

Autopilot AP-45

The AP-45 pneumo-hydraulic autopilot is designed to stabilize the aircraft along three axes in straight horizontal flight. When the pilot acts on the corresponding autopilot control buttons, it is possible to perform ascent, descent, planning, flat turn and turn.

The principle of operation of this AP is to control the aircraft's rudders with a hydraulic steering machines (three channels with feedback), driven over a pneumatic device by the sensitive elements of the AP - a directional gyro indicator and an attitude indicator.

The proposed package includes three interconnected devices: automatic directional and transverse-longitudinal stabilization unit, switching AP systems valves unit and a 2-pointer pressure gauge.

Features:

- custom logic of the autopilot operation, which consists in direct influence on the deflected planes
 - the directional gyro indicator (hereinafter referred to as the DGI) of the course automatic machine does not have a constant guiding magnetic force and therefore must be set manually to any desired course (including magnetic)
 - realized DGI deviations:
 - own - (up to ± 12 degrees/h);
 - latitudinal or "apparent" - $(15\sin(f) \text{ deg/h})$;
 - azimuthal correction (meridian convergence angle or Givry correction)
 - original night illumination of the automatic stabilization unit
- Note: the own simulator gyroscope drift has no effect on this device. Also, resetting the drift with the "D" key (default) is useless for him.



1. Feedback card (course changes)
2. DGI card (current course)
3. Longitudinal stabilization feedback card
(blue area - pitch up, brown - pitch down)
4. Bank scale
5. Bank feedback index
6. Index-indicator of the lateral bank amount
7. Airplane index, similar in principle to gyro horizon
8. Locking gyroscope knob for setting it to the desired relative course
9. Rotating feedback card knob for changing the course of the aircraft (L - for a left turn, R - for a right turn)
10. Lateral stabilization control knob (L - left bank, R - right bank)
11. Longitudinal stabilization control knob (P - ascent, S - descent)

To ensure the functionality of the AP, air pressure/vacuum and oil pressure in its own system are required, which is provided by the operating engine of the aircraft. The both operating ranges is controlled by a two-pointer pressure gauge AP;

discrepancy between the pressure gauge values and the working ones will disconnect the steering machines with the planes (for example, at minimum or maximum engine rpm).



Air and oil pressure gauge in the autopilot system

left scale - air pressure (0-200 mm Hg)
right scale - oil pressure (0 -20 kg/cm²)



AP activation valves:

upper - turning on the steering machines, lower - turning on the hydraulic system

Working with autopilot AP-45

The autopilot is allowed to be activated at an altitude of 600m at least

Turning autopilot on

- adjust the aircraft trims so as to remove the load from the controls
- turn on the autopilot hydraulic system valve
- check the air pressure (80-100 mm Hg) and oil pressure (5-12 kg/cm²) shown by pressure gauge.
- by rotating the control buttons, combine all feedback indices with marks on the scales (gyro horizon and DGI)
- turn on the steering machines valve
- Make sure the autopilot has taken control

Note:

Rotation of the buttons is produced by mouse scrolling up or down ("locking" button - with additionally pressed LMB).

When loading an aircraft in the simulator, the autopilot DGI is set to random value. Setting to the desired course (including magnetic) is produced manually using the "locking" button. And at will solely.

Controlling the autopilot

Using the autopilot, you can fly on a given course, climb, planning and turn.

If it is necessary to change the initially set course of the aircraft, slowly rotate the "turn" button until the aircraft reaches a new course.

To transfer the aircraft for planning, reduce the engine rpm first and then rotate the "altitude" button in the direction shown by the "C" symbol (descent, scroll up) until the aircraft is tilted to the desired angle. To put the aircraft into ascent, increase the engine rpm first and then rotate the "altitude" button in the direction shown by the "P" symbol (climb, scroll down) until the aircraft reaches the position required for climb.

To perform a turn, tilt the plane with the “bank” button to the desired angle and immediately begin to rotate the “turn” button in the direction of the turn. The slip indicator ball should be in the center at the moment. If the aircraft tends to descend or climb during a turn, the aircraft’s position is corrected with the “altitude” button.

To take the aircraft out of a turn, stop rotating the button “turn” and level the plane using the “bank” button.

Note: periodically, after 15-20 minutes during a flight on a given course, it is necessary to check the aircraft's heading using a magnetic compass and return it to the given course by rotating the "turn" button in the appropriate direction in case of deviation of the aircraft (or locking the autopilot DGI, as described above).

To avoid sudden jerks when turning, it is recommended not to exceed the difference between the current and set course more than 30-40°

Turning autopilot off

To disable the autopilot, you need to close the steering machines valve by clicking on it with LMB.

For convenience during the landing process, the ability to disable the AP using standard method has been introduced (the “Z” key, or a correspondingly assigned joystick button); At the same time, the steering machines valve is turned off. However, it should be taken into account, this will not be possible to turn the AP-45 on, and pressing "Z" when the AP is turned off will trigger the activation of the default autopilot with unpredictable consequences.

After the AP is turned off, the position of the deflection planes remains at the previous state, therefore, if the AP shutdown did not occur in horizontal flight, it is necessary to level the aircraft manually.

Recommendations for use in models

This package includes three devices:

- stabilization automatic unit (AP-45.xml);
- autopilot activation valves unit (AP-45_valve.xml);
- 2-pointer pressure gauge (AP-45_gauge.xml)

The pressure gauge made in two versions: caseless, for placement on the co-pilot panel, to the right of the automatic stabilization unit (IL-14T), and boxed, for placement on the left under the first pilot instrument panel (IL-14P, IL-14M). The boxed version is located in the AP-45.cab file; to replace it with the another one, you need to copy over 2 files from the AP-45_gauge_caseless folder.

If for any reason you are not satisfied with the proposed illumination option for the automatic stabilization unit, the xml without it is located in the AP-45_wo_light folder. Copy with overwrite.

All three devices are required to be used; they are interconnected. The installation is standard.

For proper operation of the kit, it is necessary to register the string `normal_pressure=1565.000000` in the [hydraulic_system] section of the aircraft.cfg.

This number corresponds to a general hydraulic system pressure of 110 kgf (according to the technical description of the IL-14).

In some cases, it may be necessary to modify the devices to suit existing needs.

This package was tested on the IL-14P model made by Jens B. Kristensen

I express my deep gratitude to Alexander Belov for his help in creating the autopilot logic and the DGI behavior.