

CITATION X

Autopilot

It consists of 4 control modules and a visualization module:

The central panel where the different modes of operation 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 aircraft, offset by about 4°.



In "NAV" mode the travel 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 the selected beacon or transition point.

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

BC : (BACKCOURSE). It is used for counter-directional approaches to an ILS beacon.

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

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

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

STBY : (STANDBY). Autopilot neutral position.

FLC : (FLIGHT LEVEL CHANGE). Maintain the speed during altitude changes.

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

VS : (VERTICAL SPEED). It maintains a rate of climb or descent in ft/min.

SPD : (SPEED) . Activate the speed control.

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

AP : Autopilot activation. It can only be activated above the MINIMUMS (200 ft) value on the PFD (200 RA). When it is activated, it is set to A but it will switch to B on a failure of the corresponding FGS (Flight Guidance System).

YD : (YAW DAMPER) : It acts on the rudder to avoid the aircraft oscillations around the Z-axis (Dutch Roll). It is integrated into the auto pilot when it is active but the YD can be used alone without the autopilot. Selection A or B is automatic upon commissioning.

M TRIM : (Mach TRIM) : It disables the automatic horizontal stabilizer when the auto pilot is not in service. An error appears on the EICAS. Selection A or B is automatic upon commissioning.

PFD SEL : (PFD Select) : It selects data from the computer that manages the pilot's or copilot's PFD.

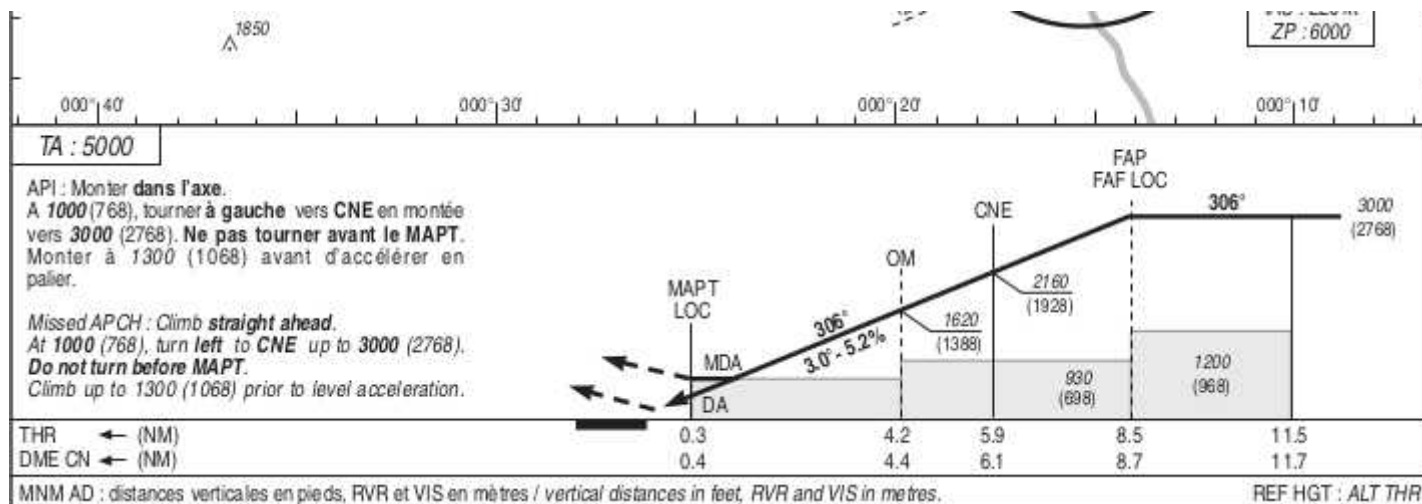
To put all this into practice, let's schedule a small flight from LFOH (Le Havre) to LFRK (Caen) in NAV mode.

Take-off from LFOH on Runway 22 – Landing at LFRK Runway 31 via LGL VOR.

VOR LGL = 115.000

ILS LFRK = 110.950 axis 306°

The 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 that we switch to the 1st line. In stand-by, we enter the frequency of the ILS, 110.950.



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

By setting the BRG button to VOR1, we will have the direction of the VOR « LGL »



For the moment, the green needle means nothing because we are outside the reception zone 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 take-off, we adjust, by means of the HDG button, the blue index of heading on the direction of the aircraft (a click on the button allows the automatic adjustment).

The aircraft is ready to take off. We selected 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 VOR reception area, the HDG indication also illuminates, which means that when the autopilot is activated, the aircraft 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 turn as soon as the autopilot activates.



We have activated the TOGA function (button on the side of the throttles) for an assisted take-off. TO is indicated on the PFD and ALT is waiting. TO will turn off with autopilot activation and ALT will be active. This TOGA function is not mandatory and should not be used on short runways because it takes more take-off distance.



The plane took off, the landing gear retracted and the flaps as well. 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 received. 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 needles. We will therefore align them using the CRS button.



The two needles 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 thumbwheel.



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



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



Upon switching the «To From » indicator, we switched to the LFRK LOC frequency (110.95) by pressing the NAV button, which changed us from NAV1 to NAV2 using the frequency programmed in RMU2. We could also have stayed on NAV1 and passed the stored frequency in STBY (110.95) from the RMU to the active position. We are lucky, the LOC is recognized by the autopilot who 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 track, the ILS has been intercepted and the glide indicators are visible. We switch the autopilot to « APP » (APPROACH) mode. It's time to get the machine ready for landing.



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



The plane is descending to catch up with the glide. If the speed has trouble falling to 180 Kts, the speed brakes are extended (CTRL B). The information is listed on the EICAS.



To prevent the reactors from revving up, at around 190 Kts, lower the speed to 160 Kts and extend the flaps by 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.



The « MINIMUMS » having been reached (200 ft), the altitude index changes to orange. The autopilot turns off.
We're back in control for landing.



Rounding and landing.



Braking using the « REVERSE » (SUPPR key on the keyboard) while putting the throttle to the maximum.

We will now 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 appears 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 airport, the Glide indicators have appeared. It's time to get the machine ready for landing.



The autopilot automatically switched to « APPR » (Approach) mode. We put on 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 go out 15 ° of flaps. 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.