

EMBRAER 190



Automatic Flight System

DO NOT USE FOR FLIGHT

The Automatic Flight Control System (AFCS) is an integrated system that processes inputs from several airplane systems and sensors, applying the processed data to the Flight Guidance Control System (FGCS) and Thrust Management System (TMS), thus enabling their operation and producing visual and aural information.

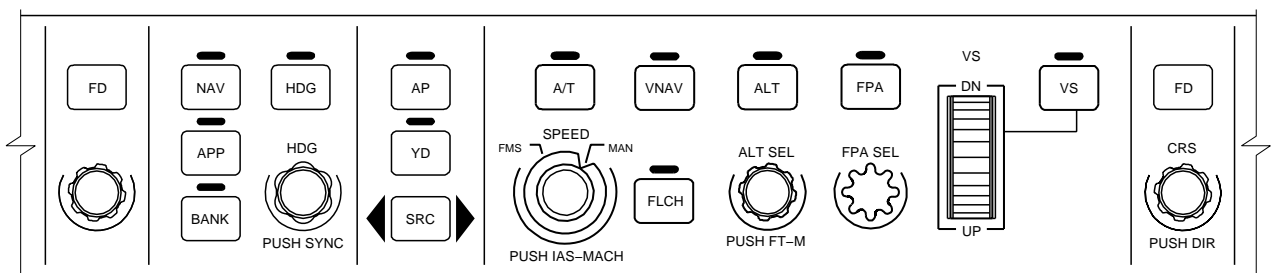
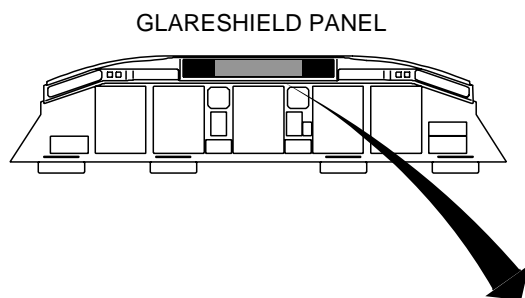
1. GUIDANCE PANEL

The Guidance Panel (GP) provides means for selecting functions and modes as follows :

- Lateral Guidance Control,
- AFCS Management Control,
- Vertical Guidance Control.

The GP contains two independent channels (A and B), each one providing independent communication to the FGCS.

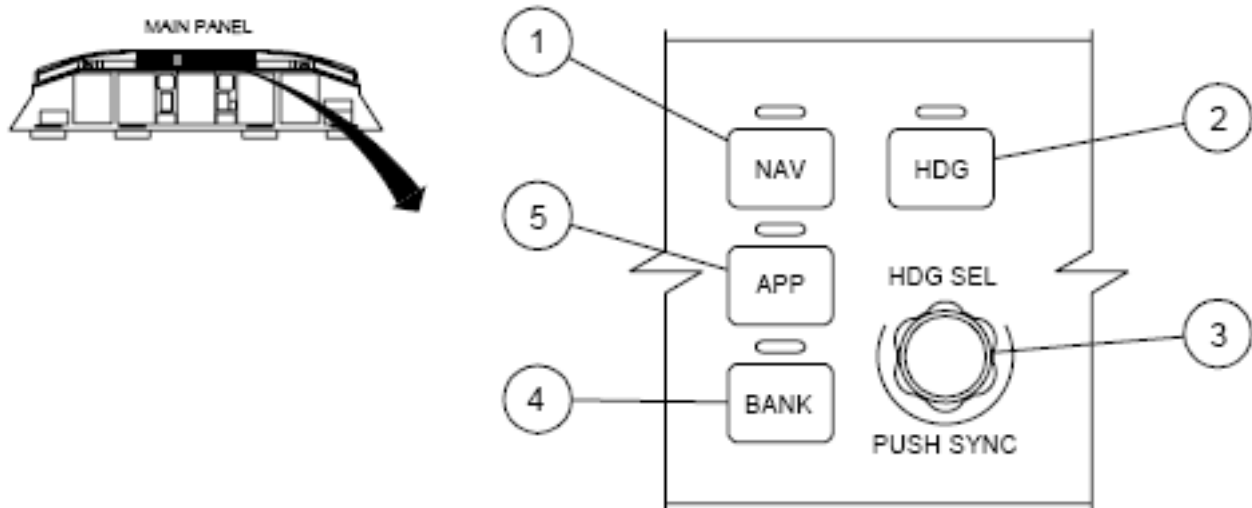
GUIDANCE PANEL



2. LATERAL GUIDANCE CONTROLS

N°	DESCRIPTION
①	NAV BUTTON : <ul style="list-style-type: none"> - Enables and disables the LNAV mode (FMS selected lateral modes). The FMA lateral mode annunciation displays LNAV.
②	HDG BUTTON : <ul style="list-style-type: none"> - Activates and deactivates the heading select mode, - The FMA lateral mode annunciation displays HDG.
③	HDG SELECTOR KNOB : <ul style="list-style-type: none"> - Manually selects the desired heading. Pressing this knob synchronizes the heading select to the current heading.
④	BANK BUTTON : <ul style="list-style-type: none"> - Selects a bank angle limit of 17° used by the FGCS, - A white arc is automatically displayed on the PFD when above 25000 ft. The white arc is manually indicated whenever the Bank Button is pushed and HDG is the active roll mode.
⑤	APP BUTTON : <ul style="list-style-type: none"> - Activates and deactivates the mode for interception of an ILS. - The FMA lateral mode annunciation displays the following : <ul style="list-style-type: none"> • LOC : ILS approach mode. - The FMA vertical mode annunciation displays the following : <ul style="list-style-type: none"> • GS : ILS approach mode. - The Autopilot Approach Status Annunciator displays the following : <ul style="list-style-type: none"> • APPR 2 : CAT II ILS approach capable. • APPR 1 : CAT I ILS approach capable. • APPR 1 ONLY : CAT I ILS approach capable. Requirements for CAT II ILS approach mode not accomplished. <p>NOTE : When the APP mode is intercepted, the heading mode (HDG) is automatically deactivated.</p>

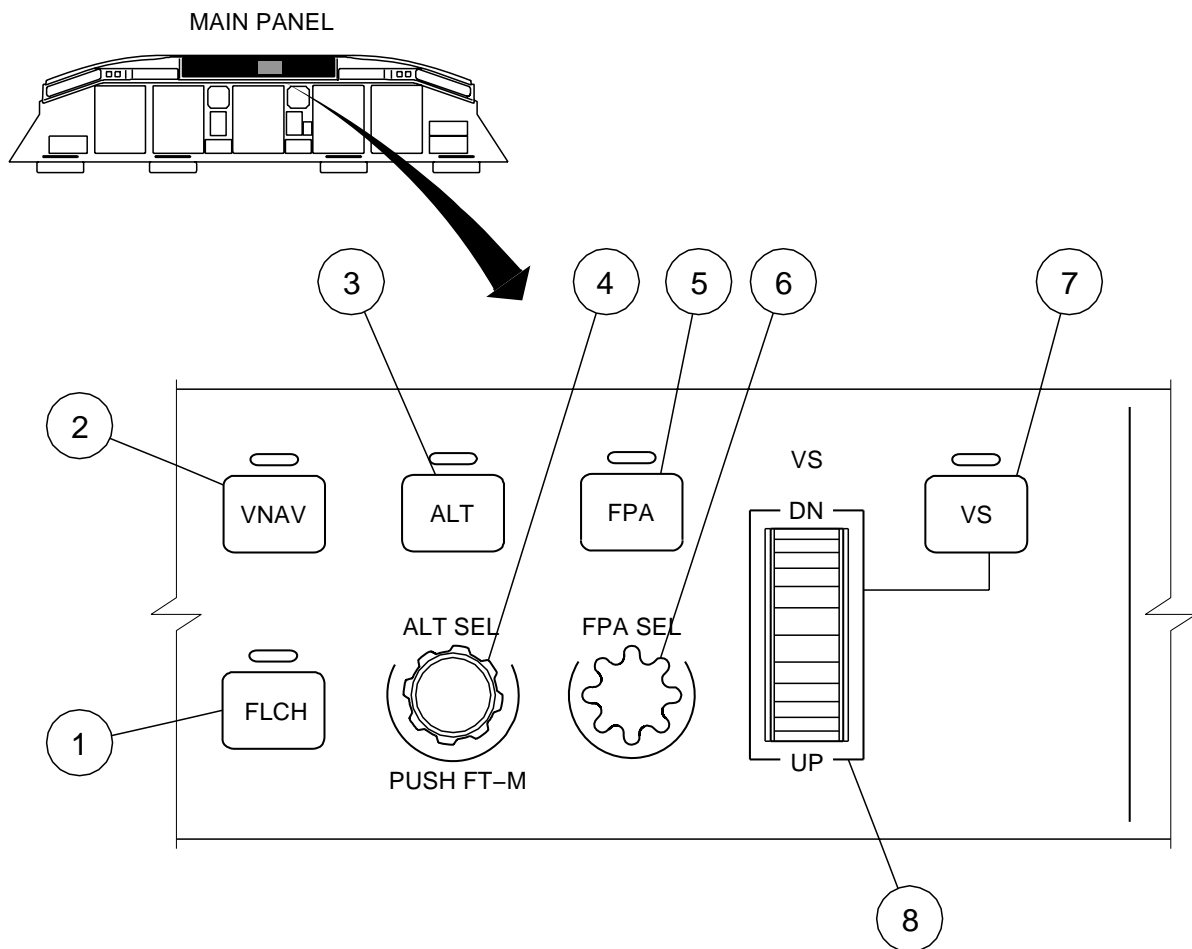
LATERAL GUIDANCE CONTROLS



3. VERTICAL GUIDANCE CONTROLS

N°	DESCRIPTION
①	FLCH BUTTON : <ul style="list-style-type: none"> - Activates and deactivates the Flight Level Change mode, - The FLCH mode is associated to Climb or Descend depending on the selected altitude, - The Flight Mode Annunciation (FMA) vertical mode displays FLCH.
②	VNAV BUTTON : <ul style="list-style-type: none"> - Activates and deactivates the VNAV mode (FMS vertical navigation).
③	ALT BUTTON : <ul style="list-style-type: none"> - Activates and deactivates the altitude holding mode (ALT), - The FMA vertical mode annunciation displays ALT.
④	ALT SELECTOR KNOB : <ul style="list-style-type: none"> - Selects the desired altitude, - Clockwise rotation: increases the altitude target, - Counter clockwise rotation: decreases the altitude target. <p><i>NOTE : A pushbutton in the center of the ALT SEL selector knob provides the selected altitude in meters to be displayed on the meters window (metric altitude) readout and above the ALT pre-selected window on the PFD.</i></p>
⑤	FPA BUTTON : <ul style="list-style-type: none"> - Activates and deactivates the Flight Path Angle mode, - This is the basic vertical mode, - The FMA vertical mode annunciation displays FPA. <p><i>NOTE : Engaging the autopilot when no FD mode is active causes FPA mode to become the active mode, and the FD guidance cue to come into view.</i></p>
⑥	FPA SELECTOR KNOB : <ul style="list-style-type: none"> - Manually selects the desired Flight Path Angle, - The flight path angle is limited to 9.9 degrees nose up or nose down.
⑦	VS BUTTON : <ul style="list-style-type: none"> - Activates and deactivates the Vertical Speed mode, - The FMA vertical mode annunciation displays VS.
⑧	VS THUMB WHEEL SELECTOR : <ul style="list-style-type: none"> - The thumb wheel selector manually selects the desired vertical speed rate. <p><i>NOTE : The VS mode must be active for the thumb wheel selector to become effective.</i></p>

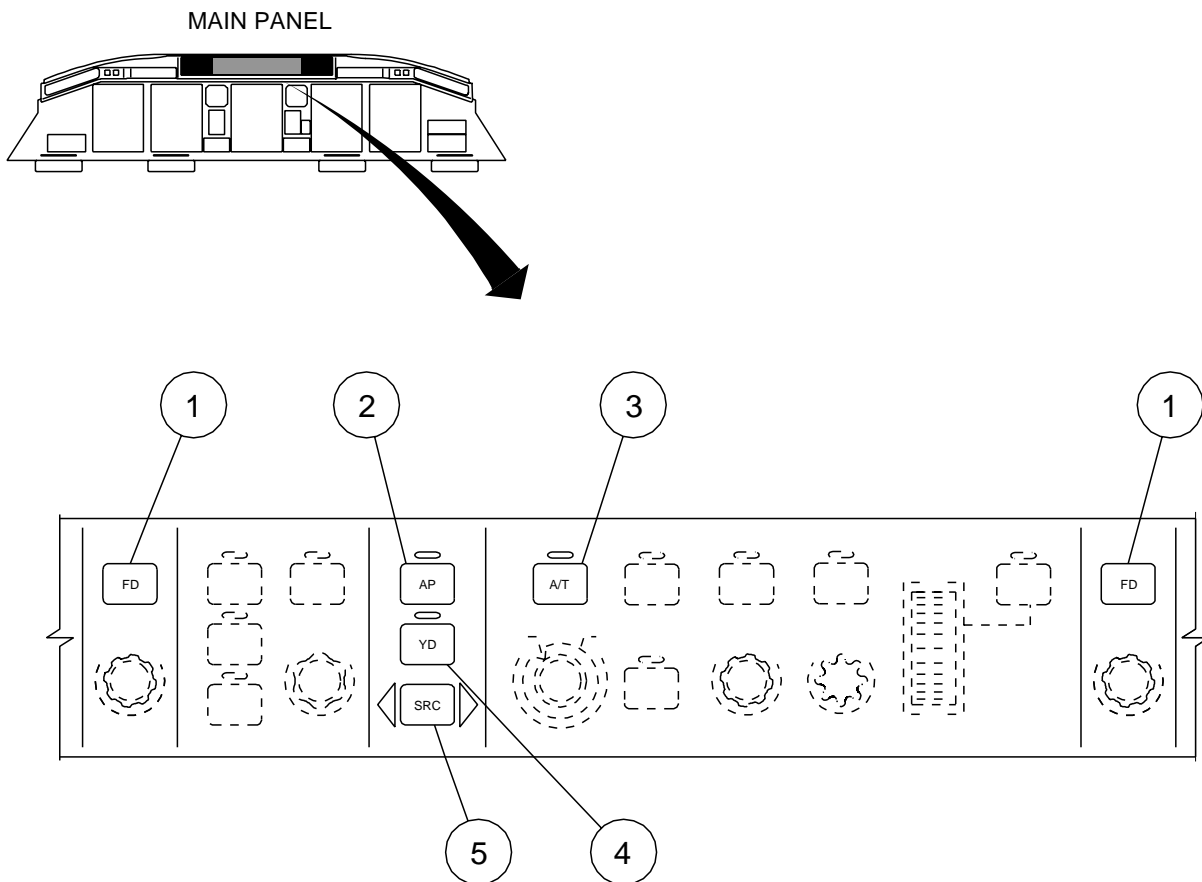
VERTICAL GUIDANCE CONTROLS



4. AFCS GUIDANCE CONTROLS

N°	DESCRIPTION
①	FD BUTTON : <ul style="list-style-type: none"> - Declutters the FD cue presentation on the PFD. With the FD decluttered, the FD is still active and the FD modes are still selectable in the FGP. - If the AP is engaged, the FD can not be removed from the PFD in the side selected to be the AFCS source.
②	AP BUTTON : <ul style="list-style-type: none"> - Commands the autopilot engagement or disengagement.
③	A/T BUTTON : <ul style="list-style-type: none"> - Commands the autothrottle engagement or disengagement.
④	YD BUTTON : <ul style="list-style-type: none"> - Engages or disengages the Yaw Damper/Turn Coordination function.
⑤	SRC BUTTON : <ul style="list-style-type: none"> - Alternates the Captain or First Officer AFCS side as data source. A green arrowhead on the FMA indicates the respective source selected.

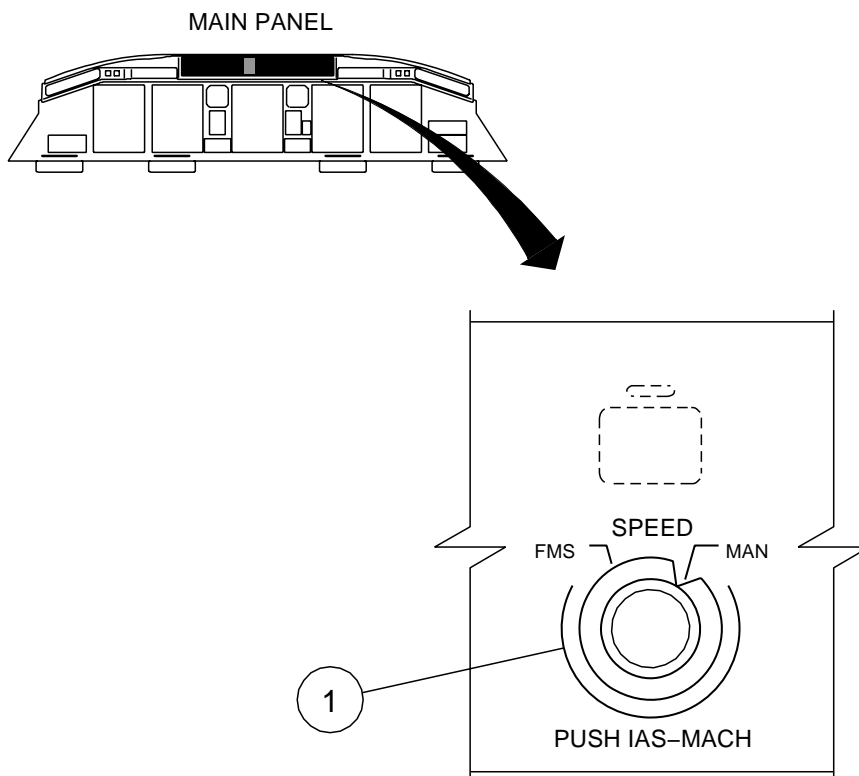
AFCS GUIDANCE CONTROLS



5. SPEED AND MODE CONTROLS

N°	DESCRIPTION
①	<p>SPEED SELECTOR KNOB :</p> <ul style="list-style-type: none">- FMS : FMS speed control,- MAN : The desired speed is controlled manually, displayed in cyan on the PFD. <p><i>NOTE : The alternate speed selection (IAS or Mach) can be selected by pressing the speed selector knob.</i></p>

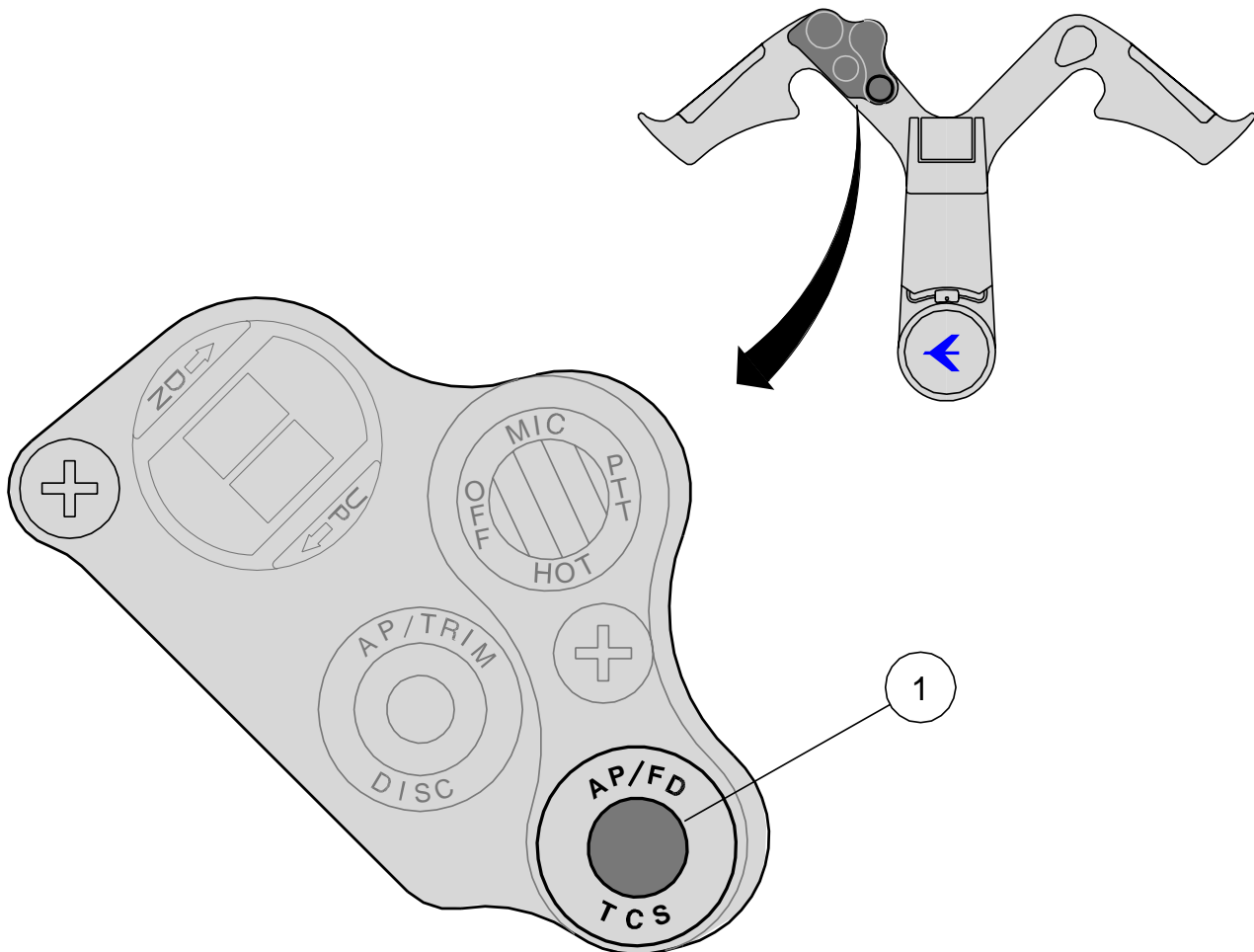
SPEED AND MODE CONTROLS



6. AUTO PILOT/FD TCS BUTTON

N°	DESCRIPTION
①	<p>TOUCH CONTROL STEERING BUTTON (TCS) :</p> <ul style="list-style-type: none"> - The TCS button allows manual airplane maneuvering (primary servos) to any desired pitch, overriding autopilot function. Release of the button cause : <ul style="list-style-type: none"> • Primary servos reengage, • The airplane maintains the new attitude requested, • Lateral control returns to previous selected lateral mode. <p>NOTE : After glide slope capture in APP mode with the autopilot engaged, if the TCS button is pressed and released, the autopilot regains the control and turns the airplane back towards the ILS center beam.</p>

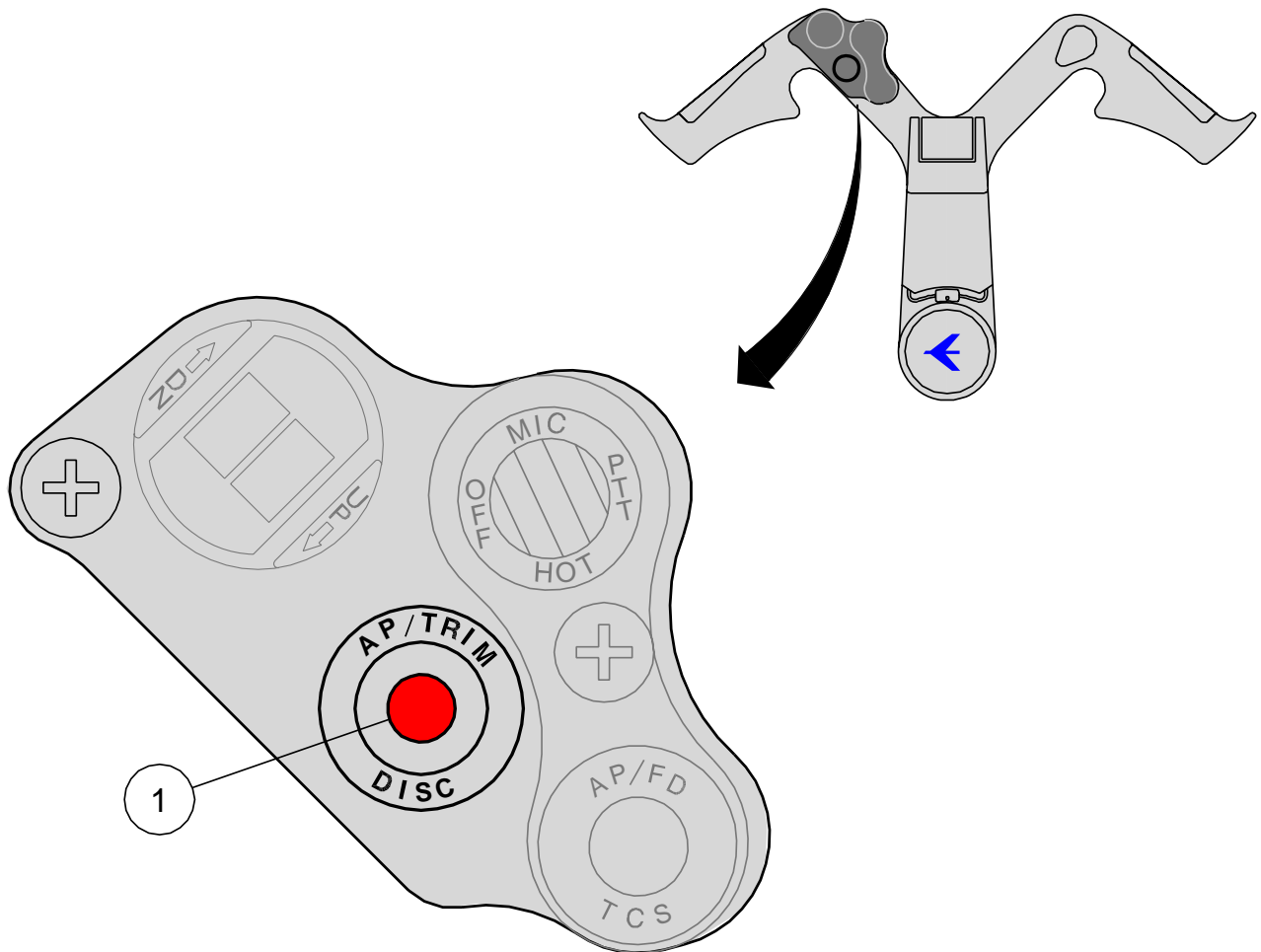
AUTO PILOT/FD TCS BUTTON



7. AUTOPILOT QUICK DISCONNECT BUTTON

N°	DESCRIPTION
①	<p>AP DISCONNECT BUTTON :</p> <ul style="list-style-type: none">- Provides the means to disengage the autopilot. <p><i>NOTE : Captain and first Officer's buttons are interconnected to allow autopilot cancellation from either side.</i></p>

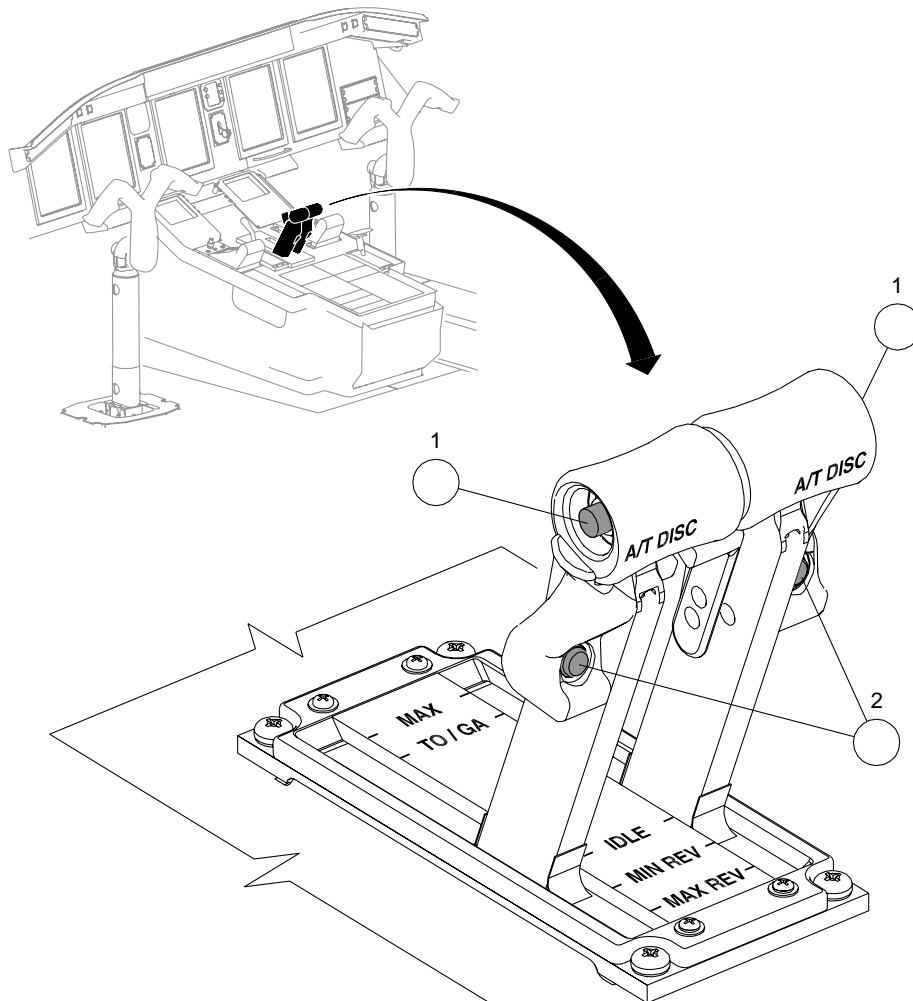
AUTOPILOT QUICK DISCONNECT BUTTON



8. AUTOTHROTTLE DISCONNECT AND GO-AROUND BUTTONS

N°	DESCRIPTION
①	AUTOTHROTTLE DISCONNECT BUTTON : <ul style="list-style-type: none">- Manually disengages the autothrottle.
②	TAKEOFF AND GO AROUND BUTTON : <ul style="list-style-type: none">- Selects the TO or GA modes according to the airplane status.- The FMA lateral mode annunciation displays the following :<ul style="list-style-type: none">• TRK : go-around lateral mode.• ROLL : take-off lateral mode.- The FMA vertical mode annunciation displays the following :<ul style="list-style-type: none">• TO : take-off vertical mode.• GA : go-around vertical mode.• WSHR : vertical mode in windshear detection.

AUTOTHROTTLE DISCONNECT AND GO-AROUND BUTTONS



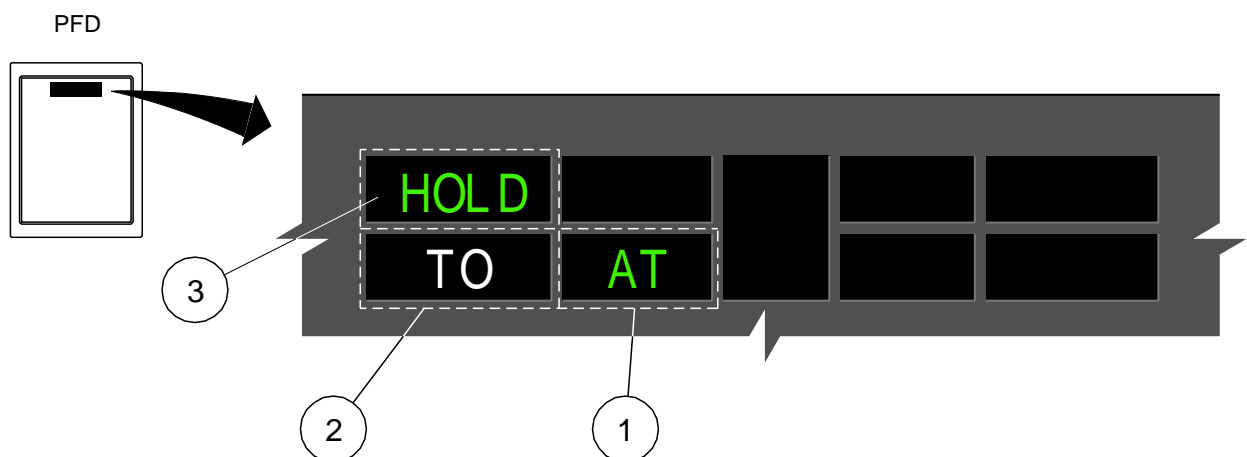
9. AUTOTHROTTLE INDICATIONS ON FLIGHT MODE ANNUNCIATION (FMA)

The AT mode labels displayed on FMA are the following :

- SPDT,
- SPDE,
- TO,
- GA,
- HOLD,
- LIM,
- OVRD.

N°	DESCRIPTION
①	AUTOTHROTTLE ENGAGEMENT ANNUNCIATION : <ul style="list-style-type: none">- Color :<ul style="list-style-type: none">• Green : Autothrottle engaged,• Amber : Autothrottle failed.
②	AUTOTHROTTLE ARMED MODE : <ul style="list-style-type: none">- Color : WHITE.
③	AUTOTHROTTLE ACTIVE MODE : <ul style="list-style-type: none">- Color :<ul style="list-style-type: none">• Green : Autothrottle active mode,• Amber : The LIM label is displayed to indicate that vertical speed and target speed are incompatible with thrust rating available.

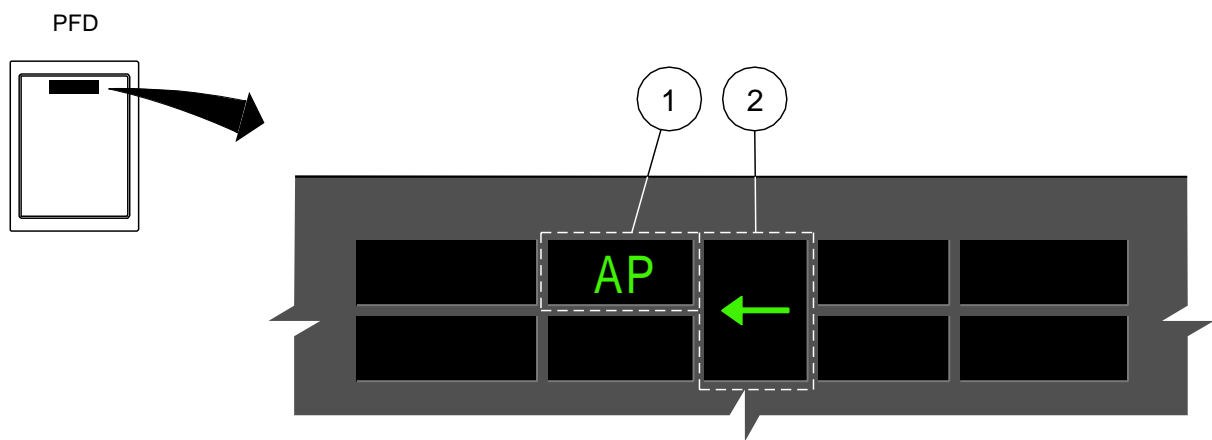
AUTOTHROTTLE INDICATIONS ON FLIGHT MODE ANNUNCIATION (FMA)



10. AUTOPILOT INDICATIONS ON FMA

N°	DESCRIPTION
①	AUTOPILOT ENGAGED ANNUNCIATION : <ul style="list-style-type: none">- Color :<ul style="list-style-type: none">• GREEN : Autopilot engaged.• AMBER : Autopilot failed.
②	FLIGHT DIRECTOR SOURCE ANNUNCIATOR : <ul style="list-style-type: none">- A green arrow indicated the selected AFCS source. <p><i>NOTE : Mode annunciation is removed if Flight Director fails.</i></p>

AUTOPILOT INDICATIONS ON FMA



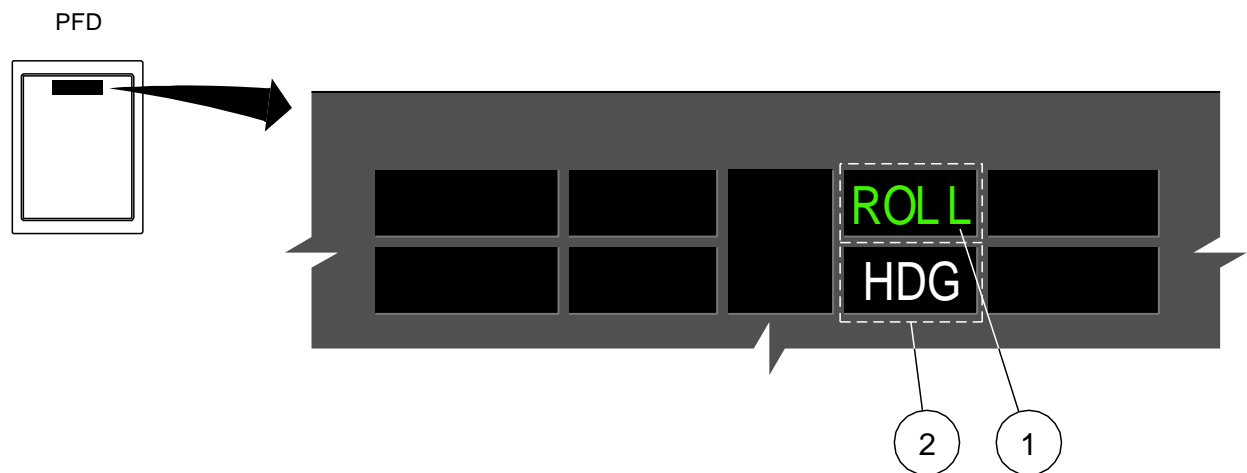
11. LATERAL MODE INDICATIONS ON FMA

The lateral mode labels displayed on FMA are the following :

- ROLL,
- HDG,
- LNAV,
- LOC,
- BC,
- TRACK.

N°	DESCRIPTION
①	FGCS LATERAL ACTIVE MODE : <ul style="list-style-type: none">- Color :<ul style="list-style-type: none">• GREEN : manually commanded on the GP.• MAGENTA : FMS commanded.
②	FGCS LATERAL ARMED MODE : <ul style="list-style-type: none">- Color : WHITE.

LATERAL MODE INDICATIONS ON FMA



12. VERTICAL MODE INDICATIONS ON FMA

The vertical mode labels displayed on FMA are the following :

- FPA,
- TO,
- ASEL,
- FLCH,
- ALT,
- VS,
- OVSP,
- GS,
- GA.

N°	DESCRIPTION
①	FGCS VERTICAL ACTIVE MODE : <ul style="list-style-type: none">- Color :<ul style="list-style-type: none">• GREEN : manually commanded on the GP.• MAGENTA : FMS commanded.
②	FGCS VERTICAL ARMED MODE : <ul style="list-style-type: none">- Color : WHITE. <p><i>NOTE : In event of AFCS fails the respective mode annunciation is removed.</i></p>

VERTICAL MODE INDICATIONS ON FMA



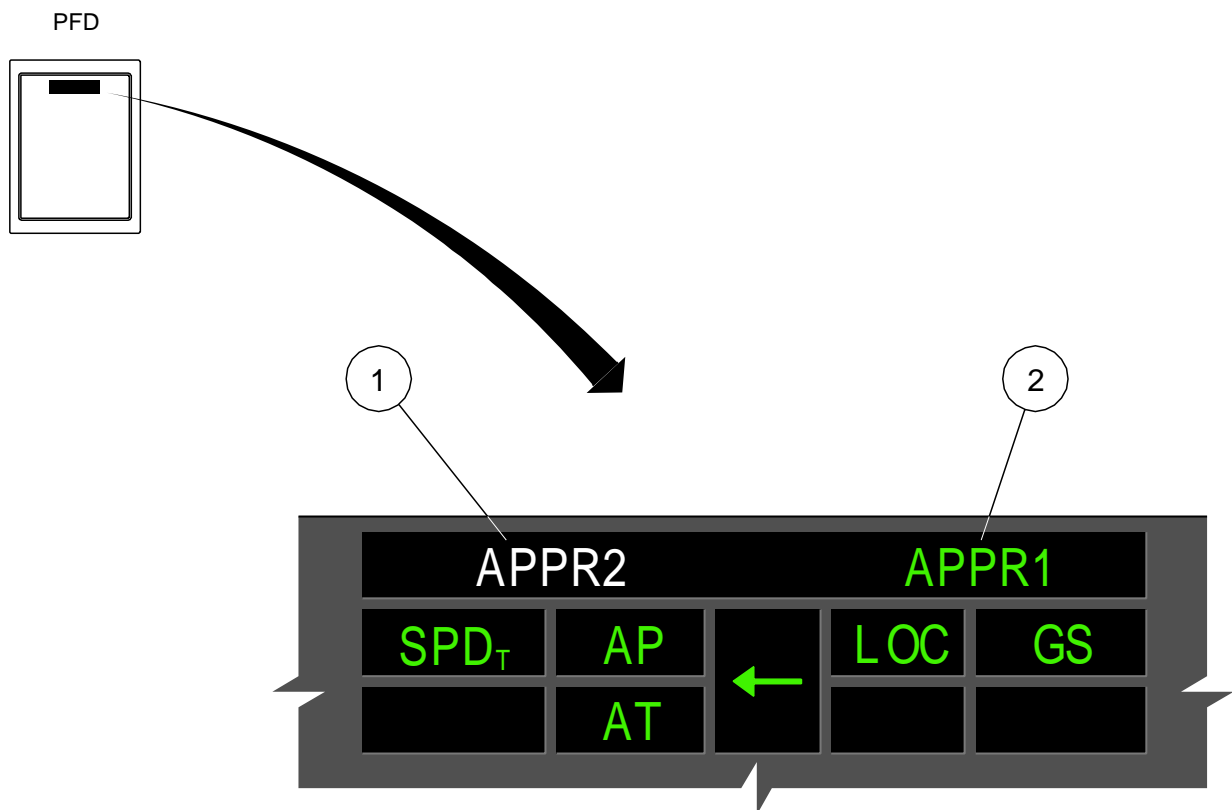
13. AUTOPILOT APPROACH STATUS ANNUNCIATOR

The autopilot approach labels displayed are the following :

- APPR 2,
- APPR 1,
- APPR 1 ONLY.

N°	DESCRIPTION
①	ARMED STATUS : <ul style="list-style-type: none">- Color :<ul style="list-style-type: none">• WHITE : Armed approach mode.• AMBER : Alert condition.
②	ENGAGED STATUS : <ul style="list-style-type: none">- Color :<ul style="list-style-type: none">• GREEN : Engaged approach mode.

AUTOPILOT APPROACH STATUS ANNUNCIATOR



FLIGHT GUIDANCE CONTROL SYSTEM (FGCS)

The FGCS is the AFCS functionality that indirectly drives the primary flight controls, through either the cockpit control column or through other AFCS processing modules.

The FGCS function includes :

- Flight Director (FD) guidance,
- Autopilot (AP) with coupled Go-Around (GA), Windshear modes and Automatic Pitch Trim,
- Yaw Damper (YD) with the Turn Coordination capability.

FLIGHT DIRECTOR (FD)

A magenta diamond displayed on the Primary Flight Display (PFD) represents the FD. It provides lateral and vertical guidance integrated with the Flight Management System (FMS) or manually commanded.

The FD engagement or disengagement is commanded via FD button on the guidance panel.

The FD automatically turns on as follows :

- TO/GA button actuation,
- Autopilot activation,
- Windshear detection.

The FD is released when the Touch Control Steering (TCS) button is pressed and it resynchronizes the references when TCS is released (deactivated).

Selecting FD OFF on the GP removes the flight director information from the non-coupled side on the PFD, if AP is engaged. Flight director information is removed from both PFDs if AP is disengaged and FD is selected OFF. FD declutter does not deactivate the current lateral and vertical modes.

Ground power-up causes both flight directors to become active, regardless of the last FD status selected.

AUTOPILOT (AP)

The autopilot provides automatic pitch and roll control of the airplane commanding dedicated servos.

The elevator AP servo is mechanically linked to the control column. The aileron AP servo is mechanically linked to the aileron control cables and wheels.

1. AP ENGAGEMENT/DISENGAGEMENT

Autopilot is engaged pushing the AP button on the guidance panel. The automatic pitch trim is ON when AP is engaged. The yaw damper automatically engages on AP engagement, although the yaw damper can be engaged or disengaged independently of the AP status.

Autopilot engagement is inhibited on the ground.

The Autopilot has two channels. One channel works as a hot spare channel. The system alternates the channel automatically if the active channel fails. The pilot can alternate the AP channel manually on the SETUP MCDU page.

SETUP MCDU PAGE



The autopilot disengages when any of the following conditions occur :

- The AP button is pressed on the guidance panel,
- The manual pitch trim switches are activated,
- Either quick disconnect switches are activated,
- Column shakers are activated,
- Reversion of fly-by-wire system to direct mode,
- Either the aileron or elevator control system disconnects,
- A column and control wheel force monitor sensors trips,
- Various internal monitors failure.

The autopilot commands the servos to disengage when TCS button is pressed. The autopilot automatically reengages the servos and resynchronizes the flight director when TCS button is released.

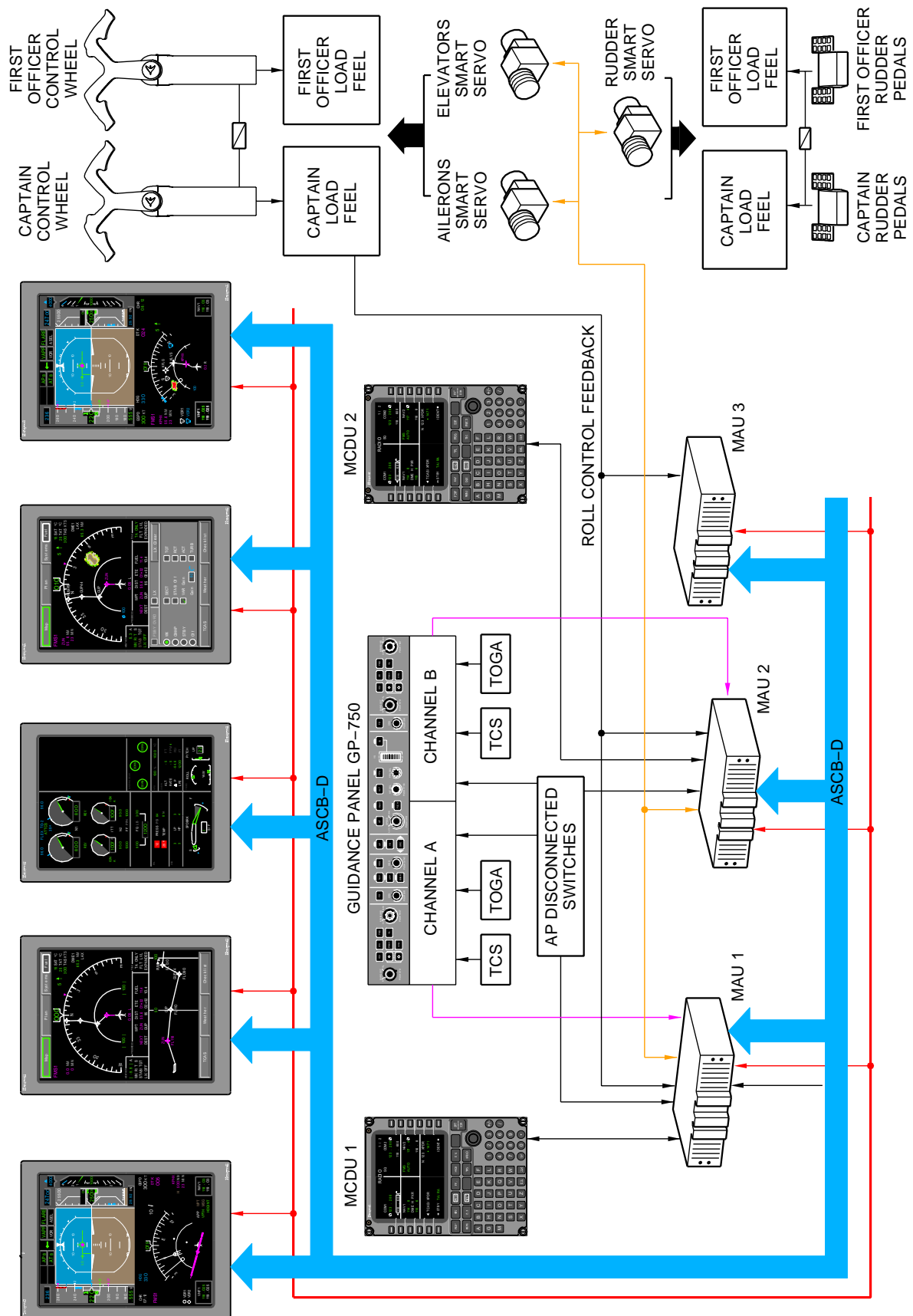
Anytime the autopilot is disengaged, an aural alarm "AUTOPILOT" is triggered and the FMA displays a flashing red "AP" indication for at least 5 seconds.

An EICAS message is also displayed for abnormal disengagement of AP. Pressing once either AP disconnect button cancels the flashing "AP" on FMA and the aural alarm. The EICAS message remains displayed.

NOTE : AP disengagement by application of force on control column and control wheel is indicated in red on FMA. The AP disengagement by application of force only on control wheel may be indicated in red on FMA and AP FAIL message may be displayed on the EICAS.

Pressing the AP disconnect button manually disengages the AP. If the pitch trim is being commanded by the elevator thrust compensation (ETC) or auto configuration trim, the EICAS CAUTION message AP FAIL momentarily displays, and the FMA AP disengagement indication will be green. The second press in the AP disconnect button cancels the aural alarm, which sounds at least once.

AUTOPILOT/FLIGHT DIRECTOR SCHEMATIC



AFCS INDICATIONS ON PFD

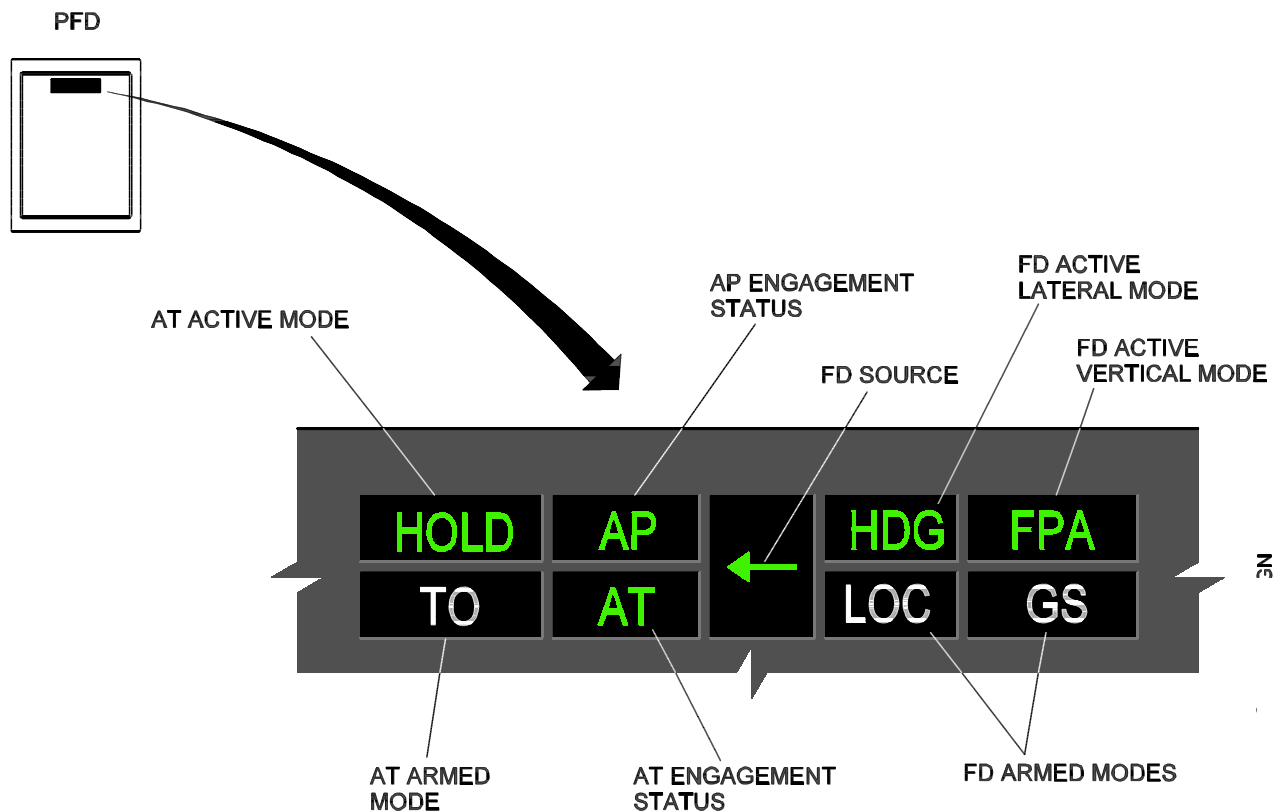
1. FLIGHT MODE ANNUNCIATION (FMA)

The FMA is displayed on the top of PFD. The FMA displays indications of autothrottle, autopilot, active AFCS channel, lateral mode and vertical mode.

The FMA color code for normal operation is the following :

- Magenta: FMS commanded active/engaged mode,
- Green: Non-FMS commanded active/engaged mode,
- White: Armed mode,
- Amber: Alert condition,
- Red: Abnormal condition.

FLIGHT MODE ANNUNCIATION (FMA)



2. AUTOPILOT APPROACH STATUS ANNUNCIATOR

Autopilot Approach Status Annunciator is displayed on top of FMA upon pressing of APP button full line to clearly describe to flight crew current approach status, and some alert levels, necessary.

Left side of the annunciator displays either the armed status (white) or the discrepancy between system capability and flight crew intention (amber). Alert function associated to amber flashing invites for correction of RA Minimums, which has a digital read-out on PFD.

Right side of annunciator displays current engaged status.

The terminology used for the two system capability levels are :

- APPROACH 2 (APPR 2) - ILS CAT II capable,
- APPROACH 1 (APPR 1) - ILS CAT I capable.

Only one lateral mode can be activated and only one can be armed at a time. The FGCS provides Lateral navigation as follows :

The FGCS pilot selectable lateral navigation modes are :

- Roll Hold - Basic Lateral Mode (ROLL),
- Heading Select (HDG),
- Lateral Navigation (LNAV),
- Localizer (LOC),
- Back-course (BC).

Pilot non-selectable mode is :

- Track Hold (TRACK).

1. ROLL HOLD (ROLL)

Roll hold is the basic lateral mode and it is activated when :

- The active lateral mode is deactivated,
- The TO mode is selected on ground by pressing TOGA button.

The AP takes different actions considering the different airplane bank angles at the moment of ROLL activation.

- Bank angle at 6° or below: AP levels the wings,
- Bank angle above 6° and below 35°: AP holds present bank angle,
- Bank angle at 35° or above: AP maintains bank angle at 35°.

The TCS button can be used to adjust the bank angle between 6° and 35°.

2. HEADING SELECT (HDG)

The heading select mode activates when one of following conditions occur :

- The HDG pushbutton on the GP is pressed,
- LNAV, LOC or BC modes are armed.

The Heading Select mode is deselected when :

- HDG pushbutton is pressed a second time,
- Selecting a different lateral mode,
- LNAV, LOC or BC modes are activated.

Pressing the HDG selector knob synchronizes the heading bug to the current heading.

The FD follows the selected heading and respects the side to which the turn was commanded, regardless of turn being greater than 180 degrees.

FGCS LATERAL MODES

3. LATERAL NAVIGATION (LNAV)

The FD provides flight director lateral guidance commands for interception, capture, and tracking.

LNAV guidance and automatic transitions are computed based on PFD data. The LNAV mode is selected when NAV button is pressed on the guidance panel. The FMS is the navigation source.

The flight director shall be capable of performing an automatic transition from LNAV to LOC mode or from LNAV to Back-Course mode (BC) via the approach preview mode.

4. LOCALIZER (LOC)

Localizer mode guidance is computed based on PFD data.

The LOC mode is selected via the APP button on the GP. The FD Localizer mode is selected when there is no GS signal available.

The FD automatically manages the LOC and Back-Course according to Localizer frequency, PFD information and airplane's position.

5. BACK-COURSE (BC)

The FD will automatically select a BC approach on the PFD.

The FGCS provides commands for capture and tracking of BC localizer indicated on the selected PFD.

6. TRACK HOLD (TRACK)

The track select mode is used to intercept and maintain an inertial derived airplane track from the IRS. This mode is engaged automatically when GA or TO is selected by the TOGA.

The automatic transition from ROLL to TRACK occurs when :

- IAS is greater than 100 kt,
- Bank angle is at 3° or below for more than 10 seconds.

Selecting another lateral flight director mode disengages track mode.

Canceling the vertical mode of GA does not disengage the TRACK lateral mode automatically.

FGCS VERTICAL MODES

One vertical mode can be active and up to two vertical modes can be armed at a time.

The FGCS vertical navigation modes are :

- Flight Path Angle (FPA) - basic vertical mode,
- Takeoff (TO),
- Altitude Select (ASEL),
- Flight Level Change (FLCH),
- Altitude Hold (ALT),
- Vertical Speed (VS),
- Vertical Navigation (VNAV),
- Overspeed (OVSP),
- Glide Slope (GS),
- Go around (GA).

1. FLIGHT PATH ANGLE (FPA)

The FPA is the basic vertical mode (except for the TO).

FPA mode becomes the active FD mode when :

- FPA pushbutton in the guidance panel is pressed,
- Engaging the autopilot when no FD mode is active,
- When a lateral mode is activated and there is no vertical flight director guidance mode active,
- Deselecting the current vertical mode.

The flight path reference line (FPR) is displayed when the FPA is active. Pressing the FPR button in the display controller panel displays the FPR line, regardless of vertical mode active.

Flight path angle ($\pm 9.9^\circ$) is selected in the FPA SEL selector knob on the guidance panel.

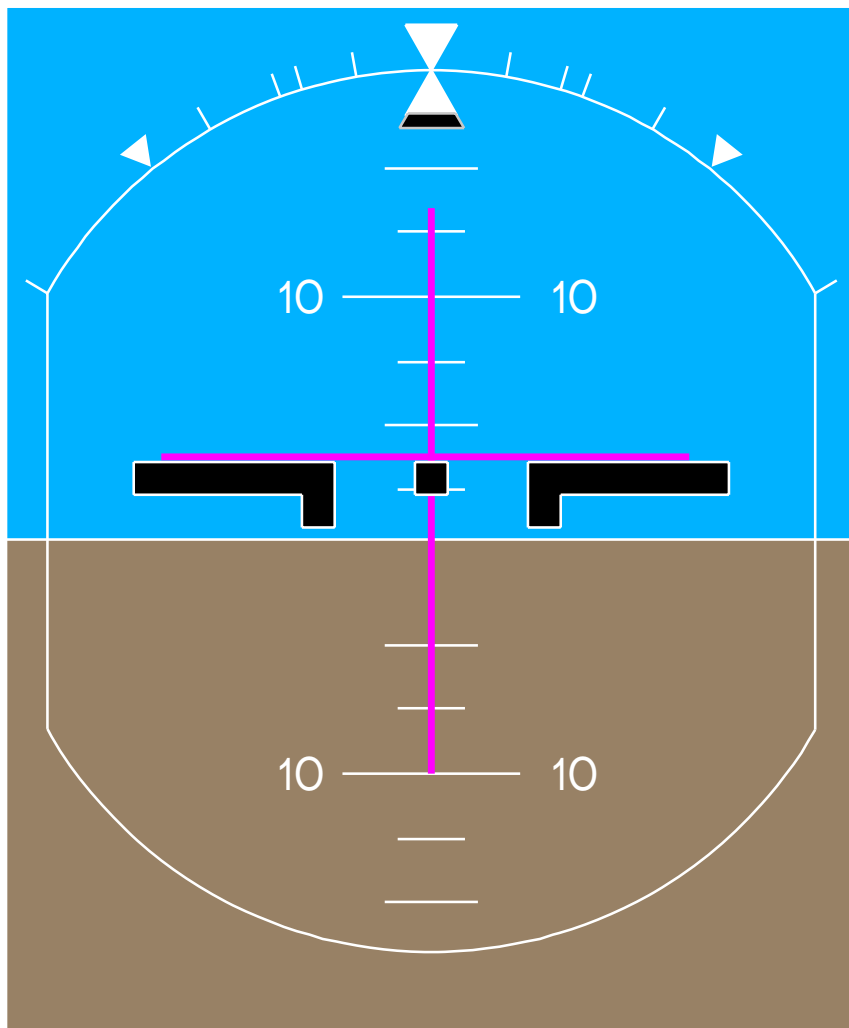
2. TAKEOFF (TO)

The takeoff mode is a FD only mode and is represented by crossbars on PFD. TO mode commands the airplane to maintain a pitch attitude reference. In takeoff the autopilot engagement is not accepted and FPA mode is inhibited. Lateral mode changes are allowed.

FPA indication is inhibited for 30 seconds after lift-off when taking off using raw-data information (no active mode on the FD).

Pressing the TOGA button activates the TO mode. Following a landing, the TO mode can be enabled after 5 seconds on ground (main gear weight on wheels).

PFD TAKEOFF MODE CROSSBAR



The TO mode is deactivated when :

- Another vertical mode is selected,
- AP/FD TCS button is pressed,
- AP is activated.

The TO mode first guidance is the flap-pitch based guidance :

- FLAP 1 - pitch 11°,
- FLAP 2 - pitch 11°,
- FLAP 3 - pitch 9°,
- FLAP 4 - pitch 12°.

When airborne and IAS is greater than speed target, the guidance will be speed target according to the following :

- All engines operating: $V_2 + 10$ kt.
- One engine inoperative :
 - Engine failure below V_2 : guides V_2 ,
 - Engine failure between V_2 and $V_2 + 10$ kt: guides present speed,
 - Engine failure above $V_2 + 10$ kt: guides $V_2 + 10$ kt.

The V_2 is inserted on the MCDU (PERF > PERF INDEX > PERF DATA > TAKEOFF 3/3).

If speed target is not valid, the airplane guides to a fixed pitch according to the flaps in use.

In TO mode the pitch is limited to a minimum of 8° and a maximum of 18°. The maximum speed target is $V_{fe} - 5$ kt and minimum speed target is $V_{shaker} + 10$ kt for all engines operating. For one engine inoperative the minimum speed target is $V_{shaker} + 3$ kt.

3. ALTITUDE SELECT (ASEL)

The altitude select mode captures and levels off at the selected altitude. A green ASEL is displayed on the FMA while altitude select mode captures the pre-selected altitude, then a green ALT takes place when leveled off at the selected altitude.

NOTE : Altitude select is armed automatically whenever any vertical FD mode is selected.

4. FLIGHT LEVEL CHANGE (FLCH)

The FLCH provides flight path command to Climb or Descend according to the speed selected in the Speed Selector knob. FLCH guidance is associated to SPDE.

The selected speed is displayed in the box on the top of speed tape and when the altitude is close to 29000 ft it switches from IAS to Mach readout during climb and from Mach to IAS readout during descent.

The FLCH button on the GP activates the FLCH mode.

The FLCH mode deactivates when :

- Another vertical mode is selected,
- TCS button is pressed.

The FLCH mode guides to the altitude selected via ALT SEL knob.

During a FLCH descent, selecting an altitude above the current airplane altitude will guide the airplane to climb. The airplane will not reach the altitude selected if AT is disengaged and sufficient thrust is not available.

5. ALTITUDE HOLD (ALT)

Pressing the ALT button on the GP enables the altitude hold mode. The altitude hold mode maintains a selected barometric altitude. The altitude can be selected via the ALT SEL knob.

After ALT mode engagement, change to another vertical mode is possible only selecting a different altitude via ALT SEL knob, otherwise the ALT indication on the FMA and the altitude digital readout in the PFD flash for 5 seconds. This logic is valid for all vertical modes, except for Glide Slope (GS). Switching from ALT mode to GS mode occurs without change in ALT SEL selection.

If the ALT Button is pressed while the altitude is varying, the altitude in the moment the ALT Button is pressed will be the new target altitude.

6. VERTICAL SPEED (VS)

The VS mode maintains a vertical speed rate. The VS mode is activated pressing the VS button on the GP. Vertical speed is selected rotating the vertical speed thumbwheel on the GP.

The vertical speed command range goes from -8000 ft/min to +6000 ft/min.

The increments of the Vertical Speed target value are: 50 ft/min (below 1000 ft) and 100 ft/min (above 1000 ft).

7. OVERSPEED PROTECTION (OVSP)

Flight Director provides overspeed protection during the following active vertical modes: ASEL, VASEL, FPA, FLCH, VS, VFLCH, and VPATH. Overspeed protection (OVSP) provides detection and prevention of airspeeds beyond the Vmo/Mmo flight envelope curve. When the FGCS detects that an overspeed condition is imminent, the FD generates guidance commands to maintain airspeed below the VLE or within +/- 5 knots or +/-0.01 Mach of VMO or MMO, whichever is applicable.

When the OVSP protection activates, an amber OVSP indication displays on the FMA. The previous active mode is displayed as armed (white) and becomes active again when OVSP protection is no longer active.

8. GLIDE SLOPE (GS)

The GS approach mode allows the ILS approach mode functions. The GS mode arms when the APP button is pressed and activates when the glide slope is captured.

9. GO-AROUND (GA)

The go-around mode automatically provides go-around guidance and thrust by pressing the TOGA switch. The flight path angle and flight director symbols are displayed when GA mode is activated.

The GA mode deactivates when :

- Another vertical mode is selected,
- TCS button is pressed.

The GA mode first guidance determines pitch 8° :

When IAS is greater than the speed target, the guidance will be the speed target according to the following :

- All engines operating: VREF + 20 kt,
- One engine inoperative: VAC (approach climb).

The VREF and VAC are inserted on the MCDU (PERF > LANDING 3/3).

If speed target is not valid, the airplane guides to pitch 8°.

In GA mode the pitch is limited to a minimum of 8° and a maximum of 18°. The maximum speed target is $V_{fe} - 5$ kt and minimum speed target is $V_{shaker} + 10$ kt for all engines operating. For one engine inoperative the minimum speed target is $V_{shaker} + 3$ kt.

10. WINDSHEAR (WSHR)

Although it is not pilot selectable, Windshear protection will display the label "WSHR" as the vertical active mode in the FMA.

The Windshear guidance is activated when any of following conditions is met :

- Windshear Caution or Windshear Warning condition is detected and Takeoff and Go-around button is pressed at the thrust lever,
- Windshear Warning condition is detected and thrust lever is set to TO/GA position,
- Automatically when Windshear Warning condition is detected and AFCS flight director mode is in TO or GA.

A green WSHR annunciation is displayed on the FMA when the Windshear guidance is activated.

The system provides flight path guidance angle, limited to stick shaker, wings level and aural alert.

The autopilot is disengaged when windshear guidance mode becomes active. After exit windshear conditions, lateral and vertical modes are selected pressing the respective buttons in the guidance panel.

Windshear protection is disabled above 1500 ft AGL.

11. VERTICAL NAVIGATION (VNAV)

The VNAV engages when :

- Upon crossing 400 ft during climb with the VNAV mode previously armed. In this case the system automatically engages,
- The airplane is above 400 ft and the VNAV button is pressed.

The VNAV mode automatically selects the appropriate FGCS mode in order to accomplish the vertical profile. However, the logics for the vertical modes reside within the FGCS. When the vertical mode is selected by the VNAV function, it is said to be a VNAV sub-mode.

11.1. VARM SUB-MODE

When VNAV is selected on the GP, the initial mode is VARM. The FMS keeps the mode VARM up to the moment that it is possible to determine which vertical mode should be used. If the FMS cannot determine which mode to use or cannot determine whether to climb or descend, it stays in VARM until the conflict is resolved. An example of conflict is to set the altitude selector to a higher altitude when the next waypoint constraint is below the current altitude. While in the VARM mode the previous AFCS vertical mode remains engaged.

11.2. VFLCH SUB-MODE

The VFLCH is the VNAV Flight Level Change that can be automatically selected by the FMS or manually by the flight crew. The manual selection of the VFLCH mode occurs when the active mode is VALT and the FLCH button is pressed in the GP. If the Alt Selector is set to an altitude different than the current airplane altitude, the VFLCH mode engages.

11.3. VASEL SUB-MODE

This is the VNAV altitude capture mode. It captures the Alt Selector altitude or the FMS waypoint altitude constraints.

11.4. VALT SUB-MODE

Maintains the altitude commanded by the FMS or the Alt Selector. If the VNAV is disengaged while in VALT, the active mode becomes FPA.

11.5. VPATH SUB-MODE

This is the VNAV FPA mode. In this mode the FMS flies a constant descent angle between two waypoints. The descent angle is defined with following priority:

- Manually entered by the flight crew,
- Defined by a procedure retrieved from the database,
- If no higher priority entry is made, the FMS automatically selects the descent angle.

The path angle can vary from 1° to 6° and it can be seen in the ACTIVE FLT PLAN page.

The FMS maintains a required geometric path sending a vertical speed command to the AFCS. If the descent angle is too steep, the system might not be able to maintain the speed command shown on PFD and on the ACTIVE FLT PLAN page.

The speed command is displayed in the ACTIVE FLT PLAN page 1/3 in CAS and MACH. VNAV selects the value, which results in the lower speed. This value is shown in bigger characters in the MCDU.

12. FLIGHT DIRECTOR OFF MODE

When there are no lateral and vertical modes active, the FD is in the OFF mode. The conditions when the FD can be turned off are:

- The AP is not coupled,
- The lateral modes are either HDG or ROLL.

If those conditions are verified, the FD is turned OFF when:

- FPA is the active vertical mode and is deselected pressing the FPA Button on the guidance panel.
- VS is the active vertical mode and is deselected by pressing the VS button on the guidance panel.

NOTE : *Removal of the FD cue depressing FD Button on the Guidance Panel does not turn off the Flight Director.*

13. SPEED CONTROL

Speed control can be manual or automatic (FMS position) depending on the selection on the Speed Selector Knob. The FMS selection allows the FMS to send its internally defined speeds as target speeds for FGCS.

13.1. MANUAL SPEED CONTROL

If the Speed Selector Knob is set to MANUAL the pilot is responsible for controlling the speed during all flight phases.

13.2. FMS SPEED CONTROL

In this mode the speed command is sent to the AFCS by the FMS.

The departure, climb, cruise, descent, approach and go-around speeds are set in the PERFORMANCE INITIALIZATION page 1/3. If a new schedule is desired these settings can be modified in flight.

13.3. SPEED PROTECTION

The FMS incorporates speed reversion (transition from VPATH to VFLCH) and latched speed protection.

VPATH to VFLCH Transition : Speed reversion is active when the descent is too steep and it is not possible to maintain the selected speed. In this case, the FMS transitions to VFLCH, which maintains the speed within limits. The transition from VPATH to VFLCH automatically occurs if :

- The speed exceeds VMO/MMO + 10 kt during VPATH descents ;
- FMS passes through a speed/altitude limit with a speed greater than 5 kt. In this case, the command is to level off until the speed deviation is below + 2 kt. Afterwards, the FMS commands VFLCH down to the Alt Selector altitude ;
- Landing Gear/Flap speed limit is exceeded by more than 10 kt ;
- In VPATH and the speed is less than VREF - 10 kt.

NOTE : If the Auto Throttle is not engaged the pilot is responsible for maintaining the speed.

Latched speed : It might occur when the FMS transitions from one VNAV sub-mode to another and there is a significant difference between those modes speed targets. It might also occur if there is a significant difference between the speed target and the current speed.

ILS APPROACH

During execution of the ILS approach, Autopilot Approach Status Annunciator displays the current status of the system and alerts whether the intended approach matches system capabilities.

The RA/BARO selector and RA Minimums setting inform the system what is the intended approach.

When ILS modes are requested via APP button, system arms for the highest capability available.

If all necessary requirements are not accomplished, an EICAS message is presented during flight and informs that category II ILS approach mode is not available.

The intended approach is informed to the system setting the barometric correction via control knobs on Display Controller panel (guidance panel).

- CAT1 - set RA/BARO selector to BARO (both sides),
- CAT2 - set RA/BARO selector to RA and adjust Minimums to 80 ft or above.

The operational conditions to accomplish a CAT II approach are :

- RA/BARO set to RA and Minimums set at 80 ft or above,
- Both NAV set to correct LOC frequency,
- Both PFDs set to correct LOC inbound course (V/L or Preview),
- Flap 5,
- All described conditions established at or above 800 ft RA.

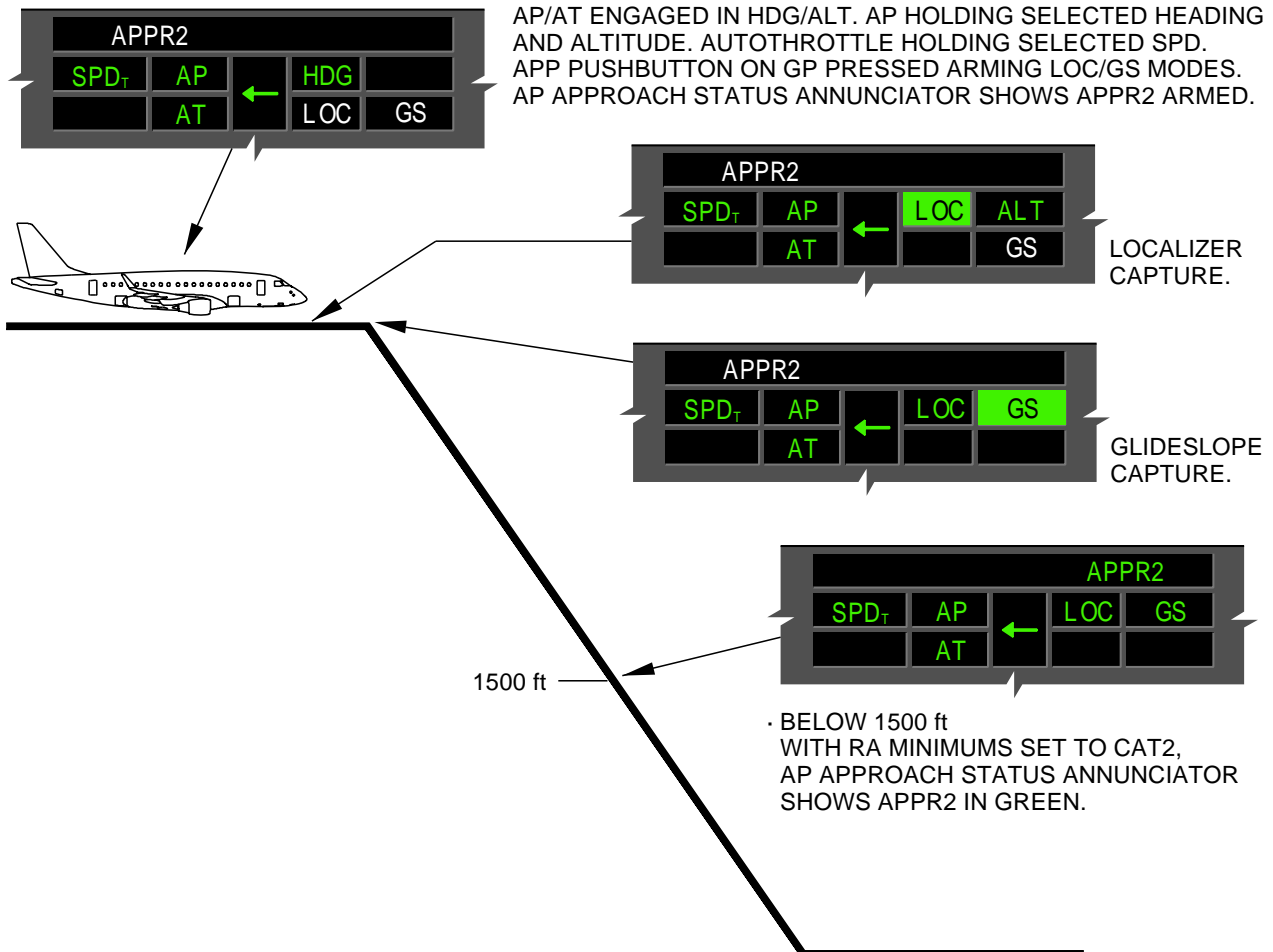
If the flap setting is the only remaining condition to be satisfied for CAT II, the armed status will remain displayed down to 800 ft RA, suggesting there is still one pilot's action pending.

The ILS approach check points are the following :

- 1500 ft RA - system starts trying to engage highest capability available,
- 800 ft RA - system "freezes" highest capability available, not allowing approach "upgrades" anymore.

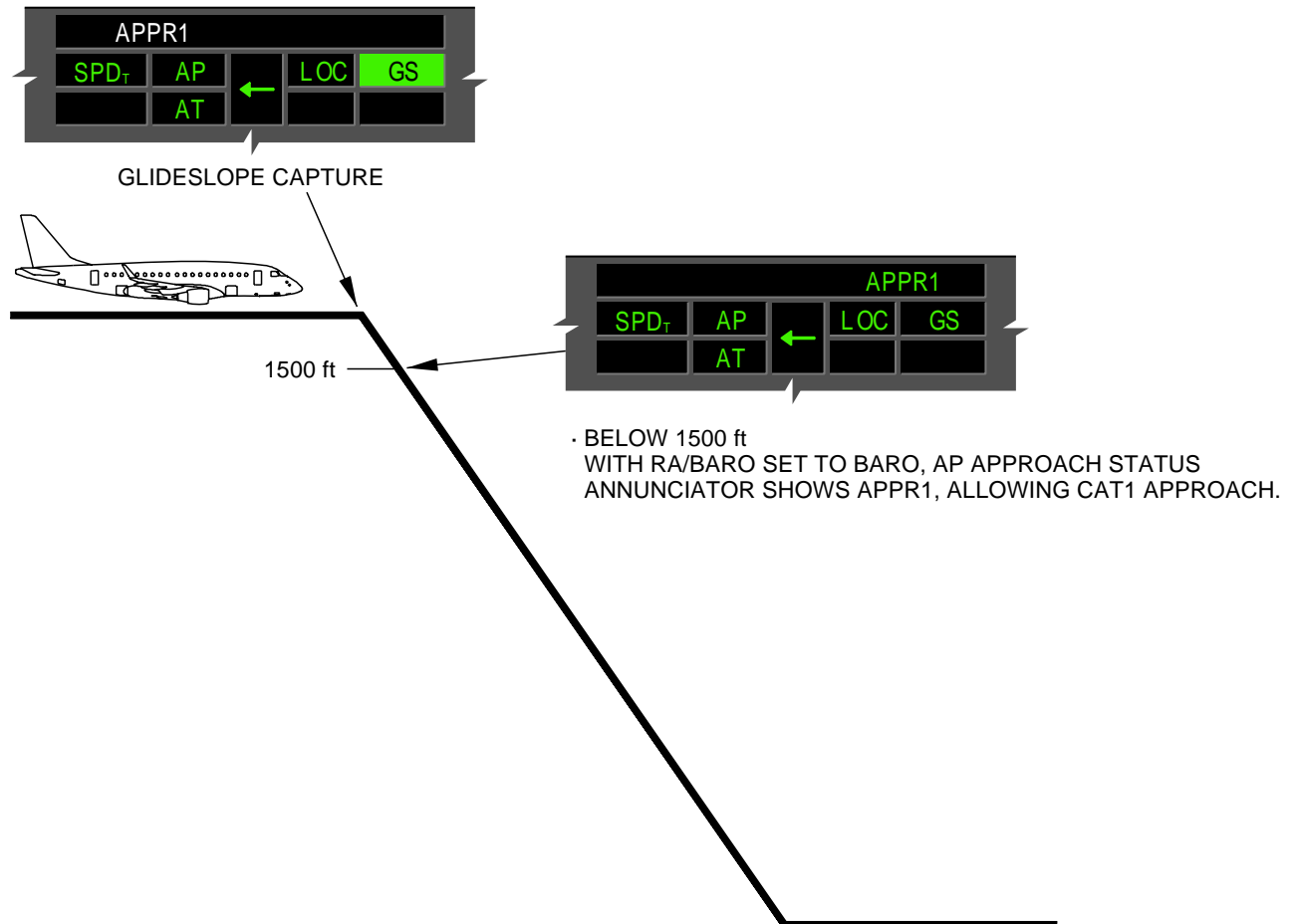
1. APPROACH SEQUENCE - CAT II

APPR 2 AVAILABLE



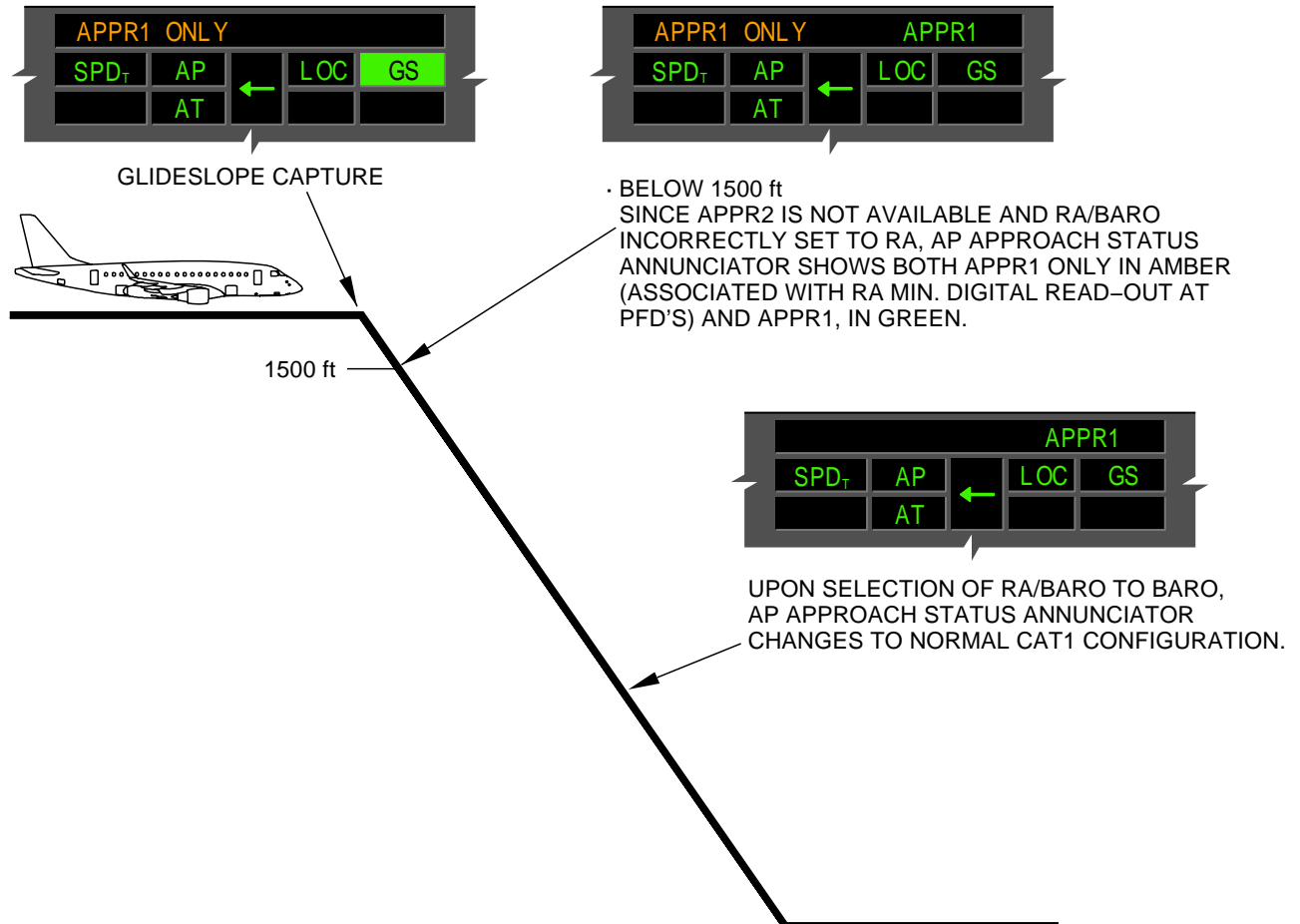
2. APPROACH SEQUENCE - CAT I

APPR 2 NOT AVAILABLE



3. APPROACH SEQUENCE - CAT I (RA/BARO SET RA)

APPR 2 NOT AVAILABLE - RA/BARO INCORRECTLY SET TO RA



YAW DAMPER

The Yaw Damper provides command to the rudder control surface and actuates independently of the autopilot and flight director system.

The YD function engages following successful AFCS on-ground power-up, assuming that valid data for calculating yaw damping is available. The YD remains engaged regardless of autopilot engagement or disengagement or even the loss of turn coordination function.

The yaw damper disengagement occurs as the following :

- The corresponding pushbutton on the GP is pressed,
- The fly-by-wire system turns to direct mode,
- The fly-by-wire system engagement status indicates that control of the rudder surface has failed.

MACH TRIM

The mach trim (MT) function positions the horizontal stabilizer surface as function of Mach number. The MT function is computed in the AFCS and the command is transmitted to HS-ACE via FCM.

Increase of Mach number moves aft the wing aerodynamic center of pressure, causing an pitch down moment. Horizontal stabilizer mach trim up command is required to compensate the pitch down moment.

MT function automatically engages when the conditions below are satisfied :

- Autopilot is not engaged,
- Indicated airspeed is above 0.70 Mach,
- Manual trim of horizontal stabilizer is not in progress,
- Neither of the quick disconnect switches are pressed,
- Any other trim function is not commanding.

If MT function disengages if at least one of conditions above is not satisfied. It also disengages if MT monitor detects a fault in trim rate command.

Mach trim is disabled with AP engagement due to AP trim operation.

The Mach Trim schedule stabilizer position reference will synchronize to the current stabilizer position upon a transition to engage state.

PREVIEW FEATURE

The preview feature allows the capture of an ILS course while still using the FMS as the basic NAV source.

The system automatically selects the ILS frequency and course if the PREV function is used with AUTO tuning enabled on the MCDU radio page. An ILS or BC procedure has to be part of the active flight plan on the FMS to allow automatic selection.

The PFD displays the CDI associated to the selected NAV frequency (LOC or VOR) with FMS selected on the PFD as the primary navigation source.

The AP will intercept the LOC while still displaying the FMS as the primary NAV source. Upon interception, the primary navigation source becomes LOC or BC, instead of FMS.

LOW VISIBILITY OPERATIONS

The system uses an ILS to generate flight guidance to the crew where the environment does not have enough visibility during approach. CAT I, CAT II or CAT III flight guidance is given by the AFCS.

ILS APPROCHES - AUTOLAND DISABLED

During execution of the ILS approach, Autopilot Approach Status Annunciator displays the current status of the system and alerts whether the intended approach matches system capabilities.

The intended approach is informed to the system setting the barometric correction via control knobs on Display Controller panel (guidance panel).

- CAT I - set RA/BARO selector to BARO,
- CAT II - set RA/BARO selector to RA.

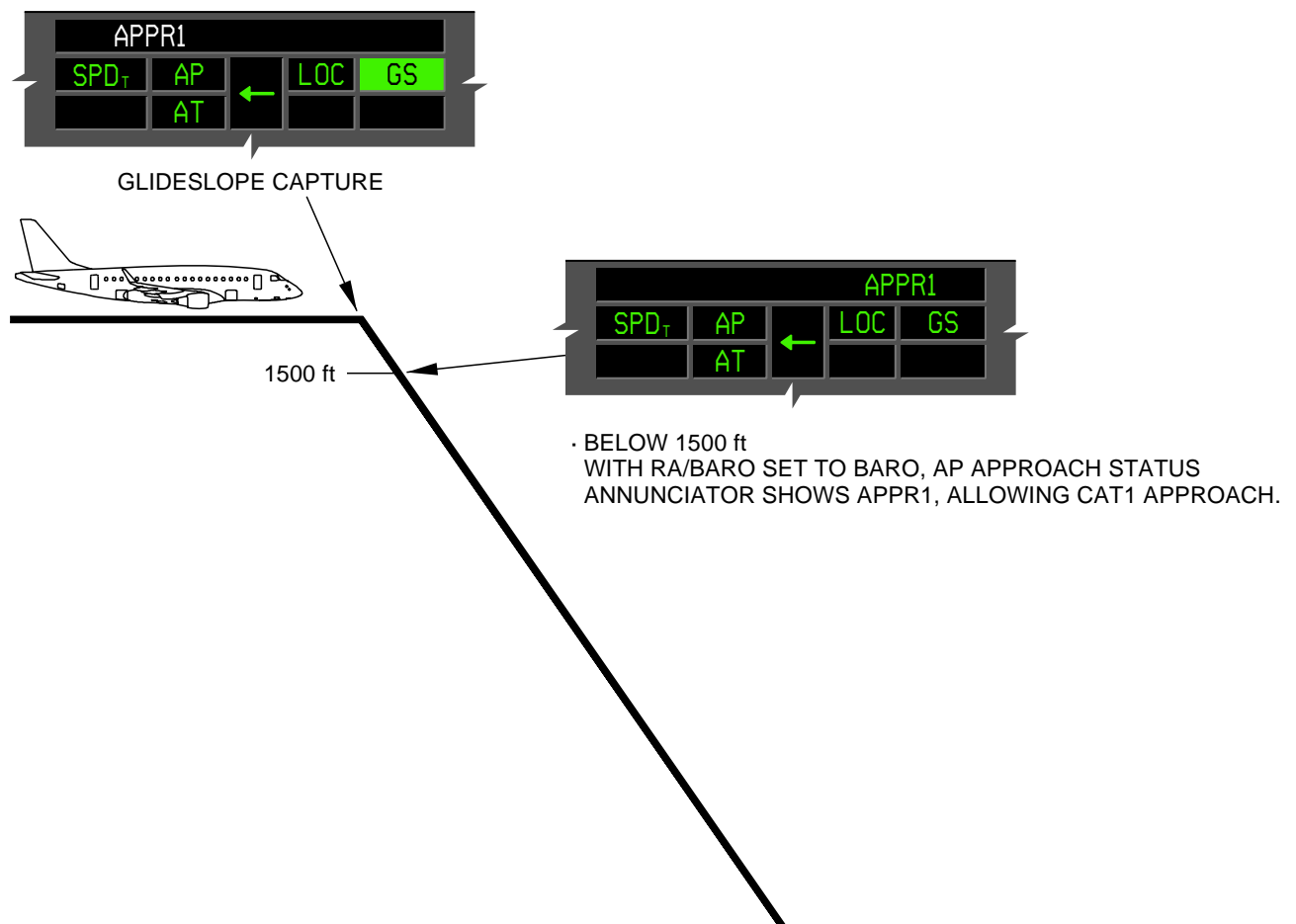
When APP button is pressed, system tries to arm the highest capability available (APPR2 or APPR1 respectively) as follows :

- 1500 ft RA - system starts trying to engage highest capability available,
- 800 ft RA - system freezes highest capability available, not allowing approach upgrades.

1. CAT I OPERATION

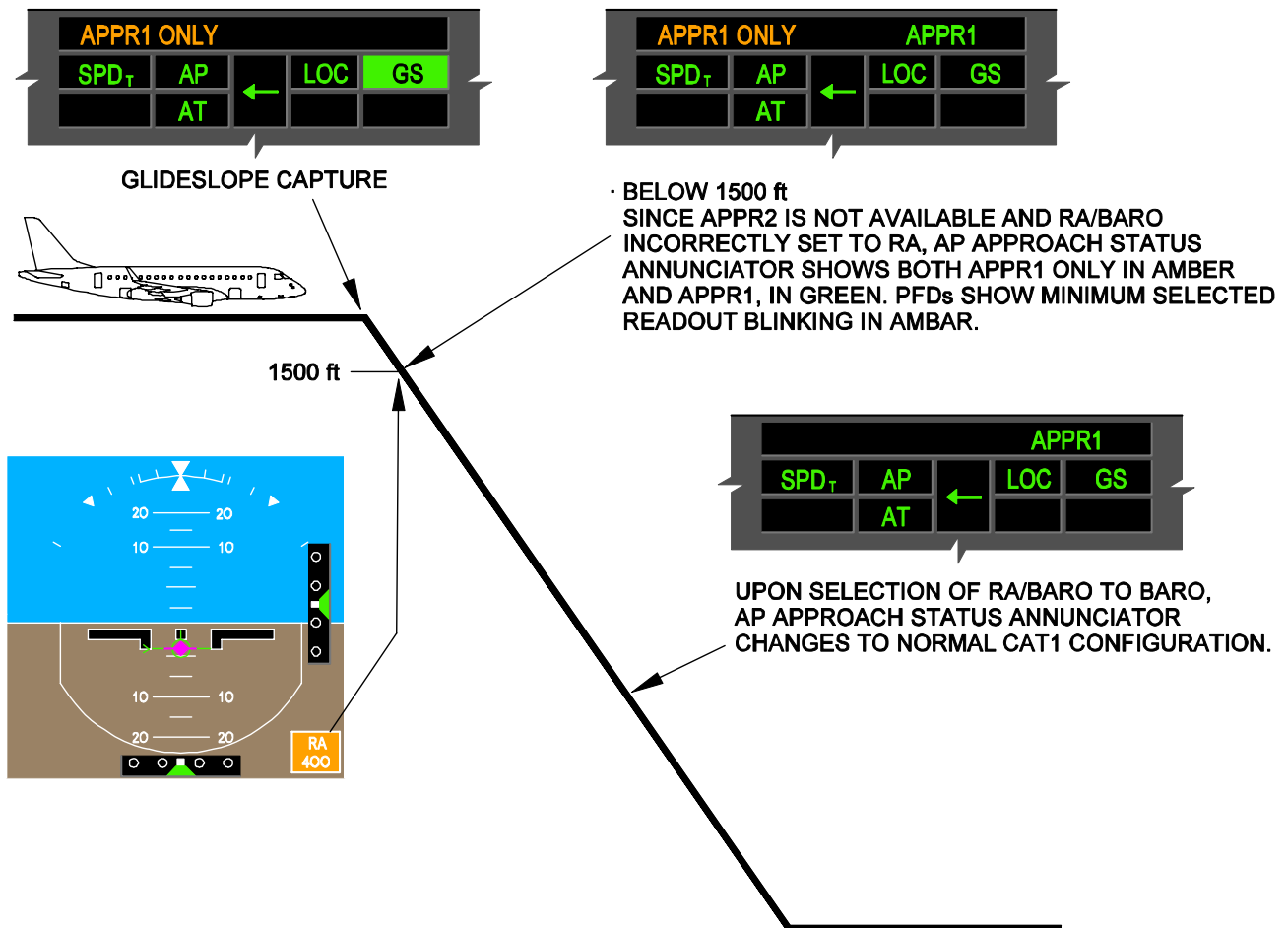
1.1. APPROACH SEQUENCE - CAT I

APPR 2 NOT AVAILABLE



1.2. APPROACH SEQUENCE - CAT I (RA/BARO SET RA)

APPR 2 NOT AVAILABLE - RA/BARO INCORRECTLY SET TO RA



2. CAT II OPERATION

2.1. CONDITIONS TO ARM/ENGAGE

The operational conditions to arm a CAT II approach are:

- RA/BARO set to RA. For CAT II, the minimums can be set to a value of 80 ft or higher, in order to set the EGPWS call outs. The minimums can also be set to OFF in order to disable the EGPWS call outs,
- Both NAV radios set to correct ILS frequency,
- Both PFDs set to correct LOC inbound course (V/L or Preview).

The operational conditions to engage a CAT II approach are:

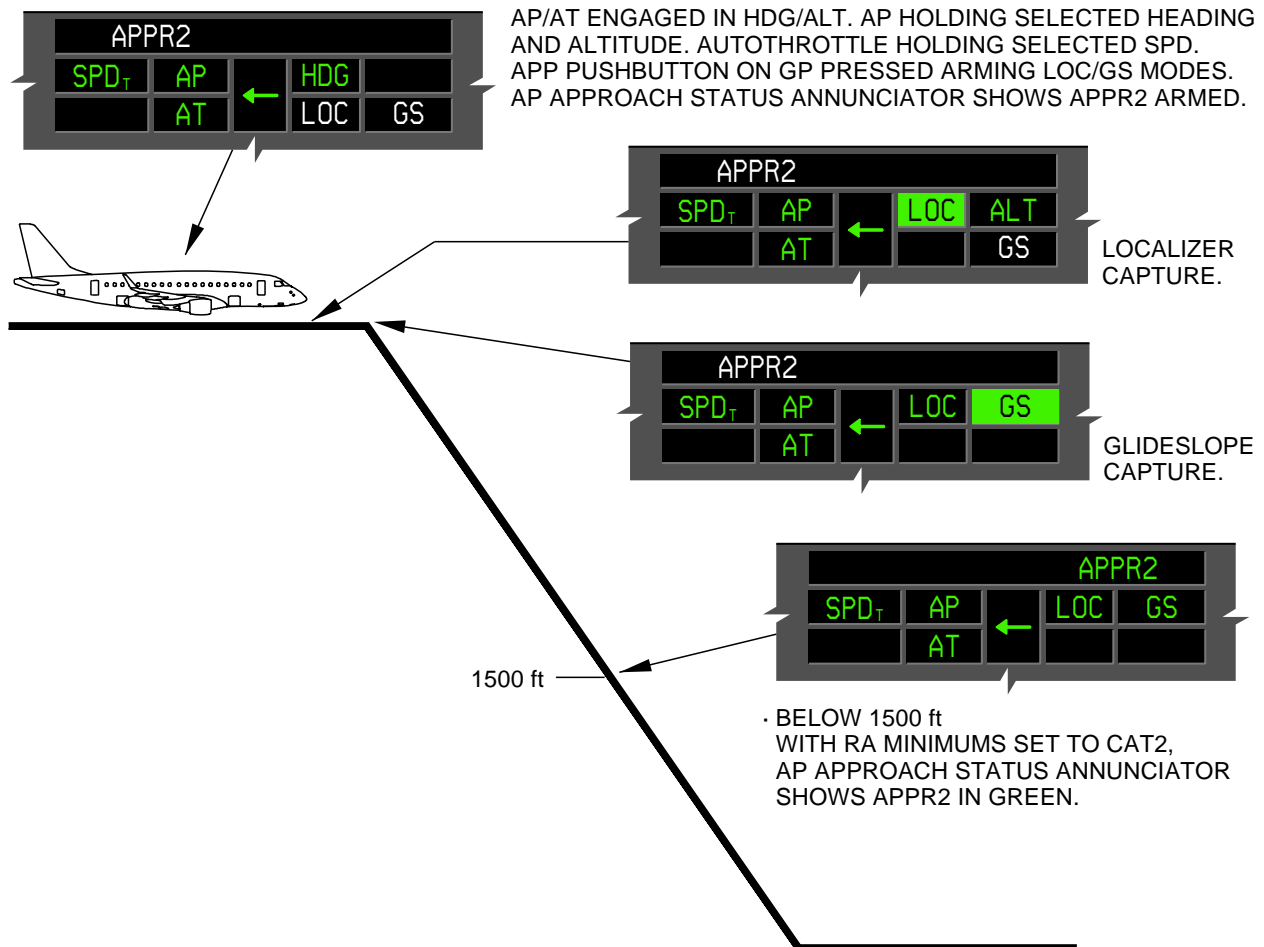
- Flap 5,
- Radio altimeters height below 1500 ft.

If the flap setting is the only remaining condition to be satisfied for CAT II, the armed status will remain displayed down to 800 ft RA, suggesting there is still one pilot's action pending.

If all necessary requirements are not accomplished, an EICAS message is presented during flight and informs that category II ILS approach mode is not available.

2.2. APPROACH SEQUENCE - CAT II

APPR 2 AVAILABLE



3. FAIL PASSIVE CAT IIIA OPERATION

A fail passive system is one that in the event of a failure causes no significant deviation of airplane flight path or attitude. The capability to continue the operation is lost and an alternate course of action is required.

A fail passive CAT IIIa operation is conducted automatically using an Autoland system, with a decision high not less than 50 ft and a runway visual range not less than 600 ft.

AUTOLAND

Autoland 1 consists of approach, touchdown and 5 seconds of roll out with the autopilot engaged. This is accomplished under the capture of localizer and glideslope during an ILS approach (CAT I, II or III beams).

Autoland can be performed with or without autothrottle.

1. CONDITIONS TO ARM/ENGAGE

The operational conditions to arm autoland are :

- Autoland is enabled (MCDU),
- Autopilot and yaw damper engaged,
- RA/BARO set to RA and Minimums set at 50 ft or above,
- LOC 1 on left PFD and LOC 2 on right PFD,
- Both NAV set to correct LOC frequency.
- Both PFDs set to correct LOC inbound course (V/L),
- No miscompares on PFDs.

The operational conditions to engage autoland are :

- Flap 5,
- Both radio altimeters indicating less than 1500 ft.

If the flap setting is the only remaining condition to be satisfied for CAT II, the armed status will remain displayed down to 800 ft RA, suggesting there is still one pilot's action pending.

2. MINIMUM EQUIPMENT REQUIRED

To satisfy the system logic and arm/engage the Autoland 1 Mode, the following equipment are necessary :

- 2 Inertial Reference Systems,
- 1 Flight Director Channel,
- 2 Primary Flight Displays (PFD),
- 2 NAV Radios,
- 2 Radio Altimeter,
- 2 Air Data System (ADS),
- 1 Autopilot System Channel.

3. AUTOLAND DISABLE/ENABLE

When airplane is powered up the autoland default is ENABLE. Autoland can be disable/enable via the SETUP MCDU page. To disable/enable autoland proceed as follows :

- Press MENU button on MCDU to go to MENU page.

MENU PAGE :

- Press line select key 1L to go to MISC MENU page 1/1.

MISC MENU PAGE 1/1 :

- Press line select key 2L to go to SETUP page 1/1.

SETUP PAGE 1/1 :

- To disable/enable autoland press line select key 4L.

SETUP MCDU PAGE



4. AUTOLAND MODES

Five modes are related specifically to Autoland :

- Align (ALIGN): engages at 150 ft and maintains the lateral guidance while the airplane aligns with the runway centerline by means of aileron and rudder control,
- Flare (FLARE): engages at 50 ft and provides vertical guidance for the transition from glideslope to main gear touchdown,
- Retard (RETD): if the autothrottle is engaged, retard engages at 30 ft and commands throttle to idle,
- De-rotation (D-ROT): engages at main gear touchdown and commands a nose pitch down, touching nose gear down,
- Roll out (RLOUT): engages at main gear touchdown and provides lateral guidance to maintain airplane on the runway centerline.

5. AUTOMATIC PITCH TRIM LOGIC

Two automatic pitch trim logics are related to Autoland operations :

- A pre-trim up is commanded at 800 ft radio altitude in order to prevent a nose down transient in an event of an autopilot disconnection. In case of autopilot disconnection a pitch up is expected due to the pre-trim, requiring pilot manual trimming,
- Automatic pitch trim inhibition below 50 ft.

6. PARALLEL RUDDER

In Autoland-equipped airplanes, yaw axis control is provided also through a rudder servo.

The parallel rudder servo engages at Autoland engagement and at go-around with AP engaged. When rudder servo is engaged a self-test is accomplished by a small and slow movement of pedals in both directions, but not causing any rudder movement.

During final approach (AEO or OEI) the system logic applies the crab technique in case of crosswind landing until 150 ft, below 150 ft sideslip is applied.

Loss of rudder servo during Autoland disengages the autopilot causing the loss of Autoland capability. The autopilot also disengages if it occurs in a go around following an Autoland approach.

The rudder servo failures during the attempt to engage the servo cause the AP RUDDER SERVO FAIL to latch. The failure is only reset on ground by a successful electrical power up.

7. ILS APPROACHES - AUTOLAND ENABLED

During execution of the ILS approach, Autopilot Approach Status Annunciator displays the current status of the system and alerts whether the intended approach matches system capabilities. The intended approach is informed to the system setting the barometric correction via control knobs on Display Controller panel (guidance panel).

- AUTOLAND/CAT I - set RA/BARO selector to RA. In order to disable the EGPWS call outs, the minimums can be set to OFF. After the capture of autoland, setting the selector knob to BARO will enable the callouts,
- AUTOLAND/CAT II - set RA/BARO selector to RA. The EGPWS minimums call outs can be set to a value of 80 ft or above. If a specific CAT II procedure chart does not authorize the use of RA, the EGPWS call outs can be disabled setting the RA to OFF,
- AUTOLAND/CAT III - set RA/BARO selector to RA. The EGPWS minimums call outs can be set to a value of 50 ft or above.

When APP button is pressed, system tries to arm the highest capability available (AUTOLAND 1, APPR2 or APPR1 respectively) as follows :

- 1500 ft RA - system starts trying to engage highest capability available,
- 800 ft RA - system freezes highest capability available, not allowing approach upgrades.

8. APPROACH SEQUENCE

Above 1500 ft :

- Pressing APP button on glareshield panel and with all conditions to arm Autoland satisfied makes the white "AUTOLAND 1" annunciation to display on the left side of FMA. The LOC lateral mode and the GS vertical modes arm. When the Autoland engages, the "AUTOLAND 1" annunciation displays in green on the right side of FMA,
- Localizer and glideslope engage when capture.

Between 1500 ft and 800 ft :

- When flap is set to 5 satisfying all conditions to engage Autoland, "AUTOLAND 1" changes place from the right to the left side of FMA. ALIGN and FLARE arm.
- The following buttons are inhibited when Autoland is engaged: TCS, SRC, NAV, APP, BANK, HDG, VNAV, FLC, ALT, FPA and VS,

NOTE : Pressing the IAS/MACH button adjusts the target speed to VFE improperly. Do not use this button during autoland operations.

- At 800 ft a pre-trim up is commanded.

At 150 ft :

- ALIGN engages. RLOUT and RETD (if autothrottle is engaged) arm.

At 50 ft :

- FLARE engages,
- Automatic pitch prim is inhibited.

At 30 ft :

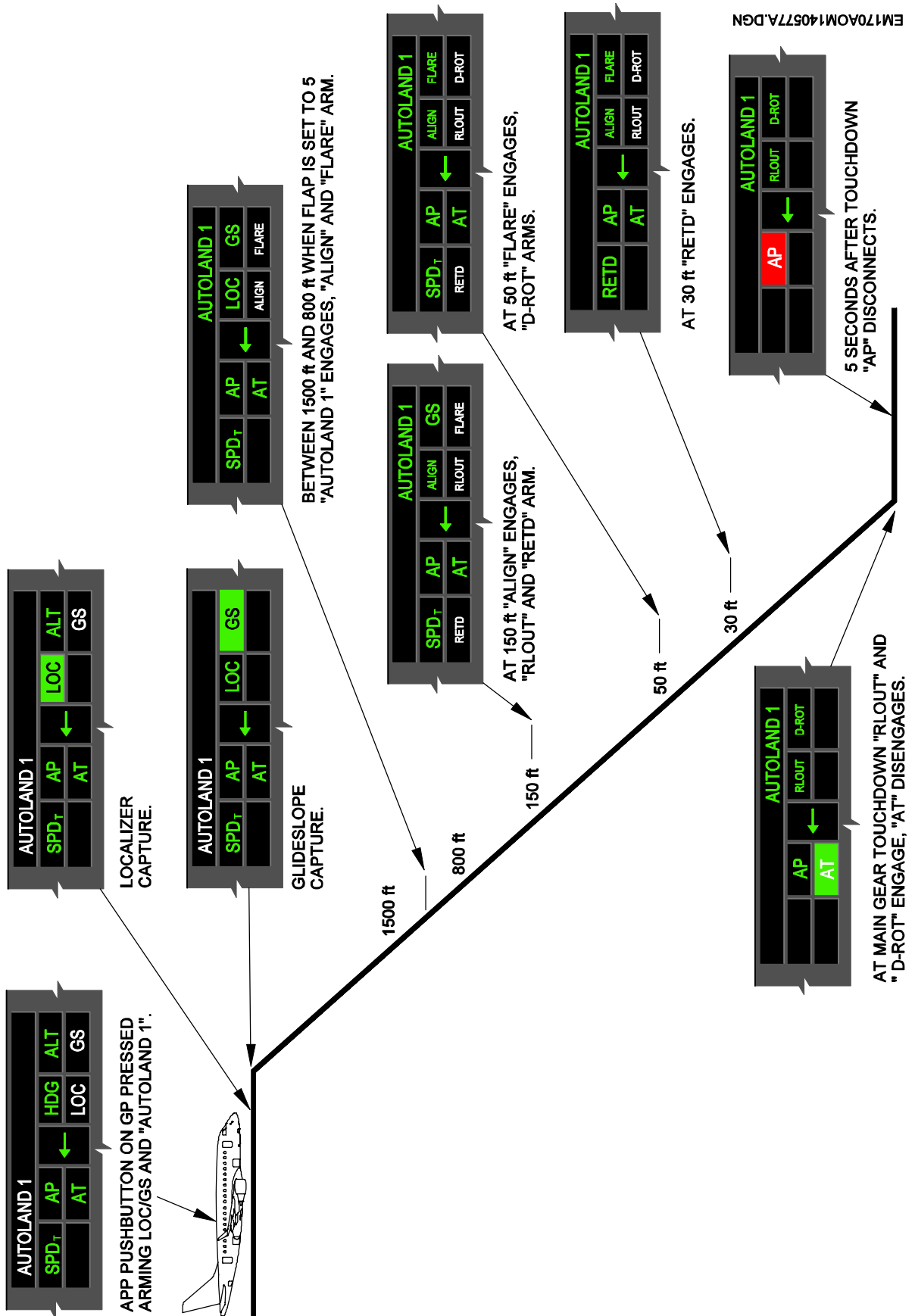
- RETD engages (if autothrottle is engaged).

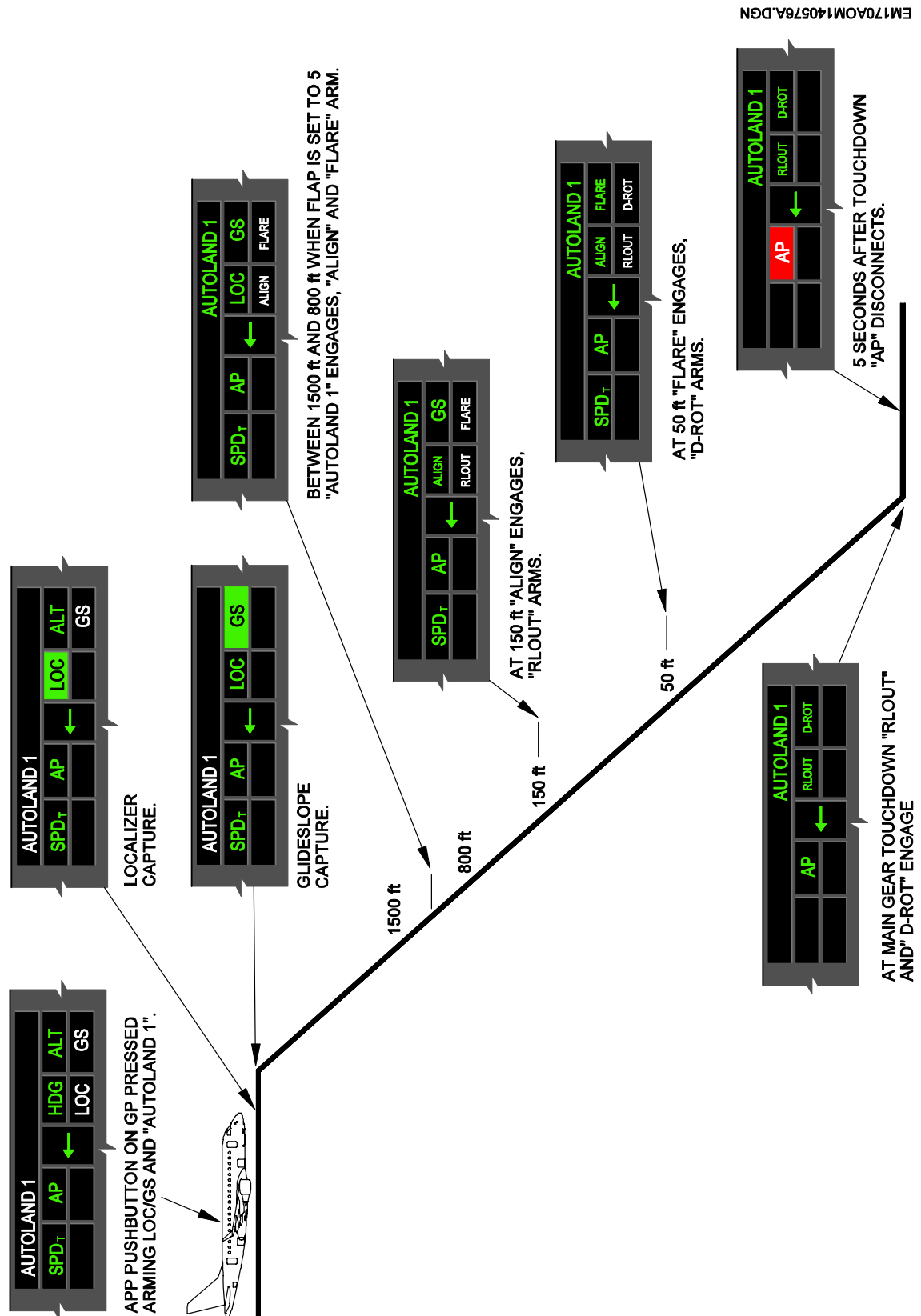
At main gear touchdown :

- RLOUT and D-ROT engage. Autothrottle disengages.

5 seconds after touchdown :

- AP disconnects.

AUTOLAND APPROACH SEQUENCE WITH AUTOTHROTTLE ENGAGED

AUTOLAND APPROACH SEQUENCE WITH AUTOTHROTTLE DISENGAGED

NOTE : The Autoland approach sequences are identical both for AEO and OEI conditions.

THRUST MANAGEMENT SYSTEM

The TMS is a dual channel system comprised of the following dual components :

- Auto Throttle (AT),
- Thrust Rating Selection (TRS),
- Thrust Lever Angle (TLA) Trim.

Only one channel is operating at any given time. The priority channel can be selected via the MCDU.

AUTOTHROTTLE

The AT uses data from the FADEC, Thrust Control Quadrant, MCDU, AFCS Flight Director and Flight Management system to provide automatic, full flight regime energy management with a minimum of pilot inputs.

The AT system provides means to maintain the airplane within its thrust and speed envelopes. Thrust limiting is based on the active N1 rating, while speed limiting is based on the low speed and maximum speed limits (Vmo/Mmo, Gear and Flaps placard).

Gust compensation is provided to increase the lower speed limit above 1.2 Vs up to 5 kts in gusty conditions, with slat/flap position greater than 0 (zero).

The AT is engaged on the ground when :

- All parameters required are valid and AT is capable,
- AT TO mode armed (AT button in the GP is pressed),
- Both thrust levers above 50° TLA.

In flight, the AT engages when :

- All parameters required are valid and AT is capable,
- AT button in the GP is pressed,
- The airplane is 400 ft AGL or above.

Disengagement of AT occurs when :

- Either AT Disconnect Button on the thrust levers is pressed,
- AT button on the GP is pressed,
- TLA difference greater than 8°,
- AT monitor tripped,
- The required system parameters become invalid,
- Transition to on-ground condition (weight-on-wheels or wheels spinning), and thrust levers at Idle and AT in Retard mode.

Anytime the auto Throttle is deactivated, an aural alarm "THROTLLE" is triggered.

Pressing the AT Disconnect Button manually disengages the AT. The second press in the AT Disconnect Button cancels the aural alarm, which sounds at least once.

A single press in the AT Disconnect Button cancels the aural warning after the system automatic disengagement of AT.

"AT" flashes on the FMA anytime the Auto Throttle is disengaged. Pressing the AT disconnect button once cancels the alarm. The visual information will always flash for at least 5 seconds.

"AT" flashes green on the FMA for normal AT disengagement. For abnormal disengagement "AT" flashes red and an EICAS message is displayed. Pressing the AT disconnect button cancels the FMA visual warning but the EICAS message remains displayed.

NOTE : *When the autothrottle is engaged, the thrust levers may have a misalignment of up to half of thrust lever handle diameter.*

The AT modes is described as follows :

- Speed Control Mode - Speed on Thrust (SPDT),
- Flight Level Change Thrust Control Mode - Speed on Elevator (SPDE),
- Takeoff Thrust Control Mode (TO),
- Go-Around Thrust Control Mode (GA),
- Takeoff Thrust Hold Mode (HOLD),
- Retard Mode.

1. SPEED CONTROL MODE - SPEED ON THRUST (SPDT)

The thrust levers are commanded to provide thrust rate as programmed to maintain the desired speed.

The selected speed is controlled by engine thrust during climb, descend and cruise phases.

The vertical modes related to SPDT mode are :

- Flight Path Angle (FPA) - basic vertical mode,
- Vertical Speed (VS),
- Glide Slope (GS),
- Altitude Hold (ALT),
- Altitude Select (ASEL).

The SPDT is also the Auto Throttle mode when the FD is turned OFF.

NOTE : With the AT in the SPDT mode and the AP off, excessive deviations from the FD guidance may cause AT degraded speed control.

2. FLIGHT LEVEL CHANGE THRUST CONTROL MODE - SPEED ON ELEVATOR (SPDE)

The AT maintains a fixed thrust setting, and the AP maintains the selected speed using the elevator command.

For small flight level changes (FLCH mode), the Auto Throttle commands only the necessary thrust in order to maintain a comfortable predetermined schedule based on vertical speed.

For large flight level changes (FLCH mode), the Auto Throttle commands climb setting CLIMB rating and descent in IDLE rating.

The vertical modes related to SPDE mode are :

- Flight Level Change (FLCH),
- Overspeed (OVSP).

3. TAKEOFF THRUST CONTROL MODE (TO)

Takeoff thrust mode (TO) advances the thrust levers to the TO/GA position when AT is engaged on the takeoff phase pressing the Takeoff and Go Around button on thrust levers.

4. GO-AROUND THRUST CONTROL MODE (GA)

The Go-Around thrust mode (GA) advances the thrust levers to the TO/GA position.

5. TAKEOFF THRUST HOLD CONTROL MODE (HOLD)

The HOLD mode prevents movements on the thrust levers that could cause undesirable thrust reductions during TO phase.

HOLD mode activates when TO mode is active and IAS is greater than 60 kt. The AT servos are deenergized and thrust lever movements are not commanded up to 400 ft AGL.

An EICAS message is displayed if HOLD mode engages with TLA position below TO/GA.

6. RETARD MODE

The Retard mode provides the retard of thrust levers to the idle thrust position during airplane flare on landing.

Retard mode is armed (white) based on the following conditions :

- Autothrottle engaged ;
- Flap at 5 or FULL position and landing gear down ;
- Radio Altitude below 150 ft AGL ;
- Radio Altimeter with valid information.

Retard mode activates based on a Radio Altitude valid and less than 30 ft and airplane is in a landing configuration. Once the airplane touches down (weight-on-wheels or wheel spin-up) the auto throttle automatically disengages.

NOTE : Landing with RAT deployed requires selection of flap/slat 3, which not comply with the condition to arm and activate the Retard mode.

7. LIMITED THRUST (LIM)

Limited Thrust (LIM) is set when the selected vertical mode requires more or less engine thrust than that available for the thrust rating selected. In these cases the AT will not be able to maintain the selected speed for climbing or descending and an amber LIM displays on FMA.

LIM is associated to Speed on Thrust mode (SPDT).

8. OVERRIDE (OVRD)

The AT can be overridden by moving the thrust levers, causing no AT disengagement. In this case a green "OVRD" is displayed on the FMA. The thrust levers return to the AT commanded position after override is discontinued.

The Auto Throttle is disengaged when :

- Thrust lever is moved beyond TO/GA position,
- TLA is reduced below 40° (aborted TO case) during TO HOLD mode.

9. AT SINGLE ENGINE OPERATION

The AT deactivates the respective thrust lever when FADEC detects an engine failure or engine shutdown. The operating engine's thrust lever remains active for AT operation.

Reducing the thrust lever to simulate an engine failure will cause AT disengagement due to thrust lever position split.

TLA TRIM

The TLA trim functions are the following :

- Perform small thrust adjustments, with limited authority,
- Reduce excessive thrust lever movements,
- Synchronize N1 rotation speed, increasing comfort.

The TLA Trim is set ON whenever AT is engaged. TLA Trim works even if AT is disengaged, if TLA Trim is set to ON on the MCDU TRS page.

The TRS page on the MCDU is available to set either TLA Trim ON or OFF manually whenever AT is not engaged.

THRUST RATING SELECTION (TRS)

The TRS automatically determines the appropriated engine thrust rating according to the flight phase.

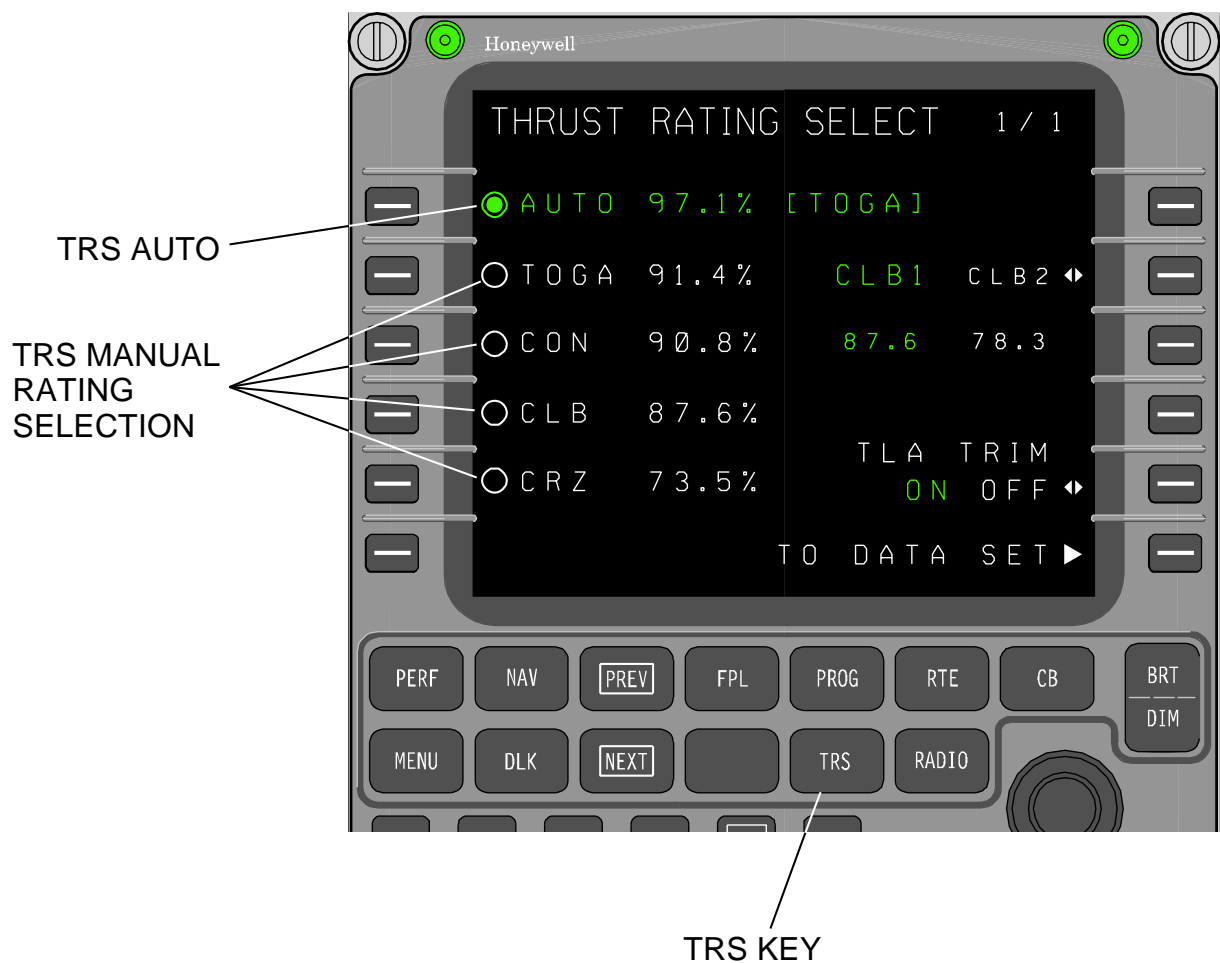
The thrust rating can also be manually selected via TRS page on the MCDU, pressing TRS key.

The FADEC transmits the thrust rating and N1 values provided by TRS for display on the EICAS.

The thrust ratings transmitted by the TRS are as the following :

- Take-off (TO),
- Go-Around (GA),
- Climb-1 : (CLB-1),
- Climb-2 : (CLB-2),
- Cruise (CRZ),
- Continuous (CON).

THRUST RATE SELECT PAGE



The Automatic Flight System has an Auto Rating Type Transition Logic that controls the engine rating changes according to flight phase, airplane configuration and number of engines running.

THRUST RATING SELECTION (TRS)

TO is the engine thrust rating selection on ground, and it remains in TO mode while airplane is below 400 ft AGL.

The change of engine thrust rating from TO to CLB is set when the following conditions occurs simultaneously :

- Any change in vertical mode is detected,
- Airplane altitude is above 400 ft AGL,
- Both engines are running,
- Landing gears are retracted.

If no change in vertical mode is detected, the engine thrust rating switches from TO to CLB at 3000 ft pressure altitude AFE.

The active TRS flight phase is set to CLB when the airplane is in air and the Altitude Pre-selector is above the current Baro altitude.

In one engine inoperative condition, the engine thrust rating changes from TO to CON at 3000 ft pressure altitude AFE.

The active TRS flight phase is set to CRZ when the airplane is in air and Baro Altitude is between 100 ft above and 100 ft below of Pre-selected Altitude for more than 90 seconds.

EICAS MESSAGES

TYPE	MESSAGE	MEANING
CAUTION	AP FAIL	Autopilot function is no longer operative.
	AP PITCH MISTRIM	Pitch trim and autopilot commanding pitch trim control in opposite directions.
	AP PITCH TRIM FAIL	Autopilot stabilizer trim is no longer operative.
	AP ROLL MISTRIM	Roll trim and autopilot commanding roll trim control in opposite directions.
	AT FAIL	Both AT have failed. Selected AT function is unavailable.
	AT NOT IN HOLD	AT not in TO Hold following the transition above 60 knots during TO roll and until the aircraft transitions 400 ft AGL and Go Around.
	ENG TLA NOT TOGA	TLA not at TO/GA position during takeoff and/or go-around phases.
	FD LATERAL MODE OFF	Disconnection of the lateral mode due to invalid conditions.
	FD VERT MODE OFF	Disconnection of the vertical mode due to invalid conditions.
	SHAKER ANTICIPATED	Indication that Shaker activation angles have been advanced to conservative settings.
	STALL PROT FAIL	Stall Warning function and Stall Protection functions are no longer operative.
ADVISORY	AFCS FAULT	Latent fault to AFCS functions.
	AFCS PANEL FAIL	Both channels of the GP have failed.
	AFCS PANEL FAULT	A single channel of the GP has failed.
	AP FAULT	The AP has one channel failed.
	AP PITCH TRIM FAULT	The AP pitch trim has one channel failed.
	APPR 2 NOT AVAIL	The AP is not capable to perform a CAT 2 precision approach.
	AT FAULT	The A/T has one channel failed.
	ENG TLA TRIM FAIL	Selected Sync function is unavailable due to an internal failure or a required input failure. AT function is available.
	FD FAIL	FD is no longer available.
	FD FAULT	A single FD channel is no longer available.
	SHAKER 1 (2) FAIL	Stall warning function has failed.

TYPE	MESSAGE	MEANING
ADVISORY	STALL PROT FAULT	AOA Miscompare Monitor (Stall Warning Subsystem) has failed.
	STALL PROT ICE SPEED	The reference speed has changed. Set reference speed to ice speed. Once the ice condition is detected, the system latches the ice condition active until 30 seconds after WOW becomes true.
	YD FAIL	Yaw damper function is no longer operative.
	YD FAULT	The yaw damper has one channel failed.
	YD OFF	Yaw damper function is off.