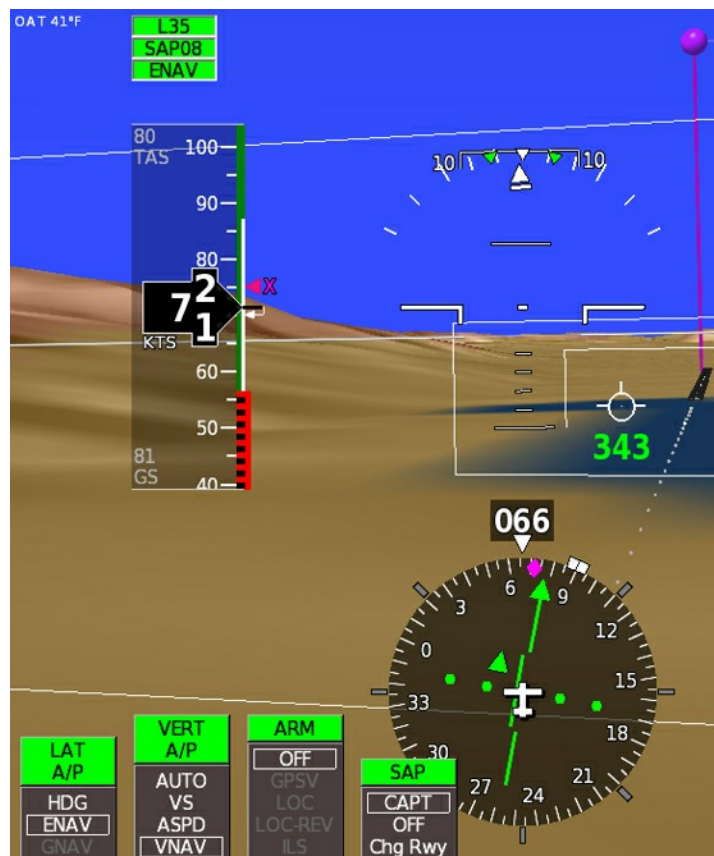




GRT Autopilot User Guide

All GRT EFIS Systems



Revision A

22-May-2014

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Revision Notes

Revision	Date	Change Description
A	22-May-2014	Complete revision. Supersedes <i>Autopilot Modes</i> dated April 2011 for users with GRT servos. Users with third-party autopilots will find additional information in the <i>Autopilot Modes</i> document..

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Section 1: General Information

1.1 About the GRT Autopilot

The GRT Autopilot provides full autopilot functionality in both roll and pitch for all phases of flight, including coupling to lateral and vertical navigation sources. Full vertical and horizontal GRT autopilot software is standard equipment in the Horizon HX, HXr, and Mini-AP. The Sport and Mini-X come standard with full lateral autopilot and altitude hold; Vertical navigation is a software option. The autopilot includes many safety features, including the ability to override the servo by applying force to the control stick at any time. Safety features are also built into the servos to prevent them from jamming the flight controls in the rare case of a mechanical failure of the servo.

This manual is intended for use with the GRT autopilot and GRT servos. While the EFIS commands described in this manual can also be used to command connected third-party autopilot systems, other autopilots may or may not have the same capabilities as the GRT autopilot, and may not perform as expected. If you are using a third-party autopilot with your GRT EFIS system, please refer to all applicable documentation from the autopilot manufacturer for proper installation, setup, checkout and in-flight procedures.

WARNING: See *GRT Autopilot Installation, Setup and Testing* guide for information on wiring and switch configurations and post-installation testing. This manual details use of the autopilot when a GRT pitch servo, roll servo, engage/disengage switch and external servo power switch are installed.

NOTE to Mini Users: Because the Mini has only one knob and four softkeys, some of the information in this manual is slightly different for Mini users. More information and screenshots specific to the Mini-X and Mini-AP are found in the *Mini-X* and *Mini-AP Installation, Setup and Pilot's Manuals*.

1.2 General Color Coding

Yellow - The AP is not following a navigation source. Examples: Heading Mode (HDG), all Autopilot OFF indications, Vertical Speed or Heading Hold.

Red - Critical labels are red. Examples: AP emergency functions (S&L and 180° turn), GPS signal or glideslope is lost while on approach, missed approach mode without a defined target altitude, pitch suspended (SUSP) and pitch servo disengaged with excessive bank angle.

Green - Labels and bearing pointers associated with GPS navigation

White - Labels and bearing pointers associated with primary VHF radio; VOR, Localizer, or ILS

Cyan - Labels and bearing pointers associated with a secondary VHF radio if installed

Black - Annunciator labels for items that are pending

Magenta - GPS course, waypoint balloons

Dark Magenta - Heading bug when coupled to autopilot (HDG mode)

NOTE: See Appendix of this manual for detailed descriptions of the lateral and vertical autopilot annunciations.


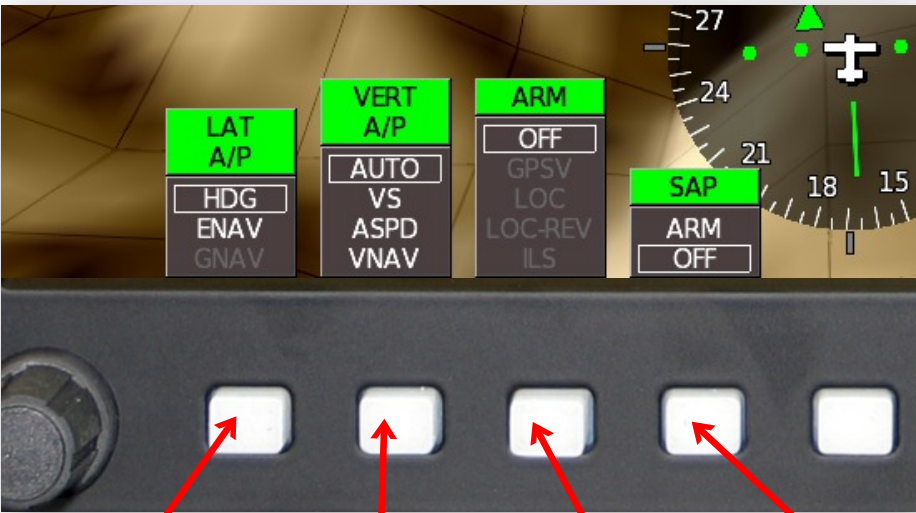
Lateral
Autopilot
Annunciators



Vertical
Autopilot
Annunciators

Autopilot navigation and mode softkeys appear across the bottom.

1.3 Main Autopilot Control Softkeys- (Press Right Knob to access)



LAT A/P
Lateral Autopilot Modes
Choose what a/p follows laterally
HDG- Heading
ENAV- EFIS Navigation (GPS or VOR/LOC)
GNAV- IFR GPS

VERT A/P
Vertical Autopilot Modes
Choose whether to use Vertical Speed, Airspeed or Vertical Command/Glideslope for climbs/descents


ARM
Select Approach Type
Tells a/p to expect and capture selected approach guidance

SAP
Synthetic Approach
Choose ARM to load SAP. System will then ask for runway selection.

EXIT
Press to exit a/p softkey menu

SEL ALT
Turn knob to set Altitude Bug and Altitude Select box. Push knob to Enter and adjust vertical rate to climb/descend to selected Altitude. (see Second Tier)

1.4 Second-Tier Autopilot Control Softkeys- (Press Right Knob TWICE or change altitude preselect window to access from HOME screen.)



Climb/Descent Presets
Choose one of the displayed preset rates to execute the climb or descent.

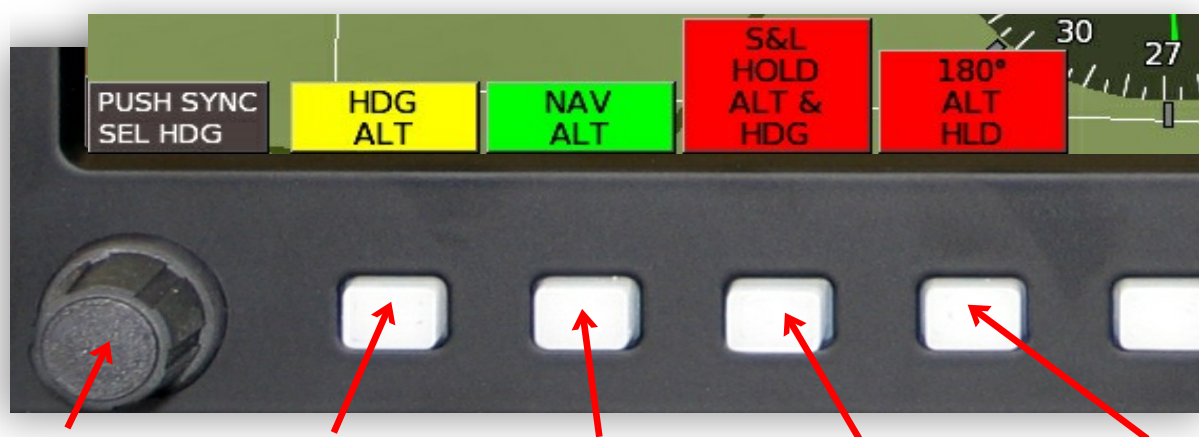
Flight Director
Press to turn Flight Director on or off.

The **preset** airspeed or vertical speed choices change as vertical a/p modes change. In this example, an altitude was dialed in that is higher than current altitude, so these softkeys automatically display the default climb presets. If a lower altitude was dialed in, they would display descent rate presets. Alternatively, turn Right Knob to manually set a custom airspeed or vertical speed. See Appendix for instructions on how to program presets. See page 13 for more information on how to use the **Flight Director**.

Section 2: Using the Autopilot

2.1 Engaging the Autopilot

1. Energize servo(s) by turning on servo power switch.
2. Press engage/disengage switch, typically located on control stick. **The aircraft will maintain present heading and pitch** and the softkeys illustrated below will appear.
3. **To engage the Emergency functions**, press the appropriate red softkey and adjust throttle setting as necessary to maintain level flight.
3. **To engage HDG/ALT function** (fly to and capture Heading and Altitude Bugs):
 - a. Enter desired altitude into Altitude Selection Box using the right knob;
 - b. Enter desired heading by turning or pressing the left knob to adjust Heading Bug;
 - c. Press yellow HDG/ALT softkey to fly to and capture heading and altitude bugs.
4. **To engage NAV/ALT function** (fly to and capture Navigation Course and Altitude Bug):
 - a. Enter desired altitude into Altitude Selection Box using right knob;
 - b. Intercept NAV radial or activate GPS flight plan
 - c. Press NAV/ALT softkey– GREEN if GPS is the active navigation and WHITE if VOR/LOC is active.



Left Knob:
Push to sync heading bug with current heading.
Turn to adjust heading bug.

HDG/ALT:
Follow selected heading and altitude. Set bugs before pressing.

NAV/ALT:
Press to fly to active nav course and selected altitude. Set course and bugs before pressing.

S&L HOLD ALT & HDG:
Engages a/p to roll wings level, then pitch to hold present altitude. Unusual attitude recovery.

180° ALT HLD:
Press to hold present altitude and enter a 180 degree turn. For level exit from inadvertent IMC.

2.2 Following a Heading

When the servos are powered on and A/P is engaged, use the following procedures from the PFD screen.

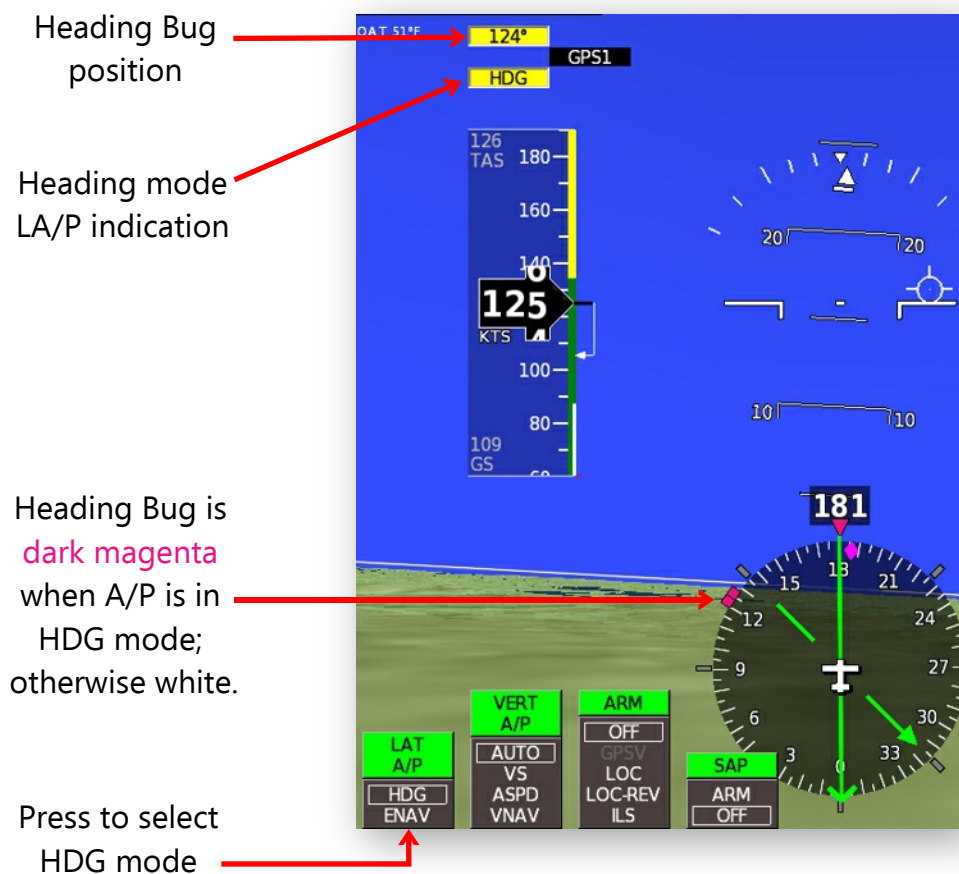
1. Turn Left Knob to adjust heading bug to desired heading; Or press Left Knob to set heading bug to current heading.

If LA/P is already in **HDG** mode, the aircraft will bank to follow the heading bug.

If A/P is in ENAV or GNAV mode:

2. Press Right Knob to activate A/P softkeys.
3. Press LAT A/P softkey to highlight HDG. Press EXIT to engage and exit back to HOME screen. Autopilot will enter **HDG** MODE and follow the heading bug.
4. Adjust heading using the Left Knob to guide the aircraft using the heading bug, such as for ATC vectors.

NOTE: The autopilot will always bank in the direction of the shortest distance to the selected heading. Make all heading bug adjustments that are more than 180 degrees in two or more smaller increments to "guide" it in the correct direction.



In this example, the heading bug is set to 124° and the Lateral A/P is engaged in heading mode. The aircraft is about to initiate a turn toward the heading bug. (Demo unit screenshot; The turn is instantaneous in actual flight.)

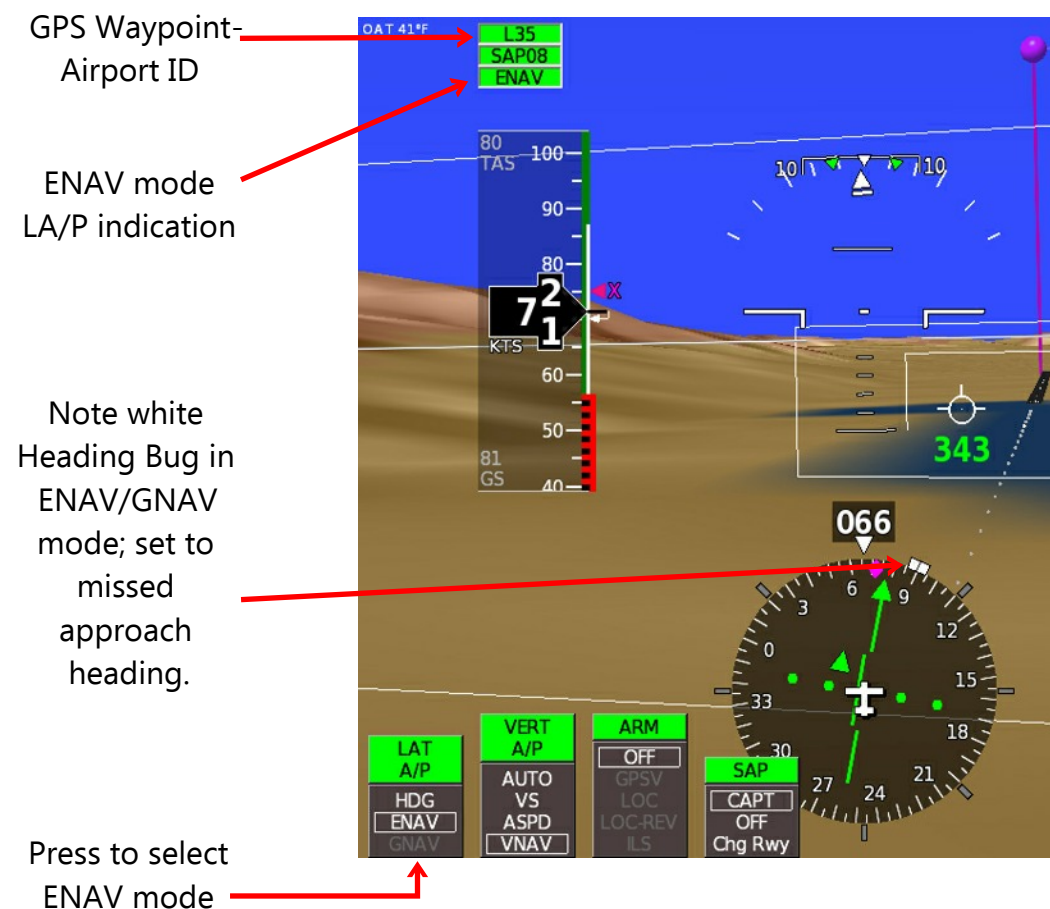
2.3 Tracking a GPS Course

1. For best results, start off in HDG mode to avoid abrupt course changes when flight plan is activated.
2. Enter GPS waypoint(s) using a Direct-To or Sequence Mode to create and activate an internal flight plan. Alternatively, enter and activate an external flight plan directly into a connected external IFR GPS navigator.
3. **Select Nav Source:** *On the HXR:* Press OBS/CDI to activate Navigation Source selection softkeys. The source driving the autopilot will be underlined in green. Select GPS1 or GPS2, as appropriate.

On all other systems: From PFD: Press NAV softkey to highlight the desired GPS1 or GPS2 selection.

GPS1 (or GPS2) will appear in the LA/P Nav Source annunciator box. If an HSI is displayed, the GPS course will appear as a Course Selection Needle.

4. Press Right Knob once or twice (as required) to activate A/P menu. **NOTE:** For smooth operation, make sure the aircraft is on the GPS course before engaging ENAV mode, as it may roll rapidly to intercept the course.
5. Press LAT A/P softkey to highlight ENAV. Press EXIT to engage and exit back to PFD/HOME screen. The autopilot will follow the GPS flight plan.

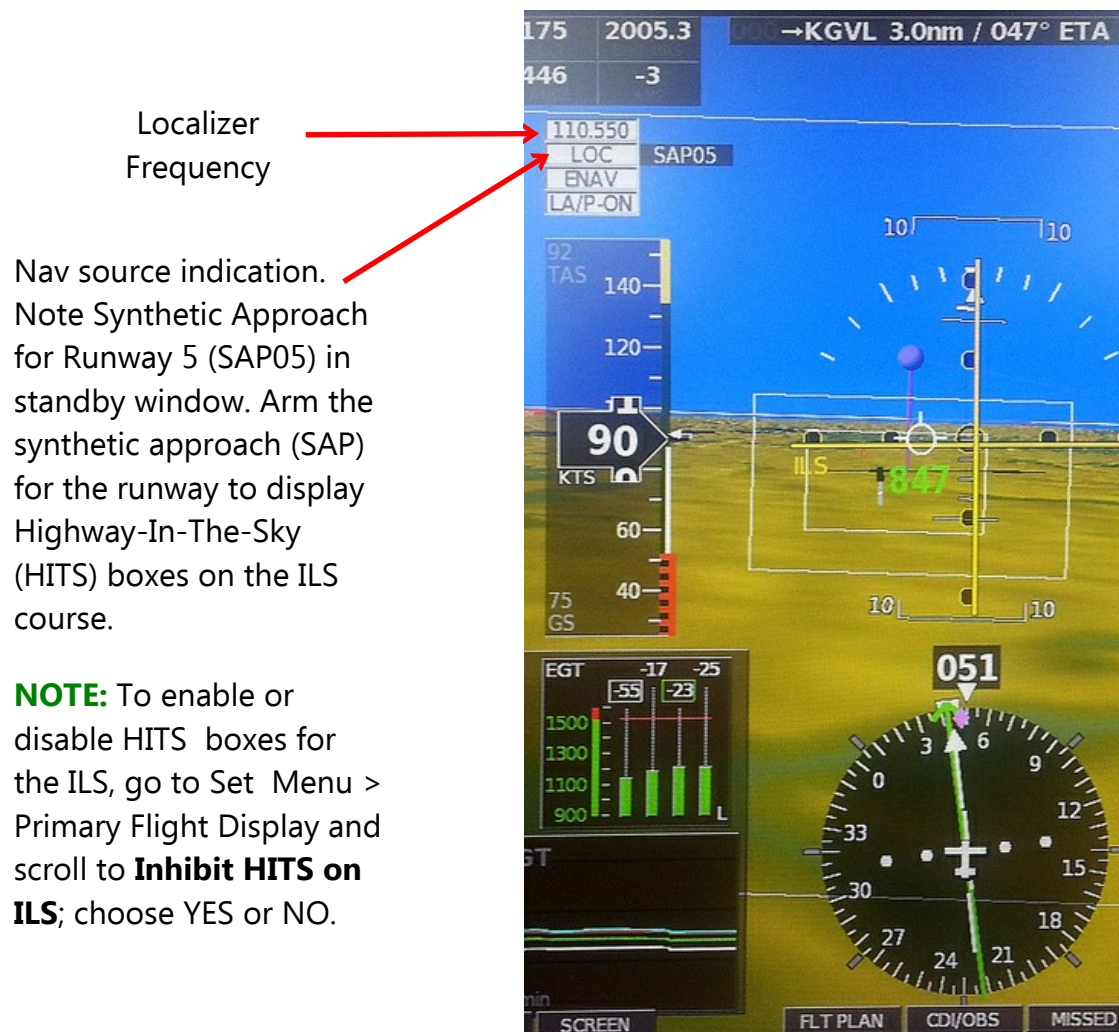


In this example, the LA/P is set for ENAV mode, following the synthetic approach (SAP) for Runway 08 at Big Bear City, CA (L35). The VERT A/P mode automatically switches to VNAV for vertical guidance when the system captures the synthetic approach. SAP is available only when the airport is listed as the last waypoint in the flight plan.

2.4 Tracking a VOR/LOC Course

1. For best results, engage HDG mode first.
2. Tune VOR or ILS frequency into the Nav radio.
3. (HXr) Press OBS/CDI softkey to activate Navigation Source selection softkeys and press softkey beneath the Nav source to be tracked (NAV1, NAV2). On other systems, from PFD screen, press NAV softkey to highlight navigation source.
4. For a VOR, adjust OBS course by turning Right Knob. ILS inbound courses are automatically tuned.
5. Press Right Knob once or twice as required to access Autopilot control softkeys.
6. Press LAT A/P softkey to highlight ENAV. The autopilot will fly to and capture the selected radial. Note that the ILS CDI replaces the horizontal bars of the attitude indicator if the selected frequency is a localizer.

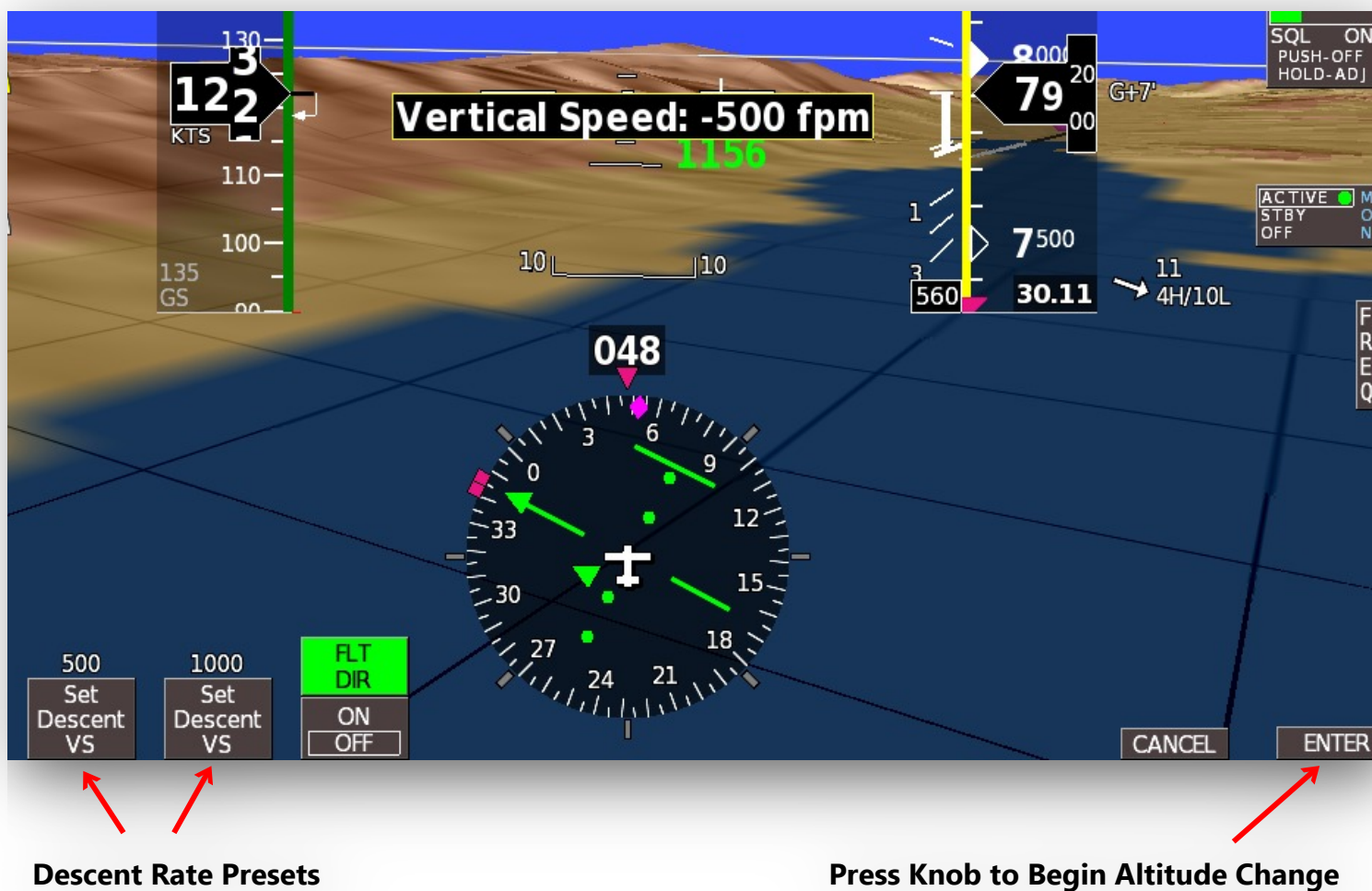
NOTE: For smooth operation, make sure the aircraft is on a shallow intercept course before engaging ENAV mode, as it may roll rapidly to intercept the course.



2.5 Altitude Changes with Autopilot Engaged

1. From the PFD/HOME screen, press/turn the right knob to enter a new altitude into the Altitude Preselect Window (Altitude Bug).
2. Press the knob to set it.
3. A message will appear on the PFD screen suggesting a rate or speed. If the new altitude is higher, it will be a positive value for climb. If the new altitude is lower, it will be a negative value for descent. Do one of the following actions:
 - a. Press the right knob to accept the displayed airspeed/vertical speed and begin the altitude change.
 - b. Press one of the preset airspeed or vertical speed softkeys displayed on the bottom of the screen, then press the right knob to acknowledge and begin the altitude change.
 - c. Turn the right knob to dial in any airspeed/vertical speed, then press it again to begin the altitude change.
 - d. Press CANCEL to abandon the altitude change and go back to the PFD/HOME screen softkeys.

NOTE: Instructions for programming the presets are found in the Appendix of this manual and the *GRT Autopilot Installation & Setup Guide*.



2.6 Synthetic Approach (SAP)

All GRT EFIS systems have the capability to draw a synthetic approach path to any runway in the navigation database. The approach path is marked by Highway-In-The-Sky boxes (also known as HITS) that are aligned with runway heading and follow a three-degree slope to the touchdown zone. This manual covers the button presses necessary to capture the approach. For more detailed information about the flying synthetic approach with all GRT EFIS systems, please see the GRT Horizon User's Guide, Rev. C.

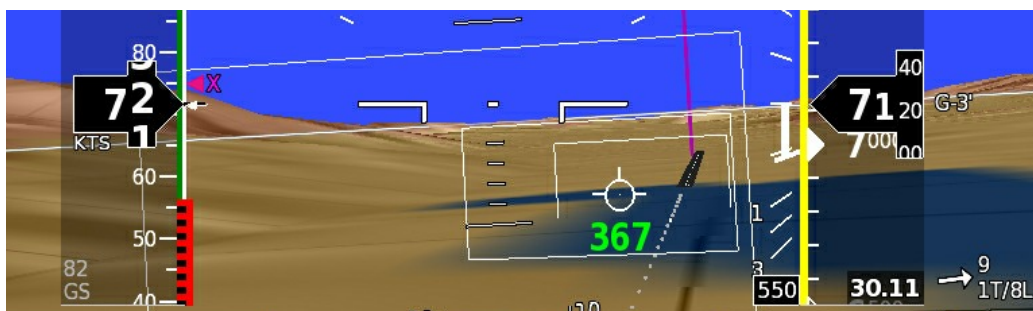
WARNING: Synthetic Approach is derived from a non-certified VFR GPS and VFR navigation database waypoints which may not be accurate. **Synthetic Approach paths have not been evaluated for obstacle and terrain clearance, and therefore are not approved for IFR use.**

Synthetic Approach is available only when the following conditions are met:

1. The last waypoint in the flight plan is an airport included in the GRT navigation database with information about runway orientation, position, and elevation, OR –
2. An approach has been loaded into a connected IFR GPS navigator and the EFIS is able to determine the selected airport and runway from that.
3. AHRS, Air Data Computer and GPS data are valid.

Capture of the SAP should occur:

- Within 20 miles of the destination airport
- 2.5 degrees off of the extended runway centerline or localizer course
- On a preferred intercept angle of 45 degrees or less, but can occur at any angle.
- When the aircraft is below glideslope intercept altitude. Abrupt dives can occur when the aircraft intercepts the SAP above the glide path.

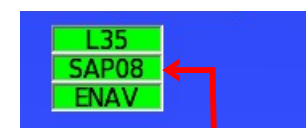


Flying the Synthetic Approach

1. Ensure the last waypoint in the active GPS flight plan is the destination airport. The autopilot can capture the synthetic approach from any mode.
2. Fly toward the airport in HDG mode if you are following ATC vectors or if you are not approaching the desired runway at a natural intercept angle. The autopilot will perform a simple turn onto the SAP when it captures the final approach course. This can result in an abrupt course reversal if care is not taken to make a smooth intercept angle of 45 degrees or less onto the final approach course.
3. From the HOME or PFD screen, press the right knob to activate the autopilot and approach controls.
4. Press the SAP softkey to highlight ARM, then press EXIT. A list of available runways appears on the bottom of the screen in the order in which they are favored by the winds aloft as calculated by the EFIS. Yellow runways have a predicted 10+mph tail wind. **CAUTION:** Traffic and actual winds on the surface may require the use of a runway other than the one favored by EFIS calculations.
5. Turn the left knob to highlight the desired runway in a white outline box, then press the knob to select it. Notice the black **SAPXX** appears as the pending lateral and vertical autopilot guidance, shown at right. In this example, we are set up to capture both the lateral and vertical components of the the SAP for Runway 08.
6. After the runway is chosen, a reminder appears to check the altimeter baro setting, and the yellow EXECUTE softkey appears on the bottom of the screen. Press EXECUTE when you are ready to allow the autopilot to capture the approach and begin descent to the airport.
7. After the yellow EXECUTE softkey is pressed, the autopilot will automatically capture the lateral and vertical guidance of the SAP when it is within intercept range. Operate the throttle and trim as necessary on approach, and disengage the autopilot when ready to land.
8. If a missed approach is necessary, apply power as required and press the MISSED softkey to command the autopilot to fly runway heading and climb to the missed approach altitude preset.



SAP capture is pending

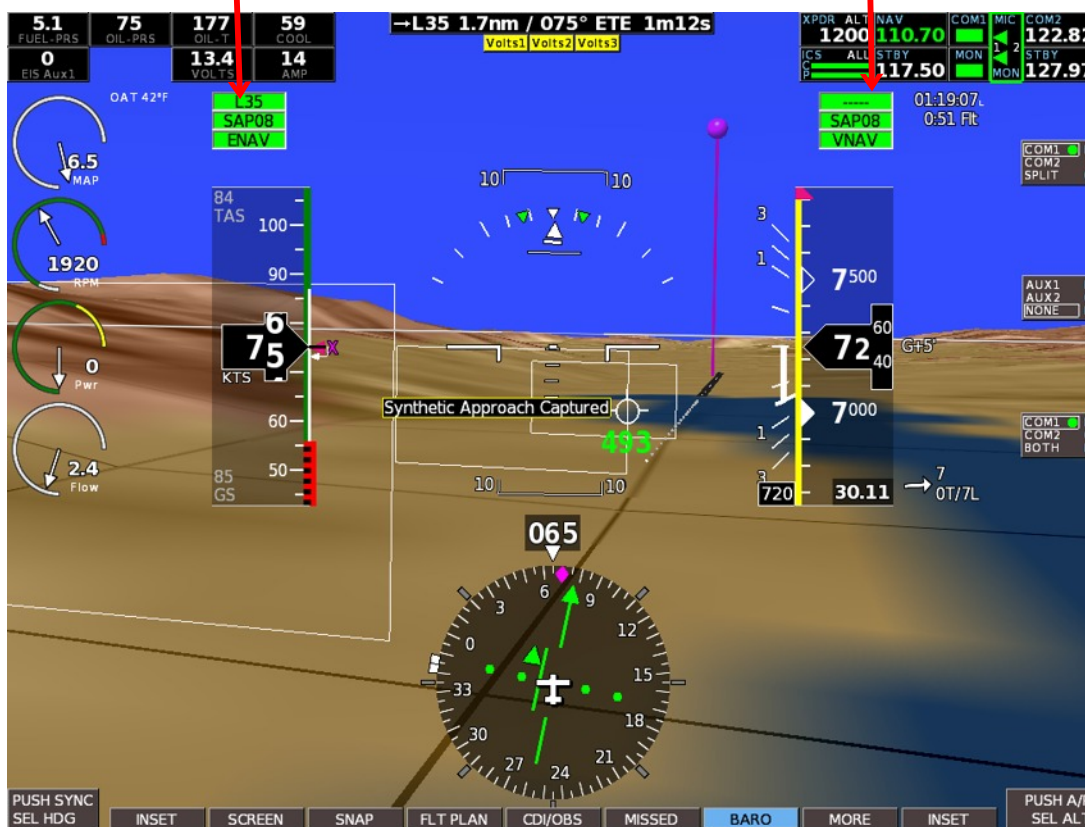


SAP is captured

Once the approach is captured, the autopilot automatically changes modes:

Lateral- ENAV

Vertical: VNAV

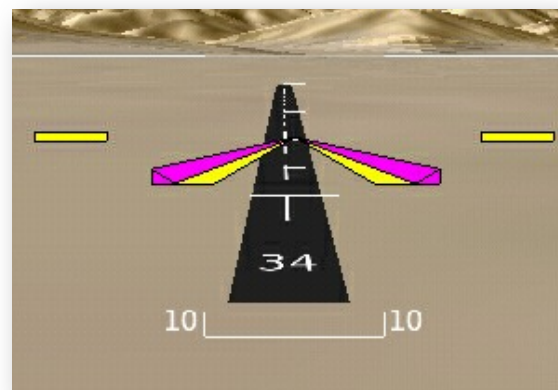


Missed Approach softkey

2.7 Flight Director

Every GRT EFIS with vertical autopilot software is capable of displaying a Flight Director. Commercial pilots may recognize it as a tool for precise hand-flying that's commonly found in larger aircraft. It is a visual indication of the same commands that the autopilot would follow to guide the airplane. Pilots who use the flight director report less fatigue during instrument conditions while hand flying because the computer does much of the instrument interpretation for you.

The concept is simple: Follow the magenta command bars. When the flight director is activated, the yellow horizontal bars and small chevron replace the wing/nose of the attitude indicator. The larger magenta chevron represents the pitch and bank angle required to achieve the heading/course and climb/descent profile entered into the system. Use the flight controls to nest the yellow chevron into the magenta one. If they are aligned, you are right where the computer says you should be. Note that upon activation, any active VOR/ILS needles will be replaced with scales to make room.



In the example above, the flight director command bars are properly aligned and the pilot is on glidepath. In the example at right, the magenta command bar is calling for a descending left bank.

To enable the Flight Director feature:

Enable both the Lateral and Vertical autopilot functions in the General Setup menu. The flight director is controlled by the autopilot functions even if you don't have an autopilot.

To use the Flight Director:

Press the right EFIS knob once to access the autopilot controls. Adjust the settings as necessary to set up the vertical and lateral navigation profile you would like to fly. For example, if the LAT A/P is set for HDG mode, the flight director will follow the heading bug. If the vertical autopilot is set up to capture a glideslope, the flight director will capture and follow it.



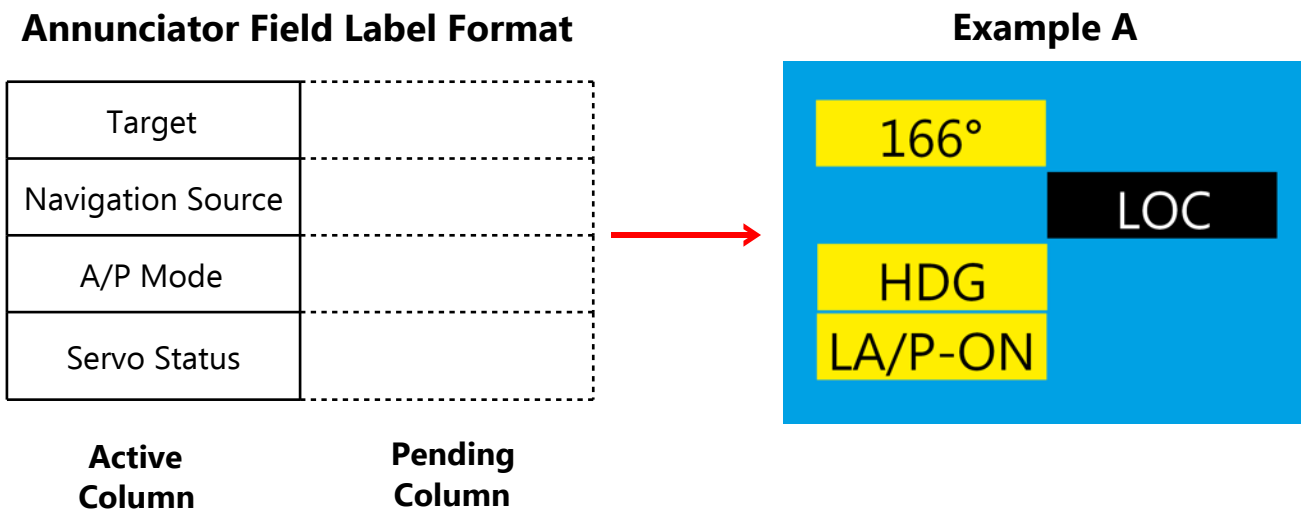
Press the right EFIS knob again (or from the main PFD page, press the right EFIS knob twice). This brings up the second tier of autopilot controls. Press FLT DIR softkey to highlight ON. The flight director will indicate pitch and roll as necessary to capture the selected settings. Follow it using the flight controls. Remember to use throttle as necessary to maintain safe airspeeds.

To quit using the flight director, press the right knob twice from the PFD page and highlight OFF with the FLT DIR softkey.

Appendix

A.1 Lateral Autopilot Annunciations

The LA/P (lateral autopilot) annunciator fields appear on the PFD above the airspeed tape. The field labels are illustrated here, along with a color Example A.



Lateral A/P Annunciator Fields and Possible Indications

<div><div>Target</div><div></div><div></div><div></div></div>	or "Steer-To;" Where the lateral A/P is going. This can be a heading, GPS waypoint, airport identifier, VHF frequency, etc. Possible indications include:		
	LA/P Mode	Indicator Example	Steer To:
	HDG HLD	- - - °	No steer-to target is defined.
	HDG	166°	Selected heading (166° in Example A above)
	ENAV	KGRR	Active GPS Waypoint ID
		166°	Reversion to last GPS course after passing last waypoint in the flight plan
		119.1	VHF NAVAID frequency before ILS or VOR approach is armed
		GRR	VHF NAVAID frequency after ILS or VOR approach is armed

Navigation Source

The navigation source the A/P is tracking. This can be VOR, ILS, LOC, GPS, or SAP (synthetic approach). Synthetic Approach indication will also display the runway number. Inactive or armed nav source labels in the Pending column are black with white lettering. If a Nav source is selected on the OBS/Nav Source page but the A/P is in heading mode, that source will appear in the Pending column.

LA/P Mode	Indicator Example	Lateral A/P is tracking:
HDG	LOC	(Pending column only) Armed approach activates when aircraft is in range; LA/P mode automatically switches to ENAV when approach is captured.
ENAV	LOC	VHF NAVAID (can also be VOR or ILS).
	SAP05	Lateral portion of GPS-derived Synthetic Approach. Note runway designation. (This example is SAP for Runway 5.)
	GPS1	Flight plan or Direct-To GPS course
	LPV	GPS LPV precision approach
any mode	GS Lost	VHF signal lost during approach. Appropriate label is displayed for each flagged or inop VHF component (GS, LOC, VOR, etc). Displays in Pending column.
	GPS1 Lost	GPS signal lost. Displays in Pending column.

LA/P Mode

Indicates lateral command mode.

LA/P Mode	Indicator Example	Lateral A/P mode definitions are:
—	HDG HLD	Heading Hold- Holds current heading upon a/p engagement.
HDG	HDG	Heading Mode. A/P follows Heading Bug.
ENAV	ENAV	"EFIS Navigation." A/P follows active GPS course (Internal Flight Plan).
	ENAV	"EFIS Navigation." A/P follows active VHF course as displayed on EFIS.
	CRS	Mode is ENAV but no valid GPS flight plan or VHF course exists. A/P holds last known course track, which can be adjusted using right knob (OBS) when CDI/OBS menu is activated.
GNAV	GNAV	GPS Navigation (meaning External GPS, or "not" the EFIS). This is a "pass-through" mode in which a connected external GPS navigator controls the autopilot directly using an External Flight Plan.

Servo Status

Indicates servo activation level.

LA/P Mode	Indicator Example	Servo power & activation:
none	LA/P-OFF	Power to the servo is disconnected. Emergency modes unavailable.
any	LA/P-ON	Servo is powered, communicating with the EFIS; LA/P is engaged.
none	LA/P-Stby	Servo powered & communicating; LA/P NOT engaged. Pending only.

A.2 Vertical Autopilot Annunciations

The VA/P (vertical autopilot) annunciator fields appear on the PFD above the altimeter tape. The field labels are illustrated here, along with a color Example B.

In Example B, the altitude bug is set for 7500 feet, the a/p is in Altitude Hold mode at 7500 feet, and Vertical a/p is engaged. An ILS approach has been armed (glideslope intercept is pending).

Annunciator Field Label Format

	Target Altitude
	Vertical Navigation Source
	A/P Mode
	Servo Status

Pending Column

Active Column

Example B



Vertical A/P Annunciator Fields and Possible Indicators

Target Altitude

Where the vertical A/P is going, MSL altitude. In VNAV mode, this field contains Decision Altitude if one has been specified. (Warning: A/P will NOT level off at Decision Altitude—it is just a reminder.)		
VA/P Mode	Indicator Example	Steer To:
any mode	- - - -	Dashes- No altitude target is defined. Color corresponds to Nav source.
any mode	7500	Altitude Bug/Target (7,500 feet in Example A above)

**Vertical Nav
Source**

Present when pilot has armed or activated a precision approach or synthetic approach. Indicators are black with white text when they are in the "Pending" column.

VA/P Mode	Indicator	Autopilot is following:
VNAV	G/S	ILS Glideslope (Nav 1).
	LPV	LPV precision GPS approach
	SAP08	Synthetic Approach with runway designation (Runway 08 in this example)
	G/S-2	ILS Glideslope (Nav 2)

**Vertical A/P
Mode**

Indicates whether vertical A/P is engaged and how it is controlling the airplane.

VA/P Mode	Indicator	Vertical Autopilot mode is:
–	PIT HLD	Pitch Hold; Holds current pitch upon a/p engagement
VS	VS HLD	Vertical Speed Hold mode; holds present vertical speed indefinitely.
	VS-500	VS or Vertical Speed mode; Climbs/descends at specified rate (500 fpm in this example).
ASPD	IAS- 125	ASPD or Airspeed mode; Climbs/descends at specified indicated airspeed. (125 knots in this example)
any mode	ALT HLD	Altitude Hold- Holds altitude specified in Target Altitude field
VNAV	VNAV	Vertical Navigation; A/P following vertical glideslope. Color specifies type of navigation- Green=GPS, White=VHF glideslope 1, Cyan=VHF glideslope 2
any mode	SUSP	Suspend; Pitch servo disengaged because of excessive roll angle.

Servo Status

Indicates servo activation level.

VA/P Mode	Indicator	Servo status is:
none	VA/P-OFF	Power to the servo is disconnected. Emergency modes unavailable.
any	VA/P-ON	Servo is powered, communicating with the EFIS and VA/P is engaged. Yellow when not following specified course/altitude.
none	VA/P-Stby	Servo powered & communicating; VA/P NOT engaged. Pending only.

A.3 Setting Up the Climb/Descent Presets

The GRT EFIS can store and recall preset airspeeds and rates for autopilot-coupled altitude changes. Customize your autopilot with 2 values for each of the following:

- Climb IAS
- Climb VS
- Descent IAS
- Descent VS

Before using the autopilot, set a gentle cruise climb/descent and a more aggressive rate for each.

1. Press NEXT (MORE on HXR) > Set Menu > Primary Flight Display
2. Scroll to **Climb IAS Preset #1** and begin entering speed/rate settings appropriate for your aircraft.
3. SAVE your settings.

