12.15 (ATA 34) NAVIGATION

12.15.1 Introduction

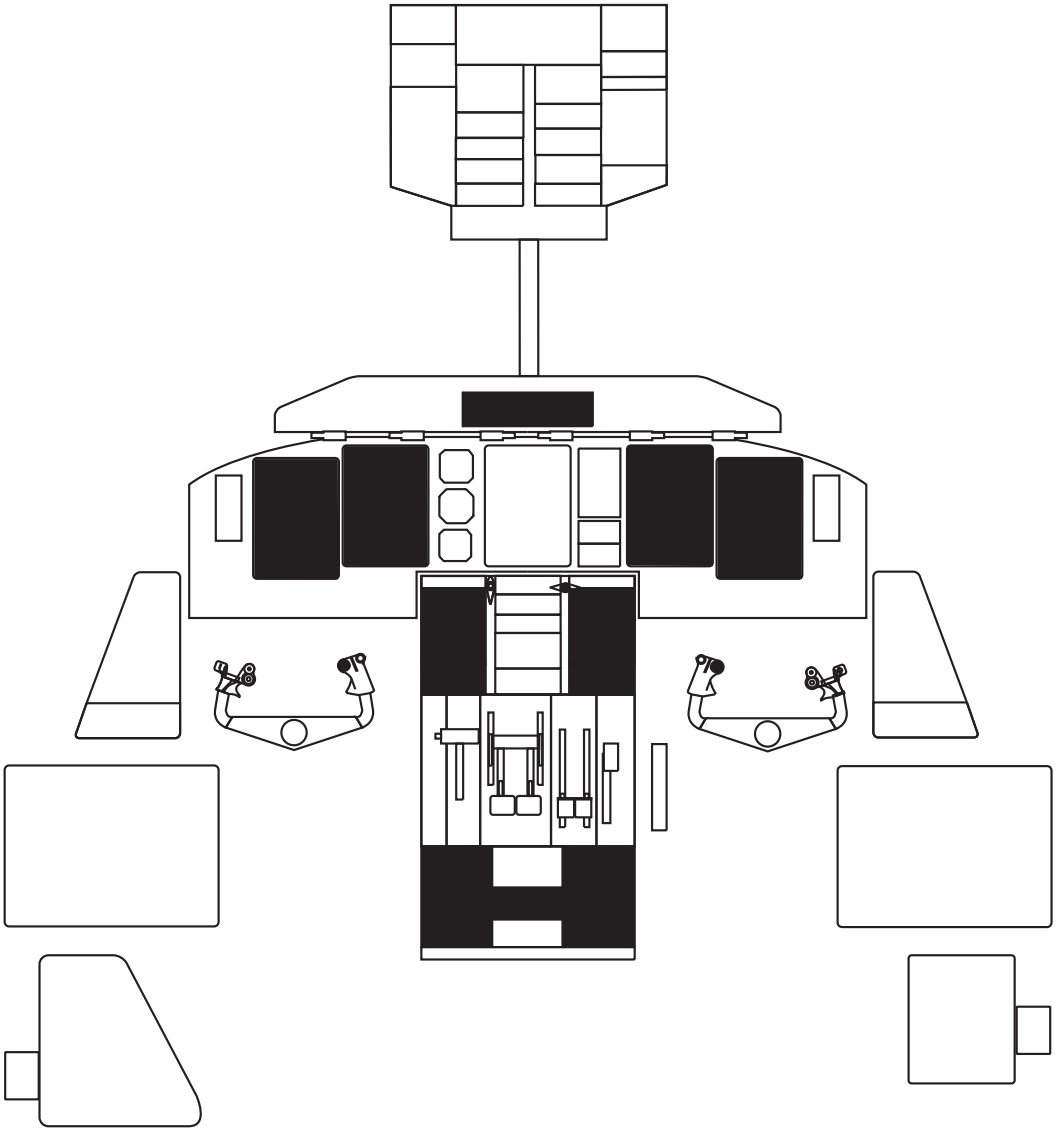
The Dash 8-Q400 has standard navigational equipment allowing it to be fully certified for VFR and IFR navigation.

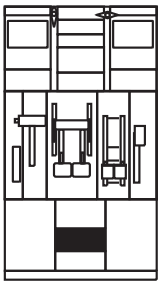
12.15.2 General

Navigation equipment includes:

- Very High Frequency Omni Range (VOR)
- Instrument Landing System (ILS)
- Marker-Beacon
- Distance Measuring Equipment (DME)
- Automatic Direction Finder (ADF)
- Transponder
- Weather Radar
- Flight Management System (FMS)

12.15.3 Controls and Indications - Navigation





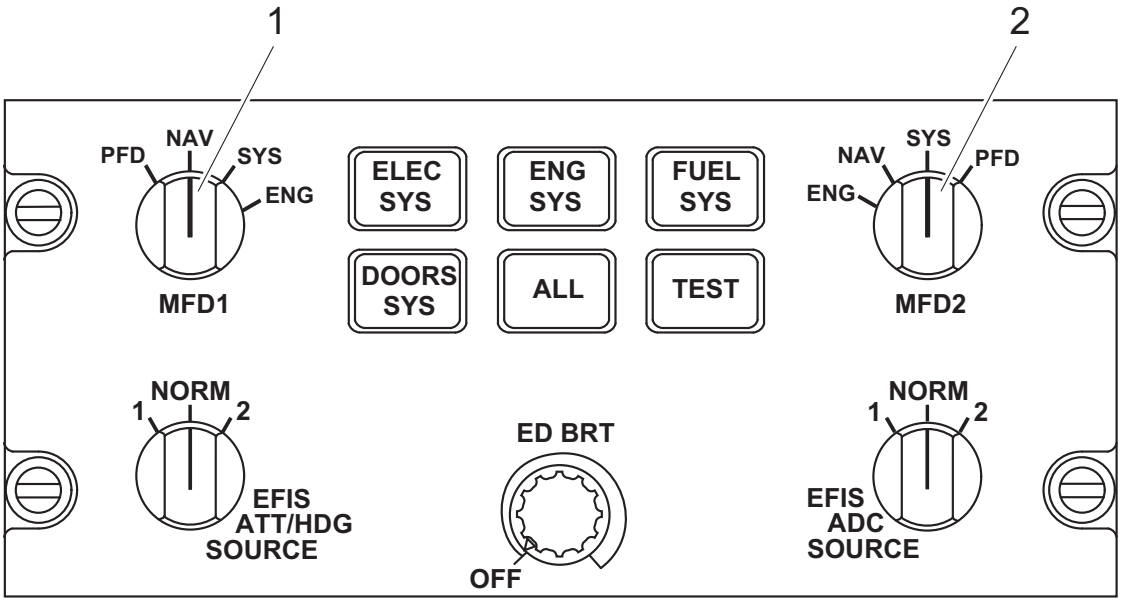
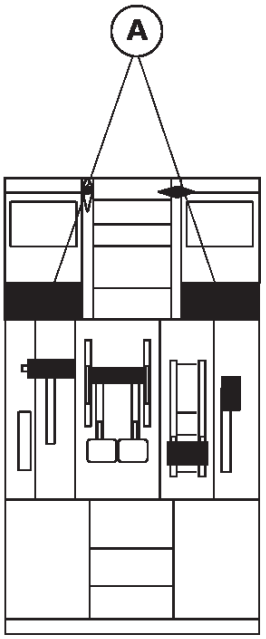


Figure 12.15-1 Engine and System Integrated Display Control Panel (ESCP)

ESCP Callouts pertaining to navigation items

1. **MFD 1 REVISION SELECTOR (rotary action, 4 position)**
   TURN - selectable positions are PFD, NAV, SYS, ENG
   - ESCP provides the pilot with the ability to select any page on the MFD1 and to control the EIS reversion after display failures
   - the MFD1 selector switch is usually set to the NAV position when the pilot is the PF, and to SYS when PNF

2. **MFD 2 REVISION SELECTOR (rotary action, 4 position)**
   TURN - selectable positions are ENG, NAV, SYS, PFD
   - ESCP provides the copilot with the ability to select any page on the MFD2 and to control the EIS reversion after display failures
   - the MFD2 selector switch is usually set to the SYS position when the copilot is the PNF, and to NAV when PF



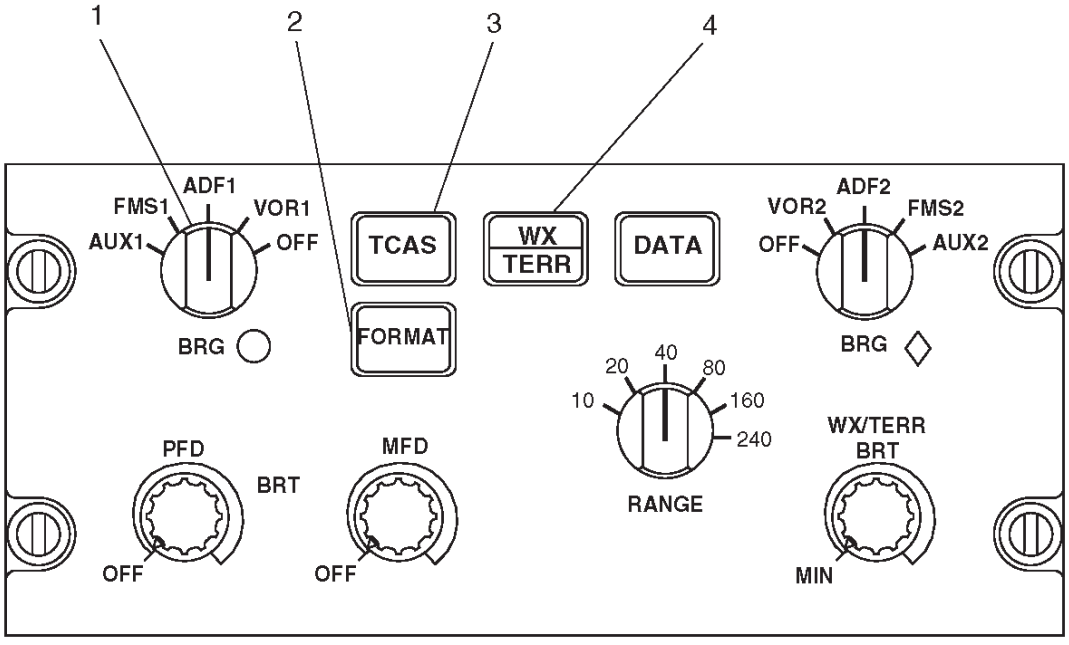


Figure 12.15-2 EFIS Control Panel (EFCP) (1 of 2)

NOTE: DISPLAY INTENSITY (PFD, MPD, BRT Knobs)

Display intensity has been fully evaluated and is adequate in all lighting conditions including bright sunlight. However, the intensity may appear degraded with certain types of sunglasses such as dark and/or polarized lenses.

EFCP CALLOUTS PERTAINING TO NAVIGATION ITEMS

1. **BEARING 1 SELECTOR knob (5 position, rotary action)**

   ROTATE - selects desired navigation source to be displayed by the white, single bar bearing pointer with a white circle, on the PFD
   - selectable positions are labeled OFF, VOR 1, ADF 1, FMS 1 and AUX 1
   - bearing pointer is removed from PFD display when turned OFF
   - selected navigation source is annunciated on the PFD
   - If VOR is selected, but the frequency is either invalid, or an ILS frequency, the pointer will be removed from view
   - If ADF is selected, but the signal of frequency is invalid, the pointer will park at the 90° position
   - If FMS i.e. selected, and the FMS is operating, the pointer will point to the next waypoint
   - AUX is only functional with optional equipment, i.e., MLS

2. **FORMAT PUSHBUTTON (momentary action, 1 second hold)**

   PUSH 1 - ARC mode with VOL/ILS as navigation source

   PUSH 2/3 - the NAV display on MFD changes back to ARC mode with FMS (default selection) as navigation source. This partial compass mode displays ± 45° around the current heading

   PUSH and HOLD (1 sec.) - the NAV display on MFD changes to a FULL mode, A/C centered, oriented with respect to north. Optional navigation data may be displayed in that mode, using the DATA pushbutton, but not the weather radar image

3. **TCAS PUSHBUTTON (momentary action)**

   PUSH 1 - shows TCAS traffic continuously when navigation page is set to arc or map Mode and range is set to 40 nautical miles or less,
   - TCAS range ring indication comes inte view to show continuous indication selection.

   PUSH 2 - automatic mode is activated.

   Note:

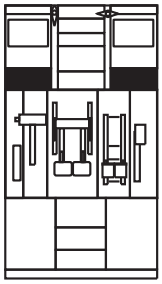
   If the EFCP malfunctions, the TCAS automatic mode is set.

4. **WX/TERR PUSHBUTTON (momentary action)**
   - shows or turns off the display of the radar or Enhanced GPWS (EGPWS) symbology on the MFD NAV page if ARC is selected and Weather/Radar and/or EGPWS are active

   PUSH 1 - removes the weather radar and EGPWS images (but WX/TERR operating mode is still displayed)

   PUSH 2 - displays EGPWS terrain information

   PUSH 3 - displays weather radar information (default selection)



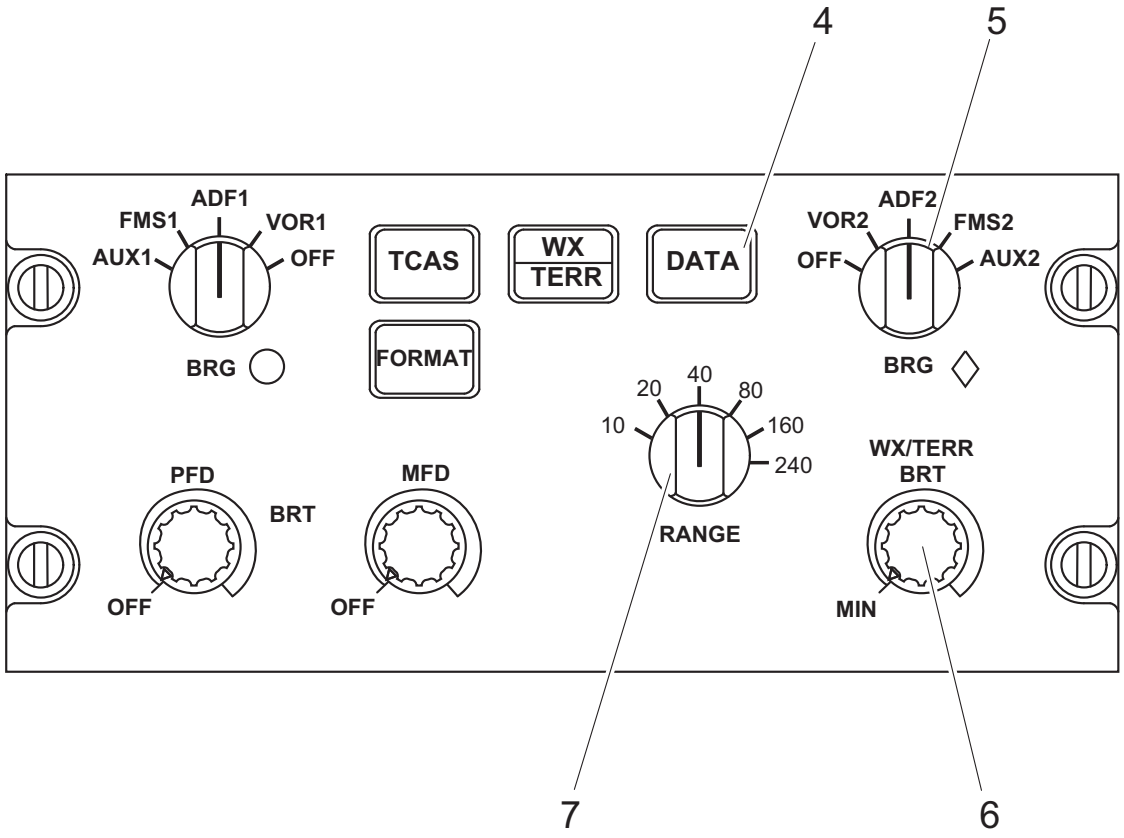


Figure 12.15-3 EFIS Control Panel (EFCP) (2 of 2)

EFCP CALLOUTS PERTAINING TO NAVIGATION ITEMS (cont'd)

4. **DATA PUSHBUTTON (momentary action)**
   - allows the FMS Data selection on MFD NAV page in following sequence:

   PUSH 1 - shows the 10 nearest navigation aids on NAV page
   PUSH 2 - shows the 10 nearest airports on NAV page
   PUSH 3 - Nav aids plus Airports (10 nearest Airports) on NAV page
   PUSH 4 - removes all options (default selection)
   PUSH and **HOLD** (1 sec.) - remove all nav aids plus airports
   - if FMS is off, pushing button flashes white NO DATA message for 5 seconds then removed in place of the NAV/APT reminder

5. **BEARING 2 SELECTOR (5 position, rotary action)**
   - same as BEARING 1 selector except selects VOR2, ADF2, FMS1 and AUX2

6. **WX/TERR RADAR BRIGHTNESS KNOB (rotary action)**
   TURN - adjusts the display brightness of the weather radar or terrain image on the navigation page of the MFD

7. **RANGE SELECTOR (rotary action, 6 position)**
   - selects the ranges on the MFD NAV display for the ARC and PLAN modes
   - selectable positions are 10, 20, 40, 80, 160, 240 nautical miles
   - selection from one position to another modifies the range scale of the radar and the map symbology
   - default selection is 40 nm. A default configuration is set at initialization or each time the NAV position is newly set on the MFD: i.e. partial compass mode (ARC), WXR display ON, No optional Map data display

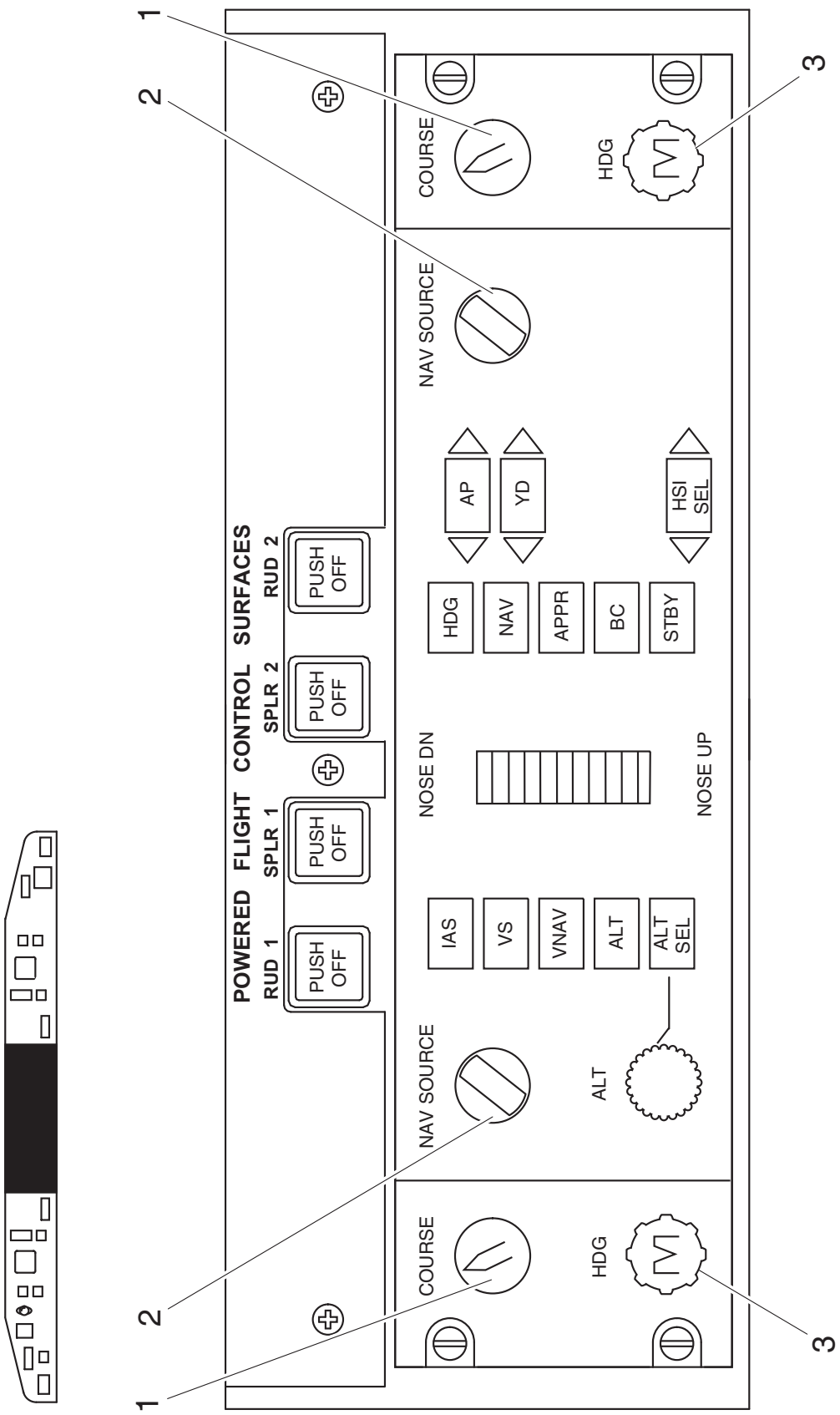


Figure 12.15-4 Flight Guidance Control Panel (FGCP)

FGCP CALLOUTS PERTAINING TO NAVIGATION

1. **COURSE SELECTION KNOB (rotary action)**
   - moves selected course pointer on PFD and MFD
   - digital value of the course is displayed on the PFD
   - variable rate tuning advances the heading several digits when the knob is rotated rapidly

2. **NAVIGATION SOURCE SELECTION KNOB (rotary action)**
   - selects the source to be used for navigation
   - indicated by the navigation source annunciator on the PFD
   - selections from fully counterclockwise to fully clockwise for both knobs are:
     - FMS1/GPS1
     - VOR1/ILS1
     - VOR2/ILS2
   - after each power up the initial position is VOR1 for Side1 and VOR2 for Side2
   - the Flight Data Processing System (FDPS) takes into account the amount of rotation to determine the navigation mode.
   - navigation source selection is dependent upon the aircraft configuration.
   - If both pilots select same nav aid, then the nav source annunciator on both PFDs will change to yellow.
   - If pilot selects a No. 2 nav source, PFD1 nav source annunciator will change to yellow
   - If copilot selects a No. 1 nav source, PFD2 nav source annunciator will change to yellow

3. **HEADING SELECTION KNOB (rotary action)**
   - moves heading bug on PFD, EHSI and on NAV page

AFCS Heading Set Knobs Coupled LH and RH

The left and right heading selector knobs synchronize all heading bugs on the pilot and co-pilot PFDs and MFDs.

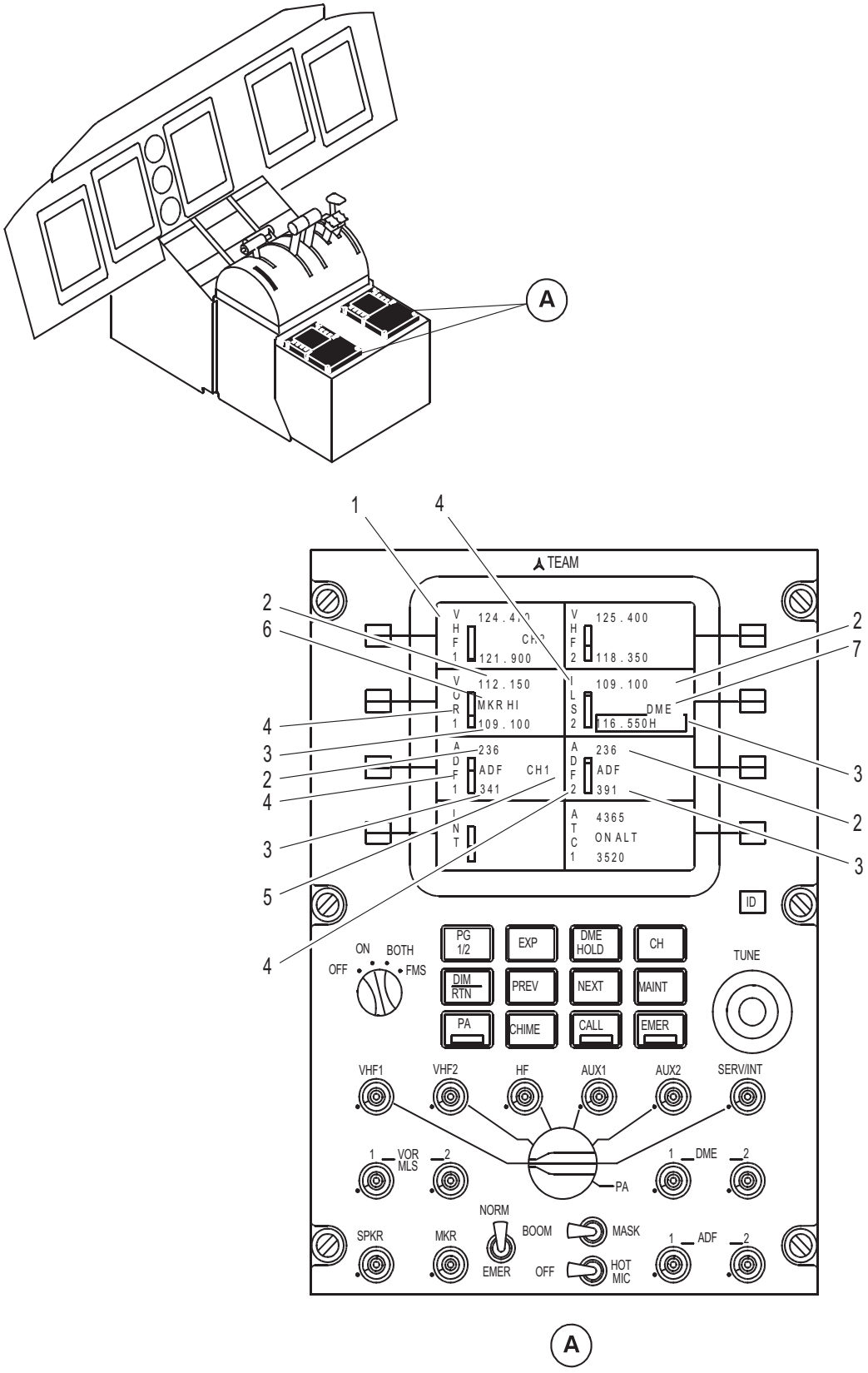


Figure 12.15-5 Audio and Radio Control Display Unit (ARCDU) (1 of 4)

ARCDU CALLOUTS PERTAINING TO NAVIGATION

1. **ACTIVE MATRIX LIQUID CRYSTAL DISPLAY AREA (colored font on black background)**
   - typical first main page shown
2. **ACTIVE FREQUENCY (green)**
   - this is the current frequency in use
   - when the particular navigation system sends valid data to the ARCDU, the digits are displayed in green
   - invalid data or no data displays the digits in white
   - for VOR frequencies only, during FMS auto tuning, the active frequency is replaced with AUTO (green) until the new active frequency is validated, at which time AUTO is replaced by the new frequency
3. **PRESET FREQUENCY (cyan)**
   - when highlighted (cyan digits change color to black digits on cyan background), this area is known as the tune window, or scratchpad
   - invalid data or no data displays FAIL in red text
4. **LABEL (white)**
   - identifies the applicable navigation receiver unit
   - ILS 1 or 2 displayed when the active frequency is a valid ILS frequency
   - VOR 1 or 2 displayed when the active frequency is a valid VOR frequency
5. **CHANNEL MEMORY ANNUNCIATION (green)**
   - indicates active frequency is a stored channel
6. **MRK HI ANNUNCIATION (green)**
   - only displayed when marker beacon sensitivity selected to HI
7. **DME ANNUNCIATION (green)**
   - appears when the DME HOLD is selected

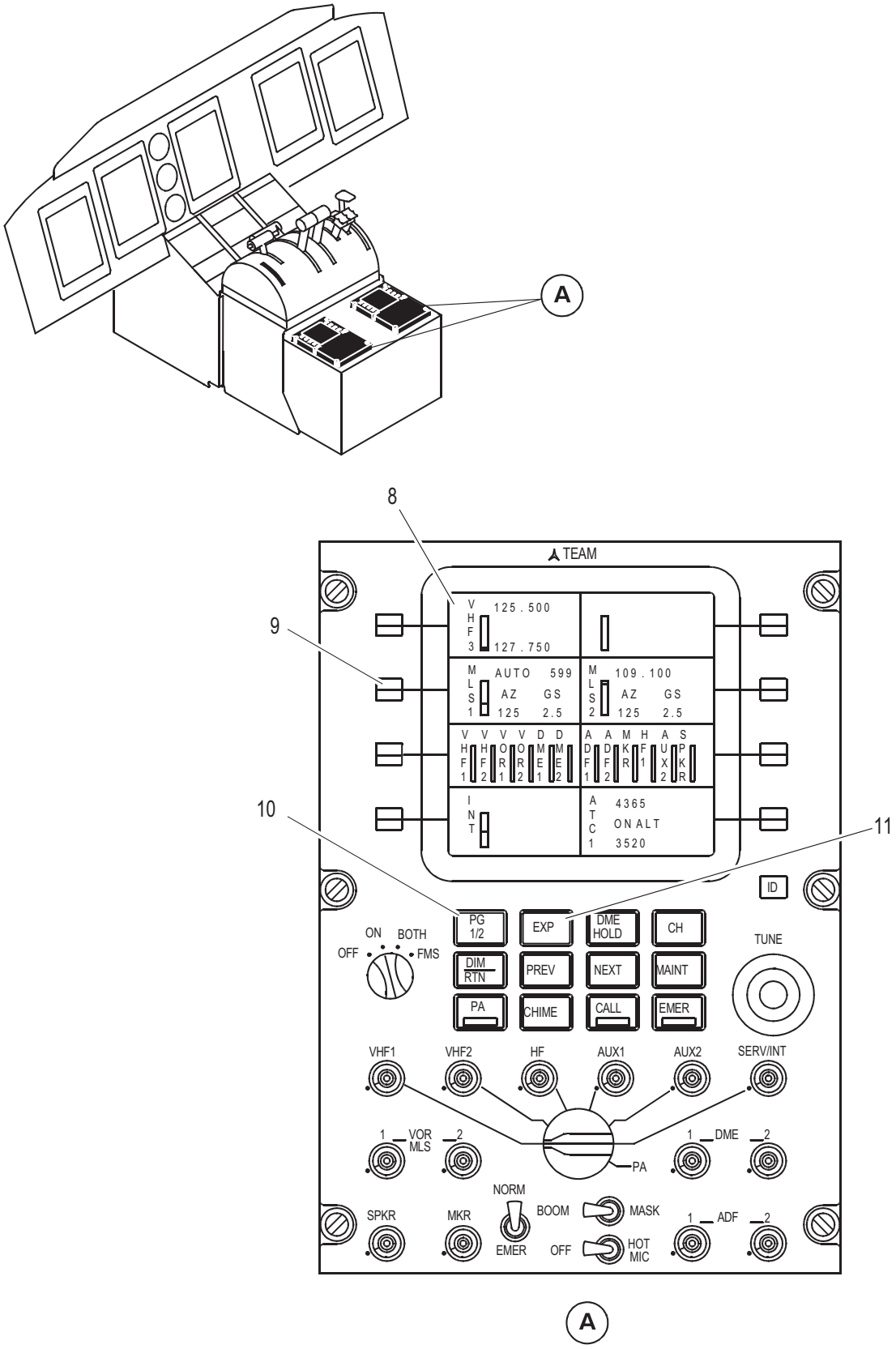


Figure 12.15-6 Audio and Radio Control Display Unit (ARCDU) (2 of 4)

ARCDU CALLOUTS PERTAINING TO NAVIGATION (cont'd)

8. ACTIVE MATRIX LIQUID CRYSTAL DISPLAY AREA (colored font on black background)

- typical second main page shown

9. SIDE KEYS (8, momentary action)

PUSH - allows two types of operations:

- changing of the preset frequency
- swapping of preset and active frequencies

- the above operations are done in conjunction with the TUNE knob
- if there is no action with the TUNE knob within 5 seconds of a side key being pushed, the selection is cancelled
- pushing on another side key within 5 seconds of the first push, will cancel the previous tune window and activate a tune window associated with this side key
- pushing a side key adjacent to a blank area, or adjacent to INT, will have no effect
- when an action on a side key is not allowed, the label associated with this key flashes for 5 seconds
- details on how to tune windows is described on the following pages

10. PG 1/2 KEY (momentary action)

PUSH - allows the display of:

- the second main page when the first main page is displayed
- the first main page when the second main page or any particular page is displayed

11. EXP KEY (momentary action)

PUSH - an action on this key done after an action on a side key, like radio communication (VHF1, etc.), radio navigation (VOR1, ILS 1 etc.), or others, allows the display of the particular pages dedicated to the selected system

- scratchpad selection remains active for a further 5 seconds as soon as the particular page is displayed
- if the EXP key is selected with no previous side key selection, nothing happens

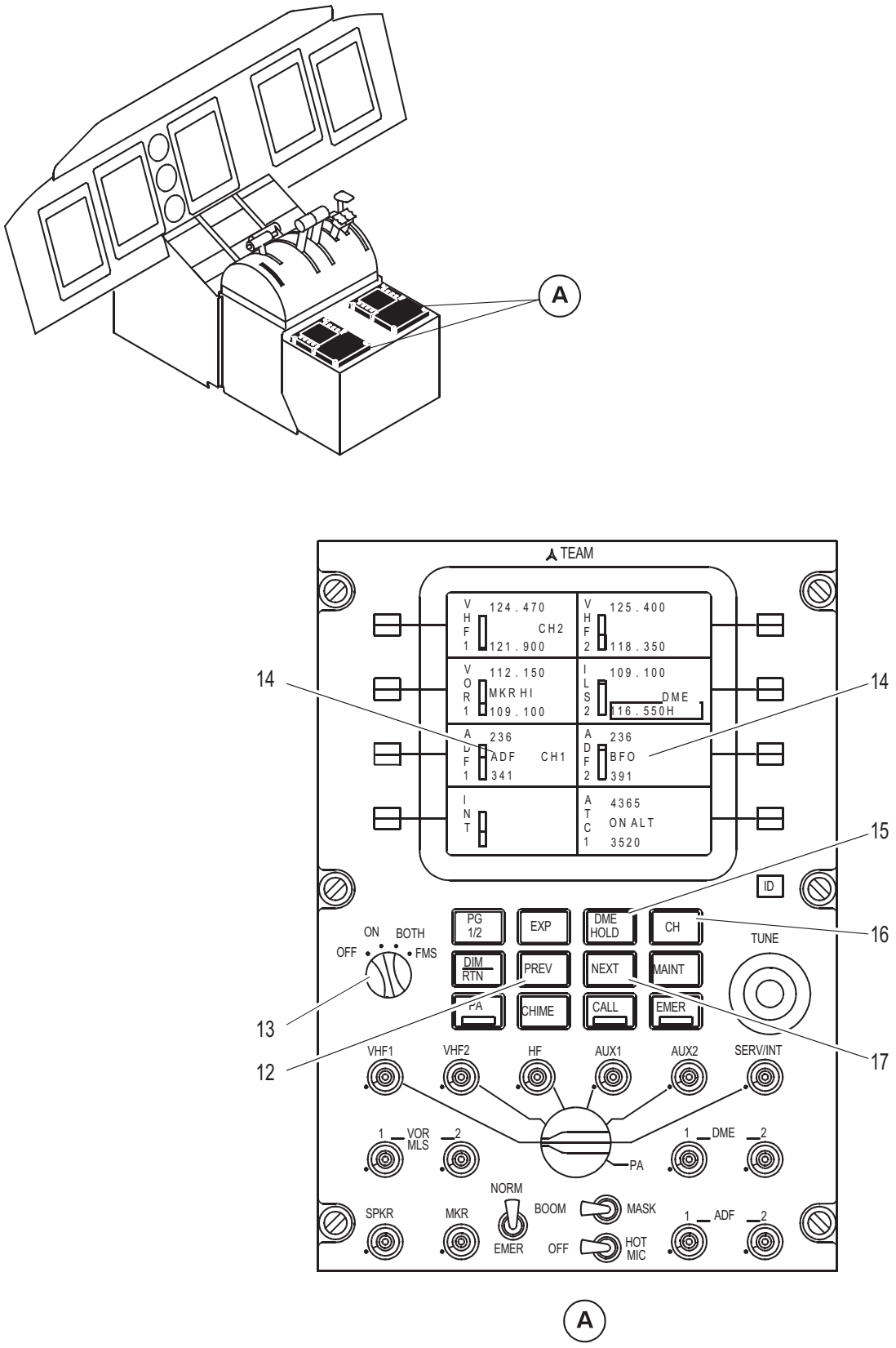


Figure 12.15-7 Audio and Radio Control Display Unit (ARCDU) (3 of 4)

ARCDU CALLOUTS PERTAINING TO NAVIGATION (cont'd)

12. PREV KEY (momentary action)

PUSH - allows the return to the previous page displayed
- if one of the main pages is displayed, the display remains the same
- maintenance function only

13. ROTARY SWITCH (4 position)

OFF - the ARCDU is not powered. The related FMS controls and tunes as a backup
ON - the ARCDU controls and tunes its related radio system
BOTH - the ARCDU controls and tunes its related and opposite radio systems (cross side tuning)
FMS - the FMS controls and tunes its related and opposite radio systems (cross side tuning)

14. ADF MODE ANNUNCIATOR (white)
- indicates the current ADF mode selected
- possible indicated modes are: ADF, ANT, or BFO

15. DME HOLD KEY (momentary action)

PUSH - toggles the DME hold function
- when the DME hold function is enabled, it appears on the display in the VHF NAV window

16. CH KEY (momentary action)

PUSH - key
- toggles the tuning mode of the selected radio between frequency tuning mode and channel tuning mode
- key is active only when one of the following radios is selected: VHF1, 2, 3 or VHF NAV1, 2 or ADF1, 2
- the TUNE knob allows the selection of one of the channels which have previously been programmed

17. NEXT KEY (momentary action)

PUSH - allows the next page to be displayed
- maintenance function only

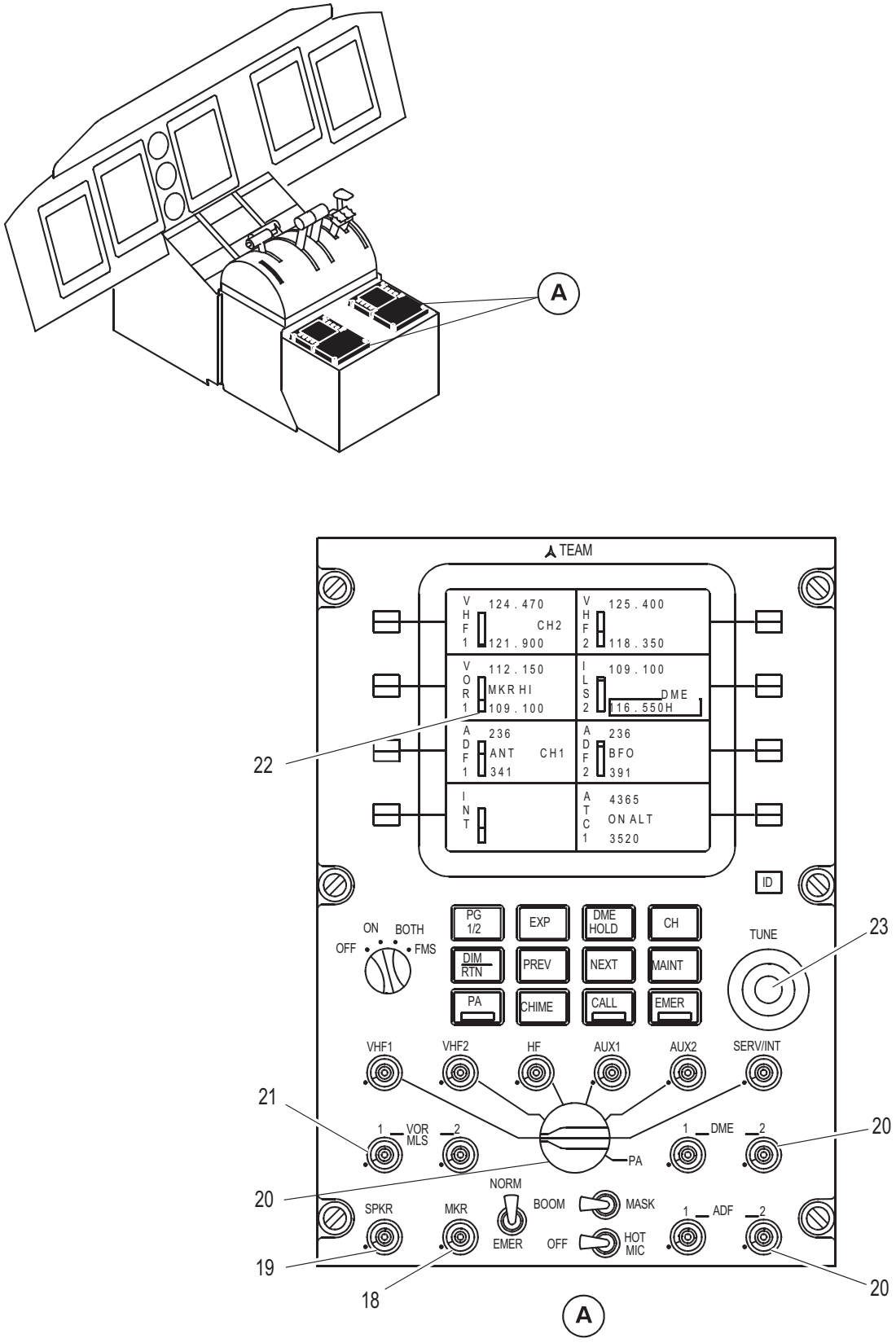


Figure 12.15-8 Audio and Radio Control Display Unit (ARCDU) (4 of 4)

ARCDU CALLOUTS PERTAINING TO NAVIGATION (cont'd)

18. MARKER BEACON PUSHBUTTON SWITCH
(alternate action switch and rotary volume control)

PUSH - turns marker beacon receiver audio ON/OFF
ROTATE - changes audio volume level; displayed on second main page

19. SPEAKER PUSHBUTTON SWITCH
(alternate action switch and rotary volume control)

PUSH - turns overhead speaker ON/OFF
ROTATE - changes speaker volume level; displayed on second main page

20. MICROPHONE/INTERPHONE SELECTOR (rotary action)

- selects communications radios (VHF 1, VHF 2, AUX 1 or 2), interphone communication (SERV/INT) or Public Address Communication Interphone System (PACIS) for transmission
- if receiver (HF, Aux 1 or 2) is not installed, position will not operate

21. NAV PUSHBUTTON SWITCH (6)
(alternate action switch and rotary volume control)

PUSH - turns respective navigation receiver audio ON/OFF
ROTATE - changes navigation audio volume level

- the display area shows the volume level as a vertical bar graph

22. VOLUME LEVEL ADJUST BAR GRAPH (white or green)

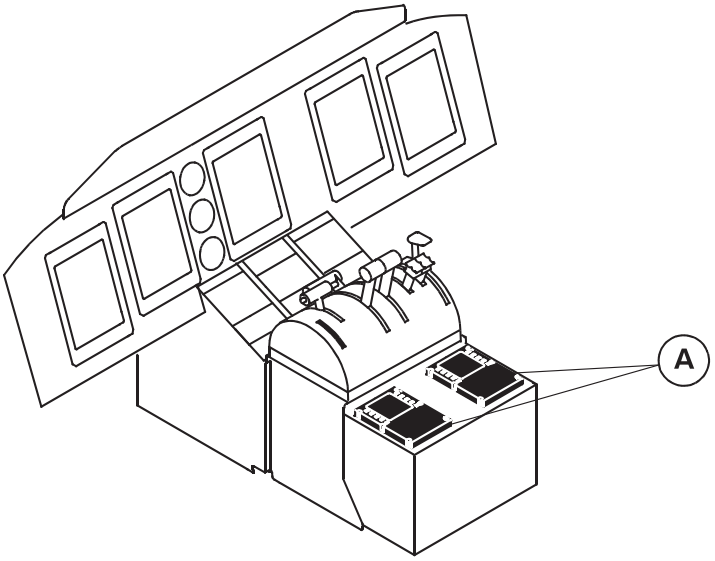
WHITE - the respective audio pushbutton is selected off
GREEN - the respective audio pushbutton is selected on

- the height of the bar graph shows the volume selection level

23. TUNE KNOBS (2, rotary action)

TURN - changes digits of selected parameter

- the outer knob selects the most significant digits
- the inner knob selects the least significant digits
- both knobs have roll over capability
- variable rate tuning advances the frequency several digits when the inner knob is rotated rapidly



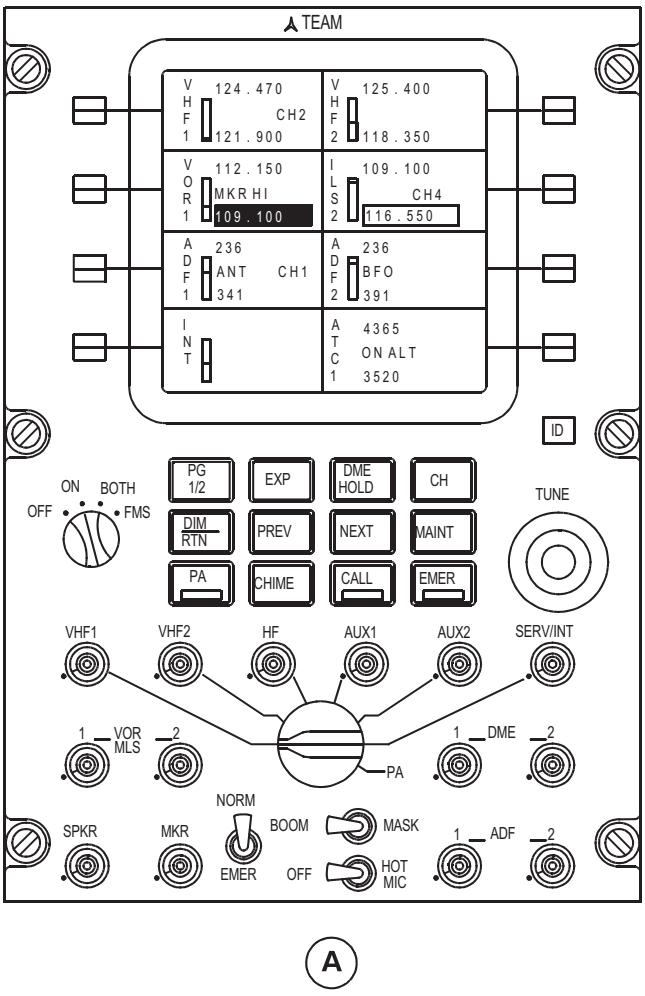


Figure 12.15-9 ARCDU VHF Nav Operation (ARCDU) (1 of 4)

ARCDU VHF NAV FREQUENCY SELECTION

Switching between Active and Preset Frequencies

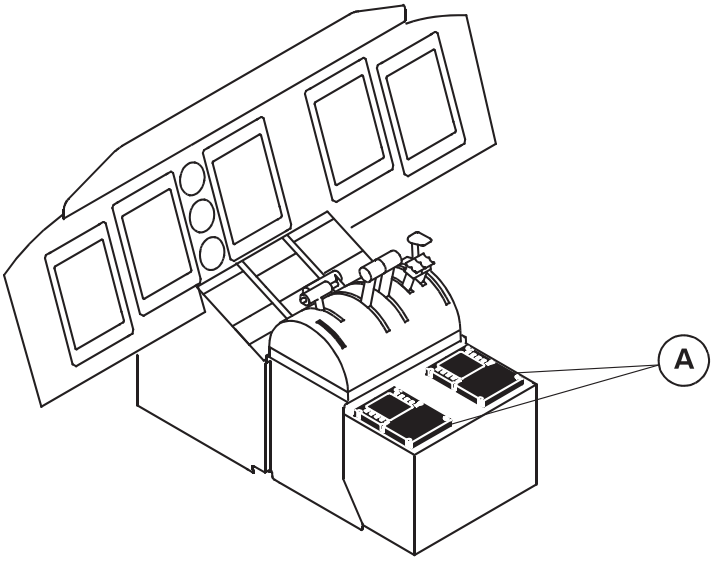
- Push the **side key** adjacent to the VOR or ILS label to highlight (black digits on cyan background) the preset code
- If no further action occurs within the next 5 seconds, the preset frequency reverts back to cyan digits
- Push the **side key** again and the preset frequency becomes the active frequency, and the active frequency becomes the preset frequency

Changing the Preset Frequency

- Push the **side key** adjacent to the VOR or ILS label to highlight the preset code
- Turn the **TUNE knobs** to change the preset code to the desired frequency
- Push the **side key** again and the preset frequency becomes the active frequency

Selecting a Memorized Preset Frequency

- Push the **CH key** to activate the channel mode selection function
- The channel memory annunciator CHx (where x is the programmed channel from 1 to 8) is displayed on the second line of the display area and its associated frequency is displayed as the preset frequency
- Push the **side key** adjacent to the VOR or ILS label to highlight and change the preset frequency
- The channel number also changes to reflect the preset frequencies memory location (8 possible per label)
- If the **TUNE knob** is not operated within the next 5 seconds, the preset frequency reverts back to cyan digits
- Turn either **TUNE knob** to display the memorized channels one after the other:
  - from the displayed channel number if a channel number is already displayed (preset frequency associated)
  - from CH 1 if no channel number is already displayed (preset frequency not associated)
- Push the **side key** again and the preset frequency becomes the active frequency
- The channel memory number appears in green below the active frequency. This shows that the active frequency is associated with a channel memory number
- When the **CH key** is pushed again, the channel memory mode changes to the normal frequency selection. All channel memory annunciators are removed



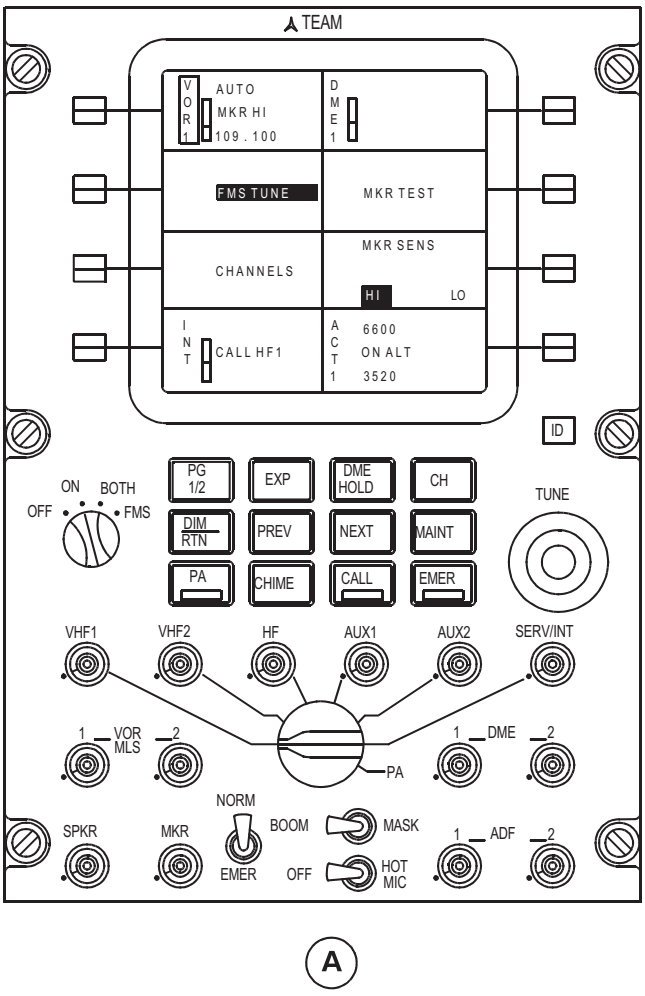


Figure 12.15-10 ARCDU VHF Nav Operation (ARCDU) (2 of 4)

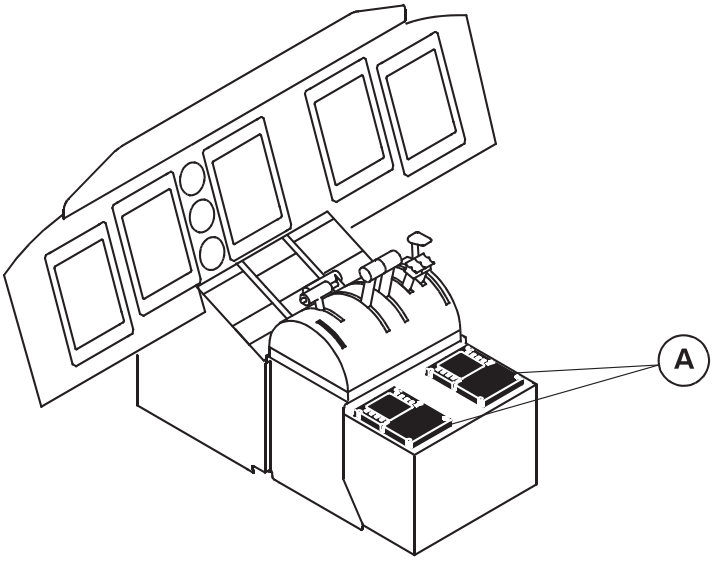
ARCDU VHF NAV FREQUENCY SELECTION (cont'd)

FMS Automatic Tuning

- Push the VOR **side key** followed by the **EXP key** to display the VOR particular page as shown
- The VOR label is displayed in black digits on a white background
- Push the **side key** adjacent to the FMS TUNE legend to change the state of the auto tune mode. If the change is not performed, the legend resets to the normal mode after three seconds. The FMS TUNE legend shows the state of the Flight Management System (FMS) auto tune mode. When the Flight Management System (FMS) is auto tuning, the FMS TUNE legend changes from a white font to a black font on a green background. An AUTO label in green characters replaces the VOR active frequency indication. A new navigation frequency selection causes the FMS auto tune mode to stop automatically.
- Push the PG 1/2 key to return to the first main page

Marker beacon operations

- While on this particular page, push the **side key** adjacent to the MKR TEST legend to start the marker test mode
- The test mode starts a three-second test of the marker receiver
- It shows the Inner (I), Outer (O) and Middle (M) marker symbols on the Primary Flight Display (PFD). In addition, it sends marker audio tones to the flight crew headsets and flight deck speakers
- During the test mode, the normally white legend lettering of MKR TEST on the ARCDU display becomes black on a green background. The legend changes to white after the test sequence is completed
- Push the **side key** adjacent to the MKR SENS legend to alternately switch between high and low sensitivities. The indication moves between LO and HI text. The selected text is black letters on a green background. The non-selected text is in white text on the black background.
- When the VHF Navigation display area shows a high sensitivity selection, it appears as a MKR HI label in green letters below the active frequency on the main page and its particular page



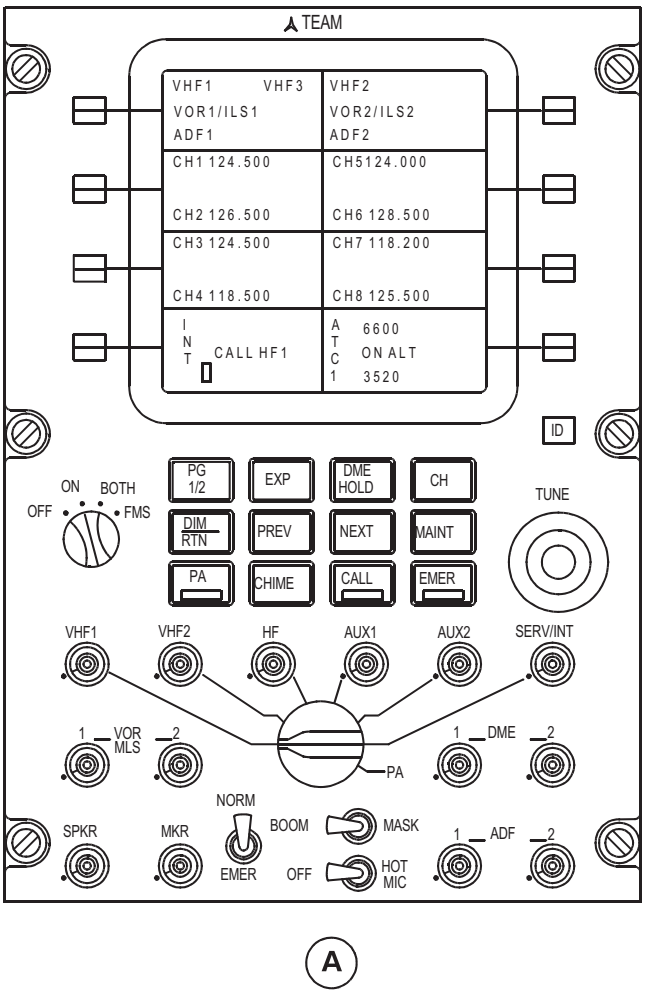


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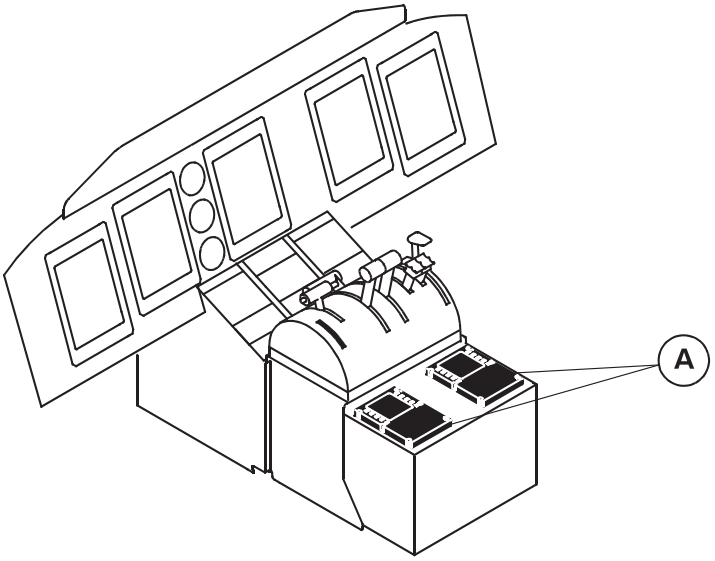
Figure 12.15-11 ARCDU VHF Nav Operation (ARCDU) (3 of 4)

ARCDU VHF NAV FREQUENCY SELECTION (cont'd)

Channel Programming

- Push the VOR **side key** followed by the **EXP key** to display the VOR particular page
- The VOR label is displayed in black digits on a white background
- Push the **side key** adjacent to the CHANNELS legend to access the Channel Programming page
- The channel programming page contains a list of radios with channel capabilities (pilots on the left, copilots on the right). One radio is selected and the frequencies for that radio are displayed
- When channel programming is selected, the radio is selected which is associated on the particular page where the CHANNEL request originated
- Eight preset channels are available for VHF communication tuning as displayed on the channel programming page
- Channel presets are labeled as CH1 through CH8 in white characters. Each channel display area contains two channel definitions. Successive pressing onside key shall successively select one of the two channels
- Push the **side key** to select the channel to be changed and the current frequency value changes to black characters on a cyan background
- Turn the two **TUNE knobs** located at the lower right side of the ARCDU to change the frequency
- The channel window shows the new frequency in cyan characters



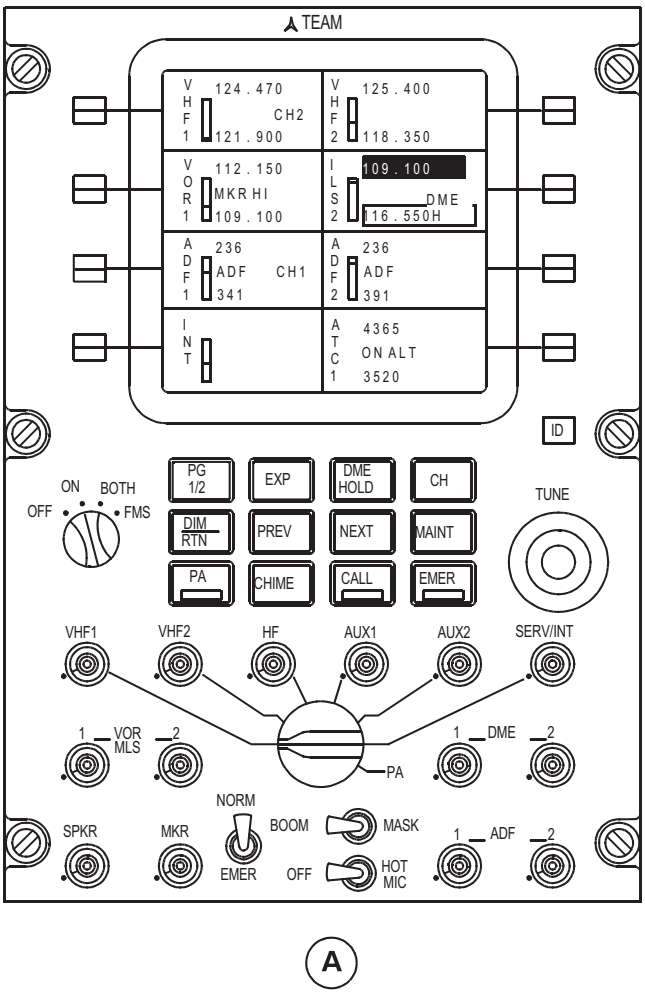
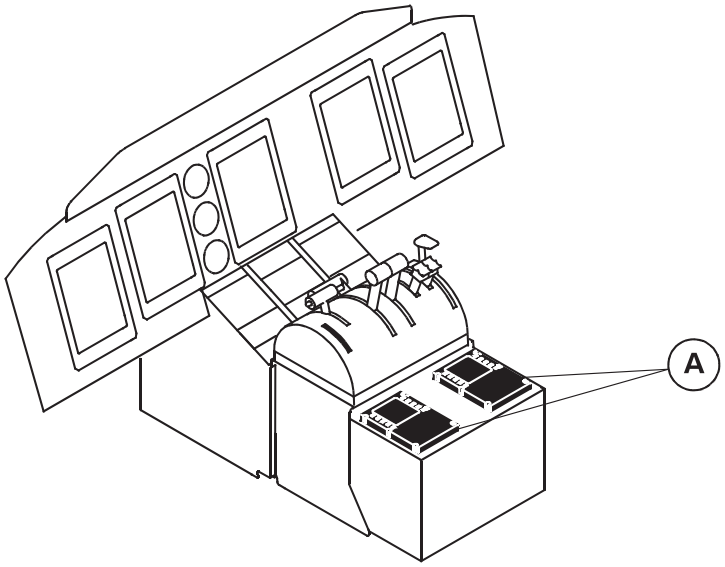


Figure 12.15-12 ARCDU VHF Nav Operation (ARCDU) (4 of 4)

ARCDU VHF NAV FREQUENCY SELECTION (cont'd)

DME HOLD OPERATIONS

- Push the **DME HOLD key** to hold the DME channel active while a new VHF Navigation frequency is selected
- The DME annunciator (white) appears above the held frequency in green letters on a black background. An yellow H appears adjacent to the held frequency
- To change the active frequency of VOR 1 push the associated **side key** so the active frequency appears in black on a cyan background
- If no further action occurs within the next 5 seconds, the display reverts back to green digits
- Turn the **TUNE knobs** to change the active code to the desired frequency
- Press the **side key** again to set the new active frequency
- The DME HOLD function is automatically deselected if:
  - AUTOTUNE mode is activated
- In this case the DME box and H annunciators are erased and the VOR 1 preset frequency is restored
- To quit the DME HOLD function, push the **DME HOLD key**
- The volume level adjust bar graph for the DME frequency identifier is shown on the VOR particular page



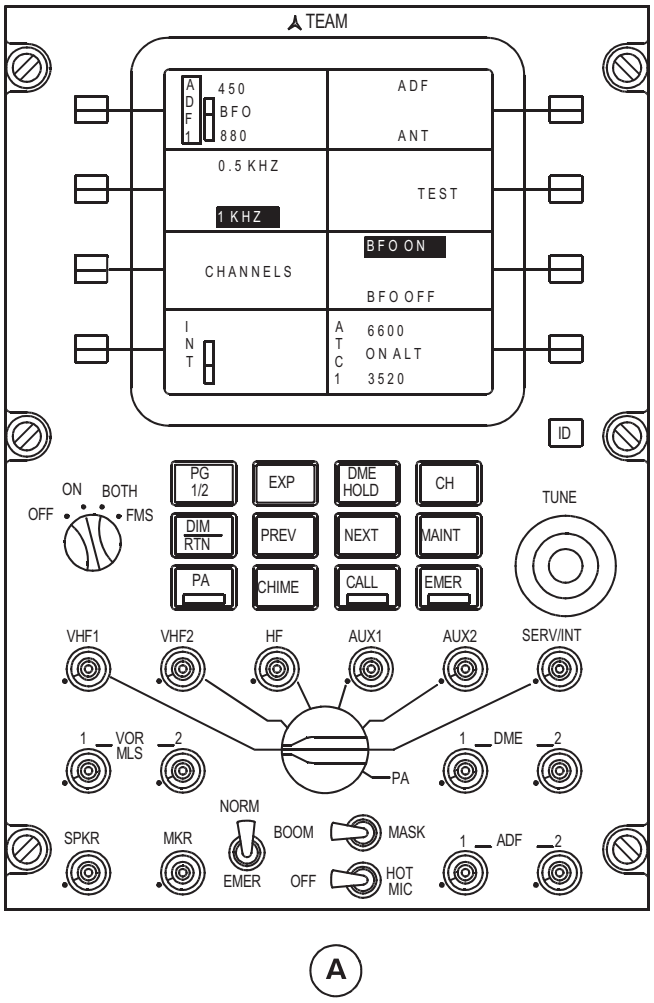


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Figure 12.15-13 ARCDU ADF Operation (1 of 2)

ARCDU ADF NAV FREQUENCY SELECTION

Switching between Active and Preset Frequencies

- See ARCDU VHF Nav frequency selection

Changing the Preset Frequency

- See ARCDU VHF Nav frequency selection

Selecting a Memorized Preset Frequency

- See ARCDU VHF Nav frequency selection

Channel Programming

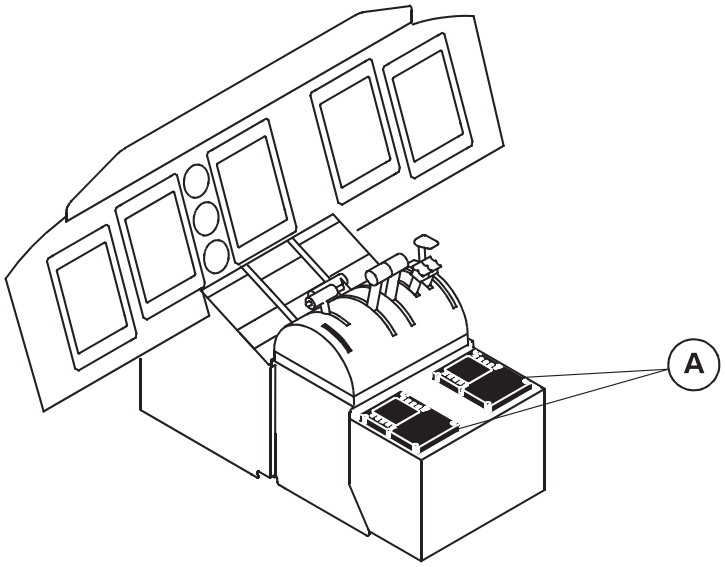
- See ARCDU VHF Nav frequency selection

Changing ADF Receiver Tuning Increments

- Push the ADF **side key** followed by the **EXP key** to display the ADF particular page as shown
- Push **side key** adjacent the 0.5 KHz, 1.0 KHz legend to alternately switch between the 0.5 KHz and 1.0 KHz tuning feature
- The selected text is black letters on a green background. The non-selected text is in white text on the black background
- If 0.5 KHz is selected, the ADF receiver is tuned in 0.5 KHz increments. If the decimal part is equal to zero, it is not displayed
- If 1 KHz is selected, the ADF receiver is tuned in 1 KHz steps

Changing ADF Receiver Modes

- Push the ADF **side key** followed by the **EXP key** to display the ADF particular page as shown
- Push the **side key** adjacent to the ADF, ANT legend to switch between the ADF and ANT modes
- The non-selected text is in white text on the black background
- The ADF or ANT position is displayed in the ADF area (in particular page and main page) as ADF or ANT in green characters on the second data line
- Push the **side key** adjacent to the BFO OFF/ON legend to swap the green box surrounding the selection between BFO ON and BFO OFF
- When BFO ON is selected, ADF mode is automatically selected. Pushing on the ADF/ANT **side key** yields no change. When BFO OFF is selected pushing on the ADF/ANT side key with again toggle between ADF and ANT mode
- BFO or ANT position is displayed in the ADF area (in particular page and main page) in green characters on the second data line



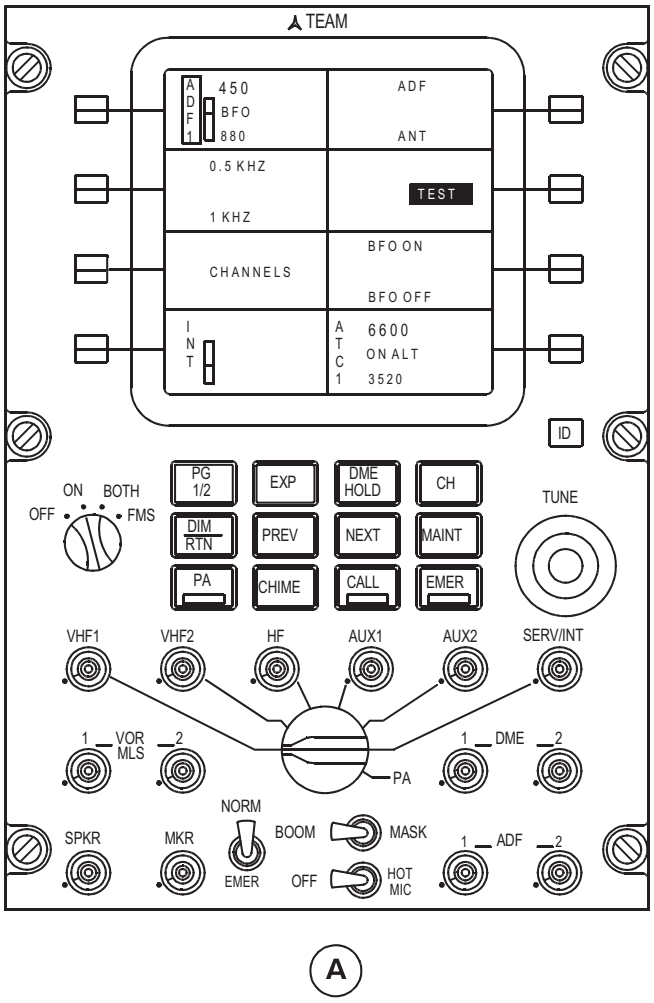
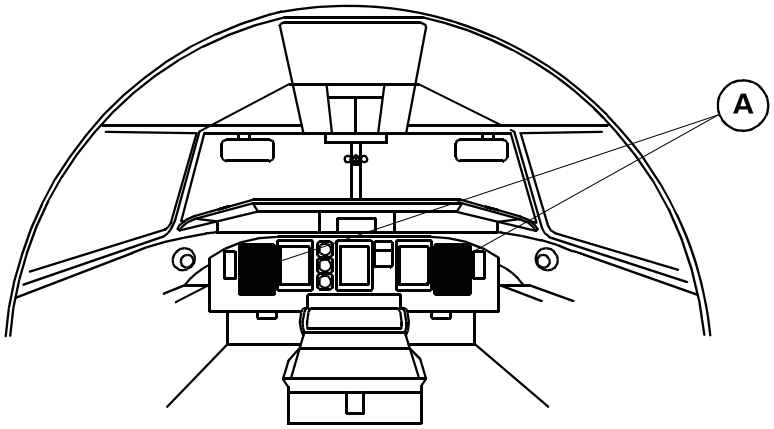


Figure 12.15-14 ARCDU ADF Operation (2 of 2)

ARCDU ADF FREQUENCY SELECTION (cont'd)

Testing the ADF Receiver

- Push the ADF **side key** followed by the **EXP key** to display the ADF particular page as shown
- Push the **side key** adjacent to the TEST legend to test the ADF receiver
- The TEST legend changes to black letters on a green background from the usually white on black background
- Test duration is of several seconds. The TEST legend will remain selected for the duration of the test
- The bearing pointer of the ADF receiver under test is parked at a relative bearing of 90 degrees. The bearing pointer is displayed on the PFD
- The display area shows OK in green letters for five seconds, if the test result is correct. It shows FAIL in red letters when the test result is not correct



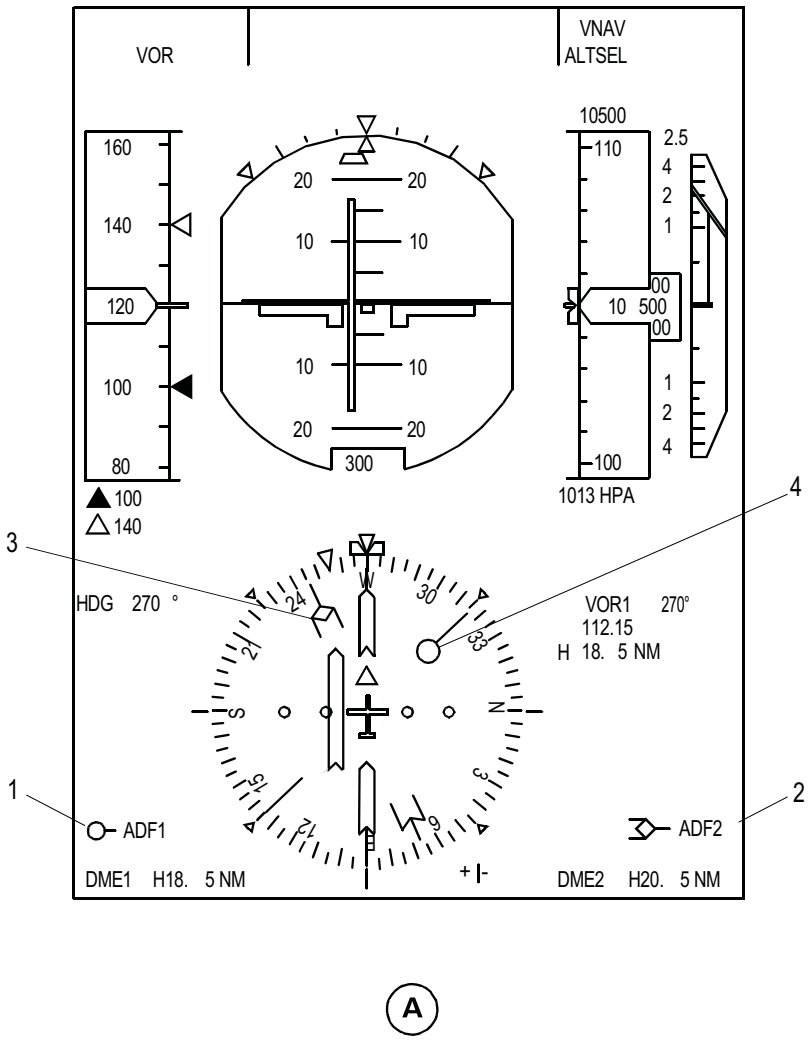
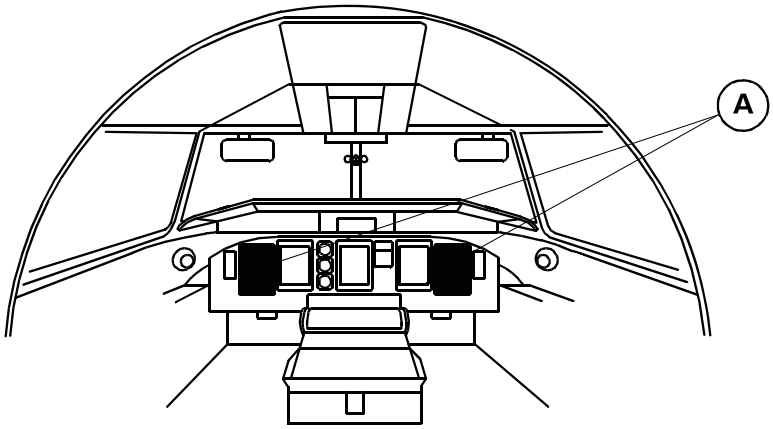


Figure 12.15-15 Primary Flight Display (PFD) (1 of 7)

PFD CALLOUTS PERTAINING TO NAVIGATION ITEMS

1. **#1 BEARING REMINDER LABEL (white symbol, white label)**
   - reminder labels possible are “VOR1, ADF1, FMS1, AUX1”
   - when the bearing pointer rotary switch of the EFCP is set to OFF or selects a source which is not installed (ADF1, FMS1, AUX1 are optional), reminder symbol and label are removed
   - when the selected bearing source data is not valid (NCD or failed), the label and relevant symbol are still displayed (pointer not shown in Figure 12.15-15)
   - In case of failure of the EFCP, the default bearing source is ADF1 and VOR1
2. **#2 BEARING REMINDER LABEL (green symbol, white label)**
   - same as #1 bearing reminder label except:
   - reminder labels possible are “VOR2, ADF2, FMS1, AUX2”
   - if the EFCP fails, the default bearing source is VOR2 for pilot and ADF2 for copilot
3. **#2 BEARING POINTER (green)**
   - this pointer indicates the bearing of the navigation source selected on EFCP for pointer 2
   - when the bearing pointer rotary switch of the EFCP is set to OFF or selects a source which is not installed (ADF2, FMS1, AUX2 are optional), pointer is removed
   - In case of HDG failure, bearing pointer is removed except if ADF2 is selected
   - when the selected bearing source data is not valid (NCD or failed), pointer is removed
4. **#1 BEARING POINTER (white)**
   - same as #2 bearing pointer except this pointer indicates the bearing of the navigation source selected on EFCP for pointer 1



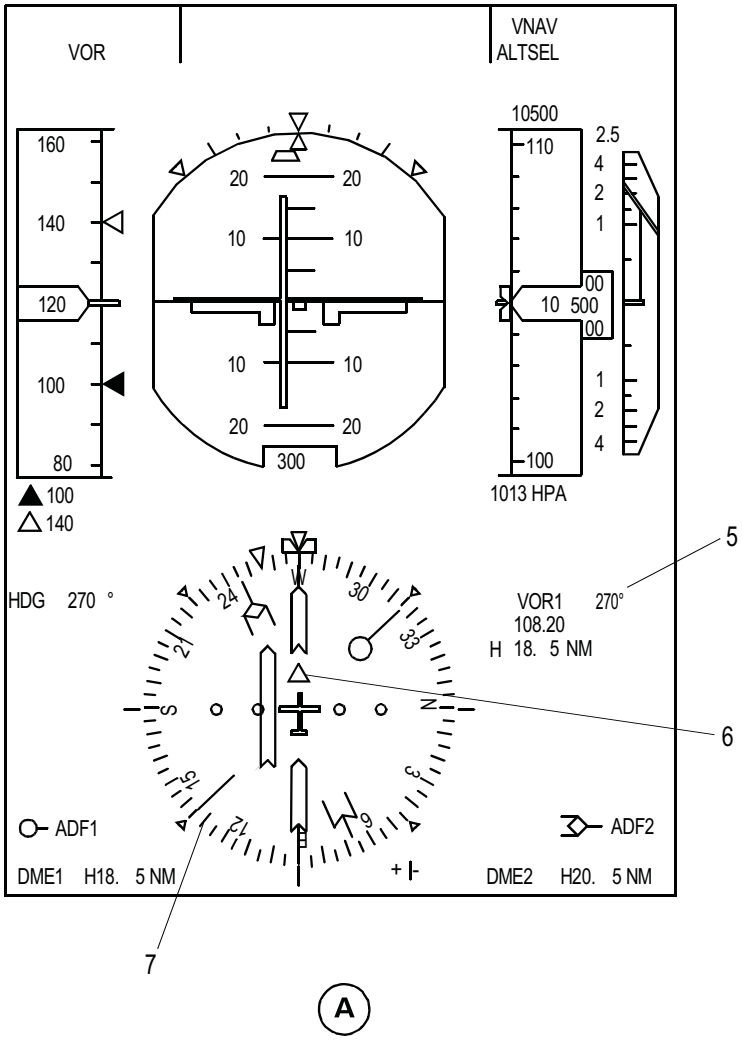


Figure 12.15-16 Primary Flight Display (PFD) (2 of 7)

PFD CALLOUTS PERTAINING TO NAVIGATION ITEMS (cont'd)

5. SELECTED COURSE/DESIRED TRACK DIGITAL VALUE
(digital value is cyan for VOR/ILS/, magenta for FMS)
(white label and white degree symbol)

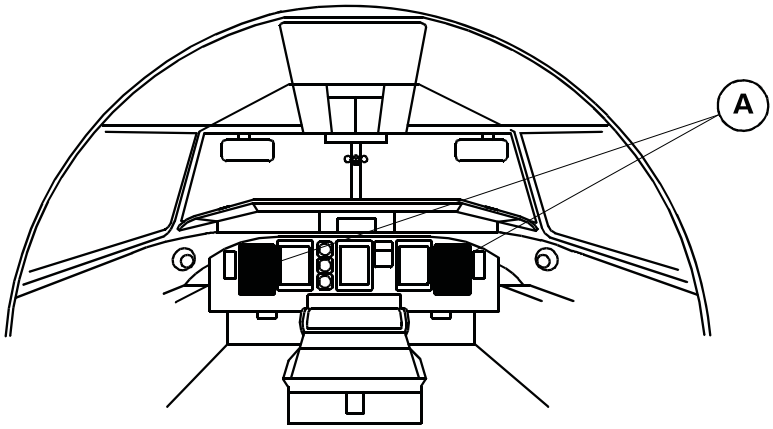
- the selected course is controlled by its related COURSE knob on the Flight Guidance Control Panel (FGCP)
- when a VOR or ILS is selected, a CRS label is shown before the digital value
- when FMS is selected, a DTK label is shown before the digital value
- when no selection data is received or not correct, dashes replace the digital value

6. TO/FROM POINTER (cyan for VOR, magenta for FMS)

- TO/FROM indication is given by the selected navigation source
- when FMS is the navigation source, the symbol is rotating with the DTK pointer. It indicates whether the A/C is flying to or from the active waypoint
- if heading is invalid, it is still displayed if VOR/FMS selected as navigation source
- in case of Course failure (if VOR is the navigation source) or when no valid data is received or when the navigation source data itself is invalid, the pointer is removed

7. HEADING SCALE (white)

- it represents a full compass rose with 5 deg graduations (small mark every 5°, bigger mark every 10°) and numeric indications every 30°
- at cardinal headings, label N, E, S, W are used instead of the digits
- in case of heading failure, the rotating part of the dial is removed



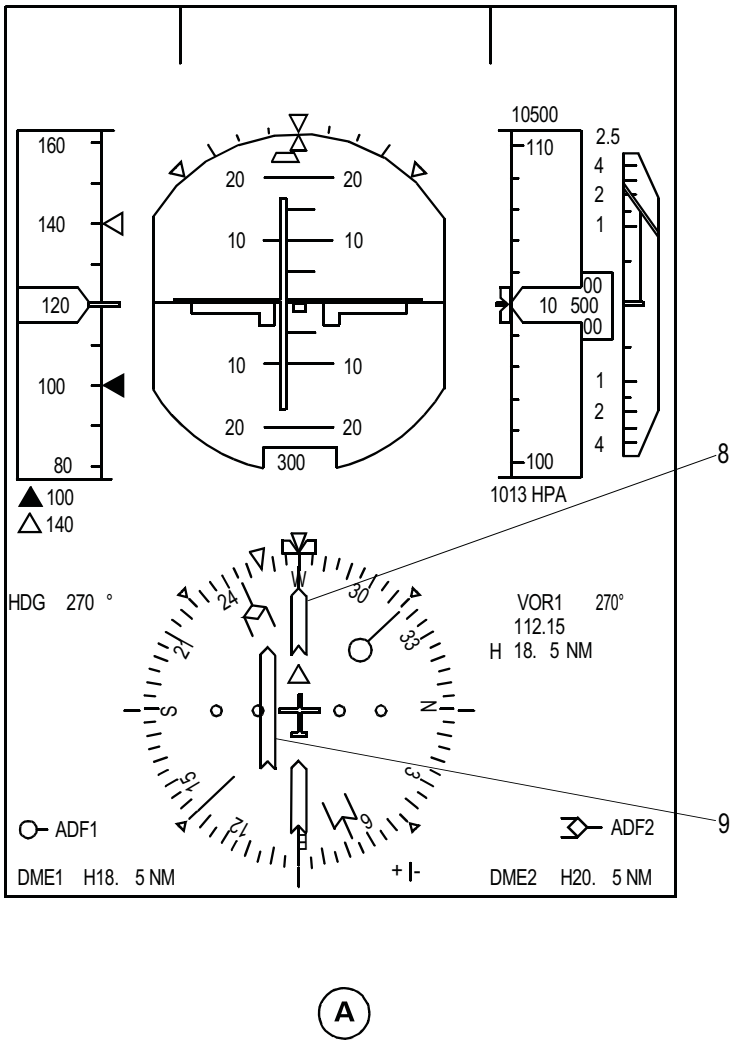


Figure 12.15-17 Primary Flight Display (PFD) (3 of 7)

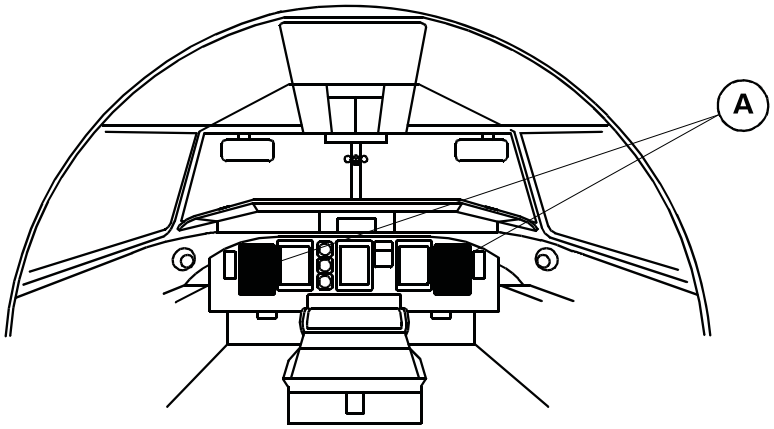
PFD CALLOUTS PERTAINING TO NAVIGATION ITEMS (cont'd)

8. SELECTED COURSE/DESIRED TRACK POINTER
(cyan for VOR/ILS, magenta for FMS, except as below)

- in case of LOC excessive deviation during a Dual FD mode approach, scale, deviation bar and course pointer are displayed in yellow and flash in concert with the expanded LOC scale
- when VOR/ILS is the navigation source, this indication provides the pilot with a graphic display of the selected course knob value of the FGCP
- when FMS is the navigation source, it represents the desired flight path selected by the FMS according to the active Flight Plan
- the symbol and the deviation bar have priority over the bearing pointers
- if the aeroplane heading is invalid or when no valid selected course/desired track data is received or when the navigation source data itself is invalid, the pointer is removed
- if the FGCP fails, the selected course is made invalid by FDPS

9. COURSE DEVIATION BAR AND SCALE
(scale always white, deviation bar cyan for VOR/ILS magenta for FMS, except as below)

- the Course Deviation Scale and Bar is part of the course pointer
- provides the crew with lateral deviation from LOC, VOR radial and FMS path
- if VOR is the selected navigation source each dot represents 5 degrees deviation from the selected course
- if ILS is the selected navigation source each dot represents 1.25 degrees deviation from the selected course
- if FMS is the selected navigation source the 2 dots represent the FMS lateral scale sensitivity
- when the pointer overshoots the limit of the scale (on either part), the bar is parked. The full deflection is reached when the bar is outside the outer dot of the scale
- in case of LOC excessive deviation during a Dual FD mode approach, scale, deviation bar and course pointer are displayed in yellow and flash in concert with the expanded LOC scale
- when a LOC discrepancy is detected between ILS1 and ILS2 or between the VHF nav receiver output and the displayed parameter during a Dual FD mode approach, a yellow flag LOC will flash 5 sec. then remain steady
- in both cases, the pilot is also warned with a message in the FMA area
- in case of heading failure or when selected course is failed with ILS as nav source, this information is still provided to the crew. In this situation the deviation scale will be displayed horizontally but without the presence of the course pointer and/or heading scale. Otherwise the bar rotates with the selected course pointer



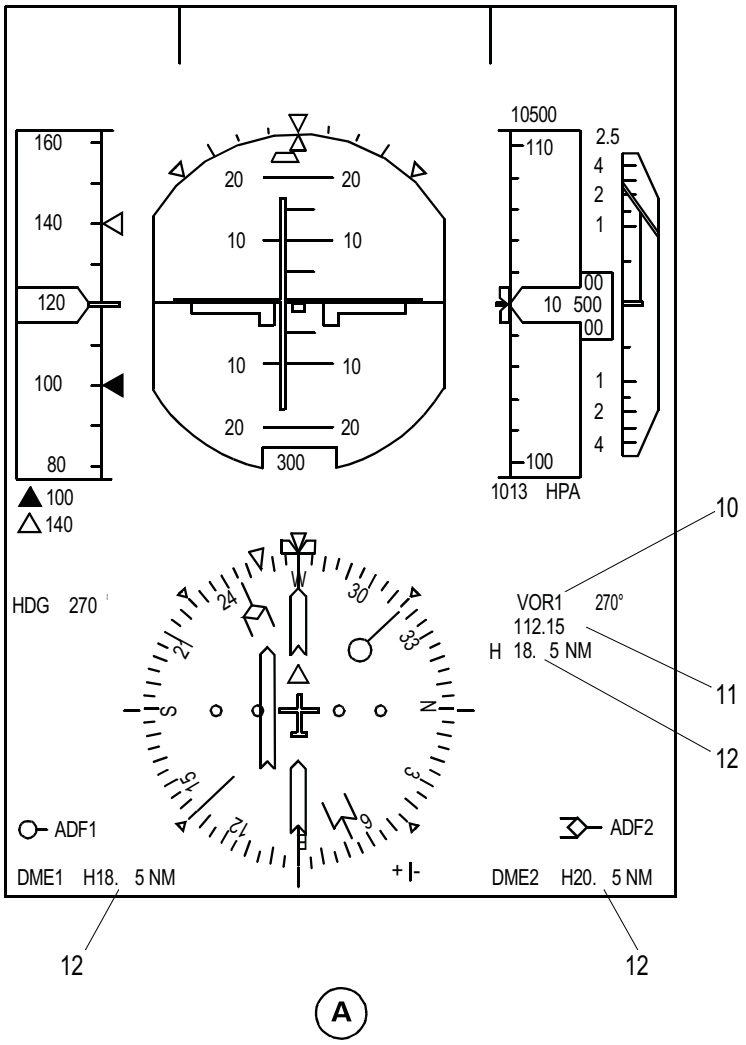


Figure 12.15-18 Primary Flight Display (PFD) (4 of 7)

PFD CALLOUTS PERTAINING TO NAVIGATION ITEMS (cont'd)

10. NAVIGATION SOURCE ANNUNCIATION
(related side source white, opposite side source yellow)

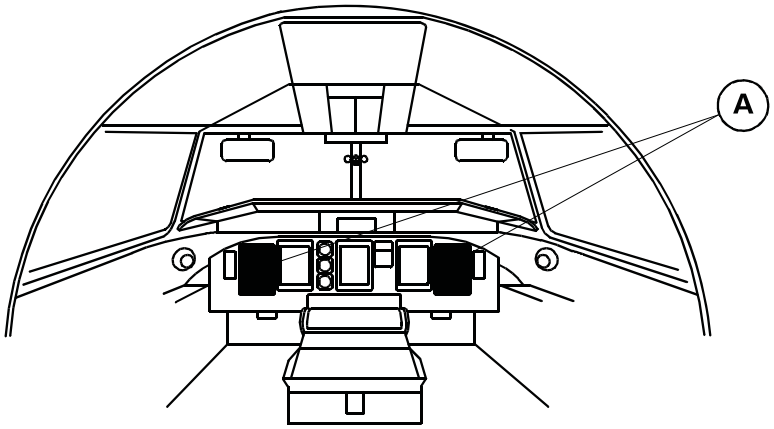
- indicates which navigation source is selected by the related NAV SOURCE rotary switch on the FGCP
- possible labels are: "VOR1/VOR2,ILS1/ILS2,FMS1" according to the selection made on the FGCP
- when VOR/ILS position is selected on FGCP, ILS is the nav source when the frequency is valid and corresponds to an ILS frequency. VOR is nav source otherwise
- when the nav source annunciation data is not valid, the indication is replaced by four white dashes

11. NAVIGATION FREQUENCY/FMS IDENT
(cyan for VOR/ILS, magenta for FMS)

- the frequency of the VOR/ILS station is displayed
- if FMS is the navigation source, the ident of the active way-point is displayed with a maximum of 6 characters
- the indication is replaced by 5 white dashes when the data is no longer valid from the relevant navigation source receiver or when the nav source data itself is invalid

12. DME DISTANCE (white digits and alpha numerics)

- for VOR and ILS it shows the distance to station information from 0 to 300 nautical miles
- for FMS it shows distance to waypoint from 0 to 999 nm. It represents the direct distance between the actual A/C position (FMS data) and the TO waypoint regardless of whether an offset has been entered or if the leg is an arc. The distance will increase when A/C has over flown the last TO waypoint.
- for VOR/ILS and FMS the range resolution is 0.1 nautical miles for distances to 99.9 nautical miles and 1 nautical mile for distances greater than 99.9 nautical miles
- if distance is not valid from the selected FMS nav source, 3 white dashes replace the numeric value. The same applies when DME distance is failed, or DME distance is out of range. In that case, current nav source must be ignored, or the nav source data itself is invalid
- one DME receiver is able to tune 3 stations. DME channel 1 is dedicated to radio-nav source from side1 (VOR1, ILS), DME channel 2 is dedicated to radio-nav source from side2 (VOR2, ILS2), DME channel 3 is dedicated to FMS use only
- pilot's EFIS displays use information provided by DME #1 and co-pilot's EFIS displays use information provided by DME #2. Data displayed on pilot's displays for VOR #1 is obtained from Channel #1 of DME #1, and for VOR #2 is from Channel #2 of DME #1. Similarly, on co-pilot's side the information is obtained from Channel #1 of DME #2 for VOR #1, and from Channel #2 of DME #2 for VOR #2. In case of loss of a DME, both EFIS sides will automatically use the remaining DME receiver.



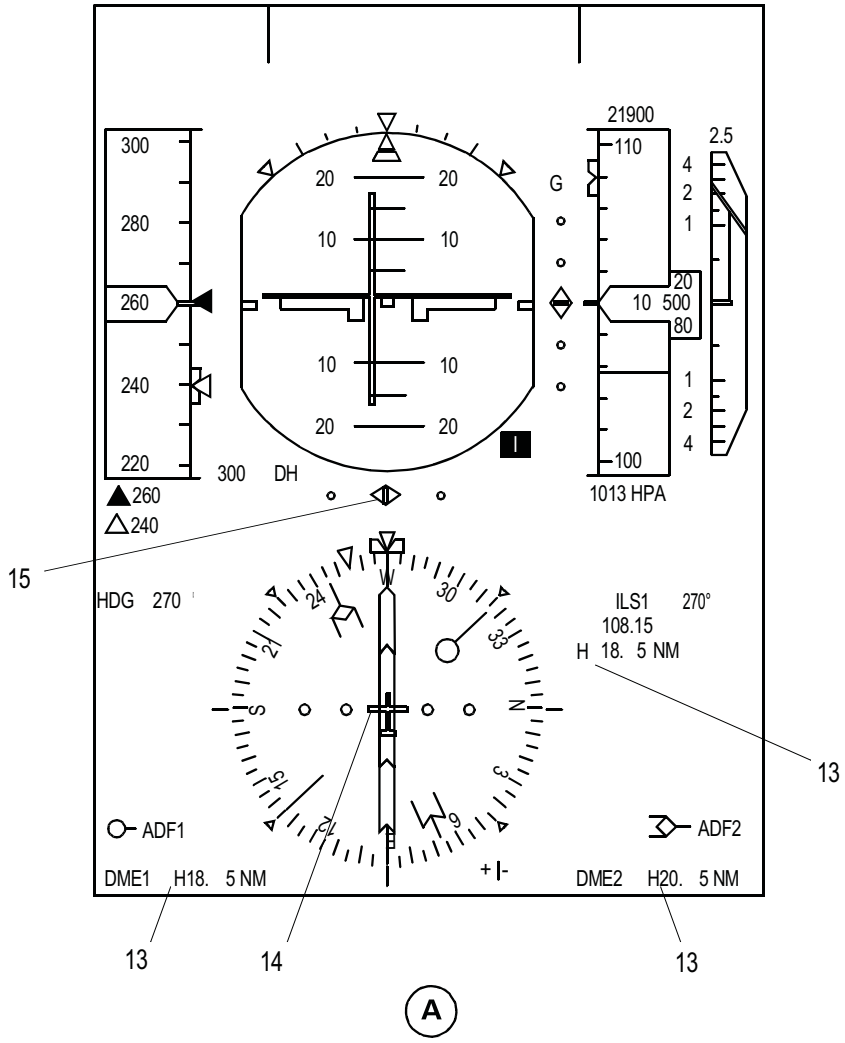


Figure 12.15-19 Primary Flight Display (PFD) (5 of 7)

PFD CALLOUTS PERTAINING TO NAVIGATION ITEMS (cont'd)

13. DME HOLD ANNUNCIATION (yellow)

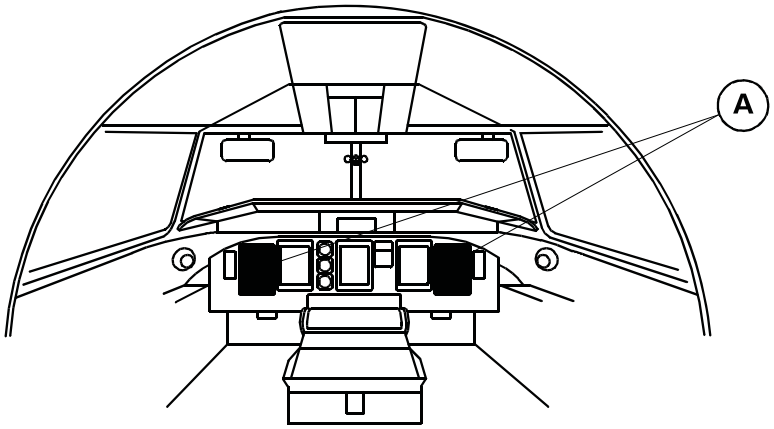
- provides indication that the pilot has selected the "DME HOLD" button of the ARCDU to hold the DME frequency for a specific DME station
- information is displayed when received valid from the same DME channel delivering the DME distance. Dashes are displayed otherwise
- the "HOLD" indication for DME #1 is not shown on the co-pilot's displays

14. AIRCRAFT SYMBOL (white)

- the aircraft symbol is always displayed steady in white at the center of the full compass rose representation

15. EXPANDED LOCALIZER POINTER AND SCALE
(scale white, pointer magenta)

- when the ILS nav source is selected this symbol is used to display localizer deviation
- the scale is 6 times more sensitive than a normal scale and the outer marks indicate the lateral deviation window for CAT II
- the pointer is displayed on the Expanded LOC scale when the LOC deviation signal is valid
- when the pointer overshoots the limit of the scale (on either part), the diamond is parked.
- the full deflection is reached when the pointer is outside the outer dot of the scale
- in case of LOC excessive deviation below 1200 ft AGL, both pointer and scale flash in yellow as long as the condition is valid
- in addition, the Flight Mode Annunciator (FMA) located on the related PFD shows a LOC EXCESS DEV message



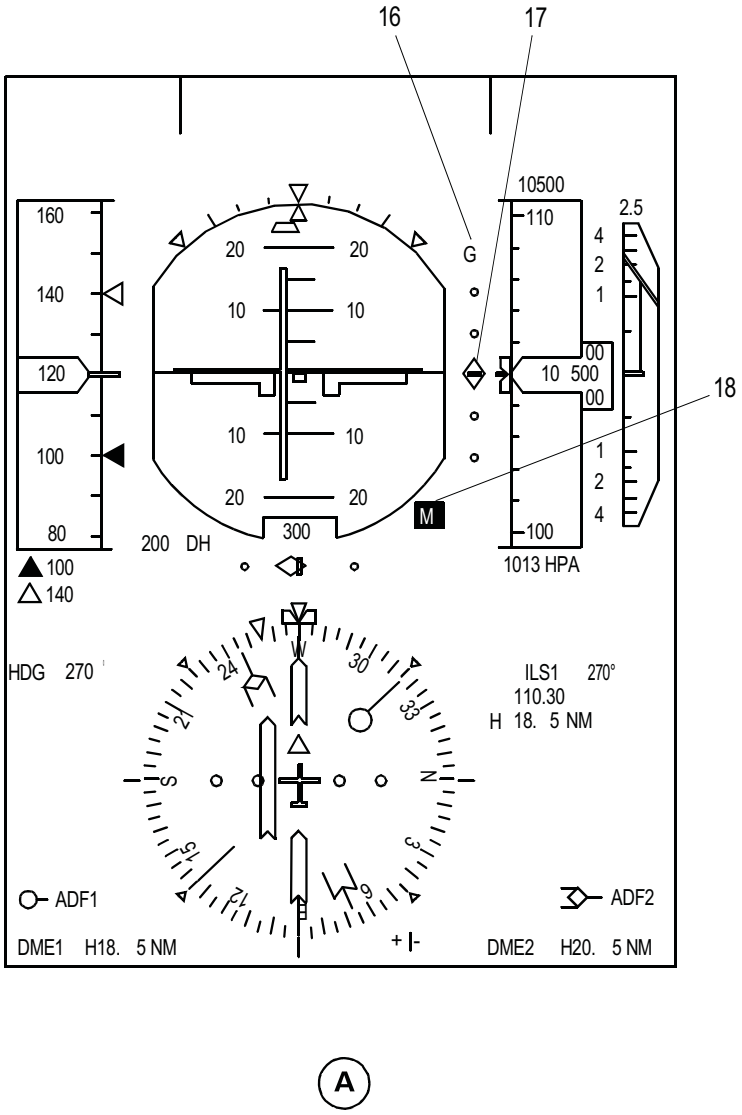


Figure 12.15-20 Primary Flight Display (PFD) (6 of 7)

PFD CALLOUTS PERTAINING TO NAVIGATION ITEMS (cont'd)

16. VERTICAL DEVIATION SOURCE (white)

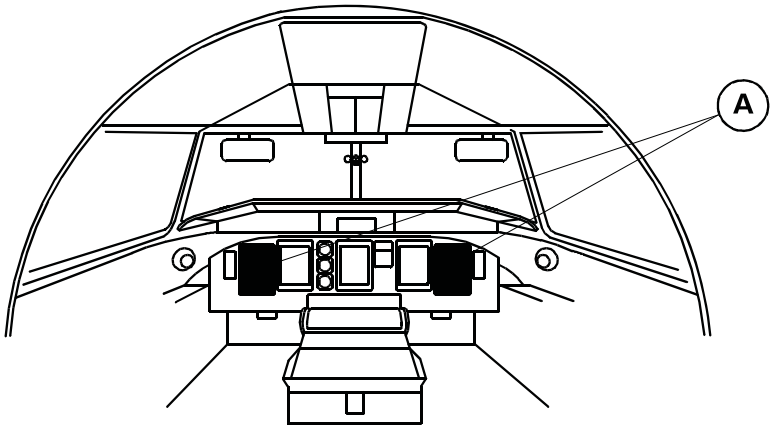
- this symbol indicates which source is feeding the glideslope deviation pointer
- "G" for ILS glide slope deviation
- "V" for FMS vertical path deviation
- the label is displayed steady on top of the glide slope scale, but can be replaced by a GS MISMATCH message

17. GLIDE SLOPE SCALE AND POINTER (scale white, pointer magenta)

- indicates to the crew the deviation from either glide slope (ILS) or vertical path (FMS)
- when no scale is activated, nothing is displayed
- when the pointer overshoots the limit of the scale (on either part), the diamond is parked. The full deflection is reached when the pointer is outside the outer dot of the scale
- in case of GS excessive deviation below 1200 ft AGL, both pointer and scale flash in yellow as long as the condition is valid
- in addition, the FMA located on the related PFD shows a GS EXCESS DEV message
- when a GS discrepancy is detected between ILS 1 and ILS 2 or between the VHF navigation receiver output and the displayed parameter during a Dual FD mode approach, a yellow flag "G", flashing for 5 seconds then steady is displayed on top of the scale

18. MARKER BEACON ANNUNCIATOR
(reverse video, black text on colored background, O on cyan, M on yellow, I on white)

- marker beacon reception is automatic and the appropriate indication is temporarily displayed depending on the received marker. It is not a function of the ILS frequency selection
- note that the 3 labels can be displayed simultaneously in a visible way during the VHF nav receiver test (each flag will be slightly shifted laterally toward the right)



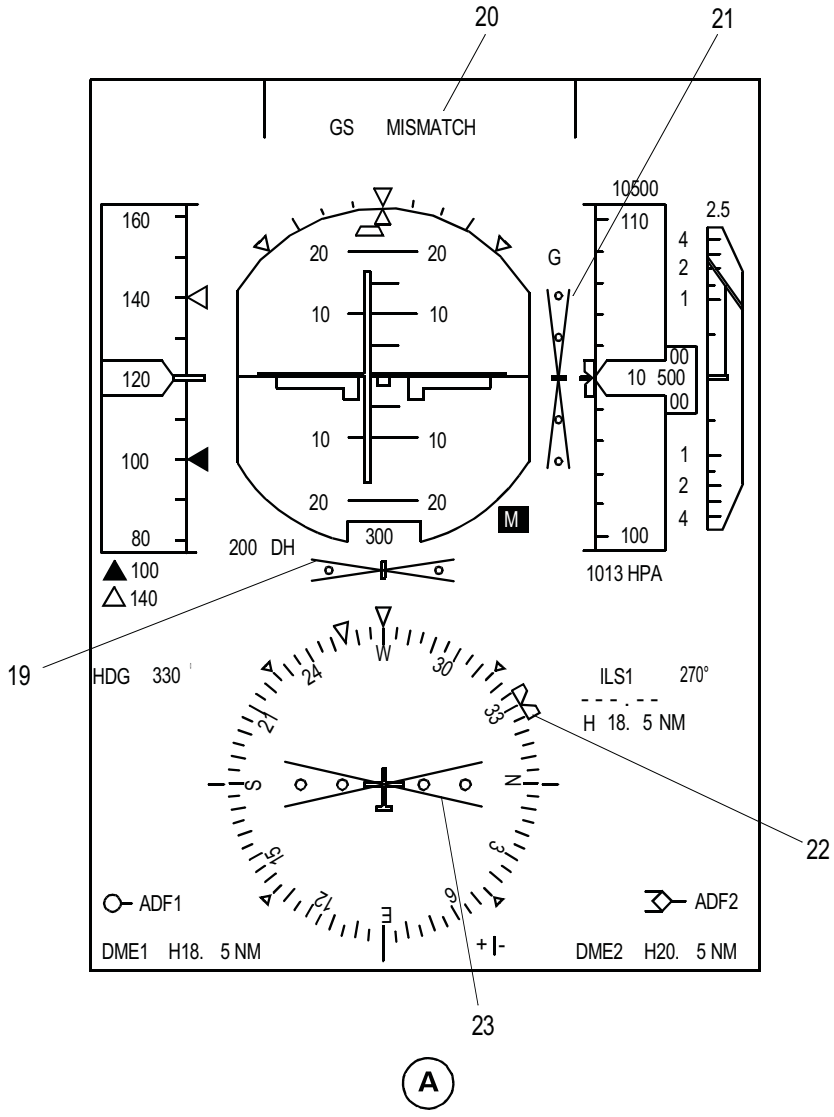


Figure 12.15-21 Primary Flight Display (PFD) (7 of 7)

PFD CALLOUTS PERTAINING TO NAVIGATION ITEMS (cont'd)

19. EXPANDED LOCALIZER FAILURE FLAG (red)

- the conditions that follow will cause it to come into view:
  - navigation receiver malfunctions
  - no navigation source selection data available

20. MISMATCH MESSAGE (5 sec. flashing yellow, then steady)

- the Flight Data Processing System (FDPS) senses signal differences between ILS1 and ILS2 and between the VHF navigation receiver output and the display data
- both Flight Mode Annunciators (FMA) located at the top of the PFDs show mismatch messages in the centre row of the centre column
- LOC MISMATCH message is shown at the same location as the GS MISMATCH message
- if a glideslope and localizer mismatch condition occur at the same time, the glideslope mismatch message will be shown. It has a higher indication priority than the localizer mismatch message

21. VERTICAL DEVIATION FAILURE FLAG (red)

- the conditions that follow will cause it to come into view:
  - navigation receiver malfunctions
  - no navigation source selection data available

22. HEADING BUG (cyan)

- moves around compass rose as HDG selector knob on FGC panel is rotated

23. COURSE DEVIATION FAILURE FLAG (red)

- the conditions that follow will cause it to come into view:
  - navigation receiver malfunctions
  - no navigation source selection data available

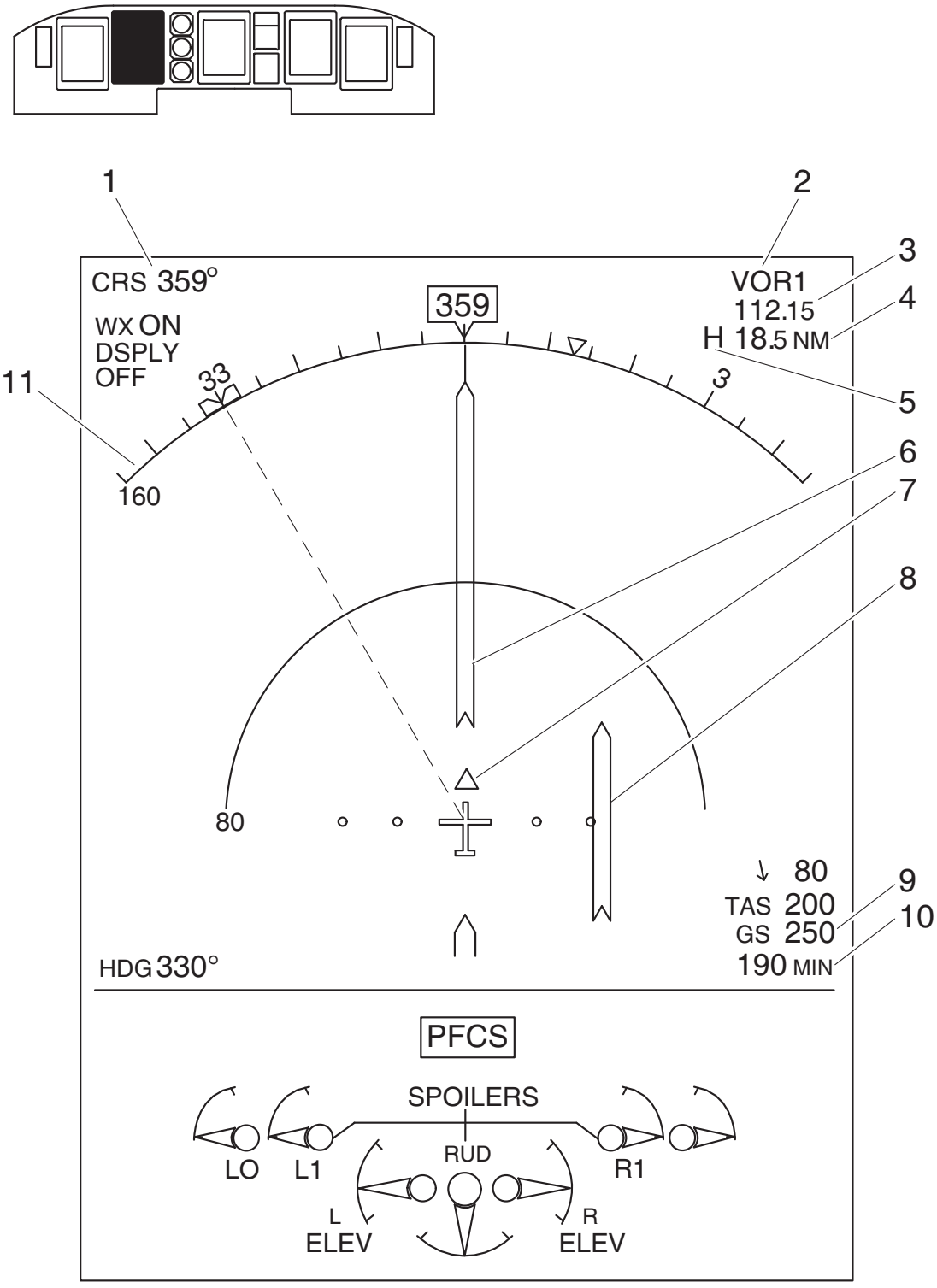
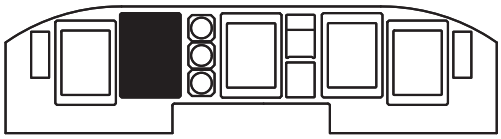


Figure 12.15-22 Multi Function Display (MFD) (ARC Mode)

MFD (ARC MODE) NON FMS NAVIGATION CALLOUTS

The Navigation Page is usually shown on the upper part of MFD1 and permanent data is shown on the bottom. The Navigation Page default view is the ARC mode format. The ARC mode shows the same course and heading parameters as its related PFD indication on a 90 degree heading arc. A different navigation source can be selected on the MFD NAV page by pushing the FORMAT pushbutton. A vertical deviation can be shown if an ILS or RMI is the navigation source.

1. **SELECTED COURSE/DESIRED TRACK DIGITAL VALUE**
2. **NAVIGATION SOURCE ANNUNCIATION**
3. **NAVIGATION FREQUENCY/FMS IDENT**
4. **DME DISTANCE**
5. **DME HOLD ANNUNCIATION**
6. **SELECTED COURSE/DESIRED TRACK POINTER**
7. **TO/FROM POINTER**
8. **COURSE DEVIATION BAR AND SCALE**
9. **DME/FMS GROUND SPEED DIGITAL VALUE (white)**
   - provides the digital indication in knots of the ground speed computed by the DME (VOR, ILS), or by FMS
   - the DME operational range is from 25 to 800 kts
   - the FMS display range is from 0 to 999 kts
   - when the ground speed data is not valid from the relevant source, the 3 digits are replaced by 3 white dashes
10. **DME/FMS TIME TO GO (white)**
11. **HEADING SCALE**
12. **VERTICAL SOURCE (white)**
13. **GLIDESLOPE SCALE AND POINTER (scale white, pointer magenta)**



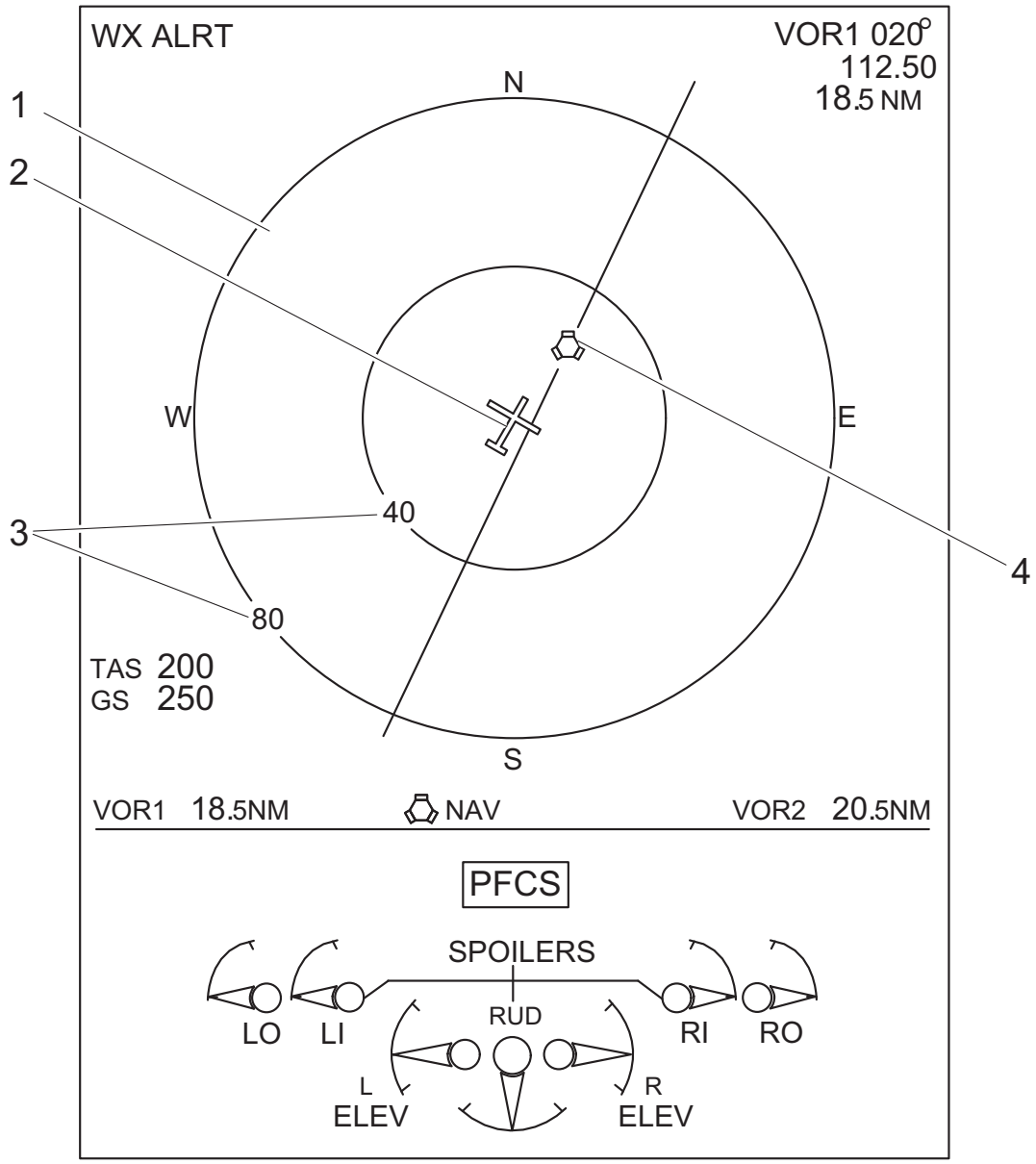


Figure 12.15-23 Multifunction Display (FULL Mode) (1 of 3)

MFD (FULL MODE) NON FMS NAVIGATION CALLOUTS

The FORMAT mode pushbutton switch located on the EFIS Control Panel (EFCP) is pushed and held for one second to select the Full Mode. The Full Mode has a selected course indication that is a VOR/DME station symbol with a course pointer.

Alternate actions of the DATA pushbutton enable the optional FMS Data selection on MFD NAV page:

- all options removed (default selection), shown in this figure
- display of the 10 nearest navigation aids as derived from the FMS data base
- display of 10 nearest airports from FMS
- display of Nav aids plus Airports (10 nearest Airports) as derived from the FMS data base (see following page)

  If FMS is not installed, or is off, pushing DATA pushbutton flashes white NO DATA message for 5 seconds in place of the NAV/APT reminder.

1. FIXED HEADING INDICATION (white)

- orientated to magnetic north

2. AIRCRAFT SYMBOL (white)

- orientated to aircraft heading relative to fixed heading indication

3. RANGE CIRCLES AND DIGITAL MARKS (white)

- the heading scale circle represents the outer range and corresponds to the selected range knob position of the own-side EFCP. The inner circle is displayed at half of the selected range
- two digital marks are displayed: 10, 20, 40, 80, 160, 240 nm for the outer range mark and 5, 10, 20, 40, 80, 120 nm for the inner mark
- they are positioned on each circle at 7.30 clock position

4. VOR/DME SYMBOL (white)

the conditions above will cause the VOR/DME symbol to go out of view

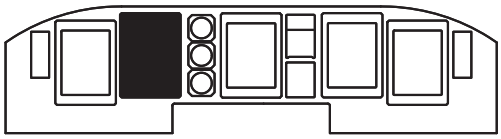
5. COURSE INDICATION (white)

- acts like the selected course pointer on the PFD
- the COURSE knob turns the course indication pointer around the VOR/DME icon. It shows the interception point of the VOR radial
- the conditions that follow will cause the selected course indication to FAIL:

  - navigation receiver malfunctions
  - no VOR course data available (ICP FAILURE)
  - no VOR navigation source selection data available

6. NAV/APT REMINDER LABEL (blue)

- if navigation aids selected by DATA pushbutton, NAV reminder is shown
- if airports selected by DATA pushbutton, APT reminder is shown
- if FMS not installed, or is off, pushing DATA pushbutton flashes white NO DATA for 5 seconds, then removed



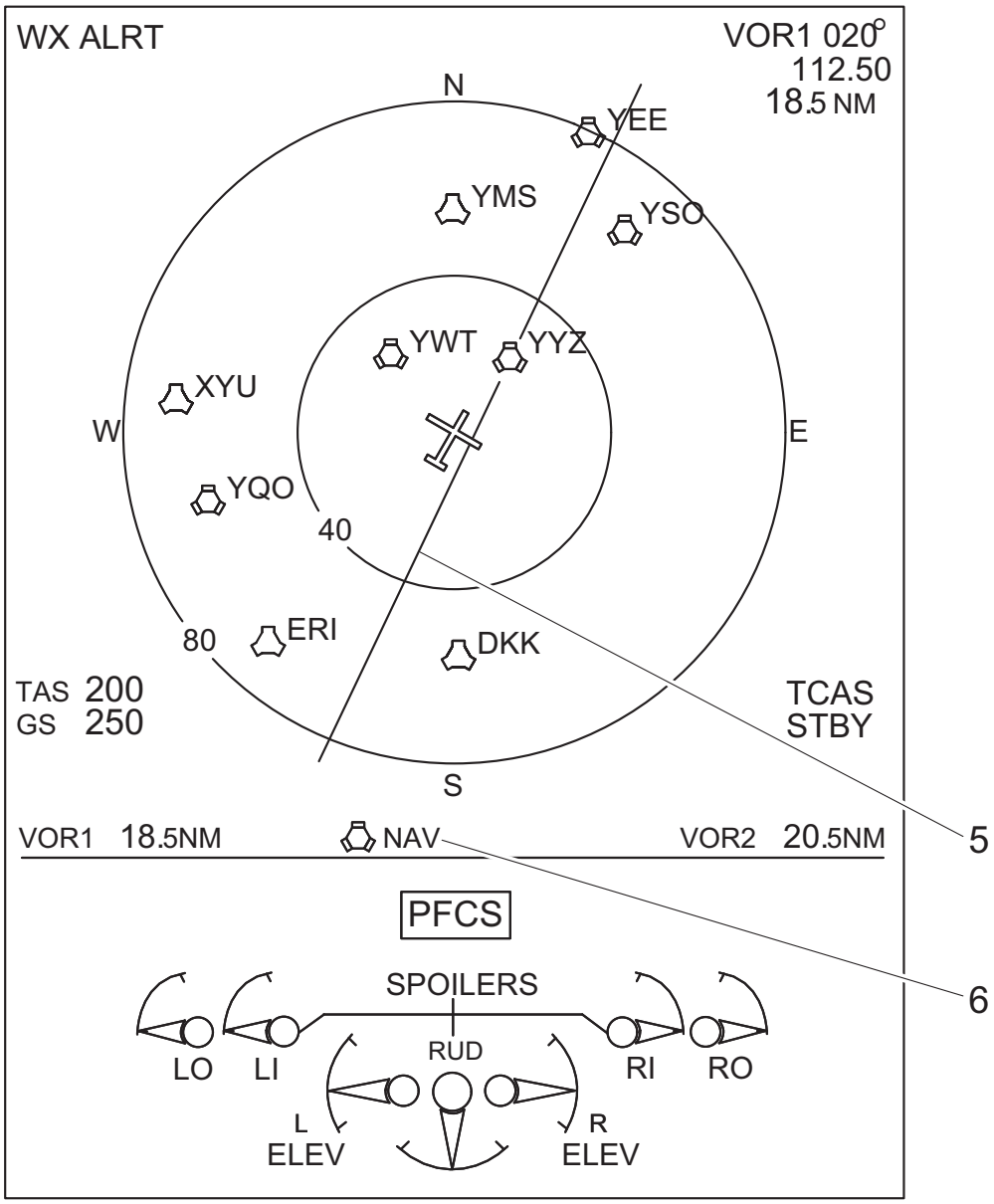
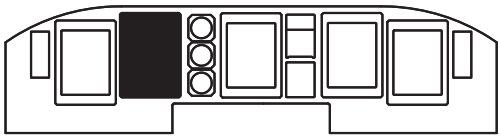


Figure 12.15-24 Multifunction Display (FULL Mode) (2 of 3)



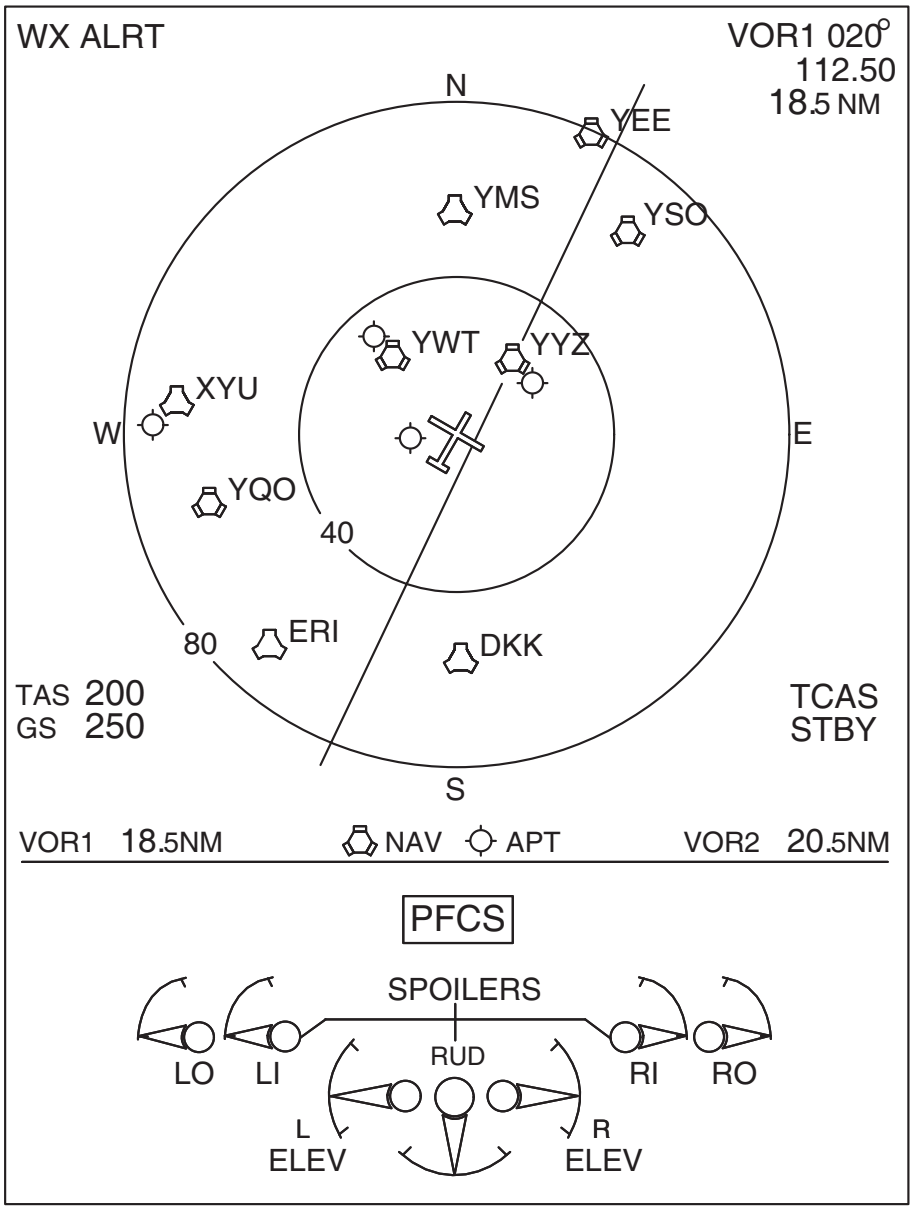
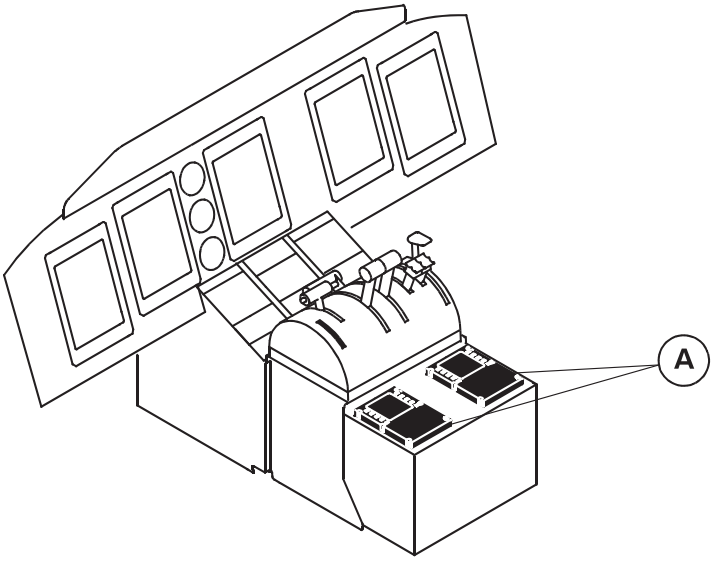


Figure 12.15-25 Multifunction Display (FULL Mode) (3 of 3)



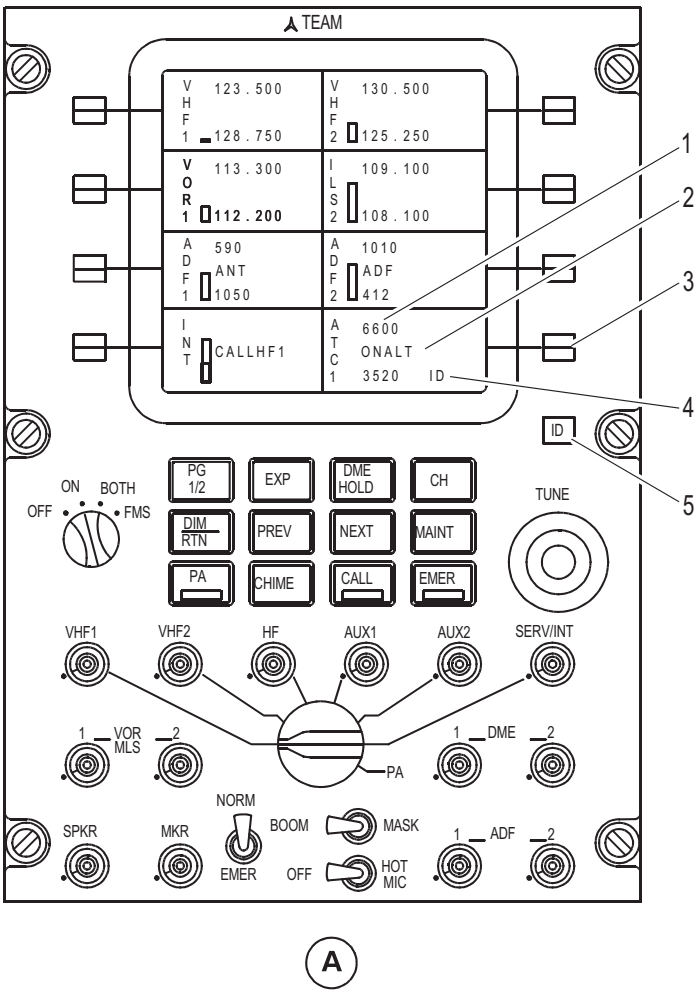


Figure 12.15-26 ARCDU (1 of 2)

ARCDU CALLOUTS PERTAINING TO TRANSPONDER ITEMS

1. **ACTIVE CODE (green)**
   - when the transponder system sends valid data to the ARCDU, the digits are displayed in green
   - invalid data or no data displays the digits in white

2. **TRANSPONDER MODE (white)**
   - indicates blank, SBY, ON, or ON ALT

3. **SIDE KEYS (8, momentary action)**

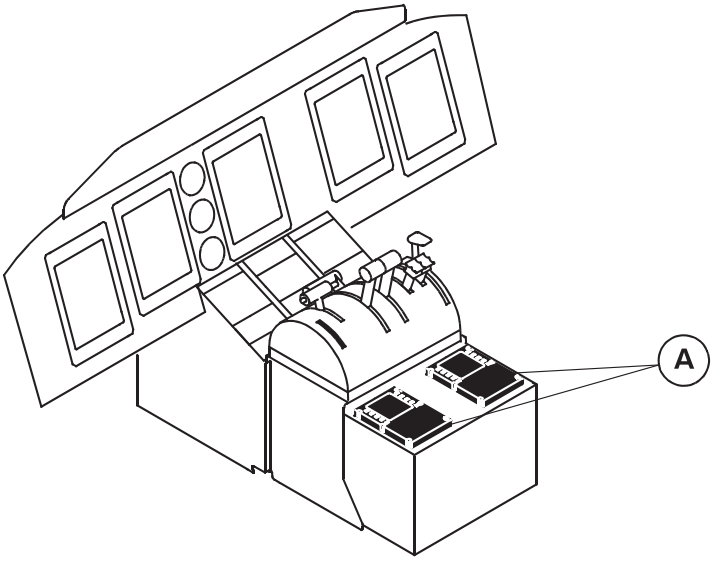
   PUSH - allows two types of operations:
   - changing of the preset code
   - swapping of preset and active codes

   - the above operations are done in conjunction with the TUNE knob
   - if there is no action with the TUNE knob within 5 seconds of a side key being pushed, the selection is cancelled
   - pushing on another side key within 5 seconds of the first push, will cancel the previous tune window and activate a tune window associated with this side key
   - pushing a side key adjacent a blank area, or adjacent INT, has no effect
   - when an action on a side key is not allowed, the label associated with this key flashes for 5 seconds
   - details on how to tune windows is described on the following pages

4. **IDENT ANNUNCIATOR (green)**
   - when the ARCDU ID key or either hand wheel located ATC IDENT pushbutton switch is pushed, it causes the transponder to transmit an identifier for 17 seconds

5. **IDENT KEY (momentary action)**

   PUSH - ID segment (green) shown in display area
   - initiates transmission of an IDENT from the selected ATC
   - the remote ATC IDENT switch on the flight control wheel has the same effect
   - attempt to IDENT while this mode is active, or when ATC is in standby mode, will cause the ATC label on the display area to flash for 5 secs



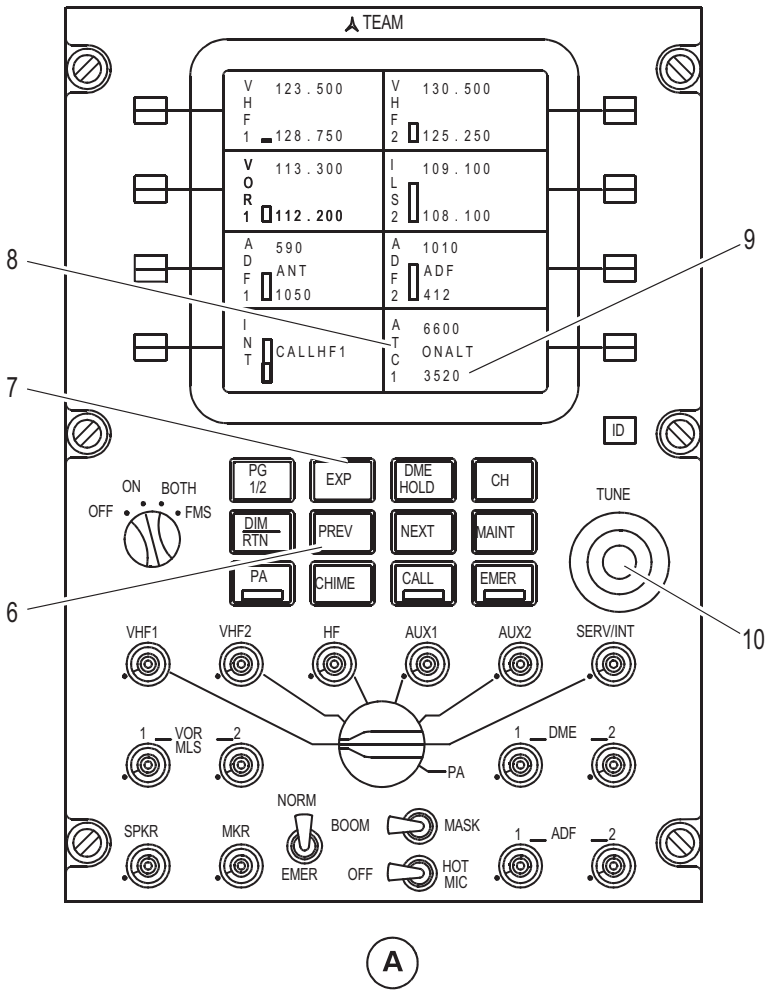


Figure 12.15-27 ARCDU (2 of 2)

ARCDU CALLOUTS PERTAINING TO TRANSPONDER ITEMS (cont'd)

6. PREV KEY (momentary action)

PUSH - allows the return to the previous page displayed
- if one of the main pages is displayed, the display remains the same

7. EXP KEY (momentary action)

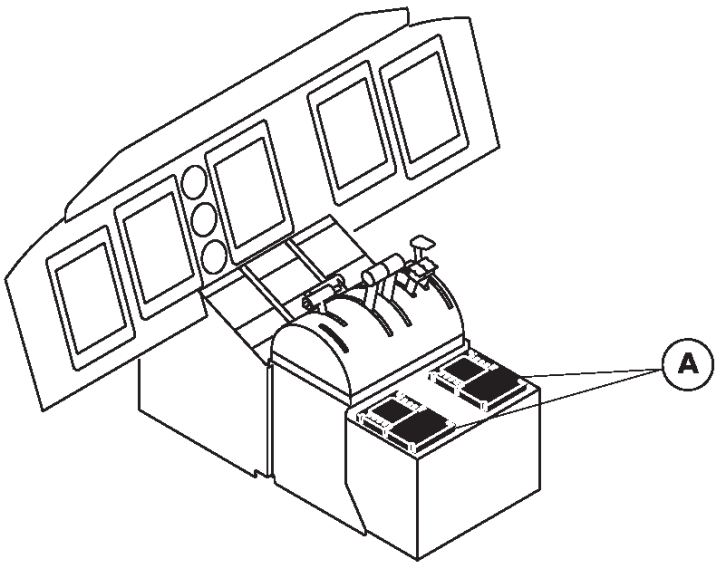
PUSH - an action on this key done after an action on a side key, like radio communication, radio navigation, or others, allows the display of the particular pages dedicated to the selected system
- scratchpad selection remains active for a further 5 seconds as soon as the particular page is displayed
- if the EXP key is selected with no previous side key selection, nothing happens
- EXP key is ineffective in particular pages

8. LABEL (white)
- identifies the applicable transponder unit
- displays ATC1, ATC, or ATC2 on both ARCDUs identically
- ATC is displayed when both units are in standby mode

9. PRESET CODE (cyan)
- when highlighted (cyan digits change color to black digits on cyan background), this area is known as the tune window, or scratchpad
- invalid data or no data displays FAIL in red text

10. TUNE KNOBS (2, rotary action)

TURN - changes digits of selected parameter
- the outer knob selects the most significant digits
- the inner knob selects the least significant digits
- both knobs have roll over capability
- both knobs have carry over capability, (i.e.) allows either knob to select the full range of the associated parameter
- variable rate tuning advances the frequency several digits when the knobs are rotated rapidly
- if the CH key has been pressed, the TUNE knobs will cycle through the programmed channels for the selected radio



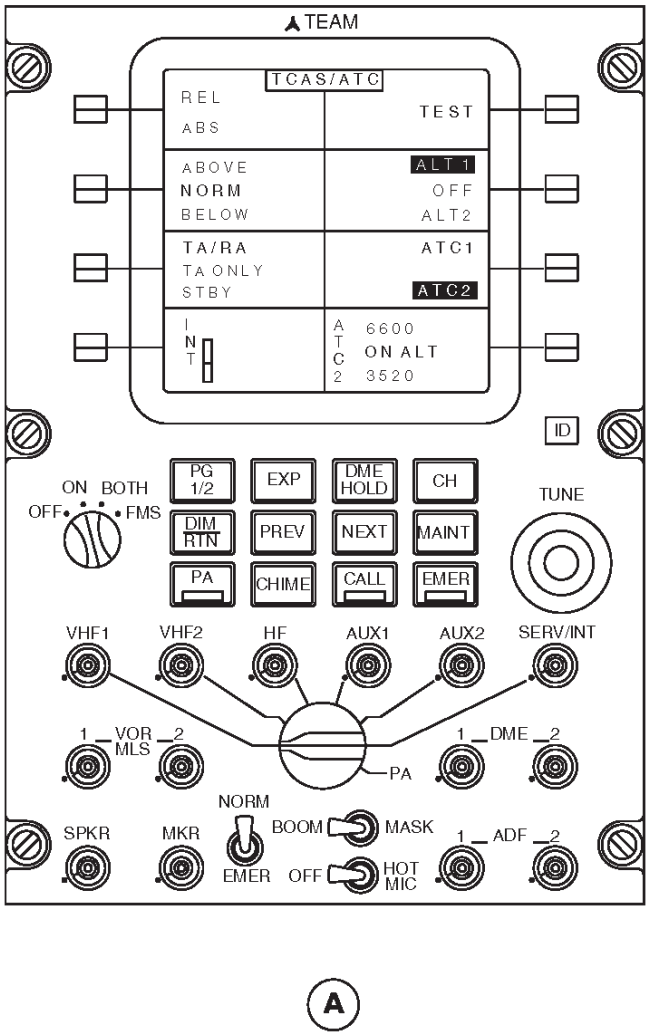


Figure 12.15-28 ARCDU ATC Operation (1 of 2)

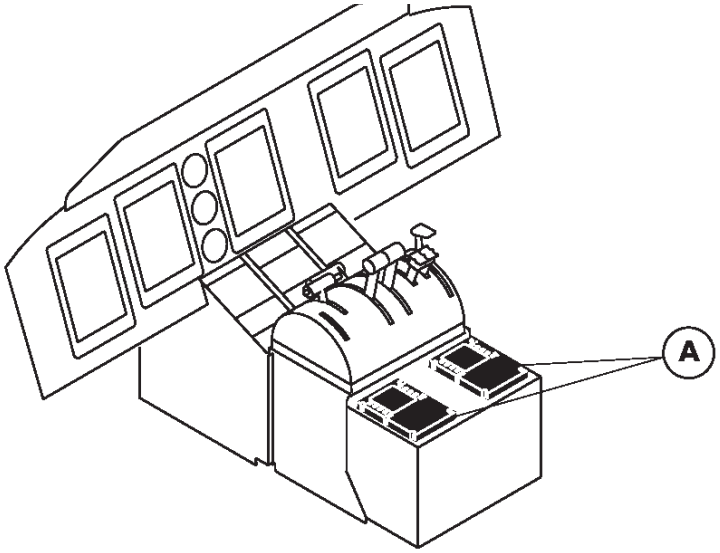
ARCDU TRANSPONDER CODE AND MODE SELECTION

Switching Between Active and Preset Codes

- See ARCDU VHF Nav frequency selection

Changing the Preset Code

- See ARCDU VHF Nav frequency selection



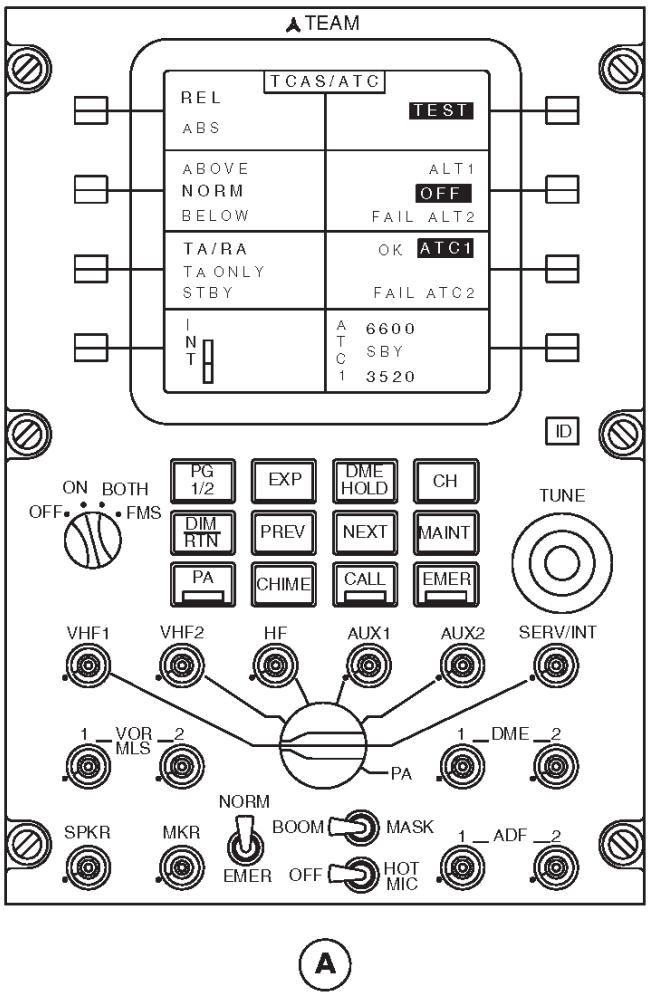
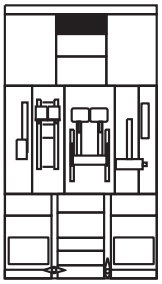


Figure 12.15-29 ARCDU ATC Operation (2 of 2)

ARCDU TRANSPONDER CODE AND MODE SELECTION (cont'd)

Changing Transponder Modes

- Push the ATC **side key** followed by the **EXP key** to display the ATC particular page as shown
- Push the **side key** adjacent to the ATC1, SBY, ATC2 display area to change the highlighted selection. It moves in a wrap round manner from ATC1, SBY, to ATC2
- The selection changes to black letters on a green background from the usually white on black background
- The second data line of the ATC display area shows a SBY or ON legend in green letters
- When ATC2 is not installed, the ATC2 selection is not displayed, and the side key swaps the selection between ATC1 and SBY only
- If the selected transponder malfunctions, a FAIL label comes into view next to the ATC1or ATC2 legend
- Push the **side key** adjacent to the ALT1, OFF, ALT2 display area to select the encoding altitude source
- The selection highlights and moves in a wrap round manner from ALT1, OFF, to ALT2
- It changes to black letters on a green background from the usually white on black background
- The second data line of the ATC display area shows an ALT legend in green letters if ALT1 or ALT2 is selected. There is no legend when OFF is selected. It also does not come into view if both transponders are operating in the standby mode
- If the selected Air Data Unit (ADU1, ADU2) malfunctions, a FAIL label comes into view next to the ALT1or ALT2 legend
- Push the **side key** adjacent to the TEST legend to test the transponder that is operating in the standby mode
- It is possible to test both transponders at the same time by setting both transponders to the standby operating mode
- Test duration is approximately 4 seconds
- The ATC1, SBY, ATC2 display area shows the test results adjacent to the ATC1 and ATC2 legends. The display area shows OK in green fonts for five seconds if the test result is successfully completed. It shows FAIL in red fonts when the test result shows a malfunction until a new test is started or power is removed
- The test feature is not available when the aeroplane is in the air. An attempt to test the transponders while the aeroplane is in the air will cause the ATC label to flash for five seconds
- On the ground, if both ACT's are not in standby mode, a push on the TEST side key starts a test of the selected ATC. When test ends, the test result is displayed (as described above) next to the tested ATC legend of the ATC1, SBY, ATC2 displayed area



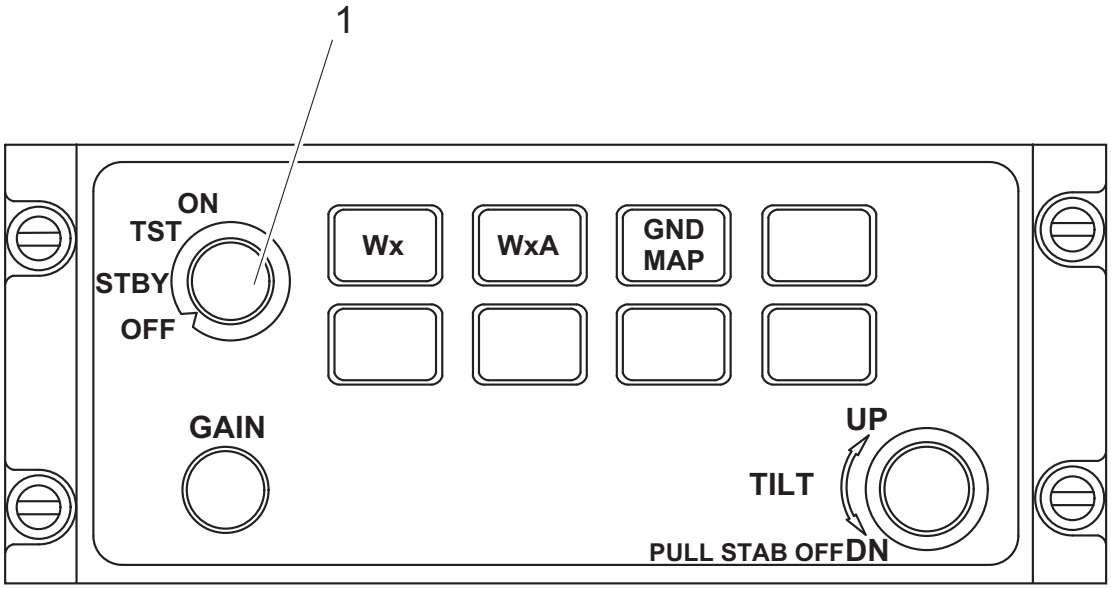


Figure 12.15-30 ARCDU Weather Radar Control Panel (WXCP) (1 of 3)

1. WEATHER RADAR CONTROL KNOB (4 position, rotary action)

- sets the operating mode of the weather radar

OFF - when the OFF mode is selected, power is removed from the transmitter/receiver electronics within the Antenna/Receiver/Transmitter (ART)

- no radar transmissions will occur when the OFF mode is selected and WX OFF will be annunciated in white text on each MFD if the radar image display is selected by the related WX pushbutton switch

STBY - when the STBY mode is set, the transmitter/receiver electronics within the ART is powered but no radar transmissions will occur

- WX STBY will be annunciated in white text on each MFD if the radar image display is selected by the related EFCP WX pushbutton switch

TST - when the TST mode is selected the transmitter/receiver electronics within the ART are powered and the ART mode selection, the status data and display data are shown in the form of a four color test pattern (i.e. Magenta/Red/Yellow/Green)

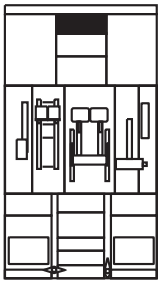
- the TST position function select switch inhibits the radar transmitter
- the four color test pattern is transmitted to each MFD approximately 7 seconds after the selection is made and can be displayed if the radar image display and the ARC option are selected by the related EFCP WX and ARC/FULL pushbuttons
- the test pattern is sized to fit the 80 NM range setting and the test pattern will be scaled according to the range setting set by its related EFCP
- WX TEST will be annunciated in yellow text on each MFD if the radar image display is selected by its related EFCP WX pushbutton switch, in both FULL and ARC modes

ON - radar transmissions will occur continuously when the ON mode is selected and after a 60 second warm-up time

- the applicable ON mode option selected (i.e. WX ON, WX ALERT or WX GMAP) will be annunciated in white text on each MFD if the radar image display is selected by its related EFCP WX/TERR pushbutton switch
- the ART display data will also be displayed on each MFD if the radar image display is selected and the ARC option is selected by the own side EFCP WX/TERR and FORMAT pushbuttons
- data can be viewed on the MFD in ARC mode only

NOTE:

1. On initial power up of the system, if the weather radar is selected directly from OFF to ON mode, the display will initially go blank and the radar enters a 60 second warm up cycle. As the radar sweeps, a blue/white band will grow outward. Just before the 60 second warm up period is completed the screen will run black for a few seconds. The radar will then begin transmitting and the screen will display radar returns. No radar transmissions occur until the warm up period is complete.
2. EGPWS information cannot be displayed on the ground if the radar is selected ON.
3. Selecting the radar rapidly from ON to OFF to ON will ususally create a system lock up or a scanning freeze and radar spoking. To reset the system, the radar must be selected to OFF for a minimum of 20 seconds and then selected to ON.
4. A power interruption to the Input Output Processor (IOP) may cause a WX fail message that will not self-clear. Selecting the radar OFF for a minimum of 10 seconds and then re-selecting ON will clear this fault.
5. The gain control will only function when the radar is in the MAP mode.



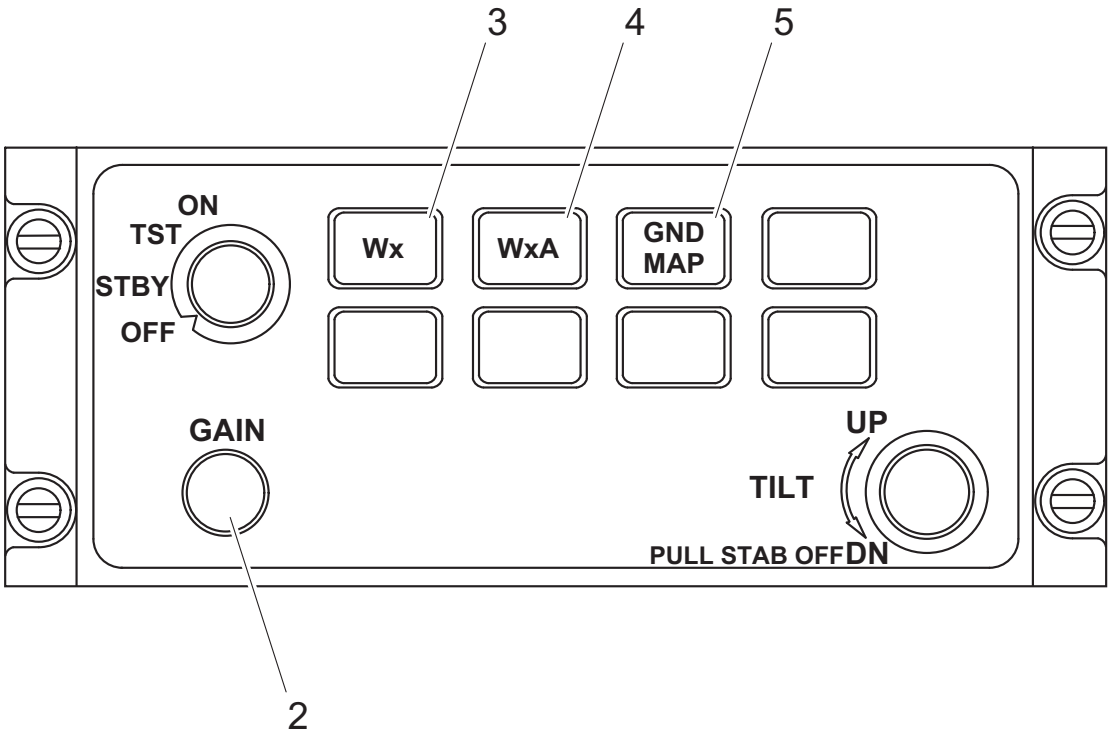


Figure 12.15-31 ARCDU Weather Radar Control Panel (WXCP) (2 of 3)
WEATHER RADAR CONTROL PANEL CALLOUTS (cont'd)

WEATHER RADAR CONTROL PANEL CALLOUTS (cont'd)

2. WEATHER RADAR GAIN CONTROL KNOB (rotary action)

TURN - changes the gain value used by the Antenna/Receiver/Transmitter (ART) when operating in ground map (GND MAP) mode through a selectable range (CCW rotation reduces gain)

- the GAIN knob will only function when in the MAP mode

3. WEATHER RADAR MODE PUSHBUTTON (momentary action)

PUSH - the WX option is annunciated as WX ON on the MFD's and is the initial default option entered when the ON mode is first selected. Thereafter, the WX option can be set when the applicable WX push-button switch is pushed

- when selected, this option is used to supply 4 color image display data that is representative of the four levels of weather precipitation sensed by the ART
- the radar display is calibrated to show five levels of target intensity: Black (level 0), Green (level 1), Yellow (level 2), Red (level 3), and Magenta (level 4)
- when the WX option is set, the receiver supplies a weather compensation capability over the range 0 to 240 NM

4. WEATHER RADAR ALERT MODE PUSHBUTTON (momentary action)

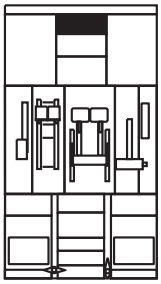
PUSH - the WXA option is annunciated as WX ALRT

- when the WXA option is set, the operation of the WXR system is identical to that of the WX option described above except when data transmitted to the MFD contains a target that has a display level of intensity 4 (i.e. display color is magenta). In this case the displayed target area will flash continuously on the applicable MFD(s)

5. GROUND MAPPING MODE PUSHBUTTON (momentary action)

PUSH - the GND MAP option is annunciated as WX GMAP on the MFD

- when the GND MAP option is selected the target alert feature is not active and the WXR system is configured to enable a gain control capability to be operative
- selection of the required WXR system GAIN value is made by the Control Panel (CP) rotary control (i.e. clockwise for increases in gain and counterclockwise for gain reductions)
- GAIN MAN will be annunciated in white text on each MFD when the GND MAP option is selected if the radar image display is selected and the ARC option is selected by the ownside EFCP WX and ARC/FULL pushbuttons
- the GAIN MAN annunciation serves to remind the flight crew that the Antenna/Receiver/Transmitter (ART) gain is variable when the GND MAP option is selected



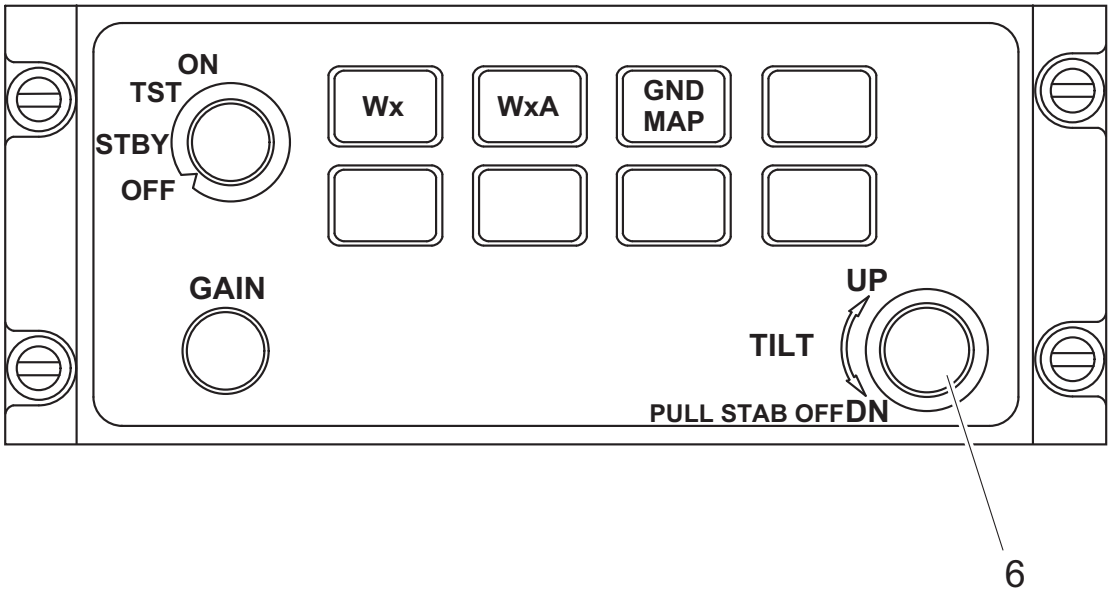


Figure 12.15-32 ARCDU Weather Radar Control Panel (WXCP) (3 of 3)

WEATHER RADAR CONTROL PANEL CALLOUTS (cont'd)

6. WEATHER RADAR ANTENNA TILT KNOB (two position pull/push, rotary action)

TURN - changes the antenna tilt angle through a selectable range of ±15 degrees

- this control also disables the automatic radar stabilization facility when the control knob is pulled if an ART input stabilization data failure condition occurs. In this situation STAB OFF will be annunciated in yellow on each MFD if the radar image display is selected and the ARC option is selected by the related EFCP WX/TERR and FORMAT pushbuttons

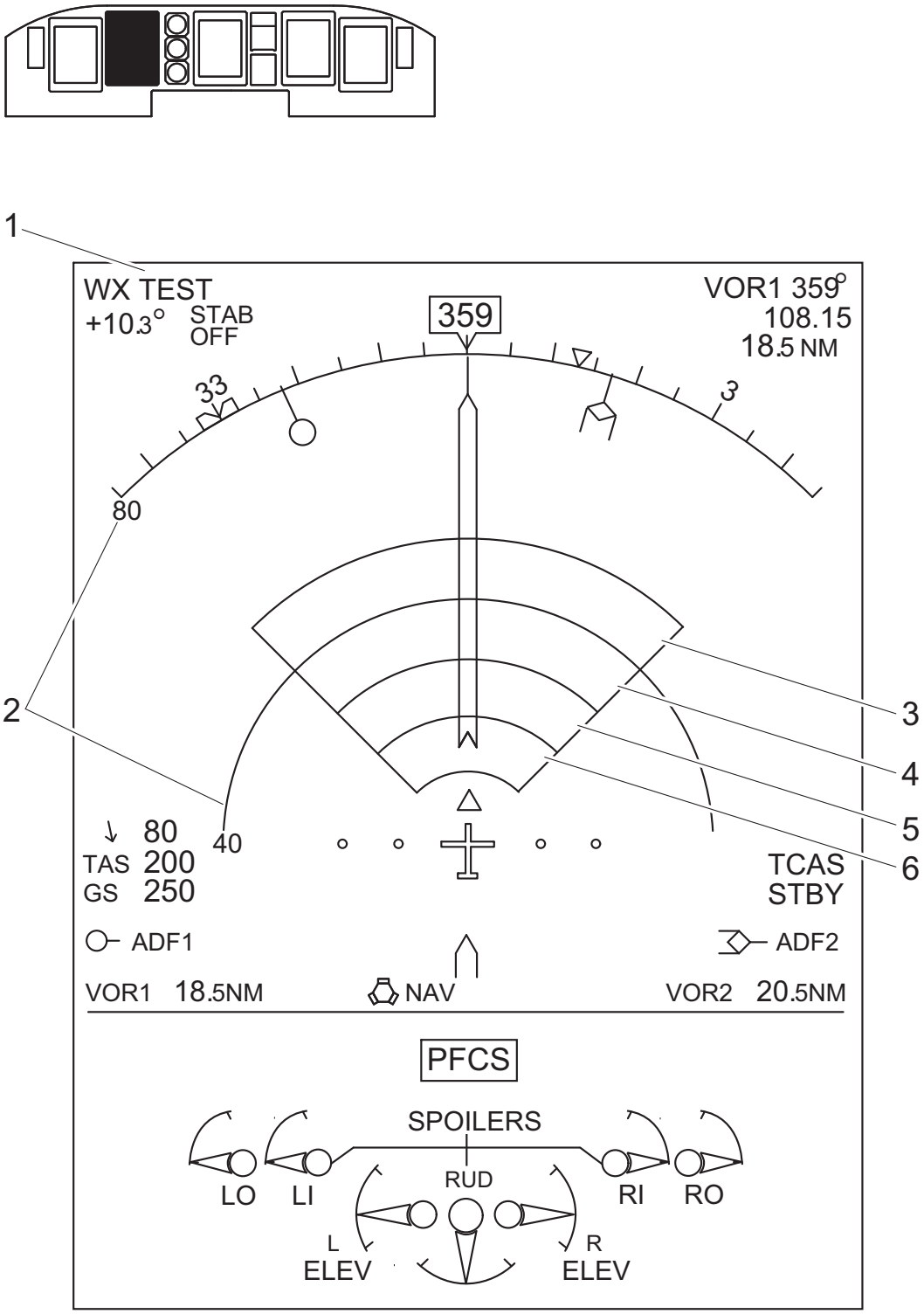


Figure 12.15-33 MFD (ARC Mode) (1 of 4)

MFD (ARC MODE) WEATHER RADAR CALLOUTS

1. **WEATHER RADAR MODE ANNUNCIATION (white, exceptions listed below)**
   - provides an indication of radar status and controls
   - possible annunciations are:
     • WX OFF
     • WX STBY
     • WX TEST
     • WX ON
     • WX ALRT
     • WX GMAP
     • WX FAIL (yellow)
   - the above listed annunciations are the only weather information that will be displayed in FULL mode
   - when the radar is OFF or in STBY, nothing of the weather radar symbology is displayed except the mode itself
   - when the radar is active (WX ON, WX ALRT or WX GMAP), the relevant mode will be displayed flashing continuously in yellow when the A/C is on ground for more than 30 seconds
   - when the radar is considered failed, none of the weather radar symbology is displayed except the failure message itself
2. **WX/MAP range arcs and digital marks (white)**
   - the heading scale arc represents the outer range and corresponds to the selected range knob position of the own-side EFIS control panel
   - an inner arc is displayed at half of the selected range
   - digital marks are 10, 20, 40, 80, 160, 240 NM for outer range mark and 5, 10, 20, 40, 80, 120 NM for the inner mark
3. **WEATHER RADAR TEST BAND (magenta)**
4. **WEATHER RADAR TEST BAND (red)**
5. **WEATHER RADAR TEST BAND (yellow)**
6. **WEATHER RADAR TEST BAND (green)**

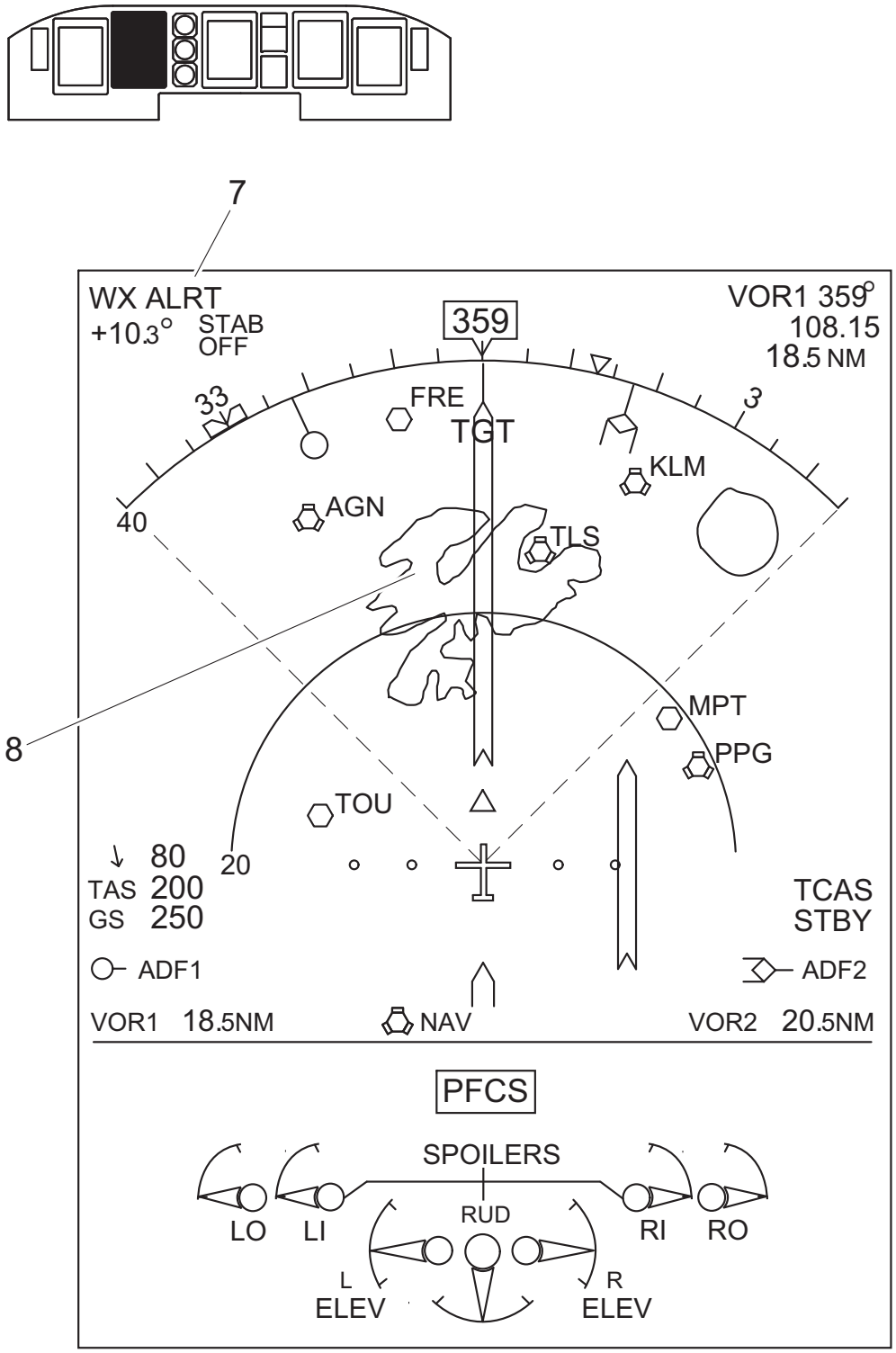


Figure 12.15-34 MFD (ARC Mode) (2 of 4)

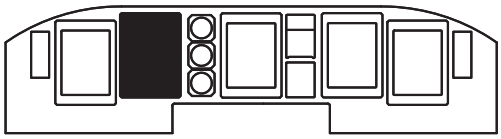
MFD (ARC MODE) WEATHER RADAR CALLOUTS (cont'd)

7. WEATHER TARGET ALERT MESSAGE (magenta)

- the message TGT is displayed continuously flashing when a weather alert is detected by the radar
- TGT is triggered when the radar detects precipitation intensity at a level red or greater ahead of the aeroplane with a minimum depth of 2 nm in range and width of 2° in azimuth that is beyond 80 nm
- the selected display range must be 80 nm or less

8. WEATHER RADAR COLORED IMAGE (magenta, red, yellow, green, black)

- the radar image is only displayed in ARC mode when the radar image display and the ARC option are selected by the ownside EFCP WX and ARC/FULL pushbuttons
- two white dashed radials appear to give the lateral boundaries of the sweep angle of +/-45°, the top part of the image is delimited by the heading arc scale
- the radar will refresh the image during both sweeps of scanning when the left and right radar selected ranges are identical. Otherwise it will be refreshed during scans to the left on pilot side and scans to the right for copilot
- the image will be erased after every radar mode or range change or when the image display is selected OFF, or in case of a confirmed radar failure
- when the radar is engaged in the weather mode (basic or alert), the color classification of the echoes is the following:
  - black when there is no radar return
  - green for the level 1 (precipitation up to 4 mm/hour); which is the least intense one,
  - yellow for the level 2 (precipitation from 4 to 12 mm/hour),
  - red for the level 3 (precipitation from 12 to 50 mm/hour),
  - magenta for the level 4 (precipitation of 50 mm/hour and over); which is the most intense one,
- in weather alert mode, magenta echoes will flash continuously
- when the radar is engaged in the ground map mode, the color classification of the echoes is the following:
  - magenta for the ground level 3 detection; which is the highest one,
  - yellow for the ground level 2 detection,
  - green for the ground level 1detection; which is the lowest one,
- radar symbology is still available if the heading parameter is invalid



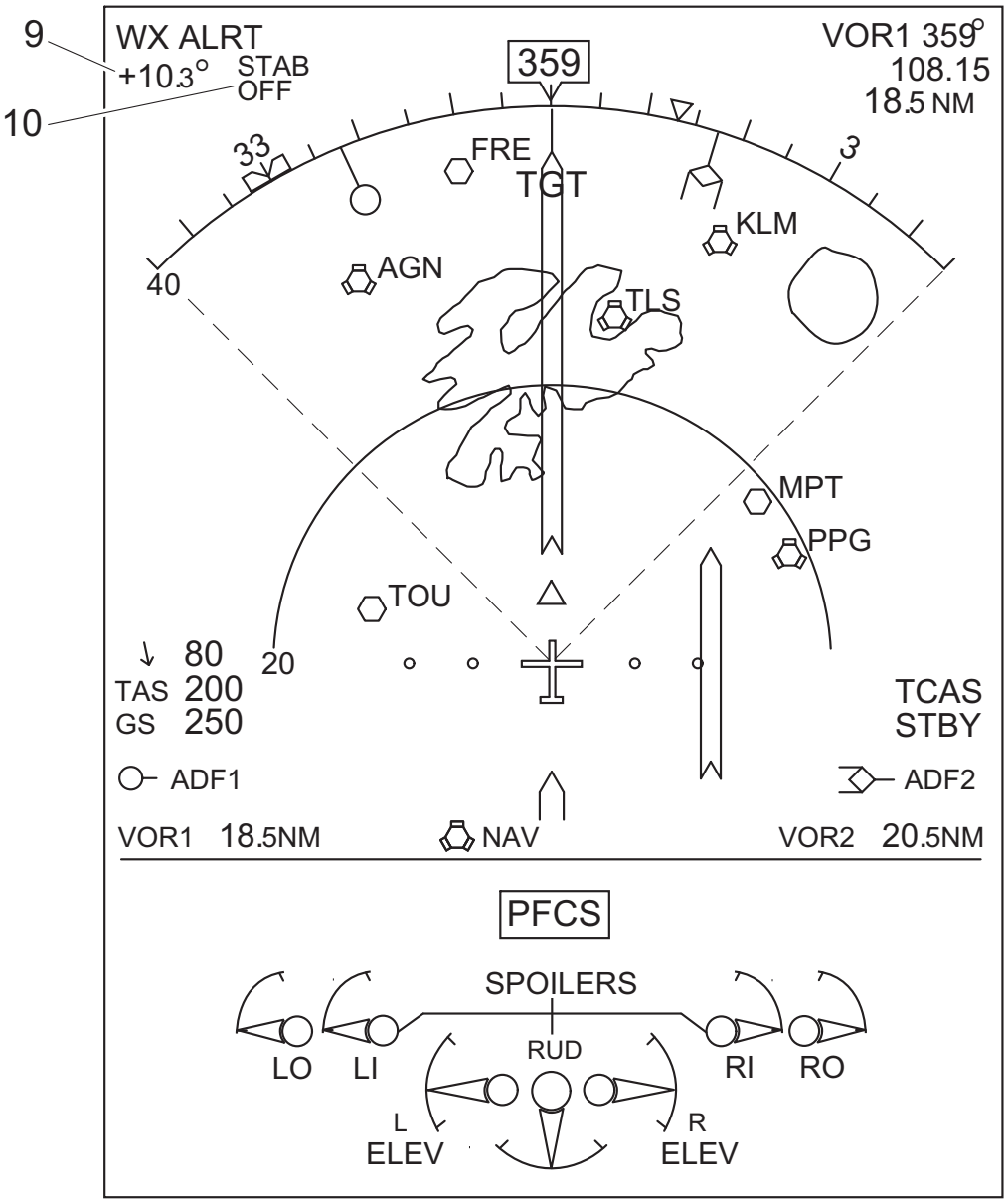


Figure 12.15-35 MFD (ARC Mode) (3 of 4)

MFD (ARC MODE) WEATHER RADAR CALLOUTS (cont'd)

9. TILT ANGLE DIGITAL VALUE (cyan)

- it is displayed in the ARC format and provided that the radar is in weather basic/alert, ground map mode or in Test mode, with WX display ON
- digits appear from - 15.9° to + 15.°, with 0.1° resolution, right justified, + or - sign displayed
- when the data is not valid from the radar, the 3 digits are replaced by 3 white dashes

10. STATUS MESSAGE ANNUNCIATION (yellow or white)

- if an ART input stabilization data failure condition is identified then STAB FAIL will be annunciated in yellow text if the radar image display is selected and the ARC option is selected by the ownside EFCP WX/TERR and FORMAT pushbuttons
- in this event the flight crew have the capability to disable the automatic radar stabilization facility by pulling the TILT control knob, and as a consequence of this action, STAB OFF will be annunciated in yellow, replacing STAB FAIL
- the message is only shown in the ARC format
- GAIN MAN is displayed in white font when the radar is engaged in the Ground map mode to remind the flight crew that the antenna gain is manually controlled in that mode
- the message is only shown in the ARC format, with WX display ON

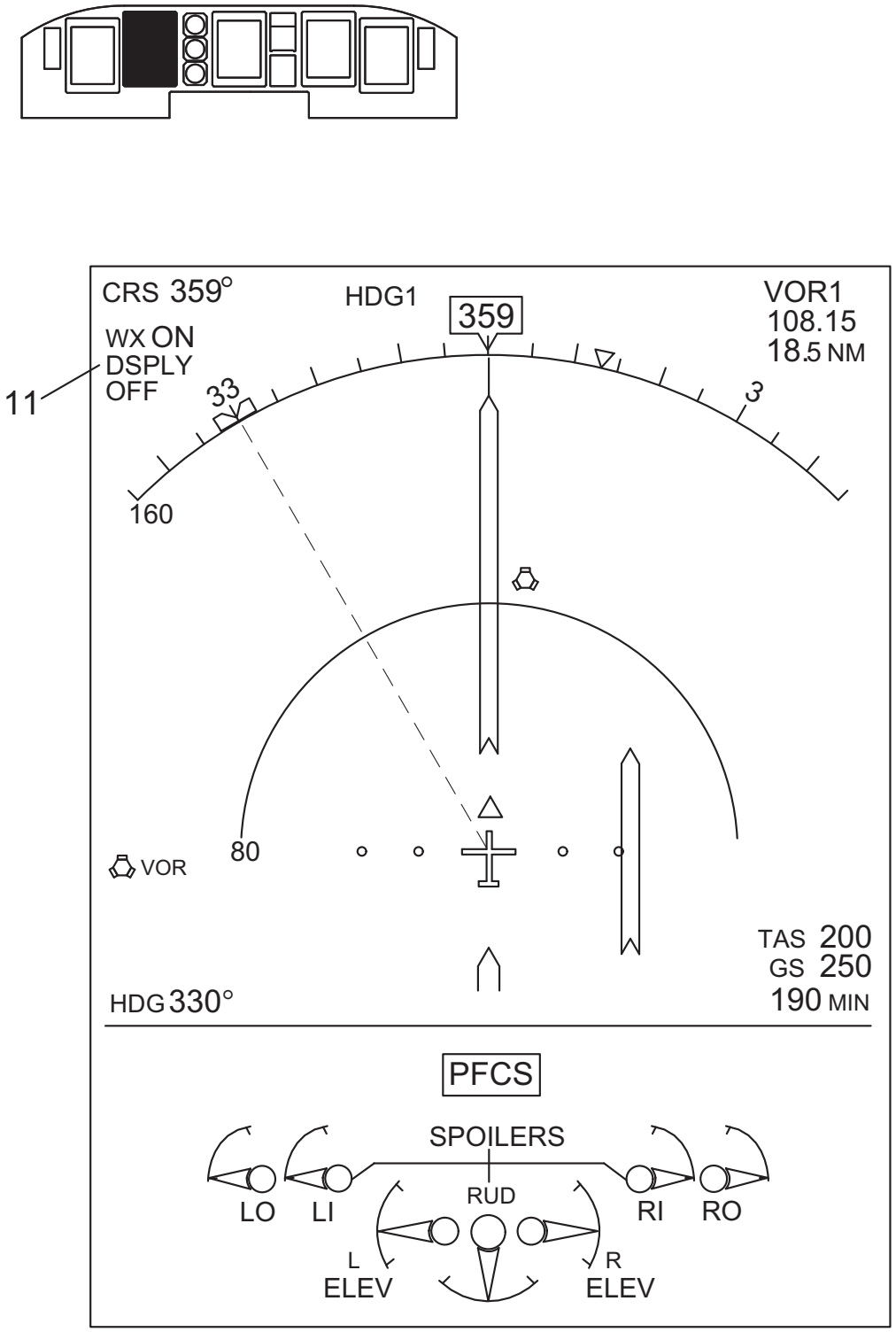


Figure 12.15-36 MFD (ARC Mode) (4 of 4)

MFD (ARC MODE) WEATHER RADAR CALLOUTS (cont'd)

11. WEATHER RADAR IMAGE DISPLAY OFF STATUS MESSAGE (yellow)

- it provides an indication of the radar image display status depending on pilot action on the EFCP WX pushbutton
- it is displayed in place of the tilt angle and stab off indications
- the message DSPLY OFF is displayed when:
  - ARC mode is selected and,
  - the radar is active (weather basic/alert or ground map mode) and,
  - the pilot has deselected the radar image by pushing on the EFCP WX pushbutton
- any action on the WX pushbutton has no effect when the NAV page is not in the Arc format or when the radar is in an inactive mode (WX OFF, in Test, Failed or in Stand-by). In such case, the Display Unit (DU) will just keep in memory the last selected state. The memory is automatically reset:
  - at DU initialization or,
  - when the MFD selector knob of the ESCP is changed to NAV position or,
  - when the EFCP is considered failed by the MFD or,
  - when the radar is set to a new active mode.

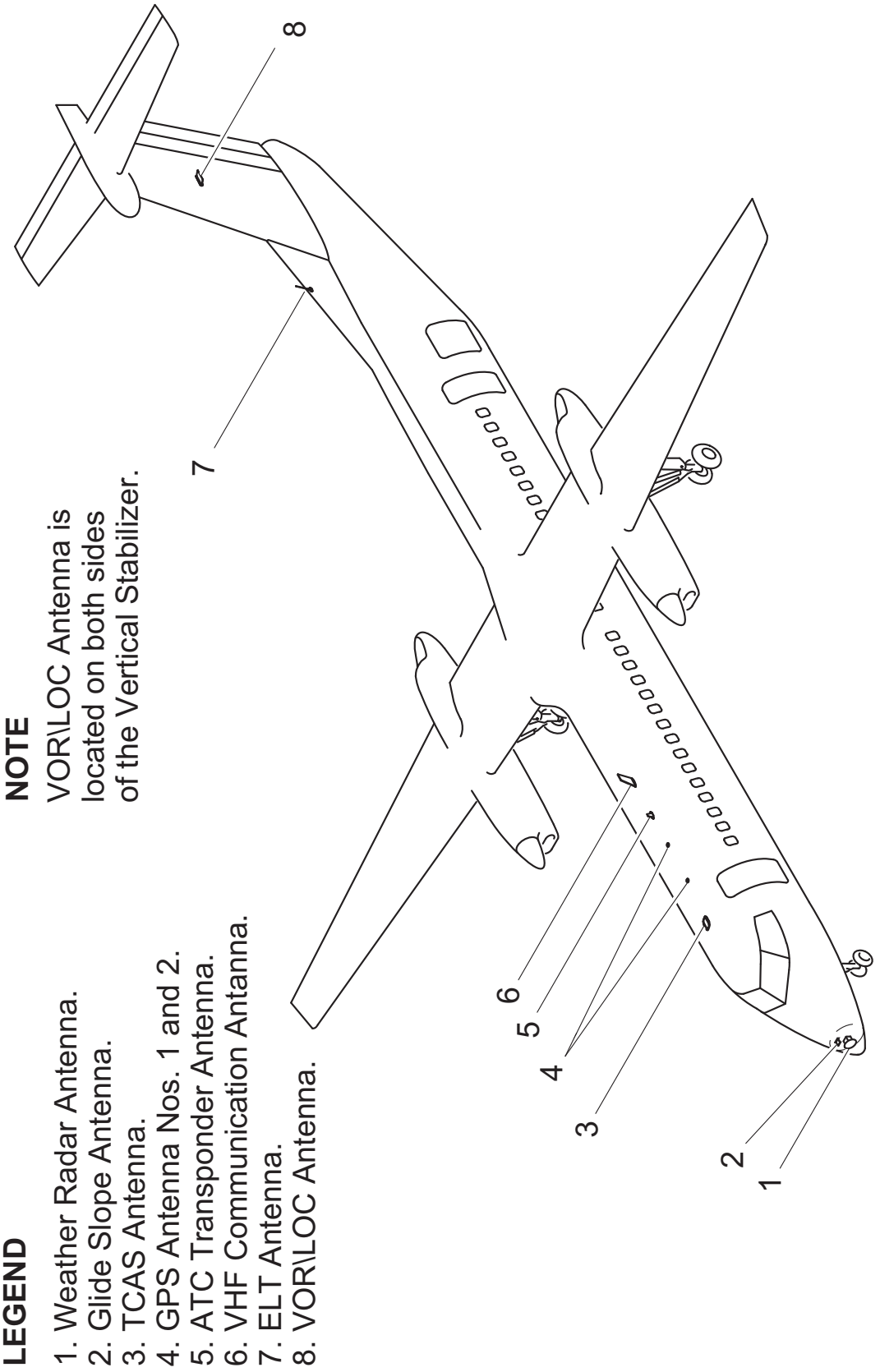


Figure 12.15-37 Navigation and Communication Antenna Locations (1 of 2)

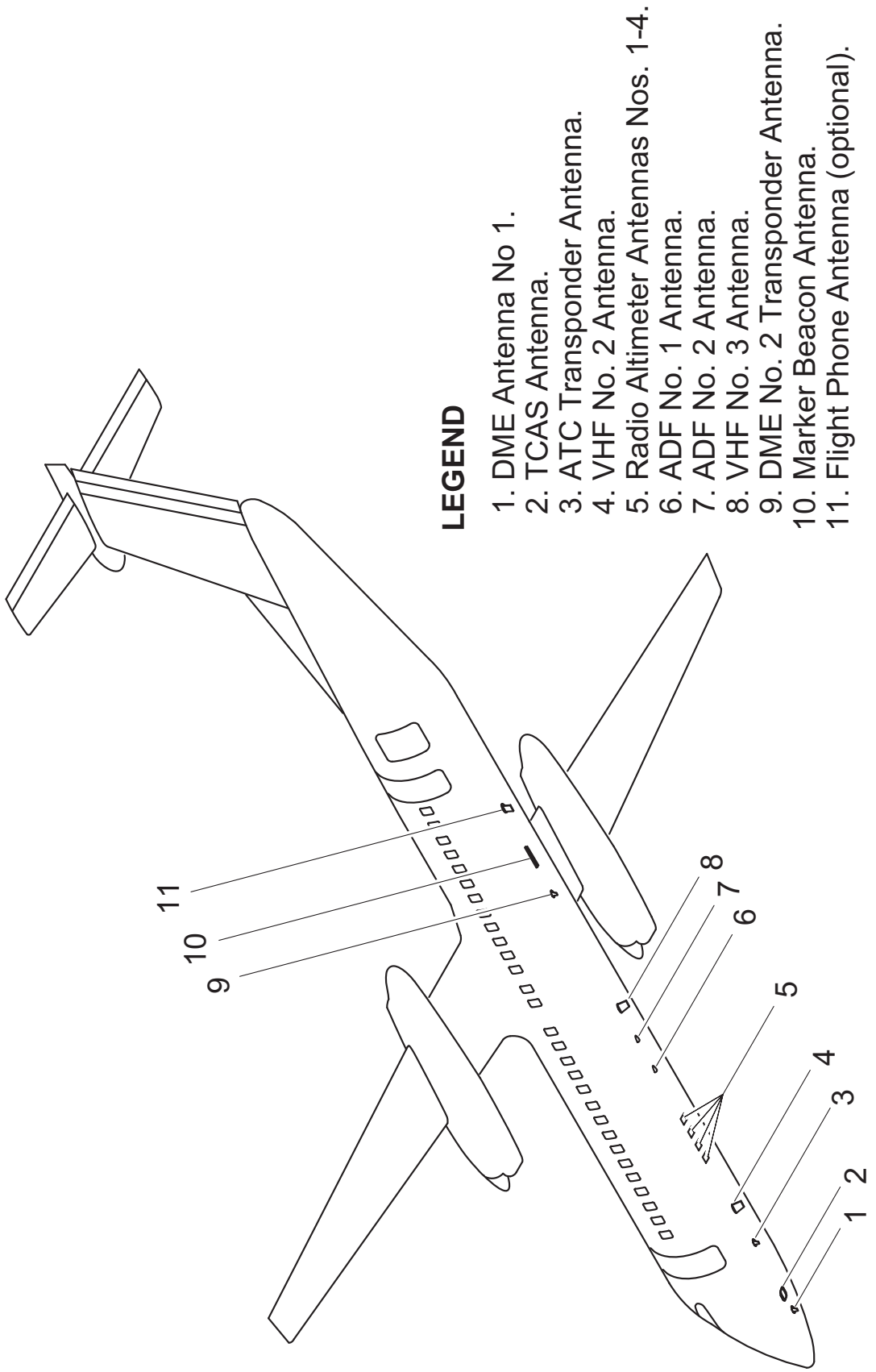


Figure 12.15-38 Navigation and Communication Antenna Locations (2 of 2)

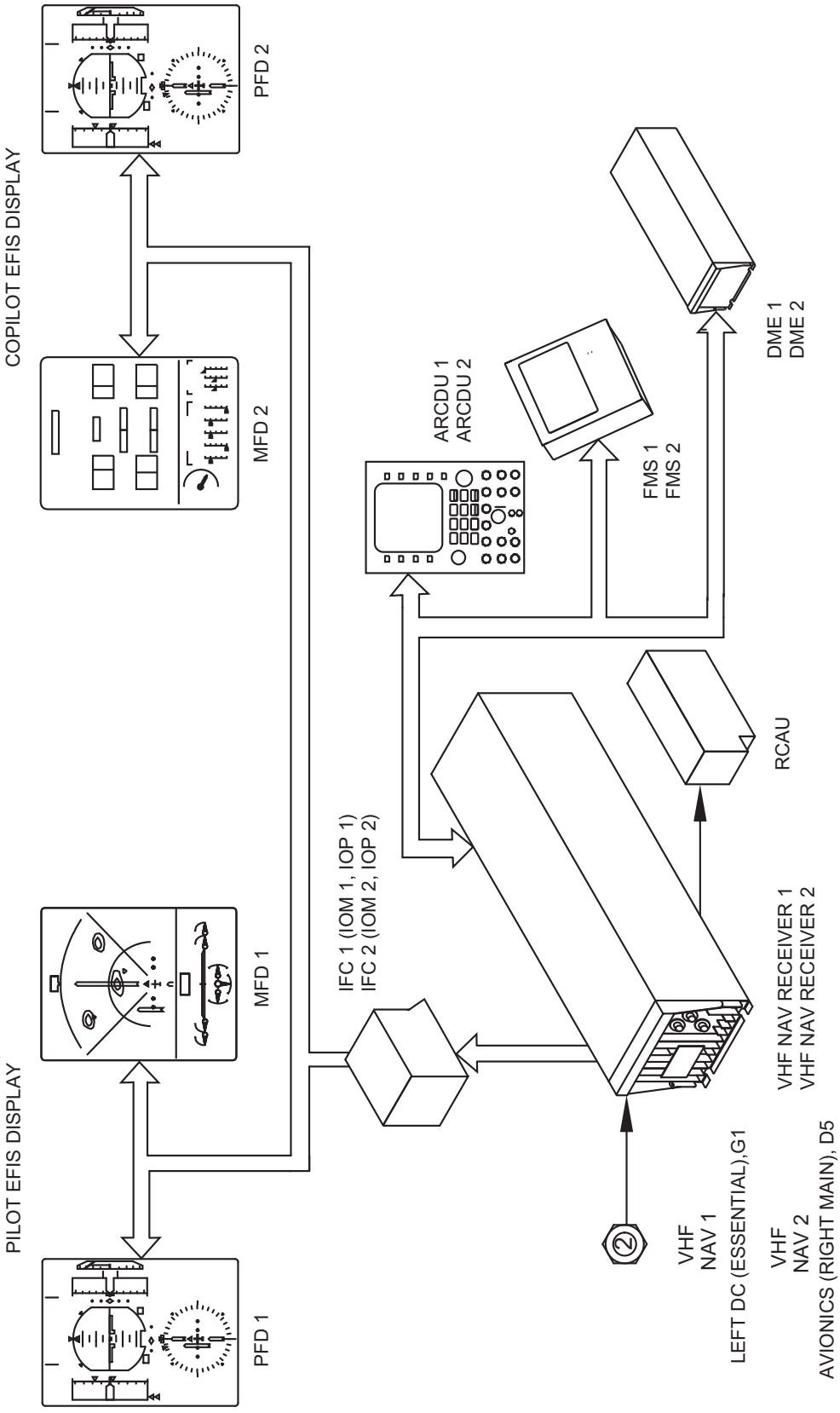


Figure 12.15-39 VHF Nav Schematic

12.15.4 VHF Navigation

Dual VHF navigation systems (Figure 12.15-39) give reception of:

- VOR
- Localizer
- Glideslope
- DME
- Marker-beacon signals

12.15.4.1 VOR/ILS

The VOR gives guidance on any track to or from a VOR, VOR/DME, or a VORTAC station. The Instrument Landing System (ILS) is an integrated system that gives the approach flight path to landing on a runway.

The two VHF Navigation System operates in VOR or ILS mode depending on frequency selection:
- VOR reception extends from 108.00 to 117.95 MHz with 50 kHz even spacing
- Localizer signals are received from 108.10 to 111.95 MHz with 50 kHz odd spacing and associated with glideslope reception.

The VHF receivers are controlled by the components that follow:
- Audio and Radio Control Display Units (ARCDU1, ARCDU2)
- Flight Management System (FMS)

The ARCDU manually tunes the VOR and ILS (Localizer and paired Glideslope) frequencies. The FMS provides automatic tuning.

The Electronic Instrument System (EIS) shows the information that follows:
- VOR bearing course
- VOR lateral deviation
- Localizer lateral deviation
- Glideslope vertical deviation
- Marker beacon passage

COURSE selector knobs on each FGCP select the desired course on the EIS.

The VHF Navigation Receivers (VHF NAV1, VHF NAV2) supply navigation data to the systems that follow:
- Flight Guidance Modules (FGM1, FGM2)
- Audio and Radio System (ARMS)
- Input/Output Processors (IOP1, IOP2)
- Distance Measuring Equipment (DME)
- Flight Management System (FMS)

12.15.4.2 Marker Beacon Receiver

The dual marker beacon receivers are integral to the dual VOR/LOC navigation receivers. The marker beacon receivers turn on a blue legend (OUT) at the outer marker, an amber legend (MID) at the middle marker, and a white legend (INN) at the inner/airway marker. The marker beacon indicator lights are shown on each. Marker beacon sensitivity may be selected to HI or LO from the ARCDU on the CENTER console.

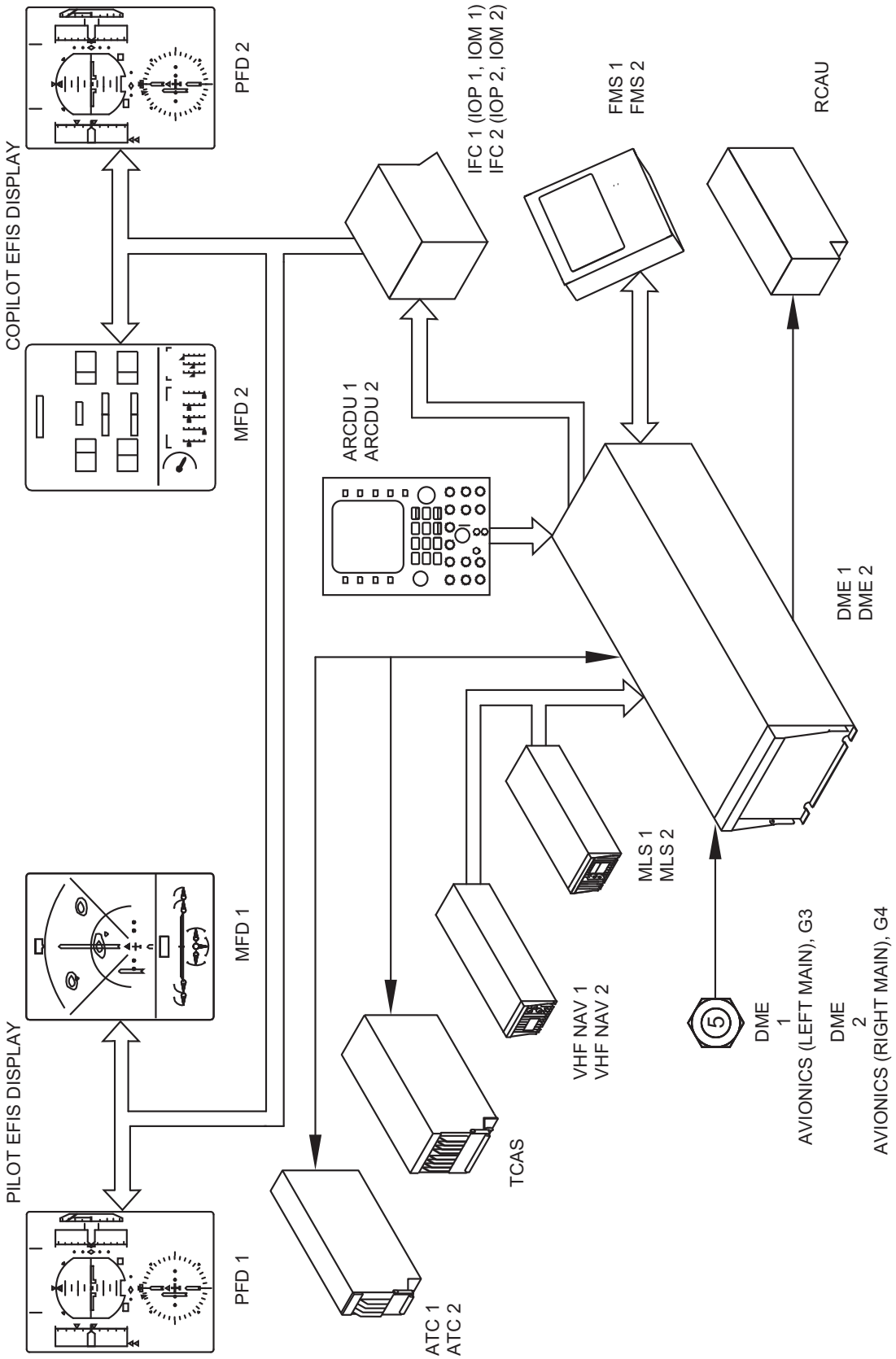


Figure 12.15-40 DME Schematic

12.15.4.3 Distance Measuring Equipment (DME)

The VHF Navigation Receivers (VHF NAV1, VHF NAV2) tune the Distance Measuring Equipment (DME1, DME2) from an Audio and Radio Control Display Units (ARCDU1, ARCDU2) selection (Figure 12.15-40). A DME HOLD selection is used to keep the current DME station active when a new frequency is selected.

The Electronic Flight Instrument System (EFIS1, EFIS2) shows the DME parameters that follow:
- Slant Range
- Ground Speed
- DME Hold

The Distance Measuring Equipment (DME) system supplies data from multiple ground stations to the Flight Management System (FMS) to calculate its position-fixing algorithm.

The DME supplies data to the systems that follow:
- Audio and Radio System (ARMS)
- Input/Output Processors (IOP1, IOP2)
- Traffic Alert and Collision Avoidance System (TCAS)
- ATC Transponder (ATC1, ATC2)
- Flight Management System (FMS)

Pilot’s EFIS displays use information provided by DME #1 and co-pilot’s EFIS displays use information provided by DME #2. Data displayed on pilot’s displays for VOR #1 is obtained from Channel #1 of DME #1, and for VOR #2 is from Channel #2 of DME #1. Similarly, on co-pilot’s side the information is obtained from Channel #1 of DME #2 for VOR #1, and from Channel #2 of DME #2 for VOR #2. In case of loss of a DME, both EFIS sides will automatically use the remaining DME receiver.

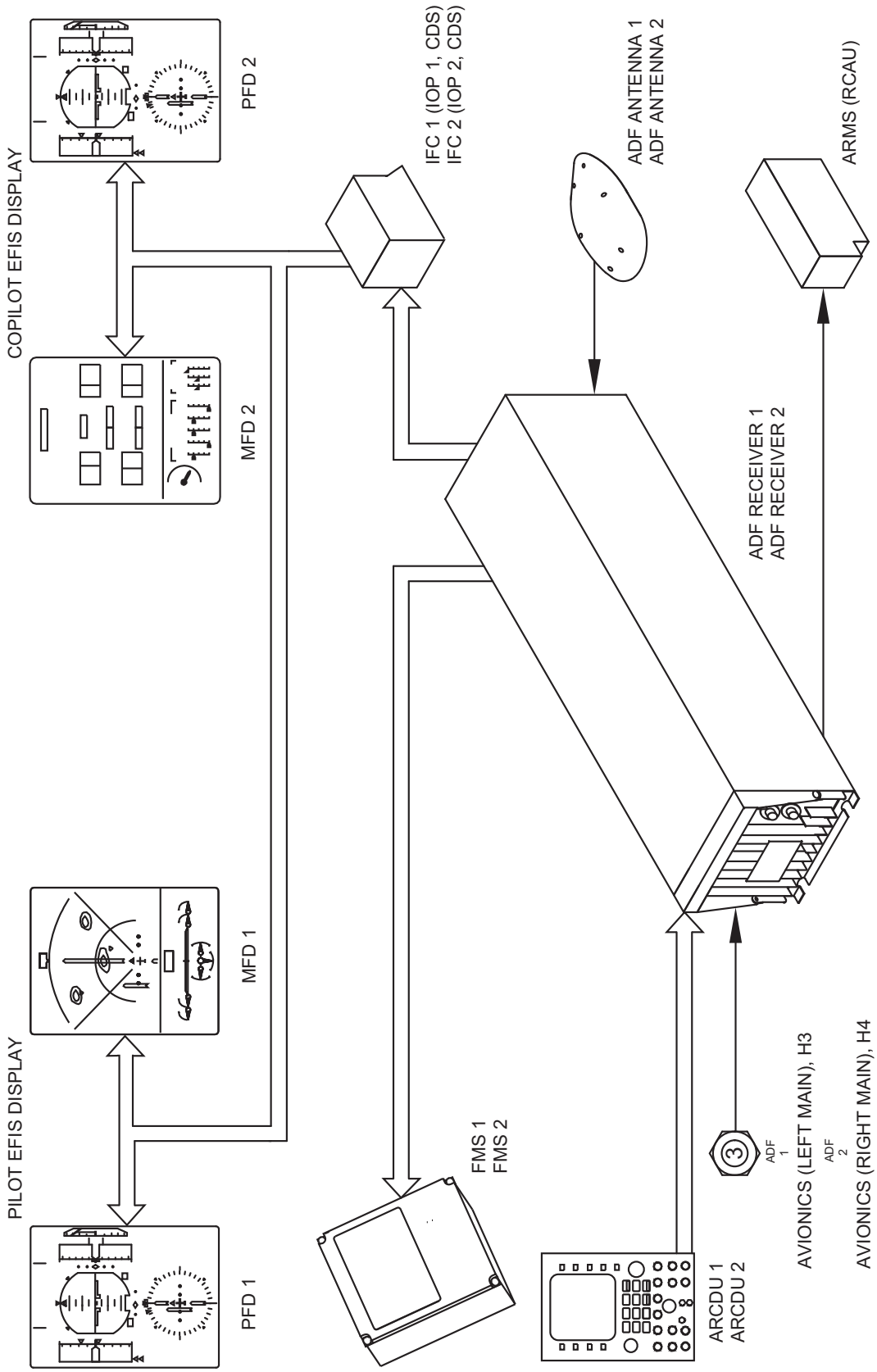


Figure 12.15-41 ADF Schematic

12.15.6 Automatic Direction Finder (ADF)

Two Automatic Direction Finding (ADF 1, ADF 2) systems (Figure 12.15-41) function independently to continuously show the magnetic bearing to the selected ground stations.

The ADF system is controlled by the components that follow:
- Audio and Radio Control Display Units (ARCDU1, ARCDU 2)
- Flight Management System (FMS 1, FMS 2)

The Audio and Radio Control Display Units (ARCDU1, ARCDU 2) are used to manually tune the ADF system frequencies and to control the audio level. The Flight Management System (FMS) is used to tune the ADF frequencies when the Audio and Radio Control Display Unit (ARCDU1, ARCDU 2) malfunctions.

The ADF Receivers (ADF 1, ADF 2) supply data to the systems that follow:
- Audio and Radio Management System (ARMS)
- Input/Output Processors (IOP 1, IOP 2)
- Flight Management System (FMS)

The Automatic Direction Finding (ADF 1, ADF 2) systems function in the modes that follow:
- ADF, Automatic Direction Finding
- ANT, Antenna
- BFO, Beat Frequency Oscillator
- Test

12.15.6.1 ADF Mode

In the ADF mode, the Electronic Instrument System (EIS) shows the bearing of the aeroplane relative to the selected ground station.

12.15.6.2 ANT Mode

In the ANT mode, the receiver functions as an audio receiver to identify stations. The loop antenna is disabled to give a higher audio sensitivity than in ADF mode. The ADF bearing pointer parks at 90 degrees relative bearing.

12.15.6.3 Beat Frequency Oscillator (BFO) Mode

In the BFO mode, an intermittent 1000 Hz audio tone is heard when the ADF receives a valid transmission that identifies the station.

The ADF system continues to show the bearing of the aircraft relative to the selected ground station in the BFO mode when ADF mode is selected.

12.15.6.4 Test Mode

The TEST mode is a confidence test. It causes the bearing pointer of the ADF receiver under test to park at a relative bearing of 90 degrees.

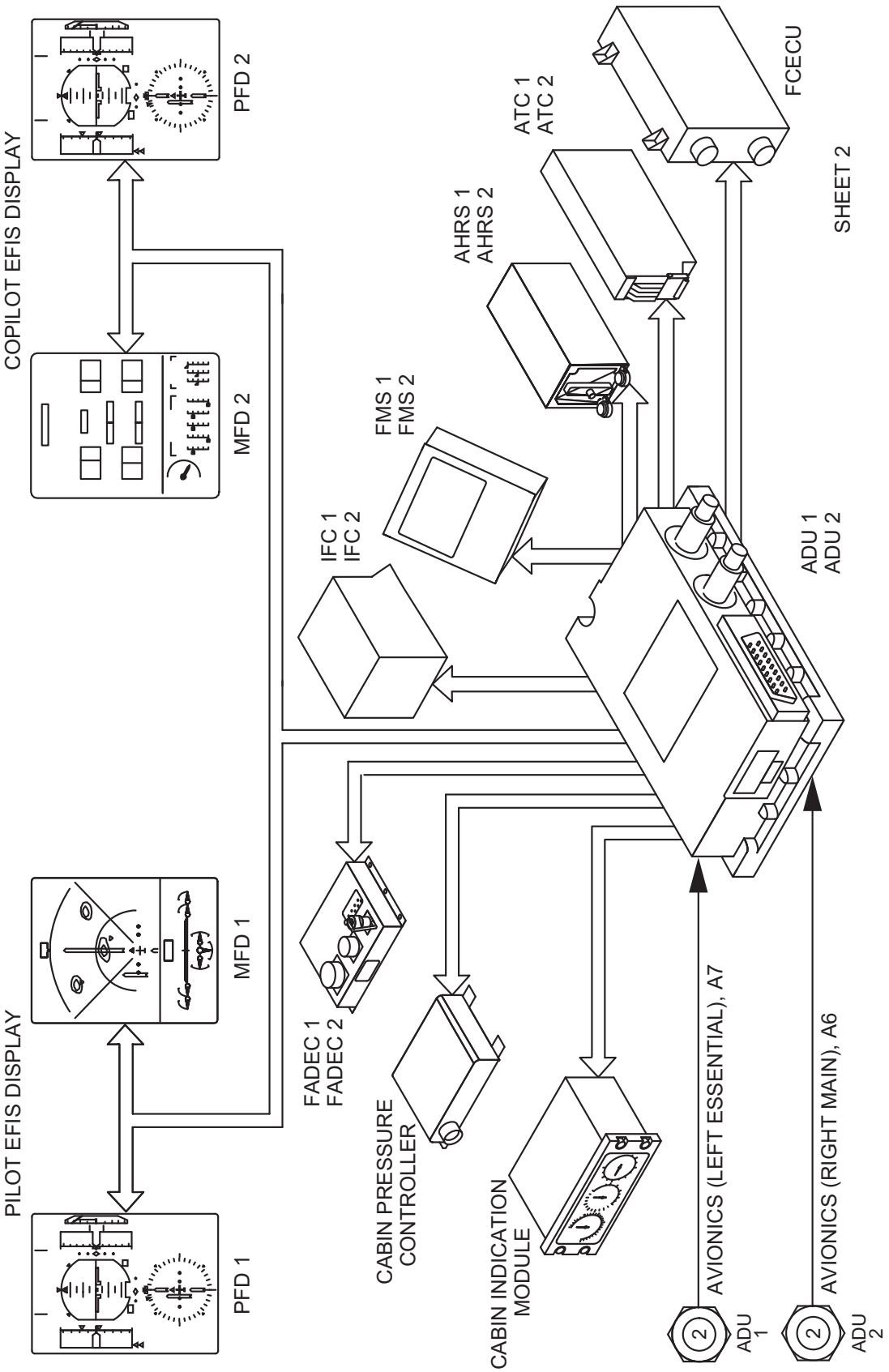
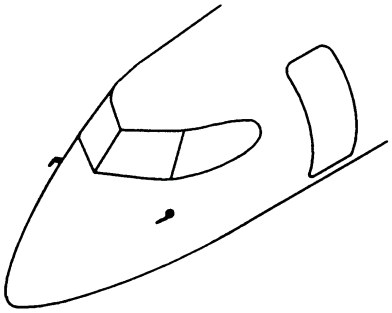


Figure 12.15-42 Outputs Schematic



NOTE

Left component shown.
Right component similar.

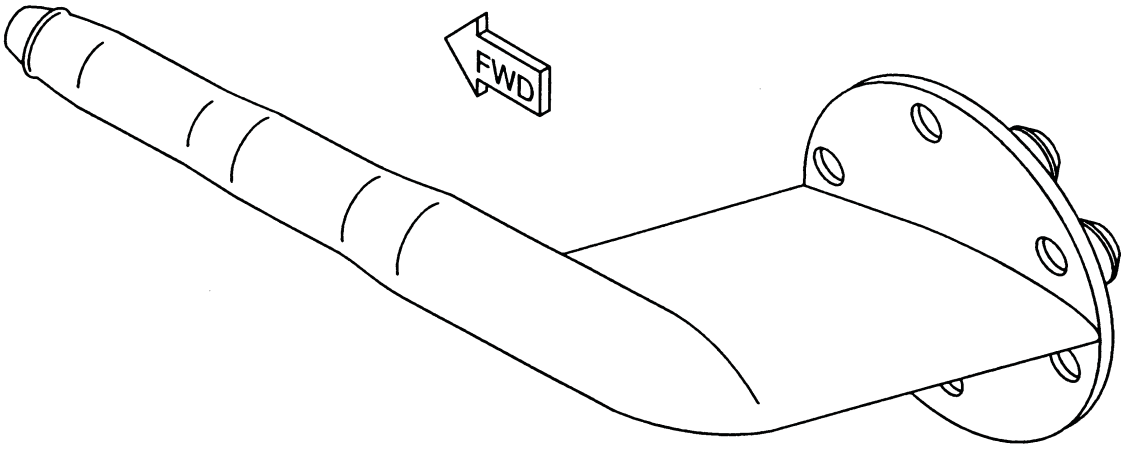


Figure 12.15-43 Pitot Static Probe

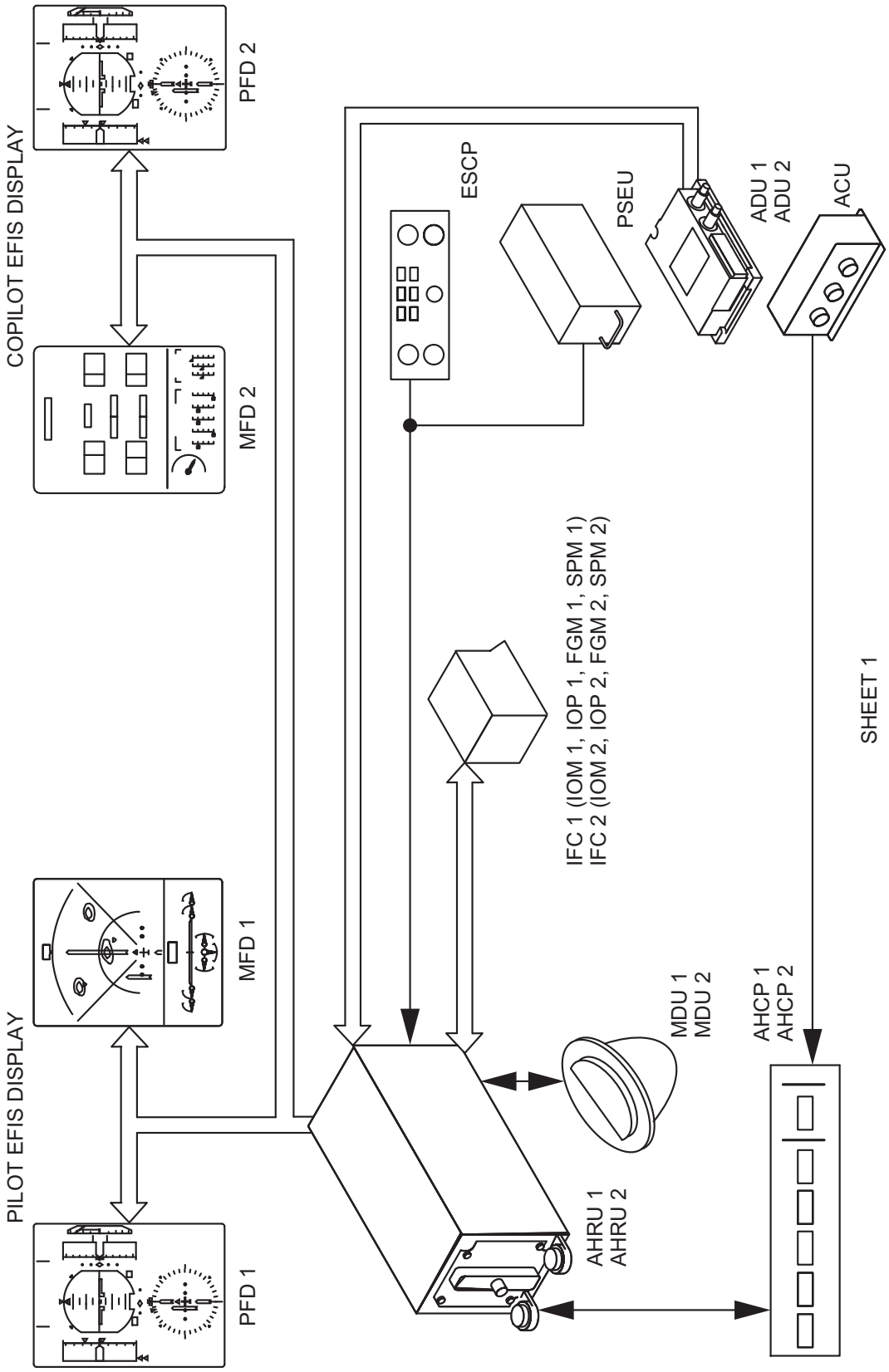


Figure 12.15-44 AHRS Schematic

12.15.7 Attitude/Heading Reference System

The Attitude and Heading Reference System (AHRS) has:

- Two AHRS control panels (AHCP1, AHCP2)
- Two Attitude/Heading Reference Units (AHRU1, AHRU2)
- Two remote flux valves (FDU1, FDU2)
- Two remote Memory Modules (RMM1, RMM2)

The Attitude and Heading Reference Unit (AHRU) supplies specific attitude and heading parameters directly to the systems (Figure 12.15-44) that follow:

- Electronic Instrumentation System (EIS)
- Auto Flight Control System (AFCS)
- Stall Protection System (SPS)

The Electronic Instrumentation System (EIS) shows the Attitude and Heading Reference Units (AHRU 1, AHRU 2) parameters that follow:

- Electronic Attitude Direction Indicator (EADI1, EADI2)
- Electronic Horizontal Situation Indicator (EHSI1, EHSI2)
- Altitude (ALT1, ALT2) displayed on the PFDs
- Inertial Vertical Speed Indicator (IVSI1, IVSI2)

The AHRU also supplies specific attitude and heading data to the systems that follow through the two Integrated Flight Cabinets (IFC1, IFC2):

- Flight Data Recorder (FDR)
- Flight Data Processing System (FDPS)
- Weather Radar (WXR)
- Ground Proximity Warning System (GPWS)
- Traffic Collision Avoidance System (TCAS)
- Central Diagnostic System (CDS)

The AHRU uses vertical and directional gyros and accelerometers to sense rate of aeroplane movement, which is then provided to the pilot as pitch, roll, and heading information.

AHRS uses the ADC altitude as a long term reference (time constant equal to 20 sec.) in order to slave the vertical channel. AHRS delivers a baro-inertial vertical speed and a baro-inertial altitude to each PFD.

AHRS selects ADC input according to the ADC source reversion controlled by crew. PFD also selects the ADC altitude source according to the ADC source reversion controlled by the crew. When the damped information, coming from AHRS is available, this AHRS altitude is displayed.

When the AHRS altitude is not valid, PFD displays uncorrected (for accesleration), ADC altitude only. Therefore, altitude is only failed when selected ADC is failed, independently of AHRS altitude validity.

This is not the case with IVSI information. Loss of AHRS or ADC will cause IVSI FAIL, until a manual reversion is performed.

The AHRS operating modes are:
- Alignment
- NORMAL mode for attitude
- SLAVED mode for heading

These modes automatically initialize, if all system components and signals are correct during power-up.

Two reduced-performance modes are also available:
- BASIC mode for attitude
- DG (directional gyro) mode for heading

During normal operation with the EFIS ATT/HDG SOURCE reversion selector set to NORM on the ESID Control Panel (ESCP), the Primary Flight Displays (PFD1, PFD2) will show data from their related Attitude and Heading Reference Units (AHRU1, AHRU2).

12.15.7.1 Operating Modes

Alignment

The alignment mode automatically starts at the end of a 5 second Power-On Self Test (POST) mode if no malfunctions are found. AHRU1, AHRU2 parameters are available 20 seconds after the alignment mode starts. The alignment mode continues for 60 seconds on the ground and 90 seconds in-flight. If the AHRS does not initialize after the required time, the system must be re-initialized.

The ATT/HDG ALIGN annunciator switch located on the AHRS Control Panel (AHCP) is pushed to make an Alignment Mode selection. An amber bar in the ATT/HDG ALIGN annunciator switch comes to show the alignment mode and the two Electronic Attitude Direction Indicators (EADI1, EADI2) show an ALIGNING message.

A re-alignment mode may be set using the AHRU Control Panels (AHCP1, AHCP2) when the aeroplane is on the ground or in flight. The aeroplane must be in unaccelerated straight and level flight when a re-alignment mode selection is made in flight.

- Crew may also initiate alignment mode at any moment in order to re-initialize attitude and heading in case of degradation.
- The aeroplane must not be moved during the alignment on ground, after Power “ON” of AHRS or if re-alignment mode is selected by the crew.

Normal Mode

True Air Speed (TAS) from the ADU is used to compensate for acceleration induced attitude error. Barometric altitude is used to calculate vertical speed data for long term reference. In the short term, acceleration measurements provide vertical speed variations.

Normally, the AHRU uses its related ADU's parameters. If the related parameter is not correct, a manual ADU reversion is initiated, using the EFIS ATT/HDG SOURCE reversion selector set to 1 or 2 on the ESID Control Panel (ESCP). In this case, the other ADU is used to supply True Air Speed (TAS) and barometric altitude (Zb) parameters.

The Attitude Heading Reference Unit (AHRU) monitors its on side ADU input. If it fails completely, the AHRU automatically reverts to use the other ADU.

Slaved Mode

When functioning in the slaved mode for heading, the AHRU slaves its inertial heading with analog magnetic heading information calculated from analog signals from the flux valve. It uses data from the FDU to calculate the magnetic heading and compensate for heading error caused by directional gyro drift.

The AHRU monitors the FDU. It causes the EIS to show a heading failure flag when the magnetic heading input from the FDU malfunctions.

12.15.7.2 Reduced-Performance Modes

Basic Mode

In the normal mode, if the TAS parameter is not available, the basic mode is automatically started. Operation in BASIC mode will cause decreased attitude accuracy, and the EADI will behave like a conventional mechanical gimbaled gyro. A green light on the AHRS Control Panel will come on to indicate the Basic mode.

DG Mode

When a heading error occurs while in the slave mode, the error may be removed by a fast selection of the DG mode and then back to the SLAVED mode. The DG push button switch on the AHRS Control Panel is pushed to start the DG mode and then is pushed again to return the system to the heading mode.

A selection and de-selection of the DG mode immediately causes the system to re initialize to the MDU heading and has no effect on attitude.

In the slaved mode, if an MDU malfunctions, the PFD will show a heading failure flag and a red SLAVE annunciation on the AHRS Control Panel will come on. When the AHRU is set to DG mode, the MDU data is removed from the heading calculation and a DG heading indication is shown on the PFD. The SLAVE annunciation remains on.

The AHRU is set to the DG mode, when the flux valve malfunctions or during degrade performance when flying close to the magnetic poles.

When the DG mode is set, the Attitude and Heading Reference Units (AHRU1, AHRU2) do not receive magnetic data from the flux valves. The heading is manually corrected by a plus or minus selection using the Attitude and Heading Control Panels (AHCP1, AHCP2).

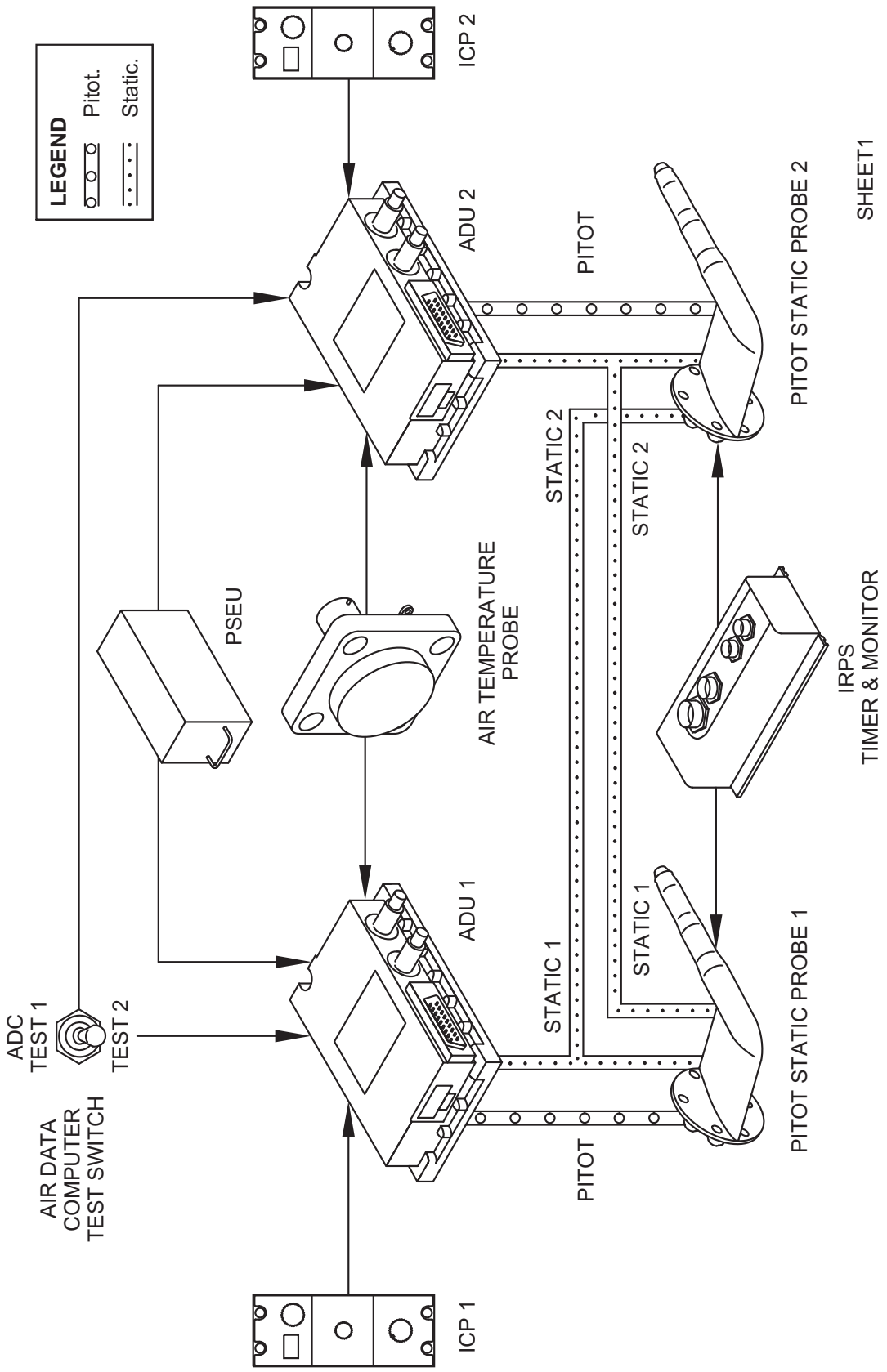


Figure 12.15-45 ADU Inputs Schematic

12.15.8 Air Data System

Two primary channel Air Data Units (ADU1, ADU2) function independently and receive inputs (Figure 12.15-45) from:

- Two pitot static probes
- Air temperature probe
- Index Control Panel (ICP1, ICP2)
- PSEU
- ADC test switch

Total and averaged static pressure values are sent to the ADUs from the primary heated pitot/static probes. The probe tube encases a heating element with a self regulating power consumption feature to prevent ice accumulation on the pressure probes and help eliminate erroneous total and static measurements. Each of the pitot static probe heaters are controlled by a separate PITOT/STATIC PORTS switch on the ice protection panel.

The static temperature probe has two sensors. Each sensor is connected to one ADU in order to supply the aircraft system with two independent temperature values.

The ADU receives a barometric correction from the Index Control Panel (ICP) to calculate the barometric altitude.

The Air Data System (ADS) senses and converts static pressure, pitot (impact) pressure, and static air temperature to electronic data for use by the systems that follow:

- Cabin Pressure Control
- Flight Guidance
- Flight Controls
- Indication
- VMO/MMO Warning
- Navigation
- Powerplant Operation

During normal operation with the EFIS ADC SOURCE reversion selector set to NORM on the ESID Control Panel (ESCP), the Primary Flight Displays (PFD1, PFD 2), and the Multifunction Displays (MFD1, MFD2) will show data from their related Air Data Units (ADU1, ADU2).

The Electronic Instrument System (EIS) shows the Air Data Unit (ADU1, ADU2) parameters that follow:

- Indicated Air Speed (IAS) displayed on the PFDs
- True Airspeed (TAS) displayed on the MFD NAV page
- Static Air Temperature (SAT) displayed on the ED
- Baro-inertial altitude on the PFDs (ADU altitude compensated with the inertial altitude AHRS)
- Baro-correction setting on the PFDs

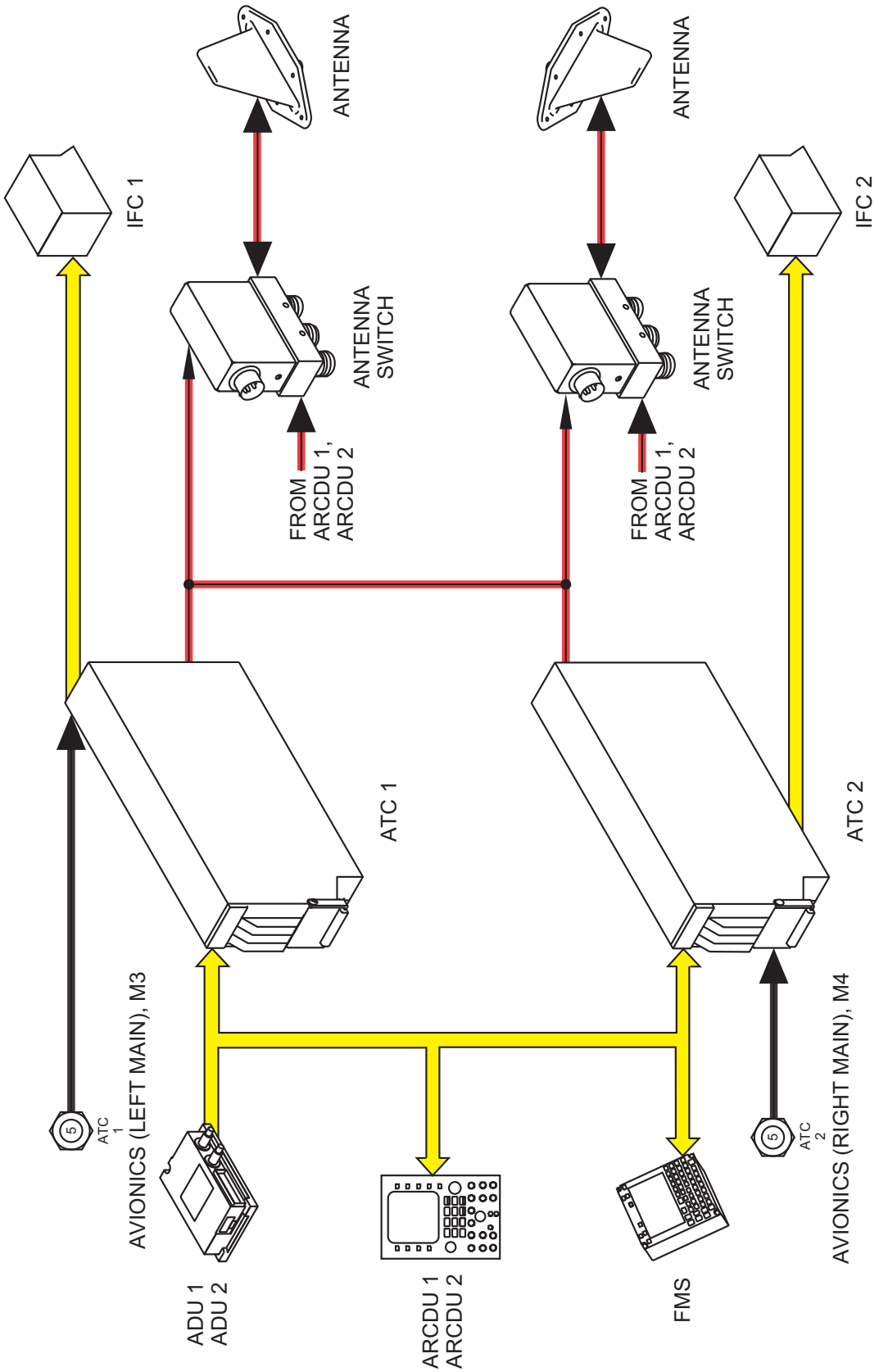


Figure 12.15-46 Transponder Schematic

12.15.9 Transponder

The Mode S Transponder system (Figure 12.15-46) transmits a signal to identify the aeroplane and its altitude parameters to Air Traffic Control (ATC) ground stations and to other aeroplane equipped with Traffic Alert and Collision Avoidance System (TCAS).

It transmits the information that follows:
- Altitude
- Maximum airspeed
- TCAS
- Mode S Identifier of the aeroplane

In addition, the interrogating Air Traffic Control (ATC) ground station or other aeroplane fitted with Traffic Collision Avoidance System (TCAS) determines aeroplane's range and azimuth.

The Mode S Transponder system has two transponders (ATC1, ATC2). One transponder operates in the active mode and the other will automatically operate in the standby mode.

The Mode S Transponder system interfaces with both of the Audio and Radio Control Display Units (ARCDU1, ARCDU2) and the Flight Management System (FMS). Pilot inputs to the ARCDU and the FMS control the operating modes of the transponder. In addition to mode selections, the ARCDU1and the FMS sends a pilot selected four-digit octal code to the transponders.

The Mode S Transponder system interfaces with the Air Data System (ADS). It converts altitude information from the ADS into formats required for Mode C and Mode S replies.

12.15.9.1 Mode S Transponder System for Elementary and Enhanced Surveillance (MS 4-309226, MS 4-901280 or MS 4-457297)

To ensure the safe and reliable detection of aircraft by Air Traffic Control, some European states have issued requirements for the carriage and operation of airborne equipment compliant with Mode S, Elementary and Enhanced Surveillance.

Enhanced Surveillance consists of the following equipment:

Description	Part number	Mode Number	Quantity
ATC Transponder	066-01143-2101	MST-67A	2
Flight Management System (FMS)	2017-14-221, (SCN 802.2 or higher)	UNS-1E	1 or 2

The installed Mode S transponder system has been shown to comply with the requirements of JAA Temporary Guidance Leaflet, TGL-13, Revision 1, Certification of Mode S Transponder Systems for Elementary Surveillance (ELS). The following aircraft derived data are transmitted by the transponder for ELS: Aircraft Indentification, Capability Report, Pressure Altitude, and Flight Status. The UNS-1E FMS is used to enter the Aircraft Identification for transmission by the Mode S transponder.

The installed Mode S transponder system has been shown to comply with the requirements of JAA NPA 20-12a, Certification of Mode S Transponder Systems for Enhanced Surveillance (EHS), except for Selected Altitude" parameter, and satisfies the data requirements of ICAO Doc 7030/4, Regional Supplementary Procedures for SSR Mode S Enhanced Surveillance in designated European airspace.

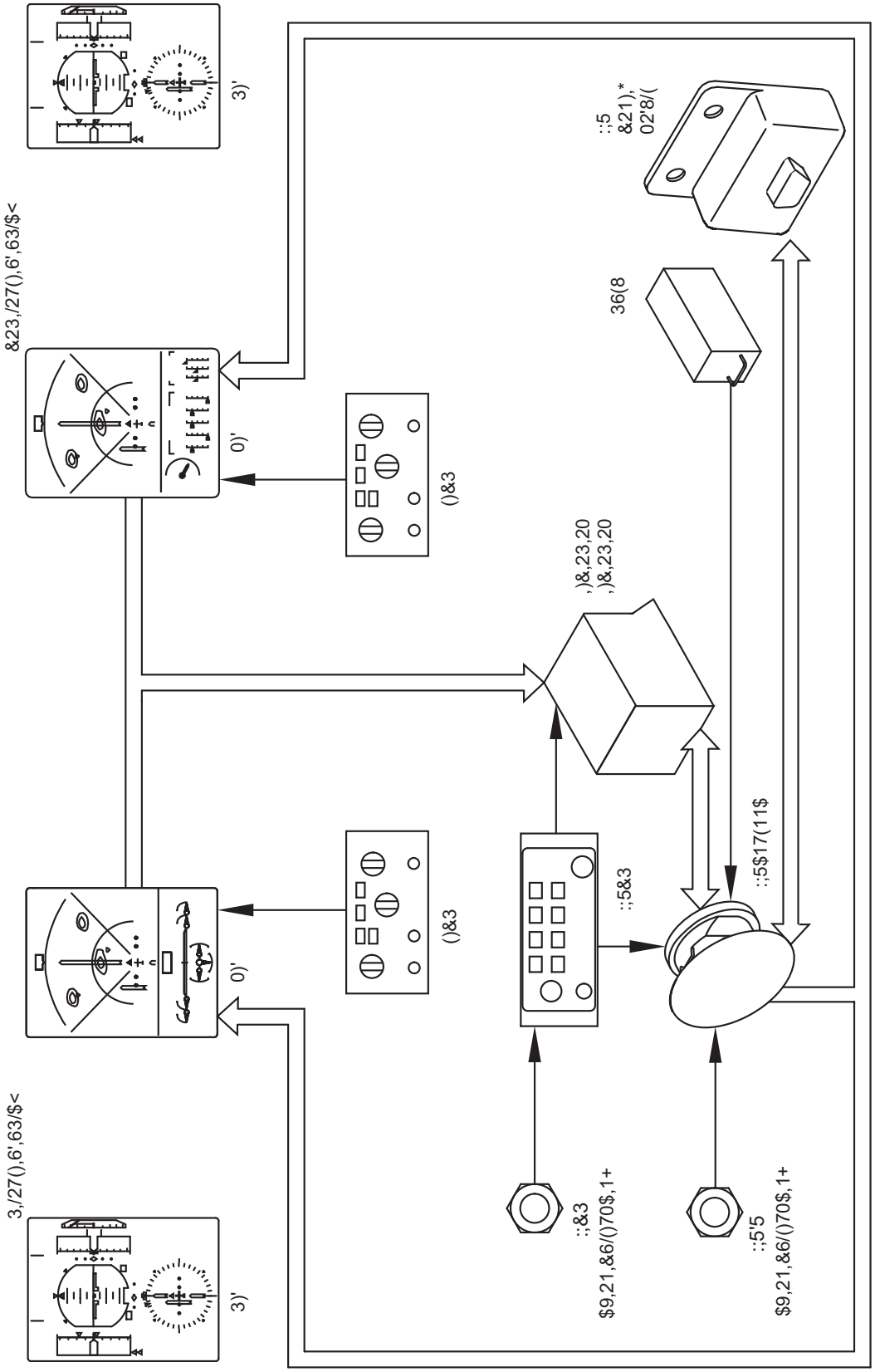


Figure 12.15-47 Weather Radar Schematic

12.15.10 Weather Radar

The weather radar system (Figure 12.15-47) helps the pilot to avoid thunderstorms and associated turbulence. When selected, it supplies a continuous visual colour display of the weather conditions to the Multi-Function Displays (MFD1 and MFD2). Precipitation intensity levels are displayed in various colors against a black background. Heavy rainfall is shown in red, medium intensity is shown in yellow and the weakest intensity returns are green.

The radar system supplies the flight crew with operational features such as:
- range selection
- ground mapping
- target alert
- fault annunciations

WXR system related controls (i.e. WXR display brightness, range selection, arc/full navigation display mode selection) are controlled by the Electronic Flight Instrument System (EFIS) and are accessible to each flight crew member by their related EFIS Control Panel (EFCP) and Weather Radar Control Panel (WXCP). Each pilot has the option of setting the range independent of the other pilot.

The Weather Radar supplies data to the systems that follow:
- Pilot and copilot Multi Function Displays (MFD1, MFD2)
- Input/Output Processors (IOP1, IOP2)

The weather radar does not detect clouds, thunderstorms or turbulence directly. Instead, it detects precipitation which may be associated with thunderstorms and turbulence. The best radar reflectors are raindrops, wet snow or hail. The larger the raindrop the better it reflects. Large drops in a small concentrated area are characteristic of a severe thunderstorm, the MFD shows the storm as a strong echo. Drop size is the most important factor in high radar reflectivity. The larger the raindrop the better it reflects. Generally, ice, dry snow and dry hail have low reflective levels and often will not be shown on the MFD.

A cloud that has only small raindrops, such as fog or drizzle, will not produce a measurable radar echo.

Illumination of terrain results in a "diffused" reflection of the beam. A portion of this reflected energy is scattered back toward the antenna and land features as well as lakes, large rivers, shore lines and ships come into view on the display.

TILT and GAIN must be carefully adjusted and balanced for different terrain and precipitation types to obtain the best picture. The radar range may be selected from 10 to 240 nautical miles. Weather returns are painted best at shorter ranges.

WARNING The system is only for weather detection and ground mapping. It should not be used nor relied upon for aeroplane proximity warning or anti-collision.

WARNING Do not operate the radar in any mode except standby if personnel are within 100 feet or if any large metallic objects (hangars, fuel trucks, other aeroplane, etc.) are within 500 feet in the 120° area scanned by the radar. Do not operate radar during refueling of aeroplane or during any nearby refueling operation.

NOTE: The weather radar should be in standby mode while taxiing.

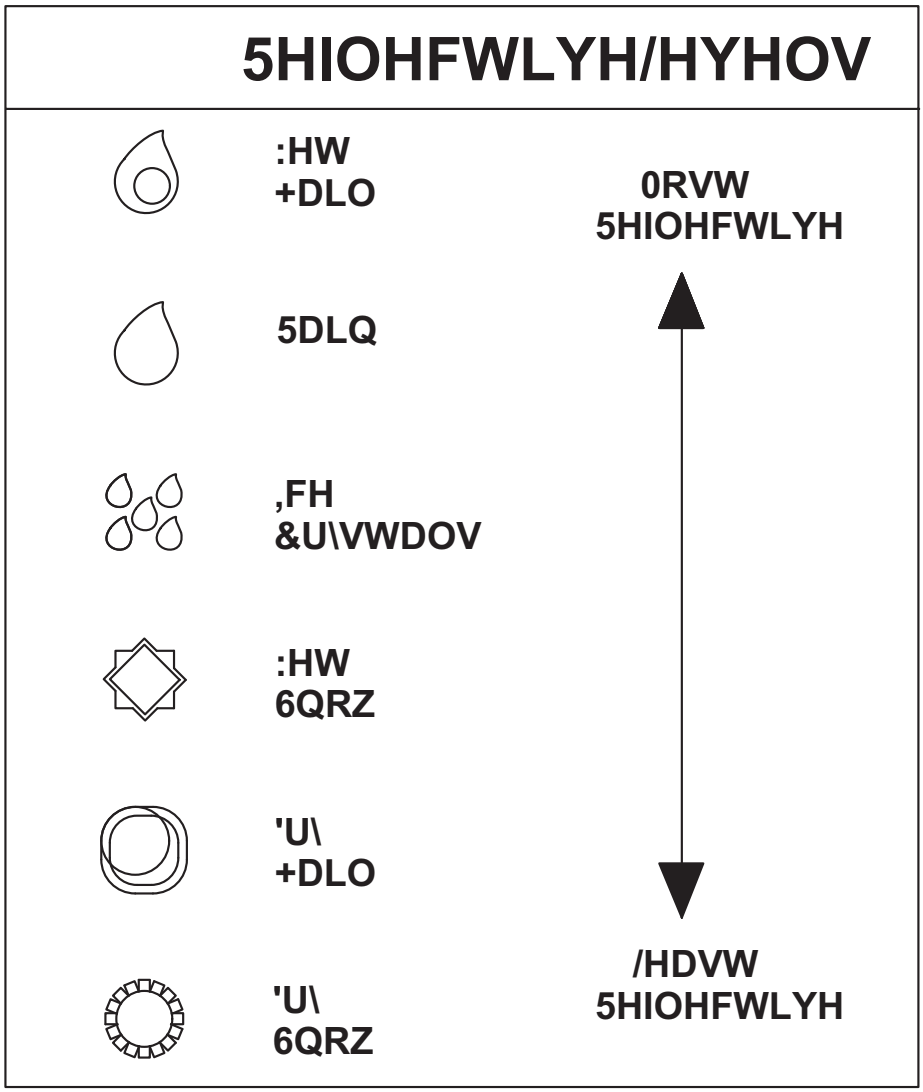


Figure 12.15-48

12.15.11 Flight Management System (FMS) UNS-1E

System description corresponds to Supplement 73 of the AFM, and covers both dual and single FMS installation.

12.15.11.1 General

NOTE: As installed, indicated by Aircraft Briefing Card

DESCRIPTION: **HONEYWELL PRIMUS® 660 DIGITAL WEATHER RADAR SYSTEM**

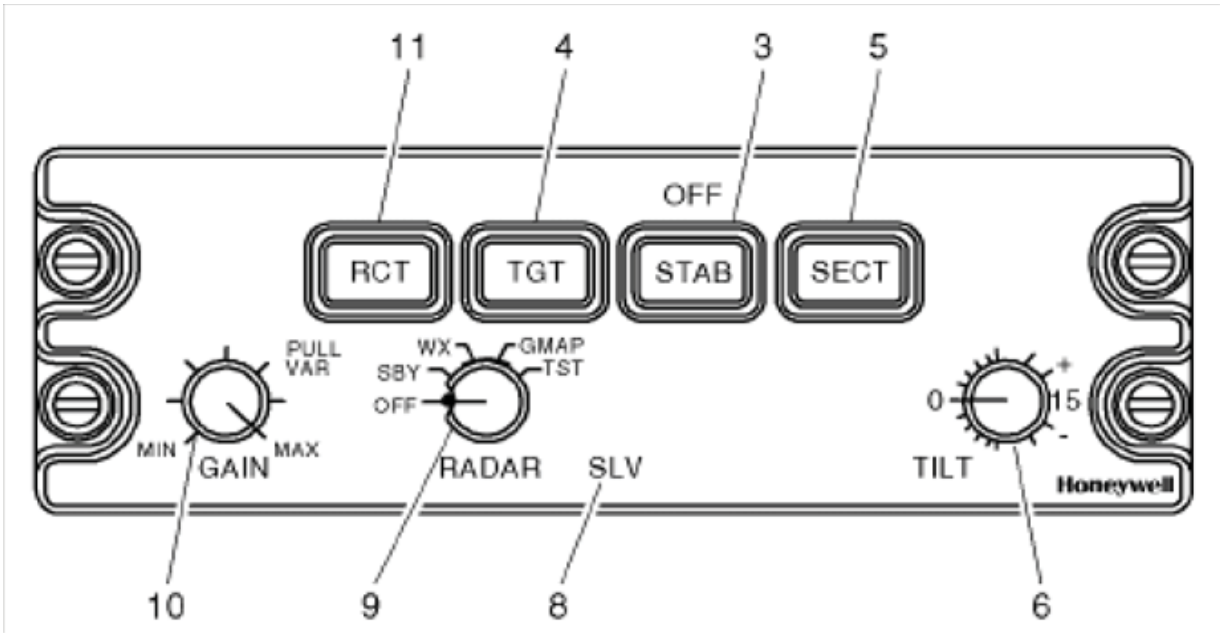
The weather radar system (Figure 12.15-47) helps the pilot to avoid thunderstorms and associated turbulence. When selected, it supplies a continuous visual colour display of the weather conditions to the Multi-Function Displays (MFD1 and MFD2). Precipitation intensity levels are displayed in various colors against a black background. With the Honeywell X-band digital Primus P-660 weather unit, the heaviest rainfall intensity is shown in magenta, the next lower level in red, the next lower level in yellow, and the least rainfall intensity is shown in green.

The Honeywell PRIMUS® 660 Digital Weather Radar System consists of a Receiver/Transmitter/Antenna and Weather Radar Control Panel that are integrated with the aircraft's avionics system. The PRIMUS® 660 Digital Weather Radar System provides weather and ground mapping information independently to the No. 1 and No. 2 Multi-Functional Displays (MFD).

Weather radar information or an EGPWS terrain map may be alternately selected on each MFD using the EFIS Control Panel (EFCP) while airborne or on the ground. The PRIMUS® 660 Digital Weather Radar System will normally go to the forced standby mode when the aircraft is on the ground. However, ground operation may be restored by use of the STAB push-button.

The DHC-8 Series 400 PRIMUS® 660 Digital Weather Radar System configuration requires the following minimum equipment to be functional and operating:

Description	Part Number	Manufacturer	Quantity
Input/Output Processor (IOP)	C12432AA06	Thales	2
Display Unit (DU)	C19190AB05	Thales	2 (MFD)
Receiver/Transmitter/Antenna	7021450-601	Honeywell	1
Weather Radar Control Panel	7008471-687	Honeywell	1



3. STAB (STABILIZATION)

The STAB button turns the pitch and roll stability ON and OFF. It is also used with the hidden modes.

NOTE: Some controllers annunciate OFF when stabilization is OFF.

4. TGT (TARGET)

The TGT switch is an alternate action, button that enables and disables the radar target alert feature. Target alert is selectable in all but the 300 mile range. When selected, target alert monitors beyond the selected range and 7.5 on each side of the aircraft heading. If a return with certain characteristics is detected in the monitored area, the target alert changes from the green armed condition to the yellow TGT warning condition. This annunciation advises the pilot that a potentially hazardous target lies directly in front and outside of the selected range. When this warning is received, the pilot should select longer ranges to view the questionable target. Note that target alert is inactive within the selected range. Selecting target alert forces the system to preset gain. Target alert can only be selected in the WX and FP modes.
In order to activate target alert, the target must have the depth and range characteristics described in the table below.

Selected Range (NM)	Minimum Target Depth (NM)	Target Range (NM)
5	5	5–55
10	5	10–60
25	5	25–75
50	5	50–100
100	5	100–150
200	5	200–250
300	N/A	N/A
FP (Flight Plan)	5	5–55

WC–660 Controller Target Alert Characteristics

5. SECT (SCAN SECTOR)

The SECT switch is an alternate action button that is used to select either the normal 12 looks/ minute 120 scan or the faster update 24 looks/minute 60 sector scan.

6. TILT

The TILT knob is a rotary control that is used to select the tilt angle of antenna beam with relation to the horizon. CW rotation tilts beam upward 0 to 15; ccw rotation tilts beam downward 0 deg to -15 deg. The range between +5 deg and -5 deg is expanded for ease of setting. A digital readout of the antenna tilt angle is displayed on the EFIS.

WARNING

TO AVOID FLYING UNDER OR OVER STORMS, FREQUENTLY ADJUST THE TILT TO SCAN BOTH ABOVE AND BELOW YOUR FLIGHT LEVEL.

8. SLV (SLAVE) (DUAL INSTALLATIONS ONLY)

The SLV annunciator is only used in dual controller installations. With dual controllers, one controller can be slaved to the other by selecting OFF on that controller only, with the RADAR mode switch. This slaved condition is annunciated with the SLV annunciator. The slave mode allows one controller to set the modes of the RTA for both sweep directions. In the slave mode, all EFIS WX displays are indentical and updated on each sweep.
With dual controllers, both controllers must be off before the radar system turns off.

9. RADAR

This rotary switch is used to select one of the following functions.

• **OFF** This position turns off the radar system.

• **STBY (Standby)** This position places the radar system in standby; a ready state, with the antenna scan stopped, the transmitter inhibited, and the display memory erased. STBY is displayed on the EFIS/MFD.

• **WX (Weather)** This position selects the weather detection mode. The system is fully operational and all internal parameters are set for enroute weather detection. If WX is selected before the initial RTA warmup period is complete (approximately 45 to 90 seconds), the WAIT legend is displayed on the EFIS/MFD. In WAIT mode, the transmitter and antenna scan are inhibited and the display memory is erased. When the warmup is complete, the system automatically switches to the WX mode. The system, in preset gain, is calibrated as described in the table below.

Rainfall Rate		Color
in/hr	mm/hr	
.04–.16	1–4	Green
.16–.47	4–12	Yellow
.47–2	12–50	Red
> 2	>5 0	Magenta

Rainfall Rate Color Coding

• **GMAP (Ground Mapping)** The GMAP position puts the radar system in the ground mapping mode. The system is fully operational and all parameters are set to enhance returns from ground targets.

NOTE: REACT or TGT modes are not selectable in GMAP.

WARNING
WEATHER TYPE TARGETS ARE NOT CALIBRATED WHEN THE RADAR IS IN THE GMAP MODE. BECAUSE OF THIS, DO NOT USE THE GMAP MODE FOR WEATHER DETECTION.

As a constant reminder that GMAP is selected, the GMAP legend is displayed in the mode field, and the color scheme is changed to cyan, yellow, and magenta. Cyan represents the least reflective return, yellow is a moderate return, and magenta is a strong return.
If GMAP is selected before the initial RTA warmup period is complete (approximately 45 to 90 seconds), the white WAIT legend is displayed in the mode field. In wait mode, the transmitter and antenna scan are inhibited and the memory is erased. When the warmup period is complete, the system automatically switches to the GMAP mode.

NOTE: Some installations have controllers that have a WX/GMAP select switch. In this case, the radar mode switch provides an ON selection. The separate WX/GMAP switch is used to select either WX (weather) or GMAP (ground mapping).

• **FP (Flight Plan)** The FP position puts the radar system in the flight plan mode, that clears the screen of radar data. This allows the radar controller to select a range for display (on EFIS) of mapping information at very long ranges.

NOTE: In the FP mode, the radar RTA is put in standby, and the FLTPLN legend is displayed in the mode field.

The target alert mode can be used in the FP mode. With target alert on and the FP mode selected, the target alert armed annunciation (green TGT) is displayed. The RTA searches for a hazardous target from 5 to 55 miles and ±7.5 degrees of dead ahead. No radar targets are displayed. If a hazardous target is detected, the target alert armed annunciation switches to the alert annunciation (amber TGT). This advises the pilot that a hazardous target is in his flightpath and he should select the WX mode to view it.

NOTE: When displaying checklist, the TGT function is inoperative.

• **TST (Test)** The TST position selects the radar test mode. A special test pattern is displayed to verify system operation. The TEST legend is displayed in the mode field.

WARNING
IN THE TEST MODE, THE TRANSMITTER IS ON AND RADIATING X-BAND MICROWAVE ENERGY.

FSBY (FORCED STANDBY)
FSBY is an automatic, nonselectable radar mode. As an installation option, the RTA can be wired to the weight-on-wheels (WOW) squat switch. When wired, the RTA is in the FSBY mode when the aircraft is on the ground. In FSBY mode, the transmitter and antenna scan are both inhibited, the display memory is erased, and the FSBY legend is displayed in the mode field. When in the FSBY mode, pushing the STAB button four times in three seconds restores normal operation.

NOTE: If a WC-650 Weather Radar Controller is installed, FSBY is overridden by simultaneously pushing both range arrow buttons.

The FSBY mode is a safety feature that inhibits the transmitter on the ground to eliminate the X-band microwave radiation hazard.

WARNING
STANDBY OR FORCED STANDBY MODE MUST BE VERIFIED IN GROUND OPERATIONS BY THE OPERATOR TO ENSURE SAFETY FOR GROUND PERSONNEL.

In installations with two radar controllers, it is only necessary to override forced standby from one controller.
If either controller is returned to standby mode while weight is on wheels, the system returns to the forced standby mode.

10. GAIN
The GAIN is a single turn rotary control and push/pull switch that is used to control the receiver gain. When the GAIN switch is pushed, the system enters the preset, calibrated gain mode. Calibrated gain is the normal mode and is used for weather avoidance. In calibrated gain, the rotary portion of the GAIN control does nothing. When the GAIN switch is pulled out, the system enters the variable gain mode. Variable gain is useful for additional weather analysis and

for ground mapping. In WX mode, variable gain can increase receiver sensitivity over the calibrated level to show weak targets or it can be reduced below the calibrated level to eliminate weak returns.

WARNING

LOW VARIABLE GAIN SETTINGS CAN ELIMINATE HAZARDOUS

TARGETS FROM THE DISPLAY.

In GMAP mode, variable gain is used to reduce the level of strong returns from ground targets. Minimum gain is attained with the control at its full ccw position.
Gain increases as the control is rotated in a cw direction from full ccw at full cw position, the gain is at maximum.
The VAR legend annunciates variable gain. Selecting RCT or TGT forces the system into calibrated gain.

NOTE: Some controllers have a preset position on the rotary knob. Rotating the knob to PRESET provides calibrated gain functions. Rotating the knob out of the PRESET position allows variable gain operation

.

11. RCT (RAIN ECHO ATTENUATION COMPENSATION TECHNIQUE REACT)

This switch position turns on RCT.
The REACT circuitry compensates for attenuation of the radar signal as it passes through rainfall. The cyan field indicates areas where further compensation is not possible. Any target detected within the cyan field cannot be calibrated and should be considered dangerous.
All targets in the cyan field are displayed as fourth level precipitation, magenta.
RCT is a submode of the WX mode and selecting RCT forces the system to preset gain. When RCT is selected, the RCT legend is displayed on the EFIS/MFD.

SYSTEM INDICATIONS/ANNUNCIATIONS

The following weather radar operating indications/annunciations are displayed at the top-left corner of the MFD, unless stated otherwise.

a.	WX OFF (white)	Indicates that the RADAR operating mode is selected OFF.
b.	WAIT (white)	Displayed for approximately 90 seconds during system warm-up.
c.	WX (white) TEST (yellow)	Indicates that the RADAR operating mode is selected to TST (Test).
d.	WX ON (white)	Indicates that the RADAR operating mode is selected to WX (Weather).
e.	WX GMAP (white)	Indicates that the RADAR operating mode is selected to GMAP (Ground Map).
f.	WX RCT (white)	Indicates that the RCT (React) function is selected.
g.	WX TGT (white)	Indicates that the TGT (Target Alert) function is selected.
h.	WX RCT/TGT (white)	Indicates that both RCT and TGT are selected.
i.	TGT (magenta)	Flashing message displayed at the top-center of the RADAR map area when a potentially hazardous weather target is detected ahead and beyond the selected range.
j.	WX STBY (white)	Indicates that the RADAR operating mode is either selected or forced to standby.
k.	WX TRANSMITTING (yellow)	Flashing message displayed in the lower-centre of the MFD, when the antenna is transmitting on ground.
l.	WX FAIL (yellow)	Indicates that the RADAR system has detected a failure.
m.	GAIN MAN (white)	Indicates that the receiver gain is being manually controlled.
n.	STAB OFF (yellow)	Indicates that the antenna STAB (Stabilization) function is not selected.
o.	STAB FAIL (yellow)	Indicates that the antenna STAB (Stabilization) function has failed.
p.	TILT angle (cyan)	Provides a digital indication of the TILT angle selected.

FLIGHT COMPARTMENT CHECK - POWER OFF

RADAR mode selector.....OFF
TILT selector.....+15

FLIGHT COMPARTMENT CHECK - POWER ON

WARNING: Heating and radiation effects of the weather radar can be hazardous to ground personnel. Personnel should remain at a safe distance from a transmitting antenna at all times. WX STBY and forced WX STBY modes must be verified for ground operation by the operator to ensure safety for ground personnel.

CAUTION: Do not operate the weather radar if large metal objects, such as hangers or other aircraft, are within the antenna scan sector. Failure to do so may result in damage to the system.

RADAR mode selector..... SBY or TST
Check WAIT message appears for approximately 90 seconds. Observe test pattern if applicable.

PRE-TAKE-OFF CHECKS

If WX radar is required for take-off:

RADAR mode selector..... WX
STAB push-buttonPush in 4 times within 3 sec. to exit forced standby (WX STBY) mode if ground operation is required.
Check WX TRANSMITTING flashing message on MFD.

TILT selector..... Adjust as required

The UNS - 1E Flight Management System (FMS) is an integrated navigation management system providing the flight crew with navigation, flight planning and fuel management data. The UNS -1E is a system consisting of a cockpit mounted Multi-functional Control Display Unit (MCDU), Flight Management Computer (FMC) and Global Positioning System (GPS) receiver enclosed in a single Line Replaceable Unit (LRU). Position information is derived from VOR#1, DME#1 and GPS#1 for the pilot's side FMS and VOR#2, DME#2 and GPS#2 for the co-pilots side FMS. True airspeed, altitude, static air temperature data, fuel flow data, etc., are routed to each FMS from the Flight Data Processing System (FDPS).

The DHC-8 Series 400 UNS-1E FMS dual configuration requires the following minimum equipment to be functional and operating:

Decription	Part Number	Model Number	FMS #1 Quantity	FMS #2 Quantity
Flight Management System				
Hardware P/N	2017-41-221	UNS - 1E	1	1
Software P/N	SCN 802		1	1
Antenna	10705	Universal Avionics	1	1
Date Transfer Unit	1406-01-1	Universal Avionics	1	(Part of FMS #1)

The FMS provides lateral navigation (LNAV) guidance and vertical navigation (VNAV) guidance based on data from the navigation receivers and air data sensors. An FMS approach mode allows the operator to fly flight director or autopilot non-precision approaches. The FMS provides course, course deviation, bearing-to-waypoint and distance-to-waypoint information displayed on the pilot's and copilot's PFD and MFD and is coupled to the AFCS for flight director and autopilot functions.

During flight the FMS automatically updates the fuel on board and gross weight as well as predicted fuel requirements and estimated time of arrival based on fuel flow, groundspeed and, if entered by the pilot, enroute flight plan winds.

A self-contained database stored in non-volatile memory provides the FMS with information on over 100,000 waypoints, navaids and airports. Data base updates are provided by Jeppesen.

Note 1:

To prevent errors, avoid pushing more than one key at a time. When selecting an MCDU page verify the page title to ensure the desired page appears. Being familiar with the locations of the functions and the operating procedures will result in efficient and accurate FMS use.

Note 2:

The FMS has met the requirements for VFR/IFR enroute, terminal and approach LNAV and VNAV guidance in accordance with AC20-130A, B-RNAV navigation in accordance with AMJ 20X2, Leaflet No.2, rev. 1, and AC20-129.

Note 3:

The FMS, with Software Control Number (SCN) 802.0 has met the airworthiness requirements for P-RNAV in accordance with JAA Temporary Guidance Leaflet No. 10 (TGL 10).

Note 4:

For complete operating instructions, refer to the FMS Operator's Manual (OM), Report No. 2423sv802/902 (dated September 16, 2003).

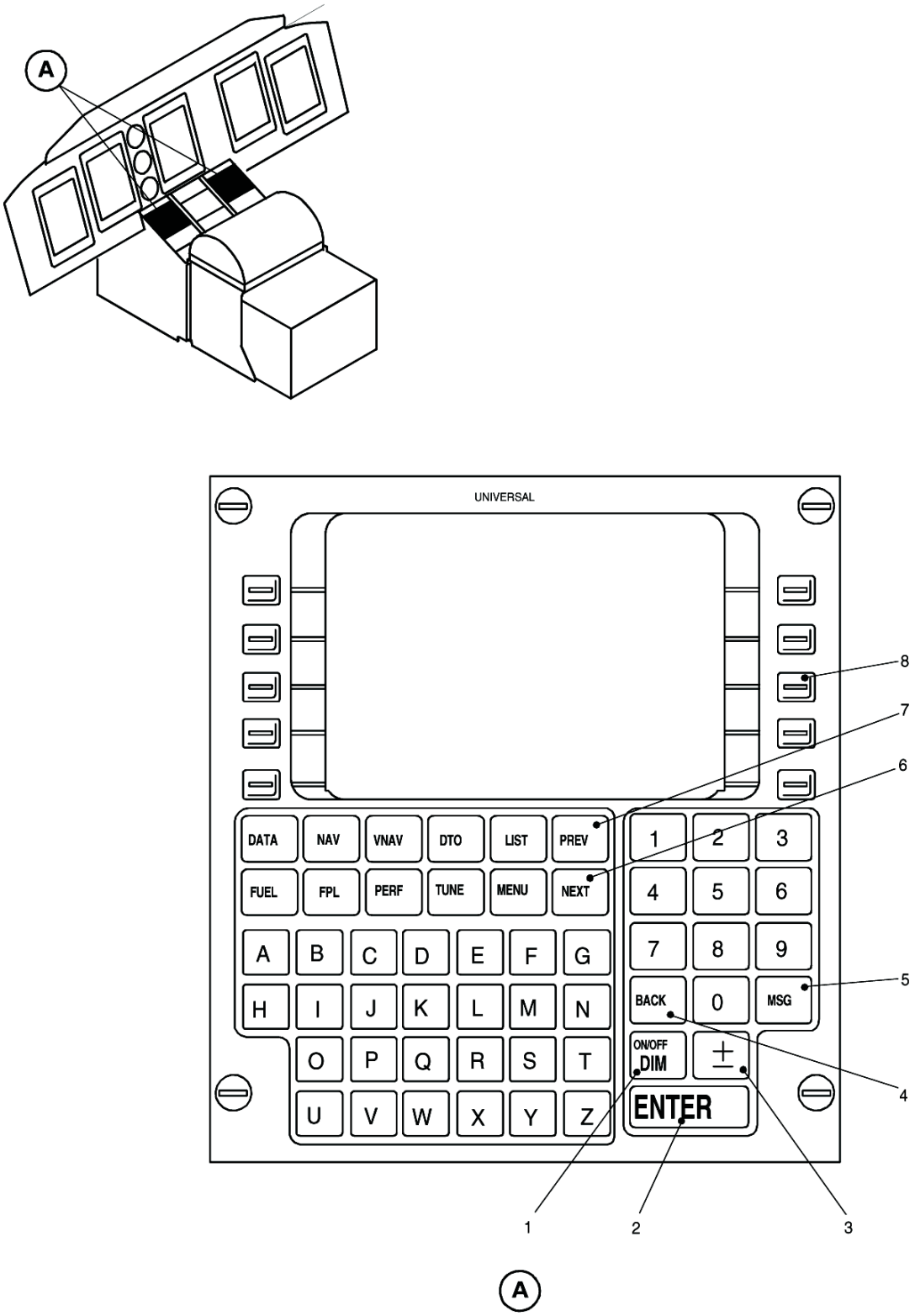


Figure 12.15-48A FMS MCDU (Sheet 1 of 2)

FMS - MCDU CONTROL KEYS:

1. **ON/OFF - DIM key (momentary action)**
   PUSH - provides power, display dimming and unit shutdown functions.

2. **ENTER key (momentary action)**
   PUSH - stores input data to memory. The cursor marks data that can be changed using the normal input processes (dark letters on a light background). When variable data ismarked by the cursor, pressing the ENTER key stores data to memory.

3. **± key (momentary action)**
   PUSH - used in conjunction with the alphanumeric keys to enter data. It reverses the selected entry data field from + to –, N to S, and L to R. In the alpha field, it is used as a dash or period.

4. **BACK key (momentary action)**
   PUSH - When the cursor is over a data entry field, the BACK key functions as a delete or backspace key.

5. **MSG key (momentary action)**
   PUSH - displays an active message when the ‘MSG’ annunciation appears on the screen. The message alerts the operator to system status and flight plan sequencing. Selecting the UniLink option will access the UniLink menu page.

6. **NEXT key (momentary action)**
   PUSH - used to cycle forward, one page at time, through multiple pages of the same mode.

7. **PREV key (momentary action)**
   PUSH - used to cycle backward, one page at a time, through multiple pages of the same mode.

8. **LSK key (momentary action)**
   PUSH - Line Select Keys (LSK’s) are used to enter data utilizing the alphanumeric keys. Pressing the ENTER key completes the entry. 10 LSK’s (5 down left side and five down right side of display) align with associated data lines.

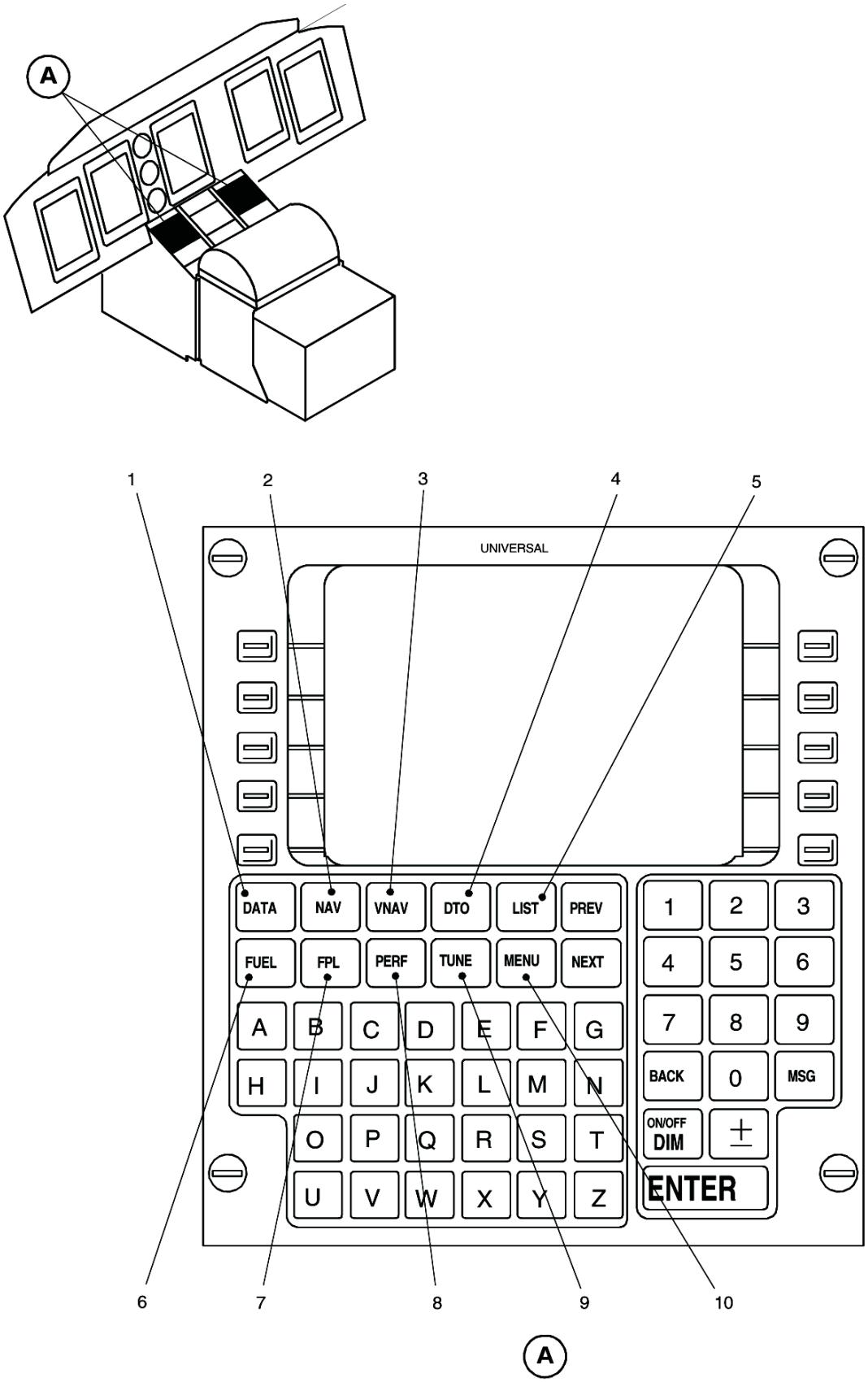


Figure 12.15-48B FMS MCDU (Sheet 2 of 2)

FMS - MCDU FUNCTION KEYS:

1. **DATA key (momentary action)**
   PUSH - to obtain information and status about the FMS, Navigation Data Base and attached sensors, which operate with the FMS. The function is also used to select/deselect individual sensors and to add/delete or change pilot defined locations.

2. **NAV key (momentary action)**
   PUSH - to display all navigation data normally required by the flight crew. There are normally three Navigation pages. Additional pages are added when APPROACH or HEADING is selected. Pressing the PREV or NEXT function keys cycles through associated pages.

3. **VNAV key (momentary action)**
   PUSH - to define a desired vertical flight profile along the flight plan route. It computes the aircraft deviation from that profile for display.

4. **DTO key (momentary action)**
   PUSH - accesses the 'Direct To' page and is specifically dedicated to changing the flight plan in response to the 'direct to' clearances. If the 'direct to' location is off the flight plan, provisions are made to link the location into the flight plan.

5. **LIST key (momentary action)**
   PUSH -to display a list of options during data entry appropriate to the entry being made.

6. **FUEL key (momentary action)**
   PUSH - to provide access to all fuel management functions. These include fuel and weight entry, range and endurance estimates, fuel requirement summary, projected landing weight, fuel flow and fuel consumption.

7. **FPL key (momentary action)**
   PUSH - to access the Flight Plan pages or to access stored arrivals and routes. The FPL function is also used to create a new flight plan, alter current flight plan, insert a SID, STAR and approach into the flight plan.

8. **PERF key (momentary action)**
   PUSH - to view a synopsis of in-flight performance information.

9. **TUNE key (momentary action)**
   PUSH - to tune, select and store pre-selected frequencies and view selected frequencies (active and preset) for each radio.

10. **MENU key (momentary action)**
    PUSH - to display a list of alternate formats or options for the FUEL, FPL, NAV, VNAV or TUNE modes. The letter 'M' will appear in a box on the title line of any page in which the MENU key is active.

12.15.11.2 System Description

The Multi-functional Control Display Unit (MCDU) located on the center console, displays information on a dimmable eleven-line color Liquid Crystal Display (LCD). Line select keys are located on either side of the display and ten function keys are located below the display screen. Separate alpha-numeric keys are located below the function keys and are used to enter data into the FMS.
Data is always entered into the FMS at a cursor location using the ENTER key. The cursor will automatically move to the next position when the ENTER key is pressed.

CONTROL KEYS

1. ON/OFF - DIM KEY

Initially pressing the ON/OFF-DIM key energizes the system, initiates the self-test and displays the self-test page on the LCD display. If all self-tests are successful the initialization page appears. No other pages are displayed until the initialization data is accepted.
Once the system is operational, pressing the ON/OFF-DIM key will display a control window with the options BRIGHT, DIM, CANCEL, DISPLAY, and OFF. Select from these options by pressing the line select key next to the desired option. Pressing the BRIGHT or DIM key will brighten or dim the display respectively as the key is held down. Pressing CANCEL will cause the control window to be removed from the active page. Pressing DISPLAY accesses the UP/DOWN keys used for display adjustment. Pressing OFF will cause CONFIRM OFF window to be displayed. Two options will appear, CONFIRM OFF and CANCEL. Selecting CONFIRM OFF will turn the system off; CANCEL returns the display to the main window.

2. ENTER KEY

The ENTER key stores input data to memory. The cursor marks data that can be changed using the normal input processes (dark letters on a light background). When variable data is marked by the cursor, pressing the ENTER key stores data to memory.

3 ± KEY

The “State Change Key” is used in conjunction with the alpha-numeric keys to enter data. Pressing this key reverses the selected data entry field from + to -, N to S and L to R. In the alpha field the key is used as a dash or period.

4. BACK KEY

When the cursor on the display screen is over a data entry field, the BACK key will delete data or back space as required.

5. MSG (MESSAGE) KEY

Pressing the MSG key will display an active message when the `MSG' annunciation appears on the LCD. The message alerts the operator to system status and flight plan sequencing. Selecting the UniLink option will access the UniLink menu page.

6. NEXT KEY

The NEXT key is used to cycle forward, one page at a time, through multiple pages of the same mode.

7. PREV KEY

The PREV (previous) key is used to cycle backward, one page at a time, through multiple pages of the same mode.

FUNCTION KEYS

Ten function keys located below the display screen are used to select data entry or command inputs. Pressing the appropriate key once will display the first page of the selected mode. Additional selections of the same key will cycle the display through multiple pages.

1. DATA KEY

The DATA function obtains information and status about the FMS, Navigation Data Base and attached sensors which operate with the FMS. The DATA key selects/deselects individual sensors and adds or deletes pilot defined locations.

DATA Page 1 allows selection of Nav Data, Pilot Data, Company Data, Disk Menu, TAWs, Cabin Display, EFIS Display, UniLink Menu, Master Crossfill, and Maintenance Menu. Pressing the line select key next to the desired option displays the appropriate menu page.

DATA Page 2 provides a synopsis of input sensor operation. The second lines shows the most significant sensor and the quality factor (ANP/RNP) associated with the FMS best computed position.

ANP (Actual Navigation Performance) is a measure of the system’s best estimate of error, calculated to allow for flight technical error, in hundredths of a nautical miles.

The RNP (Required Navigation Performance) value is the limit to position uncertainty the system will allow for continued flight and are specified for each phase of flight. RNP values are derived from either FMS default values or manual entry.

DATA Page 3 shows the FMS system position and all long range sensors with position differences expressed in radial nautical miles from the FMS position. When the line select key for a sensor is pressed, the sensor's coordinates and position difference are displayed below the FMS position.

DATA Page 4 (General Data) allows entries of date, time, variation, and heading inputs. Advisory information is provided concerning software version numbers and current aircraft steering commands. The heading source (HDG) of the heading data is displayed in parenthesis. Next to this, the present heading is displayed. A “T” indicates that it is a true heading. To access a display of optional heading source selections place the cursor over the HDG entry field and press the LIST key. If the heading is input manually (MAN) will be displayed.

2. NAV KEY

Press the NAV key to display the navigation display pages. There are normally three NAV pages in the normal flight mode. When APPROACH or HEADING mode is selected there will be additional display pages which are cycled through by pressing the PREV or NEXT function keys.

NAV Page 1 displays information about the FR (from), TO (to), and NX (next) waypoints and allows the pilot to alter the current navigation leg. Information displayed on NAV Page 1 correlates with the information on the HSI.

NAV Page 2 displays similar information to NAV Page 1 with the addition of headwind/tailwind, bearing to current terminator and track angle error.

NAV page 3 displays system position and quality factor (Q=) associated with the FMS best computed position.

3. VNAV KEY

The Vertical Navigation key allows the flight crew to define a desired vertical flight profile along the flight plan route. It computes the aircraft deviation from that profile for display.

The flight profile is defined by two waypoints with reference altitudes (i.e. present position plus one waypoint ahead, or one waypoint ahead and a target vertical speed). A climbing profile will provide VSR (Vertical Speed Required) information only. Up to eight vertical waypoint identifiers are prefilled automatically according to current flight plan waypoints, however VNAV altitudes may also be programmed on the Flight Plan pages.

4. DTO KEY

The DTO mode allows the flight crew to alter the flight plan in response to “direct to” clearances. Press the DTO (“direct to”) key to access the DTO page which displays the flight plan waypoints. The flight leg may be changed “direct to” a flight plan waypoint, a database waypoint, an airport or a pilot defined position. Selecting DTO cancels APPROACH mode. The turn direction will default to shortest turn, however the pilot can override this by selecting LEFT or RIGHT direction. Pressing AUTO will cancel LEFT or RIGHT and return default to shortest direction.

5. LIST KEY

Pressing the LIST key displays a list of options during data entry appropriate to the entry being made.

6. FUEL KEY

Press the FUEL key to access the fuel pages and the fuel management functions of the FMS. With any fuel page displayed, pressing the MENU key will access the FUEL OPTIONS page. The left side of the FUEL OPTIONS page is for viewing conversions. Pressing any of the left line select keys will place the cursor over that respective entry field. Entry of a value into one field will cause all other fields to display the same value converted per the entry field heading. The right side is for selecting crossfill (X FILL), individual tank (BY TANK) or total fuel on board entries, average passenger weight (AVG PAX WEIGHT), and RETURN to access display. After initialization, pressing the FUEL key while in any mode will display FUEL Page 1.

FUEL Page 1 is the fuel and weight entry page. It is used to input initial fuel on board, calculate the airplane gross weight, and to construct a reserves plan. If all entries are made on FUEL Page 1, pressing the FUEL key will cause FUEL Page 2 to appear.

Note:

FMS fuel mode calculations are based on the pilot's initial entry of fuel on board and subsequent automatic or manual fuel flow measurements subtracted over time. There is no direct connection to the aircraft's fuel quantity system by the FMS, so the aircraft's system remains the primary reference for all fuel and range calculations.

FUEL Page 2 displays range and endurance estimates based upon departure time and current parameters. Manual FUEL FLOW and GS (groundspeed) entries may be made for evaluation of parameters displayed.

Note:

If FUEL FLOW or GS are manually entered, the values will be lost when fuel mode is exited.

FUEL Page 3 provides a fuel requirement summary for the flight plan. Manual FUEL FLOW and GS entries may be made for evaluation of parameters displayed.

FUEL Page 4 displays projected landing weight based upon current fuel conditions. All fuel quantity and gross weight displays are computed values based upon the initial values entered by the pilot inputs from the engine fuel flow sensors. The values may not be changed and the line select keys have no function.

FUEL Page 5 shows the fuel flow and fuel consumption in kilograms per hour for each engine individually and cumulatively. The fuel flows shown are supplied by the aircraft fuel flow sensors.

The fuel management functions use a combination of manual entries, pre-programmed data, flight plan information and fuel flow data from the engines. There is no direct input from the aircraft fuel tanks and all calculations are based on fuel flows and the initial fuel quantity entered by the flight crew. The fuel gauges remain the primary source of information for fuel and range calculations. APU fuel flow data is not available to the FMS. Fuel onboard quantities should be compensated for APU consumption. System weight/volume conversion for fuel is based on 6.7 lb/US gal.

7. FPL KEY

The FPL (flight plan) function key is used to access the Flight Plan pages, stored arrivals and routes. The function also allows the pilot to construct a new flight plan, alter the current flight plan, or insert a SID, STAR and ARRIVAL (approach) into the flight plan. When the FPL key is pressed and no flight plan exists the empty FPL page (page 1/1) is displayed which is used to build a flight plan.

When a flight plan is defined, pressing the FPL key displays the normal FPL pages. The Normal FPL display pages show the flight plan waypoints, ETAs (estimated time of arrival), altitudes (when defined in VNAV), bearings and distances between waypoints. The path type and terminator of a procedural leg are shown when a SID, STAR or ARRIVAL is active. Succeeding pages of the flight plan may be displayed by pressing the PREV or NEXT keys, as appropriate.

The Flight Plan Summary page is available only during ground operations prior to departure and is located following the last flight plan page using the PREV and NEXT keys. It provides a synopsis of distance, time and fuel requirements for the planned flight.

The FPL MENU pages are accessed from any FPL page by pressing the MENU key. FPL pages are used to display formats for the flight plan waypoints, view the approach plan, insert a SID, STAR and ARRIVAL, and to delete or invert a flight plan.

8. PERF KEY

The PERF page provides a synopsis of pertinent in flight performance information. It is a read-only page as no entries can be made.

9. TUNE KEY

Pressing the TUNE key displays the TUNE page, which is used to select and store preselected frequencies, and view selected frequencies for each radio. The control window displays the last tuned radio with the cursor over the active frequency with up to four preselected frequencies displayed below. Press the appropriate line select key to view desired radio in the control window. The active frequency is changed by entering the frequency with the numeric keys or inputting the reference number (1-4) of one of the preset frequencies. The frequency is completed by pressing the ENTER key.

10. MENU KEY

The MENU key presents a list of alternate formats or options for the FUEL, FPL, NAV, VNAV or TUNE mode being displayed. When the MENU key is active the letter "M" will appear in a box on the title line of the selected page.

12.15.11.3 Pilot's Remote Annunciators

Outputs are provided to drive ten external annunciators, which alert the pilot of system status or flight plan sequencing. These annunciators are incorporated into the PFD/MFD.

1. PFD/MFD

a. Waypoint Alert annunciator (WPT ALRT)	Illuminates prior to automatic leg change or on arrival at the TO waypoint.
b. Vertical Path Alert annunciator (VERT ALRT)	Illuminates 15 seconds prior to Top of Descent or 15 seconds prior to any change in vertical path angle.
c. Message annunciator (MSG)	Illuminates in conjunction with the message advisory light on the MCDU.
d. Crosstrack annunciator (XTRK)	Illuminates whenever a left or right Cross Track (parallel offset) is activated.
e. Procedural Heading annunciator (PHDG)	Illuminates when a procedural heading leg is the active navigation leg.
f. Course Deviation Scale annunciator (TERM)	Illuminates to indicate Terminal Scaling or Missed Approach Scaling is active.
g. Course Deviation Scale annunciator (APPR)	Illuminates to indicate FMS Approach Mode and Approach Scaling is active.
h. Dead Reckoning Mode annunciation (NAV DR)	Illuminates when the FMS is navigating by dead reckoning on last known track, groundspeed, heading and TAS.
i. Navigation Integrity annunciation(NAV INTEG)	Illuminates when the required navigation performance is not guaranteed by the FMS.
j. GPS Integrity annunciation (GPS INTEG)	Illuminates whenever the integrity of the GPS position cannot be assured to meet minimum requirements for the particular phase of flight. Whenever the GPS INTEG annunciator is illuminated, GPS position must be monitored by cross-reference to other navigation sensors.

2. Lateral and Vertical Scale Sensitivity

PHASE OF FLIGHT	LATERAL SCALE SENSTIVITY	VERTICAL SCALE SENSITIVITY	COMMENTS
ENROUTE	5.0 nm for two dots of CDI scale deviation.	1,500 ft. for two dots of vertical scale deviation.	
TERMINAL	1.0 nm for two dots of CDI scale deviation.	500 ft. for two dots of vertical scale deviation.	
APPROACH	2° for two dots of scale deviation until two dots deviation is equal to 0.3 nm. The Approach Scale Sensitivity is 0.3 nm for two dots of CDI scale deviation.	200 ft. for two dots of vertical scale deviation	The lateral scale sensitivity change occurs approximately at the Final Approach Fix (FAF)

12.15.11.4 Data Base

The Data Base section contains information on Navigation Data Base, Pilot Defined Data Base, Company Routes Data Base, Off-line Flight Planning Data Base, Checklist Data Base and Performance Data Base. The Data Bases are loaded into the FMS via the Data Transfer Unit (DTU).

Offline PC created Flight Plan Data can be loaded into the FMS via the DTU. Flight Plan types consist of company routes, pilot routes, pilot waypoints and tactical waypoints.

The FMS system has two memory banks for Nav Data so that a future data base may be loaded and stored until its effective date. The memory bank being used is the active bank, the bank not being used is the inactive bank. Selection of an active memory bank can be accomplished manually or automatically at power up.

The FMS stores a diagnostic history of all configured sensors. Whenever a sensor failure is detected, a log is automatically created. The crew can also create a manual maintenance log. Maintenance data is downloaded to a disk via the DTU.

12.15.11.5 MCDU Operation - Normal Procedures

The following normal procedures are applicable to basic operation of the UNS-1E FMS and do not address all options available for each function. The procedures are arranged in logical sequence from pre-flight to after landing. Consult the FMS Operator's Manual (OM), Report No. 2423sv801/901 (dated August 22, 2001 or later), for detailed explanation of procedures.

PREFLIGHT PROCEDURES

1. Start-up/Initialization

a.	ON/OFF key	Press to activate system. System will self-test and the Initialization (INIT 1/1) page should automatically appear at the end of the self-test indicating system is ready for use. Verify the navigation data base is current and software version SCN 801.2, SCN 801.5, SCN 802.0 or SCN 802.2. If date and UTC time shown on the Initialization page are incorrect, manually correct data per OM.
b.	ACCEPT line select key	Press line select key to accept the data. If data shown on the Initialization page is incorrect, manually correct data per OM.

2. Flight Plan (FPL) Selection

a.	FPL key	Press FPL key to access Flight Plan pages. Enter desired way points for the planned flight.
or:		
b.	CPY RTE line select key	Press CPY RTE line select key to access previously stored flight plan line select key route. Enter route reference number.
then:		
c.	ENTER key	Press ENTER to load desired route. To create new flight plan route, refer to the OM.
d.	FPL key	Press FPL key to return to Flight Plan pages.
e.	PREV or NEXT keys	Press the PREV and/or NEXT keys as required to access the FPL SUMMARY page. Use the line select keys to position the cursor over each entry field and enter.

3. Incorporating a SID (Standard Instrument Departure)

a.	FPL key	Press FPL key to access Flight Plan pages.
b.	MENU key	Press to access FPL MENU page then select the DEPART line select key.
c.	DEPART line select key	Press. The FPL DEPARTURE page will appear with the departure airport already filled in and a list of runways for the airport displayed on the left side of the screen. Select the runway, SID and transitions from the lists that appear.
d.	FPL key	Press to return Flight Plan pages. The procedural legs of the SID will now be a part of the flight plan.

NOTE: 1. SCN 801.2: When a SID, STAR or approach has been linked into the flight plan, to ensure correct MFD FMS map operation, the pilot must manually eliminate any flashing "NO LINK" discontinuities that have been automatically inserted by the FMS.

2. SCN 801.2: If a GAP is inserted within two waypoints of the active TO waypoint, the MFD FMS map display may be removed from the MFD. To restore normal MFD FMS map operation, the pilot must manually delete the GAP.

4. Incorporating a STAR (Standard Arrival Route)

a. FPL key — Press FPL key to access Flight Plan pages.

b. MENU key — Press MENU key to access Flight Plan Menu pages.

c. ARRIVE line select key — Press ARRIVE line select key to display a list of runways at destination airport. Select desired runaway. Once selected, the cursor will advance to the STAR field and a list of STARs for that airport will appear. Select the desired STAR by entering the reference number. A list of transitions for the selected STAR will appear. Select using the appropriate line select key. A list of approaches will appear. Select the desired approach with the appropriate line select keys. If the approach has one or more transitions, they will be displayed and the appropriate one should be selected.

NOTE: Selecting the approach and transitions may be delayed until later in the flight.

d. FPL line select key — Select FPL line select key to return to the FPL page. The STAR legs and approach are now a part of the flight plan.

5. Flight Plan Summary

a. FPL key — Press FPL key to access Flight Plan pages.

b. NEXT key — Press to scroll to FPL SUMMARY located after last flight plan page.

6. Delete Flight Plan

a. FPL key — Press FPL key to access Flight Plan pages.

b. MENU key — Press to access FPL menu then select the DELETE FPL line select key twice to delete all waypoints in the active flight plan.

7. Fuel and Weight Entries

a. FUEL key — Press FUEL key to access FUEL data pages. Use the line select key to enter the aircraft's ZFW (zero fuel weight) or alternatively enter the individual values for BASIC WT, PAX and CARGO in the appropriate entry fields

NOTE: When using fuel data function, ensure the correct operational empty weight of the aircraft and on-board fuel is shown on FUEL data page 1.

b. MENU key — Press while on any FUEL page to access the FUEL OPTIONS page to calculate weight conversions and to select method of entering total fuel on board. Select BY TANK or enter the total fuel on board. Press the return line select key to return to FUEL Page 1.
Enter total fuel reserves in pounds under TOTAL RESRVS. Alternatively, enter the individual values for ALTERNATE, HOLD and EXTRA. The system will automatically calculate the total fuel reserve.
FUEL ONBOARD - enter the fuel quantity on board. If BY TANK is selected, a separate page is displayed for each tank value. If BY TOTAL is selected, total fuel is entered in one entry.

8. Flight Guidance Control Panel

a. HSI selector (HSI SEL)	Press to select appropriate side.
b. Navigation source selector	Select FMS 1 or FMS 2 as navigation source to display FMS generated navigation data as desired.

9. EFIS Control Panel

a. BRG knob	Select FMS 1 or FMS 2 to display FMS navigation guidance on HSI as desired on Bearing Pointers #1 or #2.

10. FMS Radio Tuning

a. ARCDU Mode selector	FMS
b. TUNE key	Press. Tune the aircraft radios in accordance with OM.

CAUTION

SCN 801.2 or SCN 801.5 and MS 4-410200: If an invalid 8.33 kHz frequency is entered from the FMS TUNE page, the applicable VHF communications radio will indicate FAIL on the ARCDU. With FAIL indicated on the ARCDU it is no longer possible to tune the applicable VHF radio from the ARCDU. To clear the FAIL indication the pilot must enter a valid VHF frequency from the FMS TUNE page.

NOTE: 1. The FMS can tune the aircraft radios only when the ARCDU Mode selector is selected to FMS or OFF.
2. FMS Autotune function on the ARCDU is not supported by the UNS-1E.

IN-FLIGHT PROCEDURES

1. Flight Guidance Control Panel

a. Navigation selector	Select FMS 1 or FMS 2 as navigation source to display FMS generated navigation data as desired on HSI.

2. EFIS Control Panel

a. BRG knob	Select FMS 1 or FMS 2 to display FMS navigation on HSI as desired on Bearing Pointers #1 or #2.

3. FMS MCDU

a. NAV key	Press NAV key to access navigation display pages. Check that the information on NAV page 1 correlates with the information displayed on the EHSI.

4. To couple the flight director to FMS lateral guidance (LNAV)

a.	HSI selector (HSI SEL)	Press to select appropriate side.
b.	Navigation Mode Selector (NAV)	Press to select flight director NAV lateral guidance mode. Check LNAV is annunciated on Flight Mode Annunciator and flight director provides lateral steering to the active leg.

5. Heading Mode and Heading Intercept Mode

The FMS HEADING mode and FMS HEADING INTERCEPT mode allow the pilot to control the aircraft heading though the NAV HEADING page of the FMS. When this mode is active while coupled to the flight director, LNAV HDGSEL or LNAV HDGINT is annunicated (as appropriate) and lateral steering commands will be in accordance with the pilot entered heading information.

6. Vertical Navigation (VNAV Mode)

To activate VNAV mode:

a.	VNAV key	Press VNAV key to access VNAV page and input desired vertical navigation waypoints as per OM.
b.	PFD/MFD	Check. Vertical path deviation scale is displayed on the PFD and a Top of Descent (TOD) pseudo-waypoint is displayed on the MFD FMS map display.

To cancel VNAV mode:

a.	VNAV key	Press VNAV key twice to access VNAV page 2.
b.	LSK 5L	Press beside the CNX VNAV annunciation to cancel VNAV.
c.	PFD/MFD	Check. Vertical path deviation scale is removed from the PFD and the TOD pseudo-waypoint is removed from the MFD FMS map display.

7. To couple the flight director to FMS vertical guidance:

NOTE: FMS lateral guidance must be active and coupled before vertical guidance can be coupled.

a.	Altitude preselector	Select to waypoint altitude.
b.	Altitude Select	Press. Check ALTSEL is annunciated on the FMA.

NOTE: With the exception of FMS Approach mode, Flight Director coupled VNAV will not couple or remain coupled unless the altitude preselector is below the aircraft altitude. If the VNAV path descends through the preselector altitude, coupled VNAV will disengage and the flight director will revert to PITCH mode unless the ALT selector is active then the altitude will capture as normal. In the Approach mode, the altitude preselector may be set above the aircraft altitude (missed approach altitude, for example) and the VNAV will not disengage.

When within 2 minutes of descent point:

c.	VNAV mode selector	Press to arm flight director VNAV vertical guidance mode.
d.	Flight Mode annunciator	Check VNAV is annunciated in white.

NOTE: Flight Director VNAV will not arm unless the TOD pseudo-waypoint is within two minutes of capture.

At VNAV capture:

e.	Flight Mode annunicator	Check VNAV Path is annunicated in green and the flight director provides vertical steering commands to the vertical path.

8. Direct-To Function

a.	DTO key	Press to access the DIRECT TO routing page to define a 'direct to' leg change. The cursor will be over the DIRECT TO waypoint entry field and a listing of flight plan waypoints will be displayed. If the desired waypoint is on the flight plan, enter the associated reference number. If the waypoint is not of the flight plan, use the LIST function or key in the identifier.

APPROACH PROCEDURES

1. FMS Approach

a.	FPL key	Press FPL key to access Flight Plan pages.
b.	MENU key	Press MENU key to access the Flight Plan Menu pages.
c.	ARRIVE line select key 4R	Press ARRIVE line select key to access the arrival/approach flight planning information pages. Insert arrival data as per OM.
d.	FPL key	Press FPL key to return to Flight Plan pages.

NOTE: 1. SCN 801.2: When a SID, STAR or approach has been linked into the flight plan, to ensure correct MFD FMS map operation, the pilot must manually eliminate any flashing "NO LINK" discontinuities that have been automatically inserted by the FMS.

2. SCN 801.2: If a GAP is inserted within two waypoints of the active TO waypoint, the MFD FMS map display may be removed from the MFD. To restore normal MFD FMS map operation, the pilot must manually delete the GAP.

e.	NAV key	Press NAV key. Check ARM APPR becomes available at line select key 3R on NAV page 1 when the aircraft is within 50 nm of the runway.

NOTE: If an approach is linked into the flight plan and is not armed before reaching 30 nm from the destination, the system will automatically arm and the CDI scaling will change to 1.0 nm.

f.	ACT APPR line select key 3R (NAV page 1)	Approach mode may be manually activated by pressing the ACT APPR line select key.

NOTE:
1. If ACT APPR is selected, all intervening waypoints from the present FR-TO leg to the first approach waypoint will be sequenced and HSI guidance will be to that waypoint. Desired track pointer will be set to the inbound course of the approach. The FMS will transition to FMS HDG mode and the pilot must manually set up the correct intercept angle. When the correct intercept angle is established, the INTERCEPT line select key on NAV page 1 must be pressed to allow interception of the final approach course.
2. If the pilot does not select ACT APPR the entire approach procedure will be flown.

At the Final Approach Fix:

g. Course Deviation Check APPR illuminates to indicate FMS Approach Mode and Scale annunicator Approach Scaling is active. (APPR)

NOTE: FMS based instrument approaches must be conducted in approach mode (APPR) and for GPS approaches, RAIM must be available at the final approach fix.

2. VNAV During Approach Operations

a. VNAV key — Press VNAV key to access VNAV page. Check altitude constraints associated with all approach waypoints are displayed and that there are no vertical discontinuities in the VNAV descent path.

NOTE:
1. It is possible to program an enroute VNAV segment to terminate at a published minimum enroute altitude that is below the FMS computed crossing altitude for the Final Approach Fix (FAF). If VNAV is active when sequencing to the FAF, the FMS will interpret this segment as a climb segment and cancel the VNAV mode. To ensure availability of VNAV guidance for the final approach segment, pilots must either ensure that no vertical discontinuities exist between the enroute segment and the approach segment or ensure that VNAV is not active when sequencing to the FAF. For the latter case, normal approach VNAV arming and activation will occur 2 nm prior to the FAF.
2. SCN 801.2 or SCN 801.5: Altitude constraints that are depicted on the MFD for some approach and missed approach waypoints may co-exist in the same area of the map display. Under these circumstances refer to the FMS MCDU VNAV or FPL page in order to verify the altitude constraints associated with these waypoints.
3. It is possible to enter waypoint altitude constraints on the FPL pages that will violate the enroute and approach flight path angle limitations. These waypoint altitude constraints will not be copied onto the VNAV pages nor will it be possible to activate VNAV to these waypoints.

3. VNAV with Temperature Compensation

To activate VNAV Temperature Compensation:

a.	FPL key	Press FPL key to access Flight Plan Pages.
b.	MENU key	Press MENU key to access the Flight Plan Menu pages.
c.	PREV or NEXT keys	Press the PREV and/or NEXT keys as required to access the FPL MENU page 2.
d.	LS key 2R (TEMP COMP)	Press to access the TEMP COMP page. Input required information as per OM.
e.	LS key 2L (ACTIVATE)	Press to activate VNAV temperature compensation.

CAUTION

SCN 801.2, 801.5, 802.0: Manually input altitude constraints in the approach transition, approach, and missed approach legs will be modified when temperature compensation is activated or deactivated, or whenever the airfield temperature is modified. Following activation, deactivation or changing the input temperature with the temperature compensation feature active, all previous manually entered VNAV altitude constraints must be re-entered.

SCN 802.2: Manually input altitudes will not have an altitude correction applied when the temperature compensation function is activated.

NOTE

1. Temperature compensation is provided for temperatures below 0 °C only.
2. SCN 801.2 or SCN 801.5: When temperature compensation is activated, TCMP (amber) is annunciated in the upper left corner of the FMS MCDU during the terminal, approach and missed approach phases of the flight plan.
3. SCN 802.0 or higher: When temperature compensation is activated, TCMP (cyan) is continuously annunciated in the upper left corner of the FMS MCDU.

To deactivate VNAV temperature compensation:

a.	FPL key	Press FPL key to access Flight Plan Pages.
b.	MENU key	Press MENU key to access the Flight Plan Menu pages.
c.	PREV or NEXT keys	Press the PREV and/or NEXT keys as required to access the FPL MENU page 2.
d.	LS key 2R (TEMP COMP)	Press to access the TEMP COMP page.
e.	LS key 5L (CANCEL)	Press to activate VNAV temperature compensation.

4. FMS Radio Tuning

a.	ARCDU Mode selector	FMS
b.	TUNE key	Press. Tune the aircraft radios in accordance with OM.

POST-FLIGHT PROCEDURES

1. System Shutdown

a.	ON/OFF key	Press. The dimming control window will be displayed.
b.	OFF line select key	Press. The CONFIRM OFF control window will be displayed.
c.	CONFIRM OFF line select key	Press. The system will shut down.

12.15.11.6 MCDU Operation - Abnormal Procedures

ANNUNCIATOR MESSAGES

1. The FMS MCDU and PFD/MFD Message (MSG) Annunciators Illuminate

a.	FMS MCDU Message key (MSG)	Press to display Message page.
b.	Message requires no action	Press MSG key again to acknowledge message and return to previous page.
c.	Message indicates pilot action required in order to maintain valid navigation guidance	Perform necessary action. Monitor position and navigation guidance accuracy (reasonableness).
d.	Message indicates system failure invalid sensor, invalid navigation	De-select FMS navigation guidance and utilize remaining navigation equipment.

2. Loss of Navigation Integrity

a.	Illumination of GPS INTEG annunciator	Monitor FMS position by cross-reference to other navigation sensor.
	NOTE: GPS-based approaches cannot be flown with the GPS INTEG message illuminated.	
b.	Illumination of NAV INTEG or NAV DR annunicator or POSITION UNCERTAIN message	Revert to an alternate means of navigation.

POWER FAILURE (In-flight Initialization)

The following procedures are to be followed after electrical power is restored after a power failure to the FMS. This may include a simultaneous power loss to the GPS sensors. For in-flight initialization refer to "Power Failure For Over Seven Minutes" procedure.

1. Power For Up To Seven Minutes

a.	ON/OFF key	Press to turn system on. Within 7 seconds of a power failure, the same page will be displayed that was in view prior to the power interruption. After 7 seconds of a power failure, a POWER FAIL page is displayed.
	NOTE: The latitude/longitude displayed on the POWER FAIL page represents the best computed position co-ordinates at the time of power failure. The UTC shown is the time of that failure, and the duration of the interruption is displayed in minutes and seconds.	
b.	DATA key	Press to access FMS Position page (DATA Page 3). Use the line select keys to select the best long range sensor that has a position available (GPS preferred).

12.15.11 Flight Management System (FMS) UNS-1E

System description corresponds to Supplement 91 of the AFM, and covers both dual and single FMS installation. As installed, indicated by Aircraft Briefingcard.

12.15.11.1 General

The UNS - 1E Flight Management System (FMS) is an integrated navigation management system providing the flight crew with navigation, flight planning and fuel management data. The UNS -1E is a system consisting of a cockpit mounted Multi-functional Control Display Unit (MCDU), Flight Management Computer (FMC) and Global Positioning System (GPS) receiver enclosed in a single Line Replaceable Unit (LRU). Position information is derived from VOR#1, DME#1 and GPS#1 for the pilot's side FMS and VOR#2, DME#2 and GPS#2 for the co-pilots side FMS. True airspeed, altitude, static air temperature data, fuel flow data, etc., are routed to each FMS from the Flight Data Processing System (FDPS).

The DHC-8 Series 400 UNS-1E FMS configuration requires the following minimum equipment to be functional and operating:

Decription	Part Number	Model Number	FMS #1 Quantity	FMS #2 Quantity
Flight Management System				
Hardware P/N	2017-41-221	UNS - 1E	1	1
Software P/N	SCN 803		1	1
Antenna	10705	Universal Avionics	1	1
Date Transfer Unit	1406-01-1	Universal Avionics	1	(Part of FMS #1)

The FMS provides lateral navigation (LNAV) guidance and vertical navigation (VNAV) guidance based on data from the navigation receivers and air data sensors. An FMS approach mode allows the operator to fly flight director or autopilot non-precision approaches. The FMS provides course, course deviation, bearing-to-waypoint and distance-to-waypoint information displayed on the pilot's and copilot's PFD and MFD and is coupled to the AFCS for flight director and autopilot functions.

During flight the FMS automatically updates the fuel on board and gross weight as well as predicted fuel requirements and estimated time of arrival based on fuel flow, groundspeed and, if entered by the pilot, enroute flight plan winds.

The enhanced Navigation Display and LNAV/VNAV option provide additional capabilities as follows:

a. Step-up/Step-down through flight plan is graphically displayed on MFD MAP;

b. Route preview of non-active flight plan on MFD MAP;

c. Pilot defined FIX waypoint is graphically displayed to show abeam, radius or radial

information on MFD;

d. Top-of-climb (TOC) and Bottom-of-descent (BOD) prediction is graphically displayed on

MFD ARC;

e. Aircraft Heading bug and FMS HDG mode are interactive when LNAV HDGSEL as active lateral mode;

f. Automatic transition to ILS approach from FMS (NAV-TO-NAV transfer);

g. Vertical Flight Level Change mode (VFLC) provides pre-programmed climb and descent speed profiles;

h. Modify flight plan information displayed on MFD for, PVOR, DTO HOLD and DTO non-flightplan waypoints; and

i. Vertical Path Approach mode (VAPP) associated with the FMS approach mode.

A self-contained database stored in non-volatile memory provides the FMS with information on over 100,000 waypoints, navaids and airports. Data base updates are provided by Jeppesen.

The UNS---1E FMS is approved to TSO---C115b and includes GPS navigation equipment approved to TSO---C129a.

The FMS has been demonstrated capable of and shown to meet the requirements of the following:

Multi-Sensor Navigation

VFR/IFR enroute, terminal and approach navigation in accordance with FAA AC 20---130A.

Vertical Navigation (VNAV)

VFR/IFR enroute, terminal and approach vertical navigation in accordance with FAA AC 20---129.

Basic Area Navigation (B-RNAV)

B-RNAV navigation in accordance with JAA AMJ 20X2, Leaflet No. 2, rev 1.

Precision Area Navigation (P-RNAV)

TheFMSmeets the airworthiness certification requirementsof JAATemporary GuidanceLeaflet No. 10 (TGL 10), except for the database requirements of Section 8.2 of TGL 10.

U.S. RNAV

RNAV Routes, Type A RNAV SIDS and STARS, Type B RNAV SIDS and STARS, in accordance with FAA AC 90---100, when using GPS-sensor positioning.

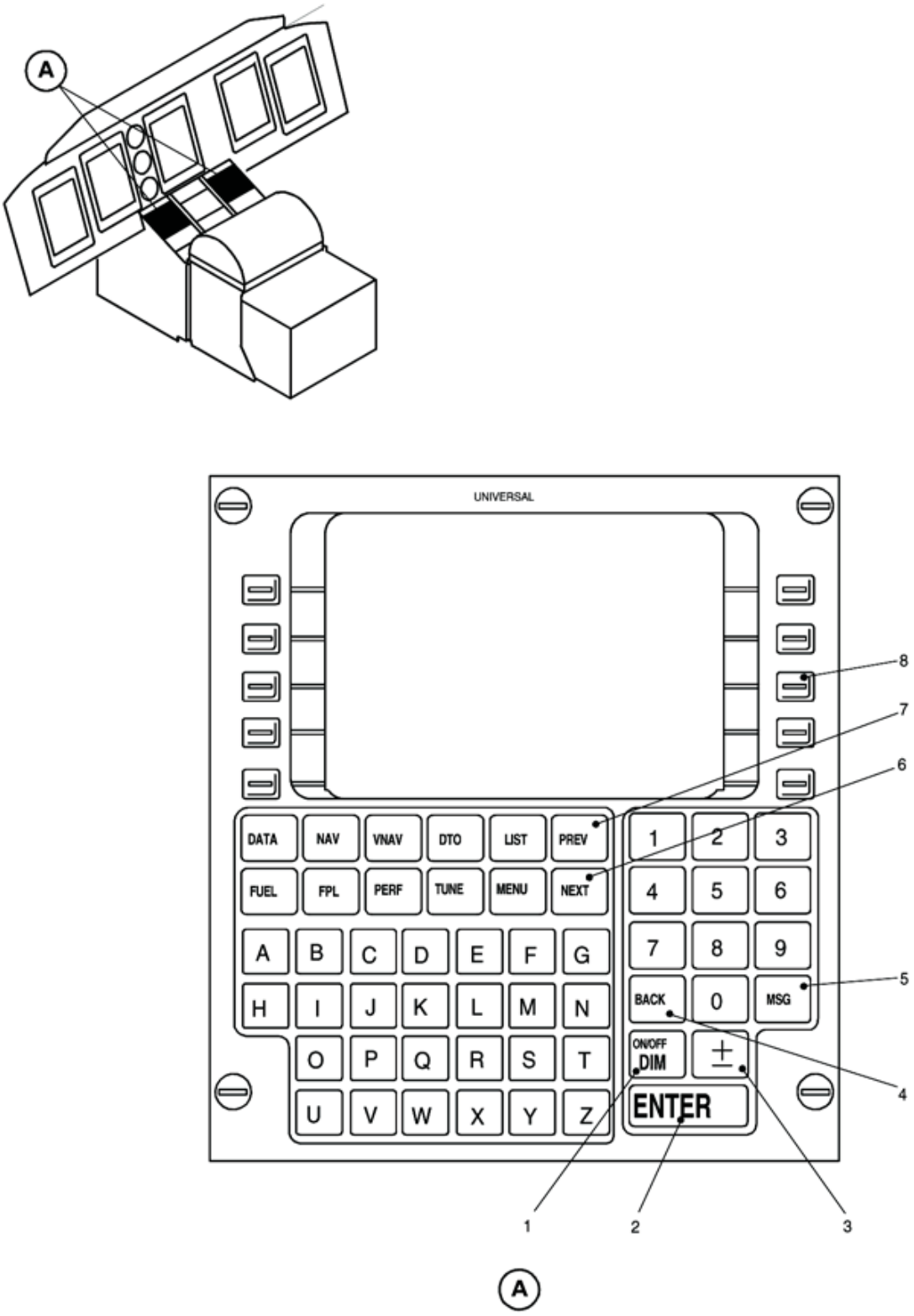


Figure 12.15-48A FMS MCDU (Sheet 1 of 2)

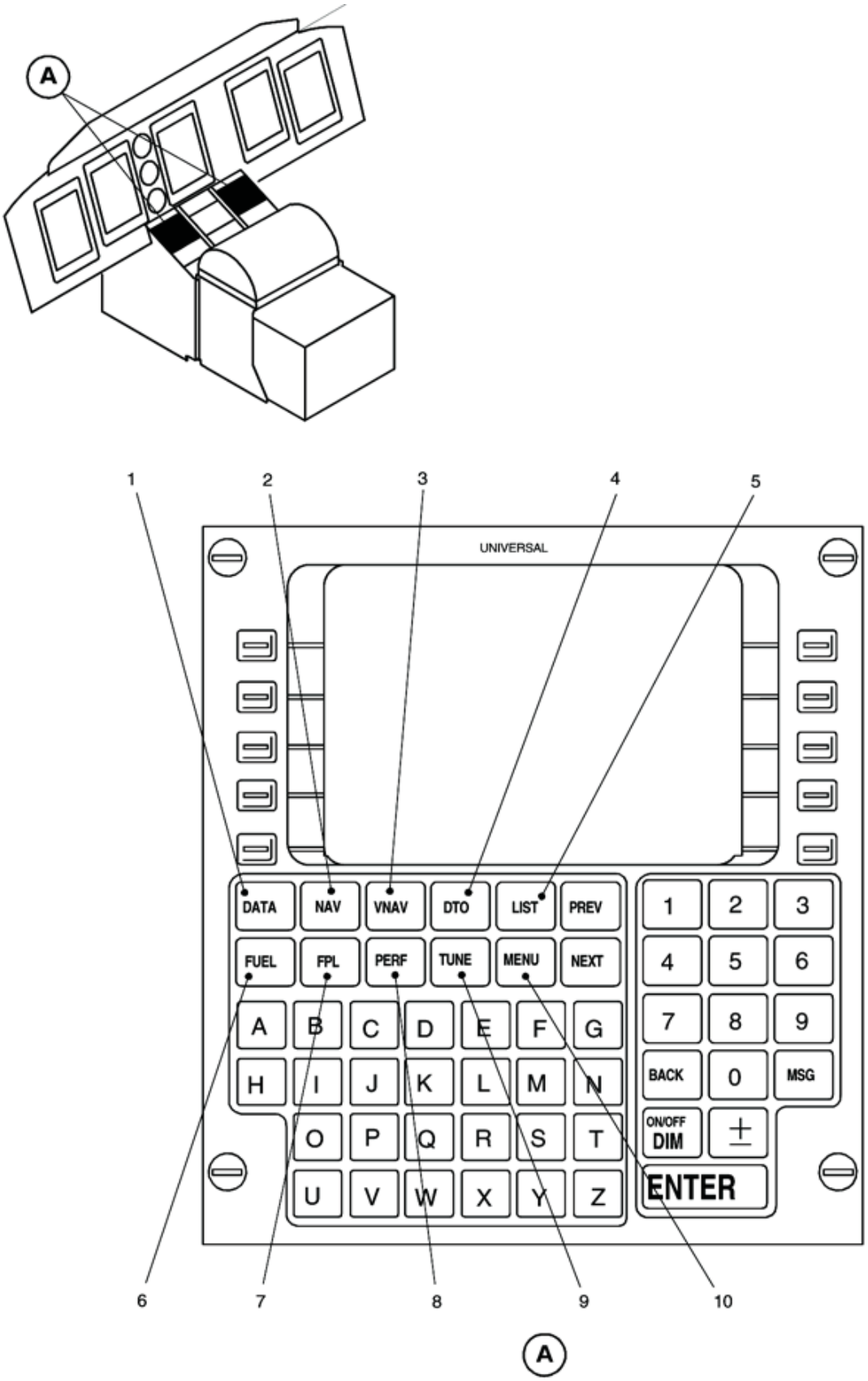


Figure 12.15-48B FMS MCDU (Sheet 2 of 2)

12.15.11.2 System Description

The Multi-functional Control Display Unit (MCDU) located on the center console, displays information on a dimmable eleven-line color Liquid Crystal Display (LCD). Line select keys are located on either side of the display and ten function keys are located below the display screen. Separate alpha-numeric keys are located below the function keys and are used to enter data into the FMS.
Data is always entered into the FMS at a cursor location using the ENTER key. The cursor will automatically move to the next position when the ENTER key is pressed.

CONTROL KEYS (Fig. 12.15 - 48A)

1. ON/OFF - DIM KEY

Initially pressing the ON/OFF-DIM key energizes the system, initiates the self-test and displays the self-test page on the LCD display. If all self-tests are successful the initialization page appears. No other pages are displayed until the initialization data is accepted.
Once the system is operational, pressing the ON/OFF-DIM key will display a control window with the options BRIGHT, DIM, CANCEL, DISPLAY, and OFF. Select from these options by pressing the line select key next to the desired option. Pressing the BRIGHT or DIM key will brighten or dim the display respectively as the key is held down. Pressing CANCEL will cause the control window to be removed from the active page. Pressing DISPLAY accesses the UP/DOWN keys used for display adjustment. Pressing OFF will cause CONFIRM OFF window to be displayed. Two options will appear, CONFIRM OFF and CANCEL. Selecting CONFIRM OFF will turn the system off; CANCEL returns the display to the main window.

2. ENTER KEY

The ENTER key stores input data to memory. The cursor marks data that can be changed using the normal input processes (dark letters on a light background). When variable data is marked by the cursor, pressing the ENTER key stores data to memory.

3 ± KEY

The “State Change Key” is used in conjunction with the alpha-numeric keys to enter data. Pressing this key reverses the selected data entry field from + to -, N to S and L to R. In the alpha field the key is used as a dash or period.

4. BACK KEY

When the cursor on the display screen is over a data entry field, the BACK key will delete data or back space as required.

5. MSG (MESSAGE) KEY

Pressing the MSG key will display an active message when the `MSG' annunciation appears on the LCD. The message alerts the operator to system status and flight plan sequencing. Selecting the UniLink option will access the UniLink menu page.

6. NEXT KEY

The NEXT key is used to cycle forward, one page at a time, through multiple pages of the same mode.

7. PREV KEY

The PREV (previous) key is used to cycle backward, one page at a time, through multiple pages of the same mode.

8. **LSK key (momentary action)**
PUSH - Line Select Keys (LSK's) are used to enter data utilizing the alphanumeric keys. Pressing the ENTER key completes the entry. 10 LSK's (5 down left side and five down right side of display) align with associated data lines.

FUNCTION KEYS (Fig 12.15 - 48B)

Ten function keys located below the display screen are used to select data entry or command inputs. Pressing the appropriate key once will display the first page of the selected mode. Additional selections of the same key will cycle the display through multiple pages.

1. DATA KEY

The DATA function obtains information and status about the FMS, Navigation Data Base and attached sensors which operate with the FMS. The DATA key selects/deselects individual sensors and adds or deletes pilot defined locations.

DATA Page 1 allows selection of Nav Data, Pilot Data, Company Data, Disk Menu, TAWs, Cabin Display, EFIS Display, UniLink Menu, Master Crossfill, and Maintenance Menu. Pressing the line select key next to the desired option displays the appropriate menu page.

DATA Page 2 provides a synopsis of input sensor operation. The second lines shows the most significant sensor and the quality factor (ANP/RNP) associated with the FMS best computed position.

ANP (Actual Navigation Performance) is a measure of the system's best estimate of error, calculated to allow for flight technical error, in hundredths of a nautical miles.

The RNP (Required Navigation Performance) value is the limit to position uncertainty the system will allow for continued flight and are specified for each phase of flight. RNP values are derived from either FMS default values or manual entry.

DATA Page 3 shows the FMS system position and all long range sensors with position differences expressed in radial nautical miles from the FMS position. When the line select key for a sensor is pressed, the sensor's coordinates and position difference are displayed below the FMS position.

DATA Page 4 (General Data) allows entries of date, time, variation, and heading inputs. Advisory information is provided concerning software version numbers and current aircraft steering commands. The heading source (HDG) of the heading data is displayed in parenthesis. Next to this, the present heading is displayed. A "T" indicates that it is a true heading. To

access a display of optional heading source selections place the cursor over the HDG entry field and press the LIST key. If the heading is input manually (MAN) will be displayed.

2. NAV KEY

Press the NAV key to display the navigation display pages. There are normally three NAV pages in the normal flight mode. When APPROACH or HEADING mode is selected there will be additional display pages which are cycled through by pressing the PREV or NEXT function keys.

NAV Page 1 displays information about the FR (from), TO (to), and NX (next) waypoints and allows the pilot to alter the current navigation leg. Information displayed on NAV Page 1 correlates with the information on the HSI.

NAV Page 2 displays similar information to NAV Page 1 with the addition of headwind/tailwind, bearing to current terminator and track angle error.

NAV page 3 displays system position and quality factor (Q=) associated with the FMS best computed position.

3. VNAV KEY

The Vertical Navigation key allows the flight crew to define a desired vertical flight profile along the flight plan route. It computes the aircraft deviation from that profile for display.

The flight profile is defined by two waypoints with reference altitudes (i.e. present position plus one waypoint ahead, or one waypoint ahead and a target vertical speed). A climbing profile will provide VSR (Vertical Speed Required) information only. Up to eight vertical waypoint identifiers are prefilled automatically according to current flight plan waypoints, however VNAV altitudes may also be programmed on the Flight Plan pages.

4. DTO KEY

The DTO mode allows the flight crew to alter the flight plan in response to “direct to” clearances. Press the DTO (“direct to”) key to access the DTO page which displays the flight plan waypoints. The flight leg may be changed “direct to” a flight plan waypoint, a database waypoint, an airport or a pilot defined position. Selecting DTO cancels APPROACH mode. The turn direction will default to shortest turn, however the pilot can override this by selecting LEFT or RIGHT direction. Pressing AUTO will cancel LEFT or RIGHT and return default to shortest direction.

5. LIST KEY

Pressing the LIST key displays a list of options during data entry appropriate to the entry being made.

6. FUEL KEY

Press the FUEL key to access the fuel pages and the fuel management functions of the FMS. With any fuel page displayed, pressing the MENU key will access the FUEL OPTIONS page. The left side of the FUEL OPTIONS page is for viewing conversions. Pressing any of the left line select keys will place the cursor over that respective entry field. Entry of a value into one field will cause all other fields to display the same value converted per the entry field heading. The right side is for selecting crossfill (X FILL), individual tank (BY TANK) or total fuel on board entries, average passenger weight (AVG PAX WEIGHT), and RETURN to

access display. After initialization, pressing the FUEL key while in any mode will display FUEL Page 1.

FUEL Page 1 is the fuel and weight entry page. It is used to input initial fuel on board, calculate the airplane gross weight, and to construct a reserves plan. If all entries are made on FUEL Page 1, pressing the FUEL key will cause FUEL Page 2 to appear.

Note:

FMS fuel mode calculations are based on the pilot's initial entry of fuel on board and subsequent automatic or manual fuel flow measurements subtracted over time. There is no direct connection to the aircraft's fuel quantity system by the FMS, so the aircraft's system remains the primary reference for all fuel and range calculations.

FUEL Page 2 displays range and endurance estimates based upon departure time and current parameters. Manual FUEL FLOW and GS (groundspeed) entries may be made for evaluation of parameters displayed.

Note:

If FUEL FLOW or GS are manually entered, the values will be lost when fuel mode is exited.

FUEL Page 3 provides a fuel requirement summary for the flight plan. Manual FUEL FLOW and GS entries may be made for evaluation of parameters displayed.

FUEL Page 4 displays projected landing weight based upon current fuel conditions. All fuel quantity and gross weight displays are computed values based upon the initial values entered by the pilot inputs from the engine fuel flow sensors. The values may not be changed and the line select keys have no function.

FUEL Page 5 shows the fuel flow and fuel consumption in kilograms per hour for each engine individually and cumulatively. The fuel flows shown are supplied by the aircraft fuel flow sensors.

The fuel management functions use a combination of manual entries, pre-programmed data, flight plan information and fuel flow data from the engines. There is no direct input from the aircraft fuel tanks and all calculations are based on fuel flows and the initial fuel quantity entered by the flight crew. The fuel gauges remain the primary source of information for fuel and range calculations. APU fuel flow data is not available to the FMS. Fuel onboard quantities should be compensated for APU consumption. System weight/volume conversion for fuel is based on 6.7 lb/US gal.

7. FPL KEY

The FPL (flight plan) function key is used to access the Flight Plan pages, stored arrivals and routes. The function also allows the pilot to construct a new flight plan, alter the current flight plan, or insert a SID, STAR and ARRIVAL (approach) into the flight plan. When the FPL key is pressed and no flight plan exists the empty FPL page (page 1/1) is displayed which is used to build a flight plan.

When a flight plan is defined, pressing the FPL key displays the normal FPL pages. The Normal FPL display pages show the flight plan waypoints, ETAs (estimated time of arrival), altitudes (when defined in VNAV), bearings and distances between waypoints. The path type and terminator of a procedural leg are shown when a SID, STAR or ARRIVAL is active. Succeeding pages of the flight plan may be displayed by pressing the PREV or NEXT keys, as appropriate.

The Flight Plan Summary page is available only during ground operations prior to departure and is located following the last flight plan page using the PREV and NEXT keys. It provides a synopsis of distance, time and fuel requirements for the planned flight.

The FPL MENU pages are accessed from any FPL page by pressing the MENU key. FPL pages are used to display formats for the flight plan waypoints, view the approach plan, insert a SID, STAR and ARRIVAL, and to delete or invert a flight plan.

8. PERF KEY

The PERF page provides a synopsis of pertinent in flight performance information. It is a read-only page as no entries can be made.

9. TUNE KEY

Pressing the TUNE key displays the TUNE page, which is used to select and store preselected frequencies, and view selected frequencies for each radio. The control window displays the last tuned radio with the cursor over the active frequency with up to four preselected frequencies displayed below. Press the appropriate line select key to view desired radio in the control window. The active frequency is changed by entering the frequency with the numeric keys or inputting the reference number (1-4) of one of the preset frequencies. The frequency is completed by pressing the ENTER key.

10. MENU KEY

The MENU key presents a list of alternate formats or options for the FUEL, FPL, NAV, VNAV or TUNE mode being displayed. When the MENU key is active the letter "M" will appear in a box on the title line of the selected page.

12.15.11.3 SYSTEM ANNUNCIATIONS

1. PFD/MFD a. Waypoint Alert annunciator (WPT ALRT)	Illuminates prior to automatic leg change or on arrival at the TO waypoint.
b. Vertical Path Alert annunciator (VERT ALRT)	Illuminates 15 seconds prior to Top of Descent or 15 seconds prior to any change in vertical path angle.
c. Message annunciator (MSG)	Illuminates in conjunction with the message advisory light on the MCDU.
d. Crosstrack annunciator (XTRK)	Illuminates whenever a left or right Cross Track (parallel offset) is activated.
e. Procedural Heading annunciator (PHDG)	Illuminates when a procedural heading leg is the active navigation leg.
f. Course Deviation Scale annunciator (TERM)	Illuminates to indicate Terminal Scaling or Missed Approach Scaling is active.
g. Course Deviation Scale annunciator (APPR)	Illuminates to indicate FMS Approach Mode and Approach Scaling is active.
h. Dead Reckoning Mode annunciation (NAV DR)	Illuminates when the FMS is navigating by dead reckoning on last known track, groundspeed, heading and TAS.
i. Navigation Integrity annunciation (NAV INTEG)	Illuminates when the required navigation performances are not guaranteed by the FMS.
j. GPS Integrity annunciation (GPS INTEG)	Illuminates whenever the integrity of the GPS position cannot be assured to meet minimum requirements for the particular phase of flight. Whenever the GPS INTEG annunciator is illuminated, GPS position must be monitored by cross-reference to other navigation sensors.

2. Lateral and Vertical Scale Sensitivity

PHASE OF FLIGHT	LATERAL SCALE SENSITIVITY	VERTICAL SCALE SENSITIVITY	COMMENTS
ENROUTE	5.0 nm for two dots of CDI scale deviation	1,500 ft for two dots of vertical scale deviation.	
TERMINAL	1.0 nm for two dots of CDI scale deviation	500 ft for two dots of vertical scale deviation.	
APPROACH	2° for two dots of CDI scale deviation until two dots deviation is equal to 0.3 nm. Then Approach Scale Sensitivity is 0.3 nm for two dots of CDI scale deviation.	200 ft for two dots of vertical scale deviation.	The lateral scale sensitivity change occurs approximately at the Final Approach Fix (FAF).

3. FMS MCDU
   Refer to the FMS OM.

12.15.11.4 PRE-TAXI CHECKS AND INITIALIZATION

a.	ON/OFF key	Press to activate system. Self test and the Initialization (INIT 1/1) page will appear at the end of the self test indicating system is ready for use. Verify the navigation database is current and software version SCN 803.0.
b.	ACCEPT LSK	Press the ACCEPT Line Select Key (LSK) to accept the data. If data shown on the initialization page is incorrect, manually correct data per OM.
c.	FPL key	Press FPL key to access Flight Plan Pages. Enter desired way points for the planned flight.

or:

d.	CPY RTE LSK	Press CPY RTE LSK to access previously stored flight plan route. Enter route reference number.

then:

e.	ENTER key	Press ENTER to load desired route. To create new flight plan route, refer to OM.
f.	FPL key	Press FPL key to return to Flight Plan Pages.
g.	PREV or NEXT keys	Press the PREV and/or NEXT keys, as required, to access the FPL SUMMARY page. Use the LSKs to position the cursor over each entry field and enter values for the required fields.
h.	FUEL key	Press FUEL key to access FUEL data pages. Use appropriate LSKs to position the cursor over each entry field and enter values for the required fields.

NOTE

When using fuel data function, ensure the correct operational empty weight of the aircraft and on-board fuel is shown on FUEL data page 1.

2. Flight Guidance Control Panel

a.	HSI selector (HSI SEL)	Press to select appropriate side.
b.	Navigation source selector	Select FMS 1 or FMS 2 as navigation source to display FMS generated navigation data as desired.

3. EFIS Control Panel

a.	BRG knob	Select FMS 1 or FMS 2 to display FMS navigation guidance on HSI Bearing Pointers #1 or #2.

12.15.11.5 IN-FLIGHT PROCEDURES

1. Flight Guidance Control Panel
   - a. Navigation selector — Select FMS 1 or FMS 2 as navigation source to display FMS generated navigation data as desired on HSI.
2. EFIS Control Panel
   - a. BRG knob — Select FMS 1 or FMS 2 to display FMS navigation guidance on HSI as desired on Bearing Pointers #1 or #2.
3. FMS MCDU
   - a. NAV key — Press NAV key to access navigation display pages. Check that the information on page 1 correlates with the information displayed on the EHSI.
4. To couple the flight director to FMS lateral guidance (LNAV):
   - a. HSI selector (HSI SEL) — Press to select appropriate side.
   - b. Navigation Mode selector (NAV) — Press to select flight director NAV lateral guidance mode. Check LNAV is annunciated on Flight Mode Annunciator and flight director provides lateral steering to the active leg.

NOTE

The FMS HEADING mode and FMS HEADING INTERCEPT mode allows the pilot to control the aircraft heading through the NAV HEADING page of the FMS or flight guidance control panel HDG knobs. When this mode is active while coupled to the flight director, LNAV HDGSEL or LNAV HDGINT is annunciated (as appropriate), the PFD heading bugs are synchronized to the current commanded heading and lateral steering commands will be in accordance with the pilot entered heading information or heading bug position.

5. FMS Approach
   - a. FPL key — Press FPL key to access Flight Plan Pages.
   - b. MENU key — Press MENU key to access the Flight Plan Menu pages.
   - c. ARRIVE LSK — Press ARRIVE LSK to access the arrival/approach flight planning information pages. Insert arrival data as per OM.
   - d. FPL key — Press FPL key to return to Flight Plan Pages.
   - e. NAV key — Press NAV key. Check ARM APPR becomes available on NAV page 1 when the aircraft is within 50 nm of the runway.

NOTE

If an approach is linked into the flight plan and is not armed before reaching 30 nm from the destination, the system will automatically arm and the CDI scaling will change to 1.0 nm.

f. ACT APPR LSK — Approach mode may be manually activated by pressing the ACT APPR LSK.

NOTE

1. If ACT APPR is selected, all intervening waypoints from the present FR–TO leg to the first approach waypoint will be sequenced and HSI guidance will be to that waypoint. Desired track pointer will be set to the inbound course of the approach. The FMS will transition to FMS HDG mode and the pilot must manually set up the correct intercept angle. When the correct intercept angle is established, the INTERCEPT LSK on NAV page 1 must be pressed to allow interception of the final approach course.
2. If the pilot does not select ACT APPR the entire approach procedure will be flown.

At the Final Approach Fix:

g. Course Deviation Scale annunciator (APPR) — Check APPR illuminates to indicate FMS Approach Mode and Approach Scaling is active.

NOTE

FMS based instrument approaches must be conducted in the approach mode (APPR) and for GPS approaches, RAIM must be available at the final approach fix.

To initiate a missed approach:

a. GA mode — Press the POWER lever GA button to activate flight director go-around mode.
b. Flight Mode annunciator — Check LNAV and GA are annunciated in green and the flight director provides steering commands to the first missed approach leg.

6. NAV–TO–NAV ILS Approach

a. FPL key — Press FPL key to access Flight Plan Pages.
b. MENU key — Press MENU key to access the Flight Plan Menu pages.
c. ARRIVE LSK — Press ARRIVE LSK to access the arrival/approach flight planning information pages. Select the desired ILS approach and insert data as per OM.
d. FPL key — Press FPL key to return to Flight Plan Pages.

e.	NAV key	Press NAV key. Check ARM APPR becomes available on NAV page 1 when the aircraft is within 50 nm of the runway.

NOTE

1. If an ILS approach is linked into the flight plan and is not armed before reaching 30 nm from the destination, the system will automatically arm and the CDI scaling will change to 1.0 nm at 30 nm from the destination.
2. Within 30 nm from the destination, if an ILS approach is armed in the flight plan but not tuned on the VHF NAV, a TUNE prompt will be displayed.

f.	VHF NAV	Manually tune the ILS frequency for the desired approach or select TUNE prompt.
g.	PFD	Observe a preview of the ILS inbound course. When received, localizer and glideslope deviation information is displayed on the PFD.
h.	Approach Mode Selector (APPR)	When in position to intercept the localizer, press APPR, on the Flight Guidance Control Panel, to arm LOC and GS capture modes and to enable the NAV-to-NAV transfer.
i.	Flight Mode annunciator	Check LOC and GS are annunciated in white.
j.	PFD	At the point of localizer capture, Observe the PFD navigation source changes from FMS to ILS, and the flight director approach modes activate to command steering to intercept and track the localizer and glideslope.

7. Vertical Navigation (VNAV)

To activate VNAV VFLC mode:

a.	VNAV key	Press VNAV key to access VNAV page and input desired vertical navigation information and activate as per OM.
b.	VFLC LSK	Press VFLC LSK to activate VFLC mode.
c.	PROFILE LSK	Select desired VFLC climb or descent profile by manually entering or by toggling INCREASE/DECREASE LSK.

NOTE

1. VFLC CLIMB or VFLC DESCENT will annunciate dependent on the position of the altitude selector above or below the aircraft altitude.
2. It is not possible to have VFLC and VPATH active at the same time.

3. VFLC CLIMB/DESCENT profiles:

	CLIMB (KIAS)	DESCENT (KIAS)
PROFILE 1 (High Speed)	a. 210 from sea level to 15,000 ft b. Decrease from 210 at 15,000 ft to 160 at 25,000 ft	a. Increase from 238 at 25,000 ft to 277 at 18,000 ft b. 277 from 18,000 ft to 12,000 ft c. Decrease from 277 at 12,000 ft to 238 at 10,000 ft d. 238 from 10,000 ft to sea level
PROFILE 2 (Mid Speed)	a. 185 from sea level to 20,000 ft b. Decrease from 185 at 20,000 ft to 160 at 25,000 ft	a. 200 from 25,000 ft to sea level
PROFILE 3 (Low Speed)	a. 160 from sea level to 25,000 ft	a. 160 from 25,000 ft to sea level

To activate VNAV VPATH mode:

a. VNAV key	Press VNAV key twice to access VPATH page and input desired vertical navigation information and activate as per OM.
b. PFD/MFD	Check. Vertical path deviation scale is displayed on the PFD and a Top-of-Descent (TOD) pseudo-waypoint is displayed on the MFD FMS map display.

To cancel VNAV mode:

a. VNAV key	Press VNAV key twice to access VNAV page.
b. CNCL VNAV LSK	Press CNCL VNAV LSK to cancel VNAV.

To couple the flight director to VFLC vertical guidance:

NOTE

VFLC mode must be active in the FMS and FMS lateral guidance must be active before vertical guidance can be armed and activated.

a. Altitude preselector	Select to waypoint altitude.
b. ALTSEL	Press. Check ALTSEL is annunciated on the Flight Mode annunciator.
c. VNAV mode selector	Press. Check VFLC is annunciated on Flight Mode annunciator.

NOTE

1. VFLC mode will not activate or remain active if a VFLC CLIMB leg will result in a descent or if a VFLC DESCENT leg will result in a climb. Pilot must manage power as required to climb or descend in accordance with the VFLC profile.
2. VFLC mode will not remain active if the aircraft climbs or descends away from the altitude preselector.

To couple the flight director to FMS VPATH vertical guidance:

NOTE

VPATH mode must be active in the FMS and FMS lateral guidance must be active before vertical guidance can be activated.

a. Altitude preselector — Select to waypoint altitude.
b. ALTSEL — Press. Check ALTSEL is annunciated on the Flight Mode annunciator.

NOTE

With the exception of FMS Approach mode, Flight Director coupled VNAV will not couple or remain coupled unless the altitude preselector is below the aircraft altitude. If the VNAV path descends through the preselector altitude, coupled VNAV will disengage and the flight director will revert to PITCH. In FMS Approach mode, the altitude preselector may be set above the aircraft altitude and VNAV guidance will remain active.

When within 2 minutes of Top–of–Descent (TOD) point:

c. VNAV mode selector — Press to arm flight director VNAV vertical guidance mode.
d. Flight Mode annunciator — Check VNAV is annunciated in white.

NOTE

Flight Director VNAV will not arm unless the TOD pseudo-waypoint is within two minutes of capture.

At VNAV capture:

e. Flight Mode annunciator — Check VNAV PATH is annunciated in green and the flight director provides vertical steering commands to the vertical path.

8. VNAV During Approach Operations (VAPP)

a. VNAV key — Press VNAV key to access VNAV page. Check altitude constraints associated with all approach waypoints are displayed and that there are no vertical discontinuities in the VNAV descent path.

NOTE

1. It is possible to program an enroute VNAV segment to terminate at a published minimum enroute altitude that is below the FMS computed crossing altitude for the Final Approach Fix (FAF) or to program a VNAV segment into the FAF that is steeper than the maximum allowable VNAV approach path angle. If VNAV is active when sequencing to the FAF, the FMS will interpret the transition as an illegal vertical leg and cancel the VNAV mode. To ensure availability of VNAV guidance for the final approach segment, pilots must ensure that no vertical discontinuities exist between the enroute segment and the approach segment and that the flight path angle into the FAF is not steeper than the allowable approach flight path angle of 4°.

NOTE (CONT'D)

2. It is possible to enter waypoint altitude constraints on the FPL pages that will violate the enroute and approach flight path angle limitations. These waypoint altitude constraints will not be copied onto the VNAV pages nor will it be possible to activate VNAV to these waypoints.

To manually couple the flight director to FMS approach vertical guidance:

NOTE

The FMS must be in ACTIVE APPR mode and FMS lateral guidance must be active before approach vertical guidance can be manually activated.

a. Altitude preselector — Select to desired altitude.

NOTE

In the Approach mode, the altitude pre-selector may be set above the aircraft altitude.

b. VNAV mode selector — Press to arm flight director VAPP vertical guidance mode.

c. Flight Mode annunciator — Check VAPP is annunciated in white.

NOTE

When automatically transitioning from enroute to approach VNAV guidance, the flight director will transition directly from VPATH to VAPP without the need to arm VAPP.

At VAPP capture:

d. Flight Mode annunciator — Check VAPP is annunciated in green and the flight director provides vertical steering commands to the vertical path.

9. VNAV with Temperature Compensation

To activate VNAV temperature compensation:

a. FPL key — Press FPL key to access Flight Plan Pages.

b. MENU key — Press MENU key to access the Flight Plan Menu pages.

c. PREV or NEXT keys — Press the PREV and/or NEXT keys as required to access the FPL MENU page 2.

d. TEMP COMP LSK — Press to access the TEMP COMP page. Input required information as per OM.

e. ACTIVATE LSK — Press to activate VNAV temperature compensation.

NOTE

1. Temperature compensation is provided for temperatures below 0 °C only.
2. Manually input altitudes will not have an altitude correction applied when the temperature compensation function is activated or cancelled.
3. When altitudes are manually entered before or after the temperature compensation function is activated, it may produce VNAV paths with climb segments and result in VNAV disconnect.

To deactivate VNAV temperature compensation:

a.	FPL key	Press FPL key to access Flight Plan Pages.
b.	MENU key	Press MENU key to access the Flight Plan Menu pages.
c.	PREV or NEXT keys	Press the PREV and/or NEXT keys as required to access the FPL MENU page 2.
d.	TEMP COMP LSK	Press to access the TEMP COMP page.
e.	CANCEL LSK	Press to deactivate VNAV temperature compensation.

10. FMS Radio Tuning

a.	ARCDU Mode selector	FMS
b.	TUNE key	Press. Tune the aircraft radios in accordance with OM.

NOTE

1. The FMS can tune the aircraft radios only when the ARCDU Mode selector is selected to FMS or OFF.
2. FMS Autotune function, on the ARCDU, is not supported by the UNS–1E.

11. Synchronized Mode Operation

NOTE

1. The potential exists for each FMS to be in a different mode or flight plan leg for short periods of time due to small differences in FMS position. If a pilot input is made on one FMS that is not available on the other unit due to the current mode of operation, Synchronized mode will automatically cancel.
2. If a pilot input is made on an FMS during the period of time it is being synchronized to the opposite unit, the FMS may display a SYNC IN PROGRESS message along the top of both FMS MCDU displays. The receiving FMS temporarily ignores the input until the conflict can be resolved. If it is not possible to resolve the conflict, Synchronized mode will automatically cancel.
3. Cancellation of Synchronized mode is indicated by a "FMS SYNC LOSS" message on the FMS MCDU and a cyan inverse video "I" appearing in the top right corner of both FMS MCDU displays.

To manually deactivate Synchronized mode:

a.	NAV key	Press NAV key to access Navigation page.
b.	MENU key	Press MENU key to access the Navigation Menu pages.
c.	SYNC LSK	Press SYNC LSK to access the Synchronization menu.
d.	INDEPENDENT LSK	Press INDEPENDENT LSK to de-activate Synchronized mode.

NOTE

A cyan inverse video "I" appears in upper right corner of the FMS MCDU to indicate Independent Mode operation.

To manually activate Synchronized mode:

a.	NAV key	Press NAV key to access Navigation page.
b.	MENU key	Press MENU key to access the Navigation Menu pages.
c.	SYNC LSK	Press SYNC LSK to access the Synchronization menu.
d.	FROM FMS # or TO FMS # LSK	Press the FROM FMS # LSK or TO FMS # LSK to initiate synchronization and instruct the onside FMS to receive data FROM the offside FMS or transmit data TO the offside FMS.

NOTE

1. The Init Sync prompt will not be available when there is a fault that prevents synchronization.
2. FMS synchronization is not available if one or both FMSs are in approach mode.

12.15.11.6 ABNORMAL PROCEDURES

The abnormal procedures in Section 4 are applicable with the addition of the following:

1. THE FMS MCDU AND PFD/MFD MESSAGE (MSG) ANNUNCIATORS ILLUMINATE.

a.	FMS MCDU Message key (MSG)	Press to display Message page.
b.	Message requires no action	Press MSG key again to acknowledge message and return to previous page.
c.	Message indicates pilot action required in order to maintain valid navigation guidance	Perform necessary action. Monitor position and navigation guidance accuracy (reasonableness).
d.	Message indicates system failure invalid sensor, invalid navigation	De-select FMS navigation guidance and utilize remaining navigation equipment.

2. LOSS OF NAVIGATION INTEGRITY.

a.	Illumination of GPS INTEG annunciator	Monitor FMS position by cross-reference to other navigation sensors.

NOTE

GPS-based approaches cannot be flown with the GPS INTEG message illuminated.

b.	Illumination of NAV INTEG or NAV DR annunciator or POSITION UNCERTAIN message	Revert to an alternate means of navigation.

12.15.11 TCAS - Traffic Alert and Collision Avoidance System

12.15.11.1 General

The ACAS II/TCAS II is an airborne aeroplane collision and avoidance system that identifies and displays potential and predicted collision threats. The system interrogates aeroplane equipped with an ATC transponder and provides appropriate voice and visual advisories to the flight crew.

This system is compliant with the ACAS II minimum performance levels defined by ICAO Annex 10, Volume IV, Chapter 4 and RTCA Document DO-185A, Minimum Operation Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II, Change 7.0). This is referred to as TCAS II change 7 in the United States and ACAS II internationally. The 'TCAS' term is used herein to be consistent with flight deck labels and annunciations.

The DHC 8 ACAS II / TCAS II configuration requires the following minimum equipment to be functional and operating:

Description	Part Number	Model Number	Quantity
ACAS II / TCAS II Processor	066-01146-1211	TPU-67A	1
Directional Antenna	071-01548-0100	ANT-67A	2
Mode S Transponder	066-01143-1602 066-01143-2101	MST-67A	1
Radio Altimeter	066-01153-0101	KRA-405B	1
TCAS Configuration Module	071-00097-1000	CM 67A	1
Omni Directional Antennas	10-203-32-H-2D	-	2

The system provides two levels of advisories:

A traffic advisory (TA) is a visual display on the Navigation Display page of the MFD (ND/MFD) of the relative position of a threat aeroplane when it is approximately 40 seconds from closest point of approach (CPA). A "TRAFFIC, TRAFFIC" announcement occurs simultaneously. The TA provides the opportunity to visually acquire the threat aeroplane and prepare for a possible evasive maneuver.

A resolution advisory (RA) is a visual indication on the ND/MFD and IVSI/PFD recommending a vertical speed (VS) range that will provide adequate vertical separation from the treat aeroplane when it is approximately 25 seconds from the CPA. The RA will be accompanied by an appropriate announcement.

Traffic advisories can be generated for intruder aeroplane with operative Mode S, Mode C or Mode A transponders. Mode A transponders do not provide altitude information, therefore resolution advisories will only be issued for Mode S or Mode C equipped aeroplane. The ACAS II / TCAS II system provides no indication of traffic conflicts for aeroplane without operative transponders.

For additional ACAS II / TCAS II information refer to Allied Signal Pilot's Guide P/N 066-08201-0000, dated April, 1999 or later. References in the pilot's guide to the Mode S / TCAS Control Panels are not applicable to the DHC-8 configuration.

12.15.11.2 ACAS II / TCAS II Operating Characteristics

1. ACAS II / TCAS II self test is inhibited in flight.
2. “INCREASE DESCENT” RA announcements are inhibited below 1,450 ft AGL.
3. All resolution advisories (RA) are inhibited below 1,100 ft AGL when climbing, below 900 ft AGL when descending.
4. All ACAS II / TCAS II announcements are inhibited below 600 ft AGL when climbing, below 400 ft AGL when descending.
5. RA increase climb announcements and advisories are inhibited during the following conditions:
   a) Landing gear down and flaps extended 15 % or greater; or
   b) Propeller Autofeather switch selected and the white ‘ARM’ annunciation on the ED.
6. During an engine-out condition, climb announcements and advisories are inhibited.
7 The ACAS II / TCAS II mode of operation automatically changes as follows:
   a) TA ONLY mode to TA/RA (AUTO) mode at 1,100 ft AGL when climbing.
   b) TA/RA (AUTO) mode to TA ONLY mode at 900 ft AGL when descending.

12.15.11.3 Traffic Advisory (TA) Announcements

“TRAFFIC, TRAFFIC”
Conduct visual search for the intruder.

12.15.11.4 Resolution Advisory (RA) Announcements

1. “CLIMB, CLIMB”
   Climb at rate shown on the green arc of the IVSI / PFD.
2. “DESCEND, DESCEND”
   Descend at rate shown on the green arc of the IVSI / PFD.
3. “ADJUST VERTICAL SPEED, ADJUST”
   Adjust rate of descent or climb to that shown on IVSI / PFD.
4. “MONITOR VERTICAL SPEED”
   Monitor present vertical speed to prevent entering restricted red arc speed.
5. “CLEAR OF CONFLICT”
   Range is increasing and separation is adequate; return to previous ATC assigned altitude.
6. “CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB”
   Safe separation will be best achieved by climbing through the intruder’s flight path.
7. “DESCEND, CROSSING, DESCEND, DESCEND, CROSSING DESCEND”
   Safe separation will best be achieved by descending through the intruder’s flight path.
8. “MAINTAIN VERTICAL SPEED, MAINTAIN”
   Maintain present vertical speed to prevent entering restricted red arc speed.
9. “MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN”
   Maintain present vertical speed to prevent entering restricted red arc speed. Indicates that own flight path will cross that of intruder.

The following voice messages are announced when the initial RA does not provide sufficient vertical separation from an intruder:

1. “INCREASE CLIMB, INCREASE CLIMB” (received after “CLIMB” advisory)
   Additional climb rate is required.
2. “INCREASE DESCENT, INCREASE DESCENT” (received after “DESCEND” advisory)
   Additional descent rate is required.
3. “CLIMB-CLIMB NOW, CLIMB-CLIMB NOW” (received after “DESCEND”advisory)
   A reversal from a descent to a climb condition is required to provide adequate vertical separation.
4. “DESCEND-DESCEND NOW, DESCEND-DESCEND NOW” (received after “CLIMB” advisory)
   A reversal from a climb to a descent condition is required to provide adequate vertical separation.

NOTE: ACAS II/TCAS II resolution advisory announcements are based on the pilot immediately adjusting the flight profile as directed.

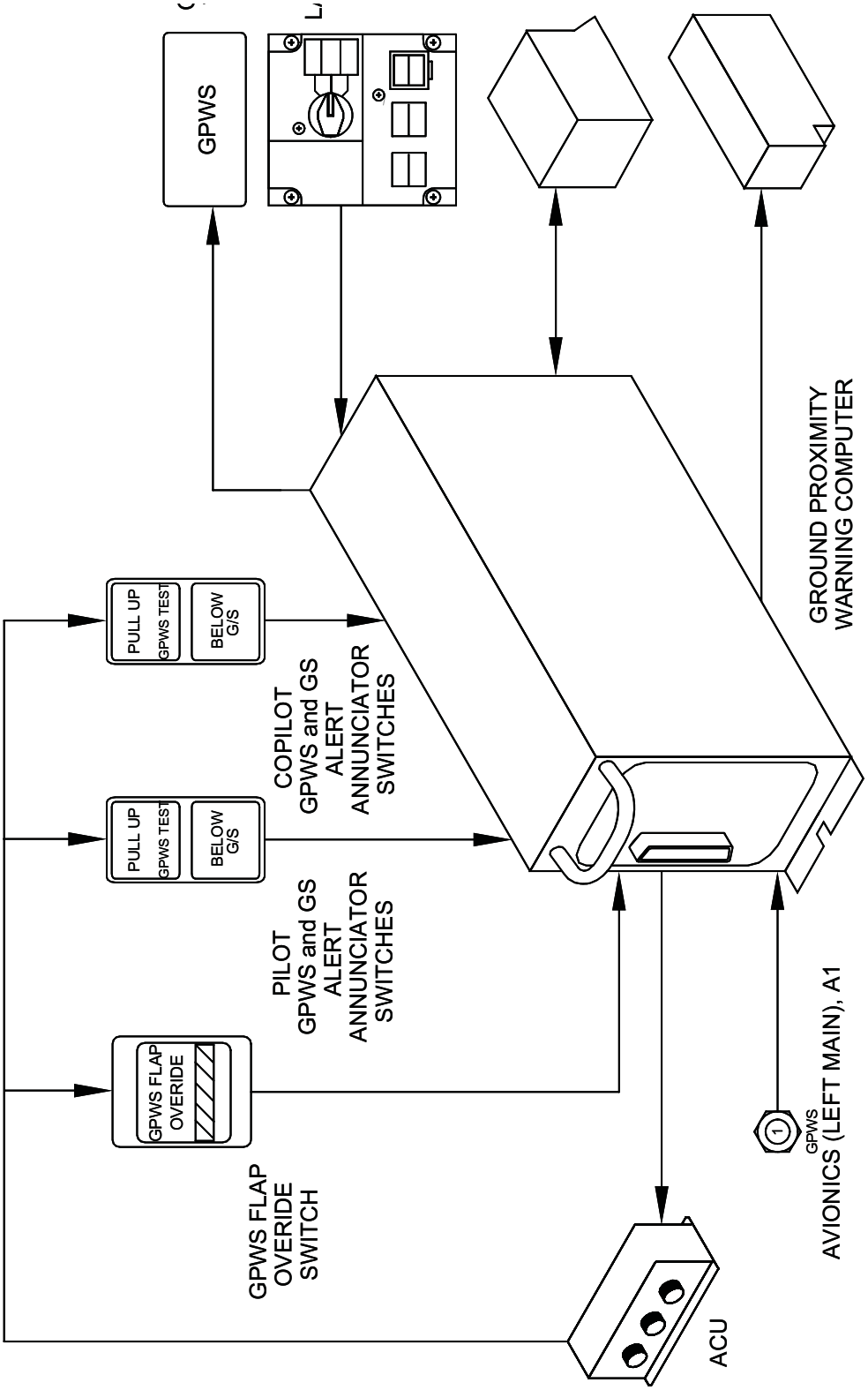


Figure 12.15-49 GPWS Schematic

12.15.12 GPWS - Ground Proximity Warning System

The Ground Proximity Warning System (GPWS), uses inputs from aeroplane systems to continuously monitor the flight path of the aeroplane when the Above Ground Level (AGL) altitude is between 50 and 2450 feet.

If the sensed flight path would cause a possible impact into terrain, the system gives a visual and aural indication for the conditions that follow:

- Excessive descent rate
- Excessive closure rate to terrain
- Descent after take-off
- Insufficient terrain clearance
- Excessive descent below the glideslope.

In addition, the GPWS gives excessive bank angle, and Decision Height (DH) callouts.

GPWS lets the pilots override unwanted indications when landing with zero or partial flaps and cancel glideslope indications. The GPWS indications are automatically cancelled by the conditions that follow:

- Stall
- GPWS malfunction sensed.

The GPWS has the components (Figure 12.15-49) that follow:

- Computer, GPWS
- Switch, Annunciator-Flap Override
- Switch, Annunciator-GPWS and GS Alert.

The GPWS receives data from the following aeroplane sources:

- Proximity Sensor Electronics Unit (PSEU)
- Air Data Units (ADU1, ADU2)
- Attitude and Heading Reference System (AHRS1, AHRS2)
- Radio Altimeters (RA1, RA2)
- VHF Navigation Receivers (VHF NAV1, VHF NAV2)
- Index Control Panels (ICP1, ICP2)
- GPWS Landing Flap Select Panel.

The GPWS supplies data directly to the systems that follow:

- Caution and Warning Lights Panel
- Advisory Control Unit (ACU)
- Audio and Radio Management System (ARMS)
- Stall Protection System (SPS).

The GPWS supplies ground proximity warning indications from calculations between the different input parameters that follow and pre-programming:

- Vertical speed, vertical speed validity
- Airspeed
- Glideslope deviation, glideslope enable
- Bank angle
- Above ground level altitude radio altitude
- Radio altitude validity
- Flap setting
- Landing gear selection
- Decision Height (DH) selection
- Back course selection
- Stall indication.

A red GPWS annunciator switch located on the glareshield panel assembly comes on when the GPWS calculates any of the warnings that follow:

- Mode 1: Excessive descent rate
- Mode 2: Excessive closure rate to terrain
- Mode 3: Descent after takeoff
- Mode 4: Insufficient terrain clearance.

The GPWS lights stay on while the aircraft is in the warning area.

12.15.12.1 GPWS - Flap Override Switch

The FLAP OVERRIDE switchlight located on the pilot's side console is pushed to prevent aural alerts when a landing is made with zero or partial flaps extended. A black and yellow crosshatch indication in the switchlight comes on to show the manual selection of the GPWS FLAP OVERRIDE feature. The switchlight is pushed again to manually cancel the GPWS FLAP OVERRIDE feature.

12.15.12.2 Landing Flap Selector Switch (LFSS)

The Landing Flap Selector Switch attached to the hydraulic control panel is turned to one of three landing flap settings for the insufficient terrain clearance mode as follows:

- 10 degrees
- 15 degrees
- 35 degrees

A related indication on the hydraulic control panel comes on to show the landing flap position selection. When the aeroplane flaps select lever is set at other than the Landing Flap Selector Switch setting, a "TOO LOW FLAPS" aural alert will sound when the AGL altitude becomes less than 200 feet.

12.15.12.3 Ground Self Test

The GPWS can be self tested when the aeroplane is on the ground. One GPWS Annunciator Switch or the other is pushed to test the system. Allow thirty seconds before initiating another self test. If this time limit is not met, the GPWS will not re-initialize. For the systems that do not supply correct data, the Ground Proximity Warning System (GPWS) gives an appropriate aural alert:

- RADIO ALTITUDE FAULT
- GLIDESLOPE FAULT
- BARO RATE FAULT

A defective Internal Ground Proximity Warning Computer (GPWC) may not give an aural alert, but will cause the GPWS caution light to come on.

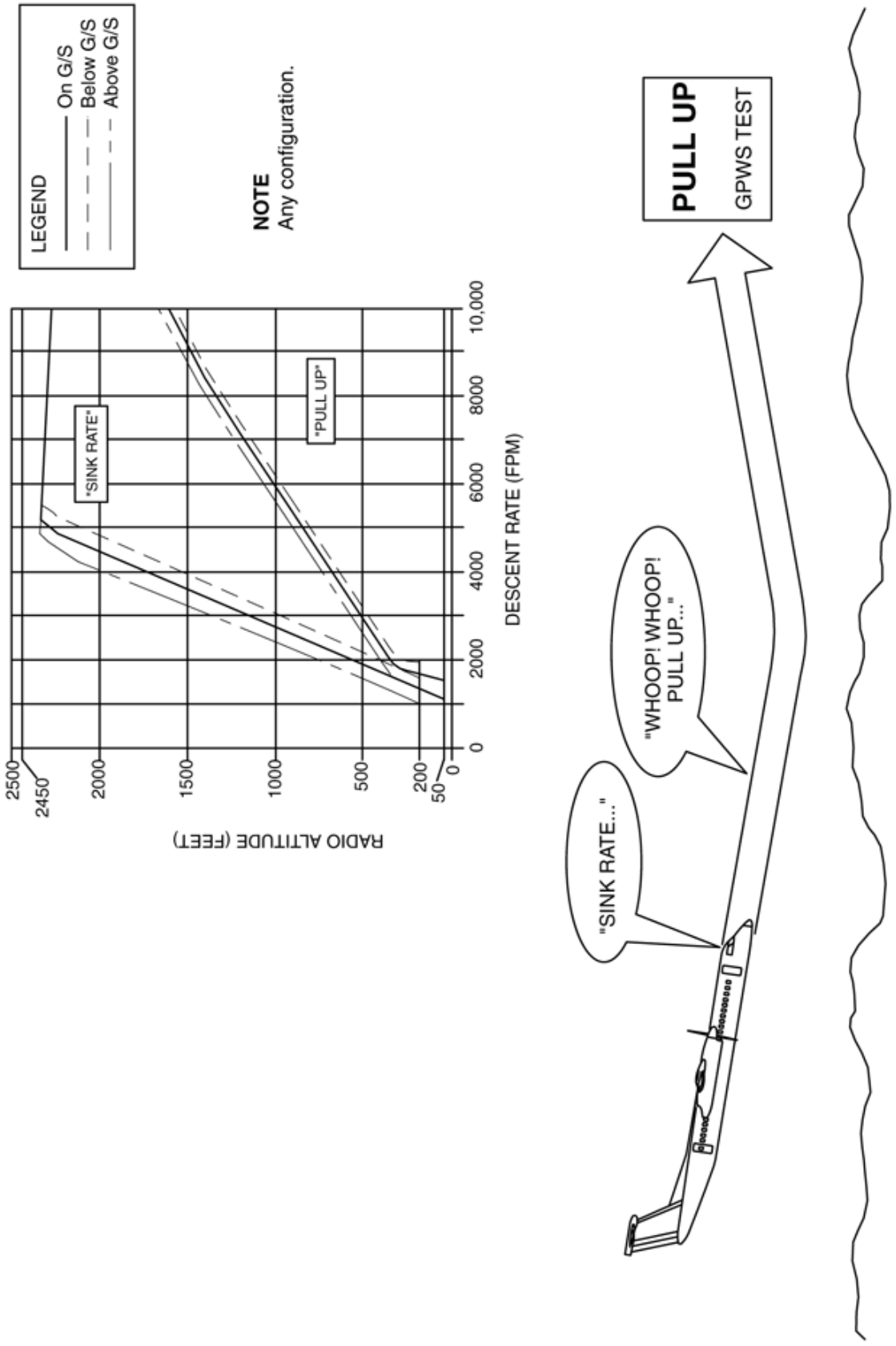


Figure 12.15-50 MODE 1 - Excessive Descent Rate

12.15.12.4 GPWS Modes

Mode 1

Excessive Descent Rate

The Mode 1 condition (Figure 12.15-50) gives indications for excessive rates of descent with respect to the aeroplane height above terrain. The indications are given well ahead of the possible impact with the ground. The GPWS computes the possible flight into terrain from the Radio Altitude (RA) and Air Data Unit (ADU) Barometric Decent Rate (FPM) data.

The Mode 1 condition gives "SINK RATE" and "PULL UP" aural alerts and turns on the GPWS annunciator lights.

The "SINK RATE" aural alert repeats every three seconds while the aeroplane is in the initial alert area. As the aeroplane goes into the second alert area in closer proximity to terrain, a "WHOOP, WHOOP, PULL UP" aural alert sounds in place of the "SINK RATE" aural alert.

The ILS glideslope selections change the alert area to minimize false warnings. When the aeroplane is above the glidepath, the alert area changes. The descent rate must increase for a GPWS alert output. This decreases the possibility of nuisance GPWS outputs. When the aeroplane is below the glidepath, a lower descent rate than when above the glidepath causes a GPWS alert output. The sensitivity of the GPWS is greater when the aeroplane is below the glidepath.

When the aeroplane is more than 200 feet Above Ground Level (AGL) altitude, 150 feet per minute is added for each dot of glideslope deviation, up to a maximum of 300 feet per minute. The descent or climb rate is set to 300 feet per minute when the aeroplane is above or below the glidepath with the GPWS Flap Override selected.

Mode 2

Excessive Closure Rate to Terrain

The Mode 2 condition gives indications when terrain below the aeroplane is rising dangerously fast. The GPWS gives the indications well ahead of the projected collision with terrain. The GPWS monitors the conditions that follow to give the Mode 2 indication:

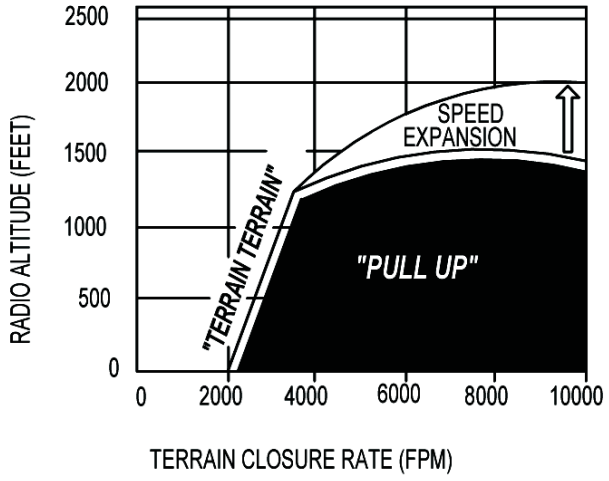
- Above Ground Level (AGL) altitude
- Airspeed
- Terrain closure rate

The Mode 2 condition causes the "TERRAIN TERRAIN" and "WHOOP, WHOOP, PULL UP" aural alerts to sound and the GPWS annunciator lights come on.

Mode 2 functions in two sub-modes:

- Mode 2A
- Mode 2B

WARNING The GPWS will not provide warning of flight toward vertically sheer terrain that does not slope at the bottom, or of slow descents into unprepared terrain while in the landing configuration.



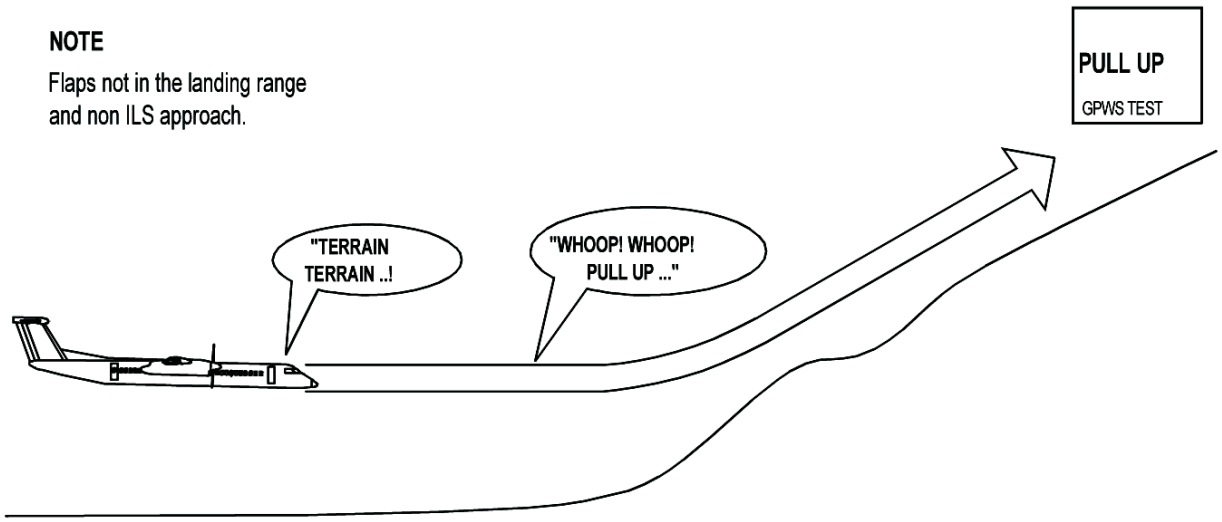


Figure 12.15-51 MODE 2A - Excessive Closure Rate

Mode 2A

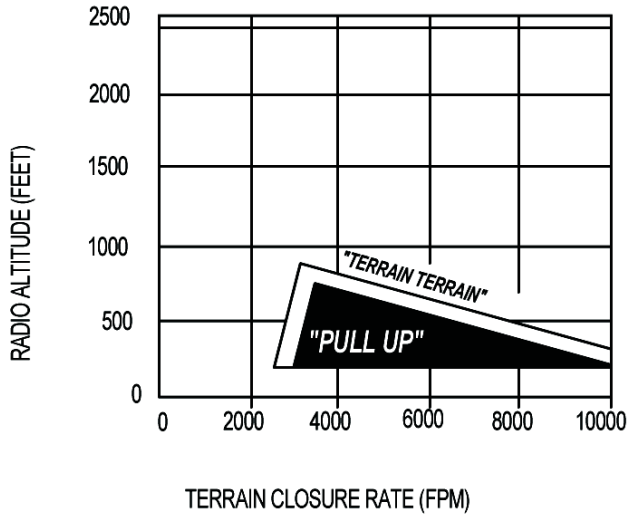
Excessive Closure Rate to TERRAIN (Flaps Up)

Mode 2A functions (Figure 12.15-51) when any one condition is met that follows:

- The flaps are not in the landing position, the GPWS flap override switch is not selected, and the aeroplane is not on an ILS or MLS approach
- The glideslope mode has been manually cancelled
- The aeroplane is more than 1.3 dots below the glidepath.

When the Mode 2A warning condition is met, a "TERRAIN TERRAIN" aural alert sounds and the GPWS P/TEST annunciators come on. If the aeroplane continues to go beyond the initial alert, the "WHOOP, WHOOP, PULL UP" aural alert sounds repeatedly and the GPWS annunciators stay on. The Mode 2A "WHOOP, WHOOP, PULL UP" aural alert will stop when the aeroplane goes out of the warning area. The GPWS annunciators will stay on until any condition occurs that follow:

- The barometric altitude increase is more than 300 feet
- An up acceleration that is a combination of barometric altitude gain and radio altitude, and time.



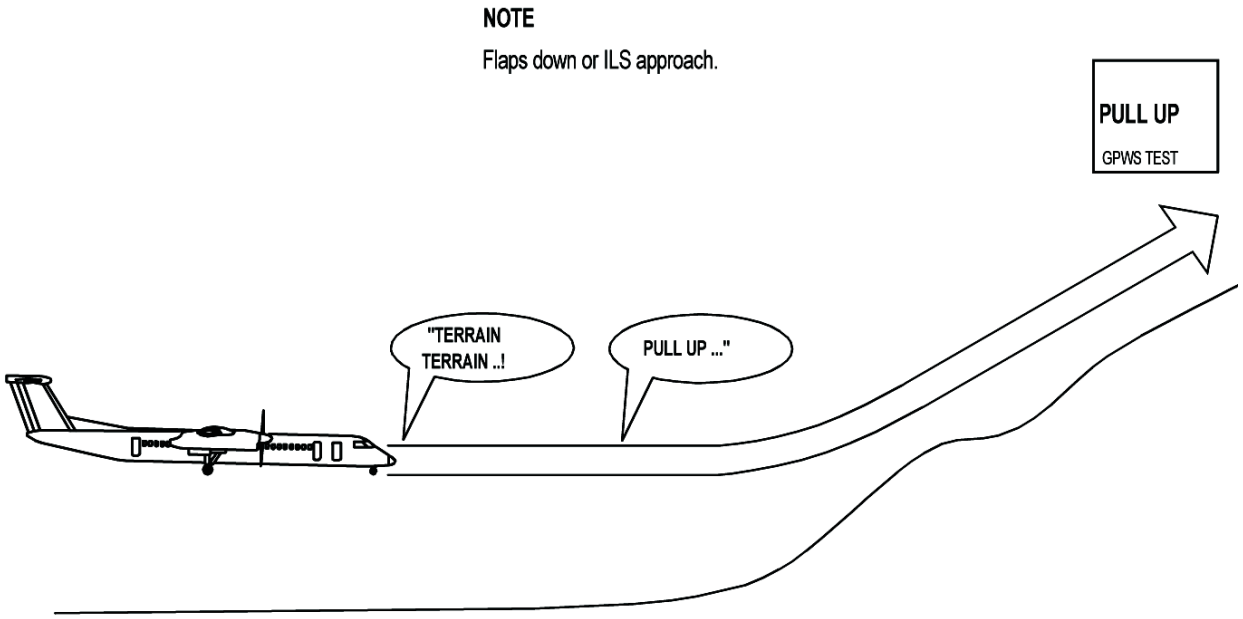


Figure 12.15-52 MODE 2B - Excesive Closure Rate - Gear Down, Flaps Down

Mode 2B

Excessive Closure Rate to Terrain (Flaps in Landing Position)

Mode 2B functions (Figure 12.15-52) when any one of the conditions is met that follow:

- The flaps are in the landing position
- The GPWS flap override switch is selected
- The aeroplane is on an ILS or MLS approach and the aeroplane localizer deviations are less than ±2 dots
- The glideslope cancel feature is not selected

When the landing gear is down, and the flaps are down or the GPWS flap override switch is set, a repetitive "TERRAIN" aural alert will sound. If the landing gear is not down, a "TERRAIN TERRAIN" aural alert will sound followed by “PULL UP” if condition persists. When the aeroplane goes out of the warning area, the aural alerts will stop and the “PULL UP” annunciators will go out.

Selecting the Flap Override annunciator switch eliminates unwanted alerts and warnings. This lets the aeroplane manoeuvre near terrain when approaching an airport.

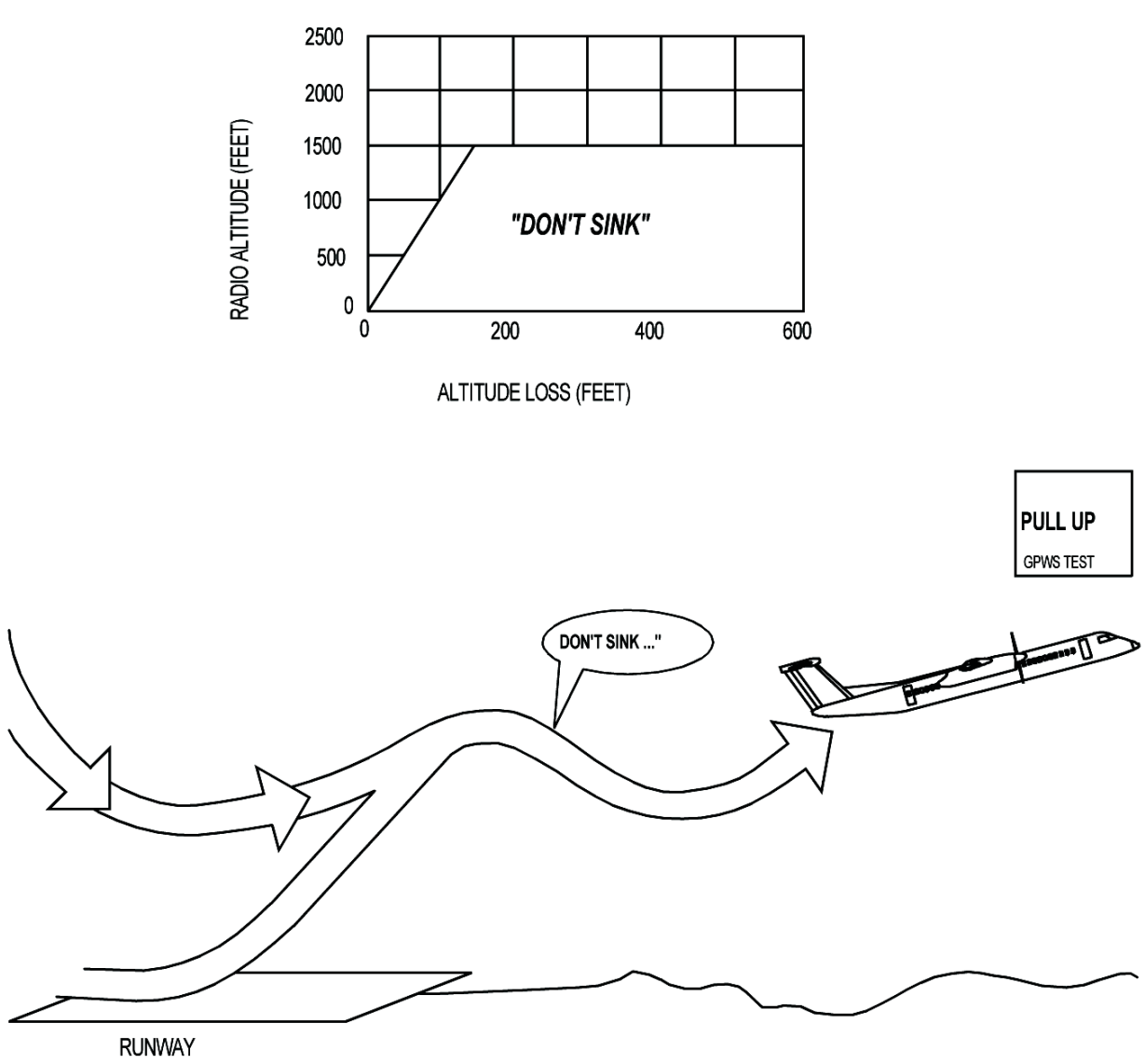


Figure 12.15-53 MODE 3 - Altitude Loss During Climb-Out or During Missing Approach

Mode 3

Altitude Loss After take-off or Go-Around

Mode 3 functions (Figure 12.15-53) during "take-off" or "Missed Approach" when the conditions that follow are met:

- Increase in airspeed
- 50 feet AGL altitude
- Increase in barometric altitude
- Landing gear retraction.

The Mode 3 gives an indication to show too much altitude decrease after take-off or after a missed approach. A barometric altitude decrease of approximately 10 percent of the AGL altitude starts the Mode 3 alert. The Mode 3 condition gives a "DON'T SINK" aural alert and the "GPWS" annunciator lights come on. An increased rate of climb cancels the "DON'T SINK" aural alerts and the GPWS annunciator lights go out.

When the AGL altitude is more than 925 feet for 17 seconds, the Mode 3 condition is cancelled. Aeroplane speed, flap and landing gear position are used to calculate a warning area below the aeroplane.

Selecting the Flap Override annunciator switch cancels the Mode 3 alert conditions if the AGL altitude is more than 50 feet. It lets the AGL altitude decrease 20 percent before giving an indication. When the aeroplane is 700 feet AGL altitude, it gives an additional altitude increase of 5 feet per second.

Mode 4

Insufficient Terrain Clearance

The Mode 4 condition gives an indication for insufficient terrain clearance during the phases of flight that follow:

- Cruise
- Approach
- Descent
- Climbout

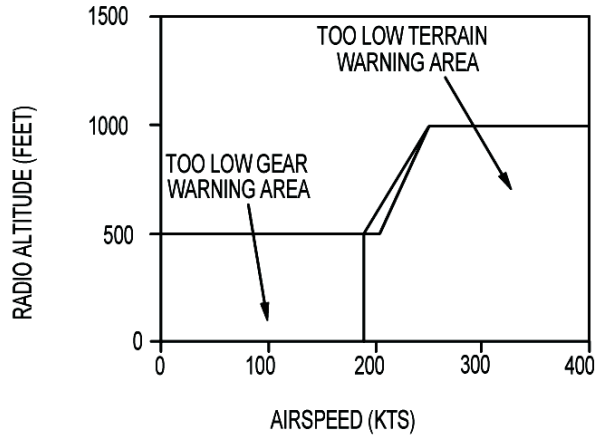
The Mode 4 condition gives indications when the flight path is too low for Mode 2 excessive closure rates with terrain or Mode1 excessive descent rate calculations. It uses the parameters that follow:

- AGL altitude
- Airspeed
- Flight phase

The Mode 4 condition functions in the modes that follow:

- Mode 4A
- Mode 4B
- Mode 4C

Warnings from Modes 4A, 4B, and 4C cannot occur at the same time.



NOTE

Gear up, flaps up.

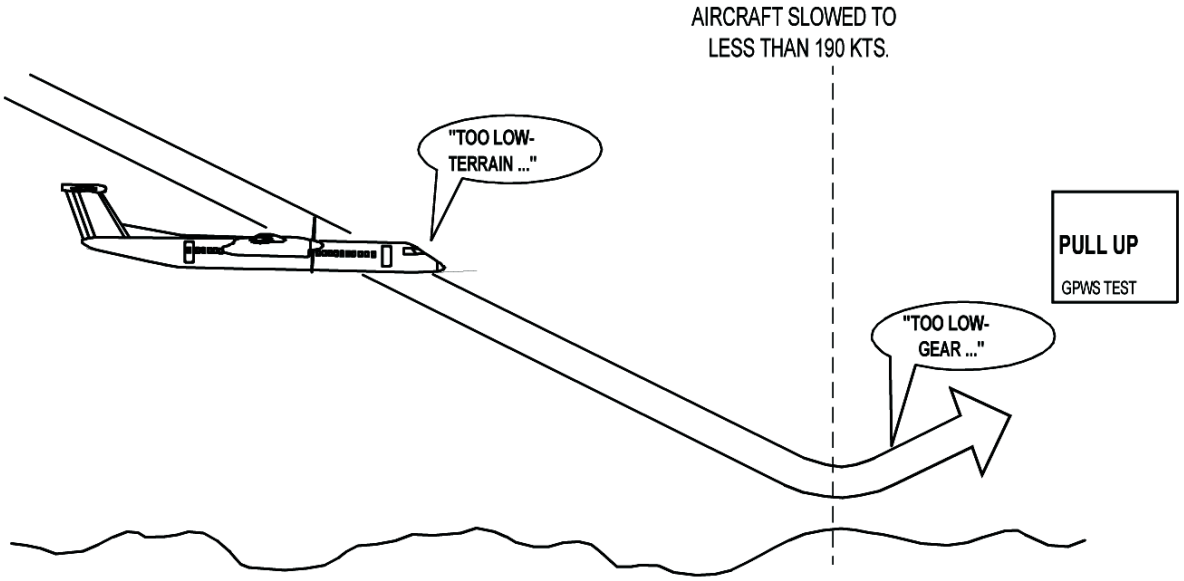


Figure 12.15-54 MODE 4A - Insufficient Terrain Clearance - Gear Up

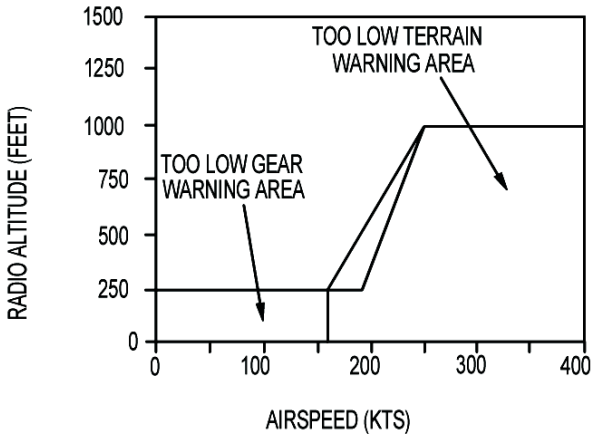
Mode 4A

Unsafe Terrain Clearance Landing Gear Up

When the aeroplane is in a configuration with the gear and flaps selected up, the GPWS calculates a "floor" below the aeroplane (Figure 12.15-54) to show insufficient terrain clearance.

During the initial approach, at speeds less than 148 knots and less than 500 feet AGL altitude, the "TOO LOW GEAR" aural alert sounds and the GPWS annunciator lights come on.

When the air speed is more than 200 knots and the AGL altitude is less than 750 feet, the "TOO LOW TERRAIN" aural alert sounds and the GPWS annunciator lights come on. Lower AGL altitudes are used to give the same alert at airspeeds 148 up to 200 knots.



NOTE

Gear up, flaps up.

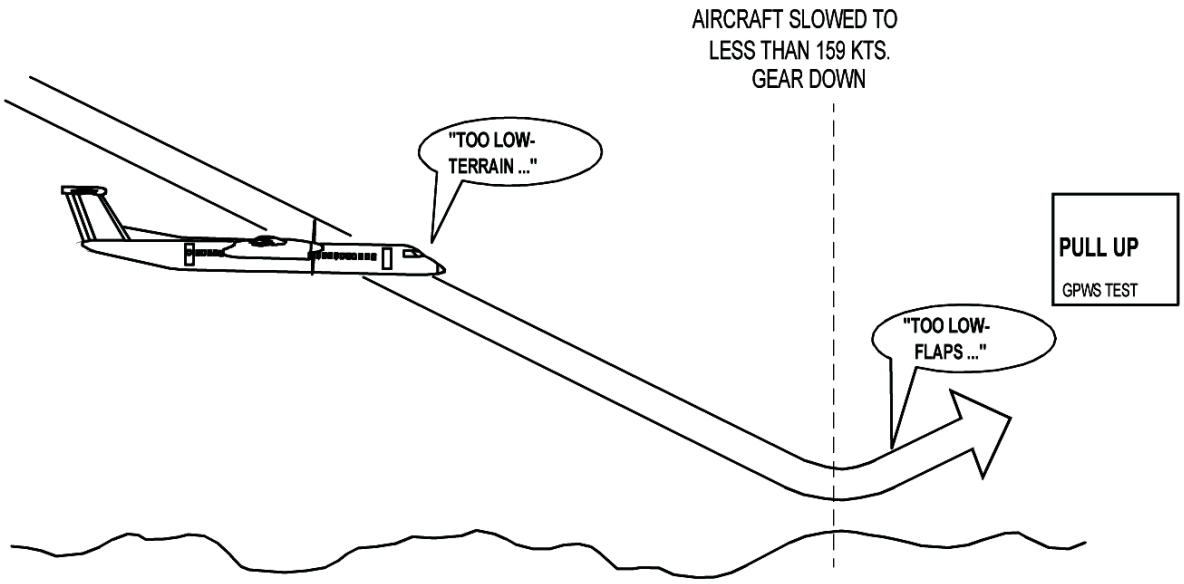


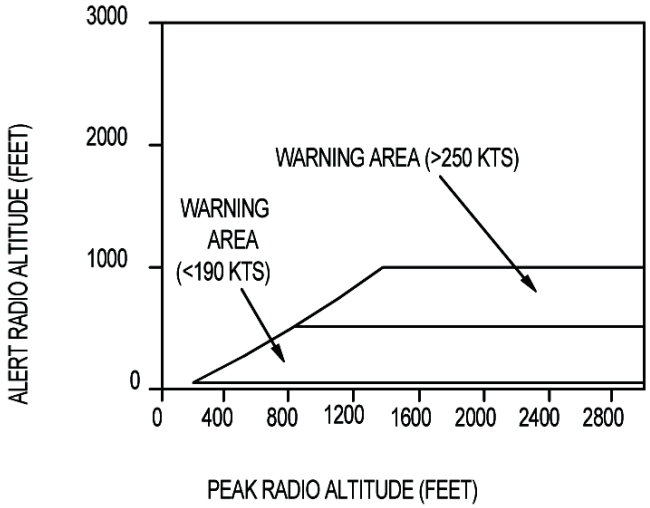
Figure 12.15-55 MODE 4B - Insufficient Terrain Clearance - Flaps Up

Mode 4B

Unsafe Terrain Clearance, Landing Gear Down, Flaps Not in Landing Position

Mode 4B (Figure 12.15-55) operates during cruise and approach when the landing gear is down, the flaps not in the landing position and the GPWS flap override switch is not set.

During the initial approach, at speeds less than 152 knots and the AGL altitude is less than 200 feet, the "TOO LOW FLAPS" aural alert sounds and the GPWS annunciator lights come on. When the flap override annunciator switch is set, the GPWS will not give any alerts for the flaps up landing. The flight crew set the Landing Flap Selector Switch (LFSS) to supply the GPWS with data relating to the specified landing flap position.



NOTE

After take-off with gear up or flaps not
in landing range. 1500 fpm climb rate.
Take-off over flat terrain or water.

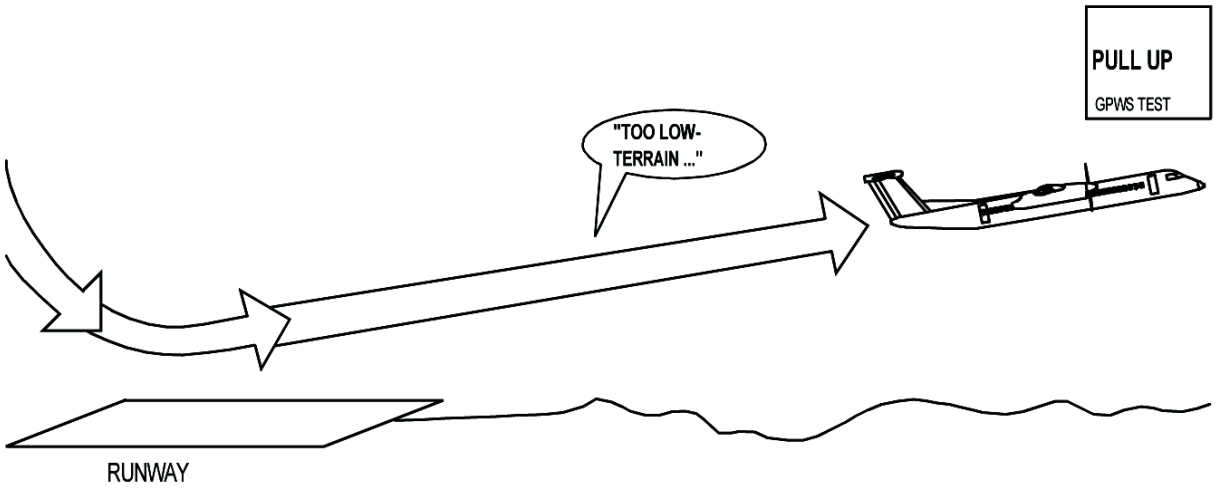


Figure 12.15-56 MODE 4C - Insufficient Terrain Clearance

Mode 4C

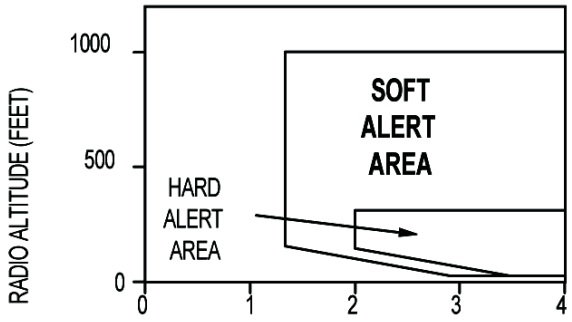
Unsafe Terrain CLearance, Landing Gear Up or Flaps Not in Landing Position

This is active during take-off or go-around. The Mode 4C (Figure 12.15-56) gives a minimum terrain clearance that increases with the AGL altitude. When the AGL altitude is more than 100 feet after take-off or 200 feet when doing a go-around, a warning floor is calculated below the aeroplane. It is 75 percent of the highest AGL altitude.

The Mode 4C continues to operate until the approach mode is activated or the AGL altitude goes below 30 feet. The conditions that follow, cause the "TOO LOW TERRAIN" aural alert to sound and the GPWS annunciator lights to come on:

- The aeroplane descents after take-off
- The terrain below the aeroplane rises at a steeper slope than when the aeroplane is climbing.

The warning will continue until the aeroplane has sufficient clearance from the terrain.



NOTE

Glideslope alert, gear down.

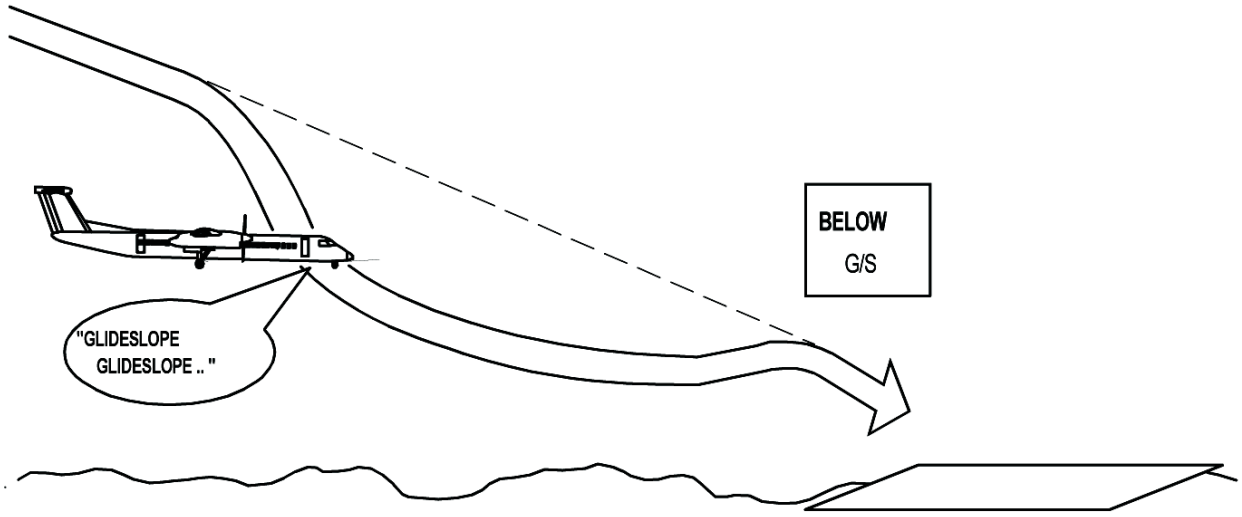


Figure 12.15-57 MODE 5 - Below Glidesplope

Mode 5

Deviation Below Glideslope

The Mode 5 (Figure 12.15-57) operates when the conditions that follow are met:

- An ILS frequency is set
- The landing gear is down
- The AGL altitude is less than 925 feet
- The aeroplane is below the glidepath
- Glideslope cancel is not set

The Mode 5 has two aural alert areas depending on the deviation from the glidepath. Each uses a different aural alert volume level. The low volume level alert is specified as the soft alert and the louder alert is named the hard alert. The hard alert sounds two times as loud as a soft alert.

When the aeroplane is below the glideslope and into the soft alerting area, the "GLIDESLOPE" aural alert sounds and the amber BELOW G/S annunciator switches come on. The volume of the initial "GLIDESLOPE" aural alert sounds is lesser than the other GPWS's aural alerts. While the aeroplane is below the glideslope, the aural repetition rate increases as the AGL altitude decreases. If the aeroplane goes into the hard alerting area, the audio volume level increases to that of the other aural alerts.

When the AGL altitude is less than 150 feet, more glideslope deviation is necessary to cause the indications to come on. The Mode 5 condition cancels when the AGL altitude is less than 50 feet or by a Flap Override annunciator switch selection.

The amber BELOW G/S annunciator switches located on the glareshield panel assembly comes on to show a Mode 5 excessive descent below the Glideslope (GS). One BELOW G/S annunciator switch or the other is pushed for 1 second or longer to cancel the aural indication. The amber light stays on to show the flight crew that the mode was intentionally cancelled. The system cancels when any of these conditions are met:

- The AGL is less than 50 feet
- The AGL is more than 1900 feet
- The ILS frequency is de-selected

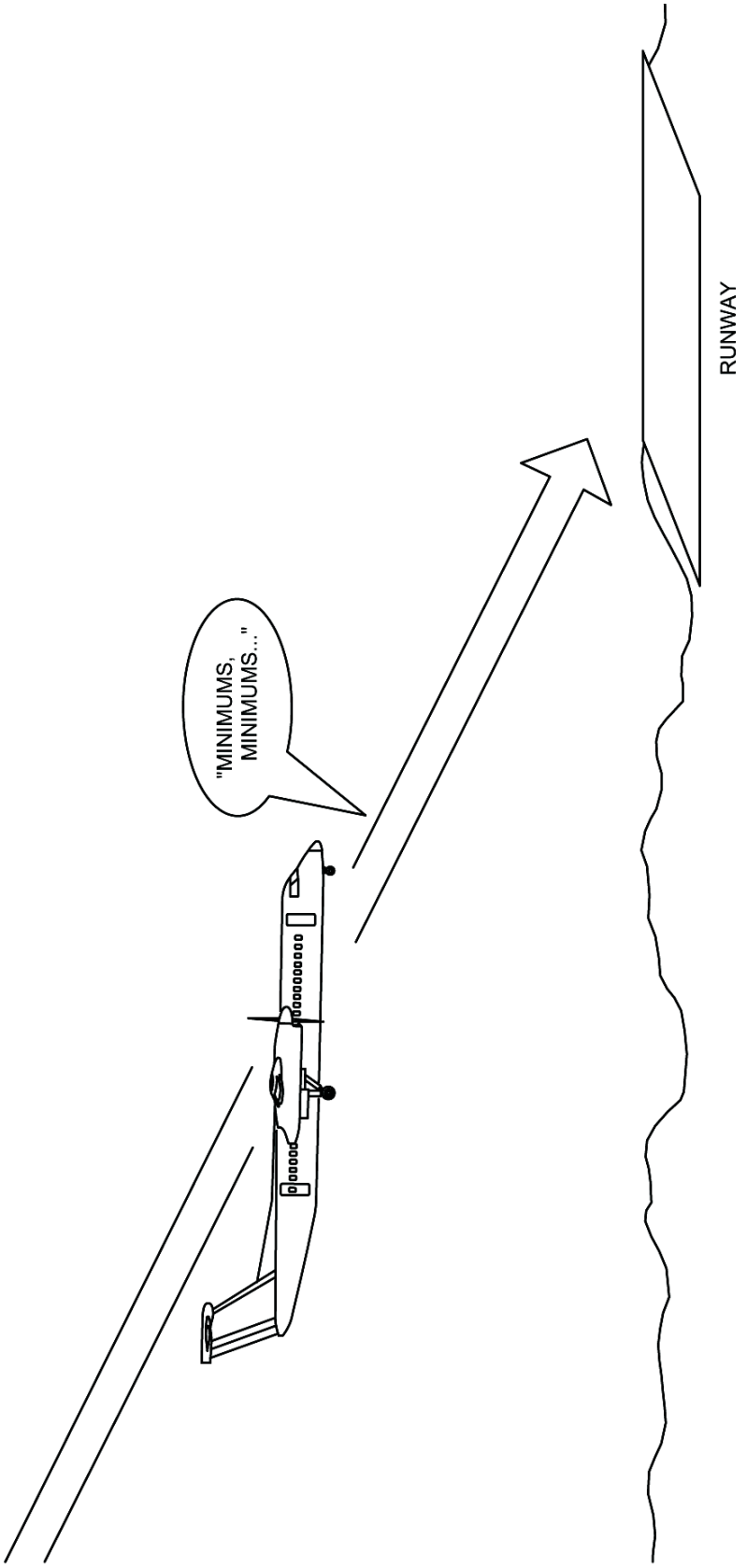


Figure 12.15-58 MODE 6 - Minimums

Mode 6

Excessive Minimums or Bank Angle Callout

The mode 6 condition gives indications for excessive bank angles while manoeuvring close to the runway.

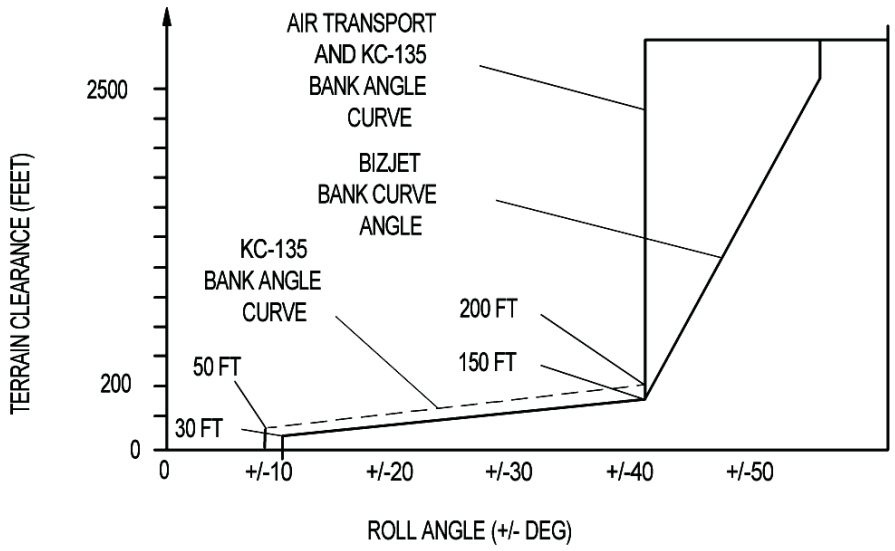
A "MINIMUMS, MINIMUMS" aural alert (Figure 12.15-58) sounds once for each approach as the aeroplane descends through the decision height "DH" setting. It resets when the AGL altitude is more than 925 feet.

A "BANK ANGLE" aural alert (Figure 12.15-59) gives indications for excessive bank angles depending on the AGL altitude. The limit of the indication decreases from 50 degrees at 190 feet AGL altitude to 15 degrees near ground level.

NOTE: In a single radio altimeter installation, the GPWS monitors both pilot and copilot decision height (DH) selection. A higher DH triggers an aural "MINIMUMS" call.

On aeroplane equipped with a dual radio altimeter system, "MINIMUMS, MINIMUMS" is triggered from the pilot’s DH setting only. In the event of a failure of the No.1 RA, the copilot’s DH setting will trigger "MINIMUMS, MINIMUMS".

No GPWS visual warning is associated with this mode. During VFR approaches, setting the ADI/EADI decision height to 0 feet may inhibit the Mode 6 warning.



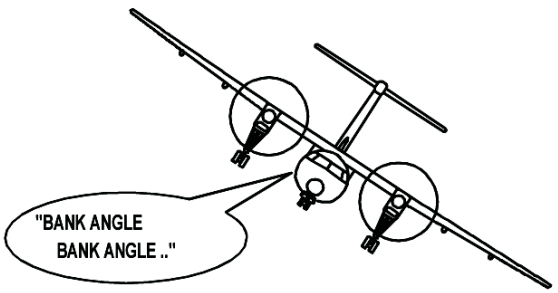


Figure 12.15-59 MODE 6 - Excessive Bank Angle

12.15.12.5 Advisory Message Priority

Since there is a possibility of activating more than one warning condition at a time, Figures 12.15-60 and 12.15-61, indicate the priority in the voice advisory messages.

12.15.12.6 Inflight Response to Aural Warnings

Whenever the following are heard, take appropriate action to correct the unsafe condition:

- "SINK RATE"
- "TERRAIN, TERRAIN"
- "DON’T SINK"
- "TOO LOW FLAP"
- "TOO LOW GEAR"
- "GLIDESLOPE"
- "BANK ANGLE"

Whenever the following are heard, immediately establish the power setting and attitude to produce the maximum climb gradient consistent with aeroplane configuration:

- "TOO LOW TERRAIN"
- "WHOOP, WHOOP PULL UP"

PRIORITY WARNING	ALERT CONDITION	MODE	AURAL WARNING	VISUAL
1	GPWC Invalid	— —	— — — — —	GPWS Caution and Warning Panel
2	External Audio Suppression from Stall Protection Module	— —	Aural Warnings Inhibited	Normal
3	Excessive Descent Rate	MODE 1	PULL UP (Immediate Repeat)	PULL UP GPWS TEST
4	Excessive Closure Rate to Terrain	MODE 2	PULL UP (Immediate Repeat)	PULL UP GPWS TEST
5	Excessive Closure Rate to Terrain	MODE 2	TERRAIN-TERRAIN (Once for each MODE 2 envelope penetration)	PULL UP GPWS TEST
6	Excessive Closure Rate to Terrain	MODE 2	TERRAIN-TERRAIN (Pause...3 second repeat)	PULL UP GPWS TEST
7	Insufficient Terrain Clearance	MODE 4	TOO LOW, TERRAIN (Pause...3 second repeat)	PULL UP GPWS TEST
8	Decision Height Callout	MODE 6	MINIMUMS-MINIMUMS (Pause...3 seconds, 1 message for each approach)	PULL UP GPWS TEST

Figure 12.12-60 Advisory Message Priority (1 of 2)

PRIORITY WARNING	ALERT CONDITION	MODE	AURAL WARNING	VISUAL
9	Insufficient Terrain Clearance	MODE 4	TOO LOW GEAR (Pause...3 second repeat)	PULL UP GPWS TEST
10	Insufficient Terrain Clearance	MODE 4	TOO LOW FLAPS (Pause...3 second repeat)	PULL UP GPWS TEST
11	Excessive Descent Rate and Descent Below Glideslope	MODE 1 & 5	GLIDESLOPE, SINK RATE (Pause...3 second repeat)	BELOW G/S
12	Excessive Descent Rate	MODE 1	SINK RATE (Pause...3 second repeat)	PULL UP GPWS TEST
13	Descent After Takeoff	MODE 3	DON'T SINK (Pause...3 second repeat)	PULL UP GPWS TEST
14	Descent Below Glideslope	MODE 5	GLIDESLOPE (Variable pause)	BELOW G/S
15	Altitude Callout	MODE 6	BANK ANGLE (Pause...3 second repeat)	— — — — — -

Figure 12.12-61 Advisory Message Priority (2 of 2Limitations)

12.15.14 EGPWS - Enhanced Ground Proximity Warning System Honeywell MK V - Option - CR 831 CH 00064 or CR 831 SO 90180

12.15.14.1 General

The EGPWS is a terrain awareness and alerting system providing terrain alerting and, terrain display functions with additional features. The EGPWS uses airplane inputs including altitude, radar altitude, airspeed, attitude, glideslope and geographic position. The EGPWS provides alerts for excessive glideslope deviation, flaps or landing gear not in landing configuration, and provides bank angle and altitude callouts. Additionally, the EGPWS uses internal terrain, obstacles and airport databases to predict a potential conflict between airplane flight path and terrain or an obstacle. A terrain or obstacle conflict results in the EGPWS providing a visual and audio caution or warning alert.

The EGPWS also includes geometric altitude. Geometric altitude is a computed pseudo-barometric altitude designed to reduce or eliminate errors potentially induced in corrected barometric altitude by temperature extremes, non-standard pressure altitude conditions and altimeter misset. This ensures an optimal EGPWS Terrain Alerting Display capability.

The DHC-8 EGPWS installation includes both an automatic display of terrain feature on the MFD's ("Auto Pop-up"), in the event that a caution or warning alert is triggered, and "Auto-range" feature when a "Pop-up" occurs. The auto-range feature sets the MFD to 10 nm range.

The DHC-8 EGPWS configuration requires the following minimum equipment to be functional and operating:

Description	Part Number	Model Number	Quantity
EGPWS Computer	965-0976-040-210-210 or 965-0976-040-212-212 or 965-0976-040-214-214	Mk V	1 1 1
Radio Altimeter	066-01153-0101 or 822-0615-102	KRA 405B ALT-4000	1 1
Flight Management System (for enhanced features)	066-01160-2501 or 066-01160-2502 or 1017-41-221 or 2017-41-221	Global Star 2100 Global Star 2100 Universal UNS-1C Universal UNS-1E	1 1 1 1

For additional EGPWS information refer to Honeywell Pilot's Guide P/N 060-4241-000, Rev. E, dated December 2003 or later.

NOTE: Detection of severe windshear is not enabled.

LIMITATIONS

1. Pilots are authorized to deviate from their current air traffic control clearance (ATC) to the extent necessary to comply with an EGPWS warning.
2. Navigation must not be predicated upon the use of Terrain/Obstacle Awareness Display on the MFD.
   NOTE: The Terrain/Obstacle Awareness Display is intended to serve as a situational awareness tool only, and may not provide the accuracy and/or fidelity on which to solely base terrain avoidance maneuvering.
3. To avoid giving unwanted alerts, the Terrain Awareness Alerting and Display function must be inhibited by selecting the TERRAIN Inhibit switch on the glareshield panel, when within 15 NM of take-off, approach or landing of an airport not contained in the EGPWS Airport Database. Refer to Honeywell Pilot's Guide P/N 060-4267-000 for airports contained in the installed EGPWS terrain database.
4. The following Modsums must be incorporated concurrently:
   Display Unit MS4-126103; Flight Guidance Module MS4-126128; Flight Data Processing System MS4-126127 and are required pre-requisites for this installation.

NORMAL PROCEDURES

FLIGHT DECK PREPARATION-POWER ON

No.1 NAV Receiver.....Operative, and tuned to a VOR frequency
FMS 1.....ON and initialized
FLAP Selector Lever.....0°
EFCP.....Select NAV and TERR
GPWS FLAP OVERRIDE switch.....Normal and guarded
GPWS Caution Light .....Out
PULL UP - GPWS TEST switch .....Press momentarily

Check that the GPWS caution light, BELOW G/S and PULL UP, advisory lights illuminate, the "GLIDESLOPE", "PULL UP" and "TERRAIN TERRAIN PULL UP" voice warnings are audible and a "TERRAIN TEST" and the terrain test pattern is displayed on the MFDs.

NOTE: Pressing PULL UP-GPWS TEST switch for longer than three seconds results in a long self test which annunciates all configured and activated alert voices, including warning voices, caution voices and altitude callout voices.

IN-FLIGHT RESPONSE TO WARNINGS

1. Whenever the "SINK RATE", "TERRAIN TERRAIN", "DON'T SINK", "TOO LOW-FLAPS, "TOO LOW-GEAR", "CAUTION TERRAIN", "CAUTION OBSTACLE", "BANK ANGLE" or "GLIDESLOPE" aural warnings are heard, take appropriate action to correct the unsafe condition.
2. Whenever the "TOO LOW-TERRAIN", "TERRAIN PULL UP", "OBSTACLE PULL UP" or urgent "PULL UP" aural warnings are heard, immediately establish the power setting and attitude which will produce the maximum climb gradient consistent with the aeroplane configuration.

NORMAL APPROACH

GPWS LDG FLAP Selector switch ..... 10°, 15° or 35°, As Req'd

NOTE: The GPWS LDG FLAP selector switch must be selected to the intended landing flap to ensure correct GPWS flap advisory logic.

The following aural altitude callouts are heard as aeroplane descends through the respective radio altitude:

Aural Altitude Callouts				Radio Altitude (ft)
BASIC	MS 4-429519 (See note 2.)	MS 4-457041 or MS 4-457043 (See note 2.)	MS 4-457062	
-	"TWENTY FIVE HUNDRED"	"TWENTY FIVE HUNDRED"	-	2,500
-	"ONE THOUSAND"	-	-	1,000
-	-	"FIVE HUNDRED"	-	500
-	"PLUS HUNDRED"	-	"PLUS HUNDRED"	100 above DH
"MINIMUMS, MINIMUMS"	"MINIMUMS"	"MINIMUMS"	"MINIMUMS"	DH (See note 1.)
-	-	"ONE HUNDRED"	-	100
-	"FIFTY"	"FIFTY"	"FIFTY"	50
-	"FORTY"	"FORTY"	"FORTY"	40
-	"THIRTY"	"THIRTY"	"THIRTY"	30
-	"TWENTY"	"TWENTY"	"TWENTY"	20
-	"TEN"	"TEN"	"TEN"	10

NOTES:
1. "MINIMUMS" is triggered from the PFD having the higher decision height (DH) setting.
2. When descending through 2500 ft (Radio Altitude) a "TWENTY FIVE HUNDRED" aural altitude callout may not be heard with MS 4-901021 not incorporated.

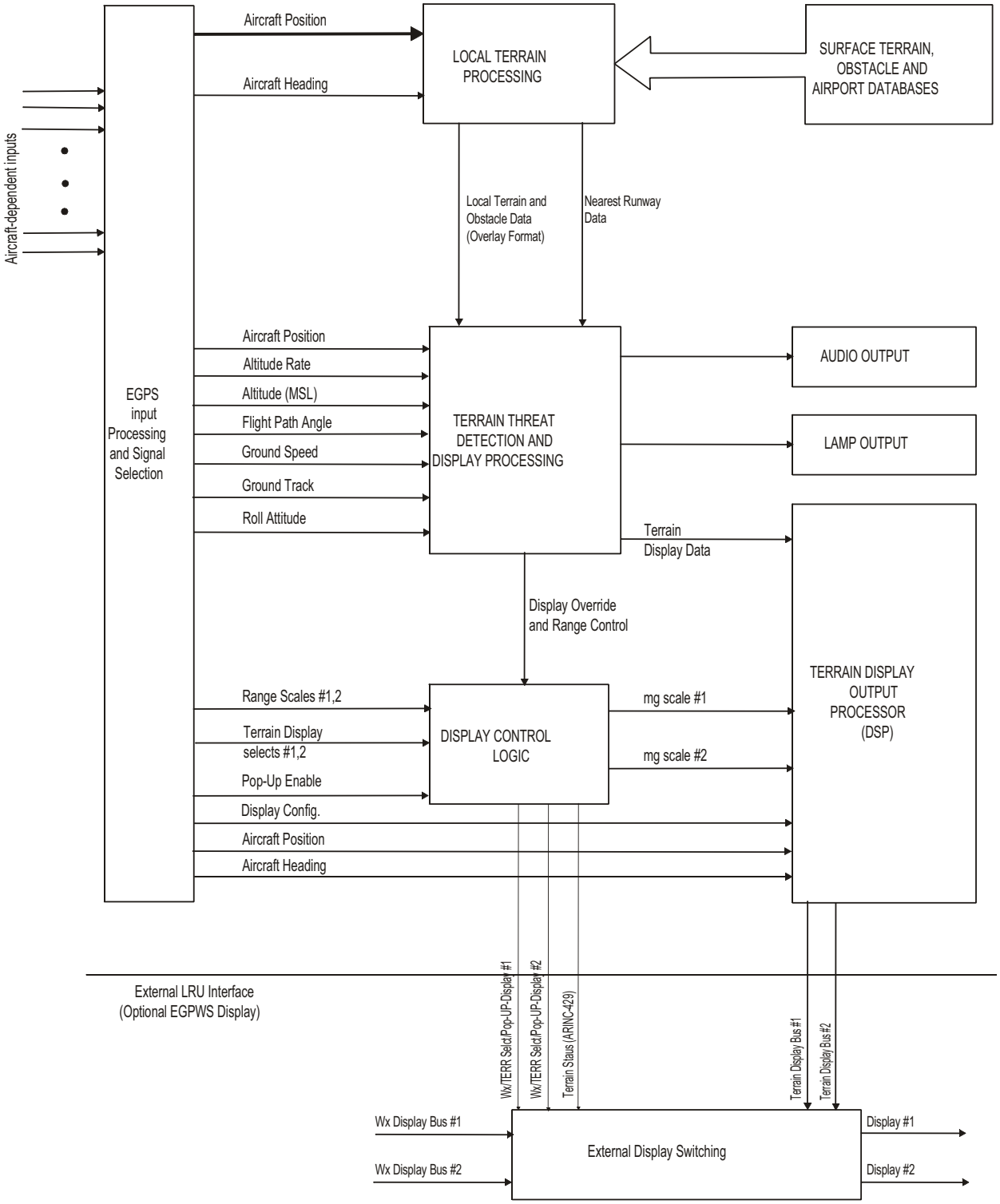


Figure 12.15-62 Terrain Awareness Functions

12.15.14.2 Terrain Awareness Display

The Terrain Awareness component of the EGPWS is divided into the functional blocks shown in Figure 12.15-62 with an interface to an optional cockpit display. The highlighted blocks monitor airplane position with respect to local database cataloged terrain and provide rapid audio and visual alerts when a terrain threat is detected. Terrain threats are recognized and annunciated when terrain violates specific computed envelope boundaries forward of the airplane path. The terrain database also includes the obstacle database providing similar annunciation when cataloged obstacles violate the same envelope boundaries.

The Terrain Awareness alert lamps and audio outputs behave in the same manner as the standard GPWS mode alerts. Any of the following: Terrain Caution Alert, Terrain Warning Alert, Obstacle Caution Alert or Obstacle Warning Alert will initiate a specific audio alert phrase (see 12.15.14.6 and 12.15.14.7).

Complementing the terrain threat alerts, the EGPWS also maintains a synthetic image of local terrain forward of the airplane for display on EFIS Navigation Displays (NDs), Multi-Functional Displays (MFDs).

The EGPWS is configured to automatically de-select the Weather Display and pop-up a display of the terrain threats when they occur.

The EGPWS provides two external display outputs, each with independent range-scaling control in the same fashion as the weather radar. Changes of range scaling to one display do not affect the other display.

The blocks in Figure 12.15-62 are described in the following sub-sections. The specific databases, Audio Output function, and Radar Display Output Processor are described in other related sections of this document.

12.15.14.2.1 Control Inputs

Installations provide discrete Terrain Display Select switches in the EFCP for each display. These are switches that are processed by the EGWPS inputs to the WX/TERR select logic.

In addition a TERRAIN INHIBIT switch is provided to de-activate the enhanced functions of the EGWPS. These switches are installed in the glareshield in front of the pilot and co-pilot. Pressing the Terrain Inhibits switch inhibits TAD and TCF alerting and display, including Obstacles and Peaks when enabled. This is used when position accuracy is inadequate or when operating at airports not in the terrain database. Selection of Terrain Inhibit causes the “Terrain Inhibit” annunciation on the MFD. Terrain Inhibit requires manual deactivation.

12.15.14.2.2 Local Terrain Processing

The Local Terrain Processing block extracts and formats local topographic data and terrain features from the related databases creating a set of Digital Elevation Matrix Overlays for use by the Terrain Threat Detection and Display Processing functions. Additionally, data for the nearest runway are also extracted for use by the Terrain Threat Detection and Display Processing functions. Processing for each topographic database and the runway database are described in the following subsections.

12.15.14.2.3 Terrain Surface Data

Local Terrain Processing of topographic surface data updates a set of Digital Elevation Matrix Overlays that are positioned with respect to Airplane Position. Each matrix element contains the highest terrain altitude with respect to mean sea level in that element's area. Elements where terrain data are not available are marked invalid.

12.15.14.2.4 Obstacle Data

In addition to terrain surface data, the terrain database contains obstacle data. The obstacles data is presented on the screen like terrain (same coloring scheme), and cause visual indications of warning and caution alerts like terrain. The current obstacle database is obtained from NOAA, it includes obstacles in the United States and parts of Canada, Mexico and the Bahamas.

Obstacle alerting is activated by defining obstacle alerting as basic to the EGPWS installation configuration.

12.15.14.2.5 Nearest Runway Data

Data for the nearest runway are extracted and processed for use by the Terrain Threat Detection and Display Processing functions. Data are extracted from the same Airport Database used by the Terrain Clearance Floor functions. This database contains data on all hard-surface runways 3500 feet or more in length with published coordinates. The contents of the database are processed by the Local Terrain Processing into Nearest Runway Center position, Nearest Runway Threshold position, and Nearest Runway Altitude for use by the EGPWS. These data are updated when the Terrain Threat Detection and Display Processing functions are performed.

12.15.14.2.6 Terrain Threat Detection

The Terrain Threat Detection and Display Processing block performs the threat analysis on the terrain data within computed caution and warning envelope boundaries below and forward of the airplane path. Results or these threat assessments are combined with background terrain data and data for the nearest runway and formatted into a terrain display image which can be displayed on a weather radar indicator of a EFIS display in place of the weather image. In the event of terrain caution or warning conditions, a specific audio alert is triggered and the terrain display image is enhanced to highlight each of the types of terrain threats.

12.15.14.3 Airplane Data Inputs

Airplane Position latitude and longitude are required for Terrain Awareness operation and are received from Global Positioning System (GPS)/Flight Management System (FMS).

Additionally, airplane Ground Track and Ground Speed data are also received from the GPS/FMS.

Airplane Altitude for the Terrain Awareness functions is computed from pressure altitude and SAT received from the Air Data Computer (ADC), Altitude from the Global Positioning System, and height above ground provided by the Radio Altimeter (see section 12.15.14.8.4). Other airplane inputs include Airplane Heading, Roll Attitude and Flight Path Angle (Gamma, derived by the EGPWC).

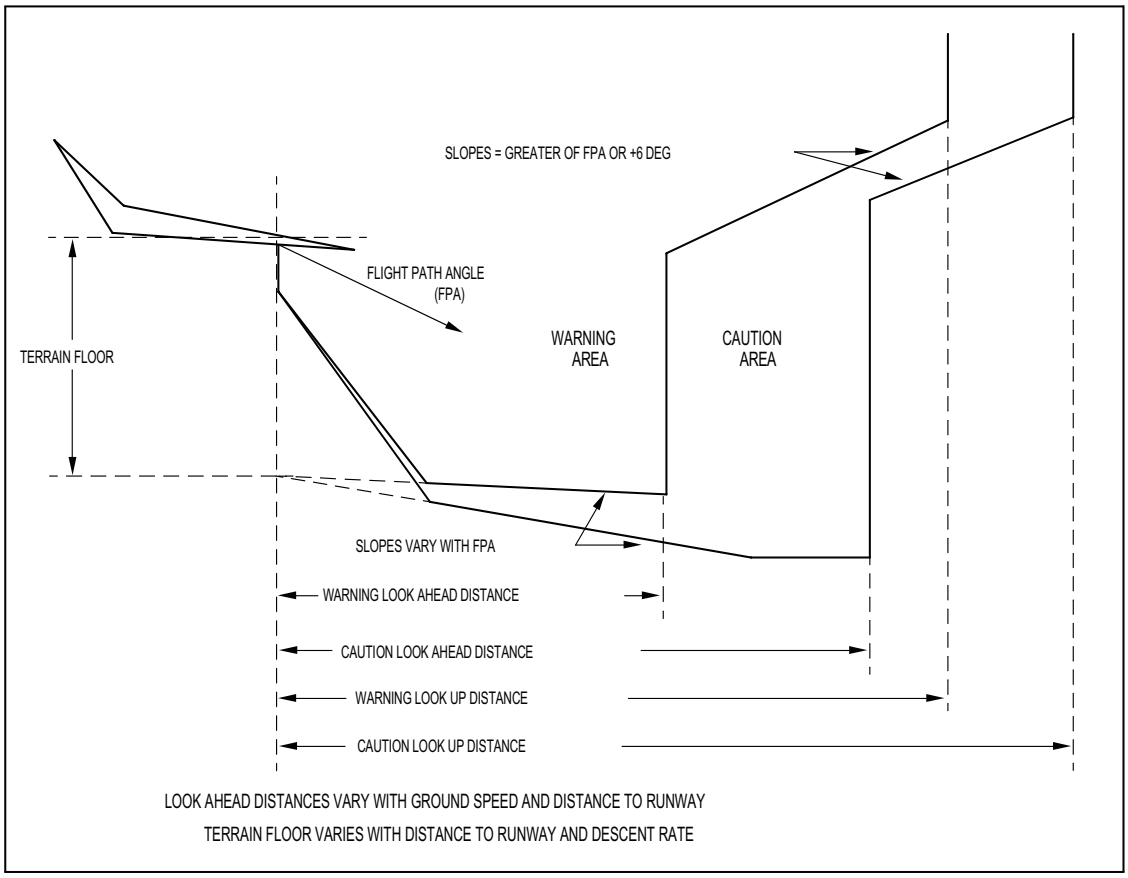


Figure 12.15-63 Terrain Caution and Warning Envelope Boundaries

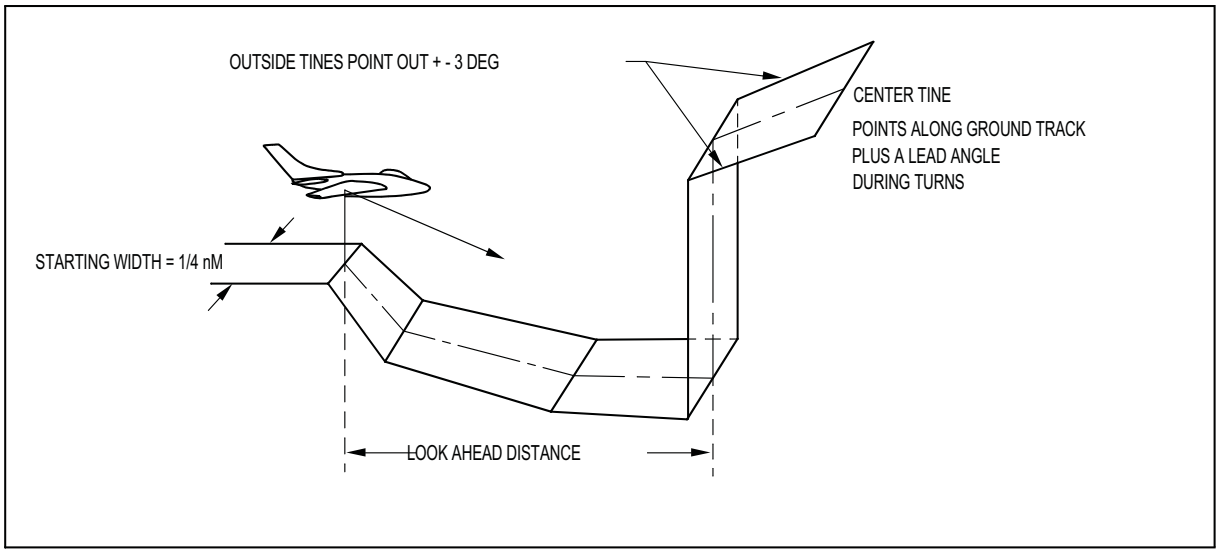


Figure 12.15-64 Terrain Detection Envelope - Perspective View

12.15.14.4 Terrain Caution and Warning Envelope

The basic Terrain Caution Envelope (or Yellow Alert Envelope) and Terrain Warning Envelope (or Red Alert Envelope) boundaries are illustrated in Figure 12.15-63.

A perspective view of the Terrain Detection envelope is illustrated in Figure 12.15-64.

12.15.14.4.1 Caution Altitude Floor

The Caution Altitude Floor (or Terrain Floor) is computed as a function of Airplane Altitude with respect to Nearest Runway Altitude and range to the Nearest Runway Threshold position. This parameter represents a distance below the aircraft. The relationship to the nearest runway threshold location prevents undesired alerts when the airplane is taking off or landing at an airport. The system is compatible with terrain clearances allowed for by Regulatory Approach and Departure Design criteria.

12.15.14.4.2 Caution Look Ahead Distance

The Caution Look Ahead Distance is computed from airplane ground speed and turn rate to provide an advanced warning with adequate time for the crew to react safely. Depending on the situation this distance roughly corresponds to between 40 and 60 seconds of advance alerting.

12.15.14.4.3 Warning Altitude Floor

The Warning Altitude Floor is set to a fraction of the Caution Altitude Floor, as illustrated in the upper part of Figure 12.15-63. The Warning Altitude Floor is computed as a function of Airplane Altitude with respect to Nearest Runway Altitude and range to the Nearest Runway Threshold position. This parameter represents a distance below the airplane. The relationship to the nearest runway threshold location prevents undesired alerts when the airplane is taking off or landing at an airport.

12.15.14.4.4 Warning Look Ahead Distance

The Warning Look Ahead Distance is a fraction of the Caution Look Ahead Distance (computed from airplane ground speed and turn rate) to provide an advanced warning with adequate time for the crew to react safely.

12.15.14.4.5 Terrain/Obstacle Displays and Alerts

The Terrain Awareness Alerting and Display function maintains a Background Display of local terrain forward of the airplane for optional flight compartment display. In the event of terrain or obstacle caution or warning conditions, an aural alert and lamp outputs are triggered. The background image is then enhanced to highlight related terrain or obstacle threats forward of the airplane. Obstacle threats forward of the airplane are also enhanced if the adjacent terrain altitude is within a lower terrain layer, or if the adjacent cells are not illuminated. Obstacle enhancement is only applicable to the 15, 30 and 60 arc second tiers.

The background terrain is depicted as variable density dot patterns in green, yellow or red. The density and color being a function of how close the terrain or obstacle (see Note) is relative to airplane altitude. Additionally, the display of terrain based on absolute terrain elevation is provided with the Peaks mode. Terrain and Obstacle Alerts are depicted by painting the threatening terrain as solid yellow or red.

The set of Digital Elevation Matrix Overlays is processed by the terrain display algorithms into a matching set of Display Matrix Overlays and passed to the Radar Display Output Processor. The Display Matrix Overlays hold display attributes rather than altitude for each matrix element. These attributes are computed for the background and terrain threat areas and kept small (one byte) to reduce memory requirements and transfer time to the Radar Display Output Processor. The Airplane Position and Airplane Heading are used at the Radar Display Output Processor to extract the radar-like sweeping image ahead of the aircraft from the display overlays.

Each element of the output Display Matrix Overlays holds a single display attribute byte with fields for the colors, patterns, and symbols shown below in Table 12.15-1.

Color	Terrain Elevation
Solid Red	Terrain Threat Area - Warning
Solid Yellow	Terrain Threat Area - Caution
50% Red Dots	Terrain that is more than 2000 feet above airplane altitude
50% Yellow Dots	Terrain that is between 1000 and 2000 feet above airplane altitude
25% Yellow Dots	Terrain that is 500 (250 with gear down) feet below to 1000 feet above airplane altitude
Solid Green	Shown only when no Red or Yellow terrain areas are within range on the display. Highest terrain not within 500 (250 with gear down) feet of airplane altitude (peaks only)
50% Green Dots	Terrain that is 500 (250 with gear down) feet below to 1000 below airplane altitude
	Terrain that is the middle elevation band when there are no Red or Yellow terrain areas within range on the display (peaks only)
16% Green Dots	Terrain that is 1000 to 2000 feet below airplane altitude
	Terrain that is the lower elevation band when there are no Red or Yellow terrain areas within range on the display (peaks only)
Black	No significant terrain
16% Cyan	Terrain Elevation equal to 0 feet MSL (peaks only - requires compatible display)
Magenta Dots	Unknown terrain

Table 12.15-1 Display Colors and Patterns

12.15.14.5 Background Display

There are two background Terrain Awareness Modes: Standard and Peaks. For both modes the background display is computed from the Airplane Altitude with respect to the terrain data in the Digital Elevation Matrix Overlays. These two modes are cumulative and are part of EGPWS Installation configuration.

For Standard mode, terrain is displayed using colors and shading patterns corresponding to the vertical displacement between a the terrain elevation, and the current airplane altitude. Red and yellow dot patterns indicate terrain near or above the current altitude of the airplane. Solid yellow and red colors indicate alert and warning areas relative to the flight path of the airplane. Medium and low density green display patterns indicate terrain that is below the airplane and within 2000 feet of the airplane altitude. Terrain more than 2000 feet below the airplane not displayed and the terrain display is typically blank during the enroute portion of the flight.

They Peaks Mode display adds additional density patterns and level thresholds to the Standard Mode display levels and patterns. These additional levels are based on absolute terrain elevations relative to the range and distribution of terrain in the display area The Peaks Mode display is thus a "merged" display applicable to all phases of flight. At altitudes safely above all terrain for the display range chosen, the terrain is displayed independent of airplane altitude emphasizing the highest and lowest elevations to provide increased situational awareness. This increased awareness can be particularly valuable to the flight crew in the event of an unplanned descent or off-route deviation and for the purpose of previewing terrain prior to descent.

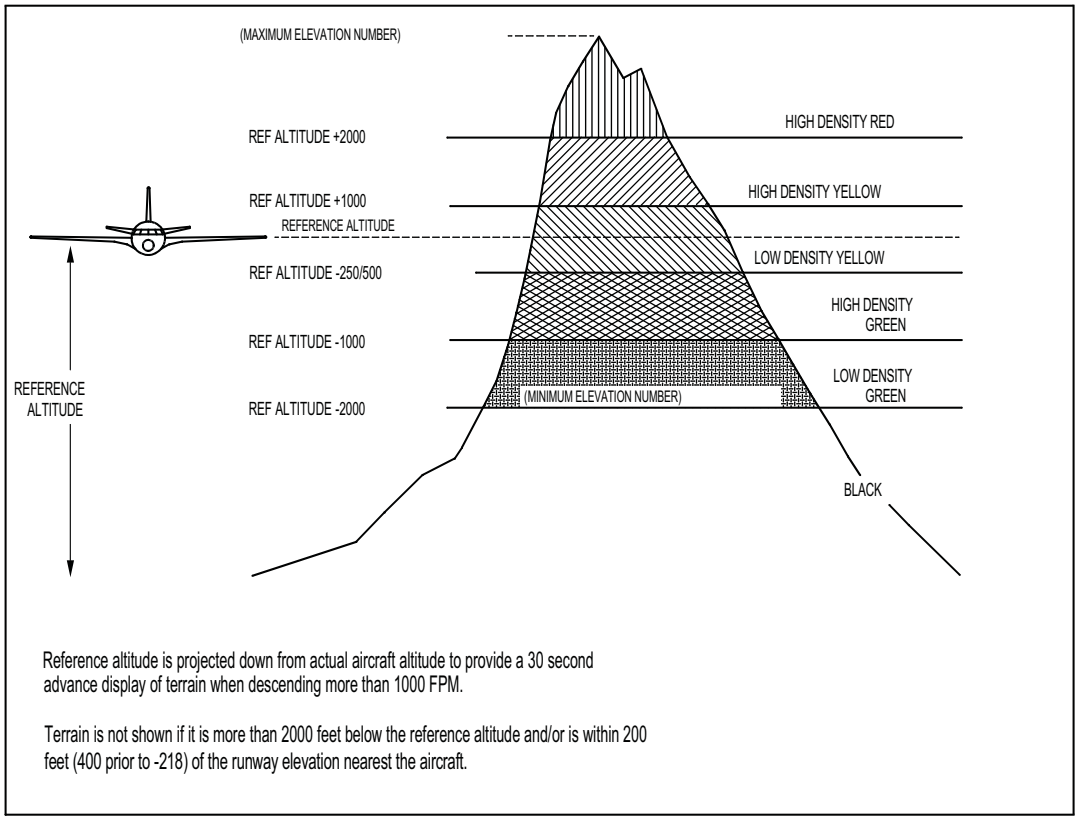
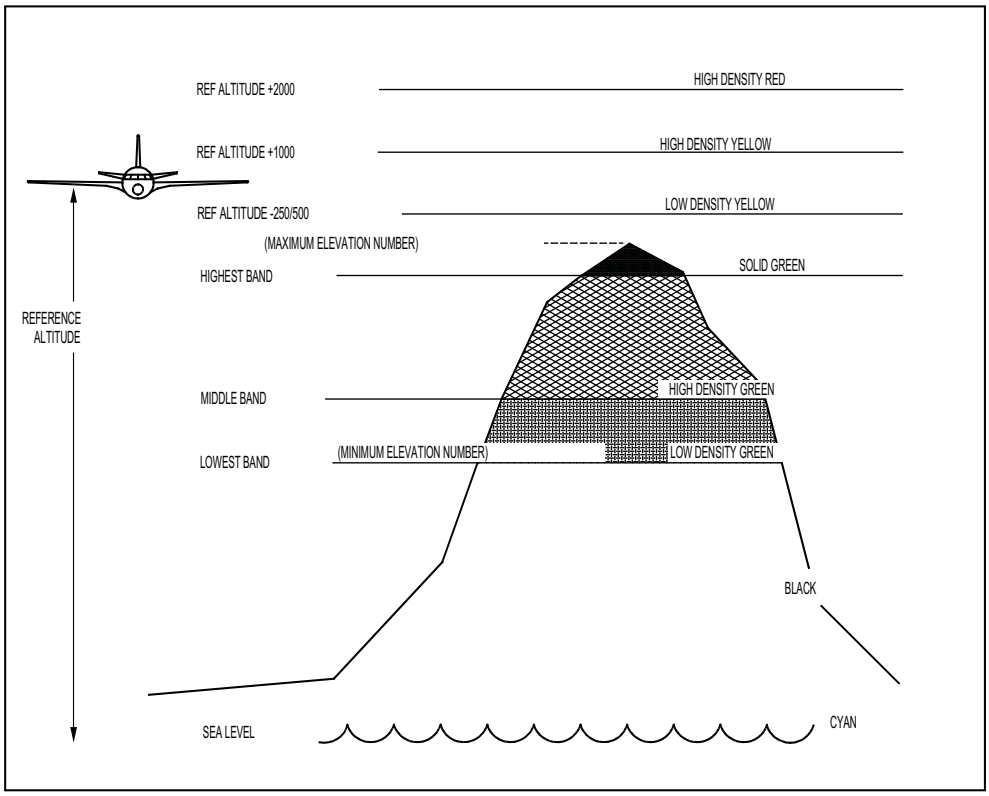
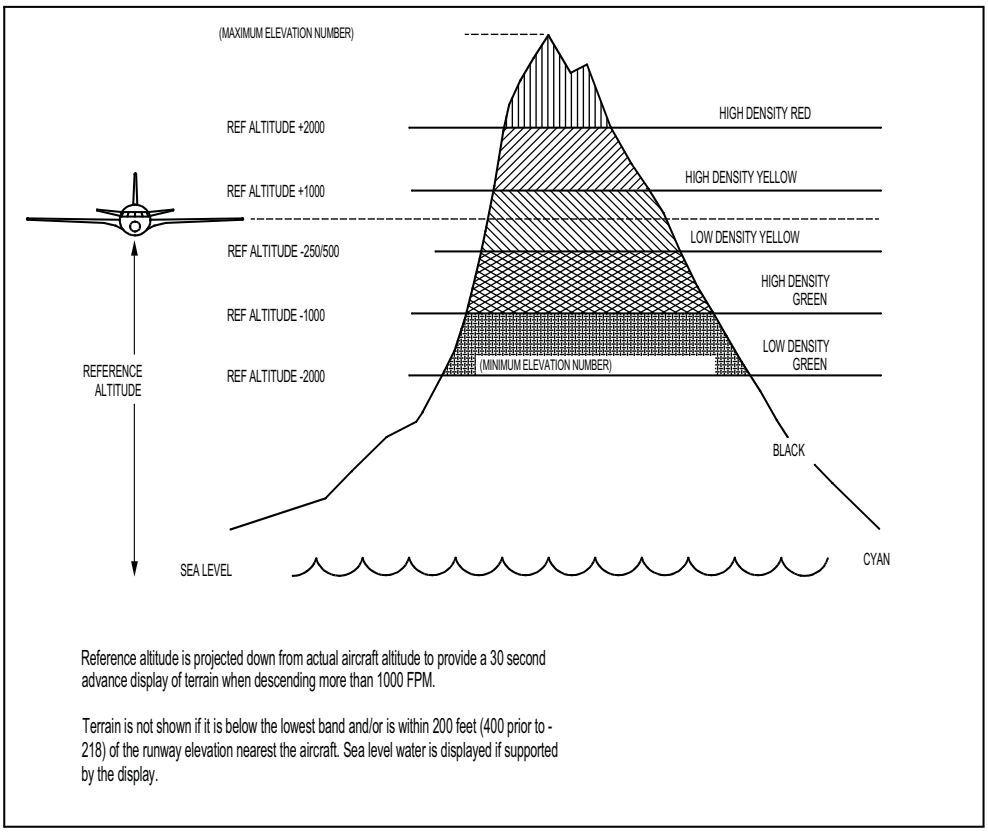


Figure 12.15-65 Standard Terrain Background Display





Reference altitude is projected down from actual aircraft altitude to provide a 30 second advance display of terrain when descending more than 1000 FPM.

Terrain is not shown if it is below the lowest band and/or is within 200 feet (400 prior to -218) of the runway elevation nearest the aircraft. Sea level water is displayed if supported by the display.

| Figure 12.15-66 Peaks Terrain Background Display at High and Low Relative Altitude

The Peaks Mode display includes a solid green level to indicate the highest, non-threatening terrain. The standard lower density green display patterns indicate mid and upper terrain in the display area as well as terrain that is within 2000 feet of the airplane. The red and yellow dot patterns are unchanged and continue to indicate terrain that is near or above the current altitude of the airplane. Solid yellow and red colors are unchanged and continue to indicate alert and warning areas relative to the flight path of the airplane. Terrain identified as water (0 Ft MSL) is displayed as cyan color dot patterns. The Peaks Mode display is prioritized such that higher level colors and densities override lower color and densities for maximum situational awareness of the most significant terrain relative to the altitude and flight path of the airplane.

With the Peaks Mode display, two elevation numbers indicating the highest and lowest terrain currently being displayed are overlaid on the display. The elevation numbers indicate terrain in hundreds of feet above sea level (MSL). The terrain elevation numbers are displayed with the "highest" terrain number on top, and the "lowest" terrain number beneath it. The "highest" terrain number is shown in the same color as the highest terrain color pattern on the display, and the "lowest" terrain number is shown in the color of the lowest terrain color pattern shown on the display. A single elevation number is displayed when the screen is all black or blue as a result of flying over water or relatively flat terrain where there is no appreciable difference in terrain elevations. The elevation numbers on the display are an additional indication that the terrain display is selected.

12.15.14.5.1 Self Test Terrain Display

During self-test, if all required inputs are valid then a display test pattern will be painted for approximately 12 second on each ND/MFD. The test pattern, as illustrated in the figure below, consists of 9 blocks, each filled with a different fill pattern and color. These 9 'styles' reflect all those that are normally used in a terrain picture on the display being used. Please note that the color names and fill percentages shown in the figure indicate the default value of each style.

Magenta	50% Red	Black or 16% Cyan
Solid Red	50% Yellow	Solid Yellow
25% Green	25% Yellow	12% or Solid Green

Table 12.15-2 Self-Test Picture

12.15.14.6 Terrain or Obstacle Caution Alert

When the conditions have been met to generate a Terrain or Obstacle Caution Alert, a specific audio alert and light output is triggered and the background image is enhanced to highlight the terrain caution threats.

At the start of a Terrain Caution Alert, the Terrain Awareness function triggers the Caution Audio Alert phrase "CAUTION TERRAIN, CAUTION TERRAIN". The phrase is repeated after seven seconds if still within the Terrain Caution Envelope. The Terrain Awareness function responds to a Obstacle Caution Alert by triggering the Caution Audio Alert phrase "CAUTION OBSTACLE, CAUTION OBSTACLE". The phrase is repeated after seven seconds if still within the Terrain Caution Envelope.

During a Terrain Caution Alert or Obstacle Caution Alerts the configured lights are activated.

During a Terrain Caution Alert, areas where terrain violates the Terrain Caution Envelope along the airplane track, and within ±90° of the airplane track, are painted with the Caution Color **yellow**.

During an Obstacle Caution Alert areas where an obstacle violates the Terrain Caution Envelope along the airplane track, and within ±90° of the airplane, are painted with the Caution Color **yellow**.

12.15.14.7 Terrain or Obstacle Warning Alert

When the conditions have been met to generate a Terrain or Obstacle Warning Alert (see Note), a specific audio alert and light output is triggered and the background image is enhanced to highlight the terrain or obstacle **caution and warning** threats.

At the start of a Terrain Warning Alert, the Terrain Awareness function triggers the Warning Audio Alert phrase "TERRAIN TERRAIN, PULL UP". The phrase "PULL UP" is then repeated continuously while within the Terrain Warning Envelope. The Terrain Awareness function responds to a Obstacle Warning Alert by triggering the Warning Audio Alert phrase "OBSTACLE OBSTACLE, PULL UP" (see Note). The phrase is repeated continuously while within the Terrain Warning Envelope.

During a Terrain or Obstacle Warning Alert the configured lights are activated.

During a Terrain Warning Alert, areas where terrain violates the Terrain Warning Envelope along the airplane track, and within ±90° of the airplane track, are painted with the Warning Color **red**.

During an Obstacle Warning Alert, areas where an obstacle violate the Terrain Warning Envelope along the airplane track, and within ±90° of the airplane track, are painted with the Warning Color **red**.

12.15.14.8 Geometric Altitude

Geometric Altitude is a computed airplane altitude designed to help ensure optimal operation of the EGPWS Terrain Awareness and Display functions through all phases of flight and atmospheric conditions. Geometric Altitude uses an improved pressure altitude calculation, GPS Altitude, Radio Altitude, and Terrain and Runway elevation data to reduce or eliminate errors potentially induced in Corrected Barometric Altitude by temperature extremes, non-standard altitude conditions, and altimeter miss-sets. Geometric Altitude also allows continuous EGPWS operations in QFE environments without custom inputs or special operational procedures.

With the Geometric Altitude function, EGPWS can operate reliably throughout extreme local pressure or temperature variations from standard, is not susceptible to altimeter miss-sets by the flight crew, and will not require any custom inputs or special procedures by the flight crew when operating in a QFE environment.

12.15.14.8.1 Required Inputs

The Geometric Altitude computation requires GPS Altitude with Vertical Figure of Merit (VFOM) and RAIM failure indication along with Standard (Uncorrected) Altitude and Radio Altitude. Ground Speed, Roll Angle, and Position (Latitude and Longitude) are used indirectly and are also required. Additionally, Corrected Barometric Altitude, Static Air Temperature (SAT), GPS Operational Mode and the Number of Satellites Tracked are used if available.

The required GPS signals can be provided directly from an external ARINC 743 / 743A receiver. Standard Altitude, Corrected Barometric Altitude, and Static Air Temperature (SAT) are provided directly from the ADC. If SAT is not available, geometric altitude is computed using Standard Altitude with a corresponding reduction in accuracy.

12.15.14.8.2 Altitude Calculation

The Geometric Altitude consists of three main functions: Calculation of Non-Standard Altitude, calculation of the component altitudes and VFOMs, and the final altitude signal blending. Additional logic exists to handle reversionary modes and signal reasonable checking for each component altitude. An overview of the Geometric Altitude function is shown in Figure 12.15-67.

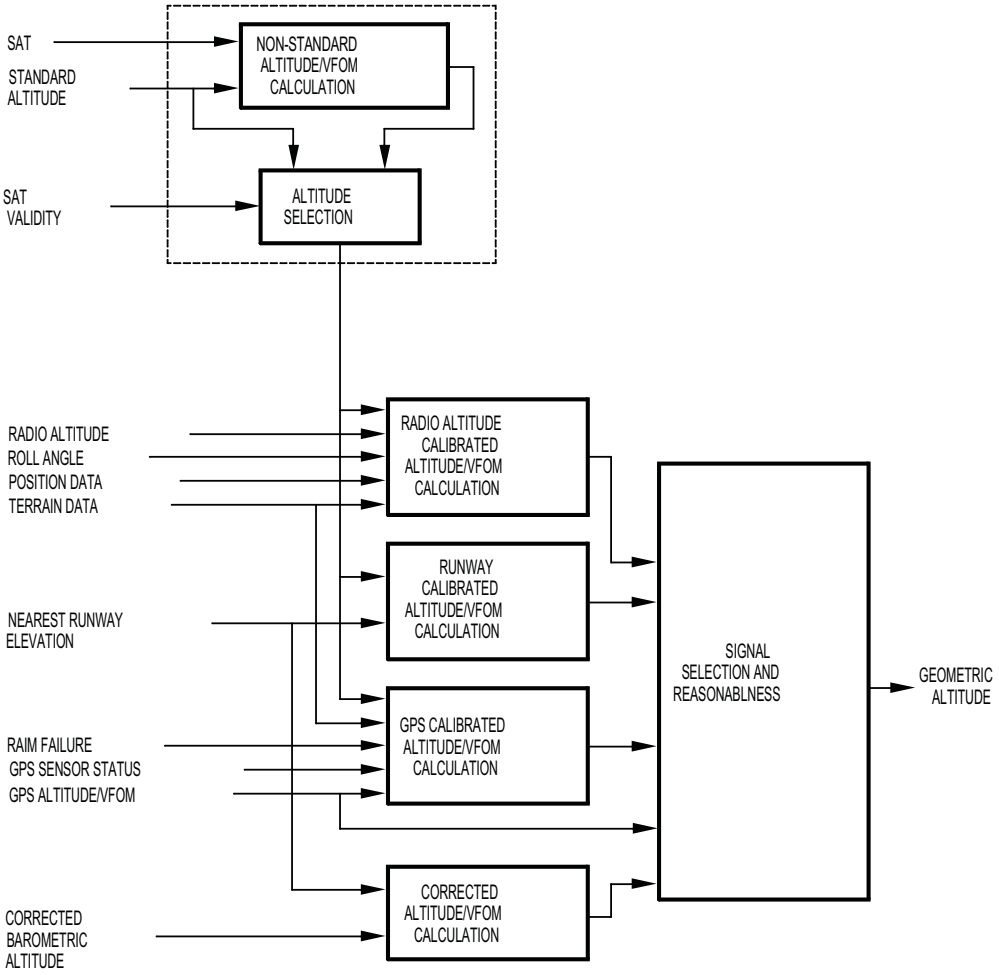


Figure 12.15-67 Geometric Altitude Block Diagram

12.15.14.8.3 Non-Standard Altitude

To support the Geometric Altitude function the EGPWS computes a Non-Standard Altitude using the hydrostatic equation relating changes in height to changes in pressure and temperature. Non-Standard Altitude uses static pressure derived from Standard Altitude, along with static air temperature, to continuously accumulate changes in geometric altitude. Since the Non-Standard Altitude algorithm incorporates actual atmospheric temperature it does not suffer from the errors due to non-standard temperatures.

Non-Standard Altitude is highly accurate for measuring relative vertical changes over short periods of time and distance, such as during take-off and approach. Non-Standard Altitude does not provide an absolute altitude and is prone to significant errors over extended periods of time and distance due to the effects of pressure gradients and long term integration errors. Due to these limitations, Non-Standard Altitude is not used directly, but is calibrated using additional signals and data to produce a set of component altitudes for use in the final altitude solution.

12.15.14.8.4 Computed Component Altitudes

The EGPWS generates three component altitudes that are combined, along with Corrected Altitude if available, to produce Geometric Altitude. These component altitudes are Runway Calibrated Altitude, GPS Calibrated Altitude. and Radio Altitude Calibrated Altitude.

Runway Calibrated Attitude, is a one-time calibration of Non-Standard Altitude during take-off roll. A correction factor for Non-Standard is computed using the runway elevation from the EGPWS Runway database while the aircraft is on the ground. Runway Calibrated Altitude is used during the take-off and climb-out portions of flight. VFOM of Runway Calibrated Altitude is estimated based on changes in altitude since calibration, time since calibration, and distance from the runway.

GPS Calibrated Altitude is produce by combining GPS Altitude and Non-Standard Altitude through a complementary filter. The complimentary filter is dynamically optimized to reduce errors in GPS Altitude caused by selective availability while minimizing pressure gradient and drift errors of Non-Standard Altitude. GPS Calibrated Altitude is accurate through all phases of flight and is the primary altitude source during the cruise portion of flight. GPS Calibrated Altitude VFOM is estimated using GPS VFOM and estimated Non-Standard Altitude drift errors.

Radio Altitude Calibrated Altitude is a calibration of Non-Standard Altitude during approach using an altitude derived from radio altitude (height above terrain) and the terrain elevation data stored in the EGPWS terrain database. This calibration is performed during the approach phase of flight when the airplane is within a minimum distance and elevation of any runway. Once a correction factor is determined, it is applied to Non-Standard Altitude until the airplane lands. VFOM of Radio Altitude Calibrated Altitude is based on the accuracy of the calibration as estimated from the resolution of the terrain data and flatness of the terrain. The altitude is re-calibrated if a correction with a higher estimated accuracy is computed.

An estimated VFOM for Corrected Barometric Altitude is computed in order to determine its weight in the final altitude. VFOM of Corrected Barometric Altitude is based on aircraft altitude above and distance from the nearest runway, with the accuracy assumed to be the highest close to runway.

12.15.14.9 Blending and Reasonableness Checking

The final Geometric Altitude is computed by combining the three computed component altitudes with optional Corrected Barometric altitude. The weighting of each altitude in the final solution is based on the corresponding estimated VFOM. The blending algorithm gives the most weight to altitudes with a higher estimated accuracy, reducing the effect of less accurate altitudes on the final computed altitude. Each component altitude is also checked for reasonableness using a window monitor computed from GPS Altitude and GPS VFOM. Altitudes that are invalid, not available, or fall outside the reasonableness window are not included in the final blended altitude.

12.15.14.10 Input Failures and Reversionary Operation

The Geometric Altitude algorithm is designed to allow continued operation when one or more of the altitude components are unavailable. Component Altitudes that are unavailable due to a failed input signal or flagged as unreasonable are not used, with the final blended altitude comprised of the remaining, valid signals. If all component altitudes are invalid or unreasonable, then GPS Altitude is used directly for the Terrain Awareness functions. Minimum Geometric Altitude operation requires either GPS Altitude or Corrected Barometric Altitude. If GPS altitude fails or is not present in the installation then the Altitude reverts to Corrected Altitude alone.

For installations without SAT or if the SAT input fails, Standard Altitude is use in place of computed Non-Standard Altitude. Under such conditions, all computed component altitudes normally requiring Non-Standard Altitude use Standard altitude with a corresponding decrease in accuracy. When using Standard Altitude in place of Non-Standard Altitude, affected estimated VFOMs are adjusted resulting in the affected signals being weighted less heavily in the final blended altitude.

12.15.15 Limitations

TBD