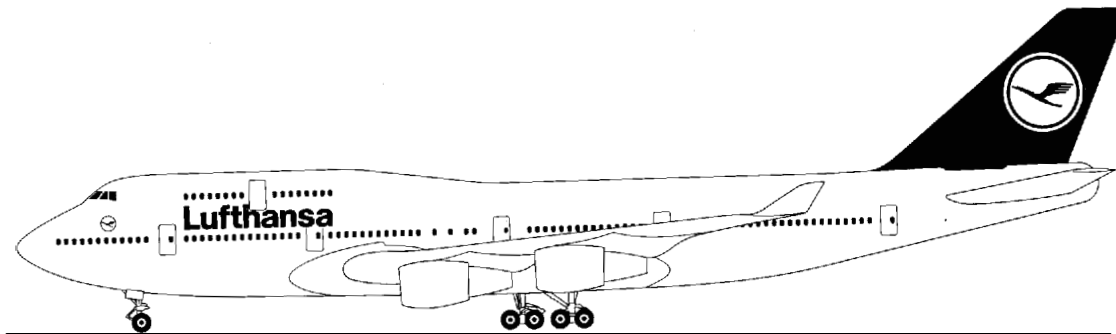




Lufthansa Technical Training

Training Manual B 747-400



ATA 34-21 Inertial Reference System

ATA Spec. 104 Level 3

Book No:

Lufthansa
Technical Training GmbH
Lufthansa Base

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ATA 34-21 INERTIAL REFERENCE SYSTEM

IRS



INERTIAL REFERENCE SYSTEM – INTRODUCTION

The inertial reference system (IRS) provides attitude, heading (magnetic and true), vertical speed, body angular rates, linear accelerations and present position to many airplane avionics systems.

The concept of inertial navigation is that a reference is established (up-down, north-south and latitude-longitude) at the aircraft's parked location. All changes in direction and velocity of the aircraft are measured. These changes are then used to update the reference to produce current attitude, position, speed, heading, etc. No external inputs are required to maintain the reference. The IRS measures airplane movement with accelerometers and laser gyros.

Because the system used on the 747-400 does not provide waypoint or flight plan steering capability, but only present position, the system is called inertial reference system (IRS). This

is the functional difference with the inertial navigation system (INS) used on earlier airplanes. The IRS uses a strapped-down platform for mounting the sensors, eliminating the gimbaled platform used in the INS. The IRS uses a computer program to keep track of the required angles that the gimbals provided in the INS. The IRS uses laser gyros, in place of the electro-mechanical gyros used in the INS. These changes eliminated many moving parts and sources of error. The IRS is significantly smaller, lighter, more reliable and uses less power than the INS.

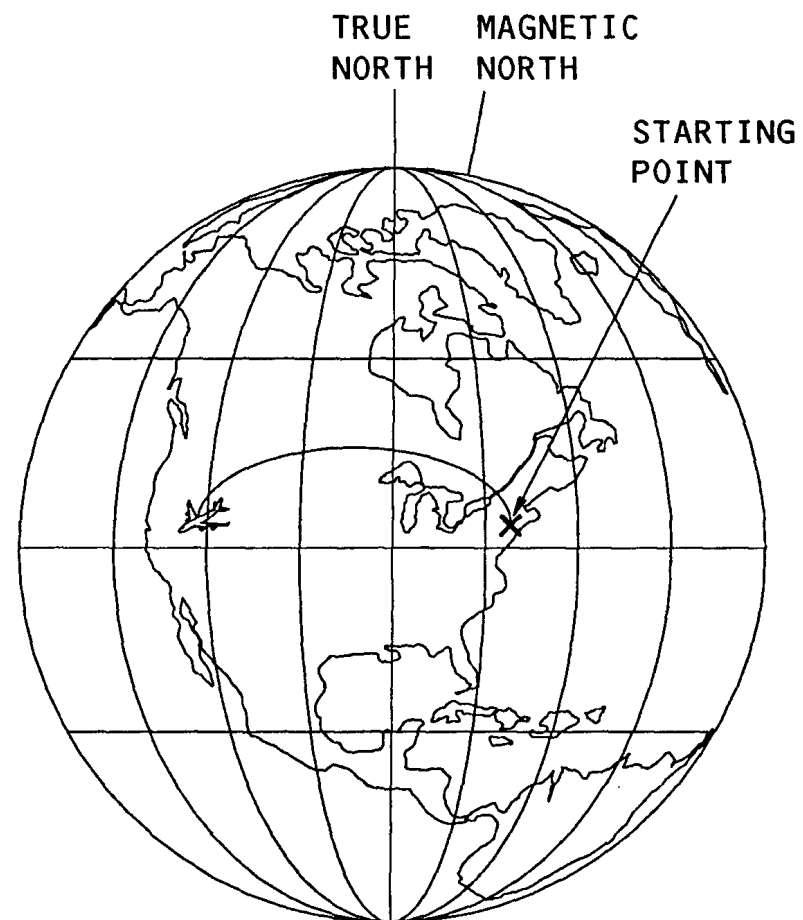
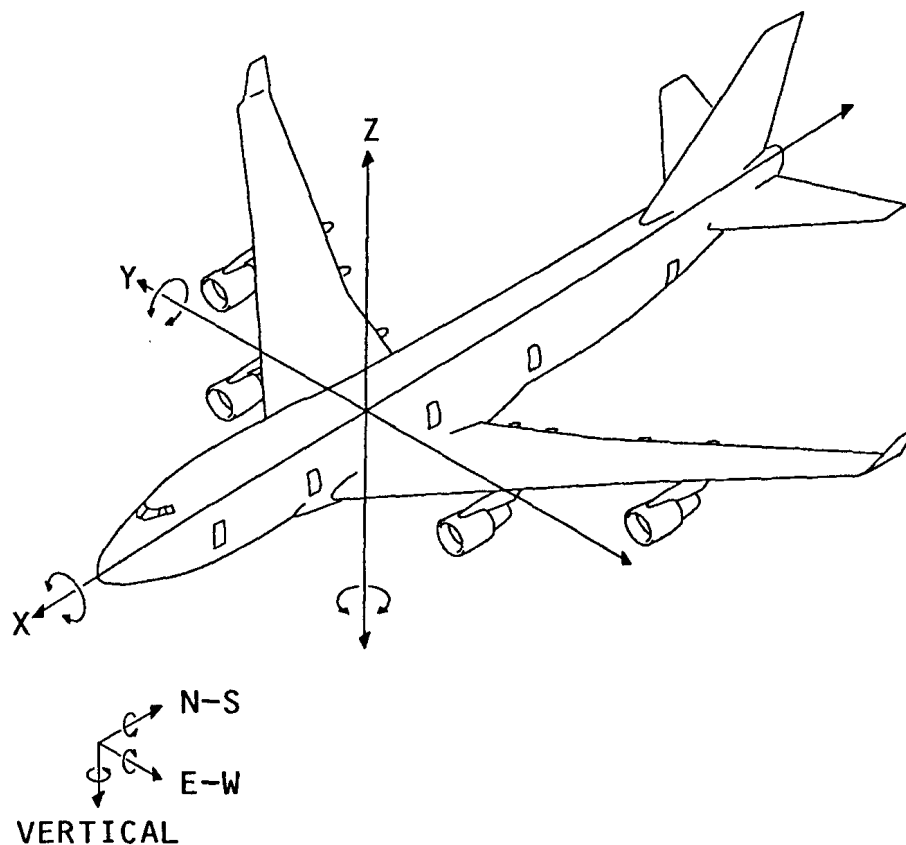
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- ATTITUDE
- HEADING
- VERTICAL SPEED
- ANGULAR RATES
- LINEAR ACCELERATIONS
- PRESENT POSITION

**Figure 1 INERTIAL REFERENCE SYSTEM – INTRODUCTION**

IRS



INERTIAL REFERENCE SYSTEM

The inertial reference system provides the data required for airplane control and navigation.

An inertial reference system consists of:

- Three inertial reference units (IRUs)
- One mode select unit (MSU)

The IRU receives inputs from:

- Air data computers (ADCs)
- Flight management computers (FMCs)
- Mode select unit
- Central Maintenance computers (CMC's)

The IRU operates in these modes:

- - Off
- - Align
- - Navigate
- - Attitude

The IRU sensors and microprocessors provide:

- Attitude and attitude rate
- Accelerations (3 axes)
- Heading (magnetic and true)
- Velocities (horizontal and vertical)
- Navigational information (position, track, ground speed, wind)

Data from each IRU is sent to the integrated display system (IDS) and the user systems on three data buses which contain identical data.

The IRU continuously monitors and tests internal operation and reports status to the central maintenance computers (CMCs), through the IDS. The CMCs can start the IRS interface test.

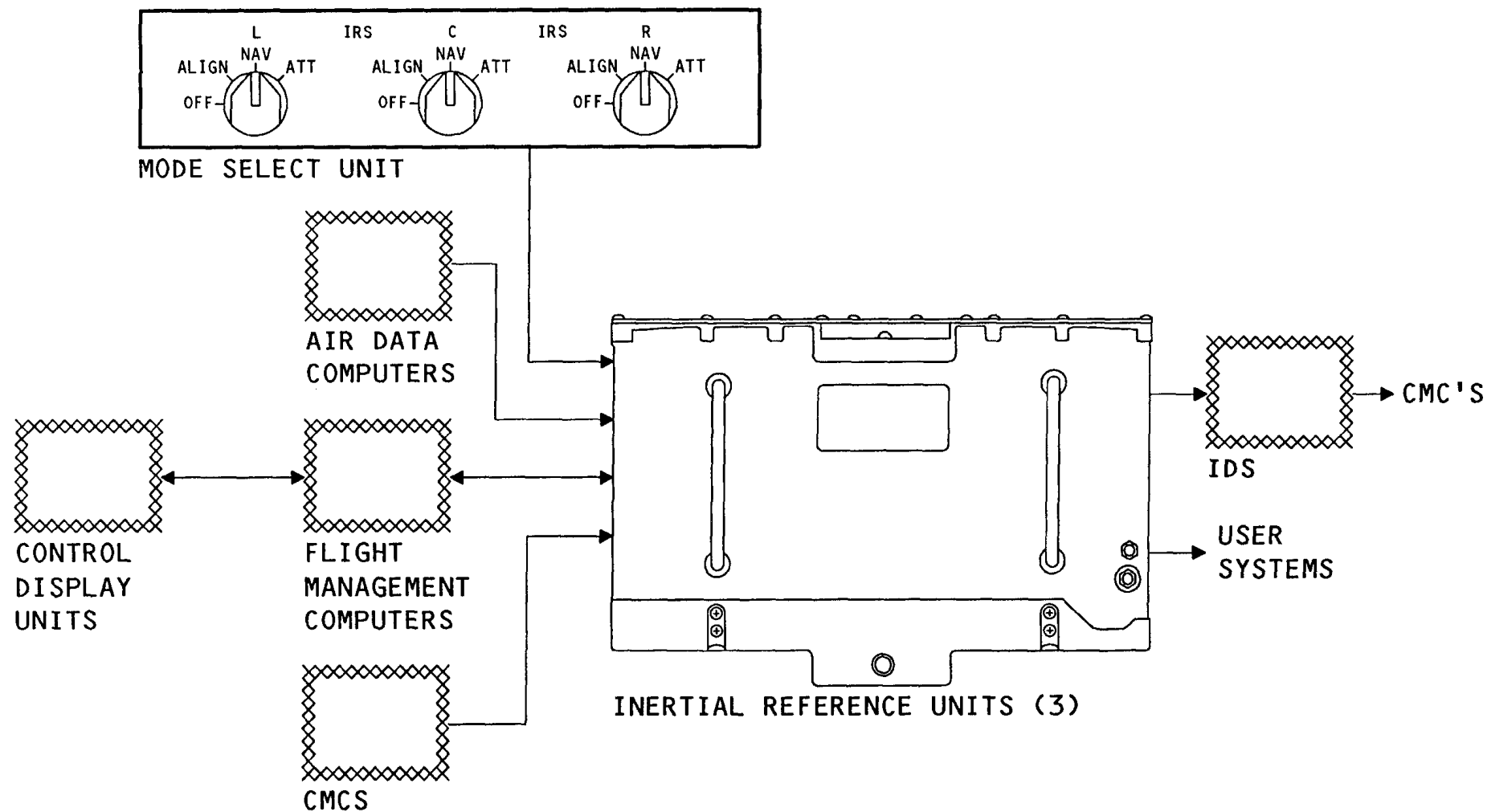


Figure 2 INERTIAL REFERENCE SYSTEM

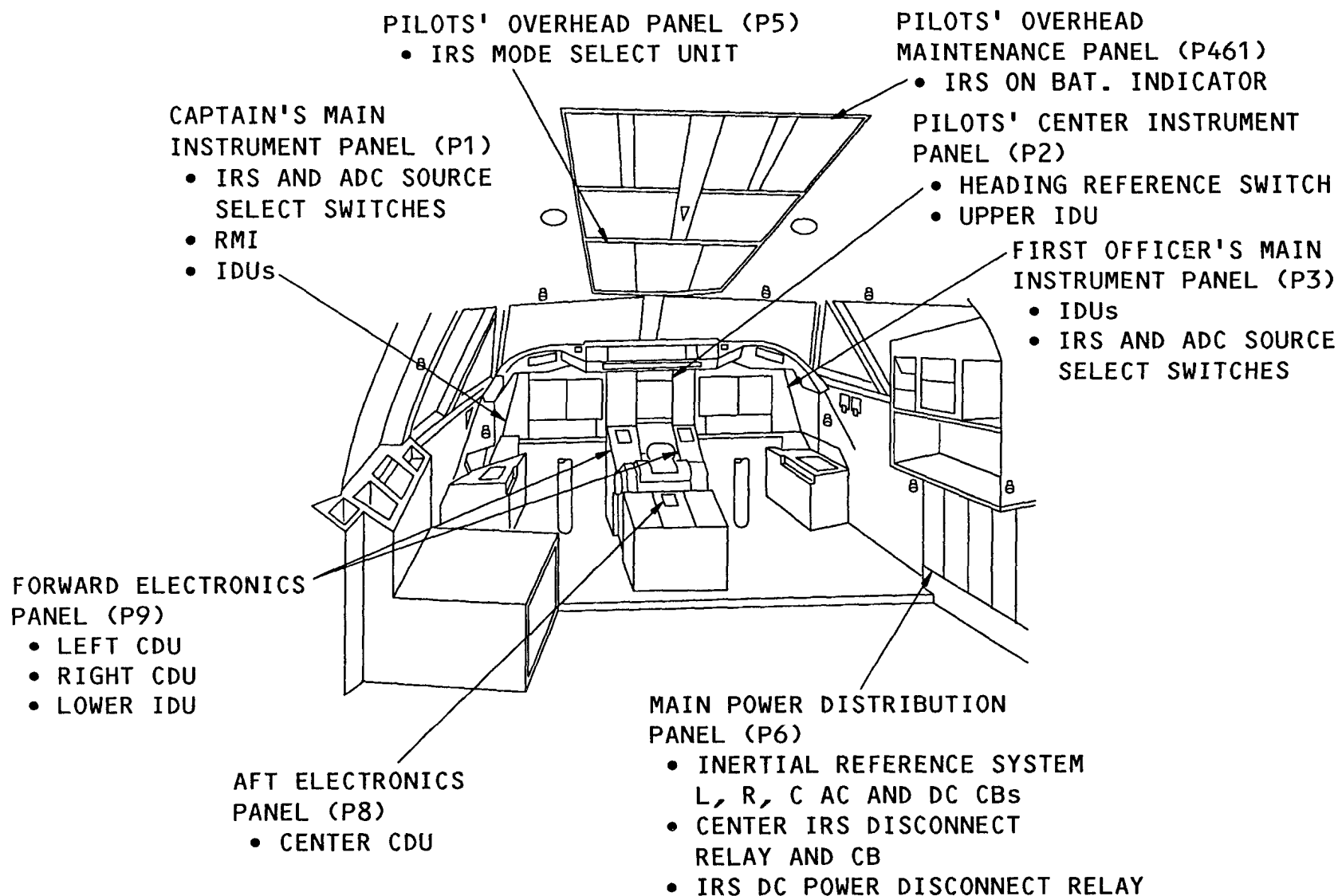
IRS



COMPONENT LOCATIONS - FLIGHT DECK

The IRS components and interfacing components located in the flight deck are as follows:

- IRS mode select unit
- Integrated display units (IDUs)
- Radio magnetic indicator (RMI)
- Control and display units (CDUs)
- IRS and air data computer (ADC) source select switches
- Heading reference switch
- IRS DC power disconnect relay
- IRS ON BAT indicator
- AC and DC power circuit breakers
- Center IRS disconnect relay and circuit breaker


Figure 3 COMPONENT LOCATIONS - FLIGHT DECK

IRS



COMPONENT LOCATIONS - MEC

The IRS components and interfacing components located in the main equipment center are:

- Inertial reference units
- IRU select relays
- IRS on battery relay
- RS on battery diodes
- IRS ON BAT CB
- IRS GND SVCE logic CB
- IRS ground service relay
- Air/ground relay



P415 RIGHT PWR DIST CTR

- R1156 LEFT IRS RIGHT SELECT RELAY
- R1157 RIGHT IRS LEFT SELECT RELAY
- R1158 LEFT IRS CENTER SELECT RELAY
- R1159 RIGHT IRS CENTER SELECT RELAY

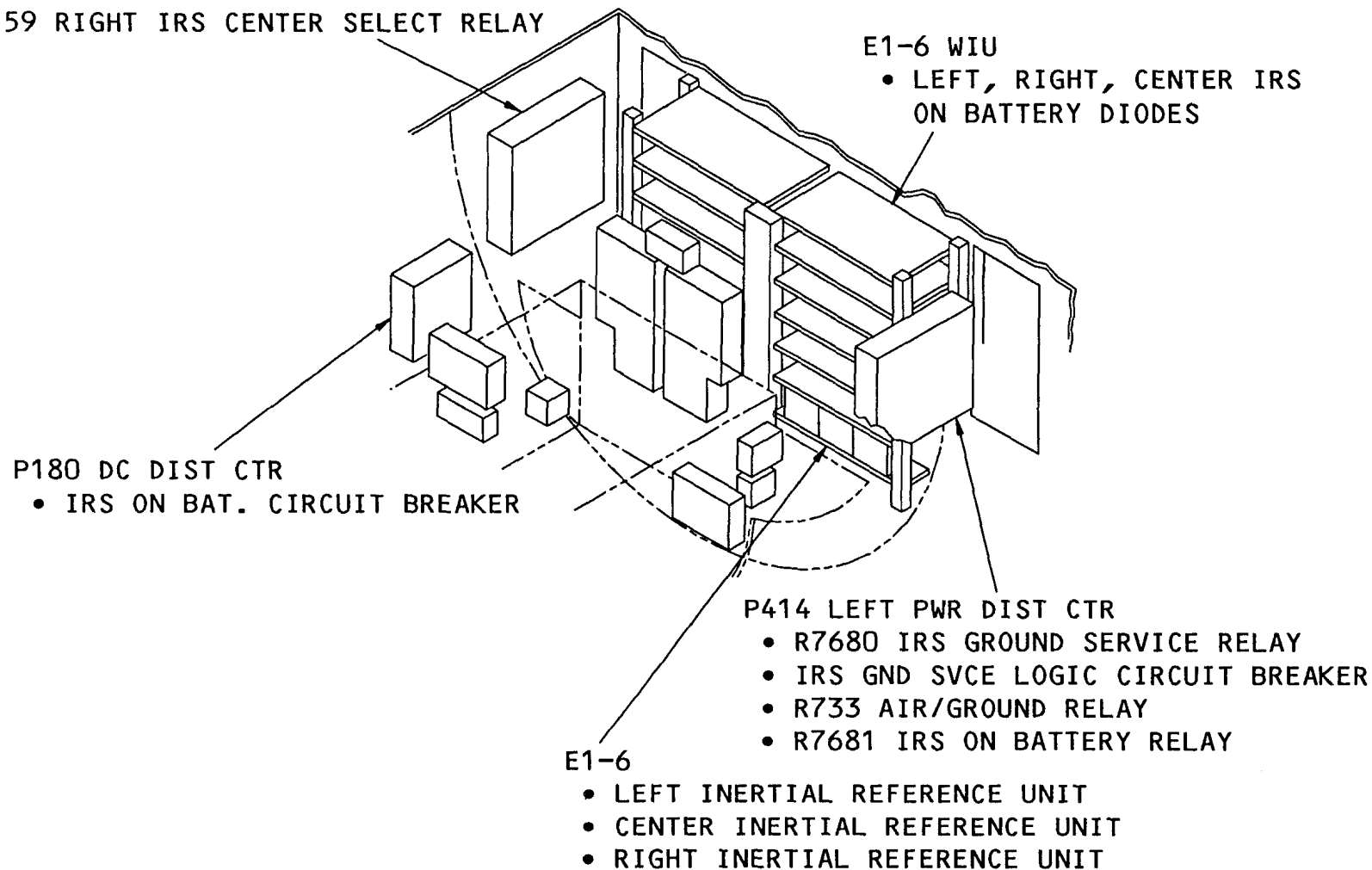


Figure 4 IRS - COMPONENT LOCATIONS - MEC



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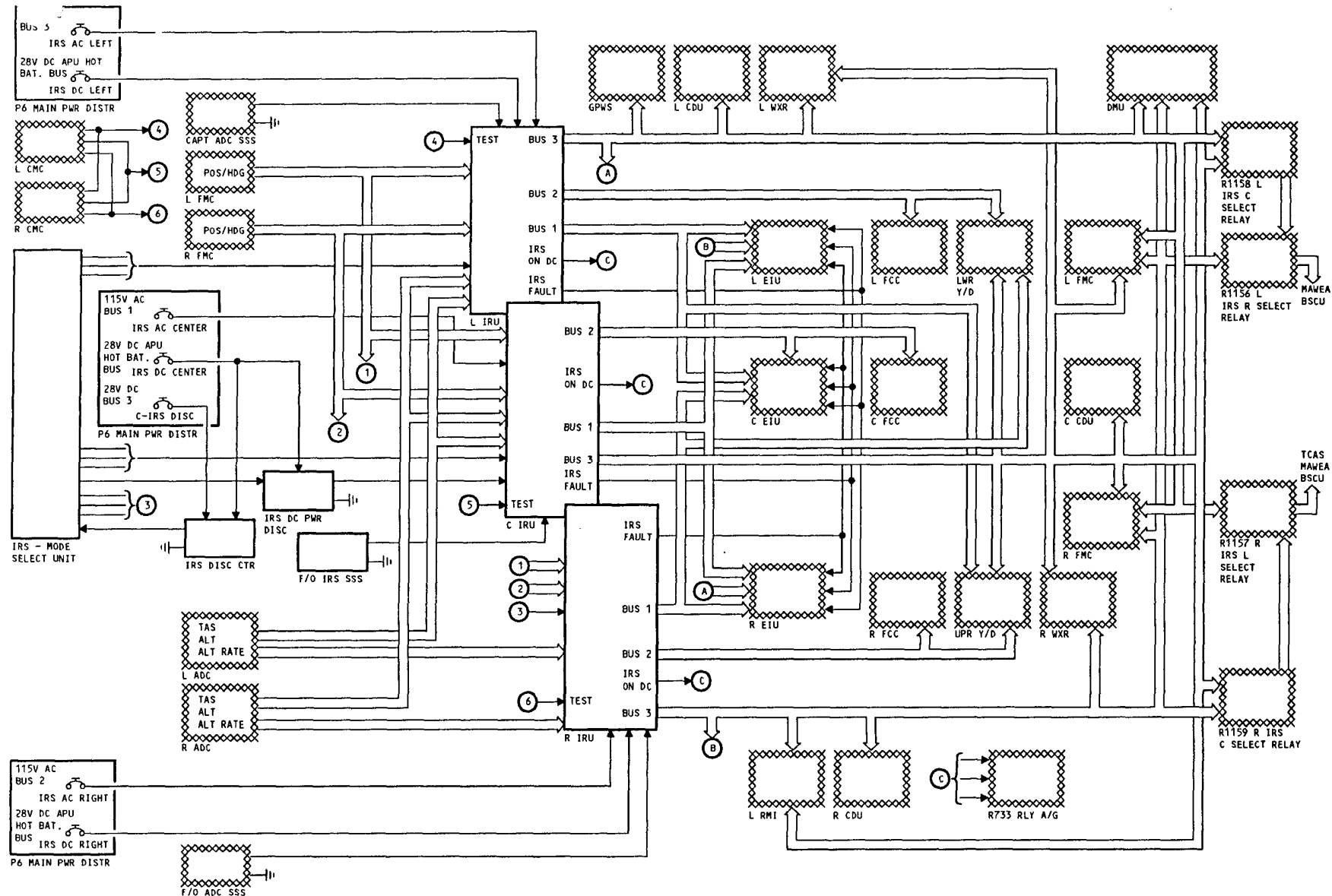


Figure 5 IRS - INTERFACE DIAGRAM

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LEFT AND RIGHT IRU - INPUT POWER

Each IRU receives 115v ac and 28v dc. Power is turned on inside the IRU in response to selection of any mode other than OFF on the MSU. The IRU normally uses ac power but will automatically switch to dc power when the ac power input fails.

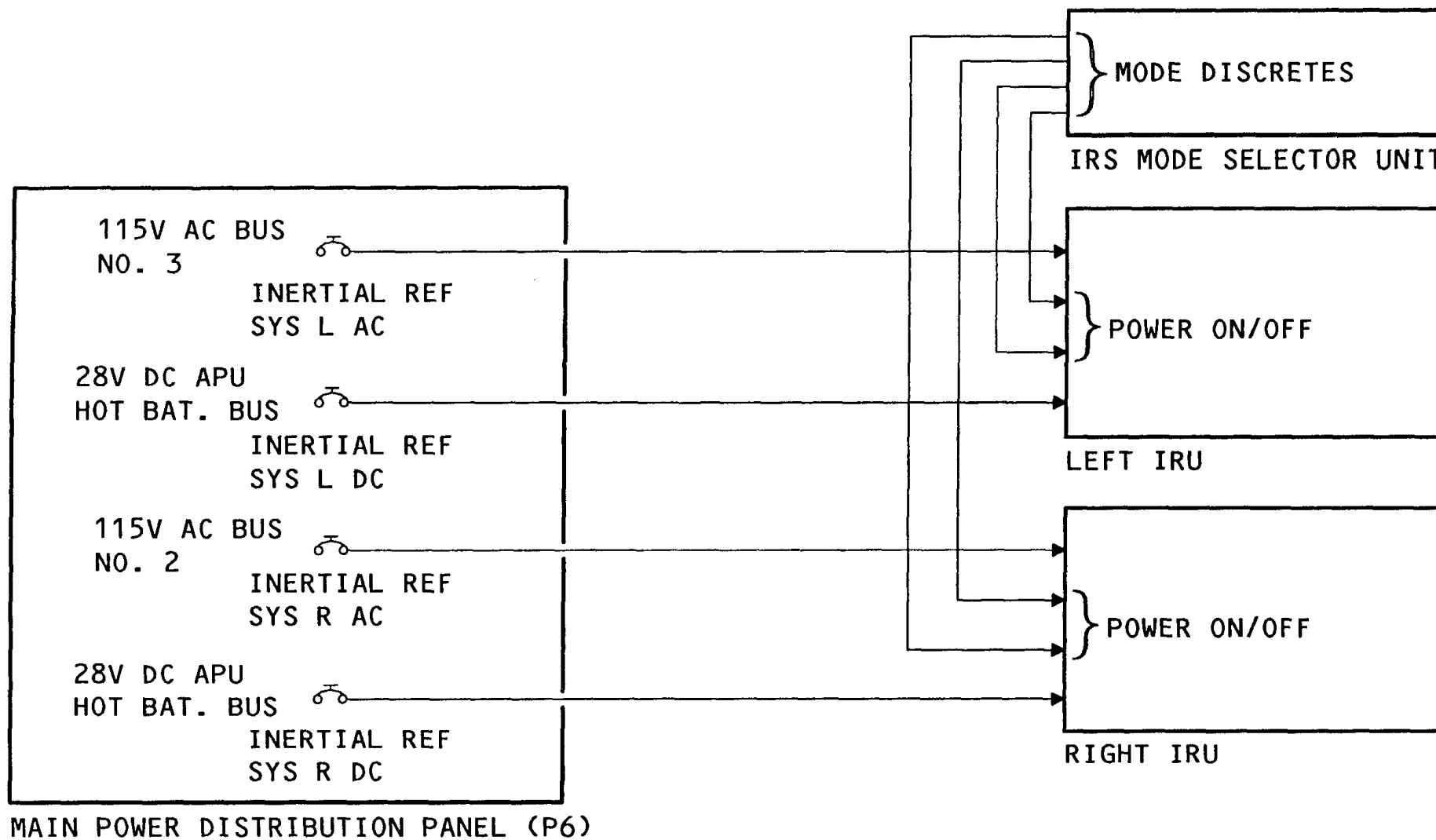


Figure 6 LEFT AND RIGHT IRU - INPUT POWER

IRS



CENTER IRU - INPUT POWER

The center IRU is supplied 115v ac and 28v dc. Power is turned on inside the IRU in response to selection of any mode other than off on the MSU. The IRU normally uses ac power but will automatically switch to dc power upon failure of the ac power input.

The center IRU may operate on dc power from the APU hot battery bus for only five minutes if dc bus No. 3 fails. The dc power from the APU hot battery bus is removed by the IRS dc power disconnect relay to conserve battery power.

The five-minute time delay is started when:

- An operating mode for the C-IRU is selected on the MSU (Align, Nav, Att).
- DC bus No. 3 power is lost.

The loss of the 28v dc bus No. 3 causes the center IRS disconnect relay to deenergize. 28v dc from the APU hot battery bus is supplied through the deenergized relay contacts to the five minute time delay in the IRS dc power disconnect relay.

The following is a description of why loss of dc bus No. 3 results in the loss of dc power to the C-IRU.

- If the C-IRU lost ac power due to loss of No. 1 ac bus, the APU battery charger also lost power.
- The APU battery bus is normally powered from dc bus No. 3. If dc bus No. 3 fails, the APU battery bus automatically transfers to the APU hot battery bus for power.
- With the added load of the APU battery bus, the APU battery is now supplying both dc busses. The C-IRU dc power is disconnected to reduce the drain on the battery.

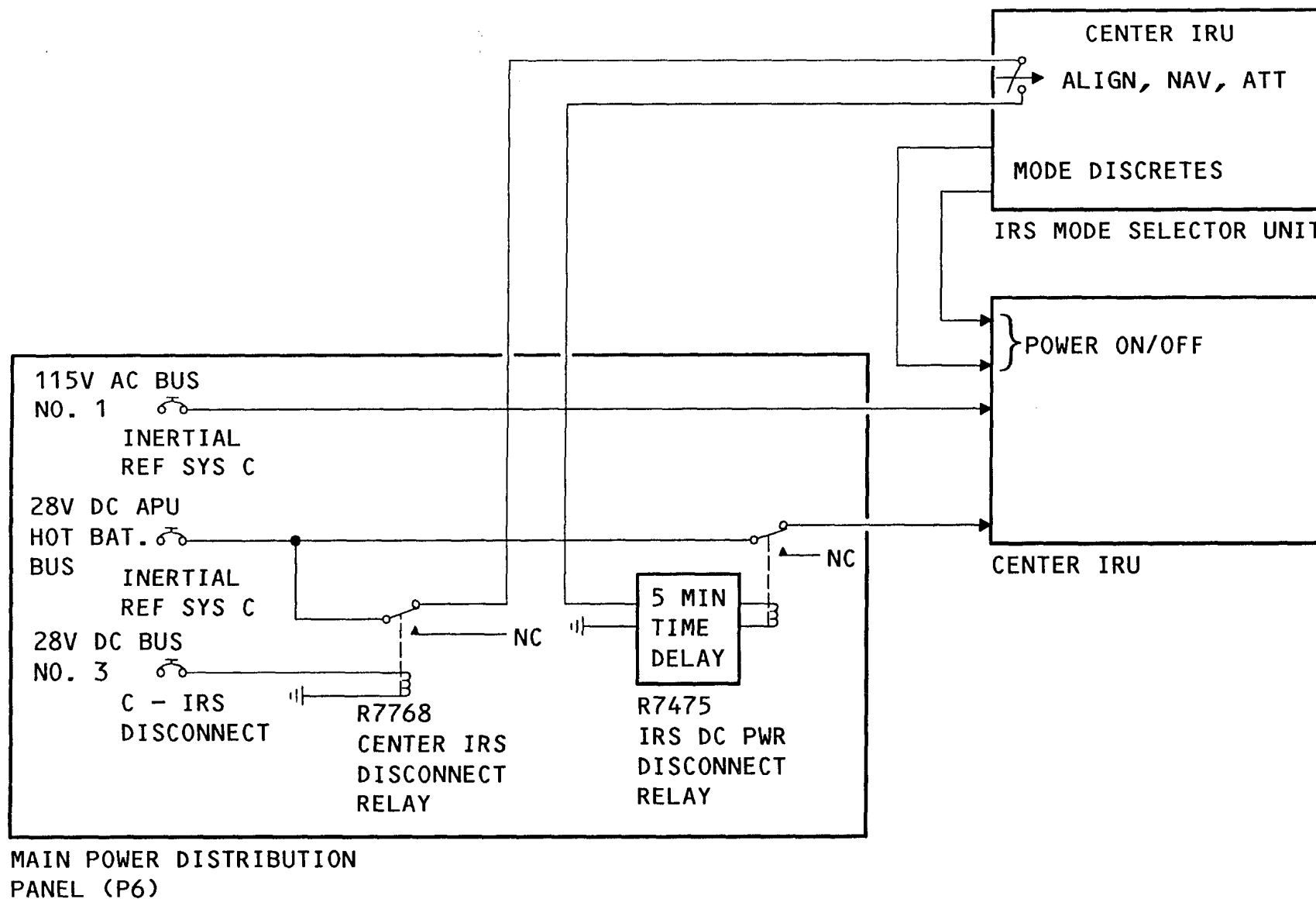


Figure 7 CENTER IRU - INPUT POWER

IRS



SOURCE SELECT SWITCH - CAPTAIN

EIU IRU Input Select Discretes.

One set of contacts on the IRS source select switch provides a ground on one of three analog discrete inputs to all three EIUs. These discretes select the IRU that provides manually selected IRS data.

Brake System and MAWEA IRU Input Select Discretes

Another set of contacts of the switch provides a ground to one of two IRS select relays. With the switch in the center position, the relays switch the left brake system channel and MAWEA inputs from left IRU to the center IRU. With the switch in the right position, the relays switch the left brake system channel and MAWEA inputs to the right IRU.

Weather Radar IRU Input Select Discretes

Another set of contacts of the switch provides a ground to the weather radar (WXR) transceiver for selection of the offside (center) IRU input.

IRS

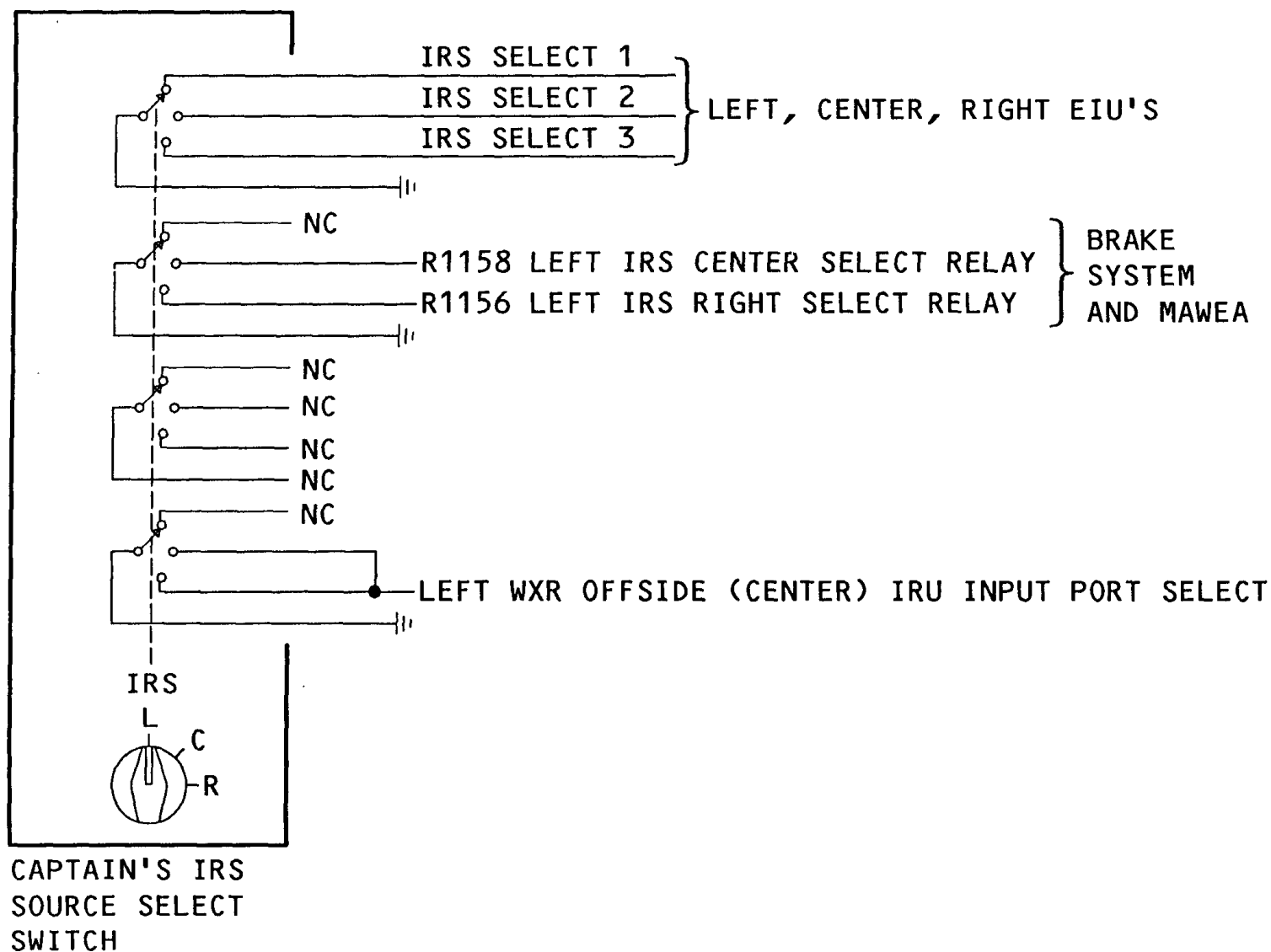


Figure 8 SOURCE SELECT SWITCH - CAPTAIN

IRS



SOURCE SELECT SWITCH - FIRST OFFICER

EIU IRU Input Select Discretes

One set of contacts on the IRS source select switch provides a ground on one of three analog discrete inputs to all three EIUs. These discretes select the IRU that provides manually selected IRS data.

TCAS, Brake System, and MAWEA IRU Input Select Discretes

Another set of contacts of the switch provides a ground to one of two IRS select relays in the center or left positions. With the switch in the center position, the relays switch TCAS, the right brake system channel, and MAWEA inputs from right IRU to the center IRU. With the switch in the left position, the relays switch TCAS, the right brake system channel, and MAWEA inputs to the left IRU.

ADC Center IRU Input Select Discrete

Another set of contacts of the switch provides a ground to the center IRU for ADC input bus selection.

Weather Radar IRU Input Select Discrete

Another set of contacts of the switch provides a ground to the weather radar (WXR) transceiver for selection of the offside (center) IRU input.

This discrete is also routed to the captain's RMI, causing the RMI to switch from the right IRU to the center IRU for its heading input data.

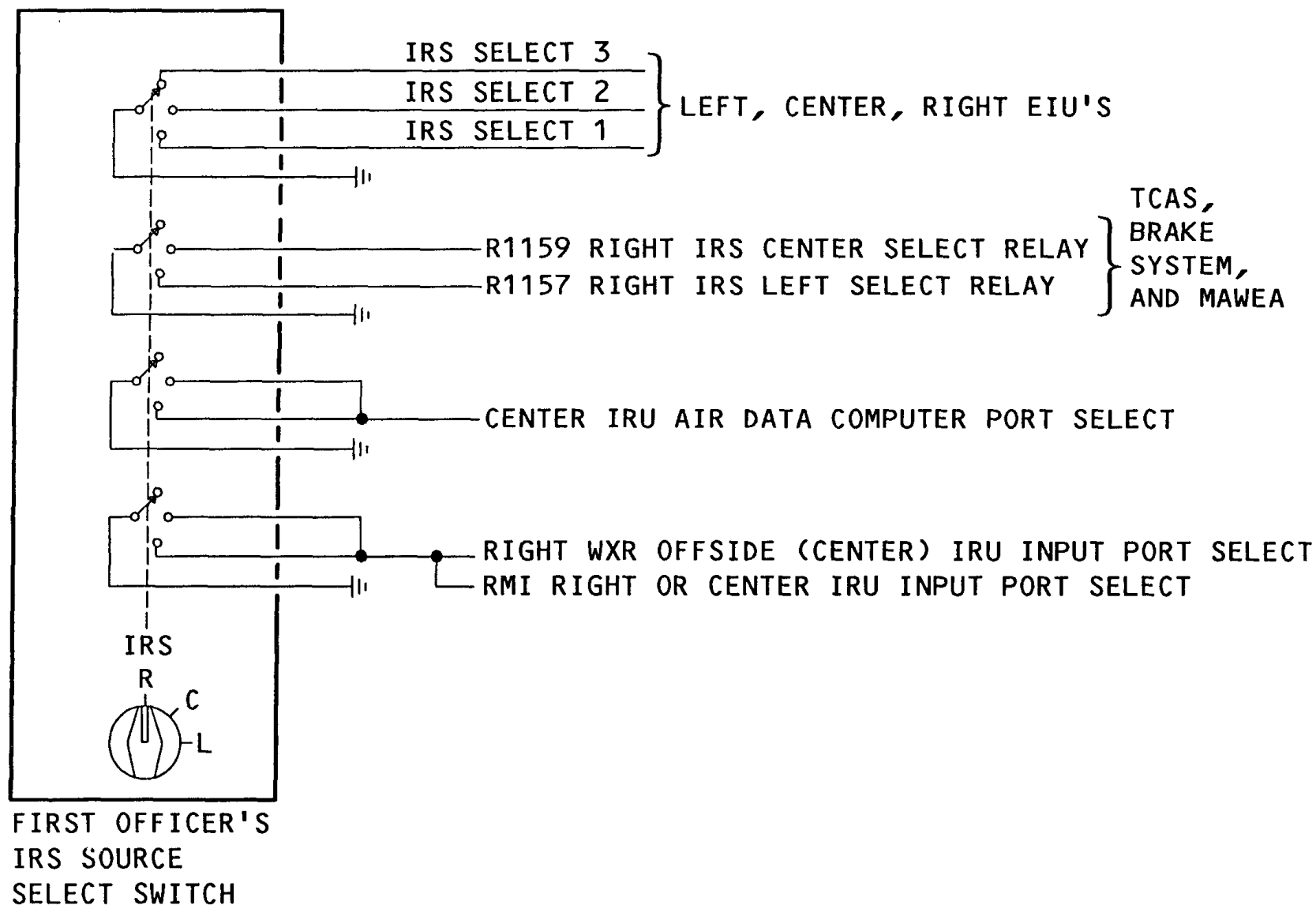


Figure 9 SOURCE SELECT SWITCH - FIRST OFFICER

IRS



SIGNAL INPUTS (FMC & CMC)

FMC Inputs

In the align mode, initial (present) position is entered through the FMC CDU. In the Att mode, reference heading is entered through the FMC CDU.

The IRU's use the last valid input from either the left or right FMC.

CMC Inputs

The test initiation discrete is supplied from the CMC when an IRU test is commanded.

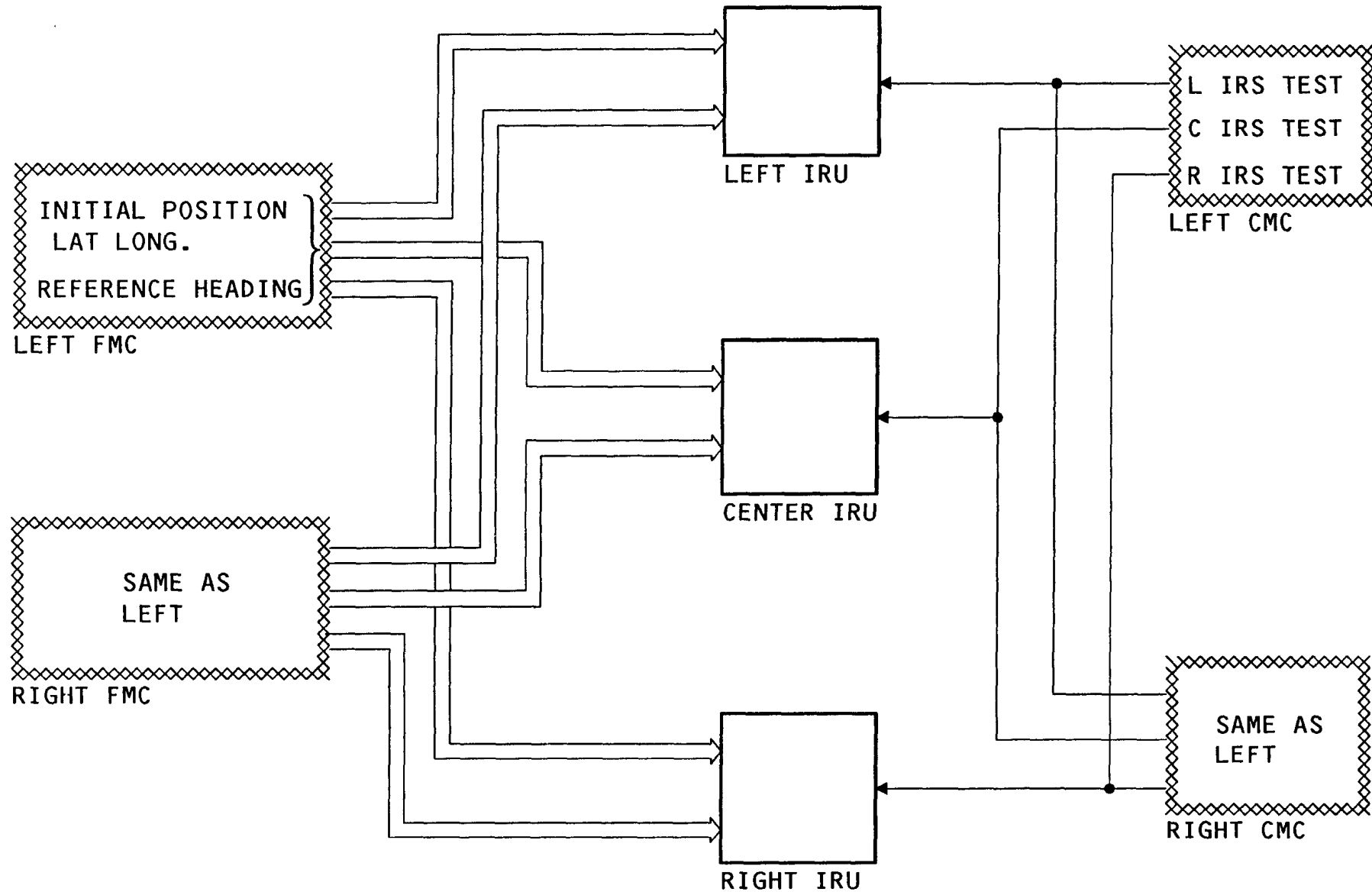


Figure 10 SIGNAL INPUTS (FMC & CMC)

IRS



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ADC SOURCE SELECTION

Any IRU can receive air data inputs from either air data computer. The captain's or first officer's ADC source select switch and the first officer's IRS source select switch provide discretes that select the input port to be used.

The captain's ADC switch controls the left IRU input and the first officer's ADC switch controls the right IRU input. The first officer's IRU source select switch controls the center IRU input.

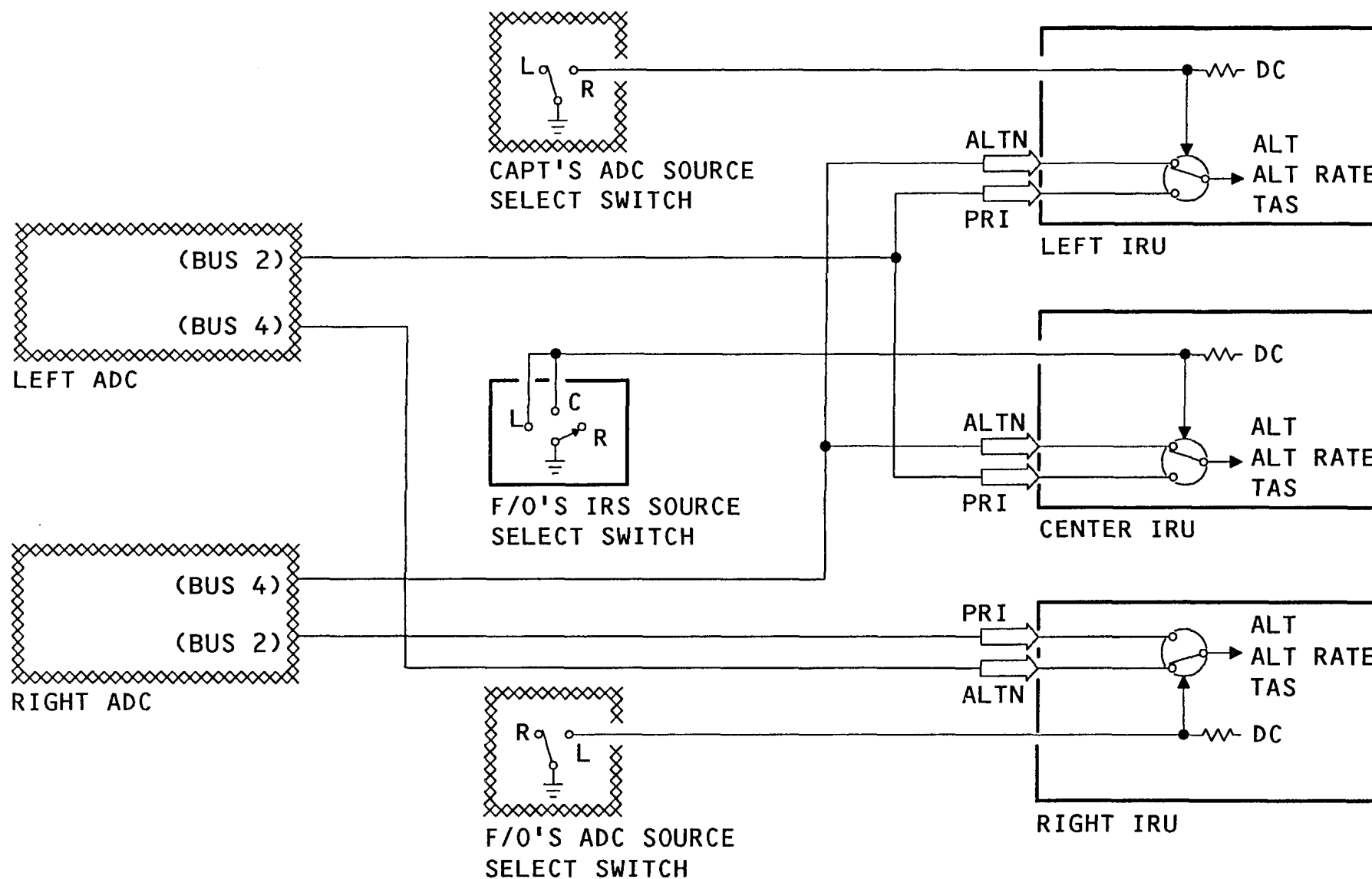


Figure 11 ADC SOURCE SELECTION

IRS



LEFT IRU BUS OUTPUTS

The IRU transmits data on three ARINC 429 high-speed output buses. All output data is sent on all three buses.

The IRU digital outputs are:

- Latitude
- Longitude
- N-S velocity
- E-W velocity
- Ground speed
- Wind speed
- Wind direction
- Track angle (magnetic and true)
- Track angle rate
- Heading (magnetic and true)
- Drift angle
- Flight path angle
- Pitch attitude
- Pitch rate
- Roll attitude
- Roll rate
- Yaw rate
- Inertial altitude
- Inertial vertical speed
- Flight path acceleration
- Body longitudinal acceleration
- Body lateral acceleration
- Body normal acceleration
- Along track horizontal acceleration
- Cross track horizontal acceleration
- Vertical acceleration

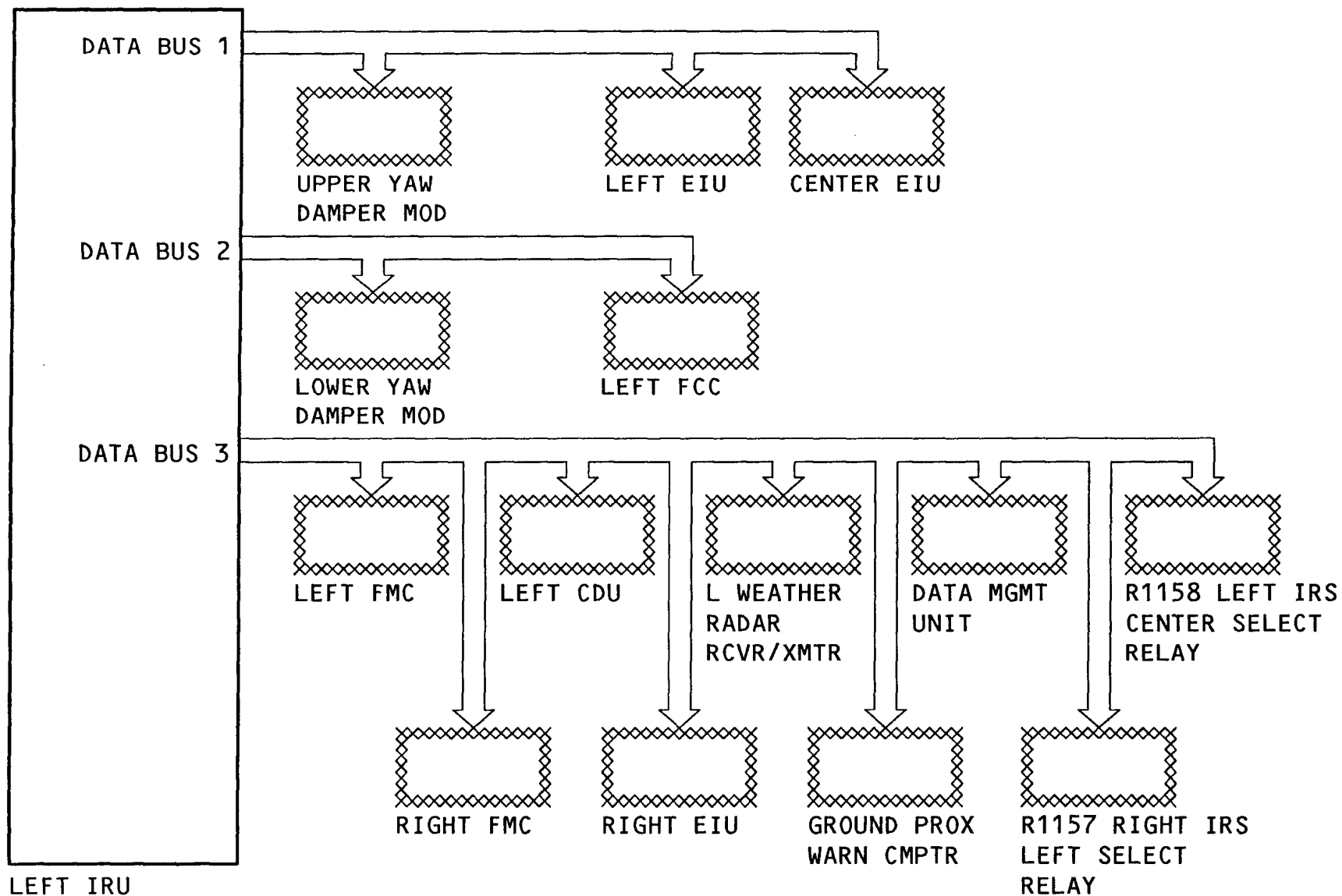


Figure 12 LEFT IRU BUS OUTPUTS

IRS



CENTER IRU BUS OUTPUTS

The IRU transmits data on three ARINC 429 high-speed output buses. All output data is sent on all three buses.

The digital data is the same as the left IRU digital data output.

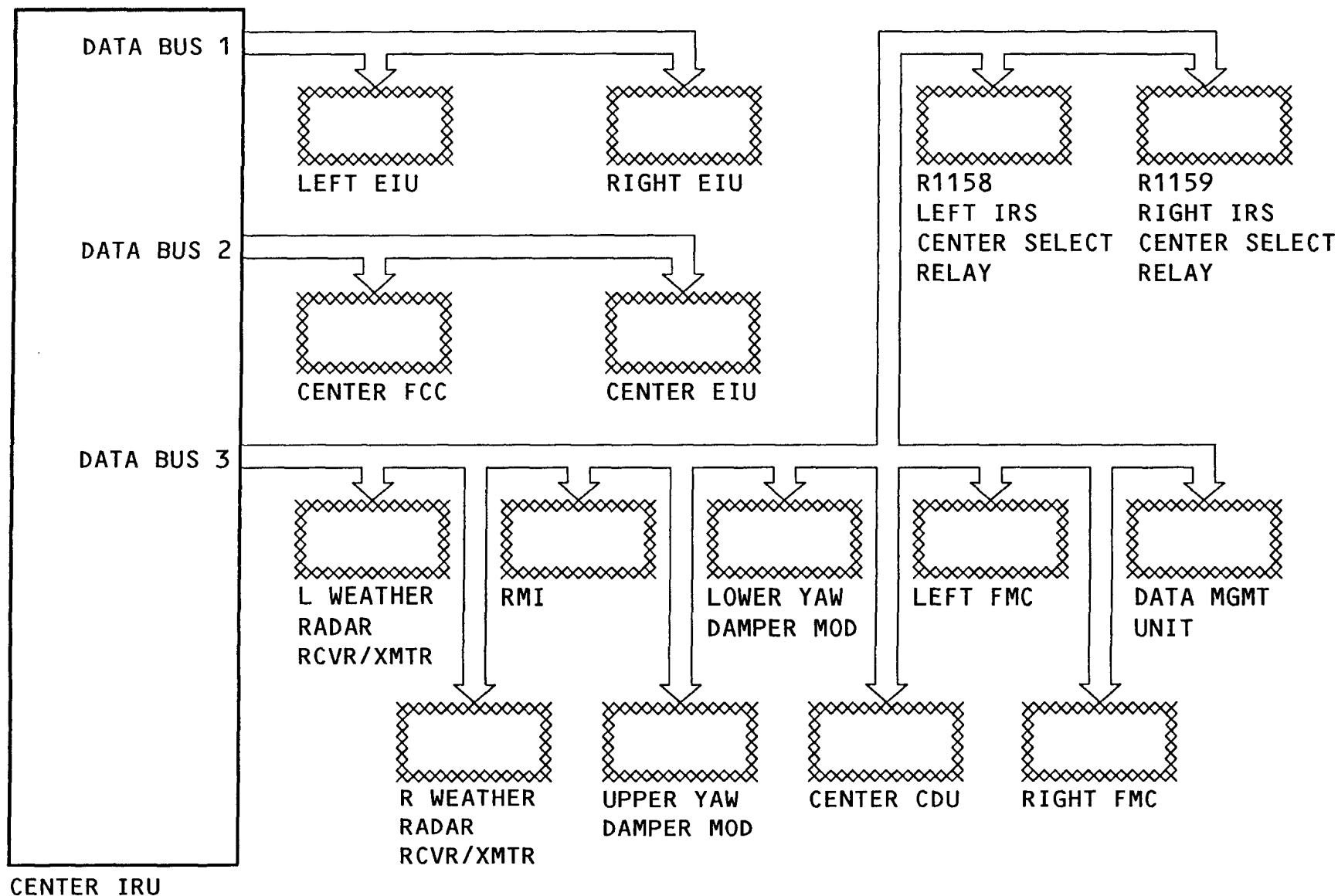


Figure 13 CENTER IRU BUS OUTPUTS

IRS



RIGHT IRU BUS OUTPUTS

The IRU transmits data on three ARINC 429 high-speed output buses. All output data is sent on all three buses.

The digital data is the same as the left IRU digital data output.

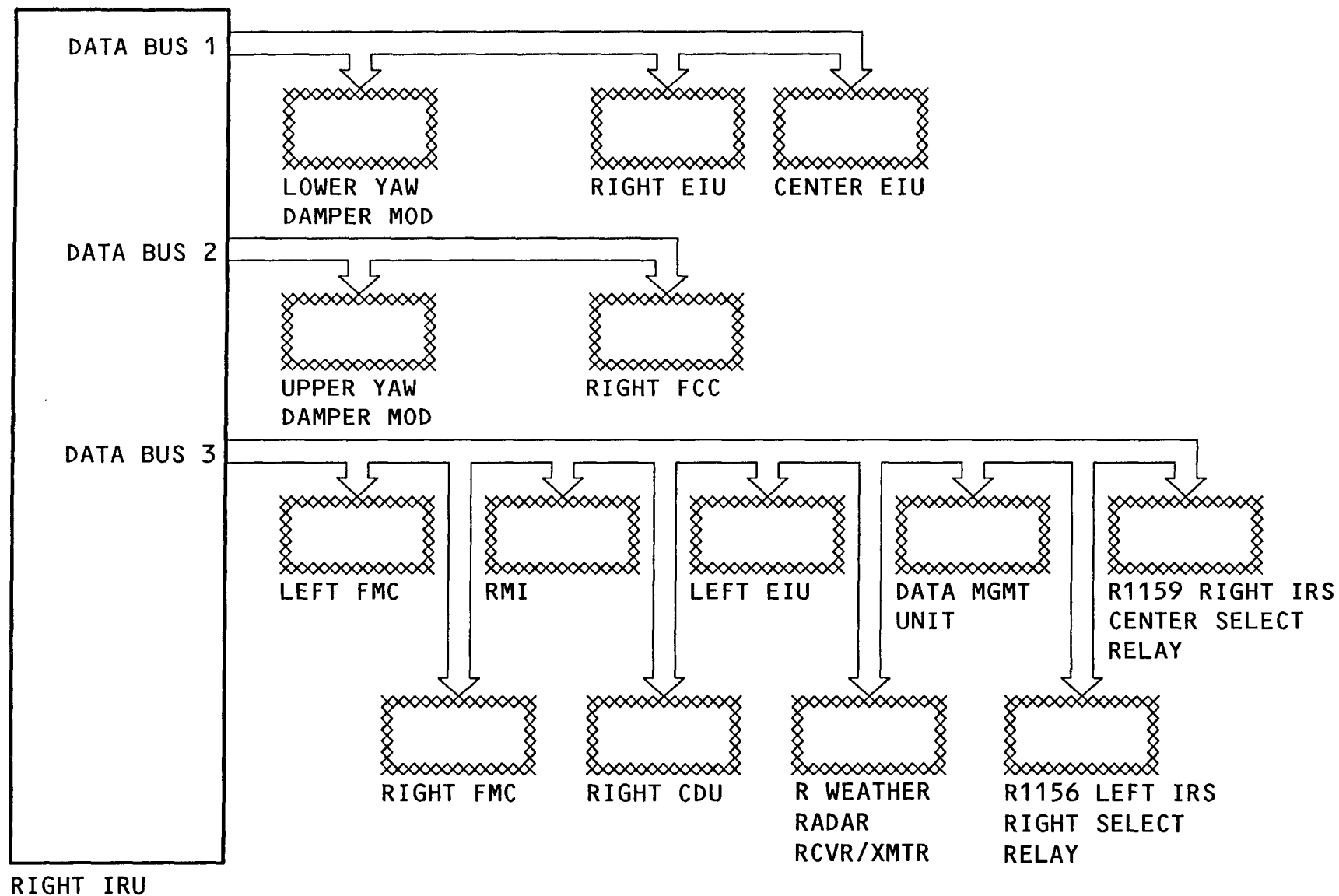


Figure 14 RIGHT IRU BUS OUTPUTS

IRS



IRS - SELECT RELAYS

The IRS select relays provide data source redundancy to user systems. The IRS select relays switch IRU data sources to the following systems:

- Stall warning computers
- Brake system control unit
- WAS computer

The select relays are controlled by the IRS instrument source select switches. The captain's IRS instrument source select switch controls the left IRS center select relay and the left IRS right select relay. The first officer's IRS instrument source select switch controls the right IRS center select relay and the right IRS left select relay.

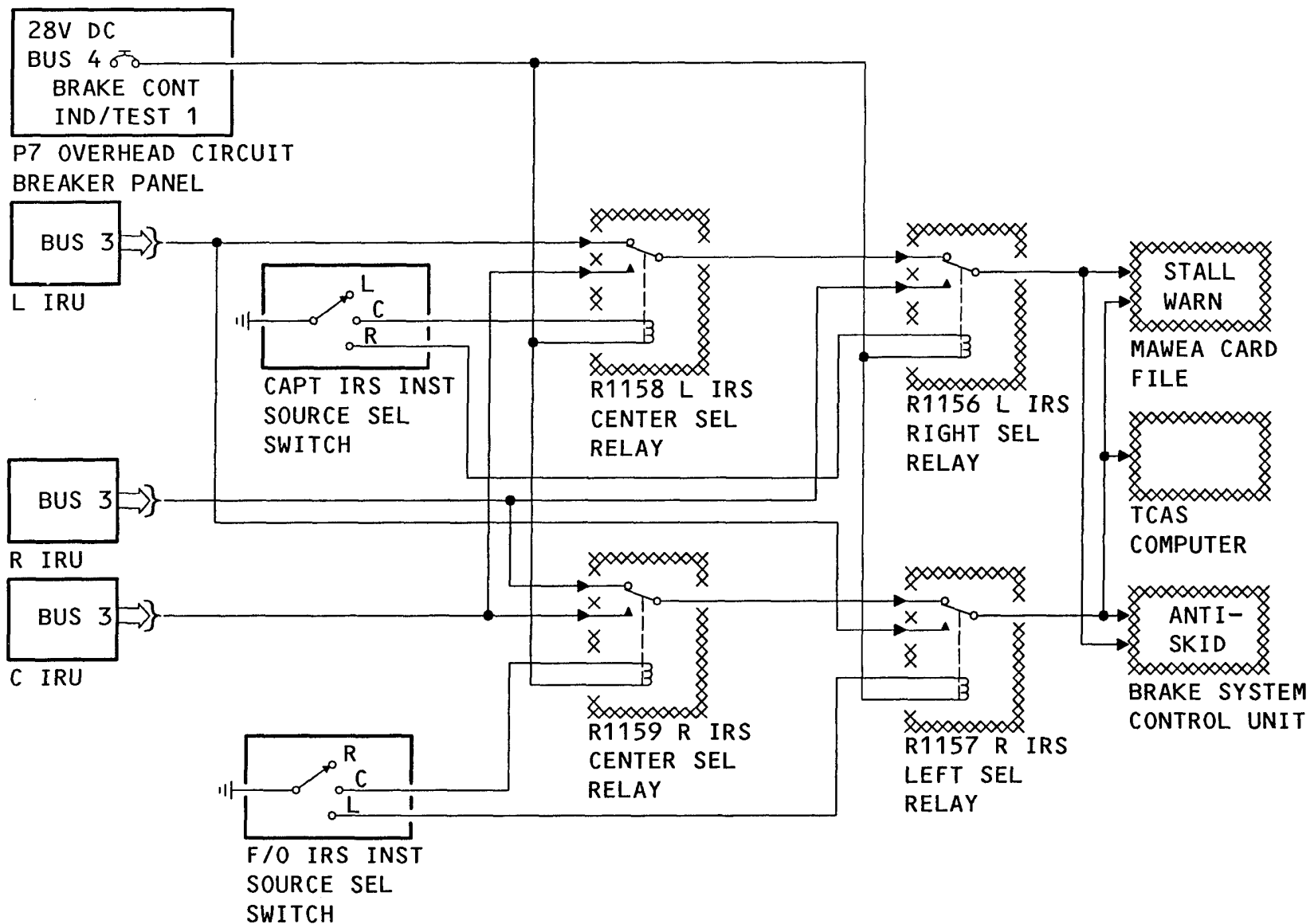


Figure 15 IRS - SELECT RELAYS

IRS



DISCRETE OUTPUTS

IRU ON DC Discrete

Each IRU sends an analog discrete when it is operating on dc power.

When any analog discrete is present, the relays in the P414 panel will energize if:

- The airplane is on the ground
- Any IRU is operating on dc only
- No ground service bus power is available

Energizing the P414 relays causes:

- The ground crew call horn in the nose wheel well to sound.
- The IRS ON BAT lamp, on the P461 panel in the flight deck, to come on.

IRU Fault Discrete

Each IRU has an analog discrete output which is routed to each EIU to show critical IRU fault conditions. The discrete will cause the IRS (left, center or right) EICAS message to be displayed. A critical fault is one that may cause erroneous outputs of attitude, heading, angular rates or accelerations.

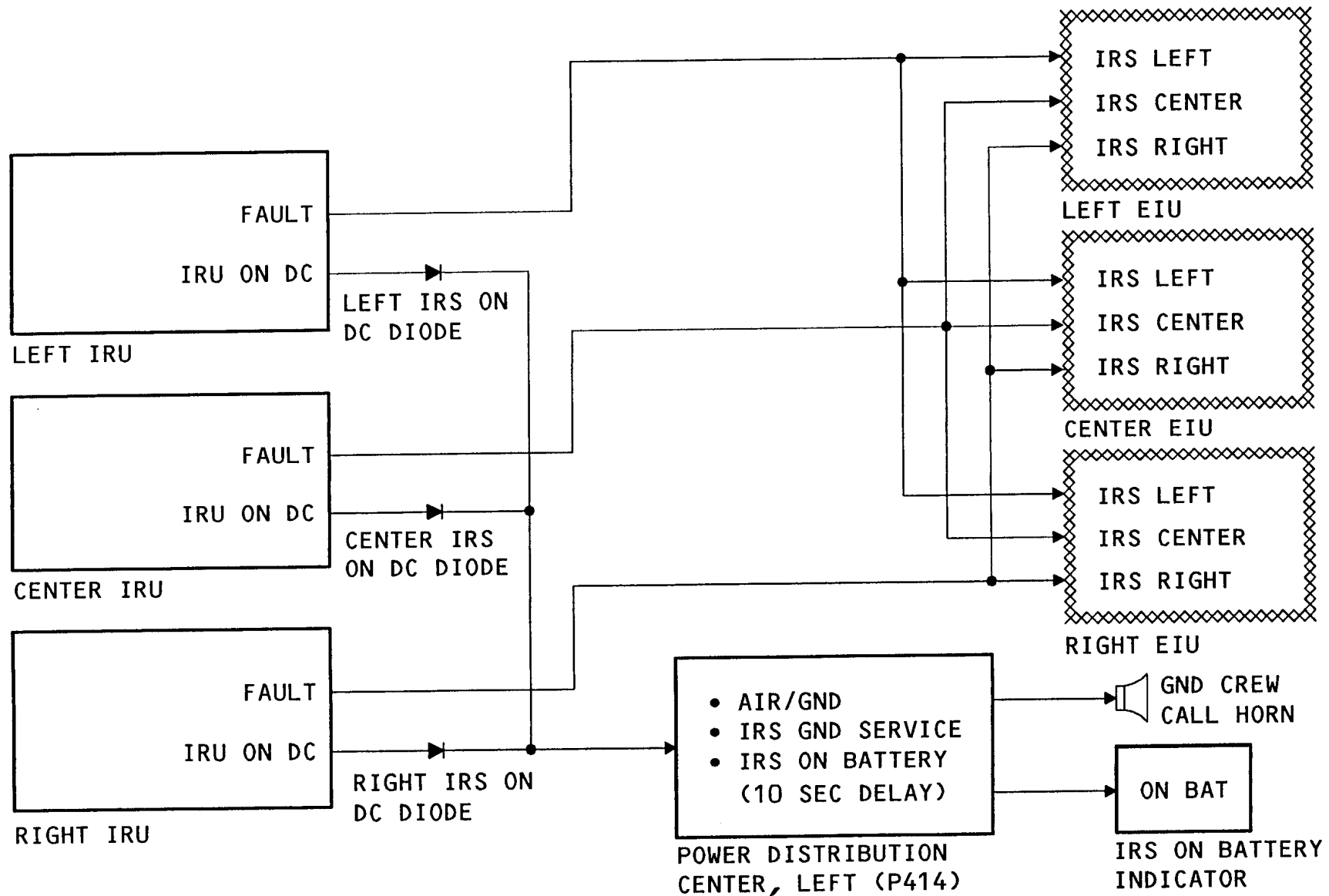


Figure 16 DISCRETE OUTPUTS



INERTIAL REFERENCE UNIT

Purpose

The purpose of the inertial reference unit is to provide:

- Attitude
- Accelerations
- Heading
- Navigation data
- Velocities

Characteristics

The IRUs characteristics are as follows:

- Ring-laser gyros measure rotation rates
- Linear accelerometers measure accelerations
- A digital computer and other electronics do signal processing and interfacing with other systems
- The IRU weighs approximately 40 pounds.
- The IRU is contained in a 10 MCU box.

Power

The IRU operates from either 115v ac 400Hz, or 28 volts dc power. If 115v ac power is lost, the IRU automatically switches to 28v dc power (APU HOT BAT BUS).

Control and Monitor

Power is turned on internally in response to two mode select analog discretes. Program pins on the IRU are used for axis orientation for a particular airplane-type installation.

There is an interface test switch on the IRU front panel which initiates an interface test of the IRU when pushed.

Installation and Removal

Special consideration should be given for removal and installation of the IRU. The IRU rack mount and guide pin is accurately aligned, and must not be subjected to excessive pressures or impacts.

CAUTION:

STATIC SENSITIVE. DO NOT HANDLE BEFORE READING PROCEDURE FOR HANDLING ELECTROSTATIC DISCHARGE SENSITIVE DEVICES (REF 20-41-02/201). CONTAINS DEVICES THAT CAN BE DAMAGED BY STATIC DISCHARGE.

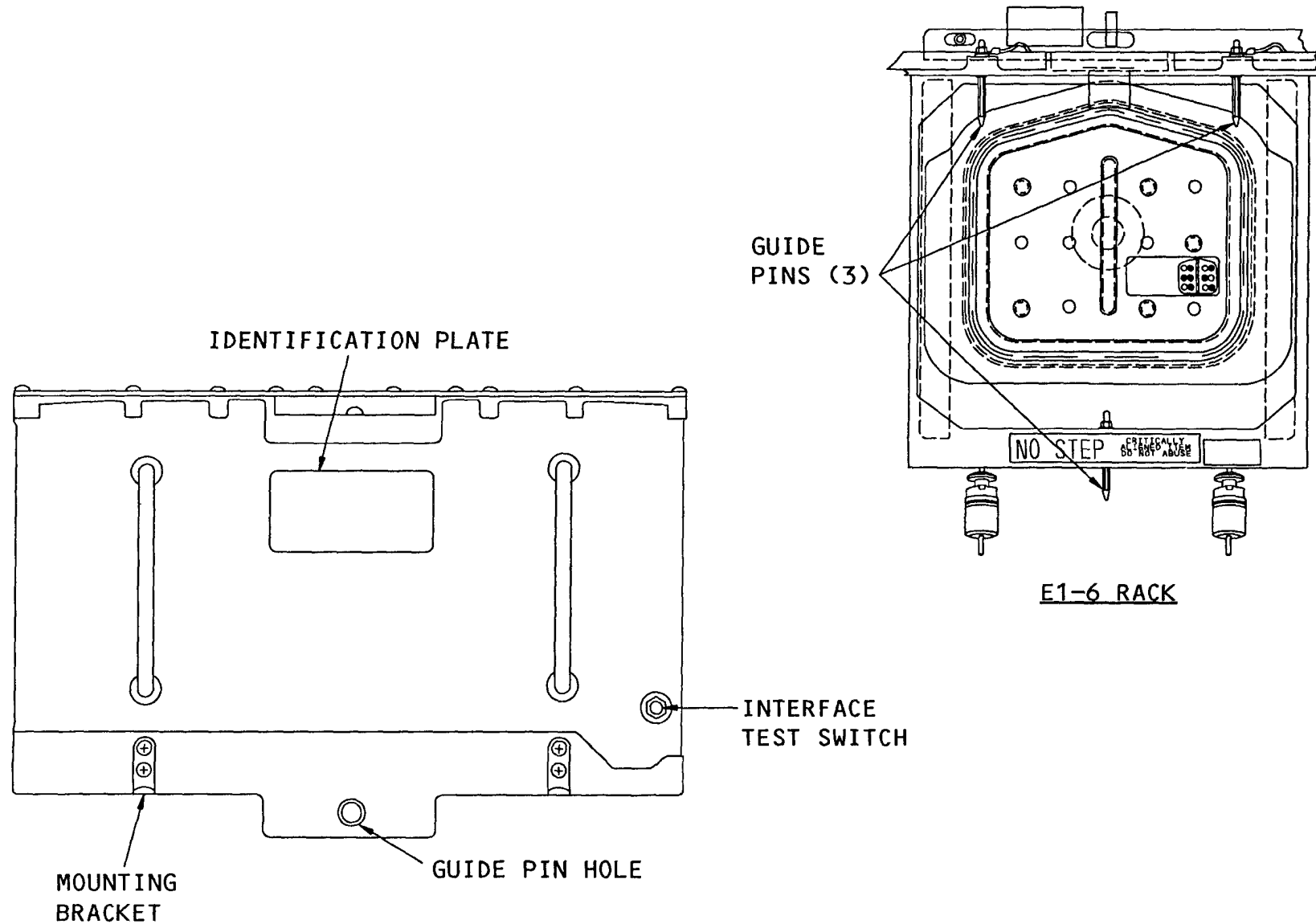


Figure 17 INERTIAL REFERENCE UNIT

IRS



MODE SELECT UNIT

Purpose

The purpose of the IRS mode select unit (MSU) is to allow selection of the IRU modes of operation.

Operation

The MSU contains one mode select switch for controlling each IRU. The switch sends discretes to the respective IRU for mode selection. The NAV position is detented to help ensure that the operator does not unintentionally switch out of the NAV position.

Characteristics

The MSU weighs less than three pounds.

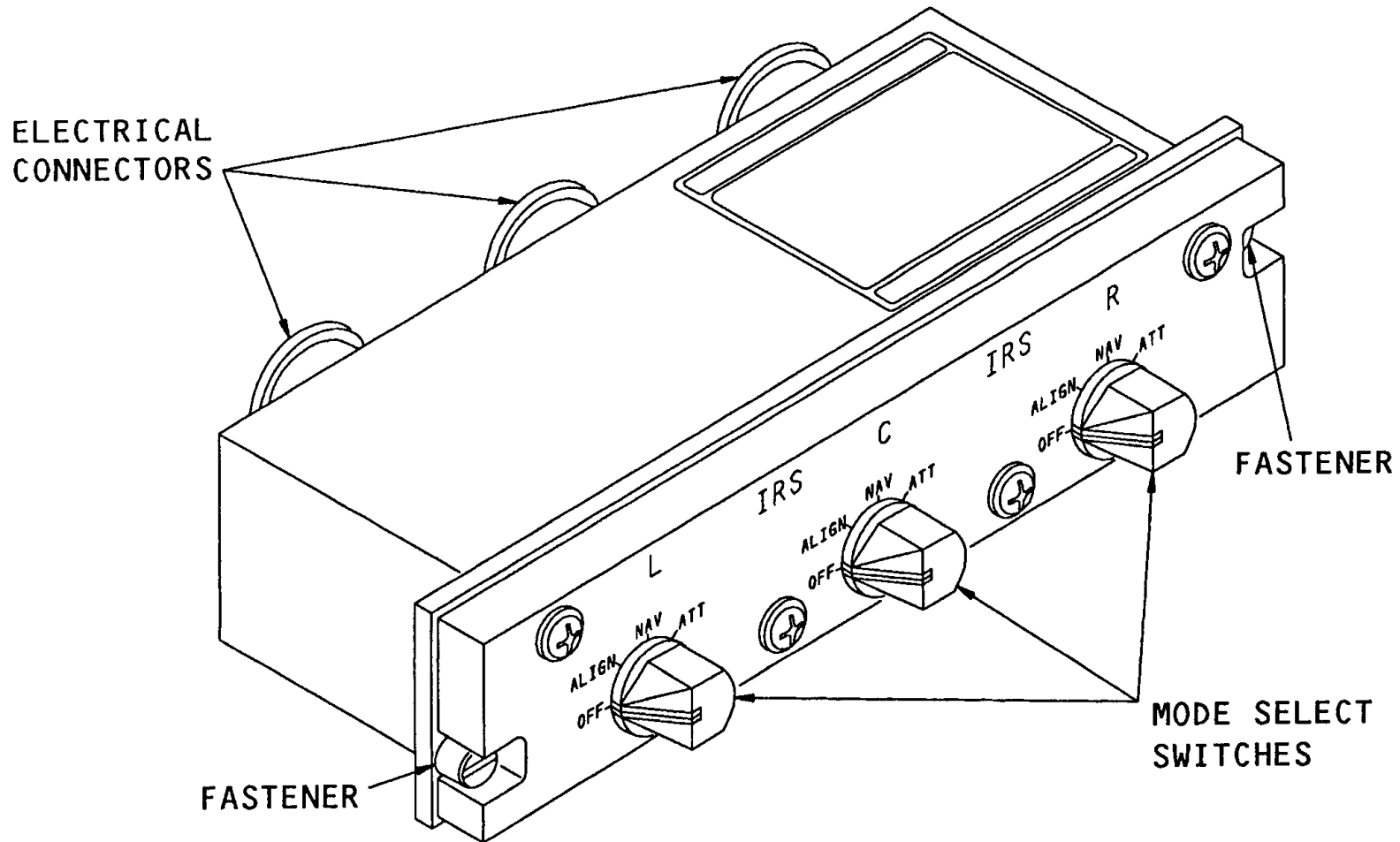


Figure 18 MODE SELECT UNIT

IRS



CONTROLS - CDU

Entries

Depending on the mode selected, the CDU is used to enter either the airplane's present position or reference heading.

Messages

The CDU scratch pad is used to show IRS related messages that indicate operator action requirements.

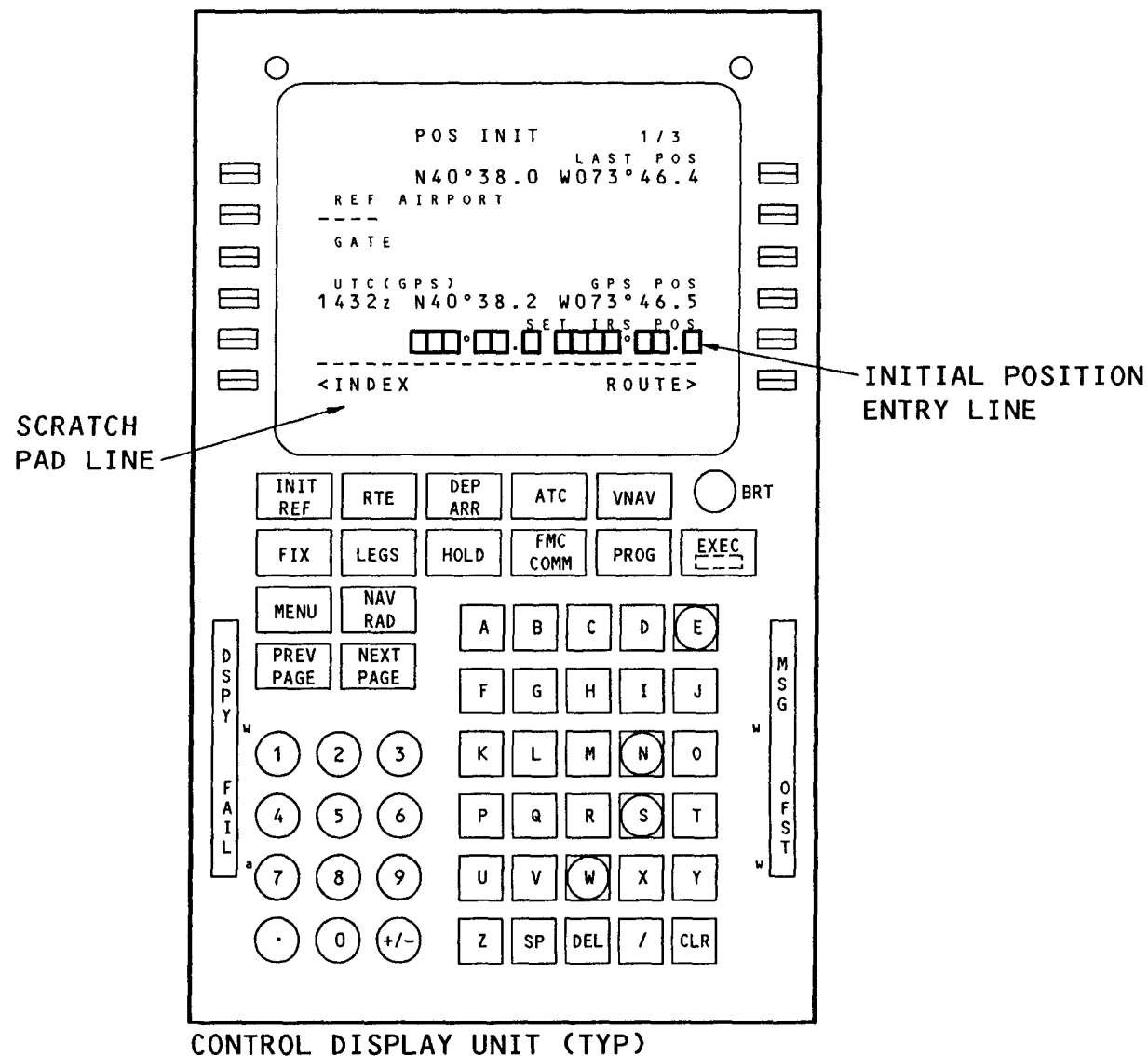


Figure 19 CONTROLS - CDU

IRS



SOURCE SELECT SWITCHES

The captain's IRS source select switch determines which IRU will provide manually selected IRS display information for the left primary flight display (PFD) and navigation display (ND). The first officer's IRS source select switch determines which IRU will provide manually selected IRS display information for the right PFD, ND and RMI and selects the ADC input port for the center IRU. These switches also control which IRU output bus goes to the brake system, to the MAWEA card file for the stall warning computer, and will stabilize the weather radars.

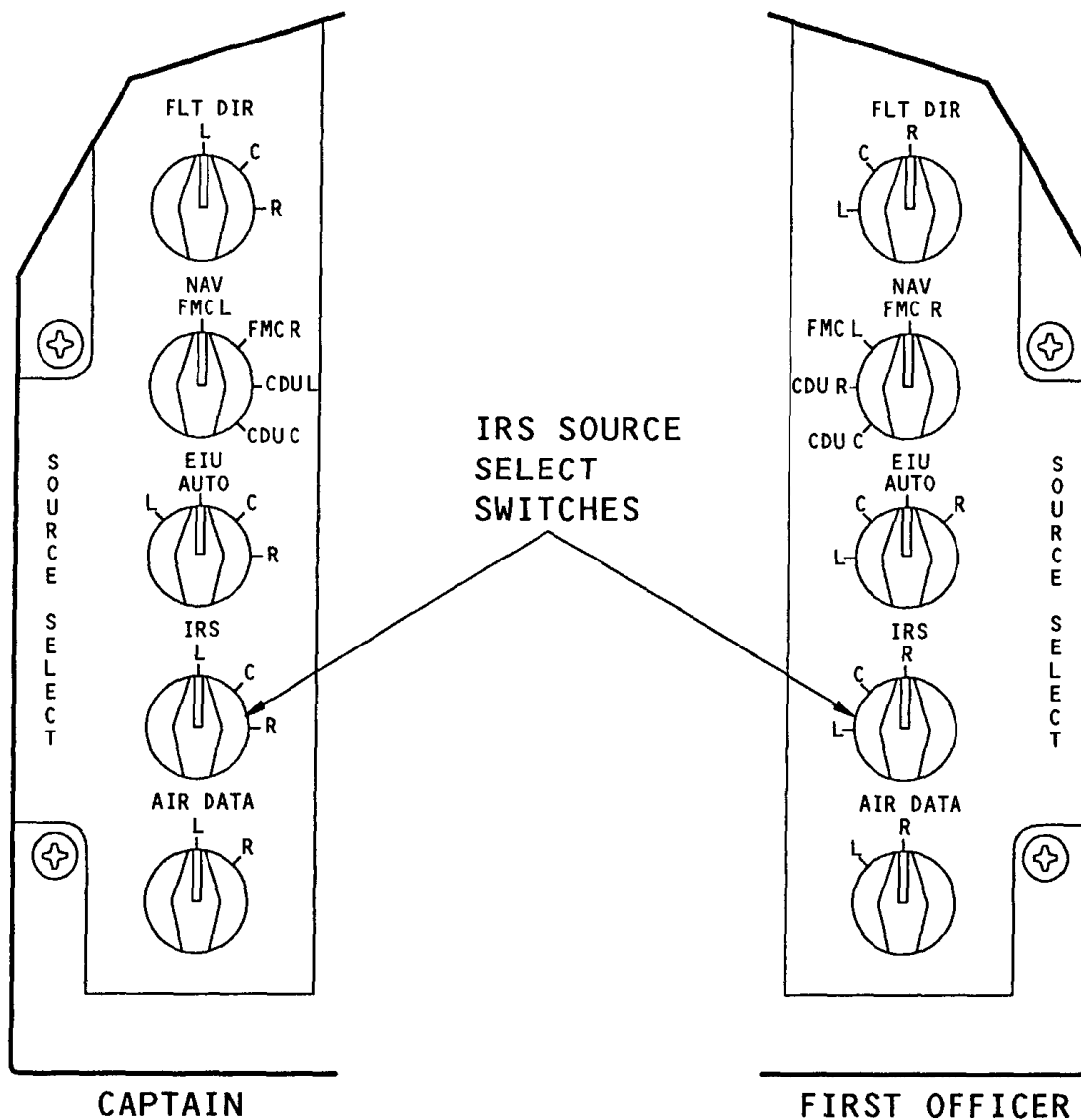


Figure 20 SOURCE SELECT SWITCHES

IRS



HEADING REFERENCE SWITCH

The position of the heading reference switch determines whether true or magnetic heading is used by the:

- Electronic Flight instruments
- Flight management computers
- Flight control computers
- Radio magnetic indicator

Above 82° north latitude and below 82° south latitude, IRS magnetic heading and track are NCD. The above mentioned systems automatically switch to true heading and track, with the exception of the radio magnetic indicator. To see true heading on the RMI, switch to HDG TRUE on the heading reference switch.

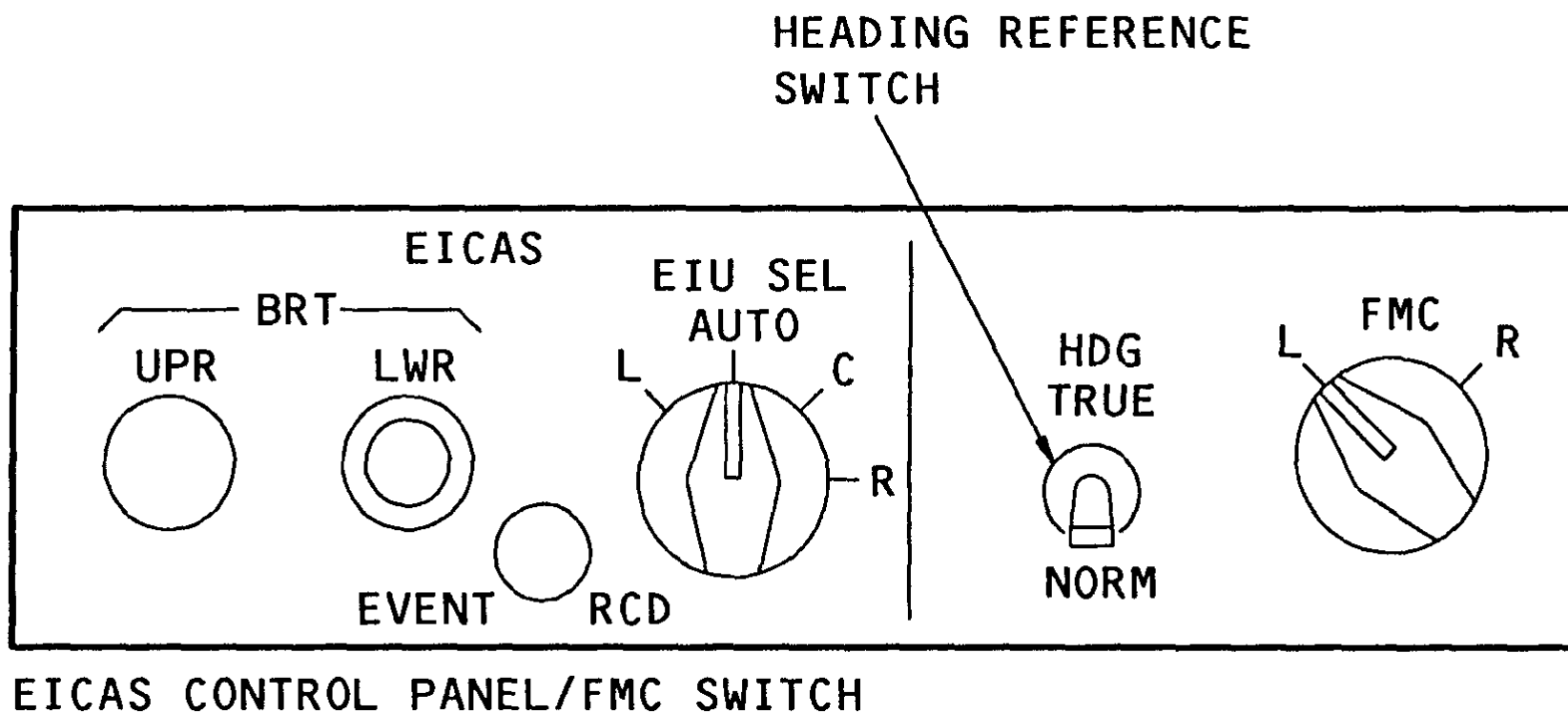


Figure 21 HEADING REFERENCE SWITCH

IRS



DISPLAYS - PFD

The primary flight display shows this IRS data:

- Pitch attitude
- Roll attitude
- Heading (magnetic/true)
- Vertical speed
- Track (magnetic/true)
- Slip/skid (body lateral acceleration)
- Flight path vector
- Attitude comparator annunciations

The source of pitch attitude, roll attitude, and vertical speed is determined by the onside IRS instrument source select switch.

The source of heading is normally selected by the onside IRS instrument source select switch, but can be changed based on data from the FMCS. At high latitudes, the FMCs each use a single IRU source. Track from one IRU may be poorly correlated with heading from a different IRU when close to the pole, if the IRU positions differ by a few miles. The PFD and ND will always use heading data from the same source which the FMC is using for track.

The source of track data is normally the selected FMC. Below 80 knots, IRS heading data is substituted for track data. If the selected FMC is invalid, the source of track defaults to the selected IRU.

The source of slip/skid data is normally the middle value of three valid IRU inputs. If only two valid IRU signals are available and the values of body lateral acceleration are within 0.05g, then the average value is used. All other situations result in the selected IRU as the source for slip/skid data.

The EFIS attitude comparator function compares the values of pitch and roll displayed on the two PFDs. If the values differ by more than three degrees the related message shows on the PFD.

The flight path vector symbol shows when selected on the on side EFIS control panel. Vertical motion of the symbol is controlled by flight path angle. Lateral motion of the symbol is controlled by track. The symbol also shows a horizon reference.

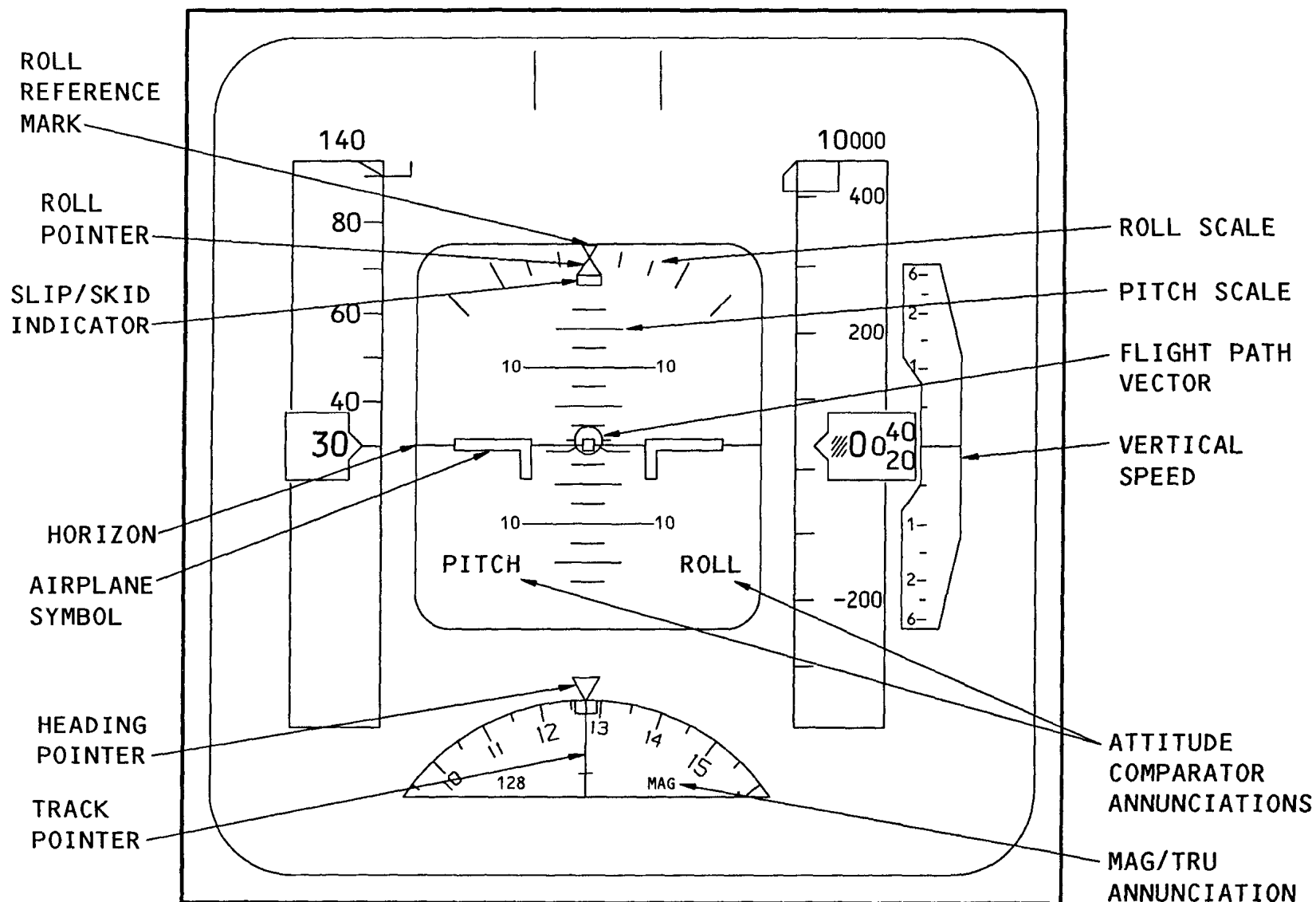


Figure 22 DISPLAYS - PFD

IRS



DISPLAYS - PFD - NCD

When IRS information is NCD, these changes occur:

- Roll pointer removed
- Pitch scale removed
- Vertical speed scale, pointer and readout removed
- Sky and ground shading removed
- Horizon line removed
- Boundary removed
- Heading scale numerics and pointer removed
- Track pointer removed
- Selected heading readout and bug removed
- MAG/TRU annunciation removed

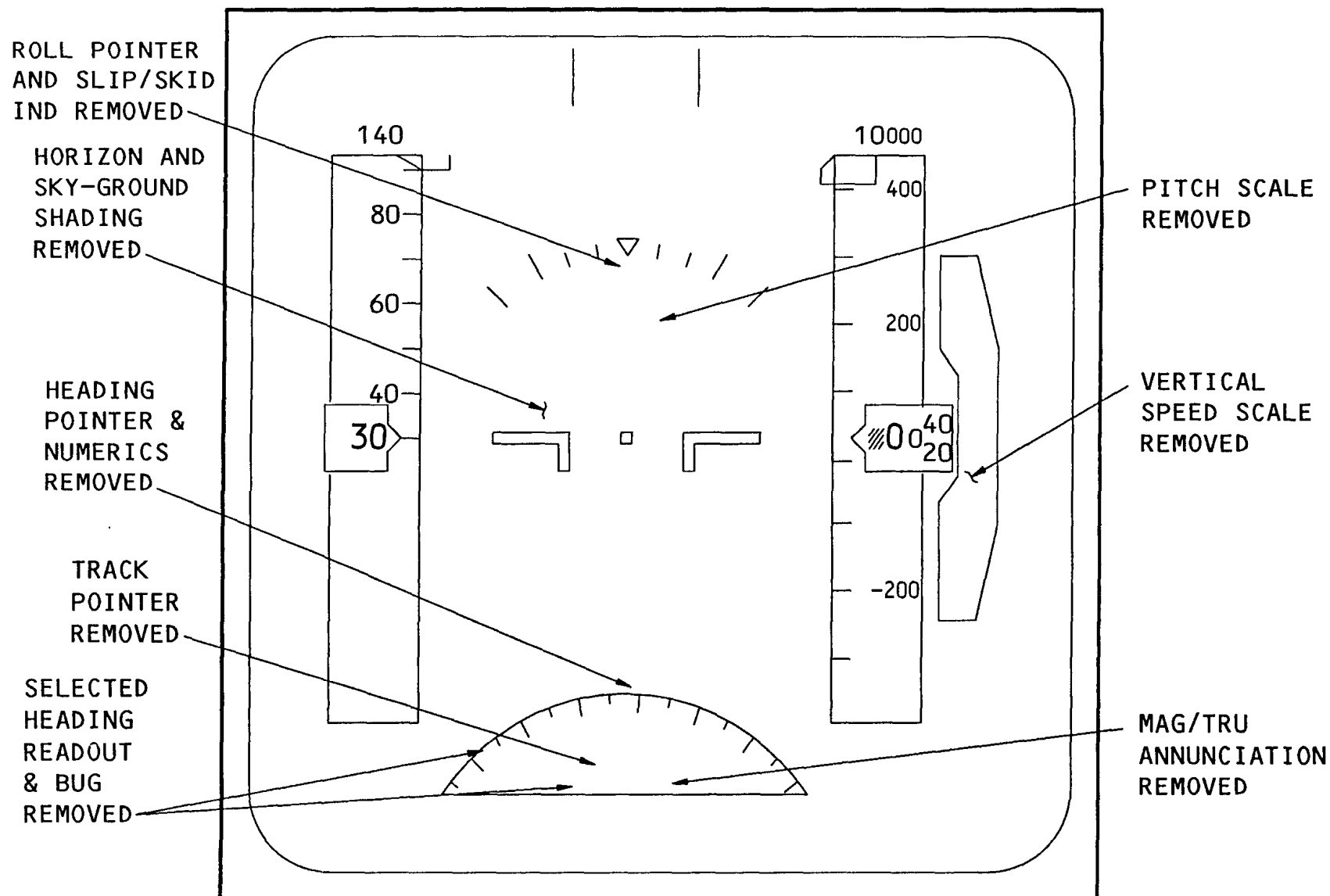


Figure 23 DISPLAYS - PFD - NCD

IRS



PFD - INVALID

When IRS information is invalid, these changes occur:

- Roll pointer removed
- Pitch scale removed
- Vertical speed scale, pointer and readout removed
- VERT flag displayed
- Sky and ground shading removed
- Horizon line removed
- Boundary removed
- ATT flag shown
- Heading scale numerics and pointer removed
- Heading scale removed
- HDG flag shown
- Track pointer removed
- Selected heading readout and bug removed
- MAG/TRU annunciation removed

When the FPV button is pushed and IRS information is invalid, the FPV flag shows.

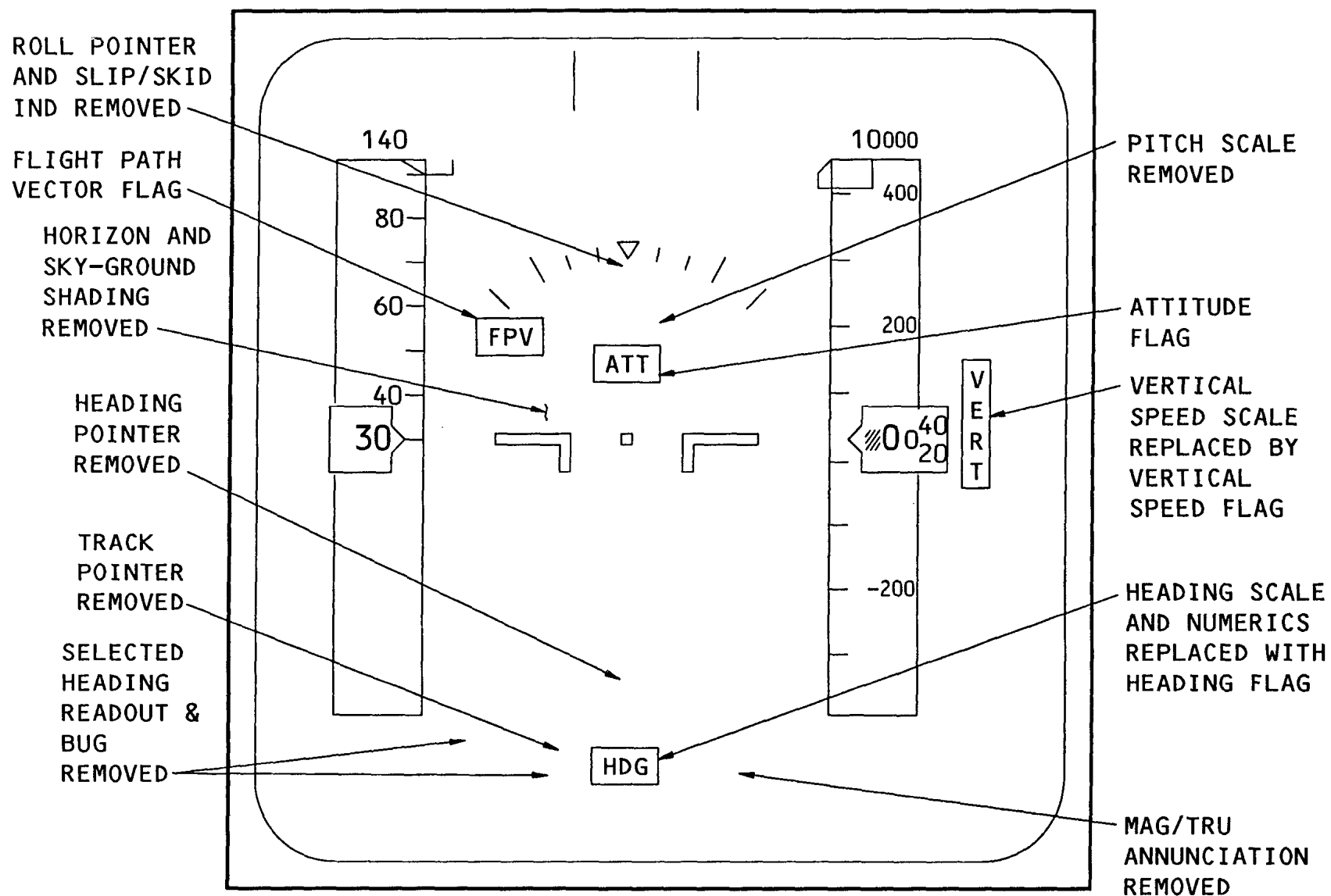


Figure 24 PFD - INVALID

IRS



ND - EXPANDED MAP

In the expanded map mode, the IRS data shown on the ND is:

- Track (magnetic/true)
- Groundspeed
- Wind direction, speed and angle
- IRU positions
- Heading (Magnetic/true)

The IRU position indicators show the left, center and right IRU positions. They show when the position display map data selector switch push button on the EFIS control panel is pushed.

The source of heading is normally selected by the onside IRS instrument source select switch, but can be changed based on data from the FMCs. At high latitudes, the FMCs each use a single IRU source. Track from one IRU may be poorly correlated with heading from a different IRU when close to the pole if the IRU positions differ by a few miles. The PFD and ND will always use heading data from the same source which the FMC is using for track.

The source of track data is normally the selected FMC. Below 80 knots, IRS heading data is substituted for track data. If the selected FMC is invalid, the source of track defaults to the selected IRU.

The values for groundspeed and wind are normally supplied by the selected FMC. If the selected FMC fails, these values come from the selected IRU.

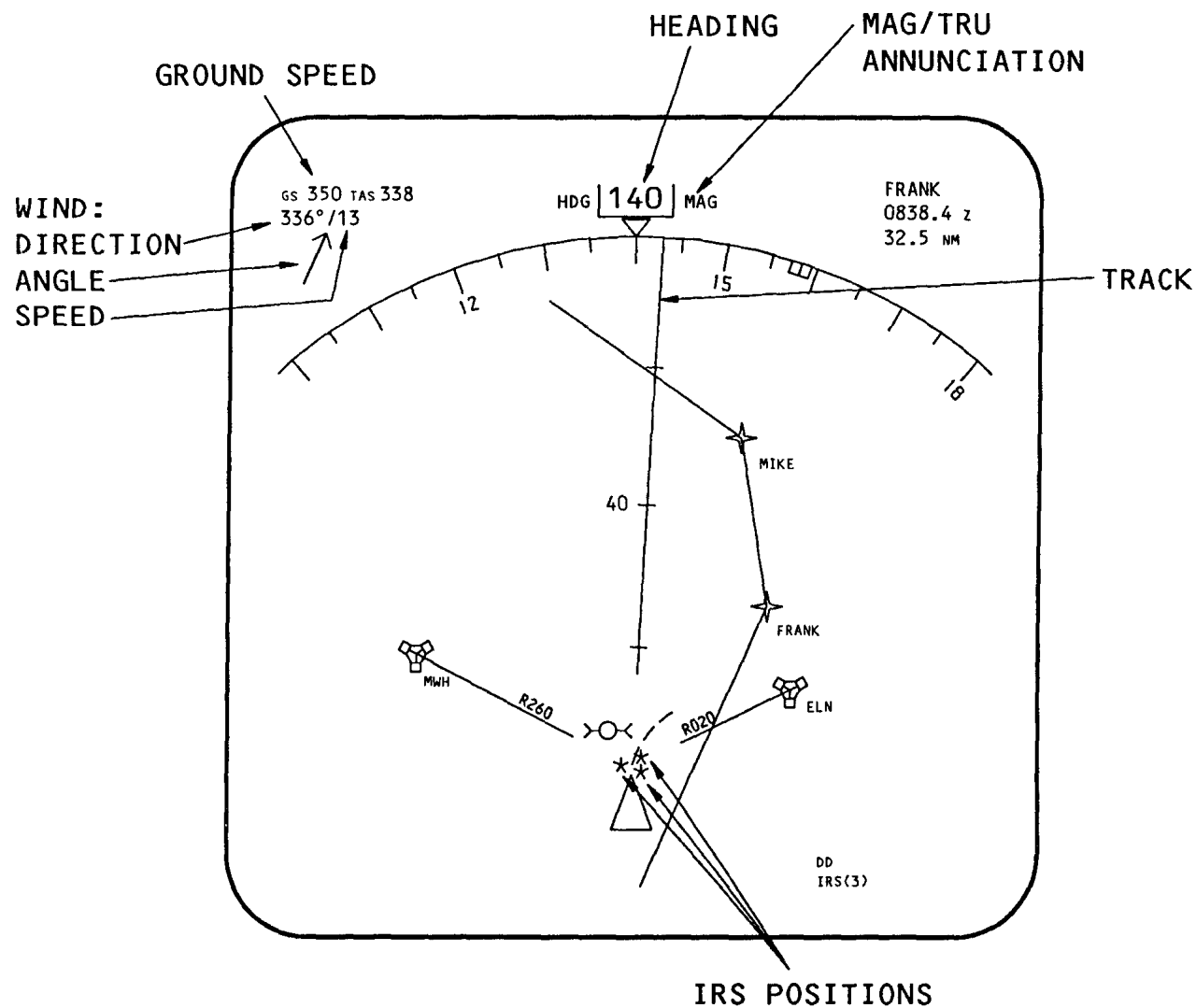


Figure 25 ND - EXPANDED MAP

IRS



ND - EXP MAP - NCD

With the EXP map mode shown on the ND and IRS information is NCD, these changes occur:

- Heading readout show dashes
- Heading tape numerics removed
- Groundspeed numerics go blank
- Wind direction and speed show dashes
- Wind direction pointer removed
- ADF pointers removed
- Selected heading bug and trend vector removed
- Heading pointer removed
- Map data removed
- Map flag displayed

NCD IRS data displays in the center map mode are the same as those described above.

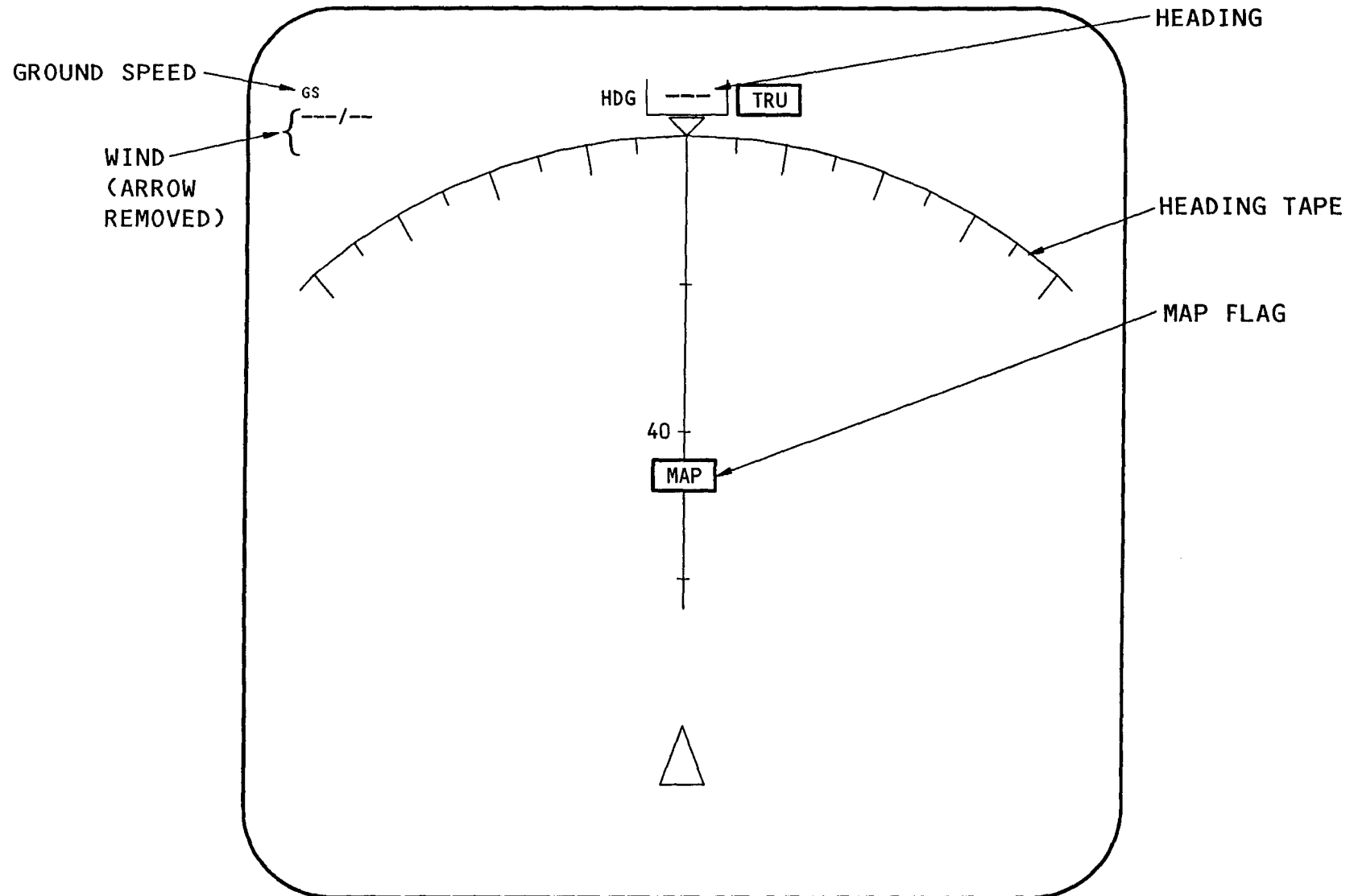


Figure 26 ND - EXP MAP - NCD

IRS



ND - EXP MAP - INVALID

With the EXP map mode shown on the ND and IRS information is invalid, these changes occur:

- HDG flap displayed
- Heading scale removed
- Heading scale numerics removed
- Groundspeed removed
- wind direction and speed removed
- ADF/VOR pointers removed
- Track pointer removed
- Selected heading bug and trend vector removed
- Map data removed
- map flag displayed

Invalid IRS displays in the center map mode are the same as those above.

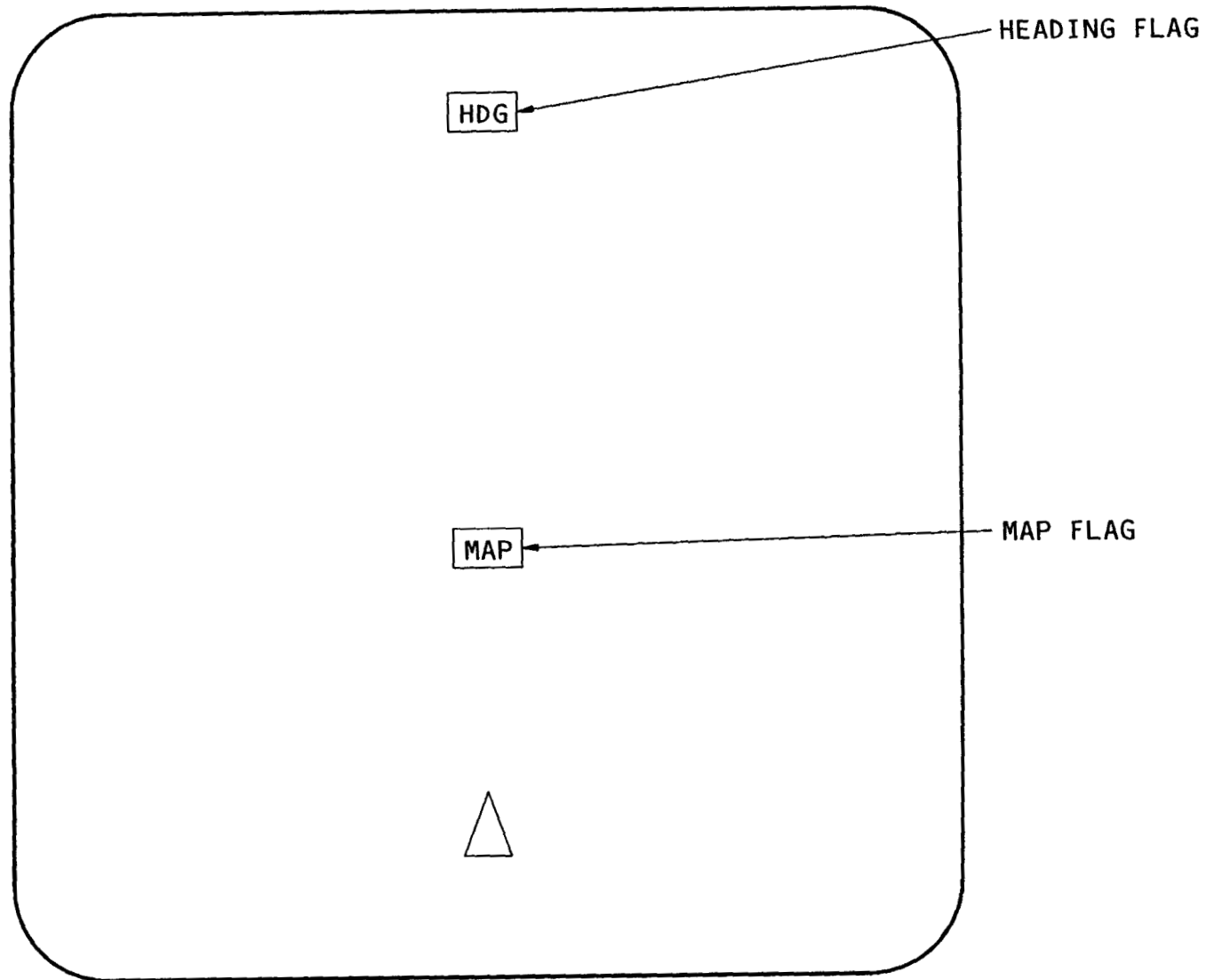


Figure 27 ND - EXP MAP - INVALID

IRS



DISPLAY - RMI

The radio magnetic indicator (RMI) shows magnetic or true heading from the selected IRU by rotating the compass card in relation to the heading marker.

The heading reference switch chooses whether the RMI will show magnetic or true heading.

When IRS heading is invalid or no computed data (NCD) or the RMI fails, the HDG flag comes into view.

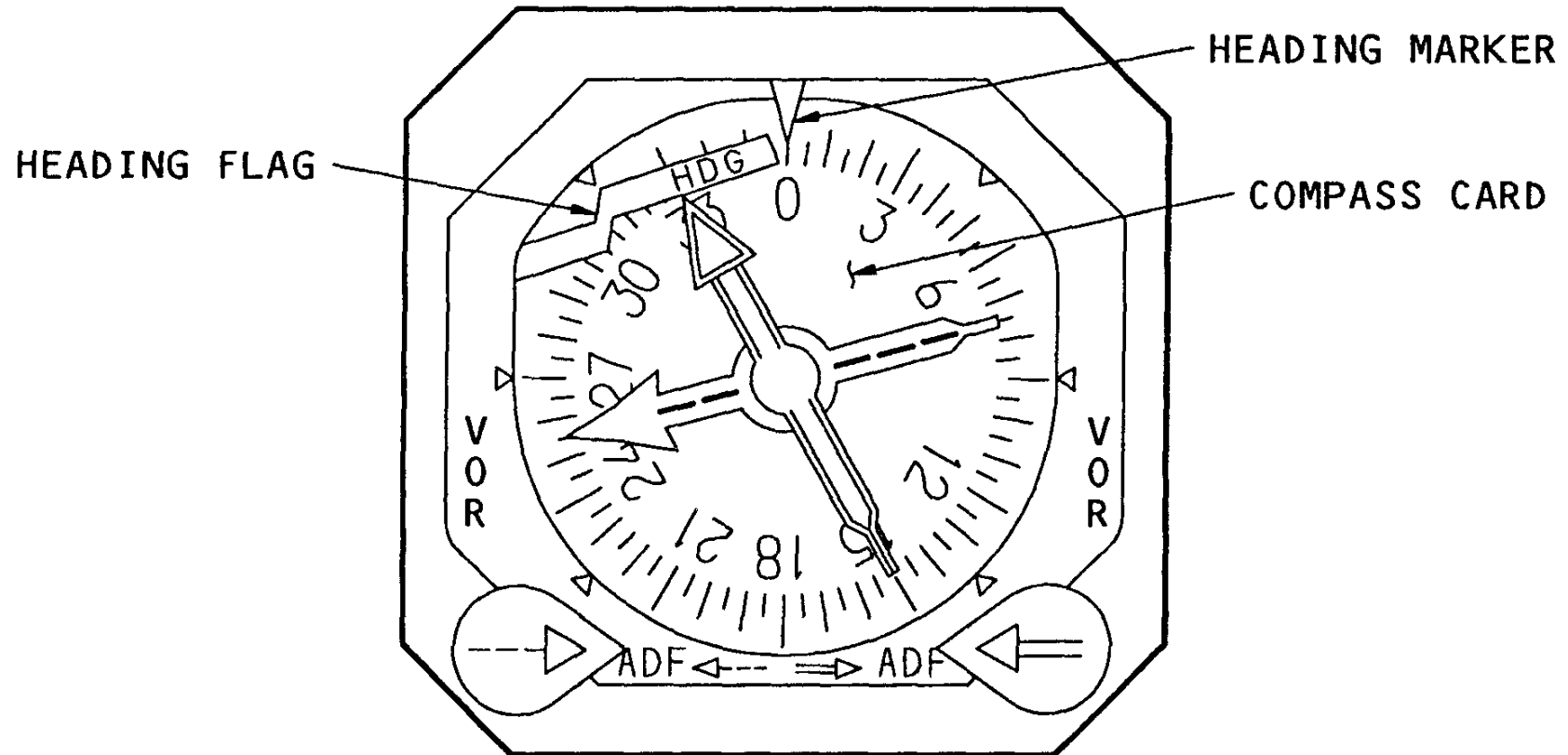


Figure 28 DISPLAY - RMI (optional)

IRS



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IRS



GENERAL OPERATION

Introduction

In normal operation, the IRS measures both the rate of rotation about the three axes of the airplane and the acceleration of the airplane along these three axes. From these measurements the IRS computes:

- Airplane attitudes relative to local level
- Headings relative to true north
- Velocities
- Present position

These computations require initial data which include the airplane's:

- Relationship to local vertical
- Relationship to true north
- Present position
- Present altitude

These measurements and computations occur in four possible modes.

Off Mode

When the mode select switch is moved to the OFF position, ac and dc power are disconnected inside the IRU. In this condition, the on-off logic circuits are still powered.

Alignment Mode

When the mode select switch is moved from the OFF to the ALIGN or NAV position, the IRU is placed in the alignment mode. During alignment the IRU:

- Determines local vertical
- Determines true heading
- Initializes attitudes, velocities, altitude (based on ADC inputs)
- Initializes present position (based on FMC inputs)

When the alignment is completed and the mode select switch is in the NAV position, the IRU will automatically enter the navigation mode. If the mode select switch is in the ALIGN position, the IRU will stay in the alignment mode until NAV is selected on the MSU.

Navigation Mode

In the navigation mode, the IRS measures rotation rates and accelerations to compute:

- Attitudes
- Velocities
- Headings
- Altitudes
- Present position

The IRU uses air data inputs to compute:

- Ground speed
- Inertial altitude
- Vertical speed
- Wind speed
- Wind direction

In the navigation mode the IRU provides:

- Attitude and attitude rates
- Accelerations
- True and magnetic headings
- Velocity vectors
- Vertical velocity
- Wind speed and direction
- Latitude and longitude
- Ground speed
- Inertial altitude



IRS

Attitude Mode

The attitude mode is used when the normal navigation mode of the IRU has failed.

When the mode select switch is moved to the ATT position, the IRS will provide:

- Attitude
- Attitude rates
- Heading
- Acceleration
- Vertical velocity

In this mode the IRU does not provide position ground speed or wind data.

True/Magnetic Heading

In the ALIGN and NAV modes, the IRU determines true heading. To calculate magnetic heading, inertial position is entered into a variation look-up table. Variation is applied to true heading to get magnetic heading. Both true and magnetic heading are output by each IRU.

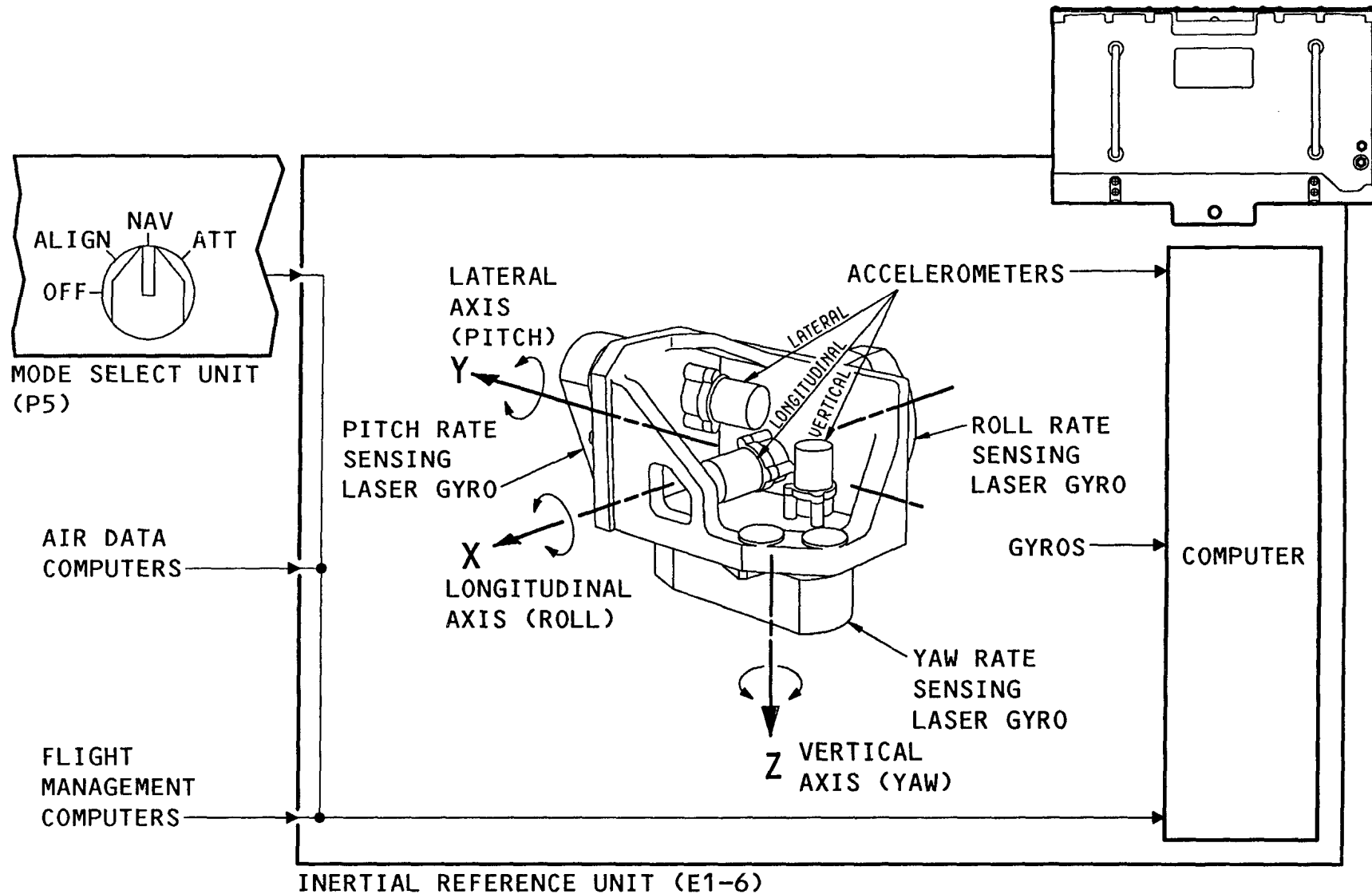


Figure 29 IRS OPERATION



LASER GYRO OPERATION

Each gyro is a triangle shaped cavity which contains a helium neon laser that produces two light beams. The two beams travel in opposite directions within the cavity. The light beams are created by a process called lasing. The helium neon gas is ionized by a high voltage between the anodes and cathode of the laser ring to produce the two beams. One corner of the triangle ring contains a prism that mixes the two beams together to form the fringe pattern which is seen at the readout detector.

When the gyro is stationary, the fringe pattern is also stationary because the frequencies of both beams are the same. When the gyro rotates, the frequencies are different because the path of the two beams are different lengths. This difference is shown by movement of the fringe pattern.

A dither motor in the center of the gyro vibrates the gyro. This vibration causes a small oscillatory rotation to be sensed by the gyro. This prevents a condition called laser lock. Laser lock is when the laser beams become coupled. This usually occurs when the gyro is rotated at a low rate. If laser lock occurs small rotations at low rotation rates may not be detected.

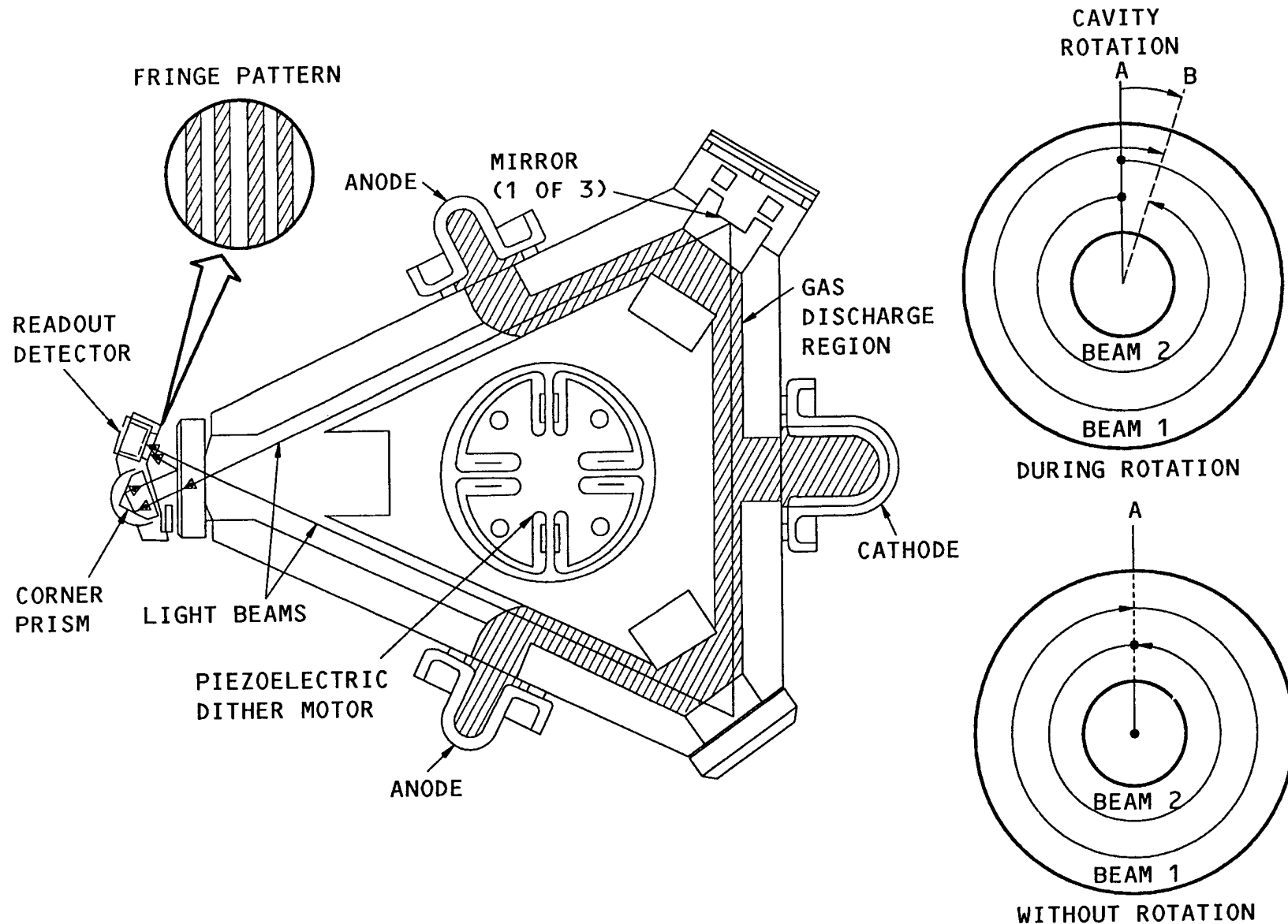


Figure 30 LASER GYRO OPERATION



IRS

POWER UP

General

The IRUs are turned on by moving the MSU mode select switch from OFF to NAV or ALIGN. When the switch is moved directly to NAV, the IRU will automatically enter the navigate mode at the end of the ten minute alignment period.

In 12 seconds, the IRS EICAS memo messages IRS ALIGN MODE L, IRS ALIGN MODE C, or IRS ALIGN MODE R appear on the main EICAS display to show that the IRU is in the alignment mode.

In approximately 12 seconds, under the title SET IRS POSITION on the POS INIT (Position initialization) page, the box prompts show. This tells the operator that a present position entry is required for the IRUs to complete alignment.

Power-Up BITE Test

At turn on, the IRUs computer looks at data for sensor bias, temperature coefficients and axis alignment for the gyros and accelerometers from memory.

At this time, the IRU performs a power-up BITE test which includes a power supply switchover test. This test verifies that the IRU power supply can switch over to the dc input. If the voltage is less than 18v dc, this test fails, and the IRU fault message appears on EICAS. If the power-up BITE test passes, the IRU continues the alignment.

Power Down

The normal procedure for turning off the IRS is to move the mode select switch on the MSU to the OFF position. When the mode select switch is moved to OFF, the IRU takes 30 seconds to store the last computed position, BITE fault data and sensor calibration update data in nonvolatile memory. After the data storage is complete power is removed from the IRU.

The IRU circuit breakers should not be used to turn off the IRU, since this causes an abrupt power down that prevents the IRU from storing last IRU position, important sensor calibration data and fault history.

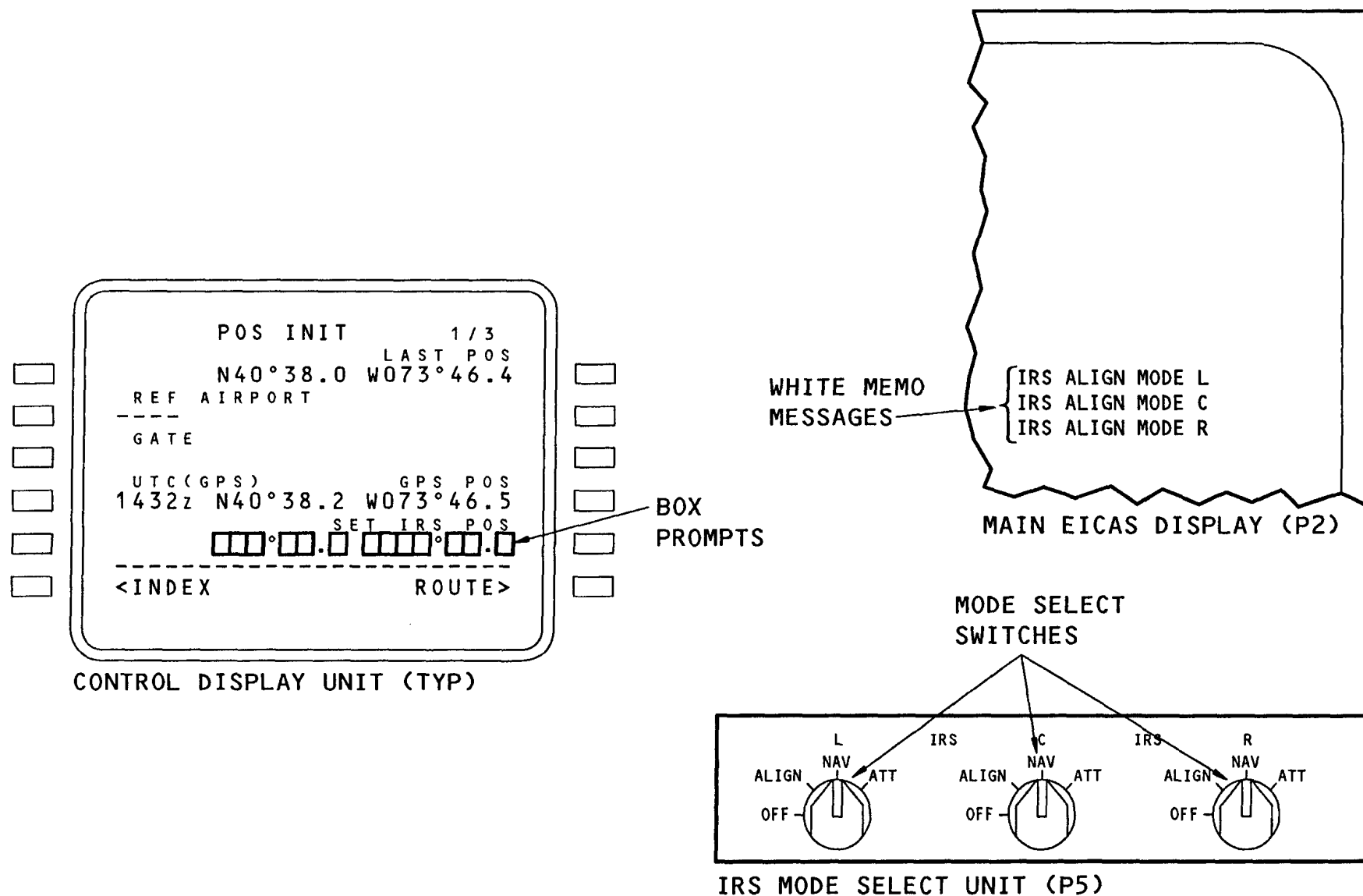


Figure 31 POWER UP

IRS



ALIGN MODE

During align the IRU determines:

- Local vertical
- True north
- Latitude

During align the IRU must be stationary. The three gyros in each IRU sense angular rate. The three accelerometers in each IRU sense acceleration along each axis. Because the IRU is stationary all sensed angular rates and accelerations are assumed to be caused by earth rotation or gravity. The IRU uses the direction of acceleration of gravity to determine local vertical (vertical for that position on the surface of the earth). The IRU uses the value of earth rotation to determine latitude. The IRU determines the direction of true north by sensing the direction of earth rotation. The IRU uses true north, direction of earth rotation and local vertical to determine northern or southern hemisphere.

During the align period, the operator must enter a present position (LAT/LONG) into the IRS. When a position entry is made, this LAT/LONG value is compared to the LAT/LONG value which was stored by the IRU at shutdown. At the end of the align period, the value of latitude which was entered by the crew is compared with the value of latitude calculated by the IRU during the align period. This comparison must be satisfactory before the IRU will enter the NAV mode.

Ten minutes are required to complete the alignment for any latitude between 70.2 degrees north and 70.2 degrees south. Seventeen minutes are required to complete the alignment for any latitude between 70.2 degrees and 78.2 degrees. Since the IRU will automatically enter the NAV mode after ten minutes if the mode select switch is in the NAV position, a high latitude alignment requires that the mode select switch be left in the ALIGN position for seventeen minutes before being selected to the NAV position.

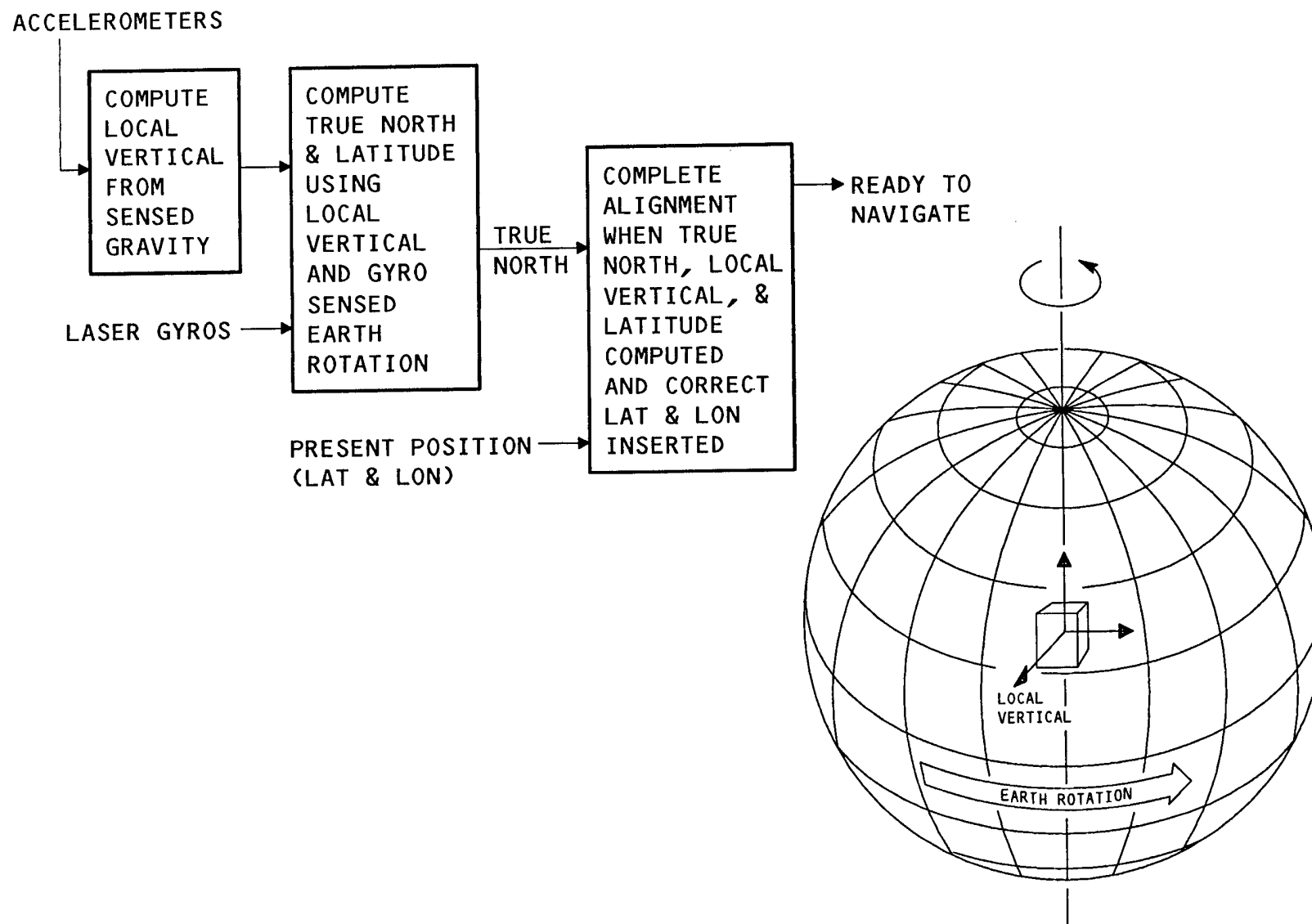


Figure 32 ALIGN MODE

IRS



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POSITION INITIALIZATION

The airplane must be on the ground and stationary to enter the present position. Initial present position is entered from the left or right CDU in one of these ways:

- Latitude/longitude is entered into the scratch pad using the keyboard, then using the line select keys into the SET IRS POS line.
- Latitude/longitude is transferred from the LAST POS line to the SET IRS POS line, using the line select keys.
- REF AIRPORT or REF AIRPORT and GATE is entered using the keyboard and the latitude/longitude is transferred to the SET IRS POS line using the line select keys.
- Latitude/longitude is transferred from the GPS POS line to the SET IRS POS line, using the line select keys.

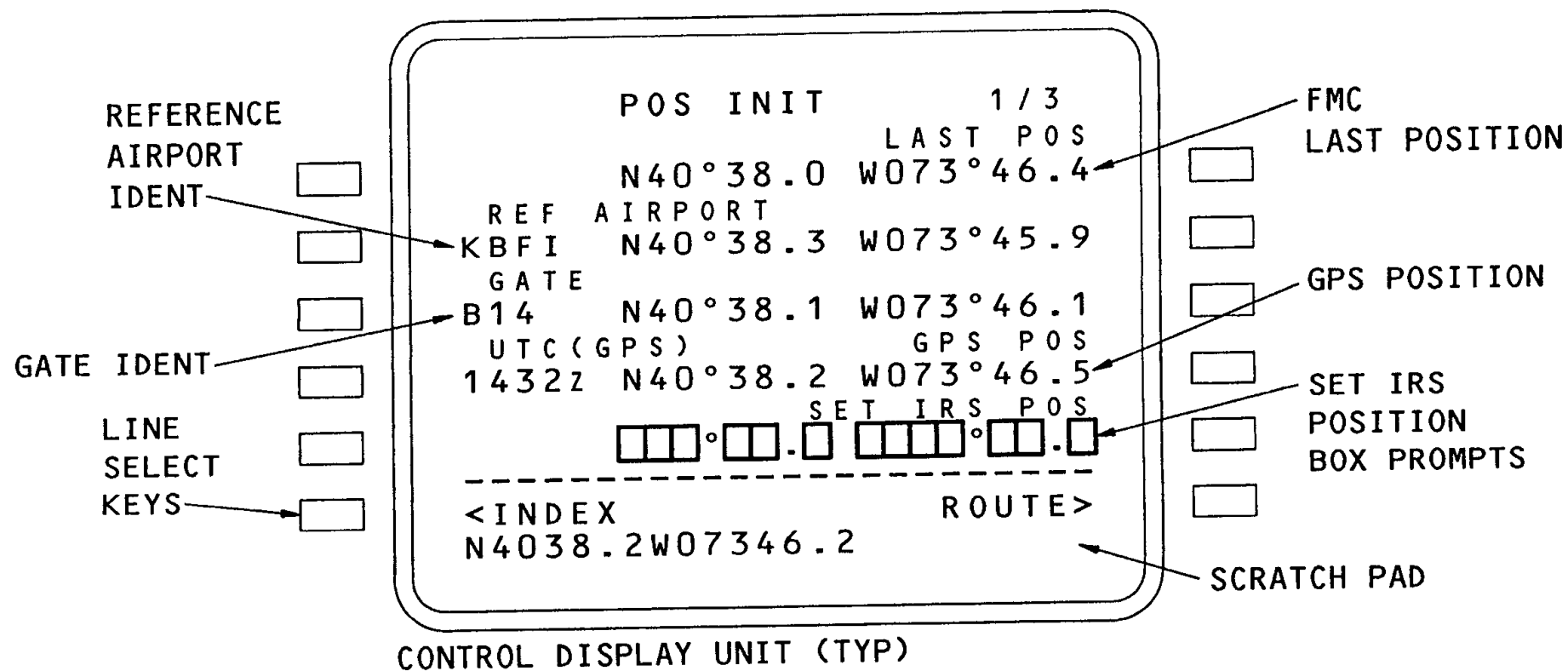


Figure 33 POSITION INITIALIZATION

IRS



INITIAL POSITION ENTRY MISCOMPARE

When present position is first entered, it is compared with the last present position value stored in the IRUs. If the entered present position is not within one degree of the stored position in either latitude or longitude, the message (MSG) light on the CDU will come on and the ENTER IRS POSITION message will appear in the CDU scratch pad. verify the position entered, clear the scratch pad message with the clear (CLR) key, and make another present position entry with necessary corrections. If this corrected position is within one degree of the IRUs last known position, the IRUs will accept it and the alignment will continue. If the same position entry is made again, the IRUs will also continue the alignment.

CAUTION: TWO IDENTICAL WRONG LONGITUDE ENTRIES WILL BE ACCEPTED AND USED BY THE IRU'S. THIS WILL CAUSE SERIOUS NAVIGATION PROBLEMS. ALWAYS VERIFY THAT THE CORRECT POSITION IS USED.

NOTE: THIS COMPARISON WILL NOT BE MADE DURING THE FIRST INITIALIZATION FOLLOWING SHOP SERVICING OF AN IRU OR SHUT DOWN OF AN IRU FROM THE ATTITUDE MODE.

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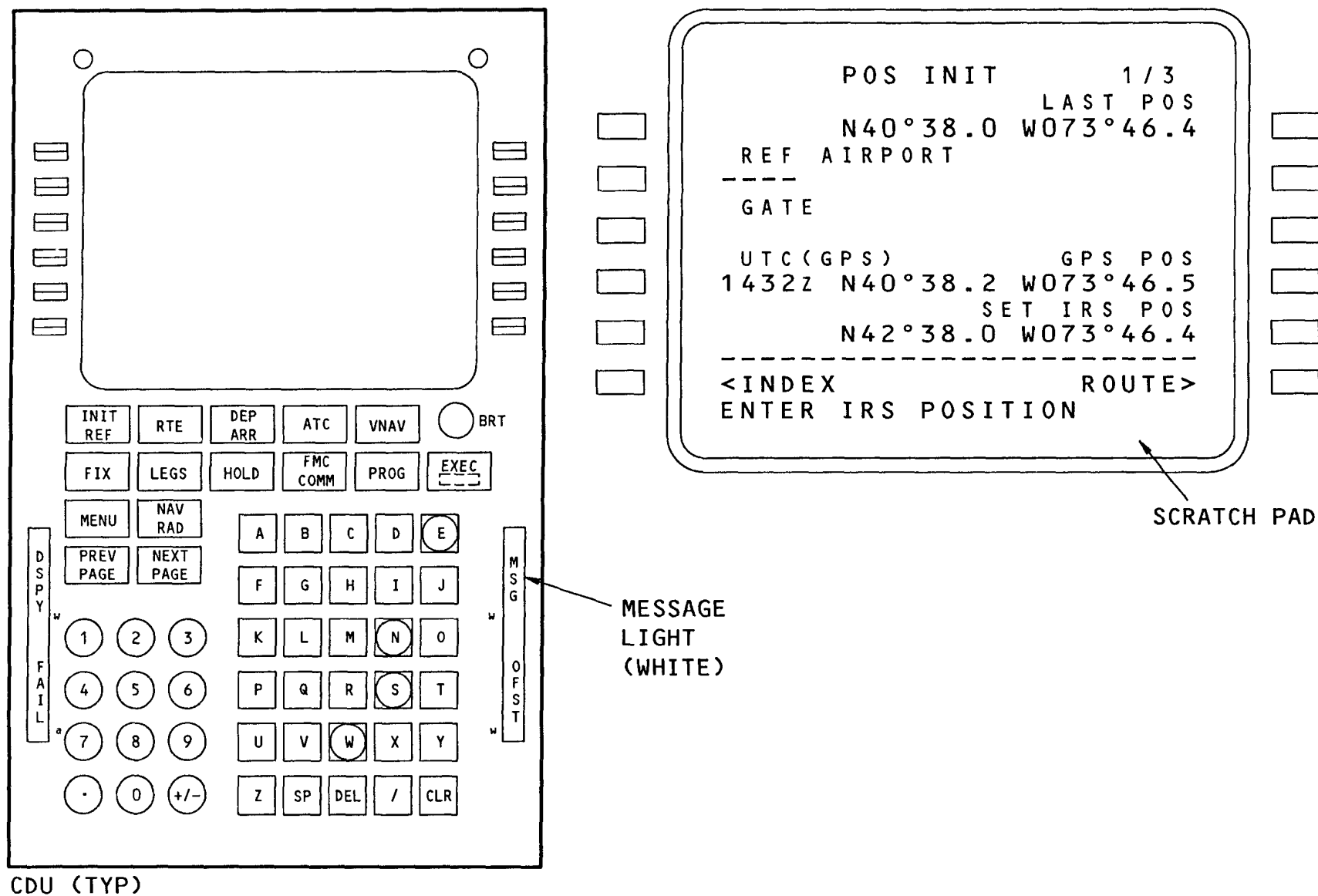


Figure 34 INITIAL POSITION ENTRY MISCOMPARE

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POS/ORIGIN DISAGREE

The FMC compares the IRU positions with the active origin airport position in the navigation data base (NDB). When any valid IRU position differs from the active origin position by more than 6 nm, with the airplane on the ground, the IRS POS/ORIGIN DISAGREE message shows in the scratch pad, an EICAS message shows, and the message (MSG) light comes on.

The active origin position is set by the entry and execution of an origin on the active ROUTE page or by the activation and execution of an inactive route. For example, when the origin airport (KBFI) is entered in IL and executed or if the company route (BO-012) is activated and executed, the IRS position and origin airport position are compared.

The message is cleared by using the clear CLR key on the CDU.

The IRS POS/ORIGIN DISAGREE message is inhibited for ten seconds after the position entry in 4R of the POS INIT page to allow the ENTER IRS POSITION message to show.

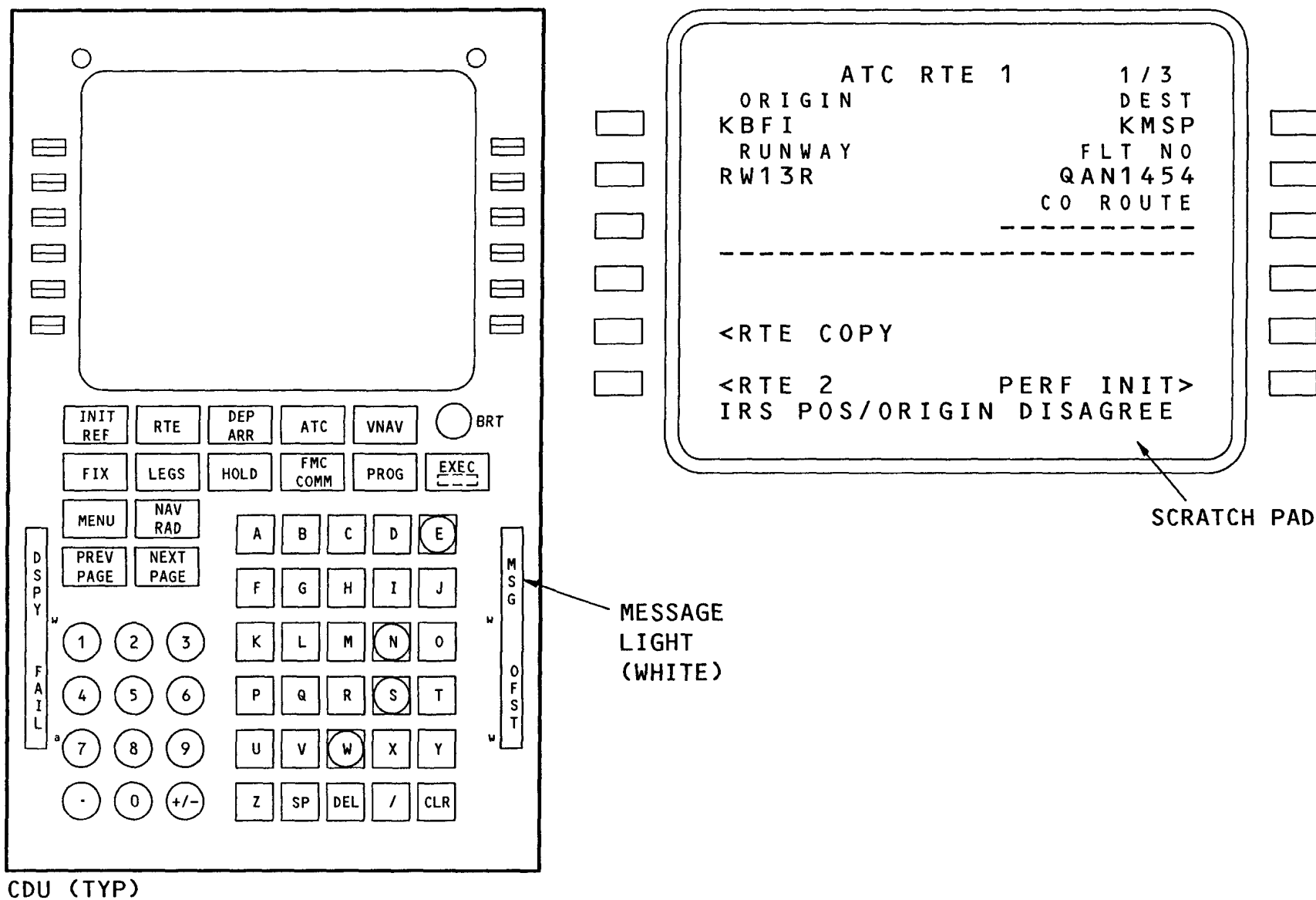


Figure 35 POS/ORIGIN DISAGREE

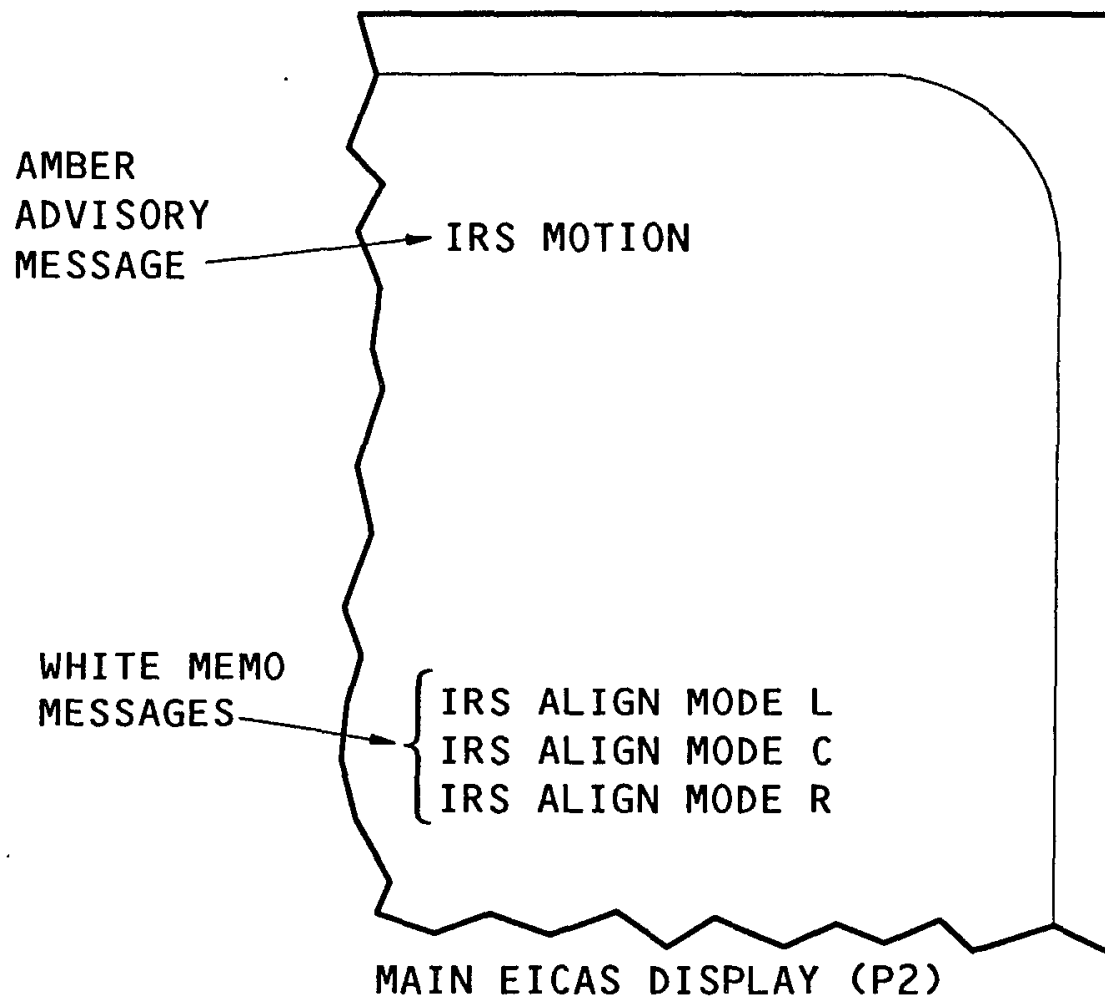
IRS



ALIGNMENT INDICATIONS - EXCESSIVE MOTION

When the airplane experiences excessive motion, while the IRUs are in the alignment mode, this will occur:

- IRU alignment stops, and memo message IRS ALIGN MODE L (C or R) no longer is displayed.
- The EICAS advisory message IRS MOTION will show on the main EICAS display for 30 seconds or until the motion stops whichever is longer.
- The IRUs will automatically restart an eight-minute alignment period when the motion stops. IRS ALIGN MODE L (C or R) is displayed.

**Figure 36** ALIGNMENT INDICATIONS - EXCESSIVE MOTION

IRS



ALIGNMENT INDICATIONS - NO PPOS ENTERED

When the 10-minute alignment period has elapsed and an initial present position (PPOS) has not been entered:

- The message ENTER IRS POSITION is displayed on the CDU.
- The MSG (message) light comes on, on the CDU.

When a valid present position is entered, the condition will be corrected.

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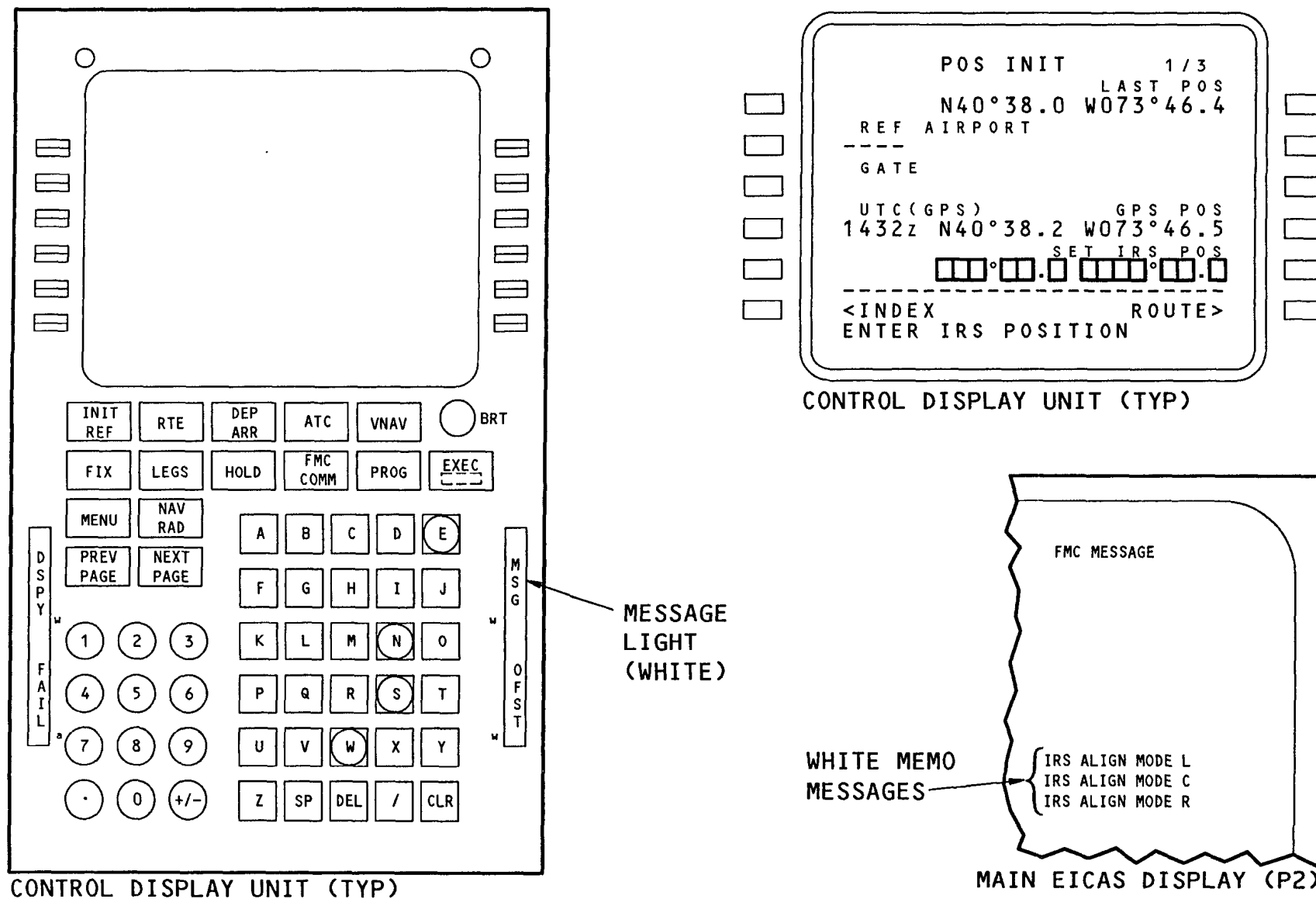


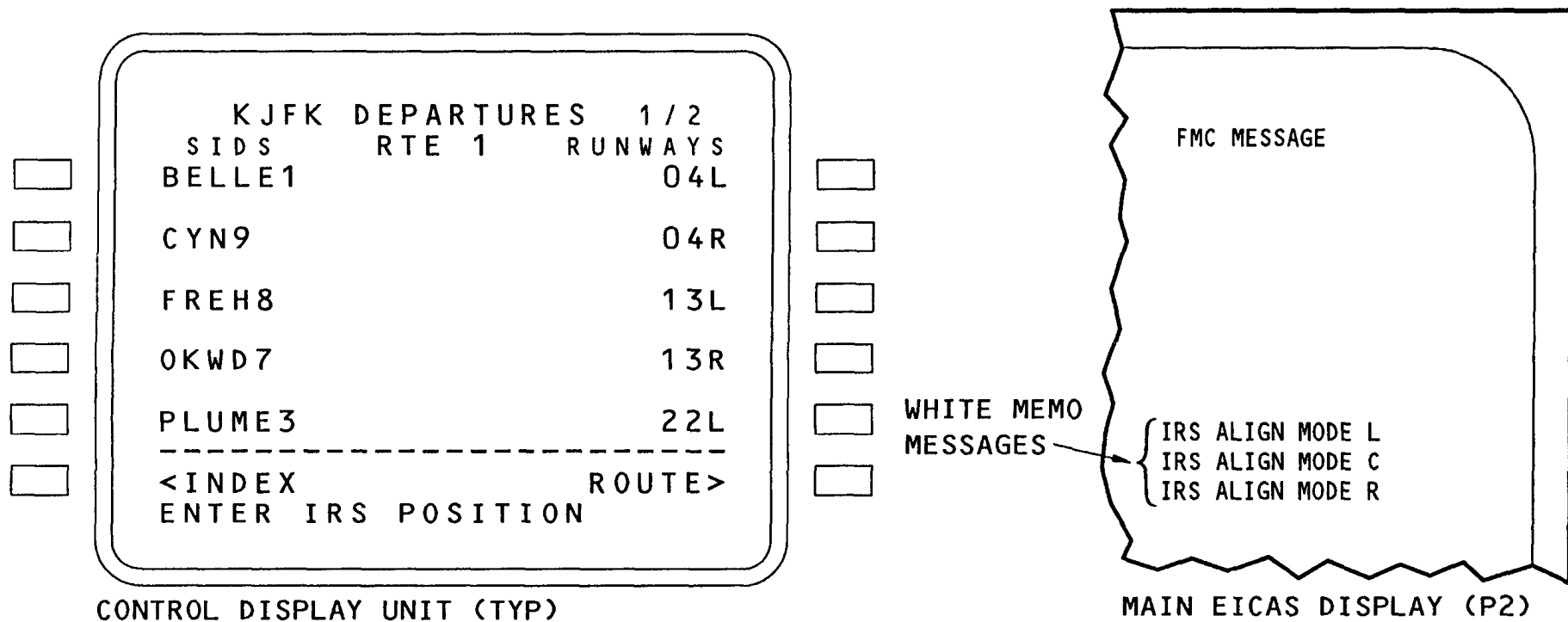
Figure 37 ALIGNMENT INDICATIONS - NO PPOS ENTERED

IRS



CALCULATED LATITUDE MISCOMPARE

By the end of the 10-minute alignment period, the IRUs will have calculated their own latitude and will compare it to the operator-entered latitude. When these values differ by a certain amount (varies with latitude), the CDU message ENTER IRS POSITION is displayed. The present position must be re-entered. If the position passes the IRU comparison, the IRU will transition to the navigation mode. The CDU message ENTER IRS POSITION and the EICAS memo messages will disappear.

**Figure 38 CALCULATED LATITUDE MISCOMPARE**

IRS



CALC. LAT. MISCOMPARE SECOND COMPARISON

By the end of the 10-minute alignment period, the IRUs will have calculated their own latitude and will compare it to the operator-entered latitude. This test serves as both a quality of alignment check and, if the IRU aligns properly, an operator input check. When these values differ by a certain amount (varies with latitude), the CDU message ENTER IRS POSITION is displayed. The present position must be verified and reentered.

If the entered position fails the latitude comparison test a second time, the IRU will report a failure and will not enter the navigation mode. This is indicated by an advisory message on the main EICAS display. The ENTER IRS POSITION data field is blank at this time.

When this failure occurs, it is advisable to re-try the alignment. The IRU must be switched off, and alignment procedures must be done again.

NOTE: IF MULTIPLE IRU'S REPORT FAILURE, IT IS MOST PROBABLY DUE TO OPERATOR ERROR RATHER THAN ACTUAL IRU FAULTS.

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SITUATION: LEFT IRU HAS FAILED
LATITUDE COMPARISON A SECOND TIME.
CENTER AND RIGHT IRUs HAVE ENTERED
THE NAV MODE.

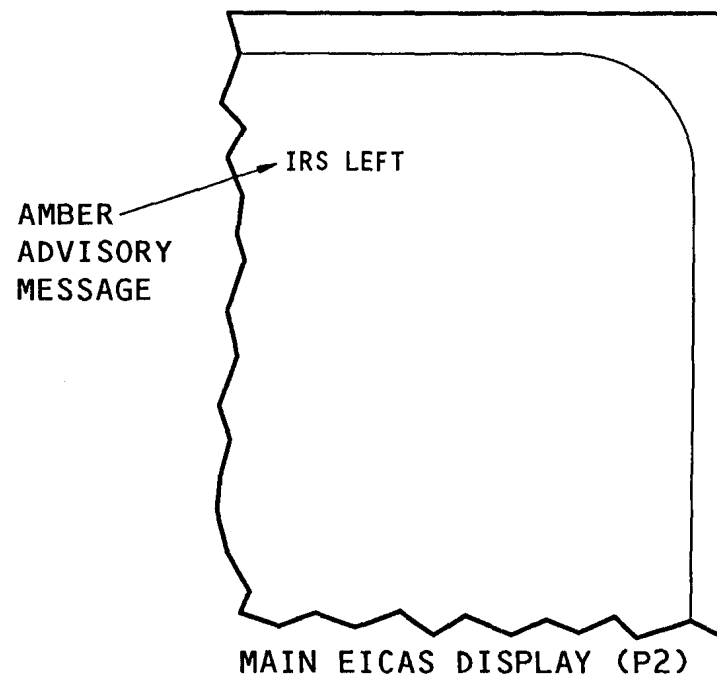
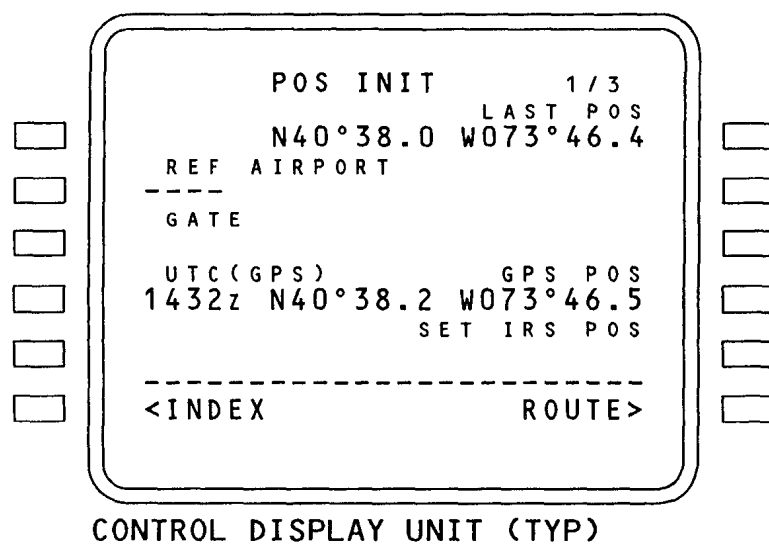
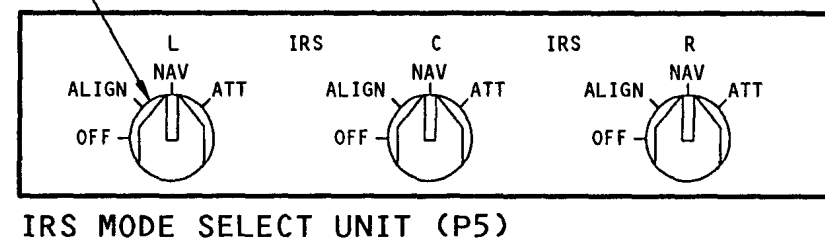
MODE
SELECT
SWITCH

Figure 39 CALC. LAT. MISCOMPARE SECOND COMPARISON



IRS

RAPID REALIGN MODE

General

The IRS can accumulate ground speed and position errors on short flight segments.

The IRS rapid realign mode provides the capability for the operator to quickly re-initialize the IRS without going through the 10-minute alignment process. This method is not to be used before long overwater flights.

NAV To ALIGN To NAV

With the IRU in the navigation mode, and with the airplane stationary and the IRU ground speed is not over 20 knots, the operator may select ALIGN and then reselect NAV on the MSU. This puts the IRU in the rapid realign mode and IRS ALIGN MODE (L, C, R) shows on the main EICAS display. In this mode, all velocities, and pitch and roll errors are corrected. Present position can be updated within thirty seconds. Approximately 30 seconds after rapid realign mode entry, the IRU will return to the navigation mode.

NAV To ALIGN

When the mode selector switch is moved from NAV to ALIGN, velocities, accelerations and rates are set to zero. Present position can be updated at any time. The IRU corrects heading and pitch and roll errors as long as the mode selector switch is in the ALIGN position.

Position Miscompare

In the case of either NAV to ALIGN to NAV or NAV to ALIGN, a newly entered position must be within 1/2 degree latitude and 1 degree longitude of the internal IRU position. If the comparison fails, the scratch pad message, ENTER IRS POSITION, is displayed. If the comparison fails again after a position re-entry, the scratch pad message, CYCLE IRS OFF-NAV, appears. The IRU has probably drifted or may be defective, a full alignment can be started over to verify the condition.

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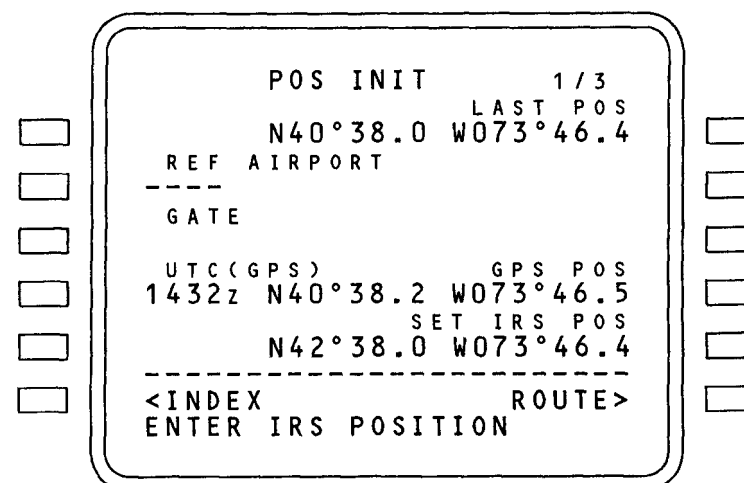
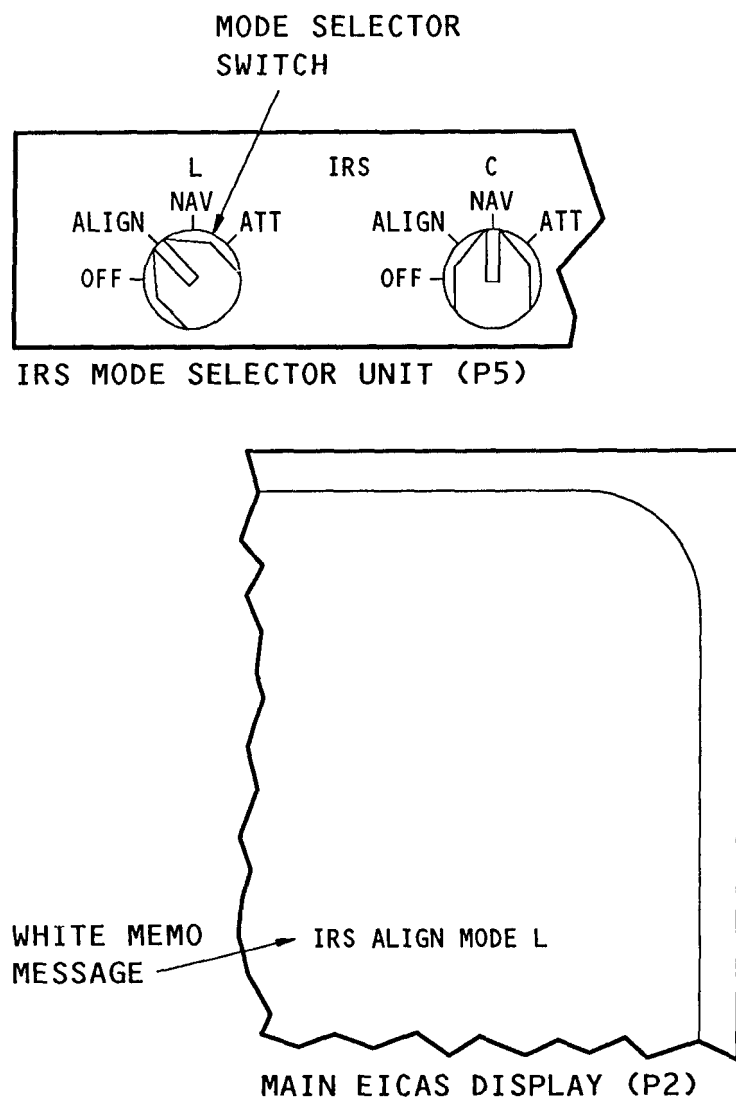
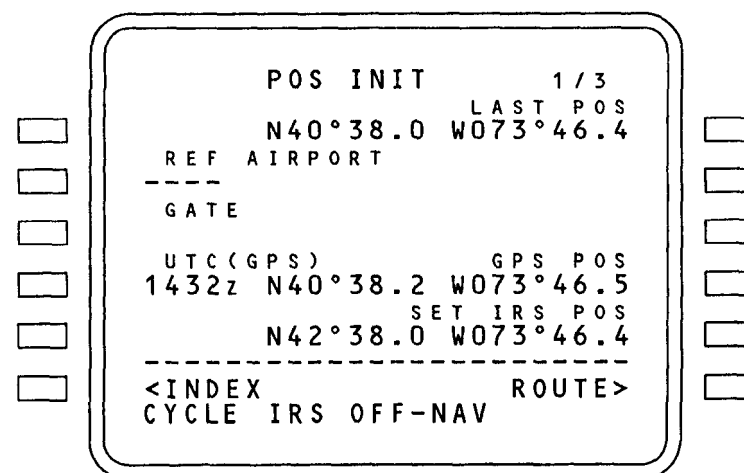
CONTROL DISPLAY UNIT (TYP)
FIRST MISCOMPARECONTROL DISPLAY UNIT (TYP)
SECOND MISCOMPARE

Figure 40 RAPID REALIGN MODE



VERTICAL SPEED AND WIND

Vertical speed

The IRU computes vertical speed from vertical acceleration. This is integrated with time to get inertial vertical speed.

Vertical acceleration provides fast response using the IRU accelerometers. Since the IRU calculation of altitude is unstable, the IRU must get valid pressure altitude from the ADC to compute inertial altitude and vertical speed.

Wind Speed/Direction

The IRU computes wind speed and direction. Wind speed and direction are computed as the difference vector between true airspeed (TAS) measured along the true heading and aircraft groundspeed measured along the true track.

The IRU must get valid TAS from the ADC to compute wind speed and direction. Wind data shows on the ND referenced to true north or magnetic north, depending on the heading reference.

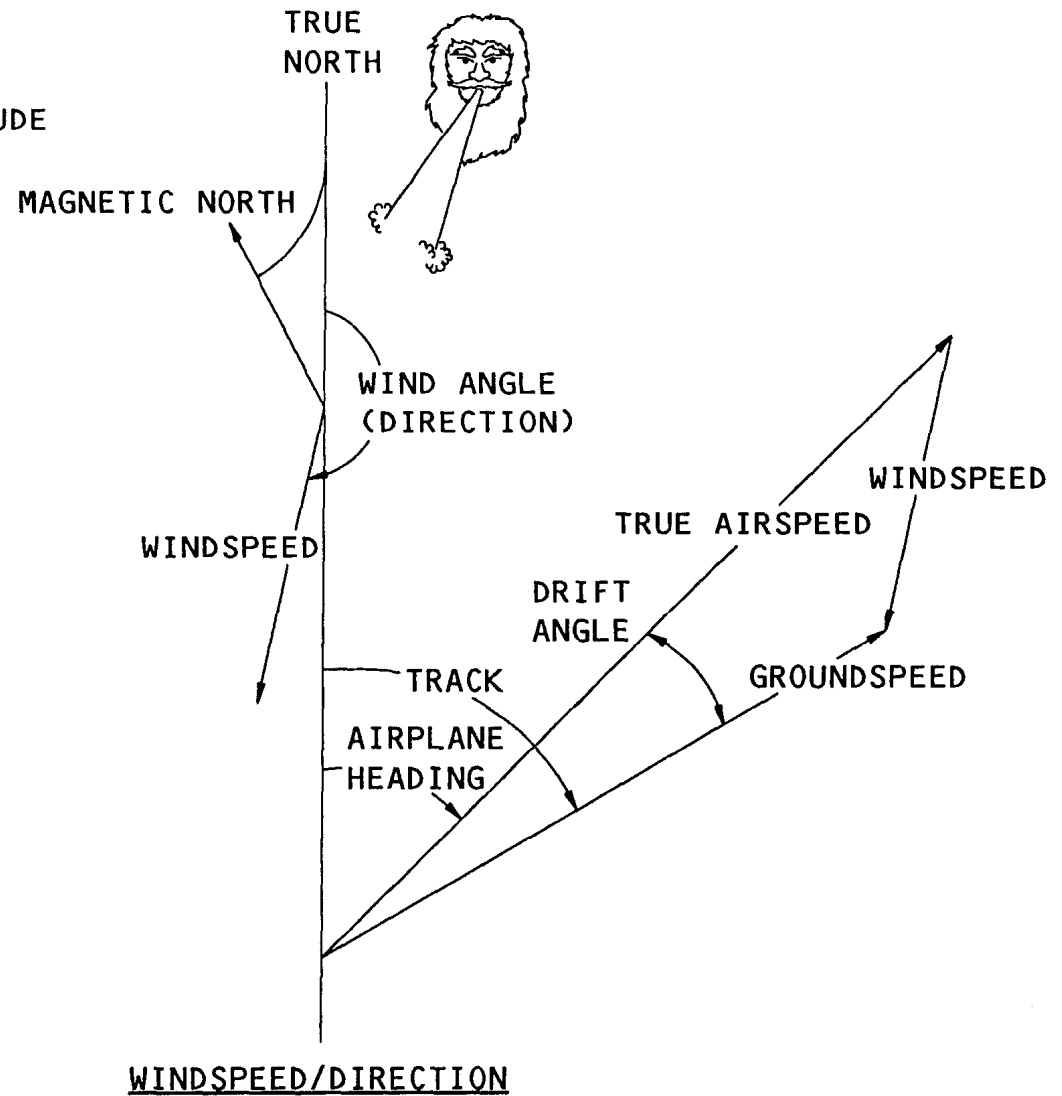
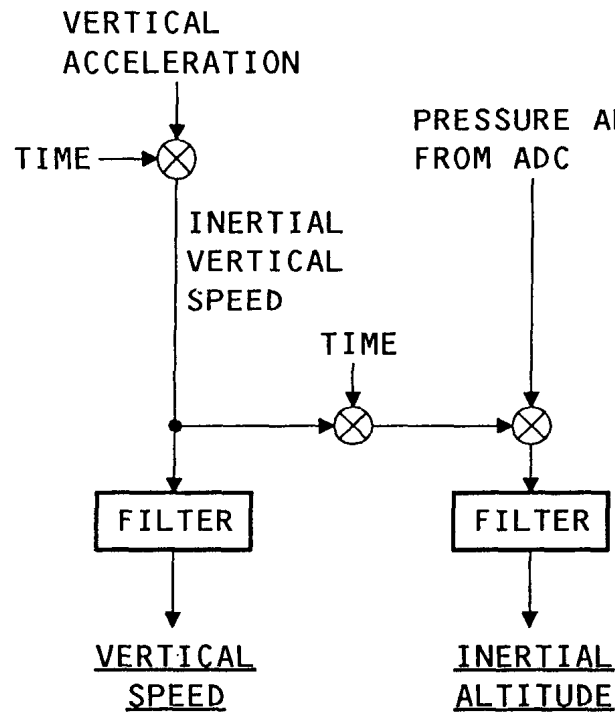


Figure 41 VERTICAL SPEED AND WIND

IRS



HEADING INITIALIZATION - ATTITUDE MODE

The attitude mode is a degraded mode of operation. If the navigation capability of an IRU fails or a temporary total power failure occurs it may be possible to operate in the attitude mode and obtain pitch, roll and heading data from the IRU. If there has been a complete loss of power to an IRU in flight, the IRU would need to be realigned and reinitialized. In this example, the right IRU mode selector switch is placed in the ATT position. The IRS EICAS memo message IRS ALIGN MODE R appears on the main EICAS display and the box prompts show on the CDU. These indications will remain until the attitude mode is fully operational which normally takes 20-30 seconds. In flight, the airplane must maintain a constant velocity and level attitude for the attitude mode to become operational.

The altitude rate from the ADC is read one time and is used to initialize the IRU vertical speed. If the altitude rate is not available the altitude from the ADC is used, vertical speed is set to zero and remains NCD for 2-1/2 minutes until the IRU can calculate a valid vertical speed. If both altitude rate and altitude are unavailable from the ADC, the IRU vertical speed will remain NCD.

When the right IRU mode select switch is placed in the ATT position, SET IRS HDG and dash prompts appear on the CDU.

This allows the operator to initialize the IRS heading. Enter the desired reference heading through the CDU keyboard. The heading entry will show for five seconds, and the display returns to dash prompts.

When ATT mode is selected, the IRU is latched into the attitude mode (regardless of MSU switch position) until power is removed from the IRU by selecting the OFF position.

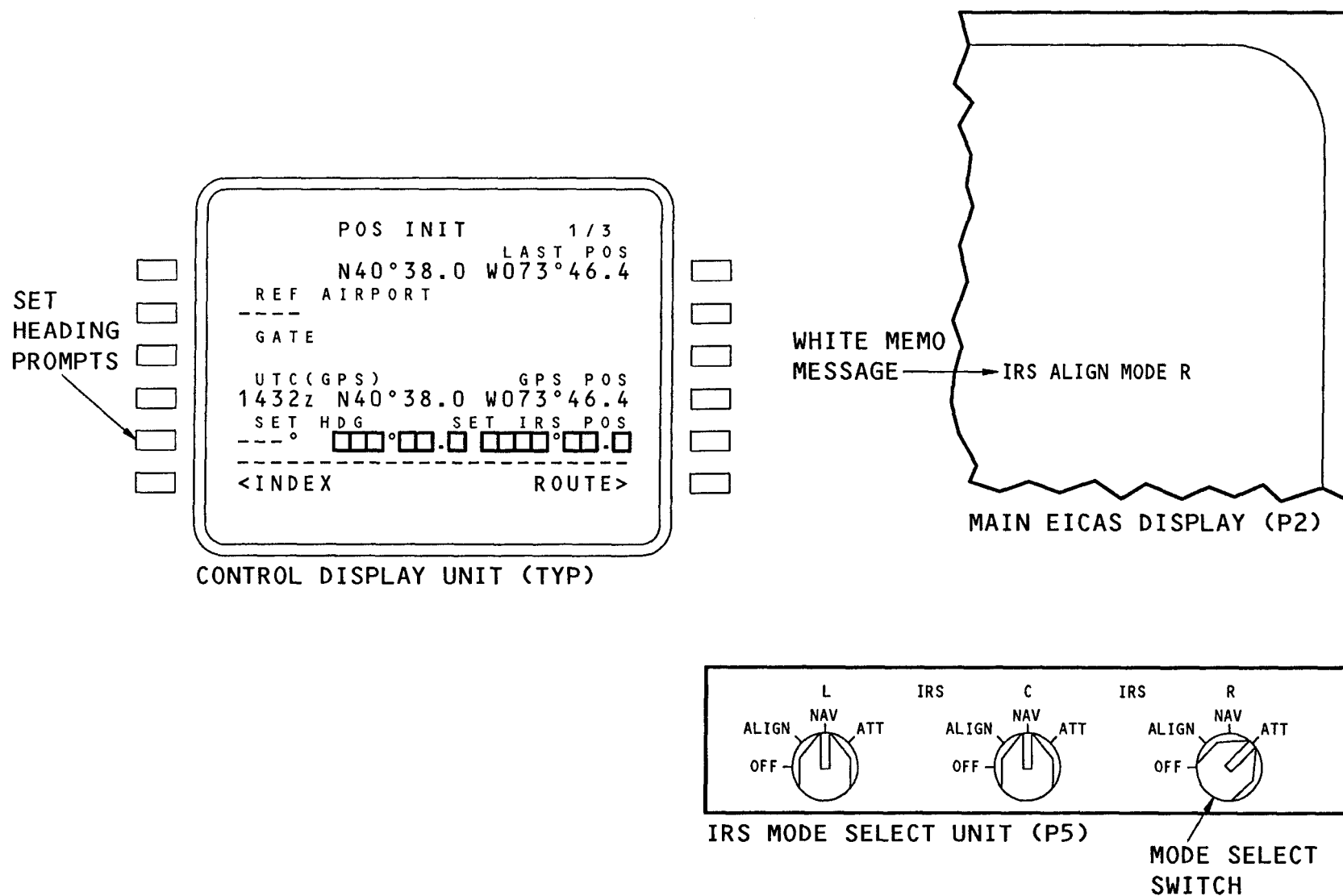


Figure 42 HEADING INITIALIZATION - ATTITUDE MODE



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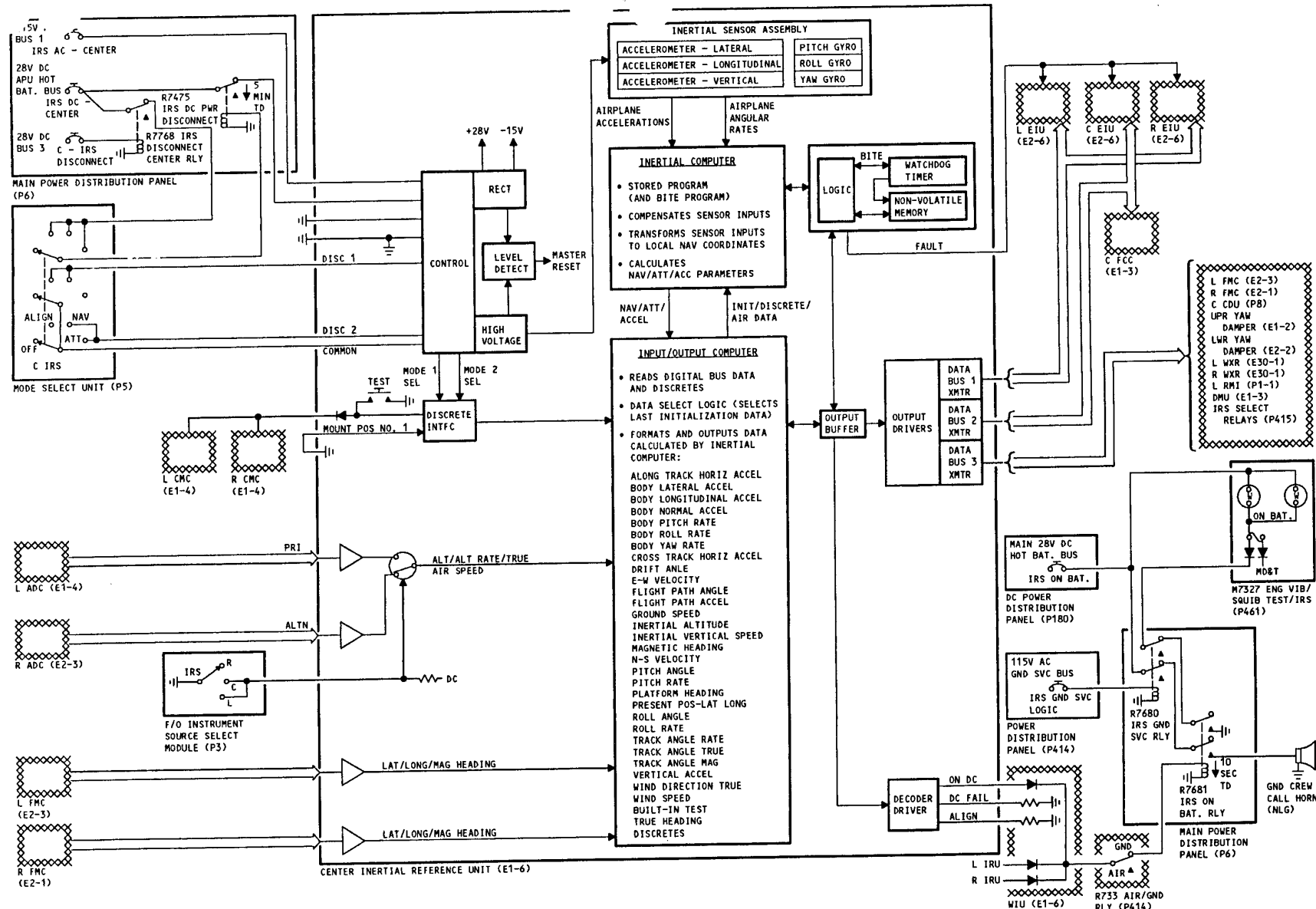


Figure 43 IRS - SCHEMATIC DIAGRAM

IRS



IRU CONTROL

The IRS mode select unit (MSU) controls the mode of each IRU operation by grounding or opening contacts on the associated mode select switch. The IRU can be commanded to off, alignment, navigation, or attitude modes by the selection of OFF, ALIGN, NAV, or ATT respectively.

Program pin connections indicate to the IRU computer the physical mounting orientation of the IRU. This is for the computer to correctly use the acceleration signals from the accelerometers and the angular rate signals from the gyros.

The FMCs provide the initial position latitude and longitude (entered by the operator) for use in alignment and navigation. The FMCs also provide operator-entered heading for use in the attitude mode. Left FMC data is used unless its data becomes invalid and then right FMC data is used.

The CMC can initiate an individual IRU interface test by grounding the remote test input.

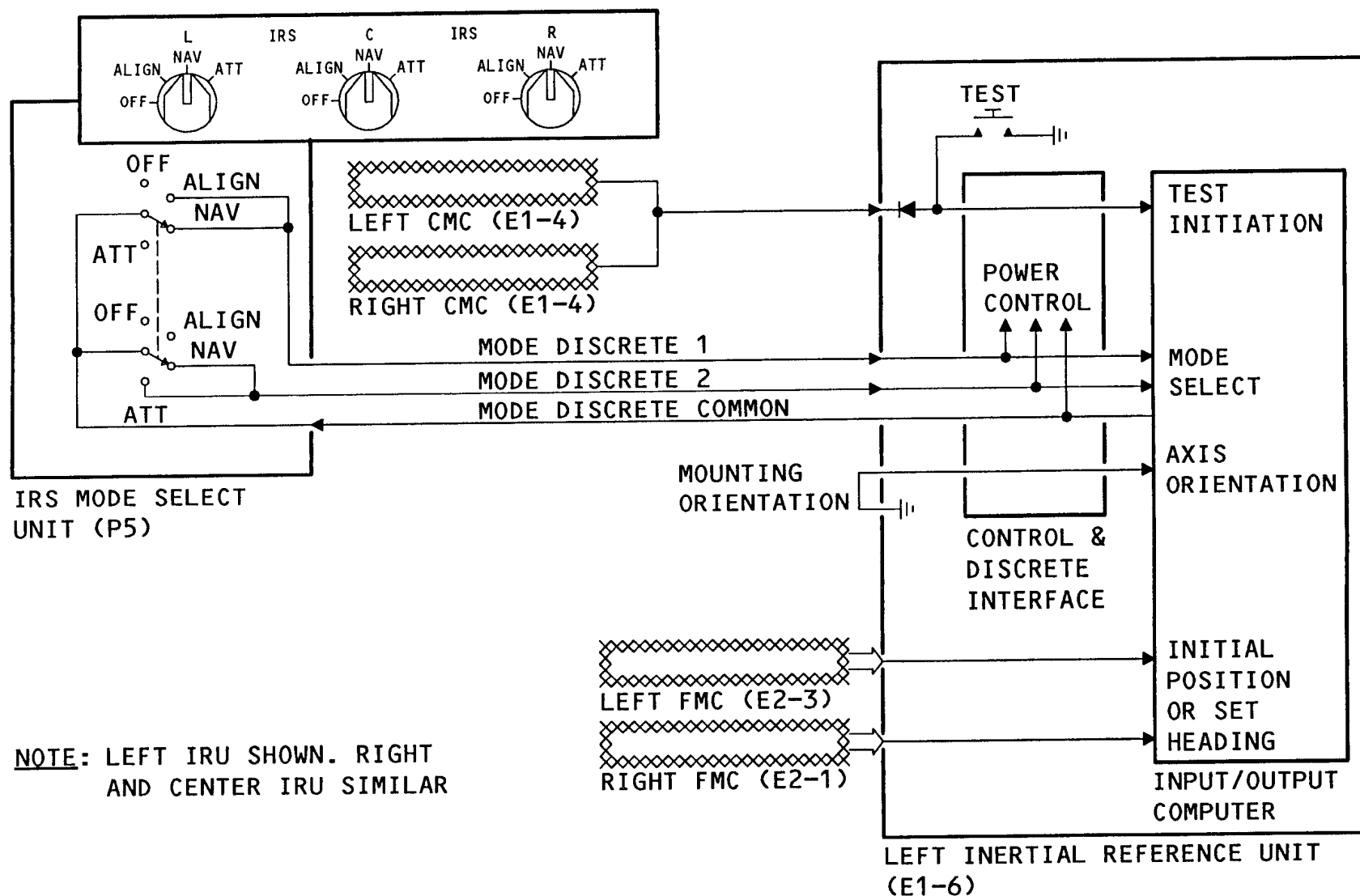


Figure 44 IRU CONTROL

IRS



IRU INTERNAL PROCESSING

Inertial Sensor Assembly

The inertial sensor assembly contains the accelerometers and gyros. The accelerometers measure the acceleration along the airplane axes. The gyros measure the rates of rotation about these axes. The data are sent to the inertial computer for use in alignment and navigation computations.

Inertial Computer

The inertial computer performs the processing required for built-in-test and monitor, alignment, navigation and status reporting.

Input/Output Computer

The input/output computer receives inputs, formats them and passes them on to the inertial computer and output buffer. It also receives inertial computer outputs that it formats and outputs to the bus output buffer and then to the BITE module, decoder driver, and bus output drivers.

BITE MODULE

The BITE module interprets the status received from the two computers and provides status feedback to the inertial computer. The BITE module provides the FAULT discrete to the EIUs for EICAS fault messages.

IRS On DC Output

When the IRS has switched to operation on dc power, a discrete is sent to initiate the appropriate annunciations.

Bus Outputs

There are three ARINC 429 output busses which transmit identical data to user systems.

Interface Test

The CMC or IRU test switch causes the IRU to perform an interface test, where the IRU sends out test data on its output buses.

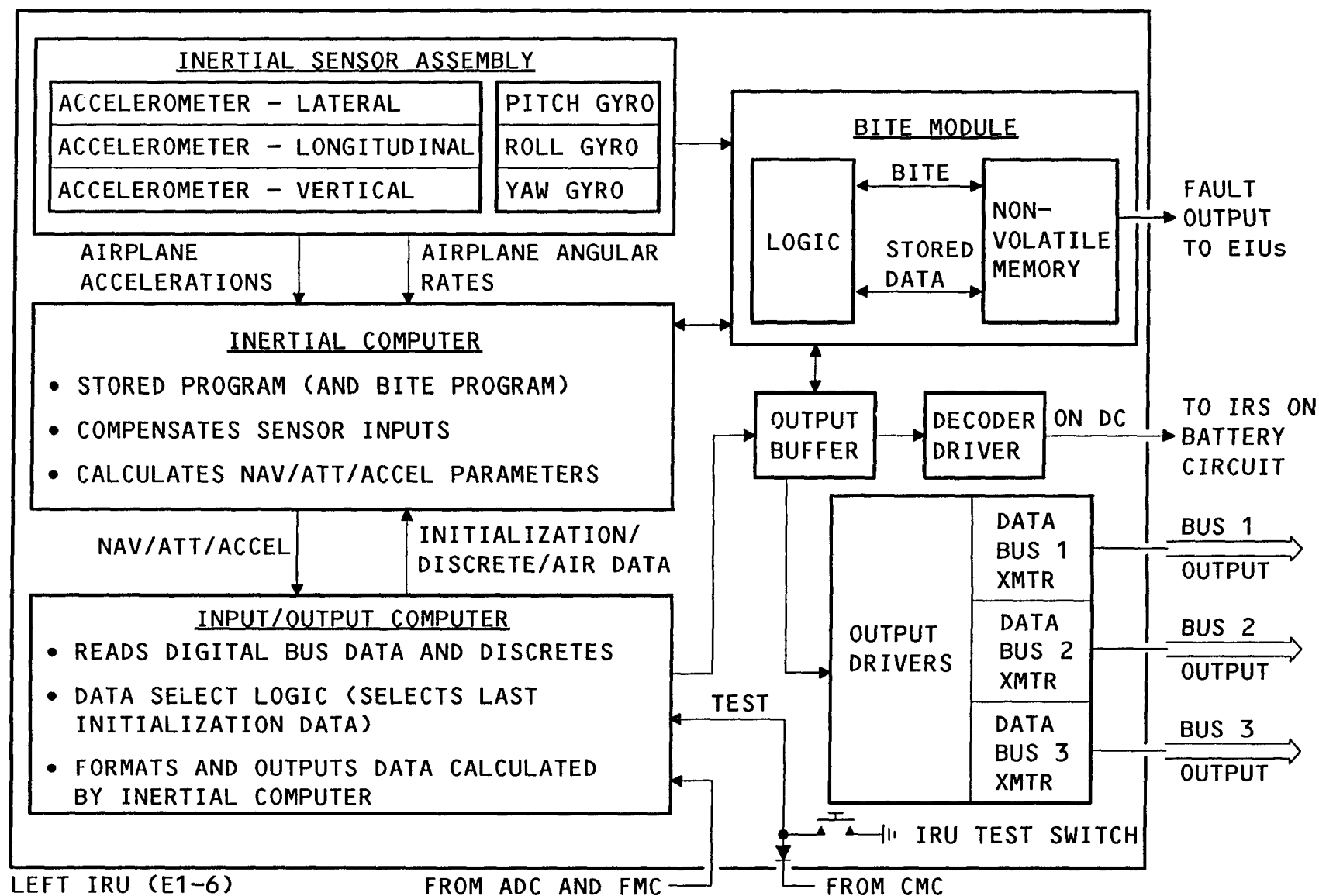


Figure 45 IRU INTERNAL PROCESSING

IRS



IRS - ON BATTERY WARNING

The IRU normally operates on ac power. If ac power is lost, the IRU will automatically switch to dc power from the APU hot battery bus. If the aircraft is on the ground, a discrete causes the IRS on battery relay to energize in 10 seconds.

Normally, the IRS ground service relay is energized by the ground service ac bus. This bus powers the APU battery charger, so dc power used by an IRU is from the charger. If the ground service bus is lost, the IRS ground service relay opens. If this happens when the IRS on battery relay is closed, the ground crew call horn sounds and the IRS ON BATTERY light comes on.

This is to alert the maintenance personnel so they will turn off the IRUs. This prevents them from discharging the APU battery and possibly operating without equipment cooling.

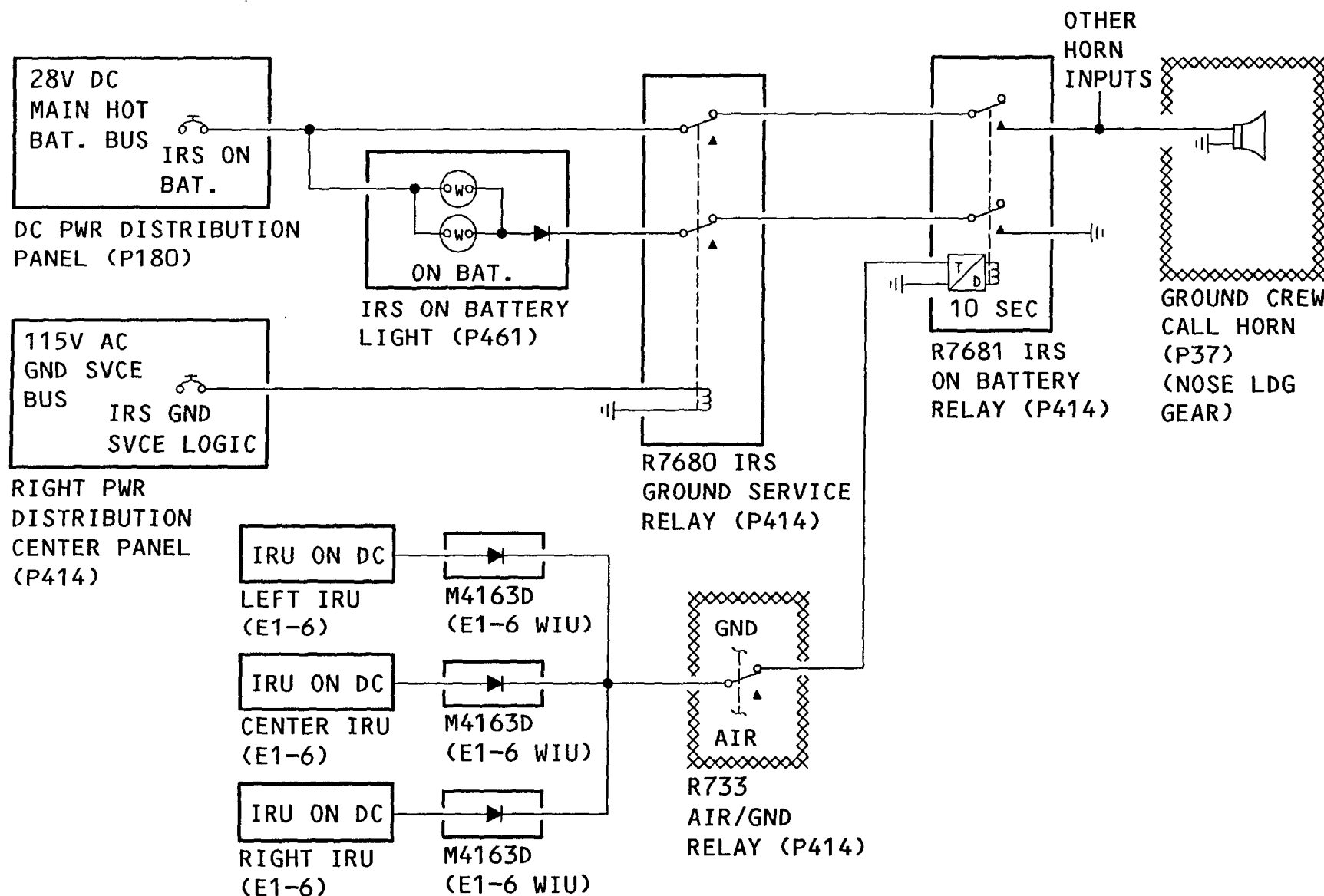


Figure 46 IRS - ON BATTERY WARNING

IRS



RMI OPERATION - CAPTAIN

The captain's RMI compass card gets data from either the right or center IRU, as selected by the first officer's IRS source select switch. Magnetic heading and true heading data go to the processor. The processor drives the compass card to magnetic heading if the HDG reference switch is in the NORM position, or true heading if the switch is in the TRUE position. Data validity, servo, and the power supply are monitored by the BITE monitor. NCD or invalid data, servo failure, or power supply failure causes the heading flag to come into view. If left or center IRU is selected by the first officer's IRS source select switch, the RMI shows center IRU data.

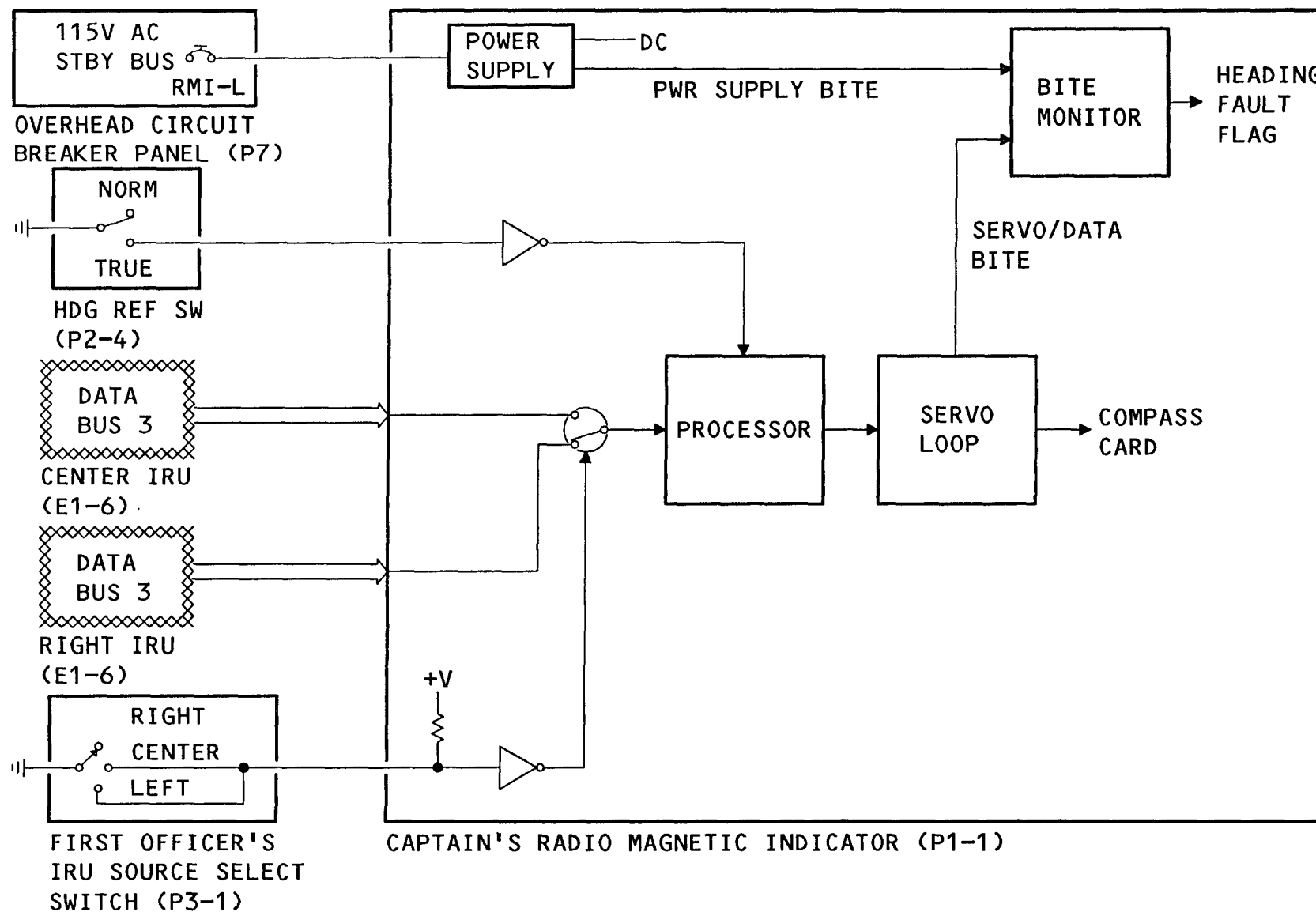


Figure 47 RMI OPERATION - CAPTAIN

IRS



FMC POSITION REFERENCE PAGES

General

The FMC position reference (POS REF) pages provide latitude, longitude and ground speed for each IRU. Note that when on the ground and parked, and with an IRU in NAV, ground speed is IRU drift rate.

Page Access

To show the POS REF pages, first access the position initialization (POS INIT) page. Access the POS INIT page by:

- Use line select POS on the index page.
- Use line select POS INIT from IDENT page.
- Select INIT/REF mode key when on the ground and the IRS position has not been initialized.
- Use line select POS INIT from the TAKEOFF REF page.

Access the POS REF pages by the NEXT PAGE or PREV PAGE mode key from the POS INIT page 1/3.

POS REF Page 2/3

(2L) IRS (3, L, C, or R): this line shows the IRS position currently used by the FMCs and the IRS update mode.

POS REF Page 3/3

(1L through 5L): these lines show the positions for the specified systems. These positions may be selected to the scratch pad.

(6L): this line selects the INIT REF INDEX page.

(1R through 5R): these lines show the ground speeds for the specified systems.

(6R) BRG/DIST: selection of this line causes the positions on line 2L, and lines 1L through 5L on the position reference page 3, to show in bearing distance format relative to the FMC position. This line then changes to LAV/LON. Selection of LAV/LON returns the displays to latitude/longitude format.

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POS REF		2 / 3
FMC POS (GPS L)		GS
N40°38.1	W073°46.4	431KT
IRS (3)		
N40°38.7	W073°46.6	430KT
RNP / ACTUAL	DME - DME	
2.80 / 0.05NM	IPDX SEA	
----- GPS NAV		
<PURGE	INHIBIT>	
<INDEX	BRG / DIST>	

POS REF		3 / 3
IRS L		GS
N40°38.7	W073°46.8	432KT
IRS C		
N40°37.5	W073°46.2	431KT
IRS R		
N40°38.5	W073°46.3	430KT
GPS L		
N40°38.1	W073°46.4	431KT
GPS R		
N40°38.1	W073°46.4	431KT

<INDEX	BRG / DIST>	

Figure 48 FMC POSITION REFERENCE PAGES

IRS



IRS - REMOVAL CRITERIA

General

Two criteria are used to determine if an IRU should be replaced. These are residual groundspeed error and radial position error.

- Residual groundspeed is the IRU ground speed when the airplane is parked.
- Radial position error is the distance between actual present position and the IRU calculated position.

NOTE: IF IRU DRIFT HAS BEEN REPORTED, THE IRUS AND FMCS SHOULD NOT BE SHUT DOWN AFTER THE PRESENT FLIGHT LEG, PRIOR TO COMPLETING THE GROUND SPEED AND RADIAL POSITION ERROR CHECKS.

Record the ground speed and latitude/longitude displayed on the POS REF page 2 for each IRU, while the airplane is parked.

Residual Groundspeed

Replace the IRU if the residual groundspeed is 21 knots or greater after one check, or 15 knots or greater after each of two consecutive checks.

Radial Position Error

Push the LEGS mode key to select the LEGS page. Enter the actual present position, latitude and longitude for the airplanes parked position using the scratch pad, and select this as the top waypoint on the RTE 1 or RTE 2 LEGS page. Enter the recorded left IRU position latitude and longitude as the next waypoint.

NOTE: IF DESIRED, THE LINE SELECT METHOD MAY BE USED TO TRANSFER THE IRU POSITIONS TO THE LEGS PAGE.

Record the distance that shows from the present position waypoint to the left IRU position waypoint, (if the distance is less than one nm the distance is blank).

Replace the left IRU position waypoint on the LEGS page with the center IRU position latitude and longitude.

Record the distance that shows from the present position waypoint to the center IRU Position waypoint.

Replace the center IRU position waypoint on the LEGS page with the right IRU position latitude and longitude.

Record the distance that shows from the present position waypoint to the right IRU Position waypoint.

Compare these radial position errors versus the navigation time (time IRUs are in navigation mode) to the accept/reject limits on the radial error chart.

NOTE: FLIGHT TIME IS ACCEPTABLE IF NAVIGATION TIME IS NOT AVAILABLE.

Replace the IRU if the radial position error exceeds the limit.

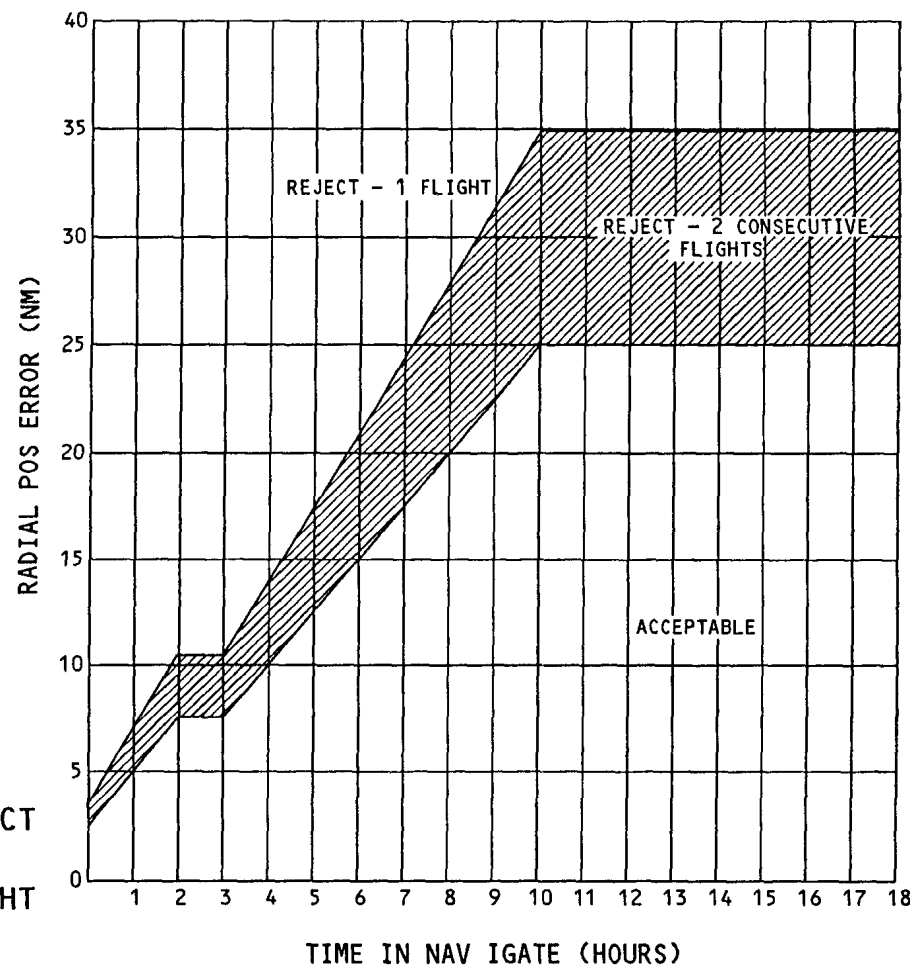
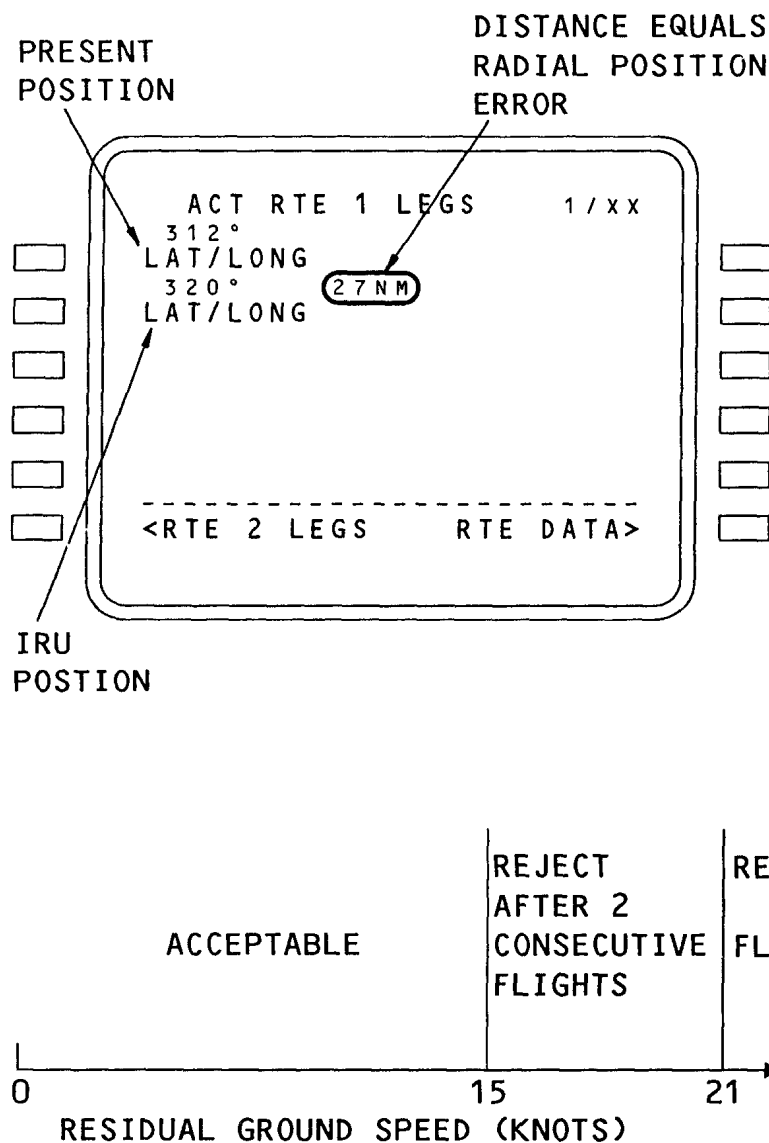


Figure 49 IRS - REMOVAL CRITERIA

**IRS****IRS - MONITOR PAGE****General**

The IRS MONITOR page shows the average rate of drift of each IRU from the FMC, during the flight.

Page Access

The IRS MONITOR PAGE is accessed only on the ground. It is accessed from the INIT/REF INDEX page via the MAINT line select key, then the IRS MONITOR line select key.

IRS MONITOR Page

The total drift (in nautical miles) of each IRU from the FMC position is obtained by multiplying the drift rate (from the page) times the flight duration (in hours). This information is not used for removal criteria determination.

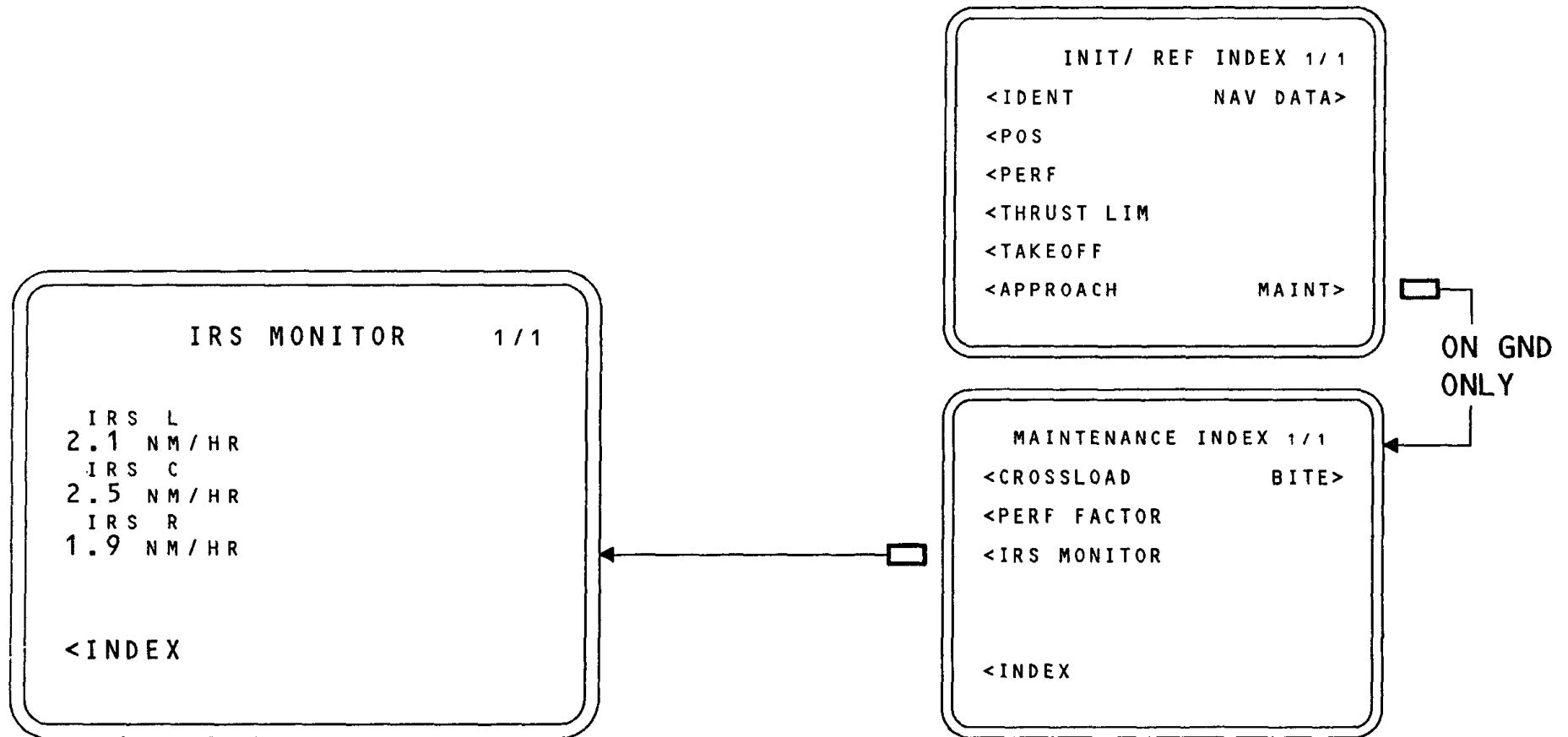


Figure 50 IRS - MONITOR PAGE



INTERFACE TEST - 1

The CMC ground tests menu lists the systems for which ground tests are available. This menu allows a ground interface test of the left, center, or right IRU. To do an IRU interface test, GROUND TESTS is selected on the CMC MENU page 1. The GROUND TESTS page containing the required IRU test is then selected (by ATA chapter number).

Push the line select key next to the desired IRU to show the TEST PRE-CONDITIONS page. Observe the preconditions and note the expected test response. Push line select key 6R to start the test. After 30 seconds of IN PROGRESS, a ground test query screen shows. The ground test query screen asks the operator to confirm the expected test response.

If a fault is detected during a ground test ' a ground test message page shows instead of the ground test query screen.

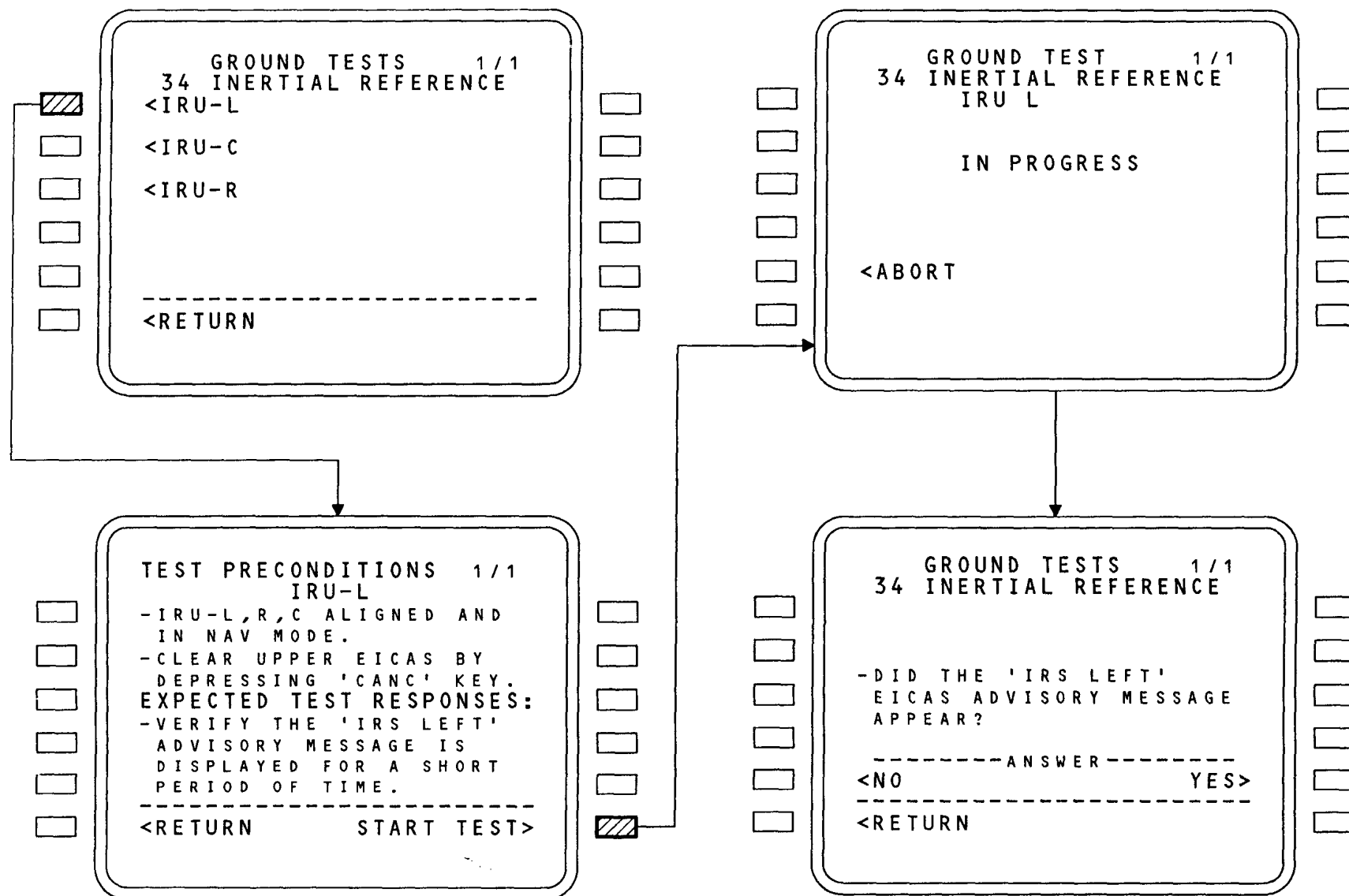


Figure 51 INTERFACE TEST - 1

IRS**INTERFACE TEST - 2****Ground Test**

The ground test query screen shows at the end of the IRU ground test. If the expected test response occurs, select YES. If the expected test response does not occur, select NO. Either selection brings the CDU back to the IRU ground tests menu. If YES is selected, PASS shows. If NO is selected, FAIL shows. Push the line select key next to FAIL to see the ground test message page.

IRU Front Panel Test

An interface test is started by a push of the interface test button on the front of the IRU. Hold the test switch in to continue the test past the normal 30 seconds.

Output Test Values

During parts of the interface test, the IRU transmits test values on the output busses. Some of these values show on flight deck displays.

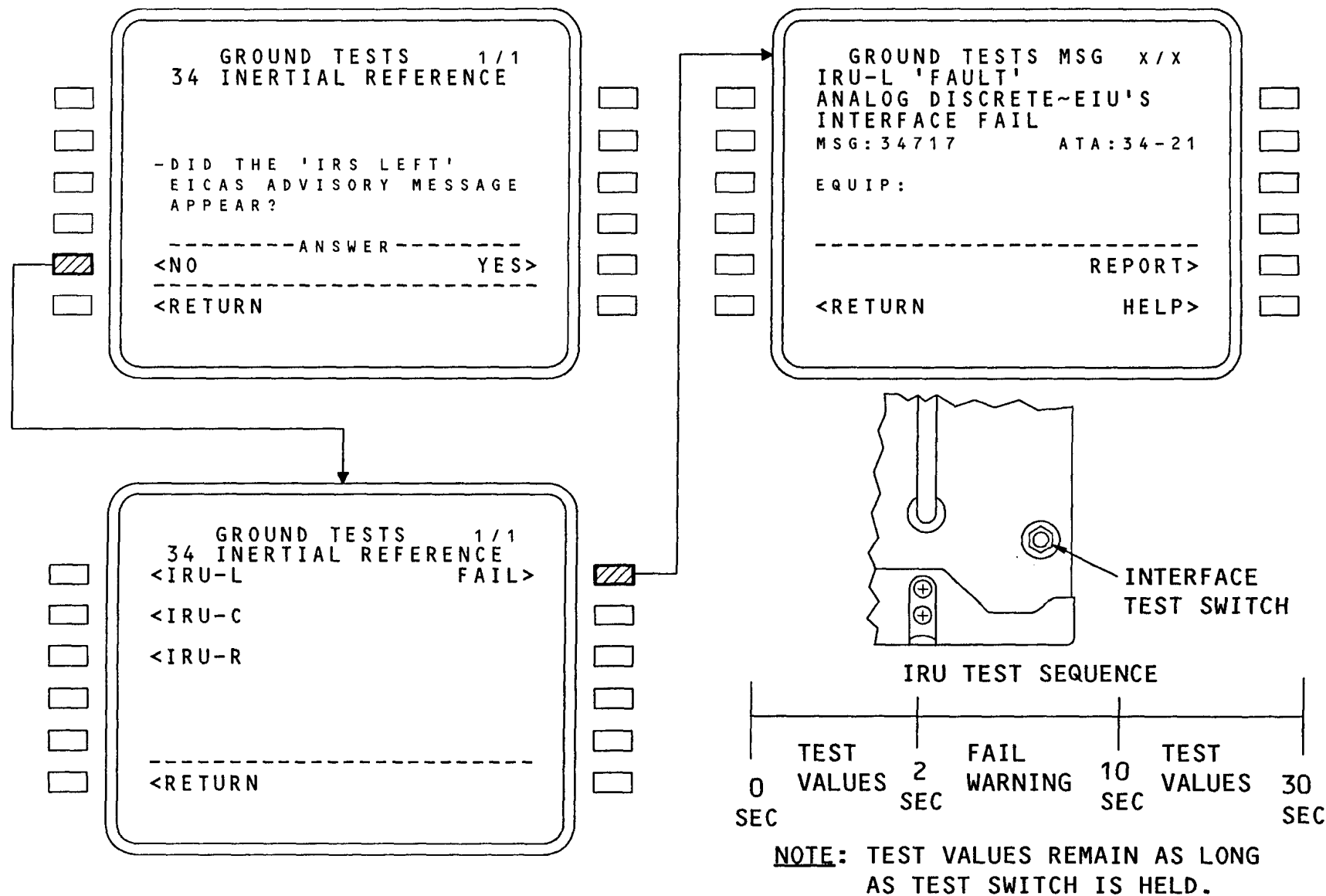


Figure 52 INTERFACE TEST - 2

IRS

**INTERFACE TEST VALUES**

The graphic shows the interface test output values from the IRU and the display locations. These outputs are transmitted during the first two seconds of the interface test and again after ten seconds. From two seconds after test initiation until ten seconds after test initiation, these test values are transmitted as failure data. Test values are also shown after ten seconds.

The IRS source select switches may be used to display the outputs from an individual IRU.

The parameters number 20 thru 40 are not shown, but could be monitored if required using CMC data monitoring or with an ARINC 429 analyzer.

<u>Parameter</u>	<u>Test Value</u>
20 PRESENT POS LAT	(N) 22 30'
21 PRESENT POS LONG	(E) 22 30'
22 PLATFORM HEADING	022.5 DEG
23 ALONG TR HRZ ACCEL	.02g
24 CROSS TK HRZ ACCEL	.02g
25 BODY NORMAL ACCEL	.10g
26 BODY LONGIT ACCEL	.01g
27 BODY ROLL RATE	10 DEG/SEC
28 BODY PITCH RATE	10 DEG/SEC
29 E-W VELOCITY	200 KTS (E)
30 N-S VELOCITY	200 KTS (N)
31 FLIGHT PATH ANGLE	-5 DEG (DN)
32 FLIGHT PATH ACCEL	.02g
33 INERTIAL ALTITUDE	10,000 FT
34 PITCH ATT RATE	10 DEG/SEC
35 ROLL ATT RATE	10 DEG/SEC
36 TRACK ANGLE RATE	10 DEG/SEC
37 VERTICAL ACCEL	0.1g
38 WIND DIRECTION TRUE	030 DEG
39 WIND SPEED	100 KTS
40 IRS DISCRETES	TEST

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<u>PARAMETER</u>	<u>DISPLAY</u>		<u>TEST VALUE</u>
1 TRUE HEADING	EFIS	PFD/RMI	010 DEG
2 MAGNETIC HEADING	EFIS	PFD/RMI	015 DEG
3 DRIFT ANGLE	EFIS	PFD	-10 DEG (L)
4 TRACK ANGLE TRUE	EFIS	PFD	000.0 DEG
5 TRACK ANGLE MAG	EFIS	PFD	005 DEG
6 PITCH ANGLE	EFIS	PFD	5 DEG (UP)
7 ROLL ANGLE	EFIS	PFD	45 DEG (R)
8 INERTIAL VERT SPD	EFIS	PFD	-600 FPM
9 BODY LATERAL ACCEL	EFIS	PFD	.10G (R)
10 TRUE HEADING	EFIS	ND	010 DEG
11 MAGNETIC HEADING	EFIS	ND	015 DEG
12 DRIFT ANGLE	EFIS	ND	-10 DEG (L)
13 TRACK ANGLE TRUE	EFIS	ND	000.0 DEG
14 TRACK ANGLE MAG	EFIS	ND	005 DEG
15 GROUND SPEED	EFIS	ND	200 KTS
	<u>DISPLAY</u>	<u>PAGE</u>	
16 BODY LATERAL ACCEL	EICAS	FLT CTL	.10G
17 BODY YAW RATE	EICAS	FLT CTL	10 DEG/SEC
18 ROLL ANGLE	EICAS	FLT CTL	45 DEG (R)
19 GROUND SPEED	EICAS	PERF	200 KTS

Figure 53 INTERFACE TEST VALUES

IRS



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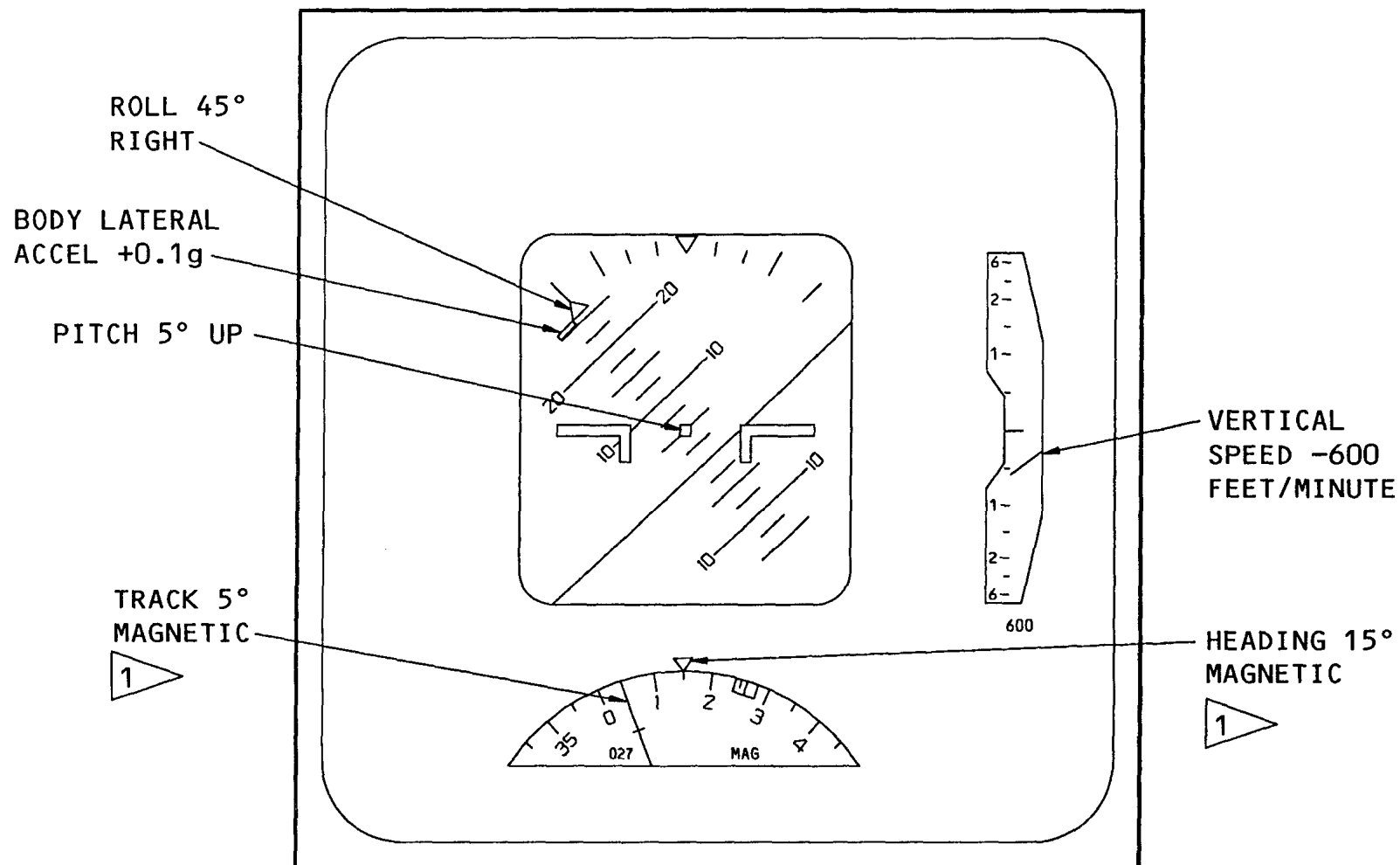
34-21

INTERFACE TEST - PFD INDICATIONS

The IRU test outputs on the PFD are shown on the graphic.

Some of the test values do not show on the PFD if more than one IRU is aligned. When the selected IRU goes into the test mode, the FMCs switch to another IRU if available. The heading and track displays come from another IRU for the duration of the test.

Move the outside NAV source select switch to a CDU position. This allows the selected IRU to show the test displays, and removes the FMC as the source of track in favor of the selected IRU.



1 WITH MORE THAN ONE IRU
ALIGNED, TRACK AND HEADING
TEST VALUES DO NOT SHOW

Figure 54 INTERFACE TEST - PFD INDICATIONS

IRS

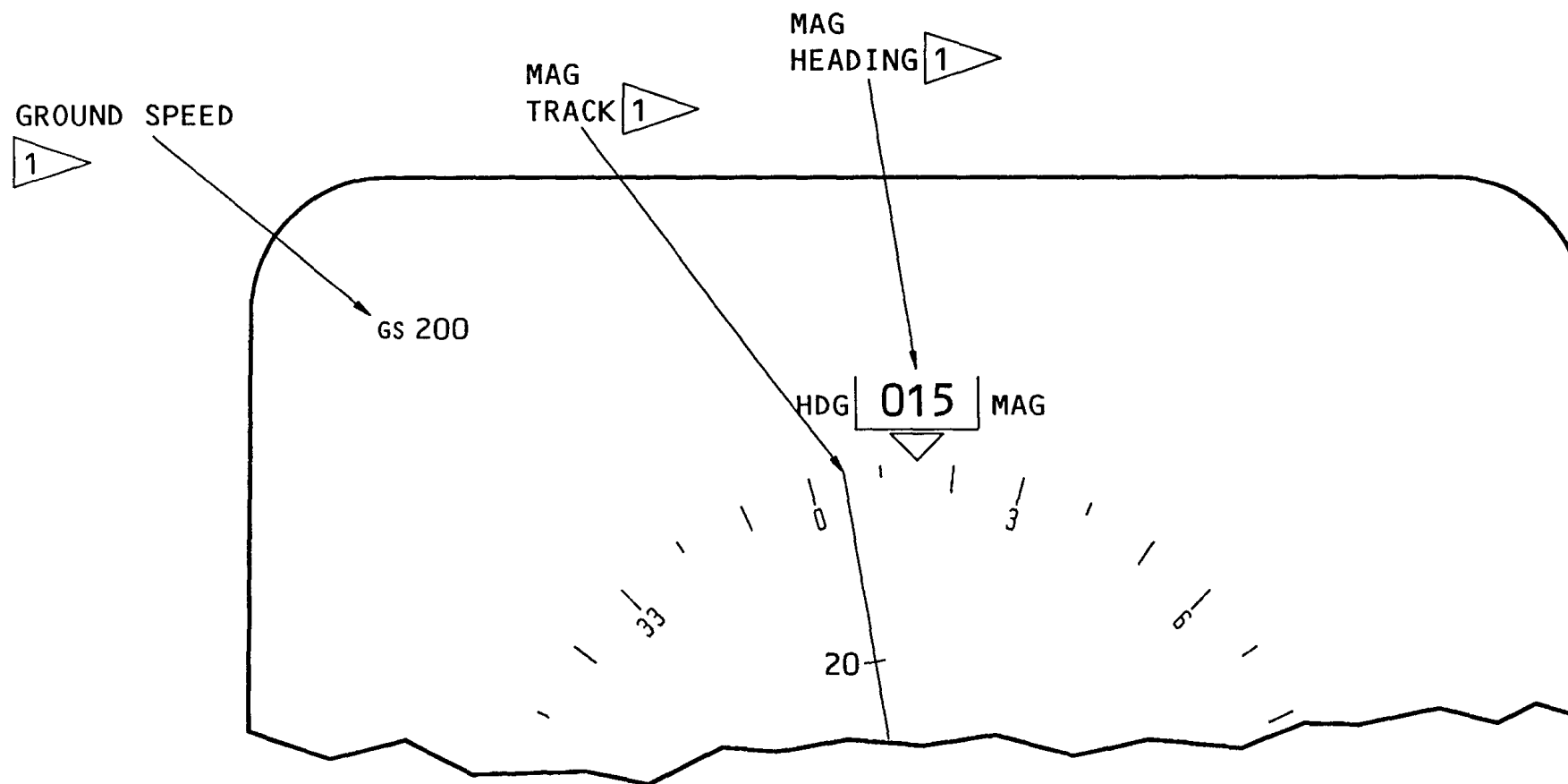


INTERFACE TEST - ND INDICATIONS

The IRU test outputs on the ND are shown on the graphic

Some of the test values do not show on the ND if more than one IRU is aligned. When the selected IRU goes into test mode, the FMCs switch to another IRU if available. In this case, the heading, track, and ground speed displays come from another IRU for the duration of the test.

Move the onside NAV source select switch to a CDU position, to allow the selected IRU to show the test displays. This removes the FMC as the source of track and ground speed in favor of the selected IRU.



1 WITH MORE THAN ONE IRU ALIGNED, TEST VALUES DO NOT SHOW

Figure 55 INTERFACE TEST - ND INDICATIONS

IRS**INTERFACE TEST - RMI INDICATIONS****Test Values**

A magnetic heading value of 015 and a true heading value of 010 are transmitted to the RMI during the first two seconds of self-test and again after ten seconds. With the heading reference switch in the NORM position, the RMI compass card will be driven to 015. With the heading reference switch in the TRUE position, the RMI compass card will be driven to 010.

Input Data Failure

From two seconds after test initiation until ten seconds after test initiation, the magnetic and true heading IRU outputs are transmitted as failed and cause the RMI heading flag to appear.

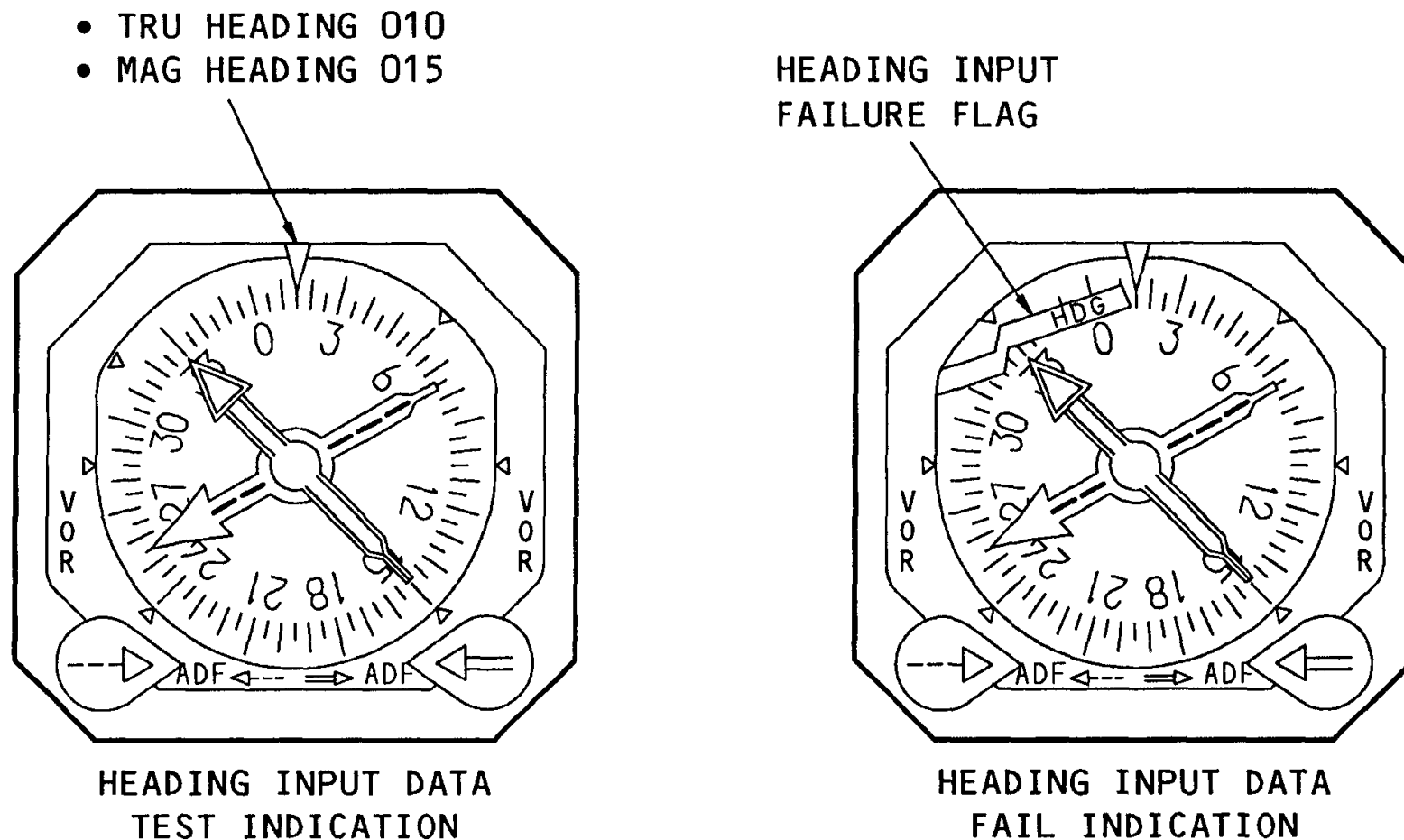


Figure 56 INTERFACE TEST - RMI INDICATIONS

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IRS



FLIGHT DECK EFFECTS

General

This graphic contains a summary of all maintenance related flight deck effects associated with this system.

Flight Deck Effect

The EFIS attitude annunciations are PITCH and/or ROLL displayed on the PFD. When the captain's and first officer's pitch and/or roll displays differ by 3 degrees or more for .75 seconds.

The EICAS messages for the inertial reference system and the meaning of these messages are:

- >ATTITUDE indicates captain and first officer pitch and/or roll differ by three degrees or more
- >IRS AC indicates an IRU operating on dc power
- >IRS DC indicates an IRU dc power input failure
- IRS MOTION indicates an IRU detected motion during alignment
- IRS (x) indicates an IRU system fault. This fault may show when the airplane lands and the IRS displays remain. In this case if the IRU is turned off and a new alignment is successful, the fault is a laser intensity monitor fault and the IRU will fail in the near future. The IRU should be changed soon, but may be used if a replacement is not immediately available.
- >SOURCE SEL IRS indicates both pilots selected a common IRU as an instrument source
- >HEADING captain and first officer IRU heading displays differ by four degrees
- >TRACK captain and first officer IRU track displays differ by six degrees
- IRS ALIGN MODE (x) IRU operating normally in align mode or initial attitude mode selected

<u>FLIGHT DECK EFFECTS</u>	<u>TYPE</u>	<u>DESCRIPTION</u>
PITCH	PFD	PITCH ATTITUDE COMPARATOR MESSAGE
ROLL	PFD	ROLL ATTITUDE COMPARATOR MESSAGE
>ATTITUDE	CAUTION	ATTITUDE COMPARATOR MESSAGE
>IRS AC (X)	ADVISORY	AC POWER INPUT FAULT MESSAGE
>IRS DC (X)	ADVISORY	DC POWER INPUT FAULT MESSAGE
IRS MOTION	ADVISORY	MOTION DETECTED DURING ALIGNMENT
IRS (X)	ADVISORY	IRU FAILURE MESSAGE
>SOURCE SEL IRS	ADVISORY	BOTH PILOTS SELECTED TO SAME IRU
>HEADING	ADVISORY	HEADING COMPARATOR MESSAGE
>TRACK	ADVISORY	TRACK COMPARATOR MESSAGE
IRS ALIGN MODE (Y)	MEMO	IRU IN ALIGN MODE
IRS AC (X)	STATUS	AC POWER INPUT FAULT MESSAGE
IRS DC (X)	STATUS	DC POWER INPUT FAULT MESSAGE
IRS (X)	STATUS	IRU FAULT MESSAGE

(X) = LEFT, CENTER, RIGHT

(Y) = L,C,R

Figure 57 FLIGHT DECK EFFECTS

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<u>FLIGHT DECK EFFECTS</u>	<u>TYPE</u>
PITCH	PFD
ROLL	PFD
>ATTITUDE	CAUTION
>IRS AC (X)	ADVISORY
>IRS DC (X)	ADVISORY
IRS MOTION	ADVISORY
IRS (X)	ADVISORY
>SOURCE SEL IRS	ADVISORY
>HEADING	ADVISORY
>TRACK	ADVISORY
IRS ALIGN MODE (Y)	MEMO
IRS AC (X)	STATUS
IRS DC (X)	STATUS
IRS (X)	STATUS
<u>CMC MESSAGES</u>	
<u>COMPONENT FAILURE</u>	
IRU-Y FAIL	
IRU-Y FAIL (NO BUS OUTPUTS)	
<u>INPUT SENSOR FAILURE</u>	
AC BUS-Z ~ IRU-Y INTERFACE FAIL	
DC BATTERY BUS ~ IRU-Y INTERFACE FAIL	
IRU-Y FAIL OR ADC-Y ~ IRU-Y BUS FAIL	
<u>GROUND TEST FAILURE</u>	
IRU-Y 'FAULT' ANALOG DISCRETE ~ EIU'S	
INTERFACE FAIL	

(X) = LEFT, CENTER, RIGHT

(Y) = L,C,R

(Z) = 1,2,3

Figure 58 FLIGHT DECK EFFECTS AND CMS MESSAGES

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