AutoFlight AutoPilot

Specification and Installation Instructions

Rev1.0

June 2025

Models

- AutoFlight
- ELM45
- AP-01

Note:

AutoFlight is a non-TSO certified autopilot system.

Credits

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For inquiries regarding the contents of this manual or the products described herein, please contact us at info@360avionics.com.

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Revision History

Below is the document's revision hi story.

Revision #	Revision Date	Comments
Rev 1.0	June 01, 2025	Initial Release of this document

Contents

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1. Introduction

The AutoFlight autopilot system is a sophisticated solution designed to assist with aircraft control under a wide range of flight conditions. By reducing pilot workload, it enhances safety and allows for a more relaxed and enjoyable flying experience—especially in challenging weather.

This product manual provides comprehensive information on the features, installation, and operation of the AutoFlight autopilot. It serves as a practical guide to ensure proper setup and effective use.

The AutoFlight system is composed of several modules, such as the AP-01, ELM45, ELM1000, and ELM800. These components may be used individually or in combination, depending on the specific system configuration.

Note: Throughout this manual, the terms *"AutoFlight"*, *"device"*, and *"unit"* are used interchangeably to refer to the AutoFlight autopilot system.

2. General Description

The AutoFlight autopilot system is built around a modular architecture, consisting of at least two core components:

- The **AP-01** analog servo controller module
- One of the following autopilot control interfaces: **ELM45** control head, or an EFIS unit such as **ELM800** or **ELM1000**

Currently, the AutoFlight system is designed to operate with servos manufactured by **TruTrak**, a well-established name in general aviation autopilot hardware. The supported servo models include:

- **DSP-C or DSP-B** (used for pitch control)
- **DSB-B** (used for roll control)

The **DSP-series** servos are equipped with an integrated sensor that detects when trim input is needed, enabling automatic trim guidance during autopilot operation. For systems with pitch trim capability, an optional **ITS-01 SmartTrim** module may be connected to enable **automatic pitch trim control**, enhancing flight precision and comfort.

AP-01 Servo Controller Module

The AP-01 module functions as an analog-to-digital converter and servo control interface, capable of driving **two servos**—one for pitch and one for roll. It can be connected **directly** to EFIS units like the ELM800 or ELM1000, with **no additional interface modules required**.

ELM45 FlightMate Control Head

The ELM45 FlightMate is a multifunctional autopilot control head. It can operate as a **standalone control interface** when paired with the AP-01 module or serve as a **remote autopilot control head** when used in conjunction with an ELM800 or ELM1000 EFIS system.

The AutoFlight autopilot system is designed to support both **VFR and IFR operations**. A critical safety feature—**LEVEL mode**—allows the pilot to immediately return the aircraft to **straight and level flight** in the event of spatial disorientation or unexpected weather conditions.

All user interfaces and controls have been designed with simplicity and clarity in mind. Mode activation and deactivation require **minimal pilot input**, making the system intuitive and easy to operate in high-workload situations.

3. Technical Specifications

Description	AP-01
Input voltage	+10 to +28 Volts
Power consumption	30.0W
Current	2.5A at 12V
Unit size	95mm x 95mm x 100mm (with knobs)
Weight	150 g
Operation humidity	25% to 90%
GPU processor	ARM Multicore
Sensors processor	ARM
System startup time	26 sec

Description	**ELM45**
Display	4.5” ultra-bright 900x480px Touch enabled
SD Card slot	Standard MicroSD 64Gb max FAT32
Panel opening	5.5” (79mm)
External communication	CAN bus (proprietary protocol) and RS232
Pitch/Roll range	360 degrees
Altitude range	-1000ft to 32000ft
Vertical speed range	10000ft/min up/down
Receiver	GPS receiver high sensitive Ublox
Antenna	Mag mount GPS with male SMA connector
Pitot/Static lines	¼” Quick connect
Manufacturer	360 Avionics Company

4. ELM45 FlightMate

The **ELM45 FlightMate** is a versatile avionics control module developed by **360 Avionics**. It is primarily designed to interface with and control the **AutoFlight autopilot system**, but also offers several additional avionics integration and backup functionalities. The ELM45 is available in **two configurations**:

4.1 Remote Autopilot Control Head Mode

In this configuration, the ELM45 functions as a **dedicated remote control head** for the AutoFlight autopilot with 4.5” diagonal sun readable touch display. It is designed to be connected via **CAN bus** to an EFIS system such as the **ELM800** or **ELM1000**, which must be running the AutoFlight autopilot software.

When used in this mode, the ELM45 provides full control over autopilot operations, including:

- Mode activation and deactivation (e.g., HDG, ALT, VS, NAV, LVL)
- Adjustments to target values such as:
    - **Altitude**
    - **Heading**
    - **Vertical speed**
    - **Airspeed (if IAS mode is available)**

This setup allows for a compact and intuitive interface that brings autopilot control closer to the pilot’s fingertips without requiring direct interaction with the EFIS screen.

4.2 Standalone FlightMate Mode

In the **FlightMate** version, the ELM45 includes a **built-in AHRS (Attitude and Heading Reference System)** as well as an **integrated AutoFlight autopilot controller**. This enables it to function as a **completely self-contained autopilot system**, without the need for connection to the ELM800 or ELM1000 EFIS units.

In standalone mode, the ELM45 handles all:

- Flight data acquisition (attitude, heading, and rate sensing)
- Autopilot computation and control
- Servo output (via connected AP-01 module)

This mode is ideal for installations where a full EFIS is not required or where a compact, self-sufficient autopilot solution is desired.

4.3 Additional Capabilities

The ELM45 FlightMate also includes a range of auxiliary functions that enhance safety and redundancy:

- **Engine Monitoring Backup:**
  The ELM45 can connect to the **EnGood EM-01 engine monitor module** and display vital engine parameters directly on its screen. This acts as a **backup** to the engine data displayed on the EFIS (ELM800 or ELM1000), ensuring redundancy in the event of EFIS failure.
- **Transponder Control:**
  When a **tailBeaconX** transponder is connected

to the EFIS system, the ELM45 can be used to remotely control transponder settings, provided appropriate integration is enabled in the EFIS.

- **Backup Attitude Display:**
  The ELM45 includes a **backup artificial horizon mode** displaying pitch and roll attitude. It can also show:
  - **Altitude**
  - **Speed** (either GPS ground speed or true airspeed depending on configuration)

  This is useful in emergency or degraded mode scenarios when EFIS functionality is impaired.

Summary

The ELM45 FlightMate provides both **dedicated autopilot control** and **full standalone capability**, depending on system configuration. Its integration with other avionics modules—along with built-in safety features—makes it a valuable and flexible component for both simple and complex avionics installations.

5. AP-01 Analog Servo Control Module

While 360 Avionics is actively developing its own line of servos for the AutoFlight autopilot system, the initial release of the product line is fully compatible with **TruTrak** analog servos—a widely used and proven solution in general aviation.

To support this compatibility, the **AP-01 analog servo controller module** was specifically designed to interface seamlessly with **TruTrak DSP-B**, **DSP-C**, and **DSB-B** servos. This provides a smooth upgrade path for existing customers who already have TruTrak servos installed in their aircraft, allowing them to adopt the AutoFlight system with minimal hardware changes.

5.1 Servo Compatibility

The AP-01 supports up to **two servos**—one for pitch and one for roll control. The following servo types are supported:

- **DSP-B / DSP-C (Pitch Axis)**
  These servos feature a **built-in torque sensor** that allows the autopilot to monitor control surface resistance. This feedback enables the system to:
  - Alert the pilot when manual trim is required
  - Automatically activate the **SmartTrim (ITS-01)** module for precise pitch trimming

  Note: A DSP-type servo **must** be used on the **pitch axis** to support trim feedback functionality.

- **DSB-B (Roll Axis)**
  This is a **basic analog servo** with no internal torque sensor. It is suitable for the **roll axis**, where trim feedback is typically not required.

  Optional: A DSP-B or DSP-C servo may also be used for **roll** if torque feedback is desired or for future upgrade considerations.

5.2 System Integration

The AP-01 connects to the aircraft's avionics system via **CAN bus** and is fully compatible with:

- **ELM800 EFIS**
- **ELM1000 EFIS**

When connected to one of these EFIS units, the AP-01 enables a **fully functional 2-axis autopilot system**—no additional interface modules are required.

For enhanced control and situational awareness, the installation of an **ELM45 FlightMate** module is recommended. It provides a dedicated autopilot control interface and optional backup display features.

The AP-01 module is a critical component that bridges advanced autopilot algorithms with reliable servo actuation. Its compatibility with proven TruTrak hardware ensures dependable operation and straightforward retrofit for a wide range of experimental and light-sport aircraft.

6. Product installation

6.1 Space requirements

The **AP-01 analog servo control module** is designed for simple and flexible installation behind the instrument panel. It can be mounted directly to a flat surface using **four standard mounting bolts**.

Mounting Guidelines

- The AP-01 module does **not require any special mounting hardware or preparation**.
- It is recommended to mount the unit on a **rigid, vibration-isolated surface**, typically the rear of the avionics subpanel or an avionics tray.
- Ensure the unit is **securely fastened** to prevent vibration-induced movement during flight.

Connector Clearance

- **Important:** Provide adequate clearance around the module's **connector interface**.
- Sufficient space must be available to allow for easy **plug-in and removal** of the connector during installation, servicing, or future upgrades.

- Avoid placing the unit too close to walls or other equipment that could obstruct access to the connector.

Proper installation of the AP-01 ensures long-term reliability and ease of maintenance. If needed, extension cables or custom bracket solutions can be used to accommodate tight installation environments.

The **ELM45 FlightMate** is designed for easy integration into standard instrument panels and requires a specific cutout and additional connections depending on the selected version.

Panel Cutout

The ELM45 must be installed using a **5.25" x 3.00" (5¼" x 3")** rectangular cutout in the instrument panel. Ensure the panel area selected provides sufficient structural support and meets visibility and accessibility requirements for safe operation.

Installation Considerations by Version

- **AHRS Version**
  For FlightMate units equipped with a built-in **AHRS system**, a connection to a **GPS receiver** is required. Ensure that GPS signal routing and antenna placement are planned as part of the installation.
- **Pitot/Static Version**
  If the unit includes a **pitot/static air data module**, appropriate **plumbing to the aircraft's pitot and static ports** must be installed. Use certified or approved fittings and tubing compatible with aviation pitot/static systems.

When selecting the installation location, be sure to account for:

- **Rear clearance** for wiring and connectors
- **Routing space** for pitot/static lines (if applicable)
- **Line-of-sight visibility** for safe in-flight operation

Proper installation ensures reliable performance and accurate flight data interpretation. Refer to the system wiring diagram and plumbing schematic (if applicable) for detailed integration instructions.

6.2 Proper alignment of the ELM45 FlightMate (version with AHRS)

For optimal performance of the **ELM45**, it is essential that the instrument panel is aligned **perpendicular** to the aircraft's flight path. To ensure accurate functionality of the AHRS sensors (accelerometer and gyroscope), the **X-axis** of the device must be oriented in the direction of the flight path, the **Y-axis** perpendicular to the flight path, and the **Z-axis** perpendicular to the ground.

If the instrument panel is **not perpendicular** to the flight path, the AHRS sensor axes will be misaligned, leading to incorrect operation. In such cases, the device will require calibration or leveling. For detailed instructions on the AHRS sensor leveling procedure, please refer to the relevant section of this manual.

6.3 Connections

The **ELM45** features various connectors located on the backside of the unit, including plumbing connectors (¼"), a GPS antenna port, and the main power/interface connection. For all electrical connections, the device employs a **26-pin D-SUB male connector** positioned centrally. A **female D-SUB connector** is included in the kit for all necessary wiring. For optimal performance and reliability, it is recommended to use wire gauges between **22 AWG** and **24 AWG**.

Quick connect ¼" Pitot line is marked as **'P'** and Static line is marked as **'S'** on the back of the unit (or on the connector's body). It is recommended that the installer labels the tubing connected to the two ports. This will ensure that correct connections will be made, should unit be removed / reinstalled.

GPS Antenna:

The GPS port uses SMA type female connector. Any type of GPS antenna with SMA male connector and 3.3V-5V voltage level can be used. Magnetic mount GPS antenna is included with the kit. The best location for the GPS antenna would be on top of the instrument panel under the windshield window where best and unobscured sky visibility is achieved. GPS antenna should never be mounted underneath the panel or behind the panel.

In case when antenna is installed outside of the airplane on the roof, it must be secured to the surface using a very strong adhesive, to ensure that the antenna will withstand strong winds. If planning to install the GPS antenna on the roof of the airplane, please seek advice from an experienced aviation maintenance specialist.

When tightening the GPS connector, hand-tightening is sufficient. Do not overtighten.

ELM45 Flight Mate 26-pin Main connector pinout:

1 – A/C Power **+V** (positive) 2 - A/C Power **+V** (positive) 3 – CAN bus Low 4 – CAN bus High 7 – Analog Input 1 14 – RS-232 Tx1 15 – RS-232 Rx1 19 – Analog Input 2	25 – A/C Power **GND** (negative) 26 – A/C Power **GND** (negative)

For optimal performance, it is recommended to use **22 AWG** wire for all power connections (pins **1, 2, 25, and 26**). For all other connections, **24 AWG** wire is acceptable. It is advisable to use military specification (milspec) wires for all connections to ensure high quality and robustness of the wiring.

The kit includes a **female D-SUB 26-pin connector header** with options for soldering or crimping the pins. A plastic enclosure for the connector header is also provided. If soldering wires, please ensure that they are securely attached without any cold solder joints.

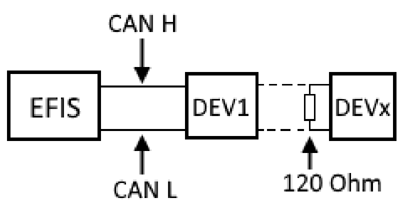
CAN Bus termination:

The **ELM45** can be installed in the aircraft in conjunction with compatible **360 Avionics** engine monitors, EFISes and other instruments connecting them to a single **CAN** line.

When the **ELM45** is installed independently (with connection to AP-01 only), it is necessary to install a **120 Ohm termination resistor** (included with the kit) between **pin 3** and **pin 4** of the CAN line. This resistor must be securely installed on the connector and left within the enclosure.

If ELM45 comes with pre-assembled power cable do NOT add 120 Ohm resistor.

When an external module (DEV) such as the **EnGood engine monitor**, **ELM800/1000**, or other instrument is connected, a CAN bus termination resistor must be installed to properly terminate the CAN bus at the end of the line. Please refer to the diagram below for proper configuration.



Power bus:

Use AWG22 or less gauge of wires to connect power to the unit (pins 1,2,25,26). It is required to have 2A circuit breaker on power line for the ELM45. This circuit breaker should be accessible from pilot's seat. Ground wire can be connected to chassis ground or directly to the battery negative terminal.

Power line with circuit breaker is usually connected via Avionics master switch or via Main master switch depending on the airplane configuration.

AP-01 Servo Controller Module 25-pin Main connector pinout:

1 – A/C Power **GND** (negative) 2 - CAN bus Low 3 – Switch 1 Input 4 – Analog Out 1 5 – Analog Input 1 8 – Drv Out 1 9 – Drv Out 2 10 – Drv Out 3 11 – Drv Out 4 12 – Trig 1 13 – Analog Out 3	15 – CAN bus High 16 – Analog Out 2 17 – Analog Input 2 20 – Drv Out 5 21 – Drv Out 6 22 – Drv Out 7 23 – Drv Out 8 24 – Analog Out 4 25 – A/C Power **+V** (positive)

TruTrak Servo Module 9-pin Main connector pinout:

<u>Pitch Servo (DSP-P or C)</u>	**<u>Roll Servo (DSP-B)</u>**
1 – A/C Power **+V** (positive) 2 - Drv Out 3 (AP01 pin 10) 3 – Drv Out 4 (AP01 pin 11) 4 – Drv Out 2 (AP01 pin 9) 5 – Drv Out 1 (AP01 pin 8) 6 – Analog Out 1 (AP01 pin 4) 7 – Analog Input 1 (AP01 pin 5) 8 - 9 – A/C Power **GND** (negative)	1 – A/C Power **+V** (positive) 2 - Drv Out 7 (AP01 pin 22) 3 – Drv Out 8 (AP01 pin 23) 4 – Drv Out 5 (AP01 pin 20) 5 – Drv Out 6 (AP01 pin 21) 6 – Analog Out 2 (AP01 pin 16) 7 – 8 - 9 – A/C Power **GND** (negative)

7. ELM45 FlightMate controls.

The **ELM45 FlightMate** is equipped with **two dual rotary encoders**, each featuring an **inner and outer knob**, as well as a **push-button function** integrated into the inner knob.

Knob Functions

- **Outer Knob (Left or Right)**
    - Rotating **clockwise (CW)** or **counterclockwise (CCW)** scrolls through operating modes or adjusts values depending on the current screen.
    - Used for quickly switching between autopilot modes, setting target values (altitude, heading, etc.), or navigating lists.
- **Inner Knob (Left)**
    - Rotates to **navigate through menu icons** displayed on screen.
    - **Pressing** the inner knob selects or activates the highlighted menu item.
- **Inner Knob (Right)**
    - Typically used for fine adjustments or parameter changes within the active mode (e.g., vertical speed setting, altitude fine-tune).

Touchscreen Alternative

All knob functions are fully mirrored on the **touchscreen display**. You can use your finger to:

- Tap icons for direct menu access
- Swipe or scroll to change values
- Activate or deactivate autopilot functions

This dual-control interface allows pilots to choose between **tactile rotary input** and **touchscreen interaction**, depending on preference and flight conditions. The design ensures **intuitive, quick access** to all functions—even when wearing gloves or in turbulent air.

8. Maintenance and Repair

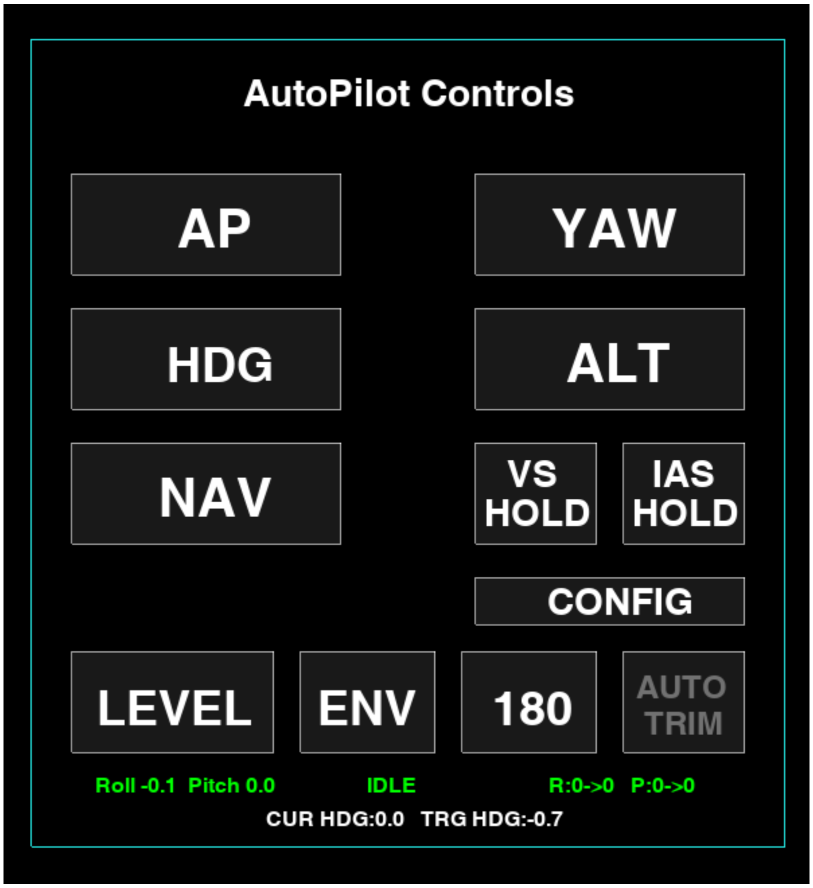
For ELM45 (version with AHRS) the leveling procedure should be performed annually (every 12 months). Pitot/static systems leak test should be performed every 24 months to ensure proper operation of the device.

There are no field repairable parts inside of the ELM45 FlightMate. In case of any malfunction, the unit should be returned to the manufacturer for test and repair.

There is no specific maintenance requirements for AP-01 module.

9. Operations

he **AutoFlight autopilot** can be controlled from the **ELM800**, **ELM1000**, or **ELM45 FlightMate** using an intuitive and easy-to-navigate **touchscreen menu interface**.



The **AutoFlight menu interface** provides access to all primary autopilot functions, including:

- **Altitude Hold**
- **Heading Hold**
- **Vertical Speed Hold**
- **Indicated Airspeed (IAS) Hold**
- **Navigation Path Following (NAV mode)**
- **180° Turn (Turn Around mode)**
- **Emergency Leveling (LEVEL mode)**

The currently active mode is **highlighted** on the display for clear situational awareness.

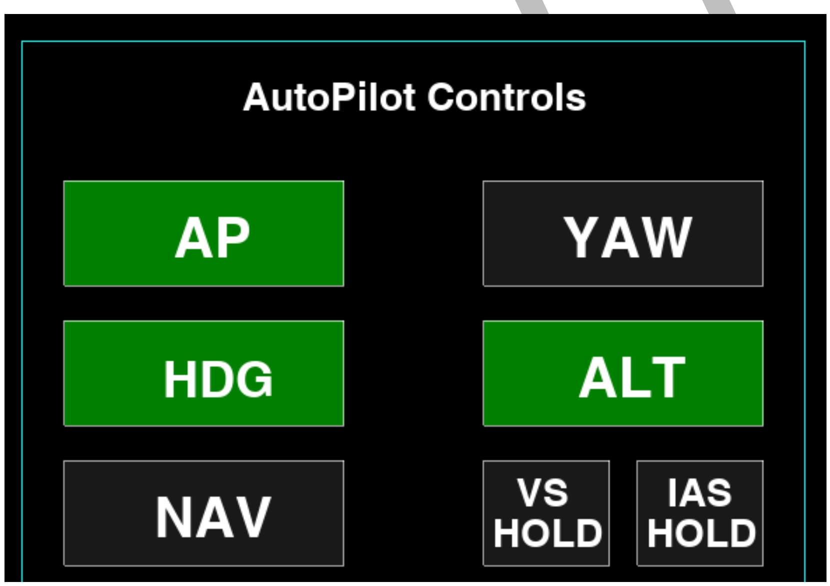
Independent Pitch and Roll Axis Control

The **AutoFlight autopilot** allows **independent activation** of the pitch and roll control axes. This means you can engage **Altitude Hold** mode while manually steering the aircraft left or right using the control stick. Similarly, you can enable **Heading Hold** mode while manually controlling pitch with the stick.

This flexibility is especially useful during partial automation or when fine-tuning aircraft attitude manually.

Note:
When **Altitude Hold** is active and the aircraft is manually banked beyond approximately **40 degrees**, the autopilot may be unable to maintain the target altitude due to aerodynamic limitations. In such cases, **temporary altitude deviations** may occur. This behavior is normal and can be minimized by maintaining moderate bank angles during manual roll inputs.

To activate autopilot in both Pitch and Roll axis hold simply press AP button in display.



10. Autopilot Control Descriptions

The AutoFlight autopilot system provides a set of clearly labeled control buttons, allowing the pilot to activate specific modes as needed. Each mode can be engaged independently or in combination, depending on flight requirements.

AP

Activates both Pitch and Roll Hold modes simultaneously.
This is the primary autopilot activation button for maintaining straight and level flight or engaging basic stabilization.

HDG (Heading Hold)

Activates heading hold mode only.
The autopilot maintains the current or selected heading. **Pitch control remains manual** and should be managed by the pilot via the control stick.

ALT (Altitude Hold)

Activates altitude hold mode only.
The autopilot maintains the current or target altitude. **Lateral control (heading/bank)** remains manual.

NAV (Navigation Track Hold)

Engages flight plan tracking mode and commands the autopilot to follow an active GPS route.

Note: NAV mode is available **only** when the system is controlled via the **ELM800 or ELM1000 EFIS**.

YAW

Reserved for **yaw damper activation** (functionality not currently available).

VS Hold (Vertical Speed Hold)

Maintains a constant vertical speed as selected by the pilot. **Heading and roll remain under manual control.**

IAS Hold (Indicated Airspeed Hold)

Maintains a constant airspeed using pitch adjustments. This mode is useful during climb or descent. **Heading remains manually controlled.**

LEVEL (Emergency Level Mode)

Immediately activates both pitch and roll control and returns the aircraft to **straight and level flight**, regardless of its current attitude.
This function is intended for use in **emergency or spatial disorientation situations**.

180 (Turn Around Mode)

Engages roll hold and commands a **180-degree turn** from the current heading—useful for rapid course reversal in low-visibility conditions.

ENV (Envelope Protection)

Activates or deactivates the **protective envelope** feature.
When enabled, the autopilot will **limit manual control inputs** to keep the aircraft within **predefined pitch and bank angle limits**, even when the autopilot is disengaged.

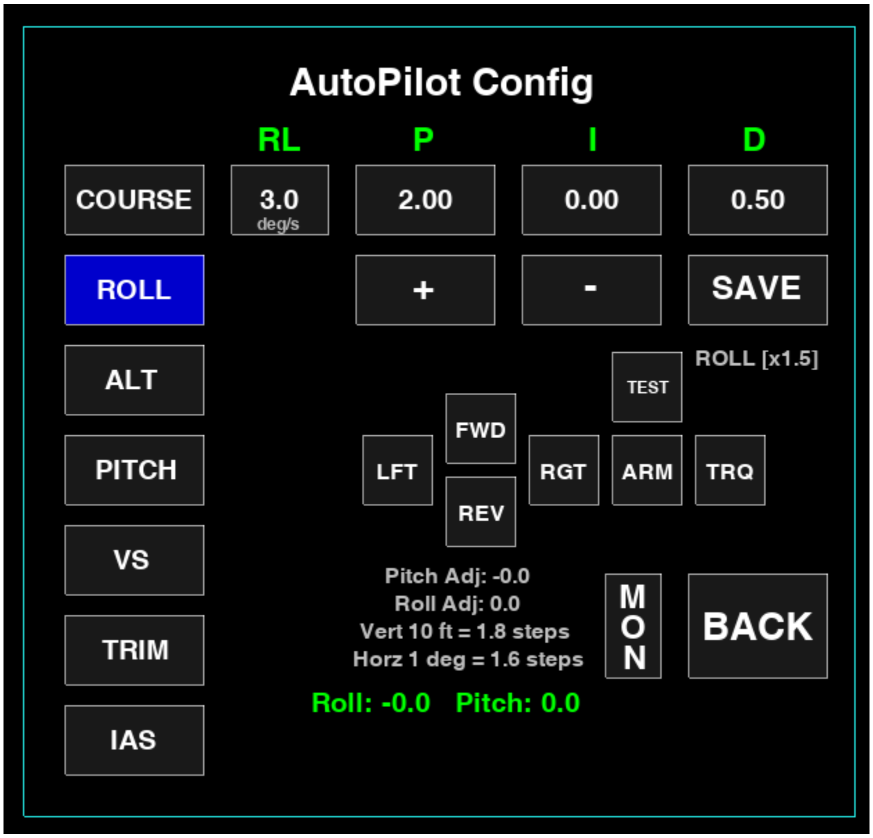
Auto Trim

Toggles the **Auto Trim** function on or off.

Note: This feature is available **only if the ITS-01 SmartTrim module** is installed.

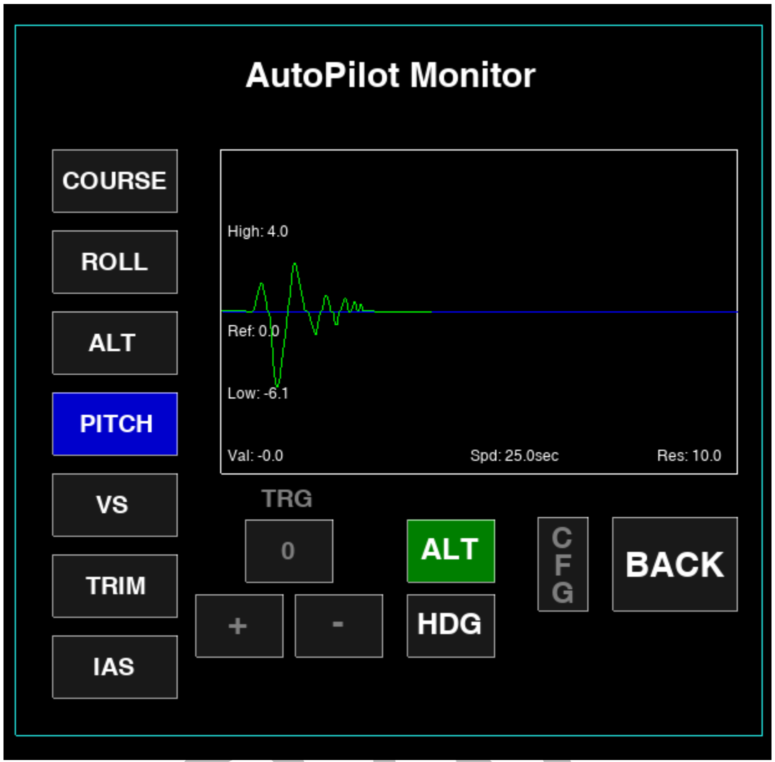
Config / Monitor

- When the autopilot is **inactive**, this button opens the **Configuration Menu**, allowing adjustment of key autopilot parameters specific to the aircraft.



- When the autopilot is **active**, it opens the **Monitor Menu**, where real-time autopilot behavior can be observed and fine-tuned

during flight testing.
Once tuning is complete, this button can be disabled to prevent unintentional adjustments.



Example: Changing Altitude During Flight Using AutoFlight

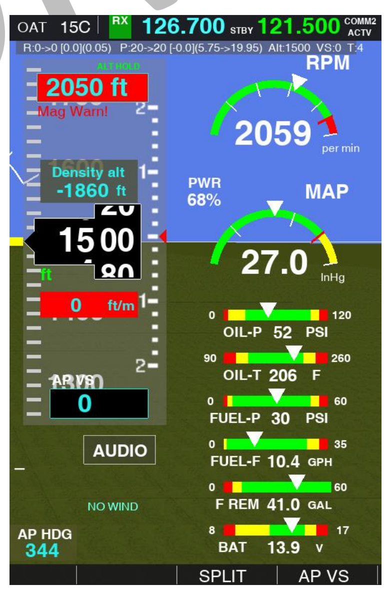
This example demonstrates how to command the autopilot to climb or descend to a new altitude using the **Altitude Hold** mode and vertical speed input.

Step-by-Step Instructions:

1. **Activate Altitude Hold Mode**
   - While in stable flight, press the **ALT** button on the autopilot interface.
     The autopilot will now maintain your **current altitude**.
2. **Set a New Target Altitude**
   - On the **ELM800 or ELM1000**, push the **right knob** until the label above it reads **AP ALT**. Alternatively touch with finger the Target Altitude label at the right side on top of the altitude block.

     On the **ELM45**, enter the target altitude using the touchscreen autopilot menu.

   - Rotate the knob **clockwise or counterclockwise** to adjust the target altitude in **50-foot increments**.
   - Once the desired altitude is set:
     - On **ELM800/ELM1000**, **press the knob once** to confirm.
     - On **ELM45**, simply leave the selection at the desired value—no confirmation press is required.



3. **Set the Desired Vertical Speed**
    - On the **ELM800/ELM1000**, the right knob label will now switch to **AP VS**.
    - On the **ELM45**, rotate the **outer right knob** or use the touchscreen to set the vertical speed.
    - Adjust to your preferred **climb or descent rate** (e.g., 500 ft/min or 800 ft/min).
4. **Autopilot Will Begin Climb or Descent**
    - The aircraft will smoothly transition toward the new altitude.
    - Once the **target altitude is reached**, the autopilot will automatically **level off** and re-enter **Altitude Hold** mode.

This method provides a smooth and intuitive way to change flight levels using the AutoFlight autopilot while maintaining full control over the climb/descent rate.

When using the **AutoFlight autopilot system** through the **ELM800** or **ELM1000 EFIS**, key autopilot target parameters are clearly displayed on the **main artificial horizon screen** for quick reference and control.

Displayed Autopilot Information

- **Target Altitude**
  Displayed on the **right side**, directly **above the altitude tape**.
  This value shows the selected altitude the autopilot is climbing or descending to.

- **Autopilot Status**
  Shown **above the target altitude**, the status label indicates the current autopilot vertical mode:
    - IDLE
    - CLIMB
    - DESCENT
    - ALT HOLD

- **Target Vertical Speed**
  When the autopilot is in **CLIMB**, **DESCENT**, or **VS HOLD** mode, the selected vertical speed is shown in a **boxed label at the bottom of the altitude tape**.

- **Target Indicated Airspeed (IAS)**
  When in **IAS Hold** mode, the commanded airspeed is displayed **at the top of the airspeed tape**, on the **left side** of the screen, just **beneath the TAS (True Airspeed)** value.

Adjusting Target Parameters

- **To change target altitude:**
  - Tap directly on the **target altitude label** on the screen,
  - Or press the **right rotary knob** until the label above it reads **AP ALT**. Then rotate to adjust the value.
- **To change vertical speed (if in climb/descent/VS mode):**
  - Tap the **vertical speed label** beneath the altitude tape,
  - Or press the **right knob** until the label reads **AP VS**, then rotate to set the new climb or descent rate.

These intuitive touch and knob-based inputs allow for quick and safe in-flight adjustments without navigating away from the primary flight display.

11. Auto Pilot Parameters Tuning

Every aircraft has unique flight characteristics based on its **weight**, **control surface dimensions**, **aerodynamic design**, and **engine power**. While the AutoFlight autopilot system comes with **predefined default settings**, fine-tuning may be necessary to optimize performance for your specific airframe.

Proper tuning ensures that the autopilot maintains precise and stable control in both the **pitch** and **roll** axes under a variety of flight conditions. This process may require conducting **several test flights** in **calm weather** to safely evaluate and adjust the control response.

Tip: It is strongly recommended to have a **copilot** onboard during tuning flights. This significantly reduces the workload, allowing one pilot to hand-fly the aircraft while the other monitors and adjusts parameters.

This section is intended for **pilots, installers, and integrators** working with the **360 Avionics AutoFlight system** in **small general aviation aircraft**. It explains the core logic behind the autopilot control system and provides step-by-step guidance for tuning **proportional–integral–derivative (PID)** controller parameters.

Each section covers:

- The **purpose** of a specific control loop (e.g., pitch hold, heading hold)
- The **effect** of adjusting the P, I, and D terms
- **Default values** provided as a starting baseline

Proper tuning improves comfort, stability, and confidence in autopilot performance throughout all phases of flight.

General PID Control Overview

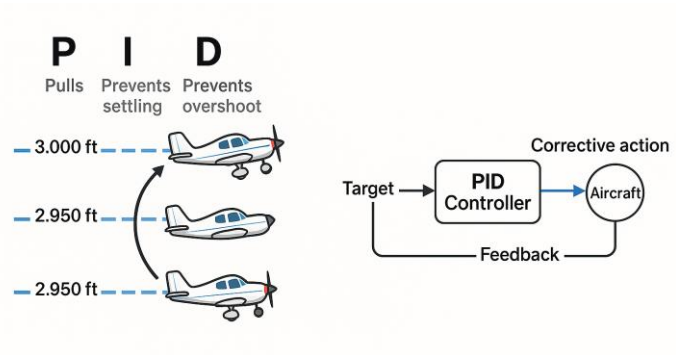
Every autopilot behavior — from holding a heading to climbing at a set rate — is controlled by PID loops:

- **P (Proportional):** This is like a spring. The more you're off from target, the more force is applied to correct.
- **I (Integral):** This is like a memory. If the error persists over time, it builds up correction to remove it.
- **D (Derivative):** This is like a shock absorber. It dampens sudden movements to prevent overshooting.

Everyday Example:

Imagine your airplane is supposed to climb to 3,000 ft:

- **P** pulls you toward the target altitude.
- **I** ensures you don't settle at 2,950 ft due to small steady-state errors.
- **D** prevents the airplane from bouncing up and down past 3,000 ft.



11.1 Course Hold (Heading Mode)

Default PIDs: P = 0.8, I = 0.04, D = 0.01

Purpose: Course Hold commands the bank angle (through Roll Hold) needed to steer the aircraft to a selected heading — not to correct for turbulence or wings rocking. That's Roll Hold's job.

Parameter Descriptions:

- **P:** A higher P causes the aircraft to bank more steeply when there's a big difference between current heading and desired heading. Too high and it may zig-zag.
- **I:** Eliminates slow heading drifts. If the aircraft is always off by 2°, I slowly brings it back.
- **D:** Dampens the heading correction by watching how fast the heading is changing. It makes turns smoother.

Pilot Scenario:

Flying a Cessna 172, you dial in 270°. The wind is from the left, so you're being pushed off course. The autopilot gently banks you right (via Roll Hold) to correct. If P is too high, it might bank too steeply. If I is too low, it won't fix the drift. If D is too low, turns might feel jerky.

11.2 Roll Hold

Default PIDs: P = 2.0, I = 0, D = 0.5
Rate Limit: `params->r_rl = 3 deg/sec`

Purpose: Maintains the commanded bank angle. It is the layer that actually responds to gusts or turbulence — stabilizing the wings.

Parameter Descriptions:

- **P:** Rolls the aircraft back when the bank angle is off. If your target bank is 15°, and wind tips you to 20°, P rolls it back.
- **I:** Not used by default. It would help correct long-term aileron deflection imbalances.
- **D:** Prevents overcorrection by using roll rate — the faster you're rolling, the less correction applied.

Rate Limit (**RL**):

Limits how fast the autopilot can roll the airplane. 3 degrees per second is slow and smooth — ideal for GA aircraft.

Pilot Scenario:

During a turn to 30°, a gust rolls you to 35°. P responds to the 5° error. D ensures the correction doesn't overshoot. The rate limiter keeps the motion passenger-friendly.

11.3 Altitude Hold

Default PIDs: P = 0.5, I = 0.01, D = 0.65

Purpose: Maintains a target altitude by adjusting pitch. This is not responsible for directly stabilizing the pitch attitude — that's Pitch Hold.

Parameter Descriptions:

- **P:** If you're 100 ft low, this pitches the nose up. Too much P and you'll bob up and down.
- **I:** Gently corrects for persistent drift (e.g., altitude slowly sags 20 ft due to air pressure shifts).
- **D:** Applies nose-down force if you're climbing too fast past target — prevents overshooting.

Pilot Scenario:

Level at 3,000 ft, you notice the aircraft holds 3,020 ft. I slowly trims the pitch to bring it down. A gust pushes you to 3,050 — D dampens the response. P ensures you don't stay 50 ft too high for long.

11.4 Pitch Hold

Default PIDs: P = 3.5, I = 0, D = 0.5
Rate Limit: `params->p_rl = 2 deg/sec`

Purpose: Holds a specific pitch angle — for level flight or commanded pitch climbs/descents.

Parameter Descriptions:

- **P:** Immediate nose correction if pitch is off. If target is 5° nose up, but plane is at 3°, P increases elevator to raise it.
- **I:** (Unused by default) Would correct for trim or minor long-term pitch imbalance.
- **D:** Uses pitch rate to keep things smooth. If you're already pitching up fast, D reduces the rate.

Rate Limit (**RL**):

Limits how fast pitch can change. Prevents steep or abrupt transitions.

Pilot Scenario:

In cruise, you set 4° nose up. The autopilot holds it. If a bump tilts the nose down, P commands up elevator. D prevents "seesawing" up and down. The 2°/sec limiter ensures no jerky movements.

11.5 Vertical Speed Hold (VS Hold)

Default PIDs: P = 0.1, I = 0.1, D = 0
Blend Factor: `alpha = 0.1`

Purpose: Maintains a selected vertical speed using pitch. This is the mode you use to climb or descend at a steady rate.

Parameter Descriptions:

- **P:** If your target climb is 500 ft/min, but you're at 300, P nudges pitch up.
- **I:** If you've been off by 100 ft/min for a while, I builds correction to fix it.
- **D:** (Not used by default) Would reduce pitch commands if vertical speed is already changing fast.

Blend Factor (`alpha = 0.1`):

When switching between Altitude Hold and VS Hold, alpha ensures pitch change is smooth. 0.1 = very gentle transition.

Pilot Scenario:

You command a 500 ft/min descent. P commands pitch down. I makes sure you're really holding that rate. Alpha ensures a smooth switch back to level-off as you near target altitude.

11.6 Auto Trim

Default PIDs: P = 1, I = 0, D = 0

Purpose: Automatically adjusts trim to reduce elevator servo workload.

Parameter Descriptions:

- **P:** If elevator servo works hard, trim adjusts. Higher P means faster trim response.
- **I & D:** Not used. Would smooth long-term trim correction if enabled.

Pilot Scenario:

After a long climb, the elevator servo is deflecting hard to maintain pitch. Trim shifts the elevator balance point so the servo doesn't have to strain.

11.7 Airspeed Hold (Using Pitch)

Default PIDs: P = 0.1, I = 0.1, D = 0

Purpose: Holds indicated airspeed by pitching up/down. Often used during climbs or descents to prevent stall or overspeed.

Parameter Descriptions:

- **P:** If your IAS is low, P pitches the nose down to speed up.
- **I:** If speed is consistently 5 knots low, I slowly lowers the nose further.
- **D:** Not used by default. Could help dampen airspeed corrections.

Pilot Scenario:

In a climb at 80 KIAS, headwinds slow you to 75. P corrects pitch. If the error persists, I pitches even further down.

Final Tips for Pilots

- **Start with defaults.** They work well for most light aircraft.
- **Tweak one axis at a time.** Start with Roll and Pitch Hold before fine-tuning altitude or VS.
- **Fly in calm air.** Avoid testing in turbulence.
- **Observe.** Graph your flight data to visualize how each PID setting impacts flight.

Always test autopilot changes at safe altitudes and conditions.

Example: Tuning the Altitude Hold – *D Parameter*

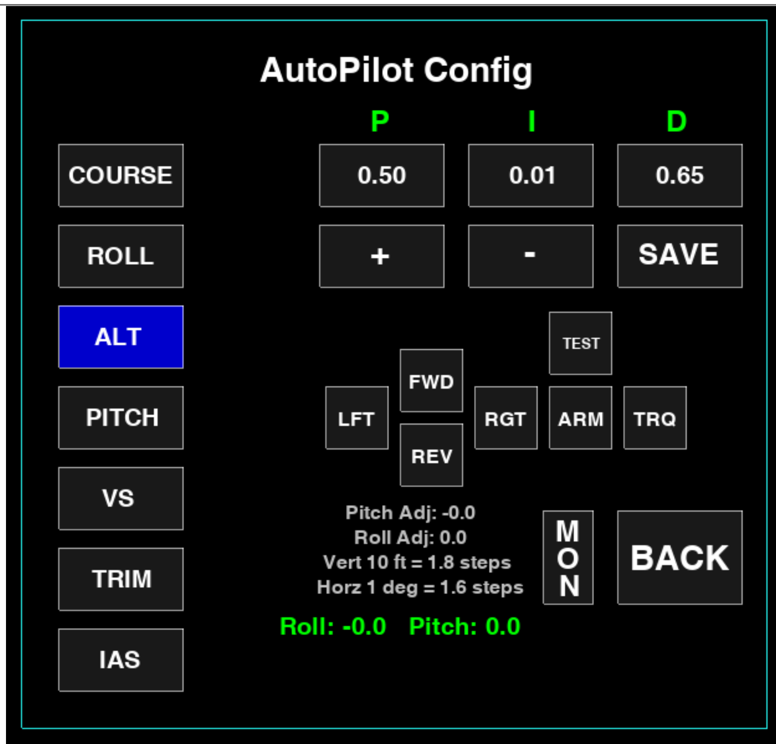
When tuning the **Altitude Hold** mode in the AutoFlight autopilot, you may need to adjust the **D (Derivative)** parameter to improve stability and response during altitude changes or turbulence.

⚠ Important:

- **Always record the previous value** before making any changes. This allows you to revert back if needed.

Step-by-Step Instructions:

1. **Enter the Configuration Menu**
   - Tap the **Config** button on the main display.
2. **Select the Altitude Hold Controller**
   - Tap the **ALT** button located on the left side of the screen.
     The button will be **highlighted in blue** to indicate it is active.
3. **Select the D Parameter**
   - Tap on the **D parameter field**.
     It will also be highlighted in blue to indicate it is selected.
4. **Adjust the Value**
   - Use the **+** or **–** buttons to increase or decrease the value.
     Alternatively, you can **rotate the right-hand knob** on the EFIS to fine-tune the setting.
5. **Save the New Value**
   - Press the **Save** button to apply the new setting.
6. **Confirmation**
   - The new D parameter is now active and will be used by the autopilot in Altitude Hold mode.



12. Operation Limitations

- Information from airplane's POH is always supersedes information provided in this manual
- This unit is non-TSO certified and cannot be installed on the certified airplane unless special permission is obtained from regulatory agency/airplane manufacturer.

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14. TSO approval and Liability limitations

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