

CITATION X

Autopilot

It consists of 4 control modules and a display module:

The central panel where the different operating modes of the autopilot are grouped



The CRS (Course), ALT SEL (Altitude Select) and HDG (Heading) selection buttons.



The navigation mode selection module.



The PFD (Primary Flight Display)





The position of the two lines indicates the offset between the aircraft's travel and that it should have to reach the beacon. Here the axis of the beacon is to the right of the plane, offset by about 4°.



In "NAV" mode the course indications are green, as in the previous screen view, while in "FMS" mode they are magenta.

The autopilot controls :



HDG : (HEADING). The autopilot follows the heading displayed by the HDG button.

NAV : (NAVIGATION). The autopilot follows the heading displayed by the CRS or FMS to reach the selected beacon or transition point.

APP : (APPROACH). Used to follow an ILS and its GLIDESLOPE for landing.

BC : (BACKCOURSE). Used for approaches against the direction of an ILS beacon.

ALT : (ALTITUDE). It stabilizes the aircraft at the altitude selected by the ALT SEL button.

VNAV : (VERTICAL NAV). Used to follow the altitude indications given by the FMS.

BANK : Used to select the aircraft maximum angle of turn of the aircraft : 20° or 35° (default). The value is displayed on the bottom left of the MFD.

STBY : (STANDBY). Neutral position of the autopilot.

FLC : (FLIGHT LEVEL CHANGE). Maintain speed during change in altitude.

C/O : (CHANGE OVER). Allows the autopilot in FLC mode to regulate the aircraft speed in mach instead of kts.

VS : (VERTICAL SPEED). Used to maintain a constant rate of climb or descent in ft/min.

SPD : (SPEED) . Activate speed regulation.

NOSE DN – NOSE UP : Manual change of altitude when the autopilot is in VS, FLC or STBY mode. Speed change if SPD is enabled.

AP : Control of the autopilot. It can only be activated above the MINIMUMS (200 ft) value indicated on the PFD (200 RA). When it is activated, it is on A but it will switch to B if the corresponding FGS (Flight Guidance system) fails.

YD : (YAW DAMPER) : It acts on the rudder to prevent the aircraft from oscillating around the Z axis (Dutch Roll). It is integrated into the autopilot when the latter is active, but the YD can be used alone without the autopilot. The selection A or B is automatic on commissioning.

M TRIM : (Mach TRIM) : It turns off the automatic horizontal stabilizer when the autopilot is not in use. An error then appears on the EICAS. The selection A or B is automatic on commissioning.

PFD SEL : (PFD Select) : It selects the data coming from the computer which manages the PFD of the pilot or that of the co-pilot.

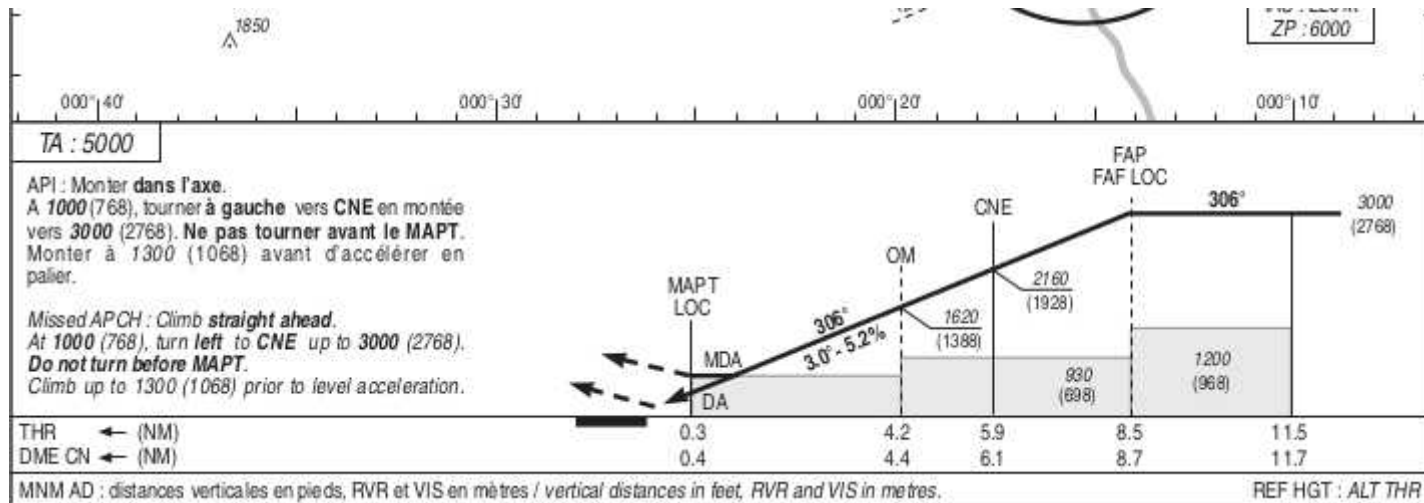
To put all this into practice, let's schedule a short flight from LFOH (Le Havre) to LFRK (Caen) in NAV mode.

LFOH take-off on runway 22 - Landing at LFRK runway 31 via LGL's VOR.

VOR LGL = 115.000

ILS LFRK = 110.950 axis 306°

AIS IAC charts provide the following approach:



Arriving at 3000 feet at a distance of 11.5 nm from the runway threshold and maintaining this altitude until the GLIDE intercept point (FAP). Alignment is at 306°.

In the RMU1, in the NAV part, we enter the frequency 115,000 in stand-by which we switch to the 1st line. In stand-by, we enter the ILS frequency, 110.950.



We can also program it in RMU2 if we plan to use NAV2.

By turning the BRG knob to VOR1, we will have the direction of the VOR « LGL »



The green needle is not indicating anything yet because we are outside the reception area of the VOR « LGL ». To anticipate the capture of the VOR, we can align, by means of the CRS button, the green needle with the indication given by the blue needle corresponding to the direction of the VOR.



For takeoff, we use the HDG button to position the blue heading index on the direction of the plane (clicking on the button allows automatic adjustment).

The aircraft is ready for take off. We choose an altitude of 5000 ft (FL50) using the ALT SEL button.

We program the auto pilot as follows: NAV – ALT – SPD.

Not being in the reception area of the VOR, the HDG indication also lights up, which means that when the autopilot is activated, the airplane will take off in the direction of the HDG index until it is at an altitude sufficient to intercept the VOR.

We could also have programmed the heading directly in the direction of the VOR given by the DTK indication. In this case, the aircraft will make its turn as soon as the autopilot is activated.



We have activated the TOGA function (button on the side of the throttles) for an assisted takeoff. TO is indicated on the PFD and ALT is pending. TO will turn off with the activation of the autopilot and ALT will be active.

This TOGA function is not mandatory and is not recommended on short runways because it requires a longer take-off distance.



The plane took off, the landing gear and flaps are retracted. The minimum altitude of 200 ft is exceeded, indicated by the green color of the altitude index, the autopilot can therefore be activated. The course followed is that of the HDG until the VOR is landed. TO was turned off with the activation of the autopilot and now altitude control takes over.



The VOR is intercepted. HDG turned off on the autopilot and on the PFD. The plane takes its course. There is an offset on the hands. We will therefore align them using the CRS button.



The two hands are aligned, the plane is on the right path.
 The speed can be increased to 260 Kts (maximum allowed at this altitude) by means of the dial.



The aircraft is approaching the VOR « LGL ».
 We set the HDG index to 306° which is the orientation of LFRK runway 31 in case the Caen LOC is not recognized after passing the beacon.



The tag is out of date. The « To From » needle changed direction and moved to the « From » side.



As soon as the "To From" indicator was switched, we switched to the LOC frequency of LFRK (110.95) by pressing the NAV button, which made us switch from NAV1 to NAV2 using the frequency programmed in the RMU2. We could also have stayed on NAV1 and shifted the frequency stored in STBY (110.95) from the RMU to the active position.

We are lucky, the LOC is recognized by the autopilot who therefore did not go through HDG regulation.



We align (optional) the green needle on the heading of the plane (click on the CRS button).
We lowered the altitude to 3000 ft to prepare for the ILS interception and reduced the speed to 250 Kts.



We are less than 20 Nm from the runway. We reduce the speed to 200 Kts.



We are 10Nm from the runway, the ILS has been intercepted and the glideslope indicators are visible. We switch the autopilot to « APP » (APPROACH) mode. It's time to get the plane ready for landing.



Speed reduction to 180 Kts, flaps at 5 °, landing gear extended. The plane begins its descent.



The plane is descending to follow the glideslope. If the speed has trouble falling to 180 Kts, the airbrakes are extended (CTRL B). The information is shown on the EICAS.



To prevent the turbines from revving up, at around 190 Kts, lower the speed to 160 Kts and extend the flaps to 15°. Retract the speed brakes (CTRL B). The indication turns off on the EICAS.



At around 170 kts, lower the speed to 140 kts and fully extend the flaps.



When reaching "MINIMUMS" (200 ft), the altitude index changes to orange. The autopilot turns off. We resume manual piloting.



Flare and landing.



Braking using the "REVERSE" (DEL-key on the keyboard) while putting the throttle to the maximum.

We are now going to make a direct flight from LFOH - 22 to LFRK - 31 in FMS mode.

LFRK ILS 31 frequency: 110.95 to enter the RMU.

The flight having been previously saved in the memory of the CDU (see CDU tutorial), we just need to recover it (FPL LIST of the CDU).



It appears on the MFD in magenta color.



After pressing the FMS button, the trajectory is inscribed on the PFD in magenta color.



We will adjust the cruise altitude so that a TOD (Top Of Descent) is displayed on the MFD. For this flight it will be FL65 or FL70.

The TOD is also visible in the menu « Autopilot → Route manager ».

Route Manager

Departure: **LFOH** Le Havre-Octeville Rwy: **22** SID:

Arrival: **LFRK** Caen Carpiquet Rwy: **31** Approach: STAR:

Cruise Speed (kts): **0** Cruise Altitude (ft/FL): **7000**

Target: LFOH-22 Dist: 0.01 nm ETA:

> 000 LFOH-22 (22)	000 LFOH-22 (22)
001 22-3	223 3.0nm 3300'
002 22-6	223 3.0nm 6300'
003 TOD	189 17.9nm
004 APP-4	189 5.7nm
005 31-12	260 2.9nm 4300'
006 31-8	306 4.0nm 2300'

Waypoint: Add

Format: list of (airport|fix|nav|lon,lat) with optional @alt -- e.g. "KSFO@900", "SAHEY CITY@6000"
 Lon,lat can be entered signed, with NSEW, or as degrees and minutes, e.g. "-2.5,51.3", "2.5W,51.3N", "11°47'17"E,48°21'23"N"
 Any location can be be offset by a radial and distance in Nm, e.g. DCS/45/10 or 18.5E,33.9S/290/4.5

Clear List Remove Route Jump To Activate Load ... Save ... Close



We are now programming the autopilot in « VNAV » mode which will also activate « NAV » mode. The « SPD » speed control was automatically activated when the « FMS » button was pressed.



We are ready to take off. Pressing the «TOGA » button will allow us to take off automatically. «TO» is displayed on the PFD with « VALT » in standby. The « Flight Director » indicates the angle of climb calculated for takeoff in «TOGA » mode.



After takeoff, retraction of the landing gear and flaps. The minimums being exceeded, the altitude index is green and the autopilot can be activated. The speed is automatically regulated by the FMS computer and cannot be changed using the thumbwheel.



First turn performed automatically by the FMS computer and the autopilot.



The flashing yellow « TOD » indication on the MFD indicates that the « TOD » is less than 4 Nm. The FMS computer also reduces the plane's speed to 200 Kts to prepare for the descent that will take place after the « TOD » has passed.



The « TOD » is reached, the plane begins its descent.



We are less than 10Nm from the destination, the Glideslope indicators have appeared. It's time to get the plane ready for landing.



The autopilot automatically switched to « APPR » (Approach) mode. We set 5° of flaps and lower the landing gear. The computer programs the speed at 180 Kts



As the speed does not drop quickly enough due to the descent, we extend the speed brakes (CTRL B), which is indicated on the EICAS.



We set flaps to 15°. The computer programs the speed at 160 Kts.



We retract the speed brakes and extend the flaps to the maximum. The computer programs the speed at 140 Kts.



The minimums are reached, the autopilot has deactivated. We're back in control for landing.