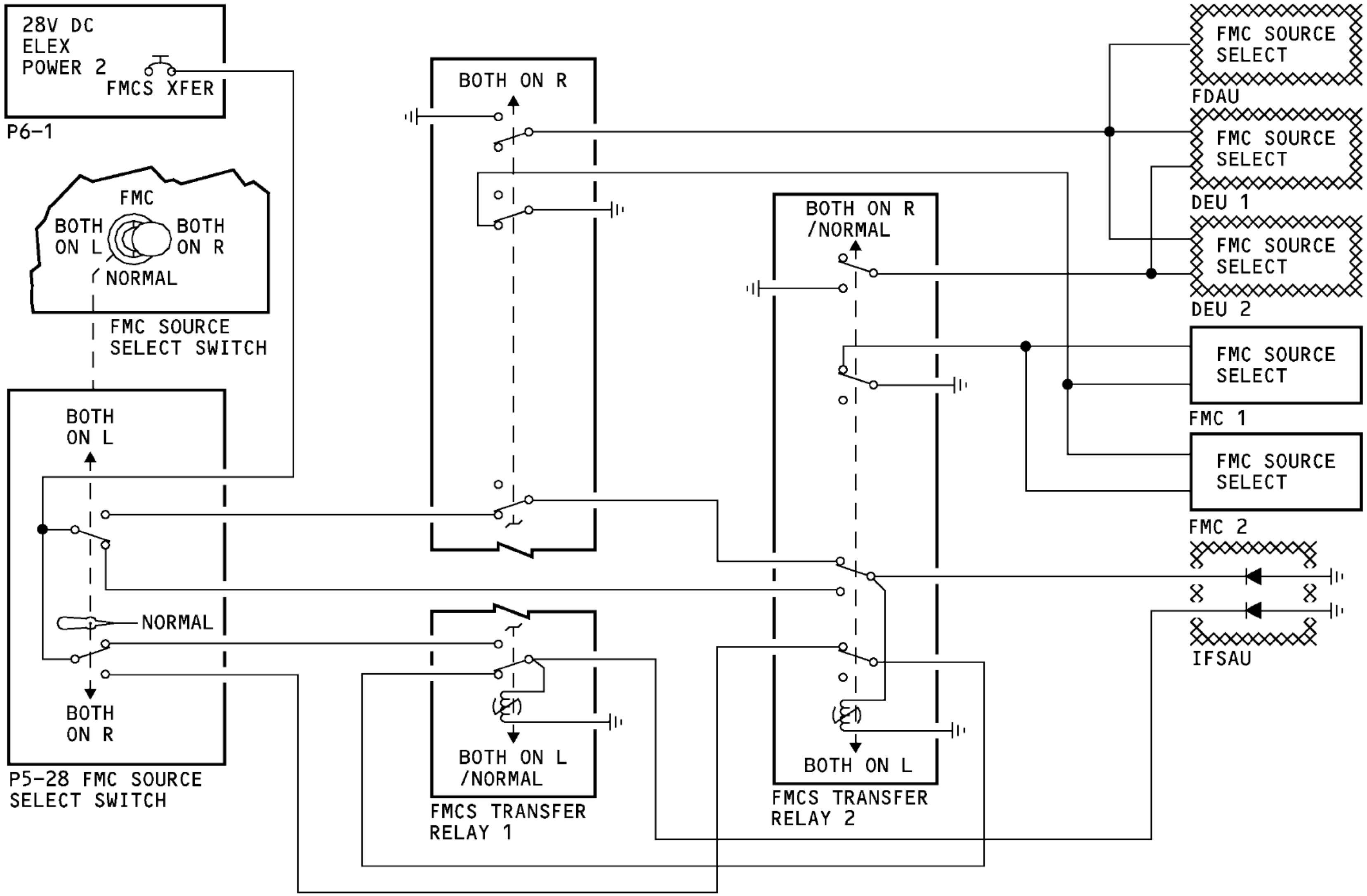
When the FMC source select switch is set to the BOTH ON L position, 28v dc goes from the source select switch, to the coil on relay 1. Relay one latches in the BOTH ON L/NORMAL position. The FMC source select switch then sends 28v dc through a contact on transfer relay 1 to the relay 2 coil winding. Relay 2 moves to the BOTH ON L position and mechanically latches to that position.

Other contacts on the transfer relays supply the necessary logic to tell these LRUs the position of the transfer relays:

- DEU (1&2)
- FDAU
- FMC (1&2).

Training Information Point

You use the FMCS BITE on the ANALOG DISCRETES page 3/4 to do a check of the FMC source selection.



TRANSFER RELAY POWER INTERFACE

DIGITAL INPUT INTERFACE - 1

General

These LRUs supply data to the FMCS:

- VOR/MB
- MMR
- DME.

VOR/MB

VOR 1 and VOR 2 receivers give the bearing and the frequency data of the VOR stations that are manually tuned by the flight crew.

The FMC uses this data for FMC position updating in the VOR/DME mode. The effective range for this mode is up to a maximum of 25NM.

ILS/GPS/MMR

MMR 1 and MMR 2 give localizer deviation and the station frequency data of the ILS transmitters that are manually tuned by the flight crew.

The FMC uses this data for FMC position updating during a final approach. The airplane must be within 20NM of the tuned ILS transmitter and below 6000 feet.

The GPS receivers in the MMRs give this data to the FMC:

- Latitude
- Longitude
- Time
- Horizontal Figure of Merit
- Horizontal Integrity Limit

The FMC uses this data for FMC position updating and actual navigation performance (ANP) calculation.

DME

DME 1 and DME 2 interrogators give the slant range distance and the station frequency data that are automatically tuned by the FMC.

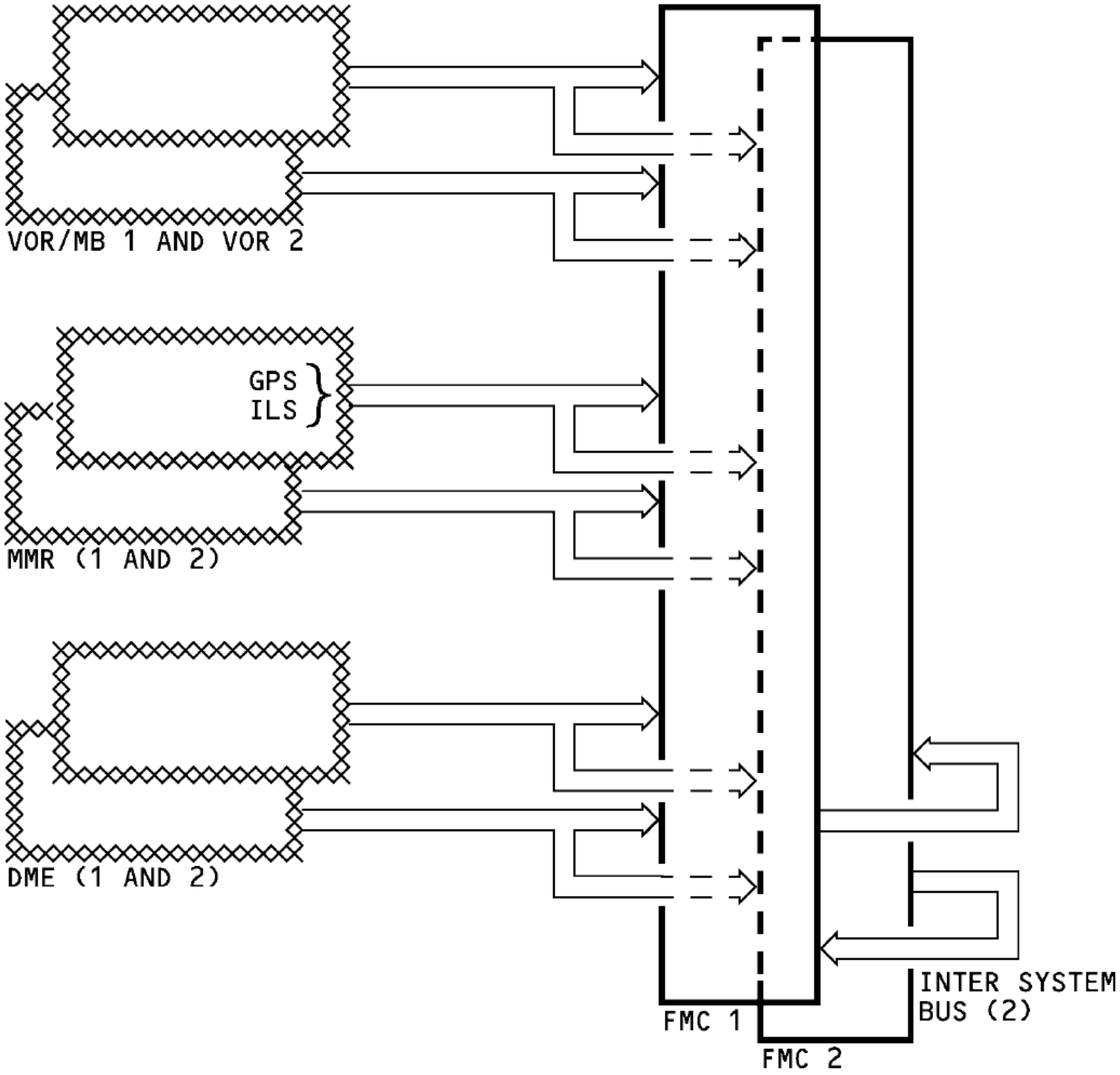
The FMC corrects this slant range for airplane altitude and uses the data for FMC position updating in the DME/DME or VOR/DME modes.

Clock

The clock input to both FMCs is from the selected GPS. If the GPS is not valid, you can set the time with the CDU and the FMCs calculate time.

Intersystem Bus

The intersystem bus is used to compare data between the primary and secondary FMCs.



DIGITAL INPUT INTERFACE - 1

DIGITAL INPUT INTERFACE - 2

These components send data to the FMCS:

- DFCS MCP
- A/T
- ADIRU
- DEU
- Engine electronic control (EEC)
- APU engine control unit (ECU)
- FQPU.

DFCS

The flight control computers (FCC) send data to the DFCS mode control panel (MCP). The MCP sends this data to the FMCS:

- Local selected course
- Foreign selected course
- Selected altitude
- Trailing edge flap position
- DFCS mode discretes
- DFCS BITE response
- Selected airspeed
- Selected mach.

The FMCS uses the selected course data in the navigation sub-function. The selected altitude and trailing edge flap position are used in the performance and guidance sub-functions. The mode discretes show VNAV/LNAV switch position, TO/GA switch position, and system status.

A/T

The autothrottle computer sends A/T BITE response to the FMCS.

ADIRU

The ADIRUs send this inertial reference (IR) data to the FMCS:

- Present position Latitude
- Present position Longitude
- Ground speed
- True heading
- Magnetic heading
- Pitch angle
- Roll angle
- Inertial altitude
- Inertial vertical speed
- N-S velocity
- E-W velocity.

The ADIRUs send this air data reference (ADR) data to the FMCS:

- Uncorrected barometric altitude
- Baro corrected altitude
- Mach
- Computed airspeed
- True airspeed
- Total air temperature
- Static air temperature.

The FMCS uses this data to calculate these functions:

- Aircraft position (latitude, longitude and altitude)
- Groundspeed
- Flight path angle
- Drift angle
- Track angle
- Wind velocity and direction
- Horizontal position accuracy (actual navigation performance).

ADIRU Selection

The FMC sees the inertial reference (IR) data and the air data reference (ADR) data as two different sensors.

Usually, the FMCs receive inertial data from their on-side ADIRU (left ADIRU to FMC 1 and right ADIRU to FMC 2). If the on-side ADIRU malfunctions or it is in the ATT or ALIGN mode, the FMC uses the data from the other ADIRU.

The FMCs use the same air data source as the DFCS. Flight control computer (FCC) A gets ADR data from the left ADIRU and FCC B gets ADR data from the right ADIRU. If FCC A is engaged, the FMCs use ADR data from the left ADIRU. If FCC B is engaged, the FMCs use ADR data from the right ADIRU.

DEU

The display electronic units (DEUs) send CDS BITE response data and EFIS control panel mode discretes to the FMCS.

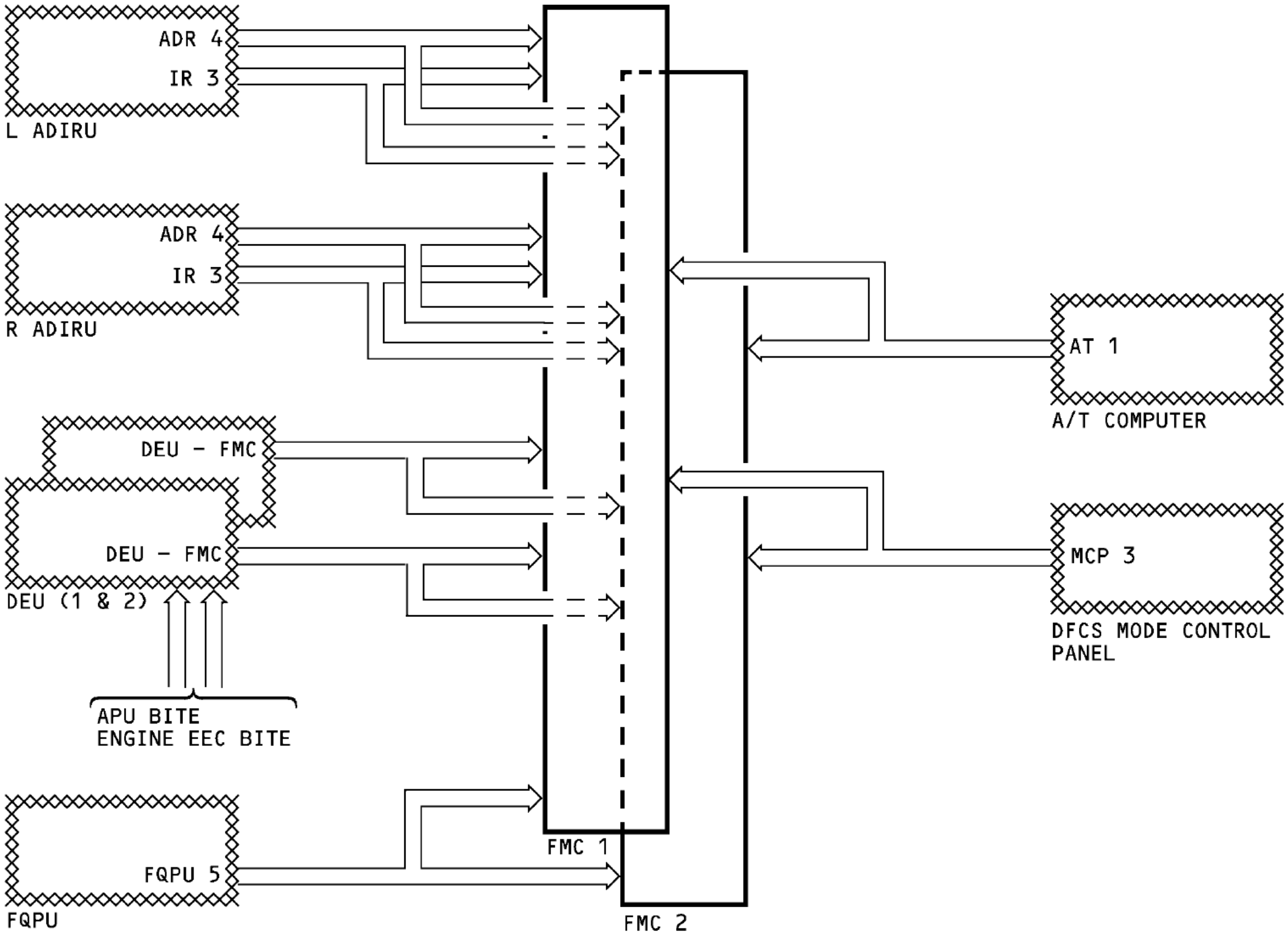
The DEUs send these EFIS control panel discretes to the FMC:

- Center display format
- Airports selected
- Route data selected
- Waypoint selected
- Ground station data selected
- Position data selected
- Plan mode selected
- Map mode selected
- VOR mode selected
- Approach mode selected
- Range selected.

The DEUs also send APU and main engine EEC BITE response data on the same bus. There is no direct BITE interface between the FMCS and the APU and EEC. The DEUs are a buffer between the APU, EEC, and the FMCS.

FQPU

The fuel quantity processor unit (FQPU) calculates total fuel weight and sends it to the FMCS. Fuel quantity BITE response data also comes from the FQPU.



DIGITAL INPUT INTERFACE - 2

DIGITAL OUTPUT INTERFACE - 1

The FMC data on bus 01 and 02 goes directly to the ADIRUs. The other user systems get this FMC data through the transfer relays.

Data Output

Bus 01 and 02 have this data:

- Distance-to-go (waypoint)
- Groundspeed
- VOR/DME frequencies
- Set latitude
- Set longitude
- Set magnetic heading
- Origin/destination
- Destination runway
- Destination estimated time of arrival (ETA)
- Gross weight
- Total fuel
- FMC target altitude
- FMC target airspeed
- FMC target mach number
- Horizontal command
- Vertical speed command
- Desired track
- Waypoint bearing
- Cross-track deviation
- Vertical deviation
- Magnetic track angle
- Drift angle
- GMT
- Date
- Static air temperature (SAT)
- Selected temperature
- Flight number
- Minimum airspeed
- Minimum buffet airspeed
- Maximum buffet airspeed
- Continuous N1 limit
- Go-around N1 limit
- Cruise N1 limit
- Climb N1 limit
- Target N1
- NDB effectivity
- BITE test word
- FMC discrete word 1
- FMC discrete word 2
- FMC discrete word 3.

FMC discrete word 1 has this data:

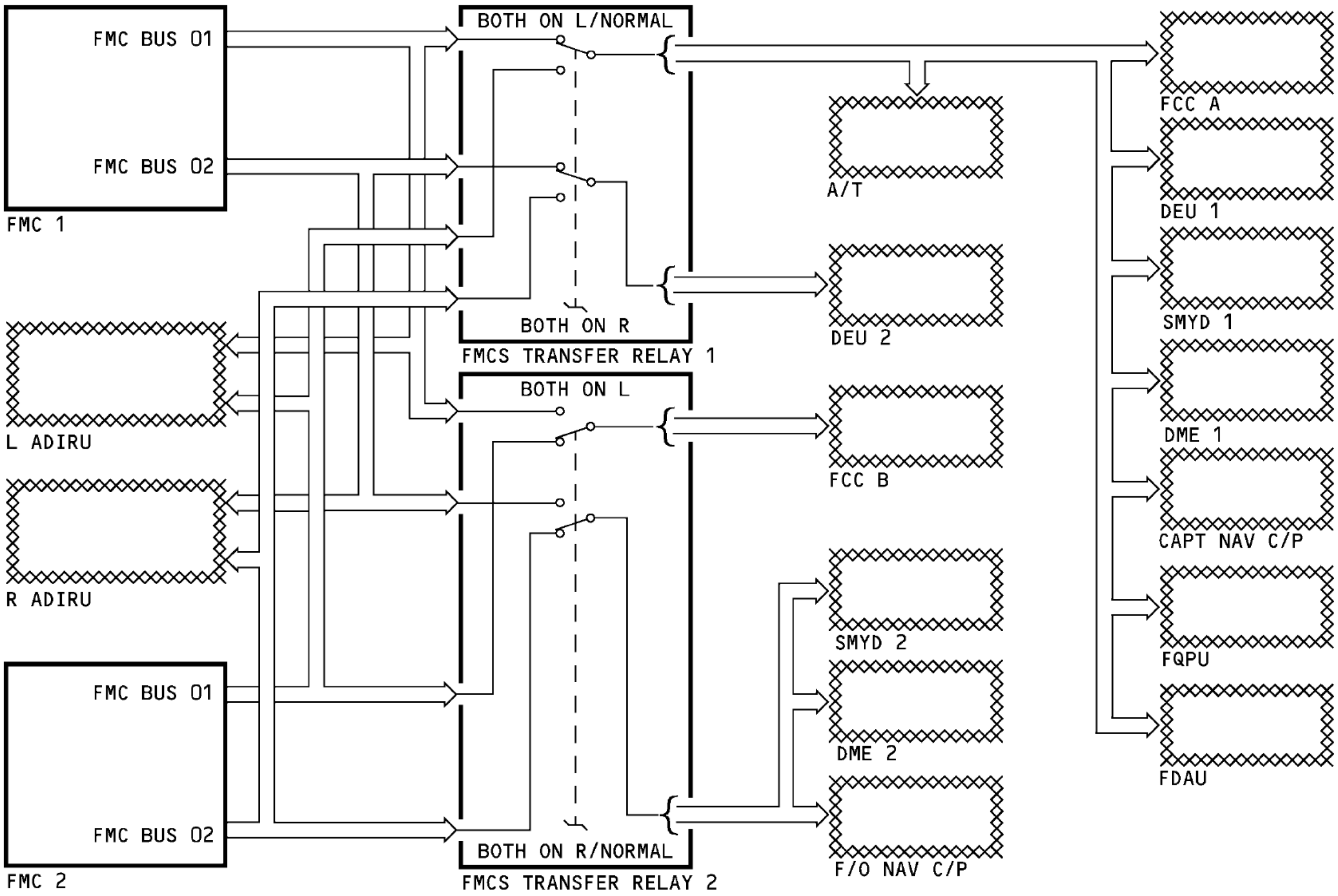
- Isolation valve open
- Wing antice on
- Cowl-R antice on
- Cowl-L antice on
- ECS pack-R H/L
- ECS pack-L H/L
- ECS pack-R
- ECS pack-L
- Engine bleed 2 on
- Engine bleed 1 on

FMC discrete word 2 has this data:

- Lateral alert
- Computer master/slave
- Annunciator test
- FMC valid
- Offset
- Dead reckoning
- Vertical alert.

FMC discrete word 3 has this data:

- IAS/mach
- Engine out engaged
- Landing flaps selected
- Manual N1 select
- Level decel
- Autothrottle to idle arm
- Autothrottle to arm
- FMC vertical speed
- N1 limit mode
- Speed on elevator
- Reduced thrust (derate)
- LNAV takeoff enabled
- Level change request
- VNAV valid
- Thrust cutback enable
- Initiate thrust cutback.



DIGITAL OUTPUT INTERFACE - 1

DIGITAL OUTPUT INTERFACE – 1 (Continue)

ADIRU

The ADIRUs use this data from the selected FMC:

- Set latitude
- Set longitude
- Set heading
- BITE test word.

The ADIRUs use the latitude and longitude data during alignment. Magnetic heading is used when the ADIRU is in the attitude mode (ATT) and the BITE test word is used to start BITE through the CDUs.

SMYD

The SMYDs use this data from the selected FMC (on-side, 1 or 2):

- Gross weight
- Lower buffet margin speeds
- Upper buffet margin speeds
- Landing flap position.

The SMYDs use gross weight to adjust the gain in the yaw damper command signal. They use all the FMC inputs to calculate the upper and lower amber bands on the airspeed indication for CDS. The flap input enables the pitch limit indication on CDS.

DME

The DMEs use four autotune frequencies (channels 2 - 5) from the selected FMC. In normal operation, the FMCs autotune the DME interrogators through their onside NAV control panels. If a NAV control panel fails, its on-side DME interrogator is autotuned directly from the selected FMC.

Autothrottle

The autothrottle computer uses this data from the selected FMC:

- Target N1
- FMC gross weight
- Minimum airspeed
- N1 limit mode
- FMC altitude
- GMT and date
- Static air temperature
- N1 thrust limits (CLB, CRZ, CONT & GA)
- BITE test words.

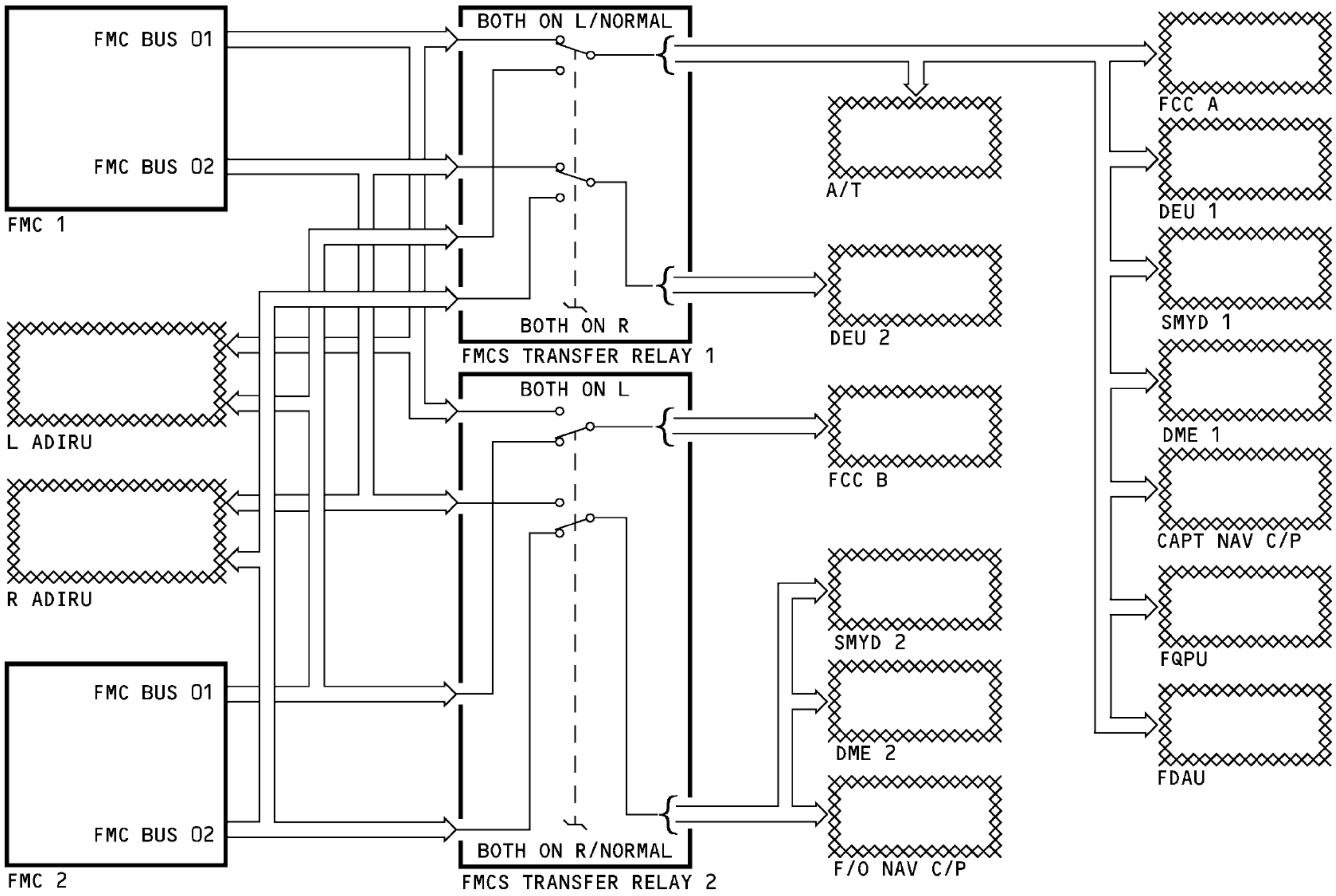
The autothrottle computer uses this data to maintain specific engine N1 targets or airspeeds from takeoff to touchdown.
The autothrottle computer changes the target N1 values to an equivalent thrust resolver angle (TRA) target. The target N1 rating is dependent on the FMC engaged mode.
Gross weight is used in the A/T go-around control logic and approach control logic.
Minimum airspeed is the lowest airspeed that is acceptable by the A/T during VNAV operations.
The N1 limit mode discretes are used to determine control law gains and limits.
FMC altitude is used by the autothrottle computer for anticipation of altitude acquire during VNAV operation.
GMT and date are used in A/T BITE for fault data storage.
SAT is used by the autothrottle computer to calculate a backup TRA limit value.
N1 thrust limits are used to limit A/T authority and prevent possible engine overboost.

Fuel Quantity Processor Unit

The fuel quantity processor unit uses a BITE word from the selected FMC to start the BITE program.

FDAU

Navigation data from the selected FMC goes to the FDAU where it is stored in the solid state memory.



DIGITAL OUTPUT INTERFACE - 1

DIGITAL OUTPUT INTERFACE – 1 (Continue)

DEU

The DEUs use this data from the selected FMC:

- N1 limit mode
- Target N1
- Gross weight
- GMT and date
- BITE test words.

The DEUs use this data to show the thrust modes on the center upper display unit (DU). Target N1 shows on the engine display. Gross weight is used by the CDS to calculate the flap maneuver speeds that show on the MASI. GMT and date are used in BITE for fault data storage.

Target N1, GMT, and date also go from the DEUs to the engine electronic controls (EEC). The EECs use the N1 target to calculate an equivalent TRA for engine control. GMT and date are used in EEC BITE.

The BITE test words are for the DEUs and these systems:

- Engines (EEC)
- APU (ECU).

There is no direct BITE interface between the FMCs and the electronic engine controls (EECs) and APU ECU. The DEUs are the interface between the EEC, APU ECU, and the selected FMC.

FCC

The FCCs use this data from the selected FMC:

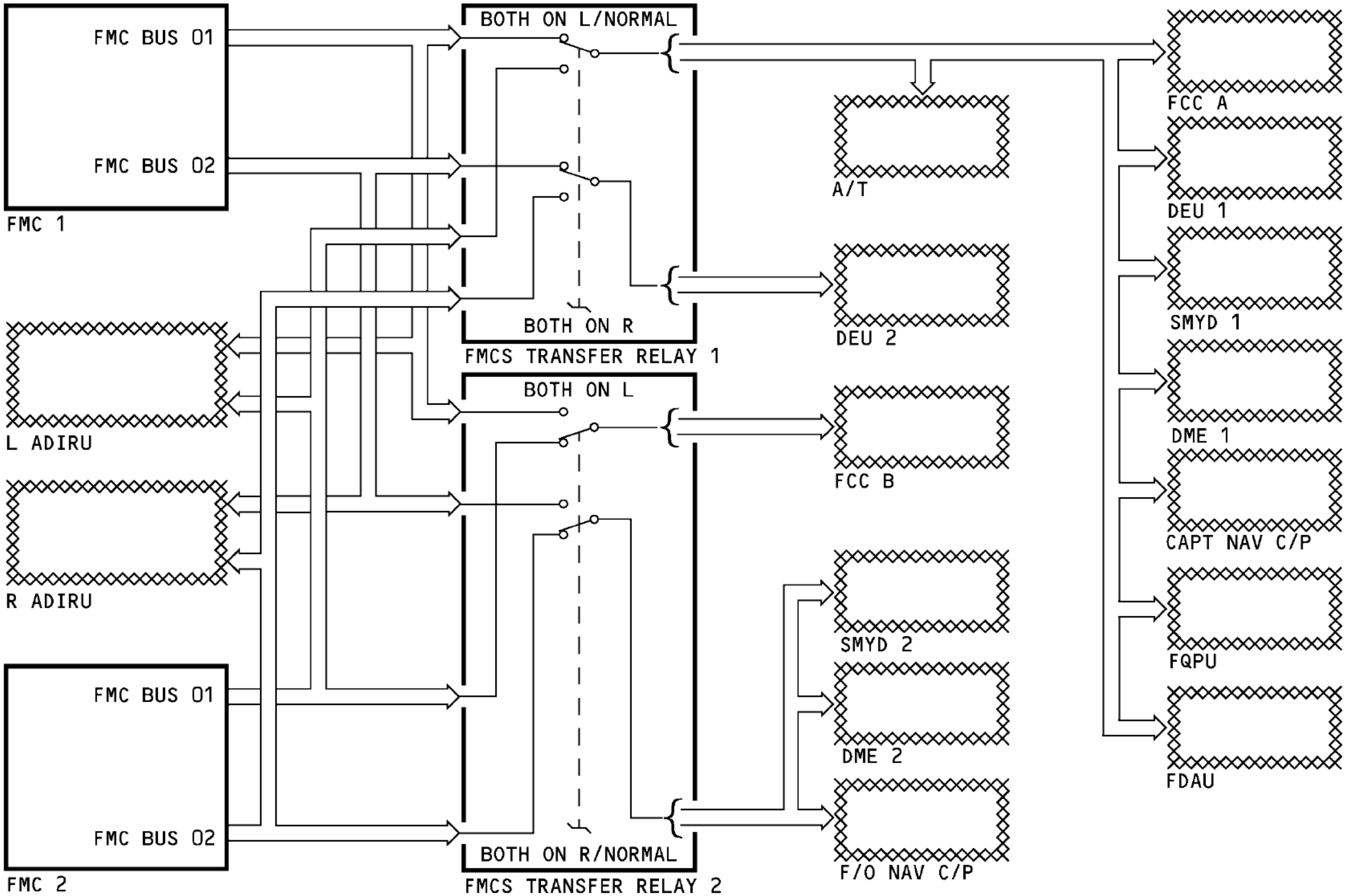
- FMC target altitude
- FMC target airspeed
- FMC target mach number
- Horizontal command
- Vertical speed command
- GMT and date
- Flight number
- FMC discrete words
- BITE test word.

The FCCs use the altitude, airspeed, mach number, horizontal commands, vertical commands, and FMC discretes to control the airplane lateral and vertical flight profile.

GMT and date, flight number, and the BITE test word are used by the FCC in the BITE function.

You select the source of FMC data with the FMC source select switch.

FMC SOURCE SELECT	FCC A	FCC B
NORMAL	FMC 1	FMC 2
BOTH ON LEFT	FMC 1	FMC 1
BOTH ON RIGHT	FMC 2	FMC 2



DIGITAL OUTPUT INTERFACE - 1

DIGITAL OUTPUT INTERFACE - 2

General

The FMC data on bus 08 and 09 goes directly to the DEUs. The other user systems get this data through the transfer relays.

Data Output

The buses 08 and 09 have this data:

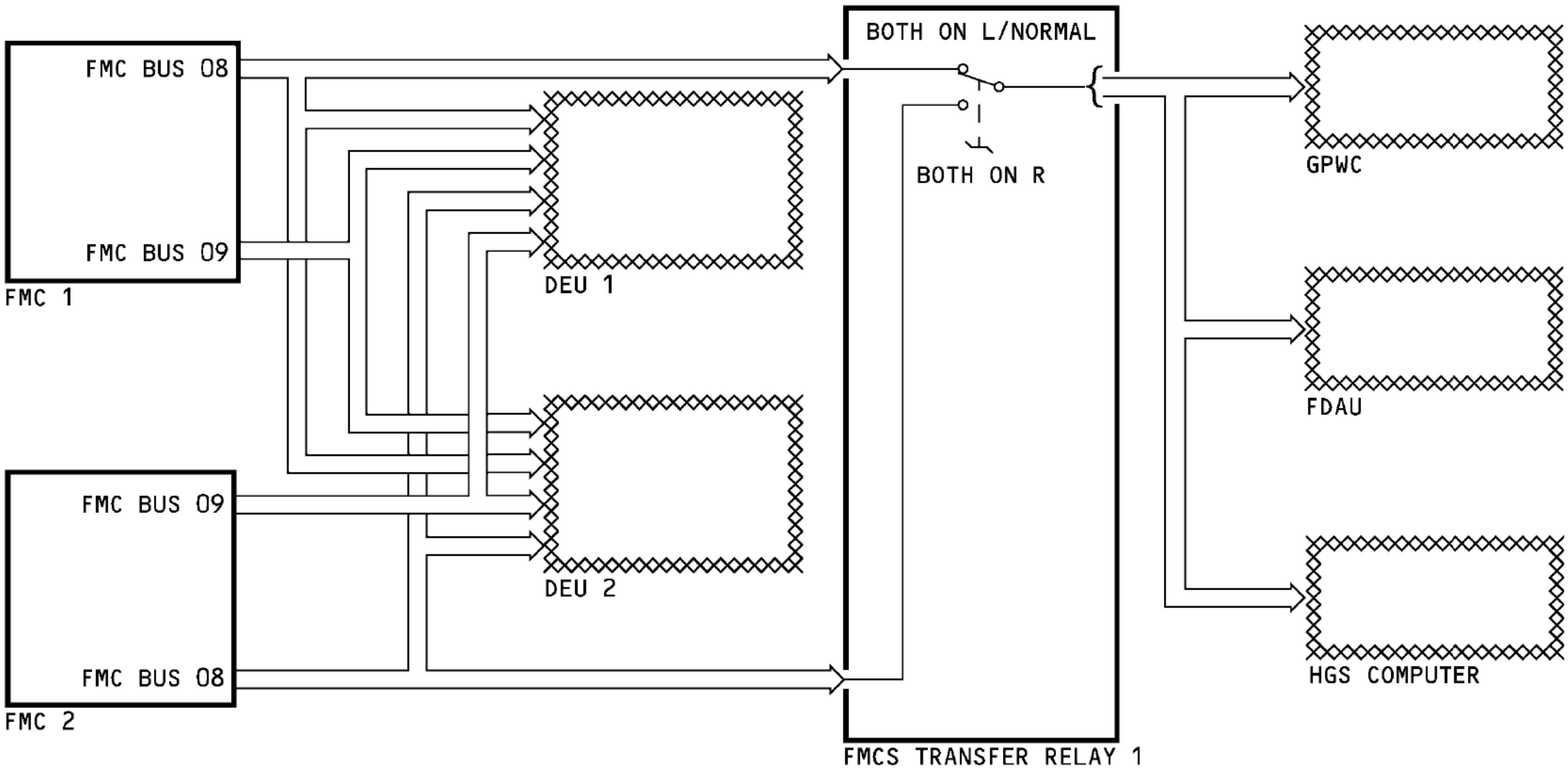
- Distance to go (waypoint)
- Groundspeed
- Estimated time of arrival (ETA)
- V speeds
- GPS position data
- Desired track
- Waypoint bearing
- Cross-track deviation
- Range to altitude
- Vertical deviation
- Set landing altitude
- DME elevation
- Transition altitude
- Clean
- Speedbrakes
- FMC navigation source (GPS, VOR, LOC, ADIRU)
- Map background word/block count
- Dynamic data start word
- FMC position
- Track angle (magnetic and true)
- Wind speed and direction
- Drift angle
- Flight path angle
- Alphanumeric display data (wpt, navaids etc.)
- Flight number
- FMC discrete word 2
- FMC discrete word 3.

The FMC discrete word 2 has this data:

- ADIRU position difference
- Alerts (lateral and vertical)
- FMC source select annunciation
- Annunciator test
- FMC valid
- Offset
- Dead reckoning.

The FMC discrete word 3 has this data:

- IAS/Mach
- Engine out engaged
- Man N1 select
- Level decel
- A/T to idle arm
- A/T to arm
- FMC vertical speed
- Speed on elevator
- Reduced thrust derate
- Level change request
- VNAV valid
- Thrust cutback enable
- Initiate thrust cutback
- Landing flaps selected
- N1 limit mode.



DIGITAL OUTPUT INTERFACE – 2

DIGITAL OUTPUT INTERFACE – 2
(Continue)

DEU

The DEUs get navigation and flight display data from both FMCs. There are two types of data, dynamic data and background data. Dynamic data changes as a function of time while background data does not change as a function of time.

Dynamic data has the following information:

- Distance-to-go
- Groundspeed
- Estimated time of arrival
- V speeds
- GPS position data
- Desired track
- Waypoint bearing
- Cross-track deviation
- Range to altitude
- Vertical deviation
- Set landing altitude
- DME elevation
- Transition altitude
- FMC discrete word 2
- FMC discrete word 3
- FMC position
- Track angle (magnetic and true)
- Wind speed and direction
- Drift angle
- Flight path angle
- Alpha numeric display data
- Flight number.

Background data has this type of information:

- Vector lines
- Special symbols
- Standard character text messages
- Discrete words defining map/plan mode and range data.

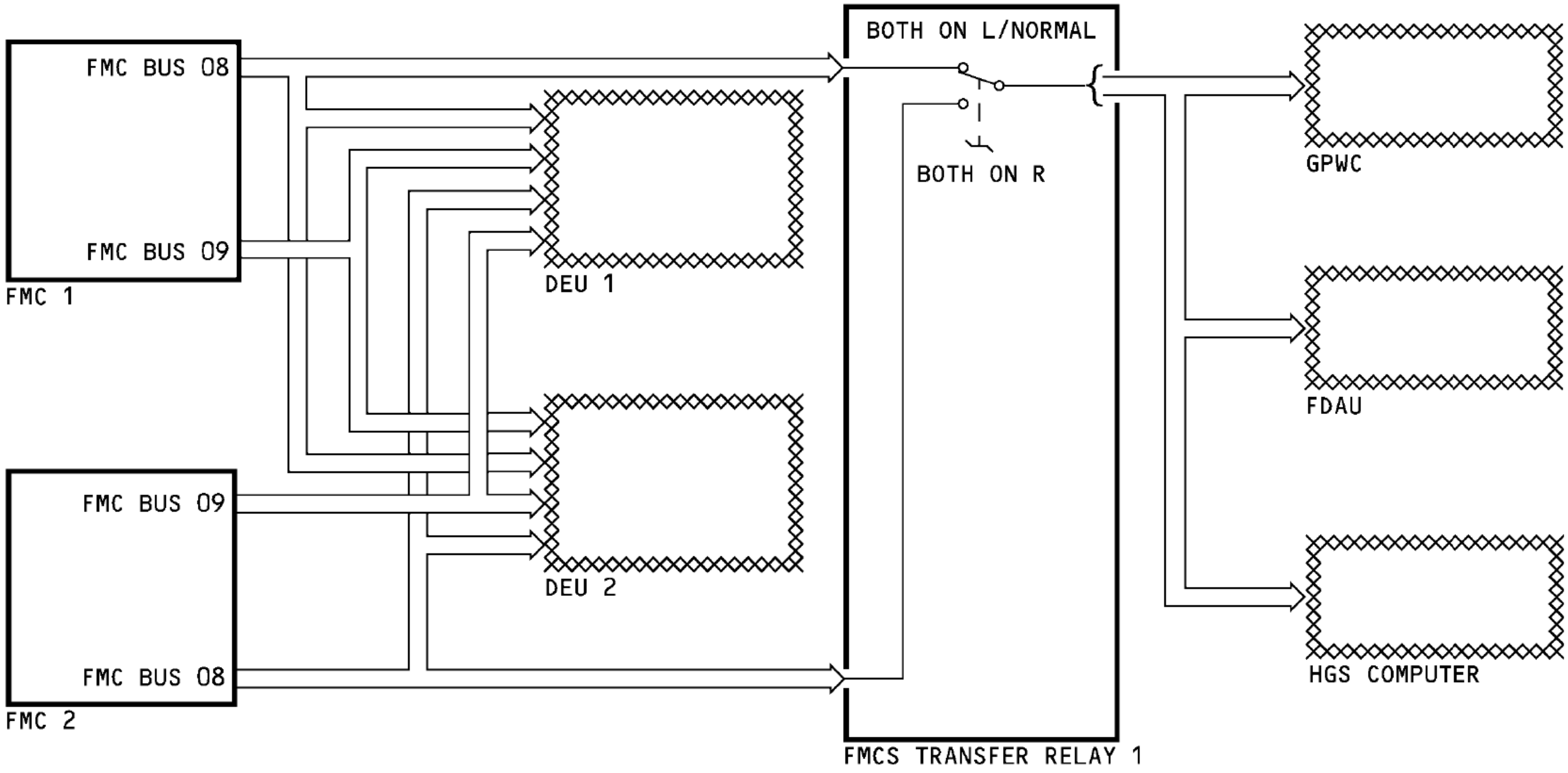
This data is formatted and sent by the DEUs to the display units (DUs) to show the airplane position with respect to the flight plan path and navigation facilities (navaids, waypoints, airports etc.).

GPWC

The GPWC uses magnetic track and present position (latitude and longitude) from the selected FMC for its envelope modulation calculations.

FDAU

Display data from the selected FMC goes to the FDAU where it is stored in the solid state memory.



DIGITAL OUTPUT INTERFACE - 2

CDU INTERFACE

FMC Digital Output

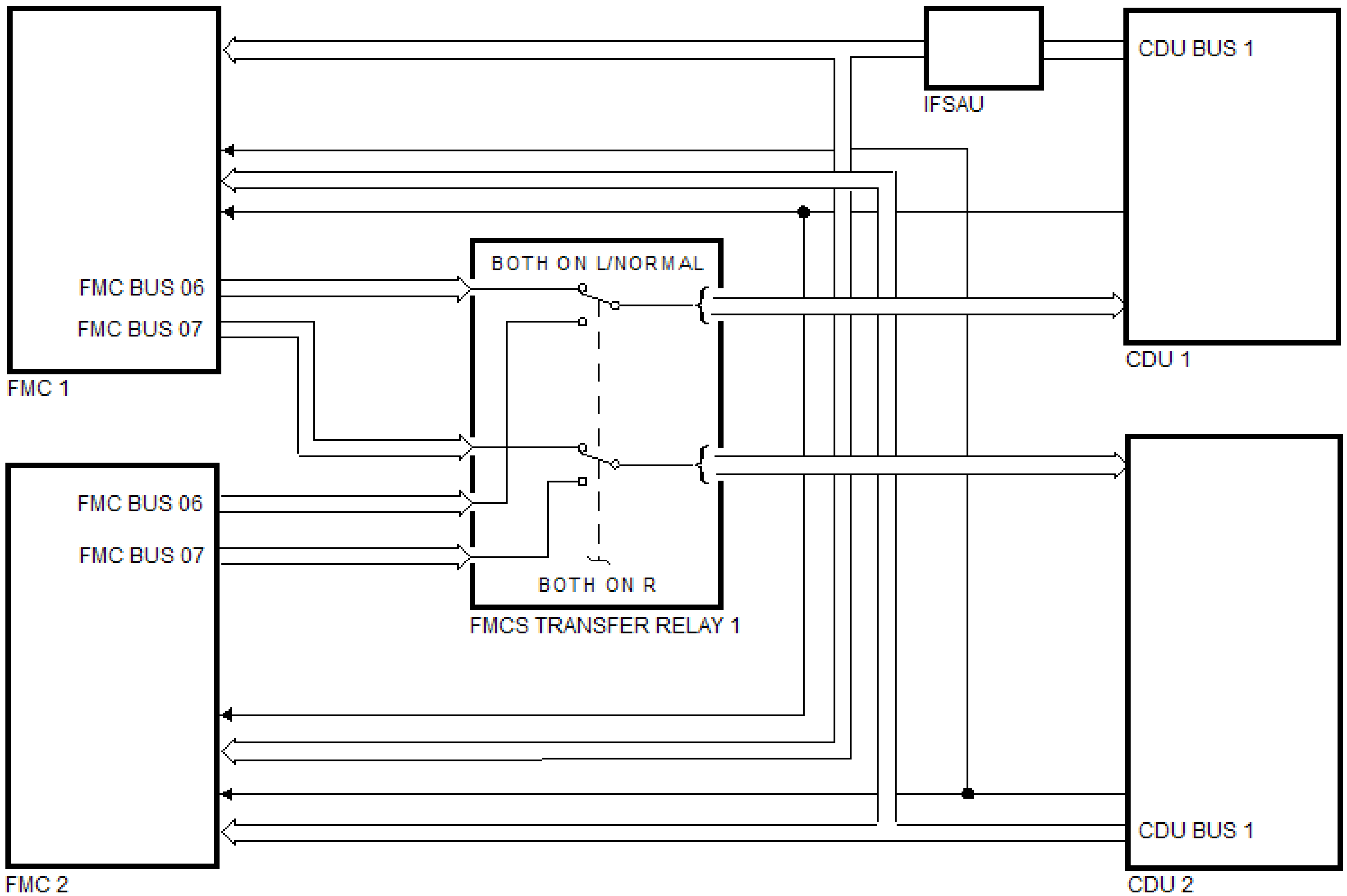
When the FMC source select switch is set to the BOTH ON L or the NORMAL position, CDU 1 and CDU 2 get data from FMC 1. When the source select switch is set to the BOTH ON R position, both CDUs get data from FMC 2.

FMC Digital Input

CDU 1 sends data through the integrated flight system accessory unit (IFSAU) to FMC 1 and FMC 2. This allows a portable CDU to be connected in the electronic equipment compartment in place of CDU 1. CDU 2 sends data directly to both FMCs.

CDU Analog Output

Each CDU sends an analog discrete to both FMCs to show a failure of the CDU.



CDU INTERFACE

THIS PAGE IS INTENTIONALLY LEFT BLANK

FMC DATA LOADER INTERFACE

General

The airborne data loader (ADL) connects to the FMCs through the data loader control panel.

The data loader gets 115v ac power from the P18 circuit breaker panel. It goes through the data loader control panel to the airborne data loader.

The data loader digital inputs and output connect to FMC 1 and FMC 2 through the data loader control panel. The control panel must be set to the FMC position to transfer data to and from the FMCs.

Option 1

When the FMC source select switch on the P5 panel is set to the BOTH ON L or NORMAL position, the data is loaded into FMC 1. When the source select switch is set to the BOTH ON R position, the data is loaded into FMC 2. The new data base(s) may then be crossloaded between the FMCs.

Option 2

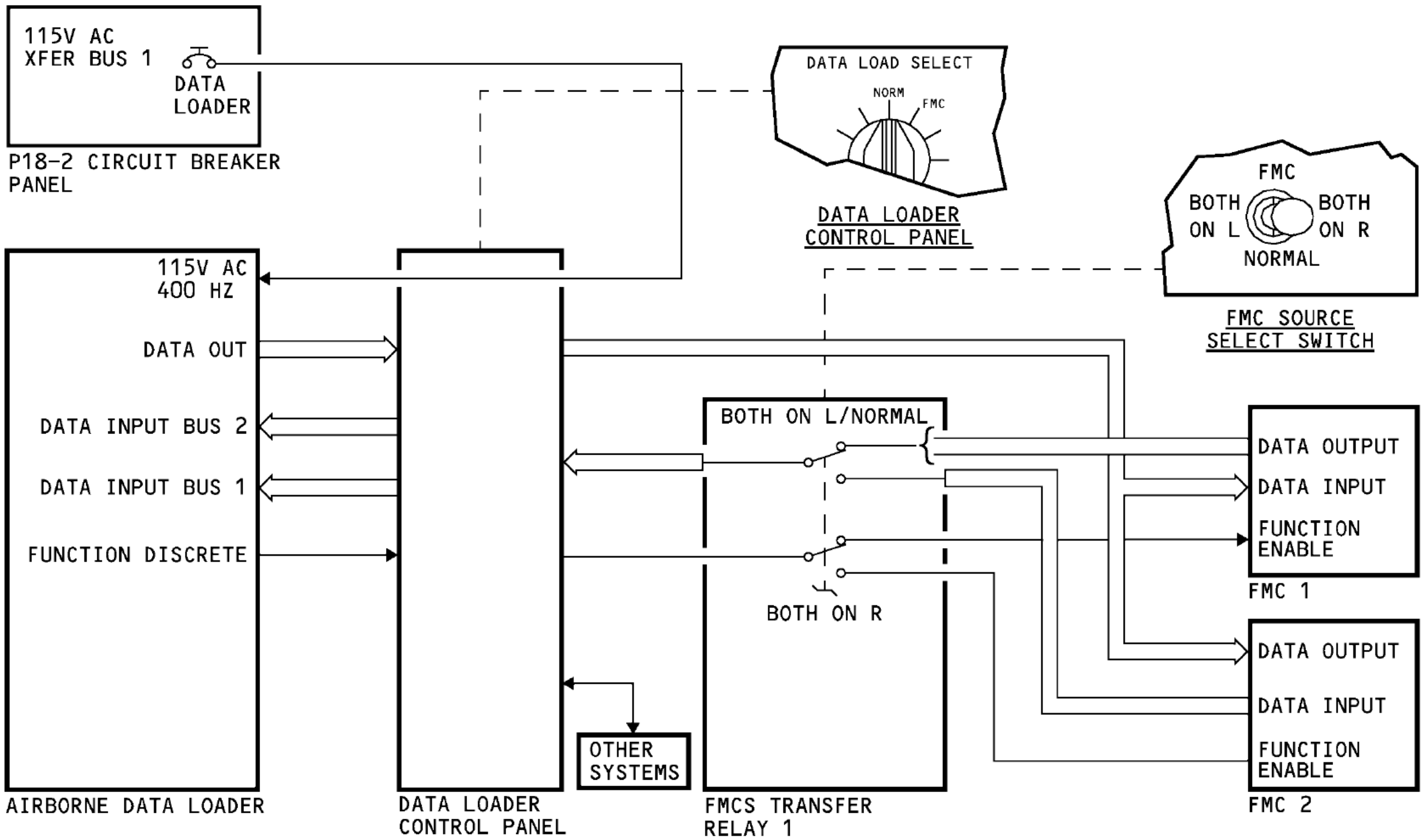
When the data loader 3-position switch is set to the L position, the data is loaded into FMC 1. When the data loader 3-position switch is set to the R position, the data is loaded into FMC 2. The new data base(s) may then be crossloaded between the FMCs.

Note: **Option 2**

The FMC source select switch on the P5-28 panel must be set in the BOTH ON L or NORMAL positions to see the load progress on the MCDUs if FMC 1 is being loaded. If the 3-position switch is in the R position, the FMC source select switch must be set to BOTH ON R to see the load progress on the MCDUs.

A function discrete from the data loader goes through the data loader control panel to the FMC. This is the load enable signal to the FMC.

The data loader control panel also has other digital inputs and outputs to other airplane systems. In this way, these other systems can be updated through the data loader.



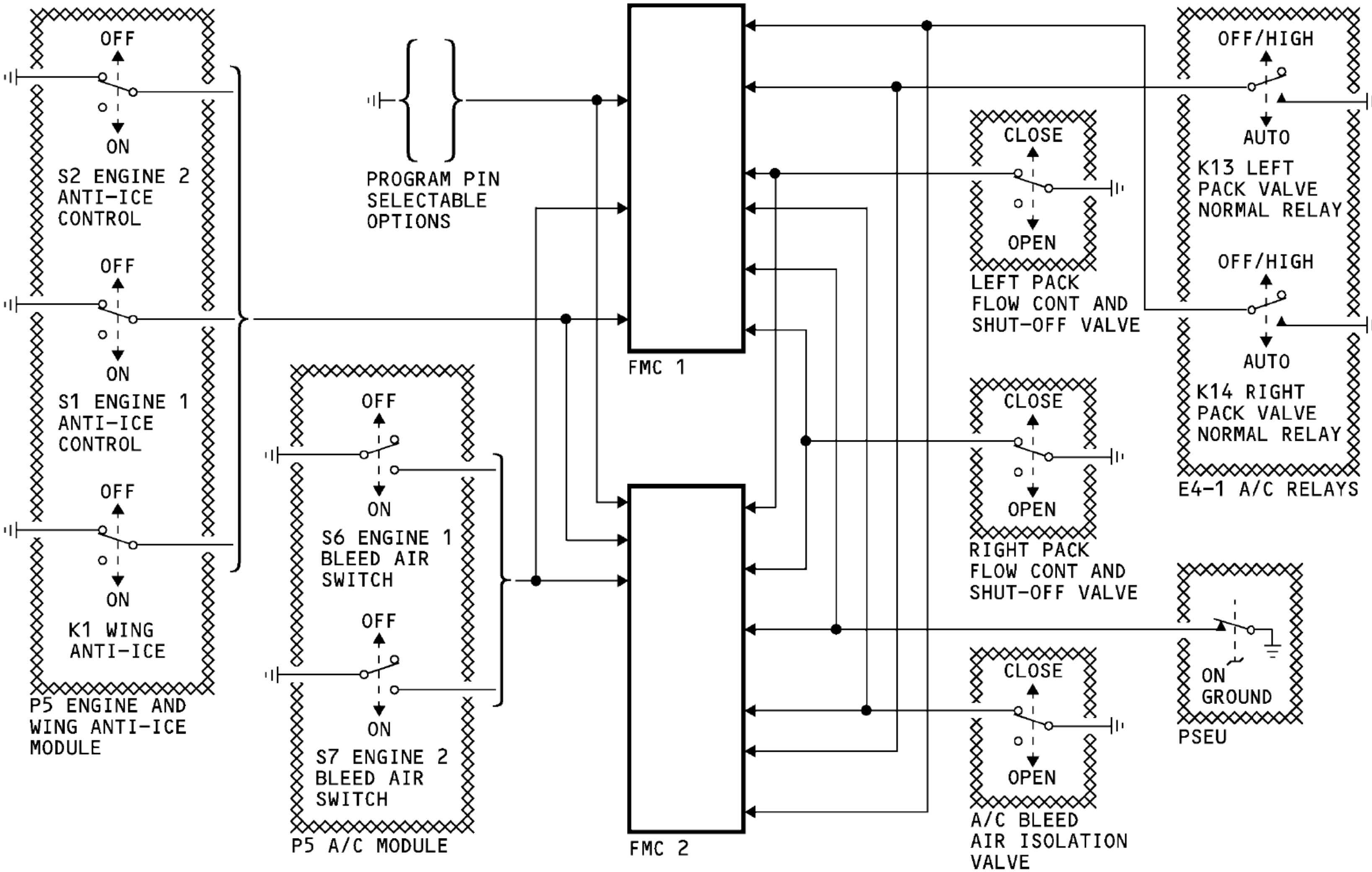
FMC DATA LOADER INTERFACE

ANALOG DISCRETES

Inputs from switches and valves give engine bleed air data to the FMCS. The FMCS uses these signals to calculate the N1 limits for the engines.

The program pin selectable options customize the FMCS to the airline configuration.

The proximity switch electronics unit (PSEU), supplies an air/ground discrete input to the FMCS to set flight leg count. The air/ground discrete also goes to the FMC to inhibit data load in the air.



ANALOG DISCRETES

STATUS ANNUNCIATOR INTERFACE

The autoflight status annunciators (ASAs), have three warning lights. The warning lights are push to reset. The ASA also has a TEST switch.

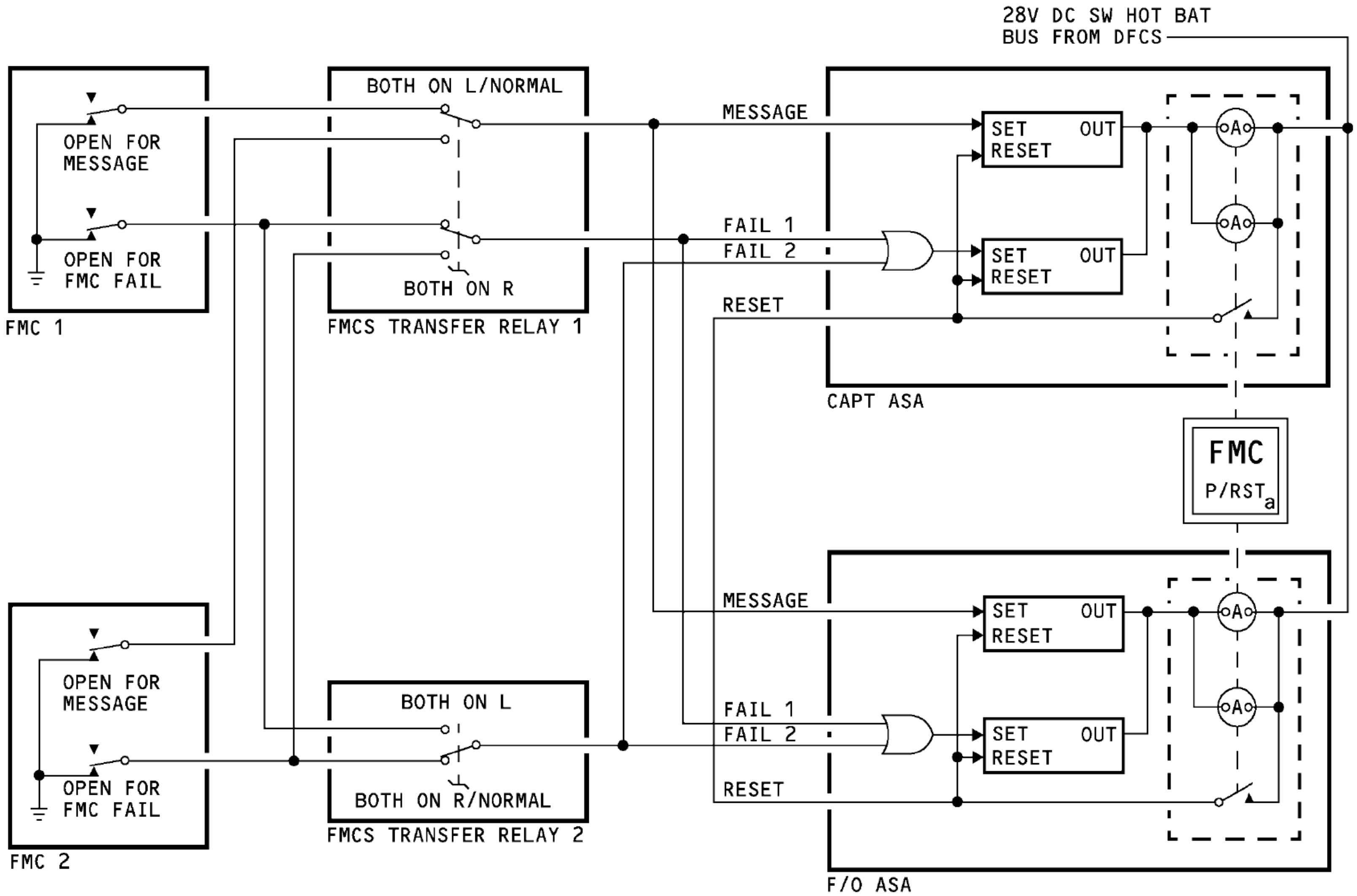
The ASAs show a change of condition for these systems:

- Autopilot
- Autothrottle
- Flight management computer system (FMCS).

FMCS

The FMC warning light is amber when an FMC has an alert message or when an FMC fails. The light also comes on when you put the TEST switch in position 1 or 2.

Push the FMC warning light to reset the latch and turn the light off.



STATUS ANNUNCIATOR INTERFACE

PROGRAM PIN INTERFACE

General

FMCS hardware program pin options are set with the FMC program switch modules. The program pins customize the FMCS to your airline configuration.

Note: Program pin status can be verified on the FMCS BITE analog discretes pages and model engine configuration pages on the CDU.

Configuration Options

The airframe/engine configuration is found by a combination of eight program pins.

This combination sets these conditions:

- Airplane model
- Engine thrust
- Engine combustor type
- Brake type.

The next generation 737 program pin determines that the aero/propulsion data is stored in the model engine data base (MEDB).

The airframe/engine parity pin determines that the airframe/engine configuration is valid. Odd parity is used.

The performance option code defines levels of reduced climb thrust so that climb thrust can not be more than take off thrust.

The source/destination identifier identifies the FMC as left or right. It is always set to left.

Computation Options

The JAA flight rules option sets the default values for cruise center of gravity (CG) and maneuver margin.

The runway position update on TOGA option enables the FMC to update the FMC position to the present runway position when the TOGA switch is pushed.

Display Options

The kilogram weight option sets the weight default for CDU entries.

The degrees C default option sets the temperature default for CDU entries.

The autotune navaid suppression option inhibits the display of autotuned navaids on the CDS map display.

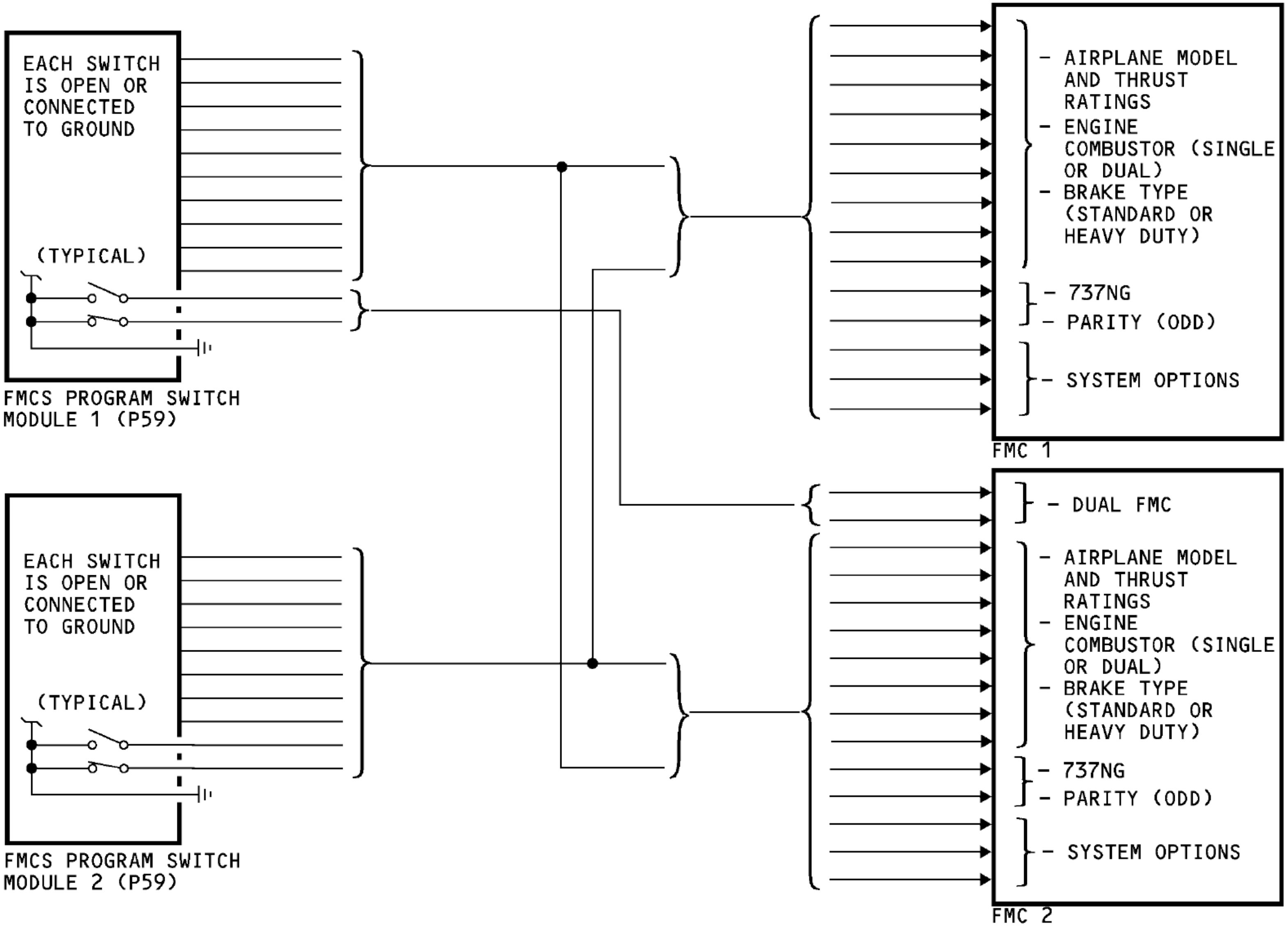
The selected course inhibit option inhibits the display of selected course radials for manually tuned navaids on the CDS map display.

Interface Options

The aspirated TAT probe option lets the FMC use the temperature from the TAT probe on the ground to calculate V1, VR, and V2 speeds.

The flight number entry option lets the crew enter flight number which shows on the PROGRESS pages.

The SEL CONFIG mode option is used to see the configuration data for the loadable software of a non FMC system.



PROGRAM PIN INTERFACE

BITE PRINTER AND PORTABLE CDU RECEPTACLES

Printer Receptacle

You can connect a portable printer to the BITE printer receptacle connector on the P-18 panel. When the printer is connected, you can print CDU and FMC data.

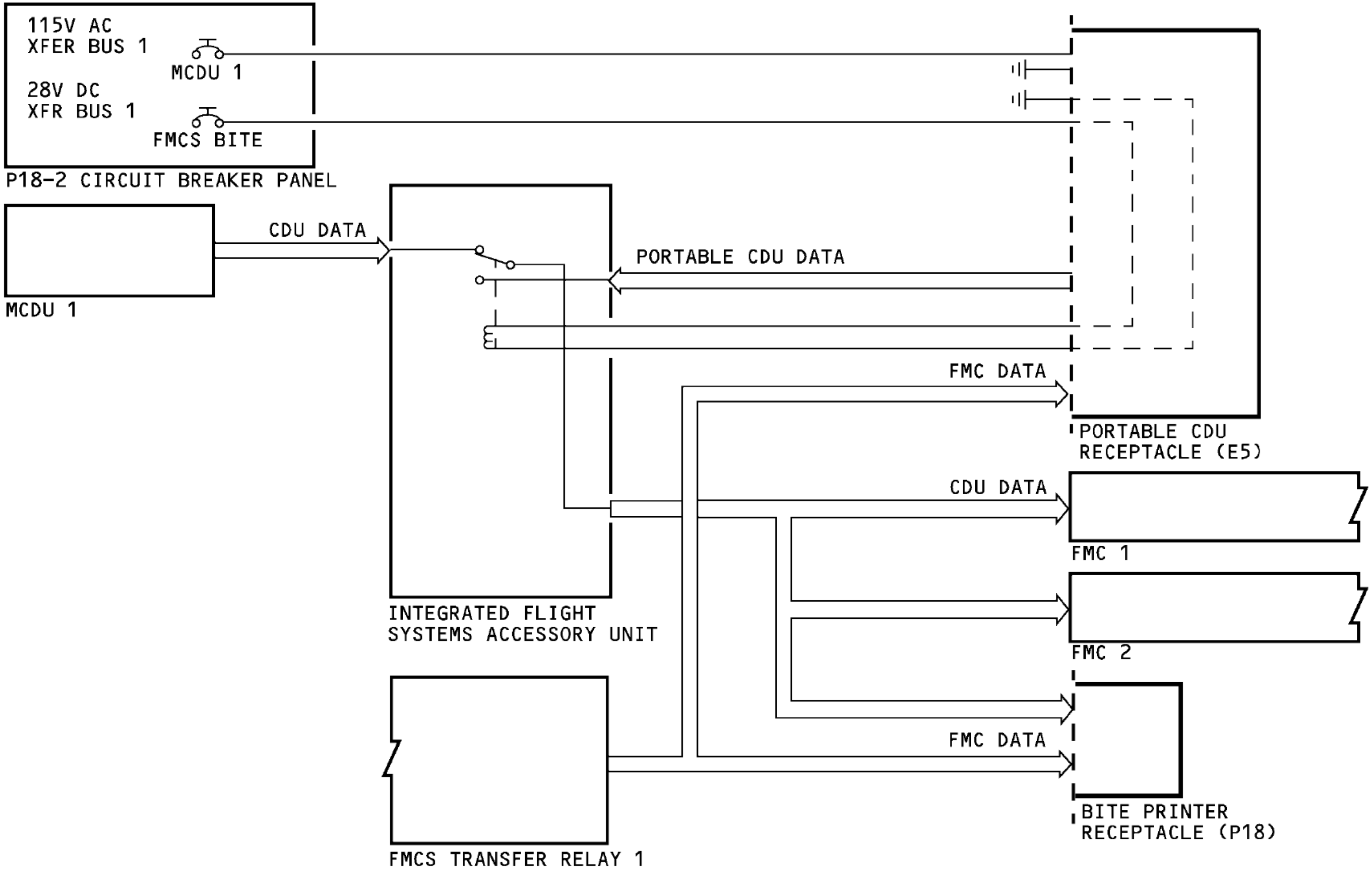
The printer is supplied by the customer.

Portable CDU Receptacle

You can connect a portable CDU to the portable CDU receptacle connector in the main electronic equipment compartment. With the CDU connected, you can do maintenance BITE in the electronic equipment compartment.

The portable CDU is supplied by the customer.

Note: Data will still show on CDU 1 while the portable CDU is connected.



BITE PRINTER AND PORTABLE CDU RECEPTACLES

FMCS – COMPONENTS

FLIGHT MANAGEMENT COMPUTER

Purpose

The FMC uses data from the airplane sensors and data stored in the FMC to do the calculations for navigation, performance, and guidance of the airplane.

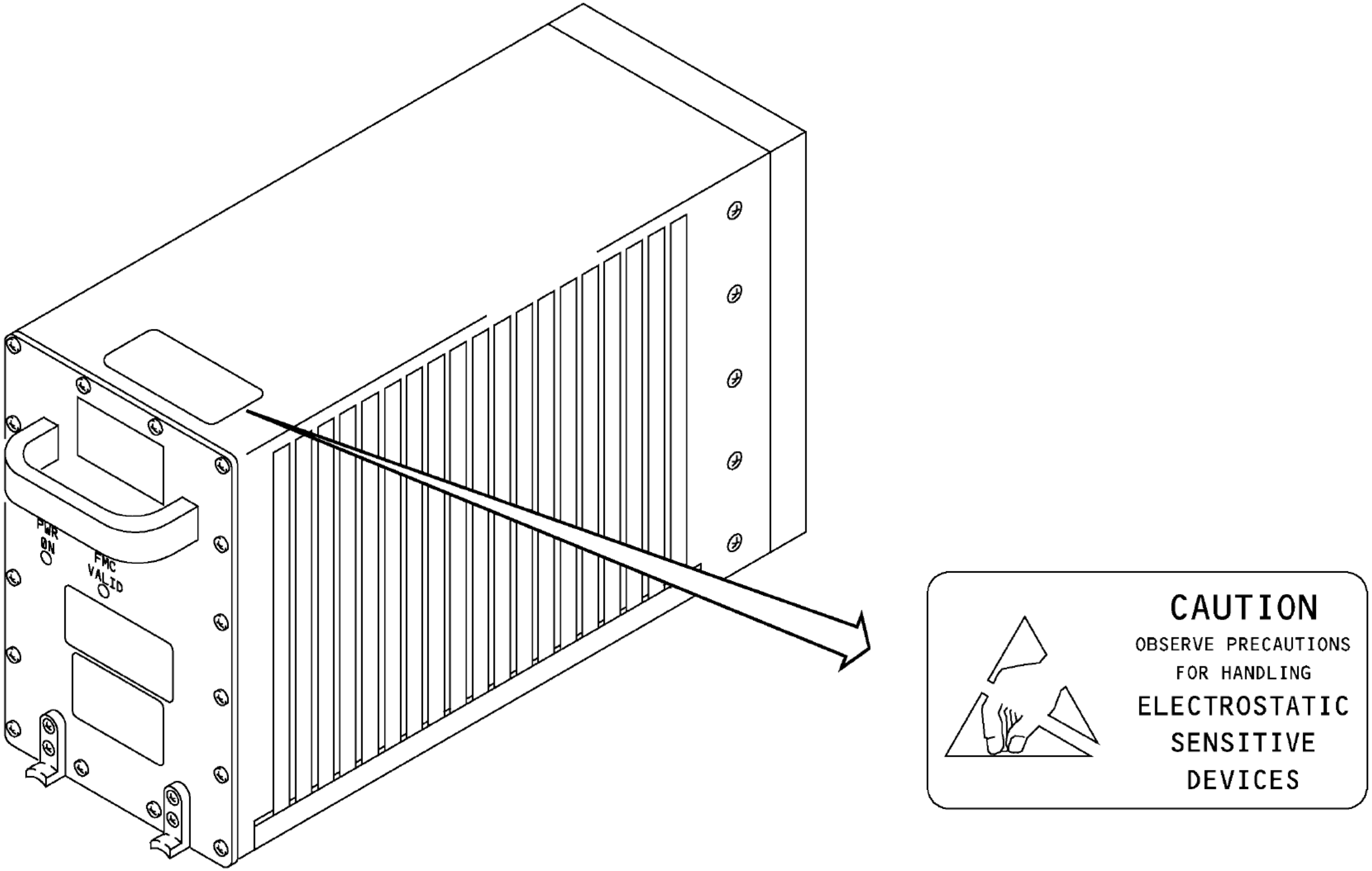
Physical Description

The FMC is a rack-mounted chassis assembly in an ARINC 600, 4 MCU box. It weighs less than 22 pounds (10 kilograms). It uses 115V AC, 400 Hz single phase electrical power.

The FMCs are cooled with air from the equipment cooling supply and exhaust systems. Cooling air for FMC 1 is blow-through. Cooling air for FMC 2 is draw- through.

Two green light emitting diodes (LEDs) show through openings in the front of the unit. The PWR ON LED comes on when the FMC has power. The FMC VALID LED comes on after power is on and the unit passes internal tests.

Caution: FAILURE TO OBSERVE ELECTROSTATIC DISCHARGE PRECAUTIONARY PROCEDURES WHEN TOUCHING, REMOVING, OR INSERTING PARTS OF ASSEMBLIES, MAY RESULT IN DEGRADATION OR FAILURE OF THE FMC.



FLIGHT MANAGEMENT COMPUTER

FLIGHT MANAGEMENT COMPUTER - FUNCTIONAL DESCRIPTION

General

These are the primary components of the FMC:

- Processor card
- Memory card
- ARINC I/O module
- Power supply.

Processor Card

The primary components of the processor card are the processor and the application specific integrated circuit (ASIC).

The processor card does these functions:

- Flight plan management
- Navigation and navaid tuning function
- Performance management function
- Guidance function
- Control and display functions.

The processor card also has the memory for the FMC boot and maintenance programs. The random access memory (RAM) is used for the scratchpad memory.

The ASIC controls the intersystem bus (ISB) between the two FMCs and the MAINT BITE processing. It also controls the real time clock and the system reset and power down logic.

Memory Card

The memory card contains the memory used for the storage of the operational flight program (OFP).

It also contains these data bases:

- Navigation data base (NDB)
- Model/Engine data base (MEDB)
- Software options data base.

All memory on the memory card is electrically erasable programmable read only memory (EEPROM).

ARINC I/O Card

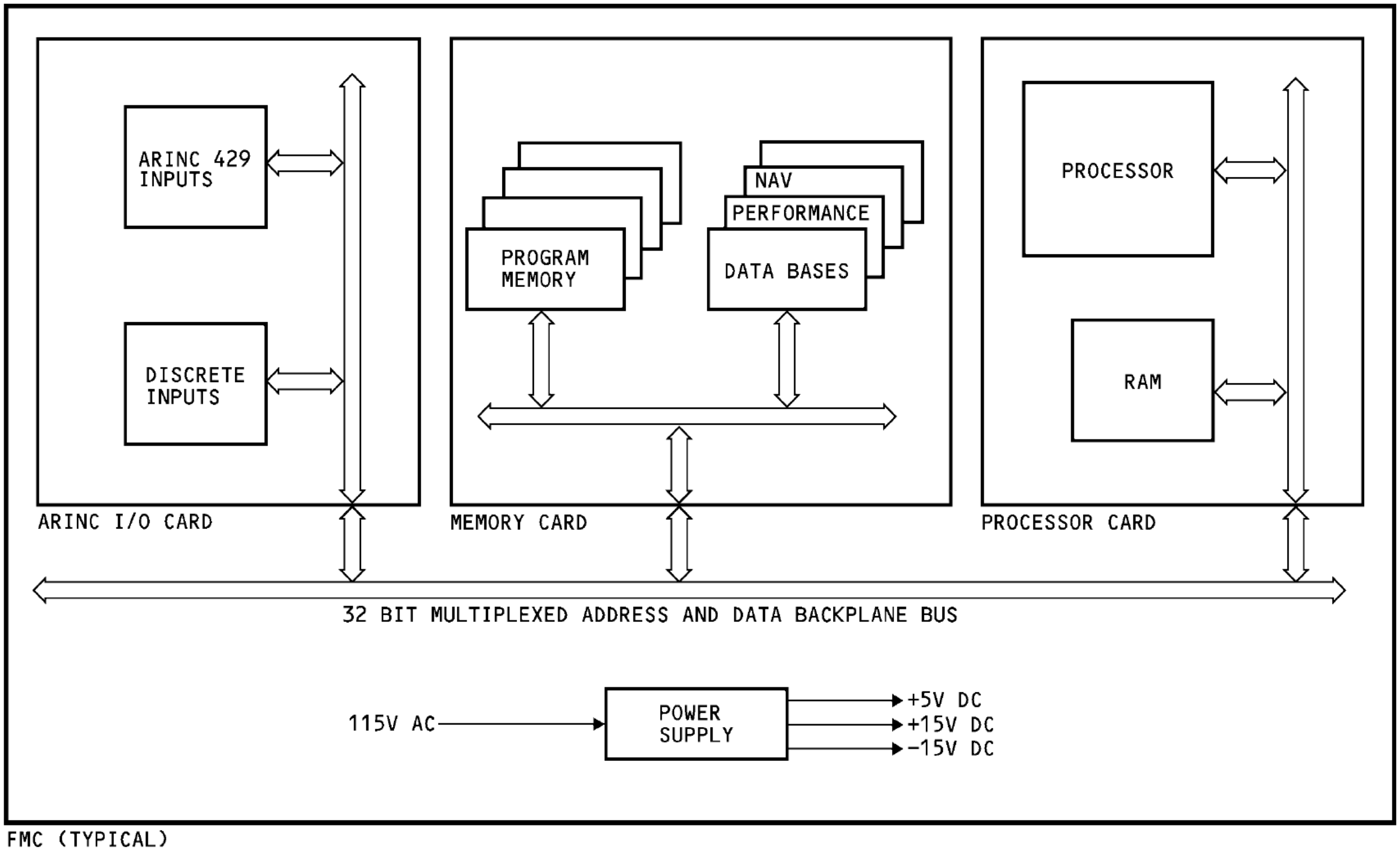
The I/O card does all the functions necessary for communication between the FMC and external systems. The card is divided into a discrete I/O function and an ARINC 429 I/O function.

The I/O card also includes an ASIC which acts as the primary controller for the I/O function. There are 16 ARINC 429 output drivers, 32 ARINC input translators, 6 discrete outputs and 6 discrete inputs.

An LED on the I/O card comes on when there is a BIT failure.

Power Supply

The power supply uses 115v ac, single phase from the aircraft electrical system. It supplies + 5v dc, +15v dc and -15v dc to internal components of the FMC. Total output power is 40 watts. There is a 50 microsecond hold up feature for short term power interrupts. An LED on the power supply card comes on when the power supply is valid.



FMC – FUNCTIONAL DIAGRAM

CONTROL DISPLAY UNIT (CDU)

Purpose

The flight crew uses the control display unit (CDU) to put in flight data and to select displays and modes of operation. They also use the CDU to start ADIRU alignment. You use the CDU to do tests of the FMCS and other systems.

There are two CDUs in the airplane. They are functionally and physically interchangeable.

Physical Description

Option 1

The CDU weighs 20 pounds (9.1 kg).

Option 2

The CDU weighs 9 pounds (4.1 kg).

There are holes in the chassis for cooling air. The equipment cooling system supplies cooling for the CDUs. Keep dust and dirt build-up from the vent and surfaces. The procedures to clean the CDU are in the maintenance practices section.

The CDU has these annunciators:

- Fail
- CALL
- MSG (message)
- OFST (offset).

The annunciators each use a two-lamp circuit board assembly. Each board assembly is line replaceable.

The execute (EXEC) key is on the right of the CDU. This key has a lamp assembly with two lamps. The lamp assembly is line replaceable.

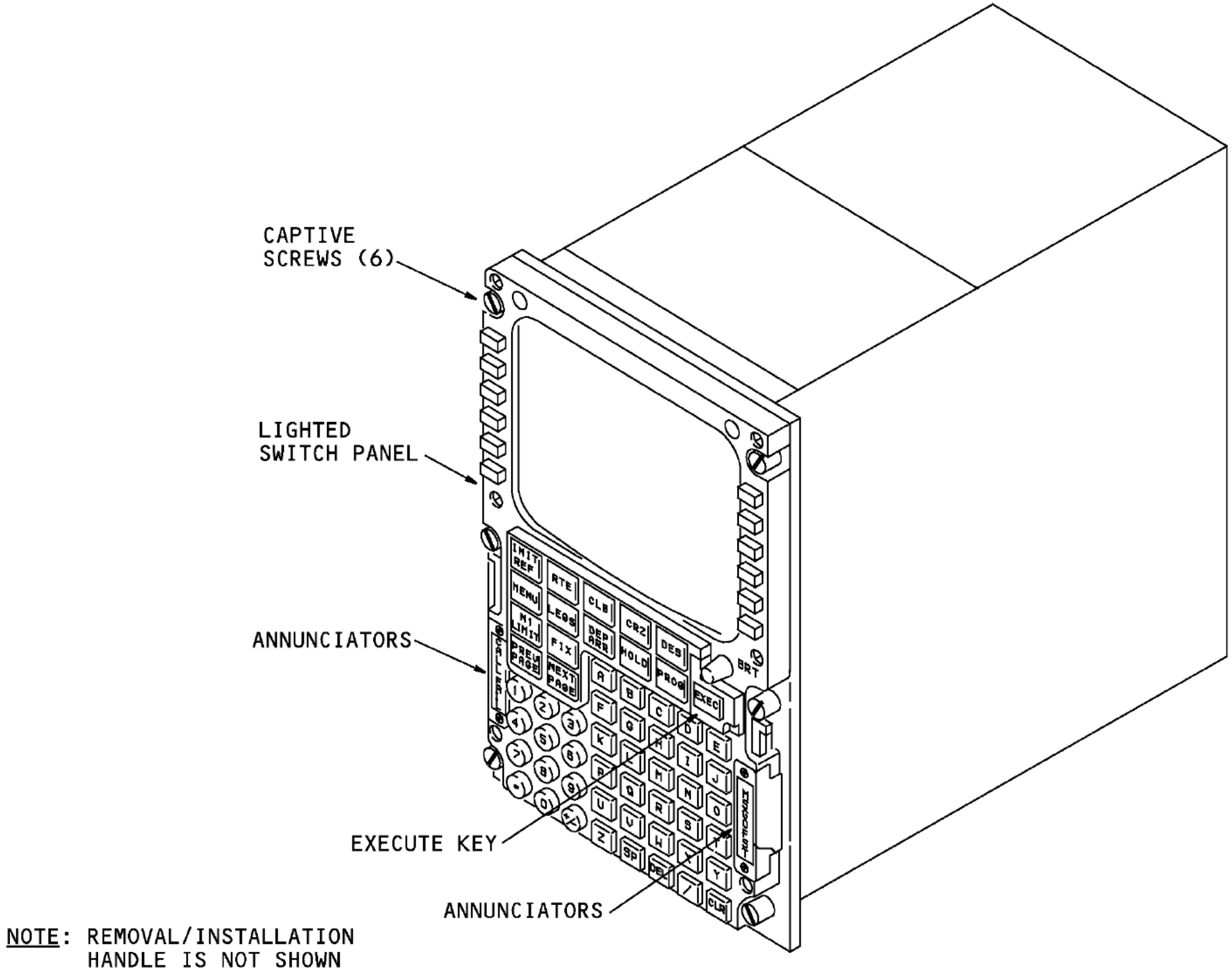
The lighted switch panel is line replaceable. Six screws hold the panel in place.

Caution: FAILURE TO OBSERVE ELECTROSTATIC DISCHARGE PRECAUTIONARY PROCEDURES WHEN TOUCHING, REMOVING, OR INSERTING PARTS OR ASSEMBLIES MAY RESULT IN DEGRADATION OR FAILURE OF THE CONTROL DISPLAY UNIT.

Training Information Point

If you remove CDU 2, install the ground lock assemblies on the landing gear. Put the control lever for the landing gear in the OFF position.

Caution: MAKE SURE THAT YOU INSTALL THE GROUND LOCK ASSEMBLIES ON THE LANDING GEAR BEFORE YOU MOVE THE CONTROL LEVER FOR THE LANDING GEAR. YOU WILL DAMAGE THE AIRPLANE IF YOU RETRACT THE LANDING GEAR WHILE THE AIRPLANE IS ON THE GROUND.



CONTROL DISPLAY UNIT

CDU - FUNCTIONAL DESCRIPTION

The LCD CDU has these sub-assemblies:

- Low voltage power supply
- Rear connector filter assembly
- Processor and interface circuit card assembly
- LCD module
- Backlight assembly
- Lighted switch panel.

Power Supplies

The low voltage power supply module in the CDU receives 115v ac, 400Hz, single phase power from the airplane electrical system.

It provides the following operating voltages within the LCD CDU:

- +5v dc
- +12.7v dc
- -12.7v dc
- +26v dc
- +28v dc
- Switched +28v dc (used for the backlight and LCD heaters).

The airplane master dim and test circuits supply 28v dc to the CDU for annunciator power and lamp test. Also, 5v ac power is used for the lighted switch panel lighting.

Rear Connector Filter Assembly

The CDU receives data on up to seven ARINC data buses and four discrete inputs. Output data is sent over two ARINC data buses and one discrete output.

All input and output data goes through the rear connector filter assembly (RCFA) which provides electromagnetic interference (EMI) protection.

Processor/Interface Circuit Card

The processor and interface circuit card (P&I CCA) provides all of the control and external interface circuitry for the CDU. It provides the following functions:

- Read lighted switch panel inputs to determine CDU modes/inputs
- Receive ARINC inputs from other airplane systems
- Read and interpret airplane discrete inputs
- Generate CDU fail output discrete
- Control CDU annunciator operation
- Send ARINC outputs to FMCS
- Communicate with other airplane sub-systems
- Generate data for LCD and backlight assembly
- Perform BITE.

LCD Module

The LCD module provides the display of 24 columns and 14 rows. It is a non- light emitting device that requires a separate light source (backlight assembly) to make the display viewable.

During power-up, the LCD provides a display within 10 seconds at normal operating temperatures (0-55 degrees C, 32-131 degrees F). At or below freezing temperatures, the LCD can take up to 2 minutes to provide a normal display. The LCD contains a temperature regulating function which improves operation over a wide range of temperatures.

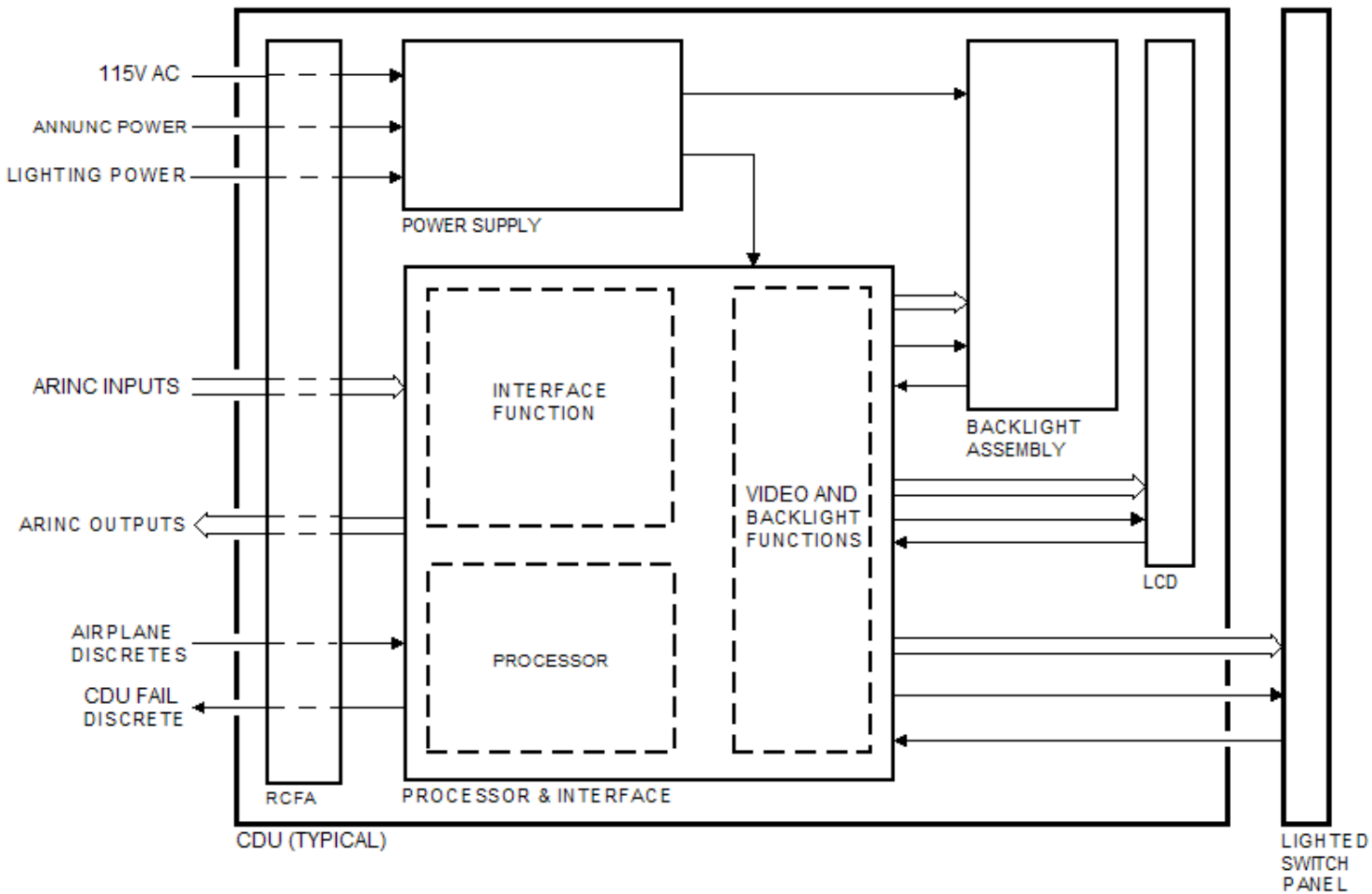
Backlight Assembly

The backlight assembly has a lamp and control circuitry to provide the required illumination for the LCD. It is controlled by the P&I CCA.

The backlight assembly also sends ambient light level information to the P&I CCA so that it can adjust the luminance level for the LCD. The backlight assembly also sends temperature information to the P&I CCA so that, when necessary, it can turn on the LCD heater.

Lighted Switch Panel

The lighted switch panel provides the interface between the operator and the FMCS through the CDU. The panel contains two ambient light sensors which are used to adjust the display brightness and contrast.



CDU - FUNCTIONAL DIAGRAM

CDU - CONTROLS AND DISPLAYS

Display Format

The multi-purpose control display unit (MCDU) data shows on the five-inch liquid crystal display (LCD). The basic display is a set of fourteen lines. Each line can show 24 characters. Each line can show alphanumeric characters and symbols.

Color

- **Option 1 -** The MCDU cathode ray tube (CRT) uses green text on a black background.
- **Option 2 -** The MCDU contains a liquid crystal display (LCD). It shows white text on a black background.

Display Layout

The first line shows Status, Title, pafe number data blocks.

- **Status** - Status shows that the information on the display is the active executed plan (ACT) or a modified plan (MOD). When the data on the display is not active or not a part of the flight plan, the status block is blank.
- **Title** - The next block is the title for the display. An example of a title is POS INIT.
- **Page number** - The last character spaces in the first line show the page number for each display. This tells the operator the active page and the total number of pages.

Data on lines two through thirteen (data field) applies to operation of the airplane.
Line fourteen is a scratch pad to enter data from the keyboard. Also, this line shows this data:

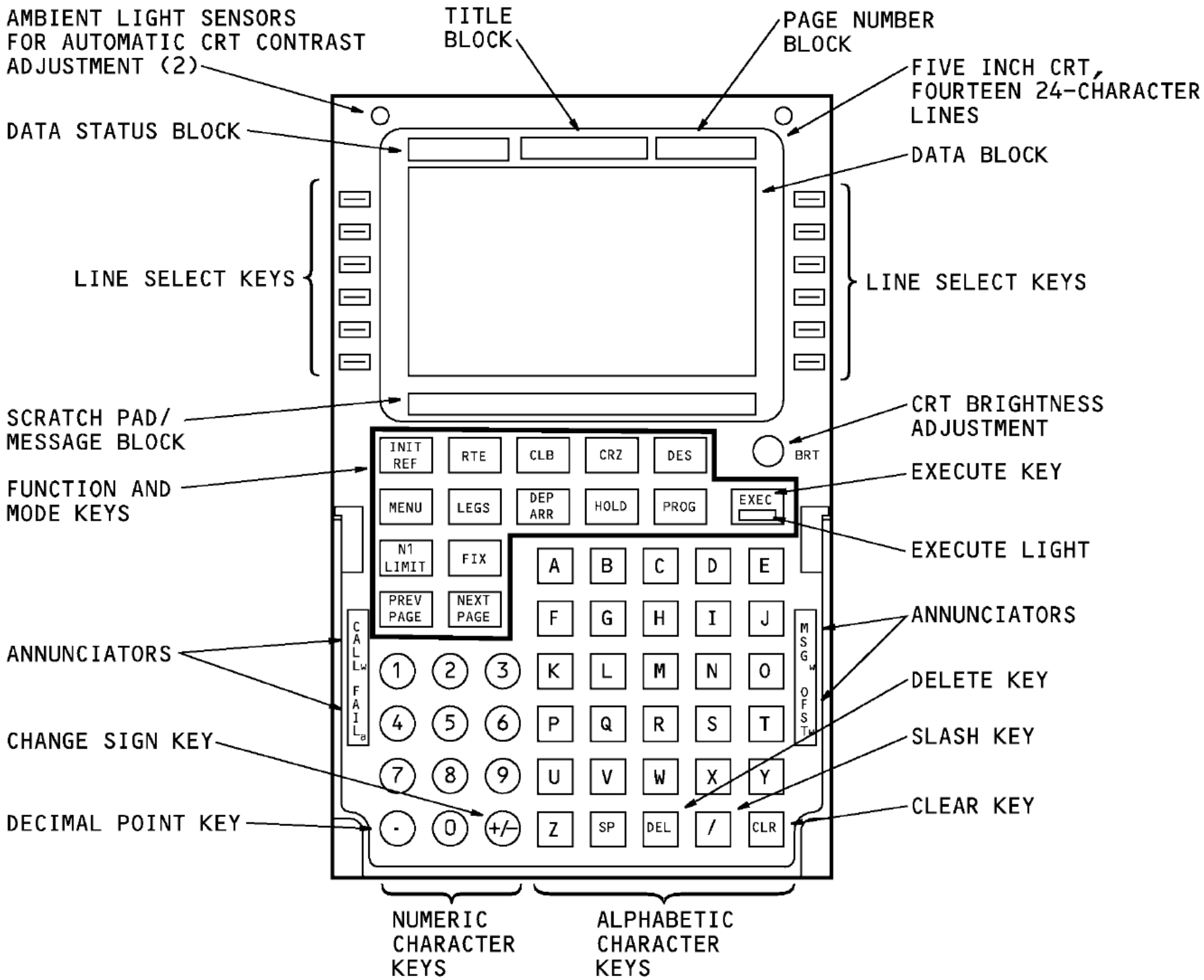
- Failure messages
- Alerts during operation
- Advisory prompts.

Alphanumeric Key Board

You use the key board to enter data into the FMCS and to make changes to a flight plan. Each time you push an alphanumeric key, the entry shows in the scratch pad (line 14). In the scratch pad, you can edit the entry or clear it.

Function and Mode Keys

- The **INIT REF** key supplies access to a selection of data pages necessary to start the FMCS and ADIRU. Also, the operator can access navigation data and maintenance pages.
- The **RTE** key selects the page you use to enter route data. This includes the flight origin and destination plus the takeoff runway number.
- The **CLB** key shows the climb modes. Top-of-climb (T/C) altitude and speed/altitude restrictions show here. Information about time and distance to the next waypoint is also shown here.
- The **CRZ** key shows the cruise modes. Information about optimum altitude, maximum altitude, step climb savings and turbulence N1 targets also show.
- The **DES** key shows the descent modes. The end-of-descent altitude and speed/altitude restrictions show here. Information about flight path angle, airplane vertical speed and vertical bearing also show.
- The **MENU** key gives access to other airplane data communication systems.
- The **LEGS** key shows and accepts input of data about each leg of the flight plan. Information about heading between the waypoints, speed and altitude is also shown.
- The **DEP/ARR** key supplies access to a selection of departure and arrival runways and procedures for the origin and destination airports.
- The **HOLD** key lets you plan or start a hold at a waypoint or present position. The PROG key shows this current flight status information.
- The **N1 LIMIT** key shows the FMC calculated N1 thrust limits for specific flight phases. This page also shows the reduced climb thrust limits CLB-1 (Climb 1)and CLB-2 (Climb 2). The flight crew can set N1 limit data from this page.
- The **FIX** key shows range and bearing data from the present position to a selected reference position (SRP).
- The **EXEC** key is used to make active or to modify a page with data entry when the EXEC light comes on.



CDU – CONTROLS AND DISPLAYS

CDU - CONTROLS AND DISPLAYS (Continue)

Page Select Keys

You push the NEXT PAGE key to advance the display to the next higher number page. You push the PREV PAGE key to back-up the display to the next lower number page. The page strings are continuous. If the first page of a string is shown (1/9) and you push the PREV PAGE key, the display shows the last page in the string (9/9). If you go past the last page in a string (past 9/9 for example), this takes the display back to the first page in the string (1/9).

Line Select Keys

You use the line select keys for these operations:

- Move data from the scratch pad to a data field
- Copy data from a data field to the scratch pad
- Remove data from a data field
- Select a BITE operation from the maintenance bite index.

Lighted Annunciators

CALL, MSG, OFST are the active annunciators.

- The **CALL** light is on when there is a call from another system other than the FMCS.
- The **MSG** light is on to show there is an alert or advisory message. The MSG light stays on until you clear the message.
- The **OFST** light is on when a parallel offset is active.

Special Keys

The keyboard has special keys in addition to the alpha-numeric keys.

These are the special keys:

- Change sign (+/-)
- Space (SP)
- Delete (DEL).
- Slash (/)
- Clear (CLR).

The change sign **(+/-)** and slash **(/)** keys are standard keys on a keyboard.

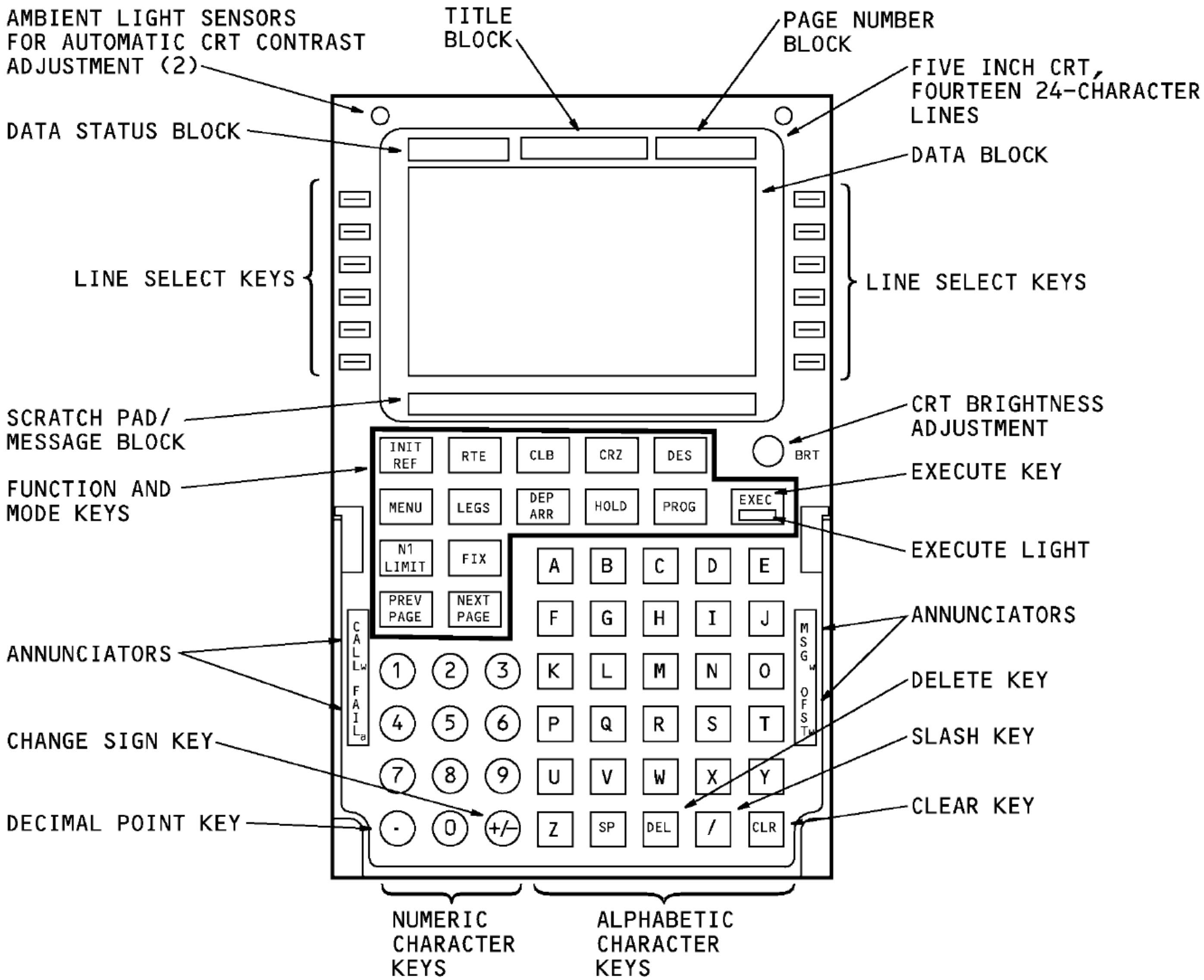
The space key **(SP)** puts a space into the scratchpad. This will allow the flight crew to write messages into the scratchpad.

A push of the **DEL** key puts the word DELETE in the CDU scratch pad. This lets the operator delete a data field with the line select key next to the data field.
The DEL key does not work when the scratchpad contains data. Some data fields do not permit the DEL key function. In this case, the INVALID DELETE message shows in the CDU scratchpad.

Push the **CLR** key once to remove one alphanumeric character in the scratch pad or an alert or advisory message from the scratch pad. Hold the CLR key down for one second to remove all scratch pad data.

BITE

The FMCS BITE function does a check of all key functions.



CDU – CONTROLS AND DISPLAYS

AIRBORNE DATA LOADER

Purpose

You use the airborne data loader (ADL) to load data into selected LRUs and to record data from selected LRUs. You use the data loader control panel to select the LRU.

Physical Description/Features

The airborne data loader (ADL) is an ARINC-615 high speed loader.

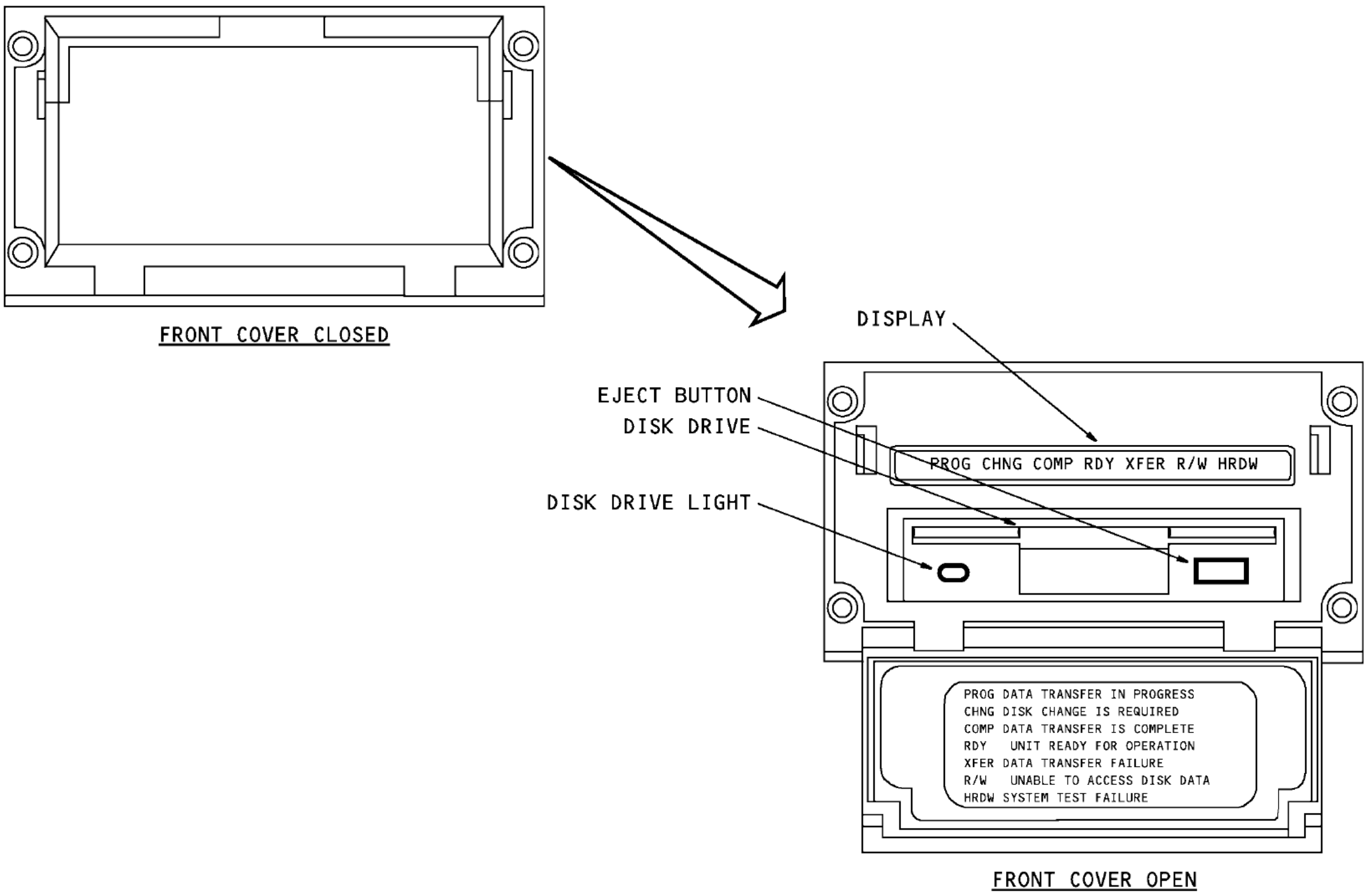
These are the ADL features:

- Access door
- Disk drive
- Disk drive light
- Disk drive eject button
- Display.

These messages show on the display:

- READY (The loader test is complete. No failure)
- READY (A diskette is in the loader)
- WAIT RESPONSE (A diskette is in the loader. The LRU has not started the transfer)
- TRANSF IN PROG (The data transfer has started)
- BUS N: XXXXXX (The data transfer has started on bus N, and XXXXXX bytes have transferred or remain to be transferred)
- EJECT DISK (Remove this diskette)
- INSERT NEXT DISK (There are multiple diskettes. Put in the next diskette)
- INSERT DISK NN (There are multiple diskettes. Put in diskette NN)
- BAD DISC CHANGE (Data on this diskette does not compare with the LRU software. Remove the diskette)
- DISC CHANGE (Change the diskette)
- DISC ERROR (There is a problem with this diskette)
- UNIT FAIL (The loader is defective)
- TRANSF FAIL (LRU found error in data from the diskette)
- TRANSF COMPLETE (Transfer is complete)
- TEST IN PROG (A loader self test is in progress)
- TEST COMPLETE (Self test was satisfactory).

The data loader does an internal self test at power up. If there is a failure at power up, the message UNIT FAIL shows on the display. If the self test is satisfactory, the message UNIT READY shows. The other messages show as the data loader moves through the load or transfer.



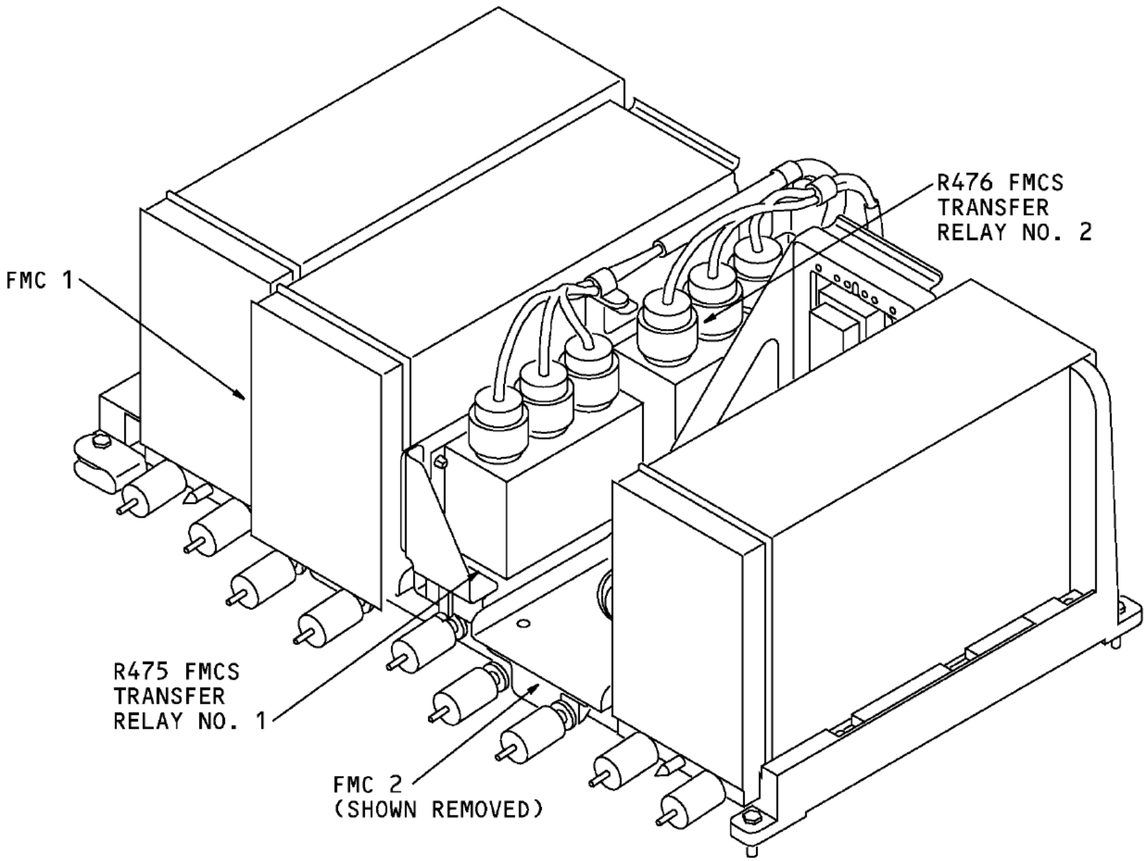
AIRBORNE DATA LOADER

TRANSFER RELAYS

There are two FMCS transfer relays. The relays select the FMC to send data to the systems that interface with the FMCS. The FMC SOURCE SELECT SWITCH controls the relays. The source select switch is in the flight deck.

The relays are on the E5-2 shelf in the electronic equipment compartment.

The relays are Ledex type relays. They mechanically latch and are hermetically sealed.



ELECTRONIC EQUIPMENT SHELF E5-2

TRANSFER RELAYS

THIS PAGE IS INTENTIONALLY LEFT BLANK

FMC FUNCTIONAL DESCRIPTION

INTRODUCTION

These are the primary FMC functions:

- Navigation
- Performance
- Guidance.

The FMC does the primary functions with data input from these sources:

- Flight crew
- Airplane system sensors
- Data stored in the FMC memory. This is the data in memory:
- Operational flight program (OFP)
- Navigation data base (NDB)
- Performance default data base
- Airplane model/engine performance data base (MEDB)
- Software options data base.

FMC Data Bases

The operational flight program is the computer software that the FMCS uses to do the navigation, performance, and guidance functions.

The navigation data base contains all the data necessary for the airplane operation over a defined route network.

This type of information is available:

- Waypoints
- Navaids
- Airport data
- Airway data
- Standard instrument departures (SIDs)
- Standard terminal arrival routes (STARs).

There are two navigation data bases, the current and a set of update revisions, stored in the FMC.

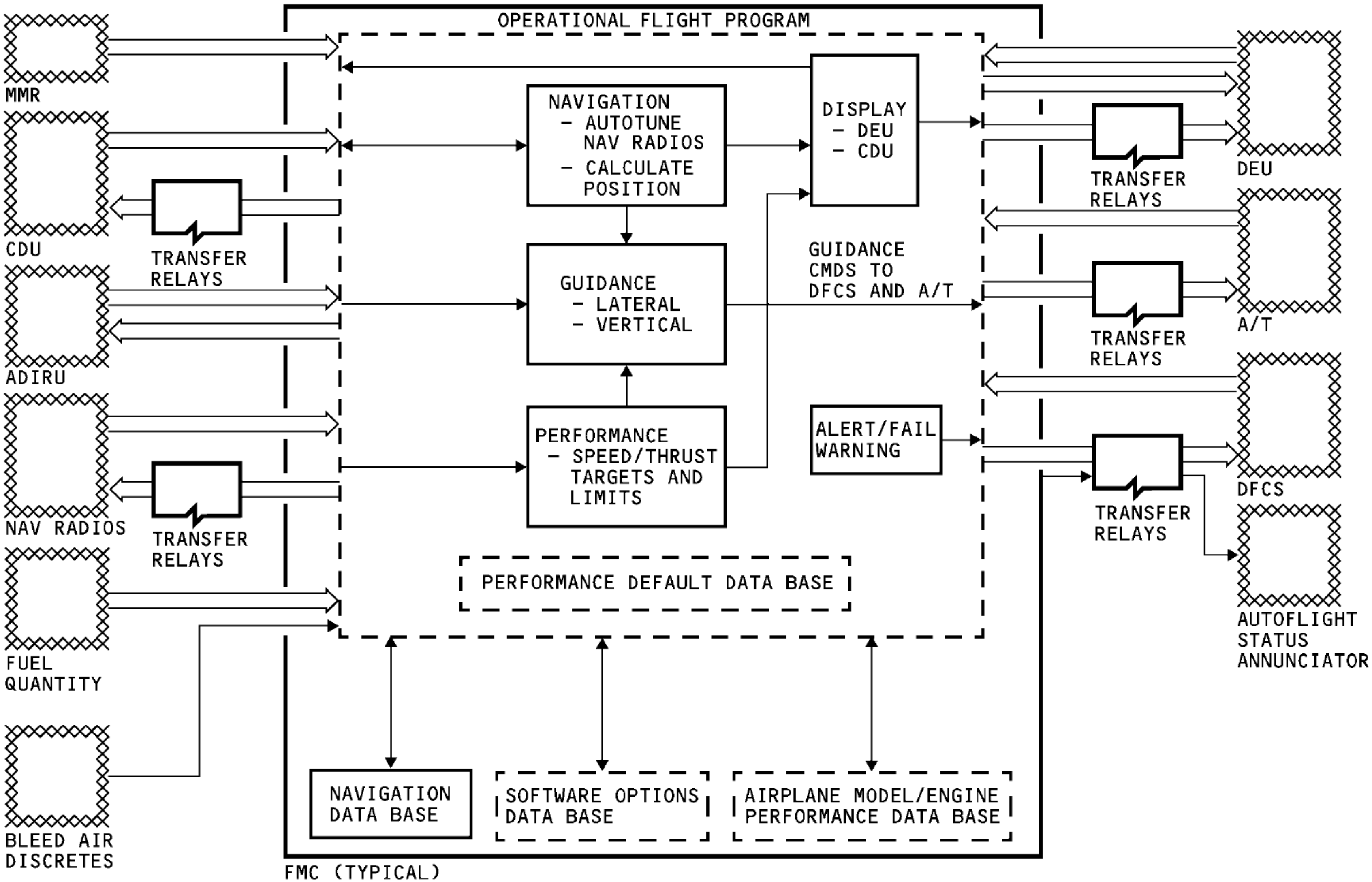
The performance default data base is part of the operational flight program. It has an aerodynamic model of the 737-300/400/500 series airplanes and a fuel flow/N1 thrust model for the specific engine on the airplane. This data is used to predict the performance characteristics that give the optimum vertical profile for the airplane.

The fuel flow/N1 thrust model is used to calculate fuel flows and thrust limits corrected for the effects of air conditioning and airframe anti-ice bleed air demands.

The model/engine performance data base (MEDB) has the same type of information and does the same function as the performance default data base. However, the MEDB contains the data for the 737-600/700/800 series airplanes. The MEDB is loadable through the data base loader and is not part of the operational flight program.

The software options data base has the software options that have been selected.

All these data bases are loadable with a data base loader.



FMC FUNCTIONAL DESCRIPTION - INTRODUCTION

FMC FUNCTIONAL DESCRIPTION – INTRODUCTION (Continue)

Navigation

The navigation function gives airplane position (FMC position) and autotuning capability for the navigation radios.

The FMCS uses these sensors to calculate the FMC position:

Global positioning system
NAV radio data
ADIRS.

The flight crew can manually build the route or select it from the company navigation data base. When the route has been activated, it shows on the navigation display of the CDS.

Performance

The performance function gives flight profile information and target engine N1 speeds. This lets the airplane fly at the most economical altitudes and speeds for the conditions.

The FMC uses this information to calculate performance data:

- CDU data (cost index, CRZ altitude, etc.)
- Air data and inertial reference information
- Fuel weight
- Engine bleed air data
- Airplane and engine information from the model/engine performance database.

The economy mode is the primary performance mode for the climb, cruise, and descent phase of flight. The flight crew can select other operating modes at any time.

Guidance

The guidance function sends flight path and steering commands to the digital flight control system (DFCS) and the autothrottle (A/T).

For lateral navigation (LNAV), the FMC calculates the route and compares it to the FMC position. If they are different, the FMC calculates a roll steering command and sends it to the DFCS.

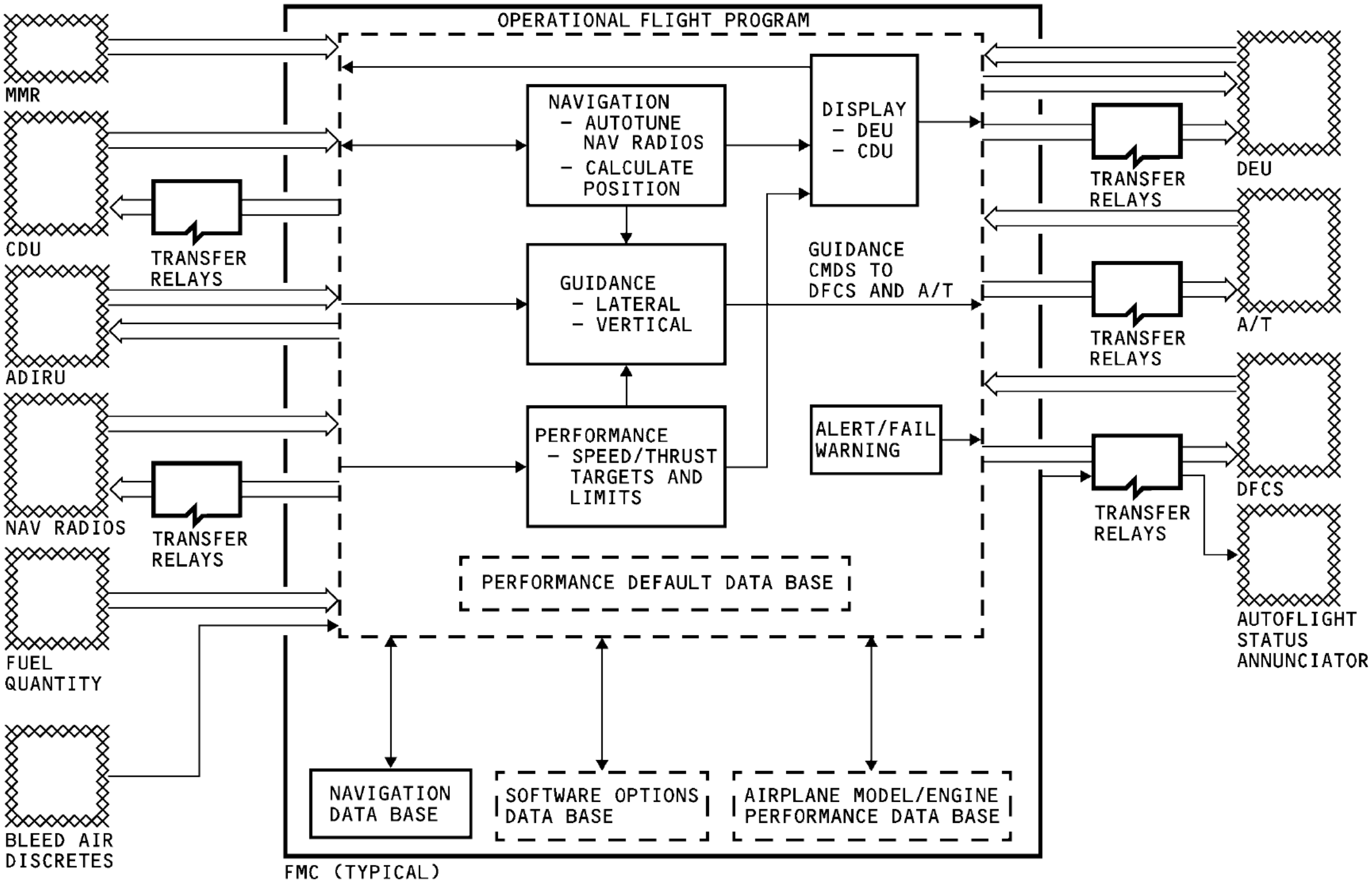
For vertical navigation (VNAV), the FMC calculates speed and vertical speed targets and sends them to the the DFCS. The FMC also calculates N1 thrust and speed targets and sends them to the A/T. The autothrottle and autopilot follow the targets and commands to keep the airplane on the calculated flight path.

During climb or descent, the FMCS sends speed and altitude targets to the DFCS. During level flight, the FMCS sends speed commands to the A/T.

Other Functions

The display function sends display data to the common display system and the CDUs. The data includes route and position data and N1 data.

The ALERT function does a check of the FMC status. It turns on the FMC light on the autoflight status annunciators when the FMC fails or when there is a message that makes flight crew awareness and subsequent action necessary.



FMC FUNCTIONAL DESCRIPTION - INTRODUCTION

NAVIGATION SUB- FUNCTION

The FMCS navigation sub-function calculates this data:

- Lateral position
- Vertical position
- Actual navigation performance (ANP).

The primary data source for the lateral and vertical position calculations is the ADIRU. Because the ADIRU data drifts over time, the FMC navigation function uses data from other sensors to correct the ADIRU data that it receives.

The FMC uses independent measurements from the navigation sensors filtered with ADIRU position, heading and velocity data to produce an accurate calculation of the airplane's position in the horizontal plane.

Note: The ADIRU must be in the NAV mode to provide valid data to the FMC.

The FMC will select only one navigation update mode at a time. The navigation update mode with the least amount of position uncertainty will be used.

These are the sensors used to calculate/update the FMC position and their selection priority:

- ADIRU/GPS
- ADIRU/DME/DME
- ADIRU/DME/VOR
- ADIRU/DME/LOC
- ADIRU ONLY.

The first priority for FMC position updating is GPS data from the GPS receiver in the MMRs.

The next priority is a pair of DME stations that have the best range and geometry. The maximum range for DME/DME updating is nominally 200 nautical miles (NM) but the FMC will always use those stations that are nearest the airplane position. The FMC will also always tune two DMEs that are not within 30 degrees of each other or not greater than 150 degrees apart (90 degrees being the optimum angle).

If there are not two DME stations within range or that do not have the necessary geometry, the FMC uses DME distance and VOR bearing from a co-located VOR/DME station. The maximum range for VOR/DME update is 25 nautical miles.

Note: The FMC will autotune the DME interrogators but VOR must be manually tuned by the flight crew.

In an airport terminal area when the airplane is on a localizer approach, the FMC uses localizer deviation and DME distance to update the FMC position. The maximum range for LOC/DME update is 20 nautical miles and the airplane altitude must not be greater than 6000 feet above the localizer station elevation.

Also, the airplane track must be within 45 degrees of the localizer inbound course and localizer deviation must be less than 1.25 dots for at least 5 seconds.

With all VHF NAV radio updates, the FMC will correct the DME slant range distance for airplane altitude.

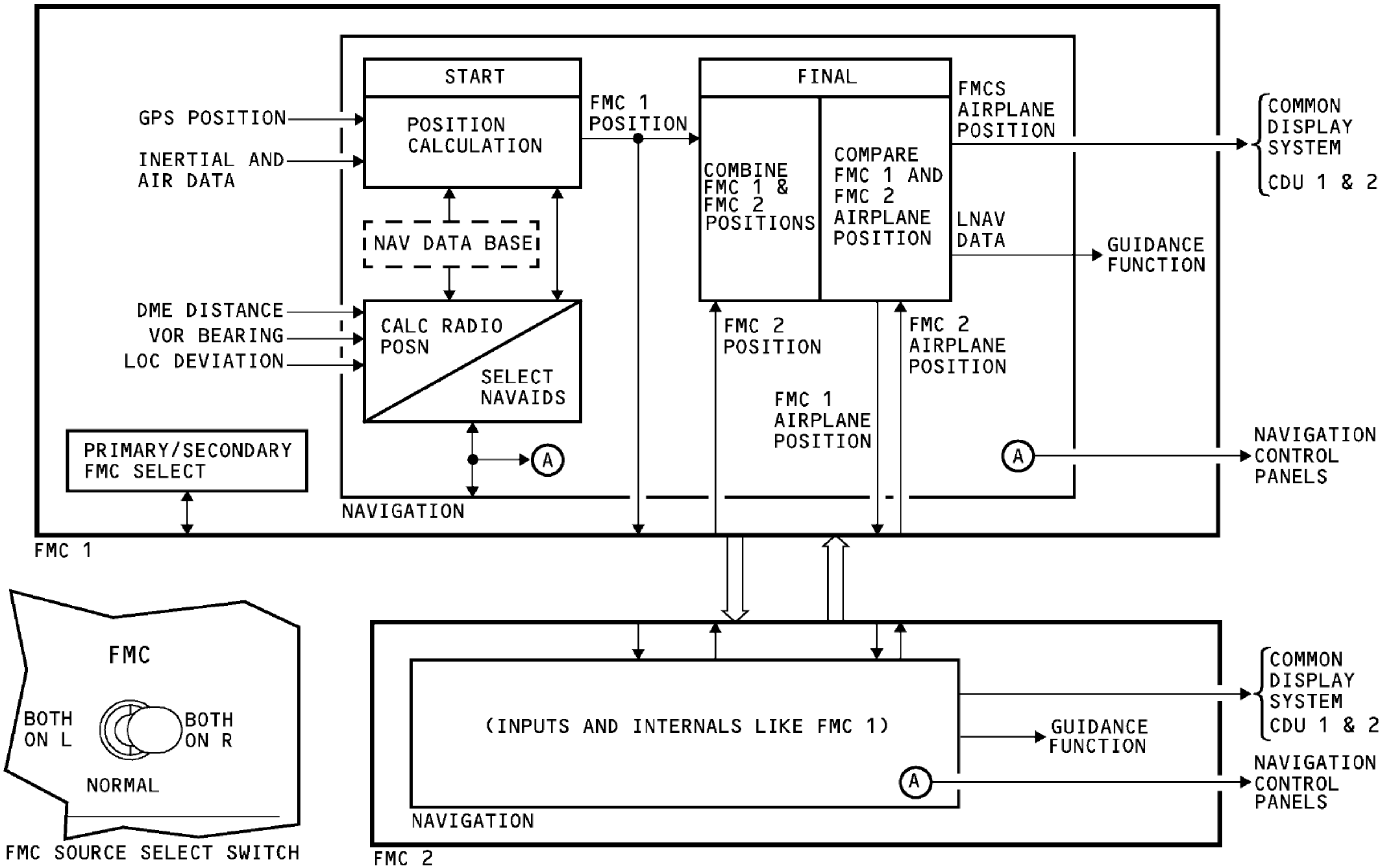
If GPS data and NAV radio data are not available or become invalid, the FMC uses ADIRU data only corrected by a fixed error bias calculated by the FMC.

The FMCS can use GPS data on the ground to update the FMC position if the GPS data is valid. VHF NAV radio update is not enabled on the ground.

The navigation sub-function also calculates the following nav data:

- Airplane position (latitude, longitude and altitude)
- Groundspeed
- Flight path angle
- Drift angle
- Track angle
- Wind velocity and direction
- Horizontal position accuracy (actual navigation performance).

The FMC uses the following inputs to calculate these parameters:Inertial position (latitude, longitude and inertially smoothed altitude), Vertical speed (inertially smoothed), Groundspeed components (N-S, E-W velocity vectors), Heading (magnetic and true), Pressure altitude (uncorrected and baro-corrected), True airspeed, GPS data, DME slant range, VOR bearing, ILS LOC deviation.



NAVIGATION SUB-FUNCTION

NAVIGATION SUB FUNCTION (Continue)

Lateral Position

This function calculates latitude and longitude.
The FMCs use the position calculated from the GPS data and the ADIRU inputs to correct their ADIRU based inertial lateral positions. These are the FMC positions and are calculated in terms of latitude and longitude. The FMCs will use their onside GPS input from the multi mode receivers (MMR) if the data is valid. The offside GPS data will be used if the onside data is invalid.

Vertical Position

This function calculates altitude and flight path angle (FPA).
Altitude is calculated from ADIRU inertial altitude corrected by barometric pressure altitude. Flight path angle is calculated from inertial vertical speed and FMC calculated ground speed. The FPA is zero when the airplane is on the ground.

FMCS Composite Position

Each FMC sends its FMC position to the other FMC with a confidence factor. The confidence factors are based on the estimated accuracy of each FMC and the navigation sensors that are being used in the position calculations.

In each FMC, FMC 1 position and FMC 2 position are used to give a final FMC position. This final position calculation from each FMC is a combination of the two positions weighted from their respective confidence factors. This final FMCS position and navigation data is continually compared between the two FMCs.

Actual Navigation Performance (ANP)

The ANP is the accuracy of the FMC calculated position. It is calculated in nautical miles by the FMCS during all parts of the flight. It is measured in nautical miles and it shows the radius of a circle around the calculated FMC position where the probability of the airplane being inside the circle is 95%.

The ANP calculation uses this data:
- The NAV stations in use
- GPS availability and accuracy
- Accuracy of DME range data
- Accuracy of VOR bearing data
- ADIRU drift.

The required navigation performance (RNP) is the accuracy requirement of the FMC navigation performance within a defined airspace. It is calculated in nautical miles and represents the radius of a circle where the probability of the airplane being within that circle is more than 95%. The default values for RNP are contained in the navigation data base.

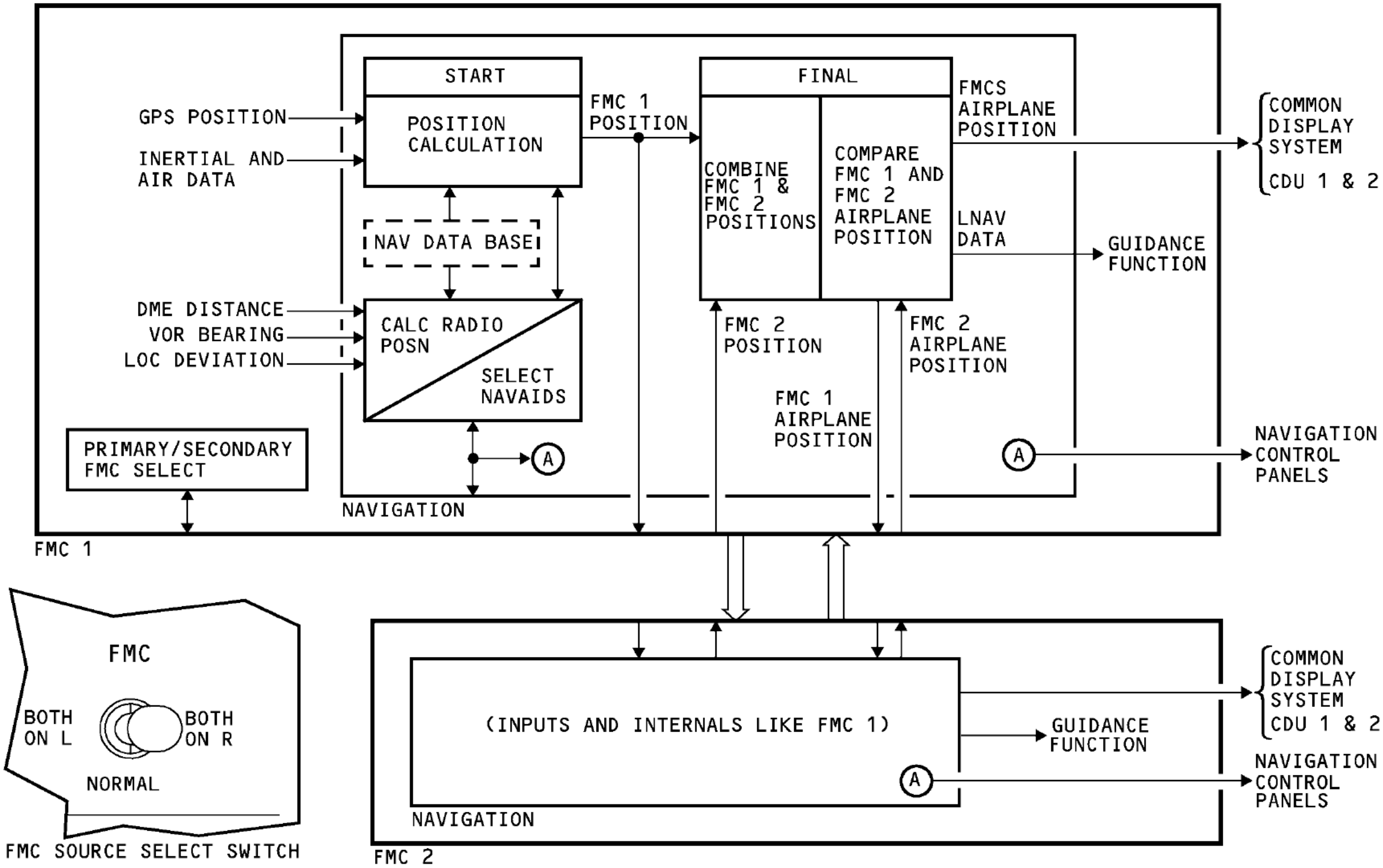
The default values for RNP are as follows:
- Oceanic - 12.0 NM
- Enroute - 2.0 NM
- Terminal - 1.0 NM
- Approach - 0.5 NM.

When the ANP exceeds the RNP, the message UNABLE REQD NAV PERF-RNP will show in the scratchpad on the MCDUs.

NAVAID Selection and Tuning

The primary FMC selects the navaids that both FMCs use. It selects the navaids that give the most accurate estimate of position and have the best range and geometry.
Each FMC sends four navaid frequencies to its on-side navigation control panel. The frequencies then go to the DME interrogators. If there is a fault with a control panel, the DME interrogators get the data directly from the FMC.
Each FMC is allocated two navaid pairs for position updating. These pairs will be dissimilar with at most one navaid in common between the two FMCs. The primary FMC will use the best and third best pairs and the secondary will use the second and fourth best pairs.

If there is only one navaid pair available, the primary FMC will use that data for position updating while the secondary FMC will propagate its position using ADIRU data only corrected by a fixed error bias. This enables some independence in the individual FMC position calculations.



NAVIGATION SUB-FUNCTION

NAVIGATION SUB FUNCTION (Continue)

Navigation Data Base

The navigation data base is stored in the flash EEPROM memory of the FMC in two parts. There is the main body of active data which is effective until a specified expiration date and also a set of data revisions for the next period of effectivity.

This information is in the navigation data base:

- VOR, DME, VORTAC, and TACAN navigation aids
- Waypoints, Airports and runways
- SIDs/STARs
- Procedure turns and holds, holding patterns
- Missed approaches
- Approach Procedures
- Approach and departures transitions
- Company route structure
- Terminal gates.

FMC Selection

You use the FMC source select switch to select the primary FMC.

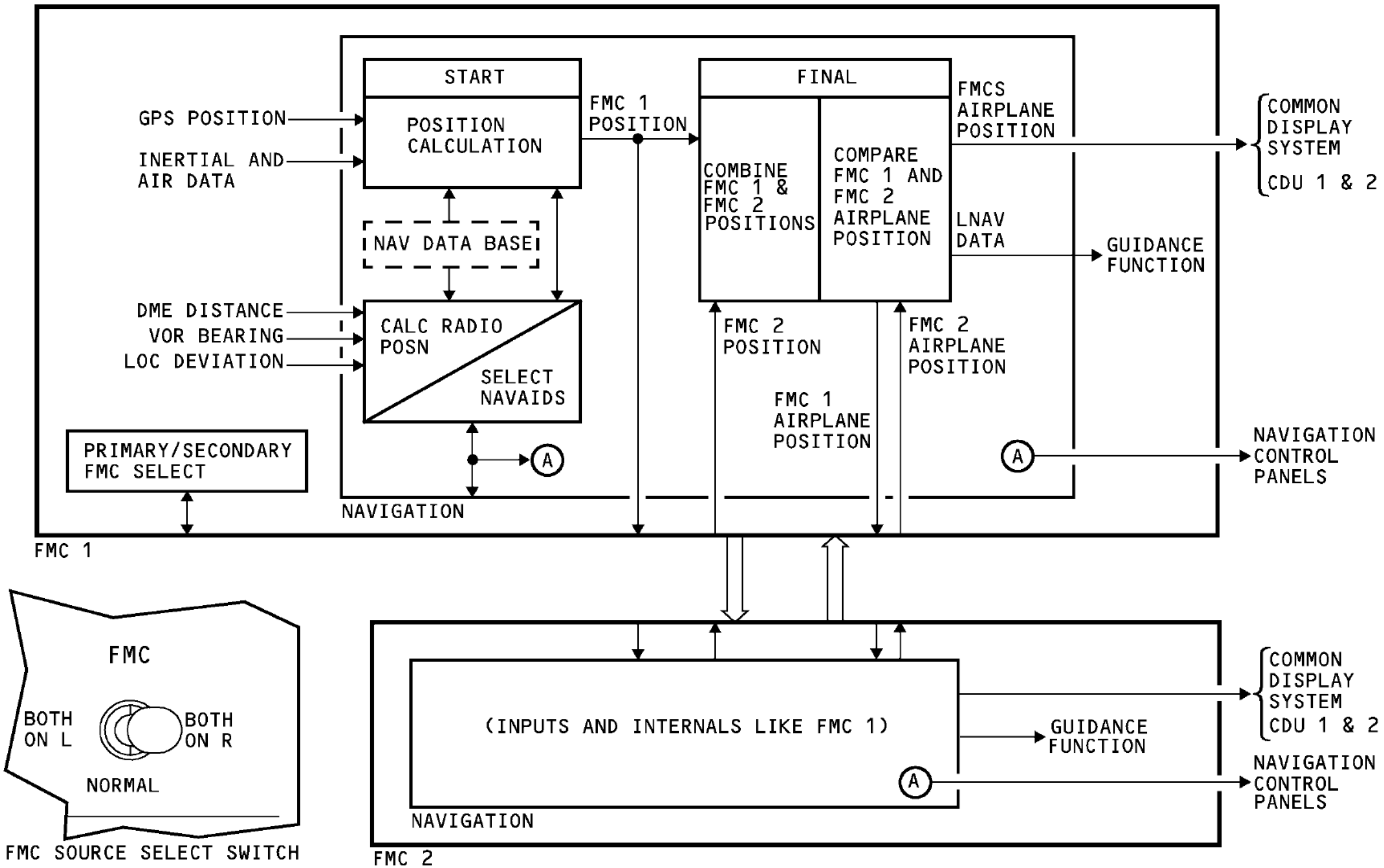
FMC Source Select Switch Position	Primary FMC	Secondary FMC
NORMAL	FMC 1	FMC 2
BOTH ON L	FMC 1	FMC 2
BOTH ON R	FMC 2	FMC 1

The primary FMC does these functions:

- Selects the navaids for tuning for both FMCs
- Determine the navigation update mode (ADIRU/DME/DME etc.)
- Transmit the initial alignment position to the ADIRUs.

Dual FMC Operation

When the source select switch is in the NORMAL position, dual mode operation is enabled. The secondary FMC is synchronized with the primary FMC at all times. In dual mode the FMCs compare their calculations and input data.
In the dual mode, if the current aircraft state data and static data do not compare within tolerance, the data is automatically crossloaded from the primary FMC to the secondary FMC (synchronization). The data is then compared again and if it is satisfactory, dual FMC operation is maintained.
If the data still miscompares after this synchronization, the failure is logged into BITE against the secondary FMC and the system reverts to single FMC operation.
The message SINGLE FMC OPERATION shows in the MCDU scratchpads. In this configuration, the calculations from the primary FMC are used and the secondary FMC is set to a conditional fail state.
If the secondary FMC is set to a conditional fail state, the intersystem bus between the FMCs will remain active and both FMCs will continue to process data. All outputs from the secondary FMC will be set to no computed data (NCD).
After one FMC has become conditionally failed and the FMC source select switch is set to the BOTH ON L or BOTH ON R positions, synchronization will be attempted again between the FMCs using data from the primary FMC as the source for the synchronization. If the synchronization is successful, the message DUAL FMC OP RESTORED shows on the MCDU and the system goes to dual operation.
Following a failure to restore dual operation by movement of the FMC source select switch, an additional attempt at synchronization will be made 5 minutes after the failure. This attempt will only be made if the FMC source select switch is in the BOTH ON L or BOTH ON R positions.
When one FMC has conditionally failed and the FMC source select switch is in the BOTH ON L or the BOTH ON R position, the calculations from the selected FMC are used. The output systems receive data from the selected FMC.
The primary FMC processes all CDU operations and sends them to the secondary FMC via the intersystem bus. This ensures that the secondary FMC is synchronized to the primary FMC with regard to MCDU keypush events.



NAVIGATION SUB-FUNCTION

PERFORMANCE SUB FUNCTION

General

The performance sub-function provides optimum values for airspeed and engine thrusts to provide the most economical vertical path profile. It uses aerodynamic and engine models to do these calculations.

It calculates this data:

- Speed targets
- Speed limits
- N1 targets
- N1 limits
- Airplane gross weight.

Speed and Thrust Targets

The performance sub-function calculates the optimum speed and thrust targets. These calculations occur during climb, cruise and the descent phases of flight. The economy mode (ECON) is the default mode for each flight phase.

In the economy mode of operation, the FMC uses the data input from the flight crew (cruise altitude, cost index etc.) to calculate the most cost efficient flight profile. Other modes (maximum rate climb, long range cruise, speed descent etc.) are also available and can be selected by the flight crew through the MCDU.

When the VNAV mode is engaged, the speed and thrust targets go to the FMC guidance function. The guidance function then sends out commands to the DFCS and the autothrottle computer to control the vertical flight path of the airplane.

Speed targets do not go to the DFCS during takeoff or approach/go-around operation. Only target N1 (limit value or reduced value if engine derate has been selected) is used.

Speed and Thrust Limits

The performance sub-function also calculates minimum and maximum speed and thrust limits for the climb, cruise and descent phases of the flight. These make sure that the airplane operates within its flight envelope and the engines are protected against possible overboost.

Gross Weight

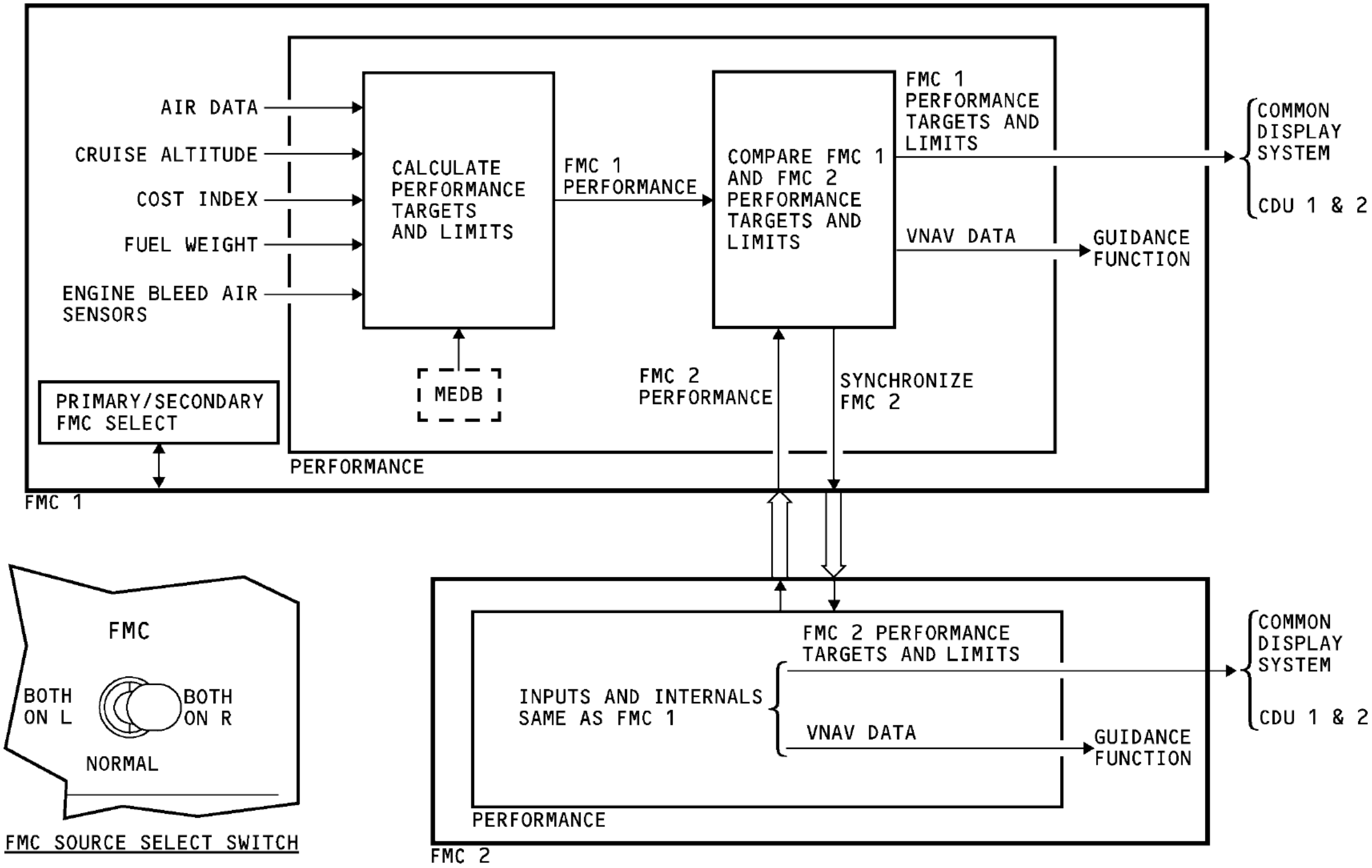
The FMCS calculates airplane gross weight or the flight crew manually enters the data. Total fuel weight from the fuel quantity processor unit goes to the FMC. The flight crew can enter either gross weight or zero fuel weight through the MCDUs.

If the flight crew enter gross weight, the FMC subtracts total fuel weight from gross weight to calculate zero fuel weight. If the flight crew enter zero fuel weight, the FMC adds total fuel weight and zero fuel weight to calculate gross weight.

Performance Data

The FMC uses this data for the performance calculations:

- Air data
- Cruise altitude
- Cost index
- Fuel weight
- Engine bleed air sensors
- Model/engine data base.



PERFORMANCE SUB-FUNCTION

PERFORMANCE SUB FUNCTION (Continue)

Air Data

The FMC uses this air data from the ADIRUs:

- Air temperature is used to calculate thrust limits.
- Altitude is used to calculate speed and thrust targets and limits.
- Airspeed is used to calculate DFCS/Autothrottle commands.

Cruise Altitude

Cruise altitude is entered by the flight crew through the MCDUs. It is used to establish the altitude for the top of climb (T/C) point.

Cost Index

The cost index is a number which is a ratio of the operator time costs (such as labor) to the fuel cost.

A low value for cost index means that fuel costs are more important than time costs. A high cost index means that time costs are more important than fuel costs. For flights where fuel costs are high, the performance economy speed schedules are slower. For flights where time costs are high, the economy speed schedules are faster.

The flight crew enters the cost index in the MCDU and changes the data as necessary. The range is from 000 (most economical) to 200 (time critical). This lets the operator adjust the economy speed schedules (climb, cruise and descent) for the conditions and routes they operate.

Fuel Weight

Fuel weight data is sent by the fuel quantity processor unit to the FMC. It is used by the FMC in the gross weight calculations.

If the total fuel weight data from the fuel quantity processor unit is invalid, the flight crew can manually input the fuel weight to the FMC on the MCDUs. Every 30 minutes, the FMC prompts the flight crew to enter a new fuel weight with the message VERIFY GW AND FUEL. After the airplane is past the T/D (top of descent) and a Vref value is entered, the FMC will not show this message.

Engine Bleed Air Sensors

The FMC receives analog discretes from the air conditioning system and the thermal antice (TAI) systems for both the engines and wings. The FMC uses this data to correct calculated thrust values.

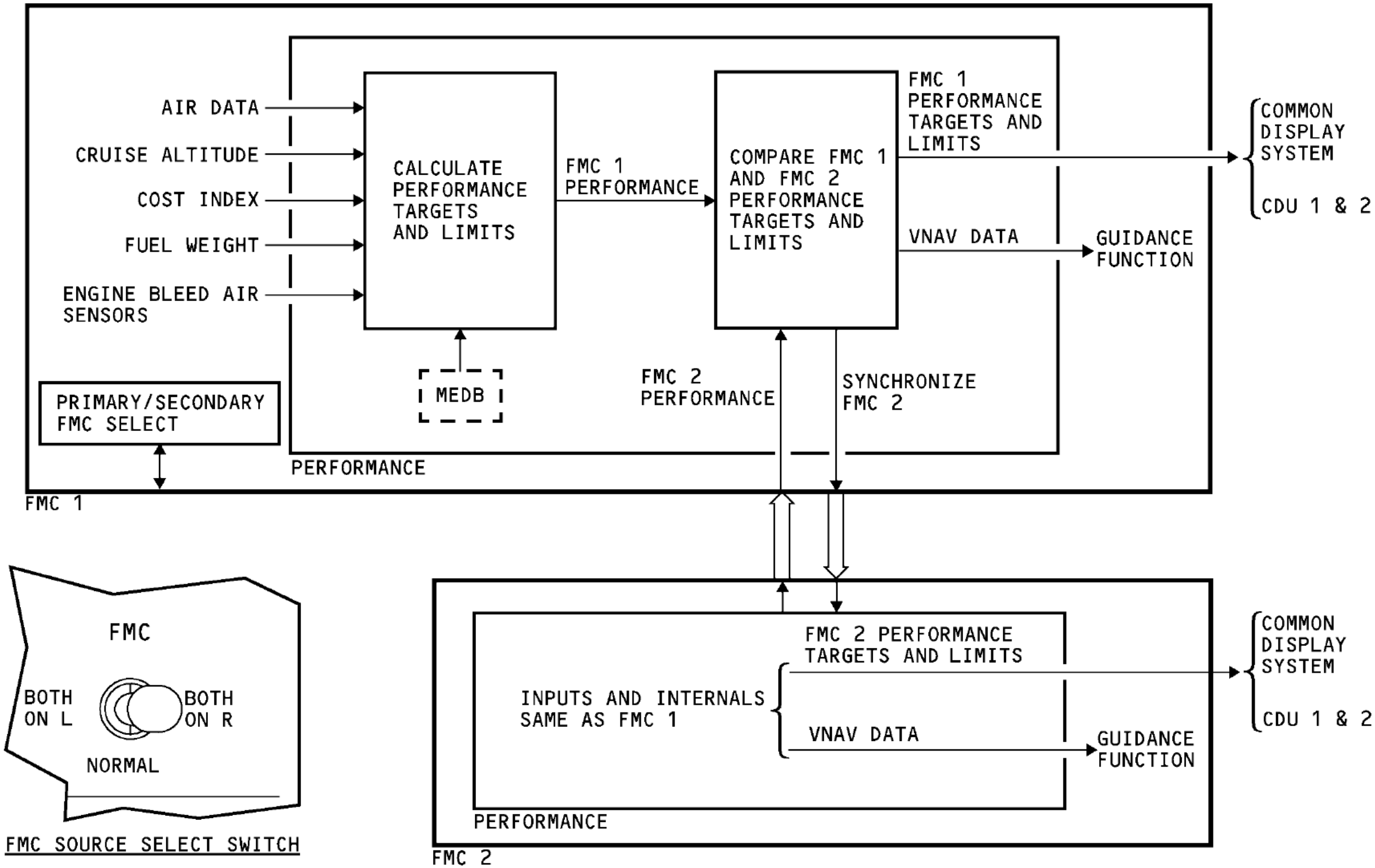
Model/Engine Data Base (MEDB)

The MEDB contains this data:

- An aerodynamic model of the airplane. This consists of recommended speed schedules, optimum operating altitudes, buffet limit envelope and the certified operating limits for the airplane. Engine out operating conditions including speed and drag data are also contained in this data base.
- Fuel flow and N1 thrust models for the engine thrust rating selected on the airplane. These are used to calculate fuel flow, thrust limits, engine limits and to compensate for engine air bleed loads.

Flight Envelope Protection

The operational flight program (OFP) continually monitors computed performance targets against the airplane operation limits. If any performance target is more than the limit, the FMC will restrict the performance target to the correct value and maintain both airplane and engine optimal performance.



PERFORMANCE SUB-FUNCTION

GUIDANCE SUB FUNCTION

General

The guidance sub-function calculates data for the lateral and vertical guidance functions and supplies guidance commands to the digital flight control system (DFCS) and autothrottle (A/T) system. The calculations start when the guidance sub-function receives an active route (lateral flight plan) and an active performance plan (vertical flight plan).

The DFCS and A/T use the commands to automatically guide the airplane along a lateral path and to control airspeeds, vertical speeds and N1 targets/limits. The LNAV mode must be active to enable the lateral guidance function and the VNAV mode must be active to enable the vertical guidance function.

Note: In path descents, LNAV must be valid and a valid end of descent point must be defined in order to engage the VNAV mode.

These are the major parts of the guidance sub-function:

- Flight plan management
- Lateral guidance commands
- Vertical guidance commands.

Flight Plan Management

The lateral route is a set of navigation legs. A navigation leg is a path between two waypoints. The flight plan management process calculates the great circle and turn segments for each path. Navigation legs are great circle tracks between the flight plan waypoints or constant heading legs. A waypoint shows as latitude, longitude and altitude. The waypoints come from the navigation data base or are put in by the flight crew.

This data is calculated for each way point:

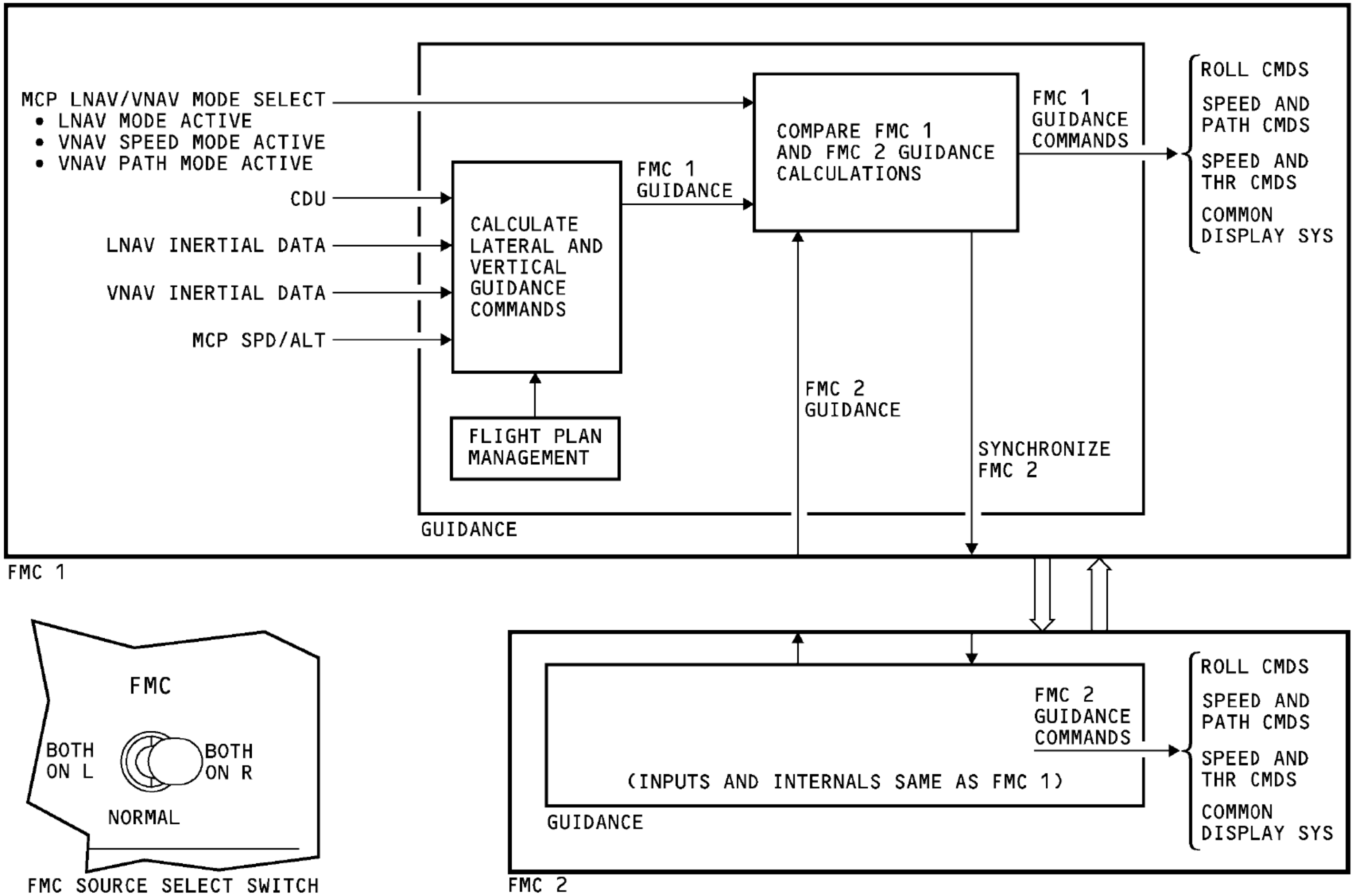
- Predicted altitude
- Time-of-arrival
- Speed
- Fuel remaining
- Distance between the waypoints
- Flight path course between the waypoints.

The performance plan (ZFW, cost index, cruise altitude, performance modes) determines the performance speed schedules and thrust that will be calculated by the FMC. The path calculations then use the performance data to calculate altitude, time, airspeed and fuel for each waypoint. If there are any speed or altitude restrictions attached to the lateral waypoints in the flight plan, these will be incorporated into the vertical flight profile calculated by the FMC.

Initially the flight plan management calculates the parameters for the waypoints in the climb and cruise phases but the top of descent (T/D) waypoint will be unknown.

The T/D is calculated using the last waypoint in the flight plan and working backwards. The approximate T/D is estimated to get a descent speed schedule and descent path gradient together with fuel remaining. Range in descent is first calculated from the altitude change in descent and an assumed flight path angle. The T/D will be calculated by subtracting range in descent from the total flight plan range.

Next the estimated fuel remaining at T/D and wind profile are used to calculate descent range, speed schedules, path gradient and final fuel remaining. Then the full descent leg is calculated using the last set of data backward from the terminal waypoint. This gives the T/D and a predicted fuel remaining value. The descent phase of the flight plan is now combined with the climb and cruise phases to complete the flight plan predictions.



GUIDANCE SUB FUNCTION

GUIDANCE SUB FUNCTION (Continue)

Lateral Guidance Commands

When a complete route has been activated in the FMCS and the LNAV mode is valid, the lateral guidance function sends lateral steering commands to the DFCS.

If the LNAV function is not valid and lateral guidance outputs are not calculated, the FMCS sets the lateral guidance outputs to no computed data (NCD). The DFCS disconnects the LNAV mode and reverts to control wheel steering (CWS).

Vertical Guidance Commands

The vertical guidance function calculates and sends airspeed or vertical speed targets to the DFCS. Airspeed, N1 limit and mode commands are also calculated and sent to the A/T system.

These are the two basic modes for vertical guidance:

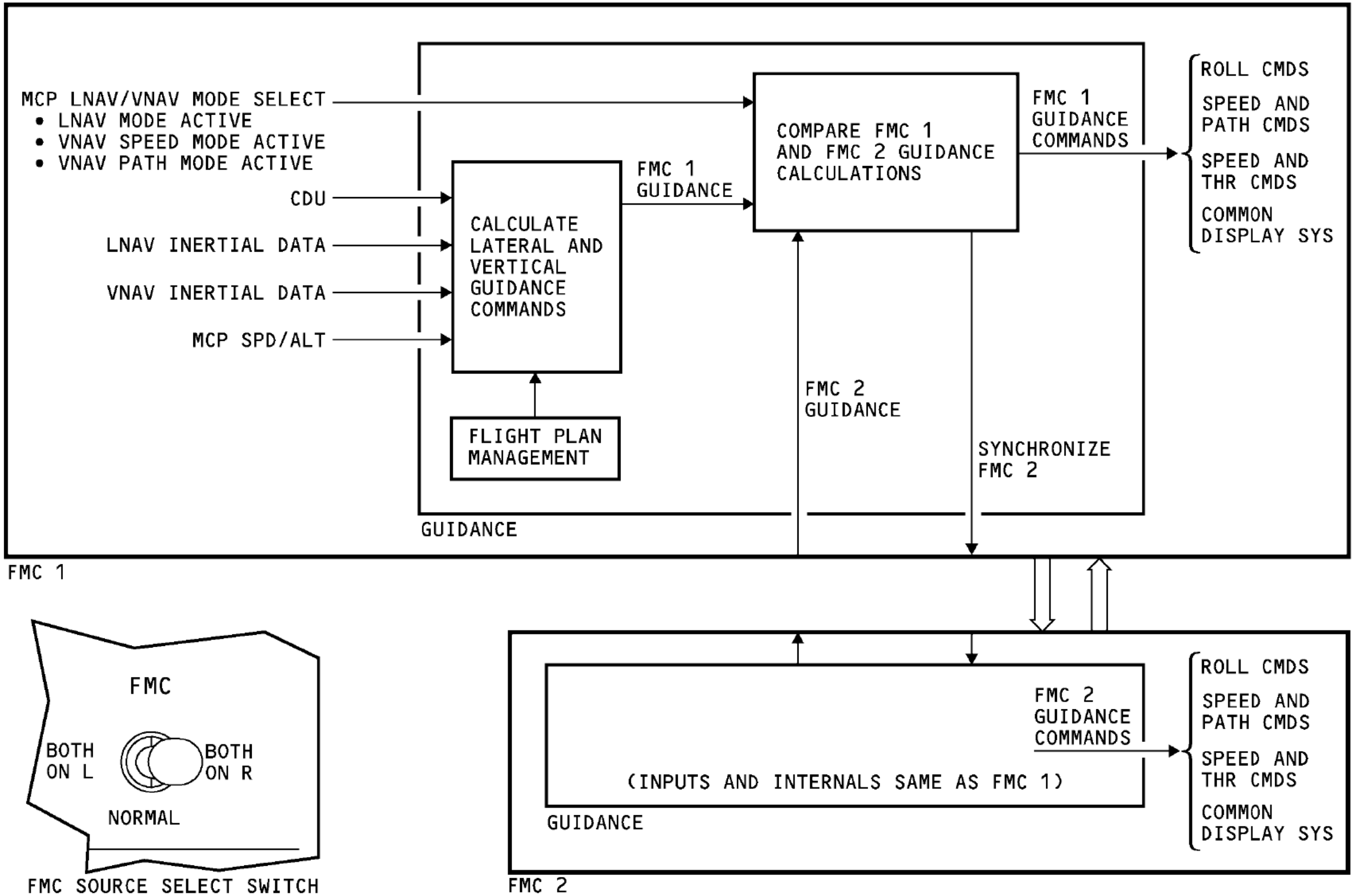
- Airspeed (VNAV SPD)
- Path (VNAV PATH).

In the airspeed mode, the DFCS controls the airplane to a target FMCS airspeed while thrust is set to an N1 climb limit rating or idle. Both the speed target and the thrust limit values are provided by the FMCS. VNAV SPD will show on the flight mode annunciators (FMA).

In the path sub-mode, the DFCS controls the airplane to a target FMCS vertical speed. This path will be calculated for a specified speed/thrust profile. In descents, the default will be idle thrust and economy speeds. VNAV PATH will show on the FMAs.

If the VNAV function is not valid and vertical guidance outputs are not calculated, the FMCS sets the vertical steering command to no computed data (NCD). The DFCS disconnects the VNAV mode and reverts to CWS mode. The FMC lights on the ASAs will illuminate to alert the flight crew to this condition together with the VNAV DISCONNECT message in the MCDU scratchpads.

For descent, a vertical path deviation display is sent to the common display system. The deviation shows the difference between the reference altitude on the vertical reference path and the current airplane altitude.



GUIDANCE SUB-FUNCTION

GUIDANCE SUB FUNCTION - LNAV AND VNAV MODE LOGIC

General

LNAV and VNAV logic uses inputs from several sources to engage the LNAV and VNAV modes.

The FMCS guidance sub-function needs these logic inputs to complete its guidance command output path to the DFCS and the A/T system.

LNAV/VNAV Mode Activation

To engage LNAV or VNAV, push the LNAV or VNAV switch on the mode control panel (MCP). The MCP then sends the mode requests by way of the flight control computers (FCCs) to the guidance sub-function in the FMC.

FMC LNAV Logic

These are the inputs to the FMCS necessary to engage the LNAV mode:

- ADIRU in the Nav mode and the data is valid
- LNAV capture criteria is satisfied (The present airplane track will intercept the active flight leg at an angle of 90 degrees or less and the crosstrack deviation is less than 3 nautical miles)
- Active route (no discontinuity to the next waypoint)
- Localizer mode is not active
- Go-around mode is not active
- LNAV arm/operate (MCP).

FMC VNAV Logic

These inputs to the FMCS are necessary to engage the VNAV mode:

- Airplane in the air
- ADIRU in the Nav mode and the data is valid
- Performance data (ZFW or GW, fuel reserves, cost index and cruise altitude) is valid
- Glideslope mode is not active
- Go-around mode is not active
- VNAV arm/operate.

VNAV will engage in VNAV SPEED mode when:

- A climb or a speed descent flight phase is active
- The airplane is not in level flight
- VNAV mode is active.

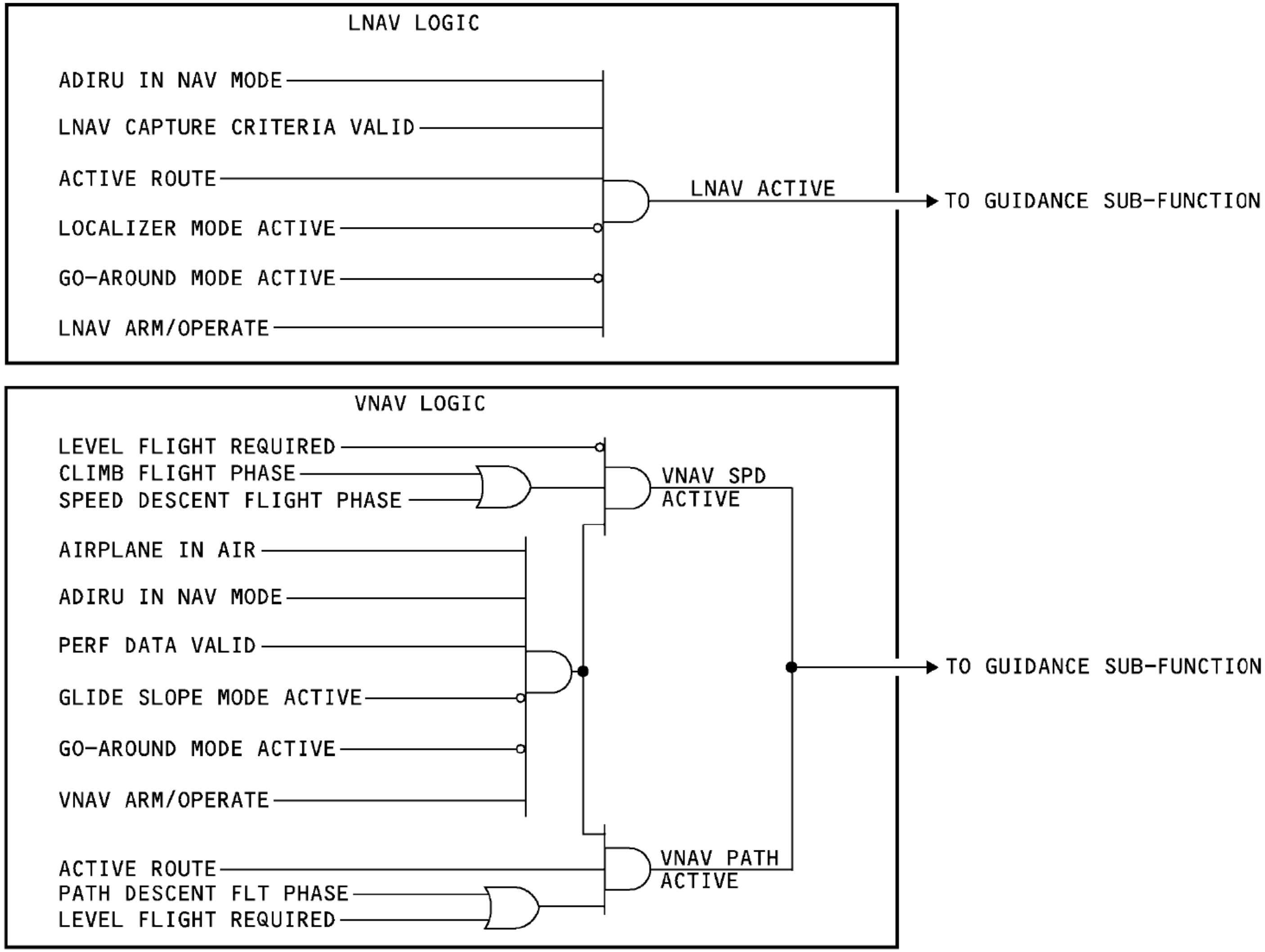
VNAV will engage in VNAV PATH mode when:

- The airplane is holding altitude or a path descent is active
- Active lateral route (LNAV engaged)
- VNAV mode is active.

The climb flight phase is active when the flight crew sets a new altitude on the mode control panel (MCP) and the airplane climbs to the new altitude.

The speed descent flight phase is active when the flight crew selects the SPEED prompt on the CDU descent (DES) page.

The path descent flight phase is active when the flight crew selects PATH on the CDU descent (DES) page.



GUIDANCE SUB FUNCTION – LNAV AND VNAV MODE LOGIC

FMCS OPERATION PAGES – CDU DISPLAYS

GROUND POWER UP – CDU NORMAL DISPLAY

The MCDU and FMCS both do internal BITE tests at power up. If the power up test is normal, the MCDUs show the MENU page.

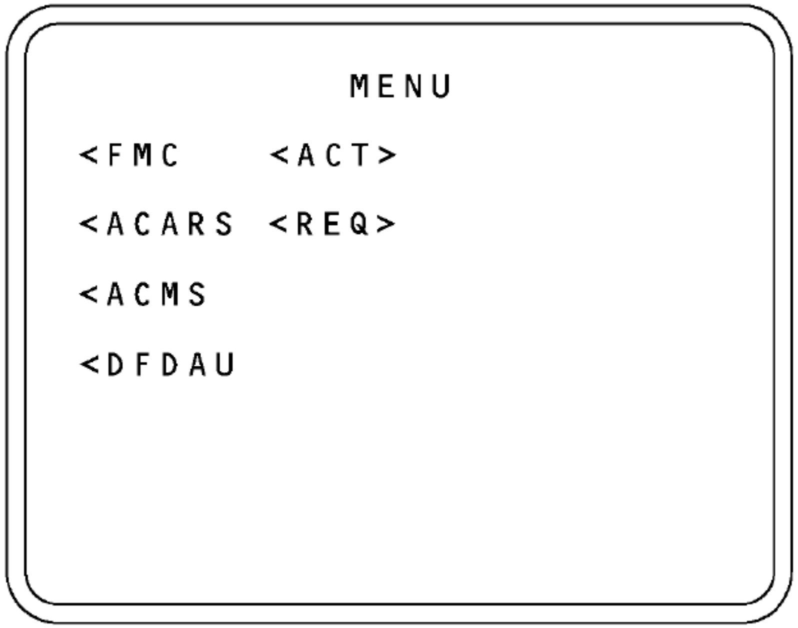
The MENU page always shows the FMC prompt at line select key 1L. The other available sub-systems show below the FMC prompt.

Selection of the FMC prompt or any FMCS mode key on the MCDU makes the FMCS the active user and the IDENT page shows.

The status of the sub-systems shows on the MENU page by the label <ACT> to the right of the active sub-system. The label <REQ> shows to the right of a sub- system if it is not active but has sent a request to the MCDU to request operator attention.

The MENU page automatically shows if the primary FMC fails but the FMC prompt will not show.

INITIAL PAGE



MENU PAGE

GROUND POWER UP – CDU NORMAL DISPLAY

GROUND POWER UP – CDU NON-NORMAL DISPLAYS

FMC
At power-up, each FMC does a check of the status of the other FMC. During power-up, the MCDU annunciators come on momentarily. If the primary FMC fails at power-up, the FMC prompt does not show on the MENU page. The FMC warning light on the autoflight status annunciators also comes on. If the secondary FMC fails, the primary FMC shows the SINGLE FMC OPERATION message in the scratch pad on the IDENT page. If the transfer switch is in normal, the FMC warning light comes on.

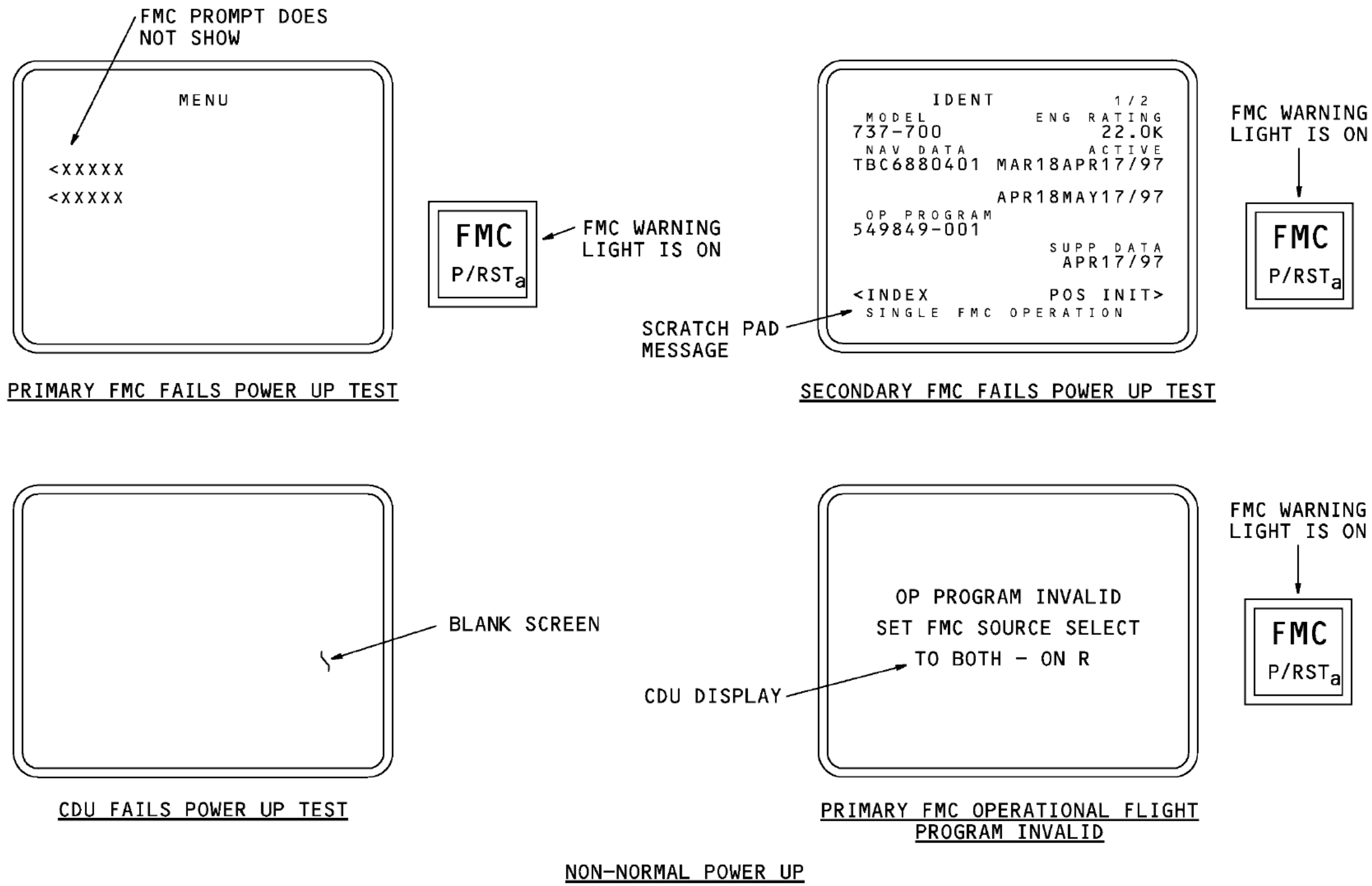
MCDU
A MCDU display is blank if the MCDU fails at power-up.

Other Tests

The FMCs also do a check of these functions at power-up:

- Airplane and engine configuration program pins for parity
- Cross compare FMC 1 and FMC 2 data bases and operational flight programs.

For example, the message OP PROGRAM INVALID shows if the operational flight program (OFP) of the primary FMC is invalid at power-up. If the secondary FMC has a valid OFP, the message tells the operator to switch to the both on right position.



GROUND POWER UP – CDU ABNORMAL DISPLAY

PRE-FLIGHT PAGE (INTRODUCTION)

General

This is an introduction to the MCDU pages the flight crew uses to enter pre-flight data into the FMCS. More information about each page is described in detail on subsequent pages.

Data

The flight crew uses this type of data to pre-flight the FMCS:

- Airplane initial position
- Route structure
- Performance data.

The flight crew uses the line select keys (LSK) and function keys to enter and verify data on the following pages:

- **IDENT Page**

This page lets the flight crew verify the FMCS operational flight program and data base identification numbers.

- **POS INIT Page**

This page lets the flight crew set the reference airplane initial position. This data is necessary to start ADIRU alignment. Access to the POS REF and POS SHIFT pages is from this page.

- **RTE Page**

This page lets the flight crew make a flight plan or set a company route from the navigation data base. If the entered route or company route does not have an origin departure or destination approach the crew must also select a departure runway and arrival data.

- **DEP/ARR INDEX Page**

This page lets the flight crew select the departure runway and standard instrument departure (SID) data. The standard terminal arrival route (STAR), approach, and destination runway can also be selected on this page.

- **PERF INIT Page**

This page lets the flight crew enter aircraft and atmospheric parameters necessary for the FMCS to calculate the vertical flight profile performance data.

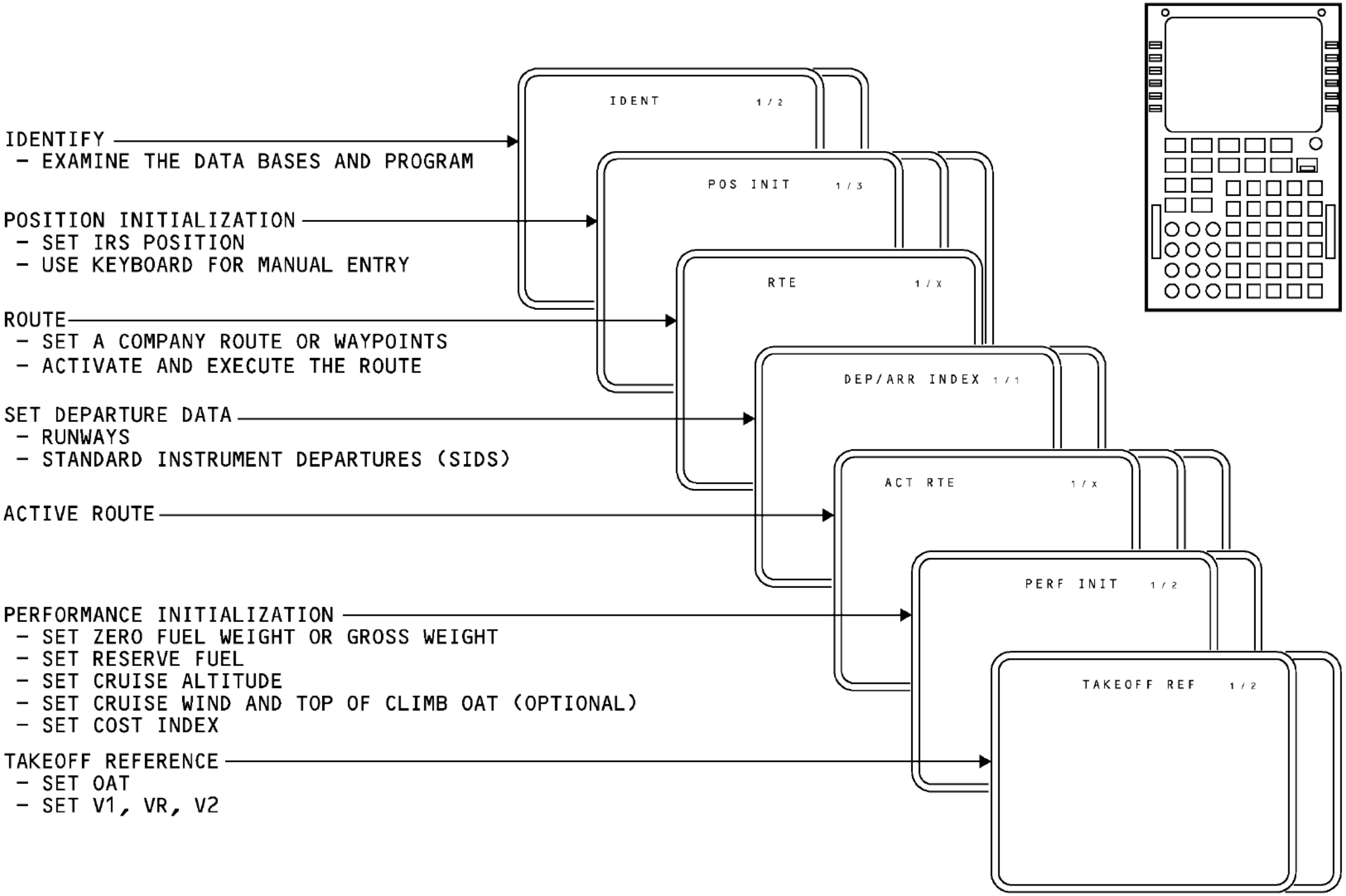
- **N1 LIMIT Page**

This page lets the flight crew select the engine thrust limits for display by the N1 limit bugs on the engine indication and for use by the autothrottle. Outside air temperature is also selected from this page.

- **TAKEOFF REF Page**

This page lets the flight crew select the takeoff flaps setting and takeoff V speed values.

Caution: ANY FMC ENTRIES MADE ON NON-BITE PAGES SHOULD BE REMOVED AT THE COMPLETION OF MAINTENANCE ACTIVITIES. THIS PREVENTS MAINTENANCE ACTIVITIES FROM HAVING AN UNINTENTIONAL IMPACT ON FMC FLIGHT OPERATIONS. FMC ENTRIES MAY BE REMOVED BY USING THE DELETE KEY OR BY TURNING OFF POWER TO THE FMC FOR AT LEAST TEN SECONDS.



PRIE-FLIGHT(INTRODUCTION)

IDENTIFICATION PAGE

Purpose

The IDENT page lets the crew verify the FMCS operational flight program and data base identification numbers. Also, you can select the POS INIT and INDEX pages from the IDENT page.

Page Access

The IDENT page is the first page that shows on the MCDU when you select the FMC prompt on the MENU page. It can also be selected from the INIT/REF INDEX page.

Page 1 Information

Line 1L shows the airplane model. The airframe/engine program pin configuration sets this information. This line is blank if the FMC finds a parity error for the airframe/engine program pins or a valid performance data base is not loaded into the FMC. It is also blank if the loaded performance data base does not contain data for the current airframe/engine program pin configuration.

Line 2L shows the navigation data base identification number loaded in the FMC. This data field is blank if a navigation data base is not loaded.

Line 4L shows the FMC operational program software part number and the update version.

Line 5L can show the Smiths Industries operational program software part number. To show the number, enter the word SIPART into the scratch pad and select key 5L. This line is blank when the part number is not shown.

Line 6L shows the INDEX prompt. This selects the INIT/REF page. Line 1R shows the engine thrust rating. This information is set by the airframe/engine program pin configuration. This line is blank if the FMC finds a parity error for the airframe/engine program pins or a valid performance data base is not loaded into the FMC. It is also blank if the loaded performance data base does not contain data for the current airframe/engine program pin configuration.

Lines 2R and 3R show the effective dates of the active and inactive navigation data bases. You can exchange the data on these two lines to activate a new data base or recall the old one. The exchange can only be done when the airplane is on the ground. The active data base is compared to the FMC clock input at initial power-up and if the active data base is out of date, the CDU message NAV DATA OUT OF DATE shows in the scratchpad.

Line 5R shows there is supplemental data and gives the effective date of that data. The line is blank if an effective date is not set or there is no supplemental data.

Line 6R shows the POS INIT prompt. This selects the POS INIT page.

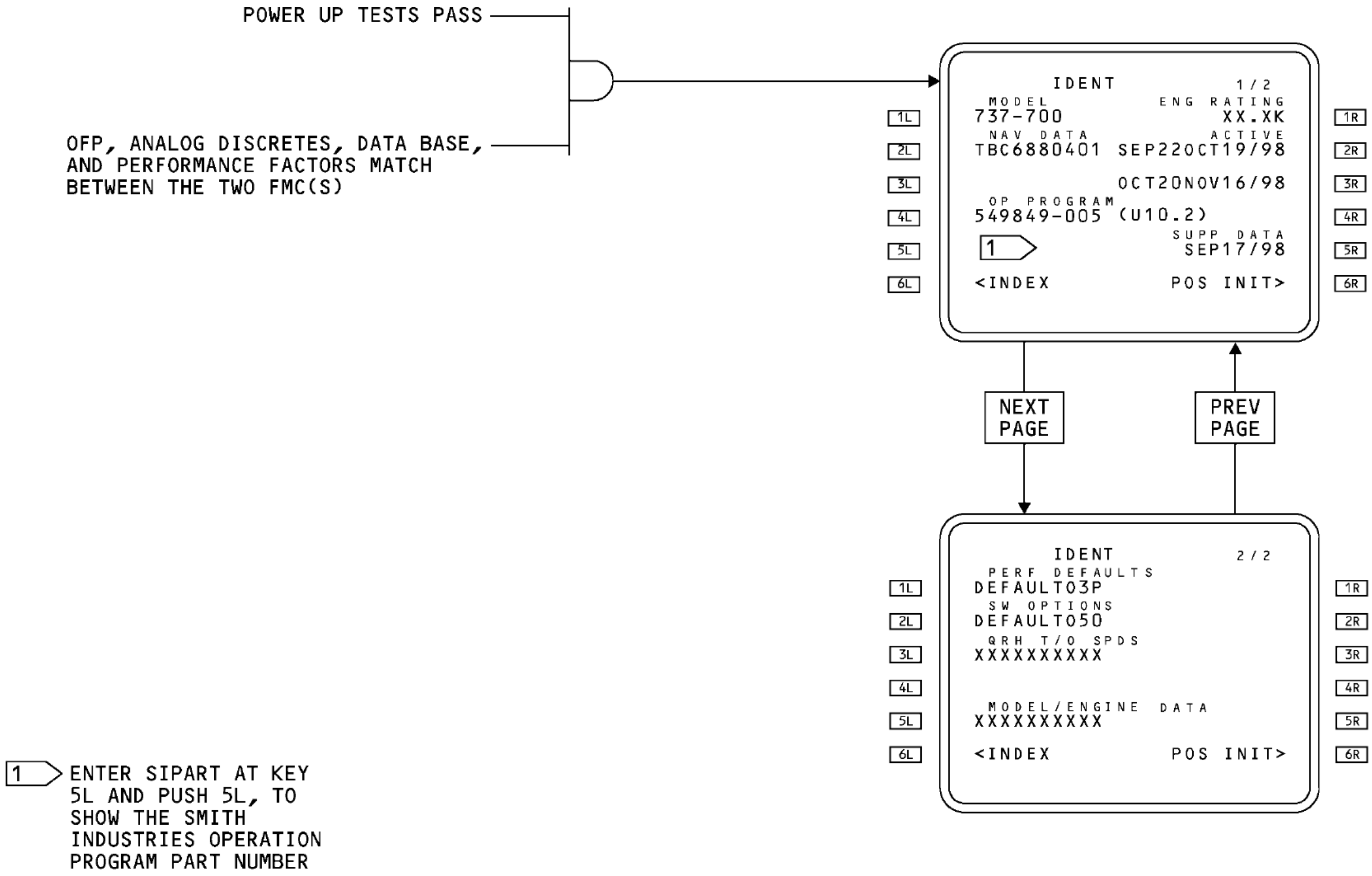
Page 2 Information

Line 1L shows the identification number of the performance default data base in the FMC operational flight program.

Line 2L shows the identification number of the software options data base.

Line 5L shows the identification number of the model/engine performance data base. This line is blank if the data base is not loaded.

Line 6L shows the INDEX prompt. This selects the INIT/REF page. Line 6R shows the POS INIT prompt. This selects the POS INIT page.



IDENTIFICATION PAGE

INIT/REF INDEX PAGE

Purpose

The INIT/REF INDEX page shows a menu of pages you can use to initialize the following:

- FMCS
- ADIRU
- Other reference data.

Also, you can use this page to go to the FMCS MAINT BITE INDEX page.

Page Access

To select this page, push line select key 6L on pages that show the index prompt and are not BITE pages. The INDEX prompt on BITE pages changes the display back to the last menu.

Information

Line select key 1L (LSK) shows the first page of the configuration identification IDENT pages. These pages show the FMCS data base and program configuration data.

LSK 2L shows the first page of the position initialization (POS) pages. These pages are for ADIRS initialization and to show navigation sensor positions.

LSK 3L shows the first page of the performance initialization (PERF) pages. These pages are to enter the airplane parameters that the FMC needs for VNAV calculations.

LSK 4L shows the first page of the TAKEOFF pages. These pages are to select takeoff thrusts and speeds.

LSK 5L shows the approach reference (APPROACH) page. This page gives specific information on the condition of the airplane and the selected runway and approach procedures of the flight plan.

LSK 6L shows the OFFSET page. This page is to start and end an offset to the flight plan route.

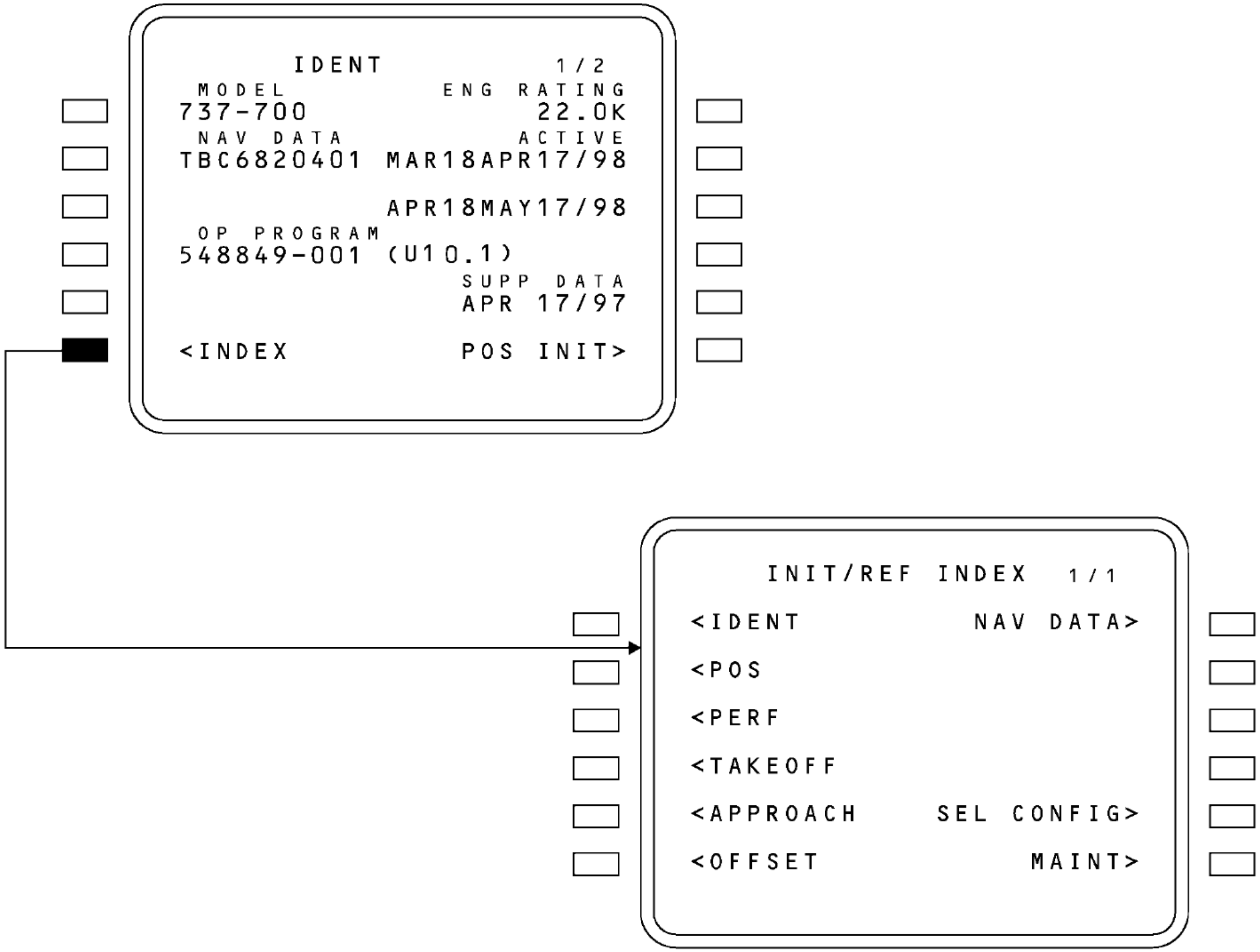
LSK 1R shows the navigation data reference (NAV DATA) page.

This page is to enter this data into the temporary navigation data base:

- Waypoints
- Navaids
- Airports.

LSK 5R shows the selectable configuration (SEL CONFIG) page. This page is used to see the configuration data for loadable software. It shows only when the airplane is on the ground.

LSK 6R shows the maintenance bite index MAINT page. The MAINT prompt shows only when the airplane is on the ground and the groundspeed is less than 20 knots. When the airplane is in the air, the NAV STATUS prompt shows in place of the MAINT prompt.



INIT/REF INDEX PAGE

POSITION PAGES

These are the three position pages:

- Position initialization (POS INIT)
- Position reference (POS REF)
- Position shift (POS SHIFT).

The POS INIT page is used to enter the present position for ADIRU alignment.

The box prompts show that data must be entered to complete the preflight. The dash prompts show that the data entry is optional.

The POS REF page shows airplane position and groundspeed as calculated by the FMC, each ADIRU, each GPS, and radio position.

The POS SHIFT page is used to shift the FMC position to the specified navigation sensor position.

Page Access

You use the INIT REF function key or these CDU pages, to go to the first position page:

- INIT/REF INDEX
- IDENT
- TAKEOFF REF.

POS INIT Page

Line 2L shows dash prompts for an airport identifier. The identifiers you put here must also be in the navigation data base. If the identifier you put in is valid and is in the data base, the latitude/longitude (LAT/LON) for the airport shows at LSK 2R.

Line 3L shows dash prompts for airport gate identifiers. If the identifier you put in is valid and is in the data base, the LAT/LON for the gate shows at LSK 3R. The airport identifier must have been entered first.

Line 5L shows airplane clock input. The clock input (time and date) to both FMCs is from the GPS. If GPS is not valid, the FMCs calculate time with an FMC internal clock. The time may be set on this page.

Line 6L shows the INDEX prompt. This selects the INIT/REF INDEX page.

Line 1R shows the last calculated present position of the primary FMC. This data is saved in the FMC at power down.

Lines 2R and 3R show the LAT/LON position for the reference airport and gate identifiers set at Line 2L and 3L.

Line 4R shows the header SET IRS POS and box prompts. This data field is used to enter present position for initialization of the ADIRUs when the airplane is on the ground.

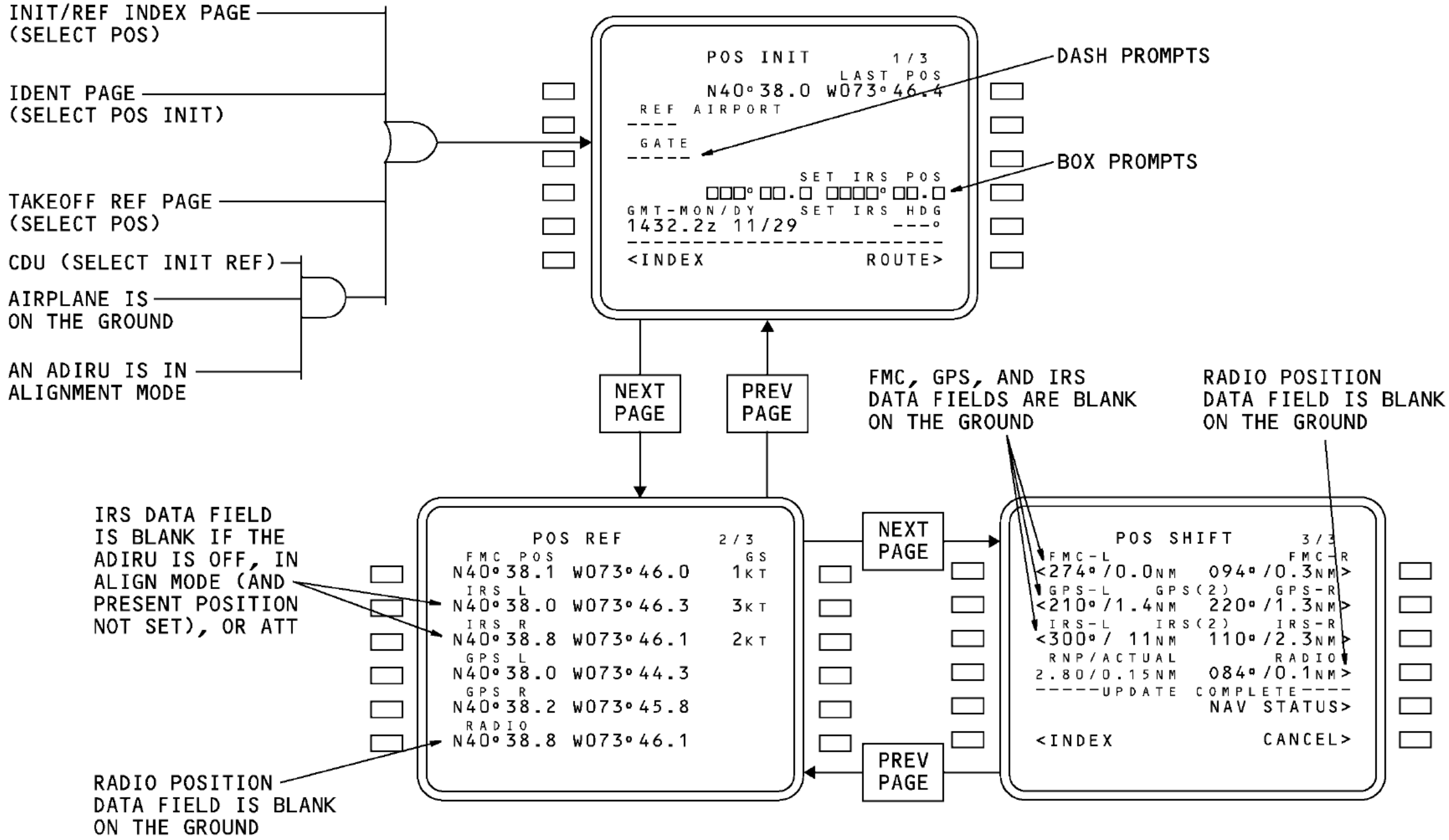
Line 5R shows the header SET IRS HDG. This data field is used to enter heading data when any ADIRU is in the attitude (ATT) mode. It will be blank if there is no ADIRU in the ATT mode.

Line 6R shows the ROUTE prompt. This selects the route page.

POS REF Page

This page shows the airplane position and ground speed calculated by the FMC, each ADIRU, each GPS and radio position. Any data field may be selected to the scratchpad and used to initialize the ADIRUs. These data fields will be blank if the position data is invalid.

The radio position will always be blank on the ground.



POSITION PAGES

POS SHIFT Page

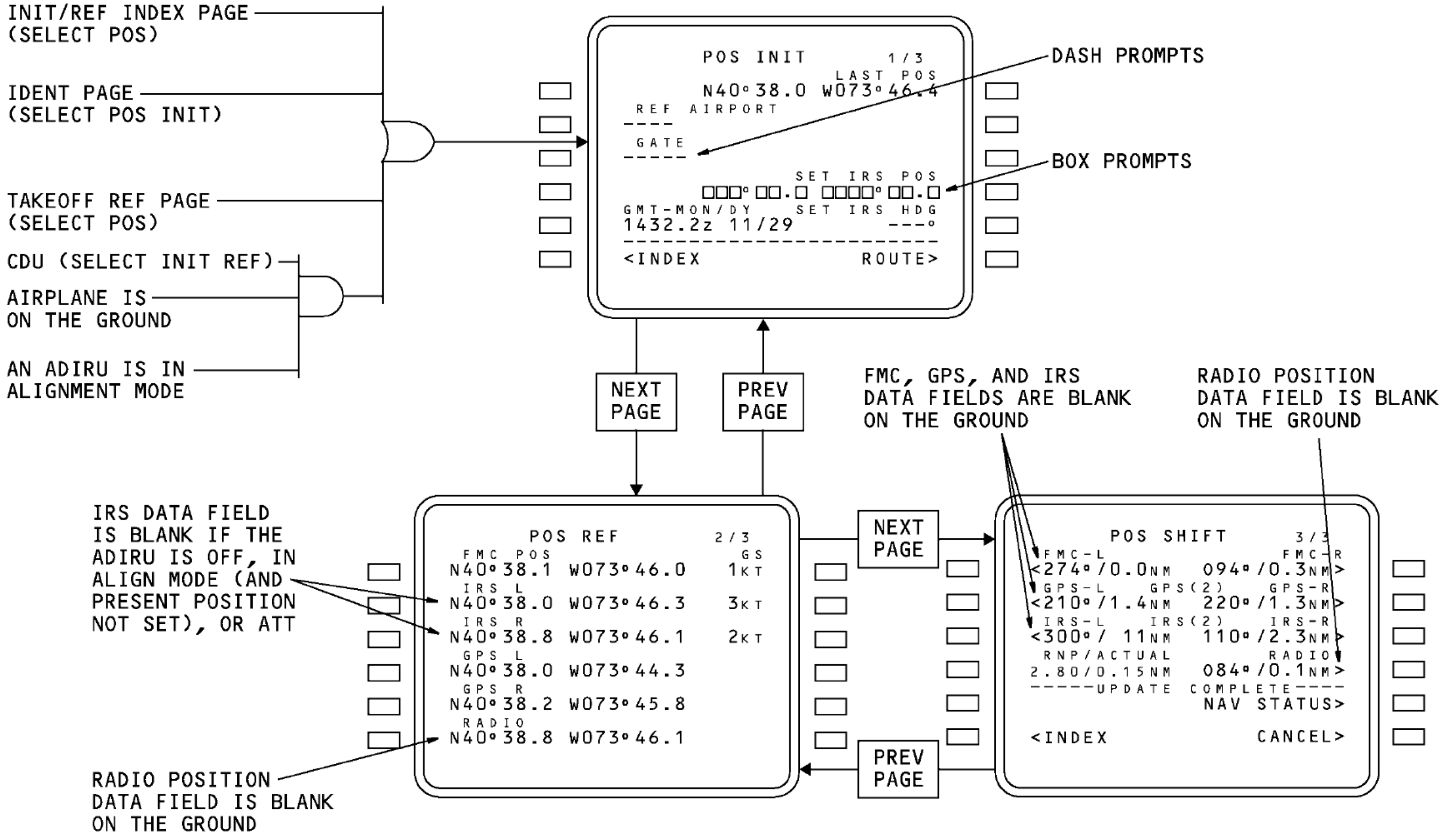
This page shows the bearing and distance between the FMCS calculated position shown on the POS REF page and the position of the individual FMCs, ADIRUs, GPS, and radio systems. This page also provides the capability to update the FMCS calculated position to one of the positions shown when the airplane is in the air.
The FMC position may be overridden by selection of the particular navigation sensor position with the line select key. The selected sensor will now be highlighted and the EXEC light will come on. When you select EXEC, the FMC navigation position changes to the selected sensor position and UPDATE COMPLETE will show at line 5L in small font.

The FMC, ADIRU, GPS, and radio data fields are blank on the ground.
Line 4L shows the RNP/ANP values.
Line 5L shows UPDATE COMPLETE in small font after a position shift has been selected and executed (EXEC).

Line 6L shows the INDEX prompt. This selects the INIT/REF INDEX page.

Line 5R shows the NAV STATUS prompt. This selects the NAV STATUS pages.

Line 6R shows the CANCEL prompt. This shows only when a sensor has been selected for position shift. This lets the crew cancel the selected sensor for position shift.
The data in the center of the GPS and IRS data fields at line 2 and 3 shows that both GPSs and ADIRUs are used in the FMC position calculation.



POSITION SHIFT PAGE

THIS PAGE IS INTENTIONALLY LEFT BLANK

ROUTE PAGE

Purpose

The route (RTE) page lets the flight crew enter the route into the FMCS.

Page Access

Access to this page may be from any of these pages:

- POS INIT
- TAKEOFF REF
- DEP/ARR
- SELECT DESIRED WPT.

Also, selection of the RTE mode key on the MCDU will get access to this page.

Page 1/X Information

Line 1L shows dash prompts for an origin airport identifier. The origin airport may be entered here or it may be in the company route data. The navigation data base must contain the airport identifier. Entry or re-entry of the origin airport identifier will clear any existing route.

Line 2L shows dash prompts for a company route. If a company route is set, the route structure shows on the route pages. The navigation data base must contain the company route.

Line 3L shows dash prompts for a departure runway. The runway may be set from this page or the DEP/ARR pages. The navigation data base must contain the runway identifier. This data field is removed when the airplane gets to the first waypoint in the flight plan.

Lines 4L and 5L show the VIA prompt. The VIA data fields show the lateral path AIRWAYS, SIDs, STARs, and DIRECT great circle paths. When a waypoint is set into the TO field, DIRECT shows in the VIA field.

Line 6L can show the ERASE prompt. This shows on all modified pages. It lets the flight crew delete a route modification and return the display to the first active RTE page.

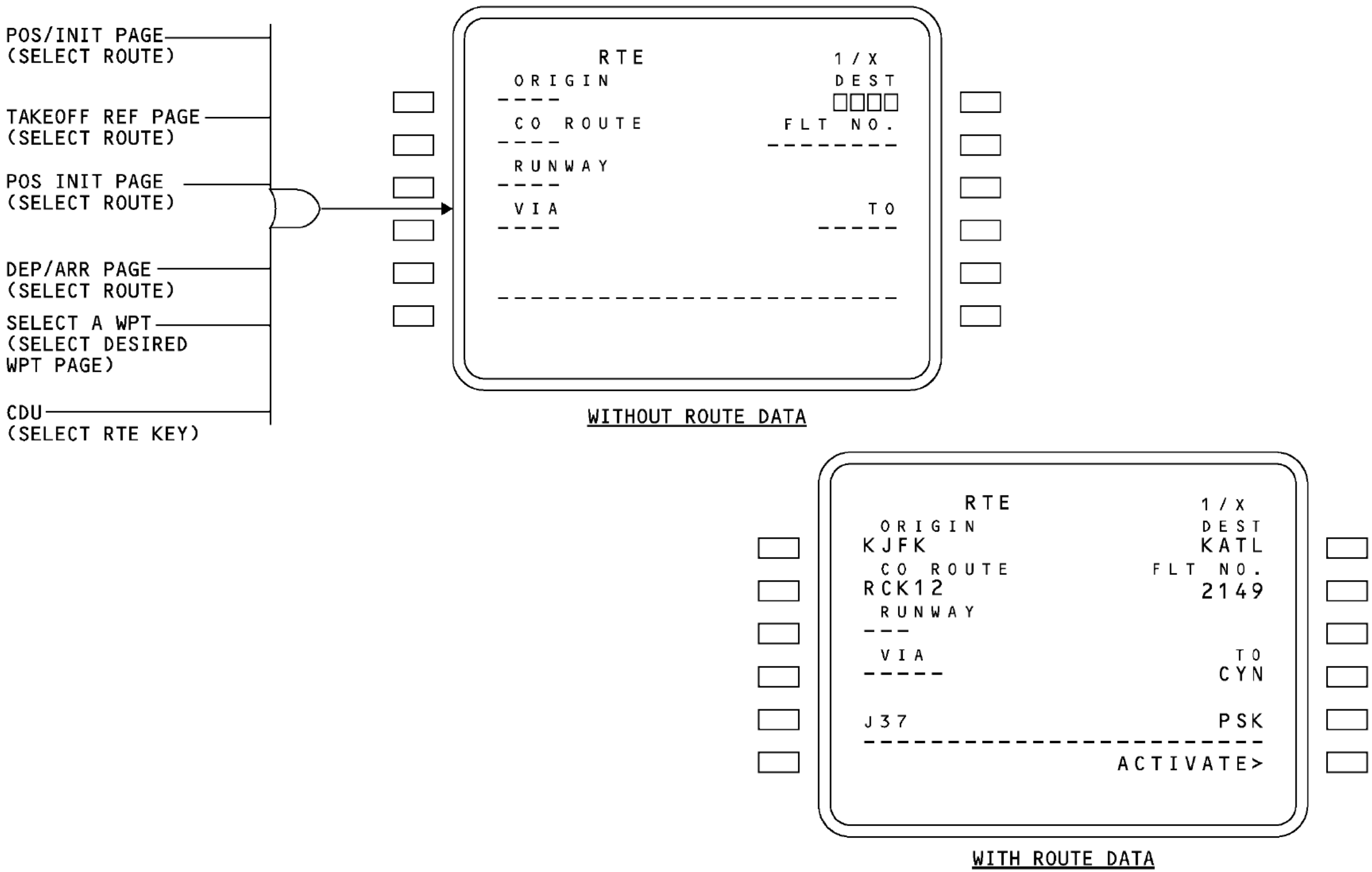
Line 1R shows box prompts for a route destination identifier. The destination may be entered here or it may be in the company route data. The navigation data base must contain the identifier. A valid entry is necessary in this data field to enable VNAV.

Line 2R shows dash prompts for a flight number. The flight number shows on the PROGRESS page title line. This data field shows dashes again at flight completion.

Lines 4R and 5R show the TO prompt. The TO data fields show valid navaid or waypoint identifiers in the route that are in the data base or have been entered on the keyboard.

Line 6R can show one of these prompts:

- ACTIVATE - This shows only on non-active route pages. Selection causes the EXEC light. After the EXEC key is selected, the PERF INIT prompt shows
- PERF INIT - This shows on the ground on active or modified pages if the PERF INIT page is not complete. This selects the PERF INIT page
- TAKEOFF - This shows on the ground on active or modified pages if the PERF INIT page is complete. This selects the TAKEOFF REF page
- OFFSET - This shows only in the air on active or modified pages. This selects the LATERAL OFFSET page.


POS/INIT PAGE
(SELECT ROUTE)
TAKEOFF REF PAGE
(SELECT ROUTE)
POS INIT PAGE
(SELECT ROUTE)
DEP/ARR PAGE
(SELECT ROUTE)
SELECT A WPT
(SELECT DESIRED
WPT PAGE)
CDU
(SELECT RTE KEY)
RTE
1/X
ORIGIN
DEST

CO ROUTE
FLT NO.

RUNWAY

VIA
TO

WITHOUT ROUTE DATA
RTE
1/X
ORIGIN
DEST
KJFK
KATL
CO ROUTE
FLT NO.
RCK12
2149
RUNWAY

VIA
TO

CYN
J37
PSK
ACTIVATE>
WITH ROUTE DATA

ROUTE PAGE

CDU MESSAGES

The FMCS shows alerting or advisory messages when there is a condition that degrades the system. The FMCS also shows entry error messages.

The messages are prioritized and show in the CDU scratch pad. This is the priority:

- Data entry error advisory
- Alerting messages
- Advisory messages.

- **Entry error** messages show that the entered data is not correct. The message must first be cleared and then the data must be entered correctly. These messages will only show on the CDU on which the incorrect data entry was made. The MSG annunciator on the CDU on which the invalid entry was made will be on for these messages.
- **Alerting** messages show an FMC condition that must be shown to the flight crew and corrected before further FMC operation is advisable or possible. The MSG annunciators will be on for these messages as well as the FMC warning lights on the ASAs.
- **Advisory** messages show the FMCS status and certain flight profile parameters and requirements. The MSG annunciators will be on for these messages.

The message with the highest priority will show in the scratch pad. If there are two messages of the same priority, the one that occurred first will show. When it is cleared the next message will show.

To clear a message, push the CLR key or remove the conditions that caused the message. Some messages clear when you change the page. The PROGRAM PIN ERROR message cannot be cleared with the CLR key or a page change.

Below are the messages in the different categories. The airplane operations manual contains a complete list of the CDU messages.

TYPE OF MESSAGE	OTHER INDICATION FOR THIS MESSAGE	EXAMPLE CDU MESSAGES
ALERTING	FMC P/RST a; MSG W	DATA BASE INVALID NAV DATA OUT OF DATE ENTER IRS POSITION CYCLE IRS OFF-NAV IRS MOTION MODEL ENGINE DATA INVALID
ENTRY ERROR ADVISORY	MSG W	INVALID ENTRY NOT IN DATA BASE
ADVISORY	MSG W	PROGRAM PIN ERROR CHECK FMC FUEL QUANTITY PROGRAM PIN NOT IN DB

CDU MESSAGES

FMCS - DISPLAYS

CDS - FLIGHT MODE ANNUNCIATIONS

FMCS Flight Mode Annunciation

The DFCS makes all the FMC flight mode annunciations (FMAs). They show in green at the top of the primary flight displays.

These are the active FMCS flight mode annunciations that can show during FMCS operation:

- Autothrottle (A/T) mode annunciation
- Pitch mode annunciation
- Roll mode annunciation.

Autothrottle Mode Annunciation

These are the autothrottle modes that can show during FMCS operation:

- FMC SPD
- N1
- RETARD
- ARM.

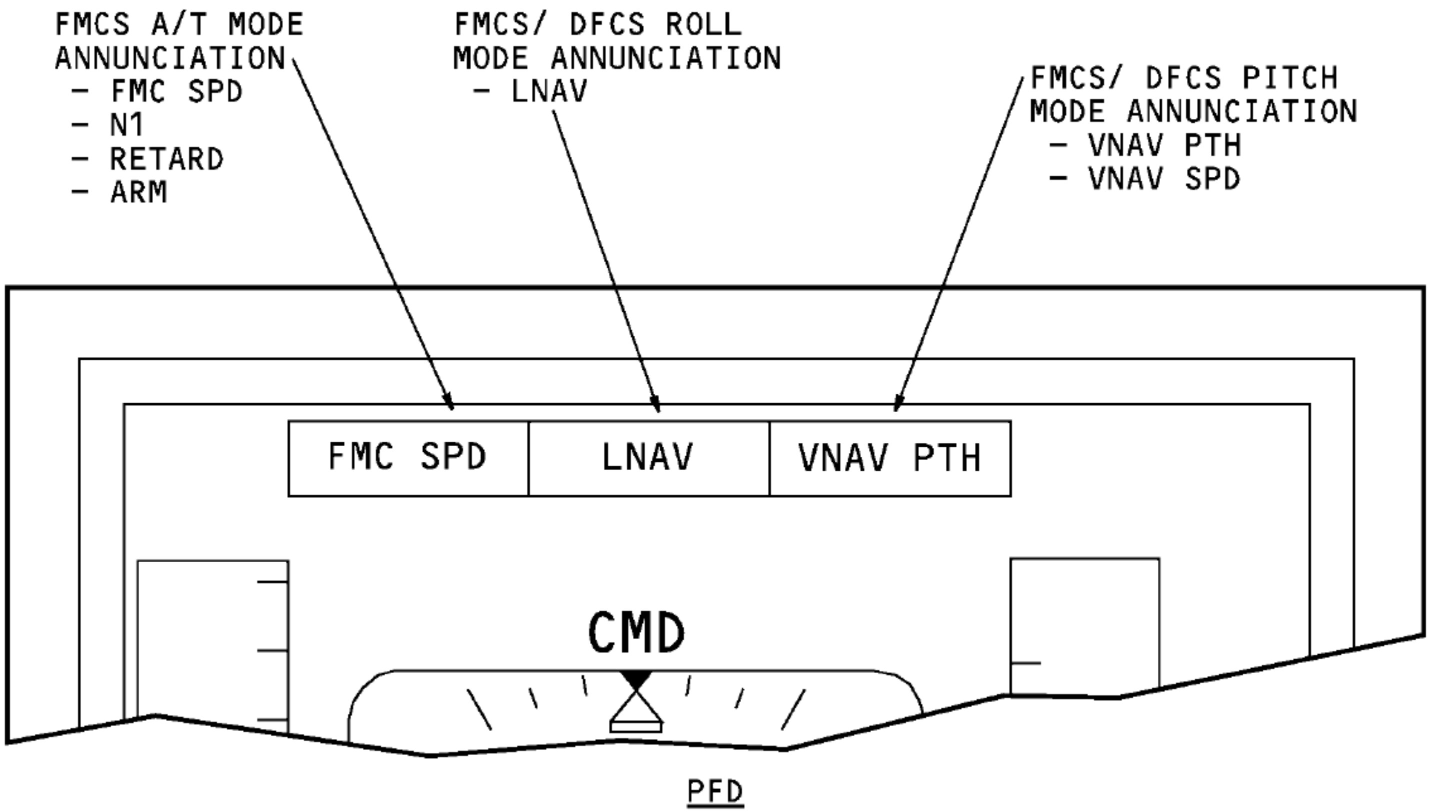
Pitch Mode Annunciations

These are the pitch modes that can show during FMCS operation:

- VNAV PTH
- VNAV SPD.

Roll Mode Annunciation

The roll mode annunciation LNAV can show during FMCS operation.



CDS – FLIGHT MODE ANNUNCIATIONS

CDS - THRUST MODE

General

The thrust mode annunciation display shows the active N1 limit mode calculated by the FMCS. The reference N1 bugs (2) show the N1 limit for the active mode. The N1 limit mode controls the N1 limit for autothrottle operation.

The reference N1 readouts may be set manually. They are set with the N1 SET CONTROL inner knob. When the reference N1 readout is set manually, the N1 bugs show the N1 reference readout value. These manually set limits have no effect on autothrottle operation.

Thrust Mode Display

These thrust modes show on the engine display:

- TO (Takeoff)
- R-TO (Reduced takeoff)
- CLB (Climb)
- R-CLB (Reduced climb)
- CRZ (Cruise)
- CON (Continuous)
- GA (Go-around)
- (no computed data from the FMCS). Only one thrust mode can show and be active.

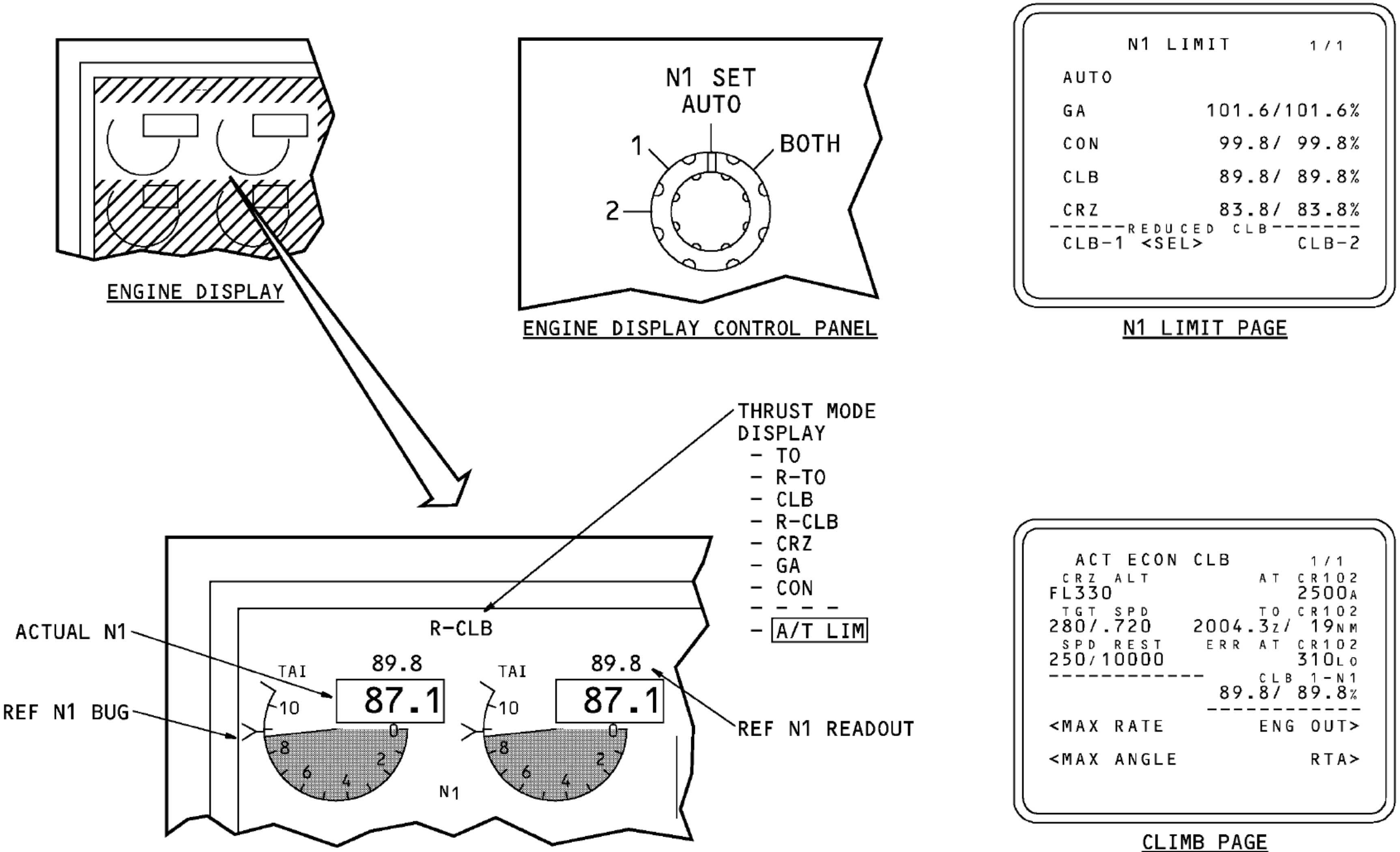
Display Control

When the N1 SET CONTROL outer knob is set to the AUTO position, the thrust mode display and N1 bug position are set by the FMCS as a function of DFCS mode logic. To override automatic control, you can line select another mode from the N1 limit page. The displays go back to automatic control when the DFCS pitch mode changes.

When the outer knob is set to the BOTH, 1 or 2 position, you can manually set the reference N1 bugs and the N1 reference readouts will be displayed above the digital N1 displays. With the outer knob in the AUTO position, the readout is blank.

Non-Normal Operation

In automatic operation, the thrust mode display and reference N1 bug are calculated by the FMCS. If the FMCS limit calculations are not valid, the autothrottle limit message A/T LIM shows and three dashes show in the thrust mode display field. The autothrottle computer then calculates a single N1 limit for both engines.



CDS – THRUST MODE

CDS - AIRSPEED INDICATION

General

The takeoff and landing airspeed bugs show on the PFD speed indicator. The bugs are set automatically by the FMC or, they can be set manually by the flight crew using the speed reference selector on the engine control panel. When set manually, the airspeeds show on the PFD speed indicator and a digital display of the set value shows.

You also use the speed reference selector to manually set the airplane takeoff or landing gross weight. CDS will use this weight value to calculate and display the flap maneuvering speeds.

Speed Reference Selector

The outer control has these functions:

- AUTO (the FMCS supplies the reference airspeeds and gross weight automatically)
- V1 (shows the takeoff decision speed on the ground and shows INVALID ENTRY in-flight)
- VR (shows takeoff rotation speed on the ground and shows INVALID ENTRY in-flight)
- WT (the pilot can set the gross weight manually)
- VREF (shows the landing reference speed (REF) in the air and shows INVALID ENTRY on the ground)
- Triangle symbol (shows an airspeed bug the pilot can set)
- SET (the FMC and the inner control cannot move the airspeed bugs).

The inner control sets the selected bug to the desired airspeed or sets gross weight. The control is spring loaded to center.

Takeoff

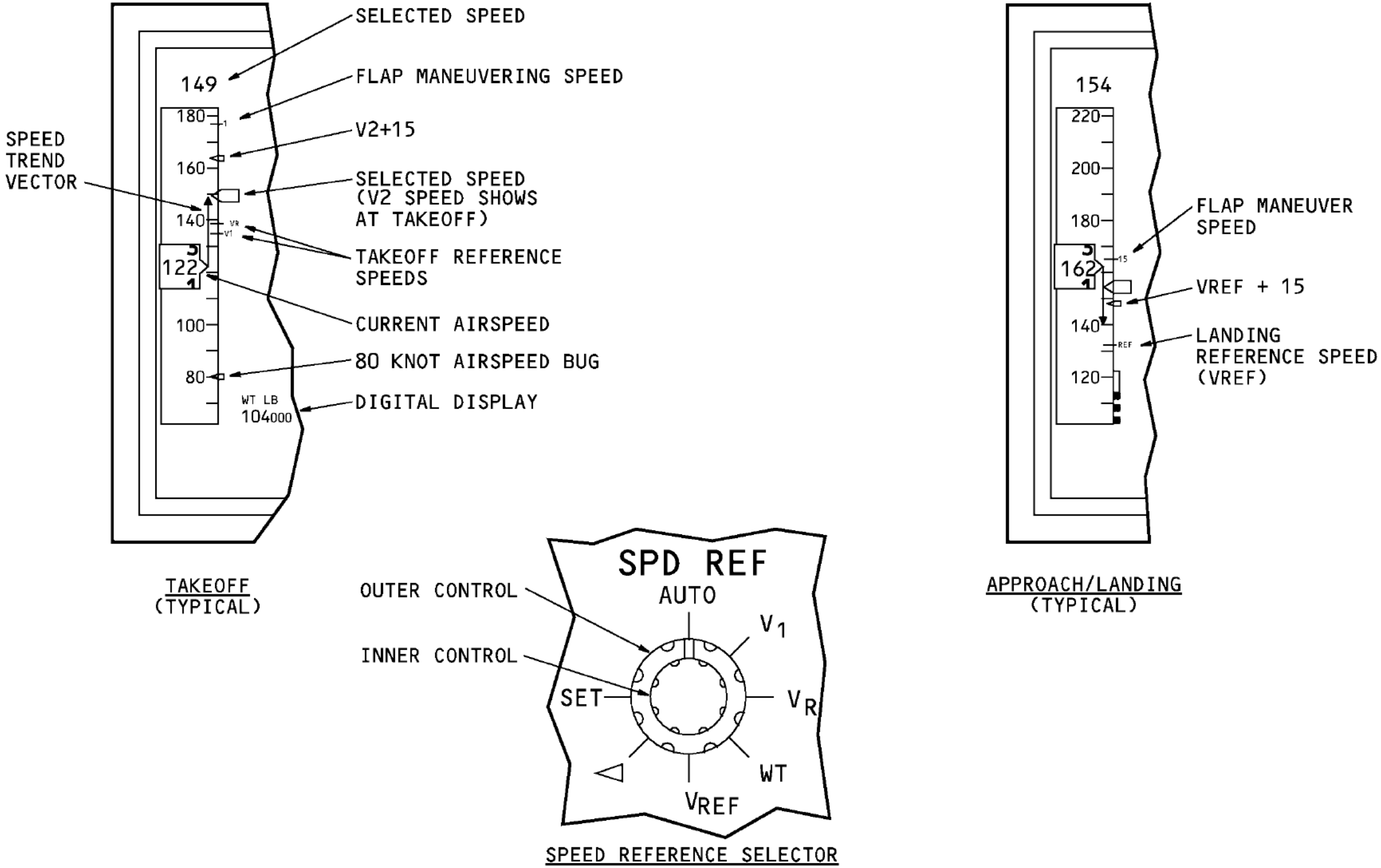
This data shows on the PFD speed tape indicator:

- Digital display (the display shows if the airspeed bug(s) or weight is set with the speed reference selector)
- V1 (decision speed)
- VR (rotation speed)
- Selected speed (indicates the airspeed manually set in the IAS/MACH display on the DFCS mode control panel (MCP) or the FMC computed airspeed when the IAS/MACH window is blank)
- V2 (single engine climb speed)
- V2+15 (single engine climb speed plus 15 knots)
- Flap maneuver speed (maneuver speed for flap position shown. It does not show for 30 or 40 units of flap.)
- Flaps up speed (shows after zero fuel weight is set in the CDU and takeoff gross weight is calculated, or after takeoff gross weight is set with the speed reference selector)
- Airspeed bug at 80 knots (this shows during preflight and is removed when the flaps start to retract).

Approach/Landing

This data can show on the PFD speed tape indicator during approach:

- REF (landing reference speed VREF is set on the CDU APPROACH REF page or set with the speed reference selector)
- VREF+15 (this shows after VREF is set)
- Flap maneuver speed (maneuver speed for flap position shown).



CDS – AIRSPEED INDICATION

CDS - MAP DISPLAY

General

The FMCS provides the navigation data for the MAP mode displays on the common display system (CDS). There are two types of navigation data, dynamic data and background data. Dynamic data changes as a function of time while background data is stationary data that does not move as a function of time.

The FMCS formats and transmits the data (FMC bus 08 and FMC bus 09) to show the airplane position with respect to the flight plan and vertical profile. The CDS controls symbol color, size, and brightness.

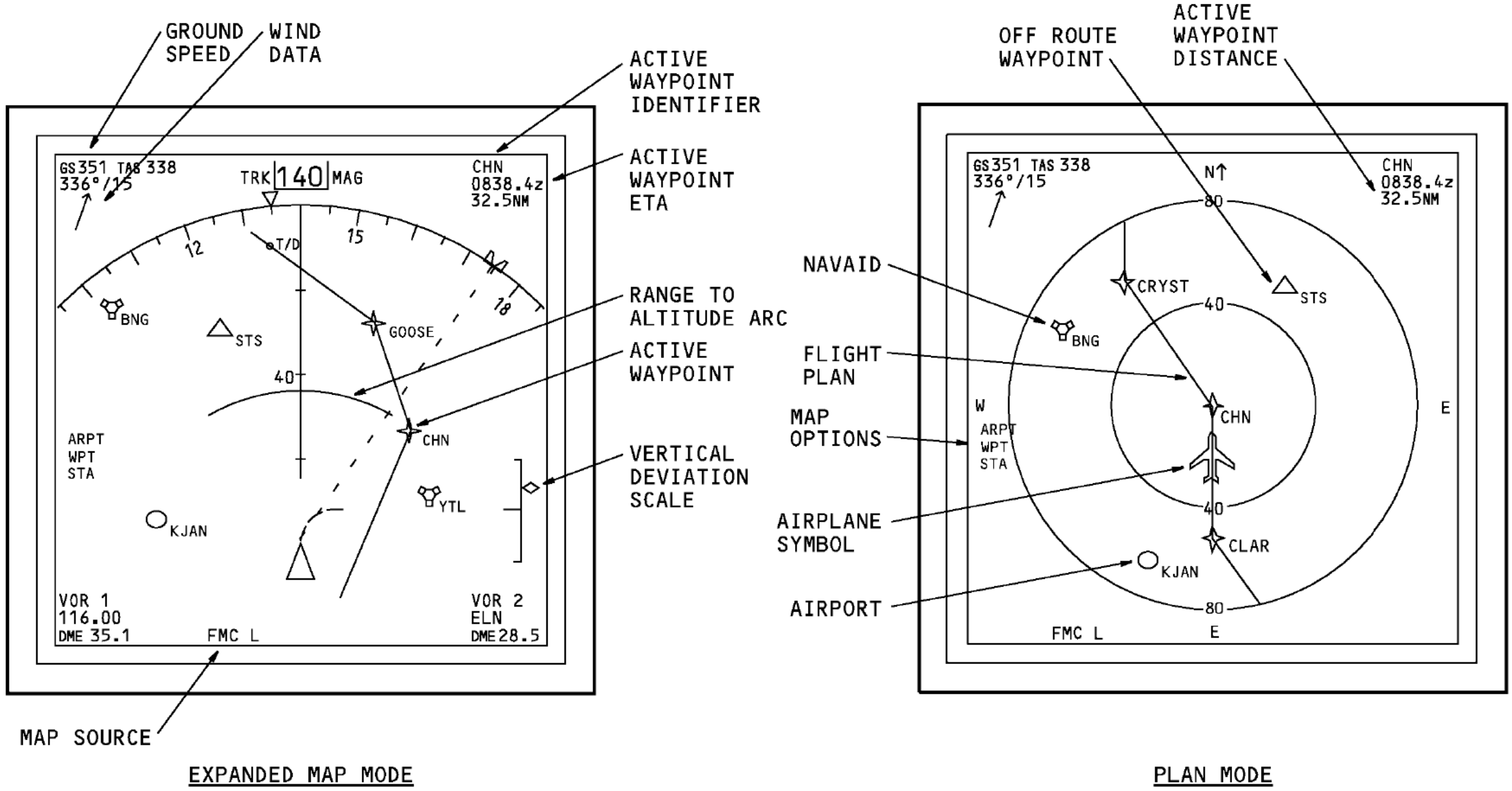
MapMode

The map mode shows the progress of the flight and is the normal display the crew uses for navigation in flight. This display may show in either the expanded mode or the centered mode. The display is dynamic and moves as the airplane moves.

SymbolDefinitions

This data is shown:

- Active waypoint distance (distance to go to the active waypoint. White)
- Active waypoint ETA (estimated time of arrival for the active waypoint. White)
- T/C altitude profile point (top of climb position in the active route. Green)
- T/D altitude profile point (top of descent position in the active route. Green)
- E/D altitude profile point (end of descent position in the active route. Green)
- S/C altitude profile point (step climb position in the active route. Green)
- Speed profile point (deceleration point in the active route. Green)
- Active waypoint (next waypoint in the active route. Magenta)
- Range to altitude arc (range at which the airplane will reach the MCP altitude. Green)
- Trend vector (predicted position of airplane at the end of 30, 60 or 90 second intervals. White)
- Inactive waypoint (waypoint other than the active waypoint in the active route. White)
- Vertical deviation scale (vertical deviation from the calculated descent profile. Scale is white and pointer is magenta)
- Map options (options selected on the EFIS control panel. Cyan)
- Wind data (wind speed and direction. White)
- Map source (source of dynamic and background data. Green)
- Navaids (navigation stations within the selected map area. Cyan)
- Off route waypoints (waypoints within the selected map area but not in the active route. Cyan)
- Airports (airports within the selected map area. Cyan)
- Route data (altitude constraints and ETAs for the waypoint in the active route. Magenta or white)
- Track angle (airplane track. White).



CDS - MAP AND PLAN DISPLAY

CDS - PLAN DISPLAY

General

The FMCS provides the navigation data for the PLAN mode displays on the common display system (CDS). There are two types of navigation data, dynamic data and background data. Dynamic data changes as a function of time while background data is stationary data that does not move as a function of time.

The FMCS formats and transmits the data (FMC bus 08 and FMC bus 09) to accurately show the airplane position with respect to the flight plan and vertical profile. The CDS controls symbol color, size, and brightness.

Plan Mode

The plan mode shows NORTH UP. The crew uses the plan mode with the FMC/CDU LEGS page and the STEP line select key to review the route. The plan mode display is a static display.

Range information shows as circles around the reference point that is in the middle of the display.

The airplane symbol shows the current position and track if the airplane is in the range of the flight plan shown.

Display Data

Ground speed, wind data, and true airspeed show the same as for the APP, VOR, and MAP modes except that the wind direction arrow does not show.

This data shows in the upper left corner:

- Distance to active waypoint
- True airspeed.

This data shows in the upper right corner:

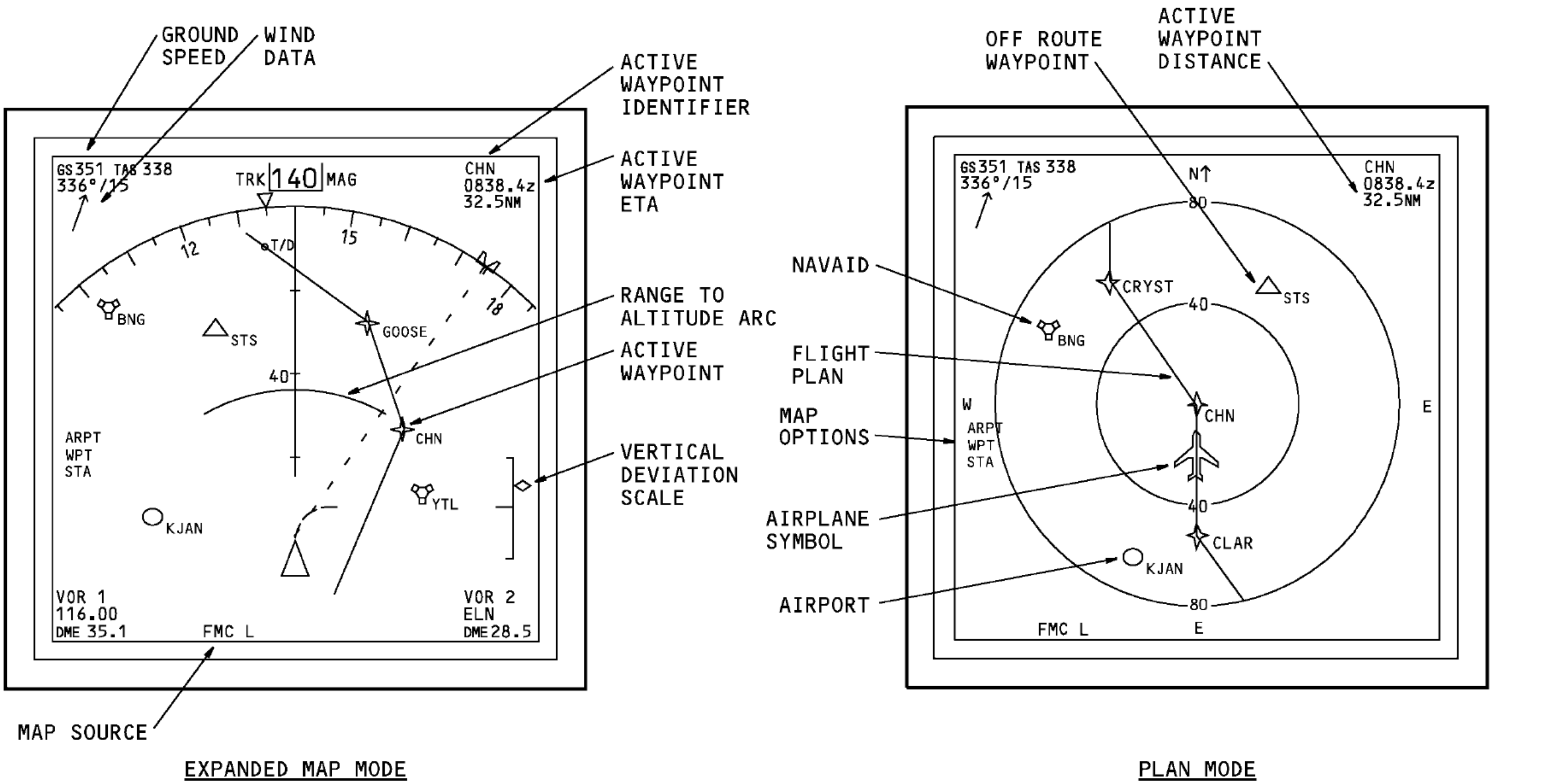
- Estimated time of arrival at the active waypoint
- Groundspeed.

Only TCAS traffic alert messages show in the plan mode. TCAS mode/status information shows in the upper left corner.

Symbol Definitions

This data shows:

- Distance to go to the active waypoint (white)
- Estimated time of arrival for the active waypoint (white)
- Active waypoint (next waypoint in active route) (magenta)
- Waypoints other than the active waypoint in the active route (white)
- Options selected on the EFIS control panel (cyan)
- Source of the dynamic and background data (green).



CDS - MAP AND PLAN DISPLAY

CDS - NON-NORMAL DISPLAYS

These non-normal messages can show:

- UNABLE REQD NAV PERF - RNP
- MAP RANGE DISAGREE. These non-normal flags can show:
- MAP flag
- Vertical track (VTK).

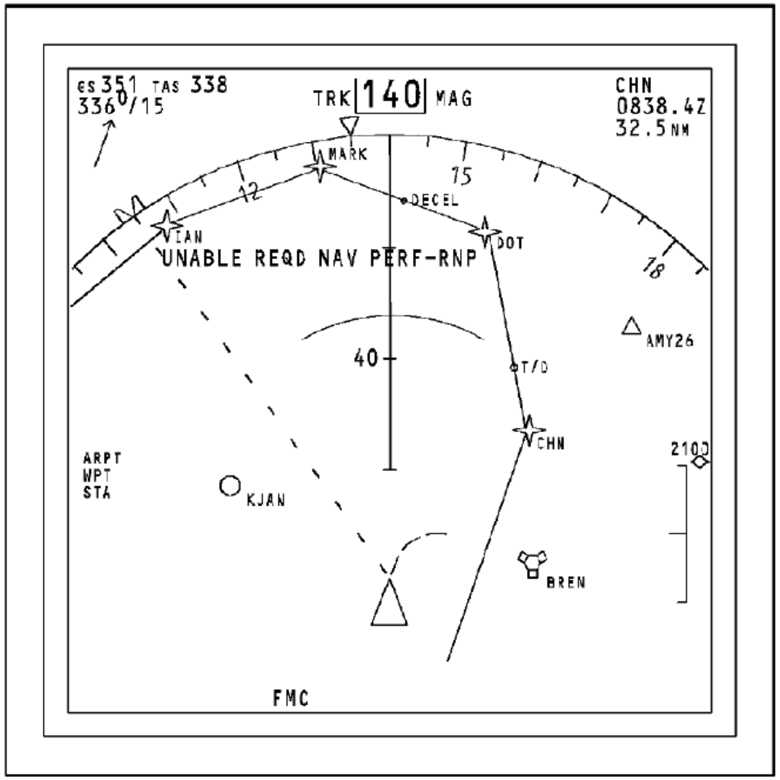
The UNABLE REQD NAV PERF - RNP message shows when the actual navigation performance (ANP) exceeds the required navigation performance (RNP) for the current flight environment. The map data is not blanked in this condition.

The MAP RANGE DISAGREE message shows when a new range has been selected on the EFIS control panel and new map data is not received from the FMC. All map data is blanked in this condition.

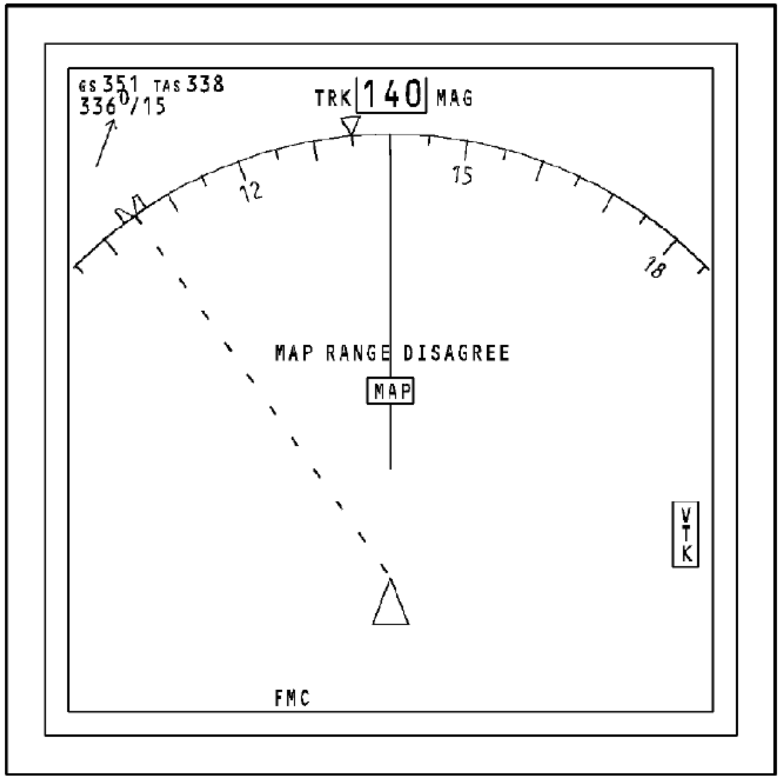
The MAP flag shows if the map data from the FMC is invalid or NCD. All map data is blanked in this condition.

The VTK (vertical track) flag shows when the vertical deviation data from the FMC is invalid or NCD. Only the vertical deviation scale is blanked in this condition.

All these non-normal messages and flags can show in the map and plan modes. They are amber.



EXPANDED MAP MODE



EXPANDED MAP MODE

CDS – NON-NORMAL DISPLAYS

THIS PAGE IS INTENTIONALLY LEFT BLANK

FMC DATA LOADING (TRAINING INFORMATION POINT)

INTRODUCTION

You use the airborne data loader (ADL) to load data into the FMCS and other airplane systems. The steps to load data into the FMCS and the other systems are similar.

To load data into the FMCS, you set the data loader control panel selector to the FMC position. This connects the loader to the primary FMC.

You can load these databases into the FMCS:

- Operational flight program (OFP)
- Navigation data base
- Performance default data base
- Airplane model/engine performance data base
- Software options data base.

Note: The performance default data base is part of the OFP and cannot be loaded seperately.

Preparation

The information below shows the steps to load a navigation data base. The procedure to load the other systems data or the other FMCS data is similar.

This is a summary of the steps to load data with an ADL:

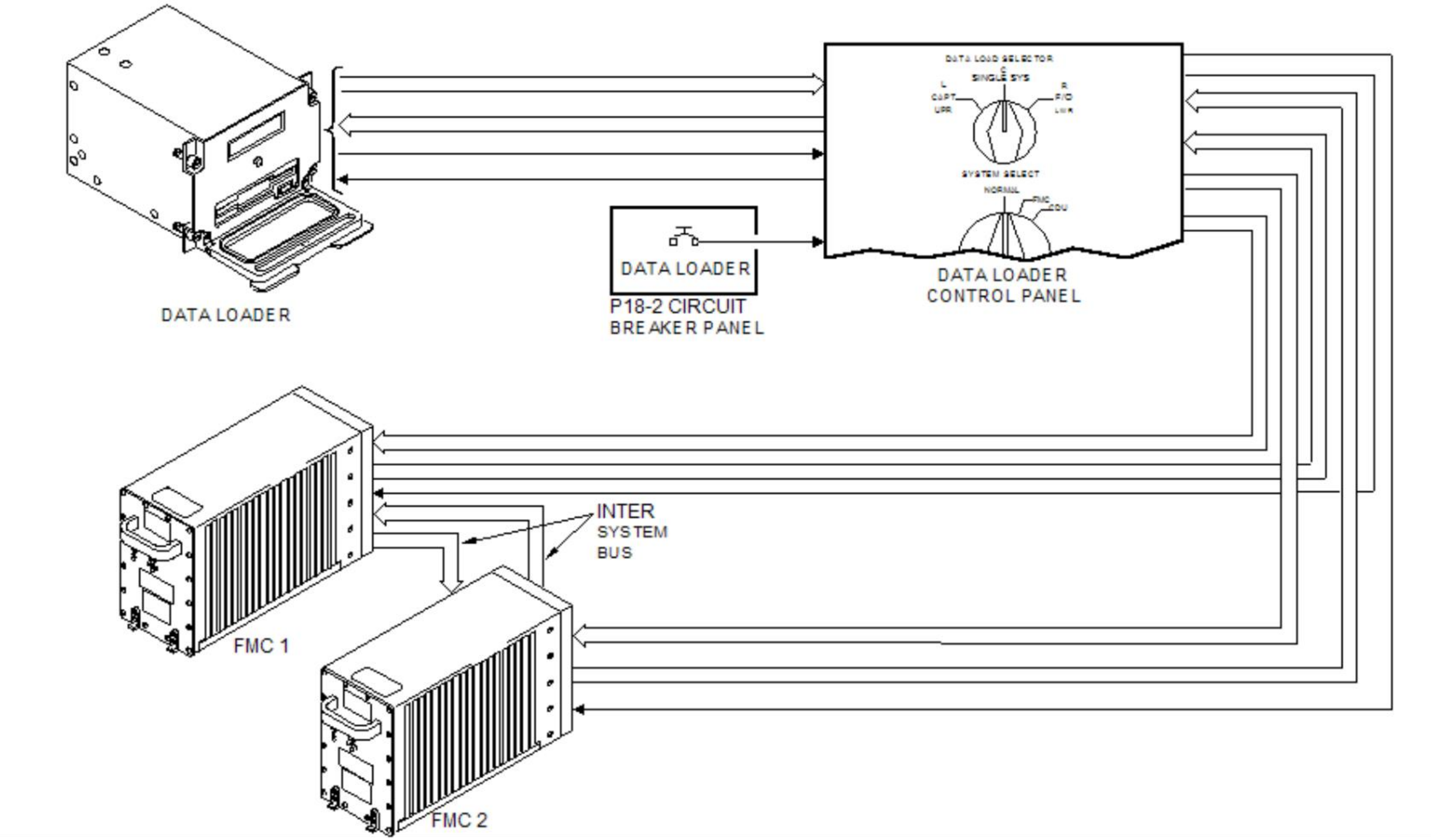
- Airplane must be on the ground
- Apply electrical power to the airplane
- Set the data loader 3-position switch to the FMC you will load (the L position will load FMC 1 and the R position will load FMC 2)
- Set the data load selector to the FMC position
- Open the data loader access door
- Put the necessary diskette into the ADL.

Note: The FMC source select switch on the P5 panel must be set in the BOTH ON L or NORMAL positions to see the load progress on the MCDUs if FMC 1 is loaded. If the 3-position switch is in the R position, the FMC source select switch must be set to BOTH ON R to see the load progress on the MCDUs.

The CDUs automatically go to the FMCS DATALOAD page when the CDU receives valid data from the loader.

The data load process is automatic. When the data loader 3-position switch is set to the L position, the data loads into FMC 1. You then do a crossload and load the data into FMC 2 via the FMCS inter system bus.
Return the data loader control panel to the NORM position after the transfer is complete.

Note: Do not interrupt electrical power to the system during software loading. If power is interrupted, you will need to do the software load procedure again.



FMC DATA LOADING

CDU DATA LOADING

General

You use the airborne data loader (ADL) to load the operational program software (OPS) into the CDUs.

To load the OPS into the CDUs, set the data loader selector to the CDU position and the data loader 3-position switch to the L or R position depending on which CDU is to be loaded. This connects the loader to the CDU being loaded.

Preparation

This is a summary of the steps to load the OPS with an ADL:

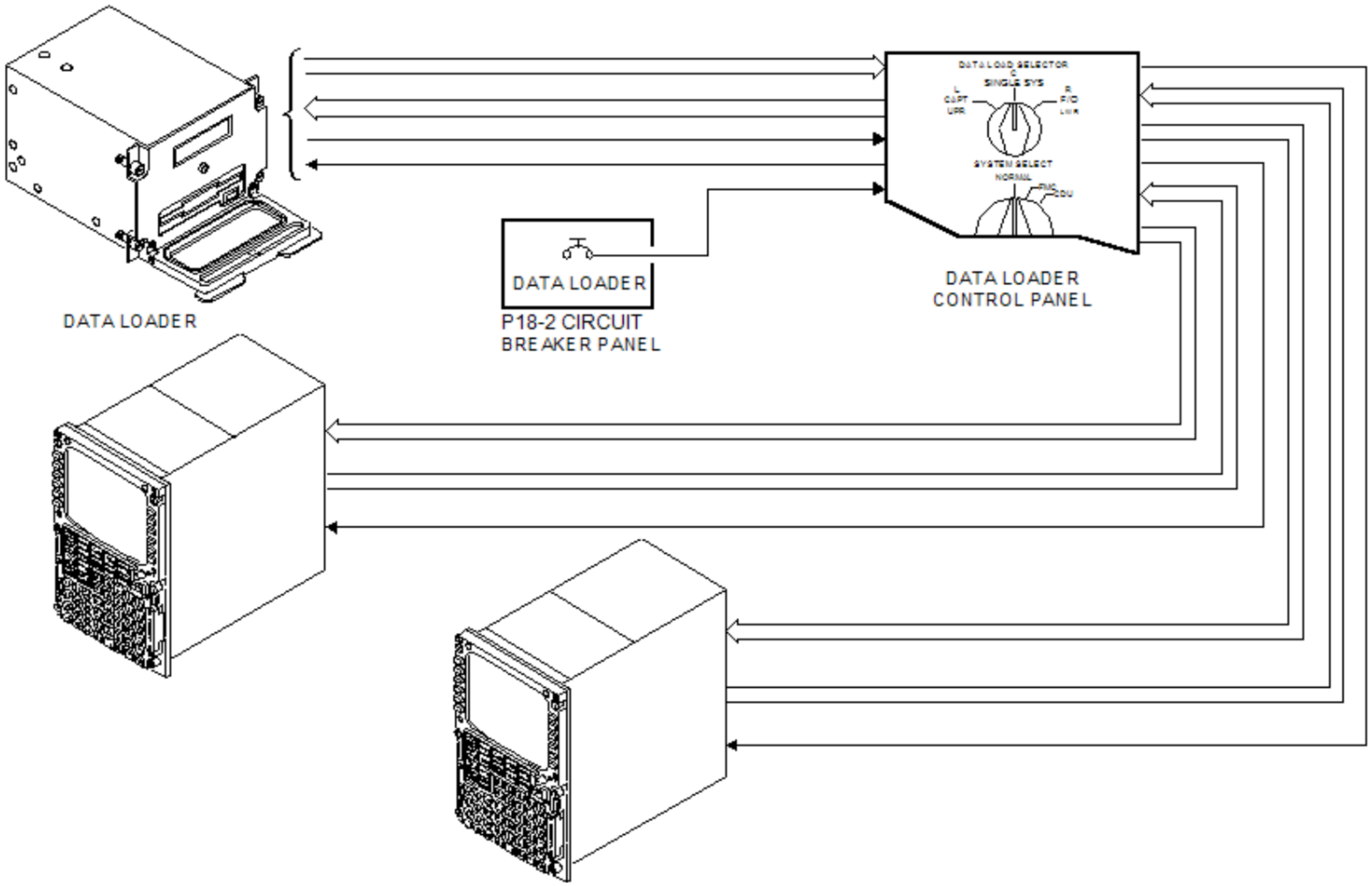
- Airplane must be on the ground
- Apply electrical power to the airplane
- Set the data loader selector to the CDU position
- Set the data loader 3-position switch to the CDU you will load (the L position loads CDU 1 and the R position loads CDU 2)
- Open the data loader access door
- Put the CDU OPS software diskette into the ADL.

The CDUs show the DATA LOADER page when the CDU receives valid data from the loader.

The data load process is automatic. When the CDU shows the message LOAD COMPLETE, remove the diskette from the ADL and perform the applicable software verification procedure.

Return the data loader selector to the NORM position after the transfer is complete.

> Note: Do not interrupt electrical power to the system during software loading. If power is interrupted, you will need to do the software load procedure again.



CDU DATA LOADING

DATABASE LOAD

Load

After you put the diskette into the loader, the load process is automatic. Except to change diskettes, no further operation is necessary.

CURRENT RECORD shows the number of data base records that are loaded into the FMC data base memory. TOTAL RECORDS show the total number of records to be loaded into the FMC data base memory.

During the loading process, the message LOAD IN PROGRESS shows. INSERT NEXT DISK shows during multi-disk data base load.

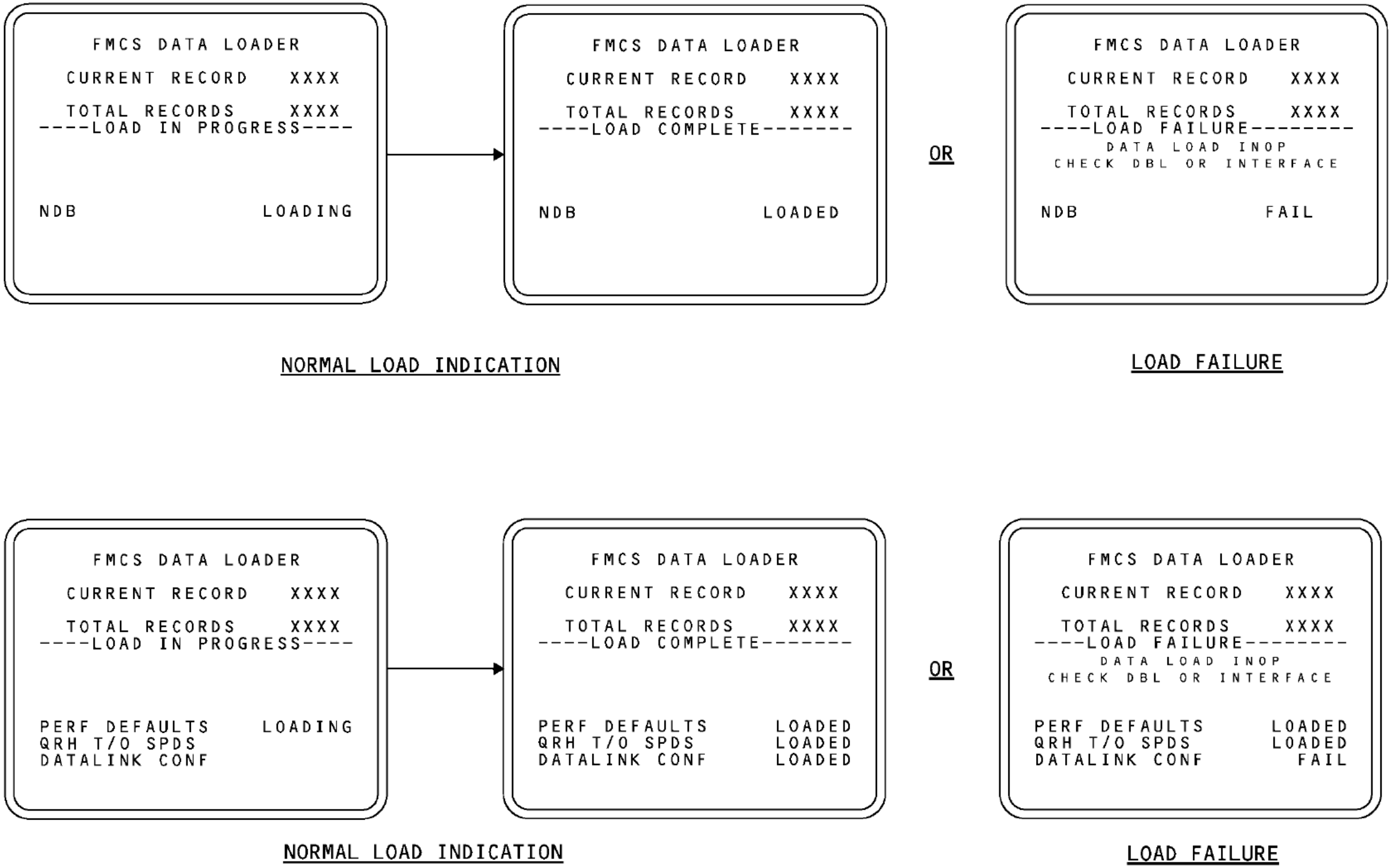
The load is complete when LOAD COMPLETE shows on the CDU. Push the eject button on the loader to remove the diskette.

Load Failure Indications

If the loader finds a problem, a message shows on the data loader display and DATA LOAD INOP shows on the CDUs.

If the FMC finds a problem with the data from the loader, the CDU shows one of these messages:

- CHECK DBL OR INTERFACE (there is a problem that the FMCS cannot isolate to the FMC or the loader)
- DB EXCEEDS FMC (the data on the disk is too large for FMC memory)
- RESET COUNT EXCEEDED (five load attempts have failed)
- DB-OFP INCOMPATIBLE (the data on the disk does not compare with the FMC operational program)
- CHECK MEDIA (part of the data on the disk cannot be read by the loader)
- INCORRECT DISK INSERTED (the diskette does not compare with the diskette you used before).



DATABASE LOAD

CROSSLOAD PAGES

General

These are the two crossload pages that can show on the MCDU:

- OFP CROSSLOAD
- DATABASE CROSSLOAD.

> Note: The OFP CROSSLOAD page will have priority over the DATA BASE CROSSLOAD page.

The OFP CROSSLOAD page shows for any of these conditions:

- If, during ground power up, the primary FMC finds a mismatch between its valid OFP and that of the secondary FMC
- An OFP with a different update version is loaded into one FMC
- Selecting the CROSSLOAD prompt on the FMCS BITE INDEX page if an OFP mismatch currently exists.

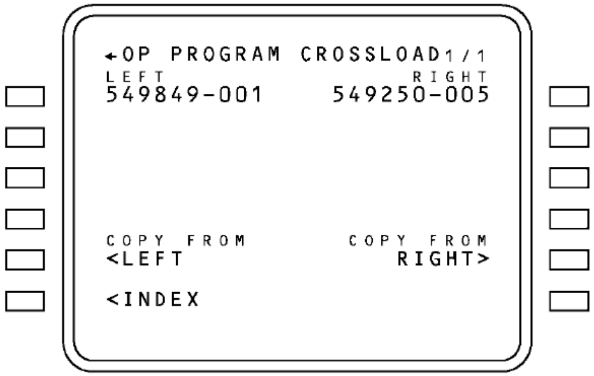
> Note: If the OFP in the primary FMC is not valid, the MCDU shows a message to set the FMC source select switch to the BOTH ON R position.

If there is no mismatch between the OFPs but there is an analog discrete mismatch, the ANALOG DISCRETE page will show with the specific mismatch highlighted.

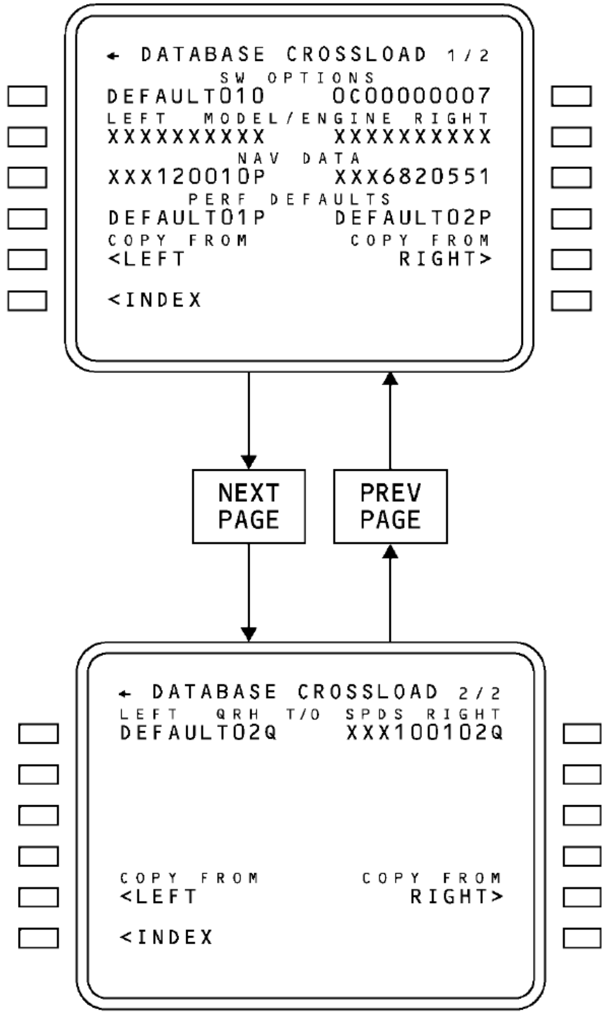
The DATABASE CROSSLOAD page will show if there are not any OFP or analog discrete mismatches for any of these conditions:

- If, during ground power up, there is a data base mismatch between the primary and secondary FMCs.
- A database with a different update version is loaded into one FMC
- Selecting the CROSSLOAD prompt on the FMCS BITE INDEX page if a data base mismatch currently exists.

The database pages show only the databases that do not match between FMCs. The data and header fields will be blank if there is no mismatch.



OPERATIONAL PROGRAM CROSSLOAD PAGE



DATABASE CROSSLOAD PAGES

CROSSLOAD PAGES

DATABASE CROSSLOAD PAGE

General

The database crossload page lets you review and, if necessary, transfer the various data bases between the FMCs.

These are the applicable data bases:

- Model/engine
- Navigation
- Performance defaults
- Software options.

Page Access

This page shows for any of these conditions:

- During ground power-up, if there is a data base mismatch between the primary and secondary FMCs
- Data base with a different update version is loaded into one FMC
- Selection of the CROSSLOAD prompt on the FMCS BITE INDEX page if there is a data base mismatch.

Note: The data base crossload page shows if there is not an OFP mismatch or an analog discrete mismatch between the FMCs. These have higher priority than the data base crossload pages.

Data Base Crossload Page Information

Lines 1L through 4L show the data fields for the individual data bases. If there are no mismatches, the data fields are blank.

Lines 5L and 5R show the crossload status.

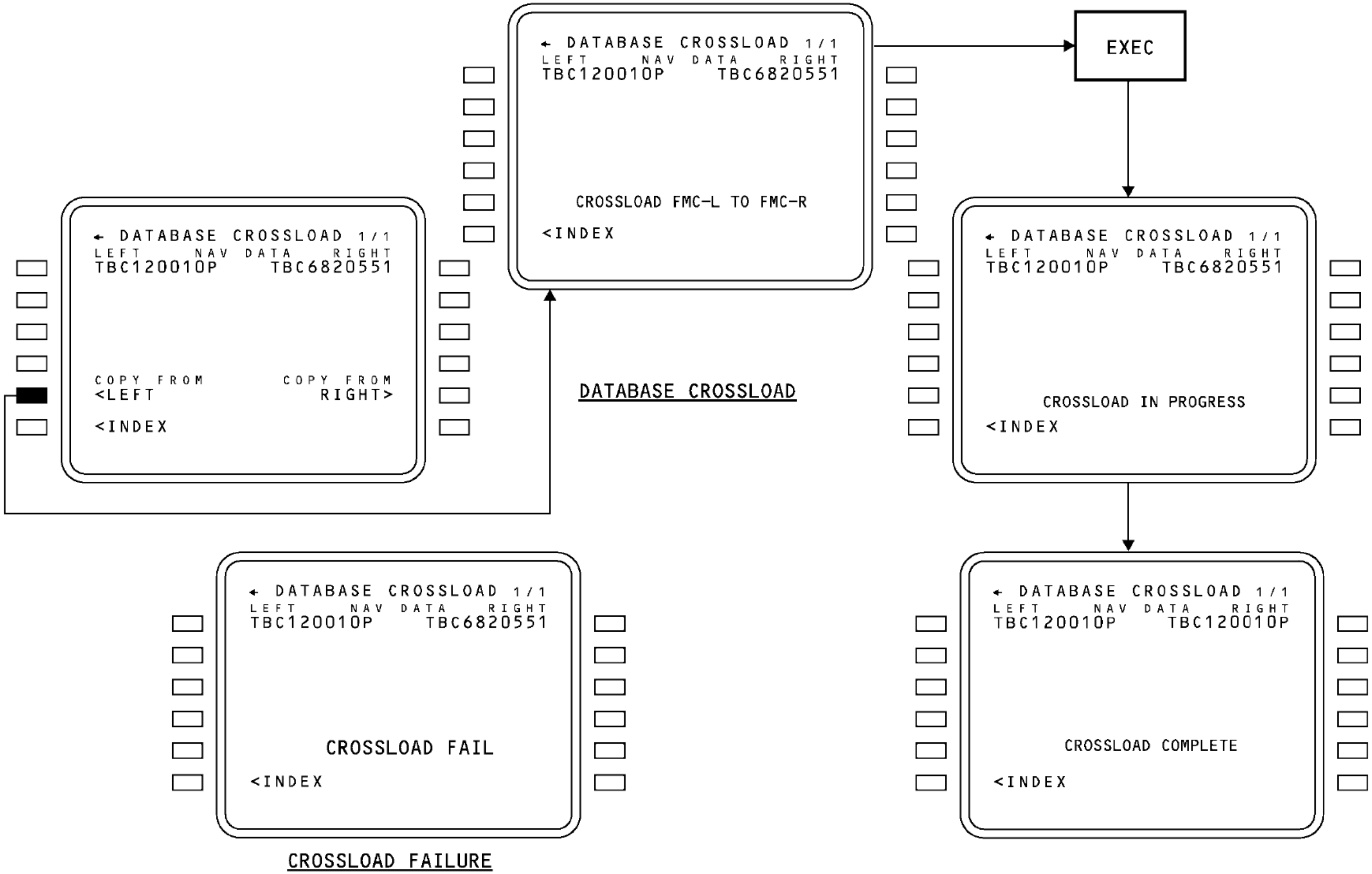
These messages may show:

- COPY FROM <LEFT/RIGHT>
- CROSSLOAD FMC-L TO FMC-R
- CROSSLOAD FMC-R TO FMC-L
- CROSSLOAD IN PROGRESS
- CROSSLOAD COMPLETE
- CROSSLOAD FAIL (the data base in the source FMC did not crossload to the target FMC)
- CROSSLOAD UNAVAILABLE (the source FMC cannot interface with the other FMC)
- SET FMC SOURCE SELECT TO BOTH ON R (shown when the primary FMC is also the target FMC).

To start the crossload, select COPY FROM LEFT or COPY FROM RIGHT on the MCDU and push the EXEC key. The message, CROSSLOAD IN PROGRESS shows during the crossload process. At the end of the crossload, the message, CROSSLOAD COMPLETE shows on the MCDU.

If there are no more mismatches between the FMCs, the INDEX prompt shows.

Note: The example on the graphic shows a mismatch between the navigation data bases of the two FMCs.



DATABASE CROSSLOAD

FMCS BITE PAGES (TRAINING INFORMATION POINT)

INTRODUCTION

The FMCS has BITE functions for maintenance and test of the system. The BITE is in the FMC. You operate the BITE with the MCDUs.

The BITE functions continuously monitor the status of the FMC and MCDU. The functions also continuously monitor the status of airplane sensor systems which interface with the FMCS. The monitors operate at all times. This includes power- up.
These are the BITE functions:

- INFLT FAULTS
- CDU TEST
- SENSORS
- DISCRETES
- FMCS - FIXED OUTPUTS
- MODEL/ENG
- SW OPTIONS
- PERF FACTR
- IRS MONITOR
- LCD CDU.

INFLT FAULTS

The FMCs record their in-flight faults and in-flight faults for the MCDUs and the LRUs they interface with. They have storage capacity for nine flights. Also, the FMCs record their ground faults and ground faults for the MCDUs.

CDU TEST

The MCDU test page shows the tests for the MCDU display and keyboard.

SENSORS

The sensor status pages show the current status of all the sensors that send data to the FMC selected as the BITE source.

DISCRETES

These pages show the current status of the analog discretes that send data to the FMC selected as the BITE source.

FMCS - FIXED OUTPUTS

This function shows the values of the FMCS outputs to the common display system (CDS)and the autoflight status annunciators (ASA).

MODEL/ENG

The model/engine configuration page shows the airplane and engine configuration. It also shows the engine combustor type and the brake option selected.

SW OPTIONS

The software option pages show the status of the options that are in the software options database.

PERF FACTOR

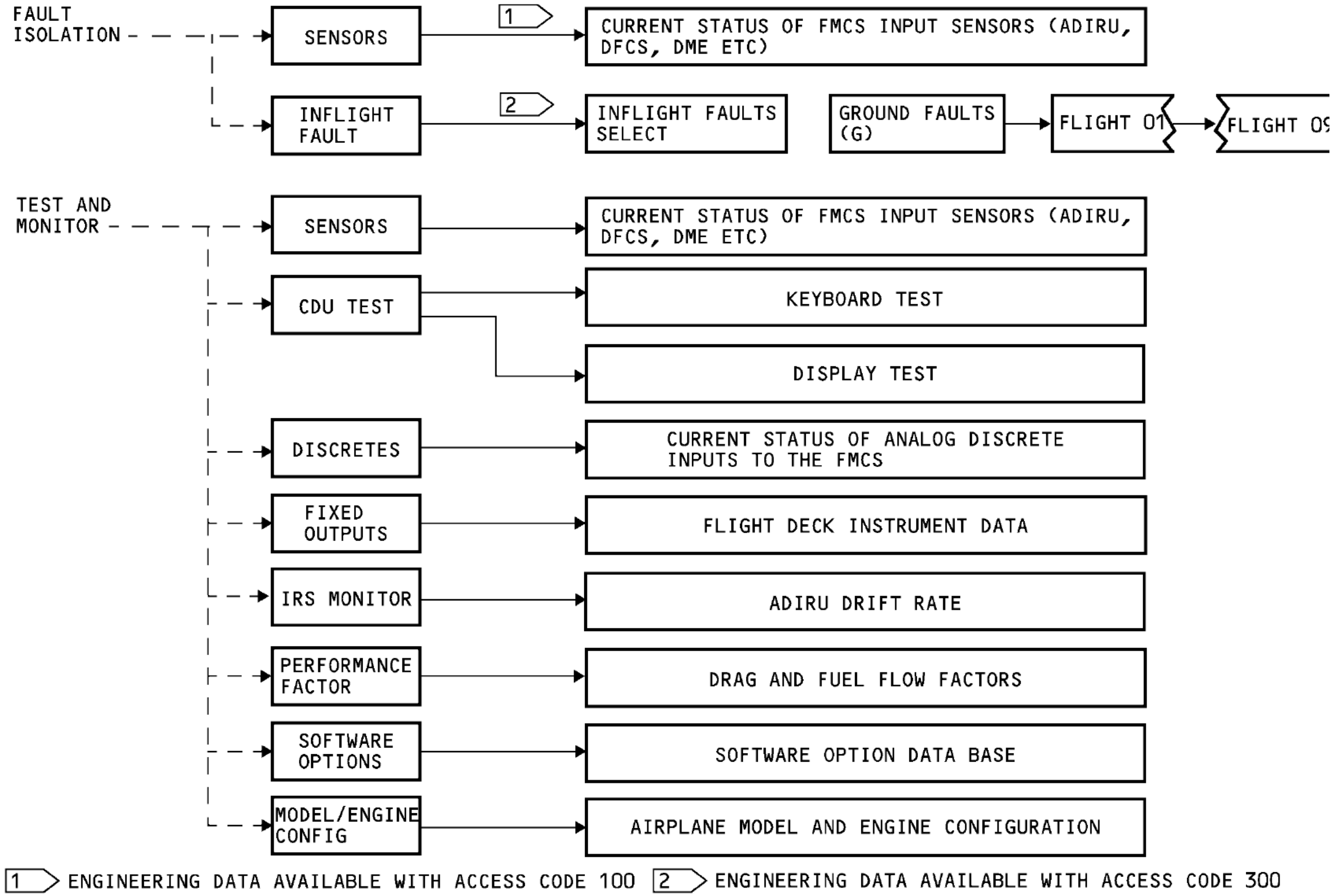
The performance factors page permits the display and entry of performance factors to optimize airplane performance for individual operators or airplane characteristics.

IRS MONITOR

This page shows the ADIRU position error rate calculated by the FMC.

LCD CDU

The LCD CDU page shows the MCDU BITE pages.



FMCS BITE PAGES - INTRODUCTION

BITE ENTRY

To get access to the MAINT BITE INDEX page, use the MAINT> prompt (LSK 6R) on the INIT/REF INDEX page.

The MAINT prompt only shows if the airplane is on the ground and the groundspeed (as sensed by the IR section of the ADIRU) is less than 20 knots.

Note: In the air on the INIT/REF INDEX page, NAV STATUS shows at LSK 6R.

The MAINT BITE INDEX page shows these airplane sub-systems:

- FMCS
- DFCS
- A/T
- ADIRS
- CDS
- ENGINE
- APU
- FQIS.

Also, there is a prompt for FMC DOWNLOAD at LSK 6R.
On the FMCS BITE page, either FMC LEFT (FMC 1) or FMC RIGHT (FMC 2) can be selected as the BITE data source.
It is possible to select FMC 1 as the BITE data source on the left CDU and FMC 2 as the BITE data source on the right CDU. In this configuration, sensor data can be compared for both FMCs.
If the BITE information from the FMC is not available or invalid, the caret (<) does not show and the message LEFT (or RIGHT) FMC BITE INOP shows.
The CROSSLOAD prompt gives the capability for crossload of the OFP or other data bases between FMCs.

The process starts by selection of the CROSSLOAD prompt (LSK 6R). The CDU then shows the FMCS CROSSLOAD page which has instructions for crossloading the applicable data base between FMCs.

Primary/Secondary FMC Select
The primary FMC provides the CDU display data. The arrow direction in the top left corner of the CDUs shows which FMC is primary. You use the FMCS transfer switch to select the primary FMC.

In the example on the graphic, the arrow points to the left to show that FMC 1 is the primary FMC. If the arrow points to the right, this shows that FMC 2 is the primary FMC.

When the FMC select switch on the P5 overhead panel is in the NORMAL or BOTH-ON-LEFT position, FMC 1 is the primary FMC. In the BOTH-ON-RIGHT position, FMC 2 is the primary FMC.

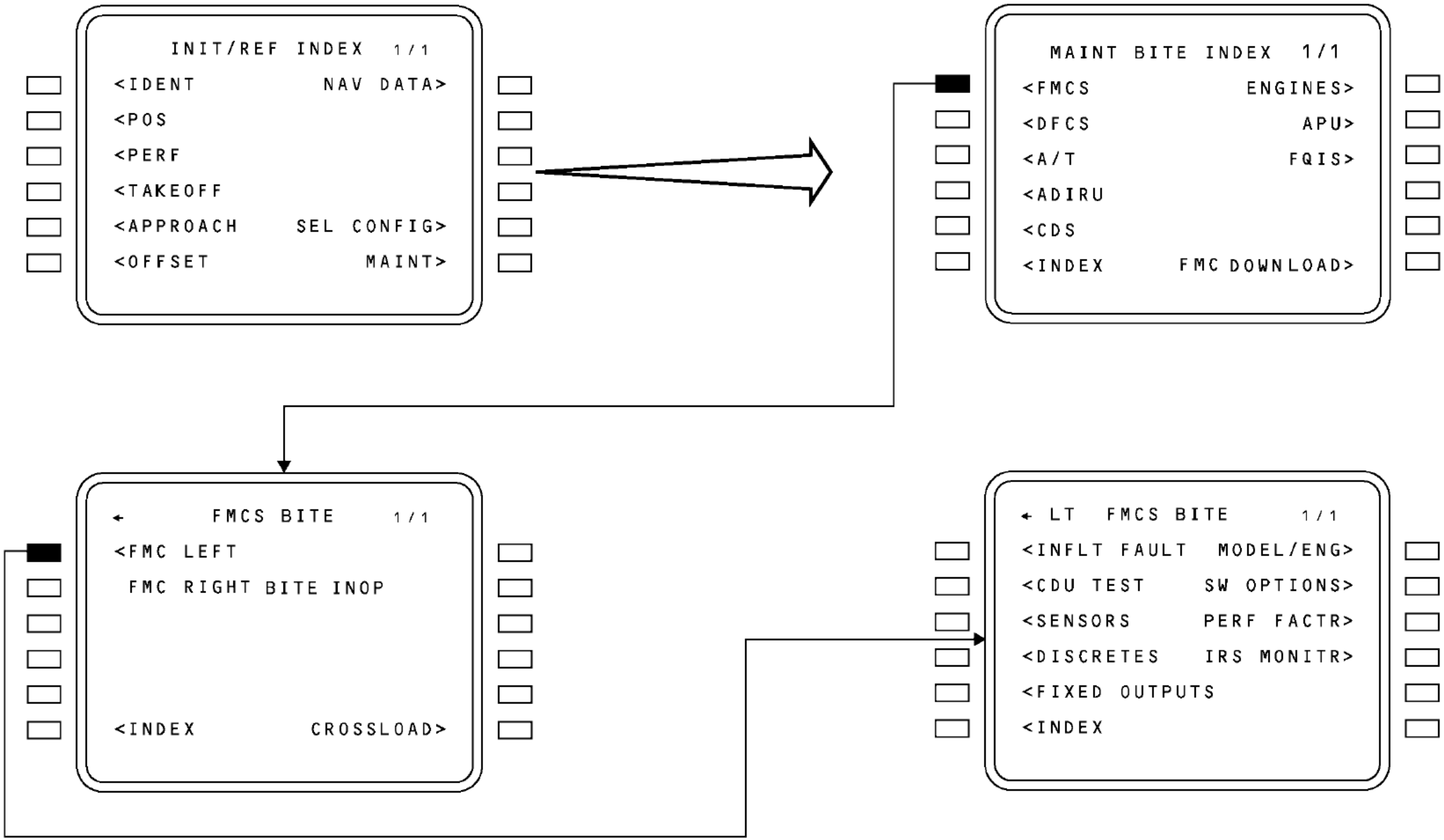
FMCS BITE Page
The FMCS BITE page has these FMC maintenance categories:

- INFLT FAULTS
- CDU TEST
- SENSORS
- DISCRETES
- FIXED OUTPUTS
- MODEL/ENG
- SW OPTIONS
- PERF FACTOR
- LCD CDU
- IRS MONITOR.

FMC Download
The FMC DOWNLOAD prompt gives the capability to copy FMC internal diagnostic data to a 3.5-inch diskette without removal of the FMC from the airplane. The data is downloaded to the airborne data loader (ADL) from specially formatted diskettes.

The process starts by selection of the FMC DOWNLOAD prompt (LSK 6R). The CDU shows the FMCS DATA LOADER page which has instructions for downloading the data to the ADL.

The position of the FMC select switch determines which FMC gives the download data.


INIT/REF INDEX 1/1
<IDENT NAV DATA>
<POS
<PERF
<TAKEOFF
<APPROACH SEL CONFIG>
<OFFSET MAINT>
MAINT BITE INDEX 1/1
<FMCS ENGINES>
<DFCS APU>
<A/T FQIS>
<ADIRU
<CDS
<INDEX FMC DOWNLOAD>
FMCS BITE 1/1
<FMC LEFT
FMC RIGHT BITE INOP
<INDEX CROSSLOAD>
LT FMCS BITE 1/1
<INFLT FAULT MODEL/ENG>
<CDU TEST SW OPTIONS>
<SENSORS PERF FACTR>
<DISCRETES IRS MONITR>
<FIXED OUTPUTS
<INDEX

BITE ENTRY

BITE PAGES - AUTOMATIC BITE ENTRY

General

At start-up on the ground, the primary and secondary FMCs compare this information over the intersystem bus from one FMC to the other:

- Operational flight programs (OFP)
- Navigation data base
- Supplemental navigation data base
- Model/Engine data base
- ACARS datalink data base
- Software options data base
- Analog discretes/program pins
- Performance factors.

Ground Start-up

If the two OFPs do not agree, the primary FMC shows the OP PROGRAM CROSSLOAD page. You use this page to crossload the correct OFP.

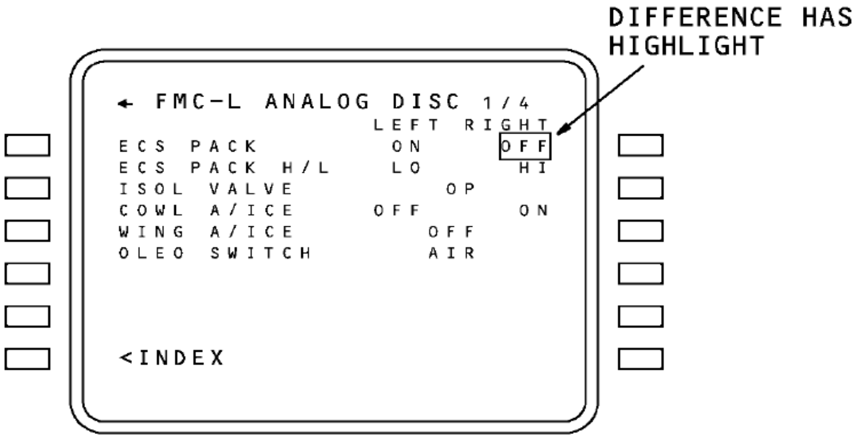
If the databases do not agree, a crossload page for that particular database shows on the CDU.

If an analog discrete/program pin or a performance factor does not agree, the analog discrete or the performance factor page shows. A highlight shows around the item that does not agree.

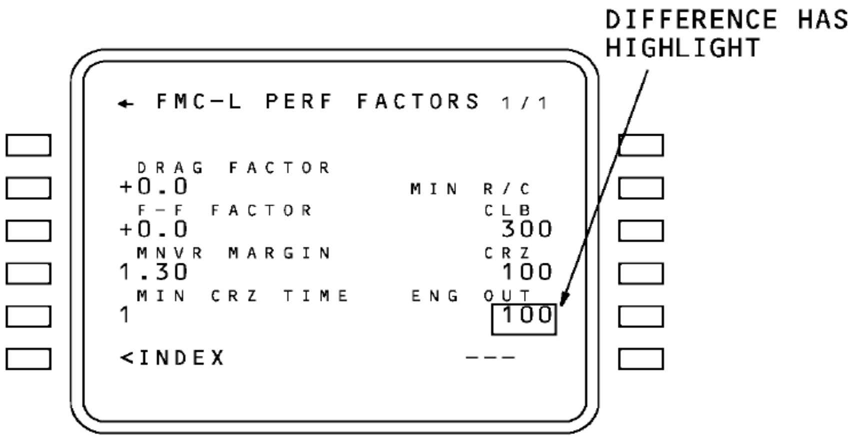
If you exit BITE before corrective action is taken, the secondary FMC is conditionally failed and the message SINGLE FMC OPERATION shows in the scratchpad on the CDUs.

In Flight Restarts

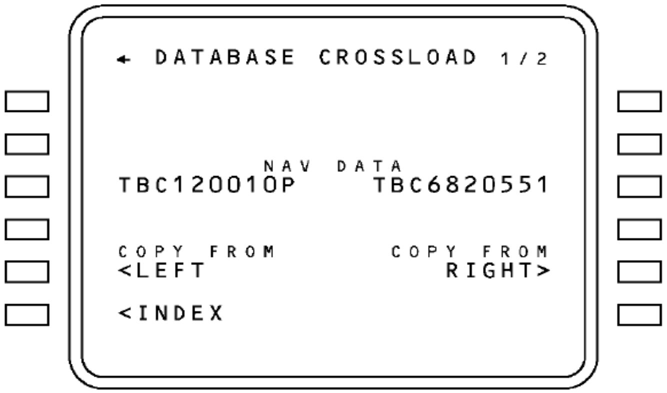
For in flight restarts, the two FMCs also compare their information. If the information does not agree, the secondary FMC is conditionally failed and the message SINGLE FMC OPERATION shows in the scratchpad on the CDUs.



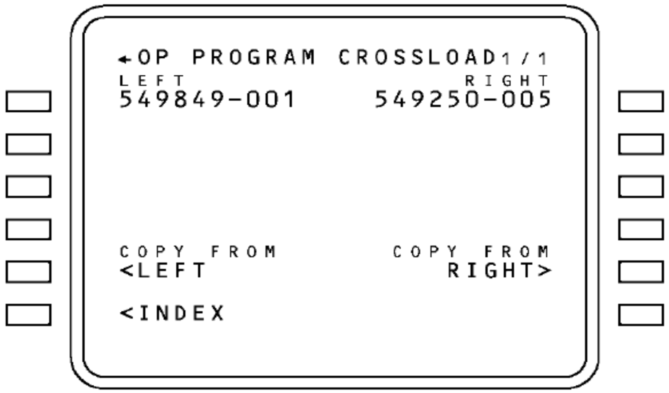
ANALOG DISCRETES
DISAGREE AT POWER UP



PERFORMANCE FACTORS
DISAGREE AT POWER UP



NAV DATABASE
DISAGREE AT POWER UP



OPERATION FLIGHT PROGRAM
DISAGREE AT POWER UP

BITE PAGES – AUTOMATIC BITE ENTRY

BITE PAGES - INFLIGHT FAULT

To see in-flight faults, select INFLT FAULT (LSK 1L) on the FMCS BITE page.

The FMC stores in-flight faults for the last nine flight legs and faults that occur on the ground. The FMC can store up to 20 faults for each flight leg.
A new flight leg starts when the groundspeed is more than 20 knots and the airplane goes into the air mode. The flight stops when the airplane touches down and the groundspeed is less than 20 knots.
Faults that occur on the ground are stored as ground faults. These faults clear from the non-volatile memory in the FMC when the groundspeed is more than 20 knots and the airplane becomes airborne. If the fault is still present at this time, it becomes an in-flight fault.

In-Flight Faults Page

The in-flight faults page shows this data:

- Name of the LRU/sub-system
- Where the fault occurred (in flight or on the ground)
- Fault was recorded by one or both FMCs
- Flight leg when the fault occurred.

All of the LRU/sub-systems that interface with the FMCS show on the IN FLTS FAULTS pages.

These LRU/sub-systems show on pages 1, 2, and 3:

- Air data inertial reference system (ADIRS)
- Digital flight control system (DFCS)
- Distance measuring equipment (DME)
- Fuel quantity indicatng system (FQIS)
- Common display system (CDS)
- VHF omni-directional range (VOR)
- Multi-mode receiver (MMR)
- Clock
- Control display unit (CDU).
- Flight management computer (FMC)
- Printer

The LRU/sub-systems with a failure show one of these letters:

- L (FMC 1)
- R (FMC 2)
- B (FMC 1 and FMC 2).

This shows the FMC that recorded the fault. The alpha-numeric characters at the top of the page show which flight leg the fault occurred in or if it occurred on the ground.

Flight number 1 is the last flight and flight number 9 is 9 flights ago. The letter G shows that the fault was recorded on the ground after the last flight.

Note: Ground faults are FMC and MCDU faults only.

If no faults were recorded by the FMCS for that LRU, the display to the right of the LRU is blank.

Line select key 6L shows the INDEX prompt. This selects the FMCS BITE INDEX page.

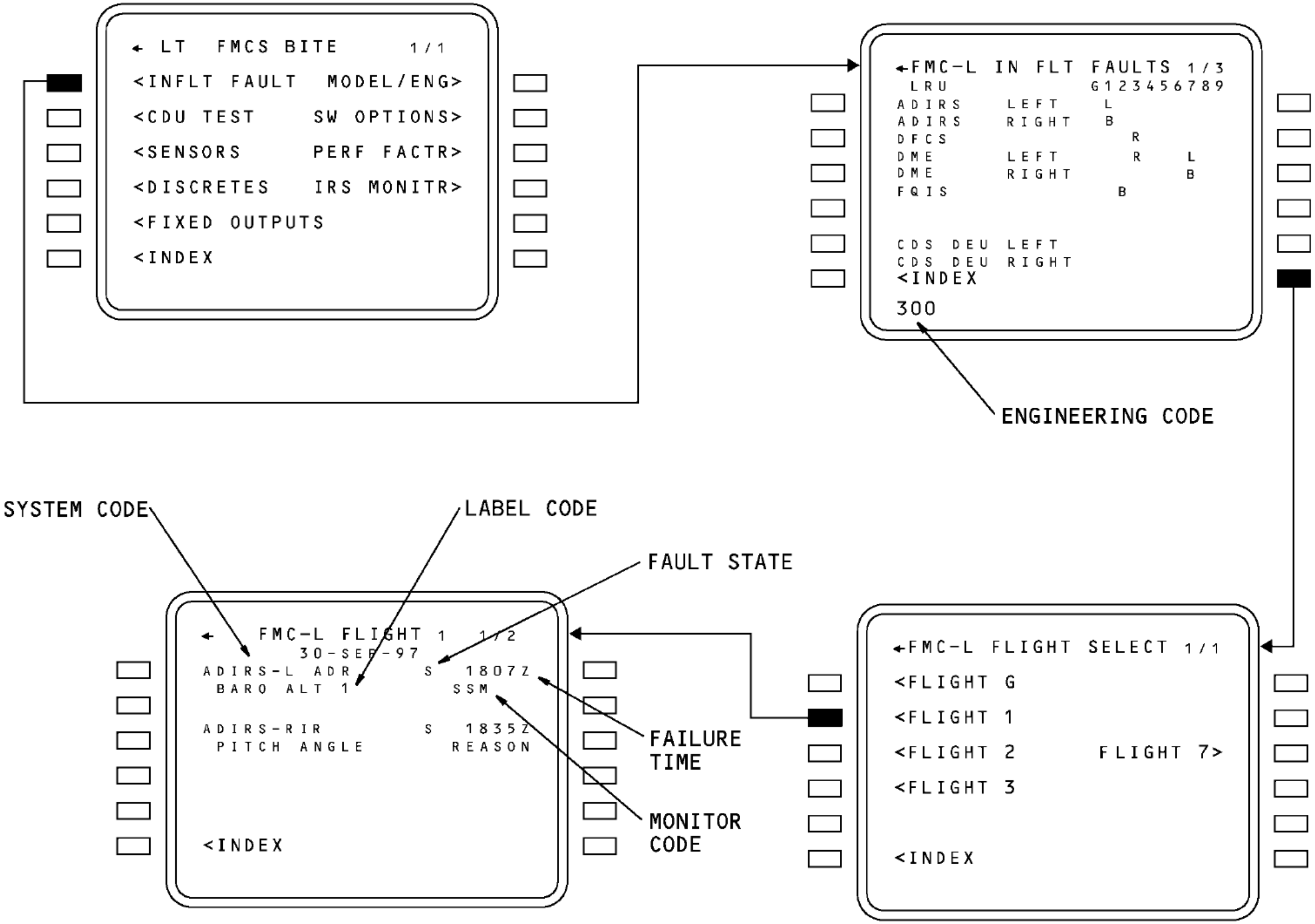
To see more details about the possible LRU failures, you can set the engineering code 300 into the scratch pad and push LSK 6R. This shows the flight select page**.**

Flight Select Page

This page shows a menu of the flight legs that have faults recorded. If no faults were recorded by the FMCS for a particular flight leg, the flight leg does not show on the CDU.

The engineering data can be selected for a particular flight leg or ground fault from this page and show on the FLIGHT page.

Line select key 6L shows the INDEX prompt. This selects the IN FLT FAULTS page.



BITE PAGES – INFLIGHT FAULT

Flight Select Page

This page shows the engineering data for the selected flight leg. The faults show in chronological order.

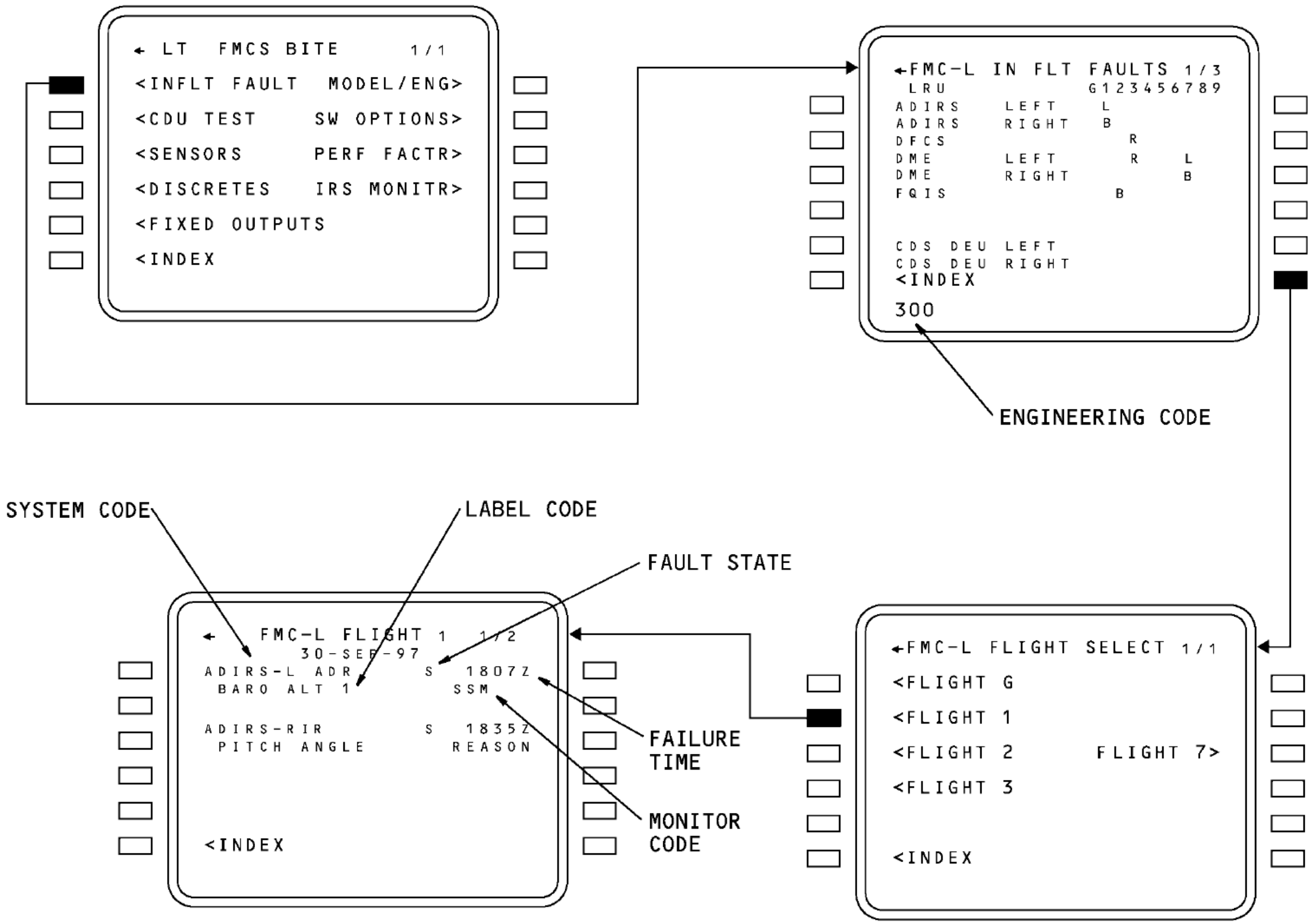
This engineering data shows for each fault:

- System code
- Label code
- Fault state
- Failure time
- Monitor code.

The system code shows the failed LRU or sub-system.
For an FMCS fault, the label code shows the failed circuitry or a program fault in the FMC. For a sensor input fault, the label code identifies the ARINC word with the fault.
Fault condition shows if the fault was steady (S) or intermittent (I). All faults are initially recorded as a steady fault. If the fault goes away, the indication changes to intermittent.
Failure time shows the GMT of the first occurrence of the fault. This time does not change if the fault goes away and then comes back.
For an FMCS fault, the monitor code shows the type of program fault in the FMC. For a sensor input fault, the monitor code shows the specific type of ARINC 429 failure.
These are the monitor codes for ARINC 429 failures:

- Rate (receive rate failure)
- Parity (parity failure)
- SSM (sign/status matrix failure)
- Reason (reasonableness failure).

Line select key 6L shows the INDEX prompt. This selects the FLIGHT SELECT page.



BITE PAGES –FLIGHT SELECT PAGE

THIS PAGE IS INTENTIONALLY LEFT BLANK

BITE PAGES - CDU TEST

General

To test the MCDUs, select CDU TEST on line select key (LSK) 2L, from the FMCS BITE page.

The CDU TEST is an interactive self test that shows the MCDU characters. It also tests the MCDU push buttons and annunciators.

FMCS CDU TEST Page

On this page you can select the CDU DSPLY TEST (LSK 5R) or the CDU KEY TEST (LSK 5L).

FMCS DSPLY TEST Page

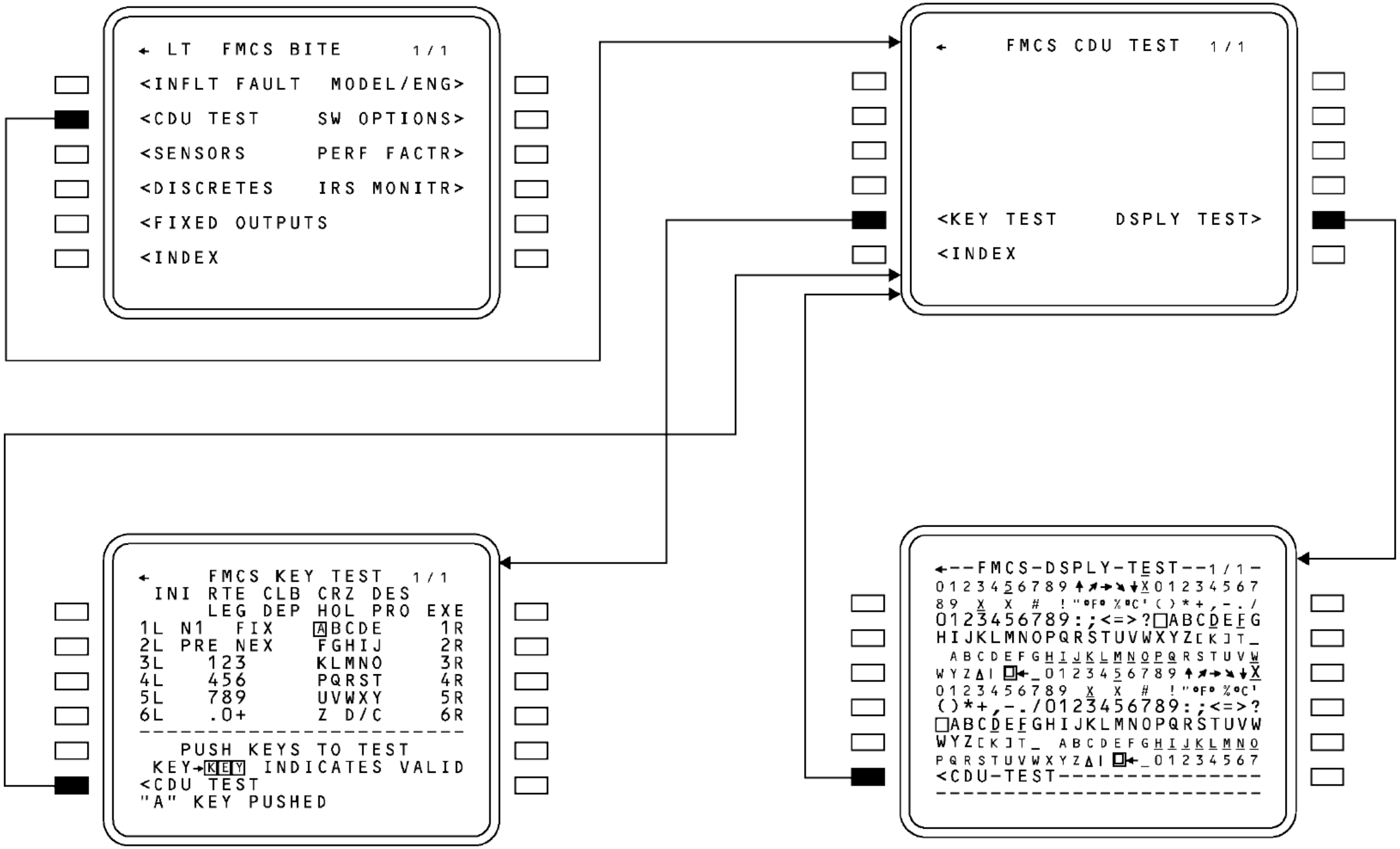
This test shows the complete MCDU character set. Push LSK 6L to go back to the FMCS CDU TEST page.

FMCS KEY TEST

This test shows the MCDU faceplate keys on the MCDU screens. As you push each key on a keyboard, the MCDUs highlight the key on the screen while the scratchpad shows the name of the key you pushed.

When you push LSK 6L the second time, the MCDU goes back to the FMCS CDU TEST page.

When you push the INIT/REF key the second time, the MCDU goes back to the INIT/REF page.



BITE PAGES – CDU TEST

BITE PAGES - SENSORS

To see FMCS sensor status, select SENSORS on line select key (LSK) 3L from the FMCS BITE page.

Sensor Status Pages

The sensor status pages show the current status of all the sensors that send data to the FMC selected as the BITE source.

These systems send data to the FMCS:
- VOR
- DME
- ADIRS
- MMR (ILS & GPS)
- DFCS
- FQIS
- Clock
- FMC
- CDS DEU.

If the two FMCs do not agree on the status of an LRU, a highlight shows around the status field for that IRU. In the example shown on the graphic, FMC L and FMC R do not agree on the status of the right VOR.

Dashed lines in the status field show the LRU does not exist or the FMC selected as the BITE source does not interface with the LRU. In the example shown on the graphic, the DFCS FCC A is the master FCC and it is the FCC that reports DFCS status to FMC 1 and FMC 2.

The elapsed time indication (ETI) shows the current value in hours for the selected FMC. In the example shown on the graphic, the ETI for the left FMC is shown.

To see the engineering data for the current faults, you can set the engineering code 100 in the scratch pad and select LSK 6R. This will show the sensor data pages.

Sensor Data Pages

This page shows engineering data for sensors which have a FAIL status on a SENSOR STATUS page. The faults show in chronological order.

This engineering information shows for each fault:
- System code
- Label code
- Fault state
- Failure time
- Monitor code.

The system code shows the failed LRU or sub-system. The label code shows the ARINC word for the fault.

Fault state shows if the fault was steady (S) or intermittent (I). All faults are initially recorded as a steady fault. If the fault later goes away, the indication changes to intermittent.

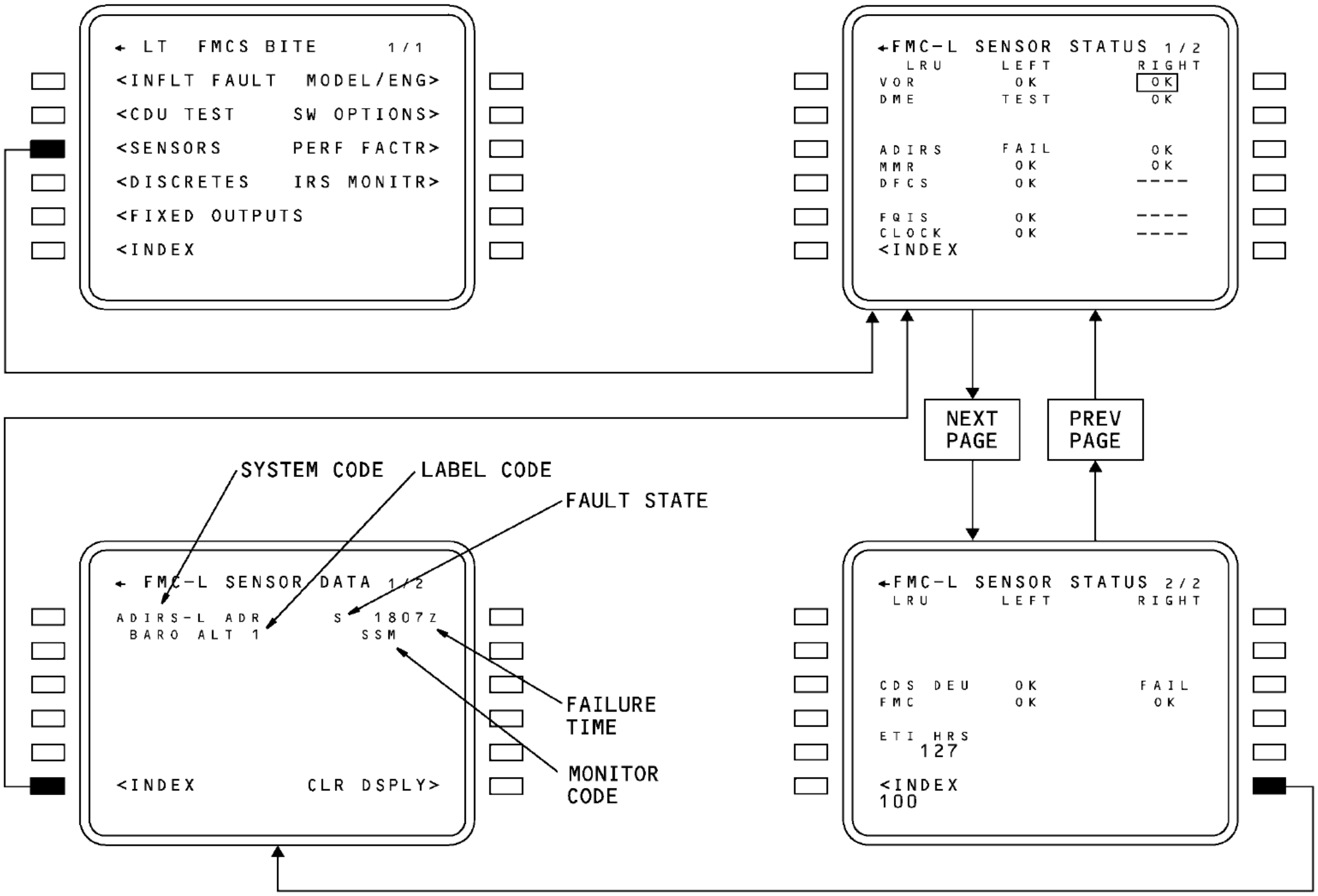
Failure time shows the GMT of the first occurrence of the fault. This time does not change if the fault goes away and then comes back later.

The monitor code shows the specific type of ARINC 429 failure.

These are the monitor codes for ARINC 429 failures:
- Rate (receive rate failure)
- Parity (parity failure)
- SSM (sign/status matrix failure)
- Reason (reasonableness failure).

To clear the screen, push LSK 6R. After you push the key, only engineering data for faults that are still current will show.

The clear key only clears the engineering data for the FMC selected as the BITE source. It does not clear the data for both FMCs.



BITE PAGES - SENSORS

BITE PAGES - DISCRETES

General

To do a check of FMCS discretes status, select DISCRETES on LSK 4L, from the FMCS BITE page.

Discretes Pages

These pages show the current status of the analog discretes that send data to the FMC selected as the BITE source.

If the two FMCs do not agree on the status of a discrete, a highlight shows around the status field for that discrete. In the example shown on the graphic, FMC 1 does not see the right ECS PACK on.

These are the discretes that you can see on page 1:

- ECS PACK. Shows the position of the ECS flow control and shut off valve in each pack.
- ECS PACK H/L. Shows if the pack is in normal or high flow mode.
- ISOL VALVE. Shows the position of the bleed air isolation valve.
- COWL A/ICE. Shows the position of the engine cowl anti-ice switches on the P5 overhead panel.
- WING A/ICE. Shows the position of the wing anti-ice switches on the P5 overhead panel.
- OLEO SWITCH. Shows the airplane in the ground or air modes. This input comes from the proximity switch electronic unit (PSEU).

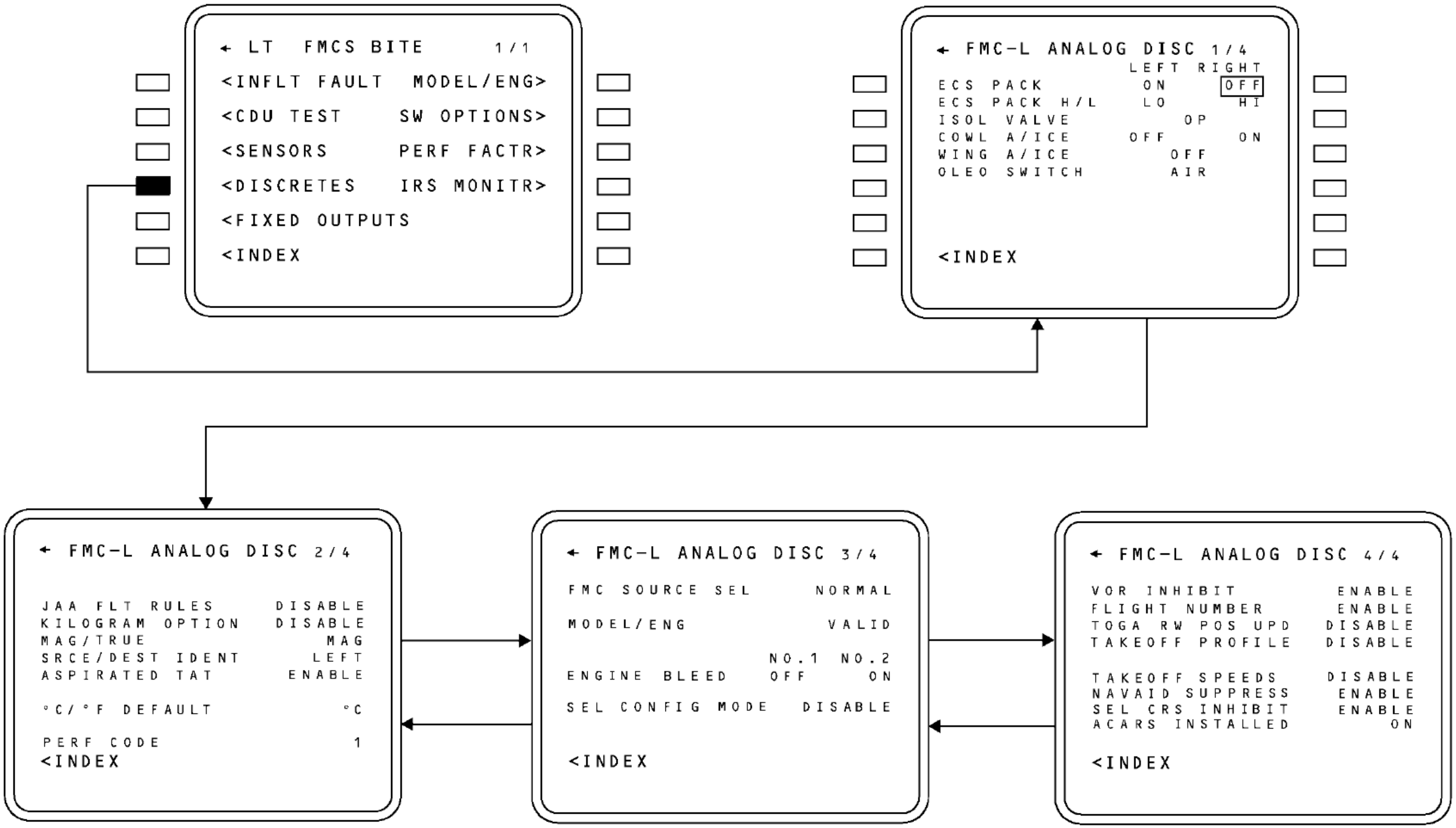
These are the discretes that you can see on page 2:

- FAA/JAA FLIGHT RULES - This option sets the CG for the applicable regulatory flight rules.
- KILOGRAM OPTION - This option sets the default for weight entries on the CDU.
- MAG/TRUE - This option is not used.
- SRCE/DEST IDENT. This option is used to identify the FMC. It is always configured to left.
- ASPIRATED TAT - This option is enabled when an aspirated TAT probe is installed on the airplane.
- DEGREE C/DEGREE F DEFAULT. This option sets the default for temperature entries on the CDU.
- PERF CODE - This option sets the performance code for the FMC. It is normally set to 1.

All the options on page 2 are set with the programmable switch modules.

These are the discretes that you can see on page 3:

- FMC SOURCE SEL. Shows the position of the FMC source select switch on the P5 overhead panel.
- MODEL/ENGINE. Shows the current status of the engine/airframe program pins to the FMC. This is set through the programmable switch modules.
- ENGINE BLEED. Shows the position of the engine bleed air switches on the P5 overhead panel.
- SEL CONFIG MODE. This option enables the loadable software configuration. This is set through the programmable switch modules.



FMCS BITE PAGES - DISCRETES

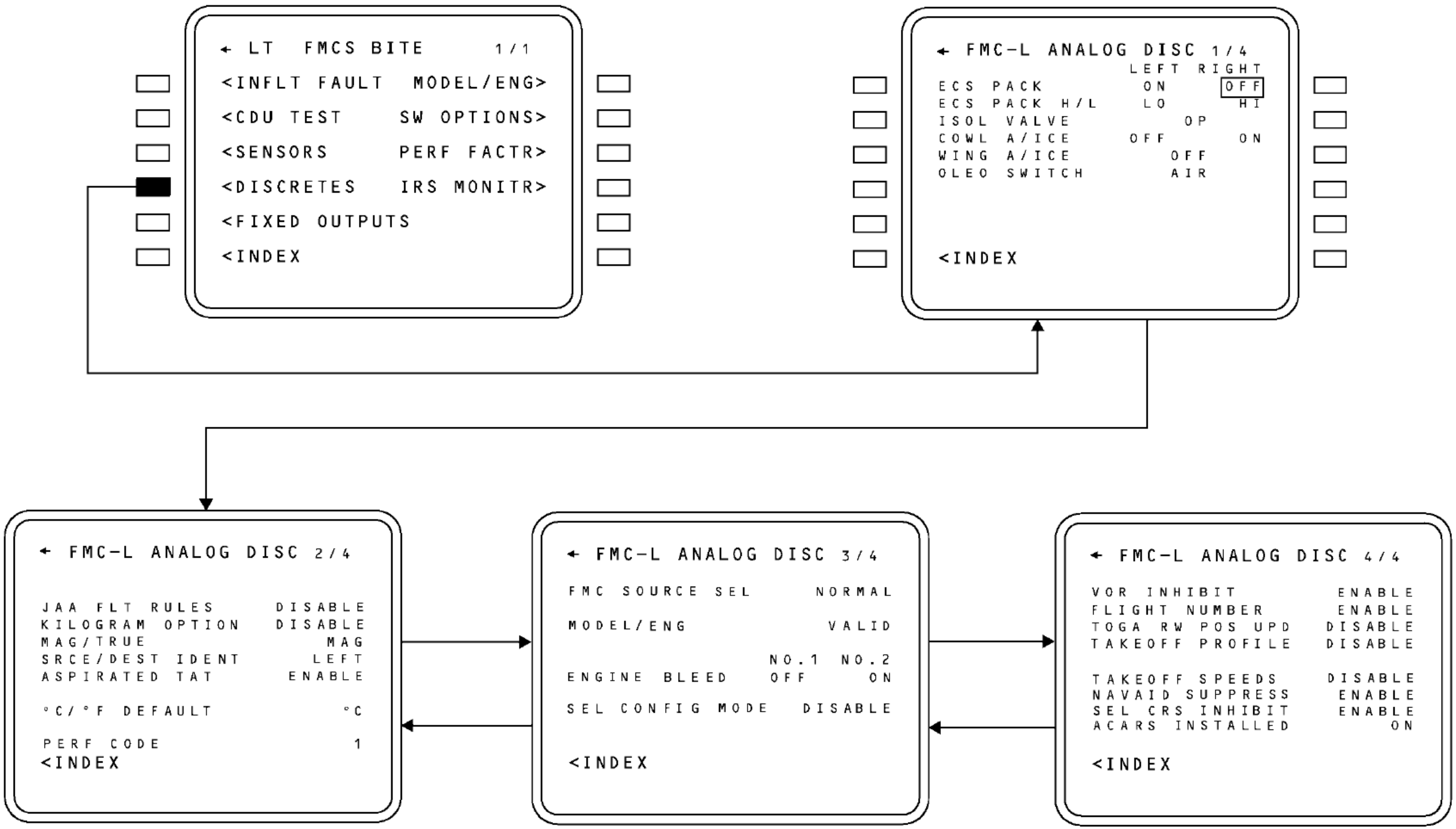
BITE PAGES – DISCRETES
(Continue)

These are the discretes that you can see on page 4:

- VOR INHIBIT - This option disables VOR inputs for the navigation function.
- FLIGHT NUMBER - This option lets the crew enter the flight number on the RTE page.
- TOGA RW POS UPD - This option lets the FMC do a position update when the TOGA switches are pushed on the ground.
- TAKEOFF PROFILE - This option gives FMC control of the altitude at which takeoff thrust is reduced to climb thrust.
- TAKEOFF SPEEDS - This option enables the FMC to calculate the takeoff speeds based on the QRH and shows them on the TAKEOFF page.
- NAVAID SUPPRESS - This option suppresses autotuned navaids on the CDS map display.
- SEL CRS INHIBIT - This option suppresses selected course radials for manually tuned navaids on the CDS map display.
- ACARS INSTALLED - This option enables the ACARS/FMC interface.

All the options on page 4 are set with the programmable switch modules.

Warning: MAKE SURE THAT PERSONS AND EQUIPMENT ARE CLEAR OF THE SLATS BEFORE YOU REMOVE ELECTRICAL POWER FROM THE AIR/GROUND RELAYS. THE SLATS CAN MOVE AUTOMATICALLY WHEN FLAPS ARE IN POSITION 1, 2, OR 5, AND THE NOSE OR MAIN LANDING GEAR AIR/GROUND RELAYS INDICATE AN AIRBORNE CONDITION. THIS CAN CAUSE INJURY TO PERSONS OR DAMAGE TO EQUIPMENT.



FMCS BITE PAGES - DISCRETES

BITE PAGES - FMCS-FIXED OUTPUTS

General

To look at the FMCS fixed outputs, select FIXED OUTPUTS on line select key (LSK) 5L from the FMCS BITE page. The mode selectors on both EFIS control panels should also be set to the MAP mode.

FIXED OUTPUTS Page 1/2

This page shows FMCS data that goes to the thrust mode annunciation (TMA) on the CDS engine display.

The thrust modes show in sequence on the TMA. The word ON shows on the CDUs as each mode comes into view on the TMA.

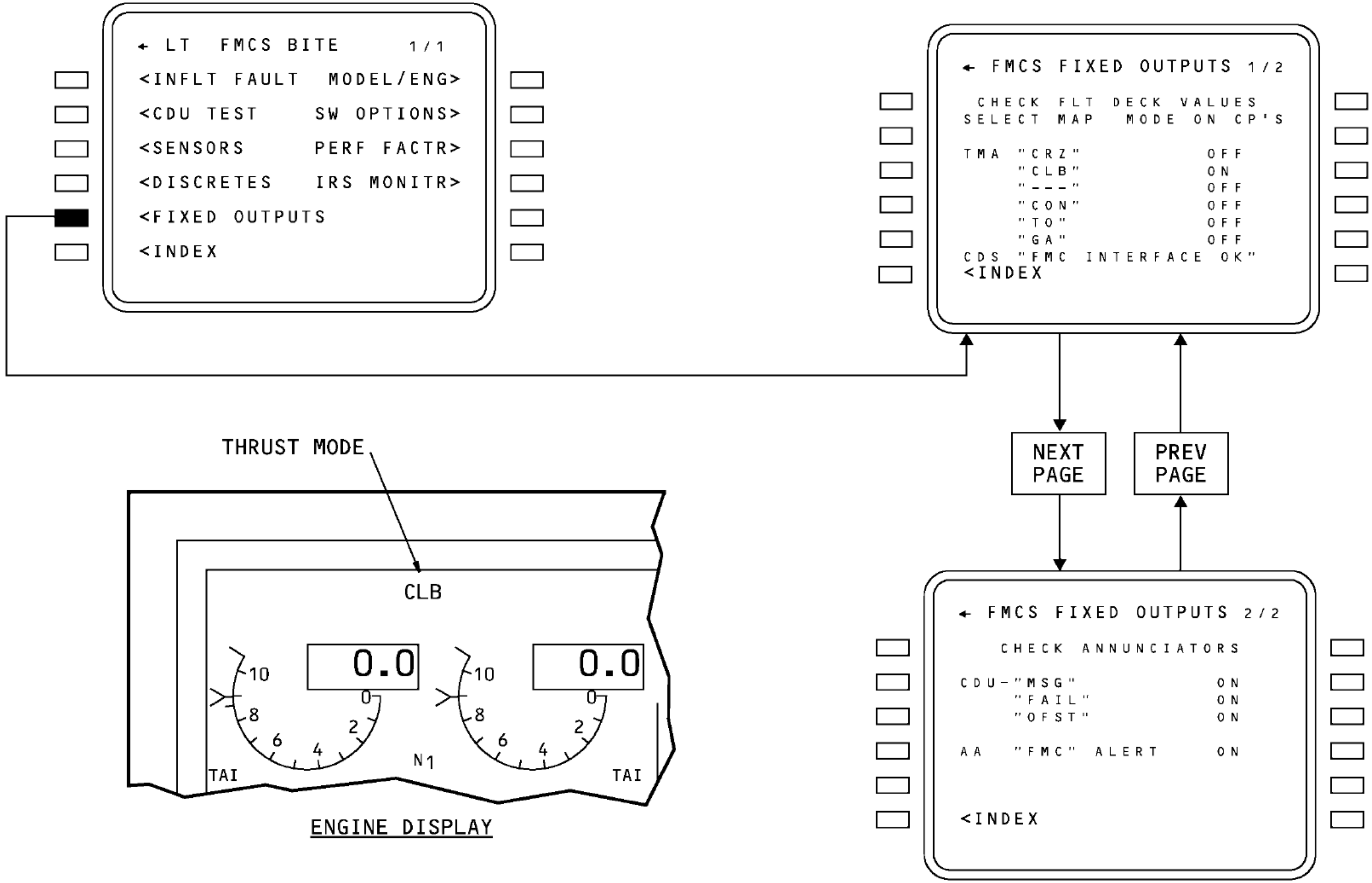
On the CDS navigation displays, the message FMC INTERFACE OK will show.

FIXED OUTPUTS Page 2/2

These CDU annunciators are ON during the FIXED OUTPUTS test:

- MSG
- FAIL
- OFST.

On the autoflight status annunciators (ASA), both FMC annunciators will also be on.



BITE PAGES – FMCS-FIXED OUTPUTS

BITE PAGES – AIRPLANE MODEL AND ENGINE CONFIGURATION

General

The model/engine configuration page shows the airplane and engine configuration. It also shows the engine combustor type and the brake option selected.

The engine ratings will show this data:

- Full rated takeoff thrust
- First takeoff derate thrust
- Second takeoff derate thrust
- Takeoff bump thrust rating (if selected).

If the takeoff derate (TO-1 or TO-2) or the takeoff bump rating do not exist for the selected engine/airframe configuration, NONE will be shown in that thrust data field.

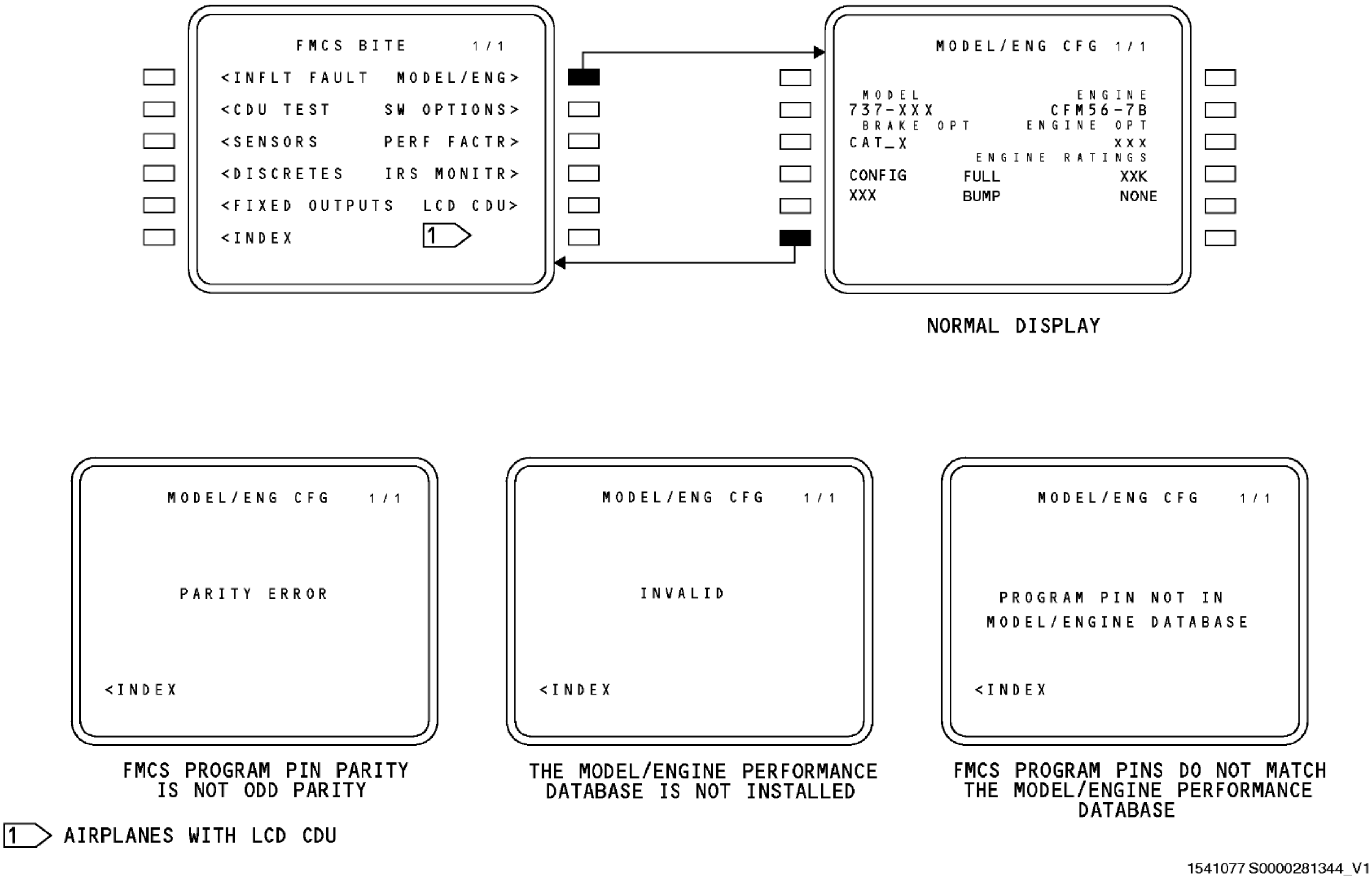
To access this page select MODEL/ENG (LSK 1R) from the FMCS BITE page.

FMC MODEL/ENG Pages

When you power up, the FMC monitors the airframe/engine configuration program pins to make sure the configuration is valid.

If there is a non-normal condition, one of these messages shows:

- Message PARITY ERROR shows if the airframe/engine configuration program pins are not set to odd parity. It also shows for an invalid SDI discrete configuration
- INVALID shows if the model/engine performance database is not installed or the loaded MEDB has failed its validity check
- PROGRAM PIN NOT IN MODEL/ENGINE DATA BASE shows if the airframe/engine configuration program pins do not match the data in the model/engine performance database.



BITE PAGES – AIRPLANE MODEL AND ENGINE CONFIGURATION

BITE PAGES - SOFTWARE OPTIONS

To show the FMCS software options, select SW OPTIONS on line select key (LSK) 3R, from the FMCS BITE page.

Software Option Pages

The software option pages show the status of the options that are in the software options database. The graphics show pages with example options.

PRE SB 737-34-1607

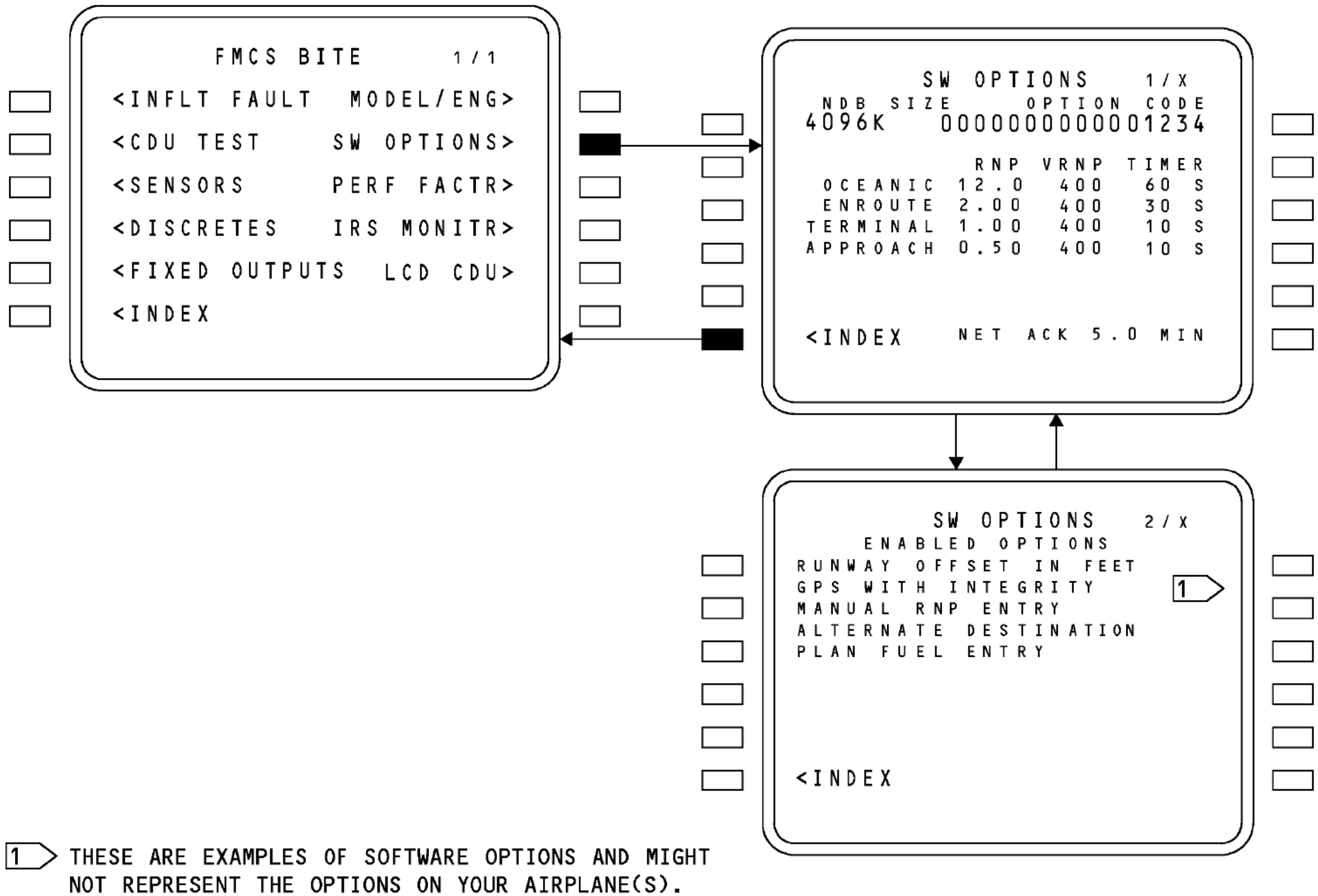
The navigation data base (NDB) size is 2048K words. The default size is 2.5 Mwords or 5.0 Mbytes.

POST SB 737-34-1607

The navigation data base default size is 3.5 Mwords or 7 Mbytes.

The software option code is a 12 (or 16) digit hexadecimal number. To find your option code add each column in the software code (start with the left column).

If your airline did not select any software options, your code is - 000000000000.



BITE PAGES – SOFTWARE OPTIONS

THIS PAGE IS INTENTIONALLY LEFT BLANK

BITE PAGES - PERFORMANCE FACTORS

Purpose

The performance factors page permits the display and entry of performance factors to optimize airplane performance for individual operators or airplane characteristics.

Page Access

You use the PERF FACTR line select key (3R) on the FMCS BITE page to get access to the performance factors page.

This page will automatically show if there is a performance factors mismatch during power-up and it is the only mismatch.

Performance Factors Page

The aerodynamic and engine models in the performance data base are from airplane design and flight test data. Since each production airplane may be different, the FMCS PERF FACTORS page lets the operator make adjustments for some of the factors in the model/engine database.

If the two FMCs do not agree on the value for a performance factor, the factor is highlighted. In the example shown on the graphic, FMC 2 does not agree with the value for the engine out minimum rate of climb.

Line select key 2L shows the DRAG FACTOR value. This is a correction factor applied to drag calculations and is a percentage. The default value is 0.0 and the allowable entry range is - 9.9 to + 9.9

Line select key 3L shows the fuel flow (F-F) value. This is a correction factor applied to fuel flow calculations and is a percentage. The default value is 0.0 and the allowable entry range is - 9.9 to + 9.9.

Line select key 4L shows the maneuver margin (MNVR MARGIN) value. The maneuver margin is used for flight envelope and bank angle calculations. The default value is 1.3g and the allowable entry range is 1.3 to 1.6.

Line select key 5L shows the minimum cruise time (MIN CRZ TIME) value in minutes. This value is a lower limit to the minimum cruise time from the performance data base for trip altitude calculations. The default value is 1.0 and the allowable entry range is 1.0 to 20.

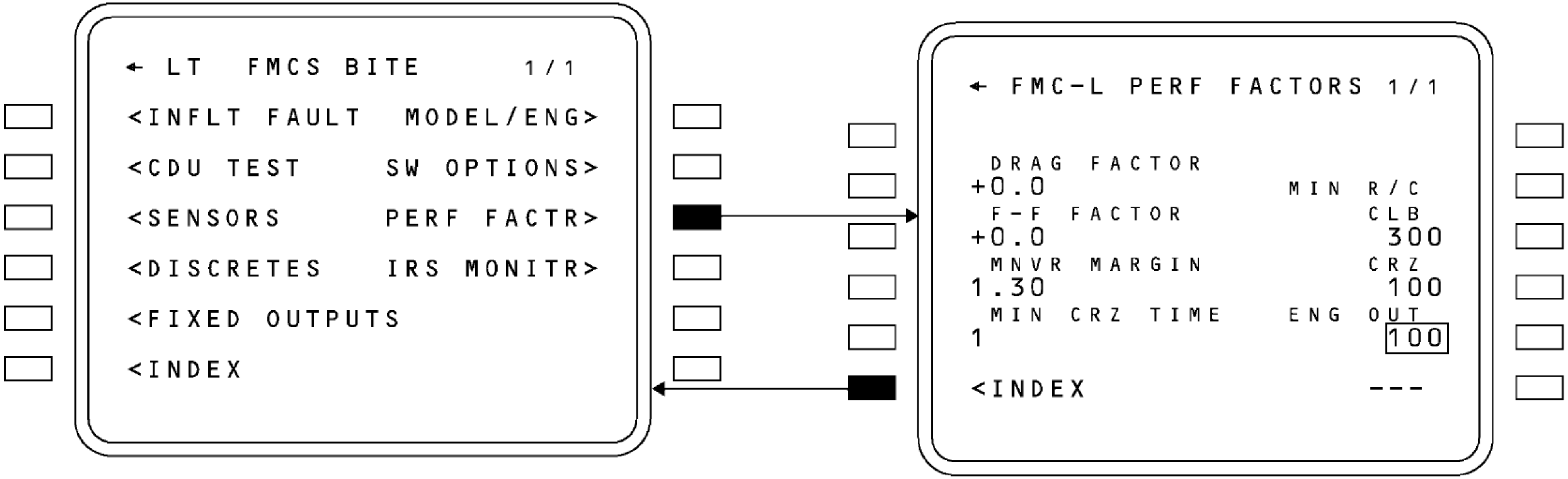
Line select key 6L shows the INDEX prompt. This selects the FMCS BITE page.

Line select key 3R shows the minimum rate of climb (MIN R/C CLB) value in feet/minute. This is a margin for flight envelope calculations at climb speed and maximum climb thrust. The default value is 300 and the allowable entry range is 0.0 to 999.

Line select key 4R shows the minimum rate of climb (MIN R/C CRZ) value in feet/minute. This is a rate of climb margin for flight envelope calculations at cruise speed and maximum cruise thrust. The default value is 300 and the allowable entry range is 0 to 999.

Line select key 5R shows the minimum rate of climb (MIN R/C ENG OUT) value in feet/minute. This is a margin for flight envelope calculations at engine out speed and maximum continuous thrust. The default value is 300 and the allowable entry range is 0 to 500.

Line select key 6R permits the entry of the word ARM. This is a necessary entry to enable data entry on this page. After you enter ARM and push LSK 6R, you may enter the new value into the scratch pad and line select it to the applicable performance factor.



BITE PAGES – PERFORMANCE FACTORS

BITE PAGES - IRS MONITOR

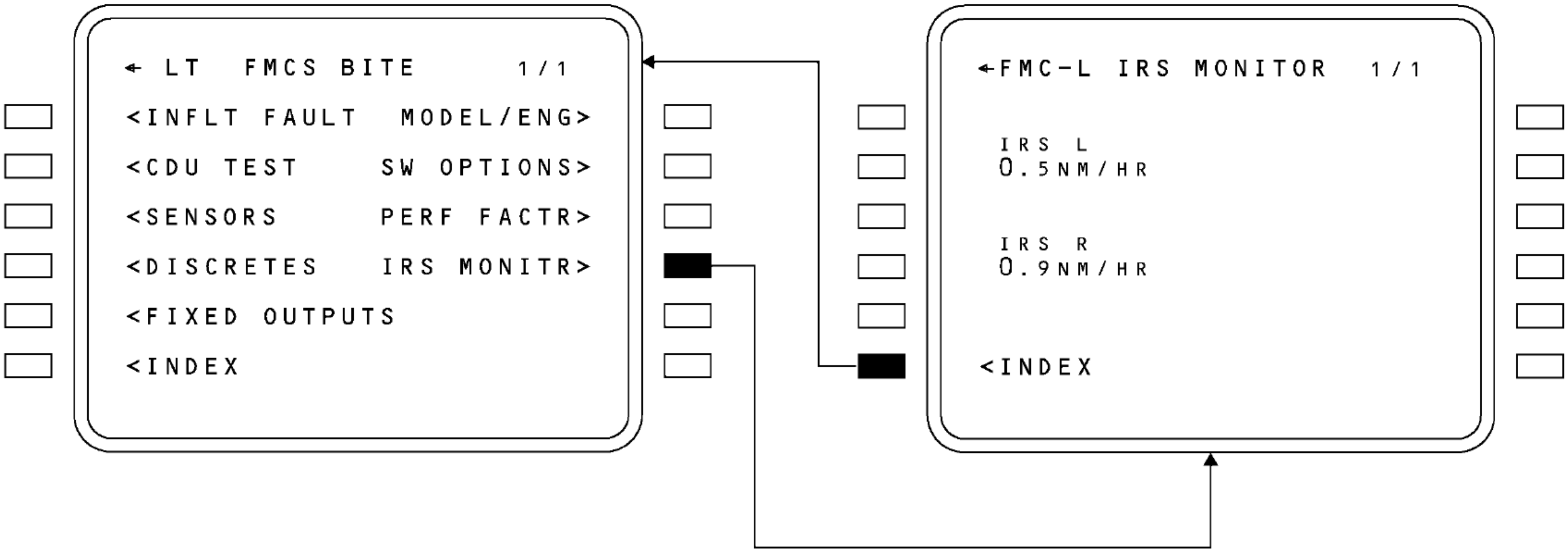
To see the ADIRU inertial reference position error rate, select IRS MONITOR on line select key (LSK) 5R, from the FMCS BITE page.

IRS MONITOR Page

The position error rate (nautical miles per hour) for each ADIRU inertial reference shows at LSK 2L and 5L on this page.

To calculate the position error rate, the FMCS divides the difference between the FMCS position and ADIRU position by the total flight time. The FMCS calculates this error rate at the end of each flight. The display is cleared when the airplane is in the air.

The position error rate will be blank if the ADIRU is not in the NAV mode.



BITE PAGES – IRS MONITOR

BITE PAGES - LCD CDU

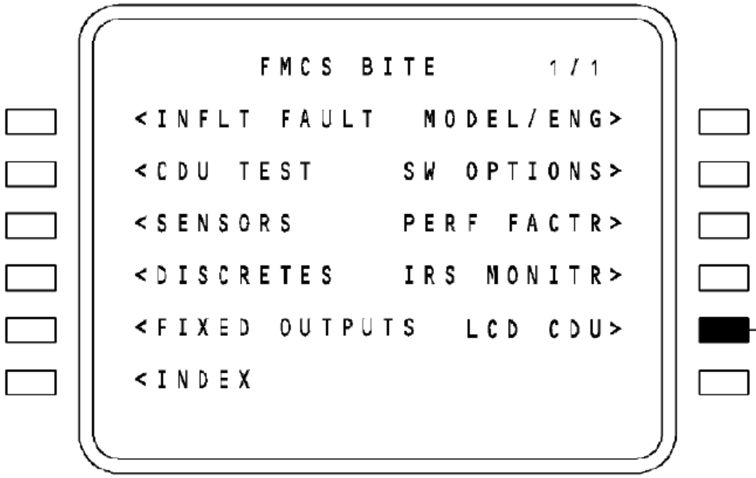
To see the CDU MAINT BITE INDEX page, use the LCD CDU prompt (LSK 5R) on the FMCS BITE INDEX page.

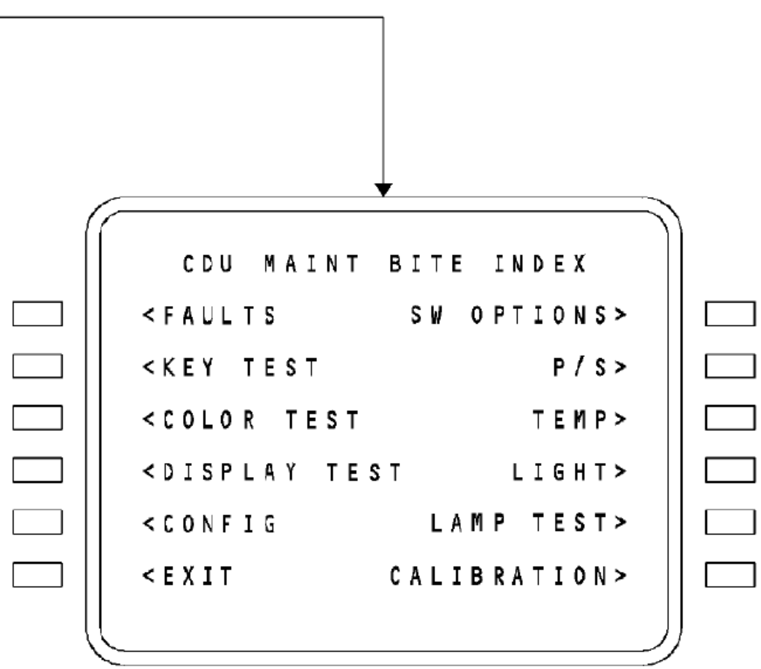
Note: Power supply, temperature, light, lamp test, and calibration are used primarily for bench test of the CDU.

The CDU MAINT BITE INDEX page has these CDU maintenance categories:

- FAULTS
- KEY TEST
- COLOR TEST
- DISPLAY TEST
- CONFIG
- SOFTWARE OPTIONS
- POWER SUPPLY (P/S)
- TEMPERATURE
- LIGHT
- LAMP TEST
- CALIBRATION.

The EXIT prompt (LSK 6L) selects the FMCS BITE INDEX page.





BITE PAGES – LCD CDU

CDU BITE PAGES - FAULTS

General

To see the CDU faults page, first select FAULTS on line select key (LSK) 1L from the CDU MAINT BITE INDEX page. This selects the CDU BITE DISPLY INDEX page.

CDU BITE DISPLAY INDEX Page

This page shows the fault history for the last ten full power-up cycles. When no faults are recorded during a cycle, the data field is blank.

To see the fault data for a specific cycle, select that line select key. This selects the CDU BITE DISPLAY page for that power up cycle.

Line select key 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page.

CDU BITE DISPLAY Page

This page shows the fault data for a specific cycle. Up to a maximum of five faults are recorded per cycle. The header shows the cycle number.

This data shows for each fault:

- Failed unit
- Failure description
- Fault state
- Failure frequency
- Failure time
- Extended fault code.

The failed unit can show FMC, CDU, or USER 1-5 where USER is an airplane sub-system.

These are the failure descriptions that can show:

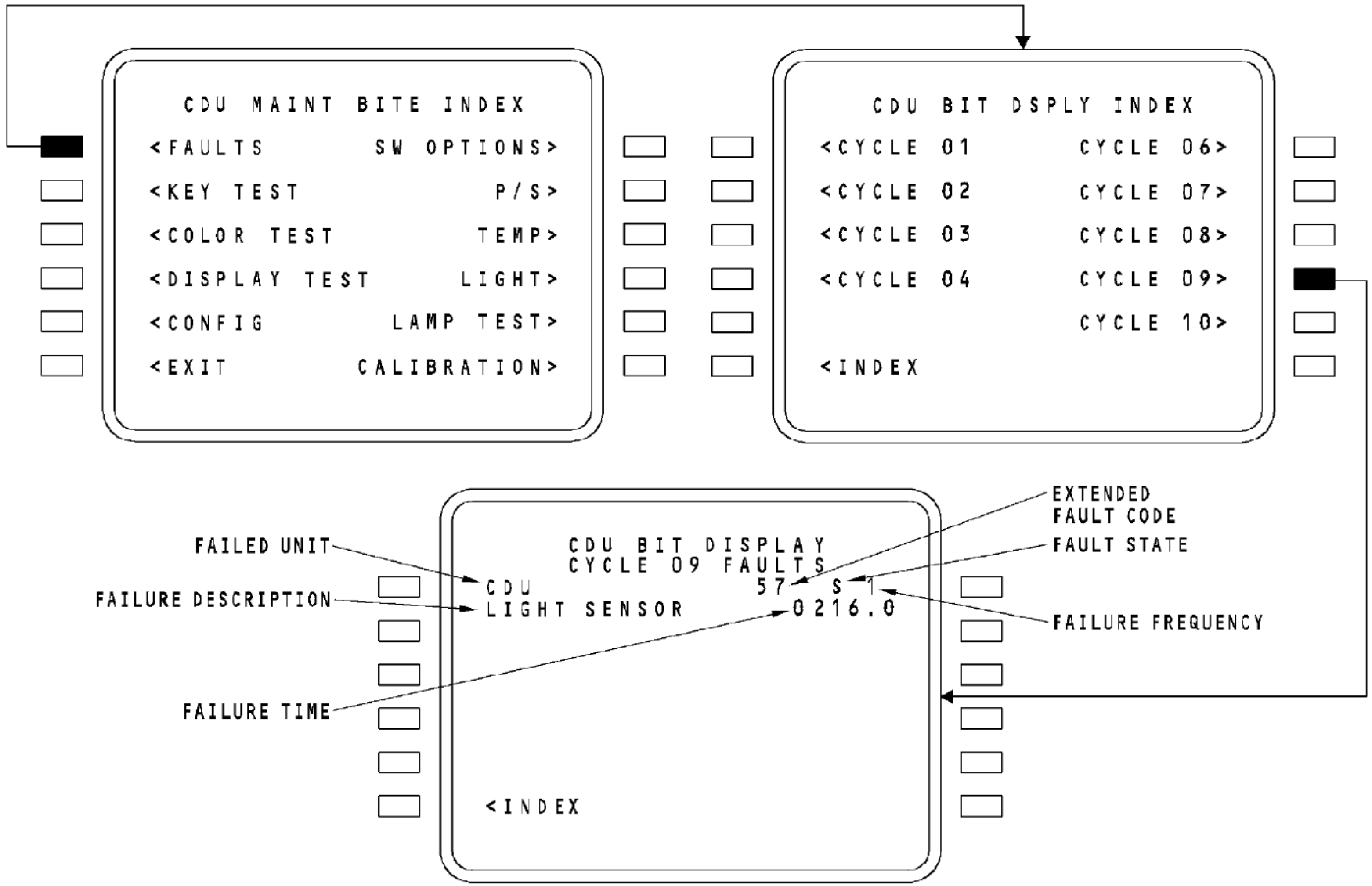
- PROCESSOR
- WATCHDOG TIMER
- 429 FAULT
- ANNUN FAULT
- LCD
- KEYBOARD
- MEMORY
- R/C TIMER (resistor/capacitor)
- POWER SUPPLY
- LIGHT SENSOR
- ADC (analog to digital converter)
- TEMP SENSOR
- FMC FAULT
- SUB-SYSTEM FAULT
- EDC (error detection and correction logic)
- SOFTWARE FAULT
- FONTROM (read only memory).

The fault state shows if the fault is steady (S) or intermittent (I). All faults are initially recorded as a steady fault. If the fault later goes away, the indication changes to intermittent.

The failure frequency shows the number of times the fault occurs.

The failure time shows the CDU elapsed time indication when the fault first occurred.

The extended fault code is used by shop personnel only.



CDU BITE PAGES - FAULTS

CDU BITE PAGES - KEY TEST

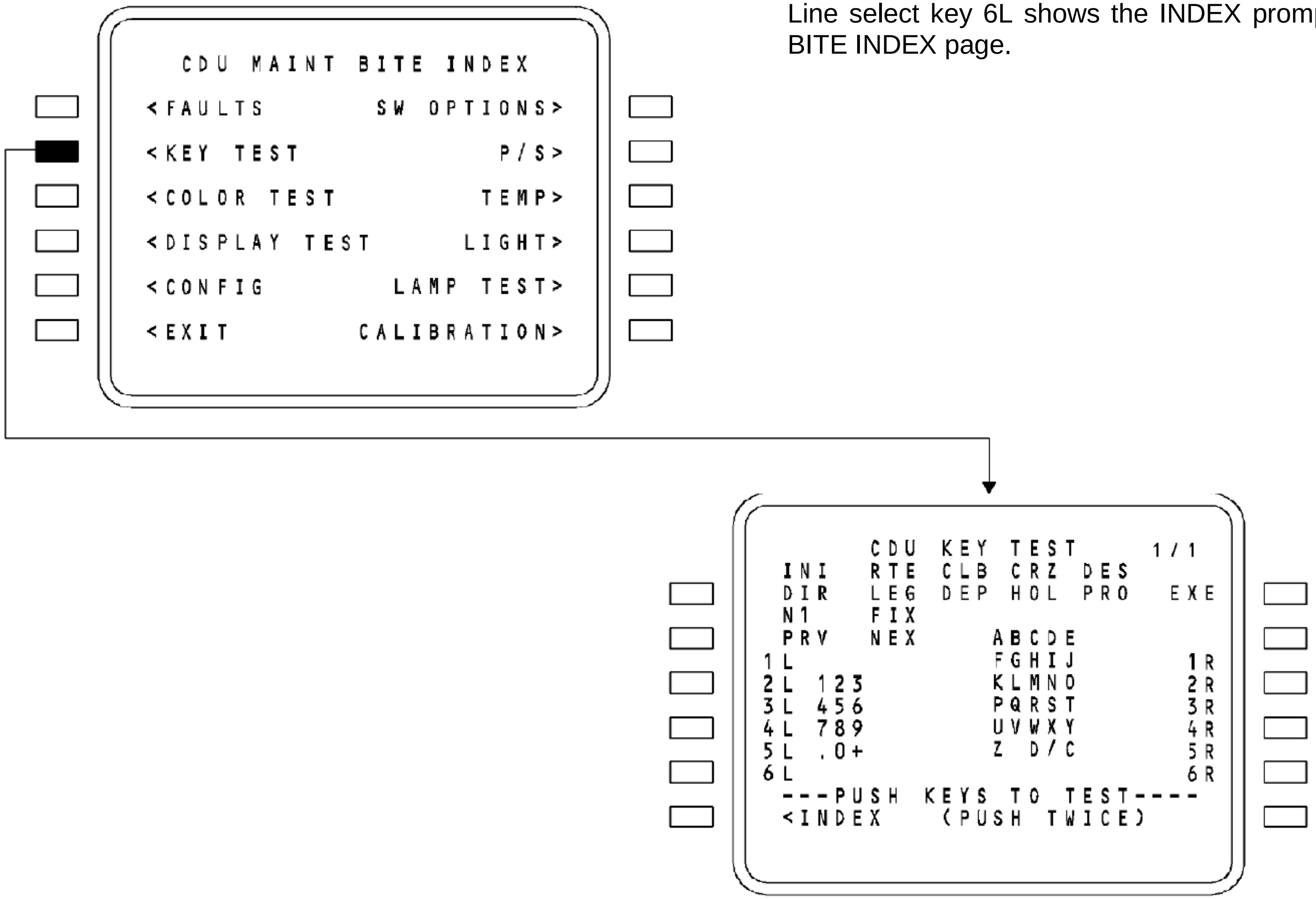
General

To see the CDU KEY TEST page, select KEY TEST on LSK 2L from the CDU MAINT BITE INDEX page.

Key Test Page

This page shows the test displays for the MCDU faceplate keys on the MCDU screens. As you push each key on the keyboard, the corresponding character set will be highlighted (shaded white) on the CDU screen. Push the same key again to return the character set to normal.

Line select key 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page.



CDU BITE PAGES – KEY TEST

CDU BITE PAGES - COLOR TEST

To see the CDU color test page, select COLOR TEST on LSK 3L from the CDU MAINT BITE INDEX page.

Color Test Page

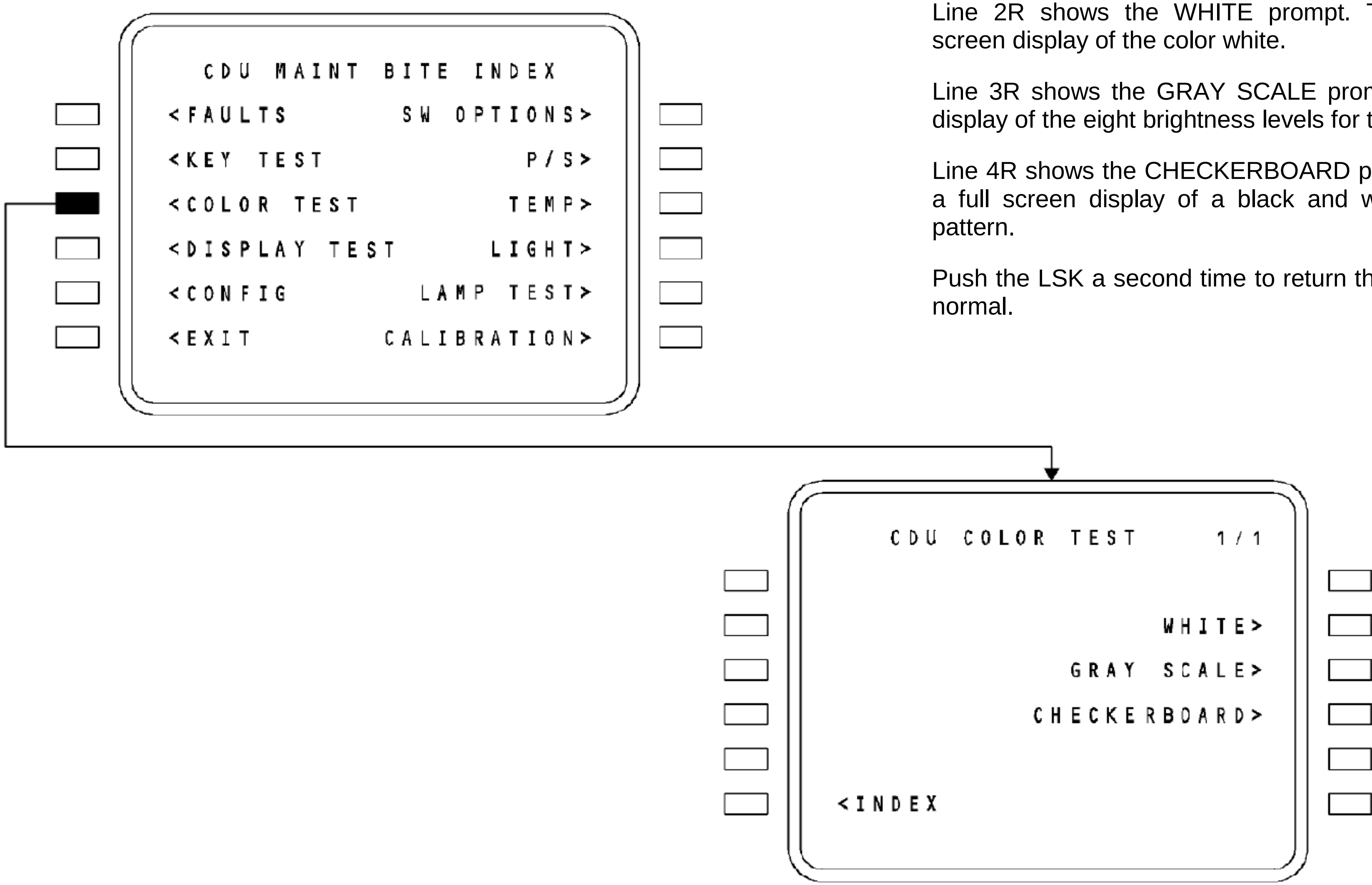
Line 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page.

Line 2R shows the WHITE prompt. This selects a full screen display of the color white.

Line 3R shows the GRAY SCALE prompt. This selects a display of the eight brightness levels for the gray scale.

Line 4R shows the CHECKERBOARD prompt. This selects a full screen display of a black and white checkerboard pattern.

Push the LSK a second time to return the MCDU screen to normal.



CDU BITE PAGES – COLOR TEST

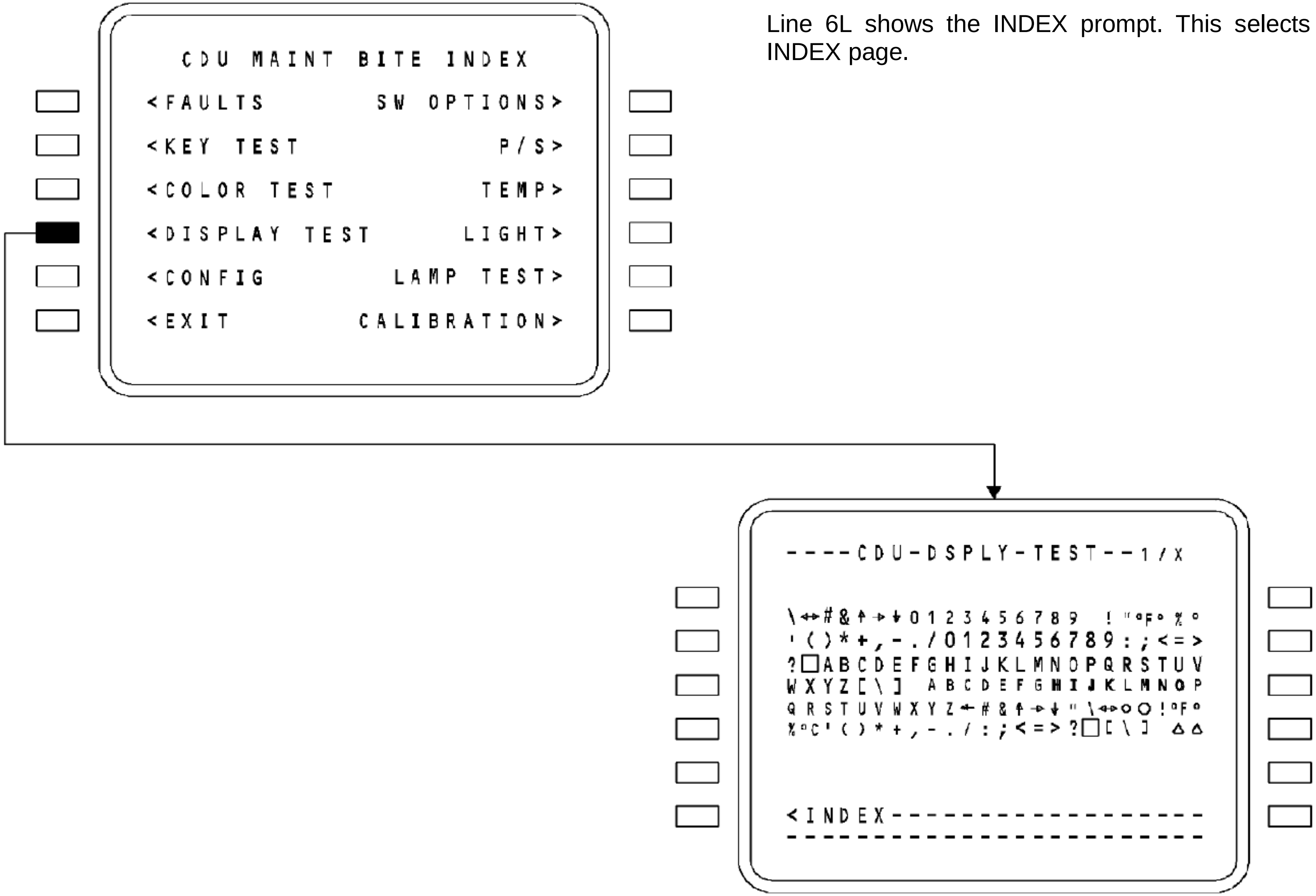
CDU BITE PAGES - DISPLAY TEST

To see the CDU display test page, select the DISPLAY TEST prompt on LSK 4L from the MAINT BITE INDEX page.

Display Test Page

This page shows the complete MCDU character set.

Line 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page.



CDU BITE PAGES – DISPLAY TEST

CDU BITE PAGES - CONFIGURATION

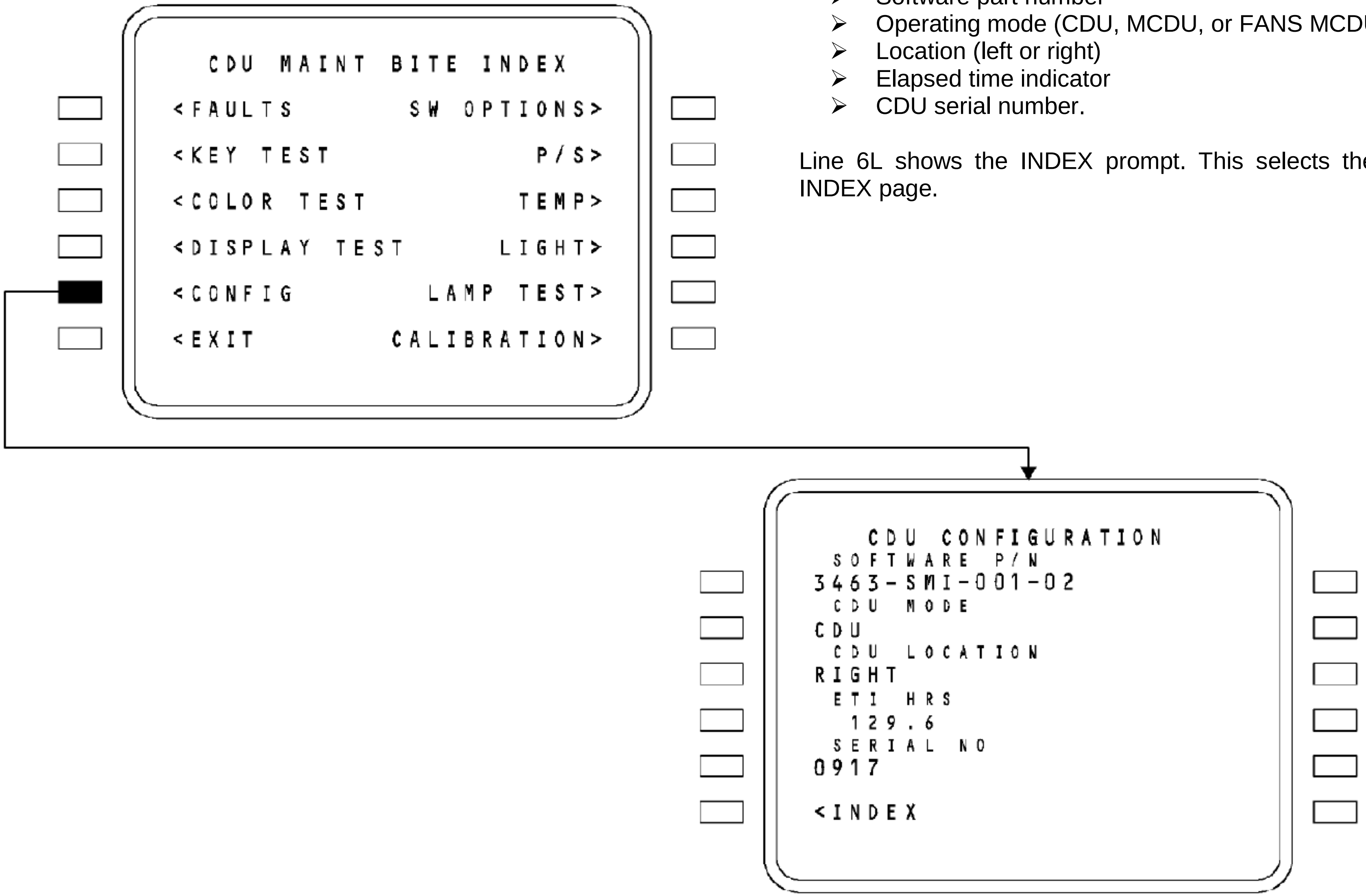
To see the CDU CONFIGURATION page, select CONFIG on LSK 5L from the CDU MAINT BITE INDEX page.

Configuration Page

The CDU CONFIGURATION page shows this information:

- Software part number
- Operating mode (CDU, MCDU, or FANS MCDU)
- Location (left or right)
- Elapsed time indicator
- CDU serial number.

Line 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page.



CDU BITE PAGES - CONFIGURATION

CDU BITE PAGES - SWITCH OPTIONS

General

To see the software options page, select SW OPTIONS on LSK 1R from the CDU MAINT BITE INDEX page.

Software Options Page

The software option page shows the status of the options that are in the CDU software options database.

The software option code is an eight-digit hexadecimal number.

These option codes are available:

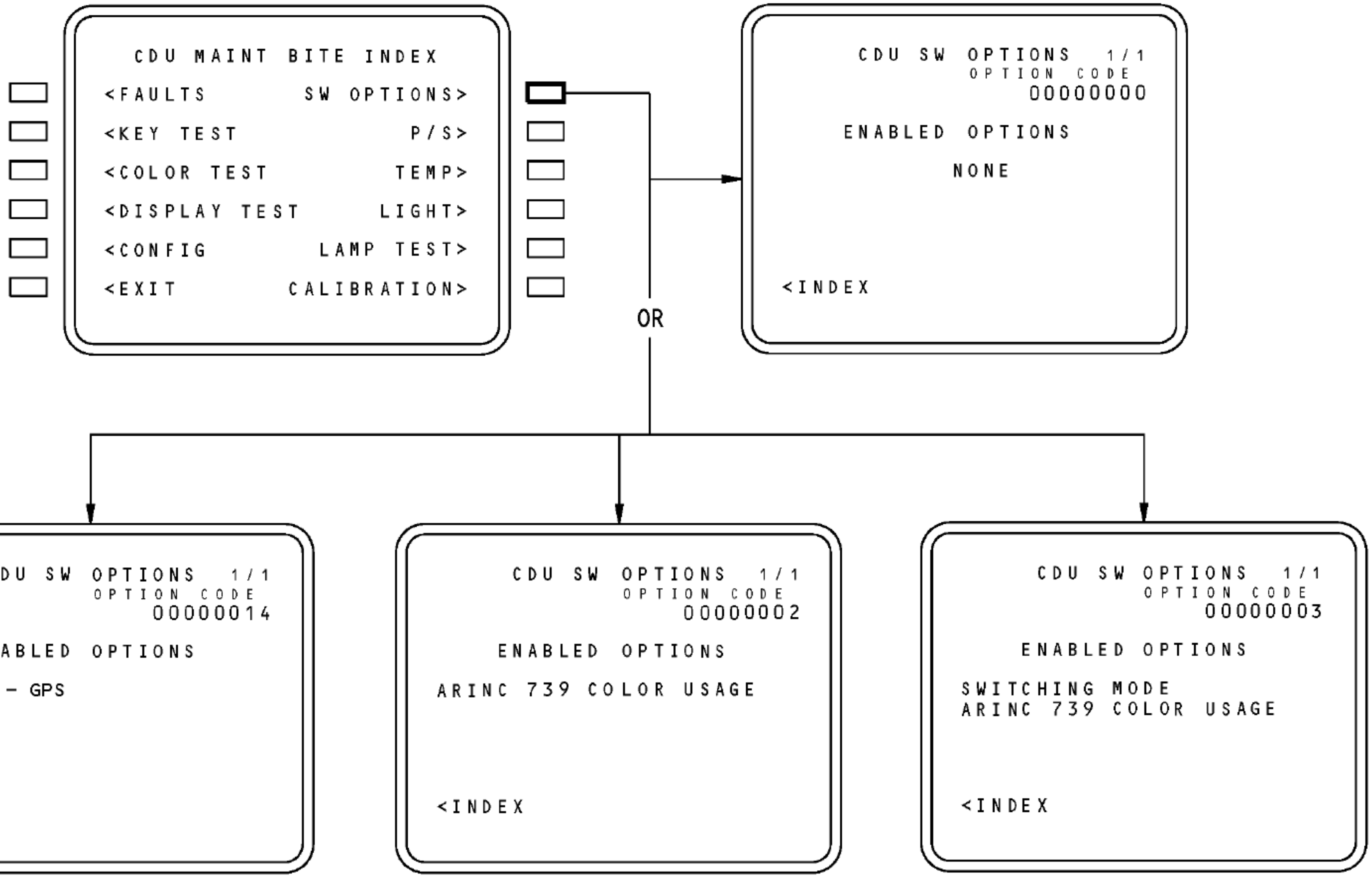
- No option code - 00000000
- Switching mode - 00000001
- ARINC 739 color usage - 00000002
- Switching mode & ARINC 739 color usage - 00000003.

The enabled options show at line 3L. If there are no option codes enabled, NONE shows.

Line 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page.

Line 6R allows the entry of the word ARM. This is a necessary entry to enable software option entry on this page. After you enter ARM and push LSK 6R, you may enter the new software option into the scratch pad and line select it to the option code (LSK 1R).

Note: When you enter an option code, all eight digits must be entered.



CDU BITE PAGES – SWITCH OPTIONS

CDU BITE PAGES - POWER SUPPLY

General

To see the CDU power supply page, select P/S on LSK 2R from the CDU MAINT BITE INDEX page.

Power Supply Page

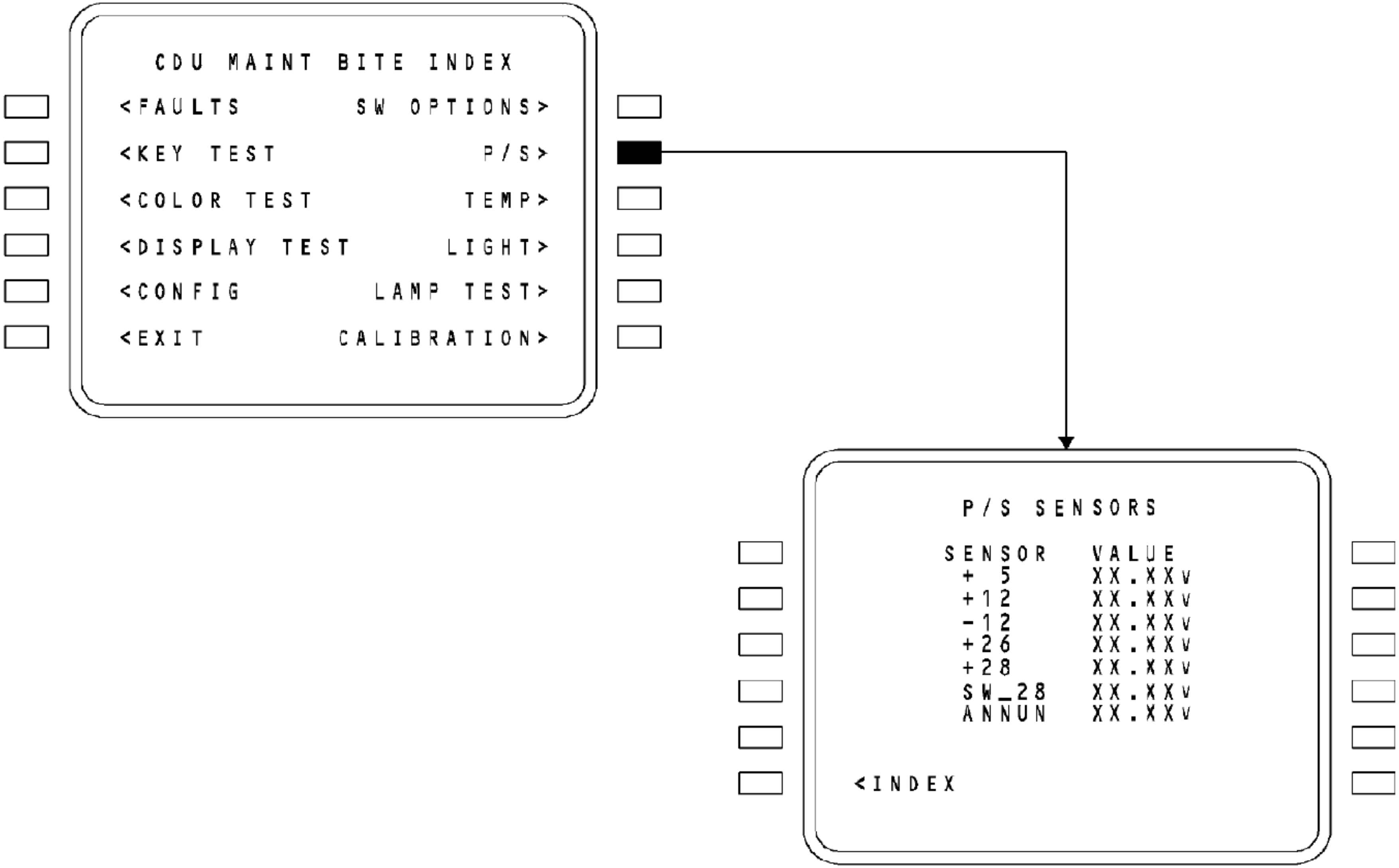
This page shows the voltage levels from the MCDU power supply.

These voltages come the power supply:

- +5v dc
- +12v dc
- -12v dc
- +26v dc
- +28v dc
- Switched +28v dc
- Annunciator +5v dc.

Note: The switched 28v dc power supply is only active when the CDU heater is on and the voltage will be displayed. If the heater is off, the data field will be blank.

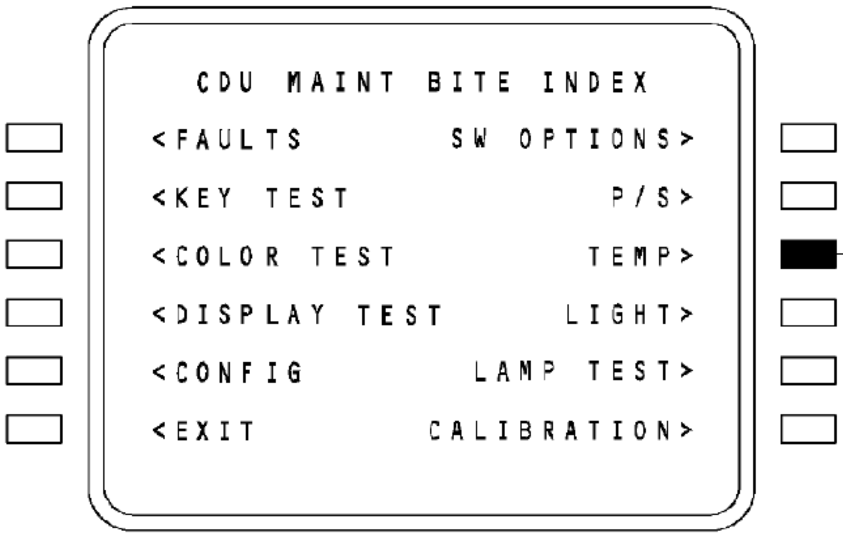
Line 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page.

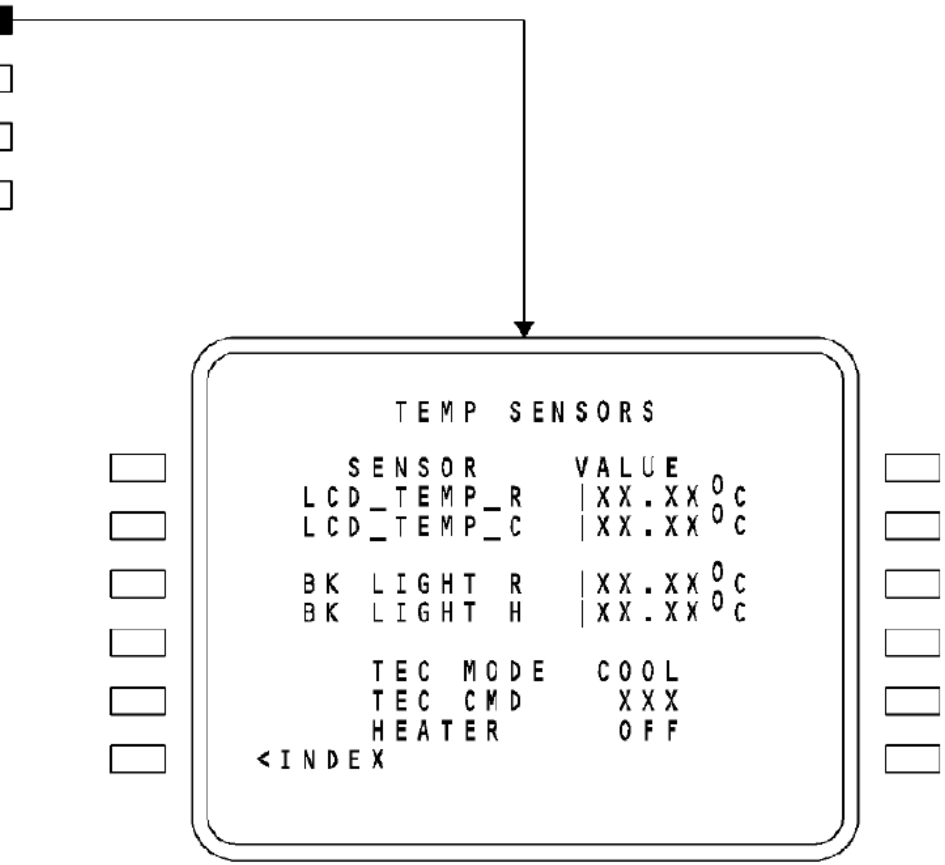


CDU BITE PAGES – POWER SUPPLY

CDU BITE PAGES - TEMPERATURE SENSORS

To see the CDU TEMP SENSORS page, select TEMP on LSK 3R from the CDU MAINT BITE INDEX page.





Temperature Sensors Page

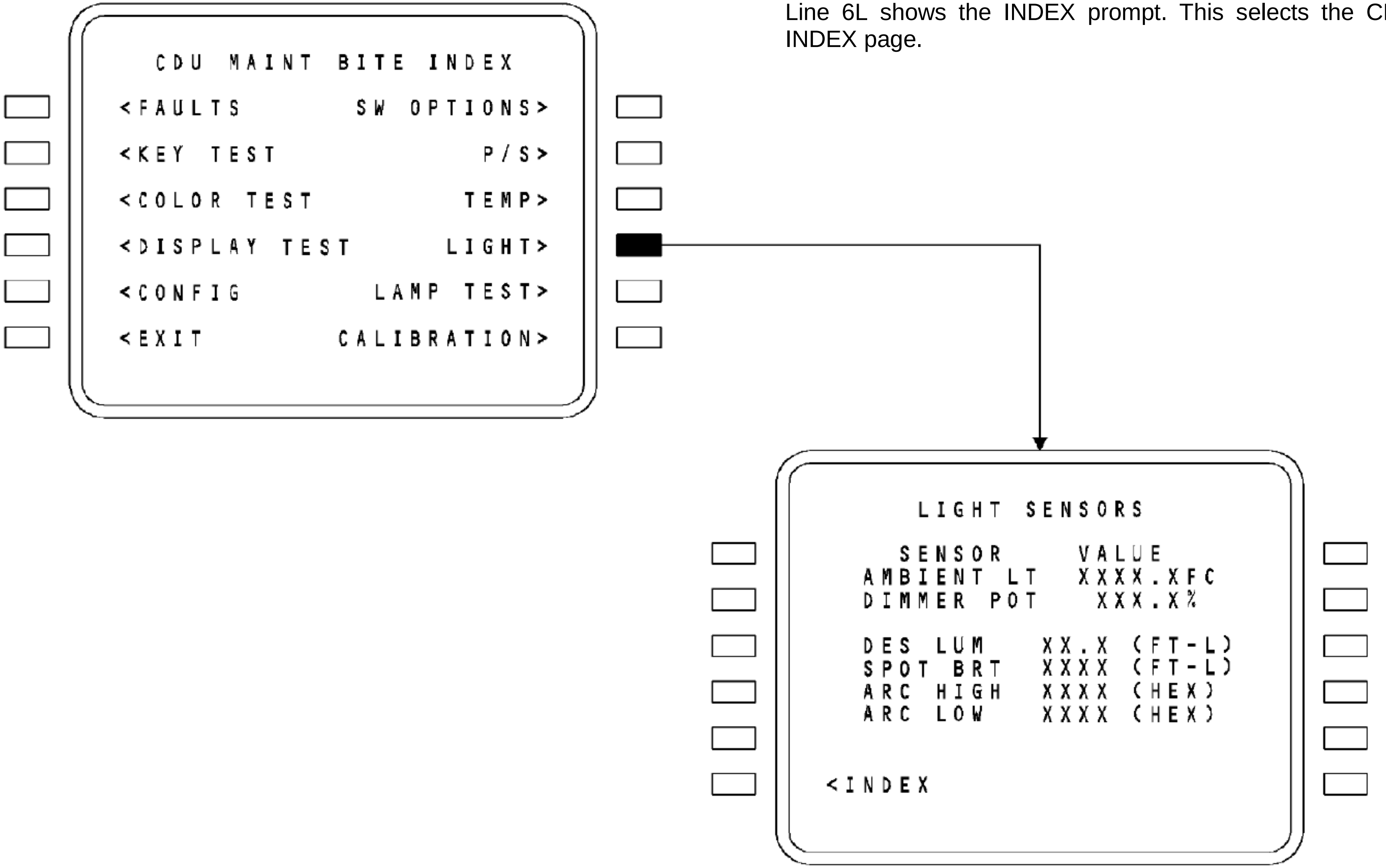
This page shows the temperature values from the sensors in the LCD module and the backlight assembly. It also shows the operational status of the thermal electric coolers (TEC) and the heater.

Line 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page.

CDU BITE PAGES – TEMPERATURE SENSORS

CDU BITE PAGES - LIGHT SENSORS

To see the CDU LIGHT SENSORS page, select LIGHT on LSK 4R from the CDU MAINT BITE INDEX page.



Light Sensors Page

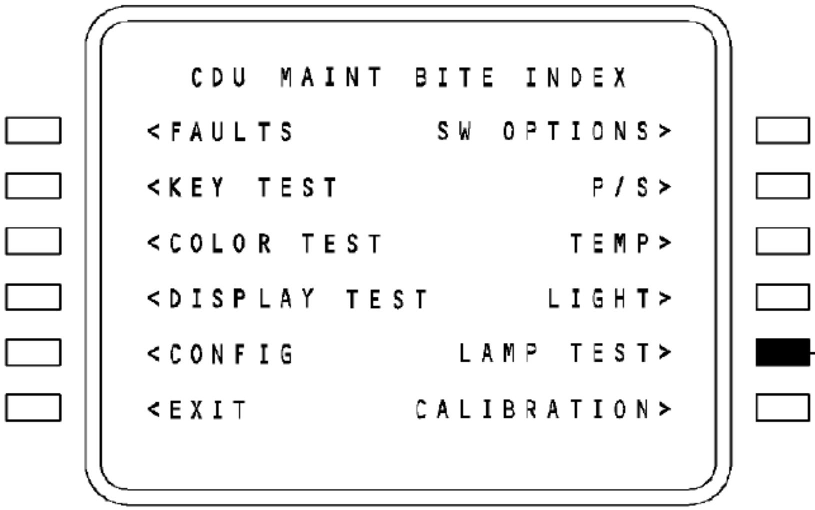
This page shows the voltage levels from the MCDU light sensors.

Line 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page.

CDU BITE PAGES - LIGHT SENSORS

CDU BITE PAGES - LAMP TEST

To see the CDU lamp test page, select LAMP TEST on LSK 5R from the CDU MAINT BITE INDEX page.

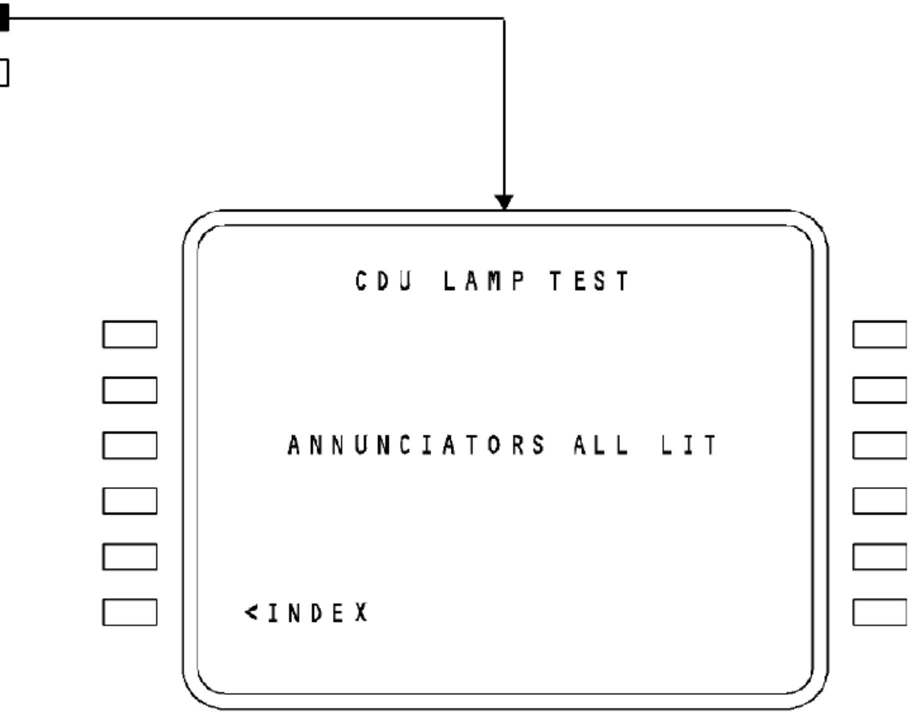


Lamp Test Page

This page does a test of the MCDU annunciators. The message ANNUNCIATORS ALL LT shows on the CDU and these annunciators come on:

- CALL
- FAIL
- MSG
- OFST
- EXEC.

Line 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page and the annunciators go out.



CDU BITE PAGES – LAMP TEST

CDU BITE PAGES - CALIBRATION

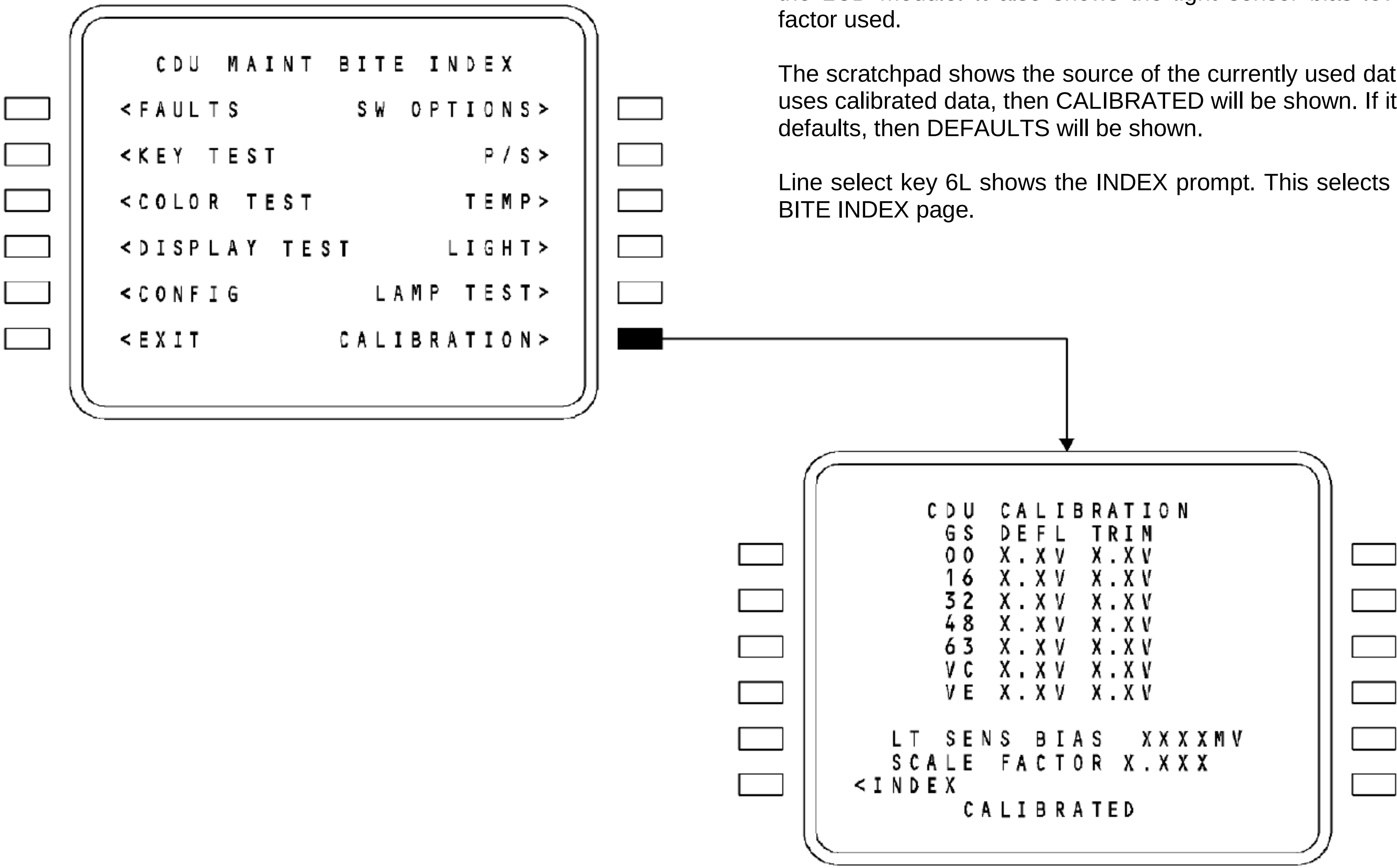
To see the CDU calibration page, select CALIBRATION on line select key (LSK) 6R from the CDU MAINT BITE INDEX page.

Calibration Page

This page shows the current deflection voltages and calibration factors for the LCD module. It also shows the light sensor bias level and the scale factor used.

The scratchpad shows the source of the currently used data. If the software uses calibrated data, then CALIBRATED will be shown. If it uses hardcoded defaults, then DEFAULTS will be shown.

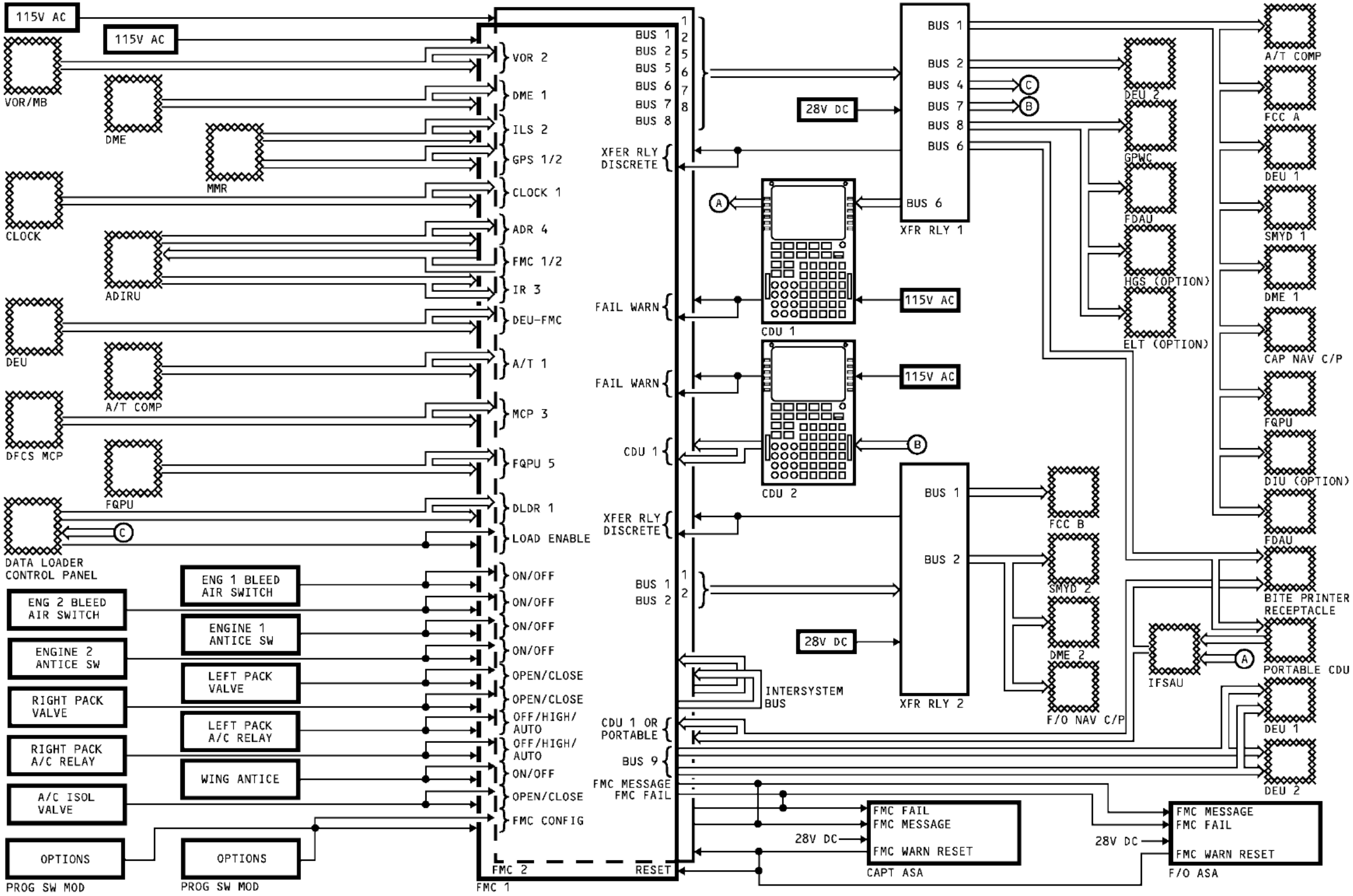
Line select key 6L shows the INDEX prompt. This selects the CDU MAINT BITE INDEX page.



CDU BITE PAGES –CALIBRATION

FMCS - SYSTEM SUMMARY

General



FMCS – SYSTEM SUMMARY