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Introduction

The navigation systems calculate and display the attitude, altitude and position of the aircraft, based on data from other aircraft systems, ground stations and sensed environmental conditions around the aircraft. The displayed information includes aircraft movement, distance, speed and direction of travel about all three axes. The present position and computed future positions can also be displayed.

This chapter will cover:

- Independent Position Determining Systems
- Dependent Position Determining Systems, and
- Flight Management System (FMS)


Independent Position Determining Systems

Operating independently of ground installations or orbital satellites, the independent position determining systems establish accurate aircraft location in three dimensions. They are comprised of the following avionics systems:

- Inertial Reference System (IRS)
- Weather Radar System
- Enhanced Ground Proximity Warning System (EGPWS)

Dependent Position Determining Systems

The dependent position determining systems use ground installations, aircraft transponders, or orbital satellites to determine the location of the aircraft, and include the following avionics systems:

- VHF Navigation System
- Automatic Direction Finder (ADF) System
- Distance Measuring Equipment (DME) System
- ATC Transponder
- Traffic Alert and Collision Avoidance System (TCAS II)
- Global Positioning System (GPS)
Flight Management System (FMS)

The FMS is a fully integrated navigation and flight data system providing:

- cockpit management - NAV sensor control, secondary radio tuning, and MFD control menus
- flight management - lateral point-to-point navigation, Vertical Navigation (VNAV), flight parameter computation; and
- diagnostic functions

The FMS, when equipped with a current navigation database, provides accurate flight planning and three-dimensional steering command outputs to facilitate optimum great-circle, point-to-point navigation within the limits of the aircraft.

Associated Components

The following components (based on a standard cockpit configuration) are associated with the operation of the navigation systems:

- two Display Control Panels (DCPs)
- two Primary Flight Displays (PFDs)
- two Multifunction Displays (MFDs)
- two Radio Tuning Units (RTUs)
- two FMS Control Display Units (CDUs)
- one Source Selector Panel
Inertial Reference System (IRS)

Description

The IRS installed in the Challenger 604 is the Litton LTN-101 Inertial Reference Unit. It is a fully independent, self-contained navigation system which provides attitude, directional, position, and three-axis rate/acceleration data to the following aircraft systems:

- PFD and MFD displays
- Automatic Flight Control System (AFCS)
- Weather Radar System
- EGPWS
- TCAS
- Fuel System (for fuel quantity indications)
- Flight Data Recorder (FDR)
- Air Data Computer (ADC)
- Flight Management System (FMS)

The standard installation consists of two IRS systems, IRS 1 and IRS 2 (see Figure 17-1). A dual MSU (Mode Select Unit) installed in the cockpit provides control functions for the two IRS systems. An optional third IRS including a single MSU may also be installed.

Components and Operation

Inertial Reference Unit (IRU)

Each IRU uses three laser gyros and three linear accelerometers to sense aircraft attitude and acceleration. After alignment is successfully completed, the IRU outputs the following data for use by other aircraft systems:

- Attitude (pitch, roll, yaw)
- Heading (True and magnetic)
- Inertial position (latitude and longitude)
- Ground speed
- Wind direction and speed
- Three-axis body rate and acceleration (include an inertial vertical velocity component to the VSI)
- Flight path data
Each IRS receives true airspeed and altitude from the on-side air data system. In the event of a failure of the on-side air data input, the cross-side input is automatically selected.

Power Supply

Each IRU has two power sources, a 115-volt AC source and a backup 28-volt DC source. Either source is sufficient for operation but both are required for initial startup. Inside the IRU, the battery backup circuit automatically switches to the backup 28-volt DC source when the normal 115-volt AC source is not available. During startup, the battery backup circuit verifies that backup power is available by momentarily switching off the 115-volt AC input. The IRS 1(2)(3) ON BATT advisory EICAS message is displayed when an IRU is operating on DC power only.

115-volt, 400-Hz AC power is also supplied to the IRU cooling fans.

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IRU Power Sources

Mode Select Unit (MSU)

The mode select unit provides the necessary switches that select the modes of operation of each IRS. All IRS-related annunciations are displayed as EICAS messages or FMS CDU scratchpad messages.

Each MSU switch has three positions: OFF, NAV, and ATT. Power is applied to the IRU whenever the respective switch is selected to the NAV or ATT position.
Figure 17-1 illustrates the dual MSU (for IRS 1 and 2) and the single MSU for the optional third IRU.

**Mode Select Unit**  
*Figure 17-1*

**IRS Reversionary Mode Selectors**

IRS reversionary mode selector switches are provided to control IRU outputs to the pilot’s and copilot’s PFD and MFD displays. In the event of an IRU failure, the selectors can be used to restore IRU data to the affected side’s displays.

With the reversionary switches at NORM, the PFD and MFD displays normally receive data from their on-side IRS. In a dual-IRS installation, selecting the reversionary selector to 1 or 2 results in both the pilot’s and copilot’s displays receiving information from the selected IRU. In a triple-IRS installation, selecting ALTN replaces the appropriate IRU data with IRU 3 data.

Single-source or cross-side IRS source annunciations are displayed on the affected PFDs (see Figure 17-2).

Figure 17-3 shows the standard reversionary panel and optional reversionary panels based on the indicated avionics configuration.
PFD IRS Source Annunciations

Figure 17-2
Source Selector Panel - IRS Reversionary Mode Selectors

*Figure 17-3*
IRS Normal Alignment

Normal alignment is achieved for IRS alignments between ±73° of latitude. When the mode selector switches are in OFF, power is removed from the IRUs. When NAV is selected, power is applied to the IRUs, and the IRUs automatically progress through a self-test mode, followed by an alignment period before navigation (NAV) mode becomes available. The IRU will automatically sequence to NAV mode 7 minutes after the MSU selector switch is turned to NAV if all of the following conditions are met:

- aircraft is on the ground with no excessive motion detected
- the gyro temperature is above 0°C
- the latitude and position tests have passed
- valid IRS initialization data has been received

IRS Initialization

In order to initialize the IRS, the present latitude and longitude coordinates must be entered from either FMS CDU via the POS INIT page. The IRUs remain in the alignment mode with NAV selected on the MSU if the present position is not entered. The initialization data can be changed during the alignment, but both latitude and longitude coordinates must be entered.

During IRS initialization, the IRS ALIGNING DO NOT TAXI message appears on the Primary Flight Displays (PFDs). When alignment is complete, the PFD message goes out and position entry is no longer accepted. IRS alignment cannot be accomplished in flight.

NOTE

If possible, use of the GPS coordinates is recommended for initialization since they provide the most accurate aircraft position.
Low-Temperature Alignment

At an IRS internal temperature between -54°C and -40°C, the power supply will turn on but normal alignment will not start until the IRS temperature is greater than -40°C. The alignment mode is inhibited when the gyro temperature exceeds +80°C.

The following table shows the time to complete alignment when the gyro temperature is below 0°C. IRU time to complete alignment is displayed on the FMS CDU POS INIT page 3/3.

<table>
<thead>
<tr>
<th>IRU INTERNAL TEMP (°C)</th>
<th>TIME TO COMPLETE ALIGNMENT (MIN.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; -12.5</td>
<td>16 (see note)</td>
</tr>
<tr>
<td>-12.5 to -10.0</td>
<td>15</td>
</tr>
<tr>
<td>-10.0 to -7.5</td>
<td>14</td>
</tr>
<tr>
<td>-7.5 to -5.0</td>
<td>13</td>
</tr>
<tr>
<td>-5.0 to -2.5</td>
<td>12</td>
</tr>
<tr>
<td>-2.5 to 0</td>
<td>11</td>
</tr>
<tr>
<td>&gt;0</td>
<td>7</td>
</tr>
</tbody>
</table>

Low-Temperature Alignment Times
Table 17-2

NOTE
Alignment time is extended beyond 16 minutes if the gyro temperature has not reached at least -40°C. The system will not go into NAV mode until the gyro temperature reaches -15°C.

Extended 15-Minute Alignment

The extended 15-minute alignment procedure allows the system to align at latitudes up to 80° north and south.

After NAV has been selected, wait 15 minutes before entering the present position.

Refer to the CL-604 Airplane Flight Manual - Supplement 7, FMS Navigation in Polar Regions, for additional navigation procedures when operating in polar regions.
IRS Rapid Realignment

When the IRS is operating in the NAV mode, it is possible to perform a rapid realignment whenever the aircraft is on the ground. If the MSU selector switch is rotated from NAV to OFF and back to NAV within 5 seconds, the system will sequence into the rapid realignment mode. Velocity components are set to zero, a 30-second leveling mode corrects the pitch and roll angles, and no gyro compassing is performed (the last heading from the NAV mode is used). The total rapid realignment sequence takes approximately 32 seconds. Present position must be reentered.

**NOTE**

If excessive motion is detected during rapid realignment, the system restarts rapid realignment and resets the time remaining to align to 30 seconds.

IRS Attitude (ATT) Mode

Attitude mode is normally used when an IRS malfunction occurs. It may also be used if all power to the IRS (including battery backup power) is lost then restored during flight. In attitude mode, the IRS provides only pitch, roll, and heading outputs.

Attitude alignment takes 1 minute from power OFF to ATT mode or 34 seconds from NAV to ATT mode, provided the airplane is stationary on the ground or in straight-and-level flight. The IRS ALIGNING DO NOT TAXI message appears on the PFD on ground or IRS ALIGNING message appears in flight.

If excessive motion is detected, the attitude alignment is run for an additional 20 seconds. Once attitude alignment is complete, a free DG heading operation is available. Heading is entered from the FMS CDU IRS CONTROL page via the SET IRS HDG prompt. Heading entries are periodically required while the IRS is in attitude mode to correct for heading drift.
IRS Shutdown

The recommended method of shutting down the IRS is by setting the MSU selector switch to OFF. During this shutdown process, the IRU will remain powered for an additional 10 seconds to allow system record storage (aircraft power should not be removed until 15 seconds after the MSU is selected OFF).

To ensure proper system record storage, it is also recommended to keep the IRS in NAV mode for a minimum of three minutes after the aircraft is parked.

Record storage at shutdown consists of the Elapsed Time Indicator (ETI) record update and NAV updates which are required to ensure the best possible alignments and NAV performance. If power is removed from the IRU during the 10-second shutdown, then NAV updates and ETI may not be stored.

Operating Tips

The IRS manufacturer recommends the following operating tips:

<table>
<thead>
<tr>
<th>PHASE OF FLIGHT</th>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment</td>
<td>For best performance the IRS should be aligned at random headings. Continuous alignments at or near one cardinal heading may degrade performance.</td>
</tr>
<tr>
<td>Initial position entry</td>
<td>Initial latitude and longitude should be entered within two minutes of start-up. The initial latitude and longitude position should be within 1 nautical mile of actual aircraft position to ensure the most accurate IRS alignment.</td>
</tr>
<tr>
<td>Prior to taxi</td>
<td>It is recommended to remain in NAV mode prior to taxi for at least five minutes. The IRS continues to adjust for bias errors and temperature changes as long as the aircraft is stationary.</td>
</tr>
<tr>
<td>Taxi</td>
<td>If practical, it is recommended that the aircraft stops during taxi for a period of one to three minutes with a heading 90 to 180 degrees different than the alignment heading. NAV updates are performed during taxi but will not be used unless the aircraft has stopped for a minimum of one minute.</td>
</tr>
<tr>
<td>Intermediate stops</td>
<td>During intermediate stops, it is recommended to use the Rapid Realign feature when the IRS remains on during the stop. This will minimize drift errors during subsequent flights as drift error is zeroed.</td>
</tr>
<tr>
<td>Post-flight</td>
<td>Keep the IRS on for a minimum of three minutes after the aircraft is parked. After the IRS is turned off with the mode select switch, keep the power applied for a minimum of 15 seconds to allow storing of the Nav Update records in the IRS memory.</td>
</tr>
</tbody>
</table>

IRS Operating Tips

Table 17-3
Controls and Indicators

IRS Mode Select Unit (MSU)

IRS 1/2 Mode Selector Switches
- OFF - Removes power from IRS
- NAV - Selected for normal operation
- ATT - Selected for reversionary

IRS Reversionary Mode Selectors (Dual IRS Configuration)

IRS Reversionary Mode Selector Switch
- 1 - Pilot's and copilot's systems receive IRS data from IRS 1
- NORM - Pilot's and copilot's systems receive data from their on-side system
- 2 - Pilot's and copilot's systems receive IRS data from IRS 2
PFD IRS Source Annunciations (Dual IRS Configuration)

Figure 17-8

IRSI Reversionary Mode Selectors (Triple IRS Configuration)

Figure 17-9

EICAS Messages

<table>
<thead>
<tr>
<th>MESSAGE</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRS 3 ALIGNING</td>
<td>IRS 3 is in align mode or ATT mode with no IRS 3 INOP status message.</td>
</tr>
<tr>
<td>IRS 1 (2) (3) DC FAIL</td>
<td>Indicates the respective IRS DC power supply failed.</td>
</tr>
<tr>
<td>IRS 1 (2) (3) IN ATT</td>
<td>Indicates the respective IRS is operating in attitude mode.</td>
</tr>
<tr>
<td>IRS 3 INOP</td>
<td>Indicates a failure of IRS 3.</td>
</tr>
<tr>
<td>IRS 1 (2) (3) ON BATT</td>
<td>Indicates the respective system is operating on backup battery power.</td>
</tr>
<tr>
<td>IRS 1 (2) (3) OVEATEMP</td>
<td>Indicates an overtemperature condition in the respective IRU.</td>
</tr>
</tbody>
</table>
Weather Radar System

Description

The weather radar consists of a single unit that detects wet precipitation and precipitation-related turbulence along the flight path of the aircraft. A ground mapping function is incorporated to assist with navigation. An optional Lightning Detection System adds lightning detection to the weather radar displays.

The Radar Transceiver processes weather radar/turbulence data into a digital bus format that may be selected for display on the pilot’s or copilot’s Multifunction Display (MFD).

The baseline weather radar system includes one Weather Radar Control Panel (WXP) that allows selection of various operating modes. An optional second WXP may be installed to provide a split-scan capability. The Display Control Panels (DCPs) control selection of the weather radar overlay and radar range on the MFDs.
Components and Operation

Receiver Transmitter Antenna (RTA)

The Receiver Transmitter Antenna is an integrated unit with a 12-inch flat-plate antenna. The radar scan is ± 60 degrees of the aircraft heading, and the selectable antenna tilt angle is ± 15 degrees above and below the horizontal.

The RTA is powered by DC Bus 1.

Weather Radar Control Panel (WXP)

The weather radar panel provides all the operating controls, except range and weather radar overlay control, to the weather radar RTA. In single WXP installations, control selections are sent to both channels of the radar, and identical reflectivity data shows on both MFD displays.

The WXP(s) are powered by DC Bus 1.

In dual-WXP installations, individual control selections are sent to separate radar channels. This provides a split-scan capability where the radar functions like two independent radars. The pilot’s WXP controls the left side weather radar display and the copilot’s WXP controls the right side display. Each weather radar overlay updates on alternate sweeps of the antenna; the pilot’s on the clockwise sweep and the copilot’s on the counterclockwise sweep.
**Mode Knob**

The mode knob selects the weather radar operating mode. Available modes are:

- OFF
- TEST (test mode)
- MAP (ground mapping mode)
- WX (weather)
- WX+T (weather and turbulence)
- TURB (turbulence only)

Annunciation of the selected mode is displayed on the MFD weather radar mode line.

**Sector Control (SEC) Button**

Pushing the SEC button on the WXP alternatively selects or deselects sector scan mode. When selected, radar scans ± 30 degrees from aircraft heading. When deselected, normal ± 60° scan resumed.

**Transfer Control (XFR) Button**

Pushing the XFR button on the WXP alternately selects or deselects the transfer function. In single-WXP installations, weather radar range control transfers to the cross-side DCP when the XFR function is selected.

In a dual-WXP installation, operation of the XFR button transfers complete weather radar control to the cross-side WXP and DCP (range, mode, gain and tilt). The cross-side WXP and DCP units control both MFD radar displays. Transfer is allowed on one side only, and the pilot has priority.

When transfer is selected, an “X” annunciates on both MFD radar mode lines and the slaved side line is shown in yellow. The weather radar message RADAR NOT AT THIS RANGE will appear on the slaved side anytime MFD range disagrees with the master side.

**Stabilization Control (STAB) Button**

Pushing the STAB button on the WXP alternately selects or deselects antenna stabilization. Normally, antenna stabilization is selected to automatically stabilize the radar antenna with attitude input data from the IRS system. This provides a constant antenna scan attitude regardless of the aircraft pitch and roll attitudes.

If antenna stabilization is not selected, attitude input data is removed from the antenna drives. This allows the weather radar system to remain operational if an IRS input failure occurs.

If an IRS failure occurs or if stabilization has been deselected via the STAB button, USTB flashes in cyan for 10 seconds then remains steady, indicating that stabilization...
is not available. If an IRS failure occurs, or two WXPs are installed and the cross-side WXP is in control, the annunciation is in yellow.

**Tilt Control**

The weather radar antenna tilt arc is 30 degrees above and below the horizon. Fifteen degrees is for manual tilt selection and the remaining 15 degrees is for automatic stabilization. The system automatically adjusts the antenna tilt in response to aircraft pitch and roll attitude changes.

The selected tilt angle (-15° to +15°) is displayed on the weather radar mode line of the MFDs.

**Auto-Tilt Control**

Pushing the PUSH AUTO button in the center of the TILT knob alternately selects or deselects automatic tilt. When selected, the antenna tilt is adjusted to maintain a constant tilt/range ratio as radar range selection is changed. The MFD tilt angle readout is appended by “A” to indicate that automatic tilt is enabled.

The antenna tilt is automatically adjusted when aircraft altitude or radar range is changed. This will keep a ground return at the same relative position on the display. For example, if a ground return was indicated at 40 miles on a 50-mile range setting, it would show at 80 miles (4/5 of the display) if the range setting were changed to 100 miles.

**Display Control Panel**

**WX Button**

Pushing the WX button selects the weather radar and/or lightning detection system displays on the MFD. Each push of the WX button sequentially cycles through the following selections:

- WX (weather displayed only)
- LX (lightning displayed only)
- WX/LX (weather and lightning displayed), then
- OFF (removing both from the MFD display)

Display selections are shown on the weather radar mode line of the MFD.

**Range Knob**

The range knob on the DCP is used to set the display range. The outer range ring of the MFD is numbered with the selected range. The middle range ring indicates half the selected range. The available ranges are 5, 10, 25, 50, 100, 200 and 300 NM when weather radar is in use.
In a dual-WXP installation, weather radar range and weather radar overlay selections are controlled individually on each the DCP. The applicable range selection is shown on each MFD.

In a single-WXP installation, radar range is controlled with the DCP located on the same side of the cockpit as the WXP, providing transfer mode is not selected (XFR button on the DCP).

**Display Control Panel (DCP)**

*Figure 17-11*

**Weather Radar Displays**

Pushing the WX button on the DCP adds the weather radar overlay to the following MFD formats:

- NAV SECTOR
- FMS MAP
- TCAS

Figure 17-14 shows an example of the weather radar overlay on the supported MFD formats.

Weather radar system and/or lightning detection system failure messages are displayed on the weather radar mode line, or in the lower left and right corners of the MFDs.
MFD Formats - Display of Weather Radar

*Figure 17-12*
Display Levels

The colors used on the radar display to represent rainfall intensity are as follows:

<table>
<thead>
<tr>
<th>DISPLAY LEVEL</th>
<th>RAINFALL RATE (MM/HR)</th>
<th>RAINFALL RATE (INCHES/HR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 (magenta)</td>
<td>Turbulence</td>
<td>Turbulence</td>
</tr>
<tr>
<td>5 (yellow)</td>
<td>PAC (path attenuation correction)</td>
<td>PAC (path attenuation correction)</td>
</tr>
<tr>
<td>4 (magenta)</td>
<td>Intense</td>
<td>&gt; 51</td>
</tr>
<tr>
<td>3 (red)</td>
<td>Strong</td>
<td>&gt; 12.7 - 51</td>
</tr>
<tr>
<td>2 (yellow)</td>
<td>Moderate</td>
<td>&gt; 3.8 - 12.7</td>
</tr>
<tr>
<td>1 (green)</td>
<td>Weak</td>
<td>&gt; 0.76 - 3.8</td>
</tr>
<tr>
<td>0 (black)</td>
<td></td>
<td>&gt; 0.15 - 0.76</td>
</tr>
</tbody>
</table>

Weather Radar Display Levels
Table 17-5

Path Attenuation Correction (PAC) Alert Mode

When a precipitation cell is of sufficient dimension to use the full range of attenuation correction, a condition known as Path Attenuation Correction (PAC) alert occurs. Its function is to allow a true image of a precipitation cell to be rendered by making allowances for the radar beam’s absorption as it penetrates the precipitation cell. The PAC alert puts into view those areas which absorb the radar beam.

The heading to these areas is shown by a yellow arc at the edge of the radar display. All precipitation in the sector between the displayed weather targets and the yellow PAC alert arc may be incorrect and should be avoided.
Weather Radar Display Modes

Refer to the “Collins Pro Line 4 Avionics System for the Challenger 604” Pilot’s Guide for additional operational information on the weather radar system.

**Test Mode**

Selecting TEST mode initiates the weather radar RTA functional self-test. The TEST mode ensures that the MFDs are capable of processing and displaying the weather data represented by various colors. Six colored arcs show on the MFD in TEST. The fifth arc changes between red and magenta on alternate sweeps.

The transmitter is disabled in TEST mode, but antenna scan and tilt functions remain operational.

---

**WARNING**

THE AREA WITHIN THE SCAN ARC AND WITHIN TWO FEET OF AN OPERATING WEATHER RADAR SYSTEM CONSTITUTES A HAZARDOUS AREA. DO NOT OPERATE THE SYSTEM IN ANY MODE OTHER THAN TEST WHEN THE ANTENNA MIGHT SCAN OVER PERSONNEL. DO NOT OPERATE THE RADAR INSIDE A HANGAR.
Weather Only (WX) Mode
Detectable weather appears as one of four colors: green, yellow, red, or magenta. The highest precipitation rates are represented in magenta.

Weather Plus Turbulence (WX+T) Mode
Weather plus turbulence adds the detection of precipitation-related turbulence targets to the weather mode. The highest precipitation rates and turbulence show in magenta.
WX+T is operational for ranges less than or equal to 40 NM. When ranges greater than 50 NM are selected in WX+T mode, the weather radar reverts to the WX mode.

Turbulence Only (TURB) Mode
The TURB mode on the WXP is a spring-loaded position. Selecting TURB mode removes all targets except detected precipitation-related turbulence within the 50 NM range. TURB mode is useful in analyzing areas of precipitation-related turbulence that have been detected while in the WX+T mode. By removing all weather returns from the display, the areas of turbulence (magenta) can be observed alone.

Lightning Detection System (Optional)
The lightning detection system maps electrical discharge activity (lightning) 360 degrees around the aircraft to a distance of 200 nautical miles. Three levels of electrical activity intensity are identified. Level one represents the lowest rate of electrical discharge and level three the highest.
The system transmits the location of up to 63 thunderstorm cells to the MFDs. The data set is updated every two seconds. Electrical discharge activity is presented as thunderbolts on the MFD in yellow, red, and magenta, with yellow signifying level one, and magenta signifying level three activity.
The lightning detection system is selected by the WX button on the Display Control Panel (DCP).
Controls and Indicators

Transfer Switch
Transfers control of WX radar display range to pilot's or copilot's display control panel.

Sector Scan Switch
When pressed in, multifunction display indicates azimuth angle of ±30° on either side of flight path. Not pressed, multifunction display indicates azimuth angle of ±60° on either side of flight path.

Receiver Gain Switch
Controls receiver gain in map and WX modes
-1, -2, -3 positions - Reduce sensitivity
+1, +2, +3 positions - Increase sensitivity

Ground Clutter Suppression (GCS) Switch
When pressed in during WX mode, reduces the intensity of ground returns and permits clearer definition of precipitation. Clutter suppression lasts approximately 12 seconds. When selected, GCS is displayed on MFD. Any mode or range change cancels GCS.

Stabilization Select Switch
Normally, antenna stabilized by IRS system. No MFD indication. During an airplane attitude system failure (USTB flashing), when pressed, MFD displays USTB.

Tilt Control Switch
Rotate to change antenna tilt up or down angle for desired radar scanning. Multifunction display (MFD) indicates tilt angle selected. Tilt limits are from 15° up to 15° down.

Auto-tilt Correction Switch
Push to select or deselect antenna auto-tilt. Multifunction display indicates auto-tilt selected as an "A" suffixed to the tilt angle (T + 10.7A)

Mode Select Switch
Mode selections indicated at top of MFD. Modes are:
OFF - Removes power to weather radar receiver/transmitter/antenna unit. WX off mode displayed on MFD.
TEST - Starts weather self-test program, and test pattern indicated on MFD, test mode displayed on MFD.
MAP - Ground targets displayed in cyan, green, yellow, or magenta (least to most reflective) on MFD. Map mode displayed on MFD.
WX - Detectable weather displayed in green, yellow, red, or magenta, from least reflective to most reflective. PAC compensation and alerts enable. WX mode displayed on MFD.
WX+T - Enables the RTA to detect both weather and turbulence targets
TURB - Enables the RTA to detect turbulence targets. The MFD displays only the detected areas of turbulence when in the TURB mode.

Weather Radar Control Panel (WXP)

Figure 17-14
Radar Mode Selection

<table>
<thead>
<tr>
<th>Current Format</th>
<th>MFD Format After WX Press</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSI</td>
<td>FMS MAP + RADAR</td>
</tr>
<tr>
<td>PLAN MAP</td>
<td>FMS MAP + RADAR</td>
</tr>
<tr>
<td>FMS MAP</td>
<td>FMS MAP + RADAR</td>
</tr>
<tr>
<td>FMS MAP + RADAR</td>
<td>FMS MAP + RADAR + LX</td>
</tr>
<tr>
<td>FMS MAP + RADAR + LX</td>
<td>FMS MAP</td>
</tr>
<tr>
<td>NAV SECTOR</td>
<td>NAV SECTOR + RADAR</td>
</tr>
<tr>
<td>NAV SECTOR + RADAR</td>
<td>NAV SECTOR + RADAR + LX</td>
</tr>
<tr>
<td>NAV SECTOR + RADAR + LX</td>
<td>NAV SECTOR</td>
</tr>
<tr>
<td>TCAS</td>
<td>TCAS + RADAR</td>
</tr>
<tr>
<td>TCAS + RADAR</td>
<td>TCAS + RADAR + LX</td>
</tr>
<tr>
<td>TCAS + RADAR + LX</td>
<td>TCAS</td>
</tr>
</tbody>
</table>

TFC Switch
Selects TCAS for display on the MFD

FORMAT
Format menu has “electronic stops” at HSI (always available), and at its most clockwise available selection. The modes are shown below in the order that they are available on the knob from the furthest counterclockwise to the furthest clockwise:
- HSI
- NAV SECTOR
- FMS MAP
- PLAN MAP
- TCAS

RANGE
Range values are listed in the order that they occur from the most clockwise positions of the range knob (there are “electronic stops” at both ends of the range knobs).
Standard RANGE Menu (MAP and RADAR Modes):
5, 10, 25, 50, 100, 200, 300

Display Control Panel (Weather Radar Functions)

Figure 17-15
Weather Radar Display

**Figure 17-16**

- **Weather Radar Mode Indicators**
  - Indicates WX system status at all MFD display modes:
    - LX - Lightning
    - WX - Weather radar only
    - MAP - Ground mapping mode
    - RADAR OFF - Weather input data is missing
    - STBY - Weather radar in standby
    - TEST - Radar test mode
    - TRB - Turbulence only
    - WX+TRB - Weather radar + turbulence
    - GCS - Ground Clutter Suppression

- **Receiver Gain**
  - G+1, G+2, G+3 - Indicates progressive increased gain
  - G-1, G-2, G-3 - Indicates decreased gain

- **USTB - Stabilization**
  - Indicates antenna tilt angle from 15° up to 15° down, the readout is appended by an "A" to indicate that auto-tilt is selected on.

- **Dynamic Sweep Mark**
  - Represents position of weather radar antenna.

- **Range Arcs**
  - 2 arcs displayed on weather radar display, marking range increments (full range and half scale range), when weather radar is superimposed on the following MFD formats:
    - NAV Sector Mode
    - FMS Map Mode
    - TCAS Mode (if installed)
    - PAC (Path Attenuation Correction) Alert - Yellow arc displayed.

- **Weather Reflectivity**

- **Lightning Symbology**

- **Range Readout**
  - Indicates nautical mile range

- **Antenna Tilt Readout**
  - Indicates antenna tilt angle from 15° up to 15° down, the readout is appended by an "A" to indicate that auto-tilt is selected on.

**MULTIFUNCTION DISPLAY PILOT'S & COPILOT'S INSTRUMENT PANEL**
**Weather Radar/Lightning Detection System Messages**

Weather radar system and/or lightning detection system failure messages are displayed on the MFD as shown below:

<table>
<thead>
<tr>
<th>WXR RANGE/CONTROL FAULT ANNUNCIATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RADAR CONTROL FAULT</strong></td>
<td>Range received from the weather radar system disagrees with the range received from the DCP.</td>
</tr>
<tr>
<td><strong>RDR NOT AT THIS RANGE</strong></td>
<td>Control is transferred and the range received from the weather radar system disagrees with the range received from the DCP.</td>
</tr>
</tbody>
</table>

**WXR Range/Control Fault Annunciation**  
*Table 17-6*

<table>
<thead>
<tr>
<th>LX/WX FAULT ANNUNCIATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>WX FAULT</td>
<td>Weather radar system detects an internal fault.</td>
</tr>
<tr>
<td>LX FAULT</td>
<td>Lightning Detection System detects an internal fault or the MFD detects invalid data.</td>
</tr>
<tr>
<td>LX/WX FAULT</td>
<td>Weather radar system detects an internal fault and Lightning Detection System detects an internal fault or the MFD detects invalid data.</td>
</tr>
</tbody>
</table>

**Lightning/Weather Fault Annunciation**  
*Table 17-7*
Pilot and Copilot MFD - Weather Radar Fault Annunciation

*Figure 17-17*
Enhanced Ground Proximity Warning System (EGPWS)

Description

The EGPWS alerts and warns the flight crew when the airplane’s flight path and position relative to terrain requires immediate crew attention and action. EGPWS alerts the flight crew when predetermined thresholds are exceeded using the following modes:

- Mode 1 - Excessive Descent Rate
- Mode 2 - Excessive Terrain Closure Rate
- Mode 3 - Altitude Loss after Takeoff or Go-Around
- Mode 4 - Unsafe Terrain Clearance when not in a Landing Configuration
- Mode 5 - Below Glideslope Deviation Alert
- Mode 6 - Callouts
- Mode 7 - Windshear Detection and Alerting
- Terrain/Obstacle Awareness Alerting and Display (TAAD)
- Terrain Clearance Floor (TCF)

Modes 1 through 6 are installed in all aircraft (basic GPWS). Mode 7, TAAD, and TCF are installed in the aircraft equipped with “Enhanced” GPWS. Consult your Airplane Flight Manual supplement for individual aircraft installation.
EGPWS Functional Schematic

Figure 17-18

Voice Logic:
- Only 1 message at a time
- Highest priority takes precedence and will interrupt lower priority messages
- Once a message starts, it will complete unless overridden by higher priority message, even if alert/warning condition no longer applicable
- Pause (approx. 3/4 second) at end of each message.
Components and Operation

EGPWS Computer (EGPWC)

The EGPWC receives inputs from the air data system, radio altimeters, VHF Nav receivers, GPS, IRS, Angle-of-Attack vanes, gear and flap selector levers and glareshield switch/lights. These inputs are used to compute potential terrain conflicts.

Mode 1 - Excessive Descent Rate

Mode 1 provides aural and visual alerts and warnings in the event that the EGPWC determines that the rate of descent is excessive with respect to airplane altitude. The mode is active when the airplane is less than 2500 feet AGL. Mode 1 requires radio altitude and rate of descent data.

The annunciation envelope consists of two areas: alert and warning.

- penetration of the alert area will illuminate the GND PROX switch/lights on the glareshield and generate an aural “SINKRATE SINKRATE”. The aural alert will be annunciated once, and will be repeated only if condition degrades by more than 20% based on computed time to impact. The visual alert will remain until the condition is rectified.

- penetration of the warning area will illuminate the PULL UP switch/lights on the glareshield and generate an aural “WHOOP, WHOOP, PULL UP” warning. The aural warning is annunciated continuously until the condition is rectified.

![EGPWS Mode 1](image-url)

**Figure 17-19**
Mode 2 - Excessive Terrain Closure Rate

Mode 2 provides alerts and warnings when the EGPWC detects that the closure rate between the airplane and terrain is excessive. The airplane need not be in descent, rising terrain may be encountered in level flight, or the terrain may be rising at a rate greater than the airplane rate of climb. Mode 2 uses radio altitude, vertical speed and aircraft configuration inputs.

Mode 2 has two submodes: Mode 2A and Mode 2B.

• Mode 2A - Activated when flaps are not in the landing position and the aircraft is not in the GS beam. Penetration of the alert area will illuminate the GND PROX switch/lights on the glareshield and generate an aural “TERRAIN, TERRAIN”. The aural is annunciated once, and the visual alert will remain displayed, until the condition is rectified. Penetration of the warning area will illuminate the PULL UP switch/lights on the glareshield and generate an aural “PULL UP” warning. The aural and visual warnings are annunciated continuously until the condition is rectified.
• Mode 2B - Activated when flaps are in the landing configuration, or in the event the flaps are up and the airplane is on an ILS approach and the glideslope and localizer deviations are less than ±2 dots and for 60 seconds after takeoff. Penetration of the alert area will illuminate the GND PROX switch/lights on the glareshield and enable an aural “TERRAIN, TERRAIN”. The aural and the visual alerts are annunciated continuously and will remain until the condition is rectified. Penetration of the warning area will illuminate the PULL UP switch/lights on the glareshield and generate an aural “PULL UP” warning. The aural and visual warnings are annunciated continuously until the condition is rectified.

**EGPWS Mode 2B**
*Figure 17-21*
Mode 3 - Altitude Loss after Takeoff

Mode 3 provides warnings when the EGPWC detects that a significant amount of altitude is lost immediately after takeoff or during a go-around. Mode 3 uses radio altitude, barometric altitude and altitude rate.

If a descent is initiated following takeoff or go-around, the EGPWC stores the altitude value at which the descent began, and compares successive altitude data to the stored value. Activation of the warning is induced when the minimum terrain clearance, as a function of altitude lost, is exceeded.

Penetration of the alert area will illuminate the GND PROX switch/lights on the glareshield and generate an aural “DON’T SINK, DON’T SINK” warning. The aural warning is annunciated only once, unless the altitude value degrades by more than 20% from the initially stored value, and again at each additional 20% degradation from the initially stored value. This condition will remain until the airplane regains the initial altitude value. Mode 3 is inhibited for radio altitude in excess of 1500 feet.
Mode 4 - Unsafe Terrain Clearance

Mode 4 provides alerts and warnings for insufficient terrain clearance based on airplane phase of flight and airspeed. Mode 4 requires radio altitude, computed airspeed, gear position and flap position inputs. The alert and warning envelopes are based on minimum allowable terrain clearance as a function of computed airspeed.

Mode 4 is divided into 3 submodes: Mode 4A, Mode 4B and Mode 4C.

- Mode 4A - Active when the airplane is in cruise or approach phase of flight, and the landing gear is not in the landing position. The alert envelope for Mode 4A begins at 30 feet AGL and extends vertically to an altitude of 500 feet AGL. Penetration of the alert area, above 190 knots (the upper boundary increases with airspeed to a maximum of 1000 feet radio altitude at 250 knots or more) will illuminate the GND PROX switch/lights on the glareshield and generate an aural “TOO LOW TERRAIN” warning. Penetration of the alert area, below 190 knots, will illuminate the GND PROX switch/lights on the glareshield and generate an aural “TOO LOW GEAR” warning. The aural and visual remain until the airplane exits the envelope.

EGPWS Mode 4A

*Figure 17-22*
• Mode 4B - Active when the airplane is in cruise or approach phase of flight, and the landing gear is in the landing position and flaps are not in the landing configuration. The alert envelope for Mode 4B extends vertically to an altitude of 245 feet AGL. Penetration of the alert area, above 159 knots, will illuminate the GND PROX switch/lights on the glareshield and generate a continuous aural “TOO LOW TERRAIN” warning. The aural and visual warning remains until the airplane exits the envelope. Penetration of the alert area, below 159 knots, will illuminate the GND PROX switch/lights on the glareshield and generate an aural “TOO LOW FLAP” warning. These alerts can be deactivated by selecting the GPWS FLAP OVRD switch to override.
• Mode 4C is based on a minimum terrain clearance, or floor, that increases with radio altitude during takeoff. At takeoff the Minimum Terrain Clearance (MTC) is at zero feet. As the aircraft ascends, the MTC is increased to 75% of the aircraft’s current (average of the previous 15 seconds) radio altitude. This value is limited to 500 feet AGL for airspeed less than or equal to 190 knots. If the airspeed is greater than 190 knots, the MTC increases linearly with increasing airspeed up to 250 knots. Beyond 250 knots, the MTC is limited to 1000 feet AGL. Any decrease in altitude below minimum terrain clearance will illuminate the GND PROX switch/lights on the glareshield and generate an aural “TOO LOW TERRAIN” warning.

• It is activate after takeoff when the gear or flaps are not in the landing configuration. It is also active during a low altitude go-around if the aircraft has descended below 245 feet AGL.

![Diagram of EGPWS Mode 4C](image-url)
Mode 5 - Descent Below Glideslope

Mode 5 provides two levels of alerting if the aircraft flight path descends below the glideslope. The first alert occurs whenever the aircraft is more than 1.3 dots below the beam and is called a “soft alert” because the volume level is reduced. A second alert occurs below 300 feet Radio Altitude with greater than 2 dots’ deviation and is called a “hard alert” because the volume is louder.

To avoid unwanted glideslope alerts when capturing the localizer between 500 and 1000 feet AGL, the upper limit of the alert envelope is varied in the following ways:

- glideslope alerts are only enabled if the localizer is within ± 2 dots. This allows a lateral capture of the localizer
- the upper altitude limit for the glideslope alert is modulated with vertical speed. For normal descent rates above 500 FPM, the upper limit is set to the normal 1000 feet AGL. For descent rates lower than 500 FPM, the upper limit is desensitized to allow a level flight capture of the localizer

The above requirements are overridden when the aircraft descends below 500 feet AGL.

Alerts for Mode 5 activate the GND PROX switch/lights on the glareshield and the aural message “GLIDESLOPE”. Only two “GLIDESLOPE” warnings are given while in the Mode 5 outer “soft” envelope. If the conditions worsen, two more “GLIDESLOPE” aural messages annunciate at a faster rate. This pattern continues until the inner “louder” area is penetrated (2 dots or greater deviation, below 300 feet AGL) at which time the “GLIDESLOPE” message will become louder and continuous.
Below 150 feet AGL, glideslope alerting is desensitized to reduce the possibility of nuisance alerts.

To permit maneuvering on final approach with an unreliable glideslope, the Mode 5 alert can be inhibited by pressing the GND PROX/PULL UP switch/light on either side of the glareshield. The GND PROX/PULL UP switch/light can be engaged below 2000 feet AGL and is automatically reset before the next approach, provided the aircraft has descended below 30 feet or climbs above 2000 feet.
Mode 6 - Callouts

Mode 6 provides the following advisory alerts: transition through approach minimums, altitude callouts on approach and excessive bank angles.

- **Approach minimums**: the “MINIMUMS” callout occurs as the aircraft descends through the decision height (DH) as set on the radio altimeter. One hundred feet above the radio altimeter DH, the “APPROACHING MINIMUMS” alert will sound.

- **Altitude callouts**: specific callouts are program-pin selectable. Typical installation includes: 1000, 500, 50, 40, 30, 20, 10. Consult your Operating Manual for aircraft-specific installation.

- **Excessive bank angle**: the excessive bank angle alert is a function of the roll angle with respect to altitude above ground level. The alert envelope varies linearly from a 10° bank at 30 feet AGL, to 40° of bank at 150 feet AGL, to 55° of bank at 2450 feet AGL. This will generate an aural “BANK ANGLE, BANK ANGLE” alert. The alert is annunciated once, and will repeat if the bank angle increases by 20%. The alert will be annunciated continuously if the bank angle is increased to 55°. The alert will be annunciated until the bank angle is decreased below threshold value.

![EGPWS Mode 6 Bank Angle](image)

**EGPWS Mode 6 Bank Angle**

*Figure 17-26*
Mode 7 - Windshear Detection and Alerting

Mode 7 provides alerts and warnings in the event that significant windshear is detected by the EGPWC. Mode 7 is active during takeoff and landing phases of flight only, between 10 and 1500 feet AGL.

EGPWS Mode 7 Windshear Thresholds

There are two types of windshear warnings: increasing performance (updraft / headwind) and decreasing performance (downdraft / tailwind).

- for an increasing performance shear (updraft / headwind), an amber WINDSHEAR message is annunciated on the PFD and flashes for 5 seconds, then remains steady. No aural message is given
- for a decreasing performance shear (downdraft / tailwind), a red WINDSHEAR message is annunciated on the PFD and flashes for 5 seconds, then remains steady, and an aural siren and “WINDSHEAR, WINDSHEAR, WINDSHEAR” warning are activated. Two seconds after a windshear warning is issued, the autopilot, if engaged, is disconnected and the flight director bars are removed. No escape guidance is provided
PFD Windshear Display

Figure 17-28
Terrain Clearance Floor (TCF)

The TCF function of the EGPWS provides an additional terrain clearance alert envelope around airports. This alert mode complements the existing Mode 4 protection by providing an alert based on insufficient terrain clearance even when in landing configuration.

TCF creates an increasing terrain clearance envelope around the intended airport runway directly related to the distance from the runway. TCF alerts are based on current airplane location, nearest runway center point position and radio altitude, with an integral TCF airport database.

Penetration of the alert envelope will illuminate the the GND PROX switch/lights on the glareshield and generate an aural “TOO LOW TERRAIN” alert. The aural alert is repeated twice, and again thereafter if the radio altitude value decreases by more than 20% from the altitude at which the initial warning was issued. The aural message remains displayed and the switch/lights remain flashing until the airplane exits the alert envelope.

Terrain Clearance Floor Database

The TCF database is integral to the EGPWC and includes worldwide coverage of all airports with hard-surfsed runways longer than 3,500 feet in length.

Note:

\[ k = \frac{1}{2} \text{Runway length} + \text{Envelope Bias Factor (EBF)} \]

(Typically 1/2 to 2 NM)
Terrain/Obstacle Awareness Alerting and Display (TAAD)

A feature of the EGPWS is the incorporation of the Terrain / Obstacle Awareness Alerting and Display function. This function uses aircraft geographic position, aircraft altitude and a terrain and obstacle database to predict potential conflicts between the aircraft flight path and the terrain or obstacle, and to provide terrain display overlay of the conflicting terrain or obstacles.

The terrain awareness alerting algorithms continuously compute terrain clearance envelopes ahead of the aircraft as a function of ground speed, flight path angle and track. If the boundaries of these envelopes conflict with terrain elevation data in the terrain database, alerts are issued. Two envelopes are computed, one corresponding to a Terrain Caution Alert level and the other to a Terrain Warning Alert level.

EGPWC Position and Altitude Determination

The EGPWC determines aircraft position and altitude using GPS sensor data primarily. The EGPWC monitors RAIM status and applies geometric altitude algorithms to ensure the required level of precision is maintained laterally and vertically. If GPS is not available, the EGPWC applies barometric altitude calculations for vertical position determination, and uses the FMS integrated navigation solution for lateral position determination.
Terrain/Obstacle Awareness Alerting and Display (TAAD) Database

The TAAD database is comprised of a terrain database and an obstacle database integral to the EGPWC. The terrain database includes worldwide coverage of the earth’s surface divided into grid sets referenced to the WGS-84 datum.

The obstacle database contains known man-made obstacles that are higher than 100 feet AGL. This database covers all of the USA but only portions of Canada, Mexico, and the Bahamas.

Terrain Awareness Display

The Terrain Awareness Display displays an image of surrounding terrain in varying density dot patterns of green, yellow, and red. The display is generated from the aircraft altitude compared to terrain data in the EGPWS computer. These dot patterns represent specific terrain separation with respect to the aircraft. Terrain more than 2000 feet below the aircraft is not displayed. Areas with no terrain data available are shown as a low-density magenta color.

The obstacle data included is depicted on the terrain display in the same fashion as terrain.

Terrain/Obstacle Awareness Display Color Patterns

The crew may independently select the Terrain Display on either MFD by pushing the TERR button on the appropriate DCP. The Terrain Display can be overlaid on any MFD format that supports weather radar overlay. A cyan TERRAIN annunciation appears on the top left corner of the MFD to inform the flight crew that the terrain overlay has been selected. Weather radar and terrain cannot be displayed simultaneously on the same MFD.
Auto Pop-Up

When a Terrain Awareness Caution or a Terrain Awareness Warning are detected, the Terrain overlay automatically pops up on both MFDs and the format and range automatically change to FMS MAP and 10 NM.

Display Control Panel - TERR Button

MFD Terrain Awareness Display

NOTE

Navigation must not be predicated upon the use of the terrain awareness display.

If a terrain display fault condition is present when the terrain is being displayed, one of the following cyan messages will be presented in the bottom left corner of the MFD (i.e., in the weather radar fault message field): “TERRAIN FAIL”, “TERRAIN CONTROL FAULT”, “TERRAIN NOT AVAIL”. All terrain messages, except the normal condition “TERRAIN”, flash for 10 seconds when they are posted.
Terrain/Obstacle Awareness Caution Alert

If the aircraft penetrates the Caution envelope boundary, the aural message “CAUTION TERRAIN” or “CAUTION OBSTACLE” is generated, and the amber “GND PROX” lights flash. Simultaneously, terrain/obstacle areas which conflict with the caution criteria are shown in solid yellow color on the Terrain Awareness Display.

The caution alert is typically given 60 seconds ahead of a terrain/obstacle conflict.
Terrain/Obstacle Awareness Warning Alert

If the aircraft penetrates the Warning envelope boundary, the aural message “TERRAIN TERRAIN, PULL UP” or “OBSTACLE, OBSTACLE, PULL UP” is generated, and the red “PULL UP” lights flash. Simultaneously, terrain/obstacle areas which conflict with the warning criteria are shown in solid red color on the Terrain Awareness Display.

The warning alert is typically given 30 seconds ahead of a terrain/obstacle conflict.

Terrain/Obstacle Awareness Warning Alert

EGPWS Glareshield Switch/Lights

 Terrain Inhibit (TERR INHB) Switch/Lights

A GPWS TERR INHB switch/light is installed above each “PULL UP / GND PROX” switch/light on the glareshield. These switch/lights are used by the flight crew to manually inhibit the Terrain Awareness Alerting and Display and the Terrain Clearance Floor functions when required. Pressing either TERR INHIB switch/light will inhibit these functions. A second push of either switch/light will reactivate these functions. Note that when the Terrain Inhibit is selected, the basic GPWS and windshear detection functions remain operational.

If the terrain is selected for display while the Terrain functions have been inhibited by the crew, a cyan “TERRAIN INHIBITED” message replaces the “TERRAIN” message in the top left corner of the MFD and both switch/lights illuminate white.
The GPWS TERR INHB switchlight should be selected before flight if the airport is not in the EGPWS database or if GPS is not available during QFE operations.

It should also be selected during descent within 15 NM of approach if any of the following conditions applies:

- Runway is less than 3500 feet in length, or
- Airport is not in the EGPWS database, or
- Intended approach is not compatible with EGPWS terrain awareness alerting, or
- QFE operation with no GPS available

**PULL UP/GND PROX Switch/Lights**

The red PULL UP light is activated when an EGPWS “PULL UP” aural warning occurs. The amber GND PROX light is activated for all other ground proximity alerts.

Momently pushing of the PULL UP/GND PROX switch/light will activate the EGPWS self-test when on the ground (the EGPWS self-test is inhibited in flight). In flight, a momentary push of this switch/light may be used by the crew to cancel “Mode 5 - Below Glideslope” alerts as required.

**EGPWS Glareshield Switch/Lights**

*Figure 17-36*
Controls and Indicators

GPWS TERR INHB Switch/Light (Alternate-action)
Press - Inhibits Terrain Clearance Floor (TCF) and Terrain/Obstacle Awareness Alerting and Display (TAAD) Modes
Illuminated white - Indicates Terrain Inhibits is selected

PULL UP/GND PROX Switch/Light (Momentary-action)
Press -
On the Ground - Initiates EGPWS self-test
In Flight - Cancels Mode 5 - Below Glideslope alerts
PULL UP annunciator
Flashes red - Indicates an EGPWS “PULL UP” alert is active
GND PROX annunciator
Flashes amber - Indicates EGPWS caution alert is active

GPWS/FLAP Override (guarded toggle switch)
GPWS/FLAP OVRD - Mutes flap aural warning when entering the landing configuration with flaps at a position other than 45°
NORM (guarded) - Normal operation

EGPWS Controls and Indicators

Figure 17-37
Windshear Message

**Amber** - Flashes then comes on steady to indicate that the airplane is entering an increasing performance windshear condition

**Red** - Flashes then comes on steady to indicate that a severe decreasing performance windshear condition has been encountered

PFD Indications

*Figure 17-38*

---

EGPWS Self-Test - Terrain Test Pattern

*Figure 17-39*
### EGPWS Abnormal Annunciation

<table>
<thead>
<tr>
<th>EGPWS ABNORMAL ANNUNCIATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>TERRAIN FAIL</td>
<td>The TAAD is inoperative due to an EGPWC internal fault or due to the failure of a required input.</td>
</tr>
<tr>
<td>TERRAIN NOT AVAIL</td>
<td>The TAAD and the TCF have been temporarily inhibited by the EGPWC because the estimated navigation accuracy from both the GPS and the FMS is insufficient.</td>
</tr>
<tr>
<td>TERRAIN CONTROL FAULT</td>
<td>The range of the terrain elevation data does not agree with the current MFD range.</td>
</tr>
</tbody>
</table>

#### EGPWS Abnormal Annunciation

*Table 17-8*

#### MFD Terrain Abnormal Annunciations

*Figure 17-40*
EICAS Messages

The following white EICAS status messages are provided to inform the crew when EGPWS functions are inoperative:

<table>
<thead>
<tr>
<th>MESSAGE</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPWS FAIL</td>
<td>The basic Ground Proximity Warning function (Mode 1 to 6) is inoperative.</td>
</tr>
<tr>
<td>WINDSHEAR FAIL</td>
<td>The windshear detection function is inoperative.</td>
</tr>
<tr>
<td>TERRAIN NOT AVAIL</td>
<td>The terrain awareness alerting and display functions and the Terrain Clearance Floor function have been temporarily disabled by the EGPWS because the FMS navigation accuracy is insufficient.</td>
</tr>
<tr>
<td>TERRAIN FAIL</td>
<td>The terrain awareness alerting and display functions and the Terrain Clearance Floor function are inoperative due to a fault condition.</td>
</tr>
</tbody>
</table>

EICAS Messages

*Table 17-9*
The following table lists a summary of the EGPWS modes and associated indications:

<table>
<thead>
<tr>
<th>MODE</th>
<th>CONDITION</th>
<th>AURAL WARNING LEVEL 1</th>
<th>VISUAL WARNING LEVEL 1</th>
<th>AURAL WARNING LEVEL 2</th>
<th>VISUAL WARNING LEVEL 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Excessive Descent Rate</td>
<td>&quot;SINK RATE&quot;</td>
<td>GND PROX</td>
<td>&quot;PULL UP&quot;</td>
<td>&quot;PULL UP&quot;</td>
</tr>
<tr>
<td>2A</td>
<td>Excessive Terrain Closure Rate (Flaps not extended)</td>
<td>&quot;TERRAIN TERRAIN&quot;</td>
<td>GND PROX</td>
<td>&quot;PULL UP&quot;</td>
<td>&quot;PULL UP&quot;</td>
</tr>
<tr>
<td>2B</td>
<td>Excessive Terrain Closure Rate (Flaps fully extended)</td>
<td>&quot;TERRAIN TERRAIN&quot;</td>
<td>GND PROX</td>
<td>&quot;PULL UP&quot;</td>
<td>&quot;PULL UP&quot;</td>
</tr>
<tr>
<td>3</td>
<td>Altitude Loss after Takeoff or Go-Around</td>
<td>&quot;DON'T SINK DON'T SINK&quot;</td>
<td>GND PROX</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>4A</td>
<td>On Approach with Gear and Flaps Up</td>
<td>&quot;TOO LOW TERRAIN&quot;</td>
<td>GND PROX</td>
<td>&quot;TOO LOW GEAR&quot;</td>
<td>GND PROX</td>
</tr>
<tr>
<td>4B</td>
<td>On Approach with Gear Down and Flaps not in Landing Configuration</td>
<td>&quot;TOO LOW TERRAIN&quot;</td>
<td>GND PROX</td>
<td>&quot;TOO LOW FLAPS&quot;</td>
<td>GND PROX</td>
</tr>
<tr>
<td>4C</td>
<td>Takeoff or Go-Around Unsafe Terrain Clearance</td>
<td>&quot;TOO LOW TERRAIN&quot;</td>
<td>GND PROX</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>Descent Below Glideslope</td>
<td>&quot;GLIDESLOPE GLIDESLOPE&quot; (Soft alert)</td>
<td>GND PROX</td>
<td>&quot;GLIDESLOPE GLIDESLOPE&quot; (Hard alert)</td>
<td>GND PROX</td>
</tr>
<tr>
<td>6</td>
<td>Approaching Minimums</td>
<td>&quot;APPROACHING MINIMUMS&quot;</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>6</td>
<td>Minimums</td>
<td>&quot;MINIMUM&quot;</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>6</td>
<td>Altitude Callouts</td>
<td>1000, 500, 50, 40, 30, 20, 10 feet RA</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>6</td>
<td>Excessive Bank Angle</td>
<td>&quot;BANK ANGLE&quot;</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>7</td>
<td>Windshear Alerting Caution (increasing performance) Warning (decreasing performance)</td>
<td>None</td>
<td>Amber WINDSHEAR on PFD &quot;WINDSHEAR, WINDSHEAR, WINDSHEAR&quot;</td>
<td>Red WINDSHEAR on PFD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Terrain Look Ahead</td>
<td>&quot;CAUTION TERRAIN CAUTION TERRAIN&quot;</td>
<td>GND PROX</td>
<td>&quot;TERRAIN TERRAIN PULL UP&quot;</td>
<td>&quot;PULL UP&quot;</td>
</tr>
<tr>
<td></td>
<td>Obstacle Detection</td>
<td>&quot;CAUTION OBSTACLE CAUTION OBSTACLE&quot;</td>
<td>GND PROX</td>
<td>&quot;OBSTACLE OBSTACLE PULL UP&quot;</td>
<td>&quot;PULL UP&quot;</td>
</tr>
<tr>
<td></td>
<td>Terrain Clearance Floor</td>
<td>&quot;TOO LOW TERRAIN&quot;</td>
<td>GND PROX</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

**GPWS Aural and Visual Alerts**

*Table 17-10*
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VHF Navigation System

Description

The VHF Navigation System is a dual-receiver system used for en route navigation and for precision approach and landing. Signals from VHF Omni Range (VOR), Instrument Landing System (ILS) stations and marker beacons are received and processed. Separate VOR and ILS modes of operation are provided.

The VHF Navigation System consists of two VHF Navigation Receivers and associated antennas.

Components and Operation

VHF Navigation Receiver

The VOR/LOC receiver operates in the frequency range of 108.0 MHz through 117.95 MHz. The frequencies are spaced 50 kHz apart, giving 200 channels. Forty channels are designated for Localizer and 150 channels are assigned to VOR. The frequency range of the Glideslope Receiver is 329.15 to 335.00 MHz. There are 40 channels with 150-kHz spacing. The Localizer and Glideslope channels are paired. The Marker Beacon operates on a fixed frequency of 75.0 MHz.

The VHF NAV 1 receiver is powered by the DC Essential Bus and VHF NAV 2 by DC Bus 2.

Nav Tuning

NAV tuning is normally performed from the top level page of the on-side RTU (see Figure 17-44). Tuning may also be accomplished by the cross-side RTU or by the FMS CDU.

When the NAV main display page is selected, the sensitivity of the marker beacon receiver can be controlled via the MKR SENS line select key.

Course Selection and Tracking

The desired VOR/LOC course may be displayed on the PFD horizontal situation indicator (HSI), by selecting VOR/LOC using the NAV SOURCE knob on the DCP, and then setting the desired course with the COURSE knob on the Flight Control Panel (FCP). Pushing the PUSH DIRECT inset button of the COURSE knob on the FCP sets the VOR course direct to the tuned VOR station.

The VOR/LOC course may also be displayed on the HSI and NAV SECTOR formats of the MFD.
Tracking of the VOR/LOC course is accomplished using the flight director and autopilot. For more information, see Chapter 4 Automatic Flight Control System.

**Bearing Pointer Selection**

The BRG pushbuttons on the DCPs allow selection of pilot’s side or copilot’s side VOR information in the form of bearing pointers. The single magenta bearing pointer displays the direct bearing to the NAV 1 VOR station. The cyan double bearing pointer displays the direct bearing to the NAV 2 VOR station.

Both pointers may be displayed simultaneously on either PFD’s HSI, and on the HSI, NAV SECTOR, and FMS MAP formats of the MFD.

**Cross-Side Course Display**

The PUSH X-SIDE inset button on the NAV SOURCE knob may be used to display cross-side course information on the HSI and NAV SECTOR MFD formats.

**Controls and Indicators**

The figures that follow outline the controls and indications relevant to VHF navigation. Refer to Chapter 6 Communications, and Chapter 11 Flight Instruments for additional information on the Radio Tuning Unit (RTU) and EFIS displays.
VHF Navigation RTU Display

Figure 17-41
Navigation Systems

Audio and Display Control Panel

Figure 17-42

No. 1/2 Bearing Pointer
Source Switches
Push to select No.1/2 (single/dual bar) source:
- OFF
- VOR 1/2
- ADF 1/2-FMS 1/2
- (FMS 3)
Source indicated on PFD/MFD.

Voice/BOTH Switch
VOICE – CW signals are filtered out of VOR, ILS and ADF
BOTH – Station identification and voice signals are audible

Navigation Receive
Switches
Press to monitor respective navigation receiver.
Press again to deselect.
Any number of audio sources can be monitored at the same time.
Rotate to adjust volume.

Marker Beacon Receive
Switches
Press to monitor marker beacon audio signals:
3000 Hz - inner marker
1300 Hz - middle marker, and
400 Hz - outer marker
Press again to deselect.
Rotate to adjust volume.
Marker-receive sensitivity and output volume are set by MKR sens mode, on NAV main page of RTU

Navigation Source Knob
Rotate to select navigation source:
- (FMS 3)
- FMS 1
- VOR 1 / LOC 1
- OFF
- VOR 2 / LOC 2
- FMS 2
- (FMS 3)

Cross-side Course
Selection Pushbutton
Used only on MFD. In HSI and NAV sector formats, displays currently selected cross-side course, along with course deviation and course labeling from cross-side. Selection does not remove existing data from MFD. Push on/push off.
Flight Control Panel Course Knobs

**Figure 17-43**

**Marker Beacon Indicator**
Colored box is displayed as airplane passes over applicable marker beacon and flashes to indicate:
- inner or airway marker (BLANK) (white)
- middle marker (MM) (yellow)
- outer marker (OM) (cyan).

**Vertical Deviation Display (G/S or FMS)**
ILS G/S appears when all necessary conditions are met. If deviation data becomes invalid, display replaced by red GS flag. When back course selected, scale is presented without pointer or flag annunciation. When pointer moves to top or bottom of the display, diamond pointer changes to a ½ diamond pointing in the direction of the deviation. Excessive deviation causes the pointer to flash (amber).

**PFD Navigation Display**

**Figure 17-44**
Course Display
Indicates the active NAV course. The value is numerically repeated in the course display.

No. 1 Bearing Pointer
Pointer removed if bearing source failed.

No. 2 Bearing Pointer
Pointer removed if bearing source failed.

Course Pointer
Indicates the active NAV course. The value is numerically repeated in the course display.

Lateral Deviation Bar
Indicates airplane deviation from VOR or localizer beam.

Lateral Deviation Scale
Indicates relative deviation.

To/From Indicator
Indicates direction to or from a tuned VOR or selected waypoint. Color matches navigation source.

Bearing Source Indicator
Indicates navigation source selected to obtain bearings.
PFD - VHF NAV - Failure Displays

*Figure 17-46*
Distance Measuring Equipment (DME) System

Description

There are two Distance Measuring Equipment (DME) receivers installed on the Challenger 604, DME 1 and DME 2. The DME systems measure the slant distance between the aircraft and a ground station to a maximum range of 300 nautical miles. Distance information is supplied to the FMSs, the PFDs and the MFDs.

Components and Operation

DME Transceivers

The DME transceivers compute distance for display on PFDs and MFDs and also provide position updating data to the FMSs.

The transceivers transmit, receive and process RF signals to produce slant range to a ground station. The DME frequency range consists of 252 channels in the frequency band of 962 to 1213 MHz, designated as X and Y channels 1 to 126.

DME 1 is powered by DC Bus 1, and DME 2 is powered by DC Bus 2.

Tuning

Each DME is a three-channel transceiver. Channel one is manually tuned by the on-side RTU, the cross-side RTU or by the FMS. Channels two and three are automatically tuned by the FMS and are used for multisensor navigation.

DME Hold

Pushing the DME-H key (on the right side of each RTU) holds the last DME frequency. This permits changing to, and working with, another VOR/LOC station while still receiving DME distance information from the last DME station.

DME Aural Identification

The DME three-letter Morse code identifier is supplied to the audio integrating system. Audio outputs are monitored using the DME 1 and DME 2 switches on the audio control panels. When listening to other NAV idents simultaneously, the DME is recognizable by its higher pitch.
DME Status Page Selection

The DME status page can be selected by pushing the MFD MENU switch on the FMS Control Display Unit, followed by pressing the VOR STATUS line select key. For each DME channel, the following data is displayed:

- received DME ident
- received DME frequency
- received DME slant range

The identifier shown adjacent to the DME label corresponds to the ident received from the DME sensor. The display of an identifier adjacent to the VOR label is determined by the FMS. If a DME is in Hold mode, its frequency is followed with an amber “H”.
MFD - VOR / DME Status Page

Figure 17-47
Controls and Indicators

The DME distance and station identifier are displayed in the lower left corner of the PFD. When DME system information is not valid or unavailable, the DME distance display is removed.

On the PFD, the H annunciator next to the frequency readout indicates that the HOLD mode has been selected.

On the MFD, DME information is displayed on the upper left corner of the HSI and NAV SECTOR format when VOR/LOC is selected as the NAV SOURCE.

On aircraft equipped with “Precision Plus”, DME 1 and DME 2 are continuously displayed on the left and right sides of the MFDs.
NAVIATION SYSTEMS

DME Controls (RTU / Audio Control Panel)

Figure 17-48
DME Displays (PFD / MFD)

**Distance Readout**
Indicates DME distance (slant range maximum 300 NM) to tuned navigation aid.

**DME HOLD** (H) Symbol (yellow)
When DME-H is selected, H replaces NM legend on distance readout.

**Ground Speed Readout** (white)
When VOR is navigation source, readout indicates DME ground speed.
When DME failed, readout and label blanked.

**Multifunction Display (FMS Map Page)**
- **Navigation Source Indicator**
- **Station Identifier**
- **Time-To-Go Display**
- **Distance Display**
- **Nautical Miles (NM)**
- **DME Hold (H) Symbol**

**Multifunction Display (Nav Sector Page)**
- **Cross-Side Course Displays**
- **Primary Flight Display**
- **Pilot's and Copilot's Instrument Panels**

*Figure 17-49*
Automatic Direction Finder (ADF) System

Description

The Automatic Direction Finder (ADF) system is a dual low-frequency radio navigation system (ADF 1 and ADF 2). The receivers are independently tunable in 0.5-kHz increments, in the frequency ranges of 190.0 to 1799.5 kHz and 2179 to 2185 kHz. The transmitting stations can be non-directional beacons (NDBs) or standard AM broadcasting stations.

Components and Operation

ADF Receivers

The ADF receivers supply bearing-to-station and audio outputs to the navigation and audio systems, and digital bus outputs to the Integrated Avionics Processor System (IAPS) and Electronic Flight Instrument System (EFIS).

ADF 1 is powered by the DC essential bus, and ADF 2 is powered by the DC bus 2.

ADF Antenna

The ADF Antenna contains one sense antenna and two loop antennas mounted 90° relative to each other.

ADF Tuning

The ADF receiver is normally tuned by the on-side RTU, but may also be tuned by the cross-side RTU or by the FMS. The audio is controlled by ADF 1 and ADF 2 switches on the audio control panel. A VOICE/BOTH switch filters out the station identification or selects both identification and voice.

When the 1/2 switch on the RTU is pushed, each RTU can control the on-side and cross-side ADF receivers.

ADF Bearing Pointer Selection and Navigation

The BRG pushbuttons on the DCPs allow selection of pilot's side or copilot's side ADF information in the form of bearing pointers. The magenta single bearing pointer displays the direct bearing to the ADF 1 station. The cyan double bearing pointer displays the direct bearing to the ADF 2 station.

Both pointers may be displayed simultaneously on either PFD’s HSI, and on the HSI, NAV SECTOR, and FMS MAP formats of the MFD.
ADF bearings cannot be coupled to course tracking or flight guidance systems. If navigation is being conducted using ADF information, the pilot is responsible to assign heading or course commands using the airplane’s other navigational systems.

**ADF Operation Modes**

The ADF system has two selectable modes of operation: ANT and ADF.

- when ANT is selected on the ADF page of the RTU, the NDB station signal may be received at long range, but no bearing information is available
- when ADF is selected, the reception range for the NDB signal is reduced, but bearing to the station is available

**ADF Failure Indication**

An ADF system failure is displayed as follows:

- the ADF frequency display on the RTU top level page is replaced with dashes
- on the pilot’s and copilot’s PFDs and MFDs, the applicable bearing pointer is removed
- the applicable magenta or cyan bearing source indicator is replaced with a red boxed bearing source indicator

**ADF Self-test**

To conduct the self-test, the ADF receiver must be in the ADF mode with a valid NDB frequency tuned in. The self-test is started by pushing the ADF TEST key on the RTU ADF main page. During the test, the bearing pointer rotates 90 degrees counterclockwise and the tone generator activates. The self-test is completed when the bearing pointer returns to its original bearing.

**Controls and Indicators**

The figures that follow outline the controls and indications relevant to ADF navigation. Refer to Chapter 6 Communications and Chapter 11 Flight Instruments for additional information on the Radio Tuning Unit (RTU) and EFIS displays.
**ADF Bearing Display (PFD)**

*Figure 17-50*

### No. 1 Bearing Pointer

Source Switches:
- Push to select No. 1 source:
  - OFF
  - VOR 1
  - ADF 1
  - FMS 1
  - (FMS 3)

Source indicated on PFD/MFD.

### No. 2 Bearing Pointer

Source Switches:
- Push to select No. 2 (single/dual bar) source:
  - OFF
  - VOR 2
  - ADF 2
  - FMS 2
  - (FMS 3)

Source indicated on PFD/MFD.
ADF Bearing Display (MFD)

*Figure 17-51*
ADF Controls (RTU / Audio Control Panel)

Figure 17-52

**FREQ Change / Radio Page**
- **Key**
  - **Tune** – Push key once to directly tune active frequency with tuning knobs
  - **Radio Page** – Push key twice to select ADF main page

**ADF Mode Key**
- Selects either ADF or antenna functions:
  - **ANT** – Used for range navigation, optimum station tuning, or monitoring.
  - **ADF** – Used to select directional antenna which seeks signal source. Bearing to selected station is displayed on the HSI portion of the primary flight display or the multifunction display.

**Tone Key**
- Selects tone circuit either on or off.
  - **ON** – Superimposes an aural signal on unmodulated carrier waves to aid in precise frequency selection.

**VOICE / BOTH Switch**
- **VOICE** – Station identification CW signals are filtered out of VOR, ILS and ADF audio
  - **BOTH** – Station identification and voice signals are audible

**ADF Receive Switches**
- Press to monitor selected ADF receiver.
  - Press again to deselect ADF receiver audio.
  - Rotate to increase volume

**RTU (Pilot Shown)**

**AUDIIO CONTROL PANELS**
Air Traffic Control (ATC) Transponder System

Description

The ATC Transponder system is an automatic altitude and identification reporting unit which responds to ground ATC interrogators and airborne traffic alert and collision avoidance system (TCAS) interrogators.

There are two Air Traffic Control transponders, ATC 1 and ATC 2. The transponders have three modes of operation:

• Mode A - aircraft identity reporting
• Mode C - altitude reporting
• Mode S - data links with other mode C and S transponders for the traffic collision avoidance system (TCAS)

Components and Operation

Transponder

The solid-state transponders receive and decode air traffic control interrogations and reply automatically. The system can receive but cannot reply to interrogations when on the ground.

The ATC 1 system is powered by the DC Essential Bus, and the ATC 2 system is powered by DC Bus 2.

Antennas

Each transponder system has two paired antennas. Each system has an upper and lower antenna located on the forward fuselage.
Controls and Indicators

ATC Selector Knob

The ATC selector knob is located on the REVERSIONARY / INHIBIT panel of the center pedestal. The selector has three positions: 1, STBY and 2. When ATC 1 transponder is selected, it uses altitude information from ADC 1 to respond to mode C and mode S interrogations. ATC 2 receives altitude information from ADC 2. When either transponder is selected, the RTU four-digit identification code turns green. When in STBY, the RTU code is white.

NOTE

In RVSM airspace, the pressure altitude source for the transponder must be the same as the pressure source used by the automatic altitude control system (i.e., the flight director and autopilot). If flight director 1 is in use, select ATC 1 as the transponder. If flight director 2 is in use, select ATC 2 as the transponder.

Code Selection

Selection of ATC identification code and altitude reporting are performed via the ATC Main Page on the RTUs. The TUNE page on the FMS permits manual selection of the ATC code.
Transponder Controls (RTU)

Figure 17-53
Transponder Controls (Reversionary / Inhibit Panel)

Figure 17-54
Traffic Alert and Collision Avoidance System (TCAS)

Description

The TCAS is an airborne traffic surveillance system that provides collision avoidance alerts and conflict resolution cues to pilots. Operating with the Mode-S transponder, interrogations are transmitted, responses from other similarly equipped aircraft are received and analyzed, potential traffic threats are identified and displayed, and conflict resolutions are presented visually and aurally.

TCAS monitors a radius of approximately 5 to 40 NM around the aircraft. The TCAS transceiver transmits mode-C and mode-S transponder interrogation signals and monitors all replies. Internal processing determines the range, bearing, and altitude of each transponder-equipped aircraft within range. When a conflict exists, the TCAS generates traffic advisory (intruder alert), resolution advisory (recommended vertical escape maneuver), and/or synthesized-voice audio outputs. When an intruder aircraft is also equipped with a functioning mode-S transponder, the TCAS uses the transponder to transmit collision avoidance data to that aircraft. This mode-S link allows the two TCAS systems to coordinate conflict resolution between aircraft.

Components and Operation

TCAS Transmitter / Receiver

The TCAS transmitter / receiver contains the TCAS computer, and is installed in the underfloor avionics compartment. It selectively transmits interrogation signals, receives and analyzes the responses, determines if potential conflicts exist, generates collision avoidance solutions, and formats the data to visually and/or aurally present that information to the pilots.

The TCAS transmitter / receiver receives bearing information from the TCAS directional antenna on the top of the fuselage, and receives altitude information from the TCAS omnidirectional antenna located on the underside of the fuselage.

Power for the TCAS transmitter / receiver is supplied by the AC Essential Bus.

TCAS Traffic Symbology

The TCAS computer classifies nearby aircraft into one of four types:

- Other traffic (OT)
- Proximate traffic (PT)
- Traffic alert (TA)
- Resolution advisory (RA)
**TCAS MFD Traffic Symbology Display**

*Figure 17-55*

**Traffic Detail:**

- **VS Arrow** (if VS > 500 fpm)
- **Intruder Symbol**
- **ALT Data** (REL/ABS Altitude x 100 feet)

**Intruder Symbology:**

- **RA Traffic**
- **TA Traffic**
- **Proximate Traffic**
- **Other Traffic**

**The following TCAS messages may display on the MFD screens:**

<table>
<thead>
<tr>
<th>Message</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCAS FAIL</td>
<td>TCAS system failure (amber)</td>
</tr>
<tr>
<td>TCAS TEST</td>
<td>TCAS computer is in test mode (white)</td>
</tr>
<tr>
<td>TD FAIL</td>
<td>TCAS data not received (amber)</td>
</tr>
</tbody>
</table>

**The following TCAS messages may display on the PFD screens:**

<table>
<thead>
<tr>
<th>Message</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRAFFIC</td>
<td>RA (red) or TA (amber) intruder detected</td>
</tr>
<tr>
<td>RA FAIL</td>
<td>TCAS data not received (amber)</td>
</tr>
<tr>
<td>TCAS FAIL</td>
<td>TCAS system failure (amber)</td>
</tr>
<tr>
<td>TCAS OFF</td>
<td>TCAS system is off (white)</td>
</tr>
<tr>
<td>TCAS TEST</td>
<td>TCAS computer is in test mode (white)</td>
</tr>
</tbody>
</table>
Other Traffic (OT)

Other Traffic (OT) is non-threat traffic within the TCAS surveillance area. The display of OT symbols on the MFD may be set to on or off. The control for this function is located on the RTU TCAS main display page.

Other Traffic is available for display in variable altitude volumes. The controls for this feature are also located on the RTU TCAS main display page. “NORMAL” mode is the default mode. “NORMAL” mode sets the OT window from between 2700 feet above to 2700 feet below own airplane altitude. Selecting “BELOW” extends the lower portion of the OT window to 9900 feet below own airplane altitude. Selecting “ABOVE” extends the upper portion of the OT window to 9900 feet above own airplane altitude.

Proximate Traffic (PT)

Proximate traffic are non-threat aircraft within ± 1200 feet relative altitude and six NM of own aircraft. Proximate traffic cannot be deselected, and is always shown on the traffic display as an aid to the pilots when visually acquiring TAs and RAs.

Traffic Alert (TA)

The TCAS computer issues Traffic Alerts as appropriate when TA/RA mode is active. TA/RA mode is selected on the TCAS RTU main menu page. Traffic alerts are issued for non-threat intruder aircraft that should be monitored because, depending upon their continued flight path, they may become RA traffic. Traffic alerts are issued aurally and visually on the MFD, starting 20 to 48 seconds before the calculated closest point of approach. The audio message “TRAFFIC, TRAFFIC” is annunciated over the aircraft audio system, and the message “TRAFFIC” shows in yellow below the VSI on the PFD when the system detects TA traffic.

When the TCAS computer is operating in TA ONLY mode, RA traffic shows as TA traffic, and no commanded vertical speeds show on the PFD. TA ONLY mode is selected via the RTU TCAS main display page. “TA ONLY” shows in white on the PFD when the system is operating in TA ONLY mode. “TA ONLY” shows in yellow when the system is operating in the TA ONLY mode and TA traffic is detected.

NOTE

TA ONLY mode is automatically selected when below 1100 feet AGL on takeoff and 900 feet AGL on landing.
Resolution Advisory (RA)

The TCAS computer issues Resolution Advisories as appropriate when TA/RA mode is active. TA/RA mode is selected on the TCAS RTU main menu page. When the system determines a potential threat requires immediate pilot action, a resolution advisory shows on the MFD. The TCAS system gives an RA on the PFD in the form of a vertical speed command designed to increase the separation between the intruding threat aircraft and own aircraft.

Resolution advisories show as red-only, or red-and-green bands. To comply with a resolution advisory, avoid flying vertical speeds within the red banded areas, and fly the vertical speeds within the green banded areas (if presented). “TRAFFIC” shows in red below the vertical speed scale on the PFD when the system detects RA traffic. There are two types of RA: corrective and preventive.

Corrective RA:

A corrective RA is issued if the TCAS computer has determined that corrective action needs to be taken to avoid the threat traffic. The computer displays the vertical speed range to seek and/or avoid on the PFD vertical speed display. Corrective RA audio announcements are issued by the TCAS computer over the cockpit audio system. (See Table 17-12).

Preventive RA:

A preventive RA is issued if the TCAS computer has determined that the current vertical speed will resolve the threat situation. The computer displays the vertical speed range to maintain, and the vertical speed range to avoid, on the PFD vertical speed display. The command “Monitor Vertical Speed” is issued by the TCAS computer over the cockpit audio system.

RA Communication and Coordination

In a case where both aircraft are TCAS equipped, the TCAS communicates with the other aircraft to coordinate evasive strategies. This coordination may occur before an advisory is issued and is calculated for optimum safe separation using the least disruptive maneuver possible. For example, if one aircraft is in a particular vertical speed (VS) profile, it may be advantageous for that aircraft to increase or decrease its VS as opposed to the other assuming an evasive VS. Whatever maneuver is selected, this information is communicated to other aircraft and ground facilities.

If the other aircraft is not TCAS equipped, the corrective or preventive maneuver responsibility is assumed by the TCAS-equipped aircraft, and only the ground facility communication is possible.
## TCAS Vertical Speed Advisories

*Figure 17-56*

<table>
<thead>
<tr>
<th>TCAS ADVISORY</th>
<th>RANGE THRESHOLD (SECONDS)</th>
<th>ALTITUDE THRESHOLD (FEET)</th>
<th>FIXED RANGE THRESHOLD, USED WITH SLOW CLOSURE RATES (NMI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic advisory</td>
<td>V6.04a V7</td>
<td>V6.04a V7</td>
<td>V6.04a V7</td>
</tr>
<tr>
<td>FL200 - FL300</td>
<td>48 48</td>
<td>850 850</td>
<td>1.3 1.3</td>
</tr>
<tr>
<td>FL300 - FL420</td>
<td>48 48</td>
<td>1200 850</td>
<td>1.3 1.3</td>
</tr>
<tr>
<td>Corrective RA</td>
<td>V6.04a V7</td>
<td>V6.04a V7</td>
<td>V6.04a V7</td>
</tr>
<tr>
<td>FL200 - FL300</td>
<td>35 35</td>
<td>600 600</td>
<td>1.1 1.1</td>
</tr>
<tr>
<td>FL300 - FL420</td>
<td>35 35</td>
<td>700 600</td>
<td>1.1 1.1</td>
</tr>
<tr>
<td>Preventive RA</td>
<td>V6.04a V7</td>
<td>V6.04a V7</td>
<td>V6.04a V7</td>
</tr>
<tr>
<td>FL200 - FL300</td>
<td>35 35</td>
<td>700 700</td>
<td>1.1 1.1</td>
</tr>
<tr>
<td>FL300 - FL420</td>
<td>35 35</td>
<td>800 700</td>
<td>1.1 1.1</td>
</tr>
</tbody>
</table>

## TCAS Threat Resolution Parameters

*Table 17-11*
<table>
<thead>
<tr>
<th>TCAS ADVISORY</th>
<th>VERSION 7 AURAL ANNUNCIATION</th>
<th>VERSION 6.04 AURAL ANNUNCIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Advisory</td>
<td>Traffic, Traffic</td>
<td>Traffic, Traffic</td>
</tr>
<tr>
<td>Climb RA</td>
<td>Climb, Climb</td>
<td>Climb, Climb, Climb</td>
</tr>
<tr>
<td>Descend RA</td>
<td>Descend, Descend</td>
<td>Descend, Descend, Descend</td>
</tr>
<tr>
<td>Altitude Crossing Climb RA</td>
<td>Climb, Crossing Climb; Climb, Crossing Climb</td>
<td>Climb, Crossing Climb; Climb, Crossing Climb</td>
</tr>
<tr>
<td>Altitude Crossing Descend RA</td>
<td>Descend, Crossing Descend; Descend, Crossing Descend</td>
<td>Descend, Crossing Descend; Descend, Crossing Descend</td>
</tr>
<tr>
<td>Reduce Climb RA</td>
<td>Adjust Vertical Speed, Adjust</td>
<td>Reduce Climb, Reduce Climb</td>
</tr>
<tr>
<td>Reduce Descent RA</td>
<td>Adjust Vertical Speed, Adjust</td>
<td>Reduce Descent, Reduce Descent</td>
</tr>
<tr>
<td>RA Reversal to a Climb RA</td>
<td>Climb, Climb NOW; Climb, Climb NOW</td>
<td>Climb, Climb NOW; Climb, Climb NOW</td>
</tr>
<tr>
<td>RA Reversal to a Descend RA</td>
<td>Descend, Descend NOW; Descend, Descend NOW</td>
<td>Descend, Descend NOW; Descend, Descend NOW</td>
</tr>
<tr>
<td>Increase Climb RA</td>
<td>Increase Climb, Increase Climb</td>
<td>Increase Climb, Increase Climb</td>
</tr>
<tr>
<td>Increase Descent RA</td>
<td>Increase Descent, Increase Descent</td>
<td>Increase Descent, Increase Descent</td>
</tr>
<tr>
<td>Maintain Rate RA</td>
<td>Maintain Vertical Speed, Maintain</td>
<td>Monitor Vertical Speed</td>
</tr>
<tr>
<td>Altitude Crossing, Maintain Rate RA (Climb and Descend)</td>
<td>Maintain Vertical Speed, Crossing Maintain</td>
<td>Monitor Vertical Speed</td>
</tr>
<tr>
<td>Weakening of Initial RA</td>
<td>Adjust Vertical Speed, Adjust</td>
<td>Monitor Vertical Speed</td>
</tr>
<tr>
<td>Preventive RA (No change in vertical speed required)</td>
<td>Monitor Vertical Speed</td>
<td>Monitor Vertical Speed, Monitor Vertical Speed</td>
</tr>
<tr>
<td>RA Removed</td>
<td>Clear of Conflict</td>
<td>Clear of Conflict</td>
</tr>
</tbody>
</table>

**TCAS Aural Annunciation Table**

*Table 17-12*
TCAS Resolution Advisories (RAs) Inhibits

TCAS resolution advisories and some audio annunciations are inhibited below certain radio altitudes. Radio altitudes and the associated RA status are as follows:

<table>
<thead>
<tr>
<th>RADIO ALTITUDE</th>
<th>RESOLUTION ADVISORY (RA) STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 900 feet AGL descending Below 1100 feet AGL climbing</td>
<td>All RAs inhibited (TA ONLY) and TA audio annunciations inhibited</td>
</tr>
<tr>
<td>Below 1000 feet AGL descending Below 1200 feet AGL climbing</td>
<td>DESCEND RA inhibited</td>
</tr>
<tr>
<td>Below 1450 feet AGL</td>
<td>INCREASE DESCENT RA inhibited</td>
</tr>
</tbody>
</table>

**TCAS RA Inhibits**

*Table 17-13*
Controls and Indicators

RTU Controller

The TCAS is controlled by the RTUs. The TCAS Main Display Page can be selected from the Top Level Display by pressing the TCAS line select button on the right side of the RTU display.

TCAS Mode Select Key

AUTO – Traffic resolution indication automatically appears on vertical speed indication.

STBY – Standby.

TA ONLY – TRAFFIC indication on PFD indicates amber and flashes for TA indication.

Altitude Tag Key

Used to select altitude readout type on MFD.

REL – Relative to own aircraft altitude.

ABS – Altitude reference is corrected barometric altitude. ALTXXX displays on MFD.

TCAS TEST Key

Used to initiate TCAS self-test. Takes normally about 8 seconds to complete

Note: the TCAS test is disabled with the airplane in the air

TCAS Main Page

Used to select TCAS modes and display formats accessed through TCAS key on top level page

Traffic Display Select Key

Used to select display mode: ON – Displays all transponder-equipped traffic (threat, proximate and other).

OFF – Displays threat traffic only

Altitude Range Select Key

Used to select relative range values:

NORM – -2700 feet to +2700 feet

ABOVE – -2700 feet to +9900 feet

BELOW – -9900 feet to +2700 feet

RETURN Key

Used to return to top level page

TCAS Controls (RTU)

Figure 17-57
MFD TCAS Displays

The altitude, relative position, distance and vertical speed of mode C or mode S transponder-equipped aircraft are displayed on the following MFD formats:

- MFD TCAS format
- MFD NAV SECTOR format, when the TFC button is pushed on the DCP
- MFD FMS MAP format, when the TFC button is pushed on the DCP

The TFC button operates as follows:

- if the MFD is in NAV SECTOR or FMS MAP format at a range of 50 NM or less, pushing the TFC button alternately selects or removes the clock position hash marks and traffic display
- at MFD ranges greater than 50 NM in NAV SECTOR or FMS MAP format, pushing the TFC button once removes the traffic display. Pushing the TFC button a second time automatically displays the MFD TCAS format at 10 NM range
- if the MFD is in HSI or PLAN MAP format, pushing the TFC button automatically displays the TCAS format at 10 NM range
PFD TCAS Displays

Resolution advisories are displayed on the vertical speed indicator (VSI) portion of the PFD. The VSI shows the appropriate vertical maneuver required to avoid a conflict.

TCAS Message Area
- TRAFFIC - RA (red) or TA (amber) intruder detected.
- TCAS FAIL (amber) - Indicates TCAS failure.
- TCAS RA FAIL (amber) - Indicates TCAS resolution advisory failure.
- TA ONLY (white) - Indicates that TCAS has been selected to traffic advisory mode.
- TCAS OFF (white) - Indicates that TCAS has been selected to standby mode.

Traffic Resolution Advisory Indication on Vertical Speed Scale
- Red Band – Indicates that pilot is advised to fly out of, or not to enter, indicated vertical speed range (corrective/preventive RA).
- Green Band – Advises pilot of vertical speed range (corrective RA) to attain to avoid traffic.
Self-Test

The TCAS self-test is initiated from the RTU TCAS main page by pushing the TEST line select key. The following indications should be evident during the test:

- PFD and MFD display “TCAS TEST”
- Each PFD displays flashing red “TRAFFIC” and vertical traffic resolution cue on the VSI (red/green)
- MFD traffic display shows the TCAS self-test pictorial representation. The display should show four intruder symbols as follows:

TCAS Test
Indicates TCAS test has been selected

TCAS Test PFD and MFD Indications

Successful test completion is indicated by an aural, “TCAS SYSTEM TEST OK” voice message. An unsuccessful test will give a “TCAS SYSTEM TEST FAIL” aural message.
Global Positioning System (GPS)

Description

The GPS is a space-based navigation system that provides highly accurate three-dimensional position, velocity and time information to ground or aircraft receivers.

The GPS is a sensor used by the flight management system to compute an accurate position. All GPS data is accessed through the FMS CDU.

The GPS has three main segments:

- space segment
- control segment (ground)
- user segment

Space Segment

The space segment of the GPS is made up of 24 NAVSTAR satellites. There are 21 operational satellites at all times and three are spares. The satellites:

- are in a 10,900-mile-high orbit
- are in six orbital planes with 3 to 4 satellites in each plane
- have a 12-hour orbit
- are spaced to provide a minimum of 4 satellites in view at all times
- have atomic clocks and transmit on two coded frequencies

Control Segment

The control segment monitors the space segment and adjusts the orbits when operationally required. It includes five ground stations around the world. One is the master control station and the others are monitor stations.

The monitor stations passively track all satellites in view and acquire range data from them. This data is forwarded to the master control station. The master control station uses the data from the monitor stations to estimate satellite orbit and clock data. This information is transmitted to the satellites and down to the users as a navigation message.

User Segment

The FMS uses the signal from the GPS satellites as a navigation sensor to upgrade its own position. A minimum of three satellites is required for two-dimensional calculations and four satellites are required for three-dimensional calculations.
Components and Operation

GPS Receivers

Dual GPS receivers are installed in the Challenger 604 (GPS 1 and GPS 2). The GPS receivers process signals from the orbiting constellation of GPS satellites to determine geographic position. Each of the GPS receivers is capable of receiving up to 12 satellites. Tuning is fully automatic, and does not require any pilot input/action.

GPS 1 is powered by DC Bus 1, and GPS 2 is powered by DC Bus 2.

GPS Sensors and Navigation

The flight management system (FMS) is the interface between the GPS receivers and the aircraft navigation systems. GPS position information is supplied to each FMS by the on-side GPS receiver (GPS 1 supplies FMS 1, and GPS 2 supplies FMS 2). The FMS then calculates the integrated navigation solution (FMS position) using a combination of GPS, DME/DME, VOR/DME, and IRS sensor information.

In the event that on-side GPS information is not available, the FMS will automatically use cross-side information, and display the GPS REVERTED message on the FMS CDU.

GPS RAIM

GPS Receiver Autonomous Integrity Monitoring (RAIM) is used to assure that the GPS position information meets the required accuracy:

- 4 NM oceanic/remote
- 2 NM en route
- 1 NM terminal
- 0.3 NM final approach

The current RAIM accuracy limit and measured accuracy limit are displayed on the MFD LRN STATUS page 2/2. The measured accuracy limit indicates the maximum estimated error based on measurement inconsistency. Unless an error is detected by RAIM, this value is always less than the RAIM accuracy limit.

When an error is detected, it is annunciated on the MFD LRN STATUS page 2/2. If the detected error cannot be predicted to be less than the required integrity threshold, GPS is removed from the navigation solution.

If no error is detected by RAIM, the probable GPS error is shown. This is a statistical number based on normal satellite error characteristics.
### LRN STATUS (Page 2/2)

**GPS 1**

- **Position**: N32°40,87 W116°59,50
- **Status**: 071°/405
- **Mode**: NAV
- **SATELLITES**: 8
- **MEAS ACCURACY LIMIT**: 0.10 NM
- **RAIM ACCURACY LIMIT**: 0.10 NM
- **PROBABLE ERROR**: 0.05 NM

**GPS 2**

- **Position**: N33°40,87 W116°59,50
- **Status**: 071°/405
- **Mode**: NAV
- **SATELLITES**: 8
- **MEAS ACCURACY LIMIT**: 0.10 NM
- **RAIM ACCURACY LIMIT**: 0.10 NM
- **PROBABLE ERROR**: 0.05 NM

**GPS 2**

- **Position**: N53°43,30 W000°12,30
- **Status**: 315°/254
- **Mode**: NAV
- **SATELLITES**: 12
- **MEAS ACCURACY LIMIT**: 0.23 NM
- **RAIM ACCURACY LIMIT**: 0.41 NM
- **PROBABLE ERROR**: 0.05 NM

**GPS 2**

- **Position**: N53°43,30 W000°12,30
- **Status**: 315°/254
- **Mode**: NAV
- **SATELLITES**: 7
- **MEAS ACCURACY LIMIT**: 0.40 NM
- **RAIM ACCURACY LIMIT**: 0.46 NM
- **RAIM DETECTED ERROR**

**NORMAL RAIM INDICATIONS**

**RAIM DETECTED ERROR ON GPS 2**

---

**MFD LRN STATUS (Page 2/2)**

*Figure 17-62*
In the terminal environment, RAIM accuracy is indicated by the white TERM message below the NAV SOURCE display of the PFD.

On final approach, RAIM accuracy is indicated by the white GPS APPR message below the NAV SOURCE display of the PFD.

If RAIM accuracy does not reach final approach tolerances, the yellow NO APPR message is displayed below the NAV SOURCE display of the PFD.
For a complete listing of GPS and RAIM messages, see the “Collins FMS-6000 for the Challenger 604” Pilot’s Guide.

**FMS CDU RAIM Message**

*Figure 17-64*
Controls and Indicators

FMS-GPS Control Page

The GPS control page allows the pilot to monitor the FMS aircraft position in relation to the GPS. The position differential (POS DIFF) is shown in direction and magnitude from the FMS position.

To alternately enable or disable use of a specific GPS sensor, push the left side line-select key of that sensor. Enabled sensors show in large green font, and disabled sensors show in small white font.

The DEST and ETA entries are those of the active flight plan. You can manually enter changes to see if RAIM is available for other destinations and/or arrival times.

Satellite Deselect

Individual satellites can be deselected from use by entering the identifier for the satellite in the FMS. This function would be used if the satellite is NOTAMed under test. When deselected, the FMS ignores the data from the satellite. Deselected satellites are not included in the predicted RAIM computations.
Flight Management System (FMS)

Description

A dual flight management system (FMS) provides integrated cockpit and flight management functions. Each flight management system (FMS 1 and FMS 2) is composed of a Control Display Unit (CDU) in the cockpit and a Flight Management Computer (FMC) in the underfloor avionics equipment bay. A single Data Base Unit (DBU) allows data to be uploaded or downloaded to all of the FMCs. A third flight management system (FMS 3) may be installed as a customer option.

The FMS cockpit management functions include:
- Navigation sensor control
- Radio tuning
- Multifunction display (MFD) control menus
- Navigation database management
- Control and management of the data loader
- Management of the data interface with external systems (AFIS)

Flight management functions include:
- Continuous calculation of the integrated navigation solution
- Flight plan inputs by the crew
- Lateral flight plan point-to-point navigation
- Vertical navigation
- Performance calculation
- Lateral/vertical steering commands to the flight control system

The third FMS, if installed, is defined as a “hot spare” and is fully functional when selected.

For a comprehensive description of FMS functions and operation, refer to the “Collins FMS-6000 for the Challenger 604” Pilot’s Guide.
Components and Operation

**FMS Control Display Units (CDUs)**

The FMS CDU is the cockpit interface of the Flight Management System. It allows the flight crew to input, modify, and execute flight plans, as well as calculate aircraft performance. It also acts as a radio tuning interface through a dedicated TUNE page, and is the primary means of control for most navigation sensors. The CDU controls certain information displays on the MFDs, and advises the flight crew of FMS system status through a variety of message formats.

**Power Supplies**

- The No. 1 (left) CDU is powered by DC Bus 1
- The No. 2 (right) CDU is powered by DC Bus 2
- The No. 3 CDU is powered by the DC Essential Bus

In the event of loss of normal electrical power, the No. 1 CDU will be powered by the BATT BUS when the ADG deploys.

**Scratchpad and Line Select Keys**

The FMS CDU is arranged so that all flight crew inputs are conducted through a “scratchpad” which allows easy data input and retrieval. An alphanumeric keypad permits entry of all relevant data to the scratchpad, and line-select keys are used to insert the data in the appropriate area of the display page. Most information contained on the display page can similarly be “line-selected” and is then transferred to the scratchpad for reference or modification.

**Execute Key**

Most entries made into the flight plan or performance calculations are considered modifications to the active flight plan, and must be executed using the EXEC function key before they become active components of the flight plan. This permits the flight crew to cross-check any modifications prior to committing them to the active flight plan.

**Function Keys**

Dedicated function keys allow direct access to certain flight management or cockpit management features of the FMS.

Certain CDU displays have multiple pages as indicated in the top right corner of the display screen. Access to the other pages is achieved using the PREV and NEXT function keys.
MFD Function Keys

Three function keys relate specifically to MFD displays. The MFD DATA and MFD MENU keys control the type of information available on the MFD. The MFD ADV key allows access to multiple pages of MFD information. When the PLAN MAP format of the MFD is in use, the MFD ADV key allows the flight crew to view the waypoints of their flight plan.

FMS Control Display Unit (CDU)

*Figure 17-66*
Flight Management Computers (FMCs)

The flight management computers are installed in the Integrated Avionics Processor System (IAPS). The FMCs receive flight crew inputs from the CDU, and perform all the flight management and cockpit management functions. Each FMC contains a navigation database, which it uses to execute the active flight plan.

Integrated Navigation Solution

The integrated navigation solution is the FMS-calculated position of the aircraft in latitude and longitude. The FMCs receive data from all aircraft navigation sensors, and continuously calculate the integrated navigation solution. GPS is normally the highest priority sensor used in this position calculation, but a combination of DME/DME, VOR/DME, and IRS information is also used according to predetermined blending algorithms. The FMC rejects sensor data that is not valid, and advises the flight crew of position determination errors through the CDU message system.

Flight Plan Tracking

By comparing the integrated navigation solution to the navigation database and the active flight plan, the FMC calculates and displays the aircraft’s position relative to the flight plan routing, and issues steering commands to the flight control computers to track the lateral and vertical components of the active flight plan.

Data Base Unit (DBU)

The Data Base Unit (DBU) is a panel-mounted data loader with a disk drive that is used with the FMS system and the maintenance diagnostic computer. The FMS system uses the DBU to load database updates from diskettes into the FMS computers. The Integrated Avionics Processor System (IAPS) maintenance diagnostic computer uses the DBU to upload maintenance tables from diskette or download maintenance data files to diskette. High-density and double-density 3-1/2 inch diskettes are acceptable. The unit has a “drive in-use” indicator and a disk eject button.

The navigation database is loaded into each FMC individually through the DBU. Flight plans and waypoints may also be loaded or stored on disk through the DBU.
Data Base Unit

Figure 17-67

DBU

Used to revise FMS NAV data base upload / download data from AFIS maintenance diagnostic computer.
Synchronized / Independent Operation

Dual-FMS systems have provision for operation in synchronized (SYNC) or independent (INDEP) modes. By default, dual-FMS airplanes power up in SYNC, and triple-FMS airplanes power up in INDEP mode.

In the triple-FMS configuration, the flight crew decides which two FMSs to synchronize. FMS 3 is selected using the FMS reversionary selector switch (see Figure 17-69). SYNC / INDEP mode selections are made on the FMS CONTROL page of the CDU.

When two FMSs are synchronized, they share the following parameters:

- Flight Plan edits
- Performance initialization
- Leg sequencing
- Active database selection
- Fix entries
- Deselection of navaids
- Performance mode selection
- MAG / TRU display mode
- Thrust management

Parameters that are not synchronized include:

- FMC position initialization
- Selection of left / right sensors

When the FMSs are operated in INDEP mode, all parameters must be manually entered in each FMS.

For additional information about SYNC / INDEP operation, see the “Collins FMS-6000 for the Challenger 604” Pilot’s Guide.
Controls and Indicators

FMS Tune Inhibit

The FMS may be inhibited from tuning the radios by selection of the FMS TUNE INHIB switch/light located on the Reversionary/Inhibit panel.

FMS Tune Inhibit Switch/Light - Disables radio tuning from FMS CDU
FMS TUNE INHIB Light Illuminates when FMS auto tune inhibit selected

FMS TUNE INHIB Switch/Light

Figure 17-68
FMS 3 Reversionary Selector

FMS 3 may be selected using the FMS 3 reversionary selector switch on the center pedestal. FMS 3 replaces FMS 1 or FMS 2 when the rotary selector switch is moved to the position 1 or 2 respectively.
FMS Message Displays

The FMS messages are displayed in several locations. Typically, a message remains displayed as long as the condition that generated the message persists. For a complete description of messages and message categories, see the “Collins FMS-6000 for the Challenger 604” Pilot’s Guide.

CDU Messages

Messages may appear in the scratchpad or in the message line immediately below the scratchpad. Selection of the MSG function key cycles the CDU display to a dedicated message page, where new and old messages may be reviewed.
PFD Messages

FMS messages also appear on the PFD, immediately under the NAV SOURCE display (when FMS is the NAV SOURCE). Additionally, certain PFD messages may be displayed in the center of the HSI.

**A1 and A2 FMS Messages**
- Only highest priority MSG displayed if more than one active.
- Only displayed if FMS is the NAV source shown on that PFD. MSGs will clear if cause ceases to exist.
- A1 MSGs will flash for 5 secs then remain on.
- A2 MSGs two types:
  1. Clearable using "MSG" key.
  2. Non-clearable until condition(s) clear.

**NO FLIGHT PLAN**
FMS that is selected as NAV source has no active flight plan

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*PFD Message Display*  
*Figure 17-71*
**MFD Messages**

FMS messages may be displayed on the lower portion of the MFD display area.

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**MFD Message Display**

*Figure 17-72*
FMS Color Conventions

The FMS color conventions are outlined in the following table. The EFIS FMS colors have been included for reference only.

<table>
<thead>
<tr>
<th>COLOR</th>
<th>FMS CDU USE</th>
<th>EFIS USE (REFERENCE ONLY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED</td>
<td>Not used.</td>
<td>Warnings.</td>
</tr>
<tr>
<td>YELLOW</td>
<td>Cautions usually requiring timely pilot intervention.</td>
<td>Cautions.</td>
</tr>
<tr>
<td>GREEN</td>
<td>Active selections VNAV data on legs page.</td>
<td>Safe/normal operation altitudes on map.</td>
</tr>
<tr>
<td>CYAN</td>
<td>Secondary information (e.g. from waypoint, page titles, and route plan legs).</td>
<td>Legends, pilot-selected values, secondary map data.</td>
</tr>
<tr>
<td>MAGENTA</td>
<td>Active leg (&quot;to waypoint&quot;).</td>
<td>“To waypoint”, fly-to-reference flight director, airspeed bug, preselect altitude.</td>
</tr>
<tr>
<td>WHITE</td>
<td>Primary information (e.g. flight plan data, down track waypoints, and FPLN and legs ACT or MOD state).</td>
<td>Reference symbols, scales NAV MAP, alternate source sensor, on-side FMS, AFDS armed modes.</td>
</tr>
</tbody>
</table>

FMS Color Conventions Table

*Table 17-14*