

12.3.1 Introduction

The Automatic Flight Control System (AFCS), provides fail-safe operation of flight director guidance, autopilot, yaw damper and automatic pitch trim functions.

12.3.2 General

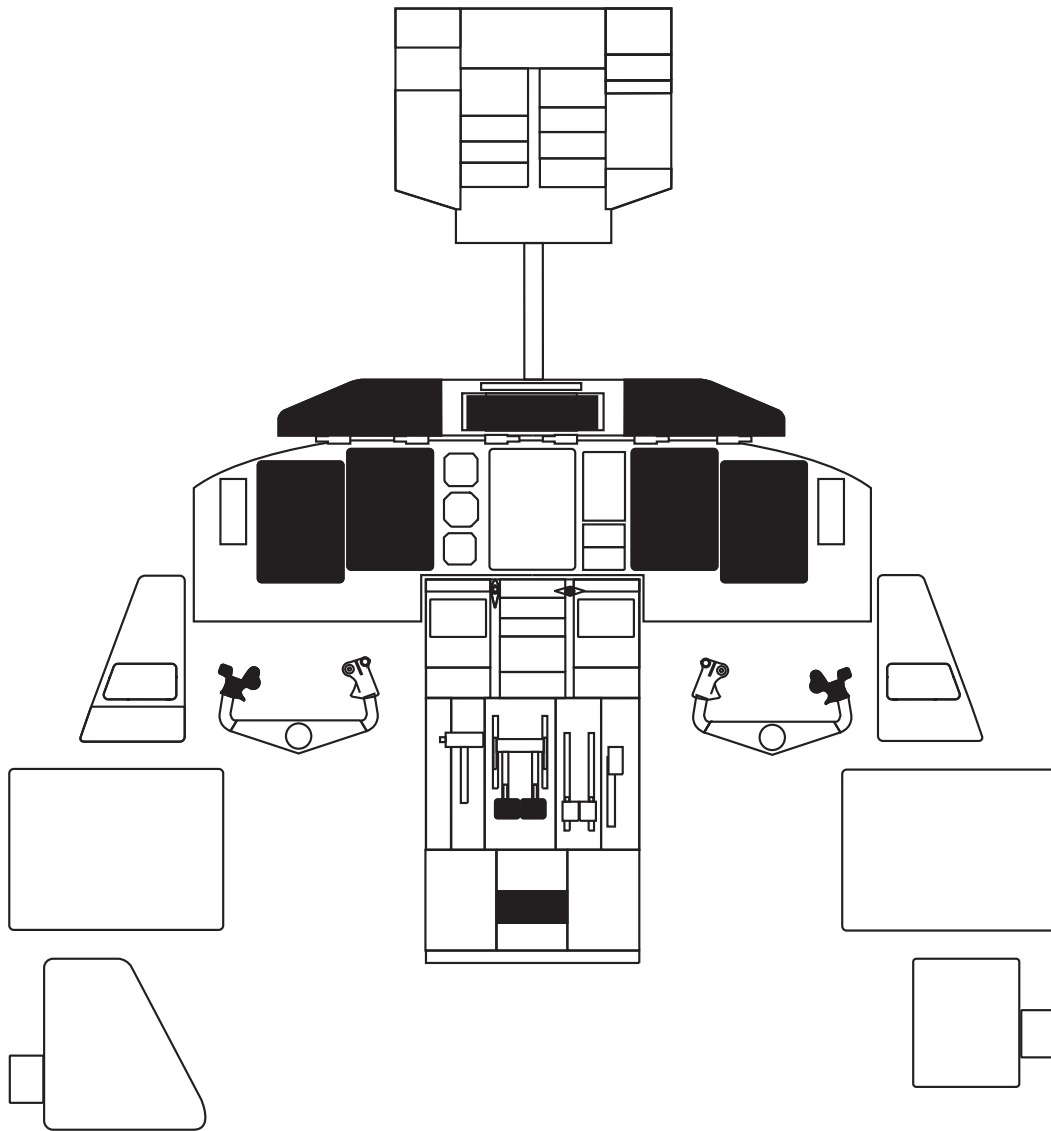
The Automatic Flight Control System (AFCS) provides several major functions. The Flight Director (FD) function provides lateral and vertical guidance to fly the aircraft, either manually or automatically. The Autopilot (AP) function couples the Flight Director guidance to the aircraft control surfaces for automatic control of the aircraft. The Automatic Pitch Trim function reduces the mistrim force on the Pilot's and Copilot's control columns when the AP is engaged. The Flap Auto Pitch Trim function reduces the mistrim force on the Pilot's and Copilot's control columns when the AP is not engaged and the flaps are in transit. The Yaw Damper (YD) function provides yaw stabilization and turn coordination.

The AFCS provides dual Flight Director capability, a single Autopilot, and a single Yaw Damper. The AFCS is designed to provide all weather approach capability to Category I and II limits for ILS. The AFCS is also capable of non-precision VOR approaches, front and back course Localizer approaches, and FMS approaches.

AFCS Heading Set Knobs Coupled LH and RH

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

12.3.3 Controls and Indications - Communication



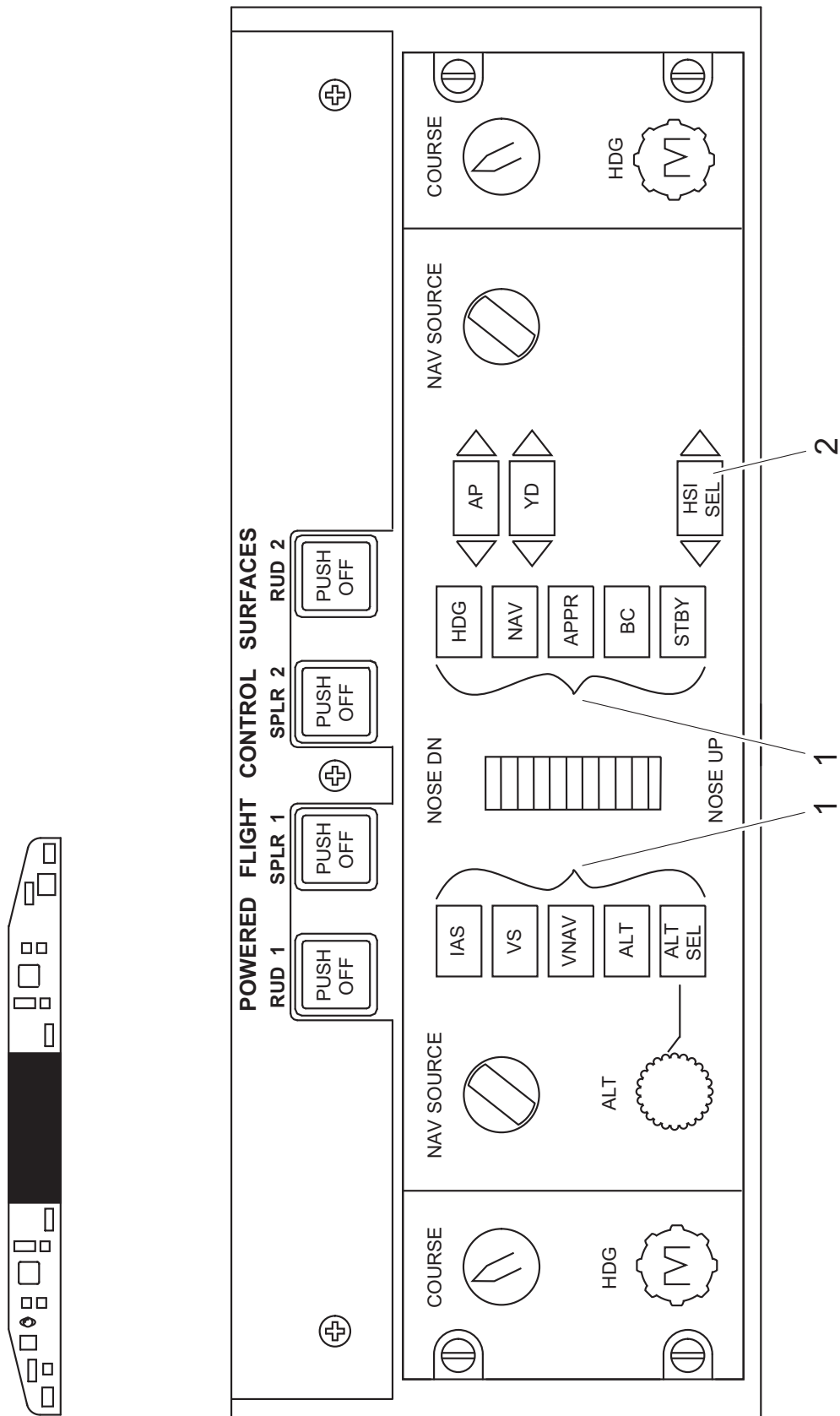


Figure 12.3-1 Flight Guidance Control Panel (1 of 4)

FLIGHT GUIDANCE CONTROL PANEL CALLOUTS

1. FLIGHT GUIDANCE MODE SELECTORS (momentary action)

PUSH selects flight director modes of operation

- flight director command bars display lateral and vertical guidance commands depending on selected mode
- pilot can manually fly the displayed commands or engage autopilot to automatically fly the commands
- the selected flight director mode appears in the Flight Mode Annunciator (FMA) area of each PFD

2. HSI SEL (momentary action)

Pointer segments (white)

PUSH - the HSI SEL pushbutton selects which PFD (1 or 2) the FD is coupled to. The PFD set of parameters used include: NAV source, course targets, HDG targets, and ADU and AHRS

- pressing the HSI SEL pushbutton switches from the left NAV SOURCE, HDG, and COURSE and ADU/AHRS selections displayed on the pilot's PFD, to the right NAV SOURCE HDG, and course and ADU/AHRS selections displayed on copilot's PFD, and vice-versa
- the selected side is indicated by lighting the corresponding arrow next to the HSI SEL pushbutton on the FGCP. The selected side is also indicated on the non-selected PFD by an HSI plus an arrow
- if the Dual FD mode is active, both the left and right arrows on either side of the HSI SEL pushbutton are lit, and pressing the HSI SEL push button has no effect
- pressing the HSI SEL pushbutton has the following effects on the AFCS:
 - No effect on AP/YD engagement
 - Clears all active and armed lateral and vertical FD modes and removes the FD bars if the AP is not engaged
 - Clears all active and armed lateral and vertical FD modes if the AP is selected (reverts to basic mode) (FD bars remain)

Upon power-up, the HSI SElection defaults to the left side

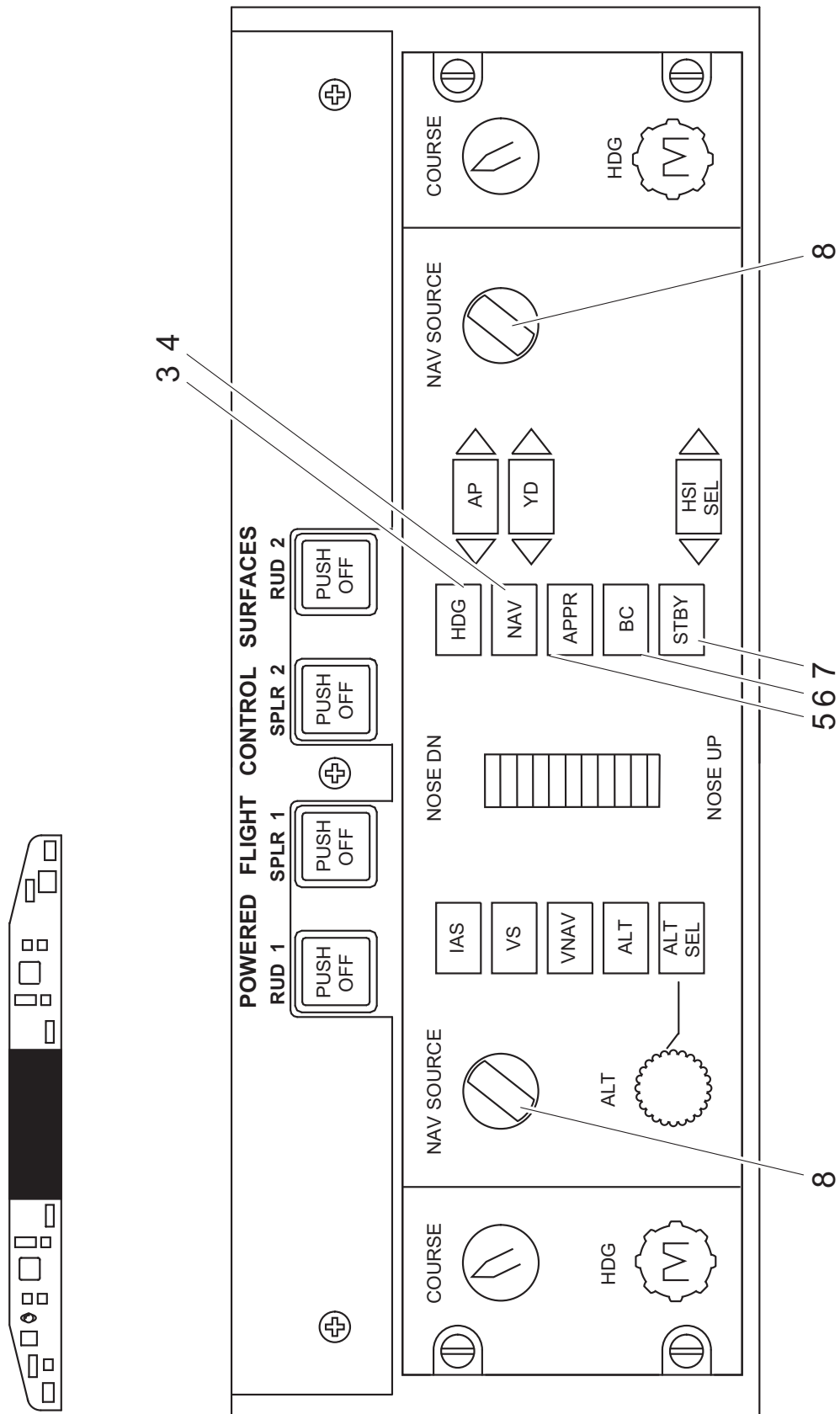


Figure 12.3-2 Flight Guidance Control Panel (2 of 4)

FLIGHT GUIDANCE CONTROL PANEL CALLOUTS (cont'd)

3. HDG MODE (momentary action)

PUSH - activates the lateral guidance commands based on selected heading (indicated by heading bug) as displayed on active PFD

4. NAV MODE (momentary action)

PUSH - arms the lateral guidance commands for capture of the selected navigation source that is displayed on the active PFD

- HDG mode is active until navigation mode transitions from arm to capture mode as displayed on the FMA

5. APPR MODE (momentary action)

PUSH - arms lateral commands (and vertical commands if glideslope present) to capture and track the approach navigation aid displayed on the active PFD

- if APPR is selected when: EFIS ADC source ? NORM, EFIS ATT/HDG source ? NORM, VOR/LOC 1 ? L, VOR/LOC 2 ? R, L & R course, L & R DH on ICP, both pointers (white) beside HSI SEL switch will come on indicating a DUAL approach mode when both localizer and glideslope signals are valid and radio altitude is below 1200 feet

6. BC MODE (momentary action)

PUSH - activates lateral commands to track backcourse localizer displayed on active PFD

7. STBY MODE (momentary action)

PUSH - pressing the STBY pushbutton has the following effects on the AFCS:

- No effect on AP/YD engagement
- Clears all active and armed lateral and vertical FD modes and removes FD bars if the AP is not engaged
- Clears all active and armed lateral and vertical FD modes if the AP is engaged (reverts to basic mode)
- Clears FD abnormal messages

8. NAV SOURCE SELECTION KNOB (rotary action)

TURN - selects the source to be used for navigation

- indicated by the navigation source annunciator on the PFD and MFD (NAV page in both ARC and FULL)
- see chapter 12.15 (ATA 34) NAVIGATION for further information

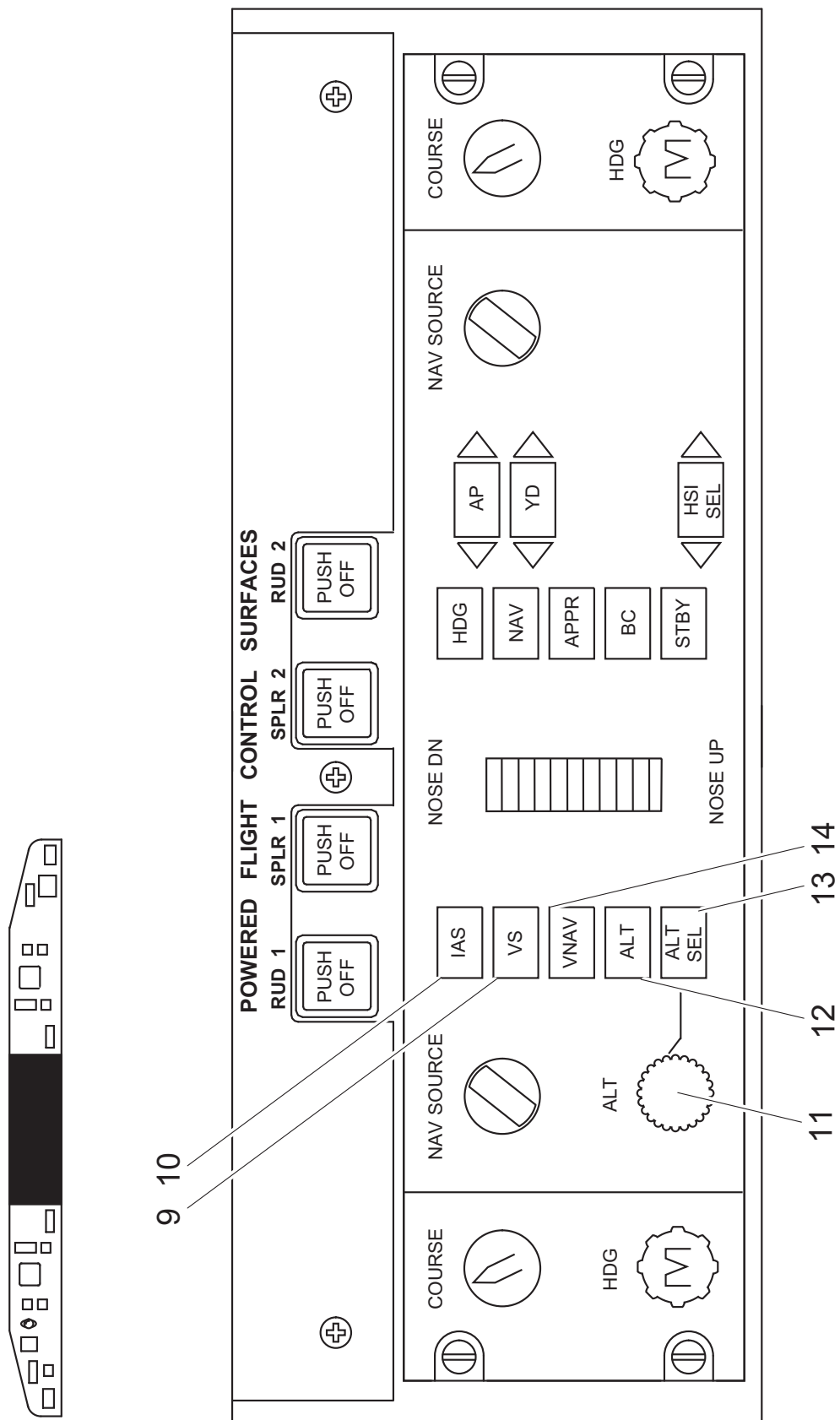


Figure 12.3-3 Flight Guidance Control Panel (3 of 4)

FLIGHT GUIDANCE CONTROL PANEL CALLOUTS (cont'd)

9. VS MODE (momentary action)

PUSH - activates vertical commands to hold vertical speed

- vertical speed being held is annunciated on the PFD
- rotate NOSE DN/NOSE UP trim wheel to change vertical speed
- Tactile Control Steering (TCS) switch may also be used to establish or change to a new vertical speed

10. IAS MODE (momentary action)

PUSH - activates vertical commands to hold indicated airspeed

- airspeed being held is annunciated on the PFD
- rotate NOSE DN/NOSE UP trim wheel to change airspeed
- TCS switch may also be used to establish or change to a new airspeed

11. ALT KNOB (rotary action)

ROTATE - to select desired altitude

- pilot selects ALT SEL on flight guidance controller and initiates a maneuver to fly toward the preselected altitude

12. ALT MODE (momentary action)

PUSH - activates vertical commands to hold aircraft altitude at the time of mode engagement

- TCS switch may be used to establish a new altitude

13. ALT SEL MODE (momentary action)

PUSH - arms vertical guidance to capture the pre-selected altitude displayed on the PFD

- IAS, VS, VNAV, or PITCH HOLD mode can be used to capture the selected altitude (aircraft must be initially maneuvered to fly toward the pre-selected altitude)

14. VNAV MODE (momentary action)

PUSH - activates vertical commands to acquire and hold a vertical flight path computed by the FMS (FMS selected as NAV source on selected PFD)

- the VNAV mode is available only if the FMS is installed on the aeroplane
- the VNAV mode is only active when the LNAV mode is also active (NAV PB)

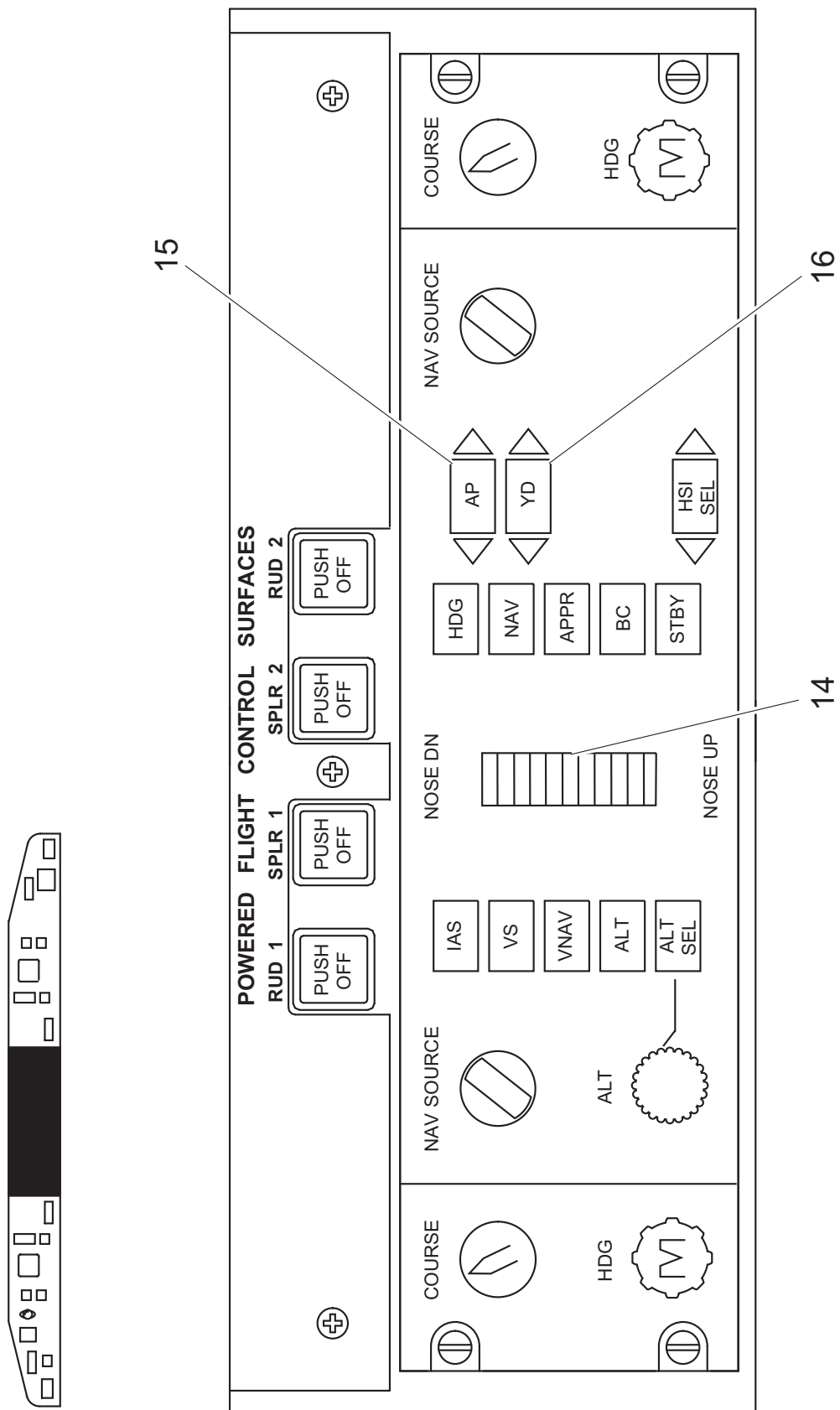


Figure 12.3-4 Flight Guidance Control Panel (4 of 4)

FLIGHT GUIDANCE CONTROL PANEL CALLOUTS (cont'd)

14. PITCH THUMB WHEEL (rotary action)

- ROTATE** - with autopilot engaged and no flight guidance mode selected pitch attitude changes proportional to the amount of pitch wheel displacement
- with a vertical flight guidance mode selected (VS, PITCH HOLD, IAS) vertical reference is changed (displayed on the PFD)

15. AP PUSHBUTTON (momentary action)

Pointer segments (white)

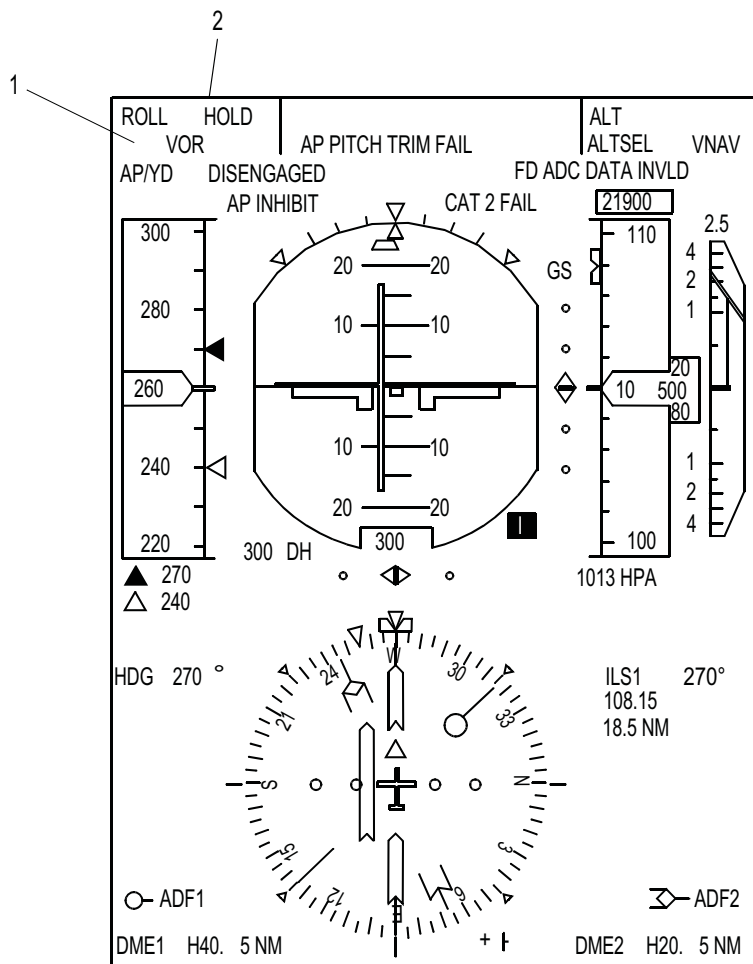
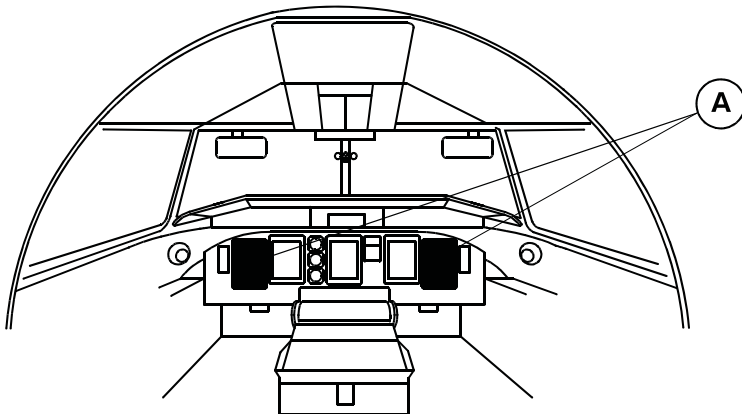
- PUSH** - engages autopilot and yaw damper function (if not already engaged) simultaneously
- autopilot engagement is indicated by lighting two arrows on either side of the AP pushbutton on the FGCP, and by displaying AP on the PFD
 - press again to disengage the autopilot (yaw damper will remain engaged)

16. YD PUSHBUTTON (momentary action)

Pointer segments (white)

- PUSH** - engages yaw damper
- YD engagement is allowed with the aircraft both on ground and airborne
 - Yaw Damper engagement is indicated by lighting two arrows on either side of the YD pushbutton on the FGCP
 - press again to disengage the yaw damper (the autopilot will disengage if engaged)

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Figure 12.3-5 PFD FMA Annunciations (1 of 5)

PFD CALLOUTS PERTAINING TO FLIGHT GUIDANCE

1. LATERAL MODE ARMED ANNUNCIATION (white)

- this information indicates which lateral mode is armed
- messages are:
 - VOR
 - LOC
 - VOR APP
 - BC
- for all lateral or vertical, armed or engaged modes, messages are exclusive for each zone (Management made by the FGM)
- information is taken from FGM1 if valid, from FGM2 if FGM1 is not valid
- when engaged in DUAL FD mode, FGM1 and FGM2 supply information to their own side

2. LATERAL MODE ENGAGED ANNUNCIATION (green) (green, reverse video for 5 s then in normal video)

- this information indicates which lateral mode is engaged
- messages are:
- (*) denotes capture mode
 - ROLL HOLD
 - HDG HOLD
 - WING LVL
 - HDG SEL
 - VOR*
 - VOR
 - VOR OS
 - LOC*
 - LOC
 - VOR APP*
 - VOR APP
 - VOR APP OS
 - BC*
 - BC
 - LNAV
 - LNAV HDG SEL
 - LNAV HDG INT
- LNAV submodes are displayed when the LNAV mode is engaged upon selected FGM
- LNAV HDG mode is displayed when the FMS is in the heading select mode (HDG SEL) or the heading intercept mode (HDG INT)
- if the FMS submode data is not available to the displays, "LNAV ---" is displayed

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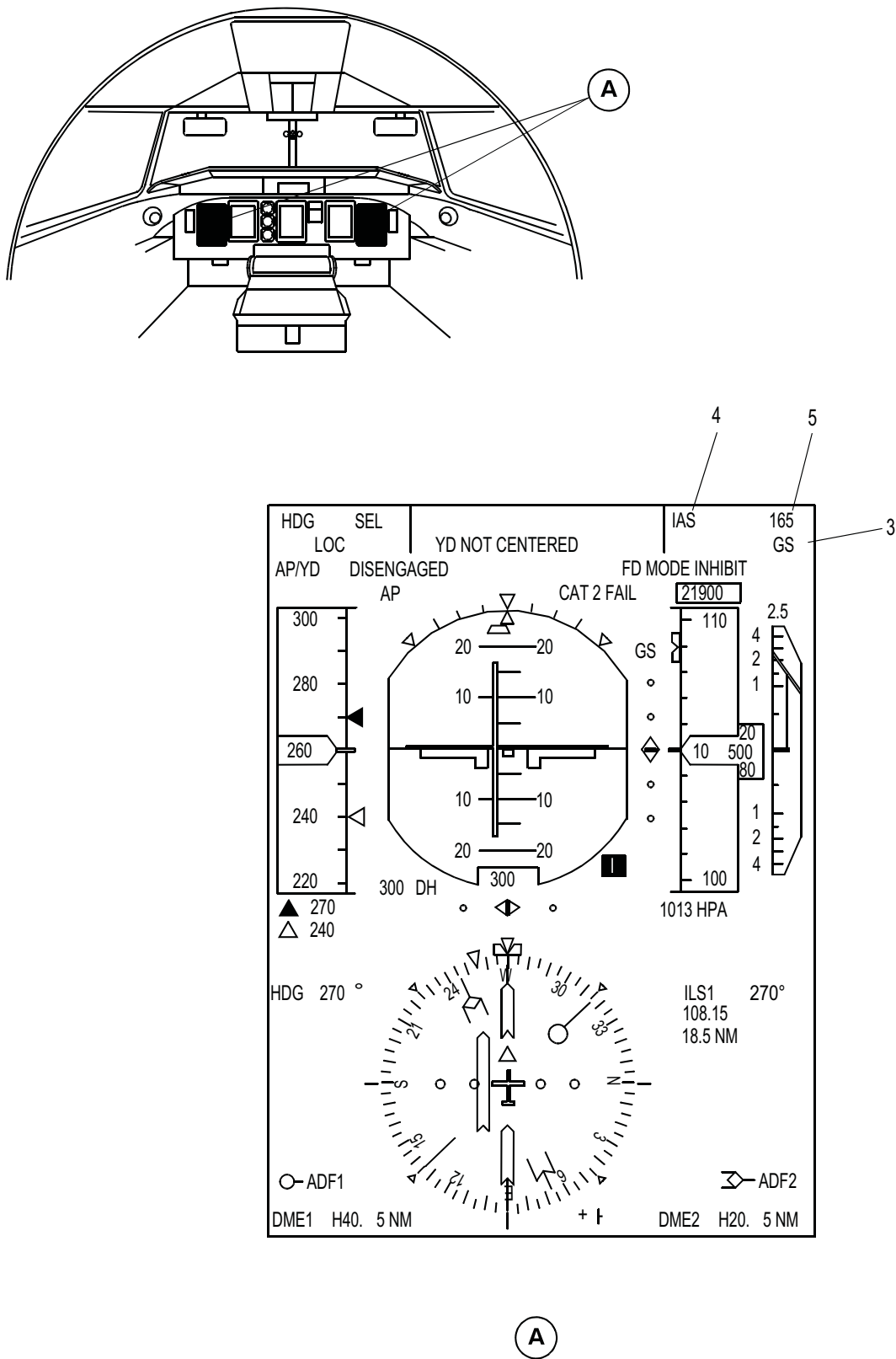


Figure 12.3-6 PFD FMA Annunciations (2 of 5)

PFD CALLOUTS PERTAINING TO FLIGHT GUIDANCE (cont'd)

3. VERTICAL MODE ARMED ANNUNCIATION (white)

- this information indicates which vertical mode is armed
- messages are:
 - ALT SEL on the left side of the column and
 - GS, VNAV (FMS mode), EL on the right side since ALT SEL may be armed at the same time as the others

**4. VERTICAL MODE ENGAGED ANNUNCIATION
(green, reverse video for 5 s then in normal video)**

- this information indicates which vertical mode is engaged
- messages are:
 - PITCH HOLD
 - IAS
 - VS
 - ALT*
 - ALT
 - GA
 - GS*
 - GS
 - EL *
 - EL
 - VNAV PATH
 - VNAV FLC
 - VNAV ALT
 - VNAV ALT*
- VNAV submodes are displayed when the VNAV mode is engaged upon selected FGM
- if the FMS submode data is not available to the displays, "VNAV" is displayed

5. SELECTED IAS NUMERIC VALUE ANNUNCIATION (green)

- displayed in knots, from 0 to 999 kts
- digits are replaced by 3 white dashes if TCS is active

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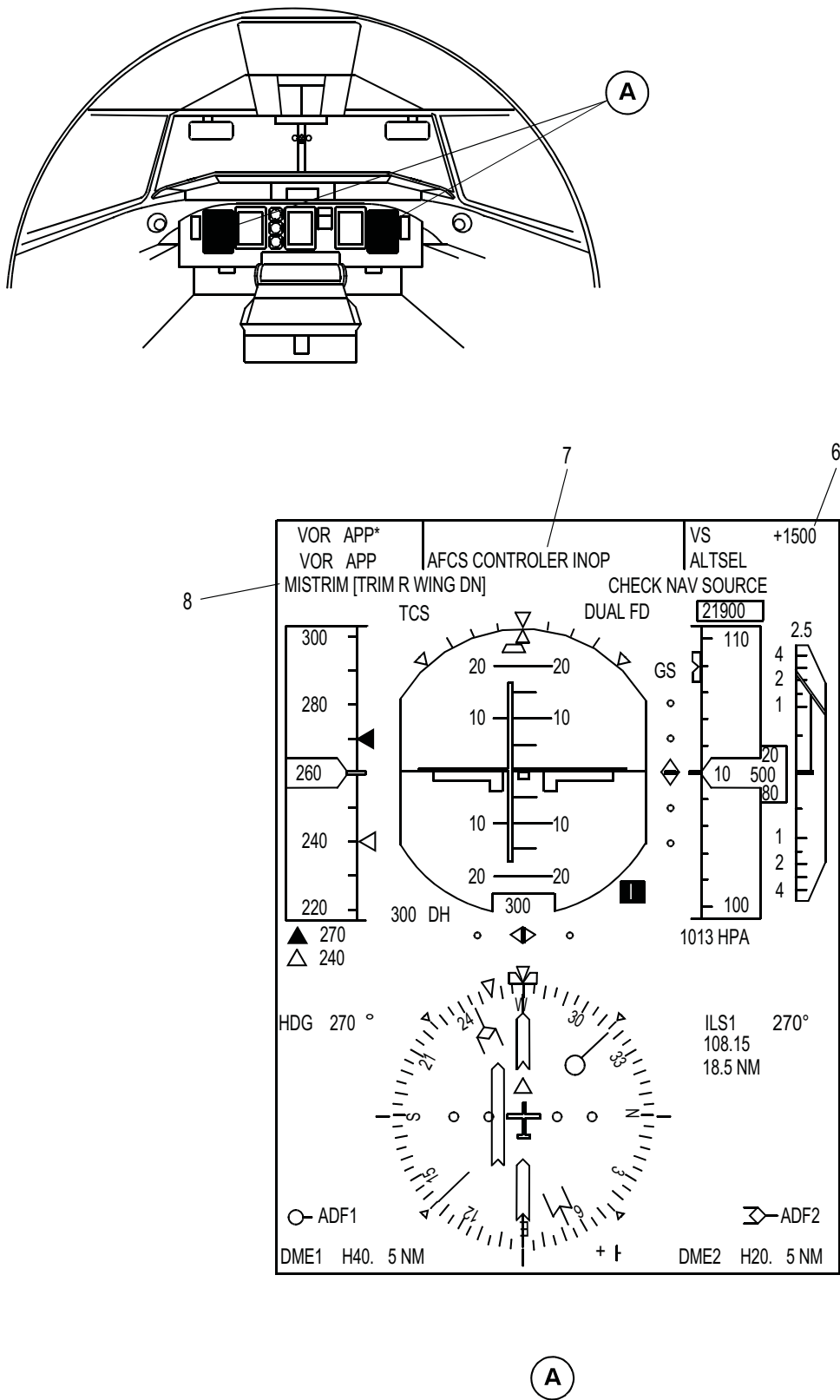


Figure 12.3-7 PFD FMA Annunciations (3 of 5)

PFD CALLOUTS PERTAINING TO FLIGHT GUIDANCE (cont'd)

6. SELECTED VS NUMERIC VALUE ANNUNCIATION (green)

- the value is displayed in 100 ft/min, from -9,900 to +9,900 ft/min
- digits are replaced by 4 white dashes if TCS is active

7. AFCS GENERAL FAILURE MESSAGES

(flashing yellow message for 5 seconds, then steady yellow)

- these messages are non-resettable, except if the origin of the failure disappears
- they have the following display priority:
 - AFCS FAIL
 - AP PITCH TRIM FAIL
 - AUTO TRIM FAIL
 - YD NOT CENTERED
 - L or R FD FAIL
 - AFCS CONTROLLER INOP

8. AP/YD STATUS MESSAGES (yellow)

- they are displayed with the following display priority:
 - AP/YD DISENGAGED
 - AP DISENGAGED
 - YD DISENGAGED
 - AP/YD FAIL
 - AP FAIL
 - MISTRIM [TRIM NOSE UP] or MISTRIM [TRIM NOSE DN]
 - MISTRIM [TRIM L WING DN] or MISTRIM [TRIM R WING DN]
- the first three messages will flash upon FGM request following an automatic disconnect. Flashing is stopped after pilot action on the A/P DIS switch on either control wheel, then message is steady for 5 seconds before being automatically removed
- if it is a manual disconnect, then the message is displayed steady for 5 seconds then removed
- these messages are picked from whichever FGM sends the information
- the last four messages are displayed flashing for 5 seconds then steady as long as one FGM has detected the failure

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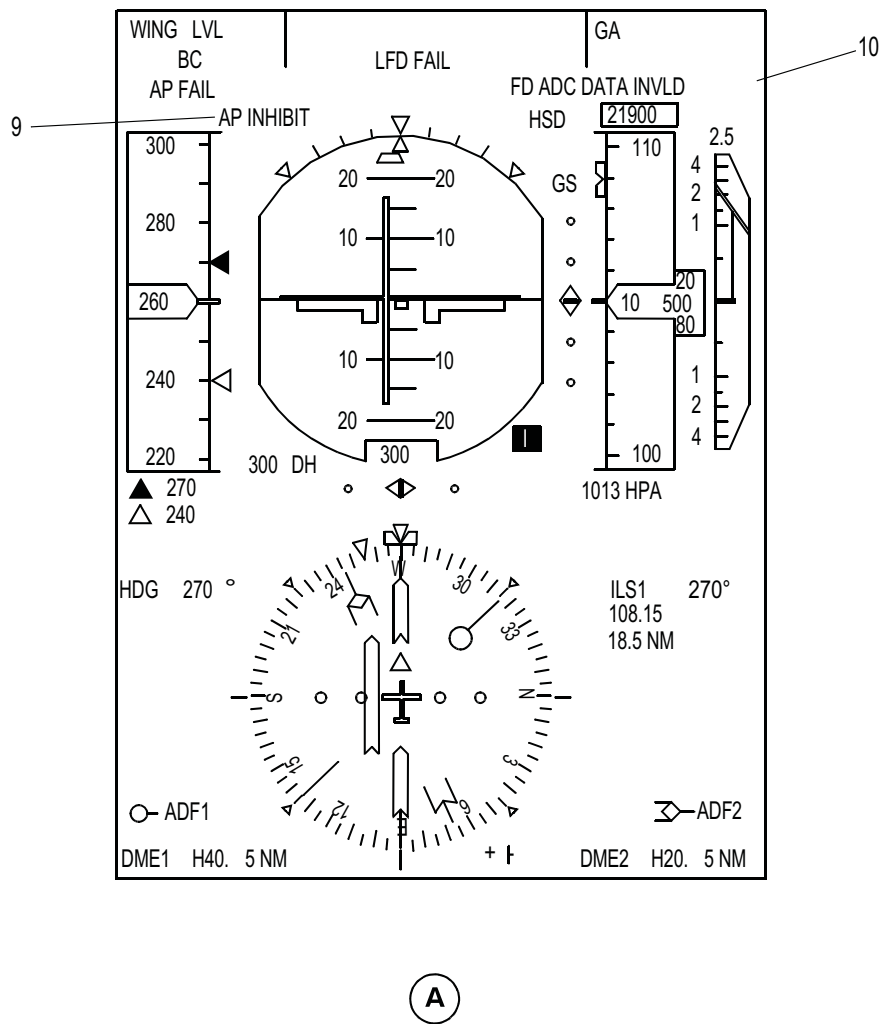
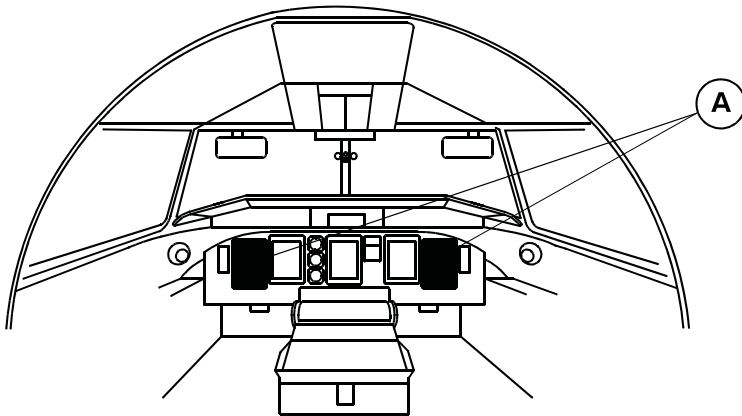


Figure 12.3-8 PFD FMA Annunciations (4 of 5)

PFD CALLOUTS PERTAINING TO FLIGHT GUIDANCE (cont'd)

9. AP/YD ENGAGEMENT MESSAGES

- displayed with the following display priority:
 - TCS (steady white)
 - AP (steady green)
 - AP INHIBIT (steady white for 5 seconds)
 - YD INHIBIT (steady white for 5 seconds)
- nothing is displayed otherwise
- messages 1, 3 and 4 are displayed from whichever FGM sends the information
- message 2 is displayed from both FGM's

10. FLIGHT DIRECTOR ABNORMAL MESSAGES

- displayed with the following display priority:
 - FD ATT DATA INVLD
 - FD ADC DATA INVLD
 - FD HDG DATA INVLD
 - FD NAV DATA INVLD
 - FD MODE INHIBIT
 - CHECK NAV SOURCE
 - ALT OFF
- these messages displayed in yellow or in white upon FGM request:
 - flashing yellow for 5 seconds then steady when there is a system malfunction, then steady for 5 seconds removed after corrective pilot action (HSI change, attempt to engage, another FD mode or by pressing STBY PB)
 - steady white for 5 sec. when data invalid
- all these messages are mutually exclusive
- information is taken from own-side FGM indication if valid, from opposite FGM otherwise

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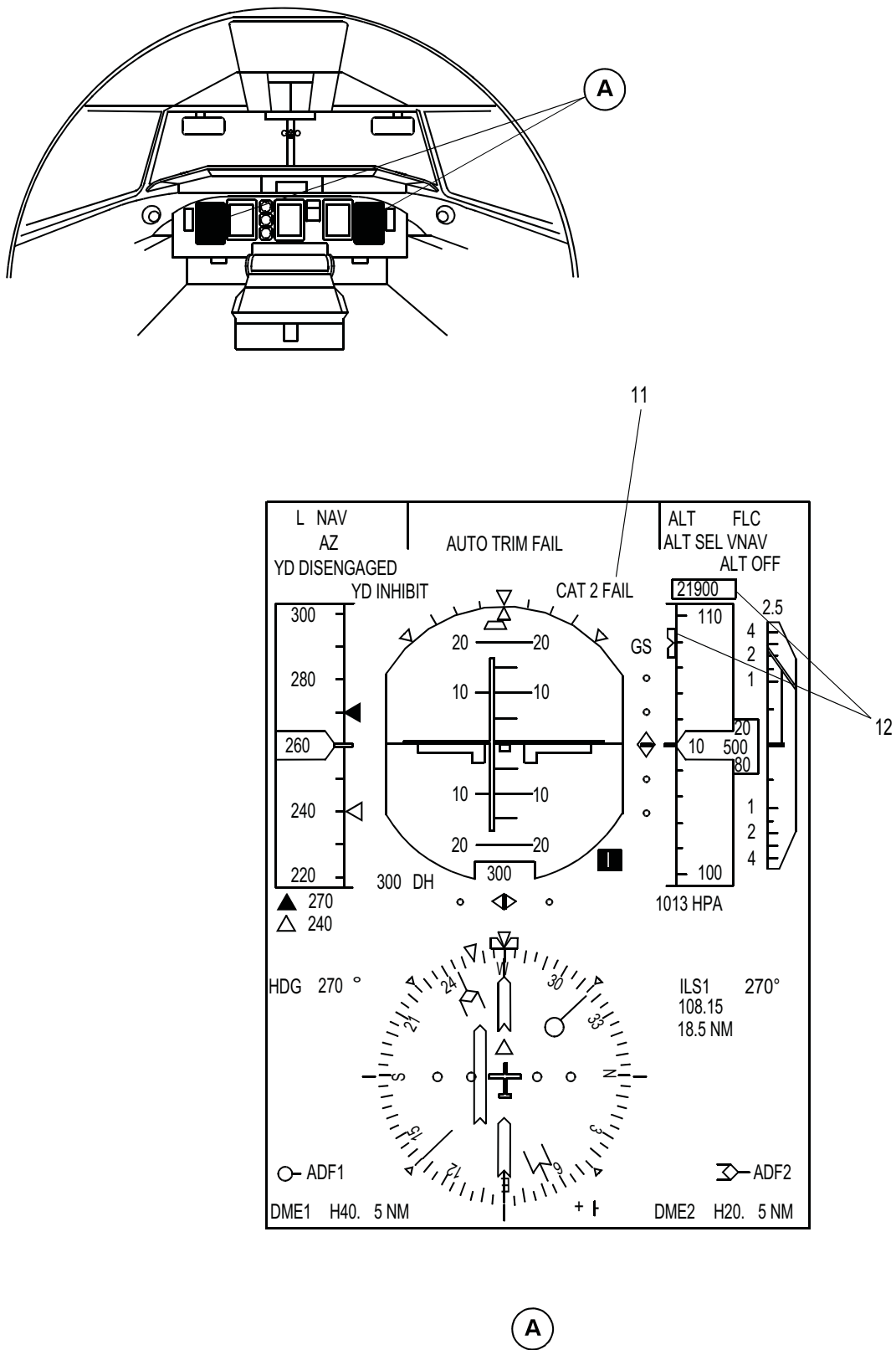


Figure 12.3-9 PFD FMA Annunciations (5 of 5)

PFD CALLOUTS PERTAINING TO FLIGHT GUIDANCE (cont'd)

11. HSI/DUAL MODE MESSAGES

(see Detailed Description for colors)

- these messages give a status of the FD or HSI select engagement
- they are displayed with the following display priority:
 - CAT2 FAIL
 - DUAL OFF
 - DUAL FD
 - HSI> (left MFD)
 - <HSI (right MFD)

12. SELECTED ALTITUDE READOUT AND BUG

- provides digital and analog readout of the preselected altitude
- the analog bug moves vertically along the altitude scale; half of the symbol is displayed at the top or bottom of the scale, when selected value is out of scale

ALTITUDE ALERT

- aircraft is within ± 1000 ft to ± 250 ft of selected altitude
- based on the difference between the FGCP selected altitude and the baro-altitude
- the digital readout, and the analog bug is turned yellow when in alert condition; otherwise in cyan
- when altitude alert data is not valid, the digits are replaced by 5 white dashes

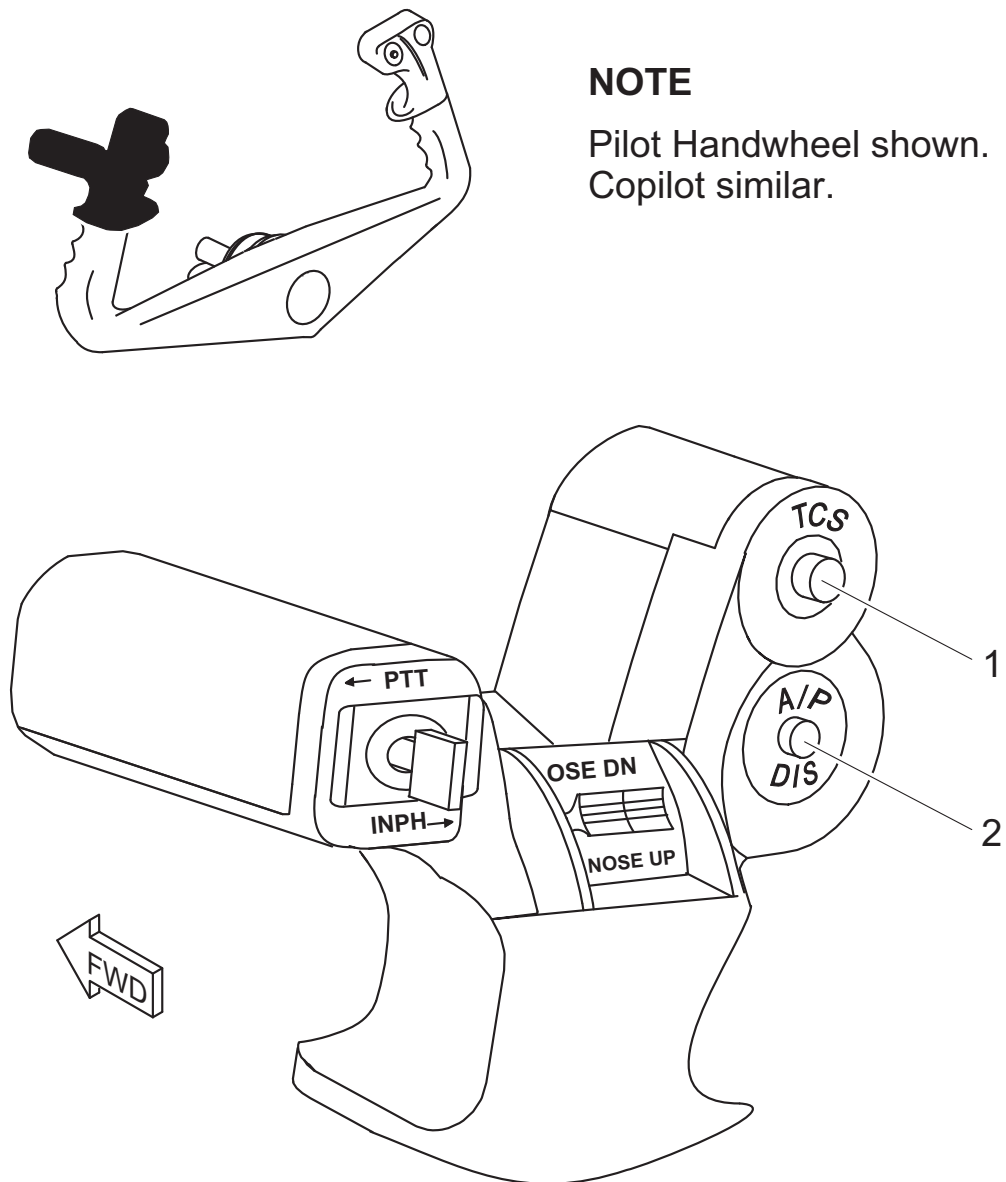


Figure 12.3-10 Autopilot Disconnect Pushbutton and TCS

CONTROL WHEEL CALLOUTS PERTAINING TO AUTOFLIGHT

1. TACTILE CONTROL STEERING (TCS) PUSHBUTTON (momentary action)

PUSH and HOLD - allows the pilot to override the AP momentarily without disengaging the AP

- when the TCS mode is active, the FD command bars are removed from the PFD, and the numerical displays of the active vertical mode targets on the PFD are dashed
- the TCS active status is displayed on the PFD in white letters. If the AP is engaged, the TCS indication replaces the AP engagement indication on the PFD. The AP engaged arrows on the FGCP remain on
- when the TCS mode is active, manual selection of a new vertical or lateral FD mode is inhibited. Automatic transitions from armed modes to capture modes, and from capture modes to track modes are not inhibited when the TCS mode is active. Also, the AP is inhibited from engaging.
- when the pilot releases the TCS switch, the FD modes update their targets to the values that existed at TCS switch release, for the following modes:
 - Roll Hold submode of the Lateral Basic mode
 - Pitch Hold mode
 - Altitude Hold mode
 - Indicated Airspeed mode
 - Vertical Speed mode
- when the Wings Level submode is active and the pilot releases the TCS switch, the lateral mode automatically transitions to the lateral basic mode
- in any other FD modes, the FD commands return to their previously selected values

2. AUTOPILOT DISENGAGE SWITCH (momentary action)

PUSH - disengages the autopilot

- resets autopilot disengage warnings
- resets the yaw damper disengage PFD annunciation

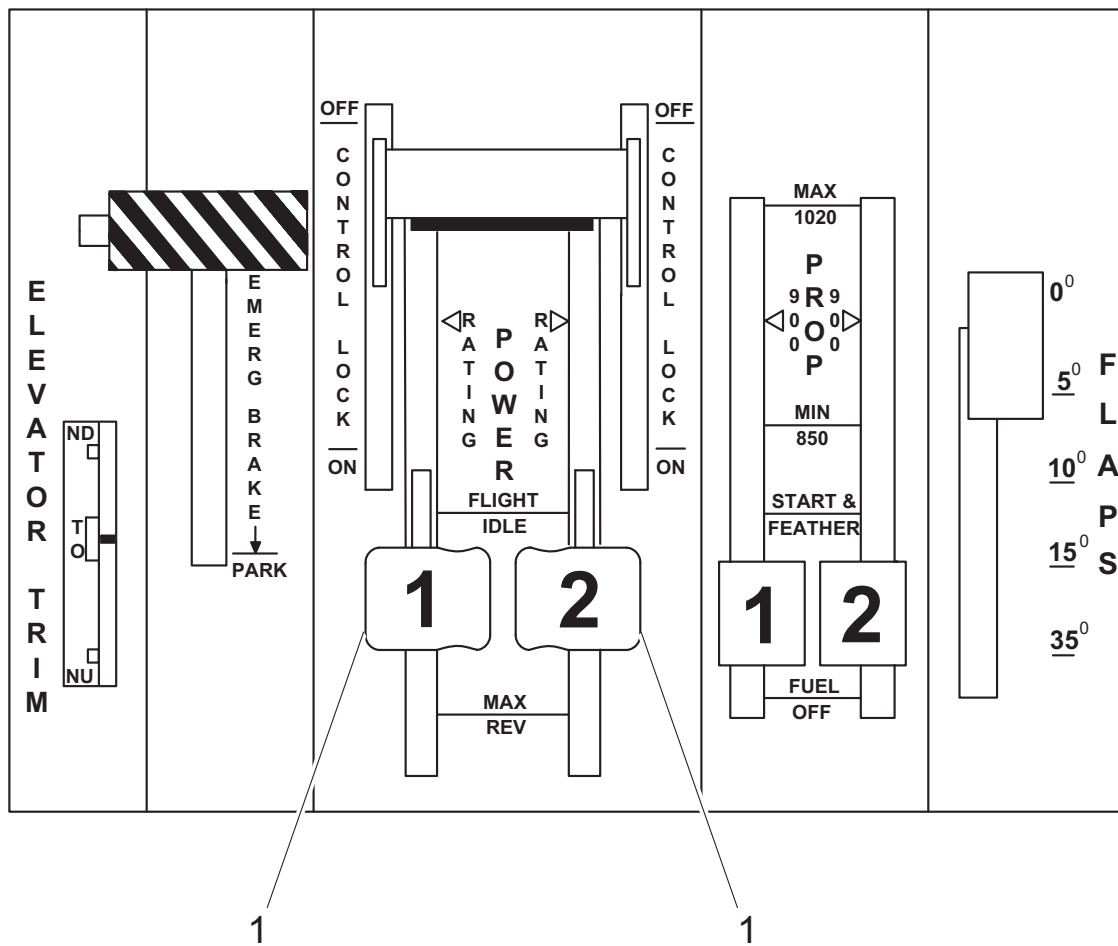


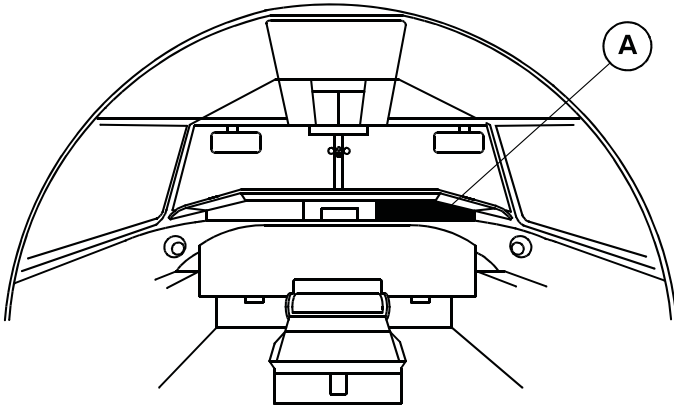
Figure 12.3-11 Go-Around Pushbuttons

POWER QUADRANT CALLOUTS PERTAINING TO AUTOFLIGHT

1. GO AROUND (GA) PUSHBUTTONS (momentary action)

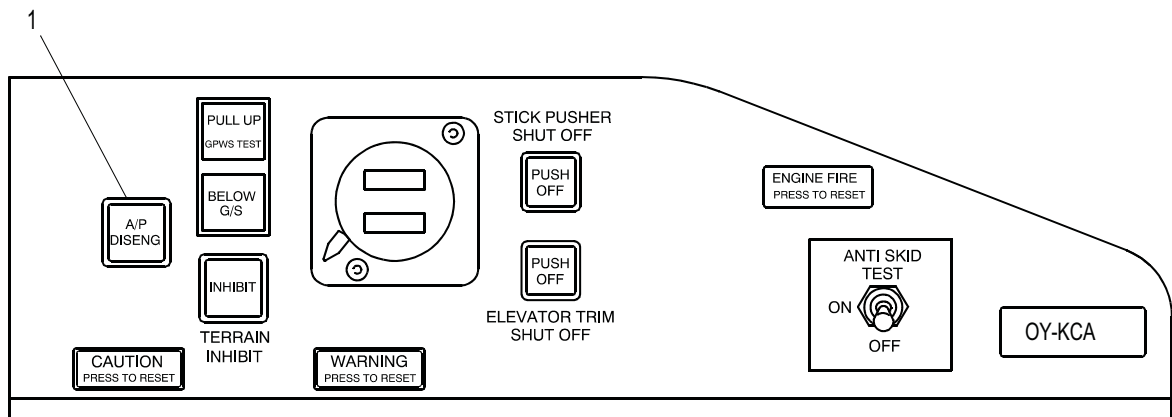
- PUSH** (either button) - the AP disengages, and the FD vertical mode transitions to Go Around mode, which commands a fixed pitch angle of 10 degrees
- the FD lateral mode transitions to the Wings Level submode, which commands zero roll attitude
 - all FD armed modes are disarmed
 - WING LVL and GA are displayed on the PFD

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NOTE

Right Side Shown.
Left Side Similar.



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Figure 12.3-12 Autopilot Disconnect Switchlight

GLARESHIELD CALLOUTS PERTAINING TO AUTOFLIGHT

1. AUTOPILOT DISCONNECT LIGHTS (momentary action, flashing red)

A/P DISENG segment (flashing red) - indicates automatic autopilot disengagement

- the A/P Diseng lights flash until acknowledged by the flight crew
- the A/P Diseng lights are not lit for a manual AP disengagement
- both A/P Diseng lights are lit if the A/P disengagement was caused by a failure of one of the two FGM power sources
- automatic autopilot disengagement is also annunciated by flashing an amber AP DISENGAGED (or AP/YD DISENGAGED) message on the PFD
- the PFD message also flashes until A/P DIS on either Control Column is pushed then remains steady for 5 seconds

12.3.4 Description

The Automatic Flight Control System consists of the following:

- 1 Flight Guidance Control Panel (FGCP)
- 2 Flight Guidance Modules (FGM)
- 1 Yaw Damper Actuator Unit (YDAU)
- 2 Autopilot Actuator Units (APAU)

In addition, the following other cockpit switches and annunciators are dedicated for the AFCS:

- 2 Autopilot Control Wheel Quick Disconnect Switches
- 2 Tactile Control Steering (TCS) Switches
- 2 Go Around (GA) Switches
- 2 Autopilot Disengage Warning Lights

The core of the AFCS are the two independent, but identical Flight Guidance computation channels, each consisting of a Flight Guidance Module.

The Flight Guidance Control Panel provides for selection of the FD modes and targets, the navigation source for the FD, and engagement of the AP and YD.

The Flight Guidance Modules perform all the necessary data processing for the FD commands, the commands to the AP and YD actuators, and the commands to the pitch trim system. Each FGM can independently process FD commands. Both FGMs are required to perform the AP and YD functions. FGM1 provides the actual commands to the AP and YD actuators, while FGM2 monitors the commands and the performance of the AP and YD actuators.

12.3.5 System Operation

The operation of the Automatic Flight Control System includes the FD, AP, Automatic Pitch Trim, Roll Mistrim Annunciation, YD, Flight Guidance Control and Flight Mode Annunciation functions.

Engagement of the YD is inhibited when the aircraft roll attitude exceeds ± 45 degrees. Engagement of the AP is inhibited when the aircraft roll attitude exceeds ± 45 degrees, or the aircraft pitch attitude exceeds ± 20 degrees. Engaging the AP also engages the YD, but the YD may be engaged without the AP.

12.3.6 Flight Director

The Flight Director (FD) provides aircraft lateral and vertical guidance which is:

- Displayed on the PFDs for the pilot to manually control the aircraft.
- Coupled to the Autopilot for automatic control of the aircraft.

12.3.6.1 Flight Director General Operation

Normally, FGM#1 is master and FGM#2 is slave. If FGM#1 fails, FGM#2 automatically becomes master. Whenever at least one FGM is able to perform the FD function, the pilots are able to select lateral and vertical guidance modes.

Only the FD commands from FGM#1 are coupled to the Autopilot. However, if either FGM fails, the Autopilot disengages and is inhibited from being engaged again.

The PFDs display the message L (or R) FD FAIL to indicate an FGM failure that has disabled the FD. If both FDs are disabled due to failure of both FGMs, the PFDs display the message AFCS FAIL.

Since either FGM can independently provide the FD function, both FGMs process:

- FD mode selections
- FD command computations for display
- Sensor selection and monitoring

12.3.6.2 Flight Director Mode Selections

FD mode selections are performed using inputs from the Flight Guidance Control Panel and the Go Around mode switches. Both FGMs receive inputs from the FGCP and the GA switches.

The FD modes include both active and armed modes. An active FD mode provides guidance for display on the PFD, and for coupling to the Autopilot. An armed FD mode is waiting for necessary conditions to be satisfied, at which point it will automatically transition to an active mode, replacing the previous active mode for that axis.

12.3.6.3 Flight Director Display

Both FGMs send to the displays the following:

- Pitch and roll commands for display as the Flight Director bars on the PFD
- Pitch and roll active and armed modes for display in the Flight Mode Annunciator (FMA) area on the PFD
- AFCS messages for display in the FMA area on the PFD

When not in DualFD mode (for ILS approaches), both PFDs display the Flight Director command bars and mode annunciations from the master FGM. Therefore, if both FGMs are healthy, FD data from FGM#1 is displayed on both PFDs. FD data from FGM#2 is displayed on both PFDs only if FGM#1 is failed.

In Dual FD mode, PFD#1 displays Flight Director command bars and mode annunciations from FGM#1, and PFD#2 displays Flight Director command bars and mode annunciations from FGM#2.

The FD commands are displayed in a cross bar pointer format on the PFD.

12.3.6.4 Flight Director Source Selection

The FGMs use the data displayed on either PFD for processing FD guidance commands. FGM #1 and FGM#2 process FD commands using the same sensors, except in Dual FD mode. In Dual FD mode, FGM#1 uses the #1 side sensors, and FGM#2 uses the #2 side sensors.

When not in DualFD mode, both FGMs select the same side data as the PFD selection of sensors for the FD. The PFD selection is selected by the HSI SEL pushbutton and NAV SOURCE selection switches located on the FGCP, and the EFIS ATT/HDG SOURCE and EFIS ADC SOURCE reversion switches located on the ESCP.

The PFD selection applies to the selection of the following:

- ADC sensors
- AHRS sensors
- NAV sources
- CRS targets
- HDG targets

A detected failure of a sensor input required in the processing of an armed or active FD mode automatically clears the FD mode, with an appropriate message displayed on the PFD. If the flight crew attempt to select a mode that requires sensor data that is not valid, a mode transition will not occur, and a message will be displayed on the PFD.

Except in DualFD mode, a mismatch between sensors detected by the FGM does not clear the FD mode, since both FGMs still use the selected side information. In DualFD mode, a mismatch between ILS sensors detected by the FGM automatically clears DualFD mode. Both FG Modules process FD commands with only one AHRS valid or only one ADC valid, but DualFD mode requires two valid AHRS and two valid ADCs.

12.3.6.5 Flight Director Modes

1. Lateral Basic Mode

The Lateral Basic mode consists of three submodes:

- Roll Hold submode (ROLL HOLD)
- Wings Level submode (WING LVL)
- Heading Hold submode (HDGHOLD)

In the Roll Hold submode, the FD commands to hold the target roll attitude, which is equivalent to the bank angle that existed at mode engagement, or when the TCS switch was released with the bank angle greater than 6 degrees. The roll attitude target domain is limited to ± 45 degrees.

In the Wings Level submode, the FD commands to hold a zero degree bank angle.

In the Heading Hold submode, the FD commands to hold the target heading, which is equivalent to the heading that existed at engagement of the Heading Hold submode. The FD commands are limited to ± 13 degrees of roll attitude in the Heading Hold submode.

The Lateral Basic mode is activated if the AP or a vertical FD mode is engaged when no lateral mode is active. The Lateral Basic mode is also activated in the Wings Level submode when Go Around is selected.

Except for when Go Around is selected, at Lateral Basic mode activation a lateral basic submode is selected as follows:

- The Roll Hold submode is selected if the roll angle is greater than 6° .
- The Wings Level submode is selected if the roll angle is less than 6° .

If the flight crew operate the TCS switch when the Lateral Basic mode is active, the above logic also applies when the TCS switch is released.

The Lateral Basic mode submode automatically transitions from the Roll Hold submode to the Wings Level submode when the bank angle is less than 6 degrees. Except when Go Around is active, the Lateral Basic mode submode automatically transitions from the Wings Level submode to the HDG Hold submode when the bank angle is less than 3 degrees for 10 seconds.

When Go Around mode is active, the Lateral Basic mode submode does not automatically transition to the Heading Hold submode, but instead remains Wings Level until another lateral mode is selected, or until TCS is operated and released with the roll angle greater than 6 degrees.

The Lateral Basic mode is deactivated by:

- Activating any other lateral mode (manual selection or automatic capture of a lateral mode).
- Disengaging the AP when the Pitch Hold mode is active.
- A STBY or HSI SEL selection if the AP is not engaged.
- If the selected ADC or AHRS source is changed and the AP is not engaged.

The Lateral Basic mode is deactivated and inhibited from activation by:

- A failure of CAS or TAS data from the selected ADC. (This disengages the FD).
- A failure of attitude data from the selected AHRS. (This disengages the FD).

The Heading Hold submode is deactivated and inhibited from activation by a failure of heading data from the selected AHRS.

2. Heading Select Mode

The Heading Select mode acquires and holds a heading target which is selected on the FGCP. There are two Heading (HDG) knobs on the FGCP which the flight crew use to set the Selected Heading target. The FD uses either the left or right heading target, as determined by the HSI SEL pushbutton selection.

In the Heading Select mode, the FD commands are limited to ± 24 degrees of roll attitude, and rate limited to ± 4 degrees/second of roll rate.

The Heading Select mode is activated:

- When HDG is selected on the FGCP.
- When NAV or APPR or BC is selected on the FGCP to arm a VOR, Localizer, Back Course Localizer, or Azimuth mode.

The Heading Select mode is deactivated by:

- Deselecting HDG on the FGCP.
- Activating any other lateral mode (manual selection or automatic capture of a lateral mode).
- A STBY or HSI SEL selection.
- If the selected ADC or AHRS source is changed.

The Heading Select mode is deactivated and inhibited from activation by:

- A failure of heading data from the selected AHRS.
- A failure of the Selected Heading target from the FGCP.
- A failure of CAS or TAS data from the selected ADC. (This disengages the FD).
- A failure of attitude data from the selected AHRS. (This disengages the FD).

3. VOR Mode

The VOR mode acquires and holds a VOR radial. The VOR mode consists of the following sub-modes:

- VOR Arm
- VOR Capture
- VOR Track
- VOR Overstation

Transitioning between these submodes is performed automatically by the FD.

The flight crew use the VOR mode operationally as follows:

- Select a VOR/LOC Receiver as the navigation source.
- Tune a VOR frequency.
- Select a course on the FGCP corresponding to the desired VOR radial.
- Select the intercept heading target on the FGCP.
- Press the NAV pushbutton on the FGCP to arm the mode.

This automatically arms the VOR mode and engages the Heading Select mode. The FD then automatically transitions to VOR Capture mode from VOR Arm when the aircraft intercepts the desired VOR radial. The FD automatically transitions to VOR Track mode from VOR Capture when the aircraft has turned on to the desired VOR radial.

When the aircraft approaches a VOR station it will enter into a “zone of confusion” where the VOR deviation signal is very noisy. When this occurs, the FD automatically transitions to the VOR Overstation mode. In the VOR Overstation mode, the FD does not use the VOR deviation signal, but instead commands the aircraft to a heading equivalent to the Selected Course. When the aircraft departs the zone of confusion, the VOR deviation signal will again become clear of noise, and the FD automatically transitions to the VOR Capture mode to capture the desired VOR radial.

When the VOR Overstation mode is active, the flight crew can change the Selected Course without exiting VOR Overstation mode. Course changes in VOR Overstation mode should be limited to a maximum of 30 degrees to ensure adequate performance.

The maximum intercept for a VOR capture should be ± 90 degrees, but the performance may be degraded for course cuts greater than ± 45 degrees at capture. In VOR Capture and VOR Track, the FD commands are limited to ± 24 degrees roll attitude, and rate limited to ± 4 degrees/second of roll rate. In the VOR Overstation mode, the FD commands are limited to ± 30 degrees of roll attitude. The performance following a Selected Course change of greater than ± 30 degrees in the VOR Overstation mode may be degraded.

The VOR mode is armed by Selecting NAV on the FGCP.

The VOR mode is disarmed by:

- Deselecting NAV on the FGCP.
- Selecting APPR on the FGCP (arms VOR Approach mode).
- Transition to VOR Capture mode.
- Changing the Selected Nav Source (on the selected side).
- Selection of Go Around mode.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.
- Changing the VOR/LOC Receiver frequency to a LOC frequency.

The VOR mode is deactivated by:

- Deselecting NAV on the FGCP.
- Selecting APPR on the FGCP (activates VOR Approach mode).
- Activating any other lateral mode.
- Selecting Go Around.
- Changing the Selected Nav Source (on the selected side).
- Changing the VOR/LOC Receiver frequency to a LOC frequency.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

The VOR mode is disarmed, deactivated, and inhibited from arming by:

- A failure of VOR data from the selected VOR/LOC Receiver for 30 secs.
- A failure of the Selected Course from the FGCP.
- A failure of heading data from the selected AHRS.
- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of attitude data from the selected AHRS (this disengages the FD).

4. VOR Approach Mode

The VOR Approach mode is similar to the VOR mode, but is intended to be used in the approach flight phase. The VOR Approach mode acquires and holds a VOR radial. The VOR Approach mode consists of the following submodes:

- VOR Approach Arm
- VOR Approach Capture
- VOR Approach Track
- VOR Approach Overstation

Transitioning between these submodes is performed automatically by the FD.

The flight crew use the VOR Approach mode operationally as follows:

- Select a VOR/LOC Receiver as the navigation source.
- Tune a VOR frequency.
- Select a course on the FGCP corresponding to the desired VOR radial.
- Select the intercept heading target on the FGCP.
- Press the APPR pushbutton on the FGCP to arm the mode.

This automatically arms the VOR Approach mode and engages the Heading Select mode. The FD then automatically transitions to VOR Approach Capture mode from VOR Approach Arm when the aircraft intercepts the desired VOR radial. The FD automatically transitions to VOR Approach Track mode from VOR Approach Capture when the aircraft has turned on to the desired VOR radial.

When the aircraft approaches a VOR station it will enter into a “zone of confusion” where the VOR deviation signal is very noisy. When this occurs, the FD automatically transitions to the VOR Approach Overstation mode. In the VOR Approach Overstation mode, the FD does not use the VOR deviation signal, but instead commands the aircraft to a heading equivalent to the Selected Course. When the aircraft departs the zone of confusion, the VOR deviation signal will again become clear of noise, and the FD automatically transitions to the VOR Approach Capture mode to capture the desired VOR radial.

When the VOR Approach Overstation mode is active, the flight crew can change the Selected Course without exiting VOR Approach Overstation mode. Course changes in VOR Approach Overstation mode should be limited to a maximum of 30 degrees to ensure adequate performance.

The maximum intercept for a VOR capture should be ± 90 degrees, but the performance may be degraded for course cuts greater than ± 45 degrees at capture. In VOR Approach Capture, the FD commands are limited to ± 30 degrees roll attitude, and rate limited to ± 7 degrees/second of roll rate. In VOR Approach Track, the FD commands are further limited to 27° roll attitude, and rate limited to ± 5.5 degrees/second of roll rate. In the VOR Approach Overstation mode, the FD commands are limited to ± 30 degrees of roll attitude. The performance following a Selected Course change of greater than ± 30 degrees in the VOR Approach Overstation mode may be degraded.

The VOR Approach mode is armed by selecting APPR on the FGCP.

The VOR Approach mode is disarmed by:

- Deselecting APPR on the FGCP.
- Selecting NAV on the FGCP (arms VOR mode).
- Transition to VOR Approach Capture mode.
- Changing the Selected Nav Source (on the selected side).
- Selection of Go Around mode.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.
- Changing the VOR/LOC Receiver frequency to a LOC frequency.

The VOR Approach mode is deactivated by:

- Deselecting APPR on the FGCP.
- Selecting NAV on the FGCP (activates VOR mode).
- Activating any other lateral mode.
- Changing the Selected Nav Source (on the selected side)
- Changing the VOR/LOC Receiver frequency.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

The VOR Approach mode is disarmed, deactivated, and inhibited from arming by:

- A failure of VOR data from the selected VOR/LOC Receiver for 5 seconds.
- A failure of the Selected Course from the FGCP.
- A failure of heading data from the selected AHRS.
- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of attitude data from the selected AHRS (this disengages the FD).

5. Localizer Mode

The Localizer mode acquires and tracks an ILS localizer beam. The Localizer mode consists of the following submodes:

- Localizer Arm
- Localizer Capture
- Localizer Track

Transitioning between these submodes is performed automatically by the FD.

The flight crew uses the Localizer mode operationally as follows:

- Select a VOR/LOC Receiver as the navigation source.
- Tune a Localizer frequency.
- Select a course on the FGCP corresponding to the desired runway.
- Select the intercept heading target on the FGCP.
- Press the NAV pushbutton on the FGCP to arm the mode.

This automatically arms the Localizer mode and engages the Heading Select mode. (The Localizer mode also arms if the flight crew select APPR on the FGCP.) The FD automatically transitions to Localizer Capture mode from Localizer Arm when the aircraft intercepts the desired ILS localizer beam. The FD automatically transitions to Localizer Track mode from Localizer Capture when the aircraft has turned on to the localizer beam.

The maximum intercept selected by the flight crew for a localizer capture should be ± 90 degrees. The FD commands are limited to ± 30 degrees roll attitude in Localizer Capture and ± 24 degrees roll attitude in Localizer Track. The FD commands are rate limited to ± 7 degrees/second of roll rate in Localizer Capture and ± 5.5 degrees/second of roll rate in Localizer Track.

The Localizer mode is armed by:

- Selecting NAV on the FGCP.
- Selecting APPR on the FGCP.

The Localizer mode is disarmed by:

- Deselecting NAV on the FGCP.
- Deselecting APPR on the FGCP after Glideslope mode is armed.
- Selecting BC on the FGCP.
- Transition to Localizer Capture mode.
- Changing the Selected Nav Source (on the selected side).
- Selection of Go Around mode.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.
- Changing the VOR/LOC Receiver frequency to a VOR frequency.

The Localizer mode is deactivated by:

- Deselecting NAV on the FGCP.
- Deselecting APPR on the FGCP after Glideslope mode is armed or captured.
- Selecting any other lateral mode.
- Changing the Selected Nav Source (on the selected side).
- Changing the VOR/LOC Receiver frequency
- Selecting STBY.
- Selecting HSI SEL when the DualFD submode is not active.
- Changing the selected ADC or AHRS source.

The Localizer mode is disarmed, deactivated, and inhibited from arming by:

- A failure of Localizer data from the selected VOR/LOC Receiver for 5 secs.
- A failure of the Selected Course from the FGCP, except for Localizer Track mode.
- A failure of heading data from the selected AHRS, except for Localizer Track mode.
- A failure of CAS or TAS data from the selected ADC. (This disengages the FD).
- A failure of attitude data from the selected AHRS. (This disengages the FD).

6. Back Course Localizer Mode

The Back Course Localizer mode acquires and tracks an ILS back course localizer beam. The Back Course Localizer mode consists of the following submodes:

- Back Course Localizer Arm
- Back Course Localizer Capture
- Back Course Localizer Track

Transitioning between these submodes is performed automatically by the FD.

The flight crew use the Back Course Localizer mode operationally as follows:

- Select a VOR/LOC Receiver as the navigation source.
- Tune a Localizer frequency.
- Select a front course on the FGCP corresponding to the desired runway.
- Select the intercept heading target on the FGCP.
- Press the BC pushbutton on the FGCP to arm the mode.

This automatically arms the Back Course Localizer mode and engages the Heading Select mode. The FD automatically transitions to Back Course Localizer Capture mode from Back Course Localizer Arm when the aircraft intercepts the desired ILS localizer beam. The FD automatically transitions to Back Course Localizer Track mode from Back Course Localizer Capture when the aircraft has turned on to the localizer beam.

The maximum intercept angle selected by the crew for a localizer capture should be ± 90 degrees. The FD commands are limited to ± 30 degrees roll attitude in Back Course Localizer Capture and ± 24 degrees roll attitude in Back Course Localizer Track. The FD commands are rate limited to ± 7 degrees/second of roll rate in Back Course Localizer Capture and ± 5.5 degrees/second of roll rate in Back Course Localizer Track.

The Back Course Localizer mode is armed by:

- Selecting BC on the FGCP.

The Back Course Localizer mode is disarmed by:

- Deselecting BC on the FGCP.
- Selecting NAV or APPR on the FGCP.
- Transition to Back Course Localizer Capture mode.
- Changing the Selected Nav Source (on the selected side).
- Selection of Go Around mode.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.
- Changing the VOR/LOC Receiver frequency to a VOR frequency.

The Back Course Localizer mode is deactivated by:

- Deselecting BC on the FGCP.
- Selecting any other lateral mode.
- Changing the Selected Nav Source (on the selected side).
- Changing the VOR/LOC Receiver frequency
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

The Back Course Localizer mode is disarmed, deactivated, and inhibited from arming by:

- A failure of Localizer data from the selected VOR/LOC Receiver for 5 seconds.
- A failure of the Selected Course from the FGCP (except for Back Course Localizer Track mode).
- A failure of heading data from the selected AHRS (except for Back Course Localizer Track mode).
- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of attitude data from the selected AHRS (this disengages the FD).

7. FMS LNAV Mode

The LNAV mode acquires and holds a lateral flight path computed by the FMS.

The flight crew use the LNAV mode operationally as follows:

- Select FMS as the navigation source.
- Activate a lateral flight plan.
- Press the NAV pushbutton on the FGCP to activate the LNAV mode.

The FMS continuously transmits a roll steering command to the AFCS. If the FMS roll steering command is valid, then the LNAV mode can be engaged, otherwise engagement is inhibited. There is no arm logic or capture phase for the LNAV mode. The FMS commands the aircraft to intercept the desired flight path when LNAV is initially engaged.

In the LNAV mode, the FD commands to track the roll steering command from the FMS, which is equivalent to a roll attitude command. The FD commands are limited to ± 30 degrees of roll attitude, and rate limited to ± 4 degrees/second of roll rate.

The LNAV mode is deactivated by:

- Deselecting NAV on the FGCP.
- Activating any other lateral mode.
- Changing the Selected Nav Source (on the selected side).
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

The LNAV mode shall be deactivated, and inhibited from activating by:

- An invalid roll steering command from the selected FMS.
- A failure of the FGCP.
- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of attitude data from the selected AHRS (this disengages the FD).

8. Vertical Basic (Pitch Hold) Mode

In the Pitch Hold mode, the FD commands to hold a pitch attitude target. The pitch attitude target is initially set to the aircraft pitch attitude that exists when the Pitch Hold mode is activated. The pitch attitude target can then be modified by manual rotation of the Pitch thumbwheel located on the FGCP. The pitch attitude target can also be modified using the Tactile Control Steering function. The pitch attitude target is set to the aircraft pitch attitude that exists when the TCS switch is released.

In the Pitch Hold mode, the FD target pitch attitude is limited to ± 20 degrees. The FD commands are further limited to a maximum aircraft normal acceleration of ± 0.2 g.

The Pitch Hold mode is activated:

- If the AP is engaged when no vertical mode is active.
- When an active vertical mode is de-selected by the crew.
- When the Pitch thumbwheel is operated and the active vertical mode is not Vertical Speed or Indicated Airspeed or Go Around.
- When another active vertical mode fails.
- When a lateral mode is activated and no vertical mode is active.
- At STBY or HSI SEL selection if the AP is engaged.
- If the selected ADC or AHRS source is changed and the AP is engaged.

The Pitch Hold mode is deactivated by:

- Activating any other vertical mode (manual selection or automatic capture of a vertical mode)
- Disengaging the AP when the lateral mode is the Lateral Basic mode (this disengages the FD).
- At STBY or HSI SEL selection if the AP is not engaged.
- If the selected ADC or AHRS source is changed and the AP is not engaged.

The Pitch Hold mode is deactivated and inhibited from activation by:

- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of attitude data from the selected AHRS (this disengages the FD).

9. Altitude Select Mode

In the Altitude Select mode, the FD commands to acquire and hold a Selected Altitude target. The Altitude Select mode consists of the following submodes:

- Altitude Select Arm
- Altitude Capture

The flight crew uses the Altitude Select mode operationally as follows:

- Preselect an altitude target using the FGCP ALT knob.
- Press the ALT SEL pushbutton on the FGCP to arm the mode
- Manoeuvre the aircraft towards the preselected altitude target. This may be performed using a different FD vertical mode.

This automatically arms the Altitude Select mode. When the aircraft baro corrected altitude approaches the Selected Altitude target, the FD automatically transitions to the Altitude Capture mode. When the Selected Altitude target has been captured, the FD automatically transitions to the Altitude Hold mode.

The domain of the Selected Altitude is 0 to 27,000 feet. In the Altitude Capture mode, the FD commands are limited to ± 20 degrees of pitch attitude, and the altitude capture manoeuvre is limited to ± 0.1 g.

The Altitude Select mode is armed by:

- Selecting ALT SEL on the FGCP.
- Changing the Selected Altitude when the vertical mode is Altitude Capture.

The Altitude Select mode is disarmed by:

- Deselecting ALT SEL on the FGCP.
- Transitioning to Altitude Capture mode.
- Transitioning to Altitude Hold mode.
- Transitioning to Glideslope Capture or Elevation Capture mode.
- Selection of Go Around mode.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

The Altitude Capture mode is deactivated by:

- Deselecting ALT SEL on the FGCP.
- Transitioning to Altitude Hold mode.
- Activating any other vertical mode.
- Changing the Selected Altitude (re-arms Altitude Select).
- Operating the Pitch Thumbwheel.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

The Altitude Select mode is disarmed, deactivated, and inhibited from arming by:

- A failure of altitude data from the selected ADC.
- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of the Vertical Speed data from the selected AHRS.
- A failure of the attitude data from the selected AHRS (this disengages the FD).
- A failure of the Selected Altitude from the FGCP.

10. Altitude Hold Mode

In the Altitude Hold mode, the FD commands to hold an altitude target.

The flight crew use the Altitude Hold mode operationally in the following ways:

- Set up an automatic altitude capture using the Altitude Select mode.
- Press the ALT pushbutton on the FGCP to activate the mode directly.

If the Altitude Hold mode is activated using the Altitude Select mode, then the altitude target is set to the aircraft baro corrected altitude equivalent to the Selected Altitude. If the flight crew changes the baro correction during Altitude Capture mode, the altitude captured and held will be the baro corrected altitude equivalent to the Selected Altitude, adjusted for the baro correction change. If the Altitude Hold mode is activated using the ALT push button on the FGCP, the altitude target is set to the aircraft baro corrected altitude that exists at the time of the activation, rounded to the nearest 100 feet.

If the flight crew changes the baro correction during Altitude Hold mode, the FD commands to maintain the baro corrected altitude, adjusted for the baro correction change. The altitude held can be modified by activating the Tactile Control Steering function. The Altitude hold target is set to the aircraft baro corrected altitude that exists at the time the TCS switch is released, rounded to the nearest 100 feet.

The domain of the Altitude Hold mode ranges from 0 to 27000 feet. Outside of this domain, Altitude Hold mode is inhibited. The FD commands are limited to ± 20 degrees of pitch attitude, and the altitude capture manoeuvre is limited to ± 0.1 g.

The Altitude Hold mode is deactivated by:

- Deselecting ALT on the FGCP.
- Transitioning to VNAV, Glideslope Capture, or Elevation Capture mode.
- Activating any other vertical mode.
- Operating the Pitch Thumbwheel.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

Note: With V800 upgrade: To de-select altitude mode, press and hold the ALT SEL pushbutton for greater than one second.

The Altitude Hold mode is deactivated, and inhibited from activation by:

- A failure of altitude data from the selected ADC.
- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of the Vertical Speed data from the selected AHRS.
- A failure of attitude data from the selected AHRS (this disengages the FD).

11. Indicated Airspeed Mode

In the Indicated Air Speed mode, the FD commands to hold an IAS target. The IAS target is initially set to the aircraft indicated airspeed that exists when the IAS mode is activated. The IAS target can then be modified by manual rotation of the Pitch thumbwheel located on the FGCP. The IAS target can also be modified using the Tactile Control Steering function. The IAS target is set to the aircraft indicated airspeed that exists when the TCS switch is released, rounded to the nearest knot.

The IAS target is limited to integer values ranging from 95 to 290 knots. Outside of this domain, the Indicated Airspeed mode is inhibited. The speed target is always less than Vmo. Thus when Vmo is decreasing, the maximum speed target is decreased automatically by the FD to avoid an overspeed condition. The FD commands are limited to ± 20 degrees of pitch attitude, and ± 0.1 g.

The IAS mode is activated by:

- Selecting IAS on the FGCP.

The IAS mode is deactivated by:

- Deselecting IAS on the FGCP.
- Activating any other vertical mode (manual selection or automatic capture of a vertical mode).
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

The IAS mode is deactivated and inhibited from activation by:

- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of Vmo data from the selected ADC.
- A failure of attitude data from the selected AHRS (this disengages the FD).
- An FGCP failure.

12. Vertical Speed Mode

In the Vertical Speed mode, the FD commands to hold a vertical speed target. The vertical speed target is initially set to the aircraft vertical speed that exists when the Vertical Speed mode is activated, rounded to the nearest 100 feet/minute. The vertical speed target can then be modified by manual rotation of the Pitch thumbwheel located on the FGCP. The vertical speed target can also be modified using the Tactile Control Steering function. The vertical speed target is set to the aircraft vertical speed that exists when the TCS switch is released.

The domain of the Vertical Speed mode ranges from - 6000 feet/minute to + 6000 feet/minute. Out-side of this domain, the Vertical Speed mode is inhibited. The FD commands are limited to ± 20 degrees of pitch attitude, and ± 0.1 g.

The Vertical Speed mode is activated by:

- Selecting VS on the FGCP.

The Vertical Speed mode is deactivated by:

- Deselecting VS on the FGCP.
- Activating any other vertical mode (manual selection or automatic capture of a vertical mode).
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

The Vertical Speed mode is deactivated and inhibited from activation by:

- A failure of inertial vertical speed data from the selected AHRS.
- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of attitude data from the selected AHRS (this disengages the FD).
- An FGCP failure.

13. FMS VNAV Mode

The VNAV mode is only active when the LNAV mode is also active. The VNAV mode acquires and holds a vertical flight path computed by the FMS. The VNAV mode has two submodes:

- VNAV Armed
- VNAV active

The flight crew use the VNAV mode operationally as follows:

- Select FMS as the navigation source.
- Activate a lateral and vertical flight plan.
- Press the NAV pushbutton on the FGCP to activate the LNAV mode.
- Press the VNAV pushbutton on the FGCP to arm the VNAV mode.

This engages the LNAV mode and arms the VNAV mode. The active vertical mode at the time VNAV is pressed remains active. The FMS continuously transmits a pitch steering command to the AFCS. The pitch steering command contains a bit which indicates if the VNAV mode may be armed. The FD does not arm VNAV mode unless this bit is set. The FD automatically activates VNAV mode from VNAV Arm when the pitch steering command label is valid, indicating that the VNAV mode may be activated.

In the VNAV mode, the FD commands to track a pitch steering command from the FMS, which is equivalent to a pitch attitude command. The FD commands are limited to ± 20 degrees of pitch attitude, and a maximum aircraft normal acceleration of ± 0.2 g.

The VNAV mode is disarmed by:

- Deselecting NAV or VNAV on the FGCP.
- Activating a lateral mode other than LNAV.
- Selecting Go Around.
- VNAV activating.
- Changing the Selected Nav Source (on the selected side).
- FMS indicating the VNAV mode may not be armed.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

The VNAV mode is deactivated by:

- Deselecting NAV or VNAV on the FGCP.
- Operating the Pitch Thumbwheel.
- Activating any other vertical mode, either manually or automatically.
- Selecting Heading mode.
- Changing the Selected Nav Source (on the selected side).
- FMS invalidating the VNAV pitch steering command label.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

The VNAV mode is dearmed, deactivated, and inhibited from arming by:

- A failure of the selected FMS.
- A failure of the FGCP.
- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of attitude data from the selected AHRS (this disengages the FD).

14. Go Around Mode

The Go Around mode is normally used to transition from an approach to a climbout for a missed approach, but can be selected at any time.

The flight crew select Go Around mode by pressing either of the two Go Around switches located on the power levers. When Go Around is selected, the following occurs:

- The AP disengages.
- The FD vertical mode transitions to Go Around mode, which commands a fixed pitch angle of 10 degrees.
- The FD lateral mode transitions to the Wings Level submode, which commands zero roll attitude.
- All FD armed modes are disarmed.

The Go Around mode is deactivated by:

- Activating any other vertical mode, either manually or automatically.
- Engaging the AP.
- Selecting STBY or HSI SEL.
- Changing the selected ADC or AHRS source.

Selecting a lateral FD mode other than Wings Level does not deactivate Go Around.

Selecting TCS in Go Around mode does not modify the Go Around pitch target, and does not deactivate Go Around mode. Upon TCS release, the FD lateral mode may transition from the Wings Level submode to the Roll Hold submode of the Lateral Basic mode, depending upon the aircraft bank angle.

The Go Around mode is deactivated and inhibited from activation by:

- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of attitude data from the selected AHRS (this disengages the FD).

15. ILS Approach Mode

The ILS Approach mode is a combined lateral and vertical mode used to perform precision Cat I and Cat II ILS Approaches. The ILS Approach mode captures and tracks ILS localizer and glideslope beams. The ILS Approach mode consists of the following submodes:

- Localizer Arm
- Localizer Capture
- Localizer Track
- Glideslope Arm
- Glideslope Capture
- Glideslope Track

Transitioning between these submodes is performed automatically by the FD. Transitioning from Glideslope Arm to Glideslope Capture is inhibited until the lateral mode has transitioned to Localizer Capture or Localizer Track.

The flight crew use the ILS Approach mode operationally as follows:

- Select a VOR/LOC Receiver as the navigation source.
- Tune a Localizer frequency (the VOR/LOC Receiver automatically tunes the corresponding Glideslope frequency).
- Select a course on the FGCP corresponding to the desired runway.
- Select the intercept heading target on the FGCP.
- Press the APPR pushbutton on the FGCP to arm the mode.

This automatically arms the Localizer mode, engages the Heading Select mode, and arms the Glideslope mode. The active vertical mode at the time APPR is pressed remains active. If no vertical mode was active, then Pitch Hold is activated.

The Localizer mode can also be armed using the NAV switch on the FGCP. If the flight crew first select NAV to arm the Localizer mode, then a subsequent selection of APPR automatically arms the Glideslope mode.

The FD Localizer Arm, Localizer Capture, and Localizer Track modes are described earlier in this chapter.

The FD automatically transitions to Glideslope Capture mode from Glideslope Arm when the aircraft intercepts the desired ILS glideslope beam and the lateral mode has transitioned to Localizer Capture or Localizer Track. The FD automatically transitions to Glideslope Track mode from Glideslope Capture when the aircraft has pitched onto the glideslope beam.

The FD commands are limited to +10/-15 degrees pitch attitude in Glideslope Capture and Glideslope Track. The FD commands are load factor limited to ± 0.2 g in Glideslope Capture, and ± 0.1 g in Glideslope Track.

The Glideslope mode is armed by:

- Selecting APPR on the FGCP.

The Glideslope mode is disarmed by:

- Localizer mode is disarmed and Localizer Capture is not activated.
- Localizer Capture mode is deactivated, except when transitioning to Localizer Track.
- Localizer Track mode is deactivated.
- Transition to Glideslope Capture mode.

The Glideslope mode is deactivated by:

- Localizer Capture mode is deactivated, except when transitioning to Localizer Track.
- Localizer Track mode is deactivated.
- Operating the Pitch Thumbwheel.
- Activating any other vertical mode.

The Glideslope modes are disarmed, deactivated, and inhibited from arming by:

- A failure of CAS or TAS data from the selected ADC (this disengages the FD).
- A failure of attitude data from the selected AHRS (this disengages the FD).
- A failure of the Vertical Speed data from the selected AHRS.
- A failure of Glideslope data from the selected VOR/LOC Receiver for 5 seconds.

16. Dual FD Mode

The Dual FD mode is a submode of the ILS Approach mode which indicates to the flight crew that the AFCS is in a configuration valid for Category II ILS approaches. In the Dual FD submode, both FGMs independently display FD commands on the PFDs, with FGM#1 providing the FD commands for the left PFD, and FGM#2 providing FD commands for the right PFD.

In the Dual FD mode, FGM#1 uses Localizer and Glideslope deviations from the left VOR/LOC Receiver, air data from ADC#1, attitude and Vertical Speed data from AHRS#1, and left course data from the FGCP. FGM#2 uses Localizer and Glideslope deviations from the right VOR/LOC Receiver, air data from ADC#2, attitude and Vertical Speed data from AHRS#2, and right course data from the FGCP.

The flight crew use the Dual FD submode in conjunction with the ILS Approach mode operationally as follows:

- Set the EFIS ADC Source Selection switch to the NORM position.
- Set the EFIS ATT/HDG Source Selection switch to the NORM position.
- Select the VOR/LOC Receiver #1 as the left navigation source.
- Select the VOR/LOC Receiver #2 as the right navigation source.
- Tune both #1 and #2 VOR/LOC Receivers to the same Localizer frequency.
- Select both left and right courses on the FGCP to the desired runway.
- Select the intercept heading target on the FGCP.
- Press the APPR pushbutton on the FGCP to arm the mode.
- Set the left and right Decision Height on the ICP.

This automatically arms the ILS Approach mode, as described earlier.

The Dual FD submode is activated if:

- Both FGMs are available.
- Both AHRS are valid for both FGMs.
- The EFIS ATT/HDG Source Selection switch is set to the NORM position.
- Both ADCs are valid for both FGMs.
- The EFIS ADC Source Selection switch is set to the NORM position.
- ILS data from both VOR/LOC Receivers is valid and agree for both FGMs.
- The VOR/LOC Receiver #1 is the selected left Nav Source Selection.
- The VOR/LOC Receiver #2 is the selected right Nav Source Selection.
- Both #1 and #2 VOR/LOC Receivers are tuned to the same Localizer frequency.
- Both left and right courses on the FGCP are the same.
- The lateral and vertical active modes are Localizer Track and Glideslope Track.
- The Radio Altitude is valid and below 1200 feet.
- The FGM#1 and FGM#2 Flight Director commands agree.
- TCS is not active.

The Dual FD submode is cancelled by:

- A failure of one or both FGMs.
- A failure of a parameter from either AHRS that is used by the Localizer Track or Glideslope Track modes.
- Changing the EFIS ATT/HDG Source Selection to the '1' OR '2' position.
- A failure of a parameter from either ADC that is used by the Localizer Track or Glideslope Track modes.
- Changing the EFIS ADC Source Selection to the '1' OR '2' position.
- An ILS data failure for 5 seconds or a mismatch between the ILS data.
- Changing either left or right Nav Source Selection.
- Changing the frequency of either left or right VOR/LOC Receiver.
- Automatic or manual cancellation of Localizer Track or Glideslope Track mode.
- Invalid Radio Altitude data.
- A mismatch between the FD commands.
- Activating TCS.

When the Dual FD submode is active, a DUAL FD message is displayed in green on each PFD, and the arrows located on either side of the HSI SEL push button on the FGCP are both lit.

When the Dual FD submode is cancelled, the DUAL FD message is removed from the PFD. When the Dual FD submode is cancelled, a CAT II FAIL message is displayed if the lowest of the two selected Decision Heights is less than 200 feet, indicating a CAT II approach, or if the two Decision Heights are invalid. Otherwise, a DUAL OFF message is displayed.

If one ILS, ADC, or AHRS source fails in the Dual FD submode, the following occurs:

- Both FGMs cancel the Dual FD submode.
- The master FGM selects the remaining valid source and keeps the APPR mode engaged.
- On the FGCP, the arrow corresponding to the source still valid remains lit.

If a discrepancy between the two ILS sources occurs in the Dual FD submode, the following occurs:

- Both FGMs cancel the Dual FD submode.
- The master FGM selects the ILS source that was selected before activating the Dual FD submode and keeps the APPR mode engaged.
- On the FGCP, the arrow corresponding to the selected nav source remains lit.

17. Tactile Control Steering (TCS)

The flight crew operate the TCS mode by pressing a Tactile Control Steering switch, located on both the pilot's and copilot's control wheels. If the Autopilot is engaged, the pitch and roll AP actuators automatically declutch, and the actuator monitoring is inhibited, allowing the pilot manual control of the pitch and roll flight controls with normal control forces, and without disengaging the Autopilot.

12.3.7 Autopilot

The Autopilot (AP) couples the FD commands to the flight control surfaces using pitch and roll servos for automatic control of the aircraft flight path.

12.3.7.1 Autopilot Engagement / Disengagement

The Autopilot is engaged by pressing the AP pushbutton on the FGCP. Engaging the Autopilot also automatically engages the Yaw Damper, if not already engaged. If a failure inhibits the Yaw Damper from engaging, the Autopilot also is inhibited. If a failure causes the Yaw Damper to disengage, then the Autopilot also disengages.

The Autopilot engages when the pilot presses the AP switch on the FGCP, and all of the following conditions are met:

- AHRS 1 and AHRS 2 are valid.
- AHRS 1 and AHRS 2 do not disagree.
- ADC 1 and ADC 2 are valid.
- ADC 1 and ADC 2 do not disagree.
- The aeroplane is airborne.
- The aeroplane attitude is within the AP engagement limits.
- The Manual Pitch Trim AP Disconnect discrete is not set.
- The AP Disengage Switches are not selected.
- TCS function is not failed.
- TCS function is not active.
- The Stall Warning AP Disconnect discretess from SPM#1 and SPM#2 are not set.
- The GA switches are not selected.
- AP Disengagement Warnings are not active.
- The Yaw Damper function is available.
- Internal AFCS monitoring is valid.

The flight crew disengage the AP manually using the AP or YD pushbutton on the FGCP. The flight crew also manually disengage the AP by pressing an AP Disengage Switch, by selecting Go Around, or by operating manual pitch trim.

The Autopilot disengages when one of the following conditions is met:

- AHRS 1 or AHRS 2 is failed.
- AHRS 1 and AHRS 2 disagree.
- ADC 1 or ADC 2 is failed.
- ADC 1 and ADC 2 disagree.
- The aeroplane is not airborne.
- The crew press the AP or YD pushbutton on the FGCP (manual disengagement).
- The crew operates manual pitch trim, setting the Manual Pitch Trim AP Disconnect discrete, except if TCS is active (automatic disengagement).
- The crew manually override the AP using the control column or wheel.
- The crew press an AP Disengage Switch (manual disengagement).
- The TCS function fails.
- A Stall Warning AP Disconnect discrete from SPM#1 or SPM#2 is set.
- A GA switch is selected (manual disengagement).
- An AP actuator failure is detected.
- The Yaw Damper disengages automatically.
- Internal AFCS monitoring is failed.
- A Power interrupt greater than the transparency time occurs.
- The aeroplane attitude is outside the domain limits.

12.3.7.2 Autopilot Engagement Indication

Autopilot engagement is indicated by lighting two arrows either side of the AP pushbutton on the FGCP, and by displaying AP in green letters on the PFD.

12.3.7.3 AP INHIBIT Message

If the flight crew attempt to engage the Autopilot, but AP engagement is inhibited by a source external to the AFCS, then the message AP INHIBIT is displayed on the PFD.

AP INHIBIT is displayed when the AP engagement inhibit condition comes from one of the following sources:

- AHRS monitoring.
- ADU monitoring.
- The aircraft is not airborne.
- The aircraft attitude exceeds the AP engagement limits.
- An AP Disengage Switch is currently pressed.
- A GA switch is selected.
- TCS is active.
- The Manual Pitch Trim AP Disconnect discrete is set.
- A Stall Warning AP Disconnect discrete from SPM#1 or SPM#2 is set.
- The AP disengagement warnings are active.

12.3.7.4 AP FAIL Message

If the flight crew attempt to engage the Autopilot, but AP engagement is inhibited by an internal failure to the AFCS, then the message AP FAIL is displayed on the PFD. If the failure also inhibits engagement of the Yaw Damper, then the message displayed on the PFD is AP/YD FAIL.

12.3.7.5 Autopilot Disengagement Visual Warning

Automatic Autopilot disengagement is annunciated by the two dedicated red AP Disengage Warning lights located on the glareshield.

The flight crew acknowledge automatic Autopilot disengagement visual warnings using the AP Disengage Switches located on the two control wheels.

Manual Autopilot disengagement is annunciated by displaying an amber AP DISENGAGED (or AP/YD DISENGAGED) message on the PFD for 5 seconds. This message does not flash for manual Autopilot disengagement. This message is not cancelled by pressing an AP Disengage Switch.

AP engagement is inhibited while the AP disengagement visual warnings are active. For an automatic AP disengagement, the flight crew need to reset the AP disengagement warnings prior to attempting reengagement.

12.3.7.6 Autopilot Disengagement Aural Warning

Automatic Autopilot disengagement is annunciated by an aural tone which sounds continuously until acknowledged by the flight crew. The AP disengagement aural warning also sounds if the AP disengagement was caused by a failure of one of the two FGM power sources.

The flight crew acknowledge automatic Autopilot disengagement aural warnings using the AP Disengage Switches located on the two control wheels.

Manual Autopilot disengagement is annunciated by an aural tone which sounds for 1.5 seconds. This aural tone is not cancelled by pressing an AP Disengage Switch.

When the AP disengagement aural warning is active, AP engagement is inhibited.

12.3.7.7 Autopilot Disengage Switches

An AP Disengage Switch (AP DIS) is located on each of the Pilot's and Copilot's control wheels. The flight crew use the AP Disengage Switches for the following functions:

- Disengaging the Autopilot.
- Resetting Autopilot disengage warnings.
- Resetting the Yaw Damper disengage PFD annunciation.

12.3.8 Automatic Pitch Trim

The AFCS Automatic Pitch Trim function performs the following functions:

- Autopilot Pitch Trim when the AP is engaged.
- Flap Auto Pitch Trim when the AP is not engaged and the flaps are transitioned.

The AFCS performs both of these functions using commands to the Flight Control Electronic Control Unit (FCECU).

12.3.8.1 Autopilot Pitch Trim

When the Autopilot is engaged, the AFCS commands pitch trim to reduce the mistrim control column force held by the AP pitch servo, ensuring that the pitch transient at AP disengagement is minimal. The AFCS measures the torque applied to the controls by the AP pitch servo to determine when to trim. This AP Pitch Trim function is disabled when TCS is active.

The AP Pitch Trim function operates at two speeds:

- Trim high speed for Calibrated Airspeed (CAS) below 180 knots.
- Trim low speed for CAS above 180 knots.

The high speed trim provides the AP with adequate controllability during flaps extension/retraction, landing gear extension/retraction, accelerations and decelerations, or combinations of the above. The low speed trim provides the AP with sufficient precision for when small trim motion has a large effect.

The FCECU gives priority to manual pitch trim commands from the flight crew over automatic pitch trim commands from the AFCS. When the flight crew operate manual pitch trim with the AP engaged, they are effectively overriding the AP, so the AP disengages.

If the AP Pitch Trim function is failed, either due to an input monitor, an output monitor, or an AFCS failure, an amber AP PITCH TRIM FAIL message is displayed on the PFD. The flight crew can engage the Autopilot when the AP Pitch Trim function is failed, provided that the normal AP engagement criteria are met. An AP Pitch Trim failure does not automatically disengage the AP.

12.3.8.2 AP Pitch Mistrim Message

When the AP is engaged, each FGM monitors the AP pitch servo torque. When the AP pitch servo torque exceeds a threshold, the FGMs command display of an amber MISTRIM [TRIM NOSE UP] or MISTRIM [TRIM NOSE DN] on the PFD. The Pitch Mistrim message is removed from the PFD when the AP pitch servo torque is reduced below a threshold.

The Pitch Mistrim message is not set by the AFCS when the AP is disengaged, or when TCS is active.

The Autopilot does not disengage automatically when a pitch mistrim occurs. The Pitch Mistrim message indicates to alert the flight crew that the control column is mistrimmed, and that there may be a significant control column force and pitch transient upon AP disengagement.

12.3.8.3 Flap Auto Pitch Trim

The purpose of the Flap Auto Pitch Trim function is to reduce the mistrim control column force during flap transitions when the pilot is manually flying the aircraft. The Flap Auto Pitch Trim function automatically trims the elevator control system to reduce the control column force the pilot must input to maintain attitude during flap extension and retraction.

To perform the Flap Auto Pitch Trim function, the AFCS transmits commands to the FCECU, which in turn controls a pitch trim actuator that repositions the neutral position of the elevator control system, in a similar manner as for the Auto-pilot Pitch Trim function.

The Flap Auto Pitch Trim control law computes the Flap Position Rate from the Flap Position received from the FPIU. The Flap Auto Pitch Trim function initiates Nose Up or Nose Down trim commands when the magnitude of the Flap Position Rate is greater than a threshold, and stops the Nose Up or Nose Down trim command when the magnitude of the Flap Position Rate decreases below the threshold. The Flap Auto Pitch Trim function commands Nose Down trim for flap extension, and Nose Up trim for flap retraction.

The Flap Auto Pitch Trim control law commands pitch trim at a rate to produce 2 degrees of Elevator trim for flap transitions from Flaps 15° to 35°, and Flaps 35° to 15°. The Flap Auto Pitch Trim function uses modulation of the Trim Speed Selection to obtain this pitch trim rate.

The Flap Auto Pitch Trim function automatically engages when all of the following conditions exist:

- Weight On Wheels (WOW) input indicates the aircraft is airborne for two seconds.
- CAS is less than 180 knots.
- The Autopilot is not engaged.
- The flight crew are not operating Manual Pitch Trim.
- The AFCS detects that the flaps are moving between Flaps 15° and Flaps 35°.

The Flap Auto Pitch Trim function automatically disengages when any of the following conditions occur:

- Weight On Wheels (WOW) input indicates the aircraft is on ground.
- CAS is greater than or equal to 180 knots.
- The Autopilot is engaged.
- The flight crew operate Manual Pitch Trim.
- The AFCS detects that the flaps stop moving.

The Flap Auto Pitch Trim function also automatically disengages and inhibits engagement for AFCS failures, FCECU failures, and failures of essential inputs.

There is no annunciation for Flap Auto Pitch Trim engaged or disengaged.

If the Flap Auto Pitch Trim function is failed, either due to an input monitor, an output monitor, or an AFCS failure, an amber AUTO TRIM FAIL message is displayed on the PFD.

If the Flap Auto Pitch Trim function is disengaged or inhibited from engaging due to a pitch trim system failure detected by the FCECU, there is no specific annunciation displayed for the Flap Auto Pitch Trim function, since the pitch trim system failure is annunciated by a Pitch Trim Fail light. Similarly, if the Flap Auto Pitch Trim function is disengaged or inhibited from engaging due to the pilot selecting Elevator Trim off, there is no specific annunciation displayed for the Flap Auto Pitch Trim function.

12.3.8.4 Roll Mistrim

When the AP is engaged, each FGM monitors the AP roll servo torque. When the AP roll servo torque exceeds a threshold, the FGMs command display of an amber MISTRIM [TRIM L WING DN] or MISTRIM [TRIM R WING DN] on the PFD. The Roll Mistrim message is removed from the PFD when the AP roll servo torque is reduced below a threshold.

The Roll Mistrim message is not set by the AFCS when the AP is disengaged, or when TCS is active.

There is no automatic roll trim function.

The Autopilot does not disengage automatically when a roll mistrim occurs. The Roll Mistrim message indicates to the flight crew that the control wheel is mistrimmed, and that there may be a significant control wheel force and roll transient at AP disengagement. The flight crew must disengage AP, trim the lateral control system to remove the Roll Mistrim condition, and re-engage AP as desired.

12.3.9 Yaw Damper

The Yaw Damper provides through control of the rudder:

- Damping of the aircraft Dutch Roll mode.
- Turn coordination.

The Yaw Damper authority is limited to a maximum of ± 4.5 degrees of rudder by mechanical stops. Yaw Damper commands are limited in software as a function of airspeed.

12.3.9.1 Yaw Damper Engagement / Disengagement

YD engagement is allowed with the aircraft both on ground and airborne. However, engagement of the YD is inhibited when the Roll Attitude exceeds ± 45 degrees.

The YD is engaged by either:

- Pressing the YD pushbutton on the FGCP.
- Pressing the AP pushbutton on the FGCP.

AP engagement automatically engages the Yaw Damper. AP disengagement does not disengage the Yaw Damper, unless the AP disengagement was caused by a failure that also causes the Yaw Damper to disengage. Yaw Damper disengagement automatically disengages the Auto-pilot.

The flight crew disengages the YD using the YD pushbutton on the FGCP. The YD pushbutton on the FGCP is monitored to detect a stuck condition. If a stuck YD pushbutton is detected, the YD automatically disengages.

The Yaw Damper engages when the pilot presses either the YD or the AP pushbutton switch on the FGCP, and all of the following conditions are met:

- AHRS 1 and AHRS 2 are valid.
- AHRS 1 and AHRS 2 do not disagree.
- ADC1 and ADC 2 are valid.
- ADC 1 and ADC 2 do not disagree.
- The aircraft attitude is within the YD domain limits.
- Internal AFCS monitoring is Valid.
- The YD DISENGAGE message is not active.

The Yaw Damper disengages when one of the following conditions is met:

- AHRS 1 or AHRS 2 is failed.
- AHRS 1 and AHRS 2 disagree.
- ADC 1 or ADC 2 is failed.
- ADC 1 and ADC 2 disagree.
- A Yaw Damper actuator failure is detected.
- The flight crew press the YD pushbutton on the FGCP (manual disengagement).
- YD Push-button on Guidance controller is stuck
- Internal AFCS monitoring is failed.
- A power interrupt greater than the transparency time occurs.

12.3.9.2 Yaw Damper Engagement Indication

Yaw Damper engagement is indicated by lighting two arrows on either side of the YD pushbutton on the FGCP. These two arrows are not lit when the Yaw Damper is disengaged.

12.3.9.3 YD INHIBIT Message

If the flight crew attempt to engage the Yaw Damper, but YD engagement is inhibited by a source external to the AFCS, then the message YD INHIBIT is displayed on the PFD.

YD INHIBIT is displayed when the YD engagement inhibit condition comes from one of the following sources:

- AHRS monitoring
- ADU monitoring
- The aircraft attitude exceeds the engagement limits

12.3.9.4 YD FAIL Message

If the flight crew attempt to engage the Yaw Damper, but YD engagement is inhibited by an internal failure to the AFCS, then the message AP/YD FAIL is displayed on the PFD.

12.3.9.5 Yaw Damper Disengagement Indication

Automatic Yaw Damper disengagement is annunciated by flashing an amber YD DISENGAGE (or AP/YD DISENGAGE) message on the PFD. The PFD message flashes until acknowledged by the flight crew, then remains steady for 5 seconds.

The flight crew acknowledge the Yaw Damper disengagement PFD message using the AP Disengage Switches located on the two control wheels.

Manual Yaw Damper disengagement is annunciated by displaying an amber YD DISENGAGE (or AP/YD DISENGAGE) message on the PFD for 5 seconds. This message does not flash for manual Yaw Damper disengagement. This message is not cancelled by pressing an AP Disengage Switch.

YD engagement is inhibited while the YD DISENGAGE message is active.

12.3.9.6 Yaw Damper Recentering Function

The Yaw Damper actuator is automatically recentered following a manual YD disengagement, or an automatic disengagement caused by an external AFCS failure. Because of safety considerations, the Yaw Damper actuator is not automatically recentered following an automatic YD disengagement caused by an internal AFCS failure.

If the YD is not engaged and the Yaw Damper actuator is not centered, an amber YD NOT CENTERED message is displayed on the PFD. This message is displayed continuously while the YD is not engaged and the YD actuator position is not null.

12.3.10 Flight Guidance Control

The Flight Guidance Control Panel (FGCP) is located in the center of the cockpit glareshield, providing both pilots the means for selection of FD, AP, and YD functions.

The ESID Control Panel (ESCP) located on the center aisle stand provides the means to select the ADC and AHRS sources.

12.3.11 Flight Mode Annunciation

The mode of operation and the status of the AFCS is continuously displayed in the Flight Mode Annunciator area of the Primary Flight Display (PFD). The FMA displays the following information:

- AP or TCS engage status
- AP/YD status messages
- Mismatch messages
- Mismatch messages
- FD selected targets
- Lateral active mode
- Lateral armed mode
- Vertical active mode
- Vertical armed mode
- FD abnormal conditions messages
- Selected HSI, Dual FD, or Cat II Fail indications
- AFCS general failure messages

The FMA area is located in the upper part of each PFD.

12.3.12 AFCS Messages

The AFCS sends operational messages (Table 12.3-1) to the PFD to warn or to advise the flight crew of the status of the AFCS. A message is displayed whenever the flight crew attempt to engage a function but the function is inhibited.

Some messages are reset by pilot action. The FGMs send these messages until the flight crew perform the appropriate action to clear the message.

Four types of AFCS messages are defined:

- FD modes and targets.
- Non-resettable messages that indicate a failure.
- Messages requiring a pilot action to be cleared.
- Advisory messages indicating non-execution of a pilot request. These messages are related to attempts to engage the AP and YD, or attempts to engage FD modes.

When more than one message for the same location on the FMA is commanded by the AFCS, the PFD displays only one message, according to a priority ranking.

Each FGM generates these messages and sends them to both PFDs. The PFDs perform a source selection of the FGM inputs before displaying the messages, using one of the following criteria:

1. FGM#1 if valid, FGM#2 otherwise, except in Dual FD mode where own side FGM shall be selected.
2. FGM#1 or FGM#2, whichever FGM sends the information.
3. FGM#1 and FGM#2, when both FGMs send the information.

Table 12.3-1. AFCS Messages (1 of 7)

MESSAGE	COMMENTS
FD LATERAL ARMED MODES (white)	////////////////////////////////////
VOR	When mode is armed
VOR APP	When mode is armed
LOC	When mode is armed
BC	When mode is armed
FD LATERAL ACTIVE MODES (green)	////////////////////////////////////
ROLL HOLD	When mode is active
HDG HOLD	When mode is active
WING LVL	When mode is active
HDG SEL	When mode is active
VOR*	When mode is active in capture phase
VOR	When mode is active in track phase
VOR OS	When mode is active in track phase and over station
VOR APP*	When mode is active in capture phase
VOR APP	When mode is active
VOR APP OS	When mode is active in track phase and over station
LOC*	When mode is active in capture phase
LOC	When mode is active in track phase
BC*	When mode is active in capture phase
BC	When mode is active in track phase
LNAV	When mode is active
LNAV HDGSEL	When LNAV mode is active in a heading select submode, with the submode determined by the EIS directly from the FMS
LNAV HDGINT	When LNAV mode is active in a heading intercept submode, with the submode determined by the EIS directly from the FMS

Table 12.3-1. AFCS Messages (2 of 7)

MESSAGE	COMMENTS
FD VERTICAL ARMED MODES (white)	////////////////////////////////////
ALT SEL	When mode is armed
GS	When mode is armed
EL	When mode is armed
VNAV	When mode is armed
FD VERTICAL ACTIVE MODES (green)	////////////////////////////////////
PITCH HOLD	When mode is active
IAS	When mode is active
VS	When mode is active
VNAV PATH	When VNAV is active in the Path submode, with the submode determined by the EIS directly from the FMS
VNAV FLC	When VNAV is active in the Flight Level Change submode, with the submode determined by the EIS directly from the FMS
VNAV ALT*	When VNAV is active in the Altitude Capture submode, with the submode determined by the EIS directly from the FMS
VNAV ALT	When VNAV is active in the Altitude Hold submode, with the submode determined by the EIS directly from the FMS
ALT*	When mode is active in capture phase
ALT	When mode is active
GS*	When mode is active in capture phase
GS	When mode is active in track phase
EL*	When mode is active in capture phase
EL	When mode is active in track phase
GA	When mode is active

Table 12.3-1. AFCS Messages (3 of 7)

MESSAGE	COMMENTS
SELECTED TARGETS (green)	////////////////////////////////////
XXX	When IAS mode is active - Numerical value when IAS mode is active - Dashed numerical value when TCS is active
XXXXX	When VS mode is active - Numerical value when VS mode is active - First character indicates the sign of the target - Dashed numerical value when TCS is active
AFCS GENERAL FAILURE MESSAGES non resettable	////////////////////////////////////
AFCS FAIL Flashing yellow message for 5 seconds, then steady yellow	When a display unit does not receive data from both FGMs (determination performed by the EIS)
AP PITCH TRIM FAIL Flashing yellow messages for 5 seconds, then steady yellow, not resettable except if AFCS is failed or the failure is no longer present	Displayed when the AFCS is not able to command the pitch trim (torque failure or pitch trim failure) and the AP is engaged
YD NOT CENTERED Flashing yellow message for 5 seconds, then steady yellow	When YD actuator is not centered and YD is not engaged
L FD FAIL or R FD FAIL Flashing yellow message for 5 seconds, then steady yellow	When a display unit does not receive data from one FG module (determination per- formed by the EIS)
AFCS CONTROLLER INOP Flashing yellow message for 5 seconds, then steady yellow	Detection of a FGCP stuck pushbutton or an invalid FGCP bus
AUTO TRIM FAIL Flashing yellow message for 5 seconds, then steady yellow	When either FG module is unable to perform the Flap Auto Trim function and the AP is not engaged. The message shall be suppressed if the flight crew select Elevator Trim OFF

Table 12.3-1. AFCS Messages (4 of 7)

MESSAGE	COMMENTS
AP / YD STATUS MESSAGES	////////////////////////////////////
AP / YD DISENGAGED Yellow message - Flashing until reset when automatic disengagement, then steady for 5 seconds. Reset by quick instinctive disconnect switches located on both control wheels - Steady for 5 seconds when manual disengagement	Following a Yaw Damper and Autopilot disengagement, manual or automatic
AP DISENGAGED Yellow message - Flashing until reset when automatic disengagement, then steady for 5 seconds. Reset by quick instinctive disconnect switches located on both control wheels - Steady for 5 seconds when manual disengagement	Following Autopilot disengagement, manual or automatic
YD DISENGAGED Yellow message - Flashing until reset when automatic disengagement, then steady for 5 seconds. Reset by quick instinctive disconnect switches located on both control wheels - Steady for 5 seconds when manual disengagement	Following a Yaw Damper disengagement, manual or automatic
AP / YD FAIL Yellow message, flashing 5 seconds, then steady while the failure is detected	When an AFCS internal failure inhibits Yaw Damper engagement
AP FAIL Yellow message, flashing 5 seconds, then steady while the failure is detected	When an AFCS internal failure inhibits Yaw Damper engagement
MISTRIM [TRIM NOSE UP] Yellow message, flashing 5 seconds, then steady until the torque is reduced or the AP is disengaged	Control column will move forward on AP disengagement
MISTRIM [TRIM NOSE DOWN] Yellow message, flashing 5 seconds, then steady until the torque is reduced or the AP is disengaged	Control column will move backward on AP disengagement

Table 12.3-1. AFCS Messages (5 of 7)

MESSAGE	COMMENTS
MISTRIM [TRIM L WING DOWN] Yellow message, flashing 5 seconds, then steady until the torque is manually reduced (crew shall trim in the sense indicated by the message) or the AP is disengaged	Control wheel will move clockwise on AP disengagement
MISTRIM [TRIM R WING DOWN] Yellow message, flashing 5 seconds, then steady until the torque is manually reduced (crew shall trim in the sense indicated by the message) or the AP is disengaged	Control wheel will move counter-clockwise on AP disengagement
FD ABNORMAL MESSAGES	////////////////////////////////////
FD ATT DATA INVLD - Yellow message, flashing for 5 seconds, then steady until failure is cleared by changing selection or by selecting another mode. (If the attempted FD mode selection is itself inhibited, then the appropriate FD XXX DATA INVLD message will be displayed in white) - White message, steady for 5 seconds	- FD mode dropped off following an AHRS attitude or vertical speed data failure - Engagement of FD mode attempted but AHRS attitude or vertical speed data failure (HDG data not included) inhibits engagement (HDG data not included)
FD ADC DATA INVLD - Yellow message, flashing for 5 seconds, then steady until failure is cleared by changing the ADC source selection or by selecting another mode. (If the attempted FD mode selection is itself inhibited, then the appropriate FD XXX DATA INVLD message will be displayed in white) - White message, steady for 5 seconds	- FD mode dropped off following an ADC failure - Engagement of FD mode attempted but ADC failure inhibits engagement

Table 12.3-1. AFCS Messages (6 of 7)

MESSAGE	COMMENTS
FD HDG DATA INVLD - Yellow message, flashing for 5 seconds, then steady until failure is cleared by changing the AHRS source selection, or by selecting another mode. (If the attempted FD mode selection is itself inhibited, then the appropriate FD XXX DATA INVLD message will be displayed in white) - White message, steady for 5 seconds	- HDG SEL or HDG HOLD mode dropped off following a heading data failure - Engagement of HDG SEL mode attempted but a heading data failure inhibits engagement
FD NAV DATA INVLD - Yellow message, flashing for 5 seconds, then steady until failure is cleared by changing the NAV source or by selecting lateral mode - White message, steady for 5 seconds	- FD NAV armed or active mode dropped off, following a NAV source failure - Arming or engagement of a FD NAV mode attempted but inhibited by a NAV failure
FD MODE INHIBIT White message, steady for 5 seconds	Invalid pilot request: ALT SEL engagement while GS or EL capture or track mode is active or while Altitude Hold mode is active
CHECK NAV SOURCE - Yellow message, flashing for 5 seconds, then steady until failure is cleared by changing the NAV source selection or by selecting another mode. (If the attempted FD mode selection is itself inhibited, then the appropriate FD XXX DATA INVLD or CHECK NAV SOURCE message will be displayed in white) - White message, steady for 5 seconds	- FD if armed or active NAV mode dropped off following a NAV source change, or a VOR/LOC NAV frequency change. - Engagement of FD NAV mode or VNAV mode attempted and wrong NAV source selected
ALT OFF Yellow message, flashing for 5 seconds, then steady until selection of a new vertical mode or a new altitude target	When the Pitch Thumbwheel is used in Altitude Capture or Altitude Hold mode

Table 12.3-1. AFCS Messages (7 of 7)

MESSAGE	COMMENTS
AP / YD ENGAGEMENT MESSAGES	////////////////////////////////////
TCS White message, steady, displayed while TCS is active	When TCS is active and the AP is engaged
AP Green message, steady, displayed while the AP is engaged	When AP is engaged
AP INHIBIT White message, steady for 5 seconds	When AP engagement is attempted and an AFCS external failure or condition inhibits Autopilot engagement
YD INHIBIT White message, steady for 5 seconds	When YD engagement is attempted and an AFCS external failure or condition inhibits Autopilot engagement
DUAL MODE MESSAGE	////////////////////////////////////
CAT 2 FAIL Yellow message, flashing for 5 seconds, then steady until selection of a new lateral or vertical mode	When Dual FD Approach mode is cancelled and the Decision Height is less than 200 feet and greater than 50 feet. This message is computed by the EIS using data from the AFCS
DUAL OFF Yellow message, flashing for 5 seconds, then steady until selection of a new lateral or vertical mode	When Dual FD Approach mode is cancelled and the Decision Height is not selected for a CAT II approach. This message is computed by the EIS using data from the AFCS
DUAL FD Green message, steady, displayed while Dual FD Approach is active	When Dual FD Approach mode is activated
HSI> <HSI Steady yellow message	When Dual FD Approach mode is not active. Displayed only on the side not selected as the HSI source. (The determination of the selected HSI source is performed by the FDPS using information from the AFCS)