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## **CHAPTER 17 – ELECTRONIC SYSTEMS AND DISPLAYS**

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## ELECTRONIC SYSTEMS AND DISPLAYS

Electronic data displays, using cathode ray tubes (CRT) or liquid crystal displays (LCD) are described as "the glass cockpit". These revolutionary forms of display are a logical step in the development of modern aircraft with their complex systems of interconnected digital computers. As aircraft systems have become more automatic and the available information more diverse, there has been an increasing need to bring together into easy-to-read displays that information which is most important to the pilot in a given phase of flight or situation.

The data displayed may concern navigation or aircraft systems. The former is displayed by the Electronic Flight Instrument System (EFIS) and the latter by the Engine Indication and Crew Alerting System (EICAS). This chapter contains information about EFIS. The major aircraft manufacturers BOEING and AIRBUS have adopted different EFIS terminology. These notes are not intended to be type-specific but for consistency a choice has been made to use Boeing terminology throughout.

## FLIGHT MANAGEMENT SYSTEM

It is not possible to describe EFIS without describing the aircraft's FMS (Flight Management System) of which EFIS is a sub-system. FMS has been described as a pilot-interactive navigational computing and display systems designed to assist in flying an aircraft with maximum economy and safety to a previously defined planned route planned both laterally and vertically".

The sub-systems that allow FMS to fulfil these functions are as follows:

1) Inertial Reference System

This sub-system provides navigation, attitude and heading data.

2) Flight Management Computer System

This sub-system contains the navigation and performance data bases which facilitate route selection. It includes Control Display Units and the Flight Management Computer

3) Digital Flight Control System

This sub-system allows selection of normal flight director and autopilot modes and commands. It also translates FMC commands into control surface movements.

4) Auto-throttle

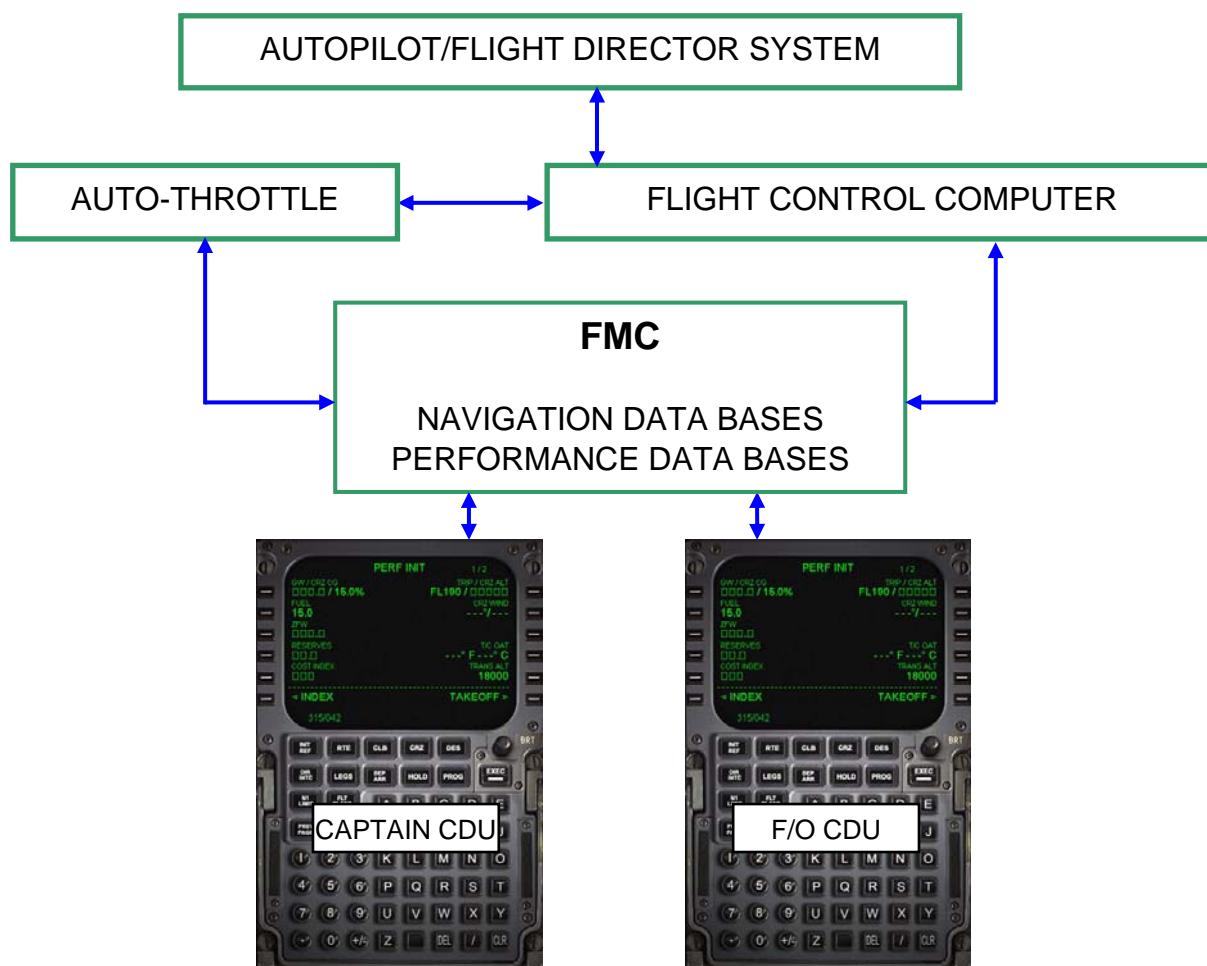
This sub-system allows engine thrust to adjust under control of the Flight Management Computer System or Digital Flight Control System.

5) Electronic Flight Instrument System

This sub-system displays, along with normal flight parameters such as airspeed and altitude, the flight management computer system route relative to aircraft position and the Digital Flight Control System Mode annunciations. This chapter will allow study of the EFIS displays.

## FMS - DATA INPUT/OUTPUT

The term FMS implies the concept of joining independent components into one integrated system which provides continuous automatic navigation, guidance and performance management. The Flight Management Computer (FMC) is the heart of the system, performing navigational and performance computations and providing control and guidance commands. The data bank of the FMC contains navigational information, such as the position of waypoints, and performance data, such as thrust limits, as found in the performance and flight planning sections of the aircraft's flight manual. In effect, the FMC serves as an electronic flight bag. Crew communication with the FMC is achieved through the Control Display Units (CDUs). The crew can enter flight plan routes and performance parameters into the FMC via the CDUs and then monitor the computations on the CDUs. The FMS achieves savings in both time and fuel by optimising the management of performance and navigation.

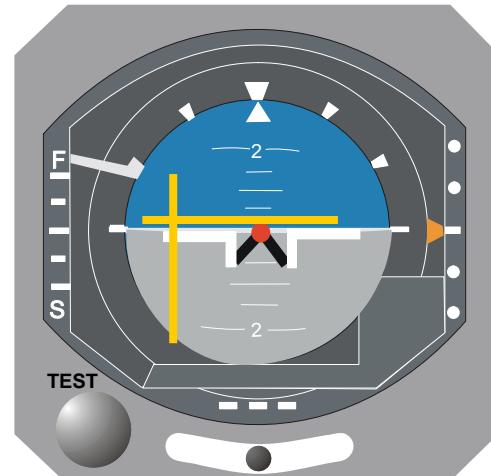
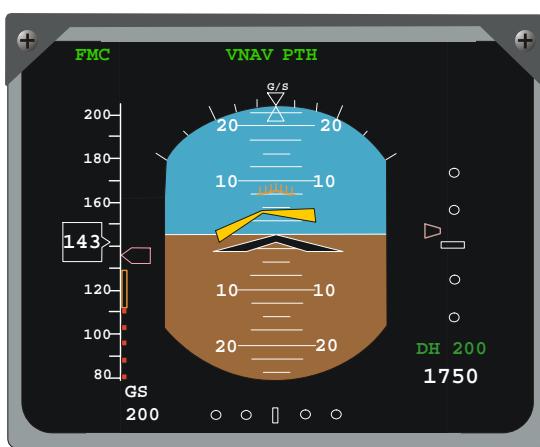


## AREA NAVIGATION SYSTEMS

Area Navigation (RNAV) systems can be used in conjunction with a FMC so allowing the aircraft to be flown along routes between pre-stored waypoints. A typical system is operated with the VHF Nav Radios selected to AUTO so that the FMC automatically tunes stations having DME capability (DME or VOR/DME). The FMC has stored knowledge of the frequencies and exact location of the nav. aids and these are selected to obtain the best available signals for updating the RNAV/FMC position. With AUTO tuning, each radio is normally tuned to a separate DME but a single radio can be made to cycle between two DMEs. The lowest priority is the use of both VOR and DME from a single station. The best accuracy is achieved with AUTO DME-DME because the FMC selects stations based on best geometry. VOR is less accurate than DME and some systems do not use VOR beyond a range of 25 nm. RNAV normally provides accurate navigation data but consideration must be given to the possibility of propagation anomalies and other abnormalities which may be undetected because of AUTO tuning. RNAV is also used to update IRS positions. For more on RNAV see Radio Nav Aids.

## FLIGHT DIRECTORS

The Electronic Attitude Director Indicator, described in the following pages, is an example of the type of display associated with Flight Director Systems. The display of pitch and roll attitude is integrated with radio nav. systems, such as VOR and ILS. It can also display command bars which, according to the pilot's selections on the Mode Control Panel, provide the commands required to manoeuvre the aircraft in pitch and roll. The command bars may appear as cross pointers (as in the diagram below) or as V shaped bars, towards which the aircraft is manoeuvred.



Along the top or bottom of the display are mode annunciators showing the Mode Control Panel selected commands which may be directed to the autopilot and/or to the command bars. The Mode Control Panel, illustrated below, allows the selection of thrust, pitch and roll commands so that the aircraft will fly the required manoeuvre.



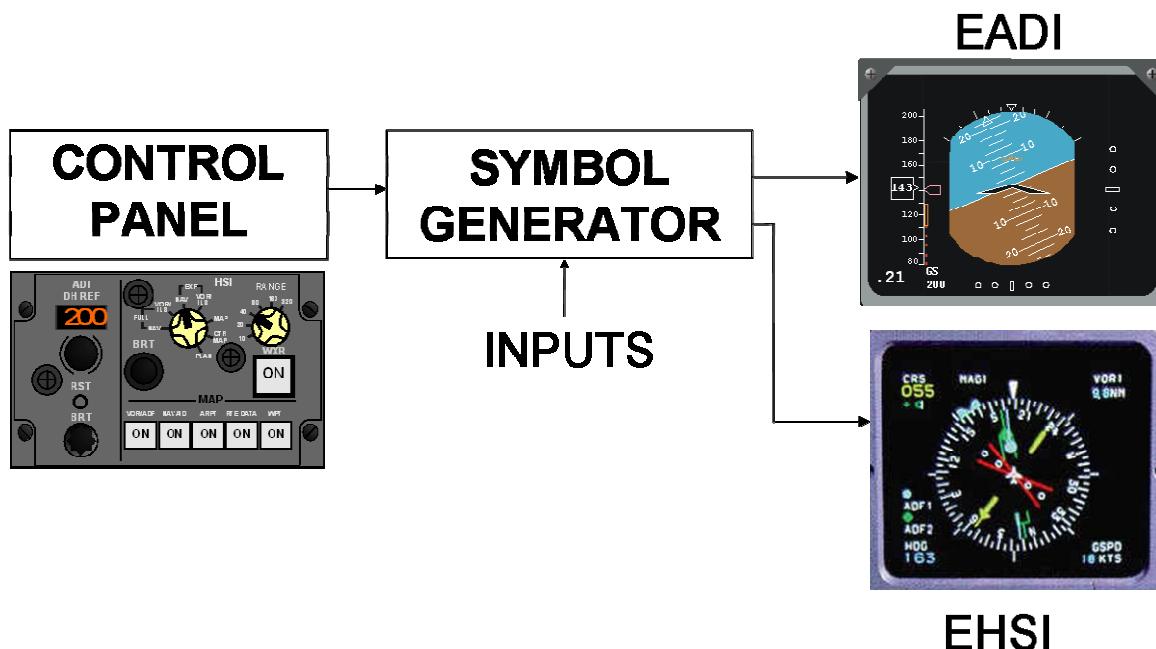
Some examples of the selections are as follows:

- SPEED - The aircraft will capture and maintain the selected speed using auto-throttle.
- LVL CHG - The aircraft will climb or descend at the selected airspeed.
- V NAV - Pitch commands are controlled by the FMC.
- L NAV - Roll commands are controlled by the FMC.
- V/S - The aircraft will climb or descend at the selected vertical speed.
- HDG SEL - Roll commands will enable the selected heading to be captured and maintained.

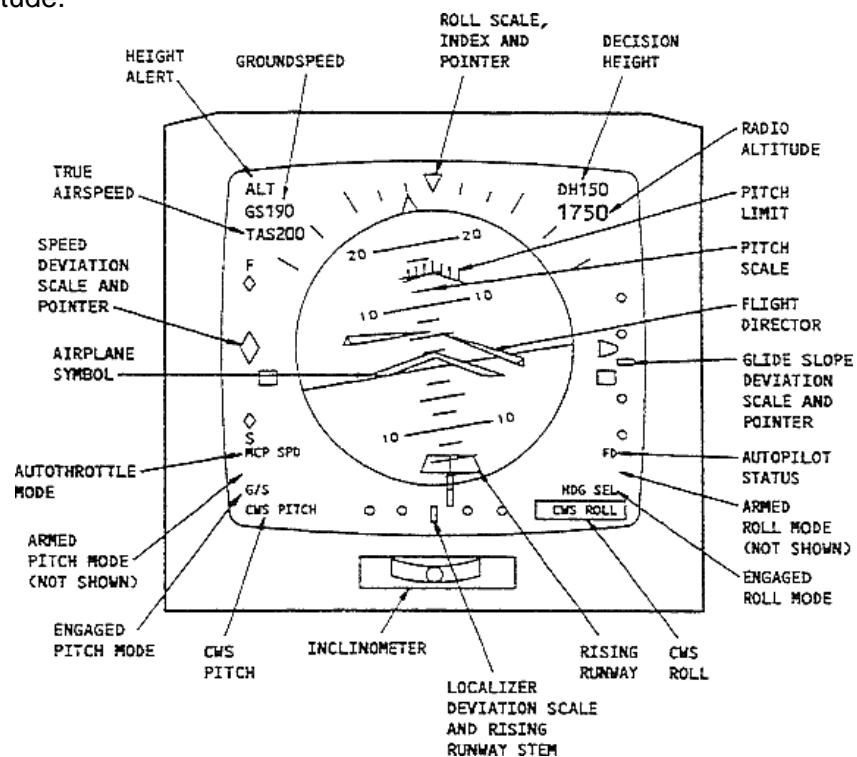


## EFIS COMPONENTS

The EFIS consists of Control Panels, Symbol Generators, Electronic Attitude Director Indicators (EADI), Electronic Horizontal Situation Indicators (EHSI) and ambient light sensing units.



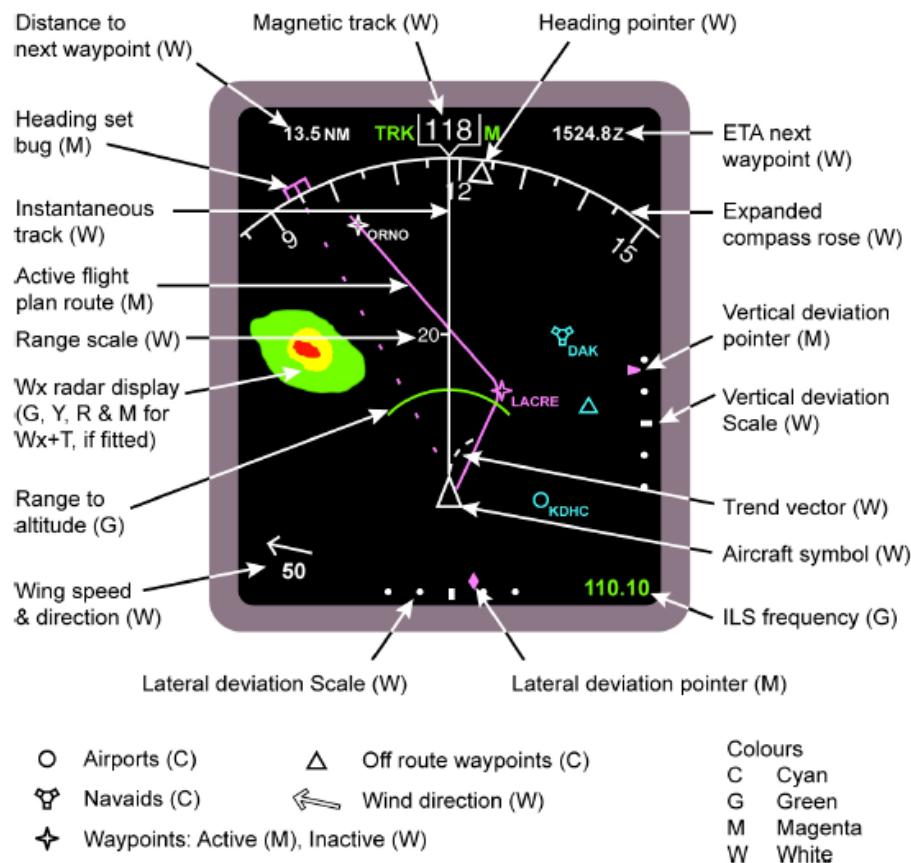
The ELECTRONIC ATTITUDE DIRECTOR INDICATOR (EADI) presents conventional displays for pitch and roll altitude, flight director commands and ILS deviations. It also displays autopilot mode annunciations, airspeeds (current CAS and minimum/maximum/reference speeds), pitch limits, Mach N°, ground speed, decision height and radio altitude.



Further information about the EADI display is given on later pages.

The ELECTRONIC HORIZONTAL SITUATION INDICATOR (EHSI) presents conventional HSI navigation data, which is left-right deviation from a defined lateral flight path, in VOR/ILS and NAV modes. The EHSI is also capable in the MAP modes of displaying aircraft position in relation to FMS defined tracks between waypoints. The PLAN mode allows the FMS flight plan to be reviewed on a plan-view map orientated to true north.

### Map mode



Further information about EHSI displays is given on later pages.

The AMBIENT LIGHT SENSING UNITS automatically adjust display intensity to maintain a constant brightness relative to changing ambient conditions.

## ADVANTAGES OF EFIS

EFIS has several advantages when compared with conventional mechanical instruments:

- 1) **INTEGRATION.** EFIS brings together information from a variety of sources and displays that information in a format that facilitates the pilot's task of monitoring and co-ordinating the flight situation. The EADI combines attitude information, as displayed by an Artificial Horizon, with information from radio aids and other external sources. The EHSI can combine IRS/RNAV derived position with FMS route data and can also display information from various radio aids, for example VOR, ILS and DME.
- 2) **FLEXIBILITY.** Information can be displayed on more than one CRT or transferred from one CRT to another as required. Furthermore, the information displayed can be whatever is important to the current phase of flight. By displaying only the relevant information, scanning workload is reduced.
- 3) **IMPROVED PRESENTATION.** The use of colour CRTs allows almost total freedom in the choice of form of presentation. Information is displayed in alphanumeric form or as symbols which may flash or change colour if they are of special significance.
- 4) **RELIABILITY.** A further advantage of EFIS compared with mechanical instruments is reliability. The CRT effectively has no moving parts.
- 5) **REDUNDANCY.** System failures are accommodated either by driving left and right hand displays from a common source or by bringing in an alternative source. For example, a symbol generator failure would be overcome on a B737-400 by driving both left and right CRTs from a common symbol generator whereas on a B747-400, the spare symbol generator would be brought on line.

## USE OF COLOUR

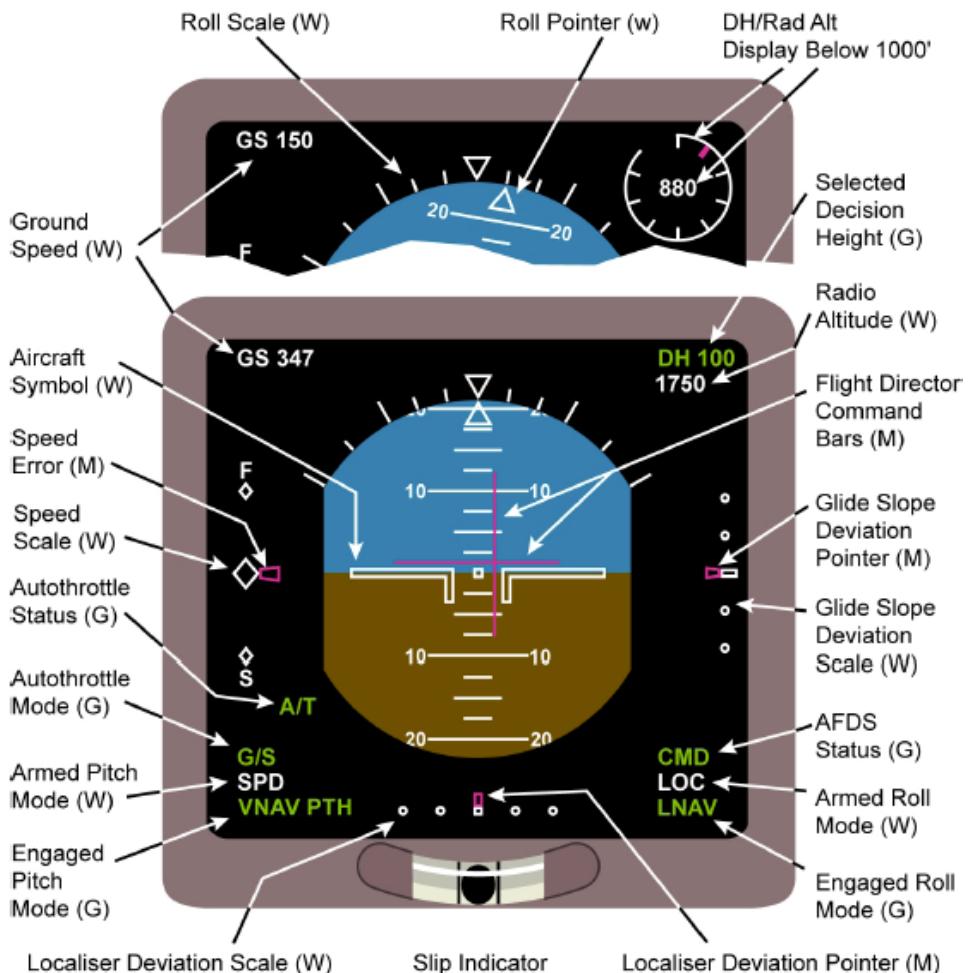
Colours are generally used as follows:

COLOUR	TYPE OF INFORMATION
Green	Present situation information of low priority including source of data e.g. VOR or ILS with frequency.
White	Present status situation and scales--for example, mode annunciators, distance to waypoint, present heading.
Magenta	Command information, pointers, active waypoints, selected heading bug, bearing to active waypoint.
Cyan	Non-active and background information--for example, off-route waypoints, navaids that are not in use.
Red	Warnings
Yellow	Cautions, alerts, faults and flags
Black	Blank areas, off condition

Note that CRTs may be replaced by full-colour LCDs (liquid crystal displays) with claimed advantages of lighter weight, fewer parts and higher resolution. Their disadvantage is that they provide a narrower field of vision. In the unlikely event of total EFIS failure, the pilots can revert to standby instruments - airspeed indicator, altimeter and artificial horizon.

## EADI DISPLAYS

The EADI may be referred to as the Primary Flight Display (PFD) as it shows basic information: airspeed, altitude, attitude and flight director commands.



The following are some of the features of the EADI:-

- **ALTITUDE DISPLAY.** In modern airline aircraft, altitude data is provided by the Inertial Reference Systems (IRS). Pitch and roll altitude is valid through  $360^{\circ}$  and is seen by viewing the aircraft symbol against a background, the upper half of which is blue and the lower half brown.
- **MODE ANNUNCIATIONS.** Autoflight mode annunciations for autothrottle, pitch and roll are displayed at the top of the EADI displays.
- **FLIGHT DIRECTOR COMMANDS** are displayed in pitch and roll either by two pointers or by command bars which form a shallow inverted V. The command bars move up and down to command a change in pitch altitude and rotate clockwise and anti-clockwise to command a change of bank attitude. As EFIS displays are produced electronically, it is possible to readily change the form of the flight director display from separate pointers to V command bars.

- GLIDESLOPE and LOCALIZER DEVIATION DISPLAYS are shown in conventional positions with a RISING RUNWAY symbol at the top of the Localizer Deviation pointer. It displays the aircraft's close proximity to the ground as the aircraft descends through the last 200 feet of radio altitude. The glideslope deviations scale may change from white to amber (alert) if there is an excessive deviation from the glideslope.
- PITCH/ROLL COMPARATOR. If there is a difference of more than 3° between the Captain's and First Officer's pitch or roll display, the words PITCH or ROLL in amber will appear on both EADIs.
- RADIO ALTITUDE and DECISION HEIGHT. Radio altitude is displayed when height is less than 2,500 feet AGL. It is compared with the decision height that has been set and when this height is reached, a DH ALERT occurs.
- MACH NUMBER is obtained from the AIR DATA COMPUTER.
- GROUNDSPEED is obtained from the INERTIAL REFERENCE SYSTEM via the FLIGHT MANAGEMENT COMPUTER
- AIRSPEED TAPE DISPLAY consists of a graduated scale which moves relative to a fixed reference pointer. Various reference speeds related to aircraft performance are displayed on the speed tape. A trend arrow points to the speed that the aircraft will achieve in the next 10 seconds.
- INCLINOMETER The state of balance of a turn is displayed by a conventional "ball-in-tube" slip indicator.

## EHSI DISPLAYS

As described earlier, the EHSI uses a conventional fly left/fly right display in VOR/ ILS and NAV modes and shows aircraft position relative to planned tracks in the MAP modes. Depending on the mode, weather radar will also be displayed if selected, as well as airports and navigation aids.

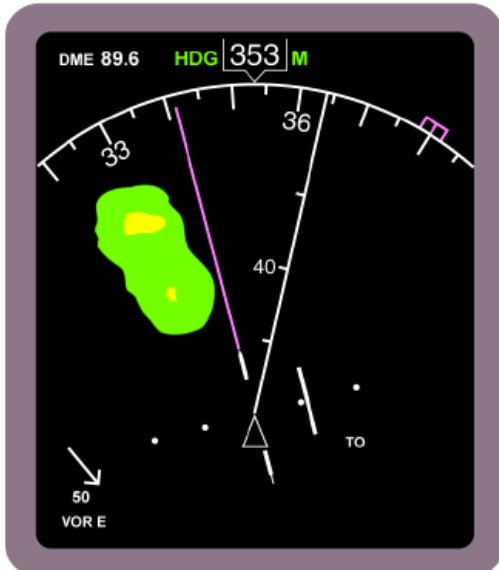
The following pages show the EHSI as it would appear when the various modes are selected.

**NAV** - Displays lateral and vertical navigation guidance information similar to conventional HSI but orientated to airplane track. The FMC is the primary source of the guidance data. Weather Radar returns are displayed when the WXR Switch is ON.

**VOR/ILS** - With a VOR frequency selected, The EHSI displays VOR navigation data oriented to the airplane heading.

- Displays the source of navigation data as VOR 1 or VOR 2 in the lower left corner of the EHSI.
- Displays TO/FROM annunciation and the navigation source frequency in the lower right corner of the EHSI.
- Weather Radar returns are displayed when the WXR Switch is ON.

Expanded VOR Mode



Full VOR Mode



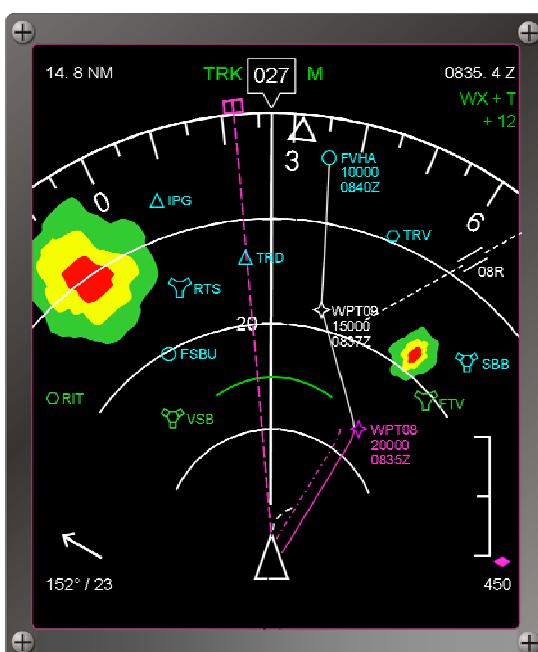
**VOR/ILS** - With and ILS LOC frequency selected, the EHSI displays ILS navigation data oriented to the airplane heading.

- Displays the source of navigation data as ILS 1 or ILS 2 in the lower right corner of the EHSI.
- Displays the navigation source frequency in the lower right corner of the EHSI.
- Weather Radar returns are displayed when the WXR Switch is ON.

Expanded ILS Mode

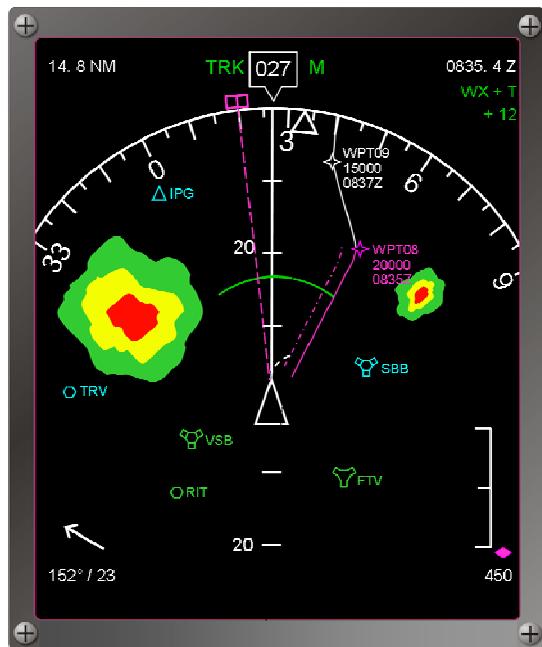


Full ILS Mode



**MAP** - Displays plan view of flight progress by means of a fixed aircraft symbol superimposed on a moving map background. The basic map background data includes origin/destination airports, flight plan route, and display of navaids in use. Optional background data includes off-route navigation aids, airports and named waypoints; tuned VOR/ADF relative bearing or radials; and flight plan route waypoint ETAs and altitude constraints.

- Weather Radar returns are displayed when the WXR Switch is ON.



**CTR MAP** - Displays the same data and symbols as the MAP mode, but the Airplane Symbol is placed in the centre of the map area so that MAP information behind the airplane is displayed.

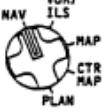
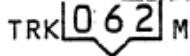
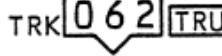
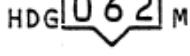
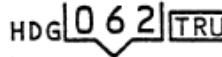


**PLAN** - The PLAN mode is a map display which may be used to view an FMC flight plan route, either in total for a short route, or waypoint-by-waypoint for a longer route. The display is orientated to True North.

## EHSI SYMOLOGY

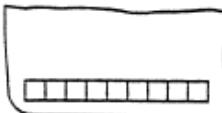
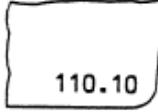
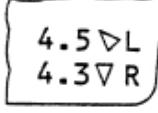
The following symbols may be displayed on each HSI depending on EFIS Control Panel selections. General colour presentation is as follows:

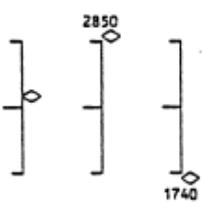
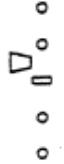
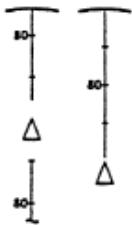
<b>Green</b>	Indicates active or selected mode and/or dynamic conditions.
<b>White</b>	Indicates present status situation and scales.
<b>Magenta</b>	Indicates command information, pointers, symbols, and fly-to conditions, weather radar turbulence.
<b>Cyan</b>	Indicates non-active and background information
<b>Red</b>	Indicates warnings.
<b>Yellow</b>	Indicates cautionary information, faults, flags.
Black	Indicates blank areas, off condition.

SYMBOL(S)	DATE NAME/(COLOUR)	APPLICABLE MODE(S)	REMARKS
200NM OR DME 124	DISTANCE DISPLAY (W)		Distance to next navigation waypoint (NM) or tuned navaid (DME) is displayed. (When displayed distance is less than 100 miles, tenths are displayed).
	ACTIVE WAYPOINT NAME (M)		Displays the name of the active waypoint.
TRK  062 M	HDG - Displayed data (G) is referenced to A/P HEADING		
TRK  062 TRU	TRK - Displayed data (G) is referenced to A/P TRACK.  [ ] - TRACK/HDG index pointer.  062 - Numeric value (W) of HDG or TRK.	TRK (track-up)  	Indicates number under index pointer is the current track.
HDG  062 M	M - Indicates (G) display is oriented to MAGNETIC North	HDG (heading-up)  	Indicates number under index pointer is the current heading.
HDG  062 TRU	[ ] - Indicates TRU (G) display is oriented to TRUE North.  BOX (W)		

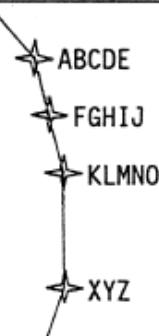
SYMBOL(S)	DATE NAME/(COLOUR)	APPLICABLE MODE(S)	REMARKS
	ETA DISPLAY (W)		Indicates FMC or AN/CDU computed ETA for the active waypoint.
	WEATHER RADAR ANNUNCIATION  GAIN (G)/MODE (G) TILT (G)		GAIN - VAR indicates gain control on weather radar control panel is not in the CAL (calibrated) detent.  MODES: MAP - Weather radar is operating in map mode. WX - Weather radar is operating in weather mode. WX+T - Weather radar is operating in weather mode with turbulence detection enabled. TEST - Weather radar is in test mode and test pattern is displayed. TILT - Indicates antenna tilt.
	Expanded Compass Arc (W)		The heading/track compass arc can rotate through a full 360°. In the NAV, VOR/ILS, MAP, and PLAN modes, an arc of approximately 70° is displayed. An arc of approximately 120° is displayed when the CTR MAP mode is selected.
	Selected Heading Bug (M)  and  Reference Line (M)		Indicates the heading selected on the MCP. A dashed line extends from the marker to the airplane symbol (except for Plan mode) for ease in tracking the marker when it is out of view.

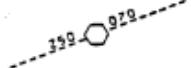
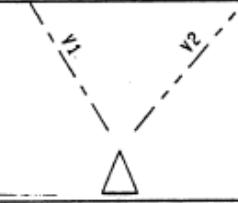
SYMBOL(S)	DATE NAME/(COLOUR)	APPLICABLE MODE(S)	REMARKS
	Heading Pointer (W)		Indicates airplane heading when selected mode has track-up orientation. Drift angle can be determined by observing the difference between current heading and current track.
	WAYPOINT BEARING POINTER (M)		Displays relative bearing to active waypoint.
ADF 1      ADF 2 	ADF BEARING POINTERS (G)		Indicates relative bearing to tuned ADF station as received from the respective ADF radio.
	DIRECTION ARROW (W) WIND DIRECTION/SPEED (W)		Indicates wind direction and wind speed in knots with respect to the map display orientation (TRK or HDG) and compass reference (MAG or TRU). Direction arrow rotates through 360°. Displayed if wind magnitude is greater than 6 knots and blanked if wind magnitude becomes less than 4 knots.

SYMBOL(S)	DATE NAME/(COLOUR)	APPLICABLE MODE(S)	REMARKS
VOR 1 or VOR 2 ILS 1 or ILS 2 	RADIO NAV DATA SOURCE (G)		Indicates the source of the displayed navigation data. Data source is a function of:  VOR/ILS mode - tuned frequency (VOR or LOC) and position of VHF NAV transfer switch.  NAV mode - position of Captain's or F/O's NAV switch on light shield.
NAV ALT NAV L ALT NAV R			
	COURSE CHANGE ALERT ANNUNCIATION (A)		Displayed 10 seconds prior to course change or 10 seconds prior to sequencing a waypoint if no course change is required. Removed as A/P begins roll to new course or when waypoint is sequenced.
	VOR/ILS FREQUENCY DISPLAY (G)		Displays frequency of manually tuned navaid. The word "AUTO" is displayed in place of the frequency if the VHF NAV radio is in the auto tune mode.
	POSITION DIFFERENCE DISPLAY (W)		<p>ALPHA Characters - Indicate which IRS the displayed difference is associated with.</p> <p>ARROWS - Rotate thru 360° to indicate relative bearing to the respective IRS position.</p> <p>NUMERICS - Indicate the distance in NM between the selected NAV data source (FMC, ANS L or ANS R) and the right IRS and left IRS positions respectively.</p> <p>Display is enabled when the position difference exceeds predetermined limits as detected by the FMC or by the Symbol Generator.</p>

SYMBOL(S)	DATE NAME/(COLOUR)	APPLICABLE MODE(S)	REMARKS
N ↑	TRUE NORTH POINTER (G)		Indicates map background is oriented to true north.
	VERTICAL POINTER (M) DEVIATION SCALE (W) NUMERIC DISPLAY (W)		Displayed only during descent. Displays vertical deviation from FMC descent profile. Scale range is $\pm 400$ feet deviation. Numeric value is displayed when pointer moves beyond the scale limits. Pointer represents path. Center of scale represents airplane position.
	GLIDESLOPE DEVIATION POINTER (M) AND DEVIATION SCALE (W)		Displays glideslope deviation. Scale appears when LOC frequency is tuned. Pointer appears when signal is usable. The pointer is not displayed when track and the front course on the MCP differ by more than $90^\circ$ (Back course).
	AIRPLANE SYMBOL (W)		Represents the airplane. In MAP modes, present position is indicated by the apex of the triangle.
	CURVED TREND VECTOR (W)		Displays prediction of airplane's ground track. The furthest end point of each vector segment represents the airplane's predicted position after a period of 30, 60 and 90 seconds respectively. The selected range determines number of segments displayed.  Range > 20 NM ..... 3 segments Range = 20 NM ..... 2 segments Range = 10 NM ..... 1 segment
	PRESENT TRACK LINE (W) AND RANGE SCALE (W)		Displays present ground track based on airplane heading and wind. The displayed range numeric value(s) is (are) one-half the actual selected range. With heading-up orientation (VOR/ILS mode), the track line will be rotated left or right at an angle

SYMBOL(S)	DATE NAME/(COLOUR)	APPLICABLE MODE(S)	REMARKS
	ALTITUDE RANGE ARC (G)		The intersection of the arc with the track line is the predicted point where the MCP altitude will be reached. The prediction is based on present ground speed and airplane vertical speed.
	LATERAL DEVIATION INDICATOR BAR (M) AND DEVIATION SCALE (W)		Displays ILS, VOR or NAV (FMC or AN/CDU) course deviation. ILS 1 dot = 1° VOR 1 dot = 5° NAV 1 dot = 2 NM
	SELECTED COURSE POINTER (W) and LINE (M)		Points to selected course as set by the respective MCP course selector in VOR/ILS. It represents Desired Track in NAV.
	TO/FROM ANNUNCIATION (W)		Operative in VOR mode only. Indicates whether or not the selected course, if intercepted directly, and tracked, would take the aircraft TO or FROM the station.
(Standard WPT)  (Conditional WPT) 	FLIGHT PLAN WAYPOINT: ACTIVE (M) DOWNPATH (W)		Active - Represents the flight plan waypoint the airplane is currently navigating to. Downpath - Represents a waypoint in an Active or Modified flight plan route. Data with parenthesis for conditional waypoints indicates type of conditional waypoint (altitude, "VECTORS" "INTC", etc.).
	OFF-ROUTE WAYPOINT (C)		When the WPT switch is ON, FMC data base waypoints are displayed. Displayed only for HSI ranges of 10, 20 or 40 NM.

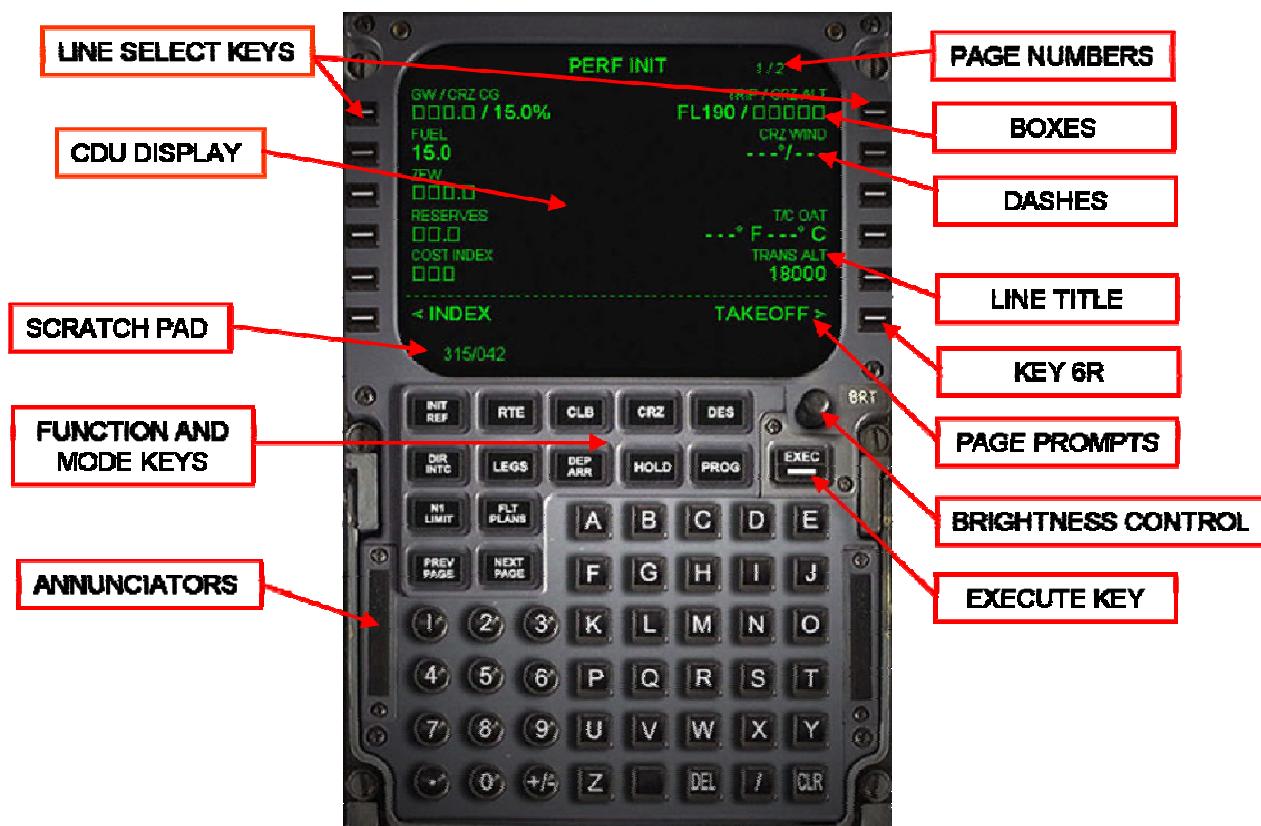
SYMBOL(S)	DATE NAME/(COLOUR)	APPLICABLE MODE(S)	REMARKS
○ KXYZ	AIRPORT (C)		ARPT switch - OFF Only origin and destination airports are displayed. ARPT switch - ON All FMC data base airports within the MAP area are displayed.
○ KABC 22L	AIRPORT IDENTIFIER AND RUNWAY (W)		Available when the EHSI display range is 80, 160, or 320 NM.  Displayed if the airport has been selected as the origin or destination airport with a specific runway selected.
22L 	AIRPORT AND RUNWAY (W)		Available when the EHSI display range is 10, 20 or 40 NM.  Displayed if the airport has been selected as the origin or destination airport with a specific runway selected.  Runway symbol is scaled to represent the length of the selected runway.  The dashed center lines extend outward 14.2 nm from the runway threshold.
ABCDE FGHIJ KLMNO XYZ 	INACTIVE ROUTE (C) ACTIVE ROUTE (M) ACTIVE ROUTE MODIFICATION (W)		An active route is displayed with continuous lines between waypoints. An active route modification is displayed with short dashes between waypoints. When a modification is executed, the short dashes are replaced with the continuous lines. Inactive routes are displayed with long dashes between waypoints.
ABCDE 12000 0835Z 	ROUTE DATA (M, W)		When the RTE DATA switch is ON, altitude constraints and ETA's for route waypoints will be displayed.

SYMBOL(S)	DATE NAME/(COLOUR)	APPLICABLE MODE(S)	REMARKS
<input type="radio"/> T/C <input type="radio"/> S/C <input type="radio"/> T/D <input type="radio"/> E/D <input type="radio"/>	VERTICAL PROFILE POINTS (G)  IDENTIFIERS (G)		<p>Represents an FMC computed vertical profile point in the active flight plan as T/C (top-of-climb), T/D (top-of-descent), S/C (step climb), and E/D (end of descent).</p> <p>A deceleration segment point has no identifier.</p>
<input type="radio"/>  	VOR (C, G)  DME/TACAN (C, G)  VORTAC (C, G)		<p>NAV AID switch - OFF Tuned navaids (excluding NDB's) are displayed in green.</p> <p>NAV AID switch - ON All appropriate navaids contained in the FMC data base and within the MAP area are displayed when the range is 10, 20 or 40 nm. Only high altitude navaids are displayed when selected range is 80, 160 or 320 NM. Nav aids not being used are displayed in cyan (blue).</p>
	MANUALLY TUNED VOR RADIALS (G)		When a VOR navaid is manually tuned, the associated MCP selected course and its reciprocal are displayed.
	VOR BEARING RADIALS (G)		The VOR/ADF switch on the EFIS Control Panel must be ON and a valid VOR signal must be received. Displays relative bearing to the tuned VOR station(s)

SYMBOL(S)	DATE NAME/(COLOUR)	APPLICABLE MODE(S)	REMARKS
	ADF BEARING RADIALS (G)		The VOR/ADF switch on the EFIS Control Panel must be ON and a valid ADF signal must be received. Displays relative bearing to the tuned ADF station(s).
	SELECTED FIX CIRCLE (G) FIX SYMBOL AND IDENTIFIER (C or G)		Depicts the selected reference point as entered on the FMC/CDU FIX INFO page. Can appear with other special map symbols (e.g. VOR, VORTAC, airport or waypoint, etc.) if stored in the FMC data base.
	SELECTED FIX RADIAL (G) SELECTED FIX DISTANCE CIRCLE (G)		A fix reference radial is displayed for each downtrack bearing entered on the FMC/CDU FIX INFO page.  A distance reference circle is displayed for each distance entered on the FMC/CDU FIX INFO page.
	HOLDING PATTERN ACTIVE (M) MODIFICATION (W) INACTIVE (C)		Appears as a fixed size holding pattern if selected range is greater than 80 NM. A scaled representation of the holding pattern is displayed when the selected range is 80 NM or less and the airplane is within 3 min. of the holding fix.
	WEATHER RADAR RETURNS (G, Y, R, M) RANGE ARCS (W)		When either WXR switch is selected to the ON position, multicoloured weather radar returns are displayed. The most intense precipitation areas are displayed in red; less intensities, yellow and lowest intensities, green. Areas of turbulence associated with precipitation are displayed in magenta.
	RANGE ARCS (W)		Range arcs are displayed in the expanded rose VOR/ILS and NAV modes when the Weather Radar Switch is ON. Range arcs are displayed in the MAP mode with or without the WXR Switch ON.

## CONTROL AND DISPLAY UNITS (CDUS)

The Control Display Unit (CDU) is the interface unit between the pilot and the Flight Management Computers (FMC). It provides the means of manually inserting system control parameters and selecting modes of operation. It also allows the pilot to read data that is entered, data that is already in the FMC memory and ACARS messages. The CDU includes mode/function keys, data entry keys, annunciators and an alphanumeric keyboard.



FUNCTION AND MODE KEYS select the pages of FMC data for display.

SCRATCH PAD is the bottom line of the display. It displays keyboard entries, data being moved from one line to another and system generated messages.

LINE SELECT KEYS when pushed select or enter data on the adjacent line. If the scratch pad is blank, pressing the key will copy the adjacent data to the scratch pad where it can be modified. If the scratch pad contains data, pressing the key will transfer the data to the adjacent line.

BOXES identify lines where data entry is required for FMC operation.

DASH PROMPTS identify lines where a data entry is optional.

CLEAR when pressed clears scratch pad data from the CDU.

EXEC is an abbreviation for execute and when this key is pressed any modification to the route or vertical profile will be activated.

SLASH KEY is used to separate data entries for speed/altitude etc.

PAGE PROMPTS > or < appear adjacent to line select keys 6L and 6R. When these keys are pressed the display changes to the indicated new page.

KEY 6R changes the display to the next page in the pre-flight sequence.

## FUNCTION AND MODE KEYS

**INIT**  
**REF**

- Display index of pages used for initialising the FMC with navigation and other reference data

INIT/REF pages:

**IDENT** allows the pilot to check the installed performance and navigation data base and to read information such as the engine model contained in the performance data base.

**POS** allows the pilot to enter present position into the IRS during pre-flight alignment and to enter heading into the IRS during ATT mode operations.

**PERF** is used to initialise the FMC for performance calculations. Entries include ISA deviations, fuel quantity and cruise altitude.

**TAKE-OFF** allows entry of V1 VR and V2 speeds which are then displayed on the PFD (Primary Flight Display) speed tape

**APPROACH** is used to display data relevant to approach such as the length of the runway and ILS frequency. It also displays VREF for the various flap settings.

**NAV DATA** provides information about waypoints in the data base or on an active route.

**RTE**

- used to ENTER a route into the FMC for subsequent reference and guidance

**CLB**

- used to select climb speed,  
Note: The available speeds are economy, selectable speed and engine out

**CRZ**

- used to evaluate or change cruise altitude and speed.  
Note: The available speed are economy, selected speed, long range cruise, engine out, cruise climb and cruise descent.

**DES**

- used to evaluate or revise the descent phase of the flight.  
Note: The available speeds are economy and selected speed.

**DIR  
INTC**

- permits flying direct (or intercepting a course) to a waypoint.

**LEGS**

- provides means of entering and displaying details of each leg of the route.

**DEP  
ARR**

- provides access to the index of pages for the origin and destination of each route and for any other airport in the data base.  
Note: On the ground the CDU will initially present the departures page and in flight the arrivals page will appear. From these, the index can be selected to gain access to departure or arrival pages for other airports.

**HOLD**

- used to modify ( or to exit from) a holding pattern.

**PROG**

- displays information relative to the progress of the flight  
Note: Information includes last, to and next waypoints, distance-to-go, ETA at waypoint and destination, estimated fuel remaining and active command speed and mode.

**MENU**

- used to select CDU function

Note:

- FMC (Flight Management Computer)
- ACARS(Aircraft Communication Addressing and Reporting System)  
or
- ACMS(Aircraft Condition Monitoring System)  
can be selected

**FIX**

- permits the creation of waypoints from the intersection of the active route and bearings from the entered fix.

Note: Bearings are magnetic between 73°N and 60°S, otherwise true north.

A waypoint abeam a fix can be readily created by using the appropriate line select key.

**EXEC**

- is the execute key.

If illuminated, it indicates that a modification to the active route or vertical profile is armed.

When pushed, the modification is activated and the light is extinguished.

## CDU/FMC INTERFACE

In a typical aircraft, two FMCs are installed. They operate independently but occasionally compare data. If this comparison shows a difference which is out-of-tolerance, resynchronisation takes place following which one FMC may shut down.

One FMC is normally acting as the master and the other is the slave. Usually the master FMC resynchronises the slave FMC but if the master detects a potential threat, the slave resynchronises the master. During these processes one CDU may freeze while the other shows the appropriate message.

## CDU OPERATION

Entries made from either CDU are sent to both computers. It is recommended that only one CDU at a time is used for entering information. The second CDU selected to the same page can be used to check information being entered on the other CDU. It is important to confirm that data displayed on the CDU is correct before pushing the EXEC key. If an error has been made, correct the data or push the ERASE line select key and then restart the procedure. Messages on the CDU that indicate an error has been made are NOT IN DATA BASE, INVALID ENTRY and INVALID DELETE