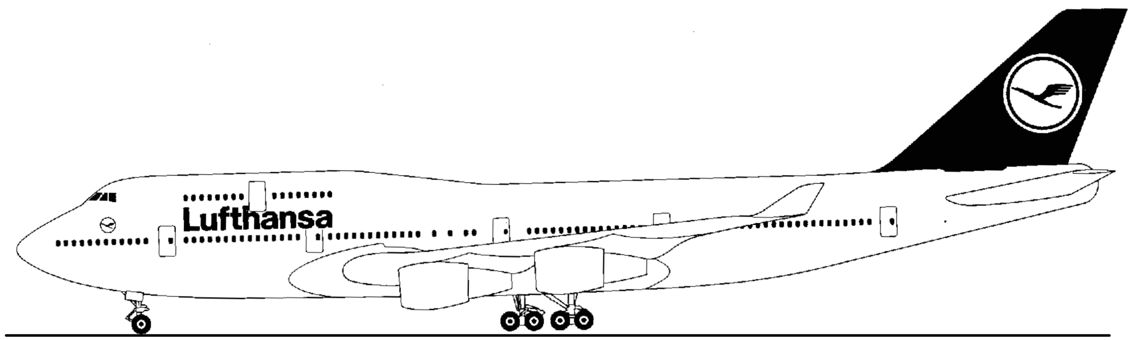
Lufthansa Technical Training

Training Manual
B 747-400



ATA 34-12
AIR DATA COMPUTER

ATA Spec. 104 Level 3

Lufthansa
Technical Training GmbH
Lufthansa Base

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Lufthansa
Technical Training

Lufthansa Technical Training GmbH

Lufthansa Base Frankfurt

D-60546 Frankfurt/Main

Tel. +49 69 / 696 41 78

Fax +49 69 / 696 63 84

Lufthansa Base Hamburg

Weg beim Jäger 193

D-22335 Hamburg

Tel. +49 40 / 5070 24 13

Fax +49 40 / 5070 47 46

ATA 34-12 AIR DATA COMPUTER SYSTEM

AIR DATA COMPUTER SYSTEM - INTRODUCTION

Air data computers get inputs from a variety of sensors and use this data to calculate air data parameters needed to fly the airplane.

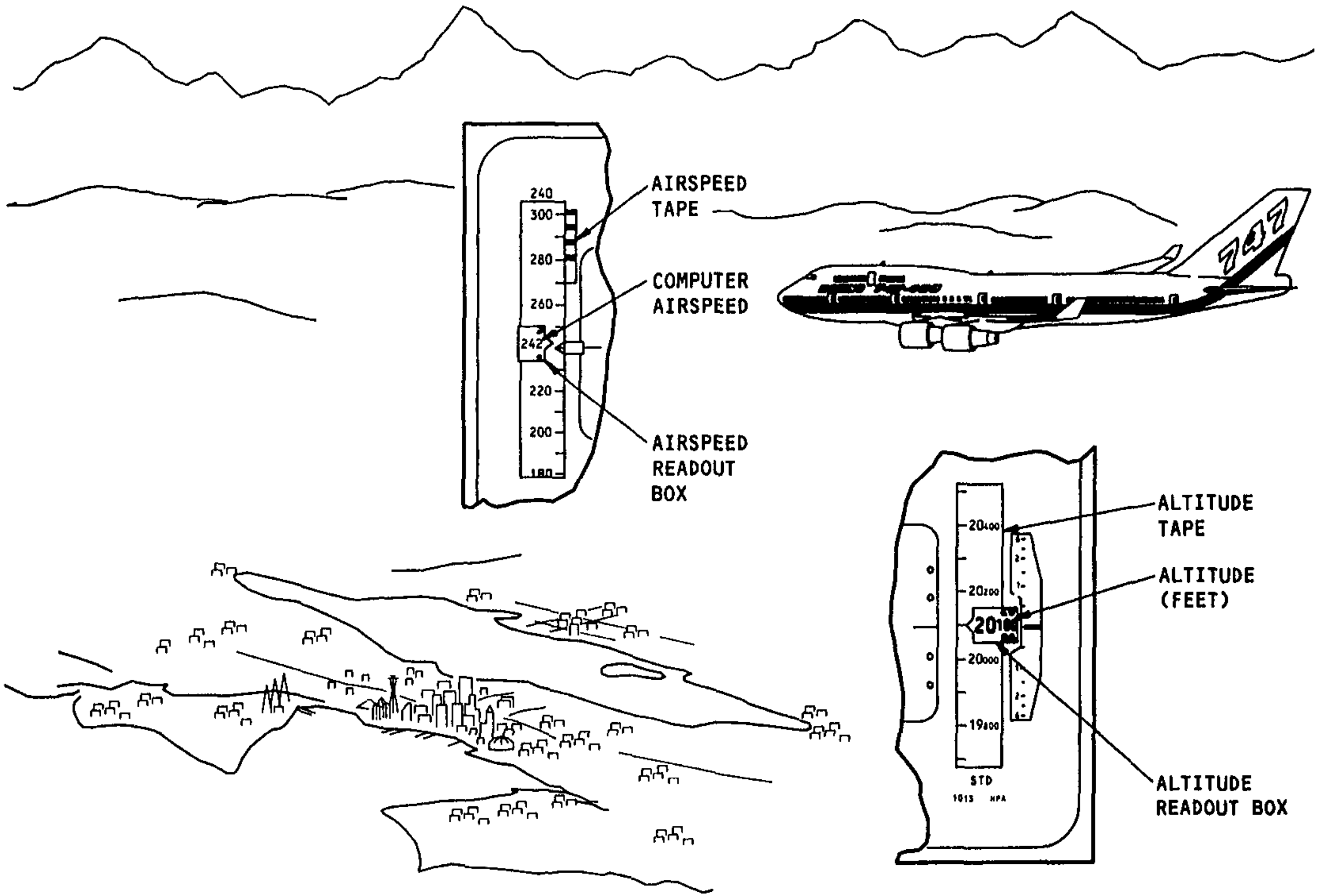


Figure 1 AIR DATA COMPUTER SYSTEM - INTRODUCTION

AIR DATA COMPUTER SYSTEM

System Description

The air data computer (ADC) system has three digital computers and a variety of associated sensors, switches and relays used for input and control. Each computer operates independently of the others and supplies multiple air data values to many different airplane systems.

Operation

The ADC gets pitot-static air data (Pt and Ps) from the pitot-static system. Barometric reference correction data comes from the left and right EFIS control panels through the left and right control display units (CDU's). Angle-of-attack (AOA) sensor data and total-air-temperature (TAT) data is sent from the on-side AOA and TAT sensors. Test request is made through an air/ground relay and an enable relay from the left or right central maintenance computer (CMC).

A variety of discretes and program pin options provide the ADC with configuration data, and sets performance criteria for output air data parameters.

The ADC provides air data parameters on four ARINC 429 buses to a variety of airplane systems. An airplane overspeed discrete is sent to the modularized avionics & warning electronics assembly (MAWEA) and to the three EFIS/EICAS units (EIU's).

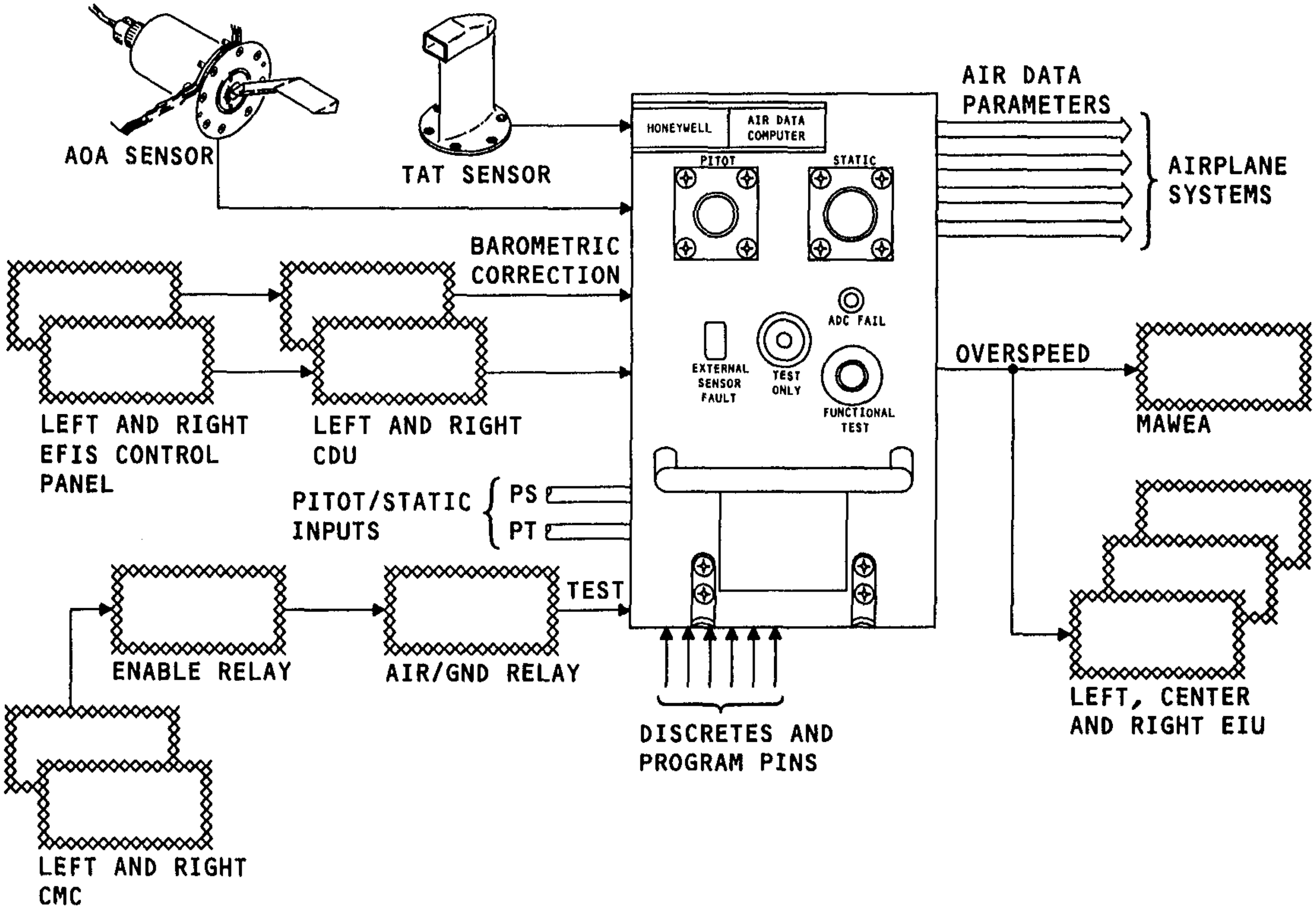


Figure 2 AIR DATA COMPUTER SYSTEM

COMPONENT LOCATIONS 1

These ADC system components are on the nose section of the airplane:

- Angle-of-attack sensors (left and right)
- Total-air-temperature probes (left and right)

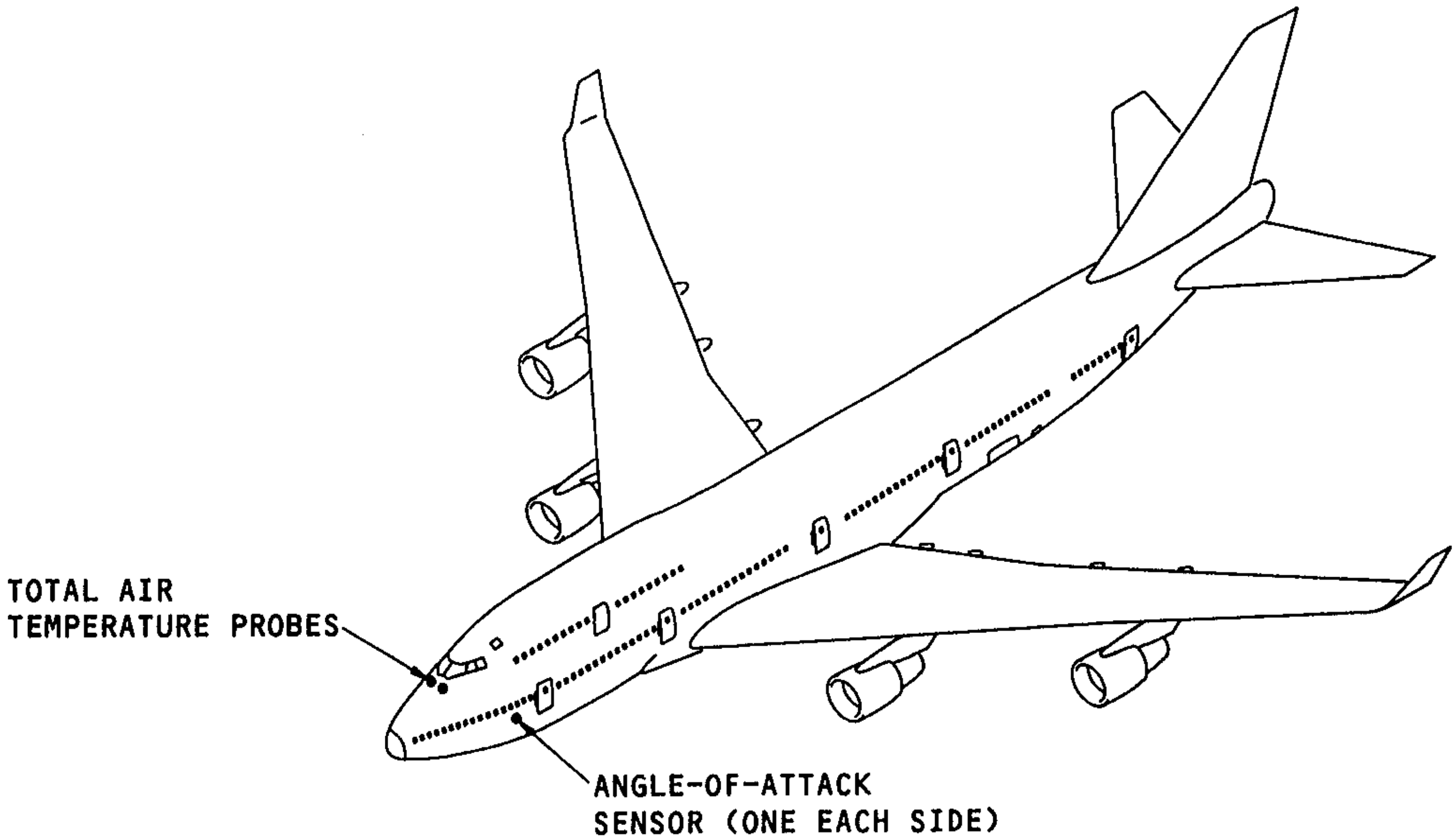


Figure 3 COMPONENT LOCATIONS 1

COMPONENT LOCATIONS - FD

These ADC system components are on the flight deck:

- Circuit breakers
- Baro reference controls
- Captain’s air data instrument source select switch
- First officer’s air data instrument source select switch
- Left, center, and right ADC ac transformers

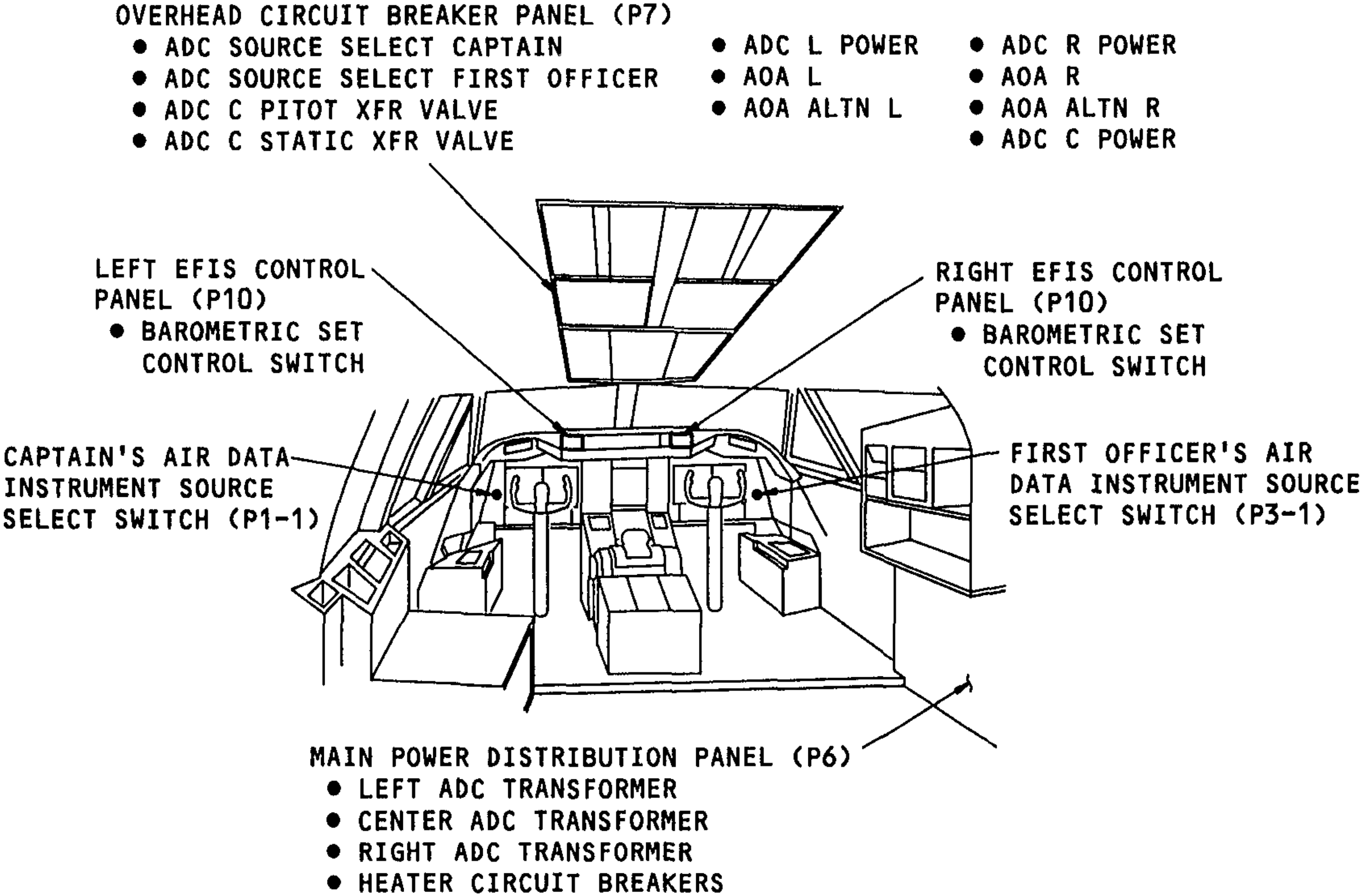


Figure 4 COMPONENT LOCATIONS - FD

COMPONENT LOCATIONS - MEC

These ADC system components are in the main equipment center (MEC);

- Left ADC
- Center ADC
- Right ADC
- Captain's ADC source select relay
- First officer's ADC source select relay
- Captain's ADC source select diode
- First officer's source select diode
- Gear down dispatch switch
- Fifth engine carriage switch

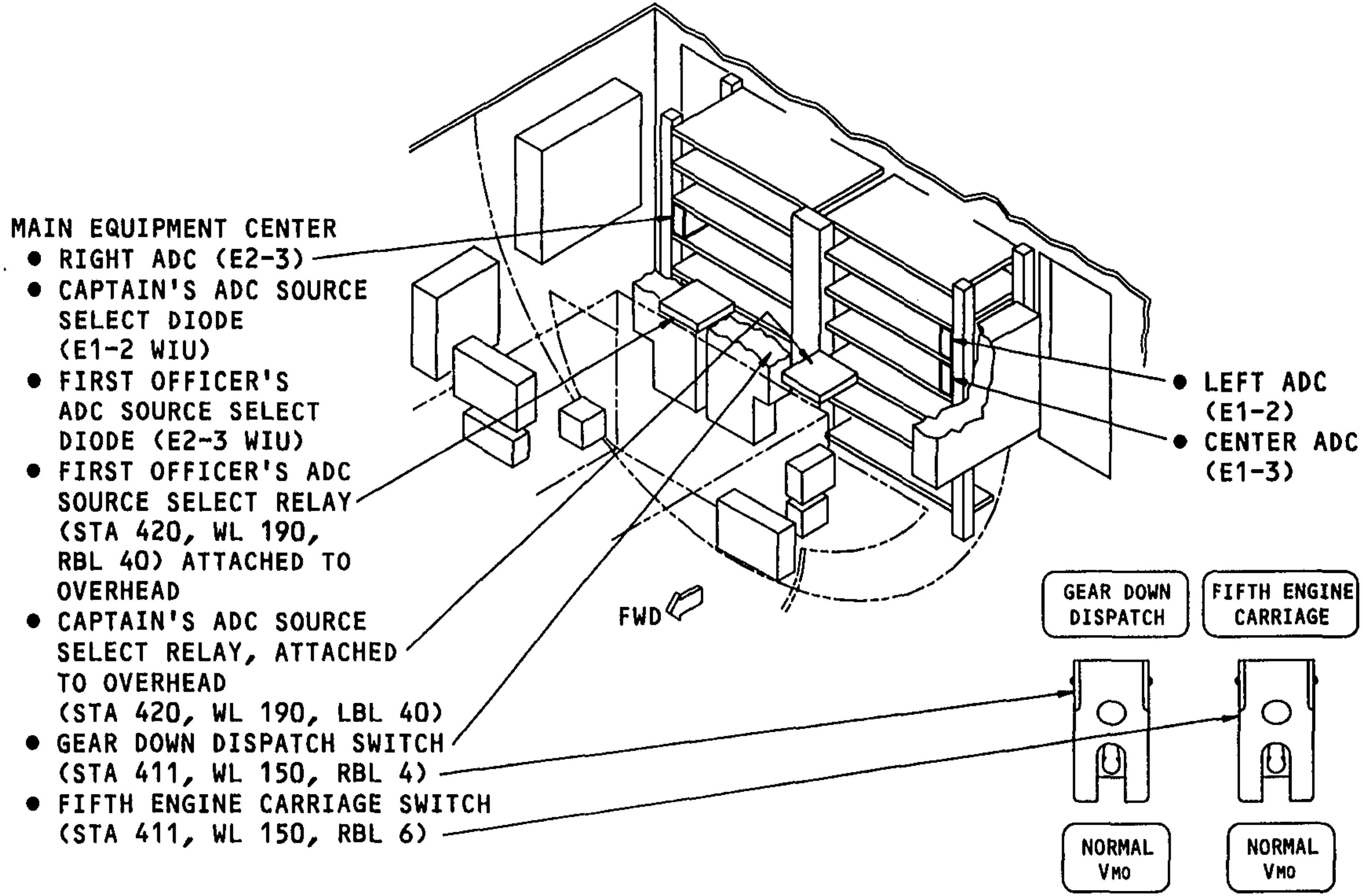


Figure 5 COMPONENT LOCATIONS - MEC

NOTES

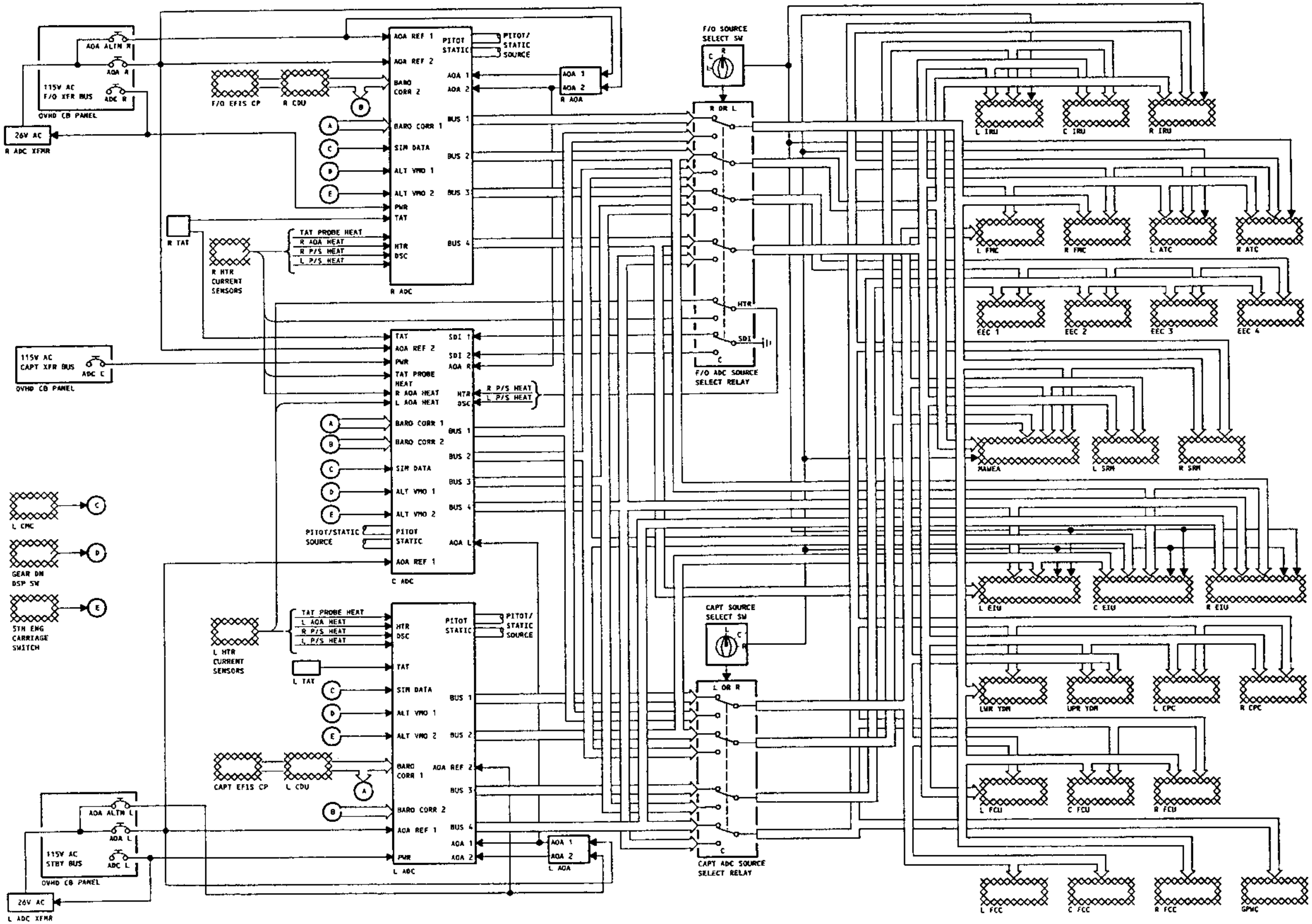


Figure 6 ADC SYSTEM – INTERFACE DIAGRAM

POWER AND ANGLE OF ATTACK

Power

The right ADC gets 115v ac from the F/O XFR bum. The left ADC gets 115v ac from the STBY bus. The center ADC gets 115v ac from the CAPT XFR bus. There are two 26v ac step-down transformers that get power from the 115v ac buses. These transformers supply a synchro reference voltage to each ADC, and also synchro excitation to the left and right angle of attack (AOA) sensors.

Angle of Attack

Each AOA sensor has two synchro transmitter outputs. Output No. 1 of the left AOA sensor sends AOA signals to the left and center ADC. Output No. 2 sends AOA signals to the left ADC only. Output No. 1 of the right AOA sensor sends AOA signals to the right ADC. Output No. 2 sends AOA signals to the right and center ADC.

AOA Input Control

Each ADC has two input ports for AOA sensor signals. The source destination indicators (SDI) program pins tell each ADC if it is a left or right ADC. The AOA rotational reference program pin allows the ADC to properly process AOA resolver angles either from two onside resolvers or from one resolver from each AOA sensor. Unique AOA will cause the ADC to average the two AOA inputs or set One input to be primary and the other as alternate.

Each ADC has two SDI pins to determine left or right configuration. With SDI-1 set to ground and SDI-2 open, the ADC is programmed to be a left ADC. With SDI-1 open and SDI-2 set to ground the ADC is programmed to be a right ADC. The center ADC is programmed to be a left or right ADC as determined by the F/O source select relay position.

The AOA rotational reference program pin is grounded for the left and right ADC and open for the center ADC. When grounded, the ADC's get both AOA resolver inputs from the same sensor. With SDI set to be a left ADC and AOA rotational reference grounded, the sign of the AOA inputs are reversed. The center ADC gets AOA resolver inputs from both AOA sensors, left AOA to AOA input 1 and right AOA to AOA input 2. The sign of AOA input 1 will be reversed for the center ADC as the AOA rotational reference pin is open.

Unique AOA is grounded for all three ADC's. This causes the ADC to use one AOA input as primary and the other input as an alternate when the primary fails. With AOA rotational reference grounded, AOA input 1 is primary. With AOA rotational reference open, the SDI determines the primary input. If SDI is set to left ADC then AOA input 1 is primary. If SDI is set to right ADC then AOA input 2 is primary.

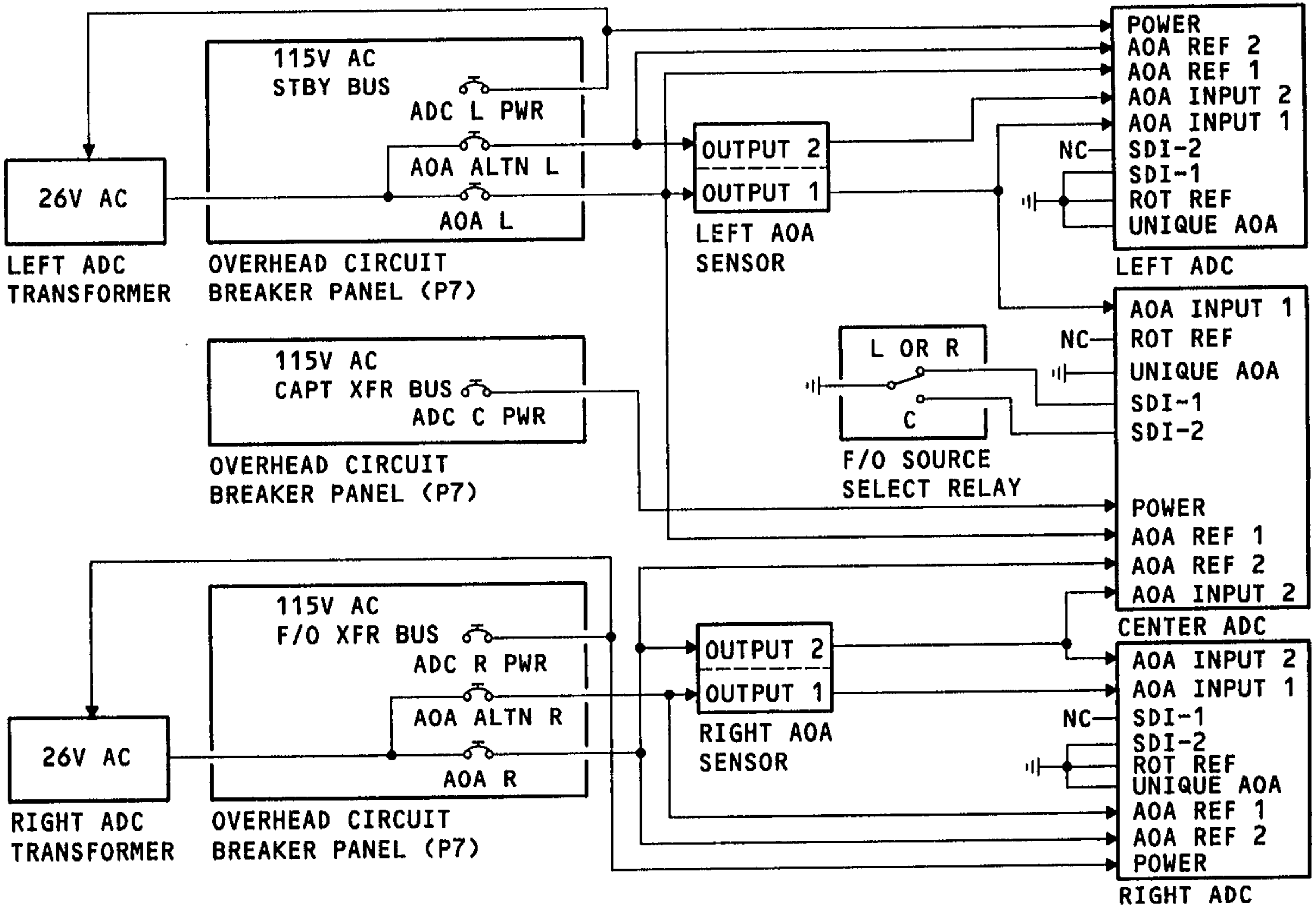


Figure 7 POWER AND ANGLE OF ATTACK

PRESSURE INPUTS

General

The left and right ADCs are permanently connected to separate pressure sources. The center ADC is used to replace either a left or right ADC. When the center ADC is used as a right ADC, it's pressure inputs must be switched.

Center ADC Pressure Inputs

When the center ADC is used as a replacement for a left ADC, it is programmed to operate as a left ADC. Then it uses pitot pressure from the AUX 2 pitot and static pressure from the AUX 1 static. When the center ADC is used as a replacement for a right ADC, it is programmed to operate as a right ADC. Then it uses pitot pressure from the first officer's pitot and static pressure from the AUX 2 static.

Source Selection

When the first officer's air data source select switch is set to the center position, the first officer's ADC source select relay energizes to the center position. This causes the center ADC to change pitot-pressure and static pressure sources as it programs from a left to a right ADC. A set of switch contacts in the pitot source and static source select valves sends discrete (ground) signals to each EIU to verify the switch position.

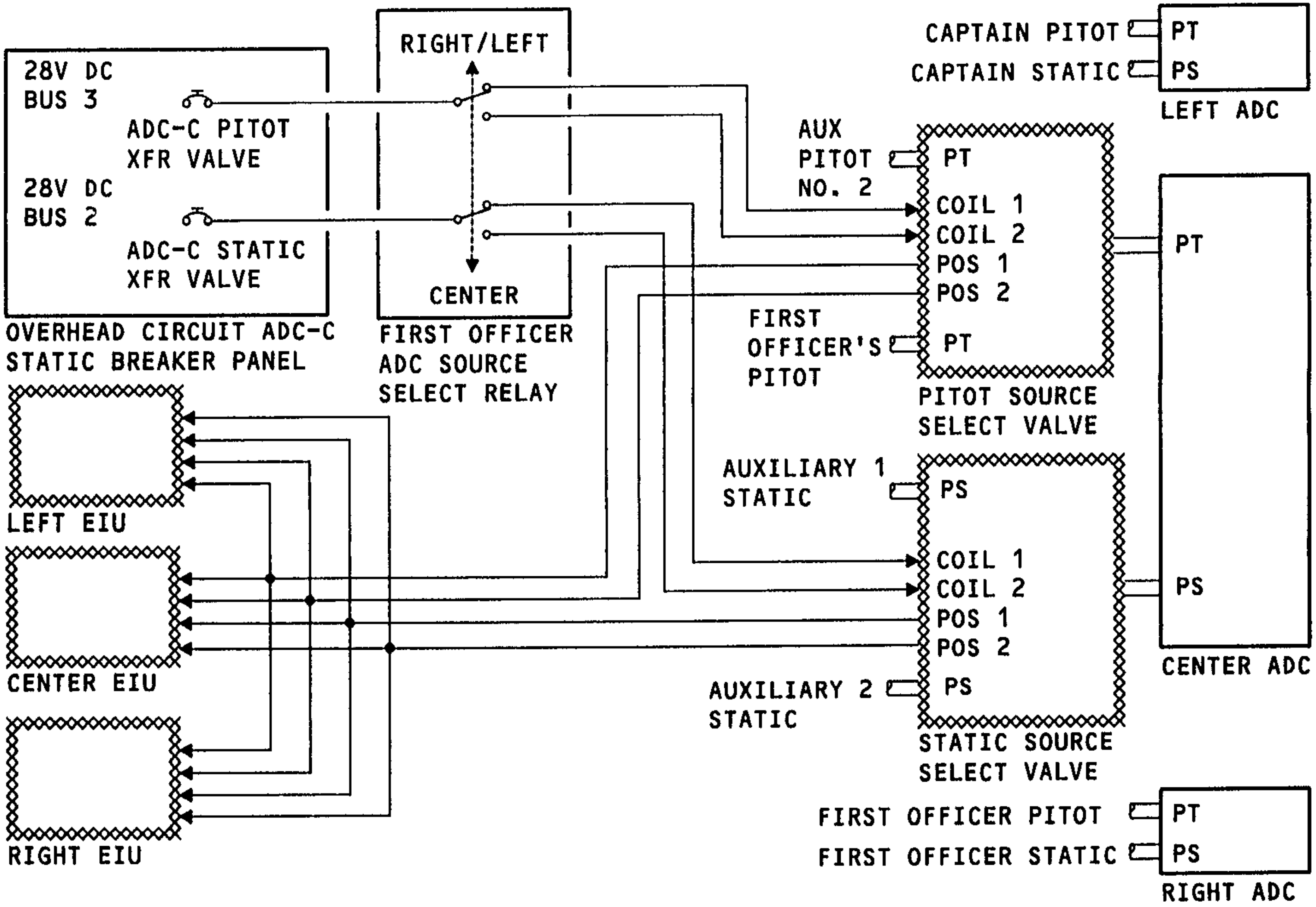


Figure 8 PRESSURE INPUTS

HEATER DISCRETES & PROGRAM PIN SWITCHING

General

The left and right ADC's normally provide air data information to the captain's and first officer's PFD's respectively. The center ADC is used as a standby unit with program and selected inputs that are changed to match those of the ADC it is selected to replace. It is normally programmed to operate as a left ADC. If the first officer selects the center ADC first, the center ADC switches program pin selections and HEAT ON discretes and functions as a right ADC.

HEAT ON Discretes

The anti-ice heating circuits has a current sense relay that energizes when heater current is on. Each ADC gets a HEAT ON discrete that shows the status of the heater circuits.

Program Pin Switching

The first officer's ADC source select relay also controls the selection of different program pins when the center ADC is selected as a right ADC.

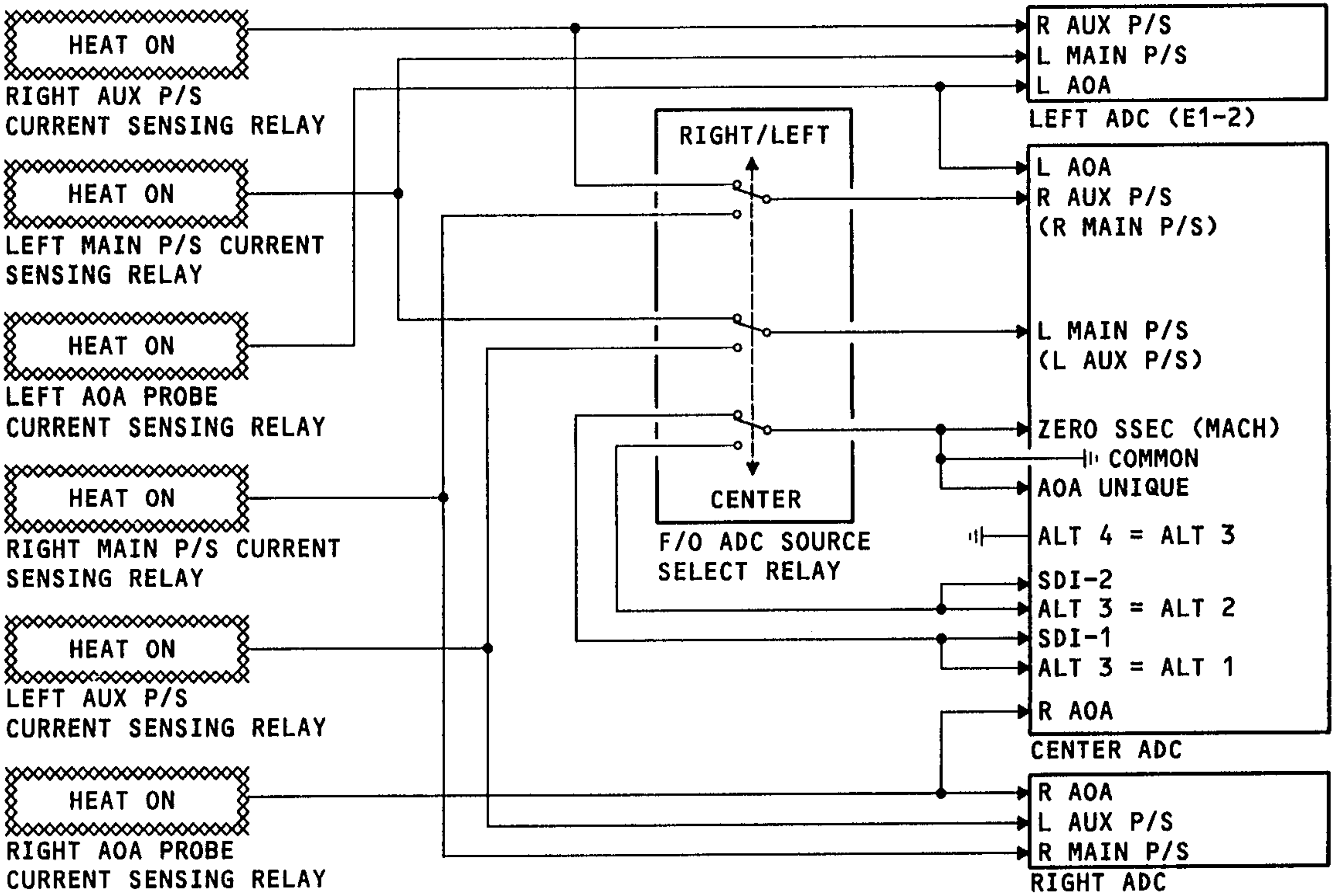


Figure 9 HEATER DISCRETES AND PROG. PIN SWITCHING

SOURCE SELECT RELAYS & CONTROL DISCRETES

General

The ADC source select relays control selection of the center ADC as a backup for the left or right ADC. The ADC source select relays switch various input and output signals to multiple airplane systems. The relays are switched based on the position of the flight crews ADC instrument source select switches.

Relay Operation

When the center ADC is selected by either the captain or first officer, the stepping relay energizes and switches to the center position. This removes power from the stepping relay coil, and the relay stays in the last selected position. The captain's source select relay gets power through the first officer's source select relay. The first officer's relay operation is similar, making it impossible for both relays to be in the center position at the same time.

Control Discretes

The captain's and first officer's ADC instrument source select switches are multi-functional layered switches. Three outputs provide analog port select discretes for ADC output source selection. The captain's switch supplies discretes to the left ATC, left IRU, left FMC, three EIU's, and the MAWEA. The first officer's switch supplies discretes to the right ATC, right IRU, right FMC, three EIU's, and the MAWEA.

An additional output controls the captain's and first officer's ADC source select relays. The left and right pins on the instrument source select switches are wired together.

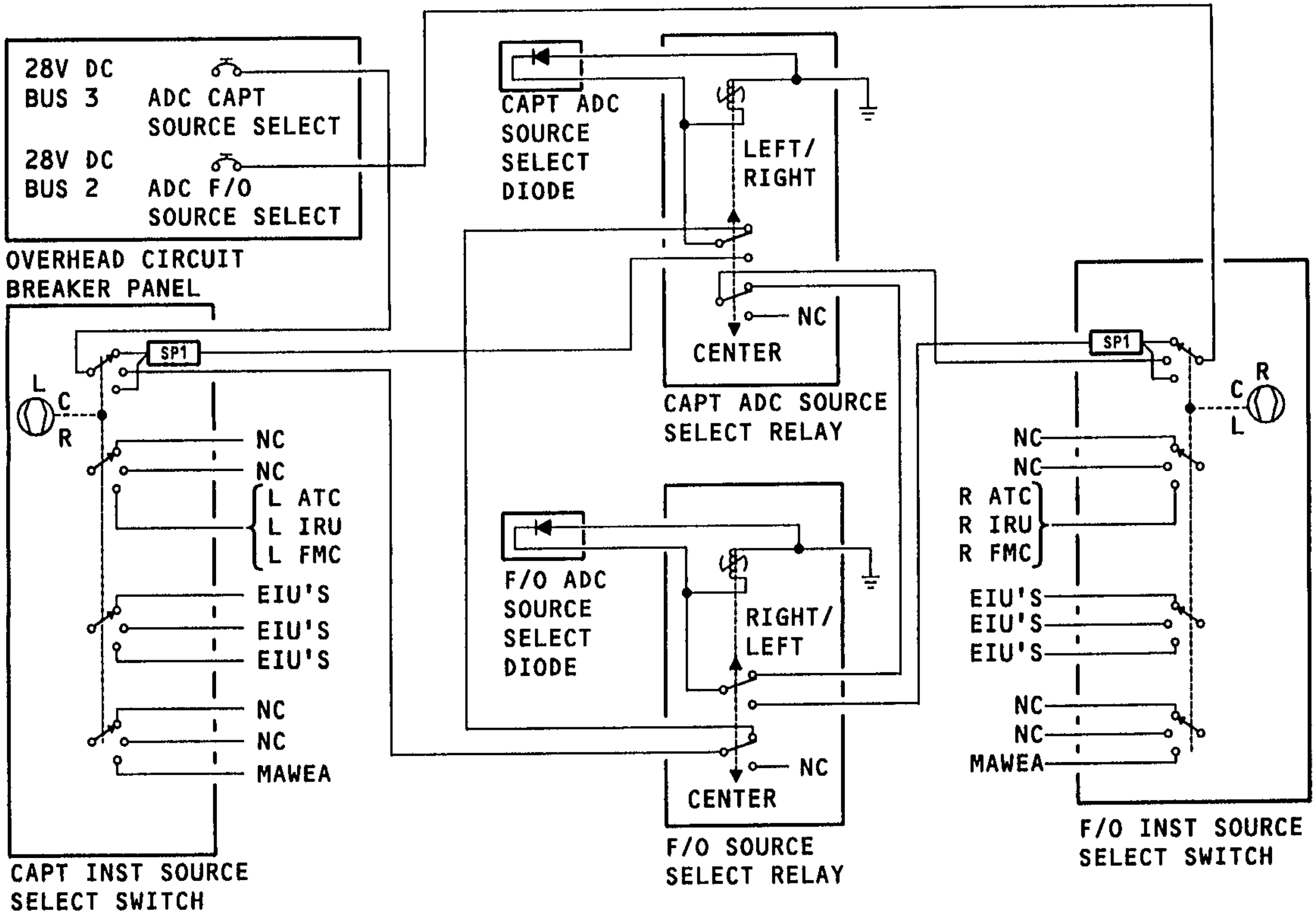


Figure 10 SOURCE SELECT RELAYS & CONTROL DISCRETES

BAROMETRIC CORRECTION INPUT

The barometric reference correction is entered on the captain's and first officer's on-side EFIS control panels. Baro reference No. 1 is entered with the captain's EFIS control panel BARO knob. Baro reference No. 2 is entered with the first officer's EFIS control panel BARO knob. These baro reference correction factors are sent to all three ADC's through the onside CDU's.

The selected baro reference is also sent to each EIU for IDU display and to the FMC's for transition altitude functions.

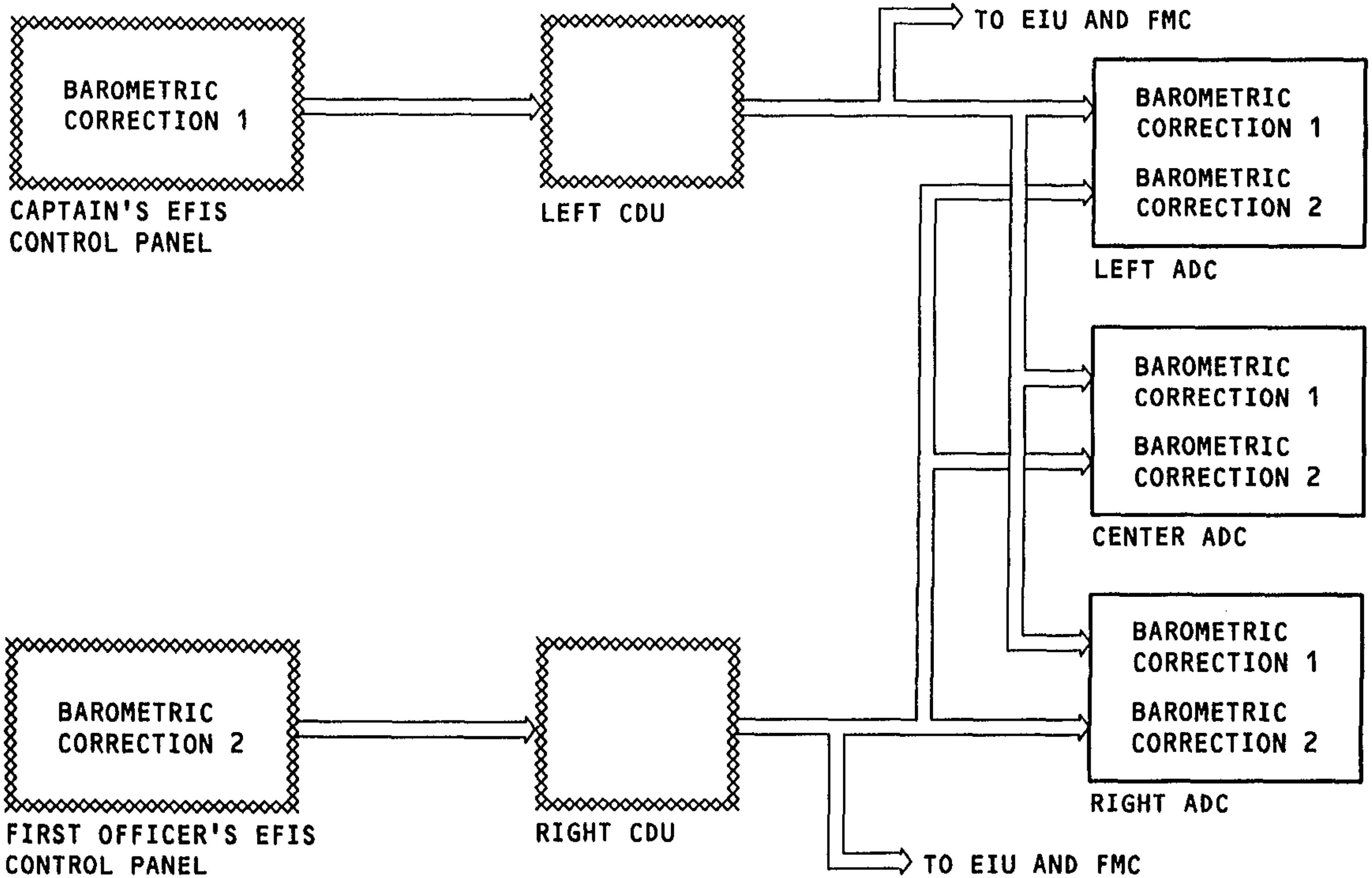


Figure 11 BAROMETRIC CORRECTION INPUT

TOTAL AIR TEMPERATURE (TAT) INPUT

General Description

The two TAT probes (right and left) supply total air temperature to the ADC system. When the TAT probes are heated , a heat current sensor energizes a relay that sends a HEAT ON discrete to the ADC's.

TAT Input

Each TAT probe has two temperature sensing elements. The right probe supplies an analog temperature to the right and center ADC's. The left probe uses only one element for the left ADC.

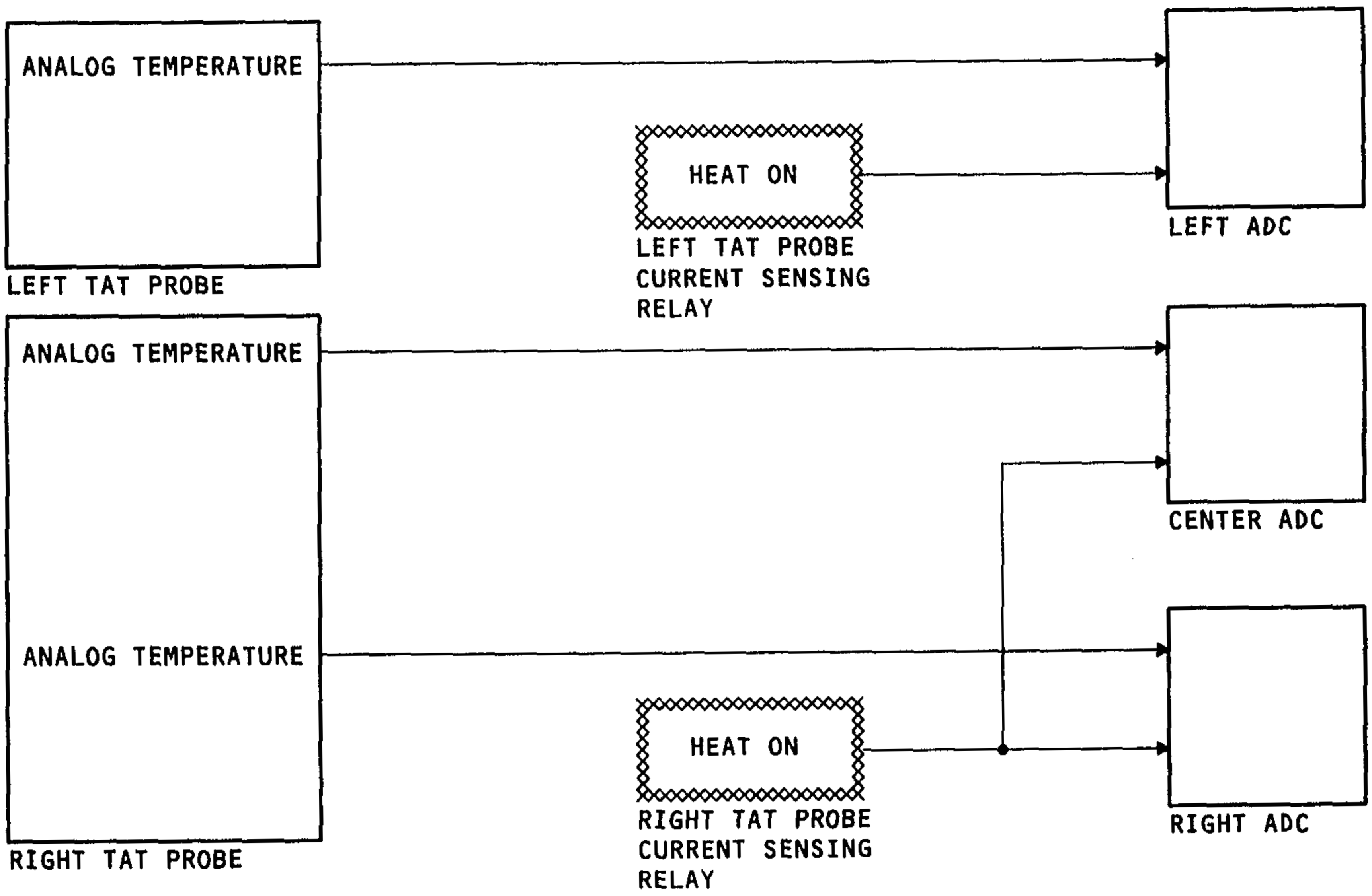


Figure 12 TOTAL AIR TEMPERATURE (TAT) INPUT

GEAR DOWN, 5. ENGINE CARRIAGE & TEST DISCR.

Gear Down/Fifth Engine Carriage Discretes

Contacts on the gear down dispatch and fifth engine carriage switch send analog discretes to the left, center, and right ADC. The gear down discrete and fifth engine carriage switches are used by the ADC to modify the Vmo curves.

Test Discrete

The central maintenance computers (CMCs) can request ground test of any ADC. A test discrete is sent through enable relays 1 and 2 and the air/ground system relays, to ensure the test can only be performed on the ground.

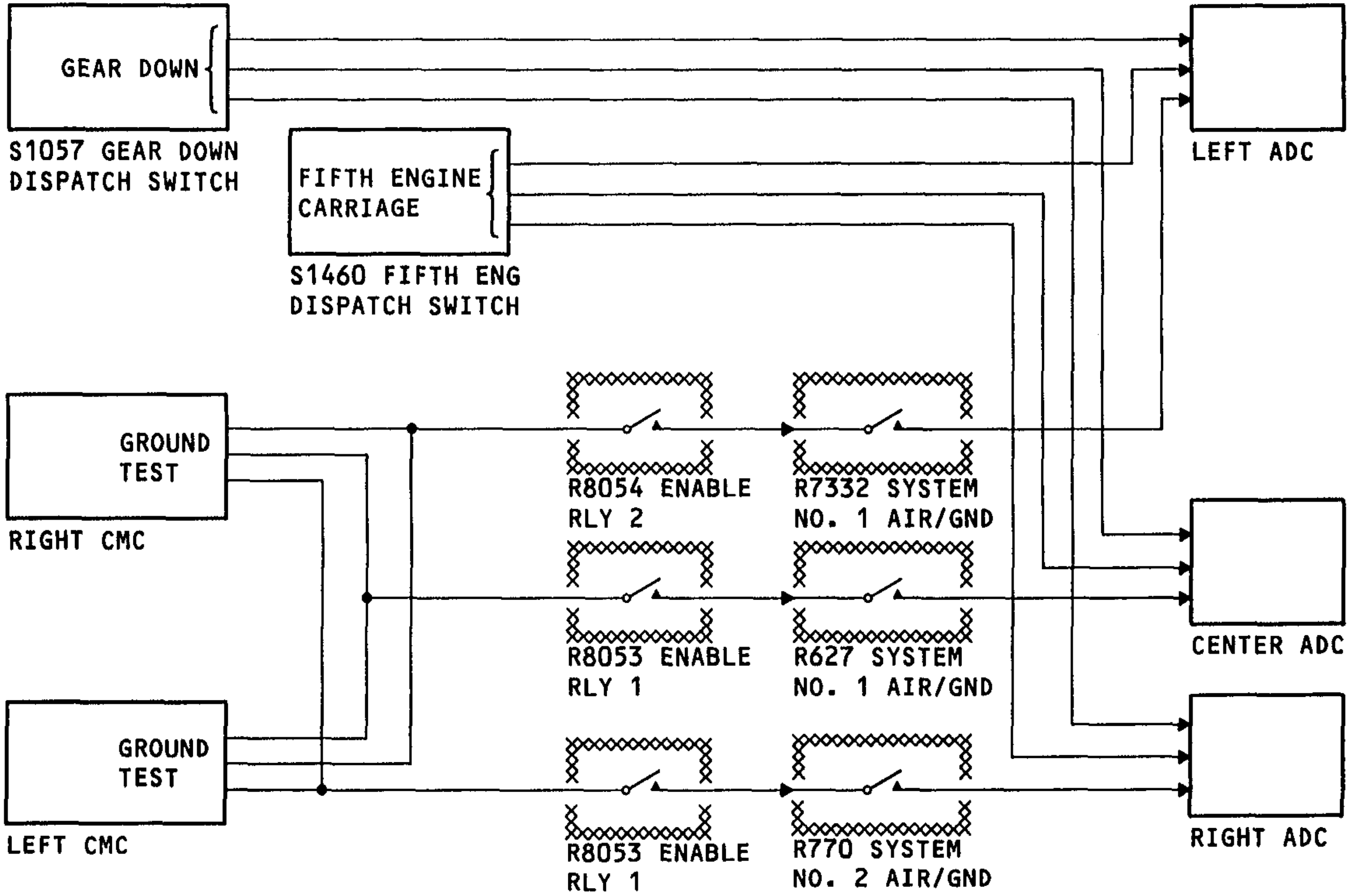


Figure 13 GEAR DOWN, 5. ENGINE CARRIAGE & TEST DISCR.

DATA OUTPUTS 1

Each ADC sends digital data out on four identical data buses. All data buses from the left and center ADCs are sent to the captain's ADC source select relay which selects either the group of four buses from the left or the group of four buses from the center ADC. The selection depends on the selected position of the captain's instrument source select switch.

All data buses from the center and right ADCs are sent to the first officer's ADC source select relay which selects either the four buses from the center ADC or the four buses from the right ADC. The selection depends on the selected position of the first officer's instrument source select switch.

Data buses two and four are always sent directly from the left, center and right ADC to certain user systems.

Each ADC also supplies an overspeed analog discrete to all three EIU's and the MAWEA.

The overspeed signal causes an overspeed message to be displayed on the EICAS display and PFD. It Will also produce a warning (level A) in the MAWEA.

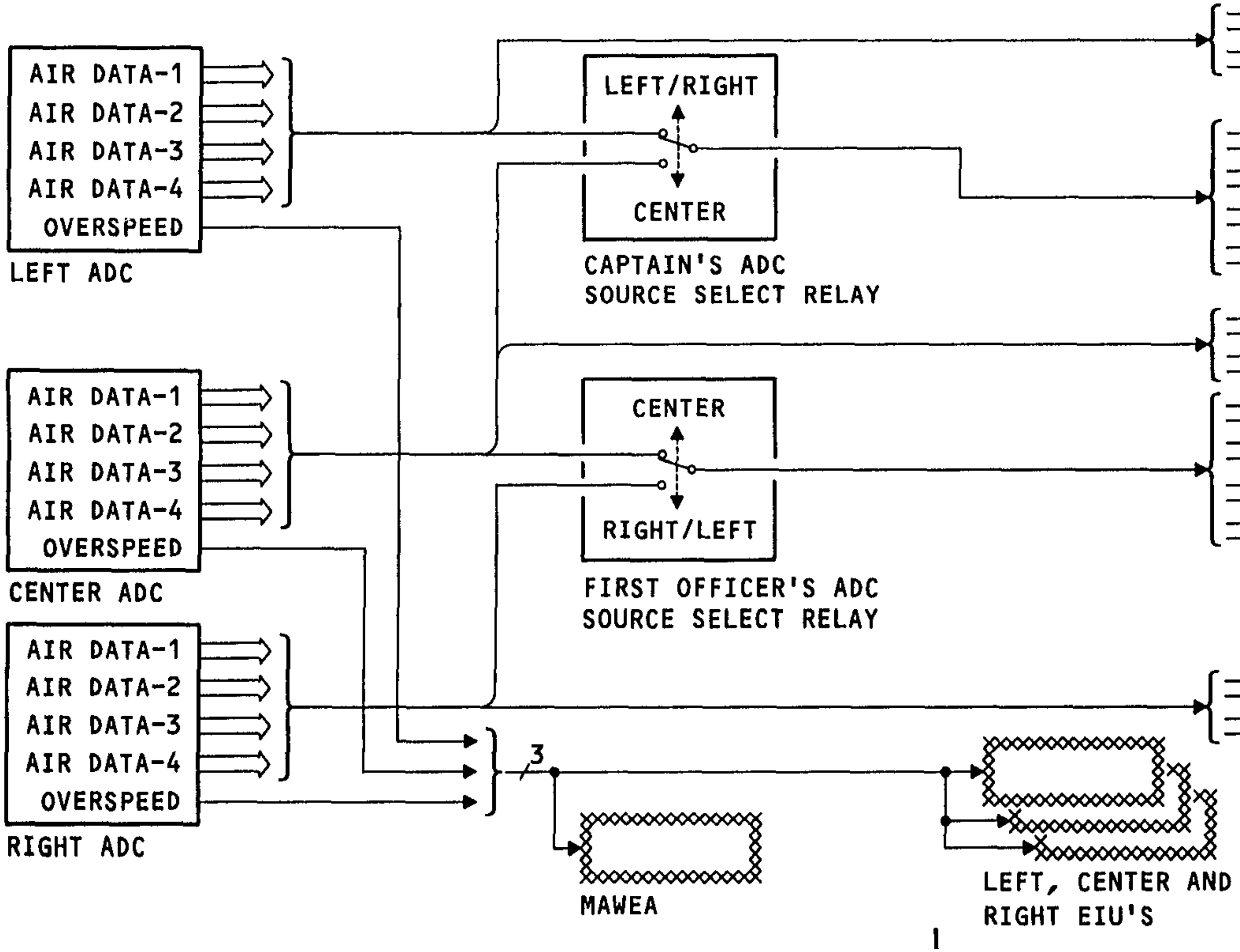


Figure 14 DATA OUTPUTS 1

DATA OUTPUTS 2

This table shows the distribution of the ADC output buses to various other airplane systems that use ADC data. The systems shown are in ATA chapters 21, 22 and 27.

SOURCE	BUS	LEFT CPC (21)	RIGHT CPC (21)		LEFT SRM (22)	RIGHT SRM (22)	LEFT FCC (22)	CENTER FCC (22)	RIGHT FCC (22)	UPPER YDM (22)	LOWER YDM (22)		LEFT FCU (27)	CENTER FCU (27)	RIGHT FCU (27)						
LEFT ADC	2																				
	4																				
CAPTAINS SOURCE SELECT RELAY - LEFT OR CENTER ADC	1				X		X	X		X			X								
	2																				
	3																				
	4	X	X			X					X			X	X						
FIRST OFFICERS SOURCE SELECT RELAY - RIGHT OR CENTER ADC	1					X			X		X			X	X						
	2																				
	3																				
	4	X	X		X					X			X								
RIGHT ADC	2																				
	4																				

NOTE: THE NUMBER AFTER THE LRU INDICATES ATA CHAPTER

Figure 15 DATA OUTPUTS 2

DATA OUTPUTS 3

This table shows the distribution of the ADC output buses to various other airplane systems that use ADC data. The systems shown are in ATA chapters 31, 34 and 73.

SOURCE	BUS	LEFT EIU (31)	CENTER EIU (31)	RIGHT EIU (31)	DMU (31)	MAWEA (31)		LEFT FMC (34)	RIGHT FMC (34)	LEFT IRU (34)	CENTER IRU (34)	RIGHT IRU (34)	LEFT ATC (34)	RIGHT ATC (34)	GPWC (34)		EEC NO. 1 (73)	EEC NO. 2 (73)	EEC NO. 3 (73)	EEC NO. 4 (73)	
LEFT ADC	2	X	X																		
	4			X	X																
CAPTAINS SOURCE SELECT RELAY - LEFT OR CENTER ADC	1					X		X													
	2					X				X	X										
	3																X	X	X	X	
	4								X			X	X	X	X						
FIRST OFFICERS SOURCE SELECT RELAY - RIGHT OR CENTER ADC	1					X			X												
	2					X						X									
	3																X	X	X	X	
	4							X		X	X		X	X							
RIGHT ADC	2		X	X																	
	4	X			X																
CENTER ADC	2		X																		
	4	X		X	X																

NOTE: THE NUMBER AFTER THE LRU INDICATES ATA CHAPTER

Figure 16 DATA OUTPUTS 3

SOURCE SELECT RELAYS FUNCTIONAL SUMMARY

The captain's and first officer's ADC Source Select Relays have two basic functions:

Configure the center ADC to function as a replacement for either the left or the right ADC.

Switch the data bus outputs when the center ADC is configured as a left or a right ADC replacement.

The First Officer's ADC Source Select Relay switches the center ADC configuration between its normal configuration as a left ADC to a Right ADC when selected by the F/O's ADC Source Select Switch.

The Captain's ADC Source Select Relay enables the center ADC to act as a replacement for the left ADC when selected by the Captain's ADC Source Select Switch.

FIRST OFFICER'S ADC SOURCE SELECT RELAY SWITCH FUNCTIONS

FUNCTION	SIGNALS SWITCHED (FROM/TO) RIGHT ADC TO CENTER ADC	DESTINATION
PITOT/STATIC SOURCE	AUX 2 PITOT - TO - F/O PITOT AUX 1 STATIC - TO - AUX 2 STATIC	CENTER ADC
HEATER DISCRETE	CAPT P/S - TO - L AUX P/S	CENTER ADC
HEATER DISCRETE	R AUX P/S - TO - F/O P/S	CENTER ADC
PROGRAM PINS	LEFT ADC PROGRAM - TO - RIGHT ADC PROGRAM	CENTER ADC
DATA BUS OUTPUTS	RIGHT BUSES 1,2,3,4 - TO - CENTER BUSES 1,2,3,4	USER SYSTEMS

CAPTAIN'S ADC SOURCE SELECT RELAY FUNCTIONS

DATA BUS OUTPUTS	LEFT BUSES 1,2,3,4 - TO - CENTER BUSES 1,2,3,4	USER SYSTEMS

Figure 17 SOURCE SELECT RELAYS FUNCTIONAL SUMMARY

AIR DATA COMPUTER

General

The air data computers sends air data in both digital and discrete analog format to a variety of airplane systems. The ADC is a modular designed digital computer packaged in a 4 MCU case. The computers use both hardware and software to calculate air data values based on a variety of sensor data received.

Front Panel Features

Pitot and static air pressure connections are at the top of the ADC front panel. Additional features are:

- A FUNCTIONAL TEST pushbutton. When pushed, this button does a self-test and outputs ADC test parameters.
- An ADC FAIL indicator. This is a latched maintenance monitor fault ball which shows yellow when an ADC failure is detected.
- An EXTERNAL SENSOR FAULT display. This LED dot matrix display shows a sensor input failure code on the ADC front panel.
- A TEST ONLY connector. This connector connects data bus No. 1 for bench test.

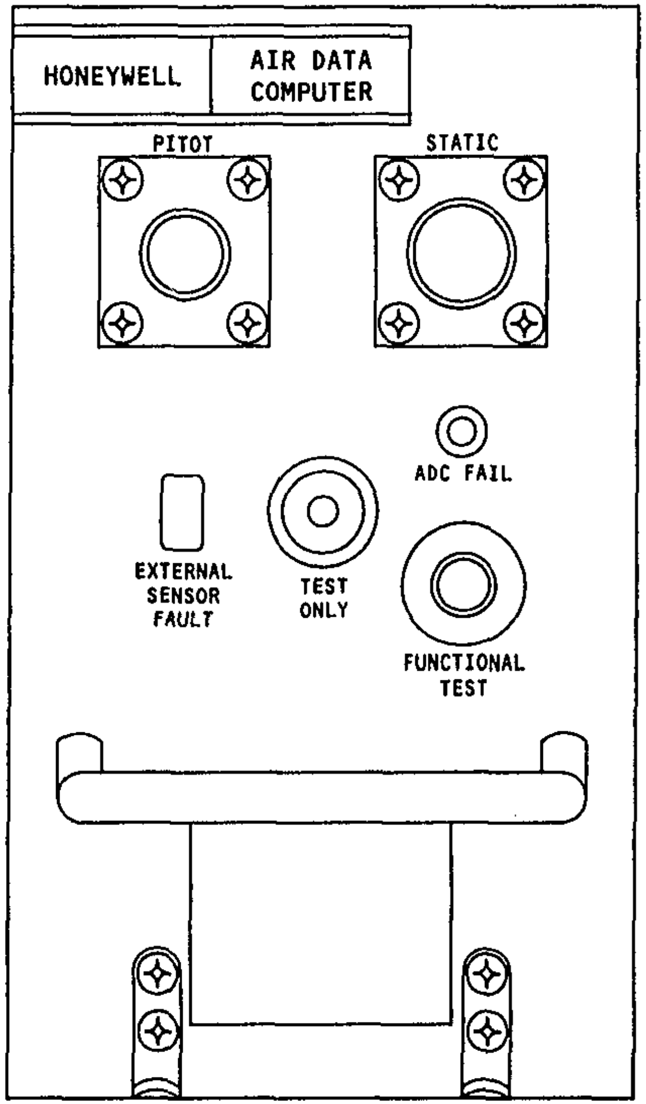


Figure 18 AIR DATA COMPUTER

SOURCE SELECT SWITCHES

The ADC source select switches are located on the captain's and first officer's instrument source select modules (P1-1 and P3-1).

The ADC source select switches control the captain's and first officer's ADC source select relays and supply switching information to systems which use ADC data.

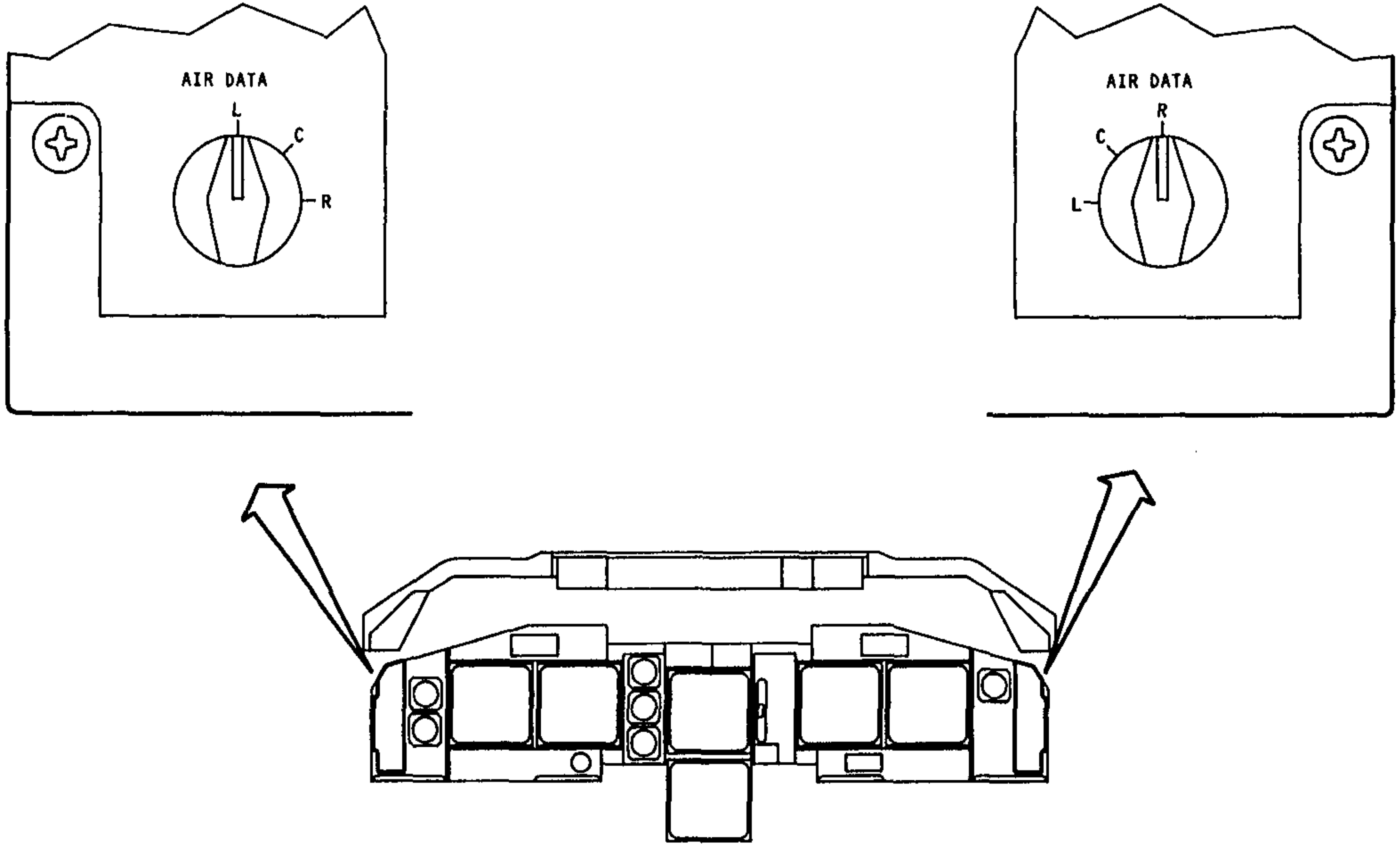


Figure 19 SOURCE SELECT SWITCHES

ANGLE-OF-A TTACK SENSOR

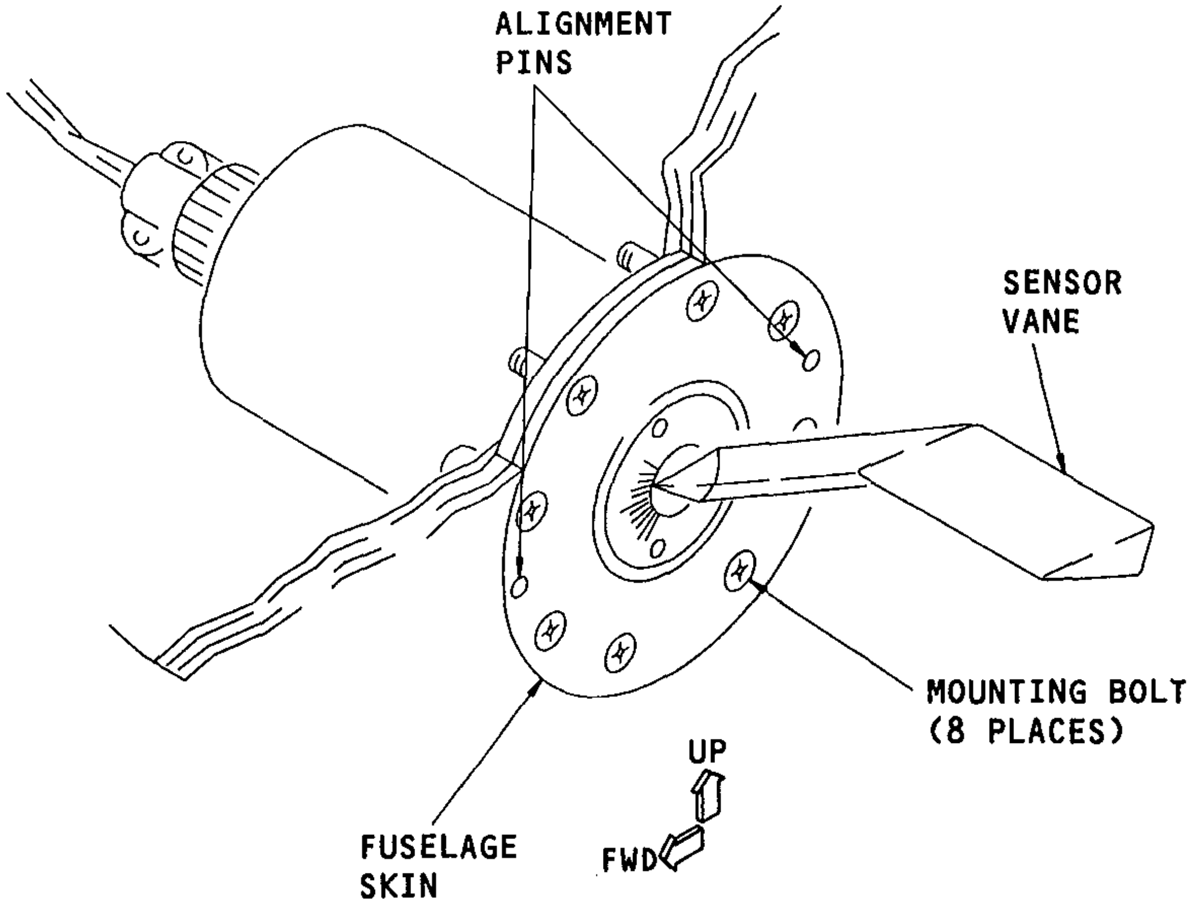
General

Angle-of-attack sensors are installed on the left and right sides of the airplane fuselage at the forward end of the airplane. These units give two synchro outputs of angle-of-attack. The vanes are heated in-flight and on the ground when the engines are running to prevent ice.

Installation

The sensor is installed from outside the airplane as shown.

WARNING: ANGLE-OF-A TTACK SENSOR MAY BE HOT IF HEATER POWER HAS BEEN ON RECENTLY AND CAN CAUSE INJURY TO PERSONNEL WHEN TOUCHED.



NOTE: LEFT SENSOR SHOWN - RIGHT SENSOR SIMILAR

Figure 20 ANGLE-OF-A TTACK SENSOR

TOTAL AIR TEMPERATURE PROBE

General

The probe senses the temperature of air flow over the airplane and changes temperature to an analog electrical signal.

Access

Access the electrical connector and bleed air fitting with removal of the probe from the airplane.

WARNING: ENSURE PROBE HEAT HAS BEEN REMOVED TO AVOID SERIOUS BURNS.

WARNING: ENSURE PNEUMATIC POWER HAS BEEN REMOVED TO AVOID SERIOUS BURNS.

Characteristics

This probe is a small metal strut and has two temperature-sensitive wire elements, the resistance of the wire elements changes with temperature.

Engine bleed air into the probe makes a negative pressure which pulls outside air across the sensing elements. This is at a rate that the heating elements have little effect. This permits accurate TAT information while the airplane is on the ground, and in-flight at low airspeeds.

The TAT probe’s anti-icing is discussed later.

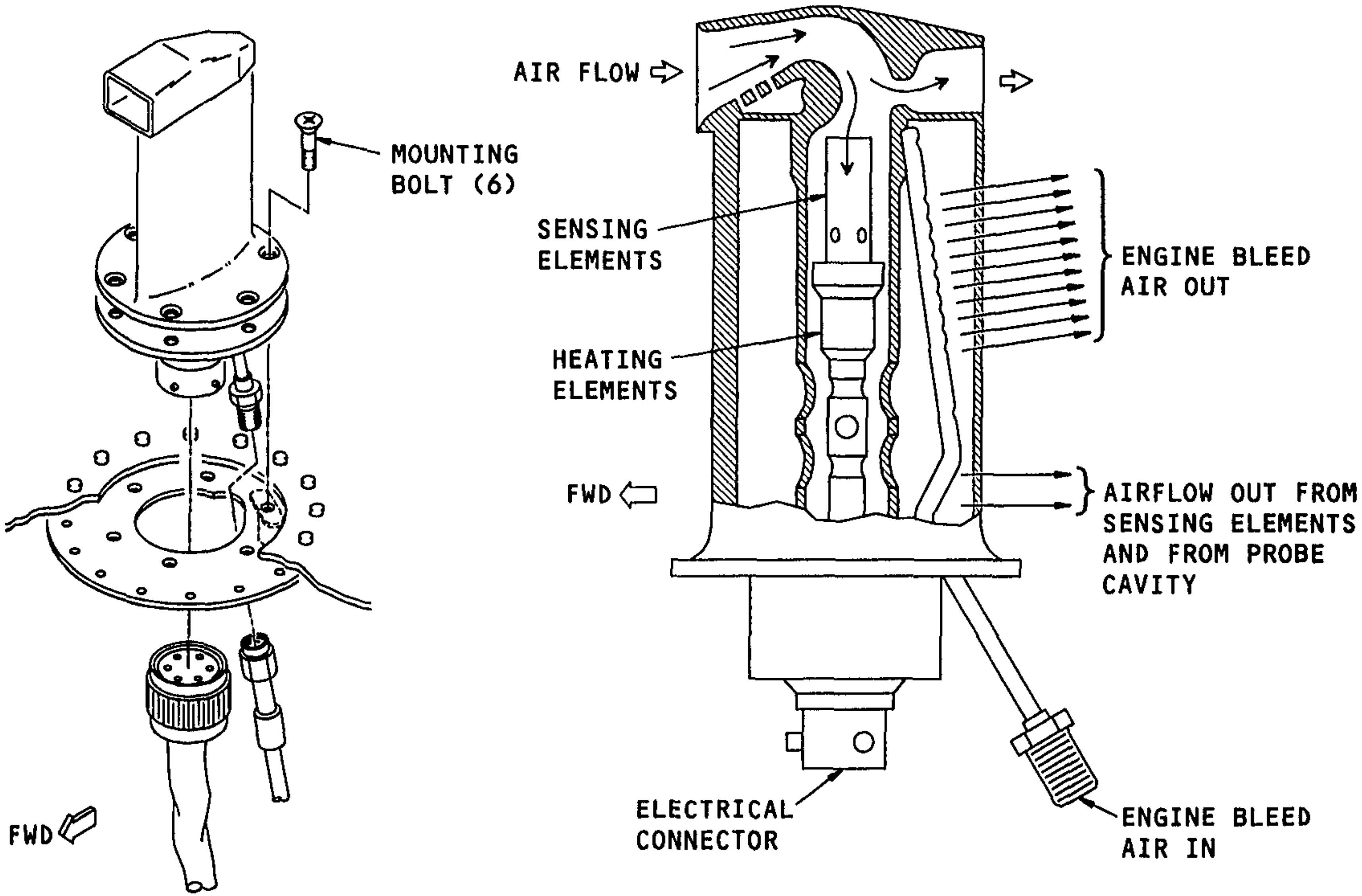


Figure 21 TOTAL AIR TEMPERATURE PROBE

PFD AIRSPEED DISPLAY

General

Airspeed information from the air data computer shows on the primary flight display (PFD). The airspeed display consists of a calibrated airspeed tape moving against a fixed pointer. Pointers, reference values, speed limits, and special speeds show on the airspeed tape to give additional information to the pilots.

Airspeed Tape

The white airspeed tape shows a range of 121.50 knots at any given time. Numerals are on the tape's 10-knot indices starting at 40 knots and every 20 knots from 40 to 980 knots.

The CAS digital readout within the airspeed readout box rolls in an odometer-like fashion. The lowest value shown is 30 knots, which is also shown if the information is less than 30 knots or no computed data (NCD). A failure of airspeed data from the air data computer causes removal of the airspeed tape. A yellow SPD flag shows in place of the airspeed tape.

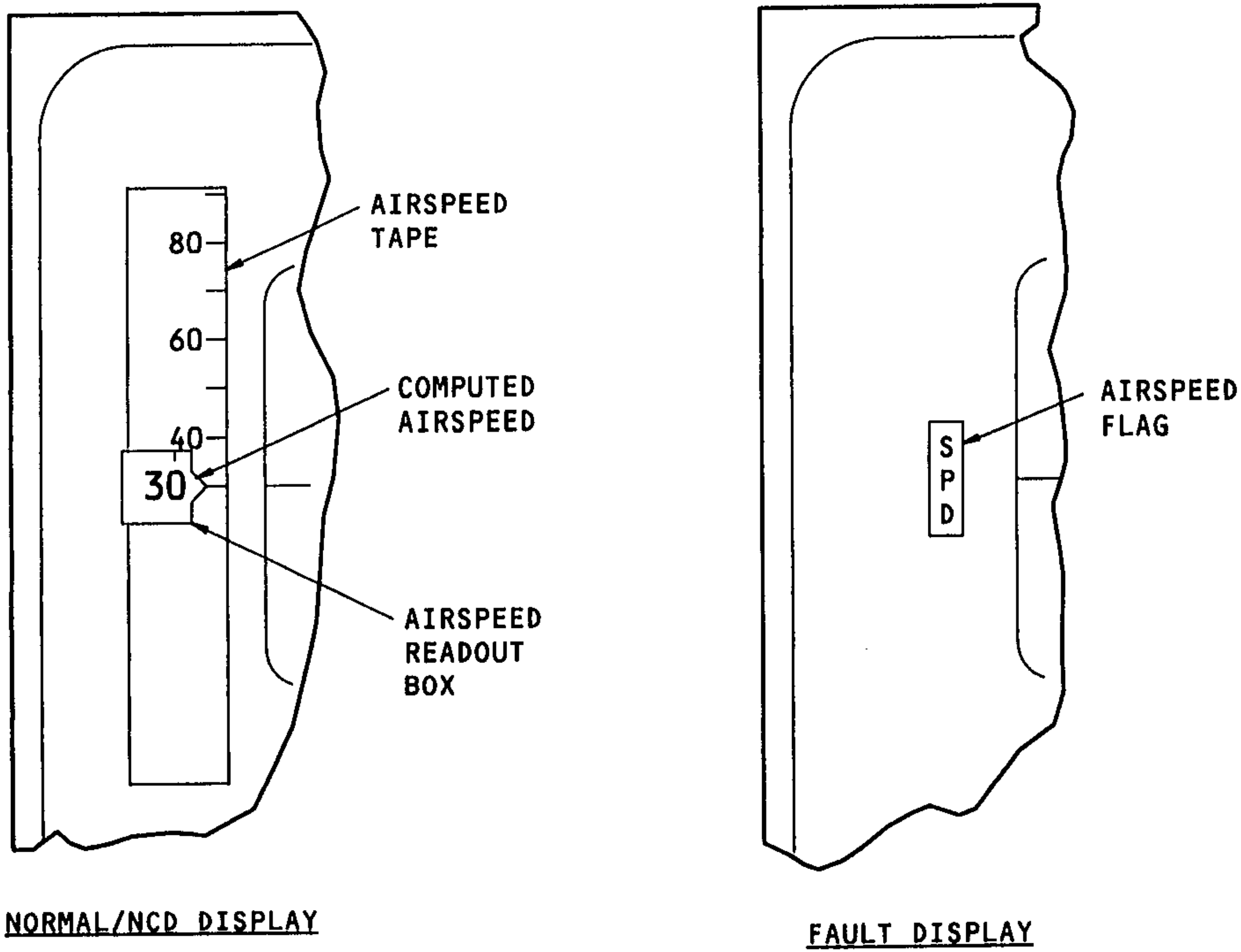


Figure 22 PFD AIRSPEED DISPLAY

PFD MACH DISPLAY

The mach display is below the airspeed tape display. The display consists of a decimal point followed by a white 3digit display of computed mach. The mach display is blank for values less than .4 or if the mach data is NCD. At .4 mach the display appears and remains until the mach data from the air data computer fails. This causes the numerics to be removed, and a yellow mach flag to appear in its place.

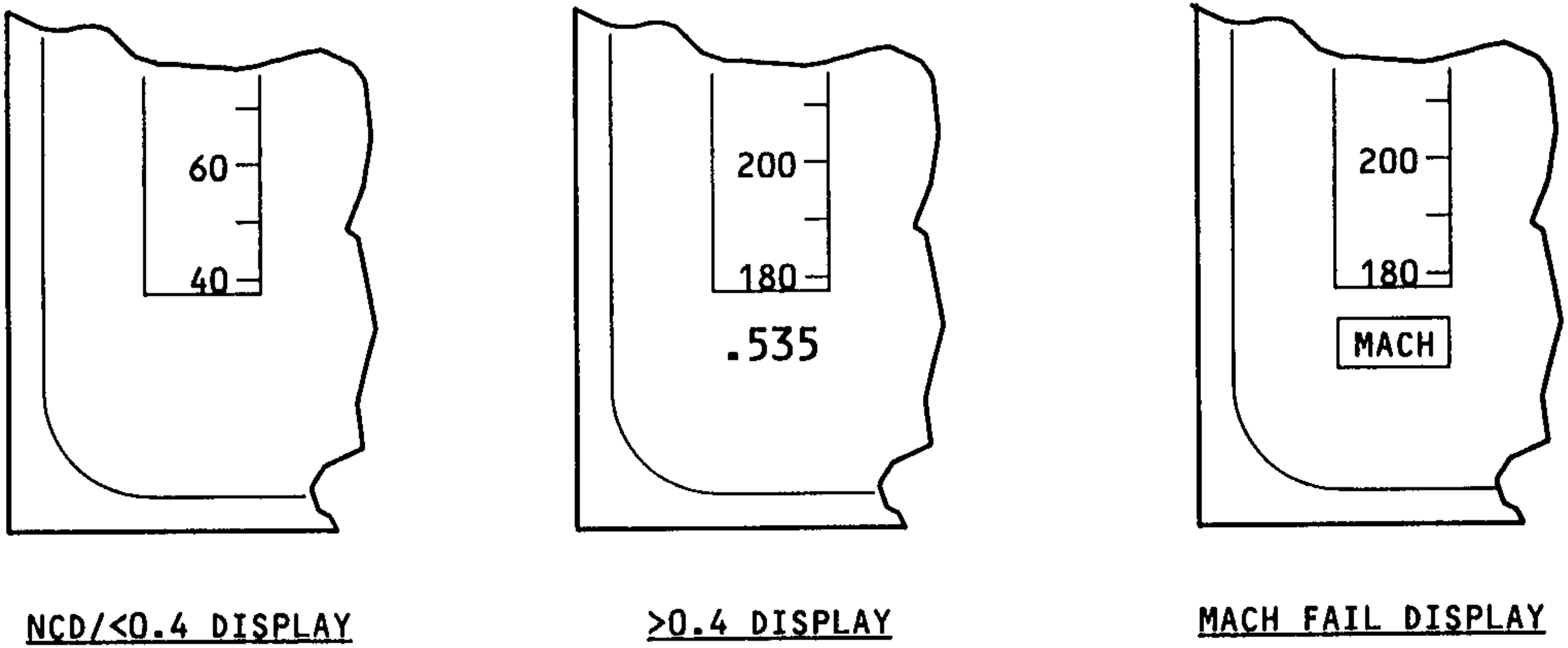


Figure 23 PFD MACH DISPLAY

PFD ALTITUDE DISPLAY

General

Altitude information from the air data computers shows on the primary flight display (PFD). The altitude display consists of a barometric altitude tape moving against a fixed pointer. Pointers, digital readouts, and selected values show on the altitude tape to give additional information to the Pilots.

Altitude Tape

The white altitude tape shows a range of 825 feet. Numerals are placed on the 100foot indices, showing 200-foot intervals. The digital readout within the altitude readout box rolls in an odometer-like fashion. Negative altitudes are preceded by a minus sign. Below 10,000 feet, the leftmost portion of the cursor shows a green crosshatch pattern.

A failure of altitude data from the air data computer causes removal of the altitude tape and readout box. A yellow ALT flag shows in place of the altitude tape.

Metric Altitude

If selected on the EFIS control panel, the altitude readout box shows metric altitude. The numerals are followed by an M to indicate the readout is in meters. Metric altitude is shown in addition to the barometric altitude in feet. The metric altitude readout is contained within a white box that is added to the top of the altitude readout box.

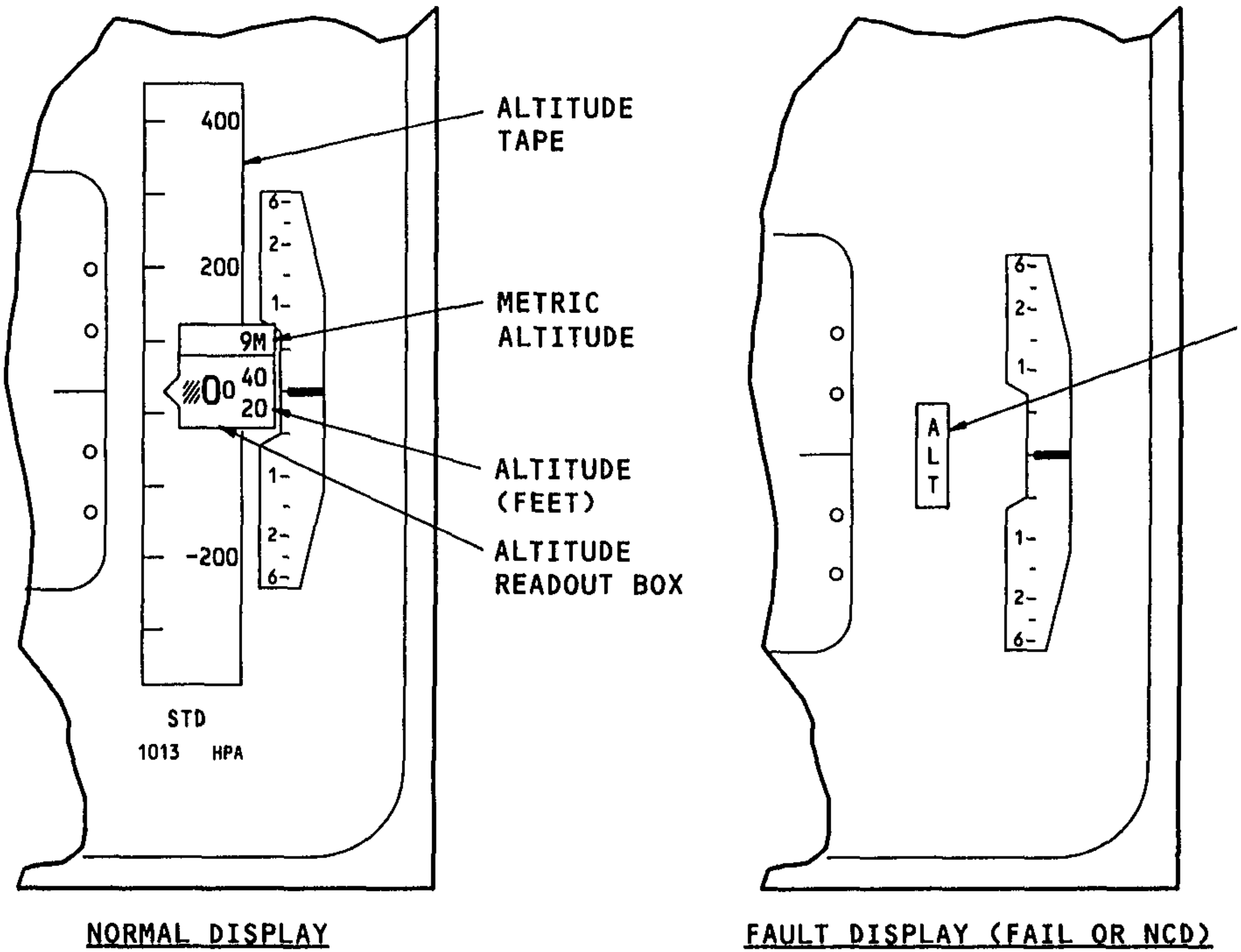


Figure 24 PFD ALTITUDE DISPLAY

BARO CONTROL AND DISPLAY

General

The baro reference correction data on the PFD shows on two lines. The top line (line 1), shows the selected baro reference correction. This value is either numbers, or the letters 'STD', when the STD button is active on the EFIS control panel. The second line (line 2) is the pre-selected baro reference correction value. This shows when STD is active on line 1 and the rotary knob (middle section) is rotated to enter a new baro reference correction value.

The baro reference correction values on lines 1 and 2 show in either inches (IN), or hecto Pascals (hPa). At power-up, both line 1 and line 2 show the value in effect when airplane power was removed.

Control

The barometric reference correction is entered with the EFIS control panel BARO knob. This knob has these three functions:

The outer part is a two- position switch which select IN (inches of mercury) or hPa (hecto Pascals) as units for barometric correction.

The middle part is a rotary knob that is a rate encoded potentiometer used to set in the desired barometric correction factor.

The inner or center part is a momentary pushbutton switch. This switch is used to select STD (standard) barometric correction of 29.92 in. or 1013 hPa when the selected transition altitude is reached. The inner part does not turn, but remains stationary with the letters STD always horizontal.

Operational Sequence

The sequence of operation that explains the baro correction procedures are:

- In figure A, the STD pushbutton is pushed (or the airplane has been powered-up with STD selected). The baro reference value is 29.92 IN or 1013 hPa. The last preselected baro reference is stored in the ADC memory.
- In figure B, the middle knob is rotated and a new pre-selected value of 29.50 IN shows on line 2.
- In figure C, the STD switch is pushed and the baro reference value changes to the new pre-select value of 29.50 IN. If the STD switch is pushed without a new pre-select baro reference, the baro reference value changes to the previous baro value stored in memory.

If the baro reference knob is rotated again, line one shows the newly selected baro reference value as the switch rotates.

In figure D, the STD switch is pushed again. The baro reference changes to 29.92 IN or STD, and 29.50 IN is stored in memory. Line 2 remains blank until a new pre-select value is entered by rotation of the baro set knob.

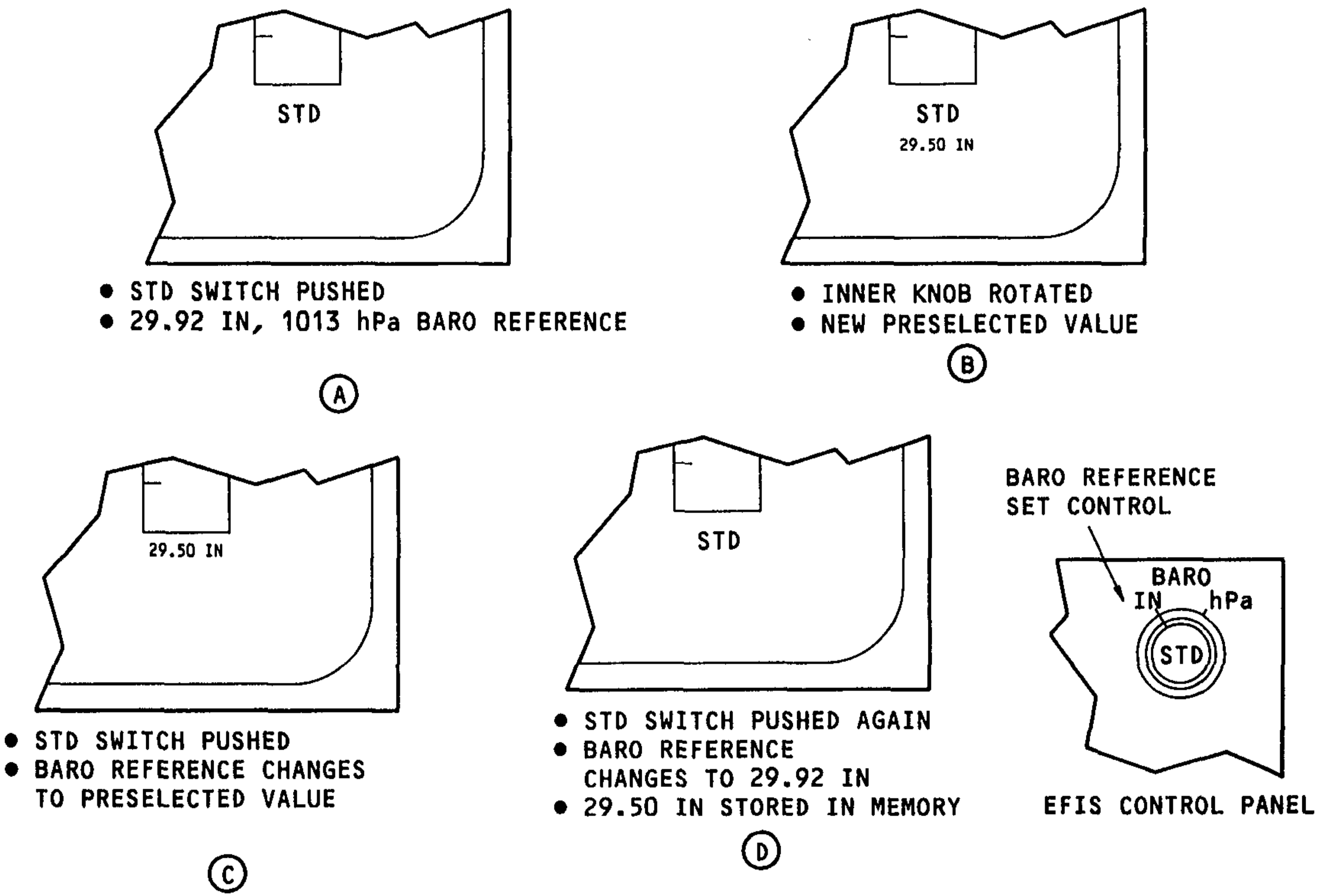


Figure 25 BARO CONTROL AND DISPLAY

BARO TRANSFER WARNING

General

The PFD shows a BARO transfer warning when the airplane is:

- Climbing without transition to standard barometric reference (BARO set not standard)
- Descending without transition to local barometric reference (BARO set standard)

The PFD uses the FMC transition altitude, MCP selected altitude, and active barometric altitude to show the BARO transfer warning.

Alert Display

The alert display changes the barometric reference or STD from green to yellow. A yellow mode change highlight symbol shows around the barometric reference or STD for ten seconds. The altitude tape, readout, and selected parameters are not affected by this alert display.

BARO Set Not Standard

The BARO transfer warning shows during climb when:

- The barometric altitude is greater than the FMC transition altitude plus 300 feet, and
- The MCP selected altitude is greater than the FMC transition altitude.

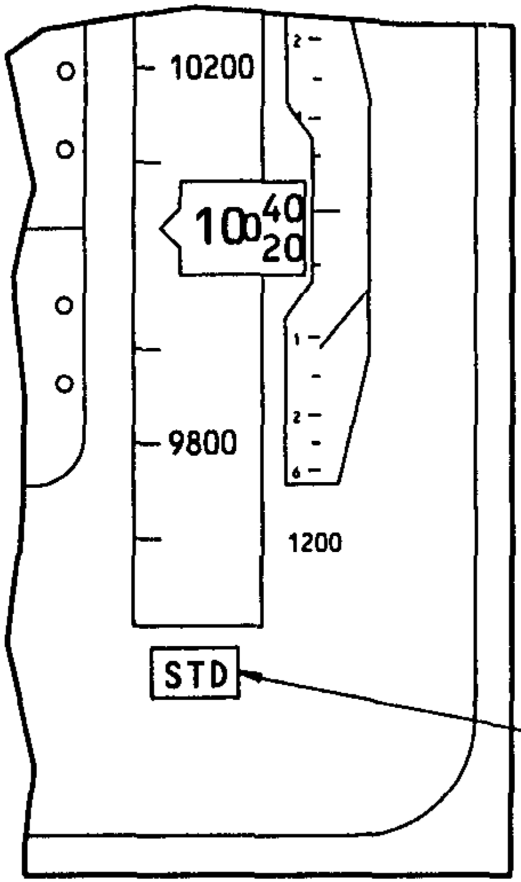
BARO Set Standard

The BARO transfer warning shows during descent when:

- The barometric altitude is less than the FMC transition altitude minus 300 feet, and
- The MCP selected altitude is less than the FMC transition altitude.

DURING BARO TRANSFER WARNING:

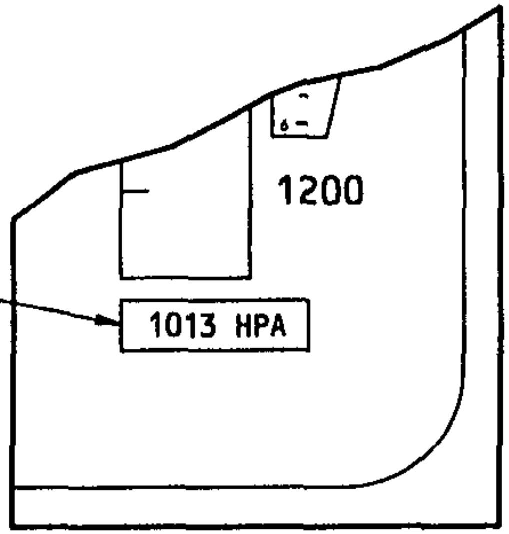
- BAROMETRIC REFERENCE (OR STD) CHANGES FROM GREEN TO YELLOW
- A YELLOW MODE CHANGE HIGHLIGHT SYMBOL SHOWS FOR 10 SECONDS



MODE CHANGE HIGHLIGHT SYMBOL

BARO SET STANDARD (DESCENT)

MODE CHANGE HIGHLIGHT SYMBOL



BARO SET NOT STANDARD (CLIMB)

Figure 26 BARO TRANSFER WARNING

CDU / EICAS DISPLAY DATA

Altitude

Barometric uncorrected altitude shows on the auxiliary EICAS performance maintenance page. BARO uncorrected ALT is calculated from pressure altitude and referenced to the standard altitude. Altitude range is -2000 to +500000 feet. Failure of the ADC's ALT causes removal of the altitude display.

CAS

Computed airspeed shows on the auxiliary EICAS performance maintenance page. CAS is computed from a combination of calibrated pitot and static pressure inputs that are compensated for ambient air temperature. Static pressure is also corrected for static pressure source errors. CAS ranges from 30 to 450 knots. Failure of the ADC's CAS causes removal of the CAS display.

Mach

Mach number shows on the auxiliary EICAS performance maintenance page. Mach is calculated the same as CAS. Range is from 0.100 to 1.000 Mach. Failure of the ADC's Mach causes removal of the Mach display.

TAS

True airspeed shows on the CDU progress page 2/2. TAS also shows on all navigation displays when above 100 knots. TAS is calculated from a combination of Mach and static air temperature (SAT). The range is from 100 to 599 knots. Failure of the ADC's TAS causes removal of the TAS display.

TAT

Total air temperature (TAT) in degrees centigrade shows in the upper left corner of the main EICAS display. It also shows on the auxiliary EICAS performance maintenance page. TAT is calculated from the analog output of the TAT probe and values range from -600C to +99*C. Failure of the ADC's TAT causes removal of the TAT display.

TAT

Static air temperature shows on the auxiliary EICAS performance maintenance page and the CDU pages 2/2. SAT is calculated from a combination of Mach and TAT. SAT ranges from -990C to +60*C. Failure of the ADC's SAT causes removal of the SAT display.

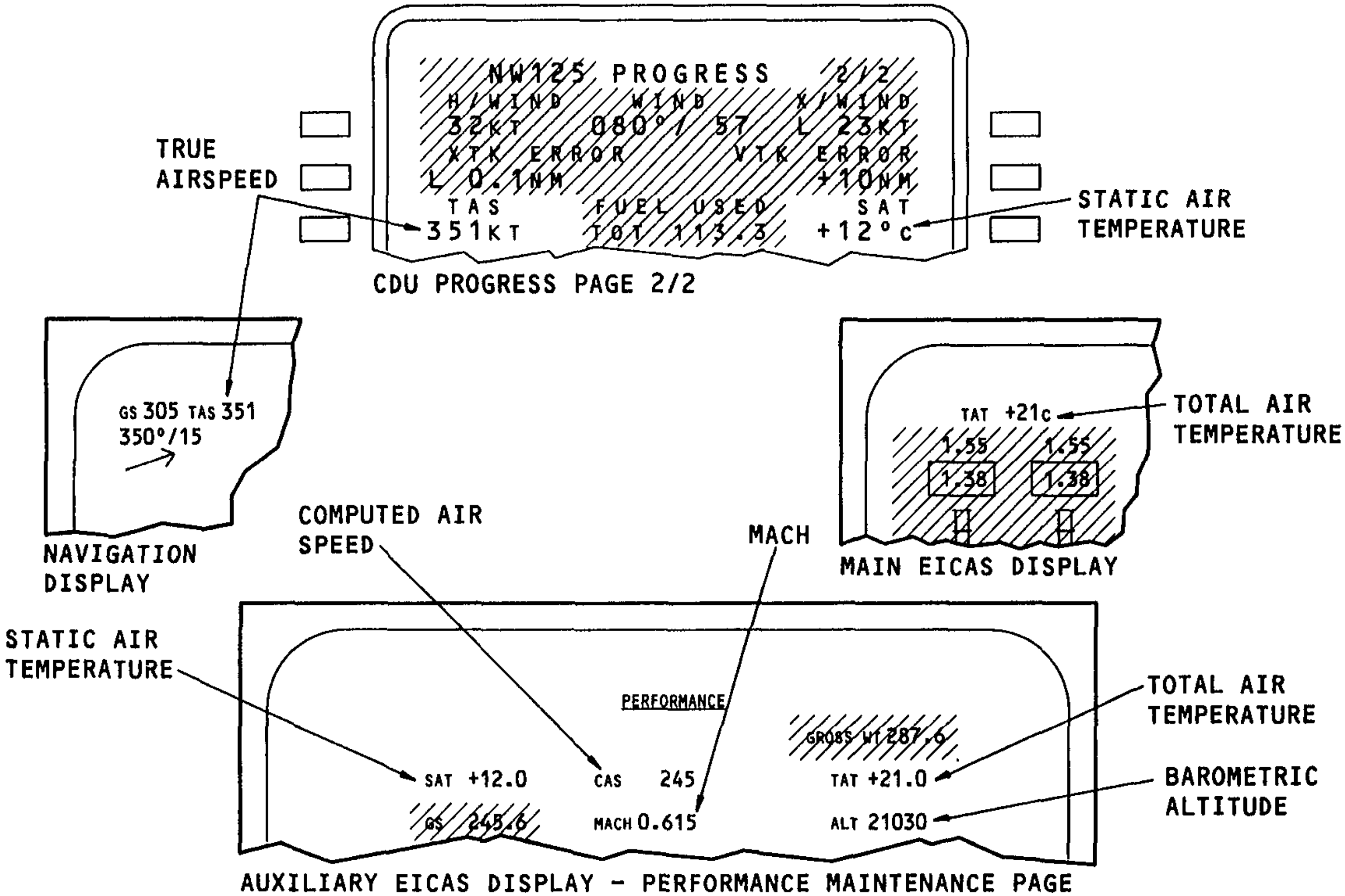


Figure 27 CDU / EICAS DISPLAY DATA

NOTES

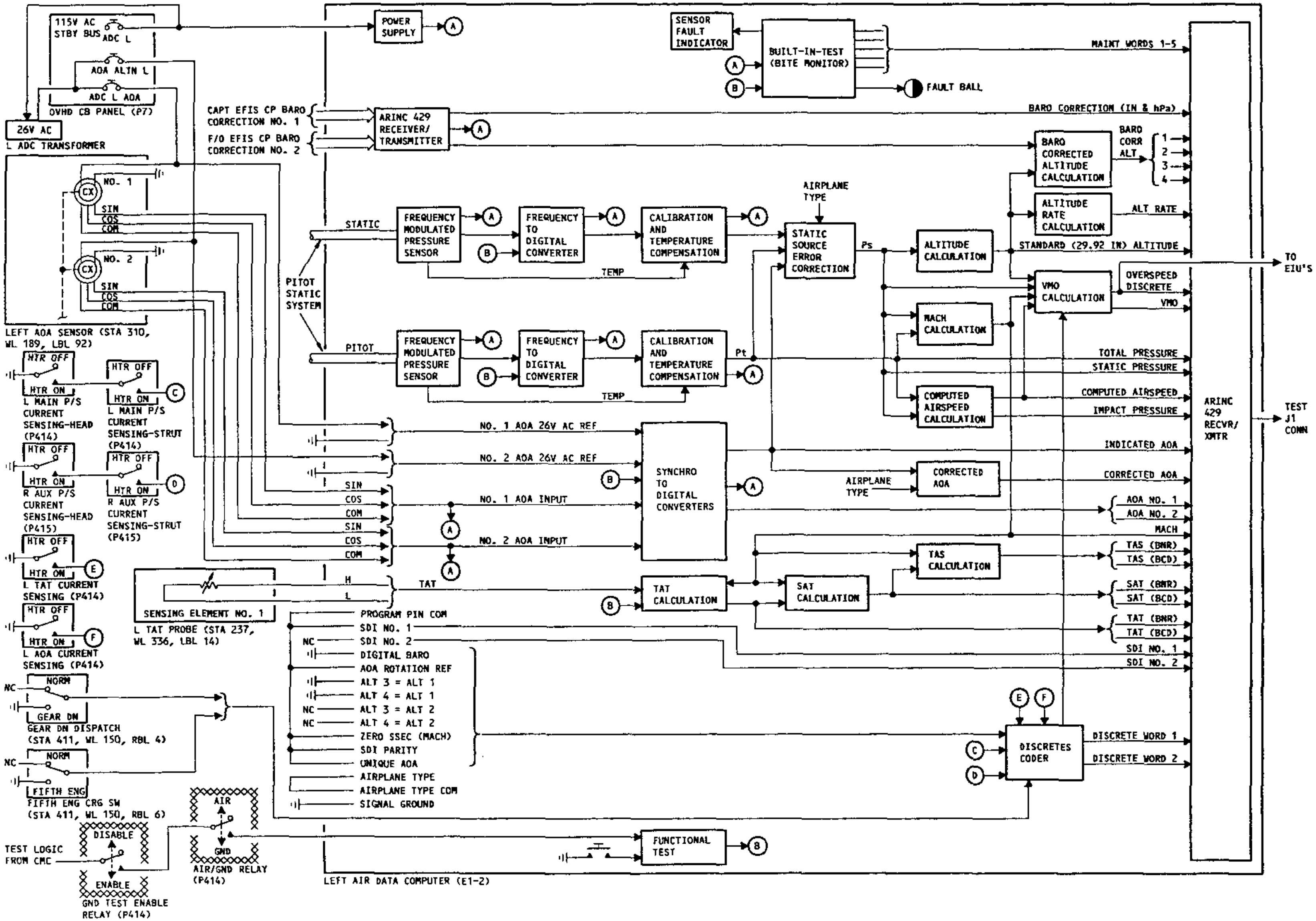


Figure 28 ADC SYSTEM – SCHEMATIC

POWER AND AOA SCHEMATIC

AOA Power

The two synchro transmitters in the AOA sensor sends the AOA synchro position signals to the ADC. The 26v ac synchro reference voltage is sent from the on side ADC transformer. This transformer, also supplies the AOA sensor with synchro excitation voltage.

Outputs

The synchro to digital converters have three outputs. These are AOA 1 and 2 and indicated AOA. Indicated AOA is selected from AOA 1 unless it fails and then AOA 2 is used. Indicated AOA is used for static source error correction (SSEC) in each ADC. A correction factor based on airplane type is applied to indicated AOA and calculates the value of corrected AOA. Corrected and indicated AOA is sent to all airplane user systems on ARINC 429 data buses.

A test value is sent to the synchro to digital converters for front panel self test or ground test.

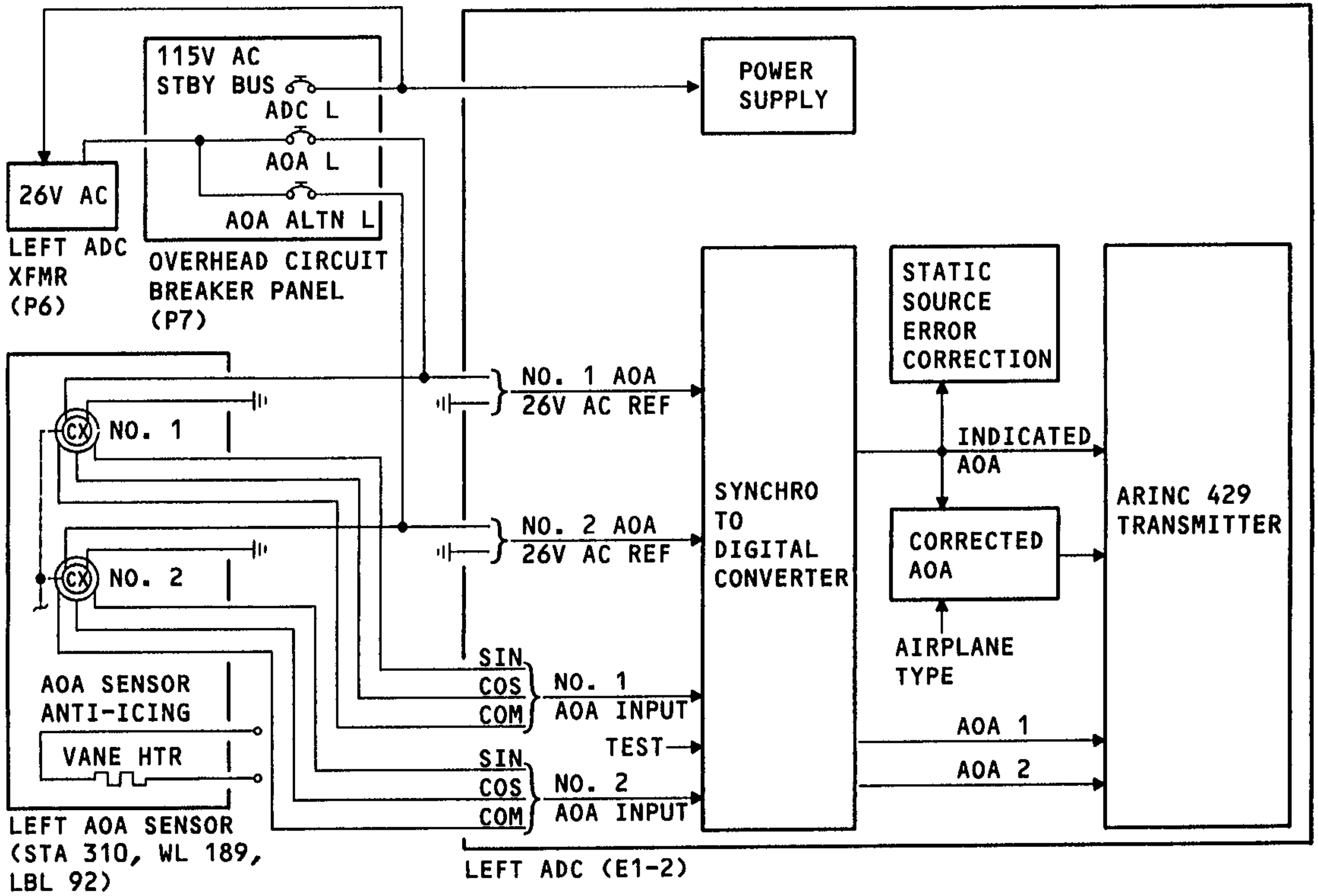


Figure 29 POWER AND AOA SCHEMATIC

TOTAL PRESSURE AND AIRSPEED

General

Total pressure and airspeed calculations are based on the total pressure input from the pitot/static system. To this pressure other data is applied to obtain various air data used for display and by other airplane systems.

Total Pressure Calculation

Total pressure is calculated with the pitot pressure input. A calibration factor and temperature compensation is added. This value is sent to the output transmitter and is used for calculations of airspeed and mach. During self-test, a test value is applied.

Impact Pressure and Computed Airspeed Calculation

Impact pressure and computed airspeed are calculated with total pressure and static pressure.

Mach Calculation

Mach is calculated with total pressure and static pressure.

True Airspeed Calculation

True Airspeed (TAS) is calculated with mach and Static Air Temperature (SAT). TAS is sent to the output transmitter as both a binary number and as a binary coded decimal value.

VMO Calculation

Maximum Operating Velocity (VMO) is calculated based on curves stored in software. Also stored are curves for Maximum Operating Mach (MMO). The VMO value is reduced when the gear down dispatch or fifth engine carriage discrete is set. Overspeed is detected based on the VMO/MMO value stored and the airplane's existing altitude, CAS and mach. When an overspeed condition exists, an overspeed discrete is sent out as an analog discrete and as a digital discrete.

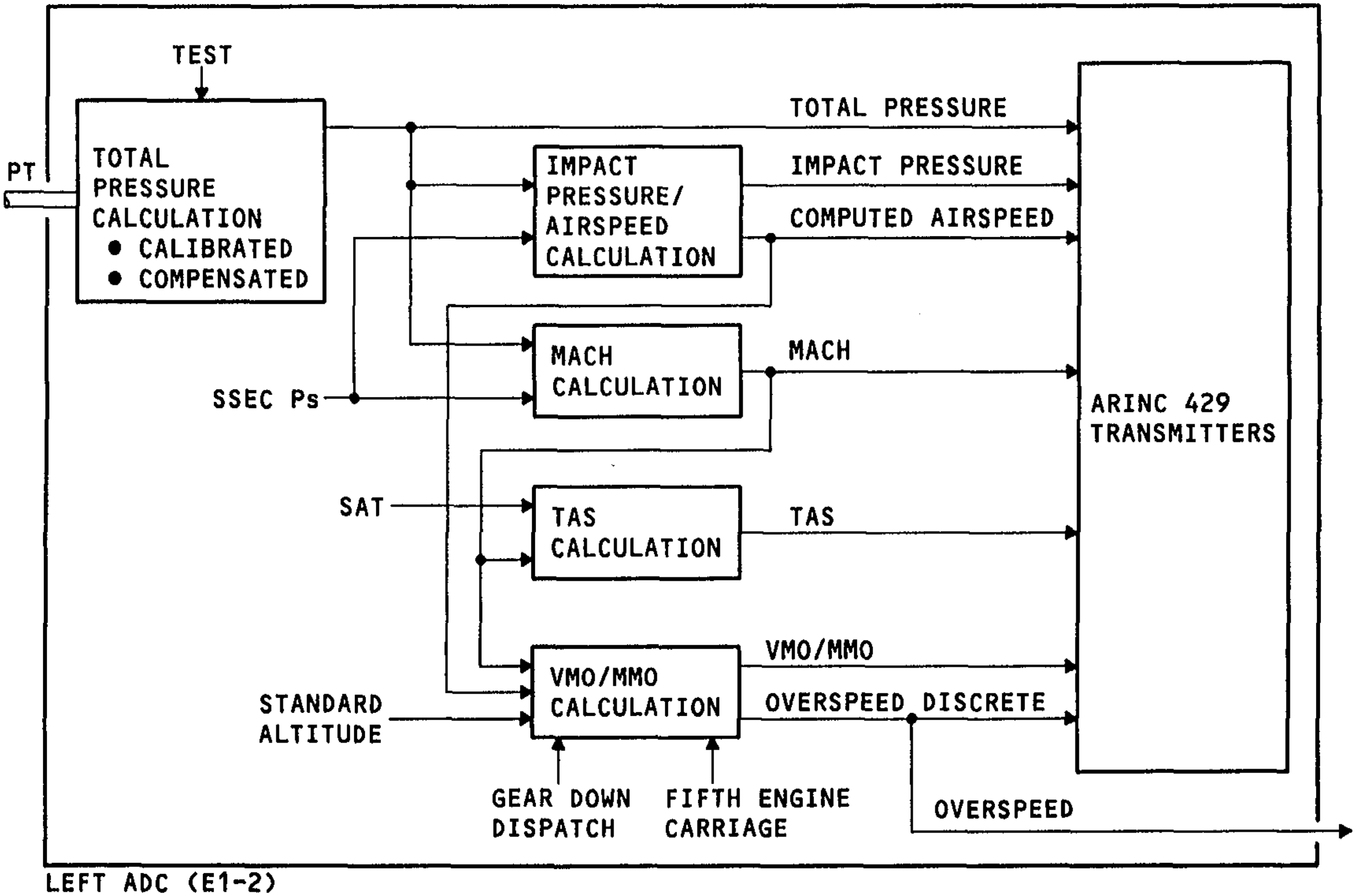


Figure 30 TOTAL PRESSURE AND AIRSPEED

VMO / MMO CURVES

General

The maximum Operating velocity (VMO) curves are stored in the ADC memory. VMO is transmitted to other airplane systems and also used by the ADC to monitor for an overspeed condition.

Operation

Three VMO curves are calculated. One for gear down dispatch, one for fifth engine carriage and one for normal conditions. The selection is based on the position of the gear down dispatch switch and/or the fifth engine carriage switch.

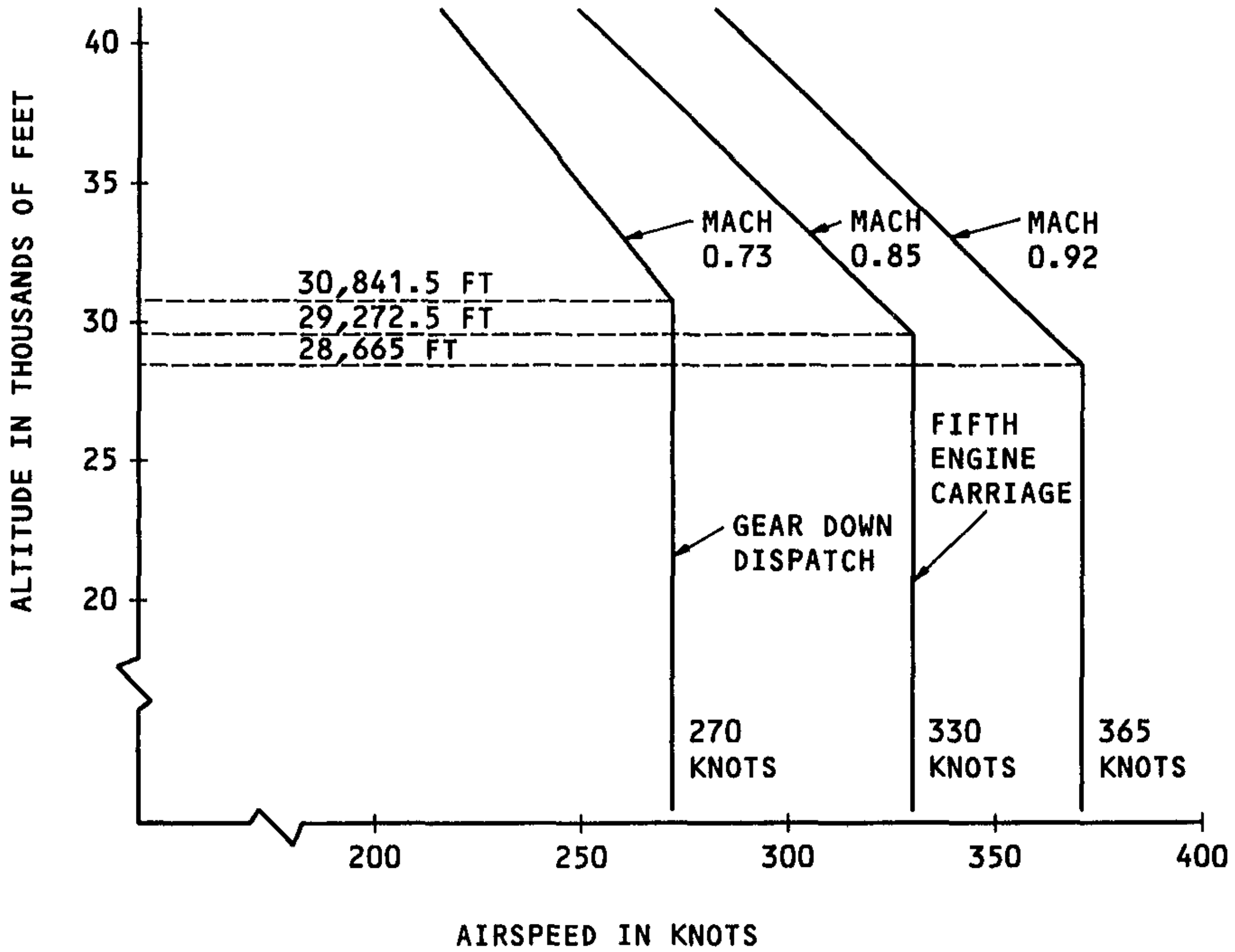


Figure 31 VMO / MMO CURVES

STATIC PRESSURE AND ALTITUDE

General

Static pressure and altitude calculations are based on the static pressure input from the pitot/static system. To this pressure, other data is applied to obtain various air data used for display and by other airplane systems.

Static Pressure Calculation

Static pressure is calculated using the pressure input after a conversion to digital. A calibration factor and temperature compensation is added to this. A static source error correction (SSEC) is then added based on airplane calibrations and angle-of-attack. The static pressure is then sent to the output transmitter and is used for airspeed/mach calculations.

Standard Altitude Calculation

The standard altitude calculation is based on calculated static pressure and standard barometric altitude pressure of 29.92 inches of mercury.

Altitude Rate Calculation

The altitude rate calculation is based on the rate of change of calculated standard altitude.

Barometric Reference Corrected Altitude Calculations

A barometric reference correction is added to the barometric altitude to produce four outputs of barometric corrected altitude. For these outputs, program pin selection sets a configuration such that barometric corrected altitude Nos. 11 3 and 4 use baro correction No. 1 and barometric corrected altitude No. 2 uses baro correction No. 2. For the right ADC, barometric corrected altitude Nos. 21 3 and 4 use baro correction No. 2 and barometric corrected altitude No. 1 uses baro correction No. 1.

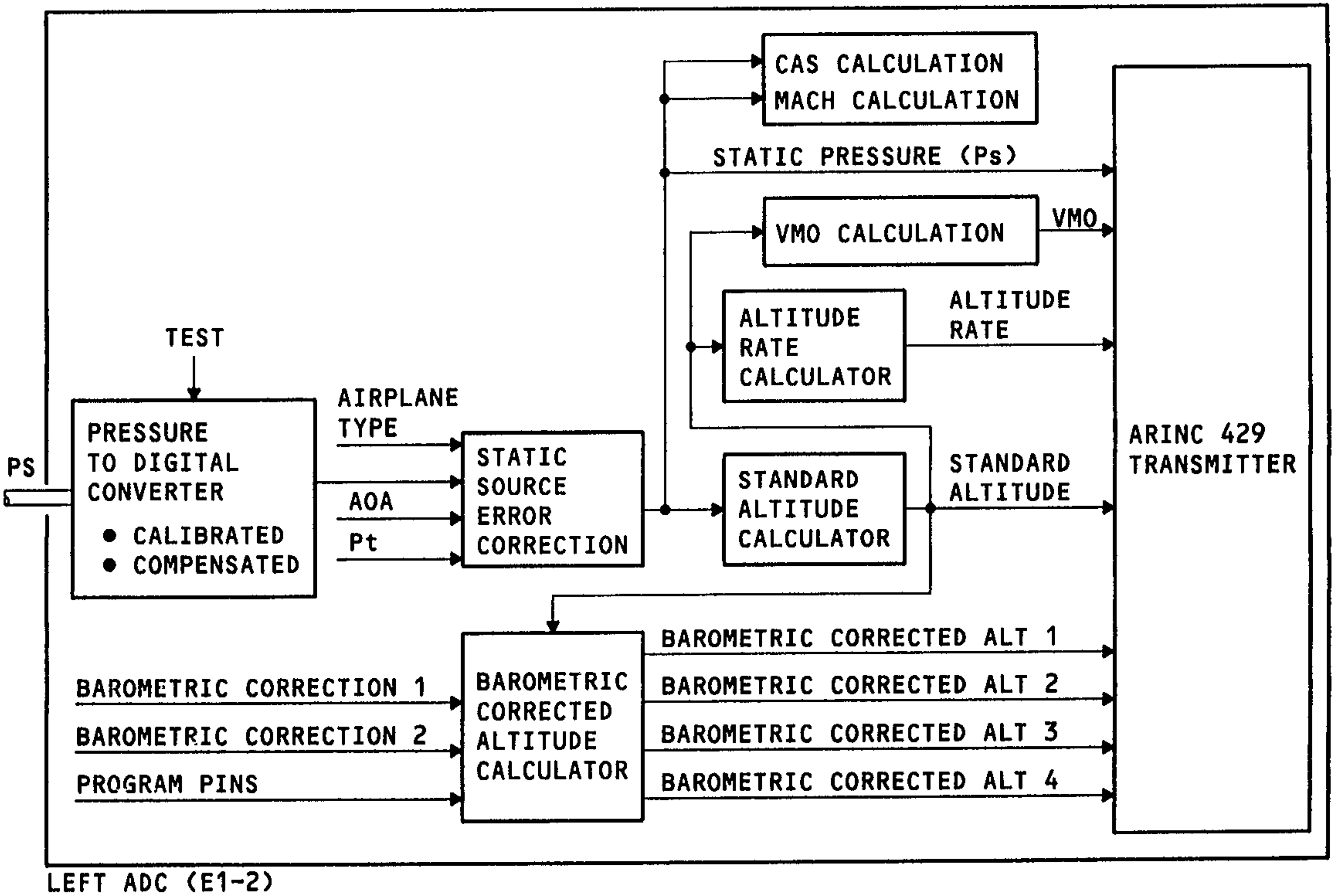


Figure 32 STATIC PRESSURE AND ALTITUDE

EFIS CP BARO REFERENCE CORRECTION

General

Two barometric reference correction values are set on the flight crews onside EFIS control panels (C/P), or the on-side CDU's. Baro reference correction No. 1 comes from the left EFIS C/P or left CDU, and baro reference correction No. 2 comes from the right EFIS C/P or right CDU.

Operation

The baro reference correction from the EFIS C/P is sent to the on-side CDU, where it is routed to the EIU's, FMC's, and ADC's, and checked for validity. When a failure of the EFIS C/P is detected, the CDU takes control and sends out the stored in memory baro reference correction value. This baro reference correction value can then be changed on the alternate EFIS control page of the on-side CDU.

The ADC's get baro correction in inches of mercury (in Hg) and hecto Pascals (hPa). The ADC receives these digital words on a ARINC 429 receiver. The baro reference corrected altitude calculation module calculates baro corrected altitude and sends this digital data word to the output ARINC 429 transmitter.

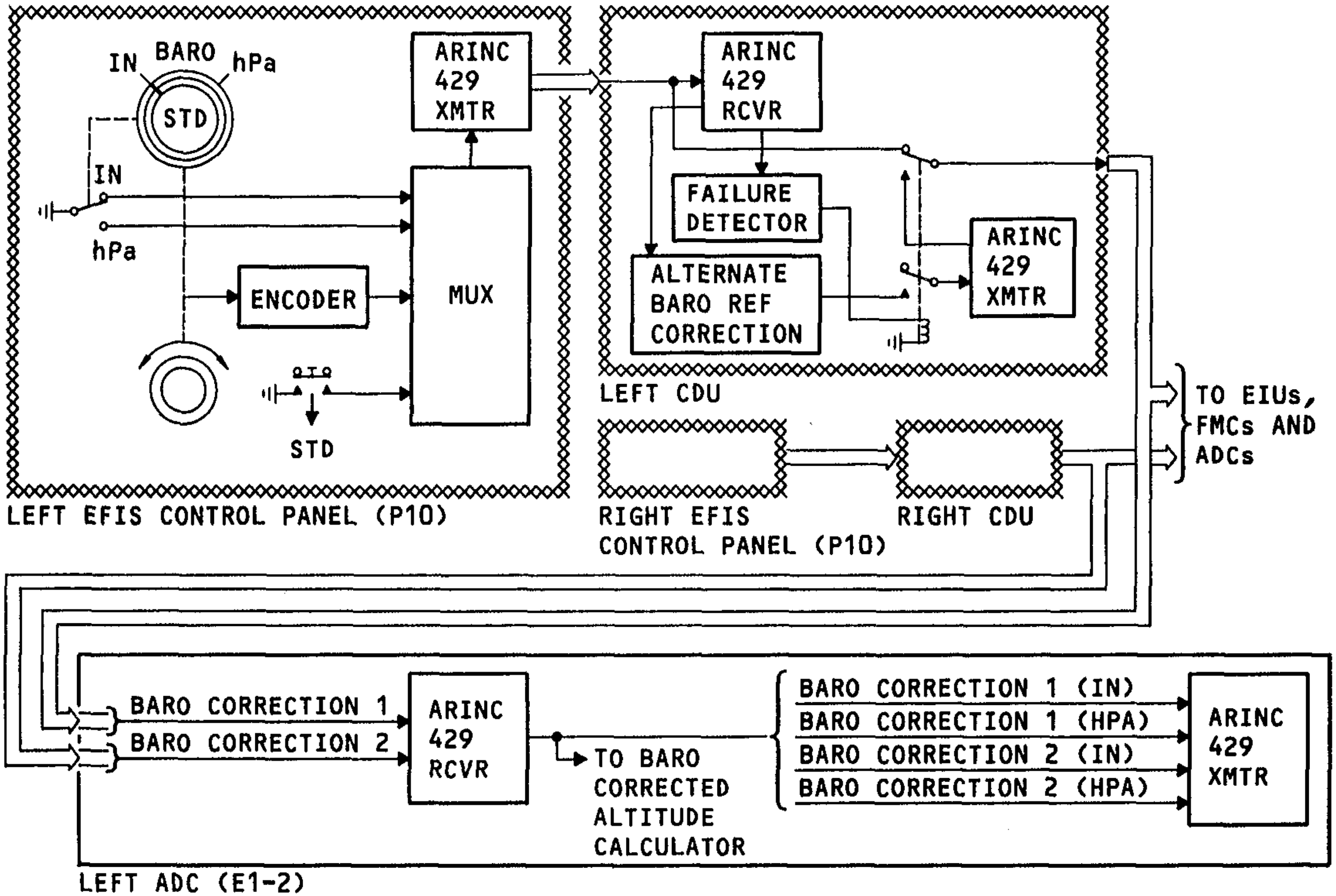


Figure 33 EFIS C/P BARO REFERENCE CORRECTION

TEMPERATURE AND PROGRAM PINS

TAT Calculation

Total air temperature (TAT) is calculated using the total air temperature input from the TAT probe. During a functional test, a test value is produced. TAT is sent to the output ARINC 429 transmitter as both a binary number and a binary coded decimal value.

SAT Calculation

Static air temperature (SAT) is calculated using TAT and MACH number. SAT is sent to the output ARINC 429 transmitter as both a binary number and a binary coded decimal value. SAT is also used in the TAS calculation.

Program Pins

The ADC program pins allow these functions:

- Source destination identifier (SDI) pins are used to identify the source of ADC data being sent to the airplane user systems. For the left ADC, SDI No. 1 is grounded, and SDI No. 2 is open. For the right ADC, this is reversed. For the center ADC, the input to these pins is switched by the ADC source select relay. SDI parity is always grounded.
- The AOA rotation reference program pin allows the ADC to properly process AOA resolver angles either from two onside resolvers or from one resolver from each AOA sensor.
- If the pin is grounded, the ADC assumes it is receiving both inputs from the same sensor and will reverse the sign of both AOA inputs, if the SDI pins identify the ADC is on the left side of the airplane but will not reverse the sign of either input if the SDI pins indentify the ADC is on the right side.
- if this pin is open, the ADC will assume it is receiving information from both the left and right AOA sensors and will reverse the sign of the number one resolver.
- Digital baro pin programs the ADC to accept baro correction from digital buses rather than from analog synchroresolvers.
- ALT program pins tell the ADC which baro correction input to use for the calculation of the baro altitudes three and four. Baro #1 (ALT1) is set by the L EFIS control panel. Baro #2 (ALT2) is set by the R EFIS control panel. Baro *3 and Baro #4 are set by a ground on ALT3 and ALT4 to be equal to ALT1 or ALT2.
- Unique AOA program pin when grounded, causes the ADC to use one AOA resolver input as primary with the second input as alternative in case the primary fails. With AOA rotation reference also grounded, the number one resolver input is primary. With AOA rotation reference open, the SDI determines the primary input. If SDI is set to left ADC, the number one resolver input is primary. If SDI is set to right ADC, then number two resolver input is primary.
- If unique AOA program pin is open, the ADC will average both AOA resolver inputs.
- Airplane type program pins program the ADC to use the proper SSEC and AOA calculations.

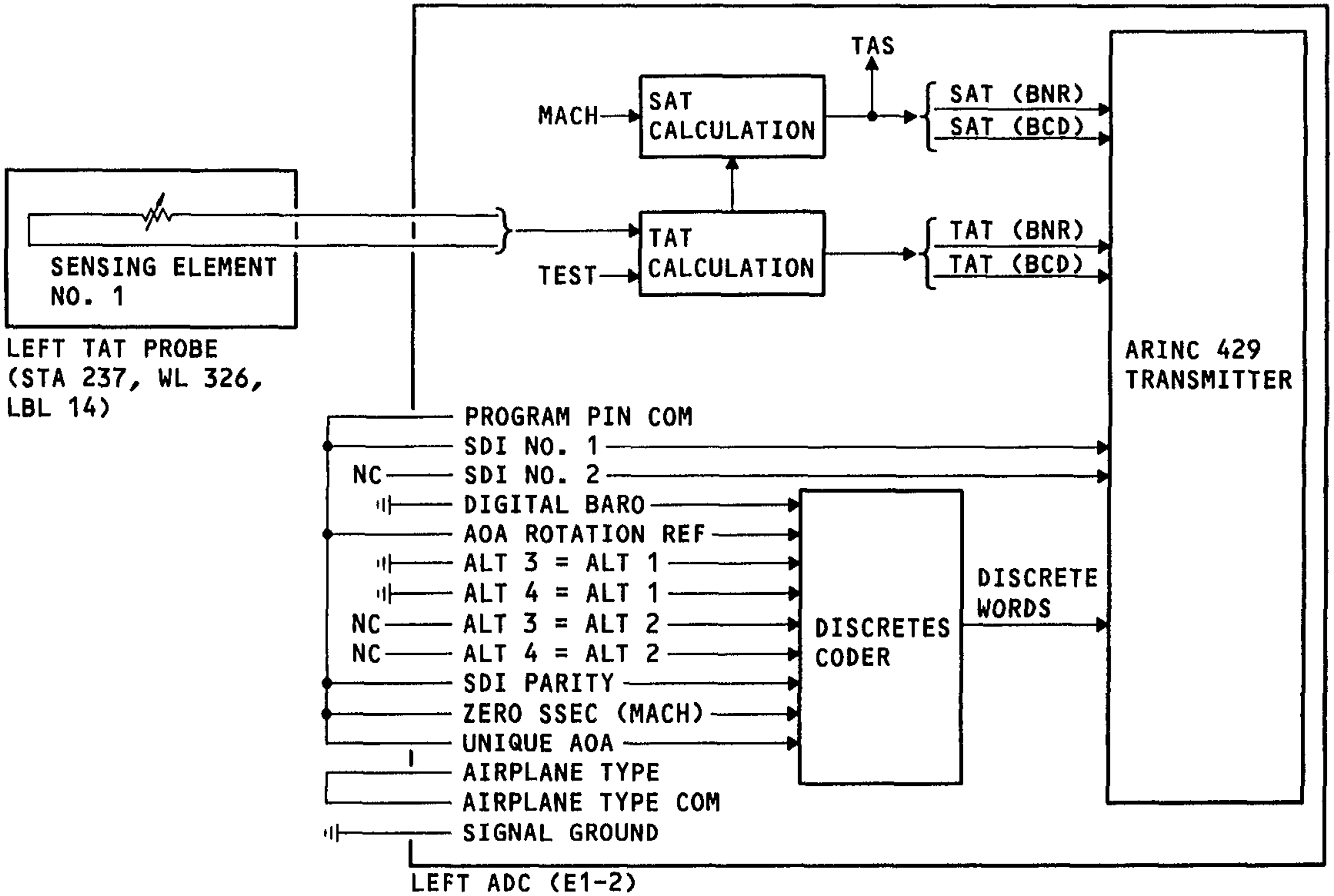


Figure 34 TEMPERATURE AND PROGRAM PINS

DISCRETE CODER

The ADC discrete coder receives analog discrete inputs from the current sensing relays related to four airplane sensors that are heated. A low, or ground, discrete goes to the ADC discrete coders when the anti-ice heat in the sensor is on. Also discretes go to the ADC discrete coders while the gear down dispatch or fifth engine carriage switches are on.

These digital discretes are sent on ARINC 429 discrete words. Also, the gear-down dispatch and fifth engine carriage discretes are sent to the VMO calculator.

The discrete coder sends these discretes to the ARINC 429 transmitter in a digital word that is used by the user airplane systems. The gear down dispatch and fifth engine carriage discretes are sent to the VMO calculation module.

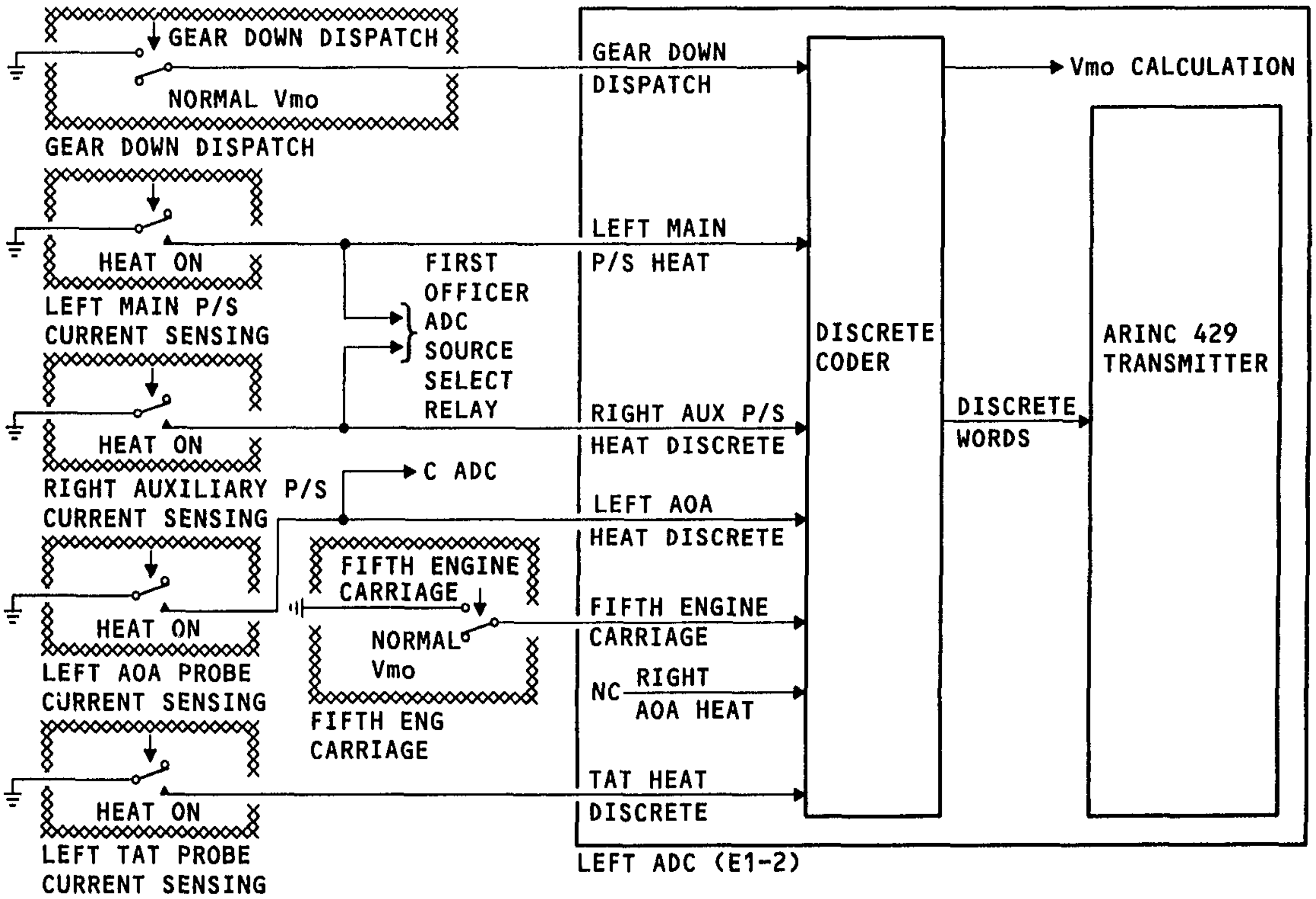


Figure 35 DISCRETE CODER

TEST AND MONITOR

Built-In-T est (BIT)

The ADC built-in-test equipment uses software and hardware tests to detect internal ADC faults and input sensor faults. BIT tests are performed at regular times during the CPU operational program.

The results of the BIT tests are reported in five maintenance words on the ADC output data bus. The results can set a fail bit in the sign status matrix of the outputs.

For detected ADC internal faults, the fault ball on the front of the ADC changes from black to yellow. Also, the BIT logic will store in-flight faults in a fault memory for bench maintenance use.

The BIT also makes sure that the operational program is done. If it is not, the fault ball sets yellow and all outputs from the ADC will fail.

Self-T est

The self-test provides a confidence test of the ADC. The test is started by pushing the TEST switch on the ADC front panel or from the left or right CDU through the CMC. The test discrete from the CMC is sent through the ground test enable relay and, the air/ground relay to prevent ADC test in-flight.

During self-test, preprogrammed values of PS, PT, AOA, and TAT come from memory and are processed by their respective circuits.

The BITE monitor looks at some special inputs during self-test. If the fault ball has been set, and the fault causing the set condition is corrected, the fault indicator will reset during self-test. if during self-test, an external sensor fault is detected the LED display will light with a number related to the failed parameter. If more than one fault is detected the ADC gives a repetitive display of all fault codes detected while the test switch is held down.

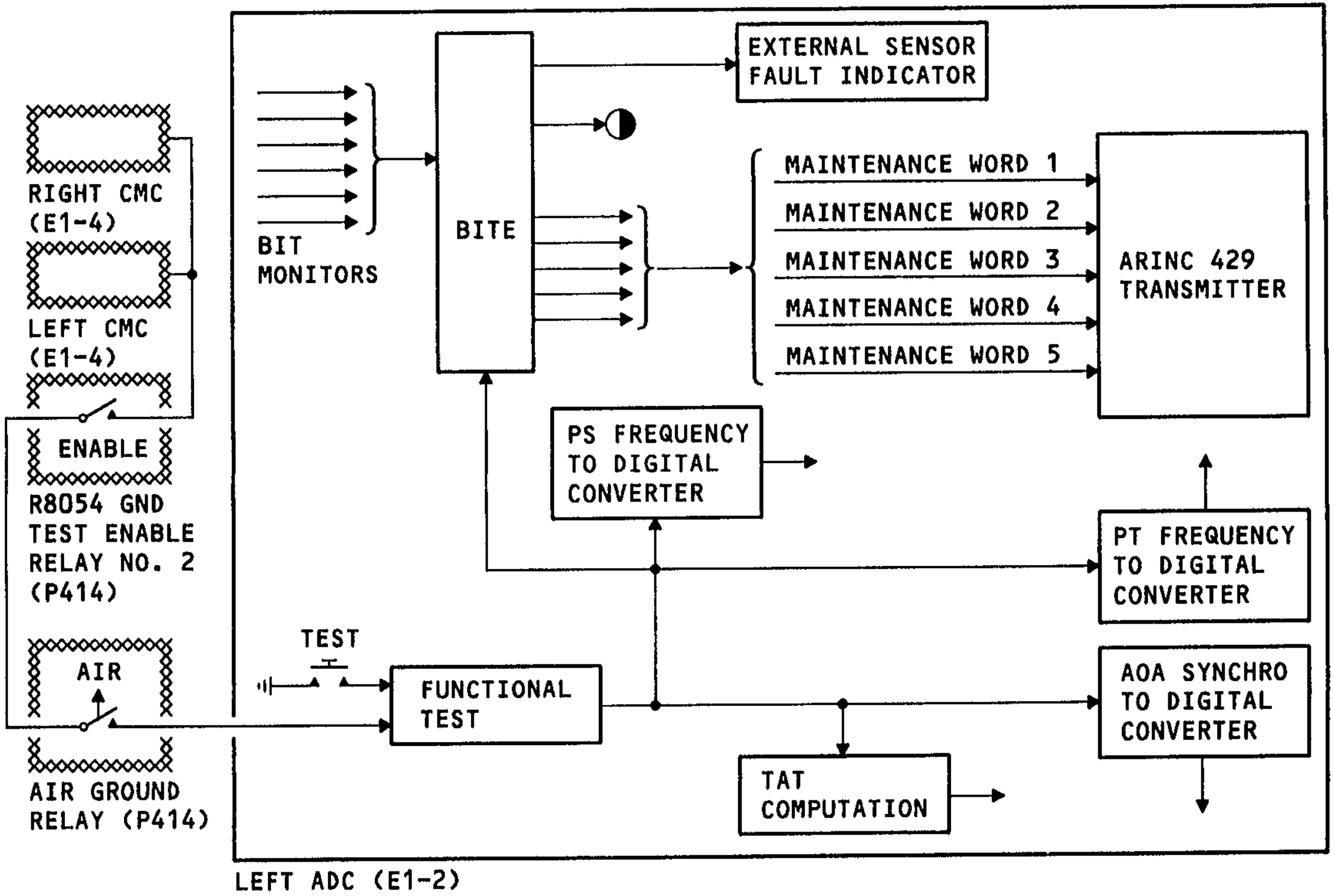


Figure 36 TEST AND MONITOR

MANUAL SELF-TEST

General

The front panel of the air data computer has a manual functional test switch. This switch performs the same self-test as using the CMC ground tests page. The test is done the same as using the CMC. In addition to running a self-test routine the ADC activates the external sensor fault display.

Manual Self-Test

The external sensor fault display, active only during manual self-test, is a single digit, dot matrix LED. This display will show numbers corresponding to external faults. External faults do not set the fault ball display to yellow or produce a failure warning.

FAULT NUMBER	FAULT CONDITION
1	#1 ANGLE OF ATTACK INPUT
2	#2 ANGLE OF ATTACK INPUT
3	SDI PARITY
4	SPARE
5	TOTAL AIR TEMPERATURE INPUT
6	NO. 1 BARO-CORRECTION INPUT
7	NO. 2 BARO-CORRECTION INPUT
8	NO. 3 BARO-CORRECTION INPUT
9	AIRCRAFT TYPE PROGRAM PIN
0	SPARE
-	NO FAULT DETECTED

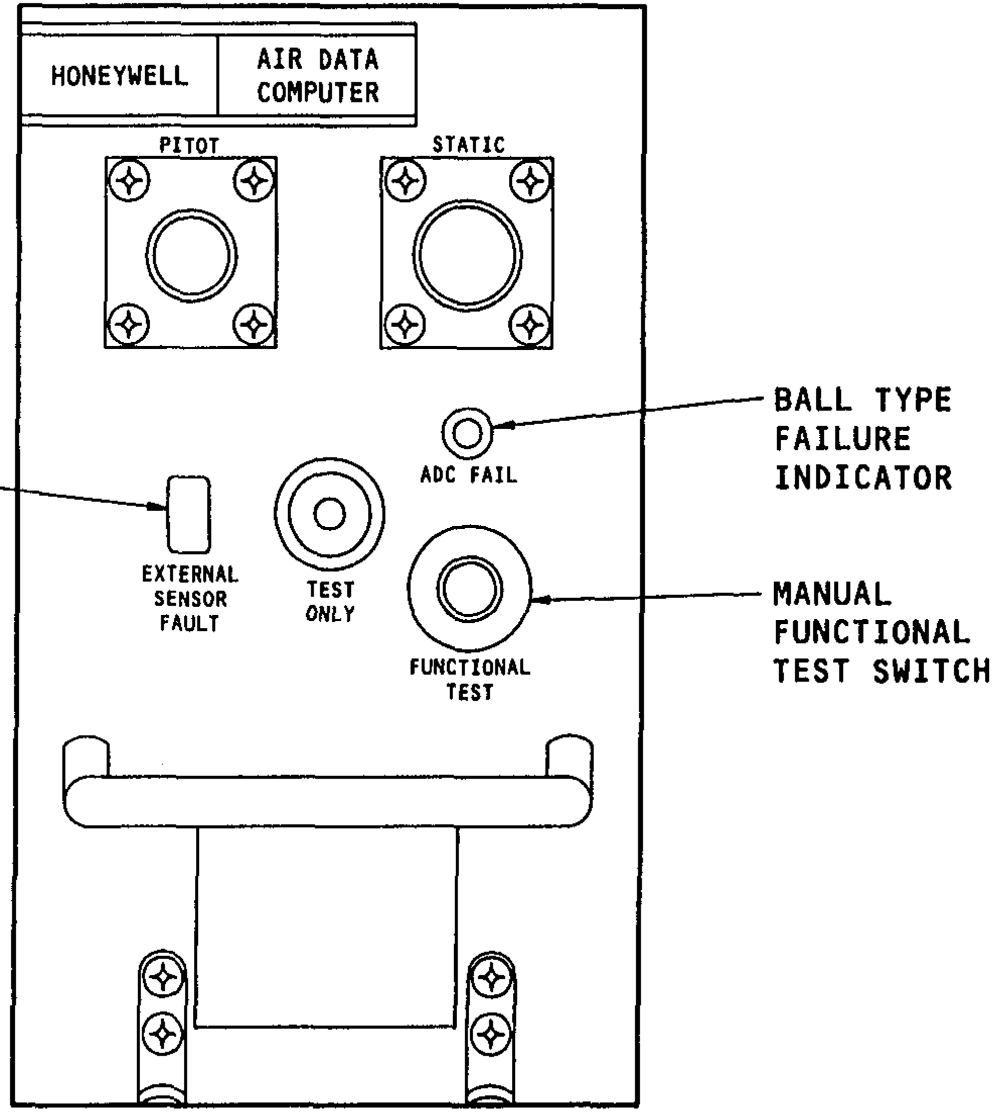


Figure 37 MANUAL SELF-TEST

SELF-TEST VALUES

General

During a self-test, the air data computer provides test values while the ADC functional test button is pushed to verify proper operation of the ADC and its associated displays.

Test Sequence

The ADC performs a test routine consisting of three events. For the first two seconds all data is labeled functional test. For the second to the seventh second all data is labeled failure warning. For the remainder of the test, the data returns to functional test.

Test Values

ADC test values may be seen on the associated flight deck displays. These displays will show the test value and a failure display as indicated on the table.

CONDITION	1	2	3
TIME (SEC)	0 TO 2	2 TO 7	7 TO END
ALTITUDE (FT)	10,000	PFD ALT FLAG	10,000
MACH	0.75		0.25
TOTAL AIR TEMPERATURE (°C)	+35		+35
TAS (KNOTS)	486		170
CAS (KNOTS)	419.5	PFD SPD FLAG	137
SAT (°C)	3.8		31.2
OVERSPEED	ON	OFF	OFF
OUTPUT VALID	FUNCTIONAL TEST	FAILURE WARNING	FUNCTIONAL TEST

Figure 38 SELF-TEST VALUES

GROUND TEST

Purpose

The CMC ground tests menu allows for the selection of a left, right, or center ADC self-test. This will cause the selected ADC to start its self-test routine, show self-test values on the associated displays, and show test results on the CDU.

Ground Test

To start an ADC ground test:

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

The ENABLE TEST screen lists the condition that must be satisfied to complete the ADC-L test. This condition is:

- SET GND TEST SWITCH ON P461 (OR IN MAIN EQUIP CTR) TO ENABLE

After the condition is satisfied, push the RETURN LSK and then push the ADC-L LSK on the GROUND TESTS menu page.

Ground Test Result

The test result DONE is shown in the data field next to the test. There are no fail indications shown. All ADC test parameters must be visually checked to determine the ADC status.

NOTE: ADC-R AND ADC-C TESTS ARE EQUIVALENT TO THE ADC-L TEST.

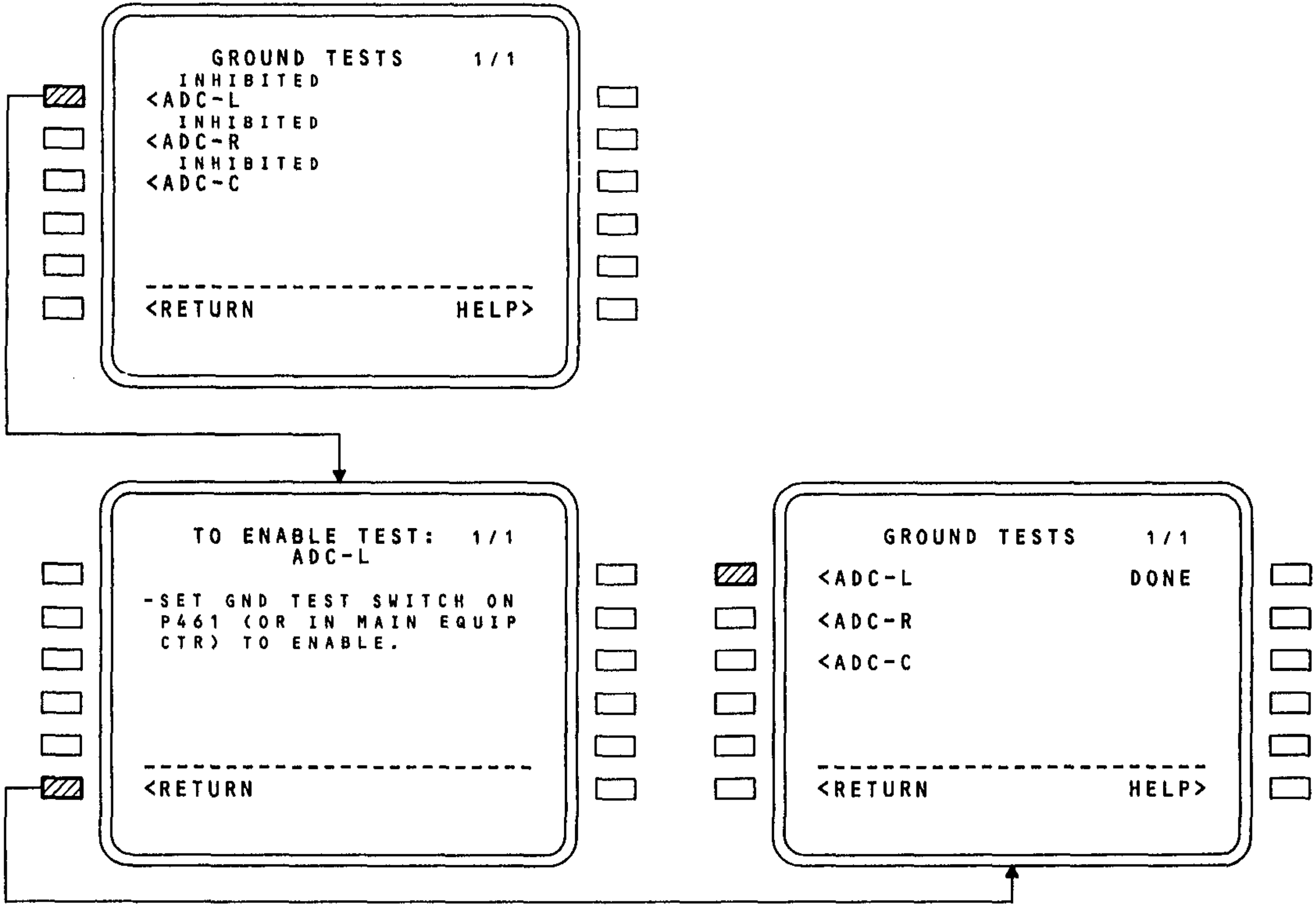


Figure 39 GROUND TEST

FDE AND CMC MESSAGES

Flight Deck Effects

A selected captain or first officer ADC failure will cause flags to show on the on-side PFD, and the applicable EICAS messages. The different types of fault flags and EICAS messages are:

- SPD flag - shows loss of selected ADC airplane speed data
- MACH flag - shows loss of selected ADC airplane MACH number data
- ALT flag - shows loss of selected ADC airplane altitude
- OVERSPEED message - Warning message shows selected ADC detection of airplane speed exceeds VMO/MMO curve
- SOURCE SEL ADC message - Advisory message shows both Capt and F/O have the same ADC selected
- HEAT X TAT message - Advisory message shows loss of left or right TAT probe heater power
- HEAT X AOA message - Advisory message shows loss of left or right ADA sensor heater power
- AOA X message - status message shows left or right AOA sensor failure
- ADC Z message - status/advisory message shows left, center, or right ADC failure

CMC Messages

The different types of CMC messages used in fault identification are:

- ADC-Z FAIL - ADC or AOA sensor failure
- SHELF>ADC-Z INTERFACE FAIL ROT REF/SDI PROG PIN - ADC prog pin error
- ECP-X>CDU-X>ADC-Z BUS FAIL BARO CORRECTED - EFIS control panel failure
- SHELF>ADC-Z INTERFACE FAIL A/C TYPE PROG PIN/WRONG PART #' - A/C type or part # program pin error
- SHELF>ADC-Z INTERFACE FAIL VMO PROG PIN - VMO program pin error
- SHELF>ADC-Z INTERFACE FAIL BARO ALT4 PROG PINS - barometric altitude - 4 program pin error
- ADC-Z>EIU-Z BUSSES FAIL - ADC - EIU bus failure
- AOA VANE-X FAIL - AOA sensor fail
- X AOA VANE HEAT FAIL - AOA sensor heat fail

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

FLIGHT DECK EFFECT	TYPE	DESCRIPTION
SPD	EFIS (PFD) FLAG	LOSS OF CAPT OR F/O SPEED DATA
MACH	EFIS (PFD) FLAG	LOSS OF CAPT OR F/O MACH DATA
ALT	EFIS (PFD) FLAG	LOSS OF CAPT OR F/O ALTITUDE
OVERSPEED	WARNING MSG	SELECTED ADC DETECTS AIRPLANE SPEED EXCEEDS VMO/MMO CURVE
SOURCE SEL ADC	ADVISORY MSG	BOTH CAPT AND F/O HAVE SAME ADC SELECTED
HEAT X TAT [1]	ADVISORY MSG	LOSS OF LEFT OR RIGHT TAT HEATER PWR
HEAT X AOA [1]	ADVISORY MSG	LOSS OF LEFT OR RIGHT AOA HEATER PWR
AOA X [1]	STATUS MSG	AOA LEFT OR RIGHT SENSOR FAILURE
ADC Z [2]	STATUS/ADVISORY MSG	ADC LEFT, CENTER, OR RIGHT FAILURE

CMC MESSAGES

ADC-Z FAIL [2]	~ ADC OR AOA SENSOR FAILURE
SHELF>ADC-Z INTERFACE FAIL 'ROT REF/SDI PROG PIN' [2]	~ ADC PROGRAM PIN ERROR
ECP-X>CDU-X> [1] ADC-Z BUS FAIL 'BARO CORRECTED' [2]	~ EFIS CONTROL PANEL FAIL
SHELF>ADC-Z INTERFACE FAIL 'A/C TYPE PROG PIN/ WRONG PART #' [2]	~ A/C TYPE OR PART # PROG PIN ERROR
SHELF>ADC-Z INTERFACE FAIL 'VMO PROG PIN' [2]	~ VMO PROG PIN ERROR
SHELF>ADC-Z INTERFACE FAIL 'BARO ALT-4 PROG PINS' [2]	~ BARO ALT-4 PROG PIN ERROR
ADC-Z>EIU-Z BUSSES FAIL [2]	~ ADC - EIU BUS FAILURE
AOA VANE-X FAIL [1]	~ AOA SENSOR FAIL
X AOA VANE HEAT FAIL [1]	~ AOA SENSOR FAIL

[1] X = L (LEFT), OR R (RIGHT)

[2] Z = L (LEFT), C (CENTER), OR R (RIGHT)

Figure 40 FDE AND CMC MESSAGES

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