Horizon HXr
User Manual

Rev B - September 2019

GRT Avionics, Inc.
3133 Madison Avenue SE
Wyoming, MI 49548
616-245-7700

support@grtavionics.com
www.grtavionics.com

1 FOREWORD

Thank you for choosing the GRT EFIS!

This manual describes the operation of a **Horizon HXr EFIS** using the software version shown in the Record of Revisions. Some differences may be observed when comparing the information in this manual to other software versions. Every effort has been made to ensure that the information in this manual is accurate and complete. GRT is not responsible for unintentional errors or omissions in the manual or their consequences. The builder of the aircraft and the pilot have the final authority on the airworthiness of the aircraft.

Information in this document is subject to change without notice. GRT Avionics, Inc. reserves the right to change or improve their products and to make changes in the content of this material without obligation to notify any person or organization of such changes or improvements.

1.1 Important Safety Information

!WARNING!: This is an Experimental EFIS system intended ONLY for use in experimental and light-sport aircraft. Various functions of this system may be incomplete or untested with your particular avionics combination. Exercise caution when using the EFIS after installing new software updates. **All software and hardware updates must be tested thoroughly in VFR conditions before using for IFR flight.**

!WARNING!: Obstacle clearance is NOT assured in Synthetic Approach mode.

***CAUTION*:** If any display unit is inoperable in a multiple-display system, the display units will not be able to share information and some features or instruments may become disabled.

***CAUTION*:** If GPS position data is lost for more than 30 seconds, the HXr issues a **No GPS Position** warning and automatically reverts to dead-reckoning using the AHRS heading, true airspeed, last known winds and time. This data is used to estimate changes in position, which are applied to the last known GPS position to give an approximate navigation solution. The accuracy of the dead- reckoning function will degrade with time depending on the accuracy of this data and changes in the winds.

***CAUTION*:** Dual Nav radios tuned to Localizer frequencies with autopilot function **ARM** engaged will result in the EFIS selecting either NAV radio to fly the Localizer.

1.2 Warranty and Return Policy

1.2.1 Satisfaction Guarantee

If for any reason you are unhappy with your GRT product, you may return it for a refund anytime during the first 60 days you own it.

Please call EFIS Tech Support before returning any system or component.

1.2.2 Limited Warranty

All GRT products include a 2-year warranty starting on the day the instrument is put into service (or three years after purchase, whichever comes first) against manufacturer defect. Contact Tech Support before returning a display unit or component to GRT for repair or warranty work. Many issues are installation-related and can be resolved over the phone, saving expense. All returns for repair or upgrade must be accompanied by a Service Request Form, downloadable from the GRT website Support section.

1.3 Technical Support

Our tech support staff has real-world experience installing, flying and troubleshooting GRT equipment in many different types of aircraft. We are here to help you.

Please visit the Contact page of our website for up-to-date contact information for tech support via email.

Check the home page of the GRT website often for new manual updates, video tutorials, and other instructional materials as we release them.

1.4 RECORD OF REVISIONS

Revision	Date	EFIS SW Revision	Description
A	August 2019	3.00	Initial Release

2 Contents

3 Introduction

This manual was written to help both original builder/pilots and subsequent owners of experimental aircraft learn how to use and customize the EFIS. The system can be used in many types of aircraft and for many different types of flying. While we do our best to cover all the information pilots need to know, one manual cannot cover all scenarios for installation and use with third-party radios, GPS units, autopilots and other items.

3.1 Revisions

The manuals are always a work in progress as software changes are made to incorporate new features in the EFIS system. New updates of this and other GRT manuals are published in the Documentation section of our website as they are completed. The Record of Revisions page in the beginning of the manual details which changes were made and which pages or sections were affected. If you keep a printed copy of the manual, you can update only the pages that were changed.

3.2 Warnings, Cautions and Notes

Throughout this manual, you will see notes punctuated with the following bold type:

!WARNING!: A special notice that could lead to injury or death if not followed.

***CAUTION*:** A notice that could lead to damage of equipment if not followed.

NOTE: An item of special interest that is not immediately apparent through normal usage.

3.3 EFIS Control Sequence Instructions

Many tasks require that a sequence of softkeys, or buttons, be pressed. Softkey labels and controls are typed as they appear on the EFIS screen and separated by a **>** symbol. For example:

Press MORE > Set Menu > Primary Flight Display

Softkey labels are displayed with any button is pressed, but since the three left-most buttons can be configured to be active when the labels are not displayed, we suggest you

use either of the rightmost two buttons to activate the softkey labels. The softkey label timeout period is user adjustable.

After bringing up the softkey labels, press the NEXT softkey to bring up additional sets of softkey labels. Depending on how your EFIS is configured, the number of times you must press the "NEXT" softkey may vary to find the next softkey. Press the NEXT softkey as many times as necessary until you find the "Set Menu" softkey.

Now press Set Menu softkey, and the set menu will be displayed. In this example, "Primary Flight Display" is a choice in a scrollable list of items on the screen. As indicated on the screen, use the right knob (turn to select, press to activate) to access the Primary Flight Display menu page and complete your task.

3.4 Electronic Manuals and Internet Links

Many customers now choose to store electronic copies of the manuals on a tablet computer or phone for easy access to the newest material. It is easy to carry a lot of written materials aboard the aircraft without the added weight and bulk of paper. Because of this, we have added links to videos and other aids to the manual text. Simply touch or click on the link to access interactive materials and tutorials.

3.5 Transition from Round Gauges to Glass Cockpit

Digitization of flight instrumentation can build a subtle trap for pilots new to EFIS systems. EFIS systems can present so much information that the line between enhanced situational awareness and information overload can become blurred. At all times FLY THE AIRPLANE FIRST! Guard against letting any EFIS system become a "heads down display." Aviate, navigate, communicate, and compute - in that order. Dual instruction with a qualified flight instructor with experience behind an EFIS will ease the transition to a glass cockpit and help you get the most out of your new system. Keep in mind that the airplane can be flown from the primary flight page without pushing any buttons, and the usual six-pack data is all shown on that screen.

3.6 Feedback and Corrections

If you notice any errors or would like a better explanation of something that relates to your EFIS system, please contact GRT tech support. We are always striving to make our customers' lives easier.

4 GENERAL SYSTEM INFORMATION

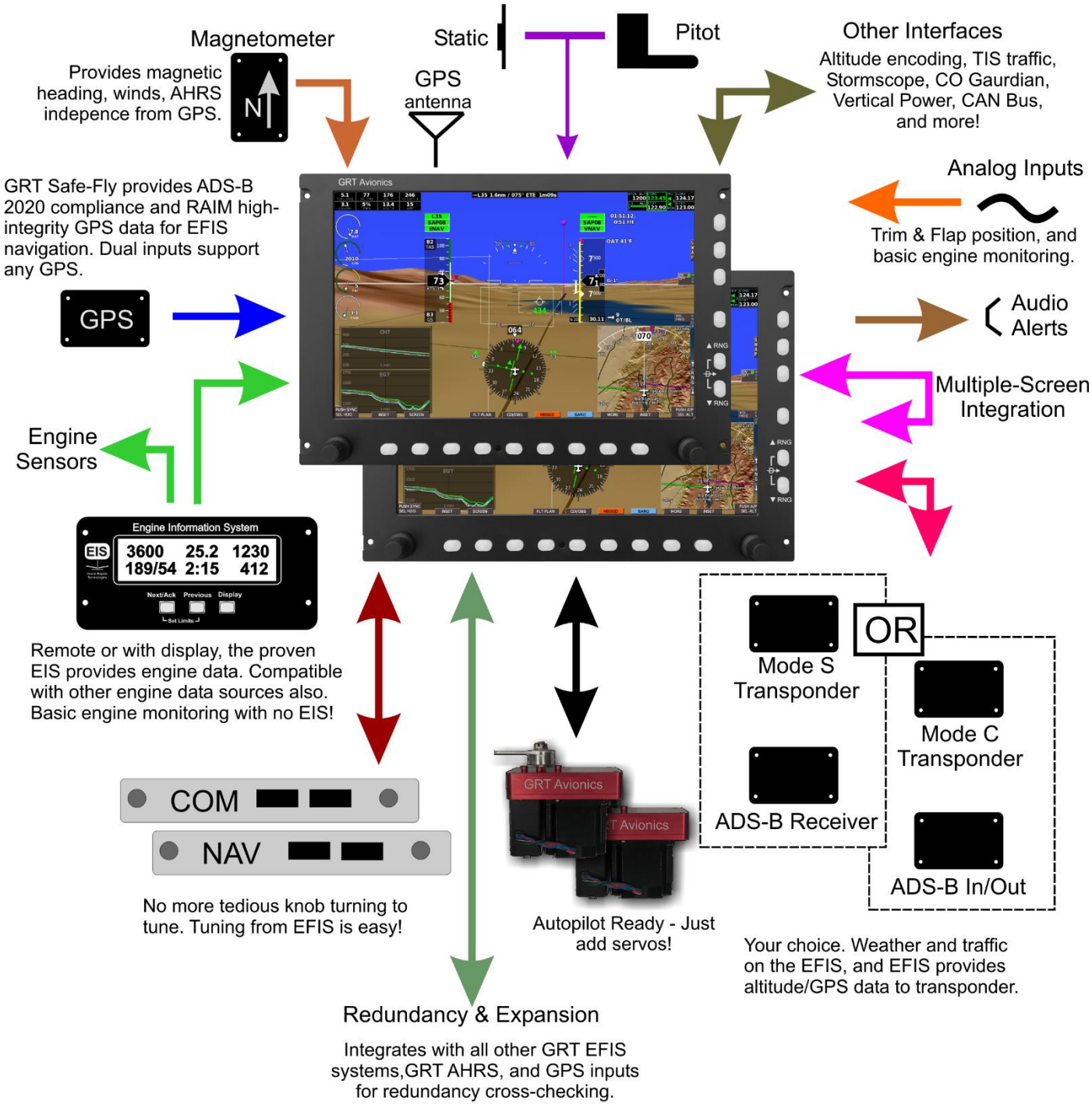
4.1 The Horizon HXr

In addition to its display and interface functions, the EFIS includes an internal attitude/heading reference system (AHRS) which replaces the traditional gyros for attitude and direction, and an air data computer for measuring airspeed, altitude, vertical speed, and optionally, angle-of-attack. It also accepts AHRS/Air Data from an external GRT AHRS/air data computer. A second internal AHRS is an option with the Horizon HXr.

The functions provided by the Horizon HXr EFIS vary depending on the software/hardware options included with the EFIS. Software options may be expanded at any time without removing the unit from the airplane, and this is sometimes true of hardware options also. Check the website for option pricing or call use for more details.

The EFIS may be used alone, as is common in VFR and some IFR airplanes (with appropriate back-ups), or together with another Horizon/Sport 10.1, Sport EX, GRT Mini, or HX as part of a system. The following figures illustrate typical system configurations.

Installation is quick and simple as the internal AHRS/air data computer means these do not require separate mounting. In the most basic installations, the EFIS is ready to fly when power/ground and pitot/static connections are made since all sensors are internal to the EFIS. Engine monitoring is also supported with a serial data connection to any model of the GRT Avionics EIS engine monitor.



The Horizon HXr supports basic single screen panels as well as multiple screen redundancy using any combination of GRT EFIS systems, AHRS, and sensors, making it easy to grow your panel with your budget. Multiple-screen integration shares pilot inputs between screens and data that is only connected to one screen.

4.2 AHRS and Air Data Computer

Traditional spinning gyros are replaced by the internal Attitude/Heading Reference System (AHRS) to provide roll and pitch (attitude) reference and gyro heading slaved to magnetic heading (when a magnetometer is connected). The GRT Avionics AHRS features the ability to operate without external aiding from GPS or air data – a feature that preserves the integrity of this critical data even when air data or GPS is corrupted, and exclusive to GRT Avionics among experimental aircraft instrument manufacturers.

The aircraft's pitot/static system connects to the air data computer inputs at the rear of the display unit for measurement of indicated airspeed, altitude and vertical speed. Additional calculations within the EFIS provide true airspeed and winds (when magnetic heading is available).

The AHRS and air data computer are located with the display unit, simplifying installation of the system.

4.2.1 Adaptive AHRS Operation

The angular rate maximum of 250 deg/second is impossible to exceed with all airplanes except highly aerobatic airplanes, and even those can exceed these limits only with aggressive maneuvering. If angular limits are exceeded, the attitude information is removed until the AHRS recovers from the attitude errors that could be induced. The air data (airspeed and altimeter) will remain valid.

After power-up the AHRS will enter alignment and will provide attitude data once this process is complete. With minimal movement of the airplane attitude data is usually available by the time the EFIS completes booting. Continuous movement can extend the alignment time.

4.2.2 AHRS/Air Data Computer Limitations

The AHRS/Air Data Computer have the following range limits:

AHRS/Air Data Computer Range Limits	
Max. Angular Rate:	200-250°/s, All Axis Simultaneously
Airspeed (Standard):	35-285 mph
Airspeed (High-speed):	50-580 mph
Altitude:	-1,000 to 32,000 feet
Voltage:	9-35VDC
Operational Temperature:	-13°F to 158°F (-25°C to 70°C)

4.3 Optional Components and Software

4.3.1 EIS Engine Monitor

The GRT Avionics EIS Engine Monitor provides all engine data to the EFIS. The HXr uses this data to drive its graphical engine display and compute additional engine performance information. The EIS is available with or without a display. Data is transmitted to the EFIS through a single RS-232 serial output. When Data Recording is enabled in the HXr, EIS data is recorded to the USB stick and can be analyzed by computer programs or web-based engine analyzers such as SavvyAnalysis.com.

4.3.2 GRT Autopilot

The GRT Sport comes standard with 2-axis autopilot software for driving GRT servos. The Sport is also compatible with third-party autopilots, such as TruTrak and Trio. While the Sport interfaces well with these autopilots using the GRT servos provides superior performance and simpler operation. The autopilot includes lateral functions for heading select and following any navigation sources (GPS, localizer, and VOR). The Sport's standard vertical autopilot function includes only altitude hold, but vertical Commands for climbs, descents, and glideslope coupling (including coupling to the EFIS generated synthetic approach) is an optional software upgrade. Learn more about the GRT Autopilot in the dedicated autopilot manuals, downloadable from the grtavionics.com.

4.3.3 ARINC 429 Module

When equipped with an optional ARINC 429 module, the Sport can interface with avionics that require ARINC 429 communication, such as IFR GPS navigation units from Garmin and Avidyne, as well as coupling to the vertical channel of external autopilots, TCAS and TIS-A equipped transponders.

4.3.4 GPS Receiver Compatibility

The Horizon HXr is intended to be used with an external GPS receiver. The EFIS supports two inputs for redundancy. The external GPS can be a remote unit (no display), or a stand-alone GPS navigator that does allow the pilot to enter a flight plan. Practially all GPS receivers provide a serial output that is compatible with the EFIS.

For installations that requires an FAA accepted GPS for ADS-B output, we recommend the GRT Safe-Fly GPS 2020 complaint GPS. Unlike other 2020 compliant GPS sources, the Safe-Fly allows the EFIS to display accuracy and integrity indications that cannot be provided from other 2020 complaint sources. In addition, the Safe-Fly includes a serial port combiner that adds additional serial inputs to the EFIS.

4.3.5 Synthetic Vision

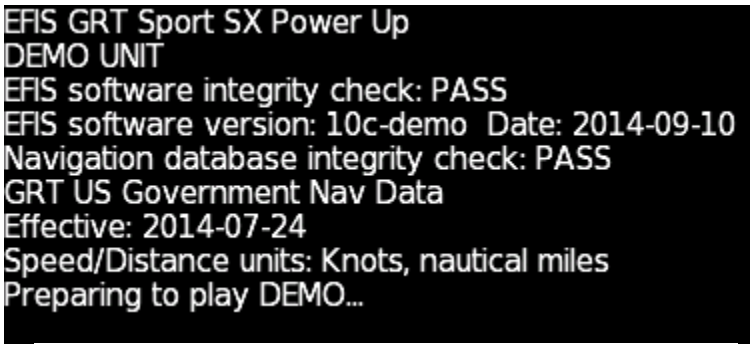
Synthetic vision is standard in the Horizon HXr and provides a 30 mile range. Pilots with Synthetic Vision enjoy a virtual "view out the windshield" featuring terrain, obstacles, runways, waypoints, and when equipped with ADS-B or TIS, 3D traffic icons.

5 OPERATING THE EFIS

5.1 System Power-Up

The EFIS is normally wired to the avionics bus and will boot up with this bus is powered.

Power may be applied before or after the engine is started without damage to the EFIS, however voltage drops while starting the engine will usually cause it to reboot. This makes it preferable to leave the EFIS (and all other avionics) off during engine start.



Boot screen of the EFIS upon power-up. (Demo unit boot screen shown.)

After power-up, the "Startup Accept" screen will show software and navigation database version and GRT system status. Check the navigation database date to make sure it is not more than 60 days old. New nav database updates are posted on the GRT Avionics website every 60 days. Instructions for updating it can be found in Section 10 of this manual. Press the Accept softkey to continue.

NOTE: The "Startup Accept" screen is not shown if the EFIS is powered-up in-flight.

During the boot-up of the EFIS the AHRS will begin its alignment automatically. For more details about the AHRS alignment period and startup, see the AHRS and Air Data Computer section above.

5.2 The Pilot's Controls

The pilot controls the EFIS using knobs (they turn and push) and softkeys. The softkeys illuminate for night flying.

Labels are shown above the rotary knobs and white softkeys identifying their function. When no label exists, they have no function.

5.2.1 Softkeys

The function of the softkeys are identified by the label adjacent to them. Softkeys without labels have no function until a label appears above them.

The labels for the softkeys are color-coded to make certain functions easy to identify. Blue softkey labels are used for navigating "BACK" one menu level, or to the "HOME" or top level menu.

Light blue is used to identify the "BARO" set function. It is the only softkey with this colored label.

All top-level (or Home) softkeys on the bottom row with brown backgrounds can be pressed to observe their submenu and pressed again to return back to home. You will note that the sub-menus for these keys always becomes the "HOME" softkey when it is pressed. This is handy feature that makes it easy to see what options each of these softkeys provide without altering any setting in the EFIS.

In some cases, a "Long-Click", holding the softkey pushed for more than a second, will perform a secondary "shortcut" function. The "Screen" and "Inset" softkey are examples of keys that have this feature. In most cases the shortcut feature will be displayed above the softkey label when it is depressed. The remote radio rack selector is an exception, as described below.

5.2.2 Knobs

Knobs provide selections by turning, and activation by pressing them. They always include a label above them to identify their function. The knob functions from the top level menu provide commonly used functions. In the case of the left knob, it sets the selected heading. Even when the EFIS is not equipped with servos, or connected to an external autopilot, this knob drives the flight director, and function that simplifies hand flying. We encourage you to read more about this.

5.2.3 Right Knob Short Cut Functions

When on the PFD or Map pages, pressing the right knob provides shortcuts to commonly used functions:

PFD: The Autopilot/Flight Director Menu will appear when the right knob pressed.

MAP: The softkeys become the shortcut menu, providing "Waypoint Details" (information about the current goto waypoint), direct-to waypoint selection, the nearest list, and waypoint creation.

5.2.4 Remote Radio Rack and EFIS Shortcut Softkeys

Any remote radio rack devices connected to a display unit will be displayed in the upper right portion of the EFIS. Other display units capable or remote radio rack functions that are communicating with this display unit will also show these remote devices. Remote radio rack devices include communication or navigation radios, remote transponder, or intercom that are configured to communicate (via serial interfaces) with the EFIS.

5.2.4.1 Device Selector and its Shortcuts

Pressing this softkey selects the next remote radio rack device. Selection of the comm radio or transponder is normally made using the long-click shortcut. See text.

Com1 shortcut - A long-press (more than 1 second) of the device selector selects communication radio 1, if installed. Otherwise it selects the transponder.

Transponder shortcut – When com radio 1 is selected, a long-click of the device selector selects the transponder.

EFIS Shortcut softkeys are provided instead of radio rack functions when the selector is not displayed. This is always the case when no radio rack devices are connected, or by

repeatedly pressing the device selector until the green selector box is off. If the remote radio rack does not include a com radio and transponder, a long click of the device selector when the COM or transponder is currently selected will turn off the green selector box and display the EFIS shortcut functions.

Our preference is to leave the device selector on the COM1 radio, as radio tuning is a common EFIS function. If the remote app is being used for radio control (via a connected android device), then we prefer selecting the selector off to make the EFIS shortcut functions available.

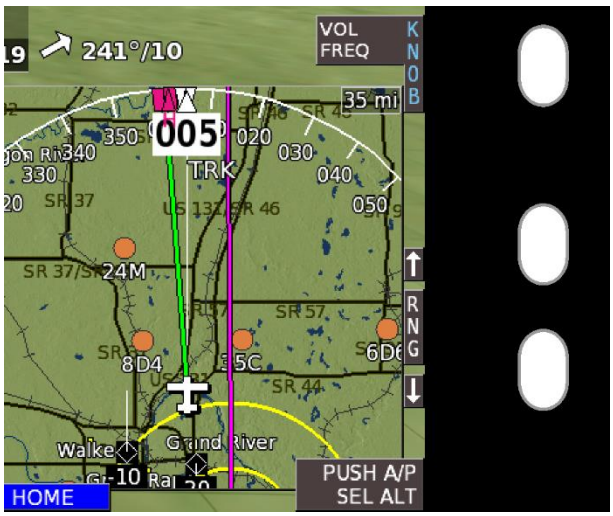
5.2.4.2 Radio Rack Volume and Tuning Knob

For communication and navigation radios, volume and tuning is made using the right side knob. The knob function is selected using the pressing it as shown below.

This "KNOB" controls volume and tuning. Alternate functions, such as squelch, are provided by pressing the knob.

5.2.4.3 Direct-To/Map Range Softkeys

The map range softkeys control the range of the map on the full screen map page, the split screen PFD/MAP/Engine page, and of the inset. The traffic inset has its own range buttons on the traffic inset softkey menu.



Map Range Softkeys – These function for all maps (full screen, split, and insets).

5.2.4.4 Dimming the Screen

To change the screen brightness, press the "Screen" softkey from the top menu. The left knob will be labeled as "DIM". Turn it as necessary to dim the screen. A dimming value of 1-10 is displayed in the upper left corner of the screen.

5.2.4.5 Rebooting the Screen

In the unlikely event a of a serious software fault, the EFIS will automatically restart itself. This process is very fast (a few seconds) and will return the EFIS to the page it was previously on. It is unlikely you would ever encounter this.

In the even less likely event that the automatic recovery failed to detect the serious software fault, causing the screen to stop responding, the EFIS can be rebooted using the front panel softkeys. To force a re-boot, press and hold the outer left and outer right white softkeys at the same time to reboot the display unit. Since this action does not affect the AHRS, it will continue to provide attitude data without interruption, thus attitude data will be available when the EFIS finishes re-booting. This re-booting process will take about 30 seconds.

All GRT EFIS systems can be re-booted by pressing and holding the two outer softkeys. This is illustrated here with a 6.5" screen.

5.3 The Settings Menu

Settings, preferences and calibration for the EFIS are found on the Set Menu pages. To access:

1. Press "MORE" and then "SET MENU".

2. Turn either knob to move the cursor down the list. Press the knob to view the highlighted page or make changes to the values of highlighted settings.

5.3.1 Settings Menu Pages

The Settings Menu contains the following pages (Note that if your system has autopilot enabled, you will also have an **A/P Maintenance** menu page):

- **General Setup:** Serial port assignments, units of measure, clock, data recording, etc…

- **Primary Flight Display:** V-speed settings, PFD display preferences and G-meter settings.

- **Moving Map:** Map symbol and features preferences.

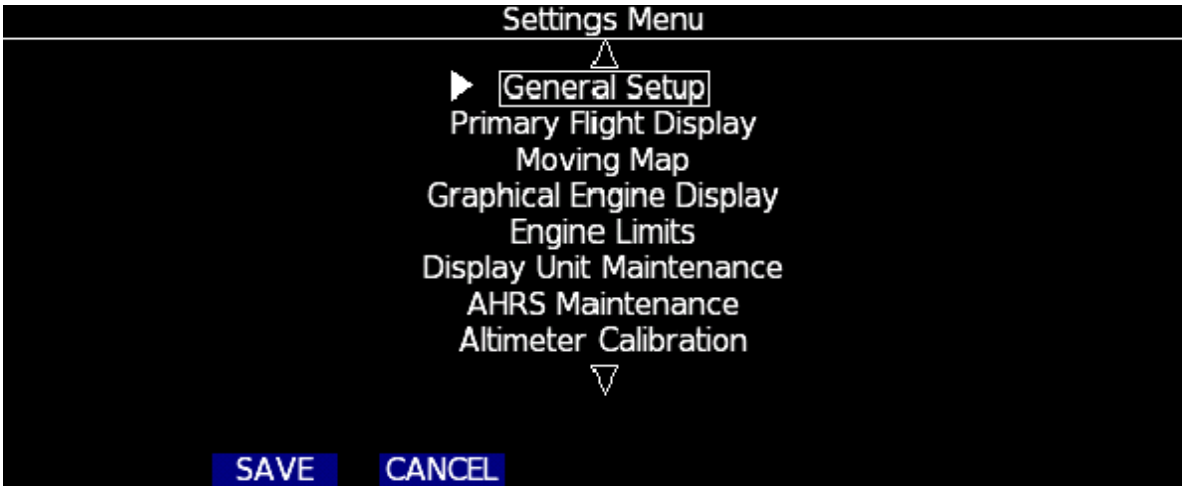
- **Graphical Engine Display:** Customize the engine display pages, including dials and bar graphs.

- **Engine Limits:** Customize the graphical engine display for your engine and electrical system limitations, fuel gauge display calibration and flight timers.

- **Display Unit Maintenance:** Display software updates, settings backup, nav database updates and other internal functions.

- **AHRS Maintenance:** AHRS software updates; gyro and magnetometer raw data.

- **Altimeter Calibration:** Calibration page for the altimeter.



5.3.2 Adjusting Individual Settings

To adjust any setting in the Set Menu:

1. Press NEXT until the Set Menu softkey appears. Press it to open the Set Menu main page.

2. Use either knob to scroll the cursor to the appropriate sub menu, and press the knob to select it and open the menu page.

3. Use the knob to scroll to the desired setting. Press the knob to select it.

4. Turn the knob to either change the value or open a sub-menu where further items can be found.

5. Adjust the value as desired, then press SAVE to save your settings.

6. Press EXIT to exit the set menu page, CANCEL to abandon changes or MAIN to back up one menu.

NOTE: In this and other GRT manuals, you will often see the above steps shortened and stylized, where **>** symbolizes a page, knob or softkey selection.

5.4 Display Page Groups

Primary flight display views are supported as both **split-screen** and **full screen with insets**. Either view is suitable as the primary flight display. The choice of how to use the EFIS is influenced by whether it is a single or dual screen system, and pilot preference.

A six-pack view is also provided for those that prefer traditional instruments, or for training purposes.

5.4.1 Selecting the View

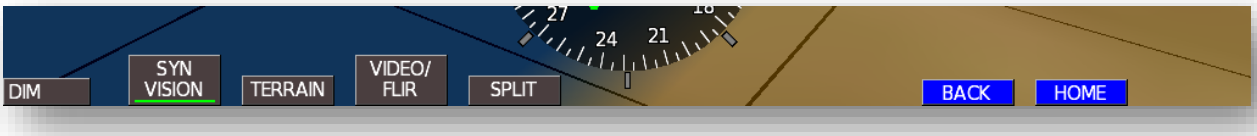
Selecting what is displayed on the EFIS is made using the "SCREEN" softkey on the top level softkey menu.

Holding this softkey for a second or longer provides a shortcut to swap between the most recent PFD and MAP pages

This will display the next menu which allows selecting the view desired and setting further options for them.

Note that the "SCREEN" softkey becomes "HOME". This allows for easily returning to the top level menu. This is common with most softkeys, making it easy for new users to view selections without inadvertently altering the current EFIS settings.

PFD and MAP options allow setting these views as desired.

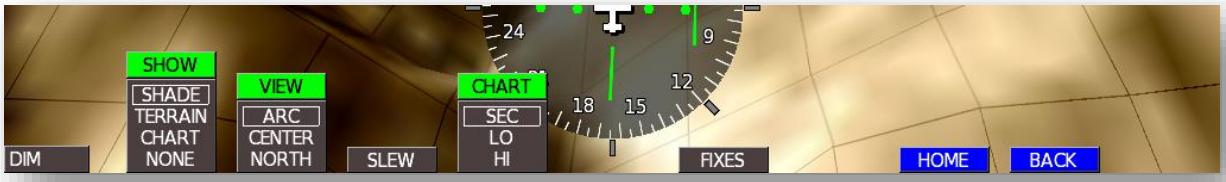


PFD Options

The PFD options include:

- SYN VISION – Normally this is left on. During extended over-water flights it can be useful to turn it off so that the color of the terrain is shown as tan, instead of the dark blue that represents water.
- TERRAIN – When on, terrain is colored or yellow to identify terrain near your altitude. (See the PFD section for more details.)
- VIDEO/FLIR – Replaces the synthetic vision with video that is connected to the EFIS via a USB video adapter. This allows for the use of infrared or low-light cameas. Low-light cameras can be purchased at very low cost and can add the ability to view terrain at night in many conditions. Infrared cameras sense heat differences, allowing terrain to be visualized in complete darkness. Either of these can be very useful in a forced landing at night.
- SPLIT – Switches between the full PFD and split PFD/MAP/ENG screen.

See the "PFD Description" section below for more details.



MAP Options

MAP options include:

- SHOW – The map background is set to SHADE (topographical coloring), TERRAIN (colored according to altitude proximity), CHART (sectional – requires chart on USB memory stick), or NONE (solid color of black or green according to MAP Set Menu selection).
- VIEW – ARC (Airplane symbol located at bottom third of map), CENTER (equal view in front and behind airplane), or NORTH (north up view).
- SLEW – Allows scrolling the map at any map range.
- CHART – Chart type is set as follows: SEC (Sectionals), LO (Low Enroute Chart), HI (High Enroute Chart)
- FIXES – Enables/Disable various fix types.

See the "Moving Map Description" section below for more details.

5.4.2 Split Screen PFD View

Split screen views provide a combination of primary flight data and a similar size moving map. Engine data is also displayed as shown here. This view is commonly used in single-screen installations, but the full screen view should be considered as in the next section.

Split-Screen PFD view includes map and engine data. It is commonly used in single-screen installations when map details are important, such as when navigating near airspace.

5.4.3 Full Screen PFD View

The full screen primary flight display view uses insets to supplement the view with the information that makes it a suitable choice for single-screen (or dual) operation. The wide field-of-view allows the PFD to intuitively provide more navigation data than might be expected. Insets are easily selectable (or turned off).

The runways, waypoints, obstacles, and terrain provided on the full screen view reduce dependence on the moving map display. An inset with map data is sufficient in most cases. The wide field-of-view provides a more natural "out the front window" sensation that many pilot find more comfortable.

5.4.4 Six Pack PFD View

This view uses familiar conventional round instruments overlaid on a synthetic "out the front window" view. This familiarity of the conventional instruments is preferred by some, and allows for maintaining proficiency for flying airplanes with this type of instrumentation. The darkness of the shading of these instruments is adjustable by pressing "SCREEN" and setting the background transparency with the right knob.

The six-pack view during approach. See the text for how to configure for emulating conventional mechanical instruments for training.

Here the background transparency is set to 10%, increasing the readability of the synthetic vision detail. This provides conventional instrumentation displays with the benefits of synthetic vision.

5.4.4.1 Emulating Conventional Mechanical Instruments

When practicing for flying airplanes with conventional instrumentation, the EFIS can be configured as follows:

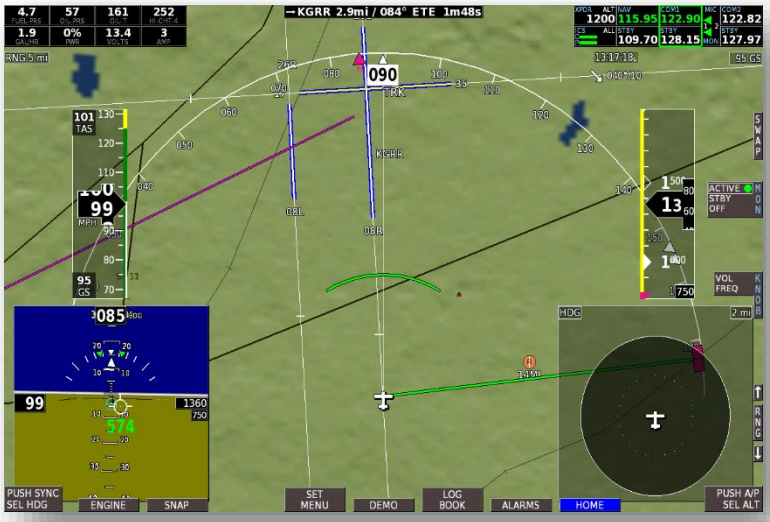
- Set the background to 100%: SCREEN>Right Knob to 100%
- Turn off the synthetic vision: SCREEN>PFD OPTIONS>SYN VISION
- Turn off the artificial runways, synthetic vision grid overlay, waypoint balloons, course ribbons, and flight path marker: MORE>SET MENU>PRIMARY FLIGHT DISPLAY (These settings are grouped together about 20 settings from the top of the menu.)

When practice is completed, return these settings as desired. It is highly recommended that all PFD Set Menu items listed above be returned to “ON”, and synthetic vision be re-enabled.

5.4.5 Full Screen Map View

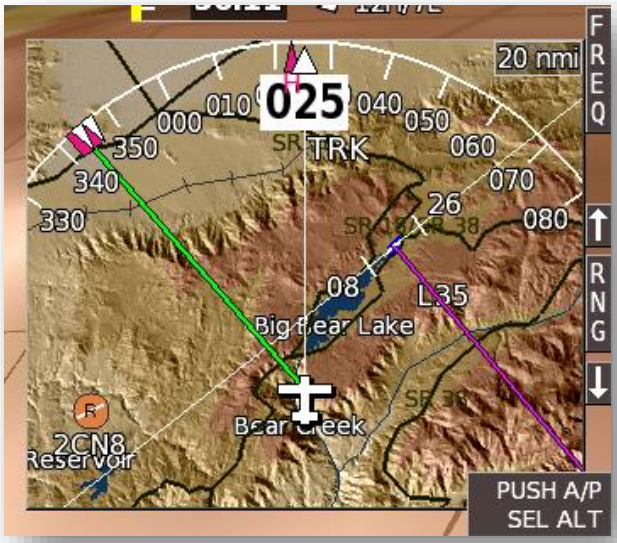
Typically used in dual-screen installations, insets can be displayed on the map view if desired, as well as airspeed/altimeter tapes.

A long click (holding the softkey for more than one second) of the "SCREEN" softkey easily swaps the view between the primary flight display and map view.



5.4.6 MAP and PFD Insets

Insets are selected using the "INSET" softkey on the side of the screen corresponding to where it is to be displayed.



Moving Map – Follows the configuration selected for the full screen moving map, thus allowing a wide range of configurations. Map range set using RNG softkeys.

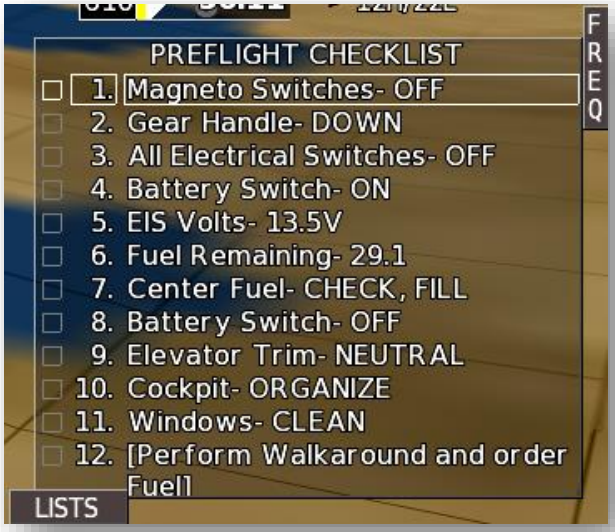
PFD Display – Allows for monitoring primary flight data from the moving map page. Runways and obstacles displayed (no terrain).

Traditional EGT/CHT bar graphs with EGT time history. In most cases the EGT/CHT time history is preferred for its ability to show trends.

COMBO – Customizable fields allow configuring for your needs. We like monitoring SFC (engine efficiency) and EGT time history when in cruise. The databoxes are configured via the SET MENU >Graphical Engine Display > Comb Box 1-4 settins. Bar graphs correspond to Bar Graph A1-A6 on this set page.

EGT/CHT HISTORY – Trends and unexpected changes are easy to observe. CHT time history shows if corrective actions to manage CHT on a climb are adequate.

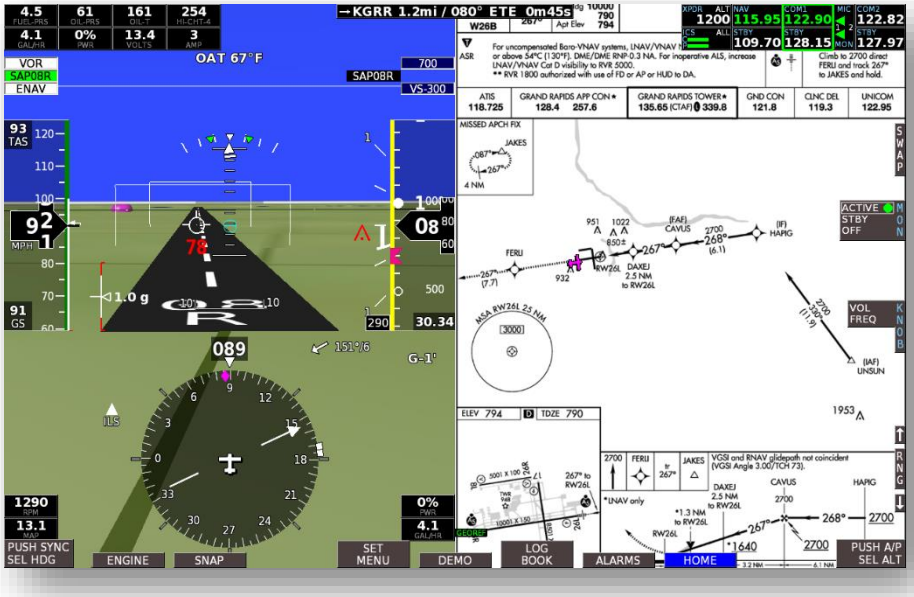
TRAFFIC – Alarms will alert when traffic is a factor, but this allows confirming traffic to ATC, tracking traffic nearby, and observing traffic before takeoff. Simple and clear.

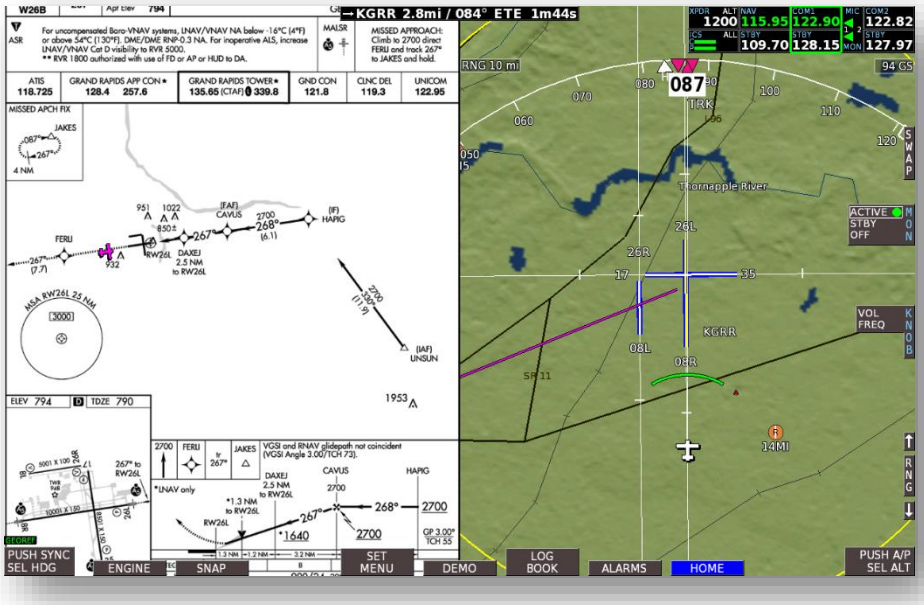


CHECKLIST – The "USE" softkey allows acknowledging the checklist items. This inset is one of the ENG/STAT options.

5.4.7 Split views of Plates

Approach plates are displayed using the PFD/Plate or MAP/Plate selections.

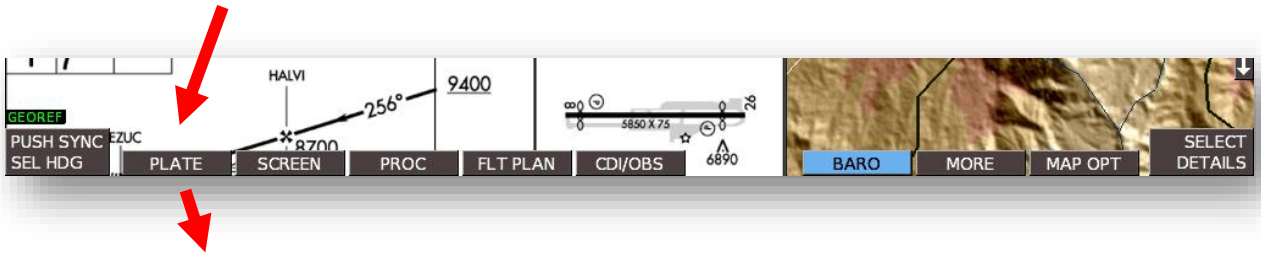




5.4.7.1 Selecting an Approach Plate

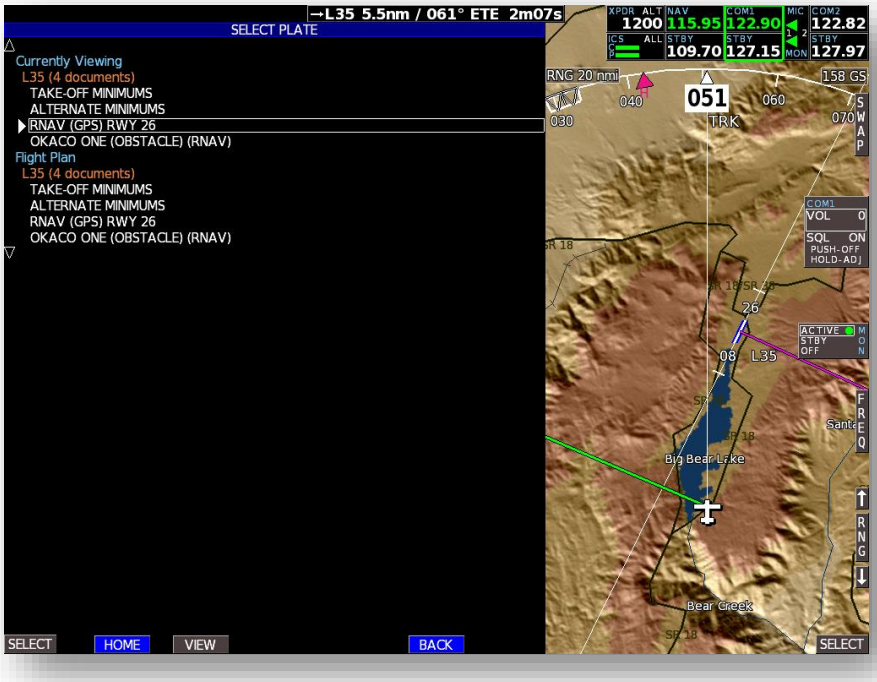
An approach plate is selected for display on the MAP/PLATE or PFD/PLATE page as follows. It may also be selected on the WPT DETAILS page, which is accessed by pressing the right knob on the map page to show the map shortcuts.

When either of these pages is selected, the INSET softkey for that side of the screen becomes the "PLATE" softkey.



The "PLATE" menu allows for selecting the plate and viewing.

The approach plate (or taxi diagram) for the destination airport is selected using the "LIST" softkey. (The airport must be part of the flight plan), or via the WPT DETAILS from the map shortcuts that are displayed when the right knob it pressed on the map page.



This provides softkeys to zoom in and out and rotate. The knobs allows moving the plate. Traffic may be overlaid on the plate. The "LIST" softkey selects the desired plate.

5.4.8 Split Map/Engine View

This view provides detailed engine data, including the EGT time history. It is commonly used for the map view in dual-screen installations.

5.5 Single Screen Operation

In a single screen installation, the EFIS provides two different ways it may be used. The "Split-Screen" view, where the PFD and map share the width of the screen, or the "Full Screen PFD" view, where insets are used to show additional information, such as maps, traffic, and additional engine data. Your choice will be influenced by personal preference and what other equipment is in the airplane

5.5.1 Single screen EFIS with no EIS or GPS navigator

Split-screen PFD operation is normally recommended. The PFD and map are of significant size, and EGT time history is shown in the engine strip along with traditional engine information. Although lacking redundancy for IFR flight, a single screen operated this way is an effective and efficient option.

In single-screen systems, the disadvantage of the full screen PFD view is the small size of the map in the inset. This disadvantage is offset by the ability to see common navigational information (such as the waypoint balloon, runways, lakes, etc.) in the PFD. The excellent sense of awareness provided by the wide field-of-view makes this view a common choice in all situations except when navigating near complex airspace or 1terrain.

5.5.2 Single screen with an external GPS navigator

The capabilities of the external GPS may dictate how much you end up using the EFIS map. If the external GPS can display weather and traffic, if it is easy to retrieve airport and other information from it, and if it displays extended runway centerlines, your dependence on the EFIS moving map may be reduced to the point you prefer to use the full screen PFD view, and rely on your external GPS. The flight plan for this GPS will transfer automatically into the EFIS (but not the other way around).

When using the heading select function to navigate, an inset can be used to show a map on the EFIS with the heading selector overlaid on this map. The EFIS heading selector will not appear on an external GPS display.

If your GPS does not have these features, or if it is difficult to enter a flight plan into it, you may prefer the EFIS map, which would make the split-screen view preferred.

5.5.3 Single Screen with a non-Remote (display equipped) EIS

The integration of the engine data in the EFIS, and the EGT time history provided by the EFIS, reduces the benefit of the display equipped EIS. However, the EIS can provide a convenient means to monitor CHT during the climb (we like displaying the highest CHT in the upper right corner of the default EIS screen), and of course the EIS provides a redundant engine display of all other engine data also.

5.6 Dual Screen Operation

Dual screen installations in which both screens are accessible by the pilot allow one screen to operate in the full screen PFD mode, and the other as a map. Engine data can be displayed as a vertical strip on the map page when detailed information is desired. Engine displays provided on the PFD, and via its insets (especially for EGT time history) make the engine displays on the map a pilot preference issue at most times.

Dual screens where the screens are located directly in front of the two pilots (and thus both screens are not easily accessible by the pilot) may warrant the considerations of the single screen EFIS operation noted above.

5.6.1 Default Screen

At power-up the EFIS will display the page set as the default. To make this selection, go to Set Menu > General Setup > Default Page to set the default screen view for each display unit in the aircraft.

5.6.2 Pilot's Interaction with an EFIS

Be conscious of the habits you develop

The EFIS is much more than a replacement for traditional round instruments. Habits will be developed as the pilot develops familiarity with the EFIS. These habits could be influenced by just finding the EFIS equivalent of the information he used from a traditional panel, or by developing habits that also make use of the extra information provided by the EFIS. We encourage the pilot to consciously form habits that favor the latter.

More than a gyro replacement…

Unlike conventional gyro instruments, the attitude provided by the primary flight display provides significant navigation data. Waypoints, runways, obstacles and terrain are provided in the synthetic view of the world. Pilots new to EFIS systems will be surprised how much they will use this intuitive sense airplane position and motion relative to the outside world, reducing use of the map. As such, it will be noted that the PFD display provided by the PFD-Split screen view occupies the screen space that allows it to provide these benefits. This will also explain why pilots often remark about the comfort provided by the full screen PFD view.

This tends to shift the moving map's value to longer range considerations, such as airspace, terrain, and larger bodies of water that influence our navigation decisions. In addition, the map becomes a source of conveniently extracting detailed information, such as frequencies and airport details, and ADS-B weather and traffic.

Engine data is continually tested with alarms, practically eliminating the pilot's traditional role as a "is it in the red?" monitor, but the pilot's ability to unconsciously evaluate and detect "is this normal?", or "what does this imply?" is valuable far beyond what simple limits can provide. EGT time history makes the greatest use of this human ability. Any engine mechanical malfunction is almost certain to be captured by the ease in which ***changes*** in EGT can be observed on the time history. Bar graphs or other displays of current EGTs do not provide this information, significantly limiting their benefit. This is why you will see EGT time history so prominent in our engine displays.

Note: Cooling problems are not reflected in EGT data. CHT and oil temperature limits are effective tools to detecting over-heating conditions, as well a pilot observation of CHT trends during the climbs.

6 Primary Flight Display Description

The primary flight display provides the basic flight instruments, navigation steering, autopilot/flight director modes and targets, and more. For pilots transitioning from traditional round instruments it is important to start by familiarizing yourself with the basics (airspeed, altitude, vertical speed and heading). In time you will learn to use the extras that will ultimately simplify and enhance your flying. Even the basic data, such as airspeed with its rotating airspeed digits, will provide a greater sense of the rate-of-change, resulting in less effort required to control speed on approach.

Split-screen PFD views are also available that displays primary flight display data next to a detailed moving map/HSI with or without an engine instrumentation strip across the bottom.

***CAUTION*:** The magnetometer should be calibrated before the first flight to validate and maximize the magnetic heading accuracy. When a magnetometer is connected to the EFIS, by default it will be used to slave the directional gyro shown on the primary flight display. See the Sport Installation Manual for instructions.

***CAUTION*:** A PFD requires a different instrument scan than a traditional "6 pack" grouping of analog flight instruments, and different methods of interacting with it (for example, to set barometric pressure). It is imperative that you develop proficiency using the PFD and become accustomed to the different instrument scans needed for an EFIS before flying in actual instrument conditions. Dual instruction with a CFI experienced with EFIS systems is highly recommended.

6.1 Primary Flight Instruments on the PFD

- Full-width Artificial Horizon with 10-mile Synthetic Vision.
- Altimeter Tape with trend marker and sensitive baro setting.
- Airspeed Tape with programmable V-speeds, color strips and trend marker.
- Heading tape with heading bug.
- Vertical Speed Indicator with programmable range, visual needle and digital readout.

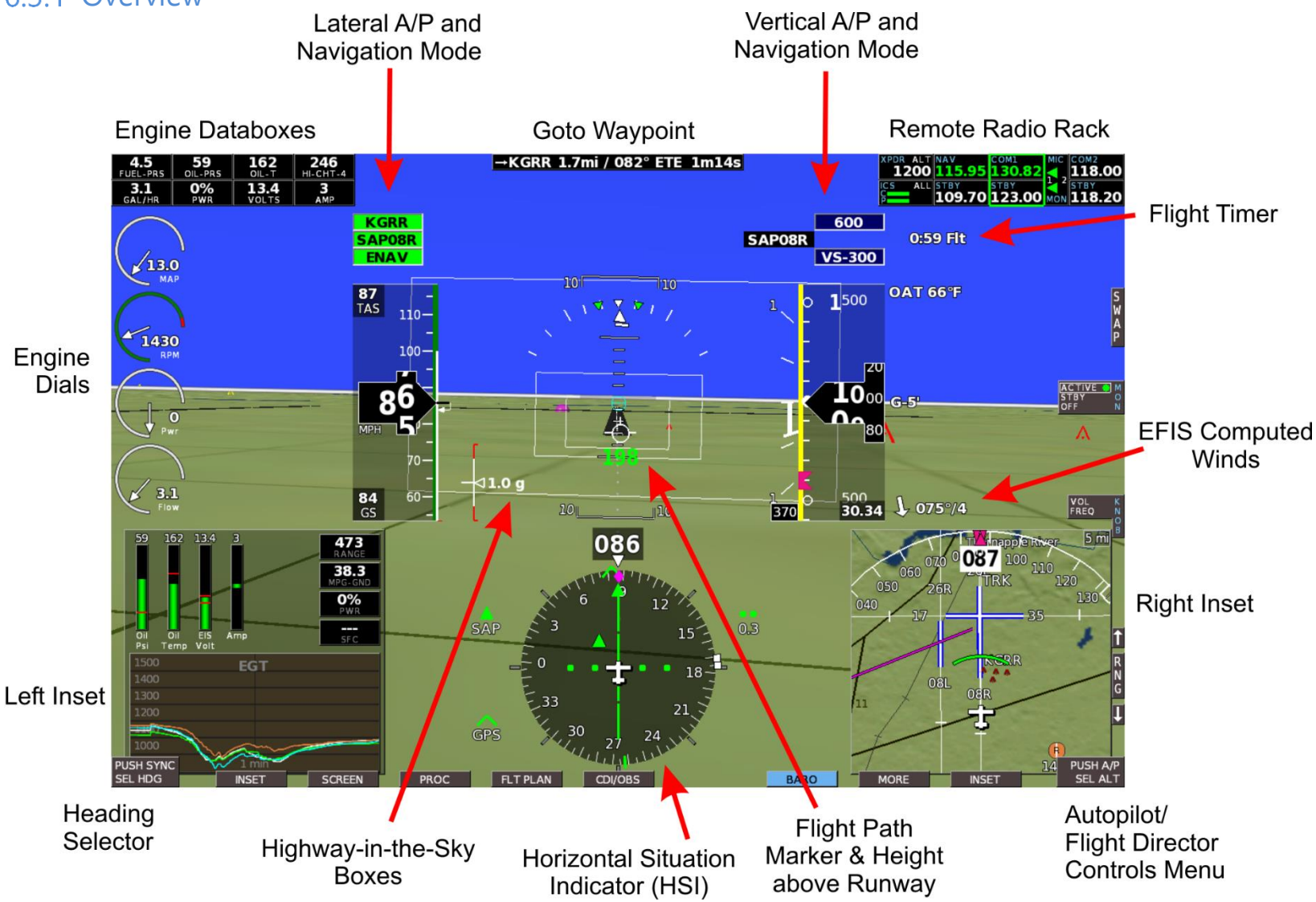
- Pitch Ladder, Bank Angle indicators, Turn Coordinator and Slip/Skid indicator.

6.2 Secondary Information on the PFD

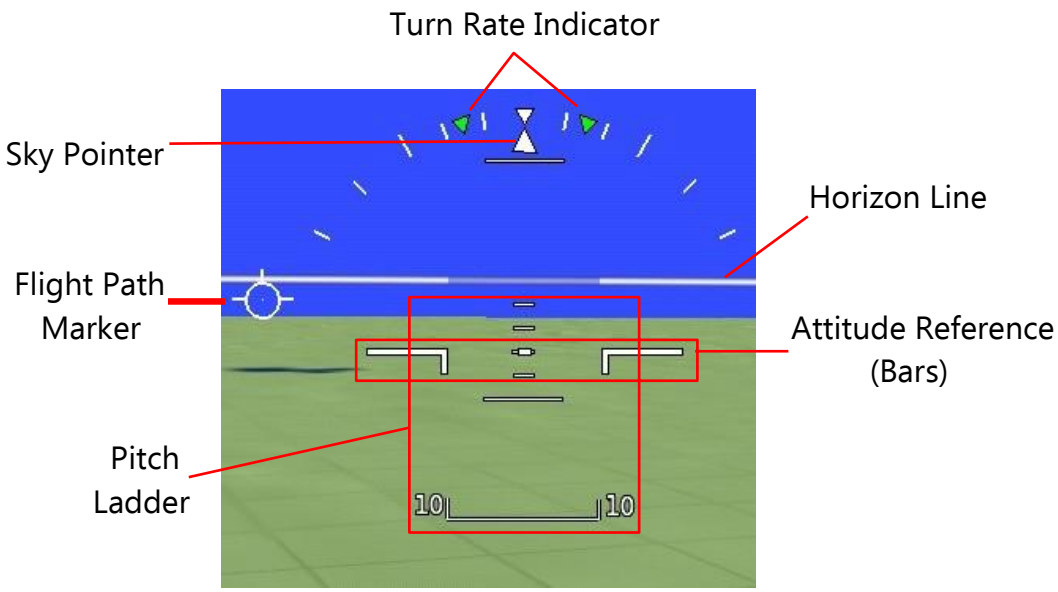
- Wind vectors, true airspeed, GPS groundspeed and waypoint information.
- Sky Pointer and Flight Path Marker to add awareness of aircraft position and motion in space.
- Synthetic vision terrain, course ribbons and waypoint markers to make enroute navigation easy.
- G-Meter programmable for individual aircraft limits.
- Trim and flap indicators (optional trim/flap position sensor required).
- Angle-of-Attack indicator.

6.3 PFD View

6.3.1 Overview



6.3.2 Central Elements



6.3.3 Attitude Indicator/Artificial Horizon

Roll and pitch attitude information is displayed as a colored background on the EFIS. If attitude information is not available (such as when the AHRS is aligning), the background will be black.

The colored background uses the traditional blue to represent the sky. If the EFIS is equipped with synthetic vision, and it is on, the actual terrain will be shown, otherwise a flat-earth representation of the ground will be displayed in a brownish-green color.

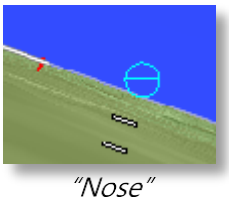
When the synthetic vision is showing the ground, the actual horizon is shown as a thick white line. Since the synthetic vision extends 10 miles in front of the airplane (and not to infinity), it is common for the horizon line to appear above the terrain when at higher altitudes.

6.3.4 Attitude Reference Index

The attitude reference index is always displayed in the center of the screen. The horizon line, pitch ladder and sky pointer move in relation to it, providing the indications of pitch, roll and "which way is UP."

The traditional attitude "bars" or "wings" can be replaced by a "nose" indicator (shown on the following page). This small indicator allows slightly less obscuration of the synthetic vision terrain and is less prominent than the traditional bars.

"Bars" or wings



"Nose"

To Select Nose or Bars (Wings):

1. Press NEXT > Set Menu > Primary Flight Display > Attitude Reference Index.

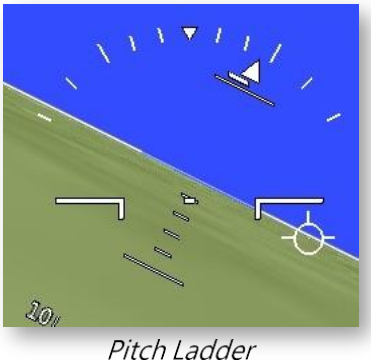
2. Select NOSE or BARS.

NOTE: When ILS CDI deviation needles are displayed on the PFD, the scales for the needles replace the attitude reference index.

NOTE: When the flight director is on, the fixed flight director chevron becomes the attitude reference index.

6.3.5 Zenith and Nadir (+/- 90° Pitch Display)

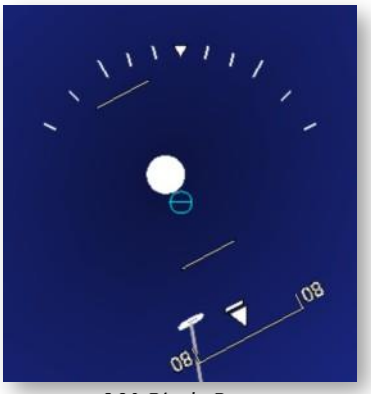
A solid circle represents 90-degree pitch up (zenith). A hollow circle represents 90-degree pitch down (nadir).



Pitch Ladder

6.3.6 Pitch Ladder Offset

A setting is provided to allow adjusting the indicated pitch angle by a fixed amount. Typically, this is set so that the displayed pitch angle is zero in cruising flight. This setting is not equivalent to the pitch reference index adjustment on traditional attitude indicators. The EFIS does not have this adjustment. The effect of this is the pilot will always sense his nose position relative to the horizon, thus in slow level flight, the pilot will observe a nose up indication.



90° Pitch Rung

Adjusting Pitch Ladder Offset:

During straight and level unaccelerated flight at the normal cruise power setting, the pitch ladder offset should be set so that the attitude reference index is aligned with the horizon line. This setting is made as follows:

1. Press NEXT > Set Menu > Primary Flight Display.

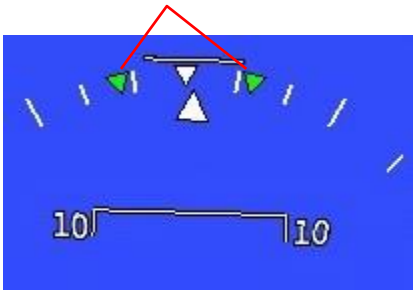
2. Scroll to Pitch Ladder Offset. Adjustments are made in positive or negative 1° increments; a positive setting will move the Attitude Reference Index up while a negative setting will move it down.

3. Adjust in small increments until the Attitude Reference Index and the zero-pitch line are aligned during level, normal cruise flight.

This setting is not used to adjust the attitude indication for varying airspeeds that result in changing angles-of-attack. When flying at low speeds, the increased angle-of-attack and resulting increased pitch angle is visible on the EFIS, imparting an intuitive sense of the state of the airplane.

6.3.7 Sky Pointer

The Sky Pointer is the white triangle just below the bank angle tic marks. It serves as a roll angle reference and will always appear to point toward the sky.



Sky Pointer

6.3.8 Turn Coordinator/Standard Rate Turn Indicator

The Turn Coordinator is a pair of inverted green triangles on the roll angle scale that show the bank angle that will result in a standard rate turn. Bank the airplane to align the Sky Pointer with the green triangle to maintain a standard-rate turn.

6.3.9 Slip Indicator

The slip indicator is an electronic version of the traditional ball inclinometer. It can be turned on and off under Set Menu > Primary Flight Display > Slip Indicator.

Slip Indicator

6.3.10 Flight Path Marker

The flight path marker shows the airplane's path through space relative to the background. This means that when the flight path marker is on the horizon, the airplane is flying level. If the flight path marker overlays an obstacle, runway or terrain feature (mountain for example), the airplane's path will take it there. You will find in VFR conditions you will unconsciously see the flight path marker overlaying, or very close to the synthetic view of the runway. With familiarity you will find that it is a very useful feature of the EFIS, and especially valuable at night or in lower visibility when it is more difficult to judge your approach path by the view out the window.

In cross-winds you will see the flight path marker move to one side to show the effect of the wind. (This is true when a magnetometer is connected, and the "Up Reference" is heading.)

In strong cross-winds (or if the magnetic heading is inaccurate due to installation errors) the flight path marker can become "display limited". This means its real position would be off the screen (or too close to the edge of the screen), so the software limits its position. When this happens the position of the synthetic vision background is adjusted so that the flight path marker relative to the background is always correct.

If the EFIS is equipped with synthetic vision, the flight path marker can be used in conjunction with waypoint balloons, as shown here. Positioning the flight path marker over the waypoint balloon will take you from your current position directly to the waypoint (although this may not be on the flight plan path between waypoints).

6.3.11 Airspeed Tape

The primary function of the airspeed tape is to display indicated airspeed and its associated color bands representing speed limitations.

The instantaneous airspeed readout is contained in the black box with large, bold numbers. The rotating digits impart an intuitive sense of speed trend much better than a traditional airspeed indicator. The units of distance/speed are displayed below the digital readout. True airspeed (TAS) and GPS ground speed (GS) can be displayed within the empty areas of the airspeed tape using the "Show TAS in tape" and "Show GS in tape" in

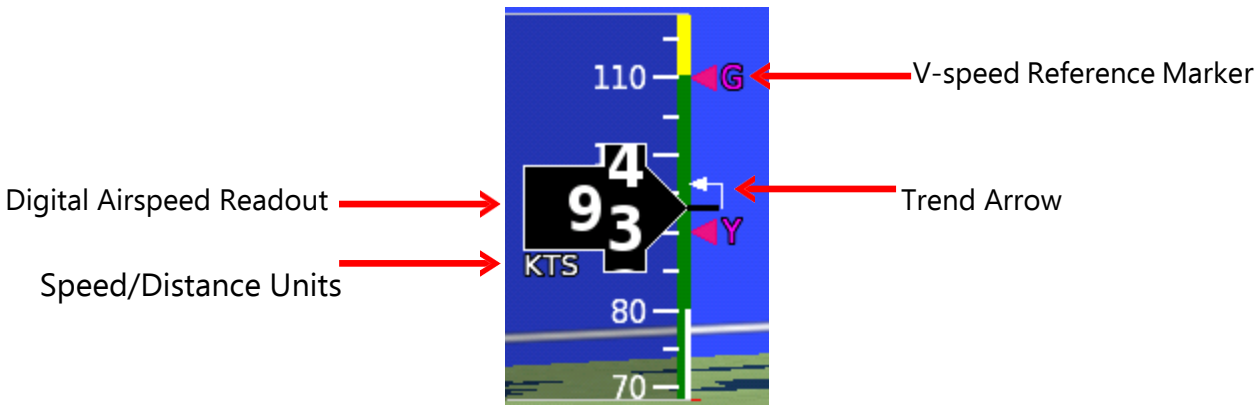
the PFD settings menu. This data can also be displayed in the programmable data boxes on the PFD.

When the airspeed is too low for the EFIS to measure, the digital value will be shown as dashes.

The airspeed indicator will not show airspeeds greater than the limits of the airspeed tape.

6.3.11.1 Airspeed Trend Arrow

The trend arrow points to the predicted speed of the aircraft in 5 seconds at the current rate of acceleration.



6.3.11.2 V-speed Reference Markers

The airspeed tape also features three programmable V-speed reference markers that appear as magenta triangles with letters X, Y and G; these stand for for V_X, V_Y and V_G (best rate of climb, best angle of climb and best glide, respectively).

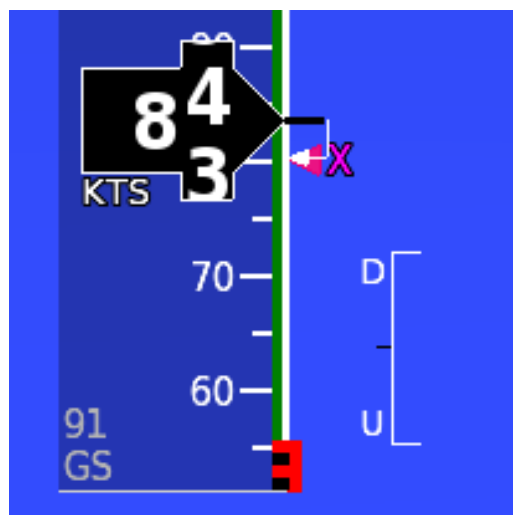
Normally, Vne is displayed as an indicated airspeed limit (since this was the only option with traditional airspeed indicators). While this is a rather complex topic, some airplanes are limited by flutter speed limits, which are a function of true airspeed. In this case, most aircraft designers must compromise by choosing an indicated airspeed limit, but may provide a TAS limit as well. If a TAS Vne limit is provided, the EFIS can automatically display Vne as true airspeed by setting "Convert Vne from TAS to IAS" to YES on the PFD settings menu.

6.3.11.3 Colored Airspeed Bands

The colored band on the airspeed tape follows the standard airspeed color scheme. The digital airspeed value turns yellow or red when it is within the yellow or red ranges for additional emphasis.

Airspeed Tape Color Scheme	
Red/Black (Optional)	Zero to full-flap stall speed (V_{S0}). Option: Red or clear.
White	Full-flap stall speed (V_{S0}) to flap extension upper airspeed limit (V_{FE}).
Green	Stall speed (V_{S0}) to maximum structural cruise speed (V_{NO}).
Yellow	Maximum structural cruise speed (V_{NO}) to never-exceed speed (V_{NE}).
Red/Black	Never-exceed (V_{NE}) and beyond.

6.3.11.4 Barber-Pole Stall Speed Indicator



A vertical red/black bar is displayed on the bottom portion of the airspeed tape. The top of this bar corresponds to the stall speed at the current "G" loading and is based on the stall speed entry made in the EFIS, and the normal acceleration "G's" sensed by the AHRS. The top of the barber pole is just visible in this figure at about 56 knots.

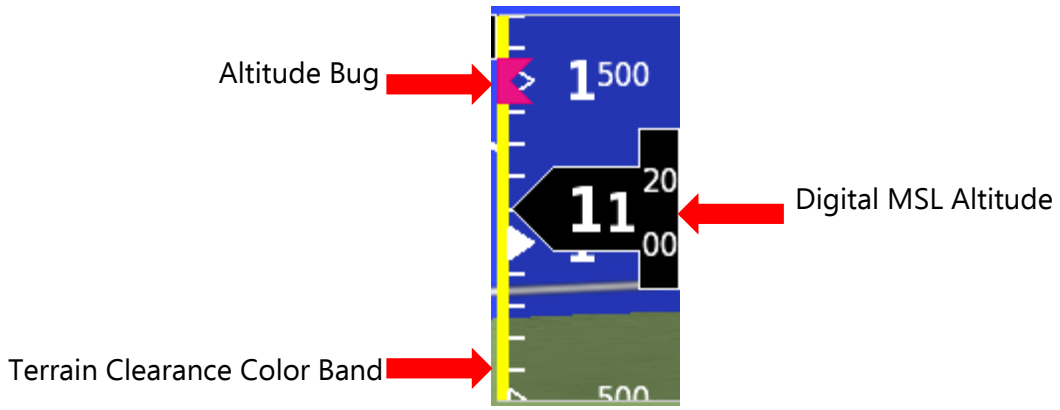
6.3.11.5 Customizing the Airspeed Tape for Your Aircraft

The airspeed indicator settings are programmed in SET Menu > General Setup > Primary Flight Display. They should be programmed before the first flight, according to the design limitations of the aircraft, and can be fine-tuned during flight testing to account for the aircraft's flight characteristics and pitot-static errors.

6.3.12 Altimeter Tape

The Altimeter Tape displays altitude above mean sea level (MSL) in hundreds of feet or meters. Even thousands are depicted by a solid marker (either a circle, triangle or

rectangle). 500-foot increments are depicted by a hollow marker. The baro setting is displayed in the lower right corner of the screen, just above the right knob that controls it.



The terrain clearance color band on the edge of the altimeter tape shows the Off-Route Obstacle Clearance Altitude (OROCA) which provides 1000-foot obstruction clearance in non-mountainous terrain areas and 2,000-foot obstruction clearance in designated mountainous areas within the United States. An altitude below the OROCA is shown yellow, above the OROCA is shown green.

To Adjust the Barometric Pressure Setting on the Altimeter:

1. From the PFD screen, turn the right knob to the current altimeter setting.

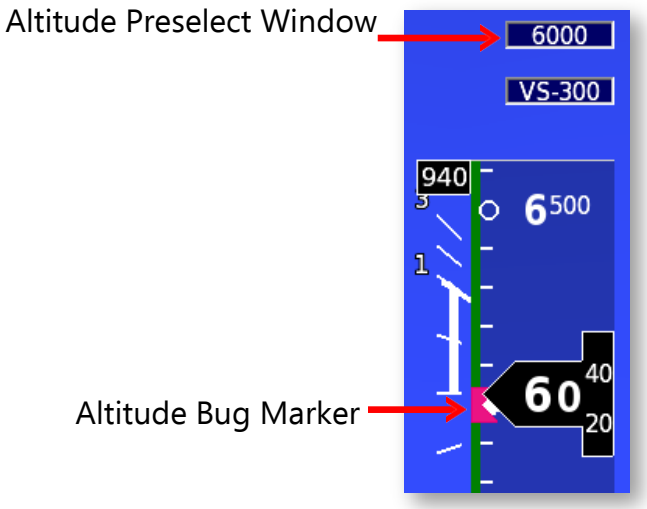
2. Press the knob again to accept the new baro setting or CANCEL to abandon the changes.

NOTE: The difference between the baro altitude and GPS-derived altitude is displayed in the window above the right knob when the baro setting controls are active. This box will turn yellow or red if the difference becomes large. This difference is computed using assumed standard atmospheric conditions, which are uncommon, and will increase with height above ground. This means the altimeter should not be zeroing out this difference. The difference should be used to alert you if you make a large error in the altimeter setting (for example, when off by a full inch of Hg), or when on the ground (where baro-alt and GPS elevation should be very close).

6.3.12.1 Altitude Bug

The Altitude Bug has a window located above the altimeter tape and is marked on the altimeter tape itself by a magenta rectangle with a notch. The altitude bug serves two functions:

- The commanded altitude for the autopilot to climb/descend to and hold.
- A reminder for a cruise altitude or any other altitude the pilot wishes to remember.



To Set the Altitude Bug from Any HOME Page:

1. Click the right knob to bring up the ALT selection control.
2. Turn the knob to enter the desired altitude into the Altitude Preselect Window.
3. Click the knob to set.
4. If the EFIS includes autopilot vertical functions, the system will then display a message to set the speed or rate of the climb or descent desired to fly to the set altitude. See **Autopilot** section of **this manual** for more information on coupled climbs and descents.

6.3.12.2 Altitude Deviation Alerts

An alert can be set to flash on the EFIS when the altitude specified in the Altitude Bug Window is exceeded by a certain amount. To set an Altitude Alert:

1. Press NEXT > Set Menu > Primary Flight Display.

2. Scroll to **Altitude Alerting** and turn it ON.

3. Highlight **Max Altitude Deviation**. Set the altitude deviation alert threshold—typically 200 feet.

6.3.13 Vertical Speed Indicator

The vertical speed indicator (VSI) is shown on the left side of the altimeter as a needle that deflects up and down. Attached to the needle is a white tape. Behind the needle is the vertical speed scale. The vertical speed is also presented digitally at the bottom of the scale when descending and at the top of the scale when climbing. The VSI tape's range is user-settable. While it can be set to show accommodate the maximum climb rate of the airplane, we prefer to set it to 1000 feet/min. This provides a more useful display when attempting to precisely control the airplane on approach. The digital display is not limited to the range of the tape.

Setting the VSI Scale

1. Press NEXT > Set Menu > Primary Flight Display.

2. Scroll to **Max Indicator Vertical Speed**. Set to 1000 fpm or as appropriate, according to the aircraft's performance.

6.3.14 Heading Indicator

The magnetic heading/track indicator is presented on the HSI on the primary flight display. The HSI is normally displayed as heading up with a ground track indicator, but will revert to track up if heading is not available. The top of the HSI will show "TRK" when it reverts to a ground track up mode. Track will be displayed when a magnetometer is not connected, or when the user setting, "Up-Reference," is set to "Track."

The heading/track display can be thought of as a directional gyro that is slaved to the heading or GPS ground track. Under some conditions it may be noted that the display is slowly changing for a few seconds when it seems the airplane is holding a steady heading/track. This is normal as the directional gyro synchronizes with the slaving data.

For both the Primary Flight Display and Moving Map Setup pages, a setting is provided for the "Up Reference" at the top of the respective setting pages. Heading or track may be selected. Most pilots prefer their PFD heading indicator to be Heading Up so they can accurately follow ATC vectors, and feel a sense of the cross-wind in the PFD. Track Up is usually preferred for the moving map screen so that navigating on course shows the desired path as a vertical line.

Dashes will be displayed when no magnetometer is connected, and no ground track has been provided by the GPS (common before the airplane is moved). Once any of this data becomes available, the dashes will be replaced with actual data.

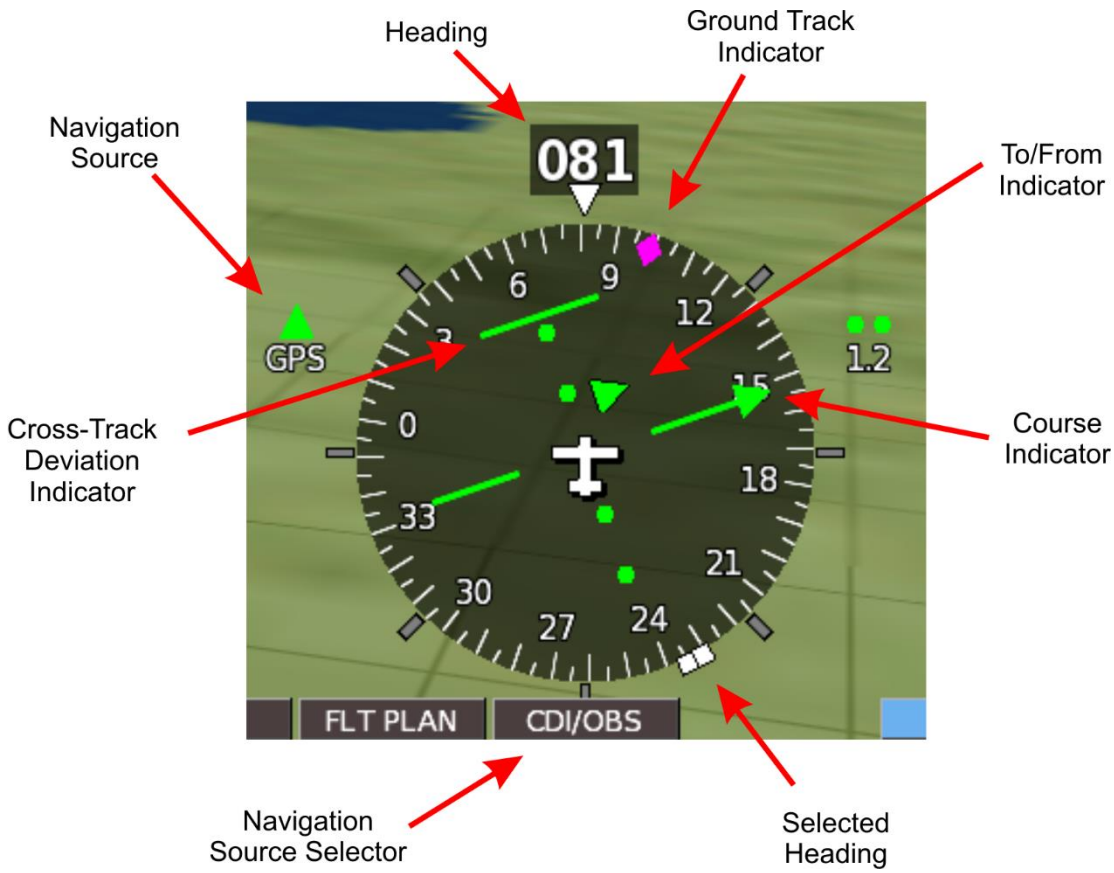
6.3.14.1 Nav Mode Selection

When more than one navigation source is provided to the EFIS, the PFD screen will include a CDI softkey on its first page of softkeys for selecting the navigation mode of the EFIS. Pressing this softkey will display all the available navigation sources. When a navigation source is selected, it will drive the HSI, selected track, and the appropriate cross-track

deviation indicator. Autopilot coupling and flight director commands will always follow the selected navigation mode. GPS flight plan data is always displayed on the moving map, even when the navigation mode is not GPS. See the **TBD** section for more details.

6.3.14.2 Navigation Steering on the PFD

The HSI is used to display all sources of navigation information. It operates following aviation conventions.



Steering information to follow the navigation source is provided on HSI via its display of course, cross-track deviation, heading and ground track. If the flight director is on, and is set to follow the navigation (as compared with heading) it will also provide navigation steering also. The flight director combines roll and pitch commands into a single-cue that includes turn anticipation. Most pilots find the flight director easier to use, with less workload and more precision when hand flying.

For more information about the HSI, see "Horizontal Situation Indicator (HSI)" on page 96.

6.3.14.3 Desired Track and Ground Track Indicators

Aligning the GPS ground track and desired course indicators will fly the airplane in a direction that is parallel to the GPS flight plan leg.

6.3.15 GPS Cross-Track Deviation Indicator (CDI)

The GPS CDI appears at the center of the HSI. It displays how far the airplane is displaced from the current GPS course. Combined with the desired course/ground track, this allows the pilot to navigate precisely on the GPS path. The scaling of the indicator is shown on the left side, and will change automatically depending on the type of waypoints. Scaling will become more sensitive when navigation to terminal area and approach waypoints.

6.3.16 Selected Heading Bug

The heading bug is driven by the selected heading. The selected heading is set with the left knob on the map and PFD pages. In addition to graphically indicating the heading you wish to fly, the Selected Heading Bug also drives the autopilot and flight director cues when the autopilot/flight director lateral mode is "HDG". It is one of the most useful tools for VFR and IFR flying. It provides a great reminder of a heading that ATC has requested of you and provides a simple way to steer the airplane when coupled to the autopilot, or even when hand flying.

For more information about using the heading bug with the autopilot, please refer to the GRT Autopilot User Guide.

!WARNING!: Moving the heading bug while the autopilot is engaged in Heading Mode will result in an immediate turn to the new heading specified by the bug!

6.3.17 Wind Vector and Crosswind Component

The wind vector is located above the lower right data box on the PFD. It is calculated using GPS ground track, ground speed, and heading and true airspeed data provided by the AHRS.

It consists of two main parts- a vector arrow with velocity and direction, and a headwind/crosswind component. At its simplest, it is an arrow with a velocity number next to it. The wind blows from tail to head. The velocity is given in the speed/distance units

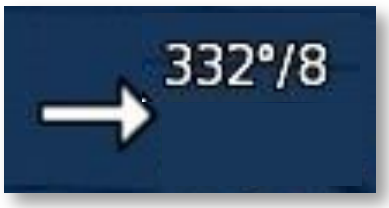
chosen for the EFIS system. In addition to the vector arrow, a magnetic compass direction can also be displayed.

The arrow points from left to right, signifying a crosswind from the left at 8 knots.

To Turn on the Wind Vector:

1. Press NEXT > Set Menu > Primary Flight Display.

2. Scroll to **Wind Indicator Mode**. Choose OFF, Vector and Digital Speed (shown above), or Vector and Digital Speed/Direction (adds magnetic wind direction to the above display; shown at right).



Headwind/Crosswind Component

The headwind/crosswind component gives headwind (H) or tailwind (T) first and left (L) or right (R) crosswind second. To turn on head/crosswind component:

1. Press NEXT > Set Menu > Primary Flight Display

2. Scroll to **Digital Head/Crosswind Display** and turn it ON or OFF.

NOTE: If insufficient data exists for calculation of winds, the wind information is not displayed. Accurate winds require accurate magnetic heading and airspeed data, which are enhanced by performing proper calibration of magnetometer and pitot/static systems as detailed in the EFIS Installation Manual. While the absolute accuracy of the winds decreases at higher speeds, the EFIS will continue to display it so that you may judge the trend of the wind change as you are climbing to you cruise altitude.

6.3.18 G-Meter

The G-meter measures the G-loading of the airplane based on forces measured by the accelerometers inside the AHRS. It is displayed to the right of the airspeed tape on the

Primary Flight Display. The display can be configured to be always on, always off, or on only when the G-loads exceed a threshold you have set. We recommend configuring it to display above 1.5g, especially if trim indication is displayed on the EFIS.

6.3.18.1 G-Meter Thresholds Definitions

Press NEXT > Set Menu > Primary Flight Display to access G-Meter settings.

- **G-Meter Mode:** Choose if or how to display it on the Primary Flight Display.
- **G-Meter Maximum:** Sets the maximum positive G-loading on the scale.
- **G-Meter Minimum:** Sets the minimum negative G-loading on the scale.
- **G-Meter Caution Max:** Positive G-load caution threshold—turns yellow beyond this value.
- **G-Meter Caution Min:** Negative G-load caution threshold—turns yellow beyond this value.
- **Auto G-Meter High Threshold:** Displays the G-meter on the PFD in "Auto" setting when this positive-G value is exceeded.
- **Auto G-Meter Low Threshold:** Displays the G-meter on the PFD in "Auto" setting when this negative value is exceeded.

6.3.18.2 G-Meter Mode Selection

1. Press NEXT > Set Menu > Primary Flight Display.
2. Scroll to the G-Meter options near the bottom of the screen. Select an option on the **G-Meter Mode** setting:
    a. **Off:** Does not display. Note that even when the G-Meter Mode is set to "OFF," all G force data is recorded during data logging.
    b. **On:** Displays at all times.

c. **On with Min/Max:** Displays at all times with the minimum and maximum Gs experienced during the flight.

d. **Auto:** Comes on if a preset Auto G-Meter High or Low Threshold is exceeded. This allows it to replace Trim Indicators temporarily until the G limits loads are within these thresholds.

6.3.18.3 Setting Up the G-Meter

We recommend setting the G-Meter thresholds as follows:

Recommended G-Meter Thresholds	
G-Meter Min/Max	85% of maximum/minimum for the airplane. If not specified by the airplane designer, use no more than +3.2g, and no less than -1.3g (For example, use +2.5g and -1.0g).
G-Meter Caution Min/Max	66% of maximum/minimum for the airplane. If not specified by the airplane designer, use no more than +2.5g, and no less than -1.0g (For example, use +2.0g and -0.8g).
Auto-G-Meter Threshold Min/Max	+1.5g for maximum and -0.5g for minimum.

6.3.18.4 Using the G-Meter with Trim Indicators

Space on the PFD is limited, and the best place for the flap and pitch trim indicators happens to be the same place the G meter resides. The G-Meter Mode "Auto" setting will automatically make the G meter appear in place of the trim indicator when the Auto G-Meter Max and Min Threshold limits are exceeded in flight.

6.3.18.5 G-Meter Data Logging

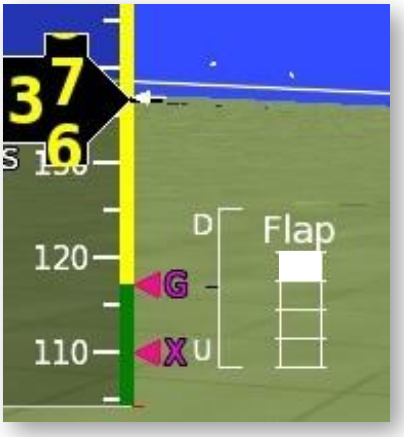
G-force data is recorded during a demo recording. For instructions on how to record a permanent record of your G readings, see "Utility Features."

6.3.18.6 G-Meter Limitations

The G-meter has the same limitations as the AHRS: +/- 8 G of acceleration. It may not register accelerations beyond this limit.

6.3.19 Flap and Trim Indicators

If the aircraft is equipped with electronic flap and trim position sensors, they can be wired to EIS Aux inputs with the indication programmed to appear on the screen, eliminating the need for external LED indicator lights. See the EIS and EFIS installation manuals for information on wiring and setup.



The indicators appear to the immediate lower right of the airspeed indicator, as shown at right.

To change the direction of the Pitch Trim indication (UP on top or DOWN on top):

1. Press NEXT > Set Menu > General Setup.

2. Scroll to **Elevator Trim Orientation** and choose Down trim (D) at the top or UP trim (U) at the top.

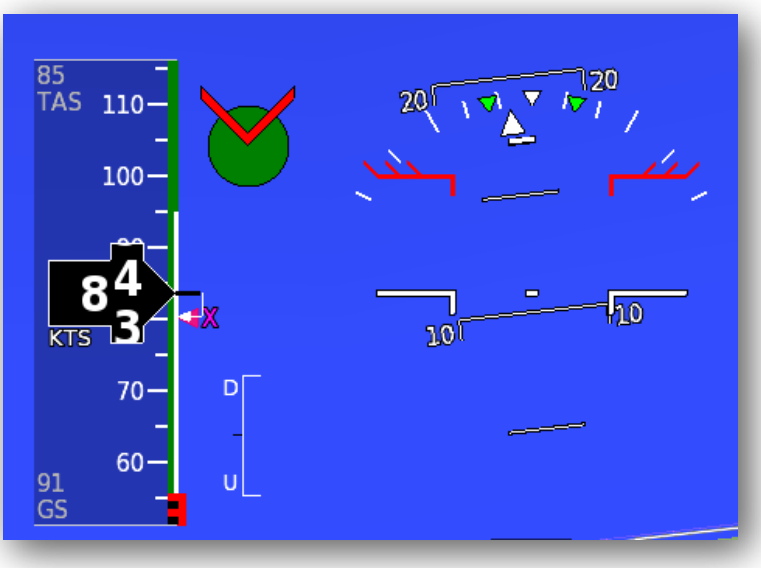
6.3.20 Clock

The clock appears on the upper right portion of the PFD and map screens; it may be configured On or Off and in Local or Zulu time. We recommend Zulu time to provide a handy reference for determining the age of audio weather data and ATC reporting.

To access the clock options:

1. Press NEXT > Set Menu > General Setup.
2. Scroll to **CLOCK** setting and press the knob to access the menu.
3. To display Local time instead, set the Local Time Offset from Zulu for your location.

6.3.21 Angle-of-Attack (AOA) Indicator



Angle-of-Attack (AOA) refers to the angle of the local airflow relative to the wing. Since the wing will stall when the "critical" Angle-of-Attack is exceeded, AOA indication is useful for stall warnings and as a means of establishing an approach speed that accounts for the current weight of the airplane.

The GRT EFIS can display AOA that is derived from either a "calculated" or "measured" source.

The "measured" AOA source refers to use of the GRT AOA option with a dual port pitot probe. This method uses the two pressures from the pitot probe, and the static pressure, to measure the AOA. This method provides the most accurate and fastest responding AOA measurement.

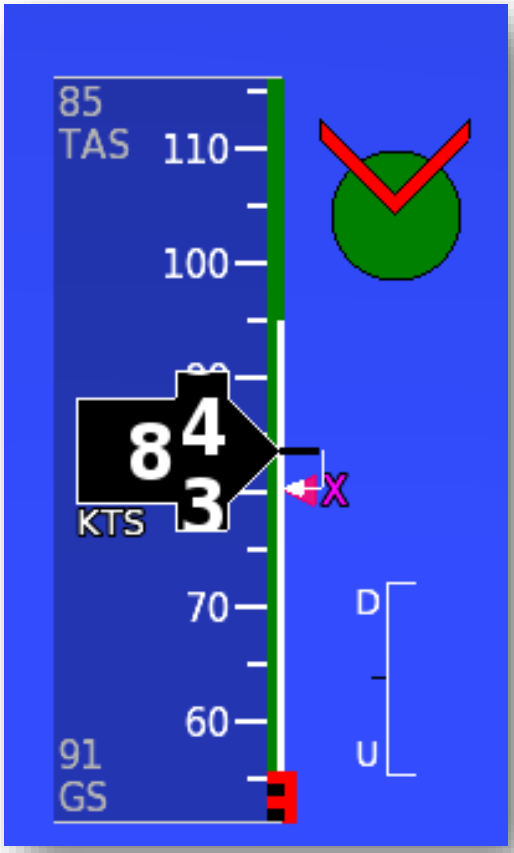
Angle-of-Attack can also be calculated by the EFIS by combining a variety of sensor data. AOA calculated in this manner has the benefit that it does not require any dedicated hardware. The drawbacks are that the calculated AOA is dependent on proper functioning of the pitot/static and pitch attitude data. Also, the accuracy of the calculated AOA degrades when flying through rising or descending air. Either type of AOA data may be used to drive two different indicators on the PFD screen.

!WARNING!: The AOA must be activated in the Primary Flight Display set menu and calibrated before use.

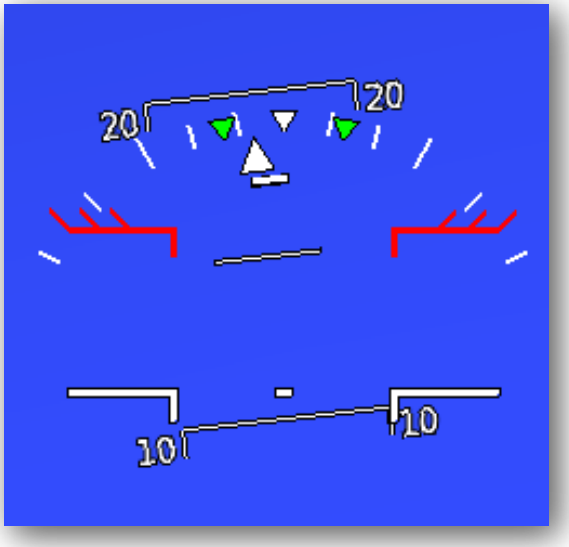
!WARNING!: The use of this indication is purely at the judgment of the pilot. The accuracy of this AOA indexer, and its stall warning, is affected by EFIS sensor errors and the accuracy of the calibration procedure. The calculated angle-of-attack, and the approach AOA indexer should not be used as the only stall warning instrument. Some indication lag and error will occur when flying through areas of rising and falling air; Do not rely on the indexer in turbulent conditions.

6.3.21.1 Approach AOA Indexer

The indicator appears just to the right of the airspeed tape and shows the angle-of-attack relative to the optimal for approach. When the angle-of-attack too low (the airplane is flying faster than optimal approach speed), yellow chevrons pointing up into a yellow circle prompt the pilot to increase back pressure to reduce speed, and similarly, red chevrons pointing down into a circle prompt the pilot to push forward to increase speed. When stall is imminent, the word "PUSH" appears above the AOA indexer. The indexer will show a green circle, with no chevrons, when the angle-of-attack is in the optimal range for approach. The approach AOA indexer will not appear at low angles-of-attack.



6.3.21.2 Pitch Limit Indicator



When enabled on the PFD settings page, the pitch limit indicator appears on the PFD screen when the angle-of-attack is less than 8 degrees from stall and goes away when the angle of attack more than 9 degrees from stall. It resembles a red pair of antlers and is shown in the screenshot below. The indicator moves downward toward the nose or bars pitch indicator as the angle of attack increases. Stall will occur approximately when this indicator is on the nose or bar pitch indicator. This indicator is limited to 30 degrees pitch to prevent chasing a pitch limit that could temporarily be at a very high pitch angle due to high airplane speed.

The pitch limit indicator was originally created to give pilots a maximum pitch angle reference when performing a windshear escape maneuver in commercial airliners. While this may be of little use for the typical experimental aircraft pilot, it could be useful for assisting with terrain avoidance in a low airspeed situation. In that case, the pilot can use the pitch limit indicator as an approximate reference of a pitch angle that will result in stall.

6.3.21.3 AOA Settings

To turn on or off AOA functions:

1. Press NEXT > Set Menu > Primary Flight Display.

2. Scroll to **AOA**. Select ON or OFF. This will activate more settings just below the AOA setting.

3. Turn on the Pitch Limit Indicator if desired.

NOTE: AOA must be calibrated before use. The AOA indexer and pitch limiter functions are inhibited until calibration has been performed, even if the EFIS Angle-of-Attack function has been enabled.

6.3.21.4 AOA Calibration

Every aircraft and wing are different. Therefore, the AOA must be calibrated before use. This is accomplished by adjusting the "AOA Pitch Offset" setting so that the EFIS stall warning occurs at the desired AOA threshold.

***CAUTION*:** It is strongly suggested that you fly the aircraft with a safety pilot while calibrating AOA, with one pilot to control the aircraft and look for traffic, and another pilot to calibrate the EFIS.

Perform AOA calibration as follows:

1. Press NEXT > Set Menu > Primary Flight Display. Scroll to **Angle of Attack (AOA)** and select ON.

2. Scroll to **AOA Pitch Offset** and press the knob. The EFIS will return to the PFD screen and will show the pitch limit indicator and AOA indexer on the screen, with the right knob showing "ADJUST" and a value above it.

3. Start with the airplane at 5000' above terrain. Slow the airplane and extend the flaps. Reduce power to idle and establish gliding flight.

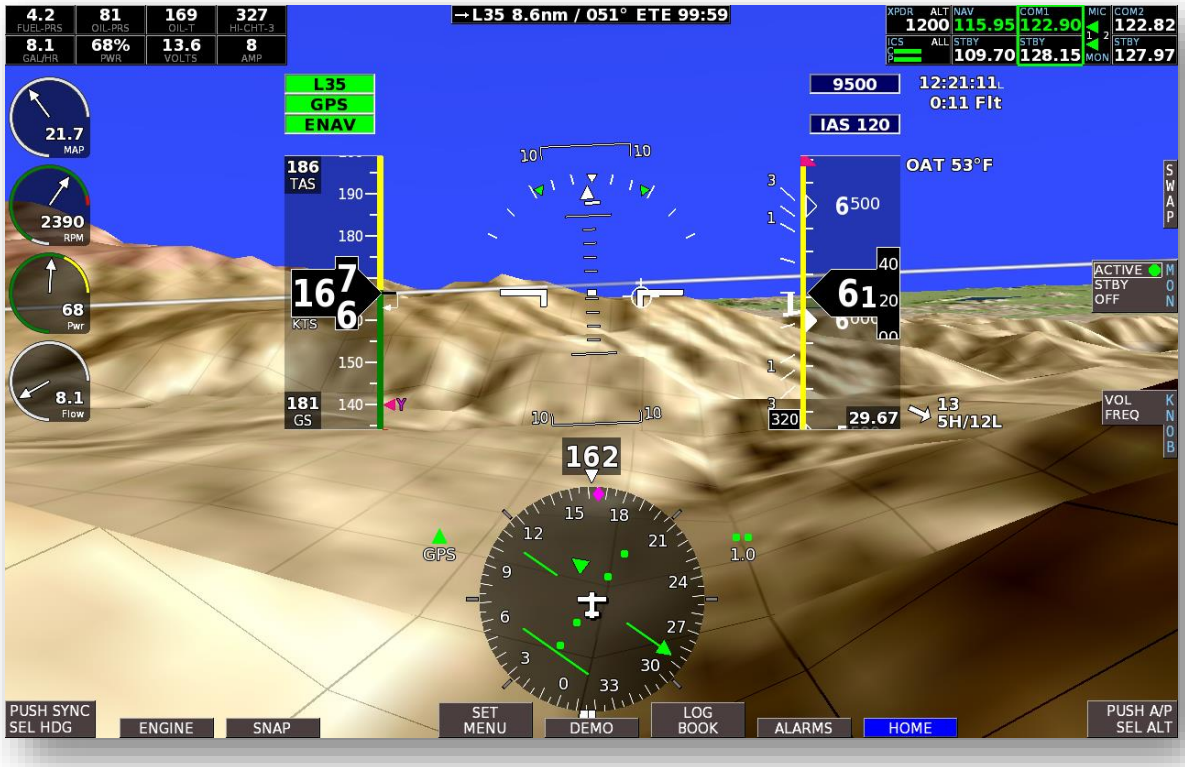
4. Gradually slow the airplane and note the speed at which stall occurs.

5. Resume gliding flight and slow the airplane to within 1 or 2 mph of stall. Use the right knob to adjust the pitch limit indicator until it is on nose or bar pitch indicator. The screenshot above shows the pitch limit indicator nearing the attitude bars.
6. Press the "EXIT" softkey to end calibration.

NOTE: Calibration must be repeated if the AHRS mounting orientation is changed.

7. Enter **Optimal AOA Multiplier** value. The AOA indexer will show optimal AOA when the airplane's speed is the multiplier value times the stall speed. A value of 1.4 is suggested.

6.4 Synthetic Vision Features and Settings



Synthetic Vision (SV) is an optional software feature on all EFIS units. It displays a 10-mile "out the window" view on the PFD of terrain, runways, obstacles, and traffic. It also provides a top-down terrain view on the map pages. GRT technicians load the synthetic vision terrain database appropriate for the area of the world in which the EFIS system will be used prior to shipment.

Synthetic vision is provided when valid GPS position, attitude, heading, and database information is available. Terrain database is provided between +/- 60 deg latitude, and most of Alaska. Runway and obstacle data are derived from the EFIS navigation database. Display of traffic is dependent on a source of traffic data, such as ADS-B or TIS-A.

!WARNING!: Synthetic vision is not to be used for terrain avoidance. It is intended only as a backup to pilot or navigation errors while flying known routes at published safe altitudes. Due to the resolution of the terrain database and other factors, some terrain will be higher than depicted by the EFIS.

NOTE: The synthetic vision terrain database does NOT need to be periodically updated and is not downloadable from the GRT website. Contact GRT for support if you encounter any problems with the synthetic vision database or if you are flying in an area of the world

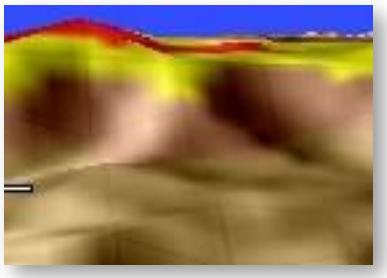
that is different from the database loaded in your system. To access synthetic vision database status for troubleshooting, press NEXT > Set Menu > Display Unit Maintenance > Database Maintenance page.

6.4.1 Terrain

Terrain features are presented on the primary flight display as they would appear out the window. Mountains, rivers, lakes, valleys, and other features appear on the screen and help guide the pilot in low-visibility situations.

In addition to the normal green-to-brown terrain shading, portions of the surrounding terrain that are close to the aircraft's present altitude can be colored yellow (500-1000 feet below the aircraft) and red (within 500 feet of the aircraft's altitude and higher).

NOTE: Turning terrain warning ON will color all terrain within 1000 feet of present altitude, even during landing approach.



To turn on red and yellow terrain warning shading on the PFD:

- Press NEXT > SV > TERRAIN.

To turn off terrain warning shading and go back to default SV:

- Press NEXT > SV > ON.

6.4.2 Obstacles

Towers and other obstacles in the 56-day Navigation Database are displayed on the PFD as either simple lines or chart-style graphic tower symbols. The same altitude color-coding as Terrain applies.

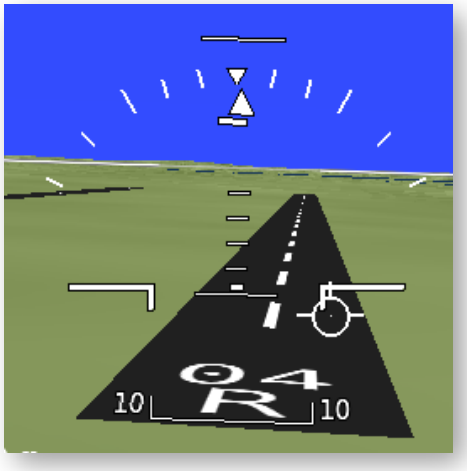
To choose how obstacles are depicted on the PFD screen:

1. Press NEXT > Set Menu > Primary Flight Display.

2. Scroll to **Obstacle Style** and choose Line or Chart.

6.4.3 Runways

Runways can be displayed on the PFD as a black strip with centerline and runway designation number. This is extremely useful for spotting runways from the air and for flying into airports with multiple runways.



NOTE: Turf runways will be depicted as black strips even though they are not paved. Private runways can be added to the database by adding them as User Waypoints. See Section 3, Adding User Waypoints.

To display runways on synthetic vision:

1. Press NEXT > Set Menu > Primary Flight Display.

2. Scroll to **Artificial Runways** and select ON.

6.4.4 Grid Overlay

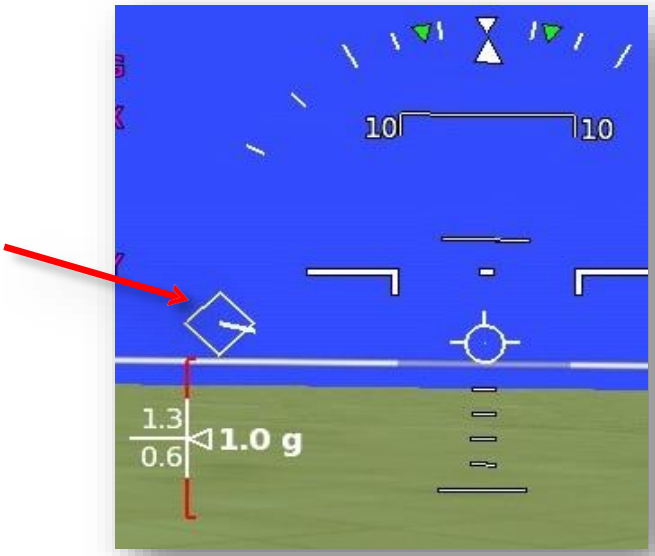
A grid overlay onto the terrain of the PFD is provided to creating an enhanced sense of depth, height and direction to the synthetic vision. The grid is aligned with the cardinal true directions (N, S, E, and W). It fades with height and distance to create an illusion of height above the surface. The squares are about 1,200 feet apart and follow the shape of the terrain. Although not recommended, the grid may be disabled.

To disable the grid overlay (NOT recommended):

1. Press NEXT > Set Menu > Primary Flight Display.

2. Scroll to **Synthetic Vision Grid Overlay** and select OFF.

6.4.5 Traffic on PFD View



Traffic targets picked up by ADS-B or TIS can be displayed "in space" on the PFD to mimic the view out the windshield. The traffic vector line points from the diamond-shaped target in the direction of motion. See Traffic Alert inset or map for target altitude relative to your position in hundreds of feet.

To display traffic on the PFD:

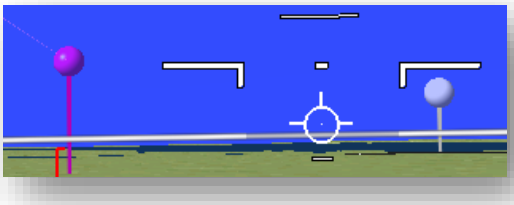
1. Press NEXT > Set Menu > Primary Flight Display.

2. Scroll to **Traffic In View** and select ON.

6.4.6 Waypoint Balloons

Waypoint balloons are markers that highlight the next GPS waypoints in the flight plan on the PFD. They have a "tether" that points directly downward to the waypoint and are raised and lowered with the altitude bug. They are visible beyond the 10-mile range of the synthetic vision, but in that case, they do not have a tether (as shown on the next page). In an enroute crosswind situation, keep the flight path marker on the waypoint balloon to fly directly to the waypoint. The active waypoint balloon is magenta. Subsequent waypoint balloons in the flight plan are white.

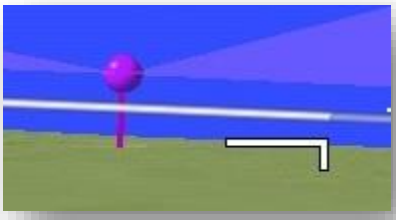
To turn on waypoint balloons:



1. Press NEXT > Set Menu > Primary Flight Display.

2. Scroll to **Waypoint Balloons** and select ON or OFF.

6.4.7 Course Ribbons



Course ribbons connect waypoint balloons and draw a path in the sky that corresponds to the active flight plan leg- essentially, a 3D version of the course lines drawn on the map screen. Course ribbons can take the form of a magenta course centerline or dual magenta-shaded boundaries on each side of the course, starting at 200 feet apart and tapering inward as the waypoint gets closer. Like the balloons, ribbons beyond the next waypoint show as white centerlines. The height of the course ribbons corresponds to the altitude bug.

To turn course ribbons on and select their form:

1. Press NEXT > Set Menu > Primary Flight Display.

2. Scroll to **Course Ribbons**. Select NONE, CENTER or BOUNDARIES.

6.4.8 Enroute Highway-in-the-Sky (HITS)

Enroute HITS (Highway-in-the-Sky) is a series of boxes drawn along a Sequence Mode GPS flight plan. The boxes move up and down according to the altitude bug, forming a visual corridor that is centered on the set course and altitude.

Enroute HITS will appear only if:

- Enroute HITS is turned ON in the Primary Flight Display set menu.

- The airplane is on the active leg of a Sequence Mode flight plan with a defined beginning and ending waypoint.

NOTE: The HITS boxes do not anticipate turns.

Boundary course ribbons form the edges of a corridor. This view shows a waypoint 15 miles away, beyond the reach of the 10-mile synthetic vision. Beyond 10 miles, the waypoint balloons are "untethered" and the boundary ribbons end 10 miles out. The calculated altitude above terrain is also shown here, in yellow under the attitude bars. Note traffic icon crossing left to right near the altimeter tape.

Centerline course ribbons are shown here, along with **enroute highway-in-the-sky** boxes (SX software v. 10a and later). Note the traffic is still in view near the VSI, this time flying in the same direction.

7 Moving Map Description

When the EFIS is receiving a valid GPS position, or dead-reckoning after loss of all GPS positions data, it provides a moving map screen that is viewable in several different forms, including full-screen or split screen with PFD and engine instruments. All map views have the same basic components:

- **Aeronautical Features:** Airports, airspaces, fixes and navaids. When zoomed in, runways are displayed as individual strips with labeled extended runway centerlines.

- **Topographical Features:** Cities, towns, major roads, borders, rivers, lakes, obstacles and terrain. Terrain can be color-coded as a visual proximity warning.

- **Airplane Symbol:** Represents your present GPS position.

- **Range/Zoom:** Press, then turn left knob (RNG).

- **Compass Rose/Heading Arc:** Magnetic compass reference.

- **Path Line:** Thin white line represents either present heading or present ground track, as set in the Moving Map setup menu, and radiates forward from the airplane symbol.

- **Flight Plan Course Lines:** Magenta is the active leg; all others are white. See **Flight Planning & Navigation**.

- **Heading Bug Course Line:** Green course line that appears when the EFIS is set to navigate in HDG mode.

- **Weather Information:** Weather data such as radar and METARs. ADS-B or XM receiver is required.

- **Traffic:** Displayed when equipped to receive traffic data and within range.

7.1.1 Moving Map Database

The moving map is derived from the GRT cities/water/railroads/roads/state boundaries database, the terrain database, and the navigation database. The navigation database provides data that may change more frequently. This database should be updated every 56 days. A free version is available from the GRT website for the continental U.S. Users outside the U.S. must use the Jeppesen subscription-based service. Both navigation database options include airports, airspace, navaids, fixes and obstacles on the map. Airport/Facilities and radio frequency information is also included in the navigation database and is viewable on the EFIS through the map screen.

NOTE: Databases from external GPS receivers do not communicate navigation database information, and thus the EFIS must use its own databases to drive its maps.

7.1.2 Map Screen Setup and Customization

The Map Screen has many options for customization in the Moving Map Setup Menu.

NOTE: To access the options in this section, press NEXT > Set Menu > Moving Map.

7.1.2.1 Map Screen Orientation

The map can be set up for "Track" or "Heading" up. The default and recommended setting is "Track Up". The EFIS will use this setting if possible. For example, when no heading information is available, the map will be displayed "Track" up. The up reference (TRK or HDG) is displayed just below the map heading/track reference at the top of the map.

With "Track" up the course to the next waypoint will appear as a vertical line on the EFIS when navigating on course, the out-the-window view of map features (such as airports, lakes, and weather) will appear displaced when flying in a crosswind. With "Heading Up" the course to the next waypoint will not be vertical when on course in a crosswind, but it will more accurately represent where map features appear out the window (assuming magnetic heading is accurate).

To choose the desired orientation:

1. Highlight **Up Reference**, on top of the Moving Map setup page.

2. Select **Track**, **Heading** or **North**.

NOTE: This setting does **NOT** affect the heading tape on the PFD, which can be set for Track- or Heading-up on the Primary Flight Display Set Menu page.

7.1.2.2 Airport Symbols and Label Fonts

The airport and font sizes can be enlarged from the default "small" setting.

To change font and airport symbol sizes:

- Highlight **Airport Symbol Size** and/or **Label Font Size** and choose a size option.

7.1.2.3 Map Information Range Filtering

The map can be customized to show the data of interest for your flying needs by setting the maximum range at which different types of data will be displayed.

Most pilots will find they use the 35- or 50-mile range when navigating enroute to their destination. Ranges of 100 or more miles are typically used to look ahead to anticipate airspace and weather. When near the airport ranges of 20 miles or less are used to display details and runway extended centerlines.

In general, only the items important for long-range planning should be displayed on the map at long range. Displaying too many things at long ranges can result in an overly cluttered display that is difficult to read.

***CAUTION*:** Be aware of the maximum range settings for airports. In the event of an emergency you may not have time to use the "Nearest Feature". As a result, you are likely to look at the map to locate the nearest airport. When doing so, be sure the map range is set at or below the maximum range to show all airports, and that the map is set to center view so that airports behind you are visible.

7.1.2.4 Recommended Range Settings

The maximum range settings are made by accessing Set Menu > Moving Map.

Our recommended settings for the map range filters are:

Recommend Maximum Range Settings	
Item	**Setting (Miles)**
Private Airports	50 or 100
Small Airports	50 or 100
Medium Airports	50 or 100
Large Airports	500
VOR	300
NDB	100
User Waypoints	50 or 100
Airspace	150
High Fix/Intersection	50
Low Fix/Intersection	35
Terminal (Term) Fix/Intersection	35
Lakes/Streams	35
Lakes/Streams Labels	15
State Outlines	500
Roads	35
Railroads	35
Obstructions	10

The choice of 50- or 100-mile range may be influenced by the concentration of airports in the areas you typically fly.

7.1.2.5 Auto-Declutter

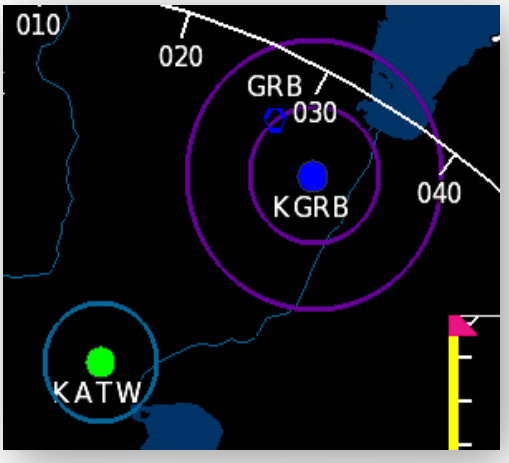
This setting automatically removes items from the map in order to make the map more readable, starting with small airports first. The recommended setting for this is "OFF".

***CAUTION*:** Auto-declutter may not display nearby airports that could be important to be aware of in an emergency. For this reason, Auto-declutter should not be used unless another moving map is the primary source of navigation in the airplane.

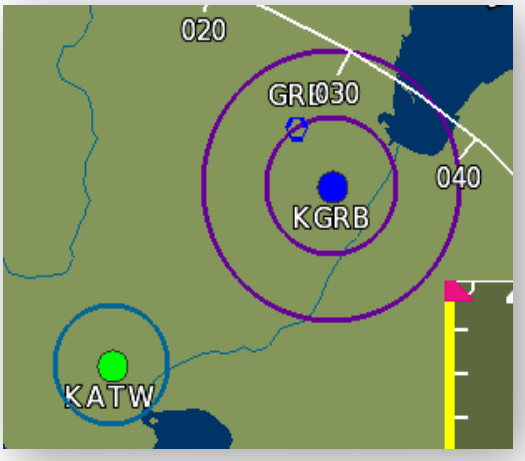
7.1.2.6 Map Background Color

When equipped with the synthetic vision option, the moving map background is normally set to "Terrain." However, when the "SHOW" selection for the map is set to "NONE," the EFIS is not equipped with synthetic vision or is displaying weather radar, the map is shown with a solid color as the background. There are two color options that are set up in the Moving Map Set Menu:

- Turn **Background Color** ON to display an even, olive green background color for the map. This creates a neutral background that displays all of the text and features clearly.



Background Color OFF with METAR airport color coding



Background Color ON with METAR airport color coding

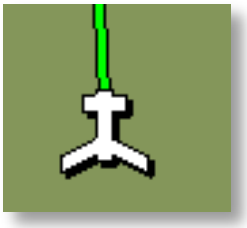
- Turn **Background Color** OFF to display a black background for the map. Pilots may prefer this option over the colored background for flying at night.

7.1.2.7 Color-Coding Airports Using METARS

This setting colors the airport symbols of airports with METAR reports according to VFR, IFR and Marginal VFR flight conditions when there is an operating weather receiver on board and within data range.

7.1.2.8 Airplane Symbol

The airplane symbol represents your aircraft's present position and can be customized as a conventional airplane or a canard.



Canard

To change the symbol to a canard profile:

1. Scroll to **Plane Symbol** on the Set Menu > Moving Map page.
2. Select Canard.

7.1.3 Flying with the Moving Map

The map can be displayed as an arc view, center or north-up view. While most often the information about what is behind the airplane is of less interest, this is not the case when an emergency requires landing as soon as possible. The view is selected via from the main softkey menu via SCREEN > MAP OPTIONS > VIEW. Insets are selected via the inset softkey directly below them. Airspeed/Altimeter tapes are enabled/disabled on the SET MENU> MOVING MAP page.

Arc View

Arc View with insets on and airspeed/altimeter tapes on.

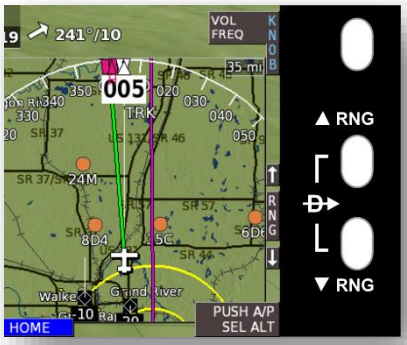
Center View

North-Up View

7.1.3.1 Moving Map Range Selection

The range of any map displayed on the EFIS (full screen, split, or inset) is controlled via the full time "RNG" softkeys on the lower right portion of the EFIS. Pressing the "UP" arrow moves your view up (larger range). The map range is displayed on the map in a rectangular box.

Map range display



Map range softkeys

7.1.3.2 Path Line

The Path Line is the fine white line between the Airplane Symbol and the heading/track readout (**Up Reference** as set in the Moving Map set menu). If the map orientation is set to Track Up, this line is a visual indicator of the map features to be crossed if the present ground track remains the same. In Heading Up mode, this line has less value because the path is affected by crosswinds.

When the path line crosses over an airspace boundary and the altitude of the aircraft falls within the airspace upper and lower limits, the airspace boundary line turns yellow, as shown at right, or flashes bright red in the case of prohibited areas. In this screenshot, the Heading Bug course line (bright green) points off to the 10 o'clock position, but the aircraft is not following the desired heading. The path line crosses into the airspace, warning the pilot that the airspace will be penetrated if the current ground track stays the same.

7.1.3.3 Showing Weather and Terrain

The SHOW softkey lets the pilot choose one of several mapping data sets to display on the map. This setting affects all map screens, including those split with the PFD and engine pages.

MAP Options are accessed by via the "SCREEN" softkey. The options available depend on the equipment connected to the EFIS.

NOTE: Options in the SHOW menu may be different from those displayed here and depend upon the type of weather receiver in the aircraft.

The mapping data sets include:

- **RADAR:** Displays ADS-B or XM NEXRAD radar if the aircraft is equipped with an operable receiver and is within range.
- **SHADE:** (Available only on display units with synthetic vision) Displays enhanced topography shading like that shown on a VFR Sectional chart. The data is derived from the internal synthetic vision database. See **Map Topography Shading** below for more information.
- **TERRAIN:** Shows yellow and red coloring as a visual terrain proximity warning. Uses an internal terrain database.
- **WIND:** Shows winds aloft received by XM Weather.
- **METARS:** Displays airport symbols colored according to the latest received METAR report and displays a surface wind vector, ceiling in hundreds of feet and visibility.
- **NONE:** Displays default map settings as defined in the Moving Map setup menu. Shows basic map background (either olive or black, as set up in section **Map Screen Setup and Customization**) with no topography shading.

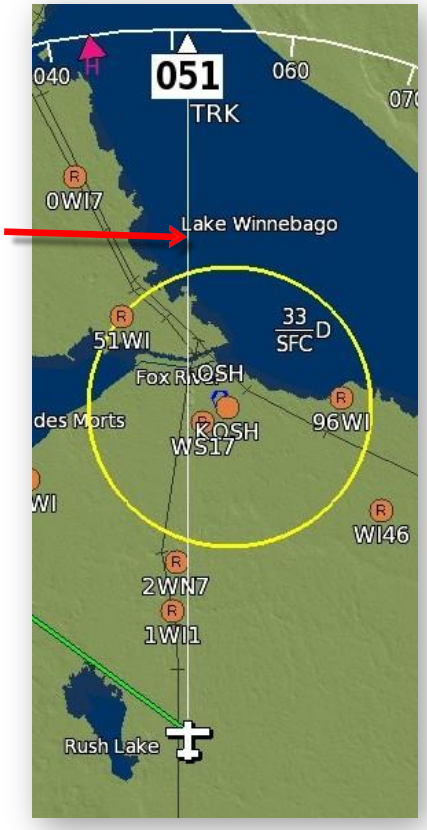
7.1.3.4 Map Topography Shading

The SHADE option under the VIEW menu colors the map according to the terrain and the Topography Shading Color Key shown below. The base colors are enhanced by shadows in mountainous terrain to give the map texture and bring attention to the

mountain peaks.

Topography Shading Color Key	
Elevation (Ft Above Sea Level)	**Color**
0-500	
501-2000	
2001-3000	
3001-5000	
5001-7000	
7001-9000	
Above 9000	

7.1.3.5 Airspace



The GRT map database contains information for all the airspace in the U.S. including lateral and altitude boundaries, controller frequencies and times of operation. Use the Map details selector and Waypoint Details page to access information about different airspaces along your route.

Airspace Boundaries: Airspace boundaries are colored according to the U.S. VFR Sectional Chart except for restricted areas, which are bright red for visibility.

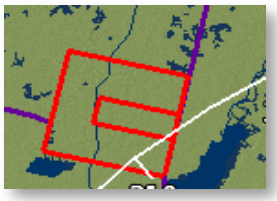
Airspace Labels: When the aircraft's projected path passes through airspace boundary, the airspace is highlighted, and the airspace dimensions appear next to it. This feature also considers altitude– Airspace projected to pass below or above the aircraft is not highlighted.
In the screenshot on the previous page, the boundary of the Class D airport is yellow because the aircraft is on course to enter it. The dimensions of the airspace are noted inside the airspace boundary ring at the 2 O'Clock position.

NOTE: Labels and effective altitudes for airspaces that are not in the path of the aircraft are not displayed on the map for a cleaner, decluttered presentation. To view these labels, use the Map details selection function (the right knob).

Class B

Class C

Class D



Restricted/Prohibited

Upper number represents top of airspace in hundreds of feet. Lower number represents bottom or SFC for ground surface. The airspace class (D) is to the right.

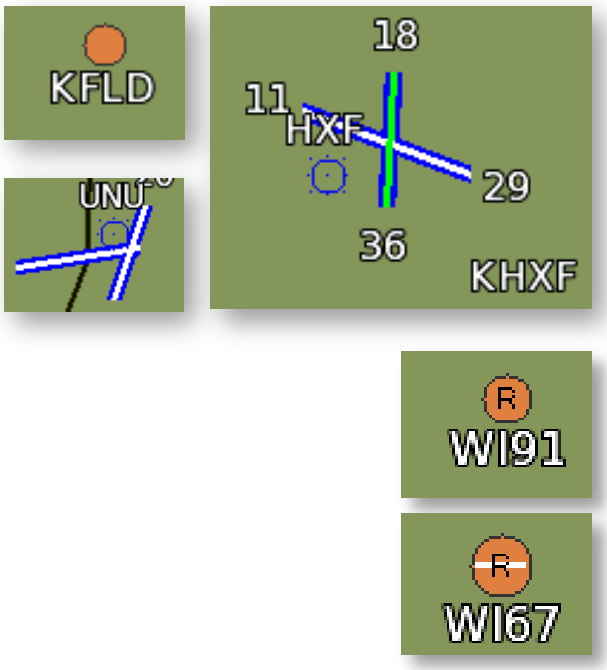
7.1.3.6 Map Symbology

Symbols on the map other than airports and airspace are depicted in the following table.

NOTE: U.S. state boundaries are thin white lines.

Navigation		Map Features	
	VOR		Railroad
	VOR/DME		Major Road
	VORTAC		Populated Place (City or Town)
	NDB		Body of Water (Irregular Shapes)
	Fix		Man-made Obstacle. Color Corresponds to Terrain Warning (Black, Yellow or Red)

7.1.3.7 Airports and Runways



Public airports are depicted as an orange circle icon when the map range is greater than 20 miles, similar to a sectional. At or below 20-mile range, the airport may be replaced with its runways. This is dependent on the how much data is included for an airport's runways in the database.

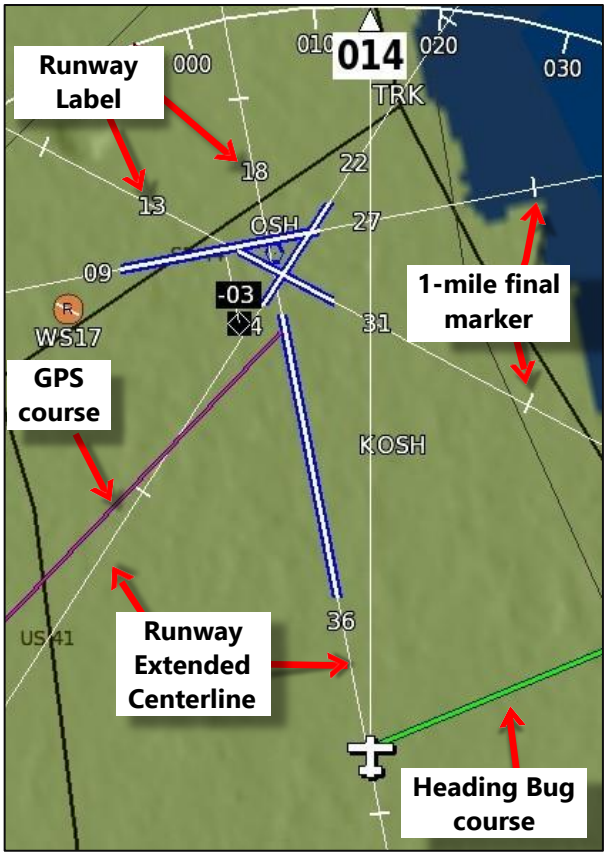
When the database includes enough data about the runways, the airport symbol will be replaced with runways, scaled to actual size. Only the portion of the runway usable for landing will be shown. Runways are shown with blue borders in their magnetic orientation. Hard surface runways are white and turf or soft runways are green.

For airports without enough detailed runway data, a white stripe may appear in the airport symbol that shows the orientation of the longest runway at the airport.

Private airports are depicted in the same way as public airports, except with an "R" inside the circle symbol, as shown in the examples at right. Note the runway orientation stripe of WI67, shown here at a map range of 20 miles or less.
Private airports often don't have actual runway coordinates in the database; therefore, the runway view may not be available for private airports. Runway coordinates can be added to the database manually via the user definable database entries.

7.1.3.8 Destination Airport

If an airport is the last waypoint in the flight plan, it is treated as the "destination airport." Extended centerlines are shown for the destination airport at or below 20 miles of map range to make it easier to locate the final approach path for the intended runway. The perpendicular mark on each extended centerline is placed 1 mile from the end of the runway. Runway labels are always shown for the destination airport, even if it is not the nearest airport.



In the screenshot to the right, we see the aircraft turning onto final approach for a clearly-labeled Runway 36 in Oshkosh, WI (KOSH). Oshkosh has multiple runways, the centerlines of which are all displayed on this map. The magenta line is the original GPS flight plan, tracking to the center of the airport. The green line radiating eastward from the airplane symbol represents the heading bug, which was set up for a left base for Runway 36.

7.1.3.9 Altitude Intercept Arc

The Altitude Intercept Arc appears as a green arc on the map screen. It is a visual depiction of the distance required to reach the selected altitude based on the current vertical speed and groundspeed.

The Altitude Intercept Arc is very useful for:

- Controlling your descent to reach pattern altitude prior to the destination (set the selected altitude to the pattern altitude).
- Monitoring climb progress for clearing airspace, terrain and obstacles (set the selected altitude to the altitude needed for clearance).
- Complying with IFR crossing restrictions.
- Predicting glidepath intercept with the runway on non-precision approaches or emergencies when the selected altitude is set to the field elevation.

7.1.3.10 Map Details Selector

This selector function is an essential tool for extracting additional information about details on the map. It is simple and efficient, and we recommend the pilot become familiar with its use.

This functions as a selection tool that can be used to:

- Select and go direct to a waypoint.
- Access the waypoint details page for any waypoint on the screen, which also includes ADS-B METARS.
- View airspace dimensions and effective altitude.
- Provide a continuous display of the range and bearing to points on the map, which is useful for position reports to ATC, when crossing bodies of water (use this to show the distance to point near the shore behind you), etc…

To use the Map Details Selector:

1. From the Map screen, press the right knob to activate the Map Details Selector (note that this also changes the softkeys into the map shortcut functions).

2. Rotate the knob until the yellow line intersects the waypoint or airspace in question. The edges of the selected airspace glow turquoise. Information is displayed on the map and in a data box above the *LEFT* knob. For airspace, the data box displays the airspace class and altitude range. For waypoints, the box displays the identifier and bearing/distance to the airport reference position.

After highlighting a waypoint:

Press the right knob again to display the waypoint details page for the selected waypoint. (Note: Pressing the "WPT DETAILS" softkey shows the details about the current goto waypoint, not the selected waypoint.)

Press the (direct-to) softkey to create a Direct-To flight plan to the selected waypoint. Turn the right knob to select "USE MAP" and the highlighted waypoint with a description will populate the direct-to selection. Use the "ENTER" function on the right knob to set it as the goto.

7.1.3.11 Map Shortcuts

Pressing the right knob when on a full screen map page changes the softkeys to map shortcuts. This is an efficient way to do common map functions. There are two pages of shortcuts.

The first page includes:

- **WPT DETAILS:** Shows the waypoint details page for the current goto in the GPS flight plan.
- **Direct-To:** Goes to the Direct-To selection page. From this page, a direct-to may be specified or it may be set to the waypoint that was highlighted by the map details selector.
- **NEAR:** Allows selection of the nearest list for AIRPORTS, WEATHER FREQ, NAVAIDS or METARS. Any item in these lists can then be set as a direct-to.
- **CREATE WP:** Creating a user waypoint.

7.1.3.12 Waypoint Details Page

The Waypoint Details or Airport Facilities Directory page can be accessed several different ways:

- Through the Map screen using the Map Details Selector; highlight a waypoint, then press the right knob.

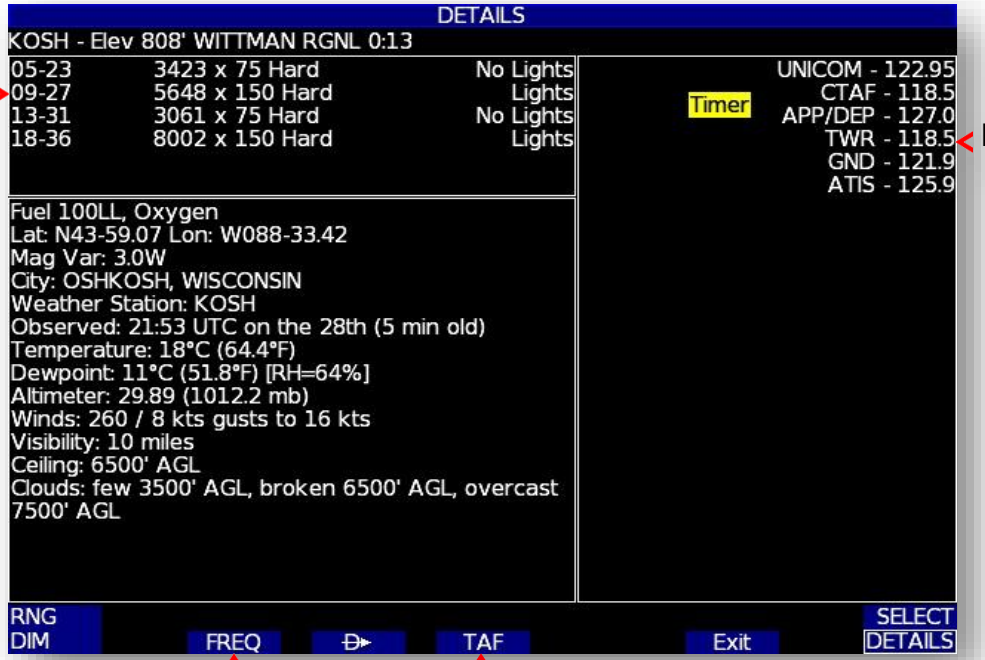
- Through a Flight Plan page by highlighting an airport or NAVAID and pressing the right knob.

- By pressing WPT DETAILS softkey on the Map screen to see details about the active goto. This is an especially easy way to familiarize yourself with your destination waypoint when it is the direct-to or current goto.

- From the nearest list by pressing the right knob.

Waypoint Details Page Breakdown

Runway Info



Frequencies

Press **FREQ** to access radio tuning softkeys, SET COM or SET NAV.

These display a scrollable list of frequencies for the airport. Press the right knob to send the frequency to a remotely-mounted radio or panel-mounted radio with serial input from the display unit.

TAF displays the Terminal Aerodrome Forecast, if available (only if receiving current weather from an installed ADS-B or XM receiver). Note that METAR information shows up in the body of the Details page.

7.1.3.13 Nearest Airport, Weather Report or NAVAID

1. From the MAP page, press the right knob.

2. Press the NEAR softkey, the choose AIRPORT, WTHR FREQ, METAR or NAVAID.

   - WTHR FREQ includes nearest AWOS and ASOS weather frequencies that you can select and monitor.

   - METAR shows a list of METARs from nearby airports if you are equipped with an XM or ADS-B weather receiver and receiving information. This is extremely useful if weather is closing in on your location.

     NOTE: WTHR FREQ and METAR softkeys do not appear on the Flight Plan's Nearest pages.

     NOTE: On the Flight Plan page, the NEAR softkey only appears if you are following an internal flight plan because flight plans utilizing external GPS units ("external" flight plans) cannot be edited from within the GRT EFIS display unit. See **SECTION 5: FLIGHT PLANNING AND NAVIGATION** for more information.

3. In the example below, AIRPORT was chosen. Turn the right knob to highlight the desired airport, then press GO TO or the D→ softkey to create a Direct-To flight plan with the selected airport as the waypoint.

4. Press EXIT to exit the Flight Plan page and return to the PFD or Map screen.

NEAREST AIRPORTS

ID	Range	Bearing	CTAF	Length	Surface	Lights
14MI(R)	1.4	170°		900	Soft	No
KGRR	2.3	83°	135.650	10000	Hard	Yes
2MI5(R)	5.7	48°		3050	Soft	No
MI78(R)	9.5	291°		1700	Soft	No
26MI(R)	9.2	76°		2700	Soft	No
08C	10.8	296°	122.900	3920	Hard	Yes
41C	11.3	201°	122.900	2200	Soft	No
24C	11.3	69°	123.000	2700	Soft	No
Z98	15.9	263°	122.900	3800	Hard	Yes
35C	15.6	16°	122.900	2200	Soft	No
8D4	15.9	348°	122.800	4032	Hard	Yes
6MI7(R)	16.3	261°		2000	Soft	No
9D9	16.1	146°	123.075	3900	Hard	Yes
MI82(R)	16.7	276°		2400	Soft	No
MI88(R)	16.8	245°		2000	Soft	No
76MI(R)	17.0	342°		1200	Soft	No

7.1.3.14 Panning (Slewing) the Map

To view objects and waypoints outside of the map viewing area, you can slew, or pan, the map. Normally this function is rarely used, as changing to a larger map range is easier to see further ahead. However, slewing the map can be useful when flight planning or when looking more closely (lower map range) at details above, including weather.

Slew the map by performing the following:

- From the Map screen, press NEXT > Slew. Four directional softkeys appear, along with EXIT, which returns to the Map screen.

NOTE: The SLEW map view is always in North-Up mode. The map range/ zoom knob and Map Details Selector work just as they would on the normal Map screen.

7.1.3.15 Traffic Display

The EFIS Map screen displays traffic targets if the aircraft is equipped to receive either TIS or ADS-B traffic information.

8 FLIGHT PLANNING AND NAVIGATION

The EFIS supports GPS and traditional nav radio navigation, as well as approach navigation via GPS, ILS, VOR, and its own synthetic approach.

8.1 Single GPS Navigation

In many installations, a single GPS will be the only source of navigation data provided to the EFIS. In this case, no navigation mode selection is provided; the navigation mode will always be GPS. If this is the case for your system, the following navigation mode sections may be skipped and reading can be resumed with section **Loss of GPS Position**.

8.2 Multiple Navigation Inputs

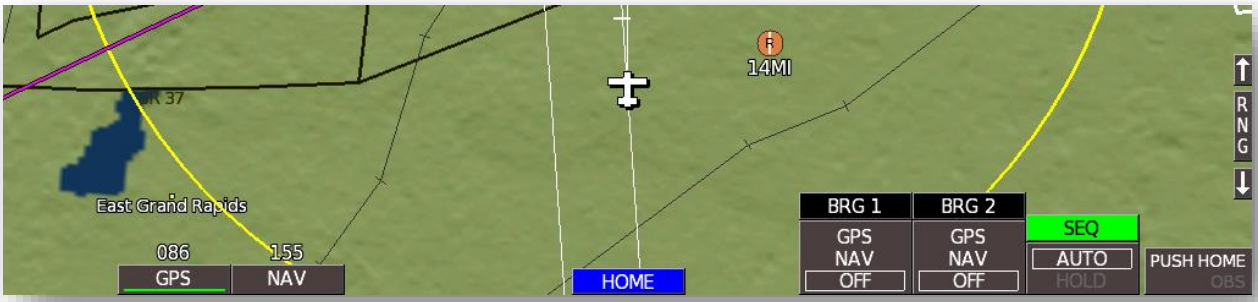
The EFIS fully supports GPS and traditional navigation radio inputs, as well as approach GPS with lateral and vertical inputs. When the EFIS is provided with more than one navigation source, such as a GPS and navigation radio(s), two GPS inputs, or any combination of these, the EFIS will provide a softkey to select the EFIS navigation mode. When a navigation mode is selected, the HSI will be driven by the selected device, as will autopilot/flight director coupling. PFD displays will change to show this data as it's needed; the GPS moving map and PFD GPS flight plan information will remain unchanged.

External control of the navigation mode from combination nav sources (those that provide both GPS and navigation radio data), such as a Garmin 430/530/480/650/750/etc…, is fully supported. These combination nav sources mode to the EFIS (usually selected by their "CDI" button), allowing the combination nav source to control the EFIS navigation mode. This allows the combination source to change modes, with the EFIS automatically following the changes. For example, the combination source may change from GPS navigation to localizer when the localizer is captured; the EFIS, in turn, would switch over to localizer navigation. Enabling the EFIS to follow the external navigation mode requires setting the "PFD Nav Mode Source" to external. This setting is made on the PFD settings menu.

8.3 Selecting the EFIS Navigation Mode

Selection of the navigation mode is made on the first set of softkeys from either the PFD or Map pages by pressing the "CDI" softkey. The navigation mode selects the source of data that is used to provide steering information to the pilot on the PFD/Map pages, as

well as to the autopilot. The navigation choices available on the EFIS depend upon the equipment that it is interfaced to. An example of an airplane with one GPS and one NAV radio would be:



Navigation modes of GPS and NAV radio are shown with the selected course above them. Bearing pointers on the HSI can be turn on using the BRG selections. GPS waypoint sequencing for the EFIS internal flight plan can be suspended or resumed using the SEQ selection.

The labels for the navigation mode are selectable to make it easy to identify the navigation source selected. In this example the G650 label was selected as GPS/Nav radio source 1. A second GPS is connected (GPS2) and a second navigation radio (NAV2).

Up to two GPS and two VOR/ILS sources may be provided to the EFIS. When multiple navigation sources are available, the selection will include a 1 or 2 to identify the source, such as GPS1 or GPS2.

Navigation sources may be selected even if data is not available from that source, as is common with localizer and glideslope data from a navigation radio. When this happens, the EFIS will hold its current heading until navigation data becomes available.

Note: If an SL30 Nav/Com (or equivalent) is connected to the EFIS, it is treated by the EFIS as a single VOR receiver, even though it is capable of providing bearing to 2 VOR stations. If the EFIS is not configured for a second navigation radio (such as another SL30 or a GNS430), then the second VOR receiver within the SL30 is used to drive the VOR2 bearing pointer on the EHSI page.

8.4 External Navigation Mode (EXTERN)

Combination GPS/Nav receivers, such as the Garmin 430/530/480/650/750 and those from Avidyne, provide a "CDI" button to change their navigation mode between GPS and NAV (where NAV refers to VOR/LOC), as well as automatic switching. These combination sources provide their navigation mode to the EFIS, so the EFIS will stay consistent with it. While the EFIS allows EFIS-only control of the navigation source from a combination nav source, this is discouraged. External control of the EFIS navigation mode from combination units is recommended, as it maintains consistency between the EFIS and the combination GPS/Nav receiver modes.

Note: If the EFIS is configured with only a single combination GPS/Nav radio source, with external control of the navigation mode selected, a "NAV MODE" softkey will not be provided, as the only navigation modes will be selected on the external combination navigator.

8.5 GPS Navigation Mode (GPS/GPS1/GPS2)

When a GPS navigation mode is selected, the steering information and commands provided to the autopilot/flight director will follow the flight plan (route) associated with the selected GPS. Internal or remote GPS modules (such as the Safe-Fly 2020 GPS) must be configured for internal flight plans. External GPS navigators which allow entry of a flight plan are normally configured to use their own flight plan (an external flight plan).

If the selected GPS is configured to use an external flight plan, the EFIS's internal flight plan will be suspended, meaning no sequencing of waypoints will occur. External flight plans are not controlled by the EFIS and will hold or sequence based on selections made on the external GPS.

When flying manually, the pilot must maneuver the airplane so that the GPS cross-track deviation indicator is nulled and that the course indicator is aligned with the ground track indicator. The cross-track deviation indicator shows the distance the airplane is displaced laterally from the line between the previous and current waypoint. The course indicator shows the course between these waypoints. The EHSI screen displays this information in the traditional HSI format.

If a GPS nav mode is selected with no GPS flight plan specified by the GPS source, the GPS course may be set on the moving map page using the right knob. The EFIS will provide steering and autopilot/flight director commands to fly this ground track.

***CAUTION*:** When flying a GPS ground track, if the airplane deviates from the ground track, steering will return to the selected course (ground track), but may be offset laterally from the path originally observed on the map when the course was selected. A GPS flight plan must be used to navigate around obstacles and airspace.

8.6 Loss of GPS Position

If GPS position data is lost from a GPS source, the following will occur:

- If the selected GPS is using the Internal Flight Plan and another GPS input that is providing position data is connected to the EFIS, the second GPS position data will be used.
- If the selected GPS is using an external flight plan, the EFIS will hold the last
- If all GPS position data is lost for more than 30 seconds, the EFIS issues a "No GPS Position" warning and automatically reverts to dead-reckoning using the AHRS heading, true airspeed, last known winds and time. This data is used to estimate changes in position, which are applied to the last known GPS position to give an approximate navigation solution.

The accuracy of the dead-reckoning function will degrade with time depending on the accuracy of the available data and changes in the winds. (If no heading data is available to the EFIS, dead-reckoning will occur, but the accuracy will degrade more rapidly due to drifting of the yaw gyro.)

When in dead-reckoning mode, a red flashing box just above the nav mode display will show "NO GPS XX:XX." The XX:XX will be replaced with the time (minutes and seconds) since GPS data was lost. All map pages will show "NAV UNRELIABLE - NO GPS," and "DEAD RECKONING - XX:XX" in large flashing text. **This warning indicates that the navigation position is of unknown accuracy and the EFIS shall, under no circumstances, be used for obstacle avoidance.**

***CAUTION*:** The intent of this mode is to provide a position, albeit degraded, to allow fixing the position with other navigation aids, such as VOR, pilotage, etc. This is important when flying on longer cross-country trips, especially in higher speed airplanes, where the pilot may not be constantly aware of his position to the precision required to easily locate themselves on a sectional, and begin navigation using these alternate means.

If no GPS position is available, or no flight plan is provided by the selected GPS source, the EFIS will hold the airplane's heading at the time of this loss and will annunciate the navigation mode as "GPS-HDG", until the position or flight plan is restored.

8.7 Internal Vs. External Flight Plans

During EFIS system setup, the GPS input(s) can be configured for internal or external flight plans. The "Internal" setting causes the EFIS to ignore any flight plan from an external GPS and use the active flight plan in the EFIS. ***Internal must be used if the GPS does not provide a flight plan, such as a GPS module or a GPS internal to the EFIS.*** Recall that the EFIS provides a direct-to (single waypoint only), and a "Sequence" (any number of waypoints) flight plans. The selection between these two is made on the "Flight Plan" page.

"External" causes the EFIS to use the flight plan in the external GPS. This flight plan will be displayed, and steering/autopilot coupling will follow this flight plan. This flight plan must be created, edited, and will be controlled (waypoints sequenced) in the external GPS. The EFIS cannot edit or control waypoint sequencing from an external flight plan. Since the external GPS controls waypoint sequencing, waypoint sequencing will occur even when this GPS is not the EFIS navigation source.

8.8 When to Use External Flight Plans

There are two cases where an external flight plan should be used:

- When the external GPS has approach capability.
- When the pilot is more comfortable/familiar with flight planning on an external GPS.

When using an external GPS that does not have approach capability, we prefer flight planning in the Sport. We find flight planning is easier in the Sport easier than all non-touch screen external GPS navigators, and even easier than a touch screen GPS when in turbulence, but we leave this to the judgement of the pilot. Some also prefer external flight plans because the flight plan will appear in both the external GPS and the EFIS.

NOTE: If the external GPS was to fail, the pilot may copy the external flight plan to the internal flight plan (from the EFIS flight plan page), which will allow for the EFIS to control waypoint sequencing.
Regardless of which flight plan is active, the moving map and PFD show the goto waypoint identifier, as well as range/bearing and time to this waypoint.

8.9 Flight Planning Terms

- **Waypoint:** An airport, NAVAID, fix, intersection or user-defined place in the navigation database.

- **Direct-To or ⊕→ :** Direct GPS navigation to a single waypoint.

- **Seq Mode:** Sequence Mode, or multi-waypoint flight plan.

- **External Flight Plan:** A flight plan created with an external GPS navigator. External flight plans are displayed with a yellow header and cannot be edited in the display unit. However, they can be copied into the internal flight plan.

- **Internal Flight Plan:** A flight plan created inside the GRT EFIS display unit. Internal flight plans are displayed with a blue header.

- **NAV Vs. GPS EFIS Navigation Mode:** The term "NAV" refers to VHF navigation (VOR/LOC, ILS) sources. "GPS" refers to the selected GPS (since two could be configured as inputs to the EFIS) and its flight plan. GPS navigation uses green symbols; Nav1 uses white symbols and Nav2 uses cyan.

8.10 Using Direct-To and Sequence Flight Plans

Internal flight planning provides separate "Direct-To" and a "Sequence Mode" flight plans. The flight plan type is selected on the "FLT PLAN" page (selectable from the Map Shortcut and map softkeys). The Direct-To flight plan is used by the EFIS when you select a waypoint from the map or a nearest list. It also includes a feature that allows you to easily recall previous direct-to waypoints, and will navigate you only to the single waypoint. Sequence mode flight plans allow you to create plans with multiple waypoints to simplify navigation around airspace and other obstacles.

Note: When editing the flight plan while flying on autopilot you may prefer to use "HDG" for the lateral autopilot mode. This will prevent unexpected turns if the current goto waypoint is being altered.

The GRT Remote app running on an android phone or tablet can be used to edit the sequence mode flight plan when connected to the EFIS. It may also be used to create

flight and save flight plans when away from the airplane. This app includes many other useful features.

8.10.1 Direct-To Navigation

Direct-to navigation can be performed from the sequence mode flight plan by just selecting "Go Direct" while highlighting any waypoint in this flight plan, or by using the "Direct To" flight plan. "Direct-To" navigation will navigate you along a line from where you were when you created or reset the direct-to, to the direct-to waypoint.

When flying direct-to a waypoint in the sequence mode flight plan, navigation will continue to the next waypoint in the plan when this waypoint is sequenced, or along the last course (ground track) if this is the last waypoint.

From the "Internal Direct-To" flight plan page, the right knob can be turned to recall the previous direct-to waypoints. For pilots that expect to only fly direct-to, this can be a handy feature.

8.10.1.1 Using the Map to Select a Direct-To

Except for touchscreen equipped models, the map may be used to select the waypoint for the direct-to flight plan mode only.

To set the Direct-To flight plan to an airport, navaids or fix on the map:

1. Press the right knob to activate the map details selector.
2. Rotate the knob to highlight the airport, navaids or fix you to fly to.
3. Press the right knob to select the "Details" page.
4. Press the ⊕→ softkey.
5. Press EXIT to go back to the Map screen. There should be a magenta line drawn from your present position to the new Direct-To waypoint.

Above: Press the right knob to show the "Details" page to set "Calkins Field – 41C" as the direct-to waypoint. Pressing the Direct-to softkey will show the current direct to but will allow you to use the map details selector to change the goto waypoint.

8.10.1.2 Direct-To Waypoint Selection Using an Identifier

NOTE: If you have an external GPS selected as the Nav source, the Flight Plan page appears with a yellow header and says "External Flight Plan." This flight plan cannot be edited. Press the right knob and turn it to highlight "Internal Flight Plan," and press the knob to select the editable Internal Flight Plan page.

To set the Direct-To flight plan with an identifier:

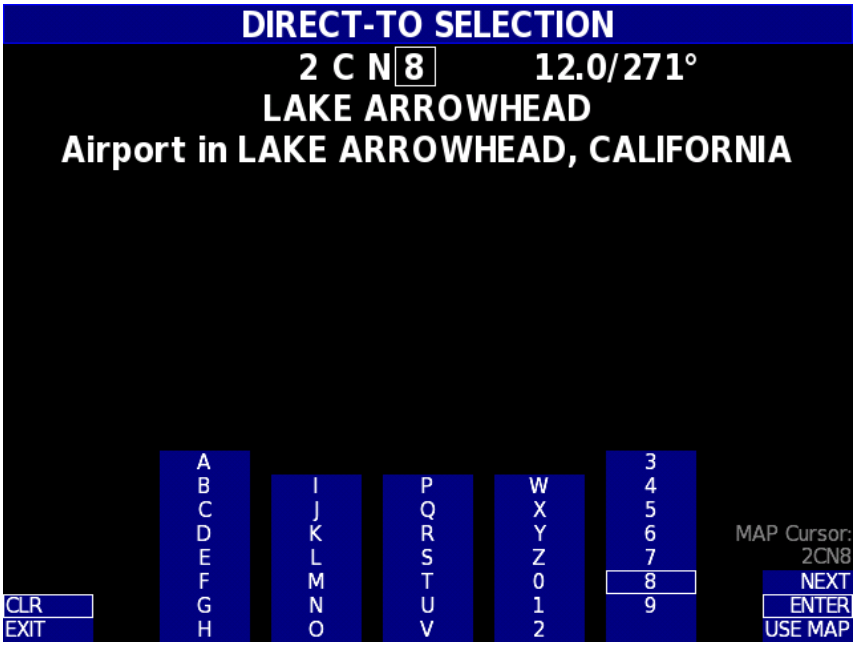
1. From the Moving Map page, press NEXT > Flight Plan to access the Active Flight Plan page.

2. If necessary, select the Direct-To flight plan mode using the center softkey.

3. Repeatedly press the softkey under the column that contains the first letter of the waypoint identifier until the letter is highlighted. Press the right knob ("NEXT") to move the cursor to the next letter in the identifier OR press the softkey under the next letter if it is in a different column to automatically move the cursor.

4. Keep entering letters in this way until the entire identifier is displayed. The name of the airport or navaid and the location will be displayed under it for verification.

5. Turn the right knob to select "ENTER" and press it to set the new goto.



Press EXIT to return to the Moving Map page. A magenta line from your present position to the selected waypoint will appear.

8.10.1.3 To Select a Previously Used Direct-To Waypoint

Waypoints are saved in a list on the "Internal Direct-To" page, with the most recent one displayed.

Once on the Internal Direct-To page:

1. Turn the right knob to scroll up through the list.

2. When the waypoint you want is highlighted, press EXIT to activate the Direct-To flight plan and go back to the Map screen.

8.10.1.4 Resetting the Direct-To

Often a flight plan will be created on the ground. Once in flight the pilot will wish to proceed to this waypoint starting from where they are now, not from where they were when the direct-to was selected on the ground. This is accomplished by resetting the direct-to.

To accomplish this:

- From the map page, press the right knob to show the moving map shortcut softkeys. Press the Direct-To softkey, then EXIT.

OR

- Select the "Flight Plan" softkey from the normal map softkey menu. The current Direct-To will be displayed. Press the Direct-To softkey, followed by the right knob ENTER on the Direct-To Selection page, then EXIT.

8.10.2 Sequential Flight Plans

Flight plans can be entered using waypoint identifiers or can be recalled from saved flight plans as follows:

1. From the Moving Map page, press NEXT > Flight Plan to access the Active Flight Plan page.

2. If necessary, select the sequence mode using the center softkey.

3. The last flight plan in use will appear. The left knob can be used to select a previously saved flight plan (Sel FP) or clear the current flight plan (Clr FP).

4. The right knob controls the cursor. When the cursor is over the blank spot at the end of the list, an ADD softkey appears. Press ADD to bring up the flight plan selection page and add a waypoint just like you did in Steps 3 and 4 of the Direct-To entry.

5. Keep adding waypoints to the flight plan in this manner. If you want to add one in the middle of the sequence, use the right knob to highlight the waypoint after the new point, and press the INSERT BEFORE softkey.

6. Once the flight plan is complete, the cursor box is positioned on the first waypoint to be flown to, and the "Set Leg" softkey or "Go Direct" (on the right knob) is used to specify how to navigate to this waypoint. When the first waypoint in the flight plan is selected, the "Set Leg" selection will create a waypoint at the present position, and navigate from this origin to the first waypoint along this leg.

Above: The arrow symbol pointing from KOBE to KAVO indicates the leg between these will be followed. If navigating Direct-To KAVO using "Go Direct," a direct-to symbol would replace this arrow.

8.10.2.1 Set Leg and Go Direct

- **Set Leg:** Causes the EFIS to navigate to a waypoint on the path connecting this waypoint and the previous waypoint in the flight plan. If the airplane is significantly away from this path, flight director/autopilot steering will cause the airplane to intercept this path at a 45° angle.

- **Go Direct:** Causes the EFIS to navigate to this waypoint on the path from the origin (location where the Go Direct was selected) to the waypoint. The "Go Direct" is selected using the right knob by turning it to highlight "GO DIRECT" and pressing the knob. The origin can be reset by reselecting the "Go Direct."

8.10.2.2 Active Flight Plan (Sequence Mode) Page Breakdown

Del WP: Delete highlighted waypoint.

Sel FP: Access/select saved flight plans.

Rev FP: Reverse flight plan sequence.

Save: Save flight plan for future use.

User WP: Create/save user waypoint.

Clr FP: Deletes the current flight plan.

Insert new waypoint before highlighted waypoint.

Switch to Direct-To flight plan.

Activate highlighted leg.

Exit screen and activate flight plan.

Details: Displays details page for highlighted waypoint.

Go Direct: Skip a portion of the flight plan and go direct to highlighted waypoint from the present position.

PFD On/Off: Displays attitude line, airspeed and altitude behind flight plan page, as shown here.

External: Display and activate external flight plan.

Copy: Overwrite current flight plan with external flight plan.

Import: Import .GPX flight plan from USB stick.

8.11 External Flight Plans

An external flight plan is displayed on the moving map and the flight plan page when the selected GPS is configured for an external flight plan. If two GPS inputs are supplied to the EFIS, this will be the GPS selected by the EFIS navigation mode selection on the PFD page. If the EFIS navigation mode is NAV radio, then GPS 1 is used if functioning, otherwise GPS 2 is used.

An external flight plan cannot be edited on the EFIS. It must be edited within the GPS navigation unit that created it.

As always, the autopilot/flight director steering will follow whatever is selected for the EFIS navigation mode.

To access an external flight plan:

If necessary, select the external GPS unit as the Nav Mode source on the PFD.

Go to a full-screen Map page and press NEXT > Flight Plan. The flight plan will be displayed, with a yellow header indicating an "EXTERNAL FLIGHT PLAN."

NOTE: The external GPS must be wired to the GRT Sport and designated as GPS1 or GPS2 when using an External Flight Plan source (Set Menu > General Setup page.)

Copying the External Flight Plan into the Internal Flight Plan

From the Flight Plan page:

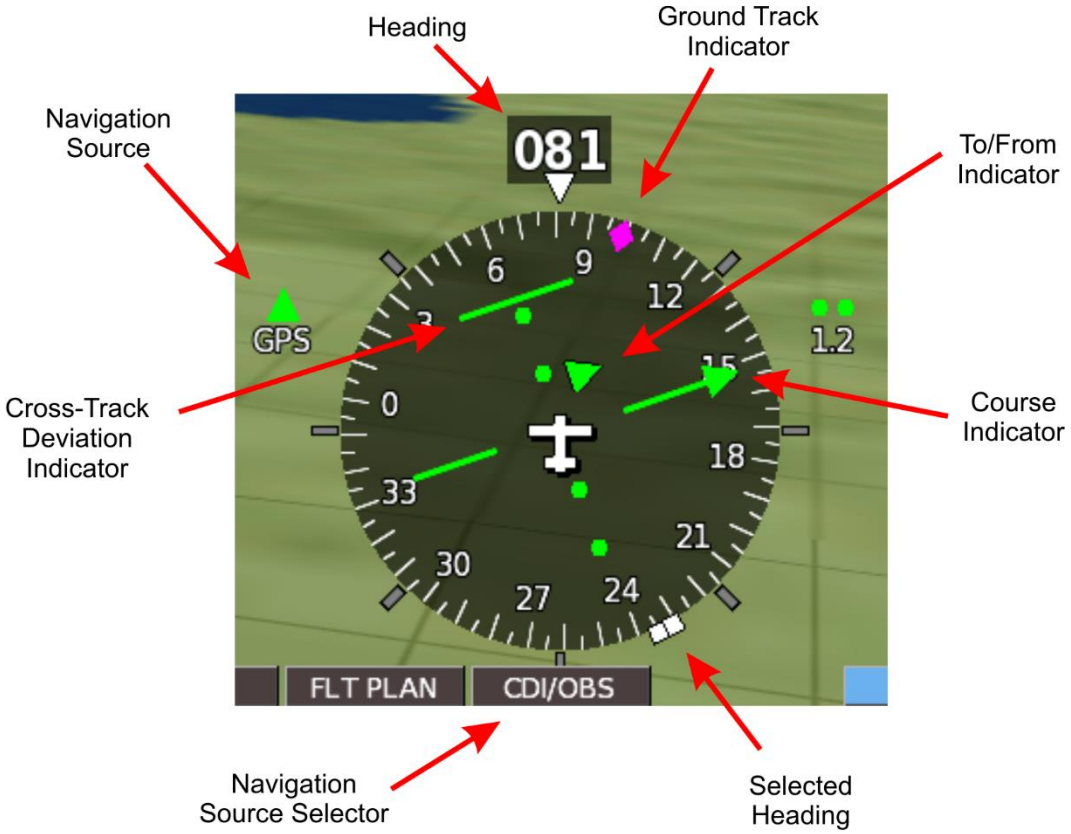
1. Turn the right knob and highlight COPY, as shown above. Alternatively, press the COPY softkey.

2. Press the knob. The system will ask you to confirm that you want to overwrite the current Internal Flight Plan with the waypoints in the External Flight Plan. Press YES.

3. The display unit will then switch to show the Internal Flight Plan editing page (blue header) with the waypoint sequence copied into it.

8.12 Horizontal Situation Indicator (HSI)

The EFIS includes an HSI that operates like a conventional mechanical HSI, overlaid on the PFD and via the MAP OPTIONS, "SHOW" selection. The HSI normally uses the heading to drive its compass card (the 360-degree circle marked in magnetic degrees), and displays the selected or desired course relative to the compass card with a cross-track deviation indicator. The EFIS navigation mode sets the HIS navigation source data, and can be can be GPS, VOR or LOC. One or two bearing pointers are also included. A ground track indicator is included when GPS ground track is available to simplify compensation for cross-winds when following navigation radio sources.



Horizontal Situation Indicator Elements

- **Vertical Compass Card Presentation:** This is driven by magnetic heading, when available, and GPS ground track when it isn't.

- **Magnetic Heading/Track:** The present magnetic heading/track is displayed in large numbers at the top, with a "HDG" or "TRK" indicator to distinguish the source.

- **Heading Bug:** A small rectangle, either white (inactive) or magenta with a green radial line (active lateral autopilot mode); moves around the compass card according to the selected heading. The heading bug position is set with the left knob. Selected heading drives the autopilot/flight director.

- **GPS Track:** Shown by a magenta diamond Aligning the course pointer between this diamond dashed lines will result in flying the desired course.

- **Desired/Selected Course Needle:** Represents the active nav course. The center segment of this needle is a course deviation indicator. It is blanked when no data is available (such as when there is no flight plan in GPS mode or when LOC or VOR data is flagged.) It deflects laterally over the dotted course deviation scale to indicate how far the aircraft is off course.

- **To/From Indicator:** A green triangle that appears when tracking a VOR radial or GPS waypoint; TO points toward Course Selection Pointer head while FROM points toward Course Selection Pointer tail.

- **Bearing Pointers:** Arrow heads (chevrons) and tails (short line segments) that point in the direction of the GPS waypoint or nav radio direction. Nav1 is white, Nav2 is cyan and GPS is green. In the screenshot above, the green GPS bearing pointer is pointing at the airport, which is the goto waypoint in the flight plan.

  NOTE: Bearing pointers are presented as unconnected heads and tails for decluttering purposes. To view them as solid lines, go to Set Menu > Moving Map > Connect Bearing Pointers and select YES.

To access the HSI from the Map page group:

Press SCREEN > MAP OPTIONS and set the "SHOW" selection to HSI.

8.13 Navigation Using VOR/LOC

The EFIS supports one or two traditional navigation radios, providing course selection and deviation display.

These functions are further enhanced with:

- Automatic localizer inbound course setting.
- Autopilot/flight director coupling.
- Automatic capture of the localizer changes EFIS navigation autopilot modes.
- Ground track indicator to simplify tracking in crosswinds.
- Display of lateral and vertical deviations on the Primary Flight Display.
- Flight path marker and runway depiction to enhance situational awareness on approaches.
- LOC/ILS drives Highway-in-the-Sky, reducing pilot workload.

These enhancements significantly simplify use of navigation radios during approach, providing inexpensive means of satisfying FAA navigation requirements for IFR approach.

8.13.1 Initializing VOR/LOC Navigation

1. Tune the VHF nav radio frequency to a VOR or ILS that is within range.

2. If flying on autopilot, switch to HDG mode while you set up the VOR/LOC.

3. From the PFD page, press any softkey to bring up the NAVE MODE softkey. Select the appropriate radio to make it the active EFIS navigation source. The nav radio data will now drive the HSI displays and will appear on the PFD screen if you have configured the EFIS to do so.

8.13.2 Setting the Selected (OBS) Course

- Turn the right knob on any MAP page, including the Map HSI page, to set the OBS course.

Radios that use SL30 protocol can be set up so that the OBS knob on the radio face adjusts the OBS course on the EFIS.

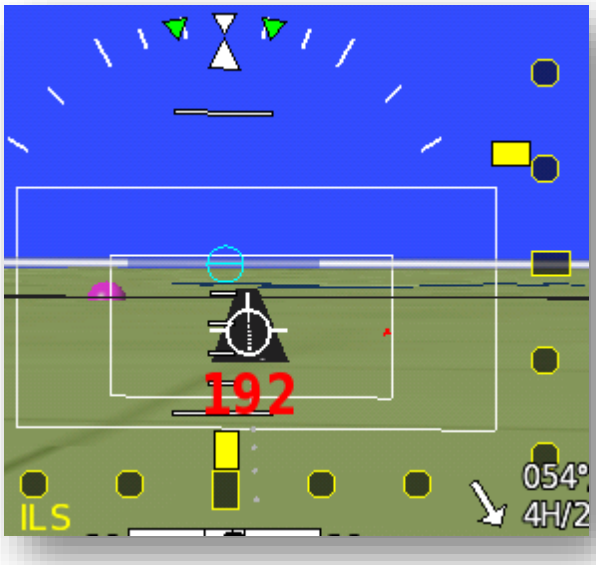
To set it up:

1. Go to Set Menu > General Setup > SL30 OBS Source.

2. Select SL30 Nav Head. Save settings.

8.13.3 VOR/LOC CDI Display Options on the PFD

The CDI can be displayed as NEEDLES or SCALES on the primary flight display, as shown here, or may be inhibited. Needles are more familiar to many general aviation pilots. The scales are more common to airline pilots and are preferred to reduce clutter in the center of the PFD screen, and are the recommended setting.



"Scales" CDI presentation

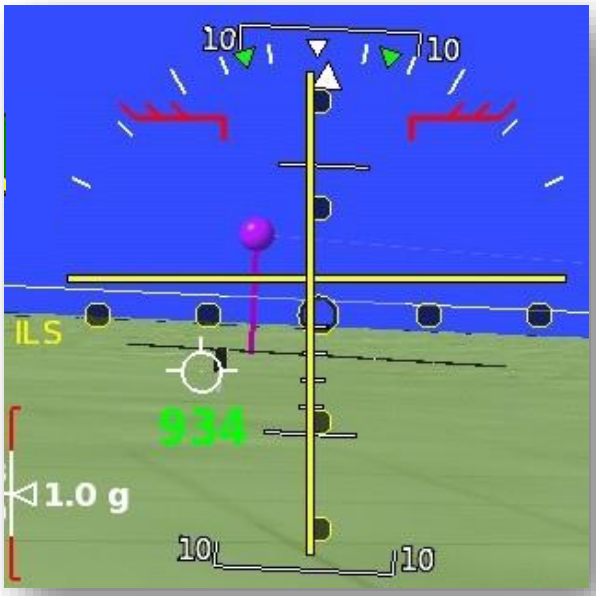
To setup:

1. Go to Set Menu > Primary Flight Display.

2. Scroll to **ILS Type** and select "Needles" or "Scales." Choose "Off" if deviation displays on the PFD are not desired.

3. To display Synthetic Approach HITS boxes on the ILS, as shown here, scroll to **ILS Inhibit of HITS** and select "NO" (SAP must also be armed during ILS approach.)

4. See EFIS Setup Guide for more VOR/LOC CDI options.



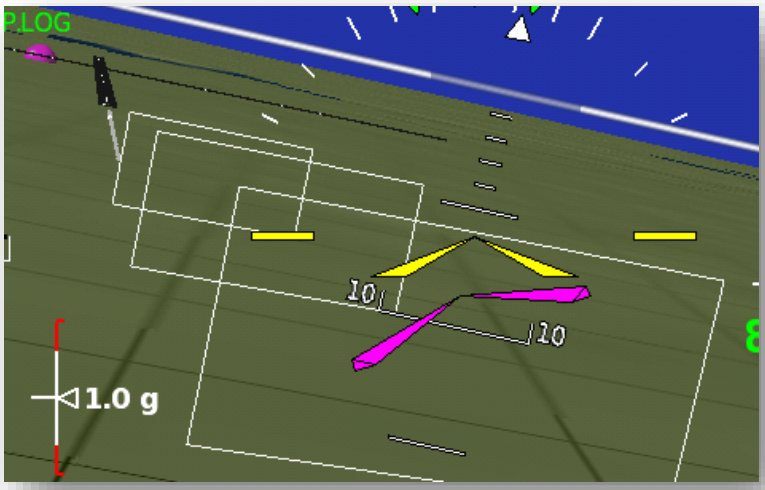
"Needles" CDI presentation

9 Autopilot, Flight Director and Navigation Mode Display

9.1 Overview -- No Servos Required…

With GRT autopilot servos the EFIS provides comprehensive roll and pitch autopilot functions, but even without servos ***the autopilot function provides a single cue flight director guidance that simplifies hand flying.*** Commercial pilots may recognize it as a tool that's commonly found in larger aircraft. 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.

We recommend that all pilots, especially VFR pilots without an autopilot, familiarize themselves with this useful feature, as it can simplify instrument flight if you unintentionally enter IFR conditions.



The flight director commanding a pitch down/roll left to capture the synthetic approach. The flight director simplifies hand flying.

Annunciation of the Autopilot/flight director and navigation modes is essential to keep the pilot aware of what the automation is and will be doing. The EFIS incorporates indicators that display current *and* pending modes. Display of pending modes, such as the capture of a synthetic approach or temporary loss of navigation data that results in reversion to heading hold mode is especially useful.

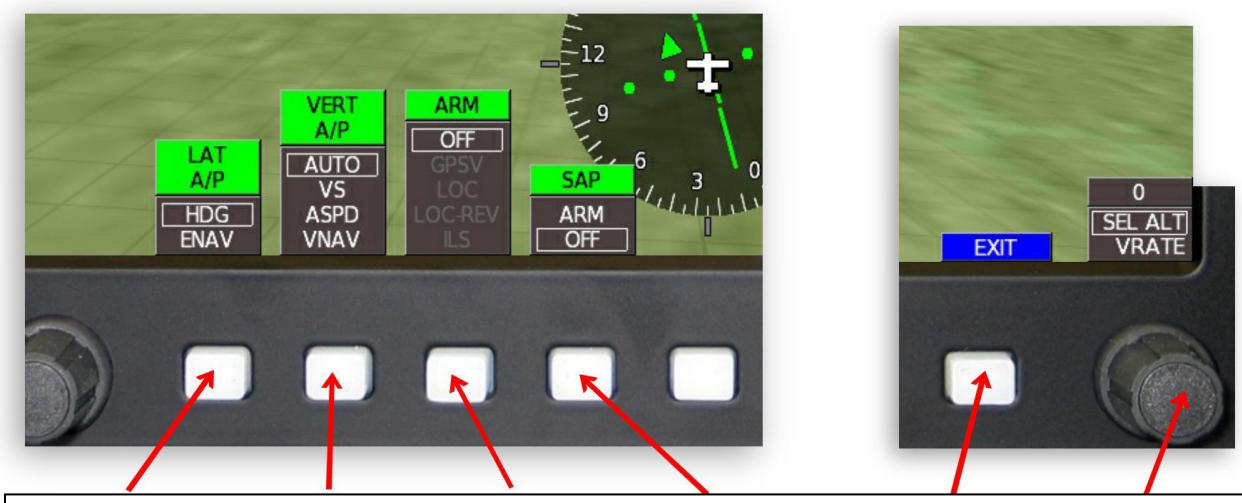
Autopilot/flight director modes are shown above the airspeed and altimeter tapes. If servos were installed, their status would be shown also.

9.2 Autopilot Mode and Target Selection

Whether hand flying using the flight director, or engaging the autopilot servos, the mode and target selections are made the same way.

The autopilot/flight director controls are displayed by pressing the right knob from the PFD screen.

This displays the first of two menus, the mode and altitude selections.



The autopilot controls shown here. The autopilot controls are displayed when the right knob is pressed from the PFD screen for all GRT EFIS models, allowing a mixture of GRT EFIS types while maintaining a common autopilot interface.

9.3 Selecting Autopilot Modes

The Lateral Autopilot mode selections. The GNAV mode is provided when a GPS with roll steering is connected to the EFIS. This is common with approach GPS navigators, allowing the GPS to fly around holds and procedure turns.

HDG – Flies to the selected heading.
ENAV – Couples to the EFIS navigation mode, including GPS, Localizer or VOR
GNAV – Follows steering from a GPS that provides roll steering commands.

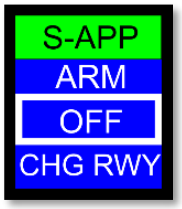
The Vertical Autopilot mode selections. "AUTO" is most commonly used for climbs and descents, as climbing on a selected airspeed accounts for reduction in climb performance as altitude increases. Vertical speed on descent allows easy selection of a descent that ends near the airport.

AUTO – Climbs on selected airspeed. Descends on a selected vertical speed.
VS – Climb and descent at a selected vertical speed.
ASPD – Climb and descent on a selected airspeed.
VNAV – Couples vertical steering to vertical navigation source, such as ILS glideslope, GPS approach, or synthetic approach.

Arming functions. These allow automatic capture of the approach when conditions are suitable. When capture occurs, the autopilot/flight director mode is set to ENAV or GNAV (if needed) and the EFIS navigation mode will change as needed.

OFF – No arming selected.
GPSV – Vertical coupling to the GPS approach occurs when GPSV guidance becomes valid.
LOC – Capture of the localizer will occur when valid and according to intercept angle
LOC-REV – Capture of the localizer backcourse when valid and according to the intercept angle
ILS – Capture of the glideslope will occur automatically after capture of the localizer.

Synthetic Approach is always armed, allowing the EFIS to switch its autopilot mode as needed to fly you down the approach when conditions are right. A "Display Only" option is provided when an instrument approach has been armed which displays the highway-in-the-sky while coupling remains to the instrument approach navigation source.



ARM – Arms synthetic approach for the destination airport and will prompt you for the desired runway. See the "**Error! Reference source not found.**" section.
OFF – No synthetic approach armed
CHG RWY – Allows changing the runway after S-APP is armed.

TIP: The autopilot will always bank in the direction of the shortest distance to the selected heading. Make all heading bug adjustm1ents that are more than 180 degrees in two or more smaller increments to "guide" it in the correct direction.

9.4 Selecting Autopilot Targets

9.4.1 First Autopilot Menu

The right knob sets the selected altitude from the first autopilot menu. This altitude is also used for the altitude alerting function, and for display of the green arc on the map showing where you will be when you reach this altitude.

After setting, pressing the right knob selects the second autopilot menu where the knob is used to set a vertical rate (airspeed or vertical speed target) for the climb/descent.

The left knob sets the selected heading. Pressing it sets the selected heading to the current heading. The heading selection function is commonly used. The main function of the left knob on the PFD and MAP pages is heading selection, allows the pilot to alter it easily.

9.4.2 Second Autopilot Menu

The second autopilot menu appears after the right knob is pressed again. In addition to allowing setting of the vertical rate using the knob, this menu provides two pre-sets for convenient selection of this target. Presets are available for climb and descent on an airspeed or vertical speed. They are set on the Set Menu > Primary Flight Display settings menu.

The second autopilot menu provides shortcuts to allow conveniently selecting climb/descent rates. The flight director is also turned on here.

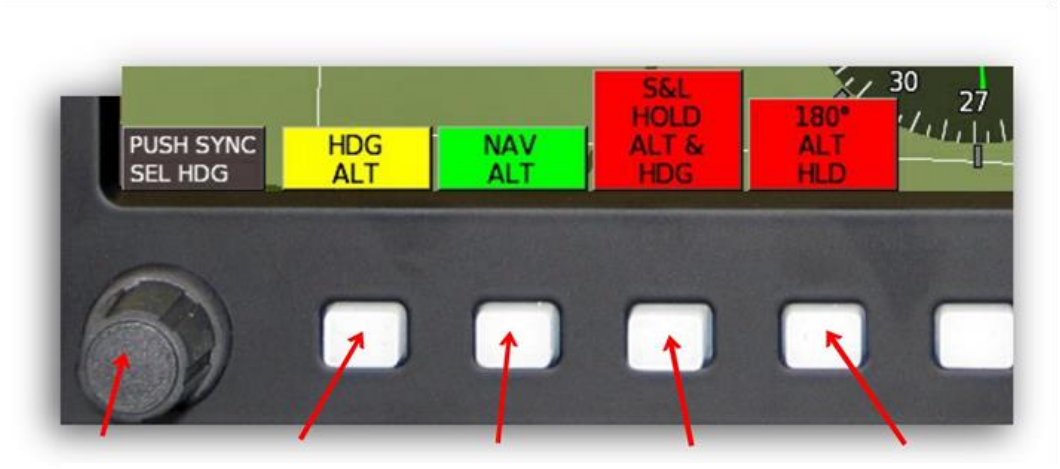
The flight director is also enabled on the second autopilot menu. It will default to "OFF" at power-up of the EFIS.

9.5 Engaging the Autopilot

When servos are connected to the EFIS, pressing the "Engage" button activates the servos. The autopilot will immediately roll the airplane level and begin holding the current heading, while holding the current pitch attitude. This allows engaging the autopilot in a climb or descent. The autopilot shortcut menu is also displayed.

9.5.1 Autopilot Shortcut Menu

This menu provides a convenient means to select common modes. The right knob can also be used to set the autopilot modes and targets as described above.



This menu appears when the autopilot is engaged. The "Straight & Level" button conveniently sets bugs and modes with a single push.

TIP: Coupling the autopilot to the GPS when off course will result in the autopilot turning to capture the current leg. To avoid this, reset the direct-to (when on a direct-to flight plan) or us the "Go Direct" function from the sequence flight plan to fly from your present position directly to the waypoint.

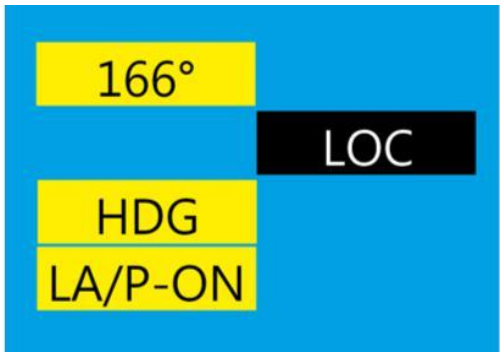
9.6 Mode Display

Pilot awareness of the autopilot mode and target is essential. This information is always displayed on the PFD page above the airspeed and altimeter tapes, along with any modes that may be pending. Pending modes occur when the pilot has armed automatic capture of an approach, or when navigation data becomes unavailable, such as loss of VOR data when VOR mode has been selected.

9.6.1 Lateral Autopilot Mode and Target Annunciation

Annunciator Field Label Format **Example**

Active	Pending
Target	
	Navigation Source
A/P Mode	
Servo Status	



In this example the localizer data was lost, so the EFIS switched the heading hold mode, and is holding the last heading of 166 degrees. Localizer mode is pending and shown in the pending column until valid localizer data returns. The lateral autopilot is on, as indicated by the "LA/P-ON" indicator.

9.6.2 Vertical Autopilot Mode and Target Annunciation

Annunciator Field Label Format **Example**

Pending	Active
	Target Altitude
Vertical Navigation Source	
	A/P Mode
	Servo Status

In this example the pilot selected VNAV for the vertical autopilot while the EFIS navigation mode was navigation radio (NAV), but no valid glideslope data was available. The EFIS maintained altitude hold and showed glideslope as pending. This technique for coupling to the glideslope is not recommended. The ARM feature should be used, or VNAV mode selected after the localizer is captured.

9.7 Color Coding

Modes indicators are color coded to provide intuitive awareness of the navigation, autopilot modes, and active steering cues.

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 - Current GPS flight plan leg, steering bugs that are active based on the autopilot/flight director navigation mode, waypoint balloons

10 Remote Transponders

EFIS's simplicity of controlling remote transponders make them popular with GRT EFIS systems. The pilot interface and display are similar to traditional panel mounted transponders. Remote transponders save panel space, provide a cleaner instrument panel appearance and allows for other equipment that is more beneficial to the pilot.

The transponder controls provide for setting the squawk code and mode.
The "AUTO" mode allows the EFIS to control the transponder mode.

10.1 Accessing Transponder Controls

The transponder controls can be accessed by the radio rack selector, as described in section "5.2.4.1 Device Selector and its Shortcuts" on page 13. When the transponder is selected, its controls appear as shown below:

The MODE softkey provides the following transponder modes. Mode changes are effective when they are made and are not undone by pressing CANCEL:

- **STBY:** Transponder will not respond to radar interrogations.
- **AUTO:** The EFIS uses its air/ground sensing logic and transponder type (Mode S or C) to set the transponder appropriately. In most cases, AUTO mode should be used, as this eliminates the need for the pilot to remember to set the correct mode.
- **ON:** The transponder will reply to radar interrogations but will not provide altitude encoding.
- **ALT:** The transponder is active (will reply to radar interrogations) and will provide altitude encoding.

- **CANCEL:** Exits the transponder menu without changing the transponder squawk code. Any mode changes made will remain.

- **1200:** Sets the squawk code to the VFR setting (this setting can be changed on the General Setup menu.)

- **IDENT:** Activates the identification mode of the transponder.

10.1.1 Setting the Transponder Code

The transponder code is set by pressing the "CODE" softkey. The following menu will appear.

The squawk code is set by pressing the "CODE" softkey. The above menu will appear and the code is entered by pressing the knob/softkeys below the digits. When the four digits have been entered into the tranponder scratchpad (identified by the red arrow), the "ENTER" will appear, and this softkey is pressed to complete the setting.

10.2 Transponder Display

The EFIS provides a continuous display of the transponder mode and status in the upper right portion of the screen. When the transponder mode is set to AUTO, the mode will be displayed in green and will change as the EFIS controls it. When the transponder mode is white, AUTO mode has not been selected and the pilot is responsible for controlling its mode.

A small square to the left of the transponder code (not shown here) will flash when the transponder is interrogated.

When IDENT is active, the transponder mode will alternate between its mode and IDENT.

If the transponder is not communicating with the EFIS, or indicating it has failed, the transponder display will be grayed out and overwritten with a red X.

10.3 Squawk and Mode Control from Multiple Display Units

For installations which include more than one display unit, the pilot may control the transponder from any display unit which was configured to share transponder control via the inter-display unit link. See the **EFIS Installation Manual** for transponder control setup.

10.4 Redundant Transponder Controllers

For installations which include more than one display unit the installation may include a provision for redundant control of the transponder. The redundancy allows continued control of the transponder when the display unit normally used to control it is failed.

The pilot actions to use this redundancy are as follows:

- When a Trig TT22 is used with the dual interface module, no pilot action is required. The module will use both of its serial inputs to control the transponder.

- When a transponder's RS-232 input is connected to two display units via a switch, the switch must be set to select the functioning display unit.

- Redundant control of a transponder that uses RS-485 is not supported at this time.

11 Graphical Engine Monitoring

When connected to the Engine Information System (EIS), the EFIS provides all data necessary to monitor engine performance. Warnings are provided for all data, making detection of unsafe engine conditions easy, and relieving the pilot of much of the traditional engine monitoring duties.

In addition to the typical engine monitoring functions, the EFIS includes several engine monitoring functions that are unique to GRT Avionics. These are based on our extensive experience in this area. They are described in the "Enhanced Engine Monitoring" functions section below.

Engine displays are provided via dials databoxes, and graphical indicators as described below.

Support for Vertical Power electrical system control is also included with an additional engine page when this system is interfaced with the EFIS. This page is accessed by pressing the VP-X softkey that appears after the "SCREEN" softkey is pressed.

11.1 How to use the Graphical Engine Monitoring

During primary flight instruction we are taught to monitor our engine instruments. However, pilot monitoring is unlikely to detect engine problems. Alarms, with their ceaseless testing of limits, never miss an out-of-limit condition. I recall a story about the first airplanes to circle the world where the pilot noted oil streaming out the engine and covering the fuselage, AFTER which he noted oil pressure was zero. Without alarms, there is little chance of detecting abnormal conditions before the engine makes them known.

Still, displaying of engine data has its place. Certainly, we derive a sense of confidence when we observe engine operation appears normal, and when it comes time to interact with our engine, such as when power is set, or leaning, we focus on these measurements. This is a small portion of the flight but motivates us to have this data available.

Maybe we can do a bit more? Maybe we can use our pilot to leverage our ability to increase our insight into engine operation? This should be the primary consideration of what data you should choose to show when you set up your engine displays.

The most valuable data for detecting and providing insight into an engine problem will not be the traditional RPM, oil temperature or pressure we are required to have. It won't even be CHT or EGT, or fuel flow. It will be the EGT time history.

EGT time history shows a graph of the last 2 minutes of EGTs. This single graph includes about 500-750 measurements, presented in a way that our pilot can see changes and detect patterns…including patterns of unusual operation. It is the insight this provides that makes maximum use of what our pilot brings to the game…his powers of observation.

EGT time history is not a conventional instrument. We rarely have prospective customers ask us if we provide this function. But it is EGT time history that you will find brings you the greatest awareness of engine operation. Learn to use it. All it requires is looking at it. Make it a goal to show it at all times, and certainly on takeoff and when flying near the ground.

Equally important, we recommend showing all fuel levels and totalizer on a single dial using the "Fuel (combined)" dial setting. Read about this below in the "Recommended Fuel Display Configuration" section.

While you are at it, learn about specific fuel consumption. You will be surprised how often you will find yourself cruising at less than an optimal mixture setting.

11.2 Graphical Engine Monitoring Displays

Engine data is displayed in various forms on the full and split PFD pages, full map page, and the engine/map page as shown in the following figure. Insets may also be used to show specific groupings of engine data as described in "5.4.6 MAP and PFD Insets" on page 26.

Engine data is commonly accessed via the areas shown above outlined in red. Insets may be used to show additional engine data on the map full screen also. An upcoming software update will be bringing EGT time history to the PFD/MAP/Engine split page.

11.2.1 Types of Engine Displays

Databoxes – Up to 8 user-definable databoxes. These databoxes appear on all pages except the MAP/PLATE page. These boxes change color when limits are exceeded making them ideal for detecting a go/no-go condition during takeoff, such as low fuel or oil pressure. These databoxes are configured via the SET MENU > Graphical Engine Monitoring > Box 1 thru Box 8 Settings. The text for these boxes is selectable as white or gray.

Dials – Up to 4 user-definable dials. These dials appear on the full and split PFD page, and in the ENG/MAP page (horizontally). The dials are configured via the SET Menu > Graphical Engine Monitoring > Dial #1 thru Dial #4 settings.

Strips – These provide a combination of data, including the databoxes, dials, and bar graphs, as well as some fixed displays. A vertical strip is available on the MAP page, and a horizonal on the PFD split page.

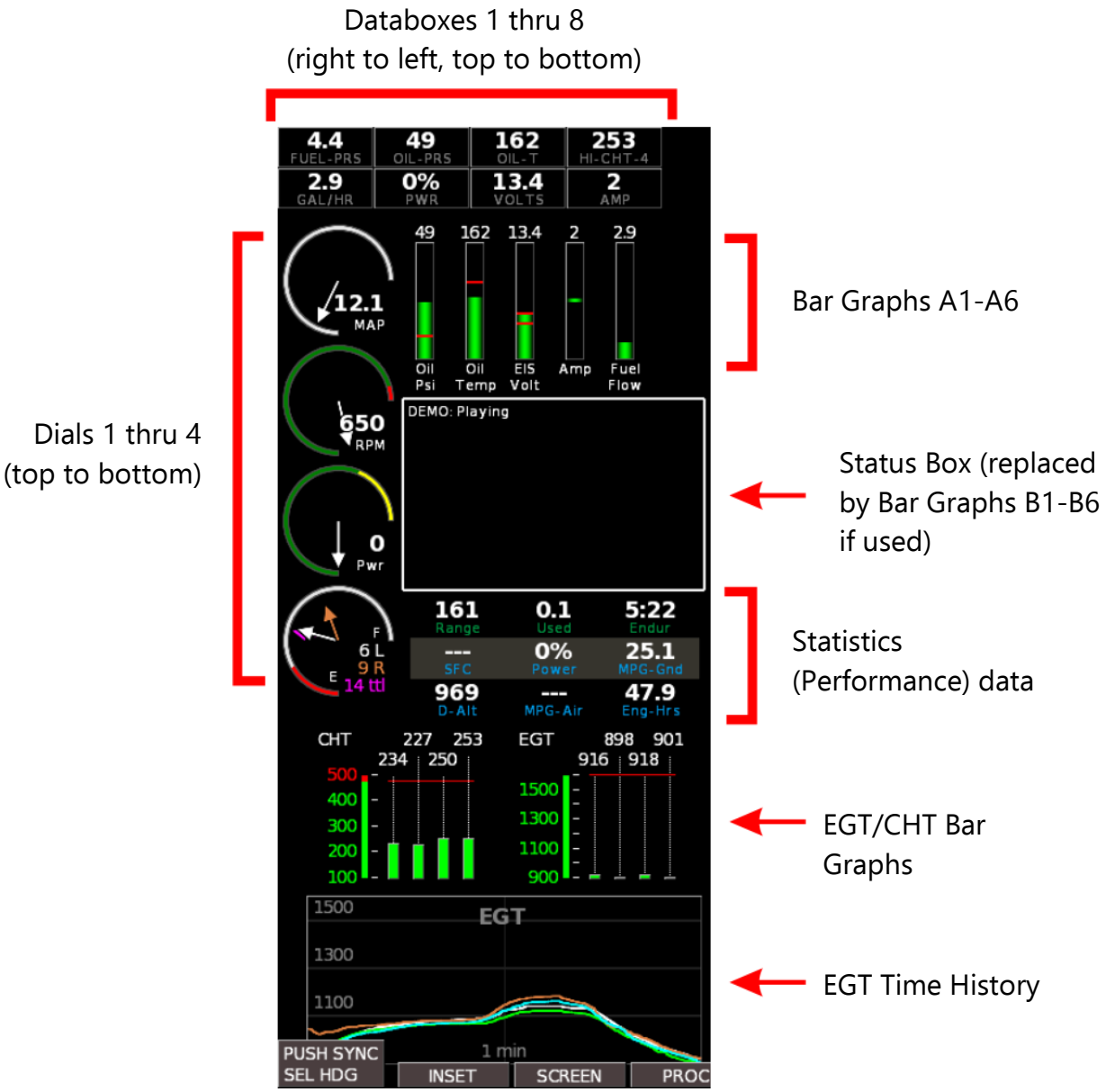
Insets – These provide various combinations of information that is easily selectable on the PFD or MAP full screen pages.

Bar Graphs – Up to 12 bar graphs can be configured.

Up to 4 databoxes are also definable for the PFD/Plate split page. These databoxes are configured via the SET MENU > Graphical Engine Monitoring > PFD/PLATE Box 1 thru PFD/PLAT Box 4 settings.

11.2.2 Engine Monitoring Strip

The engine monitoring strip displayed on the ENG/MAP view provides the single most comprehensive engine display.



11.2.3 Engine Display Elements

The full-screen engine pages include a portion that is fixed, and a portion that varies depending on which engine page is selected. The fixed data includes a fuel group, main dials, bar graphs and data boxes. These groups all include customizable features and are configured on the Set Menu > Graphical Engine Display page; they should be considered permanent mainstays of the Engine Page display. The Variable Group can be easily changed in flight by the pilot by pressing Next > Data. These pages are described in the previous sections.

11.3 CHT/EGT Tools

Exhaust gas temperatures reveal much about the health of the engine. They vary with the mixture, power setting, and load on the engine. During the cruise portion of the flight, these variables are fixed, making changes in exhaust gas temperature due to engine problems easier to detect. By paying attention to the EGT readings, especially changes in EGT of each cylinder, you can detect a host of cylinder-specific problems difficult to detect by the human senses. Precise EGT monitoring is also a great tool for saving fuel.

11.3.1 What and Why of CHT/EGT Time History

Traditional CHT and EGT temperature gauges display current temperatures, but without the full attention and constant monitoring by the pilot, reveal nothing about changes or trends. Even with constant attention by the pilot, it is practically impossible to observe changes and trends in 4 cylinders. But it is these changes and trends that reveal much more about engine operation than the current temperatures. With this you can determine if perceived engine roughness was real or imagined, if an engine problem is associated with one cylinder, or the entire engine, if leaning is progressing normally, and much more. Something as subtle as a single spark plug failing in cruise (which results in only the slightest engine vibration) are easily discernable as that cylinder's EGT increases as much as 50 degrees. In short, EGT/CHT time histories, exclusive to GRT Avionics, are the only practical way to detect a large variety of developing engine problems.

11.3.2 CHT/EGT Time History Display

All full screen engine pages include EGT and CHT time history graphs, differing between pages only in their size. The graph shows a two-minute window. The right side of the graph represents the current time. The last 10 minutes of history may be reviewed by turning the right knob. When the most recent two minutes is not being displayed, the temperature range is replaced with the age of the information being displayed.

The 10-minute window allows a pilot to remain focused on flying tasks until their workload permits an in-flight review the data. Data recording features can also be enabled to record engine data to a USB memory stick for later review on the ground.

EGT time history provides the most insight into engine operation. Practically any change in the engine's operation will cause a change in exhaust gas temperature. During periods of throttle movement or varying loads on the engine it can be difficult to determine if small changes are abnormal, however this is not an issue in cruising flight. Even during

climbs and descents temperatures change slowly, making it easy to notice sudden changes that are associated with abnormal engine behavior.

If (or when) you suspect the engine might not be running normally, make it a habit to look at the EGT time history. Problems with a single cylinder will be noted as one EGT abruptly changing more than the other EGTs. When a problem causes a significant loss in power in one cylinder, the EGTs for the other cylinders will drop as they take on more of the load, but not as much as the bad cylinder. If all cylinders show a significant change, up or down, the problem is affecting the entire engine. For example, in one magneto quits, all EGT will rise significantly.

In time you will find that the EGT time history will be the first place you look to reassure yourself at time when you are unsure. We find this is our most common use for the EGT time histories.

Depending on how your airplane is configured, you may have the option to display the EGT time history during takeoff. If this is possible, we highly recommend this, as you may, depending on the circumstances, use this to make a judgement as to whether an engine problem is likely to result in loss of the entire engine, or one that affects a single cylinder. This could impact your decision about how to react to it (head for the nearest open area, or attempt to return to the airport, for example).

Keep in mind that your EFIS supports use of a heads-up display (HUD). The HUD provides all primary flight data, allowing you to use your EFIS for engine monitoring during the takeoff.

In this screenshot all EGTs changed slightly about 1 minute ago. This was likely caused by pilot action, such as a small power change.

Cylinder head temperatures change much more slowly that EGTs, making them less useful for examining engine operation, however the CHT time history is useful for determining if pilot actions to control CHTs are sufficient. For example, during a climb in hot weather is not unusual for our RV-6A to reach our personal limit of 425 degrees. Often, we are first aware of it due to an alarm, at which time our typical response is to lower the nose to

CHT cooling trends are easily observable on the time history display. This is especially useful for verifying if pilot actions are sufficiently to manage CHT during climb.

climb at a higher airspeed, and sometimes reduce power. After we have taken this action, the CHT time history make it easy to observe if this action is stopped the increase. Note that we use a limit significantly below the manufacturers limit of 480 degrees to give us time to control the temperatures before they get close to manufacturers limit.

11.3.3 EGT Increase and Decrease Alarms

In addition to the minimum and maximum values, these limits provide alerting when any EGT changes by more than the specified amount. Separate limits are provided for increase and decrease. This alarm is active only when the normalize function is active. Normalize is activated using the "LEAN" softkey on any full screen engine page. Typically, the normalize function is activated after leaning in cruise flight, when EGTs are not expected to change much. The alarm can be reset by re-selecting the normalize function.
Some problems, such as sticking valves, can be intermittent and difficult to isolate. This alarm is ideal for alerting you when a known, but intermittent problem, is occurring. We have used this function to determine which cylinder had a sticking valve, and found it very useful. We used and decrease limit of 20 degrees, but this is a tight limit that will result in false alarms when flying in turbulence where engine loads can fluctuate.

This function may also be used routinely in cruise flight to give you early warning of unusual conditions. Limits can be established based on experience, but 50 degrees Fahrenheit is a good starting point.

11.4 Fuel Efficiency and Management Tools

Private pilots suffer from a much higher rate of fuel exhaustion accidents than commercial pilots. These accidents are avoidable, and we encourage the pilot to read this section carefully and develop good techniques for fuel management. This section provides information about tools for cruise efficiency, and for fuel management.

11.4.1 Recommended Fuel Display Configuration

The Fuel (combined) dial allows comparison of totalizer and fuel levels when properly configured.

Fuel level displays rank among the highest level of importance. While alarms do provide alerting to low fuel levels we may miss, failing to select the fullest tank for landing (who hasn't?) and other fuel management errors are responsible for many accidents. Like our recommendation for showing EGT time history to enhance our awareness, we also recommend configuring the EFIS to show fuel levels and totalizer whenever possible.

The dials provide the ideal display for fuel, and specifically, the "Fuel (Combined)" setting. Dials are displayed on the full PFD screen, Engine/Map page, and the split PFD/MAP/Engine page, without any pilot action required (as compared with insets, where pilot action is required).

In addition, the Fuel (combined) dial displays fuel levels and totalizer, and when properly configured, makes it easy to detect a fuel leak or confirm the totalizer is accurate.

11.4.2 Configuring the Fuel (combined) Dial

The goal of the configuring this dial is to scale it so that we can compare the totalizer and fuel levels easily. This is accomplished by first setting the "Fuel Flow MAX FUEL" setting to

match the total fuel capacity of the airplane. (This also sets the shortcut for re-setting the totalizer.) This will cause the totalizer needle to move from full to empty over the full scale of the dial. Similarly, we will do the same thing with the fuel levels. This is accomplished by **setting the "Dial End" to the "Fuel Flow MAX FUEL" setting divided by the number of tanks** in the airplane. In most cases the fuel level sensing will not be able to sense the first few gallons of fuel, so you may be tempted to scale the fuel dial to match what can be sensed. This is not recommended.

When calibrating the fuel level readings they should be to the maximum fuel quantity that can be sensed, and not to the capacity of the tank. This provides the maximum accuracy as the fuel level reaches the range that can be sensed. (This requires noting when the fuel level readings stop increasing as the tank is filled, and using the quantity of fuel in the tank at this point as the maximum when calibrating the fuel levels.)

Scaling the dial in this manner makes it easy to compare the totalizer with the fuel levels. When all readings are accurate, you will observe **the totalizer needle will always be between the fuel level needles**.

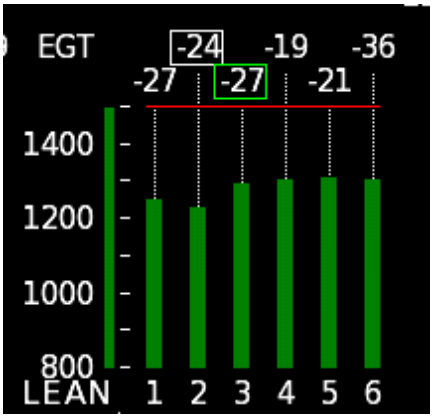
When the totalizer needle is outside of the fuel level needles, this is indicating the airplane may have less fuel on board than expected. This is common when the tanks are filled, as the fuel level indicators will be unable to measure the first few gallons in the tank, and thus show less than actual fuel. However, as fuel burns off, the fuel levels should become accurate and the totalizer needle should appear between the fuel level needles.

This scaling makes it easy to quickly determine if the totalizer and fuel levels agree.

11.4.3 Lean Assist

When Lean Assist is activated, the EFIS first clears its record of peak EGTs for each cylinder. It then continually stores the highest EGT for each cylinder as the new peak EGT, and displays how far each cylinder is from this temperature. This is show as a negative number above each EGT bar graph.

To use this function for leaning:



1. Select any full-screen engine page. The EGT page is ideal, as the large EGT time history helps you visualize your progress during leaning. Cylinders are numbered in sequence from left to right.

2. Press LEAN softkey to highlight the "LEAN" selection.

3. Slowly lean the engine. As you do, the EGTs should all increase. As the EGTs increase, the EFIS updates its internally-stored highest EGT for each cylinder. As leaning continues, the cylinders will reach peak EGT and then begin to fall.

4. Once a cylinder has fallen below peak, the value shown on the screen will switch to a negative number. The first cylinder to peak is surrounded by a white box. The last cylinder to peak is surrounded by a green box.

5. For operation **rich of peak**, use the first cylinder to peak as the baseline. After reaching the peak EGT, enrichen the mixture back through peak until the number in the white box is the desired change in temperature (typically, 50°F rich of peak.)

6. For operation **lean of peak**, use the last cylinder to peak (the green box) as the baseline. After peak, continue to lean the engine until the desired value below peak is in the green box. A manifold pressure is highly recommended to enable monitoring of **percent power** to ensure leaning is not attempted above 75% power, as most engine manufacturers warn against it.

11.4.4 Fuel Flow, Totalizer and Fuel Level Displays

The accuracy of the fuel remaining estimate (totalizer) derived from the fuel flow sensor is a valuable function for any pilot who uses their airplane for cross-country flight and is essential if using most of the airplane's fuel capacity. Additionally, it provides the rate of fuel burn which is displayed and used in other EFIS calculations to provide efficiency measurements that are useful for adjusting cruise power setting when maximum economy, maximum range, or time/fuel burn tradeoffs are of interest.

Dials are an ideal way to show fuel status, including the totalizer, and fuel levels.

NOTE: The totalizer and range data require **pilot entry of the fuel onboard** whenever fuel is added to the airplane, as described below. The totalizer shows an estimate of the total fuel on board, but not individual tanks in airplanes with more than one fuel tank.

Fuel Flow must be calibrated for full accuracy. This is simply a matter of keeping track of how much fuel is consumed according to the totalizer compared with the actual fuel used and adjusting the "FloCal" entry. For information on how to install and calibrate a fuel flow sender, please refer to the documentation appropriate for your fuel flow sender on the GRT EIS Documentation web page.

The fuel totalizer may be displayed on a dial by setting the dial to "FUEL (Combined)" or ""Fuel Flow Remaining" to show fuel levels and totalizer or just the totalizer, respectively. The dial is configured on the Graphical Engine "TTL" indicate fuel totalizer. The "Fuel Flow MAX FUEL" should be set on this set page to correspond to the maximum fuel the airplane can hold.

Bar graphs and data boxes can also be configured to show fuel totalizer data, and other data related to fuel management.

11.4.4.1 Resetting the Totalizer After Adding Fuel

The totalizer can be updated on the EIS engine monitor, or the EFIS display unit. If the EIS is mounted in the instrument panel, it should be used. This allows both the EIS and EFIS

to provide totalizer data. Updates to totalizer data will be transmitted to, and displayed on, all display units which are communicating on the inter-display link.

If the EIS with a display is mounted remotely (not reachable by the pilot), or a Remote EIS is used, the fuel quantity can be set on any display unit, but only if the fuel quantity in the EIS has been set to zero. (not necessary for the Remote EIS which does not have a display). A non-zero totalizer setting in the EIS will cause the EFIS to use the EIS totalizer data.

The Totalizer can be reset as follows:

1. From the top level (HOME) softkey menu, press, "MORE", and then "ENGINE". The following softkey menu will appear:

2. The fuel quantity you will set will correspond to to the total amount of fuel on board and includes ALL tanks. The number to the left of "BACK" is a preset of the maximum fuel the airplane can hold. (This setting is made on the SET MENU > GRAPHICAL ENGINE DISPLAY> Fuel Flow MAX FUEL setting. To set the totalizer to this value, press the softkey below it.
3. To adjust the totalizer to another value, turn the right knob to select the desired value (Enter the total fuel onboard, not the quantity of fuel you just added.) Press the knob to enter this setting.

NOTE: The accuracy of the Fuel Total value depends upon whether the pilot remembers to reset it after refueling. We suggest adding "Reset EFIS Fuel Qty" to your preflight or pre-taxi checklist.

11.4.4.2 Fuel Totalizer Errors

***CAUTION*:** Experience with a well calibrated fuel flow totalizer will show it to be very accurate. Unlike the fuel levels, it is not affected by sloshing of the fuel in the tanks that cause fuel level readings to fluctuate; its tenth-of-a-gallon resolution will further impart a sense of accuracy. The pilot is cautioned **NOT TO RELY SOLELY on the Totalizer**, as it is subject to possible sources of error. **Fuel level readings MUST BE USED by the pilot when managing fuel**. Only when the totalizer and fuel levels agree should the pilot consider the totalizer's estimate of fuel remaining when managing their fuel.

Some sources of Fuel Totalizer errors include:

- Incorrect setting of the Fuel Totalizer when fuel is added. This can be caused by fueling errors in which the airplane is not filled to capacity as was assumed. This is not uncommon when fueling on uneven ground or if fueled by someone not familiar with the airplane.

- Loss of fuel due to a leak upstream of the fuel flow sensor.

- Inaccurate setting of the "FloCal" calibration entry.

- Obstructions at the flow sensor or flow sensor failure.

- Loss of power to the EIS in flight will always result in more fuel being displayed than is actually available, since the EIS will not be aware of the fuel that is burned while it is off.
- Fuel pumps can alter the fuel flow reading depending on if they're on or not. Generally, an operating fuel pump will cause an increase in the fuel flow reading.

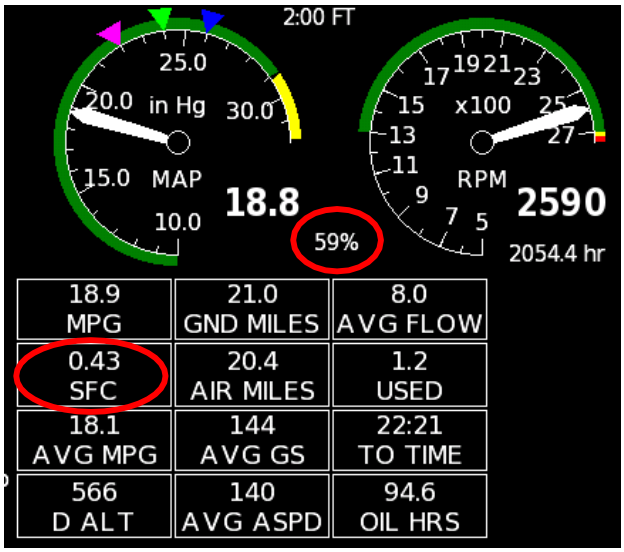
- Entering the Totalizer amount on the EFIS and then entering it on the EIS at a later time.

11.4.5 Interval Alarm

Both the EIS and the EFIS include interval alarms. For airplanes with multiple fuel tanks, good fuel management requires the pilot periodically manage the fuel in these tanks. We find the interval alarm essential for this purpose, and highly recommend use of this alarm.

11.4.6 Engine Efficiency Measurement Using SFC

A direct indication of engine efficiency, the GRT Avionics exclusive continuously computed specific fuel consumption (SFC) is ideal for verifying proper leaning and shows you when you need to lean again. SFC requires no setup. It displays the number of pounds of fuel consumed for each horsepower generated for 1 hour. A lower value indicates higher fuel efficiency (less fuel burned for the power generated.)



Circled in red, SFC is displayed in a databox on the engine STATS page, and percent power appears between the dials, just above the table.

EFIS calculation of SFC requires fuel flow and percent power calculation. Percent power requires entry of engine performance data, RPM and manifold pressure. If this is not available, or the power setting is too low, SFC cannot be computed and will be displayed as dashes. Unusually low SFC values may indicate inaccurate fuel flow calibration, inaccurate power setting table, or other sources of error. Even with such errors, the guidelines below are applicable.

11.4.6.1 Verifying Proper Leaning Using SFC

After power has been set, and the engine leaned as desired, the SFC should be reviewed. Efficient leaning should result in an SFC of close to 0.40 for a piston engine. Leaning to a richer than max efficiency will result in a slightly higher value. Regardless of your goal, consistent leaning technique should result in the same SFC, and for the most part is unaffected by power setting or altitude. Thus, SFC provides a simple way to confirm you have leaned to your goal.

11.4.6.2 Detecting Inefficient Engine Operation with SFC

Without the SFC being displayed, the only way to confirm that the engine is operating at max efficiency is to re-lean. With SFC, comparison of the SFC achieved after leaning to the current SFC indicates when re-leaning is necessary.

With Fixed-Pitch Propellers:

An increase in SFC from its normal (post-leaning) value indicates the engine is no longer operating at maximum efficiency. Every 0.01 increase in SFC represents about 2.5% in additional fuel burn.

With Constant Speed Propellers:

Any change (up or down) in SFC from its normal (post-leaning) value indicates the engine is no longer operating at maximum efficiency. While it would seem a lower SFC would indicate the engine is operating at higher efficiency, this is not the case with a constant speed propeller, as the propeller pitch will change automatically as power diminishes, resulting in an inaccurate percent power calculation.

11.4.7 Percent Power

The percent power calculation is of equal value to airplanes with fixed or constant speed propellers. The EFIS will compute percent power whenever a valid power setting table has been entered, and tachometer, and manifold pressure are available.

With percent power being calculated:

The pilot can be assured his power setting is sufficiently low enough to allow safe leaning to maximum efficiency. Typically, engine manufacturers require power settings no greater than 75%.

The specific fuel calculation can provide engine efficiency information essential for ensuring efficient engine operation.

Entry of the Power Setting Table

1. Press NEXT > Set Menu > Engine Limits

2. Scroll to Engine Performance and press the knob to access the Engine Performance table. An example for a 180-horsepower Lycoming is shown below:

Engine Performance

▶ Rated Horsepower: 180

RPM	Sea Level Performance 55% MAP	75% MAP
2000	21.6	26.7
2100	21.0	26.0
2200	20.3	25.2
2300	19.8	24.6
2400	19.2	23.9
2500	18.9	23.5
2600	18.6	23.2
2700	18.2	22.7

Altitude Performance Altitude	Delta HP
2000	2.3
4000	4.6
6000	6.9
8000	9.1
10000	11.4
12000	13.7
14000	16.0

3. Enter the values for your engine based on the engine manufacturer's documentation. The left side contains entries for the manifold pressure values representing 55% power and 75% power at sea level. The right side contains values for the change in horsepower with altitude (for a given manifold pressure, engine power increases with altitude due to a greater pressure difference across the piston. This data is derived from the power setting chart.) Estimated horsepower value charts for common engines are also located on the GRT EIS Documentation web page. Use the engine manufacturer's documentation whenever possible for the best accuracy.

12 GPS/VOR/ILS APPROACHES

The EFIS provides full support of instrument approaches.

It provides:

- Display of raw data lateral and vertical deviations, such as localizer, glideslope and GPS deviations on the PFD and HSI.
- Coupling to the autopilot and flight director.
- Loss of data alerts.
- Setting of selected course (OBS) or reading of the selected course from external sources.
- Automatic setting of inbound course for localizer approaches.
- Automatic capture of the approach.

***CAUTION*:** Test and verify all instrument approach procedures for all types of approaches you plan to fly in VFR conditions first to make sure everything works together as you intended it to. **ALWAYS** repeat the test in VFR conditions after installing any new AHRS or display unit software.

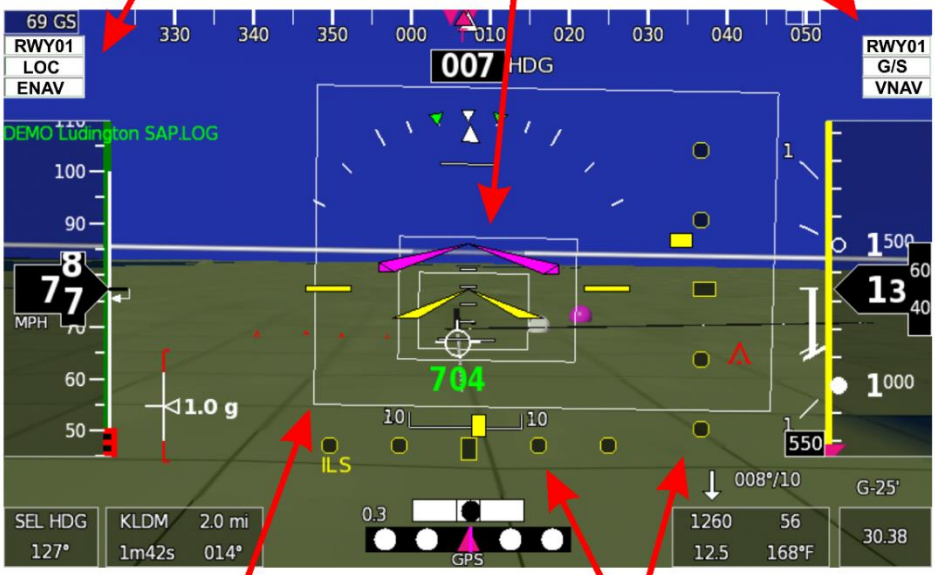
12.1 Displays During Approach

Raw deviation data can be displayed on the primary flight display in two different formats. These are illustrated in the following screenshots. The "Scales" format is recommended to keep the center of the screen de-cluttered. Use of the flight director during approach is recommended; it will force the "Scales" format for displaying raw lateral and vertical deviations from the VOR/ILS/GPS approach source.

The flight director is driven using loc/glideslope deviations. For most pilots following it results in a more accurate approach with less pilot workload. Here it is commanding a pitch up of 2 degrees, as the glideslope is above the airplane at this point.

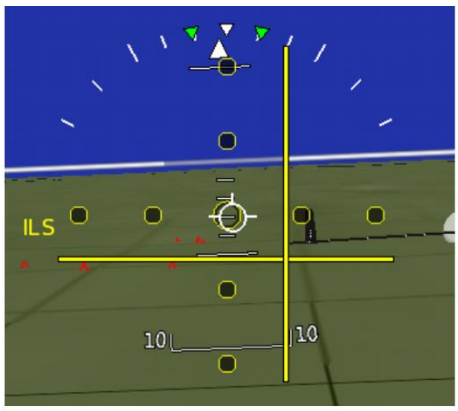
Lateral Mode shows the EFIS identified the nav radio frequency as the localizer for runway 01.

Vertical Mode shows the EFIS has captured the glideslope for runway 01.



In this screenshot the synthetic approach has been selected. Since the navigation mode is LOC/GS, and not "SAP" (synthetic approach) the boxes are dislayed only, and have no effect on the autopilot and flight director steering.

Localizer and Glideslope deviations are shown here in the "Scales" format. The "ILS" label indicates the source of the data. Note how this declutters the center of the screen. This format is also forced by the EFIS when the flight director is turned on.



The "Needles" display of deviation data follows general aviation conventions. For pilots who prefer this format, and flying from raw data (as compared with the flight director), this is an option. Scales with the flight director enabled is recommended for most pilots however.

12.2 GPS Approach

The EFIS displays GPS approach lateral and vertical deviations in the same manner they are displayed for ILS deviations. These deviations will appear on the PFD and HSI when the EFIS navigation mode is set to an approach GPS navigation source (such as a Garmin 650, Avidyne IFD440, etc.) and this source indicates the data is valid. The deviations will be identified as "GPS." Lateral autopilot/flight director coupling will occur when the autopilot mode is "ENAV" or "GNAV."

The vertical autopilot/flight director mode can be manually set to VNAV to follow the GPS glideslope. This can be done by selecting "VNAV" for the vertical autopilot mode after lateral deviations are active and captured. However, the preferred method is using the "ARM" feature. Capturing the GPS glideslope works identically to capturing the ILS glideslope. Refer to section **8-3-3: Autopilot/Flight Director Coupling to the ILS** for more details.

12.2.1 Automatic Capture of GPS Approach Glideslope

Automatic capture of the GPS glideslope is preferred, as it reduces pilot workload. This is accomplished by selecting the "GPSV" selection on the "ARM" softkey from the first page of the autopilot softkey menu. The feature will keep the vertical autopilot/flight director mode unchanged (normally it would be altitude select) until the GPS glideslope is captured from below, at which time the EFIS will change the vertical autopilot mode to VNAV and begin following the GPS glideslope.

12.2.2 GNAV Lateral Autopilot Mode

"GNAV" lateral autopilot/flight director mode uses the roll steering provided by the approach GPS instead of the guidance normally computed by the EFIS in "ENAV" mode. This can differ from the EFIS steering (and flight plan depiction on the EFIS map) as the GPS can provide turn anticipation and guidance around course reversals. The approach GPS does not provide enough flight plan information to the EFIS to provide turn anticipation and course reversals.

12.3 NAV (Radio) Mode

The "NAV" navigation mode refers to the use of a VOR/ILS navigation radio as the source of navigation data. The EFIS detects whether a VOR or LOC has been tuned on the navigation receiver and indicates VOR or LOC mode appropriately.

12.3.1 LOC and VOR Course Pointer

Unlike a mechanical HSI, the course pointer on the EFIS's electronic HSI remembers its last course setting for the VOR and localizer modes. When the nav mode is changed between VOR and localizer, the course pointer will change to the last setting it had for VOR or localizer. This allows the pilot to select one of these nav modes and pre-set the course as desired.

12.3.2 ILS—Localizer/Glideslope Mode

Setting the "NAV Mode" to "NAV" and tuning the navigation radio to a localizer frequency selects the LOC mode. This displays the localizer/glideslope deviation on the HSI deviation indicator, displays the deviation on the PFD and couples the autopilot to the localizer and selected course data. The accuracy of autopilot tracking of the localizer data is dependent on the type of autopilot, whether an external autopilot is being commanded via GPSS (GPS Steering) commands or NMEA 0183 data, and other factors. **After selecting this mode, the selected course must be set to match the runway course to provide correct sense for the HSI deviation indicator. The pilot must closely monitor the tracking of the localizer to verify acceptable performance.**

Note: The display of localizer/glideslope deviation data on the PFD will occur whenever an ILS frequency is tuned and the data is valid, regardless of the selected nav mode. (The ILS display on the PFD must be enabled via the "ILS Type" selection on the PFD settings menu.)

12.3.3 Autopilot/Flight Director Coupling to the ILS

12.3.3.1 Manually Coupling to the Localizer

The manual method requires the pilot to select the localizer navigation mode at the appropriate time and setting the autopilot/flight director mode. The localizer will be captured (if you are not already on it) in two different ways, depending on the autopilot mode.

If the autopilot mode is "NAV" before the localizer is valid, the airplane will be commanded to hold the current heading until localizer becomes valid, and then will always turn to intercept the localizer at 45°.

If the autopilot mode is “HDG,” the pilot must change the autopilot/flight director mode to “NAV” at the time they wish to begin tracking the localizer.

Since the course selection affects the steering provided to the autopilot, it is preferable to have the autopilot in the heading select mode while the inbound course to the localizer is set.

If localizer data is lost during the approach, the autopilot will revert to a heading hold mode, and the nav mode indicator will change to “LOC-HDG” until localizer data becomes valid.

12.3.3.2 Manually Coupling to the Glideslope

The Vert A/P mode can be set to "VNAV" for coupling to the glideslope whenever localizer is valid. Coupling to the glideslope will not occur until the airplane is at or above the glideslope and localizer is valid. See **Capturing the Glideslope** for more information.

12.3.4 Automatically Coupling to the ILS with the ARM Feature

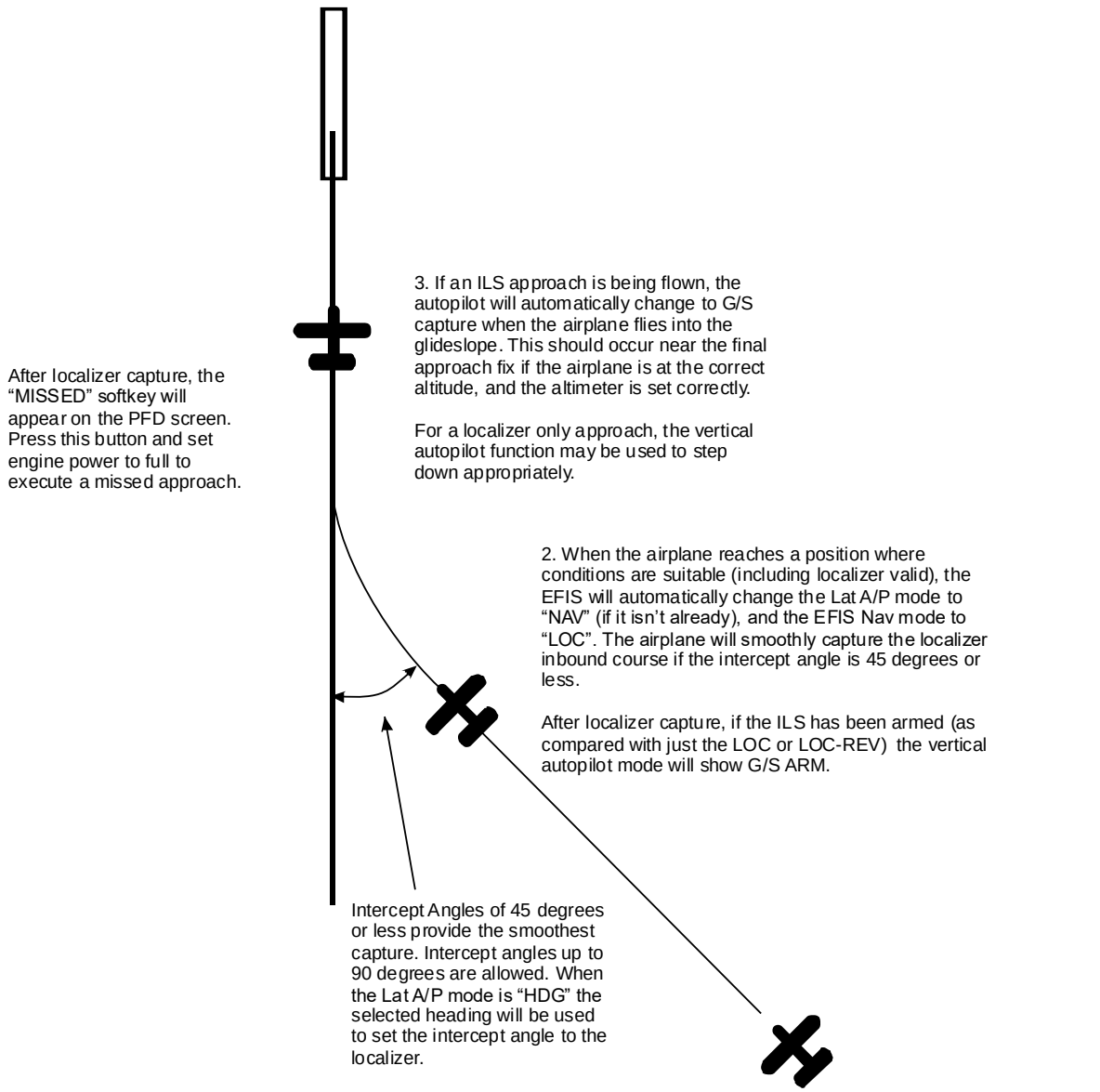
The second method of coupling the autopilot to the ILS is automatic and allows the pilot to navigate with other navigation sources (such as the GPS, VOR or a selected heading) until the localizer becomes valid, at which time the navigation and autopilot modes change automatically as needed to track the localizer with no input from the pilot. This method is preferred, as it requires less input from the pilot.

The automatic method is accomplished using the "ARM" softkey and arming the appropriate functions. The steps to accomplish this are illustrated in **Figure 8-1: Capturing the ILS with ARM**.

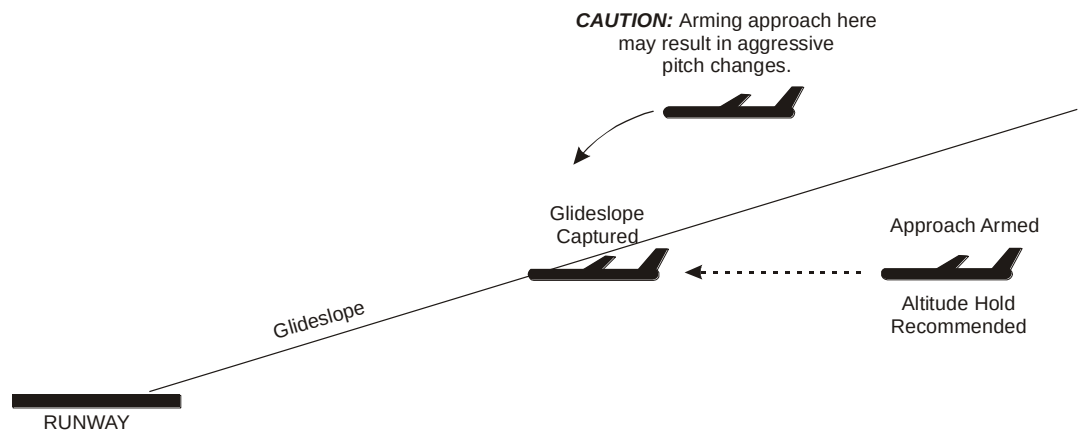
12.3.5 Flying the Localizer Back-Course Using the LOC-REV ARM Feature

The ARM function includes a "LOC-REV" selection. This selection is provided for flying outbound on the localizer front course or inbound on the localizer back course. **The selection will reverse the sense of the LOC deviations displayed on the PFD/EHSI**

pages and the commands to the autopilot, so that the localizer sensing appears as it does on a front course. This eliminates the need to mentally reverse the localizer sense. As with the other "ARM" functions, this selection will automatically switch the navigation mode to NAV (LOC) and lateral autopilot mode to NAV when the conditions are suitable, then capture and track the localizer. This function also triggers the automatic localizer course setting to select the reverse course if a match is found in the database. Whether the course is set automatically or manually, the pilot should set the course 180° from the inbound front course.



12.3.5.1.1 Capturing the ILS with ARM



The synthetic and ILS glideslope will be captured (meaning, the steering to the autopilot will begin following this guidance) when the airplane flies above it, and, in the case of the ILS, the localizer is valid and is less than +/- 2 dots. Similarly, the synthetic approach will capture the glideslope when the synthetic approach is captured, and the airplane flies above the synthetic glideslope.

If the guidance is armed above the glideslope, the glideslope will be immediately captured, but autopilot commands may result in aggressive pitch changes to bring the the airplane down onto the glideslope.

The recommended method to capture the glideslope is to approach this glideslope in altitude hold mode. This will result in the smoothest transition onto the glideslope. Capture of the glideslope will be allowed no matter what Vert A/P mode is selected however.

It is necessary to set engine power to control airspeed on the approach.

Capturing the Glideslope

12.3.5.1.2 Capturing the Glideslope

12.3.6 Automatic Localizer Course Setting

When the EFIS detects an ILS frequency tuned on the nav receiver and the pilot uses the ARM function to enable the LOC, LOC-REV, or ILS, the EFIS will attempt to automatically set the EHSI course. The EFIS will search its database to find the nearest localizer to its present position. If a localizer is found within 40 nm of the present position and the next closest localizer is more than 50 nm from the present position, the EFIS will set the EHSI course to the inbound course for the closest localizer and generate the message “Course set to Localizer Inbound XXX.”

If serial data connections to the EFIS provide the ILS frequency, the frequency will be used while the EFIS navigation database is searched. If a unique localizer is found in the database within 40 nm of the present position matching this frequency, its inbound course will be used when setting the EHSI course.

If the EFIS detects that an ILS has been tuned, but is unable to determine the inbound course, a caution message of "Set Inbound Course" will be displayed (if the display unit is currently selected to the EHSI display page).

***CAUTION*:** The accuracy of the course setting should be verified.

If the nav mode is GPS at the time an ILS frequency is tuned, a second course pointer is displayed, in white, on the EHSI, allowing the localizer course to be pre-set. (The GPS course pointer is being driven by GPS flight plan data.)

If the nav mode is VOR at the time the ILS frequency is tuned, the EFIS will pre-set its internal ILS course pointer. Since the selected course knob on the EHSI is being used for the VOR, the ILS course may not be pre-set by the pilot without changing the nav mode to LOC.

When the EFIS detects the ILS frequency is no longer being tuned, the EHSI course will be reset to its previous, non-localizer course.

12.4 VOR Navigation Mode

Setting "NAV Mode" to "NAV" and tuning the navigation radio to a VOR frequency selects the VOR navigation mode. When VOR mode is active, the pilot must select the desired course (VOR radial) using the OBS course selection on the EHSI page. The EHSI will display the VOR data in the traditional format and will couple the autopilot to the VOR data.

Note: VOR deviation data may also be displayed on the PFD's localizer display if desired using the "Show VOR CDI on Localizer" selection. If enabled, VOR deviation data is displayed on the PFD's localizer deviation indicator when in VOR mode.

When the lateral autopilot is set to "NAV," and the navigation mode is VOR, the autopilot will be coupled to the VOR. When significantly displaced from the selected radial, the autopilot will intercept the radial at 45° until it is smoothly captured. Tracking of the radial will become somewhat unstable as the airplane nears, and then passes over, the VOR. When VOR data is lost, the autopilot will hold the last heading until VOR data returns.

Typically, it will be necessary to manually select heading mode before passing over the VOR to avoid undesirable fluctuations in the tracking of the VOR.

The autopilot coupling to the VOR does not require GPS data.

12.5 ILS Approach Examples

These examples assume the autopilot includes GPSS vertical steering. These procedures still apply if your installation does not include this feature. However, the pilot will need to control the altitude manually or via manual selections, using whatever vertical autopilot functions are available directly from the autopilot control head.

12.5.1 Vectors to Localizer

1. Set the Lat A/P mode to HDG. Set the heading bug to the desired heading and engage the autopilot.

2. Tune the ILS frequency on the nav receiver.

3. ARM "LOC" or "ILS."

4. Verify that the ILS inbound course is set correctly (the EFIS will attempt to set it for you). To manually set it, set the navigation mode to LOC or GPS. This will allow you to set the LOC course pointer on the EHSI screen.

5. Fly the airplane using the heading bug. When the conditions are suitable, the EFIS will automatically change the navigation and lateral autopilot modes to "NAV" and will capture the localizer smoothly.

12.5.2 GPS Enroute to Localizer

1. Set the navigation mode to GPS and the Lat A/P mode to NAV. Select the approach procedure on the GPS and engage the autopilot (the approach procedure will navigate the airplane to the localizer intercept).

2. Tune the ILS frequency on the nav receiver.

3. ARM "LOC" or "ILS."

4. Verify that the ILS inbound course is set correctly on the EHSI screen (the EFIS will attempt to set it for you).

5. When the conditions are suitable, the EFIS will automatically change the navigation and lateral autopilot modes to "NAV" and will capture the localizer smoothly.

12.5.3 VOR Enroute to Localizer (Two Nav Receivers)

1. Set the navigation mode to whichever navigation receiver is being used for VOR and the Lat A/P mode to NAV. Tune the VOR to the appropriate frequency and set the course pointer on the EHSI page. The autopilot will track the VOR.

2. Tune the ILS on the other nav receiver.

3. ARM "LOC" or "ILS" (ideally, this arming should occur before the localize is valid, allowing the pilot time to verify/set the inbound course in the next step).

4. Verify that the ILS inbound course is set correctly (the EFIS will attempt to set it for you). To manually set it, the nav mode must be momentarily changed to LOC and then returned to VOR for continued enroute VOR navigation.

5. When the conditions are suitable, the EFIS will automatically change the navigation mode to the other NAV (LOC), using whichever nav receiver is set to a localizer frequency and will capture the localizer smoothly.

12.5.4 VOR Enroute to Localizer (One Nav Receiver)

1. Set the navigation mode and the Lat A/P mode to NAV. Tune the VOR to the appropriate frequency and set the course pointer on the EHSI page. The autopilot will track the VOR.

2. When near the localizer, set the Lat A/P mode to HDG.

3. Tune the localizer frequency.

4. Verify that the ILS inbound course is set correctly (the EFIS will attempt to set it for you). Manually set it on the EHSI page if necessary.

5. ARM the LOC or set the Lat A/P mode back to NAV. Since no LOC data is valid yet, the EFIS will hold the current heading and will show LOC-ARM. When the LOC becomes valid, the EFIS will capture and track the localizer.

12.5.5 Back-Course with LOC-REV ARM Feature

The back-course can be easily flown by following the same steps as listed above using LOC-REV on the ARM softkey. The EFIS will attempt to automatically set the course selector to the back-course, but if it is unable to, the pilot should set the back-course manually. Glideslope coupling to the vertical autopilot steering will not occur automatically in LOC-REV mode.

If the back-course is being used for course reversal via a procedure turn or hold, the following steps should be used:

1. Use the LOC-REV ARM feature to capture and track the localizer outbound.

2. When ready, set the Lat A/P mode to HDG and use the heading bug to make a course reversal. When making 180° direction changes, the autopilot will make turns in the direction the heading bug is moved.

3. On the completion of the course reversal, while flying the inbound leg to the localizer front-course, follow the procedures in section **8-5-1: Vectors to Localizer** to capture and track the inbound localizer.

12.5.6 Precision Approaches (Glideslope Coupling to Autopilot)

12.5.6.1 ILS Armed

When the ILS is Armed using the ARM softkey, the autopilot will automatically capture the glideslope when the airplane is at or above the glideslope. The vertical autopilot/navigation mode displayed in the upper left corner of the PFD will show "G/S Arm" and then "G/S CAPT."

12.5.6.2 Unarmed ILS

When the ILS has not been armed, the glideslope can be coupled by selecting a vertical autopilot mode of "VNAV." The EFIS will wait until the airplane is at or above the

glideslope before it captures. The vertical autopilot/navigation mode displayed in the upper left corner of the PFD will show "G/S Arm" and then "G/S CAPT."

12.5.7 Non-Precision Approaches—Stepping Down

The vertical autopilot modes provide a convenient method to control the altitude on non-precision approaches. Set the Vert A/P mode to either AUTO or VS. Select the desired step-down altitude and vertical speed for the descent. The autopilot will descend and hold the selected altitude. **The Vert A/P ASP (airspeed) mode is NOT recommended for approaches.**

12.6 VFR and IFR Approaches Using Synthetic Approach

Our synthetic approaches are intended for both VFR and IFR pilots; they are simple enough that any pilot will benefit from the awareness the guidance provides, even those flying by VFR. The synthetic approach mode provides lateral and vertical guidance to any runway contained within the EFIS navigation database that includes position data for each end of the runway. The vast majority of airports within the database include this information. This guidance is provided via the non-traditional highway-in-the-sky on the primary flight display page and drives traditional GPS course and cross-track deviation indicators. This approach mode can be easily coupled to the autopilot and drives the flight director for easy-to-follow roll and pitch guidance.

This feature provides the following benefits:

- Enhanced situational awareness during all landings. Reduces the chance of an unintentional low approach—especially useful at night.

- Emergency means of guidance to the runway for the VFR pilot who inadvertently enters IFR conditions.

  ***CAUTION*:** This is at the discretion of the pilot, as obstacle clearance is not assured.

- Redundant guidance during an ILS approach. The synthetic approach duplicates the ILS approach path using GPS and baro-altitude data.

- Emergency backup to ILS receiver; the synthetic approach follows the same path as the ILS, which has assurances of obstacle clearance.

12.6.1 The Synthetic Approach Lateral Path

Lateral steering for the synthetic approach will be constructed by the EFIS according to the following criteria, in order of priority:

1. **Automatic Runway Selection from an IFR GPS Source:** If the EFIS navigation mode is set to an external IFR GPS and an approach has been selected in that GPS, the EFIS will detect the airport and runway for the approach. A message will be generated confirming that the runway selected by the GPS approach was identified (for example, "Synthetic App using 26L at KGRR").

2. **Manual Runway Selection:** If automatic runway selection is not possible, but the last waypoint in the active GPS flight plan is an airport, the pilot will be prompted to select the runway for that airport from a list of possible runways. If the runway includes a localizer in the EFIS database, the approach will be constructed to mimic the localizer. Otherwise, the approach will be constructed to follow the extended runway centerline.

   ***CAUTION*:** Extended runway centerline paths have no assurance of obstacle clearance. See more about this in the "Manual Runway Selection section below.

The flight plan from the GPS that the EFIS is using must have one of these two conditions to allow it to identify the airport and runway where you intend to land to allow arming a synthetic approach.

12.6.2 The Synthetic Approach Vertical Path

The "Approach Glideslope Angle" setting on the Set Menu > Primary Flight Display menu defines the glideslope angle used for the synthetic approach. Vertical guidance will be to the runway touchdown zone (if the database includes this information), otherwise will be 500 feet past the approach end of the runway.

However, this will be overridden if the runway includes an ILS glideslope in the database. In this case, the vertical guidance will follow the ILS glideslope path. The pilot will be alerted to this by a message when the synthetic approach is armed.

12.6.3 Activating the Synthetic Approach

The synthetic approach is turned on by first "arming" it. When armed, the EFIS will begin displaying the highway-in-the-sky boxes. The EFIS navigation mode and autopilot/flight director mode are not changed until the EFIS determines the airplane is near the approach end of the runway. This allows the pilot to arm the synthetic approach far from the runway and fly to the approach end of the runway by any means, such as using autopilot heading select mode.

When near the approach end of the runway, the lateral path will be automatically "captured." When capture occurs, the EFIS will annunciate "SAP Lateral Path Captured" and will change its navigation mode to "SAP" and the autopilot/flight director lateral mode to "NAV." The airplane will now be navigated toward the runway. If this autopilot was on, it will turn the airplane toward the runway, as it will now be in "NAV" mode and will be following the EFIS navigation mode of synthetic approach.

The automatic capture of the synthetic approach can be delayed until the pilot enables it by using the "Require EXECUTE for approach" setting in the Set Menu > Primary Flight Display. This will cause an "SAP Execute" softkey to appear, that must be pressed before the EFIS will capture the approach. This can be useful to prevent the automatic capture from activating too early.

After lateral capture, vertical capture can occur. It will occur when the airplane is at or above the synthetic approach glideslope. When vertical capture occurs, the "SAP Vertical Path Captured" message will be displayed and the autopilot/flight director vertical mode will change to "SAP." The vertical guidance will now be along the synthetic approach glideslope.

12.6.4 Manual Runway Selection

For manual runway selection, the EFIS will provide a list of the available runways for the destination airport. The desired runway is selected using the left rotary knob. This list shows the runway identifier, length, surface (hard or soft), lighting and headwind/ crosswind components based on the winds sensed by the EFIS. The EFIS-sensed wind could be inaccurate or different on the surface, so the pilot should not use this to make his runway selection, but only to help him confirm his choice made by wind data from other weather observations.

The crosswind component is shown as X-Wind = speed L/R, where the speed is in the units selected on the EFIS. The L/R indicates a left or right crosswind, such that a left crosswind indicates the wind is blowing from left to right when on the approach. The EFIS will list the runways in order of how closely aligned they are with the calculated wind direction. Runways that are predicted to have a greater than 10 mph tailwind are shown with a yellow background.

After selecting a runway, it may be changed by using the "SAP" softkey using the "Chg Rwy" selection.

CAUTION: The pilot **MUST NOT** rely on this EFIS sensed wind data for selection of the appropriate runway. Wind speed and direction is usually different on the surface. The EFIS is making its winds prediction based on its calculated winds at the time the approach mode is activated. The accuracy of the wind calculation is affected by the accuracy of the pitot-static measurements and the calibration of the magnetometer.

If the selected runway includes an associated localizer in the EFIS navigation database, the message "Synthetic Approach using Loc Course" will be provided to remind the pilot that the approach will follow the localizer and my not necessarily be aligned with the runway centerline.

If the approach mode is selected, but the GPS flight plan does not contain an approach or an airport as the last waypoint that can be matched to the EFIS database, then the synthetic approach cannot be activated. The EFIS will respond with a message "No Airport found for Synthetic App" and the approach mode will be turned off.

12.6.5 Transitioning from Enroute to Synthetic Approach

If an approach has been selected in the external IFR GPS flight plan, the transition from enroute to a path that aligns the airplane with the runway will be inherent in the GPS flight plan. The synthetic approach will be considered "captured" (causing the synthetic approach highway-in-the-sky to be displayed and enabling vertical guidance to the runway) when the airplane is within 2.5° of the synthetic approach course and within 20 nm of the runway threshold, emulating the typical capture of a localizer.

When the runway has been manually selected, the EFIS will override the GPS flight plan or HDG selection to turn the airplane onto the extended runway centerline. This will typically occur when the airplane is within 2.5° of the extended runway centerline and within 20 nm of the runway threshold. A message of "Synthetic Approach Captured" will

be displayed when this transition occurs. The GPS CDI, course indicator and autopilot will then be driven by the synthetic approach.

If capture of the synthetic approach is attempted close to the runway, the EFIS will try to predict when it must begin turning onto the synthetic approach course based on groundspeed and intercept angle so that it does not overshoot the course. Since the response of the autopilot and airplane cannot be predicted perfectly, overshoot is possible and some loss of accuracy in the initial tracking of the synthetic approach may be expected.

Note: Depending on the intercept angle when the approach is captured, the turn rate available through the autopilot and other factors, pilot intervention may be required to capture the approach without overshoot. The recommended procedure for intercepting the synthetic approach is to do so at a distance of 4 nm or more from runway, at an intercept angle of 30° or less. The accuracy of the autopilot to track the synthetic approach will be maximized when the intercept occurs in this manner.

12.6.6 Step-By-Step Synthetic Approach Activation

Use the following procedures for appropriate Synthetic Approach activation:

1. Plan which runway you will use. Obtain current wind information from reported weather information. EFIS-reported winds may be different than winds on the surface.

2. Be sure you have an airport selected as the last waypoint in the GPS Flight Plan. The EFIS navigation mode, if selectable, must be in GPS mode, not LOC or ILS mode. Additionally, the LOC/ILS must not be armed.

3. From the Primary Flight Display, press the right knob to bring up the autopilot/flight director softkeys. Select ARM on the SAP softkey. Press the right knob twice to exit the autopilot/flight director softkey menu.

4. In most cases, you will be prompted to select the desired runway using the left knob. You will then be reminded to check the altimeter setting, as baro-altitude will be used for vertical guidance. Set the baro setting to what is being reported at the airport. **DO NOT** adjust the baro setting to zero the GPS altitude difference. The GPS altitude difference is provided to detect large baro setting errors **ONLY**.

5. Fly the airplane to the approach end of the runway such that you will cross over the extended runway centerline at less than a 30° angle. The EFIS will capture the inbound course to the runway automatically. The EXECUTE softkey, if enabled, must be pressed before capture will occur. The altitude of the airplane at the location you expect to crossover the extended centerline should be below the Synthetic Approach glideslope. A good rule-of-thumb is to allow for about 4 miles per 1000 feet above the runway.

   Note: Refer to section **Autopilot-Coupled Synthetic Approaches** for executing a Synthetic Approach while coupled to the autopilot.

6. Vertical guidance will begin when the airplane is at or above the Synthetic Approach glideslope. Ideally, you will start with the glideslope above you, flying at a constant altitude until you fly into and intercept the glideslope.

7. Fly the airplane down the approach by keeping the flight path marker in the center of the Highway-in-the-Sky boxes. For more precise guidance, the flight director should be used. It is turned on using the second softkey page for the AUTOPILOT menu.

8. While descending toward the runway, the GPS-Baro-Altitude difference should diminish to near zero when on the ground. This difference represents the actual deviation from an idealized glideslope due to errors induced by non-standard air temperatures in baro altitude.

!WARNING!:

- The Synthetic Approach is for VFR use only.

- The Synthetic Approach does not provide any assurance of obstacle clearance, meaning there could be obstacles or terrain present that might make the approach unsafe.

- The accuracy of the vertical guidance is directly affected by the accuracy of the EFIS baro-altitude. This means incorrect altimeter settings and errors in the altimeter and static system will cause the vertical path to be inaccurate and could cause your descent path to intercept the ground at an unsafe location.

12.6.7 Autopilot-Coupled Synthetic Approaches

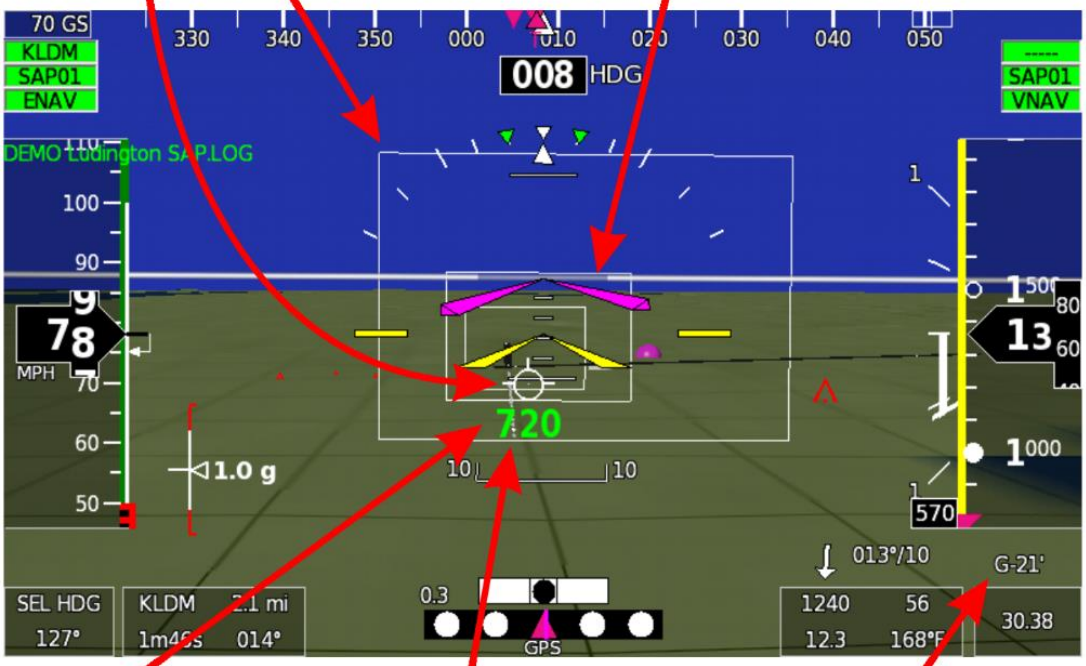
We find autopilot-coupled synthetic approaches especially useful when landing at an unfamiliar airport, at night and/or in lower-visibility conditions. Properly executed, they will place you on the extended centerline and on glidepath, freeing you to devote full attention to monitoring the progress of the approach, traffic, obstacles, etc…

To maximize the accuracy of coupled approaches:

- Slow to approach speed, set flaps for approach and trim the airplane before engaging the autopilot.
- Intercept the extended centerline at less than a 30° angle using Heading Select to navigate the airplane.
- Ensure that glideslope interception occurs from below by planning to cross over the extended runway centerline at least 4 miles from the approach end of the runway for every 1000 feet you are above the runway (at least 4 miles when 1000 feet above the runway, 8 miles when 2000 feet above, etc…).
- **DO NOT** change flap settings during the approach.
- Reduce power when the airplane captures the glideslope to maintain a constant airspeed.
- Expect that trimming may be required.
- Monitor your approach path and speed. Disconnect the autopilot and abort the approach if any aspect of the approach becomes unsafe.

Guidance is for synthetic approach is always provided by the highway-in-the-sky (HITS). Fly the flight path marker so that it passes through the center of the boxes.

The flight director is also driven during synthetic approach. Here it is commanding a pitch up of 3 degrees because the airplane is passing through the lower part of the HITS boxes.

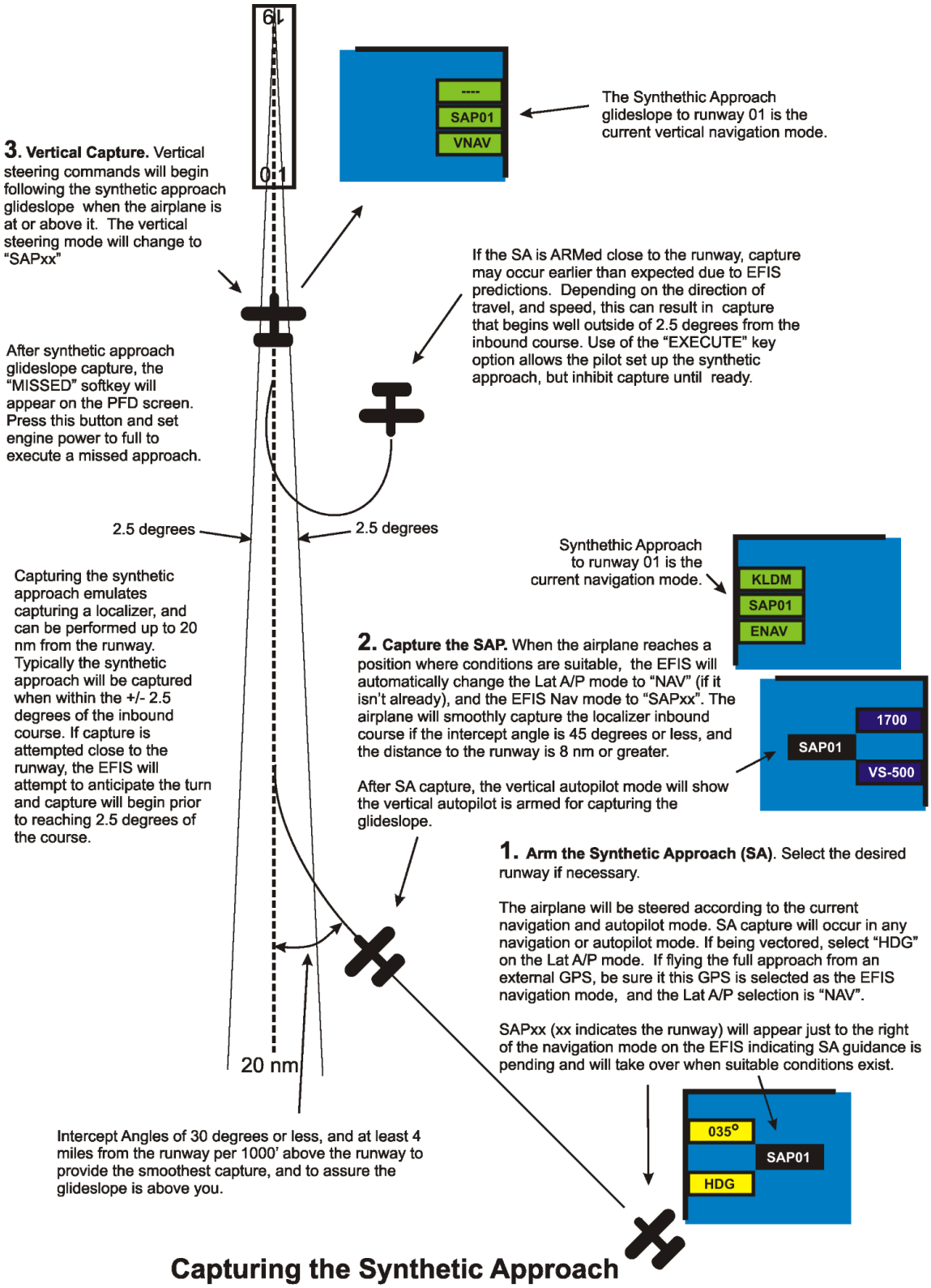


Height above the runway

Lead-in lights show the runway selected for the approach.

Difference between BaroAltitude and GPS Altitude

Synthetic Approach PFD Display



12.6.7.1.1 Capturing the Synthetic Approach

12.6.8 When is a Synthetic Approach Unavailable?

If you cannot select a Synthetic Approach, it is because one of the following conditions have NOT been met:

- The last waypoint in the flight plan is an airport and is contained within the EFIS navigation database, or an approach has been selected and the EFIS is able to determine the airport and runway being used by the approach.

- The database contains the necessary information about the selected airport, including runways, runway orientation, position, elevation, etc…

- AHRS/Air Data and GPS data are valid.

Figure **Capturing the Synthetic Approach** illustrates the necessary conditions and criteria for capturing a Synthetic Approach.

12.6.9 Synthetic Approach During LOC/ILS Approaches

When the localizer is armed or the nav mode is set to LOC, the synthetic approach mode will display the highway-in-the-sky, but will **NOT** provide steering (via the desired course and cross-track deviation indicators) or autopilot/flight director coupling. This is indicated by the DISP selection in the SAP softkey menu and the lack of synthetic approach mode indication.

Note: When displaying localizer data during the synthetic approach, it is normal to see differences in the guidance provided by these two dissimilar sets of data. This difference is most noticeable when further from the runway. When the EFIS navigation mode is LOC or ILS, the synthetic approach will still be based on GPS data (laterally), but its inbound course will be adjusted by up to +/- 1.5 degrees to more accurately match the localizer data.

13 Checklists

Checklists can be displayed on the EFIS, providing significant benefits over the use of traditional paper checklists, including:

- Readable under all lighting conditions.
- Cannot be lost or become unreachable.

13.1 Using the Checklist

Insets are displayed in an inset..

Any checklist may be displayed at any time by selecting "Checklist" from the ENG/STAT inset submenu (Inset > ENG/STAT > Checklist). The checklist to be displayed is selecting by pressing "LIST" and then using the right knob to select the desired checklist. The "ACCEPT" softkey is pressed to acknowledge a checklist item and advance to the next item. The right knob is used to scroll through this list or to skip over a checklist item.

13.2 Loading a Checklist

The default checklist in the EFIS (if loaded) can be easily replaced with one customized for your airplane. The checklist is created using any text editor, and creating a file named "checklist.txt".

A sample checklist is provided on the GRT Avionics website. The file has two elements, CHECKLIST and ITEM, and allows displaying current data using special %% codes as described below. The checklist file must have "CHECKLIST" preceding the name of a checklist. All the items in this checklist must follow and are preceded with the word "ITEM". Each "ITEM" label identifies another checklist item.

13.2.1 Recommended Checklist Names

While any checklist names may be used, an upcoming feature will require checklists with specific names to allow them to be displayed automatically. These names are:

Checklist Names
Pre-Start
Startup
Taxi
Run-Up
Takeoff
Climb
Lean
Cruise
Descent
Initial Appr
Final Appr
Taxi/Shutdown
Emergency

13.2.2 Live Data in the Checklist

Current data can be displayed in the checklist if desired. This data selected by entering a code between to percent signs. The code specifies the data the EFIS will include in the checklist as follows:

EIS1 RPM - %0%
EIS1 RPM2 - %82%
EIS1 RPM3 - %86%
EIS1 N1 - %83%
EIS1 N2 - %84%
EIS1 N3 - %87%
EIS2 RPM - %91%
EIS2 RPM2 - %92%
EIS2 RPM3 - %93%
EIS2 N1 - %94%
EIS2 N2 - %95%
EIS2 N3 - %96%
EIS1 EGT 1 - %1%
EIS1 EGT 2 - %2%
EIS1 EGT 3 - %3%
EIS1 EGT 4 - %4%
EIS1 EGT 5 - %5%
EIS1 EGT 6 - %6%
EIS1 EGT 7 - %7%
EIS1 EGT 8 - %8%
EIS1 EGT 9 - %9%
EIS1 EGT 10 - %88%
EIS1 EGT 11 - %89%
EIS1 EGT 12 - %90%
EIS2 EGT 1 - %97%
EIS2 EGT 2 - %98%
EIS2 EGT 3 - %99%
EIS2 EGT 4 - %100%
EIS2 EGT 5 - %101%
EIS2 EGT 6 - %102%
EIS2 EGT 7 - %103%
EIS2 EGT 8 - %104%
EIS2 EGT 9 - %105%
EIS2 EGT 10 - %106%
EIS2 EGT 11 - %107%
EIS2 EGT 12 - %108%
EIS1 CHT 1 - %10%
EIS1 CHT 2 - %11%
EIS1 CHT 3 - %12%
EIS1 CHT 4 - %13%
EIS1 CHT 5 - %14%
EIS1 CHT 6 - %15%

EIS2 CHT 1 - %109%
EIS2 CHT 2 - %110%
EIS2 CHT 3 - %111%
EIS2 CHT 4 - %112%
EIS2 CHT 5 - %113%
EIS2 CHT 6 - %114%
EIS1 VOLTS - %16%
EIS2 VOLTS - %115%
EIS1 FUEL FLOW - %17%
EIS2 FUEL FLOW - %116%
OVERALL FUEL FLOW - %117%
EIS1 TEMPERATURE - %18%
EIS2 TEMPERATURE - %118%
EIS1 CARB TEMPERATURE - %19%
EIS2 CARB TEMPERATURE - %119%
EIS1 COOLANT TEMPERATURE - %20%
EIS2 COOLANT TEMPERATURE - %120%
EIS1 HOURMETER - %21%
EIS2 HOURMETER - %121%
FUEL REMAINING - %22%
FLIGHT TIME - %23%
EIS1 OIL TEMPERATURE - %24%
EIS2 OIL TEMPERATURE - %122%
EIS1 OIL PRESSURE - %25%
EIS2 OIL PRESSURE - %123%
EIS1 AUX 1 - %26%
EIS1 AUX 2 - %27%
EIS1 AUX 3 - %28%
EIS1 AUX 4 - %29%
EIS1 AUX 5 - %30%
EIS1 AUX 6 - %31%
EIS2 AUX 1 - %124%
EIS2 AUX 2 - %125%
EIS2 AUX 3 - %126%
EIS2 AUX 4 - %127%
EIS2 AUX 5 - %128%
EIS2 AUX 6 - %129%
FUEL ENDURANCE - %32%
FUEL RANGE - %33%
ENGINE 1 PERCENT POWER - %34%
ENGINE 2 PERCENT POWER - %130%

EFIS VOLTS 1 - %35%
EFIS VOLTS 2 - %36%
EFIS VOLTS 3 - %37%
ANALOG AUX 1 - %38%
ANALOG AUX 2 - %39%
ANALOG AUX 3 - %40%
ANALOG AUX 4 - %41%
ANALOG AUX 5 - %42%
ANALOG AUX 6 - %43%
ANALOG AUX 7 - %44%
ANALOG AUX 8 - %45%
OAT - %46%
INDICATED AIRSPEED - %47%
TRUE AIRSPEED - %48%
VERTICAL SPEED - %49%
ALTIMETER - %50%
PRESSURE ALTITUDE - %51%
DENSITY ALTITUDE - %52%
BAROSET - %53%
AHRS ALIGNMENT - %54%
AHRS STATUS - %55%
AHRS ATTITUDE STATUS - %56%
AHRS ALTITUDE STATUS - %57%
AHRS ROLL - %58%
AHRS PITCH - %59%
AHRS HEADING - %60%
AHRS SLIP - %61%
AHRS VOLTS 1 - %62%
AHRS VOLTS 2 - %63%
AHRS VOLTS 3 - %64%
AHRS TEMPERATURE - %65%
FLAPS - %66%
AILERON TRIM - %67%
ELEVATOR TRIM - %68%
ACTIVE WAYPOINT - %69%
ESTIMATED TIME TO WAYPOINT - %70%
RANGE TO WAYPOINT - %71%
BEARING TO WAYPOINT - %72%
GROUNDSPEED - %73%
WIND SPEED - %74%
WIND DIRECTION - %75%
NAV MODE - %76%
A/P MODE - %77%
VNAV MODE - %78%
SELECTED HEADING - %79%
SELECTED COURSE - %80%
SELECTED ALTITUDE - %81%
RUDDER TRIM - %85%

13.2.3 Sample Checklist

A portion of the sample checklist is shown below. A text version of the full checklist may be downloaded from the GRT Avionics website. This example includes live data codes are included in this checklist to show fuel levels and totalizer.

```
CHECKLIST Pre-Start

ITEM Pre-Flight – Done
ITEM Avionics Master – Off
ITEM Taxi/Land Lts – Off
ITEM Alternator – Off
ITEM Breakers - In

CHECKLIST Startup

ITEM Seat Belts – ON
ITEM Headsets – ON
ITEM Verify Fuel Levels
ITEM Set Totalizer
ITEM Fuel Tank - Fullest
ITEM Master - On
ITEM Avionics Master – OFF
ITEM Throttle ¼"
ITEM Prop-Forward
ITEM Mixture-Rich1
ITEM Fuel Pump – On
ITEM Prime – As Req
ITEM "CLEAR"
ITEM Ignition-Start
ITEM Oil Prs – %25%- No OP Alarm
ITEM Alternator On
ITEM %35%V – No Volt Alarm
ITEM Fuel Pump – Off

CHECKLIST Taxi

ITEM Avionics Master – On
```

14 ALARMS, ALERTING AND STATUS

The EFIS uses on-screen messages, a warning light (controlled via discrete output), audio outputs and a status page to notify the pilot when an alarm condition exists.

They each have their benefits and shortcomings:

- On-screen messages proved the most detail regarding the fault condition, but may not be noticed immediately.
- The warning light grabs the pilot's attention more easily than the on-screen messages and is not subject to be missed like an audio alert is. The warning light activates for all alarm conditions.
- An audio alert is the most likely to be immediately noticed; however, it can be missed if an incoming radio transmission causes the audio panel to block the alert. Some alarm conditions do not generate an audio alert.
- The Status page allows alarm conditions to be reviewed at any time, but it requires the pilot to manually go through the list.

We recommend using both audio alerts and the warning light outputs. Audio alerts are essential when flying with a heads-up display (HUD), as the HUD does not show alarms, and by its nature (and intent), will tend to keep the pilot's attention outside the cockpit.

14.1 On-Screen Messages

Coincident with the audio alerting and flashing warning light output, the EFIS shows the alarm condition on-screen. This will occur on any screen except a Set Menu screen.

High-priority alarms will generate a flashing red annunciation. Lower priority alarms use yellow.

Alerts generate a MSG softkey. Pressing it provides a more detailed explanation of the alarm and options for acknowledging or inhibiting this condition.

Pressing the MSG softkey provides these options to the pilot. Holding the "HELP" softkey depressed displays an explanation of the alarm.

The SHOW softkey will bring up the display page associated with the alarm condition while it is depressed. In this case, pressing the SHOW button will display the engine page while it is depressed, allowing the pilot to quickly evaluate the engine condition beyond just the alarm condition. HELP provides a text description of the alarm.

14.1.1 Acknowledging an Alarm

Pressing the ACK button ends the alerting for this alarm and is normally the action that should be taken when the pilot is presented with an alarm. The alarm condition will occur again only if it goes away, and then comes back.

14.1.2 Inhibiting an Alarm

An alarm may also be inhibited for a short time or the remainder of the flight.
Inhibiting an alarm allows the pilot to be reminded of an alarm 1 or 15 minutes in the future. This is useful for when the pilot wishes to be reminded of the condition when they are not busy, or if their corrective actions are unsuccessful. For example, the pilot may inhibit a CHT alarm for 15 minutes during the climb out when he may be devoting more attention to engine cooling and does not wish to be re-alerted.

The FLIGHT inhibit option inhibits the alarm for the remainder of the flight. The 1 and 15-minute inhibit will re-alert the pilot if the alarm conditions still exist after that time.

Alarms that become a nuisance because they are continually being re-generated, such as from a fluctuating output (like fuel level) or a faulty sensor, can be inhibited for the remainder of the flight using the FLIGHT selection.

14.2 Audio Alerting

Audio alerting is the most effective way to alert the pilot of conditions that warrant their attention. These alerts include user options to control the type of alarms that are issued and even allow you to use your own audio files, if desired.

14.2.1 Automatic Inhibiting After Takeoff

To prevent nuisance audio alerts following takeoff, all audio alarms except those in the "Warning" category (see table below) are inhibited for the first minute after takeoff (on

ground/In air is determined based on airspeed/groundspeed). The audio alert will be generated if the condition still exists when the one-minute period expires.

14.2.2 Setting Up Audio Alerting

Audio alerting must be set up and tested prior to use. This setup is detailed in the **EFIS Installation Manual** and is summarized here.

Audio alerting is controlled on the AUDIO set menu selection near the bottom of the GENERAL SETUP menu. The audio set menu allows alarms to be enabled or disabled, altitude alerts for height above the runway and minimum descent altitudes, traffic, and volume levels. This menu also allows you to use your own audio files (the GRT-supplied audio alert files use a computer-generated voice to make it distinguishable from other audio sources).

We recommend enabling all types of alerting, including the altitude alerts. Even for VFR flying, the altitude alerts provide a reminder of your progress on the approach that are helpful. We find the 500' reminder is especially useful as a pre-landing checklist reminder (pump on, prop control forward, flaps as desired).
All audio alerts are preceded by a short chime. The volume for the chime is adjustable independent of the voice alert.

Audio Alerts			
Priority	**Alarm**	**GRT-Supplied Audio**	**Category**
1	Min Oil Pressure (Applies to Cruise or Normal Min Oil Pressure Alarms)	"Oil Pressure"	Warning
2	Landing Gear	"Landing Gear" (Repeats Every 15 Seconds)	Warning
3	AOA (If AOA is Enabled)	Tone; Goes From 10% to 100% Volume as AOA Goes From 4° Below Stall AOA to Stall AOA. Tone Repeats at 2 Hz	Warning
4	Obstacle Warning	"Obstacle"	Warning
5	Traffic	"Traffic"	Warning
5.5	Autopilot Disconnect (For Reasons Other Than Manual Disconnect)	"Autopilot Disconnect"	Warning
6	Max Oil Temperature	"Oil Temperature"	Caution
7	Max CHT	"Cylinder Head	Caution

	(Applies to Highest CHT. Multiple Hight Temperature Cylinders Will Not Generate Multiple Alarms)	Temperature"	
8	Voltage	"High Volts" and "Low Volts"	Caution
9	Max Fuel Flow	"Fuel Flow"	Caution
10	V_{NE} Exceeded	"Speed"	Caution
11	Height Above Runway (Applies Only When Synthetic Approach is Selected. "Minimums" Applies if Decision Altitude)	"500," "200," "100" and "Minimums"	Advisory—Audio Only
12	Autopilot Elevator Trim Required	"Elevator Trim"	Advisory
12	200 Feet Above Min Descent Altitude	"Approaching Minimums"	Advisory
13	Autopilot Disconnect (For Any Reason, Including Manual Disconnect)	"Autopilot Disconnect"	Advisory
14	Waypoint Sequencing	"Waypoint"	Advisory
15	All Other Messages/Alerts That Generate a Message on the EFIS	Chime Sound	Advisory

14.3 Status Page

All pages include a "Status" softkey in their softkey menus. Pressing this softkey displays a list of alarm conditions, followed by built-in test messages. The alarm conditions correspond to user alarms which are currently beyond limits and have been acknowledged by the pilot. Built-in-test messages provide information about the status of that display unit and all equipment connected to it.

15 DATA RECORDING

Recording features in the EFIS allow you to electronically record data. Recorded data can be useful for: measuring airplane performance, extracting information that might help troubleshoot an intermittent engine problem, replaying approaches to evaluate your own flying skills, providing GRT tech support with information that can help to resolve issues you may encounter, monitoring long-term engine performance, investigating cruise power/economy tradeoffs, and more.

"Demo" recordings are especially useful for learning about your GRT EFIS, as they can be replayed through the EFIS while on the ground, when you are able to devote 100% of your attention to the EFIS.

There are three basic types of files that you can record:

- **Snapshot:** A simple, still shot of the screen. This is saved a PNG file on your USB drive. Snapshots are nice for times when you want to record things like a high ground speed or unusual performance.

- **Demo:** A recording of the flight data for later playback on the Display Unit itself or for extracting the data to examine using a spreadsheet. These recordings include: all the serial data received by the EFIS, user inputs (such as baroset, EFIS navigation modes, etc…), and internal sensor data (such as AHRS, air data, GPS and ARINC 429, if applicable). All user settings can be reviewed from a demo by playing the demo and viewing the various set menus.

- **USB Flight Data Logger:** Samples data at a user-selected interval and writes it to a CSV file. It's designed as an always-on, continuous data recorder that requires less memory and stores data in an easier to use format than a demo recording. Data is always added to the end of the "GRT Flight Data Log.CSV" file on the USB flash drive.

15.1 Recording a Screen Snapshot

A Snapshot can be recorded as follows:

1. Go to SET MEN > General Setup.

2. Scroll to near the bottom of the list and find "SNAP Button." Highlight it and select YES.

3. **SNAP Button Saves Menu:** Select YES to always display the softkey labels and NO to never display softkey labels in a Snapshot.

4. To imprint the filename on the Snapshot image, select YES for "Show DEMO Filename."

5. Save to exit the set menu. Your display unit will now have a SNAP button on the last softkey page. Using the SNAP button on menu screens can be very useful for recording settings in picture form to share with your friends (Ex: Autopilot gain settings, etc…) or to send them to us for troubleshooting.

6. To take a Snapshot, simply press SNAP to save the screen image to the installed USB flash drive.

15.2 Demo Recordings

Demo recordings can be recorded on a one-by-one manual basis or you can set up your EFIS to automatically record every flight. Files are not overwritten, so eventually you will need to either erase the USB stick or install a new one. Most flights average less than 1 MB/minute, allowing up to 1000 minutes (16 hours) of recording per GB of USB capacity. This gives an 8 GB memory stick an approximate demo recording capacity of 130 hours.

Demo recording options are made on the General Setup menu, accessed from the Set Menu. Highlight DEMO Settings (right above the SNAP settings) and press the right knob to activate the menu.

15.2.1 DEMO Settings

The DEMO Settings menu includes the following settings:

- **Use Date/Time in Filename:** Imprints the date and time in the upper left corner of the recording. Also places the start date and time in the DEMO filename in the format "DEMO-YYYYMMDD-HHMMSS.LOG" if the date and time are available. Otherwise, the file is named with a number only, starting with DEMO0000.LOG.

- **Max File Size:** Specifies the maximum file size of the recording, from 1 to 15MB. Specifying the file size allows for easier handling or emailing. A typical recording is less than 1MB/minute. Your rate may be more or less, depending on how much data is being recorded. Upon reaching the max file size, the display unit will stop recording momentarily to write the data to the USB drive. The bigger the file, the more continuous data you will get. The smaller the file, the more often it will save the data.

- **Max File Time:** Specifies the maximum recording time, from 1 to 120 minutes.

- **Automatic Start/Stop:** Allows you to start and/or stop recordings automatically. Under the Automatic Start/Stop heading, choose to record nothing automatically (OFF), start recordings automatically, stop recordings automatically or start and stop recordings automatically. When automatic data recording is enabled, the EFIS will start and stop/save automatically when the Auto Start and Auto Stop menu setting conditions are met, whether it's a specified RPM, airspeed, ground speed or N1 for turbines. Do not turn off the EFIS before or immediately after these recording conditions are met, as it will take the display unit a few seconds to write the data from the last file recorded to the USB drive.

15.2.2 Starting and Saving Recordings Manually

In flight or on the ground, press NEXT repeatedly until you see the DEMO softkey. START starts recording the demo. STOP ends and saves the demo. When manually recording, do not forget to STOP the demo, as this is the action that saves the flight from temporary internal memory to the USB stick.

15.2.3 Playing or Extracting Data from Demo Recordings

15.2.3.1 Playing Demo Recordings Back on the EFIS

From the PFD screen, press NEXT until you see the DEMO softkey. Press it to highlight PLAY to run the demo. If multiple demo files are on the USB stick, you will be taken to a menu page where you can select the file to play. File names will include the date and time in the name if this data was available to the EFIS.

15.2.3.2 Extracting Data for Review on a Spreadsheet

Download the GRT DECODE program from the GRT Avionics website (http://grtavionics.com/home/miscellaneous-software/). Open the program and use it to open the demo file. It will create a spreadsheet with all the data points.

15.3 Automatic Demo Recordings

Automatic demo recordings are a great way to keep detailed recordings of the performance of your airplane and engine. These recordings are compatible with Savvy Analysis (savvyanalysis.com) for detailed engine analysis and can be used to document flight testing of your airplane. To use this feature, keep a USB memory stick plugged into your EFIS (or the USB hub that is connected to your EFIS) whenever you fly.

The following settings are recommended:

Setting	Value
Use Date/Time in Filename	Yes
Max File Size (MB)	15
Max File Time (Minutes)	120
Automatic Start/Stop	Start and Stop
Auto Start RPM	300
Auto Start N1	0
Auto Start Airspeed	0
Auto Start Ground Speed	0
Auto Stop RPM	100
Auto Stop N1	0
Auto Stop Airspeed	0
Auto Stop Ground Speed	0
USB Flight Data Logger	On
USB FDL Record Interval (ms)	1000
USB FDL Save Interval (s)	60
USB FDL File Type	Single
USB FDL Always Record	Yes

15.3.1 USB Flight Data Logger (Black Box Feature)

The USB Flight Data Logger feature was designed to provide automatic recording of a limited number of important flight data parameters. The data is saved within the EFIS and then periodically written to the USB drive according to user settings.

Go to SET MENU > General Setup > Demo Settings. Press the knob to open the page and bring up the following settings:

- **USB Flight Data Logger:** (ON/OFF) When ON, the EFIS will record data when any of these are true: airspeed is valid (above the sensor minimum), ground speed is above 5 knots, RPM/N1 input is non-zero, fuel flow is non-zero.

- **USB FDL Record Interval (ms):** Data samples are recorded within the EFIS at this interval: 200-30000 ms in steps of 200 ms. Default is 1000 ms (1000 ms = 1 second).

- **USB FDL Save Interval (s):** The recorded data is written to the USB flash drive at this interval: 0-300 seconds. Default is 60 seconds (if set to zero, the file is only written when the internal buffer fills up or the data logger stops).

The data is saved as a .CSV (comma separated variable) file on the USB stick called "GRT Flight Data Log.csv and can be opened using any spreadsheet program.

15.3.2 Legal Considerations of Data Recording

Recorded data can be recovered and analyzed in the event of an accident. All GRT Avionics EFIS and EIS systems do not record any flight, engine or navigation information unless data recording has been specifically enabled, with the exception of engine hours and flight timer values.

15.4 Backing Up EFIS Settings

The EFIS Settings Backup feature allows you to save your settings on a USB drive and reload them at a later date or in a new display unit.

To make it easy, back up each display unit separately to its own USB drive. The information does not take up much memory—much less than 1 MB. This process will save all display unit settings, user waypoints and flight plans. Note that it will not save logbook files—those need to be downloaded separately. The user settings backup file may be copied from the USB drive and stored on a computer like any other file.

To backup your user settings:

1. Insert the USB drive into the display unit.

2. Go to SET MENU > DISPLAY UNIT MAINTENANCE.

3. Right at or near the top is EFIS Settings Backup. Highlight this and push the knob. Highlight Backup All Settings and push the knob. Answer YES at the prompt. The system will back up all the display unit's settings onto the USB drive.

To restore previously saved settings:

- Insert a USB drive with the backup settings file. Click on EFIS Settings Backup from the SET MENU > DISPLAY UNIT MAINTENANCE list. Highlight Restore All Settings and press either knob.

Can I save settings files for multiple display units on one USB drive?

Yes. Note that the first setting in the Backup All Settings menu, Backup Directory. The default value is Main Directory, which saves the SETTINGS.BAK file onto the root directory of the USB drive (meaning it is not inside a folder).

The display unit will only recognize files named SETTINGS.BAK as settings files. If multiple settings files are stored in the main directory, one of the files would need to be named something different, which the display unit will not recognize. To get around this, highlight Backup Directory, press the knob and turn it one click. You will see BACK0000. Keep turning the knob to enter your display unit's serial number, then press the knob to enter. This will tell the display unit to create a folder on the USB stick by that name. The display unit will recognize this file folder as its own settings folder and open it to retrieve the SETTINGS.BAK file when it comes time to restore settings. Now, you can use the same USB drive to store the settings for multiple display units—just repeat this step with each display unit before saving their respective settings files.

Why would I need to do this?

If you decide to upgrade your display unit, save your settings before you send it in so that you can easily restore them when you get your unit back. Some hardware updates wipe the settings clean. In the case of an upgrade from one type of system to another, you can avoid having to reprogram many settings in your new display unit. For example, during an upgrade from an HX to an HXr, this process will fill in most, if not all, of your new settings, saving setup time. You will still need to go through the setup menu and program the settings that are new, but it will save you some time at the very least.

This is especially important for aircraft that do not have good wiring diagrams. Many second- and third-owners of kitplanes call us for help with their system and have no idea how the serial ports are wired and have no documentation about the electrical system. If you do not have a good set of paper wiring diagrams specific to your airplane and you lose your settings, you could be in for a lot of detective work if you do not have a saved backup.

During troubleshooting, sometimes our techs find it useful if you can email us a copy of your settings file.

16 Altimeter Calibration

FAR 91.411 requires calibration of the altimeter portion of the EFIS system with the EFIS is to be used for IFR flight. This requires the use of an air data test set to provide calibrated air pressures for the full calibration procedure. However, a simple procedure is available, called, "Partial Altimeter Calibration" that can be performed easily without a test set and will improve the accuracy of the altimeter and will correct for errors due to aging of the air data components, especially the pressure sensor.

The adjustments are stored within the AHRS/Air Data Computer. This means that is not necessary to enter these corrections into other display units that use data

16.1 Partial Altimeter Calibration – Correcting Altimeter vs Baroset

This calibration adjusts the relationship between the altitude display, and the barometric pressure setting. This calibration does not require an air data test set, and may be performed on an annual basis, or as needed as follows:

Position the aircraft at a location with a known elevation. Airport field elevations represent the highest point of all the usable runways, so this location could be used, but often other, more convenient locations are also surveyed to allow for accurate altimeter setting before takeoff based on field elevation. Refer to airport diagrams or other sources of information if possible.

Note that this process must be repeated for all altimeter sources controlled by this EFIS. An altimeter source is controlled by the EFIS is it has an internal air data module (pitot/static connections will be made to it), or if it controls an external GRT AHRS/Air data computer with a serial output from the EFIS connected to this AHRS.

1. Turn on the EFIS (and any connected GRT AHRS/Air Data Computer and allow at least 5 minutes to elapse before continuing to allow the for stabilization of the sensor.
2. Obtain the current barometric pressure setting. This setting should be provided by the airport at which the airplane is located, or a nearby airport, and should be as recent as possible.
3. Select Set Menu > Altimeter Calibration.
4. Using the left knob, highlight the **Altimeter Calibration – OFF** selection.
5. Toggle this to (**Initiate**)**ON**.

6. Set the baroset to the currently reported altimeter setting.
7. Select **Altimeter Bias**. Adjust the setting until the altimeter matches the airport elevation. (Note that there is about a 2 second delay until adjustments are reflected in the displayed altitude.)
8. Press the "SAVE" softkey to exit.

This completes the partial altimeter calibration. Do not alter any other altitude settings. The altimeter calibration will be turned off automatically when this page is exited.

16.2 Full Altimeter Calibration – Using Air Data Test Set

This calibration adjusts the relationship between the altitude display, and the barometric pressure setting using an Altimeter Test Set.

1. Turn on the EFIS (and any connected GRT AHRS/Air Data Computer and allow at least 5 minutes to elapse before continuing to allow the for stabilization of the sensor.
2. Connect air data test set to the pitot AND static ports of the airplane.

> **CAUTION:** Failure to connect the test set to the pitot connection may damage the airspeed sensor in the AHRS, and any mechanical airspeed indicators which are also connect to the pitot/static system under test.

3. Set the test set to sea level (0').
4. On the EFIS Select Set Menu > Altimeter Calibration.
5. If the EFIS altimeter calibration page includes a "Scale Factor" setting, use the left knob to select this value, press the knob to highlight it, and then set it to 1.000.
6. Set the baroset to 29.92 on the EFIS altimeter calibration page using the right knob.
7. Use the left knob to select the **BIAS** setting and press the knob to highlight the value.
8. Adjust the **BIAS** on this page until the altimeter reads 0 ft.
9. Set the air data test set to 5000'. Use the left knob to select the 5000 adjustment value, press it to set it, and adjust it until the altitude reported on this page matches the 5000' set in the air data test set.
10. Repeat step 9 up to the maximum altitude you with to certify the altimeter to, adjusting the corresponding value to correct the altimeter reading. The accuracy of the scale factor adjustment can be verified by noting a small altitude error (less than 200 feet) is observed with a zero correction at 30,000 feet.
11. Exit the calibration page by pressing the "SAVE" softkey.

Full calibration is complete. If necessary, the **BIAS** adjustment can be made without affecting the other corrections at any time.

17 A Typical Flight EFIS (Read if you don't like manuals!)

Follow a typical VFR flight with the chief engineer, describing his habits with the EFIS and his RV-6A, to see how he uses the EFIS to enhance his flying experience. We don't claim that his flying habits are perfect, but we hope it gives you better insight into how the EFIS is used for safer and more enjoyable flying. You might also find it more interesting than a traditional manual descriptions, and even the experienced GRT user might discover useful features that they were unaware of!

17.1 Startup

After my pre-flight (which always includes, at the absolute minimum, a look at the pavement under the cowl, oil level, and tires) the engine is started, I verify no oil pressure alarm from the engine information system, which starts up immediately. (All other engine alarms will be generated by the EFIS when it completes booting.) I then turn on the avionics bus which powers up all avionics. With the adaptive AHRS it is not necessary to hold the airplane motionless for any time, however, by the time I complete my checklist my EFIS and HUD have booted up and AHRS is aligned and providing attitude data.

For those with the legacy AHRS (analog), it is also not necessary to hold the airplane motionless until the AHRS has aligned, although it is necessary for the first 10-20 seconds after the AHRS is powered-up.

17.2 Runup

I lean for taxi and then head for the runway, stopping for my run-up. Runup begins with selecting the ENG/MAP page to display the engine strip. This provides a time history of the EGTs, and a tachometer dial display. I perform my runup as most other pilots I have observed, with the addition of a final check of the EGT time history to verify all EGTs increased and appear typical for the run up. A mis-firing cylinder would probably cause noticeable roughness, but why not use the EGT time history to observe that all cylinders are running normally? Finally, I verify the fuel totalizer is agreeing with the known fuel quantity and a quick check of voltage/amperage to verify the alternator. Alarms will alert me if anything is abnormal, but intentionally reviewing them gives me an extra sense of confidence that everything is normal. (See page 121.)

As a side-note, I once discharged my battery significantly just before a night flight. Prior to takeoff I noted a battery voltage of only 12.9 volts, and 20 amps (instead of the normal

6-8 amps) being delivered by the alternator. I was reluctant to take off into the darkness with what appeared to be a failed electrical system, until I realized that the combination of a discharged battery and lighting that was on was responsible for the unusually high alternator output and low battery voltage, and no real problem existed.

17.3 Takeoff

For takeoff it is my preference to have the EGT time history visible for the initial climb-out. If engine roughness was to occur on the climb-out, the EGT time history can show me if the roughness is due to one cylinder (as one EGT will typically drop much more than the others), or a problem common to all cylinders (all EGTs dropping similar amounts). My actions may differ if a single cylinder fails as compared with the entire engine exhibiting problems.

To display the EGT time history I normally use the "EGT/CHT Bar" inset. This includes both bar graphs (which I will use at the top of climb for lean detection) and the EGT time history.

For those with a single screen EFIS installation, a Hudly heads-up display is especially useful, as it provides full time primary flight data, freeing the EFIS to be used however you wish, such as showing the EGT time history on takeoff. I find the HUD a great addition to my airplane and use it for all phases of flight. I especially find the airspeed is much easier to monitor on takeoff and landing, and the reassurance of the runway overrun protection is great.

17.4 Initial Climb

Until reaching the 1000-2000 feet above the ground my attention has been the controlling the airspeed in the climb and watching for traffic. Upon reaching this altitude, I turn off the electric pump, adjust prop RPM, and switch the EFIS to the map page to take a quick look for traffic, as most airplanes are concentrated around airports!

Depending on where I am going, I may need to navigate myself around some controlled airspace. I am equally likely to hand fly as use the autopilot at this point, however I usually enter my flight plan into the EFIS once I am enroute, and for this I take advantage of the autopilot. If I am taking off from someplace less familiar, or for some reason I expect a high workload after takeoff (such as taking off under class B airspace), I will enter my flight plan, and pre-set my selected altitude before takeoff.

Normally I am in my climb when I want the autopilot (GRT servos) to assist me, so I find it easiest to just hit the engage button. The autopilot immediately begins holding the heading and pitch attitude, so my climb continues as it was. I then hit the left knob to synchronize the heading bug to my current heading, then hit the right knob to show my autopilot controls, select Lat A/P to "HDG", Vert A/P to "AUTO" and set my climb altitude and speed. Now I am free to enter a flight plan while the autopilot flies for me.

17.5 Entering the Flight Plan?

For VFR flights my flight plan is typically just a direct-to. From the map page I hit the right knob to get my map shortcut, press the "FLT PLN" softkey, and enter the direct-to. If my flight plan was more complex, I probably entered it into the GRT app, so I would use my phone or tablet to send the flight plan into the EFIS. Note that the GRT Remote app only controls the sequence flight plan, so if I have the direct-to flight plan selected, I must switch to the sequence mode flight plan.

If I don't recall the identifier for my destination, I use the "slew" feature on the map to bring my destination into view on the map. Keep in mind that the map range can be changed while slewing, so I may slew to the general area on a larger map range and reduce the map range to show the airport identifiers. At that point the right knob can be pressed to display the details selector, the destination selected, and the direct-to softkey is pressed to set it.

For those new the GRT EFIS, entering a flight plan is very easy using the softkeys. In fact, I find it much easier than any other GPS I have used. When entering the identifier, new users must remember to press the right knob to advance the cursor when same softkey is used to enter two consecutive letter/numbers. Turn the right knob to select "ENTER" when the waypoint entry is complete.

17.6 Resetting the Direct-to

At that point I switch the lateral autopilot to "NAV" to follow my flight plan. If much time had elapsed before doing this, I might be off the line connecting the origin to my direct-to, causing the EFIS to turn the autopilot to capture this path. Normally I wish to just "reset" my direct-to. This is easily accomplished by hitting the right knob from the map page, clicking direct-to softkey, and the pressing the right knob to "Enter" this direct-to again. If I was on a sequenced flight plan and wished to go direct to the first waypoint (or any waypoint), I would highlight it with the knob (if needed) and select the "Go Direct".

17.7 Climbing and Overheating

At this point I am free to watch for traffic and monitor my CHTs to manage my engine temperatures during the climb. If I climb at higher airspeed (135 mph) I probably won't have to worry about exceeding my personal CHT limit of 425, but if I climb at a lower speed, depending on the outside air temperature, I may need to adjust power/airspeed to stay below 425. (My RV-6A has an O-360 with constant speed prop, but this was also true with my previous RV-6A which had a fixed pitch prop and a 160 hp O-320.)

The task of watching the CHTs on the climb is probably the only manual "monitoring" task I have for myself. My habit is to use the EIS for the hottest CHT reading (the default settings show the highest CHT on the upper right corner of the first combination page). For installations where the EIS is not mounted in the panel, I like the engine strip on the bottom of the PFD screen (8.4" screens and smaller), or the use of an Engine inset of the EGT/CHT (HXr and 10.1 Horizon).

17.8 Setting power and Leaning

Upon reaching my cruise altitude I am ready to lean, as normally the "EGT/CHT Bar" inset is being displayed. (By now I have probably used it to reassure myself of normal engine operation…I have an overly sensitive "roughness" detector!) I adjust RPM and MAP for my desired power setting using the percent power display. I normally cruise between 50%-65%. Pressing "MORE" and "ENGINE" provides the "LEAN" softkey to activate lean detection.

Most I have talked to cruise at wide-open-throttle to take full advantage of the speed the RV's offer, but I like this lower power setting range because my cruise speed is not reduced much, I have excellent fuel economy (and thus range, or reserves are increased), and I am comfortable with leaning aggressively when the power is well below 75%, and for whatever reason, slightly closing the throttle tends to result in EGTs between cylinders becoming better matched.

Everyone seems to have their own technique for leaning, so here is mine. I select the "LEAN" function on the engine page, pull the mixture to about half of where I expect it to end up, and then begin turning it at a slow, steady rate. The EGT time history will show the EGTs steadily increasing initially, but after a bit they curve they draw shows the EGTs flattening out (not changing much). In my RV-6A with carbureted engine I can expect roughness to be felt when the first cylinder to peak drops only 10 or 15 degrees lean of peak (which is highlighted by a box around the EGT reading). The combination of the

flattening EGT time history and peak detected by the leaning function makes it easy to detect the first signs or roughness, which normally goes undetected by my passenger (but not me!). One full turn back on the mixture control and my leaning process is complete. I verify I have done a good job by noting the "SFC" display on the "STATS" engine page is now displaying it usual value (0.40 in my case).

17.9 Cruise Checks

As cruise continues, I will occasionally check the SFC (specific fuel consumption) to confirm conditions have not changed that warrant leaning again. In my case, with the constant speed propeller, engine efficiency has dropped, and leaning is required if the SFC goes up ***or down***. This is because of the propeller RPM remaining constant when power is lost. With a fixed pitch propeller, the SFC will only go down when engine efficiency drops. Most often, when I notice a change in SFC, it was because I decided to cruise up to a higher altitude and forgot to re-lean, although changes in air temperature can cause this also.

With little to do in cruise I tend to review the EGT time history to look for any unusual variations in EGTs. Some variation might be noted if flying in turbulence, or if hand-flying and altitude is not steady. This is normal. Most often my attention goes to the EGT time history when I think some engine roughness is occurring. I am normally reassured when I see steady EGT time histories. I may also activate the "NORM" function to track changes in EGT, especially when crossing water, such as Lake Michigan. If I forget to de-activate this function before beginning my descent, I will be reminded with "EGT Change" alarms.

As a fun side note, I once flew partial panel for a biannual flight review by selecting the engine page to hide the EFIS PFD screen. While hand flying on back up instruments, I happen to notice my EGTs showed a shallow sine wave as the engine reacted to my slight but steady altitude fluctuations. It was somehow reassuring to see this.

17.10 Checking Weather Enroute

If weather conditions are of interest, I find the ADS-B METARs data is easier to read than AWOS is to listen to, but it updates only hourly, so I may choose to listen to current weather conditions also. METARs data is accessed using the detail selector (right knob) on the map page. This can also be done while slewing the map. The detail selector is displayed after pressing the right knob, turning it to highlight the airport of interest, and pressing the knob again to see the METARs. For the nearest list of weather frequencies, that same press of the right knob that brings up the details selection also displays the map shortcut softkeys, one of which will be "NEAREST". Press that softkey, select

"WEATHER", and scroll through the list to find weather of interest. Note that the nearest weather frequencies list includes the range and bearing to the station, so it is easy to choose stations in your direction of travel. If your communication radio provides a serial tuning that is wired to the EFIS, you can conveniently tune the radio from this list also.

Anybody that flies with a GRT EFIS should make use of these functions, and the shortcuts provided by pressing the right knob on the map page.

NEXRAD is provided by ADS-B (or XM Weather), and is displayed by selecting the "RADAR" on the "SHOW" map softkey. Slewing and map range changes can be used to review weather to the desired detail. Areas for which the ADS-B (or XM Radio) is not providing weather will have blue cross hatching. Typically, this will be for areas more than 250 miles from your position.

17.11 You do use the Interval Timer, right?

If you have two fuel tanks, you are using the interval timer, right? Both the EFIS and the EIS provide this function, and I find it essential for fuel management. I set mine for 30 minutes. When this alarm goes off, check your fuel! I switch tanks 30 minutes into the flight, and then every hour after that.

17.12 Planning for Landing

Just prior to descend, I use this low-workload time to review the airport details for my destination. Once again, the map shortcut softkey come in handy. From the map, press the right knob, and then press the "WPT Details" softkey. The airport details will be displayed. Now is a good time to use METARs and runway data to anticipate the preferred runway. Communication radio frequencies are listed and can now be tuned. Note the airport elevation (or pattern altitude, if noted) before exiting this page.

At this point I also select the best tank for landing. I probably won't burn much fuel on my descent, and sometimes (yikes!) I get distracted by traffic and whatever and forget to select the fullest tank before landing when I am near the airport. So I do it now as a precaution, and (hopefully) when I perform my landing checklist.

17.13 Descent

Descent begins from the PFD screen by pressing the right knob to change the selected altitude to pattern altitude and setting the descent rate. I always use vertical speed mode, which is assumed by the autopilot when a lower altitude is selected, and "AUTO" is used for the VERT A/P mode. The autopilot will pitch over smoothly, and my preference is to reduce power to hold my cruise airspeed. When within a couple thousand feet of the surface I prefer my airspeed to be reduced, as bird strikes are much more common near the surface, and it is my experience that birds seem less likely to avoid airplanes that exceed about 100 knots.

During the descent I am periodically enriching the engine and checking my descent progress using the green arc displayed on the map. This arc shows you where you will be when you reach your selected altitude based on the airplane's current vertical and horizontal speed. Adjust your vertical or airspeed as needed to keep this arc a mile or two before your destination, as it will be affected by winds that will probably change on descent.

During the descent I will make my final runway choice, after which I always activate the synthetic approach. This provides me with my height above the runway (it is displayed just under the flight path marker), highlights the runway end on the PFD with lead-in lights so I don't land on the wrong runway (again!?), provides lateral and vertical guidance (so I don't get too shallow on my approach and hit an obstacle), and reminds me to re-set my barometric pressure.

17.14 Landing

To navigate to the runway, I set the map range to 20 miles or less and use the extended runway centerlines to establish myself inbound. If I am flying a coupled approach (for the fun of it, or because the weather is marginal), I will intercept this extended centerline several miles from the runway end and stay in altitude hold mode until intercepting the synthetic approach glideslope. Power reduction will be required when the glideslope is intercepted.

As the approach progresses, I glance at the EFIS wind indicator. Magnetometer heading errors will induce wind speed and direction errors, but with reasonable care your installation should provide enough accuracy to allow good anticipation of the crosswind direction and magnitude. If the EFIS is indicating a tail wind on approach, re-check your choice of runway, as the headwind component is normally accurate. More than once I have changed runways when the EFIS showed I had a tailwind on approach, and it has always been correct!

Occasionally I will note significantly higher winds on the EFIS than being reported on the surface. If this persists during the approach, I use this to anticipate a loss of airspeed may occur during the approach due to wind shear.

If you are lucky enough to be flying with the HUD, it can be configured to show you a prediction of your touchdown point and stopping distance. I find this especially useful when flying the RV-6A into any runway less than 3500 feet. Its intent is to warn you if you are in danger of going off the end of the runway (or approaching too low). I tend to be quite aware of my approach precision into short runways, so I don't expect to see the dreaded "OVERRUN" warning persistently in my HUD. ("OVERRUN" may momentarily be displayed with over-corrections to your glidepath on approach, but if it is persistent, go-around!)

I also glance at the runway use prediction on the HUD prior to making the runway. With the reassurance this prediction provides that I have spare runway I find I no longer reduce power after crossing the runway end to "optimize" my approach for short runways. Instead, I feel comfortable maintaining a consistent approach power setting until flare. This simplifies the flare maneuver and reduces the chance of "banging it on".

17.15 Take it home with you!

That ends the flight. Since I configured my EFIS to automatically record demos throughout the flight, when arriving at my home airport I remove the USB memory stick and take it home to save it on my home computer. This gives me a long-term and detailed record of my airplane's performance (and mine!).