

virgin atlantic A340-600 <i>Flight Crew Operating Manual</i>	FMGS OPERATIONAL PRINCIPLES FLIGHT GUIDANCE PRINCIPLES	4.02.30 SEQ 001	P 1 REV 07
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MANAGED TARGETS

When the aircraft is using managed targets, the flight management and guidance system (FMGS) guides it along lateral and vertical flight paths and speed profiles computed by the flight management function (FM) from data in the MCDU.

FM manages the guidance targets.

SELECTED TARGETS

When the pilot is using selected targets, the FMGS guides the aircraft along lateral and vertical flight paths and speed profiles to meet targets that the pilot has selected manually on the FCU.

The pilot selects the guidance targets.

FLIGHT GUIDANCE MODES

Lateral and vertical modes may be :

- armed
- engaged
- disengaged

Autothrust modes may be :

- armed
- active
- disconnected

LATERAL MODES

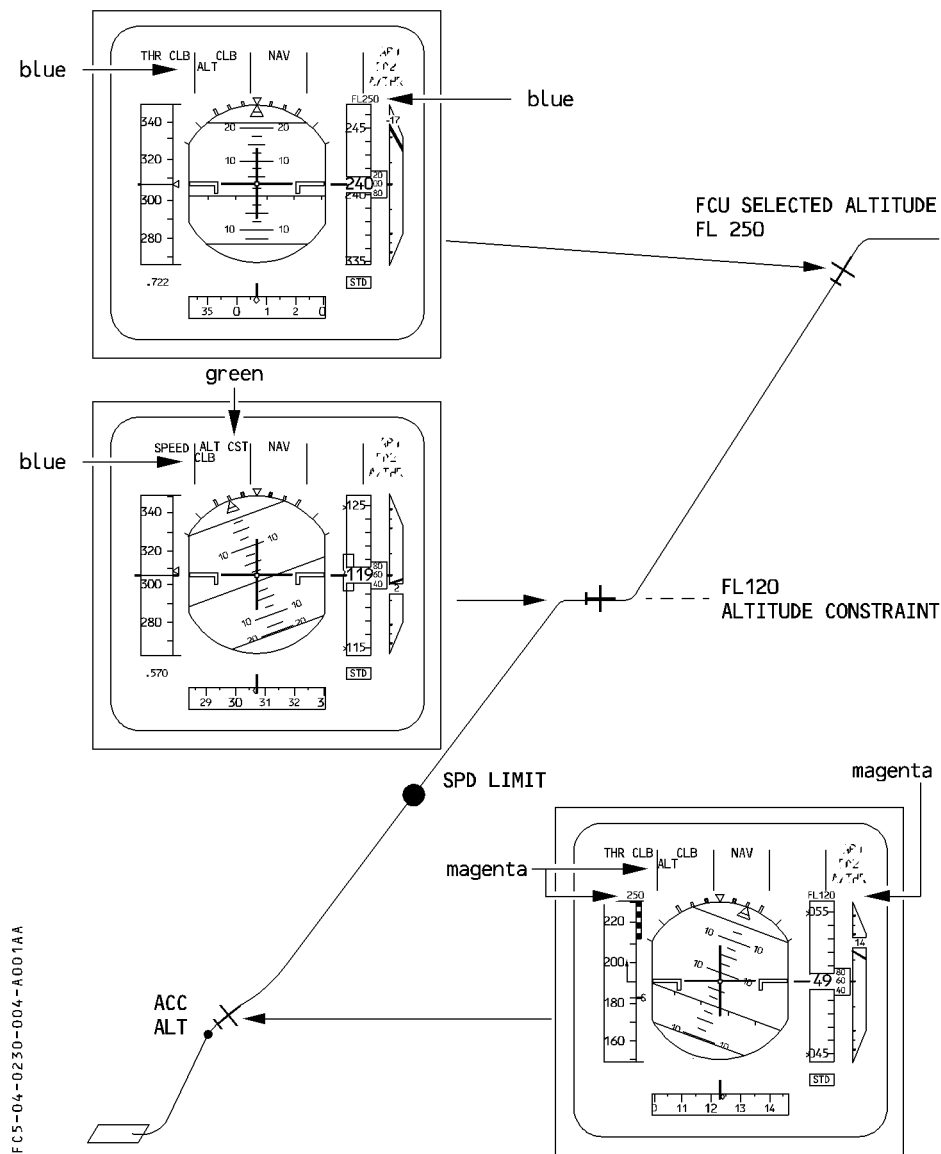
MODE	TYPE	GUIDANCE	REMARK
RWY	MANAGED	Mode used at takeoff to guide the a/c along the runway center line using LOC.	Triggered by the thrust levers at FLX or TOGA position.
RWY TRK	MANAGED	Mode used to guide the aircraft along the track the aircraft was following at the mode engagement.	
GA TRK	MANAGED	Mode used to guide the aircraft along the track the aircraft was following at the mode engagement.	Triggered by the thrust levers at TOGA with Slats/Flaps in, at least CONF 1.
NAV	MANAGED	Mode used to guide the a/c along the lateral F-PLN. Available above 30 ft after takeoff.	Automatically armed at takeoff unless HDG/ TRK is preset. In that case RWY TRK engages after takeoff.
HDG-TRK	SELECTED	Mode used to guide the a/c on a heading or a track selected by the crew. The target value is displayed in the FCU window.	Note : HDG/TRK is called "basic mode" because it is a back up mode for certain situations : —F-PLN discontinuity entry. —AP engagement with no FD. —Loss of F-PLN —MCDU NAV BACK UP
LOC* LOC APP NAV	MANAGED	Mode used to guide the a/c on the lateral approach path (LOC or F-PLN approach path).	Selected by pressing APPR pb on the FCU ; the mode that engages depends upon the selected approach in the F-PLN.
LAND	MANAGED	Common mode engaged below 400 ft RA during an automatic ILS approach.	Engaged only if LOC mode and G/S mode are already engaged.
ROLLOUT	MANAGED	Mode used to guide the a/c on the runway following an automatic landing.	FDroll out symbol is displayed on PFD at touch down.
LOCB/C* LOC B/C	MANAGED	Mode used to guide the aircraft on the back beam of a localizer.	Selected by LAT REV at destination. Activated by pressing the LOC pushbutton on the FCU

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VERTICAL MODES

MODE	TYPE	GUIDANCE	REMARK
SRS	MANAGED	Mode used at takeoff or Go Around to maintain SRS speed (V2, V2+10, VAPP ...).	Triggered by the thrust levers at FLX or TOGA position. Disengages automatically at ACC ALT or when another VERT mode is engaged.
CLB	MANAGED	Mode used to climb towards FCU SEL ALT along VERT F-PLN taking into account ALT CSTR. Available only if NAV engaged. The A/THR is in THRUST mode (CLB).	The speed target may be either selected or managed. If managed, SPD CSTR, SPD LIM, and HOLD SPD are taken into account. ALT mode is always armed ; displayed in magenta if the next level off is predicted at an ALT CSTR, and in blue if the next level off is predicted at the FCU selected altitude
DES	MANAGED	Mode used to descend towards FCU SEL ALT along the computed descent path taking into account ALT CSTR. Available only if NAV engaged. The A/THR may be in THRUST or SPD mode.	
OPEN CLB OPEN DES	SELECTED	Mode used to climb/descend directly to the FCU selected ALT. These modes disregard all ALT CSTR. The A/THR is in THRUST mode (CLB/IDLE)	The speed target may be either selected or managed. ALT mode is systematically armed and blue. Altitude target is blue on PFD.
ALT CSTR* ALT CSTR	MANAGED	Mode automatically engaged when reaching an ALT CSTR before the FCU SEL ALT.	CLB/DES mode are systematically armed (blue).
ALT* ALT ALT CRZ* ALT CRZ	SELECTED	Mode used to maintain a level flight at the FCU selected altitude.	Soft N1 mode engages when FCU selected altitude = CRZ FL Soft N1 is part of the managed guidance.
V/S-FPA	SELECTED	Mode used to guide the a/c along a vertical speed or a selected flight path angle.	Altitude target is blue on PFD. V/S-FPA is a basic mode. (Refer to HDG/TRK remark).
GS* G/S FINAL	MANAGED	Mode used to guide the a/c along the final approach path (GS or non ILS)	Selected by pressing the APPR pb on the FCU. The mode engaged depends upon the selected approach in the F-PLN. Linked to APPR common mode (APPR pb).
FLARE	MANAGED	Common mode which provides the alignment to the runway center line on the yaw axis and the flare on the pitch axis.	Engages below 50 ft RA as a function of the current vertical speed.

CLIMB MODE



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When CLIMB mode is engaged (always associated with lateral NAV mode), the system takes into account all constraints defined by the database or manually entered by the crew.

Nevertheless this mode has the following particularity :

When, the aircraft being in CLB mode, the system predicts that it will miss an altitude constraint, it will not modify the target speed.

In this case, the pilot may select an appropriate speed in order to meet the ALT CSTR.

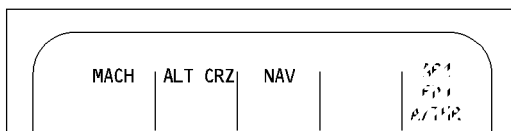
SPECIFIC MODES IN CRUISE PHASE

A/THR SOFT MODE

The autothrust soft mode engages when the aircraft is in ALT CRZ mode with the autopilot engaged, autothrust engaged in MACH mode, and is within a ± 3 kt range of the target speed. This mode decreases the autothrust gains, to reduce thrust variation in cruise with turbulence.

The autothrust soft mode disengages when the speed deviation from the target becomes too large or the target is modified ; auto thrust transition from soft to basic mode may lead to transient thrust variation. This mode is inhibited with speedbrakes extended, or with engine out or when mach target is below 0.65, or with slats extended, or with landing gear down.

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Typical FMA in CRZ with soft altitude mode engaged

STEP CLB or STEP DES

The pilot inserts a step when planning to change the cruise flight level. The system responds by displaying predictions for the new situation.

If the pilot inserts an optimum or geographic step to an altitude, a start-of-climb or descent (S/C or S/D) pseudo waypoint on the ND and the MCDU.

The minimum step size is 1 000 feet.

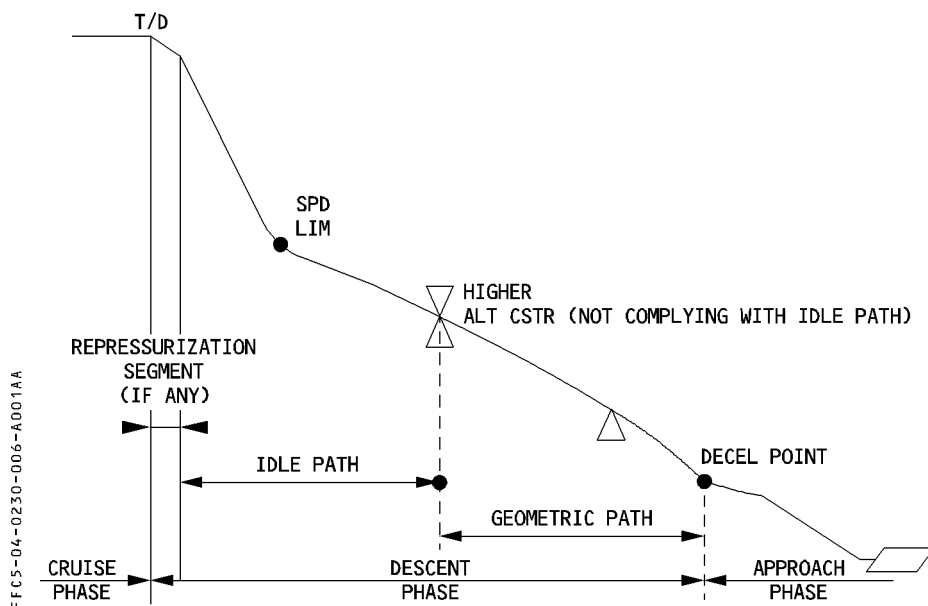
The STEP automatically reassings the new CRZ FL, SOFT ALT mode reengages when reaching the new altitude.

DES MODE

The DES mode guides the aircraft along the descent path computed by the FMGS.

The system computes this flight path backwards from the deceleration point up to the top of descent (T/D) with respect to the speed and altitude constraints.

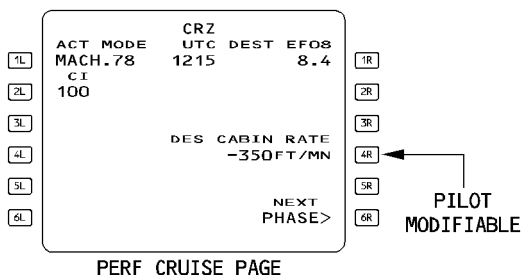
Internally, the computer divides the descent path into various segments, depending on the relative positions of the constraints. It starts at top of descent (T/D) by setting up an "idle" segment that takes the aircraft down to the first constraint, and follows this with "geometric" segments between constraints.



REPRESSURIZATION SEGMENT

The top of descent (T/D) may be updated if the pilot modifies the cabin rate of descent (default rate is – 350 feet/minute).

If the flight crew enters a lower cabin rate, the system computes a repressurization segment that takes into account the additional time needed for repressurization.



DESCENT SPEED PROFILE

The descent speed profile is usually the economical speed profile amended by any speed constraints and speed limit contained in the flight plan.

Before the descent phase is active, if the pilot does not intend to fly the ECON speed/Mach profile, a different speed or Mach can be selected to amend the speed profile.

This selected speed/Mach is obtained by entering a Mach number and/or a speed in the MANAGED field of the PERF DES page. (3L key).

PERF DES PAGE (ECON SPD)

	DES		
1L	ACT MODE MANAGED	UTC DEST 1215	EFOB 8.4
2L	CI 40	PRED TO UTC	FL200 DIST
3L	MANAGED .78/300	1159	19
4L			
5L	EXPEDITE ACTIVATE	1155	15
6L	←APPR PHASE 290		NEXT PHASE>

PERF DES PAGE

1L	ACT MODE	DES	UTC	DEST	EFOB	1R
2L	MANAGED	1215			8.4	2R
3L	C1					3R
4L	40	PRED	TO	FL200		4R
5L	MANAGED	UTC		DIST		5R
6L	-78/290	1200			19	6R
EXPEDITE 1155 15						
ACTIVATE NEXT						
←APPR PHASE PHASE→						

If the pilot manually modifies the speed during descent, the profile is not modified and the aircraft flies the same profile at a different speed.

Basic managed SPD/MACH profile in DES mode is :

- * Economical Mach or selected Mach
- * Economical Speed or selected speed
- * SPD CSTR (if any)
- * SPD LIMIT
- * GD/S/F/VAPP
- * VAPP TARGET

GUIDANCE IN DES MODE

The aircraft will not start its descent automatically when reaching the top of descent (T/D).

In order to initiate the descent, the pilot will set the clearance altitude then push the ALT selector knob.

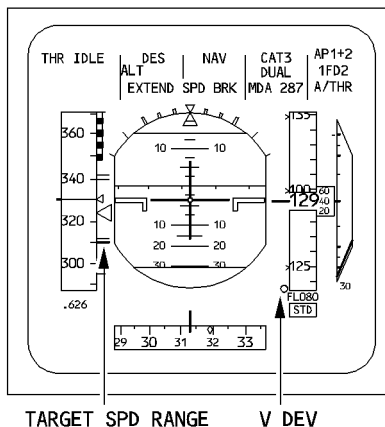
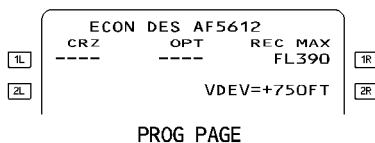
The aircraft will descend immediately.

- * If the top of descent is not reached, the aircraft descends at a constant V/S converging on the descent path.
- * If the aircraft is at or beyond T/D, it descends at idle thrust.
- During the descent :

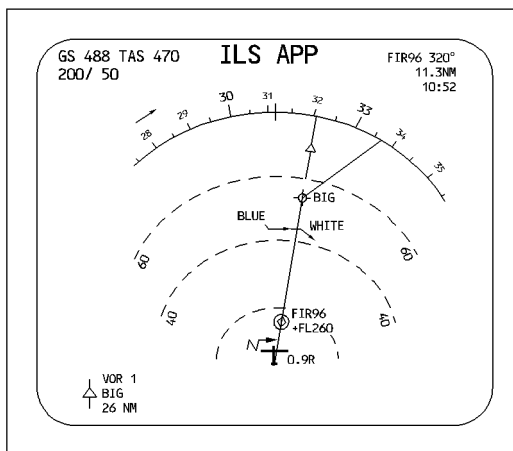
The pilot will see a vertical deviation symbol (VDEV) along the ALT scale on the PFD and a VDEV value on the PROG page, so that the aircraft's vertical position can be monitored versus the calculated descent profile.

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

- unexpected wind conditions is encountered.
- anti-icing is turned on.
- the lateral flight plan is changed.



- When the speed is managed, a target speed range displayed on the PFD defines acceptable speed variations around the nominal descent speed target.
 - If the aircraft is above the descent profile, the speed increases toward the upper limit of the target speed range as the aircraft converges on the descent profile. If this does not increase the descent angle enough, the aircraft deviates from the descent profile. (A/THR is at IDLE).
 - If the aircraft is below the descent profile, the aircraft maintains the target speed until it reaches the vertical profile. The lower margin becomes effective when the aircraft is on the descent profile but has to loose speed in order to stay on it.
- The ND shows an intercept symbol  that indicates the position where the system predicts that the aircraft will be back on the descent profile. When the aircraft is above the descent profile, the prediction is based on the assumption that the pilot will extend half speedbrakes. If necessary, the message “EXTEND SPD BRK” comes up on the PFD and the MCDU, and remains there as long as more drag (speedbrakes) is still required. The pilot should respond to this message by deploying half speedbrakes.

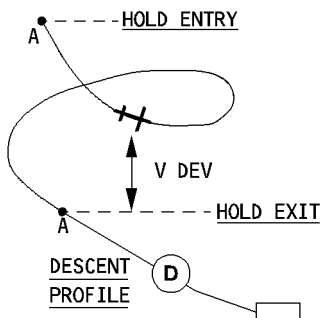


Note : With DES mode engaged, extending the speedbrakes does not necessarily increase the descent rate. It does so only if the aircraft is above profile.

● When in a holding pattern

The DES mode commands $V/S = -1000$ feet/minute while A/THR maintains the holding speed. The current VDEV is the vertical deviation from the altitude at which FM predicts the aircraft will be when it reaches the exit fix.

Until the pilot exits the hold, the FMGS in DES mode will maintain $V/S = -1000$ feet/minute considering downpath vertical constraint. This means that the aircraft will not descend below the next altitude constraint. If the aircraft reaches the next altitude constraint it will level off and ALT CSTR mode will engage.



● Too steep path

A descent segment is called “too steep path” when the FMGS predicts that the descent segment between two constraint waypoints is impossible to fly at the planned descent speed with half speedbrake extended.

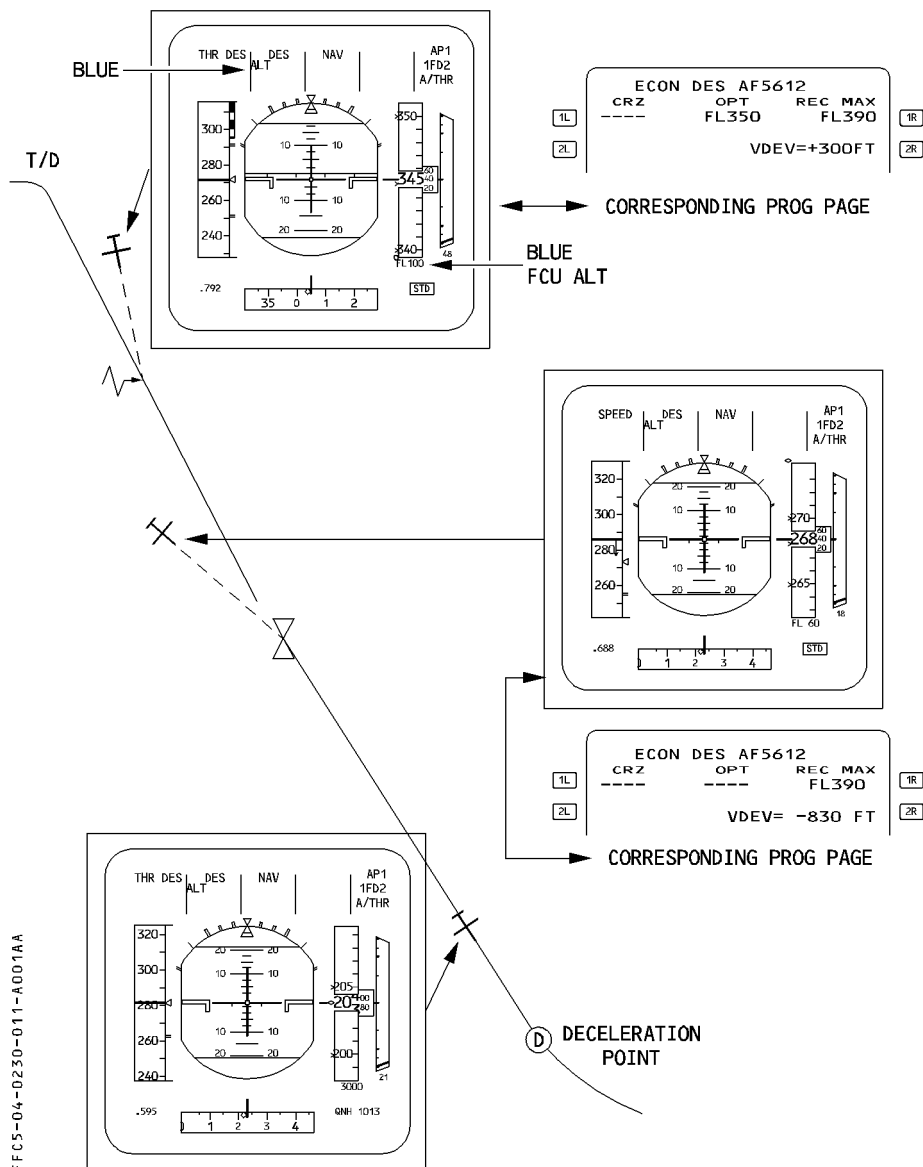
When this occurs :

The MCDU displays no predictions between the upper and the lower points of the too steep path. Relevant message “TOO STEEP PATH” is displayed on MCDU.

				AI101 →			
1L	UB191	UTC	SPD/ALT	1R			
	ABB	1238	/ FL330				
			13NM				
2L	(T/D)	1239	.79/ FL330	2R			
	BIG1A	TRK320°	21				
3L	FIR96	1242	310/★FL260	3R			
4L	-----TOO STEEP PATH-----						4R
	BIG1A						
5L	CLIFF	1246	293/★FL120	5R			
	DEST	UTC	DIST	EFOB			
6L	EGLL27R	1301	149	6.1	6R		
	TOO STEEP PATH AHEAD ↑↓						

NO PREDICTIONS BETWEEN THE
UPPER AND LOWER POINTS

DES MODE PROFILE



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APPROACH MODES

The aircraft can fly two different types of approaches :

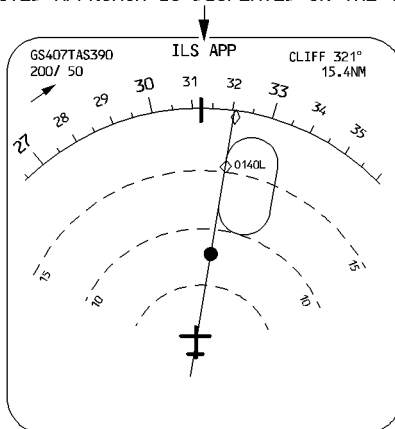
- LS (ILS or MLS) approaches
- Non-LS approaches (VOR/DME, VOR, NDB, RNAV, LOC or B/C)

The pilot uses an ARRIVAL lateral revision to insert these approaches into the flight plan.

The pilot uses the APPR pushbutton on the FCU to arm or engage the guidance modes related to the approach that he has inserted into the flight plan.

- If it is an ILS approach, the guidance modes are LOC and G/S.
- If it is a non-ILS approach, the guidance modes are APP NAV and FINAL.

THE TYPE OF SELECTED APPROACH IS DISPLAYED ON THE TOP SIDE OF THE ND



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APP NAV - FINAL MODES

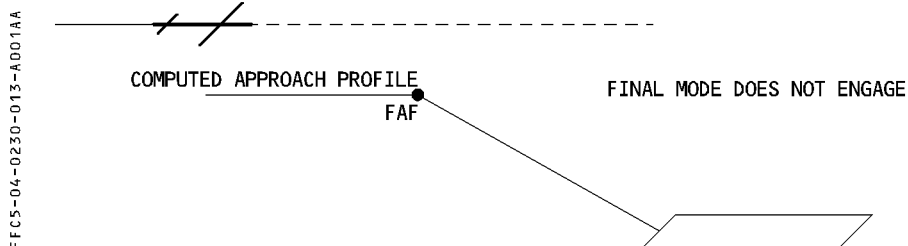
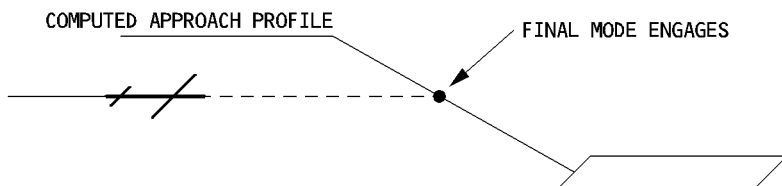
When a non precision approach is selected in the active flight plan and the APPR pushbutton is depressed, APP NAV and FINAL will arm.

If NAV mode was currently engaged, APP NAV mode engages immediately.

FINAL mode will engage when, APP NAV being engaged, the aircraft trajectory intercepts the non precision flight profile (usually a descending leg).

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If the aircraft trajectory does not intercept the approach profile computed by the FMGS, the FINAL mode will not engage :



Refer to 1.22.30, NON PRECISION APPROACH Mode.

FLIGHT MODE ANNUNCIATOR (FMA)

The purpose of the FMA is to display the guidance modes of the aircraft. The FMA shows the A/THR and AP/FD modes, as well as the engagement status of these systems and their ILS approach capabilities.

The AP/FD and A/THR use only the guidance modes displayed on the first line.

- **The first line displays :**

- * A/THR and AP/FD engaged modes in green
- * Landing capability in white (CAT 1, CAT 2, CAT 3 DUAL or CAT 3 SINGLE)
- * AP engagement (AP1, AP2 or AP1 + 2) in white

Note : CAT 1 is the lowest capability displayed in that field. CAT 1 covers different requirements including raw data.

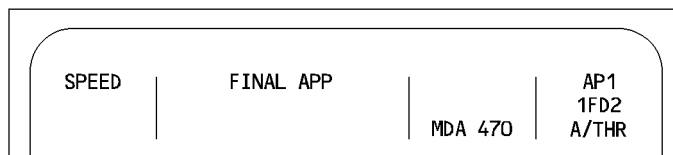
- **The second line displays :**

- * Armed mode in blue except ALT mode when it is armed because of an altitude constraint (magenta).
- * Preset speed or Mach when it is selected by the crew.
- * FD engagement in white. (1FD2 ...).

- **The third line displays :**

- * MDA/MDH or DH/NO DH in blue followed by the value entered manually by the pilot.
- * A/THR status in white when active, in blue when armed.
- * Operational messages

For a detailed description of all indications displayed on the FMAs. (Refer to 1.22.30).



TYPICAL FMA DURING NON PRECISION APPROACH

- Both FMAs are driven by the master FMGC (for a detailed description of the FMA, Refer to 1.22.30).
- Each new annunciation is boxed for 10 seconds.