CHAPTER 11

AVIONICS

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CHAPTER 11 INSTRUMENTS / FCS

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LIST OF EFFECTIVE PAGES

CHAPTER 11

AVIONICS

1. Introduction

A. The aircraft has the following avionic equipment installed:

- Dual Integrated Communication Unit (dual VHF COM and ATC)
- Dual Radio Management Units (RMU)
- Clearance Delivery Unit
- Dual Integrated Navigation Unit (dual VHF NAV, dual ADF and dual DME)
- Three Audio Control Panels
- A four tube Electronic Flight Instrument System (EFIS)
- Dual Symbol Generators
- Dual Display Control Units
- Pilots Instrument Remote Controller (IRC)
- Co-Pilots IRC
- Flight Director (FD)
- Autopilot
- Dual Digital Air Data Computers (DADC)
- Dual Attitude and Heading Reference System (AHRS)
- Weather Radar Transceiver
- Weather Radar Indicator
- Ground Proximity Warning System
- Dual Altimeters
- A Standby Altimeter
- A Standby Airspeed Indicator (ASI)
- A Standby Artificial Horizon
- A Passenger Address (PA) system
- A Radio Altimeter System
- Dual Radio Magnetic Indicators (RMI)
- Dual Digital Flight Clocks

This chapter describes the above avionic systems.

2. Electronic Flight Instrument System (EFIS)

A. General

The standard EFIS installation consists of two independent systems (No.1 and No. 2). Each system consists of the following equipment:

- Electronic Horizontal Situation Indicator (EHSI)
- Electronic Attitude Director Indicator (EADI)
- Symbol Generator (SG)
- Display Controller.

Two remote instrument controllers allow the pilots to set EFIS parameters. The pilots instrument controller sets the course (No.1 Nav system), IAS and HDG. The co-pilots instrument controller sets the altitude select and No.2 Nav system course.

B. Symbol Generator

The SGs process and convert data received into video and deflection signals for the electronic displays. The SGs also process and output decision height information calculated from the radio altitude.

The two SGs are installed in the nose equipment bay and are cooled by integral fans. Each SG interfaces with the on-side navigation system, No.1 and No.2 AHRS, No.1 and No.2 DADC and the Flight Control System (FCS).

The SGs are linked by a digital data bus (Avionics Standard Communications Bus ASCB) that allows the transmission of data between each EFIS SG.

C. Electronic Attitude Direction Indicator (EADI)

Each EADI is installed above the associated EHSI in the left (No.1) and right (No.2) instrument panels and display the following parameters:

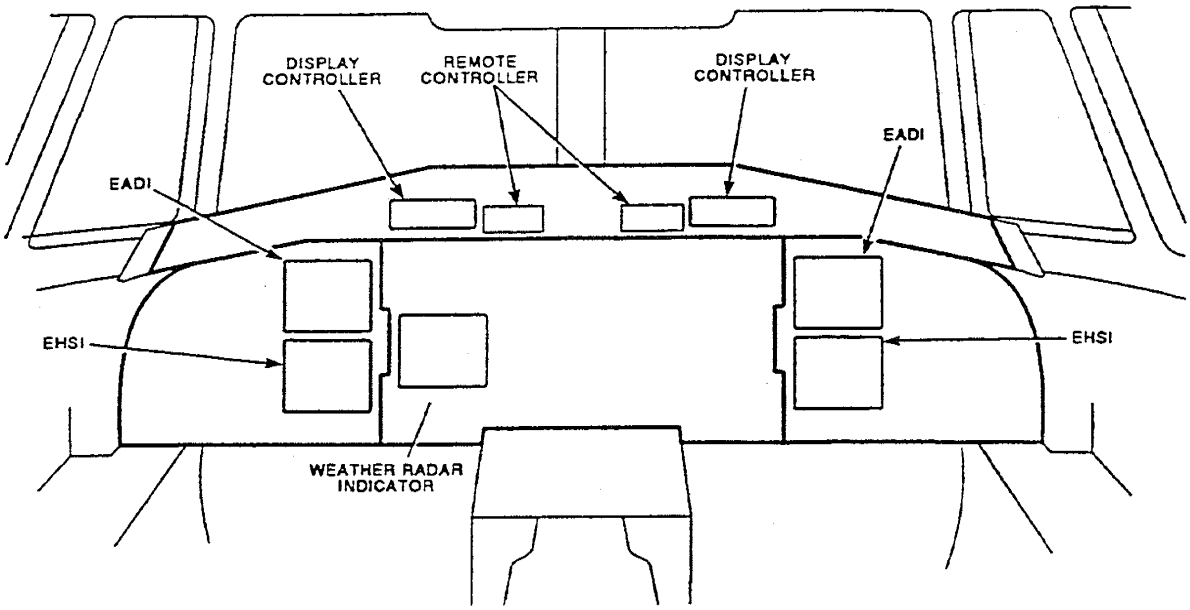
- Primary pitch attitude ± 90 deg
- Primary roll attitude ± 180 deg
- Selected Altitude, displayed in cyan, in the top right hand corner of the display. As the selected altitude is reached, the "ASEL" legend, preselected digits and box turn amber and flash
- Primary Indicated Airspeed, displayed digitally on a vertical tape on the left hand side of the EADI. High airspeeds are displayed at the top of the scale
- Overspeed awareness, Vmo displayed as a red vertical line on the left of the airspeed scale

- Low airspeed awareness, V_{LAA}, displayed as a red vertical line on the right of the airspeed scale. The speed at which this occurs will correspond to 1.07 Vs (stall ident speed)
- Mach number, displayed continuously above 15000ft. Mach number is always displayed in even numbers
- Vertical speed is displayed on a curved pointer scale on the right side of the display. The scale has a range of ± 3000 ft per minute (fpm) and is linear within ± 1000 fpm
- Radio altitude, displayed on a four digit display from -20 to 2500 ft with a display resolution of 10 ft between 200 to 1500 ft and 50 ft between 1500 ft and 2500 ft. Above 2500 ft the radio altitude display is not in view
- Decision Height (DH) is displayed instead of Mach number below 15000 ft and is selectable in the range 10 to 990 ft. Between 10 and 200 feet the DH can be set in 5 ft increments, above 200 ft the DH can be set in 10 ft increments
- Marker beacon annunciation (shown by the letters OM, MM or IM) is above and to the right of the attitude sphere. The letters are of the appropriate colour and flash at the appropriate rate
- Glideslope in the range of ± 2 dots. When the associated Nav receiver is not tuned to an ILS frequency, the glideslope display is removed
- Expanded Localizer. When not tuned to an ILS frequency, the expanded Localizer is removed. When back course is selected or the selected course is more that 90 deg from heading, the deviation is automatically reversed to provide correct sensing with respect to the localizer
- Flight Director Command Bar
- Flight Director mode annunciators. Armed modes are annunciated in white and captured modes are annunciated in green
- Airspeed select bugs. Four independent airspeed bugs (1, R, dot and triangle) are available and selectable via a single control knob located on the centre coaming. Default values are 40, 45, 50 and 55 respectively. The 1 and R bugs reset to their default values on takeoff.

Each EADI has an inclinometer consisting of a white ball on a black background installed below the display area.

The EFIS is provided with an automatic display declutter mode. In the case of an unusual aircraft attitude, all EFIS displays will be removed from the EADI, except for pitch, roll IAS, Mach and vertical speed. An unusual attitude is defined as pitch attitude of greater than + 30 deg, - 20 deg or roll attitude of greater than 45 deg.

Each EADI is cooled by the installation of a remote cooling fan beneath the EHSI which directs cooled air beneath the EHSI and EADI.



4 TUBE EFIS WITH DEDICATED WEATHER RADAR INDICATOR

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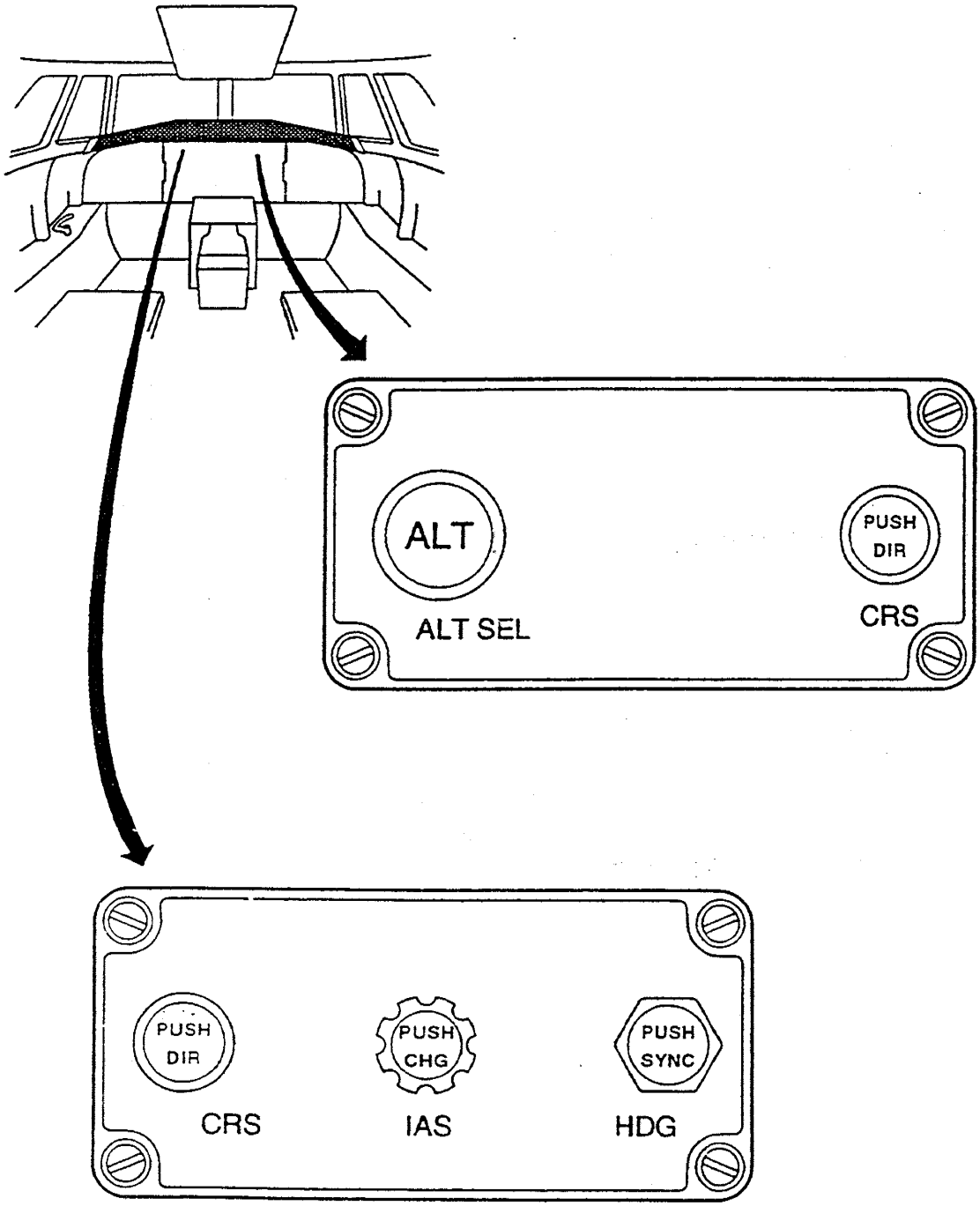
EFIS With Weather Radar Options

D. Instrument Remote Controllers (IRC)

The instrument remote controllers are used to select desired course and heading displays on the EHSI. They allow a value for altitude preselect to be set and airspeed reference bugs can be set.

- CRS (Course) Knob. Each pilot can select the desired course on the EHSI. When the PUSH DCT button is pushed, the course pointer will point to the selected VOR station. With LRN installed, the course knob does not select the desired course; they are supplied by the LRN
- HDG (Heading) Knob. A single heading knob selects the position of both EHSI heading bugs. When the PUSH SYNC button is pushed, the heading bugs will slew to the EHSI lubber line.
- ALT SEL (Altitude Select) Knob. Selects the altitude preselect value which is displayed in the upper right corner of each EADI.
- IAS (Indicated Airspeed) Knob. Sets one of four IAS bugs. The PUSH CHG button is used to toggle between the IAS bugs.



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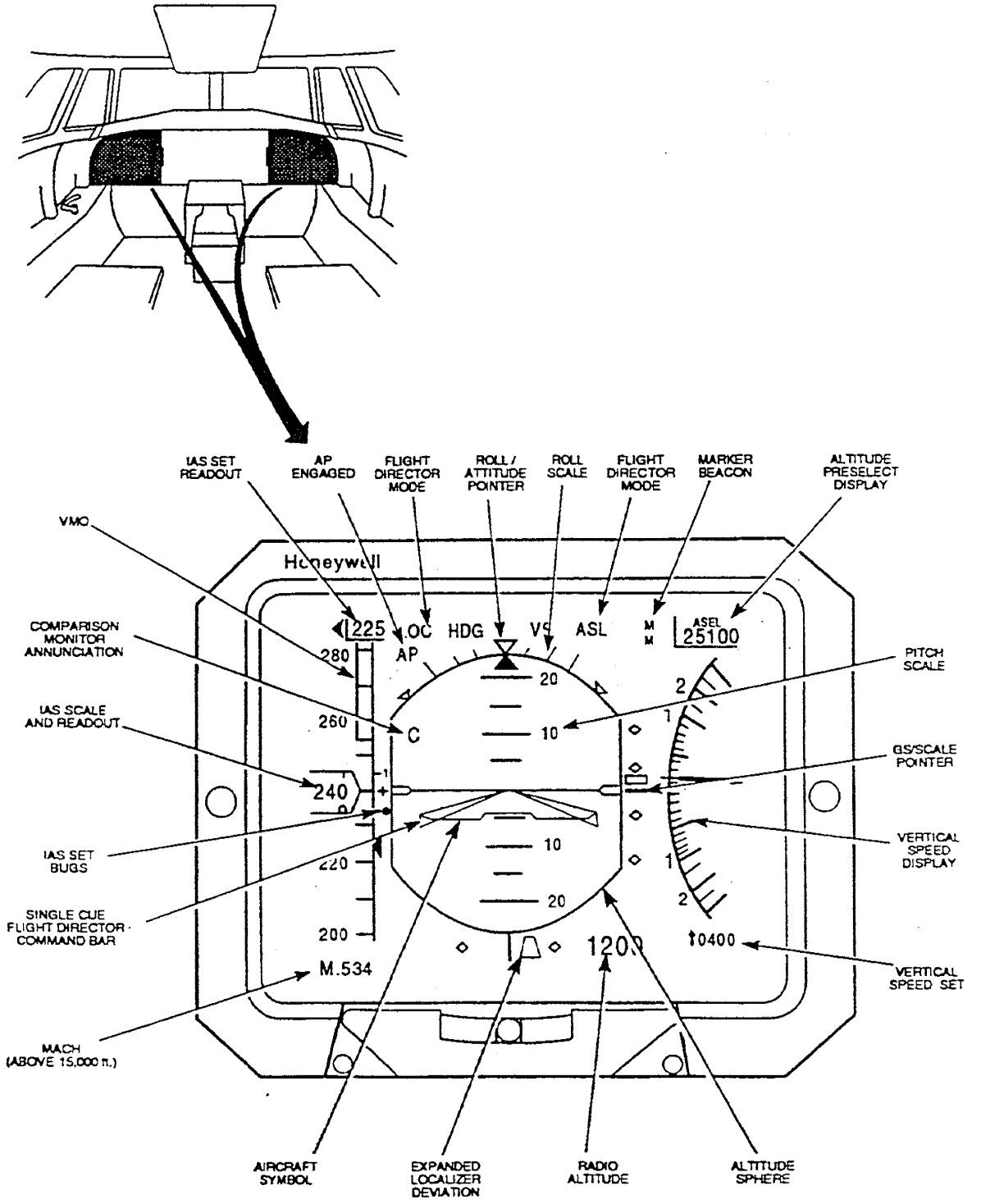
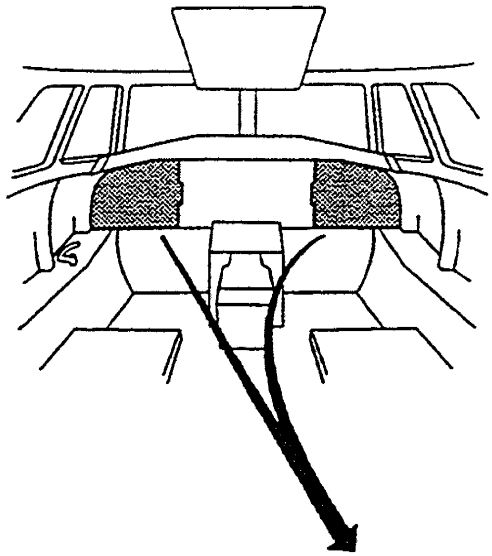
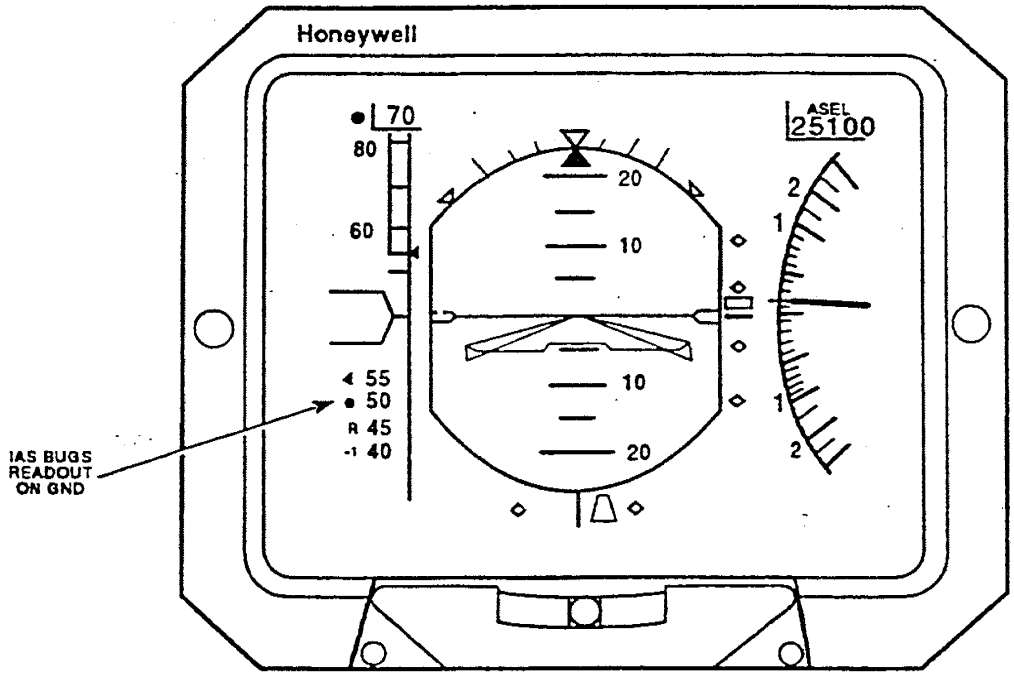
Instrument Remote Controllers



EADI with Single Cue Command Bar





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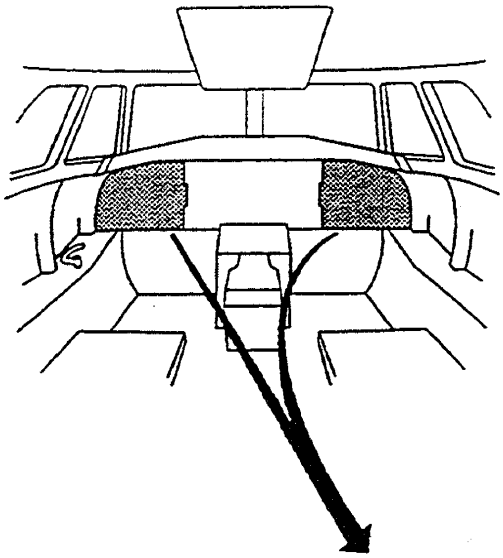
EADI with Airspeed Bugs

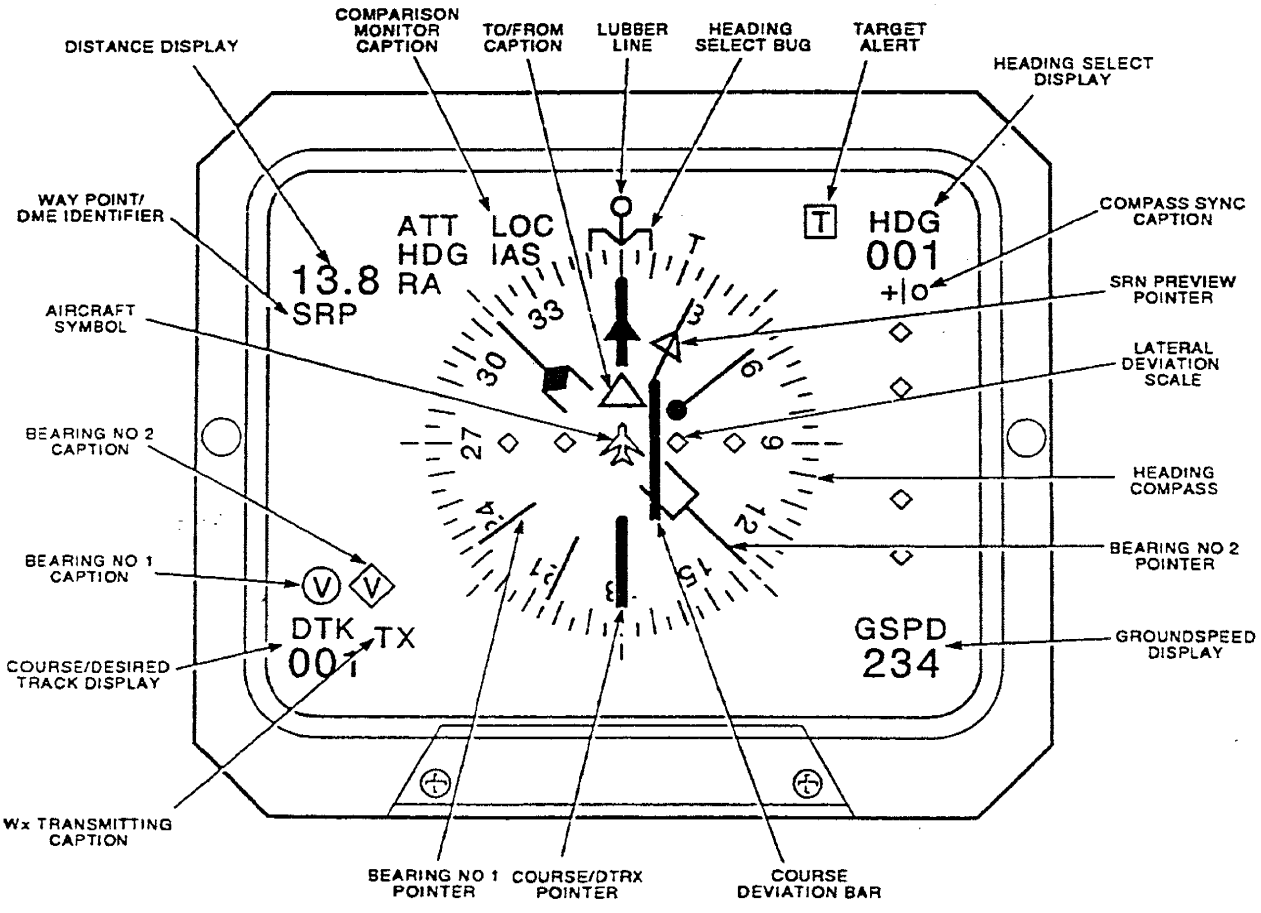
E. Electronic Horizontal Situation Indicator (EHSI)

Each EHSI is installed below the associated EADI in the left (No.1) and right (No.2) instrument panels and display the following parameters:

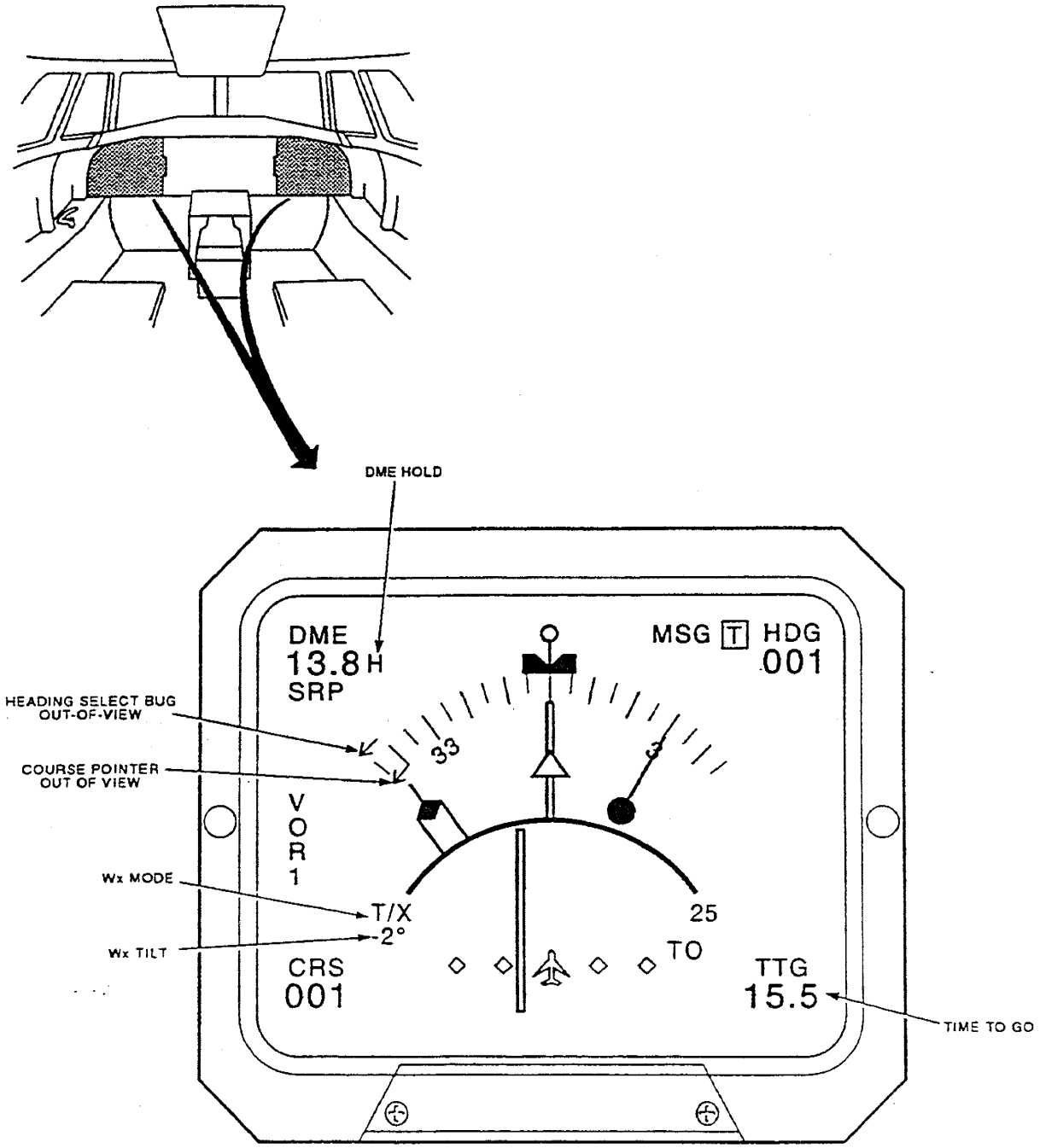
- Primary Heading. Displayed in the range of 0 deg to 360 deg on an electronically rotating heading dial graduated in 5 deg (minor) and 10 deg (major) increments
- Course Select Pointer and digital readout. Course select is adjusted and controlled by a remote control knob. Each EHSI has a dedicated course select control knob which is located on the pilots and co-pilots remote controllers for the No.1 and No.2 EFIS respectively
- Heading Select Bug. This bug is adjusted and controlled by the pilots remote controller. A digital readout of selected heading is also provided
- Course deviation bar. Indicates deviation from the selected Nav source on a ± 2 dot scale
- Navigation source annunciation. Indicates the Nav source that is being indicated on that EHSI
- Heading Source Annunciation. Indicates the heading source that is being displayed on that EHSI
- Bearing Pointers. Two pointers are provided on each EHSI. The pointers can be switched between Nav sources via the associated EFIS controller
- Elapsed Time (ET). The ET display has a readout in minutes and seconds or hours and minutes. By selection of a GS/TTG button on the associated EFIS controller, the ET display can read either ground speed or time to go
- ILS Glideslope when the ILS frequency is tuned
- Compass sync indicator. Displayed below the heading readout in the top right corner of the display. The indicator is of the cross/dot style, with a moving bar to indicate out-of-sync error.

Each EHSI can display weather radar and/or lightning information on a partial compass display. This function is achieved via the EFIS controller.





EHSI with Full Compass Display



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EHSI with Partial Compass Display

F. EFIS Display Controller

The EFIS display controllers are installed on the left and right side of the coaming panel and allow the selection of display modes and navigation data on the associated EADI and EHSI. The display controller provides the following functions:

- FULL/ARC. Display of full compass mode (0 to 360°) or partial compass mode (90° of heading) on the EHSI
- MAP. The full compass mode is changed to the partial compass mode and VOR/DME ground station positions can be displayed
- WX. Weather radar is displayed and partial compass mode is set on the EHSI
- GSPD/TTG. Selects groundspeed or time to go for display on the EHSI
- ET. Selects elapsed time (and cycles start, stop and reset functions) to be displayed on the EHSI
- V/L (VOR/LOC). Allows selection of VOR and LOC navigation display. Alternate presses of the switch allows on side or cross side navigation information to be displayed
- LRN. Allows display of the long range navigation data
- Two bearing pointer control knobs (BRG) dedicated to the 'circle' pointer and 'diamond' pointer on the associated EHSI allow the selection of OFF/VOR 1/ADF 1 (circle pointer) and OFF/VOR 2/ADF 2 (diamond pointer)
- A control consisting of two concentric rotary controls labelled ADI DIM/DH/TST allows dimming of the EADI with the outer control while rotation of the inner control sets the DH. Pressing the inner control tests the EFIS, radio altimeter and FD systems, dependant on system status and aircraft status If the outer (DIM) control is rotated fully Counter Clockwise (CCW) to its off position, the EADI display is presented on the EHSI (lower) tube
- A control, consisting of two rotary controls, labelled HSI DIM/ WX DIM allows the EHSI display to be dimmed. This is done by rotation of the outer control. The WX radar display on the EHSI is dimmed by rotation of the inner control.

G. EFIS Reversionary Modes and Failure Indications

It is not possible to have a composite display of the EHSI and EADI on one tube, due to the amount of data presented.

In the event of an EADI failure, selection of the EADI DIM control on the display controller to the fully CCW position allows the EADI display to be presented on the EHSI tube. In the event of an EHSI failure it is not possible to display the EHSI display on the EADI tube.

(1) SG Failure

In the event of a single SG failure both the pilot's and co-pilot's displays are driven by the remaining serviceable SG. This is achieved by selecting the SG rev switch located on the coaming panel. The SG driving both systems is annunciated in amber on each EADI (SG1/SG2). A failure of the two SGs will result in the total loss of the EFIS displays. Flight data is also displayed on the standby instruments, primary altimeters, RMIs and DME indicators.

(2) AHRS Failure

In the event of an AHRS failure the pitch scale, roll pointer and aircraft symbol are removed from the associated EADI. The attitude sphere is "painted" blue and the legend ATT (Red) is displayed on the EADI.

On the EHSI the bearing pointers, course select pointer and readout, and the heading select bug and readout are removed. The legend HDG is displayed in a red box at the top of the compass display.

To enable the EFIS to receive cross-side AHRS data, select the AHRS reversion switch on the coaming panel to the serviceable system. The AHRS selected is annunciated on the upper right side of the EADI (ATT1/ATT2).

A failure of both AHRS systems results in the total loss of primary heading and attitude data. Standby heading and attitude data are available on the standby instruments.

(3) DADC Failure

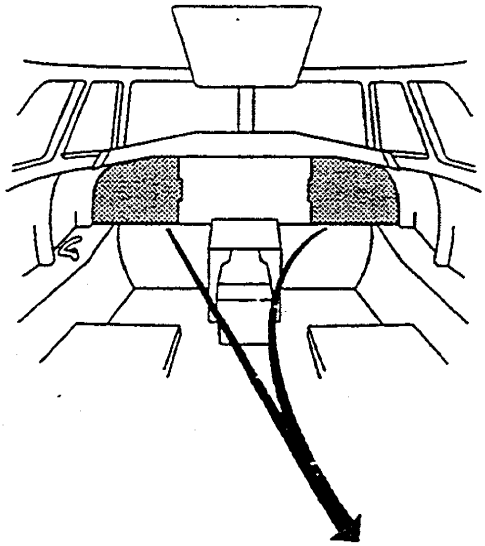
In the event of a DADC failure the parameter legends (eg IAS, VS) are displayed in red boxes on the EADI.

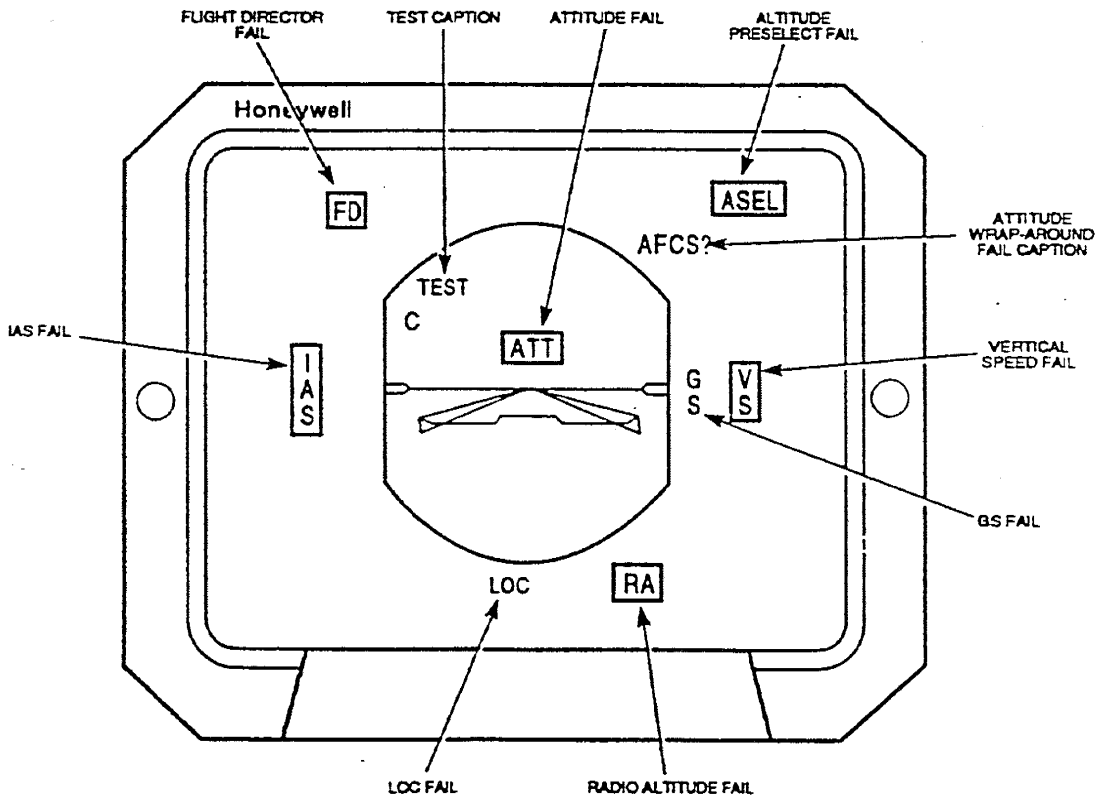
To enable the EADI to receive the cross-side DADC data select the DADC reversion switch on the coaming panel to the serviceable system. The DADC selected is annunciated on the lower left side the attitude sphere of the EADI (ADC1/ADC2).

A failure of both DADCs results in the total loss of primary air data information. Standby airspeed and altitude are available on the standby ASI and standby altimeter.

The rotary reversionary selector switches are labelled BOTH1/N/BOTH2. When set to:

- N, left hand systems are driven by No.1 SG/AHRS/DADC and right hand systems by No.2 SG/AHRS/DADC
- BOTH1, No 1 and No 2 systems are driven by the No 1 sensor.
- BOTH2, No 1 and No 2 systems are driven by the No 2 sensor.





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System Failure Displays

(4) Navigation System Failure

In the event of a navigation unit failure, the glideslope, expanded Localizer and course deviation pointers are removed from the EFIS displays. On the EADI a red NAV legend will appear in the GS window, and on the EHSI a red NAV legend will appear in place of the VOR/LOC legend.

When the glideslope or localizer signal is invalid (and the Nav unit is tuned to a localizer frequency), a parameter legend GS and/or LOC as appropriate will be displayed in red on the EFIS displays.

(5) Flight Director Failure

In the event of a FD failure (or during FCC warm-up), a FD warning is displayed in a red box on the EADI. All FD cues and captions will be removed from the EADI.

(6) Comparison Monitoring

The EFIS compares on-side and cross-side system data continuously. If a difference between data exceeds predetermined values, or if data is invalid, the EFIS shows an amber 'C' on the EADI and shows the mis-compared parameter on the EHSI.

The comparison monitor functions for the following parameters:

- Pitch
- Roll
- Heading
- Airspeed
- Localizer Deviation
- Glideslope Deviation.

If a single SG fails the serviceable SG compares the data on the on-side and cross-side inputs. Any comparison failures will be indicated as described above.

(7) Cooling Fans

In the event of an EFIS/nose equipment bay cooling fan failure a CAP [AV FAN] (amber) caption will come on.

H. EFIS Power Supplies

The two EFIS systems are electrically independent except for the ASCB data bus that links the two SGs. The failure of one EFIS system does not affect the other system.

The No.1 system is supplied with power from the 28V dc left essential avionic busbar.

The No.2 system is supplied with power from the 28V dc right essential avionic busbar.

A single generator failure will have no effect on the system. A double generator failure will result in a total loss of the EFIS system. Data is available on the No.1 primary altimeter, No.1 RMI, DME indicator and standby instruments.

I. EFIS Overheat Indication

Each symbol generator and display tube has a temperature monitoring facility that detects an over-temperature situation. An equipment over-temp is indicated on the maintenance test panel and on an Avionic Maintenance Panel located in the nose bay.

Air Data System (ADS)

A. General

The air data system provides dual primary and secondary air data functions and consists of the following equipment:

- Two Digital Air Data Computers (DADC)
- Three pitot heads
- Two dual passage static plates (S1-S2)
- Two single passage static plates (S3)
- One Total Air Temperature probe (TAT)
- Two electric primary altimeters
- One pneumatic standby altimeter
- One pneumatic standby airspeed indicator.

B. Digital Air Data Computers

Two DADCs provide the primary air data functions. Each DADC is installed in the nose equipment bay.

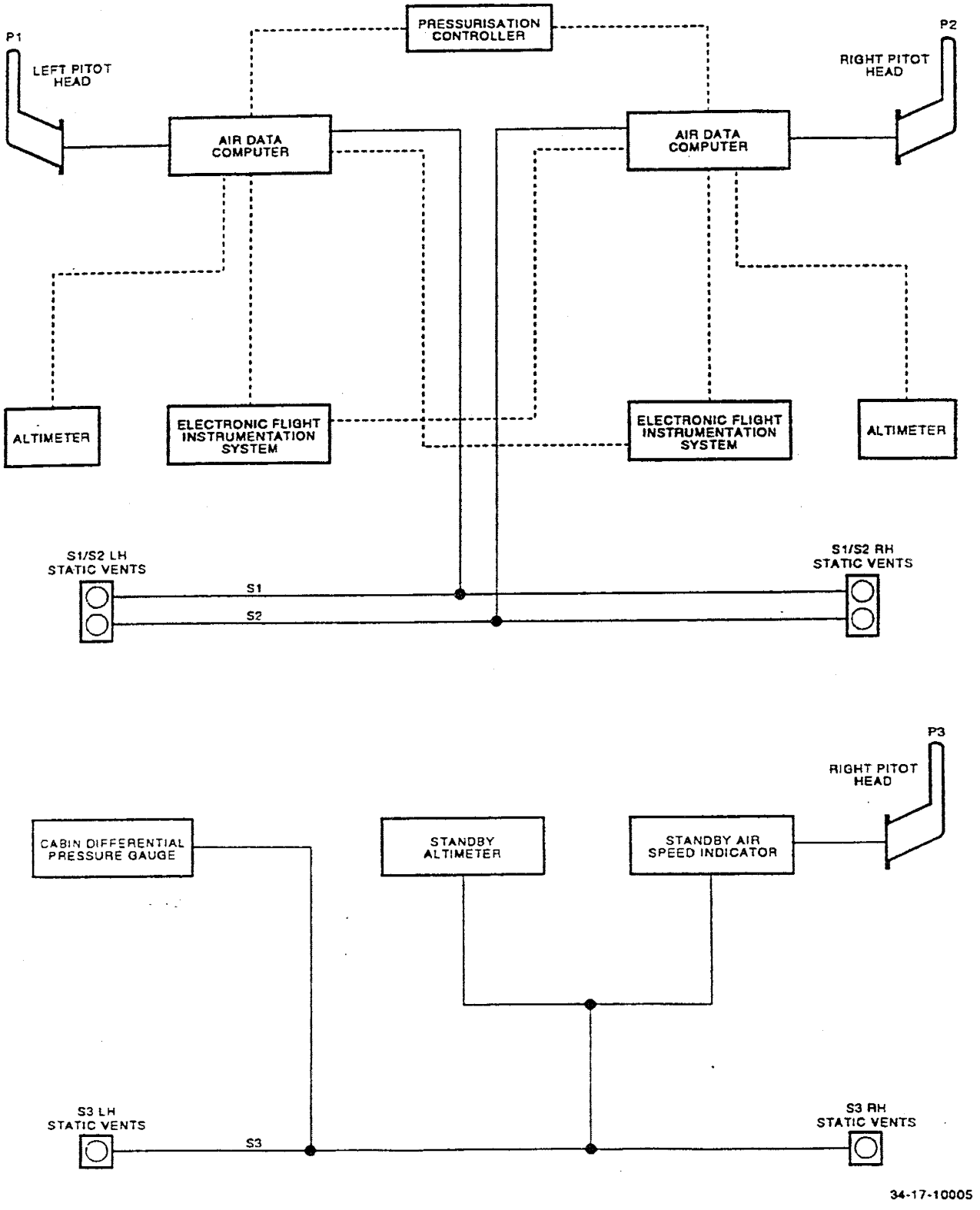
The DADCs take inputs of static air pressure, pitot (ram) air pressure, temperature, baro-correction and stall warning data. From this the DADCs give the following outputs:

- Pressure altitude
- Baro-corrected altitude
- Indicated Airspeed (IAS)
- Low airspeed awareness
- True Airspeed (TAS)
- Vertical Speed (VS)
- Maximum Operating Speed (Vmo)
- Static and Total Air Temperature (SAT and TAT)
- Various airspeed determined switched outputs
- Altitude alert.

The No.1 DADC is connected to the No.1 pitot head and the No.1 static system. The No.2 DADC is connected to the No.2 pitot and static systems.

The TAT interface is provided by a single, dual element temperature probe. Each DADC is connected to a dedicated element.

Each DADC has two electrically independent ARINC 429 outputs which provide interface to the EFIS, FDR and pressurization systems. No.1 ARINC 429 output is linked to the on side EFIS and the No.2 ARINC 429 to the cross-side EFIS, FDR and pressurization system. Primary altitude for each pilot is provided by an interface between each DADC and its related electric altimeter.



Pitot/Static System Schematic

AHRS NO.2		
	PRI	AUX
GND	28V dc right essential avionic busbar	Standby Battery Busbar
FLT	Right Essential Avionic Busbar	Left Essential Avionic Busbar

The standby artificial horizon is normally supplied with power from the avionic emergency busbar.

A switch, labelled STBY INST POWER, located on the centre instrument panel allows the power supply to the standby artificial horizon (and the standby altimeter) to be switched from the emergency switched avionic busbar to the standby battery busbar. This action is only to be carried out if the aircraft batteries become exhausted.

The No.1 RMI is supplied with power from the 28V dc emergency switched avionic busbar whilst the No.2 RMI is supplied with power from the 28V dc right essential busbar.

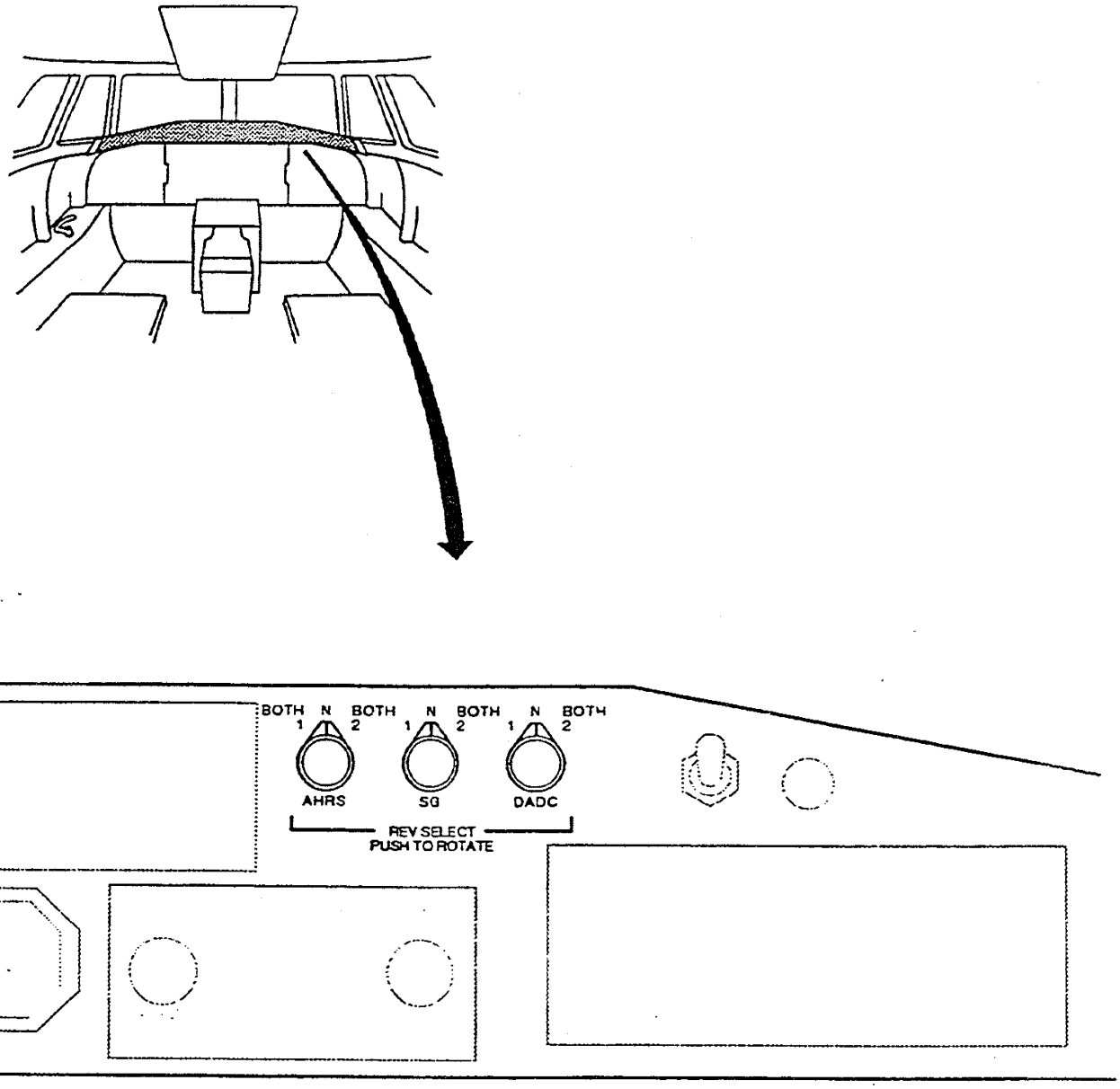
The standby compass does not require electrical power for its operation.

In the event of a single generator failure the AHRS, standby artificial horizon and the RMIs will continue to operate normally without any reversionary switching. A double generator failure will cause the No.2 AHRS and the No.2 RMI to fail. The No.1 AHRS, standby artificial horizon and the No.1 RMI continue to be powered.

Each SG can derive data from either AHRS.

Under normal operating conditions, failure of an ac inverter will cause primary attitude and heading to be lost from the appropriate EFIS. Primary heading and attitude are restored on the failed side by selecting the appropriate AHRS rev rotary switch, located on the coaming panel, to the remaining serviceable AHRS.

CAUTION: THE AHRS TAKES 3 MINUTES TO RUN UP AND 2 MINUTES TO RUN DOWN. THE AIRCRAFT MUST NOT BE MOVED DURING THESE RUN UP AND DOWN TIMES OR DAMAGE MAY OCCUR TO THE GYROS.



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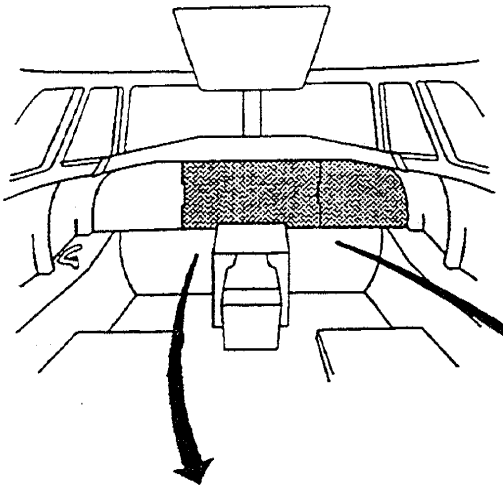
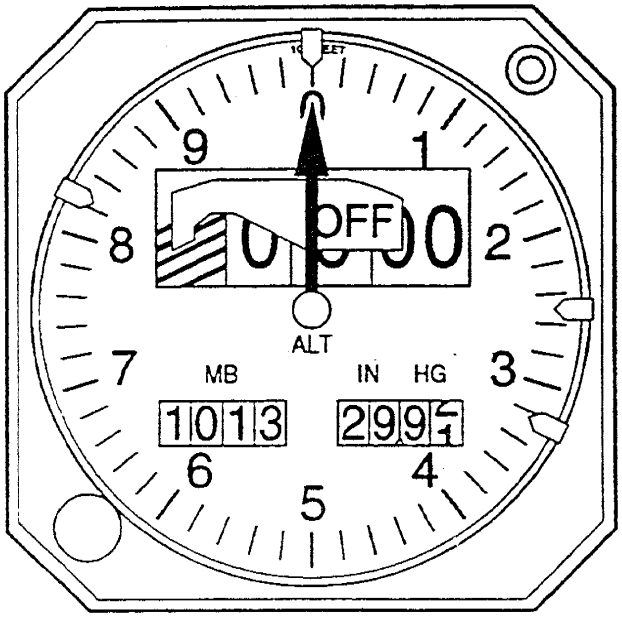
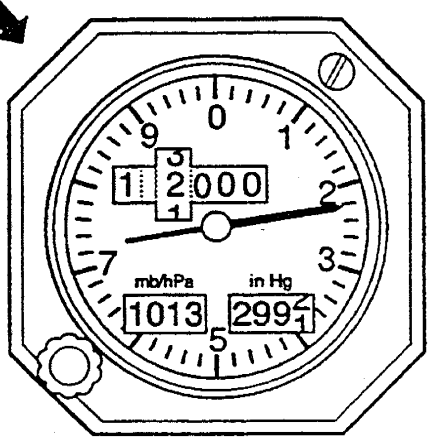
Systems Reversionary Switches

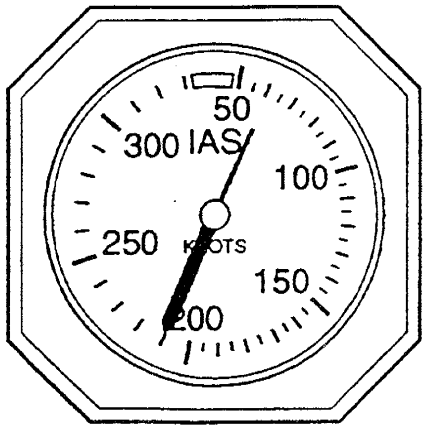




B141 ALTIMETER



STANDBY ALTIMETER



STANDBY AIRSPEED INDICATOR 34-21-10006

Altimeter and Standby Altimeter and Airspeed Indicators

C. Air Data Displays

(1) Altitude display and altitude alert indication

Altitude is displayed on electric altimeters located on the right side of each EADI. Each altimeter has a baro-correction knob on its bezel. The baro-correction setting for each DADC is displayed on the associated altimeter in milli-bars (mb) and inches of mercury (in Hg).

The altitude alert function is controlled by the altitude select knob on the co-pilots instrument controller. The set altitude (when set) is shown in cyan digits in the top right corner of each EADI, below the annotation ASEL. As the aircraft reaches 1000 ft. from the selected altitude (above or below) the selected altitude changes to amber and will flash for 5 seconds. This is accompanied by an amber annunciator on each altimeter flashing and a two second audio warning in the pilots headsets and cockpit speakers. The selected altitude and annunciators remain at amber until the aircraft is 250 ft. from the selected altitude. Within 250 ft. the selected altitude display shows in cyan. If the aircraft deviates from the selected altitude by more than 250 ft., the selected altitude will flash in amber for 5 seconds and then go steady. The annunciators on the altimeters will flash and a two second audio warning will be given. The visual warning will continue until the aircraft returns to within 250 ft of the selected altitude or a new selected altitude is set.

(2) Airspeed, Vmo and low airspeed awareness indication

Airspeed is displayed on the left side of the EADI by digits on a vertical tape and on a rolling drum.

Vmo is displayed on the airspeed tape as a vertical red line, starting at Vmo and extending parallel to the airspeed tape for speeds greater than Vmo. When the airspeed tape indicates Vmo or greater, the digital IAS readout turns red.

Low airspeed awareness is displayed on the airspeed tape as a vertical red line, starting at the airspeed calculated by the DADC to be 1.07 Vs and extending parallel to the airspeed tape for speeds less than this value.

There are four adjustable airspeed bugs which can be displayed. The bugs are selected and set by the IAS control knob on the right instrument remote controller. The airspeed bugs are displayed by symbols adjacent to the appropriate speed on the airspeed tape.

Each DADC provides an output at 253 kts (Vmo + 3 kts) to activate an overspeed audio warning. Above altitudes of 17,400 ft, the overspeed warning is limited to 0.525 M (Mmo + 0.005).

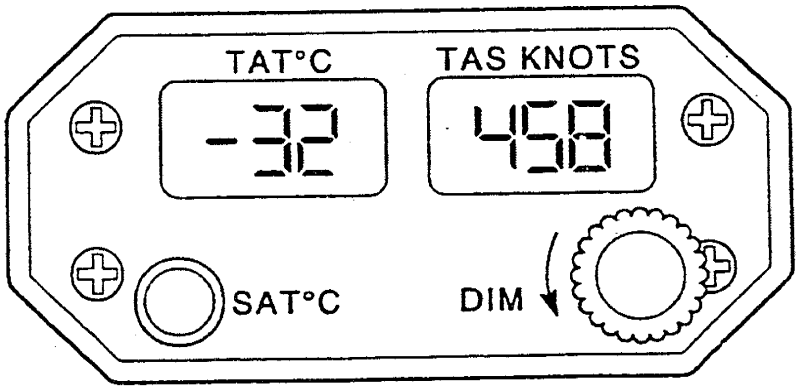
F. Pitot, Static and TAT Probe

The No.1 pitot head and the TAT probe are mounted on the left side of the forward fuselage. The No.2 and No.3 pitot heads are mounted on the right side of the forward fuselage.

There are three static systems with two vents each (to eliminate error caused by differential pressures). The two static plates (each with three vents) are mounted on the forward fuselage (one each side).

The pitot heads, TAT probe and static plates are all electrically heated to prevent icing. Indication of a heating failure is given by amber captions in the roof panel and a CAP [ICE] (amber) caption.

The power supply for the No.1 pitot head, left static plate and TAT probe is the 28V dc left essential busbar. The supply for the No. 2 pitot head and right static plate is the 28V dc right essential busbar. The power for the No. 3 pitot head comes from the 28V dc emergency busbar.



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TAS Temperature Indicator

(3) Vertical speed indication

Vertical speed is displayed on the right side of each EADI on a fixed arc scale with digits and a moving pointer.

(4) Invalid air data displays

An invalid air data parameter is indicated by removal of the associated tape and digital readout from the display and replacing it with the parameters abbreviation (eg IAS) surrounded by a red box.

(5) True airspeed and temperature indication

TAT and TAS are displayed on a dedicated indicator installed in the coaming panel. SAT can be set to momentarily display instead of TAT when the switch on the indicator is pushed and held in. The indicator receives TAT, TAS and SAT data from the No.1 DADC only. The input cannot be transferred to No.2 DADC on reversionary selection, when No.1 DADC is unserviceable.

D. Standby Air Data Instruments

(1) Standby altimeter

A standby altimeter is installed in the centre instrument panel and is connected to the No.3 static system. The instruments baro-correction is displayed in both mb and in Hg.

(2) Standby airspeed indicator

A standby ASI is installed in the centre instrument panel below the standby altimeter and it is connected to the No.3 pitot and No.3 static systems.

E. DADC Power Supplies

The No.1 DADC is supplied with power from the 28V dc emergency busbar and the No.2 DADC from the 28V dc right essential busbar.

A single generator failure will have no effect on the No.1 and No.2 DADCs. If a double generator failure occurs the No.2 DADC is lost.

The TAS Temperature indicator is supplied with 26V 400Hz from the 26V ac left busbar.

The standby altimeter vibrator is supplied with power from the 28V dc emergency busbar. The standby ASI does not require an electrical power supply to display airspeed.

Lighting for the standby instruments is supplied from the flight deck lighting system.

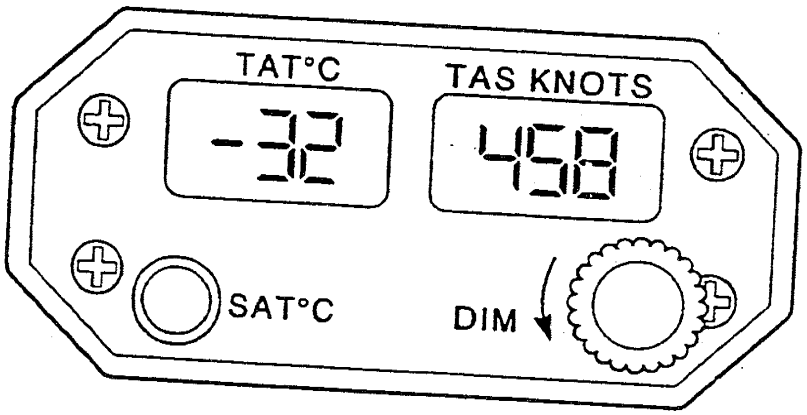
F. Pitot, Static and TAT Probe

The No.1 pitot head and the TAT probe are mounted on the left side of the forward fuselage. The No.2 and No.3 pitot heads are mounted on the right side of the forward fuselage.

There are three static systems with two vents each (to eliminate error caused by differential pressures). The two static plates (each with three vents) are mounted on the forward fuselage (one each side).

The pitot heads, TAT probe and static plates are all electrically heated to prevent icing. Indication of a heating failure is given by amber captions in the roof panel and a CAP [ICE] (amber) caption.

The power supply for the No.1 pitot head, left static plate and TAT probe is the 28V dc left essential busbar. The supply for the No. 2 pitot head and right static plate is the 28V dc right essential busbar. The power for the No. 3 pitot head comes from the 28V dc emergency busbar.



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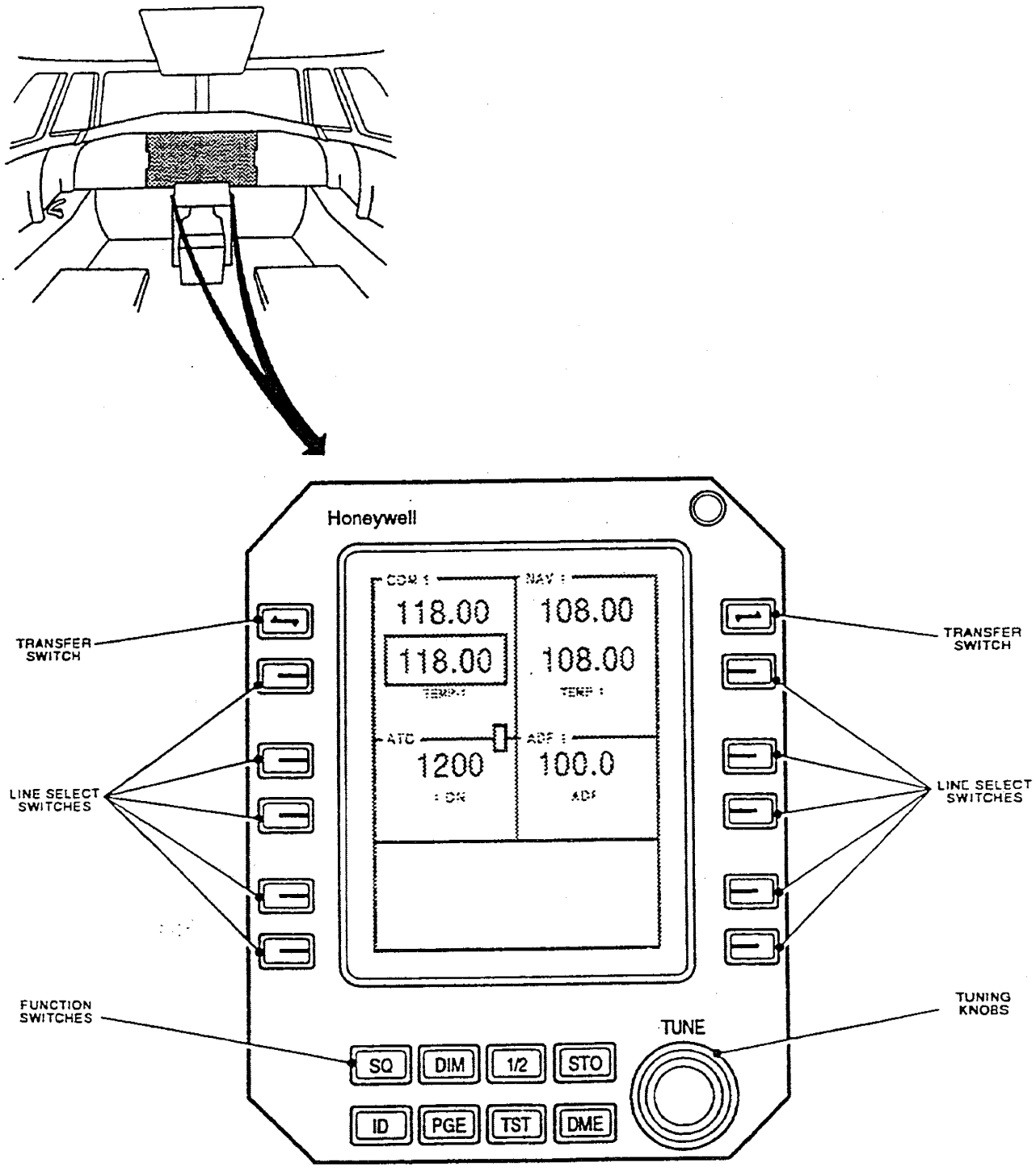
TAS Temperature Indicator



RMU Display

C. Radio Management Unit

Control of the navigation system is achieved by two RMUs, one for each Nav Unit. The RMUs are located on the centre instrument panel, to the left and right of the engine instruments.

The RMU is a colour CRT display based controller that controls the navigation (nav) and the communication (comms) systems by select keys. Additionally each RMU has the ability to be switched from its on-side Nav Unit to the cross-side Nav Unit.

The RMU has five tuning areas (windows) on its screen (COM, NAV, ADF, ATC and MLS) MLS is not installed in the aircraft and this window remains blank. Each window contains all the information associated with a particular function e.g. the ADF window shows the operating frequency and operating mode. Each window is controlled by a select button and concentric tuning controls.

To change pages, press the PGE switch until the desired page is displayed. To display cross-side information press the 1/2 switch. A second press will return the display to the on-side selection.

D. Navigation System Displays and Failure Modes

The VOR, ILS and ADF information is primarily displayed on the EFIS. VOR and ADF data from each Nav Unit can be set to display on the RMIs. Navigation data from system 1 is shown on the single bar pointers (RMIs) and bearing No. 1 pointer (ball) on the EFIS. Navigation data from system 2 is shown on the double bar pointers (RMIs) and bearing No. 2 pointer (diamond) on the EFIS. VOR or ADF selections are made on the EFIS controller for the on-side EFIS and on each RMI for each RMI. Different selections can be made on each EFIS and each RMI.

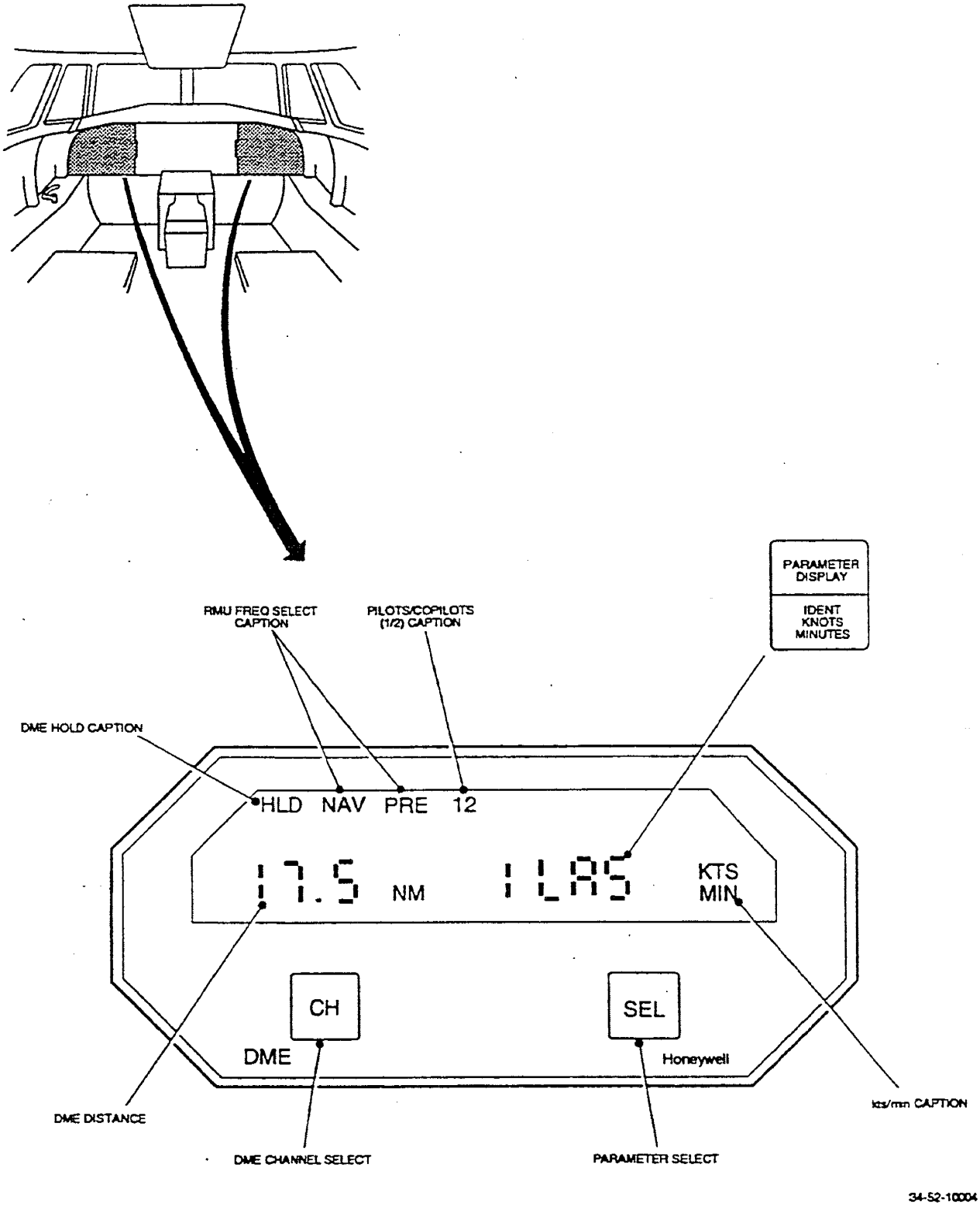
ILS data from the No.1 Nav Unit is also displayed on the standby artificial horizon and is used as a back-up display in the event of a total failure of the EFIS system.

If a Nav Unit fails, the information from the serviceable Nav Unit is displayed on the cross-side EFIS display by pressing the V/L button on the appropriate EFIS controller.

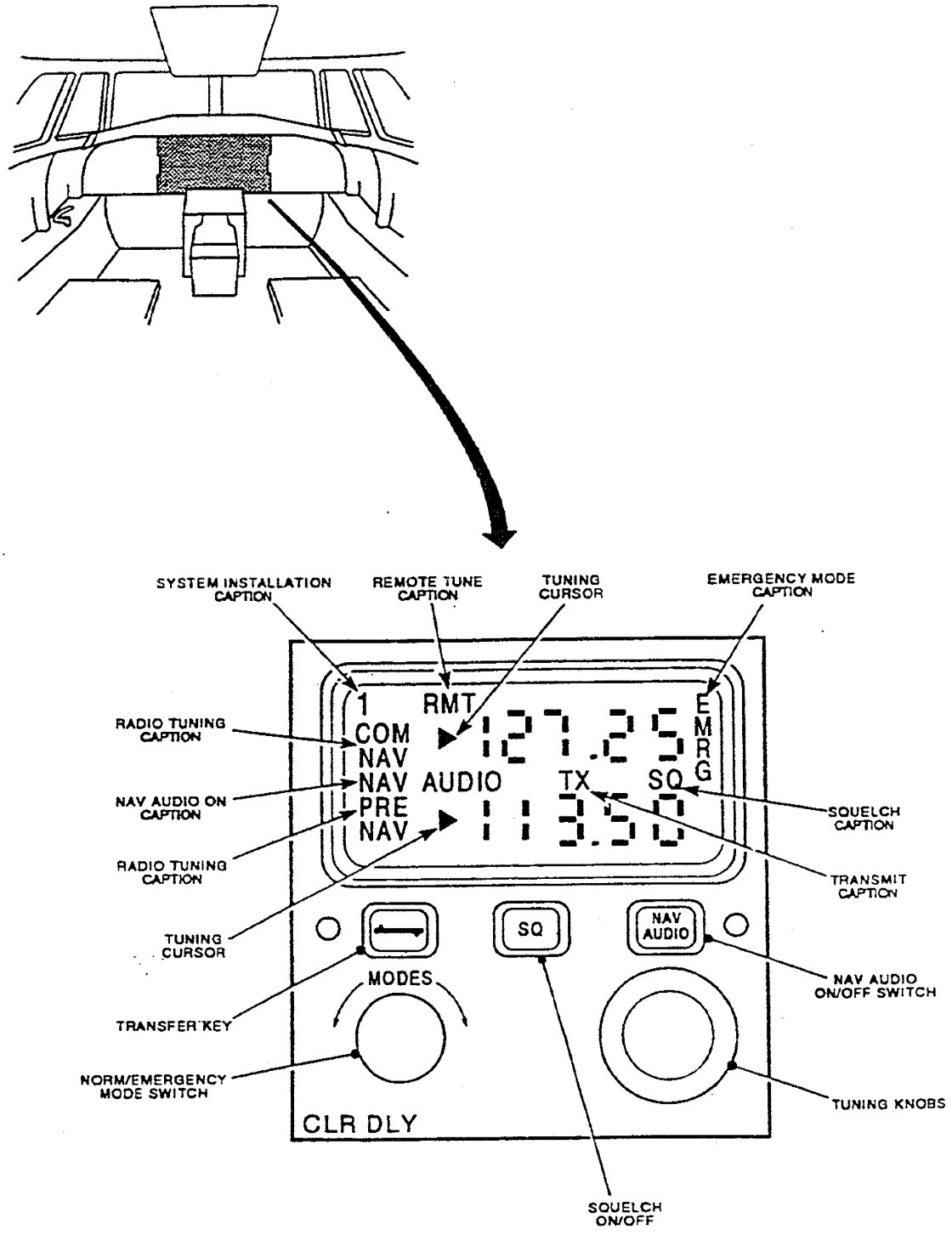
E. Navigation System Power Supplies

The No.1 navigation system is supplied with power from the 28V dc emergency switched avionic busbar, the No.2 system is supplied with power from the 28V dc right essential avionic busbar.

If a single generator failure occurs, it will have no effect on the system. In the event of a double generator failure, the No.1 system remains fully functional but the No.2 system is lost.



DME Indicator



Clearence Delivery Unit

6. Communications and Audio System

A. General

The communication system consists of the following equipment:

- Two Integrated Communications units (Comms Unit) with VHF Communications and ATC transponders
- Two RMUs (shared with the Nav system)
- One Clearance Delivery Unit (CDU)
- Three Audio Control Panels
- PA and Cabin interphone
- Two Comms antennas
- Two ATC transponder antennas.

The third crew member (observer) is provided with an Audio Control Panel mounted on the right side of the cockpit. The Audio Control Panel provides full audio and mic facilities.

The ground crew can plug a headset into a connector on the nose gear. The connector is in parallel with the pilots audio control panel and gives direct communication to the pilot.

B. Integrated Communications Unit (Comms Unit)

Each Comms Unit is installed in the nose equipment bay.

The Comms Units contain the VHF comms and ATC transponder systems and are normally controlled by their respective RMUs. A similar method of cross-side control as the NAV system is provided.

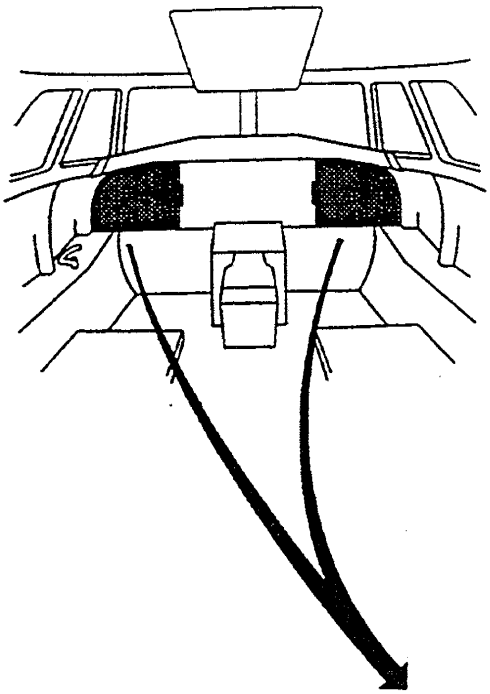
The ATC transponder function has modes A, C and S. The dual ATC transponder system has a lockout to prevent both transponders being active at the same time. Control of the transponder system is by the RMUs.

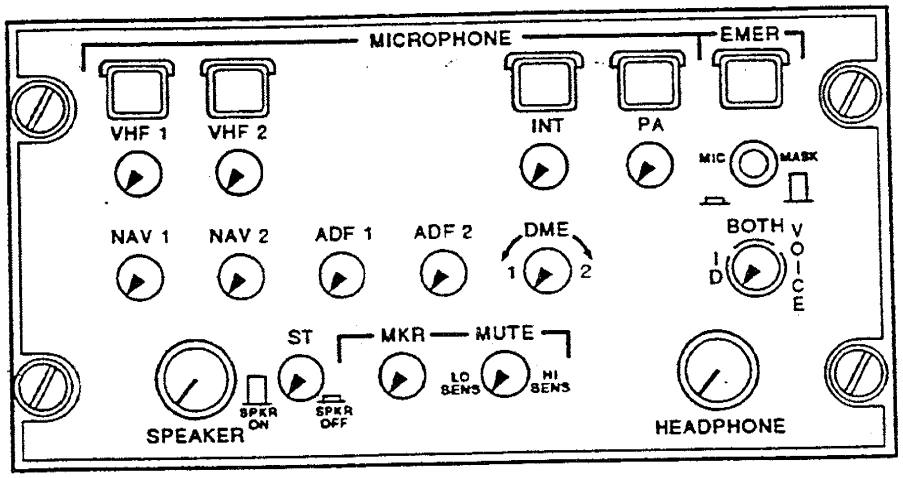
No.1 and No.2 VHF comms systems have dedicated antennae located on the lower and upper fuselage respectively.

(1) System control

The Comms Units are normally controlled by the same RMUs that control the Nav Units. The Comms Units have their own dedicated windows on the RMUs.

A back-up control for the No.1 VHF comms and VOR/ILS is provided by the CDU. This is only a means of tuning the No.1 Comms and Nav units, it is not a separate radio/navigation system.





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Audio Control Panel

C. Audio Control Panel (ACP)

Two ACPs, one located on the left and one located on the right instrument panel give selection and control of the audio received and transmitted by each pilot. A third ACP mounted to the right of the Observers position (below the circuit breaker panel) provides audio and microphone facilities for the Observer. The ACPs also change the digital sound on the digital bus to analogue signals for the headsets and speakers. Each ACP controls on-side facilities (audio, mic signals and speaker).

The ACP allows individual selection of VHF1, VHF2, Interphone (INT) or passenger address (PA) for transmission by buttons on the facia. The buttons are interlocked so only one facility can be selected at a time. Transmission on the selected radio is achieved by the operation of a PTT switch.

Received audio is controlled by rotary push-buttons. The appropriate receiver channel is selected when the required button is out. Rotation of the button will change the volume level of the selected receiver, the push-buttons are not interlocked and can be selected as required. The speaker is controlled by a rotary push-button, turning the button will adjust the speaker sidetone level. The volume of the headset and the speaker can be individually controlled by volume knobs on the ACP.

Each ACP can be used with a boom mic (headset) or an oxygen mask and headset, all microphone signals are of analog format. When mask is selected, the audio to the speaker cannot be turned off.

If power is lost or an ACP fails, pressing the EMER button on the ACP will cause all emergency VHF (1) comms and VHF (1) nav audio (analog format) to be output directly to the headset.

Each ACP interfaces with the audio warning system. All audio warnings are applied to the headsets and flight deck speakers simultaneously. Warning audio signals to the speaker cannot be turned off by the speaker switch.

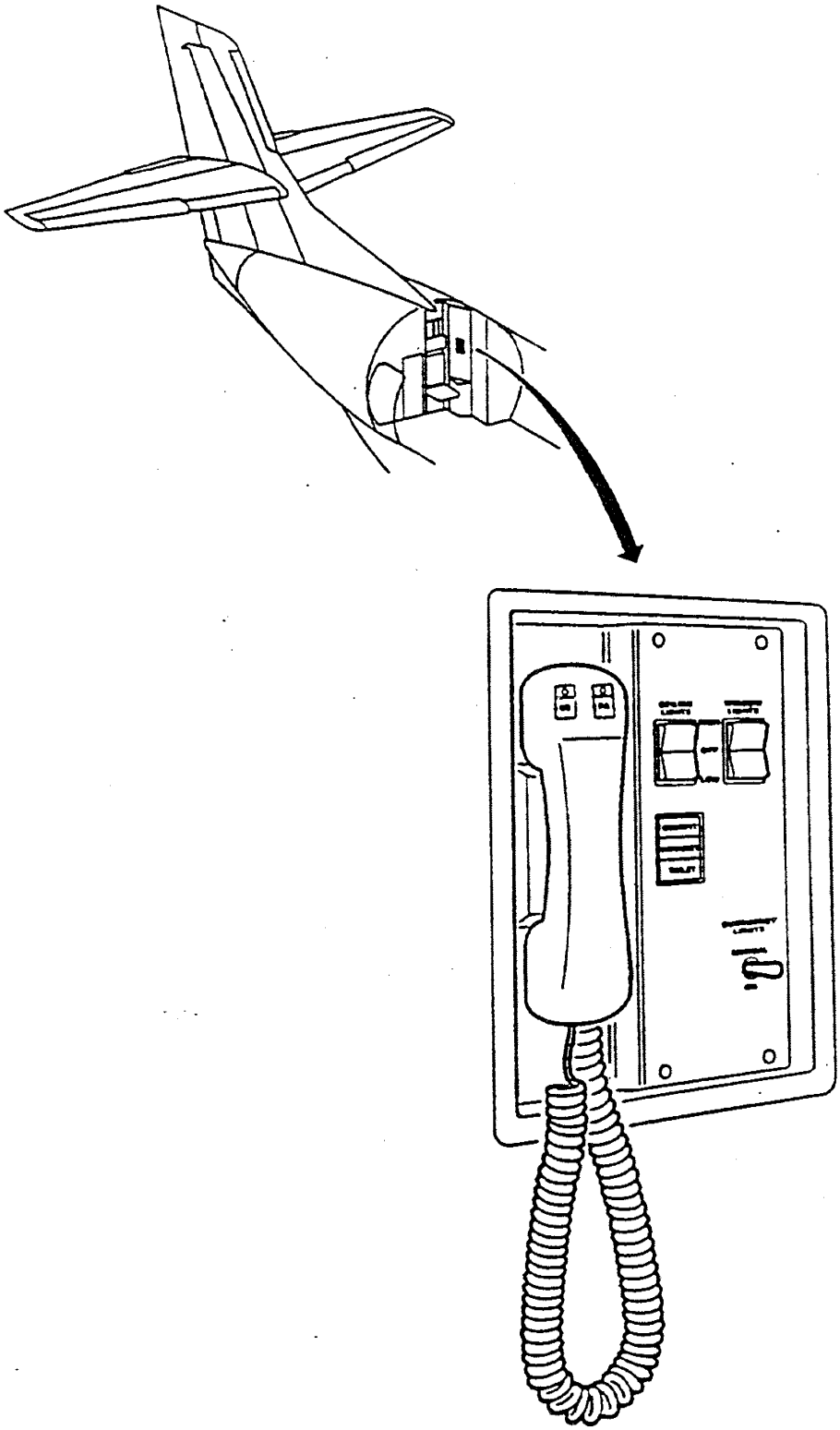
D. Communication and Audio System Power Supplies

The No.1 and No.2 Radio Communications Units are supplied from the 28V dc Unswitched Emergency avionics busbar and the 28V dc Right Essential avionics-busbar respectively.

The No.1 ACP is supplied from the 28V dc Left Essential busbar. The No.2 ACP is supplied from the 28V dc Right Essential busbar. Both ACPs are also dual-supplied from the 28V dc Switched Emergency avionics busbar to enable starts and smoke drills.

The No.1 and No.2 Radio Management Units are supplied from the 28V dc Emergency and the 28V dc Right Essential busbars respectively.

The clearance delivery control unit is supplied from the 28V dc Emergency avionics busbar.



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Flight Attendant Position

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In the event of a single generator failure, all Communications and Audio Systems will be automatically supplied from the functional generator.

In the event of a double generator failure, the No.1 Comms system, all Audio Control Panels and the CDU will remain operational. The remaining components, of the No.2 Comms system and the No.1 RMU will not be operational.

E. Clearance Delivery Unit (CDU)

The CDU is located on the left instrument panel and provides a means of tuning the No.1 Comms and Nav units. The controls on the front panel (and their function) are:

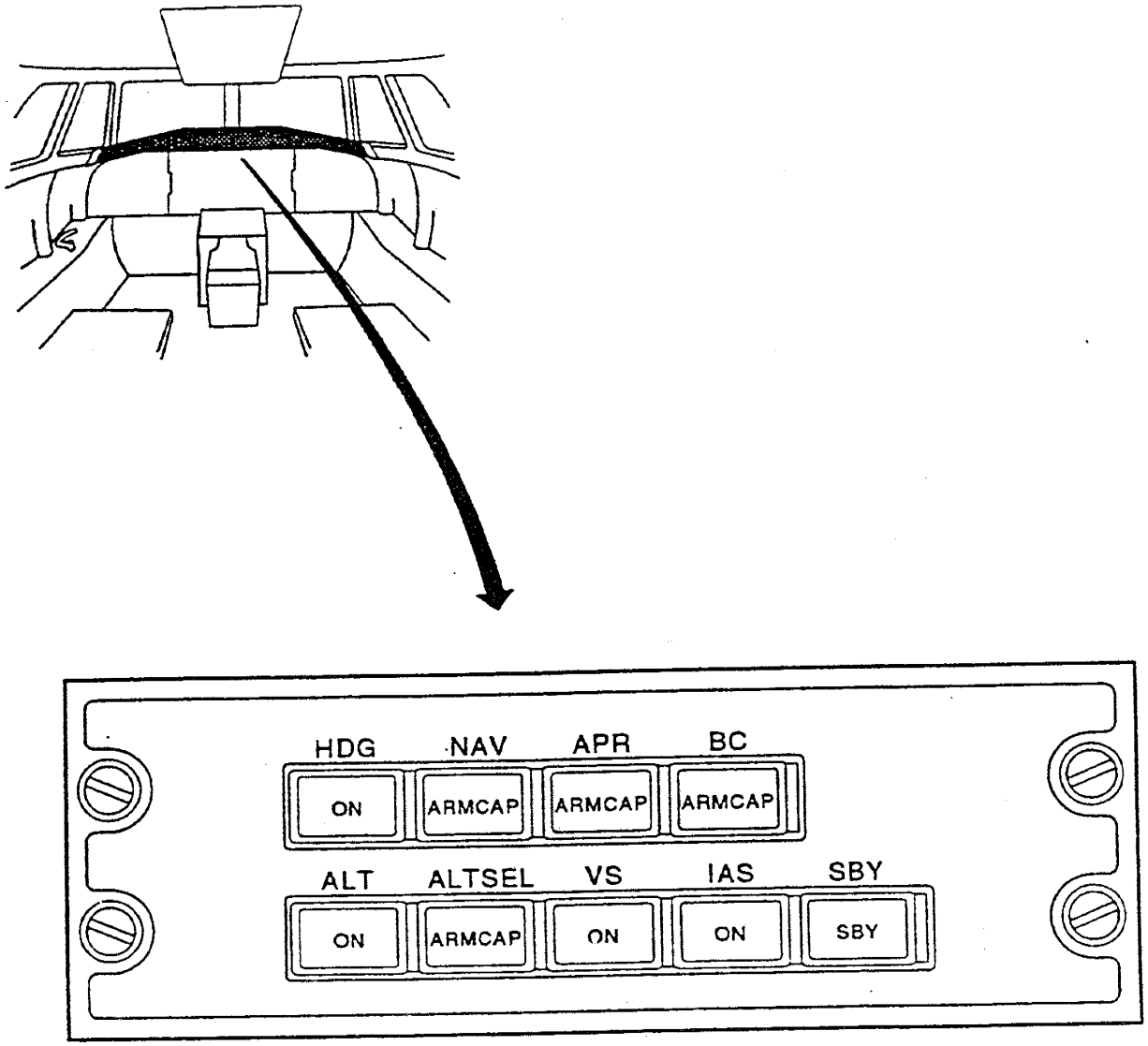
- Transfer key. Sets the arrow cursor adjacent to the displayed COM or NAV frequency
- SQ on/off switch. Sets the Comms Unit squelch to on or off
- NAV AUDIO on/off switch. Sets the Nav Unit audio to on or off
- MODES switch. Sets the mode of operation of the CDU. Normal mode is set with the switch turned clockwise. Emergency mode is set with the switch turned counterclockwise
- Tuning Knobs. Sets the Comm or Nav Unit frequency selected by the transfer key. Large changes of data are set by the outer knob, small changes of data are set by the inner knob. The data change is in proportion to the rate at which the tuning knobs are turned.

F. Passenger Address (PA) System

The PA system provides the following functions:

- Interphone between the pilots and the flight attendant
- Cabin announcements from the flight deck
- Cabin announcements from the flight attendant
- Cabin alerting by the illumination of Fasten Seat Belt and No Smoke Signs
- Flight attendant and flight deck call features.

The PA system is linked to the cabin speakers. The system is accessible to the flight crew and flight attendant at all times. The PA system is supplied with 28V dc from the unswitched emergency avionics busbar.



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FD Mode Selector

7. Flight Control System

The Flight Control System (FCS) consists of :

- A Flight Control Computer (FCC)
- A Mode Selector.

A. Flight Control Computer

The FCC is installed under the cabin floor aft of the flight deck bulkhead.

The FCS functions as a Flight Director (FD) and provides lateral and vertical cues on the EADI for the following modes of operation.

(1) Heading Mode

Momentary depression of the mode selector HDG button engages the heading mode, if the compass system from the selected pilot is valid. When the mode is engaged the mode selector button will indicate a green HDG caption. In this mode the command bar will indicate roll commands on the EADIs to achieve the selected heading. The heading mode can be cancelled by capture of another lateral mode, standby mode or momentary reselection of the HDG button.

(2) Navigation Mode

Momentary depression of the Mode selector NAV button causes the FCC to engage either:

- NAV ARM and HDG if the aircraft is outside the 1 dot/ 5 deg capture zone
- NAV mode if within the capture zone with valid nav and compass signals.

When the mode is engaged the mode selector button will indicate an amber ARM or a green CAP caption and the EFIS will indicate a white NAV arm or Green NAV caption as appropriate.

(5) Vertical Speed Hold

Operation of the vertical speed mode is the same as the IAS mode except that the aircraft is controlled to the vertical speed present when the mode is selected. Cancellation of the mode is the same as cancellation of the IAS mode.

(6) Back Course (BC)

Momentary operation of the mode selector BC button causes the FCC to engage the BC mode or if outside the reverse ILS capture zone it arms the mode. On selection outside the capture zone the BC button will indicate an amber ARM caption and a white BC caption is shown on the EADIs. When the capture zone is entered the mode selector BC button indicates a green CAP caption and the caption on the EADIs indicate a green BC.

Back course approaches can be carried out on any single direction ILS approved for BC operations.

When BC is displayed glideslope data is locked out and not displayed.

(7) VOR Approach

The VOR approach mode permits precision lateral guidance on an approach to a runway, provided the runway has a VOR located on the extended centre line.

The mode is enabled by momentary depression of the mode selector APR button with the appropriate RMU tuned to the VOR frequency.

(8) Altitude Hold (ALT)

Momentary depression of the mode selector ALT button causes the FCC to engage the altitude hold mode, if the DADC data is valid. When the mode is engaged the mode selector button indicates a green ALT caption and a green ALT caption is shown on the EADIs.

The FCC produces commands to maintain the aircraft at the altitude at which the mode is selected. The commands are shown by the vertical deflection of the command bar on the EADIs.

The mode is cancelled by a selection of another vertical mode, standby mode or momentary reselection of the ALT button.

In the NAV ARM mode the heading mode provides steering commands to capture an intercept angle set by the heading bug on the EHSIs. When the capture zone is entered, the heading commands are automatically cancelled and the nav mode produces the steering commands.

The navigation mode is cancelled by selection of another lateral mode*, standby mode or momentary reselection of the NAV button.

*NOTE: Back Course at any time. HDG if Nav is captured, though not if Nav is armed when HDG is on as well.

(3) Approach Mode

Momentary depression of the mode selector APR button causes the FCC to engage either:

- NAV ARM, APR ARM and HDG or
- APR CAP.

The mode engaged depends on the aircraft's position relative to the ILS. Operation of the APR mode is similar to the NAV mode but existing vertical guidance is maintained (and annunciated) until glideslope capture. Glideslope capture is locked-out until localizer capture.

During the approach, glideslope gain is a function of the altitude from the Radio Altimeter (Rad Alt). The gain is reduced at the aircraft gets closer to the glideslope transmitter. If the Rad Alt fails the glideslope gain is controlled as a two stage function as follows:

- Time from glideslope capture (and)
- Time from middle marker.

The approach mode is cancelled by selection of another lateral mode, standby mode or momentary reselection of the APR button.

(4) IAS Hold

Momentary depression of the mode selector IAS button causes the FCC to engage IAS hold if the DADC output is valid. The mode selector button indicates a green IAS caption and a green caption is presented on the EADIs when the the IAS hold mode is engaged. The FCC produces pitch commands to maintain the IAS present when the mode is selected. This is displayed as the vertical deflection of the pitch command bar on the EADIs.

The mode is cancelled by selection of another vertical mode, standby mode or momentary reselection of the IAS button.

B. Mode Selector

The mode selector is installed in the centre of the coaming panel. It is configured so that all lateral mode switch/captions are on the top row and all vertical ones on the bottom row.

Indication of mode selection is repeated on the EADIs.

C. Control of Flight Control System

The Flight Control System (FCS) receives navigation, course and air data information from the Nav unit(via the Symbol Generator), AHRS and DADC systems, No.1 or No.2 as selected by the pilot/co-pilot.

The switching is controlled by pushbutton switch/annunciators with the split legend "PILOT/CO-PILOT". The switches are labelled "FCS CONTROL" and are located on the left and right main instrument panels. The annunciation on a black background is PILOT (green) or CO-PILOT (white).

The switching system operates such that when selected to a particular pilot, the air data AHRS and NAV information selected to that pilot's EFIS is also selected to the flight control system. When the switch is selected to the other pilot all selected flight director modes are cancelled and must be reselected by the pilot to whom the FCS control has been switched.

D. Flight Control System Fail Modes

The FCC has internal fault monitoring circuits. In the event of an FCC failure a red FD FAIL warning annunciator is displayed on top left centre of the EADIs, all other FD cues and annunciators are removed from view.

If an autopilot is fitted and the monitoring circuits detect a 'hard over' the autopilot is automatically disengaged.

E. Flight Control System Power Supplies

The flight control system is supplied from the 28V dc Left Essential avionics and left 26V ac busbar.

In the event of a single generator failure, the flight control system will be automatically supplied via the functional generator, and will not be shed.

In the event of a double generator failure, the flight control system will not be available to the flight crew.

(9) Altitude Select (ALT SEL)

Momentary depression of the mode selector ALT SEL button causes the FCC to arm the ALT SEL mode. The mode selector ALT SEL button indicates an amber ARM and ALT ARM is shown on the EADIs.

The desired altitude is selected by the ALT SEL control (on the co-pilots instrument controller), the FCC then generates commands for the aircraft to acquire the selected altitude. As the aircraft approaches the selected altitude the mode selector ALT SEL button changes to indicate a green CAP and the EADIs change to show ALT CAP.

On reaching the selected altitude, the altitude hold mode is engaged and vertical commands are given on the command bar to maintain the selected altitude.

The ALT SEL mode cancels any other vertical mode. It can itself be cancelled by selection of another vertical mode, standby mode or reselection of the ALT SEL button.

(10) Standby Mode (SBY)

Selection of SBY cancels all previously selected FD modes and removes the command bars from the EADIs. When SBY is pressed (and held) all the mode captions come on and the FD warning flag on the EADIs come into view. When SBY is released all the mode captions extinguish and the FD warning flag goes out of view.

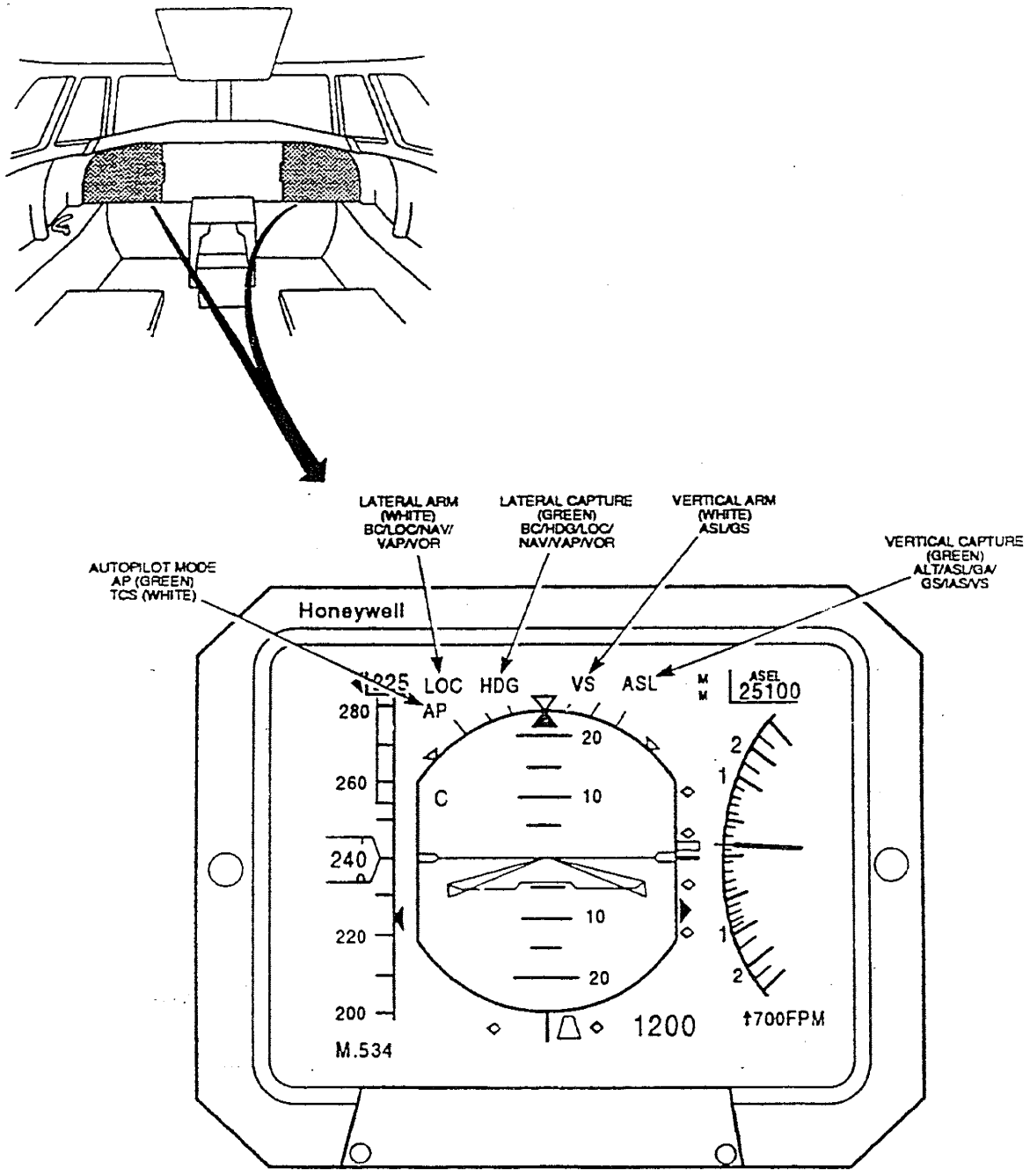
(11) Go-Around (GA)

Momentary operation of the GA switch on the left POWER lever causes the FCC to engage the GA mode and cancel all other selected modes.

The FCC produces commands to achieve a wing level, approximately 8 deg pitch up.

If autopilot is engaged when GA is selected it will be disengaged.

Selection of any lateral mode, commands lateral guidance but maintains the pitch angle. Selection of a vertical mode cancels the GA mode.



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EADI with Autopilot/FD Mode Captions

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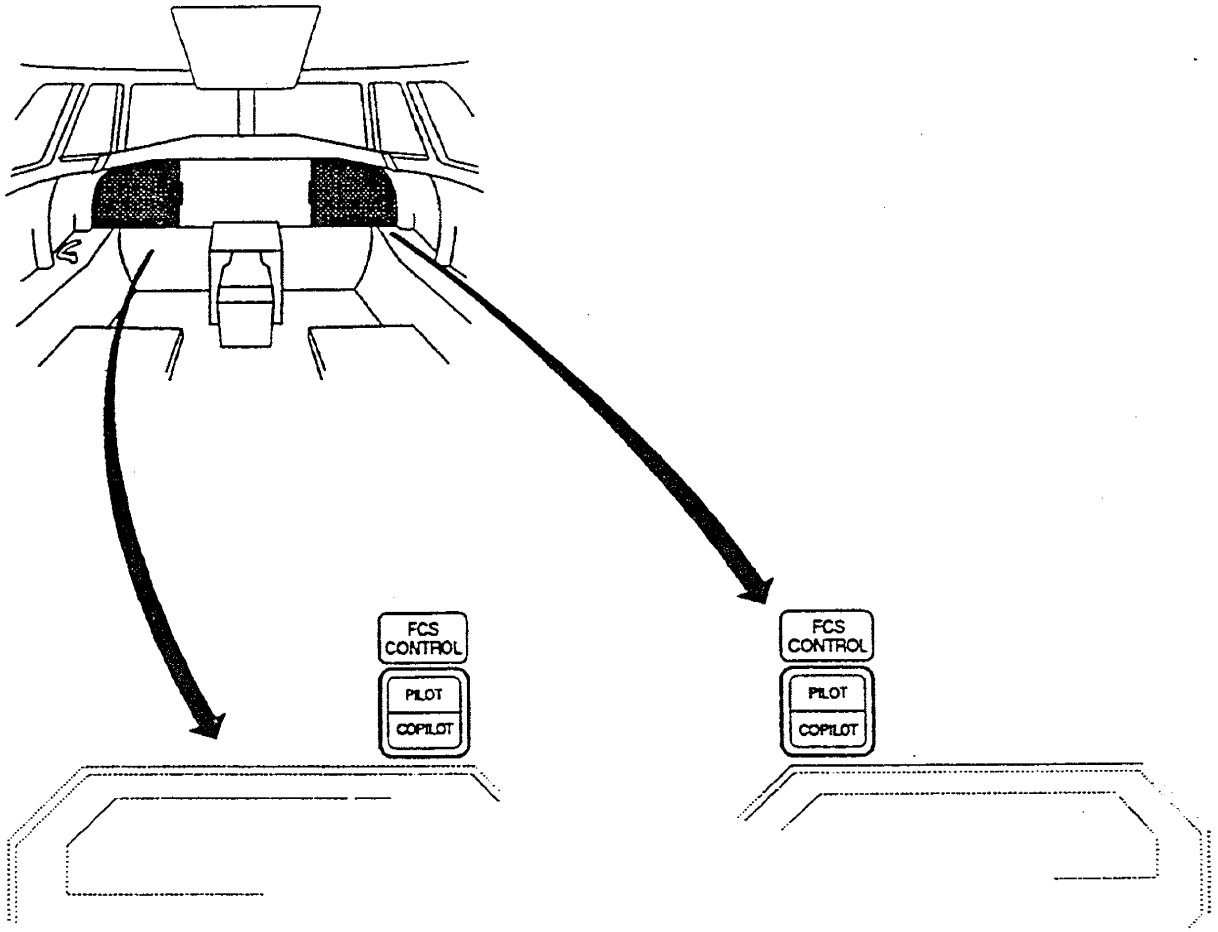

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FCS Control Switches/Captions

RCT	Turns on/off the Rain Echo Attenuation Compensation Technique (REACT) mode. The REACT mode compensates for the attenuation of the radar signals as it passes through rain fall. The presence of a cyan field indicates areas where compensation is not possible and bad weather may be located.
WX	Sets the radar system to weather detection mode (from GMAP or FP modes).
GMAP	Sets the radar system to ground mapping mode. The system enhances returns from ground targets, and reduces returns from weather targets.
RANGE	The maximum radar range is selectable by two switches. The switch with the up arrow increases the range, and the switch with the down arrow decreases the range. The selectable ranges are 5, 10, 25, 50, 100, 200 and 300 nm.
AZ	Turns on/off the azimuth marks on the display at 30 degree intervals left and right of the aircraft centre line.
SCT	Selects either fourteen scans per minute (120 deg scan) or twenty eight scans per minute (60 deg scan).
BRT	Adjusts the brightness of the display. Clockwise to increase and counter-clockwise to decrease the brightness.
TILT	Sets the antenna tilt angle between ±15 deg from the horizontal. When the switch is pulled out auto-stabilization is switched off.
GAIN	When the switch is pushed in, the gain of the receiver is preset (calibrated) and rainfall rates are shown by the appropriate colour. When pulled out the gain can be varied to enhance the weather picture. When target alert is on the gain is automatically fixed at the preset value.

Rainfall rates are indicated as follows:

Rainfall rate	Colour
1-4 mm/hr	green
4-12 mm/hr	yellow
12-50 mm/hr	red
greater than 50 mm/hr	magenta

8. Weather Radar System (WRS)

A. General

The Weather Radar System consists of the following equipment:

- Receiver/Transmitter/Antenna Unit (RTAU)
- Weather Radar Indicator (WRI).

Weather radar information is controlled by and displayed on the dedicated WRI, it can also be displayed on the EHSIs.

B. Receiver/Transmitter/Antenna Unit

The RTAU is an integral RX/TX with a 12 inch flat plate antenna mounted in the nose cone of the aircraft. It scans 60 deg (30 deg left and right) or 120 deg (60 deg left and right) in azimuth. The tilt angle of the antenna beam can be set by the pilot within the range of ± 15 deg from the horizontal. The antenna is stabilized by a signal from the No.2 AHRS and will maintain a horizontal scan if the aircraft attitude does not exceed 30 deg in pitch or roll.

On the ground the RTAU defaults to the enforced standby mode to prevent hazardous radiation effects to the ground crew.

C. Weather Radar Indicator

The WRI is installed in the centre instrument panel. The WRI incorporates the following control and selector switches:

OFF	Sets the radar system to off.
STBY	Sets the radar system to the standby mode, this inhibits the transmitter and the antenna scan. The system will warm-up (45 seconds) during which time it displays WAIT. When warmed-up the system shows STBY.
ON	Sets the radar system to on, and starts WX or GMAP mode as previously selected (mode is shown on the screen). If not warmed-up in SBY mode the system shows WAIT for 45 seconds before WX or GMAP modes are started.
FP	Sets the radar system in the flight plan mode (not used).
TST	Sets the radar self test mode. A special test pattern is displayed which allows verification of correct system operation. TST is shown on the screen. The radar radiates microwave energy during the test.
TGT	Turns on/off the target alert feature. The alert feature advises the crew of potentially dangerous targets directly in front of the aircraft but outside of the selected range. TGT is shown on the screen.

D. Weather Radar System Power Supplies

The weather radar system is supplied from the 28V dc right essential busbar. A stabilisation reference voltage is supplied from the 26V ac right avionics busbar.

A single generator failure will have no effect on the system. A double generator failure will result in the total loss of the weather radar system.

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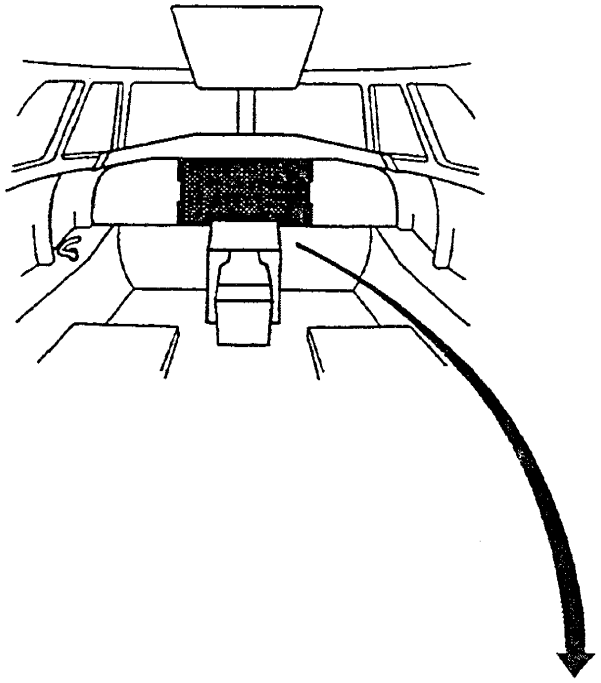
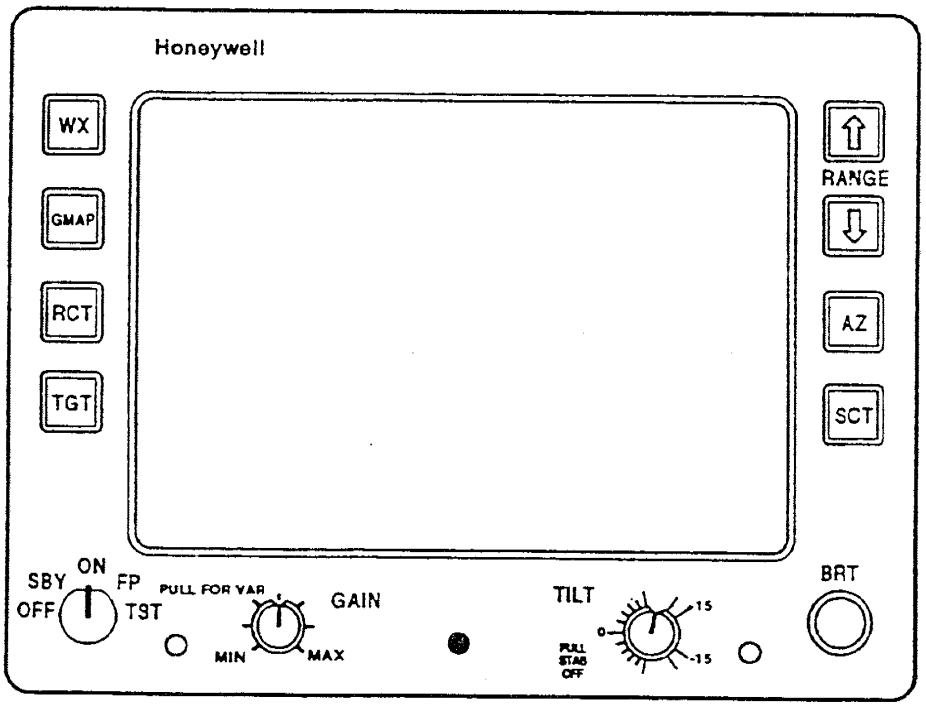




34-41-10001

Weather Radar Indicator

9. Radio Altimeter System (Rad Alt)

A. General

The Rad Alt system consists of the following equipments:

- Rad Alt transmitter/receiver
- Rad Alt antennas.

B. Rad Alt Transmitter/Receiver

The Rad Alt transmitter/receiver is installed beneath the cabin floor, aft of the flight deck bulkhead, on the left side of the fuselage.

The radio altimeter provides an accurate output of height data (above the ground) between 0 and 2500 ft. The height data goes to the EFIS, FDR and FCC (for gain programming).

A test facility is available and is initiated by the selection of test on the left or right EFIS control panel. The on-side Rad Alt display will show 100 ft and the cross-side Rad Alt display will show RA in red (boxed). If the test is initiated by the coupled side (pilot/co-pilot switch) all flight director / autopilot captions come on, (while the test switch is held in) and the flight director goes into standby mode when the test switch is released. The Rad Alt can be tested in the air or on the ground.

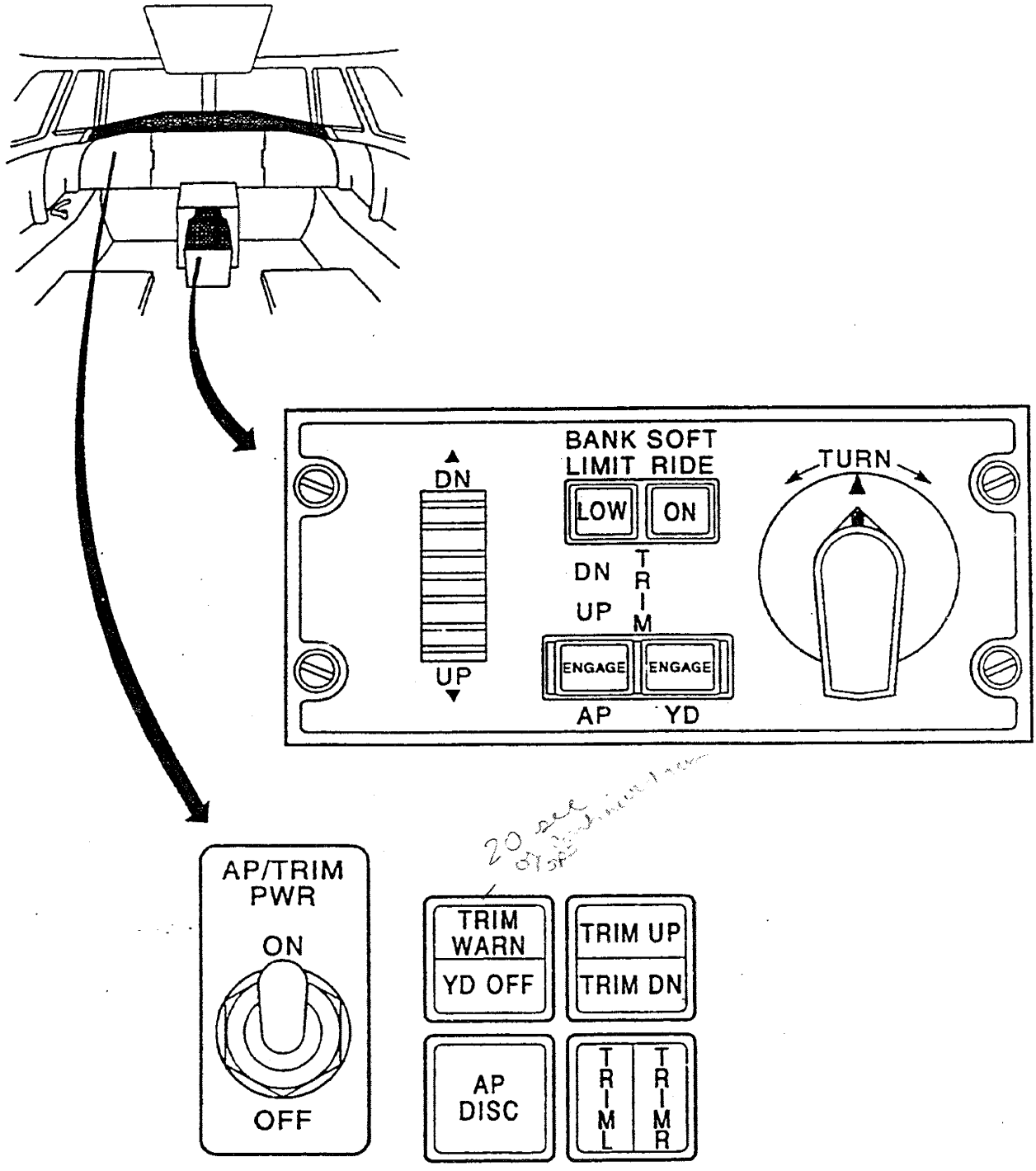
C. Rad Alt Antennae

The antennae for the Rad Alt system are located along the axis of the forward lower fuselage.

D. Rad Alt System Power Supplies

The Rad Alt system is supplied from the 28V dc left essential busbar.

A single generator failure will have no effect on the Rad Alt system. A double generator failure will result in the total loss of the Rad Alt system.



22-10-10001

Autopilot Controller and Control Switches/Captions

10. Autopilot

The autopilot converts the steering commands from the FCS into control surface movement to automatically follow the commanded flight path. It is controlled by an autopilot controller installed in the centre console to the rear of the engine controls. When the autopilot is engaged, the FCC provides an automatic electric trim facility.

A. Autopilot Controller

The autopilot controller provides the means of engaging the autopilot and yaw damper. In addition it also gives manual control of the autopilot by a TURN knob and PITCH wheel. The controls on the autopilot controllers are as follows.

(1) AP ENGAGE switch/caption

The AP ENGAGE switch is used to engage the autopilot. Engaging the autopilot automatically engages the yaw damper. The autopilot may be engaged with the aircraft in any reasonable attitude and will couple automatically to any flight director modes selected on the mode selector upon engagement.

Engagement of the autopilot causes the AP ENGAGE and YD ENGAGE switch/caption to come on. Subsequent pressing of the switch will cause the autopilot to disengage but the yaw damper will remain engaged. When the autopilot is engaged, the automatic electric trim (pitch only) will trim the aircraft if a continuous out-of-trim condition occurs.

(2) YD ENGAGE switch/caption

When the autopilot is not engaged, the YD ENGAGE switch can be used to engage the yaw damper only. If the autopilot is engaged and the yaw damper is disconnected the autopilot will not disconnect. The autopilot must have two valid sources of attitude and one valid source of heading before it can be engaged.

(3) SOFT RIDE switch/caption

The SOFT RIDE mode reduces autopilot gains while still maintaining stability in rough air, when this mode is selected a green caption in the switch shows ON. Soft ride mode can be used with any flight director mode, though it will be cancelled on localizer capture. The SOFT RIDE switch should only be used when flying in turbulence.

(4) BANK LIMIT switch/caption

When in the HDG mode this facility limits the flight director roll command bank. A green caption in the switch shows ON when the mode is on. Bank limits are 5 and 13 deg when heading error is less or more then 10 deg respectively.

D. A/P OUT switch

The A/P OUT switches (instinctive cut-out) are mounted on the pilots control columns and are connected to the autopilot disconnect circuit. They provide a means of disengaging the autopilot and yaw damper.

If the autopilot is engaged, the first push of the switch will disconnect the autopilot and the automatic electric trim.

The second push, (or the first push if the autopilot is not engaged) will disconnect the yaw damper.

If a switch is pushed and held for more that three seconds, the autopilot and yaw damper will be disconnected.

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(5) PITCH wheel

Rotation of the PITCH wheel results in a change of pitch attitude. The change in pitch attitude is proportional to the rotation and in the direction of the wheel movement.

Movement of the PITCH wheel cancels the ALTitude hold and ALTitude SELect modes.

When the VS or IAS mode is selected movement of the PITCH wheel changes the air data command reference.

PITCH wheel movement has no effect when the flight director has captured the glideslope.

(6) TURN knob

Rotation of the TURN knob out of the detent (centre) position results in a roll command. The roll angle is proportional to and in the direction of rotation of the TURN knob.

The TURN knob must be in the detent position before the autopilot can be engaged.

Rotation of the TURN knob cancels any lateral mode selected.

B. Servo Motors

The servo motors change electrical input demands from the FCC into a clutched rotational mechanical output to drive the control cables.

There are four servo motors each with its own function. The pitch and roll servos are controlled by the autopilot pitch and roll channels. The yaw servo is controlled by the yaw damper function, and the trim (pitch only) servo is controlled by the autopilot when the autopilot is engaged.

The trim servo motor can be operated manually be means of the electrical trim switches on the pilot's and co-pilot's control columns. Operation of the manual electric trim switches from either pilots position disconnects the autopilot but not the yaw damper.

C. Touch Control Steering (TCS)

A TCS button is mounted on each pilots control column. Operation of the TCS button temporarily disconnects the autopilot servo clutches allowing the pilot to manually manoeuvre the aircraft. When the TCS button is released, the servo clutches re-connect and the current aircraft parameters become the new autopilot datum.

E. Master Power Switch

The autopilot master power switch is located on the coaming panel. The switch is labelled AP/TRIM PWR, ON/OFF and controls the power supplies to the autopilot (FCC, including flight director), yaw damper and electric trim.

F. Captions

A cluster of captions are located on the coaming panel. These indicate as follows:

- AP DISC (red)
- YD OFF/TRIM WARN (red - split caption)
- TRIM UP/TRIM DOWN (amber - split caption)
- TRIM L/TRIM R (amber - split caption).

(1) AP DISC

Disconnection of the autopilot causes the AP DISC (red) caption to come on.

The AP DISC caption comes on for two seconds following a pilot induced disconnection (eg stick shaker operation, GA selection or deliberate disconnection) and is on continuously following an autopilot sensed failure condition or AHRS failure. A continuous warning is cancelled by pushing the A/P OUT switch.

An output to the Audio Warning System (AWS) causes a cavalry charge to sound following an autopilot disconnect. The horn sounds at the same time (and duration) as the AP DISC caption.

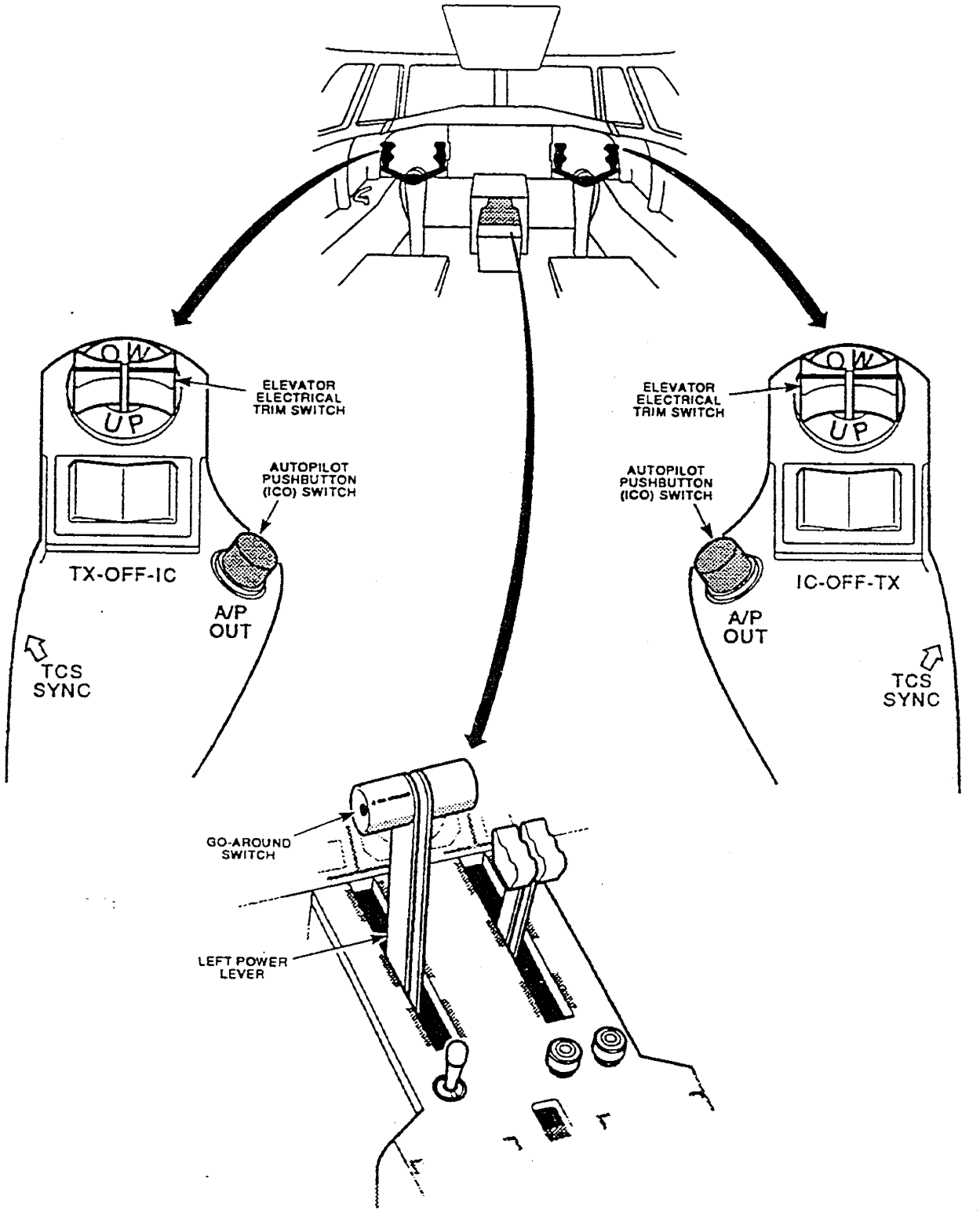
(2) YD OFF/TRIM WARN

Following a yaw damper disconnection a YD OFF (amber) caption comes on. The caption follows the same logic as the AP DISC caption, as does the AWS operation of the 'cavalry charge'.

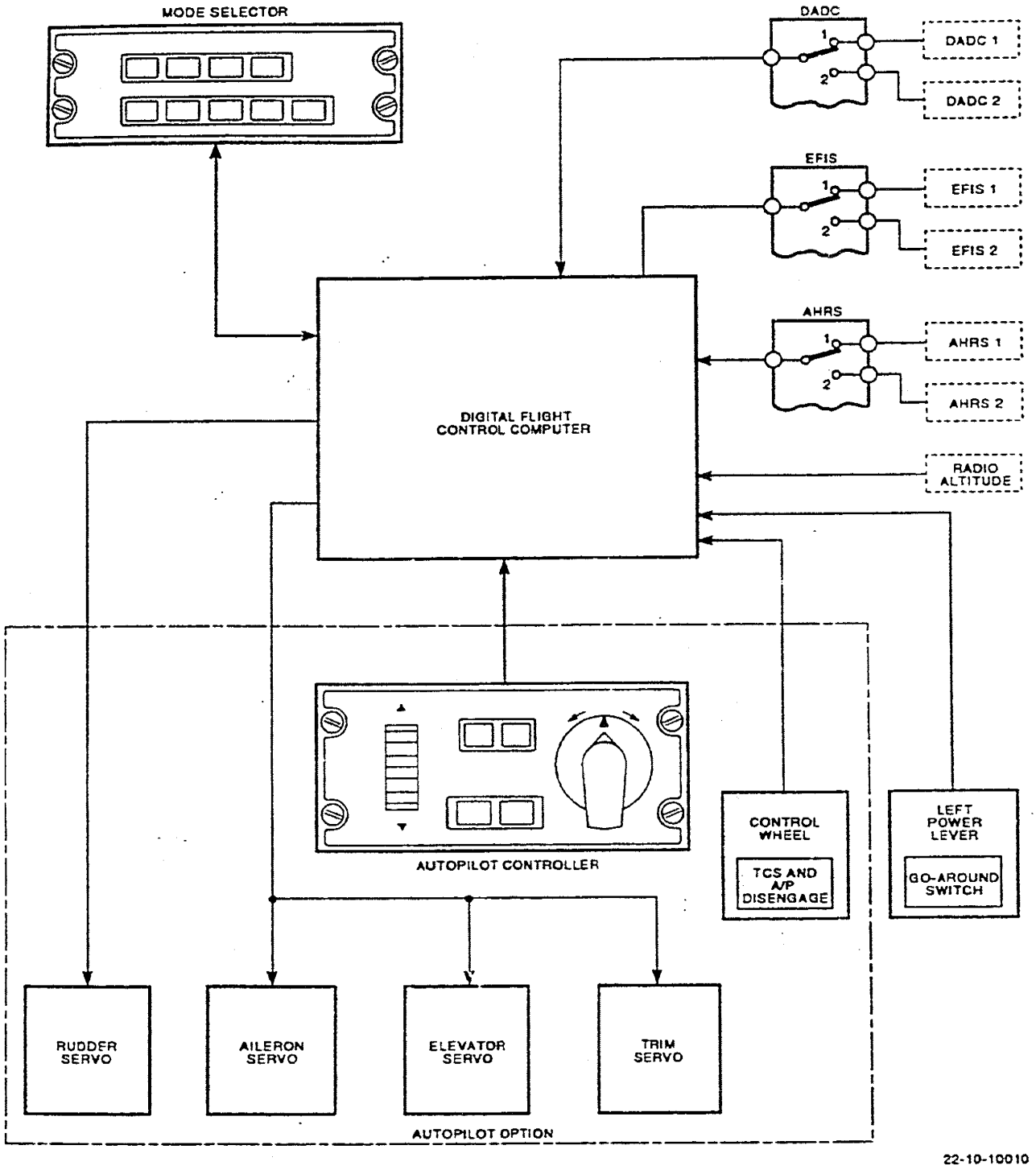
The TRIM WARN (red) caption comes on to indicate a sustained servo operation in excess of 20 seconds.

(3) TRIM captions

The split TRIM UP/TRIM DN and TRIM L/TRIM R (amber) captions (on the coaming panel) come on to indicate that the aircraft is out of trim in the pitch or roll axis. The pitch captions (also on the autopilot controller) show the direction of excessive trim. The roll captions show the direction in which the aircraft must be trimmed to reduce the out of trim condition.



Autopilot Cut-Out Switches



Autopilot Schematic

G. Pilot in Command Switch

Each pilot has a split switch/caption which allows either pilot to couple the autopilot and Flight Control System (FCS). The inputs to the Flight Control Computer (FCC) are switched to use the appropriate on-side NAV, DADC and AHRS systems.

The split switch/caption will come on either PILOT (green) or COPILOT (white).

If PILOT is selected, the FCS recieves data from NAV 1, DADC 1 and AHRS 1. If the DADC or AHRS are selected to the reversionary mode, then number 2 system data is supplied to the FCS. The same logic applies to the selection of COPILOT using the number 2 system and number 1 reversionary selections.

H. Autopilot Cut-out

The autopilot will disengage if any of the following conditions exist:

- Pressing the AP ENGAGE button on the controller when it is lit
- Pressing once the auto pilot electric trim switch on either pilots control column
- Pressing an A/P OUT switch
- Pressing the go-around switch on the left POWER lever
- Initiating a test of the coupled AHRS
- Loss of either attitude or coupled heading valid signal (ie both AHRS must be functional for the autopilot to engage)
- Any failure detected by internal FCC monitors
- Operation of the FCS CONTROL - PILOT/CO-PILOT switch
- Setting AHRS to a reversionary mode
- Stick shaker operation
- CAP "Press to Test"
- ICO operation
- Manual over-ride by the pilot beyond a point at which a servo clutch becomes disengaged.

I. Flaps Input

Inputs from the flap system indicate flap movement up or down. These inputs are used to reduce the control gain of the autopilot system during the time that the flaps are in motion.

J. Power Supplies

Power supplies to the AP/TRIM master switch are supplied from the 28V dc left essential busbar.

A single generator failure will have no effect on the autopilot or electric trim functions. A double generator failure will result in the loss of autopilot, yaw damper and electric trim functions.

11. LONG-RANGE NAVIGATION

Equipment not fitted.

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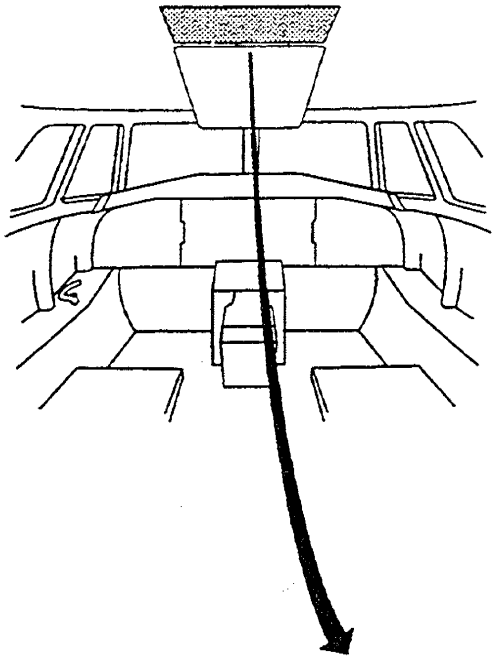
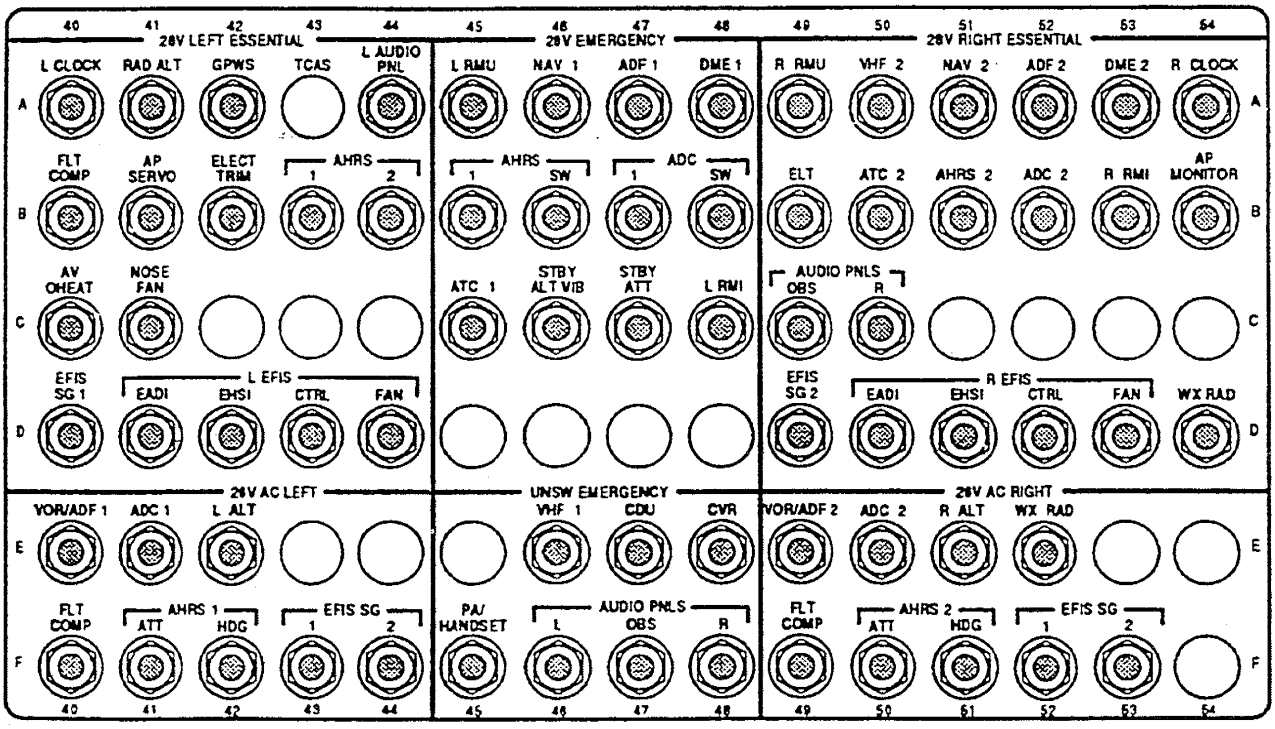
12. CHECK-LIST READER

Equipment not fitted.

Printed in the U.K.





31-10-10055

Avionic Circuit Breaker Panel

13. Clocks

A digital clock is installed on the left and right side of the main instrument panel.

Each clock displays time in hours, minutes and seconds; elapsed time in hours, minutes and seconds up to 99 hours 59 minutes; and flight time in hours, minutes and seconds.

The functions are individually selectable and controlled by two push-buttons located on the facia of each clock. At any time during the flight, the flight time which is started via the weight-on-wheels switch can be examined without automatically zeroing.

A. Clock Functions

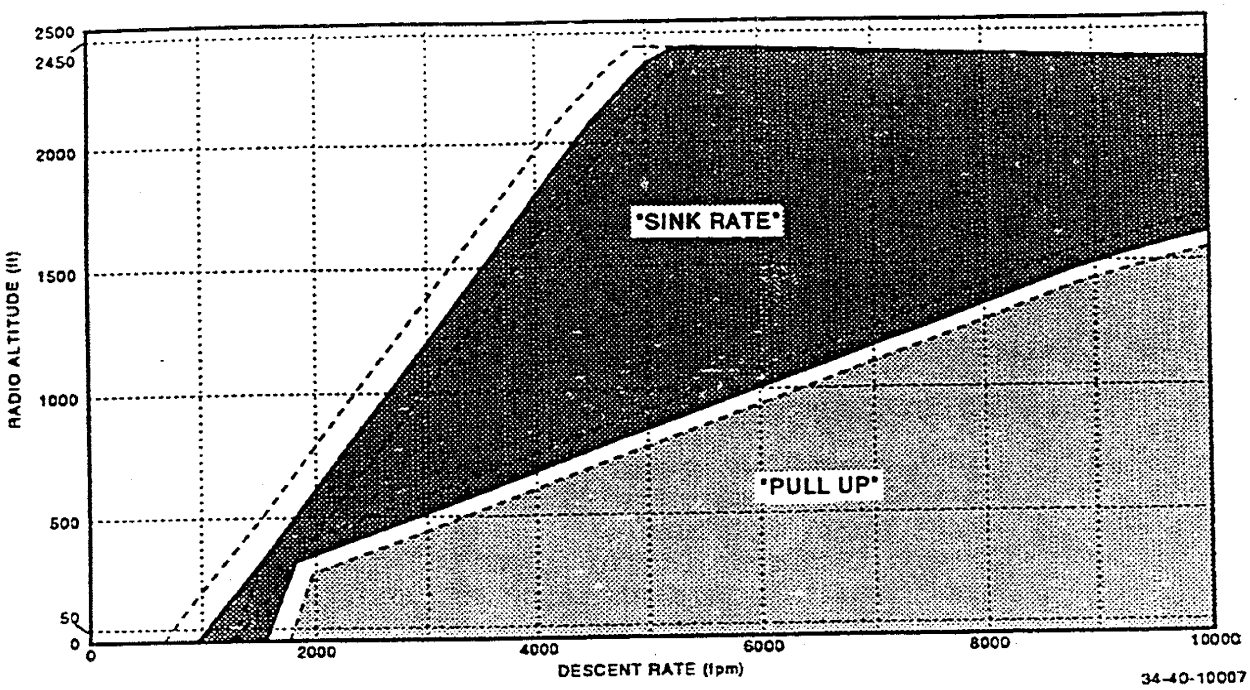
GMT	In 24-hour format.
LOCAL TIME	In 24-hour format.
FLIGHT TIME	In hours and minutes.
ELAPSED TIME COUNT-UP	In minutes and seconds up to 59 minutes and 59 seconds, then hours and minutes up to 99 hours and 59 minutes.
ELAPSED TIME COUNTDOWN	Can be set to countdown anywhere from 1 second to 59 minutes and 59 seconds.
ELAPSED TIME ALARM	When the countdown time reaches zero the display flashes.

B. Power Supplies

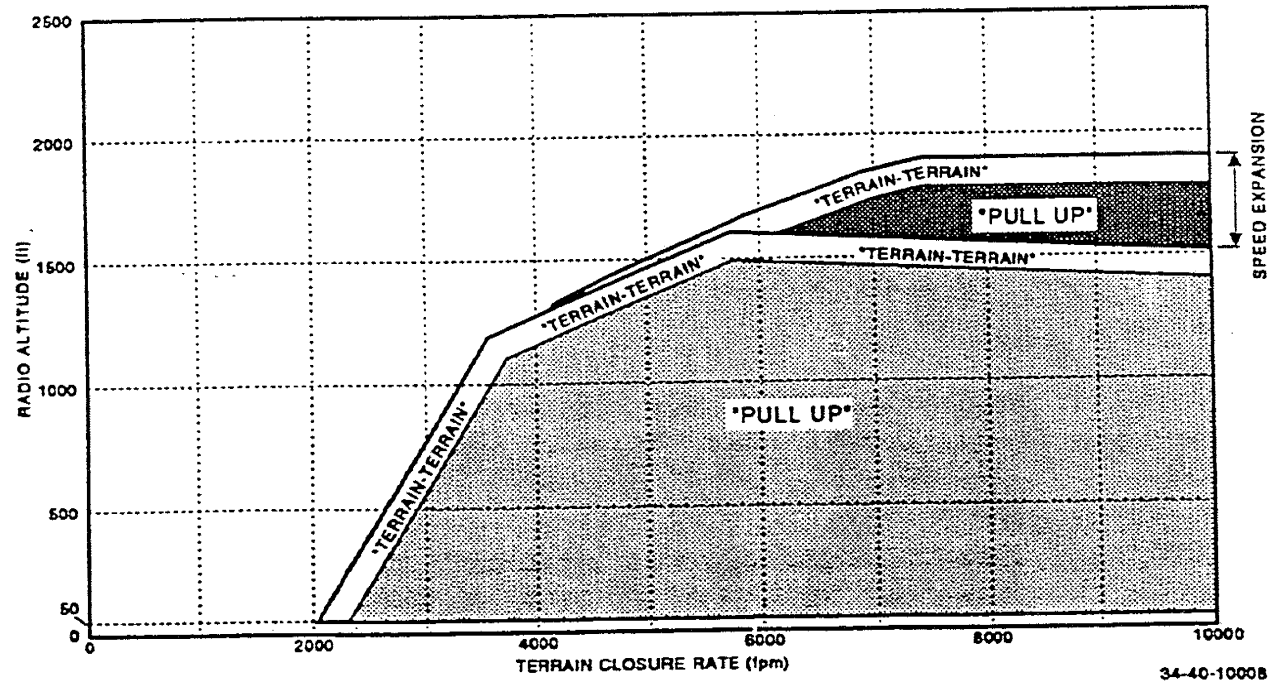
The left clock is powered from the 28V dc left essential avionic busbar, and the right clock is powered from the 28V dc right essential avionic busbar.

The clocks have an internal alkaline battery to keep the clock circuits 'alive' when power is unavailable from the busbars.

MODE 1



MODE 2A



Modes 1&2A

14. Ground Proximity Warning System (GPWS)

A. General

The GPWS uses a Ground Proximity Warning Computer (GPWC) to provide alerts and warnings for inadvertent flight into terrain.

For flight situations where the pilot must land without full flaps, the GPWS can be desensitized to eliminate unwanted alerts and warnings. This feature can also be utilized during operation at airports where steep approaches or incompatible terrain clearances are involved.

B. System Interfaces

The GPWS utilizes signals from the:

- ADCs (vertical speed, airspeed)
- navigation receivers (glideslope deviation)
- AHRS (roll attitude)
- radio altimeter (radio height)
- gear and flap systems (aircraft configuration)
- EFIS (back course input)
- Stall warning system (no callouts during stick shake).

The PILOT/CO-PILOT FCS CONTROL switches data from No.1 and No.2 systems (ADC, EFIS, nav receiver and AHRS) to the GPWC. Audio alerts are output to all crew headsets and cockpit speakers.

C. Modes of Operation

There are 6 modes of operation:

- Mode 1-Excessive Descent Rate
- Mode 2-Excessive Closure Rate to Terrain
- Mode 3-Descent After Take-Off
- Mode 4-Insufficient Terrain Clearance
- Mode 5-Descent Below Glideslope
- Mode 6-Altitude Callouts/Excessive Bank Rate.

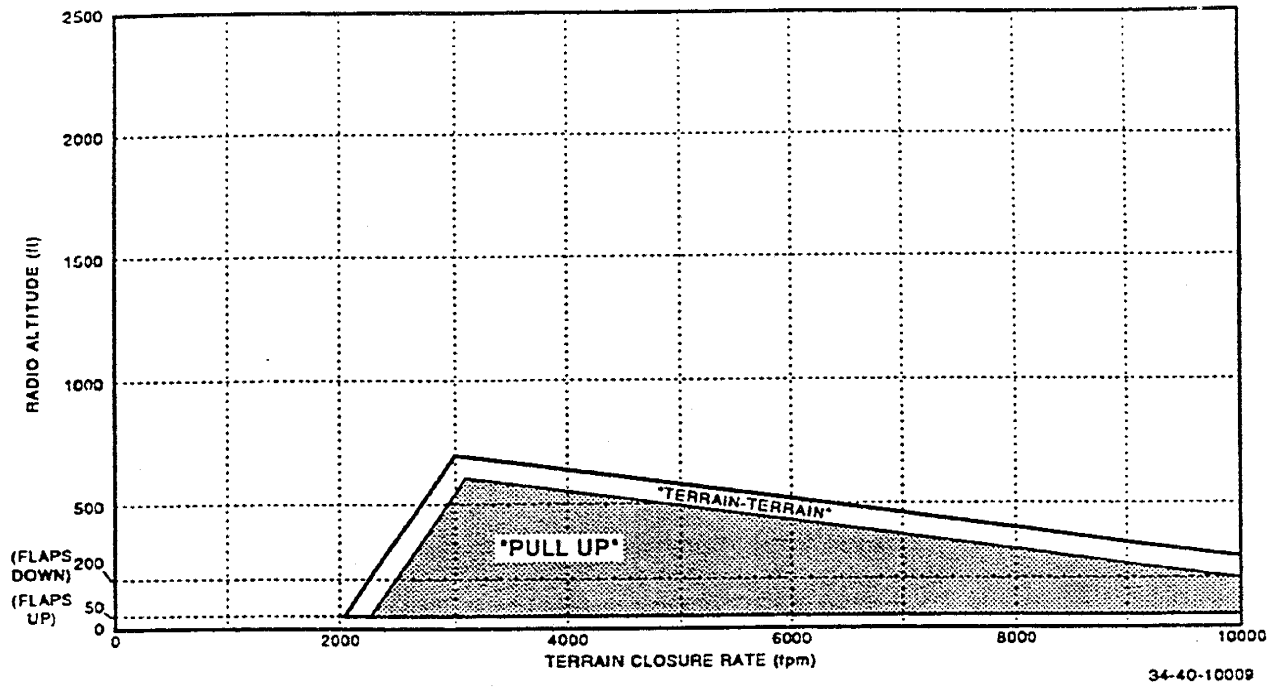
(1) Mode 1

Mode 1 provides alerts and warnings for high descent rates into terrain. When the outer alert envelope is penetrated, the message "SINKRATE" is given every 3 seconds and the GPWS alert lamps illuminate.

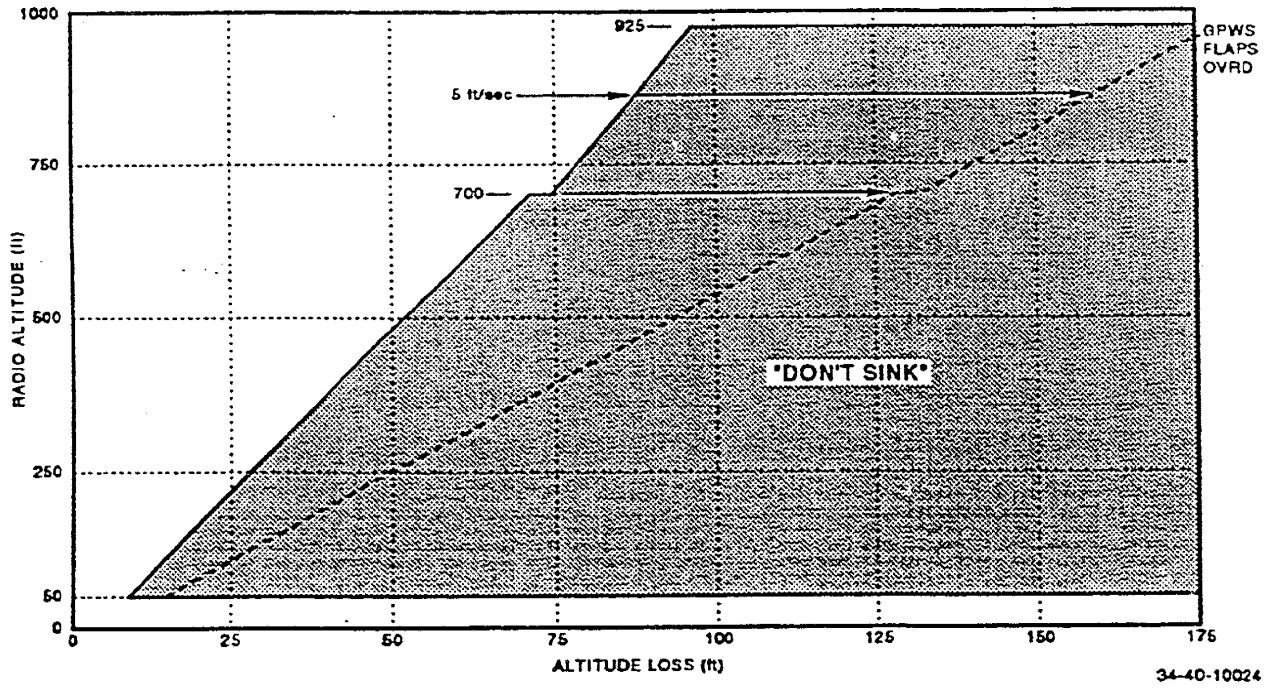
When the inner warning envelope is penetrated, an urgent "PULL UP" message with increased emphasis is given continuously. This warning starts 10 seconds before predicted ground impact. The GPWS alert lamps are illuminated.

Both the inner and outer warning envelopes are shifted to allow for glideslope deviations above and below the beam centreline to ensure that the warnings are timely and reduce possible nuisance warnings.

MODE 2B



MODE 3



Modes 2B&3

(2) Mode 2

Mode 2 provides 2 types of alerts and warnings to help protect the aircraft from impacting the ground.

(a) Mode 2A is active when:

- Flaps are not in the landing position
- GPWS FLAPS OVRD is not selected
- The aircraft is not on ILS approach or glideslope mode has been manually cancelled or the aircraft is more than 1.3 dots below the glideslope.

When the warning envelope is penetrated, a "TERRAIN-TERRAIN" message is given once and the GPWS alert lamps are illuminated.

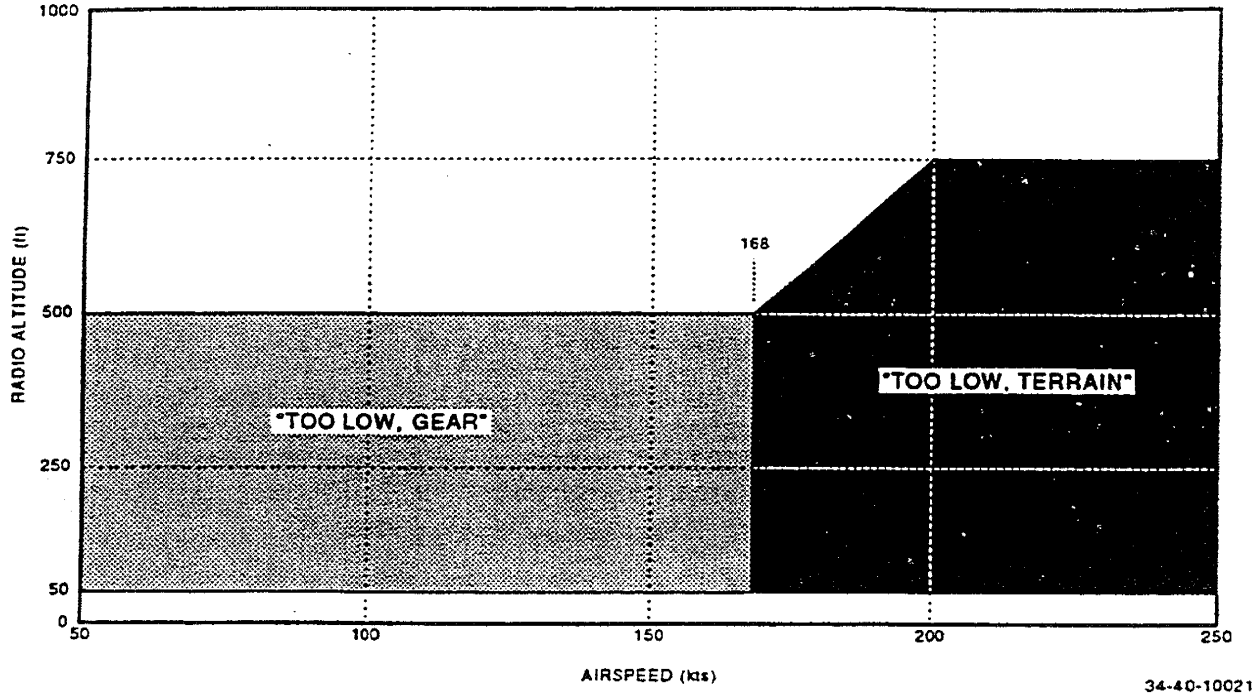
If envelope penetration continues after the initial message, the normal "PULL-UP" message occurs repetitively and the GPWS lamps remain illuminated.

When the envelope is exited, the messages will cease but the GPWS lamps remain illuminated until:

- A gain in barometric altitude of 300 ft or
- An accumulation of radio altitude and time equal to 200,000 ft-seconds occurs.

If during this time the terrain closure rate exceeds 2,000 ft/min, the "TERRAIN-TERRAIN" message will be repeated every 3 seconds. If the warning envelope is re-entered the repetitive "PULL-UP" message will be given and the accumulated combination value towards 300ft is reset to zero.

MODE 4A



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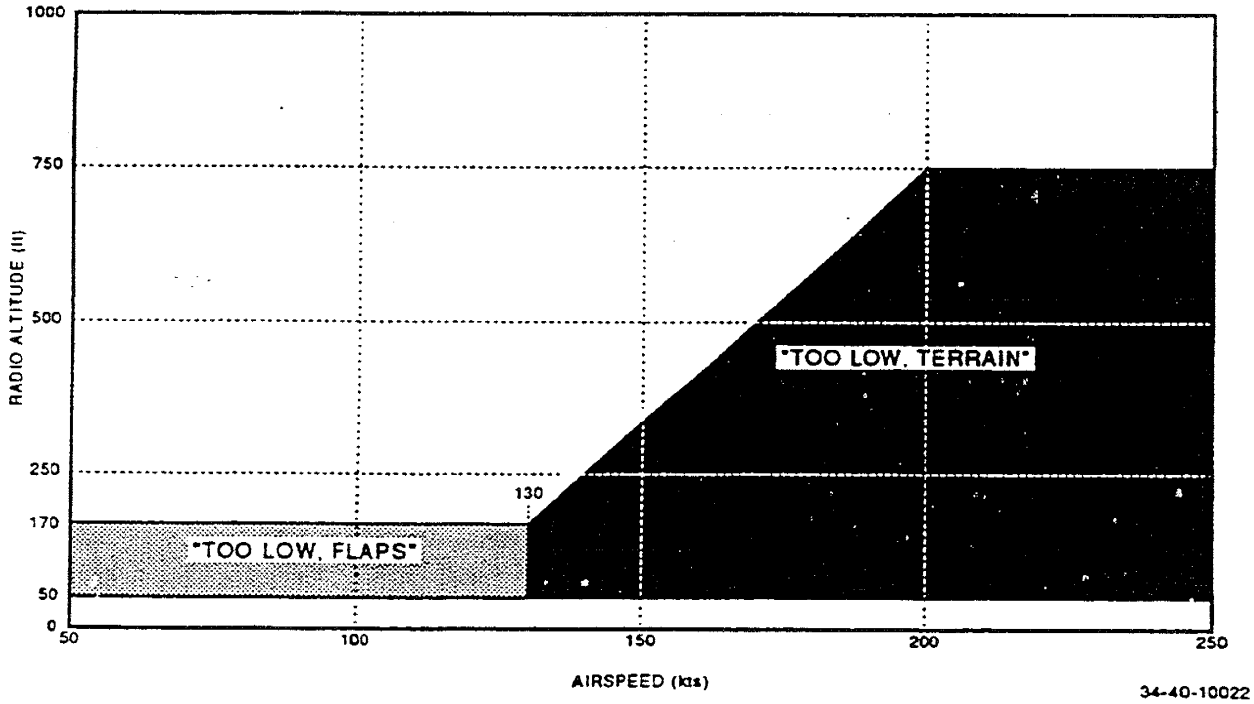
MODE 4B



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Modes 4A&B

(b) Mode 2B is activated when:

- Flaps are in the landing position or GPWS FLAPS OVRD is selected or whilst on an ILS approach and:
- The glideslope function is not cancelled
- The aircraft is not more than 1.3 dots below the glideslope
- The mode 2B envelope is penetrated the "TERRAIN-TERRAIN" message is given and the GPWS lamps are illuminated
- If the landing gear is DOWN and either flaps are down or GPWS FLAPS OVRD is selected a repetitive "TERRAIN" message is given. Otherwise a repetitive normal "PULL-UP" message is given when the previous is complete
- When the warning envelope is exited the messages cease and the GPWS lamps go out.

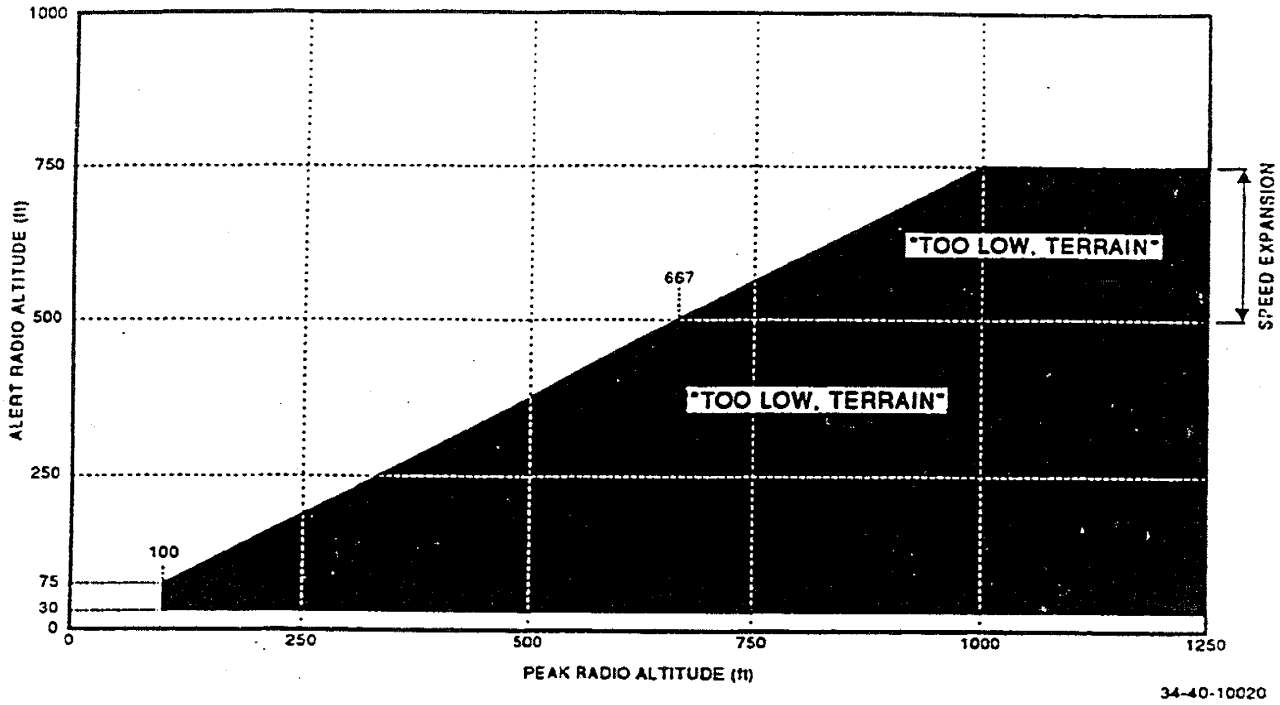
(3) Mode 3

Mode 3 provides alerts for excessive altitude loss after take-off or a go-around from below 245ft.

When a mode 3 alert occurs, a "DONT SINK" message is given every 3 seconds and the GPWS lamps illuminate

Selection of GPWS FLAPS OVRD increases the allowable altitude loss before the alerts and warnings are given. An additional desensitizing of the envelope occurs above 700ft AGL at the rate of 5ft additional altitude loss allowed per second.

MODE 4C



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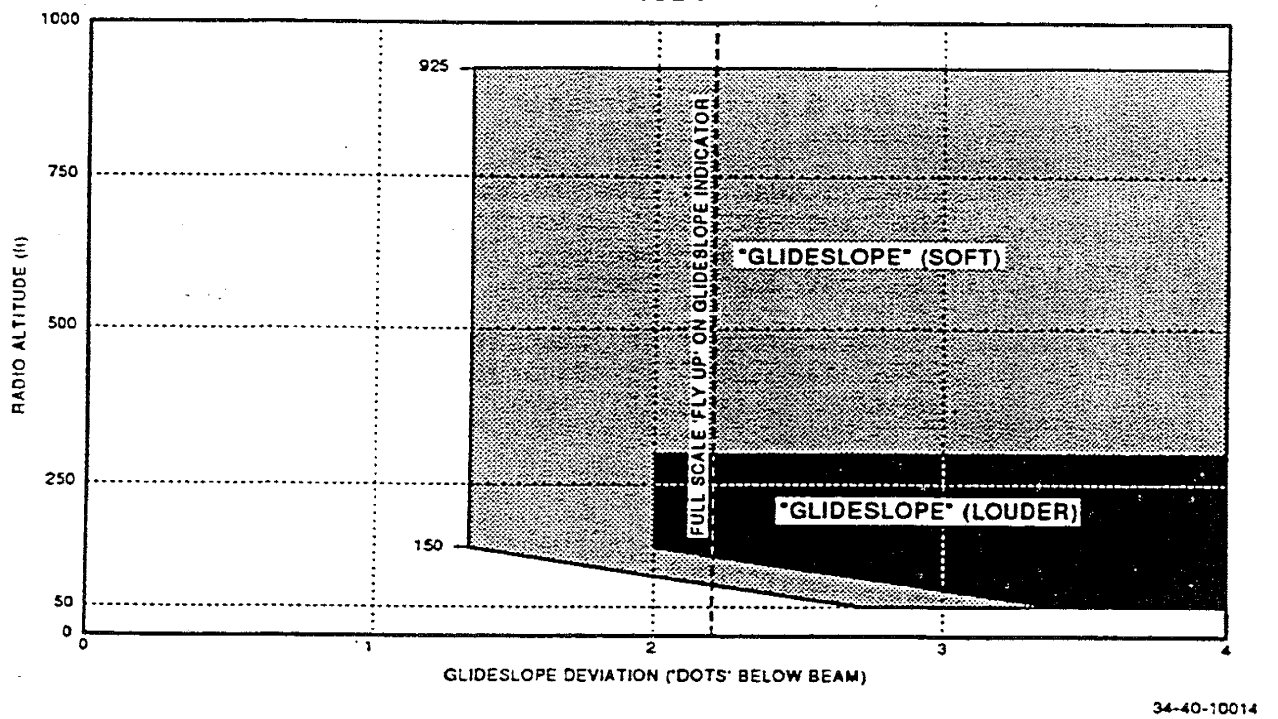
MODE 5



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Modes 4C&5

(4) Mode 4

Mode 4 provides 3 types of alerts based on radio altitude, airspeed and flight mode. These are sub divided into modes 4A, 4B and 4C.

Mode 4A is active during cruise and approach with the landing gear up, 4B during cruise and approach with the landing gear down and the flaps up or GPWS FLAPS OVRD selected and 4C during take-off. Warnings for 4A, B and C cannot occur simultaneously.

(a) Mode 4A

A mode 4A alert occurs when its envelope is penetrated and causes a message to be repeated every 3 seconds and the GPWS lights to illuminate.

If the aircraft speed is below 168 kts the message is "TOO LOW GEAR". Above 168 kts the message is "TOO LOW TERRAIN".

(b) Mode 4B

The mode 4B envelope is selected whenever the landing gear is down below 750ft AGL or GPWS FLAPS OVRD is selected. If the mode 4B envelope is penetrated the GPWS lights illuminate and one of 3 messages is given.

Flaps retracted and landing gear down and airspeed less than shown on the envelope and GPWS FLAPS OVRD not selected a "TOO LOW FLAPS" message is repeated every 3 seconds.

Landing gear up, having previously been down below 700ft AGL to select this mode initially and; airspeed below the figure in the envelope a "TOO LOW GEAR" message is repeated every 3 seconds.

If the airspeed is above the figure in the envelope and GPWS FLAPS OVRD is not selected a "TOO LOW TERRAIN" message is repeated every 3 seconds.

(6) Mode 6

(a) Altitude Callouts

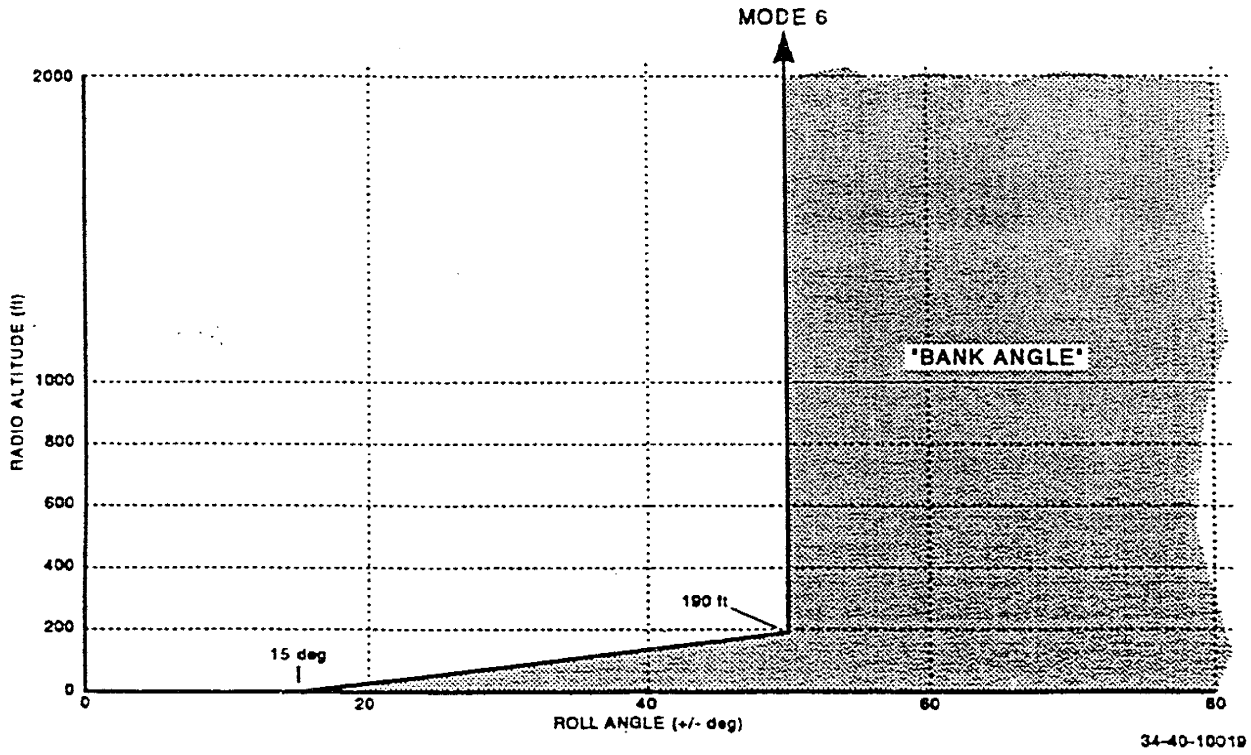
"MINIMUMS-MINIMUMS" is called once per approach as the aircraft descends through the decision height (DH) altitude set on the indicator. For approaches when minimums callout is not required the DH setting should be set below 50ft.

No GPWS lamps illuminate with this callout. If the callout cannot be made due to existing messages of a higher priority, the callout is latched off until the aircraft climbs through 925ft AGL when it is reset (no callout made).

(b) Excessive Bank Angle

A "BANK ANGLE" callout warns against excessively high bank angles at low altitude. Excessive roll rate advances the warning. The callout is repeated every 3 seconds until the flight condition is corrected.

No GPWS lights are illuminated with this callout.



Mode 6

(c) Mode 4C

Mode 4C is based on a minimum terrain clearance, or floor, that increases with radio altitude during take-off. The floor is 3/4's of the highest value of radio altitude that has occurred during take-off. The mode 4C radio altitude on take-off and continues until the approach mode is activated or until the radio altitude decreases below 30ft. The upper limit expands with airspeed. If a go-around is being performed, the warning floor is enabled at 245ft.

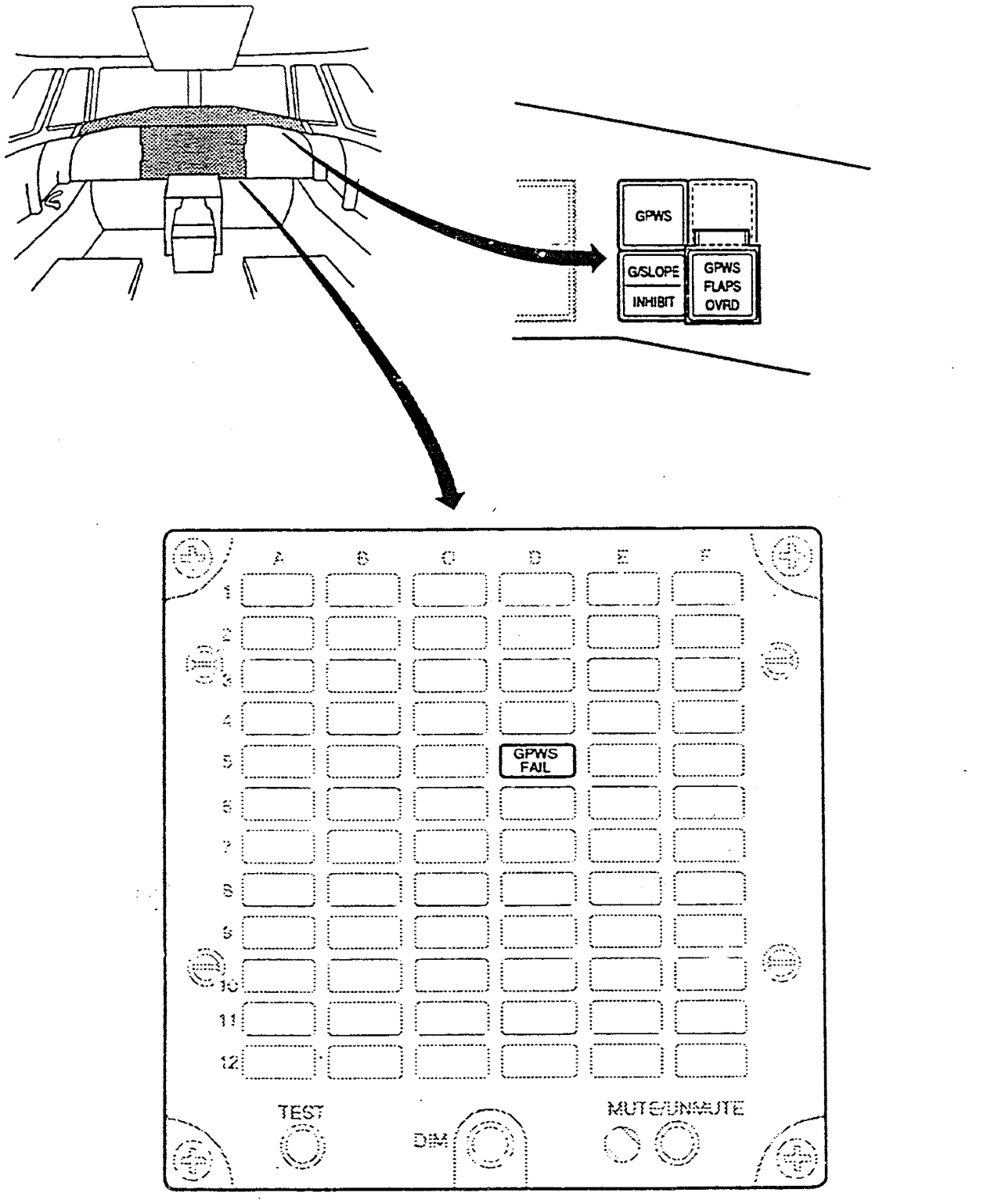
If the aircraft descends below the accumulated floor value, which will occur if the aircraft commences a descent after take-off, or the terrain rises below the aircraft at a steeper gradient than the aircraft is climbing the "TOO LOW TERRAIN" message is repeated every 3 seconds and the GPWS lamps illuminate. The alert and warnings continue until the aircraft has gained sufficient clearance from the terrain.

(5) Mode 5

Mode 5 provides alerts and warnings for excessive glideslope deviation below the beam on front course ILS approaches. Depending upon the severity of the deviation 2 levels of "GLIDESLOPE" message are given. The low volume alert is a 'soft' alert and the normal volume alert referred to as a "hard" alert. The time between messages is variable according to deviation and radio altitude. It decreases as the severity of the mode 5 condition increases.

In addition to the messages G-SLOPE warning lights illuminate with mode 5.

For simultaneous mode 5 and mode 1 alert conditions "GLIDESLOPE", pause, "SINKRATE" messages are repeated every 3 seconds.



GPWS Captions

D. Self Test

GPWS/GPWC can be manually self tested on the ground by operating the GPWS test switch on the systems test panel (right console).

E. GPWS Power Supplies

The GPWC receives 28V dc from the avionics left essential busbar via a 1 amp circuit breaker.

F. GPWS Control and Indication

GPWS and GPWC are activated when the power supplies are available and deactivated when the power supply is removed from the avionics left essential busbar. There is no separate switch. The six modes are activated when their envelopes are penetrated and deactivated when the alert situation no longer exists in accordance with the mode descriptions. The highest priority warning is always the one broadcast when more than one warning is activated.

(1) Indications

On the left and right coaming panels there are identical indications and control buttons for the GPWS.

GPWS illuminates in accordance with the warnings described in the mode descriptions.

G-SLOPE illuminates with the warnings of glideslope deviation in mode 5 unless it is inhibited.

GPWS FLAPS OVRD illuminates when the caption is pressed to desensitise the system. This allows operations which would require the GPWS to be completely deactivated whilst retaining the GPWS functions. The effects of GPWS FLAPS OVRD are described in the mode operations.

GSLOPE INHIBIT illuminates when the caption is pressed and inhibits the glideslope alerts and warnings associated with mode 5.

A CAP [GPWS FAIL] (amber) caption illuminates when the power supplies to the GPWC fail or a fault is detected in the GPWS.

15. Traffic Alert and Collision Avoidance System (TCAS)

A. General

The TCAS provides the flight crew with data on possible airspace danger from other aircraft.

The TCAS receives external data from other aircraft transponders. It uses this data to calculate the range, the altitude and the bearing of the other aircraft. From this calculated data, the TCAS informs the flight crew of the possible collision danger (from other aircraft) and the necessary avoidance measures to be taken.

TCAS can only interrogate aircraft that are fitted with Air-Traffic Control Radio-Beacon System (ATCRABS) transponders (Mode C or A/C) or mode S transponders.

B. System Interfaces

The TCAS gets data about the:

- Control and operation of the system from the Radio Management Unit (RMU)
- Position of the landing gear from the extension and retraction system
- Aircraft-on-ground from the AOG switching system
- Airspeed from the Air Data System (ADS)
- Attitude valid from the Flight Director system (FD)
- Attitude and heading from the Attitude and Heading Reference System (AHRS)
- Radio altitude from the Radio Altitude system
- Mode S transmitter signal from the ATC system
- Audio-warning inhibit signal from the Ground Proximity Warning System (GPWS).

The TCAS sends data about the position of other aircraft to the :

- Audio integrating system
- Electronic Flight Instrument System (EFIS).

C. Modes of Operation

(1) Manual control

The RMU gives manual control of the modes of operation of the TCAS. The set modes of operation, controlled from the RMU ATC/TCAS control page, are the:

- ABOVE/NORMAL/BELOW
- TCAS RANGE
- INTRUDER ALTITUDE
- TA DISPLAY.

(a) ABOVE/NORMAL/BELOW

The ABOVE/NORMAL/BELOW section of the control page, allows the flight crew to set the altitude display on EFIS, at the display limits that follow:

- ABOVE: 7000 ft above and 2700 ft below the aircraft
- NORMAL: 2700 ft above and below the aircraft
- BELOW: 2700 ft above and 7000 ft below the aircraft.

(b) TCAS RANGE

The TCAS section of the control page, allows the flight crew to set the TCAS range display on EFIS. The ranges are 6nm, 12nm, 20nm or 40nm. The 6nm and 12nm ranges also show a 2nm dotted range-ring on the display.

(c) INTRUDER ALTITUDE

The INTRUDER ALTITUDE section of the control page, allows the flight crew to set either REL (relative) or FL (flight level) target acquisition on EFIS. When REL is set, the altitude of the target aircraft is shown with relation to own aircraft altitude. When FL is set the altitude of the target aircraft is shown as a flight level.

NOTE: If FL is set on the RMU, the EFIS display returns to a REL display after 15 seconds.

(d) TRAFFIC ADVISORY (TA) DISPLAY

The TA section of the control page, allows the flight crew to set either the AUTO or MANUAL modes of operation.

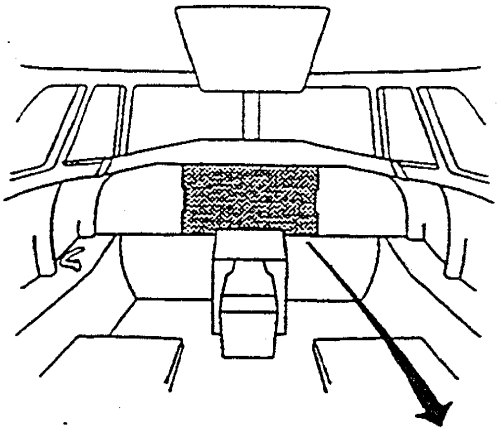
1 In the AUTO mode, no TCAS targets are displayed on the EFIS until a TA intruder aircraft is detected. The TA intruder aircraft is then displayed on EFIS. At the same time, all other TCAS traffic (proximity or non-threat) are also displayed.

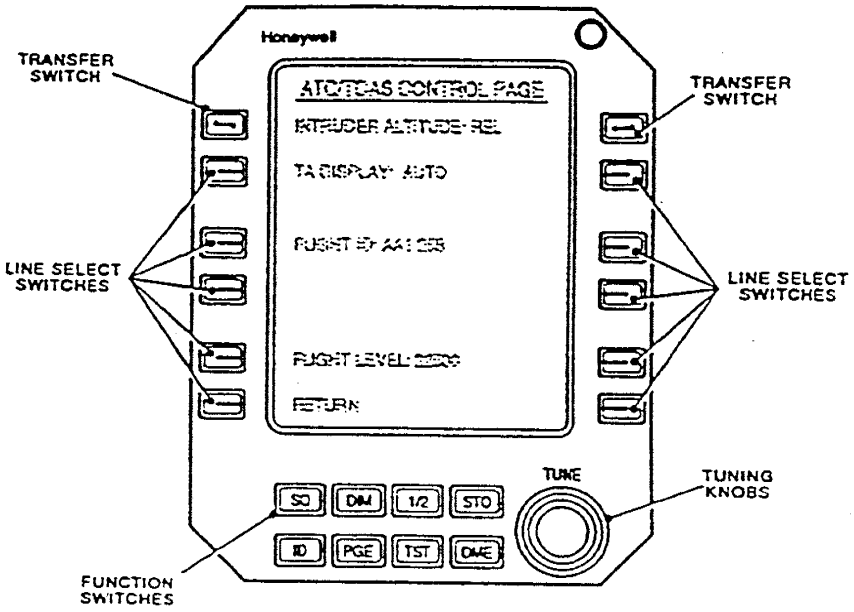
2 In the MANUAL mode, all TCAS targets (maximum of 12) are displayed on EFIS.

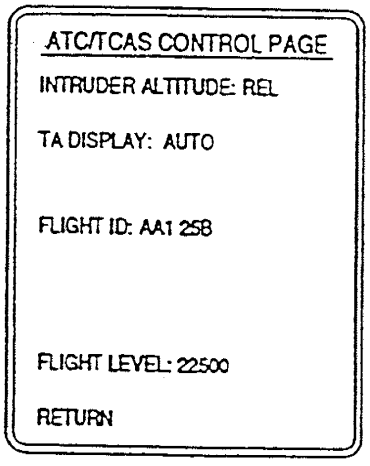
(2) Aircraft classification

TCAS identifies and displays the intruder aircraft on EFIS as:

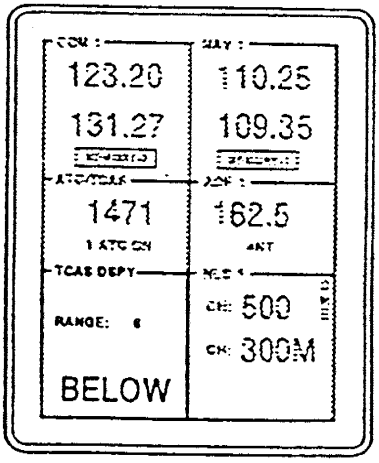
- NON-THREAT
- PROXIMITY
- TRAFFIC ADVISORY
- RESOLUTION ADVISORY.







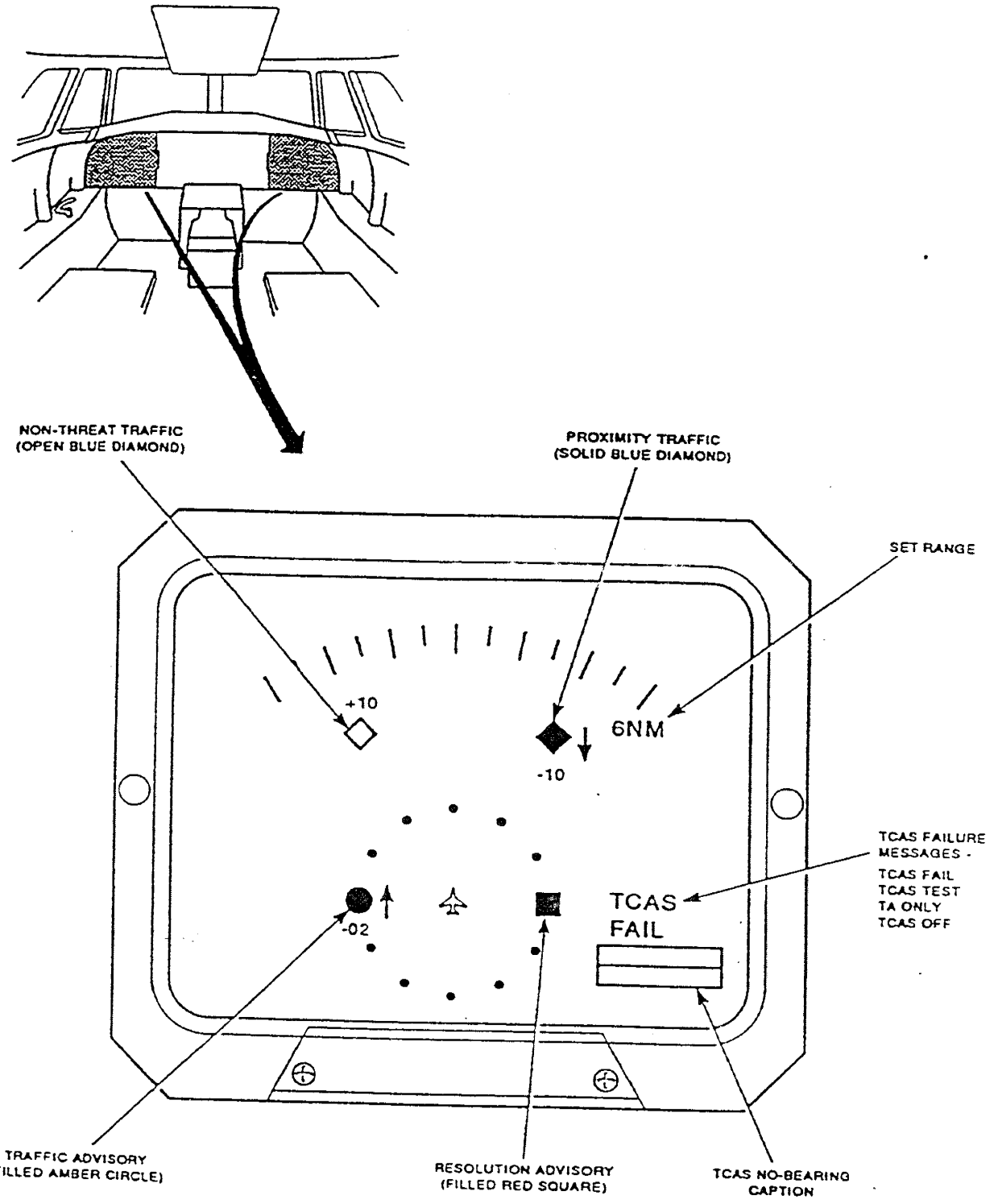
TCAS CONTROL PAGE SELECTED



TCAS CONTROLS ON RMU

23-80-10072

Radio Management Unit TCAS control



EHSI with TCAS Display

(a) Non-threat traffic symbol

Non-threat aircraft are shown on EFIS as an open blue diamond. The data tags (adjacent to the symbol), show the altitude and climb or descent direction of the non-threat aircraft.

(b) Proximity traffic symbol

Proximity aircraft are shown on EFIS as a filled blue diamond. The filled diamond shows the distance and bearing of the aircraft. The data tags (adjacent to the symbol), show the altitude and climb or descent direction of the aircraft.

(c) Traffic advisory symbol

Traffic advisory aircraft are shown on EFIS as a filled amber circle. Shown adjacent to the symbol is the altitude data tags and a climb or descent arrow. At the same time, the audio-warning TRAFFIC TRAFFIC is sent to the flight crew headsets and the flight compartment speakers.

(d) Resolution advisory symbol

Resolution advisory aircraft are shown on EFIS as a filled red square. Each symbol has data tags that show the separation altitude (in hundreds of feet) and direction arrows (climb or descent at more than 500 ft a minute).

(e) Non-Altitude Reporting (NAR) aircraft data

Intruder aircraft whose transponders reply in mode A (non-altitude reporting) are shown on EFIS as a TA symbol with no data tags.

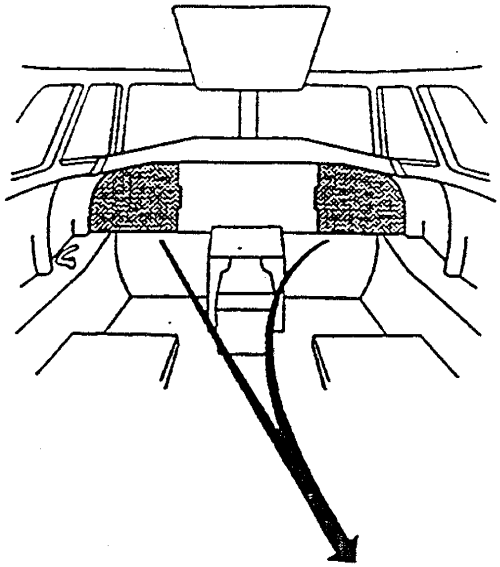
(f) No-bearing data

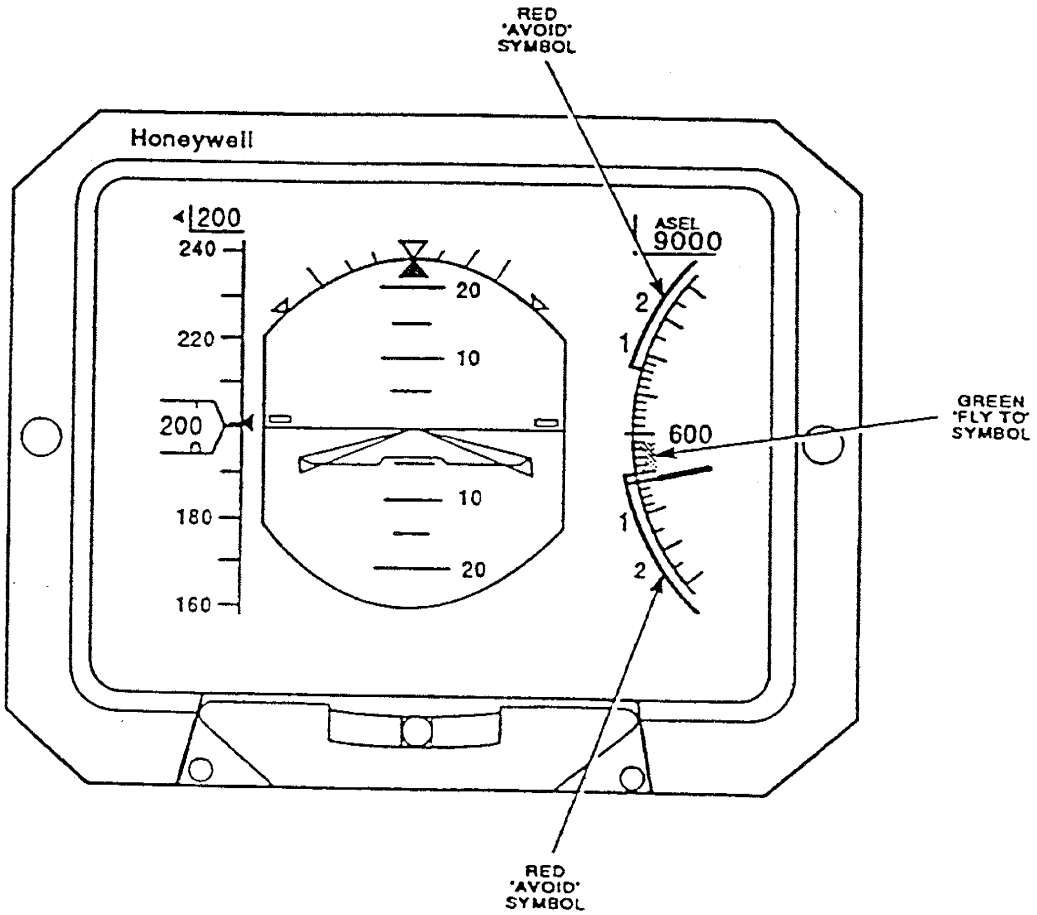
When the system has range but no bearing information to other aircraft the data is displayed in the lower right corner of the EHSI display.

(g) TCAS failure

TCAS failures are indicated on the EFIS by removal of the TCAS symbology (as appropriate) and an annunciated fail message.

NOTE: TCAS cannot provide an alert for traffic conflicts with aircraft without operating transponders.





34-26-10051

EADI with TCAS Resolution Advisory Display

D. Threshold Warnings

(1) TCAS divides the airspace around the aircraft into seven variable-sensitivity threshold levels, dependant on the aircraft altitude. These threshold levels give the threat level to the aircraft and generate the related traffic advisory warnings.

(2) If another aircraft is 25 seconds (lower threshold) or 45 seconds (upper threshold) from the Closest Point of Approach (CPA) the system identifies the aircraft as an intruder. The intruder aircraft is shown on EFIS as a TA display. At the same time, the traffic-advisory audio warning is sent to the flight crew headsets and the flight compartment speakers.

(3) If the intruder is 20 seconds (lower threshold) or 35 seconds (upper threshold) from the CPA, the system identifies the aircraft as a threat. The threat aircraft is shown on EFIS as a RA display. At the same time the resolution advisory audio-warning is sent to the flight crew headsets and the flight compartment speakers. The audio message gives the recommended vertical change of altitude (shown on the VSI) to prevent a collision with the threat aircraft.

E. Audio Warnings

The processor sends the RA audio-warnings that follow, to the flight crew headsets and the flight compartment speakers.

(1) CLIMB - CLIMB - CLIMB. Change the altitude of the aircraft at the rate shown (in the green 'fly to' arc) on the VSI of the Electronic Attitude-Direction Indicator (EADI).

(2) DESCEND - DESCEND - DESCEND. Change the altitude of the aircraft at the rate shown on the green arc on the VSI.

(3) MONITOR VERTICAL SPEED - MONITOR VERTICAL SPEED. Monitor the vertical speed and make sure it is out of the red 'avoid' arc shown on the VSI.

(4) REDUCE CLIMB - REDUCE CLIMB. Adjust vertical speed of the aircraft to a value shown in the green arc of the VSI.

(5) CLEAR OF CONFLICT. The aircraft separation is sufficient and the range increases to allow the aircraft to return to the correct flight path.

(6) CLIMB, CROSSING CLIMB - CLIMB, CROSSING CLIMB. Change the altitude of the aircraft at the rate shown in the green arc of the VSI. This allows a safe aircraft-separation climb, through the flight path of the other aircraft.

(7) REDUCE DESCENT- REDUCE DESCENT. Adjust the vertical speed of the aircraft to a value shown in the green arc of the VSI.

(8) DESCEND, CROSSING DESCEND - DESCEND, CROSSING DESCEND. Change the altitude of the aircraft at the rate shown in the green arc of the VSI. This allows a safe aircraft-separation descent, through the flight path of the other aircraft.

TCAS audio warnings are inhibited if the Ground-Proximity Warning System (GPWS) is in operation.

F. System Self Test

TCAS sends a self-test complete or self-test fail signal to the audio integrating system. On conclusion of a successful self test, the audio message TCAS SYSTEM TEST OK is given. If a failure is detected, the audio message TCAS SYSTEM TEST FAIL is given.

G. TCAS Power Supplies

The TCAS receives 28V dc from the avionics left essential busbar via a 7.5 amp circuit breaker.

H. Validity Interfaces

The processor monitors the valid data inputs to the system from the other aircraft systems. If the processor detects a fault (in the data), a TCAS FAIL caption is shown on the EFIS.