

3.3 AFCS OPERATION

The AFCS provides the following main operating functions:

- **Flight Director (FD)** — The Flight Director function provides pitch and roll commands needed to guide the aircraft toward the active reference selected by the pilot. These pitch and rolls commands are displayed on the G5 PFD Page as Command Bars. When the Flight Director is active the pitch and roll commands can be hand-flown by the pilot. When the Autopilot is engaged the autopilot servos drive the flight controls to follow the commands issued by the Flight Director.
- **Autopilot (AP)** — The Autopilot function is provided by servo actuators which move the flight control surfaces in response to Flight Director steering commands, aircraft attitude, and airspeed. The optional pitch auto-trim function serves to relieve any sustained effort required by the pitch servo to keep the aircraft in trim.
- **Yaw Damper (YD)** — The optional Yaw Damper function provides Dutch Roll damping, assists in turn coordination, and provides a steady force to help maintain directional trim. If installed the YD comes on when the autopilot is engaged. It can be turned on/off independent of the autopilot and may be used during normal hand-flying maneuvers.
- **Manual Electric Trim (MET)** — The optional Manual Electric Trim uses the same servo as the auto-trim function and allows the pilot to command trim via a trim switch when the autopilot is not engaged. The MET function does not preclude the use of the aircraft's basic mechanical trim system.
- **Electronic Stability & Protection (ESP) (GFC 500)** — The ESP function provides a soft barrier to keep the aircraft within the desired operating envelope when the autopilot is not engaged. When the AFCS senses that the aircraft is near the defined operating limit in pitch attitude, roll attitude, high airspeed, or low airspeed, the ESP function will automatically engage one or more servos to nudge it back to the nominal operating envelope. While ESP utilizes the same sensors, processors, and actuators as the AFCS autopilot it is a separate mutually exclusive function. ESP can be easily overpowered by the pilot and can be disabled using the **AP DISC / TRIM INT** button.

3.5 ELECTRONIC STABILITY & PROTECTION (ESP) (GFC 500)

System Overview



WARNING: Do not assume ESP will provide stability protection in all circumstances. There are in-flight situations that can exceed the capabilities of ESP technology.



WARNING: A GPS navigator that can provide AGL height data is required for low-airspeed protection.



WARNING: The autopilot (or ESP) will disengage if the roll attitude exceeds 75° or the pitch attitude exceeds 50°.

Flight Instruments

AFCS

Additional Features

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Electronic Stability and Protection (ESP) is a feature that is intended to monitor the aircraft and provide control input feedback when necessary to discourage operating the aircraft at potentially unsafe attitudes and/or airspeeds. If enabled, this feature will automatically arm when the aircraft is above 500 feet AGL and the autopilot is not engaged, and disarm when below 200 feet AGL (if AGL height data is unavailable, ESP can be armed on the ground, but low-airspeed protection will not be available).

When selected, ESP engages automatically when the aircraft approaches or exceeds one or more predetermined airspeed or attitude limitations. Stability protection for each flight axis is provided by the autopilot servos, which apply force to the appropriate control surface(s) to discourage pilot control inputs that would cause the aircraft to exceed the normal or "protected" flight envelope. This is perceived by the pilot as resistance to control movement in the undesired direction when the aircraft approaches a steep attitude, and/or the airspeed is below the minimum or above the maximum configured airspeed.

As the aircraft deviates further from the normal attitude and/or airspeed, the force increases proportionally (up to an established maximum) to encourage control movement in the direction necessary to return to the normal attitude and/or airspeed range.

When ESP has been engaged for more than 10 seconds (cumulative; not necessarily consecutive seconds) of a 20-second interval, the autopilot can be configured to engage with the flight director in Level Mode, bringing the aircraft into level flight. An aural "Engaging Autopilot" alert is played and the flight director mode annunciation will indicate 'LVL' for vertical and lateral modes.

Level mode as activated by ESP is limited by altitude. ESP will not be able to activate Level mode until the aircraft climbs above 2000 feet AGL. ESP will be locked out of automatically activating Level mode after the aircraft descends below 1500 feet AGL as well. Also note that Level mode as activated by ESP is different than manually selected Level mode. Manually selected Level mode is not limited by altitude at all.



NOTE: If AGL height data is unavailable automatic engagement of Level mode is not supported.

ESP is enabled or disabled from the PFD Page Menu.

Enabling/Disabling ESP using the G5 Menu:

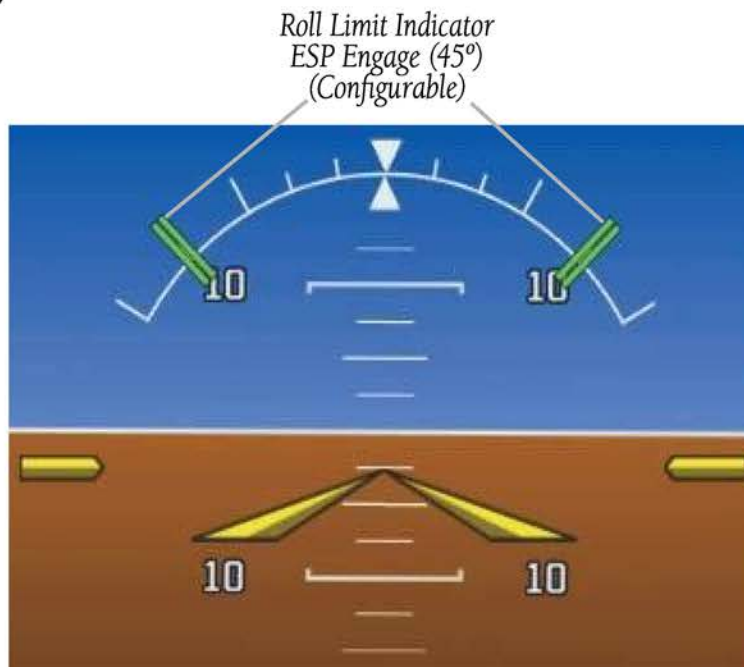
- 1) From the PFD Page, press the **Knob** to display the Menu.
- 2) Turn the **Knob** to highlight **ESP**.
- 3) Press the **Knob** to enable or disable ESP.



Figure 3-25 AFCS (ESP Enabled)

3.5.1 ROLL ENGAGEMENT

Roll Limit Indicators displayed on the roll scale are configurable between 45° and 60° right and left, indicating where ESP will engage. As roll attitude exceeds the configured limit, ESP will engage and the Roll Limit Indicators will move to 15° less than the configured ESP bank limit. The Roll Limit Indicator now indicates where ESP will disengage as roll attitude decreases.



**Figure 3-26 ESP Roll Engagement Indication
(ESP Enabled but NOT Engaged)**

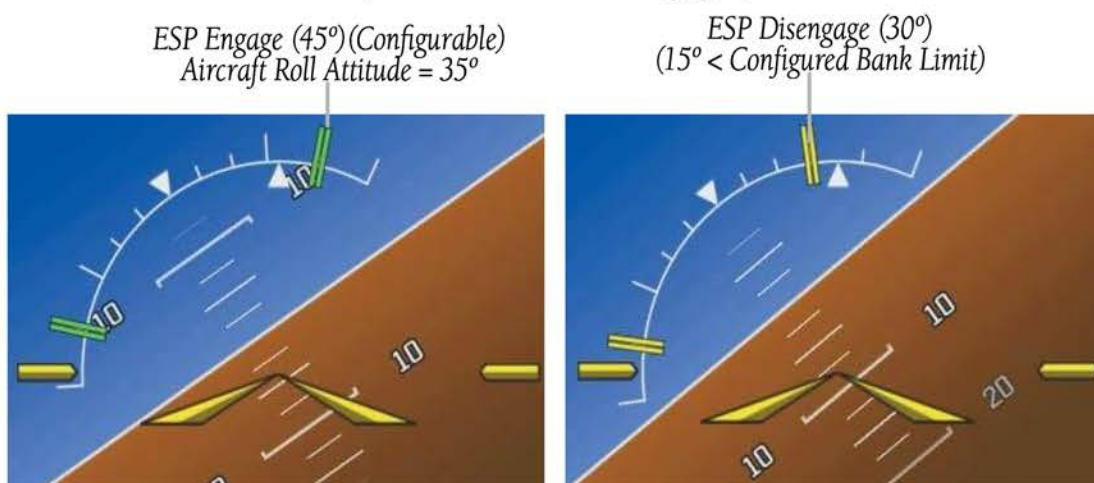


Figure 3-27 Roll Increasing to ESP Engagement

Once engaged, the torque applied by ESP is at its maximum when bank angle is 15° more than the configured bank limit, and tapers to the minimum applied torque when the bank angle is 15° less than the configured bank limit. The force increases as roll attitude increases and decreases as roll attitude decreases. The applied force is intended to encourage pilot input to return the airplane to a more normal roll attitude. When beyond 15° of the configured bank limit, the maximum torque is held until the aircraft returns inside the protected envelope.

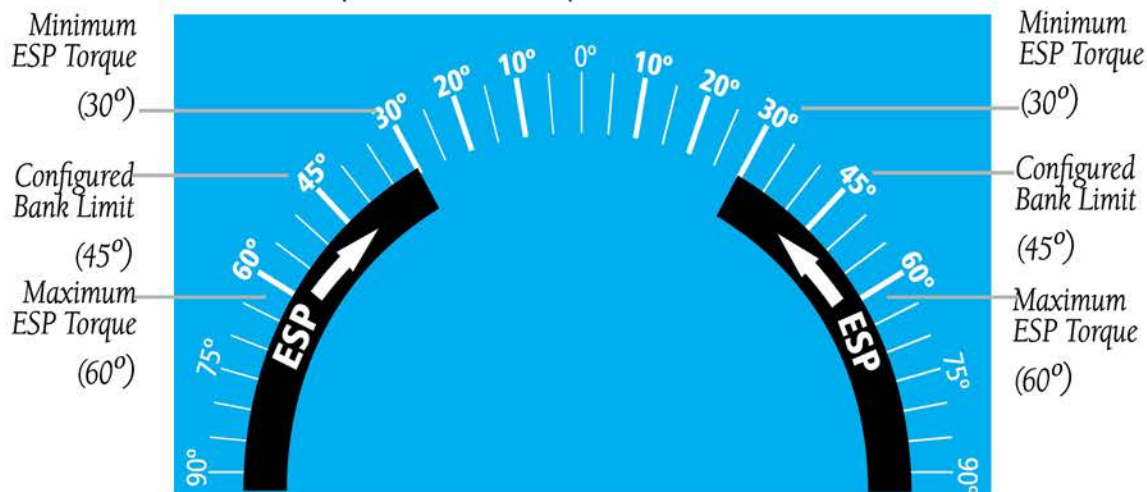


Figure 3-28 ESP Roll Operating Range When Engaged
(Force Increases as Roll Increases & Decreases as Roll Decreases)

3.5.2 PITCH ENGAGEMENT

ESP pitch engagement is configurable between 10° and 25° nose-up and between 5° and 25° nose-down. Once engaged, the torque applied by ESP is at its maximum when pitch is 5° more than the configured nose-up and nose-down pitch limits, and tapers to the minimum applied torque when pitch is 5° less than the configured nose-up and nose-down pitch limits. When beyond 5° of the configured pitch limit, the maximum torque is held until the aircraft returns inside the protected envelope.

The opposing force increases or decreases depending on the pitch angle and the direction of pitch travel. This force is intended to encourage movement in the pitch axis in the direction of the normal pitch attitude range for the aircraft.

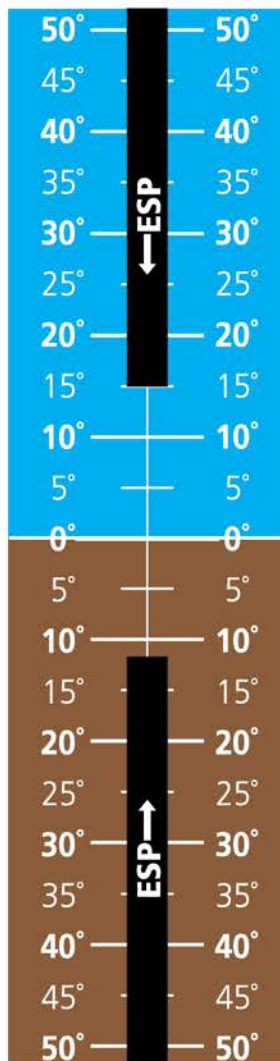


Figure 3-29 ESP Pitch Operating Range When Engaged
(Force Increases as Pitch Increases & Decreases as Pitch Decreases)

3.5.3 AIRSPEED PROTECTION (GFC 500 ONLY)



NOTE: If AGL height data is unavailable low-airspeed protection is not supported.

An airspeed below the minimum configured airspeed or above maximum configured airspeed will result in ESP applying force to raise or lower the nose of the aircraft. When the high or low airspeed condition is remedied, ESP force is no longer applied.

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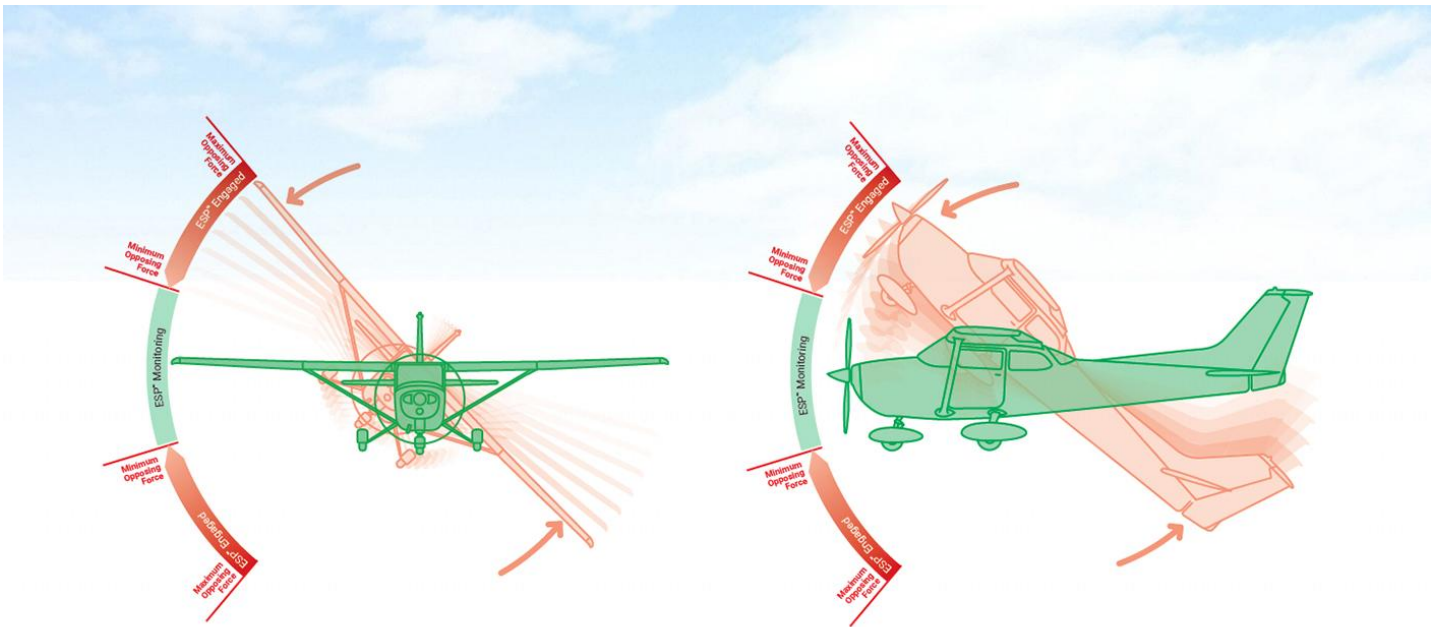
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Understanding Garmin Electronic Stability and Protection (ESP)

January 25, 2018

E-S-P. Three simple letters, with an extremely powerful meaning: Electronic Stability & Protection. It's a feature our team designed to keep a watchful eye on an aircraft's flight condition — and lend a helping hand if needed.

What is ESP? ESP is a safeguard created to assist you in maintaining safe, stable flight when hand-flying your aircraft. It monitors the aircraft's flight condition, functioning independently of the autopilot, and it applies a control force toward stable flight whenever pitch or roll deviations exceed recommended limits. ESP can also recognize when underspeed or overspeed conditions are about to occur — such as a stall or too-steep of a descent — and it makes appropriate adjustments to the controls. Plus, if the system detects that ESP has been activated for a specified period of time — such as in the event of pilot incapacitation — the autopilot will engage with the flight director in level mode to bring the aircraft back to level flight. However, if you're training or practicing, ESP can be manually disabled to allow intentional flight maneuvers.

Where is ESP? ESP can be found in many of our most popular integrated flight decks, including a number of G1000 NXi- and G3000-equipped aircraft, along with our new cost-effective [GFC 500 retrofit autopilot](#) for light single-engine aircraft, and [GFC 600 retrofit autopilot](#) for high-performance, more complex aircraft. Experimental/LSA owners and pilots can also take advantage of ESP with our G3X and G3X Touch experimental flight display systems by utilizing compatible G3X autopilot servos.

How can ESP help? Lately, an important discussion within the aviation community has centered around aircraft loss-of-control scenarios—in fact, it’s on the NTSB’s “Most Wanted” list. ESP is a direct result of these conversations. By helping to avoid the onset of inadvertent stall/spins, steep spirals or other loss-of-control situations, we want to help make the flight environment even better.

Garmin GFC™ 500 and GFC™ 600: Advanced Digit...



For more information about ESP, plus our extensive line of aviation products, visit our website at garmin.com/aviation.

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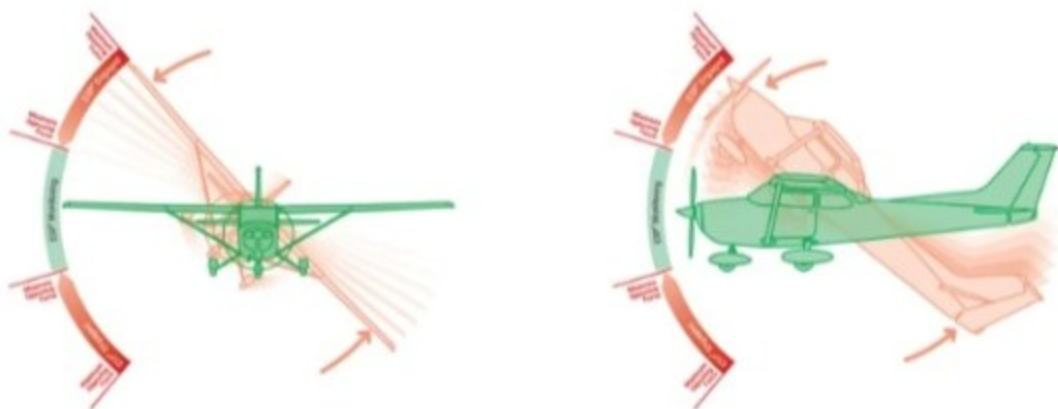
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Hand-fly with Stability Protection

Any pilot who's ever been startled to attention by a stall warning horn in a busy cockpit will appreciate the proactive stability augmentation of our ESP technology, which is standard on the GFC 500 system. When the aircraft is being hand-flown, this ESP feature functions independently of the autopilot — although it uses the same control servos — to nudge the controls toward stable flight whenever pitch or roll deviations exceed the recommended limits or underspeed/overspeed conditions occur. In the event of pilot incapacitation, after the system detects that it has been activated for a specified period of time, the autopilot will engage with the flight director in level mode, bringing the aircraft back to level flight and helping to avoid the onset of inadvertent stall/spins, steep spirals or other loss-of-control scenarios. Additionally, ESP can be manually disabled to allow for intentional flight maneuvers.



Plus, pairing GFC 500 with a GTN Xi series navigator enhances our [Smart Glide™](#) technology for emergency engine power loss situations. Once Smart Glide is activated, GFC 500 automatically activates IAS mode at best glide speed and flies the generated route near the airport so the pilot can land.

An Autopilot Knows Its Limits

With the autopilot engaged, GFC 500 also provides overspeed and underspeed protection. In a high airspeed situation — for example, if you're descending and your aircraft is approaching VNE or VMO — the system will increase the aircraft's pitch attitude, preventing a further increase in airspeed and potential structural damage. Likewise, at the other end of the speed spectrum, GFC 500 provides underspeed (stall) protection. For example, in the event the pilot does not immediately advance the throttle to full power, with the autopilot engaged while flying a missed approach sequence, the autopilot will help prevent an aircraft stall by reducing pitch attitude and provide the pilot with an "airspeed, airspeed" audible alert.

It's a Total Peace-of-mind Investment

There is no substitute for a safe and vigilant pilot. But there are times when a "helping hand" at the controls can have a significant impact on the safety, comfort and enjoyment of your flight. Backed by a comprehensive warranty and the industry's No. 1-rated product support team, our GFC 500 autopilot system is a price- and peace-of-mind breakthrough for pilots who want to add these valuable capabilities to their existing light piston GA aircraft. With supplemental type certification (STC) completed for [a growing list of aircraft models](#), it's easy to select an approved installation that meets your mission requirements and budget. See your authorized Garmin installation center for more details on configuring a GFC 500 autopilot system for your aircraft.