CHAPTER 22 - AUTO FLIGHT

TABLE OF CONTENTS

LIST OF FIGURES

GENERAL

The mission of the Auto Flight system is to aid the flight crew by providing automatic control of the main controls of the aircraft by means of an Automatic Pilot and a Yaw Damper, or to obtain indications, by means of a Flight Director System, of the manual manoeuvres to perform.

The Auto Flight System provides the following functions:

- ***Automatic Pilot (AP):*** automatically controls the main aircraft control surfaces to adjust pitch and roll.

- ***Yaw Damper (YD):*** automatically controls the main rudder control to provide:

  1. Yaw Stability,

  2. Coordinated Turns, and

  3. Sideslip Control

- ***Pitch Trim:*** decreases the torque applied by the Automatic Pilot Elevator servomotor to trim the elevator when the Automatic Pilot is engaged.

- ***Flight Director (FD):*** provides visual indication, by means of command bars, of the manual manoeuvres to perform. These are the same manoeuvres as would be performed by the Automatic Pilot if it were engaged.

- ***Auto Flight:*** allows automatic flight of the aircraft by connecting the Flight Director commands to the Automatic Pilot.

AUTO-PILOT / FLIGHT DIRECTOR

The main functions of the Auto-Pilot / Flight Director System are:

– Stabilization of the aircraft around its centre of gravity, maintaining as basic mode its attitude and enabling its modification by the pilots.

– Acquisition and maintenance of new flight conditions.

– Automatic approach.

DESCRIPTION

The Auto Flight Control System is a digital triaxial system that includes the following functions:

– Flight Director (FD) and

– Automatic Pilot/Yaw Damper (AP/YD)

The Flight Director (FD) function provides lateral and vertical guidance, displaying on the Primary Flight Displays (PFD) the command bars that have to be followed and centred by the pilot for the correct performance of the manoeuvre or followed by the Automatic Pilot (AP) when it is engaged. The Flight Director has two guidance modules so that if one fails the other provides full system operation.

The Automatic Pilot (AP) function connects the guidance outputs from the Flight Director to the primary control surfaces through the Automatic Pilot servomotors, thus obtaining aircraft control in its pitch, roll and yaw axes. With the Automatic Pilot engaged it is possible to check that the guidance instructions given by the FD (command bars) are followed by the AP.

The Automatic Pilot and the Flight Director are fully integrated with the FMS through the LNAV (Lateral Navigation) and VNAV (Vertical Navigation) modes of operation.

The system has a Yaw Damper (YD) function that gives lateral stability and enables coordinated turns and sideslip control. The YD function can be used independently from the AP, although the AP cannot be used unless the YD function is engaged.

The Automatic Pilot also provides automatic pitch trimming by reducing the torque applied by the normal Elevator servomotor. Automatic pitch trimming is carried out by the AP using the aircraft pitch trim system (through the ARTCU).

The components of the system are:

– ***Flight Guidance Modules (FGM):*** each of them located in one of the Integrated Flight Compartments (IFC). These control the pitch and trim servomotors, perform the Flight Director and Automatic Pilot functions, and cross checks and safety checks. The module performing the servomotor command function (Auto Flight) is located in IFC1. The second module performs the monitoring functions and is located in IFC2.

– ***Automatic Pilot and Yaw Damper Servomotors:*** linked to the primary control surface command chains, these allow the Auto Flight to control the aircraft in three axes: pitch, roll and yaw.

– ***Control Engagement Unit (CEU):*** allows connecting the Yaw Damper and the Automatic Pilot (AP) and provides basic attitude control.

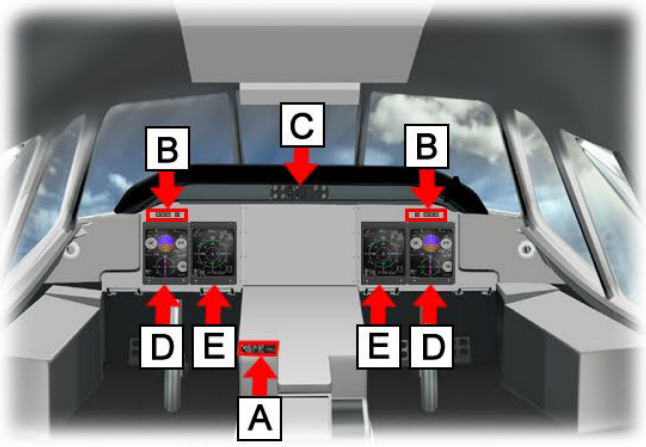
– ***Flight Guidance Control Panel (FGCP):*** allows selection of the Auto Flight and Flight Director modes, captures and holds magnetic heading, indicated airspeed, vertical speed, barometric altitude, lateral and vertical navigation, ILS approach, etc. The FGCP is divided into three zones: Left, Central and Right. The right and left zones are intended for the pilot and co-pilot. From each zone the pilot can select the heading, course radial and the navigation data source used: VOR, ILS or FMS. The central zone is dedicated to the selection of vertical and lateral modes.

– ***Control Wheel Controls:*** there are three buttons on each control column:

  • the first one (AP pushbutton) allows fast disengagement of the Automatic Pilot and Yaw Damper,

  • the second button (SYN pushbutton), allows to operate the clutch on the Automatic Pilot servos, allowing manual control by the pilot while pushed, and

  • the third button (GA pushbutton), disengages the AP and YD and displays Flight Director command bars to perform a manual Go-Around.



Wheel Controls

A Control and Engage Unit (CEU)

B AP DSENG Light

C Flight Guidance Control Panel (FGCP)

D Primary Flight Display (PFD)

E Navigation Display (ND)

Figure 22-1 Auto Flight Control - Components

OPERATION

Flight Director (FD)

The Flight Director (FD) displays pitch and roll guidance commands so that the crew can manoeuvre the aircraft manually by centring the command bars shown on the EADI (located on the PFDs) in the same way the Automatic Pilot would do if engaged. The aircraft symbol on the PFDs should follow and centre the FD command bars.

The FD command bars are visible when the Flight Director (FD) or Automatic Pilot (AP) is activated.

With the AP disengaged, when a Flight Director mode (refer to "Modes of Operation") on the FGCP is activated, the command bars come on the FD (these will be shown on the PFDs). From this point on, the pilot can follow them manually, or engage the AP (refer to "Engaging the AP") so that the commands from the FD are followed automatically.

If the AP fails, it is still possible to activate the modes for FD operation.

Automatic Pilot (AP)

When the Automatic Pilot is engaged (AP), the commands generated by the Flight Director are executed by the servomotors (pitch, roll and yaw). The command bars of the FD remain visible on the PFDs.

The AP commands the pitch and roll servomotors.

The AP has an isolated function allowing automatic pitch trimming.

When the AP is engaged, if no FD mode has been selected, the basic AP mode is activated by default (WING LVL, ROLL HOLD or HDG HOLD) in lateral and (PITCH HOLD) in vertical. If any of the FD modes are active when the AP is engaged, the AP will function in the selected modes.

If there is an external failure to the Automatic Flight Control System (AFCS), engaging the AP will be inhibited. The text INHIBIT will appear on the AP in white and for five seconds on the PFDs when an attempt to engage the AP is made. (After that time it will go off).

In case of an internal failure to the Automatic Flight Control System (AFCS) the AP FAIL message will be shown on the PFDs in amber (flashing for 5 seconds and then steady). In this case, until the conditions causing the failure have disappeared it will not be possible to engage the AP (if the AP was engaged it will be disengaged automatically). However, it will be possible to engage the YD (which will remain engaged if previously engaged). Nevertheless, it will still be possible to active the modes for FD operation.

Engaging the Automatic Pilot (AP)

The Automatic Pilot is engaged from the Control Engagement Unit (CEU). In order to engage the AP, the AP switch needs to be set to the ENGAGED position. A mechanical linkage between the AP and YD makes it impossible to engage the Automatic Pilot without activating the Yaw Damper (YD) function at the same time.

1. Necessary conditions to engage the AP:

   – AHRU 1 and AHRU 2 must be functioning correctly and have the same data.

   – ADU 1 and ADU 2 must be functioning correctly and have the same data.

   – The attitude of the aircraft must be within the AP range of operation (see the range of operation of each mode).

   – The emergency pitch trim guard must be in the normal position (down).

- The SYN pushbutton (TCS function) must not be pushed.
- There must be no STALL ANNUNCIATION.
- Pitch trim should not be in use in manual mode.
- The AP actuators must be functioning correctly.
- Internal AFCS monitoring must be satisfactory.
- The Yaw Damper (YD) must be functioning correctly.
- To have a valid position in the FMS (BCP).

2. Operating Modes:
   - Basic Lateral Modes: ROLL HOLD, WING LVL and HDG HOLD
   - Basic Vertical Modes: PITCH HOLD
   - Higher Lateral Modes: HDG SEL, LNAV, LOC (APP) and BC
   - Higher Vertical Modes: ALT SEL, ALT, IAS, VS, VNAV and GS (APP)

Automatic Pilot Pitch Trimming

The Automatic Pitch Trim function runs by the AP, when it is engaged, having the purpose of reducing (almost to zero) the value of the torque applied by the elevator normal servomotor. The AP acts on the pitch trim tabs through the ARTCU.

The Automatic Pilot Pitch Trimming function is activated automatically when the AP is engaged provided the Tactile Control Steering function (TCS) is not active.

The fact that this function is present has the following effects when the AP is disengaged:

- Low sensation of force in the pitch control at the moment the AP is disengaged manually.
- Slight movement of the pitch controls in case of an automatic disengagement.
- Availability of all the pitch servomotor torque for manoeuvres.

Yaw Damper (YD)

The Yaw Damper (YD) system controls the Rudder servomotor to give:

- Yaw Stability
- Coordination in Turns
- Sideslip Control

The Yaw Damper is turned on by setting the YAW switch located in the Control Engagement Unit (CEU) to the ENGAGED position.

The AP cannot operate without the YD activated. However, the YD function can operate separately from the AP. There is a mechanical linkage between the AP and YD switches on the CEU. This linkage means that when the AP switch is set to the ENGAGED position the YD also gets engaged (if not already engaged). Likewise, when the YD switch is set to DISENGAGED the AP also gets disengaged.

If there is a failure external to the Automatic Flight Control System (AFCS), engaging the YD will be inhibited. The text INHIBIT will appear on the YD in white and for five seconds on the PFDs when an attempt is made to engage the YD (after that time it goes off).

In case of an internal failure of the Automatic Flight Control System (AFCS) the AP/YD FAIL annunciation will be shown on the PFDs in amber (flashing for 5 seconds and then continuously). In this case, until the conditions causing the failure are over it will not be possible to engage the YD (if the YD was engaged it will be disengaged automatically). Nevertheless, it will still be possible to activate the modes for FD operation.

Tactile Control Steering (TCS)

The Tactile Control Steering (TCS) function allows to disengage the AP servomotors (pitch and roll) momentarily.

The TCS function is activated using any of the SYN pushbuttons on the Control Columns. While the pushbutton is pushed, the pilot can manoeuvre the aircraft and modify its attitude manually. When the SYN pushbutton is released the TCS function is deactivated and the AP is re-engaged without loss of the previously activated AP/FD modes.

If the ROLL HOLD, PITCH HOLD, HDG HOLD, IAS, VS or ALT hold modes are active, when the SYN pushbutton is released the new values of the pitch angle, vertical speed, indicated speed, altitude or heading will be taken as the reference to be followed by the AP.

If the LNAV, LOC, BC, ALT SEL, HDG SEL or GA, modes are active, when the SYN pushbutton is released the same values existing before pushing-in in the SYN pushbutton will be kept as the reference to be followed by the AP.

HSI Selection (HSI SEL)

By changing the active HSI (left or right) it is possible to change the data sources (primary and navigation data) used as a reference by the flight control system. Changing the active HSI is achieved by pushing the HSI SEL pushbutton on the FGCP repeatedly. The active HSI is also shown on the PFD of the opposite side.

CONTROLS AND INDICATORS

Control Engagement Unit (*CEU*)

(1) Pitch Control:

increases or decreases the pitch angle as a function of the turn amplitude. When the existing pitch angle is turned and modified, the new value displays in green on the PFDs next to the PITCH annunciation.

When the PITCH value is not valid, or is being modified using the SYN pushbutton, three white dashes are shown instead of the numerical value.

(2) AP Switch:

- *ENGAGED:* engages the roll, pitch and yaw servos to the Flight Director (FD) commands if the checking sequence completes successfully. The YAW switch also moves to the ENGAGED position due to the mechanical linkage.

  When the switch is set to this position and the AP is engaged correctly, the PFDs show the AP annunciation in green. The basic modes are also activated and the corresponding annunciation displays on the FMA: ROLL HOLD (roll >6º and <30º), WING LVL (roll <6º) or HDG HOLD (roll <3º for 10 seconds in WING LVL mode) and PITCH HOLD. If any of the FD modes are active when the AP is engaged, the selected modes will remain.

- *DISENGAGED:* disengages the pitch and roll servos.

  When the switch is in this position and the AP is disengaged the AP DISENGAGED annunciation is displayed on the PFD in amber for 5 seconds. The red AP DSENG lights on the C/M-1 and C/M-2 instrument panels come on and an annunciation bell rings.

(3) YAW Switch:

- *ENGAGED:* engages the yaw servo if the checking sequence completes successfully.

  When the switch is set to this position and the YD is engaged correctly the PFDs display the YD annunciation in green.

- *DISENGAGED*: disengages the yaw servo. Due to the mechanical stop, it also sets the AP switch to the DISENGAGED position.

  When the switch is set to this position and only the YD disengaged, the PFD displays the YD DISENGAGED annunciation in amber for 5 seconds. If the AP and YD disengage simultaneously, the AP/YD DISENGAGED annunciation will be displayed (in amber for 5 seconds), the red AP DSENG lights on the C/M-1 and C/M-2 instrument panels will come on and an annunciation bell rings.

(4) Turn Control:

turning the control causes the angle of roll of the aircraft to change as a function of time, proportional to the displacement of the control, up to the maximum angle of roll with AP (± 30º). When released the control automatically returns to the central position and the AP holds the angle of roll that the aircraft had at that moment. The variations in roll induced by the operation of this control are shown on the PFDs.

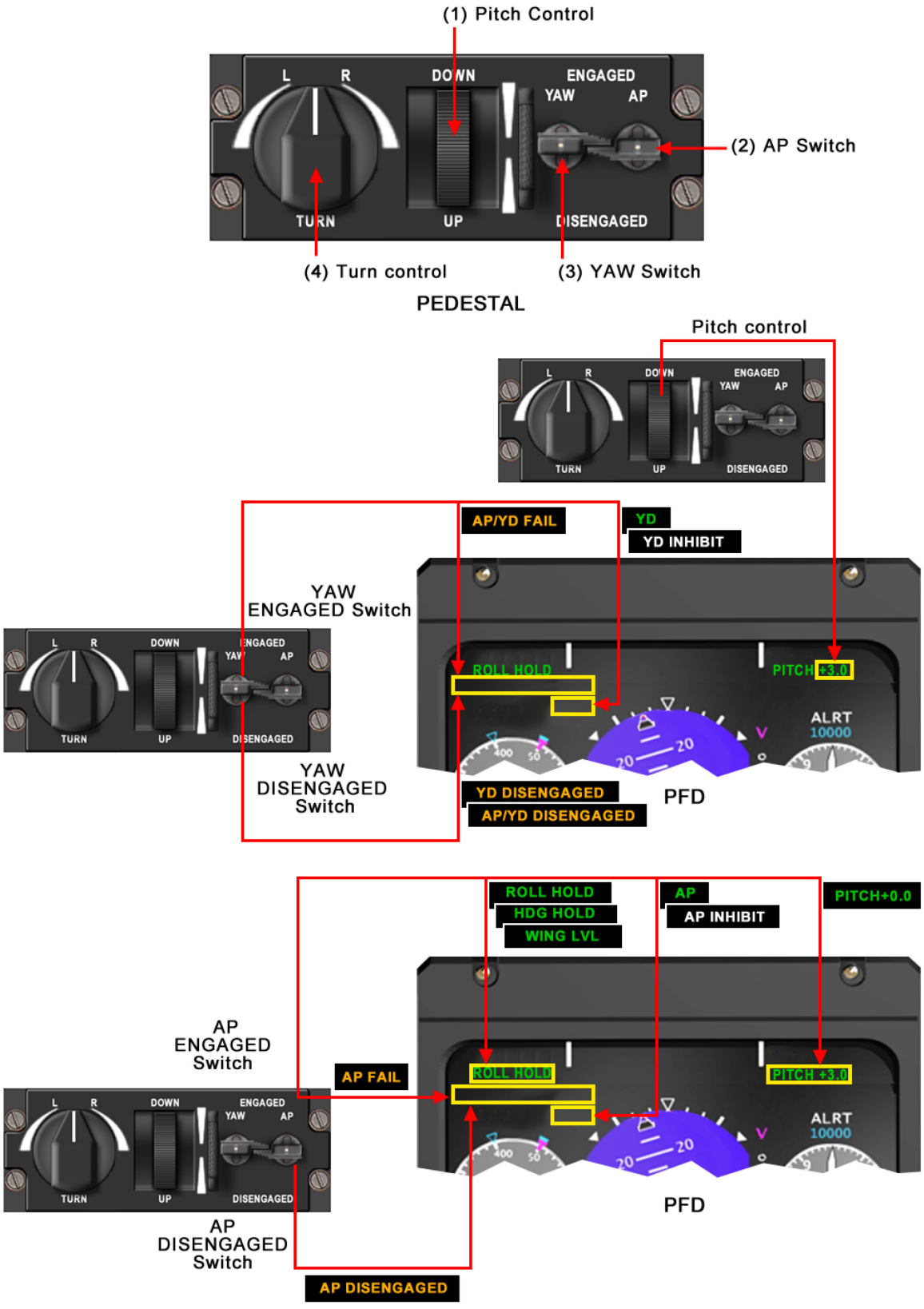


Figure 22-2 Control and Engagement Unit (CEU)

Flight Guidance Control Panel (FGCP)

(1) COURSE selector:

when turned clockwise the selected course/radial is increased, when turned counter clockwise it is decreased. The course/radial value shown on the HSI corresponding with the FGCP sector. The value of the course displays in blue with a range of 1º / 360º, accompanied by the CRS indication in white colour. In the HSI of the PFD and ND the indicator needle of the selected course is also displayed in blue.

(2) Navigation Source selector (NAV SRCE):

selects the Navigation Source for the Higher Navigation modes of the FD. The choice is between VOR or ILS (depending on the frequency tuned), and FMS. When the source is valid, the lateral deviation relative to the selected course is shown on the corresponding side of both the ND and the PFD. The deviation shown does not depend on the active mode of the FD or the state of the HSI SEL.

The selected navigation source is shown on the PFD on the side corresponding to the FGCP selector. The possible indications are: VOR1 (V/L1), VOR2 (V/L2), ILS1 (V/L1), ILS2 (V/L2), FMS1 or FMS2.

The colour of the indication of the Navigation Source is amber if both PFDs use the same source or if the source selection is crossed. In other cases, the indicated colour of the source will be white.

(3) AP/FD Mode Pushbuttons:

once pushed they enable the various modes of the AP/FD. Pushed a second time they cancel the previously active modes.

- *HDG:* The HDG pushbutton activates the interception and hold mode for a selected heading. The HDG SEL annunciation (green) is shown on the Flight Modes Annunciator of the PFD flight automatic control system (FMA).
- *LNAV:* activates the Lateral Navigation Mode. When this mode is pushed, following selection of a navigation source and its frequency, any of the following annunciations will appear (as Lateral Mode Armed and in white):
  - *LOC* (having selected V/L1 or V/L2 and the ILS frequency)
  - *VOR* (having selected V/L1 or V/L2, the VOR frequency and the course)
- *BC:* activates the localizer back course approach mode. When this mode is pushed, following selection of V/L1 or V/L2 as the navigation source and setting the ILS frequency, the BC annunciation is shown. This annunciation appears in white on the FMA of the PFD.
- *APP:* activates the ILS approach mode. When this mode is pressed, after selecting V/L1 or V/L2 as the navigation source and setting its frequency, the following annunciations may appear on the FMA:
  - *LOC (white):* This annunciation corresponds to the Lateral Armed Mode of an ILS approach.
  - *GS (white):* This annunciation corresponds to the Vertical Armed Mode of an ILS approach.
- *VS:* activates vertical speed selection and hold mode. When this mode is pushed, the AP/FD will hold the present vertical speed (rounded to the nearest 100 feet/minute) of the aircraft while selected. When this mode is pushed the VS annunciation is shown in green on the PFD FMA, escorted by the value of the vertical speed, as the Active Vertical Mode.

- *IAS:* activates both indicated airspeed selection and hold mode. When this mode is pushed the AP/FD tries to hold the indicated air speed (rounded to the nearest 1 Kt). When this mode is pushed the IAS annunciation is shown in green on the PFD FMA, accompanied by the value of the indicated speed, as the Active Vertical Mode.
- *VNAV:* activates the Vertical Navigation Mode. When this mode is pushed, a descent profile is generated and the VPATH annunciation is shown in green on the FMA of the PFD.
- *ALT:* activates barometric altitude hold mode. When this mode is pushed the ALT annunciation is shown in green on the PFD FMA as the Active Vertical Mode.
- *ALT SEL:* activates the barometric altitude selection and hold mode. When this mode is activated (following selection of the desired altitude), the mode is armed and the ALT SEL annunciation is displayed in white on the FMA of the PFD as the active Vertical Mode.

(4) HDG Selector:

when turned clockwise, the selected course is increased, when turned counter clockwise it is decreased. The selected course value shown on the HSI corresponding to the FGCP selector. The heading-value displays in blue with a range of 1º / 360º, accompanied by the HDG indication in white colour. In the HSI of the PFD and ND the reference HDG bug of the selected course also displays in blue.

(5) HSI SEL Pushbutton:

- *Pushed:* permits the selection of the source (pilot/copilot seats) for guidance through the AP/FD (selected heading, selected course and navigation source). Repeatedly pushing the selector changes the selected side. The active HSI displays (by means of an HSI annunciation and amber arrow) on the PFD of the not-selected side.

(6) Speed Control:

with the IAS or VS modes already activated, permits to modify the Indicated Speed or Vertical Speed the system to hold. The new value of Vertical Speed or Indicated Speed displays in green on the FMA of the PFD.

(7) ALT Selector:

with the ALT SEL mode selected, permits to modify the target barometric altitude to reach. The value of the requested altitude displays in blue on the PFD above the altitude indication. The reading has a 100 ft resolution. If the selected value is not valid, the reading is replaced by five white dashes.

OVERHEAD PANEL

(8) LAMP AVL PNL Button:

(refer to MULTIPURPOSE CONTROL AND DISPLAY SYSTEM, in CHAPTER 31)

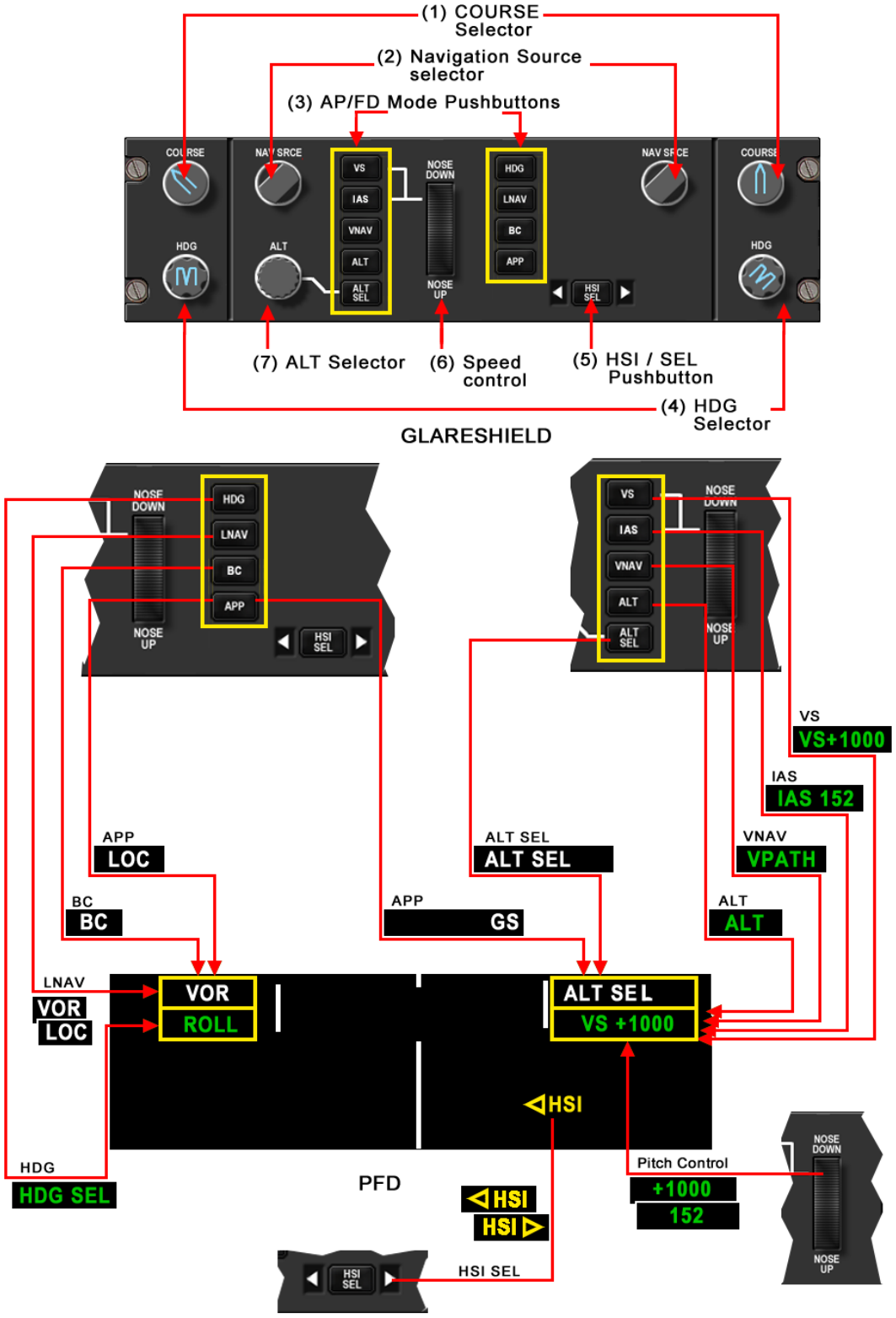


Figure 22-3 Flight Guidance Control Panel (FGCP) - Controls and Indicators (Sheet 1 of 2)

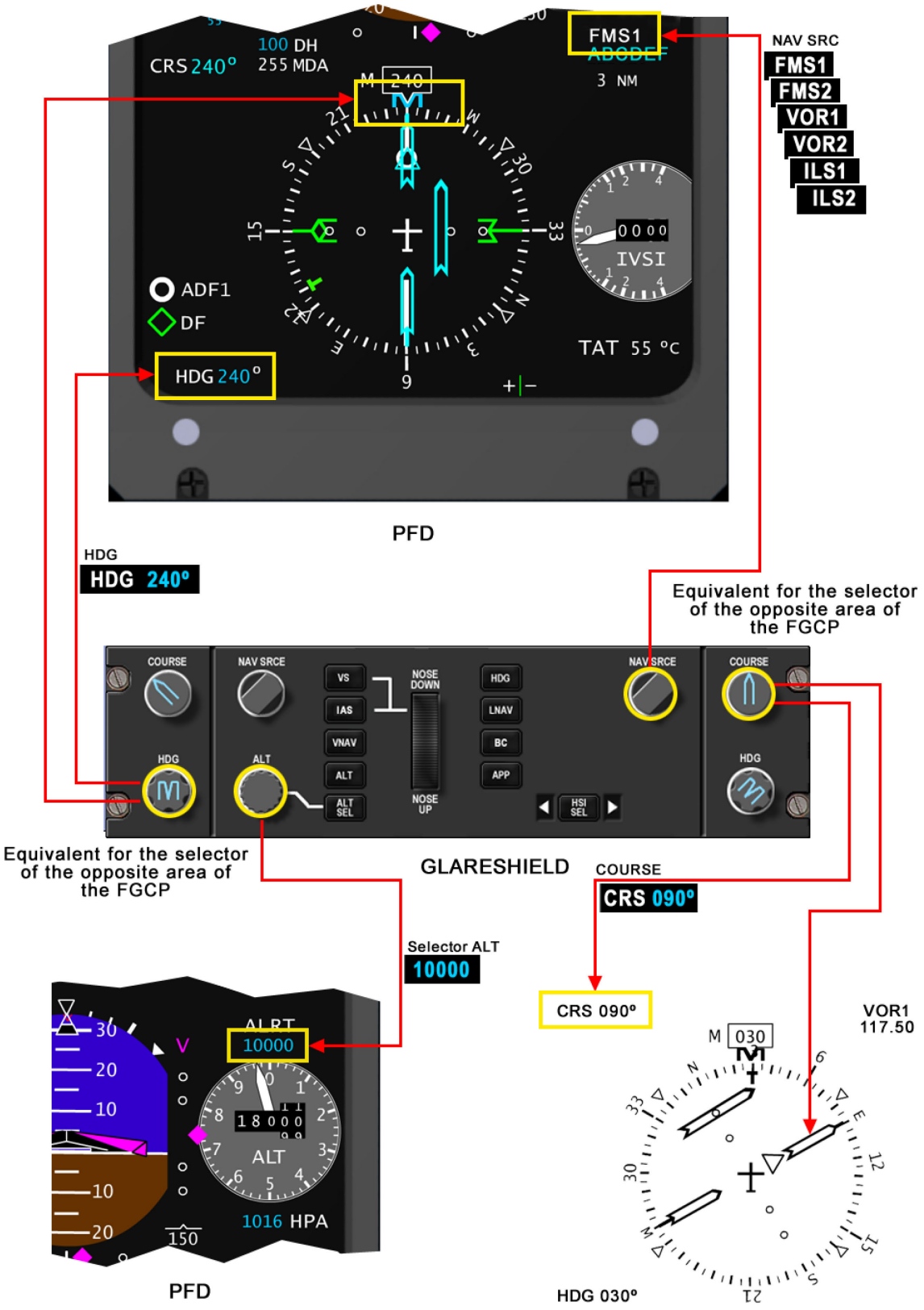


Figure 22-3 Flight Guidance Control Panel (FGCP) - Controls and Indicators (Sheet 2 of 2)

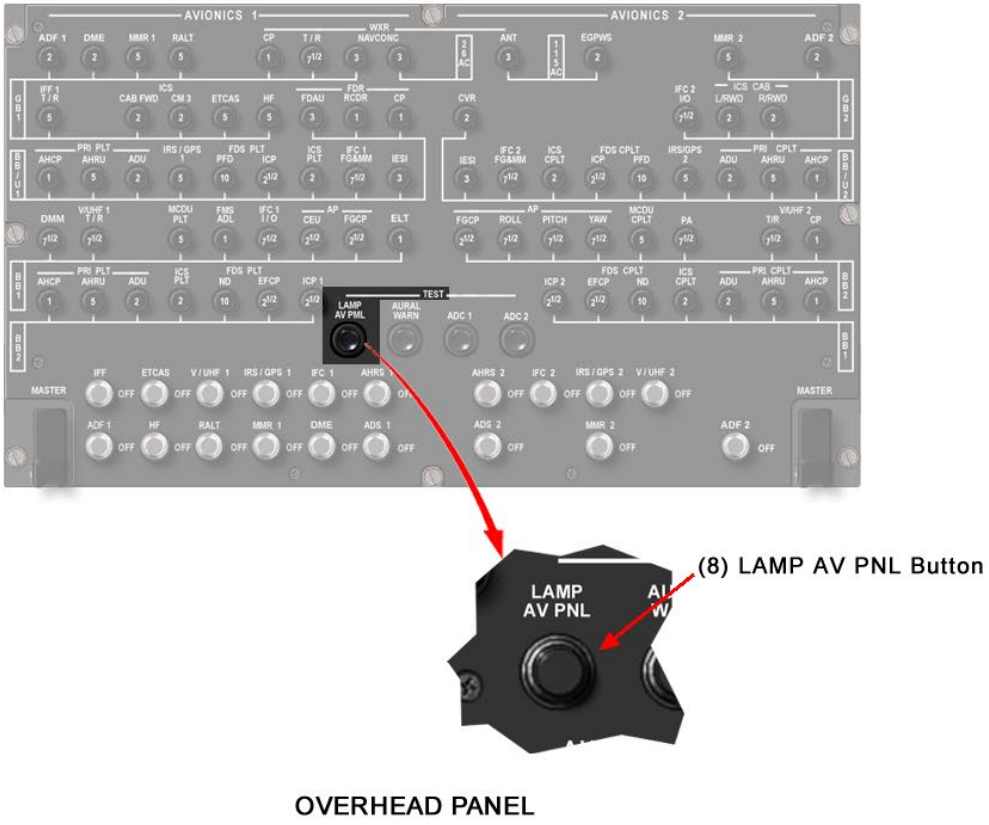


Figure 22-4 Flight Guidance Control Panel (FGCP) - Lamp test - Controls and Indicators

System Pushbuttons on the Control Wheels

(1) GA Pushbutton:

permits Go-around mode. When pushing-in GA:

1. Both AP and YD are disengaged.
2. GA annunciation displays in green on the FMA of the PFD.
3. FD command bars indicates a climb angle of 7º.
4. WING LVL annunciation displays in green on the FMA of the PFD.

(2) AP Pushbutton:

fast and intuitive pushbutton which permits Automatic Pilot (AP) and Yaw Damper (YD) to disengage.

When the AP, YD or AP/YD is automatically disengaged, an annunciation will flash on the FMA of the PFD (and if the AP was engaged its disengage alarm bell will ring and the red AP DSENG lights on the C/M-1 and C/M-2 instrument panels will come on). When the AP pushbutton on the control column is pushed, the annunciation remains for 5 seconds (and then goes off). The alarm bell is also cancelled.

(3) SYN Pushbutton:

Pushed: activates the Tactile Control Steering (TCS) which allows, while pushed, modification of the preset angles of pitch and roll. This changes the reference parameters in the PITCH HOLD, ROLL HOLD, IAS, VS y ALT.

When SYN is pushed the TCS annunciation displays in white on the FMA of the PFD. If the AP was engaged, the TCS annunciation (white) replaces the AP annunciation (green). While the SYN pushbutton is held down, the command bars go off from the PFDs.

When SYN is held down and the aircraft manoeuvred to change pitch or roll condition, the target values of VS, IAS and PITCH are replaced by white dashes. When the SYN pushbutton is released, the new values of these angles are displayed.

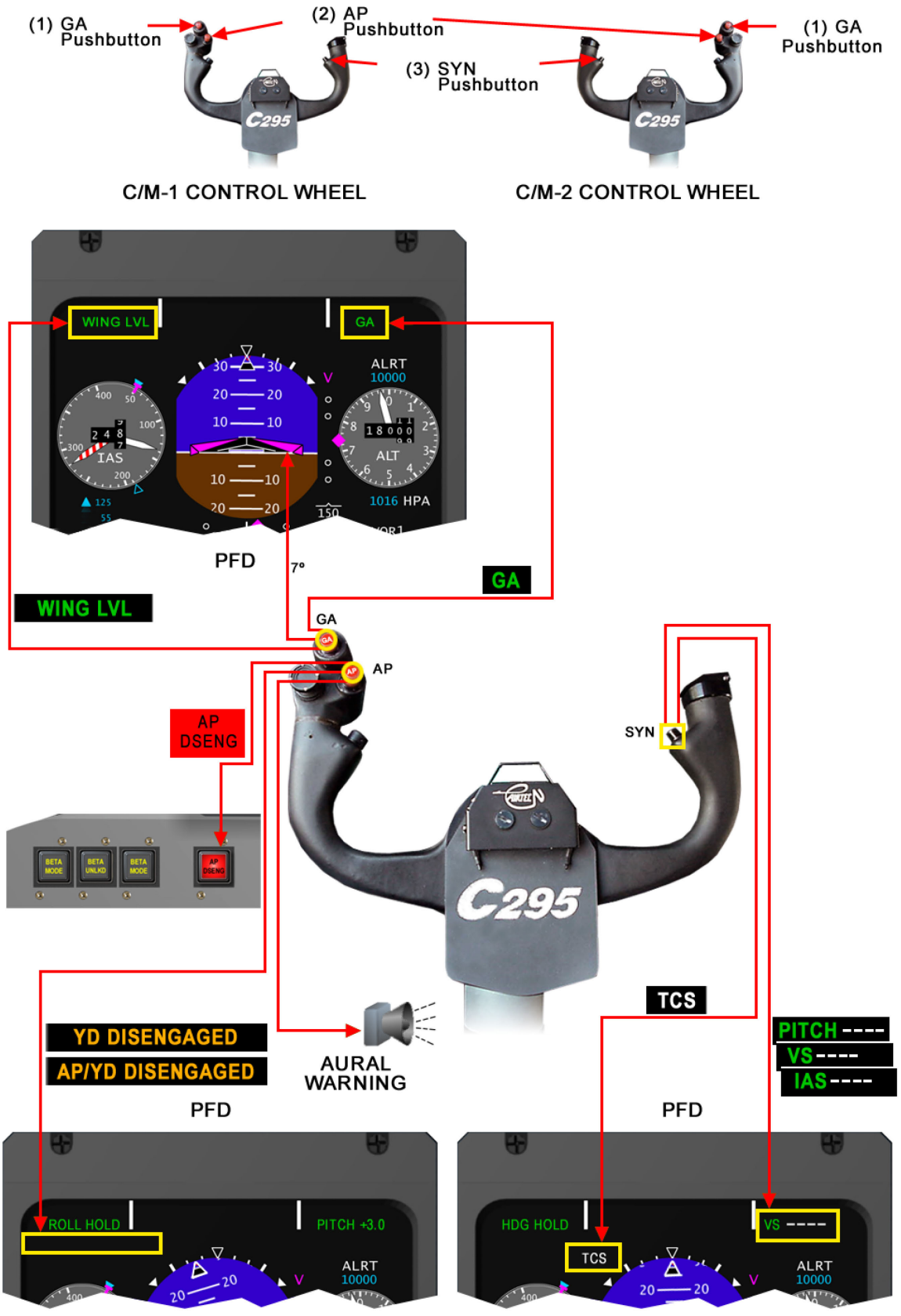


Figure 22-5 System Pushbuttons on the Control Wheels - Controls and Indicators

Automatic Flight Control System Flight Mode Annunciator (FMA)

Mode indications are displayed on the Flight Mode Annunciator (FMA) as follows:

– Lateral Modes are shown on the left hand.

– Vertical Modes are shown on the right hand.

– Failure annunciations are displayed on the central zone.

(1) Lateral Modes Armed Annunciations:

displayed on the left-hand side of the FMA as follows:

- *LOC (white):* displays when the APP or LNAV pushbuttons on the FGCP are pushed with the V/L1 or V/L2 navigation source selected and an ILS frequency tuned on the active navigation source. Refers to the Lateral Localizer Mode for an ILS approach.
- *VOR (white):* displays when the LNAV pushbutton on the FGCP is pushed with the V/L1 or V/L2 navigation source selected, a VOR frequency tuned on the active navigation receiver and the course set (automatic capture of the selected VOR course).
- *BC (white):* displays when the BC pushbutton of the FGCP is pushed, with reference to the Lateral Mode of the back course localizer. This is used to make a back course approach to an ILS navaid.

(2) Vertical Modes Armed Annunciations:

displayed on the right-hand side of the FMA as follows:

- *GS (white):* displays (aligned to the right in its column) when the APP pushbutton on the FGCP is pressed with the V/L1 or V/L2 navigation source selected and an ILS frequency tuned on the active navigation source. Refers to the Vertical Glide Slope Mode for an ILS approach. This annunciation goes out when the mode changes from "Armed" state to "Capture Phase" or while on "Tracking".
- *ALT SEL (white):* displays (aligned to the left in its column) when the ALT SEL mode is armed. Used to automatically capture a selected altitude. This annunciation goes out when the mode changes from "Armed" state to "Capture Phase" or while going to "Altitude Hold" Mode.

(3) Lateral Modes Active Annunciations:

optional mode status are:

– Armed

– In course of Radial Capture Phase (shown with an asterisk)

– Tracking the course, heading or radial (Captured)

Annunciations are displayed for five seconds in reverse video on a green background in each transition to Captured Mode.

- *LOC* (green):* displays when the aircraft is in Capture Phase for the localizer course. The system only shows if the mode has been previously armed.
- *LOC (green):* displays when the aircraft has captured the localizer. Shown once the Capture Phase has been completed (LOC*).
- *VOR* (green):* displays when the aircraft is in Capture Phase of the VOR radial. The system only displays if the mode has been previously armed.
- *VOR (green):* displays when the aircraft has captured the VOR radial. Shown once the Capture Phase has been completed (VOR*).

- *LNAV (green):* displays when the aircraft is following an FMS route.
- *BC* (green):* displays when the aircraft is in Capture Phase of the back course localizer. The system only shows if the mode has been previously armed.
- *BC (green):* displays when the aircraft has captured the localizer back course. Shown once the Capture Phase has been completed (BC*).
- *HDG SEL (green):* displays when the HDG pushbutton on the FGCP is pushed. The AP/FD will try to capture the selected heading. Once the aircraft is on the selected heading the mode remains "HDG SEL".
- *ROLL HOLD (green):* displays when a roll command is selected on the CEU or when the AP is engaged with a roll angle higher than 6°
- *WING LVL (green):* displays when the AP is engaged with an angle of roll between 0° and 6° or when a Go-Around is required. The AP commands the aircraft to turn at an angle of 0º.
- *HDG HOLD (green):* selected automatically when the AP is engaged when the roll angle is less than 3º for more than 10 seconds (WING LVL mode).

(4) Vertical Modes Active Annunciations:

optional mode status are:

– Armed

– In Capture Phase (shown with an asterisk)

– Tracking a course or radial (Captured)

– Holding (altitude, IAS, VS or pitch attitude)

Annunciations are displayed for five seconds in reverse video on a green background in each transition to Holding or Captured Mode.

- *GS* (white):* displays when the aircraft is in Capture Phase for the glide slope. The system only shows if the mode has been previously armed.
- *GS (green):* displays when the aircraft has captured the glide slope. Shown once the Capture Phase has been completed (GS*).
- *ALT* (green):* displays when the aircraft is in Capture Phase for the preset altitude. Capture Phase is only shown when ALT SEL has been previously selected.
- *ALT (green):* displays when the aircraft has reached the preset altitude or when the ALT pushbutton on the FGCP is pushed. The AP/FD holds the current altitude.
- *IAS (green):* displays when the IAS mode is activated by pushing-in the IAS button on the FGCP. The AP/FD holds the Indicated Air Speed (IAS) at the moment of the selection. The IAS value to maintain (modifiable from the FGCP) is displayed next to the IAS annunciator.
- *VS (green):* displays when the vertical speed (VS) mode is activated by pushing-in the IAS button on the FGCP. The AP/FD holds the Indicated Vertical Speed (IAS) at the moment of the selection. The VS value to hold (modifiable from the FGCP) is displayed next to the IAS annunciator.
- *GA (green):* displays when Go-Around mode is activated using the GA pushbutton on the Control Column. This is exclusively an FD mode. The command bars indicates 7º nose up and wings levelled.
- *PITCH (green):* displays when the basic AP Vertical Mode is activated. It is activated when the AP is engaged. The AP/FD holds the pitch attitude at the moment of the selection. The pitch value to hold (modifiable from the CEU) is displayed next to the PITCH annunciator.

- *VPATH (green):* displays when VNAV mode is activated. The FMS provides the target pitch to track during the vertical descent profile to the runway.
- *VCLB (green):* displays when VNAV mode is engaged while on climb or cruise conditions. The FMS provides the target IAS to hold in order to make the initial climb to cruising altitude or the climb steps. The value of the IAS to hold is displayed next to the VCLB annunciator.
- *VDES (green):* displays when the VNAV mode is engaged while cruising. The FMS provides the target VS to hold in order to complete descending steps. The value of the VS to hold is displayed next to the VDES annunciator.

(5) AFCS Failure Annunciations:

- *AFCS FAIL (amber):* displays when a PFD does not receive data from both FGMs. This annunciation initially flashes for 5 seconds and then stays on until the failure disappears.
- *L FD FAIL / R FD FAIL (amber):* displays when a PFD does not receive data from an FGM. This annunciation initially flashes for 5 seconds and then stays on until the failure goes out.
- *AP PITCH TRIM FAIL (amber):* displays when the AFCS is not able to command the pitch trim due to a failure of the pitch trim tab or the ARTCU. This annunciation initially flashes for 5 seconds and then stays on.
- *CEU P/R INOP (amber):* displays when the Pitch Control or the Turn Control on the CEU are inoperative. This annunciation initially flashes for 5 seconds and then stays on until the failure goes out.

(6) AP/YD Status or Anomaly Annunciations:

- *AP/YD DISENGAGED (amber):* displays when the AP and YD are disengaged (manually or automatically). If they are disengaged manually (using the AP switch) the annunciation stays on for 5 seconds and then disappears. If the disengagement is automatic, the annunciation flashes until the crew notice it and push the AP button on the Control Column. It then remains on for 5 seconds and then goes out.
- *AP DISENGAGED (amber):* displays when the AP is disengaged (manually or automatically). If manually disengaged (using the AP switch) the annunciation stays on for 5 seconds and then goes out. In case of automatic disengagement, the annunciation flashes until the crew notice it and press the AP button on the Control Column. It then remains on for 5 seconds and then goes out.
- *YD DISENGAGED (amber):* displays when the YD is disengaged (manually or automatically). If manually disengaged (using the YAW switch) the annunciation stays on for 5 seconds and then goes out. In case of automatic disengagement, the annunciation flashes until the crew notice it and push the AP button on the Control Column. It then remains on for 5 seconds and then goes out.
- *AP/YD FAIL (amber):* displays when an internal failure of the AFCS inhibits engagement of the YD (if previously engaged, it will be disengaged automatically). This warning initially flashes for 5 seconds and then stays on until the failure goes out.
- *AP FAIL (amber):* displays when an internal failure of the AFCS inhibits AP engagement (if previously engaged, it will be disengaged automatically). This warning initially flashes for 5 seconds and then stays on until the failure goes out.
- *MISTRIM [TRIM NOSE UP] or MISTRIM [TRIM NOSE DN] (amber):* displays when an elevator mistrim condition occurs. The annunciation initially flashes for 5 seconds and then remains on the screen until the mistrim condition goes out or the AP is disengaged.
- *MISTRIM [TRIM L WING DN] or MISTRIM [TRIM R WING DN] (amber):* displays when an aileron mistrim condition occurs. The annunciation initially flashes for 5 seconds and then remains on the screen until the mistrim condition goes out or the AP is disengaged.

- *MISTRIM [TRIM NOSE LEFT] or MISTRIM [TRIM NOSE RIGHT] (amber):* displays when a rudder mistrim condition occurs. The annunciation initially flashes for 5 seconds and then remains on the screen until the mistrim condition goes out or the AP is disengaged.

(7) FD Anomaly Annunciations:

- *FD ATT DATA INVLD:* displays as a result of an attitude failure of one of the AHRUs, such that:
  - With the FD activated, all the FD indications go out. This annunciation initially flashes for 5 seconds (amber) and then stays on until the failure goes out.
  - If the AHRU failure precedes the activation of the FD, when trying to activate the FD the annunciation displays constantly (in white) for five seconds and then goes out.
- *FD ADC DATA INVLD:* displays as a result of a failure of the ADU, such that:
  - With the FD activated, all the FD indications go out. This annunciation initially flashes for 5 seconds (amber) and then stays on until the failure disappears.
  - If the ADU failure precedes the activation of the FD, when trying to activate the FD the annunciation displays permanently (in white) for five seconds and then goes out.
- *FD HDG DATA INVLD:* displays as a result of a data failure of the HDG, such that:
  - With the FD activated, HDG SEL or HDG HOLD mode goes out. This annunciation initially flashes for 5 seconds (amber) and then stays on until the failure goes out.
  - If the failure of the HDG data precedes the activation of this FD mode it is inhibited when trying to activate it. The annunciation displays permanently (in white) for 5 seconds and then goes out.
- *FD VS DATA INVLD:* displays as a result of a data failure of the Vertical Speed, such that:
  - With the FD activated the VS mode goes out. This annunciation initially flashes for 5 seconds (amber) and then stays on until the failure goes out.
  - If the failure of the VS data precedes the activation of this FD mode, it is inhibited when trying to activate it. The annunciation is permanently displayed (in white) for 5 seconds and then goes out.
- *FD LNAV DATA INVLD:* displays as a result of a failure of a navigation sensor, such that:
  - With the FD activated the LNAV mode goes out. This annunciation initially flashes for 5 seconds (amber) and then stays on until the failure goes out.
  - If the failure of the navigation sensor precedes the activation of this FD mode, it is inhibited when trying to activate it. The annunciation displays permanently (in white) for 5 seconds and then goes out.
- *FD VNAV DATA INVLD:* displays as a result of a failure of a navigation sensor, such that:
  - With the FD activated the VNAV mode goes out. This annunciation initially flashes for 5 seconds (amber) and then stays on until the failure goes out.
  - If the failure of the navigation sensor precedes the activation of this FD mode, it is inhibited when trying to activate it. The annunciation displays permanently (in white) for 5 seconds and then goes out.
- *FD MODE INHIBIT (white):* displays when the pilot has made an invalid request. The annunciation displays permanently for 5 seconds and then goes out.
- *CHECK NAV SOURCE:* displays as a result of a change in the navigation source or while trying to activate BC mode with an invalid navigation source selected, such that:

– With the FD activated the affected NAV mode goes out. This annunciation initially flashes for 5 seconds (amber) and then stays on until the failure goes out.

– If the change of navigation source or incorrect selection precedes the activation of the affected FD mode, while attempting activation it is inhibited. The annunciation displays permanently (in white) for 5 seconds and then goes out.

(8) TCS/YD/AP Activation Annunciations:

- *YD INHIBIT (white):* displays when attempting to engage the YD but an AFCS condition or external failure inhibits engagement. The annunciation only lasts 5 seconds.
- *AP INHIBIT (white):* displays when attempting to engage the AP but an AFCS condition or external failure inhibits engagement. The annunciation only lasts 5 seconds.
- *TCS (white):* shows that the Tactile Control Steering (TCS) is being used and appears while any of the SYN pushbuttons are pushed on the Control Column.
- *AP (green):* displays when the AP and the YD are engaged.
- *YD (green):* displays when the YD is engaged without the AP.

(9) Incompatibility Annunciations:

- *CHECK PFD1 (amber) and CHECK PFD2 (amber):* Indicates that a failure has been detected when comparing one of the critical parameters (attitude, heading, IAS or barometric altitude) on both PFDs. The failed parameter displays on the corresponding PFD as follows:
  - *"IAS" CAPTION OF ANEMOMETRIC READING:* in case of discrepancy between the IAS readings on the ADUs or if there has been a failure of the IAS value monitoring, the corresponding PFD (if due to a monitoring failure) or both (if the failure is due to discrepancy between the ADUs) this caption will turn from white to amber (flashing for 5 seconds and then continuously).
  - *"ALT" CAPTION ON THE BAROMETRIC ALTITUDE READING:* if there is any discrepancy between the ALT readings on the ADUs or if there has been a failure of the monitoring of the ALT value, the corresponding PFD (if due to a monitoring failure) or both (if the failure is due to a discrepancy between the ADUs) this caption will turn from white to amber (flashing for 5 seconds and then continuously).
  - *ATTITUDE READING FAILURE ANNUNCIATIONS:* indicate the pilot that the inertials are providing different values of ROLL and/or PITCH or that there is a failure in the monitoring of the affected attitude indication. The Electronic Attitude Display Indicator (EADI) on both of the PFDs (in the first case) or on the affected PFD (in the second case) will show the following annunciations (flashing for 5 seconds then continuously):
    - ROLL (amber)
    - PITCH (amber)
  - *HEADING READING FAILURE ANNUNCIATION:* indicates the pilot that the inertials are providing different values of HDG or that there is a failure in the monitoring of the relevant heading indication. The centre of the rose of the Electronic Attitude Display Indicator (EADI) on both of the PFDs (in the first case) or on the relevant PFD (in the second case) will show the HDG annunciation in amber (flashing for 5 seconds then continuously).

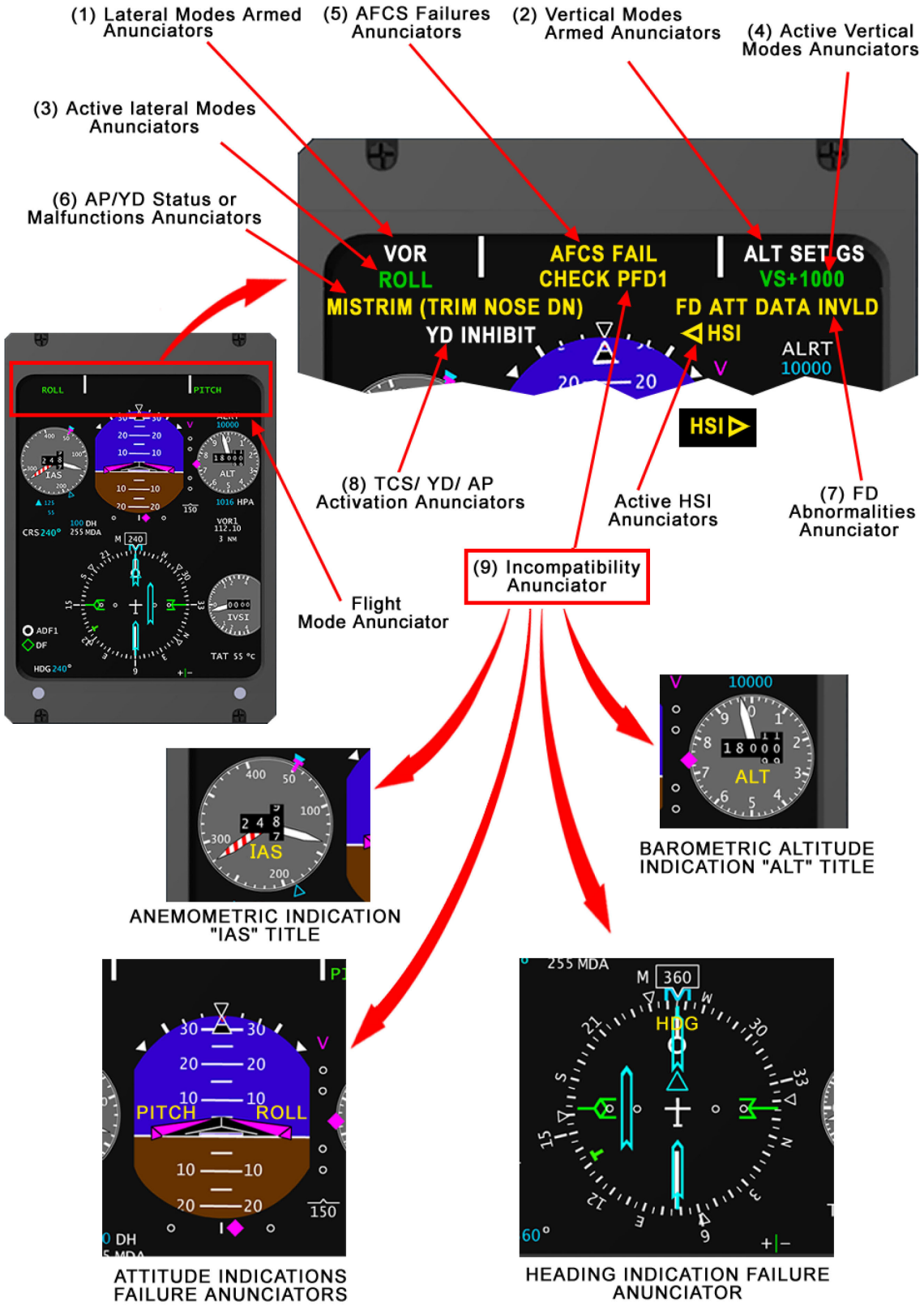


Figure 22-6 Automatic Flight Control System Flight Mode Annunciator (FMA) - Controls and Indicators

OPERATING MODES

LATERAL MODES

Basic Lateral Mode (ROLL HOLD, WING LVL and HDG HOLD)

Basic Lateral Mode is activated by engaging the AP or activating a vertical mode of the FD (with no lateral mode active at this moment).

The Basic Lateral Mode of the AP holds the roll angle (ROLL HOLD), the wings level (WING LVL) or the current heading (HDG HOLD) depending on the value of the roll angle of the aircraft at the time the AP was engaged.

This mode is activated as follows:

– Engage the AP by setting the AP switch on the CEU to the ENGAGED position.

– Once activated, the AP holds the roll angle (ROLL HOLD) for angles between ± 6º y ± 30º or levels the wings (WING LVL) for angles less than ± 6º. In this latter case, if the roll angle is less than 3º for more than 10 seconds in WING LVL mode, HDG HOLD mode will be entered automatically and the aircraft heading will be held.

– Roll angle can be changed by turning the Turn Control on the CEU or using the SYN pushbutton on the control column. When the SYN pushbutton is pushed, the Tactile Control Steering (TCS) function is activated. While the SYN pushbutton is pushed it is possible to manoeuvre the aircraft manually and change the roll angle values. When the SYN pushbutton is released the AP will return to basic lateral mode and hold the new roll angles as its target.

Range of operation:

– Basic lateral mode can only be activated for roll angles in a range of ± 30º

NOTE

When engaged between 30º and 35º bank, the automatic pilot will return airplane to 30º bank.

– The AP will disengage if the roll angle exceeds ± 35º.

– The FD will disengage if the roll angle exceeds ± 60º.

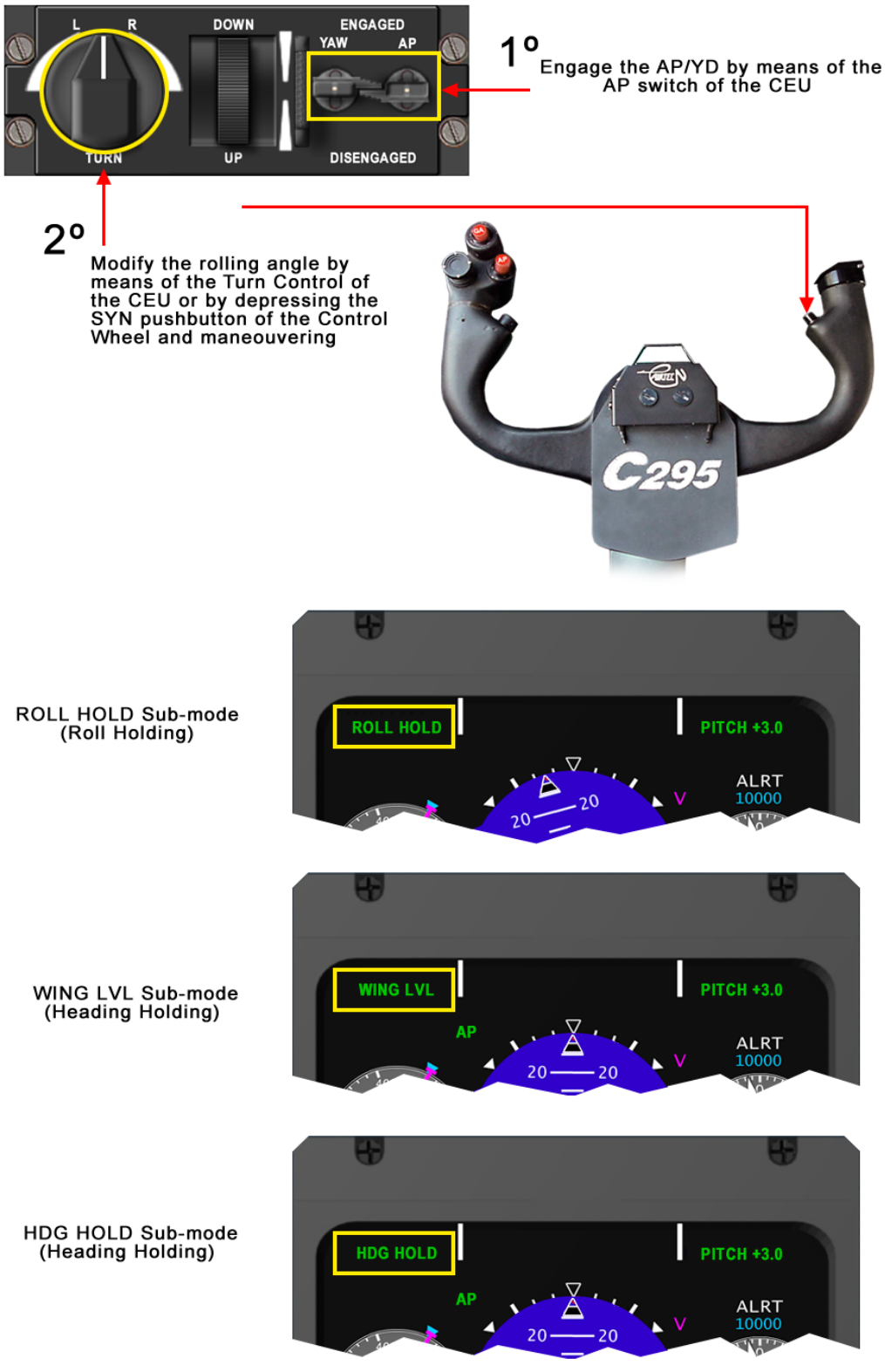


Figure 22-7 ROLL HOLD, WING LVL and HDG HOLD Mode

Capture and Hold Magnetic Heading (HDG) Mode

In this mode the AP/FD captures and maintains the heading selected on the HDG Selector. This selector is located on the FGCP.

This mode is activated as follows:

- Select the required heading using the HDG Selector (left or right) on the FGCP.
- Activate the mode by pushing the HDG pushbutton on the FGCP.

The expected behaviour of the system is as follows:

- PFD and ND will display the preset heading and the selection on the HSI (HDG bug).
- After pushing-in in the HDG pushbutton, the aircraft will look for the selected heading while the HDG SEL mode is active.
- Command bars of the FD will be visible on the PFDs.
- With the mode active, when the HGD selector is turned, the aircraft will follow the heading changes.
- HDG SEL mode is selected automatically when LNAV, APP or BC modes are armed.

Range of operation:

- Maximum roll angle permitted by the AP in this case is ± 25º.

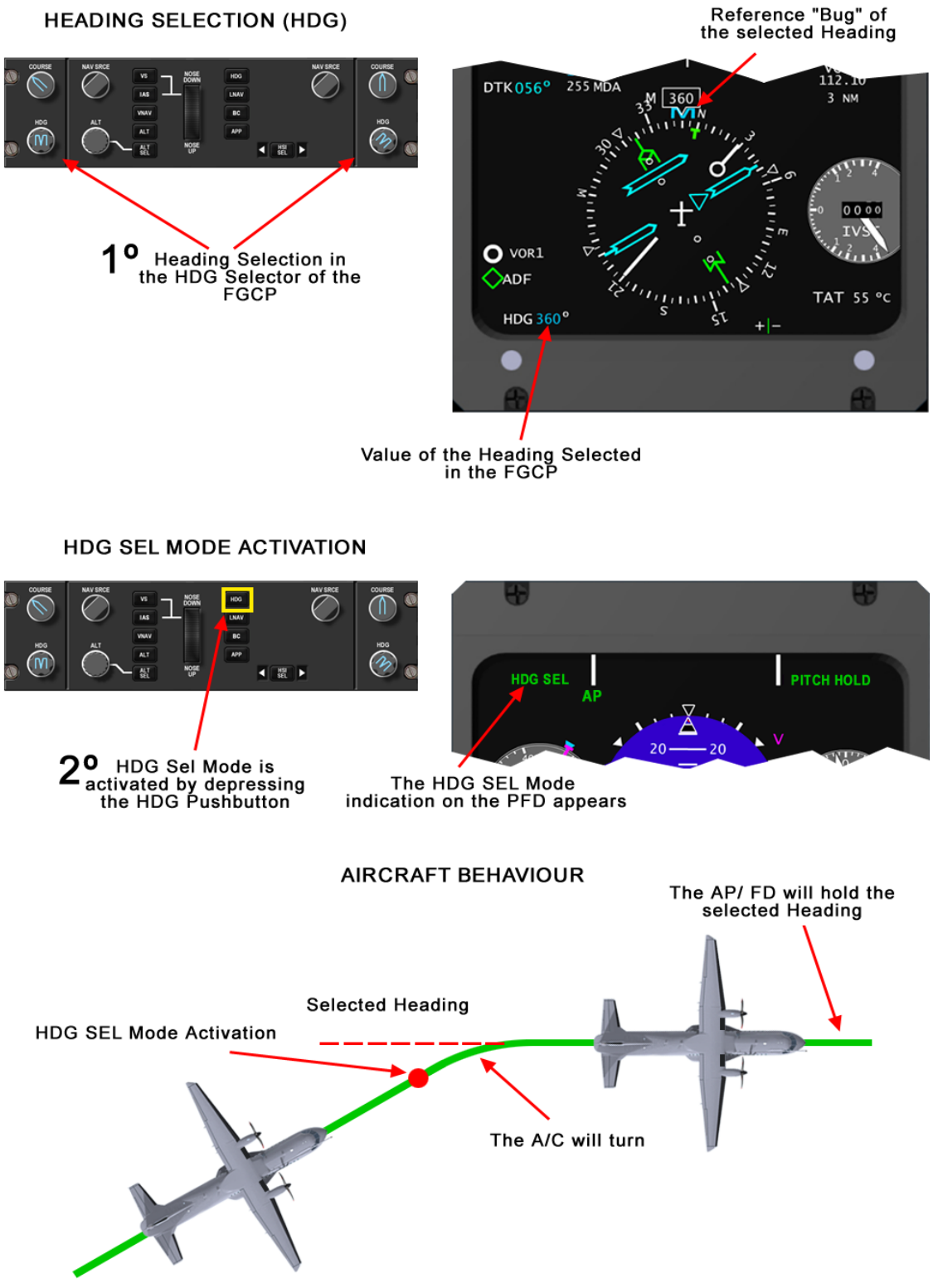


Figure 22-8 HDG SEL Mode

VOR Radial (LNAV) Capture and Tracking Mode

In this mode the AP/FD captures and holds a VOR radial. This mode has five phases:

- VOR Mode arming
- VOR in Capture of the Course Phase
- VOR Tracking
- Overflying the VOR station (VOR OS)
- VOR in back following

Transition between one phase and another is automatic.

This mode is activated as follows:

- Select a VOR/LOC receiver (V/L1 or V/L2) as the navigation source using the NAV SRCE selector on the FGCP.
- Confirm the VOR frequency on the MCDU TUNE or on the PFD/ND.
- Select the course corresponding to the desired VOR radial using the COURSE selector of the FGCP.
- Select the heading to follow in order to intercept the radial using the HDG selector of the FGCP.
- Arm the mode by pushing-in the LNAV pushbutton on the FGCP.

The expected behaviour of the system is as follows:

- Command bars of the FD will be visible on the PFDs.
- Phase A: VOR Mode arming

  Once the mode is activated the following annunciations will display on the PFDs: VOR (white) as Lateral Mode Armed and HDG SEL (green) as Lateral Mode Active.
- Phase A/B: VOR in Capture of the Course Phase

  At this point the aircraft will turn to capture the selected radial and the VOR* annunciation (green) will displays as Active Lateral Mode on the PFDs. This annunciation replaces HDG SEL (green).
- Phase B: Tracking

  Tracking of radial (TO or FROM), during this phase is the VOR (green) annunciation is displayed as the Active Lateral Mode on the PFDs.
- Phase C: Overflying VOR Station

  During this phase the VOR OS (green) annunciation will be displayed as the Active Lateral Mode on the PFDs.

  During overflight, the system ignores the navigation data and the AP/FD will hold the course present at the time of detecting the OS.

  During the OS phase, it is possible to change the radial selected and leave the station (FROM) for another radial in approach phase (TO). The capture and tracking of the departure radial is performed automatically.
- Phase D: VOR in back following

Range of operation:

- Maximum interception angle is 90º.
- Maximum roll angle is ± 25º.

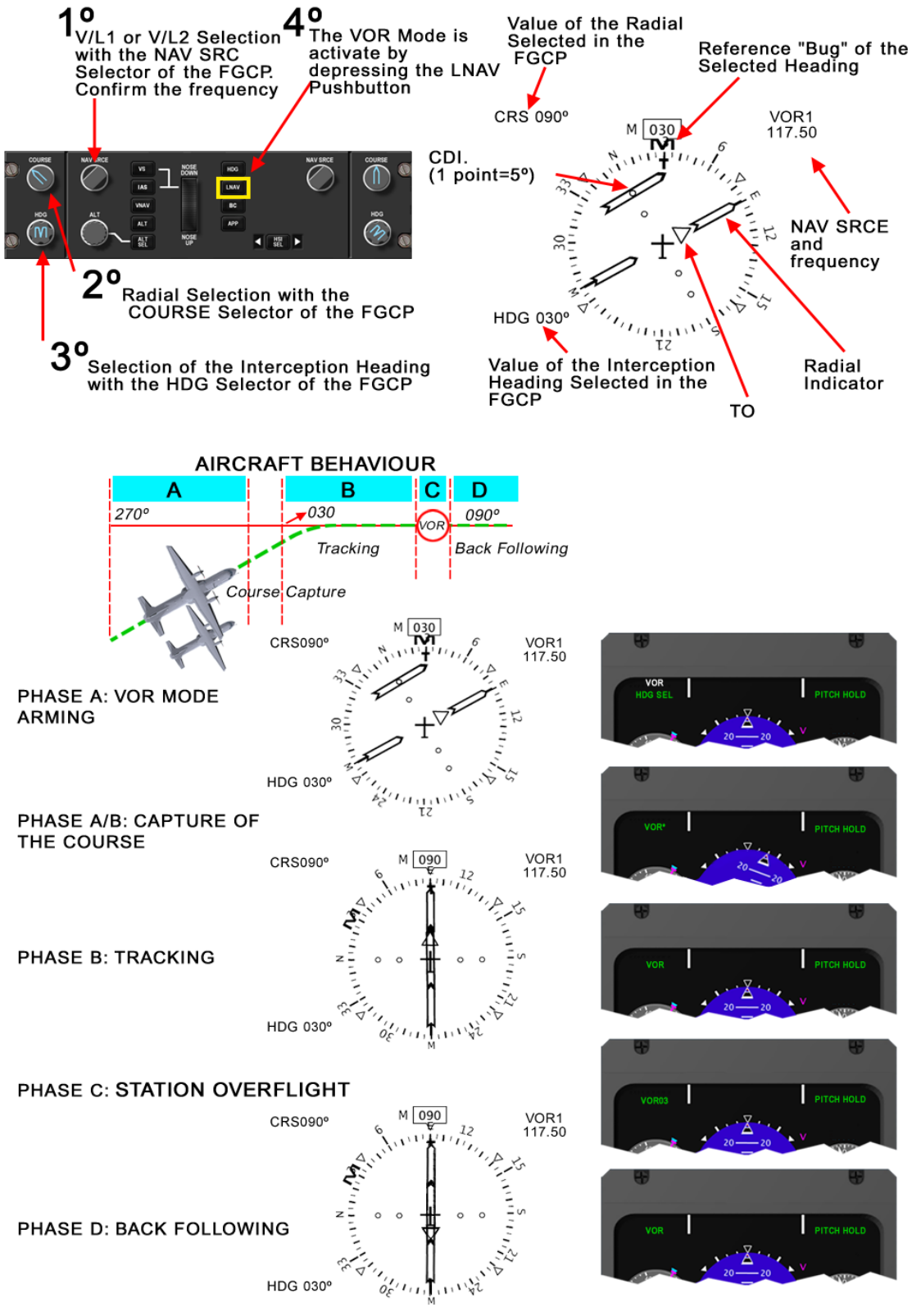


Figure 22-9 VOR mode

Interception and tracking of an ILS Localizer (LNAV)

LOC submode of the APP mode captures and holds the localizer (without simultaneous GS interception) in an ILS approach. This mode has three phases:

- LOC Armed
- LOC in Capture Phase
- LOC Tracking

Transition between one phase and another is automatic.

This mode is activated as follows:

- Select a VOR/LOC receiver (V/L1 or V/L2) as the navigation source using the NAV SRCE selector on the FGCP.
- Confirm the ILS frequency on the MCDU TUNE page or on the PFD/NDs.
- Select the course of the localizer using the COURSE selector of the FGCP.
- Select the heading to follow in order to intercept the localizer using the HDG selector of the FGCP.
- Arm the mode by pressing the LNAV pushbutton on the FGCP. The APP pushbutton will be used when simultaneous arming of the GS is required (refer to the COMBINED MODES-ILS Approach Mode (APP) section).

The expected behaviour of the system is as follows:

- Command bars of the FD will be visible on the PFDs.
- Phase A: Armed

  Once the mode is activated the following annunciations display on the PFDs: LOC (white) as Lateral Mode Armed and HDG SEL (green) as Lateral Mode Active.
- Phase B: Localizer capture

  At this point the aircraft will turn to capture the radial. During capture of the selected radial the LOC* (green) annunciation displays on the PFDs as the Active Lateral Mode. This annunciation replaces HDG SEL (green).
- Phase C: Tracking of the Localizer

  During this phase the LOC (green) annunciation displays on the PFDs as the Active Lateral Mode.

Range of operation:

- Maximum interception angle is 90º.

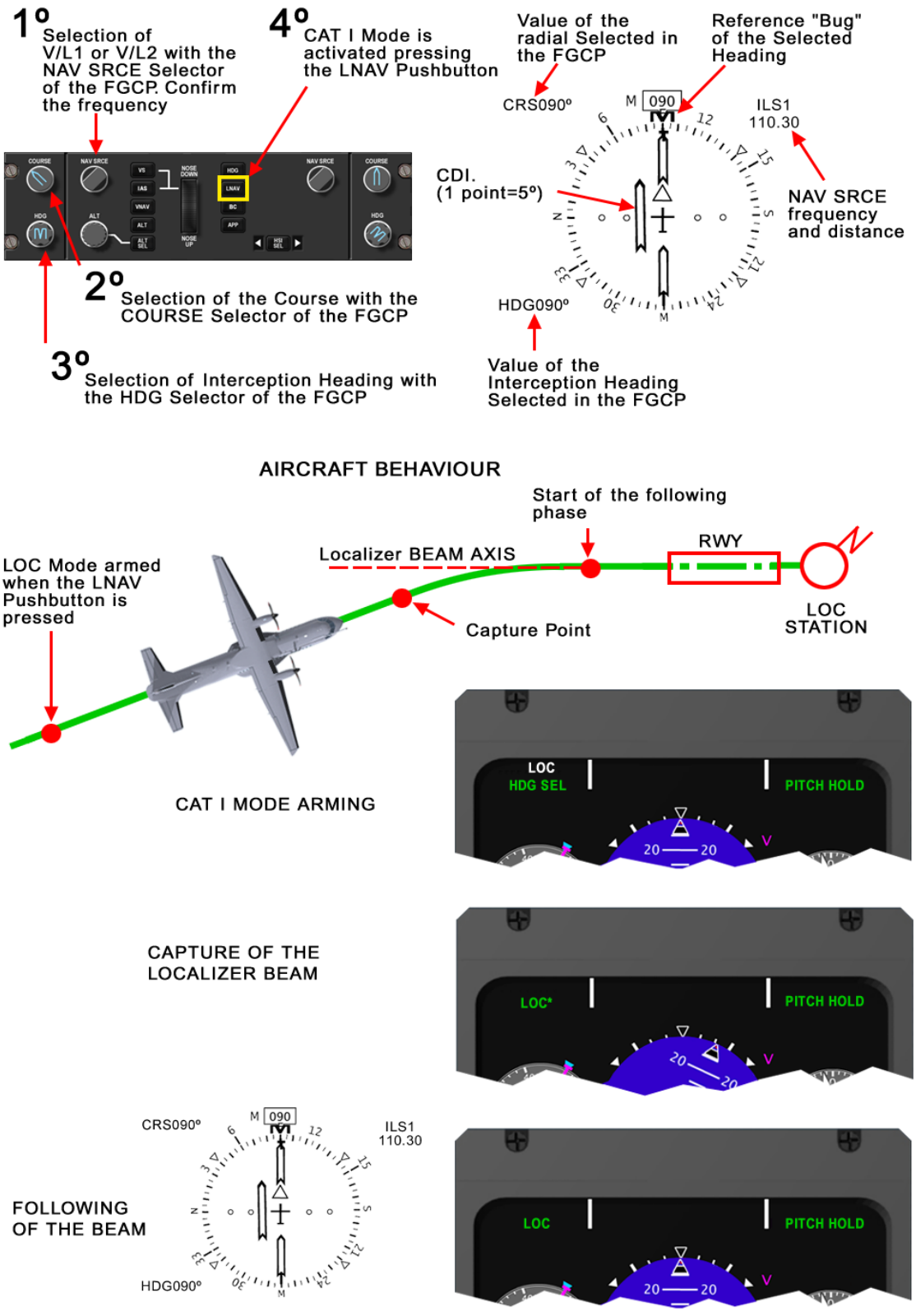


Figure 22-10 LOC Mode

Interception and tracking of a Back Course Localizer (BC) mode

In this mode the AP/FD captures and holds Back Course Localizer. This mode has three phases:

- BC Armed
- BC in Capture Phase
- BC Tracking

Transition between one phase and another is automatic.

This mode is activated as follows:

- Select a VOR/LOC receiver (V/L1 or V/L2) as the navigation source using the NAV SRCE selector on the FGCP.
- Confirm the ILS frequency on the MCDU TUNE page or on the PFD/NDs.
- Select the course on the FGCP using the COURSE selector of the FGCP.
- Select the heading to follow in order to intercept the localizer using the HDG selector of the FGCP.
- Arm the mode by pushing-in in the BC pushbutton on the FGCP.

The expected behaviour of the system is as follows:

- Command bars of the FD will be visible on the PFDs.
- Phase A: Armed

  Once the mode is activated the following annunciation displays on the PFDs: BC (white) as Lateral Mode Armed and HDG SEL (green) as Lateral Mode Active.
- Phase B: Capture of Localizer Rear Radial

  At this point the aircraft will turn. During capture of the selected radial the BC* (green) annunciation displays on the PFDs as the Active Lateral Mode. This annunciation replaces HDG SEL (green).
- Phase C: Tracking of the Rear Radial of the Localizer

  During this phase the BC (green) annunciation displays on the PFDs as the Active Lateral Mode.

Range of operation:

- Maximum interception angle is 90º.

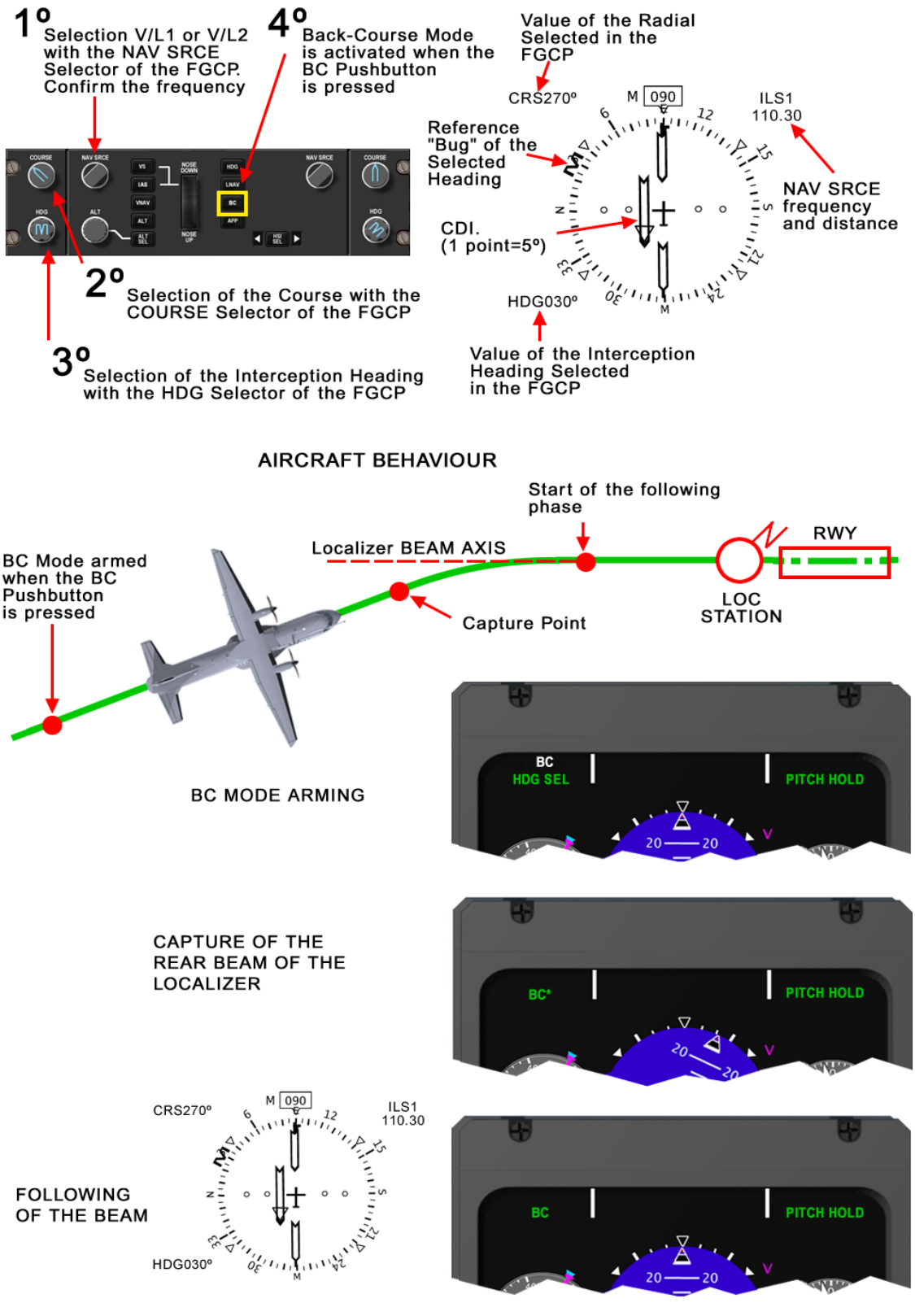


Figure 22-11 BC Mode

FMS Lateral Navigation Mode (LNAV)

In this mode the AP/FD captures and tracks a route defined in the FMS as a Lateral Flight Plan.

This mode is activated as follows:

– Activate a Lateral Flight Plan on the MCDU to use as a navigation source. To do so, use the FPLN INIT page, selecting the type of flight plan (refer to CHAPTER 34 - NAVIGATION).

– Select FMS as the navigation source using the NAV SRCE selector on the FGCP.

– Engage the Automatic Pilot by setting the AP switch on the CEU to the ENGAGED position (if you only require the FD function this step is not necessary).

– Activate the mode by pushing-in the LNAV pushbutton on the FGCP.

The expected behaviour of the system is as follows:

– Command bars of the FD will be visible on the PFDs.

– When this mode is activated the AP will capture the first leg of the flight plan at a maximum angle of 45º.

– A waypoint alert is generated 10 seconds before the initiation of a turn or prior to arrival at the waypoint when there is no turn anticipation.

Range of operation:

– Maximum roll angle is 30º.

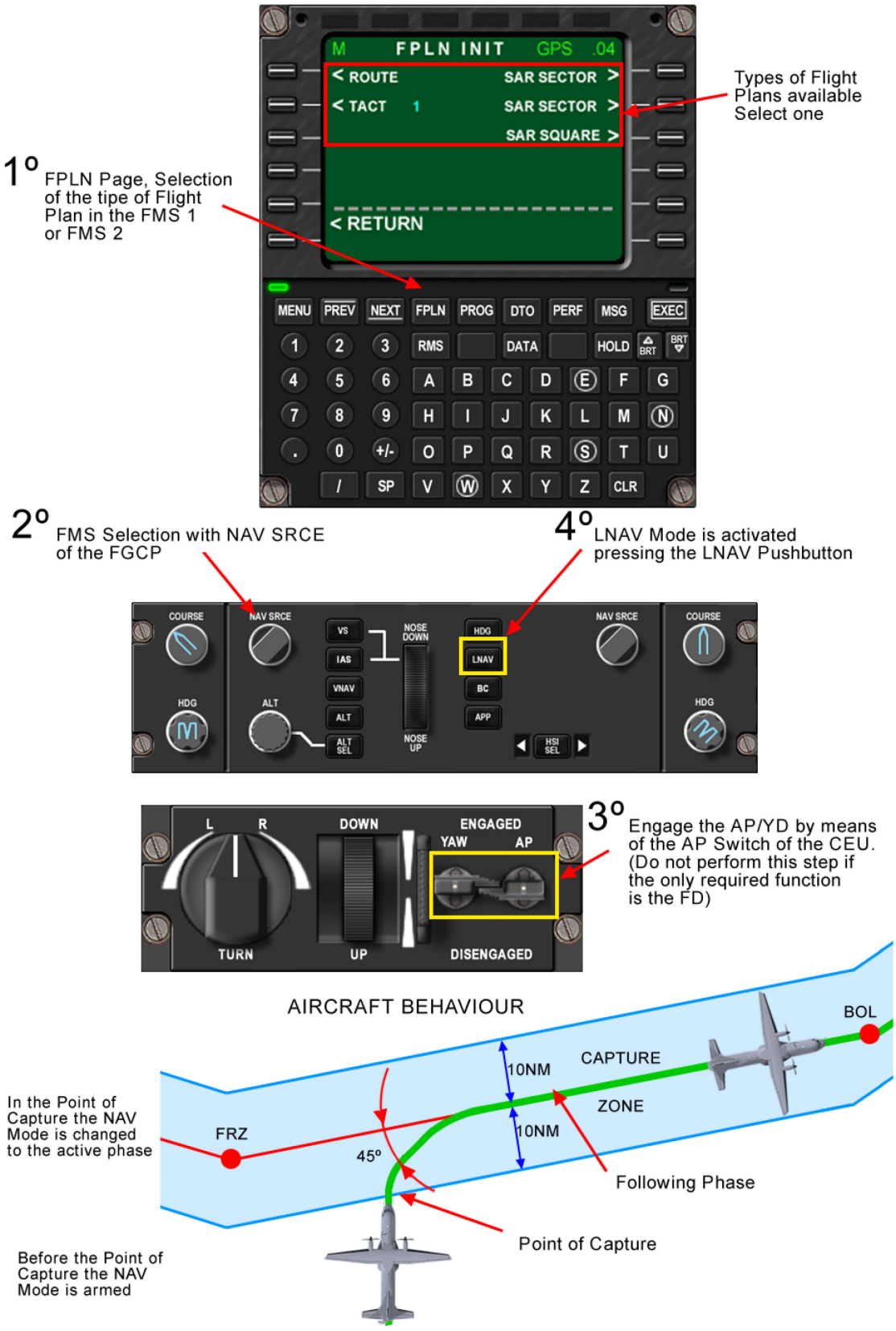


Figure 22-12 LNAV Mode

VERTICAL MODES

Basic Vertical Mode (PITCH HOLD)

The Basic Vertical Mode, holding the pitch attitude, is activated when the AP is engaged.

This mode is activated as follows:

– Engage the AP by setting the AP switch on the CEU to the ENGAGED position. From this point on the AP maintains the pitch angle of the aircraft at the moment it was engaged.

– Once the pitch angle has been set it is possible to modify it from the CEU by turning the Pitch Control in the desired direction (DOWN or UP). It is also possible to change the pitch value from the control column by holding the SYN pushbutton pushed, manoeuvring manually until the desired pitch angle is obtained and then releasing the button.

The expected behaviour of the system is as follows:

– Command bars will be visible on the PFDs.

– The value of the pitch angle at the time of activation of the mode becomes the target to be held by the AP/FD. This value displays on the FMA of the PFDs next to the PITCH indication (green) as the Active Vertical Mode with a 1º precision.

Range of operation:

– Maximum allowable pitch angle at the moment of engaging the AP is ± 20º.

NOTE

When engaged between 20º and 22º pitch up or 20º and 22º pitch down, the automatic pilot will return airplane to 20º pitch.

– AP will disengage if the pitch angle exceeds ± 22º.

– FD will disengage if the pitch angle exceeds ± 25º.

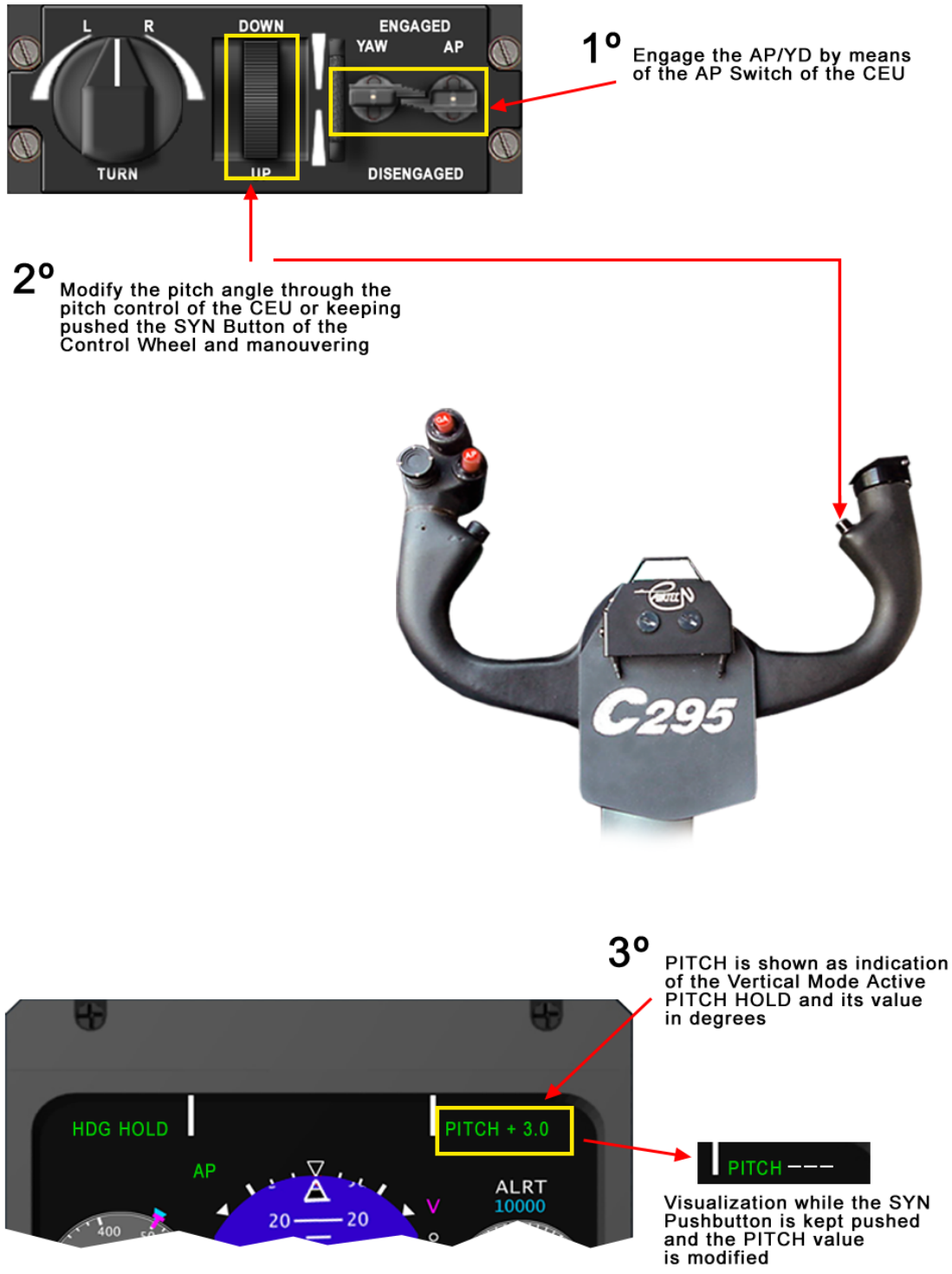


Figure 22-13 PITCH HOLD Mode

Altitude Capture Mode (ALT SEL)

In this mode the AP/FD captures and holds a selected altitude. This mode has three phases:

- ALT SEL Armed
- ALT SEL in Capture Phase
- ALT SEL in Holding Altitude Phase

This mode is activated as follows:

- Manual engagement. By pressing ALT SEL pushbutton on the FGCP:
  - Select one of the following vertical modes:
    - PITCH HOLD
    - IAS
    - VS
  - Altitude Hold mode is not engaged.
  - Select a target altitude with the ALT selector on the FGCP. The altitude value selected displays on the altitude dial of the PFDs.
  - Press the ALT SEL pushbutton on the FGCP to arm the mode.
  - Fly the aircraft toward the preselected altitude manually or with AP engaged.
- Automatic engagement. After ALT selector is moved, ALT SEL mode will be enabled automatically if:
  - IAS or VS vertical mode is active.
  - Vs≥300ft/min and the difference between altitude selected and current altitude is higher than 500 ft or Vs≤-300 ft/min and the difference between altitude selected and current altitude is smaller than -500ft.
- Once the selected altitude has been reached, it may be changed by holding down the SYN pushbutton on the control column, manoeuvring to the new altitude, and then releasing the button.

The expected behaviour of the system is as follows:

- Command bars of the FD will be visible on the PFDs.
- Phase A: Armed:

  When the ALT SEL pushbutton on the FGCP is pushed or ALT SEL mode is activated automatically, the ALT SEL annunciation will be displayed (white) as Armed Vertical Mode on the FMA of the PFDs. While some of the modes: PITCH HOLD, IAS or VS are displayed as Active Vertical Mode on the FMA of the PFDs.

  At an altitude of 1000 feet the selected altitude will activate an alarm bell and the ALRT annunciation (on the altitude dial of the PFDs) will be displayed in reverse video. At 200 feet from the selected altitude the ALRT annunciation will be displayed normally.

- Phase B: Capture:

  When the selected altitude is captured, the ALT SEL annunciation (white) goes out and the ALT* (green) annunciation displays as the Active Vertical mode on the FMA of the PFDs.

- Phase C: Holding Altitude:

  Once the selected altitude is reached, the Altitude Hold Mode is activated and the ALT indication (green) displays on the FMA of the PFDs as Active Vertical Mode.

Observations:

– In case of any inconsistency between the preset altitude value and the aircraft flight level or condition (climb or descent), the selected altitude indication (ALT SEL) will flash amber to warn the crew that they need to correct the selected altitude or the aircraft flight condition (climb or descent) in the right direction.

– Given that the AP/FD does not have automatic throttle control (Auto-Throttle) and controls variations in altitude by changing the pitch angle, a good idea might be to activate this mode once established the aircraft rate of climb/descent.

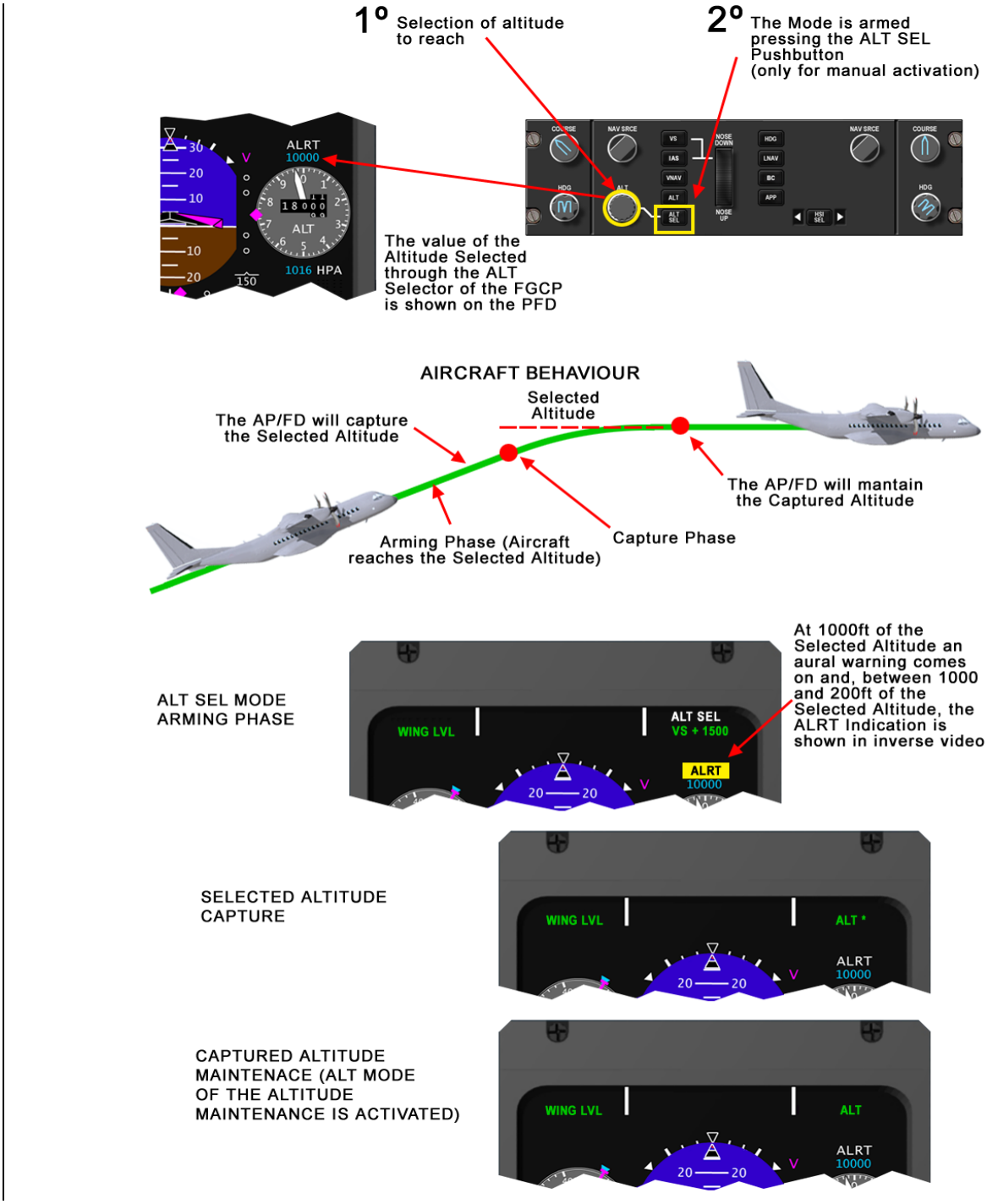


Figure 22-14 ALT SEL Mode

Altitude Hold Mode (ALT)

In this mode the AP/FD holds a reference altitude. The mode is selected by pushing-in the ALT pushbutton on the FGCP. This mode is also activated automatically in the Capture Phase of the ALT SEL mode.

This mode is activated as follows:

- Pushing-in the ALT pushbutton on the FGCP. The value of the corrected barometric altitude existing at this moment becomes the altitude to be held by the AP/FD.
- The altitude may be changed by holding down the SYN pushbutton on the control column, manoeuvring to the new altitude, and then releasing the button.

The expected behaviour of the system is as follows:

- Command bars of the FD will be visible on the PFDs.
- The value of the corrected barometric altitude existing at the moment of activating ALT mode will be held by the AP/FD.

Range of operation:

- The range of altitudes in which this mode can be activated runs from 0 to 30000 feet.

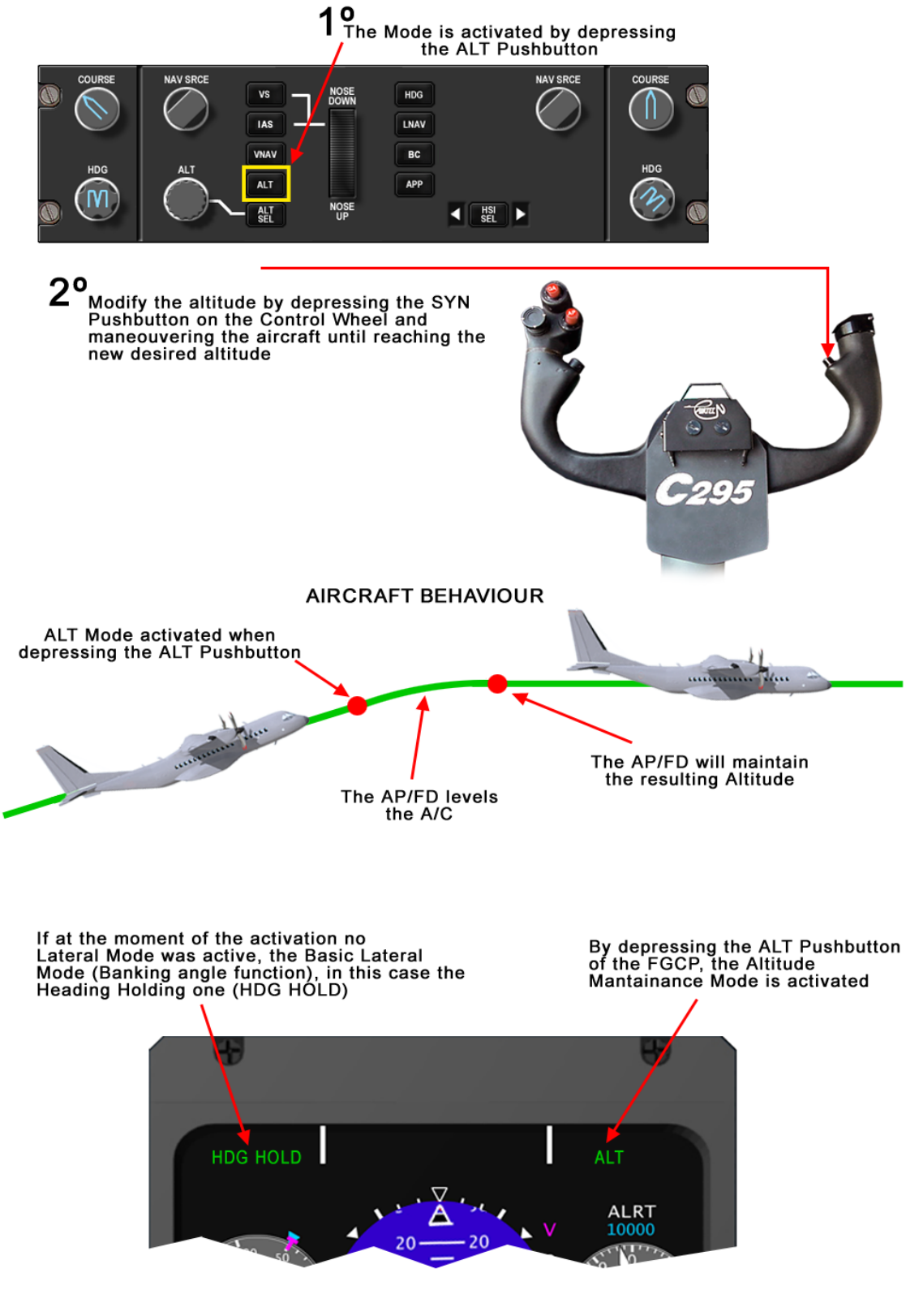


Figure 22-15 ALT Mode

Indicated Air Speed (IAS) Hold Mode

In this mode the AP/FD holds an Indicated Air Speed (IAS) reference.

This mode is activated as follows:

– Push the IAS pushbutton on the FGCP. The value of the IAS existing at this moment becomes the IAS to be held by the AP/FD.

– Once the reference IAS has been set it can be changed. From the FGCP, turn the airspeed control in the desired direction (NOSE DOWN or NOSE UP) to increase or decrease the desired speed reference (IAS). The indicated airspeed reference can also be shifted by holding down the SYN pushbutton on the control column, manoeuvring to the new speed as desired, and then releasing the button.

The expected behaviour of the system is as follows:

– Command bars of the FD will be visible on the PFDs.

– The value of the IAS to be held by the AP/FD is that existing at the moment the mode is activated.

– The value of the IAS to be held displays beside the IAS Active Vertical Mode annunciation (green) on the FMA of the PFDs. When the value of the reference IAS is being changed using the SYN pushbutton on the control column, the value is replaced by white dashes on the FMA of the PFDs.

Range of operation:

– This mode can be activated when the aircraft speed is higher than 95 knots and lower than the Maximum Operating Speed (with a resolution of ± 1 knot).

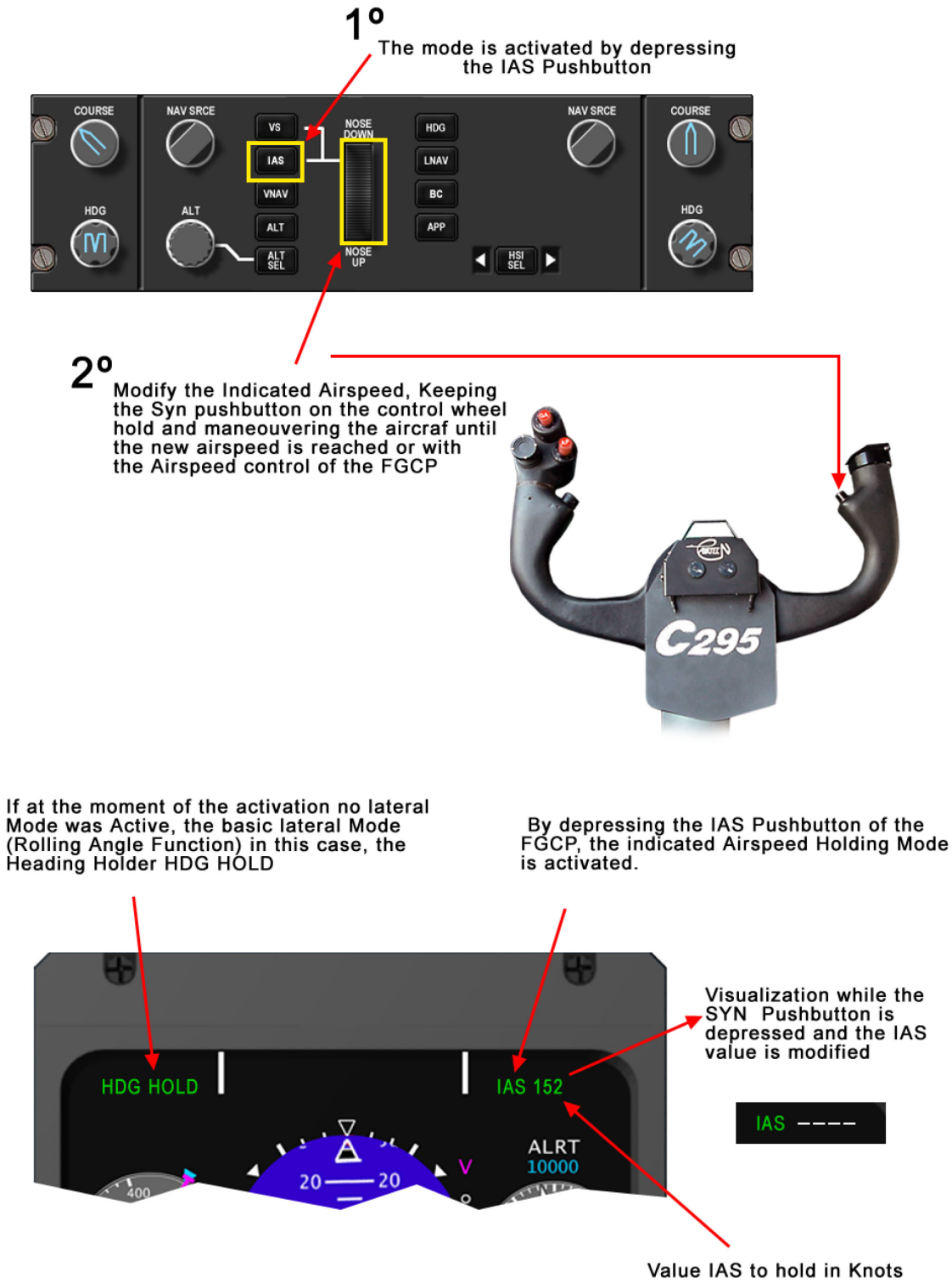


Figure 22-16 IAS Mode

Vertical Speed (VS) Hold Mode

In this mode the AP/FD holds a reference vertical speed (VS).

This mode is activated as follows:

– Push the VS pushbutton on the FGCP. The value of the VS existing at this moment becomes the VS to be held by the AP/FD.

– Once the reference VS has been set it can be changed. From the FGCP, turn the Speed Control in the desired direction (NOSE DOWN or NOSE UP) to increase or decrease the desired reference vertical speed (VS). The reference vertical speed can also be changed by holding down the SYN pushbutton on the control column, manoeuvring to the new desired Vertical Speed, and then releasing the button.

The expected behaviour of the system is as follows:

– Command bars of the FD will be visible on the PFDs.

– The value of the VS to be held by the AP/FD is that existing at the moment the mode is activated.

– The value of the VS to be held displays beside the VS Active Vertical Mode annunciation (green) on the FMA of the PFDs. When the value of the reference VS is changed using the SYN pushbutton on the control column, the value is replaced by white dashes on the FMA of the PFDs.

Range of operation:

– The range of VS to select is ± 6000 feet/min (with a resolution of ±100 feet/min).

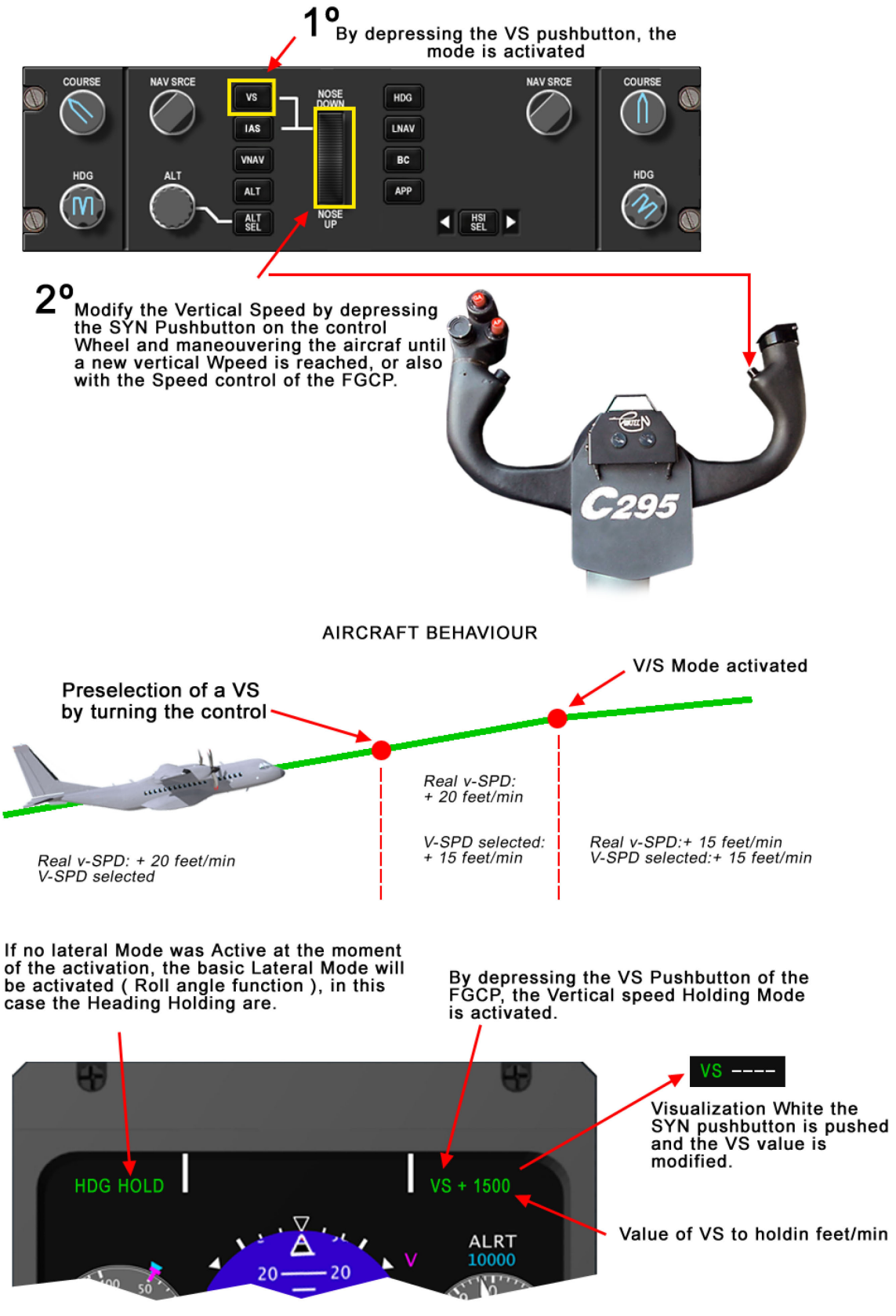


Figure 22-17 VS Mode

FMS Vertical Navigation Mode (VNAV)

In this mode the AP/FD reaches and holds a Vertical Flight Path as calculated by the FMS. This mode is only operative when the LNAV mode is operative as well. This mode has two phases:

- VNAV Armed
- VNAV Active

This mode is activated as follows:

- Activate a Lateral and Vertical Flight Plan on the MCDU to use as a navigation source. To do so, use the FPLN INIT page, selecting the type of Flight Plan (refer to CHAPTER 34 - NAVIGATION).
- Select FMS as the navigation source using the NAV SRCE selector on the FGCP.
- Engage the Automatic Pilot by setting the AP switch on the CEU to the ENGAGED position.
- Activate the mode by pushing the LNAV and VNAV pushbuttons on the FGCP. This will activate the LNAV mode and arm the VNAV mode. The Active Vertical Mode existing before the VNAV pushbutton was pushed will remain active.

The expected behaviour of the system is as follows:

- Command bars of the FD will be visible on the PFDs.
- The activation of the Lateral Flight Plan on the MCDU will not affect pilot´s aircraft control.
- The navigation information used for the AP/FD command derives from the C/M-1 side or C/M-2 side, depending on the selection made on the FGCP (HSI selection).
- FMS sends continuously commands to vary the pitch angle.
- AP/FD will automatically activate the VNAV mode when the command signal indicating a change of pitch, is valid and lets the VNAV mode to be activated. When it changed to armed, the VPATH annunciation (green) displays.

Range of operation:

- Maximum roll angle is ± 20º.
- AP/FD signals will be limited to a maximum vertical acceleration of ± 0.2 g.

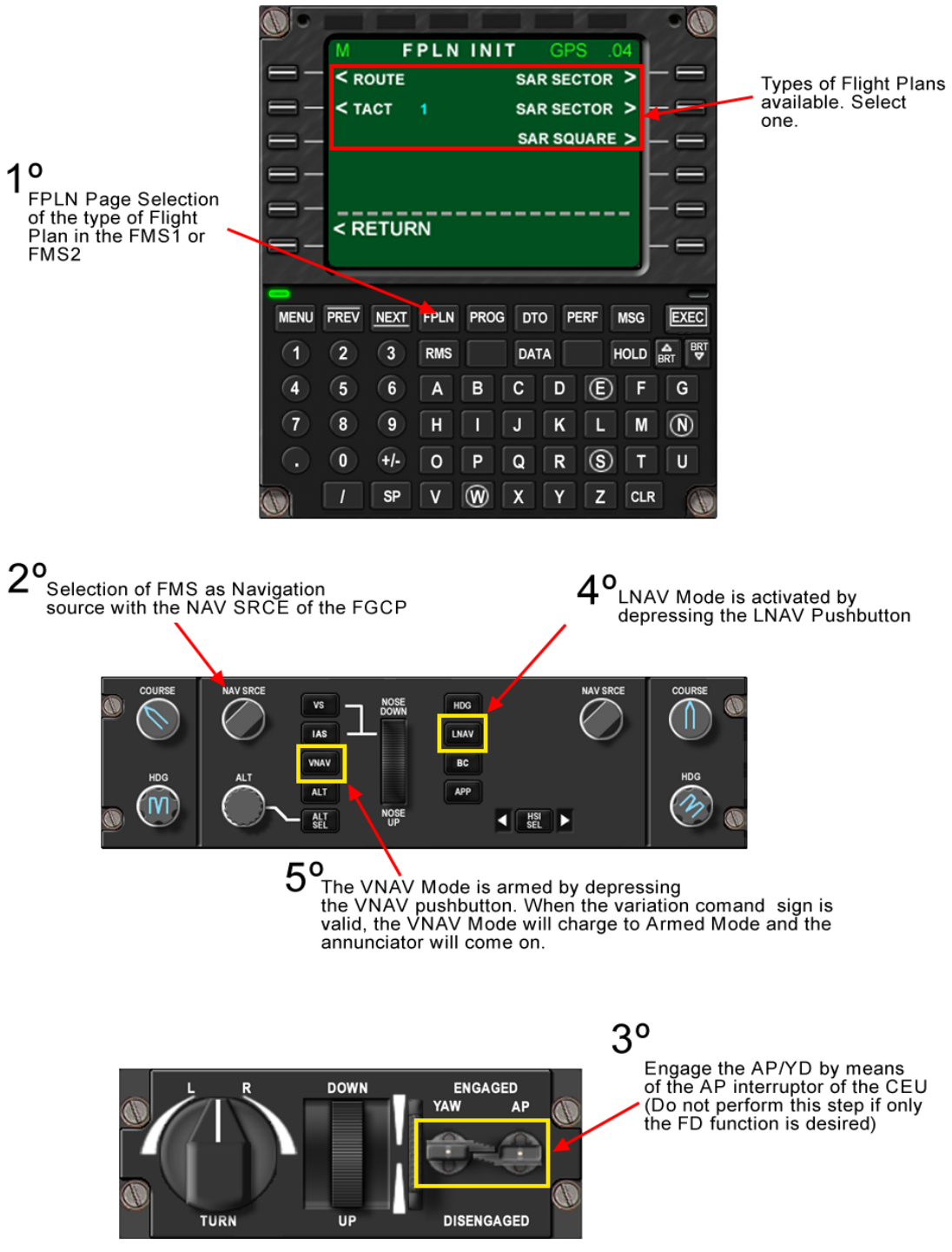


Figure 22-18 VNAV Mode

COMBINED MODES

Go Around (GA) Mode

This is exclusively an FD mode.

This FD mode provides a command bar indication of the transition from Approach to Climb during a Go Around (Missed Approach).

This mode is activated as follows:

– Pushing-in any of the GA pushbuttons on the control columns.

The expected behaviour of the system is as follows:

– Automatic Pilot and the YD are disengaged. This is an FD mode, which means the pilot has manual control of the aircraft.

– The GA annunciation (green) displays on the FMA of the PFDs.

– Vertical Mode of the Flight Director goes to Go-Around mode, indicating a pitch angle of 7º.

– Lateral Mode of the Flight Director goes to WING LEVEL, indicating zero roll angle (the WING LVL annunciation (green) displays on the FMA of the PFDs).

– Indications associated with the APP mode go out if previously displayed.

– The mode is deactivated if one of the higher vertical modes is activated (WING LVL will change to HDG HOLD).

Figure 22-19 GA Mode

ILS Approach Mode (APP)

This is the automatic ILS approach mode. In this mode the AP/FD leads the aircraft to a minimum decision altitude of 200 feet (Minimum CAT I). This mode has 6 phases:

- LOC Armed
- LOC in Capture Phase
- LOC Tracking
- GS Armed
- GS in Capture Phase
- GS Tracking

Transition between one phase and another is automatic. Transition between the Glide Slope Armed phase (GS white) and the Glide Slope in Capture Phase (GS* green) is inhibited until the lateral LOC mode changes from capture to tracking the localizer beam.

This mode is activated as follows:

- Select a V/L1 or V/L2 localizer receiver as the navigation source using the NAV SRCE selector on the FGCP.
- Confirm the localizer frequency on the MCDU TUNE page or on the PFD/ND.
- Set the course on the FGCP to the direction of the desired localizer using the COURSE selector of the FGCP.
- Select the heading to follow in order to intercept the localizer using the HDG selector of the FGCP.

NOTE

While capturing the Glide slope signal from above the 3 degree nominal path, a spurious Glide Slope capture may occur due to a wrong Glide Slope deviation signal. This spurious capture will order unexpected commands which may lead, or approach, to stall conditions. Whenever the pilot notices the pitch movement, or the spurious Glide Slope capture (GS*), or the trajectory deviation, he will immediately disconnect the AP, if engaged, to re-establish a normal attitude and will disengage APP mode.

- Arm the mode by pushing-in the APP pushbutton of the FGCP in order to arm the Lateral LOC Mode and the Vertical GS Mode.

The expected behaviour of the system is as follows:

- Command bars of the FD will be visible on the PFDs.
- Until the capture conditions of the lateral and vertical modes occur, the previous lateral and vertical modes will remain active. If there was no active mode at the time of activating this mode (pushing-in APP), HDG SEL and PITCH HOLD modes will be activated until the capture conditions arise.
- When the localizer capture conditions arise, the capture phase (LOC*) of the LOC mode (armed) becomes active. When the LOC course is captured, the tracking phase is entered (LOC).
- When the Glide Slope capture conditions arise, the capture phase (GS*) of the GS mode becomes active. When the Glide Slope (GS) is captured, the tracking phase is entered.

– The Glide Slope (GS) cannot be captured until the localizer beam itself has been captured.

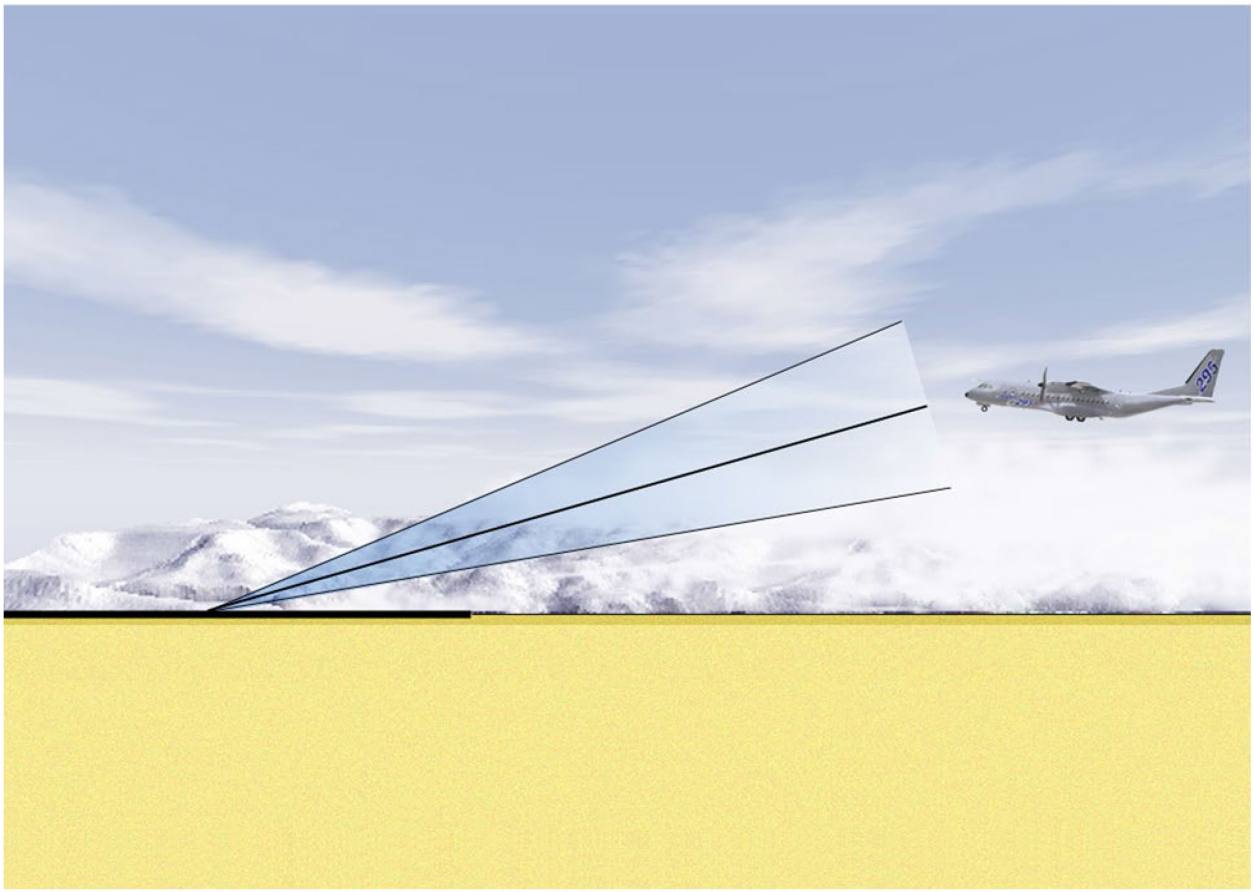


Figure 22-20 GS Mode