22.00 CONTENTS

22.10 GENERAL

22.20 FLIGHT MANAGEMENT

PREAMBLE

The Auto Flight System is described in Volumes 1 and 4 :

- Volume 1, Chapter 22 gives a general description of the system and the different functions (architecture, modes, FMA, functions...).
- Volume 4 "FMGS PILOT'S GUIDE" is devoted to the FMGS System operation (MCDU pages, MCDU message, Procedures).

DESCRIPTION

The Flight Management Guidance System (FMGS) contains the following units :

- Two Flight Management Guidance Computers (FMGC)
- Two Multipurpose Control and Display Units (MCDU) (third MCDU optional)
- One Flight Control Unit (FCU)
- Two Flight Augmentation Computers

GENERAL PHILOSOPHY

The Flight Management and Guidance System (FMGS) provides predictions of flight time, mileage, speed, economy profiles and altitude. It reduces cockpit workload, improves efficiency, and eliminates many routine operations generally performed by the pilots.
During cockpit preparation, the pilot inserts a preplanned route, from origin to destination, via the Multifunction Control and Display Units (MCDUs). This route includes the departure, enroute waypoints, arrival, approach, missed approach and alternate route, as selected from the NAV database. The system generates optimum vertical and lateral flight profiles and predicted progress along the entire flight path. Either FMGC performs all operations, if one FMGC fails.
The pilot may modify any flight parameter on a short-term basis (SPD, V/S, HDG...) and the FMGS will guide the aircraft to the manually-selected target. This pilot-controlled guidance is referred to as "selected".
There are two types of Guidance :

R — Managed Guidance : The aircraft is guided along the preplanned route, vertical, lateral, and speed/mach profile. This type of preplanned guidance is called "Managed". Predicted targets are computed by the FMGS.
R — Selected Guidance : The aircraft is guided to the selected target, modified by the pilot. Targets are selected on the flight control unit located on the pilot's glareshield. The decision to engage a "selected" or "managed" guidance is always under the control of the pilot.
R Selected guidance has priority over managed guidance.

FLIGHT MANAGEMENT GUIDANCE COMPUTER (FMGC)

Each FMGC is divided into two main parts.

- The Flight Management (FM) part controls the following functions :
  - · Navigation and management of navigation radios.
  - · Management of flight planning.
  - · Prediction and optimization of performance.
  - · Management of displays.
- The Flight Guidance (FG) part performs the following functions :
  - · Autopilot (AP) command
  - · Flight Director (FD) command
  - · Autothrust (A/THR) command

Each FMGC has its own set of databases. The individual databases can be independently loaded into their respective FMGC, or independently copied from one FMGC to the other.
Each FMGC contains these main databases :

1. The Navigation database (2.8 Mbytes) contains standard navigation data : Navaids, waypoints, airways, enroute information, holding patterns, airports, runways, procedures (SIDs, STARs, etc.), company routes, alternates.
   The airline updates this part every 28 days, and is responsible for defining, acquiring, updating, loading, and using this data. The updating operation takes 20 minutes to complete or 5 minutes if cross load from the opposite FMGC.
2. The Airline Modifiable Information (AMI, also referred to as the FM Airline Configuration file), contains :
   - Airline policy values : THR RED altitude, ACC altitude, EO ACC altitude, PERF factor, IDLE factor.
   - Fuel policy values : Fuel for taxi, % of route reserve, maximum and minimum values of route reserve, etc.
   - ACARS interface customization
3. The Aircraft Performance database, is a set of Engine model, Aerodynamical model, and Performance model. The airline cannot modify this database.
4. The Magnetic Variation database.

In addition, each FMGC contains pilot-stored elements that enable the pilot to create 20 waypoints, 10 runways, 20 navaids, and 5 routes.

MULTIPURPOSE CONTROL AND DISPLAY UNIT (MCDU)

Two MCDUs are installed on the pedestal for flight crew loading and display of data. The use MCDU allows the flight crew to interface with the FMGC by selection of a flight plan for lateral and vertical trajectories and speed profiles. The crew may also modify selected navigation or performance data and specific functions of Flight Management (revised flight plan, engine-out, secondary flight plan, etc.). Additional data from peripherals (Centralized Fault Display System (CFDS), ARINC Communications, Reporting System (ACARS) can also be displayed. Data that is entered into the MCDU that is illogical or beyond the aircraft capabilities will either be disregarded or will generate an advisory message.

FLIGHT CONTROL UNIT (FCU)

The FCU located on the glareshield, is the short-term interface between the crew and the FMGC. It is used to select any flight parameters or modify those selected in the MCDU. The autopilots and autothrust functions may be engaged or disengaged. Different guidance modes can be selected to change various targets (speed, heading, track, altitude, flight path angle vertical speed).

FLIGHT AUGMENTATION COMPUTER (FAC)

The FAC controls rudder, rudder trim and yaw damper inputs. It computes data for the flight envelope and speed functions. The FAC also provides warning for low-energy and windshear detection if these functions are installed.

OTHER CREW INTERFACES

THRUST LEVERS

The thrust levers are the main interface between the Flight Management Guidance Computer, the Full Authority Digital Engine Control System (FADEC), and the flight crew. They :

R — arm the autothrust at takeoff, when "FLX " or "TOGA" is selected,
— limit the maximum thrust by their position when autothrust is active,
— disconnect the autothrust system when the flight crew sets them to "IDLE",
— command the thrust manually when autothrust is not active,
R — engage the common modes (takeoff or go-around) when TOGA (or "FLX" for takeoff) is
R set,
R — when positionned between IDLE and CL detent (MCT in engine out), set the autothrust
R to the active mode.

ELECTRONIC FLIGHT INSTRUMENTS (EFIS)

Two Primary Flight Displays (PFD) and Navigation Displays (ND) provide the crew with full-time flight guidance, navigation and system advisory information for all flight phases. An EFIS control panel is located at each end of the glareshield and is used to control both Primary and Navigation Displays. This panel includes controls to select various modes within the PFD. A selector allows the barometric altimeter setting to be displayed on the PFD. Various distance ranges can be selected on the ND, and two toggle switches allow either the left or right VOR/ADF bearing pointers to be displayed on the ND.

PRIMARY FLIGHT DISPLAYS

The PFDs combine several conventional flight instrument indications on one color display panel, for centralized reference of flight data.
This centralized color display includes :
- Flight Director attitude guidance targets
- Armed and engaged modes
- Navigation and instrument approach information
- Altimeter setting
- Barometric altitude
- System messages.

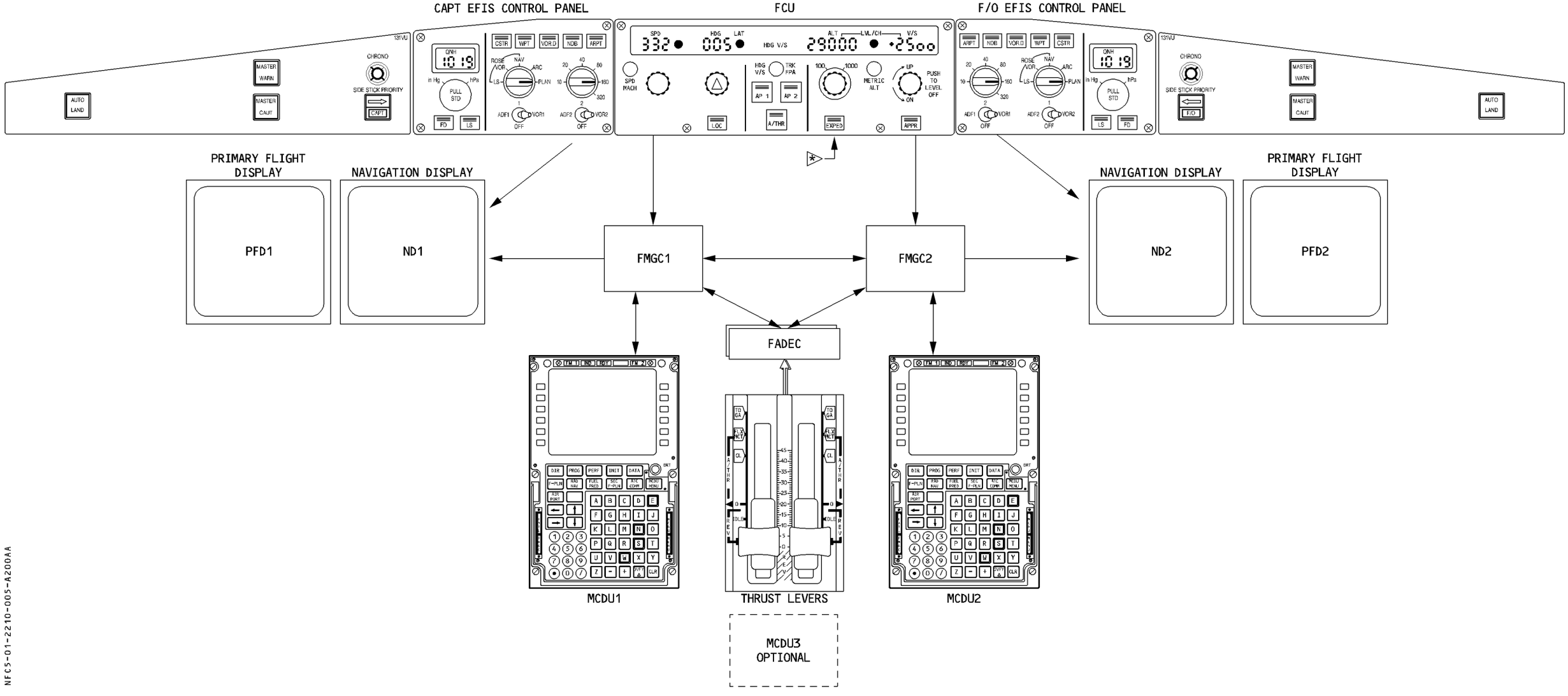
NAVIGATION DISPLAYS

Five different color navigation compass displays can be selected :
- ARC (map mode)
- ROSE NAV (map mode)
- ROSE VOR
- ROSE LS
- PLAN

Information displayed on these modes uses the aircraft's position as a reference point for the flight plan navigation data (lateral and vertical information).

R

CREW INTERFACE WITH FMGC



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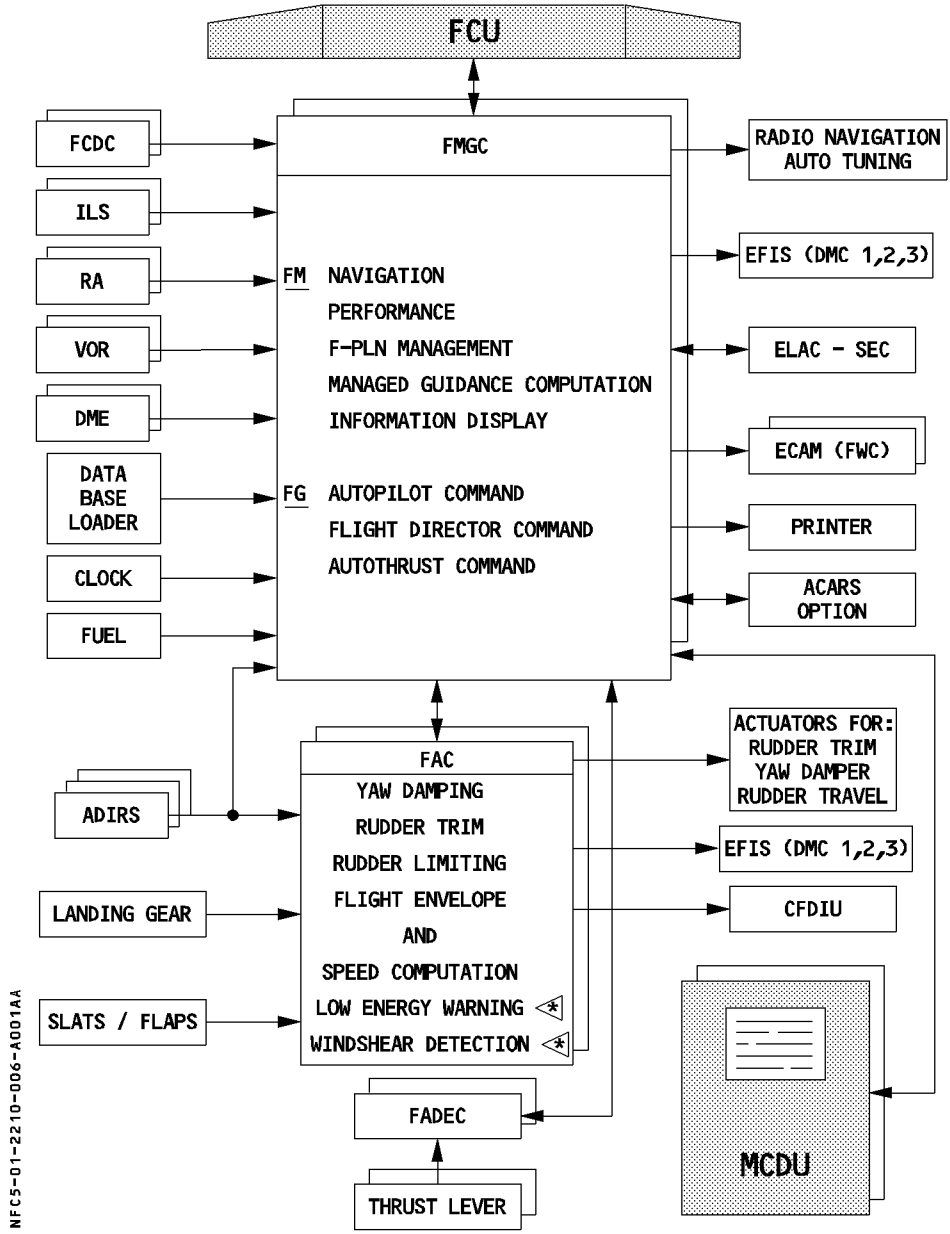
SYSTEM INTERFACE DIAGRAM

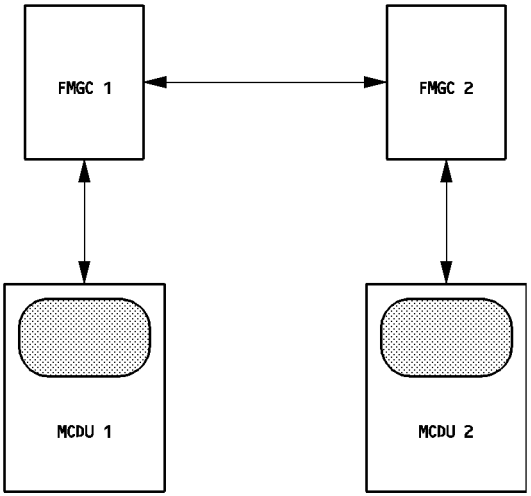


FMGS MODES OF OPERATION

The FMGS has three modes of operation :
- dual mode (the normal mode)
- independent mode. Each FMGC being controlled by its associated MCDU.
- single mode (using one FMGC only)

DUAL MODE

This is the normal mode. The two FMGCs are synchronized : each performs its own computations and exchanges data with the other through a crosstalk bus.
One FMGC is the master, the other the slave, so that some data in the slave FMGC comes from the master. All data inserted into any MCDU is transferred to both FMGCs and to all peripherals.



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MASTER FMGC LOGIC :

- If one autopilot (AP) is engaged, the related FMGC is master :
  - it uses the onside FD for guidance
  - it controls the A/THR
  - it controls the FMA 1 and 2
- If two APs are engaged, FMGC1 is master.
- If no AP is engaged and
  - the FD1 pushbutton is on, then FMGC1 is master.
  - the FD1 pushbutton is off, and FD2 pushbutton on then FMGC2 is master.

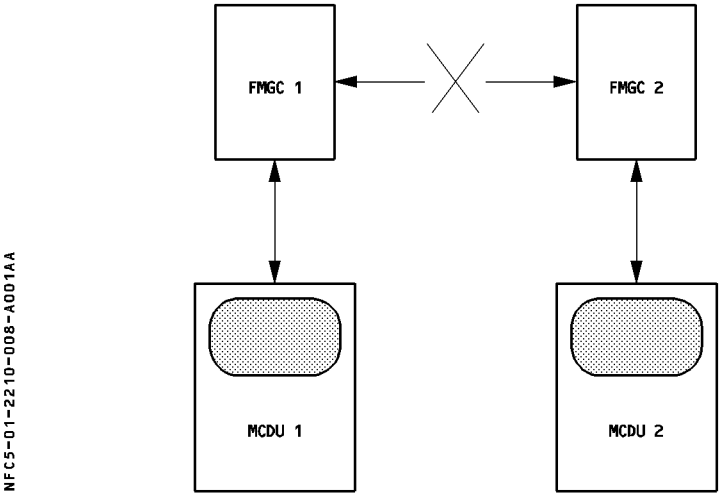
R - if no AP/FD is engaged, A/THR is controlled by FMGC1.

INDEPENDENT MODE

The system selects this degraded mode automatically if it has a major mismatch (database incompatibility, operations program incompatibility . . .). Both FMGCs work independently and are linked only to peripherals on their own sides of the flight deck ("onside" peripherals).

When this occurs, "INDEPENDENT OPERATION" appears on the MCDU scratchpad.

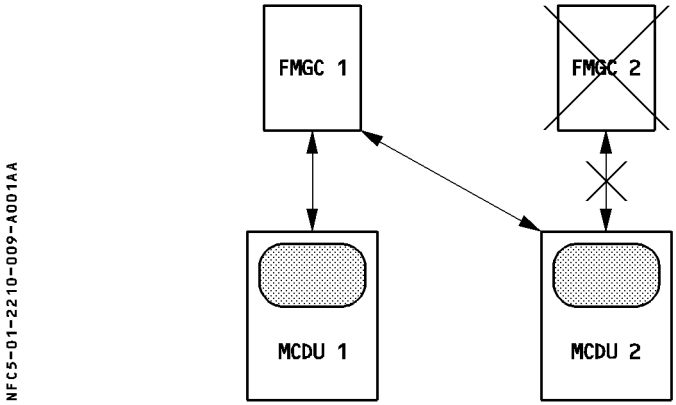
Each MCDU transmits data it receives only to its onside FMGC, and it affects only the onside EFIS (Electronic Flight Instrument System) and RMP (Radio Management Panel).



R For independent mode procedure refer to 4.06.10.

SINGLE MODE

The system selects this degraded mode automatically if one FMGC fails. The remaining FMGC drives all the peripherals, so, for example, any entry on one MCDU goes to both MCDUs.
When one FMGC fails, the corresponding MCDU displays "OPP FMGC IN PROCESS" in white. The ND on the side with the failed FMGC has to be set to the same range and mode as the other ND. Otherwise the ND displays "SELECT OFFSIDE RNG/MODE" in amber.

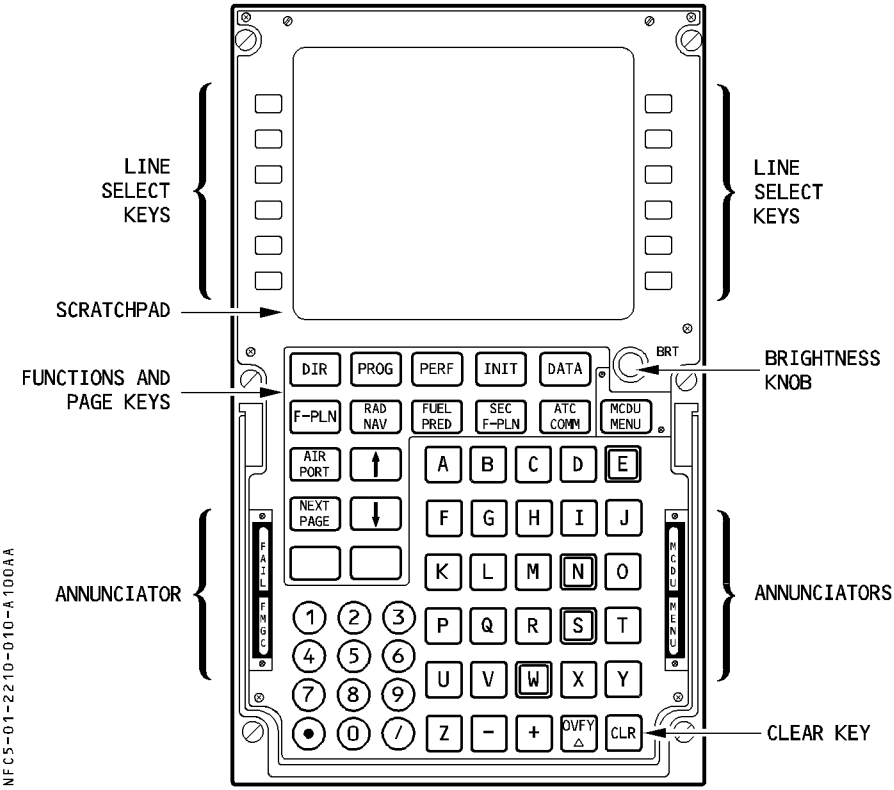


For single mode procedure refer to 4.06.10.

PILOT INTERFACE

MULTI CONTROL DISPLAY UNIT (MCDU)

R



GENERAL

The Multi Control Display Unit (MCDU) is a cathode ray tube that generates 14 lines of 24 characters each, including :

- A title line that gives the name of the current page in large letters ;
- Six label lines, each of which names the data displayed just below it (on the data field line) ;
- Six data field lines that display computed data, or data inserted by the pilot ;
- The scratchpad line which displays :
  - Specific messages
  - Information the pilot has entered by means of the number and letter keys, and which can then be moved to one of the data fields.

LINE SELECT KEYS

There is a column of line select keys on each side of the screen. The pilot uses these to:
- Move a parameter he has entered in the scratchpad to the appropriate line on the main screen.
- Call up a specific function page indicated by a prompt displayed on the adjacent line.
- Call up lateral or vertical revision pages from the flight plan page.

KEYBOARD

The keyboard includes :
- Function and Page keys — Call up functions and pages the pilot uses for flight management functions and computations.
  - ↑ ↓ (or SLEW) keys — Move a page up or down to display portions that are off the screen.
  - NEXT PAGE key — Moves to the next page of a multi-page element. An arrow in the top right corner indicates that another page is available.
  - AIRPORT key — Calls up the flight plan page that contains the next airport along the current flight plan. Successive pushes on the key show the alternate airport, the origin airport (before takeoff), and the next airport again.
- Number and letter keys allow the pilot to insert data in the scratchpad so that he can use a line select key to enter it in the main display.
- Two keys have special functions :
  - CLR (clear) key — Erases material (messages or inserted data) from the scratchpad or from certain areas of displayed pages.
  - OVFY (overfly) key — Allows the aircraft to overfly a selected waypoint.

ANNUNCIATORS (on the side of the keyboard)

- FAIL (amber) — Indicates that the Multipurpose Control and Display Unit (MCDU) has failed.
- MCDU MENU (white) — Indicates that the pilot should call up a peripheral linked to the MCDU (such as ACARS or CFDS).
- FMGC (white) — Comes on while the crew is using the MCDU to display peripherals.

R

BRT KNOB

Controls the light intensity of the entire MCDU.

DATA ENTRY

The pilot enters data by typing it into the scratchpad on the MCDU. Next, pressing the line select key will load the data from the scratchpad into the desired field. An error message appears, if the data is out of range, or not formatted correctly. To correct data, the pilot may clear the message with the clear (CLR) key and then retype the message into the scratchpad. Pressing the CLR key, when the scratchpad is empty, displays "CLR". To clear data from a field, line select CLR from the scratchpad to the data field to be cleared.

MCDU ENTRY FORMAT

The pilot enters information into the MCDU at the bottom line of the scratchpad. When data has lead zeros, they may be omitted if desired. For example, a three-digit wind direction of 060 may be typed as 60. The display will still show 060. To enter an altitude below 1000 feet, the lead zero must be added as 0400 for 400 feet. This differentiates the altitude from a flight level.
To enter a double data entry such a speed/altitude, the separating slash must be used. If entering only the first part of a double entry, omit the slash. To enter only the second part of a double entry, a leading slash must be used i.e./0400 feet.

MESSAGES

The scratchpad displays various messages for pilot information. These messages are prioritized by importance to the pilot as either amber or white.
Amber messages are :
- Navigation messages
- Data entry message
- EFIS repeat messages.

There are two types of amber messages :
- Type 1 messages are a direct result of a pilot action. Type 1 messages are displayed immediately in the scratchpad, ahead of other messages.
- Type 2 messages inform the pilot of a given situation or request a specific action. They are stored in a "last in", "first out" message queue that holds a maximum of 5 messages.
  Type 2 messages are displayed in the scratchpad only if there are no Type 1 messages or other data. They will remain displayed until all the messages have been viewed and cleared with the CLR key.

White messages are advisory only.

CHARACTERS

Small and large fonts are displayed according to the following rules :

- The title line and the scratchpad are displayed in large font.
- Datafields are usually displayed in large font.
- Label lines are displayed in small font.
- Pilot entries and modifiable data are displayed in large font.
- Defaulted/computed and non modifiable data are displayed in small font.

COLORS

DATA	MCDU COLOR
TITLES, COMMENTS <, >, ↑ ↓ ← → DASHES, MINOR MESSAGES	WHITE
MODIFIABLE DATA SELECTABLE DATA BRACKETS	BLUE
NON MODIFIABLE DATA ACTIVE DATA	GREEN
– MANDATORY DATA (BOXES) – PILOT ACTION REQUIRED – IMPORTANT MESSAGES – MISSED CONSTRAINT	AMBER
CONSTRAINTS MAX ALTITUDE	MAGENTA
PRIMARY F-PLN	GREEN WAYPOINTS, WHITE LEGS
TEMPORARY F-PLN	YELLOW WAYPOINTS, WHITE LEGS
SECONDARY F-PLN	WHITE WAYPOINTS AND LEGS
MISSED APPROACH (not active)	BLUE WAYPOINTS, WHITE LEGS
ALTERNATE F-PLN (not active)	BLUE WAYPOINTS, WHITE LEGS
OFFSET	GREEN WAYPOINTS, WHITE LEGS OFST DISPLAYED IN THE TITLE OF F-PLN PAGE
TUNED NAVAID	BLUE
"TO" WAYPOINT AND DESTINATION	WHITE

SCREEN PROMPTS

R

→ UPPER RIGHT CORNER OF THE SCREEN INDICATES THAT NEXT PAGE IS AVAILABLE BY DEPRESSING NEXT PAGE KEY.

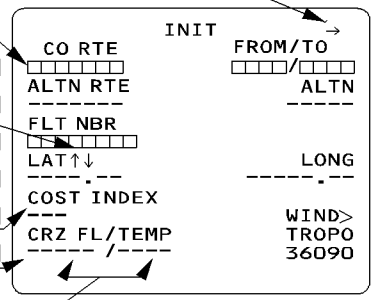
□□□ : DATA ENTRY IS MANDATORY TO ALLOW THE FMGC TO PERFORM ALL ITS FUNCTIONS.

↑↓ : WHEN THESE ARROWS ARE BESIDE A LABEL LINE, IT IS POSSIBLE TO INCREASE OR DECREASE THE VALUE DISPLAYED BELOW BY PRESSING ⍐ OR ⍗ KEYS ON THE KEYBOARD.

LABEL LINE

DATALINE OR DATA FIELD

--- : THIS DATA WILL BE COMPUTED BY THE FMGC IF IT HAS ENOUGH INFORMATION, OR PROVIDED OUT OF THE DATA BASE, OR INSERTED BY THE CREW.

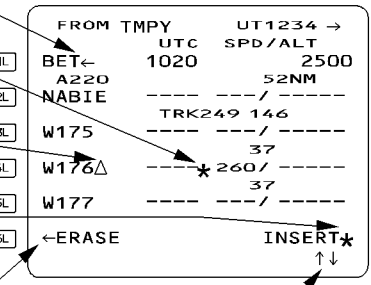


← → A TURN (LEFT ← OR RIGHT →) IS SPECIFIED ON THE LEG WHICH STARTED AT THE WAYPOINTS ADJACENT TO THE ARROW.

* : INDICATES THAT A CONSTRAINT HAS BEEN INSERTED. DISPLAYED ONLY IF PREDICTIONS AVAILABLE.

△ : DISPLAYED BESIDE A FIXED WAYPOINT ON THE F-PLN PAGE TO INDICATE THAT THE A/C WILL OVERFLY THE FIXED WAYPOINT

* : INDICATES THAT PRESSING THE ADJACENT LS KEY WILL CHANGE PARAMETERS AFFECTING THE ACTIVE SITUATION.



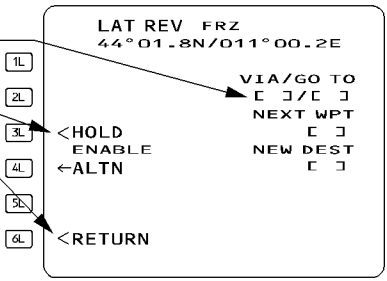
← → : INDICATES THAT PRESSING THE ADJACENT LS KEY WILL ACTIVATE THE PROMPT OR SELECT SOME DATA.

↑↓ : SCROLLING IS AVAILABLE BY PRESSING ↓OR↑ KEY ON THE KEYBOARD. THE PAGE IS NOT LARGE ENOUGH TO DISPLAY THE WHOLE INFORMATION.

[ ] : A DATA INSERTION IS POSSIBLE.

<OR> : MEANS THAT ANOTHER PAGE MAY BE ACCESSED BY PRESSING THE ADJACENT LS KEY.

+,-:WHEN AN ALTITUDE CONSTRAINT HAS BEEN ENTERED AT A WAYPOINT, THE CONSTRAINT VALUE IS DISPLAYED ON THE VERT REV PAGE.
A PLUS (+) IS DISPLAYED FOR AT OR ABOVE ALTITUDE CONSTRAINT AND A MINUS (-) FOR AT OR BELOW ALTITUDE CONSTRAINT.



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MCDU FUNCTION KEYS

The function keys on the Multipurpose Control and Display Units allow the pilot to call up MCDU pages quickly.

The following is a summary of the purpose of each key. (Volume 4, FMGS Pilot's Guide provides a full description of the pages.

R DIR — Calls up the DIR TO page, and allows the pilot to proceed directly from present position to any waypoint entered manually or selected in the active flight plan.

PROG — Calls up the progress page corresponding to the phase of the active flight plan that is in progress.

This page displays navigation information and active data such as the optimum and maximum recommended cruise flight levels. It allows the pilot to update the FMGS position and to get a bearing and distance to any location.

PERF — Calls up the performance pages, which display the optimum speed or Mach number for each phase. The pilot can amend these pages. The first page to be displayed is the one corresponding to the current flight phase (except for preflight and done phases).

The pilot can then use the appropriate 6L or 6R LSK to call up pages corresponding to future flight phases.

INIT — Calls up the flight plan initialization A page, which also gives the pilot access to the B page. The pilot uses the INIT pages to initialize Flight Management for the flight.

The pilot uses the INIT A page primarily to insert his flight plan and to align the inertial reference system.

The pilot uses the INIT B page to insert aircraft weight, fuel on board, CG and various fuel requirements. The FMGS uses this data to compute predictions and fuel planning parameters.

The pilot has access to the INIT A page only in the preflight phase.

INIT B page (not accessible after engine start) is called up by pressing the "NEXT PAGE" key.

DATA — Calls up the data index page. This gives the pilot access to various reference pages that show aircraft position, aircraft status, runways, waypoints, navaids, routes and data stored by the pilot.

F-PLN — Calls up the flight plan A and B pages, which contain a leg-by-leg description of the active primary flight plan.
The pilot can use the slewing keys to review the entire active flight plan. He can make all lateral and vertical revisions to the flight plan through these pages, using the left LSKs for lateral revision and the right keys for vertical revision.

RAD NAV — Calls up the Radio Navigation Page. This page displays The Radio Navaids tuned automatically or manually through the FMGC.

FUEL PRED — Calls up the fuel prediction page. Once the engines are started, this page displays the fuel predicted to be remaining at the destination and the alternate, as well as fuel management data.

SEC F-PLN — Calls up the index page for the secondary flight plan.The pilot can use this page to call up the secondary flight plan and all the functions related to it (copying, deleting, reviewing, activating, and the INIT and PERF pages).

ATC COMM — Calls up the ATC applications. (not activated).

MCDU MENU — Calls up the MCDU MENU page, which displays the subsystems currently addressed via the MCDU. The key next to the name of a subsystem enables the crew to select that subsystem.
When the MCDU MENU annunciator lights up, the pilot should press the MCDU MENU key. The menu will have [REQ] displayed next to the name of the subsystem that requires attention.

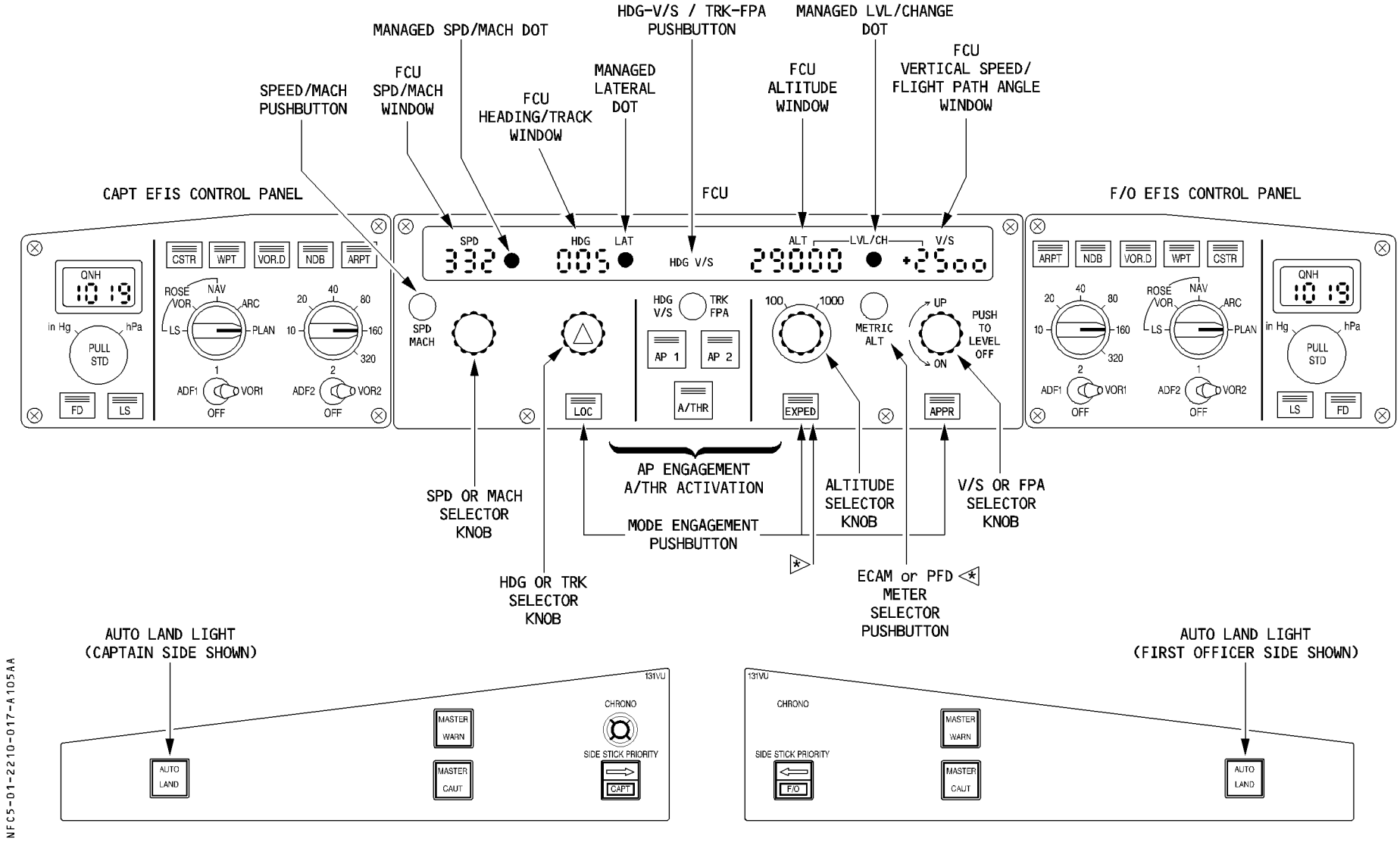
MCDU PAGES

(Refer to FCOM 4.03.20).

FLIGHT CONTROL UNIT (FCU)

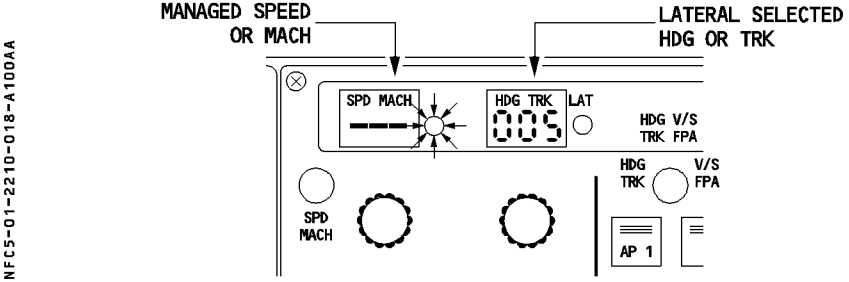
The FCU, which is on the glareshield, is actually three control panels : One for the automatic flight controls and two for the Electronic Flight Instrument System (EFIS).
For a description of the EFIS control panel, see Chapter 1.31.
The FCU has two channels each of which can independently command the central panel. If one channel fails, the other channel can control all the functions.

R



FCU PHILOSOPHY

The pilot can use two types of guidance to control the aircraft in auto flight. One type is managed by the Flight Management Guidance System (FMGS). The other uses target quantities which are manually entered by the pilot.
When the aircraft uses target quantities from the FMGS (managed guidance), the FCU windows display dashes and the white dots next to those windows light up.
When the aircraft uses target quantities, entered by the pilot (selected guidance), the windows display the selected numbers and the white dots do not light up.



Note : The altitude window always displays an altitude selected by the pilot (never dashes).

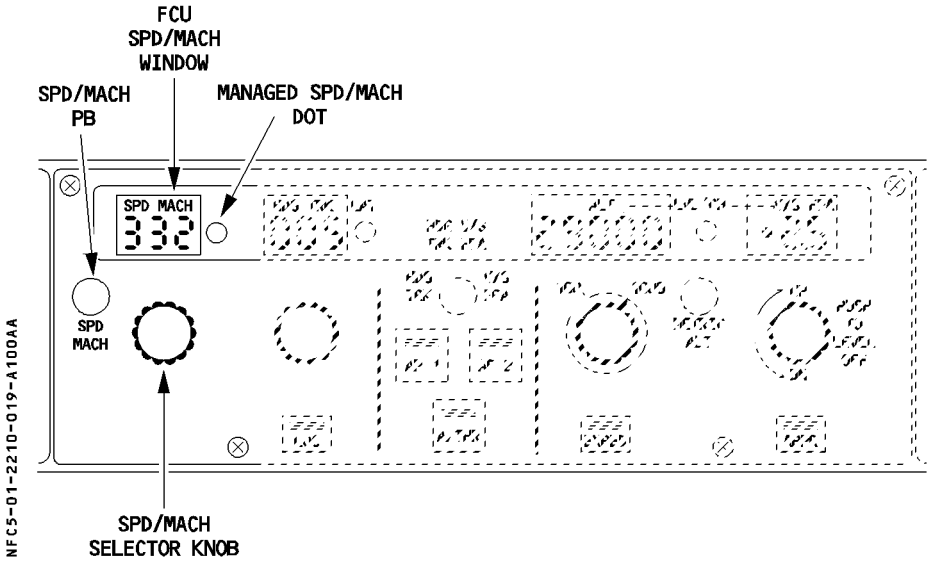
The FCU has four selector knobs :
- SPD-MACH
- HDG-TRK
- ALT
- V/S-FPA

The selector knobs can be rotated, pushed in, and pulled out.

- In order to arm or engage managed guidance for a given mode, the pilot pushes in the associated selector knob. If, for example, he pushes in the HDG selector knob, he engages
R or arms the NAV mode.
- In order to engage a selected guidance mode, the pilot turns the selector knob to set the desired value, then pulls the knob out to engage the mode with a target value equal to the selected value.

R *Note : In managed guidance (lateral, vertical guidance or managed speed), the*
R *corresponding window is dashed. Turning a selector knob without pulling it,*
R *displays a value that is the sum of the current target and the turn action value. The*
R *display remains 45 seconds on the HDG/TRK and V/S windows and 10 seconds on*
R *the Speed/Mach window before the dashes reappear. This rule does not apply to*
R *the ALT selector knob/window.*

SPEED/MACH CONTROL AREA



- **SPD/MACH selector knob**

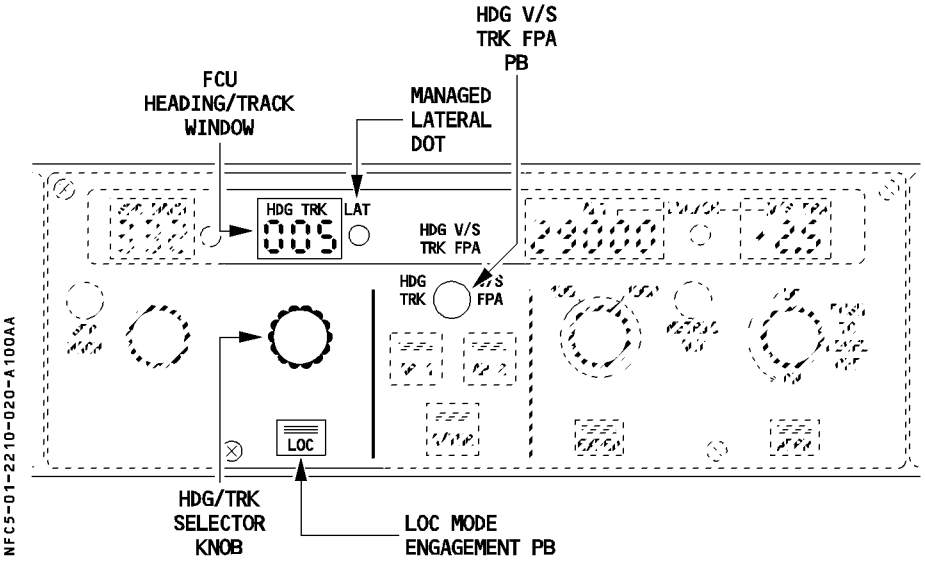
  Display range : between 100 and 399 knots for speed, between 0.10 and 0.99 for Mach number.

  One rotation of the knob corresponds to approximately 32 knots or 0.32 Mach.

- **SPD/MACH pushbutton**

  Pushing this pushbutton changes the SPD target to the corresponding MACH target and vice versa.

LATERAL CONTROL AREA



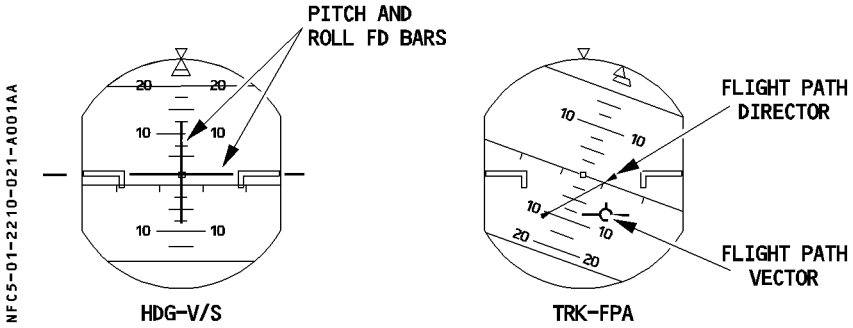
- **HDG/TRK selector knob**
  Display range : between 0° and 359°.
  One rotation of the knob corresponds to 32° (1° per click).

- **LOC pushbutton**
  Pushing this pushbutton arms, engages, or disengages the LOC mode.

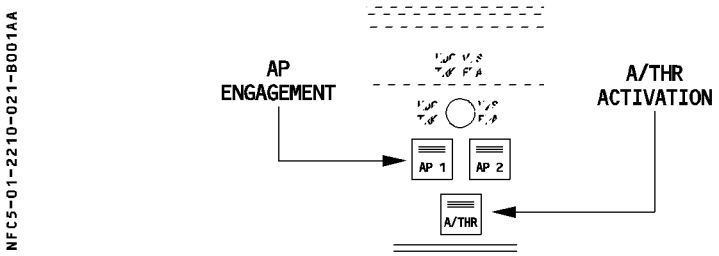
· **HDG V / S - TRK FPA pushbutton**

R The pilot uses this pushbutton to select HDG (associated with V/S) or TRK (associated
R with FPA). Pushing it :

- Displays the Flight Path Vector (FPV) on the Primary Flight Display (PFD) or deletes it.
- On the PFD, changes the FD crossbar display (with the aircraft attitude as its reference) to the aircraft Flight Path Director (with the flight path vector as its reference) and vice versa.
- Changes heading reference into track reference in the HDG/TRK window and vice versa.
- Changes vertical speed reference target into flight path angle reference target in the V/S-FPA window and vice versa.



AP-A/THR CONTROL AREA



· **AP1 AP2 pushbuttons**

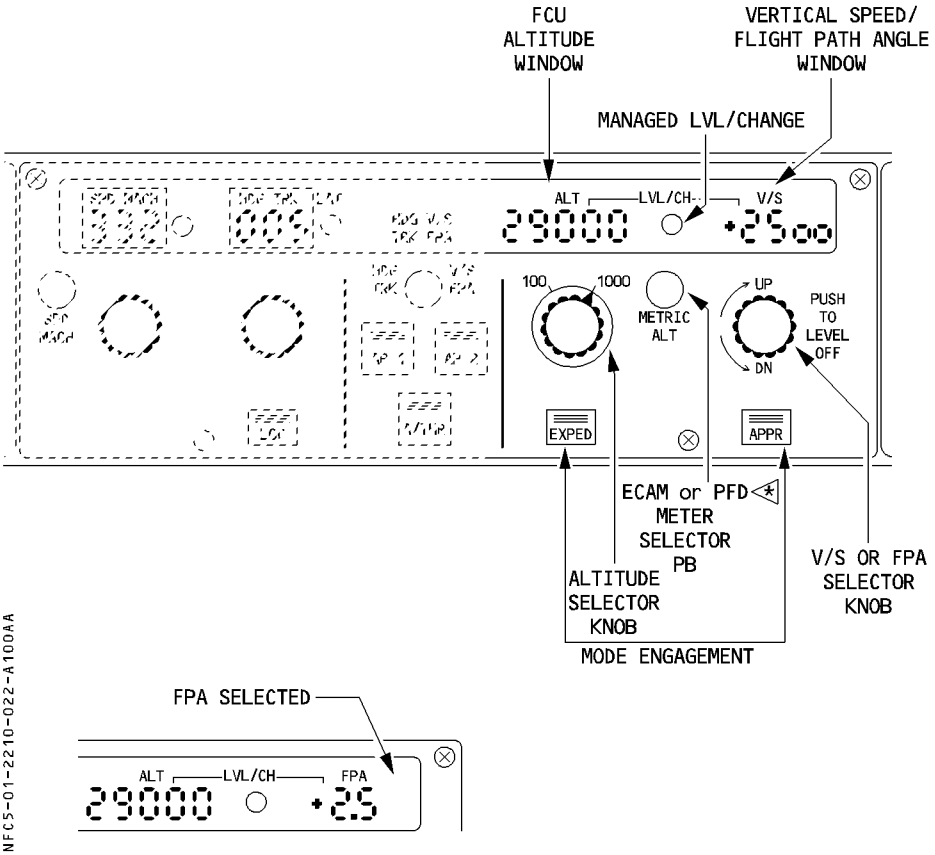
R The pilot uses these pushbuttons to engage or disengage the autopilots. The buttons
R illuminate green when the autopilot is engaged.

· **A/THR pushbutton**

The pilot uses this pushbutton to arm, activate, or disconnect the autothrust (A/THR).
R This button illuminates green if the A/THR is armed or active.

VERTICAL CONTROL AREA

R



VERTICAL CONTROL AREA (Cont'd)

The FCU altitude window always displays a target value selected by the pilot. It never displays dashes.

· **Altitude selector knob (inner and outer)**
Display range : 100 to 49000 feet
– The outer knob has two positions : 100 and 1000.
– The inner knob sets the altitude in the FCU windows in increments of 100 or 1000 feet, depending upon the position of the outer knob.

R · **EXPED pushbutton**
R This pushbutton is used to engage the expedite mode. (See the EXPEDITE, 1.22.30).

· **METRIC ALT pushbutton**
This pushbutton is used to display the FCU altitude target in meters on the ECAM, or the current altitude and FCU/FM altitude target in meters on the PFD ◁.

· **V/S or FPA selector knob**
Range (V/S) : – 6000 to + 6000 feet/min
2 clicks = 100 feet/min
If the pilot turns the knob slowly, each click equals 100 feet/min.
Range (FPA) : – 9.9° to + 9.9°
1 click = 0.1°
The pilot turns this knob to set the value of the vertical speed (V/S) or flight path angle (FPA) to be displayed in the V/S or FPA window. (He chooses which, V/S or FPA, is to be displayed by pushing the HDG V/S/TRK FPA pushbutton, as discussed previously).
One rotation of the knob corresponds to 32 clicks. One complete rotation sets :
FPA = 3.2°
V/S = 1600 ft/min
When the pilot pushes in the V/S or FPA knob the system commands an immediate level-off by engaging the V/S or FPA mode with a target of zero. The flight mode annunciator (FMA) then displays "V/S = 0" in green when V/S or FPA is nulled. If the pilot now turns the knob to put in a new setting for V/S or FPA, the aircraft changes flight path accordingly.

· **APPR pushbutton**
This pushbutton arms, disarms, engages, or disengages the approach modes :
LOC and G/S modes, if an ILS approach is selected in the active F-PLN.
APP NAV-FINAL modes, if a non precision approach is selected in the active F-PLN.

GENERAL

The Flight Management part of the FMGC performs four main functions :
- Navigation
- Flight planning (lateral and vertical)
- Prediction and optimization of performance
- Management of the displays (MCDU, ND, PFD).

NAVIGATION

Essential navigation functions are :
- Computation of position.
- Evaluation of position accuracy (also see FCOM Vol 4 for a detailed description of pilot's procedure).
- Radio navigation tuning.
- Alignment of Inertial Reference System.

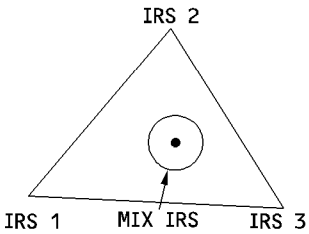
POSITION COMPUTATION

Each FMGC computes its own aircraft position (called the "FM position") from a MIX IRS position (see below), and a computed radio position or GPS position.
The FMGS selects the most accurate position, considering the estimated accuracy and integrity of each positioning equipment.
GPS/INERTIAL is the basic navigation mode provided GPS data is valid and successfully tested. Otherwise, navaids plus inertial or inertial only are used. (Refer to Navigation modes).

MIX IRS POSITION

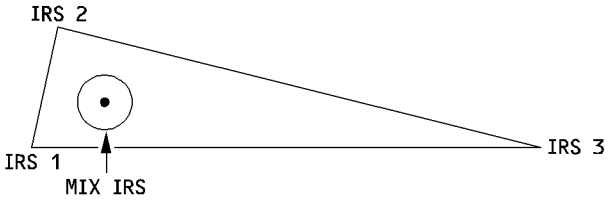
Each FMGC receives a position from each of the three IRSs, and computes a mean-weighted average called the "MIX IRS" position.

NFCS-01-2220-002-A220AA



– If one of the IRSs drifts abnormally, the MIX IRS position uses an algorithm that decreases the influence of the drifting IRS within the MIX IRS position.

NFCS-01-2220-002-B220AA



– If one of the IRSs fails, each FMGC uses only one IRS (onside IRS or IRS3). Each IRS position and inertial speed are continuously tested. If the test fails, the corresponding IRS is rejected.

R – When the CHECK IRS (1, 2 or 3)/FM POSITION message appears on the MCDU, refer to FCOM 4.03.35.

GPS POSITION

R Each IRS computes a hybrid position that is a mixed IRS/GPS position called GPIRS. For this, each IRS can independently select their GPS source in order to maximize GPS data availability. Among these 3 GPIRS positions received by each FMGC, one is selected according to a figure of merit and priority. The selection is performed using the following hierarchy :

- Onside GPIRS position
- GPIRS 3
- Opposite GPIRS position

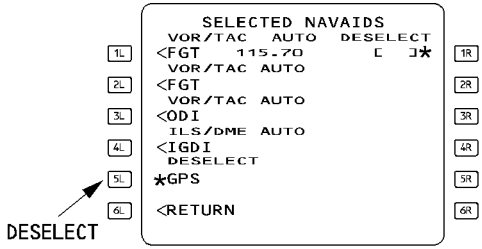
If the GPIRS data does not comply with an integrity criteria, the GPS mode is rejected, and radio position updating is used, the "GPS PRIMARY LOST" message is displayed on the ND and on the MCDU scratchpad.

During non ILS approach, the loss of the GPS primary function triggers a triple click aural warning.

When the GPS primary function is recovered, the "GPS PRIMARY" message comes up on the ND and on the MCDU scratchpad. It means that GPIRS data again complies with the required integrity criteria.

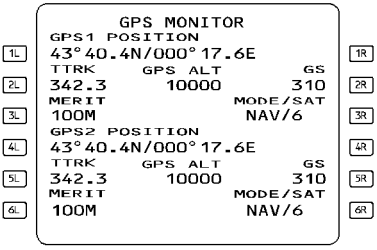
As long as GPS primary is in use, all usual navigation performance requirements are met. The crew can deselect/select the GPS on the SELECTED NAVAIDS page, if necessary.

NFC5-01-2220-003-A110AA



Information concerning the GPS position is displayed on the GPS MONITOR page.

NFC5-01-2220-003-B110AA



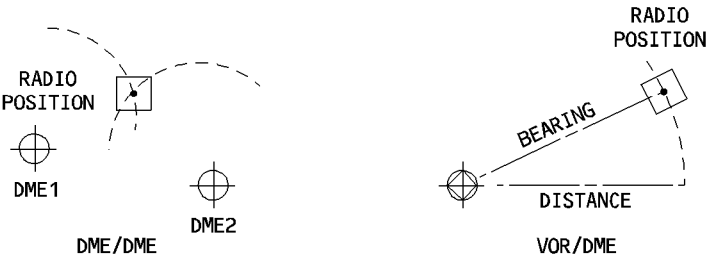
R *Note : In normal operations, all ADIRUs may elect the same GPS source. As a result, data*
R *of the non-elected GPS may be dashed on the GPS MONITOR page, without any*
R *detected GPS failure or triggered "GPS PRIMARY LOST" message.*

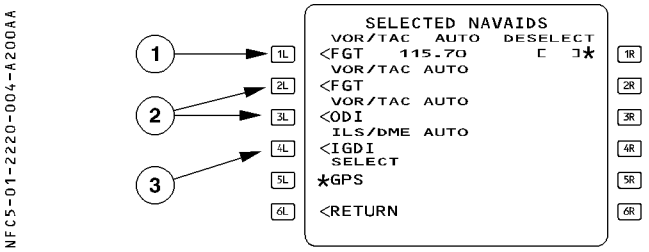
RADIO POSITION

Each FMGC uses onside navaids to compute its own radio position. These navaids are displayed on the SELECTED NAVAIDS page. The available navaids are :

- DME/DME
- VOR/DME
- LOC
- DME/DME-LOC
- VOR/DME-LOC

It uses LOC to update the lateral position, using LOC beam during ILS approach.
LOC is also used for quick update, when in GPS/IRS mode.
If one or more navaids fail, each FMGC can use offside navaids to compute the VOR/DME, or the DME/DME radio position.
The radio navaid selection is displayed on the DATA "SELECTED NAVAIDS" page.





(1) VOR/DME selection (auto or manual) for display (onside VOR)

(2) DMEs automatic selection for DME/DME onside radio position.

(3) ILS selection auto or manual for LOC update computation.

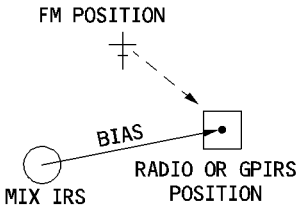
FM POSITION

At flight initialization, each FMGC displays an FM position that is a mixed IRS/GPS position (GPIRS).

- At takeoff, the FM position is updated to the runway threshold position, as stored in the database, possibly corrected by the takeoff shift entered on the PERF TO page.
- In flight, the FM position approaches the radio position, or the GPS position, at a rate that depends upon the aircraft altitude.

Note : The FM position update at takeoff is inhibited when GPS PRIMARY is active.

NFC5-01-2220-005-A205AA

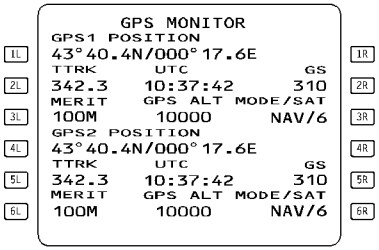


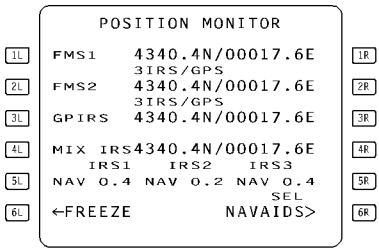
Bias

Each FMGC computes a vector from its MIX IRS position to the radio or GPIRS position. This vector is called the "bias". Each FMGC continuously updates its bias, if a radio position, or a GPIRS position is available.
If an FMGC loses its radio/GPIRS position, it memorizes the bias and uses it to compute the FM position, which equals the mix IRS position plus the bias.
Until the radio or the GPIRS position is restored, the bias does not change.
The crew can manually update the FM position. This also updates the bias.

POSITION MONITOR

The crew may check the position computation using the "GPS MONITOR" or "POSITION MONITOR" page.





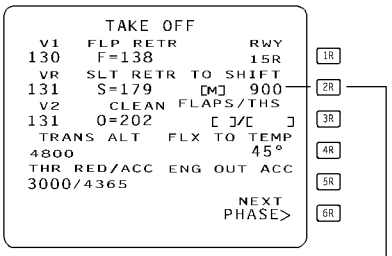
NFCS-01-2220-006-A21OAA

1L	FM POSITION (ONSIDE FMGC)
2L	FM POSITION (OFFSIDE FMGC)
3L	GPIRS OR RADIO POSITION (ONSIDE FMGC), WHICHEVER IS USED FOR POSITION UPDATING
4L	MIX IRS POSITION (ONSIDE FMGC)

TAKEOFF UPDATE (GPS PRIMARY not active)

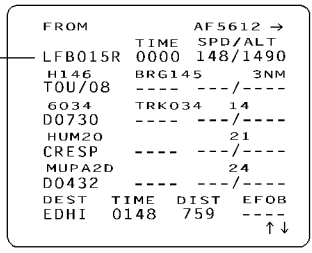
A takeoff update requires that the takeoff runway be part of the flight plan. This provides the most accurate position update.
If the takeoff run starts at an intersection, enter a takeoff shift on the PERF TO page to refine the takeoff update.
An accurate takeoff update ensures a precise aircraft position during departure.

PERF TO PAGE



IF THE TAKEOFF IS NOT INITIATED FROM RUNWAY THRESHOLD, TO SHIFT SHOULD BE INSERTED TO UPDATE THE POSITION.

F-PLN A PAGE
(WITHOUT PREDICTIONS)



TAKEOFF RUNWAY IN THE FLIGHT PLAN.

NFCS-01-2220-006-B21OAA

NAVIGATION MODES

The FMGS updates the FM position using GPS or radio navaids if the GPS function in inoperative.
It can use 4 main different FM navigation modes to make this update. The decreasing priority order is:
– IRS-GPS
– IRS-DME/DME
– IRS-VOR/DME
– IRS only
During ILS approaches the system performs, a lateral temporary updating using one of the following modes :
– IRS-GPS/LOC
– IRS-DME/DME-LOC
– IRS-VOR/DME-LOC
– IRS-LOC

EVALUATION OF POSITION ACCURACY

The FMGS computes an Estimated Position Error (EPE) continually.
It is an estimate of how much the FM position has drifted, and is a function of the navigation mode the system is using.

CURRENT NAV MODE	EPE (RATE or THRESHOLD)	REMARK
IRS/GPS	$\sqrt{(FOM^2 + 100^2)}$ in meters	FOM = Figure of Merit of GPS If above 0.28 NM the GPS position is rejected.
IRS/DME/DME	Tends towards 0.28 NM	EPE decreases from initial value to 0.28 Nm.
IRS/VOR/DME	0.1 NM + 0.05 X DME DIST minimum : 0.28 NM	EPE increases or decreases as the distance between the a/c and the VOR/DME.
IRS ONLY	+ 8 NM/h for the first 21 min. + 2 NM/h after	EPE increases continuously

Note : After an IRS alignment or at takeoff the EPE is set at 0.2 NM.

The system displays the EPE to the crew, and compares it with the required navigation performance (RNP).

– If the EPE does not exceed the appropriate criteria, accuracy is HIGH.
– If the EPE exceeds the appropriate criteria, accuracy is LOW.

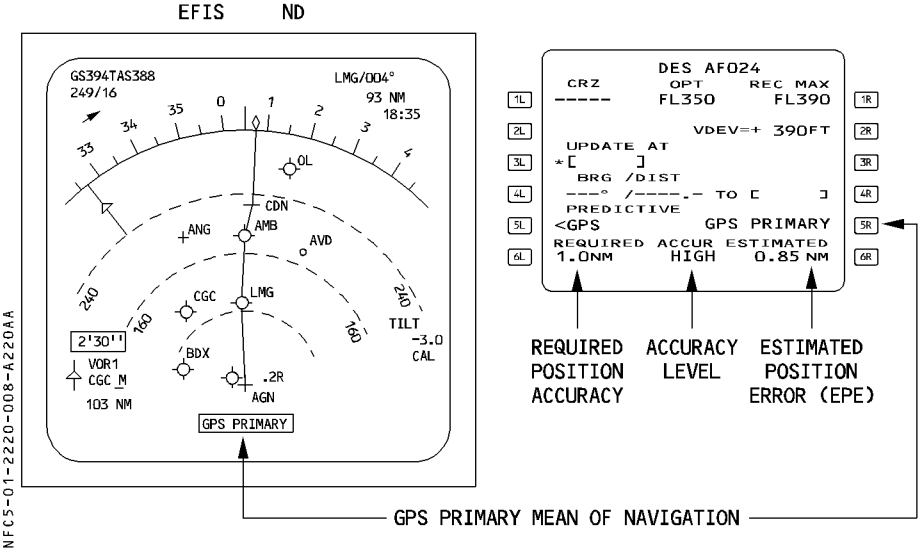
The number displayed in the REQUIRED NAVIGATION PERFORMANCE (RNP) field is (in decreasing order of priority) : The pilot-entered value, the database procedure value, or the system's default value. When a pilot enters a RNP that is larger than the published value, one of the following messages is displayed : "PROCEDURE RNP is XX.XX", or "AREA RNP IS XX.XX". When this occurs, the crew should check the entered value, and modify it, if necessary.

The RNP value shall be in accordance with the specified RNP values of the navigation/approach charts (if a RNP is specified).

This message is also displayed upon a flight area change, if the new required criteria (default value) is smaller than the displayed manually-entered value.

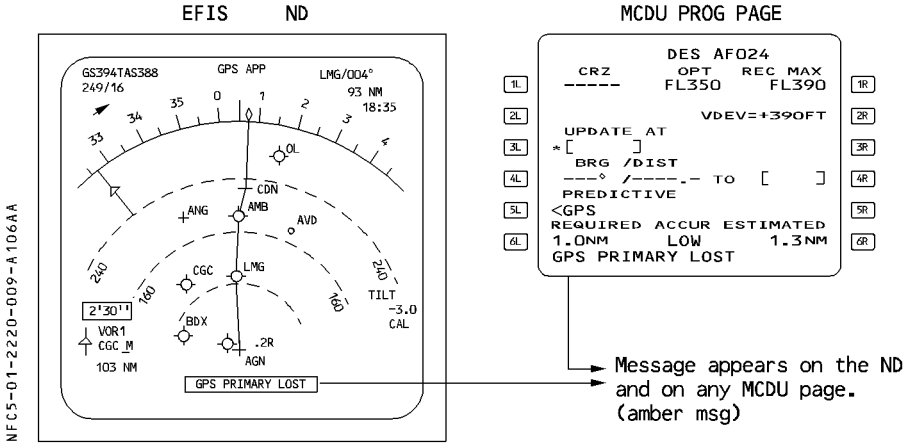
DEFAULT AREA RNP VALUES	
EN ROUTE	2.0 NM
TERMINAL	1.0 NM
APPROACH	GPS 0.3 NM OTHER CASES 0.5 NM

When the position computation uses IRS/GPS mode, the EPE is always smaller than any airworthiness required value. As a result, accuracy is HIGH and GPS is the primary mean of navigation. "GPS PRIMARY" is displayed on PROG page and temporarily on ND.



NFCS-01-2220-008-A220AA

When the GPS function is lost, a "GPS PRIMARY LOST" message is displayed on the ND and MCDU scratchpads. The MCDU message can be cleared ; the ND message cannot. During a non ILS approach, a triple click aural warning is also triggered.
When the GPS is lost, NAV accuracy does not immediately downgrade ; but only when the EPE exceeds the required criteria.



CAUTION

"HIGH" or "LOW" indicates FM position accuracy, based upon estimated drift. This is why the flight crew must periodically check position accuracy, when the GPS function is lost.

When the GPS is manually deselected, the "GPS IS DESELECTED" message is displayed on the MCDU, 80 NM before T/D or at approach phase transition.

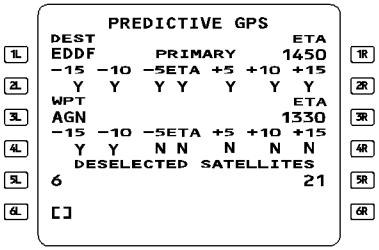
GPS/FMS POSITION DISAGREEMENT

R When GPS primary is active, and either of the FMGC positions deviate from the GPS positions 1 or 2 by more than 0.5 minutes of latitude or longitude, then the lower ECAM display unit displays the NAV FMS/GPS POS DISAGREE amber message and A/C POS... CHECK in blue.
The master caution light comes on, and the single chime sounds.

PREDICTIVE GPS

R The predictive GPS page is only operative with the Honeywell ADIRS equipment.
The predictive GPS function predicts the availability of the GPS within ± 15 minutes of ETA at destination, or at any waypoint entered by the crew.

NFCS-01-2220-010-A100AA



Predictions are displayed on the predictive GPS page at time intervals of 5 minutes (+15 and –15 minutes of ETA).
To access this page, press the 5L key of the PROG page.
This page also enables the deselection of up to 4 satellites at a time.

RADIO NAVIGATION TUNING

Radio navaids are tuned for two different purposes : display and computation.
Tuning for display may be performed in three different ways :

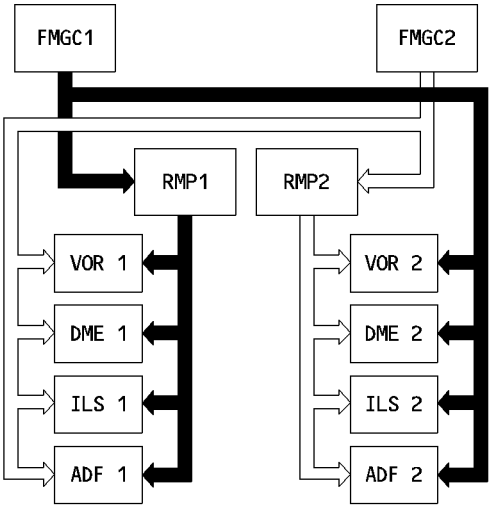
- automatic tuning (FMGC software)
- manual tuning through the MCDU RAD NAV page
- manual tuning through the Radio Management Panel (RMP) if both FMGCs or both MCDUs fail.

The FMGS automatically tunes the radio navaids for the computation of radio position.

Note : The manual selection of a VOR or VOR/DME may prevent the FMGS from tuning a VOR/DME automatically to compute position. If so, the relevant MCDU will display "TUNE BBB FFF.FF" (BBB = ident, FFF.FF = frequency).

ARCHITECTURE

R



NFC5-01-2220-011-A001AA

- In dual mode and independent mode each FMGC tunes the navaids on its side of the console (one VOR, 5 DMEs, one ILS, and one ADF) simultaneously. In these modes, the pilot can also tune the VOR (and associated DME), ILS, and ADF manually.
- In single mode, the valid FMGC will tune both side navaids. The pilot can also use the RAD NAV page to tune both VORs, both ADFs and the ILS manually.

Manual tuning has priority over autotuning.

Note : If one radio receiver fails, both FMGCs use the operative radio receiver to compute the aircraft position.

VOR

Each FMGC may tune only one VOR (manual or automatic).
Autotuning follows the following VOR tuning priorities :

1. The navaid specified for the approach.
2. The navaid to be used for computing the present radio position.
3. For display purposes :
   - A navaid specified for the active leg ;
   - The "to" waypoint (TO WPT), if it is a navaid ;
   - The "from" waypoint (FROM WPT), if it is a navaid ;
   - A waypoint farther along the flight path, if it is a navaid ;
   - The navaid closest to the aircraft's present position.

The scratchpad displays "SPECIFIC VOR-D UNAVAIL", if the VOR or VOR/DME required for tuning has been deselected.

DME

Each FMGC automatically uses its five DMEs as follows :

- One DME for display. It may be manually or automatically tuned.
- Two DMEs in DME/DME mode for calculating the aircraft's radio position. The FMGC autotunes these as a function of their best accuracy. The flight crew receives no indication that this process is going on.
- One DME autotuned for radio position. This occurs in the VOR/DME mode, whenever DME/DME is unavailable and the conditions for a VOR/DME update are met. In this case, the VOR/DME, used for display, is identical to the VOR/DME navaid used for the computation of a radio position.
- One DME is linked to the ILS/DME.

ADF

The FMGC autotunes one ADF, when the flight plan specifies an NDB approach and a fix in the approach is the "TO" waypoint.
The scratchpad displays "SPECIFIC NDB UNAVAIL", if the NDB required for autotuning has been deselected.

ILS

Each FMGC autotunes one ILS frequency :

- In the PREFLIGHT or TAKEOFF phase, when the takeoff runway has an associated ILS.
- In the CLIMB-CRUISE-DESCENT, APPROACH, or GO-AROUND phase, when the type of approach in the flight plan is ILS.

The scratchpad displays "RWY/ILS MISMATCH" when the pilot has manually tuned the ILS and the entered frequency does not match the ILS or LOC IDENT/FREQ requested for
R autotuning. The FMGS logic does not allow the crew to modify the course of an ILS when
R its frequency is identical to the ILS selected in the F-PLN.

SELECTION OF NAVAIDS ON MCDU PAGES

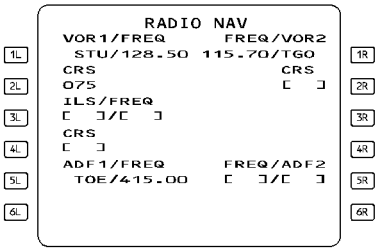
The MCDU displays the navaids tuned by the FMGC on two pages :

– RADIO NAV page
– SELECTED NAVAIDS page

· RADIO NAV page

This page shows which navaids have been tuned automatically or manually for display purposes.

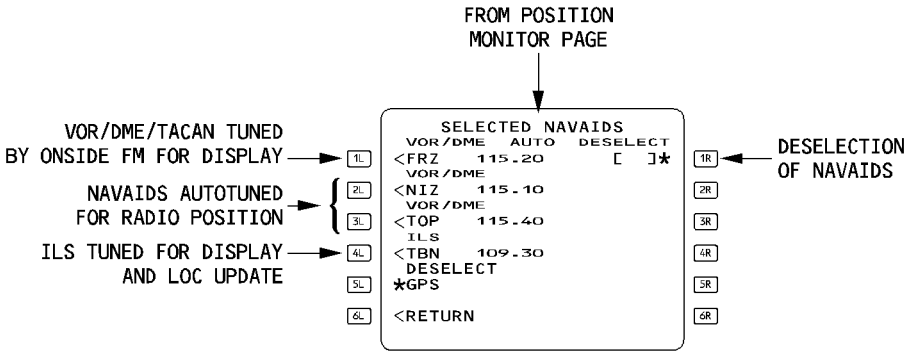
NFC5-01-2220-013-A105AA



· SELECTED NAVAIDS page

This page lists the navaids tuned by the onside FMGC. No navaids can be modified on this page. The pilot may deselect as many as six unreliable navaids for the whole flight (using 1R key).

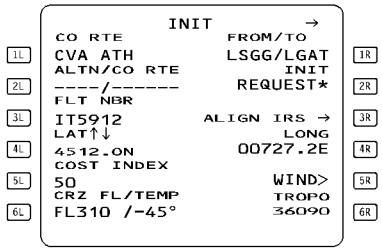
NFC5-01-2220-013-B105AA



ALIGNMENT OF INERTIAL REFERENCE SYSTEM

The FMGS uses the reference point coordinates of the departure airport to align the IRS. It automatically calls these up from the database after the flight crew has entered a company route, or an origin-destination city pair, and pressed the ALIGN IRS key. The flight crew can manually adjust these coordinates to the gate position. A normal alignment takes ten minutes ; a fast alignment takes 30 seconds.
Fast alignment is used to refine a position, when time is limited.

NFC5-01-2220-014-A120AA



Note : If the ADIRS overhead CDU flashes "ALIGN" during the alignment process, it indicates one of the following :

- *It has detected excessive motion. (It automatically restarts the alignment).*
- *It has detected a mismatch between the position the MCDU has sent to the IRS, and the last memorized IRS position. The pilot must enter new coordinates in the MCDU, and realign the IRS.*
- *It has detected a mismatch between the latitude the MCDU has sent to the IRS, and the latitude the IRS has computed during the alignment.*
- *The IRS has not received a position from the MCDU or the ADIRS overhead CDU.*

FLIGHT PLANNING

For flight planning, the pilot inserts the following into the FMGS via the MCDU :
- the intended lateral trajectory (lateral flight plan)
- the intended vertical trajectory, which is a speed and altitude profile (vertical flight plan)

The system must have this information in order to compute performance and guidance commands.

GENERAL

The FMGS can contain two different flight plans :
- the ACTIVE flight plan, which is the basis for :
  - lateral and vertical guidance
  - MCDU and ND display
  - radio navigation autotuning
  - performance predictions
  - fuel planning
- the SECONDARY flight plan which the pilot may use :
  - R when an alternate takeoff runway is probable
  - to plan a diversion
  - to prepare the next flight
  - R to compare predictions or evaluations

Each flight plan is composed of the same elements :
- the primary flight plan, from origin to destination and missed approach
- the alternate flight plan, from destination to alternate destination

The pilot enters the flight plan in either of two ways :
- automatically by selecting a company route. Such a selection will call all the elements of the route out of the database.
- manually by selecting an ORIGIN/DEST pair, and then selecting all successive waypoints, procedures, and vertical constraints on the MCDU.

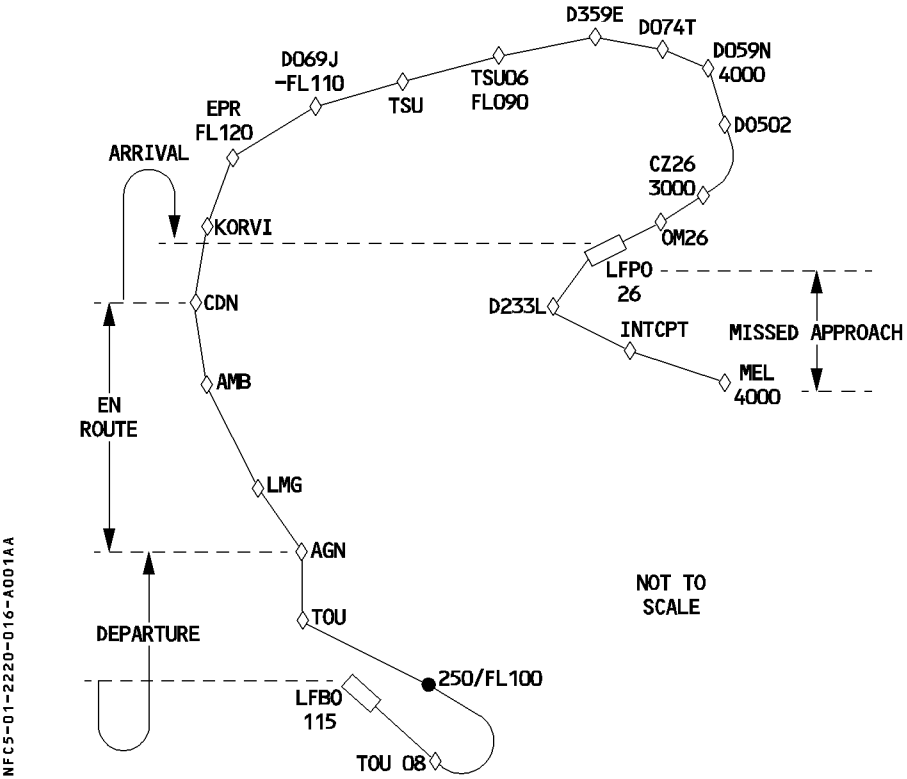
The pilot may then modify the flight plan on the ground or in flight, by making lateral and vertical revisions.

LATERAL FLIGHT PLAN

The lateral flight plan includes the following elements :

- Departure
  - Takeoff runway
  - SID
  - En route transition
- En route
  - En route waypoints and airways
- Arrival
  - En route transition
  - STARs/VIAs
  - Landing runway with selected approach
  - Missed approach
- Alternate flight plan

These elements are defined by waypoints and legs between the waypoints.



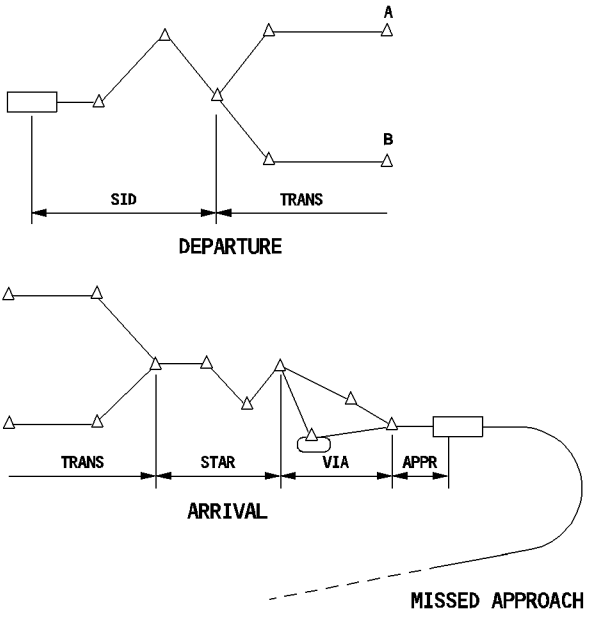
The FMGC automatically strings the legs in sequence.
The flight plan has a discontinuity if any two waypoints do not have a leg defined between them.
The computer assumes that the aircraft will fly a direct leg between the two waypoints that define the discontinuity.

Note : *When the aircraft enters a flight plan discontinuity, the NAV mode automatically switches to the HDG (TRK) mode.*

The FMGS automatically strings additional types of legs, when departure or arrival procedures (SID-STAR-TRANS) are defined. Some of these legs are specific legs, such as:
- DME arc leg
- Holding pattern to a fix, or reverse turn
- Course-to-fix leg
- Heading leg
- MANUAL leg

The pilot cannot create these types of legs : They are part of the stored departure/arrival procedures he has selected.
The pilot can only create direct legs between manually-defined geographic points (navaids, airports, waypoints).

Note : *The departure and arrival procedures are defined in the database to minimize the amount of memory required. They are divided, as follows :*
DEPARTURE = SID + EN ROUTE TRANSITION
ARRIVAL = APPR VIA + STAR + EN ROUTE TRANSITION
The SID is the central common part of the departure procedure, as the STAR is of the arrival procedure. Enroute transitions (TRANS) are the various possible trajectories defined between the last SID point and the first enroute waypoints, and between the last enroute waypoint and the first fix of the STAR.
"APPR VIAs" are the possible trajectories, defined between the last STAR point and the first point of the approach.



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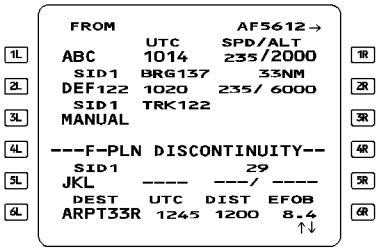
MANUAL LEGS

A MANUAL leg stays on a constant TRK or HDG and has no termination point. You cannot insert it into a flight plan manually : it is part of a given procedure such as a SID or a STAR. When the aircraft is flying a MANUAL leg, the NAV mode remains engaged and predictions assume that the aircraft will fly a direct leg from its present position to the next waypoint
R (DIR TO). When the aircraft is cleared to fly to the next waypoint of the flight plan, the pilot
R performs a DIR TO.

Note : — In NAV mode a MANUAL leg is sequenced only by performing a DIR TO.
— The use of the descent mode (DES) on a MANUAL leg is not recommended.



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LATERAL REVISIONS

There are two types of lateral revisions :

- Lateral revisions that have an immediate effect on the active flight plan
  - · The pilot inserts, deletes, or changes an individual waypoint on the flight plan page.
  - · The pilot creates a direct leg (DIR TO) from his present position to a selected waypoint.
- Lateral revisions that lead to a temporary flight plan (TMPY) before they take effect. For these, you can select, delete, or modify waypoints that belong to an airway or to a procedure (SID, STAR, HOLD, TAKEOFF or LANDING RWY). This modification is made on specific "LAT REV" pages from the flight plan page.

Possible revisions are :

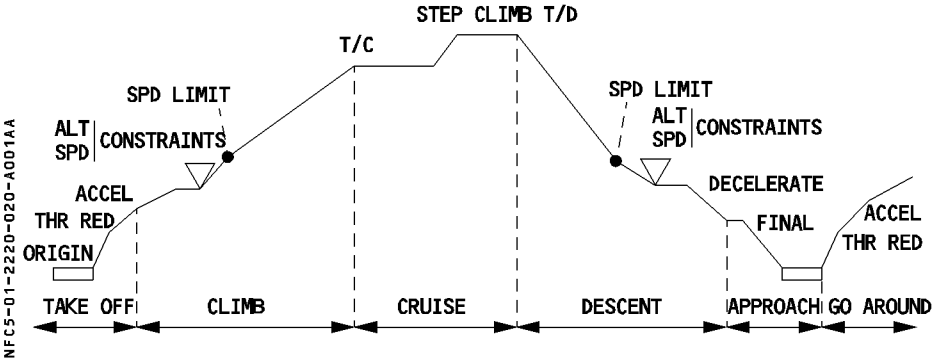
· Insert or modify departure procedure.
· Insert or modify arrival procedure.
· Insert a waypoint.
· Change the destination.
· Insert an airway.
· Insert an offset.
· Insert a holding pattern.
· Select or enable an alternate flight plan.
· Fix information.

TEMPORARY FLIGHT PLAN

The purpose of the temporary flight plan is to allow the pilot to check a revision on the MCDU and EFIS ND before inserting the changes into the active flight plan. It is a copy of the active flight plan that has been changed according to the pilot revision. While it is displayed the aircraft will continue to follow the original active flight plan.
No predictions are computed or displayed on the pages of the temporary flight plan.
For details, refer to the TEMPORARY F-PLN chapter (FCOM 4.04).

VERTICAL FLIGHT PLAN

The vertical flight plan is divided into the following flight phases.
Preflight - Takeoff - Climb - Cruise - Descent – Approach - Go Around - Done.
All but preflight and done are associated with speed and altitude profiles.



Each phase has an assigned profile of target speeds. For each phase the FMGS computes an optimum (ECON) speed as a function of the strategic parameters (CI, CRZ FL, ZFW, ZFCG, block FUEL) and performance criteria.
ECON speed is the basis of the managed speed profile.
The ECON speed can be modified by presetting a speed or Mach number on the MCDU (PERF page) for the next phase, or by selecting on the FCU a speed or a Mach number for the active phase, or by inserting speed constraints or speed limits on the MCDU vertical revision (VERT REV) page.
The vertical flight plan includes vertical constraints (altitude, speed, time) that may be stored in the data base or entered manually by the crew through vertical revision pages. The crew may also define step climbs or step descents for cruise purposes. If the crew plans to climb to a higher flight level or descend to a lower level, it can use a vertical revision at any waypoint to insert the new level.
When all the vertical data has been defined, the FMGC computes the vertical profile and the managed speed/Mach profile from takeoff to landing.

R For details, refer to vertical revision pages 4.03.20.

PERFORMANCE

The performance function includes optimization and predictions.

OPTIMIZATION

The FMGC minimizes cost by optimizing speed. The optimization function computes the following items :

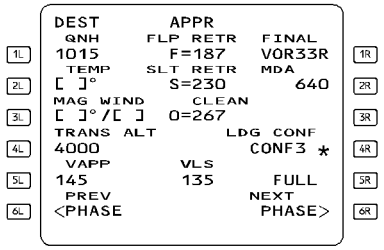
- takeoff, approach, and go-around speeds (F, S, Green Dot, VAPP)
- an optimum target speed for CLB and DES phases (ECON CLB/DES SPD)
- an optimum target Mach number for CRZ phase (CRZ MACH)
- an optimum FL, for information purposes
- an optimum descent profile from CRZ FL down to the destination airport.

These items depend on the data the pilot inserts during lateral and vertical flight planning and revision procedures.
Most are displayed on the PERF pages associated with the appropriate flight phases.

Takeoff, approach and go around speeds

The FMGC computes takeoff speeds (F, S, Green Dot) during the preflight and takeoff phases, using the performance model in the database and the takeoff weight.
The pilot has to insert V1, VR, and V2 in the PERF TO page manually.
The FMGC uses the performance model and either the predicted landing weight or the current gross weight at transition to the approach phase to compute approach speeds (VLS, VAPP, F, S, Green Dot). On the PERF APPR page, the selected LDG CONF determines the applicable VLS and VAPP, the latter being updated by the WIND correction that the pilot enters on the same page.
The FMGC uses the performance model and gross weight to compute go-around speeds (F, S, Green Dot).

R



PERF APPROACH PAGE

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Optimum target speed for CLB or DES phase

The FMGC computes optimum speeds, based on :

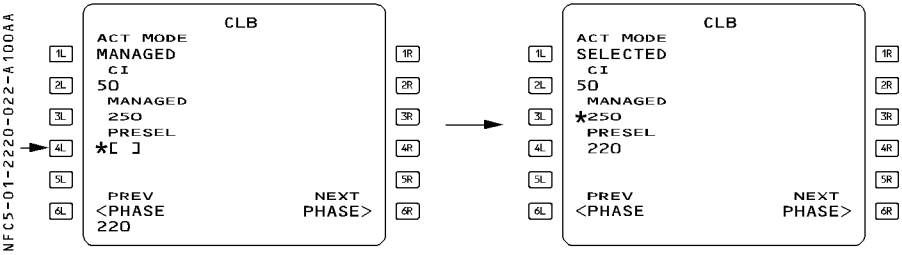
- Gross weight (GW)
- Cost index (CI)
- Cruise flight level (CRZ FL)
- Wind and temperature models
- Performance factor

When there is no time or speed constraint/limit, ECON SPEED is the optimum speed for the selected cost index. It refers to fuel and time cost, and not directly to fuel saving.

The FM calculates ECON CLB, ECON DES and the associated top of climb and top of descent as a function of the cost index, cruise FL, and meteo data.

Preset target speed for CLB phase

The pilot can preselect the climb speed before the CLB phase begins, by inserting a speed in the PRESEL field :

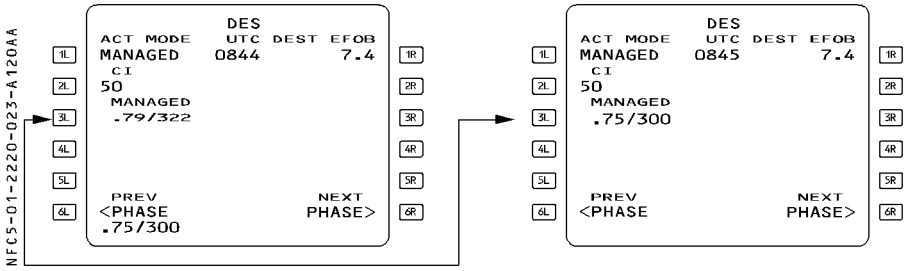


The active mode field changes from MANAGED to SELECTED, and the FM will use the entered speed for climb predictions' computation. The pilot can revert to managed mode by pressing the 3L key.

Preset target speed/Mach for DES phase

The pilot can change the speed and/or Mach displayed in the MANAGED field, before the DES phase begins, by inserting a speed and/or Mach in the MANAGED field.

Although the entered speed is selected by the pilot, the FMGS uses it to compute the descent flight path and the top of descent. It is, therefore, part of the managed descent profile.



The pilot can revert to the optimum speed/Mach by clearing the 3L field.

Optimum target Mach number in cruise

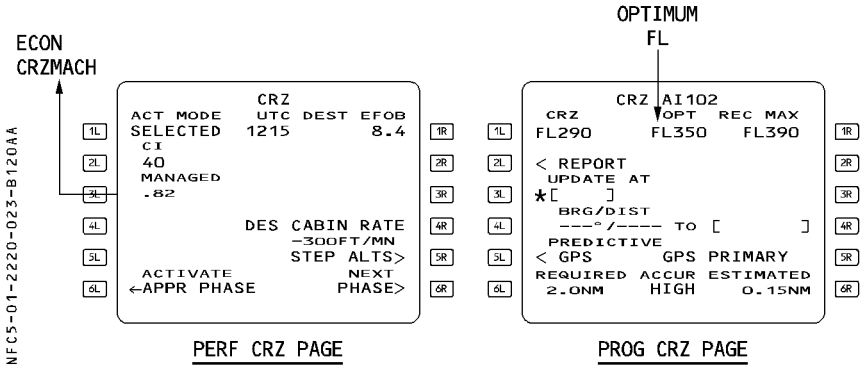
The FM computes ECON CRZ MACH as the optimum speed and continuously updates it, taking into account :

- Current weather conditions
- Modifications to the flight plan

Note : Below FL 250, the FMGS calculates ECON CRZ SPD instead of ECON CRZ MACH.

Optimum flight level in cruise

The optimum flight level is the flight level at which the aircraft incurs the lowest cost for a given flight plan, cost index, and gross weight. The FM continuously updates it during the cruise phase, and displays it on the PROG page. The PROG page displays dashes for this quantity, when the system detects an engine-out condition.



PERF CRZ PAGE PROG CRZ PAGE

COST INDEX (CI)

CI is the ratio of flight time cost (CT) to fuel cost (CF).
CI = CT/CF KG/MIN or 100 LB/H
The cost index is used to compute the best economic speed and Mach to be flown considering the ratio between the flight time cost and the fuel cost.
CI = 0 Corresponds to minimum fuel consumption (max range).
CI = 999 Corresponds to minimum time.

PREDICTIONS

The FMGC computes predictions for the primary and secondary flight plans and displays them on the Multipurpose Control and Display Units (MCDUs), and on the navigation display (ND) of the Electronic Flight Instrument System (EFIS).
The computations use the current state of the aircraft (GW, CG, position, altitude, speed, engaged mode of the autopilot or flight director, time, wind, temperature) for the active flight plan.
The computations use pilot-entered data for the secondary flight plan when it is not a copy of the active flight plan.
When the secondary flight plan is a copy of the active flight plan, it uses the same data.

PREDICTIONS FOR THE PRIMARY FLIGHT PLAN

The predictions displayed on the MCDU assume that the system will guide the aircraft along the preplanned lateral and vertical flight plans.
The predictions displayed on the ND assume that the aircraft will continue to operate in the modes (selected or managed) that are currently active.
As long as the aircraft is flying the flight plan under managed guidance, the predictions on the MCDU will match those on the ND.

R If the pilot does not fly the flight plan, the MCDU predictions assume that :
R – The pilot will fly back towards the flight-planned route.
R – The pilot will immediately resume flying the FMGC-managed modes.
R If the pilot does not fly the managed speed profile, the MCDU predictions assume that he
R will maintain the selected speed until he reaches :
R – In the climb or descent phase, the next speed limit or speed constraint if any, or next
R phase,
R – In cruise, the top of descent.
R Then, the predictions assume that the pilot will revert to managed speed.

UPDATE OF PREDICTIONS

The FMGCs recompute the predictions, whenever there is a modification to the :
- Lateral flight plan
- Vertical flight plan
- Forcasted atmospheric conditions, entered by the crew
- Cost index
- Speed control (managed/selected).

Note : During recomputation, the prediction fields on the MCDU pages display dashes.

WINDS USED FOR PREDICTIONS

See VERTICAL FUNCTIONS, FMGS Pilot's Guide, 04.04.25.

EFIS ND PREDICTIONS

Refer to FLIGHT MANAGEMENT PRINCIPLES, 4.02.20.

MCDU PREDICTIONS

Refer to FLIGHT MANAGEMENT PRINCIPLES, 4.02.20.

Predictions for secondary flight plan
Refer to FCOM 4.04.30 Secondary flight plan.

OTHER COMPUTATIONS

Engine-out case
The FMGS computes an engine-out target speed for each flight phase.
It computes an engine-out maximum altitude at long-range cruise speed, and displays it on the PROG page.
The new speed target becomes green dot in climb, and EO CRZ SPD in cruise.
The system computes the flight plan predictions down to the primary destination. If the aircraft is above EO MAX ALT, the predictions are computed, assuming that a drift down descent will immediately be performed to reach EO MAX ALT.

Recommended maximum altitude (REC MAX)
The recommended maximum altitude is the lowest of the maximum altitude that :
- The aircraft can reach with a 0.3 g buffet margin
- The aircraft can fly in level flight at MAX CRZ rating
- The aircraft can maintain a V/S of 300 feet/minute at MAX CLB thrust
- The aircraft can fly, at a speed higher than green dot, and lower than VMO/MMO
- for which the aircraft is certified.

The REC MAX altitude is displayed on the PROG page.
A maximum altitude using a 0.2 g buffet margin is also computed. It is not displayed, but the system uses it to limit CRZ ALT entry.

Predictions for alternates

Predictions for alternates are displayed on the ALTERNATES page.

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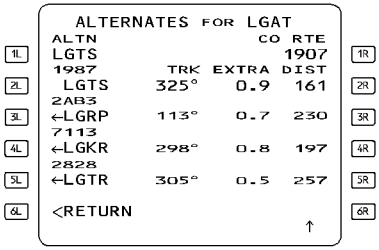

They are based on :
- A default cruise FL equal to 220, if the airway distance is less than 200 NM. Otherwise, it is FL 310.
- Simplified wind/temperature models, based on crew entries :
  - ALT CRZ wind, as entered on the FUEL PRED page.
  - CRZ temperature interpolated from the temperature model for the primary flight plan.
- Airway distance, or direct distance, as provided by the database (manual entry, if not in the database).
- Cost index = 0 (minimum fuel).
- Initial aircraft weight equal to landing weight at primary destination.

Note : – *No step can be inserted in an alternate flight plan.*
– *No predictions are displayed for the selected alternate on flight plan pages ; but, the pilot can read ALTN trip fuel and time on the INIT B page before engine start, and estimated time and estimated fuel on board at alternate on the FUEL PRED page after engine start.*

RETURN-TO-TRAJECTORY ASSUMPTIONS

If the aircraft is not on the lateral flight plan, predictions assume an immediate return to the active lateral leg with a 45° convergence angle, or that it will fly direct to the "TO" waypoint
R whenever the required convergence angle is greater than 45°. (Refer to 4.02.20).

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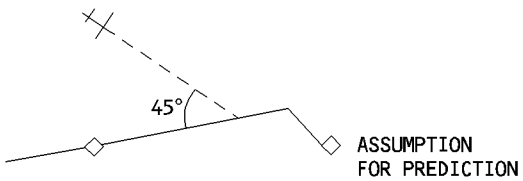
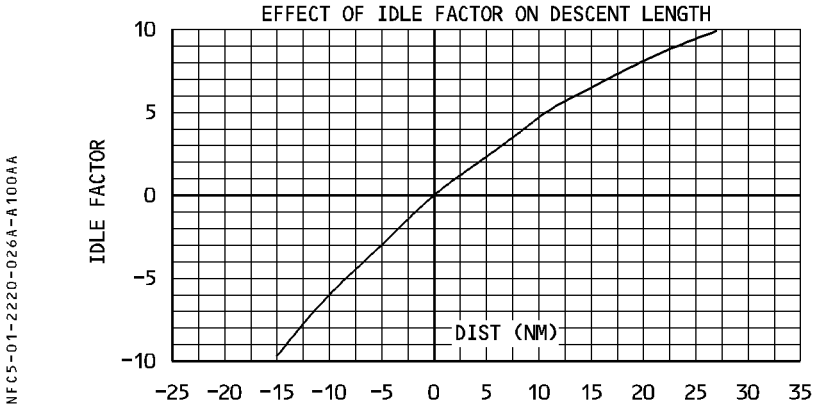


IDLE FACTOR

IDLE and PERF factors follow the same principle.
The PERF factor is mainly used for prediction during the cruise phase.
The IDLE factor is dedicated to the FM descent segment.
The aim of the IDLE factor is to adjust FM descent predictions. In particular, the Top of Descent (TOD) position, with the actual engine idle thrust used during descent.
A positive IDLE FACTOR gives an earlier Top of Descent (shallower path).
A negative IDLE FACTOR delays the Top of Descent (steeper path).

R The following graph provides an example (average values) of the IDLE FACTOR's effect on
R descent length :
R



R Example : An IDLE FACTOR of - 3 decreases the computed descent length by 5 NM.

Procedure for modifying the IDLE factor :
Refer to the PERF Factor paragraph.

ENERGY CIRCLE

The energy circle is a green arc, centered on the aircraft's position and oriented towards the current track line. It is displayed on the NDs during descent, when HDG or TRK mode is selected. It represents the required distance to land from the aircraft's position down to airport elevation at VAPP speed, considering all speed constraints on the vertical profile.

PERF FACTOR

The PERF factor is a positive or negative percentage that is used to correct the predicted fuel flow, used for fuel prediction computation within the FMGS. It is necessary when the aircraft's performance differs from the performance model stored in the FMGS database. This difference can be due to one or both of the following cases :

1. The FMS contains a performance database, used to compute the predictions and the performance data. Due to the numerous possible aircraft configurations, the same performance database is sometimes used for aircraft with slightly different behaviors. In these cases, a PERF factor is entered to correct the computations performed with a database not exactly tailored for the given configuration. As a result, the aircraft or engine type identification on the MCDU's A/C STATUS page may not correspond to that of the actual aircraft.
2. Since the actual aircraft drag and engine performance deviate from the nominal model, due to the aircraft's age, airline Flight Operations will periodically apply a correction factor to adapt fuel predictions to actual fuel consumption.

The PERF factor modifies the predicted fuel flow, according to the following formula :
FFpred = FFmodel (1 + PERF FACT/100).
FFpred is the FF used for prediction.
FFmodel is the FF from the aero-engine model.
This correction is applied throughout the flight, and modifies the performance predictions and the ECON speed or Mach. For example : Entering a PERF factor of + 1.5 means that flight operations have evaluated the aircraft fuel deviation as 1.5 %, compared to the basic performance model (0.0).

Procedure for modifying the PERF factor (on ground only) :
On the aircraft status page :
– ENTER "ARM" in the CHG CODE line's [5L] brackets.
– WRITE the new IDLE/PERF factors.
– INSERT using [6L] key.
A manually-entered IDLE/PERF factor is displayed in large blue fonts. Changing an IDLE/PERF factor is usually the responsibility of maintenance, or Flight Operations.

PERF factor to be used on FMS 2, depending on engine type :

– For CFM 56-5B engines only :
Depending on the engine type : CFM 56–5B SAC (Single Annular Chamber) or DAC (Double Annular Chambers), or non/P (without the new LP and HP blade compressor), a positive performance factor has to be entered on the MCDU STATUS page to increase the FMGS' predicted fuel consumption and match the actual fuel burnt.

		Non/P		/P	
		SAC	DAC	SAC	DAC
A321-111	CFM56-5B1	2.0	2.0	0.0	1.0
A321-112	CFM56-5B2	2.0	2.0	0.0	1.0
A321-211	CFM56-5B3	2.0	2.0	0.0	1.0
A321-212	CFM56-5B1	2.0	2.0	0.0	1.0
A321-213	CFM56-5B2	2.0	2.0	0.0	1.0
A320-214	CFM56-5B4	3.0	3.0	0.0	1.0
A319-111	CFM56-5B5	4.5	4.5	0.0	1.0
A319-112	CFM56-5B6	4.5	4.5	0.0	1.0
A319-115	CFM56-5B7	4.5	4.5	0.0	1.0

– For other engines :
· A318 "CFM" : 0.0 %
· A320 "CFM" Family fitted with CFM 56-5A engines : 0.0 %
· A319/A320 "IAE" Family : 0.0 %
All these numbers assume that : The aircraft is brand-new, anti-ice is off, the air conditioning is on NORMAL for "IAE" engines and on LOW for "CFM" engines, and the conservative Fuel Lower Heating Value (FLHV) is 18400 btu/lb.
When an aircraft ages, fuel consumption degradation will be measured to determine the so-called "monitored fuel factor". This factor corresponds to the deviation of the
R aircraft's actual fuel consumption from the nominal model. Generally, the FLHV that is
R used during fuel factor monitoring is higher than the FMS value. In order not to penalize
R FMS predictions, it is necessary to correct the "monitored fuel factor". For example, add
R – 1% to the "monitored fuel factor", when an FLHV of 18590 btu/lb is used. Once this factor is established by the airline, it should be arithmetically-added to the above-noted performance factor.

Note : – *At delivery, ENTER the Performance factor (given in the table above) directly in the MCDU (no correction factor is needed).*
– *When replacing an FMS legacy by an FMS2, on any given aircraft model, the performance model that is stored in the FMS2 may be different from the one that was previously stored in the FMS legacy. As a result, DISREGARD the performance factor previously entered in the MCDU. ADD the "monitored fuel factor" (when available) to the performance factor (given above), and ENTER the resulting factor in the MCDU.*

MANAGEMENT OF THE DISPLAYS

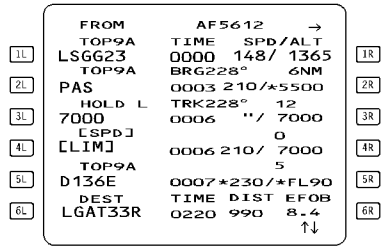
The flight management system displays navigation, performance, and guidance information on the :

- Multipurpose Control and Display Unit (MCDUs) ;
- Navigation Display (ND) of the Electronic Flight Instrument System (EFIS) ; and
- Primary Flight Display (PFD) of the EFIS.

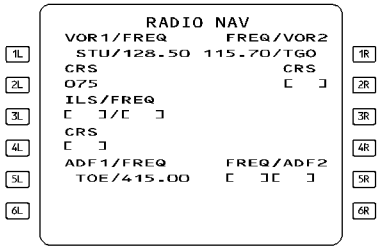
MCDU DISPLAY

The MCDUs display :

- Position and accuracy information
- Tuned navaids
- Lateral and vertical flight plans (waypoints, pseudo waypoints, constraints)
- Predictions (SPD, TIME, ALT, WIND)
- Fuel predictions and fuel management information (estimated fuel on board, extra fuel)
- Performance data



F-PLN A page



RADIO NAV PAGE

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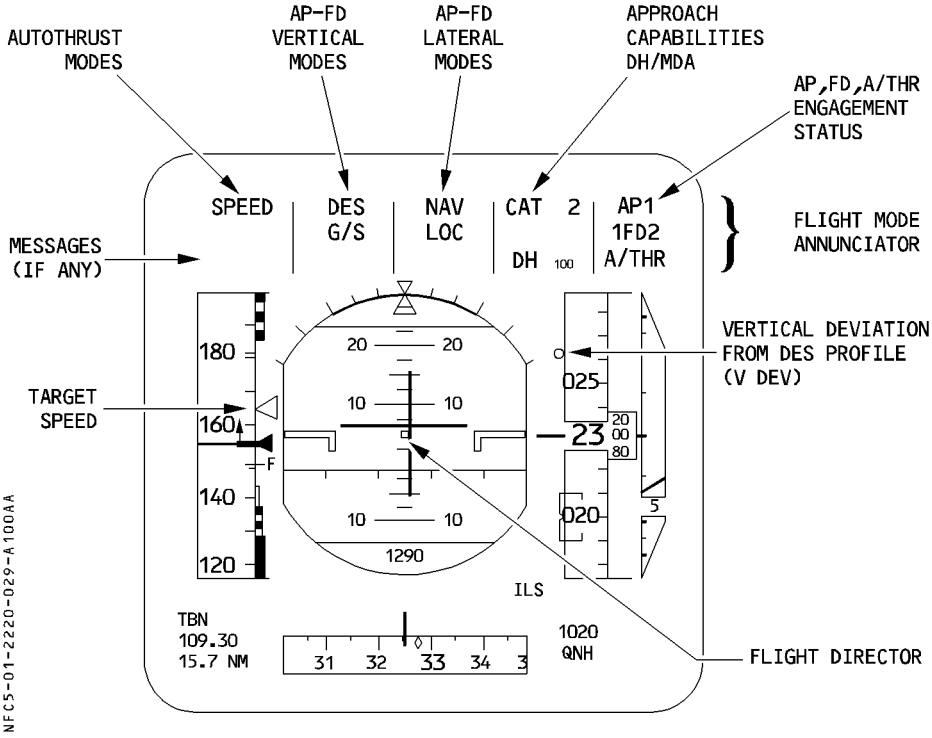
EFIS PRIMARY FLIGHT DISPLAY (PFD)

Flight Management (FM) generates the following information :
- Armed and engaged modes displayed on the Flight Mode Annunciator (FMA) ;
- FMGS guidance targets (SPD, ALT, HDG) ;
- Vertical deviation from descent profile ;
- Messages ;
- Navigation information.

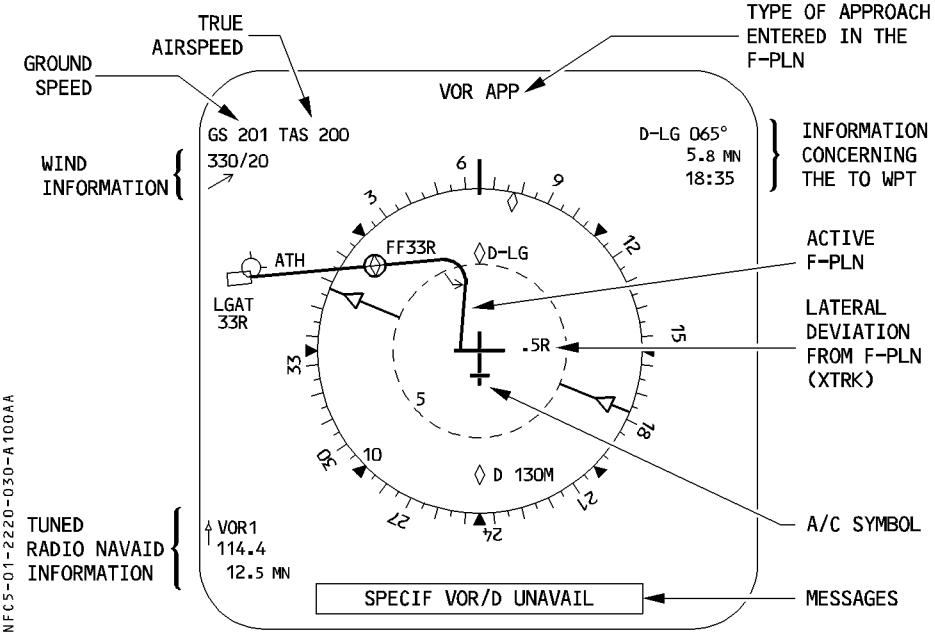


Note : For more details on the EFIS PFD, refer to Chapter 1.31.

EFIS NAVIGATION DISPLAY (ND)

The FMGS generates the following information, displayed on the NDs :
- Flight plan (active secondary, temporary, dashed) ;
- Aircraft position and lateral deviation from the flight plan ;
- Pseudo-waypoints along the flight plan ;
- Raw data from tuned Navaids and type of selected approach ;
- Various display options (waypoints, Navaids, NDBs, airports, constraints) ;
- Wind information and various messages.

R



FLIGHT PLAN DISPLAY COLORS

Primary flight plan	Managed mode : Steady green. Selected mode : Dashed green.
Track line	Steady green
Alternate flight plan	Dashed blue
Missed approach	Steady blue
Offset flight plan	Steady green (Original flight plan : Dashed green)
Temporary flight plan	Dashed yellow
Engine-out SID (not inserted)	Steady yellow
Secondary, flight plan	Steady, dimmed white
Abeam/Radial	Dashed blue

GENERAL

The Flight Guidance (FG) part of the FMGS controls the :
- Flight Director (FD)
- Autopilot (AP)
- Autothrust (A/THR).

GUIDANCE MODES

Two types of autopilot and flight director modes are available to guide the aircraft :
- Managed modes, which steer the aircraft along the lateral, vertical, and speed profiles according to the data the pilot inserts into the MCDU. Flight Management (in the Flight Management and Guidance Computer) computes the corresponding guidance targets.
- Selected modes, which steer the aircraft according to target values that the pilot selects and the FCU windows display.

R

GUIDANCE	MANAGED modes	SELECTED modes
LATERAL	NAV, APP NAV LOC*, LOC RWY RWY TRK GA TRK ROLL OUT	HDG-TRK
VERTICAL	SRS (T.O and G.A) CLB, DES ALT CST, ALT CST* ALT CRZ G/S*, G/S FINAL, FINAL APP FLARE	OP CLB, OP DES V/S, FPA ALT*, ALT EXPEDITE ◁
SPEED	FMGC REFERENCE (ECON, Auto SPD, SPD LIM) EXPEDITE	FCU REFERENCE

MODE SELECTION

MANAGED MODES

- At takeoff, the managed modes engage automatically, when the pilot sets the thrust levers at the TO or FLX detent.
- During flight, the pilot can arm or engage the managed modes (if the aircraft meets engagement conditions) by pushing in the appropriate knobs on the Flight Control Unit (FCU).
- The pilot pushes the "DIR TO" key on the MCDU to insert a DIR TO leg. It engages or maintains the NAV mode.
- The pilot pushes the "APPR" pushbutton on the FCU to arm or engage the localizer and glide slope or " FINAL APP", depending upon the approach type he had inserted in the flight plan.
- The "LOC" pushbutton arms or engages only the localizer mode.

SELECTED MODES

The pilot can engage the selected modes by pulling out the appropriate FCU selection knobs.

INTERACTION BETWEEN AP/FD AND A/THR MODES

The AP and FD pitch modes can control a target SPD/MACH or a vertical trajectory, and the A/THR mode can control a fixed thrust or a target SPD/MACH. However, the AP/FD and the A/THR cannot both control a target SPD/MACH simultaneously. Therefore the AP/FD pitch modes and A/THR mode are coordinated as follows :

- If an AP/FD pitch mode controls a vertical trajectory, the A/THR mode controls the target SPD/MACH.
- If an AP/FD pitch mode controls a target SPD or MACH, the A/THR mode controls the thrust.
- If no AP/FD pitch mode is engaged, the A/THR mode reverts to controlling the SPD/MACH mode.

  In other words, the selection of an AP/FD pitch mode determines which mode the A/THR controls.

AP/FD pitch modes	A/THR modes
V/S – FPA DES (geometric path) ALT*, ALT ALT CRZ*, ALT CRZ ALT CST*, ALT CST G/S*, G/S FINAL, FINAL APP	SPEED/MACH MODE
AP/FD OFF	
CLB/DES (idle path) OPEN CLB/OPEN DES EXP CLB/EXP DES ◁ SRS	THR (CLB, IDLE) MODE
FLARE	RETARD (IDLE)

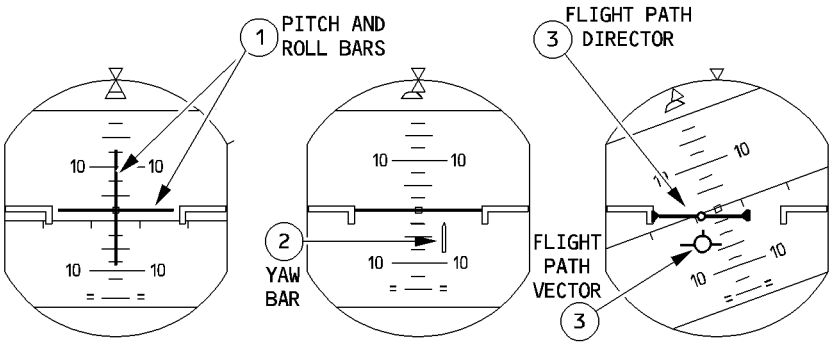
FLIGHT DIRECTOR

GENERAL

The Flight Director (FD) displays guidance commands from the Flight Management and Guidance Computer (FMGC) on the Primary Flight Display (PFD).
You may manually fly the aircraft , following FMGC guidance commands, or crosscheck the FMGC orders when the autopilot is engaged.
In normal operations, FD1 displays FMGC1 orders on the PFD1, and the FD2 displays FMGC2 orders on the PFD2.
The FDs use their respective onside FMGCs.
On the PFD :

1. The FD pitch and roll crossbars show pitch and roll demands.
2. Below 30 feet during landing and takeoff, when a localizer is available, the vertical bar is replaced by a yaw bar that gives lateral orders.
3. The Flight Path Director (FPD) symbol relates to the Flight Path Vector (FPV).

R



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The HDG V/S – TRK FPA pushbutton on the FCU enables the pilot to select either type of reference and display.
The FD pushbutton on the Electronic Flight Instrument System (EFIS) control panel allows the FD bars to be displayed or removed.

FD bars (HDG V/S selected on the FCU)

- The pitch bar is displayed, if a vertical mode is engaged. It gives pitch orders for the vertical guidance.
- The roll bar is displayed, if a lateral mode is engaged. It gives roll orders for lateral guidance.

R **Flight Path Director (TRK FPA selected on the FCU)**

The display is an alternate way of transmitting flight director commands.

- The Flight Path Vector (FPV) symbol illustrates the track and flight path angle actually being flown.
- The Flight Path Director (FPD) symbol shows the pilot how to intercept and fly the vertical and lateral flight path defined by the FMGC.
  When the pilot superimposes the FPV and the FPD symbols, the aircraft is flying the commanded trajectory.

Yaw bar

The yaw bar is displayed in RWY mode on takeoff and in FLARE and ROLL OUT modes at landing.

FLIGHT DIRECTOR (FD) ENGAGEMENT

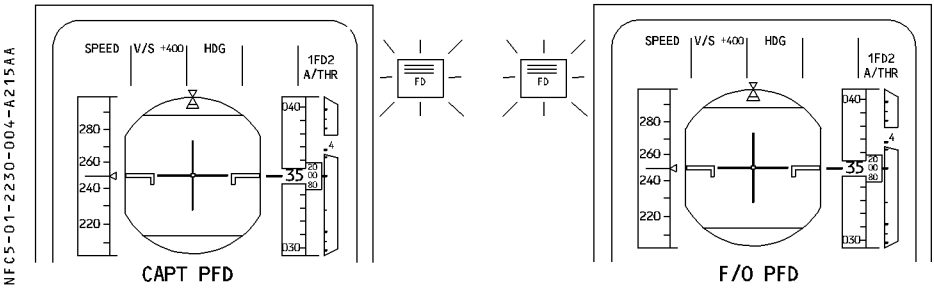
The FDs are engaged automatically whenever the FMGC powers up.

GROUND ENGAGEMENT

- The symbol "1 FD2" appears on both PFDs.
- No FD bars appear on the PFDs. The PFD displays FD orders when a mode is active on the corresponding axis.
- The FCU windows display dashes.

MANUAL FLIGHT ENGAGEMENT

The two FDs engage in the HDG V/S or TRK FPA mode (basic modes).



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AUTOMATIC FLIGHT ENGAGEMENT

- FD bars are automatically restored in SRS/GA TRK modes at go around engagement. If FPV/FPD was previously selected, it reverts to FD bars.

FLIGHT DIRECTOR (FD) DISENGAGEMENT

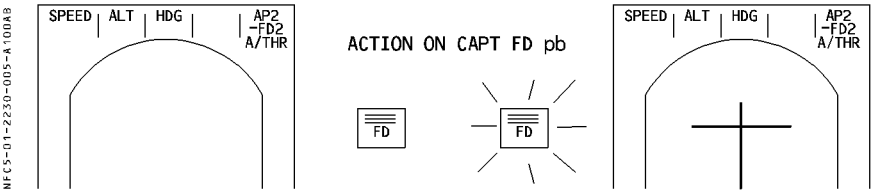
The flight crew may disengage one or two FDs manually, or FDs may disengage automatically if there is a failure.

MANUAL FLIGHT DIRECTOR DISENGAGEMENT

One FD off :

- The FD bars no longer appear on the associated PFD.
- The corresponding FD is disengaged.

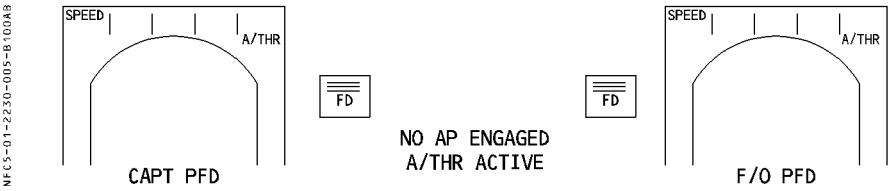
R



Both FDs off:

- The FD bars disappear from both PFDs.
- If no AP was engaged, lateral and vertical modes disengage. The A/THR, if active, automatically reverts to (or remains in) SPEED/MACH mode.
- If one AP was engaged when FDs are switched OFF, this AP remains engaged in the active modes but the FDs are no longer displayed.

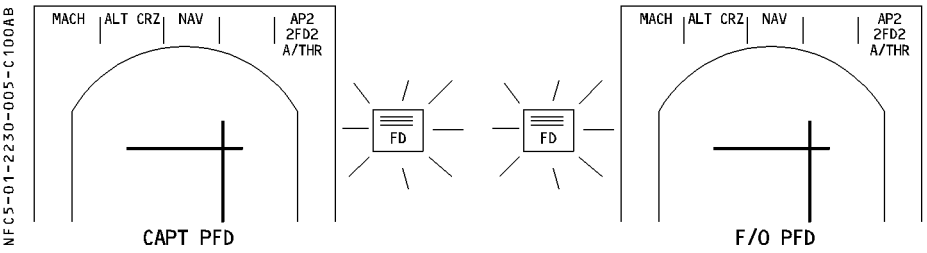
R



AUTOMATIC FLIGHT DIRECTOR DISENGAGEMENT

If one FD fails or one FMGC is not valid, both PFDs display the remaining FD.

R



AUTOMATIC DISENGAGEMENT DUE TO SPEED PROTECTION

When APs are not engaged and the pilot does not follow the FD bars to maintain the commanded trajectory, in climb with CLB or OP CLB, (or EXP CLB ◁) engaged or in descent with DES or OP DES (or EXP DES ◁) engaged the FDs will disengage at the activation of the automatic speed mode protection.
Refer to FCOM 1.22.30 AUTOMATIC SPEED MODE PROTECTION for the conditions of activation.

AUTOMATIC FD REMOVAL

- The FD pitch bar is removed when no vertical mode is engaged or when ROLL OUT is engaged.
- The roll FD bar is removed when no lateral mode is engaged or when the RWY or ROLL OUT mode is engaged.
- Both FDs are removed when the aircraft pitch exceeds 25° up or 13° down, or bank angle exceeds 45°.

Note : If from AP/FDs off, FD2 then FD1, are engaged within 180 milliseconds (one computation cycle), a flip flop of master FMGC may occur.
R *As a result, no vertical mode engages, the FMA 1st column, 1st line (A/THR mode)*
R *is blank, or displays dashes.*
Engaging V/S mode manually reselects the correct FMGC and restores the display.

FD WARNINGS

FD WARNINGS	CONDITIONS
Pitch FD bar (or FPV) flashes 10 seconds	– if the ALT* mode is lost further to FCU altitude reference change of more than 250 ft. – when in APPR mode (G/S*, G/S, LAND, FINAL) FD reverts to V/S mode (pilot action or loss of vertical approach mode) – one AP or one FD is engaged while both AP/FD were previously off.
Pitch FD bar (or FPV) flashes permanently	Transmission of the GLIDE data is interrupted when in G/S, G/S* or LAND modes above 100 ft RA.
Roll FD bar (or FPV) flashes 10 seconds	– When in APPR mode (LOC*, LOC, LAND, APP NAV) FD reverts to HDG mode (Pilot action or loss of lateral approach mode). – One AP or one FD is engaged while both AP/FD were previously off.
Roll FD bar (or FPV) flashes permanently	Transmission of the LOC data is interrupted when in LOC, LOC* or LAND modes above 15 ft RA.

AUTOPILOT (AP)

GENERAL

The AP :
- stabilizes the aircraft around its center of gravity
- acquires and tracks a flight path
- flies the aircraft to an automatic landing or go-around.

R The AP commands the :
R - position of the flight control surfaces for pitch, roll, and yaw
R - nose wheel position.

AP ENGAGEMENT

R The flight crew can engage AP1 or AP2 by pressing the corresponding pushbutton on the
R FCU if the aircraft has been airborne for at least five seconds.
R When one AP is engaged, the corresponding FCU pushbutton comes on and AP1 (or 2) is
R displayed on the FMAs.

Note :
- *One AP can be engaged on the ground if the engines are not running. It disengages when one engine is started.*
- *Two APs may be engaged at a time (AP1 active, AP2 in standby), when the localizer/glide-slope or roll out or go-around mode is armed or engaged. Only one AP can be engaged at a time in all other cases.*
- *If one AP pushbutton is set to on with both FDs off, the AP engages in HDG V/S or TRK FPA mode, depending upon which the pilot has selected on the FCU.*
- *If one AP pushbutton is set to on with at least one FD already on, the AP engages in the current active FD modes.*
- *AP engagement increases the break out force on the sidestick controllers and on the rudder pedals.*

AP engagement is indicated by the lighting of the corresponding FCU pushbutton and by the appearance of "AP1" (or 2) on the PFD's Flight Mode Annunciator.

AP DISENGAGEMENT

AP1 or 2 disengages when :

- The pilot presses the takeover pushbutton on the sidestick.
- The pilot presses the corresponding AP pushbutton on the FCU.
- The pilot pushes on the sidestick harder than a certain threshold or moves on the rudder pedals above a threshold.

R
- The pilot moves the pitch trim wheel beyond a certain threshold.

- The other AP is engaged, except when localizer/glideslope modes are armed or engaged, or when the rollout or go-around mode is engaged.
- Both thrust levers are set above the MCT detent and the aircraft is on the ground.
- The aircraft reaches the MDA- 50 feet (MDH-50 feet), or 400 feet AGL if no MDA/MDH, with APPR mode engaged and a non-ILS approach selected.
- One of the engagement conditions is lost.

  Furthermore, in normal law with all protections available, the AP will disconnect if :
  - High speed protection is active ;
  - Angle-of-attack protection is active (α prot + 1° is reached) ;
  - Pitch attitude exceeds 25° up, or 13° down, or bank angle exceeds 45° ;
  - A rudder pedal deflection is more than 10° out of trim.

The standard way for the flight crew to disengage the AP is to press the takeover pushbutton on the sidestick.

When the AP is OFF, the associated FCU pushbutton goes off, and "AP1" (or AP2) disappears from the PFD's FMA.

AP WARNINGS

When the AP is disengaged, the system warns the pilot.

- If the pilot disengages it with the takeover pushbutton on the sidestick, the warnings are temporary.
- If the disengagement results from a failure, from the pilot pushing the pushbutton on the FCU, or from a force on the sidestick, the visual and audio warnings are continual.

		AP DISENGAGEMENT	
		TAKE OVER PB on SIDESTICK	**BY OTHER MEANS**
CONSEQUENCE	MASTER WARNING	flashing red during 3 sec max	flashing red
	ECAM	red AP OFF message 9 sec maximum	red warning AUTO FLT AP OFF
	AUDIO	cavalry charge 0.5 sec min 1.5 sec maximum	continuous cavalry charge 1.5 sec minimum
	CLR PB on ECAM CONTROL PANEL	extinguished	illuminated
ACTION	MASTER WARNING	extinguishes M.W erases ECAM warning stops audio if pressed within 1.5 sec	extinguishes M.W stops audio after 1.5 sec
	CLR PB on ECAM CONTROL PANEL	No effect	extinguishes CLR pb erases ECAM message calls status
	TAKE OVER PB	extinguishes M.W. erases ECAM warning stops audio if pressed within 1.5 sec.	extinguishes M.W. stops audio after 1.5 sec
ECAM STATUS MESSAGE		NO	YES

AUTOLAND WARNING

The autoland red warning flashes in LAND mode when :

- the radio altitude goes below 200 feet and
- the aircraft gets too far off the beam (LOC or GLIDE)
  or both autopilots fail
  or both localizer transmitters or receivers fail
  or both glide slope transmitters or receivers fail.

SPEED/MACH CONTROL

In flight, either the AP/FD pitch control, or autothrust may acquire and hold a target speed or Mach number, depending on the engaged modes.
Speed control is :
- Managed, when the target comes from the FMGS
- Selected, when the target comes from the SPD/MACH FCU window.

MANAGED SPEED/MACH TARGET

When the speed target is managed, the SPD/MACH window of the FCU shows dashes, and the corresponding dot is lit. The PFD speed scale shows the speed target in magenta.

ENGAGEMENT CONDITIONS

The SPD target is managed, whenever AP or FD is engaged, and one of the following occurs:
- The pilot pushes in the SPD/MACH selector knob.
- V2 is inserted in the MCDU.
- The speed reference system (SRS) is engaged (takeoff or go-around mode).
- EXPEDITE mode is engaged ◁.

Note : At takeoff, SRS will not engage, if V2 is not available.

DISENGAGEMENT CONDITIONS

Managed speed disengages any time the pilot selects a speed target on the FCU, or if the speed was preselected.

SPEED PROFILE

The form of the managed SPD profile depends on the lateral NAV mode.
- If NAV mode is engaged, the SPD profile takes into account all the constraints linked to the flight plan.
  The SPD profile is :
  V2 - SPD LIM - SPD CSTR (if applicable) - ECON CLB SPD/MACH - ECON CRZ MACH -
R ECON or preset DES MACH/SPD - SPD LIM - SPD CSTR (if applicable) - HOLD SPD (if applicable) - VAPP

– If NAV mode is not engaged, the SPD/MACH constraints are not considered.
The SPD profile is :
V2 - SPD LIM - ECON CLB SPD/MACH - ECON CRZ MACH - ECON or preset DES MACH/SPD - SPD LIM - VAPP.

Note : – When both AP/FDs are OFF, A/THR reverts to selected SPEED mode, except when the approach phase is activated on the MCDU, where both managed and selected SPD are available.
– When expedite mode is engaged, the system disregards SPD LIM and SPD CSTR, regardless of the lateral mode engaged.
– The managed speed/Mach target may be set below maneuvering speed but, as long as the speed target is managed, the FMGS limits the aircraft to the maneuvering speed of the current slats/flaps configuration (VAPP, F, S, Green Dot).
– If the managed speed/Mach target is set above VMAX (VFE, VMO, MMO), the FMGS automatically limits the speed to VMAX.

MINI GROUND SPEED

In approach phase, the managed speed target is the Mini Ground Speed target computed by the Flight Guidance (FG) part of the FMGS (refer to 1.22.30–Autothrust).

SELECTED SPEED/MACH TARGET

To use a selected speed/Mach target, the pilot uses the knob on the FCU to set the target speed, which is then displayed in the FCU window. It is also displayed on the PFD speed scale in blue.

Note : The selected speed/Mach target may be set below VLS or above VMAX. But, when autothrust is active, the guidance limits the speed to VLS or VMAX.

Selected speed has priority over managed speed. The only automatic changeover from the selected to managed speed target may occur at go-around mode engagement.
In flight, if the situation calls for managed speed, both the PFD and the MCDU display a message proposing a manual change to managed speed (for example, SET MANAGED SPEED), SET HOLD SPEED, or SET GREEN DOT SPEED).

ENGAGEMENT CONDITIONS

The aircraft has a selected speed target, under any one of the following conditions :
– The pilot pulls out the SPD/MACH selector knob (5 seconds after lift-off).
– Both AP/FDs are OFF (except in APPR phase).
– The FM speed target is lost (except in SRS, G/S, LAND, and GO AROUND modes).
– The MCDU has a preselected speed for the next phase, and the aircraft transitions into that phase.
– The FMGC is powered-up in flight.

DISENGAGEMENT CONDITIONS

The selected speed target disengages :
- when the managed SPD engages
- when the aircraft is on the ground at engine start.

R *Note : With engine running, the pilot can select a speed on the FCU only after takeoff.*

AUTO SPD

The pilot may insert the AUTO SPD (speed or Mach) on the PERF DES page to replace the ECON DES SPD.
In this case, the managed speed profile takes into account the selected value. The top of descent and the descent path are computed on AUTO SPD assumption.

SPEED/MACH SWITCHING

R - At the crossover altitude, the FMGC automatically changes the selected speed target to the corresponding MACH target.
The FCU displays the Mach number corresponding to the speed at the switching altitude.

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SPEED/MACH CROSS OVER TABLE.

ALTITUDE							
30500	280						
29500		290					
28500	295		300				
27500		305		310			
26500	300		315		325		
25500		310		325		330	
24500			320		335		350
MACH	0.76	0.77	0.78	0.79	0.80	0.81	0.82

R *Note : when the speed is selected the pilot can do the switching manually by pressing the SPEED/MACH pushbutton on the FCU. The FCU then displays the aircraft Mach number.*

- When the target speed is managed, the FMGC commands the switchover automatically as a function of the ECON MACH value.

MANAGED SPEED TARGET MEMORIZATION

A dual FM failure has different consequences when it occurs in different phases of the flight. The system handles target speed and SPD mode as follows :

- During approach with LOC and G/S engaged and radio altitude < 700 feet, the target speed is set to VAPP as previously memorized, and managed SPD target is maintained.
- At go-around, the target speed becomes the memorized go-around speed, which is the higher of VAPP or the speed when go-around was initiated. Managed SPD target is maintained.

R - In all other cases managed target speed reverts to selected, the value being the speed
R at the moment of the failure.

SPEED/MACH FCU WINDOW SYNCHRONIZATION

When the target SPD is managed, the SPD/MACH display of the FCU shows dashes. However, the window displays the target SPD or MACH in the following situations.

- The pilot turns the SPD/MACH selector knob.
  If the pilot does not pull the knob within 10 seconds after turning it, the selection reverts to dashes.
- The pilot manually engages a selected SPD target.
- If the flight crew has manually preselected a speed or Mach number for the next phase on the MCDU PERF page, that preselected SPD/MACH engages when the aircraft enters that phase and the FCU window then displays as the target the preselected speed or Mach.
- If the FMGS is powered up in flight, the synchronized speed/Mach value is the current aircraft speed or Mach number.
- If no V2 is entered at takeoff, the V/S mode engages 5 seconds after lift-off (no speed reference system). The FCU speed target is the speed at V/S mode engagement. (A/THR becomes active when the thrust levers are set in the active range).

AP/FD MODES GENERAL

The FMGS has guidance parameters for both AP/FD lateral and vertical modes.

The AP/FD lateral modes are :

RWY, RWY TRK	Runway, Runway track mode
NAV	Nav mode
HDG, TRK	Heading, track mode Also called basic modes
APP NAV	Approach Nav mode
LOC*, LOC	Loc capture, Loc track mode
LOC B/C	Lock back course mode
ROLL OUT	Rollout mode. (Autoland)
GA TRK	Go-around track mode
• LAND	Land mode. Managed submode that includes LOC and G/S modes below 400 feet RA.
• FINAL APP	Final approach mode Managed submode that includes APP NAV and FINAL modes during non precision approaches.

The AP/FD vertical modes are :

	SRS	SRS mode used for takeoff and go-around
	CLB	Climb mode
	DES	Descent mode
	OP CLB	Open Climb mode
	OP DES	Open Descent mode
	EXP CLB ◁	Expedite mode in climb
	EXP DES ◁	Expedite mode in descent
	V/S or FPA	Vertical speed mode or Flight Path Angle mode. Also called basic modes.
	ALT*	Altitude capture,
	ALT	Altitude Hold mode
	ALT CST*	Altitude constraint capture,
	ALT CST	Altitude constraint hold mode
R	ALT CRZ	Altitude hold of the cruise flight level
	G/S*	Glide slope capture
	G/S	Glide slope mode.
	FINAL	Final mode (non precision approach)
	FLARE	Flare mode (Autoland)

AP/FD LATERAL MODES

HEADING OR TRACK : HDG - TRK

These modes guide the aircraft laterally along a heading or track selected by the flight crew.
The HDG/TRK window of the FCU displays the target heading or track.
R The pilot uses the HDG V/S -TRK FPA pushbutton to select heading or track.

ENGAGEMENT CONDITIONS

HDG or TRK is engaged when one of the following conditions is met :
- The pilot pulls out the HDG-TRK selector knob (not sooner than five seconds after lift-off).
- NAV is disengaged, either by the loss of the lateral flight plan or by the pilot entering a flight plan discontinuity.
- FINAL mode (armed or engaged) is lost when the aircraft is in APP NAV mode.
- LOC or LOC* mode is lost.
- The pilot engages the AP/FD with no other mode already engaged (basic mode of AP/FD engagement).
  · LOC mode is armed when APP NAV FINAL were previously engaged.

DISENGAGEMENT CONDITIONS

The engagement of any other lateral mode disengages HDG or TRK.

SYNCHRONIZING THE HDG/TRK WINDOW OF THE FCU

The lateral window of the FCU displays a heading or a track value when :
- The HDG/TRK mode is engaged. The displayed value is the current HDG/TRK or the manually selected value of the target.
- The pilot turns the HDG/TRK selection knob. The value in the window first synchronizes with the current HDG/TRK, then displays the manual selection. It remains displayed for 10 seconds or 45 seconds depending upon FCU standard, then vanishes if the pilot does not pull the knob (except in HDG preset).
- A HDG/TRK is preset (see below).
- AP/FD is lost. The value becomes that of the aircraft current heading or track.

Note : If HDG is switched to TRK (or vice versa), the value displayed in the window switches from heading to track (or vice versa).

HDG/TRK PRESET

The system has a HDG/TRK preset function for takeoff and go around.
If the pilot chooses not to fly the flight plan after takeoff or go around, he may preset a HDG or a TRK on the FCU by turning the HDG/TRK selector knob. The value he sets remains
R displayed in the FCU HDG/TRK window until the knob is pulled.

Operation at takeoff

HDG/TRK preset is available before takeoff and up to 30 feet RA. Turning the HDG/TRK selector knob before 30 feet sets the desired HDG/TRK. As a consequence:

– NAV is disarmed
– At 30 feet, RWY TRK is annunciated until the HDG/TRK knob is pulled.

Operation at go around

Whenever the LOC*, LOC, LAND, FINAL, or GA modes are engaged, the HDG preset is
R available. If the pilot rotates the HDG/TRK knob to set the value, it will remain displayed in
R the window. Pull out the HDG/TRK knob to activate the mode and turn the aircraft on to the preset value.

Cancellation

The pilot can cancel a preset HDG/TRK by :

· engaging the NAV mode (DIR TO)
· pushing in the HDG/TRK knob (arming NAV mode)
· disengaging AP/FD

NAVIGATION (NAV)

NAV mode is a managed mode that steers the aircraft laterally along the flight plan defined in the FMGS. It is designed to have a zero cross-track error. The pilot can arm or engage the NAV mode if the MCDU contains a lateral flight plan.

ARMING CONDITIONS

Satisfying one of the following conditions arms NAV :

– The aircraft is on the ground with no HDG/TRK preset and no other lateral mode except runway mode
– The pilot pushes in the HDG/TRK selector knob, unless the LOC mode is engaged.
– The pilot presses the APPR pushbutton, if a non-ILS approach is selected.

DISARMING CONDITIONS

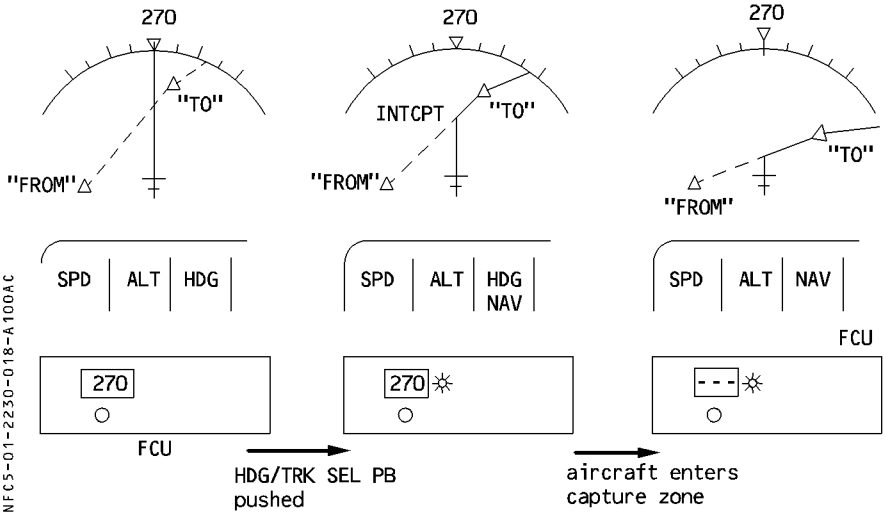
NAV mode disarms if one of the following occurs :

– The pilot pulls out the HDG/TRK selector knob.
– The pilot selects a preset HDG/TRK (TO or GA)
– The pilot arms the LOC mode by pressing the LOC pushbutton.
– The pilot selects GA mode.
– LAND mode has engaged.
– The pilot presses the APPR pushbutton to deselect the non-ILS approach.

ENGAGEMENT CONDITIONS

NAV mode engages :
- Automatically at 30 feet RA after takeoff (if armed on the ground).
- When the pilot orders "DIR TO" (except below 700 feet RA in LOC mode).
- When the pilot pushes in the HDG/TRK select knob when the aircraft is close to (within ~ 1 NM of) the active flight plan leg.
- Automatically in flight when NAV is armed and the aircraft reaches the capture zone for the active flight plan leg.

R



CAUTION

When NAV is armed, it will automatically engage if :
* the aircraft track line intercepts the flight plan before the TO waypoint and
* the intercept waypoint (INTCPT) is displayed on the ND and
* the aircraft reaches the active flight plan leg.

Note : The TO waypoint is displayed in white on NDs and MCDUs.

DISENGAGEMENT CONDITIONS

The NAV mode disengages when :
- Any other lateral mode is engaged.
- The flight plan is lost or the aircraft enters a flight plan discontinuity.

INTERACTIONS WITH VERTICAL MODES

R When NAV mode is engaged, the vertical managed modes CLB or DES or FINAL take into
R account altitude and speed constraints linked to waypoints on the lateral flight plan. If NAV
R mode is disengaged the vertical managed modes are not available and all downpath
R altitude and speed constraints are ignored.

LOCALIZER MODE THROUGH THE LOC PUSHBUTTON

This mode captures and tracks a localizer beam independently of the glide path beam. Pilots use it to fly localizer-only approaches or to initiate an ILS approach when intercepting the glide slope from above.

ARMING CONDITIONS

The pilot arms the LOC mode by pressing the LOC pushbutton, provided that :
- An ILS is tuned (frequency and runway course).
- The aircraft is above 400 feet RA.
- TO or GA mode is not engaged.

DISARMING CONDITIONS

R LOC mode is disarmed by :
R - Pressing the LOC pushbutton when LOC is armed.
R - Arming the NAV mode.
R - Engaging the GA mode.

Note : Engaging NAV mode by selecting DIR TO does not disarm the LOC mode.

ENGAGEMENT CONDITIONS

The LOC mode engages automatically when capture conditions are met.

DISENGAGEMENT CONDITIONS

The LOC mode disengages :
- When another lateral mode is engaged.
- When the pilot presses the LOC pushbutton again (engaging the HDG/TRK mode on the current HDG/TRK).

AP/FD VERTICAL MODES

Vertical modes guide the aircraft in the vertical plan.

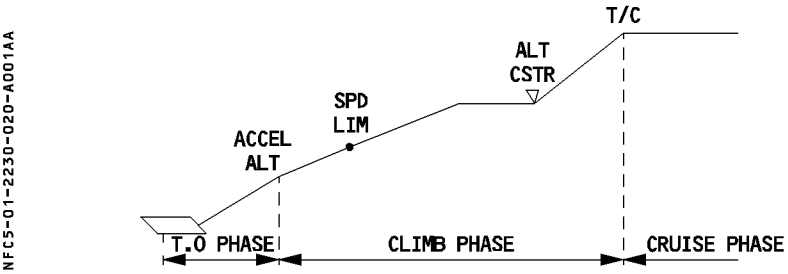
PRINCIPLES

R To leave an FCU selected altitude for another target altitude, two things must happen : the pilot must turn the altitude (ALT) selector knob in order to display the new target altitude and either :
- pull out the ALT selector knob to engage the OPEN CLB/DES mode, or
- push in the ALT selector knob to engage the CLB/DES mode, or
- select a target vertical speed (V/S) and pull out the V/S FPA selector knob to engage V/S mode, or
- select EXPEDITE ◁.

This arms ALT mode.

R CLIMB MODE (CLB)

CLB mode guides the aircraft in a managed climb, at either a managed or a selected target speed, to an FCU selected altitude, taking into account altitude constraints at waypoints. The system also considers speed constraints if the target speed is managed.
The vertical flight path may include several segments :



The pilot can arm the CLB mode during the takeoff, go around, climb, and cruise phases and engage it during the climb and cruise phases.

ARMING CONDITIONS

The CLB mode is armed :
- on the ground or when SRS mode is engaged (TO or GA) if the following conditions are met :
  - No other vertical mode is engaged.
  - The ACCEL ALT (defined on the MCDU PERF TO or GA pages) is below the FCU selected altitude and the lowest altitude constraint.

– In flight, when the climb or go-around phase is active, and the following conditions are met :
  – The lateral NAV mode is engaged, and
  – The FCU-selected altitude is above the aircraft's present altitude and the aircraft captures or flies an altitude constraint.

DISARMING CONDITIONS

The CLB mode is disarmed, if one of the following conditions is met :
– Another vertical mode is engaged.
– The FCU-selected altitude is lower than the present aircraft level.
– The FCU-selected altitude is set at the altitude constraint while ALT CSTR* or ALT CSTR mode is engaged.
– The aircraft transitions to DES or APPR phase.
– Arming requirements are no longer met.
– Vertical flight path validity is lost, or NAV mode is lost while ALT CSTR*, ALT CSTR, ALT* or ALT mode is engaged.

ENGAGEMENT CONDITIONS

The CLB mode can be engaged, if the following conditions are all met :
– The aircraft has been in flight for more than 5 seconds.
– The selected FCU level is above the present aircraft level.
– The descent, approach, or go-around phase is not active.
– NAV mode is engaged.
– Glideslope (G/S) mode is not engaged.

CLB mode automatically engages when the aircraft reaches ACC ALT, or sequences a waypoint with an altitude constraint while the CLB mode is armed.
CLB mode manually engages when the pilot pushes in the ALT select knob, with the CLB mode not armed and the current altitude is not an effective altitude constraint of the flight plan.

Note : When CLB mode is engaged :
  – The V/S (FPA) window of the FCU shows dashes.
  – The managed LVL/CH dot on the FCU lights up.
  – The Flight Mode Annunciator displays "CLB" in Column 2.

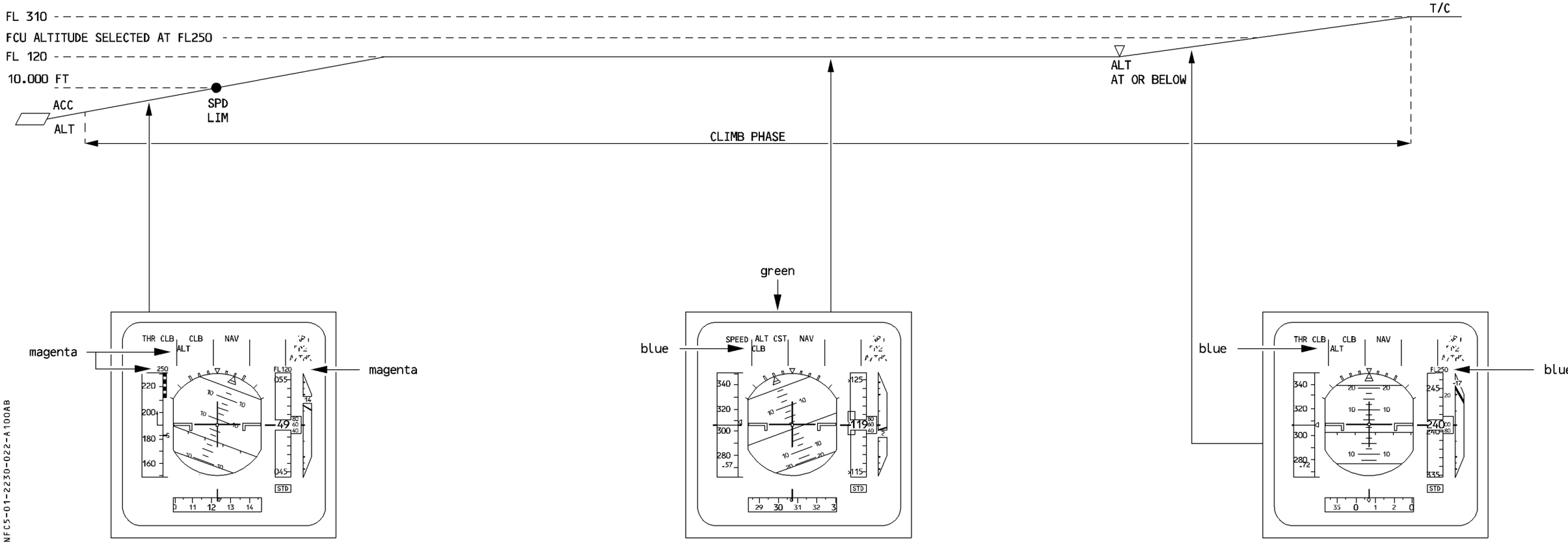
DISENGAGEMENT CONDITIONS

The CLB mode disengages, if one of the following conditions is met :
– NAV mode is lost or disengaged (OP CLB engages). In this case, the reversion to OP CLB is accompanied by a triple click aural warning.
– Another vertical mode engages.
– The pilot selects an altitude on the FCU that is lower than the present aircraft altitude. V/S (FPA) engages on the current V/S (FPA).

GUIDANCE

Climb mode gives the aircraft managed vertical guidance to the FCU selected altitude. It meets altitude constraints at waypoints either with managed speed incorporating speed constraints or with selected speed as target speed. The AP/FD pitch controls the speed or Mach number target and the A/THR is in thrust mode (CLB) corresponding to maximum climb thrust. The flight path may include several segments.

R



NFCS-01-2230-022-A100AB

- When CLB mode is engaged :
  The system arms ALT and displays the applicable target altitude on the ALT scale.
  - If the next predicted level-off is an ALT CSTR, ALT is magenta on the FMA and the ALT CSTR is displayed in magenta on the altitude scale.
  - If the next predicted level-off is the FCU altitude, ALT is blue on the FMA and the FCU-selected altitude is displayed in blue on the altitude scale.
- The guidance does not modify the target speed in order to satisfy an altitude constraint. Therefore the constraint may not be met and may be predicted as missed.
- When the aircraft levels off at the ALT CSTR, CLB mode arms automatically, then engages when the aircraft passes the constrained waypoint (if the FCU altitude is above the constraint altitude).

OPEN CLIMB MODE (OP CLB)

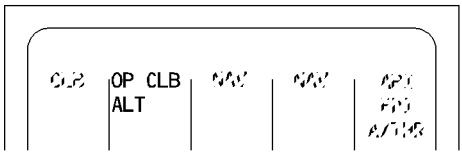
The OPEN CLIMB mode is a selected mode. It uses the AP/FD pitch mode to maintain a SPD/MACH (selected or managed), while the autothrust, if active, maintains maximum climb thrust.

ENGAGEMENT CONDITIONS

The OPEN CLB mode can only be engaged, if all of the following conditions are met :
- The aircraft is in flight for more than five seconds.
- The LAND mode is not engaged.
- The FCU-selected altitude is higher than the aircraft's present altitude.

The OPEN CLB mode is engaged, if one of the following conditions occurs :
- The pilot pulls out the ALT selector knob.
- The pilot pulls out the SPD/MACH selection knob, when TOGA mode or EXPED CLB ◁ is engaged.
- Acceleration altitude is reached, with CLB armed, and NAV mode not engaged.
- Guidance reverts to ensure speed protection. (Refer to 1.22.30 reversions).
- NAV mode is lost (or disengaged), when previously in CLB mode. Reversion to OPEN CLB is accompanied by a triple click aural warning (see mode reversions).

When OPEN CLB is engaged : "OP CLB" is displayed on the FMA and the managed LVL/CH dot on the FCU goes out.



Typical FMA in OPEN CLIMB

NFCS-01-2230-023-A100AA

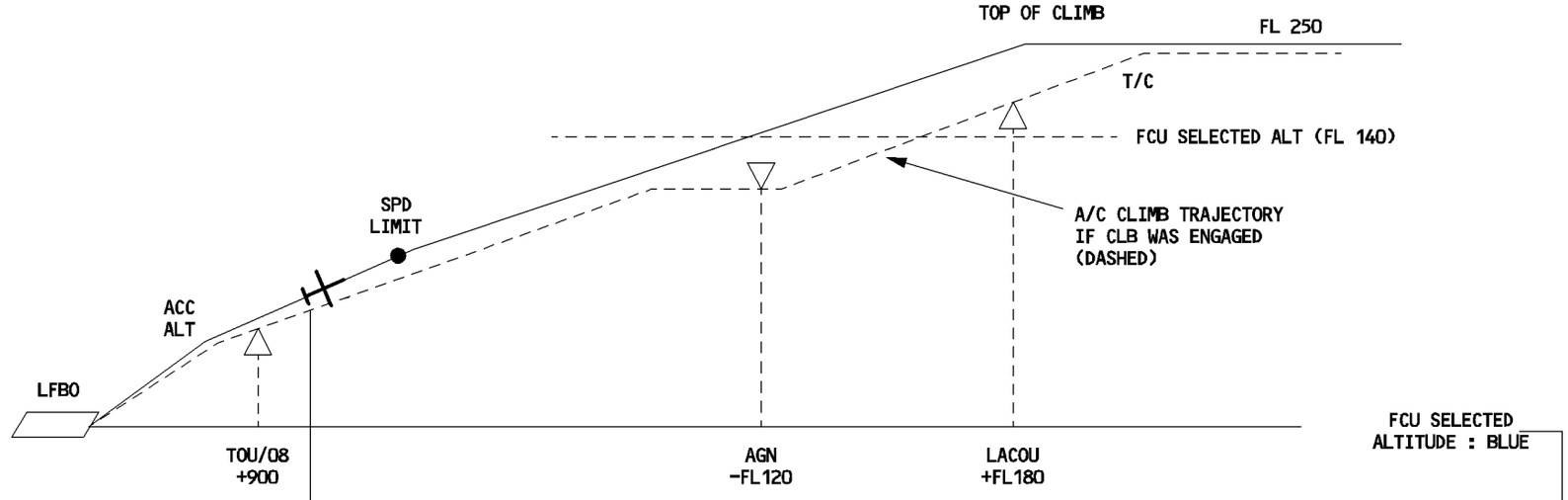
DISENGAGEMENT CONDITIONS

The OPEN CLB is disengaged by one of the following conditions :
- Engagement of any other vertical mode.
- Reversion to V/S mode (Refer to 1.22.30 reversions).
- Selection of a lower altitude than the current aircraft altitude. V/S (FPA) engages on the current V/S (FPA).

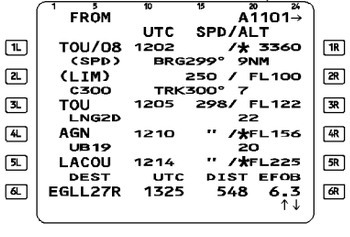
GUIDANCE

When OPEN CLB is engaged, the target speed/Mach is maintained by adjusting the pitch with the elevator, whereas thrust is maintained either by the A/THR, or manually by the pilot. Speed target may either be selected or managed.
The OPEN CLB mode disregards all altitude constraints up to the FCU-selected altitude.

OPEN CLB modes, MANAGED SPEED

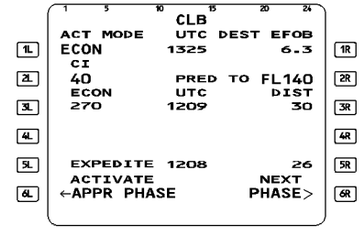


MCDU F-PLN A PAGE



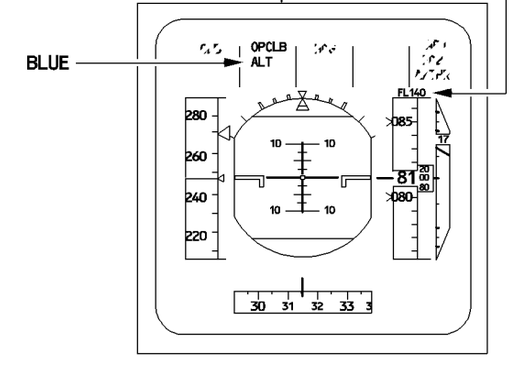
ALL CONSTRAINTS ARE IGNORED. THE AIRCRAFT CLIMBS DIRECTLY TO THE FCU ALTITUDE.

PERF CLB PAGE



PREDICTIONS TO FL 140 AS SELECTED ON FCU ASSUMES OP CLB.

PFD



BECAUSE ALL CONSTRAINTS ARE DISREGARDED, THE ALTITUDE TARGET IS THE FCU SELECTED ALTITUDE. TARGET SPEED IS 250 Kt UNTIL SPEED LIMIT ALTITUDE IS REACHED

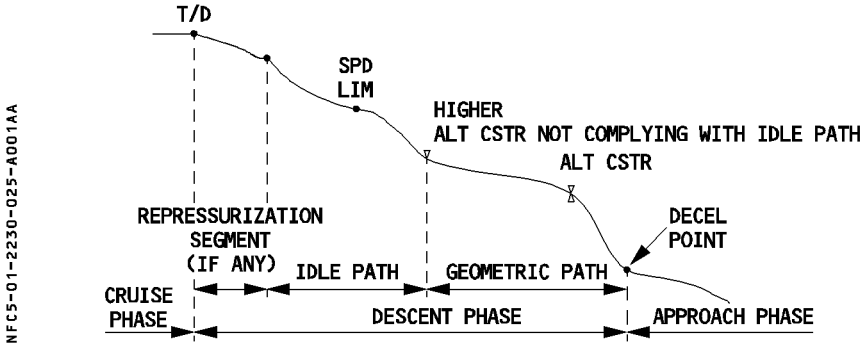
NFC5-01-2230-024-A001AA

Note : If the change is less than 1200 feet in OPEN CLB mode, the aircraft responds with a rate of climb of 1000 ft/min.

DESCENT MODE (DES)

DES mode provides managed vertical guidance along a computed descent profile. The profile is computed from "Top of Descent" at the cruise flight level down to the "Decel" point, where guidance begins the deceleration to VAPP, to be reached at 1000 feet above touchdown on the final descent path.
The descent profile takes into account wind data and data from the lateral and vertical flight plans, and it is based upon the managed descent speed profile. It does not take holding patterns into consideration.
The descent profile has several segments :

- A repressurization segment. When necessary, this produces a repressurization rate for the cabin during descent. It is a function of the destination airport altitude and the selected cabin rate (defaulted to – 350 feet/min but this can be modified).
- Idle path segment. The AP/FD controls the speed and autothrust stays at idle thrust. Guidance computes this profile from top of descent or the end of the repressurization segment to the first vertical constraint that cannot be flown at idle thrust.
- Geometric path segments. The AP/FD controls the vertical path, and autothrust controls the speed. These segments take the aircraft from the first constraint to the deceleration point.



The descent mode is a managed mode that may be engaged during cruise. It can be armed or engaged in descent and approach phases (unless the FCU selected altitude is higher than the present aircraft altitude).

R ARMING CONDITIONS

R The DES mode is armed when an altitude constraint is captured and all the following
R conditions are met :
R – FCU-selected altitude is lower than present altitude.
R – NAV, LOC* or LOC mode is engaged.
R – Takeoff or go-around phase is not active.
R – Flight profile is available.

DISARMING CONDITIONS

The DES mode is disarmed, if one of the following conditions is met :
- Engagement of another vertical mode.
- FCU-selected altitude is set above the aircraft's current altitude.
- Loss of NAV, LOC*, or LOC mode.
- Switching to the go-around phase.
- Loss of vertical flight path validity.
- Setting the FCU-selected altitude at an altitude constraint, while ALT CSTR* was engaged. (ALT* engages and DES mode disarms).

ENGAGEMENT CONDITIONS

The DES mode can be engaged, when the following conditions are met :
- The FCU-selected altitude is lower than the present altitude.
- NAV, LOC*, or LOC is engaged.
- Takeoff, climb, or go-around phase is not active.
- Vertical flight path is valid.
- TO, G/S, LAND, FINAL or GA mode is not engaged, and :
  - The aircraft sequences a waypoint, with an ALT CSTR and DES mode armed. The DES mode engages automatically, or
  - The pilot presses the ALT selector knob, while ALT CSTR* or ALT CSTR (ALT* or ALT magenta ◁) is not engaged, or
  - The pilot presses the ALT selector knob, while ALT* or ALT is engaged, and the current altitude is not an effective altitude constraint of the F-PLN.

Note : When DES mode is engaged :
- *The V/S (FPA) window of the FCU shows dashes.*
- *The managed LVL/CH dot on the FCU lights up.*

DISENGAGEMENT CONDITIONS

The DES mode is disengaged, if one of the following conditions is met :
- NAV mode is lost or disengaged, and the V/S (FPA) mode engages. A triple click aural warning will sound. (Refer to 1.22.30, mode reversion).
- Another vertical mode engages.
- The pilot selects an altitude on the FCU that is higher than the aircraft's present altitude, and the V/S (FPA) engages on the current V/S (FPA). Same triple click logic, as for the OP DES case. (Refer to 1.22.30).
- NAV mode is lost due to a discontinuity in the descent profile. AP/FD reverts to basic mode, and a triple click aural warning sounds. The vertical mode is boxed in white for 10 seconds.

GUIDANCE

Descent initiation

In order to initiate the descent, the pilot :

R — Turns the ALT selector knob to set the cleared altitude.

— Pushes in the ALT selector knob.

R · If the aircraft has not reached top of descent (T/D), it will descend immediately at a constant V/S, converging on the descent profile.

· If the aircraft is at or beyond T/D, it descends immediately at idle thrust.

During the descent :

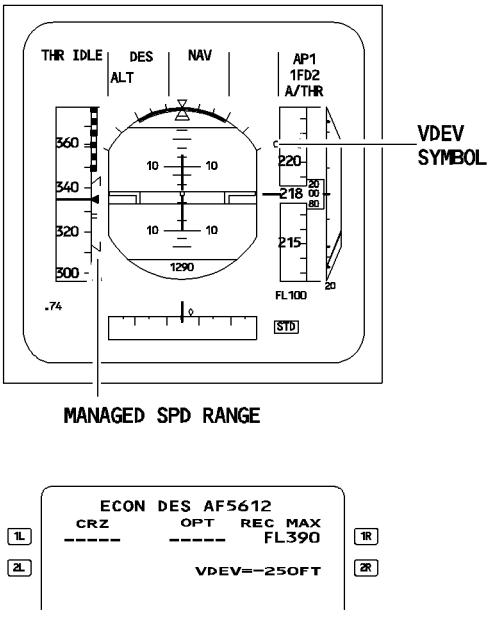
The pilot sees a vertical deviation symbol (VDEV) along the ALT scale on the PFD and on
R the PROG page, so as to monitor the aircraft vertical position on the calculated descent profile.

The aircraft may deviate from the DES path while DES mode is engaged if :

R — unexpected wind conditions is encountered or,

R — anti-icing is turned on or,

R — lateral flight plan is modified.



PFD display in managed DES mode.

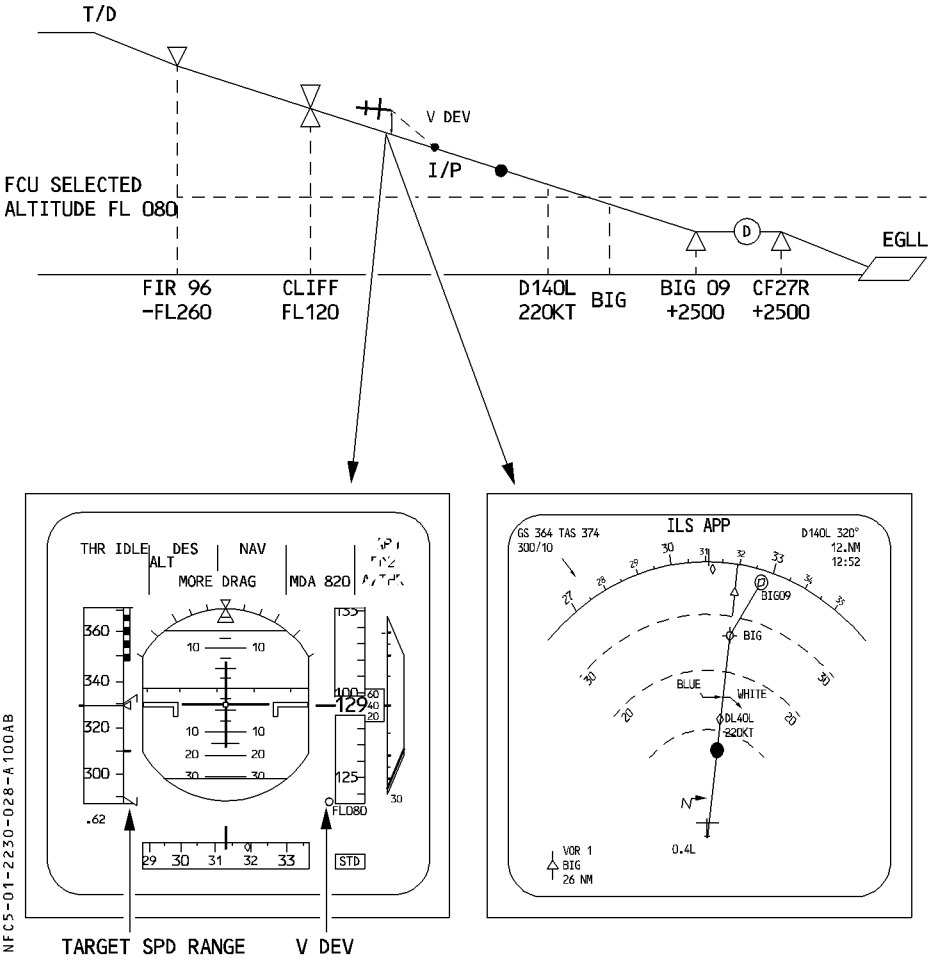
VDEV value on the PROG page

NFC5-01-2230-027-A100AA

R When the speed is managed, a managed SPD range shows, on the PFD, acceptable speed
R variations around the nominal descent speed target (limited to ± 20 knots).

Associated with the V DEV displayed on PFD, the ND shows an intercept point ∿→ on the flight plan. It indicates the position where the system predicts that the aircraft will intercept the descent profile.

R



– **Aircraft above the descent profile :**

R If the aircraft is above the descent profile, the speed will increase toward the upper limit
R of the managed speed range. If the speed reaches the upper limit, the aircraft will
R maintain the speed but will deviate from the profile (autothrust at idle).

The navigation display presents a pseudo waypoint ∿↦ (intercept point) along the flight
R plan, that assumes the aircraft will return to the profile using :

- idle thrust
- 1/2 speedbrake extension
- ECON speed plus a margin (until intercepting the profile).

Whenever the intercept point is predicted to be close to a constrained waypoint, the PFD and MCDU display an "AIRBRAKES" or "MORE DRAG" message depending upon the FMGS standard.

Note : With DES mode engaged, the speedbrakes extension will not necessarily increase the descent rate. It increases only if the aircraft is above path.

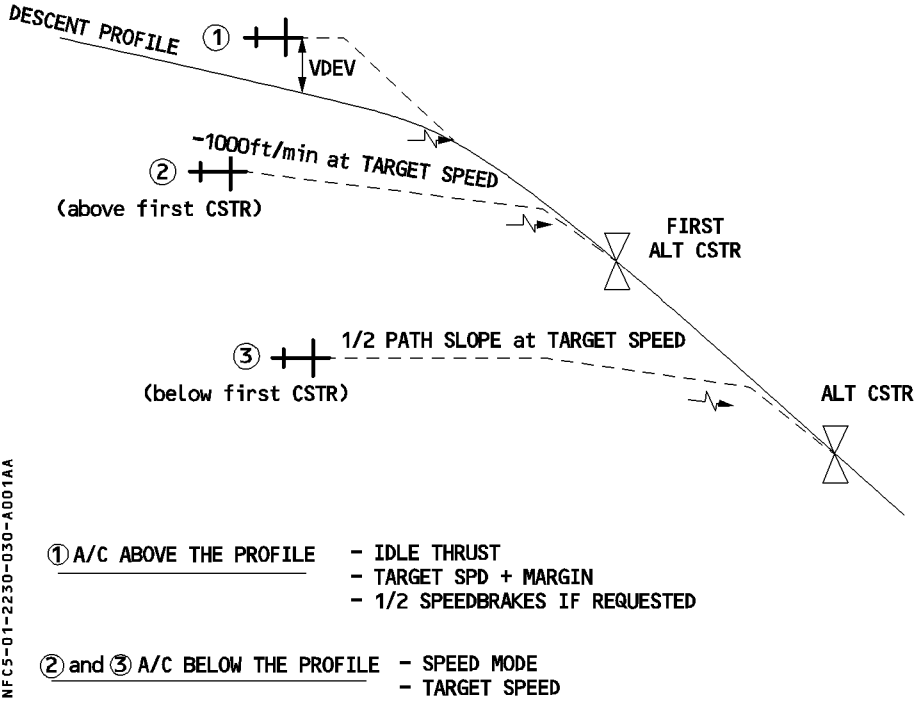
– **Aircraft below DES profile**

If the aircraft is below the DES profile, its speed will be maintained at target speed until
R it reaches the descent profile.

The intercept point on the navigation display is based on the following assumptions :

· if the aircraft is flying an idle segment :
The FMGS maintains V/S = – 1000 ft/min and target speed, until it reaches the constraint altitude or intercepts the profile.

· if the aircraft is flying a geometric segment :
The FMGS maintains a constant flight path angle (half of the theoretical FPA of the profile) until it intercepts either the altitude constraint or the profile.



– **Leveling off at a constraint**

· If the aircraft levels off at an ALT CSTR, the DES mode arms and remains armed until the aircraft passes the constraint, then reengages (if the FCU altitude is set below the altitude of the constraint).

· if the FCU selected altitude is that of a constraint, the pilot may continue the descent below that altitude by turning the ALT SEL knob and pushing it in. This arms the DES mode, which reengages when the aircraft passes the constraint waypoint.

– **Guidance in a hold :**

Just before the aircraft enters a holding pattern, the speed target becomes the holding speed. In the holding pattern, the DES mode commands V/S = – 1000 ft/min while autothrust maintains the holding speed. The aircraft will level off at the next altitude constraint if it is reached during the hold.

R The vertical deviation (VDEV) is based on the altitude at which the aircraft is supposed
R to cross the exit fix in order to be properly positioned on the descent profile.

– **Too steep path :**

A segment between two constraints is called "too steep path" when Flight Management predicts that it is impossible to fly it at the preplanned speed with 1/2 speedbrakes extended. The MCDU displays TOO STEEP PATH and FM does not furnish predictions for the waypoints included in the TOO STEEP PATH segment. When the aircraft reaches the beginning of the too steep path segment, the FM recomputes the VDEV using an idle segment from the end of the too steep path segment.

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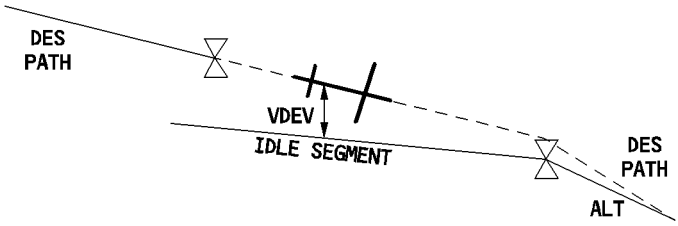


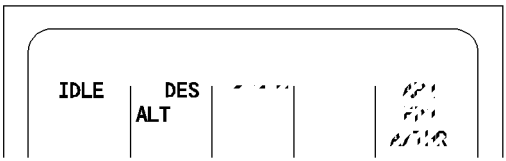
– **FMA display**

When DES mode is engaged, the system arms ALT and displays the applicable target altitude on the PFD altitude scale.

- If the next predicted level-off is an altitude constraint, ALT is magenta on the FMA second line and the PFD displays the altitude constraint magenta above the altitude scale.

  When ALT CSTR (green) is engaged (aircraft flying at ALT CSTR), the system arms DES
R blue. When the aircraft meets the constraint, DES engages again automatically.
- If the next predicted level-off is the FCU altitude, ALT is blue on the FMA and the PFD displays the FCU selected altitude in blue.

NFC5-01-2230-031-B100AA



Typical FMA in DES

OPEN DESCENT

The OPEN DESCENT mode is a selected mode. It maintains a SPD/MACH (selected or managed) with the AP/FD pitch mode, while autothrust (if active) maintains IDLE thrust. It is not to be used for final approach.

ENGAGEMENT CONDITIONS

The OPEN DES mode can only be engaged, if the following conditions are met :
- The aircraft has been in flight for more than five seconds,
- LAND mode is not engaged.
- The FCU-selected altitude is lower than the present altitude.

The OPEN DES mode is engaged by one of the following :
- Pulling out the ALT selection knob.
- Selecting a manual speed when EXP mode is engaged. ◁

Note : When OP DES is engaged :
- *The FMA displays "OP DES".*
- *The managed LVL/CH dot on the FCU goes out.*
- *The system arms the ALT mode.*

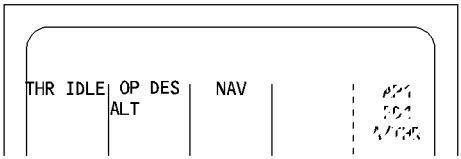
DISENGAGEMENT CONDITIONS

- Manual engagement of another vertical mode.
- Selection of an altitude higher than the present altitude. V/S (FPA) engages on the current V/S (FPA). The vertical mode is boxed white. If within 5 seconds after the reversion to V/S, the pilot does not confirm the altitude target change by another expected action, a triple click aural warning sounds, and the V/S (FPA) is boxed white and flashes for 10 seconds.

GUIDANCE

When OPEN DES is engaged, pitch control maintains the target speed/Mach number, and autothrust maintains idle thrust (or the pilot maintains it manually).
The speed target may either be selected or managed.
The OPEN DES disregards all altitude constraints.

NFCS-01-2230-033-A100AA



Typical FMA in OPEN DES

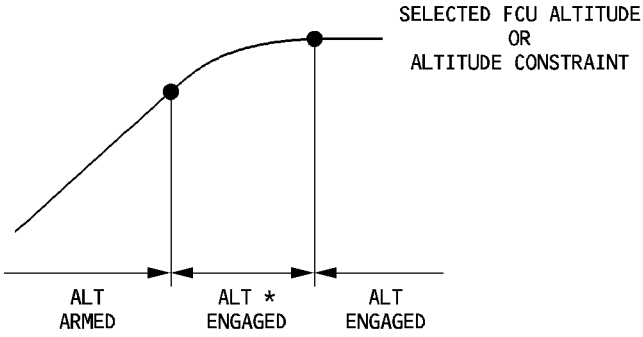
ALTITUDE ACQUIRE MODE (ALT*, ALT CSTR*)

ALT* mode guides the aircraft to acquire the FCU-selected altitude.
R ALT CSTR* guides the aircraft to acquire an altitude constraint, provided by Flight
R Management.
R Once the aircraft has reached the altitude, the altitude mode (ALT or ALT CSTR green) engages.

ENGAGEMENT CONDITIONS

The mode engages when the aircraft reaches the altitude capture zone, defined by the aircraft vertical speed (among other parameters).

NFCS-01-2230-033-B100AA



Note : ALT and ALT CSTR* cannot be engaged below 400 feet, if either the takeoff or the go-around mode is engaged.*

DISENGAGEMENT CONDITIONS

– Engagement of V/S mode on the current vertical speed, by changing the FCU altitude selector knob by more than 250 feet.

If within 5 seconds after reversion to V/S (FPA) the pilot does not confirm the altitude target change by :

– Pulling the ALT knob, or
– Setting a new V/S (FPA) target, or
– Pushing the ALT pushbutton on the FCU,

a triple click aural warning sounds, and the V/S (FPA) is boxed white for 10 additional seconds.

– Engagement of another vertical mode, provided the FCU altitude has been changed by more than 250 feet.

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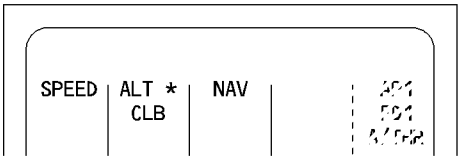

Typical FMA in ALT *

GUIDANCE

The ALT* and ALT CSTR* modes have internal V/S guidance that is a direct function of the difference between the present and target altitudes.

ALT * and ALT CSTR * modes have internal protections that decreases the vertical speed when VLS or VMAX is reached (VLS or VMAX becomes the priority target).

The system switches automatically to ALT (altitude hold) when the altitude deviation becomes less than 20 feet.

Note : – *If the baro setting is changed during ALT*, this may lead to an FCU target overshoot due to the change of the current value of the altitude. However ALT* mode will allow the FCU altitude to be regained.*

– *For aircraft equipped with QFE option, a switching from STD to QFE (or vice versa) in ALT CSTR*, will change the target value and a reversion to V/S may occur if the target value is modified of 250 feet or more.*

R ALTITUDE HOLD MODE (ALT/ALT CST/ALT CRZ)

R The ALT mode maintains a target altitude. This target altitude is either the FCU selected altitude or an altitude constraint delivered by Flight Management.

ARMING CONDITIONS

The ALT mode arms automatically whenever the aircraft climbs or descends toward the target altitude.
When ALT is armed, the FMA displays the ALT message on its second line :
- blue when the target altitude is the FCU selected altitude
- magenta if the target altitude is an altitude constraint.

ENGAGEMENT CONDITIONS

- The ALT mode is engaged automatically when the difference between present altitude and the target altitude becomes less than 20 feet with ALT* engaged.

DISENGAGEMENT CONDITIONS

The ALT mode disengages when any other vertical mode engages.

GUIDANCE

- The altitude that ALT mode holds is the altitude it memorized when engaged. It is not affected by a change of reference in the ALT window or by a change in the barometric correction.
- When ALT is engaged, the FMA displays "ALT" in green (FCU altitude hold) or ALT CSTR in green if it is an altitude constraint.

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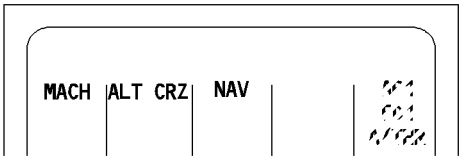
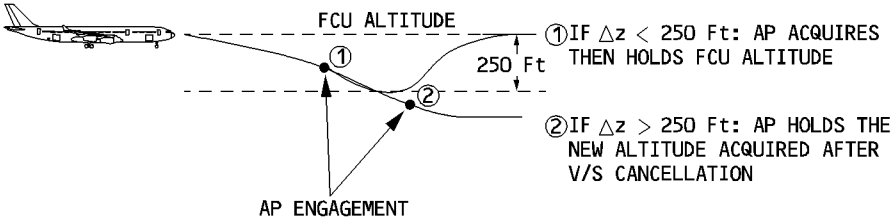


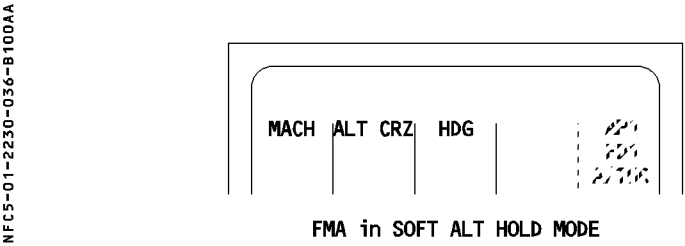
typical FMA in ALT MODE

– If the AP is engaged while FD is already engaged in ALT mode at the FCU-selected altitude, the autopilot :
· acquires and holds the FCU altitude if present altitude is within 250 feet of it, or
· commands a level-off if present altitude is more than 250 feet from the FCU altitude.



SOFT ALTITUDE

R On reaching the planned cruise altitude, ALT CRZ engages and A/THR maintains the
R speed/mach target.
R Two minutes after ALT CRZ engages, if the mach mode is operative, SOFT ALT mode
R engages. This allows the aircraft to deviate ± 50 feet from the target altitude, thereby
R minimizing thrust variations and reducing fuel consumption.

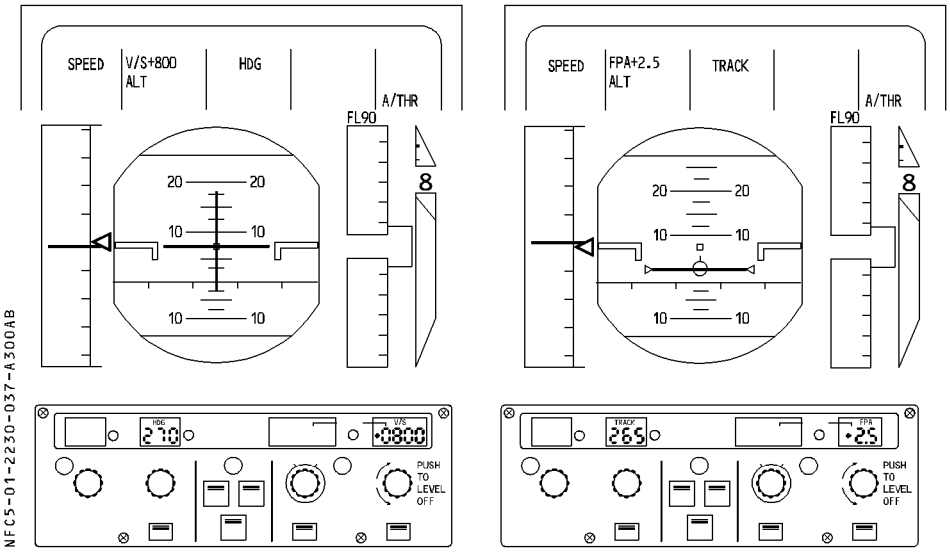


FMA in SOFT ALT HOLD MODE

VERTICAL SPEED MODE — FLIGHT PATH ANGLE MODE (V/S - FPA)

The V/S - FPA is a selected mode. It acquires and holds the vertical speed or the flight path angle displayed in the V/S - FPA window of the FCU.
The HDG V/S TRK FPA pushbutton on the FCU allows the pilot to select either type of reference to be used for guidance and for display on the PFD.

R



ENGAGEMENT CONDITIONS

The pilot can engage the mode manually as follows :
- Pull out the V/S FPA selection knob (at least five seconds after lift-off) or push it in for an immediate level-off (V/S = 0).
- Engage the AP and/or FD if AP and FD were not engaged (basic mode of AP/FD engagement).
- Select a different altitude (more than 250 feet from present altitude) when in ALT*.
- Select a higher altitude than present altitude when in DES, OP DES, or EXP DES◁ mode.
- Select a lower altitude than present altitude when in CLB, OP CLB, or EXP CLB◁ modes.

The mode engages automatically :
- five seconds after lift-off, if no other vertical mode is engaged
- upon loss of G/S* or G/S mode
- upon loss of FINAL mode
- upon loss of LOC* or LOC mode
- upon loss of NAV mode when DES mode is engaged
- upon loss of vertical flight path in DES mode

DISENGAGEMENT CONDITIONS

The pilot can disengage the V/S mode manually by :
- pulling or pushing the altitude selector knob
- pushing the EXPED pushbutton ◁ or
- initiating a go-around.

It disengages automatically :
- when the aircraft reaches the FCU altitude or
- upon G/S* engagement.

GUIDANCE

The FMGC pitch mode guides the aircraft to the target V/S or FPA. The corresponding A/THR mode is SPEED or MACH. The FMA displays "V/S (FPA)".
The V/S (FPA) guidance has priority over the speed guidance. If the selected target V/S or FPA is too high (relative to the current thrust condition and speed), the FMGC will steer the aircraft to the target V/S or FPA, but the aircraft will also accelerate or decelerate. When the speed reaches the authorized limit, the V/S or FPA decreases automatically to maintain the minimum (or maximum) speed limit.

Note : If the pilot sets V/S = 0 or pushes the V/S-FPA pushbutton to level off (if the push to level off function is installed), it automatically sets the V/S or FPA target to zero and the aircraft levels off and maintains its altitude.

EXPEDITE

Expedite mode is an OPEN mode, used in climb or descent, to reach the desired altitude with the maximum vertical gradient.

ENGAGEMENT CONDITIONS

The pilot can engage EXPEDITE, if :

- The aircraft has been in flight for more than 5 seconds.
- Managed speed is available.
  The pilot manually engages EXPEDITE by pushing the EXPED pushbutton on the FCU.
  If the FCU-selected altitude is higher than the present altitude, EXP CLB mode engages.
  If the FCU-selected altitude is lower than the present altitude, EXP DES mode engages.

DISENGAGEMENT CONDITIONS

The pilot can manually disengage EXPEDITE by :

- Pulling out the V/S (FPA) selector knob to engage the V/S (FPA) mode.
- Pulling out the altitude selector knob to engage OP CLB or OP DES.
- Pulling out the speed selector knob to activate the selected speed target, and engage OP CLB or OP DES. A white box appears around the longitudinal mode and flashes for 10 seconds. A triple click sounds.
- Pushing in the ALT selector knob to engage the CLB or DES mode, provided that the engagement conditions are met.
- Selecting a higher altitude than the present altitude, when in EXP DES. If this action is not followed by another expected pilot action within 5 seconds, a triple click sounds. A steady white box appears around the longitudinal mode, then flashes for 10 seconds after the triple click.
- Selecting a lower altitude than the present altitude, when in EXP CLB. If this action is not followed by another expected pilot action within 5 seconds, a triple click sounds. A steady white box appears around the longitudinal mode, then flashes for 10 seconds after the triple click.
- Activating a reversion to V/S to protect the aircraft from exceeding VLS or VMAX. A white box appears around the longitudinal mode and flashes for 10 seconds. A triple click sounds.
  * In FD mode only, if the crew does not follow the FD orders, a reversion to V/S occurs when reaching VMAX + 4 in EXP CLB or VLS – 2 in EXP DES (VLS – 17 with speedbrakes). (Refer to 1.22.30 "reversions").

EXPEDITE automatically disengages with ALT* engagement.

GUIDANCE

R When the aircraft is in EXP CLB, the target speed is Green Dot, which is maintained with
R pitch control. Autothrust if active sets the thrust at CLB THRUST automatically.
R When the aircraft is in EXP DES, the target speed is 340 knots or Mach 0.8 which is
R maintained with pitch control. Autothrust if active sets the thrust at IDLE automatically.
When EXPEDITE is engaged, the system disregards SPD CSTR, ALT CSTR, and SPD LIM.

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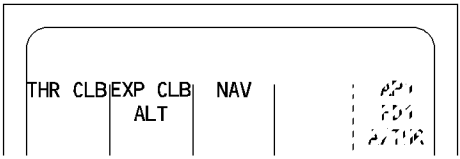


FMA in EXP CLB

MODE REVERSIONS

There are several types of mode reversions. Each one observes a specific logic that can be described as follows :

INTERACTION BETWEEN LATERAL MODES, VERTICAL MODES, AND MANAGED SPEED PROFILE

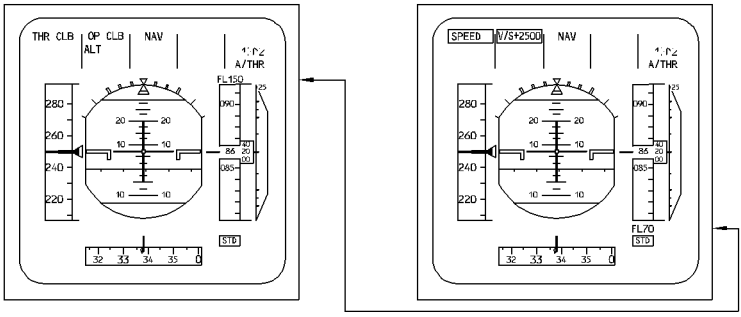
· **When NAV mode is engaged :**
The FMGS guides the aircraft along the flight plan and considers the constraints attached to the F-PLN waypoints. As a result :
– Managed CLB and DES modes are available.
– The managed speed profile includes :
V2 - SPD CSTR (if applicable) - SPD LIM - ECON CLB SPD/MACH - ECON CRZ MACH - ECON DES (MANAGED SPD) - SPD/MACH - SPD CSTR - SPD LIM - HOLD SPD - VAPP/GS MIN.
It is valid for all vertical modes, except EXPEDITE ◁.

· **When NAV mode is not engaged :**
The FMGS considers that the flight plan is not followed, and ignores all speed and altitude contraints linked to the flight plan waypoints. As a result :
– The managed vertical CLB and DES modes are not available.
– The managed SPD profile disregards the speed constraints and includes :
V2 - SPD LIM - ECON CLB - ECON CRZ - ECON DES (MANAGED SPD) - SPD LIM - VAPP/GS MIN target.

As a consequence : When NAV mode disengages (manual or automatic)
– CLB mode, when engaged, reverts to OPEN CLB. The lateral mode is boxed white for 10 seconds. The vertical mode is boxed white.
If within 5 seconds the disengagement of the NAV mode is not confirmed by one of the following crew actions :
· FCU altitude change
· Level-off
· Selection of the V/S mode, then
A triple click aural warning sounds. In addition, a white box flashes around the vertical mode for 10 additional seconds.
– DES mode, when engaged, reverts to V/S mode on current value.
If within 5 seconds the disengagement of the NAV mode is not confirmed by one of the following crew actions :
· FCU altitude change
· Level-off
· Selection of the V/S mode, then
A triple click aural warning sounds. In addition, a white box flashes around the vertical mode for 10 additional seconds.
– Speed and altitude constraints are disregarded (but speed limit is retained).

MODE REVERSION DUE TO FCU ALTITUDE CHANGE

1. When an OPEN mode is engaged, the aircraft climbs or descends towards the altitude set on the FCU. If the pilot sets the FCU altitude to a target incompatible with the active open mode, a mode reversion occurs and V/S (FPA) engages on the current V/S (FPA). This reversion applies to CLB, OP CLB, DES, OP DES, EXP DES ◁ , EXP CLB ◁.
e.g. : Reversion from OP CLB to V/S



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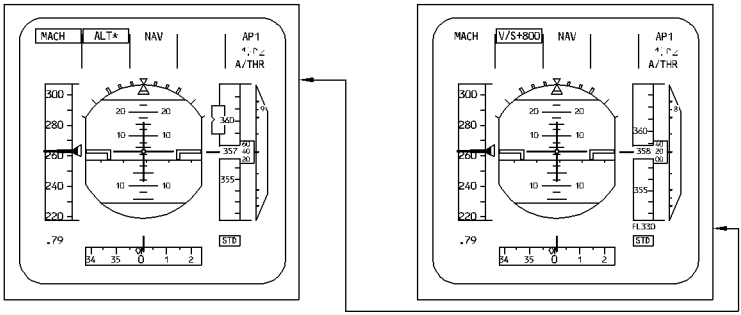
FCU ALTITUDE CHANGE FROM FL150 to FL70

2. With ALT* engaged, if the target altitude is changed by any value greater than 250 feet, V/S (FPA) engages on the current V/S. (Also Refer to the mode reversion table).



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FCU ALTITUDE CHANGE FROM FL360 TO FL330

If within 5 seconds after the reversion to V/S (FPA) the pilot does not confirm the altitude target change by :
- Pulling the ALT knob, or
- Setting a new V/S (or FPA) target, or
- Pushing the ALT pushbutton on the FCU.

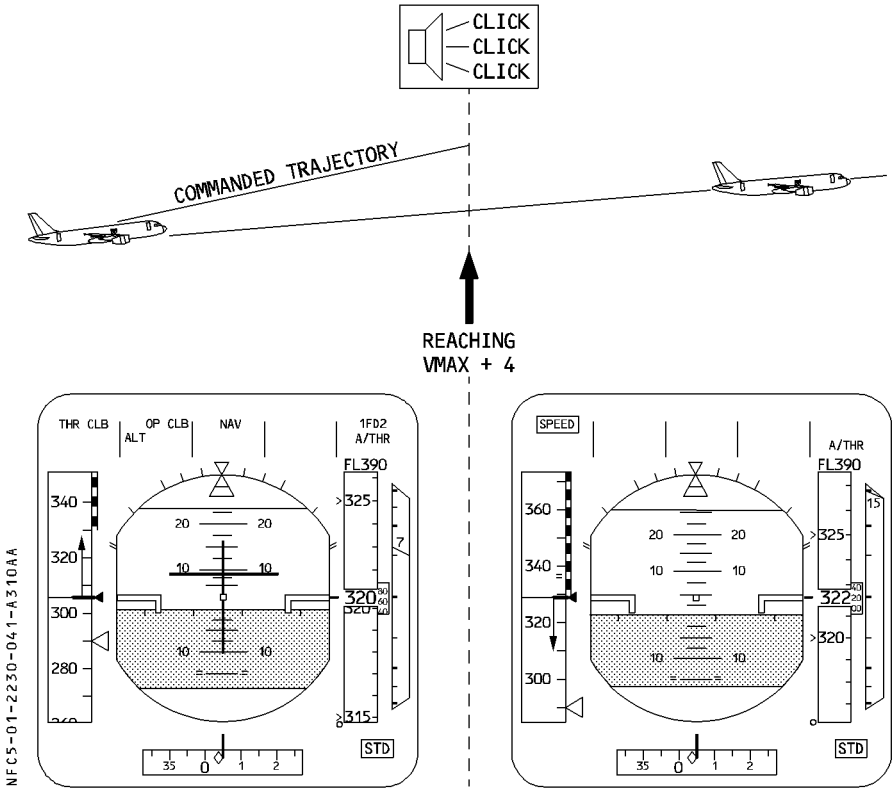
A triple click sounds, and the V/S (FPA) is boxed white for 10 additional seconds.

AUTOMATIC SPEED MODE PROTECTION

FDs are engaged in an OPEN mode in climb with AP not engaged

If FDs are engaged in CLIMB, or OPEN CLIMB mode, or EXP CLB (if installed) and the pilot does not follow the FD bars to maintain the commanded climb (pitch too low and autothrust in maximum climb thrust), the aircraft accelerates.

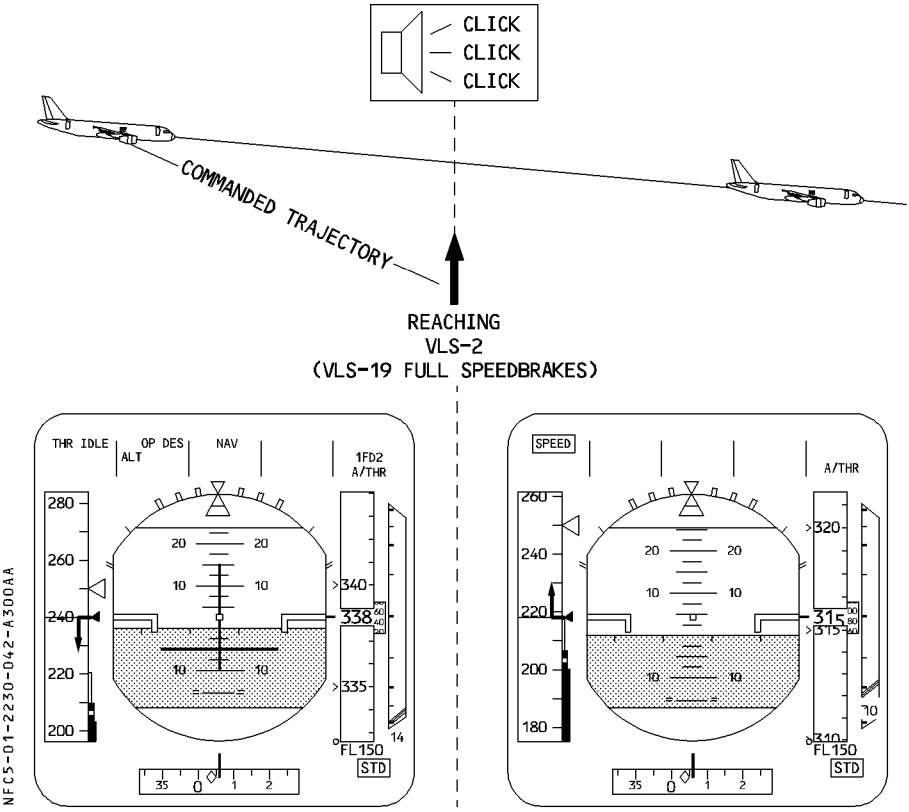
Both FDs disengage when VMAX+4 is reached (VMAX being VMO, VLE or VFE). If the A/THR is active, it reverts to SPEED mode and reduces thrust to recover the speed target. A triple click aural warning sounds.



AUTOMATIC SPEED MODE PROTECTION

FDs are engaged in an OPEN mode, in descent with the AP not engaged

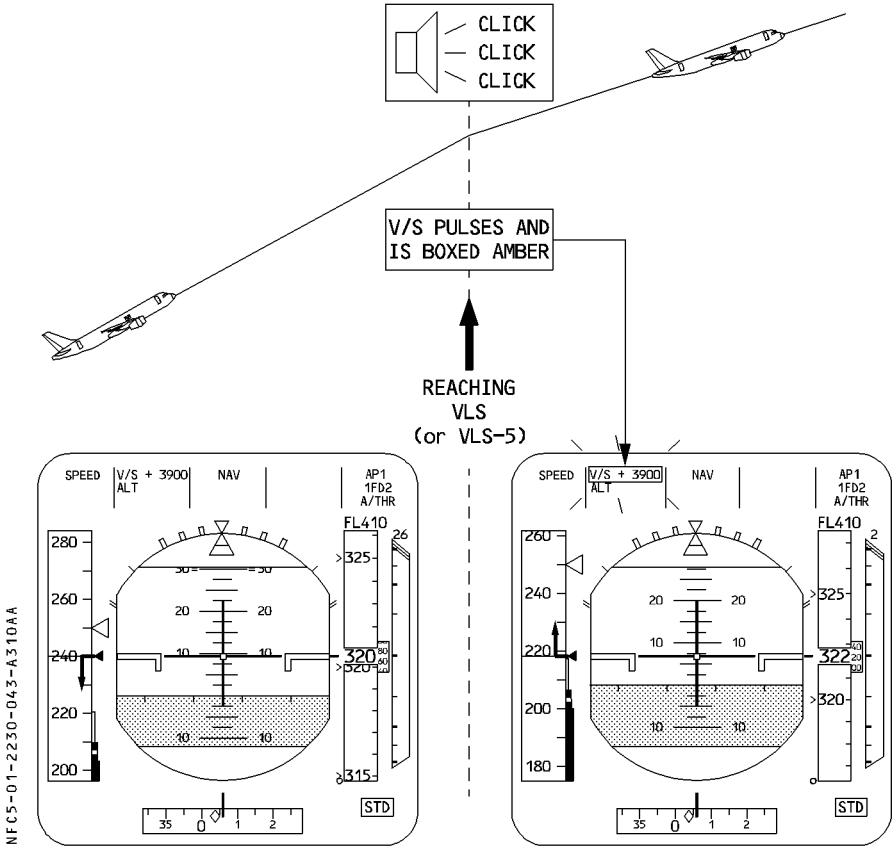
If the FDs are engaged in DES, or OP DES mode, or EXP DES (if installed) and, if the pilot does not follow the FD bars to maintain the commanded pitch, the aircraft decelerates
R (insufficient descent rate and idle thrust).
R If the airspeed reaches VLS-2, both FDs disengage. (If speedbrakes are extended, the FDs
R disengage between VLS-2 and VLS-19, depending on the position of the speedbrakes).
The A/THR, if active, reverts to SPEED mode upon FD bars disengagement, and increases thrust to recover the speed target. A triple-click aural warning sounds.
R



AUTOMATIC SPEED PROTECTION IN V/S (or FPA) MODE

R **In climb**

R When climbing with V/S mode engaged : If the selected V/S value is excessive (with
R regards to thrust and speed), the FMGS maintains the V/S target, but the airspeed
R decreases. When reaching VLS (or VLS - 5, if the speed target is VLS), the AP temporarily
R abandons the V/S target, and automatically decreases the vertical speed to maintain VLS.
R The same applies, if FPA mode is used with an excessive FPA target.
R



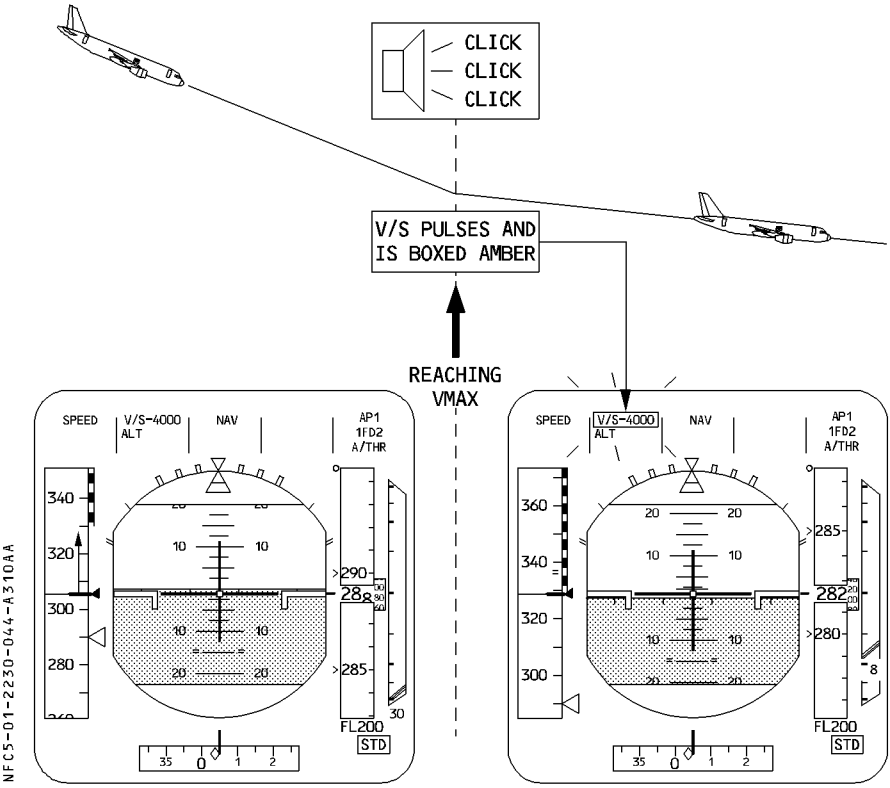
R V/S mode remains engaged.
R On the FMA, the V/S target is boxed with a flashing amber rectangle, and the V/S value
R pulses. Besides, an aural triple click is generated.

R *Note : When flying with FD bars only (AP OFF), the FMGS adjusts the pitch bar so that VLS*
R *is maintained. However, no triple click is generated and the V/S target display on*
R *the FMA remains unchanged.*

AUTOMATIC SPEED PROTECTION IN V/S (or FPA) MODE

R **In descent**

R When descending with V/S mode engaged : If the selected V/S value is excessive (with
R regards to thrust and speed), the FMGS maintains the V/S target, but the airspeed
R increases. When reaching VMAX (VMO or VLE in clean, or VFE + 4 knots), the AP
R temporarily abandons the V/S target, and automatically decreases the vertical speed to
R maintain VMAX.
R The same applies, if FPA mode is used with an excessive FPA target.
R



R V/S mode remains engaged.
R On the FMA, the V/S target is boxed with a flashing amber rectangle, and the V/S values
R pulses. Besides, an aural triple click is generated.

R *Note : When flying with FD bars only (AP OFF), the FMGS adjusts the pitch bar so that*
R *VMAX is maintained. However, no triple click is generated and the V/S target*
R *display on the FMA remains unchanged.*

MODE REVERSIONS (SUMMARY)

R There are only 2 types of vertical mode reversions on aircraft equipped with global speed
R protection.

Reversion due to a change of the FCU selected altitude

Vertical mode engaged	FCU altitude selection change	Vertical mode switches to
CLB - OP CLB EXP CLB ◁	BELOW AIRCRAFT ALTITUDE	V/S on current V/S
DES - OP DES EXP DES ◁	ABOVE AIRCRAFT ALTITUDE	
ALT* ACTIVE	ANY CHANGE	

Reversion due to the loss of NAV mode (manual or automatic)

CONDITIONS	EVENT	CONSEQUENCE
CLB engaged	Loss of NAV mode	OP CLB engages
DES engaged		V/S engages

R **SPEED PROTECTION when FD orders are not followed by the crew (AP NOT engaged)**
R

CONDITIONS	EVENT	CONSEQUENCE
· FD engaged only (no AP) and · OP DES or EXP DES ◁ or DES engaged · A/THR active (IDLE thrust)	IAS = VLS – 2 (if speedbrakes are extended between VLS – 2 and VLS – 19)	FD bars disappear. If A/THR active, automatic engagement of SPEED mode on the A/THR. Thrust increases, and the speed is regained.
· FD engaged only (no AP) and · OP CLB or EXP CLB ◁ or CLIMB engaged · A/THR active (CLIMB thrust)	IAS = VMAX + 4 VMAX = VFE or VLE or VMO/MMO	FD bars disappear. If A/THR active, automatic engagement of SPEED mode on the A/THR. Thrust increases, and the speed is regained.

R **SPEED PROTECTION due to excessive V/S**
R

CONDITIONS	EVENT	CONSEQUENCE
· Excessive V/S or FPA selected in climb	IAS = VLS (or VLS – 5 if target = VLS)	The selected V/S (or FPA) target is temporarily abandoned to maintain VLS in climb or VMAX in descent.
· Excessive V/S or FPA selected in descent, and · Clean configuration	IAS = VMAX	
· Excessive V/S or FPA < 0 selected in descent, and · Configuration other than clean	IAS = VMAX	

Enhanced mode reversion alertness

The following sequences, or mode reversions, are highlighted by a triple click :

- V/S selection in ALT*
- SPD selection in SRS
- CLB (or EXP CLB) to OP CLB, upon lateral crew action while climbing toward a constraint
- ALT* to V/S, upon ALT target change
- FD disengagement in OPEN modes
- Alerting FMA display when V/S-(FPA) target is not held
- CLB to OP CLB reversion, upon profile loss
- Automatic FD re-engagement in basic mode
- DES to V/S upon flight plan loss, or upon no lateral crew action
- FINAL DES to V/S, upon NAV loss
- Reversion to V/S when selected ALT crosses the current altitude
- Automatic FD re-engagement in basic lateral mode
- NAV to HDG, upon NAV loss

AP/FD COMMON MODES

GENERAL

These modes are called "common" because they are related to both the lateral and the vertical axes.
The AP/FD common modes are :
– On takeoff : Runway/Runway track associated to SRS vertical modes.
– In approach : ILS approach (LAND) or non-ILS approach (APP NAV FINAL).
– In go around : Go around track associated to SRS vertical modes.
These modes are engaged simultaneously on both axes.

<table>
<tr><th colspan="2">COMMON MODES</th><th>VERTICAL</th><th>LATERAL</th></tr>
<tr><td colspan="2">TAKEOFF</td><td>SRS</td><td>RWY
RWY TRK</td></tr>
<tr><td rowspan="3">APPROACH MODES</td><td rowspan="2">ILS APPROACH</td><td>G/S*
G/S</td><td>LOC*
LOC</td></tr>
<tr><td colspan="2">LAND, FLARE,
ROLL OUT</td></tr>
<tr><td>NON ILS APPROACH</td><td>FINAL</td><td>APP NAV</td></tr>
<tr><td colspan="2">GO AROUND
(GA)</td><td>SRS</td><td>GA TRK</td></tr>
</table>

TAKEOFF

Takeoff mode combines the SRS (Speed Reference System) vertical mode with the RWY lateral mode.
Both are simultaneously engaged, but may be disengaged separately.
Takeoff mode is available :
– During the takeoff run and initial climb for FD bars guidance.
– Five seconds after lift-off for AP use.

SRS (SPEED REFERENCE SYSTEM)

The SRS mode controls pitch to steer the aircraft along a path in the vertical plane at a speed defined by the SRS guidance law.

– **Engagement conditions**

The SRS mode automatically engages, when the thrust levers are set to the TOGA or FLX/MCT detent, providing :

- V2 has been inserted in the MCDU PERF TO page.
- The slats are extended.
- The aircraft has been on the ground for at least 30 seconds.

– **Disengagement conditions**

The SRS mode disengages :

R - Automatically, at the acceleration altitude (ACC ALT), or if ALT* or ALT CST* mode
R engages (above 400 feet RA).
R - If the crew engages another vertical mode.
R - If the crew selects a speed while in SRS mode : SRS reverts to OP CLB mode, and a
R triple-click aural warning is heard.

R *Note : In Engine Out conditions, the SRS mode does not automatically disengage at EO*
R *ACC ALT. Refer to Engine Out procedures.*

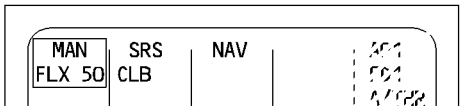
– **Guidance**

In SRS mode, the aircraft maintains a speed target equal to V2 + 10 knots in normal engine configuration. When the FMGS detects an engine failure, the speed target becomes the highest of V2 or current speed, limited by V2 + 15 knots.

The SRS guidance law also includes :

- Attitude protection to reduce aircraft nose-up during takeoff (18° maximum or 22.5° maximum in case of windshear).
- Flight path angle protection that ensures a minimum vertical speed of 120 feet/minute.
- A speed protection limiting the target speed to V2+ 15 knots.

Note : If during takeoff the pilot inadvertently sets an altitude on the FCU below the current altitude, the aircraft will remain in SRS mode until the pilot takes some other action.



Typical FMA at takeoff with a Flex temperature

RUNWAY (RWY)

The RUNWAY mode has two submodes :

- RWY mode, which gives lateral guidance orders during takeoff roll and initial climb out (up to 30 feet RA) if a LOC signal is available
- RWY TRK mode, which gives lateral guidance on the track the aircraft was flying at mode engagement (at 30 feet RA)

R

– **Engagement conditions**

The RWY engagement conditions are :

– The conditions required for SRS mode engagement :
  - V2 is inserted in the MCDU PERF TO page
  - slats are extended.
  - the aircraft has been on ground for at least 30 seconds.
– The aircraft is receiving a LOC signal and LOC deviation is less than 1/2 dot.
– The aircraft heading is within 20° of the ILS related course.
– The ILS course is identical to the runway heading of the origin airport as selected for the active flight plan, if any.

The RWY TRK mode engages automatically at 30 feet (RA) if NAV mode does not engage (NAV not armed prior to takeoff).

– **Disengagement conditions**

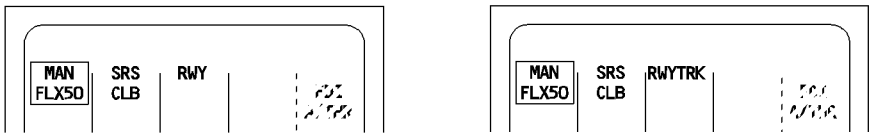
RWY mode disengages if :

– The LOC signal is lost below 30 feet RA or the aircraft heading and the runway heading differ by more than 20°.
– Another lateral mode is engaged.

Note : If the takeoff runway has no ILS, RWY mode is not available and the PFD does not display the yaw bar nor RWY on FMA.

– **Guidance**

– The RWY mode uses the LOC signal to guide the aircraft on the runway centerline while the aircraft is on the ground.
  The PFD displays the FD yaw bar.
  The FMA displays RWY.
– The RWY TRK mode guides the aircraft on the track the aircraft was flying at mode engagement.
  The FD displays the conventional guidance bar.
  The FMA displays "RWY TRK".



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Typical FMA with RWY mode engaged.

APPROACH

The aircraft can fly two different types of approaches :
- ILS (or LOC) approaches
- Non-ILS approaches (VOR/DME, VOR, NDB, RNAV)

The pilot uses an ARRIVAL lateral revison to insert these approaches into the flight plan. The APPR pushbutton on the FCU is used to arm engage the guidance modes related to the approach inserted into the flight plan.
- For an ILS approach, the guidance modes are LOC and G/S.
- For a non-ILS approach, the guidance modes are FINAL and APP NAV.

ILS APPROACH

The ILS approach mode includes the following modes :

VERTICAL MODE	LATERAL MODE
G/S* (capture) G/S (track)	LOC* (capture) LOC (track)
COMMON MODES LAND - FLARE - ROLL OUT	

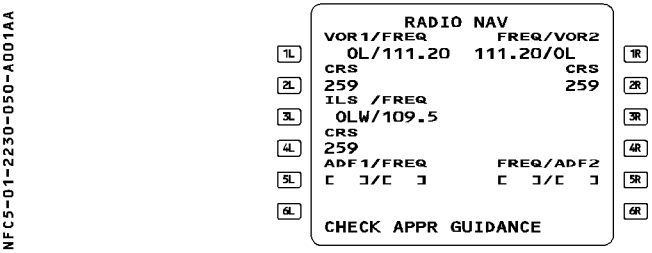
The sequencing of these modes is automatic once the pilot has pushed the APPR pushbutton and the conditions for engagement are met.

Selection

R The ILS approach is selected when the approach pushbutton of the FCU is pressed and
- an ILS approach or a runway only or no approach is inserted in the Flight Management flight plan (arrival page), and an ILS frequency is set in on the MCDU, or
- both radio management panels are set to NAV and each has the ILS frequency and course set in.

Check approach guidance message

If the pilot inserts a non-ILS approach into the flight plan, and then uses the RAD NAV page to tune an ILS manually, the MCDU displays "CHECK APPR GUIDANCE". This message is a reminder that the available APPR guidance modes are APP NAV and FINAL.



Example : OLW was manually entered on the RAD NAV page although a VOR approach is selected in the flight path.

R **(ILS) APPR MODE**

Arming conditions

The pilot arms the (ILS) APPR mode (LOC and G/S in blue on the FMA) by pushing the APPR pushbutton on the FCU, provided that :

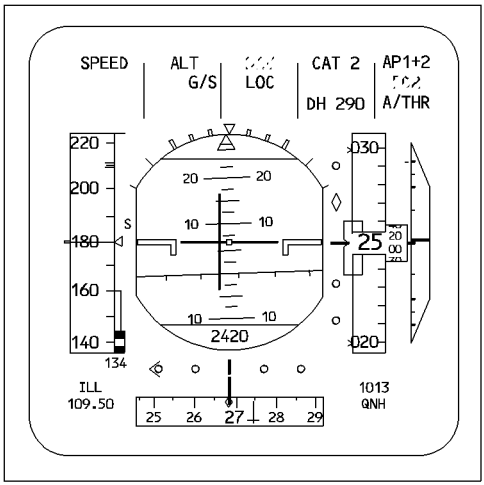
· An ILS approach is selected,
· The aircraft is above 400 feet RA,
· The ILS and RA are available,
· Go-around or takeoff or final mode is not engaged,
· ILS frequency and course are identically set on both receivers.

– LOC and G/S blue are displayed on the FMA. Both modes will automatically engage when conditions are met.
– Second autopilot may be engaged.
– Current landing capability is displayed on the FMA.

Disarming conditions

ILS APPR mode is disarmed, if the aircraft is above 400 feet and :

– When the pilot presses the APPR pushbutton, both the LOC and the G/S modes disarm.
  · The HDG/TRK mode engages, if the LOC mode was engaged, and the V/S FPA mode engages if the G/S mode was engaged.
– When the pilot presses the LOC pushbutton, only the G/S mode disarms.
  · The V/S (FPA) mode engages, if the G/S mode was engaged.
R – When the pilot pulls the HDG/TRK selector knob.
R – When the pilot engages the go-around mode.



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LOC AND G/S ARMED

Engagement conditions of LOC and G/S modes

When ILS capture conditions are fulfilled :

- LOC* mode engages, and
- G/S* mode engages. No radio altimeter validity is required with this FMGC standard for G/S engagement. The FMA displays "LOC*", or "G/S*", or both, in green.

Nevertheless, G/S* mode cannot engage if the aircraft is above the glide path and its trajectory does not cross the ILS G/S beam.

Once the aircraft is established on the LOC axis, the LOC mode engages.

When the aircraft is established on the G/S axis, the G/S mode engages. G/S* and G/S may engage before LOC*.

The FMA displays "LOC" and "G/S" in green. The AP/FD guides the aircraft along the G/S down to 30 feet, and along the LOC during the flare and the roll out.

Disengagement conditions of LOC and G/S modes

If the aircraft is above 400 feet, the (ILS) APPR mode disengages when the pilot :

- Presses the APPR pushbutton, HDG V/S or TRK FPA engages.
- Presses the LOC pushbutton, the LOC mode remains engaged. The system reverts to V/S (FPA), if G/S was engaged.
- Pulls out the HDG/TRK selector knob, HDG V/S or TRK FPA engages.
- Engages the go-around mode.
- When the LOC or G/S signal has been lost for 7 seconds or more above 200 feet RA. AP/FDs disengage and FDs reengage in basic modes (HDG V/S or TRK FPA).

Note : G/S or G/S modes may be engaged above the operating range of the radio altimeters (8000 feet for TRT, and 5000 feet for Collins and Honeywell RA). The landing capability displayed on the FMA will reflect the lack of RA validity (CAT 1) until the radio altimeters become active.*
But, if the radio altimeters fail, or if the FMGS receives no radio altimeter data, LOC, G/S, and AP/FDs will disengage and FDs will re-engage on basic modes.

R

Disengagement conditions of G/S only

- The pilot pulls out the V/S FPA selector knob. LOC mode remains engaged, but G/S mode disengages and V/S or FPA engages.
- When the pilot pushes or pulls the ALT selector knob. LOC mode remains engaged, and the mode selected by the crew engages, as a function of the FCU-selected altitude.

LOC capture assistance function

In NAV mode, and when within 20 NM of the destination runway, the aircraft is guided with a track angle of 20° from the LOC axis. This helps the aircraft intercept and capture the LOC beam. When the ILS frequency or the ILS ident entered on the RAD NAV page differs from the ILS of the destination runway entered in the Flight Plan :

- The aircraft loses the LOC capture assistance function ;
- The "RWY/ILS MISMATCH" message is displayed on the scratchpad ;
- The pilot should select HDG mode to perform the LOC capture.

Note : There is no glideslope capture assistance. The pilot shall ensure that the aircraft flight path intercepts the G/S beam.

LAND MODE

Engagement conditions

LAND mode automatically engages when the LOC and G/S modes are engaged, and the aircraft is below 400 feet RA. The FMA displays "LAND", indicating that LOC and G/S are locked. No action on the FCU will disengage LAND mode. FLARE and ROLL OUT modes will successively engage.

Disengagement conditions

LAND mode disengages :

- Upon engagement of the go-around mode ;
- If the pilot presses the APPR pushbutton, when the aircraft has been on the ground for at least 10 seconds with the autopilot disconnected.
- When both AP/FDs are disengaged.

Note : When LAND is not displayed on the FMA, at/or slightly below 400 feet, the landing capability degrades to CAT1 and the triple click is generated. No autoland is authorized with CAT1 displayed on the FMA.

FLARE MODE

Once the aircraft reaches approximately 40 feet RA (the precise value is a function of V/S):
- The FLARE mode engages.
- The FMA displays "FLARE" in green.

R At 30 feet RA, the AP/FD aligns the yaw axis with the runway centerline and the aircraft
R flares on the pitch axis. If the autothrust is active, thrust is automatically reduced to IDLE
R (refer to A/THR RETARD mode).
R When both AP/FDs are disengaged, FLARE mode disengages.
R After main landing gear touchdown, the autopilot (if engaged) sends a nose down order.

R **Align sub-mode**
R Align is a sub-mode of LAND that lines up the aircraft's axis with the ILS course. It is not
R displayed to the crew.

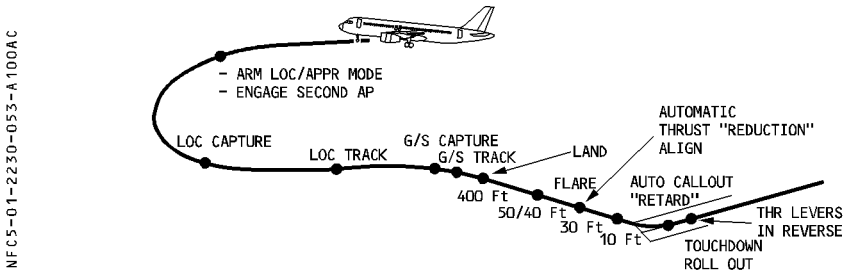
R ROLL OUT MODE

R At touchdown, the ROLL OUT mode engages and guides the aircraft along the runway
R centerline. The FMA displays "ROLL OUT" in green, and the PFD displays the yaw bar and
R no FD bars.

SPEED CONTROL

R The autothrust, when active, controls speed. The approach speed target (VAPP) is either
R managed by the FMGS or selected by the crew :
R · When managed, the speed target is computed by the FMGS and may be modified by the
R crew through the MCDU. At 700 feet RA, the current speed target value is memorized by
R the autothrust, to ensure stabilized speed guidance, even if Flight Management fails.
R Below 700 feet, any new VAPP or WIND entry in the MCDU has no effect on the speed
R target.
R · When selected, the autothrust always targets the speed selected on the FCU.

TYPICAL ILS APPROACH



AUTOLAND WARNING LIGHT

The following situations, when occurring below 200 feet RA, with the aircraft in LAND mode, trigger the flashing AUTOLAND red warning and a triple click aural warning :

- Both APs OFF below 200 feet RA ;
- Excessive deviation in LOC (1/4 dot above 15 feet RA) or GLIDE (1 dot above 100 feet RA) In addition, LOC and GLIDE scales flash on the PFD.
- Loss of LOC signal above 15 feet, or loss of GLIDE signal above 100 feet. The FD bars flash on the PFD. The LAND mode remains engaged.
- The difference between both radio altimeter indications is greater than 15 feet.

LANDING CAPABILITIES

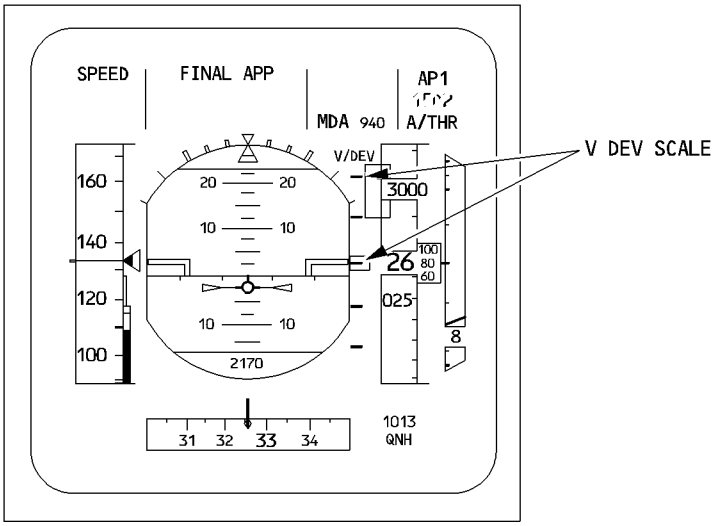
Each FMGC computes its own automatic landing capability.
The FMA displays "CAT1", "CAT 2", "CAT 3 SINGLE" or "CAT 3 DUAL" messages as soon as the APPR pushbutton is pushed in to arm ILS approach modes (Refer to 4.05.70).

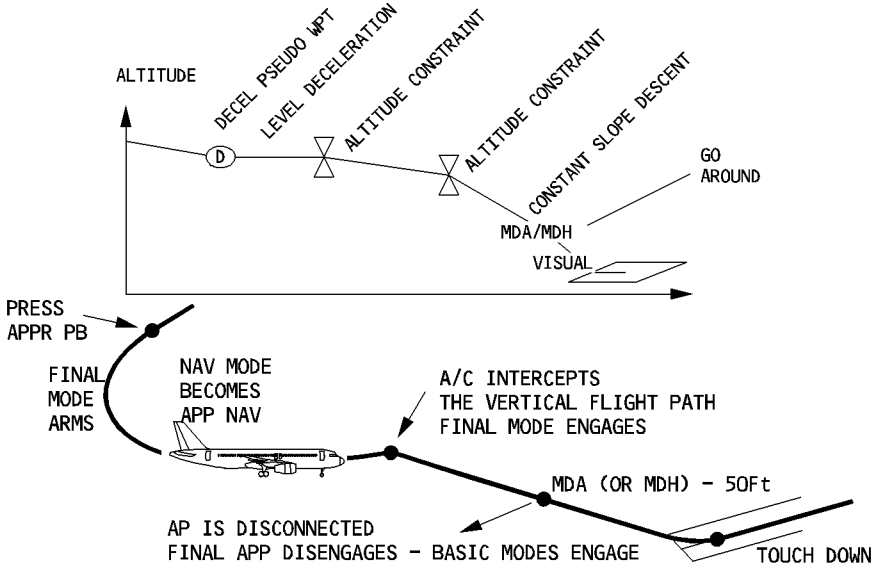
NON PRECISION APPROACH MODE

This mode guides the aircraft laterally and vertically down to the Minimum Descent Altitude (MDA) or Minimum Descent Height (MDH) along the final descent profile computed by the FMGS.

This mode is used to fly a NON ILS approach (VOR, VOR/DME, NDB, RNAV..). as inserted into the flight plan.

R





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The NON ILS approach includes the following managed modes :
APP NAV mode for lateral guidance
FINAL mode for vertical guidance

SELECTION

A NON ILS approach (VOR, VOR/DME, NDB, RNAV) is selected, if the active flight plan calls for it (and it has been inserted in that flight plan).

ARMING CONDITIONS

The pilot arms the APP NAV and FINAL modes by pressing the APPR pushbutton on the FCU, if all of the following conditions are met :
– The aircraft is above 400 feet AGL.
– The flight plan is valid (lateral and vertical profile).
– The active flight plan has selected a NON ILS approach.
– GA mode is not engaged.
The FMA displays "FINAL" and "APP NAV" in blue.
If NAV mode was already engaged, APP NAV engages immediately.

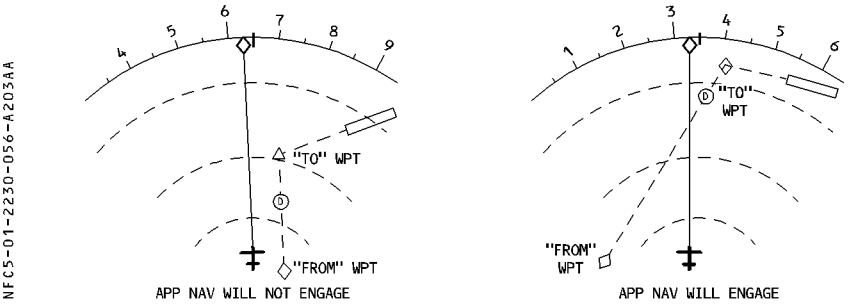
DISARMING CONDITIONS

FINAL and NAV modes are disarmed if the pilot :
– Presses the APPR pushbutton, or
– Presses the LOC pushbutton arming the LOC mode, or
– Engages the GO AROUND mode.

ENGAGEMENT CONDITIONS

APP NAV and NAV modes engage under the same conditions :
If NAV mode was engaged, APP NAV engages immediately. If HDG/TRK is engaged, APP NAV engages when the intercept conditions are met (aircraft track line must intercept the flight plan active leg).
FINAL mode engages, if :
– APPR phase is active, and the deceleration point has sequenced, and
– APP NAV is engaged, and
– Crosstrack error is less than 1.5 NM, and
– FINAL is armed, and
R – The aircraft intercepts a descending leg of the vertical flight path, or
R – In V/S (FPA) or OPEN DES, the aircraft intercepts a level-off segment of the vertical
R flight profile, with an FCU-selected altitude different from this level-off segment.

The "TO" waypoint is displayed in white on the ND and MCDU.



DISENGAGEMENT CONDITIONS

The FINAL and APP NAV modes disengage :
- If the pilot presses the APPR pushbutton (HDG V/S or TRK FPA mode engages)
- If the pilot presses the LOC pushbutton (LOC mode arms, if an ILS is selected and HDG V/S or TRK FPA mode engages).
- If the pilot pulls out the HDG TRK selector knob, the FMGS reverts to basic modes HDG V/S or TRK FPA.
- Automatically, at MDA (or MDH) – 50 feet or 400 feet AGL, if no MDA/MDH entered.
- When the GO AROUND mode engages.

Note : If the pilot engages V/S or FPA mode, only FINAL mode disengages. NAV mode remains engaged.

GUIDANCE

The FINAL mode guides the aircraft on the vertical profile down to the Minimum Descent Altitude (or the Minimum Descent Height, if the aircraft has the QFE pin program installed).
The FINAL mode :
- Displays a vertical deviation scale (± 200 feet) on the Primary Flight Display and a VDEV symbol showing deviation from descent path.
- Anticipates leaving the altitude selected by the Flight Control Unit, when the aircraft reaches the Continue Descent symbol (arrow blue on the navigation display)
- Gives precise vertical guidance on the descent and final path, with an internal vertical speed limitation to avoid excessive V/S.

If the autopilot is engaged while you are using the APP NAV/FINAL modes, it automatically disengages at MDA (or MDH) – 50 feet.
FD modes revert to basic HDG-V/S or TRK-FPA.

WARNING

If, during a non ILS approach, the GPS PRIMARY function is lost, a triple click aural warning is triggered.

GO AROUND (GA)

Go-around mode combines the speed reference system (SRS) vertical mode with the GA TRK lateral mode.

ENGAGEMENT CONDITIONS

Setting at least one thrust lever to the TOGA detent engages both SRS/GA TRK modes, if :

- The flaps lever is at least in position 1, and
- The aircraft is in flight, or
- The aircraft has been on the ground for less than 30 seconds (AP disengages and can be re-engaged five seconds after lift-off).
- FD bars are automatically restored in SRS/GA TRK modes.
  If FPV/FPD was previously selected, it reverts to FD bars.
  The FMA displays "SRS" and "GA TRK" in green.

DISENGAGEMENT CONDITIONS

- The SRS mode disengages :

R
  - Automatically, if ALT* mode engages (above 400 feet RA).
  - If the crew engages another vertical mode.
  - If the crew selects a speed while in SRS mode : SRS reverts to OP CLB mode and a triple-click aural warning is heard.

Note : The SRS mode does not automatically disengage when climbing through the GA ACC ALT. The pilot has to manually engage OP CLB mode to increase the speed target to Green Dot speed.

Note : In Engine Out conditions, the SRS mode does not automatically disengage at EO ACC ALT. Refer to Engine Out procedures.

- GA TRK disengages, when the pilot engages another lateral mode above 100 feet RA.

Note : In dual AP configuration, disengagement of the Go-around mode, on either axis, causes AP2 to disconnect.

GUIDANCE

- The SRS law maintains the current speed at Go-around engagement, or VAPP, whichever is higher. Nevertheless, the SRS speed target is limited to VLS + 25 knots, in a two-engine configuration, and VLS + 15 knots, in an engine-out configuration. When the SRS mode disengages, the target speed becomes Green Dot speed.
- GA TRK mode guides the aircraft along the current track at Go-around initiation.

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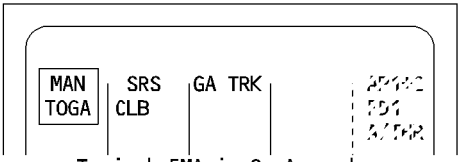


Typical FMA in Go Around

AUTOTHRUST

GENERAL

The autothrust (A/THR) is a function of the FMGS, it includes 2 independent A/THR commands, one per FMGC. Each one is able to control the thrust of both engines simultaneously through 2 engine interface units and 2 electronic engine controls (IAE engines) or 2 engine control units (CFM engines). Only one FMGC controls the active A/THR, it is called the master FMGC.

Thrust is controlled :

- automatically when the A/THR is active
- manually by the pilot.

The autothrust is active when the A/THR pushbutton of the FCU is lighted green and A/THR is displayed white in the FMA 5th column.

The position of the thrust levers determines whether A/THR is armed, active, or disconnected.

The autothrust system, when active :

- maintains a specific thrust in THRUST mode
- controls the aircraft speed or MACH in SPEED/MACH mode
- uses ALPHA FLOOR mode to set maximum thrust when the aircraft angle of attack exceeds a specific threshold.

The autothrust system can operate independently or with the AP/FD.

- When performing alone, A/THR always controls the speed.
- If the autothrust system is working with the AP/FD, the A/THR mode and AP/FD pitch modes are linked together. (Refer to 1.22.30 Interaction between AP/FD and A/THR modes).

R When autothrust is active, the FMGS commands the thrust according to the vertical
R mode logic, but uses a thrust not greater than the thrust commanded by the position of the thrust lever. For example, when the thrust levers are set at the CL (climb) detent, FG can command thrust between idle and max climb.

The autothrust system, when armed, automatically activates if the thrust levers are moved into the active range sector. Outside of this range, thrust levers control thrust directly.

THRUST LEVERS

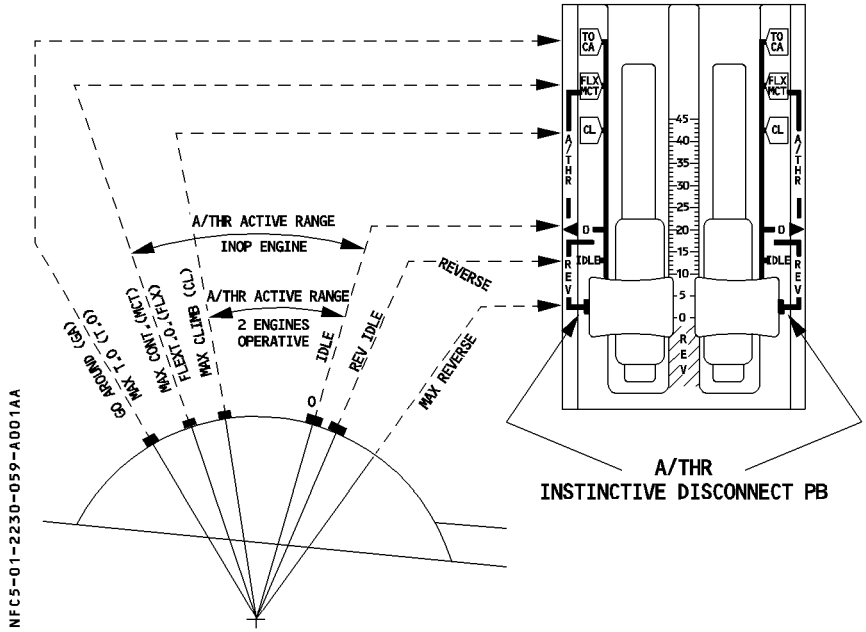
The pilot uses the thrust levers to do the following :
– Manually select engine thrust.
– Arm and activate autothrust (A/THR).
– Engage reverse thrust.
– Engage the takeoff and go around modes.

When autothrust is disconnected, the thrust levers control thrust directly : each lever position corresponds to a given thrust.

Five detents divide each of the thrust lever sectors into four segments. The detents are :

TO GA : Max takeoff thrust
FLX MCT : Max continuous thrust (or FLX at takeoff)
CL : Maximum climb thrust
IDLE : Idle thrust for both forward and reverse thrust
MAX REV : Maximum reverse thrust

When the thrust levers are at the IDLE position, the pilot can pull them up to clear the IDLE stop and select reverse thrust. (There is no reverse detent as such).



A/THR ARMING

Arming conditions of the A/THR are numerous, let's quote the most important :

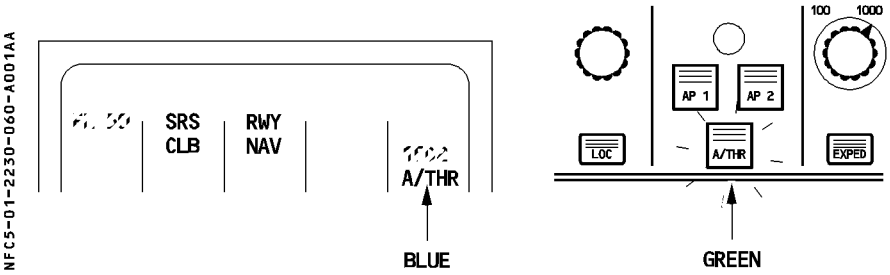
- one FMGC operative
- one FAC operative
- 2 ADIRS operative
- 2 FADECs operative
- one channel of the FCU operative
- one LGCIU operative
- A/THR is not manually disabled (instinctive disconnect pushbutton has not been pressed for more than 15 seconds).

The pilot arms A/THR :

- on the ground
  - by pushing the A/THR pushbutton on the FCU when the engines are not running or
  - by setting the thrust levers at the FLX or TOGA detent when the engines are running.
- in flight
  - by pushing the A/THR pushbutton on the FCU while the thrust levers are out of the active range or
  - while A/THR being active (A/THR white on FMA), the pilot sets both thrust levers beyond the CL detend or one above the MCT detent.
  - by engaging the go around mode.

A/THR armed is indicated by :

- illumination of A/THR pushbutton on FCU
- A/THR displayed in blue on the FMA



A/THR ACTIVATION

The A/THR is active when it controls thrust or speed. The position of the thrust lever determines the maximum thrust that the A/THR system can command (except in α-floor condition).

R The A/THR being armed, is activated :

- when the pilot sets both thrust levers between the CL and IDLE detents (two engines operative)
- R when the pilot sets one thrust lever between the MCT and IDLE detents (one engine R inoperative).

R The A/THR being disconnected, is activated when the pilot pushes the FCU pushbutton R while the thrust levers are within the active range, including IDLE position.

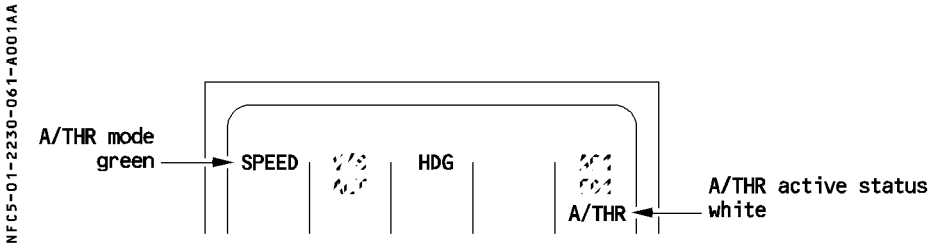
R

R *Note : When the pilot sets both thrust levers to IDLE position, the A/THR disconnects but,*
R *if the pilot pushes the A/THR pushbutton of the FCU, he will simultaneously arm and*
R *activate the autothrust. Due to the thrust levers position, IDLE thrust will be*
R *maintained.*

- when ALPHA FLOOR is activated, regardless of the initial status of A/THR and the position of the thrust levers.

When A/THR is active :

- The A/THR pushbutton on the FCU lights up.
- R The FMA displays A/THR mode in green in the first column and A/THR in white in the R fifth column.



EFFECTS OF THRUST LEVER MOVEMENT WHILE A/THR IS ACTIVE

- When both thrust levers are set above the CL detent (both engines operative) or one thrust lever is set above MCT (one engine operative) the A/THR reverts from active to armed. "A/THR" turns to blue on the FMA and the thrust levers control the thrust directly. The FMA displays "MAN THR" white in its first column.
  The thrust levers provide the crew with an immediate increase of thrust when both thrust levers are pushed above the CL detent (2 engines) or the active thrust lever above the MCT detent (one engine operative).
- When both thrust levers are set below the CL detent (both engines operative) or one thrust lever is set below MCT (one engine operative), a repeating warning (amber caution, single chime, ECAM message "A/THR LIMITED") is activated every 5 seconds until the pilot moves the lever back into the detent. "THR LVR" green is displayed on the FMA
  "LVR CLB" (both engines operative) or "LVR MCT" (one engine operative) flashes white in the first column of the FMA.
  This device reminds the crew that the normal operating position of the thrust levers, when A/THR is active, is the CL detent (2 engines) or the MCT detent (one engine operative).
- When one thrust lever is in the CL detent and the other one out of the detent, the "LVR ASYM" amber message comes up until both levers are set in the CL detent (only with both engines operative).

A/THR DISCONNECT

When the A/THR is disconnected, it is neither armed nor active.
The A/THR can be disconnected in two ways :

* Standard disconnection
  - The pilot pushes the instinctive disconnect pushbutton on the thrust levers (which immediately sets the thrust corresponding to the lever positions) or
  - The pilot sets both thrust levers to IDLE detent.
* Non-standard disconnection
  - The pilot pushes the A/THR pushbutton on the FCU while A/THR is armed/active, or
  - The system loses one of the arming conditions.

R **Below 100 feet radio altitude**
R When the radio altitude is below 100 feet and the pilot sets both thrust levers above the
R CL detent or one above the MCT detent, the autothrust will disconnect. It will rearm
R automatically when at least one of the thrust levers is set to TOGA.
R If the PF sets the thrust levers slightly above CL detent but below TOGA and come back
R to CL detent, the A/THR will disconnect and remain disconnected. As a result, the thrust
R will increase up to CLIMB thrust. The crew has to manually set the appropriate thrust for
R landing (or go around).

CAUTION

If the pilot pushes and holds one instinctive disconnect pushbutton for more than 15 seconds, the A/THR system is disconnected for the remainder of the flight. All A/THR functions including ALPHA FLOOR are lost, and they can be recovered only at the next FMGC power-up (on ground).

THRUST LOCK FUNCTION

The THRUST LOCK function is activated when the thrust levers are in the CL detent (or the MCT detent with one engine out) and the pilot pushes the A/THR pushbutton on the FCU or the A/THR disconnects due to a failure.

– "THR LK" flashes amber on the FMA.
– ECAM "ENG THRUST LOCKED" flashes every five seconds.
– ECAM displays "THR LEVERS..... MOVE"
– A single chime sounds and the Master Caution Light flashes every five seconds.

The thrust is locked at its level prior to disconnection. Moving the thrust levers out of CL or MCT suppresses the thrust lock and gives the pilot manual control with the thrust levers. All warnings cease when the pilot moves the thrust levers out of the detent.

A/THR DISCONNECT CAUTION

		A/THR DISCONNECTION	
		BY INSTINCTIVE DISCONNECT OR SETTING TWO LEVERS TO IDLE (if above 50 ft RA)	**BY OTHER MEANS**
CONSEQUENCE	MASTER CAUTION	illuminated-3 sec max	illuminated
	ECAM MESSAGE	amber A/THR OFF message 9 sec maximum	Flashing "ENG THRUST LOCKED" (amber AUTO FLT A/THR OFF THR LEVERS..... MOVE (blue)
	AUDIO	single chime	single chime
	CLR pushbutton on ECAM CONTROL PANEL	extinguished	illuminated
ACTION	MASTER CAUTION pushbutton	extinguishes MASTER CAUTION light erases ECAM message	extinguishes MASTER CAUTION light
	CLR puhbutton on ECAM CONTROL PANEL	No effect	extinguishes MC light and CLR pushbutton, erases ECAM message calls status
	INSTINCTIVE DISCONNECT pushbutton	extinguishes MASTER CAUTION light erases ECAM message	extinguishes MASTER CAUTION light
ECAM STATUS MESSAGE		NO	YES

R – Standard disconnection triggers temporary ECAM message and caution light. Single
R chime sounds.
R – Non standard disconnection triggers caution light and ECAM message removed only by
R a pilot action. Single chime sounds.

A/THR MODES

Except in takeoff and go around situations, normal operation of the A/THR system requires the thrust levers to be :

- In the CL detent for the two-engine configuration. If they are not set in the CL detent, "LVR CLB" flashes white on the FMA.
- In MCT detent when in the one-engine-out configuration. If the appropriate lever is not set in the MCT detent, "LVR MCT" flashes white on the FMA.

The A/THR modes are selected automatically in conjunction with the AP/FD modes (except for ALPHA FLOOR).

A/THR in THRUST mode	AP/FD pitch mode maintains the speed : OP CLB - OP DES - CLB - EXP CLB◁ - EXP DES◁ - SRS - FLARE and DES (IDLE path)
A/THR in SPEED/MACH mode	If neither AP nor FD is engaged
	If AP/FD controls a vertical path V/S-FPA-ALT*- ALT CST*-ALT-ALT CRZ-G/S* -G/S-FINAL and DES (geometric path)
A/THR in RETARD mode	Automatic landing (AP engaged in LAND mode).

THRUST mode

- In THRUST mode, autothrust commands a specific thrust level in conjunction with the AP/FD pitch mode. This thrust level is limited by thrust lever position.

FMA display	Meaning
THR MCT	Single engine thrust in climb. The live engine is at maximum continuous thrust (thrust lever in MCT detent)
THR CLB	Climb thrust two engine configuration (at least one thrust lever in the CL detent, the other one below CL)
THR LVR	Undetermined thrust (neither CLB or MCT thrust)
THR IDLE	Minimum thrust (both engines at IDLE thrust)

Note : When the A/THR is armed for takeoff or go around, the FMA displays "MAN TOGA" (or "MAN FLX") in white to remind the crew that the thrust levers have been positioned properly.

RETARD MODE

The RETARD mode is only available during automatic landing (AP engaged in LAND mode). At approximately 40 feet RA, the RETARD mode engages and remains engaged after touchdown. The A/THR commands IDLE thrust during the flare, and the FMA and engine warning display "IDLE". If the autopilot is disengaged during the flare before touchdown, the SPEED mode replaces the RETARD mode, and the pilot has to manually reduce thrust.

Note : In an automatic landing, the system generates a "RETARD" callout at 10 feet radioaltitude (RA), which prompts the pilot to move the thrust levers to IDLE in order to confirm thrust reduction. In manual landing conditions, the system generates this callout at 20 feet RA, as a reminder.

ALPHA FLOOR

ALPHA FLOOR is a protection that commands TOGA thrust, regardless of the thrust levers' positions. This protection is available from lift-off to 100 feet RA on approach.
ALPHA FLOOR calls up the following indications :
- "A FLOOR" in green, surrounded by a flashing amber box on the FMA, and in amber on the engine warning display, (as long as α-floor conditions are met).
- "TOGA LK" in green, surrounded by a flashing amber box on the FMA, when the aircraft leaves the α-floor conditions. TOGA thrust is frozen.

To cancel ALPHA FLOOR or TOGA LK thrust, the pilot must disconnect the autothrust.

SPEED/MACH mode

In SPEED/MACH mode, the A/THR adjusts the thrust in order to acquire and hold a speed or Mach target.
The speed or Mach target may be :
- Selected on the FCU by the pilot.
- Managed by the FMGC.

When in SPD/MACH mode, the A/THR does not allow speed excursions beyond the following limits, regardless of the target speed or Mach number :
- For a selected speed target, the limits are VLS and VMAX (VMO-MMO, VFE-VLE, whichever applies).
- For a managed speed target, the limits are maneuvering speed (Green Dot, S, F, whichever applies) and maximum speed (340/.80-VFE-VLE, whichever applies).

The changeover from SPEED to MACH mode is either automatic, performed by the FMGC, or manual, with the pilot pushing the SPD/MACH changeover pushbutton.
The FMA displays "SPEED" or "MACH".

Approach autothrust :

R Below 3200 feet radioaltitude, with at least CONF 1, the A/THR logic is modified to be more responsive to speed variation. This is referred to as approach autothrust.

SPEED MODE IN APPROACH PHASE

When the aircraft flies an approach in managed speed, the speed target displayed on the PFD in magenta, is variable during the approach.
This managed speed target is computed in the FMGS, using the "ground speed mini function".

GROUND SPEED MINI FUNCTION PRINCIPLE

The purpose of the ground speed mini function is to take advantage of the aircraft inertia, when the wind conditions vary during the approach. It does so by providing the crew with an adequate indicated speed target. When the aircraft flies this indicated speed target, the energy of the aircraft is maintained above a minimum level ensuring standard aerodynamic margins versus stall.
If the A/THR is active in SPEED mode, it will automatically follow the IAS target, ensuring an efficient thrust management during the approach.
The minimum energy level is the energy level the aircraft will have at touchdown, if it lands at VAPP speed with the tower reported wind as inserted in the PERF APPR page.
The minimum energy level is represented by the Ground Speed the aircraft will have at touchdown. This Ground Speed is called "GROUND SPD MINI".
During the approach, the FMGS continuously computes the speed target, using the wind experienced by the aircraft, in order to keep the ground speed at or above the "Ground Speed Mini".
The lowest speed target is limited to VAPP and its upper limit is VFE of next configuration in CONF 1, 2, 3 and VFE - 5 in CONF FULL.
The speed target is displayed on the PFD speed scale in magenta, when approach phase and managed speed are active. It is independent of the AP/FD and/or ATHR engagements.
Wind is a key factor in the ground speed mini function.

TWR WIND

It is the MAG WIND entered in the PERF approach page. It is the average wind, as provided by the ATIS or the tower. Gusts must not be inserted, they are included in the ground speed mini computation.

TWR HEADWIND COMPONENT

The TWR HEADWIND COMPONENT is the component of the MAG WIND projected on the runway axis (landing runway entered in the flight plan). It is used to compute VAPP and GS mini.

CURRENT HEADWIND COMPONENT

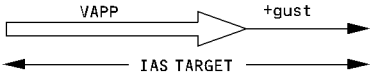
The actual wind measured by ADIRS is projected on the aircraft axis to define the CURRENT HEADWIND COMPONENT (instantaneous headwind). The CURRENT HEADWIND COMPONENT is used to compute the variable speed target during final (IAS target).

VAPP COMPUTATION

VAPP, automatically displayed on the MCDU PERF APPR page, is computed as follows :
VAPP = VLS + 1/3 of the TWR HEADWIND COMPONENT or
VAPP = VLS + 5 knots, which ever is highest.
"1/3 of the TWR HEADWIND COMPONENT" has 2 limits :
– 0 knots as the minimum value (no wind, or tailwind)
– + 15 knots as the maximum value.
The crew can manually modify the VAPP and TWR wind values on the PERF APPR page.

SPEED TARGET COMPUTATION

The FMGS continuously computes a speed target (IAS target), that is the MCDU VAPP value plus an additional variable gust.



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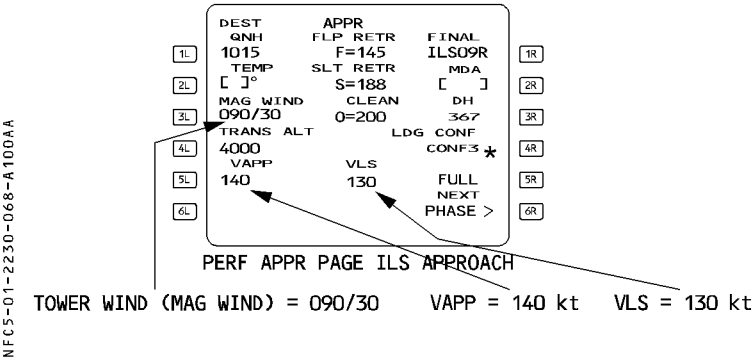
The gust is the instantaneous difference between the CURRENT HEADWIND COMPONENT and the TWR HEADWIND COMPONENT. It is always positive (or equal to zero for no wind or tailwind). The IAS target is displayed on the PFD as a magenta triangle moving with the gust variation. The IAS targets have 2 limits :
– VAPP as the minimum value
R – VFE – 5 kts in CONF FULL, or VFE of the next configuration in CONF 1, 2 or 3 as the maximum value.

GROUND SPEED MINI (GS mini) COMPUTATION

Ground speed mini concept has been defined to prevent the aircraft energy from dropping below a minimum level during final approach. The GS mini value is not displayed to the crew.

EXAMPLE

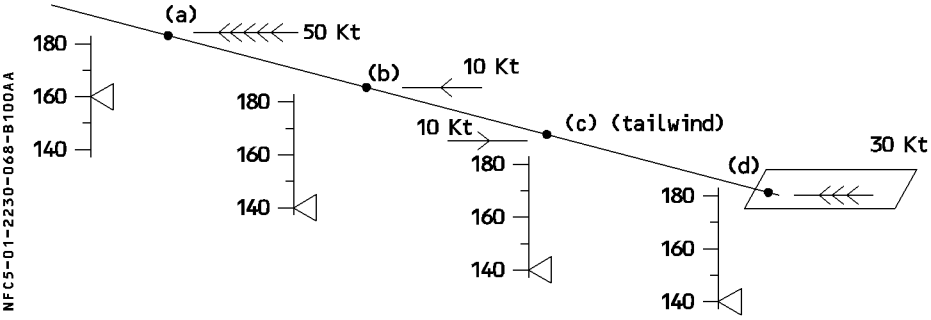
R Approach on runway 09
R The tower wind direction is on the runway axis.
R



R IAS TARGET VALUES

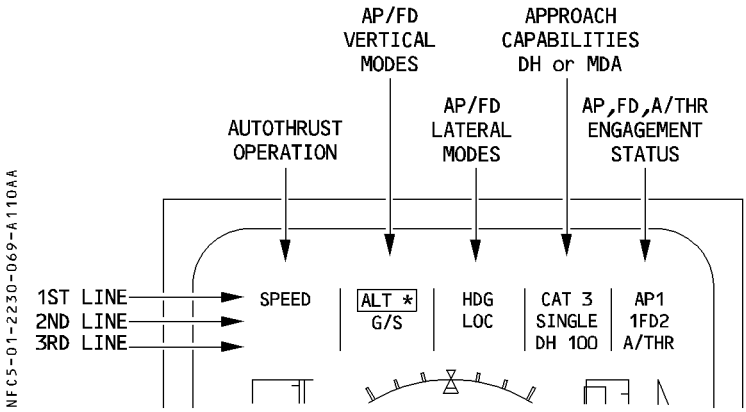
R If we turn the previously explained speed target definition into formulae, we obtain the
R following result :
IAS TARGET = Max [VAPP, (VAPP + CURRENT HEADWIND - TWR HEADWIND)]

Current wind in approach	IAS target
(a) 090/50	Max [VAPP, (140 + 50 - 30) = 160 kt
(b) 090/10	Max [VAPP, (140 + 10 - 30) = 140 kt
(c) 270/10	Max [VAPP, (140 + 0 - 30) = 140 kt
(d) 090/30	Max [VAPP, (140 + 30 - 30) = 140 kt



FLIGHT MODE ANNUNCIATOR (FMA)

The Flight Mode Annunciator (FMA), located on the top of the PFDs, reflects the status of the A/THR, the AP/FD vertical and lateral modes, the approach capabilities, and the AP/FD-A/THR engagement status.
A white box is displayed for 10 seconds around each new annunciation. The white box display time may be increased to 15 seconds in some mode reversion cases associated with an aural triple click.



In the three left columns :
The engaged modes are displayed in green on the first line.
The armed modes are displayed in blue, or in magenta, on the second line.
Modes, armed due to a constraint, are displayed in magenta.
Special messages, are displayed on the third line :
– First priority is given to messages related to flight controls :
  · MAN PITCH TRIM ONLY flashes red for 9 seconds, then remains steady.
  · USE MAN PITCH TRIM pulses amber for 9 seconds, then remains steady.
– Lower priority messages related to FMGS.

In the fourth column, approach capabilities are displayed in white.
DH or MDA/MDH is displayed in blue.

In the right column, AP, FD, A/THR engagement status are displayed in white.
FD is boxed for 10 seconds, in case of automatic FMGC switching.
When armed, A/THR is displayed blue.

Note : The FMGS synchronizes A/THR mode, AP/FD modes, and landing capability to provide identical information on both PFDs.

AUTO THRUST ANNUNCIATIONS (FMA COLUMN 1)

First line

R

DISPLAY	COLOR	MEANING
MAN TOGA	White White box	A/THR is armed, at least one thrust lever is in TOGA detent.
MAN FLX XX	White White box blue numbers	A/THR is armed, at least one thrust lever is in MCT/FLX detent, with FLX TO temp set at XX°. The other thrust lever is at, or below, the MCT/FLX detent.
MAN MCT	White White box	A/THR is armed, at least one thrust lever is in the MCT/FLX detent, the other is at, or below, this detent.
MAN THR	White Amber box	A/THR is armed, and the most advanced thrust lever is above CL detent (2 engines operative, or one above MCT/FLX (engine-out) and not in a detent.
THR MCT	Green	A/THR is active in thrust mode and the most advanced thrust lever is in the MCT/FLX detent (engine-out).
THR CLB	Green	A/THR is active in thrust mode, and the most advanced thrust lever is in the CL detent.
THR IDLE	Green	A/THR is active in thrust mode and commands idle thrust.
THR LVR	Green	A/THR is active in thrust mode with both thrust levers below CL detent, or the live thrust lever (1 engine) below MCT.
SPEED or MACH	Green	A/THR is active in SPEED or MACH mode.
A. FLOOR	Green Amber box	A/THR is active and commands TOGA thrust, while α FLOOR conditions are met.
TOGA LK	Green Amber box	A/THR is active and TOGA thrust is locked (α FLOOR conditions are no longer met).

Third line

DISPLAY	COLOR	MEANING
LVR CLB (flashing)	White	Request to set the thrust levers in CL detent.
LVR MCT (flashing)	White	Request to set the live thrust lever in MCT/FLX detent.
LVR ASYM	Amber	(2 engines only). One thrust lever is in CL or MCT/FLX detent, and the other one is not in this detent.
THR LK (flashing)	Amber	After A/THR disconnection (pilot's action on FCU or failure) resulting in thrust being frozen. Both thrust levers being in CL detent, or one in MCT/FLX (engine-out) detent.

Note : The amber caution light flashes and a single chime sounds every five seconds, as long as the pilot takes no appropriate action in the following cases :
- *THR LK*
- *LVR CLB (if the thrust levers are below the CLB detent).*
- *LVR MCT (if the thrust levers are below the FLX/MCT detent).*

AP/FD VERTICAL MODES (FMA COLUMN 2)

First line

DISPLAY	COLOR	MEANING
SRS	Green	Takeoff or go-around mode is engaged.
CLB	Green	Climb mode is engaged. The FMGS target altitude is higher than the actual altitude. ALT CSTR are taken into account.
OP CLB	Green	Open Climb mode is engaged. The FCU-selected altitude is higher than the actual altitude. ALT CSTR are disregarded.
EXP CLB	Green	Expedite Climb is engaged. The selected altitude is higher than the actual altitude. Green dot is maintained, ALT CSTR are disregarded.
ALT* or ALT CST*	Green	ALT CAPTURE is engaged. – ALT* green, in case of FCU-selected altitude capture. – ALT CST* green, in case of ALT CSTR capture (vertical profile)
ALT or ALT CST	Green	ALTITUDE HOLD mode is engaged. – ALT is green, when the FCU-selected altitude is held. – ALT CST is green, when an ALT CSTR is held (vertical profile)
ALT CRZ	Green	ALT mode is engaged and CRZ FL is held.
DES	Green	Descent mode is engaged. The FMGS target altitude is lower than the actual altitude. ALT CSTR are taken into account.
OP DES	Green	Open Descent mode is engaged. The FCU-selected altitude is lower than the actual altitude. ALT CSTR are disregarded.
EXP DES	Green	Expedite descent is engaged, the selected altitude is lower than the actual altitude. Mach. 0.80 or 340 knots is maintained ALT CSTR are disregarded.
G/S*	Green	Glide Slope capture mode is engaged.
G/S	Green	Glide Slope mode is engaged.
V/S ± XXXX	Green + blue numbers	Vertical speed mode is engaged to acquire and hold the V/S selected on the FCU. ALT CSTR are disregarded. If the aircraft reaches VLS or VMAX and cannot maintain the target, the indication is boxed amber and flashes, and the target pulses.
FPA ± XX	Green + blue numbers	Flight Path Angle mode is engaged to acquire and hold the FPA selected on the FCU. ALT CSTR are disregarded. If the aircraft reaches VLS or VMAX and cannot maintain the target, the indication is boxed amber and flashes, and the target pulses.

AP/FD VERTICAL MODE (FMA COLUMN 2)

Second line

DISPLAY	COLOR	MEANING
CLB	Blue	Climb mode is armed.
ALT	Blue or Magenta	Altitude mode is armed. – blue when the target altitude is the FCU selected altitude – magenta when the target altitude is an ALT CSTR.
DES	Blue	Descent mode is armed before the descent phase.
G/S	Blue	Glide Slope mode is armed.
FINAL	Blue	Final descent mode is armed.
ALT G/S	Blue/Blue	ALT and G/S modes are armed.
ALT G/S	Magenta/ Blue	ALT CSTR and G/S modes are armed.
ALT FINAL	Blue/Blue	ALT and FINAL modes are armed.
ALT FINAL	Magenta/ Blue	ALT CSTR and FINAL modes are armed.
DES G/S	Blue/Blue	DES and G/S modes are armed.
DES FINAL	Blue/Blue	DES and FINAL modes are armed.

Third line

DISPLAY	COLOR	MEANING
SPEED SEL : XXX	Blue	Indicates a preset speed associated with the cruise or climb phase
MACH SEL : .XX	Blue	Indicates a preset Mach associated with the cruise or climb phase

Note : These two messages use both the first and second columns (third line).

AP/FD LATERAL MODES (FMA COLUMN 3)

First line

DISPLAY	COLOR	MEANING
RWY	Green	RWY mode is engaged.
RWY TRK	Green	RWY mode is engaged once airborne at or above 30 feet RA.
HDG	Green	HEADING mode is engaged.
TRACK	Green	TRACK mode is engaged.
NAV	Green	NAV mode is engaged to guide the aircraft along the FM lateral F-PLN.
LOC*	Green	LOC capture mode is engaged.
LOC	Green	LOC track mode is engaged.
APP NAV	Green	NAV mode is engaged during a NON ILS approach.
GA TRK	Green	GO AROUND track mode is engaged.

Second line

DISPLAY	COLOR	MEANING
NAV	Blue	NAV mode is armed.
LOC	Blue	LOC mode is armed.
APP NAV	Blue	NAV mode is armed for a NON ILS approach.

AP/FD COMMON MODES (FMA COLUMN 2 AND 3)

DISPLAY	COLOR	MEANING
LAND	Green	Land mode is engaged below 400 feet RA.
FLARE	Green	Flare mode is engaged.
ROLL OUT	Green	Roll out mode is engaged.
FINAL APP	Green	APP NAV and Final modes are engaged during a NON ILS approach.

APPROACH CAPABILITIES (FMA COLUMN 4)

First line

DISPLAY	COLOR	MEANING
CAT 1	White	CAT 1 capability available
CAT 2	White	CAT 2 capability available
CAT 3	White	CAT 3 capability available

Second line

DISPLAY	COLOR	MEANING
SINGLE	White	CAT 3 capability available, with FAIL PASSIVE condition.
DUAL	White	CAT 3 capability available, with FAIL OPERATIONAL condition.

Third line

DISPLAY	COLOR	MEANING
MDA/MDH XXXX	White Blue	Minimum descent altitude or minimum descent height as inserted by the pilot on PERF APPR page.
DH XXX NO DH	White/Blue White	Decision height as inserted by the pilot on PERF APPR page. NO DH : when NO inserted on PERF APPR page.

AP/FD - A/THR ENGAGEMENT STATUS (FMA COLUMN 5)

First line

DISPLAY	COLOR	MEANING
AP 1 + 2	White	Autopilot 1 and 2 are engaged.
AP 1	White	Autopilot 1 is engaged.
AP 2	White	Autopilot 2 is engaged.

Second line

DISPLAY	COLOR	MEANING
X FD Y	White	X and Y give the FD engagement status on PFD1 and PFD2. X and Y can be 1, 2, –. – : no FD is engaged on the corresponding PFD 1 : FD1 is engaged on the corresponding PFD 2 : FD2 is engaged on the corresponding PFD e.g. : the normal status (FD 1 and 2 engaged) is 1FD2.

Third line

DISPLAY	COLOR	MEANING
A/THR	White	A/THR is active.
A/THR	Blue	A/THR is armed.

SPECIAL MESSAGES (FMA COLUMNS 2 AND 3)

The third line displays three types of messages :
- It gives first priority to flight control messages ;
- It gives second priority to vertical Flight Management messages ;
- It gives last priority to EFIS reconfiguration messages.

DISPLAY	COLOR	MEANING
MAN PITCH TRIM ONLY	Red	Displayed in case of L + R elevator loss.
USE MAN PITCH TRIM	Amber	F/CTL are in direct law.
CHECK APP SEL	White	The aircraft is in cruise at less than 100 NM from the Top of Descent, or in descent, or in approach and : – A non ILS approach has been selected. – An ILS frequency is tuned on the RAD NAV page.
SET MANAGED SPD	White	The SPEED target is selected, but a preselected SPEED does not exist for the next flight phase.
SET GREEN DOT SPD	White	The aircraft is in Engine-Out mode, and the SPEED target is selected. This message is displayed, if the FCU-selected speed is : ≤ Green Dot –10 knots, or ≥ Green Dot + 10 knots except in ALT*, ALT mode
SET HOLD SPD	White	The aircraft is in selected SPEED control, a Holding pattern is inserted in the F-PLN, and the aircraft is 30 seconds before the deceleration point to the precomputed HOLD SPEED.
DECELERATE	White	This message is displayed, if the thrust is not reduced when passing the top of descent, and the aircraft is above the descent profile.
MORE DRAG	White	DES mode is engaged, idle is selected, and : – Either the aircraft is above the vertical profile and the predicted intercept point of the theoretical profile is at less than 2 NM from the next ALT CSTR, or – In auto speed control and the aircraft enters a speedbrake decelerating segment.

GENERAL

The aircraft has two flight augmentation computers (FACs) that perform four main functions:

- Yaw function
  - Yaw damping and turn coordination
  - Rudder trim
  - Rudder travel limitation
- Flight envelope function
  - PFD speed scale management
    - Minimum/maximum speed computation
    - Maneuvering speed computation
  - Alpha-floor protection
- Low-Energy Warning function ◁
- Windshear detection function ◁

In performing these functions the FAC uses independent channels :

Yaw damper
Rudder trim
Rudder travel limit
Flight envelope

Each FAC interfaces with the elevator aileron computers (ELACs) when the APs are disengaged, or with the FMGS when at least one AP is engaged.

Both FACs engage automatically at power-up.

The pilot can disengage or reset each FAC (in case of failure) by means of a pushbutton on the flight control overhead panel.

When a FAC is disengaged (FAC pushbutton set off) but still valid, the flight envelope function of the FAC remains active.

R If both FACs are valid, FAC1 controls the yaw damper, turn coordination, rudder trim, and rudder travel limit, and FAC2 is in standby.

FAC1 keeps the aircraft within the flight envelope through FD1 ; FAC2 performs this function through FD2.

If a failure is detected on any channel of FAC1, FAC2 takes over the corresponding channel.

YAW FUNCTIONS

YAW DAMPING

Yaw damping stabilizes the aircraft in yaw and coordinates its turns.

R In automatic flight (AP engaged) during takeoff and go around, it assists rudder application after an engine failure (short-term yaw compensation).

Note : When the AP is engaged, the FMGS sends orders to the FAC to give :
- *yaw damping during approach*
- *yaw control for runway alignment in ROLL OUT mode*

RUDDER TRIM

The rudder trim function :

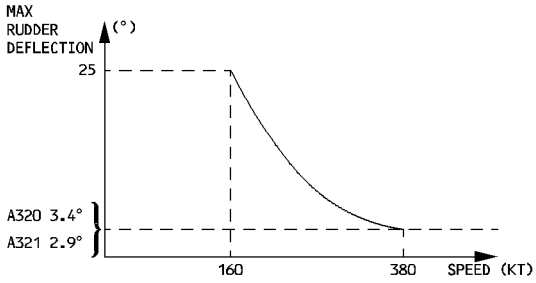
- Executes trim orders the pilot enters with the manual trim knob
- When AP is engaged
  - executes trim orders from the FMGS.
  - Assists the system in recovering from engine failure (long-term yaw compensation) in all flight guidance modes.
  - If the pilot pushes the rudder more than 10° out of trim, it disengages the AP.

Note : When the AP is engaged, the rudder trim knob is inoperative : the master FMGC sends rudder trim orders to the FAC.

RUDDER TRAVEL LIMITATION

This function limits rudder deflection as a function of speed in order to avoid high structural loads. It is governed by the following law :

R



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If both FACs lose the rudder travel limitation function, the value of the rudder deflection limit is locked at the time of the second failure.
When the slats are extended, the FACs automatically set the rudder deflection limit at the low-speed setting (maximum authorized deflection).

FLIGHT ENVELOPE FUNCTION

As long as one Flight Augmentation Computer (FAC) is valid, it governs the flight envelope function, the rudder position display, and the rudder trim indication regardless of what the pilot does with the FAC pushbutton.

PFD SPEED SCALE MANAGEMENT

The FAC controls the speed scale on the PFD. (Refer to 1.31)
When both FACs are operative, FAC1 supplies data to PFD1 and FAC2 supplies it to PFD2.
The FAC computes :

- The minimum and maximum speeds :
  - VSW (stall warning)
  - VLS
  - VFE and VFE for the next configuration
  - VLE
  - VMO/MMO
- The maneuvering speeds :
  - Green Dot Speed
  - S speed
  - F speed

  (Refer to 3.04.10 for speed definition).

The FAC also computes the speed trend and displays it as an arrow on the PFD speed scale.
The PFD displays these various speeds as appropriate, and they also go to the FMGC to be used as limits for various guidance modes

Note : The principle of the speed computation is as follows :

R *- First, the FAC computes VS1G (stall speed). From VS1G it computes the gross*
R *weight which is also sent to the Elevator Aileron computers :*
  - *When the aircraft is below 14500 feet and 250 knots, it computes this from current angle of attack, speed/Mach, altitude, thrust, and CG.*
  - *When the aircraft is above 14500 feet or 250 knots, it computes this out of the GW, which it has memorized and updated with a fuel consumption model set in the FAC.*
- *Finally the FAC computes the various minimum and maneuvering speeds, Vα prot and Vsn.*
- *The accuracies of the various minimum and maximum speeds are functions of the accuracy with which the FAC computes aircraft gross weight. Normal accuracy for VLS in CONFIG FULL is about ± 3 kt.*

ALPHA-FLOOR PROTECTION

Alpha-floor protection automatically sets the thrust at TOGA thrust, when the aircraft reaches a very high angle of attack.
The Flight Augmentation Computer (FAC) generates the signal that triggers the alpha-floor mode. This, in turn, sets TOGA thrust on the engines, regardless of the thrust lever positions (Refer to 1.22.30 A/THR modes).
The FAC sends this signal when the angle of attack is above a predetermined threshold, that is a function of the configuration.
In CONF3 and CONF FULL, this threshold decreases as a function of the aircraft deceleration rate (down to – 3°).
Alpha-floor is available from lift-off until the aircraft reaches 100 feet RA in approach.

Note : – Alpha-floor is lost, when one of the following combinations of failures occurs :
SFCC1 and FAC2, or
SFCC2 and FAC1, or
Both FCU channels, or
1 EIU, or
Both FMGCs.
– Alpha-floor is lost under alternate or direct flight control law.
R *– Alpha-floor is lost in engine-out, when slats/flaps are extended.*

LOW-ENERGY WARNING

An aural low-energy "SPEED SPEED SPEED" warning, repeated every five seconds, warns the pilot that the aircraft's energy level is going below a threshold under which he will have to increase thrust, in order to regain a positive flight path angle through pitch control.
It is available in Configuration 2, 3, and FULL. The FAC computes the energy level with the following inputs :
– Aircraft configuration
– Horizontal deceleration rate
– Flight path angle
The warning is inhibited when :
– TOGA is selected, or
– Below 100 feet RA, or
– Above 2000 feet RA, or
– Alpha floor, or the ground proximity warning system alert is triggered, or
– In alternate or direct law, or
– If both radio altimeters fail.
During deceleration, the low-energy warning is triggered before alpha floor (unless alpha floor is triggered by stick deflection). The amount of time between the two warnings depends on the deceleration rate.

WINDSHEAR DETECTION FUNCTION

Whenever a flight augmentation computer (FAC) detects windshear conditions, it triggers a warning :

- "WINDSHEAR" in red on both PFDs (for at least 15 seconds)
- an aural warning, "windshear", repeated three times

The windshear detection function is operative during takeoff and during approach, as follows:

- at takeoff, from lift-off up to 1300 feet
- during approach, from 1300 feet to 50 feet

R In both situations, the aircraft must be in configuration 1, 2, 3 or FULL.

WINDSHEAR DETECTION PRINCIPLES

The FACs generate the windshear warning whenever the predicted energy level for the aircraft falls below a predetermined threshold.
In computing this energy level prediction, the FACs use data from different sources. From ADIRS comes data such as vertical speed, air and ground speeds and slope ; from other sources come such derived parameters as total slope, longitudinal wind gradient, and vertical wind.
The FACs express this energy level as an angle of attack and compare it with an angle-of-attack threshold above which windshear conditions are most likely and pilot action is required.

GUIDANCE

In windshear conditions, flight guidance acts on specially adapted FD pitch orders received from the speed reference system (SRS). The pilot must set go around thrust immediately (which also triggers the FD SRS mode), and follow the pitch order to execute the optimum escape maneuver.

CONTROLS AND INDICATORS

FAC ENGAGEMENT

See 1.27 FLIGHT CONTROL CHAPTER

RUDDER TRIM OPERATION

See 1.27 FLIGHT CONTROL CHAPTER

GENERAL

The FMS ACARS function gives an interface between a ground station and one onboard FMGC, allowing data transmission between these two computers via the ACARS Management Unit.
Two different sets of message can be exchanged :
UPLINK messages from the ground station. They consist in reception of data requested or directly sent to the crew.
DOWNLINK messages from the FMGC (master). They consist in reports or requests sent to the ground station.
The FMGS/ACARS interface enables the following ACARS capabilities.
– F-PLN initialization (flight plan and performance data)
– Takeoff data
– Wind data
– Flight reports
– Broadcast data
Crews can send message using ACARS function pages or relevant MCDU pages.
Only one FMGC talks to the ground station. This FMGC is called FMGC "master".

GENERAL SCRATCHPAD MESSAGES

NOT XMITTED TO ACARS : A crew request or report was sent to the ground but the communication was not established or not acknowledged.

NO ANSWER TO REQUEST : A crew request was previously sent to the ground and no answer (uplink message) was received within 4 minutes.

FLIGHT PLAN INITIALIZATION FUNCTION

This function enables lateral and vertical flight plan data as well as performance data to be exchanged between the aircraft and a ground station. The aircraft may send flight plan requests for active and secondary flight plan. (downlink messages). The ground station may send flight plan and performance data (uplink messages) either under aircraft request or automatically without any request.

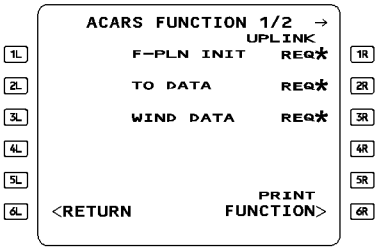
Each uplink message concerns either the active or secondary flight plan but never both flight plans at the same time. The data sent to the aircraft are checked for flight plan consistency.

A MCDU message comes up when an uplink message is received. "ACT (or SEC) RTE UPLINK".

If an error prevents the decodind process of the message, "INVALID RTE UPLINK" is displayed on MCDUs.

Au uplink message can be routed to the active flight plan if no engine is started and no active flight plan exists. Otherwise, it is routed to the secondary. The crew will insert it into the secondary flight plan or will reject it using the CLR key.

Note : The flight plan may also be initialized using the ACARS function page selected from DATA INDEX page.



ACARS FUNCTION PAGE 1
(FROM DATA INDEX)

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PERFORMANCE DATA

On ground and before engine start, the ground station may also send performance data to the aircraft.
Performance data are always associated with the uplink flight plan. It is either automatically inserted with the active flight plan data, or stored in the secondary with the corresponding flight plan.
This message contains part or all of the following data :
ZFW, ZFWCG, taxi fuel, block fuel, cruise flight level, tropopause altitude, cruise temperature, transition altitude, cost index, performance factor.

Note : After engine start an uplink performance data message is rejected automatically without any scratchpad message.

SCRATCHPAD MESSAGES RELATED TO FLIGHT PLAN AND PERFORMANCE

INVALID RTE UPLINK	An error is detected, the uplink message is rejected.
ACT or SEC RTE UPLINK	A F-PLN is stored in the active or secondary flight plan.
FLT NUMBER UPLINK	FLT NBR has been initialized within a F-PLN message without previous request.
CHECK FLT NUMBER	The uplinked FLT NBR differs from the one specified in the request.
CHECK CO RTE	The uplinked CO RTE ident differs from the one specified in the request.
INVALID FLT NBR UPLINK	The uplink contains a valid F-PLN but the FLT NBR is invalid.
PERF DATA UPLINK	Performance data is received
INVALID PERF UPLINK	Performance uplink message has been rejected
RTE DATALINK IN PROG	A flight plan modification is performed after a F-PLN INIT request has been sent ; this message is displayed until the uplink is received.
UPLINK INSERT IN PROG	This message is displayed during insertion of a Flight Plan.

TAKEOFF DATA FUNCTION

The takeoff data function is available for the active flight plan only. It is used to request to the ground station, information data for up to 2 runways and to receive this data for up to 4 runways.

The crew sends a request indicating the departure airport, runway idents, CG, GW and weather conditions (such as baro setting wind, temperature...). In response he receives the takeoff speeds for up to 4 runways but only one set of data may be inserted in the active flight plan for the selected active runway.

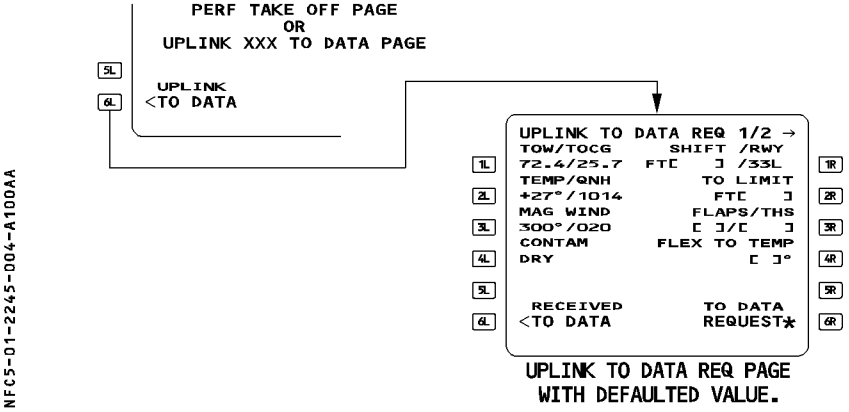
Takeoff speeds are computed for max and flex takeoff.

The takeoff data function has required the modification of the standard PERF TAKEOFF page and the addition of 2 news pages :

· UPLINK TO DAT REQ page that enables the crew to specify a request to the ground.

· UPLINK XXX TO DATA page (XXX for MAX or FLEX)

These 2 pages are accessed from the PERF TAKEOFF page in PREFLIGHT and DONE phase only.



UPLINK TO DATA REQ PAGE WITH DEFAULTED VALUE.

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SCRATCHPAD MESSAGES RELATED TO TAKEOFF DATA

TAKEOFF DATA UPLINK : Takeoff data uplink message is received
INVALID TAKEOFF UPLINK : The UPLINK message is rejected

WIND DATA FUNCTION

This function enables the crew to request and to receive forecasted winds associated to the active or secondary flight plan.
The uplink message (ground station to aircraft) may be received upon crew request or automatically without crew request.
The request is initiated from WIND pages or from ACARS function page (Refer to 4.03.20).
The uplink wind data when received are directly displayed on the wind pages but not inserted in the flight plan, one set for each flight phase : CLIMB, CRUISE, DESCENT. The alternate wind at alternate cruise flight level is displayed on DESCENT page.

* Winds are associated to altitude for climb an descent phases
* Winds are associated to waypoint for cruise phase and step level. One wind per waypoint.
  - On ground and without entered winds, an uplink message is directly inserted in the flight plan.
  - In flight, winds are temporary stored until the crew inserts it phase per phase. Phase of flight is indicated in the WIND title page.
  - Clearing the INSERT UPLINK* prompt using the CLR key deletes the uplink wind data for the selected phase.

When uplink winds are deleted, the wind page reverts to the previous status.
The flight plan B page is modified of the uplink wind only after it is inserted by the crew.
ACARS uplink winds are then considered as crew manual entries (large font).

SCRATCHPAD MESSAGES RELATED TO WIND DATA

INVALID WIND UPLINK	An error is detected, the uplink is rejected.
WIND DATA UPLINK	Uplinked winds are received.
WIND UPLINK PENDING	A temporary flight plan exists or a DIR TO page is displayed when a wind uplink is received. The message is stored.
WIND UPLINK EXISTS	A F-PLN modification (active or secondary) is attempted when uplink winds are not inserted. This message disappears automatically when the wind uplink is inserted or deleted.
CHECK DEST DATA	The aircraft is at 180 NM from destination, and the destination QNH, TEMP or WIND displayed on the PERF APPR page was received by ACARS uplink or, if following insertion of a descent wind uplink, a conflict concerning the above parameters exists.
CHECK ALTN WIND	The uplinked alternate cruise flight level differs from the default alternate cruise flight level.

FLIGHT REPORTS

Flight reports provide real time information to the ground concerning the aircraft current situation and position.
Several types of flight reports are available :
- The Position report : provides current aircraft position
- the Progress report : provides data relative to the destination
- The Flight-Plan report : provides the active route
- the Performance Data report : provides performance data currently used by FMS.

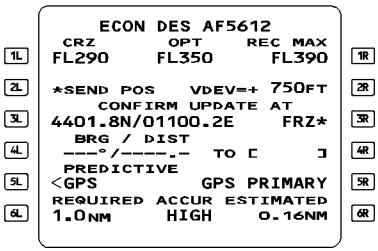
These reports may be manually initiated via a dedicated prompt or automatically sent in response to a ground request or upon specific conditions.

POSITION REPORT

This report is sent :
- manually via a MCDU prompt or
- following a ground request or
- automatically upon sequencing a designated reporting fix (designated by the ground in a uplink message).

The manual POSITION REPORT downlink prompt is displayed on the PROG page. (SEND POS prompt).

PROGRESS PAGE (STANDARD)



PROGRESS PAGE WITH GPS STANDARD

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Note : Position report are initiated from active flight plan only.

POSITION report content

- Aircraft position
- Overfly reporting waypoint
- Time of report (UTC)
- Aircraft altitude
- Next reporting waypoint
- ETA at next reporting waypoint
- Reporting waypoint following next report
- SAT
- Current wind
- Remaining fuel

PROGRESS REPORT

A progress report contains data relative to the aircraft arrival time and EFOB at destination for the active F-PLN.
This downlink message is automatically sent following :

- a ground request or
- a change of destination or
- a change of runway or
- a specific event. The possible events that can be selected in the navigation database policy file are :
  - X minutes to Top of Descent
  - Z minutes to Destination
  - ETA changes more than W minutes from the previous report.

  X, Z and W are minutes of time set in the navigation database policy file.

The progress report cannot be manually sent by the crew via a dedicated MCDU prompt.

PROGRESS report content

- Flight Number
- Arrival Airport Ident
- Destination Runway Ident
- Predicted remaining fuel
- ETA at destination
- Reason for report (specific event, ground request...).

FLIGHT PLAN REPORT

The F-PLN report broadcasts flight plan data to the ground. Only data from the active flight plan can be sent.
This downlink message is sent to the ground :
- automatically following a ground request
- manually by the crew using a prompt displayed on the ACARS function page. (Refer to ACARS page description). This prompt may be invalidated through the navigation database policy file.

The Flight Plan report can be downlinked either while on ground or in flight during any flight phase.

FLIGHT PLAN report content

The report contains the active and alternate flight plan.

PERFORMANCE DATA REPORT

The Performance Data report is a downlink message that allows the transmission of performance data (CG, FUEL, CG...) relative to the active F-PLN.
This message is automatically sent following a ground request. Manual sending is not possible.

PERFORMANCE DATA report content

Sends to the ground :
- Current GW
- Cruise Altitude
- Current CG
- Fuel on Board
- Block Fuel
- Reserve Fuel
- Cost Index
- Top of Climb Temperature
- Climb Transition Altitude
- Tropopause Altitude
- Taxi Fuel
- ZFW
- ZFWCG

PRINT FUNCTION

The print function enables several types of data and report to be printed :
* Flight plan initialization data
* Takeoff data
* Wind data
* Preflight report
* In flight report
* Post flight report

The 3 first reports may differ when automatically or manually printed for the following reason :
The automatic process prints the uplink message although the manuall process prints the current active data as displayed on the relevant MCDU pages.
The last 3 reports being processed from the same sources are identical in automatic or manual printing.

Note : ACARS is not necessary linked to printing process. The printing function may be activated within the FMGS and selected independently from the ACARS.

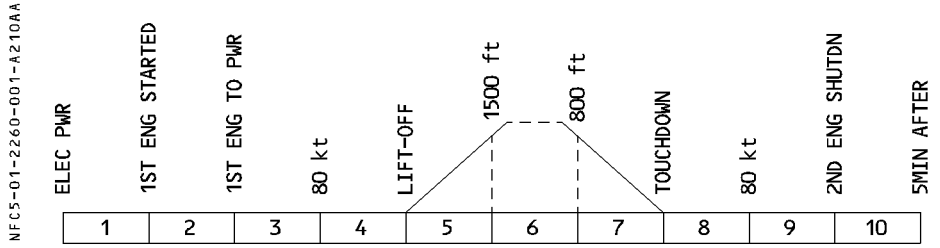
- One or several print functions may be deactivated (refer to PRINT FUNCTION PAGE).
- If an ACARS function is not active, (not selected in the nav database policy file) the printing process is invalidated for this specific ACARS function.

ACARS/PRINTER PROGRAMMING OPTIONS ◁

Option programming for the ACARS/PRINTER functions is obtained through the Navigation Data Base policy file.
The list summarizes the possible options :

ACARS Inhibit	Disables ACARS function
F-PLN Data Request Inhibit	Disables uplink and downlink requests of F-PLN initialization data
Performance Data Request Inhibit	Disables uplink and downlink requests of Performance Initialization data
Takeoff Data Request Inhibit	Disables uplink and downlink request of Takeoff Initialization data
Wind Data Request Inhibit	Disables uplink and downlink request of predicted wind data
Flight Number Enable	Flight Number is included within the F-PLN Request or Progress Report downlinks
Position Report Inhibit	Disables a manual Position Report downlink
Progress Report Triggers	Defines the triggers for the automatic downlink of the Progress Report
F-PLN Report Inhibit	Disables the manual downlink of the F-PLN Report
Auto Print of ACARS uplink	Selects/Deselects the automatic printing of the F-PLN, INIT, TO and wind data uplinks. If Autoprint is selected, the crew can deselect it manually. If auto printing is deselected, the crew cannot manually reselect it.
Auto Print of Flight Reports	Selects/Deselects the automatic printing of the Preflight, Inflight, Postflight reports. If selected, the crew can deselect it manually. If autoprint is deselected, the crew cannot manually preselected it.

WARNINGS AND CAUTIONS



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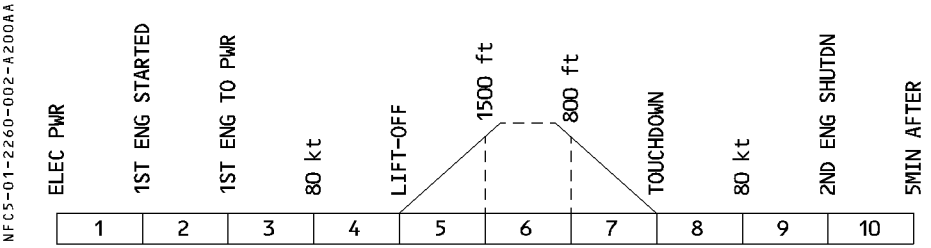
E / WD: FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
FAC 1 (2) FAULT	SINGLE CHIME	MASTER CAUT	NIL	FAC FAULT lt	3, 4, 5 7,8
YAW DAMPER 1 (2)	NIL	NIL	NIL	NIL	3, 4, 5 7, 8, 10
RUDDER TRIM 1 (2) FAULT RUD TRV LIM 1 (2) FCU 1 (2) FAULT					3, 4, 5 7, 8
FAC 1 + 2 FAULT	SINGLE CHIME	MASTER CAUT		FAC FAULT lts	4, 5, 7, 8
YAW DAMPER SYS				NIL	4, 5, 7, 8, 10
RUD TRIM SYS			F/CTL		4, 5, 7, 8
RUD TRV LIM SYS			NIL		
A/THR OFF A/THR disconnection (Refer to 1.22.30).					4, 8, 10
A/THR LIMITED A/THR is active but thrust levers are set below CL detent (2 engines), or MCT detent (1 engine).	SINGLE CHIME every 5 seconds	MASTER CAUT every 5 seconds			1, 2, 3, 4 8, 9, 10
FCU 1 + 2 FAULT	SINGLE CHIME	MASTER CAUT			3, 4, 5, 7, 8
AP OFF AP disengagement (Refer to 1.22.30).	CAVALRY CHARGE	MASTER WARN			-
– (ILS) CAPABILITY DOWNGRADE. Condition(s) required for CAT3/CAT2 are no longer fulfilled. (Refer to 4.05.70). – Mode reversions (Refer to 1.22.30).	TRIPLE CLICK	NIL			2, 3, 4, 5, 8, 9, 10
WINDSHEAR No ECAM message.	SYNTHETIC VOICE "WINDSHEAR" repeated 3 times			"WINDSHEAR" on PFDs	1, 2, 3, 4 8, 9, 10
WINDSHEAR DET FAULT or REAC W/S DET FAULT ◁	SINGLE CHIME	MASTER CAUT		NIL	3, 4, 5 8
LOW ENERGY WARNING Available between 100 and 2000 feet in CONF ≥ 2. No ECAM message.	SYNTHETIC VOICE "SPEED" 3 times every 5 seconds	NIL			1, 2, 3, 4 8, 9, 10

WARNINGS AND CAUTIONS



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E / WD: FAILURE TITLE conditions	AURAL WARNING	MASTER LIGHT	SD PAGE CALLED	LOCAL WARNING	FLT PHASE INHIB
AUTOLAND (No ECAM message) Only available below 200 feet.	NIL	AUTO LAND (red) on glareshield	NIL	NIL	2, 3, 4, 5, 8, 9 10
When GPS primary is lost, The "GPS PRIMARY LOST" message is displayed on the ND and PFD.	TRIPLE* CLICK	NIL		ND/MCDU message	
"NAV FMS/GPS POS DISAGREE is triggered, when FMS 1 or 2 position differs from GPS 1 or 2 position by more than : – A longitude threshold that depends on the latitude : · 0.5 minutes for latitudes below 55°, · 0.9 minutes for latitudes at or above 55°, and below 70°, – A latitude threshold of 0.5 minutes, regardless of the latitude. Above 70° of latitude, a longitude difference does not trigger the alarm.	SINGLE CHIME	MASTER CAUT	NIL	NIL	1, 3, 4, 10

* Only during a non precision approach.

BUS EQUIPMENT LIST

		NORM		EMER ELEC		
		AC	DC	AC ESS	DC ESS	HOT
FMGC	1				SHED	
	2		DC2			
MCDU	1			SHED		
	2	AC2				
	3 ◁	AC1				
FCU	1				X	
	2		DC2			