



S-TEC 3100

DIGITAL AND ANALOG
FLIGHT CONTROL SYSTEM
PILOT GUIDE

Precise Performance.
Proven Experience.
Personalized Attention.



Pilot Operating Guide and Reference

Digital Flight Control System
S-TEC 3100 Digital and Analog

Doc No 87325

This pilot guide must be carried in the aircraft 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 aircraft specific information, such as unique ground tests, limitations, and emergency procedures.

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Section 1 Overview

1.1. INTRODUCTION

This pilot guide provides pre-flight and in-flight operating procedures for the S-TEC 3100 autopilot (3100) for both digital and analog interfaced systems.



NOTE:

The 3100 is designed to assist pilots with cockpit workload management. The ability of the 3100 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 3100, its modes, and operating procedures in visual meteorological conditions (VMC) prior to using it under instrument flight rules (IFR).

1.2. GENERAL CONTROL THEORY

The 3100 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, and an integrated bezel/display for mode selection and display, including trim annunciations.

S-TEC servos are coupled to the control system:

Roll Servo: Coupled to the ailerons. The 3100 senses roll attitude, roll rate, heading error, and course deviation to control the roll servo.

Pitch Servo: Coupled to the elevator. The 3100 senses pitch attitude, pitch rate, pressure altitude, indicated airspeed (IAS), vertical speed (VS), vertical acceleration, and glide slope deviation to control the pitch servo.

Trim Servo: Coupled to the elevator trim. The 3100 senses an out of trim condition whenever the trim sensor in the pitch servo is activated. In response, the 3100 drives the trim servo in the proper direction until the aircraft is in trim.

Yaw Servo (optional): Coupled to the rudder. The 3100 senses yaw rate and acceleration to control the yaw servo.

The 3100 also includes an altitude preselect function, if enabled.

1.3. LIMITATIONS

1.3.1. VNAV Limitation

Only available with compatible EFIS and navigator equipment.

1.3.2. Altitude Preselect Limitations

The 3100 relies on digital air data information for altitude preselect. Some configurations may not have altitude preselect if the baro-correction cannot be provided to the autopilot system.

1.3.3. Indicated Airspeed Mode (IAS) and Envelope Protection Limitations

The 3100 relies on digital air data information for indicated air speed hold (IAS). Some configurations may not have IAS mode if indicated airspeed data is not provided to the autopilot system.

Overspeed and underspeed protection is not available for systems without indicated airspeed.

1.3.4. Reverse (REV) Mode: Intercept/Track LOC Back Course (BC)

The 3100 relies on digital navigation information from a compatible electronic flight information system (EFIS) to intercept and track a LOC back course (BC) inbound or track a LOC front course outbound

Reverse mode is not available for systems without an EFIS that transmits back course guidance.

1.3.5. Optional Yaw Damper (YD)



Some aircraft configurations do not have a yaw damper system installed. In these cases, the yaw damper button is blank and the YD LED does not illuminate under any circumstances.

Figure 1-1: S-TEC 3100 Without Optional Yaw Damper

1.4. AUTOPILOT MODES

Autopilot (**AP**) Mode: Engages autopilot servos.

Flight Director (**FD**) Mode: Drives steering command bars (compatible flight director or electronic flight instrument system (EFIS) required).

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

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

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

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

Navigation (**NAV**) Mode: Intercepts and tracks a valid selected navigation signal.

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

Glide Slope (**GS**) Mode: Intercepts and tracks glide slope.

Level (**LVL**) Mode: Returns aircraft to wings level flight and a configured pitch angle for the aircraft (refer to AFMS for pitch angle value).

Indicated Airspeed (**IAS**) Mode: Holds indicated airspeed.

Vertical Speed (**VS**) Mode: Holds vertical speed.

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

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

Control Wheel Steering (**CWS**) Mode: Used to temporarily disengage servos and manually maneuver the aircraft or set new ALT, VS, IAS, PITCH, or ROLL mode targets.

Go-Around Mode (**GA**) Mode: Disengages AP and/or engages FD in pitch hold mode with a pre-set nose-up command and wings level until another mode is selected or a valid altitude pre-select target is reached.

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

VNAV (**VNV**) Mode: Flies a valid en route VNAV descent plan (compatible EFIS and navigator required)

1.5. SYSTEM COMPONENTS

1.5.1. S-TEC 3100 Flight Guidance Computer (FGC)

The 3100 FGC is the main processing unit for the autopilot system. It controls all the input/output processing, control law calculation, and drives up to four servos (pitch, roll, yaw, and pitch trim).



Figure 1-2: S-TEC 3100 Flight Guidance Computer (FGC)

The FGC requires navigational and target data to provide the correct servo drive signals. Mode selection may be controlled through the front panel.

The 3100 has an on-board micro-electromechanical systems (MEMS) device that calculates attitude angles and rates in the pitch, roll, and yaw axis. This may be configured to act as the primary or single source of attitude on certain interface configurations.



NOTE:

Each 3100 is loaded with a single configuration file, which contains aircraft and interface configuration data to match the installation. Any future avionics upgrades on equipment interfaced to the autopilot may require a new configuration file to be uploaded.

1.5.2. Aircraft Configuration

The aircraft configuration contains specific gains and servo drive values to match the aircraft flight characteristics. Gain values are specifically setup during STC flight testing and are calculated for the optimum flight performance of each aircraft model/type.

1.5.3. Interface Configuration

The 3100 has been designed to interface to both modern digital EFIS systems and older analog navigation and heading systems. The interface configuration ensures the 3100 maximizes performance by utilizing any available data from both digital and analog sources.

1.5.4. Servo Assemblies



The 3100 servos are used to move the aircraft control cables. They are driven by the FGC using pulse width modulated (PWM) signal. The pulse width modulation allows the FGC greater control over the speed of servo during fluctuations in aircraft voltage.

Figure 1-3: S-TEC 3100 Servos

1.5.5. Sandia Air Data Computer



The Sandia SAC7-35 is installed on non-EFIS installations that do not have a digital source of air data. The ADC provides essential airspeed and altitude data required for the 3100 internal attitude source to calculate attitude angles and rates. May also be installed to provide additional air data, which is not available from certain interfaced systems (e.g., Aspen EFD1000).

Figure 1-4: Sandia SAC7-35

1.5.6. GPS 1/2 Selector Switch

Some installations with dual GPS navigators may have a GPS 1/2 selector switch located in the panel with an associated LED. Position of the switch determines from which GPS source the 3100 is receiving navigation data.

- 1) With the LED extinguished the 3100 is following to GPS/NAV 1.
- 2) With the LED illuminated the 3100 is following to GPS/NAV 2.

If there is no GPS 1/2 selector switch installed, the navigation source is automatically switched by the interfacing EFIS or only a single GPS navigation source is available.



NOTE:

The autopilot always follows the source selected by the GPS 1/2 selector switch regardless of the source displayed on the PFD. Always ensure the GPS 1/2 selector switch position matches the navigation source displayed on the PFD.

1.6. INTERFACED AVIONICS

The 3100 may be setup to integrate with both analog and digital systems, which includes (but not limited to) the following.

1.6.1. Garmin GI-275/G500/G600/TXi EFIS

The Garmin, G500, G600, and TXi EFIS systems allows transfer of vertical speed (VS), indicated airspeed (IAS), and altitude targets for altitude preselect functionality. Targets set on the EFIS are synced with the 3100 and can be displayed on the bezel. IAS, VS, and altitude preselect targets should be set on the Garmin screen, as targets set on the 3100 do not change the bugs on the Garmin screen.

**NOTE:**

VS and IAS targets can be set on the Garmin screen if that unit has VS and IAS bug capability if not the targets are set on the 3100.

These EFIS do not have a setup option that allows autopilot mode annunciation to be displayed when connected to a 3100, therefore the 3100 FGC should be mounted within the pilot's field of view. A remote annunciator panel is not required.

**NOTE:**

EFIS displayed targets do not update if targets are set on the 3100 directly.

1.6.2. Garmin G5

Flight director command bars are not displayed on the G5 units.

1.6.3. Aspen EFD1000 Pro and MAX PFD

The Aspen EFD1000 interface uses the 3100 to set VS, IAS, and ALT targets, as these cannot be set using the PFD bugs (§ 3.8.5). This EFIS does not have a setup option that allows autopilot mode annunciation to be displayed when connected to a 3100, therefore the 3100 FGC should be mounted within the pilot's field of view. A remote annunciator panel is not required.

**NOTE:**

Indicated airspeed data is not provided from the Aspen EFD1000 Pro. Therefore, some installations may not have IAS mode or envelope protection unless supplemented with additional air data equipment.

For dual GPS navigators, a GPS 1/2 selector switch is required. See § 1.5.6 for function details.

Flight director interface box (ST-670/ST-645) required to display flight director command bars on the EFIS.

1.6.4. Advanced ARINC Autopilot Unlock

Aspen PFDs with the “Advanced ARINC Autopilot Unlock” installed have a complete digital, bi-directional interface which allows VS, IAS, and ALT targets to be set on either the EFIS or the 3100. This interface also displays autopilot mode annunciation and flight director bars on the EFIS display.

GPS and navigational data are received directly from the PFD. CDI selection and switching of NAV sources is achieved through the Aspen PFD, no external switching is required. See manufacturers’ installation manual for further guidance on setup.

1.6.5. Avidyne EXP5000 and Meggitt EFIS

The Avidyne and Meggitt interface uses the 3100 to set VS, IAS, and ALT targets, these cannot be set using the PFD bugs (§ 3.8.5). This EFIS does not have a setup option that allows autopilot mode annunciation to be displayed when connected to a 3100, therefore the 3100 FGC should be mounted within the pilot’s field of view. A remote annunciator panel is not required.

For dual GPS navigators, a GPS 1/2 selector switch is required. See § 1.5.6 for function details.

Flight director command bars are displayed on the EFIS.

1.6.6. Analog DG/HSI

All mode annunciations are displayed on the 3100. Providing baro-correction to the 3100 enables the 3100 internal altitude preselect (§ 3.8.5).

This interface is also compatible with the S-TEC ST-360 altitude selector/alerter (§ 3.8.5).

For dual GPS navigators a GPS 1/2 selector switch is required. See § 1.5.6 for function details.

External flight director indicator required to display flight director command bars.



NOTE:

Installations that do not provide baro-corrected data or have an ST- 360 installed do not have altitude preselect and need to perform a manual altitude capture for climbs and descents (§ 3.8.5.1).

1.7. DISPLAY LEGEND (WITHOUT VNAV)

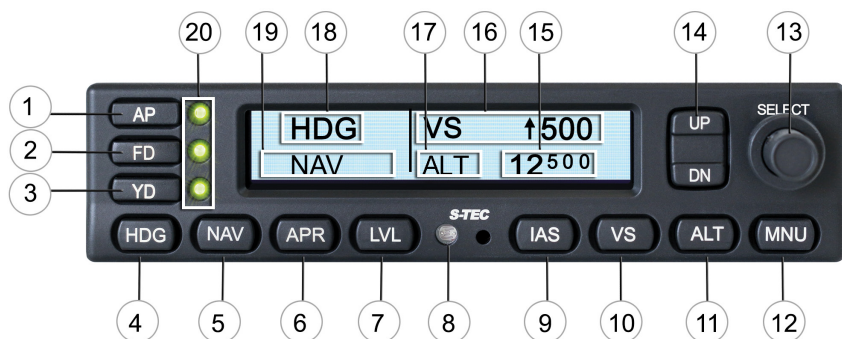


Figure 1-5: Display Legend (Without VNAV)

- 1) Autopilot (AP) Mode button
- 2) Flight Director (FD) Mode button
- 3) Yaw Damper (YD) Mode button (Optional) - (See Figure 1-1)
- 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) Mode button
- 12) Menu (MNU) Mode button
- 13) Altitude Selector (SELECT) knobs
- 14) Up/Down (UP/DN) Modifier switch
- 15) Altitude Selector/Alerter annunciation
- 16) Engaged Pitch Mode annunciation
- 17) Armed Pitch Mode annunciation
- 18) Engaged Roll Mode annunciation
- 19) Armed Roll Mode annunciation
- 20) Light Emitting Diodes (LEDs)

1.8. DISPLAY LEGEND (WITH VNAV)

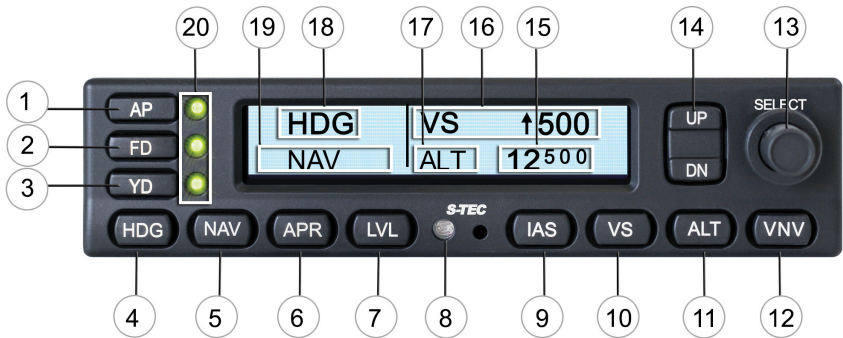


Figure 1-6: Display Legend (With VNAV)

- 1) Autopilot (AP) Mode button
- 2) Flight Director (FD) Mode button
- 3) Yaw Damper (YD) Mode button (Optional) - (See Figure 1-1)
- 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) Mode button
- 12) VNAV (VNAV) Mode button
- 13) Altitude Selector (SELECT) knobs - Push and hold to access Menu Mode (See § 3.9.6)
- 14) Up/Down (UP/DN) Modifier switch
- 15) Altitude Selector/Alerter annunciation
- 16) Engaged Pitch Mode annunciation
- 17) Armed Pitch Mode annunciation
- 18) Engaged Roll Mode annunciation
- 19) Armed Roll Mode annunciation
- 20) Light Emitting Diodes (LEDs)

OVERVIEW

PRE-FLIGHT

NORMAL IN-FLIGHT

EMERGENCIES

GLOSSARY

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 (if installed).
- 4) Set trim master to ON position (if installed).



NOTE:

For proper manual electric trim function, both the AP master switch and trim master switch must be on during the 3100 self-test.



CAUTION:

DO NOT taxi until initialization is complete, and AP READY is displayed. Taxiing during the initialization process may result in a long initialization time.

The following occur in sequence:

INITIALIZING appears upon power-up to initialize the system and align the internal attitude sensor.

INITIALIZING

Self Test In Progress appears during 3100 self-test of the following:

- 1) Memory and processor tests
- 2) Interface tests
- 3) Servo driver tests

Self Test in Progress
SW-16 CFG CN18 MOD A

AP READY indicates 3100 is ready for operation.

AP READY 12500

The 3100 cannot be engaged if any of the following failure annunciations are displayed.

If the on-board attitude sensor fails to align, **ATTITUDE FAIL** appears.

ATTITUDE FAIL

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

AP FAIL - - - -

2.2. PRE-FLIGHT CHECKS

Aircraft model specific autopilot pre-flight checks are detailed in the Aircraft Flight Manual Supplement (AFMS) and should be carried out before every flight. Any failures or unexpected behavior must be rectified before flight. The autopilot pre-flight checks detail how to check the critical phases of AP operation such as ensuring the servos can be overridden and pitch modes, roll modes, automatic/manual trim, CWS, and AP DISC/TRIM INTR are operating correctly. Trim moves while performing pre-flight checks and must be returned to take off position after completing the pre-flight check.


Section 3 In-Flight Procedures

3.1. ENGAGING THE AUTOPILOT

During normal operation, with the 3100 in AP READY state:

- 1) Pressing **AP** always engages FD Mode and YD Mode (if installed) simultaneously
- 2) FD Mode may be toggled ON/OFF independently
- 3) YD Mode may be toggled ON/OFF independently

Engaged are indicated by illuminated LED.

	AP ON/ FD ON	<ul style="list-style-type: none"> • Pitch/Roll servos are engaged • Envelope protection is active*
	AP OFF/ FD ON	<ul style="list-style-type: none"> • Pitch/Roll servos are disengaged • Drives flight director bars (if applicable) • Envelope protection is passive*
	YD ON	<ul style="list-style-type: none"> • Yaw servo is engaged
	NA	

*If envelope protection has not been disabled.

Figure 3-1: FGC LEDs

3.2. DISCONNECTING THE AUTOPILOT

The 3100 may be disconnected by any of the following means:

- 1) Press remote AP DISC/TRIM INTR switch located on the yoke; OR
 - a) First single press disconnects AP only, leaving FD engaged, envelope protection switches to passive mode (§ 3.6.1)
 - b) Second single press subsequently disconnects FD, envelope protection is off
 - c) Hold AP DISC/TRIM INTR down for ~1.5 seconds to disengage both AP and FD and mute any annunciations. AP returns to "AP READY" and envelope protection is off.
- 2) Set AP master switch to OFF position; OR
- 3) Pull the AP circuit breaker; OR
- 4) Press **AP** when AP mode is engaged.



NOTE:

AP mode also disconnects under the following circumstances:

- 1) Push the manual electric trim switch.
- 2) When the 3100 detects a fault in the system or an attitude miscompare.
- 3) When GA/TOGA switch is pressed.

3.3. AUTOPILOT (AP) OPERATION

The 3100 interprets the steering commands calculated for the selected AP mode and sends drive signals to the pitch and roll servos. The servos control the connected aircraft flight surfaces to fly the flight profile. If it has not been disabled, active envelope protection (§ 3.6.3) is operating when AP mode is engaged.

3.4. FLIGHT DIRECTOR (FD) OPERATION

The flight director (FD) calculates the vertical and lateral movement required for the aircraft to follow the selected flight profile. The flight profile is determined by the 3100 lateral and vertical mode selected and data from the interfaced avionics.

In FD mode, the 3100 outputs pitch and roll steering commands for display on a connected flight director display. The steering commands are present whether a flight director display is connected or not. The FD provides a visual indication of how accurately the pilot is tracking roll and pitch command.

If it has not been disabled, passive envelope protection (§ 3.6.1) is operating when the 3100 is in FD mode. FD mode can still be active whether a flight director display is connected or not.



NOTE:

When using FD mode on take-off, the 3100 should be in PITCH and ROLL hold modes or Take-Off Go-Around (TOGA) sub-mode.



NOTE:

If the pilot does not track the steering cues when the 3100 is operating in FD only mode, the flight director steering bars continue to increase the pitch and roll to intercept the calculated flight profile at the time of mode engagement.

It is recommended to sync up the aircraft attitude with the flight director steering bars or select a new mode before engaging the 3100 to avoid aggressive banks or climbs.

3.5. YAW DAMPER (YD) OPERATION



CAUTION:

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



NOTE:

Not applicable to aircraft without optional yaw damper installed.



YD mode may 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 3-2: Without Optional Yaw Damper Installed

3.6. ENVELOPE PROTECTION



Figure 3-3: Envelope Protection Triggered

The 3100 protects against underspeed, overspeed, and excessive bank conditions using the envelope protection feature. The envelope speed limits vary between airframes depending on stall speeds, VNE, and whether the aircraft is approved for flight-into-known-icing (FIKI). Specific limits are stated within the relevant AFMS. **ENVL PRCT** is displayed when envelope protection has been triggered and not yet recovered.



NOTE:

With software version 1.6 and later envelope protection may be temporarily disabled by the pilot. Envelope protection is enabled as described below on each power cycle.



NOTE:

Underspeed and overspeed protection requires IAS data and are not operational on installations without IAS mode available.

3.6.1. Passive Envelope Protection

Passive envelope protection is operating when FD mode is engaged, indicated by the illuminated FD LED. Passive envelope protection provides audible alarms, voice alerts, and visual alerts when limitations are reached.

- 1) Underspeed alert activates if the aircraft speed reaches the low speed limit, which triggers an audible alarm followed by the "Airspeed, Airspeed" voice alert. Alerts continue until the aircraft speed is increased beyond the underspeed recovery limit as stated in the AFMS
- 2) Overspeed alert activates if the aircraft speed reaches the high speed limit, which triggers an audible alarm followed by the "Overspeed, Overspeed" voice alert. Alerts continue until the aircraft speed is reduced below the overspeed recovery limit as stated in the AFMS.
- 3) Excessive Bank alert activates if the aircraft's roll attitude exceeds 60 degrees, which triggers an audible alarm followed by the "Attitude, Attitude" voice alert. Alerts continue until the aircraft roll attitude is reduced below 60 degrees.

3.6.1.1. Passive Envelope Protection on Approach

The overspeed and underspeed audible alarms and visual alerts are disabled when the 3100 is in any of the approach modes (APR_{LOC}, APR_{GPSS}, or APR_{GPSV}) and the 3100 is in FD only (AP not engaged). This allows pilots to hand fly slower approaches but retain flight director command bar guidance and to avoid nuisance speed callouts if AP is disconnected at minimums, but the FD remains engaged.

When the 3100 is in FD only mode and in a mode other than an approach mode (HDG, NAV, NAV_{GPSS}, ROLL) audible and visual alerts are active when reaching the speeds listed in the AFMS. When disconnecting the 3100 for landing in a non-approach mode the AP DISC/TRIM INT switch may be pressed for ~1.5 seconds to disconnect both AP and FD to avoid nuisance speed callouts.

3.6.2. Active Envelope Protection (AET)

Active envelope protection is operating anytime AP mode is engaged, indicated by the illuminated AP LED. Active envelope protection provides audible alarms, voice alerts, visual alerts, and control input when limitations are reached. Although excessive bank is still active, it is not relevant while AP is engaged as the 3100 is already under control of bank commands.

During an underspeed or overspeed alert, the 3100 vertical mode display does not change, but **ALERT** flashes to indicate envelope speed protection has been triggered and the vertical mode is no longer active. Roll mode remains engaged, but the roll commands are reduced by half during envelope speed protection.



Figure 3-4: Envelope Protection Speed Alert

The underspeed alert activates if the aircraft speed reaches the low speed limit, which triggers an audible alarm followed by the “Airspeed, Airspeed” voice alert. The 3100 automatically commands the aircraft to pitch down to increase airspeed to the underspeed recovery limit.

To recover the aircraft from an underspeed alert:

- 1) Hold down the CWS switch (§ 3.9.1) and increase aircraft speed beyond the underspeed recovery limit as stated in the AFMS, manage power, pitch, and roll as necessary for safe operation.
- 2) If required, manually fly back onto the desired course, and then release CWS to let the 3100 resume the previous active pitch and roll modes, adjust power, selected pitch, and roll mode targets as necessary for safe operation.

The overspeed alert activates if the aircraft speed reaches the high speed limit, which triggers an audible alarm followed by the “Overspeed, Overspeed” voice alert. The 3100 automatically commands the aircraft to pitch up to decrease airspeed to the overspeed recovery limit.

To recover the aircraft from an overspeed alert:

- 1) Hold down the CWS switch (§ 3.9.1) and reduce aircraft speed below the overspeed recovery limit as stated in the AFMS, manage power, pitch, and roll as necessary for safe operation.
- 2) If required, manually fly back onto the desired course, and then release CWS to let the 3100 resume the previously active pitch and roll modes, adjust power, selected pitch, and roll mode targets as necessary for safe operation.

3.6.2.1. Approach Envelope Transition

During an ILS or GPS approach, with AP engaged in approach mode, once the 3100 captures a glide slope, indicated by **GS** displayed on the engaged pitch mode section, the autopilot enters approach envelope transition (AET). A transition point is calculated as 1000' below the glide slope capture point and automatically switches to passive envelope protection once the transition point is reached.

It is recommended to capture the glide slope at 1500 feet AGL so active envelope protection is inhibited at 500 feet AGL, eliminating active envelope protection pitch commands when reducing airspeed for landing.

For temporary deviations or recovery from speed protection, it is best practice to use CWS to avoid canceling the current approach mode and AET calculations.



CAUTION:

The autopilot deviates when tracking a glide slope to protect airspeed and prevent a potential stall. The pilot is responsible for maintaining the aircraft speed within the envelope limits stated in the applicable AFMS.



NOTE:

Changing AP mode or disconnecting the autopilot cancels AET and resets the transition point. If the approach mode is re-engaged and the glide slope re-captured, AET becomes active, and a new transition point calculated.

3.6.3. AP ICE SPEED (FIKI Aircraft Only)

Aircraft approved for FIKI may have different underspeed limits for when the aircraft icing system is operating or not. Aircraft with this optional input have an LED on the panel labeled "AP ICE SPEED." All underspeed and overspeed limits are stated within the AFMS.



NOTE:

FIKI approved aircraft without the "AP ICE SPEED" option default to the higher underspeed protection limit as stated in the AFMS.

The AP ICE SPEED LED illuminates when the aircraft de-icing system is engaged and indicates the underspeed protection limit has changed to accommodate the increase in aircraft stall speed when flying into icing conditions.

With the AP ICE SPEED LED extinguished, the underspeed limit is lower and based upon the aircraft stall speed in a normal configuration.



NOTE:

Flying slow approaches may be affected when the AP ICE SPEED LED is illuminated.

3.6.4. Disabling Envelope Protection (ENVL DSBL)

With software 1.6 and later, to temporarily disable envelope protection, press and hold AP DISC/TRIM INT for ~5 seconds while in AP READY. “Speed Protection Disabled” voice alert and **ENVL DSBL** are annunciated on the 3100. Envelope protection is turned off, and no audible alarms, voice alerts, visual alerts, or control input occur when limitations are reached.

To re-enable envelope protection, first select a new AP or FD mode, then from AP READY press and hold AP DISC/TRIM INT for 5 seconds. “Speed Protection Enabled” voice alert sounds and **ENVL DSBL** disappears on the 3100. To prevent nuisance mode switching due to a stuck AP DISC/TRIM INT switch, a new AP or FD mode must be selected before changing the mode again. Envelope protection is always enabled upon each power up of the 3100.

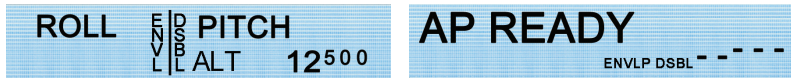


Figure 3-5: Envelope Protection Disabled

3.7. LATERAL MODES

All modes may be selected by pressing the appropriate button on the 3100. A second press of the active mode button deselects the mode, and the 3100 reverts to the armed lateral mode or ROLL mode if there is no armed lateral mode. For example, if the active mode is heading (HDG) mode press **HDG** to deselect HDG and engage ROLL.




Figure 3-6: Roll Attitude (ROLL) Mode

3.7.1. Roll Hold (ROLL) Mode

ROLL hold mode is the default active mode when the FD or AP+FD is first engaged. ROLL hold can also be activated by deselecting the current active mode. In ROLL hold, the 3100 holds the current roll attitude. Control wheel steering (CWS) (§ 3.9.1) may be used to establish the aircraft on a new roll attitude. If installed, half bank (§ 3.9.5) may be used in conjunction with heading mode for improved passenger comfort.

3.7.2. Heading (HDG) Mode



Set the heading bug to desired heading on the compass card. Press **HDG** to engage HDG. The 3100 turns the aircraft onto the selected heading at a standard rate turn and holds it. A new heading may be selected thereafter by setting the heading bug to the desired heading.

Figure 3-7: Heading (HDG) Mode



NOTE:

When using heading mode to intercept an armed NAV or approach mode course, ensure the heading bug is set to an angle that allows for an intercept (5 degrees of intercept angle minimum). Setting the heading bug parallel to or away from the desired course may not allow for intercept. If desired, when NAV is the armed mode, press **HDG** to deselect HDG. NAV becomes the active mode, and a default intercept angle is calculated.

3.7.3. Navigation (NAV) Mode

Press **NAV** to arm or engage NAV mode. If the current engaged lateral mode is HDG, press **NAV** to arm NAV. From all other lateral modes, press **NAV** to engage NAV.

The selected navigation source determines what the 3100 follows and displays:

- 1) **NAV** – VOR navigation.
- 2) **NAV_{Loc}** – LOC navigation. No glide slope capture.
- 3) **NAV_{GPSS}** – Tracks GPS steering commands sent by the connected GPS navigator.



NOTE:

When interfaced to a DG, there is no course pointer input to the 3100. Set the DG selected heading to the required course value.

3.7.3.1. Tracking a VOR (NAV)

- 1) Select VOR frequency on navigator.
- 2) Set course pointer to the desired course radial (for DG only installations, set heading to desired course value).
- 3) Select course intercept method:
 - a) Straight-In: Press **NAV**. Aircraft intercepts the selected radial at a 45° angle; OR
 - b) Pilot Selectable Angle: Set heading bug to desired intercept heading. Press **HDG** to engage HDG. Press **NAV** to arm NAV.
- 4) If armed, NAV automatically engages at the course capture point.
- 5) Once capture, the 3100 establishes the crosswind correction angle and tracks the course.



NOTE:

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



NOTE:

At point of station passage, the 3100 recognizes the condition and holds the last known course. Either allow the aircraft to pass over the station and pick it up again on the other side or select another VOR to track. **Ovrst** is annunciated in the center of the bezel to notify of over station passage.



Figure 3-8: Over Station (Ovrst) Mode

**NOTE:**

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 during or after course capture, the 3100 holds the last known crosswind corrected course and ignores CDI needle deflection until the signal becomes valid.

**NOTE:**

For analog (Non-EFIS) configurations, the course data is fed to the 3100 via both DG/HSI and GPS navigator. When intercepting a VOR, the DG/ HSI should be manually synced to the flight plan radial or the flight plan should be cleared to force the 3100 to use the DG/HSI course input and prevent conflicting course information.

3.7.3.2. GPS Steering (NAV_{GPSS}) Mode

1) Program a valid waypoint or flight plan into the GPS navigator.

2) Select course intercept method:

a) Default: Press **NAV**. Aircraft intercepts the selected radial at a 45° angle; OR

NAV _{GPSS}	PITCH
	12 ⁵⁰⁰

b) Pilot Selectable Angle: Set heading bug to desired intercept heading. Press **HDG** to engage HDG. Press **NAV** to arm NAV

HDG	ALT HOLD
NAV _{GPSS}	12 ⁵⁰⁰

3) The 3100 laterally steers the aircraft along the predefined course.

**NOTE:**

NAV_{GPSS} mode is slaved to the GPS navigator roll steering output.

**NOTE:**

During GPSS mode of operation, the 3100 does not accept any course error input from the course pointer.

3.7.4. Approach (APR) Mode

Press **APR** to arm or engage APR mode. If the current active lateral mode is HDG, press **APR** to arm APR. Only engage APR mode when cleared for the approach and when on or turning to intercept the final inbound

course. From all other lateral modes, press **APR** to engage APR. The loaded approach from the navigator determines which approach type the 3100 follows and displays:

- 1) **APR** – VOR approach
- 2) **APR_{LOC}** – LOC/ILS approach. Glide slope (GS) mode automatically arms as the vertical mode.
- 3) **APR_{GPSS}** – Tracks inbound course using internally calculated GPS steering commands.
- 4) **APR_{GPSSL}** – Follows lateral deviations from WAAS capable GPS for LPV, LNAV/VNAV, and LNAV+V approaches. APRGPSV also automatically arms as the vertical mode.

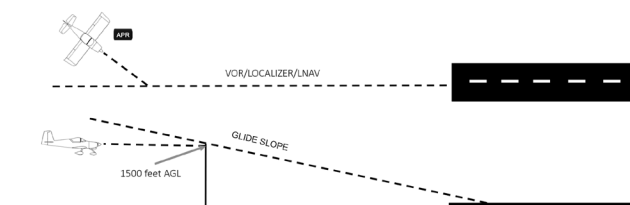


Figure 3-9: Approach (APR) Mode



NOTE:

When using the 3100 Internal Altitude Preselect (§ 3.8.5.2), a missed approach altitude may be preselected while in GA mode. Without an external altitude target (§ 3.8.5.3 and § 3.8.5.4), the altitude preselect target can not be changed while tracking a glide slope or glide path.



NOTE:

GPS holding patterns and procedure turns must be flown in NAV GPSS mode. Press **APR** once on or turning to the final inbound course.



NOTE:

When interfaced to a DG there is no course pointer input to the 3100. Set the DG selected heading to the required course value.



NOTE:

Airspeed must be kept within the envelope speeds stated within the AFMS during coupled approaches. Active envelope protection may deviate the aircraft from the glide slope path to remain within the airspeed envelope range to maintain safety of flight and reduce the risk of stall.



NOTE:

It is recommended to capture the glide slope at 1500 feet AGL to avoid active envelope protection operation below 500 feet AGL.



NOTE:

Back course (REV) approaches are only available when interfaced to an EFIS and automatically detected by the 3100. Non-EFIS interfaces do not have back course (REV) capability.

3.7.4.1. VOR Approach (APR)

A VOR may be tracked in APR mode and should only be engaged when cleared for the approach and on or turning to intercept the final inbound course. APR mode provides greater control and authority than tracking in NAV mode.

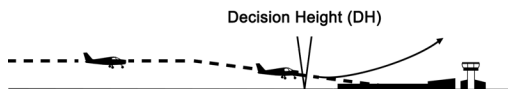


Figure 3-10: VOR Approach

- 1) Select VOR frequency on navigator.
- 2) Set course pointer to the desired course radial (for DG only installations, set heading to desired course value).
- 3) When cleared for the approach and on or turning to intercept the final inbound course select course intercept method:

a) Straight-In: Press **APR**. Aircraft intercepts inbound selected course at a 45° angle; OR

APR	ALT HOLD 03000
-----	-------------------

b) Heading Bug (Vectors): Set heading bug to desired intercept heading, press **HDG** to engage HDG. Press **APR** to arm APR.

HDG APR	PITCH 12500
------------	----------------

4) If armed, APR automatically engages and tracks the radial once the aircraft captures the inbound course.

APR	ALT HOLD 03000
-----	-------------------

5) There is no vertical guidance on a VOR approach. Use PITCH, IAS, or VS mode to descend.

APR	VS ALT 03000
-----	-----------------

6) At the decision height (DH) or missed approach point (MAP), disconnect AP to execute either a manual landing or go-around (GA), respectively.

OVERVIEW

3.7.4.2. ILS Approach (APR_{LOC})

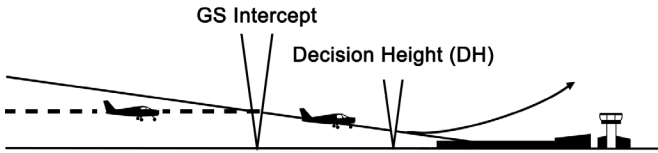


Figure 3-11: Straight-In ILS Approach

PRE-FLIGHT

- 1) Select LOC frequency on navigator.
- 2) Set course pointer to front inbound LOC course.
- 3) When cleared for the approach and on or turning to intercept the final inbound course select course intercept method:

a) Straight-In: Press **APR**. Aircraft intercepts inbound selected course at a 45° angle; OR

APR_{LOC}	PITCH
	12⁵⁰⁰

b) Heading Bug (Vectors): Set heading bug to desired intercept heading, press **HDG** to engage. Press **APR** to arm APR_{LOC}.

HDG	VS	↓500
APR_{LOC}	ALT	03⁰⁰⁰

4) APR automatically engages and tracks once the aircraft captures the inbound course.

APR_{LOC}	ALT HOLD
	GS 02⁵⁰⁰

5) GS automatically arms, and then captures once the aircraft is within ½ dot (25%), above or below, the GS centerline.

During GS capture, a VS descent proportional to the aircraft speed is established.

APR_{LOC}	CAP	↓400
	GS	02⁵⁰⁰

Recommended GS capture altitude is 1500 feet AGL.

6) GS engages and tracks the glide slope once the aircraft is within 5%, above or below, the GS centerline; or 10 seconds has elapsed since glide slope capture. When tracking the GS, the missed approach altitude can be preselected.

APR_{LOC}	GS
	04⁰⁰⁰

7) At the DH or MAP, disconnect AP to execute either a manual landing or GA, respectively.

EMERGENCIES

GLOSSARY

3.7.4.3. GPS RNAV Approach (APR_{GPS} / APR_{GPSL})

For aircraft equipped with a WAAS capable GPS navigator, the 3100 can execute the LPV, LNAV/VNAV, or LNAV+V approach sequences.



NOTE:

APR_{GPS} uses an internally calculated roll steering command to steer the aircraft onto the inbound course with greater accuracy.

If preferred, NAV_{GPS} may be used to slave the 3100 to the GPS navigator output. APR_{GPS} must then be manually selected for the 3100 to arm and track any vertical guidance.

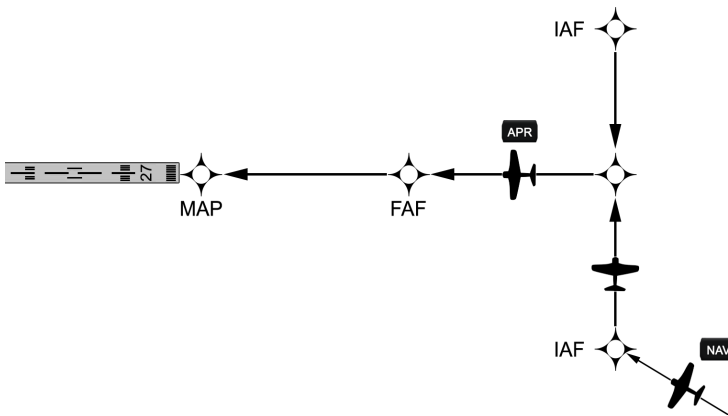


Figure 3-12: RNAV Approach Procedure

1) Program approach into GPS navigator.

2) Track the approach procedure using NAV_{GPS} mode.

APR_{GPS} should not be used until the aircraft is on the final inbound course or at the FAF and looking for vertical guidance.

NAV_{GPS}	ALT HOLD
	03000

3) Begin descent at IAF in PITCH, VS, or IAS mode. Recommended altitude at FAF is 1500 feet AGL.

NAV_{GPS}	VS	↓500
	ALT	03000

4) Prepare for turn towards FAF.

Press **APR** once established on the final inbound course to switch to approach mode and arm vertical guidance.

APR_{GPS}	VS	↓500
	GS	02500

5) Lateral mode transitions to APR_{GPSL} and tracks GPS lateral deviations when the CDI <1 dot (50%).



6) Vertical mode transitions to GPSV and tracks GPS vertical deviations when the GDI <1 dot (50%). While tracking the glide path the missed approach altitude can be preselected.



7) At the DH or MAP, disconnect AP to execute either a manual landing or GA, respectively.

3.8. VERTICAL MODES

All vertical modes may be selected by pressing the appropriate button on the 3100. A second press of the engaged mode button deselects the mode, and the 3100 reverts to the armed vertical mode or PITCH mode if there is no armed vertical mode. For example, if the active mode is VS, press **VS** to deselect VS and engage PITCH.



Figure 3-13: Pitch Attitude (PITCH) Mode

3.8.1. Pitch Attitude (PITCH) Mode

PITCH mode is engaged when the current active vertical mode is deselected or when FD or AP+FD is first engaged.

The 3100 holds the aircraft at its current (captured) pitch attitude. Press **DN** to decrease or **UP** to increase captured pitch attitude. A single press changes the pitch attitude 0.25°. Additionally, A new pitch attitude can be selected by holding CWS (§ 3.9.1), hand flying to the desired pitch attitude, and then releasing CWS.

If an altitude target is active, the aircraft automatically levels off and holds at the selected altitude target (§ 3.8.5).



NOTE:

If ROLL or PITCH mode was entered by pressing **LVL** (§ 3.9.4), the altitude target is not captured.

3.8.2. Indicated Airspeed (IAS) Mode

HDG	IAS	100
	ALT	12 ⁵⁰⁰

Press **IAS** to engage IAS mode. **IAS** appears. If a valid IAS target from an EFIS is available it is displayed in units

of knots, otherwise the current (captured) IAS is displayed (for example, **105**).

Figure 3-14: Indicated Airspeed (IAS) Mode

The 3100 holds the aircraft at the captured IAS in KTS or MPH as configured by the installer. Use the EFIS IAS target bug or press **UP** or **DN** to increase or decrease the captured IAS. Press once to change the IAS by 1 knot or 1 mile per hour (MPH) or press and hold to change at a rate of 5 KTS (or 6 MPH) per second.

If an altitude target is active, the aircraft automatically levels off and holds at the selected altitude target (§ 3.8.5).



CAUTION:

Engine power and airspeed must be monitored when IAS mode is engaged, since insufficient power at low airspeeds may cause the aircraft to stall and AP to disconnect. Although the 3100 should limit the airspeed to 3-5 KTS/MPH below the aircraft's maximum operating airspeed (V_{MO}), large power changes at higher airspeeds may cause the aircraft to momentarily exceed V_{MO} .

3.8.3. Vertical Speed (VS) Mode

NAV _{GPSS}	VS	↓500
	GS	02 ⁵⁰⁰

Press **VS** to engage VS mode. VS appears, and the VS target is displayed in units of feet per minute (fpm). The

initial VS target displayed depends on which type of altitude preselect is available (§ 3.8.5). VS target is prefixed by either ↑ (up arrow) indicating climb, or ↓ (down arrow) indicating descent (for example, ↓500 indicates 500 fpm descending).

Figure 3-15: Vertical Speed (VS) Mode

The 3100 holds the aircraft at the captured VS. Use the EFIS VS target bug or press **UP** or **DN** to increase or decrease the captured VS. A single press changes the VS by 100 fpm.

If an altitude target is active, the aircraft automatically levels off and holds at the selected altitude target (§ 3.8.5).



NOTE:

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 with **DN**, or both, until **VS** stops flashing.

3.8.4. Altitude Hold (ALT HOLD) Mode

ALT HOLD mode is engaged either by pressing **ALT** or automatically if an altitude target has been reached from altitude preselect.

HDG	ALT HOLD
NAV GPSS	12500

Subsequent modification of the altitude target does not change ALT HOLD mode. The 3100 holds the aircraft at the captured altitude until a new vertical mode is selected (VS, IAS, or PITCH). Press **UP** or **DN** to increase or decrease captured altitude. A single press changes the altitude by 20 feet. Range is ±500 ft. from the original captured altitude.

Figure 3-16: Altitude Hold (ALT HOLD) Mode



NOTE:

When the aircraft has entered ALT HOLD mode and then subsequently exceeds ±200 ft. from the captured altitude the "Check Altitude" voice alert sounds.

3.8.5. Altitude Preselect

ROLL	VS	↑500
	ALT	12500

The altitude preselect function allows for preselection of a target altitude and the VS, IAS (if within the aircraft's capabilities), or pitch angle at which the aircraft climbs or descends until the altitude is automatically captured.

Figure 3-17: Altitude Preselect

Audible alerts and voice alerts sound at 1000 ft. and 200 ft. from the target altitude. "One Thousand to Go" and "Two Hundred to Go," respectively.

At the capture point, the 3100 begins a scheduled reduction in vertical rate and CAP replaces the active annunciation indicating engagement of ALT HOLD CAP mode.


When the aircraft reaches the target altitude, the "Altitude" voice alert, sounds, and ALT HOLD mode engages.

The 3100 displays dashed lines for altitude targets (---) when there is no altitude target, or the target is invalid (altitude captured, no target selected, or loss of signal).

Altitude preselect operation differs depending on the type of installation, as follows:

- 1) No Altitude Preselect (Manual Altitude Capture)
- 2) S-TEC 3100 Internal Altitude Preselect
- 3) S-TEC ST-360 Altitude Selector/Alerter Preselect
- 4) Compatible EFIS Preselect

3.8.5.1. No Altitude Preselect (Manual Altitude Capture)



The altitude preselect function is not available on some installations. In this case, any target selected by scrolling either concentric 3100 SELECT knob is replaced with dashed lines (-----) indicating that there is not a valid altitude target, altitude preselect is not available.

Figure 2-18: No Altitude Preselect



- 1) Climb or descend in VS, IAS, or PITCH mode, as preferred.
- 2) Before desired altitude: The altitude preselect function is not available on some installations. In this case, any target selected by scrolling either concentric 3100 SELECT knob is replaced with dashed lines.
 - a) VS/IAS mode – reduce the VS/IAS target with CWS or **UP/DN** to reduce climb/descend rate.
 - b) PITCH mode – shallow the pitch angle with CWS or **UP/DN** to reduce climb/descend rate
- 3) At the desired altitude, press **ALT**. The 3100 holds the current altitude in ALT HOLD mode.

3.8.5.2. S-TEC 3100 Internal Altitude Preselect



Figure 3-19: Target Altitude in Feet with ALT HOLD Mode Armed

To use the 3100 internal altitude preselect function:

- 1) Preselect the target altitude with the SELECT knob.
 - a) Outer knob  changes target altitude in increments of 1000 feet.
 - b) Inner knob  changes target altitude in increments of 100 feet.
 - c) Target altitude appears in units of feet (for example, **12⁵⁰⁰**).
- 2) Climb or descend in VS, IAS, or PITCH modes.

- a) VS mode – VS target defaults to 500 fpm in the direction of the altitude target. Adjust the VS target with CWS or **UP/DN** to desired climb/descent rate.
- b) IAS mode – IAS target syncs to the current airspeed. Adjust the IAS target with CWS or **UP/DN** to desired speed.
- c) PITCH mode – use CWS or **UP/DN** to establish desired angle of climb or descent.

3.8.5.3. S-TEC ST 360 Altitude Selector/Alerter



ROLL	VS	↑500
	ALT	12 ⁵⁰⁰

Figure 3-20: S-TEC ST 360 Altitude Selector/Alerter, 3100 Display

To use an ST-360 altitude preselector:

- 1) Preselect the target altitude on the ST-360. The altitude target is displayed in the armed altitude window on the 3100.
- 2) Climb or descend in VS, IAS, or PITCH mode:
 - a) VS mode – VS target may be preset on the ST-360 or adjusted on the 3100 after VS mode has been engaged.
 - b) IAS mode – IAS target can only be set on the 3100. Adjust the IAS target with CWS or **UP/DN** to desired speed.
 - c) PITCH mode – use CWS or **UP/DN** to establish desired climb or descent angle.

3.8.5.4. EFIS Preselect

ROLL	VS	↑500
	ALT	12 ⁵⁰⁰

Target altitude may be preselected with the altitude bug on the PFD. This altitude target is transferred to the 3100 memory once it has been steady for 3 seconds.

Figure 3-21: Target Altitude Not Displayed

The altitude target is displayed in the armed altitude window on the 3100.



NOTE:

Altitude target on the G500/600/TXi PFD must be steady for at least 3 seconds before the 3100 reads the target into memory. This is to avoid the 3100 pitching the aircraft to chase the altitude target as it is being changed.

**NOTE:**

When interfaced to the Garmin G500/600/TXi, it is best practice to always use the PFD bugs to set the altitude, VS, and IAS targets instead of the SELECT knob and **UP/DN** modifiers.

The 3100 synchronizes to targets set on the Garmin G500/600/TXi. However, targets set with the 3100 are not automatically synchronized or displayed on the Garmin G500/600/TXi.

**NOTE:**

When interfaced to the Aspen Evolution 1000 PFD or Aspen Evolution 1000 Pro MAX PFD, without the Advanced ARINC Autopilot Interface Unlock feature, the altitude preselect target must be set on the 3100 (§ 3.8.5.2).

When Interfaced with the Aspen Evolution 1000 Pro MAX PFD with the Advanced ARINC Autopilot Interface Unlock feature the altitude preselect target can be set on either the PFD or the 3100.

- 1) Set the required altitude target using the ALT bug on the PFD
- 2) Climb or descend by engaging VS, IAS, or PITCH mode:
 - a) VS mode – Set and adjust the VS target on the PFD (if available). If the VS bug is set in the opposite direction of the target altitude, the 3100 defaults to 500 fpm in the correct direction of the altitude target. For PFDs without a valid VS bug the 3100 defaults to 500 fpm in the direction of the altitude target and can be adjusted with CWS or **UP/DN** to the desired rate of climb/descent.
 - b) IAS mode – Set and adjust the IAS target bug on the PFD (if available). If the IAS bug is in the opposite direction of the target altitude (pitch down in a climb or pitch up in a descent) the 3100 synchronizes to the current IAS. For PFDs without a valid IAS bug, the 3100 synchronizes to the current airspeed when IAS mode is engaged and can be adjusted with CWS or **UP/DN** to establish desired speed.
 - c) PITCH mode – Use CWS or **UP/DN** to establish desired climb or descent angle.

3.8.6. VNAV



Figure 3-22: Bezel with VNV Button

When the 3100 is interfaced with a compatible EFIS and navigator, it can follow en route VNAV guidance programmed in descent profiles. VNAV requires (and is armed/activated through) a 3100 bezel with a VNV button

(**VNV**). VNAV modes can be deselected by selecting another pitch mode (IAS, VS, ALT HOLD, LVL, GA). Previous bezels without **VNV** are upgradeable to the new bezel which enables this feature, contact your S-TEC dealer for details.

3.8.6.1. VNAV Hold (**VNV_{HLD}**)

After programming a valid VNAV descent profile and pressing **VNV**, **VNV_{HLD}** displays in the active pitch mode window. The 3100 hold current altitude until the VNAV descent path is intercepted.



NOTE:

If the active pitch mode is not VNAV Hold, **VNV** appears in the armed pitch mode window prior to the top of descent (TOD).

This shows VNAV is available, but **VNV** has not been pressed to arm VNAV (e.g., a valid VNAV profile has been programmed, but VNAV is not the selected vertical mode). The 3100 does not automatically capture the VNAV descent profile until the pilot presses **VNV** and engages **VNV_{HLD}**.

3.8.6.2. VNAV Available (**ALT_{VNV}**)

If the active pitch mode is VNV Hold, The 3100 is currently tracking the VNAV flight profile. In this case, prior to TOD the armed pitch mode changes from ALT to **ALT_{VNV}** and an audible tone indicates the VNAV descent is armed and within 200 feet of the capture point. The 3100 automatically captures the descent path (e.g., **VNV** does not need to be pressed again).

3.8.6.3. VNAV Capture (**VNV_{CAP}**)

When reaching the TOD point and in VNAV Hold mode, **VNV_{CAP}** becomes active. **VNV_{CAP}** in the active pitch mode window indicates the 3100 is capturing the descent path. The armed pitch mode changes to ALT.

3.8.6.4. VNAV Path (VNV_{PTH})

Once established on the VNAV descent path VNVPTH becomes active and displays in the active pitch mode window, indicating the 3100 tracks the path towards the next leg level off. The 3100 is following an internally calculated VS command based on the VNAV descent path, or the VS command coming from the navigator.



VNV_{HLD} appears in the active pitch mode window upon leveling off on each step down of the VNAV descent

profile indicating the 3100 is following the programmed VNAV descent profile. ALT appears in the armed pitch mode window until just prior to TOD where it changes to ALTVNV until the descent is initiated.

Figure 3-23: VNV_{HLD}

The 3100 automatically transitions to a preselected minimum altitude. A preselected altitude bug target takes priority over any VNAV mode. The 3100 transitions to ALT HOLD if it reaches a preselected altitude bug target during any point in the VNAV descent profile. It is best practice, before reaching the TOD point, to set the altitude bug target to the lowest cleared altitude, or FAF altitude if cleared for an approach, to fly the full VNAV profile. If the altitude bug is set at the current altitude it is not possible to enter VNAV mode. If a GPS approach has been programmed, and **APR** has been pressed prior to the FAF the 3100 automatically transitions into GPSV if it reaches an LPV glide slope (see § 3.7.4.3).

3.8.6.5. VNAV Unavailable (VNV_{UNAVL})

If **VNV** is pressed before a valid VNAV profile is programmed (e.g., VNAV criteria not met), the 3100 displays VNV_{UNAVL} for 5 seconds and remains in the currently engaged modes.

3.8.6.6. VNAV Fail

If the data is lost (GPS invalid, etc.) and already in a VNAV mode, **FAIL** flashes on the 3100, and the 3100 holds the last known pitch command until reaching a valid altitude bug target. It is best practice, before reaching the TOD point, to set the altitude bug target to the lowest cleared altitude, or FAF altitude if cleared for an approach, to have a valid altitude target selected. A new pitch mode can be selected to clear the fail annunciations, and ensure that the aircraft is kept on a safe and desired path.

3.9. ADDITIONAL MODES

3.9.1. Control Wheel Steering (CWS) Mode

CWS allows the pilot to manually control the aircraft without disengaging 3100 to set new Pitch, Roll, IAS, VS, or Altitude targets or maneuver around obstacles such as weather or traffic. If envelope protection is active, CWS can be used to establish the aircraft back inside the safe envelope – without disengaging the 3100.



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 aircraft as desired, and then release the CWS switch to disengage CWS mode. CWS extinguishes, and both servos re-engage.

Figure 3-24: Control Wheel Steering (CWS) Mode

The 3100 resumes operation in the previous mode.

- 1) If HDG, NAV, NAV_{GPSS}, APR, or REV mode was engaged, the 3100 returns to tracking the selected source.
- 2) If IAS, VS, or ALT mode was engaged, the 3100 holds the new IAS, VS, or altitude, respectively, the EFIS bugs may not change.
- 3) If ROLL or PITCH mode was engaged, the 3100 holds the new roll attitude or pitch attitude, respectively.
- 4) If TOGA mode (§ 3.9.3) was engaged, the 3100 holds the new roll attitude or pitch attitude, respectively.

3.9.2. Go-Around (GA) Button



The go-around button may be used when a missed approach is required. Once pressed, the 3100 disconnects, clears any previous engaged or armed modes, and engages flight director guidance in go-around mode with the steering bars referenced to wings level and a pitch attitude specific to the aircraft type (reference AFMS) until new roll and pitch modes are selected or a new attitude is selected with CWS.

Figure 3-25: Go-Around (GA)

The 3100 may be engaged once established in a stabilized climb and above the minimum height as stated in the AFMS to hold the pitch and roll angles. Use HDG to follow a preselected heading bug or NAV to laterally fly a missed approach procedure from the GPS/FMS. If a valid altitude preselect target has been set, the 3100 transitions to ALT HOLD when reaching the target.



NOTE:

Some GPS navigators require the pilot to un-suspend the missed approach pattern before engaging NAV mode on the 3100.

3.9.3. Take-Off-Go-Around (TOGA)



The go-around button can also be used to setup the flight director steering bars prior to take-off. The steering bars

are reference to wings level and a pitch attitude specific to the aircraft type (reference AFMS) until new roll and pitch modes are selected, or a new attitude is selected with CWS.

Figure 3-26: Take-Off-Go-Around

The 3100 may be engaged once established in a stabilized climb and above the minimum height as stated in the AFMS to hold the pitch and roll angles. Use HDG to follow a preselected heading bug or NAV to laterally fly the selected NAV source. With software 1.6 and later, if a valid altitude preselect target has been set, the 3100 transitions to ALT HOLD when reaching the target.

3.9.4. Level (LVL) Mode



Emergency level (LVL) mode is designed to bring the aircraft to wings-level recovery from any AP READY or active state.

Figure 3-27: Level Mode

3.9.4.1. Emergency Level Mode

Press **LVL** to engage emergency LVL mode. The 3100 automatically cancels any active AP modes and engages the pitch and roll servos to bring the aircraft to wings-level and the configured pitch angle for the aircraft (refer to AFMS for pitch angle value).

Engagement is indicated by 3100 modes changing to ROLL/PITCH, LVL annunciated in the center of the bezel, 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 may be engaged or disengaged at any time, regardless of the roll axis or pitch axis mode. If the 3100 was not in an active mode prior to engaging Level mode the AP LED does not illuminate, but the "Level Mode, Engage Autopilot" voice alert repeats.

To resume normal AP functionality and cancel the voice alert, AP must be manually engaged by pressing **AP** or disconnecting LVL mode using the AP DISC/TRIM INTR button.



Figure 3-28: Emergency Level Mode; Servos Engaged, No AP

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3.9.5. Half Bank (HB) Mode



Half bank (HB) mode is an optional switch/annunciator that limits the 3100's authority and improves passenger comfort. From HDG or GPSS mode, press the HB switch to engage HB mode. When HB is engaged, the 3100 limits the commanded bank angle and maximum command bank angle by 50%.

Figure 3-29: Half Bank Mode


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Some installations may have a "ON" and "OFF" annunciated switch or a momentary HALF BANK switch that toggles between half bank mode with sub-mode shown on the display as shown in Figure 3-29.

Figure 3-30: HB Mode Switch/Annunciator

3.9.6. Menu (MNU) Mode

On bezels with **VNV**, push and hold the inner select knob  for 5 seconds to enter menu selection. On bezels with **MNU**, press **MNU** to enter menu selection. Mute selected audible alerts or modify display contrast and brightness as follows:

- 1) Rotate  CW to increase or CCW to decrease display contrast.
- 2) Rotate  CW to increase or CCW to decrease display and mode button brightness.
- 3) Push  to toggle mute (indicated by icon). When muted, all audible alerts are muted except for the disconnect tone. When unmuted, all configured (loaded) audible alerts and tones sound.



Muted



Unmuted

Figure 3-31: Mute Icons

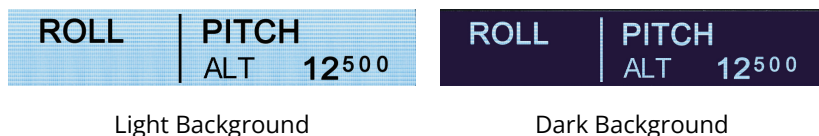


Figure 3-32: Unmute Icon on 3100 Display

- 4) Press **UP** to increase brightness of 3100, FD, and YD LEDs.
- 5) Press **DN** to decrease brightness of 3100, FD, and YD LEDs.
- 6) Press **ALT** to toggle light/dark background.

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Light Background

Dark Background


Figure 3-33: 3100 Display Backgrounds

Menu activity does not affect the engaged 3100 modes. If the 3100 does not detect any menu activity for a period of 5 seconds, it reverts to the previous display. Menu settings are not retained through subsequent power cycles.

3.10. TRIM

3.10.1. Automatic Trim Annunciations

When the trim master switch is in ON position, the 3100 indicates when it is automatically trimming the aircraft. If the servo loading exceeds a preset threshold for a period of 3 seconds, the 3100 indicates out-of-

trim () as the 3100 is automatically trimming the aircraft. If the 3100 is still automatically trimming the aircraft after 8 more seconds, the trim annunciation flashes, and “Pitch Trim in Motion” voice alert repeats. As soon as the aircraft has been sufficiently trimmed, so the servo loading is below the preset threshold, the trim annunciation extinguishes, and the voice alert ceases.




Up Trim Annunciation

Down Trim Annunciation

Figure 3-34: Pitch Trim Annunciations

3.10.2. Manual Trim Annunciations

When the trim master switch is OFF, the 3100 indicates when it is necessary to trim the aircraft. If servo loading exceeds a preset threshold for a

period of 3 seconds, the 3100 indicates out-of-trim (). In addition, the “Check Pitch Trim” voice alert sounds once. After 8 more seconds, the trim annunciation flashes. As soon as the aircraft has been sufficiently trimmed, the trim annunciation extinguishes.

3.10.3. Manual Electric Trim

The manual electric trim switch, located on the control wheel/stick, can only be used to trim the aircraft when AP mode is disengaged. Attempting to use it otherwise disconnects AP but FD mode remains engaged (if previously engaged).

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To trim the aircraft nose up, press aft and maintain pressure on both segments of the manual electric trim switch. To trim the aircraft nose down, press forward and maintain pressure on both segments of the manual electric trim switch. In either case, **TRIM** flashes.

Figure 3-35: Manual Electric Trim

3.10.4. Automatic Trim Disable

Disconnect the automatic trim function by any of the following:

- 1) Press/Hold remote AP DISC/TRIM INTR switch; OR
- 2) Set trim master switch to OFF position.

3.11. MESSAGES

Fault Message	Behavior	Location	Conditions
SELF TEST IN PROGRESS	Steady	Full screen	During servo power-on self-test
INITIALIZING	Steady	Full screen	Following self-test, while waiting for pitch angle and roll angle to be initialized. Lasts for 15 minutes or until pitch angle and roll angle become valid, whichever comes first.
ATTITUDE FAIL	Steady	Full screen	When pitch angle, roll angle, or both are failed after ADAHRS initializing is complete.
FAIL (Active Roll Mode)	Continuously flash by alternating with the active roll mode annunciation	Upper Left	Active lateral mode failure due to - invalid heading data for HDG mode - invalid course/deviation data for NAV/APR modes

Fault Message	Behavior	Location	Conditions
FAIL (Armed Roll Mode)	Continuously flash by alternating with the armed roll mode annunciation	Lower Left	Armed lateral mode failure due to invalid course/deviation data for NAV/APR modes
FAIL (Active Pitch Mode)	Continuously flash by alternating with the active pitch mode annunciation	Upper Right	Active vertical mode failure due to: <ul style="list-style-type: none"> - Invalid airspeed data for IAS mode - Invalid altitude rate data and altitude data for VS - Invalid altitude data for ALT mode - Invalid GS deviation data and/or invalid altitude rate data and altitude data for GS mode
FAIL (Armed Pitch Mode)	Continuously flash by alternating with the armed pitch mode annunciation	Lower Right	Armed vertical mode failure due to invalid GS deviation data and/or invalid altitude rate data and altitude data for GS mode







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Fault Message	Behavior	Location	Conditions
Trim (§ 3.10)	Steady	Center or Upper Right	UP arrow: Pitch auto trim up is active DOWN arrow: Pitch auto trim down is active No arrow: Manual electric trim is active Center: when AP or FD is engaged Upper right: when AP or FD is not engaged and AP READY is displayed
CWS 	Steady	Center	CWS button pressed and held when AP or FD is engaged
GA or TOGA  	Steady	Center	GA button pressed while in air: GA mode GA button pressed while on the ground: TOGA mode
LVL 	Steady	Center	LVL button on the bezel is pressed
HB or HB\GA  	Steady	Center	HB: HB is active while in HDG mode or NAV _{GPSS} mode HB\GA: HB is activated while in HDG mode or NAV _{GPSS} mode and GA mode is active

Fault Message	Behavior	Location	Conditions
<p>Ovrst</p>	Steady	Center	When VOR station passage is detected
VNV UNAVL	Steady for 5 seconds, then distinguish	Upper Right	When VNV (if equipped) button is pressed without valid VNAV deviation or target altitude, or trying to capture VNAV from above the glide path
ALERT	Steady or Flash	Lower Right	<p>1000 feet to go ALT target alert: Steady for 3 seconds or until more than 10 feet away from 1000 feet to go mark</p> <p>200 feet to go ALT target alert: Steady for 3 seconds or until more than 5 feet away from 200 feet to go mark</p> <p>200 feet ALT departure alert: Steady for 3 seconds or until more than 5 feet away from 200 feet departure mark</p> <p>Upon reaching target ALT: Flash for 2 seconds</p> <p>Envelope protection: Flash continuously</p>

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Fault Message	Behavior	Location	Conditions
VS (Selected ALT)	Flash continuously	Right	<p>While in VS mode, the direction of Selected VS is opposite to the direction of the selected ALT with respect to the current ALT (VS compatibility check failed)</p> <p>[Selected ALT] = the displayed value of selected ALT</p>
AP FAIL	Steady	Upper Left	<p>Any power-on self-test failure, including servo status, config limits check, CRC check, etc.</p> <p>Any continuous self-test failure, including data monitor (pitch angle and roll angle), miscompare monitor (all dual board + Garmin single board), envelope monitor, pitch motor or roll motor fail, bezel communication link fail, input voltage incompatibility, etc.</p> <p>Any board miscompare (mode or servo command miscompare) for dual board configuration, typically due to an external input</p>

Section 4 Emergencies

4.1. GENERAL

If the 3100 is not behaving properly, the pilot must disconnect it using AP disconnect, turning off the AP master, or pulling AP circuit breaker (CB).

4.2. TRIM RUNAWAYS

In the event of a trim malfunction, two possible events may occur:

- 1) If the 3100 is engaged and trim begins to run un-commanded up and down, the 3100 fights the trim movement and eventually trips the internal fuse (approximately 3 seconds), stopping trim movement. In this case, turn off the trim master switch or pull trim CB, and re-engage the 3100. The pilot must manually trim the aircraft.
- 2) If the 3100 is not engaged and trim begins to run un-commanded, press and hold the AP DISC to interrupt power to the trim servo. Turn off the trim master switch or pull trim CB. The pilot must manually trim the aircraft. AP use is not inhibited with the trim off, but the pilot should manually trim in response to the 3100 trim annunciations.

4.3. HARDOVERS

Every effort has been made to minimize the possibility of a hardover condition (servo runaway). On the very remote chance a hardover occurs, the 3100 has built in limiters to mitigate the severity of response. The 3100 inhibits (but not disconnect) the pitch servos if G-loading exceeds ± 0.6 G's from normal flight, or if the pitch rate exceeds $4^\circ/\text{sec}$. In roll, the servo is inhibited (but not disconnected) if the roll rate exceeds $10^\circ/\text{sec}$. If such an event occurs and is not the result of turbulence, the pilot should immediately disconnect the 3100.

4.4. SOFTOVERS

A softover is defined as an attitude failure that occurs so slowly that the pilot may not be aware of it. The 3100 is protected in two ways from such an event. A miscompare of the pitch or roll axis of more than 5° disconnects the 3100. Additionally, the 3100 is disconnected at 38° roll and/or 22° pitch if the aircraft is not recovering (AP limits attitude to 30° roll and 17° pitch). The pilot should determine the cause of the problem before re-engaging the 3100.

4.5. MULTI-AXIS HARDOVERS

The 3100 is protected from multi-axis hardovers as well and disconnects if it finds two servos driving in one direction for three seconds.

4.6. SERVO CLUTCHES AND SPEEDS

The system incorporates slip clutches on all servos to allow the pilot to overpower the 3100, trim, and yaw systems. Servo speeds are limited to reduce the effect of hardover conditions to constrain the aircraft excursion due to a hardover condition.

Section 5 Glossary

Term	Meaning
AC	Advisory Circular
ADAHRS	Air Data Attitude Heading Reference System
AET	Approach Envelope Transition
AFM	Aircraft Flight Manual
AFMS	Aircraft Flight Manual Supplement
ALT	Altitude
AP	Autopilot
APR	Approach
ARINC	Aeronautical Radio, Incorporated
BC	Back Course
CB	Circuit Breaker
CDI	Course Deviation Indication
CWS	Control Wheel Steering
DFCS	Digital Flight Control System
DISC	Disconnect
EFIS	Electronic Flight Instrument System
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FD	Flight Director
FGC	Flight Guidance Computer
FPM	Feet-per-Minute
FMS	Flight Management System
FWD	Forward
GA	Go Around
GPS	Global Positioning System
GPSS	Global Positioning System Steering
GS	Glide Slope
HDG	Heading
HITS	Highway in the Sky
IAS	Indicated Airspeed
IDU	Integrated Display Unit
ILS	Instrument Landing System
INIT	Initializing
INTR	Interrupt
LOC	Localizer

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MCP	Mode Control Panel
MEMS	Micro-electromechanical Systems
MPH	Miles Per Hour
NAV	Navigation
OBS	Omnibearing Selector
PFD	Primary Flight Display
PN	Part Number
PWM	Pulse Width Modulated
REV	Reverse

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SIC	Side-In-Command
VLOC	VOR or LOC Frequency
VMC	Visual Meteorological Conditions
VNAV	Vertical Navigation
VOR	Very High Frequency Omnidirectional Radio Range
VS	Vertical Speed

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