

# - FlightGear 747-400 – Autopilot and Route-Manager -

## General

This documentation is valid for the version of 747-400 from 'buster' (<http://flightgear.azuana.de>).

Our aircraft can be controlled by two different automatic systems. The first one is the autopilot, that controls the behaviour of the aircraft according to predefined values for heading, vertical-speed, altitude.

The second control-system is the route-manager, that calculates heading, vertical speed and altitude from specified waypoints, the route, and passes these values to the autopilot.

In our 747-400 you can specify settings for the autopilot using switches in the cockpit, the route has to be specified by using the route-manage dialog in the Menu 'Autopilot' -> 'Route Manager' in FlightGear.

In summary we can say: the route-manager controls the autopilot → the autopilot controls the aircraft.

## Autopilot



Abbildung 1: Autopilot-Dialog

The autopilot of our 747-400 comes with the following modes, that are available for now:

- 1) 'SPD': means 'Speed-Hold', holds the specified speed by using throttle.
- 2) 'HDG': means 'Heading-Bug-Hold', holds the aircraft on the specified magnetic course using the ailerons and the rudder.
- 3) 'VL': means 'Vertical-Speed-Hold', holds the specified climb-/sinkrate using the elevator.
- 4) 'ALT': means 'Altitude-Hold', holds the specified altitude using the elevator.
- 5) 'LNAV': holds course according to the specified values for NAV1 (values must be specified in the autopilot-dialog) using ailerons and rudder. As NAV1 you can specify a VOR or an ILS.
- 6) 'VNAV': holds the aircraft on the glideslope according to the corresponding values for NAV1 (values must be specified in the autopilot-dialog) using the rudder, assumed the specified NAV1 is an ILS and the ILS provides a Glideslope-signal.

By clicking on the digits of the values for the autopilot you can change those values. Using the left mouse-button you increment the digit, using the middle-mouse-button you decrease them. You can also use the mouse-wheel if

your mouse provides a wheel.

You can activate the different autopilot-modes by clicking on the corresponding switch on the autopilot-panel. To disengage the whole autopilot you can click on the disengage-button on the autopilot-panel or press 'd' on your keyboard.

If you like to perform a fully automatic landing, you can do so by keeping the switches for NAV1-hold ('LNAV'), Glideslope-hold ('VNAV') and Speed-hold ('SPD') engaged (assumed you have selected the appropriate ILS-frequency in the radio-dialog in field 'NAV1'). You have to control manually only the flaps, the speedbrakes and the gear. The autopilot applies the speedbrakes only short before touchdown, if you want to apply then earlier you have to do this manually.

After breaking down to 20 kts the autopilot will disengage automatically and you get back the control of the aircraft.

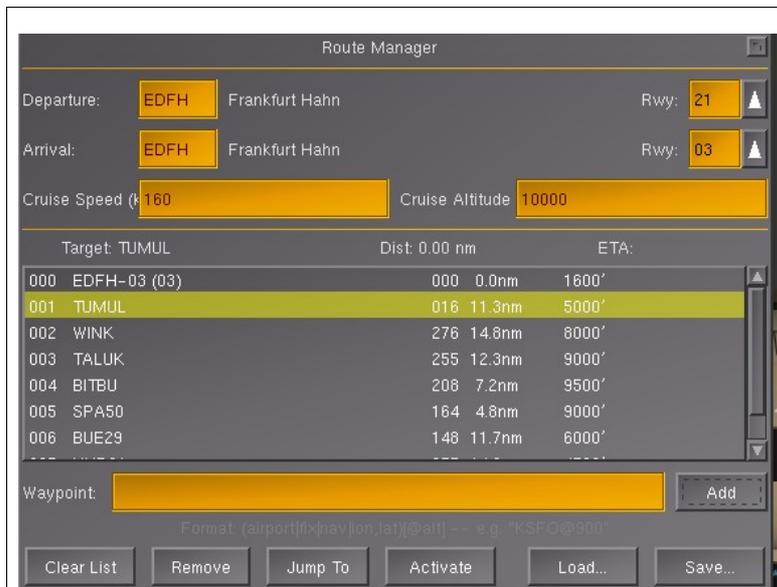
**Note:** An automatic landing is recommended only at appropriate conditions of windspeed (be careful if you got strong crosswinds). Also the terrain should be plain and not much descending/ascending some miles in front of the runway, as the autopilot uses the actual elevation over ground for controls. Of course, you should take care of an appropriate approach speed if you enter the glideslope.

## Route-Manager

To fly a route controlled by the route-manager, do the following:

Ensure all autopilot-modes are switched off.

Then type in your route by using the route-manager dialog (in FlightGear in Menü -> 'Autopilot' -> 'Route Manager'). You can specify each waypoint in the following syntax: 'waypoint-id@altitude' z.B. 'Metro@5000' where 'Metro' specifies the name of the waypoint (here the VOR 'Metro' at Frankfurt am Main), '5000' specifies the altitude you want to pass the waypoint.



*Abbildung 2: Route-Manager-Dialog with activated route*

After inserting all waypoints activate the route by clicking the 'Active'-button on the route-manager dialog. Eventually you have to jump to the first waypoint by clicking the 'Jump To'-button to make the first waypoint the active one (the first to fly), because here after activating the route, the

active waypoint is your departure airport. Now you can close the route-manager dialog.

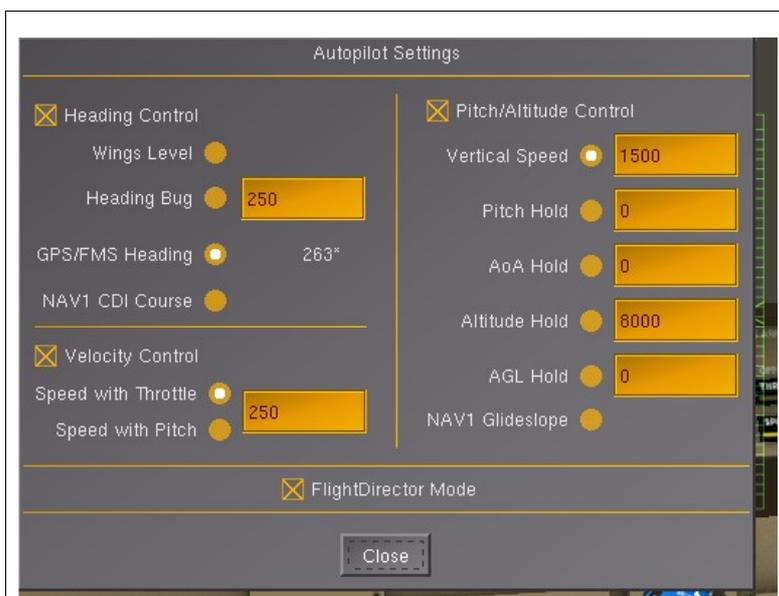
Next you start your aircraft by manual control until you established a stable flight, so the autopilot can take over the controls without getting into trouble.

Now you can switch the 'F/D'-switch left on the autopilot-panel to 'ON' to hand over the controls to the route-manager.



*Abbildung 3: F/D-Switch on Autopilot-Panel*

After a small delay the route-manager should turn on the autopilot-switch 'VS' (vertical-speed-hold) and set the values for 'Vertical-Speed-Hold' and 'Altitude-Hold', also it should turn on the autopilot-mode 'True-Heading-Hold' (you cannot see this in the cockpit-displays, because no switch/display for 'True-Heading-Hold' exists in the cockpit. To control this you can open the autopilot-dialog, here should be 'GPS/FMS Heading' activated (this is the same as 'True-Heading-Hold' on activated route-manager).



*Abbildung 4: aktivated autopilot-mode 'GPS/FMS Heading'*

The route-manager now calculates in certain intervals the necessary vertical

speed and sets them as values in the 'Vertical-Speed-Hold' display.



Abbildung 5: Autopilot settings while route-manager has been activated (VS active)

Short before reaching the specified altitude for the active waypoint the route-manager switches to the autopilot-mode 'Altitude-Hold'.



Abbildung 6: Autopilot settings after having reached the waypoint height (ALT active)

For calculation of the vertical speed the autopilot uses the following rules: below a elevation over ground of 5000 feet: minimal ascending speed is 1500 feet/min, above 5000 feet over ground: minimal ascending speed is 500 feet/min. In general the limits for ascending vertical speed is 2000 feet/min. The descending vertical speed limits are: minimal descending vertical speed is -200 feet/min, maximal descending vertical speed is -1000 feet/min.

You may change the settings for 'Vertical-Speed-Hold' and 'Altitude-Hold' manually while the route-manager is activated. If you change the setting for 'Vertical-Speed-Hold', the route-manager will not touch this setting until reaching the next waypoint, in this case you have to take care of the vertical speed yourself until crossing the actual waypoint. Also a manually set altitude-hold setting will be kept until reaching the next waypoint.

**Important:** If you want to take over the controls of the aircraft or the autopilot manually, you have to disable the route-manager by setting the 'F/D'-switch back to 'OFF'.

## Notes

Flying by route-manager always means to fly in direct direction to the next waypoint. For now there is no possibility to fly on a special radial, as it is possible to approach a VOR using radio-navigation (even if you have specified a VOR as the waypoint).

You can specify each kind of position-marker as waypoints, like airports,

VOR's, NDB's, fixes, but be careful: my experience is, that if you specify a VOR, FlightGear will not always be able to identify it, sometimes it may happen that FlightGear identifies a fix or other nearby position-marker with similar name as the waypoint instead of the VOR. You can find waypoints by using the MP-Map ('<http://mpmap01.flightgear.org>') or the build-in FlightGear Mini-Map (see the Menu of FlightGear, is available only in some newer GIT-versions of FlightGear).