Technicians Guide

EFIS HORIZON

SERIES I

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FORWARD
by Mike Casey

I have added new sections to this manual:

- This FORWARD
- APPENDIX H: WIRING LIST AND PORT SETTINGS (I strongly recommend that you follow this when wiring your EFIS. Not because it is better, but because it will give all of us a standard by which we can compare notes).
- GLOSSARY

My knowledge of this EFIS was obtained by spending many days sitting in my hangar, in the cockpit and playing with the EFIS buttons. I could not have accomplished this without a re-emitting GPS.

The problem was that inside my heated metal hangar the GPS signal couldn't be received. A re-emitting GPS was the answer. It picked up the GPS signal on the outside of the hangar and re-transmitted it inside the hangar.

The unit I have is GPS Reradiator RA-46 which you can order at http://mobilegpsonline.com for about $90.

The unit plugs into a 12V cigarette lighter. So you will probably want to get a 110V AC to 12V DC adaptor from Radio Shack.

Radio Shack Model: 22-505 and Catalog #: 22-505.

My Experience:

- Electronics Technician in the Navy
- BS-EE from New Mexico State University
- Instrumented Rated Private Pilot with 1,000 hours
- I have built an RV-7A with an Eggenfellner Subaru engine and the following avionics: SL-30, Dual GRT EFIS with weather, GPS, ARINC-429. The autopilot is a TRU-TRAK II VSGV.

Manual Conventions

▌ Indicates that an item has been updated. Inserting new items may change the table of contents and page numbers. I will not alert you to that.

Throughout the manual you may see { } or ____. This is used to indicate the settings I have made on my EFIS. I am learning the same as you, so use my setting with caution.

The first seven sections of the manual are devoted to the pilot. The remainder of the manual is for the technicians setting up the EFIS.

Please eMail any corrections or suggestions to:

mikec@caseyspm.com

1.1 Settings Menu / General Setup

See Also: Appendix H

The General Setup allows the setting of equipment inputs and outputs and units of measure.

To find the Settings Menu:

1 Press any button or knob

2 Press [NEXT] (more than once may be required)

3 Press [SET MENU]

4 Use either knob to scroll to General Setup

5 Press the knob to select

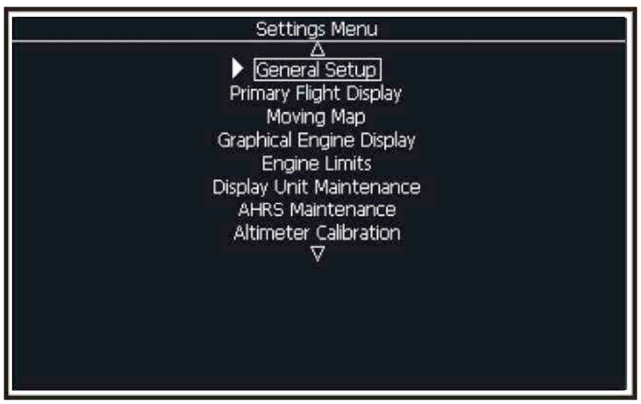


Figure 1.1 Settings Menu

To access am item:

1 Rotate then Press either knob when the Settings Menu item you wish is highlighted.

2 Then repeat the process to select an item within a menu

Note: Not all fields are user selectable. If field is not user selectable the value will not change.

To change a value:

1 Press either knob.

2 Turn knob to change value

3 Press knob to set

The Table 1.1 lists the input and output description for each setting.

NOTE: It is highly desirable to provide each display unit with its own connection to each source of data if possible, and not use the inter-display link. This increases the redundancy of the system, and reduces the amount of lost function in the event a display unit becomes inoperative.

Settings Menu / General Setup / Inter - Display Link Menu

Setting	Selections	Description
Inter-Display Link ID	Auto/Primary/ {Auto (2)}	Set one display unit to "Primary", all others to "AUTO". The numeric entries force the display unit to a particular "address", and may be useful for trouble-shooting, but should otherwise not be used.
Valid Frames Received	{counting number}	Will be continuously changing when the inter-display unit link is operating correctly. (Not a user setting.)
Compare Limits	Yes/No {Yes}	"Yes" allows the display units to compare limits, and prompt you to correct mis-matching limits between display units. Normally limits are automatically transmitted between display units when updated by the pilot.
Send EIS Data	Yes/No {Yes}	
Send Analog Inputs	Yes/No {No}	Select "Yes" only if a display unit has analog inputs wire to it that other display units do not have.
Send SL30-1 Data	Yes/No {Yes}	Select "Yes" if an SL30 is used as nav/com radio 1, and a different display unit is providing the serial output to the radio.
Send SL30-1 Commands	Yes/No {Yes}	Select "Yes" if an SL30 is used as nav/com radio 1, and a different display unit is providing the serial output to the radio.
Send SL30-2 Data	Yes/No {No}	Select "Yes" if an SL30 is used as nav/com radio 2, and a different display unit is providing the serial output to the radio.
Send SL30-2 Commands	Yes/No {No}	Select "Yes" if an SL30 is used as nav/com radio 2, and a different display unit is providing the serial output to the radio.
Send SL40 Commands	Yes/No {No}	Select "Yes" if an SL40 is used as a com radio, and a different display unit is providing the serial output to this radio.
Send GPS Data	Yes/No {Yes}	Select "No" unless another display unit is not provided with GPS serial data. Normally all display units should be wired to the GPS serial data output.
Send ARINC Data	Yes/No {No]	Set to "Yes" only if this display unit includes an ARINC 429 module, and other display units do not include this module.
Send Demo Data	Yes/No {Yes]	"Yes" is preferred, as it allows all display units to show the demo data being re-played from any other display unit.

Table 1.1 Table of Interlink Display Settings
See Also: Appendix H

Note: ____ indicates settings for Display Unit 1 and { } indicates settings for Display Unit 2.

1.2 Serial Port Settings

There are six serial ports which can be configured for any of the functions listed below. The function of the port, and the baud rate, must be set correctly according to the equipment wired to the port. The default settings correspond to the recommended wiring described in the installation and cable description documents.

Note: A suggested wiring list and port settings can be found in Appendix H.

Serial Port Input/Output Functions

- Off
- AHRS-1or 2
- EIS (Engine Monitor)
- GPS NMEA0183 1 or 2
- GPS Aviation/MapCom 1 or 2
- SL-30 1 or 2
- Sl-40
- Display-Unit Link
- Weather

If you're using more than one radio or GPS use the 1 or 2 settings.
For example:

- If you have two radios 430 and SL30, the 430 will be the number 1 radio and the SL30 will be the number 2 radio
- set accordingly, GPS Aviation/Mapcom 1 for the 430 and SL-30 2 for the SL30.

Serial Port Rate:
110 / 600 / 1200 / 2400 / 4800 / 9600 / 14400 / 19200 / 38400 / 56000 / 57600 / 115200 / 128000 / 25600

NOTE: The devices connected must match or be able to work with the baud rate set.

Serial Port Input Counter
This counter increments when any data, valid or invalid, are received. This function is useful for verify an electrical connection to the port is providing data.

1.3 Analog Function Settings

In addition to serial ports the EFIS Horizon has eight analog inputs. Each input can have any of the following functions:

- Off
- ILS Tuned 1 & 2
- GPS Deviations Active 1 & 2
- VOR/ILS Deviations Active 1 & 2
- External A/P Heading Select
- Hold/Sequence (Active Hold)
- Aux (EIS Compatible)
- Flaps
- Aileron Trim
- Elevator Trim
- Page Flip – allows remote switching between pages

NOTE: When both the analog, and serial outputs from a navigation receiver are wired to the EFIS, the EFIS will use, in order of priority:

- ARINC 429 serial data
- RS-232C serial data
- Analog data

1.4 Settings Menu / General Setup (for Display Unit 1)

1 Inter-Display Link | (Change to Activate menu) see table 1.1

2 ARINC Module Connected | <u>YES</u>

3 ARINC Receive Rate | <u>Low</u>

4 ARINC Transmit Rate | <u>Low</u>

5 ARINC Input Counter | <u>counting A:0 B:0</u>

6 Serial Port 1 Rate | <u>9600</u>

7 Serial Port 1 Input | <u>SL30-1</u>

8 Serial Port 1 Output | <u>SL30-1</u>

9 Serial Port 1 Input Counter | <u>counting</u>

10 Serial Port 2 Rate | {<u>115200</u>}

11 Serial Port 2 Input | <u>Weather</u>

12 Serial Port 2 Output | <u>Off</u>

13 Serial Port 2 Input Counter | <u>counting</u>

14 Serial Port 3 Rate | <u>19200</u>

15 Serial Port 3 Input | <u>Display-Unit Link</u>

16 Serial Port 3 Output | <u>Display-Unit Link</u>

17 Serial Port 3 Input Counter | <u>counting</u>

18 Serial Port 4 Rate | <u>9600</u>

19 Serial Port 4 Input | <u>EIS/Engine Monitor</u>

20 Serial Port 4 Output | <u>Fuel/Air Data (Z Format)</u>

21 Serial Port 4 Input Counter | <u>counting</u>

22 Serial Port 5 Rate | <u>9600</u>

23 Serial Port 5 Input | <u>NMEA0183 GPS2/GlobalPo-</u>

sitioning

24 Serial Port 5 Output | Autopilot or (NMEA0183)

25 Serial Port 5 Input Counter | counting

26 Serial Port 6 Rate | 19200

27 Serial Port 6 Input | AHRS-1/Air Data Computer #1

28 Serial Port 6 Output | AHRS-1/Air Data Computer #1

29 Serial Port 6 Input Counter | counting

30 Analog 1 Function | Off

31 Analog 2 Function | Off

32 Analog 3 Function | Off

33 Analog 4 Function | Off

34 Analog 5 Function | Off

35 Analog 6 Function | Off

36 Analog 7 Function | Off

37 Analog 8 Function | Off

38 EIS Model | 4000/6000/9000

39 EIS Temperature Units | Degrees Fahrenheit (°F)

40 EIS Fuel Flow Units | Gallons

41 EIS Baroset Units | inches Hg

42 AltEnc1 Serial Format | #AL +1212345T+25CK

43 AltEnc2 Serial Format | #AL +1212345T+25CK

44 Page Change | Double Click This setting controls how page views change. One click (press) of a button or knob will change the view. Two clicks will show the labels then another click is required to change the view.

45 Default Page | PFD This setting sets the default page after the start up screen is acknowledged.

46 Speed /Distance Units | Knots, Mile per hour, or Kilometers per hour

47 Temperature Units | Degrees Fahrenheit or Celsius

48 Fuel Units | Gallons or Liters

49 Tachometer Units | RPM

50 Manifold Pressure | in Hg or 100 mm of Hg

51 Oil Pressure Units | Psi or Kg/cm2

52 Outside Air Temperature Source | Auto, AHRS or EIS

53 Analog VOR/ILS Inputs | Off, Nav1 or Nav2

54 EXT2 Nav Mode | Off, Nav1 or Nav2

55 ARINC VOR/ILS Inputs | Off, Nav1 or Nav2

56 SL30 OBS Source | EFIS Course Knob or SL30 Nav HeadNav

57 Nav Mode Source | Internal or External
Internal tells the EFIS that NAV MODE changes will be made using the EFIS buttons. External tells the EFIS that the changes will be made by an external device such as a CDI button or a 480, 430 or 530. External switching uses the analog inputs for ILS tuned, GPS deviations, and VOR/ILS deviations for NAV MODE selection.

58 Nav EXT1 Label | EXT1, G430-2, CX80-2, G530-2

59 Nav EXT2 Label | EXT2, G430-2, CX80-2, G530-2

60 Nav 1 Label | VOR or TACAN

61 Nav 2 Label | VOR or TACAN

62 GPS1 Flight Plan Source | Internal or External

63 GPS2 Flight Plan Source | Internal or External

64 Virtual GPS2 | Off The setting allows the Horizon to use external GPS position data and internal flight plan to make a GPS2 nav mode.

65 Flaps and Trim Calibration | Unused

66 External Dimmer Scale

67 Clock Set Mode | On Auto uses GPS NMEA0183 or weather data to set time. (Clock power must be provided to retain local time settings.)

68 Lateral Autopilot Functions | On or Off, This setting turns on page view labels for LAT A/P.

69 Vertical Autopilot Functions | On or Off, This setting turns on page view labels for VERT A/P.

70 Turn Anticipation Range | 1.0 This setting determines the distance in miles the autopilot needs to be from the navaid before it will start a turn.

71 Autopilot Serial Output | Default setting is Normal This setting is for older autopilots that use a GPS coupler.

72 Cross Track Gain (XTGain) | 1.00
See: 1.7 Gain Adjustments

73 Roll Gain | 1.00

74 Heading Gain | 1.00

75 Localizer Gain | 1.00

76 VOR Gain | 1.00

77 Altitude Hold Gain | 1.00

78 Vertical Speed Gain | 1.00

79 Airspeed Gain | 1.00

80 Glideslope Gain | 1.00

1.5 Set Menu / General Setup (for Display Unit 2)

1 Inter-Display Link | (Change to Activate menu) see table 1.1

2 ARINC Module Connected | {No}

3 Serial Port 1 Rate | {4800}

4 Serial Port 1 Input | {NMEA0183 GPS1/Global Positioning}

5 Serial Port 1 Output | {NMEA0183 GPS1 Configuration}

6 Serial Port 1 Input Counter | {counting}

7 Serial Port 2 Rate | {115200}

8 Serial Port 2 Input | {Weather}

9 Serial Port 2 Output | {Off}

10 Serial Port 2 Input Counter | {counting}

11 Serial Port 3 Rate | {19200}

12 Serial Port 3 Input | {Display-Unit Link}

13 Serial Port 3 Output | {Display-Unit Link}

14 Serial Port 3 Input Counter | {counting}

15 Serial Port 4 Rate | {9600}

16 Serial Port 4 Input | {EIS/Engine Monitor}

17 Serial Port 4 Output | {Off}

18 Serial Port 4 Input Counter | {counting}

19 Serial Port 5 Rate | {9600}

20 Serial Port 5 Input | {SL30-1}

21 Serial Port 5 Output | {Off}

22 Serial Port 5 Input Counter | {counting}

23 Serial Port 6 Rate | {19200}

24 Serial Port 6 Input | {AHRS-1/Air Data Computer #1}

25 Serial Port 6 Output | {Off}

26 Serial Port 6 Input Counter | {counting}

27 Analog 1 Function | {Off}

28 Analog 2 Function | {Off}

29 Analog 3 Function | {Off}

30 Analog 4 Function | {Off}

31 Analog 5 Function | {Off}

32 Analog 6 Function | {Off}

33 Analog 7 Function | {Off}

34 Analog 8 Function | {Off}

35 EIS Model | {4000/6000/9000}_

36 EIS Temperature Units | {Degrees Fahrenheit (°F)}

37 EIS Fuel Flow Units | {Gallons}

38 EIS Baroset Units | {inches Hg}

39 AltEnc1 Serial Format | {#AL +1212345T+25CK}

40 AltEnc2 Serial Format | {#AL +1212345T+25CK}

41 Page Change | {Double Click} This setting controls how page views change. One click (press) of a button or knob will change the view. Two clicks will show the labels then another click is required to change the view.

42 Default Page | {PFD} This setting sets the default page after the start up screen is acknowledged.

43 Speed /Distance Units | {Knots}, Mile per hour, or Kilometers per hour

44 Temperature Units | {Degrees Fahrenheit} or Celsius

45 Fuel Units | {Gallons} or Liters

46 Tachometer Units | {RPM}

47 Manifold Pressure | {in Hg} or 100 mm of Hg

48 Oil Pressure Units | {Psi} or Kg/cm2

49 Outside Air Temperature Source | Auto, AHRS or {EIS}

50 Analog VOR/ILS Inputs | {Off}, Nav1 or Nav2

51 EXT2 Nav Mode | {Off}, Nav1 or Nav2

52 ARINC VOR/ILS Inputs | {Off}, Nav1 or Nav2

53 SL30 OBS Source | {EFIS Course Knob} or SL30 Nav HeadNav

54 Mode Source | {Internal} or External

55 Nav Mode Source | {Internal} or External Internal tells the EFIS that NAV MODE changes will be made using the EFIS buttons. External tells the EFIS that the changes will be made by an external device such as a CDI button or a 480, 430 or 530. External switching uses the analog inputs for ILS tuned, GPS deviations, and VOR/ILS deviations for NAV MODE selection.

56 Nav EXT1 Label | {EXT1}, G430-2, CX80-2, G530-2

57 Nav EXT2 Label | {EXT2}, G430-2, CX80-2, G530-2

58 Nav 1 Label | {VOR} or TACAN

59 Nav 2 Label | {VOR} or TACAN

60 GPS1 Flight Plan Source | {Internal} or External

61 GPS2 Flight Plan Source | Internal or {External}

62 Virtual GPS2 | {Off} The setting allows the Horizon to use external GPS position data and internal flight plan to make a GPS2 nav mode.

63 Flaps and Trim Calibration | {Unused}

64 External Dimmer Scale

65 Clock Set Mode | {On} Auto uses GPS NMEA0183 or weather data to set time. (Clock power must be provided to retain local time settings.)

66 Lateral Autopilot Functions | {On} or Off, This setting turns on page view labels for LAT A/P.

67 Vertical Autopilot Functions | {On} or Off, This setting turns on page view labels for VERT A/P.

68 Turn Anticipation Range | {1.0} This setting determines the distance in miles the autopilot needs to be from the navaid before it will start a turn.

69 Autopilot Serial Output | Default setting is {Normal} This setting is for older autopilots that use a GPS coupler.

1.6 Adjusting Autopilot Response

Gain adjustments are provided to allow the user to optimize the commands provided to the autopilot for the GPSS mode.

NOTE: It is recommended the EFIS Horizon autopilot gains be left at the factory settings of 1.0.

To access Gain Adjustments:

1 Press a button

2 Press [NEXT] button (more than once may be required)

3 Press [SET MENU] button

4 Highlight General Setup, press knob

5 Scroll to ARINC Module Connected

6 Highlight by pressing knob (setting will have a white box around it)

7 Change setting to YES

8 Press the knob to CHANGE

NOTE: Depending on the intercept angle when the approach is captured, the turn rate available through the autopilot, and other factors, pilot intervention may be required to capture the approach without overshoot.

The recommended procedure for intercepting the synthetic approach is to do so at a distance of 8 nm or more from runway, at an intercept angle of 45 degrees or less.

The accuracy of the autopilot to track the synthetic approach will be maximized when the intercept occurs in this manner. The adjustment of these gains allows the user to account for variations in the response of the autopilot, airplane and pilot's preferences for the aggressiveness of autopilot tracking.

1.7 Gain Adjustments

The following guidelines are provided to assist the pilot with adjustments to these gains. See: 1.4 Setting Values (for Display Unit 1)

Start with all gains at 1.0

1 Cross Track Gain (XTGain) | {1.00} Normally this gain should not be altered, as it currently affects GPS, Synthetic Approach, Localizer, and Glideslope. With the Roll Gain adjusted as desired, airplane on course with minimal cross-track error, change to heading mode, select a heading 20 degrees different from the current heading.
When the airplane is 500-1000' off course, and heading 20 degrees away from the course, change back to NAV mode for the lateral autopilot mode. Adjust the XTGain so that the airplane recaptures the GPS course with a small overshoot.
If XTGain is too low, the intercept angle will be at shallow angles, and will be sluggish. If too high, overshoot will be observed.

2 Roll Gain | {1.00} Put the airplane on course; with zero cross-track error (use the GPS on a 500' range scale to see when very close to being on track.)
Note how much activity there is in the ailerons in smooth air while on course. Set the roll gain as high as possible, but not so high that it results in any noticeable roll activity in smooth air.
Note: Roll Gain affects all modes except Heading.

3 Heading Gain | {1.00} Slow the airplane to the minimum speed at which you will use the heading select function.
Adjust the Heading gain as high as possible without excessive roll or heading oscillations.

4 Localizer Gain - Adjust the gain so that it is as high as possible without oscillations back and forth across the localizer until 100-200 feet above the ground.

5 VOR Gain | {1.00} Adjust the gain as high as possible so that oscillations begin when close to the VOR. If tracking of the VOR causes an uncomfortable ride (due to noise on the VOR data), reduce the gains as desired.

6 Altitude Hold Gain | {1.00} Adjust the gain to hold altitude without oscillations in turbulence.

7 Vertical Speed Gain | {1.00} Adjust the gain to hold vertical speed without oscillations in turbulence.

8 Glideslope Gain | {1.00} Adjust the gain to stay on the glideslope without oscillations in turbulence.

2.1 Settings Menu / Primary Flight Display Settings

To set PFD settings from the PFD page:

1 Press a button

2 Press [NEXT] button (more than once may be required)

3 Press [SET MENU] button

4 Scroll to Primary Flight Display

5 Press the knob to select

The following are the Flight Display Settings and are the same for Display Units 1 and 2.:

1 Up Reference | {Heading} This setting allows for Heading or GPS track to be displayed in the heading field.

2 Stall Speed (Vso) | {56} Stall speed (Vso) is the lower end of the airspeed tape at the bottom of the green and white sections. This speed setting results in airspeed below is red on the airspeed tape. *Note: These values depend on whether you are using Miles per Hour or Knots.*

3 Max Flap Extension Speed (Vfe) | {86} This setting is the top of the white section on the airspeed tape.

4 Maximum Structural Cruising Speed (Vno) | {123} Maximum Structural Cruising speed. This setting is the top of the green section of the airspeed tape.

5 Never Exceed Speed (Vne)| {200} Never Exceed speed. This setting is the top the airspeed tape.

6 Speed Bug 1 {70} These are user selectable speed bugs.

7 Speed Bug 2 {96}

8 Speed Bug 3 {50}

9 Below stall | {RED}Red or none. This allows user selectable colors for speeds below stall speed.

10 HITS (Highway – In – The – Sky) frame color | {WHITE}

11 Attitude Heading Reference Index |{BARS} Allows for BARS or NOSE to be displayed. The BAR settings shows “wings”, the NOSE setting is a circle with a line through it.

12 GPS CDI | {On} Turns on the GPS CDI in the PFD page

13 Slip Indicator | {On} Turns on the slip indicator.

14 Turn Rate Indicator | {On} Turns on the turn rate indicator

15 Wind Indicator Mode | {Vector and Digital Speed/ Direction} Turns on the wind indicator and displays, Vector/ Speed and Direction

16 Digital Head/Cross Wind Display | {On} Turns on the head or crosswind indication

17 Baroset Units | <u>inches of Hg</u> or millibars

18 Artificial Runways | <u>On</u> or Off

19 Flight Path Marker | <u>On</u> or Off. The Flight Path Marker is the projected flight path the aircraft will take with current conditions.

20 Airspeed Display Size | Normal or <u>Large</u>

21 Altimeter Display Size | <u>Normal</u> or Large

22 Track/ Heading Display size | <u>Normal</u> or Large

23 Airspeed Resolution | <u>Fine</u> or Coarse

24 Max Indicator vertical speed | {3000}This is the maximum setting for the Vertical Speed indicator

25 Pitch Ladder Offset | -15 to + 15 degrees {5}

26 Flight Level Altitude | {18000} This setting automatically sets the baroset to standard pressure when at or above this preset altitude.

27 Altitude Alerting | <u>On</u> or Off

28 Max Altitude Deviation | {100} Altitude deviation which will trigger the above mentioned alarm

29 Climb IAS Preset 1 | {96}

30 Climb IAS Preset 2 | {110}

31 Climb VS Preset 1 | {200}

32 Climb VS Preset 2 | {500}

33 Descent IAS Preset 1 | {140}

34 Descent IAS Preset 2 | {180}

35 Descent VS Preset 1 | {500}

36 Descent VS Preset 2 | {1000}

37 Upper Left Corner Box | <u>Ground Speed</u> or True Airspeed

38 Data Boxes {On}

39 Left Box, Upper Left Entry | {Data: True Airspeed}

40 Left Box, Upper Right Entry | {Data: Dest Wpt Est Time Enroute}

41 Left Box, Lower Left Entry | {Data: Dest Waypoint Range}

42 Left Box, Lower Right Entry | {Data: Density Altitude}

43 Right Box, Upper Left Entry | {Data: RPM}

44 Right Box, Upper Right Entry | {Data: MAP}

45 Right Box, Lower Left Label | {Label: RPM}

46 Right Box, Lower Right Label | {Label: MAP}

47 Synthetic Approach Glideslope Angle | {3.5}

48 Synthetic Approach Height Intercept | {4000} Maximum SAP Intercept Height AGL

49 ILS Type | Off, Needles or Scales. This setting displays scales or traditional needles for ILS course deviation.

50 Show VOR CDI on Localizer | Yes or No. This setting shows the VOR CDI when localizer is active.

51 Show GPS CDI on LOC/GS | Yes or No. This setting displays the GPS CDI when localizer and glideslope is active.

52 ILS Inhibit of HITS | Inhibit HITS or No inhibit of HITS. This setting will enable/disable the Highway-In-The-Sky when the ILS is active.

53 Default Decision Height | {200}

54 G-Meter Mode | Off, Auto, On, On with Min/Max. The auto setting displays the G-meter when a preset limit has been passed.

55 G-Meter Maximum | {8.0}

56 G-Meter Minimum | {-8.0}

57 G-Meter Caution Max | {6.0}

58 G-Meter Caution Min | {-5.0}

59 Auto G-Meter High Threshold | {2.0}

60 Auto G-Meter Low Threshold | {0.5}

2.2 Data Box Values Available

On or Off, This setting turns on the data boxes at the bottom of the PFD page.

Labels and data for these boxes at the bottom of the PFD are as follows:

1 Off {On}

2 DATA: Dest Waypoint ID

3 DATA: Dest Wpt Est Time Enroute

4 DATA: Dest Waypoint Range

5 DATA: Dest Waypoint Bearing

6 DATA: RPM

7 DATA: RPM2

8 DATA: N1

9 DATA: N2

10 DATA: Oil Temperature

11 DATA: Oil Pressure

12 DATA: Coolant Temperature

13 DATA: Carb Temperature

14 DATA: Highest EGT (Exhaust Gas Temperature)

15 DATA: Highest CHT (Cylinder Head Temperature)

16 DATA: Highest TIT (Turbine Inlet Temperature)

17 DATA: MAP (Manifold Pressure)

18 DATA: Fuel Pressure

19 DATA: Amp (Amps)

20 DATA: Outside Air Temperature

21 DATA: Density Altitude

22 DATA: Volts (from EIS) DATA: Fuel Flow

23 DATA: Fuel Remaining (from Fuel Flow)

24 DATA: Fuel Range (from Fuel Flow)

25 DATA: Groundspeed

26 DATA: True Airspeed

27 DATA: Percent Power

28 DATA: Power Bus 1 Voltage

29 DATA: Power Bus 2 Voltage

30 DATA: Power Bus 3 Voltage

2.3 Labels Available

1. Label: ETE (Estimated Time Enroute)
2. Label: RNG (Range)
3. Label: BEAR (Bearing)
4. Label: DEST (Destination)
5. Label: RPM (Revolutions per minute)
6. Label: RPM2 (Revolutions per minute)
7. Label: N1
8. Label: N2
9. Label: OilT (Oil Temperature)
10. Label: OilP (Oil Pressure)
11. Label: Cool (Coolant Temperature)
12. Label: Carb (Carburetor Temperature)
13. Label: Hi EGT
14. Label: Hi CHT
15. Label: Hi TIT
16. Label: MAP (Manifold Pressure)
17. Label: FPrs (Fuel Pressure)
18. Label: L Fuel (Left Fuel tank)
19. Label: R Fuel (Right Fuel tank)
20. Label: Amp (Amps)
21. Label: Volts
22. Label: Volt1
23. Label: Volt2
24. Label: Volt3
25. Label: D Alt
26. Label: OAT (Outside Air Temperature)
27. Label: GS (Groundspeed)
28. Label: TAS (True Airspeed)
29. Label: PowerApproach Glideslope Angle, range 2 – 8 degrees

3.1 Settings Menu / Moving Map Settings

To set Moving Map settings from the PFD page:

- Press any button
- Press [NEXT] button (more than once may be required)
- Press [SET MENU] button
- Scroll to Moving Map
- Press the knob to select

The following are the moving map settings and are the same for Display Units 1 and 2.:

1 Up Reference | {Heading} This setting allows for Heading or GPS track to be display in the heading window.

2 Airport Symbol Size | Large or Small

3 Label Font Size | Large or Small

4 HSI Plane Symbol | Conventional or Canard

5 Connect Bearing Pointers: on HSI | Yes - RMI or No - HSI

6 Max map range: Small airports | {35} This is a de-clutter setting. It will show small airports up to the set range.

7 Max map range: Medium airports | {35} This is a de-clutter setting. It will show medium airports up to the set range.

8 Max map range: Large airports | {300} This is a de-clutter setting. It will show large airports up to the set range.

9 Max map range: VOR | {300} This is a de-clutter setting. It will show VORs up to the set range.

10 Max map range: NDB | {35} This is a de-clutter setting. It will show NDBs up to the set range.

11 Max map range: Airspaces | {50} This is a de-clutter setting. It will show airspaces up to the set range.

12 Max obstructions distance: | {10} This is a de-clutter setting. It will show obstructions up to the set range.

13 Obstacle Alarm | On or Off

14 Terrain | On or Off

15 Terrain Alarm | On or Off

16 Auto Declutter | On or Off This setting turns on the preset de-clutter settings.

17 Show Lighting | {On All Map Pages} This setting displays lighting on user selected map pages.

18 Show AIRMET | {On All Map Pages} This setting displays AIRMETs on user selected map pages.

19 Show METAR | {Translated} This setting displays METARs on user selected map pages.

4.1 Settings Menu / Graphical Engine Display Settings

To set Graphical Engine Display settings from the PFD page:

1 Press any button

2 Press [NEXT] button (more than once may be required)

3 Press [SET MENU] button

4 Scroll to Graphical Engine Display

5 Press the knob to select

The following are the display settings and are the same for Display Units 1 and 2.: The following are typical settings for a 2.5L single cam supercharged Subaru engine.

1 Dial #1 Source | {MAP}

2 Dial #1 Scale | {0.1}

3 Dial #1 Units Label | {in Hg}

4 Dial #1 Start | {10.0}

5 Dial #1 End | {40.0}

6 Dial #1 Label Increment | {5.0}

7 Dial #1 Tick Increment | {1.0}

8 Dial #1 Green Start | {15.0}

9 Dial #1 Green End | {29.0}

10 Dial #1 Yellow Start | {29.0}

11 Dial #1 Yellow End | {30.0}

12 Dial #1 Red Start | {30.1}

13 Dial #1 Red End | {33.0}

14 Dial #1 Bug #1 Position | {30.0}

15 Dial #1 Bug #1 Color | {Magenta}

16 Dial #1 Bug #2 Position | {0.0}

17 Dial #1 Bug #3 Position | {0.0}

18 Dial #1 Bug #4 Position | {0.0}

19 Dial #1 Bug #5 Position | {0.0}

20 Dial #1 Bug #6 Position | {0.0}

21 Dial #2 Source | {RPM}

22 Dial #2 Scale | {100}

23 Dial #2 Units Label | {X100}

24 Dial #2 Start | {1000}

25 Dial #2 End | {5700}

26 Dial #2 Label Increment | {200}

27 Dial #2 Tick Increment | {100}

28 Dial #2 Green Start | {800}

29 Dial #2 Green End | {4500}

30 Dial #2 Yellow Start | {4500}

31 Dial #2 Yellow End | {4920}

32 Dial #2 Red Start | {4920}

33 Dial #2 Red End | {5500}

34 Dial #2 Bug #1 Position | {5400}

35 Dial #2 Bug #1 Color | {Magenta}

36 Dial #2 Bug #2 Position | {0}

37 Dial #2 Bug #3 Position | {0}

38 Dial #2 Bug #4 Position | {0}

39 Dial #2 Bug #5 Position | {0}

40 Dial #2 Bug #6 Position | {0}

41 Dial #3 Source | {Percent Power}

42 Dial #3 Scale | {1}

43 Dial #3 Units Label | {%}

44 Dial #3 Start | {0}

45 Dial #3 End | {100}

46 Dial #3 Label Increment | {10}

47 Dial #3 Tick Increment | {5}

48 Dial #3 Green Start | {0}

49 Dial #3 Green End | {0}

50 Dial #3 Yellow Start | {0}

51 Dial #3 Yellow End | {0}

52 Dial #3 Red Start | {0}

53 Dial #3 Red End | {0}

54 Dial #3 Bug #1 Position | {75}

55 Dial #3 Bug #1 Color | {Magenta}

56 Dial #3 Bug #2 Position | {0}

57 Dial #3 Bug #3 Position | {0}

58 Dial #3 Bug #4 Position | {0}

59 Dial #3 Bug #5 Position | {0}

60 Dial #3 Bug #6 Position | {0}

61 Dial #4 Source | {Fuel Flow}

62 Dial #4 Scale | {0.1}

63 Dial #4 Units Label | {No Label}

64 Dial #4 Start | {0.0}

65 Dial #4 End | {15.0}

66 Dial #4 Label Increment | {5.0}

67 Dial #4 Tick Increment | {1.0}

68 Dial #4 Green Start | {0.0}

69 Dial #4 Green End | {0.0}

70 Dial #4 Yellow Start | {0.0}

71 Dial #4 Yellow End | {0.0}

72 Dial #4 Red Start | {0.0}

73 Dial #4 Red End | {0.0}

74 Dial #4 Bug #1 Position | {8.0}

75 Dial #4 Bug #1 Color | {0.0}

76 Dial #4 Bug #2 Position | {0.0}

77 Dial #4 Bug #3 Position | {0.0}

78 Dial #4 Bug #4 Position | {0.0}

79 Dial #4 Bug #5 Position | {0.0}

80 Dial #4 Bug #6 Position | {0.0}

81 Performance/Fuel Box 2 | {Off}

82 Fuel Flow Data | {On}

83 Number of Cylinders | {4}

84 EGT Vertical Graph Min | {0}

85 EGT Vertical Graph Max | {0}

86 EGT Vertical Graph Increment | {0}

87 CHT Vertical Graph Min | {0}

88 CHT Vertical Graph Max | {0}

89 CHT Vertical Graph Increment | {0}

90 EGT Time History Temp Min | {0}

91 EGT Time History Temp Max | {0}

92 EIS Volt Graph Min | {0}

93 EIS Volt Graph Max | {18}

94 EIS Volt 1 Graph Min | {0}

95 EIS Volt 1 Graph Max | {18}

96 EIS Volt 2 Graph Min | {0}

97 EIS Volt 2 Graph Max | {18}

98 EIS Volt 3 Graph Min | {0}

99 EIS Volt 3 Graph Max | {18}

100 Fuel Flow Max Fuel | {42.0}
Total Fuel Preset and defines the top of the total fuel bar graph.

101 Flow Rate Bar Graph Max | {36}

102 Prompt for Fuel Add | {NO}

103 Aux 1 Function | {MAP}

104 MAP Integer/Decimal | {Decimal}

105 MAP Graph Min Level | {15.0}

106 MAP Graph Max Level | {36.0}

107 Aux 2 Function | {Amp}

108 Amp Integer/Decimal | {Integer}

109 Amp Graph Min Level | {-20}

110 Amp Graph Max Level | {20}

111 Aux 3 Function | {Gear Box Temp}

112 Gear Box Temp Integer/Decimal | {Integer}

113 Gear Box Temp Graph Min Level | {0}

114 Gear Box Temp Graph Max Level | {250}

115 Aux 4 Function | {Fuel Pressure}

116 Fuel Pressure Integer/Decimal | {Integer}

117 Fuel Pressure Graph Min Level | {0}

118 Fuel Pressure Graph Max Level | {40}

119 Aux 5 Function | {Left Fuel}

120 Left Fuel Integer/Decimal | {Decimal}

121 Left Fuel Graph Min Level | {0.0}

122 Left Fuel Graph Max Level | {22.0}

123 Aux 6 Function | {Right Fuel}

124 Right Fuel Integer/Decimal | {Decimal}

125 Right Fuel Graph Min Level | {0.0}

126 Right Fuel Graph Max Level | {22.0}

127 Typical Cruise Fuel Flow | {8}

128 Reserve Fuel Display at Airports | {On}

129 Bar Graph A1 | {Oil Pressure}

130 Bar Graph A2 | {Oil Temperature}

131 Bar Graph A3 | {Coolant Temperature}

132 Bar Graph A4 | {EIS Volts}

133 Bar Graph A5 | {Amp}

134 Bar Graph A6 | {Gear Box Temperature}

135 Bar Graph B1 | {EFIS Power Bus 1 Volt}

136 Bar Graph B2 | {EFIS Power Bus 2 Volt}

137 Bar Graph B3 | {Off}

138 Bar Graph B4 | {Off}

139 Bar Graph B5 | {Off}

140 Bar Graph B6 | {Off}

141 Bar Graph B7 | {Off}

142 Bar Graph B8 | {Off}

143 Bar Graph B9 | {Off}

144 Bar Graph B10 | {Off}

145 Bar Graph B11 | {Off}

146 Split: Box 1 | {RPM}

147 Split: Box 2 | {MAP}

148 Split: Box 3 | {Oil Temperature}

149 Split: Box 4 | {Off}

150 Split: Box 5 | {Off}

151 Split: Box 6 | {Oil Pressure}

152 Split: Box 7 | {Off}

153 Split: Box 8 | {Off}

154 Split: Box 9 | {Off}

155 Split: Box 10 | {Off}

156 Split: Box 11 | {Off}

157 Reset Oil Hours on Next SAVE | {NO}

5.1 Settings Menu / Engine Limits:

These settings are the same for Display Units 1 and 2.

Setting	Use	Recommended Setting
Max Flight Time {0}	Alerts pilot when flight time exceeds this limit. Useful as a warning to check fuel. Limit is entered in minutes, so 2 hours is entered as 120, etc. Range is 0-500 minutes.	30-45 minutes less than airplane's endurance.
Interval {60}	Provides a warning that repeats at the interval entered in minutes. Useful as a reminder to perform periodic tasks such as switching fuel tanks. Acknowledging this alarm cancels the warning completely, therefore the warning light will not remain on after acknowledging this alarm. Range is 0-500 minutes.	As required. Typically 30-60 minutes is used for changing fuel tank selection.
Min EFIS Voltage Bus 1 {10.8}		
Max EFIS Voltage Bus 1 {15.6}		
Min EFIS Voltage Bus 2 {10.8}		
Max EFIS Voltage Bus 2 {15.6}		
Min EFIS Voltage Bus 3 {0}		
Max EFIS Voltage Bus 3 {0}		
Max Fuel Flow {14}	Maximum Fuel Flow – Generates a warning when the fuel flow (rate of fuel burn) exceeds this limit. Useful for detecting badly leaking fuel lines, loose connections to fuel injectors, etc. Very useful safety feature for all engines, but especially fuel injected engines. Be sure to use it! Range of Max Fuel Flow Limit is 0-500 gph, in increments of 1 gallon/hour.	Set about 10-20% above max fuel flow rate at full takeoff power. Applicable only if the fuel flow option is installed.
Min Oil Pressure {20}	Minimum Oil Pressure – Essential! Be sure to use this one! Warns of loss of oil pressure. As this is the most serious alarm, some pilots may take drastic action when seeing this alarm. Consider you situation carefully if you get this alarm. An instrumentation failure (sensor failure) is possible, as is complete engine stoppage or anything in between. Use your judgment! Range is 0-99 psi	As recommended by the engine manufacturer, or 20 psi.
Max Oil Pressure {95}	Maximum Oil Pressure. Useful as a reminder to reduce RPM when warming a cold engine, especially in winter conditions, to avoid excessive oil pressure. Range is 0-99 psi	98 or less. Max oil pressure displayed by the instrument is 99 psi.
Min Cruise Oil Pressure {0}	Minimum Cruise Oil Pressure -Generates a warning when the oil pressure is below this limit. This limit is active only when the engine RPM is above the min Lim-RPM setting. This allows setting a low oil pressure limit that apply only at higher engine. RPM.	As recommended by engine manufacturer, if available. If not provided, set based on experience.
Min Oil Temperature {0}	Minimum Oil Temperature – Intended for troubleshooting engine problems. Also useful as an "engine not warmed up yet" reminder. Range is 0-300 F.	Set limit based on experience.
Max Oil Temperature {230}	Maximum Oil Temperature Range 0-300 deg F.	As recommended by engine manufacturer.

Min RPM {800}	Warns when engine RPM falls below this entry. Useful for troubleshooting engine problems. May also be used as a warning that the engine RPM is dropping too low on the landing rollout which could result in engine stall. No warning is generated when the engine RPM is zero. Range is 0-9990.	Set limit based on experience.
Max RPM {5500}	Warns when engine exceeds maximum RPM. Range of Max RPM Limit is 0-9990.	Set according to engine manufacturer's recommendation.
Min N1 | {0}		
Max N1 | {0}		
Min N2 | {0}		
Max N2 | {0}		
Min Fuel {10}	Minimum Fuel Quantity – Generates a warning when the fuel flow function's fuel quantity drops below this limit. Range is 0-500 gallons.	Set to at least enough useable fuel to provide 30-60 minutes of fuel at cruise power. Applicable only if the fuel flow option is installed
Min Aux 1 (MAP){4}	Minimum & Maximum for Aux input. (Jeff – ideally these limits would use the name the user selected for this input. The displayed value must be either an integer, or a decimal number with 1 digit after the decimal, according to the user selections below.) Range is 0-999, or 0-99.9	Set limit as needed depending on the use of the auxiliary input. Some uses of the auxiliary inputs do not require limits (such as manifold pressure) and some do, such as fuel pressure.
Max AUX 1 (MAP) {30.1}		
Min Aux 2 (Amp){-5}		
Max AUX 2 (Amp) {10}		
Min Aux 3 (Gear Box Temp){0}		
Max AUX 3 (Gear Box Temp) {225}		
Min Aux 4 (Fuel Pressure){20}		
Max AUX 4 (Fuel Pressure) {34}		
Min Aux 5 (Left Fuel){5.0}		
Max AUX 5 (Left Fuel) {22.0}		
Min Aux 6 (Right Fuel) {5.0}		
Max AUX 6 (MAP) {22.0}		
Min H2O {0}	Minimum water temperature limit. Intended for troubleshooting engine problems. Also useful as an "engine not warmed up yet" reminder. Range is 0-300 deg F.	Set limit as recommended by engine manufacturer
Max H2O {230}	Maximum water temperature limit Range is 0-300 deg F.	Set limit based on experience.

Min Volt {11.5}	Minimum Voltage Limit – Allows for detection of loss of charging. Range is 0-35.0 volts (increments of 0.1 volts)	Set limit to about 12.8 volts to get immediate alerting of loss of charging, although this will cause low voltage alarm whenever instrument is on while engine is not running. Set to 12.4 volts or less to avoid alarm when engine not running, but still gives alarm shortly after battery discharging has begun.
Max Volt {15.6}	Maximum Voltage Limit – Allows for detection of failed regulator. Loss of correct voltage regulation resulting in over-charging (and subsequent high voltage) will greatly shorten the life of the battery, and could be dangerous. Range is 0-35.0 volts (increments of 0.1 volts)	Start with 15.6 volts. Lower as much as possible without getting false alarms. Typical limit should be 14.6 Volts.
Min Carb {0}	See Max Carb Range is –30 to +120 deg F	0-20 deg F
Max Carb {0}	Carb temp warning is generated when the carb temp falls between the Max Carb and Min Carb Limit. Range is –30 to +120 deg F	40-60 deg F
Min EGT {0}	Minimum EGT – This alarm is active only when the engine RPM is above the entry for EGT-RPM. This alarm is useful to detecting the loss of a cylinder, or for troubleshooting engine problems. Range is 0-1900 deg F	800-1200 deg F, depending on sensitivity desired. If false alarms are consistently generated, reduce the limit to less than 800 deg F, or set to 0.
Max EGT {0}	Maximum EGT – Not all engines have published limits, nor do all engines require a maximum EGT limit. This alarm can be useful for troubleshooting engine problems also. Range is 0-1900 deg F	Set limit according to engine manufacturer recommendation, or based on experience.
Min TIT | {0}		
Max TIT | {0}		
Lim-RPM {0}	Defines the RPM at which the following RPM dependant limits become active. These are: Min EGT and Min Crz_OP Range is 0-9990 RPM.	Set limit to an RPM slightly less than the RPM used for the MAG check. This allows the Min Volt test to become active during the MAG test to automatically test for charging.
Max EgtSpan {0}	Maximum difference between the highest and lowest EGT. This limit can be used to help detect changes in normal engine operation. It is also useful when leaning using the digital leaning pages, as it is possible to not notice a EGT that is abnormally low when using these pages to lean the engine. (Its more obvious on the bar graph pages.) Range is 0-1900 deg F.	Set this limit based on experience. It may take some trial and error to arrive at a good limit. After establishing a limit that rarely generates alarms, activation of this alarm may indicate developing engine problem.
Max EGT-Inc {0}	Maximum Increase in EGT from the Lean Point. This alarm is active while lean point is active. This alarm will often generate a false alarm when the load on the engine significantly reduced during descent. To avoid this false alarm, reset the Lean Point. (Selecting "Set Lean Page" and "Yes" activates alarm; "Reset" de-activates alarm.) This limit also sets the horizontal red line on the vertical bar graph. Range is 0-1900 deg F.	Set limit based on experience. A small value will allow sensitive detection of EGT increases, which is useful for detection of intermittent problems. Normal operation may require a larger setting to prevent false alarms due to normal EGT fluctuation caused by turbulence or other small power/load fluctuations.
Max EGT-Dec {0}	Maximum Decrease in EGT from the Lean Point. See also Max EGT-Inc description. Range is 0-1900 deg F.	Set limit based on experience. You may find that this limit is significantly different from the Max EGT-Inc. See also Max EGT-Inc description.

Max Cooling Rate {0}	Maximum Cooling Rate for CHT – The alarm is provided in degrees/minute, and corresponds to the maximum rate of decrease in CHT. No limit applies to the maximum rate of increase. All cylinders are checked for this limit. Range is 0-255 deg F/minute.	Set limit based on engine manufacturer's recommendation. If no limit is provided, establish a limit based on experience.
Min CHT {0}	Minimum Cylinder Head Temperature. Intended for engine troubleshooting problems. Also useful as an "engine not warmed up yet" reminder. Range is 0-700 deg F	Set limit based on experience.
Max CHT {0}	Maximum Cylinder Head Temperature. Often engines will normally operate significantly lower than the engine manufacturer's limit. Consider setting this limit lower than the maximum to get early warning of abnormal CHTs. This limit also sets the horizontal red line on the vertical bar graph. Range is 0-700 deg F	Set according to engine manufacturer's recommendation.
Engine Performance | {Invalid}		
Fuel Data Scale | {Disabled/ Invalid}		

SECTION 6: SETTINGS MENU / DISPLAY UNIT MAINTENANCE

6.1 Settings Menu / Display Unit Maintenance

This page allows system maintenance and installing/recording data within the EFIS Horizon.

EFIS Settings Backup

This feature allows you to backup and restore all settings to a USB flash drive. The Backup Directory function will name a directory on the flash drive for easy identification. It is recommended you backup settings after they have been entered. When Activated, the Backup All Settings function should start with "Waiting for USB device...". Then it will say it's saving several things and end with "Backup complete." Saved backup of display unit 1 to BACK0000 and unit 2 to BACK0001.

Load EFIS Software

This feature allows you to load new EFIS software. The USB flash drive (memory stick) must be installed in the display unit and the unit powered.
In multiple display systems each unit must be loaded with the software and the software version must match on each display unit.

To Load EFIS Software:

- Press any button
- Press NEXT button (more than once may be required)
- Press SET MENU button
- Scroll to Display Unit Maintenance, press the knob
- Scroll to Load EFIS Software, press the knob and turn to start

Copy Terrain

This feature allows you to load terrain data, again from the USB flash drive (memory stick).To copy terrain data:

1. Press any button
2. Press NEXT button (more than once may be required)
3. Press SET MENU button
4. Scroll to Display Unit Maintenance, press the knob
5. Scroll to Copy Terrain Data, press the knob and turn to start
   To view the terrain data on the MAP page make sure TERRAIN is selected with the SHOW button.

Weather Status

To activate the weather module you must have XM Weather service established and the Horizon set to receive incoming signals.

To activate the weather module (assuming activation has been requested from XM) :

1. Press any button
2. Press NEXT button (more than once may be required)
3. Press SET MENU button
4. Scroll to Display Unit Maintenance, press the knob
5. Scroll to Weather Status, change to activate menu
6. Scroll to Activation Mode, turn to On within 4 hours of XM subscription activation
   If the activation is successful the Service
   Level will show the subscribed level and the Signal Status should be at least Marginal or better for good reception.
7. Turn Activation Mode to Off. If left On weather data will not show on MAP pages.

The other functions on this page are for troubleshooting by GRT technicians and should be changed with care.

7.1 Settings Menu / AHRS Maintenance

This page displays raw data measurements useful for calibration and troubleshooting.

Maintenance / Built-In-Test Messages

All devices connected via the serial ports can generate either of the following messages.

Device – No Communication.

This indicates a serial port has been assigned to receive data from this device, but no serial data is being provided by this device. This could occur if the device is not turned on, or its serial data output is not connected, or if it has suffered a failure

Device – Checksum Failure.

Data from the device was received in the last 10 seconds which failed its checksum test. This indicates communication with this device may be unreliable.

Status

At anytime the status to the EFIS system is available by pressing the STATUS button.

True Airspeed Corrections

This setting allows for corrections of up to 8 true airspeeds.

See Section: 15 Calibration for more detail.

SECTION 8: SETTINGS MENU / ALTIMETER CALIBRATION

Now that your system is working and communicating with the EFIS Horizon we want to make sure the information it receives is accurate. The following steps will help you accomplish this goal

8.1 Settings Menu / Altimeter Calibration

The accuracy of the altimeter can be adjusted using entries provided on this page to account for sensor errors that may occur due to aging.

The adjustments are stored within the AHRS/Air Data Computer. This means that it is not necessary to enter these corrections into other display units that use data.

Partial Altimeter Calibration – Correcting Altitude 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 EFIS Horizon and AHRS, 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 Select the Altimeter Calibration screen by selecting SET MENU from the button menu, and Altimeter Calibration from this menu.

5 Using the left knob, highlight the Altimeter Calibration – Off selection.

6 Toggle this to (Initiate) On.

7 Set the baroset to the currently reported altimeter setting.

8 Select Altimeter Bias. Adjust the setting until the altimeter matches the airport elevation. (Note that there is about a 2 second delay until adjustments are reflected in the displayed altitude.)

9 Use the buttons to [EXIT].

Calibration is complete! Do not alter any other altitude settings. The altimeter calibration will be turned off automatically when this page is exited.

Full Altimeter Calibration – Using an Air Data Test Set

This calibration adjusts the relationship between the altitude display, and the barometric pressure setting using an Altimeter Test Set.

1 Turn on the EFIS Horizon and allow at least 5 minutes to elapse before continuing.

2 Connect test set to the pitot AND static ports of the AHRS.

3 Set the test set to sea level (0').
NOTE: Failure to connect the test set to the pitot connection will damage the airspeed sensor in the AHRS, and any mechanical airspeed indicators which are also connect to the pitot/static system under test.

4 Set the baroset to 29.92 on the EFIS Horizon display unit. Turn the right knob to set baroset.

5 From the display unit which controls (has a serial output to) the ARHS select the Altimeter Calibration page in the Settings Menu

6 Verify the baroset is 29.92.

7 Use the left knob to select (blue box) and press the knob to highlight (white box) the BIAS field.

8 Temporarily adjust the BIAS on this page until the altimeter reads 0'.

9 Set the altimeter test set to 30,000' and note the EFIS Horizon altimeter reading.

10 Calculate the scale factor as follows:

Calculate the Altitude Error as:
Altitude_Error = EFIS Horizon_Altimeter_Reading 30,000.

If the EFIS Horizon altitude is too low (the Altitude_Error is negative):

Calculate the Pressure_Error by multiplying the Alitude_Error by 0.819. The result will be a negative number.

If the EFIS Horizon altitude is too high (the Altitude_Error is Positive):
Calculate the Pressure_Error by multiplying the Alitude_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.

1 Set the altimeter test set back to sea level (0')

2 Set the BIAS so that the altimeter reads 0'.

3 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.

4 Adjust the 30,000 foot correction until the altimeter reads 30,000 feet.

5 Exit the calibration page.

6 Calibration is complete.

Notes:

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

2 Current EFIS Horizon software may show ERROR next to Calibrate. This can be ignored.

3 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.

8.2 Magnetometer Calibration

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

Before performing this procedure, the magnetometer location should be validated as follows:

Magnetometer Location Validation

1 Select AHRS Maintenance, and locate the Magnetic Heading field on this screen. This shows the magnetic heading data provided by the magnetometer. (The heading data shown on the normal display screens is the gyro slaved heading, which responds slowly to magnetic heading changes.)

2 Observe this reading and verify it does not change by more than +/- 2 degrees while doing the following:

3 Turn on and off any equipment whose wiring passes within 2 feet of the magnetometer. Move the flight controls, if the magnetometer is located near retractable landing gear, operate the landing gear.

Before performing the magnetometer calibration procedure, the approximate accuracy of the uncorrected magnetic heading data must be checked by facing the plane in the 4 cardinal headings, North, East, South and West.

While the calibration procedure can remove errors as large as 125 degrees, accuracy is improved if the location chosen for the magnetometer requires corrections of less than 30 degrees.

Note: The magnetometer must be installed according to the mounting instructions provided with the magnetometer.

Calibration Procedure

The Magnetometer Calibration page will guide you through this procedure with it's on-screen menus.

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.

NOTE: Be sure your GPS is displaying MAGNETIC track, not TRUE track, if using it to align the airplane with magnetic north.

The steps you will follow are:

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

2 After the aircraft is positioned accurately, turn on the EFIS Horizon. (If it was already on, then turn it off and then back on again.)

3 Allow at least 1 minute for the AHRS to fully stabilize.

4 Activate the magnetometer calibration function by selecting the Maintenance Page, and highlighting the Magnetometer Calibration selection.

5 Change this setting with the knob to select the magnetometer calibration page.

6 Press Start.

7 Answer the question, Yes.

8 Verify the airplane is still pointed to magnetic north, and answer the question Is the airplane, AHRS, and magnetometer pointed north? with Yes.

9 A message will appear at the bottom of the screen indicating the system is waiting for the gyros to stabilize.

10 Wait until this message is replaced with the message, Calibration in Progress, and immediately (within 15 seconds) begin the next step.

11 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 pulled or 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.

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.*

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

If calibration is unsuccessful, one of two things will happen:

1 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 shown 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.

2 If the airplane is rotated too rapidly, the calibration will not end after the airplane has been rotated 380 degrees. In either case, the calibration procedure must be repeated.

The accuracy of the magnetometer calibration can now be verified.

1 Point the airplane toward magnetic north.

2 Turn on the AHRS (if already on, turn it off, and then back on).

3 Verify the AHRS 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.)

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

5 Rotate the airplane through 360 degrees, and inspect the Calculated error graph (the red line) drawn on the screen.

6 Calibration is complete.

The magnetic heading errors should be less to 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 was mounted accurately with respect to the AHRS.

8.3 Magnetometer Status

The status of the magnetometer correction data are 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 valid data are stored within the AHRS.

Valid data means that the data are present, but the accuracy of this data are not assured. The accuracy is dependent on how carefully the user performed these steps.

8.4 Magnetic Heading Accuracy

To check the accuracy of the uncorrected magnetic heading:

1 Scroll to Magnetometer Calibration

2 Press the knob to select

3 While on this page, rotate the airplane 360 degrees. A red graph will appear on this page showing the errors showing the calculated errors.

If errors of greater than 30 degrees are observed, this may be caused by magnetic disturbances near the magnetometers, such a ferrous metal, magnetic fields from electric motors, or if the magnetometer orientation is not the same as the AHRS. (For every 1 degree of misalignment between the magnetometer and the AHRS, approximately 3 degrees of heading error can be expected.)

8.5 Multiple AHRS

If more than one AHRS is configured to the EFIS Horizon the following annunciations are provided on the PFD page:

8.6 Dual AHRS

Each display unit will annunciate under the Pitch Ladder when two AHRS are providing valid data and in agreement. The roll and pitch data must be within 7.5 degrees and 5 degrees, respectively.

If the ARHS's do not agree within the above criteria the Primary Display Unit will use AHRS1 data as configured in the Inter-Display Link setup page. All other displays will use AHRS2 data.

At power-up an AHRS button label will show. The AUTO setting will use ARHS1 on the Primary Display unit or you may use another selection.

AHRS X — Each display unit will annunciate under the Pitch Ladder when only 1 AHRS (in a multiple ARHS setup) is providing valid data.

8.7 True Airspeed and Wind Calibration

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

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

True Airspeed Corrections:

The AHRS Maintenance 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 3 airspeeds be used for the corrections, as follows:

- correction at the typical cruising speed
- typical climb airspeed
- typical approach speed

For example, with an RV-6, a good approach speed might be 80 mph with flaps at 1 notch. Additional corrections as desired can be entered, 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. Press any button or knob.
2. Press [NEXT] (more than once may be required)
3. Press [SET MENU] button
4. Scroll with either knob to AHRS Maintenance
5. Scroll to True Airspeed Corrections
6. Press the knob to select
7. Turn the knob to open calibration page
8. Select a blank table entry in the correction table using a knob.
   If no entries are blank, then select an entry and press Delete to clear the entry. The Start Cal button will be displayed when the cursor box is on a blank entry.
9. Press the Start Cal button to begin.
10. Find a heading such that the ground track indicator is aligned with the heading indicator on the PFD or map pages within 5 degrees. This will result in the airplane flying directly into, or with the wind.
11. Establish the desired IAS for the correction. Do not change the power setting until the calibration is complete.
12. Press the Ready button.
    The EFIS Horizon will average the data until the on-screen count-down timer reaches 0.
13. Maintain constant heading and altitude until the count-down timer reaches 0.
14. Turn to the reciprocal heading when prompted.
15. When established on this heading, at the same altitude and power setting as in step 2, press the READY button.
    The data will be collected until the count-down timer reaches 0. The correction table will then display this correction.
16. Process is complete

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

These entries can be saved using the EFIS Horizon Settings Backup selection on the display unit maintenance page. They may also be manually entered if desired using the EDIT function.

8.8 Flap/Trim Calibration

See General Setup, Flaps and Trim Calibration. This setting assumes electric flap/trim servos.

8.9 Post Installation Checkout Procedure

The intent of this procedure is to verify each electrical connection to the EFIS Horizon has been properly made. This is accomplished by operating the EFIS Horizon, and the equipment which connects to it and observe responses that indicate the various connections.

Clearly the exact checkout procedure will be dependent on the exact configuration of the EFIS Horizon, and thus the following tests are provided as a basis from which the installer may wish to expand upon.

1. Apply power to the display unit(s).

2 Verify they start up and show the startup page.
If multiple buses provide power to the display unit, verify each bus is able to power the display unit(s).

3 Apply power to the AHRS.

4 Verify communication with the AHRS by observing that attitude data are provided on the primary flight display page.
If multiple buses provide power to the AHRS, verify each bus is able to power the AHRS. This verifies power connection, and serial input from the AHRS).

5 Select the Set Menu, AHRS Maintenance on the display unit which controls the AHRS.

6 Verify the software version is displayed. This verifies power is power connection from each bus. While on the AHRS Maintenance page, locate the Magnetic Heading field on the Primary Flight Display.

7 Verify the magnetic heading is reasonable.

8 Change the heading of the airplane by about 90 degrees and verify the heading changes and again is approximately correct.

9 Verify operation of the magnetometer with the aircraft in the North heading.

10 Apply pressure to the pitot system and verify the airspeed on the EFIS HORIZOn responds.

CAUTION: Applying pressures greater than 1.5 psi may damage the AHRS and/or other equipment connected to the pitot system.

11 Vary the static pressure and verify the altimeter responds.
This verifies static port connection.

12 If a GPS is connected, turn it on.

13 Set the navigation mode to GPS, and verify the navigation mode is displayed as GPS, and not GPS-HDG XXX, which would indicate no GPS data being received.

14 Alternatively, select the MAP page on the EFIS Horizon display unit. Select a map range of at least 50 miles.

15 Verify the map shows data, such as airports, navaids, etc. This verifies communication with GPS.

16 If the EIS is connected, turn it on.

17 Select the engine page on the EFIS Horizon, and verify the tachometer display is not dashes. This verifies communication with the EIS engine monitor.)

18 If localizer and glideslope data are provided to the EFIS HORIZOn, verify it is displayed properly by selecting a test mode on the navigation radio, or by using an ILS test set.

19 Verify the accuracy and sense (direction) of the indications on either the primary flight display, or the H.S.I. page. Note: Some navigation receivers do not provide test data on their digital bus. This verifies analog localizer and glideslope connections. Similarly validate all other interfaces, such as the connection to the autopilot, data provided by the ARINC 429 data, and any analog inputs that may be wired into the EFIS Horizon. This verifies all other connections.

20 Verify inter-display unit communication by setting the altimeter on any display unit, and verifying all other display units reflect the new setting.

CAUTION: If any display unit in the chain is inoperable, the display units will not be able to share information. The pilot must account for this down-graded mode of operation as necessary and expect data will not transfer between displays.

22 Verify all analog connections to the EFIS Horizon. This requires selecting test modes for the various pieces of equipment that connects to these inputs. The state (voltage level) of these inputs is observed by selecting Display Unit Maintenance, and then Analog Inputs menu.

8.10 Fuel Flow Totalizer Calibration

The fuel flow totalizer (fuel quantity) can be set on the EIS engine monitor, or the EFIS Horizon display unit.

If the EIS is mounted in the instrument panel, it is used to set the fuel quantity whenever fuel is added to the airplane. This data will be transmitted to, and displayed on, all display units to which it is connected.

If the EIS is not mounted in the instrument panel, the fuel quantity can be set on any display unit, but only if the fuel quantity in the EIS communicating with the EFIS Horizon, and is reporting zero fuel. If the display unit detects a change in the fuel quantity reported by the EIS fuel flow function, it will use this data, overriding the user selection made on the display unit.

By setting EIS fuel quantity to zero, it assures the EIS reported fuel quantity will not change.

The fuel flow calibration must be set in the EIS, via its FloCal entry. See *EIS* manual for more detail.3.7 Multi-Display Unit Communication

The display units share information, including user selections, analog input data, and ARINC 429 input/output data between all display units. This allows user selections that affect the entire system to affect all display units, such as the altimeter setting for instance.

The following items are updated in all display units whenever this data are changed in any display unit.

- Altimeter Setting

- Heading Selection
- Selected Altitude
- All autopilot modes and selections, including ARMing of approaches
- Navigation Mode
- Synthetic Approach On/Off
- Fuel Flow Totalizer
- Alarm Acknowledgements

NOTE: General Settings must be made and verified on each display unit. These do not update across the Inter-Display Link.

Other data may also be shared between display units using the Inter-Display Link menu on the General Setup screen, including analog data and ARINC 429 data. See the section User Settings, General Setup, for more information.

APPENDIX A: SPECIFICATIONS

Physical

Display Case Size: 6.25"W x 3.75"D x 4.65"H

Face plate Size: 7.25" W x .375" D x 4.75"H

Unit Weight: 2.25 lb.

Power: 12 VDC to 28 VDC 1.3 amps

ARHS Size: 6" L x 4" D x 3.5" H

Unit Weight: 1.75 lb.

Power: 12 VDC to 28 VDC less than .25 amps

Magnetometer Size: 5.125" W x 2.8"D x 1.125" H

Unit weight: .25 lb

EIS Size: 5.125" W x 2.375" D x 2.375" H

Face Plate Size: 5.94"W x .125"D x 2.75"H

Unit Weight: .9 lb.

Power: 9-18 Vdc, .1 amps

Power

Input: 12 VDC 28 VDC (*optional)

Interfaces

RS-232 serial, ARINC 429 (optional), analog

APPENDIX B: MOUNTING DIAGRAMS

The following diagrams show the size and mounting holes for the EFIS Horizon, AHRS and magnetometer. NOT TO SCALE, dimensions in inches.

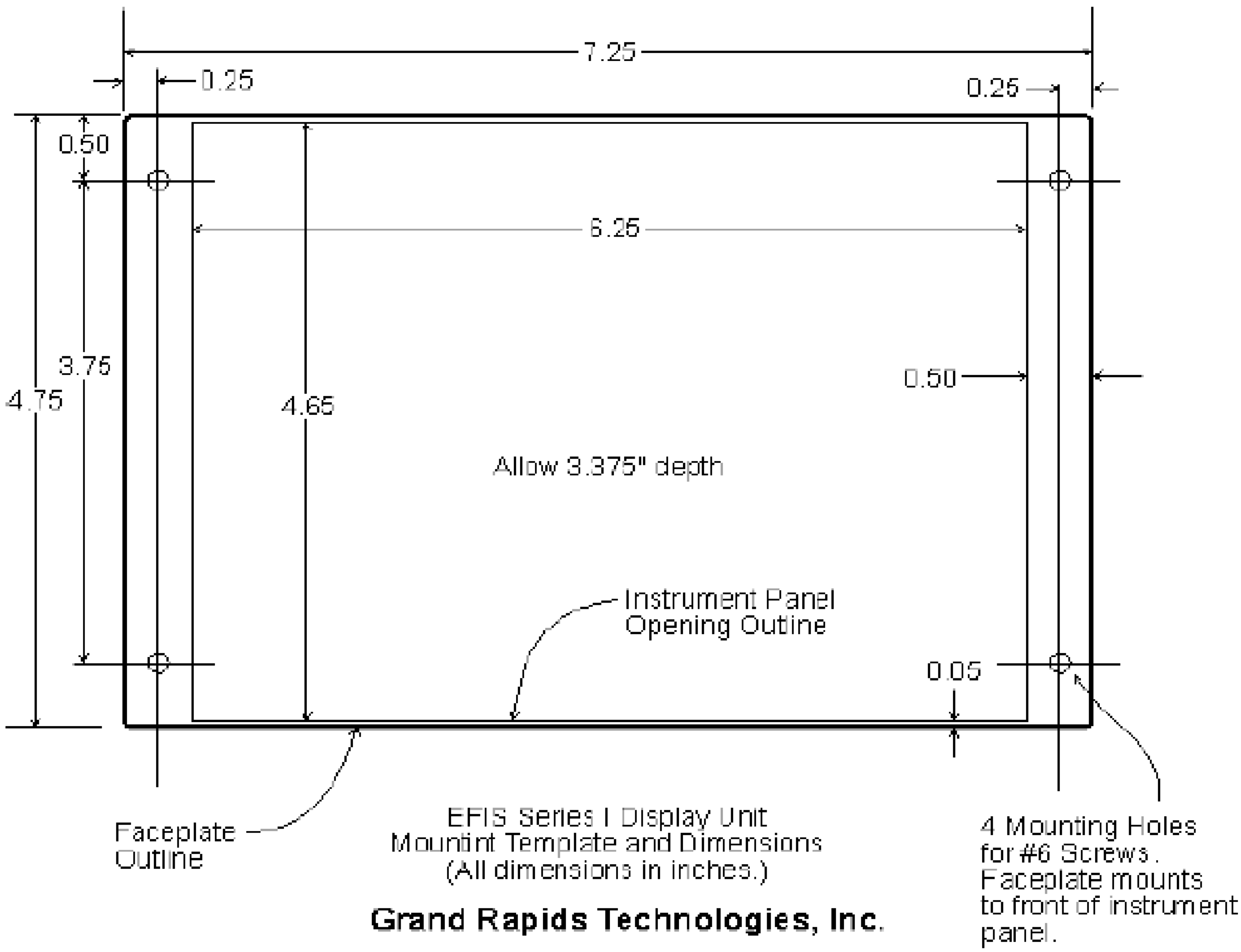


Fig. B-1 Standard EFIS Horizon

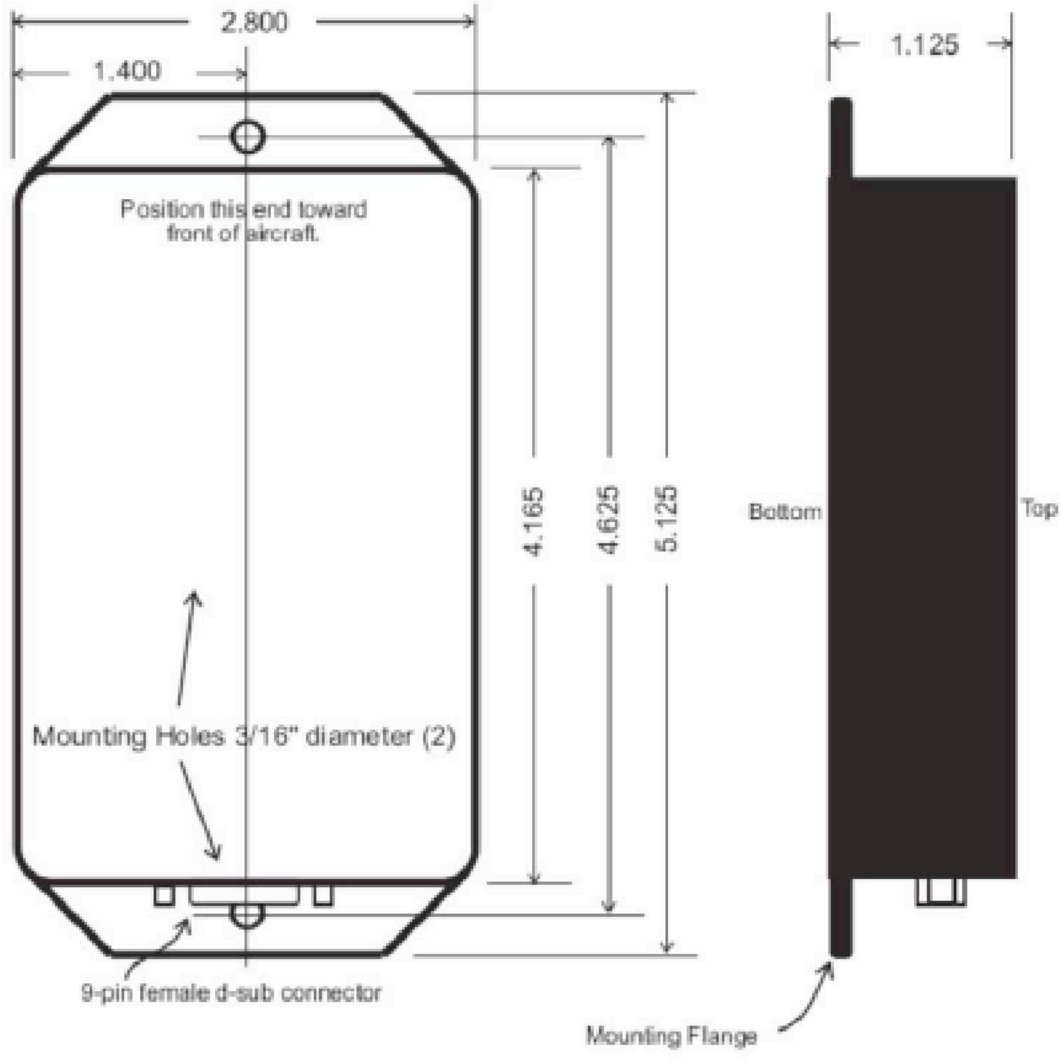


Fig. B -2 Magnetometer

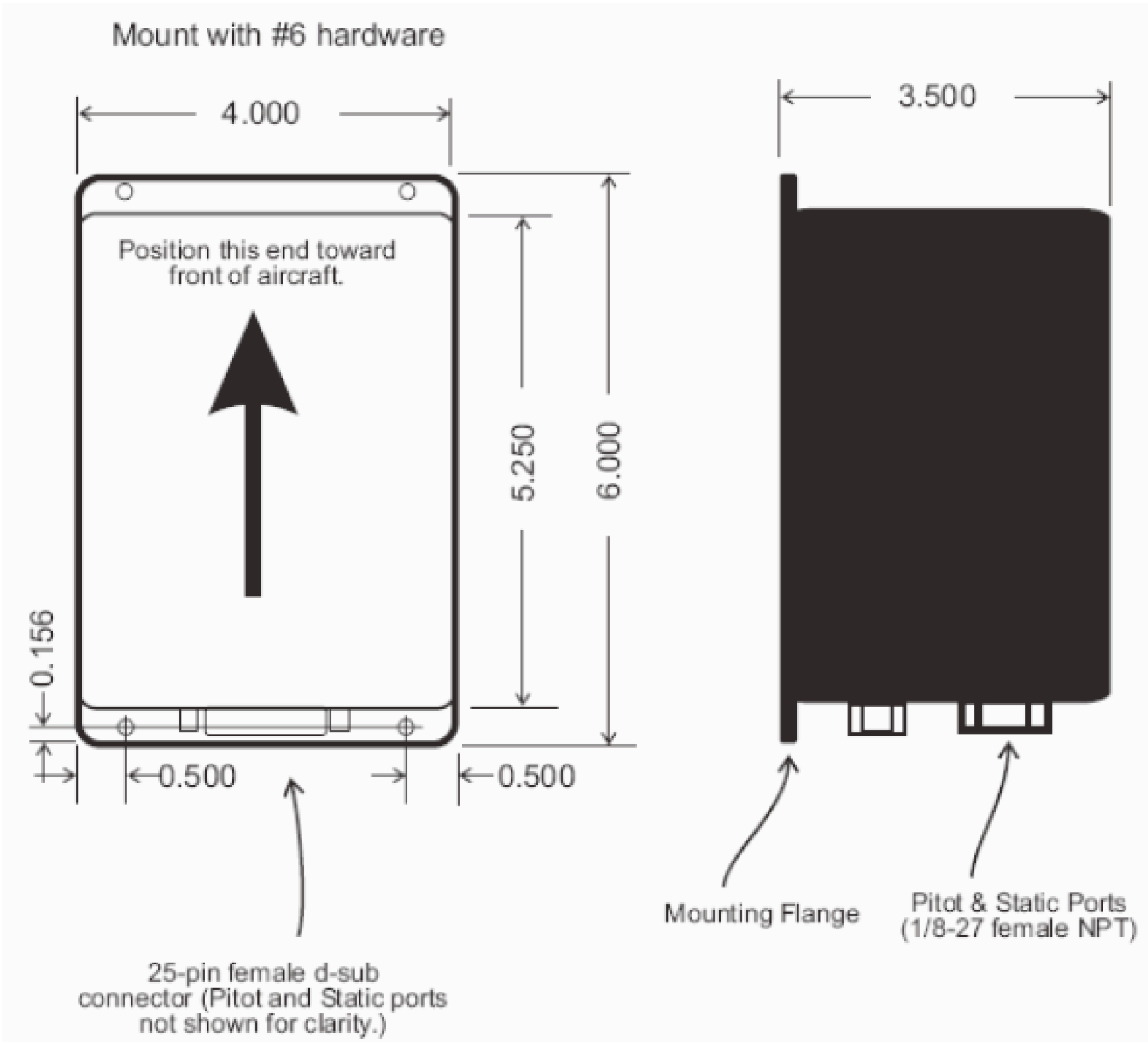

Mount with #6 hardware
4.000
3.500
Position this end toward
front of aircraft.
5.250
6.000
0.156
0.500
0.500
Mounting Flange
Pitot & Static Ports
(1/8-27 female NPT)
25-pin female d-sub
connector (Pitot and Static ports
not shown for clarity.)

Fig. B-3 ARHS

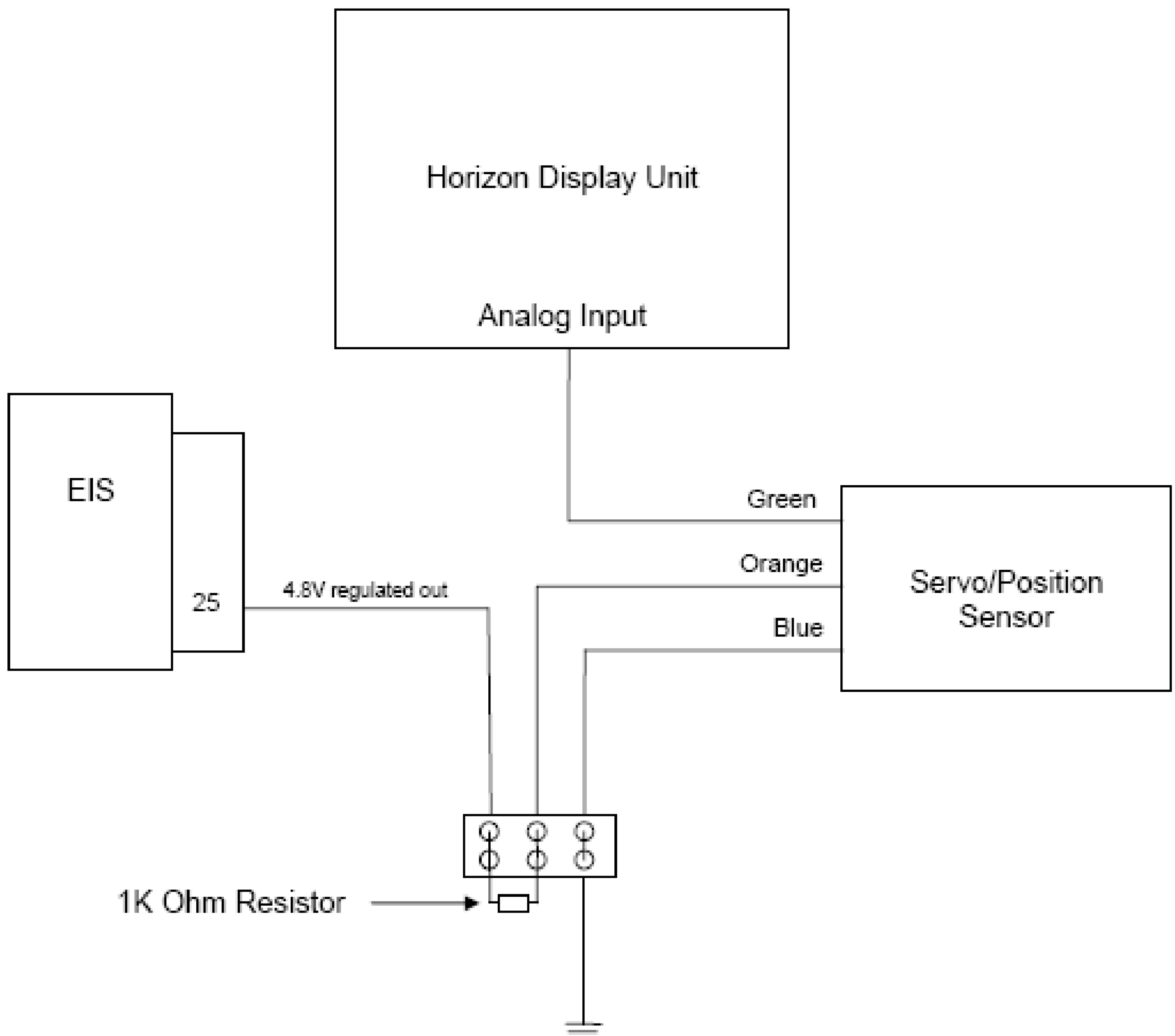


Fig B-4 Servo/Position
Sensor Installation Using

APPENDIX E: FAQ's

What is the difference between the EFIS Horizon and Sport?

The EFIS Horizon is built for Instrument Flight Rules (IFR) flying. It accepts a wide variety of radios, gps and autopilots. The autopilot command functions built into the EFIS Horizon allow for lateral and vertical coupling to the Digiflight II VSGV autopilot. This permits "hands-offstick" flying much like current and future technology airliners.

The EFIS Sport is much like the Horizon although tailored to the Visual Flight Rules (VFR) pilot. It accepts a Garmin SL30/40 radio exclusively and provides lateral-only autopilot commands. The AD/ARHS computer is physically inside the Sport instead of external like the Horizon The Sport has limited inter-display link features.

If you like would like to fly hard IFR with an automated cockpit your choice will likely be the EFIS Horizon. If you fly on fair weather days mostly with occasional light IFR your choice will likely be the EFIS Sport.

Why a wide format display?

The wide format of the display was chosen to allow a more natural sense of the horizon, this especially useful for low-time IFR, or VFR pilots. The wide format also is necessary to allow split screen displays, and allows for airspeed and altitude tapes to include analog and digital representations.

Why was the overall size chosen?

The overall size is such that two will fit, stacked on top of each other, in the RV and similar panels. This allows a great deal of flexibility, yet is still large enough to be easily readable.

Why not save the cost of the magnetometer, and make this optional?

Without a magnetometer, GPS data is required for calculation of attitude. Bad or loss of GPS data would cause unexpected loss of attitude data, and would reduce the integrity of the attitude data, and would reduce the performance of the GPS/AHRS cross-check.

Why not build the EIS into the EFIS for its engine monitoring functions?

The EIS provides a full time, easy-to-read display of engine data. This makes a single EFIS display unit completely practical. Without the EIS, a second EFIS display would be required to allow full time display of engine data.

Engine monitoring requires numerous connections to the engine and its sensors. Each of these connections is exposed to high levels of electrical noise, and has the potential of electrical faults introducing unexpected voltages to them. Bringing signals of this type into the EFIS has the potential for adversely affecting the EFIS, and thus reducing its integrity.

The EIS provides a convenient backup for altitude and airspeed data if desired.

For multiple display screen configurations, the EIS may be remotely mounted.

What are the limitations of the AHRS?

When flying close to the magnetic north or south poles, the AHRS must revert to using GPS track data, instead of magnetic heading data. This reduces the integrity of the AHRS calculation of attitude, and the effectiveness of its GPS/AHRS crosscheck. The EFIS will alert the pilot to this degraded mode of operation. Obviously, this is unlikely to affect most users.

In theory, it is possible for the AHRS to be affected by vibration, especially if resonances (flexibility) exist in the mounting of the EFIS to the airplane. A simple flight test is performed to check for this possibility. We have not seen this problem occur in our testing, but in theory, it is possible.

The maximum angular rates are 200 degrees/second in roll, pitch, and yaw simultaneously.

What backup instruments are recommended for a single EFIS Horizon installation?

For VFR flight, the addition of airspeed is suggested.

For IFR flight a turn coordinator, airspeed indicator, and altimeter is a minimum, but the pilot should consider their flying skills when configuring their cockpit. For dual electrical bus installations, the EIS can be equipped to serve as a backup airspeed indicator, and altimeter. This has the added benefit of automatic crosschecking against the EFIS Horizon's airspeed and altitude.

Why is the GPS database free?

Our database is based on U.S. government data, provided to us at no charge.

How often does the EFIS update the GPS map?

Our displays are gyro-stabilized, so our map moves smoothly when you turn, no matter how slowly or quickly your GPS updates. Our screens update at high rates, so everything appears smooth on our screens.no jerks or jumps. This makes a significant difference when rolling out to capture a new ground track on the moving maps, as you don't have to guess or anticipate what the map will look like at the next 1 second update.

Will a database be available for airspace outside of the United States?

Yes. The only difference regarding the database outside of the US is that it will only include airports with runways of 3000 feet or greater.

Can I use a low-cost handheld GPS with the EFIS Horizon?
Yes. Even low-cost GPS receivers include the required NMEA 0183 output.

Are EFIS settings user-selectable?
Yes. Practically all data may be displayed in your choice of units, including the barometric pressure setting, temperatures, fuel quantity, etc.

What is the most important feature of the EFIS Horizon?
The most feature of the EFIS Horizon is the high integrity AHRS that is not GPS dependent. What good are attitude data, and the EFIS, if you can't trust it?

How does this EFIS compare with the other EFIS systems?
There are 3 "levels" of differences.

- The First Level

  The obvious differences are the size and functionality.

  This size of the display unit is large enough to allow the artificial horizon to look "natural", that is, like a synthetic view of the outside world (complete with airports and obstructions), and still have room for both tapes and large digital displays of airspeed and altitude.

  At the same time, the size is is small enough to allow multiple display screens. Since each multi-function display unit can display any data (primary flight data, moving map, graphical engine data, or a split screen of any 2), the use of 2 display units provide twice as much viewable data, while at the same time, adding redundancy. This also allows for a simple means to expand your system to meet future avionics needs.

  The functions of our EFIS are extensive, including major functions such as integrated navigation/attitude displays on the wide-format primary flight display, graphical engine monitoring, moving map, and also including interfaces to the autopilot, localizer and glideslope inputs, with planned growth for weather and traffic.

  Clearly the functionality and size is far beyond that provided by other manufacturer's units. The difference in architecture, that is, the ability to use multiple display units independently, vastly distinguishes us from single screen systems.

  Those familiar with commercial jets may notice a similarity between the architecture (and functionality) our equipment, and that of commercial jets. This is no accident, as the chief engineer's background included 10 years experience in the aerospace industry.

  This first level is where the functionality that results in efficient and safe automation of the cockpit is built in.

- The Second Level

  These differences are more subtle. They include such things as wide-temperature range operation, direct sunlight readability and hardware designed specifically for aircraft use. The design of this hardware is based on the design principles developed over 12 years of experience with the Engine Information System (EIS) line of engine monitoring and more than 20 years of aerospace experience. This results in a robust design that has excellent tolerance for real-world exposure to wiring errors, radio and electromagnetic fields, etc.

  By comparison, other manufactures will use displays not viewable in direct sunlight, or their system may operate only over a limited temperature range, or may be limited by low maximum angular rates, incomplete interfaces, lack of built-in test functions or data validation, and further may operate in "unconventional manners".

  This second level is the level where the quality is designed in.

- The Third Level

  These details are usually unseen, but are what distinguishes aviation equipment from non-aviation equipment. It includes not only the selection of components suitable for use in an aircraft environment, but also relies on a failure modes and effects analysis. This analysis results in design features and functions (such as built-in-test functions) that add integrity. High integrity means a low probability of an undetected failure of any of the flight critical data provided to the pilot.

  This third level is the level where safety is designed in.

  Conclusion

  In the simplest terms, the difference between us and the others is the engineering and flying experience upon which our system is designed. The EFIS Horizon Series I provides aerospace grade design, at kit plane affordable prices.

Why doesn't the EFIS include an autopilot function?
While it is possible for the EFIS to also perform an autopilot function with the addition of a control panel, and appropriate servos, we intentionally choose to interface to stand alone autopilots. A stand-alone autopilot does not use the attitude data from the EFIS, and thus is effectively another source of this data. If the autopilot was driven

from the EFIS attitude data, an undetected failure of this data would result in the autopilot following the bad data. This would make detecting the failure more difficult. While undetected attitude failure is unlikely with our system, the consequences of such a failure are potentially fatal. In effect, the autopilot serves as another source of attitude data, and a good argument could be made for choosing an autopilot over a backup attitude indicator. (A turn coordinator would still be required for IFR flight) Conversely, with the independent autopilot and EFIS attitude combination we have chosen, a failure of either the autopilot, or the EFIS attitude data would result in an obvious disagreement, and could trigger an EFIS unusual attitude warning. Safety is greatly enhanced.

Also, autopilot designs are far from trivial. The safety concerns, and control laws which dictate the response of the autopilot require a degree of expertise that we feel is best left to the experts.

Why do you recommend the TruTrak autopilots?

We felt the design of the TruTrak was excellent in terms of safety, and performance. We especially liked the safety considerations in the design of the servos. More obvious to the pilot, the control laws are based on the extensive experience of the designer, Jim Younkin, which result in excellent performance in smooth air or turbulence. In the same way that we have developed extensive experience in instrumentation, TruTrak has extensive experience in autopilots.

Other autopilots work well with the Horizon also. Some may require a GPS-coupler which converts the digital data to analog used by the autopilot.

What will be your policy on revisions to the software and hardware systems?

Software updates are available via the www.grtavionics.com website at no cost. We do not have a policy for hardware revisions.

Can non-TSO instruments be approved for IFR flight in an experimental aircraft?

Yes.

What provides the land and airspace data (database)?

We have our own database derived from US government databases.

Is the HITS offset on the screen because you are crabbed for wind?

Yes, exactly. It "grows" up and out of the runway, which is obviously a ground-based reference. The primary flight display is shown in Heading Up mode, which is the preferred mode, as this makes the view on the EFIS match the view out the window. Thus, the difference between the heading up centered display and the ground-based runway guidance is the crab angle. This means that the approach is flown by maneuvering the airplane so that the flight path marker (which represents your path through space) is centered in the HITS. Even without the flight path marker displayed, interpreting the HITS is very natural, as it is identical to the visual clues you use when you look out the window and fly the airplane to the runway in the presence of a cross-wind. You instinctively develop a sense of the direction of travel of the airplane through space when you look out the window, and the flight path marker is a precise indication of this point. The flight path marker is commonly used on head-up displays in fighter aircraft.

If so, what happens if the wind is stronger - does the HITS go off screen?

It would, except that we apply "display limiting". This means we alter the position of all ground based symbology to keep the HITS and runway on the screen.

What is the sight picture if you are doing a circling approach or a close in base leg?

You see the HITS as though it was a tunnel projected up from the ground. The HITS will not appear on the screen if it is out of view, unless it is out of view due to a strong-cross wind. We will be adding guidance to bring you to the top of the HITS so that we guide you to the vicinity of the airport, and then provide steering to get you to top of the HITS. This is not trivial however.

Does the EFIS have a "Quick Erect" function?

No. The only reason to have such a function is if the attitude information was to sometimes become corrupted. The attitude data provided by our system is of very high integrity, and there is no need for a "quick-erect" function. Note that even if the airplane is continuously performing turns and/or aerobatics, the attitude data will remain accurate.

What happens if the AHRS is turned off in flight?

It would be unusual to turn off the AHRS in flight, as it is the primary source of attitude data. If it is turned off, the airplane must be flown as steady as possible for the first 10 seconds after power is re-applied. The plane can then be flown in any manner, and the AHRS will begin providing attitude data within a minute or two.

APPENDIX F: TROUBLESHOOTING

The Troubleshooting section gives aid to common installation or use questions.

Terrain

If the EFIS Horizon is unable to show Terrain data you may see one or more of these flags. This list will help in correcting in the Terrain data being displayed or not.

- DISABLED -- Terrain was disabled in the SET MENU but is still selected on the SHOW button.
- NOT READY -- The display is busy loading other databases.
- Waiting for USB -- The display did not find terrain on a flash card, and is waiting for a USB flash drive to be inserted. A USB flash drive may take up to a minute to be detected.
- No database -- A terrain database was not found on any storage device. The display will stop searching until the next boot.
- Loading --The terrain database integrity is being checked and the index is being loaded into memory. The time this requires depends on the size of the database and how busy the display is. The terrain will start up faster while on the Power Up and MAP pages.
- OK -- The terrain database has completed loading. Terrain will be drawn and the terrain alarm activated if requested.
- Low memory -- Some part of the terrain database was not able to load because the display is low on memory. This message should not normally be seen, but is possible if several memory intense features are all active at the same time. Weather, terrain, large map ranges, and DEMO recording can consume large amounts of memory. The display will attempt to use any parts of the terrain that could be loaded. Report this message to GRT.
- Bad database --The terrain database has been damaged or is not compatible with the display software.
- ERROR -- The display has detected a failure in its terrain processing and has disabled all terrain functions. Terrain will not be available until the next boot. Report this message to GRT.

AHRS/Magnetometer-Com Interference

Most problems encountered with attitude or heading after installation is the placement of the ARHS and Magnetometer near ferrous metals or com coax cables. Most of these problems can be avoided if the Installation Guide is followed.

Wire bundles from the AHRS or magnetometer must be kept away from com coax cables. It is suggested to run com coax on one side of the fuselage and ARHS/Mag wire bundles on the other. If the coax must pass by the wire bundles it is suggested that it be made perpendicular to the wire bundle.

See ARHS and Magnetometer Installation Guide for more detail.

OAT

If an Engine Information System is used connect the OAT sensor to the EIS. If the EIS is not used the OAT sensor must be connected to the Air Data/AHRS.

APPENDIX G: FACTOIDS

Below are facts which were cluttering the manual, but I didn't want to throw the facts away.

Rules for NAV Mode

1. If the EFIS Horizon detects an ILS frequency has been tuned, but is unable to determine the inbound course, a caution message, Set Inbound Course, will be displayed on the EHSI page.
2. If the GPS flight plan or synthetic approach indicates the runway being used, and the database has the ILS frequency for this runway, the ARM will be available, but attempting to ARM will generate the message TUNE LOC to XXX.X.
3. If the NAV mode is GPS at the time an ILS frequency is tuned, a second course pointer is displayed, in white, on the EHSI, allowing the localizer course to be pre-set. (The GPS course pointer is being driven by GPS flight plan data.)
4. If the NAV mode is VOR at the time the ILS frequency is tuned, the EFIS Horizon will pre-set its internal ILS course pointer. Since the selected course knob on the EHSI is being used for the VOR, the ILS course may not be pre-set by the pilot without changing the NAV mode to LOC.
5. If the EFIS Horizon detects that the ILS frequency is flagged, the EHSI course is reset to its previous, non-localizer course.
6. The [LOC-REV] selection is provided for flying localizer back course approaches.
7. The selection will reverse the sense of the LOC deviations displayed on the PFD and MAP EHSI pages, and commands to the autopilot, so that the localizer sensing appears as it does on a front course. This eliminates the need to mentally reverse the localizer sense.

Rules for Synthetic Approach Mode

Lateral steering for the synthetic approach is constructed by the EFIS Horizon according to the following list, in order of priority.

1. If an approach has been selected on the GPS, the synthetic approach path will match the course into the runway waypoint. (An approach is a flight plan that includes guidance to the runway, and will include a runway waypoint, such as RW25.)
2. If no approach has been selected on the GPS, but the last waypoint in the flight plan is an airport, the pilot will be prompted to select the runway. If the runway includes a localizer in the EFIS Horizon database, then the approach will be constructed to mimic the localizer, otherwise it will be constructed to follow the extended runway centerline
3. If no approach has been selected, and the last waypoint in the GPS flight plan is not an airport, the synthetic approach is not available.
4. If the selected runway includes an associated localizer in the EFIS Horizon navigation database, the message Synthetic Approach using LOC Course will be provided to remind the pilot that the approach will follow the localizer, and my not necessarily be aligned with the runway centerline.
5. If the approach mode is selected, but the GPS flight plan does not contain an approach or an airport as the last waypoint that can be matched to the EFIS Horizon database, then the synthetic approach cannot be activated. The EFIS Horizon will respond with a message No Airport found for Synthetic App, and the approach mode will be turned off.

Transitioning from Enroute to Synthetic Approach

If an approach has been selected in the GPS flight plan, the transition from enroute to a path that aligns the airplane with the runway will be inherent in the GPS flight plan.

The synthetic approach will be considered captured (causing the synthetic approach HITS to be displayed, and enabling vertical guidance to the runway) when the airplane is within 2.5 degrees of the synthetic approach course, and within 20 nm of the runway threshold, emulating the typical capture of a localizer. If no approach has been selected on the GPS flight plan, the EFIS Horizon will override the GPS flight plan or HDG selection to turn the airplane onto the extended runway centerline.

This will typically occur when the airplane is within 2.5 degrees of the extended runway centerline, and within 20 nm of the runway threshold.

A message **Synthetic Approach Captured** will be displayed when this transition occurs, and the GPS CDI, Autopilot and course indicator will then be driven by the synthetic approach.

Automatic Runway Selection

If an approach has been selected in the GPS flight plan, and the EFIS Horizon is able to determine the airport and runway for this approach, a message will be generated confirming the runway selected by the GPS approach was identified (For example, Synthetic App using 26L at KGRR). The selected runway will blink yellow on the MAP page.

Manual Runway Selection

If an approach has not been selected on the GPS, the last waypoint in the flight plan must be an airport. The EFIS Horizon will then provide a list of the available runways. The desired runway is selected using the left knob. This list shows the runway identifier, the length, surface (hard or soft), lighting, and crosswind component.

The crosswind component is shown as X-Wind = speed L/R, where the speed is in the units selected on the EFIS Horizon, and the L/R indicates a left or right crosswind, such that a left crosswind indicates the wind is blowing from left to right when on the approach.

The EFIS Horizon will list the runways in order of how closely aligned they are with the calculated wind direction. *To find the unit serial numbers select the PIC Calibration Data to find Serial Number.*

APPENDIX H: WIRING LIST AND PORT SETTINGS

by Mike Casey

20061129

Display Unit 1 (with ARINC-429 Module) Connector A 25-pin Female

Function	General Setup (1)	Pin	Color	Comments
Inter-Display Link	(Change to activate menu)(2)			
ARINC Module Connected	Yes			
ARINC Receive Rate	Low			ARINC module is
ARINC Transmit Rate	Low			connected to autopilot.
ARINC Input Counter				
Serial Port 1 Rate	9600			
Serial Port 1 Input	SL30-1	20		SL/30 Nav/Com, Pin #5
Serial Port 1 Output	SL30-1	2		SL/30 Nav/Com, Pin #4
Serial Port 1 Input Counter				
Serial Port 2 Rate	115200			Weather must be connected to I/O
Serial Port 2 Input	Weather	19	Yellow	port 2, all other I/O is optional.
Serial Port 2 Output	Off	4		
Serial Port 2 Input Counter				
Serial Port 3 Rate	19200			
Serial Port 3 Input	Display-Unit Link	23	White	Connects to D.U. 2 Pin 25
Serial Port 3 Output	Display-Unit Link	25	Black/Yellow	Connects to D.U. 2 Pin 23
Serial Port 3 Input Counter				
Serial Port 4 Rate	9600			
Serial Port 4 Input	EIS/Engine Monitor	21	Green/Black	EIS Pin 11
Serial Port 4 Output	Fuel/Air Data Z Format	5		Conntects to GTX 327
Serial Port 4 Input Counter				Transponder, Pin #19
Serial Port 5 Rate	9600			
Serial Port 5 Input	NMEA0183 GPS2/Global Positioning	22	Gray/Red	Lowrance 2000C GPS
Serial Port 5 Output	Autopilot (NMEA0183)	3		TruTrak DigiFlight II VSGV, Pin #17
Serial Port 5 Input Counter				
Serial Port 6 Rate	19200			
Serial Port 6 Input	AHRS/Air Data Computer	24	Yellow	
Serial Port 6 Output	AHRS/Air Data Computer	1	Brown	
Serial Port 6 Input Counter				
Primary Power Input		14	Red	
Secondary Power Input		15		
Third Power Input		16		
Ground		17	Black	

Display Unit 2 (with Weather and GPS Modules) Connector A 25-pin Female

Function	General Setup (1)	Pin	Color	Comments
Inter-Display Link	(Change to activate menu)(3)			
ARINC Module Connected	NO			
Serial Port 1 Rate	4800			
Serial Port 1 Input	NEMA0183GPS1/Global Positioning			Internal GPS
Serial Port 1 Output	NEMA0183GPS1 Configuration			
Serial Port 1 Input Counter				
Serial Port 2 Rate	115200			
Serial Port 2 Input	Weather	19	Yellow	Weather must be connected to I/O
Serial Port 2 Output	Weather	4	Brown	port 2, all other I/O is optional.
Serial Port 2 Input Counter				
Serial Port 3 Rate	19200			
Serial Port 3 Input	Display-Unit Link	23	Black/Yellow	Connects to D.U. 1 Pin 25
Serial Port 3 Output	Display-Unit Link	25	White	Connects to D.U. 1 Pin 23
Serial Port 3 Input Counter				
Serial Port 4 Rate	9600			
Serial Port 4 Input	EIS/Engine Monitor	21	White	
Serial Port 4 Output	Off	5		
Serial Port 4 Input Counter				
Serial Port 5 Rate	9600			
Serial Port 5 Input	SL30-1	22	Gray Red	SL/30 Nav/Com, Pin #5
Serial Port 5 Output	Off	3		
Serial Port 5 Input Counter				
Serial Port 6 Rate	19200			
Serial Port 6 Input	AHRS/Air Data Computer	24	Yellow	
Serial Port 6 Output	Off	1		
Serial Port 6 Input Counter				
Primary Power Input		14	Red	
Secondary Power Input		15		
Third Power Input		16		
Ground		17	Black	
Uninterrupted Battery for GPS clock (optional)		18		See Note 4

Note 1: Access via [Set Menu]/General Setup
Note 2: Inter-Display Link ID (Primary), Compare Limits (Yes)
Note 3: Inter-Display Link ID (Auto(2)), Compare Limits (Yes), Send GPS Data (Yes)
Note 4: Without this power, when the unit powers up the time set will be UTC from the GPS.
With power the user can set local time and the system will maintain local time even when the power is off.
Connect direct to battery with 10K Ohm resistor in series and fuse with 1A fuse.
Draws just mA of power, the same as the clock in your car.

Nine pin connector on EFIS

Pin 5 A output to Trutrak A input
Pin 9 B output to Trutrak B Input

Pin 1 A input
Pin 2 B input

On the EFIS ARINC 9 pin connector I suggest that you connect pin 1 to pin 5 and pin 2 to pin 9.
This connects the output to the input which will enable the input counter. By looking at the input counter you can see if there is ARINC data output. Great for trouble shooting.

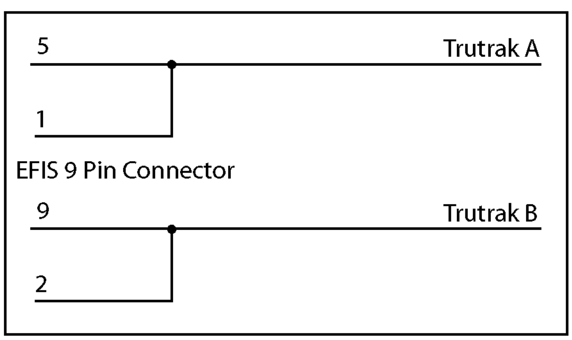
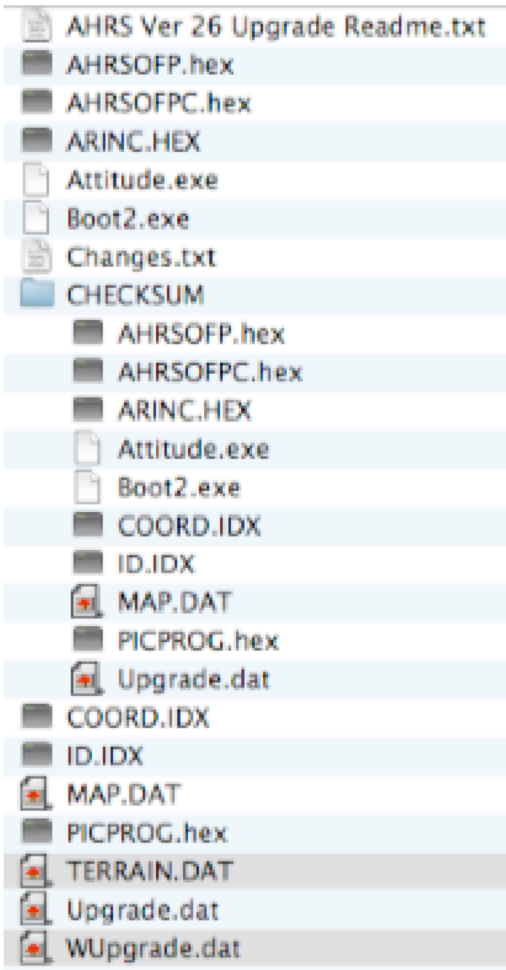


Figure I.1

Software Updates

Download the software updates from the Grand Rapids Technology web site and move the updates onto the USB memory stick furnished by GRT.



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When you download the EFIS software update, it may be in a folder. Remove all the items from the root folder and place them directly onto the USB memory stick as shown above.
Note: leave all the CHECKSUM items in the CHECKSUM folder as shown.
In the above example I also downloaded:
(Terrain 48 States - USA data) and changed the name to TERRAIN.DAT
And ((WS) Weather module version 2 (2007-08-31)) which was already named WUpgrade.dat

Some things to note:
My aircraft has two EFIS display units.
Unit 1 contains the terrain database memory card.
Unit 2 contains a GPS and a Weather module.
You will need to load the new EFIS software into both units 1 and 2.
The Terrain software will only need to be loaded into Unit 1
The Weather upgrade will only need to be loaded into Unit 2.
Any GPS upgrade was taken care of when you update the EFIS software.

Loading Updates

Insert the USB memory stick into the display unit to be updated.
Go to the [Settings Menu] and select [Display Unit Maintenance].

Use [Load EFIS Software] to update the new EFIS software

Use [Copy Terrain Database] to update the Terrain data.

Use [Weather Status] then [Software Update] to update the Weather module.

GLOSSARY

by Mike Casey

ADC	Air Data Computer
AHRS	Attitude Heading Reference System
AOG	Aircraft On Ground
ARINC-429	Aeronautical Radio Incorporated standard for data communications within an aircraft.
ASCII	American Standard Code for Information Interchange
Button	Button (the 5 white keys)
CDI	Course Deviation Indicator
CTAF	Common Traffic Advisory Frequency
EFIS	Electronic Flight Instrument System
EHSI	Electronic Horizontal Situation Indicator
EIS	Engine Instrument System
FPM	Flight Path Marker
fpm	Climb Rate Feet Per Minute
FTM	Flight Track Marker
GPS	Global Positioning Satellite
GPSS	Global Positioning Satellite Steering
GRT	Grand Rapids Technology
HITS	Highway In The Sky (Synthetic Approach)
HSI	Horizontal Situation Indicator
Knob	Rotary Encoder (two black knobs left and right)
ILS	Instrument Landing System
mph	Miles Per Hour
NDB	NonDirectional Beacon
OROCA	Off Route Obstacle Clearance Altitude
PCL	Pilot Controlled Lighting
PFD	Primary Flight Display
RMI	Radio Magnetic Indicator
TRK	Track
Va	Design Maneuvering Speed
Vc	Design Crusing Speed
Vd	Design Diving Speed
Vf	Design Flap Speed
Vfe	Maximum Flap Extension Speed
Vne	Never-exceed Speed
Vno	Maximum Structural Cruising Speed
VOR	Vhf (Very high frequency) Omnidirectional Range navigation system
Vs	Stall Speed
Vx	Speed for Best Angle of Climb
Vy	Speed for Best Rate of Climb