



# **SECTION 2-17**

## **FLIGHT INSTRUMENTS**

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JUNE 29, 2001

ADM-145/1114

## GENERAL

The Flight Instruments System comprises the Air Data System (ADS), the attitude, altitude, airspeed, and vertical speed indications on the Primary Flight Display (PFD), the Flight Data Recorder System (FDRS), and the Digital Clock.

The conventional flight data information is presented on the Primary Flight Display (PFD).

Standby electromechanical instruments are provided as backup, should there occur a complete failure in the electronic flight instrument system. The standby instruments are Magnetic Compass, Airspeed Indicator, Altitude Indicator, and Attitude Indicator.

Optionally the airplane may be equipped with an Integrated Standby Instrument System (ISIS) that replaces the standby electromechanical instruments (except the Magnetic Compass) in a single display.



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## AIR DATA SYSTEM (ADS)

The Air Data Systems are designed for sensing, processing, and transmitting air data information to various systems and instruments of the airplane.

The ADS 1 (LH) consists of one Air Data Computer (ADC), one Pitot Tube, one Total Air Temperature Probe (TAT) and two Static Ports.

The ADS 2 (RH) consists of one Air Data Computer (ADC), one Pitot Tube, one Total Air Temperature Probe (TAT) and two Static Ports.

The Standby System consists of one Pitot/Static Tube, one Standby Altimeter and one Standby Airspeed Indicator.

The Pitot and Pitot/Static tubes, TAT probes and Static Ports are heated for anti-icing purposes. For further information about the anti-icing system, refer to Section 2-15, Ice and Rain Protection.

The ADSs 1 and 2 interface with the airplane's systems through the ADCs, as follows:

- IC-600 - Both ADCs supply pressure altitude, barometrically corrected altitude, true airspeed, calibrated airspeed, vertical speed, Mach number, static air temperature,  $V_{MO}$  and total air temperature to both IC-600.
- FADEC - The ADC 1 supplies the FADEC 1A and 2A, and the ADC 2 supplies the FADEC 1B and 2B with total pressure, Mach number, and total air temperature.
- HSCU - The ADCs provide calibrated airspeed for the HSCUs.
- TRANSPONDER - Both ADCs provide pressure altitude information for both transponders/TCAS.
- AHRS (AH-900 only) - The ADC 1 supplies AHRS 1 and ADC 2 supplies AHRS 2 with true airspeed.
- FMS - The ADC 1 provides true airspeed for the FMS.
- WEATHER RADAR - The ADC 2 provides altitude data for the weather radar.
- SPS - Both ADCs provide Mach number information for the Stall Protection System.
- GPWS - The ADC 1 provides airspeed (CAS and TAS), altitude, and vertical speed information for the GPWS.

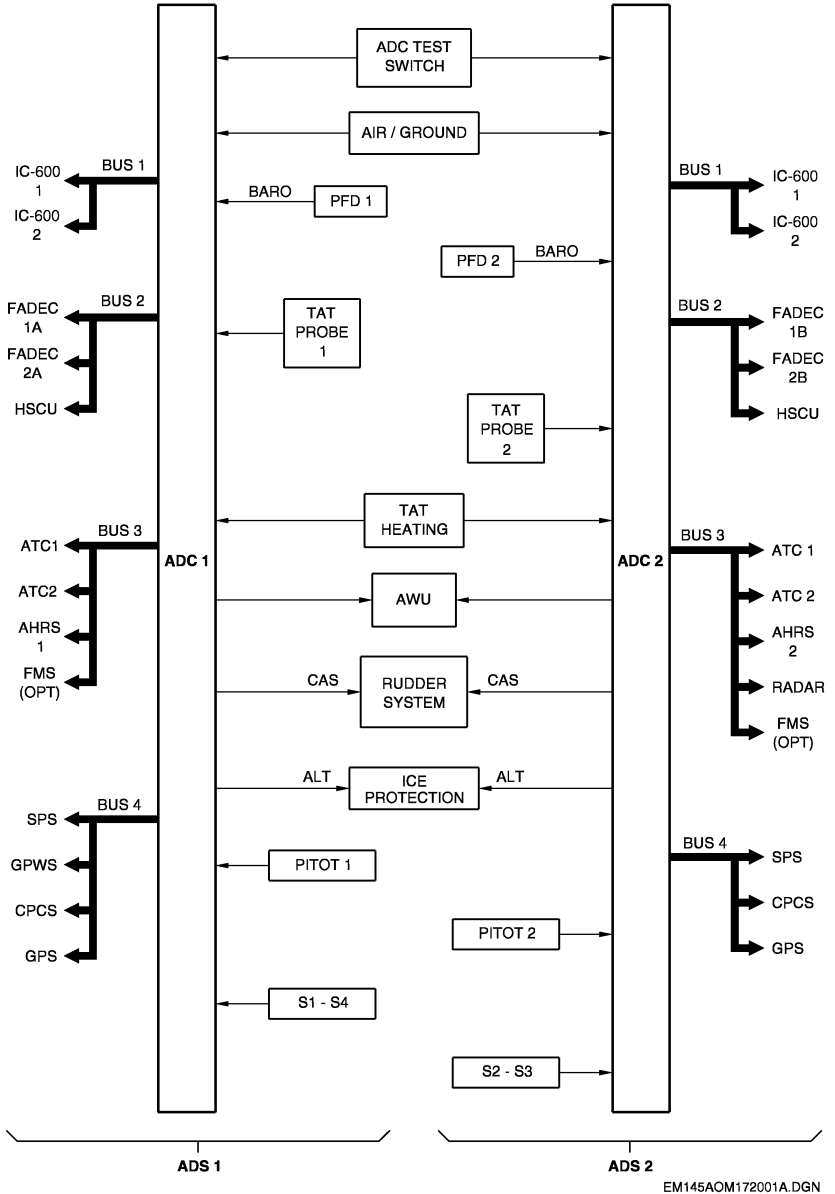


- CPCS - Both ADCs provide pressure altitude, barometric correction, and altitude rate of change data for the pressurization Digital Controller.
- ICE PROTECTION - Both ADCs provide altitude trip point for the ice protection system.
- RUDDER SYSTEM - Both ADCs supply the rudder system with the calibrated airspeed trip point.
- AWU - Both ADCs supply the AWU with the overspeed warning output.

The ADCs functional test mode is entered when the momentary ADC Test Switch, located on the Maintenance Panel, is commanded to test, provided the airplane speed is below 50 kt and the airplane is on the ground.

The barometric pressure data discrete inputs to the ADCs are set on the PFD Bezel (barometric pressure selection and correction).

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**AIR DATA SYSTEMS SCHEMATIC**

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## **ADS SENSORS**

Pitot tubes 1 and 2 are positioned on the top of the airplane's nose. Pitot/Static tube 3 is positioned on the right side of the airplane's nose.

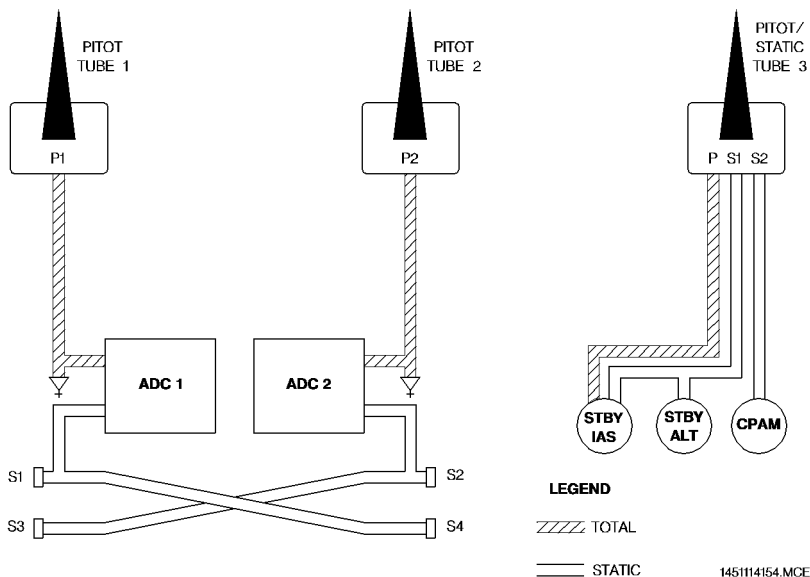
Pitot tubes 1 and 2 supply total air pressure to the respective ADC.

Four Static ports supply static pressure to both ADCs.

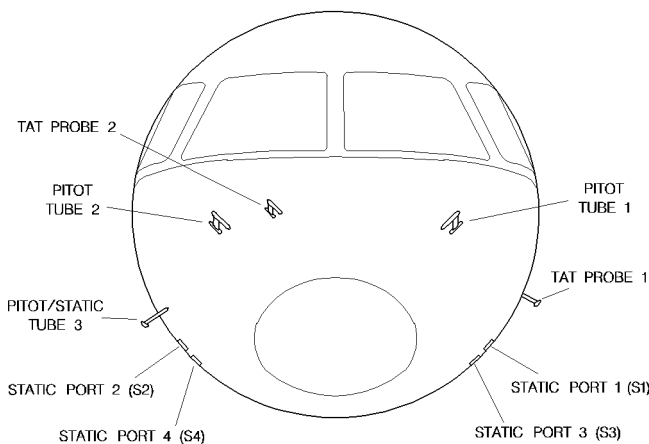
The Pitot/Static tube 3 supplies total air pressure to the Standby Airspeed Indicator, and static pressure to the Standby Airspeed Indicator and Standby Altimeter. Furthermore, Pitot/Static tube 3 supplies static pressure to the Cabin Pressure Acquisition Module (CPAM).

The TAT probe 1 is installed on the left side of the airplane's nose, and the TAT probe 2 is installed at the right side of the airplane's nose.





**ADS SENSORS SCHEMATIC**



**ADS SENSORS POSITIONING**

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## ADS INDICATIONS

### MFD

#### 1 - STATIC AIR TEMPERATURE (SAT) INDICATION

- The SAT is presented as a digital readout in degrees Celsius.
- Colors:
  - Digits: green
  - Labels: white
- Ranges from  $-99$  to  $+99^{\circ}\text{C}$  with a resolution of  $1^{\circ}\text{C}$ .
- In the event of ADC failure or invalid SAT, the digits are replaced by three amber dashes.

#### 2 - TOTAL AIR TEMPERATURE (TAT) INDICATION

- The TAT is presented as a digital readout in degrees Celsius.
- Colors:
  - Digits: green
  - Labels: white
- Ranges from  $-99$  to  $+99^{\circ}\text{C}$  with a resolution of  $1^{\circ}\text{C}$ .
- In the event of ADC failure or invalid TAT, the digits are replaced by three amber dashes.

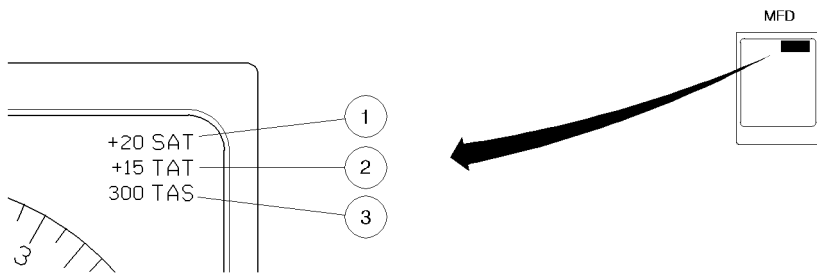
#### 3 - TRUE AIRSPEED (TAS) INDICATION

- The TAS is presented as a digital readout in knots.
- Colors:
  - Digits: green
  - Labels: white
- Ranges from 0 to 999 kts with a resolution of 1 kt.
- In the event of ADC failure or invalid TAS, the digits are replaced by three amber dashes.

### PFD

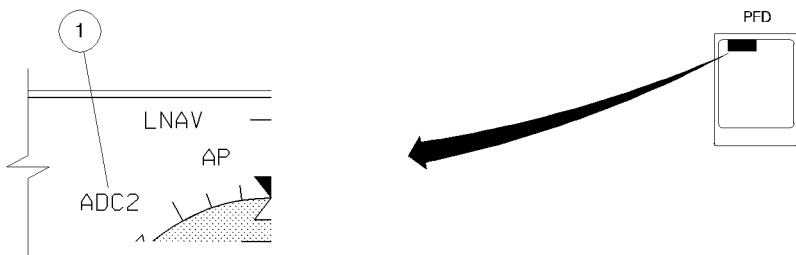
#### 1 - AIR DATA SOURCE ANNUNCIATION

- Label: ADC1 or ADC2.
- Color: amber when only one ADC is supplying both sides or each ADC is supplying opposite side systems (ADC or SG pressed on the Reversionary Panel - refer to section 2-4, Crew Awareness).
- Annunciation is removed when each ADC is supplying the respective side systems (ADC 1 supplying captain's side and ADC 2 supplying copilot's side).



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**ADS INDICATIONS ON THE MFD**



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**ADS INDICATION ON THE PFD**

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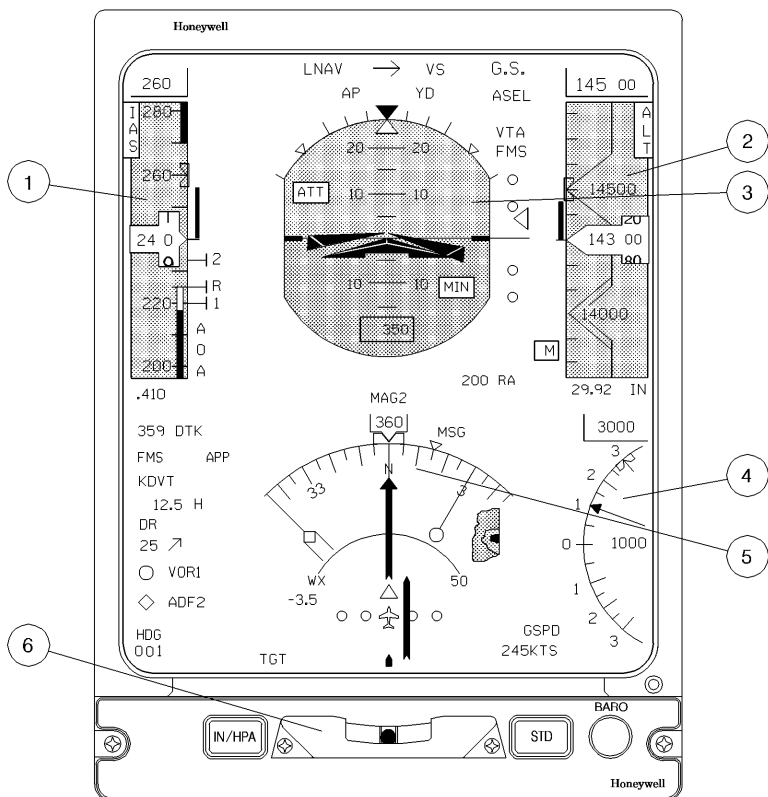
# FLIGHT INSTRUMENTS

The primary flight instruments are presented on the PFDs.

Indicated airspeed (1), altitude (2) and vertical speed (4) are provided by the ADS.

Attitude (3) and heading (5) information are provided by the AHRS or IRS. For further information on these systems and indications, refer to section 2-18, Navigation and Communication.

Slip/Skid indicator (6) is a purely mechanical system.



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## PRIMARY FLIGHT INSTRUMENTS ON THE PFD

## **AIRSPEED INDICATION**

### **SPEED INDICATION ON THE PFD**

The KIAS and Mach number are displayed in tape format on the PFDs. The speed tape also displays target speed and respective speed bug, set through the Flight Guidance Controller (refer to section 2-19, Autopilot), reference speed bugs, to be used during takeoff and landing operations (refer to “speed bugs setting through MFD”, in this section), speed trending vector and overspeed visual warnings.

#### **1 - OVERSPEED INDICATION BAR**

- Color: red
- Extends from  $V_{MO}/M_{MO}$  to higher airspeeds on the scale. If the airplane exceeds  $V_{MO}/M_{MO}$ , the digits in the airspeed window and the digital Mach readout will be displayed in red, and an aural warning will be triggered. If the acceleration trend vector exceeds  $V_{MO}$  or  $M_{MO}$ , the digits in the airspeed window and the digital Mach readout are displayed in amber.

#### **2 - AIRSPEED SCALE AND VERTICAL TAPE**

- Color:
  - Scale: white
  - Tape: gray
- Ranges from 40 to 400 KIAS with a resolution of 10 KIAS.
- The vertical tape provides a trend indication of IAS and displays digital airspeed each 20 KIAS.

#### **3 - AIRSPEED TREND VECTOR**

- Color: magenta.
- The airspeed trend vector is an indication of the acceleration direction and it represents the airspeed that the airplane would attain in 10 seconds if the current airplane acceleration is maintained.
- The trend vector extends vertically from the center of the airspeed vertical tape.
- Extends upward for positive acceleration and downward for negative acceleration.
- Disabled during takeoff.

#### 4 - REFERENCE SPEED BUGS (V<sub>1</sub>, V<sub>R</sub>, V<sub>2</sub>, AP)

- Color:
  - V<sub>1</sub>: magenta
  - V<sub>R</sub>: cyan
  - V<sub>2</sub>: white
  - AP: green
- Presented when the associated digital indication is selected or above 40 KIAS on the ground.
- Removed above V<sub>2</sub> + 42 kt.
- May be out of view, if airspeed is reduced below 230 KIAS followed by an increase above 230 KIAS. To display the speeds again, press the reference speed buttons.
- When the airplane speed is below 40 knots, V<sub>1</sub>, V<sub>R</sub>, and V<sub>2</sub>, as set on the MFD, are displayed in the bottom portion of the airspeed tape in the form of a digital indication. Upon power up, the digital indications for the set bugs are dashes.

#### 5 - MACH NUMBER DIGITAL INDICATION

- Color:
  - Green for normal airspeeds.
  - Amber for V<sub>MO</sub>/M<sub>MO</sub>.
  - Red from V<sub>MO</sub>/M<sub>MO</sub> to higher airspeeds.
- Ranges from 0.05 to 1.000 M with a resolution of 0.001 M.
- Mach number and label are displayed when speed exceeds 0.45 M and remains until it drops below 0.05 M.

#### 6 - LOW AIRSPEED AWARENESS

- Displayed in the airspeed scale when the airspeed is near stall speed for the current configuration.
- Colors:
  - White: indicates the speed range from 1.23 V<sub>S</sub> to 1.13 V<sub>S</sub>.
  - Amber: indicates the speed range from 1.13 V<sub>S</sub> to V<sub>S</sub>.  
Stick shaker may be activated in this range.
  - Red: indicates V<sub>S</sub>. Stick pusher is activated.

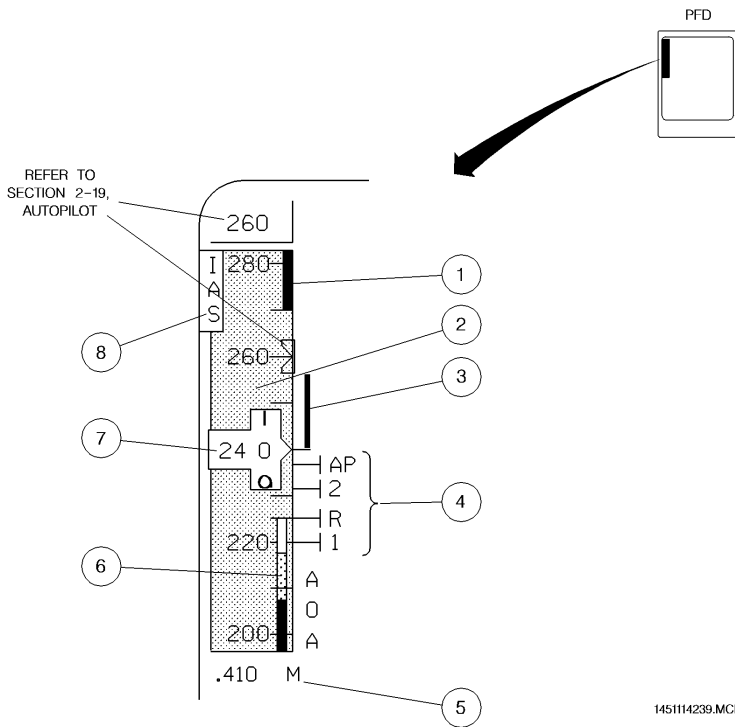
## **7- CURRENT AIRSPEED DISPLAY**

- Color:
  - Green for normal airspeeds.
  - Amber for  $V_{MO}/M_{MO}$ .
  - Red from  $V_{MO}/M_{MO}$  to higher airspeeds.
- Ranges from 40 to 400 KIAS with a resolution of 1 KIAS.

## **8 - AIRSPEED COMPARISON MONITOR DISPLAY**

- Color: amber
- Label: IAS
- Displayed in case of a difference of 5 KIAS between the airspeed indication on the PFDs.
- Flashes for 10 seconds and then becomes steady.





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**AIRSPEED INDICATION ON THE PFD**

## SPEED BUGS SETTING THROUGH MFD

The MFD SPDS submenu allows setting speed bugs on the PFD speed tape. This submenu is accessed by selecting the MFD submenu, then the SPDS submenu.

### 1 - REFERENCE SPEED DIGITAL INDICATIONS

- Minimum value is:
  - $V_1$  : 89 kt
  - $V_R$  : 89 kt or  $V_1$ , whichever is higher.
  - $V_2$  : 89 kt or  $V_R$ , whichever is higher.
  - AP : 89 kt
- Values are removed from the PFD when airplane is airborne.
- Displays dashes on power-up system.
- When selected, dashes are replaced by speed value.
- Selected Reference Speed is surrounded by two white boxes.

### 2 - REFERENCE SPEED SET KNOB

- When rotated clockwise or counterclockwise, increments or decrements the associated airspeed value and moves the associated bug accordingly (if the bug is in view).

### 3 - REFERENCE SPEED BUTTONS ( $V_1$ , $V_R$ , $V_2$ , AP)

- Allows selection of  $V_1$ ,  $V_2$ ,  $V_R$  or AP speeds, for setting purposes.
- Enables movement of the associated speed bug on the PFD.
- Sequentially pressing each button causes the following:
  - First pressing causes the associated speed indication dashes to be replaced by the speed value and two white boxes to be displayed around the indication.
  - Next pressing removes the inner box and displays the associated bug on the PFD.
  - Next pressing removes the outer box and the associated bug on the PFD.

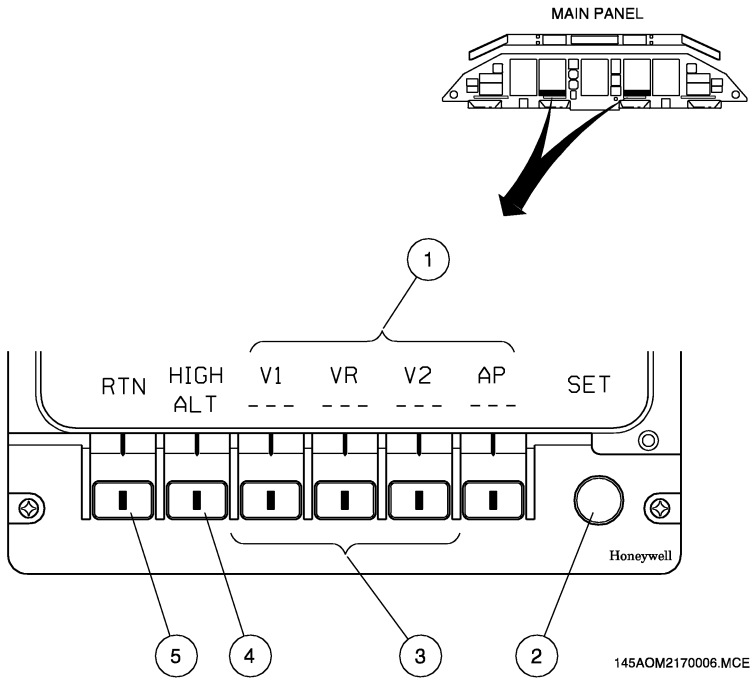
### 4 - HIGH ALTITUDE LANDING AND TAKEOFF (HI ALT) OPERATION BUTTON

- Activates HI ALT mode for takeoff and landing operations in altitudes above 8000 ft up to and including 10000 ft.

**NOTE:** HI ALT operation is available for airplanes equipped with HI ALT system and certified to operate in HI ALT mode.

**5 - RETURN BUTTON**

- Returns the MFD to the MAIN Menu.
- If any of the speeds are displayed with both surrounding inner and outer boxes, pressing the RTN Button removes the inner box before returning the menu to the MFD Bezel Menu.



**MFD SPDS SUBMENU**

## **ALTITUDE INDICATION**

### **ALTITUDE INDICATIONS ON THE PFD**

The altitude is displayed in tape format on the PFD. The altitude tape also displays the Flight Guidance Controller preselected altitude (ASEL), respective preselected altitude bug (refer to section 2-19, Autopilot), and altitude trending vector.

#### **1 - ALTITUDE SCALE AND VERTICAL TAPE**

- Color:
  - Scale: white
  - Tape: gray
- Ranges from –1000 to 60000 ft, with a resolution of 100 ft.
- The vertical tape moves behind the current altitude window and displays a range of  $\pm 550$  ft from the actual altitude.
- The vertical tape displays digital altitude every 200 ft for altitudes from zero up to 10000 ft and every 500 ft for altitudes above 10000 ft.

#### **2 - ALTITUDE COMPARISON MONITOR DISPLAY**

- Color: amber
- Label: ALT
- Displayed in case of a difference of 200 ft or more between the altitude indications on PFDs.
- Flashes for 10 seconds and then becomes steady.

#### **3 - ALTITUDE CHEVRON**

- Color: white
- The double line chevron indicates multiples of 1000 ft. The single line chevron indicates every 500 ft increments.

#### **4 - CURRENT ALTITUDE DISPLAY**

- Color: green
- Ranges from –1000 to 60000 ft with a resolution of 20 ft.

## **5 - ALTITUDE TREND VECTOR**

- Color: magenta
- The altitude trend vector represents the altitude that the airplane should attain in 6 seconds if the current altitude rate (Vertical Speed) is maintained.
- Displayed as a vertical bar that extends from the center of the altitude tape upward for positive vertical speeds and downward for negative vertical speeds.

## **6 - LOW ALTITUDE AWARENESS**

- Color:
  - band: brown
  - limiting line: yellow
- Provided through a raster band that will be displayed on the bottom of the altitude tape in case the radio altitude is below 550 ft.
- Covers the lower half of the altitude tape when the airplane is on ground.

## **7 - BAROMETRIC ALTITUDE CORRECTION DISPLAY**

- Color:
  - digits: cyan
  - label: white
- Ranges from 542 to 1083 hPa (16.00 to 32.00 inHg) with a resolution of 1 hPa (0.01 inHg).

## **8 - BARO KNOB**

- Allows setting barometric altitude correction value.
- Rotating clockwise or counterclockwise increments or decrements barometric altitude correction.

## **9 - STANDARD BUTTON**

- Adjusts barometric altitude correction to standard setting (29.92 inHg or 1013.25 hPa).

## **10 - IN/HPA BUTTON**

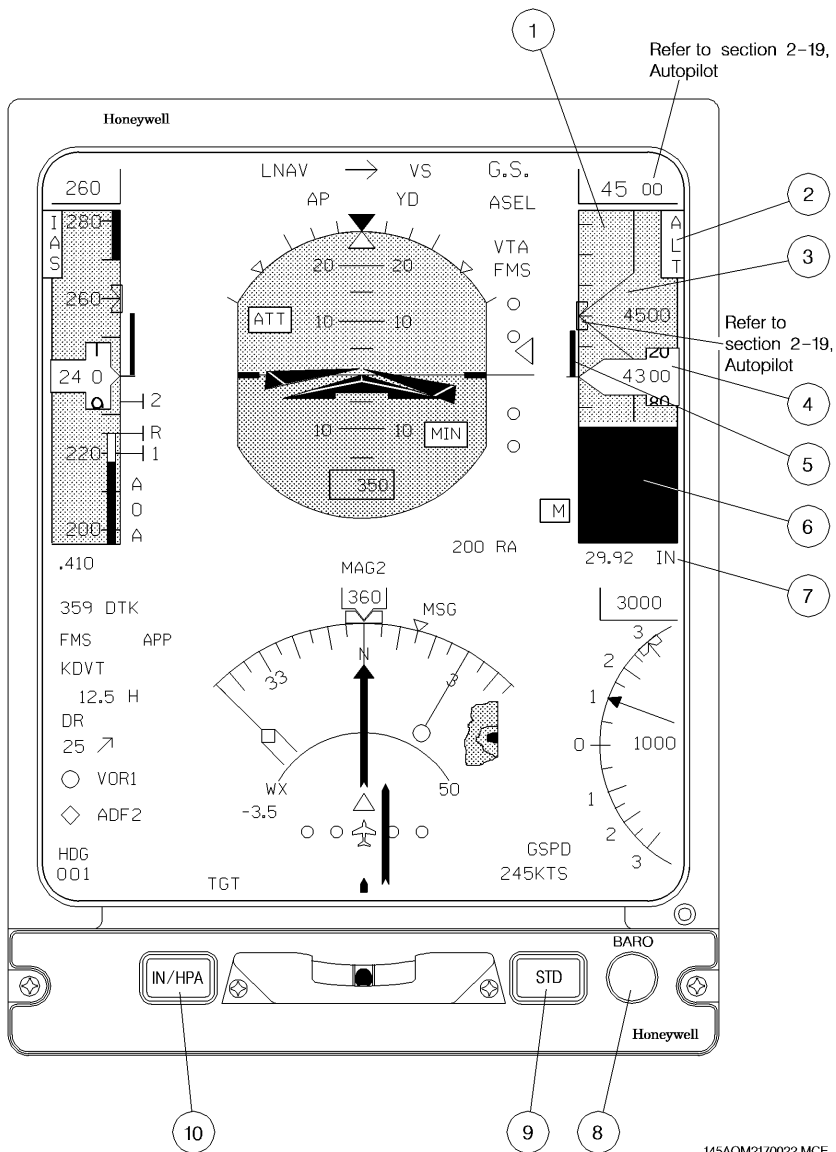
- Selects barometric pressure unit between inches of mercury (inHg) and hectopascals (hPa).



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**ALTITUDE INDICATION ON THE PFD**

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## VERTICAL SPEED INDICATION

The vertical speed is displayed in analogic and digital formats on the PFD.

Besides presenting the current vertical speed, the Vertical Speed Indicator (VSI) also displays target vertical speed and respective bug, set through the Flight Guidance Controller (refer to section 2-19, Autopilot).

The PFD VSI also indicates vertical direction and minimum vertical speed to be attended during evasive maneuvers, according to TCAS commands. For further information on TCAS, refer to Section 2-4, Crew Awareness.

### 1 - ANALOGIC VERTICAL SPEED INDICATION

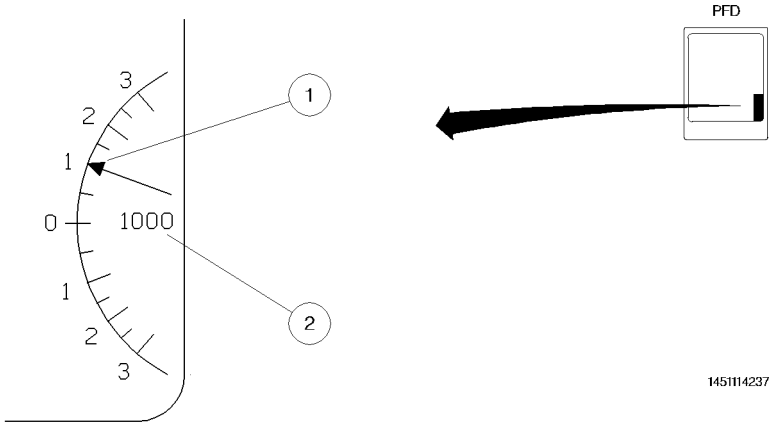
- Color:
  - Scale: white
  - Pointer: green
- Ranges from -3000 to +3000 ft/min
- Scale has marks every 500 ft/min up to 3000 ft/min, with labels every 1000 ft/min.
- The scale is non-linear to provide increased resolution around zero vertical speed.

### 2 - DIGITAL VERTICAL SPEED INDICATION

- Color: green
- Ranges from -9999 to +9999 ft/min with a resolution of 50 ft/min.
- Indication is displayed in the center of the scale.
- Indication is removed from the display when vertical speed exceeds -550 ft/min or +550 ft/min, and remains until it returns to -500 ft/min or +500 ft/min.

**NOTE:** For invalid vertical speed, the pointer and the digital indication are removed from the display and replaced by a red boxed V over S.





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### VERTICAL SPEED INDICATION ON PFD



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## **STANDBY INSTRUMENTS**

Standby instruments are provided to supply flight data information in case of PFD and MFD loss.

The standby instruments comprise the following functions: pitch and roll attitudes, airspeed, altitude and magnetic heading.

Such instruments are conventional units and most of them are available even in case of total loss of electrical power.

Optionally, the conventional units may be replaced by a single display, the Integrated Standby Instruments System (ISIS). However, as the magnetic heading displayed by this equipment is received from the AHRS 1 or IRS 1, the conventional Magnetic Compass is provided as a back-up unit.

The pilot is responsible for checking the standby instruments indications against PFD indications, in order to ensure that the back-up units will present reliable indication in an emergency situation.

## MAGNETIC COMPASS

The Standby Magnetic Compass indicates the airplane's magnetic heading by sensing the earth's magnetic field. The magnetic heading is indicated by reading a graduated horizontally-mounted card against a fixed lubber line, that represents the airplane's longitudinal axis.

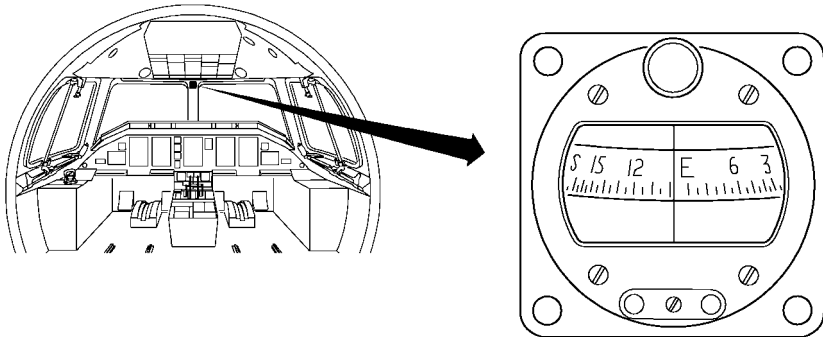
This card is graduated as follows:

- Half dots between the tens dots (005°, 015°, 025°,....).
- Full dots every ten degrees (010°, 020°,....).
- Full dots and respective magnetic heading indication every 030° (030°, 060°,....).
- Full dots and the N, E, S and W characters at the respective cardinal points (North, East, South and West).

Two calibration cards are supplied for the compass, one for normal operational condition (pitots on and windshield heating off) installed above the compass, and one for electrical emergency condition, installed on the main panel left corner.

The Standby Magnetic Compass receives 5 V DC for internal lighting.

WINDSHIELD MOUNTING BRACKET



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## MAGNETIC COMPASS

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## STANDBY AIRSPEED INDICATOR

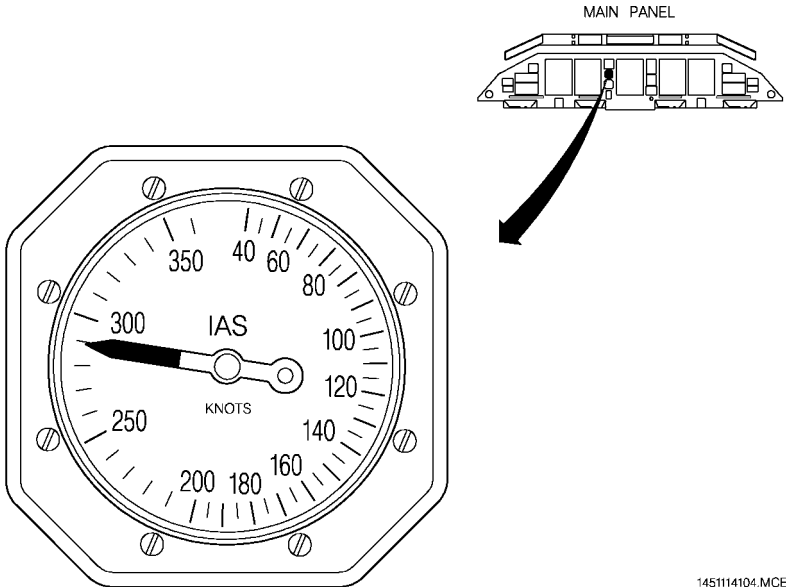
The Standby Airspeed Indicator provides airspeed indication by means of a pointer moving over a fixed scale, calibrated in knots.

The scale is graduated form 40 to 360 KIAS as follows:

- Half dots between the tens dots (45, 55, 65,...).
- Full dots every ten dots (40, 50, 60,...).
- Full dots and respective airspeed indication every 20 KIAS (40, 60, 80,...).

The Pitot/Static tube 3 provides dynamic pressure to this indicator.

The Standby Airspeed Indicator is powered 5 V DC for internal lighting.



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## STANDBY AIRSPEED INDICATOR

## STANDBY ALTIMETER

The Standby Altimeter consists of an aneroid barometer, with the altitude scale graduated in feet, and the barometric adjustment scale graduated in inches of mercury or hectopascals.

The Pitot/Static tube 3 provides static pressure to this indicator.

This instrument receives 5 V DC for internal lighting.

### 1 - ALTITUDE COUNTER

- Indicates pressure altitude.
- Ranges from -1000 ft to 50000 ft with the following increments:
  - Right drum counter is numbered at 100 ft intervals.
  - Center drum counter is numbered at 1000 ft intervals.
  - Left drum counter is numbered at 10000 ft intervals.
- First digit (left drum counter) is replaced by an orange and white crosshatched area for negative altitudes, and by a black and white crosshatched area for altitudes below 10000 ft.

### 2 - SCALE

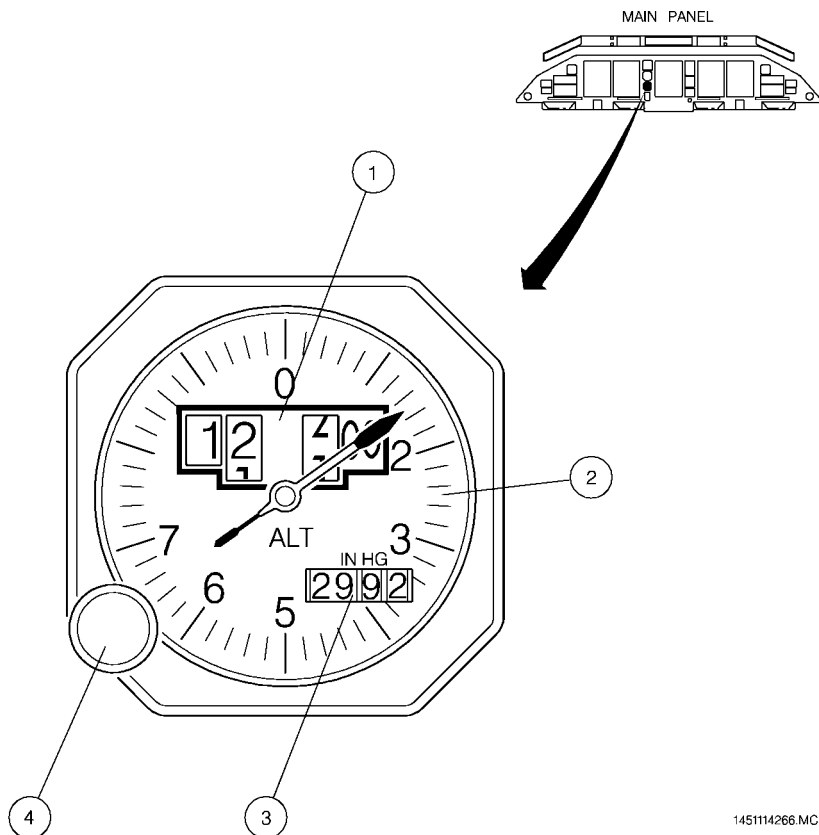
- Full dots every 100 ft.
- Half dots every 20 ft.

### 3 - ALTIMETER SETTING COUNTER

- Displays the adjusted reference pressure.
- Ranges from 22.15 to 31.00 inHg (750 to 1050 hPa), with 0.01 inHg (1hPa) increments .

### 4 - BARO KNOB

- Allows setting the reference pressure.



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**STANDBY ALTIMETER (TYPICAL)**

## STANDBY ATTITUDE INDICATOR

The Standby Attitude Indicator is a conventional electrically powered attitude gyro, whose primary purpose is to supply attitude information in the event of a total loss of the PFD and MFD.

The Standby Attitude Indicator is powered by 28 V DC, from the Essential DC Bus 2. In case of an electrical emergency, it will operate solely on the airplane batteries, and for about 40 minutes. In case of total electrical power loss to this equipment, it is capable of providing a minimum of 9 minutes of useful attitude information due to high-rotor speed and mechanical erection system. Internal lighting is provided by 5 V DC.

It is recommended that the indicator be caged before the airplane is energized and after the airplane is deenergized. Its indication will be reliable after its rotor speed is completely stabilized, which occurs within 3 minutes after it is uncaged.

Any adjustment during the flight, although not normally required, should be made by momentarily caging the indicator with the airplane in level flight.

**NOTE:** Never cage an operating indicator while the airplane is pitching or rolling.

### 1 - ROLL INDEX

- Roll scale graduated to provide measurement of bank angle by the roll pointer.
- Full dots at 0°, 30°, 60° and 90°, and half dots at 10° and 20°.

### 2 - ROLL POINTER

- Indicates the bank angle against the roll index scale.

### 3 - HORIZON LINE

- Earth's horizon relative line.
- The field below the horizon line is indicated in black ("dive"), and above, in light blue ("climb").

### 4 - CAGE KNOB

- Pull to the fully extended position, rotate clockwise and release at the detent position to cage the indicator.
- Pull, rotate counterclockwise and release smoothly to uncage.

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**5 - MINIATURE AIRPLANE**

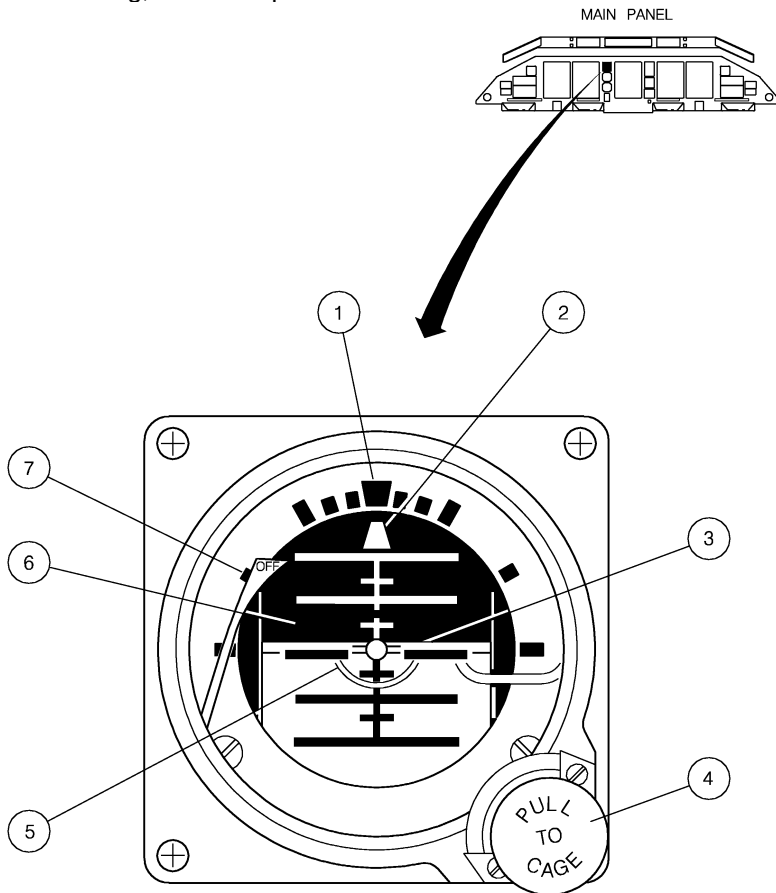
- Indicates airplane roll and pitch attitudes relative to the horizon line.

**6 - PITCH SCALE**

- Gives direct reading of airplane pitch attitude.
- Marked every 5 degrees in pitch.

**7 - POWER WARNING FLAG**

- When in view, indicates power off, caged condition, open motor winding, or loss of power.



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**STANDBY ATTITUDE INDICATOR**

## INTEGRATED STANDBY INSTRUMENT SYSTEM (ISIS THALES)

The ISIS provides the following parameters:

- Attitude (pitch and roll);
- Standard or barometric-corrected altitude and associated barometric pressure;
- Indicated airspeed;
- Indicated Mach number;
- VMO (Maximum Operating Speed);
- Skid/Slip information;
- Magnetic heading (from AHRS 1or IRS 1).

For all EMB-145 models except EMB-145 XR model the ISIS relies on 28 V DC power, provided by the Essential DC Bus 2. In case of an electrical emergency, it will operate solely on the airplane batteries for approximately 40 minutes.

For the EMB-145 XR model, the ISIS relies on 28 V DC power, provided by the Backup Hot Bus. In case of an electrical emergency, it will operate solely on the airplane batteries for approximately 240 minutes.

For the EMB-145 XR model, the ISIS will be de-energized when the battery knobs are positioned to OFF while the airplane is powered by the GPU or generators.

The system is powered as soon as the airplane batteries are switched to AUTO. Then, the ISIS starts its alignment phase, which takes about 90 seconds to be completed and can be identified on the screen by the “INIT 90 s” flag.

**NOTE:** The airplane must not be moved during the first 90 seconds after power-up, while the ISIS is undergoing alignment. Moving the airplane during this period can cause in-flight attitude indication errors, that are not noticeable on ground. For ISIS Post-Mod. SB 145-34-0049 and on, the “ATT” flag is displayed in this case.

### ATTITUDE

Using the data from the respective sensors after its conversion to digital format, the system computes and displays attitude.

The CAGE button resets attitude to provide a fast erection function. The CAGE function is not operational during the initialization mode and must only be used in stabilized flight conditions.

If a failure of the attitude function is detected by internal monitoring, attitude display information, e.g. brown and blue background, pitch scale, roll scale and roll pointer is removed and replaced by black background, and an ATT flag is displayed.

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## ALTITUDE

Altitude data is provided by processing static pressure sensed by Pitot/Static tube 3.

Altitude is displayed in tape format. Pushing the STD button sets the ISIS reference barometric pressure to standard (QNE). The barometric pressure can be adjusted, starting from the standard value, by using the rotary BARO knob.

In case a failure of the altitude function is detected by the internal monitoring system, the altitude tape is removed and an ALT flag is displayed.

## INDICATED AIRSPEED

Airspeed data is provided by processing dynamic pressure sensed by Pitot/Static tube 3.

Airspeed is presented in tape format. In case a failure is detected by the internal monitoring system, the airspeed tape and pointer are removed and a SPD flag is displayed.

## SECONDARY PARAMETERS

In addition to primary parameters, the system computes and displays the following secondary parameters:

- Magnetic heading.
- Mach number.
- VMO.
- Lateral acceleration/Slip indication.



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## ISIS CONTROLS AND INDICATORS

### 1 - BRIGHTNESS ADJUSTMENT

- Push buttons labeled + and - adjust brightness.

### 2 - AIRSPEED INDICATION

- Airspeed tape positioned vertically on the upper left segment of the display.
- Ranges from 40 to 520 kt and the scale is graduated every 5 kt between 40 and 250 kt. From 250 to 520 kt the scale is graduated every 20 kt with digital indications every 20 kt. The indications and graduations are displayed in white.

### 3 - VMO/MMO

- VMO is indicated by a red tape associated to the airspeed tape.
- Digits of the airspeed tape and Mach number display are green when the airspeed and Mach number are lower than  $V_{MO}/M_{MO}$  and red when the airspeed and Mach number are equal to or greater than  $V_{MO}/M_{MO}$ .

### 4 - ROLL INDICATION

- Roll scale graduated at 0°, 10°, 20°, 30°, 45° and 60°, to provide bank angle measurement, indicated by the roll pointer.

### 5 - STD BUTTON

- Pushing the button sets the barometric setting to Standard Atmospheric Pressure.

### 6 - REFERENCE BAROMETRIC PRESSURE

- Displayed in cyan on a digital read-out in hPa or inHg.
- When Standard Atmospheric Pressure is selected, the 1013 value is displayed in cyan instead of barometric pressure value.
- HPA or IN displayed in white and in upper case.

### 7 - LATERAL ACCELERATION

- The range is  $\pm 0.2$  g.
- Symbol displayed in black surrounded in white, just below the roll reference triangle.

## 8 - ALTITUDE INDICATION

- Altitude tape positioned vertically on the upper right segment of the display.
- Ranges from -2000 to 50000 ft with 5 digits green display read-out in a yellow frame. A NEG indication is displayed vertically in white in case of negative altitude.

## 9 - PITCH INDICATION

- The pitch scale comprises white reference lines every 2.5° between -30° and +30°, and the associated pitch angle values, in white, every 10° between -50° and +50° and at ±80°. The sector above the horizon line of the screen is blue and the sector below is brown.
- Beyond ±30°, red chevrons are displayed to indicate excessive pitch angle and the direction to follow in order to reduce it.

## 10 - BARO ROTARY KNOB

- Allows performing QFE/QNH settings.
- When the knob is turned at a slow rate, the value increases in 0.01 inHg or 1 hPa increments. When turned at a faster rate, the increment is in 0.05 inHg or 5 hPa steps.

## 11 - MAGNETIC HEADING

- Given by the horizontal displacement of the heading scale.
- Indication symbol yellow and heading scale graduated by white dots every 5°, with a white two-digit indication every 20°. The last digit (0) is not shown (e.g., 320° is thus presented as 32). The visible range is 50°.

## 12 - CAGE BUTTON

- Resets attitude to provide a fast erection function.
- When it is maintained pressed for more than two seconds, resets the horizon function to zero and warning a “ATT 10s” flag is displayed.

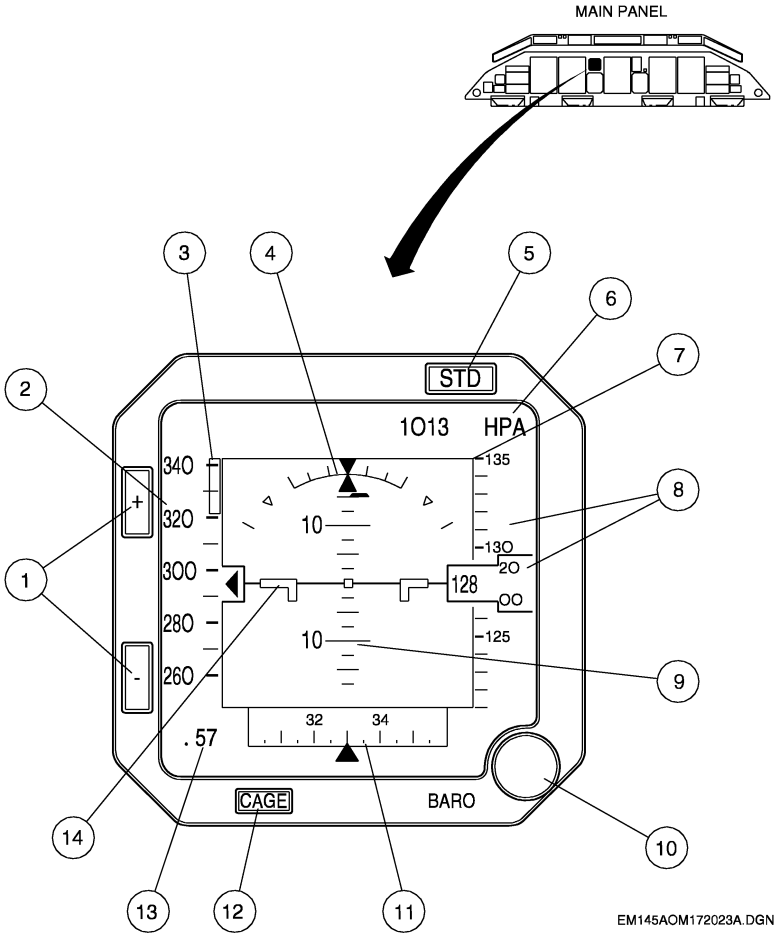
## 13 - MACH NUMBER INDICATION

- The range is from 0.1 to 1 M and is displayed for Mach above 0.45 and when decreasing until Mach 0.40.
- The decimal point and the two digits on the lower left corner of the display are green when the airspeed and Mach number are lower than  $V_{MO}/M_{MO}$  and red when the airspeed and Mach Number are equal to or greater than  $V_{MO}/M_{MO}$ .

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**14 - AIRCRAFT SYMBOL**

- Displayed on the center of the horizon area.
- Black symbol surrounded by a yellow area.



**INTEGRATED STANDBY INSTRUMENT SYSTEM**

**ISIS ABNORMAL OPERATION**

In case of abnormal operation or failure detection in one or several ISIS functions, the following flags are displayed:

LABEL	MEANING	ACTION
ALT (white digits inside a red filled box)	Indicates loss of altitude function. It is displayed instead of the altitude scale.	Report to maintenance.
ATT (white digits inside a red filled box)	If during alignment phase, indicates an ISIS failure to align.	The system's electrical power must be reset. Make sure the airplane is stationary during subsequent ISIS alignment.
	If during any other phase of operation, indicates loss of attitude function.	Report to maintenance.
ATT : CAGE (black digits inside an yellow filled box)	Indicates that ISIS has to be caged. It is displayed in the upper mid-section of the screen.	Hold the airplane in straight and level flight and at constant speed. Press the CAGE Button for at least 2 seconds until the ATT 10s flag is removed.
HDG (white digits inside a red filled box)	Indicates loss of magnetic heading function. It is displayed in place of the heading scale.	Report to maintenance.

Continued



LABEL	MEANING	ACTION
M (white digit inside a red filled box)	Indicates loss of Mach number function. It is displayed instead of the Mach number.	Report to maintenance.
MAINT (white digits)	Indicates a parity error presented by the discrete inputs. In this case, the previous discrete input configuration is maintained.	Report to maintenance.
OUT OF ORDER (white digits)	Indicates failure detection with loss of integrity. It is displayed with the associated code failure. The associated parameters are saved in memory for future equipment maintenance.	Report to maintenance.
SPD (white digits over a red filled box)	Indicates loss of airspeed function. It is displayed instead of the airspeed scale.	Report to maintenance.
VMO (white digits over a red filled box)	Indicates VMO error. It is displayed in the upper left corner of the screen, in lieu of the "MAINT" flag.	Report to maintenance.
WAIT ATT (black digits over an yellow filled box)	Indicates that IMU is out of domain attitude. In this case, the roll and pitch scale, the lateral acceleration, and the airplane symbol are not displayed. It is displayed in the upper mid-section of the screen.	Report to maintenance.

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## **RADIO ALTIMETER SYSTEM**

The Radio Altimeter system is a high-resolution, short-pulse radio altitude indicator designed for automatic continuous operation, providing radio altitude, low altitude awareness, and decision height information on the PFD.

The system consists of a radio altimeter transceiver and two flush-mounted antennas (RA 1), and is controlled through the Display Control Panels. Optionally a second Radio Altimeter Subsystem (RA 2) can be installed.

The decision height setting is provided through the decision height setting knob on the Displays Control Panel. The decision height and the associated RA label are displayed adjacent to the lower right side of the attitude sphere.

The Radio Altimeter interfaces with the Aural Warning Unit to provide an warning audio signal for autopilot disconnection. For further information, refer to section 2-18, Autopilot.

## **RADIO ALTIMETER EICAS MESSAGES**

<b>TYPE</b>	<b>MESSAGE</b>	<b>MEANING</b>
ADVISORY	RAD ALT FAIL	Indicates the RA has failed on airplanes equipped with a single unit, or both RAs have failed, on airplanes equipped with two RAs.
	RAD ALT 1 (2) FAIL	On airplanes equipped with two RA, the associated unit has failed.

## RADIO ALTIMETER CONTROLS AND INDICATORS

### DISPLAYS CONTROL PANEL

#### 1 - DECISION HEIGHT SETTING KNOB

When rotated, allows decision height setting.

#### 2 - TEST BUTTON

In flight conditions only, this button allows testing the associated Radio Altimeter.

To perform the Radio Altimeter test the DH must be set to 200 ft and the button must be kept pressed. The following indications are presented on the PFD:

- A magenta TEST annunciation is presented adjacent to the upper left side of the attitude sphere.
- An amber MIN label is displayed in the RA Minimum annunciator. The label flashes for about 5 seconds, and then becomes steady.
- An amber RA comparison label is displayed in the down left side of the attitude sphere.
- The Radio Altitude field indicates  $100 \pm 10$  ft.

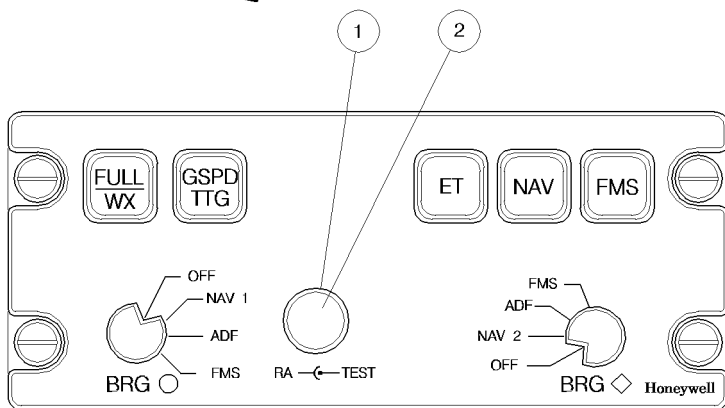
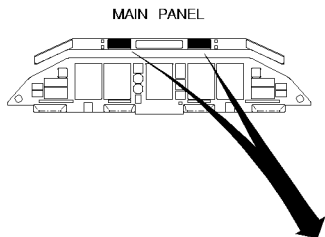
Additionally, the following EICAS messages are presented:

- (E)GPWS INOP
- WINDSHEAR INOP
- RAD ALT 1(2) FAIL

When released, the PFD indications resumes the initial condition and the EGPWS voice message may occur:

- TOO LOW TERRAIN

On the ground, pressing this button allows testing the IC-600 computers. For more details, refer to Section 2-4, Crew Awareness.



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**DISPLAYS CONTROL PANEL**

## **PFD**

### **1 - RA MINIMUM ANNUNCIATOR**

- Color:
  - Box: white
  - MIN label: amber
- Indicates that the airplane radio altitude is within a certain range of the decision height.
- When an armed RA Minimum condition occurs and the radio altitude is in the range of 100 ft above the decision height setting, a black box appears on the annunciator field.
- At radio altitudes equal to or below the decision height setting, a MIN label is displayed inside the box. The label will flashe for 10 seconds, and then becomes steady.
- The RA Minimum annunciator is armed when the following conditions occur simultaneously:
  - Airplane in flight.
  - Radio Altitude and decision height are valid.
  - Radio Altitude greater than 100 ft above the decision height setting for at least 5 seconds.
  - A decision height is being displayed.
- In the event of a Radio Altimeter failure, the RA Minimum annunciator is removed from the display.

### **2 - RADIO ALTITUDE INDICATION**

- Color:
  - Digits: green.
  - Box: white
- Ranges from -20 to 2500 ft.
- Resolution: 5 ft below 200 ft, 10 ft above 200 ft.
- Displayed inside a box on the bottom center of the attitude sphere.
- In the event of a Radio Altimeter failure, the radio altitude digits will be replaced by an amber label RA inside an amber box.

### 3 - DECISION HEIGHT INDICATION

- Color:
  - Digits: cyan
  - RA label: white
- Ranges from 5 to 999 ft.
- Resolution: 5 ft below 200 ft, 10 ft above 200 ft.
- If the decision height is set to zero, the indication is removed from the display.
- In the event of a Radio Altimeter failure, the decision height digits are replaced by amber dashes.

### 4 - RADIO ALTITUDE COMPARISON MONITOR DISPLAY

- Label: RA
- Color: amber
- Displayed when the difference between the on-side and cross-side radio altitude is greater than a set point which is variable with radio altitude.



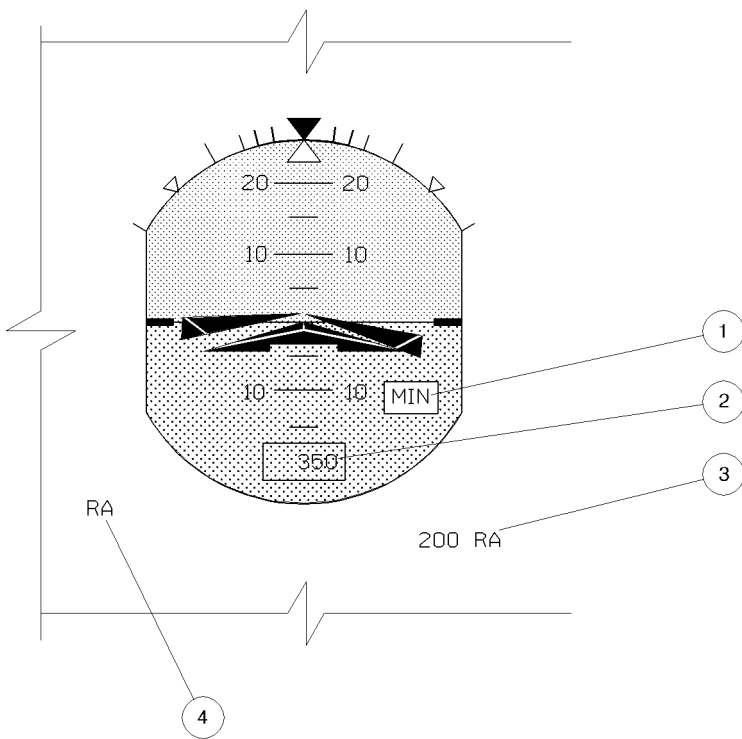
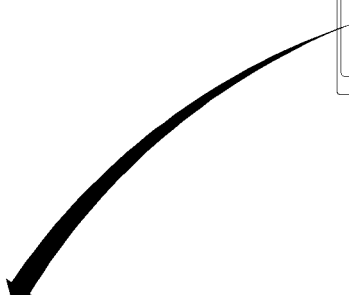
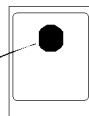
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PFD



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**RADIO ALTIMETER INDICATIONS ON THE PFD**



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## **CHRONOMETER/CLOCK**

The chronometer/clock provides the flight crew with Greenwich Mean Time (GMT), local time (LOC), elapsed time (ET), chrono time (CHR), DATE, and flight number. The instrument is powered by the airplane's electrical system and an internal battery. When the airplane is deenergized, the displays are blanked, although the functions continue to be updated in the memories with exception of the ET and chronometer functions. Display may also blank when a failure exists in the instrument.

## **CHRONOMETER/CLOCK CONTROLS AND INDICATORS**

### **1 - CHRONOMETER BUTTON**

- Successive pressings control start, stop, and reset of the chronometer indicator and pointer providing the following:
  - START: Replaces elapsed time by chronometer indications, starting its counting.
  - STOP: Freezes chronometer indicator and pointer.
  - RESET: Returns the chronometer pointer to zero and replaces chronometer indication by elapsed time.

**NOTE:** A chronometer button is also provided on each control wheel.

### **2 - GMT, LOC, DATE, AND FLIGHT NUMBER INDICATOR**

- Displays Greenwich Mean Time in the 24-hour format. A fixed dot appears between the two hour digits, above the GMT inscription.
- Displays local time in the 24-hour format. A fixed dot appears between the two minute digits, above the LOC inscription.
- Displays the date, alternating between month/day and year every second.
- Displays the flight number from 0000 to 9999.

### **3 - CHRONOMETER POINTER**

- Indicates chronometer seconds against an analog scale.

#### **4 - ELAPSED TIME AND CHRONOMETER INDICATOR**

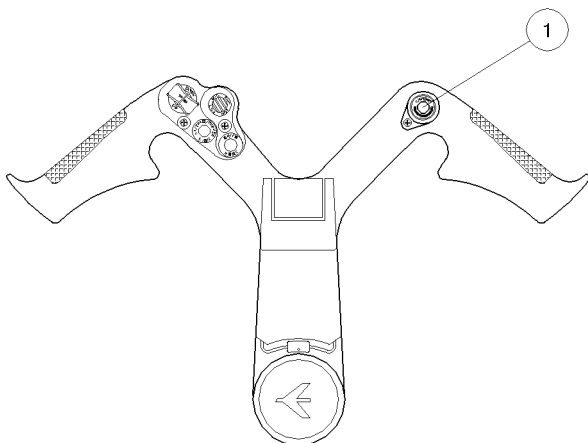
- Displays elapsed time (ET), which corresponds to the flight time (from 0 to 99 hours and 59 minutes). Elapsed time reading starts only when the airplane takes off and can only be reset to zero when the airplane is on the ground.
- Displays chronometer minutes from 0 to 99. When CHR is used, accumulated elapsed time is not affected.

#### **5 - ELAPSED TIME BUTTON**

- Successive pressings supply the following:
  - On ground: Displays ET.  
Resets ET to zero.  
Displays chronometer minutes.
  - In flight: Displays ET.  
Displays chronometer minutes.

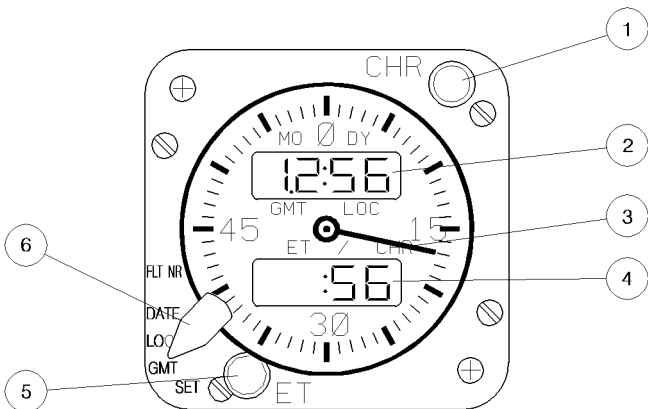
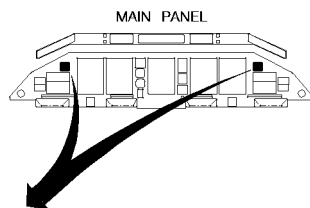
#### **6 - MULTIPLE SELECTOR**

- SET - Allows time setting. When in the SET position, successive pressings of the ET button causes the selector to cycle between GMT minutes, GMT hours, LOC minutes, LOC hours, days, months, and years (with power up, the year is preselected to 90). Once the function is selected (it flashes on and off), the CHR button may be used to increment the selected digit at a rate of one unit every half second (continuous pressing) or manually, step by step.
- GMT - Selects Greenwich Mean Time to be displayed on the associated indicator.
- LOC - Selects the local time to be displayed on the associated indicator.
- DATE - Selects the date to be displayed on the associated indicator.
- FLT NR - Selects the FLIGHT NUMBER to be displayed on the associated indicator.
- To set the flight number, proceed as follows:
    - With the selector in the FLT NR position, repeatedly press the ET button to select the digit to be set in the following order: thousands, hundreds, tenths, and units.
    - Press the CHR button to increment the selected digit at a rate of one unit per half second or manually, step by step.



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**CONTROL WHEEL**



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**CLOCK**



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## FLIGHT DATA RECORDER SYSTEM

The Flight Data Recorder System (FDRS) has been designed to automatically acquire and record several airplane and system parameters, without pilot action, from engine start to engine shutdown on every flight.

The FDRS comprises the following units and components:

- One solid-state Flight Data Recorder.
- One underwater locator beacon attached to the Crash Survivable Memory Unit (CSMU) case.
- One triaxial accelerometer.
- Five wirewound precision potentiometers.
- One impact switch.
- Two Data Acquisition Units (DAUs).
- Auxiliary Flight Data Acquisition Unit (AFDAU) (optional).

An FDR malfunction is detected by means of the power-up built-in test or the continuous self-checking test. An EICAS message is generated to indicate the failure.

The CSMU is a shock-and-heat-resistant container, which records all inputs in the last 25 hours, in a high-density solid-state memory.

The DAUs interface with various airplane systems, in order to supply data to the FDRS.

The AFDAU is solely used for the FDR system and is the unit responsible for receiving all aircraft inputs (data to be recorded from DAU's, etc.) and sending them to the DFDR unit.

Operational data is recorded when the Red Beacon is switched ON or the airplane is airborne.

The setting of the required flight number to be recorded, along with the system data, is made on the clock as described in this section.

## **QUICK ACCESS RECORDER SYSTEM**

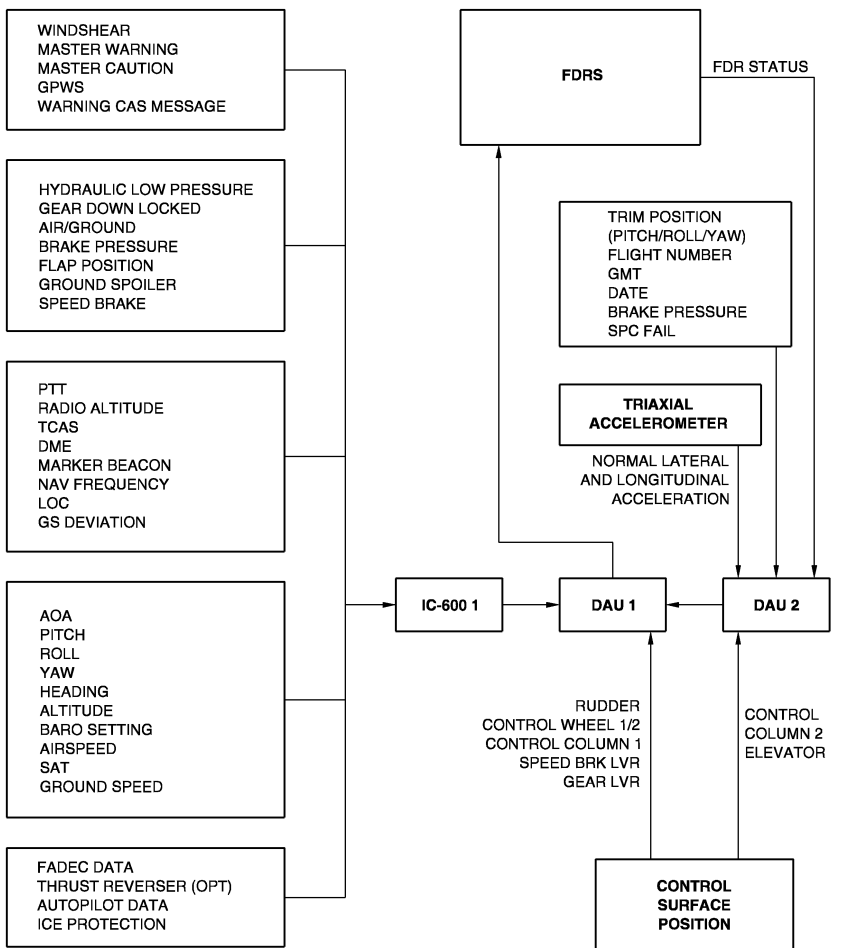
The airplane may be equipped with an Extended Quick Access Recorder (EQAR) or an Optical Quick Access Recorder (OQAR), which have been designed to automatically acquire and record the flight data sent from DAU 1 and DAU 2 to FDR and CMC, without pilot action, as soon as the airplane is energized.

All the information is recorded in a removable rewritable magnetic optical disk, thus reducing the time for ground data analysis to a minimum. No provision has been made to warn flight crew about system status; consequently, there is no EICAS message associated with this equipment.

## **FDRS EICAS MESSAGES**

<b>TYPE</b>	<b>MESSAGE</b>	<b>MEANING</b>
CAUTION	DFDR FAIL	Flight Data Recorder System failure
ADVISORY	FDAU FAIL	Auxiliary Flight Data Acquisition Unit failure





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**FLIGHT DATA RECORDER SYSTEM SCHEMATIC**

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