

Gulfstream G150

AIRPLANE FLIGHT MANUAL

Section VII
Systems

NAVIGATION

DESCRIPTION

The aircraft is equipped with the following Navigation systems:

- Two air data computers (ADC)
- Two attitude heading reference systems (AHRS)
- One integrated navigation receiver that include:
LOC/GS/VOR/marker beacon/ADF
- One integrated navigation receiver that include:
LOC/GS/VOR/marker beacon (optional ADF)
- Two radio interface units (RIU) shared with the communication radios
- Radio tuning display and control located in two multi function displays (MFD), two cursor control panels (CCP) and two CDU keyboards shared with the FMS
- Two DME's
- Two FMS's systems
- Radio altimeter
- Weather Radar
- Two mode S transponders with flight ID
- TCAS
- IAPS (integrated avionics processor system) assembly to control the following sub-systems:
 - EFIS - Electronic flight instrument system
 - EICAS - Engine indication and crew alert system
 - ADS - Air data system
 - AHS - Attitude heading system
 - FGS - Flight guidance system
 - FMS - Flight management system
 - RSS - Radio sensor system
 - WXR - Weather radar system

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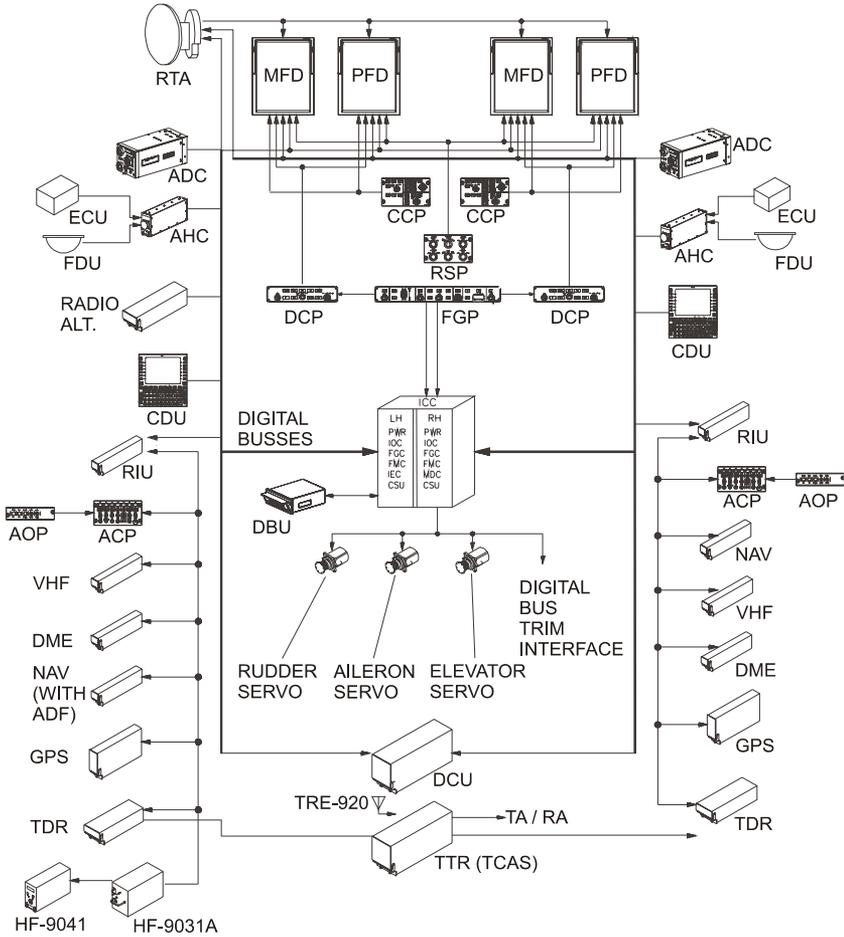


Figure 7-34-1. Avionics Systems Block Diagram

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AIR DATA SYSTEM (ADS)

The aircraft has two digital air data computers (ADC). The ADS is integrated with flight control system (FGS) and EFIS and delivers digital data to the AHS and FMS, as well as to other aircraft systems which require digital input of air data information.

The ADC receives static air pressure (Ps), total air pressure (Pt) and temperature sensor input. The ADS is programmed with static source error correction (SSEC) and maximum operating speed warnings (V_{MO}/M_{MO}).

Each ADC receive on-side system data. This data includes:

- Weight on wheels
- BARO correction
- Alternate V_{MO}/M_{MO} selection
- Alternate SSEC selection

ADS Output

The ADS calculates and delivers air data parameters on six independently buffered low speed ARINC 429 digital buses as follows:

- Pressure altitude (uncorrected)
- Barometric corrected altitude
- Barometric pressure (an echo of the received input)
- Total pressure
- Impact pressure
- Static pressure
- Vertical speed (VS)
- Airspeed (IAS/CAS)
- Mach number
- Maximum airspeed (V_{MO}/M_{MO})
- True airspeed (TAS)
- Total air temperature (TAT)
- Static air temperature (SAT)
- ISA temperature deviation
- ELT data

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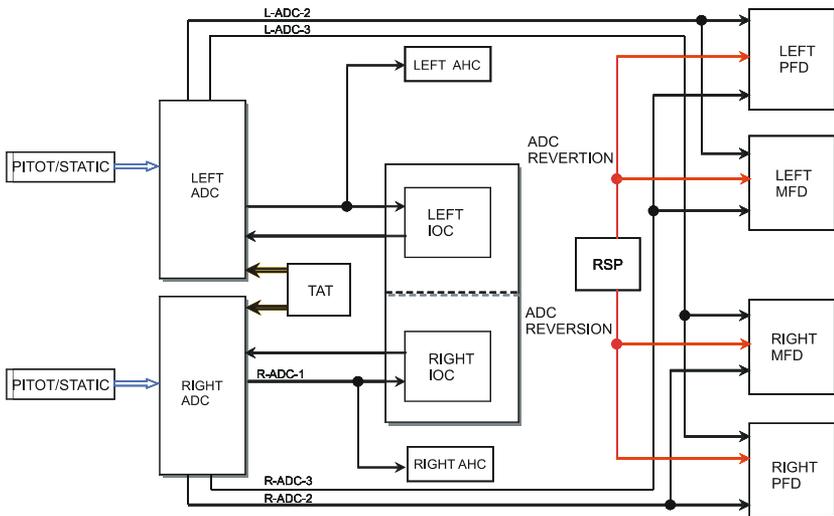


Figure 7-34-2. Air Data System - Schematic

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ANEMOMETRIC SYSTEM

Pitot System

The aircraft has two independent (left and right) pitot systems. Pitot pressure is obtained from electrically heated probes, located on each side of the aircraft nose. The left probe provides pressure to the pilot ADC and the right probe provides pressure to the copilot ADC and to the 3 in 1 flight instrument.

The systems are designed to prevent erroneous data due to moisture or dirt. The pressure lines from the probe rise vertically up to prevent entry of moisture and then are sloped towards drain points, so that any water is easily drained with the aircraft at its normal flight attitude (deck angle of approximately 5°). The drains are installed in the aircraft nose at the lowest point of the line and are easily visible.

If pitot heat is fails, **PITOT HEAT FAIL (L/R)** message comes on.

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Static System

The aircraft has four independent static sources areas follows: No. 1 (Pilot), No. 2 (Copilot), backup and ECS. Pilot and copilot static sources are connected to No.1 and No. 2 ADC respectively. The backup sources is connected to the combined 3 in 1 backup flight instrument.

Static pressure in each source is obtained by a pair of electrically heated, flush mounted static ports on either side of the fuselage. The static pressure lines from No. 1, No. 2 and backup sources are joined to form a single static air pressure source. The static air pressure lines from the ports rise vertically up to the aircraft ceiling, and then forward parallel to the aircraft deck. In other locations they are installed with a slope towards the drain points, so that any water may be easily drained.

The ECS static sources has a single static port on the aircraft right side. This system supplies static pressure to the cabin pressurization safety valve.

Drains are installed in the aircraft nose at the lowest point of the line and are easily visible.

The system is designed to minimize errors due to sideslip, pressure lag and atmospheric conditions.

Static Air Temperature

One temperature probe is installed. The probe is heated. If the heat fails, **SAT/TAS HEAT FAIL** message comes on. The temperature information is fed to the ADC's.

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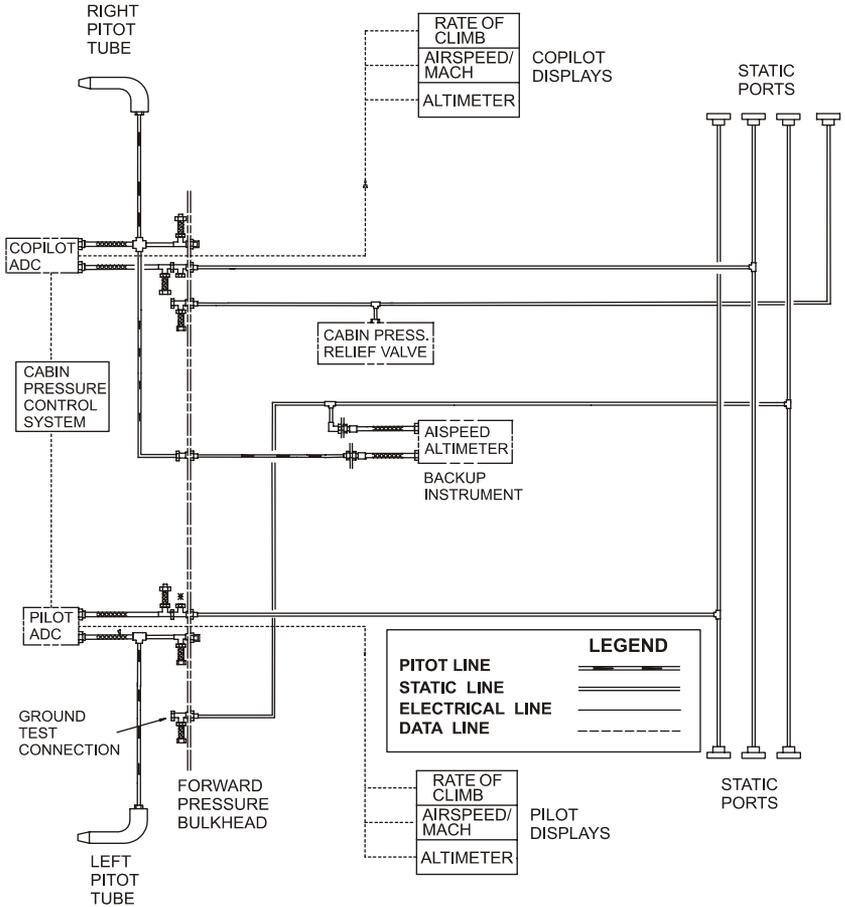


Figure 7-34-3. Pitot-Static System - Schematic

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ATTITUDE HEADING SYSTEM (AHS)

the AHS consists of a dual strap-down attitude heading reference system (AHRS) that senses the airplane attitude, heading, and 3-axis rate/accelerations. The pilot / copilot systems each contains an attitude heading computer, external compensation unit and flux detector unit.

The AHC-3000 attitude heading computer (AHC) replaces a conventional vertical gyro, directional gyro, three rate gyros and three linear accelerometers. The AHC-3000 utilizes a quartz-based inertial measurement unit that measures angular rates and linear accelerations about the axes of the airplane. The AHC provides attitude and heading parameters to the displays, flight guidance computers, and the IAPS input/output concentrators.

The ECU-3000 external compensation unit (ECU) stores the compensation data in non-volatile memory. The compensation data corrects the errors caused by the airplane altering the earth's magnetic field and flux detector units misalignment (heading) errors.

The FDU-3000 flux detector units (FDU) are mounted in the wings. The FDU provides magnetic flux measurements to the AHC. The AHC computes the airplane heading from the magnetic flux measurements.

Compass Controls

Single on-side switch allows selection between heading and DG modes. Heading mode uses inputs from the on-side flux detector unit (FDU). DG (directional gyro) mode does not use FDU input. The SLAVED/DG switch allows slewing of compass in DG mode.

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Compass Control Panel

SLAVED/DG switch - used to select either the slaved mode (slaved to the FDU) or the DG mode (the long-term input from FDU is not used). The DG mode is intended for short term operation near magnetic anomalies, and is not intended for use as a long term heading reference.

Slew switch - has a momentary action operational in both the slaved and DG modes. When operating in DG mode, it is used to correct for left and right heading drift. When operating in the SLAVED mode, it also causes the heading computations to slew toward the selected direction, but when the switch is released, the heading will slowly slave back to the heading sensed by the FDU. The SLEW buttons slew at 1 degree/second for the first 2 seconds, and then slew at 15 degrees/second

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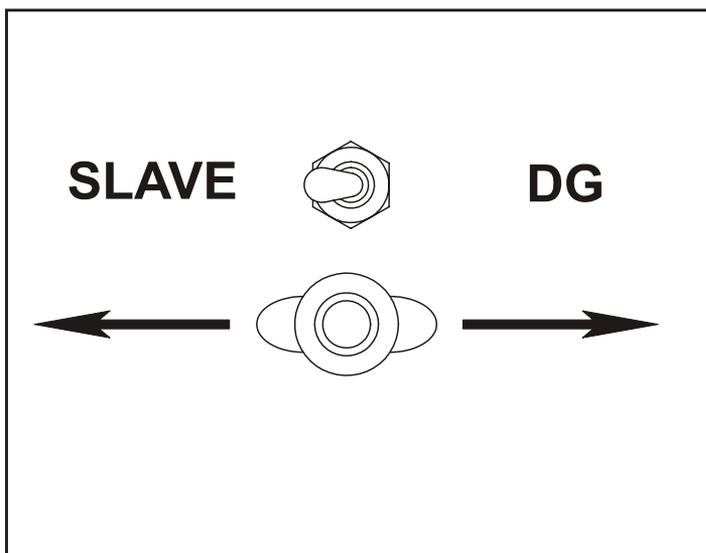


Figure 7-34-4. Compass Control and Compensation Unit

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DATA BASE UNIT (DBU)

The DBU-4100 data base unit is a data loader containing a 3.5-inch disk drive. The unit uses two types of diskettes, high density (2 MB unformatted, 1.44 MB formatted) and double density (1 MB unformatted, 720 kB formatted). The DBU can read directories and files, write files, rename files and delete files stored on diskette.

Format the diskettes on any IBM compatible PC with MS-DOS 3.30 or later operating system.

The DBU is used primarily to load database updates to the FMC, maintenance tables to the MDC, checklist data to the MDC and download maintenance data from the MDC.

DBU Controls and Indicators

Diskette eject button - This button is used to eject the 3.5-inch diskette from the disk drive.

Drive in-use indicator - Comes on during diskette access, when data is actually being read or written.

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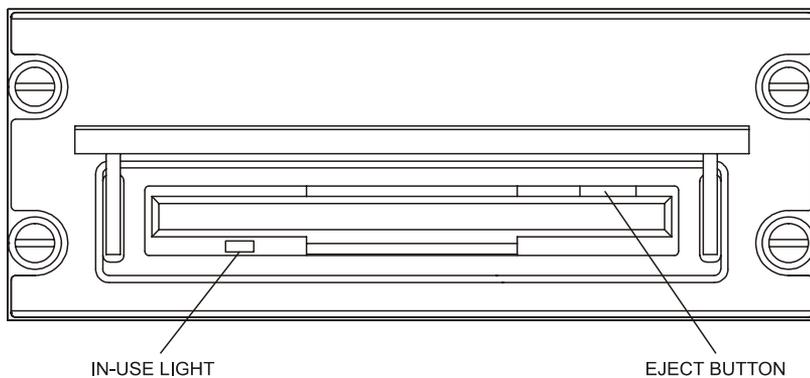


Figure 7-34-5. Data Base Unit (DBU)

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RADIO SENSOR SYSTEM (RSS)

The RSS provides communication and navigation functions. The communication and navigation radios are usually tuned by the EFIS MFD or FMS CDU. The radio sensor system include the following units:

- Radio interface units (2)
- Audio control panels (2)
- Audio options panels (2)
- VHF communications transceivers (extended range) (2)
- Optional third VHF communications transceiver (COM or datalink)
- VHF NAV receivers (optional second ADF) (2)
- DME transceivers (2)
- Mode-S transponders (2)
- TCAS II transmitter-receiver
- Radio altimeter
- Two GPS receivers
- One or two (optional) HF receiver-transmitters

The MFD or FMS CDU tune the VHF COM, VHF NAV/ADF, DME, HF, and TDR radios. The MFD or FMS CDU selects the operating frequency (or ATC code), operating mode, and self-test functions of the onside radios.

Audio Control Panel (ACP)

The ACP-4120 audio control panel (ACP) enables to select the desired radio or interphone and audio volume. The ACP controls the audio output to the headsets or speakers. The ACP receives the microphone analog audio input and outputs the digital audio output to the RIU. The ACP receives the digital audio input from the RIU. The ACP converts the digital audio into an analog audio output that drives the pilot headsets or speaker.

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Audio Options Panel (AOP)

The AOP-4120 audio options panel (AOP) enables to select the radio or interphone push-to-talk, set the headphone audio to NORM or EMER, and set the microphone input to BOOM or MASK.

Radio Interface Unit (RIU)

The RIU-4100 radio interface unit (RIU) is a dual-channel unit. Each RIU does the radio data concentration, single communications management, dual audio management, and dual radio control pass-through functions. The RIU receives data from each radio and outputs the data to other aircraft systems. The RIU has a digital audio interface to the radio sensors, the ACP, and other airplane audio sources. The RIU converts the analog audio to the digital audio format. Each RIU has dual tune paths to each on-side radio. The SELCAL compatible RIU analyzes the audio inputs from the HF transmitter-receiver for the presence of SELCAL tones. When the SELCAL option is enabled, the RIU gives the SELCAL alerts to the crew when the SELCAL tones match the pattern assigned to the aircraft.

VHF Communication Transceivers

The VHF-4000E VHF communication transceivers provide multi-channel VHF voice communications. The VHF transceivers have the SELCAL tone detection and output the alert to the RIU.

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VHF Navigation Receiver

Standard equipment include one NAV-4000 and one NAV-4500 VHF navigation receiver. The NAV-4000 contains the VOR/LOC, glideslope, marker beacon, and ADF receivers. The NAV-4000 also contains the ADF receiver that calculates the relative bearing from the airplane to a selected ground station. The ANT-462B ADF antenna supports two ADF receivers. The optional dual ADF installation (NAV-4000 replaces the number 2 NAV-4500) uses the second ADF antenna in the ANT-462B. The number 2 NAV-4500 VHF NAV receiver contains the VOR/LOC, glideslope, and marker beacon receivers.

DME Transceivers

The two DME-4000 transceivers compute the line-of-sight distance from the airplane to a ground station, relative closure rate, and station identification.

Transponders

Two TDR-94D Mode-S transponders are installed, but only one is active at a time. The selected TDR automatically transmits the identification, altitude, and select information to the air traffic control radar-beacon systems. The two transponders unique mode-S identification is interconnected. The TDR-94Ds use both top and bottom antennas, so that the airframe cannot block the mode-S TCAS communication with other aircraft.

TCAS II

The TTR-4000 TCAS II transmitter-receiver uses the TDR-94D transponders to interrogate transponders in nearby aircraft and determine if there is a potential collision threat. If an intruder aircraft also has a mode S transponder, TCAS establishes a transponder link to coordinate the avoidance maneuvers. The TCAS also provides the traffic and resolution advisory data to the cockpit displays. The top-mounted TRE-920 TCAS II directional antenna is coordinates the TTR-4000.

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Radio Altimeter

The ALT-4000 Radio Altimeter transceiver measures the airplane radio altitude (up to 2500 feet) above the terrain. This data is used by the autopilot during approach and other avionics systems.

GPS Navigation Receiver

The GPS-4000A GPS navigation receiver processes the GPS satellite signals to provide navigation data outputs. The GPS system contains two GPS receivers and two GPS antennas. The GPS navigation receiver processes the GPS signals received from the antenna together with inputs from other aircraft sensors to provide position, speed, and time outputs through the IOC's to the FMS system. The active GPS antennas amplify and filter the GPS satellite signals.

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WEATHER RADAR SYSTEM

Weather radar system (WXR) provides gyro stabilized, four color display of weather, map and turbulence modes. The system display is integrated with cockpit displays and with the AHRS for radar antenna stabilization.

The WXR consists of an integrated receiver / transmitter / antenna unit (RTA). The four colors indicate increasing intensities of rainfall with magenta indicating a rate of two inches per hour or greater. Path attenuation compensation (PAC) alert indicates areas of unknown rainfall rates caused by intervening areas of precipitation.

The RTA is entirely solid state. No wave guide is required due to the integrated packaging. The weather radar symbology is fed to all the EFIS displays (AFD's). Each pilot is able to operate the radar independently in different modes and ranges.

The RTA has the following capabilities:

- 300 nm range

- 14" antenna (integrated with the RTA)

- 120° scan

- ±15° tilt

- 27°/sec scan rate.

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ENHANCED GROUND PROXIMITY WARNING SYSTEM (EGPWS)

The Honeywell Mark V EGPWS system provides aural and visual alerts and warning for unsafe proximity to terrain (ground proximity warning or GPW), deviation below ILS glideslope excessive bank angle and onset of severe windshear. Altitude awareness callouts are also provided. The system incorporates such features as the terrain clearance floor, terrain look ahead alerting and terrain awareness display.

The EGPWS consists of warning computer which contains a worldwide terrain database with varying degrees of resolution. It also has an airport database containing information on all hard-surface runways of 3500 feet in length and longer. The system provides terrain awareness aural alerts and warning and display on the weather radar display. The system provides visual annunciations to the PFD's and direct terrain input to MFD's with electronic selection on the DCP's.

See [SUPPLEMENT No. 3](#)

Caution Messages

[EGPW SYSTEM FAIL](#) - EGPWS system failure. Ground proximity, windshear and terrain warnings unavailable

[GROUND PROX FAIL](#) - EGPWS system ground proximity warning failure

[TERRAIN FAIL](#) - EGPWS system terrain warning failure

[WINDSHEAR FAIL](#) - EGPWS system windshear warning failure

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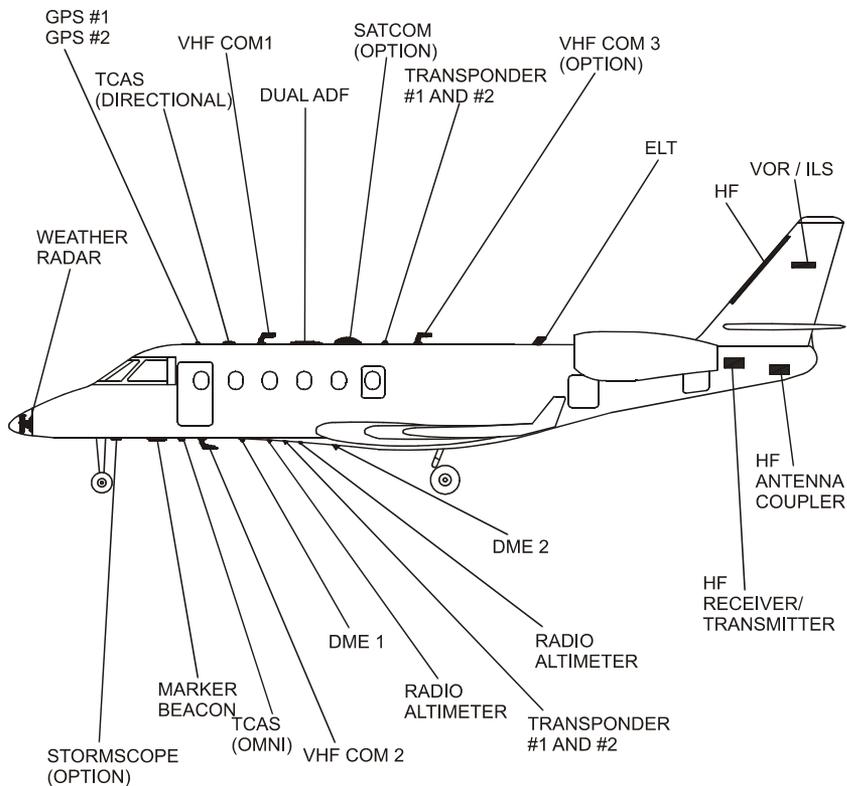


Figure 7-34-6. Antenna Locations

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FLIGHT MANAGEMENT SYSTEM (FMS)

Two FMS-6100 flight management systems are installed. The FMS provides long range and area navigation using all navigation inputs for an accurate position computations. Sensor inputs include: GPS, VOR, DME, and an optional IRS.

The FMS-6100 systems consists of the following units:

- Two control display units (CDU)
- Two flight management computers (FMC) (in the IAPS module)
- Two global positioning system (GPS)
- One data base unit (DBU) (shared with the MDC)

The FMS-6100 GPS-based navigation system has the capability of enroute, terminal, and non-precision approach lateral navigation. The GPS receiver has a 12-channel capability. A minimum of four satellites are required. The system provides receiver autonomous integrity monitoring (RAIM) suitable for non-precision approach. The system provides predictive RAIM and has hardware provisions for Wide area augmentation system (WAAS).

The FMS has optional capability for a 3D graphical flight plan map. Four maps may be stored simultaneously.

Auto radio tuning capability is available for NAV/DME radios. Radio tuning capability is provided through the CDU keyboard as well as through the CCP and MFD menu.

The CDU is capable of tuning all the radios (both on-side and cross-side). NAV receivers can be tuned by identifiers. This function uses the FMS database.

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Navigation data output is integrated with the EFIS and flight control system. The system provides Vs speeds and performance computations.

The PCD-3000 is a personal computer based data loading system for the FMS and MDC system. The PCD-3000 is used for loading of charts if optional FSU is installed.

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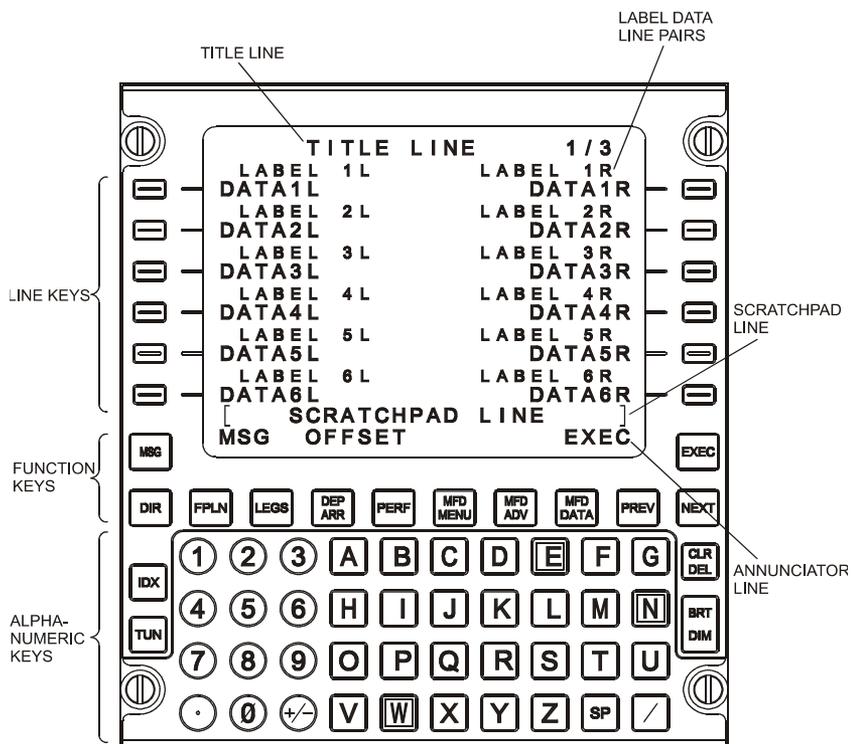


Figure 7-34-1. FMS 6100 CDU

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FMS 6100 Controls

BRT DIM button - Press the brightness trim button to set the brightness of the LCD display.

Title line - Displays the page title and page number. The page number displays the current page number followed by a slash and the total number of pages.

Line keys - Selects the function shown on that line. The line functions (and use of the line keys) depend on which page is displayed. The bottom pair of line select keys are sometimes used as control keys. On these pages, a dashed line separates the display portion of the CDU screen from the control portion of the screen.

Label/data line pairs - Two display lines are associated with each line key. One line is normally a label for the information that is shown on the data line. The data line can show large or small characters. When the data can be defined by either the system or the pilot, the data display is small (system generated) or large (pilot generated). When the data line displays a selected mode, the mode text is small (inactive) or large (active).

Scratchpad line - The scratchpad line displays data entered by the alphanumeric keys or selected for transfer by a line key. Brackets identify this line. Data is displayed on this line so that it can be visually verified before being transferred to a selected data field.

Annunciator line - A single annunciator line is reserved at the bottom line on every page for annunciation of conditions requiring pilot attention or knowledge.

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Alphanumeric keys - Press to enter data on the scratchpad line. The data entry keys are the 0-9 number keys, the A-Z letter keys, the period key, the +/- key, the SP (space) key, the slash key, and the CLR (clear) / DEL (delete) key.

Momentarily press the CLR key to clear the last entered character. Press and hold the CLR key to clear the entire scratchpad line. The CLR key also clears a system message or a DELETE command.

The DEL key deletes system data. Press the DEL key to write DELETE on the (empty) scratchpad line, then press a line key to delete the adjacent data; this action transfers the delete command to a selected data field. Some data fields cannot be deleted. The delete action sometimes deletes the current value and recalls the system default value.

Function keys - Used to directly access data pages and control selections as follows:

IDX (index) - Press to display a menu of system status, position initialization, sensor control, FMS control, database inspection, and database load functions.

FPLN - Press to display the active (or first) flight plan. Use these pages to enter, review, or modify the active flight plan.

LEGS - Press to display the legs page. Use this page to enter, review, or modify the flight plan.

DIR - Press to display the active direct-to page.

DEP/ARR - Press to display the departure/arrival index page. Use this page to select departure or arrival segments.

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PERF - Press to display the performance menu page. Use these pages to input cruise altitude or to set the transition altitude/flight level.

MSG - Press to display the system message page.

TUN - Press to display the radio-tuning page. Use these pages to tune the communication, navigation, and ATC transponder equipment.

PREV - Press to display the previous page when the current CDU function has multiple pages.

NEXT - Press to display the next page when the current CDU function has multiple pages.

EXEC - Press to execute the modified flight plan. EXEC is displayed on the CDU when the active flight plan has been modified and the changes have not been confirmed.

MFD MENU - Press to display the MFD MENU page on the CDU. The MFD MENU page displays a menu of the possible text data pages.

MFD ADV - Press to display the MFD ADVANCE page on the CDU. The MFD ADVANCE page displays a menu to move to the next or previous text data page.

MFD DATA Press to alternately display a text data page on the MFD or to the previous MFD format. The text data page being displayed is the last selected from the MFD MENU page.

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IDX (Index page) - Press to display the INDEX page. The INDEX page(s) provide a list of FMS functions. Some of the INDEX page items access the sensor control pages. The particular index page being displayed varies according to the number and type of sensors installed on the airplane. The following information can be displayed:

INDEX page 1 (Left side line keys) - An index of FMS functions including STATUS, and POS INIT (position initialization)

Press this line key to display the STATUS page. The STATUS page is the first page displayed following power up. This page displays the name of the navigation data base, the effectivity period for the active and second database, time (UTC), date, and the FMC program software configuration number. Under certain conditions, line keys may be used to update the time and date displays. If the database is out of date, the display is yellow. If either database is corrupt, the effective date is dashed. If the database has not been loaded, the effective date is blank.

STATUS - Use this page to change the active database when the airplane is on the ground. Press the SEC DATA BASE line key to copy these dates to the scratchpad line then press the ACTIVE DATA BASE line key to transfer these dates from the scratchpad to the active database line. This interchanges the active and second databases. Changing the active database erases the flight plan.

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POS INIT - Press this line key to display the first position initialization page. The POS INIT pages allow initialization of position data for the FMS computer and long range navigation sensors. An entry into the SET POS line causes the position value of the FMS computer and all sensors capable of being updated to initialize to the SET POS value.

The first POS INIT page displays a line that displays current FMS position data and a line that can be used to enter a desired airport ICAO identifier. On ground, the AIRPORT entry line contains the destination airport from the last flight, if one had been defined. The pilot may enter the identifier for any airport in the database. After an airport is entered, the location of the airport reference point is displayed to the right of the identifier. This location may be copied into the scratchpad and entered into the SET POS line for position initialization.

The PILOT/REF WPT line is used to enter a pilot database or navigation database waypoint identifier. On ground, the PILOT/REF WPT entry field is prefilled with a pilot-defined waypoint identifier if one exists within 3 nm of the current FMS position. Whenever an identifier is displayed in the PILOT/REF WPT line, the location of the waypoint is displayed to the right of the identifier. This location may also be copied into the scratchpad for position initialization. The display of PILOT/REF WPT identifier and location is cleared at lift-off.

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The second POS INIT page displays the current position and ground speeds of the FMS computer and the long range navigation sensors. Any of the displayed positions may be copied into the scratchpad for transfer into the SET POS line. This page also allows a position update using a nearby VOR/DME station. Enter an acceptable navaid identifier into the NAVAID line, press the UPDATED FROM NAVAID key, and then press the CONFIRM POS line key. If more than one LRN system is installed, additional POS INIT pages are provided. The pages display the LRN systems in the following order: global positioning system (GPS), then inertial reference system (IRS).

FMS1 VOR CTL - Press this line key to display the FMS1 VOR CONTROL page. This page is used for NOTAM entry, and allows the pilot to inhibit up to eight navaid stations. The system excludes data from these stations when performing position estimate computations. Inhibit the use of a navaid by entering the navaid identifier on the scratchpad line, then press either NAVAID INHIBIT line key to transfer the identifier to that line data field. This page also allows the pilot to exclude all VOR and DME data from the system computations. Press the line key next to the VOR AND DME USAGE line to disable system use of all VOR and DME data. Press this line key again to enable system use of all VOR and DME data.

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FMS1 GPS CTL - Press this line key to display the FMS1 GPS CONTROL page. This page is used to select a GPS sensor for position data or to deselect all GPS position data. The GPS CONTROL page displays the position difference between each GPS sensor and the FMC computed position. The POS DIFF entry is dashed if insufficient data is available to determine the position difference.

When GPS position usage is enabled, <ENABLED> is displayed adjacent to one of the GPS names. Pressing the line select key adjacent to a disabled GPS causes it to be <ENABLED>. Pressing the line select key adjacent to an enabled GPS causes that GPS to be <DISABLED>.

FMS CTL - Press this line key to display the FMS CONTROL page. The FMS CONTROL page provides DISPLAY MODE and FMS COORD MODE. Dual FMS systems may operate in either independent or synchronized mode. Press the FMS COORD MODE line key to select SYNC or INDEP mode of operation. This option is available only when the airplane is on the ground.

In SYNC mode, both FMS's automatically share data to provide synchronous control of the flight plans and certain initialization and selection data. When a flight plan is modified/executed, it is automatically copied to the cross-side FMS. Position initialization, active database selection, and navaid/sensor deselections are automatically copied to the other FMS.

In INDEP mode, the two FMS systems operate independently. Each system can maintain different flight plans, initialization, and selection data. Transfer of information between systems is not automatic.

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GPS1 POS - Press this line key to display GPS1 POS page. The GPS1 POS line key selection is displayed on the left CDU. GPS2 POS is displayed on the right CDU if two GPS receivers are installed. The GPS position page displays GPS data from the on-side GPS receiver. The page displays GPS time and date, latitude, longitude, true track angle, groundspeed, RAIM (receiver autonomous integrity monitoring) limit, probable error, the GPS operating mode, and the number of GPS satellites currently being used.

ENGINE/FUEL DATA - Press this line key to display the backup ENGINE/FUEL DATA page. The engine/fuel page provides a digital display of the following engine / fuel parameters: N_1 , ITT, N_2 , oil pressure, oil temperature, fuel flow (FF), and fuel quantity. Each parameter is displayed on a separate line. The left engine data is displayed to the left of the parameter name, and the right engine data is displayed to the right. If the received engine data parameter label is missing, the parameter is dashed. The fuel quantity line displays the fuel quantity in the left and right wing tanks. The VENTRAL parameter displays the center fuel tank status. The ventral tank status displays FULL, (tank transfer), or EMPTY.

FIX INFO page - Press this line key to display the FIX INFO page. Use the fix information page to create a pilot-defined waypoint along the flight plan. The pilot defines this waypoint as an offset from a reference waypoint. This reference waypoint cannot be a pilot-defined waypoint.

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Key the reference waypoint identifier into the scratchpad line then press the top left line key to transfer this identifier to the REF field. The CRS and DIST fields then display the course and distance from the reference waypoint to the airplane.

The reference waypoint is displayed on the MFD map as a circled waypoint symbol. Create an along-track waypoint by specifying a bearing from the reference waypoint, a distance from the reference waypoint, or a location abeam the reference waypoints follows:

Enter a bearing from the REF waypoint by keying DDD (degrees) into the scratchpad, then press the RAD CROSS line key. The MFD map displays the bearing radial line from the reference waypoint. The FMS computes DIST, ETE, and FUEL values that apply to the first intersection of the bearing radial line with the flight plan track line. This intersection is the FIX waypoint; press the REF line key to display this waypoint definition on the scratchpad line.

Enter a distance from the REF waypoint by keying NNN (nautical miles) into the scratchpad, then press the DIS CROSS line key. The MFD map displays a distance circle, centered at the reference waypoint. The FMS computes DIST, ETE, and FUEL values that apply to the closest intersection of the distance circle with the flight plan track line. This intersection is the FIX waypoint; press the REF line key to display this waypoint definition on the scratchpad line.

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Press the ABEAM REF line key to enter a location that is abeam the REF waypoint. The MFD map displays the intersection of the radial line centered at the reference waypoint. The FMS computes DIST, ETE, and FUEL values that apply to the first down-track point that is abeam (right angle to) the flight plan track line. This point is the FIX waypoint. Press the REF line key to display this waypoint definition on the scratchpad line.

If a fix cannot be computed from the entered data, a NO INTERSECTION message is displayed on the scratchpad line. This happens if there is no point of intersection using the input data.

Use the DEL key to clear a computed fix or to clear the FIX INFO page. Press the DEL key to display DELETE on the scratchpad line. Press the RAD CROSS or DIS CROSS line key to delete all fix information except the REF waypoint and the CRS/DIST data. Press the REF line key to delete all fix information from this page.

HOLD - Press this line key to display the flight plan HOLD page or a LEGS page with HOLD AT input prompts. This key is used to define or edit a holding pattern. Up to six holding patterns may be defined for each flight plan.

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LEGS page - If the flight plan does not already contain a holding pattern, press the HOLD key to display a LEGS page with HOLD AT prompts to define the holding fix. The pilot selects a flight plan waypoint, an off-flight plan waypoint, or present position (PPOS) as the holding fix as follows:

Select a flight plan waypoint - Press a left line key to select the desired waypoint, edit the MOD FPLN HOLD page, then press the EXEC key to execute the modification and insert the holding pattern into the flight plan.

Select an off-flight plan waypoint - Key the waypoint identifier into the scratchpad line then press the bottom left HOLD AT line key. The scratchpad displays a HOLD AT WPT message. Press a left line key to select the insertion point, edit the MOD FPLN HOLD page then press the EXEC key to execute the modification.

Select present position - Press the bottom right PPOS line key, edit the MOD FPLN HOLD page then press the EXEC key to execute the modification.

HOLD page - If the flight plan contains a holding pattern, press the HOLD key to display the HOLD page. This page also displayed after a holding fix is selected.

Use the HOLD page to specify holding pattern parameters. The holding FIX identifier is displayed near the top of the page.

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The inbound course/direction for the hold displays below the FIX line. Use the left line key to transfer a new desired course/turn direction from the scratchpad to the INBD CRS/DIR field. Valid formats are DDD, DDD/L, or DDD/R, where DDD is degrees and /L or /R designates a left or right turn pattern. If no turn direction is specified, a right turn is selected.

Holding speed, MAX KIAS, and LEG TIME values are displayed, based on the current altitude. Either value may be changed. The length of the inbound leg may be defined by a LEG TIME or LEG DIS entry. When either LEG parameter is entered, the other is dashed.

If a hold is active, the FIX ETA field displays the estimated time of arrival to the fix. This time is recomputed at each cycle of the holding pattern.

The expect further clearance (EFC) time may be entered on this page. Entry format is HHMM, where H is hours and M is minutes.

If a hold is active, the HOLD page displays an EXIT HOLD option next to the lower right line key. Press the EXIT HOLD line key. This label changes to EXIT ARMED. Press the EXEC key to confirm exit from the holding pattern. EXIT <SEL> is displayed by the lower right line key. The FMS then steers the aircraft to the holding fix. After passing the fix, the FMS moves to the next leg in the flight plan. A holding pattern may be immediately exited using a direct-to edit.

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PROGRESS - Press this line key to display the PROGRESS page.

PROGRESS page - The PROGRESS pages automatically display flight progress parameters. These pages are for display only. Data cannot be entered on either page.

The first PROGRESS page displays parameters for the last passed (LAST) waypoint, the TO waypoint, the (NEXT) waypoint after the TO waypoint, the destination (DEST) waypoint, and the alternate (ALTN) destination. Computed parameters include distance (DIS), estimated time enroute (ETE) and fuel remaining (FUEL). The NAVIGATION status line lists the primary sensors being used to compute present position.

The second PROGRESS page displays wind, temperature (SAT/ISA), cross-track distance, and true airspeed (TAS) parameters. The wind displays include TAILWIND (or HEADWIND), CROSSWIND, and WIND. L or R indicates left or right direction. If wind speed is less than 5 knots, the wind speed display is zero and the L/R wind direction display is blank. The cross-track distance (XTK) display includes L or R to indicate the airplane is left or right of intended track.

SEC FPLN - Press this line key to display the second flight plan page.

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Second flight plan page - SEC FPLN is displayed at the top of the page along with the page number. The ROUTE field allows the pilot to enter a company route. The route may contain an origin airport, destination airport, arrival/departure runways, and connecting legs. The ORIG, DEST, and ALTN fields allow the pilot to enter the origin, destination, and alternate airports (KCID/KDEN). This allows the system to display specific runway information that can be edited into the flight plan. Enter ROUTE, ORIG, DEST, or ALTN information by keying data into the scratchpad line, then press a line key to transfer data to the selected field.

Flight plans are direct legs between waypoints or runways. The flight plan may include airways, standard instrument departures (SID's), and standard terminal arrival routes (STAR's), approaches, holding patterns, direct legs, origin and destination airport information, pilot waypoints, and parallel offsets. Each entry below the VIA label represents a direct leg terminating at the waypoint displayed in the corresponding TO field. The current leg of the active flight plan is the entry just below the VIA label.

ROUTE MENU - Press this line key to display the ROUTE MENU page. This page is used to select the PILOT ROUTE LIST or the DISK ROUTE LIST.

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PILOT ROUTE LIST - Press this line key to display the route list page. All route names in the PILOT ROUTE LIST appear in alphabetical order, with a colon separating the origin and destination. On the PILOT ROUTE LIST page, press the line select key adjacent to any name to load that route. The FMS recalls the SEC FPLN page with the selected name inserted in the SEC FPLN title field, and route plan waypoints and associated data are automatically inserted on the respective CDU pages.

DATA BASE - Press this line key to display the DATA BASE page. Use this page to inspect data stored in the navigation data base. Enter the identifier of an enroute waypoint, navaid, or airport into the scratchpad, then press the IDENT line key.

Enter an enroute waypoint identifier to display the location and ICAO country code for that waypoint. Enter the a navaid identifier to display the location and ICAO country code for that waypoint. Enter a nondirectional beacon identifier to display the location and ICAO country code for the beacon. Enter a navaid station identifier to display the navaid type (VOR, DME, VOR/DME, TACAN, or VORTAC), the location of the navaid facility, the location of the DME facility, the frequency of the navaid signal, the magnetic variation of the VOR, and the elevation of the DME. Data is displayed as applicable for the navaid type. Use line keys to copy a desired location to the scratchpad line for transfer to another data field.

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DEFINE WPT - Press this line key to display the DEFINE PILOT WPT page. When the DEFINE PILOT WPT page first displays, the waypoint name and position fields are dashed. The pilot may enter a waypoint identifier and a position. If the waypoint identifier already exists in the pilot database, entering the waypoint identifier before any position is entered causes the current pilot-defined database position to be displayed for a possible edit. If the pilot stored the original waypoint bearing/distance waypoint referenced to a NAV database waypoint, the position is displayed as the pilot stored it and as latitude/longitude. If the pilot stored the waypoint bearing/place bearing waypoint, the position is displayed as a place bearing/distance waypoint and as latitude/longitude. If the pilot defined the original waypoint relative to another pilot defined waypoint, the waypoint display references the navigation database waypoint. Editing a position field causes the other position fields to be dashed, except for the latitude/longitude field that is updated to the newly entered position.

A new waypoint definition is not stored until the pilot presses the STORE WPT line key. If a waypoint with the same identifier is already defined, the pilot is prompted to confirm the STORE WPT command to overwrite the current definition.

WPT LIST - Press this line key to display the PILOT WPT LIST page. This page displays the pilot defined waypoints that are stored in the database. Press the line key next to the desired waypoint to view or edit the waypoint data.

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DB DISK OPS - Press this line key to display the DATA BASE DISK OPS page. Use this page to upload new performance database, route, waypoint, or navigation database from diskette into the system memory. The FMC can store both an active and a second navigation database. The route and pilot waypoint databases may be downloaded to diskette from the FMS. Each FMC must be loaded separately except for the navigation database that may be loaded into one or two FMC's simultaneously. The disk operations may be performed on the ground only.

The navigation database contains waypoint information on VOR's, DME's, enroute intersections, nondirectional beacons and airports (including airport reference points, airport runway thresholds, and airport terminal waypoints). The region of database coverage is customized to meet the needs.

The CDU first displays a page instructing the pilot to insert the diskette into the disk drive (DBU). Then press the READ NAV DB line key to cause the FMC to read the diskette. If a navigation database is found, a page displays to select that data for input to the system. Sometimes more than one diskette is required to hold the complete set of data. A display instructs to insert the additional diskettes at the proper time. After the database is loaded, a COMPLETE message is displayed for five seconds. The STATUS page is automatically displayed with the database effective dates.

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If a database read operation is not successful, an error message is displayed on the scratchpad line or annunciator line. The possible messages are as follows

NO NAV DATA BASE (The data base is not fully downloaded. The remaining data base is erased.)

DISK READ ERROR (A read error is found. Try again from INDEX page.)

NO LOADABLE FILES (The disk in the DBU is not a database disk.)

WRONG DISK (The specified disk is not in the DBU.)

DISK DRIVE COLD (The DBU is too cold for operation.)

DISK DRIVE NOT READY (There is no disk in the DBU).

DBU is in use by another LRU.

FMC FAULT (The database cannot be saved. The FMC found a fault.)

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DEFAULTS The pilot may specify the initial values for many performance and VNAV related quantities on the DEFAULTS page. When a new flight plan is loaded, the default values are automatically loaded. However the pilot may change these values on any specific flight without changing the way the next flight is initialized. Default values may be specified for the following: basic operating weight (BOW), average passenger weight (AVG PASS WT), RESERVE FUEL allocation, CLIMB SPEED targets (IAS/Mach), CRUISE SPEED targets (IAS/Mach), DESCENT SPEED targets (IAS/Mach), DESCENT ANGLE, and speed/altitude restriction (SPD/ALT LIMIT).

The DEFAULTS page also allows the pilot to specify the operating mode for certain functions. Enter a percentage for the FUEL FLOW CORRECTION. Enter a bank angle to select a reduced bank angle target for turn-anticipated maneuvers conducted at half bank mode.

The TAKEOFF & APPROACH REF page displays the DEFAULTS page for the T/O FLAP setting, FLAP SETTING, and anti-ice (A/I) ON or OFF.

FPLN key - Press this key to display the active flight plan page. If a flight plan has not been activated by the pilot, this key selects the first flight plan page. The first flight plan page has an ACTIVATE line key. Press this line key, then the EXEC key to make the first flight plan the active flight plan. Only the active flight plan gives FMS steering command outputs.

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Flight plan page - ACT FPLN (active flight plan) or FPLN (first flight plan) displays at the top of the page with the page number. The ROUTE field allows the operator to enter a route name. The route may contain an origin airport, destination airport, arrival / departure runways and connecting legs. The ORIG, DEST, and ALTN fields allow the operator to enter the origin, destination, and alternate airports (as KCID/KDEN). This allows the system to present specific runway information that can be edited into the flight plan. Enter ROUTE, ORIG, DEST, or ALTN information by keying data into the scratchpad line, then press a line key to transfer data to the selected field.

The flight plan may include airways, standard instrument departures (SID's), and standard terminal arrival routes (STAR's), approaches, holding patterns, direct legs, origin and destination airport information, pilot waypoints, and parallel offsets. Each entry below the VIA label represents a direct leg terminating at the waypoint displayed in the corresponding TO field. The current leg of the active flight plan is the entry just below the VIA label. The active flight plan automatically sequences as the flight progresses along the flight path, if FMS is selected as the active navigation source. Flight plan waypoints are saved as history data as they are passed.

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Flight Plan Edit - If the active flight plan is edited, the system creates a modified copy of the active flight plan. The flight plan page title changes to MOD FPLN. The edit is performed on this modified flight plan. There is no access to the active flight plan when a modified flight plan exists. The modified flight plan allows the pilot to edit the flight plan and see the results before making the change active. Press the EXEC key to execute the modified flight plan and make it the new active flight plan. Note that this causes the first waypoint of the edited flight plan to become active. Make sure that this waypoint is correct before executing the change. Press the CANCEL MOD line key to cancel the modified flight plan.

Waypoint identifiers (CID, KFNB, etc.) are stored in the system navigation database. Create or modify a flight plan by first keying a waypoint identifier into the scratchpad line then press a right side line key to transfer the identifier to the selected line. This line defines a direct leg to that waypoint. Repeat for each waypoint in the flight plan. Use the DEL key in to delete a line of the flight plan.

User defined waypoints can be entered in several ways. The system assigns an identifier to user defined waypoints as a latitude-longitude name (N40W003) or the associated waypoint name with a numeric extension (CID02). Transfer the system assigned identifier to the scratchpad line to see the complete coordinates of the waypoint (N40 15.3 W003 05.5).

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User defined waypoints may be entered in several formats. Enter the latitude and longitude: (N or S) DDMM.M (W or E) DDDMM.M where D is degrees and M is minutes. Enter the base waypoint identifier and bearing/distance offset: WPTBBB.B/DDD.D where WPT is an identifier, B is bearing, and D is distance. Enter the intersection of radials from two base waypoints: WPT1BBB.B/WPT2BBB.B where WPT is an identifier and B is bearing. Enter a flight plan waypoint and an along-track distance to or from this waypoint: WPT/DDD.D where WPT is an identifier and D is the + or - distance offset. If desired, this along-track waypoint may be named by adding /NAME to the entry.

Flight Plan Transfer - Dual FMS may operate in synchronized or independent mode. In SYNC mode, edits to an inactive flight plan immediately transfer to the cross-side FMS. Edits to the active flight plan transfer to the cross-side FMS only after the EXEC key is pressed.

In INDEP mode, flight plan edits do not transfer unless the pilot requests a transfer. The end of the last active, first, or second flight plan page contains a transfer option. Press the FPLN TRANSFER FROM XSIDE line key to transfer the flight plan.

LEGS key - Press to display a flight plan LEGS page. The title line on this page may be LEGS, ACT LEGS, or MOD LEGS.

If no flight plan is active, press the LEGS key to display the first flight plan LEGS page. If a flight plan has been activated, press the LEGS key to display the ACT LEGS page. If a modified flight plan exists, press the LEGS key to display the MOD LEGS page.

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LEGS page - The flight plan is displayed on the CDU using FPLN and LEGS pages. The FPLN pages display the flight plan as a series of direct legs. The LEGS pages display NAV data for each leg in the flight plan. Legs may be edited on this page. The edit procedure is similar to that of the flight plan pages. The SEQUENCE line key may be used to inhibit the sequencing of the legs display.

The LEGS page contains a line for each leg of the flight plan. This line lists the waypoint identifier for that leg with course and distance information. Each line also contains two data fields that may be used to enter airspeed and/or altitude restrictions at that waypoint. These values are for crew reference only and are not used by the FMS for computations. Use the right line keys to transfer keyed data from the scratchpad to the selected data field. Enter airspeed in KIAS (/KKK) or Mach number (/MM). Enter altitude in feet (/FFFF) or flight level (/LLL). Add an A or B to the altitude entry if value is at or above (A) or at or below (B).

Examples: 0.65/FL330 means 0.65 Mach at flight level 330. 325/ means 325 knots. /2460A3440B means at or above 2460 feet and at or below 3440 feet.

The ACT LEGS page displays the active leg of the flight plan as the first leg. Active leg data is magenta. The from waypoint is cyan, and the other waypoint data is white. The active leg distance is the great circle distance from the aircraft to the active waypoint.

The MOD LEGS page contains a CANCEL MOD line select key and displays an EXEC message. Operation is the same as for the modified flight plan.

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DIR key - Press to display the ACT DIRECT-TO page. A direct-to edit or a course edit may be performed only on the active leg of the active flight plan.

ACT DIRECT-TO page - The ACT DIRECT-TO page is similar to the LEGS page with the lateral waypoints on the left side and vertical information on the right side of the display. Entry of an off-flight plan waypoint on the scratchpad and selection of the top left line key creates a direct-to course to the diversion waypoint. Selection of the remaining left keys performs a lateral direct-to the adjacent flight plan waypoint. Selection of a right line select key performs a vertical direct-to the altitude at the associated lateral waypoint. The vertical direct-to preserves the original lateral path, but initiates an immediate descent or ascent to the selected vertical point.

A direct-to edit to the flight plan creates an active leg that is a great circle path from the aircraft position to the desired waypoint. The computed great circle path allows space to turn the airplane from the current heading to the required heading. Use the INTC CRS line key to enter an intercept course angle to this waypoint. An intercept course is the great circle path into the desired waypoint.

If the selected direct-to waypoint is on the flight plan, all waypoints between the previous active waypoint and the direct-to waypoint are deleted from the display and moved to the history memory buffer. If the selected direct-to waypoint is not on the flight plan, a discontinuity is inserted after this waypoint.

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Perform a course edit as follows. First, select a direct-to waypoint. If the selected waypoint is in the flight plan, the INTC CRS field displays the computed course angle from the flight plan leg leading into the waypoint. Enter the desired intercept course, then press the INTC CRS line key. This angle will be used to define the great circle course leading into the desired waypoint. Press the EXEC key to execute the course edit.

DEP ARR page key - Press to display the DEPART or ARRIVAL page. If the aircraft is on ground, the DEPART page of the origin airport is displayed. If the aircraft is airborne, less than 50 nm from the origin airport, and less than half way to the destination airport, the ARRIVAL page of the origin airport is displayed. Otherwise, the ARRIVAL page of the destination airport is displayed. If the origin or destination airport is not specified, the DEP/ARR INDEX page is displayed.

DEP/ARR INDEX page - The departure/arrival index page displays the names of the origin and destination airports (if entered) for both flight plans. These airports are entered in the flight plan pages. Active flight plan airports are displayed above the route plan airports.

Use this page to select a departure page or an arrival page for a listed airport or for any OTHER airport. These pages display the runways, SID's and STAR's that may be edited into the flight plan.

The departure or arrival page for any OTHER airport in the database may also be displayed from this page. Key the airport identifier into the scratchpad line, then press the bottom DEP or ARR line key.

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DEPART page - Press the DEP line key next to the desired airport to select the DEPART page for that airport. The departure page lists the names of available SID's in alphabetical order, and the available runways in numerical order.

Press a line key to select a SID or runway. A <SEL> label is displayed to identify the selected line. SID's/runways not associated with the selection are automatically cleared. Press the EXEC key to execute this modification and insert the selected departure SID/runway into the flight plan. Press the CANCEL MOD line key to cancel the modification.

ARRIVAL page - Press the ARR line key by the desired airport to select the ARRIVAL page for that airport. The ARRIVAL page lists the names of available STAR's in alphabetical order, and the available runways in numerical order.

Press a line key to select a STAR or runway. A <SEL> label is displayed to identify the selected line; STAR's/runways not associated with the selection are automatically cleared. Press the EXEC key to execute this modification and insert the selected arrival STAR/runway into the flight plan. Push the CANCEL MOD line key to cancel the modification.

PERF key - Press the to display the performance menu (PERF MENU) page.

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PERF INIT page - Press the PERT INIT line key to view the performance initialization pages. Use the performance initialization page to enter a cruise altitude and to select a transition altitude or flight level.

Basic operating weight (BOW) and average passenger weight are initialized to the default values. Enter a cruise altitude by keying the desired altitude into the scratchpad line, then press the CRZ ALT line key. Entry may be in altitude (0000 to 65,000 ft) or as a flight level (FL1 to FL650). The alternate cruise altitude may be specified for planning purposes.

Zero fuel weight (ZFW) may be entered directly, or calculated from the basic operating weight, number of passengers, passenger weight, and cargo weight. Gross weight is obtained from direct entry or from zero fuel weight entry after fuel weight has been initialized.

FUEL MGMT page - Press the FUEL MGMT line key to select the fuel management page. The FUEL MGMT page displays the current fuel on-board, selected fuel flow (measured total fuel flow or pilot specified fuel flow), selected ground speed (measured ground speed or pilot specified ground speed), reserve fuel allocation, specific range (nm/lb), time to reserves, range to reserve fuel, measured fuel flow per engine, total fuel used per engine, and measured total fuel flow.

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The PERF TRIP page provides a time, distance, and fuel calculation. The pilot determines an estimated time en route (ETE), distance (DIST), and fuel required (FUEL REQ) between locations by entering the FROM and TO waypoints. Current values for groundspeed (GND SPD) and FUEL FLOW are displayed but can be overwritten. Selecting the PPOS function enters the current location in latitude/longitude format as the FROM waypoint in the calculation.

VNAV SETUP page - Press the VNAV SETUP line key to select the VNAV CLIMB page. Press the PREV or NEXT key to select the VNAV CRUISE and VNAV DESCENT pages. The TGT SPEED for each flight phase may be modified on the VNAV setup page for the current active flight plan. The SPD/ALT LIMIT for the climb and descend flight phases may be modified or deleted.

FLIGHT LOG page - Press the FLT LOG line key to select the FLIGHT LOG page. The FLIGHT LOG page provides a summary of the flight until power is removed or the next takes-off. Fuel used is not automatically reset upon takeoff but may be reset by the pilot by entering DELETE or zero into the scratchpad, then pressing the line key adjacent to FUEL USED. No other data entry is allowed.

Message page key - Press the MSG key to display the MESSAGES page or to acknowledge a single system message. When the MESSAGES page is displayed press this key again to display the previous CDU page.

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MESSAGES page - The MESSAGES page is a list of FMS generated messages. Use the MSG key to acknowledge new messages. If a single new message exists, this message is displayed on the annunciator line. Press the MSG key to acknowledge the message and clear it from the annunciator line. If multiple new messages exist, press the MSG key to display the MESSAGES page. New messages are yellow; acknowledged messages are white. After a MESSAGES page has been displayed, all messages on that page are considered acknowledged. Note that MSG is displayed in the annunciator line when messages exist in the MESSAGES page.

The following messages may come on the CDU annunciator line and/or the MESSAGES page:

- AFIS FPLN LOADED** - The AFIS flight plan requested by the pilot has been loaded, but has not yet been viewed.
- APPR FOR REF ONLY** - An approach has been selected that is not qualified for FMS guidance.
- BEGIN POLR STEERING** - The aircraft is in the vicinity of either pole (20 nm) and steering will be terminated in two minutes.
- CHECK FPLN ALT** - There may be an error in the altitude constraints appearing in the flight plan.
- CHECK LOC TUNING** - ILS approach has been selected, the FMS has attempted to tune the localizer, and tuning has failed.
- CHECK NAV SOURCE** - The EFIS NAV source is not FMS or LOC after FMS initiated ILS capture.
- CHECK NAV TUNING** - RNAV approach has been selected, the FMS has attempted to tune the reference navaid, and tuning has failed.
- CHECK PRESELECTOR** - Preselector has not been reset to next target altitude 45 second before reaching the vertical switch point.

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- CHECK SPEED - Airspeed is too high for holding pattern or VNAV speed limit.
- CHK DATA BASE DATES - The active database date of the cross-side FMS is not the same as the active database date.
- CHK PERF DATA BASE - The FMS performance database version does not match the airplane type, or on-side and cross-side versions are different.
- CHK POS - The FMC has determined that the current accuracy may not meet the requirements for the current phase of flight.
- CRS REVERSAL IN FPLN - The flight plan has a course reversal of more than 160° at the TO waypoint.
- DME-FMS DISAGREE - The FMS has determined that the DME measurements are inconsistent.
- EXCESS IRS MOTION - The IRS detects excessive motion during alignment.
- EXEC FPLN MOD - A modified flight plan exists and no CDU keyboard activity has been observed for 15 seconds.
- FMS DR - The FMS is in dead reckoning mode because of loss of position sensor data.
- FMS DR FOR 5 MIN - The FMS has been in dead reckoning mode for more than 5 minutes in flight.
- FMS-FMS DISAGREE - The cross-side FMS position is significantly different from the on-side FMS position.
- FMS INDEPENDENT OP - Coordinated operation of the dual FMS system was lost in flight.
- FMS NAV INVALID - The FMS has been in the dead reckoning mode too long.
- FPLN DISCONTINUITY - The flight plan has sequenced past a waypoint to a flight plan discontinuity.
- GPS DISABLED - The crew has disabled use of GPS data on the GPS CONTROL page. This may degrade navigation ca
- GPS-FMS DISAGREE - The GPS to be used for position estimation has data that is significantly different from that of the FMS.

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- GPS NOT AVAILABLE - The GPS position measurements are not being used in the FMS position solution.
- GPS ONLY - The FMS is only using position data from the GPS sensors.
- HALF-BANK SELECTED - Half-bank is selected and the airplane will arrive at the hold fix in less than one minute.
- HOLD EFC EXPIRED - The pilot did not receive clearance from ATC within the allotted time to exit the holding pattern.
- INITIALIZE POSITION - The inertial navigation unit needs position initialization.
- IRS DISABLED - The crew has disabled use of IRS data on the IRS CONTROL page. This may degrade navigation capability.
- IRS-FMS DISAGREE - The IRS to be used for position estimation has data that is significantly different from that of the FMS.
- IRS ONLY - The FMS is only using position data from the IRS sensors.
- IRS REVERTED - FMS has reverted from triple IRS to single IRS use, and on-side IRS is not used.
- LAST WAYPOINT - The last waypoint of the flight plan has been passed.
- NO APPR GPS RAIM - Approach GPS RAIM is unavailable.
- NO FLIGHT PLAN - No active flight plan has been entered.
- NO GPS RAIM - GPS RAIM is unavailable.
- NO NAV DATA BASE - There is no navigation database stored in the FMC.
- NO PERF DATA BASE - There is no performance database stored in the FMC.
- NOT ON INTERCPT TRK - The FMS is steering the aircraft back to the active leg, but the current track will not intercept the active flight plan leg. This message may also indicate that the FMS has been armed for capture, but, at the current heading, the aircraft path will not intercept the active flight plan leg.
- OFFSET TERMINATED - Steering to a parallel offset path is terminated.

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- OFFSET WILL END - Steering to a parallel offset path will be terminated in two minutes.
- PERT OUT OF RANGE - Performance prediction conditions such as airspeed, weight, or altitude exceed limits of performance database contents.
- POLAR NAV - The aircraft is in the vicinity of either pole (20 nm) and output of valid steering is interrupted. The FMS will cause the airplane to fly straight and level.
- POLAR STEERING - The aircraft is in the vicinity of either pole (20 nm) and output of valid steering is interrupted, the FMS will cause the airplane to fly straight and level.
- PROGRAM DIFFER - The dual FMC's have incompatible software programs.
- RE-ENTER SET POS - The IRS or other LRN requests initialization (or reconfirmation of initialization), and the SET POS procedure has already been performed.
- RESET INITIAL POS - The position data needs to be updated via the POS INIT page.
- SET IRS HDG - The IRS needs a heading value to continue to provide heading in the attitude mode.
- UNABLE CRZ ALT - The performance predictions indicate the aircraft is unable to reach cruise altitude.
- UNABLE FPLAN ALT - Performance predictions indicate that the aircraft is unable to reach climb or descent constraint altitude in time.pability.
- UNABLE NEXT ALT - An altitude constraint will be exceeded.
- UNABLE TO SEQ FPLN - The FMS is unable to sequence the flight plan because the terminator of the active leg is indeterminable.
- UNABLE VHF NAV TUNE - The FMS attempted to auto-tune the ILS approach station.
- VNAV SENSOR FAIL - Critical VNAV sensor data is not available.
- VOR/DME DISABLED - The crew has disabled use of VOR and DME data on the VOR CONTROL page This may degrade navigation capability.

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- VOR/DME DIST > 75 NM - The FMC is navigating in the terminal area and is using a single VOR/DME whose distance is greater than 75 nmi.
- VOR-FMS DISAGREE - The FMC had determined that all received VOR measurements are not consistent with current position estimate.
- XTALK FAIL - The dual FMS system cross-talk communication has failed.

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MFD MENU page key - Press the MFD MENU key to display the MFD MENU page.

DISPLAY MENU page - The DISPLAY MENU page displays a list of selections that are available for the current MFD display. If the display is currently a plan map or present position map, then the MAP DISPLAY menu is generated. If the display is currently a remote text page, then the TEXT DISPLAY menu is generated. Use the left or right line keys to select menu items related to the MFD display as follows:

If a MFD is displaying a plan or present position map the MAP DISPLAY menu page lists available background map symbols and options related to the plan or present position map. Selected items display in large green characters. The MAP DISPLAY menu lists HI NAVAIDS, LO NAVAIDS, INTERS (airway intersections), ARPTS (airports), TERM WPTS (terminal waypoints), NDBS (non-directional beacon system), ETA (estimated time of arrival at waypoints), SPEED, ALTITUDE, MISS APPR (missed approach), VOR/DME POS, and LRN POS. This menu page also contains a WINDOW line key. Press this line key to alternately toggle the MFD data window display on or off. Press the SIDE L/R line key to toggle the display between the left and right sides.

Press the NEXT function key to select page 2 of the MAP DISPLAY menu. The MAP DISPLAY menu page 2 lists RNG: ALT SEL (range to altitude), LRN POS (LRN position), and ALTN FPLN (alternate flight plan).

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If the MFD displays remote text data, the TEXT DISPLAY menu page lists the available text data pages. Selected items display in large green characters. The TEXT DISPLAY menu lists FPLN PROG, NAV STATUS, POS SUMMARY, POS REPORT, SEC FLPN, VOR STATUS, and LRN STATUS (if LRN sensors are installed). Use the MFD DATA key to display text data and enable the MFD MENU page to display available text data pages.

If the MFD is not displaying a map or text data, the MFD MENU page for the present position map displays as a default.

MFD DATA page key - Press the MFD DATA key to display text data on the on-side MFD. Press the MFD DATA key again to display the previous MFD format. The message NO TXT WHEN PFD MAP is displayed when the PFD and MFD both display the same FMS map format. Change the format on the PFD and press the MFD DATA key to display the text data on the MFD.

MFD ADV key - Press the MFD ADV key to display the DISPLAY ADVANCE page. If the MFD has the plan or present position map displayed, the DISPLAY ADVANCE page displays the PLANMAP CENTER line key functions. Press the PREV WPT line key to center the previous waypoint on the MFD display. Press the NEXT WPT line key to center the next waypoint on the MFD display. Press the TO WPT line key to center the TO waypoint on the MFD display. The CTR WPT allows the pilot to enter a waypoint identifier from the scratchpad, then press the CTR WPT line key to center that waypoint on the MFD display.

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If the TEXT DISPLAY on the MFD contains multiple pages, press the MFD ADV key to display the DISPLAY ADVANCE, TEXT DISPLAY page. Press the PREV PAGE line key to change the MFD text page to the previous page. Press the NEXT PAGE line key to change the MFD text page to the next page. This key is not active if the selected text data consists of a single page.

Radio Tune key - Press the TUN key to display the radio TUNE page.

Radio TUNE page - Use the radio TUNE page to tune the COM, NAV, and ADF radios, and also to select the active transponder code. The pilot may also select manual or automatic tuning of the NAV radios from this page.

Tune a COM, NAV, or ADF radio by keying the desired frequency into the scratchpad line. Then press a line key to transfer this frequency to the selected field. If the frequency is valid, it shows in the data field, and the radio immediately retunes.

Select the active transponder code using the same method described above. Transfer the desired code from the scratchpad line to the ATC 1 or ATC 2 line. Note that only one transponder is active at a time. The data field below the inactive transponder label is blank; data cannot be transferred to this field.

The NAV radios may also be tuned by entering a station identifier (such as CID). Key the desired identifier onto the scratchpad line, then press the NAV 1 or NAV 2 line key. Both the frequency and the station identifier show in the NAV data field (117.60/CID).

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On the NAV CONTROL page, press the AUTO/MAN line key to select automatic or manual NAV tuning mode. The selected mode is displayed in large letters. When MAN tuning is selected, the NAV radio retunes only in response to pilot action on the CDU. When AUTO tuning is selected, the NAV radio automatically retunes in response to commands from the FMS computer. The FMS tunes the NAV radio to enroute stations throughout the flight to maintain valid position information.

COM 1/COM 2 display - Tune a COM radio by keying the desired frequency or preset number into the scratchpad line. Then press the COM 1 or COM 2 line key to transfer this frequency to the selected field. If the frequency is valid, it is displayed in the data field, and the radio immediately retunes. Press the COM 1 or COM 2 line key again to view the respective COM CONTROL page.

Note that SQ OFF is displayed next to the COM legend when squelch is disabled. TX is displayed when the radio is transmitting.

The digit to the right of the COM legend (1 or 2) identifies the radio that is tuned to that frequency.

RECALL frequency display - The RECALL frequency displays the preset VHF COM frequency that can be transferred to the (active) COM display.

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Press the RECALL frequency line key to interchange the preset and active COM frequencies. The COM radio retunes to the new frequency, and the previous active frequency becomes the new RECALL frequency. Press the RECALL frequency line key for instant recall of the old value.

Set the RECALL frequency by keying the desired frequency onto the scratchpad line. Then press the RECALL frequency line key to transfer this frequency to the selected field. If the frequency is valid, it is displayed in the data field.

When the CTL-23C is turned on, the RECALL legend is replaced by COM1/NAV1, and REMOTE is displayed

NAV 1/NAV 2 - Display NAV 1 or NAV 2 radio tuning by keying the desired frequency, preset number, or identifier into the scratchpad line, then press the NAV 1 or NAV 2 line key to transfer the frequency to the selected field. If the frequency is valid, it is displayed in the data field and the radio immediately retunes. This is the active VOR (and DME, unless held) frequency. Press the NAV 1 or NAV 2 line key again to view the respective NAV CONTROL page.

MK-HI is displayed next to the NAV legend when marker beacon receiver sensitivity is high.

The digit to the right of the NAV legend (1 or 2) identifies which radio that is tuned to the displayed frequency.

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DME 1/DME 2 display - The DME 1 or DME 2 displays normally read the DME legend with inactive HOLD in small letters. Press the DME 1 or DME 2 line key to select DME hold, the HOLD annunciation enlarges, and the held frequency is displayed.

ATC display - Set the active ATC code by keying the desired beacon code into the scratchpad line then press the ATC line key to transfer this code to the selected field. If the beacon code is valid, it is displayed in the data field, and the active transponder immediately responds to the new code. Press the ATC line key again to view the ATC CONTROL page.

ALT OFF is displayed to the right of the ATC legend when mode A is selected. STBY is displayed when standby is selected. REPLY is displayed when the active transponder replies to an interrogation. IDENT is displayed when the IDENT line key on the ATC/TCAS CONTROL page is pressed and the active transponder transmits.

The digit to the right of the ATC legend (1 or 2) indicates which transponder is active. The active transponder is selected using the IDENT button on the CCP.

TCAS MODE display - Press the TCAS MODE line key to select the TCAS mode. Press the TCAS MODE line key to cycle through the possible selections of TA (traffic advisory only), TA/RA (traffic and resolution advisories), RA (resolution advisory), and STBY (standby).

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ATC/TCAS control page - Press the TCAS line key to view the ATC/TCAS CONTROL page. The selected TCAS altitude display format (ABS or REL) is also displayed above the TCAS legend.

ADF 1/ADF 2 display - Tune the ADF by keying the desired frequency or preset number into the scratchpad line then press the ADF line key to transfer this frequency to the selected field. If the frequency is valid, it is displayed in the data field, and the radio immediately retunes. Press the ADF line key again to view the ADF CONTROL page.

If dual ADF's are installed, press the NEXT function key to access TUNE page 2, then press the ADF 1 or ADF 2 line key to view the respective ADF CONTROL page.

ANT is displayed next to the ADF frequency when antenna mode is selected. BFO is displayed when BFO mode is selected.

The digit to the right of the ADF legend (1 or 2) identifies which radio is tuned to that frequency.

HF 1/HF 2 display - Press the NEXT function key to access TUNE page 2 and then press the HF 1 or HF 2 line key to view the respective HF CONTROL page. Tune the HF radio by keying the desired frequency or preset number into the scratchpad line. Then press the HF line key to transfer this frequency to the selected field. If the frequency is valid, it is displayed in the data field and the radio immediately retunes. Press the HF line key again to view the HF CONTROL page.

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HF 1/HF 2 SQUELCH - The HF SQUELCH display show the squelch setting for the HF radios. Press the line key next to the up arrow to increase the squelch level. Press the line key next to the down arrow to decrease the squelch level. Possible squelch selections are SQ0, SQ1, SQ2, and SQ3.

COM CONTROL page - Press the COM 1 line key to select the COM1 CONTROL page. Press the COM 2 line key to select the COM2 CONTROL page.

COM active frequency display - The active VHF COM radio frequency is displayed. Enter the desired frequency or preset number into the scratchpad line then press the COM line key to transfer this frequency to the selected field.

If the frequency is valid, it is displayed in the data field, and the radio immediately retunes. The previous active frequency data is transferred to the RECALL frequency field.

The valid COM frequency limits are 118-136.975 MHz or extended range 118-151.975 MHz. The COM PRESETS numbers are 1 through 20.

RECALL frequency display -This display reads a RECALL VHF COM frequency that is available to immediately retune the radio. Press the RECALL line key to transfer the RECALL frequency to the COM active frequency field.

Enter the desired RECALL frequency or preset number into the scratchpad line. Then press the RECALL line key to transfer this frequency to the selected field. If the frequency is valid, it is displayed in the data field.

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The numbered COM PRESETS displays contains up to 20 preset COM frequencies. Press the NEXT or PREV function key to select the next or previous preset page. Press the associated line key to transfer the numbered preset frequency to the COM active frequency field.

To create or modify a COM PRESETS frequency, enter the desired frequency and/or identifier onto the scratchpad line then press the associated numbered line key to transfer this frequency to the numbered preset frequency field. If the frequency is valid, it is displayed in the data field.

SQUELCH line key and annunciator - Press the SQUELCH line key to alternately enable (ON) or disable (OFF) the receiver squelch circuits. The larger annunciator marks the squelch selection.

TEST line key and annunciator - Press the TEST line key to enable TEST for 10 seconds. The TEST annunciator enlarges during the test.

NAV CONTROL page - Press the NAV 1 or line key to select the NAV1 or NAV 2 CONTROL page.

NAV active frequency display - This display reads the active VHF NAV radio frequency. This is the active VOR (also DME, unless held) frequency. Enter the desired frequency, preset number, or station identifier into the scratchpad line then press the NAV line key to transfer this frequency to the selected field. If the frequency is valid, it is displayed in the data field, and the radio immediately retunes.

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The valid NAV frequency limits are 108-117.95 MHz or extended DME frequency range of 108-117.95 MHz and 133- 135.95 MHz. The NAV PRESETS numbers are 1 through 20.

DME hold line key and display - Press the DME HOLD line key and the NAV frequency associated with the current DME channel displays. HOLD is displayed next to the held frequency.

Marker beacon sensitivity annunciator - When the marker beacon sensitivity switch is set to the HI position, MK-HI is displayed next to the NAV source annunciator. The annunciator goes blank when the marker beacon sensitivity switch is set to the LO position.

NAV TUNING mode annunciator - Press the NAV TUNING line key to alternately select AUTO (automatic) or MAN (manual) NAV tuning. The larger annunciator marks the selection. The AUTO annunciation means the FMS is automatically tuning the NAV radios.

TEST line key and annunciator - Press the TEST line key to enable TEST for 10 seconds. The TEST annunciator enlarges during the test. If TEST INHIBITED annunciation is active, the line key is inactive.

NAV PRESETS display - The numbered NAV PRESETS displays contains up to 20 preset NAV frequencies. Press the NEXT or PREV function key to select the next or previous preset page. Press the associated line key to transfer the numbered preset frequency to the NAV active frequency field.

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To create or modify a NAV PRESETS frequency, enter the desired frequency and/or identifier onto the scratchpad line then press the associated numbered line key to transfer this frequency to the numbered preset frequency field. If the frequency is valid, it is displayed in the data field.

ADF page - Press the ADF 1 or ADF 2 line key to select the ADF1 or ADF2 CONTROL page.

When TCAS is enabled and two ADF radios are installed, the active ADF 1 frequency is displayed but not controlled on the first TUNE page. All ADF 1 and ADF 2 radio control occurs on the second TUNE page. If only one ADF radio is installed, the ADF radio is displayed and is controlled on the first TUNE page.

ADF source annunciator (top line) - The ADF 1 source annunciation indicates that the CDU is controlling a number 1 (left side) radio.

ADF active frequency display - This display reads the active ADF radio frequency. Enter the desired frequency or preset number into the scratchpad line then press the ADF line key to transfer this frequency to the selected field. If the frequency is valid, it is displayed in the data field, and the radio immediately retunes.

The valid ADF frequency limits are 190-1799.0 MHz or extended ADF frequency range of 190-1799.0 MHz and 2179-2185 MHz. The ADF PRESETS numbers are 1 through 20.

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Mode annunciator and line key - Press the MODE line key to alternately select ADF or ANT (antenna) mode. The larger annunciator marks the selection. In ADF mode, the ADF provides bearing to station and aural outputs. In ANT mode, the ADF provides aural output only.

BFO annunciator and line key - Press the BFO (beat frequency oscillator) line key to select the BFO ON or OFF. The larger annunciator marks the selection. When BFO is selected, the ADF radio generates a 1000 Hz aural BFO tone when a signal is received.

TEST annunciator and line key - Press the TEST line key to initiate the ADF self test. The TEST annunciator becomes larger during test.

ADF PRESETS frequencies display - The numbered ADF PRESETS displays contains up to 20 preset ADF frequencies. Press the NEXT or PREV function key to select the next or previous preset page. Press the associated line key to transfer the numbered preset frequency to the NAV active frequency field.

To create or modify an ADF PRESETS frequency, enter the desired frequency and/or identifier into the scratchpad line then press the associated numbered line key to transfer this frequency to the numbered preset frequency field. If the frequency is valid, it is displayed in the data field.

HF 1 CONTROL page - Press the TUN key to display the radio TUNE page 1/2. Press the NEXT key to display the radio TUNE page 2/2. Press the HF 1 line select key to display the HF 1 CONTROL page.

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Active frequency selection - Press the HF 1 line select key to enter the scratchpad data as the active HF 1 frequency. Valid scratchpad entries include: simplex frequency, duplex frequency, maritime channel, emergency channel, preset number, or emission mode.

Squelch level selection - The squelch level reads SQ0, SQ1, SQ2, or SQ3. Press the up or down arrow line select-key to adjust the squelch level.

POWER level selection and line key - Press to change the output power selection. The possible power levels are LO (low), MED (medium) or HI (high). The power level annunciator enlarges to indicate the active selection.

TEST annunciation and line key - Press the TEST line select key to test the HF system. The TEST annunciator enlarges when this mode is active. The HF test period is approximately four seconds. PASS is displayed when the test is successful. FAIL is displayed if the test fails.

Volume level selection - Press the up or down arrow line select key to adjust the volume level.

MODE selection and line key - Press to change the operational mode selection. The possible mode selections are FREQ (frequency), EMER (emergency), or MAR (maritime). The MODE annunciator enlarges to is displayed the active selection.

PRESETS annunciation and line key - Press to display the HF PRESETS page.

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HF PRESETS page - Press the TUN key to display the radio TUNE page 1/2. Press the NEXT key to display the radio TUNE page 2/2. Press the HF 1 line select key to display the HF 1 CONTROL page. Press the PRESETS line key to select the HF PRESETS page.

Active frequency selection - Press the HF 1 line select key to enter the scratchpad data as the active HF 1 frequency. Valid scratchpad entries include: simplex frequency, duplex frequency, maritime channel, emergency channel, preset number, or emission mode.

Preset frequency line keys - If the scratchpad line is blank, press a preset line key to transfer the preset frequency to the active frequency display.

Enter a preset frequency into the scratchpad line and press a preset line key to transfer the data to the numbered preset line.

CONTROL annunciation and line key - Press to display the HF CONTROL page.

ATC/TCAS CONTROL page - Press the ATC line key twice to select the ATC/TCAS page.

ATC source annunciator - The ATC 1 source annunciation indicates that the CDU is controlling the number 1 (left side) transponder. Only one transponder is active at a time.

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ATC active beacon code display - This display reads the selected transponder reply code. Enter the desired ATC code into the scratchpad line. Then press the ATC line key to transfer this frequency to the selected field. If the code is valid, it is displayed in the data field, and the radio immediately retunes.

The valid ATC code limits are between 0 and 7777.

STBY or REPLY displayed next to the right of the active beacon code. STBY is displayed when standby mode is selected using the CCP. REPLY is displayed when the transponder replies to an interrogation.

IDENT annunciator and line key - Press to transmit the code. The IDENT annunciator enlarges and remains active for approximately 18 seconds.

Altitude source annunciation - When altitude reporting is enabled, the altitude data source is displayed below the reporting altitude display.

ATC SELECT annunciator and line key - Press to alternately select ATC1 or ATC2. The larger annunciator marks the selected transponder.

MODE annunciator and line key - Press to alternately select the transponder mode ON or OFF. The larger annunciator indicates the MODE selection. In OFF mode, both transponders receive interrogation signals, but cannot send replies.

Mode S transponder annunciation - If the selected transponder is a mode S transponder TYPE S is displayed.

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Altitude reporting annunciator and line key - Press the ALT REPORT line key to alternately turn altitude reporting ON or OFF. The larger annunciator indicates the selection.

Altitude reporting ON is the normal operating mode, and should be selected for TCAS operation. The transponder replies to interrogation pulses, and transmits uncorrected barometric altitude (mode C).

Altitude reporting OFF (reply mode) is normally used only when requested by ATC. The transponder replies to interrogation pulses but does not transmit altitude data (mode A).

The transponder automatically replies to mode S ATCRBS and TCAS interrogations. No pilot action is required.

TEST annunciator and line key - Press to initiate the transponder self test. The TEST annunciator becomes larger during test.

Reporting altitude display - This display indicates the uncorrected barometric altitude transmitted in altitude reporting mode.

TCAS CONTROL page - Press the TCAS line key to select the TCAS CONTROL page.

TCAS MODE annunciator and line key - Press the TCAS MODE line key to alternately select TA, RA, or STBY mode. The larger annunciator indicates the selection.

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Traffic selection annunciator and line key - Press the TRAFFIC line key to alternately enable or disable display of the open diamond other traffic on the MFD traffic map. The larger annunciator indicates the selection.

Open diamond traffic is other traffic. RA traffic, TA traffic, and proximity traffic may still display.

Altitude tag annunciator and line key - Press the ALT TAG line key to alternately select relative (REL) or absolute (ABS) TCAS altitude display format. The larger annunciator indicates the selection.

Relative altitude is the difference between the intruder aircraft altitude and own aircraft altitude. Absolute altitude is the MSL (mean sea level) altitude of the intruder aircraft.

TEST annunciator and line key - Press the TEST line key to initiate TCAS self test. The TEST annunciator becomes larger during TCAS test for approximately 10 seconds.

Extended test annunciator and line key - Press the EXT TEST line key to initiate the TCAS self test. The TEST annunciator becomes larger during TCAS test.

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Altitude limits select line keys - Press the ABOVE, NORM, or BELOW line key to select the altitude range of TCAS protection window. The larger annunciator(s) indicates the selection.

The protection window defines a zone of vertical airspace relative to the aircraft. Intruders are tracked and considered potential threats.

When NORM is selected, the protection window is 2700 feet above and 2700 feet below the aircraft.

When ABOVE is selected, the protection window is 9900 feet above and 2700 feet below the aircraft.

When BELOW is selected, the protection window is 2700 feet above and 9900 feet below the aircraft.

When ABOVE and BELOW are both selected, the protection window is 9900 feet above and 9900 feet below the aircraft.