Mini-X EFIS

Installation, Setup, and User Manual

Revision A8

20-April-2017

3133 Madison Ave. SE
Wyoming, MI 49548
(616) 245-7700

www.grtavionics.com

Mini-X Manual Revision Notes

Manual Revision	Date	Software Revision	Change Description
A	06-June-2014	1	Initial Release
A1	16-Jun-2014	1a	Appendix, A.1.5 and A.1.6- Corrected and clarified AHRS and Air Data Software update instructions.
A2	16-Jul-2014	1b	Added & clarified wiring options for Trig TT21/TT22 remote transponder, Section 2.5 Added TT22 to list of choices for RS-232 serial ports, Section 2.6
A3	27-Aug-2014	1d	Added information about PFD navigation options (Waypoint Balloons, Course Ribbons, and Enroute Highway-In-The-Sky), Section 5.9 Updated image of North-Up map presentation with compass rose, Section 6.4. Added information about the Synthetic Approach, Section 7.4
A4	29-Aug-2014	1d	Fixed typographical errors in Section 4.6 and 4.7.
A5	11-Feb-2015	1d	Improved Magnetometer installation and calibration instructions.
A6	24-Sep-2015	1d	Added Angle-of-Attack installation and calibration instructions.
A7	23-Feb-2016	2	Backup-Battery Instructions added. Added setting magnetometer orientation before fine calibration and validation of magnetometer location.
A8	17-Apr-2017	1d	AOA Installation and calibration restored. Magnetometer wiring updated to show both possible sets of wire colors.

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 starting on the day the instrument is put into service (or three years after purchase, whichever comes first) against manufacturer defect.

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.

Satisfaction Guarantee– If for any reason you are unhappy with your GRT product, you may return it for a refund anytime during the first 60 days you own it. Some restrictions apply. Please call GRT Tech Support before returning any system or component.

Technical Support

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 9:00 AM-12:00 PM and 1:00 PM -4:00 PM Eastern Time

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

24-Hour Tech Support: The GRT Online Forum
Many questions may already have answers posted in our Online User Forum. Join today for free!

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Section 1: Introduction

1.1 About the Mini-X

We designed the Mini with two main goals in mind: A small, lightweight, economical VFR EFIS system for LSA and light kitplanes, and an affordable, high-quality backup to larger EFIS systems for IFR operations. The Mini utilizes the same pilot interface as the popular Horizon and Sport series; If you already use GRT avionics for your primary flight display, you will not have to remember a different brand's "buttonology" in an IFR emergency. The Mini has a built-in GPS for navigation, so you will always know where you are.

In addition to the basic backup flight instruments, all models of the Mini can also serve as a serial altitude encoder for any modern transponder, and serve as a control head for a remote Trig TT22 transponder. To top it off, the brilliant 1200-nit, high-resolution display shared by all three Mini models ensures great visibility in all lighting conditions.

1.2 Tools & References for Installation

In addition to basic mechanical hand tools, a D-sub pin crimper is required in most installations. A basic 4-way indent crimper is available from SteinAir for less than $35. We supply a few loose male and female pins with your wiring harness, and we have them available for sale if you need more.

If you are new to electrical systems and wiring, we highly recommend reading *The AeroElectric Connection* by Bob Nuckolls. This book has been around for almost 30 years and covers everything a homebuilder needs to know about how electrical systems work, how to design them, and how to build them. There are also numerous online video tutorials by EAA, SteinAir and others in the experimental aircraft community on wiring technique and electrical system design.

1.3 Mini System Requirements

The Mini utilizes the following systems for operation:

- Aircraft Power (12- or 28-volt system) - 0.25 Amp current draw at full brightness
- Pitot/static connection for flight instrumentation
- Built-in GPS with a remote "puck" antenna which must be within view of the sky at all times.
- Optional remote magnetometer is required for magnetic heading information and AHRS independent of GPS track– 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. G-limit affects accuracy of the readout, but exceeding it will not damage the instrument.
- Ambient Temperature Range for full accuracy: -10°F to +150°F
- Airspeed Range : 30-335 mph IAS (stock AHRS) or 50-600 mph IAS (High-Airspeed version)
- Altimeter Range : -2000 to +40,000 feet
- Magnetometer Type: Internal (Mini-B and stock Mini-X) or External remote (Mini-AP and optional for Mini-X). When the External magnetometer is installed, it overrides the Internal, which is then used only in the unlikely event of failure of the remote unit.

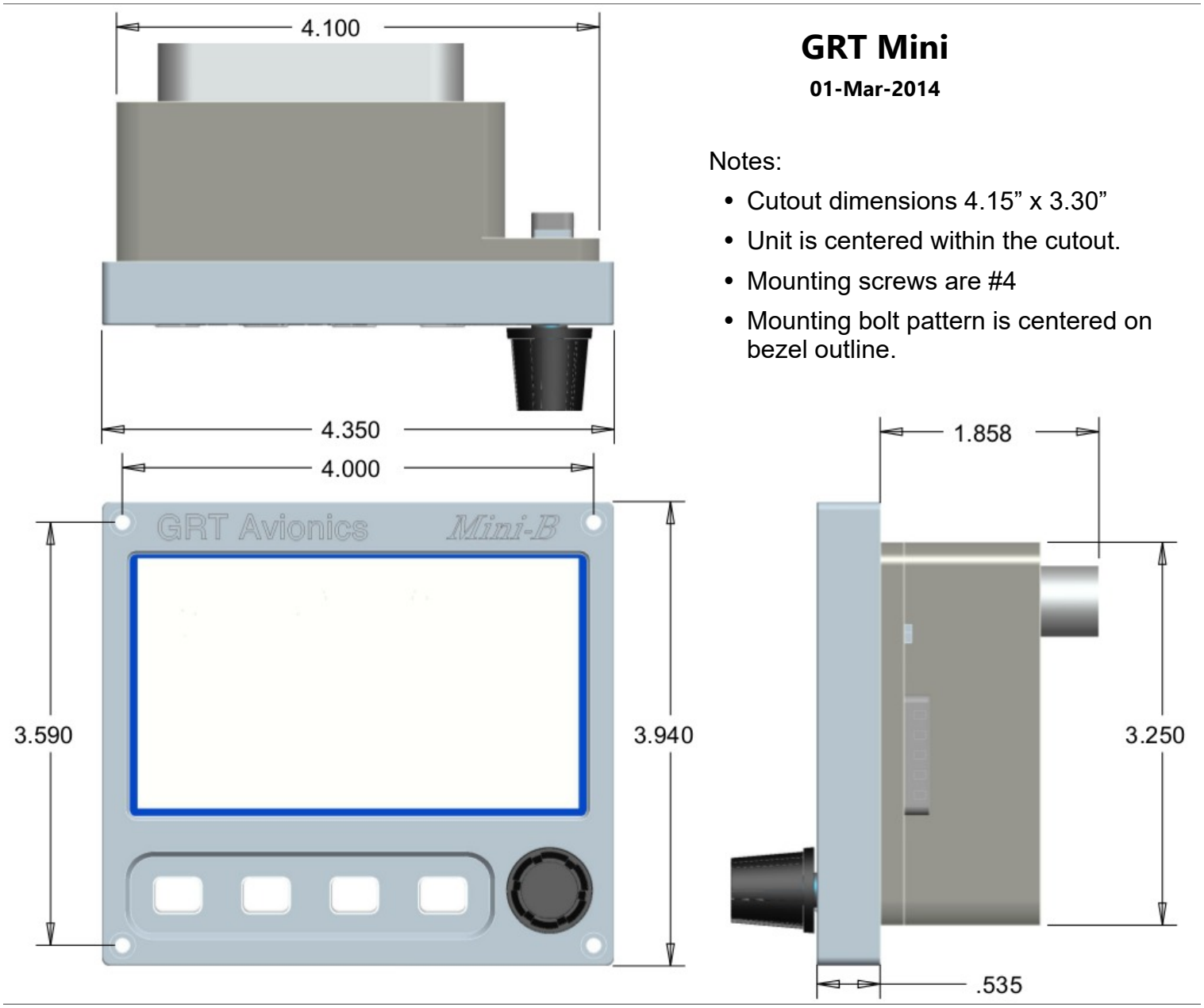
1.4.1 Mini-X AHRS and Loss of GPS Data

Normal Operation

Attitude data will be full accuracy when valid external magnetometer data or GPS ground track data is available. If no valid external magnetometer is available, and the GPS ground track data is lost (because the airplane is moving less than 4 mph, or the GPS is not able to provide position data), and the AHRS will attempt to use its internal magnetometer. If the internal magnetometer is too inaccurate due to magnetic disturbances near the instrument, the ground track display on the PFD screen will show dashes. The AHRS will provide full accuracy attitude information for at least 5 minutes.

CAUTION: If the EFIS is unable to provide any heading or 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 Dimensional Drawing (all models)



1.5 Basic Controls of the Mini

The Mini has a single knob that can be pressed and turned, as well as four buttons. The buttons are referred to as "softkeys" because their functions change as screen views and menus change. Each button and knob has a label that defines its function. If there is no label present, the button has no 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.

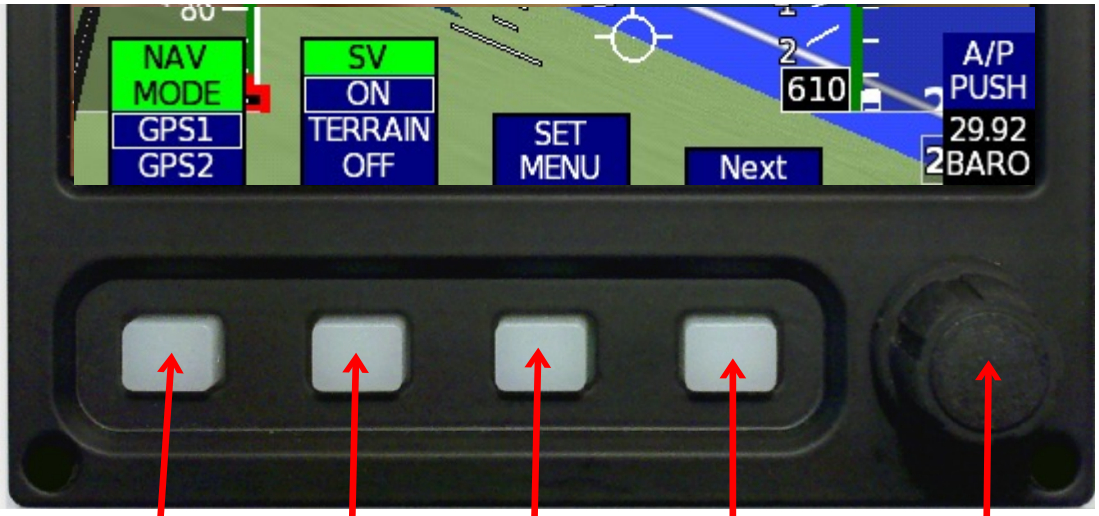
1.5.1 Overview of Pages & Softkeys

The Mini-X has a Primary Flight Display page, a Flight Plan entry page and the Set Menu. When equipped with the Moving Map option, it also includes a Moving Map page group.

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.

PFD Level 2 Softkeys (typical)



Choose Navigation Source

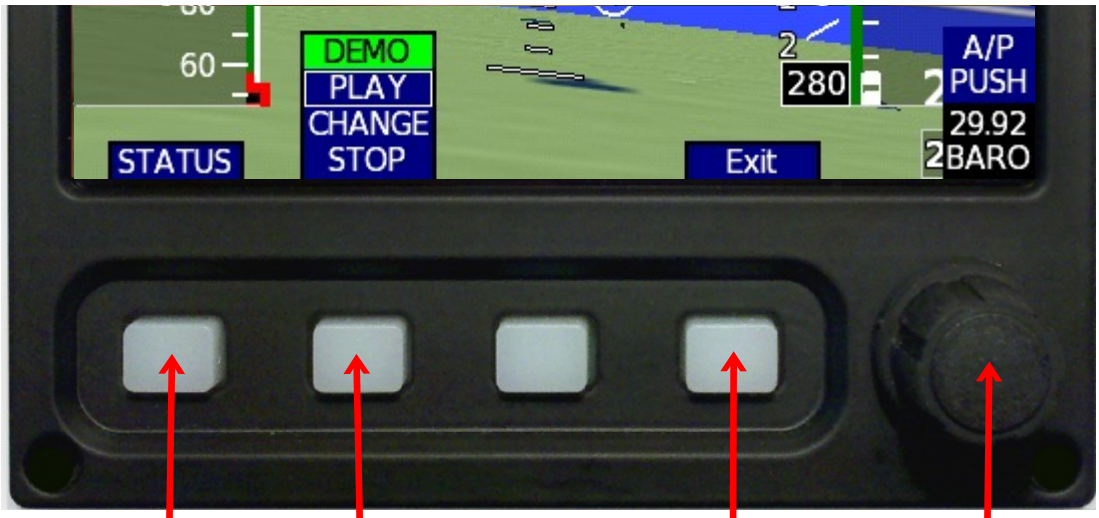
Synthetic Vision Display Options

Settings Main Menu

More items...

- **Turn to adjust Altimeter Setting**
- **Press for Autopilot**

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 Autopilot**

1.5.3 Moving Map Softkey Functions (Optional)

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 Shading

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 Autopilot 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-X Connector Definition

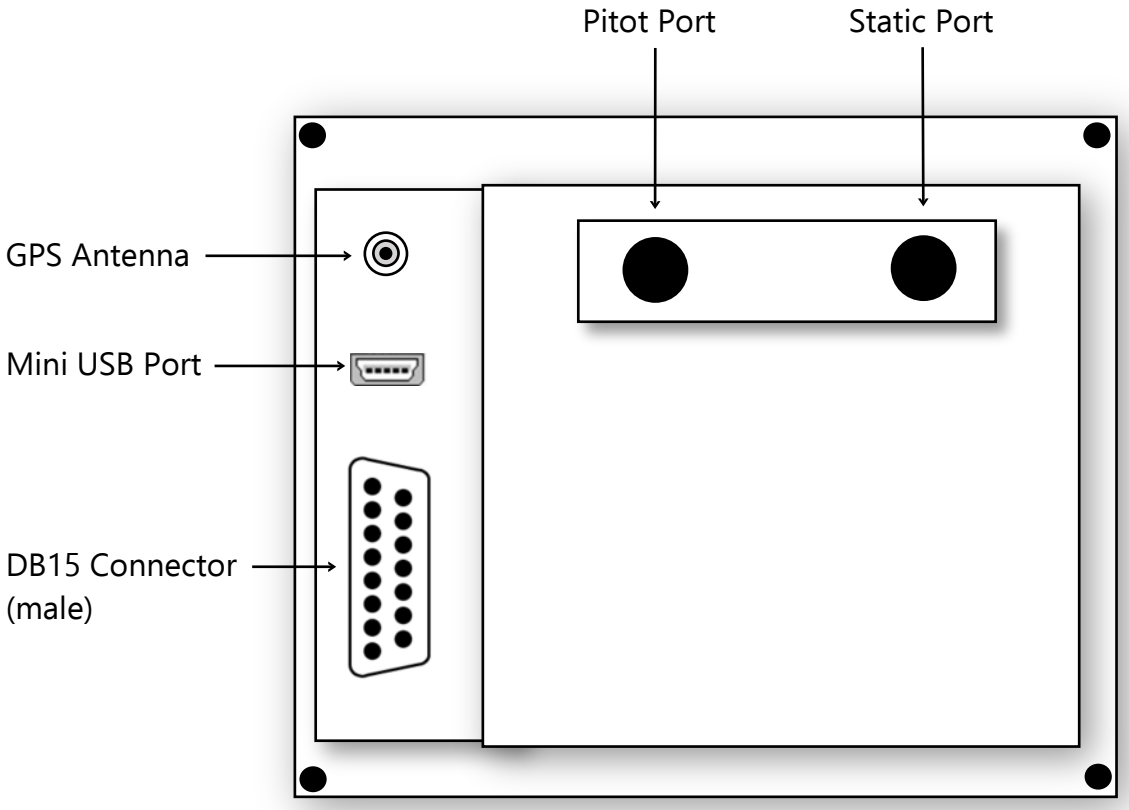
The Mini-X comes with a female DB15 connector pre-wired with the most commonly used wires. The optional remote magnetometer uses a DB9 connector and is connected to the Mini using the pins defined below. The colors shown here correspond to the colors in the supplied wiring harness.

- The supplied wiring harness for the 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 the GADAHRS.
- The magnetometer, OAT, serial ports and Trig TT22 connections are all optional.
- OAT is required for true airspeed and density altitude calculations when the Mini does not have a serial connection to a working GRT Horizon or Sport EFIS display unit.
- Use Trig TT22 A and B connections for control and encoder information for the TT22.
- Any of the serial port pairs can be used for a variety of connections, including connection to another GRT display unit for limited data sharing, serial transponder or handheld GPS.

Magnetometer DB9 Pin No.	Mini DB15 Pin No.	Use	Color
	1	Serial 2 Out	YEL
	2	Serial 2 In	YEL/WHT
	3	Trig TT22 A	
	4	Trig TT22 B	
	5	Serial 1 Out	GRN
	6	Serial 1 In	WHT/GRN
	7	Ground	BLK
	8	Power in: 8-30V	RED
8 (serial in)	9	Mag A/Serial 3 Out	ORG
9 (serial out)	10	Mag B/Serial 3 In	ORG/BLK or WHT/BRN*
5 (mag power - must be powered by Mini-X or an adaptive AHRS)	11	Mag C	BLU or WHT/RED*
1 (ground)	12	Mag D	WHT/BLU or BLK*
	13	Audio Output	
	14	Audio Ground	
	15	OAT	GRY

*Two possible wire colors sets are possible. Pin 8, serial input, is optional, an can only be connected to one Mini.

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 connectors. Optional connections to the Mini are not installed in the D-sub connectors at the factory, however, colored aviation-grade 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.
- The checkout procedures outlined in Section 4 must be completed to verify the Mini is not affected by radio transmissions on any frequency.
- Consider the effects of individual component failures in the design of the system as a whole to create redundancy where necessary.

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). It is desirable to have the Mini power off during the engine start if the bus that powers it is used for supplying power to the engine starter. Voltage drops during engine start can cause the Mini to reboot. An installed backup battery will dampen this effect, but it is good wiring practice to isolate EFIS avionics from the starter circuit.

Circuit Breaker– Power supplied to the Mini must pass through a fuse, circuit breaker, or system such as a Vertical Power electronic circuit control system. It should be sized to allow at least 1/2 amp. At full brightness, the Mini consumes approximately 1/4 amp. The Mini contains internal thermally-activated fuses to protect the equipment from internal electrical faults.

Power Inputs- The Mini has one power input to be connected to the aircraft's electrical system, plus an option for an internal backup battery, which is charged through the main power input.

Voltage Monitor- The Mini monitors its power input and backup battery level. A warning will flash to annunciate the loss of any power source that was provided and is expected to be working according to the "General Setup" menu.

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 Autopilot Source Switch (Optional)

If another GRT EFIS screen is used for the primary display, wire a switch into the instrument panel to allow the Mini to be the selected autopilot source in case the main display should fail. In normal operations, the autopilot control signals pass through the inter-display link, allowing either the Mini or a primary GRT EFIS to control the autopilot when both screens are functioning, regardless of the switch position. Refer to the GRT Autopilot wiring diagrams and installation/setup manual, downloadable from the Support > Documentation > Autopilot section of our website, for more information on wiring and setup of the GRT autopilot. (Note: In autopilot wiring & setup documentation, the Mini is treated the same as any other type of GRT Display Unit. Pilot information specific to Mini autopilot controls can be found in this manual.)

2.5 Magnetometer Wiring (Optional/Recommended)

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. 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. Note that they are the opposite orientation as the (Pins are not installed at the GRT factory because experience has shown us 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, and any Adaptive AHRS.

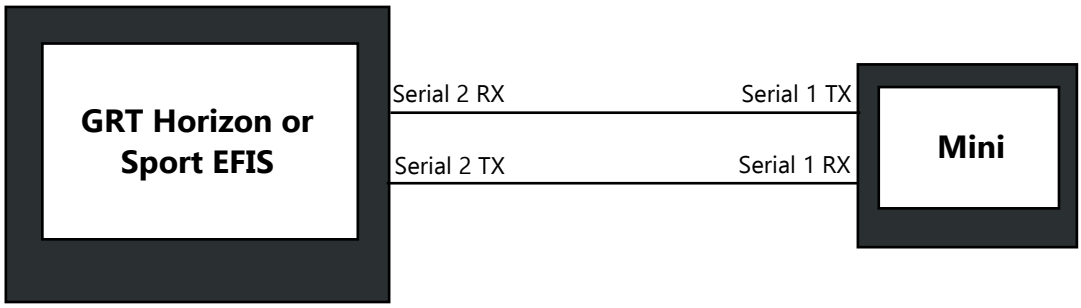
2.6 Inter-Display Communication

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. 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.)

2.7 Trig TT21/TT22 Transponder Interface

The Mini is able to function as the control head for a Trig TT21 or TT22 remote transponder. Visit



the Trig Avionics website for the TT21/22 installation manual and wiring diagrams.

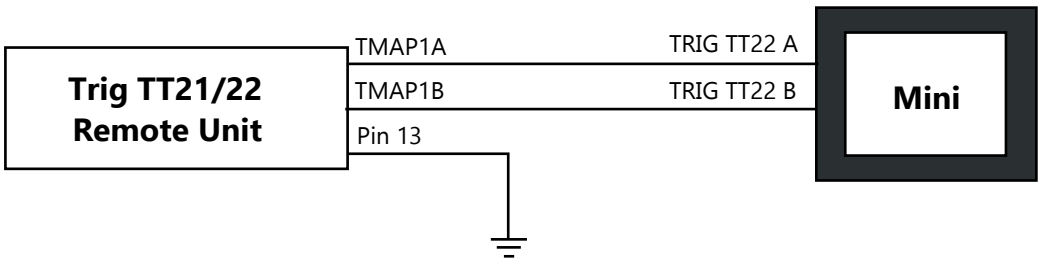
The Mini replaces the Trig TC20 control head. There are two options for wiring the Mini to the Trig.

Option 1: Wire the Trig to the Mini only using the Mini's dedicated Trig port. This output has an RS-485-based serial format that is compatible with the Trig controls. When the dedicated TT22 port is used, do not use the GRT Trig TT21/22 Serial Adapter, which is RS-232 based.

1. Wire the TRIG TT22 A and TRIG TT22 B pins on the Mini's DB15 connector to either of the Trig's two TMAP sets as shown below.

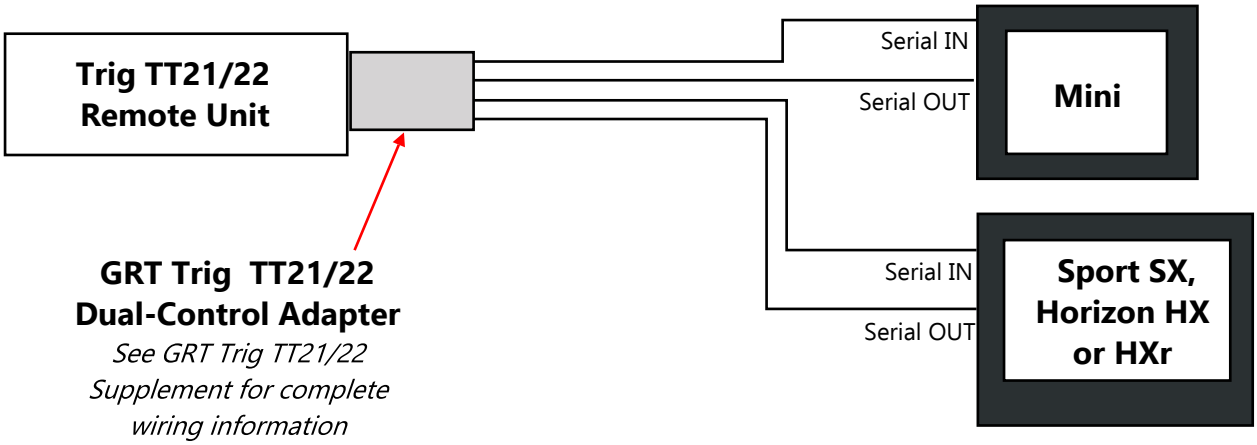
2. Wire Pin 13 on the transponder directly to ground to allow the transponder to power up.

Option 2: Wire the Trig to both the Mini and one other GRT EFIS screen (Applicable only to Sport SX and Horizon HX/HXr). Because Sport and Horizon screens do not have a dedicated RS-485-based Trig port, you must attach a GRT Dual-Control Serial Adapter to the transponder,



which is then wired to an RS-232 serial port on both the Sport/Horizon **and** the Mini as shown below. Wiring and setup information can be found in the GRT Trig TT21/22 Supplement, downloadable from the GRT website under Support > Documentation > Equipment Supplements.

Follow all other instructions in the TT21/22 installation manual for wiring and setup. Instructions for how to operate the transponder through the Mini pilot interface are found in Section 7 of this manual.



2.8 General Serial Port Wiring Information

The Mini's RS-232 serial ports can be used to connect the Mini to a variety of interfacing equipment. In systems using a larger GRT display unit as the primary EFIS, the Mini-X serial ports will most likely be used to connect to the GRT Autopilot servos and the primary GRT EFIS screen for limited data sharing, including flight plans, screen dimming, and altimeter settings. Radios with a serial interface can be tuned from the Mini's Waypoint Details frequency list.

Serial Port Basics- All serial ports have two parts: "IN" (Receive) and "OUT" (Transmit). Data packets are transmitted or received at a certain rate, called the **baud rate**. Every device that connects to a serial port has a published baud rate, which must be entered into the Serial Port Rate setting for the device to communicate with the Mini.

Some devices use both the IN and the OUT channel on a serial port, and some use either IN or OUT. If two devices share one serial port, the baud rate of both devices must be the same. For example, the Mini can take GPS position from a handheld GPS, but it can't talk back to the GPS; therefore, the GPS only requires the IN half of the serial port. The Mini transmits encoder data to a transponder, but cannot receive data from the transponder. The GPS and transponder can share the same serial port IF both devices use the same baud rate.

Choices available for the Mini serial interface include:

Serial Equipment	**Notes**
Off	No connection
NMEA0183 GPS1/Global Positioning	Primary external GPS, such as a GRT GPS module. Most handheld GPS units use this data format.
GPS1 Aviation/MapCom	Garmin IFR nav unit (GNS430, etc)
NMEA0183 GPS2/Global Positioning	Secondary External GPS
GPS2 Aviation/MapCom	Secondary Garmin IFR nav unit
SL30-1	Primary nav/com using Garmin SL30 protocol
SL30-2	Secondary nav/com using Garmin SL30 protocol
SL40-1	Primary com using Garmin SL40 protocol
SL40-2	Secondary com using Garmin SL40 protocol
Display-Unit Link	Connection to other GRT display units
SL70/STX165	Serial transponder encoder data
GRT Autopilot Servo	Splice serial wires to feed to both servos.
TT22	Trig TT22 or TT21 remote transponder using the GRT Serial Adapter. Not required if the TT22 is wired to the dedicated TT22 port instead. See Section 2.7 for more information.

Section 3: Mechanical Installation

3.1 Placement of the Mini on the Instrument Panel

The Mini is permanently mounted on the instrument panel face. The main consideration in choosing a location is the ability to view the display unit and reach its controls. The Mini includes user settings that allow it to be mounted in a wide range of orientations, including instrument panels with a high degree of tilt (pitch), sub-panels or even wing roots, that angle the Mini toward the pilot in yaw, and roll offset. These settings, which are explained in Section 4, allow the internal AHRS to function with full accuracy regardless of its orientation.

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 use of nut plates behind the instrument panel greatly simplifies the task of installing and removing the 4 screws used to retain the display unit in the panel. #4 socket cap stainless steel screws are recommended.

3.3 Pitot/Static Connections

The pitot-static connections on the back of the Mini are labeled P (pitot) and S (static) and take a 1/8 – 27 NPT male fitting. To facilitate installation and removal of the Mini unit, quick disconnect fittings may be helpful. Refer to FAA Advisory Circular 43.13-2B for approved methods to tee off existing pitot/static lines and make the whole system leak tight. Thread sealant or tape is optional. You may carefully wrap the fittings with teflon tape for a better seal, provided the tape cannot block the port. Loctite 567 thread sealant paste has also been used successfully in GRT EFIS installations.

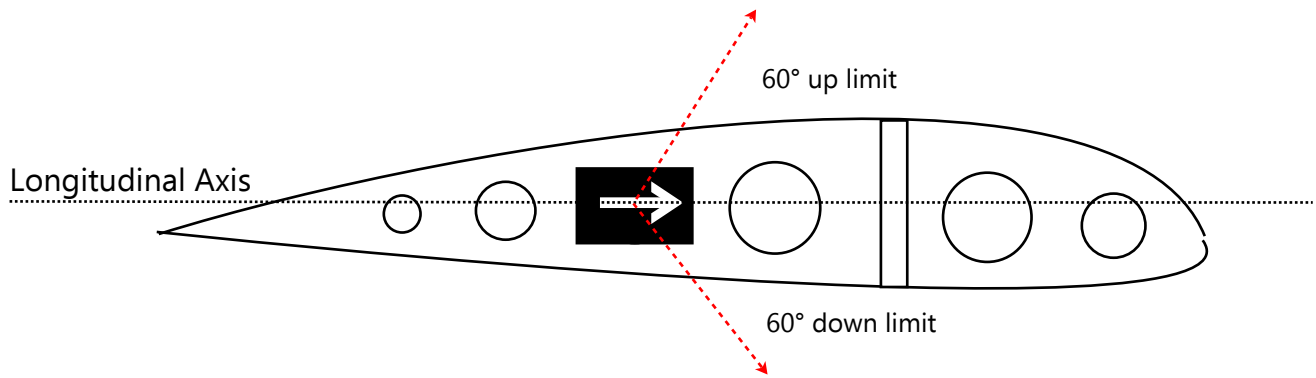
Consider placing a water trap or drain in the lowest part of the pitot-static system to prevent water from getting into the electronics. Make sure the drain is of a high enough quality that it seals completely airtight when closed.

3.4 Cooling Considerations

The Mini draws very low amounts of power and does not require external cooling. However, as with all electronic equipment, lower operating temperatures extend equipment life. If you do choose to supplement your Mini and other avionics with cooling air, be certain that cooling air does not contain water – a problem often encountered when using external forced air cooling air. A few small openings in the glare shield are usually enough to allow natural air circulation.

3.5 Remote Magnetometer Installation (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 the 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 cable 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

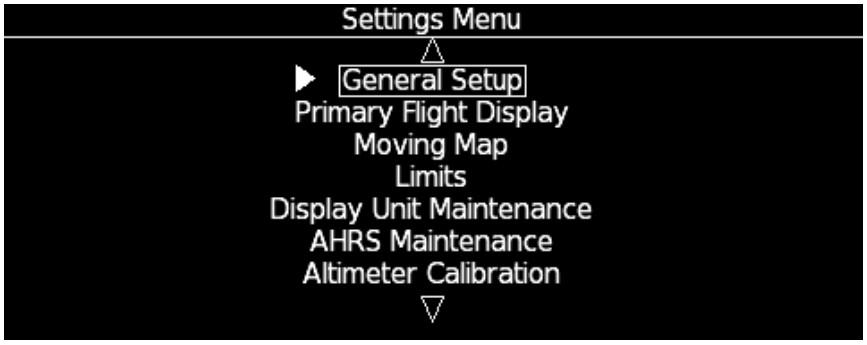
Moving Map- Map symbol & features preferences

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 page that appears when AHRS alignment 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.

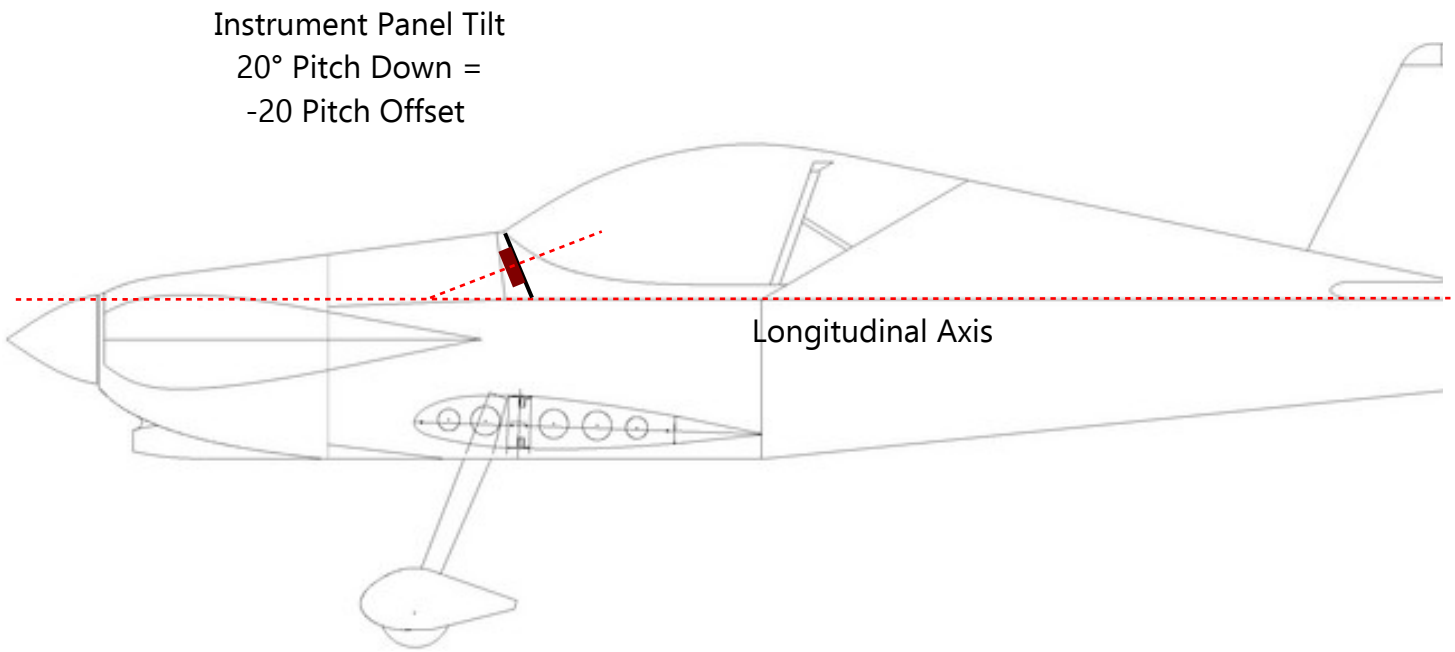
Show DEMO Filename- Shows the file name on the screen when playing back a demo recording on the Mini.

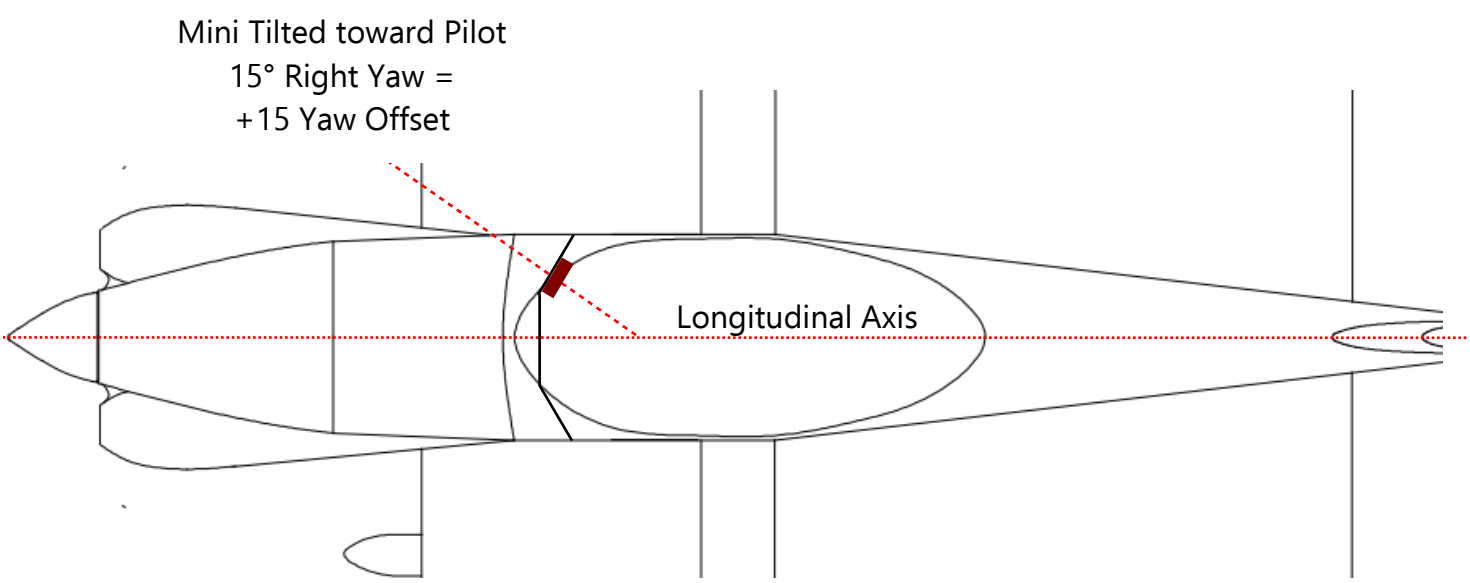
ALWAYS SAVE your settings before exiting the Set Menu!

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):





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 DB15 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. Park the aircraft on a level surface and start the engine.
2. Perform the steps in section 4.6 Set Final Magnetometer and Instrument Orientation.
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 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.

c. If errors of greater than 30 degrees are observed, there is probably a wiring problem. Review the following information to troubleshoot.

Troubleshooting Magnetometer Wiring

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 complete, cycle the power to the Mini. The magnetic heading should be approximately correct if this step was correctly performed, and the magnetometer is not located near excessive magnetic inteference..

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.

CAUTION: The steps in section, 4.6 Set Final Magnetometer and Instrument Orientation , ***MUST*** be performed before performing the fine magnetometer calibration.

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. Verify the PFD screen shows "HDG" next to the 3-digit heading display at the top-center of the screen (indicating good magnetometer communication), and the heading is reasonable (within about +/- 30 degrees of 360).

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

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

6. 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.

7. 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.

8. 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.

9. 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 not end after the airplane has been rotated 380 degrees.

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 - OVERLIMIT 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.

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

10. Point the airplane toward magnetic north.

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

12. 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.)

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

14. 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 "Change to open page," then no valid data is stored within the AHRS and it must be recalibrated. 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 groundtrack. 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

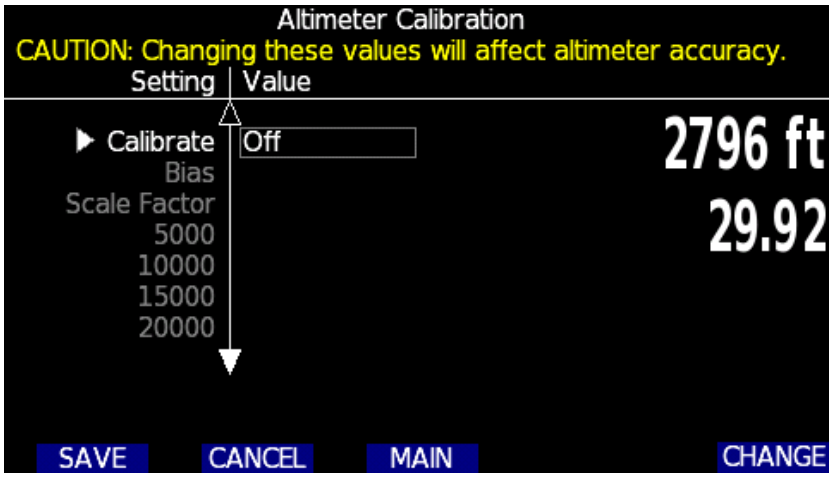
When the Mini is to be used for IFR flight, the altimeter portion of the AHRS must be calibrated to conform to FAR 91.411. This is to be done at an interval in time as dictated by FAR 91.411. It is not necessary to calibrate the altimeter more often than this requirement.

The accuracy of the altimeter can be adjusted using entries provided on this page to account 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, then EXIT. 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. Use the knob to highlight the Bias setting. Temporarily adjust the Bias setting until the altimeter reads 0 feet.
8. Set the altimeter test set to 30,000 ft and note the Mini altimeter reading.
9. Calculate the scale factor as follows:

Calculate the Altitude Error as:

Altitude_Error = GRT Sport_Altimeter_Reading with test set at 30,000 ft.

- If the Mini altitude is less than 30000 ft, the **Altitude Error** is negative.
- Calculate the **Pressure Error** by multiplying the **Altitude Error** by 0.819. The result will be a negative number.
- If the Mini altitude is greater than 30000 ft, the **Altitude Error** is Positive.
- Calculate the **Pressure Error** by multiplying the **Altitude Error** by 0.795. The result will be a positive number.

The scale factor is then calculated as follows:

- **Alt Scale Factor** = 42012 / (42012 + **Pressure Error**)
- The result should be a number greater than 0.9744, and less than 1.0255
- Set the **Alt Scale Factor** as calculated.

(Current Mini software may show **ERROR** next to **Calibrate**. This can be ignored.)

10. Set the altimeter test set back to sea level (0 ft')
11. Set the **BIAS** so that the altimeter reads 0 ft.
12. 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.
13. The accuracy of the scale factor adjustment can be verified by noting a small altitude error (less than 200 feet) is observed with a zero correction at 30,000 feet.
14. Adjust the 30,000 foot correction until the altimeter reads 30,000 feet.
15. 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

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 does 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 groundspeed 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, over-laid 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, as seen below.

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 speed realms, such as approach or cruise speed.

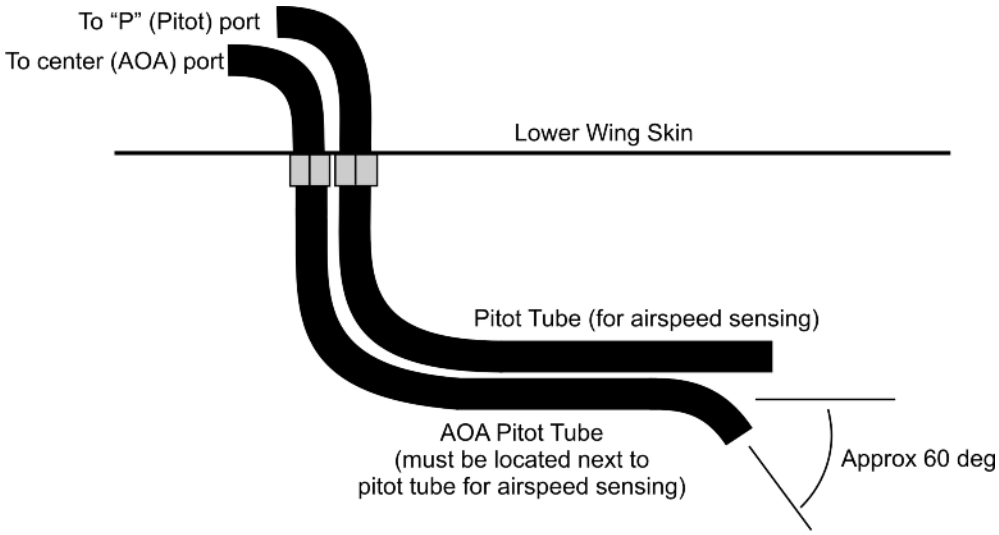
If you feel that an entry in the calibration table is inaccurate, it may be deleted by selecting it with the cursor box using the knob, and pressing the DELETE softkey. You will be asked to confirm deletion of this entry before it is erased.

These entries can be saved using the **EFIS Settings Backup** feature on the Display Unit Maintenance page. They may also be manually entered if desired using the EDIT function.

4.11 Angle of Attack (AOA) Installation and Calibration

Sensed AOA Installation

The sensed version of the angle of attack option uses a two-port pitot tube, such as the Garmin GAP-26 heated pitot probe. If a heated probe is not required, a dual port pitot probe may be fabricated by mounting a second pitot tube, bent downward at approximately a 60 degree angle, as shown here.



Fabricating a dual port pitot tube for airspeed and angle of attack sensing.

When using a dual-port pitot tube, a pressure connection (typically using the same tubing and hardware used for the pitot connection) is made from the AOA port on the pitot tube, to the AOA port (center port on the pitot/static block on the rear of the instrument.

Calculated AOA Installation

No installation is required, as the angle of attack is computed from the AHRS pitch attitude, true airspeed, and vertical speed. Note that this method, although not requiring any sensors or additional pressure connections, degrades in accuracy while in rising or falling air.

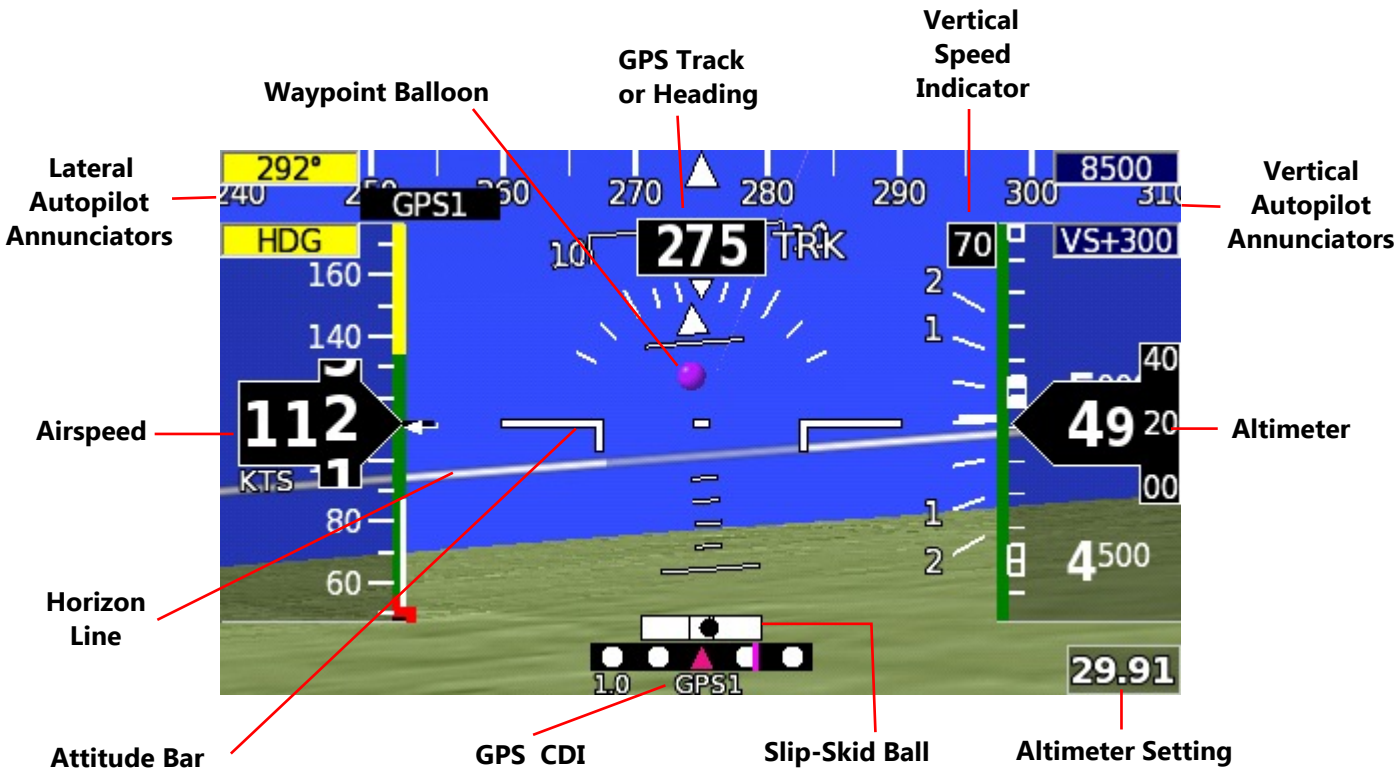
Calibration of the AOA (Calculated and Sensed)

When in flight, in smooth air and at a sufficient altitude to safely stall the airplane, select the Set Menu, Primary Flight Display. Near the end of this menu, set "Angle of Attack (AOA)" to "ON". New settings will appear below this setting when set to ON. We recommend setting "Pitch Limit Indicator" to "ON", following this setting is "AOA Pitch Offset". Change this setting to activate the calibration process, and follow the on-screen prompts. The prompts will include a step where you fly the

airplane near stall speed. When performing this step, minimal power should be used, and the flaps should be in the retracted position.

Section 5: Primary Flight Display Screen

5.1 Primary Flight Display Overview



This illustration shows the location of the various flight instruments on the Mini. 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).

The Mini-B and stock Mini-X use GPS track instead of heading for simplicity. The Mini-X has the option of using a remote magnetometer to sense magnetic heading. The remote magnetometer is required for an accurate magnetic heading because the Mini's location on the instrument panel will usually have too much electromagnetic interference for precise measurement of heading.

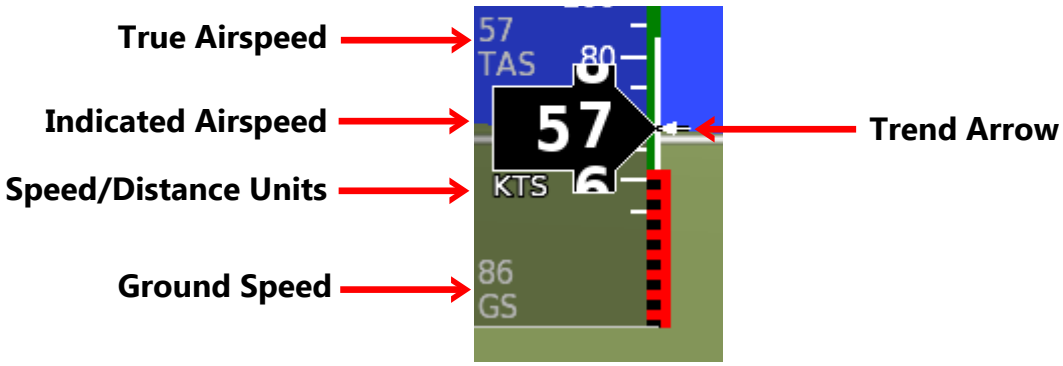
The Mini-X and Mini-AP come standard with synthetic vision, which is the 3D shaded terrain view with obstacles, runways, waypoint balloons, and course ribbons on the Primary Flight Display.

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

The primary function of the airspeed tape is to display indicated airspeed and its associated color bands, all of which are fully programmable according to the aircraft design limitations. It also has several supplemental sources of information to provide the pilot with an intuitive sense of airspeed change, as well as true airspeed and groundspeed.

The instantaneous airspeed readout is contained in the black box with large, bold numbers. The digits appear to "roll by" smoothly as speed changes. The units of distance/speed are displayed below the digital readout. True airspeed (TAS) is displayed in the upper left corner, while GPS groundspeed 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

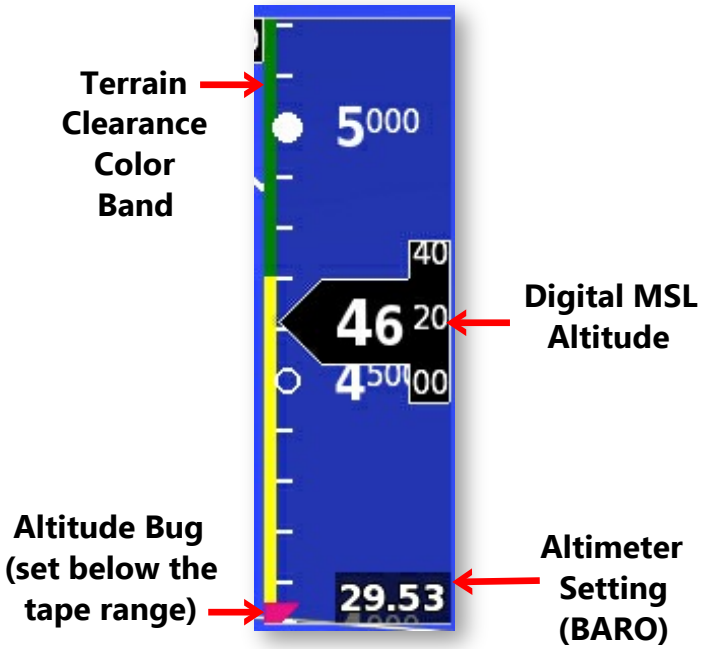
Customizing the Airspeed Tape For Your Aircraft

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

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

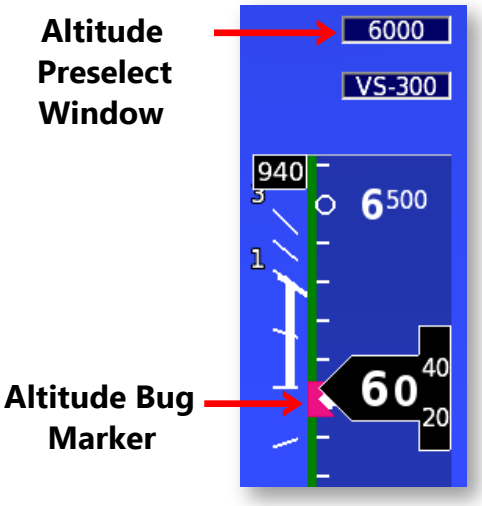
Altitude Bug

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 autopilot to climb/descend to (Mini-AP) and hold.
- A reminder for a cruise altitude or any other altitude the pilot wishes to remember.

To set the altitude bug:

1. Press the knob twice to access the Vertical Autopilot menu.
1. Turn the knob to enter the desired altitude into the Altitude Preselect Window.
2. Press the knob to set the bug to the selected altitude.
3. If an autopilot with vertical navigation capability is connected and engaged, the system will then display a message to verify the speed or rate of the climb or descent desired to fly to the set altitude. See GRT Autopilot User Manual for more information.



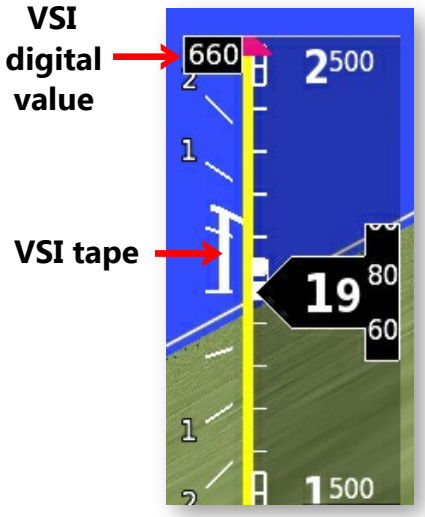
Altitude Deviation Alerts

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 or meters 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.

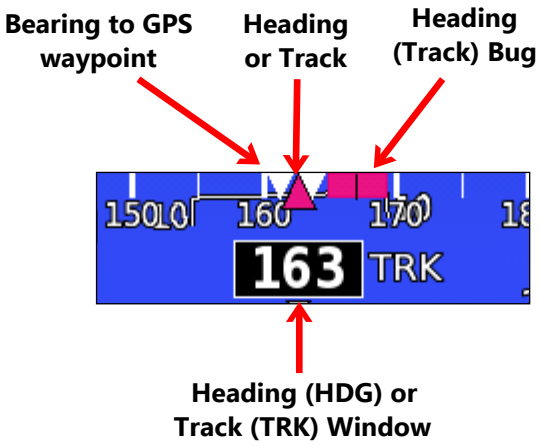
5.5 Track/Heading Indicator

The heading tape covers a 70° span and 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 selected for navigation. 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: TRACK is the only available direction indicator for the Mini-B and stock Mini-X. With the addition of the optional remote magnetometer, the Mini-X can also display magnetic heading. When the remote magnetometer is installed and enabled, choose whether to use Track or Heading on the PFD on the Set Menu > Primary Flight Display page.

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:

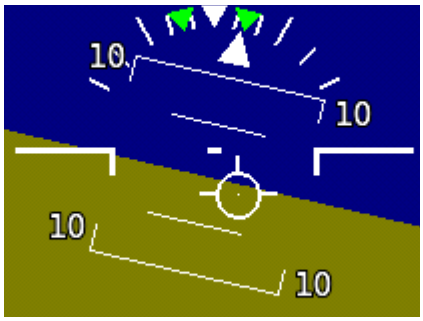
1. Press the knob once, then rotate it to display the desired heading in the Heading Select Window (right). The numerical compass position of the bug will display in the window above the left knob, and the visual bug indicator will slide across the heading tape of the PFD or the arc on the map page or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

2. For more information about using the heading bug with the autopilot, please refer to the Autopilot section of this manual.

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

5.6 Attitude Indicator/Artificial Horizon

The Artificial Horizon is just that, a pictorial representation of the earth. The blue portion represents the sky; the green or brown portion represents the ground. The Mini-X displays a computer generated representation of the "view out the window" using GPS-based technology known as **synthetic vision** to enhance the artificial horizon and make it more realistic. By adding details such as mountain peaks, runways, and obstacles to the pilot's instrument scan field of view, the system adds intuitive situational awareness even in low visibility and instrument conditions. Other instruments add motion sensing, trend vectors and environmental information to the scan as well, providing an intuitive feel for the pilot. The total picture offered by the artificial horizon consists of several graphical elements working together.

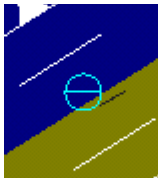


Attitude Reference Index with Flight Path Marker

Attitude Reference Index

The Attitude Reference Index is always the 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.

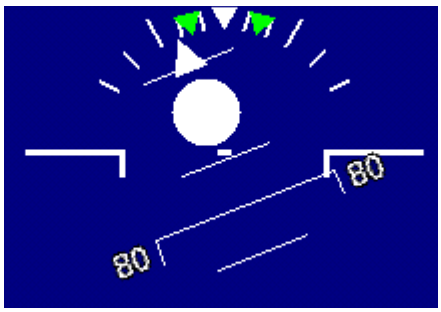

"Nose"

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 screenshot 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 screenshot 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

Adjusting Pitch Ladder Offset

During straight and level unaccelerated 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.

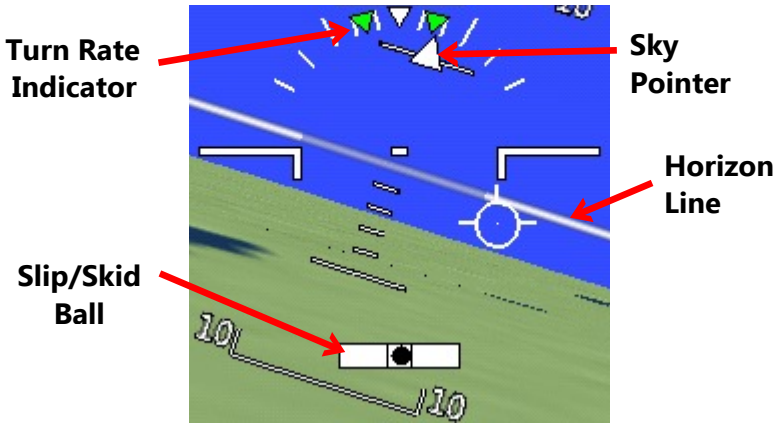
1. Access the Set Menu > Primary Flight Display page.
2. Scroll to **Pitch Ladder Offset**. Adjustments are made in positive or negative 1-degree increments; a positive setting will move the Attitude Reference Index up, and a negative setting will move it down.
3. Adjust it in small increments until 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 taildragger on the ground. When you are on the ground in a taildragger, 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 spacial 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 declutter 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 decluttering 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

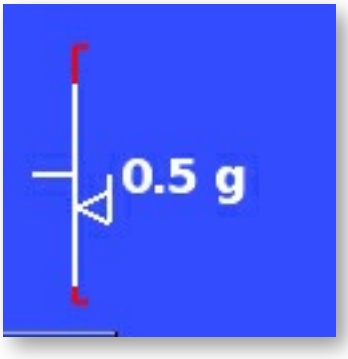
The flight path marker shows where the aircraft will go if all conditions of motion and wind stay the same. Shown as a circle with three spikes, it is a projection of the aircraft's flight path. It combines many data factors including attitude, airspeed, and wind vectors calculated from GPS ground track, ground speed, airspeed and magnetic heading. The flight path marker will appear to float about the display as the aircraft pitches and rolls. This movement is most evident in strong crosswind or unusual attitudes. For example, during a properly-flown crabbed crosswind approach, the heading (nose) will point to the upwind side, but the flight path marker (center of mass) will be superimposed on the virtual runway because that is where the airplane is going at that particular instant in time.

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-X. It displays a 10-mile "out the window" view on the PFD of terrain, runways, and obstacles. GRT factory technicians load the synthetic vision terrain database appropriate for the area of the world in which each Mini will be used prior to shipment.

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."

To turn off terrain warning shading:

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

5.9.2 Obstacles

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

To choose how obstacles are depicted on the PFD screen:

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

5.9.3 Artificial Runways

Runways from a distance

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

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

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 Grid Overlay

Runway on short final

The HXr can lay a grid onto the terrain of the PFD, creating an enhanced sense of depth, height and direction to the synthetic vision. The grid is aligned with the cardinal true directions (N, S, E, and W). It fades with height and distance to create an illusion of space. The squares are 12 arc seconds apart, or about 1,215 feet, and follow the shape of the terrain. To display the grid on synthetic vision:

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

5.9.5 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 (as shown to the right). 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:

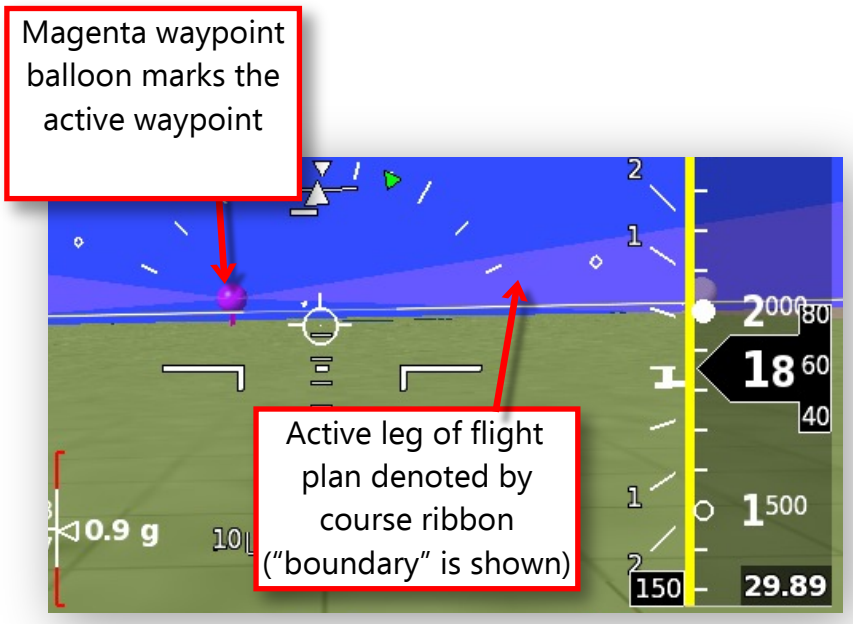
1. Press MORE > Set Menu > Primary Flight Display.
2. Scroll to **Waypoint Balloons** and select ON or OFF.

5.9.6 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 show as white centerlines.

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.



5.9.7 Enroute HITS

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

Enroute HITS will appear only if:

- Enroute HITS is turned ON in the Primary Flight Display set menu, and
- The airplane is on the active leg of a Sequence Mode flight plan with a defined beginning and ending waypoint.

NOTE: The HITS boxes do not anticipate turns.

Magenta HITS boxes are shown here with the centerline Course Ribbon, leading to a waypoint balloon in the distance.

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:

Aeronatuical 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 view only).

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.

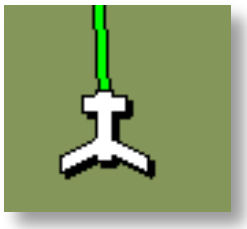
6.3.1 Airport Symbols and Label Fonts

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.

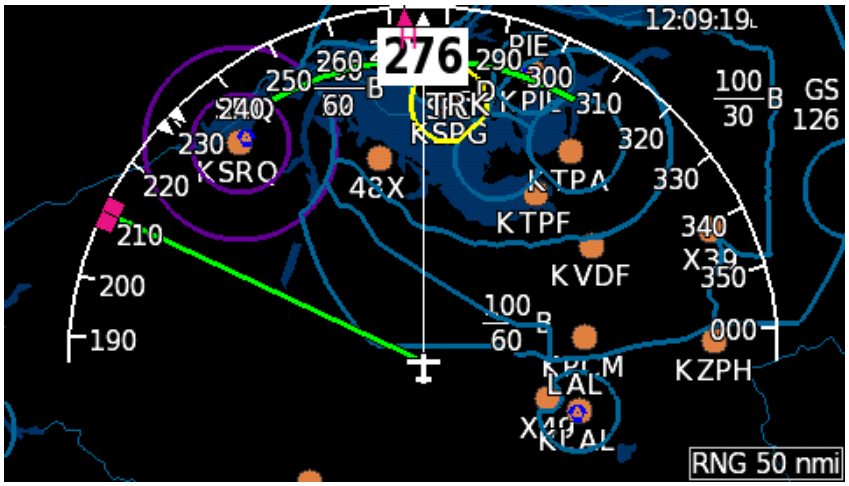
Auto Declutter- Automatically remove items from the map in congested areas, starting with small airports first. To turn on/off:

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 the RNG label is above the knob as shown above, turn the knob to zoom in and out. The knob controls several other functions, such as the heading bug and Map Selection Tool. Press the knob repeatedly until the function you want is shown in the knob label. Default is Range.

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 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 be 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 Sport. The scale is indicated under the left side of the CDI bar.

In addition to the CDI bar, the active waypoint and time/distance to that waypoint are displayed on the PFD. (Location to be determined in the next software release)

7.2 Flight Planning with the Mini

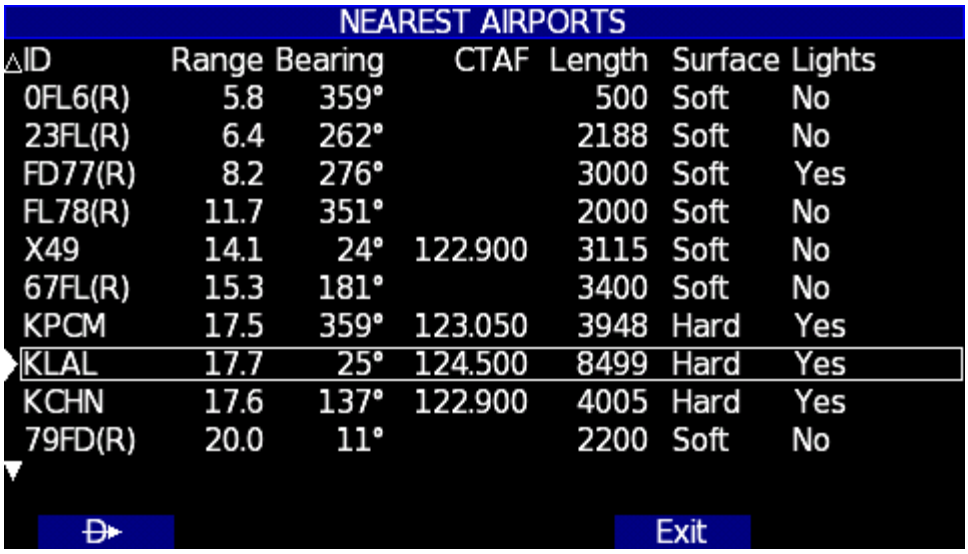
The Mini can take a flight plan in several different ways:

- Enter Direct-To (single waypoint) or Sequence Mode (multiple waypoint) flight plan directly into the Mini using the waypoint entry page. This is called an Internal flight plan because it uses the Mini's internal GPS or a GRT GPS module.
- Follow an External Flight Plan from a connected GPS, such as an iFly 720 or Garmin Aera. 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.
- 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.

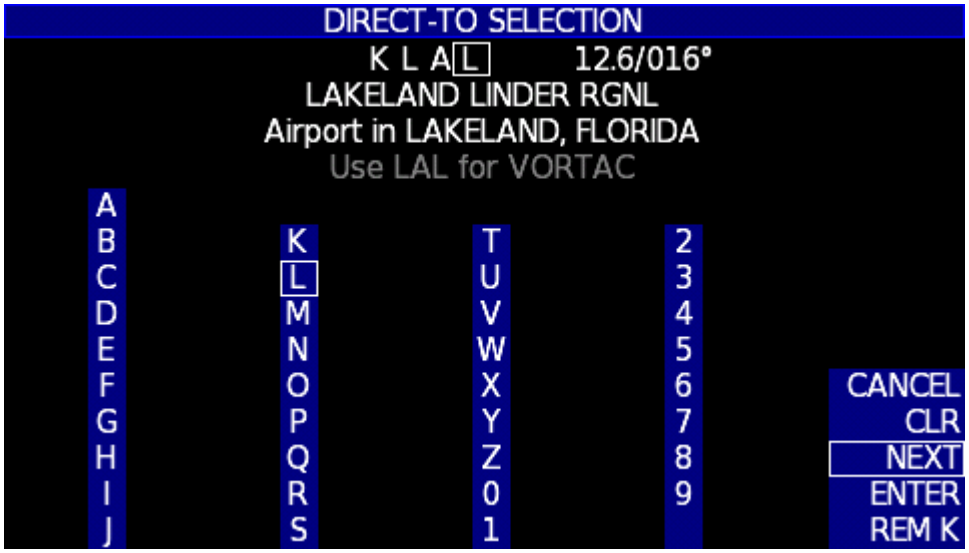


7.2.2 To Enter a Direct-To Waypoint:

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.
- 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 current flight plan to the USB stick
- **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.

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

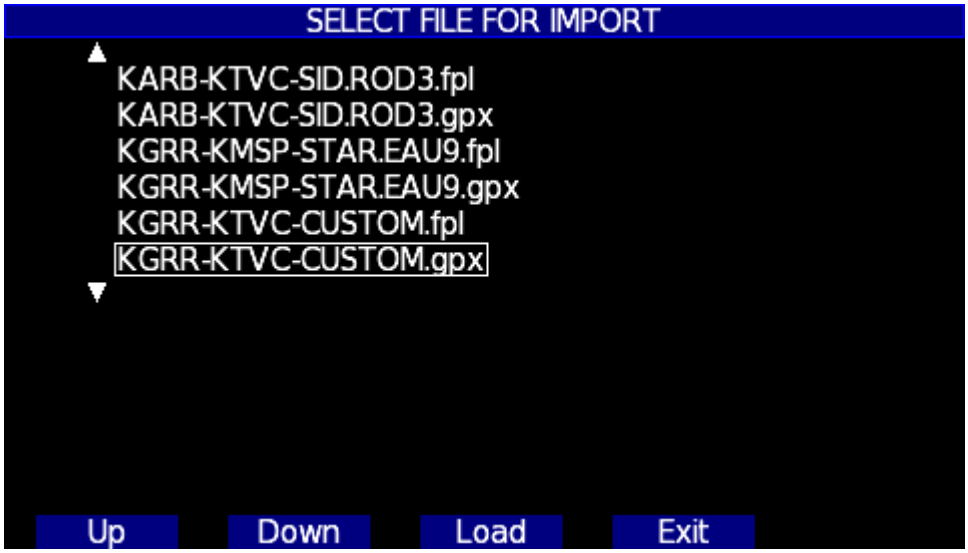
Many apps and GPS units create and store flight plans in .GPX format. The Mini, like the bigger GRT EFIS systems, can read .GPX files placed onto the USB stick.

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 Flight Plan" 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.

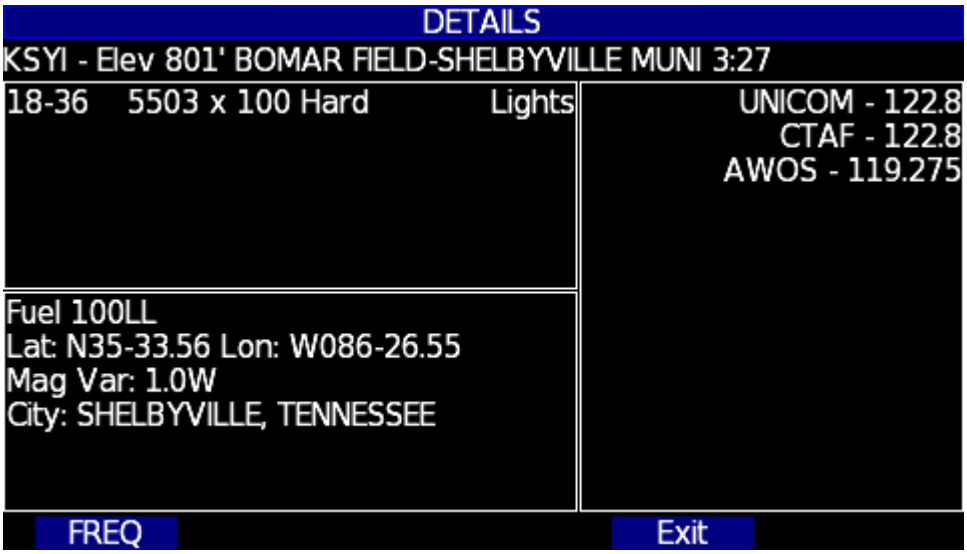


7.3 Airport/Facilities Information & Radio Tuning

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:

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-X has the capability to draw a synthetic approach path to any runway in the navigation database. The approach path is marked by Highway-In-The-Sky boxes (also known as HITS) that are aligned with runway heading and follow a glide angle (usually 3 degrees) to the touchdown zone. This manual covers the button presses necessary to capture the approach. For more detailed information about flying the synthetic approach with all GRT EFIS systems, please see the GRT Horizon User's Guide, Rev. C.

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

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

2. 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 –

3. 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.

4. AHRS, Air Data Computer and GPS data are valid.

Capture of the SAP should occur:

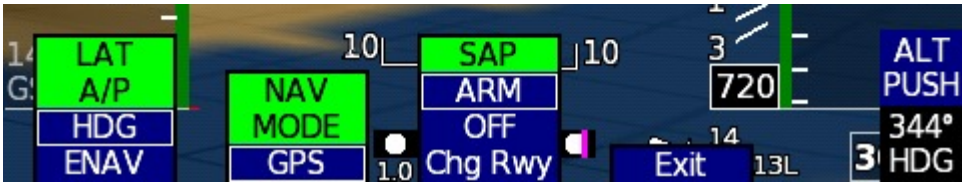
- Within 20 miles of the destination airport
- 2.5 degrees off of the extended runway centerline or localizer course
- On a preferred intercept angle of 45 degrees or less, but can occur at any angle.
- When the aircraft is below glideslope intercept altitude. Abrupt dives can occur when the aircraft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

Flying the Synthetic Approach

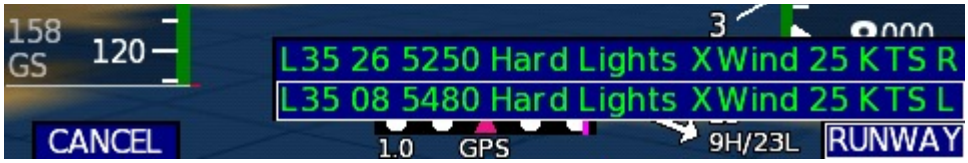
1. Ensure the last waypoint in the active GPS flight plan is the destination airport. If the autopilot is installed and engaged, it can capture the synthetic approach from any mode.

2. Fly toward the airport in HDG mode if you are following ATC vectors or if you are not approaching the desired runway at a natural intercept angle. The autopilot will perform a simple turn onto the SAP when it captures the final approach course. This can result in an abrupt course reversal if care is not taken to make a smooth intercept angle of 45 degrees or less onto the final approach course.

3. From the HOME or PFD screen, press the right knob to activate the autopilot and approach controls.



4. Press the SAP softkey to highlight ARM, then press EXIT. A list of available runways appears on the bottom of the screen in the order in which they are favored by the winds aloft as calculated by the EFIS. Yellow runways have a predicted 10+mph tail wind. **CAUTION:** Traffic and actual winds on the surface may require the use of a runway other than the one favored by EFIS calculations.



5. Turn the left knob to highlight the desired runway in a white outline box, then press the knob to select it. Notice the black **SAPXX** appears as the pending lateral and vertical autopilot guidance, shown at right. In this example, we are set up to capture both the lateral and vertical components of the the SAP for Runway 08.

6. After the runway is chosen, a reminder appears to check the altimeter baro setting, and the yellow EXECUTE softkey appears on the bottom of the screen. Press EXECUTE when you are ready to allow the autopilot to capture the approach and begin descent to the airport. You can also just hand fly the approach using the HITS boxes as a guide.

SAP capture is pending

SAP is captured

7. After the yellow EXECUTE softkey is pressed, the autopilot will automatically capture the lateral and vertical guidance of the SAP when it is within intercept range. Operate the throttle and trim as necessary on approach, and disengage the autopilot when ready to land.

8. If a missed approach is necessary, apply power as required and press the MISSED softkey to command the autopilot to fly runway heading and climb to the missed approach altitude preset.

Section 8: Miscellaneous Features

8.1 Autopilot

When the aircraft is equipped with GRT autopilot servos, the Mini-X is a self-contained 1- or 2-axis autopilot. It provides the following controls based on internal AHRS, GPS course, and optional VHF navigation data:

Lateral Autopilot:

- Heading Select & Hold
- GPS Navigation
- VOR/LOC Navigation

Vertical Autopilot:

- Altitude Select & Hold

NOTE: This manual covers autopilot controls and features unique to the Mini-X. For instructions on installing and wiring GRT servos, autopilot switches, and flight testing, please see the *GRT Autopilot Installation & Setup Manual*. For information on the autopilot annunciators, 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.

8.2.1 Mini Autopilot Controls

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

1. Press the knob once to access lateral A/P modes, navigation source, and synthetic approach controls.
2. Press the knob again to access the vertical autopilot controls. Turn the knob to change the altitude in the Altitude Select/Altitude Bug window.

8.2 Trig TT22 Transponder

The Mini can act as the control head for a Trig TT21 or TT22 Remote Transponder. See Section 2.7 of this manual for wiring information.

8.1.1 Activating TT22 Setup on the Mini

1. Go to Set Menu > General Setup.
2. If using the dedicated TT22 Port with No Adapter, scroll to TT22 A/B Port and select ON. This activates and automatically sets up the dedicated TT22 port.
3. If using an RS-232 serial port with GRT Trig Adapter, set the Input and Output of the wired serial port to TT22 and the baud rate to 9600.
4. Follow the instructions in the GRT Trig TT21/22 Supplement for full setup and checkout procedures.

8.2.2 Transponder Mode Descriptions

STBY: The transponder is on, but will not reply to any interrogations.

AUTO: The transponder is in STBY until reaching 35 knots on takeoff, when it changes to ALT mode automatically. It reverts to STBY mode upon landing rollout when airspeed goes below 35 knots.

ON: The transponder will respond to all interrogations, but altitude reporting is suppressed.

ALT: The transponder will respond to all interrogations, including Mode C altitude reporting.

8.2.3 Transponder Mode/Code Display

Once the TT22 A/B port or serial port is set up, there is a Transponder display box in the lower left hand corner of the EFIS screen under the airspeed tape. This box shows the active mode and squawk code.

8.2.4 Mode Selection

1. Press any key on the Mini to make the softkeys appear, then press XPDR softkey.
2. Press the softkey under the MODE column until the desired mode is highlighted. Then press EXIT.
3. By highlighting the AUTO mode, the transponder automatically enters ALT mode when the EFIS senses an indicated airspeed of 35 knots. Under 35 knots, it assumes ground operation and reverts to the STBY mode.

8.2.5 Code Selection

1. Press the XPDR softkey to bring up the Transponder controls.
2. Press the CODE softkey to bring up the squawk code entry page, shown below.
3. Note the cursor under the first digit of the sqauwk code. Turn the right knob to change the underlined digit. Press the knob to enter the new digit and move the cursor to the next digit.
   - In case of entry error, press the knob repeatedly until the cursor comes back to the digit you want to change.
4. OR– To quickly enter the VFR (1200) squawk code, press the 1200 softkey.
5. When finished, press SAVE.
6. OR– To exit without changing the sqawk code, press CANCEL.

8.3 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.

  Keep in mind that data on the USB stick can be recovered and analyzed by NTSB authorities after a wreck, similar to a "black box." Because demo files record all the data from the AHRS, magnetometer, and other sensors during flight, they are also useful for our techs to help customers solve problems.

8.3.1 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 menu 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

8.3.2 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 upper left corner 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 stop recording momentarily to write the data to the USB stick. 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. If multiple demo files are on the USB stick, you will be taken to a menu page where you can select the file to play.

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.

8.3.3 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 studied using any spreadsheet program.

8.4 Angle of Attack

(not in v32a software)

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 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 to push forward to increase speed. When stall is imminent, the word "PUSH" appears above the AOA indexer.

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

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

8.4.2 Barber-Pole Stall Speed Indicator

A vertical red/black bar is displayed on the bottom half 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 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-attach, 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.

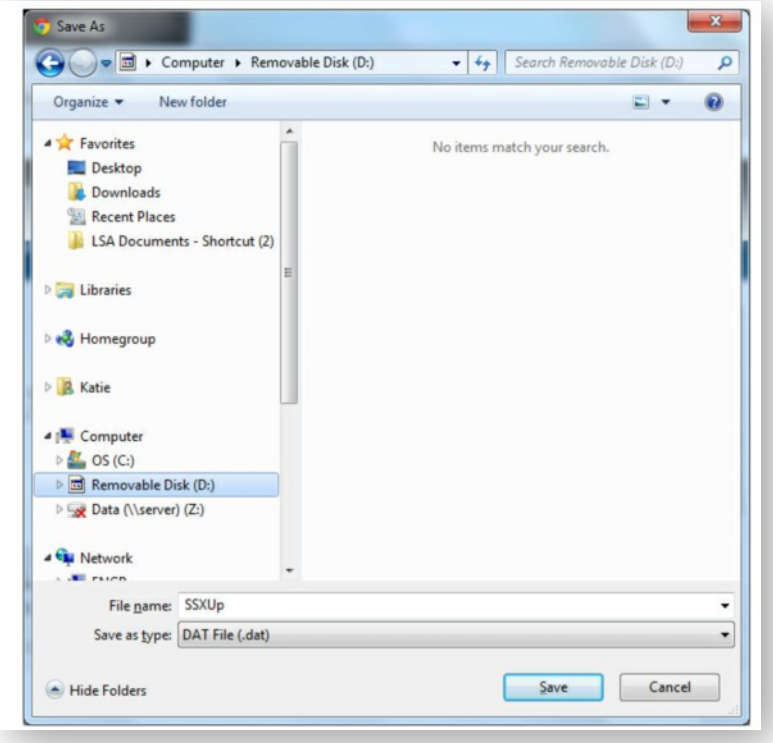
A.1.1 Locate the New Software on the GRT Website

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- Releaed every 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 parenthesis 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 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: Unlike other GRT systems, the display unit itself 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.

A.2 Backup Battery Operation

The backup battery option allows the Mini to operate from an internal user-replaceable Li-ion battery when external power is lost. The battery is charged automatically when the instrument is provided with aircraft power. The battery support circuit is designed with a variety of safeguards to prevent over-charging, charging at excessive temperatures, excessive discharge, and other abnormal conditions. The battery is enclosed within the aluminum housing to provide additional safety.

Operation from the internal battery is completely automatic. Once powered up using aircraft power, the Mini will automatically switch to its internal battery if aircraft power is lost without any interruption (no re-booting). If this occurs when the airspeed and GPS data indicate the Mini is on the ground, the pilot will be prompted to continue operation from the battery. No pilot action is required if power loss occurs in flight.

The Mini can not be powered-up without external power. This prevents the internal battery from being discharged by an inadvertently turning the Mini on when exiting from the airplane.

When operating from battery power, the Mini may be turned off by pressing the right knob, and following the on-screen instructions, or by pressing and holding the knob for more than 5 seconds.

Charging and Battery State Indication

The battery icon in the upper right portion of the screen indicates the state of charge of the battery, and the presence or absence of external electrical power. The approximate state of charge is indicated by the portion of the battery that is green. A lightning bolt is shown in the battery icon when external power is provided to the Mini.

The Mini is designed to maximize the life of the battery and the reliability of the backup power. The design prevents the battery from being excessively discharged, even if the instrument is left on until the battery operation ends. Similarly, charging terminates automatically at a level that maximizes battery life.

Caution: If safe flight in the event of an aircraft electrical failure requires operation from the Mini's internal battery, be aware of the state of charge of the battery, and do not takeoff into IFR conditions with a discharged battery. Battery life is shortened at low temperatures and with aging of the battery, such that it is prudent to expect battery life reduced by as much as 50%.

Maintenance

The Mini should be discharged on an annual basis and the operating time and ambient temperature recorded in the airplane log book. Discharge should occur at maximum screen brightness.

Battery Capacity Re-calibration

Beginning with Mini software version 2, there is a battery capacity re-calibration procedure that can be done during annual maintenance. This will re-calibrate the battery meter so that its estimate of the capacity remaining is more accuate.

1. The procedure must start with a partially or fully discharged battery. If the battery is fully charged, (which is normal), partially discharge by operating the Mini from its internal battery for at least 20 minutes. To do this, apply power to the Mini, then remove power, and over-ride the automatic shut-down message that will appear on the Mini.

2. After the the battery has been partially discharged, select the SET MENU, Display Unit Maintenance, Battery Status, Capacity Calibration. (Pressing SAVE is not necessary.) Calibration Status will indicate "Waiting for charge rate".

3. Apply external power and let the battery charge to 100%. Calibration Status will indicate "Waiting for full charge" while charging. When the charge reaches 100%, Calibration Status will change to "Measuring discharge".

4. When the calibration status changes to “Measuring Discharge”, remove external power and let the Mini operate until it discharges its battery completely. When external power is removed, the shutdown timer may appear. Stop the timer by pushing a button to prevent early shutdown. When the battery voltage gets low, the Mini will record the capacity measured during the discharge.

5. Restore external power to the Mini so the battery can recharge. Battery capacity re-calibration is complete.

Specifications:

Maximum Battery Operating Time: 1.5 hours or more at full brightness with a new battery at 72F ambient temperature. Operating time is reduced at lower temperatures, with a partially-discharged battery, and with aging of the battery.

Recharge Time : 2-3 Hours for a completely discharged battery.