

	AUTO FLIGHT FLIGHT MANAGEMENT	1.22.20 P 1	
		SEQ 001	REV 10

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.
- Polar navigation.

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.

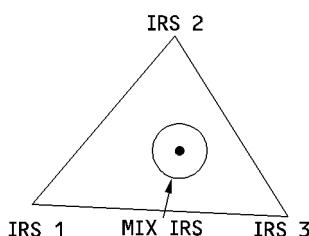
The FMGS selects the most accurate position, considering the estimated accuracy and integrity of each positioning equipment.

GPS/INERTIAL is the basic navigation mode, provided GPS data is valid and successfully tested. Otherwise, nav aids plus inertial or inertial only are used. (Refer to Navigation modes).

MIX IRS POSITION

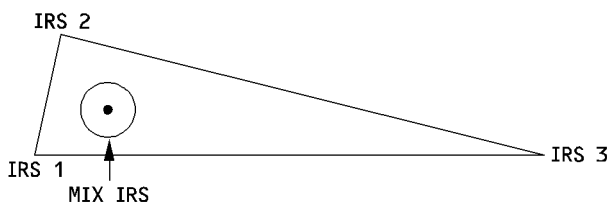
Each FMGC receives a position from each of the three IRSs, and computes a mean-weighted average called the “MIX IRS” position.

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- 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.

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- 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.

GPS POSITION

Each IRS computes an hybrid position that is a mix IRS/GPS position called GPIRS. Among these 3 GPIRS hybrid positions received by each FMGC, one is selected according to a figure of merit and a priority. The selection is performed using the following hierarchy :

- inside GPIRS position
- GPIRS 3
- opposite GPIRS position

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

As long as GPS primary is in use, all usual required navigation performance are met.

The crew can deselect/select the GPS on the SELECTED NAVAIDS page if necessary.

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SELECTED NAVAIDS	
VOR/DME	AUTO DESELECT
1L <GEN 115.70	1R
2L <NIZ 115.10 C J*	2R
3L <TOP	3R
4L ILS/DME	4R
5L <NA 110.70	5R
6L DESELECT	6R
*GPS	
<RETURN	

DESELECT

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

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GPS MONITOR	
1L GPS1 POSITION	1R
2L 43° 40.4N/000° 17.6E	2R
3L TTRK GPS ALT GS	3R
4L 342.3 10000 310	4R
5L MERIT MODE/SAT	5R
6L 100M NAV/6	6R
GPS2 POSITION	
1L 43° 40.4N/000° 17.6E	1R
2L TTRK GPS ALT GS	2R
3L 342.3 10000 310	3R
4L MERIT MODE/SAT	4R
5L 100M NAV/6	5R
6L	6R

RADIO POSITION

Each FMGC uses onside nav aids to compute its own radio position. These nav aids are displayed on SELECTED NAVAIDS page. The nav aids it can use are :

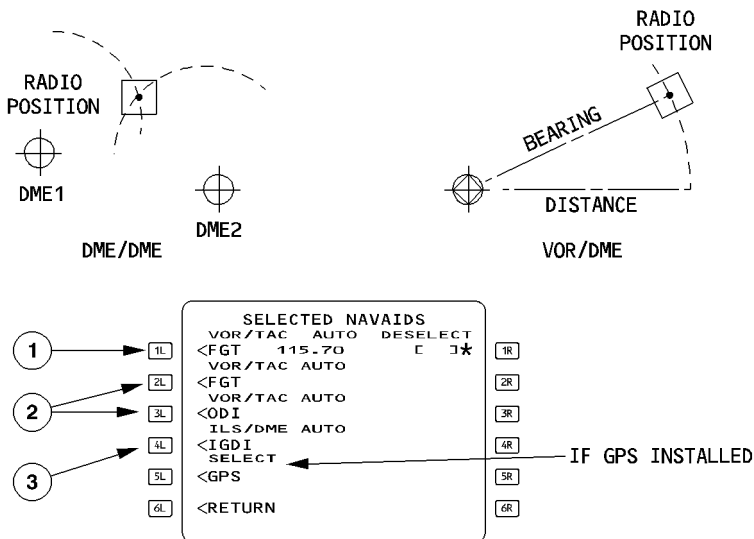
- DME/DME
- VOR/DME
- LOC
- DME/DME-LOC
- VOR/DME-LOC

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 GPS installed).

If one or more nav aids fail, each FMGC can use offside nav aids to compute VOR/DME or DME/DME radio position.

The radio nav aid selection is displayed on DATA "SELECTED NAVAIDS" page.



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

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

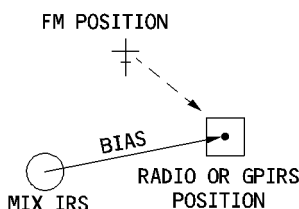
③ILS selection auto or manual for LOC update computation.

FM POSITION

At flight initialization, each FMGC displays an FM position that is a mix 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 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.



For each IRS, the FMGCs compare the FM position with the IRS position. When this difference exceeds a threshold (depending on the elapsed time since IRS alignment), the “CHECK IRS 1,2 or 3 FM position” message is displayed on the MCDUs (Refer to FCOM 4.03.30).

When the FWC detects an abnormal IRS drift, the ECAM triggers the “NAV FM/IR POSITION DISAGREE” message (Refer to FCOM 3.02.34).

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.

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NAVIGATION MODES

The FMGS updates the FM position using GPS (if available) or radio navaids if the GPS function is 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.

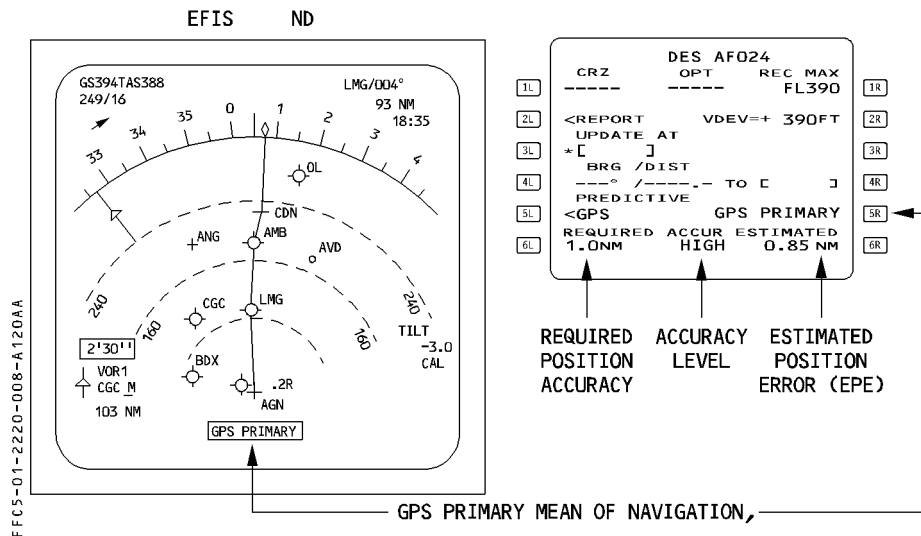
The number displayed in the REQUIRED NAVIGATION PERFORMANCE (RNP) field is (in decreasing order of priority) : The pilot-entered value, the database procedure value, or the system's default value. When a pilot enters a RNP that is larger than the published value, one of the following messages is displayed : "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 (defaulted value) is smaller than the displayed manually-entered value.

DEFAULT AREA RNP VALUES	
EN ROUTE and oceanic	2 NM
TERMINAL and takeoff	1 NM
APPROACH	GPS/LOC 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 means of navigation. "GPS PRIMARY" is displayed on the PROG page, and temporarily on the ND.

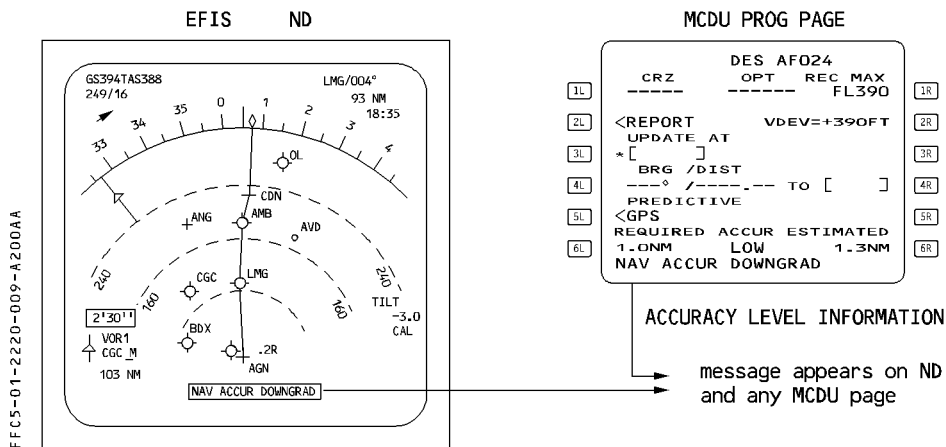


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When the GPS function is lost, a “GPS PRIMARY LOST” message is displayed on the ND and MCDU scratchpads. The MCDU message can be cleared ; the ND message cannot.

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.

FM/GPS POSITION DISAGREEMENT

The lower ECAM displays the “NAV FM/GPS POS DISAGREE” amber caution when the GPS PRIMARY function is active, and either of the FMGC positions deviate from the GPS positions 1 or 2 by more than :

- 0.5 minutes of latitude ;
- For longitude :
 - 0.5 minutes of longitude, when the aircraft latitude is included between 0° and 45° ;
 - 0.7 minutes of longitude, when the aircraft latitude is included between 45° and 60° ;
 - 1 minute of longitude, when the aircraft latitude is included between 60° and 70°.

Above 70° of latitude, a longitude difference does not trigger the alarm.

The master caution light comes on, and the single chime sounds. This amber caution is inhibited during the takeoff phase.

PREDICTIVE GPS PAGE

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.

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1L

2L

3L

4L

5L

6L

PREDICTIVE GPS

DEST
EDDF
-15 -10 -5ETA +5 +10 +15
Y Y Y Y Y Y Y
WPT
AGN
-15 -10 -5ETA +5 +10 +15
Y Y N N N N N
DESELECTED SATELLITES
6 21
C J

1R

2R

3R

4R

5R

6R

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 nav aids are tuned for two different purposes : display and computation.

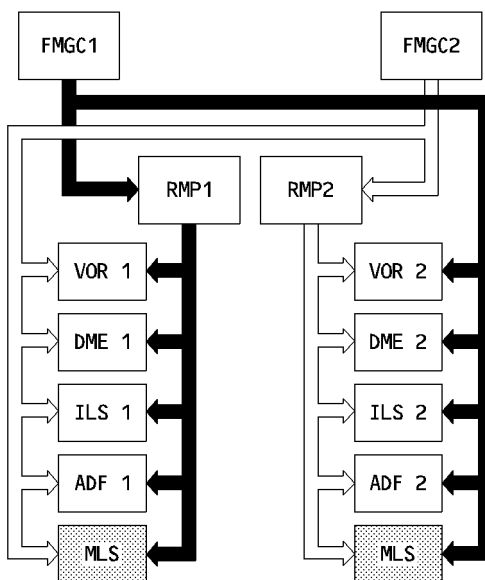
Tuning for display may be performed in three different ways :

- 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 nav aids 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



- In dual mode and independent mode each FMGC tunes the nav aids on its side of the console (one VOR, 5 DMEs, one ILS/MLS, and one ADF) simultaneously. In these modes, the pilot can also tune the VOR (and associated DME), ILS/MLS, and ADF manually.
- In single mode, the valid FMGC will tune both side nav aids. 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.

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VOR

Each FMGC may tune one VOR only (manual or automatic).

Autotuning obeys the following priorities for tuning the VOR :

1. The navaid specified for the approach
2. The navaid to be used for computing present radio position
3. For displays 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.

Note : *If the manual selection of a VOR does not match the VOR requested for autotuning the relevant MCDU will display : “TUNE BBB CRS XXX”
(BBB = ident of the requested VOR) ; (XXX = course of the requested VOR)*

DME

Each FMGC automatically uses its five DMEs as follows :

- One DME for display. It may be manually tuned or autotuned.
- 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 not available 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 radio position.
- One DME linked to ILS/DME.

ADF

The FMGC autotunes one ADF in any area if the TO or FROM waypoint is an NDB, or in approach 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/MLS (ILS)

Each FMGC autotunes one ILS frequency (and one MLS simultaneously 

- In PREFLIGHT or TAKEOFF phase, when the takeoff runway has an associated ILS/MLS.
- In CLIMB-CRUISE-DESCENT, APPROACH, or GO AROUND phase, when the type of approach in the flight plan is ILS/MLS.
- when the direct distance to destination is less than 300 NM.

The scratchpad displays “RWY/LS MISMATCH” when the pilot has tuned the ILS manually and the frequency he has entered does not match the LS or LOC IDENT/FREQ requested for autotuning.

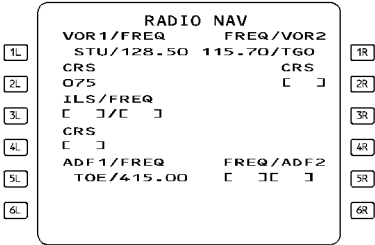
SELECTION OF NAVAIDS ON MCDU PAGES

The MCDU displays 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.

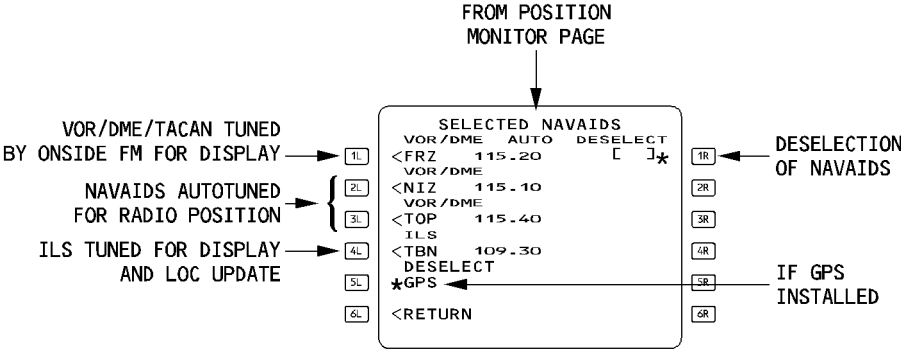
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- SELECTED NAVAIDS page

This page lists the navaids being 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).

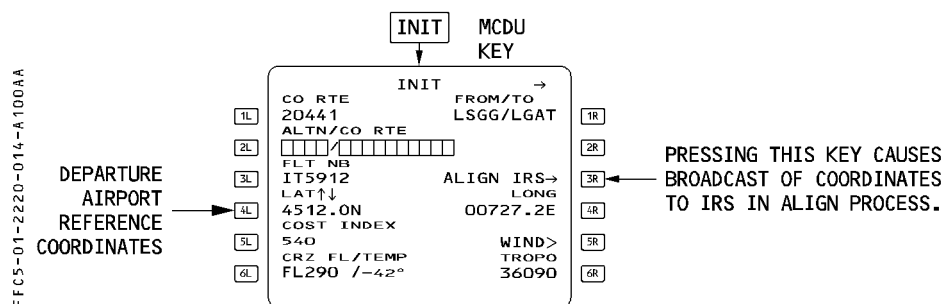
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ALIGNMENT OF INERTIAL REFERENCE SYSTEM

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

Fast alignment is used to refine a position when time is limited.



Note : If “IRS IN ALIGN” memo flashes, 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 order the MCDU to send a new position to 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.

IR IN ATT MODE : HDG SET

When one IRS is at least in ATT mode, the pilot must set and periodically update the heading to have an attitude information. The entry is performed on the MCDU IRS MONITOR page.

FROM DATA INDEX PAGE

1L

2L

3L

4L

5L

6L

IRS MONITOR

<IRS1 EXCESS MOTION
ALIGN TTN 10

<IRS2
ALIGN TTN 7

<IRS3 ENTER HEADING
ATT

SET HDG
□□□□

1R

2R

3R

4R

5R

6R

PROMPT DISPLAYED IN CASE OF IR HDG INIT

AVERAGE DRIFT COMPUTATION

The FMGC computes an average drift on the ground at the end of the flight for each IR. This drift is then displayed on the IRS page.

The drift is the difference between the IR position at landing and the geographic landing position (destination runway threshold plus a shift of 400 m).

FROM DATA INDEX PAGE

1L

2L

3L

4L

5L

6L

IRS MONITOR
DRIFT AT LFP033L

<IRS1
NAV DRIFT 1.0 NM/H

<IRS2
NAV DRIFT 1.8 NM/H

<IRS3
NAV DRIFT 1.6 NM/H

1R

2R

3R

4R

5R

6R

AVERAGE DRIFT OF EACH IR

The FMGC then computes the time since last alignment.

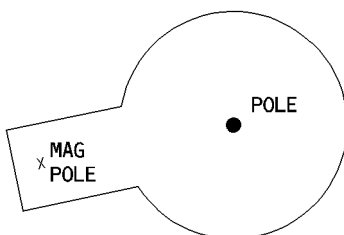
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POLAR NAVIGATION

IRS are able to provide MAG HEADING between latitudes 82°30N and 60°30S, except in the vicinity of North magnetic pole.

The FMGC computes the aircraft position within polar area even at North pole using the MIX IRS position.

Note : The IRS may be aligned up to latitude 73N without any particular procedures. Between 73N and 82N (North or South), the required alignment time is greater and a specific procedure has to be performed. Beyond 82° North or South, no ADIRS alignment is possible.



As a general rule the MCDU displays all parameters referenced to North according to the NORTH REF pushbutton switch position.

In order to provide most SAFE and FLEXIBLE operation, a MAG/TRUE NORTH REF pushbutton switch is available, with various messages provided on EFIS ND/MCDU and ECAM, indicating to the pilot what reference should be applicable in the flight area the aircraft is flying in.

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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 :
 - to prepare and store a second departure procedure before takeoff
 - to plan a diversion
 - to prepare the next flight leg
 - 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.

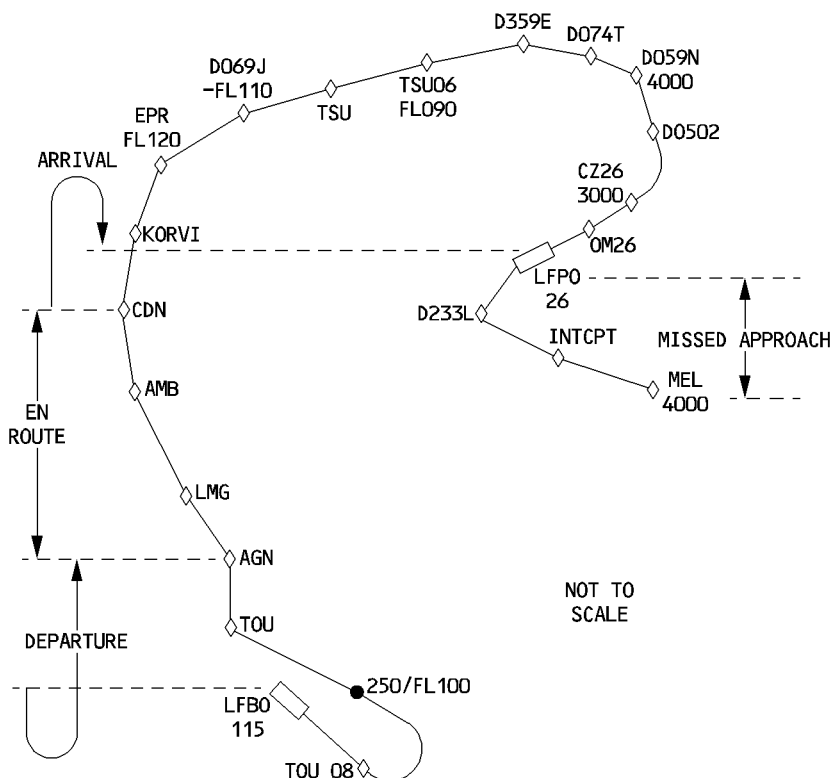
The pilot may then modify the flight plan on the ground or in flight, by making lateral and vertical revisions.

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.



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The FMGC strings the legs in sequence automatically.

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 create only direct legs between manually defined geographic points (navaids, airports, waypoints).

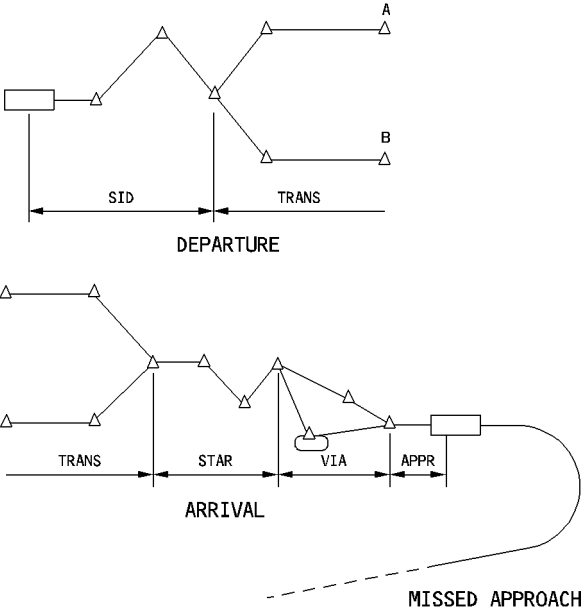
Note : *The departure and arrival procedures are defined in the database to minimize the amount of memory required. They are divided as follows :*

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. En route transitions (TRANS) are the various possible trajectories defined between the last point of the SID and the first en route waypoints and between the last en route waypoint and the first fix of the STAR.

"APPR VIAs" are the possible trajectories defined between the last point of the STAR and the first point of the approach.



MANUAL LEG

A **MANUAL** leg stays on a constant course, TRK or HDG and has no termination point. You cannot insert it into a flight plan manually (except using the DIR TO RADIAL OUT function, refer to 4.03.20) : 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 (DIR TO). When the aircraft is cleared to fly to the next waypoint of the flight plan, the pilot 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.

	FROM	AF5612→	
1L	ABC	UTC 1014 SPD/ALT 235/2000	1R
2L	SID1	BRG137 33NM	2R
3L	DEF122	1020 235/6000	3R
	SID1	TRK122	
	MANUAL		
4L	---F-PLN DISCONTINUITY---		
5L	SID1	29	4R
	JKL	----	5R
6L	DEST	UTC DIST EFOB	
	ARPT33R	1245 1200 8.4	6R
		↑↓	

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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 F-PLN

The purpose of the temporary flight plan is to allow the pilot to check a revision on the MCDU and EFIS ND before he inserts 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.

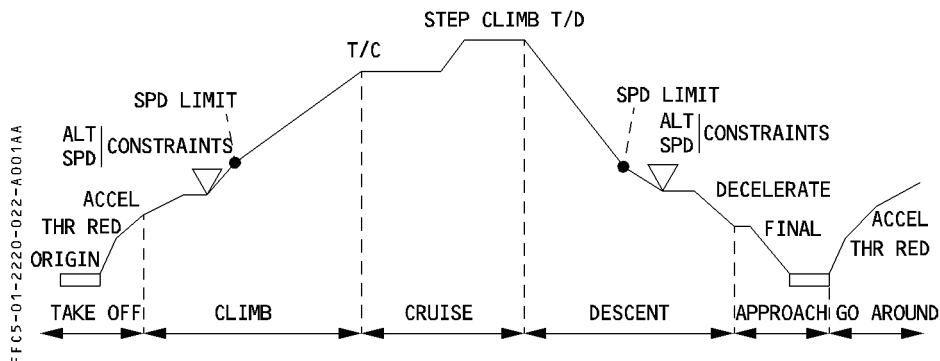
For details, Refer to 4.04.10 (TEMPORARY F-PLN).

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, ZFWCG, block FUEL, winds and temperature) 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 database 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 have been defined, the FMGC computes the vertical profile and the managed speed/Mach profile from takeoff to landing.

For details, refer to 4.03.20 (VERTICAL REVISIONS).

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).

1L

2L

3L

4L

5L

6L

DEST	APPR	
QNH	FLP RETR	FINAL
1015	F=187	VOR33R
TEMP	SLT RETR	MDA
C 1°	S=230	640
MAG WIND	CLEAN	
C 1° / C 1	0=267	
TRANS ALT	LDG CONF	
4000	CONF3 *	
VAPP	VLS	FULL
135	145	
PREV	NEXT	
<PHASE	PHASE>	

1R

2R

3R

4R

5R

6R

}

APPROACH SPEEDS

PERF APPROACH PAGE

Optimum target speed for CLB or DES phase

The FMGC computes optimum speeds as functions of :

- the gross weight (GW)
- the cost index (CI)
- the cruise flight level (CRZ FL)
- the wind and temperature models
- the performance factor

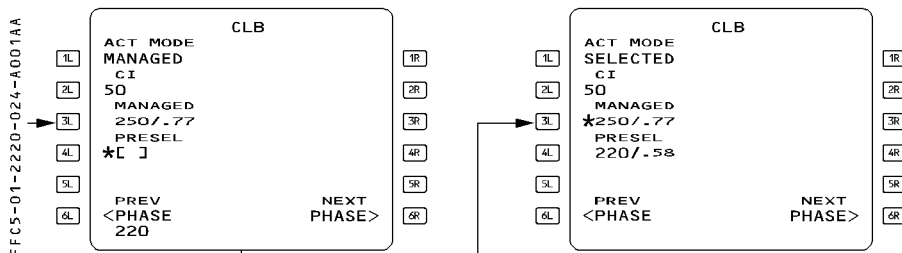
When there is no time or speed constraint/limit, ECON SPEED is the optimum speed for the selected cost index. It refers to fuel and time cost and not directly to fuel saving.

FM calculates ECON CLB speed before the climb phase begins, and this speed cannot be changed during the climb phase itself.

ECON DES speed is used to compute the optimum descent profile and the associated top of descent (T/D).

Preset target speed for CLB phase

The pilot can preselect the climb speed as long as the CLB phase is not active, by inserting a speed in the PRESEL field :

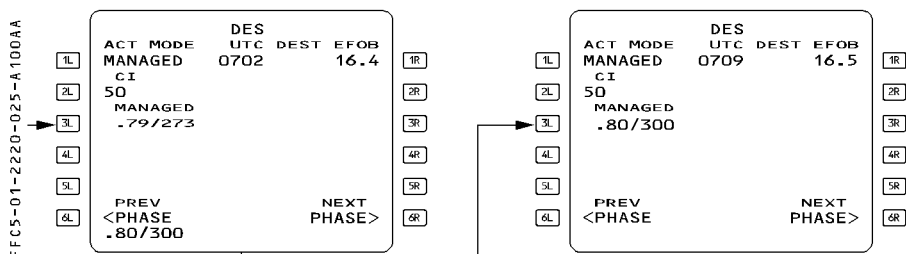


The active mode field changes from MANAGED to SELECTED, and the FM will use the entered speed for climb predictions computation. The pilot can revert to managed mode by pressing the 3L key.

Preset target speed/Mach for DES phase

The pilot can change the speed and/or Mach as long as the DES phase is not active by inserting a speed and/or Mach in the MANAGED field.

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



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

Optimum target Mach number in cruise

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

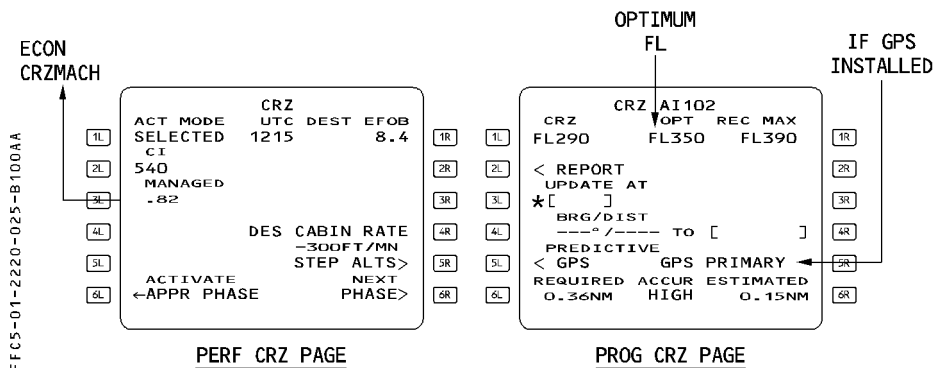
- current weather conditions
- modifications to the flight plan.

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 (assuming a 15 minute minimum cruise flight level at that altitude). FM updates it continuously during the cruise phase, and displays it on the PROG page. The PROG page displays dashes for this quantity :

- at least 15 NM before top of descent
- when the system detects an engine-out condition
- when DES phase is activated.



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PREDICTIONS

The FMGC computes predictions for the primary flight plan and the secondary flight plan 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.

PREDICTIONS FOR THE PRIMARY FLIGHT PLAN

The predictions displayed on the MCDU assume that the FMGS 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.

If the aircraft is not flying the flight plan, the MCDU predictions assume that :

- The aircraft will fly back toward the flight-planned route.
- The aircraft will resume flying the FMGC managed modes immediately.

If the aircraft does not fly the preplanned speed, predictions assume that it will maintain the selected speed until it reaches :

- the next speed limit or speed constraint, or next phase in CLB or DES or
 - the descent phase if it is now in cruise phase
- and that speed control will then revert to ECON.

UPDATE OF PREDICTIONS

The FMGCs recompute the predictions whenever there is a modification to :

- the lateral flight plan
- the vertical flight plan
- forecast atmospheric conditions entered by the crew
- the cost index
- speed control (managed/selected)

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

WINDS USED FOR PREDICTIONS

See VERTICAL FUNCTIONS, FMGS Pilot's Guide, 04.04.20.

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EFIS ND PREDICTIONS

Refer to FLIGHT MANAGEMENT PRINCIPLES, 4.02.20.

MCDU PREDICTIONS

Refer to FLIGHT MANAGEMENT PRINCIPLES, 4.02.20.

OTHER COMPUTATIONS

Engine-out case

The FMGS computes an engine-out target speed for each flight phase.

It computes an engine-out maximum altitude (EO MAX ALT) at long-range cruise speed, and displays it on the PROG page.

The new speed target becomes green dot in climb phase or EO CRZ SPD in level flight.

The system computes the flight plan predictions down to the primary destination assuming that the cruise phase is at the lower of CRZ FL or EO MAX ALT.

For the engine out obstacle strategy the system computes a drift down descent at green dot and down to a level off altitude.

Fuel Planning

After the F-PLN, CRZ FL, CI, ZFW, ZFWCG insertion, the FMGC may compute on crew request the minimum fuel to meet the requirements of the flight taking into account a predetermined fuel policy (navigation database).

Fuel predictions are automatically performed after the F-PLN, CRZ FL, ZFW insertion. The FMGC has to know the FOB either inserted by the crew (BLOCK FUEL) or computed by the system.

Equi-time point (ETP)

The ETP is a pseudo waypoint along the lateral flight plan at which the time to reach 2 reference waypoints is the same, taking distance and winds into account.

Time Marker

This pseudo waypoint may be created for display on MCDU/ND.

Recommended maximum altitude (REC MAX)

The recommended maximum altitude is the lowest of :

- maximum altitude the aircraft can reach with a 0.3 g buffet margin
- maximum altitude the aircraft can fly in level flight at MAX CRZ rating
- maximum altitude the aircraft can maintain a V/S of 300 feet/minute at MAX CLB thrust
- maximum altitude the aircraft can fly at a speed higher than Green Dot speed and lower than VMO/MMO
- maximum altitude the aircraft is certified (FL 410)

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.

ALTERNATES FOR LGAT					
ALTN	CO		RTE		
1L LGTS				1907	1R
1987	TRK	EXTRA	DIST		
2L LGTS	325°	0.9	161		2R
2AB3					
←LGRP	113°	0.7	230		3R
7113					
←LGKR	298°	0.8	197		4R
2828					
←LGTR	305°	0.5	257		5R
<RETURN					6R
					↑

They are based on :

- A default cruise FL equal to 220 if the airway distance is less than 200 NM. otherwise FL 310.
- Simplified wind/temperature models based on crew entries :
 - ALTN CRZ wind as entered in the primary DESCENT WIND page.
 - Wind/temperature at primary destination (APPR page).
A zero wind and/or zero ISA deviation is assumed by default if there is no crew entry.
- Initial aircraft weight equal to landing weight at primary destination.
- A track equal to mean track between active primary and alternative destination.
- A constant delta ISA and a constant cruise wind.
- Cost index = 0 (minimum fuel)

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.

Predictions for secondary flight plan

Predictions are provided on the SEC F-PLN, SEC INIT and SEC PERF pages as for the active primary flight plan.

However the predictions are provided for the SEC F-PLN on the condition that the primary and secondary flight plan have their active leg common (same TO WPT).

Predictions for fuel

Up to eight fuel policy records may be specified in the navigation database.

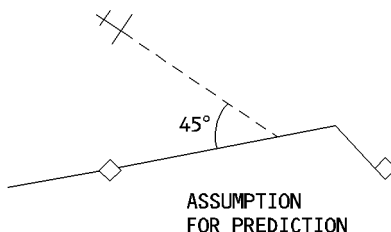
If a specific data is not provided in the database fuel policy, the value is the default value given here after :

PARAMETERS	DEFAULT VALUES
RTE RSV (percentage of route reserve)	5 %
RSV MIN (minimum value of route reserve)	0 kg
RSV MAX (maximum value of route reserve)	25.600 kg
RSV FLT (reserve remains computed in flight)	yes
RSV ALTN (reserve is computed with alternate trip fuel)	no
FINAL TIME (time for final holding pattern)	30 min
FINAL FIX (Fuel burnt in the final holding pattern)	0 kg
FINAL ALT (altitude of the final holding pattern)	1 500 ft AGL
TAXI (fuel for taxi)	600 kg
FINAL DEST (final holding pattern is flown at ALTN)	ALTN

Furthermore RTE RSV, FINAL TIME and TAXI may be modified on the MCDU through the INIT B or FUEL PRED pages.

RETURN-TO-TRAJECTORY ASSUMPTIONS

If the aircraft is not on the lateral flight plan, the FMGC assumes (for prediction) that it will return immediately to the active lateral leg with a 45° convergence angle or that it will fly direct or the "TO" waypoint whenever the required convergence angle is greater than 45°.



If the pilot flies outside the planned flight plan, predictions are still available, but they assume an immediate return to the flight plan.

For other computations, (Refer to FCOM 4 .02.20).

IDLE/PERF FACTORS

MCDU fuel predictions can be corrected to match the actual aircraft fuel consumption.

This is done, on ground only, by modifying the IDLE/PERF factor.

IDLE FACTOR

IDLE and PERF factors use the same principle.

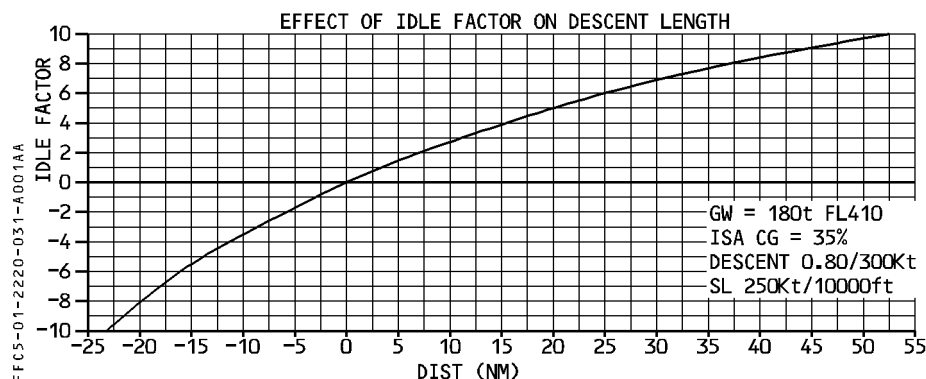
The PERF factor is mainly used for prediction during cruise phase, the IDLE factor is dedicated to the FM descent segment.

The aim of the IDLE factor is to adjust the FM descent predictions, in particular the position of the Top Of Descent (TOD), 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).

The following figure shows the IDLE FACTOR effect on the descent length.



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PERF FACTOR

The performance 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 actual aircraft performance differs from the performance model stored in the FMGS database, usually due to an increase of aircraft drag and engine performance deterioration.

This difference can be the result of 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.
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 the actual fuel consumption.

The PERF factor modifies the predicted fuel flow according to the following formula :

$$FF_{pred} = FF_{model} (1 + PERF\ FACT/100)$$

FF_{pred} is the FF used for prediction.

FF_{model} is the FF from the aero engine model.

This correction is applied throughout the entire flight and modifies performance predictions and the ECON speed or Mach.

e.g. : 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 to modify the PERF factor :

On the aircraft status page :

- ENTER ARM into the brackets in the CHG CODE line [5L].
- WRITE the new IDLE/PERF factors.
- INSERT it using [6L] key.

A manually-entered IDLE/PERF factor is displayed in large blue fonts. A change at IDLE/PERF factor is usually a maintenance, or flight operation duty.

MANAGEMENT OF THE DISPLAYS

- The flight management system displays navigation, performance and guidance information on :
- the Mutipurpose Control and Display Unit (MCDUs)
 - the Navigation Display (ND) of the Electronic Flight Instrument System (EFIS)
 - the Primary Flight Display (PFD) of the EFIS.

MCDU DISPLAY

- The MCDUs display :
- Position and accuracy information
 - Tuned nav aids
 - 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.

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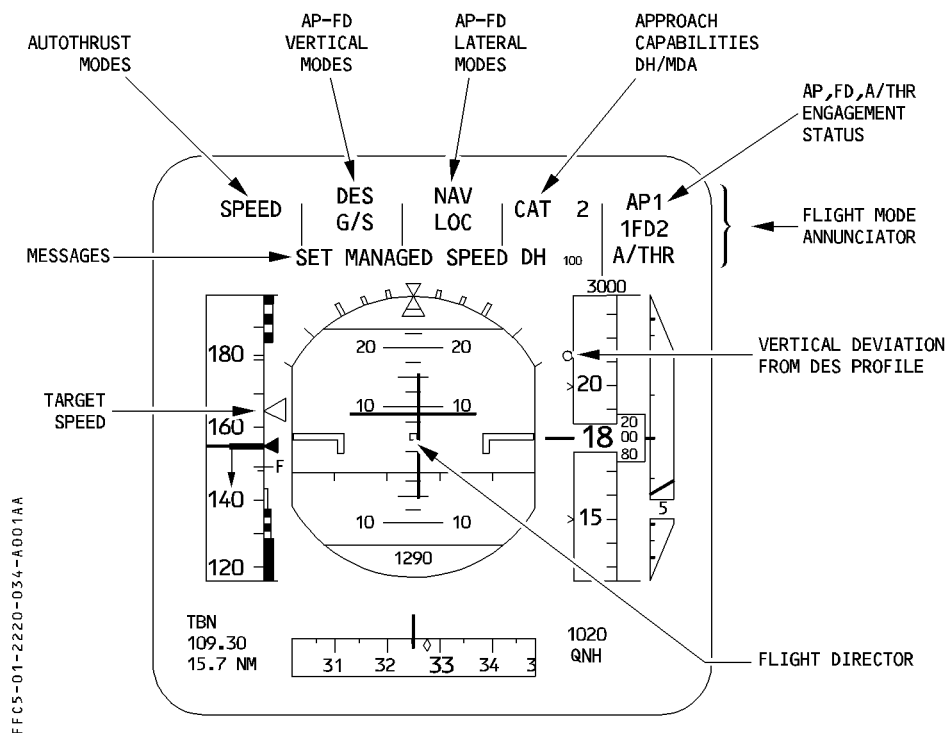
	FROM	AI 101	→	
1L	TOP9A	TIME	SPD/ALT	1R
	LSG623	0000	148/ 1365	
2L	TOP9A	BRG228°	6NM	2R
	PAS	0003	210/*5500	
3L	HOLD L	TRK228°	12	3R
	7000	0006	"/ 7000	
4L	[SPD]	0		4R
	[LIM]	0006	210/ 7000	
5L	TOP9A	5		5R
	D136E	0007*230/*FL90		
6L	DEST	TIME DIST	EF08	6R
	LGAT33R	0220	990 8.4	
			↑↓	

F-PLN page

EFIS PRIMARY FLIGHT DISPLAY (PFD)

The Flight Management generates the following information :

- Armed and engaged modes on the Flight Mode Annunciator (FMA)
- FMGS guidance targets (SPD, ALT, HDG)
- Vertical deviation from descent profile
- Messages
- Navigation information

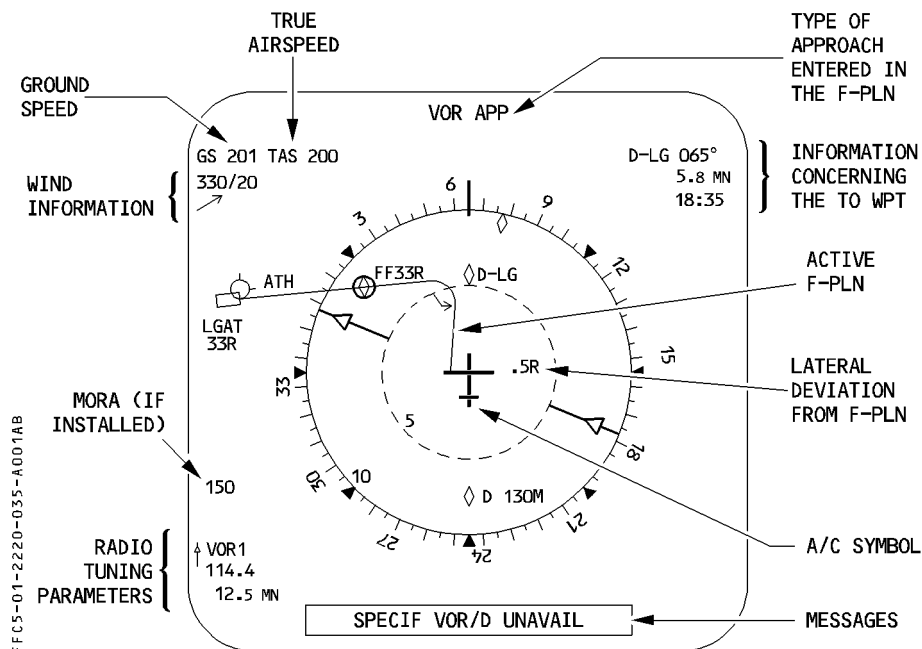


Note : For more details concerning EFIS PFD refer to 1-31 chapter.

EFIS NAVIGATION DISPLAY (ND)

Flight Management (FM) generates the following information :

- aircraft position
- flight plans (active, secondary, temporary, and dashed)
- lateral deviation from primary flight plan
- pseudo waypoints along the flight plan
- raw data from tuned nav aids
- wind information
- various options, depending on what the pilot selects on the EFIS control panel : waypoints, nav aids, NDBs, airports, constraints
- type of approach selected
- messages



Note : For more details concerning EFIS ND refer to 1-31-45.



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COLORS USED FOR DISPLAYING FLIGHT PLANS

F-PLN	Color
Primary flight plan	steady green in managed, dashed green in selected
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	steady yellow (not inserted)
secondary flight plan	dimmed white
abeam / radial	dashed blue