Mini-GA EFIS

Installation, Setup, and User Manual

Revision A

11-February-2016

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Mini-X Manual Revision Notes

Manual Revision	Date	Software Revision	Change Description
A	Thursday February 11 2016	2	Initial Release

Thank you for choosing GRT Avionics!

We hope you enjoy your new avionics system for many years to come.

Warranty & Return Policy

All GRT products include a 2-year warranty against manufacturer defect starting on the day the instrument is put into service (or three years after purchase, whichever comes first) .

Please contact Tech Support before returning a display unit or component to GRT for repair or warranty work. Many issues are installation or software-related and can be resolved over the phone, saving time and expense. Please keep in mind that the minimum bench charge for EFIS units is $100.

All returns for repair or upgrade must be accompanied by a Service Request Form, downloadable from the GRT website Support section.

30 Day Satisfaction Guarantee– If for any reason you are not completely satisfied with your GRT product, you may return it to us in its original condition (un-installed) for a full refund.

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

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Our tech support staff has many years of real-world experience installing, flying and troubleshooting GRT equipment in many different types of aircraft. We are here to make sure your project succeeds.

Tech Support Hours

Monday-Friday 10:00 AM - 12:00 PM and 2:00 PM - 4:00 PM Eastern Time

Always leave a message if you are unable to reach a technician. We will return your call.

(616) 245-7700 (EFIS Support phone menu option) or support@grtavionics.com

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Contents

Section 1: Introduction

1.1 About the Mini-GA

The Mini-GA is a small, lightweight, economical EFIS system for certified general aviation and experimental airplanes. It features an attitude indicator with synthetic vision, full-featured moving map, as well as a horizontal situation indicator (HSI) that can be driven by GPS, VOR, or ILS data (VOR/ILS data requires a serial connection to a compatible navigation radio, such as an SL30, GNC 255, GNS 430, GTN 650, etc. It qualifies as a portable electronic device, allowing it to be used in certified airplanes. It is not a certified instrument and may not replace the primary instruments in the airplane.

The Mini-GA utilizes the same pilot interface as the popular Horizon and Sport series EFIS systems that are used in experimental aircraft. The Mini has a built-in GPS for self-contained navigation, or may be wired to your primary (certified or not) GPS.

The Mini-GA includes a flight director function with full coupling to GPS, radio navigation, and pilot selections. The flight director function simplifies hand flying by giving a single cue for roll and pitch that would normally drive the autopilot, making hand flying IFR easy and more accurate. The Mini-GA uses a brilliant 1200-nit, high-resolution display shared by all three Mini models ensuring great visibility in all lighting conditions.

The Mini-GA uses electronics gyros, accelerometers, and GPS data to compute attitude data. In the event GPS data is lost, attitude data will continue to be provided using its internal magnetometer as a heading reference. If the internal magnetometer is determined to have inaccurate data (due to magnetic disturbances on the instrument panel), the accuracy of the roll attitude data may be slightly reduced.

GPS derived altitude and ground speed is displayed, and replaces the traditional baro-altitude and indicated airspeed, when the instrument is used without a remote air data computer. For certified aircraft, the Mini may be wired to a certified air data computer. For experimental aircraft, GRT will produce an external pitot/static module available the 2nd quarter of 2016.

1.2 Installation

The Mini-GA uses a mount that is screwed to the instrument panel using a 3 1/8 instrument hole format. The Mini-GA snaps into this mount. The Mini-GA is slightly larger than a standard 3 1/8 instrument and may not fit in tightly packed instrument clusters. Power and other data may be supplied to the Mini via wired connections to the airplane or via a 12V cigarette lighter plug.

The instrument features short “pig-tail” type electrical connections. These flexible connections make it easy to install and remove the instrument.

1.3 Mini System Requirements

The Mini utilizes the following systems for operation:

- Aircraft Power (9-32V provides compatibility with 12- or 28-volt systems) - 0.25 Amp current draw at full brightness for 12V systems; 0.15 amp at 24V.
- Glare shield antenna (provided). The built-in GPS with a remote "puck" antenna which must be within view of the sky at all times. The Mini-GA does not support an external GPS antenna. The active antenna supply from the Mini-GA is 3.3V. This is lower than most external GPS antennas require.
- Magnetic heading information requires an optional remote magnetometer. (See section 1.4 for more information)

1.4 AHRS Specifications and Limitations

- Maximum Angular Rate: 250 deg/sec
- Maximum G-Limit : 4G for unlimited time, 10G for up to 20 seconds. Exceeding the G-limits does not damage the instrument but the accuracy of the attitude information will be degraded.
- Ambient Temperature Range for full accuracy: -10°F to +150°F
- Magnetometer Type: Internal with optional external remote. Use of the the External magnetometer overrides the Internal, and allows display of magnetic headings. It allows increased accuracy of roll attitude data when GPS data is unavailable.

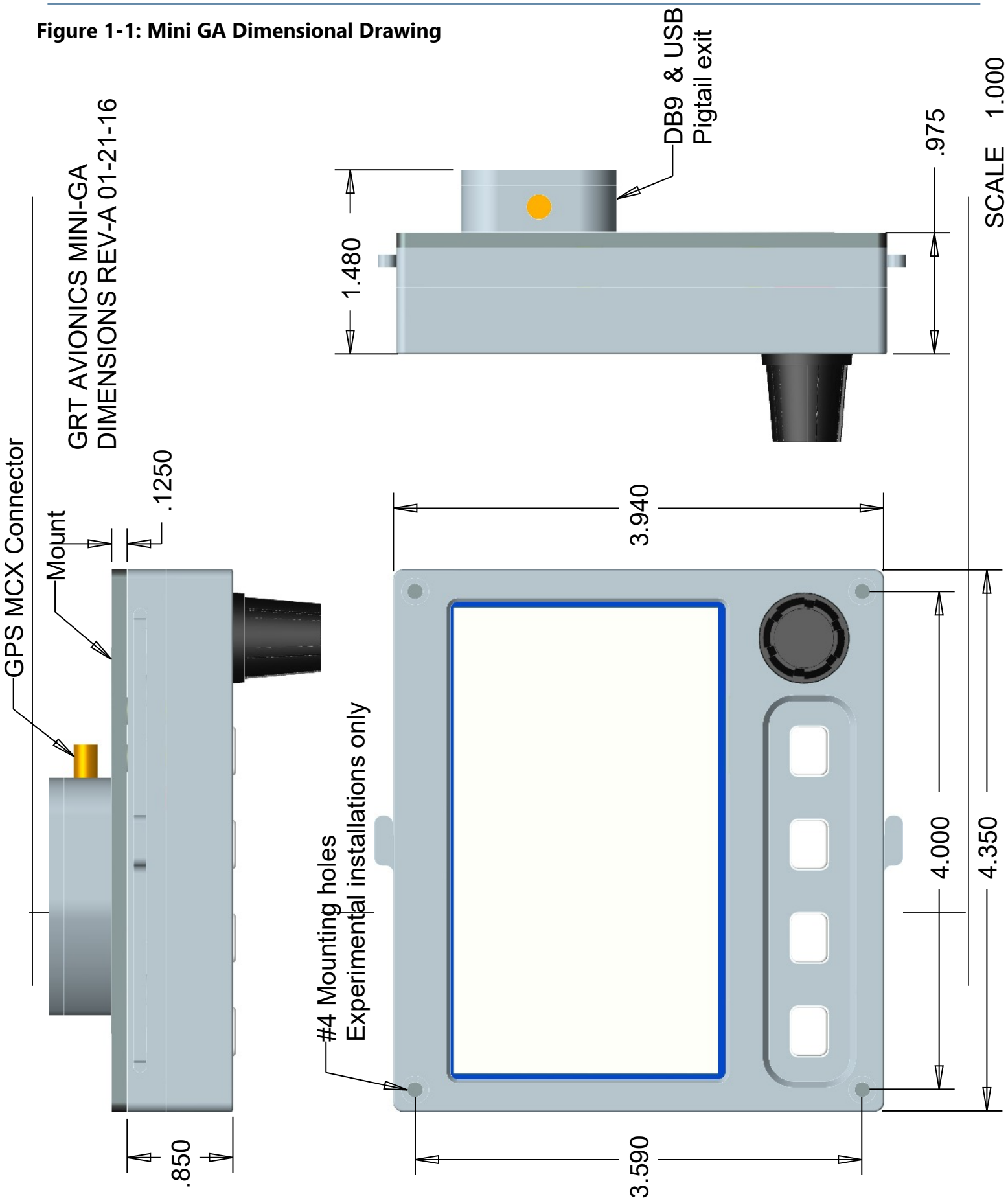
1.4.1 Mini-GA AHRS and Loss of GPS Data

Normal Operation

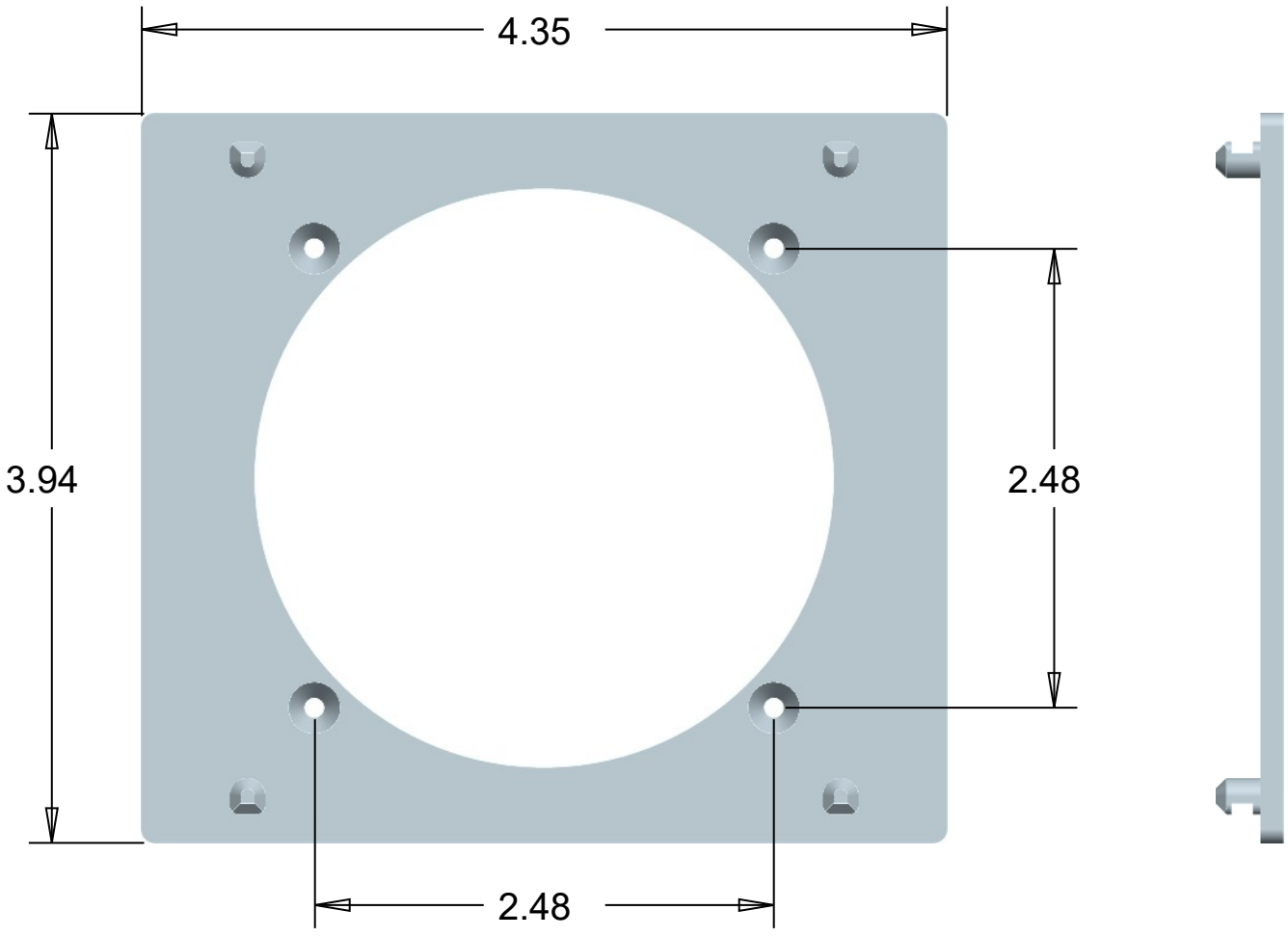
The attitude solution requires an external magnetometer or GPS ground track for full accuracy. The heading/ground track display on the PFD will be dashes when an external magnetometer or GPS ground track is not available.

CAUTION: If the EFIS is unable to provide any heading or GPS ground track data (the heading/ground track display on the PFD screen is shown as dashes) for extended periods of time (more than 5 minutes) the attitude data could become less accurate.

Figure 1-1: Mini GA Dimensional Drawing



MINI-GA MOUNT REV-A 01-21-16
6-32 Flat head screws
Fits standard 3-1/8 hole pattern
The MINI-GA is larger than the typical 3-1/8 Instrument



SCALE 1.00

1.5 Basic Controls of the Mini

The Mini has a single knob that can be pressed and turned, and four buttons, or "softkeys". The "softkeys" functions change as screen views and menus change. Each button and knob has a label that defines its function. If a label is not present, the button does not have a function on that particular screen. When the softkey labels are not visible, press any button to make the labels appear. You can define how long the labels are displayed between button presses– refer to Section 4.3, General Preferences, for more information.

1.5.1 Overview of Pages & Softkeys

The Mini-GA pages are: Primary Flight, Moving MAP, Flight Planning, HSI, and Settings.

1.5.2 Primary Flight Display Softkeys

1. Press any button to display the **PFD Level 1 Softkeys** shown below. The softkeys may be displayed in a different order depending upon your software version and equipment connected to the Mini. Use this section as a general guide to learn the functions of the softkeys.

1.5.3 Moving Map Softkey Functions

Flight Plan Entry Page

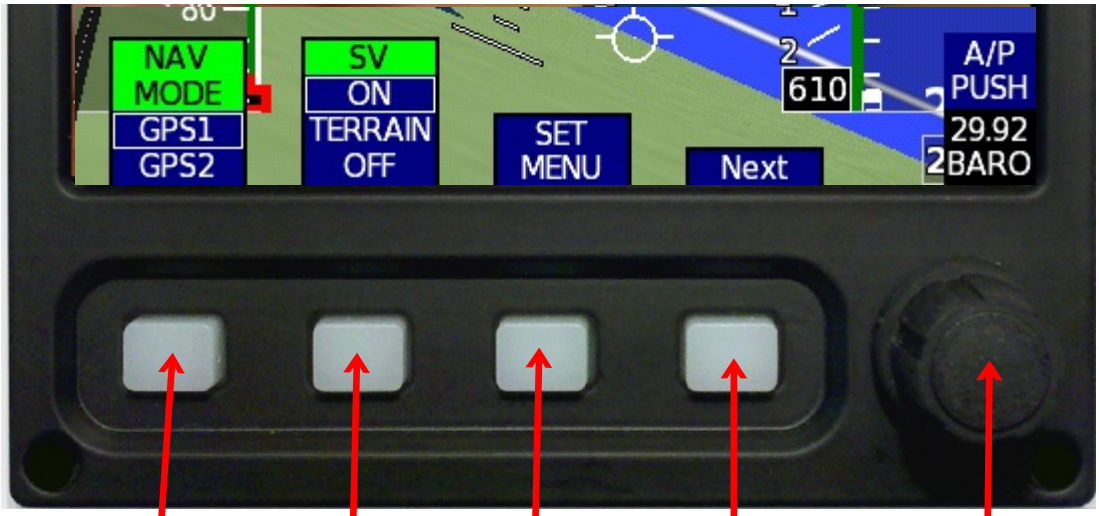
Moving Map (optional)

Screen Dimmer or Trans-ponder

More items...

- **Turn to adjust Altimeter Setting**
- **Press for A/P (Flight Director)**
- **Shown with optional air data module.**

PFD Level 2 Softkeys (typical)



Choose Navigation Source

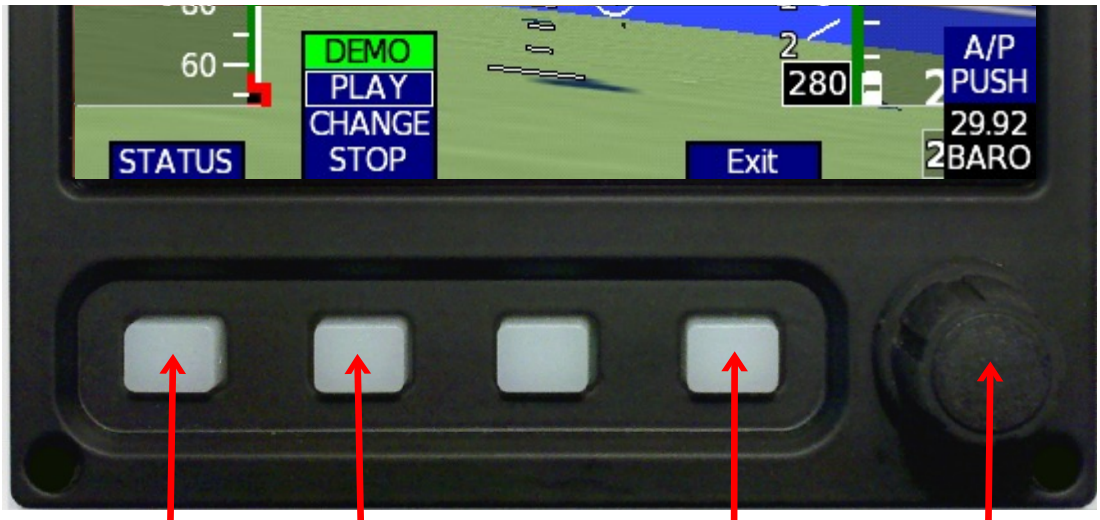
Synthetic Vision Display Options

Settings Main Menu

More items...

- **Turn to adjust Altimeter Setting**
- **Press for Flight Director Mode**

PFD Level 3 Softkeys (typical)



Error or Warning Details

Manually Record or Play Demo File

Press when finished with softkeys

- **Turn to adjust Altimeter Setting**
- **Press for Flight Director Mode**

1. Press the MAP softkey to display the Moving Map page.

Primary Flight Display

Cycle thru map views & HSI

Screen Dimmer or Trans-ponder

More items...

- **Turn to adjust map range**
- **Press once for Heading Bug**
- **Press again for Map Selection Tool cursor and Nearest selection softkeys**

Map Level 2 Softkeys (typical)

Choose Map Layer (background). When ADS-B data is provided, RADAR and METARS selections will also be shown here.

Choose Fixes to Display

Choose Nav Source

More items...

- **Turn to adjust map range**
- **Press once for Heading Bug**
- **Press again for Map Selection Tool cursor and Nearest selection softkeys**

Map Level 3 Softkeys (typical)

Choose Lateral Flight Director Source

See objects off the edge of the map

View, Create, Edit Flight Plan

More items...

- **Turn to adjust map range**
- **Press once for Heading Bug**
- **Press again for Map Selection Tool cursor and Nearest selection softkeys**

Map Level 4 Softkeys (typical)

Nearest Airport, Weather Freq, or Navaid

Settings Main Menu

Error or Warning Details

More items...

- **Turn to adjust map range**
- **Press once for Heading Bug**
- **Press again for Map Selection Tool cursor and Nearest selection softkeys**

Map Level 5 Softkeys (typical)

Manually play or record demo file

Press when finished with sofkteys

- **Turn to adjust map range**
- **Press once for Heading Bug**
- **Press again for Map Selection Tool cursor and Nearest selection softkeys**

Section 2: Wiring Considerations

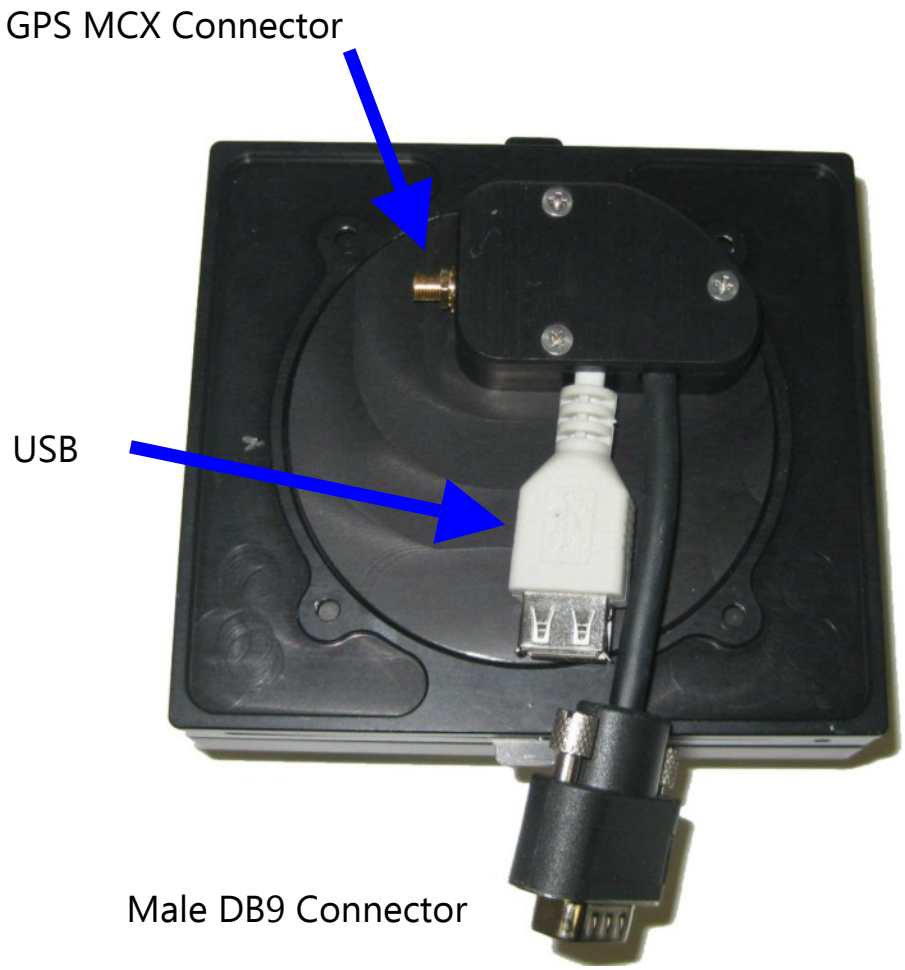
2.1 Mini-GA Wiring

The Mini-GA includes a pre-wired harness with a mating female DB9 connector and the most commonly used wires. The optional remote magnetometer (for experimental aircraft) uses a DB9 connector and is connected to the Mini using the pins defined below. The colors shown here correspond to the colors in the supplied wiring harness.

- The supplied wiring harness for the optional magnetometer is 20 feet long; all other wires are 4 feet long.
- The magnetometer serial output (Mag pin 9) may be shared with other GRT Avionics Mini-EFIS, or any GRT EFIS system using the adaptive AHRS. (All current GRT EFIS systems use the adaptive AHRS.)
- The use of the magnetometer and serial ports is optional.
- The serial input has minimal loading effect, allowing a serial output to drive the Mini serial input and another standard RS-232 serial input without reduction in signal level.
- Any of the serial port pairs can be used for a variety of connections, including connection to another GRT display unit, GPS (including connection to the primary GPS in certified aircraft), compatible navigation radios. For a full list of possible interfaces, see section 2.6 General Serial Port Wiring Information.

Pin No.	Use	Color
1	Ground	Black
2	Serial 1 In	YEL/WHT
3	Serial 1 Out	
4	Audio out	
5	9-32V Power In	Red
6	Serial 2 Out	WHT/GRN
7	Serial 2 in	BLK
8	Magnetometer Power	RED
9	Magnetometer Ground	ORG

Figure 2-1: Rear Case View- Connector Placement.



2.2 General Wiring Guidelines

Wires that are certain to be used are pre-installed in the Mini cable assembly. Optional connections to the Mini are not installed in the D-sub connectors at the factory, however, colored aviation-grade tefzel insulated wires with pre-installed D-sub connector contacts are included for these connections. The cable description diagram includes recommended wire colors for each connection to the Mini's components.

When routing the wiring, the following guidelines should be considered:

- Good practices for physical installation of the wiring should be followed, such as grommets where wires pass through sheet metal, considering for chaffing and interference with moving mechanisms, etc.
- Cable lengths should include enough extra length to allow for servicing the equipment. For example, the cables which plug into the display unit should be long enough to allow them to be connected to display unit with the display unit not installed in the instrument panel.
- In general, routing of the wiring is not critical, as the Mini is designed to be tolerant of the electrical noise and other emissions typically found in aircraft. Some consideration should be given to avoid routing wires near antennas, or other locations that could impart high levels of electromagnetic signals on the wiring.
- In certified aircraft, the Mini-GA may be wired to the aircraft's electrical system, or to a cigarette lighter plug. Excess wire length will not adversely affect the EFIS, but should be managed so that it does not pose a threat of impeding egress from the airplane.
- The checkout procedures outlined in Section 4 must be completed to verify the Mini is not affected by radio transmissions on any frequency.

2.3 Power Connections

Power Switch– No provision is included within the Mini for a power switch. If a power switch is desired for the Mini, the +12V power should be controlled with the switch (not ground). Voltage drops during engine start can cause the Mini to reboot. This will not damage the EFIS.

Circuit Breaker– Power supplied to the Mini must pass through a fuse or circuit breaker. It should be sized to allow at least 1/2 amp, but may be as large as 10 amps. The Mini contains internal current limiting circuitry to protect the equipment from internal electrical faults.

Ground Connection- The cable assembly provided includes 22 gauge wire for the ground return of the Mini. This will result in a voltage drop of about 0.015 V/foot, which is acceptable for wire lengths up to 10 feet.

2.4 Magnetometer Wiring for Experimental Aircraft (Optional)

The remote magnetometer must be placed in an area of the airplane with little or no electromagnetic interference. In certified aircraft there is the additional requirement that it be mounted in a way that allows it be be removed without tools so that it may be considered portable. The "hook" half of a Velcro strip can be used to secure the magnetometer to carpet in many cases, for certified aircraft. If mounted in this manner, consider the following:

- The location should be tested for magnetic interference. This is best accomplished by performing a magnetometer calibration as described in this manual.
- The location of the magnetometer should be repeatable, so that it may be installed in the same position if it is removed, and then re-installed.
- Baggage, seat belts, or other ferrous items can introduce magnetic heading errors.

For experimental aircraft it is recommended that the magnetometer be mounted in the wingtip. Please refer to the magnetometer installation guidelines in Section 3.5 of this manual for more information.

The magnetometer cable supplied with the Mini does not have a D-sub connector installed on the magnetometer cable end. This makes it easier to route this cable through the airplane. After the cable has been routed, the wires can be cut to length if desired. Install pins onto the ends of the magnetometer wires. (Pins are not installed at the GRT factory because experience has shown that they are too easily damaged as they are routed through the airplane.) Insert the indicated wire color into the appropriate D-sub connector housing hole according to the Mini Connector Definitions diagram in Section 2.1.

The digital magnetometer serial output may be shared between any number of the Mini-X, Mini-AP, Mini-GA, and any Adaptive AHRS.

2.5 Inter-Display Link (Two or more instruments)

GRT display units communicate between themselves so that most entries made during flight, such as flight plan information, altimeter setting, and screen dimming, can be made from any display unit and will be applied to all of them. Designate one serial port pair for the Mini and another for the GRT display you want to connect it to and wire as shown below. Set the serial port rate to 19200 for both screens. (Serial ports shown are just an example; any serial port can be used.)

2.6 General Serial Port Wiring Information

The Mini's RS-232 serial ports allow interfacing to a variety of equipment. Although serial outputs and inputs are provided, FAA regulations do not allow the Mini-GA to send any data to other systems in a certified aircraft. However, there are no restrictions on reading data. This allows the Mini-GA to read GPS flight plan and position data from the primary GPS, radio navigation data

from navigation radios which include serial data outputs, ADS-B Traffic and weather data, or even another Mini-GA, and more, as shown in the following table.

Mini-GA Serial interface Selections:

Function	Baud Rate	Connector/Pin on External Device	Notes
GRT Magnetometer	19200	Pin 9	Provides magnetic heading
GPS	As Req.	Varies	Compatible with Aviation format and NMEA0813.
SL30	9600	Tbd	Allows displaying VOR/ILS data
Display-Unit Link	Same as DU Link Output	Varies	Shares flight plan, baroset, and dimming with other GRT EFIS Systems.
Trig TT22 Transponder	9600	Tbd	Allows displaying of TIS-B traffic data

Section 3: Mechanical Installation

3.1 Placement of the Mini on the Instrument Panel

The wide viewing angle provided by the LCD screen, and the bright, high-contrast graphics allow good readability of the screen, even when mounted on the other side of the cockpit. Adjustments are provided to allow full accuracy of the internal AHRS when mounted in panels that are tilted in pitch, when the instrument is angled toward the pilot (yaw), or to account for misalignment in roll. Although the ideal location for the instrument is in front of the pilot, this mounting flexibility is very useful when mounting the instrument around existing instruments.

Some consideration should also be given to the ability of the pilot to reach the instrument to operate is controls. As a backup attitude indicator there is not much reason to use the controls, but activation of the highway-in-the-sky guidance will, for most pilots, become something they use with every landing. This requires a couple of button pushes to activate. Most pilots also find they use the moving map data-selector function frequently, as it provides the easiest way to review data, such as runway lengths, orientations, radio frequencies, and much more, regardless of what other EFIS or GPS may be installed in the airplane. This convenience is not apparent to most pilots until they have some experience with the instrument.

Since the display is fully sunlight-readable, shielding the display unit from sunlight is not required. See Section 1 of this manual for instrument and panel cutout dimensions.

3.2 Mounting Hardware

The mounting bracket mounts in a standard 3 1/8 instrument hole. It is retained by #6 flat head screws. ”

3.4 Cooling Considerations

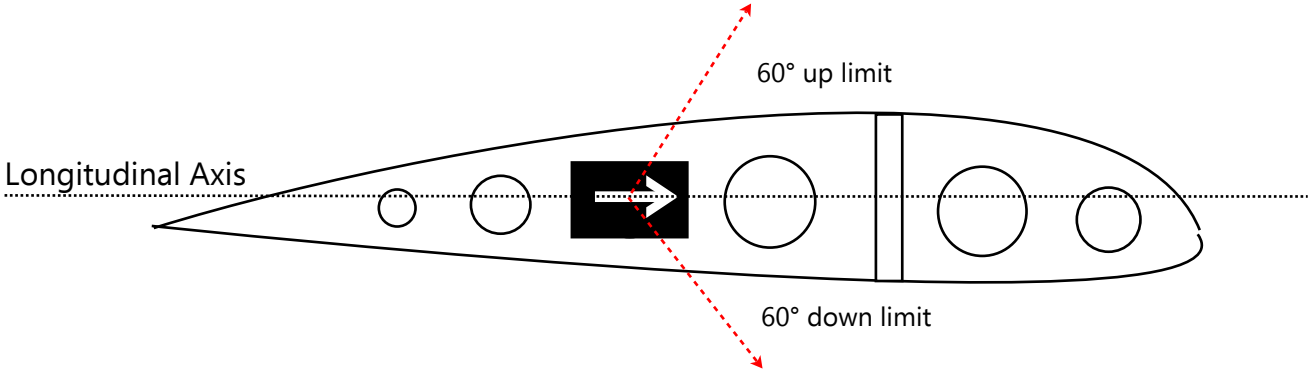
The Mini draws very low amounts of power and does not require external cooling. If other equipment does expose the instrument to high ambient temperatures, it is possible for the instrument to turn off due to excessive temperature. This is not likely however, and in most cases no consideration must be given to cooling.

3.5 Remote Magnetometer Installation Experimental Aircraft (Optional)

The remote magnetometer must be placed in an area of the airplane with little or no electromagnetic interference. The cable is 20 feet long and designed to reach out to the wingtip or tail. The magnetometer is marked with an arrow pointing in the direction of flight. Mount it with the arrow pointing forward, parallel to the centerline of the airplane. There is not a designated “top” of the magnetometer, so it can be turned on its side for easier mounting. The side of a wing tip rib is a simple place to put it. The arrow on the magnetometer should be parallel with the

centerline of the airplane for yaw. Pitch attitude is not critical as long as it is within 60 degrees nose up or nose down.

NOTE: The most common cause of magnetic sensing error is simply magnetic disturbances near the magnetometer. This can be caused by ferrous metal (any metal that a magnet will stick to), control cables, or cables carrying electrical currents, such as navigation or landing lights, being too close to the magnetometer. The magnetometer's location will be tested for interference in Section 4, after the initial boot-up checks of the Mini.



Section 4: General Setup and Calibration

NOTE: Each subsection in this section represents a step in the setup and calibration of the Mini and optional external magnetometer. Perform each step in the order presented here for the most efficient setup procedure.

4.1 Boot-Up Check

Apply power to the Mini. The display backlight should come on and show the boot page within 30 seconds. A warning, "Magnetometer Orientation Not Set," will be generated if you have a magnetometer connected. Ignore this for now. Note device communications, installed software version, and navigation database effective date, and whether there are any other errors, then press ACCEPT.

4.2 Explore the Set Menu Pages

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

1. Press any key to display the softkey labels, then press NEXT until a SET MENU softkey appears.
2. Press SET MENU to access the main menu, as displayed below.
3. Turn the knob counterclockwise to move the cursor down the list. Press the knob to view the highlighted page or make changes to the values of highlighted settings.

General Setup- Serial port assignments, units of measure, clock, data recording, etc.

Primary Flight Display- V-speed settings, PFD display preferences, G-meter settings

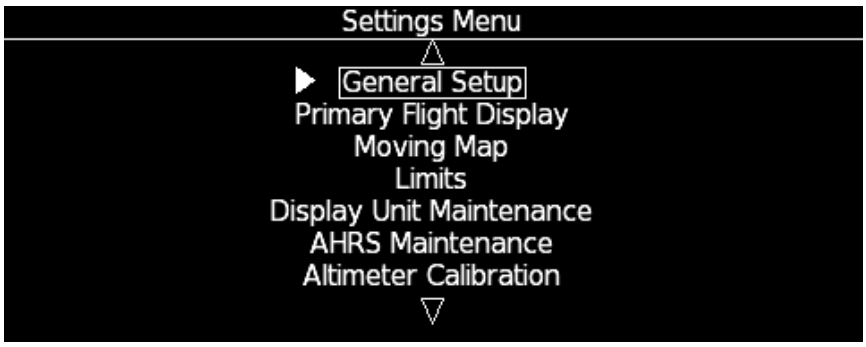
Moving Map- Map symbol & features preferences

Limits- Set up flight timers for total endurance minus reserve and interval reminders to switch fuel tanks. Set limits for EFIS (Mini) minimum and maximum bus voltage.

Display Unit Maintenance- Display software updates, settings backup, nav database updates, other internal functions

AHRS Maintenance- AHRS software updates, gyro & magnetometer raw data

Altimeter Calibration- Calibration page for the altimeter



4.3 Set Up Your General Preferences

Access the Set Menu > General Setup page. Follow the guidelines below.

Scroll down past the serial ports to **Page Change.** The softkey labels on all PFD and Map pages appear only after a button is pressed, then disappear. Set this to *Double-Click* if you want the first click to only bring up the softkey labels and not change anything. *Single-Click* allows you to toggle between the PFD and Map pages at the first button press, without bringing up the labels.

Initial Menu Timeout (sec)- This setting determines the length of time the softkey labels stay on the screen before a selection is made. We recommend setting it to at least 5 seconds until you learn the system.

Used Menu Timeout (sec)- This setting determines the length of time before the softkey labels disappear after a selection is made. 2.0 seconds is recommended.

Default Page- Choose the default that appears after boot up is complete. Most users will use the PFD as default, but some may choose to display the Map or HSI. If you have two Minis installed, one can be set to the PFD while the other can default to the Map page.

Speed/Distance Units- Choose your preferred units for the airspeed tape and waypoint information.

Temperature Units- Degrees Fahrenheit or Celsius

Clock- Turn clock ON to display. Enter the difference between your local time and Zulu time. Time is kept through the internal GPS.

DEMO Settings- Set up your preferences for data recording off the Mini. Flight data (also known as Demo files) can be set to record onto a USB thumb drive installed in the Mini USB port. Note that all flight data, including EIS engine and environmental information, can also be captured by other GRT display units in the system. More information on data recording can be found on the GRT website Feature of the Week page, at http://grtavionics.com/datarecording.html.

SNAP Button- Allows a softkey to be used to snap screen shot images in flight as a PNG image file recorded to the installed USB stick. Available on many pages that have an unused softkey.

Show DEMO Filename- Shows the file name on the screen when playing back a demo recording on the Mini.

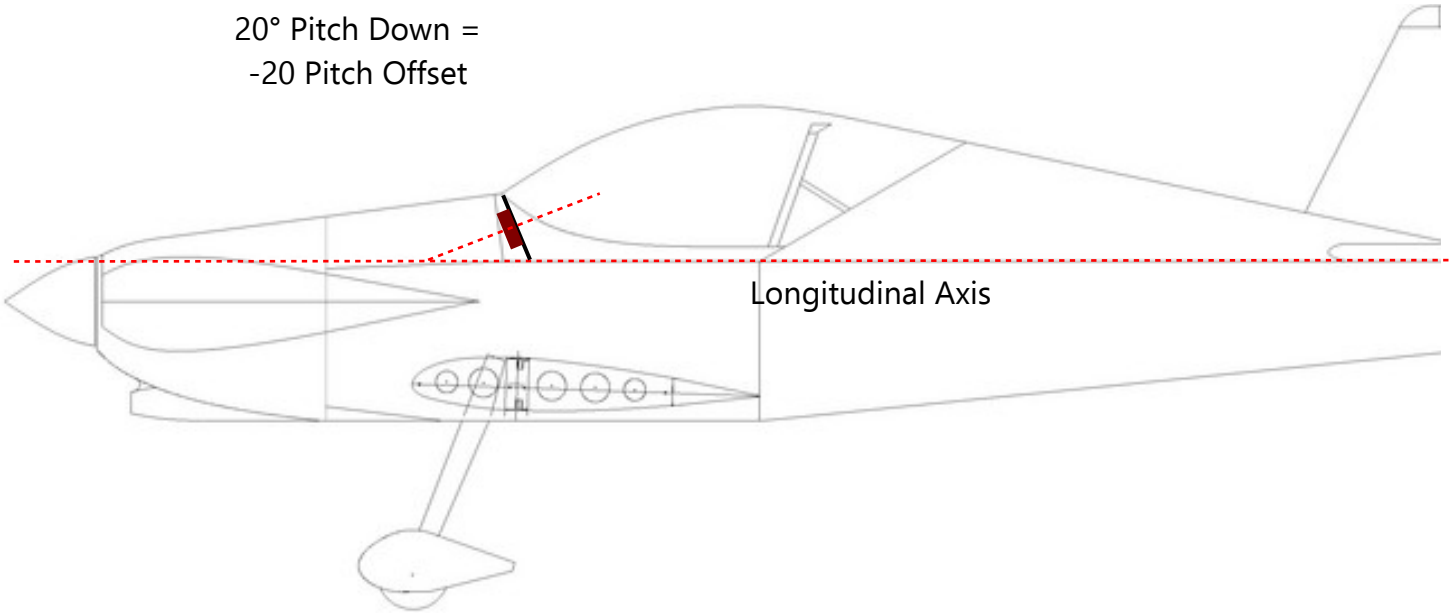
ALWAYS SAVE your settings before exiting the Set Menu!

4.4 Set Instrument Orientation

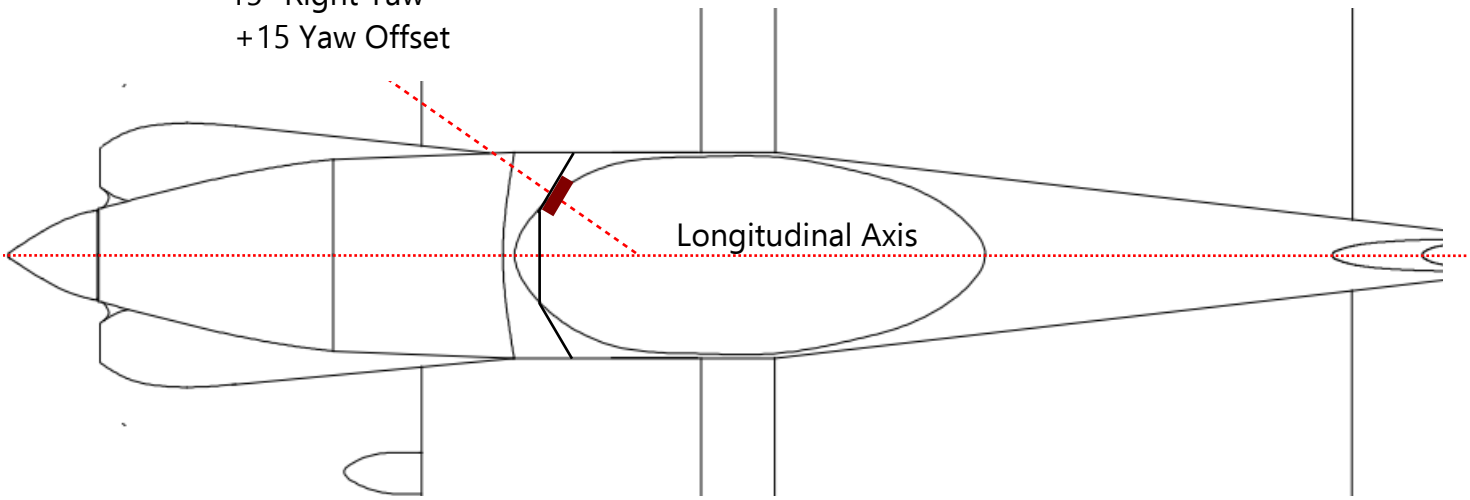
This is a coarse setting to account for angled instrument panel installations. You will fine-tune the instrument orientation again in flight after validating the location of the magnetometer (if installed).

1. Access Set Menu > AHRS Maintenance. Scroll to **Set Instrument Orientation.**
2. Enter the offset in degrees for each axis. Positive corrections correspond to right roll, pitch up, and right yaw. See example sketches below (not to scale):

Instrument Panel Tilt
20° Pitch Down =
-20 Pitch Offset



Mini Tilted toward Pilot
15° Right Yaw =
+15 Yaw Offset



Panther line drawing used with permission from Sport Performance Aviation, LLC

4.5 External Magnetometer Location Validation

Skip to Section 4.8, Altimeter Calibration, if you do not have the optional external remote magnetometer. The internal magnetometer cannot be calibrated.

NOTE: When the magnetometer wiring is connected to the designated magnetometer connection pins on the DB9 connector, the Mini will automatically detect it upon boot-up and set up or verify the magnetometer serial port settings.

Verify the PFD screen shows HDG next to the heading box at the top-center of the screen. This indicates that it is receiving valid heading data from the magnetometer.

1. Go to Set Menu > AHRS Maintenance > Set Magnetometer Orientation. Answer the prompts on the screen to begin automatic orientation of the magnetometer. For maximum accuracy, this procedure should be performed with the ambient temperature is in the range of 50-90 deg F. If the magnetometer orientation is not set, the magnetic heading data may be inaccurate, and the following steps may yield misleading results.

2. Park the aircraft on a level surface and start the engine.

3. Access Set Menu > AHRS Maintenance. Locate **Magnetometer Heading** field on this screen.

   NOTE: Do not use the heading data shown on the heading tape on the PFD for calibration because this is a composite reading of several other pieces of information. The Magnetic Heading field contains instantaneous data on magnetic heading only.

4. Observe the Magnetic Heading and verify it does not change by more than +/- 2 degrees while doing the following:

   a. Turn on and off any electrical equipment whose wiring passes within 2 feet of the magnetometer.

   b. Move all flight controls from limit to limit.

   c. Shut down the engine and observe the heading while the engine is not running.

   d. For aircraft with retractable landing gear: If the magnetometer is located within 2 feet of retractable landing gear, support the aircraft using proper jacking equipment, then observe the heading while operating the landing gear.

   e. If a greater than +/- 2 degree change is noted, either relocate the magnetometer or the offending wiring or metallic materials. Recheck. If there is any doubt about a location, try moving the magnetometer to another location. Use tape or other temporary means to hold it in place and repeat the test.

5. While the calibration procedure can remove errors as large as 127 degrees, accuracy is improved if the location chosen for the magnetometer requires corrections of less than 30 degrees. To check the uncorrected heading error:

   a. Go to Set Menu > AHRS Maintenance > Magnetometer Calibration.

   b. With the Magnetometer Calibration page in view, rotate the airplane 360 degrees. A red graph will appear on this page showing the calculated errors.

Troubleshooting Magnetometer connector

1. If HDG is not displayed on the PFD, the wiring to the magnetometer may be incorrect, or the magnetometer connect may not be plugged in.

4.6 Set Final Magnetometer and Instrument Orientation

Once the chosen magnetometer location is verified to have acceptable levels of interference, set the orientation of the magnetometer.

1. Go to Set Menu > AHRS Maintenance > Set Magnetometer Orientation. Answer the prompts on the screen to begin automatic orientation of the magnetometer. For maximum accuracy, this procedure should be performed with the ambient temperature is in the range of 50-90 deg F.

2. When the final instrument and magnetometer orientations are set, perform the Fine Magnetometer Calibration, described in the next section.

4.7 Fine Magnetometer Calibration Procedure

Magnetometer calibration is required to achieve accurate magnetic heading readings. This calibration corrects for minor errors induced by magnetic disturbances local to the sensor, such as ferrous metal objects.

NOTE: The AHRS will not allow magnetometer calibration to be initiated if the airspeed is greater than 50 mph to prevent inadvertent selection while in flight. If calibration is successful, the existing calibration data (if any) will be replaced with the new corrections.

The Magnetometer Calibration page will help guide you through this procedure with its on-screen menus and prompts. Ideally, the engine should be running and electronic equipment turned on during calibration to simulate the electromagnetic field in the aircraft during flight conditions.

1. Point the aircraft to magnetic north, in an area without magnetic disturbances, such as a compass rose.

A simple means of pointing the airplane toward magnetic north is to taxi the airplane slowly and use the GPS ground track to determine when you are taxiing in a magnetic north direction. Make small corrections to the direction of travel of the airplane, and continue to taxi for several seconds for the GPS to accurately determine your ground track. The GPS cannot determine your track unless you are moving.

It is also possible to orient the airplane to magnetic north using the magnetometer itself. This technique is more accurate assuming the magnetic disturbances from the airplane are minimal in the north direction. We recommend using this technique first, performing this calibration, and then validating the accuracy of the magnetic heading by taxiing the airplane and comparing the EFIS heading to the GPS ground track (both are displayed on the PFD.

2. After the aircraft is positioned accurately, turn ON the Mini. (If it was already on, then turn it OFF, and then back ON again) and allow at least 1 minute for the AHRS to fully stabilize.

3. Access Set Menu > AHRS Maintenance. Scroll to and select Magnetometer Calibration on this screen.

4. Press Start soft key. The first question is "Are you sure?" Press YES if you are sure.

5. Verify the airplane is still pointed to magnetic north. Answer the question "Are the aircraft, AHRS, and magnetometer pointing to magnetic north?" with YES. A message will appear at the bottom of the screen indicating the system is waiting for the gyros to stabilize.

6. As soon as the message "Calibration in Progress" is displayed (within 15 seconds), rotate the aircraft 360 degrees plus 20 degrees in a counter-clockwise manner (initially towards west). The airplane does not need to be rotated in place, but simply taxied in a circle. The airplane must be rotated completely through 360 degrees, plus an additional 20 degrees past magnetic north, within 3 minutes after initiating the calibration. The airplane should be rotated slowly, such that it takes approximately 60 seconds for the complete rotation.

7. If calibration is successful, the AHRS will re-start itself automatically, and begin using the corrections. While re-starting, the AHRS will not provide data. This will result in the AHRS data disappearing from the display unit for about 10 seconds.

8. If calibration is unsuccessful, one of two things will happen. In either case, the calibration procedure must be repeated.

    a. If the airplane is rotated too rapidly, the calibration will end after the full rotation like normal. The calibration data will be marked invalid, and the screen will indicate "Calibration Invalid - AHRS rotated too fast".

    b. It will exit calibration mode, and will show "Calibration INVALID - Maximum correction exceeded" if a correction of greater than 127 degrees is required. (Invalid - OVER LIMIT

will be displayed on the AHRS maintenance page next to the Magnetometer Calibration field.) A correction of greater than 127 degrees can be caused by incorrect mounting of the magnetometer, or location of the magnetometer too close to ferrous metal in the aircraft, or starting with the airplane not pointed toward magnetic north or magnetometer wiring errors. (NOTE: The magnetometer orientation must be set. This step may have been skipped)

The validity of the location for the magnetometer calibration can now be verified.

9. Point the airplane toward magnetic north.

10. Turn ON the Mini (if already ON, turn it OFF, and then back ON).

11. Verify the AHRS (on AHRS Maintenance page) shows a heading close to north. (Small errors are likely to be a result of not positioning the airplane to the exact heading used during magnetometer calibration.)

12. Select the Magnetometer Calibration page. (Do not activate the calibration this time.)

13. Rotate the airplane through 360 degrees, and inspect the Calculated Error graph (the red line) drawn on the screen. The magnetic heading errors should be less than 5 degrees, and can typically be reduced to about 2 degrees. Accurate magnetic heading is required for the AHRS to display accurate heading data, and to allow accurate wind speed/direction calculations.

    The graph will also show the correction stored in the AHRS as a green line. The green line will be within the +/- 30 degree range if the magnetometer was mounted in a good location and the orientation was set prior to calibration.

    The status of the magnetometer correction data is indicated by the field next to the Magnetometer Calibration setting on the AHRS Maintenance page. If the field has the message "INVALID", then no valid data is stored within the AHRS and it must be re-calibrated. If the field says "VALID", it means that the data is present. Keep in mind that the accuracy of this data is not assured because it is dependent on how carefully the user performed these steps. The calibration data should be cross-checked with reliable ground references such as a compass rose or runway headings before flight.

Measuring the Accuracy of the Magnetic Heading

The accuracy of the magnetic heading can be easily observed while taxiing and comparing the magnetic heading displayed on the AHRS maintenance page, to the GPS ground track. The difference between them is the heading error in that direction.

This can also be observed on the PFD screen, although the heading data on this screen is slaving the yaw gyro, and thus will respond slowly to the difference between the displayed heading and the the magnetometer heading. When using the PFD screen, the best technique is to point the

airplane in the direction to be tested, wait at least 20 seconds, or until the heading is not changing, and then taxi until the ground track is stable on the PFD also. The difference between them is the magnetic heading error. If it is excessive, the fine magnetometer calibration should be repeated.

How accurate should the magnetic heading be?

Achieving highly accurate magnetic heading requires that the magnetometer be installed in a good location on the airplane, and the AHRS be mounted accurately. Due to the steep angle of the earth's magnetic fields (only about 20 degrees off vertical), the attitude data from the AHRS must be used to process the magnetic field data from the magnetometer, and for every degree of attitude error, 3 degrees of heading error will be induced.

Heading error of less than 5 degrees are not normally apparent in normal flying, but errors this large will cause the winds calculated by the EFIS to be inaccurate. For every 1 degree of heading error, 1.7% of the forward speed of the airplane will be falsely reported as a cross-wind. Thus, with only a 5 degree heading error, an airplane flying at 100 knots will show a false crosswind of 8.5 knots.

4.8 Altimeter Calibration Experimental Aircraft with Air data Computer

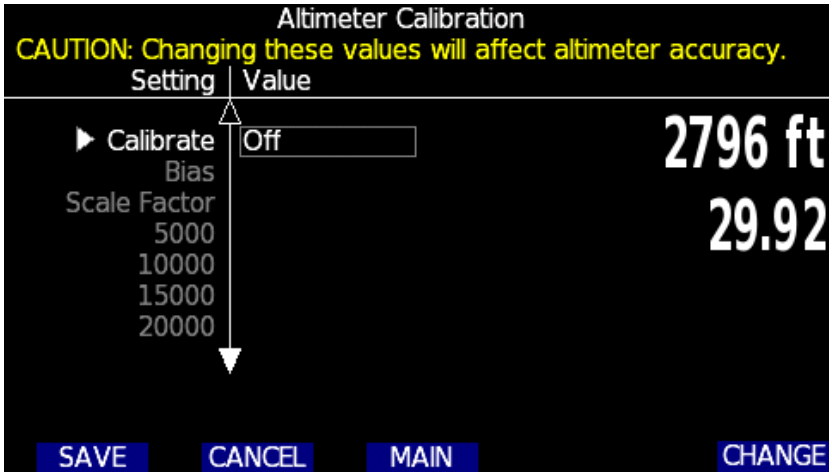
When the Mini is to be used for IFR flight, the altimeter portion of the AHRS must be calibrated to conform to FAR 91.411. This is to be done at an interval in time as dictated by FAR 91.411. It is not necessary to calibrate the altimeter more often than this requirement.

The accuracy of the altimeter can be adjusted using entries provided on this page to account for sensor errors that may occur due to aging. The adjustments are stored within the AHRS/Air Data Computer.

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:

1. Position the aircraft at a location with a known elevation.
2. Turn on the Mini and allow at least 5 minutes to elapse before continuing.
3. 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.
4. Access Set Menu > Altimeter Calibration.
5. Use the knob to highlight Calibrate- OFF. Rotate the knob to turn it ON.
6. Set the baroset to the currently reported altimeter setting.
7. Use the knob to highlight the Bias setting. 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. Calibration is complete! Do not alter any other altitude settings. The altimeter calibration will be turned off automatically when this page is exited.



4.9 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 Mini and allow at least 5 minutes to elapse before continuing.
2. Connect test set to the pitot AND static ports of the Mini.
3. Set the test set to sea level (0').
4. From the PFD page, use the knob to adjust the baroset to 29.92 on the Mini.
5. Access Set Menu > Altimeter Calibration.
6. Verify the baroset is 29.92.
7. Set the **BIAS** so that the altimeter reads 0 ft.
8. Complete the calibration by setting the altimeter test set to each altitude listed on the calibration page (5000, 10000, 15000, etc.), and adjusting the corresponding entry until the altimeter reads this altitude.
9. Exit the calibration page. Calibration is complete.

If necessary, the **BIAS** adjustment can be made without affecting the other corrections at any time.

4.10 Airspeed and Wind Calibration

(Applies when using the optional remote pitot/static module or air data computer only)

The Mini accurately calculates indicated airspeed via its measurement of the difference between pitot and static pressures. Typical instrument errors are less than 2 mph at 100 mph, and diminish to less than 1 mph at 200 mph. It is not uncommon for airspeed errors to be observed however, as the pressures provided by the aircraft's pitot/static system do not always represent the actual static and impact pressures.

The Mini provides a means of correcting the true airspeed that it displays in the PFD data box, and which is used in the wind calculation when the Mini is equipped with a remote magnetometer. Since the wind calculation is based on the difference between GPS ground speed and true airspeed, it is quite sensitive to true airspeed errors, and for some airplanes a significant improvement in the accuracy of the winds can be achieved by performing this calibration.

The Mini does not provide any means to correct the indicated airspeed, as this would result in the Mini showing a different indicated airspeed than other indicators that may be installed in the airplane.

The AHRS Maintenance setup menu page provides a **True Airspeed Corrections** selection. When selected, a correction table is shown, overlaid on the PFD screen. The table allows for up to 8 corrections. It is recommended that at least the following 3 airspeeds be used for the corrections: correction at the typical cruising speed, typical climb airspeed and typical approach speed. For example, with an RV-6, a good approach speed might be 80 mph with flaps at 1 notch. Additional corrections can be entered if desired, especially if TAS errors are noted that vary significantly with speed. Only one correction for a specific airspeed should be made.

To record a TAS correction:

1. Access Set Menu > AHRS Maintenance and scroll to **True Airspeed Corrections.**

2. Press the knob to open the calibration page. The "Airspeed Calibration" table will appear superimposed over the PFD screen.

3. Select a blank table entry in the correction table using the knob. If no entries are blank, then select an entry and press Delete to clear the entry. The START CAL softkey will be displayed

when the cursor box is on a blank entry.

4. Press the START CAL softkey to begin.

5. Find a heading such that the ground track indicator and the heading indicator (triangles labeled "H" and "T") are aligned on the PFD or map page within 5 degrees. This will result in the airplane flying directly into, or with the wind.

6. Establish the desired IAS for the correction. Do not change the power setting until the calibration is complete.

7. Press the READY softkey. Maintain constant heading and altitude until the count-down timer reaches 0. The Mini will average the data until the timer reaches 0.

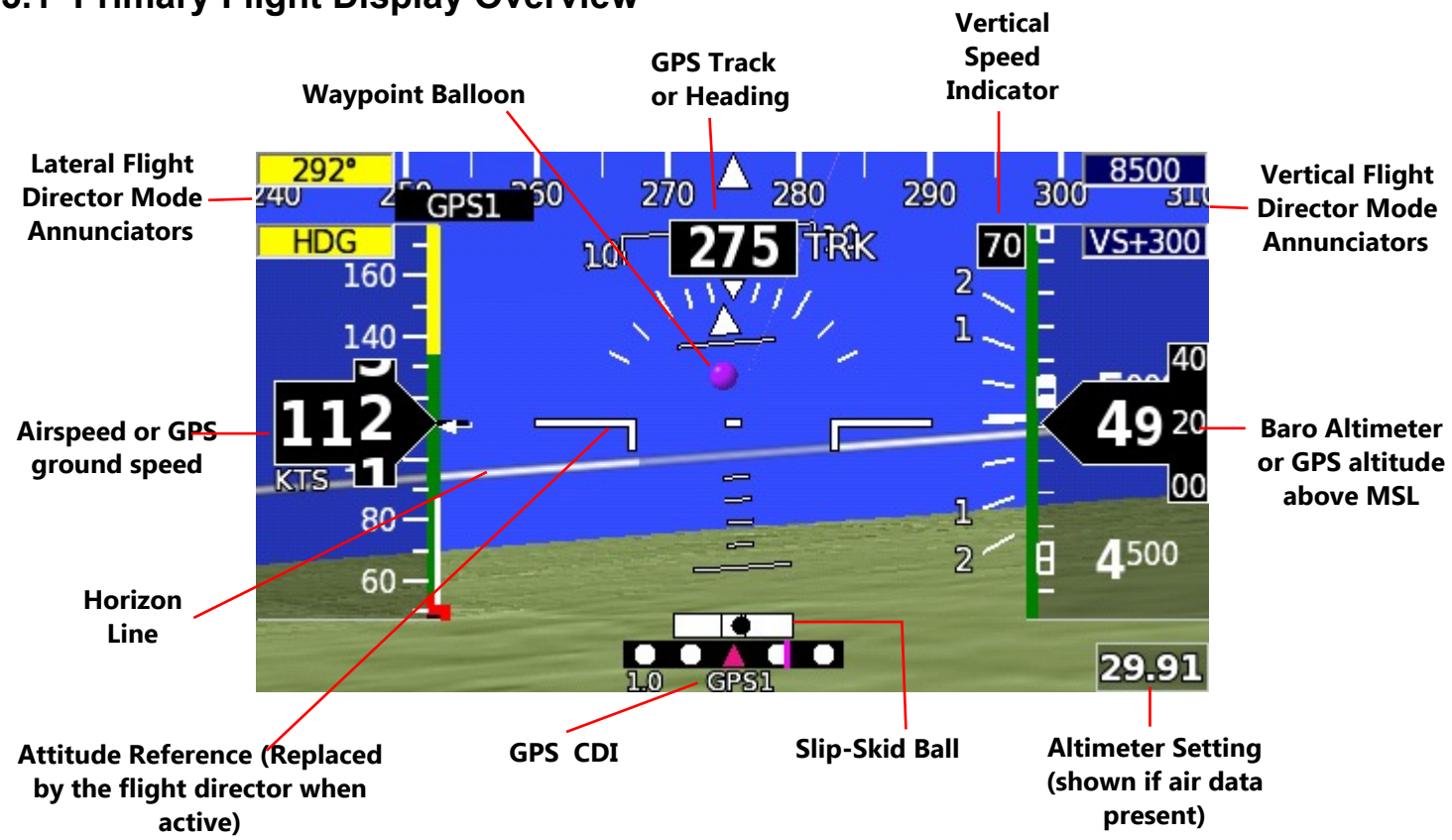
8. Turn to the reciprocal heading when prompted. When established on this heading, at the same altitude and power setting as in step 6, press the READY softkey. The data will be collected until the count-down timer reaches 0. The correction table will then display the correction, completing the process.

9. Repeat for other chosen speeds, such as approach or cruise.

If you feel that an entry in the calibration table is inaccurate, it may be deleted by selecting it with the cursor box using the knob, and pressing the DELETE softkey. You will be asked to confirm deletion of this entry before it is erased.

Section 5: Primary Flight Display Screen

5.1 Primary Flight Display Overview



This illustration shows a typical depiction of the primary flight display. In this example, the Mini-GA is being supplied with air data. More commonly, it is not, in which case GPS ground speed is displayed with the label "GND SPD". Similarly, the altimeter is labeled "GPS ALT". The Vertical Speed Indicator is a white bar that moves up and down to the left of the altimeter, with a digital FPM readout above or below it (a 70 FPM climb is shown here).

Without a source of magnetic heading (the magnetometer is optional) GPS track is shown at the top center, with its label "TRK". If heading is available heading is always shown as magnetic. Although the Mini-GA includes a magnetometer internally to stabilize the yaw axis of the AHRS, the data derived from it is not displayed due to the inaccuracy of the magnetic fields typically found in the instrument panel. Synthetic vision of terrain, obstacles, runways, waypoint balloons, and course ribbons are shown on the Primary Flight Display.

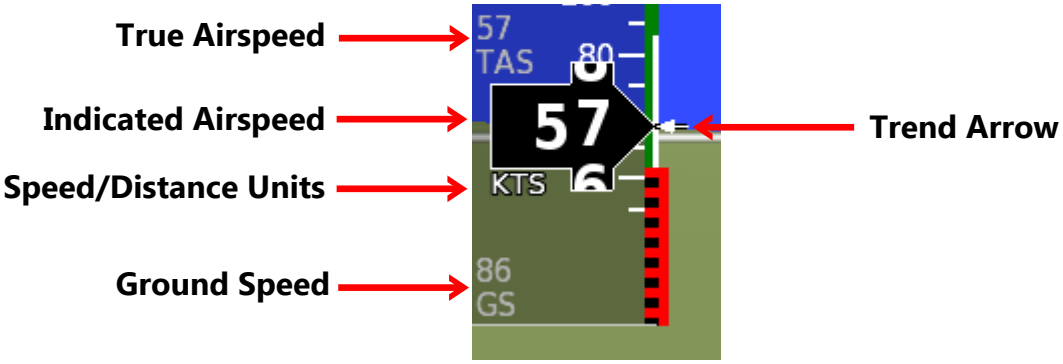
The gap between the horizon line and terrain widens as altitude increases. When flying at high altitudes, where terrain is not a factor, the synthetic vision may be turned off, resulting in a conventional attitude indicator background. This is accomplished via the softkeys.

NOTE: All of the features described in this section can be configured on the Primary Flight Display set menu page. This section of the manual provides a description and picture of each feature along with instructions for configuring it to match your airplane and personal preferences.

5.2 Airspeed Tape (applicable when air data provided)

The primary function of the airspeed tape is to display indicated airspeed and its associated color bands, all of which are fully programmable. TAS and ground speed are also provided here.

The airspeed display utilizes large, bold numbers on a black background for excellent visibility. The digits are displayed as a rotating drum display to convey both the current speed, and speed trend The trend data is much more sensitive than a typical mechanical airspeed indicator. This data allows the pilot to control the speed more precisely, with less frequent observations of this data. The units of distance/speed are displayed below the digital readout. True airspeed (TAS) is displayed in the upper left corner, while GPS ground speed is displayed in the lower left corner, as shown below.

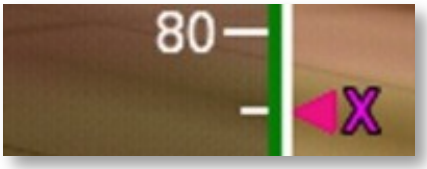


Trend Arrow

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

V-Speed Reference Markers

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



Vx airspeed marker alongside the green and white color bands

Colored Airspeed Bands

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

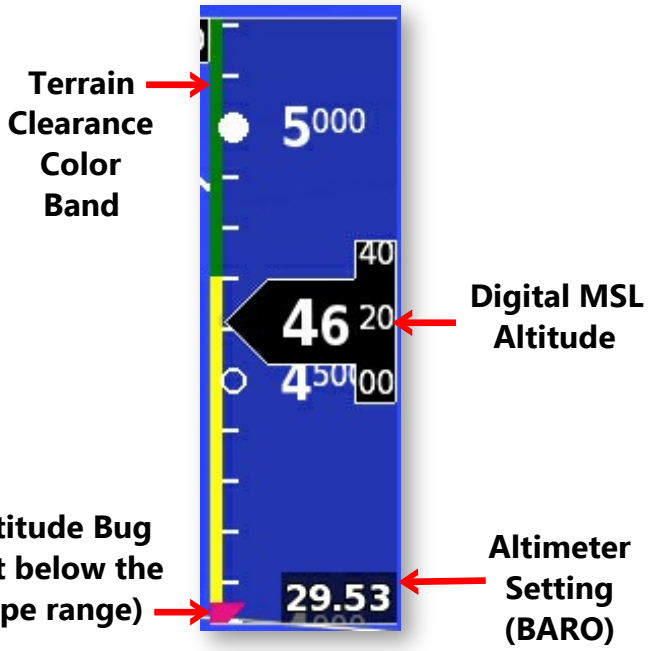
Red/Black	Zero to V_S (full-flap stall speed). Airspeed values too low to register on the EFIS will appear as a red dash (- -) in the digital readout window. Option: Red or clear.
White	Full-flap stall speed (V_{S0}) to flap extension upper airspeed limit (V_{FE})
Green	Stall speed (V_{S0}) to maximum 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

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 match the individual aircraft's flight characteristics.

5.3 Altimeter Tape (applicable when air data provided)

The Altimeter Tape displays barometric corrected altitude in hundreds of feet. Even thousands are depicted by a solid marker, either a circle, triangle or rectangle. Five-hundred foot increments are depicted by a hollow marker. The baro setting is displayed in the lower right corner.



The terrain clearance color band on the edge of the altimeter tape shows the Off-Route Obstacle Clearance Altitude (OROCA), also called the Grid Minimum Off Route Altitudes (Grid MORAs), 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 Change the Altimeter Setting:

1. From the PFD screen, turn the knob to enter the new altimeter setting.
2. Press the knob to accept the new baro setting or press CANCEL to abandon the changes.

Altitude Bug

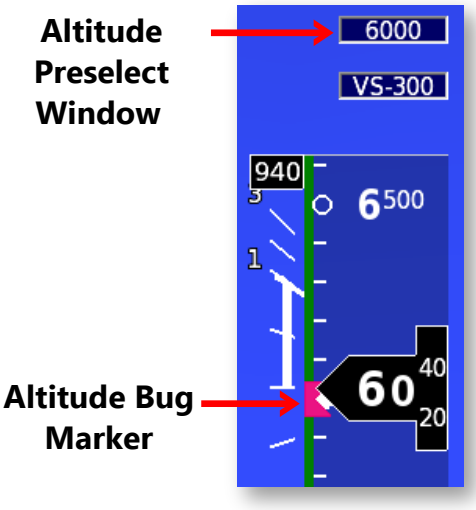
The selected altitude is displayed in the Altitude Preselect Window located above the altimeter tape and is marked on the altimeter tape itself by a magenta rectangle "bug" with a notch. The altitude bug serves two functions:

- The commanded altitude for the flight director for climb/descend and hold.
- A reminder for a cruise altitude or any other altitude the pilot wishes to remember, and for the altitude alerting function.

To set the altitude bug:

Press the knob twice to access the Vertical Flight Director menu.

1. Turn the knob to enter the desired altitude into the Altitude Preselect Window.
2. Select the vertical mode desired. IAS/GSPD commands climb/descent at a selected speed, VS commands this at a selected vertical speed, and AUTO uses speed for climb, and vertical speed for descent.
3. Press the knob to set the bug to the selected altitude.
4. Set the climb/descent rate as an IAS (or groundspeed if no air data is present), or as a vertical speed, depending on the vertical flight director mode selected.



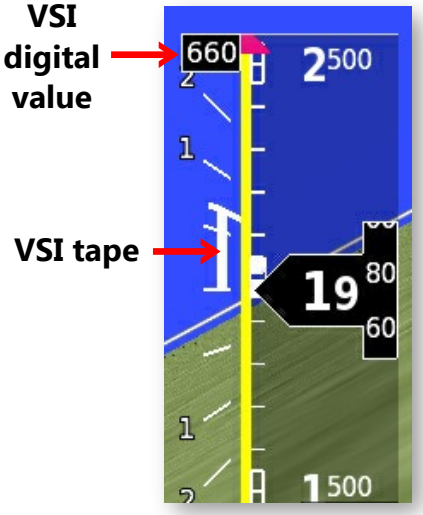
5. Altitude Deviation Alerts

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

1. Access 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.

5.4 Vertical Speed Indicator

The vertical speed indicator (VSI) is along the left side of the altimeter. The tape is white and radiates upward or downward from the neutral mark as the aircraft climbs and descends. It shows vertical speed in feet per minute. 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 upper limit can be programmed to fit the climb performance capability of the aircraft for a more precise visual representation.



To customize the VSI:

1. Access Set Menu > Primary Flight Display
2. Scroll to **Max Indicator Vertical Speed**. Choose the upper limit of the VSI scale most appropriate for the aircraft's climb performance. The actual rate of climb will still be displayed numerically even if the visual indicator is maxed out.

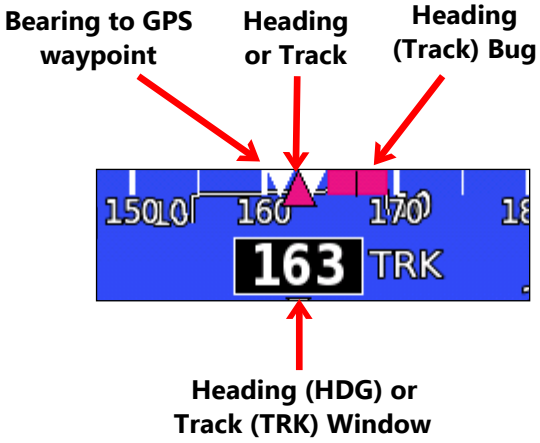
5.5 Track/Heading Indicator

The heading/track tape is presented on top of the PFD screen. In addition to the large HDG or TRK value in the main heading/track window, it displays three parameters with the following white or magenta symbols. The symbols are **magenta** when they are the active guidance reference, according to the flight director mode. The bearing and track symbols fit inside each other so they create a nice visual effect when the aircraft is on course.


GPS Ground Track or Magnetic Heading


Bearing or course to current GPS waypoint


Heading/Track Bug



NOTE: The direction indicator will be Track (TRK) without the optional remote magnetometer.

When the optional external magnetometer is installed, the reference is heading (HDG). This corresponds to the reference the pilot is expected to fly when given headings by ATC. It also allows the synthetic vision to show the effect of a cross-wind, as the pilot will observe the flight path

marker and ground-reference items (such as the runway) will shift left or right to account for the effect of the cross-wind component. This makes transitioning from heads-down to heads up flight easier, as the pilot can easily anticipate where to find the runway environment in his windscreen.

Using the Heading Bug

NOTE: If Track (TRK) is being used as the Heading reference, the Heading Select Window and Heading Bug will refer to GPS track, not magnetic heading.

To change the position of the heading bug from the PFD screen:

1. Press the knob once, then rotate it to display the desired heading in the Heading Select Window (right). The numerical compass position of the bug will display in the window above the knob, and the visual bug indicator will slide across the heading tape of the PFD or the arc on the map page or HSI.

2. If the flight director is active, and the lateral flight director mode is “HDG” or “TRK”, the flight director will provide roll guidance to achieve and maintain this target.

5.6 Attitude Indicator/Artificial Horizon

The PFD may be selected as SV: ON | TERRAIN | OFF

OFF A traditional attitude indicator display is provided, showing a flat earth and using blue to represent the sky and brown to represent the ground. This is useful when flying at altitudes where terrain is not a factor, or when over water. Symbolic representations of runways and obstacles are also shown, with a flight path marker showing the airplane's projected path relative to them.

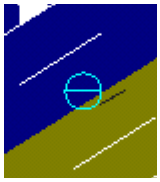
ON Generates a synthetic representation of the terrain, with scaled depictions of runways and obstacles. The flight path marker overlays this view and shows the airplane's path relative to terrain, runways, obstacles, etc.

TERRAIN Is the same as ON except it adds coloring based on your height above the terrain.

Attitude Reference Index

The Attitude Reference Index is always in the same position relative to the aircraft. 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 at right). This small indicator concisely displays the nose position of the aircraft relative to the horizon.



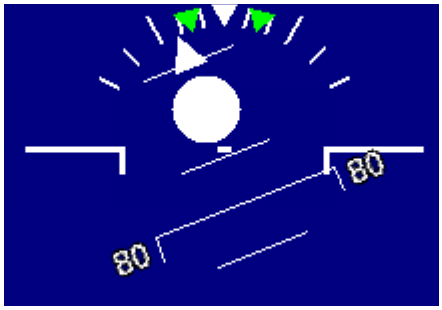
"Nose"

To select Nose or Bars (wings):

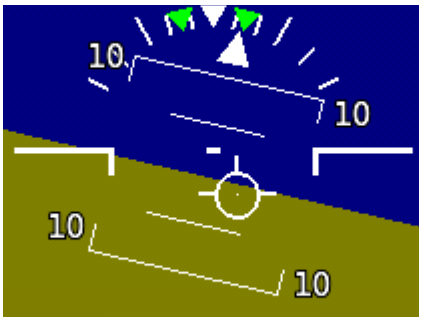
1. Access Set Menu > Primary Flight Display > Attitude Reference Index.
2. Select NOSE or BARS.

Pitch Ladder Offset

The Pitch Ladder is a portion of the artificial horizon that depicts the pitch angle of the aircraft in relation to the horizon. It consists of horizontal lines above and below the neutral horizon line. The ladder rungs are in 5-degree increments. In the screen shot above right, the pitch angle of the aircraft is about 2.5 degrees nose-high, as shown by the Attitude Reference Index (bars) crossing halfway between the first rung above the zero-pitch horizon line. In the screen shot at right, note the white circle that marks the 90-degree pitch rung. This is visible during a loop or hammerhead.



90-degree pitch rung



Attitude Reference Index with Flight Path Marker

Adjusting Pitch Ladder Offset

During straight and level un-accelerated flight at the normal cruise power setting, the pitch ladder should be set so that the Attitude Reference Index is aligned with the zero-pitch line. The object is to set the pitch ladder for the easiest possible instrument scan during cruise.

1. Access the Set Menu > Primary Flight Display page.

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

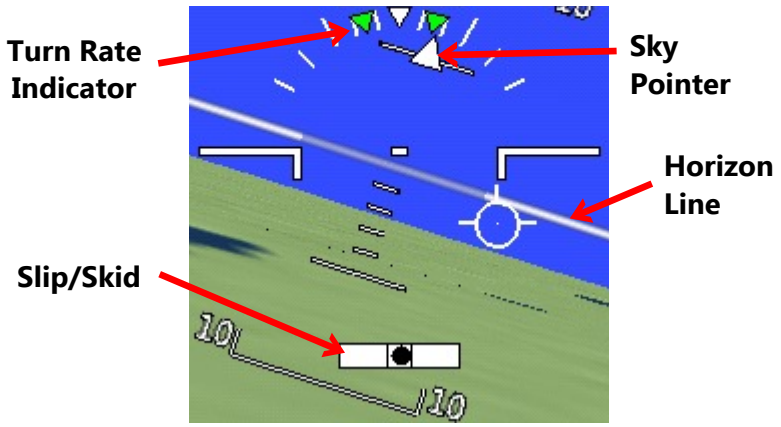
3. Adjust it in small increments until the Attitude Reference Index and the zero-pitch line are aligned during level normal cruise flight.

NOTE: Pitch Ladder Offset should *not* be used to compensate for the tail-down attitude of a tail dragger on the ground. When you are on the ground in a tail dragger, the view out the virtual EFIS window should look toward the sky, just as it looks out the windshield. Pitch ladder offset is ONLY for calibrating straight-and-level flight.

It should also never be used to adjust the attitude indication for varying airspeeds or other flight conditions. Once it's set for your particular airframe/engine/propeller combo, the Pitch Ladder Offset should not normally be moved. Adjusting this for varying flight conditions can be dangerous when those conditions change again, potentially leading to spatial disorientation in instrument conditions. Paying attention to a consistently-placed pitch ladder indication will result in greater understanding of the pitch changes that occur with changing airspeeds, power settings and cargo loading.

Sky Pointer

The Sky Pointer is the white triangle in the middle of the bank indicator hash marks. This simply points UP at all times. If you roll inverted, it will point at the sky and thus appear as if it's pointed at your floorboards. This is displayed as an aid for unusual attitude recovery and also serves as the bank angle pointer. Marks indicate 10, 20, 30, 45 and 60 degrees of bank.



Turn Rate Indicator

The Turn Rate Indicator is depicted at the top of the pitch ladder and below the heading window as a pair of inverted green triangles. The Mini calculates the angle of bank required to make a standard rate turn at the current airspeed. The rate indicator triangles spread out or in as the airspeed increases or decreases. To make a standard rate turn, align the sky pointer with the green triangle.

The Turn Rate Indicator triangles can be turned off to de-clutter the display. To turn it on or off:

1. Access the Set Menu > Primary Flight Display page.
2. Scroll to **Turn Rate Indicator** and select ON or OFF as appropriate.

Slip/Skid Inclinometer

The electronic slip/skid "ball," or inclinometer, works using the internal accelerometers in the AHRS. It can be turned off for de-cluttering purposes. To turn it on or off:

1. Access the Set Menu > Primary Flight Display page.
2. Scroll to Slip Indicator and select ON or OFF as appropriate.

5.7 Flight Path Marker

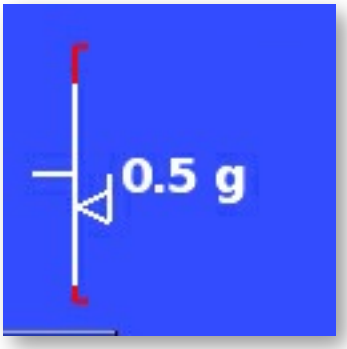
The flight path marker projects the airplanes path, accounting for the effect of cross-winds and climbs/descents. It is useful for observing the airplane's current path relative to ground-referenced items, such as runways, obstacles and terrain. When the flight path marker is positioned over any of these items it is showing that the airplane is on a path to collide with it. This is very useful for avoiding obstacles and terrain, and even more useful for controlling and observing your path relative to the runway. We find it indispensable at night.

5.8 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.

G-Meter Settings

Settings are found on the Set Menu > Primary Flight Display page.



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

G-Meter Activation & Display

1. Access the Set Menu > Primary Flight Display page.

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 all the time

   c. On with Min/Max- Displays all the time 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 settle below the threshold. (See Trim Indicator notation.)

Setting Up the G-Meter

Enter the maximum (positive limit) and minimum (negative limit) of your aircraft in the G-Meter Minimum and Maximum settings. Set the Caution limits the same way; the G meter turns red if the Max/Min limits are exceeded, and turns yellow if the Caution limits are exceeded. Your aircraft designer may have established caution levels, or you can choose your own.

G-Meter Data Logging

G-force data is recorded with all of the other AHRS data during a demo recording. For instructions on how to record a permanent record of your G readings, see the *Flight Data Recording* Feature of the Week on the GRT website for automatic recording of flight data or Section 7 of this manual.

G-Meter Limitations

The G-meter has the same limitations as the AHRS: +/- 10 G of acceleration.

5.9 Synthetic Vision Features & Settings

Synthetic vision (SV) is standard on the Mini-GA. It displays a 10-mile "out the window" view on the PFD of terrain, runways, and obstacles. The synthetic vision terrain database is pre-loaded for the expected portion of the world, but my be re-loaded by the owner to any area of the world in which each Mini will be used. See the website for details regarding changing this database.

NOTE: Synthetic vision is dependent upon GPS signal for proper depiction relative to the internal terrain database.

NOTE: The synthetic vision terrain database does NOT need to be periodically updated, and is not downloadable from the GRT website due to its large file size. 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, access the Set Menu > Display Unit Maintenance > Database Maintenance page.

5.9.1 Terrain Alerts

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. Some passengers may find this to be alarming.

To turn on red and yellow terrain warning shading on the PFD (shown below):

1. Press NEXT to activate the SV softkey.
2. Press the SV softkey to highlight "TERRAIN."

5.9.2 Obstacles

Towers and other obstacles in the Navigation Database are displayed on the PFD as either simple lines (synthetic vision off) or chart-style graphic tower symbols (synthetic vision on). Towers are colored Red if the airplane's projected path is less than 250 above the obstacle, and yellow if the obstacle is higher than the current altitude, but the projected airplane path takes it more than 250 above the obstacle.

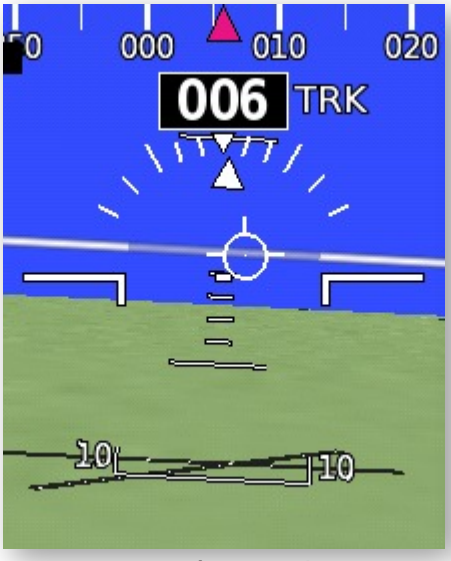
To choose how obstacles are depicted on the PFD screen:

1. Press MORE > Set Menu > Primary Flight Display.
2. Scroll to **Obstacle Style** and choose Line or Chart.

5.9.3 Artificial 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 with a user database.



Runways from a distance

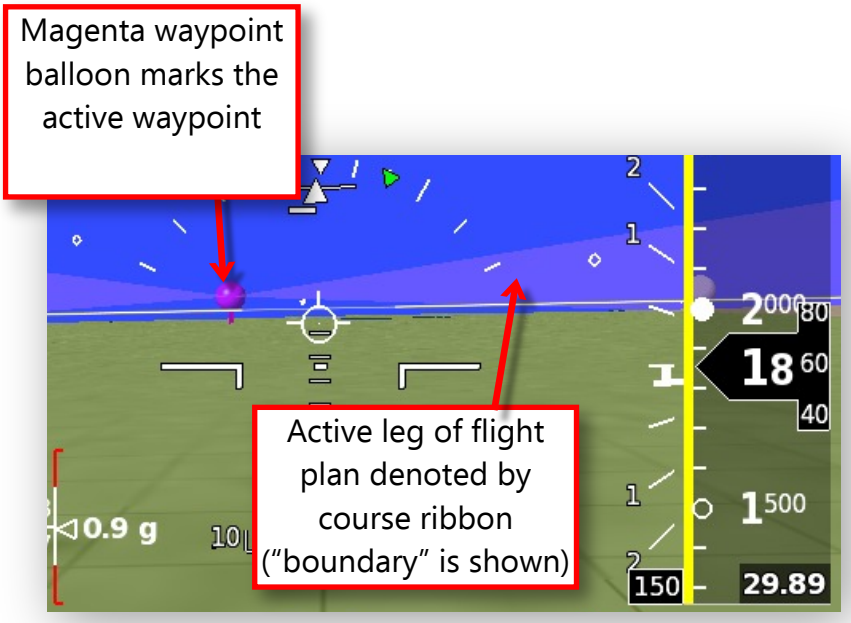
Runway on short final

To display runways on synthetic vision:

1. Press MORE>Set Menu>Primary Flight Display
2. Scroll to **Artificial Runways** and select ON.

5.9.4 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 30-mile horizon line; in that case, they do not have a tether. 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 waypoints in the flight plan are white.

To turn on waypoint balloons:

1. Press MORE > Set Menu > Primary Flight Display.
2. Scroll to **Waypoint Balloons** and select ON or OFF.

5.9.5 Course Ribbons

Course ribbons are a form of enroute Highway-In-The-Sky. They 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. Course ribbons beyond the next waypoint are white.

To turn course ribbons on and select their form:

1. Press MORE > Set Menu > Primary Flight Display.
2. Scroll to **Course Ribbons**. Select NONE, CENTER or BOUNDARIES.

To turn off terrain warning shading:

1. Press the SV softkey to highlight "ON" and display the normal SV shading.

5.9.6 Enroute HITS

Enroute HITS (Highway-In-The-Sky) is a series of boxes drawn along the 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 when all of the following are true:

- Enroute HITS is turned ON in the Primary Flight Display set menu.
- The airplane is on the active flight plan with a defined beginning and ending waypoint. (Some external GPS units do not send the origin waypoint and will not work with enroute HITS)

NOTE: The HITS boxes do not anticipate turns.

5.9.7 Grid Overlay

A grid overlay is displayed on the terrain of the PFD, creating an enhancing perception of height above the terrain, and heading/track changes. The grid is aligned with the cardinal true directions (N, S, E, and W). The grid is more bold and defined when the altitude and distance to the terrain is small, and fades as height and distance increase. The grid squares are 12 arc seconds apart, or about 1,215 feet, and follow the shape of the terrain.

Although not recommended, the grid overlay may be turned off as follows:

1. Press MORE > Set Menu > Primary Flight Display
2. Scroll to **Synthetic Vision Grid Overlay** and select OFF.

Section 6: Optional Moving Map & HSI

6.1 Moving Map Overview

When equipped with the optional Moving Map/HSI software, the Mini features a set of moving map screens, including an HSI to assist with GPS navigation and VOR/LOC tracking if a nav radio is connected. To access the Moving Map screen from the PFD, press the MAP softkey.

Each view of the map provides the following features:

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 and track.

Range/Zoom- Turn the knob to zoom in and out.

Compass rose/Heading arc- Magnetic compass reference: 180° arc or 360° compass rose.

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 (Track-Up and Heading-Up views).

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.

6.2 Moving Map Database

The moving map is derived from the internal synthetic vision terrain database, the GRT cities/water/railroads/roads/state boundaries database, and the Navigation Database. The Navigation Database should be updated every 56 days. A free version is available from the GRT website (continental U.S. only. Users outside the U.S. must use the Jeppesen subscription-based service.) Both Navigation Database options display airports, airspace, navaids, fixes, and obstacles on the map. Airport/Facilities and radio frequency information is also included in the database and is viewable on the Mini through the map screen and flight plan page. For more information, see the Appendix of this manual–Software Updates & Database Maintenance.

NOTE: Databases from external GPS units are not capable of populating the moving map. They can only transmit GPS position, flight plan data, and autopilot commands across to the Mini.

6.3 Map Screen Setup & Customization- Setup Menu

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

NOTE: To access the Moving Map setup menu, press NEXT > Set Menu and scroll to Moving Map.

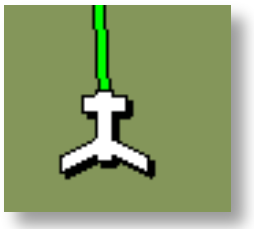
6.3.1 Airport Symbols and Label Fonts

The airport and font sizes can be enlarged from the default "small" setting. To change font and airport symbol sizes:

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

6.3.2 Choose Your Airplane Symbol

The airplane symbol represents your aircraft's present position and can be customized as a conventional airplane or a canard. To change the symbol to a canard profile:



Canard

1. Press MORE > Set Menu > Moving Map.
2. Scroll to **Plane Symbol** and select Canard.

6.3.3 Map Screen Declutter Settings

In some areas, there are so many airports, fixes, and navaids that the map gets cluttered up with information. The Mini has settings to relieve the congestion on the map automatically.

Range Filter- To maintain the readability of the map feature labels, the text size always stays the same on the screen. As a result, zooming OUT can create an overabundance of information on the map. To help remedy this:

1. Scroll to the settings for Max Map Range of various objects on the map.
2. Choose a distance for each map feature or leave it in the default setting.
3. Select OFF to never display the feature on the map.

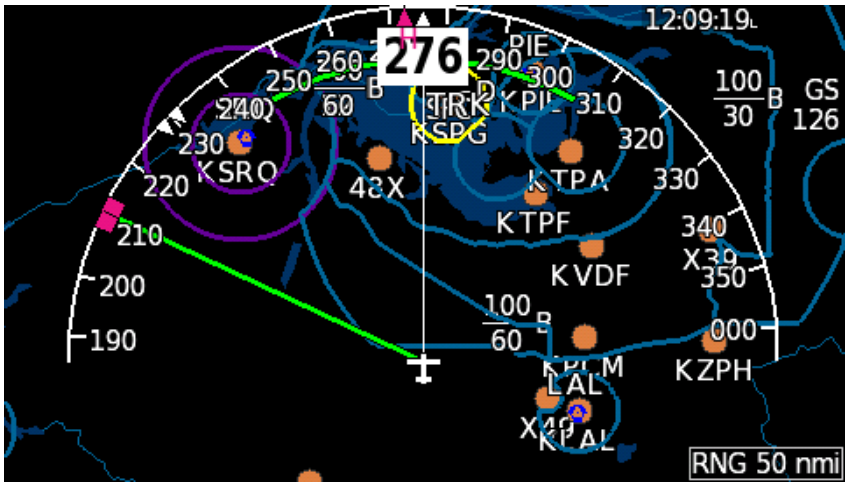
Auto Declutter- Automatically remove items from the map in congested areas, starting with small airports first. To turn on/off:

1. Scroll to **Auto Declutter** and turn it ON or OFF as desired.

6.3.4 Background Color

The backdrop for any screen that does not show topography. (To display the background color selected here, press Map > Next > SHOW > None).

- 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.
- Turn Background Color OFF (shown below) to display a black background as default for the map. Pilots may prefer this option over the colored background for flying at night.



6.4 In-Flight Map Setup

From the Map screen, press NEXT to access the softkeys shown below.

6.4.1 Compass Rose Display Options

Press the MAP softkey repeatedly to cycle through the different map display options.

ARC- Displays the compass rose as a 180° arc in front of the airplane symbol.

CENTER- Displays the compass as a 360° compass rose with the airplane symbol in the center.

HSI- Displays an HSI with bearing pointers, CDI and compass rose.

NORTH- Displays the map as North UP.

Arc View

Center View

HSI View

North-Up View

6.4.2 Map Range

When on any map screen, the rotating the knob changes the map range. Pressing the knob changes the knob function, cycling it from map range, to selected heading/track, map details selection tool, and map details for the selected item.

6.4.3 Map Background Options

The SHOW softkey lets the pilot choose one of several mapping data sets to display on the map.

SHADE- Displays topography shading similar to 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- Uses the base SHADE topography and adds yellow and red coloring as a visual terrain proximity warning.

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 6.3.4) with no topography shading.

6.4.4 Map Topography Shading

The SHADE option under the SHOW menu colors the map according to the Topography Shading Color Key shown to the right. The base colors are enhanced by shadows in mountainous terrain to give the map texture and bring attention to the mountain peaks. Elevations are derived from the internal synthetic vision database.

Elevation in Feet Above Sea Level	
0-500	
501-2000	
2001-3000	
3001-5000	
5001-7000	
7001-9000	
Above 9000	

6.4.5 Display of Fixes

The FIX softkey allows you to choose which fixes to display on screen for decluttering purposes.

6.5 Map Details Selection Tool

The yellow Map Selection Tool cursor can be used to:

- Select and go direct to a waypoint
- Access the Waypoint Information Page
- View airport information and airspace dimensions

A data box appears above the knob that displays important information for map features highlighted by the yellow Map Selection Tool cursor.

To use the Map Selection Tool:

1. From the Map screen, press the knob. The blue window above the knob will say CURSOR PUSH. Push the knob again to bring up the Map Selection Tool cursor.

2. Rotate the knob until the yellow line intersects the waypoint or airspace in question. The edges of selected airspace glow turquoise. The dimensions are displayed on the map and in a data box below the airplane symbol. When airspace is highlighted, the data box displays the airspace class, altitude range, and the bearing/distance to the point highlighted. For airports, the data box displays the identifier and bearing/distance to the center of the airport.

After highlighting a waypoint:

- Press the right knob again to display the Waypoint Details page.
- Press the ⊕ (direct-to) softkey to create a Direct-To flight plan to the selected waypoint.
- Press NEAR softkey, then AIRPORTS or NAVAIDS softkey to choose a list of nearby waypoints.

  NOTE: The WPT DETAILS softkey always shows the details for the active waypoint in the flight plan, NOT the selected waypoint on the map.

Section 7: Flight Planning & Navigation

7.1 GPS CDI Bar

The GPS CDI (Course Deviation Indicator) is located at the bottom center of the screen. It displays *cross-track deviation,* the distance from the aircraft's current position to the course line connecting the previous and next waypoint in the GPS flight plan.

The cross-track deviation is represented by the distance of the vertical magenta bar from the center of the CDI scale. A deflection to the left indicates the airplane needs to be maneuvered to the left to get back on course. The center of the CDI includes a triangle that points up or down to indicate TO or FROM the GPS waypoint respectively. Note: FROM indications result in reverse sensing for the deviation indicator, identical to that of a VOR type CDI indicator. This allows normal sensing when tracking outbound from a GPS waypoint.

The deviation bar and TO/FROM indicator are displayed whenever a waypoint is active in the GPS flight plan. The scaling of the CDI indicator changes automatically from 5.0 nm full scale when enroute, to 1.0 nm full scale in terminal phase (within 30 nm of the destination), to 0.3 nm during approach phase. Approach phase can be detected by the GRT only when Aviation format of GPS data is provided to the GRT Mini. The scale is indicated under the left side of the CDI bar.

7.2 Flight Planning with the Mini

A flight plan can be entered into the Mini in several different ways:

- Pressing the Flight Plan softkey from the PFD or Map screen, and enter a Direct-To (single waypoint) (see To Enter a Direct-To Waypoint)or Sequence Mode (multiple waypoint) flight plan using the waypoint entry page (see To Enter a Mulitple-Waypoint Internal Flight Plan). This is called an Internal flight plan because it uses the Mini's internal GPS.
- Follow an External Flight Plan from a connected GPS that is wired to a serial input. External Flight Plans cannot be edited within the Mini. They must be edited by the device that created them. However, they can be copied into the Mini unit to become an Internal flight plan. See 7.2.4 Using an External Flight Plan.
- Via an Android tablet or cell phone using a blue tooth adapter and USB hub connected to the USB port on the Mini. The app allows flight planning away from the airplane, or real-time control and display of the flight plan when in the airplane. See the website and the "GRT Remote App" for more details.

- Import a GPX flight plan from a USB stick, such as one created with iFlightPlanner.com. Imported GPX flight plans are considered "Internal" and can be edited in the Mini.

7.2.1 To Go Direct to Nearest Airport or Navaid:

1. Press FLIGHT PLAN softkey to bring up the Active Flight Plan page.
2. Press Mode softkey.
3. Press NEAR softkey, then press AIRPORT or NAVAID to bring up a list of nearest waypoints.
4. Use the knob to scroll through the list. Highlight the one you want, then press the softkey.
5. The Active Direct-To flight plan page appears. Verify the identifier of the waypoint you want to go to, then press EXIT to go back to the PFD screen.
6. Follow the GPS CDI indicator to the chosen waypoint.

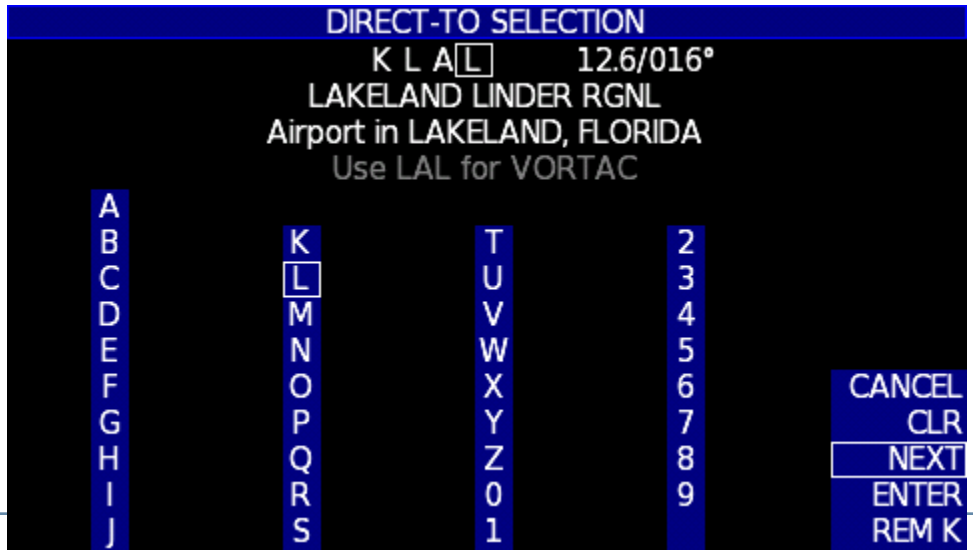
NOTE: To go directly to a waypoint selected from the Map screen, see Section 6.5, Map Selection Tool.

7.2.2 To Enter a Direct-To Waypoint:

1. Press FLIGHT PLAN softkey to bring up the Flight Plan Entry Page.
2. Press the ⊕→ Mode softkey. A page appears with columns of letters and numbers, shown below.
3. Enter the identifier of the waypoint you want to go to. To do this, press the softkey under the first letter in the waypoint until that letter is highlighted and appears in the waypoint ID field on top of the screen.
4. Press the knob (with NEXT highlighted) to advance the cursor. (HINT: If the next letter or number is in a different column, you can simply press the softkey under the next character's column to automatically advance the cursor.)
5. After the waypoint identifier is entered, turn the knob to highlight ENTER, then press the knob.
6. The Active Direct-To flight plan page appears. Verify that the waypoint shown is correct, then press EXIT.
7. Follow the GPS CDI indicator to the waypoint.

Knob Functions:

- CANCEL- Cancel waypoint entry and go back to previous screen.
- CLR- Go back one character to re-enter.
- NEXT- Advance cursor to next character.
- CREATE - If the waypoint identifier is not in the navigation database, this option will be presented to allow for creation of a user-defined waypoint.
- ENTER- Enter the waypoint into the flight plan and go to Active Flight Plan page.
- REM K or ADD K- Shortcut to add/remove the K to an airport or NAVAID identifier.



7.2.3 To Enter a Multiple-Waypoint Internal Flight Plan

1. Press FLIGHT PLAN softkey to bring up the Flight Plan Entry Page.
2. To add a new waypoint, press the ADD softkey. The waypoint entry page will appear. Follow steps 3-5 outlined in the Entering a Direct-To Waypoint section to enter the first waypoint.
3. To enter another waypoint, press ADD again and repeat step 2. Continue until all the waypoints are entered.
4. Verify that the waypoints in the Active Flight Plan list are correct, then press EXIT.
5. Follow the GPS CDI indicator and the waypoint bearing information on the PFD.
6. At any time during the flight:

- To add a waypoint to the middle of the flight plan, highlight the adjacent waypoint and press INSERT BEFORE, then repeat step 2.
- To activate a leg in the middle of the flight plan, highlight the second waypoint in the leg and press SET LEG.

Knob Sidebar Functions: (Press the knob to activate the sidebar cursor)

- **Clr FP:** Clear all displayed waypoints and start over
- **User WP:** Create a custom User Waypoint or select one from your list
- **Save:** Saves the current Flight Plan to memory
- **Rev FP:** Reverses current flight plan to fly back home
- **Sel FP:** Displays a list of previously saved flight plans so you can select one
- **Del WP:** Deletes the highlighted waypoint in the current flight plan
- **Details:** Shows Airport/Waypoint Details Page for selected waypoint. Includes elevation, runways, frequencies, fuel, lat/long, and city. See *Details Page* later in this section for more info.
- **Go Direct:** Go direct to the highlighted waypoint, then resume flight plan
- **PFD On:** Displays a basic horizon line with airspeed and altitude in the background
- **External:** Displays External Flight Plan from a connected external GPS
- **Copy:** Copies the external flight plan to the internal flight plan.
- **Import:** Displays a list of available .GPX flight plans to import from the USB stick

7.2.4 Using an External Flight Plan

External Flight Plans, highlighted by a yellow header strip, are read directly from a connected external GPS. They can be followed, but not edited, by the Mini. Some GPS navigators will not send its entire internal flight plan, but only the active waypoint, making it impossible to see the entire flight plan. (This is not common.)

Also, some GPS navigators my not send the origin waypoint when a direct-to is selected. (The origin waypoint is the airplane's location when the direct-to was activated.) In this case the Mini will attempt to estimate this position based on data it receives from the external GPS. This may cause the flight plan to appear slightly different between the external GPS and the Mini.

To follow a flight plan on an external GPS:

1. Enter the flight plan and activate it in the external GPS.
2. Select the external GPS (designated GPS1 or GPS2 during initial setup) as the Nav Source for the Mini.
3. Press the Flight Plan softkey. The Mini will automatically open the External Flight Plan page, listing all the waypoints in the active flight plan on the external GPS.
4. Press EXIT to follow the flight plan using the GPS CDI and waypoint information on the PFD.
5. At any time during the flight:
    - Press COPY to overwrite the current active Internal flight plan with the waypoints for the External Flight Plan. This will convert the external flight plan to an internal flight plan, allowing editing of the waypoints.

Highlight INTERNAL with the knob and press the knob to switch back to an Internal flight plan. Remember to also switch the GPS Nav Source on the PFD.

7.2.5 Importing a .GPX Flight Plan

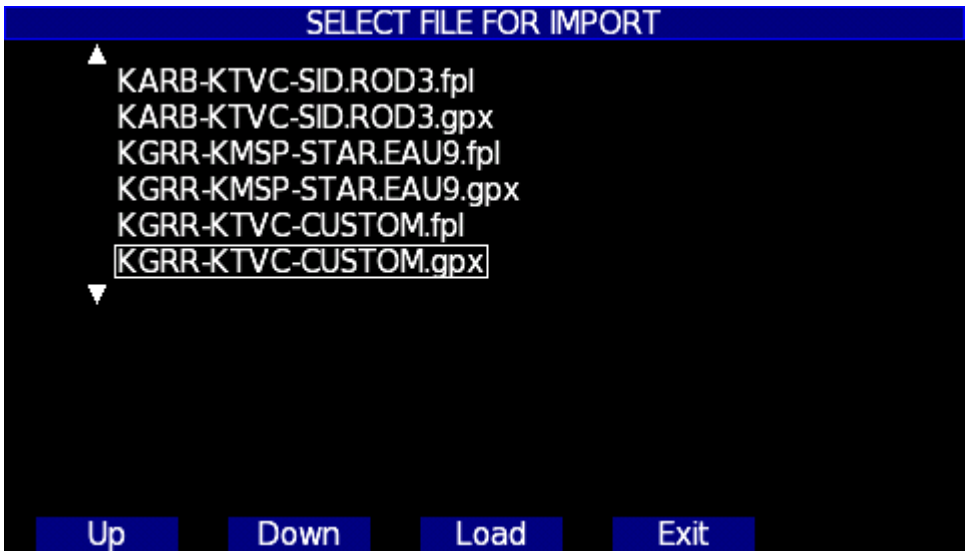
Many apps and GPS units create and store flight plans in .GPX format. The Mini, like the bigger GRT EFIS systems, can read .GPX files placed onto the USB stick.

To import and use a .GPX flight plan:

1. Use your favorite computer flight planning program, such as iFlightPlanner.com or the AOPA Flight Planner, to create and save a flight plan in .GPX format to your USB thumb drive.
2. Insert the USB drive into the USB port of the Mini.
3. Press the FLIGHT PLAN softkey to bring up the Flight Plan page.
4. Turn the knob to highlight "Import" and press the knob to activate.
5. Press UP or DOWN softkey to scroll through the list of files on the USB stick until you see the .GPX file you are looking for. (Multiple file types will be displayed on the screen.)

Highlight the one you want, press the "LOAD" softkey, and the flight plan waypoints will appear in sequence on the Mini Active Flight Plan page.

NOTE: GPX flight plans imported and activated in another connected GRT display unit will automatically load into the Mini if the inter-display serial link is connected.

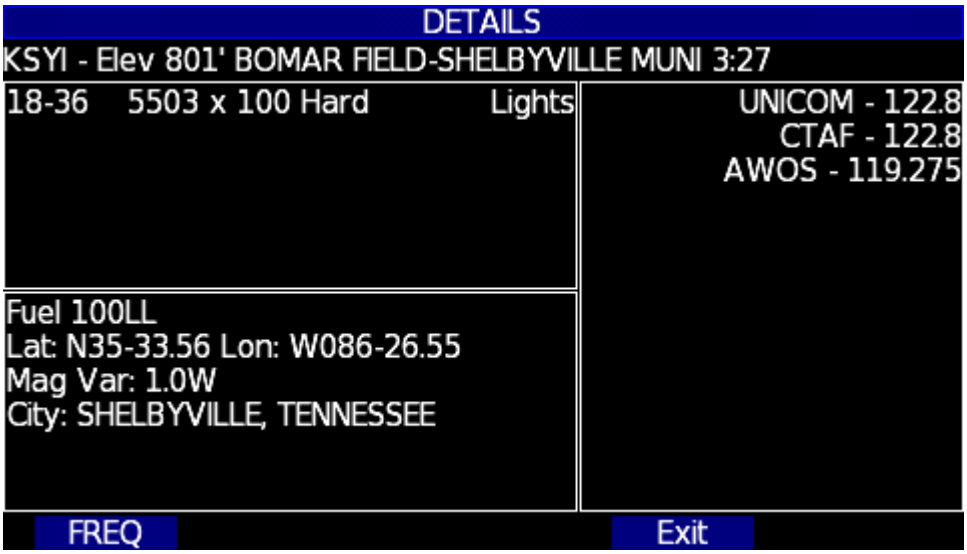


7.3 Airport/Facilities Information & Radio Tuning

Information about airports and navaids in the navigation database is available on the Mini on the Details page. Select the airport or navaid from the Active Flight Plan page.

7.3.1 To view airport or navaid details:

1. Press FLIGHT PLAN softkey to bring up the Active Flight Plan page.
2. Turn the knob to highlight the airport or navaid in the flight plan list.
3. Press the knob to activate the sidebar cursor above the knob. Highlight DETAILS and press the knob. The information display is shown below.



7.3.2 To send a frequency to a connected serial radio, such as an SL30: (Experimental aircraft only)

1. Press FREQ softkey, then press SET COM or SET NAV.
2. Choose a frequency from the dropdown list and press the knob to select.
3. This sends the frequency to the radio Standby window.

7.4 Synthetic Approach (SAP)

The Mini-GA has the capability to draw a synthetic approach path to any runway in the navigation database. The approach path is represented by Highway-In-The-Sky boxes (also known as HITS). When flying a synthetic approach, the flight director will provide capture and path guidance, and the GPS cross-track deviation and desired track will also be driven by the approach path.

The when constructing the path to the runway, the EFIS will default to the setting for the synthetic approach glideslope angle entered in the PFD set menu for the vertical path, and the selected runway's extended centerline for the lateral path. If the EFIS database includes glideslope and/or localizer alignment, this data will override these defaults, effectively providing guidance that will emulate the actual ILS data. A message is generated alerting the pilot when the default synthetic approach path is being overridden.

WARNING: Synthetic Approach using the default path provides no assurance of obstacle clearance.

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

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

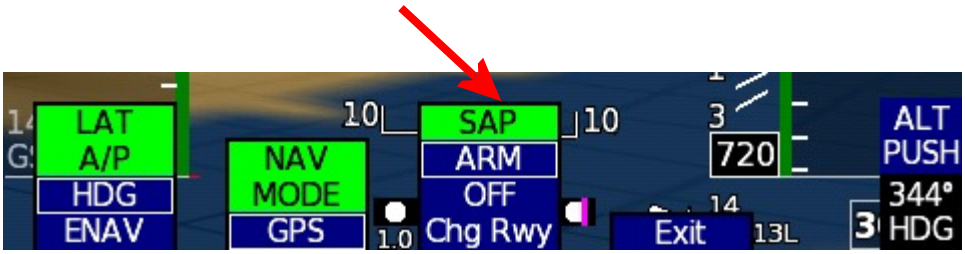
Capture of the SAP should occur:

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

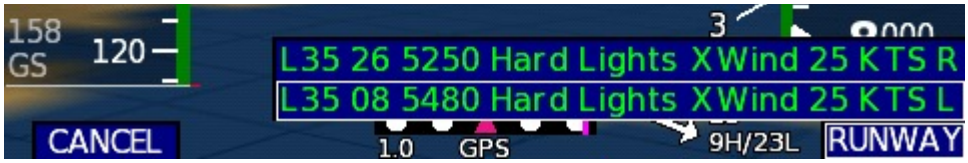
Flying the Synthetic Approach

1. Ensure the last waypoint in the active GPS flight plan, or an approach has been selected on an external GPS navigator that is supplying the flight plan to the EFIS.

2. Press the knob once to bring up the autopilot / flight director mode first page. Set the SAP (synthetic approach) to "ARM". Press "Exit" or the knob three times to exit the flight director mode pages.

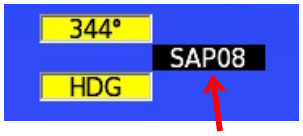


3. If an approach is being supplied to the EFIS from an external approach GPS, the EFIS will probably identify the airport and runway from the data. More commonly, the flight plan does not include an approach, just a destination airport, in which case the EFIS will prompt you to select the desired runway. Note that the runways are shown with their length available for landing, if they are lighted or not, and if winds can be computed by the EFIS (this requires the optional external



magnetometer and a source of air data), the cross-wind component will be shown based on the winds currently being sensed. Runways with a tailwind component greater than 10 mph will be shown in yellow. While winds on the surface are usually different than winds aloft, it is rare to find that the surface winds will favor a runway shown in yellow.

4. Select a runway using the knob. Push to enter your selection. If you make a mistake, use the SAP selection of "CHG RWY".



SAP capture is pending

5. Navigate by any means to cross over the extended runway centerline at least a few miles from the runway end. (The moving map will automatically show the destination airport extended runway centerlines when not on a high map range.)

SAP is captured

6. After arming, a yellow EXECUTE softkey will be displayed. Until this is pressed, automatic capture of the approach is inhibited. Press this softkey when you are cleared for the approach, or when it is safe to allow a turn towards the runway.

7. Press the knob once to access lateral A/P modes, navigation source, and synthetic approach controls.

8. Press the knob again to access the vertical autopilot controls. Turn the knob to change the altitude in the Altitude Select/Altitude Bug window.

9. The EFIS will automatically capture the approach by anticipating the turn required based on speed and intercept angle. When capture occurs the message, "Synthetic Approach Captured" is displayed. Steering data, including the fight director, will provide lateral guidance.

10. Once established on the lateral path, vertical capture will occur as the airplane flies into the SAP glideslope. If the airplane is above the glideslope when the lateral path is captured, the vertical path will be captured immediately, and flight director guidance will command a steep descent in attempt to establish you on the glidepath.

11. After arming of the SAP, but before capture, the EFIS will annunciate this arming in the upper corners of the screen. The lateral mode is shown on the left, and vertical on the right. Two columns of mode data may be shown. The inner column show modes that are pending. The outer column shows modes that are active. .

12. If a missed approach is necessary, apply power as required and press the MISSED softkey to command the flight director to fly runway heading and climb. The climb will continue indefinitely unless a missed approach altitude preset has been set. A new target altitude and rate can be set with the knob.

Section 8: Miscellaneous Features

8.1 Flight Director

The Mini-GA provides a single-cue flight director function. This function effectively makes the pilot into an autopilot, by providing roll and pitch commands. These commands include turn anticipation and automatic mode changes, and limit the bank angle commands to a safe range. This greatly reduces pilot workload, and in tests performed by GRT Avionics, we found hand flying was twice as precise using the flight director as compared with raw data. The flight director will also provide coupling to the VOR and ILS if this data is provided the the EFIS.

Lateral Flight Director Modes:

- Heading/Track Select & Hold
- GPS Navigation
- VOR/LOC Navigation
- Synthetic Approach

Vertical Autopilot:

- Altitude Select & Hold
- GPS LPV Vertical Guidance (requires interfacing to an external approach GPS.)
- Glideslope (requires interfacing to a compatible navigation receiver.)
- Synthetic Approach

NOTE: More details regarding the flight director function can be found in the "*GRT Autopilot Installation & Setup Manual*". For information on the autopilot/flight director enunciators, modes, and other general usage, please refer to the *GRT Autopilot Pilot's Guide,* which is applicable to all GRT EFIS systems. Both manuals are available in the Support > Documentation > Autopilot section of www.grtavionics.com.

Flight Director Controls

Access the flight director controls through the PFD screen. The Mini autopilot controls are displayed over three tiers of softkeys, each activated by pressing the knob.

8.2 Data Recording

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

- A simple "snapshot" is a still shot of the screen. This is saved as 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. We use customer-supplied snapshots almost exclusively for the graphics in our new manuals.

- A "demo file" recording of the flight data for later playback on the display unit itself or for displaying in a spreadsheet format. This includes all of the serial data as well as a recording of flight instrumentation, AHRS data, GPS position, and map features. You can play back the demo file recordings directly on your Mini to debrief a flight or review flight testing performance information.

- The USB Flight Data Logger samples data at a user selected interval and writes that to a CSV file at the save interval. It's designed as an always-on continuous data recorder that requires less data than a DEMO, and stores it in a more compact and easy-to-use format. Data is always added to the end of the "GRT Flight Data Log.CSV" file on the USB flash drive.

  Demo files record all the data from the AHRS, magnetometer, external devices, and other sensors during flight. They can be replayed on the ground to practice with the EFIS. They are also a powerful tool to help us understand a problem you might be experiencing when using the EFIS, as they can be e-mailed to GRT Avionics tech support.

8.2.1 How to Take a Snapshot:

1. Go to SET MENU > General Setup.

2. Scroll to the bottom of the screen 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 the screenshots.

4. To imprint the PNG filename on the snapshot image, select YES for "Show DEMO Filename."

5. Save all settings. Your display unit will now have a "SNAP" button on many screens where there is an empty softkey. Notice that it will also display a SNAP button on setting screens. This can be very useful for recording settings in picture form to share with your friends (ie. Autopilot gain settings, etc) or sending them to us for troubleshooting.

6. To take the picture, simply press SNAP to save the screen image to the installed USB stick.

8.2.2 Demo Recordings

Demo recordings can be recorded on a one-by-one manual basis or you can set up your Mini 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. This means that if you have a 2GB USB stick, you can record over 30 hours of flight time. If you use an 8 GB memory stick, you can record over 100 hours without thinking about it. Add "change or erase USB stick" to your oil-change checklist to make it really easy.

1. Go to SET MENU > General Setup. Highlight DEMO Settings (right above the SNAP settings) and press the right knob to activate the menu. Here you'll find several choices.

To imprint date and time in the filename of the recording: Choose YES next to "Use Date/Time in Filename."

Specify the maximum file size of the recordings (MB): Choose from 1 to 15 MB under "Max File Size." You can specify how big you want the files to be for easier handling or emailing. A typical recording is less than 1 MB per minute. Yours may be more or less depending on how much data is being recorded. Upon reaching the max file size, the display unit will save recording to the USB stick, and start another file. The bigger the file, the more continuous data you will get. The smaller the file, the more often it will save the data.

Specify maximum recording time in minutes: Choose from 1 to 120 minutes under "Max File Time."

Start and save recordings automatically: Under the Automatic Start/Stop heading, choose to record nothing automatically (OFF), start automatically, stop automatically, or start and stop automatically. When automatic data recording is enabled, the Mini will start and stop/save automatically when the Auto Start and Auto Stop menu settings are reached, whether it's a specified RPM, Airspeed, Ground Speed, or N1 for turbines. Do not turn off the Mini before or immediately after these limits are reached; it will take the display unit a few seconds to write the data from the last file recorded to the USB stick.

Start and save 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.

Using the Demo Recordings

Play demo recordings back on the Mini: From the PFD screen, press NEXT until you see the DEMO softkey. Press it to highlight PLAY to run the demo. You will be taken to a menu page where you can select the file to play.

Dump demo data into a spreadsheet: Download the GRT DECODE program from the GRT Avionics website (Support > Software Updates > Miscellaneous Software & Utilities). Open the program and use it to open the demo file. It will create a spreadsheet with all of the data points.

8.2.3 USB Flight Data Logger- "Black Box" feature

Because the demo files must be prompted to end and save the recording, data at the very end of a crash sequence can go unsaved. Additionally, the Demo file recording process loses data between each recording sequence. The USB Flight Data Logger feature was designed to provide a seamless recording of a limited number of important flight data parameters that are continually written to the USB stick.

Go to SET MENU > General Setup > Demo Settings. Press the knob to open the page.

USB Flight Data Logger -- On/Off. When On, the Mini 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 at this interval: 200 - 30000 ms in steps of 200 ms. Default is 1000 ms.

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.) For a more continuous black-box recording, set it to 5 seconds or less.

The data is saved as a .CSV file on the USB stick called "GRT Flight Data Log.csv" and can be opened and inspected using any spreadsheet program.

8.3 Angle of Attack (Experimental aircraft only)

Requires remote pitot/static module

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 is useful for stall warning, 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.

8.4.1 Approach AOA Indexer

This 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 red circle prompt the pilot The indexer will show a green circle, with no chevrons, when the angle-of-attack is in the optimal range.

When the AOA data used to drive the EFIS screens is based on the "calculated" AOA data, "EST" (estimated) will appear inside the indexer circle. Calculated AOA will be used if no measured AOA data is available, or if the measured AOA function has not been calibrated.

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 EFIS calculation of angle-of-attack, and the approach AOA indexer should not be used as the only stall warning instrument.

The approach AOA indexer will not appear at low angles-of-attack.

AOA Too High – Need to Pitch Down

When stall is imminent, the word "PUSH" appears above the AOA indexer.

8.4.2 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.

8.4.3 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 is more than 9 degrees from stall. 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 will be 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. While this may be of little use for the typical experimental aircraft pilot, it provides a visual representation of the proximity to stall. This data also appears on the wearable HUD smart glasses.

WARNING: The use of this indication is purely at the judgment of the pilot. The accuracy of this information is affected by EFIS sensor errors and the accuracy of the calibration procedure. The EFIS calculation of angle-of-attack, and the pitch limit indicator should not be used as the only stall warning instrument.

8.4.4 Audio Stall Warning

For versions of the GRT EFIS that include an audio output, an audio alert is provided as stall is approached. This alert begins as a beeping tone that transitions to a solid tone as the AOA approaches the stall AOA programmed during the AOA calibration procedure.

Appendix

A.1 Updating Mini Software

We continually improve our EFIS systems' features, controls, graphics, and integration with third-party equipment. After a certain period of beta-testing, we will periodically release new software updates for our systems. You may choose not to update your software, but we recommend it for optimal performance of your system.

- **WARNING:** Always thoroughly test your new software updates in VFR conditions until you are confident that your display units, AHRS, and all connected third-party equipment will work properly under all circumstances. Never fly IFR with new software updates until you have thoroughly tested all functions of the display units, AHRS, and all interfacing third party equipment, especially navigation equipment.

A.1.1 Locate the New Software on the GRT Website

1. Go to the GRT Avionics website: www.grtavionics.com.
2. Under the Support menu, click on Software Updates to take you to the Software main page, or select directly from the popup list to access the website page dedicated to your EFIS system software.
3. The dedicated Mini software page has a link for you to download the latest software for your EFIS system. It may also have a link to any available "beta software" that you should ONLY download if you would like to experiment with untested features.
4. Software available for the Mini includes:
    - Display Unit software- adds new features and corrects bugs in the display itself. Usually released every few months as new features are created.
    - Navigation Database Software- Released every 28 or 56 days to update the FAA database of airports, navaids, fixes, man-made obstacles, and airport/facilities information in the DETAILS pages.
    - AHRS software (occasional releases) - Improves and corrects bugs in the internal AHRS
    - Air Data Software- (occasional releases) Improves and corrects bugs in the pitot/static sensors
    - Servo Software- (rare releases) Improves and corrects bugs in GRT digital servos (Mini-X, -AP)

A.1.2. Load the Software onto the USB Stick

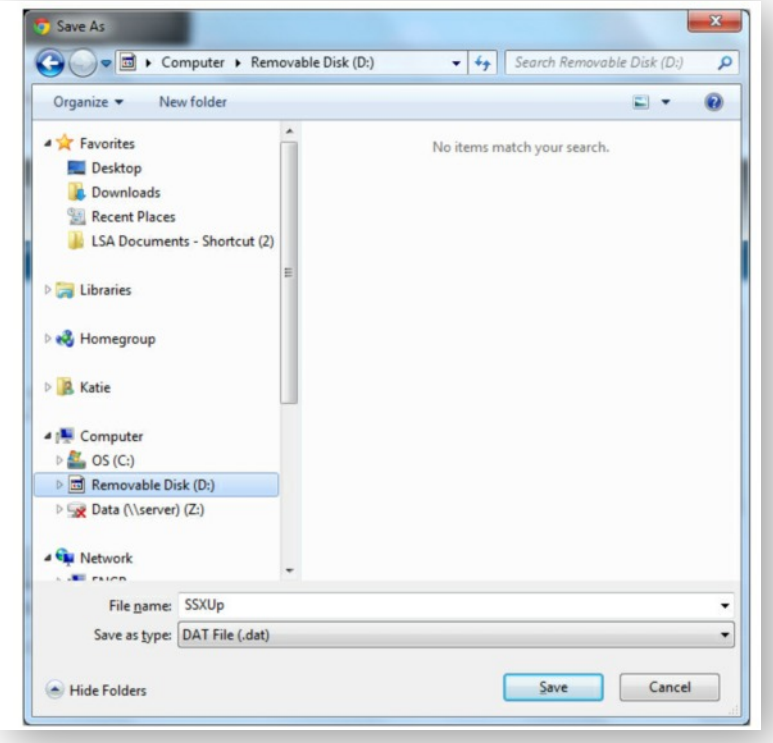
Your Mini unit came with a SanDisk USB Thumb Drive. It's a small rectangular device that looks like this. When you plug it into your computer's USB port, it acts as an additional hard drive to store files. It will usually be listed as "Removable Disk" with a letter designation in your computer's directory. Follow these steps to load the files onto your USB drive on a Windows computer. Mac computers may behave differently, but will essentially use the same process. Then you will load it into your displays.

NOTE: The Mini uses a Mini-USB port. It comes with a USB-to-Mini-USB adapter to accommodate a standard USB stick. Be sure to bring this along when you go to the airplane to update the software.

1. Insert the USB drive into the computer's USB port. A window may pop up that says "Auto Play." This window will also list the USB drive's name as "Removable Disk" with a letter designation. Remember this name because it will make it easier to find the USB drive on your computer. Open the USB drive to view the files. You may select and delete the factory SanDisk files if you wish. Delete all files from the drive with *.dat and *.db extensions.

2. Go to the Software web page for the Mini system. Find the **Display Unit** software download link.

3. Click "DOWNLOAD" with the **right mouse button** and select "Save Link As…" The window at right will appear. Click on the name of the USB drive (under the Computer heading) to tell the computer to save the file onto the USB drive.



4. Save the file in the root directory of the drive. This means it is NOT inside a folder, but in the open. The Mini will not see the file if it's hidden inside a folder on the USB drive. IMPORTANT: Make sure the filename does not have any numbers in parentheses after it. The Mini will not recognize the file if the name has been changed. Example: **MiniUP.dat** is the only name recognized for Mini display software, but if the file already exists on your computer, the computer may try to rename it **MiniUP(1).dat**. Just erase the (1).

5. Repeat steps 3 and 4 for any new AHRS or Air Data software files.

6. If desired, go to the Navigation Database updates web page, also under the Software menu of the www.grtavionics.com website. Repeat steps 3 and 4 above to save the current Free U.S. Navigation Database file to your USB drive.

7. Go to the airplane.

8. Power up the Mini. Insert the USB drive with the Mini-USB adapter into the USB port in the back of the unit, or into the USB extension cable if so equipped.

A.1.3. Load New Display Software Into the Mini

1. Press the SET MENU softkey. Turn the knob to scroll to "Display Unit Maintenance." Press the knob to select.

2. Turn the knob to "Load EFIS Software" and press the knob. The screen prompts you: Load EFIS Software– ARE YOU SURE? Press the YES softkey.

3. The display unit will find the software file on the USB drive and upload it. When it's finished, it will automatically reboot.

A.1.4 Load New Navigation Database

1. Press the SET MENU softkey. Turn the knob to scroll to "Display Unit Maintenance." Press the knob to select.

2. Scroll to "Database Maintenance" and press the knob to open the page.

3. Scroll to "Load Navigation Database." Push the knob to start. Answer the prompt with YES. The database will load from the USB drive into the display unit. When it is finished, it will automatically reboot.

A.1.5 Update AHRS Software

1. Press the SET MENU softkey. Turn the knob to scroll to "AHRS Maintenance." Press the knob to select.

2. Turn the knob to scroll to "Load AHRS Software." Press the knob to start. The screen prompts you: Load AHRS Software– ARE YOU SURE? Press the YES softkey.

3. The display will transfer the new AHRS software directly from the USB stick. This may take up to 3 minutes. When the upload is finished, the AHRS module will reboot and resume normal operation within 30 seconds.

   NOTE: The processor that drives the LCD display will NOT reboot after the AHRS upgrade.

A.1.6 Update Air Data (Pitot Block) Software

1. Press the SET MENU softkey. Turn the knob to scroll to "AHRS Maintenance." Press the knob to select.

2. Turn the knob to scroll to "Load Air Data Software." Press the knob to start. The screen prompts you: Load Air Data Software– ARE YOU SURE? Press the YES softkey.

3. The display will transfer the new Air Data software directly from the USB stick. This may take up to 3 minutes. When the upload is finished, the air data module will reboot and resume normal operation within 30 seconds.

   NOTE: The display unit itself will NOT reboot after the Air Data software upgrade.