



# S-TEC 5000 Digital Flight Control System Pilot Guide

PRECISE PERFORMANCE.  
PROVEN EXPERIENCE.  
PERSONALIZED ATTENTION.

# Pilot Operating Guide and Reference

Digital Flight Control System - S-TEC 5000

Doc No 87306

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# Section 1 Overview

## 1.1. Document Organization

Section 1 Overview

Section 2 Pre-Flight Procedures

Section 3 In-Flight Procedures

Section 4 EFIS Integration Options

Section 5 Emergency Procedures

Section 6 Operating Parameters

Section 7 Glossary

## 1.2. Purpose

This pilot guide provides pre-flight and in-flight operating procedures for the S-TEC 5000 autopilot (AP).

### NOTE:

This pilot guide must be carried in the aircraft (A/C) and available to the pilot at all times. It can only be used in conjunction with the Federal Aviation Administration (FAA) approved Aircraft Flight Manual (AFM) or Aircraft Flight Manual Supplement (AFMS). Refer to the applicable AFM or AFMS for A/C specific information, such as unique ground tests, limitations, and emergency procedures.

The S-TEC 5000 is designed to assist pilots with cockpit workload management. The ability of the AP to provide optimum assistance and performance is directly proportional to the pilot's knowledge of its operating procedures. Therefore, it is highly recommended that the pilot develop a thorough understanding of the AP, its modes, and operating procedures in visual meteorological conditions (VMC) prior to using it under instrument flight rules (IFR).

## 1.3. General Control Theory

The S-TEC 5000 is capable of being a two- or three-axis attitude-based digital flight control system. It is comprised of a computer/programmer, which performs input/output processing and control laws, with an integrated bezel/display for mode selection and display, including trim annunciations.

S-TEC servos are coupled to the control system. The roll servo is coupled to the ailerons; the pitch servo is coupled to the elevator; and the optional yaw servo is coupled to the rudder.

The AP senses roll attitude, roll rate, heading error, and course deviation to control the roll servo.

The AP senses pitch attitude, pitch rate, pressure altitude, indicated airspeed (IAS), vertical speed (VS), vertical acceleration, and glideslope deviation to control the pitch servo.

With the optional yaw control, the AP senses yaw rate and acceleration to control the yaw servo.

The AP senses an out of trim condition whenever the trim sensor in the pitch servo is activated. In response to this, the AP drives the trim servo in the proper direction until the A/C is in trim.

## 1.4. Principal Modes of Operation

### 1.4.1. Roll Axis Control

**Autopilot (AP) Mode:** Engages roll servo

**Flight Director (FD) Mode:** Laterally drives steering command bars (if applicable)

**Roll Attitude (ROLL) Mode:** Holds roll attitude

**Heading (HDG) Mode:** Turns onto a selected heading and holds it

**Navigation (NAV) Mode:** Intercepts and tracks a VOR course

**Approach (APR) Mode:** Intercepts and tracks a LOC front course or GPS approach inbound

**Reverse (REV) Mode:** Intercepts and tracks a LOC back course (BC) inbound or tracks a LOC front course outbound

**Control Wheel Steering (CWS) Mode:** Captures and holds new roll attitude, pitch attitude, indicated airspeed, vertical speed, or altitude

**GPS Steering (GPSS) Mode:** Laterally steers along a flight plan course defined by GPS/FMS

**GPS Lateral Navigation (GPSL) Mode:** Laterally steers along an approach course defined by GPS/FMS approach



**Level (LVL) Mode:** Returns A/C to wings level attitude from any condition

**Half Bank (HB) Mode:** Reduces commands in HDG and GPS/FMS steering by half

**Go-Around (GA) Mode:** Disengages AP and/or engages FD in ROLL wings-level mode

### 1.4.2. Pitch Axis Control

**Autopilot (AP) Mode:** Engages pitch servo

**Flight Director (FD) Mode:** Vertically drives steering command bars (if applicable)

**Pitch Attitude (PITCH) Mode:** Holds pitch attitude

**Indicated Airspeed (IAS) Mode:** Holds indicated airspeed (if applicable)

**Vertical Speed (VS) Mode:** Holds vertical speed (if applicable)

**Altitude Hold (ALT HOLD) Mode:** Holds altitude

**Glideslope (GS) Mode:** Intercepts and tracks glideslope

**GPS Vertical Navigation (GPSV) Mode:** Vertically steers along a glidepath defined by a GPS/FMS approach

**Level (LVL) Mode:** Returns A/C to a fixed pitch up attitude from any condition

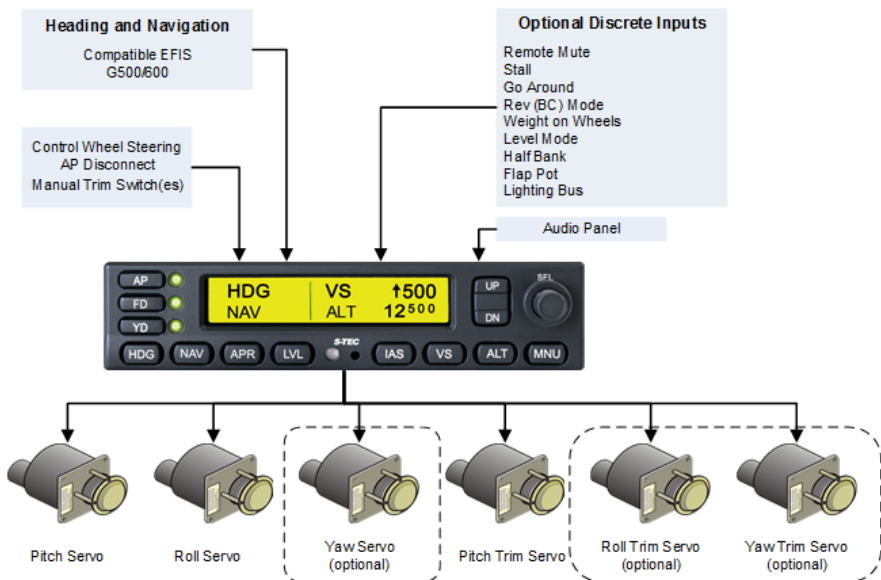
**Go-Around Mode (GA) Mode:** Disengages AP and/or engages FD (if applicable) in pitch hold mode with a preset nose-up command

**Automatic Trim Mode:** Automatically drives trim servo(s), as required, if installed.

### 1.4.3. Yaw Axis Control

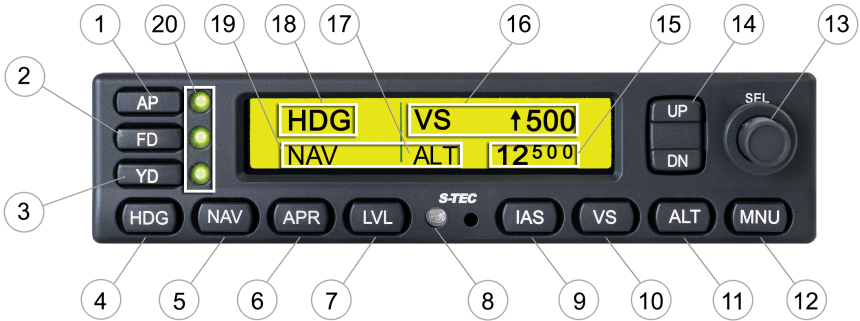
**Yaw Damper (YD) Mode:** Dampens excessive adverse yaw and coordinates turns (if installed)

## 1.5. Block Diagram



**Figure 1-1: Block Diagram**

## 1.6. Display Legend



**Figure 1-2: Display Legend**

- 1) Autopilot (AP) Mode button
- 2) Flight Director (FD) Mode button
- 3) Yaw Damper (YD) Mode button
- 4) Heading (HDG) Mode button
- 5) Navigation (NAV) Mode button
- 6) Approach (APR) Mode button
- 7) Level (LVL) Mode button
- 8) Ambient light sensor
- 9) Indicated Airspeed (IAS) Mode button
- 10) Vertical Speed (VS) Mode button
- 11) Altitude Hold (ALT HOLD) Mode button
- 12) Menu (MNU) Mode button
- 13) Altitude Selector (ALT SEL) knobs
- 14) Up/Down (UP/DN) Modifier switches
- 15) Altitude Selector/Alerter annunciation
- 16) Active Pitch Mode annunciation
- 17) Armed Pitch Mode annunciation
- 18) Active Roll Mode annunciation
- 19) Armed Roll Mode annunciation
- 20) Light Emitting Diodes (LEDs)

## Section 2 Pre-Flight Procedures

### 2.1. Power-Up Test

Perform the following actions during power-up.

- 1) Set battery master switch to ON position.
- 2) Set avionics master switch to ON position.
- 3) Set AP master switch to ON position.
- 4) Set Trim master to ON position (If Installed).

The following occur in sequence:

**Self Test In Progress** appears during AP self-test.



**ADAHRS INITIALIZING** appears during initial ADAHRS alignment.



**AP READY** indicates AP is ready for operation.



#### NOTE:

No annunciation in the AP/YD status nor ROLL and PITCH blocks indicates AP READY.


If ADAHRS is not valid after configured start-up time or data becomes invalid following the alignment, **AP FAIL** appears.



### 2.2. Pre-Flight Checks



Perform the following actions prior to take-off with engine running. See Section 4 for EFIS integration options.

- 1) Move A/C control left and right to sense freedom of movement about roll axis.
- 2) Move A/C control forward and aft to sense freedom of movement about pitch axis.

- 3) Actuate A/C rudder pedals alternately in succession to sense freedom of movement about yaw axis.
- 4) Press **AP** to engage ROLL, PITCH, FD, and YD modes. AP, FD, and YD LEDs, while **ROLL** and **PITCH** appear on AP.
 
- 5) Move A/C control left and right. Reduced freedom of movement indicates roll servo is engaged. Verify roll servo can be overridden.
- 6) Move A/C control forward and aft. Reduced freedom of movement indicates pitch servo is engaged. Verify pitch servo can be overridden.
- 7) Actuate A/C rudder pedals alternately in succession. Reduced freedom of movement indicates yaw servo is engaged. Verify yaw servo can be overridden.

### CAUTION:

**If any servo in any axis cannot be overridden or fails to disengage during the pre-flight checks, the aircraft should not be flown and the autopilot should be inspected by an authorized service facility.**

- 8) Set heading bug under lubber line.
- 9) Press **HDG** to engage HDG mode. **HDG** replaces **ROLL** on AP.
 
- 10) Turn heading bug to left of lubber line. A/C control turns to the left.
- 11) Turn heading bug to right of lubber line. A/C control turns to the right.
- 12) Set heading bug under lubber line. A/C control stops.
- 13) Press **IAS** to engage IAS mode. **IAS** replaces **PITCH** on AP. Number indicates lowest airspeed configured for A/C in KTS.
 
- 14) Press/Hold **UP**. Airspeed indication increases on AP. (For EFIS integration, see § 4.1.)
- 15) Press/Hold **DN**. Airspeed indication decreases on AP display. (For EFIS integration, see § 4.1.)

- 16) Press **VS** to engage VS mode. **VS** replaces **IAS** on AP. Number indicates current VS in feet per minute (fpm).
- |     |    |      |
|-----|----|------|
| HDG | VS | 0    |
|     |    | ---- |
- 17) Press/Hold **UP** until a commanded VS of  $\uparrow$ 500 (500 fpm climbing) is reached. A/C control moves aft – pilot may have to assist a heavy yoke. (For EFIS integration, see § 4.1.)
- 18) Press/Hold **DN** until a commanded VS of  $\downarrow$ 500 (500 fpm descending) is reached. A/C control moves forward. (For EFIS integration, see § 4.1.)
- 19) Press **ALT** to engage ALT mode. **ALT HOLD** replaces **VS** on AP, and VS indication is extinguished.
- |     |          |
|-----|----------|
| HDG | ALT HOLD |
|     | ----     |
- 20) Press/Hold CWS switch to engage CWS mode. **CWS** flashes on AP, while periodic audible alert tone sounds.
- |     |            |          |
|-----|------------|----------|
| HDG | <b>CWS</b> | ALT HOLD |
|     |            | ----     |
- 21) Move A/C control left and right. Increased freedom of movement indicates roll servo is disengaged.
- 22) Move A/C control forward and aft. Increased freedom of movement indicates pitch servo is disengaged.
- 23) Release CWS switch to disengage CWS mode and resume AP control. **CWS** is extinguished on AP.
- 24) Move A/C control left and right. Reduced freedom of movement indicates roll servo is engaged.
- 25) Move A/C control forward and aft. Reduced freedom of movement indicates pitch servo is engaged.
- 26) Verify trim master switch is set to ON position.

**NOTE:**

Reference the AFMS for the particular model as some functionality of automatic trim may differ.

- 27) One axis at a time, for the trim surfaces fitted with auto-trim, move A/C controls to apply force to simulate out-of-trim condition.



After 4 seconds, appropriate axis' trim annunciation appears on AP (**TRIM** ↓ for pitch and trim bar for roll and yaw). Trim wheel runs to counter.



After 12 seconds, **TRIM** ↓ (trim bar for roll and yaw) flashes and audible alert, "Trim in Motion," sounds repeatedly.

- 28) One axis at a time, for the trim surfaces fitted with auto-trim, move A/C controls to apply force to simulate out-of-trim condition in the opposite direction as the previous step to simulate out-of-trim condition.



After 4 seconds, appropriate axis' trim annunciation appears on AP (**TRIM** ↑ for pitch and trim bar for roll and yaw). Trim wheel runs to counter.



After 12 seconds, **TRIM** ↑ (trim bar for roll and yaw) flashes and audible alert, "Trim in Motion," sounds repeatedly.

- 29) Set trim master switch to OFF position.

- 30) Repeat steps 27 and 28. The results are identical with the exception that trim does not drive the corresponding axis, and "Check Pitch Trim" ("Check Yaw Trim" or "Check Roll Trim," if installed) sounds repeatedly to alert the pilot that trim power is off or in a failed condition.

- 31) Press and hold AP DISC/TRIM INTR switch. **AP READY** appears on AP and audible alert sounds, while all other annunciations and all LEDs are extinguished. "Autopilot Disconnect" sounds once.



- 32) Move A/C control left and right. Increased freedom of movement indicates roll servo is disengaged.
- 33) Move A/C control forward and aft. Increased freedom of movement indicates pitch servo is disengaged.
- 34) Actuate A/C rudder pedals alternately in succession. Increased freedom of movement indicates yaw servo is disengaged.
- 35) Set trim master switch to ON position.

**NOTE:**

The following steps, 36 to 44, are related to the split switch for manual pitch trim.

- 36) Press both forward and aft on each segment of manual electric trim switch, independently of the other. In each case, A/C elevator trim wheel does not run.
- 37) Press/Hold aft on both segments of manual electric trim switch. **TRIM** flashes on AP, and A/C elevator trim wheel runs nose up.
- 38) Press/Hold AP DISC/TRIM INTR switch. A/C elevator trim wheel stops.
- 39) Release AP DISC/TRIM INTR switch. A/C elevator trim wheel resumes running nose up.
- 40) Release manual electric trim switch. **TRIM** is extinguished on AP, and A/C elevator trim wheel stops.
- 41) Press/Hold forward on both segments of manual electric trim switch. **TRIM** flashes on AP, and A/C elevator trim wheel runs nose down.
- 42) Press/Hold AP DISC/TRIM INTR switch. A/C elevator trim wheel stops.
- 43) Release AP DISC/TRIM INTR switch. A/C elevator trim wheel resumes running nose down.
- 44) Release manual electric trim switch. **TRIM** is extinguished on AP display, and A/C elevator trim wheel stops.

**NOTE:**

The following steps 45 to 52 are only applicable to installation with manual roll and/or yaw trim switch installed



- 45) Press/Hold the manual roll trim switch in one direction. Ensure **TRIM** flashes on AP and the A/C roll trim runs accordingly.
- 46) Press/Hold AP DISC/TRIM INTR switch. A/C roll trim stops.
- 47) Release AP DISC/TRIM INTR switch. A/C roll trim resumes.
- 48) Repeat steps 45 to 47 in the opposite roll trim direction.
- 49) Press/Hold the manual yaw trim switch in one direction. Ensure **TRIM** flashes on AP and the A/C yaw trim runs accordingly.
- 50) Press/Hold AP DISC/TRIM INTR switch. A/C yaw trim stops.
- 51) Release AP DISC/TRIM INTR switch. A/C yaw trim resumes.
- 52) Repeat steps 49 to 51 in the opposite yaw trim direction.
- 53) Press GA switch. FD LED illuminates (AP not engaged), while **ROLL** and **PITCH** appear on AP display.
- 54) Trim A/C for take-off.

## Section 3 In-Flight Procedures

### 3.1. Normal Operating Procedures

#### 3.1.1. Roll Attitude (ROLL) Mode

From any active condition shown in Table 3-1, the corresponding action engages roll attitude mode. **ROLL** appears. The AP holds the A/C at its current (captured) roll attitude.

Active Condition	Action	Result
AP READY	<b>AP</b> pressed	Roll mode engaged
	<b>FD</b> pressed	
HDG mode engaged	<b>HDG</b> pressed	
NAV mode engaged	<b>NAV</b> pressed	
APR mode engaged	<b>APR</b> pressed	
REV mode engaged	<b>LVL</b> pressed	




Figure 3-1: Roll Attitude (ROLL) Mode

#### 3.1.2. Heading (HDG) Mode

Set the heading bug to desired heading on the compass card. From any active condition shown in Table 3-2, the corresponding action engages heading mode. **HDG** appears. The AP turns the A/C onto the selected heading and holds it. A new heading can be selected thereafter by setting the heading bug to it.

**Table 3-2: Heading (HDG) Mode**


Active Condition	Action	Result
Roll mode engaged	 pressed	HDG mode engaged
NAV mode engaged		
APR mode engaged		
REV mode engaged		


**Figure 3-2: Heading (HDG) Mode**

### 3.1.3. Navigation (NAV) Mode Tracking a VOR

Select the VOR frequency on the navigation receiver. Set course pointer to desired radial and direction to/from the station on the compass card. From any active condition shown in Table 3-3, the corresponding action engages navigation mode. **NAV** appears.

**Table 3-3: Navigation (NAV) Mode**

Active Condition	Action	Result
Roll mode engaged	 pressed	NAV mode engaged
APR mode engaged		
REV mode engaged		
HDG mode engaged, NAV mode armed	Course captured	
NAV GPSS engaged	VOR or LOC selected	

The AP establishes the A/C on a 45° intercept angle relative to the selected course, with the exception of a pilot selectable intercept angle (§ 3.1.3.1). The course is captured upon reaching the point where the AP must begin to turn the A/C onto the course. After completing the turn, the AP establishes the crosswind correction angle and tracks the course.



**Figure 3-3: Navigation (NAV) Mode**

If a reference signal required for NAV fails, NAV mode transitions to FAIL, and **NAV** and **FAIL** alternately flash until the signal is valid once more. If this occurs prior to course capture, the AP holds the aircraft's wings level and does not attempt to capture the course. However, if this occurs after course capture, it holds the last known crosswind corrected course and ignores CDI needle deflection.

Once tracking, if CDI needle deflection exceeds 50% from center for a period of 15 seconds, **NAV** flashes. If the A/C subsequently returns to within 50% CDI needle deflection from center, **NAV** stops flashing but remains.

At point of station passage, the AP recognizes the condition and holds the last known course. Either allow the A/C to pass over the station and pick it up again on the other side or select another VOR to track.

While either NAV or APR mode may be used to track a VOR, NAV mode is recommended. Do not press **APR** until cleared for approach and ready to arm to some vertical guidance.

### 3.1.3.1. Pilot Selectable Intercept Angle

To select an intercept angle other than 45°, set the heading bug to desired intercept heading on the compass card, so the difference between this heading and the desired course is the intercept angle. Set course pointer to desired course. Engage HDG mode, and press **NAV** to arm NAV mode. **HDG** and **NAV** appear.



**Figure 3-4: Heading Mode Engaged, Navigation Mode Armed**

The AP establishes the A/C on the selected intercept angle (heading) and holds this heading until the course is captured. At that point in the intercept sequence, **NAV** replaces **HDG** indicating engagement of NAV mode.

### 3.1.4. GPS Steering (GPSS) Mode

Program a valid waypoint or flight plan into the GPS navigator and press **NAV**. **NAV GPSS** appears. The AP laterally steers the A/C along the predefined course. During GPSS mode of operation, the AP does not accept any course error input from the course pointer.



Figure 3-5: NAV GPSS

While either NAV or APR mode may be used for GPS/FMS steering, NAV mode is recommended. It is recommended that **APR** is not pressed until cleared for the approach and ready to arm GS or GPSV for vertical guidance. Press **APR** to arm the AP to automatically transition to the FMS approach segment once reached. **APR-GPSS** replaces **APR-GPSS** once the FMS approach segment is reached.



Figure 3-6: APR GPSS

### 3.1.5. Control Wheel Steering (CWS) Mode

Press and hold the CWS switch to engage control wheel steering mode. **CWS** appears, while an audible alert sounds. In addition, both the roll and pitch servos disengage. Maneuver the A/C as desired, and then release the CWS switch to disengage CWS mode. **CWS** extinguishes, and both servos re-engage.



**Figure 3-7: Control Wheel Steering (CWS) Mode**

The AP resumes operation in the previous mode. If HDG, NAV, GPSS, APR, or REV mode was engaged, the AP returns to tracking the selected. If IAS, VS, or ALT mode was engaged, the AP holds the new IAS, VS, or altitude, respectively. If roll or pitch mode was engaged, the AP holds the new roll attitude or pitch attitude, respectively.

### 3.1.6. Pitch Attitude (PITCH) Mode

From any active condition shown in Table 3-4, the corresponding action engages pitch attitude mode. **PITCH** appears. The AP holds the A/C at its current (captured) pitch attitude. Press **UP** to increase or **DN** to decrease captured pitch attitude. A single press changes the pitch attitude 0.25°.

**Table 3-4: Pitch Attitude (PITCH) Mode**

Active Condition	Action	Result
AP READY	<b>AP</b> pressed	Pitch mode engaged
	<b>FD</b> pressed	
IAS mode engaged	<b>IAS</b> pressed	
ALT HOLD mode engaged	<b>ALT</b> pressed	
GS mode engaged	GA button pressed	



**Figure 3-8: Pitch Attitude (PITCH) Mode**

### 3.1.7. Indicated Airspeed (IAS) Mode

From any active condition in Table 3-5, the corresponding action engages indicated airspeed mode. **IAS** appears with the current (captured) IAS in units of KTS (for example, **105**). The AP holds the A/C at the captured IAS.

Active Condition	Action	Result
Pitch mode engaged	<b>IAS</b> pressed	IAS mode engaged
VS mode engaged		
ALT CAP mode engaged		
ALT HOLD mode engaged		
GS mode engaged		



Figure 3-9: Indicated Airspeed (IAS) Mode

Press **UP** or **DN** to increase or decrease the captured IAS. A single press changes the IAS by 1 KT, or press and hold to change at a rate of 20 KTS per second.

#### CAUTION:


**Engine power and airspeed must be monitored when IAS mode is engaged, since insufficient power at low airspeeds may cause the A/C to stall and the AP to disconnect. Although the AP should limit the airspeed to 3-5 knots (KTS) below the aircraft's maximum operating airspeed  $V_{MO}$ , large power changes at higher airspeeds may cause the A/C to momentarily exceed  $V_{MO}$ .**

### 3.1.8. Vertical Speed (VS) Mode

From any active condition shown in Table 3-6, the corresponding action engages vertical speed mode. **VS** appears with the current (captured) VS in units of fpm prefixed by either  $\uparrow$  (up arrow) indicating climb, or  $\downarrow$  (down

arrow) indicating descent (for example,  $\uparrow 500$  indicates 500 fpm climbing). The AP holds the A/C at the captured VS.

**Table 3-6: Vertical Speed (VS) Mode**

Active Condition	Action	Result
Pitch mode engaged	 pressed	VS mode engaged
IAS mode engaged		
ALT CAP mode engaged		
ALT HOLD mode engaged		
GS mode engaged		



**Figure 3-10: Vertical Speed (VS) Mode**

Press **UP** or **DN** to increase or decrease the captured VS. A single press changes the VS by 100 fpm.

During a climb, if the commanded VS exceeds the actual VS by 300 fpm for a period of 10 seconds, **VS** flashes as an alert to the potential for an impending stall condition. In this event, immediately increase the aircraft's thrust if possible, reduce the commanded VS using **DN**, or both, until **VS** stops flashing.

### 3.1.9. Altitude Hold (ALT HOLD) Mode

From any active condition shown in Table 3-7, the corresponding action engages altitude hold mode. **ALT HOLD** appears. Scroll either concentric SEL knob a single detent causes the current (captured) baro-corrected altitude to also appear in units of feet (ft.) (for example, **12500**). The AP holds the A/C at the captured altitude.

Modifying the altitude target does not change **ALT HOLD** mode. The AP holds the A/C at the captured altitude. Press **UP** or **DN** to increase or decrease captured altitude. A single press changes the altitude by 20 ft., and the range is  $\pm 500$  ft. from the original captured altitude.



**Table 3-7: Altitude Hold (ALT HOLD) Mode**

Active Condition	Action	Result
Pitch mode engaged	[ALT] pressed	ALT HOLD mode engaged
IAS mode engaged		
VS mode engaged		
ALT CAP mode engaged	[ALT] pressed	
	Target altitude captured	
GS mode engaged	[ALT] pressed	
	APR LOC mode disengaged	


**Figure 3-11: Altitude Hold (ALT HOLD) Mode**

### 3.1.10. Altitude Pre-Select Function

The altitude pre-select function allows for pre-selection of a target altitude and the speed (if within the aircraft's capabilities) or pitch angle at which the A/C climbs or descends until the altitude is captured. Pre-select the target altitude using the ALT SEL knob. Rotate either knob CW to increase or CCW to decrease the target altitude. The outer knob changes the target altitude in increments of 1000 ft., whereas the inner knob changes in increments of 100 ft. Target altitude appears in units of ft. (for example, **12500** with **ALT** to indicate ALT HOLD mode is armed).


**Figure 3-12: Target Altitude in Ft. with ALT HOLD Mode Armed**

If the AP is not receiving altitude targets from an external EFIS source, press the inner knob once to cancel the target altitude and display dashes

instead. Press it again to restore the target altitude. If no target altitude is initially selected, indicated by dashes, then rotate either knob a single detent to cause the current altitude to appear. A pre-selected altitude may be captured from VS, IAS, or PITCH (ALT armed). If the connected EFIS is providing altitude targets, pressing the inner knob cannot disarm or cancel the current target altitude, so the current target remains displayed on the AP. The target can still be altered using the AP inner and outer knobs, or adjusting the altitude target bug on the connected EFIS.

- 1) Engage VS mode. Press **UP** to set rate of climb or **DN** to set rate of descent. **VS** replaces the prior pitch axis mode annunciation, and the selected VS appears in units of fpm (for example,  $\uparrow 500$  indicates 500 fpm climbing); OR
- 2) Engage IAS mode. Press **UP** or **DN** to select desired IAS and adjust power to climb or descent. **IAS** replaces the prior pitch axis mode annunciation, and the selected airspeed appears in units of KTS; OR
- 3) Engage pitch hold mode by pressing **ALT**. Use CWS to establish desired angle of climb or descent.



**Figure 3-13: Vertical Speed in Units of FPM**

When the A/C is 1000 ft. from the target altitude, an audible alert sounds followed by the audible alert, “One Thousand to Go.” Once the point has been reached at which the AP must begin a scheduled reduction in VS, the target altitude is captured. **CAP** replaces the active annunciation indicating engagement of ALT HOLD CAP mode. At 200 ft. from altitude, the audible alert sounds again, followed by the audible alert, “Two Hundred to Go.”



**Figure 3-14: ALT HOLD CAP Mode**

When the A/C reaches the target altitude, the audible alert, “Altitude,” sounds, and ALT HOLD mode engages. **ALT** extinguishes, and **ALT HOLD** replaces **CAP** (Figure 3-11). If the A/C happens to subsequently exceed a distance of  $\pm 200$  ft. from the captured altitude, the audible alert, “Check Altitude,” sounds.

### 3.1.11. Automatic Trim Annunciations

When the trim master switch is in ON position, the AP indicates when it is automatically trimming the A/C. If the servo loading exceeds a preset threshold for a period of 4 seconds, the AP indicates out-of-trim (**TRIM**  $\uparrow$  for pitch and trim bar for roll and yaw) as the AP is automatically trimming the A/C. If the AP is still automatically trimming the A/C after 9 more seconds, the trim annunciation flashes, and the audible alert, “Trim in Motion,” sounds repeatedly. As soon as the A/C has been sufficiently trimmed, the trim annunciation extinguishes and the audible alert ceases.



Figure 3-15: Pitch Trim Annunciations - UP



Figure 3-16: Pitch Trim Annunciations - DOWN

### 3.1.12. Manual Trim Annunciations

When the trim master switch is OFF, the AP indicates when it is necessary to trim the A/C. If servo loading exceeds a preset threshold for a period of 3 seconds, the AP indicates out-of-trim (**TRIM**  $\uparrow$  for pitch and trim bar for roll and yaw). In addition, the audible alert “Check Pitch Trim” sounds once. After 9 more seconds, the trim annunciation flashes. As soon as the A/C has been sufficiently trimmed, the trim annunciation extinguishes.

### 3.1.13. Manual Electric Trim

The manual electric trim switch, located on the control wheel/stick, can only be used to trim the A/C when AP mode is disengaged. Attempting to use it otherwise disconnects the AP. To trim the A/C nose up, press aft and maintain pressure on both segments of the manual electric trim switch. To trim the A/C nose down, press forward and maintain pressure on both segments of the manual electric trim switch. In either case, **TRIM** flashes.



Figure 3-17: Manual Electric Trim

## 3.2. Precision Approach Procedures

### 3.2.1. Straight-In ILS Approach

Execute a straight-in intercept and track the front inbound LOC course with either PITCH, IAS, VS, or ALT HOLD engaged. From any active condition shown in Table 3-8, the corresponding action arms GS mode, and **GS** appears. To disarm GS mode, engage a different roll mode.

Table 3-8: Straight-In ILS Approach

Active Condition	Action	Result
APR mode	APR LOC mode engaged CDI < 50% GDI < 50% above GS	GS mode engaged



Figure 3-18: APR LOC and ALT HOLD Modes Engaged, GS Mode Armed

With GS mode armed, once the A/C arrives within 25% of the GS centerline, either above or below, the glideslope is captured. **CAP**, indicating GS CAP mode engagement, replaces the active pitch mode annunciation, and a VS proportional to the IAS is established.

With GS CAP mode engaged, once the A/C arrives within 5% of the GS centerline, either above or below, or a period of 10 seconds has elapsed, GS mode engages. **GS** replaces **CAP** marking the end of the intercept sequence and beginning of tracking.

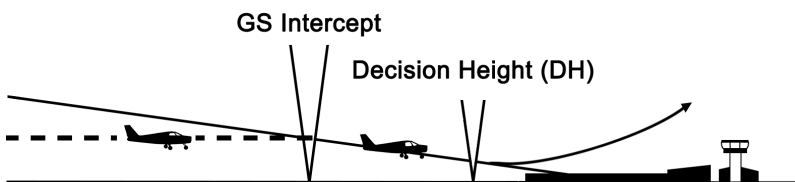


**Figure 3-19: APR LOC and GS CAP Modes Engaged**

Once tracking, if GDI needle deflection exceeds 50% from center, GS flashes. If one or more of the reference signals required for GS fail, **GS** and **FAIL** alternately flash. At the decision height (DH) or missed approach point (MAP), disconnect the AP to execute either a manual landing or go-around, respectively.



**Figure 3-20: APR LOC and GS Modes Engaged**



**Figure 3-21: Straight-In ILS Approach**

### 3.2.2. ILS Approach with Procedure Turn

Execute a procedure turn intercept and track the front inbound LOC course above the approach altitude, just until the A/C is established on the front inbound procedure turn heading, with HDG mode still engaged. Press **VS** to engage VS mode and use **DN** to select desired descent speed. Upon reaching the approach altitude, press **ALT** to engage ALT HOLD mode. Press **APR** to arm APR LOC mode, so the AP executes a straight-in intercept and track of the front inbound LOC course.

Execute a straight-in intercept and track the GS. For A/C equipped with GPS navigators providing roll steering output data with GPSS mode engaged, the AP is capable of executing the entire lateral approach sequence if it has been programmed into the GPS Navigator. Once on the front inbound LOC course, with GPS navigator set to VLOC and GS mode armed, press **APR** to engage APR LOC mode and complete the ILS approach.

### 3.3. Non-Precision Approach Procedures

#### 3.3.1. Straight-In Back Course Approach

From any active condition shown in Table 3-9, the corresponding action engages REV mode. **REV** appears.

**Table 3-9: Straight-In Back Course Approach**

Active Condition	Action	Result
Roll mode engaged	<b>APR</b> pressed while on a localizer BC	REV mode engaged
NAV mode engaged		
HDG mode engaged	<b>APR</b> pressed to arm REV mode. Localizer BC captured and BC logic identified by AP	
APR mode engaged	Localizer BC captured and BC logic identified by AP	
APR LOC mode engaged		



Figure 3-22: REV Mode

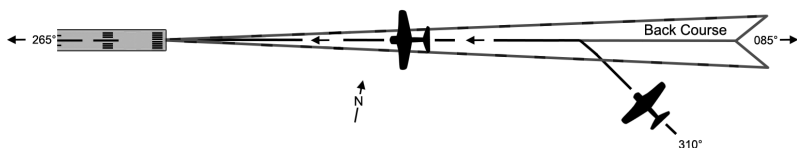


Figure 3-23: Back Inbound LOC Course Procedure

- 1) Select LOC frequency.
- 2) Set course pointer to front inbound LOC course.
- 3) Press **APR**. REV mode automatically engages if course pointer is set to inbound course and BC logic is identified by the AP. A/C intercepts the inbound selected course at a 45° angle; OR

Set heading bug to desired intercept heading, press **HDG** to engage HDG mode. Press **APR** (BC logic automatically identified by the AP) to arm REV mode.

- 4) AP intercepts and tracks the back inbound LOC course.

### 3.3.2. Straight-In LOC Approach

From any active condition shown in Table 3-10, the corresponding action engages APR LOC mode. **APR LOC** appears.

Table 3-10: Straight-In LOC Approach

Active Condition	Action	Result
Roll mode engaged	<b>APR</b> pressed	APR LOC mode engaged
NAV mode engaged		
REV mode engaged		
HDG mode engaged, APR LOC mode armed	LOC back course captured	



Figure 3-24: APR LOC Mode

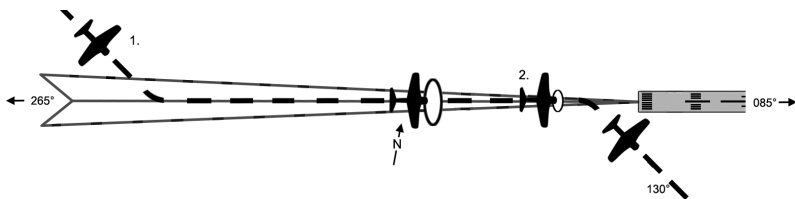


Figure 3-25: Straight-In LOC Approach

- 1) a) Select LOC frequency.
  - b) Set course pointer to front inbound LOC course.
  - c) Press **APR** to engage APR mode and intercept the inbound selected course at a 45° angle; OR  
 Set heading bug to desired intercept heading, press **HDG** to engage HDG mode, and then press **APR** to arm APR mode.
  - d) AP intercepts and tracks the front inbound LOC course.
- 2) a) At middle marker, if missed approach is declared, disengage autopilot by pressing either GA button or AP disconnect button.
  - b) Stabilize A/C.
  - c) Set heading bug to missed approach heading.
  - d) Press **HDG** to engage HDG mode.

### 3.3.3. LOC Approach with Procedure Turn

#### 3.3.3.1. Automatic Method

- 1) Load and activate the localizer approach with procedure turn.
- 2) CDI selected to GPS.

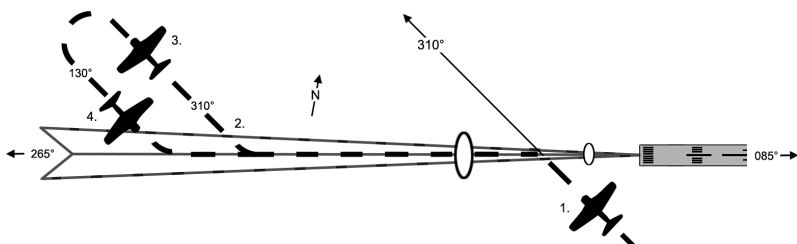


- 3) Press **NAV** to engage NAV GPSS.
- 4) AP follows roll steering commands from FMS and flies procedure turn.
- 5) Once inbound, press **APR** to enable GPSL mode.

### 3.3.3.2. Manual Method

From any active condition shown in Table 3-11, the corresponding action engages REV mode. **REV** appears (Figure 3-22).

Table 3-11: LOC Approach with Procedure Turn		
Active Condition	Action	Result
Roll mode engaged	REV button (if configured) pressed or <b>APR</b> pressed with BC logic identified by AP	REV mode engaged
HDG mode engaged, REV mode armed	Front outbound LOC course captured and BC logic identified by AP	
APR mode engaged	REV button (if configured) pressed or BC logic identified by AP	
APR LOC mode engaged		



**Figure 3-26: LOC Approach with Procedure Turn**

- 1) a) Select LOC frequency.
- b) Set course pointer to front outbound LOC course.
- c) Press **APR** (BC logic has been identified) to engage BC mode (or press BC button, if configured) and intercept the inbound selected course at a 45° angle; OR

Set heading bug to desired intercept heading, press **HDG** to engage HDG mode, and then press **APR** (BC logic has been identified) to arm BC mode.

- d) AP intercepts and tracks the front outbound LOC course.
- 2) a) At appropriate time, set heading bug to front outbound procedure turn heading. Hold heading until it is time to turn the A/C again.
    - b) Press **HDG** to engage HDG mode. **HDG** appears.



**Figure 3-27: HDG Mode**

- 3) a) Turn heading bug in two successive 90° increments, to establish A/C on front inbound procedure turn heading.
- 4) a) Press **APR** to arm APR LOC mode. **APR LOC** appears below **HDG**. Once front inbound LOC course is captured, **APR LOC** replaces **HDG** (Figure 3-24).

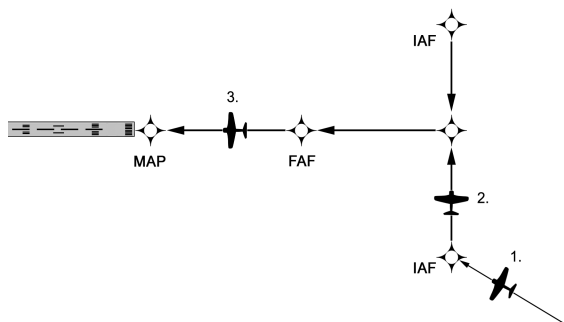


**Figure 3-28: APR LOC Mode Armed**

- b) AP intercepts and tracks front inbound LOC course.
- c) At middle marker, if missed approach is declared, disengage AP by pressing either GA button or AP disconnect button.
- d) Stabilize A/C.
- e) Set heading bug to missed approach heading.
- f) Press **HDG** to engage HDG mode.

For A/C equipped with GPS navigators providing roll steering output data, with GPSS mode engaged, the AP is capable of executing this entire lateral approach sequence, if it has been programmed into the GPS navigator. Once on front inbound LOC course, with the GPS navigator set to VLOC, press **APR** to engage APR LOC mode and complete the intercept.

### 3.3.4. GPS Steering (GPSS) RNAV Approach



**Figure 3-29: RNAV Approach Procedure**

- 1) a) Program approach into GPS navigator.
- b) Press **APR** to engage FMS mode. **APR GPSS** appears.



**Figure 3-30: GPSS and Pitch Modes Engaged**

- c) AP laterally steers the A/C along predefined approach, toward the IAF and FAF, making required turn between them.
- d) Begin descent at IAF in VS or IAS mode.
- 2) a) Prepare for turn toward FAF.
- 3) a) At MAP, if missed approach is declared, disengage autopilot by pressing either GA button or AP disconnect button.
- b) Stabilize A/C.
- c) Set heading bug to missed approach heading.

- d) Press **HDG** to engage HDG mode.

During GPSS mode, the AP does not accept any course error input from the course pointer.

For A/C equipped with the WAAS capable GPS navigator, the AP can execute the entire lateral and vertical approach sequence.

With either PITCH, IAS, VS, or ALT HOLD engaged, select the appropriate WAAS approach on the GPS navigator from the following possibilities:

- 1) LPV
- 2) LNAV/VNAV
- 3) LNAV+V

Once the following conditions are met, PGS mode is armed:

- 1) CDI < 50%
- 2) GDI < 50% above glidepath

**APR GPSL** and **GPSV** appear.



**Figure 3-31: GPS and Pitch Modes Engaged, Approach ALT HOLD Mode**

With GPSV mode armed, once the A/C arrives within 25% of glidepath centerline, either above or below, glidepath is captured. **CAP**, indicating engagement of GPSV CAP mode, replaces the active pitch mode annunciation, and a VS proportional to the IAS is established.



**Figure 3-32: GPSV CAP Mode Engaged**

With GPSV CAP mode engaged, once the A/C arrives within 5% of glidepath centerline, either above or below, or a period of 10 seconds has elapsed, GPSV mode engages. **GPSV** replaces **CAP** marking the end of intercept sequence and beginning of tracking. At decision height (DH) or missed approach point (MAP), disconnect AP to execute a manual landing or go-around, respectively.



**Figure 3-33: GPSV Mode Engaged**

### 3.4. Level (LVL) Mode

#### NOTE:

Level (LVL) mode functionality may differ from airframe to airframe. Reference the specific aircraft models AFMS for LVL mode functionality and operation.

In addition to a button on the control head for the AP, the level discrete is an optional switch in the cockpit to place the AP in an attitude recovery mode.

From AP READY mode or any other operating mode, press **LVL** to engage LVL mode. If in standby mode (AP READY), the FD engages but not the AP, unless configured to do so. To disengage this mode, press **LVL** again. Engagement is indicated by the modes on the AP display changing to **ROLL/PITCH** (or **LVL/PITCH**, if configured) and the flight director setting to wing-level and the configured pitch angle for the aircraft (refer to AFMS for pitch angle value). LVL mode can be engaged or disengaged at any time, regardless of the roll axis or pitch axis mode.



**Figure 3-34: Level Mode, Roll and Pitch Hold Modes**

### 3.5. Half Bank (HB) Mode

The half bank (HB) discrete is an optional switch in the cockpit to limit the AP authority to improve passenger comfort. From HDG or GPSS mode, press the HB switch to engage HB mode. Press it again to disengage. Engagement is indicated on the interfacing EFIS next to the annunciated roll mode. When HB is engaged, the AP limits the commanded bank angle and maximum command bank angle by 50%.

#### NOTE:

HB mode ONLY operates in HDG mode or GPSS mode.

### 3.6. Yaw Damper (YD) Mode

With **AP READY** displayed, press **AP** to engage yaw damper mode. To disengage this mode, press **YD**. The YD LED is illuminated when engaged (Figure 3-35) but extinguished when disengaged (Figure 3-36). YD mode can be engaged or disengaged at any time, regardless of roll or pitch mode. When YD mode is engaged, the yaw damper dampens any excessive adverse yaw and coordinates turns.



Figure 3-35: YD Mode Engaged



Figure 3-36: YD Mode Disengaged

#### CAUTION:

YD mode should always be disengaged prior to takeoff and landing.

### 3.7. Flight Director (FD) Operation

The flight director (FD) is a display of the flight profile comprised of a pair of command bars and an A/C symbol superimposed upon a pitch ladder. It is commanded by the AP. The FD operates either with both the AP and FD modes engaged, or with AP mode disengaged and FD mode engaged.

#### 3.7.1. AP and FD Modes Engaged

With **AP READY** displayed, press **AP** to engage AP and FD modes. Illuminated AP and FD LEDs indicate engagement of these modes, and FD bars depicted. The AP steers the A/C toward the steering command bars, until the A/C symbol is tucked into them, for any roll axis or pitch axis mode of operation. The FD provides a visual indication of how accurately the AP is tracking its own roll and pitch commands.



Figure 3-37: AP and FD Modes Engaged

#### 3.7.2. FD Mode Engaged and AP Mode Disengaged

With **AP READY** displayed, press **FD** to engage FD mode, as indicated by an illuminated FD LED. Alternately, with **AP READY** displayed, press **AP** to engage AP and FD modes. Press it again to disengage AP mode, thereby disengaging both the roll and pitch servos. With FD mode engaged and AP mode disengaged, the pilot must steer the A/C toward the command bars, until the A/C symbol is tucked into them, for any roll axis or pitch axis mode of operation. The FD provides a visual indication of how accurately the pilot is tracking roll and pitch commands from the AP.



Figure 3-38: FD Mode Engaged, AP Mode Disengaged

### 3.8. Go-Around (GA) Button

Press the GA button for the following simultaneous events:




- 1) Disengage AP mode
- 2) Engage FD mode
- 3) Engage roll mode, holding roll attitude of wings level
- 4) Engage pitch mode, holding pitch attitude specific to A/C type
- 5) Cancellation of any armed roll mode
- 6) Cancellation of any armed pitch mode
- 7) Cancellation of any target altitude



Figure 3-39: Go-Around (GA)

### 3.9. Menu (MNU) Button

Press **MNU** to modify the display contrast and brightness and to mute selected audible alerts, as follows:

- 1) Rotate  (outer knob) CW to increase or CCW to decrease display contrast.
- 2) Rotate  (inner knob) CW to increase or CCW to decrease display and mode button brightness.
- 3) Push  (inner knob) to toggle mute (indicated by icon). When muted, all audible alerts are muted except for “Autopilot Disconnect.” When unmuted, no audible alerts are muted. The icon is not always on the display. It immediately becomes visible upon pressing **MNU**. When the icon is visible, it covers up part of the selected altitude therefore it is hidden when the menu is not open.





Muted



Unmuted

Figure 3-40: Mute Icons



Figure 3-41: Unmute Icon

- 4) Press **UP** to increase brightness of AP, FD, and YD LEDs.
- 5) Press **DN** to decrease brightness of AP, FD, and YD LEDs.

Menu activity does not affect the engaged autopilot modes. If the AP does not detect any menu activity for a period of 5 seconds, it reverts to the previous display. All menu settings are retained through subsequent power cycles, except for muted audible alerts.

### 3.10. Automatic Trim Disable

Disconnect the automatic trim function by any of the following:

- 1) Press/Hold remote AP DISC/TRIM INTR switch.
- 2) Set trim master switch to OFF position.
- 3) Pull trim circuit breaker.

### 3.11. Autopilot Disconnect

The AP can be disconnected by any of the following means:

- 1) Press remote AP DISC/TRIM INTR switch.
- 2) Set AP master switch to OFF position.
- 3) Pull AP circuit breaker.
- 4) Press **AP** when AP mode is engaged, but FD mode is disengaged.
- 5) Press **FD** when FD mode is engaged, but AP mode is disengaged.

### **3.12. Maintenance Mode**

When the maintenance discrete asserted during power up, the AP enters a diagnostic mode. This mode allows for more diagnostics messages to be transmitted from the AP, a flight test tool to inject failures using controller area network (CAN) messages, and a variety of monitors to be disabled. This mode is primarily intended to be used during initial flight testing and tuning for the A/C type by a Genesys Aerosystems flight test engineer.

## Section 4 EFIS Integration Options

### 4.1. Pre-Flight Checks

- 1) Press/Hold **UP**. Airspeed indication increases on AP. If interfacing EFIS has the ability, increase IAS target on EFIS. IAS target speed flashes off, then back on with speed selected from EFIS.
- 2) Press/Hold **DN**. Airspeed indication decreases on AP display. If interfacing EFIS has the ability, decrease IAS target on EFIS. IAS target speed flashes off, then back on with speed selected from EFIS.
- 3) Press **VS** to engage VS mode. **VS** replaces **IAS** on AP. Number indicates current VS in fpm.
 

HDG	VS	0
		- - - -
- 4) Press/Hold **UP** until a commanded VS of  $\uparrow 500$  (500 fpm climbing) is reached. A/C control moves aft – pilot may have to assist a heavy yoke. If interfacing EFIS has the ability, increase VS target on EFIS. VS target speed flashes off, then back on with the VS selected from EFIS.
- 5) Press/Hold **DN** until a commanded VS of  $\downarrow 500$  (500 fpm descending) is reached. A/C control moves forward. If interfacing EFIS has the ability, decrease VS target on EFIS. VS target speed flashes off, then back on with the VS selected from EFIS.

### 4.2. Indicated Airspeed (IAS) Mode

Press **UP** to increase or **DN** to decrease the captured IAS. A single press changes the IAS by 1 KT, or press and hold to change at a rate of 20 KTS per second. If the interfacing EFIS is capable of transmitting a selected IAS, the captured IAS may also be increased or decreased on the EFIS (§ 3.1.7).

### 4.3. Vertical Speed (VS) Mode

During a climb, if the commanded VS exceeds the actual VS by 300 fpm for a period of 10 seconds, VS flashes as an alert to the potential for an impending stall condition. In this event, immediately increase the aircraft's thrust if possible, reduce the commanded VS using **DN**, or both, until VS stops flashing. If interfacing EFIS is capable of transmitting a selected IAS, captured VS may also be increased or decreased on the EFIS (§ 3.1.8).

#### 4.4. Altitude Hold (ALT HOLD) Mode

Modifying the altitude target does not change ALT HOLD mode. The AP holds the A/C at the captured altitude. Modifying the altitude target on the EFIS sets up the next pre-select altitude target to be captured from PITCH, VS, or IAS with ALT armed (§ 3.1.9).

If the interfacing EFIS is capable of transmitting a selected altitude, the pre-selected altitude may also be increased or decreased on the EFIS. Following an altitude target change on the EFIS, the target altitude displayed on the AP dashes. If it is desired to display the updated selected altitude on the AP again, press the inner ALT SEL knob once. The current select altitude is updated by the last input from either the ALT SEL knob on the AP itself or from the interfacing EFIS. A change on either overwrites the previous.

## Section 5 Emergency Procedures

### 5.1. Automatic Trim Disable

Disable automatic trim function by any of the following means:

- 1) Press/Hold remote AP DISC/TRIM INTR switch.
- 2) Set trim bar switch to OFF position.
- 3) Pull trim circuit breaker.

## Section 6 Operating Parameters

### 6.1. Roll Axis Limits

**Roll Attitude:** Greater 38° and not recovering (AP disconnects)

**Roll Rate:** 10°/sec (AP disconnects)

### 6.2. Pitch Axis Limits

**Pitch Attitude:** 22° and not recovering (AP disconnects)

**Pitch Rate:** 4°/sec (AP disconnects)

**Vertical Force Due to Acceleration:**  $\pm 0.6$  g disregarding 1g due to gravity (AP disconnects)

### 6.3. Minimums

On approach, when below the configured minimum AGL altitude for the A/C, the AP sounds a repeating audible alert (“Autopilot Minimums”) to prompt the pilot to disconnect the AP and resume manual control.

On take-off and landing, when below the configured minimum AGL altitude for the A/C, the AP does not allow engagement if not already engaged.

## Section 7 Glossary

<b>Term</b>	<b>Meaning</b>
A/C	Aircraft
ADAHRS	Air Data, Attitude, and Heading Reference System
AFM	Aircraft Flight Manual
AFMS	Aircraft Flight Manual Supplement
ALT	Altitude
AP	Autopilot
APR	Approach
BC	Back course
CAN	Controller Area Network
CAP	Capture
CCW	Counter–Clockwise
CDI	Course Deviation Indication
CW	Clockwise
CWS	Control Wheel Steering
DFCS	Digital Flight Control System
DH	Decision Height
DISC	Disconnect
DN	Down
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FD	Flight Director
fpm	Feet per Minute
FT	Feet
GA	Go Around
GDI	Glideslope Deviation Indication
GPS	Global Positioning System
GPSS	Global Positioning System Lateral Navigation
GPSS	Global Positioning System Steering

GPSV	Global Positioning System Vertical Navigation
GS	Glideslope
HB	Half Bank
HDG	Heading
IAF	Initial Approach Fix
IAS	Indicated Airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
INTR	Interrupt
KTS	Knots
LED	Light Emitting Diode
LOC	Localizer
LVL	Level
MAP	Missed Approach Point
MNU	Menu
NAV	Navigation
PN	Part Number
RDY	Ready
REV	Reverse
SEL	Selector
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omnidirectional Radio Range
VS	Vertical Speed
YD	Yaw Damper



