CHAPTER 34 - NAVIGATION

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GENERAL

The function of the navigation system is to provide the aircraft with precise navigation through every flight phase by means of providing position and guidance information.

Navigation is possible by means of:

- ***Air Data:*** to determine environmental navigation data as required.
- ***Attitude and Direction:*** to detect and display aircraft attitude and direction by means of magnetic and inertial forces.
- ***Independent Position Determining:*** provide navigation data, without needing ground stations (nor satellites) information.
- ***Dependent Position Determining:*** provide navigation data by means of ground stations (or satellites) dependent information.
- ***Flight Management System:*** combines navigation data to calculate and manage aircraft geographic position as well as its flight path.
- ***Digital Moving Map:*** provides a map function.

AIR DATA

Environmental flight data are obtained from air data, angle of attack, outside air temperature and Pitot systems.

– ***Angle of Attack System:*** provides an aircraft angle of attack visual indication.

– ***Air Data System (ADS):*** provides airspeed, vertical speed, altitude and overspeed warning based on static and Pitot pressures. It also detects outside air temperature and provides temperature a ND visual indication.

ANGLE OF ATTACK SYSTEM

Angle of Attack (AOA) system is intended to provide the flight crew with an aircraft angle of attack visual indication.

DESCRIPTION

Main system components are:

– ***Angle of Attack Sensors:*** conical sensors fitted at both sides of the fuselage. System transmitters generate an output signal linearly proportional to the air flow sensor element axial plane.

– ***Angle of Attack Indicators:*** located at both pilots instrument panels, provide them with standardized angle of attack information (no units).

OPERATION

AOA sensor supplies standardized angle of attack signals to the AOA indicator. Standardized angle of attack is calculated from the arithmetic mean of the local angle of attack detected by each AOA sensor. For given flap and anti-icing configurations, the system determines the AOA thresholds which involve risk of stalling. Standardized angle of attack value 1 corresponds to that AOA value at which the aircraft will stall for a given configuration.

Standardized angle of attack is obtained by using a set of standardization coefficients. These are determined from the aircraft lift curves for each selected configuration, based on the information provided by the angle of attack sensor. This information depends on aircraft speed, flaps position and ice presence absence. Stall and recovery systems compare a critical value that depends on the flight conditions. The system provides self-test and failure signals when a significant failure is detected. If so, fault light comes on and specific functions are halted. At the same time fault information is also stored.

CONTROLS AND INDICATORS

(1) Angle of Attack Indicator:

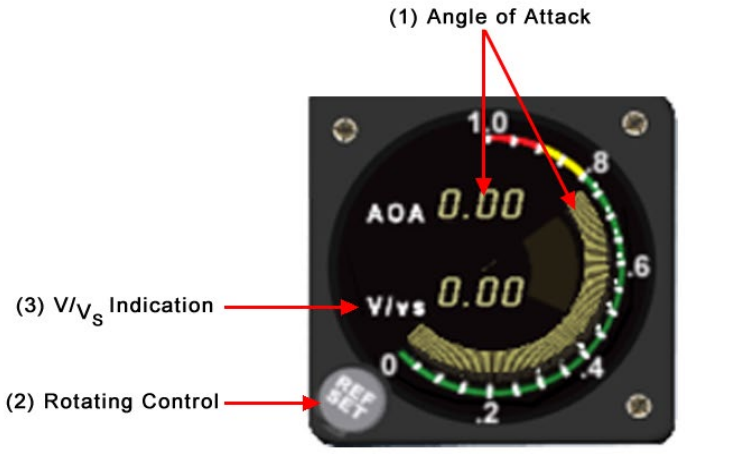
displays standardized angle of attack in a graduated sphere from the 7.30 clock position and around 225 degrees to the 12.00 position. The scale is graduated from 0.00 to 1.00. The 0.00-0.06 interval light comes on when the indicator is active. There is also an AOA reading on a digital marker with an accuracy of 0.01. A digital V/V_S reading indicates the selection (ratio between V and reference V_S). Reference selection covers the 1.2 to 1.5 range in steps of 0.05. A rotating control is used to set the reference value. The slow-fast (S-F) output signal is based on the difference between the standardized angle of attack and the standardized reference angle of attack as indicated by digital reading. When the indicator detects a failure it displays a FAIL message instead of the angle of attack reading digits, and instead of V/V_S the specific failure is displayed.

(2) Rotating control:

used by the pilot to select V/V_S value of reference as desired. V/V_S indicates the ratio between aircraft speed and stall speed.

(3) V/V_S Indication:

displays the selected ratio between aircraft speed and stall speed in digital format.



C/M-1 and C/M-2 INSTRUMENT PANELS

Figure 34-1 Angle of Attack System - Controls and Indicators

AIR DATA SYSTEM

Air data system is intended to collect external atmospheric data and process them to be used by navigation systems.

Air data system calculates the following data: Standard Altitude (correction 1013.25 hPa), Barometrically Corrected Altitude, Vertical Speed, Indicated Air Speed (IAS) and True Air Speed (TAS), Total Air Temperature and Static Air Temperature, Mach Number, Maximum Operating Speed and Overspeed Warning.

DESCRIPTION

The main components of the system are:

- ***Pitot Tubes:*** located at the aircraft nose section, to measure both Pitot and static pressures.
- ***Static Pressure Sensors:*** located at the aircraft fuselage, to measure static pressure.
- ***IOAT Sensors:*** located at the aircraft fuselage, to measure the indicated outside air temperature.
- ***Air Data Units (ADU):*** one for each pilot and a third one for IESI purposes. Located at the aircraft nose section, receive both pressure information from Pitot tubes and static temperature information from temperature sensors. Information obtained is used to calculate air data.

OPERATION

The system operates automatically.

Each unit sends calculated parameters to PFD (Primary Flight Display), ND (Navigation Display), IOP (Input/Output Processor), FGM (Flight Guidance Module) and AHRS (Attitude and Heading Reference System) located at both sides. It also sends these parameters to the FDR and to the EEC on its side, reporting the IEDS when an overspeed condition has occurred.

Data supplied by the system are displayed on both Primary Flight Displays (PFDs) and Navigation Displays (NDs). PFDs and NDs display Standard Altitude (correction 1013.25 hPa), Barometrically Corrected Altitude and Indicated Air Speed (IAS) data. NDs also display True Air Speed (TAS) and Static Air Temperature readings. PFD displays Speed Limit.

There is also an ADC 1 indication displayed in amber at the top left of both PFDs which flashes for 5 seconds and then remains on if air data sources are inconsistent. Air data indicators display a red failure message (FAIL) on the related PFD indicator when the associated information is not valid (IAS FAIL, ALT FAIL, IVSI FAIL).

In normal configuration, CM/1 PFD and ND display data from ADU-1 and CM/2 PFD and ND display data from ADU-2. However, if one ADU fails both pilots screens can be set to use either ADU as their source of data by using ADS 1/NORM/2 selector at the central panel (NAV XFR).

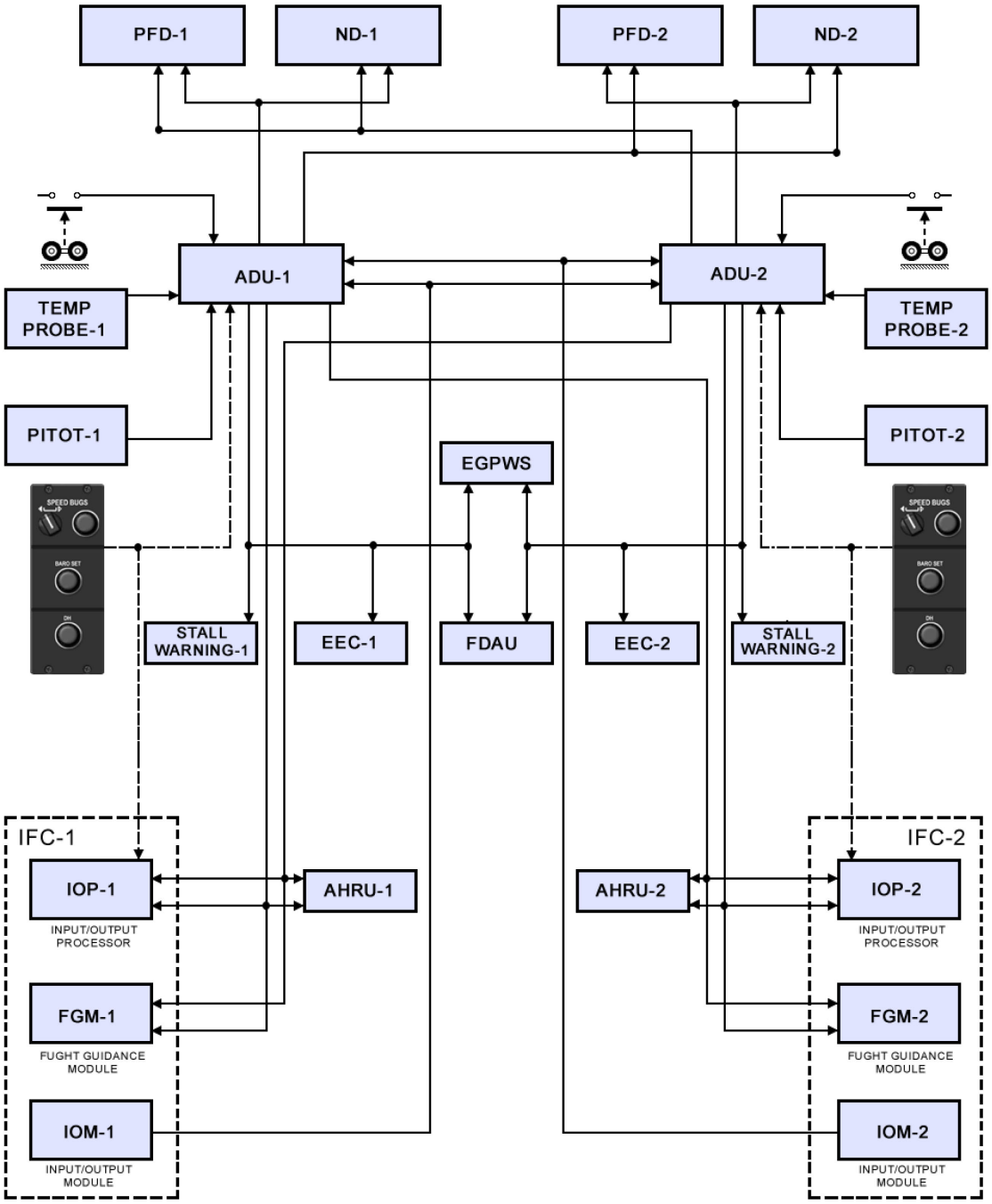


Figure 34-2 Air Data System - Architecture

CONTROLS AND INDICATORS

(1) Air Speed Indicator:

indicates air speed in knots (kts).

(2) Barometric Altitude Indicator:

indicates measured altitude from barometric pressure by means of a reference pressure value.

(3) Reference Pressure Indicator:

displays the selected reference pressure value.

(4) Air Temperature Indicator:

indicates air temperature in Celsius degrees (ºC).

(5) ADS 1/NORM/ 2 Selector:

(refer to ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS), in CHAPTER 31)

Overhead Panel

(6) ADC 2 Button:

- *Pressed and held:* performs ADC2 test to verify system integrity and the V_{MO} audio tone. During the test, PFD2 and ND2 display the following air data: altitude=14360 ft; barosetting=990 HPA; VSI=0 ft/min; IAS= 285 kts. After five seconds V_{MO} audio tone is emitted.

(7) ADC 1 Button:

- *Pressed and held:* performs ADC1 test to verify system integrity and the V_{MO} audio tone. During the test, PFD1 and ND1 display the following air data: altitude=14360 ft; barosetting=990 HPA; VSI=0 ft/min; IAS= 285 kts. After five seconds V_{MO} audio tone is emitted.

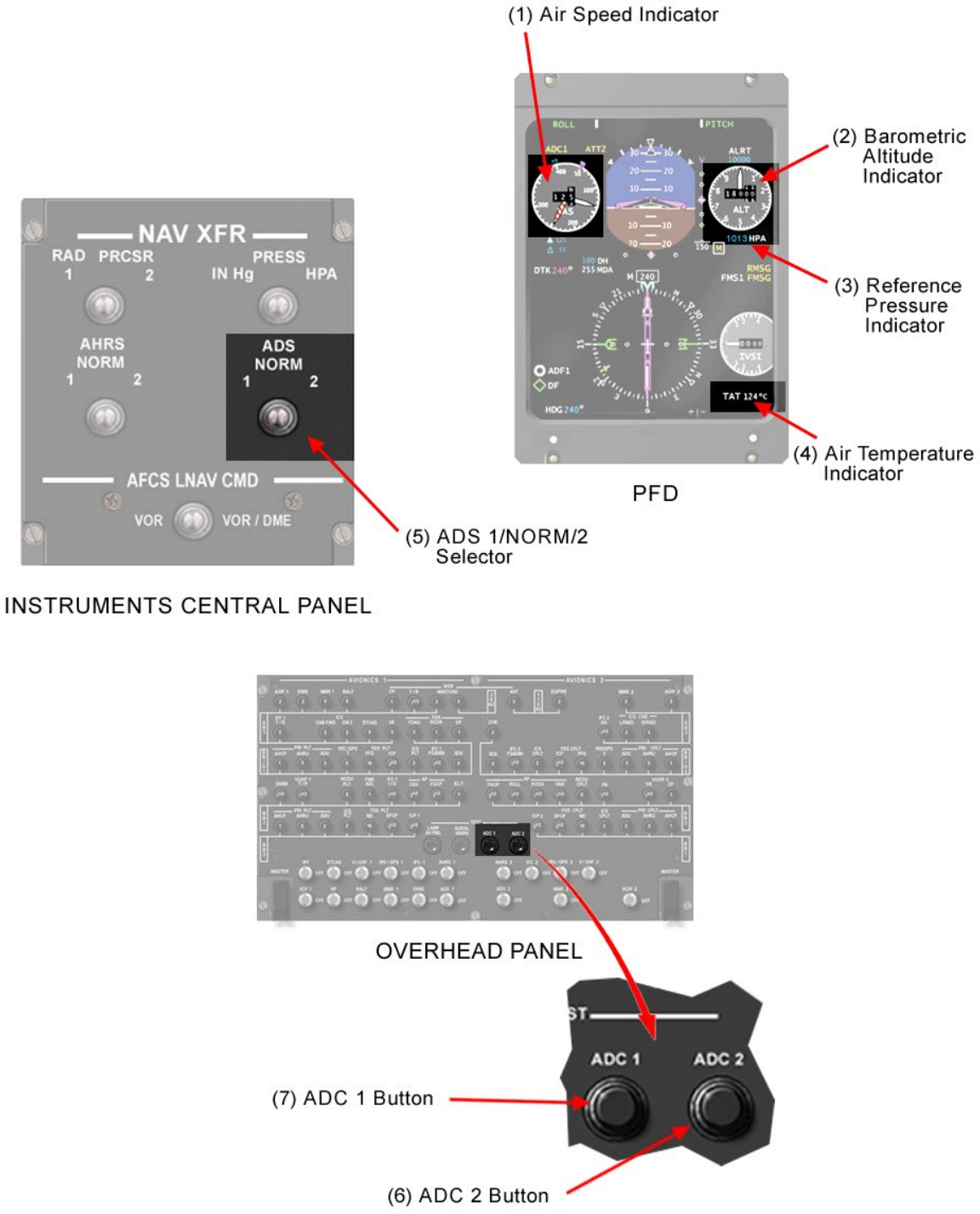


Figure 34-3 Air Data System - Controls and Indicators

ATTITUDE AND DIRECTION

Guidance systems based on magnetic forces, gyroscopic moments and inertial reference systems measurements are used to determine both aircraft attitude and heading.

Main system components are:

– ***Attitude and Heading Reference System:*** includes Attitude and Heading Reference System (AHRS).

– ***Standby Instruments:*** include standby magnetic compass and IESI (Integrated Electronic Standby Instrument).

ATTITUDE AND HEADING REFERENCE SYSTEM

Attitude and Heading Reference System (AHRS) is intended to detect and display both aircraft attitude and direction as based on magnetic and inertial forces.

By means of inertial units and magnetic flow valves, this system determines angular variations and linear accelerations relative to aircraft axes, pitch and roll, magnetic/gyroscopic heading, and vertical speed.

DESCRIPTION

Main system components are:

- ***Attitude and Heading Reference Units (AHRU):*** located beneath the cargo cabin, each unit has three fibre-optic gyroscopes and three accelerometers. They can be used in Alignment Mode, Slave Mode and Gyro Directional Mode.
- ***Flow Detection Units (FDUs):*** located at both wing tips to detect magnetic field horizontal component.
- ***Attitude and Heading Control Panels (AHCPs):*** located at the pedestal to enable system control.

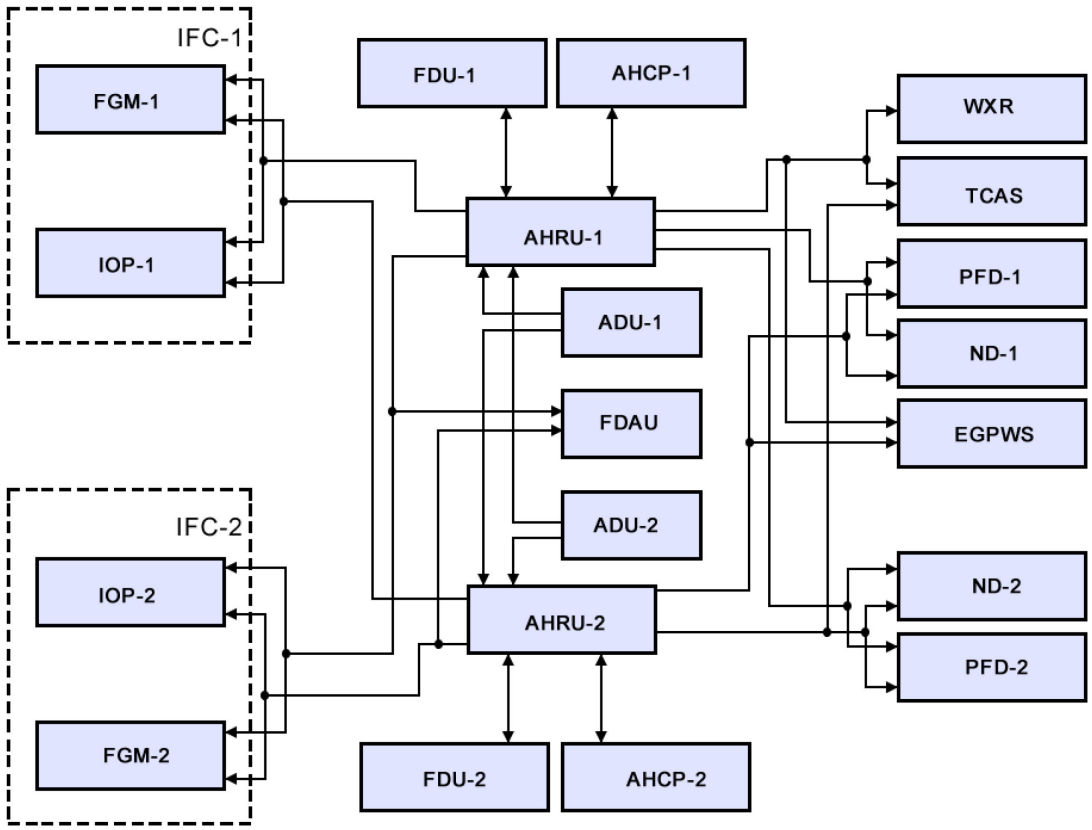


Figure 34-4 Attitude and Heading Reference System (AHRS) - Architecture

OPERATION

To be used in Alignment Mode, Slave Mode or Gyro Directional Mode.

Alignment Mode allows to initiate attitude, speed and heading data both on ground and airborne. This mode activates automatically when the unit is turned-on. For optimum results while using this mode airborne, the aircraft should be leveled and flying at a constant speed. While on ground, the alignment should be carried out immobilizing the aircraft. Operated by using the ALIGN button (even in DG mode).

Slave Mode is the normal mode of operation. In this mode, heading is updated by using inertial and magnetic data, combining these by means of predefined algorithms.

In Gyro Directional Mode the system works without magnetic data from Flow Detection Units (FDUs). Thus, it only uses inertial data to calculate attitude, speed and heading. The system has DG SLEW pushbuttons enabling heading to be updated manually.

When the system is active (using AHRS-1,2 switches at overhead circuit breaker panel), automatically goes into Alignment Mode. After alignment, the system goes into Slave Mode and, provides magnetic gyro heading, attitude and vertical speed (these obtained from both inertial and air data).

AHRS requires air data information to work normally. If this information is temporarily unavailable, operation is guaranteed but with degraded performance. When this happens and, the system is active, ALIGN pushbutton comes-on in green, for 1 minute. AHCPs annunciators (SLAVE, BASIC) and pushbutton lights (DG, ATT/HDG ALIGN) can be tested using external "LIGHT TEST" pushbutton on the overhead "SYSTEM TEST". If inconsistent information is received or no information is received from the associated FDU, "SLAVE" annunciator comes on. If True Air Speed (TAS) information is not available, "BASIC" annunciator will come on.

Each control panel (associated to each reference unit) allows control over alignment, selection of the gyro directional mode and its direction, and selection of the calibration mode as well.

System supplied data are displayed on both Primary Flight Displays (PFDs) and Navigation Displays (NDs).

PFDs show attitude data in attitude sphere format. Heading data are displayed in both digital and wind-rose formats. It also displays a sideslip indicator.

As well as heading calibration and gyro directional mode annunciators, NDs display heading data both digitally and in analogue form at headings window.

In normal configuration, CM/1 PFD and ND display data from AHRU-1 and CM/2 PFD and ND display those from AHRU-2. However, if either AHRU fails all the screens can be set to display data from the same source by using the selector located at the central panel (NAV XFR).

The system sends roll, pitch and heading signals to IFC, FDR, WXR and ETCAS and receives air data from the ADUs to update attitude, heading and vertical speed.

CONTROLS AND INDICATORS

(1) DG SLEW Pushbuttons:

allows heading manual updating as system indicated. Only available if the system operates in DG mode.

(2) DG Pushbutton:

allows SLAVE or DG mode selection. Pushbutton green light comes on when DG mode is selected.

(3) SLAVE Indicator:

red light comes on when the system detects FDU non-valid data. The system must be set to DG mode and heading should be corrected by using DG SLEW controls.

(4) BASIC Indicator:

green light comes on when the system detects any current air data input signal is non-valid.

(5) ATT/HDG - ALIGN Pushbutton:

allows to initiate system alignment at any time. Pushbutton amber light comes on while system alignment is in progress.

(6) LAMP AV PNL Button:

(refer to MULTIPURPOSE CONTROL AND DISPLAY SYSTEM, in CHAPTER 31)

(7) AHRS Selector:

(refer to ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS), in CHAPTER 31)

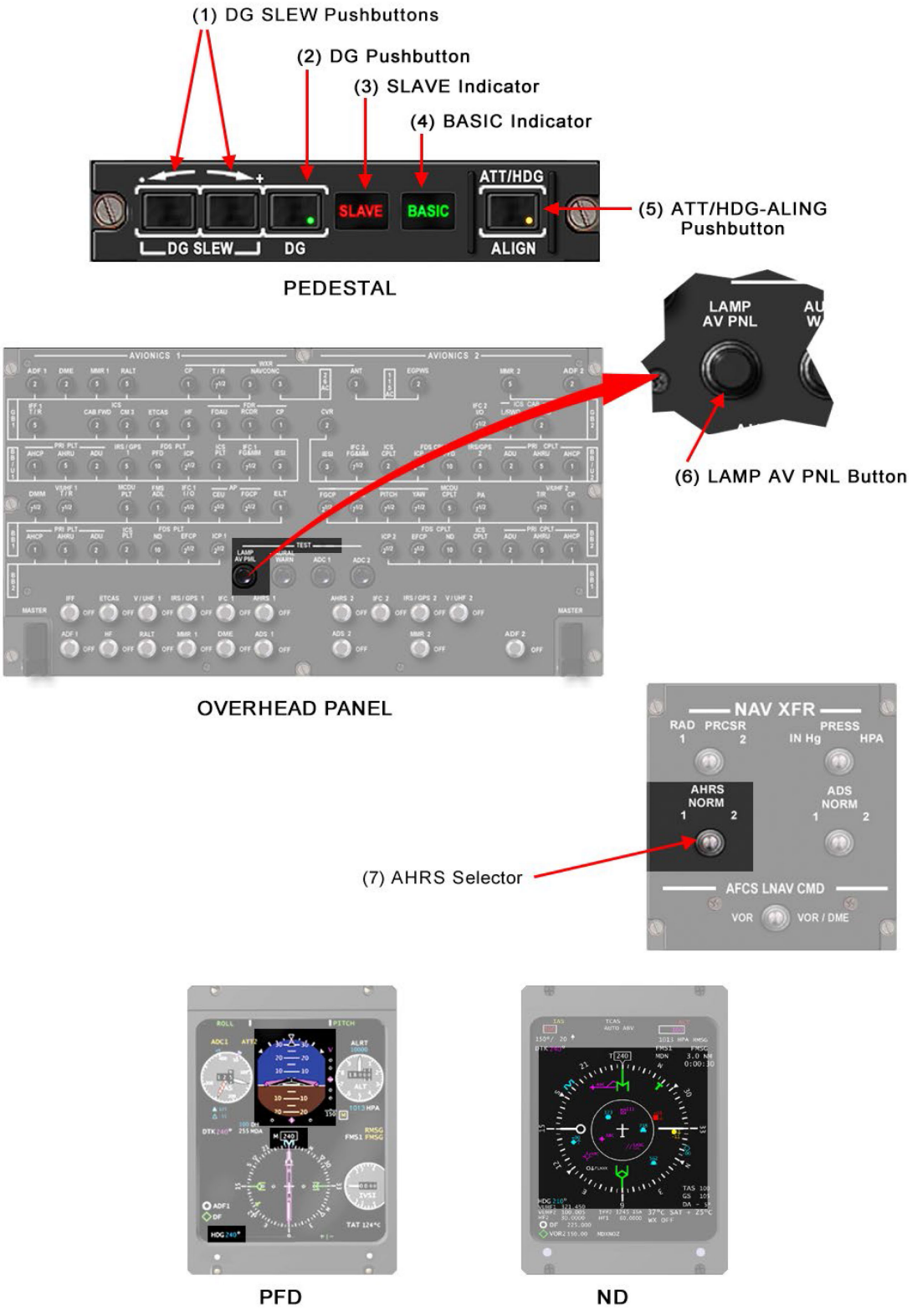


Figure 34-5 Attitude and Heading Reference System (AHRS) - Controls and Indicators

STANDBY COMPASS

The standby magnetic compass system is intended to indicate aircraft heading relative to magnetic north. It is used in case of attitude and heading reference system (AHRS) failure, or to check AHRS correct functioning.

DESCRIPTION

– ***Standby Magnetic Compass:*** located at the aircraft longitudinal axis, on the upper central windshield, consists of a floating ball marked with the compass points and numbered in 30° steps. It has 2 calibration screws to correct the aircraft magnetism effect.

MAGNETIC COMPASS

Figure 34-6 Standby Compass

INTEGRATED ELECTRONIC STANDBY INSTRUMENT (IESI)

The system is intended to provide the flight crew with data as required to progress airborne in case of a primary flight instrument failure.

The system can display the following parameters: Attitude, Standard or Barometric Altitude, Barometric Adjustment, IAS Speed, ILS Deviation (localizer and glide slope) including Back Course indication, ILS Marker Beacon indication, Maximum Operating Speed, Sideslip and Mach Number Indicator.

NOTE

Pilots must be aware of the standby airspeed and altitude indication error when flying with sideslip.

NOTE

Maximum Operating Speed is displayed in accordance with civil limitations (zone A).

DESCRIPTION

Main system component is:

– ***Integrated Electronic Standby Instrument:*** located at the central instrument panel, consists of a liquid crystal screen to display standby data.

When the system is active, IESI initiates the system test and the horizon function alignment as well. This involves a series of system tests and horizon function alignment procedures.

The system sends data to IOPs (input/output processors) and receives ILS data from MMR-1 (multimode receiver).

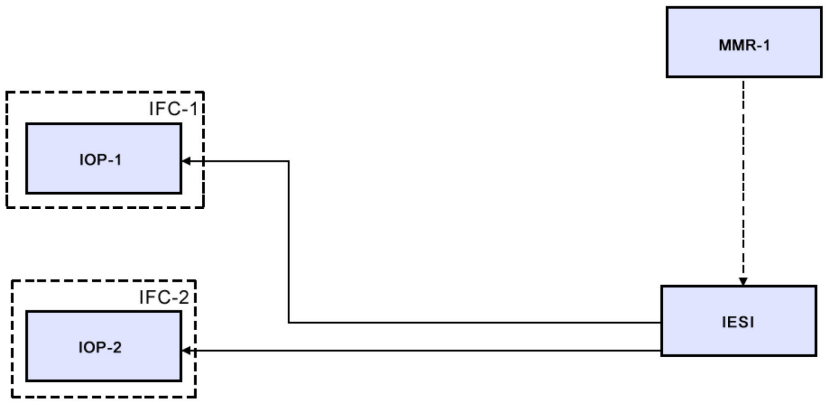


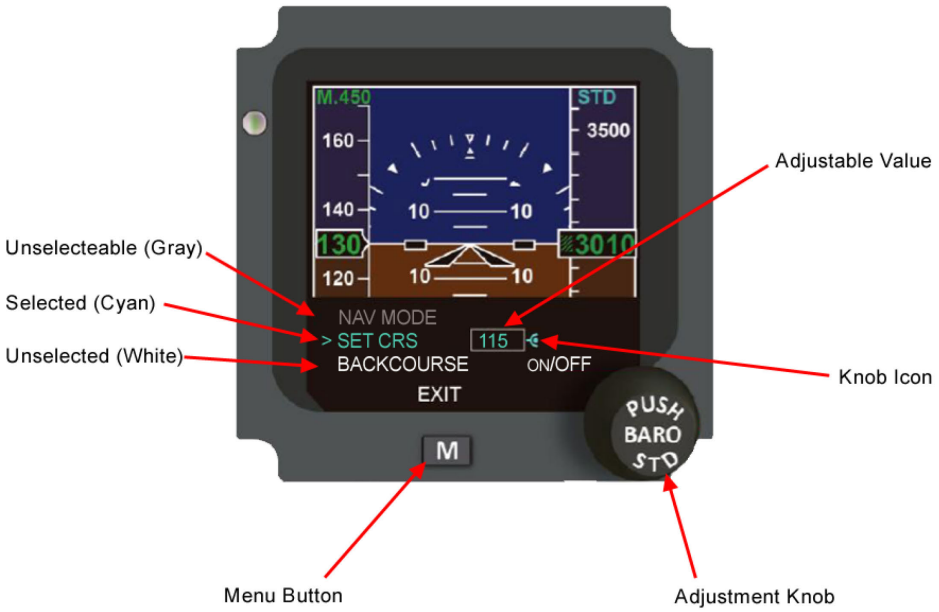
Figure 34-7 Integrated Electronic Standby Instrument - Architecture

OPERATION

The IESI enables crew members to toggle, adjust, and initiate functions through the menu, using a combination of the menu button and adjustment knob control.

MENU PRESENTATION

Selected menu items are indicated by cyan text, preceded by an open right facing arrow. Unselected menu items are indicated by white text. In certain navigation modes, menu items may show as gray text and are not selectable. Solid, right-facing triangles, after a menu item indicates an additional page. Menu toggles show options in both white and cyan text. White text indicates the option is off. Cyan text indicates the option is on.



INSTRUMENTS CENTRAL PANEL

Figure 34-8 IESI - Menu

MENU OPERATION

– Activate Menu: pressing menu button activates the menu,

  The different MENU items are:

  • NAV MODE: not operative.

  • SET CRS: provides course adjustment within a 001º to 360º range.

  • BACK COURSE: activates/deactivates back course indication.

  • BARO REF: allows choosing the unit of the barometric digital readout, among Inches of Mercury (IN), Hectopascals (HPA), or Milibars (MB).

  • SET BRT TRIM: adjusts display brightness in increments of 1 from 0 (lowest brightness level) to 100 (highest brightness level).

  • ALIGN MODE: provides attitude alignment. In order to begin aligning, the adjustment knob must be pressed. To cancel and return to the menu, the menu button must be pressed.

– Move up/down: rotate the knob to move through the list of menu items,

– Select/Toggle/Initiate Menu Items: after navigating to the desired menu item, press the knob to toggle menu items, select a menu function or access an additional menu page,

– Adjust Values: menu items with adjustable values are indicated by a knob icon. Navigate to the desired line, press the knob, and then rotate the knob to adjust the selected menu item´s value,

– Exit Menu: press the menu button to manually exit the menu.

SYSTEM FAILURES

Failure Flags

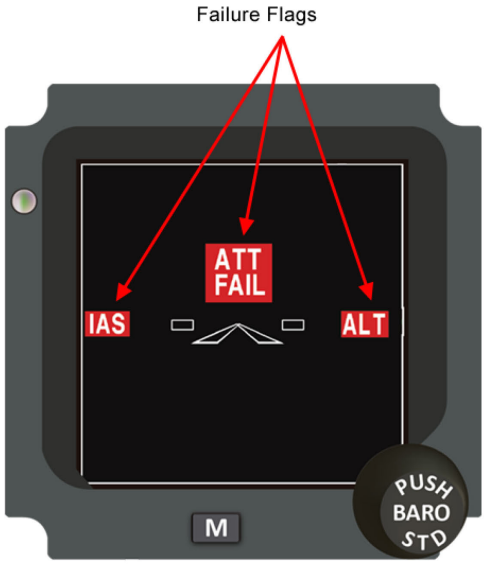
Displayed when a loss of data is detected:

– *IAS:* displayed when at least one of the following conditions is met:
  - There is a loss of airspeed data
  - There is a loss of Vmo (Maximum Operating Speed) data

  During this message all airspeed data are removed from the display.

– *ATT FAIL:* displayed when at least one of the following conditions is met:
  - There is a loss of attitude data
  - Aircraft rate of motion has exceeded 100º per second in any axis

– *ALT:* displayed when there is a loss of altitude data. All altitude data is removed from the display.



INSTRUMENTS CENTRAL PANEL

Figure 34-9 IESI - System Failures

CONTROLS AND INDICATORS

(1) ILS Indicator

displays the current navigation source

NOTE

Navigation data is removed when the menu is active, when aligning attitude, or if aircraft pitch has met or exceeded +30° or -20°, or roll has met or exceeded +/- 65°.

(2) ILS Course:

displays the selected course value.

(3) Zero Roll Marker:

a fixed pointer which indicates the zero roll position of the aircraft.

(4) Barometric Pressure:

displays barometric pressure.

(5) Roll Scale:

consists of white lines, which are set at +/- 10°, +/- 20°, +/-30°, +/- 45° and +/- 60°. The 45° roll scale marks are white triangles.

(6) Sideslip Indicator:

gives information on sideslip and has a range of +/- 7°.

(7) Vertical Deviation Indication:

a fixed scale with a moving diamond-shaped indicator displaying aircraft deviation from the glide path centre.

(8) Altitude Indication:

displays baro-corrected altitude rounded to the nearest 20 ft.

For altitude less than zero, a minus sign (-) shows to the left of the numerical digits.

(9) Altitude Tape:

numerical window displaying digits every 500 ft and white tick marks every 100 ft. The tape moves relative to the baro-corrected altitude with a minimum viewable altitude of -2000 ft and a maximum viewable altitude of 55000 ft. The altitude tape scrolls down as altitude increases.

(10) Adjustment Knob:

when the MENU is not active:

– *Turned:* adjust the barometric pressure. Milibars and Hectopascals are adjusted in increments of 1.0 and Inches of Mercury are adjusted in increments of 0.01.

– *Pressed:* establish Standar Pressure Barometric Setting (1013 hPa).

After pressing MENU Button:

– *Turned and pressed:* enables to navigate among the different menus of the IESI.

(11) Lateral Deviation Indication:

a fixed scale with a moving diamond-shaped indicator displaying aircraft deviation from localizer signal centre.

(12) MENU Button:

along with the Adjustment knob allows the crew to browse among different options and menus, selecting different operation modes or performing several adjustments.

– *Pressed:* activates the menu.

– *Pressed and held:* when the menu is not active, increases display brightness.

(13) Aircraft Symbol:

fixed in the center of the display, provides a reference to determine the aircraft pitch and roll.

(14) Airspeed Indication:

displays the IAS in increment of 1.0 kt, with a maximum value of 450 kts.

(15) Pitch Ladder:

displays the aircraft pitch angle by means of a fixed aircraft symbol beneath and a graduated moving scale marked in 10° steps from -90° to +90°.

(16) Roll Pointer:

indicates the roll angle of the aircraft with a maximum roll angle of +/- 180º.

NOTE

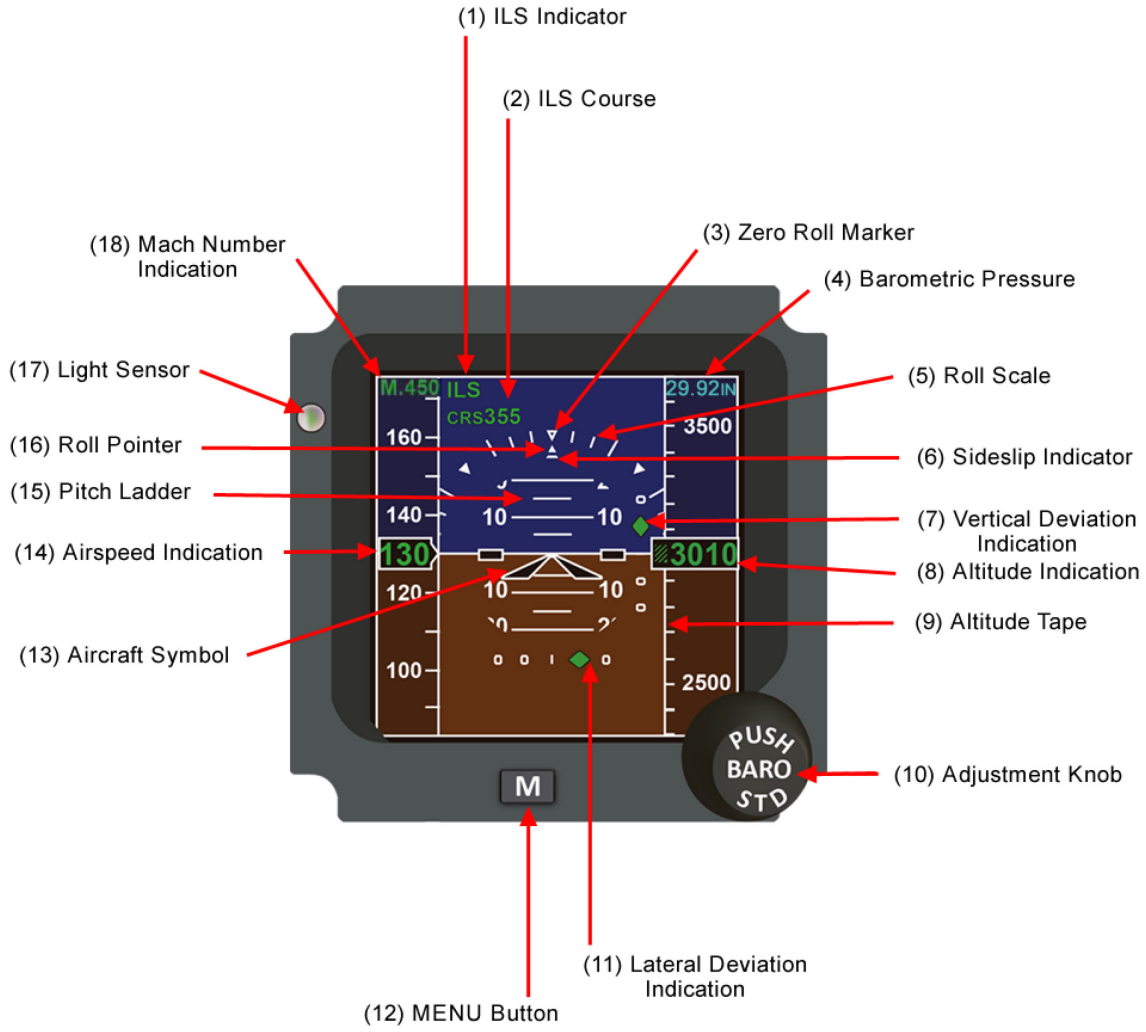
If the roll pointer is set for movable, the roll pointer rotates +/- 180º around the aircraft reference symbol boresight. If the roll pointer is set for fixed positioning, the roll scale rotates +/- 180º around the aircraft reference symbol boresight.

(17) Light Sensor:

automatically adjusts screen brightness to the ambient light conditions.

(18) Mach Number Indication:

mach number is displayed in digital format.



INSTRUMENTS CENTRAL PANEL

Figure 34-10 IESI - Controls and Indicators

INDEPENDENT POSITION DETERMINING

Independent position determining systems provide information as necessary to determine aircraft position without requiring ground stations (nor satellites) information. Systems are:

- ***Weather Radar System:*** provides airborne information on weather conditions ahead the aircraft.

- ***Radio altimeter System:*** provides the flight crew with accurate height above the ground information when flying within system effective limits.

- ***Inertial Reference System - GPS:*** provides the aircraft with independent navigational capability based on inertial forces and updated with GPS signals.

- ***Enhanced Ground Proximity Warning System - EGPWS:*** provides the flight crew with different basic warning and additional enhanced terrain alerts.

- ***Enhanced Traffic Collision Avoidance System (ETCAS):*** identifies nearby aircraft, and displays their position and provides information to avoid collision risk.

WEATHER RADAR

Weather radar is intended to provide information on weather conditions surrounding the aircraft. It also displays a short-range map including terrain characteristics such as lakes, rivers, etc. and is able to carry out oil-sliks mapping. The radar also performs the interrogation and beacon replies processing functions.

DESCRIPTION

System consists of:

- ***Transceiver:*** located at the aircraft nose section, generates radio frequency pulses from a transmitter and processes reflected signals providing radar return data.
- ***Antenna:*** located at the aircraft nose section, has a motorised flat plate allowing radio frequency pulses to be transmitted in the required aircraft-relative direction.
- ***Control Panel:*** located at the pedestal, includes every radar control except range and brightness, which are EFCP (EFIS Control Panel) controlled.
- ***Navigation Data Concentrator:*** converts radar return data from the transceiver into video signals suitable for screen displaying. It also provides control interface for every radar unit.

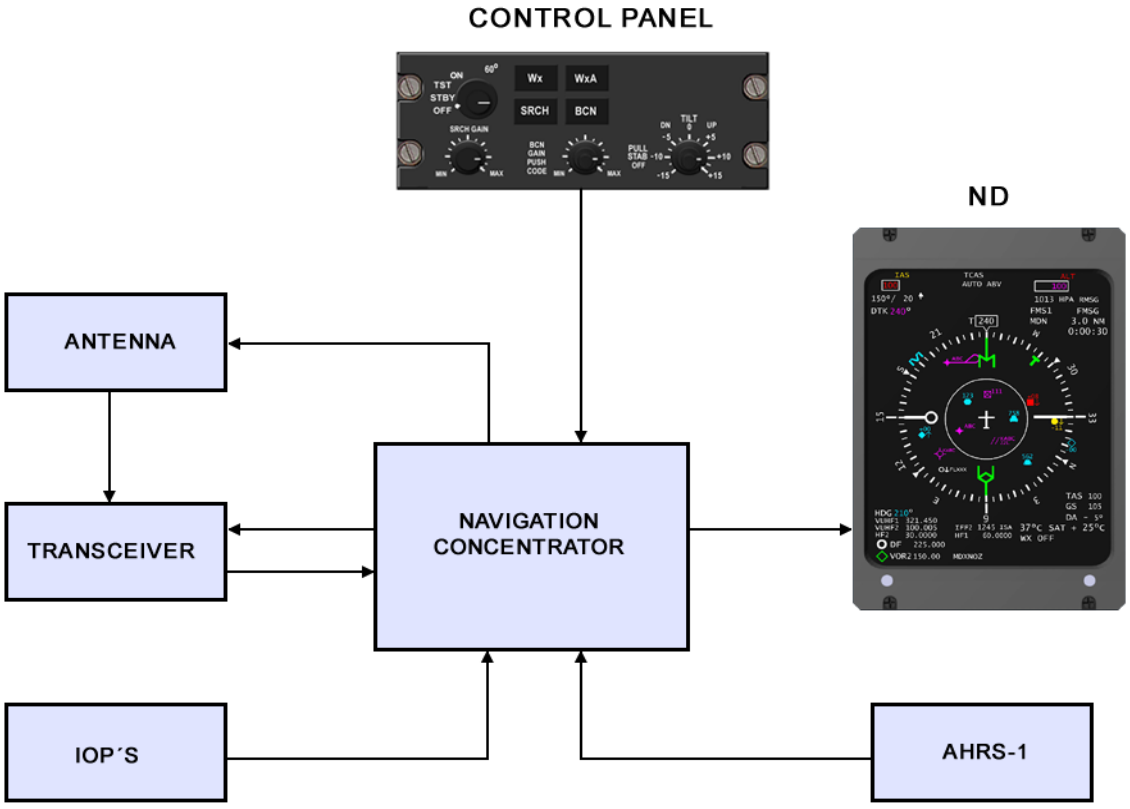


Figure 34-11 Weather Radar - Architecture

OPERATION

The navigation data concentrator receives control data from the control unit and converts information into appropriate signals to control both transceiver and antenna motor. It also receives radar return data from the transceiver for relaying to navigation screens. Finally, receives aircraft attitude data which are sent to the motor in order to keep the antenna properly stabilized.

The control panel sends inclination control and roll trim signals directly to the antenna motor, whereas the transceiver sends the antenna motor power signals.

When in weather information mode, weather radar provides data on rain cloud formation, rain density, hail storms and icing conditions zones.

Different weather conditions are distinguished by colour-coded displaying mode. In WxA mode, rain displays in green, average intensity rain displays in amber, heavy rain displays in red and extremely heavy rain displays flashing.

The system can operate in beacon processing mode simultaneously with cartographic and meteorological modes. The system is also able to operate at different ranges for CM/1 and CM/2 displays (beacon processing mode only). In this mode the weather radar can interrogate, receive and display signals from fixed transponder beacons on all ranges. The radar display beacons returns indicating the range and bearing with respect to the aircraft. Different DO-172 and standard beacons can be selected. The beacon itself is displayed as curved slashes with the position located in the centre of the closest slash.

Two exploration selectors (60º and 120º) can be selected in every operation mode.

At ND right bottom, three lines display to indicate radar operational status:

- Top line indicates the mode in which radar operates (WxA, SRCH1, BCNA, etc.)
- Central line displays angle of inclination as selected for antenna sweep purposes.
- Bottom line displays weather radar warnings. 'TGT' when a powerful storm has been detected beyond the selected range (in WxA mode).

CONTROLS AND INDICATORS

(1) Function Selector:

- *OFF:* system is not operative.
- *STBY:* system is powered-enough to operate but is not operative.
- *TST:* starts self-test sequence.
- *ON:* system is powered-enough and fully operative.
- *60°:* antenna sweep angle is 60°.

(2) Wx Pushbutton:

- *Pressed:* radar provides continuous weather information while airborne.

(3) WxA Pushbutton:

- *Pushed-in:* WxA (Weather Alert) weather displays and most intense rain areas flash.

(4) SRCH Pushbutton:

- *Pressed (once):* sets SR1 search mode. SRCH1 is ND displayed. This mode is intended to provide short-range location (up to 20 nautical miles) of marine targets in noise or distortion presence.
- *Pressed (twice):* sets SR2 search mode. SRCH2 is ND displayed. This mode is intended for accurate ground cartography purposes with a very-high short range resolution (up to 20 nautical miles).
- *Pressed (for the 3rd time):* sets SR3 search mode. SRCH3 is ND displayed. This mode is intended to receive return signals from maximum radar echoes present for use while locating oil-slicks.
- *Pressed (for the 4th time):* search mode is deactivated.

(5) BCN Pushbutton:

- *Pressed (once):* beacon mode is activated and receives signals from DO-172 beacons. BCNA label is ND displayed. DO-172 beacons are displayed as two framing slashes which are positioned approximately 2 nm apart. Within these two slashes will be a combination of up to four slashes. Varying the combination of the inner slashes makes possible to identify any one of the different DO-172 beacon codes.
- *Pressed (twice):* beacon mode receives signals from standard beacons. BCNB label is ND displayed. Standard beacons are displayed as two slashes spaced 7 nm apart or more. The weather radar can identify any one of the standard beacons.
- *Pressed (for the 3rd time):* beacon function is deactivated.

(6) TILT Selector:

- *Turned-on:* to adjust antenna elevation between +15° and -15°. When the switch is pulled-out stabilization is turned-off (STAB OFF).

(7) BCN GAIN Selector:

- *Turned-on:* to adjust system gain in beacon mode.
- *Pressed:* sets the reception code to identify and select the desired beacon.

(8) SRCH GAIN Selector:

- *Turned-on:* to adjust system gain in search mode.

(9) Image Mode Pushbuttons:

- *IMG:* displays radar image on ND screen.
- *FORMAT:* displays ROSE (full 360º compass)/ARC (partial 120º compass). ROSE is default mode. WxR can only be displayed with HDG UP orientation.

(10) Range Control (RANGE):

- *Turning:* selects ND maximum range (5, 10, 20, 40, 80, 160 and 240 nm) in case of failure, range to be considered is 40 nm.

(11) IMG BRT Selector:

to adjust image brightness. Both weather image and navigation symbols are ND superimposed.

(12) Weather Representation (WxR):

ND screen displays weather image as obtained weather radar in the selected format by using image mode pushbuttons.

(13) Sweep Angle:

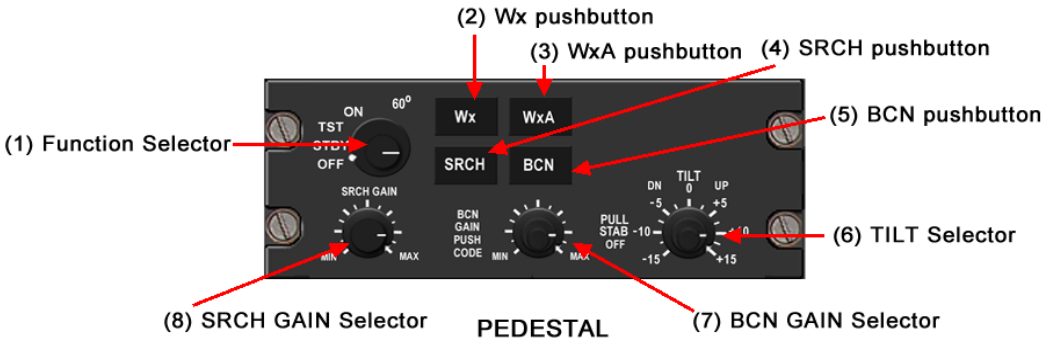
in Rose mode, displays the circular sector as displayed in graphical form.

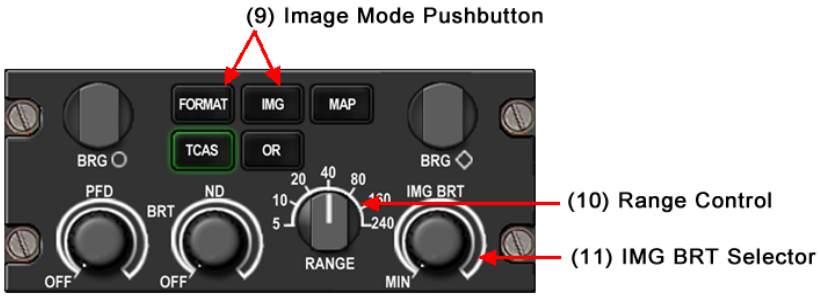
(14) Active Mode:

ND indicates radar operating mode.

(15) Angle of Inclination (TILT):

radar antenna angle of inclination numerical display relative to the aircraft longitudinal axis when STAB mode is not operative and relative to the ground when STAB mode is operative.





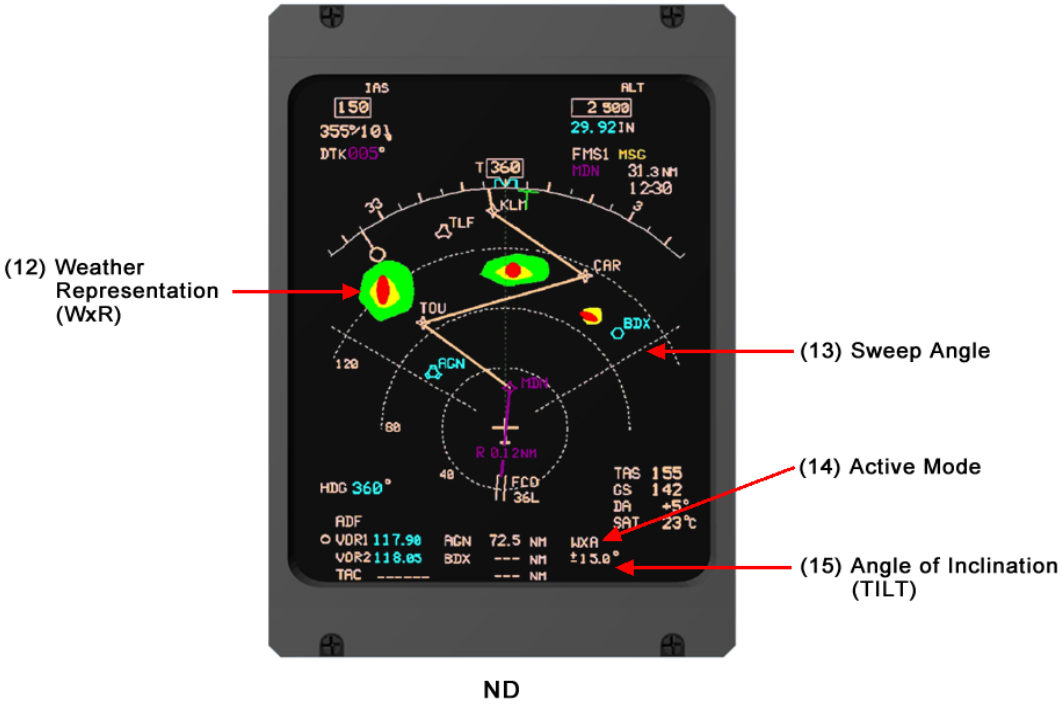


Figure 34-12 Weather Radar System - Controls and Indicators

RADIO ALTIMETER SYSTEM

Radio altimeter is intended to determine the aircraft height above the ground so it can be provided to the flight crew and sent to several avionics systems.

DESCRIPTION

The system measures the minimum distance between the aircraft and the ground by measuring the time elapsed between the emission of an electromagnetic wave and the reception of the ground-reflected signal.

The system is not operative if the aircraft is 5000 ft above the ground.

Main system components are:

- ***Transceiver:*** located beneath the cargo cabin, generates radio frequency signals, receives reflected signals and calculates aircraft height above the ground.
- ***Antennas:*** one antenna transmits the signals generated by the transceiver while the other receives them (refer to ANTENNAS, in CHAPTER 01).

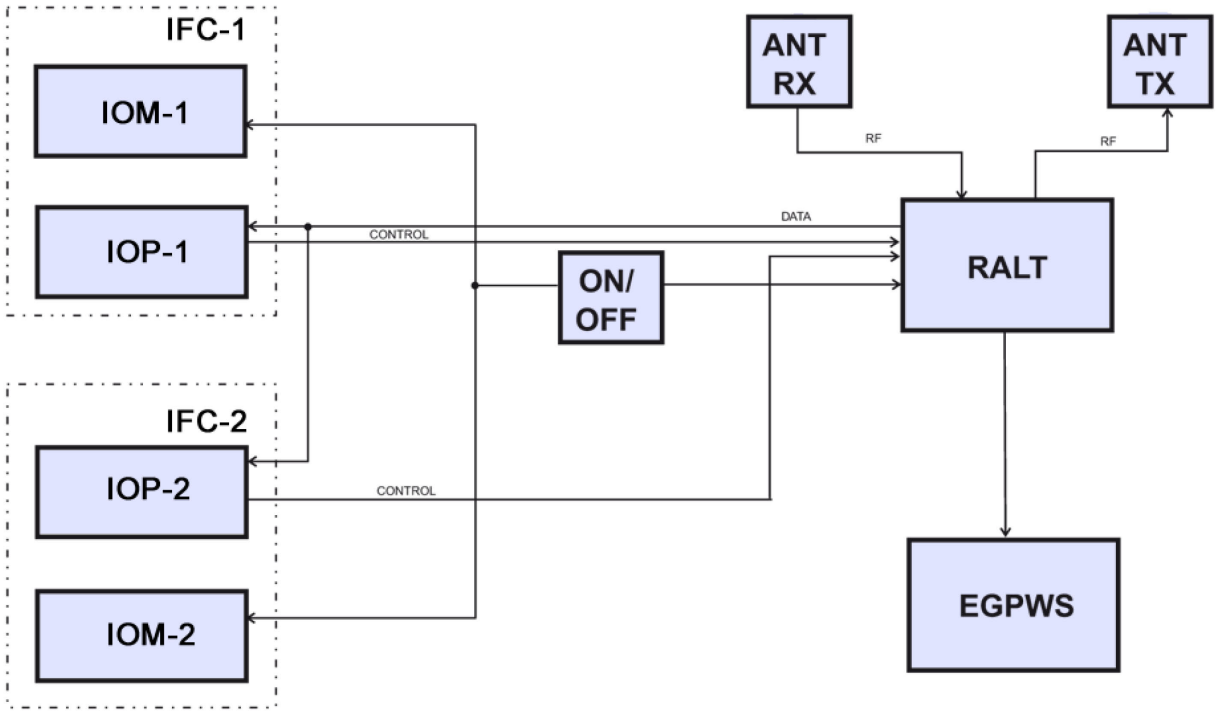


Figure 34-13 Radio Altimeter System - Architecture

OPERATION

The system starts operating automatically when electrical power is on by using RALT switch located at the overhead upper circuit breaker panel. The system has no other controls with which to operate it. Once switched-on, the system initiates a test and then starts normal operation.

The system provides altitude data to IOP processors, which-in turn, send them to be EFIS displayed. Data are also sent to AFCS, RMS, FMS, EGPWS and ETCAS.

While the system is operative, information is PFDs displayed. Screens also display decision height as selected on the associated ICP and alert the flight crew when the aircraft approaches the decision height.

In case of IOP master failure, radioaltimeter will be displayed properly in the displays unit.

The system test can be run from the relevant MCDU screen. This operation can be performed at any time except at landing approach. Test data are managed by the Centralized Diagnostics System (CDS).

CONTROLS AND INDICATORS

PFD

(1) Selected Decision Height (DH):

displays decision height as a three-digit figure in feet, followed by a DH label. When the selected DH is a non-valid one, digits are replaced by three lines.

(2) Radio Altitude (RA) Indication:

displays radio altitude value in feet, followed by an. RA label in white while operating correctly, or in amber in case of reading discrepancy. If radio altimeter fails, RA displays in red.

(3) Decision Height (DH) Alert:

to warn the crew when the aircraft approaches the decision height. A white box is displayed when radio altitude is below DH+100 ft and a box with an inner DH label in amber is displayed when radio altitude is below DH.

ICP

(4) DH Knob:

(refer to CHAPTER 31 - INDICATING / RECORDING SYSTEMS)

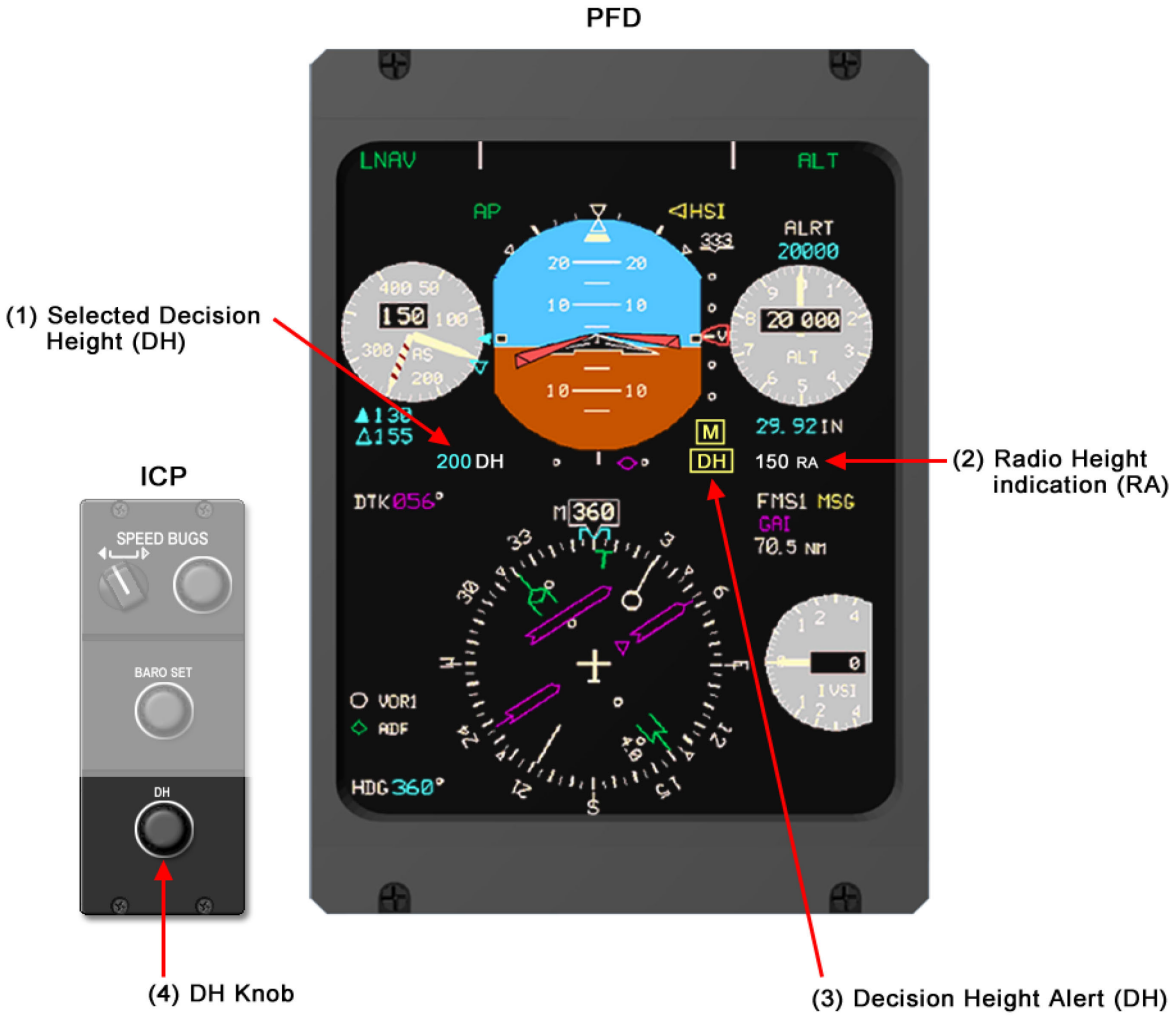
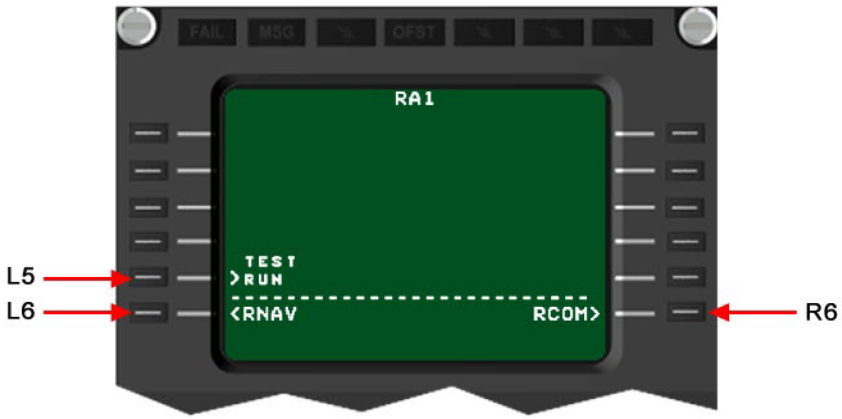


Figure 34-14 Radio Altimeter System - Controls and Indicators

MCDU

RA Page:

- *L5:* initiates system test.
- *L6:* provides access to RNAV MENU page.
- *R6:* provides access to RCOM MENU page.



RA1 PAGE

Figure 34-15 Radio Altimeter - Controls and Indicators - RA Page

COM CTL

(1) EMCON Pushbutton:

(refer to SECURE COMMUNICATIONS, in CHAPTER 23)

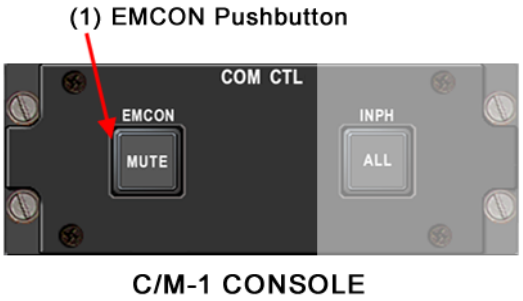


Figure 34-16 Radio Altimeter System - Controls and Indicators - EMCON function

INERTIAL REFERENCE SYSTEM - GPS

Inertial Reference System is intended to provide main inertial and global navigation data to be used by other aircraft systems when required.

The system combines an Inertial Reference System (IRS) with a Global Positioning System (GPS). It is controlled from the FMS which receives navigation data from these systems.

DESCRIPTION

Main system components are:

- ***IRS/GPS Processors:*** two processors located beneath the cabin floor, close to the aircraft centre of gravity. Each processor has an inertial platform and a GPS receiver. It uses provided information to calculate both navigation and position data. Include a Kalman filter which optimally combines data to provide a hybrid positioning solution, i.e. the solution obtained by combining data from both receivers.
- ***GPS Preamplifiers:*** two preamplifiers, each of them located close to an antenna, receive signals from the antennas and amplify them prior to be sent to the processors.
- ***GPS Antennas:*** receive signals from satellites orbiting at the aircraft visual range and transmit them to the preamplifiers (refer to ANTENNAS, in CHAPTER 01).

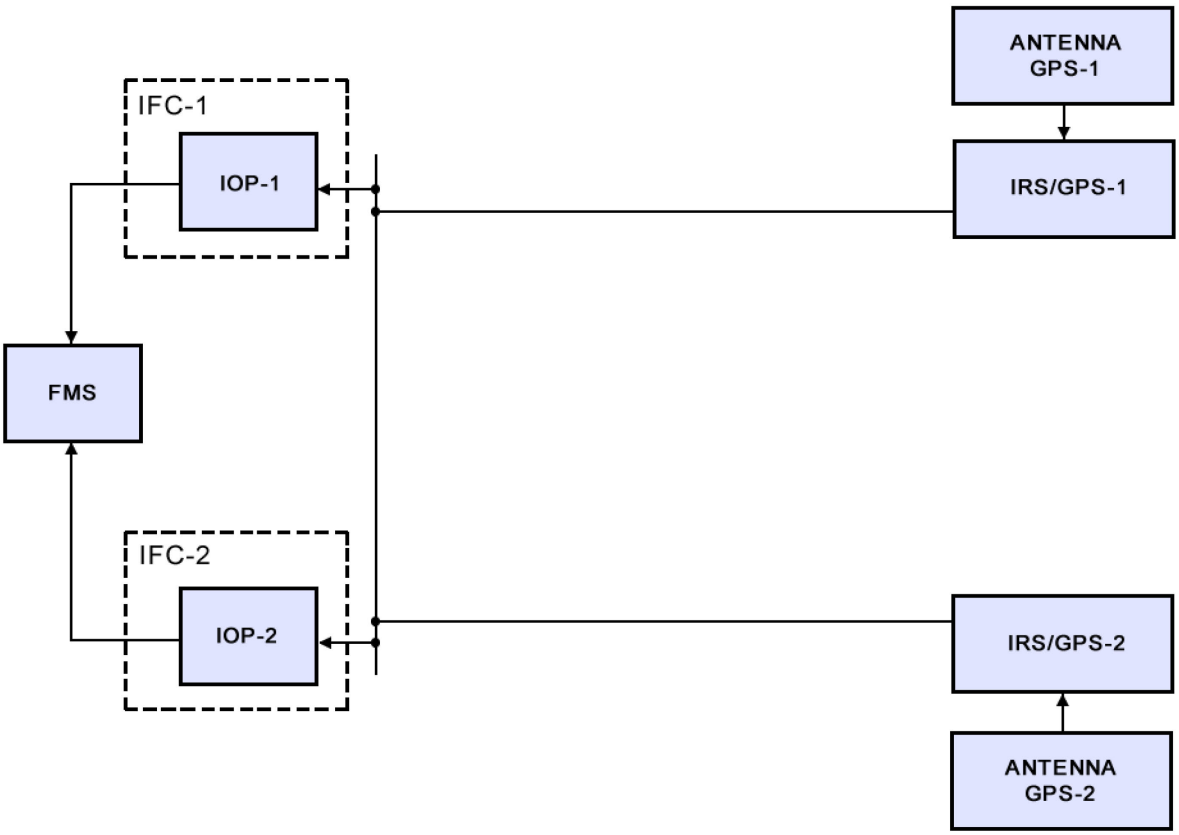


Figure 34-17 Inertial Reference System - Architecture

OPERATION

When the system is turned on with IRS/GPS 1, 2 switches on the overhead upper circuit breaker panel:

1. The IRS/GPS processor performs a PBIT and goes to STBY. If a major failure is detected during the PBIT, the system will remain in STBY.

2. It automatically starts the Gyroscopic Compass Alignment (GCA), using one of the valid positions received from the FMS (this takes several minutes):

   - Valid position from last complete GCA stored in IRS/GPS internal back-up memory. This procedure only occurs when a previous full GCA had been performed, Stored Heading Alignment (SHA) not included, and IRS status did not pass to NAV.
   - Valid GPS position available (GPS in NAV mode).
   - Valid position inserted in MCDU's POS INIT page.

NOTE

During the IRS/GPS alignment process (after a position initialization), the system will report GPS FAULT.

NOTE

IRS/GPS is capable to complete GCA when small aircraft movements are detected, but for excessive ones (brakes released, propeller unfeathered or PL above GI) it returns to STBY.

The operator can also choose a Stored Heading Alignment (SHA) if the aircraft has not moved since last alignment.

After an IRS/GPS power-off/power-on in flight, the operator is able to perform an in flight alignment pressing NAV command in MCDU SENSOR STATUS page.

If the pilot press NAV command (second time) in MCDU SENSOR STATUS page when IRS/GPS equipments are performing the in flight alignment or IRS/GPS equipments have finished the in flight alignment, the IRS/GPS equipments will go to ATT mode (in ATT mode, IRS/GPS equipments do not provide position information). If this happens, the operator will switch off/switch on the IRS/GPS equipments and perform again the in flight alignment.

The system is FMS-controlled from MCDU pages. These pages allow initializing IRS position and select alignment mode. FMS pages display the following data referred to the three IRS/GPS/Hybrid navigation sources:

– LAT/LONG: aircraft latitude and longitude.
– EPE: estimated position error.
– TK: track angle.
– GS: ground speed.
– WIND: wind direction and speed.
– SOURCE/MODE

If IRS navigation system is selected, the following modes are available:

– *STBY:* standby.
– *ALNXXX:* the GCA or SHA is in progress. XXX displays remaining seconds.

– *EIA:* the Enhance Interrupted Alignment (EIA) is in progress. EIA is automatically triggered when the GCA is finished, and it is interrupted during taxi (taxi must not exceed 10 minutes). Then continues when the aircraft takes another position with a heading difference between the first alignment greater than 70º. EIA enables to reach the best performance.

– *EIAOK:* EIA is achieved (but mode is not navigation).

– *ALNFLT:* the IRS alignment is fault.

– *NAV:* IRS navigation without hybridation IRS/GPS.

– *NAVGPS:* IRS navigation with hybridation IRS/GPS.

– *NAVEIA:* IRS and HYB navigation with achieved EIA.

If GPS navigation system is selected, also ALT (GPS altitude), HIL (RAIM Horizontal Integrity Limit) and HDOP (Horizontal Dilution Of Precision) are displayed. The following modes are available:

– *INIT:* initializing GPS.

– *ACQ:* acquisition, the GPS is tracking satellites.

– *NAV:* navigation, 3D position and time are provided.

– *ALT:* altitude/clock aiding. The GPS uses altitude or clock information (from FMS) to perform 3D localization. RAIM (Receiver Autonomous Integrity Monitoring, calculates the integrity of GPS signals) is not available.

– *TEST:* performs a BIT.

– *AIDED:* the GPS uses external speed to update its position (until enough satellites are received).

– *FAULT:* a failure has been detected.

Processors receives selected operating mode and navigation source data, as well as data from up to five satellites orbiting at the aircraft visual range.

CONTROLS AND INDICATORS

SENSOR STS Page:

- *L1:* Displays GPS1, RF and GPS1 sensor status information. It also provides information on GPS operating mode. GPS has the following key status: no key (NOKEY), verified (VERIF), unverified (UNVER), parity error (PRTY), insufficient (INSUF) and incorrect (INCOR).
- *L2:* Same as L1 but concerning GPS2.
- *L4:* Displays information on INS, ADC (air-data computer) heading or PQR status. It also provides information on IRS1 operating mode.
- *L5:* Same as L4 but concerning IRS2.
- *L6:* Moves back to previous page.
- *R1:* Provides information on IOP1 and IOP2 status.
- *R4:* When pushed repeatedly, activates several IRS1 control commands (BIT/SHA/NAV).
- *R5:* Same as R4 but concerning IRS2.

NOTE

The FMS1 will select IRS/GPS2 until IRS/GPS1 is aligned. The FMS2 will select IRS/GPS1 until IRS/GPS2 is aligned.

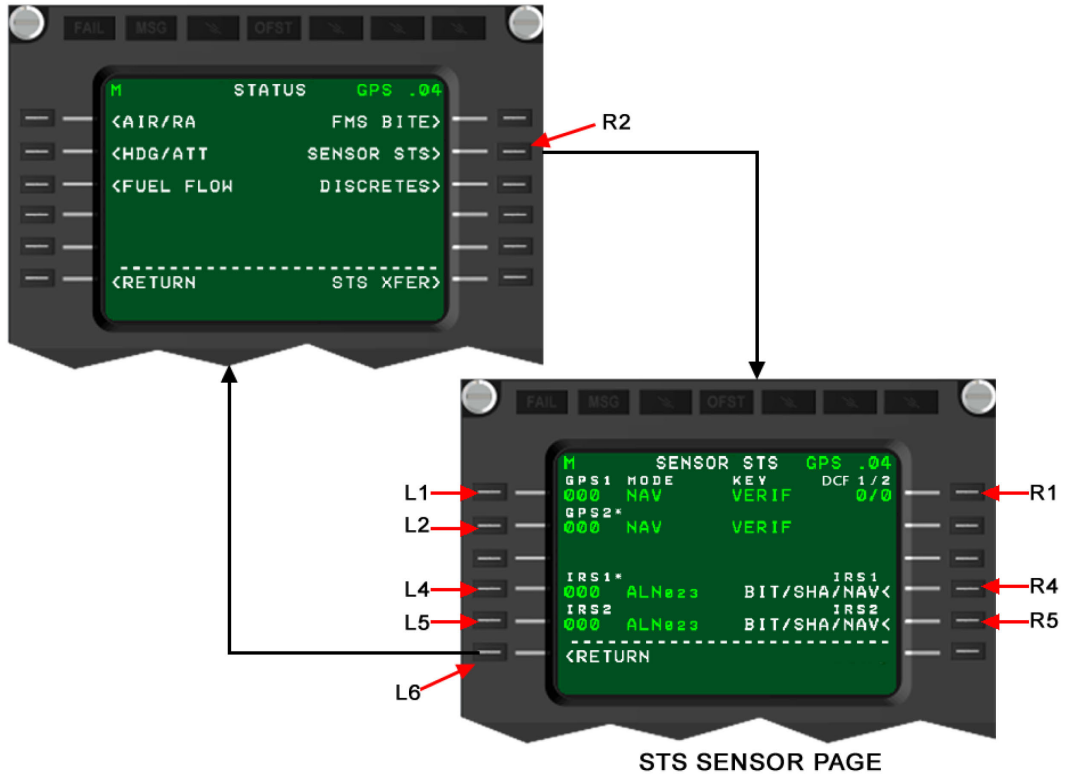


Figure 34-18 IRS/GPS - SENSOR STS - Controls and Indicators

GPS NAV, IRS NAV and HYB NAV Pages:

GPS NAV Page:

- *L1:* Displays aircraft latitude and longitude information, calculated from GPS system (LAT/LONG) provided data.
- *L2:* Displays GPS system estimated position error (EPE).
- *L3:* Displays track angle (TK) and ground speed (GS) data calculated from GPS system provided data.
- *L4:* Displays direction and both wind speed and direction (WIND) data calculated from GPS system provided data.
- *L5:* Indicates data source (SOURCE) from which GPS (GPS1 or GPS2) and GPS operating mode (MODE) parameters-calculation data are obtained.
- *L6:* Moves back to previous page.
- *R3:* Displays GPS-calculated altitude (ALT).
- *R4:* Displays GPS horizontal integrity limit (HIL).
- *R5:* Displays GPS HDOP (GPS horizontal dilution of precision).
- *R6:* Allows GPS operating mode selection by pushing (SELECT<) repeatedly. It also allows moving back to previous page.

IRS NAV Page:

- *L1:* Displays aircraft latitude and longitude information from IRS system (LAT/LONG) provided data.
- *L2:* IRS system estimated position error (EPE).
- *L3:* Displays track angle (TK) and ground speed (GS) data from IRS system provided data.
- *L4:* Displays direction and both wind speed and direction (WIND) data calculated from IRS system provided data.
- *L5:* Indicates data source (SOURCE) from which IRS and IRS operating mode (MODE) parameters-calculation data are obtained.
- *L6:* Moves back to previous page.
- *R6:* Allows IRS operating mode selection by pushing (SELECT<) repeatedly. It also allows moving back to previous page.

HYB NAV Page:

- *L1:* Displays aircraft altitude and longitude information from HYB mode (LAT/LONG) provided data.
- *L2:* HYB mode system estimated position error (EPE).
- *L3:* Displays track angle (TK) and ground speed (GS) data from HYB mode system provided data.
- *L4:* Displays direction and both wind speed and direction (WIND) data calculated from HYB mode system provided data.
- *L5:* Indicates data source (SOURCE) from which IRS and IRS operating mode (MODE) parameters-calculation data are obtained.
- *L6:* Moves back to previous page.
- *R6:* Allows HYB operating mode selection by pushing (SELECT<) repeatedly. It also allows moving back to previous page.

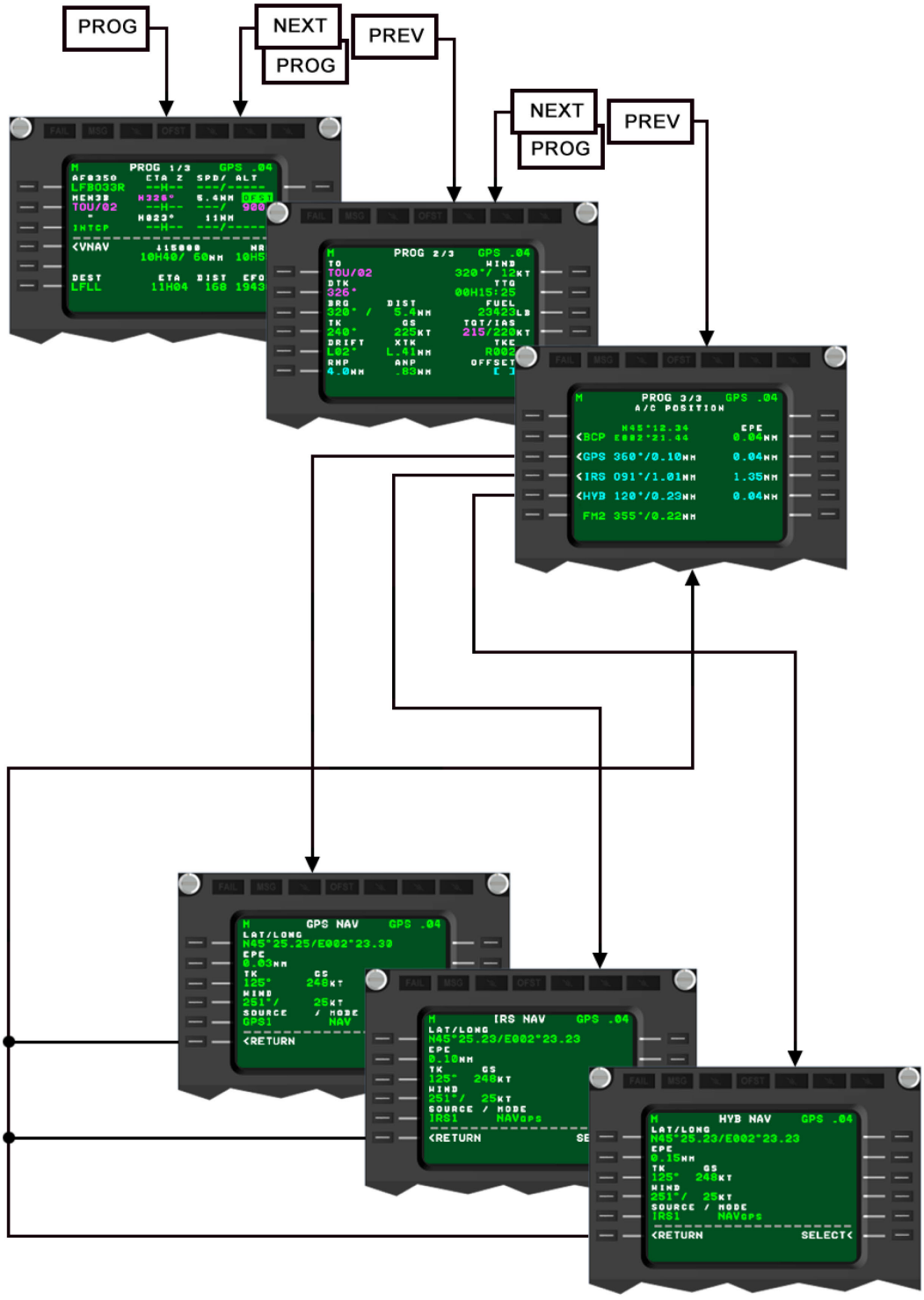


Figure 34-19 Hierarchical Line

GPS NAV PAGE

IRS NAV PAGE

HYB NAV PAGE

Figure 34-20 IRS/GPS - GPS/IRS/HYB NAV - Controls and Indicators

ENHANCED GROUND PROXIMITY WARNING SYSTEM

The Enhanced Ground Proximity Warning System is a Terrain Awareness and Alerting System (TAWS) providing basic GPWS functions plus additional enhanced terrain alerting and display features.

(For additional information, refer to Annexe 2)

To generate audio and visual signals, which advise the crew of ground proximity, the EGPWS processes the input data from:

- Air Data Computer, which gives the barometric altitude, the vertical speed and the airspeed.
- AHRSs, which give aircraft attitude data and magnetic heading.
- Radioaltimeter, which gives the radioaltitude.
- Automatic Pilot.
- EFIS, which gives the glideslope and localizer deviation.
- FMS, which gives GPS data and Glideslope and Localizer deviation.
- Microswitches in the Flaps and the Landing Gear, which give the position of these components (the flaps position signal can be inhibited by means of the selector in the EGPWS control).
- Stall Warning System.
- Weather Radar.
- Internal terrain, obstacles and airport databases to predict a potential conflict between the aircraft flight path and terrain or an obstacle.

There are six situations (MODES) in which the system generates a warning:

- Excessive Descent Rate
- Excessive Closure to Terrain
- Altitude Loss after Takeoff
- Unsafe Terrain Clearance
- Excessive Glideslope Deviation
- Advisory Callouts

Additionally, the EGPWS incorporate the following "enhanced" features:

- Terrain (and Obstacle) Awareness and Display (TAD)
- Terrain Clearance Floor (TCF)

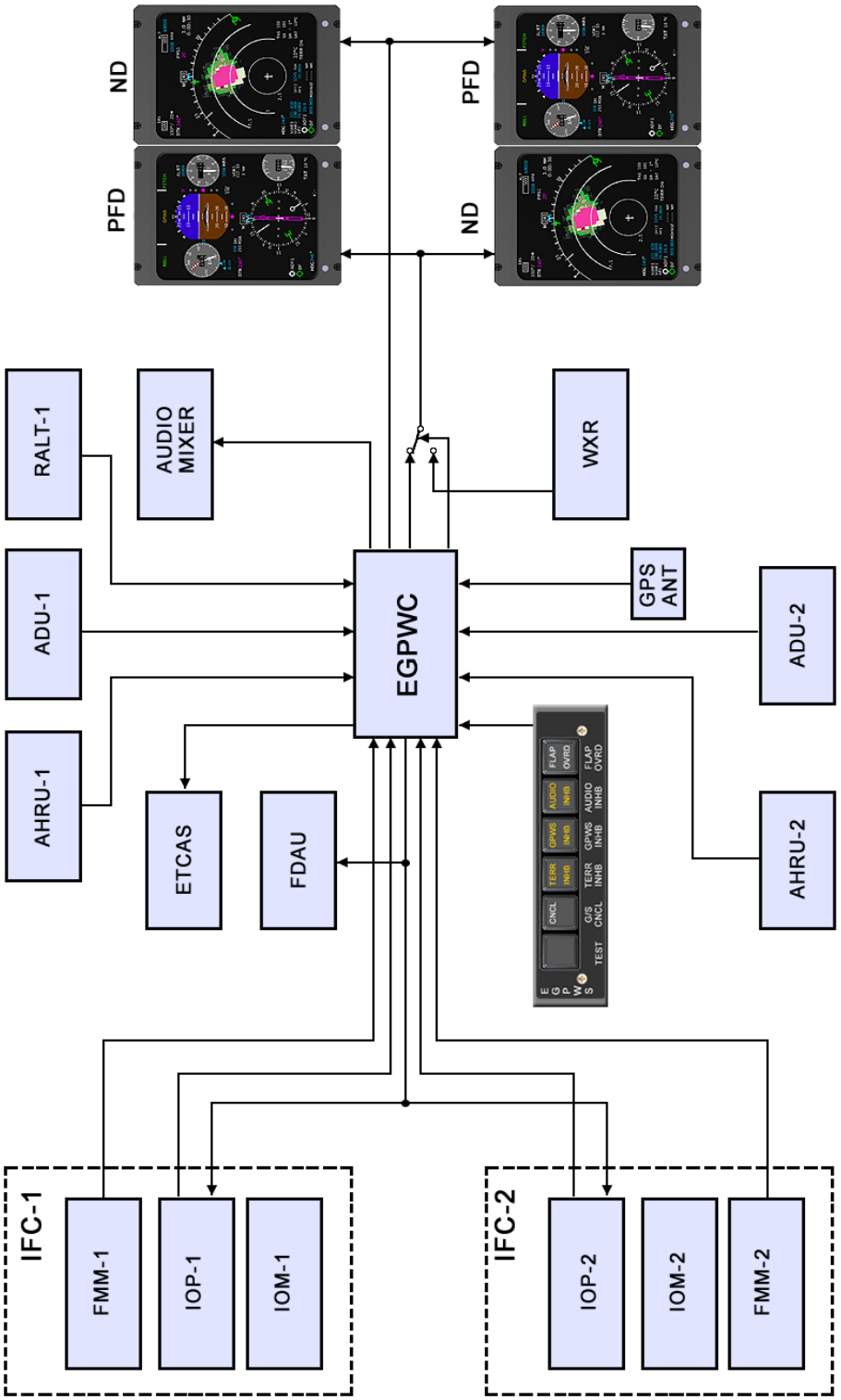


Figure 34-21 Enhanced Ground Proximity Warning System - Architecture

MODE 1. Excessive Descent Rate

This mode provides alerts for excessive descent rates with respect to altitude AGL and is active for all phases of flight.

Penetration of the outer boundary activates de GPWS caution lights and "SINK RATE, SINK RATE" alert will be heard. Additional "SINK RATE, SINK RATE" messages will occur for each 20 % degradation in altitude.

Penetration of the inner boundary actives the GPWS warning lights and changes the audio message to "PULL UP", which repeats continuously until the inner warning boundary is exited.

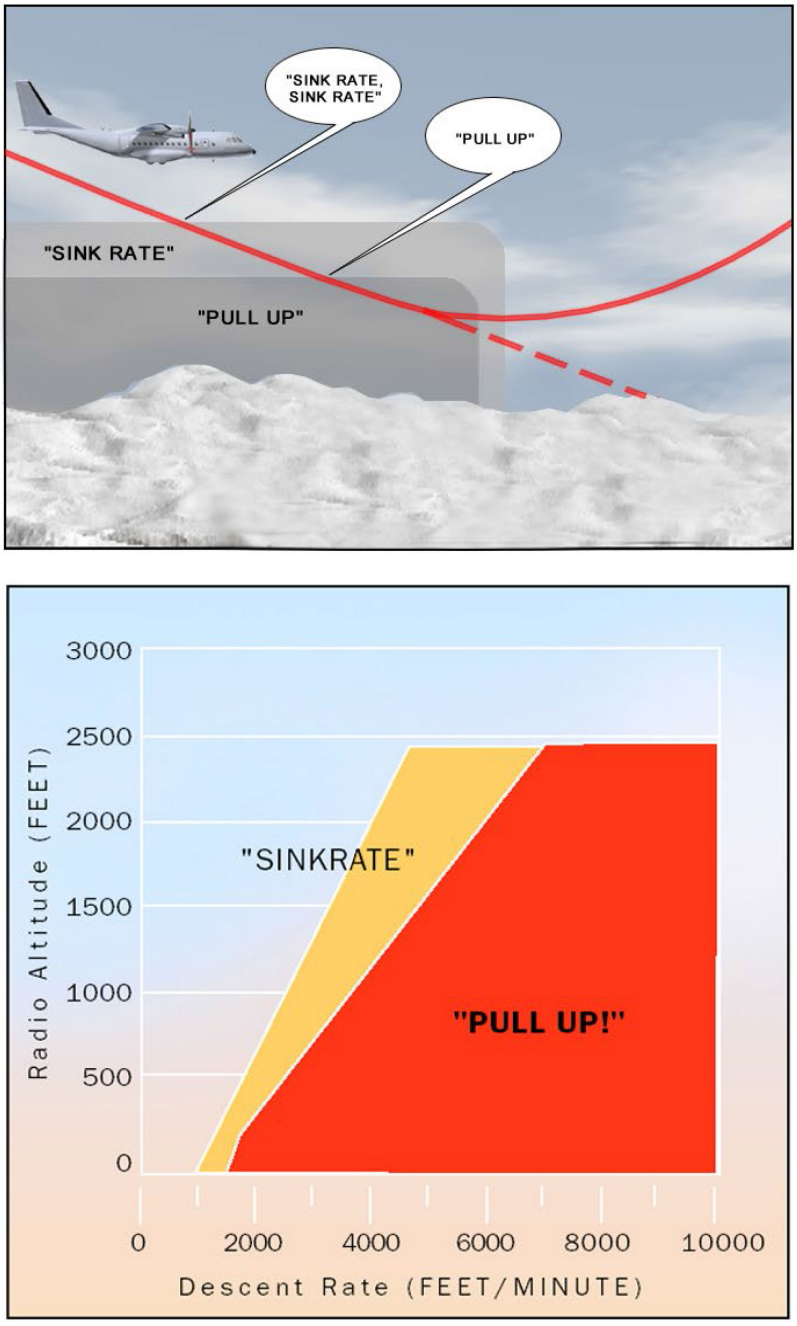


Figure 34-22 EGPWS - Mode 1

MODE 2. Excessive Closure to Terrain

Mode 2 provides alerts to help protect the aircraft from impacting the ground when rapidly rising terrain with respect to the aircraft is detected. Mode 2 is based on the Radio Altitude and normally exists in two forms, 2A and 2B.

– **Mode 2A** is active during climbout, cruise, and initial approach (flaps not in the landing configuration and the aircraft not on glideslope centerline). If the aircraft penetrates the Mode 2A caution envelope, the aural message "TERRAIN, TERRAIN" is generated and cockpit GPWS caution lights will illuminate. If the aircraft continues to penetrate the envelope, the warning lights will illuminate and the aural warning message "PULL UP" is repeated continuously until the warning envelope is exited.

  Upon exiting the warning envelope, if terrain clearance continues to decrease, the aural message "TERRAIN" will be given until the terrain clearance stops decreasing. In addition, the visual alert will remain on until the aircraft has gained 300 feet of altitude, 45 seconds has elapsed, or landing flaps or the flap override switch is activated.

  The graph shows how the upper boundary of the Mode alert envelope varies as a function of the aircraft speed.

– **Mode 2B** is not applicable to C-295 aircraft. When flaps are in landing position and gear is in up position, a gear up aural warning is heard in order to inform the pilot that this aircraft condition must be modified.

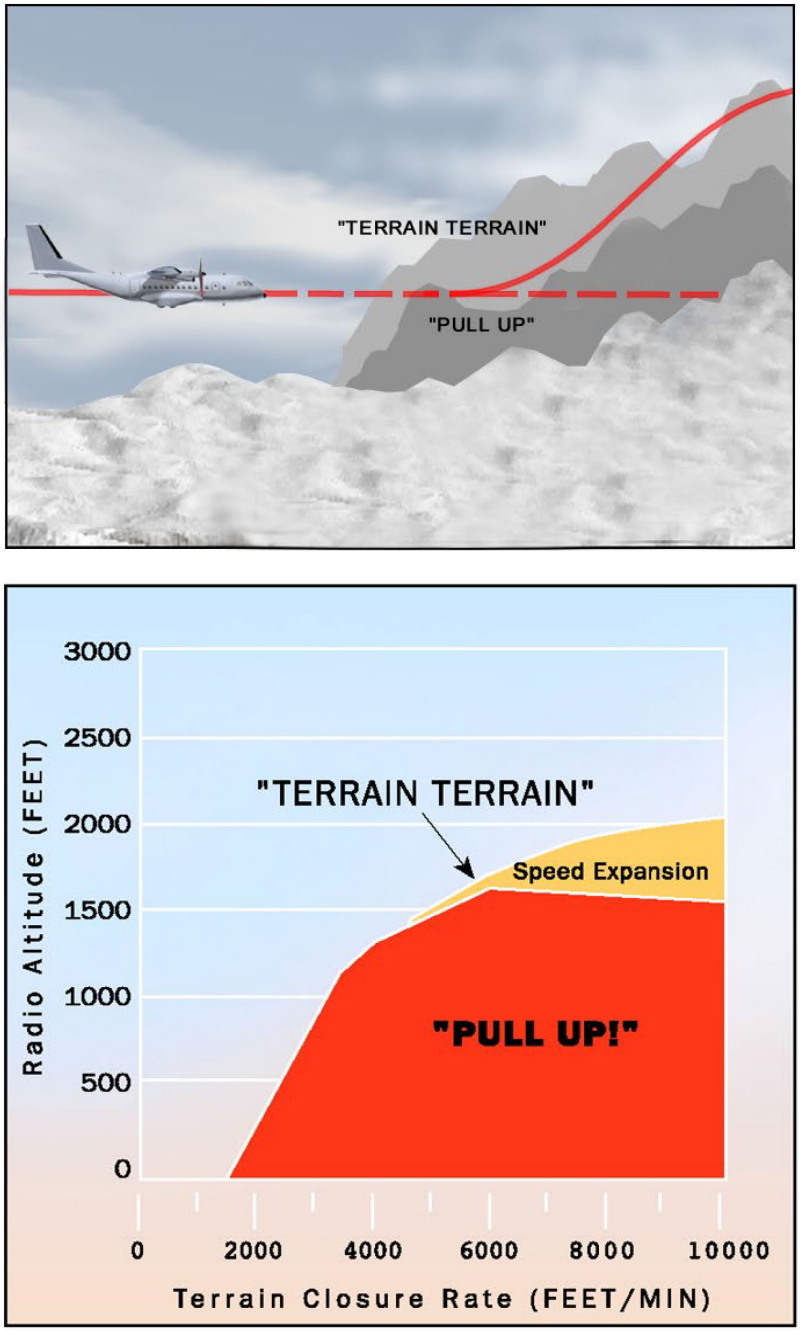


Figure 34-23 EGPWS - Mode 2A

Mode 3. Altitude Loss after Takeoff

Mode 3 provides alerts for significant altitude loss after takeoff or low altitude go-around with gear or flaps not in the landing configuration.

If the aircraft penetrates the envelope the GPWS caution lights and the aural message "DON´T SINK, DON´T SINK" will be actuated. The aural message is only enunciated twice unless altitude loss continues. Upon establishing a positive rate of climb, the caution lights and the aural alert will cease.

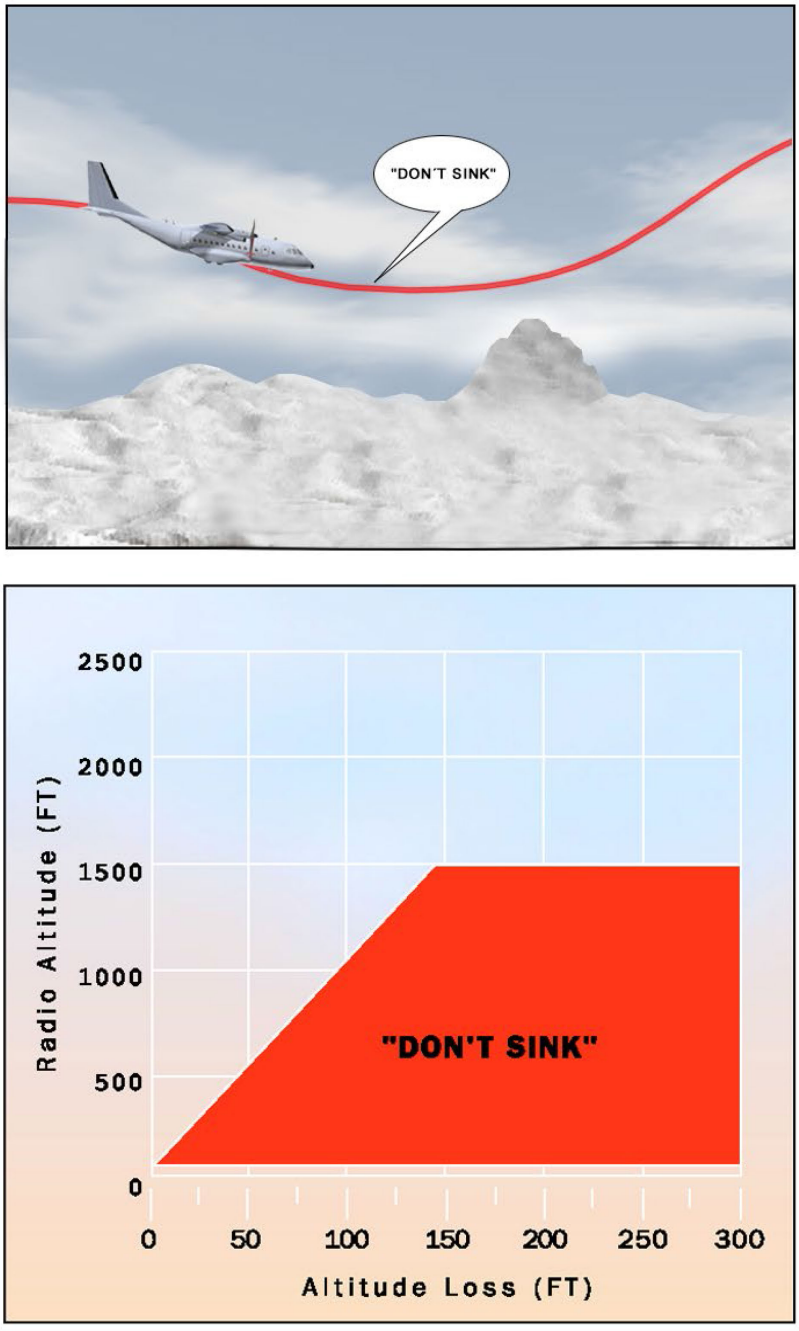


Figure 34-24 EGPWS - Mode 3

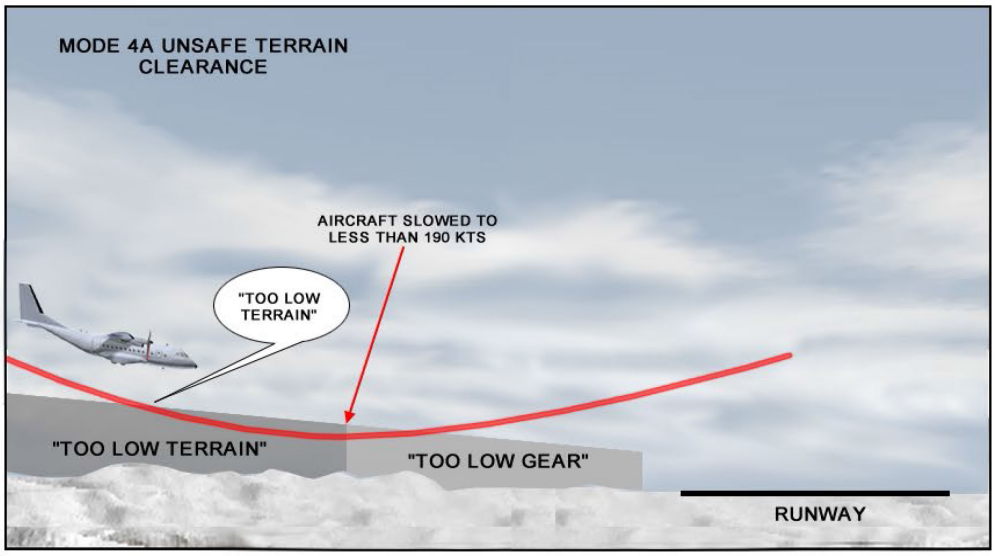
Mode 4. Unsafe Terrain Clearance

Mode 4 provides alerts for insufficient terrain clearance with respect to phase of flight, configuration, and speed. Mode 4 airspeed expansion is disabled when the Terrain (and Obstacle) Awareness and Display (TAD) function is enabled and available. This change to the envelope further reduces the potential for nuisance alerts when the aircraft is not in the landing configuration. Mode 4 exists in three forms, 4A, 4B, 4C.

- **Mode 4A** is active during cruise and approach with the gear not in landing configuration. Below 1000 feet AGL and above 190 knots airspeed, the aural alert is "TOO LOW, TERRAIN". Below 500 feet AGL and less than 190 knots, the aural alert is "TOO LOW, GEAR". For either alert, subsequent alert messages occur for each 20 % degradation in altitude. Alert lights extinguish and aural messages cease when the alert envelope is exited.
- **Mode 4B** is active during cruise and approach with the gear down and flaps not in the landing configuration. Below 1000 feet AGL and above 148 knots airspeed, the Mode 4B aural alert is "TOO LOW, TERRAIN". Below 150 feet AGL and less than 148 knots, the aural alert is "TOO LOW, FLAPS". If desired, the pilot may disable the "TOO LOW, FLAPS" alert by engaging the FLAP OVRD pushbutton.
- **Mode 4C** alert is intended to prevent inadvertent controlled flight into the ground during takeoff climb into terrain that produces insufficient closure rate for a Mode 2 alert. This mode is based on an EGPWS computed Minimum Terrain Clearance (MTC) floor, that increases with Radio Altitude. It is active after takeoff when the gear of flaps are not in the landing configuration. It is also active during a low altitude go-around if the aircraft has descended below 245 feet AGL.

  At takeoff, the Minimum Terrain Clearance (MTC) is zero feet. As the aircraft ascends, the MTC is increased to 75 % of the aircraft´s Radio Altitude (averaged over the previous 15 seconds). This value is not allowed to decrease and is limited to 500 feet AGL for airspeed less than 190 knots. Above this airspeed, the MTC increases linearly to the limit of 1000 feet at 250 knots.

  If the aircraft´s Radio Altitude decreases to the value of the MTC, the EGPWS caution illuminates and the aural message "TOO LOW, TERRAIN" is enunciated. Caution lights extinguish and messages cease when the alert envelope is exited.



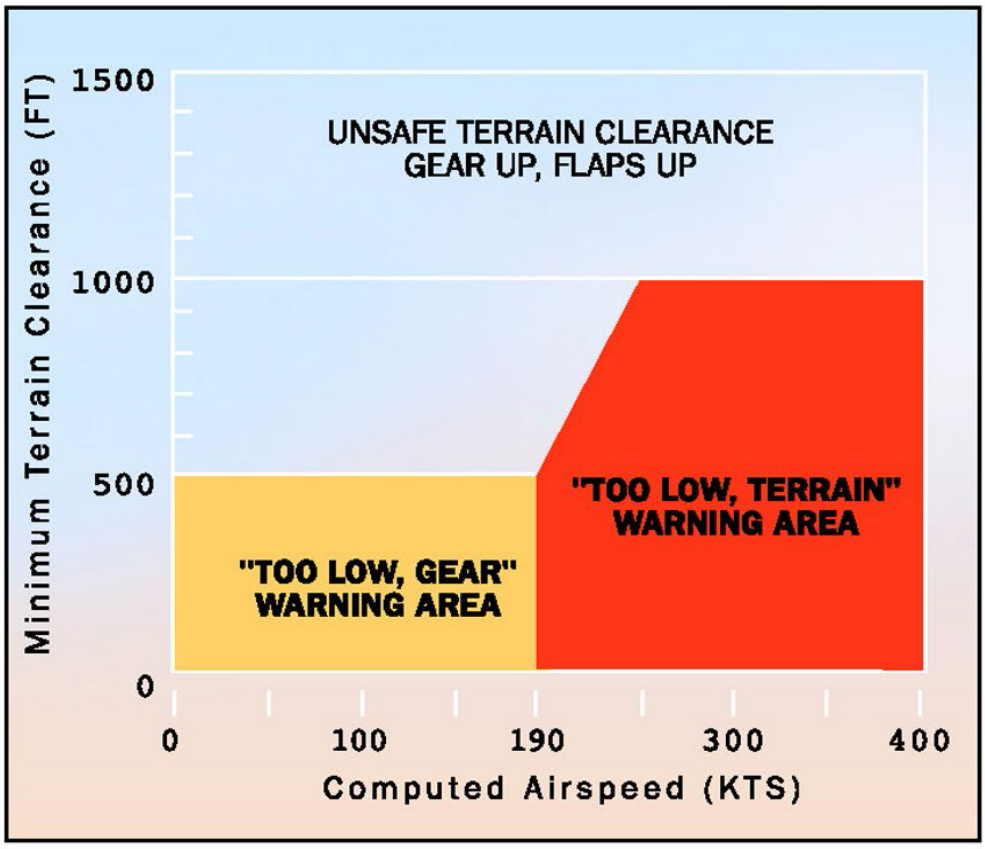


Figure 34-25 EGPWS - Mode 4A

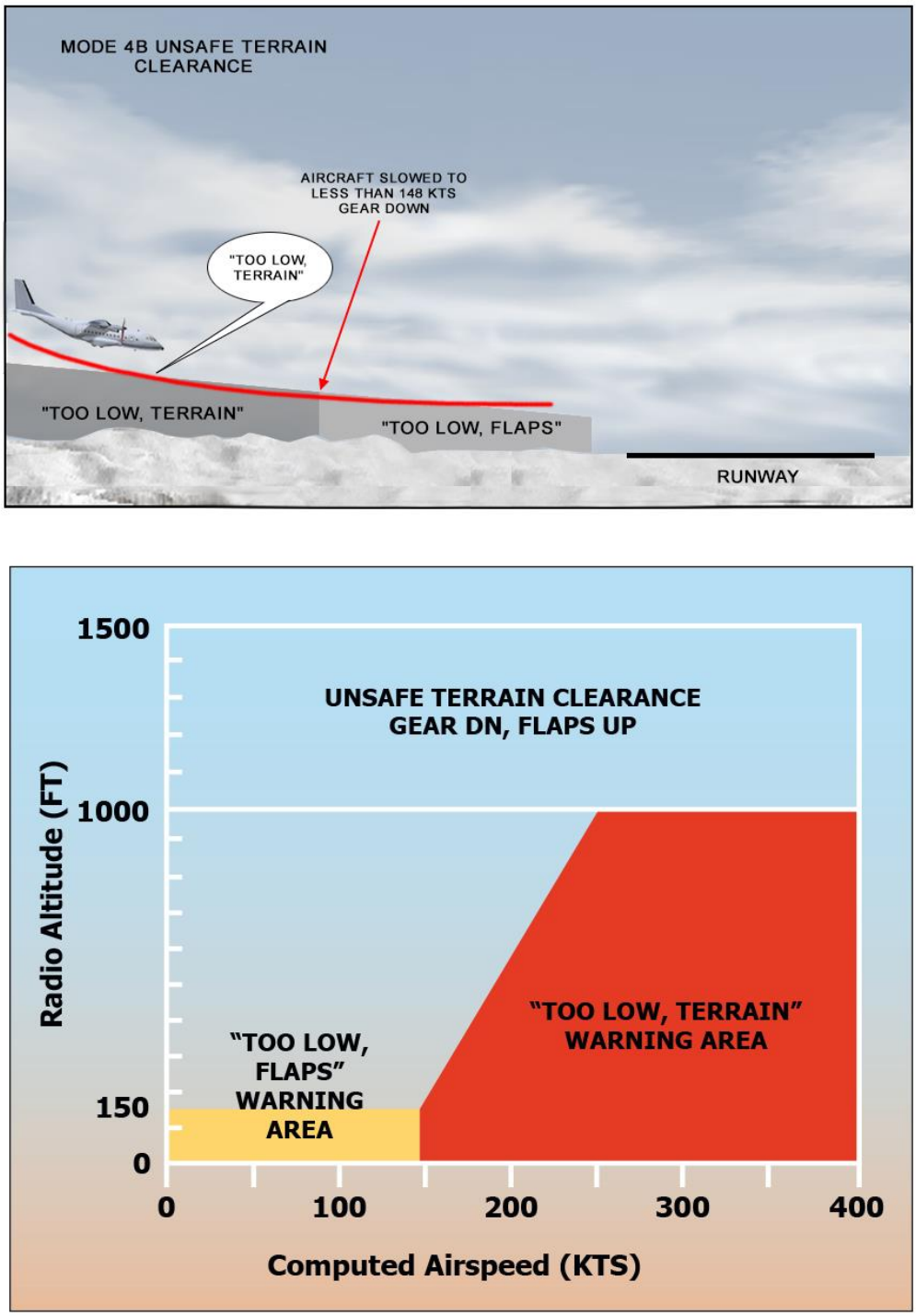


Figure 34-26 EGPWS - Mode 4B

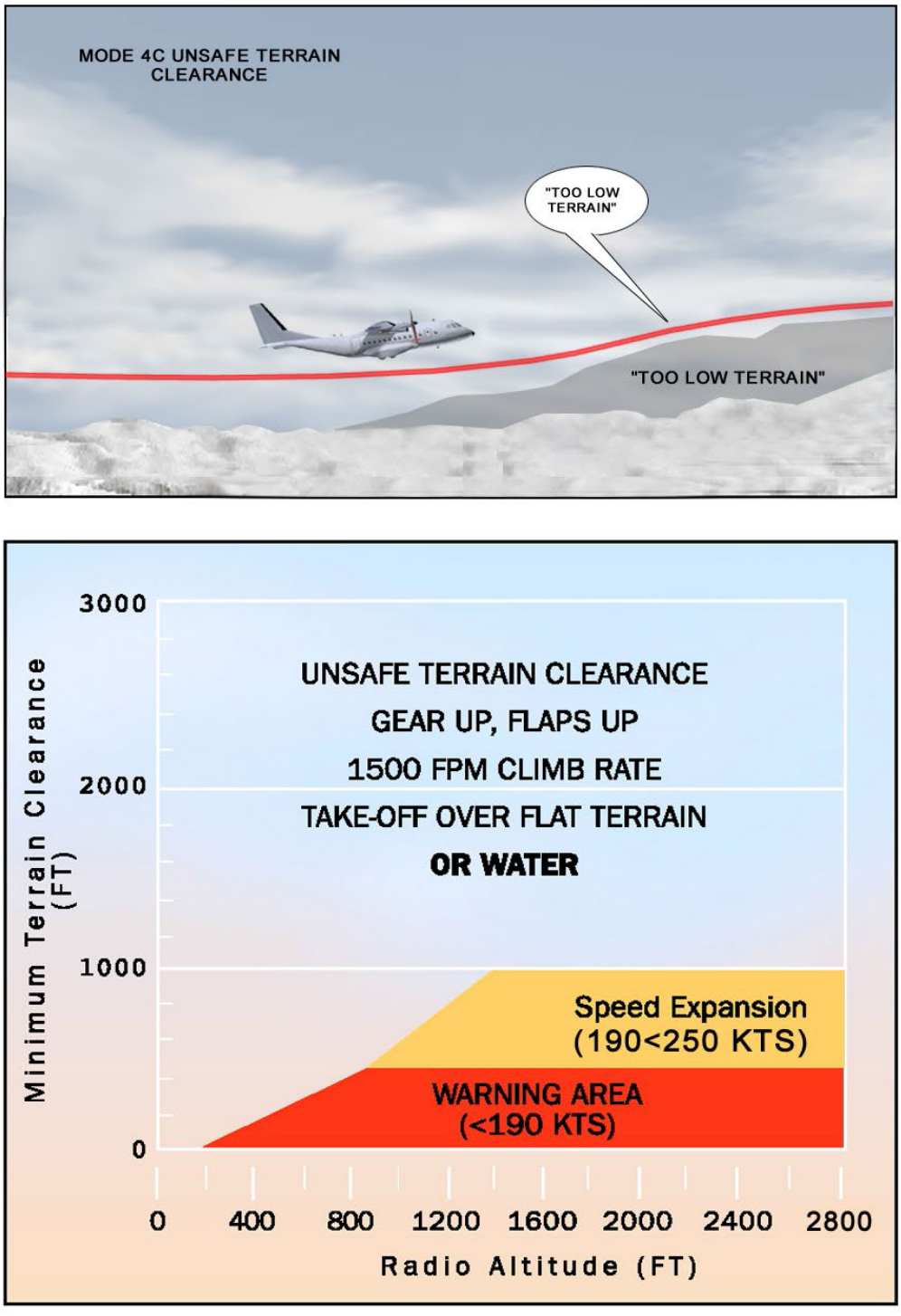


Figure 34-27 EGPWS - Mode 4C

Mode 5. Excessive Glideslope Deviation

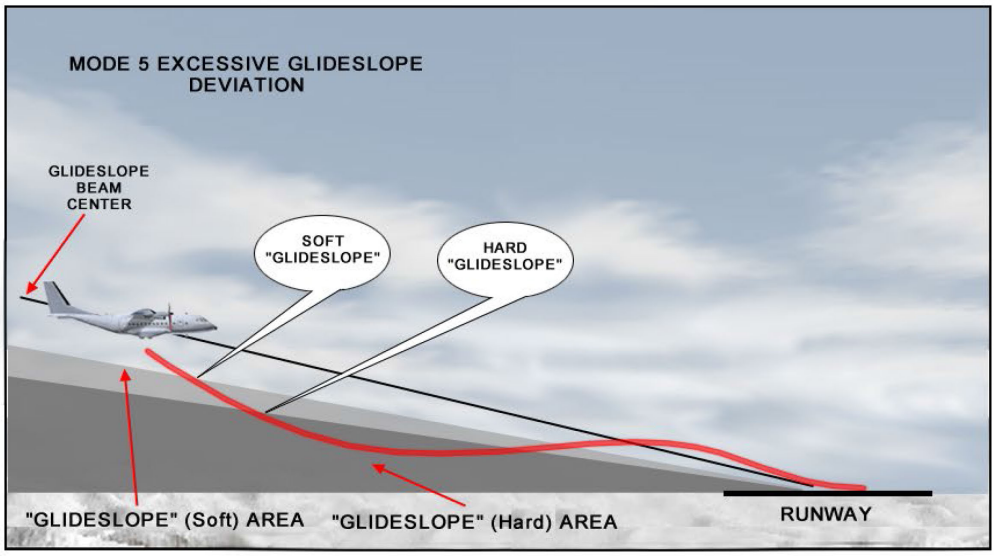
Mode 5 provides two levels of alerting for when the aircraft descends below glideslope.

The first level occurs when below 1000 feet Radio Altitude and the aircraft is 1,3 dots or greater below the beam. This turns on caution lights and is called a "soft" alert because the audio message "GLIDESLOPE" is enunciated at half volume. Twenty percent increases in the below glideslope deviation cause additional "GLIDESLOPE" messages enunciated at a progressively faster rate.

The second level alert occurs when below 300 feet Radio Altitude with 2 dots or greater glideslope deviation. This is called a "hard" alert because a louder "GLIDESLOPE, GLIDESLOPE" message is enunciated every 3 seconds continuing until "hard" envelope is exited. The caution lights remain on until a glideslope deviation less than 1,3 dots is achieved.

Additionally, both alert levels are desensitized below 150 feet AGL, to allow for normal beam variations nearer the ground, and reduce the possibility of nuisance alerts.

Mode 5 alerts can be canceled by pressing the GS CNCL pushbutton any time below 2000 feet AGL. However, Glideslope Cancel cannot be deselected (reset) by again pressing the GS CNCL pushbutton. Alerts are inhibited during backcourse approaches to prevent nuisance alerts due to false fly up lobes from the Glideslope.



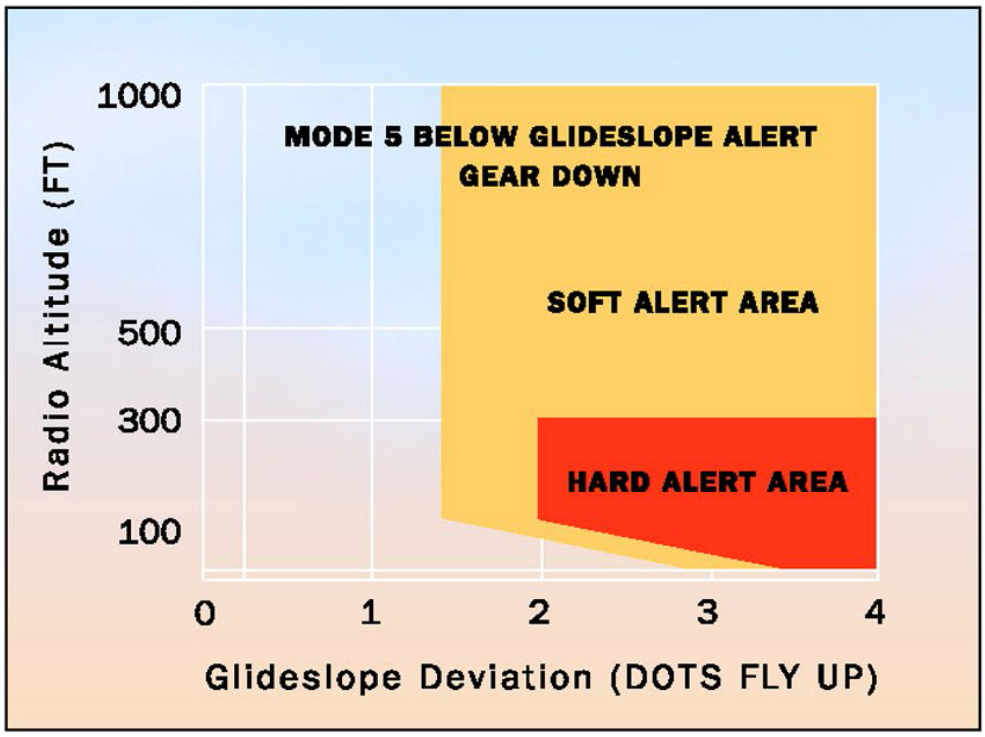


Figure 34-28 EGPWS - Mode 5

Mode 6. Advisory Callouts

Mode 6 provides advisory callouts which consist of predefined Radio Altitude based voice callouts or tones and an excessive bank angle warning. The following is a list of each of the possible altitude callouts or tones:

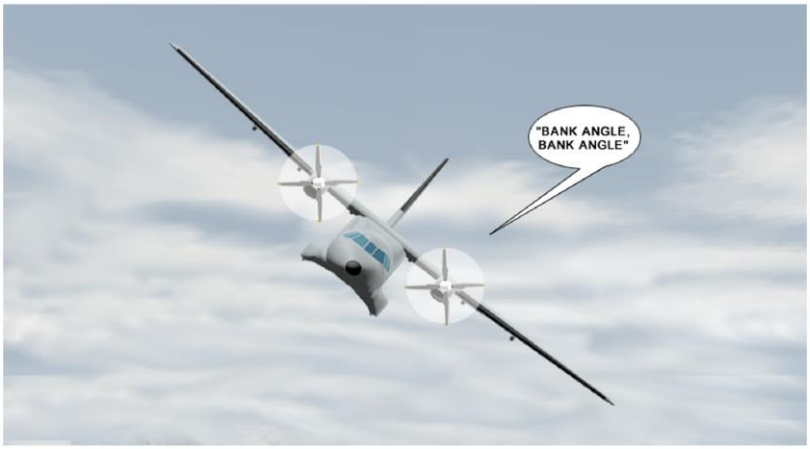
CALLOUT	OCCURS AT (FEET AGL)
"RADIO ALTIMETER"	2500
"TWENTY FIVE HUNDRED"	2500
"ONE THOUSAND"	1000
"FIVE HUNDRED"	500
Five Hundred Tone (2 second 960 Hz)	500
"FOUR HUNDRED"	400
"THREE HUNDRED"	300
"TWO HUNDRED"	200
"APPROACHING MINIMUMS"	DH + 80
"APPROACHING DECISION HEIGHT"	DH + 100
"PLUS HUNDRED"	DH + 100
"FIFTY ABOVE"	DH + 50
"MINIMUMS"	DH
"MINIMUMS-MINIMUMS"	DH
"DECISION HEIGHT"	DH
"DECIDE"	DH
"ONE HUNDRED"	100
One Hundred Tone (2 second 700 Hz)	100
"EIGHTY"	80
"SIXTY"	60
"FIFTY"	50
"FORTY"	40
"THIRTY FIVE"	35
Thirty Five Tone (1 second 1400 Hz)	35
"THIRTY"	30
"TWENTY"	20
Twenty Tone (1/2 second 2800 Hz)	20
"TEN"	10
"FIVE"	5

Table 34-1 EGPWS - Mode 6 - Advisory altitude callouts and tones

Each selected callout is only enunciated once per approach. Decision Height (DH) based callouts ("APPROACHING MINIMUMS", "MINIMUMS-MINIMUMS"...) require the landing gear to be down, and occur when descending through the Radio Altitude corresponding to the selected DH. These also have priority over other altitude callouts when overlapping.

Another feature available in the Altitude Callouts is a "Smart 500" foot callout. When selected, this callout assists pilots during a non-precision approach by enunciating "FIVE HUNDRED" feet in addition to any other altitude callout discussed above. The EGPWS determines a non-precision approach when the flight path exceeds Glideslope or Localizer beam by 2 dots or a back-course approach is detected.

An additional callout of the Mode 6 is the callout "BANK ANGLE, BANK ANGLE" which advises of an excessive roll angle. The EGPWS provides callouts according to area showed in the following figure. Bank angle advisories are inhibited below 5 feet.



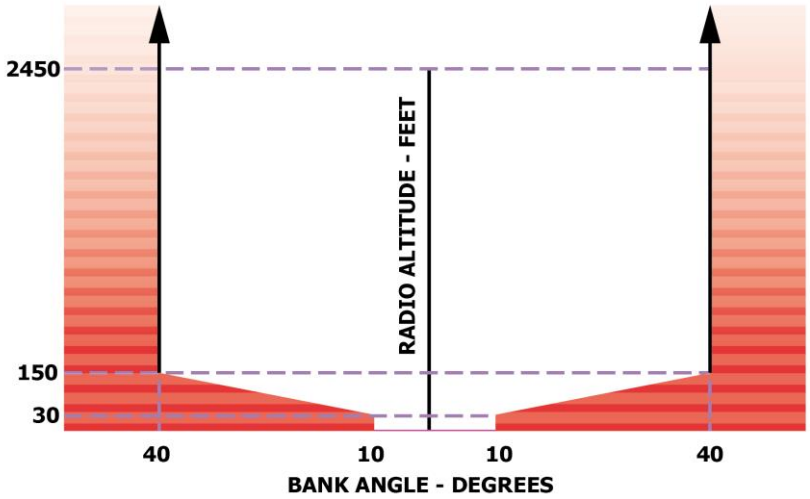


Figure 34-29 EGPWS - Mode 6

Enhanced Functions

Enhanced functions use geographic aircraft position, aircraft altitude and a terrain database to predict potential conflicts between the aircraft flight path and the terrain or catalogued human made obstacles. Additionally, it provides graphic displays of the conflicting terrain or obstacle.

When any of the EGPWS alerts are activated, the TCAS is placed in TA ONLY mode inhibiting all TCAS aural messages.

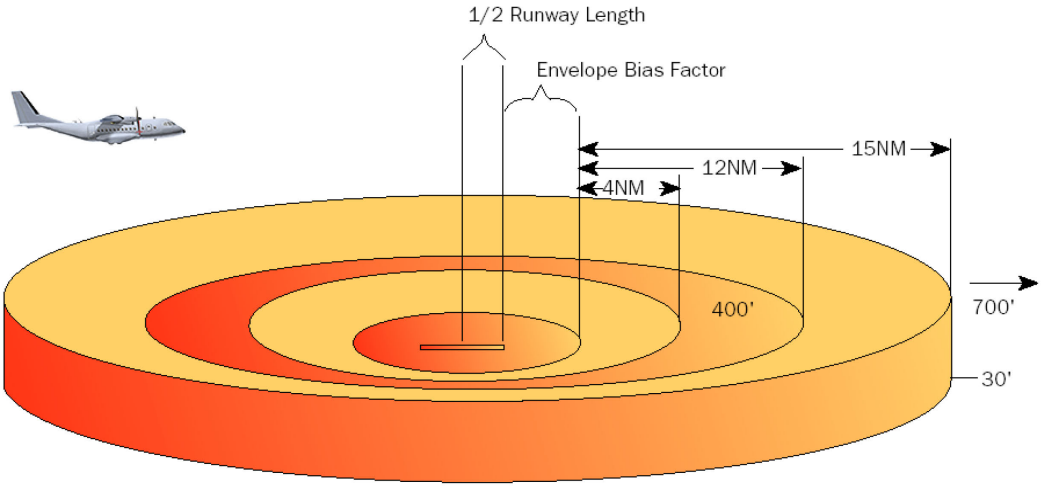
In the event that the airplane position data from the internal GPS is invalid or not updated, enhanced functions are automatically inhibited. This will not affect the basic GPWS functions. If the GPS position data accuracy is restored, the enhanced functions are automatically enabled.

Terrain Clearance Floor

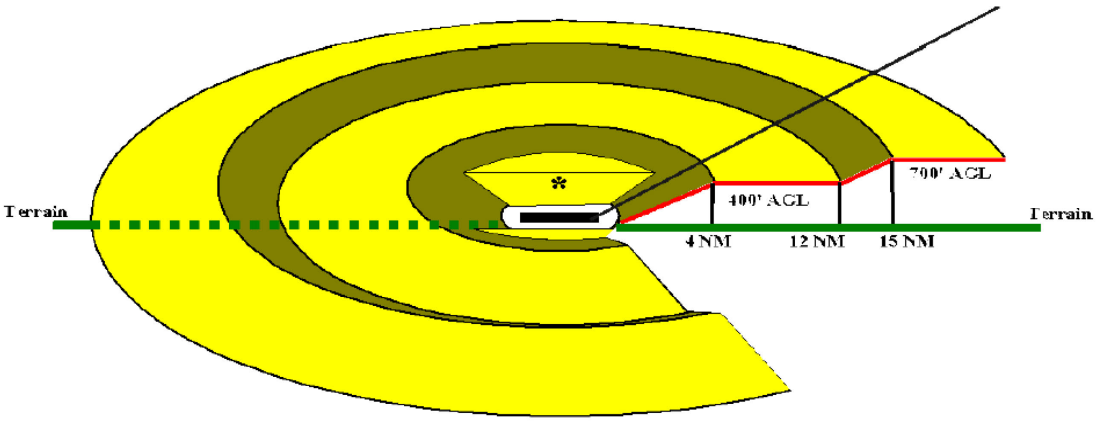
The Terrain Clearance Floor (TCF) function enhances the basic GPWS Modes by alerting the pilot of descent below a defined "Terrain Clearance Floor" regardless of the aircraft configuration. The TCF alert is a function of the aircraft´s Radio Altitude and distance relative to the centre of the nearest runway included in the database (all runways greater than 3500 feet in length). The TCF envelope is defined for all runways as illustrated in the figure and extends to infinity, or until it meets the envelope of another runway.

The Runway Field Clearance Floor (RFCF) feature is similar to TCF except that RFCF is based on the current aircraft position and height above the destination runway, using Geometric Altitude (in lieu of Radio Altitude). This provides improved protection at locations where the runway is significantly higher than the surrounding terrain as illustrated in the figure.

The TCF and RFCF alerts result in illumination of the EGPWS caution lights and the aural message "TOO LOW TERRAIN". The audio message is provided once when initial envelope penetration occurs and again only for additional 20 % decreases in Radio Altitude. The EGPWS caution lights remain on until the TCF envelope is exited.

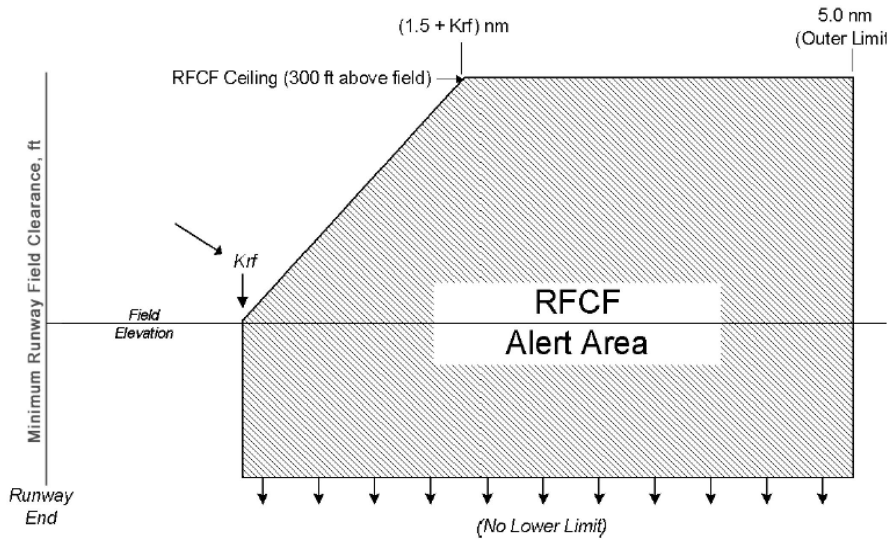


TCF Alert Envelope



Improved TCF Envelope

Figure 34-30 Terrain Clearance Floor



RFCF Alert Envelope

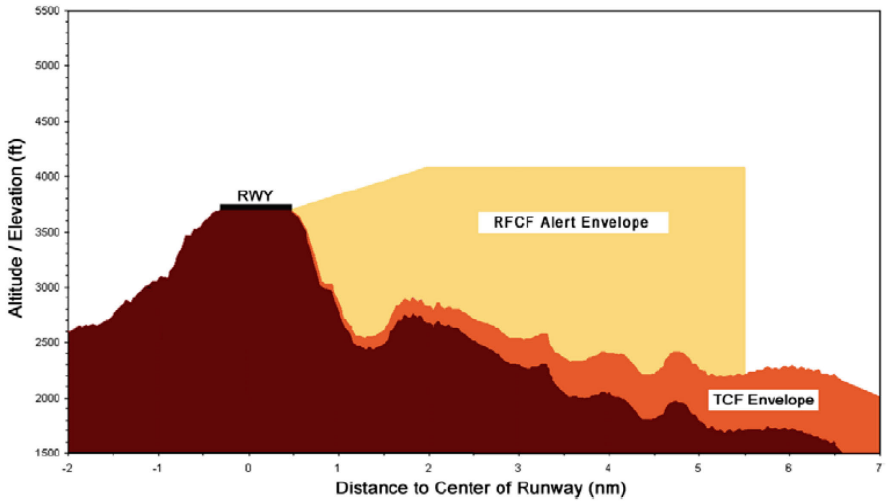


Figure 34-31 Runway Field Clearance Floor

Terrain (or Obstacle) Awareness Display

The terrain (or Obstacle) Awareness Display (TAD) provides the ability to look ahead of the aircraft and detect terrain or obstacle conflicts with greater alerting time.

The Caution and Warning envelopes use the TCF as a baseline, and "look ahead" of the aircraft in a volume determined as a function of ground speed, flight path angle and track.

A terrain conflict intruding into the Caution envelope boundary activates EGPWS caution lights and the aural message "CAUTION TERRAIN, CAUTION TERRAIN". An obstacle conflict provides a "CAUTION OBSTACLE, CAUTION OBSTACLE" message. Simultaneously, the TERRAIN message is displayed, in amber colour, on the PFD.

If the aircraft penetrates the Warning envelope boundary, EGPWS warning lights activate and the aural message "TERRAIN, TERRAIN, PULL UP" or "OBSTACLE, OBSTACLE, PULL UP" is enunciated with "PULL UP" repeating continuously while the conflict is within warning area. Simultaneously, the TERRAIN message is displayed, in red colour, on the PFD.

When the conditions for either a Terrain Caution or a Terrain Warning are dictated, the system automatically changes the ND from the weather radar picture to the terrain picture (if the weather radar display is activated), and the weather radar is automatically set to stand-by.

Two types of TAD displays are available depending on the display system and options selected. One type provides a terrain image only when the aircraft is 2000 feet or less above terrain. The second type called "Peaks" enhances the display characteristics to provide a higher degree of terrain awareness independent of the aircraft´s altitude. In either case, terrain and obstacles forward of the aircraft and within the range selected are displayed.

The Non-Peaks display provides a graphical plan-view image of the surrounding terrain as varying density patterns of green, yellow and red. The selected display range is also indicated on the display. Each specific colour and intensity represents terrain (and obstacles) below, at, or above the aircraft´s altitude based on the aircraft´s position with respect to the terrain in the database.

When a caution alert is triggered, the terrain (or obstacle) that created the alert is changed to solid yellow (100 % density). When a warning alert is triggered, the terrain (or obstacle) that created the alert is changed to solid red (100 % density).

TERRAIN IS SHOWN IN SHADES OF GREEN, YELLOW AND RED

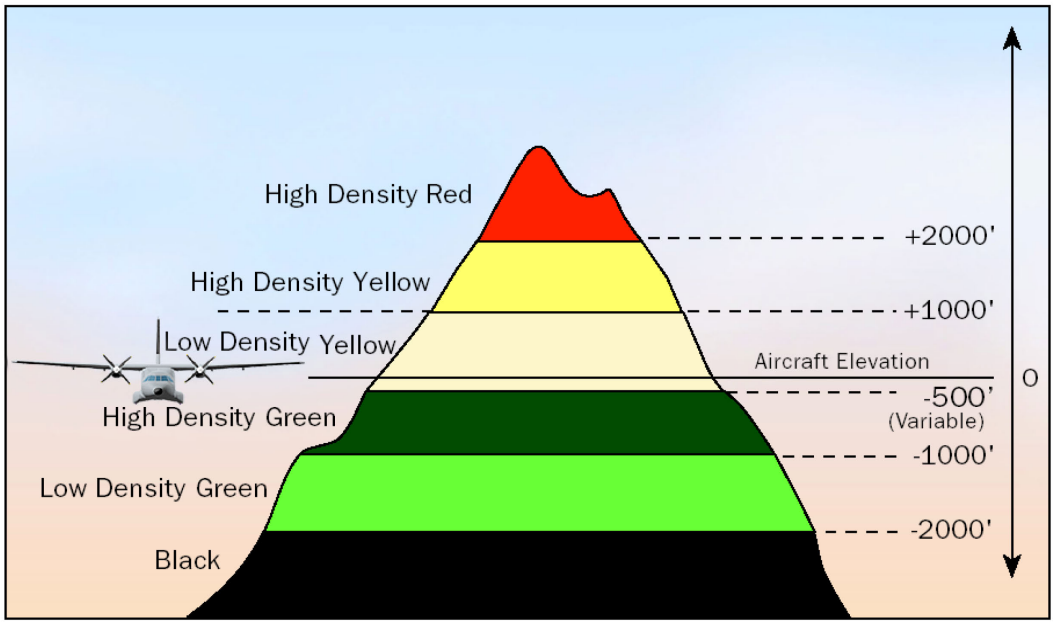


Figure 34-32 TAD Non Peaks Display

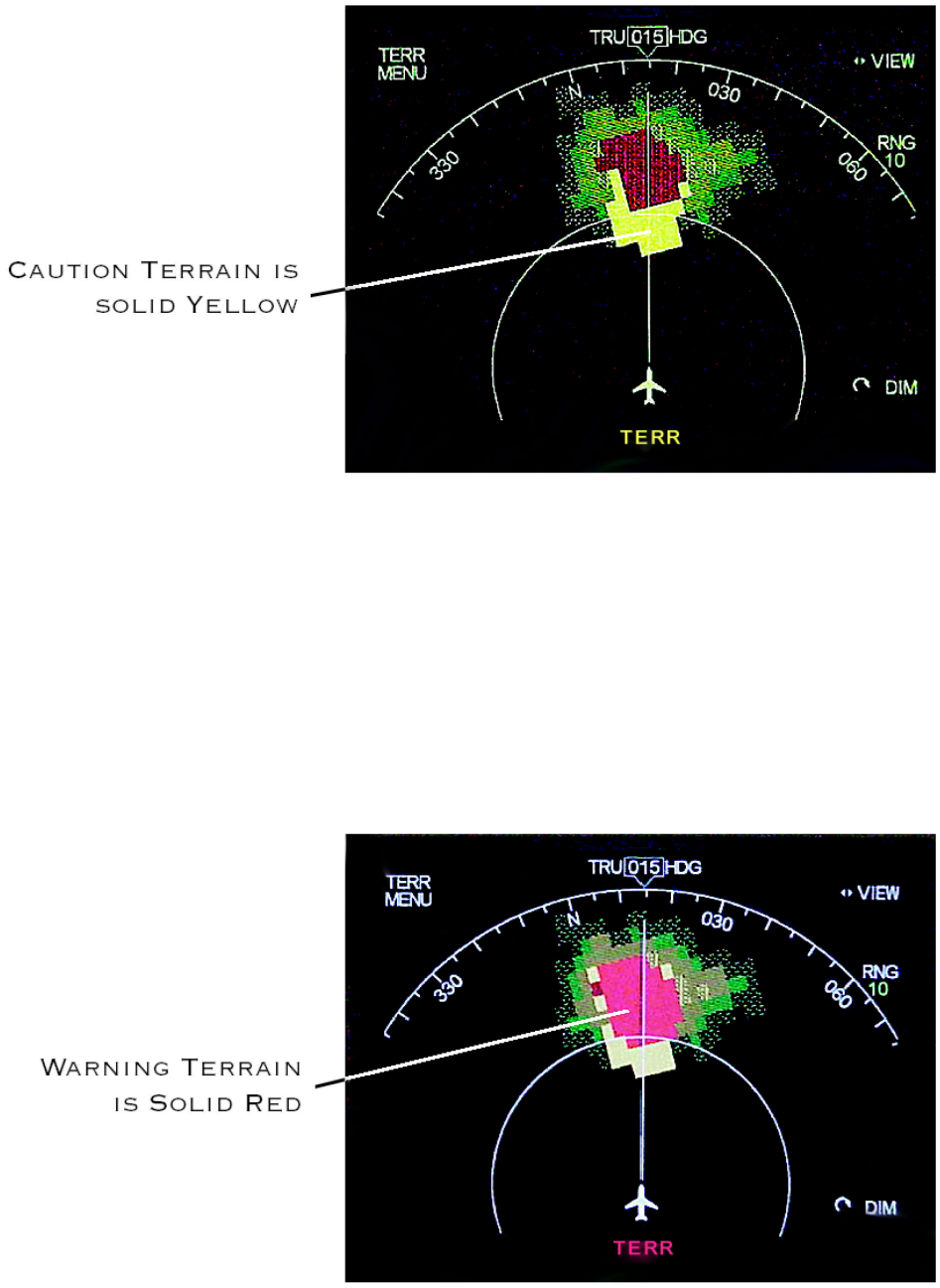
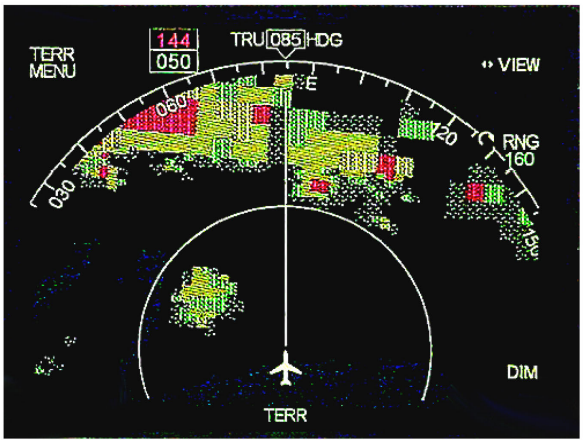
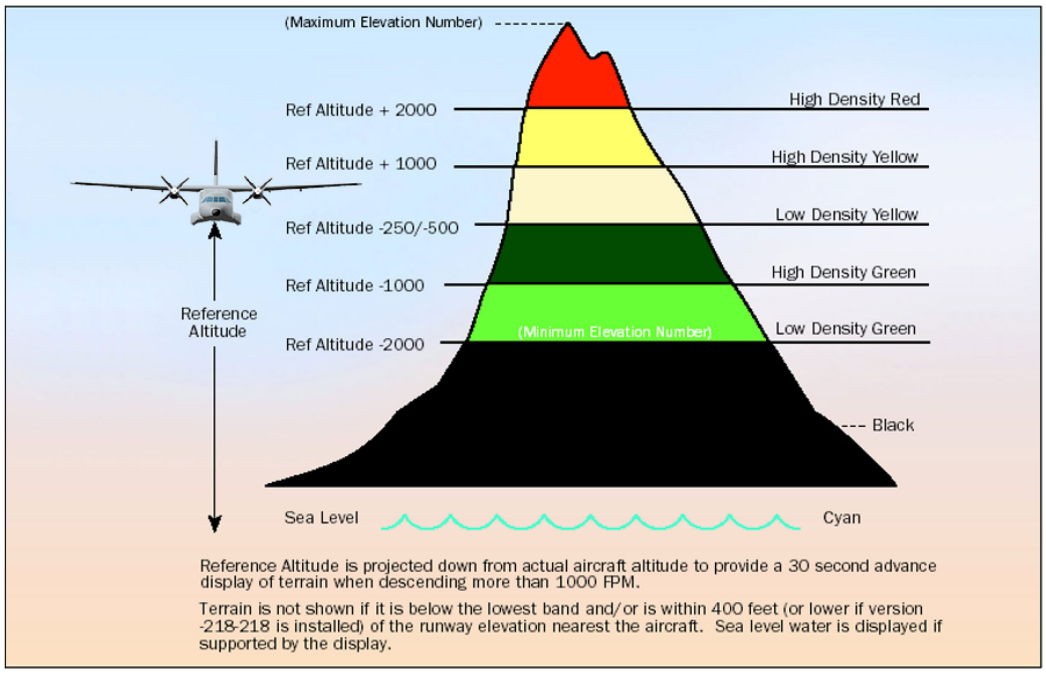


Figure 34-33 TAD Warning and Caution Zones

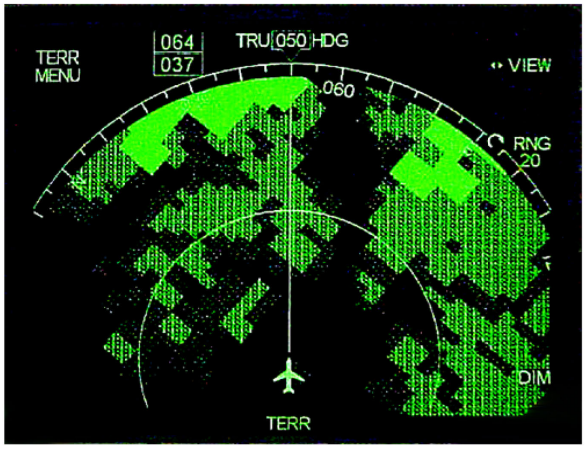
Peaks Display has all the characteristics of the Non-Peaks Display but with additional terrain display features. The principle additions are the digital display of the highest and lowest terrain/obstacle elevations currently displayed, and the display of additional solid or lower density colour bands, including the addition of the graphic representation of sea level. In the event that there is no appreciable difference between the highest and lowest terrain/obstacle elevations, only the highest value is displayed.

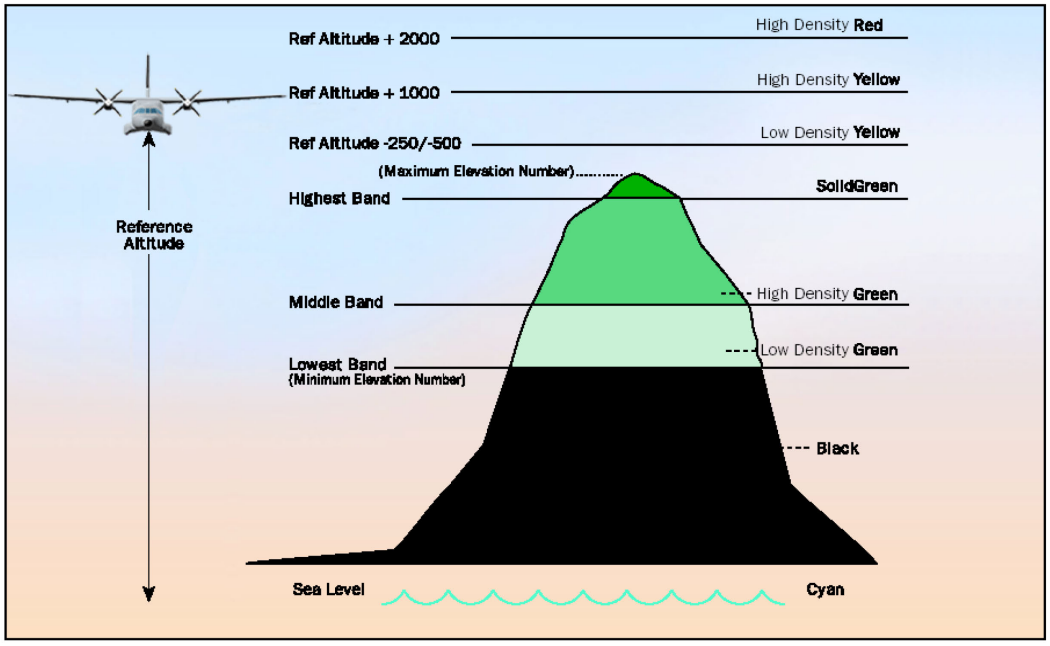




Peaks Display at a low Relative Altitude

Figure 34-34 Peaks Display (Sheet 1 of 2)





Peaks Display at a high Relative Altitude

Figure 34-34 Peaks Display (Sheet 2 of 2)

Aural Message Priority

Two or more messages may be activated simultaneously, so a message priority is established. Messages at the top of the list will start before or immediately override a lower priority message even if it is already in progress.

1. "PULL UP" (Mode 1 and 2)
2. "TERRAIN, TERRAIN" (Mode 2)
3. "TERRAIN, TERRAIN PULL UP" (Mode TAD)
4. "OBSTACLE, OBSTACLE PULL UP" (Mode TAD)
5. "TERRAIN" (Mode 2)
6. "MINIMUMS" (Mode 6)
7. "CAUTION TERRAIN, CAUTION TERRAIN" (Mode TAD)
8. "CAUTION OBSTACLE, CAUTION OBSTACLE" (Mode TAD)
9. "TOO LOW TERRAIN" (Mode 4 and TCF)
10. Altitude Callouts (Mode 6)
11. "SPEED BRAKE, SPEED BRAKE" (Mode 6)
12. "TOO LOW GEAR" (Mode 4A)
13. "TOO LOW FLAPS" (Mode 4B)
14. "SINK RATE, SINK RATE" (Mode 1)
15. "DON´T SINK, DON´T SINK" (Mode 3)
16. "GLIDESLOPE" (Mode 5)
17. "APPROACHING MINIMUMS" (Mode 6)
18. "BANK ANGLE, BANK ANGLE" (Mode 6)

CONTROLS AND INDICATIONS

(1) TEST Pushbutton:

- *Pressed once:* test the system, and if it is operative:
  - On PFD´s, INOP GPWS TERR lights, in amber colour, turn on.
  - On ND´s, TERR FAIL lights, in amber colour, turn on.
  - On PFD´s, GPWS lights, in amber colour, turn on.
  - "GLIDESLOPE" message is announced.
  - On PFD´s, GPWS lights turn off.
  - On EGPWS panels, CNCL legends of G/S CNCL pushbuttons turn on.
  - On EGPWS panels, CNCL legends of G/S CNCL pushbuttons turn off.
  - On PFD´s, GPWS lights, in red colour, turn on.

- "PULL UP" message is announced.
- "TERRAIN, TERRAIN PULL UP" message is announced.
- On ND´s, the Terrain Display self test pattern is displayed and TERR ON lights, in white colour, turn on.
- On PFD´s, GPWS lights turn off.
- On ND´s, the Terrain Display self test pattern turns off after several sweeps.

(2) TERR INHB Pushbutton:

- *Pressed (TERR INHB on, in amber colour):* inhibits TAD and TCF alerting display.

(3) AUDIO INHB Pushbutton:

- *Pressed (AUDIO INHB on, in amber colour):* inhibits all audio warnings.

(4) FLAP OVRD Pushbutton:

- *Pressed (FLAP OVRD on, in white colour):* enables to override the flap position indications during a low altitude flight.

(5) GPWS INHB Pushbutton:

- *Pressed (GPWS INHB on, in amber colour):* inhibits all audio and visual warnings alerts related to the basic GPWS modes.

(6) G/S CNCL Pushbutton:

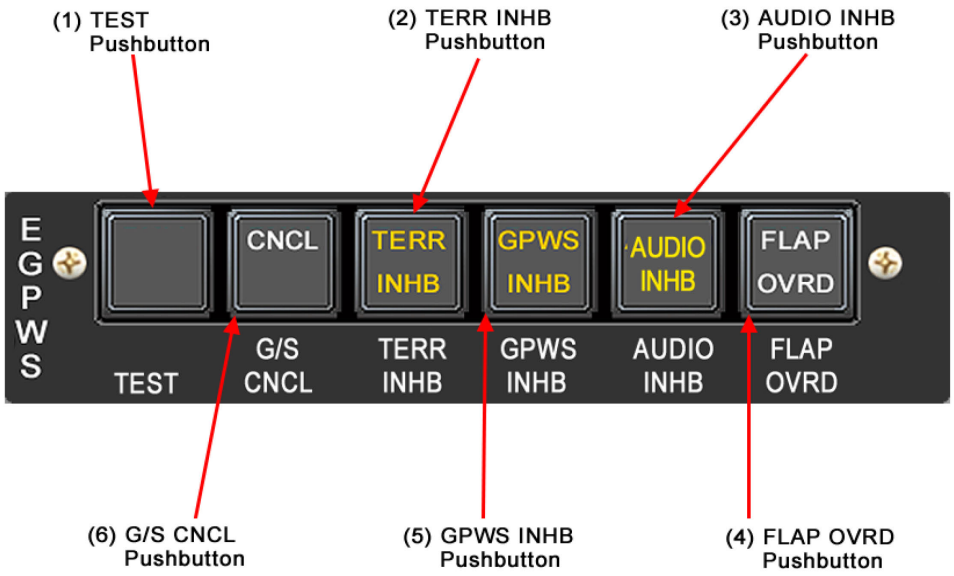
- *Pressed (CNCL on, in white colour):* is used to cancel the below glideslope warning in mode 5.

(7) EGPWS Warnings and Cautions:

- *TERRAIN (amber):* A caution situation occurs.
- *TERRAIN (red):* a warning situation occurs.
- *INOP GPWS (amber):* failure in the system and the GPWS basic modes are inoperative.
- *INOP TERR (amber):* failure in the EGPWS and the TAD and TCF functions are inoperative. This will not affect the basic GPWS functions.

(8) EGPWS Announcements:

- *EGPWS OFF (white):* EGPWS are not energized.
- *TERR ON (white):* TAD and TCF enhanced functions are energized.
- *TERR FAIL (amber):* Failure in the EGPWS and the TAD and TCF functions are inoperative. This will not affect the basic GPWS functions.



C/M-1 AND C/M-2 INSTRUMENT PANELS

Figure 34-35 Enhanced Ground Proximity Warning System - Controls and Indicators (Sheet 1 of 2)

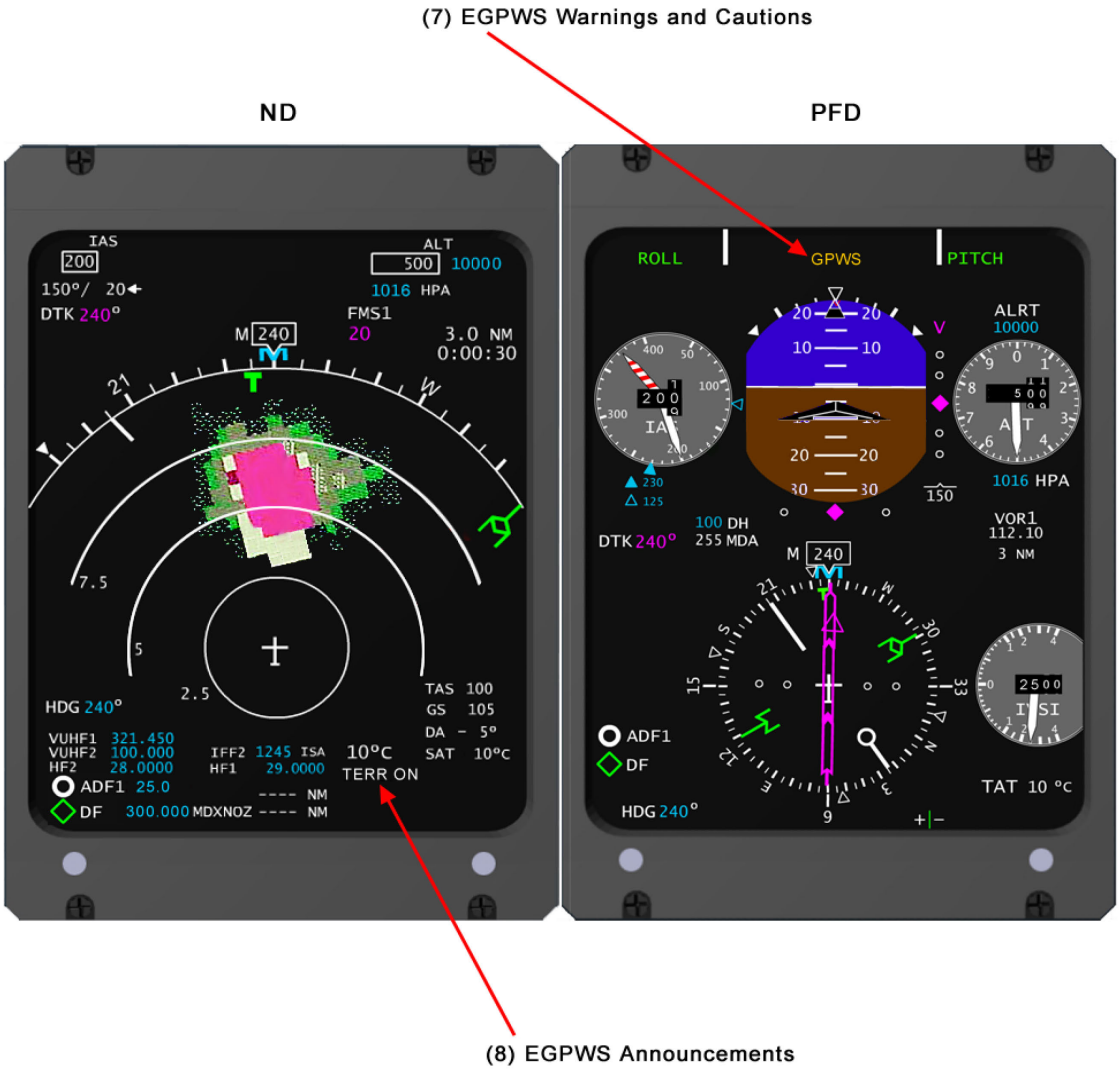


Figure 34-35 Enhanced Ground Proximity Warning System - Controls and Indicators (Sheet 2 of 2)

ABNORMAL PROCEDURES

Pressing the GPWS INHB pushbutton (in the C/M-1 and C/M-2 Instrument Panel), suppresses the basic GPWS aural and visual alerts only (TAD and TCF functions remain fully operative). Press in GPWS INHB pushbutton when landing with the gear up, or discretionary after the GPWS malfunctions.

Selecting the FLAP OVRD pushbutton can be desensitize the Mode 2 alerts to eliminate related unwanted alerts when required to operate in close proximity to terrain. The FLAP OVRD pushbutton requires manual deactivation.

CAUTION

The FLAP OVRD pushbutton should always be kept unpressed (safetied) except for approved procedures where the use of flaps at less than the landing flap position.

Pressing the FLAP OVRD pushbutton can be reduced the Mode 4 alerts. This is recommended when performing approaches with less than landing flaps selected, or landing gear not down. The FLAP OVRD pushbutton requires manual deactivation.

To permit manoeuvring on final approach to landing, such as during a back-course approach or a late transfer to a parallel runway, the GS alert function may be inhibited by pressing any of the GPWS EGPWS G/S CNCL pushbuttons at any time after the airplane has descended below 2000 feet radio altitude on the glide slope; thereafter, the mode will rear many time the airplane goes either below 30 feet, above 2000 feet radio altitude, or when a non-ILS frequency is selected.

Pressing the TERR INHB pushbutton inhibits TAD and TCF alerting display. This is typically used when operating at airports or runways not in the terrain database. TERR INHB requires manual deactivation.

When an aural alert occurs take appropriate to correct the unsafe condition; however, when flying VFR/DAY, should a warning threshold be deliberately exceeded or encountered when operations at specific locations must be conducted in close proximity terrain, the warning may be regarded as cautionary and the approach may be continued.

When an aural "PULL UP", "TERRAIN, TERRAIN, PULL UP", or "OBSTACLE, OBSTACLE PULL UP" warning occurs, execute a positive pull up, apply engine power, and climb at the best climb angle until a safe altitude is reached. In certain circumstances the warning provided by the system may be very late so recovery action should be prompt and positive.

When an aural "CAUTION TERRAIN, CAUTION TERRAIN", "CAUTION OBSTACLE, CAUTION OBSTACLE", "SINKRATE, SINKRATE", "TERRAIN, TERRAIN", "DON´T SINK, DON´T SINK", "TOO LOW TERRAIN", "TOO LOW GEAR", "TOO LOW FLAPS" occurs, take appropriate action to correct the unsafe condition.

When the "BANK ANGLE, BANK ANGLE" alert occurs, airplane bank should be reduced as necessary to effect aural alert cancellation.

When an aural "GLIDESLOPE" alert occurs, initiate corrective action to fly the airplane back to the Glideslope centerline.

When EGPWS image display is selected on ND, the "TERR ON" label is shown. In this condition, if the EGPWS loses the position information, "INOP TERR" label is shown on the PFD and "TERR ON" label remains displayed on ND, in order to indicate that when the position information is recovered, the terrain image will be shown again on the ND. "TERR FAIL" label is only displayed on ND in case of an EGPWS failure.

When GPS position is not available, the PFD shall display "TERR INOP" and ND shall display "TERR ON". ND shall display "TERR FAIL" in case of EGPWS fail.

The message "CHANGE FORMAT/OR" will be displayed on ND only the first time EGPWS information is selected on EFCP and the ND presentation mode is not the proper.

In case of simultaneous failures of both FMSs, the "INOP TERR" label is shown on PFD indicating that Enhanced function is no longer available.

If the enhanced functions have been inhibited, the EGPWS will revert to basic GPWS. In this standard GPWS condition, the system may give no advance warning time for flight into precipitous terrain where there are few or no preceding obstructions. If the aircraft is flown toward obstructing terrain, the GPWS will give no warnings if the aircraft is in landing configuration, is in a stabilized descent at a normal descent rate and there is no ILS glideslope signal being received.

ETCAS

The ACAS II/TCAS II is an airborne collision avoidance and traffic situation system that is intended to identify other aircraft and ensure adequate separation by providing a collision warning if another aircraft is close enough to be considered a threat (standard TCAS function) and, when the enhanced function is selected, provides tracking of the aircraft designated as rendevouz intruder for airplane formation. The system displays warning commands on each PFD (through IVSI) by means of red and green stripes. It also provides acoustic warnings.

DESCRIPTION

Main system components are:

- ***Processor:*** located beneath the cockpit, interrogates nearby aircraft transponders and calculates estimated tracks from their replies. If any aircraft track involves a potential threat, the processor indicates the manoeuvers to be performed in order to avoid it.
- ***Directional Antennas:*** one located at the top of the aircraft and the other at the bottom. Both antennas transmit and receive radiofrequency signals to provide spherical coverage (refer to ANTENNAS, in CHAPTER 01).
- ***IFF Mode S transponder and its antennas***
- ***MCDUs:*** both ACAS/TCAS and IFF are controlled by any MCDU through IFF/TCAS pages of the Radio Management System.
- ***Primary Flight Displays (PFDs):*** display the Resolution Advisory commands through IVSI.
- ***Navigation Displays (NDs):*** display traffic information and ACAS/TCAS operational modes.

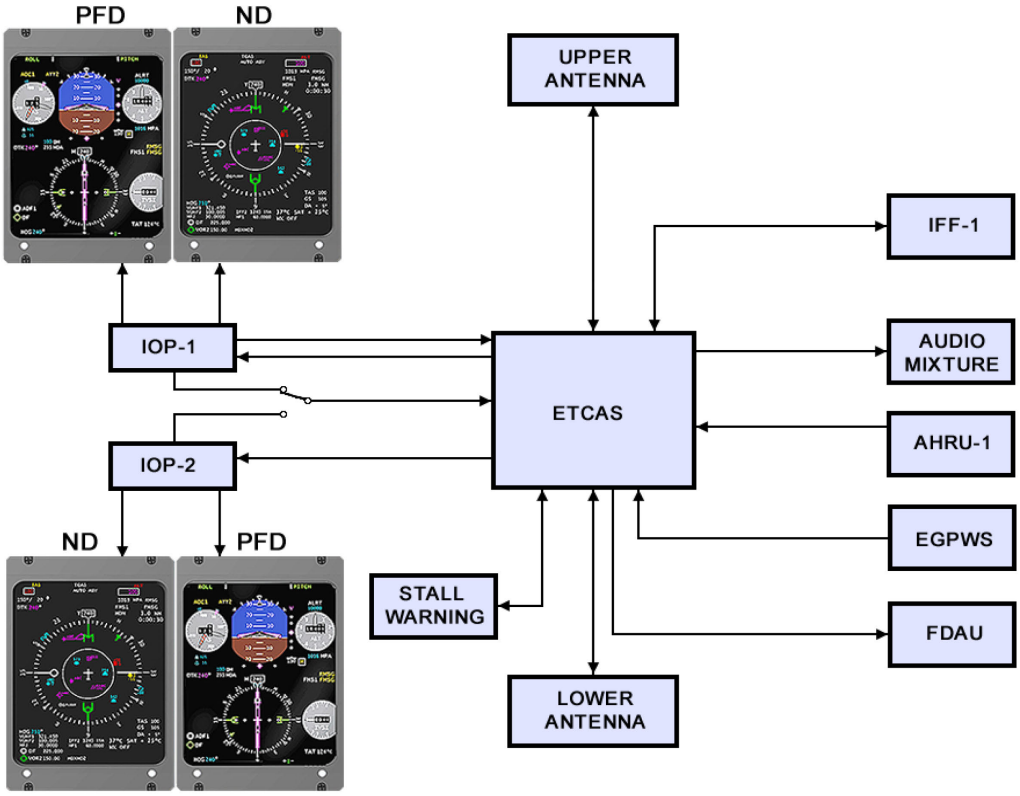


Figure 34-36 TCAS - Architecture

OPERATION

While at normal system operation, interrogate nearby aircraft transponders and calculate relative altitude, distance and bearing of any aircraft fitted with ATCRBS ('ATC radar beacon system') or Mode S Transponder with altitude information. From this information, TCAS estimates intruder aircraft flight path and compares it with the aircraft own path to determine threat level. Depending on it, the system provides the relevant warnings.

TCAS will operate up to a maximum of 100 nm (default-selected TCAS range). ND displayed TCAS range is EFCP controlled.

TCAS system carries out the following functions:

NOTE

ATCRBS equipped aircraft which only reply with Mode A information provides only altitude information; therefore, ACAS II/TCAS II cannot issue RAs for these aircraft but can issue TAs.

NOTE

The ACAS II/TCAS II will not detect aircraft without transponders.

– Surveillance: the system detects up to 30 aircraft in an airspace volume depending on whether it operates normal or enhanced. There are three types: active (send interrogation and receive reply), passive (capture squitter without sending interrogation) and hybrid (combination of active and passive surveillance, transmits position and identification without the need of an interrogation and minimizes the aircraft transponder occupancy time).

– Tracking: the system tracks nearby aircraft, determining their distance and relative altitude and bearing, displaying them properly identified according to their threat level.

– Threat Detection: TCAS system provides the following warnings depending on threatening levels:

  • Traffic Advisory (TA): Intruder aircraft not involving an imminent-but potential threat. Up to 60 advisories.

  • Resolution Advisory (RA): Intruder aircraft dangerously closer than TAs. There are two RA types, preventive and corrective. Preventive RA (PRA) requires a pilot to avoid certain vertical speeds. Corrective RA (CRA) requires a pilot to either modify the existing vertical speed of the aircraft, or to maintain minimum safe separation from a threat aircraft.

  • Proximity Traffic (PT): Intruder aircraft at less than 6 nm and within 1200 feet vertically from own aircraft, which not involving a collision threat.

  • Other Traffic (OT): Intruder aircraft not identified as TA/RA/PT.

– Threat Resolution: TCAS system calculates the aircraft Closest Point of Approach (CPA) and if there is a risk of collision it sets-off the warning sequence.

– Communication and Coordination: If the conflict is with another TCAS-fitted aircraft, the system communicates with the intruder aircraft TCAS system for manoeuvre co-ordination purposes.

– Formation Flight and Rendezvous Operation: When enhanced function is selected, ETCAS subsystem tracks the selected aircraft as formation partner or for rendezvous purposes.

"ILA" (Interference Limiting Algorith) activation indicates that the TCAS has decreased its transmit power and interrogations in order to avoid that interrogations from TCAS equipped aircraft may interfere with the ability of ATC to track aircraft. Although the general limit of 30 intruders for all TCAS systems, ILA activation is not associated to an exact number of aircrafts in the own aircraf vicinity. Depending on the selected range on the displays and the TCAS equipped aircraft distribution in the own aircraft vicinity, ILA may be activated even if the number of aircraft shown on the displays is not too high.

NOTE

ILA activation is part of TCAS normal operation and it does not suppose any system failure. The system keeps generating TAs and RAs as usual.

NOTE

When ETCAS mode is enabled or aircraft is grounded, ILA is activated with fewer TCAS equipped aircraft in the area.

Threat-solving reply from the system includes:

– If traffic is detected at 20-48 seconds CPA, an acoustic and visual TA warning is given. This level alerts of a potential collision threat as confirmed by both traffic information screen and "TRAFFIC - TRAFFIC" acoustic message, but does not recommend any particular manoeuvre.

– If the intruder aircraft is detected at 15-35 seconds CPA, it is considered a threat and both acoustic and visual RA warning will be given. This level displays a recommended vertical manoeuvre on the IVSI/TCAS display with solutions and acoustic messages, in order to required vertical separation from the intruder aircraft. Potentially dangerous manoeuvres are also displayed.

NOTE

When RA-solving, evasive manoeuvering must be made with the autopilot disengaged and must be limited to the minimum required to comply with the RA.

When an RA occurs, the pilot must respond immediately by direct attention to RA displays and manoeuvre as indicated. Avoidance manoeuvres based on visual acquisition of traffic may not always provide the appropriate means of avoiding conflicting traffic.

Resolution advisories are annunciated by the following initial voice messages as appropriate, along with the expected pilot response:

NOTE

In order to obtain an adequate TCAS system audio level, adjust the David Clark headset volume at least to position 4 above the minimum level.

– 'CLIMB, CLIMB'. Climb at the vertical speed represented by the IVSI/ETCAS ("Fly To") green arc.

– 'DESCEND, DESCEND'. Descend at the vertical speed represented by the IVSI/TCAS ("Fly To") green arc.

– 'MONITOR VERTICAL SPEED'. Ensure vertical speed is outside the IVSI/TCAS red arc.

– 'MAINTAIN VERTICAL SPEED MAINTAIN'. Maintain current vertical speed and ensure to stay outside the IVSI/TCAS red arc.

– 'MAINTAIN VERTICAL SPEED CROSSING MAINTAIN'. Take the same precautions as previously. In this case, crossing paths are expected.

– 'ADJUST VERTICAL SPEED ADJUST'. Reduce vertical speed to a value within the IVSI/TCAS green arc.

– 'CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB'. Climb at the vertical speed represented by the IVSI/TCAS ("Fly To") green arc (paths may cross at a particular altitude).

– 'DESCEND, CROSSING DESCEND, DESCEND, CROSSING DESCEND'. Descend at the vertical speed represented by the IVSI/TCAS ("Fly To") green arc (paths may cross at a particular altitude).

– 'CLEAR OF CONFLICT'. Return smoothly and promptly to the ATC-assigned airspace unless otherwise ordered. The conflict is over. If intruder aircraft information is lost, RA will end without any 'CLEAR OF CONFLICT' message.

The following acoustic messages are given if RA does not provide enough vertical separation. Message tone and inflexion suggests urgency.

– 'INCREASE CLIMB, INCREASE CLIMB'. Following a "CLIMB" warning to indicate vertical speed has to be increased to achieve a safe vertical separation, the one represented by IVSI/TCAS green arc ("Fly To").

– 'INCREASE DESCENT, INCREASE DESCENT'. Descend at IVSI/TCAS green arc ("Fly To") vertical speed to achieve a safe one.

– 'CLIMB - CLIMB NOW, CLIMB - CLIMB NOW'. Climb at IVSI/TCAS green arc ("Fly To") represented vertical speed. Following a "DESCENT" warning to indicate a change of direction is required to achieve a safe vertical separation.

– 'DESCEND- DESCEND NOW, DESCEND - DESCEND NOW'. Descend at IVSI/TCAS green arc ("Fly To") represented vertical speed. Following a "CLIMB" warning to indicate a change of direction is required to achieve a safe vertical separation.

NOTE

The RA voice messages are inhibit below 900 feet AGL during a descent and below 1100 feet AGL during a climb (TCAS automatically reverts to the TA ONLY mode).

NOTE

All TCAS voice messages are inhibited below 400 feet AGL during a descent and below 600 feet AGL during a climb.

To inhibit 'CLIMB' and 'INCREASE CLIMB' messages, IOP takes into account:

– Flap position.

– Altitude: the standard altitude taken from the selected ADU.

– Gross weight: taken from the own side FMS if valid, else from the opposite side FMS.

Flap Position	**'CLIMB'**	**'INCREASE CLIMB'**
UP (0º)	· Inhibit when above 20000 ft for all gross weight. · Inhibit above 16000 ft and gross weight above 15000 kg (33075 lb). · Inhibit above 10000 ft and gross weight above 17000 kg (37485 lb). · Inhibit above 5000 ft and gross weight above 22000 kg (48510 lb).	· Inhibit when above 10000 ft for all gross weight. · Inhibit above 5000 ft and gross weight above 15000 kg (33075 lb). · Inhibit for gross weight above 17000 kg (37485 lb).
T/OFF (10º)	· Inhibit above 14000 ft.	· Inhibit.
APPR (15º)	· Inhibit above 14000 ft.	· Inhibit.
LNDG (23º)	· Inhibit above 47000 ft or gross weight above 21000 kg (46305 lb).	· Inhibit.

Table 34-2 TCAS - Inhibition of 'CLIMB' and 'INCREASE CLIMB' messages

NOTE

If IOP does not receive flap, altitude or gross weight data, the most restrictive situation for this input (flaps LNDG, altitude above 20000 ft, gross weight above 22000 kg (48510 lb)) is considered for message inhibition.

CONTROLS AND INDICATORS

ND

(1) Traffic Symbols:

to indicate detected traffic position, relative flight level, reference climb rate and threat level.

Relative altitude is displayed in the proximity of the ownship symbol in hundreds of feet. A (+) preceding the relative altitude indicates the detected traffic is above, and a (-) indicates it is below. If the altitude is less than 1000 ft, a leading zero is used, 00 indicates the intruder is at the same altitude level but can be displayed above or below the traffic symbol if the intruder is close from above or below.

An arrow close to the symbol indicates if intruder climb/descent rate is greater than 500 fpm as well as its direction. Rate may be relative or absolute (as selected at MCDU IFF/TCAS page).

When the absolute altitude option is selected, the corrected altitude is displayed in place of the relative altitude in hundreds of feet using 3 digits with leading zeros and +/- sign.

When an intruder is not reporting altitude, the data about altitude and trend arrow are not displayed.

- Cyan Diamond (OT): non-threatening traffic not classified as TA, RA or PT.
- Solid Cyan Diamond (PT): nearby non-threatening traffic within 1200 feet vertically and 6 nm horizontally, not classified as TA or RA.
- Solid Yellow Circle (TA): Intruder aircraft not representing an immediate but potential, threat.
- Solid Red Square (RA): nearby traffic representing a threat of collision.

NOTE

Outside ND selected range, one-half of the corresponding symbol is displayed at scale edge. The symbol will appear in its proper color and have its tag data displayed provided there is room.

In Formation Flight and Rendevouz Operation the mode 3/A code for the aircraft designated as rendezvous intruders is tagged beside the corresponding intruder symbol. This symbol is a white square surrounding the TCAS intruder symbol for the corresponding above mentioned categories. The white square flashes when the rendezvous intruder's Special Position Identification has been set in its replies to TCAS.

(2) TCAS Operating Modes:

indicates MCDU IFF/TCAS page selected mode.

The first line contains TCAS status:

- TCAS STBY: the system is in stand-by mode. No TCAS advisory is displayed.
- TCAS FAIL: a failure has been detected.
- TCAS TEST: the system is performing a self test.
- TCAS TA ONLY: the TCAS is in TA ONLY mode.
- TCAS: the system is active and not in one of the previous mode (current mode is TA/RA).

The second line contains de altitude display option:

- AUTO: display RA/TA/PT/OT whenever a RA or TA is present.
- ABV: the system displays other traffic from 2700 ft below the own aircraft to 8700 ft (12700 ft ETCAS) above.
- BLW: the system displays the tracked traffic from 2700 ft above the own aircraft to 8700 ft (12700 ft ETCAS) below.

“ILA” message indicates ILA activation.

The third line contains altitude option:

- ABS: the absolute altitude option has been selected and when no RA or TA is detected.

NOTE

Second and third lines are not displayed in stand-by mode or when the TCAS has failed.

(3) Range Ring:

used to indicate both range and bearing by means of an aircraft (central symbol) surrounding 2 nm area. Displayed by operating EFCP TCAS selector to AUTO or ON position. Ring diameter depends on ND-selected range (not displayed if selected range is greater than 10 nm). In AUTO mode the ring only displays in case of RA or TA.

PFD

(4) Vertical Speed Indicator Arcs:

recommended speeds to avoid conflicts and/or collision risks display in green. Vertical speeds to avoid an accident display in red.

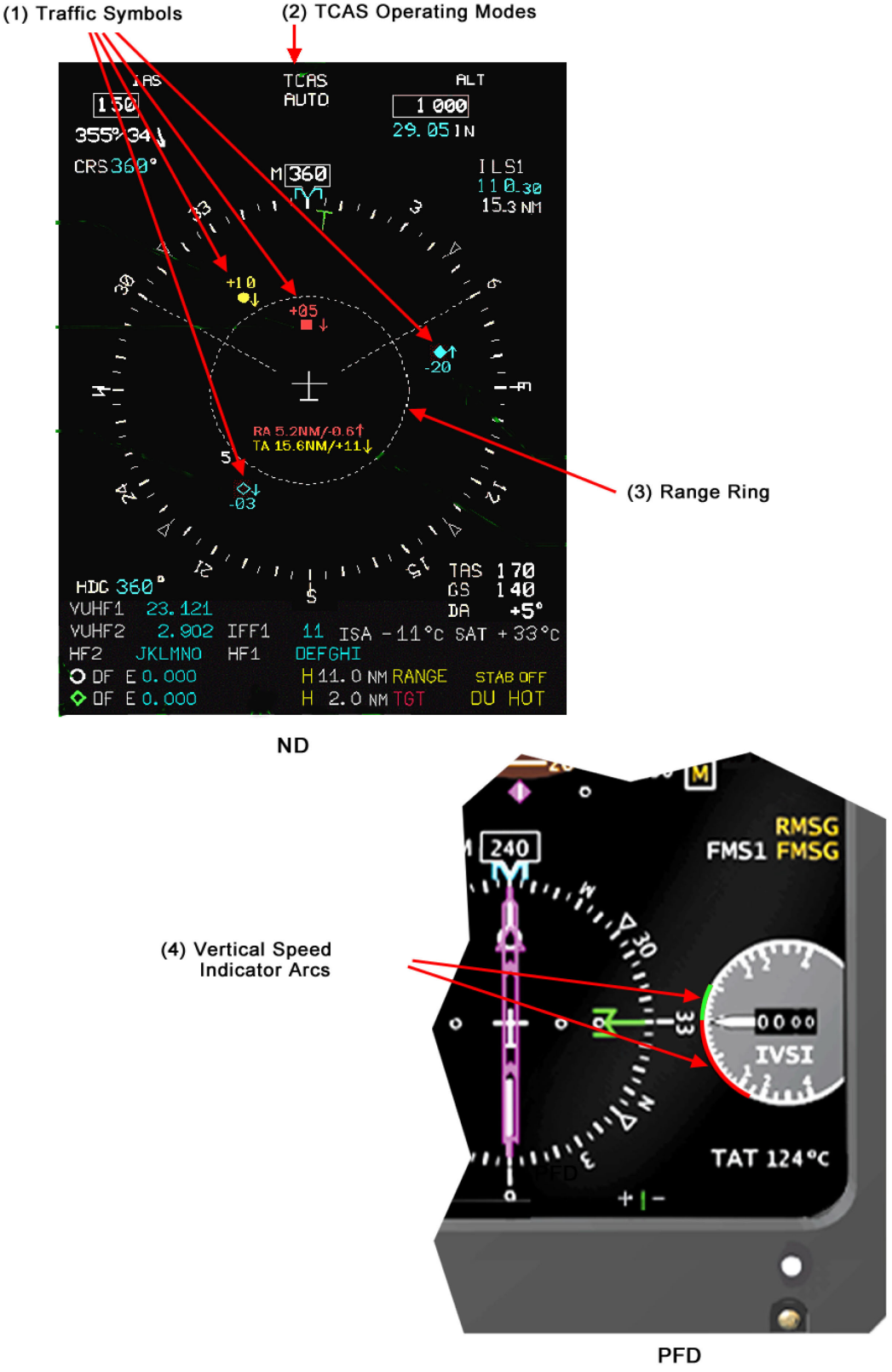


Figure 34-37 TCAS - Controls and Indicators

MCDU

IFF/TCAS Page:

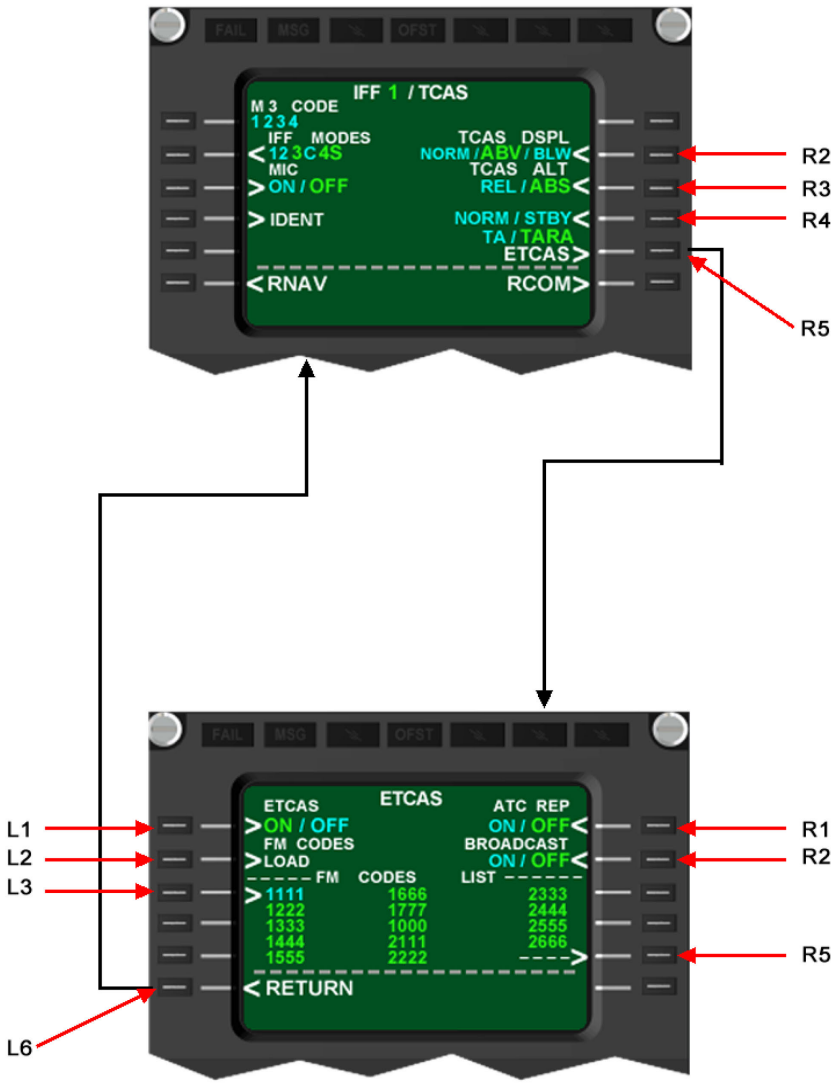
IFF/TCAS page is intended to select combined IFF/TCAS modes of operation.

TCAS modes are selected by means of the following keys:

- *R2*: when pressed, ND display mode changes from NORM→ to ABV→ to BLW→ and back to NORM.
  - In NORM mode, ND displays intruders with relative altitudes of ±2700 ft from the aircraft.
  - In ABV mode, ND displays intruders detected at -2700 ft and at +8700 ft (+12700 ft with ETCAS mode selected) from the aircraft.
  - In BLW mode, ND displays intruders detected at -8700 ft (-12700 ft with ETCAS Mode selected) and at +2700 ft from the aircraft.
- *R3:* allows to set altitude reference as relative to the aircraft (REL) or absolute (ABS) as relative to ground level. ABS mode can only be activated when no RA or TA intruders have been detected.
- *R4:* when pressed, mode goes from NORM→ to STBY→ to TA→ to TARA→ and back to NORM.
  - In NORM mode TCAS is in standby mode, while IFF operates according to its mode selection.
  - In STBY Mode both IFF and the TCAS are in standby.
  - In TA mode IFF operates according to its mode selection, while TCAS identifies both TA and RA as TA intruders. RA corrective resolution advices are also inhibited.
  - In TARA mode IFF operates according to its mode selection, while TCAS displays TA and RA warnings as usual.
- *R5:* moves to ETCAS page.

ETCAS Page:

- *L1:* selects ETCAS mode.
- *L2:* loads formation partner codes.
- *L3:* adds to the list any input-field 3/A valid code, unless the list contains 30 codes; at this point, it replaces the first code in the list. If the field is blank the list is scrolled-up sequentially. CLEAR allows to delete L3 opposite-located code.
- *L6:* moves back to IFF/TCAS page.
- *R1:* enables (ON) or disables (OFF) replies to ATC interrogations. The ATC REP must be disabled only for aircraft formation members and must not be performed unless authorization is obtained.
- *R2:* enables (ON) or disables (OFF) replies to TCAS interrogations. The TCAS broadcast must be disabled only for aircraft formation members and must not be performed unless authorization is obtained.
- *R5:* when the codes list contains more than 14 codes, any non-listed aircraft can be displayed by means of a 'line-by-line' list scrolling.



ETCAS Page

Figure 34-38 IFF/TCAS Page

COM CTL

(1) EMCON Pushbutton:

(refer to SECURE COMMUNICATIONS, in CHAPTER 23)

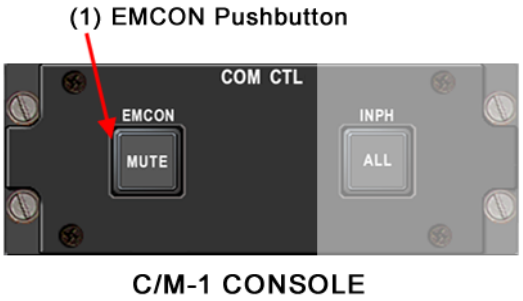


Figure 34-39 ETCAS (EMCON function) - Controls and Indicators

DEPENDENT POSITION DETERMINING

Dependent position determining system provides the flight crew with navigation data from ground stations (or satellites) dependent information.

The system has the following subsystems:

- ***Automatic Direction Finder (ADF):*** guides to the aircraft to find the direction of ground transmitter (guide the aircraft from to station) or other radio beacons that operate in V/UHF frequency.
- ***VHF Navigation:*** provides navigation, approach and landing information based on very high frequency omnidirectional radio beacons (VOR), instrument landing systems (ILS) and marker beacons (MB) information.
- ***Distance Measuring Equipment (DME):*** provides the flight crew with distance to a ground station information.
- ***Identification Friend or Foe (IFF):*** provides the ATC controller with aircraft identification, thus allowing ground radar to accurately-identify the required aircraft.

AUTOMATIC DIRECTION FINDER SYSTEM (ADF)

ADF system guides the aircraft to find the direction of transmitters and radio beacons that operate over frequency range, providing the flight crew with aircraft heading relative to a selected AM ground transmitter (commercial radio stations, non-directional radio beacons, or positioning radio beacons). It also provides an audio signal from the station with transmitter identification code, and if applicable, AM broadcasts as received from the station.

DESCRIPTION

The antenna receives signals from the selected ground station and sends these signals to the receivers which use signal data to determine ground station azimuth. Azimuth data are sent to both PFD and ND when selected for one bearing needle. Selected ground station frequency information is also sent, enabling PFD display.

Main system components are:

– ***Receivers:*** they are two receivers available, located at the LH and RH avionics compartments, both operating in 190.0-1799.5 KHz and 2179-2185 KHz frequency range, in steps of 50 Hz.

– ***Antenna:*** located at the lower aircraft, provides the receiver with data (refer to ANTENNAS, in CHAPTER 01).

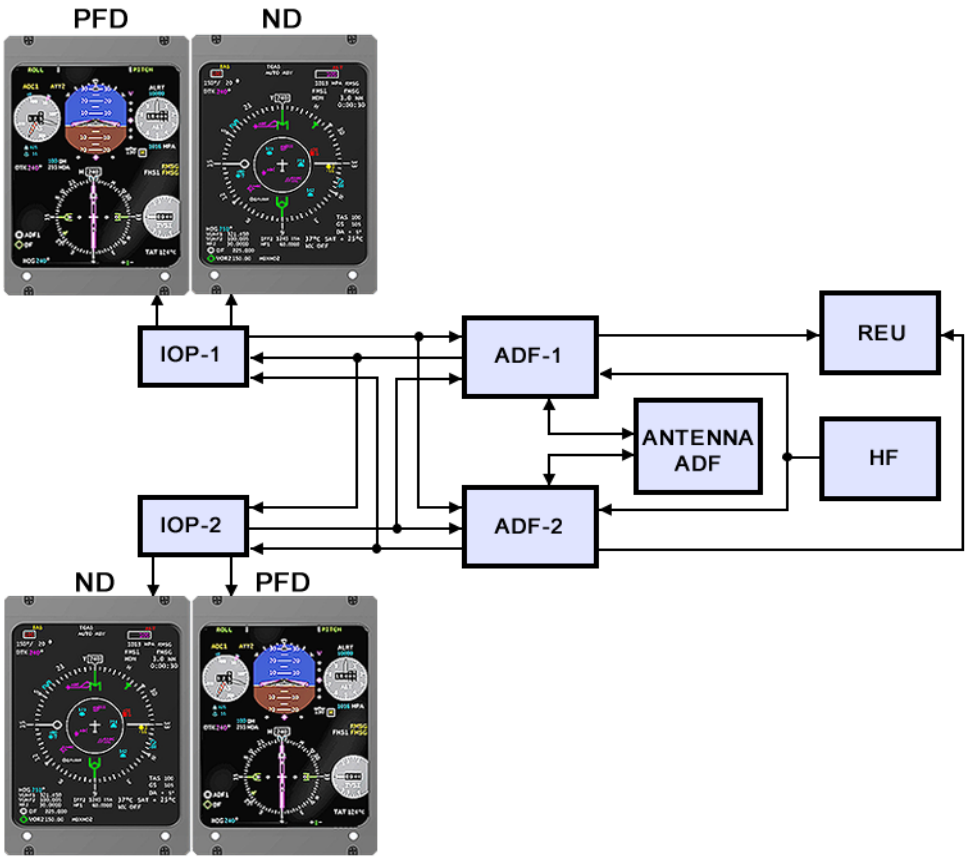


Figure 34-40 ADF System - Architecture

OPERATION

ADF system functions are controlled from MCDU ADF 1 or ADF 2 pages which control three system modes of operation (ADF, ANT and TONE), both active and preset frequencies, memory-saved frequencies and self-test function.

In ADF mode, the system calculates heading relative to the ground station and sends it to the display system. It also sends audio signal (identification or broadcast) to the integrated audio system.

In ANT mode, bearing data transmission to screens is inhibited in such way that ADF only provides received signal audio output.

In TONE mode, which is valid in both ADF and ANT modes, the system is able to receive coded carrier signals. Each receiver generates a 1000 Hz identification signal if an HF PTT (CW) signal is received.

NOTE

While an HF transmission is being performed, the ADF bearing pointer is frozen. And if the HF transmission continues more than 22 seconds, the ADF fails.

CONTROLS AND INDICATORS

PFD/ND

(1) Selected navigation sensor indication:

displays ADF-associated symbol as well as its identification (when ADF is selected on the EFCP).

(2) Bearing Pointer to the ADF station:

displays in graphical form aircraft azimuth information relative to the ADF station (when ADF is selected on the EFCP).

(3) Bearing Pointer 2:

displays in graphical form aircraft azimuth information relative to the ADF station (when ADF2 is selected on the EFCP).

(4) Bearing Source Indicator 2:

displays the frequency and navaid identifier for the ADF2 (when ADF2 is selected on the EFCP). If the frequency of navaid identifier is not available or not valid (no frequency tuned), the frequency is replaced by dashes and the identifier is left blank.

(5) Bearing Source Indicator 1:

displays the frequency and navaid identifier for the ADF1 (when ADF1 is selected on the EFCP). If the frequency of navaid identifier is not available or not valid (no frequency tuned), the frequency is replaced by dashes and the identifier is left blank.

(6) Bearing Pointer 1:

displays in graphical form aircraft azimuth information relative to the ADF station (when ADF1 is selected on the EFCP).

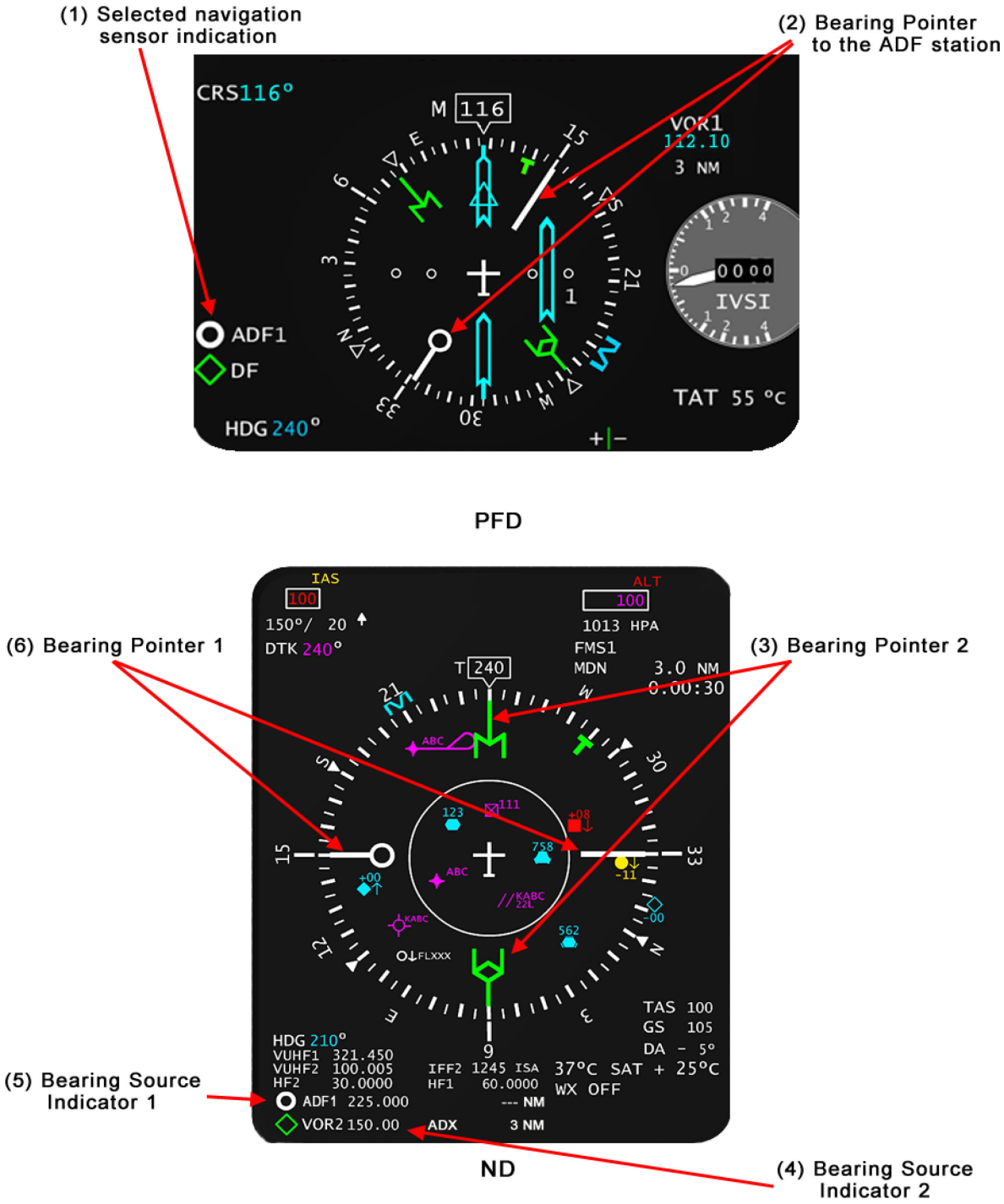
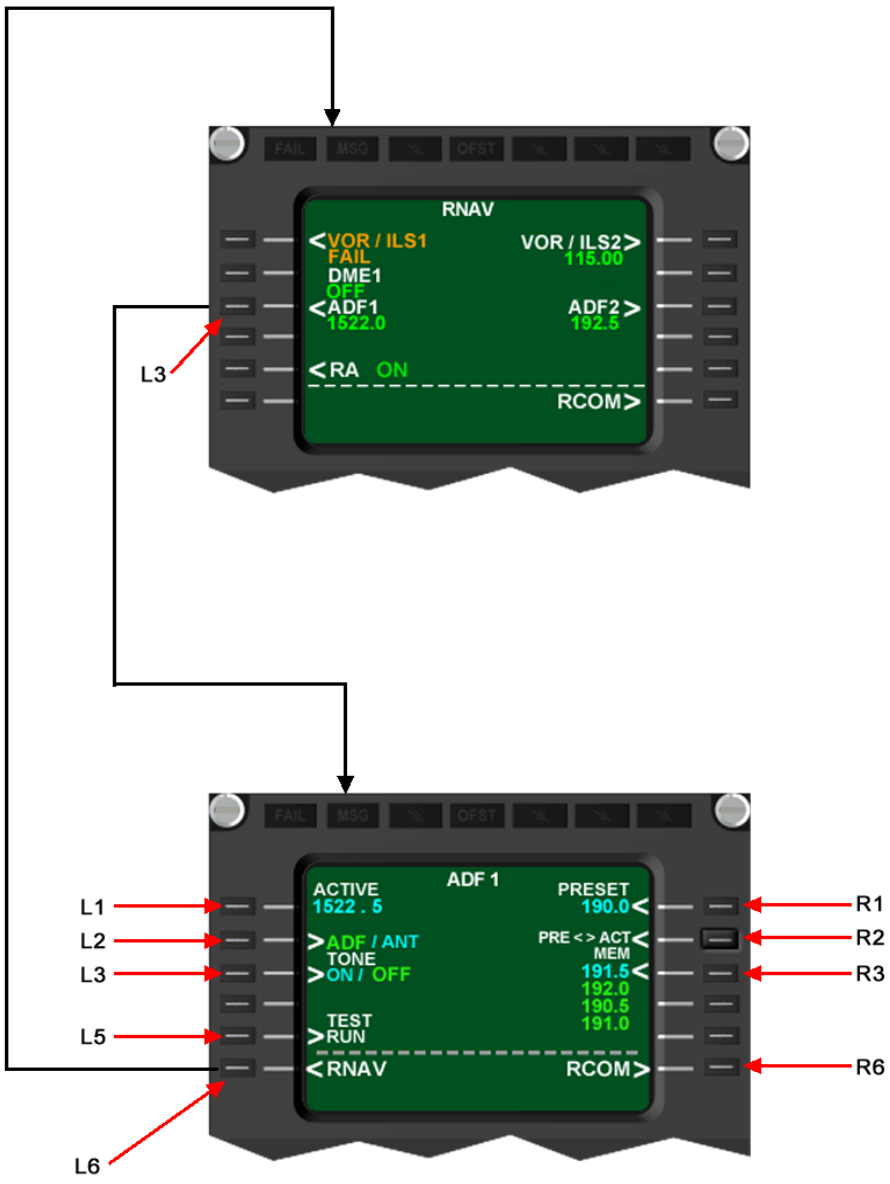


Figure 34-41 ADF System - PFD/ND - Controls and Indicators

MCDU

ADF1 or ADF2 Page:

- *L1*: if the input field contains a valid frequency, this becomes the active one.
- *L2:* ADF or ANT mode activation.
- *L3:* TONE mode activation.
- *L5:* performs ADF 1 or 2 test depending on whether the current page concerns ADF 1 or 2. During the test, TEST legend is replaced by RUNNING green legend. Once the test is finished, PASS green legend will be displayed for 10 seconds if the test was successful, and FAIL amber legend if a failure was detected. In PFD and ND, ADF bearing pointer rotates 90 degrees during the test. If the test lasts more than 10 seconds, it shall be considered failed.
- *L6:* moves to RNAV MENU page.
- *R1:* if the input field contains a valid frequency, this becomes the active one. If the input field is blank, first memory-saved frequency in the list becomes the preset one.
- *R2:* if there is a preset frequency, this becomes the active one. If not, this key is non-effective.
- *R3:* if the input field contains a valid frequency, this replaces the first memory-saved frequency in the list (which will therefore be deleted). When pushed-in repeatedly it displays all listed frequencies in sequence.
- *R6:* moves to RCOM MENU page.



ADF1 Page

Figure 34-42 ADF System - ADF 1 Page - Controls and Indicators

VHF NAVIGATION SYSTEM

VHF navigation system is a short-range navigation system based on VOR information, ILS data, and marker radio beacons.

DESCRIPTION

Signals are received by the system through the antennas. Receivers process the signals to provide both bearing and course deviations relative to a VOR station. The system also determines both lateral and vertical deviations relative to ILS station localizer beams and glide path. It also provides the flight crew with marker radio beacons flight indications.

Main system components are:

- ***Receivers:*** located beneath the cockpit floor, operate in the following frequency ranges: 108.00 - 117.95 MHz (200 channels). 160 channels for VOR frequencies and 40 channels for LOC (localizer) frequencies (and their associated GP).
- ***Antennas:*** (refer to ANTENNAS, in CHAPTER 01).
- ***Control and Monitoring System:*** located at the MCDUs, radio management system VOR/ILS pages allow to control and monitor the system operation.

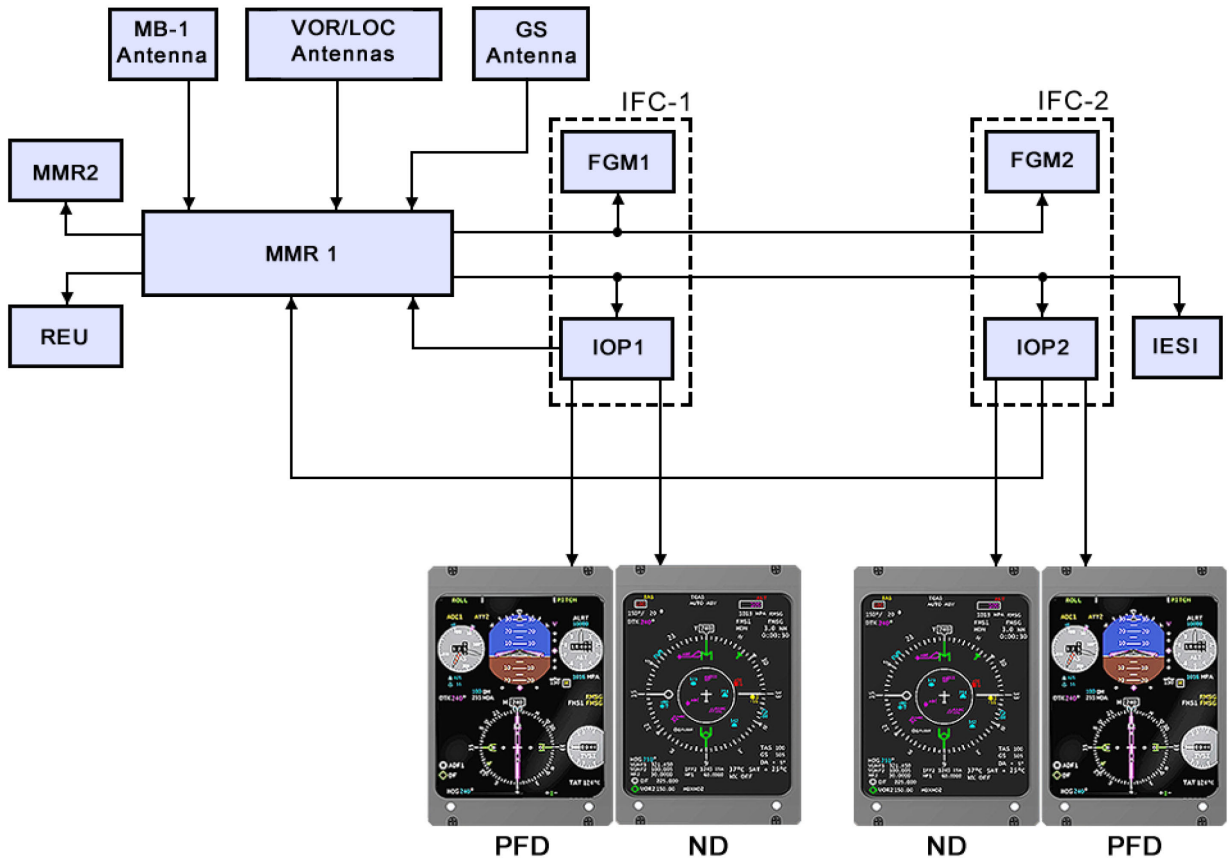


Figure 34-43 VHF Navigation System - Architecture

OPERATION

VHF navigation system functions are controlled from MCDU VOR/ILS1 or VOR/ILS2 page, thus allowing operating mode (VOR or ILS) setting as well as NAV frequency (this can be done automatically from the FMS). It also displays both active and preset frequencies, the four memory-saved frequencies in memory and allows to perform a test.

The system has two basic operating modes: VOR mode and ILS mode.

VOR Operating Mode:

The antennas receive VOR data from the ground station and send to the receiver. This processes data and provides VHF NAV DATA outputs used by both EFIS and automatic pilot systems. These outputs include:

- VOR bearing.
- CDI signal.
- FROM/TO signal.
- Audio identification signal (Morse code) (VOR AUDIO SIGNAL).

ILS Operating mode:

The antennas receive ILS data from ground ILS system and send them to the receiver. Data include LOC localizer data and GP glide path data. The receiver processes the data and provides EFIS/Automatic Pilot systems used VHF NAV DATA outputs. These outputs include:

- Localizer deviation signal (lateral or azimuth deviation relative to runway axis).
- Glide path deviation signal (vertical deviation relative to glide path).
- Marker annunciator.
- Audio output with ground station acoustic identification (ILS AUDIO SIGNAL).
- Audio output with precise radio marker tone (MB AUDIO).

The system also provides ILS/LOC/GP DATA outputs for the integrated electronic standby instrument (IESI).

CONTROLS AND INDICATORS

MCDU

VOR/ILS1 or 2 Page:

- *L1:* if the input field contains a valid frequency, this becomes the active one.
- *L3:* performs VOR/ILS 1 or 2 test, depending on whether the current page concerns VOR/ILS 1 or 2. Before performing a test, set the course deviation scale to 0º. During the test, RUN legend is replaced by RUNNING green legend. In the EFIS, when on ground, the related VOR bearing pointer points to 0 degrees and course lateral deviation is centered, and when in flight, the related VOR bearing pointer and course deviation are removed. Once the test is finished, PASS green legend will be displayed for 10 seconds if the test was successful, and FAIL amber legend if a failure was detected. If the test lasts more than 10 seconds, it shall be considered failed.
- *L6:* moves to RNAV MENU page.
- *R1:* if the input field contains a valid frequency, this becomes the active one. If the input field is blank, the first memory-saved frequency in the list becomes the preset one.
- *R2:* if there is a preset frequency, this becomes the active one. If not, this key is non-effective.
- *R3:* if the input field contains a valid frequency, this replaces the first memory-saved one in the list. When pushed-in repeatedly, displays every listed frequency in sequence.
- *R6:* moves to RCOM MENU page.

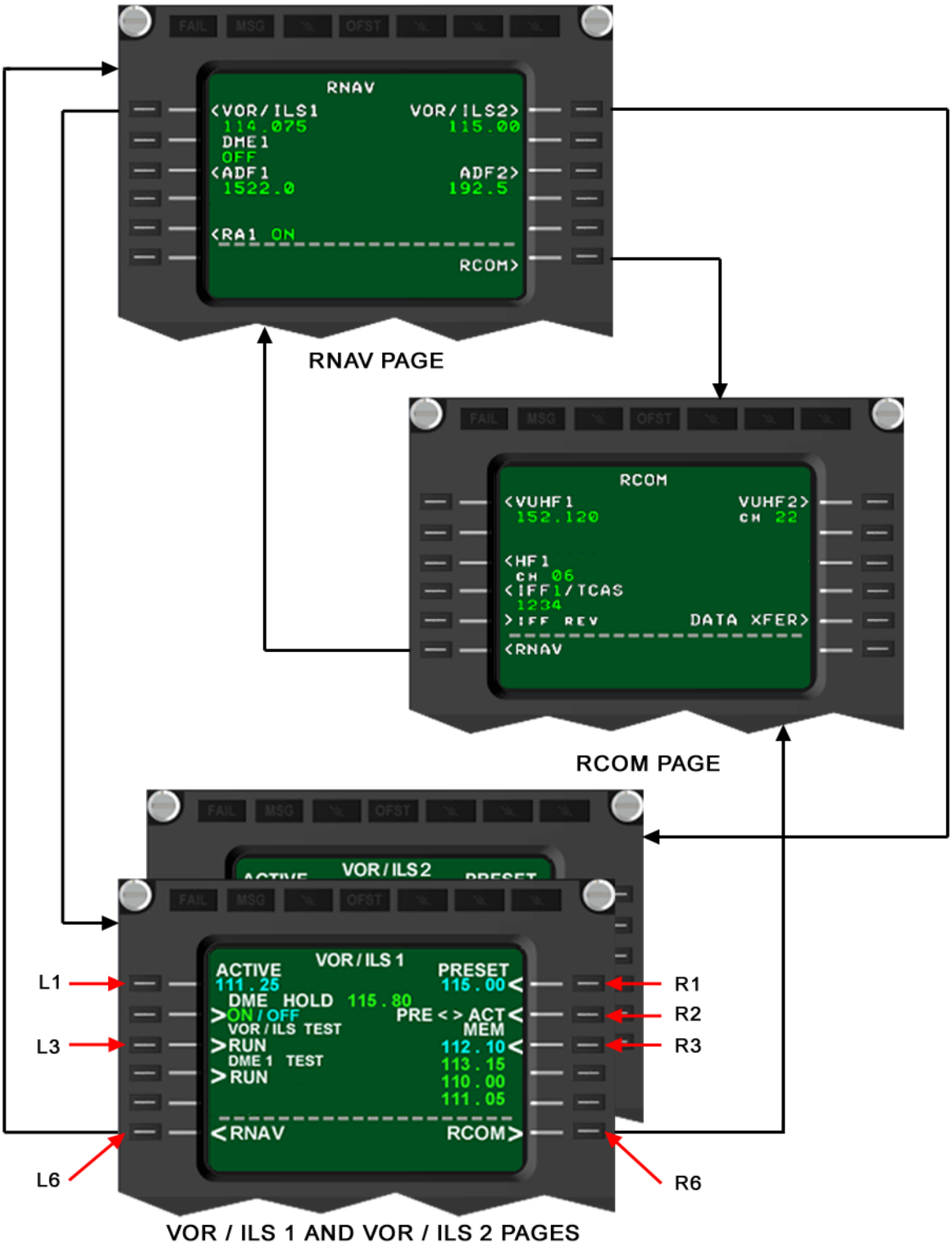


Figure 34-44 VHF Navigation System (MCDU) - Controls and Indicators

Index Control Panel (ICP)

(1) Decision height selector:

selector turns to set indicated decision height

Figure 34-45 VHF (ILS) Navigation System - Controls and Indicators

PFD indication:

(refer to ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS), in CHAPTER 31)

ND indication:

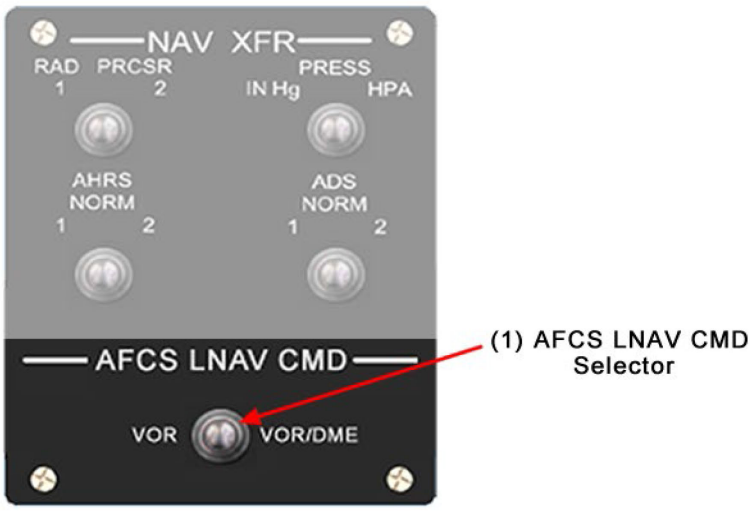
(refer to ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS), in CHAPTER 31)

AFCS LNAV CMD

(1) AFCS LNAV CMD Selector:

during navigation to a selected VOR course, system can get the deviation in two different modes:

- *VOR:* selects angular mode. Deviation value is the angular deviation from the selected course.
- *VOR/DME:* selects linear mode. Deviation value is the distance from the aircraft to the selected course. To calculate this distance the system receives the DME signal related to the VOR station.



INSTRUMENTS CENTRAL PANEL

Figure 34-46 VHF (VOR) Navigation System - Controls and Indicators

DISTANCE MEASURING EQUIPMENT (DME)

The Distance Measuring Equipment (DME) is a dependent navigation system that provides the distance (visual line) between the aircraft and a ground station.

DESCRIPTION

The unit interrogates the selected ground station and receives a reply signal after a given delay. Received data are decoded by the on-board equipment, to provide both: distance (visual line) and aircraft relative speed to the station (this will be the ground speed when flying to or from the station).

The system consists of:

- ***Transceiver:*** located at LH avionics compartments, operate in 960-1215 MHz frequency range.
- ***Antennas:*** (refer to ANTENNAS, in CHAPTER 01).
- ***Control and Monitoring System:*** located at the MCDUs, VOR/ILS pages of the radio management system allow to control and monitor the system operation.

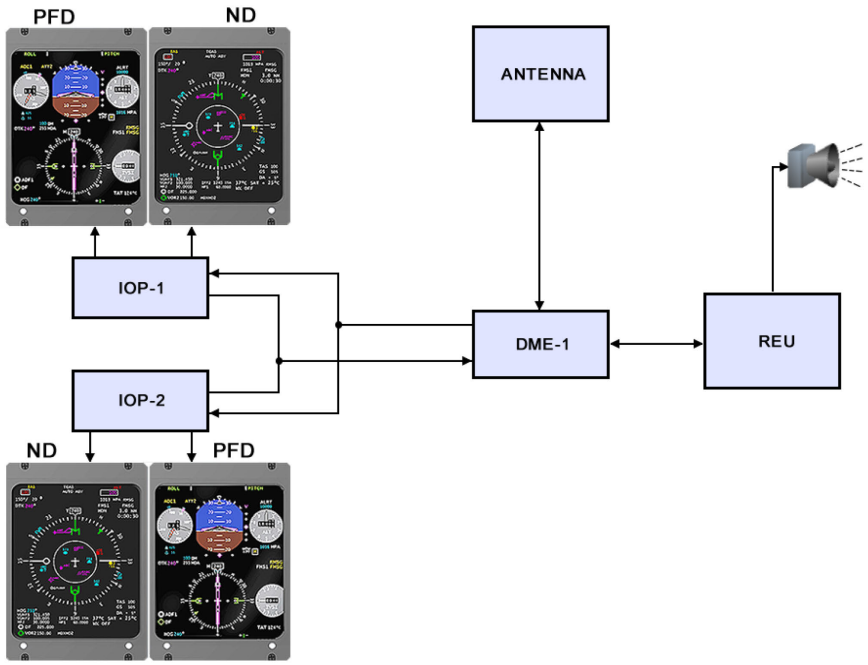


Figure 34-47 DME System - Architecture

OPERATION

DME system operates on any of 252 channels available in 960-1215 MHz frequency range. It is able to operate on three different channels. This allows to obtain distance signals simultaneously from two selected VOR stations and a third station controlled from the FMS.

System functions are controlled from MCDU VOR/ILS page. This page includes controls allowing both active and preset frequencies selection, preset frequency activation, a list of four memory-saved frequencies, DME HOLD function activation test performance.

CONTROLS AND INDICATORS

MCDU

VOR/ILS1 or 2 Page:

- *L1:* if the input field contains a valid frequency, this becomes the active one.
- *L2:* the DME HOLD locks the DME frequency. The VOR and ILS frequencies can be changed but the DME frequency will not change.
- *L4:* performs DME1 test. In the MCDU, RUN label is replaced by RUNNING and once the test is completed (it should not take more than 10 seconds), PASS is displayed for 10 seconds if the test was successful, and FAIL if a failure was detected. In PFD and ND, 100 NM is displayed as DME distance during the test. Additionally, if a DME1 test is successfully performed, "AOK" message is emitted in Morse code through the headphones.
- *L6:* moves to RNAV MENU page.
- *R1:* if the input field contains a valid frequency, this becomes the active one. Otherwise blank, the first listed frequency becomes the preset one.
- *R2:* if there is a preset frequency, this becomes the active one. Otherwise, this key cannot be used.
- *R3:* if the input field contains a valid frequency, this replaces the first memorized frequency on the list. When pushed-in several times, it displayed each listed frequency in sequence.
- *R6:* moves to RCOM MENU page.

PAGE VOR / ILS 1

Figure 34-48 DME (MCDU) System - Controls and Indicators

PFD Indication:

(refer to ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS), in CHAPTER 31).

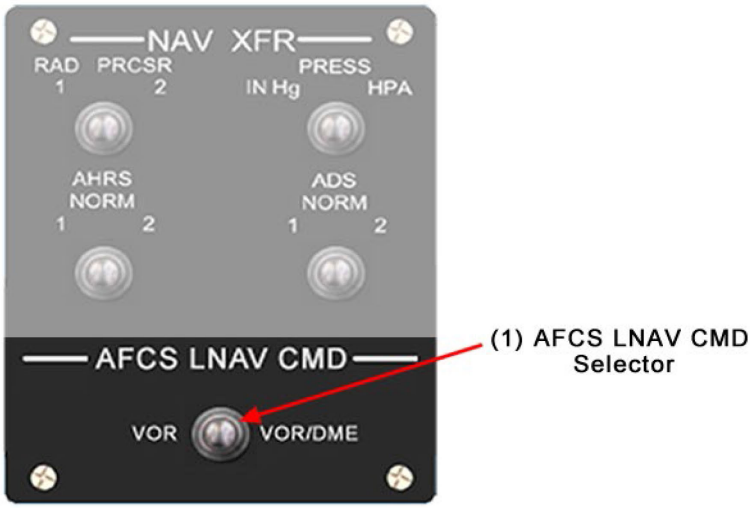
ND Indication:

(refer to ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS), in CHAPTER 31).

AFCS LNAV CMD

(1) AFCS LNAV CMD Selector:

(refer to VHF NAVIGATION SYSTEM, in this chapter)



INSTRUMENTS CENTRAL PANEL

Figure 34-49 DME (LNAV) System - Controls and Indicators

COM CTL

(1) EMCON Pushbutton:

(refer to SECURE COMMUNICATIONS, in CHAPTER 23)

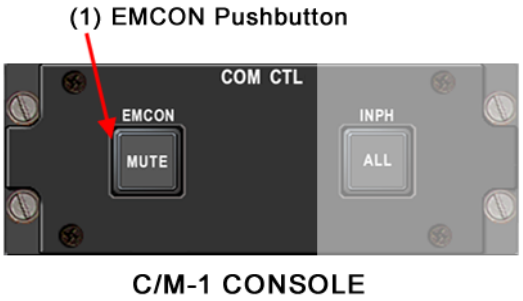


Figure 34-50 DME (EMCON function) - Controls and Indicators

IDENTIFICATION FRIEND OR FOE SYSTEM IFF SYSTEM

The Identification Friend or Foe (IFF) system is intended to receive and identify IFF interrogation signals from other aircraft or from ground transmitters, prior to send valid reply signals to valid interrogation ones.

The system responds to IFF interrogations in modes 1, 2, 3/A, C and S. The transponder is interrogated on a frequency of 1030 MHz and responds automatically on a frequency of 1090 MHz using the same code it was interrogated with.

The aircraft is fitted with one IFF system.

DESCRIPTION

Main components of the system are:

- ***IFF Transceiver:*** located at the LH avionics compartment, receives interrogation signals from both antennas, checks if they are valid, decodes them and transmits a coded reply signal.
- ***Antennas:*** two antennas to receive transmitted interrogation signal and transmit interrogation reply. These are the same antennas as for the VHF system, thus supporting IFF system D band (refer to ANTENNAS, in CHAPTER 01).
- ***IFF panel:*** located at the central panel, allows to control and monitor Emergency code activation.
- ***Control and Monitoring System:*** located at the MCDU, IFF pages allow to control and monitor system operation.

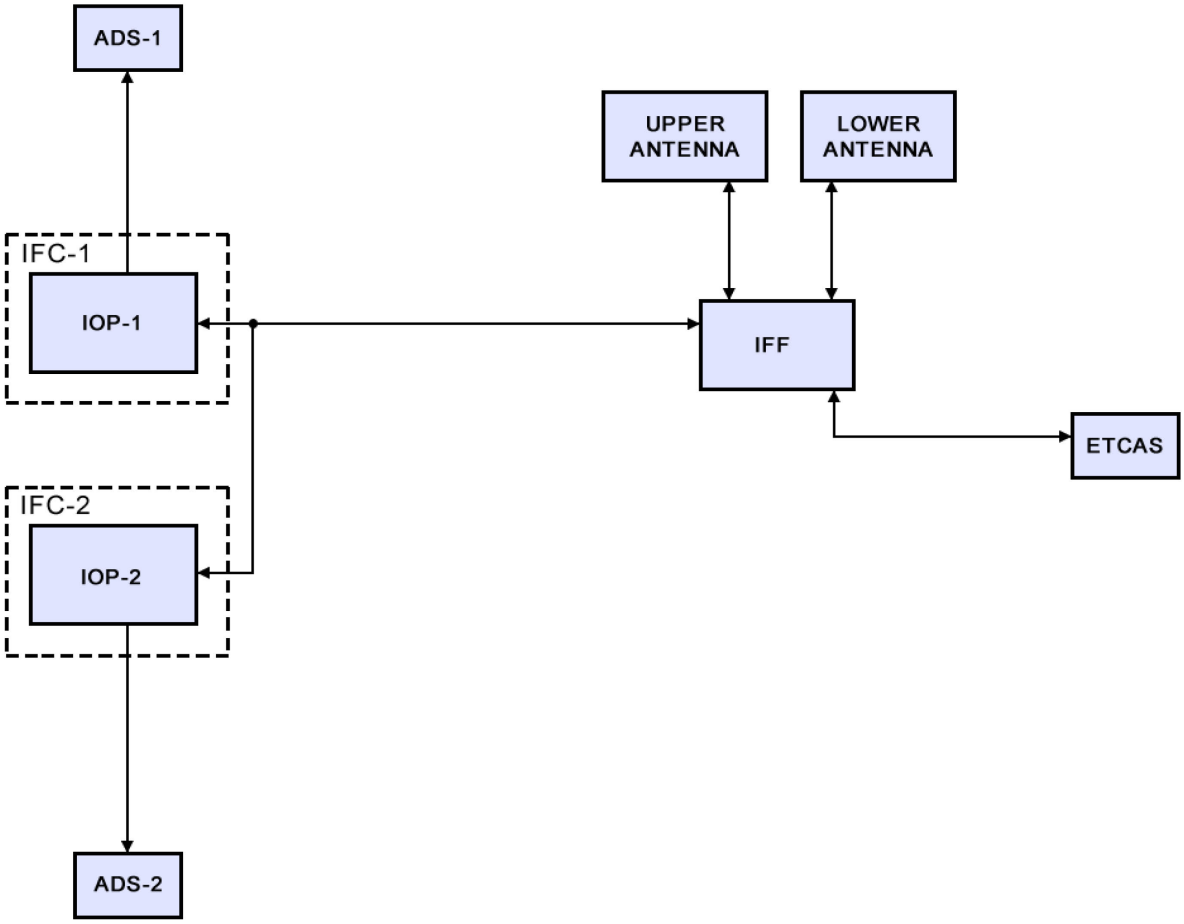


Figure 34-51 IFF System - Architecture

OPERATION

IFF system main control is performed by using MCDU IFF/TCAS pages. These are intended: to set both operating and IFF modes; to introduce Modes 1, 2, 3/A and S codes; to transmit an I/P pulse; to select the antenna; and, to perform the test.

The transponder receives the interrogation signals through two antennas and if Diversity Option is selected, transmits the reply signal through the antenna from which it received the strongest signal. The Diversity Option is selected automatically. If the user selects TOP or BOT antenna, the transponder will remain in single channel operation for 1 minute, then automatically return to Diversity Option.

IFF modes 1 and 3/A codes can be set automatically by the FMS when the frequency plan is used, or directly on the relevant pages.

Selected Mode 3/A code is also ND displayed.

If Mode S is enabled, the transponder is always in Diversity, regardless of antenna selection by the operator.

NOTE

After a switch OFF/ON sequence on IOP BC in flight, the mode S address will revert to the one default (wired in the pin programming). If the mode S address has been previously entered manually via MCDU, after switch OFF/ON sequence in IOP BC in flight, it shall be entered again.

Mode S of IFF works in the following modes:

- ELS mode (Elementary Surveillance): enabled when mode S is enabled, incorporates:
  - Altitude Reporting: IFF reported altitude values have an accuracy of +/- 25 ft.
  - Flight Status: shows aircraft status and behaviour.
  - Resolution Advisories (from TCAS): IFF sends Resolution Advisories from TCAS.
- EHS mode (Enhanced Surveillance): enabled from IFF MODES (1/2) page of MCDU by means of R5 button, it is necessary to enable mode S before activating EHS mode. EHS mode allows IFF to send the following parameters and Automatic Pilot modes:
  - AHRS Parameters: magnetic heading, roll angle and inertial vertical speed.
  - ADU Parameters: IAS / MACH, true airspeed, barometric altitude rate and baro-setting.
  - FMS Parameters: ground speed, true track angle and track angle rate.
  - Automatic Pilot Modes: ALT SEL, ALT, LNAV, APP and LNAV + VNAV.

Nevertheless, IFF will always send as MCP / FCU SEL ALT the FGCP selected altitude regardless the mode selected.

TARGET ALTITUDE will be the MCP / FCU SEL ALT except when in ALT mode, which will have AIRCRAFT ALTITUDE as TARGET ALTITUDE.

CONTROLS AND INDICATORS

IFF CONTROL PANEL

(1) EMER Pushbutton:

- *Pressed:* transceiver transmits emergency codes in every IFF operating mode.

(2) IDENT Pushbutton:

- *Pressed (momentarily):* I/P pulse transmission is shortly activated.

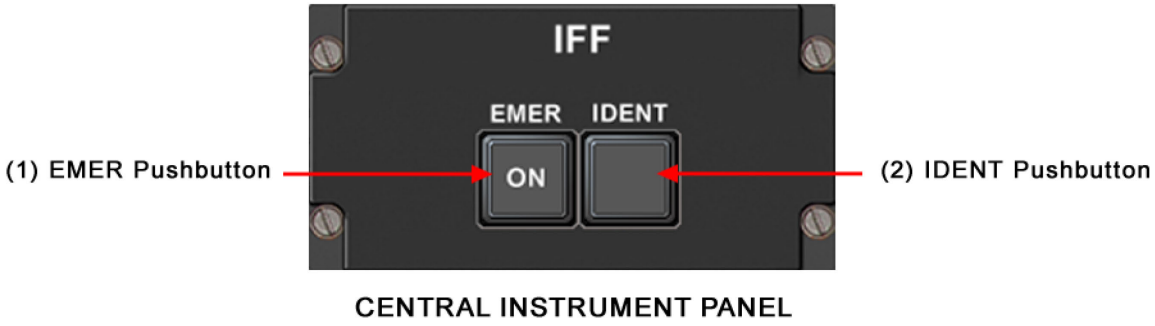
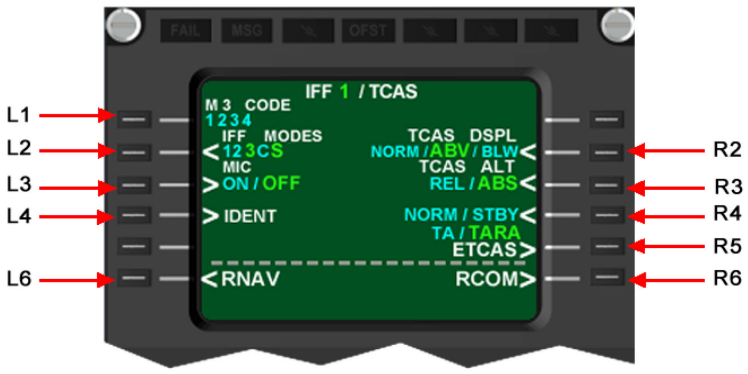


Figure 34-52 IFF System - Controls and Indicators - IFF Panel

MCDU

IFF1/TCAS Page:

- *L1:* if the input field contains a valid 3/A code, this becomes the active one. Otherwise the blank key is disabled.
- *L2:* provides access to IFF MODES page.
- *L3:* enables and disables special position identification by pushing-in the PTT button on the microphone.
- *L4:* activates special position identification (SPI).
- *L6:* moves to RNAV MENU page.
- *R2:* TCAS screen selection (Normal, Top or Bottom).
- *R3:* absolute/relative altitudes selection.
- *R4:* TCAS and IFF modes selection from: Normal (IFF normally operative while TCAS is in stby mode), Standby (IFF and TCAS in standby mode) and TA or TA/RA.
- *R5:* moves to ETCAS page.
- *R6:* moves to RCOM MENU page.

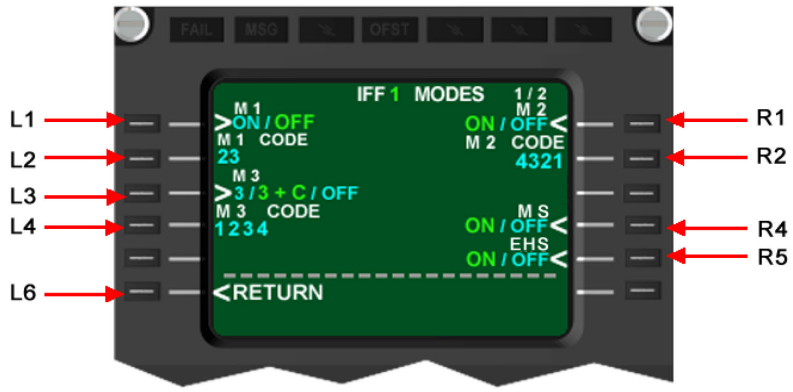


IFF 1 / TCAS PAGE

Figure 34-53 IFF System - Controls and Indicators - IFF1/TCAS Page

IFF1 MODES (1/2) Pages:

- *L1:* enables or disables Mode 1.
- *L2:* if the input field contains a valid Mode 1 code, this becomes the active one.
- *L3:* changing from mode 3 to Mode 3A, Mode 3A+C or Mode 3.
- *L4:* if the input field contains a valid Mode 3 code, this becomes the active one.
- *L6:* returns to IFF/TCAS page.
- *R1:* enables or disables Mode 2.
- *R2:* if the input field contains a valid Mode 2 code, this becomes the active one.
- *R4:* enables or disables Mode S.
- *R5:* enables or disables EHS Mode.



IFF 1 / MODES PAGE

Figure 34-54 IFF System - Controls and Indicators - IFF1 MODES 1/2 Page

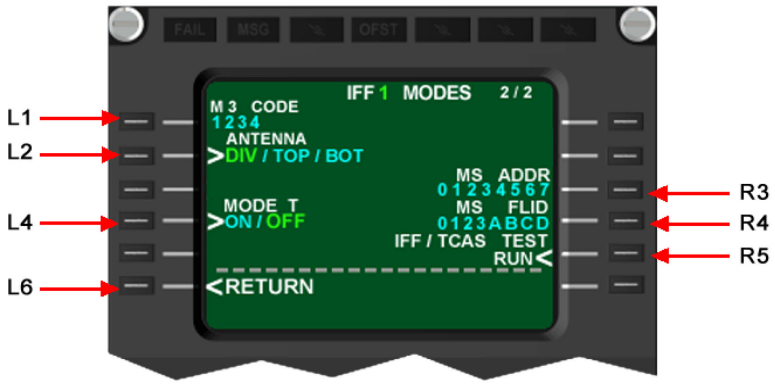
IFF1 MODES (2/2) Pages:

- *L1:* if the input field contains a valid Mode 3/A code, this becomes the active one.
- *L2:* operative antenna selection from TOP, BOT and DIV.
- *L4:* Mode 3 test reply selection to either enabled or disabled.
- *L6:* return to IFF/TCAS page.
- *R3:* if the input field contains a valid Mode S code, this becomes the active one.
- *R4:* if the input field contains a valid flight identification code, this becomes the active one.

NOTE

It is needed to use the ICAO defined format for entry of the Aircraft Identification or Registration mark as applicable to the flight. The shortened format used by International Transport Airlines Association is not compatible with the ground systems of the air traffic services.

- *R5:* IFF and TCAS test initiation.



IFF 1 MODES PAGE

Figure 34-55 IFF System - Controls and Indicators - IFF1 MODES 2/2 Page

COM CTL

(1) EMCON Pushbutton:

(refer to SECURE COMMUNICATIONS, in CHAPTER 23)

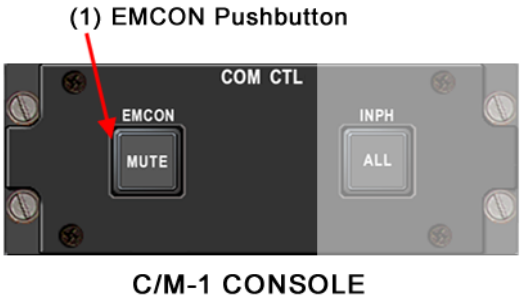


Figure 34-56 IFF System - Controls and Indicators - EMCON function

FLIGHT MANAGEMENT SYSTEM (FMS)

The Flight Management System (FMS) is intended to provide the flight crew with a computerized system for flight planning, fuel management and both the radio communications and radio navigation systems managing purposes. FMS main function is to generate position and guidance information according to the flight plan.

(For additional information, refer to Annexe 1)

DESCRIPTION

Main components of the system are:

- ***Flight Management Computer (FMC):*** processes every input/output to/from the system, manages database operations, processes navigation and mission data and calculates all data as required to share with other systems.
- ***Airborne Data Loader (ADL):*** connects the Flight Planning System (FPS) with on-board FMS. Used to upload/download FMS databases, communications schedules, etc.
- ***MCDU:*** allows FMS control and monitoring.

OPERATION

FMS uses WGS84 reference system for position calculation. Allows to select RNP accuracy level applicable to the whole flight plan. If actual accuracy does not satisfy RNPs, a RNP warning is generated.

Each FMS can be controlled by either MCDU, as selected by the pilot. After FMS power on, the CM-1 (MCDU1) should go to "MENU" MCDU page and enter to FMS1 and CM-2 (MCDU2) should go to "MENU" MCDU page and enter to FMS2. Once selected, each FMS generates pages to be displayed and receives commands from its associated MCDU. If an FMS fails, the other generates pages to be displayed on both MCDUs.

The MCDU enables the operator to select the active subsystem. Only one of the connected subsystems is active at a time. The last active subsystem shall be displayed with <ACTIVE> beside its name. A non-active subsystem that is on the menu list can at any time request access to the MCDU. The requesting subsystems shall be displayed with <REQUESTING> beside their name.

One FMS is declared as Master for those control actions that requires coordination between both FMS. The Master FMS is the associated to the HSI side selection in the FGCP.

NOTE

Harmonic interference from VHF and/or UHF frequency band transmissions may adversely affect reception of the GPS subsystem signal. Transmission in excess of approximately 15 seconds may result in loss of GPS signal reception. Navigation will be restored within five seconds after the completion of the transmission.

FMS provides the following functions:

Reference Time and Date Management

These data are received from the GPS sensor. The flight crew can enter both date and time if GPS is not available. A time difference can also be defined so if related to a local time. If this feature is used, every FMS displayed navigation time is in local time.

Primary Reference Management

FMS functions include: heading reference, air data and radio altimeter management, thus allowing both true/magnetic heading, and magnetic variation calculation as well.

Navigation Sensor Management

FMS automatically tunes radio navigation sensors: VOR1 (with its DME - channel 1 associated), VOR2 (with its DME - channel 2 associated) and DME - channel 3, to get the best possible position calculation. FMS also controls IRS/GPS sensors (including system initialisation and mode control).

Computed Air Release Point (CARP)

Any Route Reference Point on a tactical flight plan may be selected as a release point. The flight crew may designate Route Reference Point parameters as designated for release (CARP) and the type of release.

Depending on both atmospheric and flight conditions, as well as on parachute characteristics, FMS calculates a Computed Air Release Point (CARP) or a High Altitude Release Point (HARP) as well, as their associated parameters.

The CARP function manages paratroops release (at high or low altitude), gravity loads and extraction loads. It also manages LAPES.

Each release point is defined using point-of-impact coordinates and, elevation, release altitude, time on target, type of release, wind data and deceleration profile identification.

In addition, for low level releases other than LAPES, the definition of the release point includes both type and number of paratroops, cargo weight and its fuselage station as well as paratroops weight. In case of high altitude releases, the definition of the release point includes cabin opening altitude, etc.

FMS calculates and displays the following CARP/HARP data: initial release point coordinates (CARP), the difference between the dropping zone (DZ) and the initial release point (CARP), release axis, time and distance to release, exit time, dropping altitude and falling ratio/time.

Vertical Navigation

FMS calculates vertical navigation in both tactical and logistic operations. VNAV data depend on whether the flight is a tactical or logistic one. FMS also allows to define an altitude safety margin for the active tactical flight plan.

FMS approaches

The FMS210 is approved for instrument RNAV, VOR-DME and VOR published approaches using only VOR/DME (RNAV) navigation sensors in the BCP calculation.

In FMS approaches the crew must deselect IRS and GPS sensors from BCP computation in BCP NAV page before reaching FAF (Final Approach Fix).

If GPS is selected for approach phase, the FMS will not be able to enter to the approach mode and this alert will be set: "APPROACH NOT ENABLE CHECK POS EPE OR GPS HIL".

Warning Zones Definition

Tactical database contains up to ten warning zones. Each warning zone is a circle defined by the coordinates of its centre (latitude and longitude), its radius and (optionally) a ceiling altitude.

Multisensor Localizing

The system calculates position using data from the several positioning devices. It has four selectable modes, according to the system from which position is calculated.

IRS mode calculates position using information from the inertial system.

GPS mode uses data from the GPS.

HYB mode takes inertial reference data and corrects them using GPS data.

BCP mode calculates optimal position by GPS, VOR and DME data hybridation. The BCP mode uses in priority the following sensors if not deselected and if available:

- IRS/GPS (HYB mode).
- GPS (only used if HYB not available or (GPS selected and hybridation not active).
- IRS ground speed + Radio-Nav data (in flight).
- Radio-Nav data (in flight) combined with TAS vector (TAS + heading).
- IRS ground speed only (if no position data available).
- DR mode if no IRS, GPS, radio-nav data.

When the BCP mode is selected, radio navigation data is not take into account on ground. If GPS is not selected, GPS and HYB modes are deselected from BCP calculation and if IRS is not selected, IRS and HYB modes are deselected from BCP calculation.

If supplied data from a system are non compatible with other navigation systems data, this system is deselected from BCP calculation.

The FMS calculates and displays the error made between a selected navigation mode and other valid modes. It is called "POSITION DISCREPANCE".

The FMS also computes or acquires continuously the EPE (Estimated Position Error) associated to each mode:

- When in HYB or GPS mode the EPE is provided by the sensor: HYB EPE, GPS EPE and IRS EPE displayed by FMS are values which are coming directly from the sensor and they are not calculated/used by the FMS. Each IRS/GPS equipment provides the HFOM (Horizontal Figure of Merit) to both FMS (via IOP) and that HFOM value is shown by the FMS as EPE. The IRS HFOM is only depends on internal calculation of the IRS/GPS equipment.
- When in IRS/radio-nav or Radio-Nav + TAS/hdg the EPE is computed by the FMS taking into account the VOR, DME accuracy and the navaid geometry.
- When in IRS ground speed mode, the EPE diverge at a rate of 2 m/s.
- When in DR mode the EPE diverge at a rate of 10 kt.

And also the CEP (Circular Error Probable):

- CEP of latitude and longitude provided by the IRS/GPS equipment means the latitude and longitude position error (in comparison with a real latitude and longitude) generated by the IRS/GPS equipment is less than 0.8 NM in the 50% of the flight (based on a flight of the one hour), and greater than 0.8 NM the order 50% of the flights (based on a flight of one hour), taking into account that an enough number of flights should be performed.
- CEP is normally referenced to 1 hour of flight.
- There is not a direct relationship between the CEP value and the HFOM/EPE value provided by IRS/GPS equipment.

All these information (RHO, THETA, EPE) are displayed in page PROG 3/3:

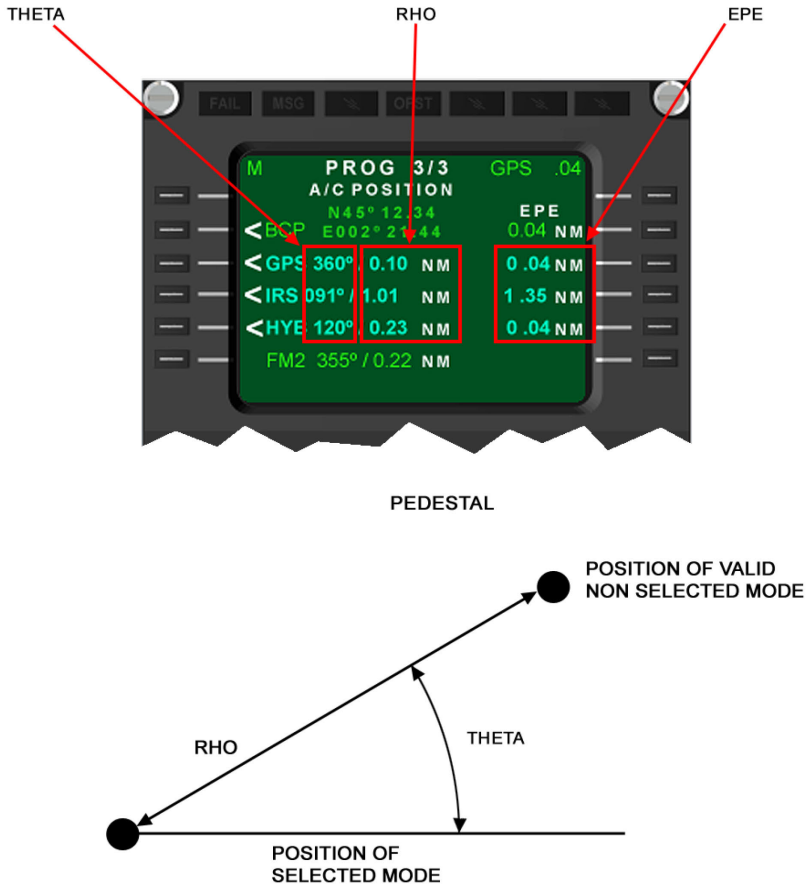


Figure 34-57 Position Discrepancy

If one RHO, corresponding to one valid non selected mode, is RHO > maximum (0.1 NM; EPE valid non selected mode + EPE selected mode), a position discrepancy alert shall be generated. The alert shall disappear when RHO < 0.95 x maximum (0.1 NM; EPE valid non selected mode + EPE selected mode).

A discrepancy in the position calculation of the airplane can happen when both FMSs exchange their positions via crosstalk.

NOTE

If the discrepancy between the 2 FMSs positions is greater than RNP, the alert shall be generated. The alert shall disappear if the discrepancy becomes lower than 0.95 x RNP.

Database Manager

FMS has 3 separate databases. ADL is intended to upload/download the following databases:

– Standard database, containing information on airports and radio navigation aids world-wide. The maximum size of this database is 8 Mbytes and it is able to store:

NOTE

Over 8 Mbytes, the FMS XTALK function will not work properly.

- 4000 airports
- 4000 enroute VHF navaids
- 30000 enroute waypoints
- 10000 enroute NDB navaids
- 8000 runways
- 12000 terminal fixes
- 4000 SIDs
- 4000 STARs
- 4000 approaches of an average of 4 legs each

– Flight crew database, users-defined, has a capacity of 70 Kbytes and it is able to store:

- 100 airports
- 100 waypoints
- 100 routes each one with a maximum of 40 standard or flight crew fixes.
- 100 VHF navaids

– Tactical database, users-defined, has a capacity of 40 Kbytes and it is able to store:

- 4 routes containing up to 100 tactical waypoints
- 10 warning zones
- 1 radio communication plan data containing up to 20 data sets

Navigation Management and Lateral Guidance

FMS performs both navigation and lateral guidance functions for logistic, tactical and SAR routes purposes. Allows route deviations and provides EFIS lateral navigation data.

Performances Management

FMS manages civilian (FAR) and military (MIL) type operations. The selected type of operation affects both weight and speed limitations, as well as take-off and landing available types.

Provides the following performances calculations:

1) Weight Management: the system calculates gross weight from empty weight, cargo weight, pax number average weight and total/reserve fuel.

2) Fuel Management: the system calculates fuel consumption and updates gross weight accordingly. It is also possible to manually update total fuel from refuelled quantity.

3) No Return Point (NRP) Calculation: the system both calculates and displays on the flight plan position, the No Return Point (NRP) to the alternate destination. It also gives a warning when the time to this point reaches a time threshold.

4) Limitations Calculation: the system calculates both Maximum Operative Speed and, Maximum Structural Speed, as well as Minimum Speed for IAS target determination.

5) Take-Off and Landing Parameters Calculations: for take-off performance, the system calculates V_1, V_R, V_2, short runway take-off refuse speed and torque. For landing purposes, the system calculates V_{APP}, V_{REF} and torque for Go-around procedures.

NOTE

The system shall not provide performance data in case of one or more initial performance parameters is missing in the different performance init pages (Take off, cruise, approach, landing, weight, fuel flow).

Radio Communication Frequency Plan

FMS automatically tunes both HF and U/VHF radio communication systems as well as IFF mode 1, and 3/A code changes accordingly to programmed sequence.

It can store up to 20 different radio communication configurations.

ABNORMAL PROCEDURES

1) If FMS210 multi-sensor equipment navigation information is not available or invalid, utilize remaining operational navigation equipment as required.

2) If VNAV information is intermittent or lost, cancel VNAV function on the FMS and use the altimeter for vertical reference.

3) Should one MCDU fail, in most cases the display will go blank, the remaining MCDU controls only one FMM at a time. To select the controlled FMM use the MCDU MENU page. MCDU control inputs to one FMM are transfer to the other FMM for those actions that requires synchronization. Both FMM navigation data will be available for EFIS display and autopilot steering.

4) Should one FMM fail, in most cases the FMS navigation flag will be displayed on the EFIS PFD and ND. The remaining FMM can be controlled by both MCDUs. To select the operating FMM use the MCDU MENU page. The operating FMM will respond to commands entered in both MCDUs. Only operating FMM navigation data will be available for EFIS display and autopilot steering.

5) Should the on-side ADU or AHRU fail, the FMM will automatically select the cross-side ADU or AHRU unless flight crew has forced the use of side 1 or side 2 using the ADS and AHRS reversion selectors on the NAV XFR panel.

6) Should the on-side IRS/GPS fail, the FMM will automatically select the cross-side IRS/GPS.

7) Should one VOR or DME sensor fail, the FMM will automatically deselected it from the Best Present Position calculation.

8) Whether a ground navigation aid is known to provide misleading navigation signals, it shall be deselected from the database using the DESELECT NAVAIDS page.

9) When the IOP master fails, all the RNAV and RCOM equipments will be displayed in fail state by the slave RMS at MCDU, except Radioaltimeter. Information from Radioaltimeter is also displayed properly in PFD and ND.

10) In case of IOP1 failure (with RAD PROCSR selector in IOP1 position), ON is displayed in green fonts for RA. FAIL in red fonts is displayed for remaining RCOM equipments.

11) In case of IOP2 failure (with RAD PROCSR selector in IOP2 position), ON is displayed in green fonts for ETCAS, RA, DME1 and DME2. FAIL in red fonts is displayed for remaining RCOM equipments.

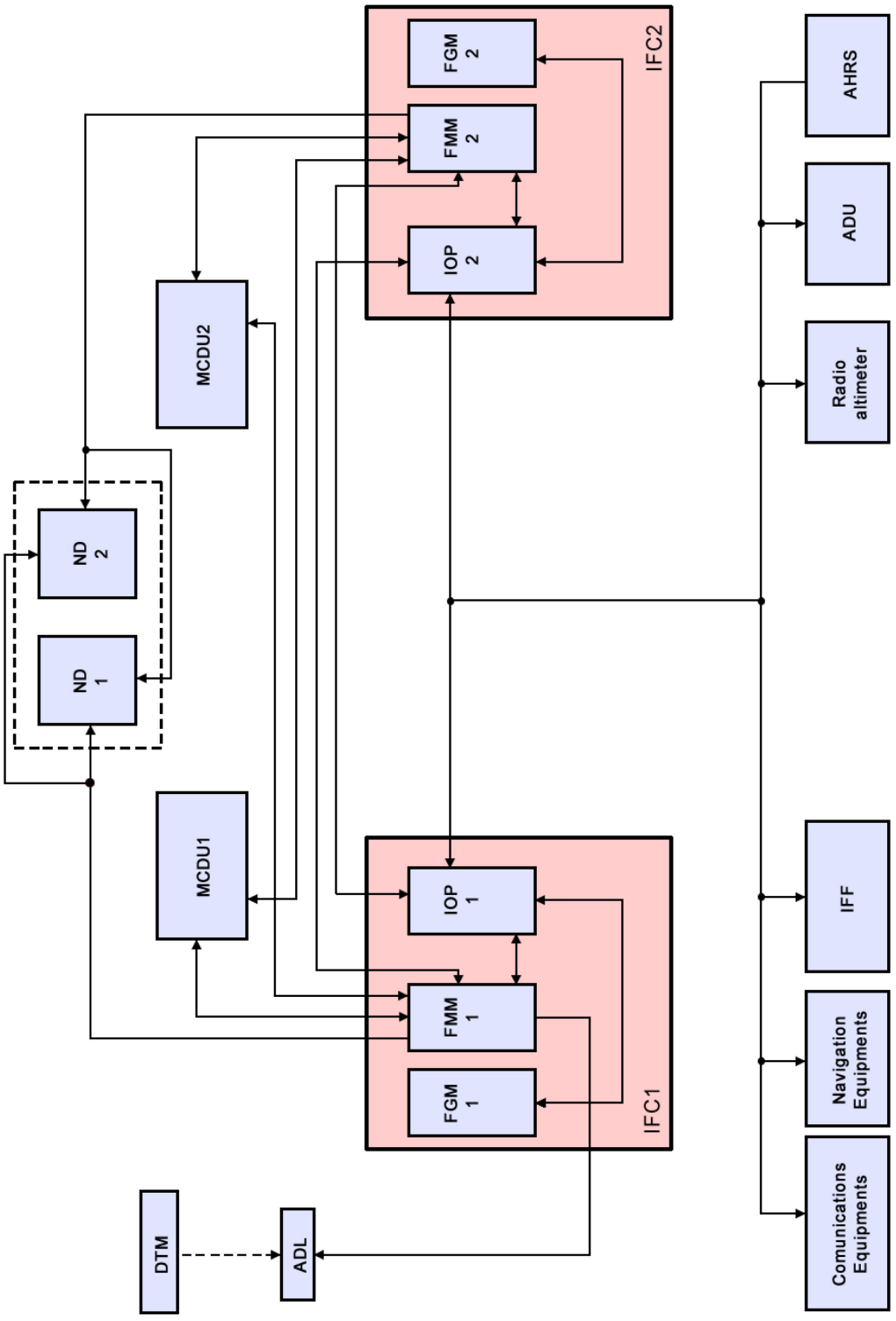


Figure 34-58 Flight Management System

CONTROLS AND INDICATORS

FMS colour code is intended for data identification while MCDU displayed:

- White: titles, headers, units, messages and warnings.
- Blue: modifiable and, selectable data as well as non-active items to select.
- Green: active and, non-modifiable data as well as active items to select.
- Amber: warnings, urgent data, negative margins.
- Magenta: flight plan and, altitude/speed/time limitations.
- Yellow: temporary data and information.

Screen´s left and right keys are intended to perform adjacent functions as specified both on the screen or on the named page (see figures showing hierarchical pages).

FAIL Light:

comes on in case of system failure.

MSG Light:

comes on in case of any sort of message.

MENU Key:

displays MCDU menu page.

PREV Key:

moves to previous page in both horizontal/vertical format.

NEXT Key:

moves to next page in both horizontal/vertical format.

FPLN Key:

provides access to Flight Management System controls FPLN 1/X page.

PROG Key:

provides access to both PROG 2/3 page (if flight plan is active) and PROG 1/3 page (if other functions are active).

DTO Key:

provides access to DIRECT TO page.

PERF Key:

provides access to performance management control page.

MSG Key:

provides access to messages page.

EXEC Key:

confirms flight plan action-or temporarily activates it, depending on current page. When the key is pushed-in, light on the key comes on.

The display of the "PRESS EXEC TO CONFIRM" message and the illumination of the green light on the EXEC key are used to require the confirmation of an action on a specific key. When the goal is to activate a function using a page where the crew can enter additional / optional data, the "PRESS EXEC TO CONFIRM" message is not displayed.

RMS Key:

provides access to navigation and communications management system.

DATA Key:

provides access to database, radio navigation and radio communications control page.

HOLD Key:

provides access to updated stored position function page.

BRT Key:

adjusts screen brightness.

Figure 34-59 Flight Management System - Controls and Indicators

Screen indications are included in the pages, which are organized in ten sections as described below:

- Start-Up Management (POWER ON, INIT, POS INIT, UNITS)
- Progress Management (PROG, VNAV, BCP NAV, GPS NAV, HYB NAV, IRS NAV, DROPPING)
- Flight Plan Management (IFR FPLN, TMPY, TACTICAL FPLN, SAR FPLN, DEPARTURE, LTRL REV, ARRIVAL, VERT REV, FPLN INIT, ROUTE SELECT, TACTICAL, SAR SECTOR, SAR LADDER, SAR SQUARE, HOLDING)
- Direction Towards Management (DIRECT TO with FPLN list, DIRECT TO with AIRPORT list, DIRECT TO with IDENT)
- Performance Management (PERF INIT, T/O PERF, CRZ PERF, DES PERF, WEIGHT)
- Tuning Management (TUNE, COM PLAN, NEAREST, DESELECTED)
- Message Management (MSM)
- Position Holding Management (HOLD)
- Data Management (DATA MENU, DATA XFER, DATABASE, STD APT, STD NAVAID, STD WPT, PILOT DATA, PLT APT, PLT NAVAID, PLT WPT, PLT ROUTE, TACT WPT, DROP DATA, WARN ZONE, NEW DATA, DUPLICATE)
- Status Management (STATUS, STS XFER, PAD, AIR/RA, HDG/ATT, FUEL FLOW, FMS BITE, SENSOR STS, DISCRETES)

A brief description of each Flight Management System page content is given below.

POWER ON Page:

displays power-on self-test results and provides access to INIT page.

INIT Page:

displays screen date/time and provides access to each page used to initialize FMS parameters.

POS INIT Page:

allows to initiate aircraft position.

NOTE

If during the aircraft power-down, the Avionics Master is switched-off before the electrical system power-off, all FMS navigation data is lost before the FMS power-off, and therefore, the FMS position becomes invalid. To have the last position available, it is necessary to switch off both FMS before navigation sensors or at the same time.

UNITS Page:

allows to select displayed data units.

FPLN INIT Page:

allows to select flight plan type.

IFR FPLN Page:

displays flight plan sections and allows to make vertical or lateral modifications to the active flight plan.

TACTICAL FPLN Page:

displays TACTICAL flight plan. When a tactical FPLN is activated, the FPLN will be available in DMM 30 seconds later.

SAR FPLN Page:

displays SAR flight plan.

NOTE

If a SAR FPLN is activated on ground, performance data calculation along SAR FPLN must not be considered.

TMPY Page:

displays provisional flight plan.

DEPARTURE Page:

displays departure procedure and allows to select it.

ARRIVAL Page:

displays arrival procedure and allows to select it.

LTRL REV Page:

allows overflight or new destination selection, as well as any flight plan HM stretch entry/ modification OFFSET value entry.

The offset value is limited to 20 NM.

Offset insertion is possible only if:

– Current leg is of TF or CF type.

– Current leg is not the last leg of the flight plan.

– Current and next leg terminations are not the destination runway.

NOTE

Otherwise, "NOT ALLOWED" is displayed in the scratchpad.

Offset stays applicable along flight plan until:

– Leg type is neither TF nor CF or

– Course change becomes greater than 90º or

– Leg is part of the approach or

– Leg terminates on the destination runway or

– Leg is followed by a discontinuity.

At offset insertion, if aircraft cannot rejoin the offset path before transition to next leg but can rejoin it on next leg, then the "OFFSET DELAYED" message is displayed in the scratchpad and offset will be applied on next leg.

At offset insertion, if aircraft cannot rejoin the offset path neither before transition to next leg nor on next leg, then the insertion is refused with the "NOT ALLOWED" message displayed in the scratchpad.

When the inserted offset is no more applicable, the offset is automatically cancelled with the "OFFSET CANCELLED" message displayed in the scratchpad.

VERT REV Page:

in IFG mode, displays vertical navigation data as well as revision point limitations.

In TACTICAL mode, displays vertical navigation data as well as revision point limitations. It also allows MARGIN value modifying.

ROUTE SELECT Page:

allows a route to be selected and displayed.

TACTICAL Page:

allows a tactical route to be selected and displayed.

SAR SECTOR Page:

allows a SAR SECTOR configuration to be selected and displayed.

SAR LADDER Page:

allows a SAR LADDER configuration to be selected and displayed.

SAR SQUARE Page:

allows a SAR SQUARE configuration to be selected and displayed.

HOLDING Page:

allows active flight plan position holding configuration entry.

PROG 1/3 page:

in IFR mode, displays FROM, TO, NEXT and DEST position points of active FPLN as well as NEXT route vertical pseudo-waypoint data.

In TACTICAL mode, displays FROM, TO, NEXT and DEST position points of active FPLN as well as next RTA limitation, if any.

In SAR mode, displays FROM, TO, and NEXT position points of active FPLN, allowing configuration parameters modification.

PROG 2/3 page:

displays navigation parameters.

PROG 3/3 page:

displays localization modes (selected or not) and relevant data.

VNAV Page:

displays VNAV data.

BCP NAV Page:

displays BCP positioning parameters.

GPS NAV Page:

displays GPS positioning parameters.

HYB NAV Page:

displays HYB positioning parameters.

IRS NAV Page:

displays IRS positioning parameters.

DROPPING Page:

displays active route release point.

DIRECT TO Page:

by means of FPLN position points list, adjusts DIRECT TO function FIX identification.

Displays nearest airports list and allows them to be selected for DIRECT TO function.

With IDENT filled in, allows to select DIRECT TO function parameters.

PERF INIT Page:

displays performances database identification and allows parameters initialization/modification.

T/O PERF Page:

displays take-off performance parameters.

CRZ PERF Page:

displays cruise performance parameters.

DES PERF Page:

displays descent/landing performance parameters.

WEIGHT Page:

allows aircraft weight values to be entered and displayed.

TUNE 1/2 Page:

displays active V/UHF and HF frequencies, as well as radio communications equipment IFF codes, and provides access to radio communications plan data.

TUNE 2/2 Page:

displays navigation aids identification, frequency, heading (QMD) and distance, as well as tuning/auto tuning status.

NOTE

If the AUTOTUNE function is active and the operator changes the VOR frequency manually through RNAV page, the frequency will turn automatically to the previous value before manual insertion 2 seconds later.

COM PLAN Page:

displays radio communications plan data.

NEAREST Page:

displays a list of the 20 nearest navigation aids.

DESELECTED Page:

allows navigation aids to be selected or deleted.

MSG Key:

displays messages as generated in order of priority.

HOLD Page:

displays frozen position allowing related SAR configuration position and perfomance as well as flight crew database.

DATA MENU Page:

provides access to Init Status and Data information.

DATA XFER Page:

displays FMC databases and allows uploading/downloading.

DATABASE Page:

provides access to standard, flight crew and tactical data.

STD APT Page:

displays selected airport data from standard database.

STD NAVAID Page:

displays ILS and VHF selected navigation aid data from standard database.

STD WPT Page:

displays selected navigation waypoints or NAV navigation aid data from standard database.

PILOT DATA Page:

by using AIRPORTS, displays an airports list from flight crew database.

By using NAVAID, displays a navigation aids list from flight crew database.

By using WAYPOINTS, displays a navigation waypoints list from flight crew database.

By using ROUTE, displays a routes list from flight crew database.

PLT APT Page:

displays airport information from flight crew database, allowing data creation/modification.

PLT NAVAID Page:

displays navigation aid information from flight crew database, allowing data creation/modification.

WPT APT Page:

displays waypoint information from flight crew database, allowing data creation/modification.

PLT ROUTE Page:

displays route information from flight crew database, allowing data creation/modification.

TACT WPT Page:

displays tactical waypoint data from flight crew database, allowing data creation/modification.

DROP DATA Page:

allows dropping parameters selection, a given release point.

WARN ZONE Page:

displays danger zone data, allowing data creation/modification.

by using LIST, displays a danger zones list from flight crew database.

NEW DATA Page:

allows FIX type to create selection.

DUPLICATE Page:

allows selection of correct data when a more-than-one data series identification has been detected.

STATUS Page:

enables access to several status management pages.

AIR/RA Page:

displays AIR parameters as well as radio altimeter height.

HDG ATT Page:

displays both heading and attitude parameters.

FUEL FLOW Page:

displays fuel flow data.

FMS BITE Page:

displays FMS self-test results.

NOTE

The MCDU TEST command makes no action. However, the MCDU status is continuously monitorized by CDS function.

SENSOR STS Page:

displays IOP, IRS and GPS sensors and modes status.

DISCRETES Page:

displays FMC discrete status.

STS XFER Page:

allows system configuration table, tactical configuration table, performance data and magnetic variation model updating, as well as FMS status downloading.

PAD Page:

allows FMS memory display and modification, and is only intended for both ground and airborne test purposes.

Some of these pages are shown below, with the way they interconnect.

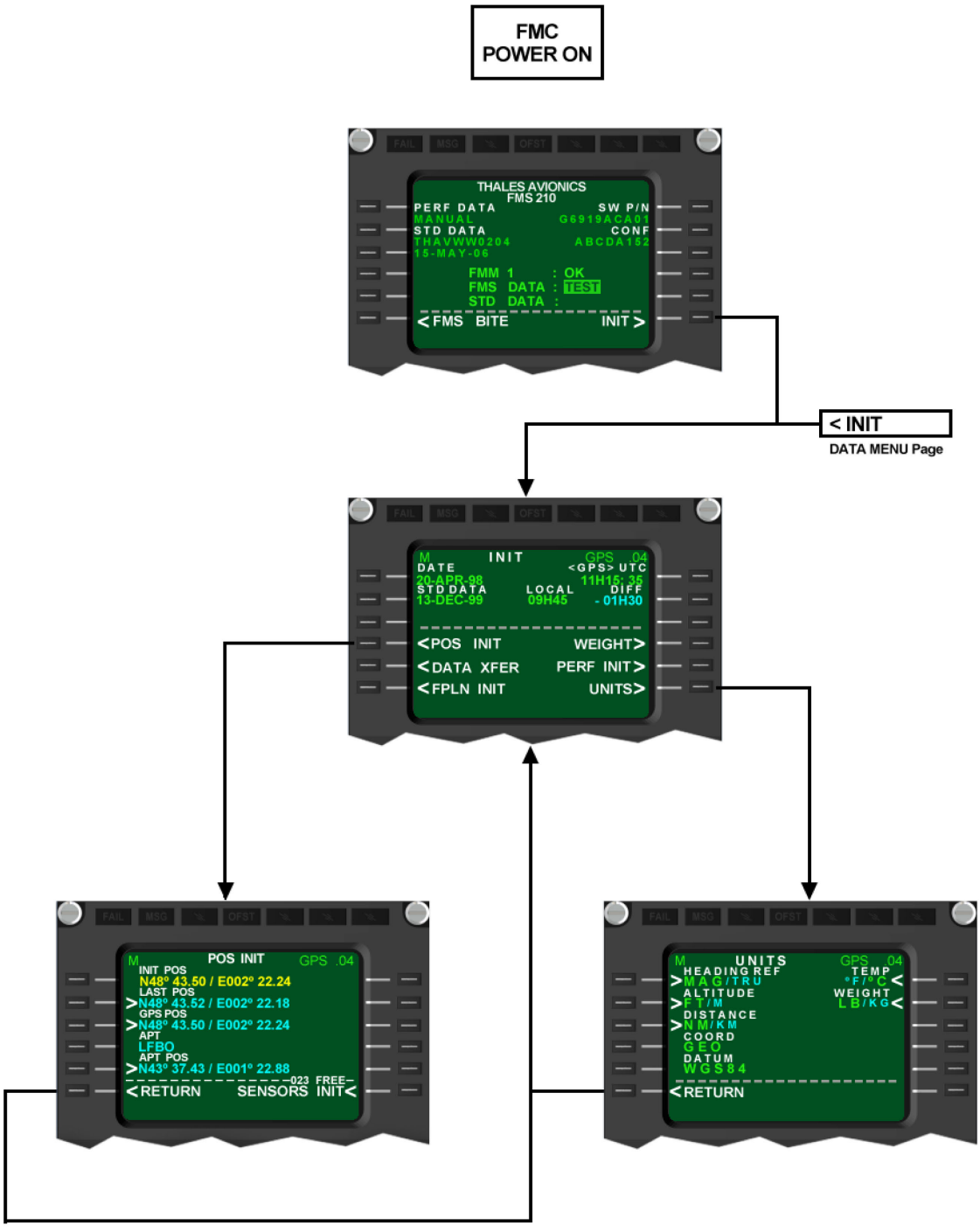


Figure 34-60 Hierarchical Pages (Sheet 1 of 5)

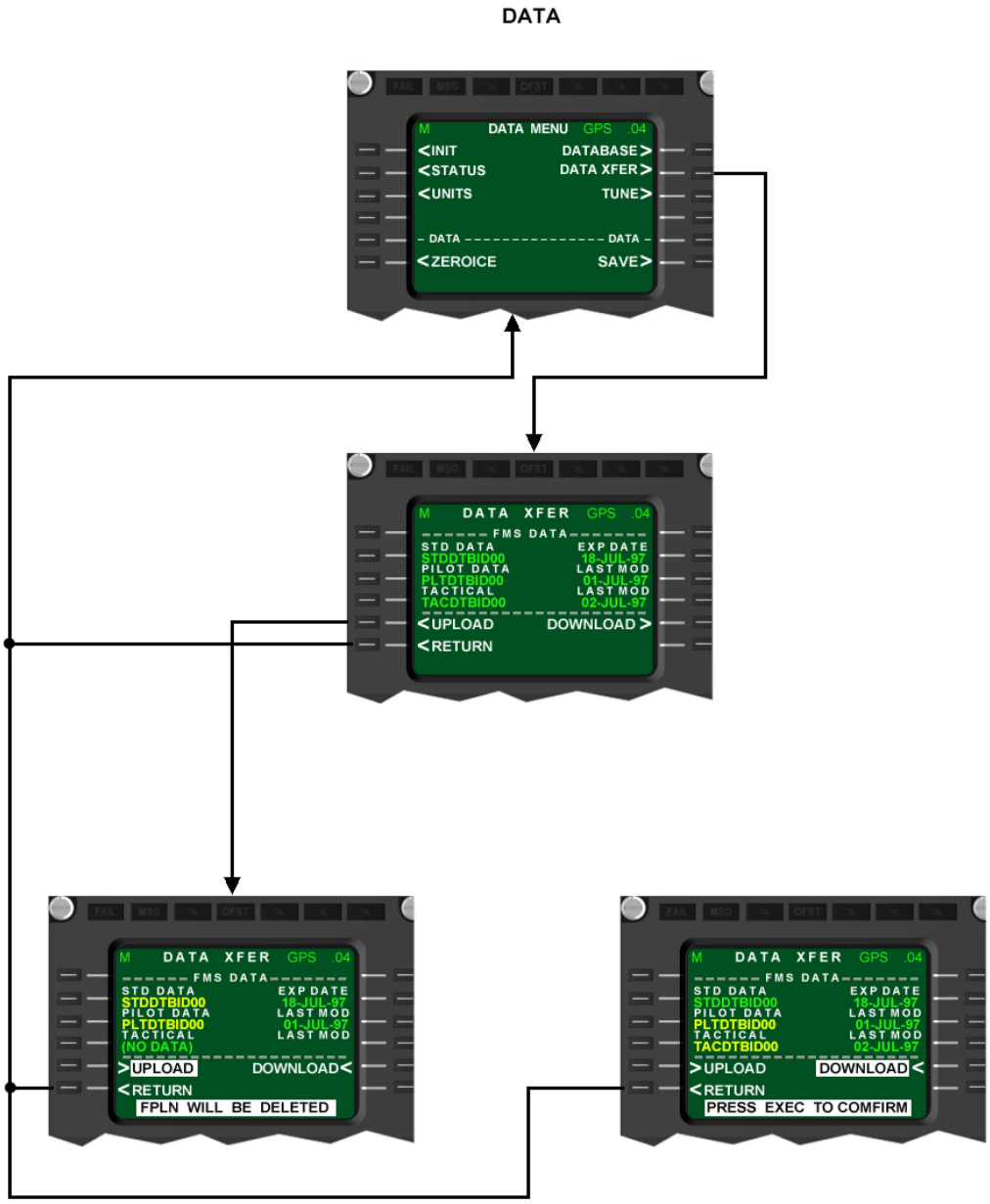


Figure 34-60 Hierarchical Pages (Sheet 2 of 5)

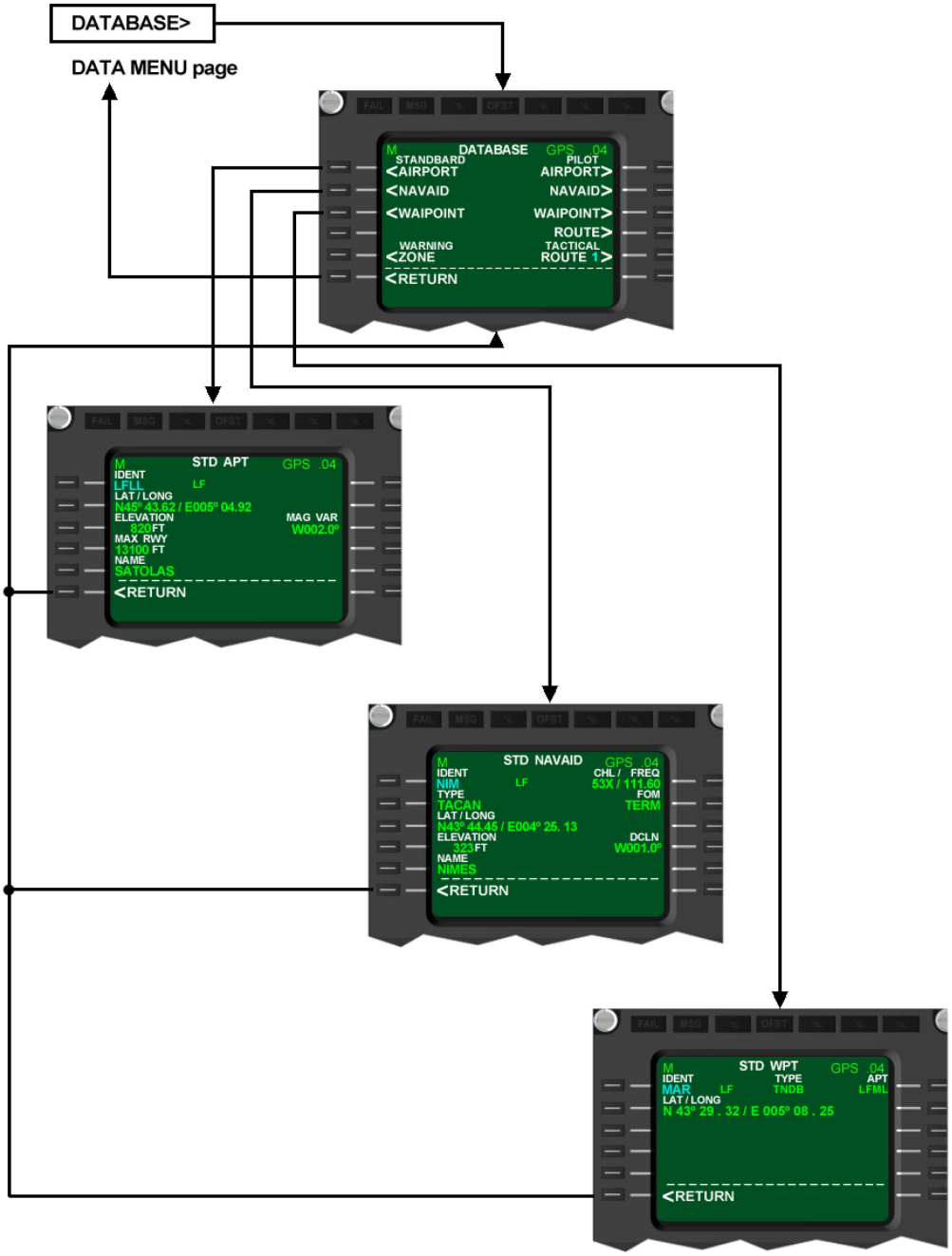


Figure 34-60 Hierarchical Pages (Sheet 3 of 5)

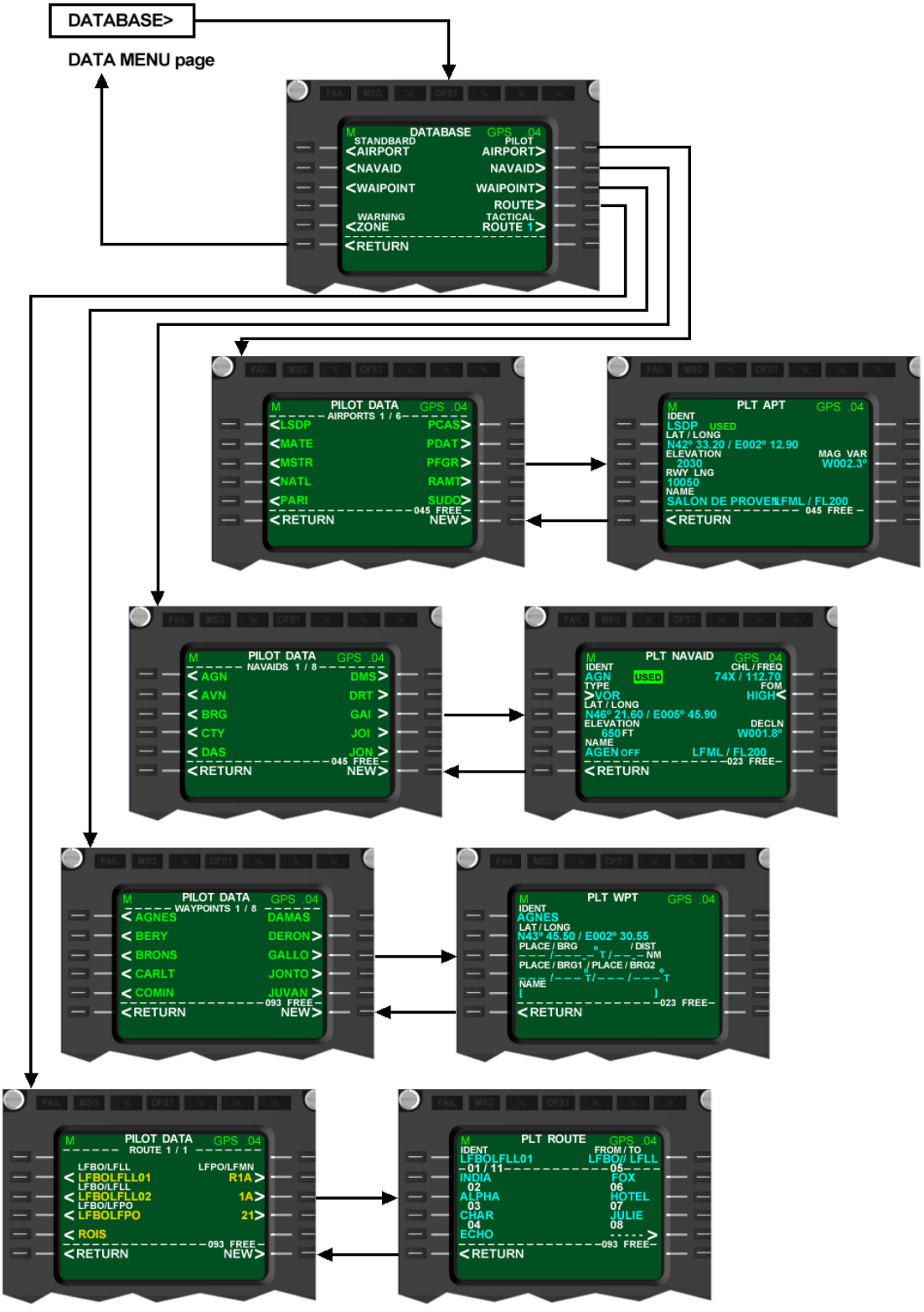


Figure 34-60 Hierarchical Pages (Sheet 4 of 5)

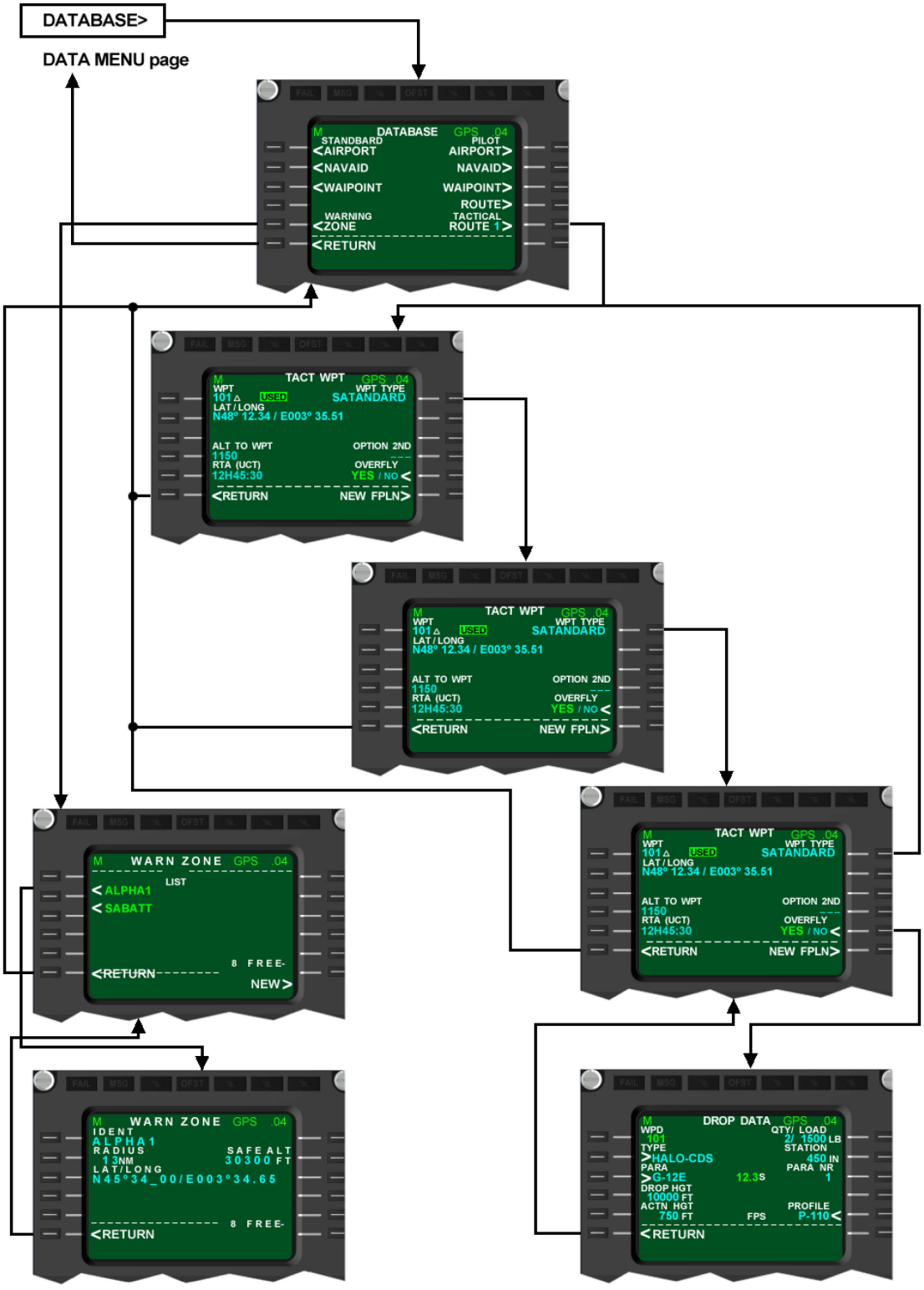


Figure 34-60 Hierarchical Pages (Sheet 5 of 5)

MAINTENANCE Control Panel

(1) FMS ZERO Switch:

- *Pressed:* encrypted data from FMS is deleted.

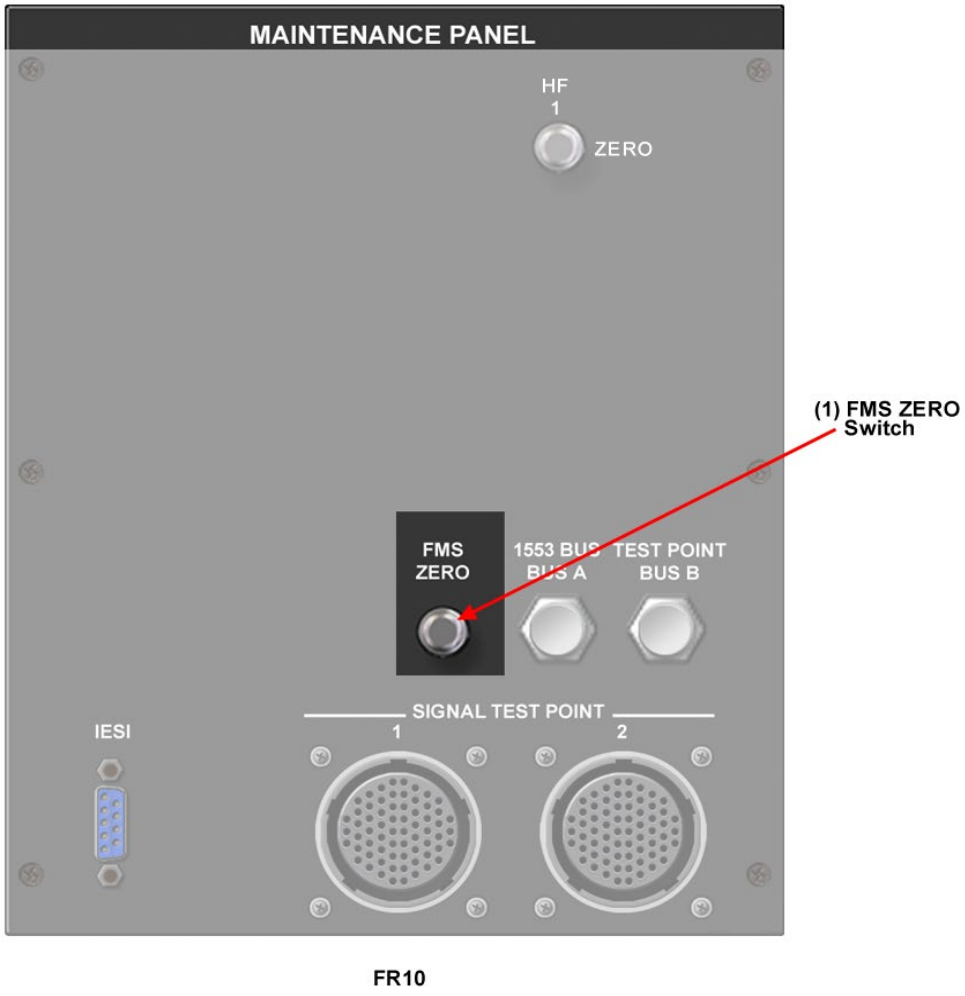


Figure 34-61 MAINTENANCE Control Panel - Controls and Indicators

DIGITAL MOVING MAP (DMM)

The Digital Moving Map (DMM) system is intended to provide an extremely user friendly, visual and highly Interactive Man Machine Interface for the moving map function.

DESCRIPTION

Main components are:

- ***Digital Map Module:*** in charge of symbol and map generation, including mass memory resources.
- ***Video Amplifier:*** allows driving two displays because the DMM can only drive one.
- ***Mass Memory Cartridge:*** is used for the storage of the on-board map database. This cartridge is inserted into the DMM. Cartridge storage compartment is located inside the left bottom stowage compartment of the rack at FR10, behind the back panel.
- ***Map Workshop (MWS):*** prepares databases.
- ***Navigation Displays:*** display all the information, menus and options of the DMM.
- ***Interactive Hand Controllers (IHC):*** located in the C/M-1 and C/M-2 armrest, enable system management.
- ***DMM Control Panel:*** located at the pedestal, allows selecting the IHC that is going to be used.

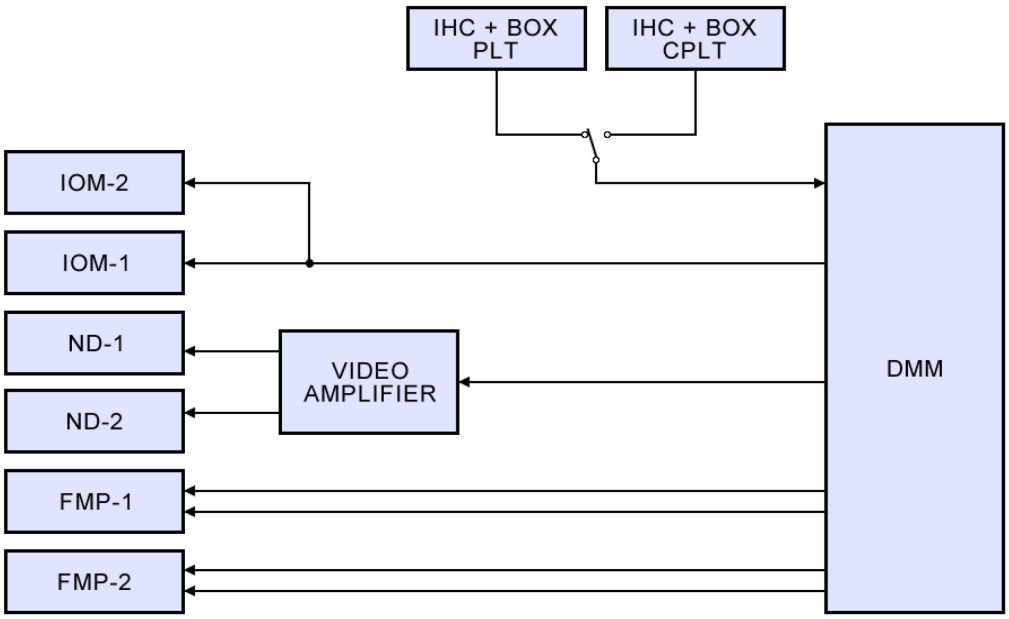


Figure 34-62 Digital Moving Map (DMM) - Architecture

OPERATION

DMM can be displayed in each ND by pressing the IMG pushbutton at the corresponding EFIS control panel. It can be simultaneously displayed in both NDs, but only one IHC can control it.

DMM generates an interactive 768 x 576 pixels image composed of 3 possible layers: a Map background, Superimposed Information (Error Messages, Symbols and Navigation Information) and Interactive Menus. This information is presented in both ND.

The DMM CTL Selector, located in the DMM Control Panel, selects which IHC manages the DMM. Once the desired option has been selected, the corresponding IHC will manage the Maps and System Menus presented on both ND.

There are 4 modes of turning on and off the system:

– *Power-up:* the DMS will support power up after or before insertion of Mass Memory Cartridge. If no database is present, a warning and a black map background are displayed.

NOTE

After completion of DMM Power-up, a self-test disclaimer box is displayed.

– *Cold Restart:* the DMM configuration is set according to the content of the configuration file stored in the cartridge. If this file is not present, the default parameters are used.

– *Warm Restart:* the DMM configuration is set according to the content of a system board dedicated memory. If a corruption is detected in this memory, a cold restart is performed.

– *Power-off:* the current content and the current man-machine interface configuration (including brightness, current scale, zoom factor…) is saved in the system board dedicated memory.

There are 3 possible map-running modes:

When intending to change between maps running modes, it is needed to use the IHC, pressing the MAP Pushbutton. According to the way this button is pressed a map-running mode will be displayed:

– A short single click will show the Scroll Map Mode, if already there, it will display the Deported Map Mode.

– A long single click will show the Auto Map Mode, if already there no change will occur.

Depending on the map-running mode selected, the cursor shape will be different from the others one.

– *Auto Mode:* the map movements are refreshed according to the aircraft ones and to the current map orientation selection.

– *Scroll Mode:* the map is translated according to the cursor movements initiated by user. The map orientation is the same as when entering the scroll mode. The cursor will be located at the centre of the screen.

– *Deported Mode:* the map is fixed centred on the cursor position captured when switching from Scroll to Deported mode.

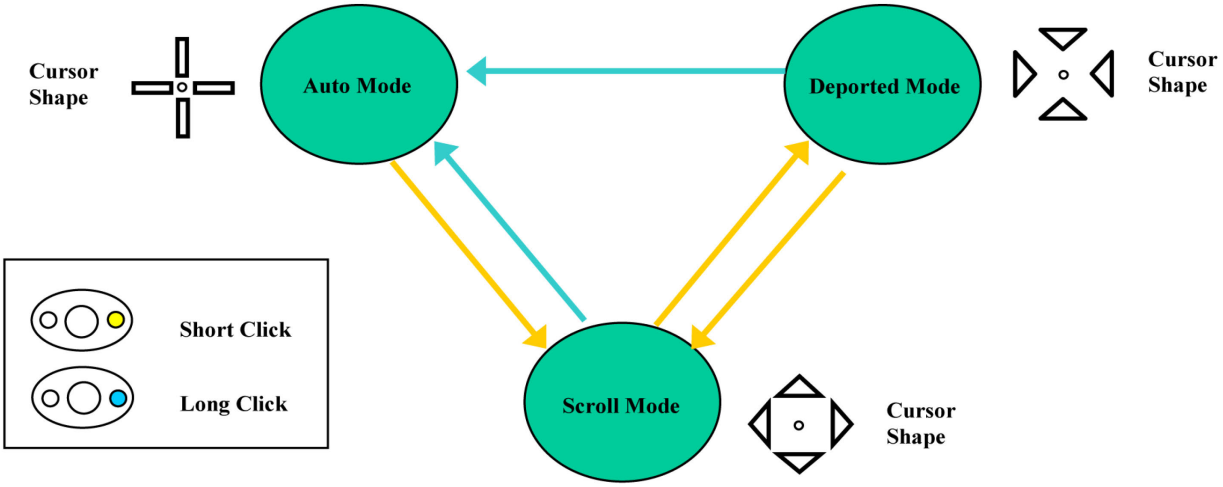


Figure 34-63 Map Running Modes and Map Pushbutton Diagram

The map database can store:

- *Raster Information:* is the result of paper map scans.
- *Vector Information:* is planimetric information (road, cities…) stored using a description of symbolic objects sorted by thematic classes. The thematic classes can be de-cluttered by the operator according to predefined de-cluttering configurations. Whatever the map is rotated, the symbols and characters strings remain horizontal.
- *Terrain Elevation Information:* is the description of the Terrain altitude only. It is used to apply real-time shading in the image, and gives access to exploitation of altitude for situation awareness and flight safety improving.

The interactive graphical interface is composed of three different menus:

- *MAP Menu:* allows setting the map view characteristics and the type of visualization that will be displayed.
- *NAV Menu:* allows establishing the Navigation requirements and procedures during the flight.
- *CONFIGURATION Menu:* will allow configuring the visualization display setting as brightness or balance.

The MAP Menu has the following sub-menus and options:

- *Map Database Popup Menu (DTB):* allows the user to choose the database to be addressed for map rendering. The map is displayed using the type of information stored in the currently selected database. The database labels should be defined on the ground station.
- *Scale Popup Menu (SCL):* selecting the button will display a popup menu containing all available scales. It allows the user to choose an item in the list of selected database scales.
- *Decluttering Popup Menu (DCT):* allows the user to select a set of planimetry thematic classes when the map is displayed using a scale contains vector information. Selecting the button will display a popup menu containing all the available configurations. Names of planimetric information should be defined on ground station.

– *Elevation Popup Menu (ELV):* allows to select the rendering for elevation data:

  • OFF: No elevation information is displayed.

  • NAT: Uniform colour is applied to the ground and shadowing is represented.

  • SGP: Ground Proximity coloration is displayed and shadowing is represented.

  • GP: Ground Proximity coloration is displayed without shadowing.

  • HYP: Hypsometric coloration is displayed and shadowing is represented. This mode is not available if the selected scale contains raster data.

  If no elevation data is present in the selected scale, this button will be disabled and the selected item will be OFF.

  If the elevation mode selected is GP or SGP, the GPREF menu will be displayed. The altitude displayed on the button is the one used to compute coloration coding overlay on the map in GP and SGP modes. The GPREF mode can be changed using the double function button:

  • AUTO mode: the altitude reference will be the current aircraft baro-corrected altitude.

  • MAN mode: the altitude reference should be set manually by the pilot via the lock button in the menu.

NOTE

In MAN mode, a "MAN" label will be displayed amber when active because this mode should not be used all along flight.

– *Orientation Popup Menu:* allows to choose the orientation of the map:

  • North Up: rotating mock-up, north always forward top of screen.

  • Track Up: rotating map, track always toward top of screen.

  • Heading Up: rotating map, heading always toward top of screen.

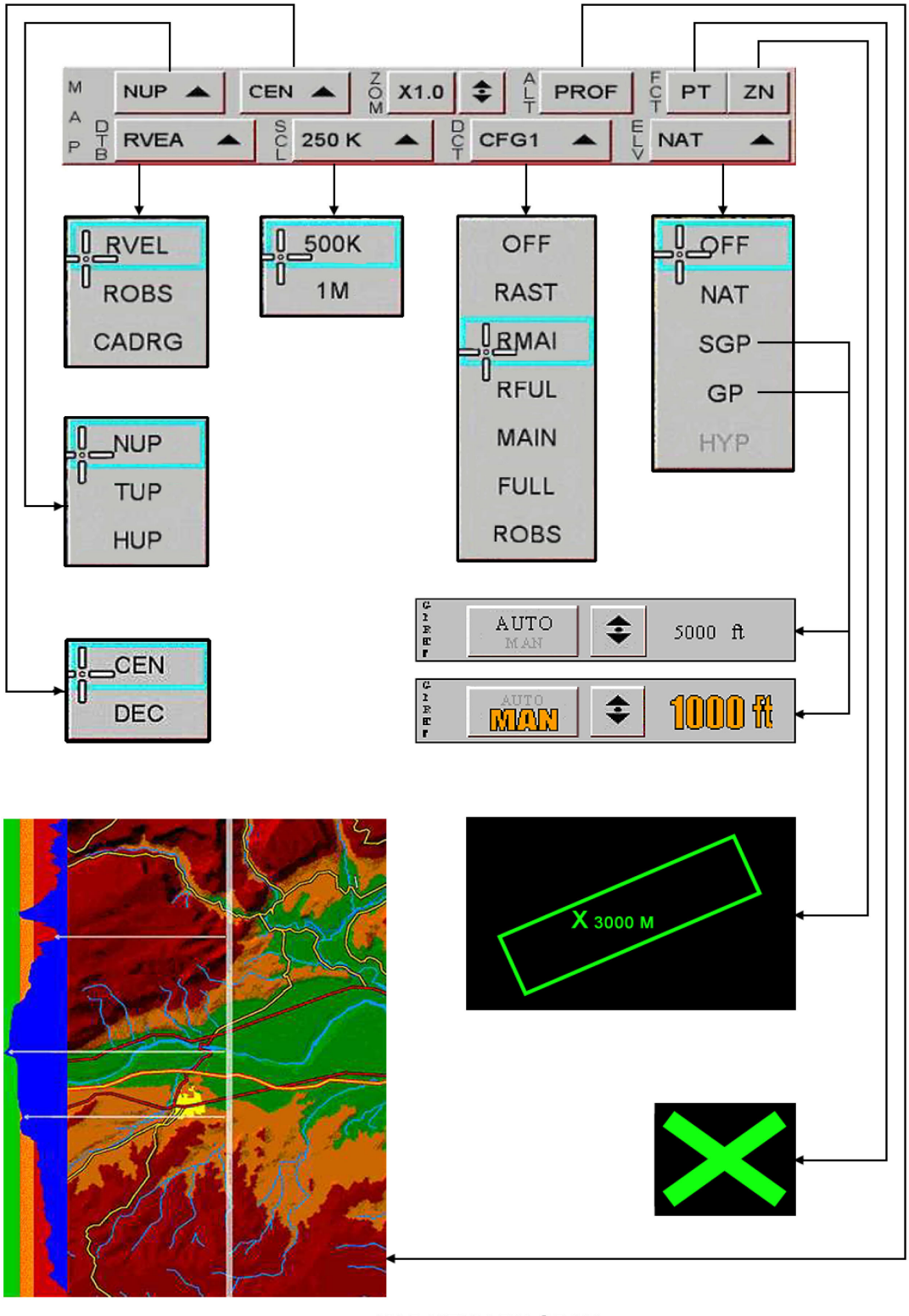
– *Position Popup Menu:* allows to choose between Centred Map and the Decentred Map presentation.

– *Zoom Adjustment Lock (ZOM):* changes the current zoom factor. A selection of the Zoom Push Button will set the zoom factor to 1.0 immediately.

– *Profile Toggle Pushbutton (ALT):* allows to choose whether to display the Terrain Profile or not. The profile window is computed in real time, scanning the terrain elevation data along a corridor. The profile window will not be displayed in the following cases: North Up or Heading Up Modes, Deported or Scroll Mode, GPREF MAN mode, "OFF" selected in ELEVATION Menu and no elevation database in memory.

– *Point Toggle Pushbutton (PT):* allows to consult the elevation by selecting points on the map area.

– *Zone Toggle Pushbutton (ZN):* allows to consult the maximum altitude of and specified area.



MAP MENU DIAGRAM

Figure 34-64 Map Menu Diagram

The NAV Menu has the following sub-menus and options:

– *Flight Plan Toggle pushbutton (FPLN):* controls the display of the Flight Plan sub-menu. This submenu provides functions relative to Flight Plan modifications and consultations. When this sub-menu is activated, the user will be allowed to perform lateral revision of the Flight Plan using:

  • CANCEL Pushbutton: allows to discard the entire modifications engaged on the active flight plan. The selection of this pushbutton also removes the Flight Plan sub-menu.

  • CLR FIX Pushbutton: allows to delete a fix of the active or secondary Flight Plan by selecting the fix with the pointing device.

  • SEC Pushbutton: allows to display the secondary flight plan. The selection of this button also removes the temporary flight plan and invalidate revisions on the active flight plan. The secondary flight plan is displayed in white dashed lines.

  • EXEC Pushbutton: allows to validate the modifications performed on the active Flight Plan. The selection of this pushbutton also removes the Flight Plan sub-menu.

  If the flight plan is IFR, the user should select a point of the flight plan (necessarily located after the active leg) and change the course of the flight plan from this point, by selecting one or more points directly upon the map background. If a chosen point is not included in any Data Base (neither Standard nor Pilot one), it is automatically created as a Temporary Waypoint. The user will then choose between EXEC and CANCEL in the Flight Plan Sub Menu.

  NOTE

  If the flight plan is tactical, no revision is allowed.

  If the selected flight plan is the secondary flight plan, the user will select a point of it and change the course of the flight plan from this point by selecting one or more points directly upon the map background.

  NOTE

  When a tactical flight plan is activated, this tactical flight plan will be available in DMM 30 seconds later.

– *Route Database Toggle Pushbutton (RTE DB):* controls the display of the Route Database sub-menu. This sub-menu provides operation modifications and consultations relative to the Routes stored in the Pilot Database using:

  • LIST Pushbutton: allows to display a Route among the available ones in the FMS memory. The route is displayed in cyan or screen.

  • NEW Pushbutton: allows to create a new route. When the pushbutton has been selected, the operator will select two points which are respectively the Departure and the Destination of the Route.

  • CLEAR Pushbutton: deletes the displayed route from the Pilot Database.

  • SELECT Pushbutton: a route becomes a temporary flight plan and the Flight Plan sub-menu (FPLN) automatically displayed. If validated (by EXEC), it becomes the active flight plan, replacing the former one.

- CLR FIX Pushbutton: enables to remove the selected fix from the displayed route. The fix is removed from the route but will remain in the concerned Navigation Database. A new leg is created to join the previous and the next fixes.
- SAVE Pushbutton: allows to validate the modifications done on the route database.

– *Standard Database Toggle Pushbutton (STD DB):* controls the display of the Standard Database sub-menu. This sub-menu provides functions relative to the Standard Database consultation using:

- WPT Toggle Pushbutton: controls the display of the Standard Database Waypoints. When selected, a waypoint is displayed in the map area if the rose range selected is the proper rose range for each type of standard waypoint.

  The following table indicates the rose range for the different standard waypoints.

Waypoint type	**Waypoint sub-type**	**Rose range**
Airport	Large Airport	≤28 NM
Navaid	VHF Navaids	
Airport	Small Airport	≤6 NM
Heliport	Heliport	
Waypoint	Enroute WPT	
Navaid	NDB	≤5 NM
Waypoint	Terminal WPT	

Table 34-3 DMM - Standard waypoints - Rose range

  The rose range depends on the zoom factor selected on the MAP Menu.

- APT Toggle Button: controls the display of the Standard Database Airports. When selected, the airports are displayed in the map area if the range is less than 80 Nm.
- NVD Toggle Button: controls the display of the Standard Database Navaids. When selected, the navaids are displayed in the map area if the range is less than 80 Nm.

– *Pilot Database Toggle Pushbutton:* controls the display of the Pilot Database sub-menu. This sub-menu provides operations, modifications and consultations relative to the fixes stored in the pilot database using:

- WPT Toggle Pushbutton: controls the display of the pilot database waypoints overlay and should be selected in order to create a new waypoint by clicking on the map background.When selected, a waypoint is displayed in the map area if the rose range selected is the proper rose range for each type of pilot waypoint.

  The following table indicates the rose range for the different pilot waypoints.

Waypoint type	**Waypoint sub-type**	**Rose range**
Airport	Large Airport	≤28 NM
Navaid	VHF Navaids	
Airport	Small Airport	≤6 NM
Waypoint	WPT	

Table 34-4 DMM - Pilot waypoints - Rose range

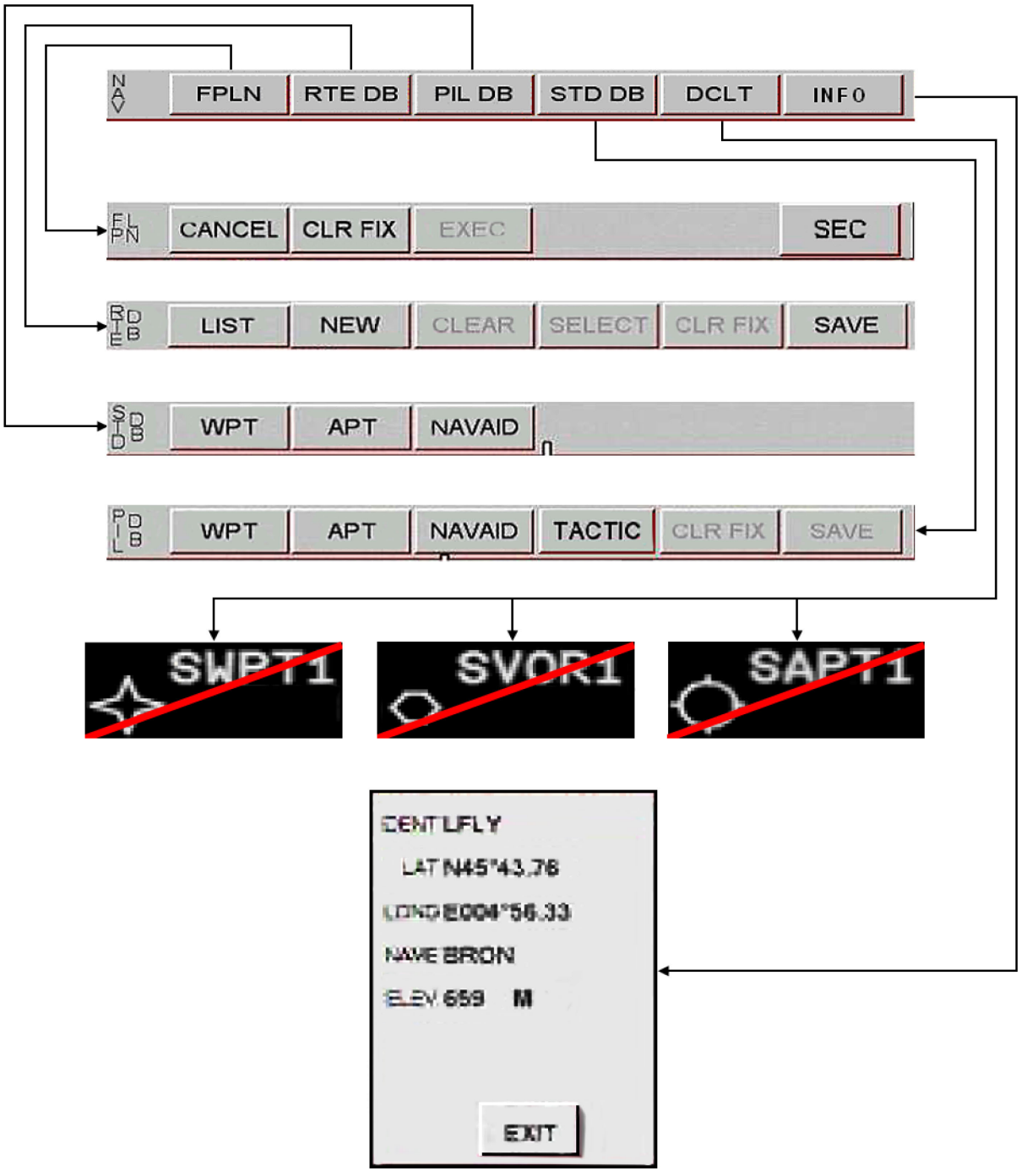
  The rose range depends on the zoom factor selected on the MAP Menu.

- NAVAID Toggle Pushbutton: controls the display of the Pilot Database Navaids Overlay. When selected, the navaids are displayed in the map area if the range is less than 80 Nm.
- APT Toggle Pushbutton: controls the display of the Pilot Database Airports Overlay. When selected, the airports are displayed in the map area if range is less than 80 Nm.
- TACTIC Toggle Pushbutton: controls the display of the Warning Zones. When selected, the warning zones are displayed in the map area if range is less than 80 Nm.
- CLR FIX Pushbutton: allows to delete a fix in the pilot database.
- SAVE Pushbutton: allows to save modifications currently engaged for future use.

– *DCLT Pushbutton:* allows to hide all navigation overlays currently activated, except the Flight Plan if visible.

– *INFO Pushbutton:* allows to consult information about the fixes drawn in the map area. When pushed, the menus are masked and a popup window with an Exit Pushbutton is displayed. When the Exit Pushbutton is pressed, the popup is masked ant the menus are displayed again. The following fixes can be selected:

- Waypoint: the identifier, latitude, longitude and full name are displayed.
- Airport: the identifier, latitude, longitude, full name and altitude are displayed.
- Navaid: the identifier, latitude, longitude, full name, altitude, type and channel/frequency are displayed.



NAVIGATION MENU DIAGRAM

Figure 34-65 Navigation Menu Diagram

The CONFIGURATION Menu (CFG) has the following sub-menus and options:

– *Brightness Pushbutton (BRT):* allows to change the brightness of the graphic display by unitary steps among 16 values.

– *Balance Pushbutton (BAL):* allows to increase/decrease the symbol brightness versus the map brightness by unitary steps among 16 values.

– *Shadow Contrast Pushbutton (SHD):* allows to change the contrast of the shadow calculated with elevation information of the database by unitary steps among 16 values.

– *Time Scale Popup Menu (REF):* allows to configure the time scale display. The popup menu contains two or three values, depending on the configuration in the parameters file: The popup menu items are:

  • OFF: no time scale is displayed.

  • <VALUE1> min: the time scale is displayed in the 2.5D window and in the profile window if displayed. The time scale length indicates the aircraft position in <VALUE1> minutes.

  • <VALUE2> min (<VALUE2> is greater than <VALUE1>): the time scale is displayed in the 2.5D window and in the profile window if it is displayed. The time scale length indicates the aircraft position in <VALUE2> minutes. A marker along the time scale indicates de aircraft position in <VALUE1> minutes.

– *Coordinate System Double Function Pushbutton (C/R):* allows to choose the coordinate system to use for the presentation on the cursor position. The cursor position is displayed in Latitude/Longitude coordinates or in true Bearing/Distance coordinates.

There are 3 types of superimposed information available on the display:

– *Alert, Warning and Error Messages:* There are three types of messages used to give information about the system to user:

  • Alert Messages: used to inform the operator of system internal fault or abnormal aircraft condition.

  • Warning Messages: used to inform the operator about navigation information. They are displayed up to three seconds.

  • Error Messages: used to inform the operator that a problem has been encountered.

– *Symbols:*

  • Rose Symbol: always displayed around the map reference point.

    In Auto Map running mode, Current track direction, Geographical north direction and Range (in Nm) of the circle radius are displayed around the rose.

    In Scroll or Deported Map running mode, Geographical north direction, Range (in Nm) of the circle radius and Aircraft mock-up direction are displayed around the rose.

  • Wind Symbol: a white arrow oriented to wind direction.

  • Aircraft Mock-up: a yellow triangle with one vertex oriented in the aircraft direction.

  • Time Scale Symbol: a yellow line with it beginning in the aircraft mock-up.

  • View Angle Symbol: this symbol appears as a line. It is displayed when the adequate equipment sends to the system the information of the view angle.

  • Cursor Symbol: the cursor have three different shapes depending of the map running mode.

- Marked Point Symbol: used in three different cases by DMM application: to designate the point corresponding to the current elevation measurement, to designate the point which has the maximum elevation in a zone and to designate the points used to define a zone.
- Zone Symbol: the zone displayed by the zone elevation measurement function is a rectangle which can be rotated. The size of this rectangle is defined by user.

– *Navigation Fixes:* each navigation fix has a legend attached composed of two character strings: the fix identifier and the information about the fix. When selecting, the fix colour changes. There are 8 types of navigation fixes:

- Waypoint Symbols: There are five types of waypoint symbols corresponding to Standard Waypoints, Pilot Waypoints, Pseudo Waypoints, Moving Waypoints and Temporary Waypoints.
- Airport Symbols: There are three types of Airport symbols: the Standard Airport, the Pilot Airports and a specific symbol for Departure and Arrival Airports.
- Dropping Zone Symbols: The waypoint number is displayed on the upper right side of the symbol. When the dropping zone is the active waypoint, the "CARP" or "HARP" label is displayed instead of the waypoint number.
- Warning Zone Symbol: A red circle represents the warning zone of a tactical database. The warning zone identification is displayed above the warning zone centre and the safe altitude is displayed below the warning zone centre.
- Navaids Symbols: There are four types of navaids: VOR, VOR/DME, DME and ADF.

The Range Value is the maximum distance between the aircraft mock-up and the edge of the graphic display. The table below gives the correspondence between the displayed scale and the range value.

Displayed Scale	**Range value (Km.)**	**Range value (Nm.)**
1/25.000	5.5	3
1/50.000	11.1	6
1/100.000	22.2	12
1/250.000	55.6	30
1/500.000	111.1	60
1/1.000.000	222.2	120
1/2.000.000	444.5	240

Table 34-5 DMM - Correspondence between Displayed Scale and Range value

Ground proximity coloration mode allows presentation of coloured map areas as a function of their relative altitude with respect to the aircraft current one. Four colours and altitude ranges are defined according to the following rules:

– RED: dangerous area (its altitude is above the aircraft current one).

– AMBER: unreliable area (below the safety margin).

– GREEN: no danger area (above the safety margin).

– BLUE: not recommended area (above the maximum flight level).

When elevation is presented along with raster planimetry, only dangerous areas are shown.

Hypsometric Coloration: Hypsometric mode assigns a colour to ranges of altitudes as in a geographical atlas. Hypsometric coloration depends upon terrain height only with respect to a specific colour table. Hypsometric coloration is not available when elevation is presented along with raster planimetry.

The Map Work Shop (MWS) enables the user to prepare Map coverage and to generate the files to be downloaded. The MWS currently manages: Tiff (raster data), VMAP0 and VMAP1 (vector data), DETED0, DETED1 and DETED2 (elevation data).

There are two types of different Alert Messages:

– *FMS User Alert Messages:*
  - IN PROGRESS: an operation, which requires a significant time, is being performed.
  - DTA: Data Base has been modified but not saved.
  - DATABASE FULL: FMS is unable to neither create a new fix or route nor even modify a route within the pilot database.
  - NOT ALLOWED: the operator tries to create more than 50 temporary waypoints, tries to insert a fix after the last fix of the displayed route or tries to modify the route that was used to initialise the currently flown active flight plan.
  - NOT IN DATABASE: a fix that does not belong to database in EDIT Mode has been selected. When creating or revising a route, only already existing fixes in database can be chosen.
  - OFFSET CANCELED: the aircraft regains its initial trajectory after an offset, as consequence of a flight plan revision.
  - FPLN FULL: the operator tried to add a fix in an already full flight plan.
  - MSG: displayed to invite the operator to check the MCDU.
  - WPT ALERT: displayed to announce the arrival at a flight plan critical part.
  - RNP Alert: ANP exceeds RNP.
  - NAVIGATION WARNING: no Lateral Guidance alert or GPS integrity alert or RAAIM GPS alert.
– *DMS User Alert Messages:*
  - IN PROGRESS: an operation is being performed.
  - CARTRIDGE FAILURE: no more communication with cartridge is detected.
  - ALTITUDE FAILURE: calculation of altitude of a point or maximum altitude within a zone is impossible due to corrupted data.
  - FLIGHT PLAN AVAILABILITY: the flight plan data has not been received for 30 seconds.
  - PARAMETER AVAILABILITY: the current aircraft position has not been received for 5 seconds.
  - SYMBOLOGY OVERLOAD: the current image contains more symbology than the DMS can process. Some symbology elements may not be displayed.

CONTROLS AND INDICATORS

DMM CONTROL PANEL

(1) DMM CTL Selector:

- *PLT:* C/M-1 IHC controls DMM system.
- *CPTL:* C/M-2 IHC controls DMM system.

INTERACTIVE HAND CONTROLLER (IHC)

(2) SELECT Pushbutton:

- *Short Click:* select an object or a Map point / Select a Widget (Menu Buttons).

(3) MENU Pushbutton:

- *Short Click:* change menu.
- *Long Click:* switch to hidden menu.
- *Double Click:* Show / Hide menus.

(4) MAP Pushbutton:

- *Short Click:* change map running mode according to diagram.
- *Long Click:* switch to Auto Map Running Mode.
- *Double Click:* cursor is moved to Menu / Map area centre (depending of the cursor position).

(5) Thumb Controller

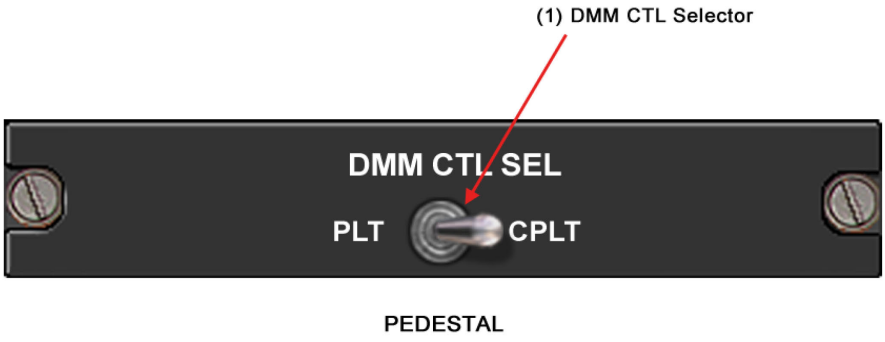


Figure 34-66 DMM Control Panel - Controls and Indicators

C/M-1 AND C/M-2 ARMREST

Figure 34-67 Interactive Hand Controller (IHC) - Controls and Indicators

MAP MENU

(6) Orientation Popup Menu Button:

- *Pressed:* displays the Orientation Popup Menu.

(7) Position Menu Button:

- *Pressed:* displays the Position Popup Menu.

(8) Zoom Lock Button:

- *Pressed:* adjusts the zoom in or out.

(9) Profile Toggle Button:

- *Pressed:* displays or hides the profile window.

(10) Point Toggle Button:

- *Pressed:* performs a point altitude request.

(11) Zone Toggle Button:

- *Pressed:* performs a zone altitude request.

(12) Elevation Popup Menu Button:

- *Pressed:* displays the Elevation Popup Menu.

(13) Decluttering Popup Menu Button:

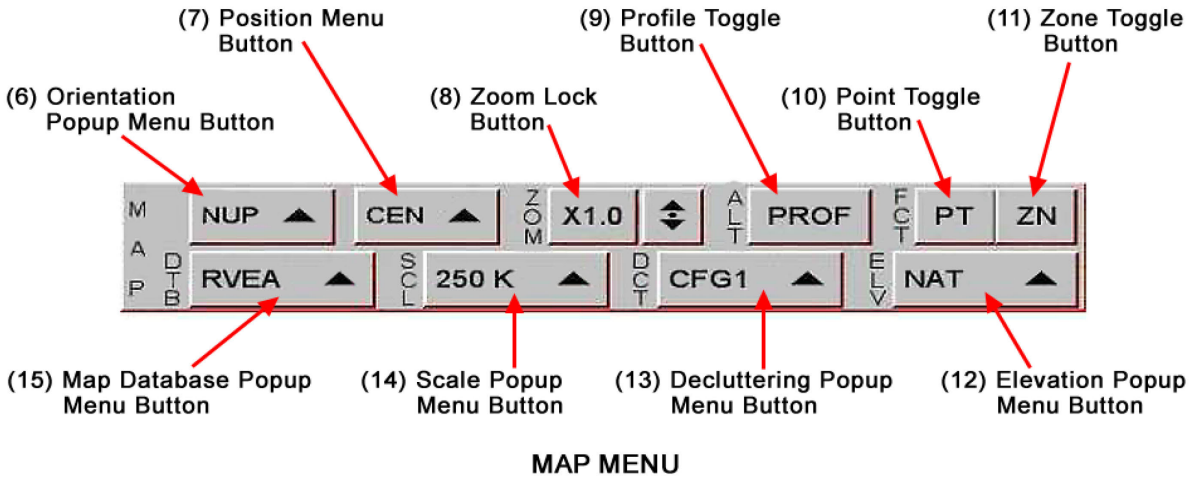
- *Pressed:* displays the Decluttering Popup Menu.

(14) Scale Popup Menu Button:

- *Pressed:* displays the Scale Popup Menu.

(15) Map Database Popup Menu Button:

- *Pressed:* displays the Map Database Popup Menu.



MAP MENU

Figure 34-68 Map Menu - Controls and Indicators

NAV MENU

(16) Flight Plan Push Button:

- *Pressed:* displays the Flight Plan functions sub-menu.

(17) Route Database Push Button:

- *Pressed:* displays the Route Database sub-menu.

(18) Pilot Database Push Button:

- *Pressed:* displays the Pilot Database sub-menu .

(19) Info Push Button:

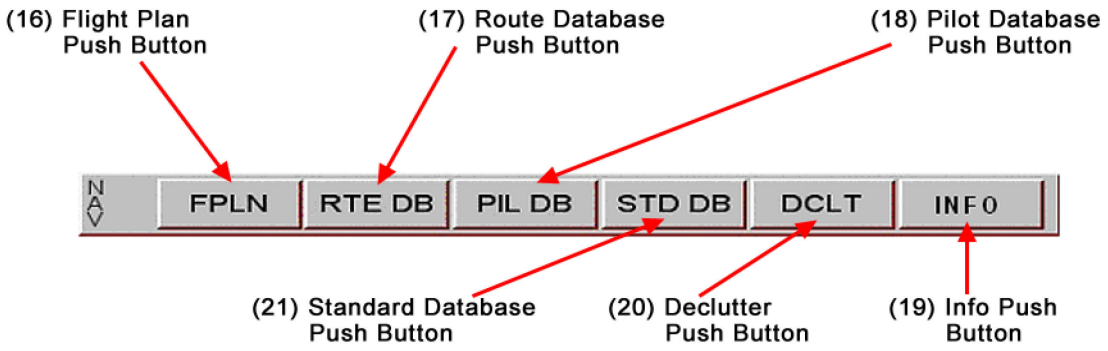
- *Pressed:* performs a consult information about fixes currently in map.

(20) Declutter Push Button:

- *Pressed:* hides all navigation overlays displayed.

(21) Standard Database Push Button:

- *Pressed:* displays the Standard Database sub-menu .



NAVIGATION MENU

Figure 34-69 Navigation Menu - Controls and Indicators

CONFIGURATION MENU

(22) General Brightness Lock Button:

- *Pressed:* adjusts the Brightness.

(23) Balance Lock Button:

- *Pressed:* adjusts the symbol brightness value versus the map brightness.

(24) Shadow Contrast Lock Button:

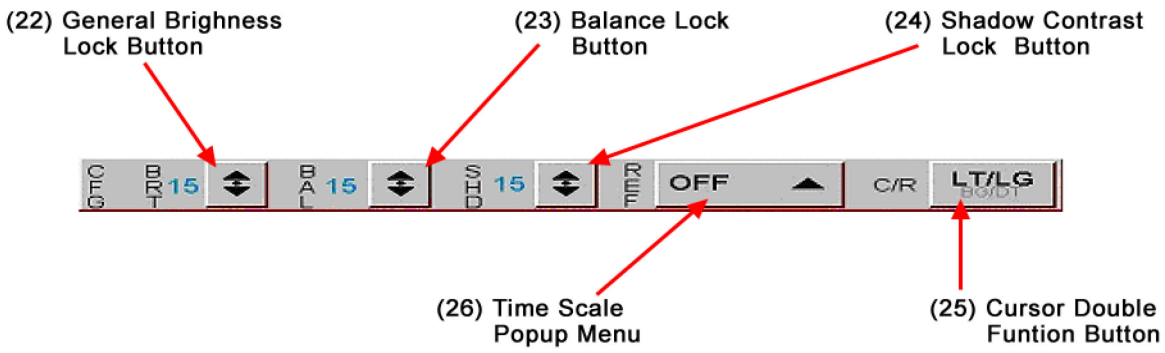
- *Pressed:* adjusts the contrast of the shadow in elevation mode.

(25) Cursor Double Function Button:

- *Pressed:* changes the coordinate system.

(26) Time Scale Popup Menu:

- *Pressed:* displays the Scale Popup Menu.



CONFIGURATION MENU

Figure 34-70 Configuration Menu - Controls and Indicators

DMM SYMBOLS

(27) Standard, SAR or Tactical Waypoint Symbol

(28) Pilot or Temporary Waypoint Symbol

(29) Moving Waypoint Symbol

(30) Pseudo-Waypoint Symbol

(31) Rose Symbol

(32) Wind Symbol

(33) Aircraft Mock Up

(34) Time Scale Symbol

(35) View Angle Symbol

(36) Cursor Symbol

(37) Marked Point Symbol

(38) Zone Symbol

(39) Standard Airport Symbol

(40) Pilot Airport Symbol

(41) Departure and Arrival Symbol

(42) Dropping Zone Symbol

(43) Warning Zone Symbol

(44) Standard or Pilot VOR Navaid Symbol

(45) Standard or Pilot VOR/DME Navaid Symbol

(46) Standard or Pilot DME Navaid Symbol

(47) Standard or Pilot ADF Navaid Symbol

(48) Holding Pattern Symbol

the cross represents the rotation centre and the dotted arrow represents the reference axis of the symbol. The cross and the arrow are not displayed on the screen.

(49) Turn Procedure Symbol:

the cross represents the rotation centre and the dotted arrow represents the reference axis of the symbol. The cross and the arrow are not displayed on the screen.

(50) Runway Symbol:

the cross represents the rotation centre ant the dotted arrow represents the reference axis of the symbol. The cross and the arrow are not displayed on the screen.

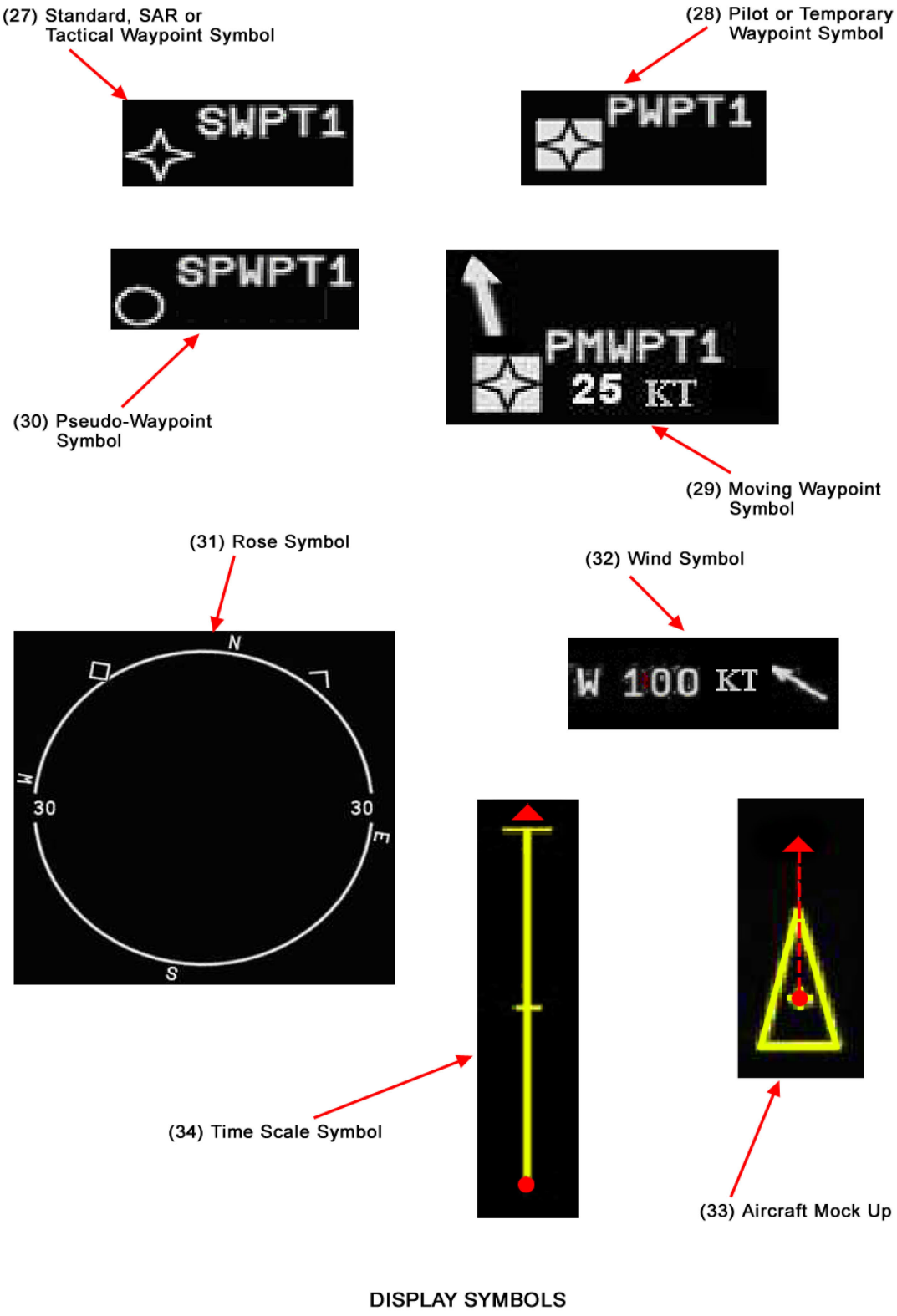
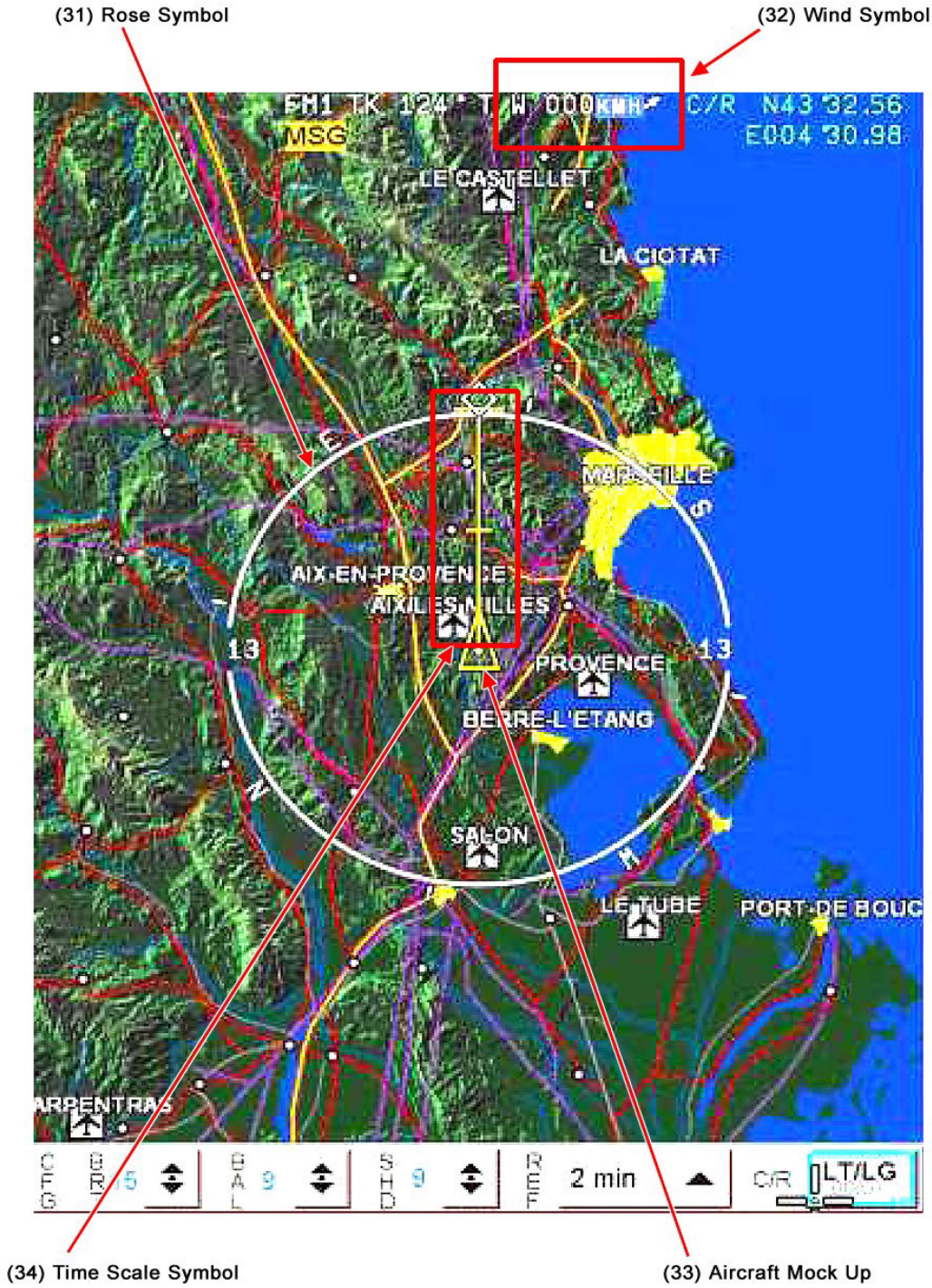


Figure 34-71 Display Symbols - Controls and Indicators (Sheet 1 of 4)



DISPLAY SYMBOLS

Figure 34-71 Display Symbols - Controls and Indicators (Sheet 2 of 4)

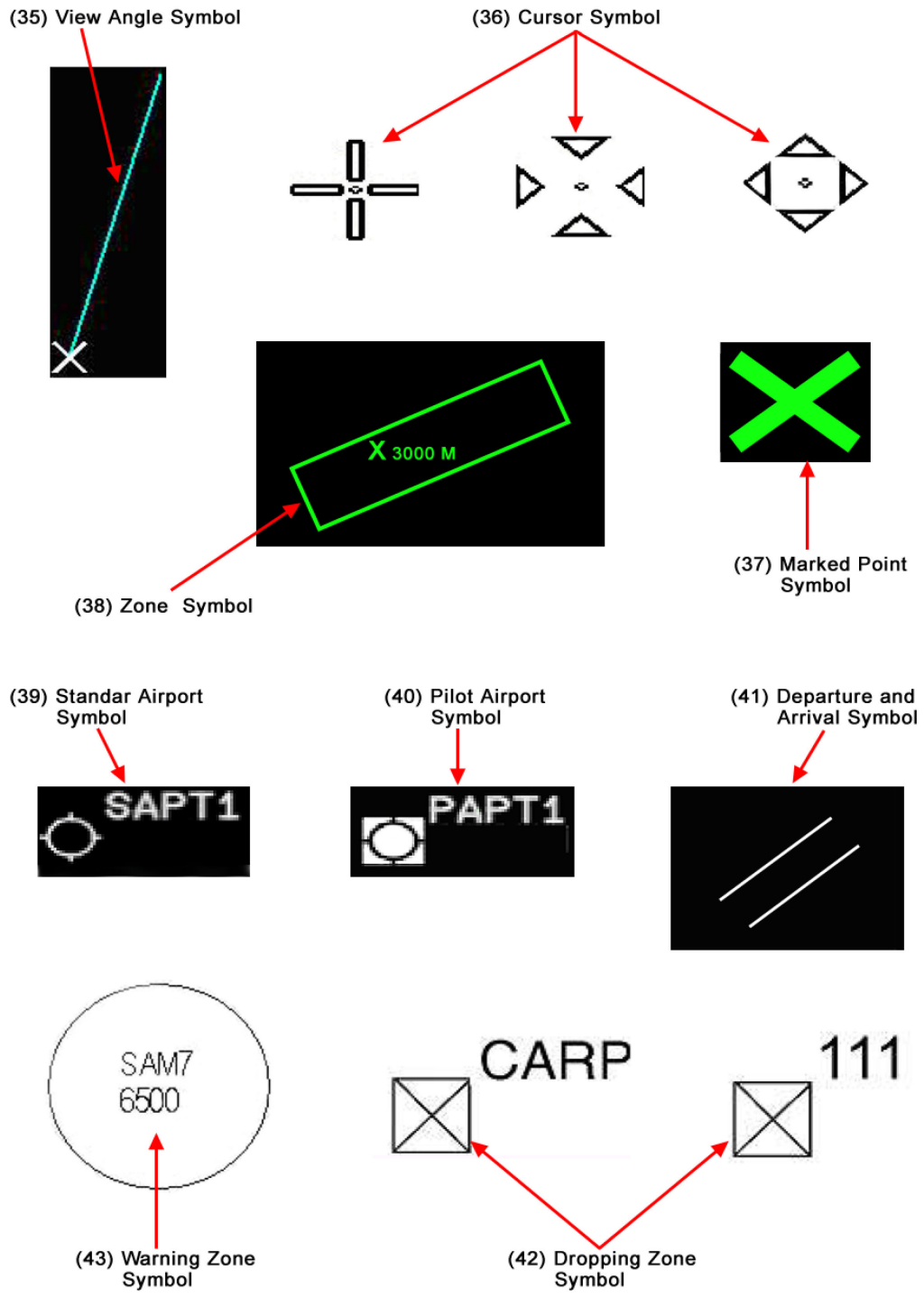


Figure 34-71 Display Symbols - Controls and Indicators (Sheet 3 of 4)

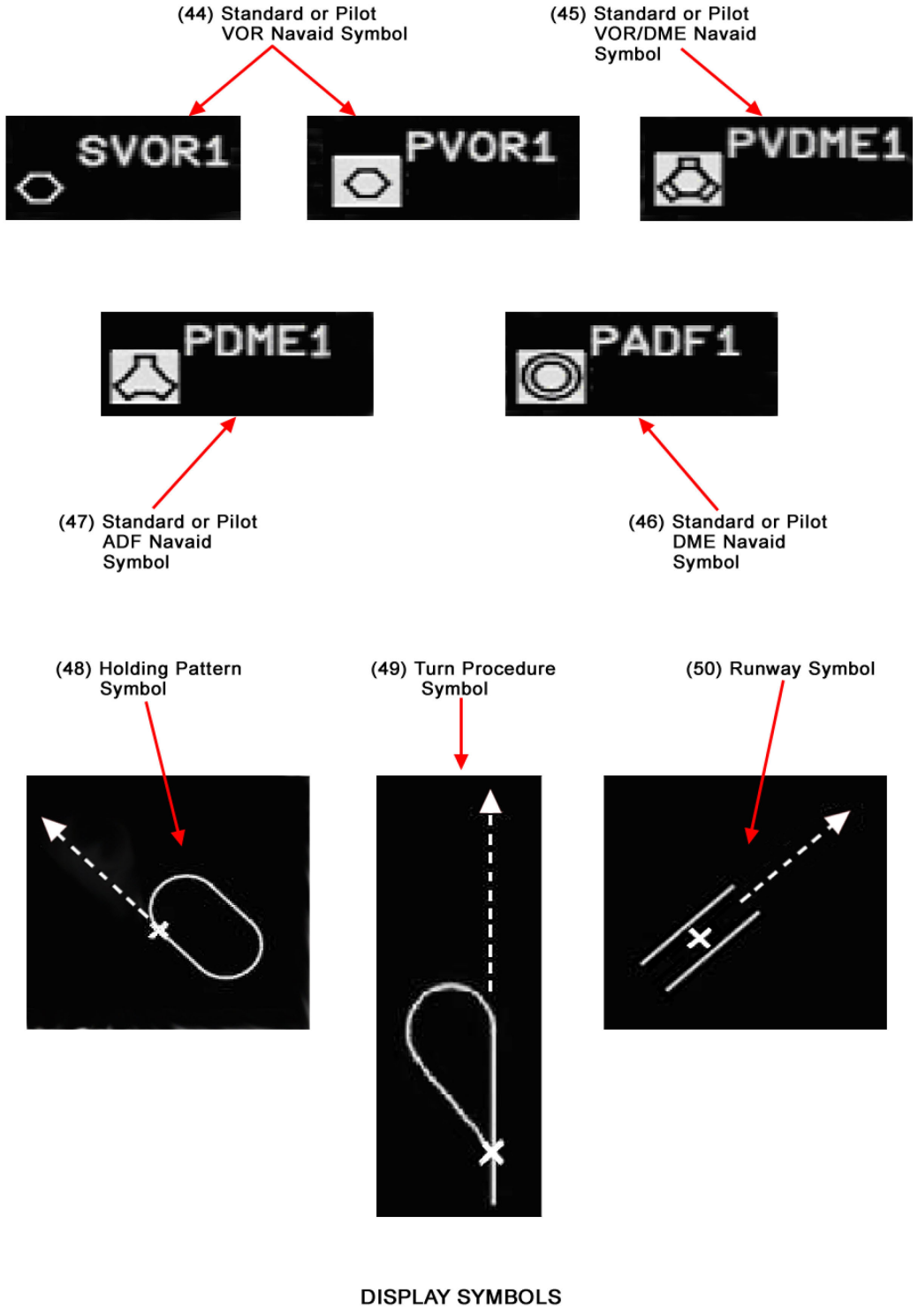


Figure 34-71 Display Symbols - Controls and Indicators (Sheet 4 of 4)

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