X-Plane

S-TEC 55 Autopilot

Pilot Operating Manual

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Tutorial

This document has been created as a companion to the official S-TEC 55 autopilot tutorial by Philipp Ringler:

https://www.youtube.com/watch?v=8jKtSFxT698

Where relevant, chapter headings also reference the relevant offset in the video, in terms of minutes and seconds.

The S-TEC 55 Autopilot

The S-TEC 55 is a high-performance autopilot that controls roll and pitch, to reduces pilot workload through all modes of flight. The device is fully IFR-capable and may be used in conjunction with ILS and GPS-based approaches. The device is capable of extremely precise hands-off GPS navigation, and features 'Control Wheel Steering' - a system that allows for the pilot to provide control input, without de-coupling the autopilot. At the end of the pilot's maneuver, the autopilot resumes authority.

S-TEC 55 Specifications and Features:

- ✓ Physical dimensions – 6.25 inches x 1.5 inches x 10.60 inches
- ✓ Weight – 3.0 lbs.
- ✓ Display size – 10 inches
- ✓ Display Type – Liquid Crystal (LCD)
- ✓ Power Requirements – 14/28 Volts DC
- ✓ Configuration – Case contained, radio-stack mounting
- ✓ Control wheel steering
- ✓ GPSS (GPS Roll Steering)
- ✓ Heading preselect & hold
- ✓ Altitude hold with optional altitude trim
- ✓ Course intercept capability
- ✓ NAV mode
- ✓ Dual mode-HDG/NAV & HDG/APR
- ✓ VOR/LOC/GS/REV/GPS coupling
- ✓ Selectable coupling gains
- ✓ VOR/LOC/GS/REV/GPS course deviation and NAV flag warning
- ✓ Digital vertical speed command
- ✓ Pitch trim annunciation

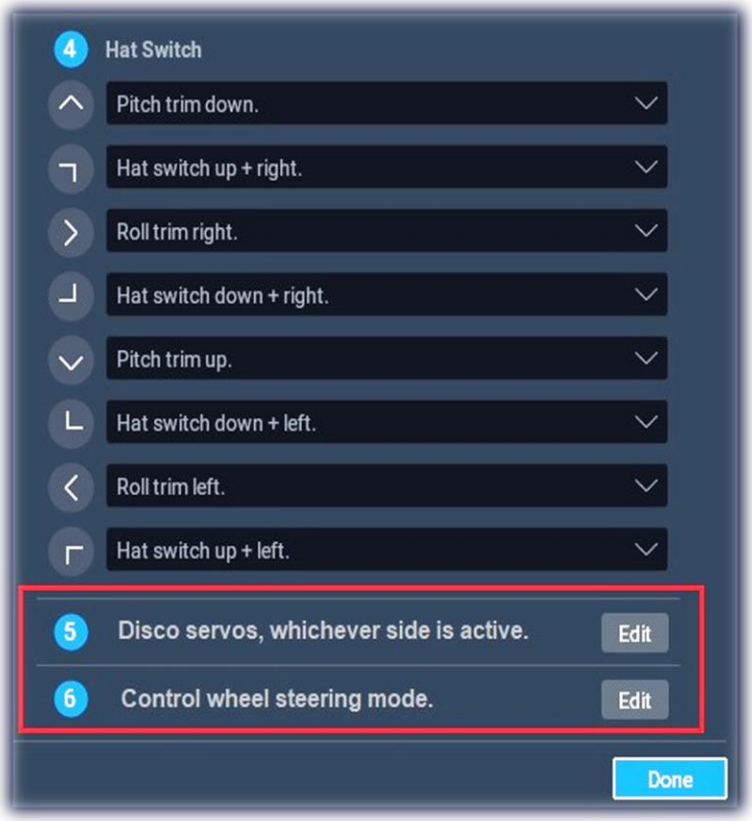
The Laminar Research S-TEC 55

The Laminar Research / X-Plane 11 S-TEC 55 has been developed to resemble the real model, both in appearance and function. However, the capability and operation of this device in the simulator may differ in some areas to the real product. This manual describes only the capabilities, and functions of the S-TEC 55 as modeled in X-Plane.

The S-TEC 55 system is featured in some of the aircraft shipped with X-Plane 11. Additionally, as a core component of the simulator, the S-TEC 55 (with associated logic) can be ‘dropped’ into a third-party aircraft and used immediately.

Assigning peripheral controls [@1:00]

This section of the manual deals with the assignment of external computer peripheral buttons to most closely simulate the operation of the autopilot in a real-life scenario. If you are missing the necessary external peripherals, you may elect to skip this section.



Autopilot Disconnect

This button provides the pilot with a rapid-disconnect capability, used in situations where full control is being returned to the pilot permanently.

Map your chosen button to the 'Disco servos, whichever side is active' function.

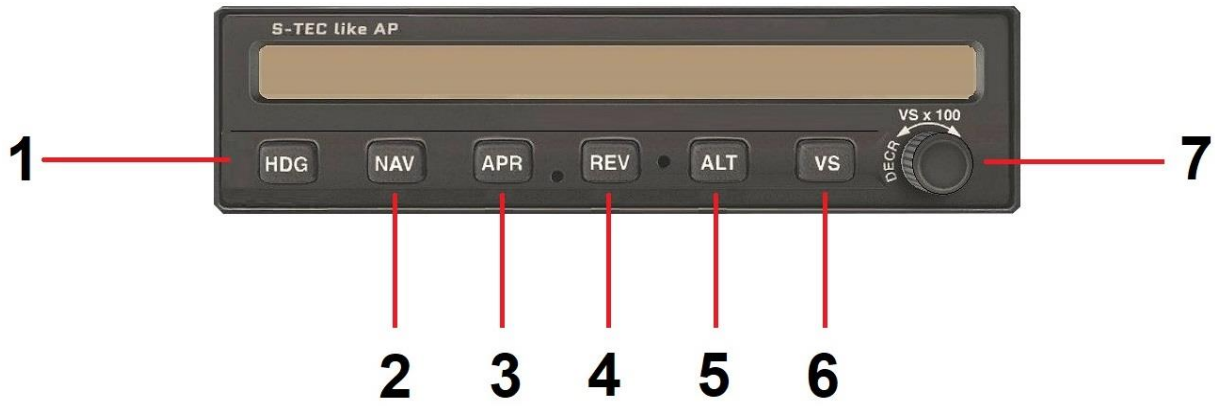
Control Wheel Steering

This button enables the pilot to temporarily override the autopilot servos and take control of pitch and roll (via the yoke or control stick). Releasing the button will return control authority to the autopilot.

Map your chosen button to the 'Control wheel steering mode' function.

S-TEC 55 Controls

This section identifies the controls of the S-TEC 55 autopilot. Where relevant, these are discussed in more detail later in the guide.

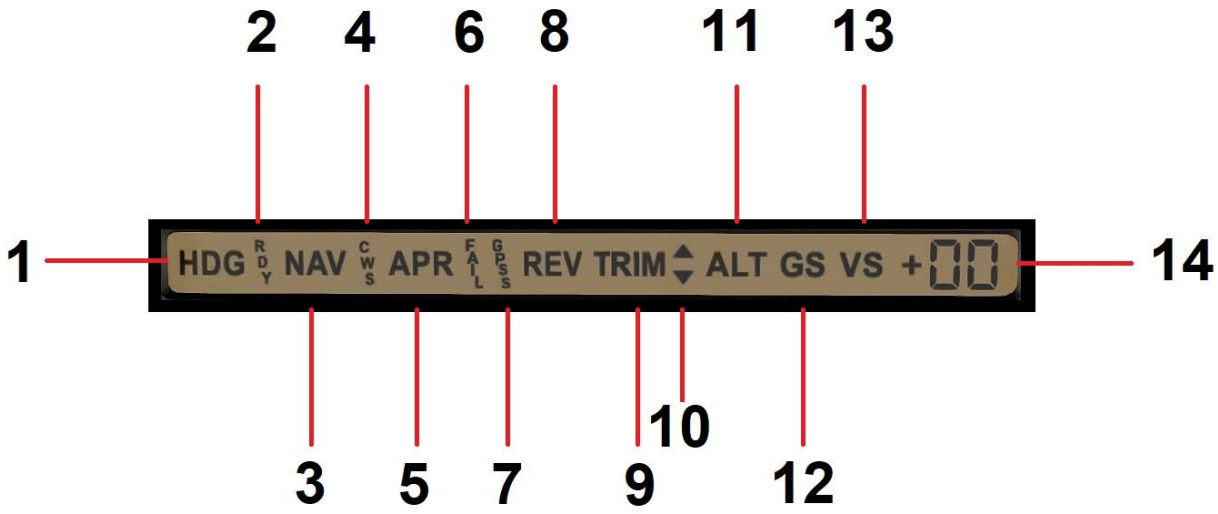


1	**HDG Button**	Selects Heading Mode. The autopilot will direct the aircraft according to the heading bug.
2	**NAV Button**	Select NAV Mode. The autopilot will intercept and track the active navigation device. Note there is a 'click spot' between the HDG and NAV buttons that simulates pressing these simultaneously – for a pilot determined intercept angle.
3	**APR Button**	Selects Approach Sensitivity – for the intercept and tracking of a navigation source, such as localizer or GPS. Arms the glideslope intercept if certain preconditions are met (see ILS Glideslope Tracking).
4	**REV Button**	Selects Reverse Sensing Mode – for ILS localizers.
5	**ALT Button**	Selects Altitude Hold Mode. The autopilot will hold the current altitude. The rotary can be used to adjust the altitude up, or down incrementally in multiples of 20 feet per click. If the autopilot is already in ALT mode, this can be used to manually arm glideslope intercept and tracking.

6	**VS Button**	Selects Vertical Speed Mode. The autopilot will hold the current vertical speed (either positive, or negative). The rotary can be used to adjust the vertical speed up, or down incrementally in multiples of 100 feet per click.
7	**Rotary Control**	This control increments or decrements the altitude, or vertical speed, depending on the current autopilot mode.

S-TEC 55 Display

This section identifiers the display features of the S-TEC 55 autopilot. Where relevant, these are discussed in more detail later in the guide.



1	**HDG illumination**	HEADING: Indicates heading mode is currently active.
2	**RDY illumination**	READY: Indicates the automated checks have been satisfied, and the autopilot is safe for flight.
3	**NAV illumination**	NAVIGATION: Indicates navigation mode is currently active.
4	**CWS illumination**	Indicates Control Wheel Steering mode is currently active.
5	**APR illumination**	APPROACH: Indicates approach mode is currently active.
6	**FAIL illumination**	Indicates the automated checks performed have NOT been satisfied, and the autopilot is unsafe for flight.

7	**GPSS illumination**	Indicates GPS Steering mode is currently active. The autopilot is coupled to the GPS and will steer according to the flight plan.
8	**REV illumination**	REVERSE: Indicates localizer back-course approach mode is currently active.
9/10	**TRIM illumination**	Indicates the elevator trim servo is operating (or manual trim is required when switched off or unavailable), to pitch the aircraft up or down, according to the selected vertical speed. The arrows alongside indicate if a positive, or negative pitch is in effect.
11	**ALT illumination**	ALTITUDE: Indicates altitude mode is currently active.
12	**GS illumination**	GLIDE SLOPE: Indicates (ILS) glide-slope capture.
13	**VS illumination**	VERTICAL SPEED: Indicates vertical speed mode is currently active.
14	**Selected Vertical Speed**	The currently selected vertical speed (either positive or negative) in units of 100 feet per minute.

S-TEC 55 Ground Test [@3:00]

Self-Test

Before using the S-TEC 55 autopilot in flight, it is important to undertake a ground test.

After powering up the avionics in your aircraft, the autopilot will perform a self-test. If a failure of the autopilot computer or turn-coordinator gyro is detected, the FAIL illumination will be present on the autopilot display.

Aileron Servo Test

If the self-test is satisfied, the RDY illumination will be present. The pilot should now perform a manual test of the aileron servo, by selecting HDG (Heading) mode, and then adjusting the directional gyro heading bug to the left, and right, of the current heading. If the aileron servo is working normally, the control column will move accordingly as it attempts to steer the aircraft to intercept the desired heading.

Servo-Override Test

Ensure you can override the servo – roll the aircraft in the opposite direction using your control column and ensure the yoke in the cockpit moves accordingly.

Manual Disconnect Test

Ensure you can disconnect the autopilot – using the button mapped for this purpose (see Assigning peripheral controls).

Trim-Actuator Test

Place the autopilot once again in HDG (Heading) mode and select VS (Vertical Speed) mode simultaneously. Using the autopilot rotary control, select both a positive, and negative vertical speed, and observe the control column (and autopilot display trim indication) behave accordingly.

Automatic Disconnect Test

With the autopilot still in HDG and VS modes, apply a manual change to the elevator trim (using a command such as a joystick button). The autopilot should immediately disconnect.

If you have a hardware trim wheel, this will (correctly) not disconnect the autopilot.

Operating the S-TEC 55 Autopilot

In this chapter, the Cessna 172 that ships with X-Plane 11 is used in the supporting examples. Your aircraft may differ.

HDG (Heading) Mode [@5:00]

Push the HDG button to select HEADING mode.

HDG mode may be used exclusively, or in conjunction with VS or ALT modes.

In this mode, the autopilot will steer the aircraft towards the heading bug.

Use the rotary control at the lower-right of the directional gyro to adjust this.

When HDG mode is selected exclusively, the autopilot will control only the aileron servos, leaving the pilot free to provide pitch input, either directly through the control column, or using the elevator trim.

Use the autopilot disconnect to disable this mode (see Assigning peripheral controls).

VS (Vertical Speed) Mode [@5:48]

Push the VS button to select VERTICAL SPEED mode.

VS mode may be used in conjunction with HDG or NAV.

In this mode, the autopilot will initially hold the current rate of climb, or descent, to the nearest hundred feet per minute - indicated at the far right as a positive, or negative integer. The pilot may subsequently adjust the vertical speed to the desired setting, using the rotary control.

The autopilot will **NOT** manage the throttles, and therefore the pilot needs to ensure the necessary thrust is set manually to maintain the desired airspeed.

Use the autopilot disconnect to disable this mode (see Assigning peripheral controls).

ALT (Altitude) Mode [@7:17]

Push the ALT button to select ALTITUDE (HOLD) mode.

ALT mode may be used in conjunction with HDG or NAV.

In this mode, the autopilot will initially hold the current altitude. The pilot may subsequently adjust this up, or down, by turning the rotary control one-click to the right or left respectively. Each click changes the altitude by twenty feet.

The autopilot will **NOT** manage the throttles, and therefore the pilot needs to ensure the necessary thrust is set manually to maintain the desired airspeed.

The autopilot uses a separate static system (via two ports in the back of the aircraft) and is not affected by your altimeter setting.

Use the autopilot disconnect to disable this mode (see Assigning peripheral controls).

Control Wheel Steering (CWS) Mode [@8:33]

PRESS and HOLD the button you mapped to Control Wheel Steering Mode (see Assigning peripheral controls).

In this mode, the autopilot suspends control of the aileron and trim servos, allowing the pilot to provide the desired input via the control column.

The pilot is now free to roll the aircraft into a turn, and pitch the aircraft into a climb, or descent.

The Vertical Speed display on the autopilot panel will mimic the rate of climb, or descent in real-time, according to the pilot's input.

RELEASE the CWS button when the aircraft is in the desired attitude, and/or altitude.

The autopilot will now maintain the situation established by the pilot

Use the autopilot disconnect to disable this mode (see Assigning peripheral controls). CWS mode is also automatically disconnected if the pilot subsequently selects HDG or NAV mode.

Tracking a VOR Radial [@10:20]

The S-TEC 55 autopilot can intercept and track a VOR radial to, or from the desired station. The method described in this section will utilize a 45-degree intercept to the desired radial – computed by the autopilot.

Using your primary navigation radio (in this example the GNS 530), select the desired VOR frequency.

Select the desired VOR radial to intercept.

In this example we have chosen 010 degrees. The Course Deviation Indicator (CDI) is showing the radial is left of our current position.

The autopilot is not connected to the OBS ring of your VOR instrument, and therefore it is necessary to also select the desired radial using the Directional Gyro (DG) Heading (HDG) rotary.

In this example, we have selected 010 degrees, which corresponds to the radial selection made on the VOR instrument itself.

Push the NAV button to select NAVIGATION mode.

The autopilot will establish a new course that will intercept the desired radial at 45 degrees.

Using our existing example, the chosen radial is 010 degrees, yielding an intercept course of 325 degrees.

When the radial intercept occurs, the Course Deviation Indicator will begin to center.

The autopilot will steer the aircraft to gradually reduce the intercept angle to the VOR radial.

When the Course Deviation Indicator on the VOR instrument is centered, the aircraft is on the desired radial, and the autopilot will maintain that situation.

Dual-Mode VOR Radial Intercept [@13:23]

The S-TEC 55 autopilot can intercept and track a VOR radial to, or from the desired station. The method described in this section utilizes a pilot-chosen intercept angle to the desired radial. The reader should be familiar with the previous section (Tracking a VOR Radial) before proceeding with this section.

Using your primary navigation radio (in this example the GNS 530), select the desired VOR frequency.

Select the desired VOR radial to intercept.

In this example we have chosen 010 degrees.

Using the HDG (Heading) bug, manually select the desired intercept course.

In this example, we have selected 300 degrees, for a 70-degree intercept angle (to the 010 radial).

A ‘click spot’ exists between the HDG and NAV buttons that provides you with the option to engage BOTH modes simultaneously.

When the radial intercept occurs, the Course Deviation Indicator will begin to center.

The autopilot will steer the aircraft to gradually reduce the intercept angle to the VOR radial.

As soon as the HDG mode indication vanishes from the display, the pilot must alter the HDG (Heading) bug to the desired front-course to the VOR (unless the aircraft is equipped with an HSI).

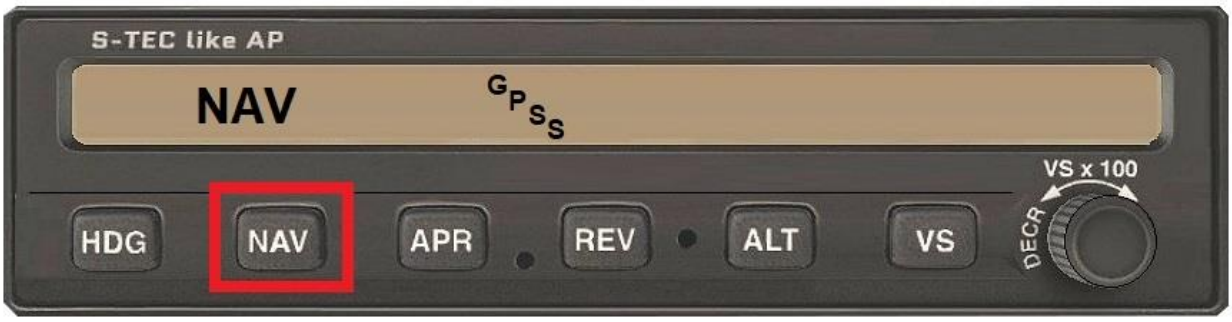
When the Course Deviation Indicator on the VOR instrument is centered, the aircraft is on the desired radial.

GPS Steering Mode [@15:18]

The S-TEC 55 autopilot can steer the aircraft according to a flight plan that has been programmed into the GPS.

With a flight plan programmed into your GPS device (in this example the GNS 530), select GPS mode.

Push the NAV button TWICE to select GPS Steering (GPSS) mode. The aircraft will steer according to the flight plan that has been programmed into your GPS device.



ILS Localizer Tracking [@17:56]

The S-TEC 55 autopilot is capable of tracking an ILS localizer (and glideslope). It is assumed the aircraft is suitably positioned relative to the localizer, such that the intercept angle is not too extreme.

Using your primary navigation radio (in this example the GNS 530), select the desired ILS frequency.

Ensure the device is in VLOC (VOR/Localizer) mode.

Push the APR button to engage APPROACH mode.

When flying an aircraft that does not have an HSI, (like the Cessna 172 in the video), the pilot must now manually inform the autopilot of the ILS front course. This is accomplished using the HDG (Heading) bug on the Directional Gyro.

Here the front course of the ILS has been set to 050 degrees.

The autopilot will now compute the aircraft's position relative to the ILS front course, and steer accordingly.

Once the localizer has been intercepted, this will be tracked.

ILS Glideslope Tracking [@18:20]

See the chapter that covers ILS Localizer Tracking [@17:56] before proceeding with THIS chapter.

For glideslope tracking to arm automatically when the autopilot is executing an ILS approach, the localizer deflection must be no more than 50% of maximum, the aircraft must be under the glideslope, and the glideslope deflection must be at least 60% of maximum.

If glideslope tracking does not arm automatically, the pilot may force this to occur manually – after satisfying the 50% / 60% rules for glideslope arming outlined above. Push the ALT button to engage ALTITUDE HOLD and GLIDESLOPE modes concurrently.

With GS (Glide Slope) mode in effect - when the glideslope is captured, ALTTITUDE mode will cancel automatically, and the autopilot will track the glideslope.

LPV Approaches [@21:30]

The S-TEC 55 autopilot is capable of executing an LPV (Localizer Performance with Vertical guidance) approach.

For the purposes of this chapter, it is assumed that GPS steering mode is in effect, and the pilot has selected an LPV approach as part of the flight plan.

Before transitioning from GPS steering mode to APR (Approach) mode, set the Directional Gyro HDG (Heading) bug to the final approach course for the runway.

This will enable the autopilot to make a smooth turn to the final approach course when intercept occurs.

When the virtual localizer intercept occurs, the autopilot will steer the aircraft toward the final approach course. At this time, the pilot must push the APR (Approach) button to engage APPROACH mode. The autopilot transitions from GPS Steering Mode to APPROACH mode and tracks the localizer and virtual glidepath.

For the virtual glideslope tracking to arm automatically when the pilot initiates APR (Approach) mode, the localizer deflection must be no more than 50% of maximum, the aircraft must be under the glideslope, and the glideslope deflection must be at least 60% of maximum.

If the virtual glideslope tracking does not arm automatically, the pilot may force this to occur manually – after satisfying the 50% / 60% rules for glideslope arming outlined above. Push the ALT button to engage ALTITUDE HOLD and GLIDESLOPE modes concurrently. When the glideslope is captured, ALTTITUDE mode will cancel automatically, and the autopilot will track the glideslope.