Stratomaster Enigma series EFIS

Enigma, Odyssey, Voyager Explorer

Preliminary User manual

Version date 27 February 2008

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The Enigma series EFIS – general overview

The Enigma series EFIS is a hardware as well as software concept that promotes a flexible, powerful EFIS platform together will a software application system that is highly user modifiable.

As a hardware platform, the EFIS provides state of the art multi-processor based processing utilizing components chosen for absolute robustness in radiation intense environments such as found at high altitudes. This is coupled with intense low power design methods to further maximize overall system application and reliability.

The large amount of flexibility built into the base system allows the adaption of the EFIS to almost any mission and aircraft. Due to low system cost, EFIS is equally suited to microlight aircraft, gliders, rotor craft but provides enough flexibility to be utilized up to twin engined aircraft with full dual engine monitoring.

Instruments in the Enigma EFIS series

The Enigma series consists of four instruments that share common features.

Stratomaster Enigma

The smallest member of the Enigma EFIS series. It is based around a 5.7” LCD screen with a QVGA resolution screen (320 x 240 pixels). This unit features the brightest screen in the range and is particularity suited smaller aircraft operating in difficult lighting conditions.

Stratomaster Odyssey

This EFIS is based on a 10.4” high brightness and contrast screen of VGA resolution (640 x 480 pixels). In addition to all of the Enigma EFIS functions it offers interfaces such as ARINC 429 and analog navigation system inputs. Many ARINC 429 based functions are included such as ARINC based autopilot interface.

Stratomaster Voyager

(Image not yet available)

This EFIS is fully compatible with the Odyssey but is slightly smaller with a 8.4" VGA (640 x 480 pixels) screen. It is intended mainly for applications where the Odyssey is too large.

Stratomaster Explorer

(Image not yet available)

The Explorer EFIS is fully compatible with Odyssey and Voyager and also features a VGA (640 x 480 pixels) resolution screen but in 5.7" format. The main intended purpose of this instrument is to act as secondary instrument to a Voyager or Odyssey installation.

EFIS hardware platform

- Odyssey,Voyager,Explorer:

  ARM 926JE 32 bit main processor with 96K high speed static memory, 16K code and 16K data cache. 2.0 MByte very low power, fully static radiation resistant RAM – non-volatile. 96MBytes of 32 bits 100Mhz high reliability SDRAM, 1 Gbyte or more internal solid state disk (no moving parts) for file and database storage.

- Enigma:

  ARM 926JE 32 bit main processor with 16K code and 16K data cache. 8MBytes of Flash memory and 4MBytes of static, low power, radiation resistant RAM

- Odyssey,Voyager,Explorer:

  Upgradable internal solid state disk compatible with Compact Flash specification 3.0 using PIO Mode 4 high speed transfers.

- ARM 7 core processor exclusively dedicated to GPS navigation.
- ATMega128 processor responsible for data acquisition, audio synthesis and general system control and monitoring
- Odyssey,Voyager,Explorer:

  ATMega88 processor used as driver for ARINC 429 interface and A/D conversions for analog navigation system inputs (+/-150mV inputs)

- Odyssey,Voyager,Explorer:

  3 ARINC 429 receivers (normally used as 2 x normal speed and 1 x high speed receivers)

- Odyssey,Voyager,Explorer:

  1 ARINC 429 transmitter (normally used in normal speed mode for connection to autopilots supporting GPS steering)

- On-board advanced 16 channel GPS, altitude, airspeed and angle-of-attack (AOA) pressure sensors

- Transponder altitude encoder output (parallel Gillman code).
- RS232 NMEA output dedicated to autopilot interface and similar applications
- RS232 output for general purpose use, intended primarily for use with attitude sensors made by third party vendors or navigation radios (VOR,ILS,DME etc)
- Odyssey,Voyager,Explorer:

  CAN/JS1939 interface to FADEC and intelligent engine monitor and control systems
- MGL Avionics Airtalk multi master interface (2 x). Primarily intended for MGL Avionics attitude and compass sensors and system extension modules.
- Audio output for voice and sound synthesizer. High level to drive a speaker and low level for interface to aircraft intercom system
- Provision for power backup battery with built in float charging circuit to ensure long battery life
- Secured supply output for supply of critical sensors in case of main power failure
- USB device port
- USB host port (2 x)
- Low power design with wide supply voltage range. System operates from as little as 6V DC (reduced display brightness) and is suitable for 24/28V systems.
- Military quality tactile high reliability membrane keypads, easy to clean and moisture/dust proof with pressure equalization system.
- SD card slot for data transfer to and from system. Will accept MMC cards as well but these are slightly slower in operation.
- Odyssey,Voyager,Explorer:

  Ability to fully operate from SD card in case of internal solid state disk failure or when experimenting with new systems and setups without affecting installed system.
- Alarm outputs in the form of on-screen alarm messages, voice audio output, switched output (switch an external alarm light for example), alarm panel light and external alarm array output via I/O extender

EFIS software platform

This document discusses EFIS systems loaded with MGL Avionics FlightOps (tm) operating system and EFIS standard application software with standard screen layouts.

Should you be using the EFIS with third party software installed, please refer to the relevant documentation provided by the third party software developer.

Should you be using the EFIS with vendor or aircraft builder/manufacturer modified screen layouts, please refer to supplemental information supplied by these organizations or individuals.

Differences between Enigma and Odyssey/Voyager/Explorer EFIS systems

Enigma and the Odyssey based EFIS systems are nearly 100% compatible from a functionality point of view. This document may refer to functions not available in the Enigma system. The following items are not available in the Enigma system or operate significantly different:

Odyssey based instruments include a ARINC 429 interface. Enigma does not include this interface and all functions related to this interface are deleted from Enigma.

Odyssey based instruments include an analog navigation interface (input). Enigma does not include this interface and functions related to this interface have been deleted.

Odyssey based instruments include a CAN (J1939) interface. Enigma does not include this interface and functions related to this interface are deleted.

Odyssey based instruments can accept an external NMEA GPS feed if setup to accept this. Enigma cannot do this and always uses the internal GPS.

Odyssey based instruments have a full VGA resolution screen of 640 x 480 pixels. Enigma supports a QVGA screen of 320 x 240 pixels.

Odyssey based instruments feature a second 8 button keypad. Enigma does not feature this keypad and instead emulates this keypad as a menu function.

Odyssey based instruments feature two rotary controls. These are not available on Enigma. Functions related to these controls are accessible by emulation with menu functions where required.

The following document generally describes a typical Odyssey system. Keep the above limitations in mind if you are using this document with an Enigma system.

Efis capabilities with standard hardware and software

- FlightOps (tm) operating system
- Standard EFIS application software with support for user designed screen layouts
- Flexible setup with metric or imperial/US units of measure
- Altimeter -700 to 40.000 ft, 1ft dynamic resolution in flight at sea-level.
- Airspeed 16mph to 250mph, 1mph resolution. Other ranges for special applications available
- Vertical speed +/-2000ft/min analog range, +/-10.000ft/min digital range. Fast response suitable for gliders
- Total energy compensated vertical speed indicator (in addition to normal indicator) without requirement for additional pressure compensation ports
- VSI/TE VSI history moving data display for thermaling and soaring

- Velocity vector display
- Altitude encoder output (parallel gillman code) for mode-C transponders
- NMEA autopilot output (9600 baud, RS232, messages RMB,RMC,GGA)
- Airtalk link support for optional SP-3,SP-4,SP-5 AHRS systems and SP-1,SP-2 compass modules. Airtalk link also used to share data in multipanel mode systems
- Multi-Panel support. Connect two or more EFIS instruments via USB to form a networked multi panel MFD system while gaining full redundancy for mission critical applications. Also supports other compatible instruments such as Enigma and Voyager either as master or slave panels.
- Support for Stratomaster Ultra as secondary instrument (Ultra uses data from EFIS)
- Engine monitoring support by means of one or two RDAC units. RDAC units can be used for either two engines or combined for engines that require a large amount of monitoring channels. Provision to use CAN/JS1939 based FADEC and engine monitoring systems.
- With two RDAC units maximum monitoring capability is: 24 channels of EGT/CHT thermocouples, six channels for NTC temperature probes (coolant, oil temperature, Rotax 912 CHT), 2 channels oil pressure, 2 fuel flows, 4 fuel tank levels, 2 RPM monitors. Further support for fuel pressure and carburetor temperature monitoring
- Rotor craft support, separate rotor RPM input not reliant on RDAC units
- Support for optional Airtalk I/O extender for monitoring of flap, gear and trim and similar items, both switched (on/off) as well as analog inputs (value). Outputs to switch various alarm type indicators
- Support for optional Airtalk battery current monitor to measure charge/discharge currents
- GPS based navigation engine with large capacity waypoint/airfield database (up to 50.000 waypoints). Active waypoint management during flight, the closest waypoints are always at hand without need to search for them.
- Support for different airfield types, intersections, altitude change waypoints (vertical navigation), navaids etc
- Moving map support using actual raster maps as backdrop. Ability to use any digital map image including scanned images. Full support for user created maps using Windows PC based Mapmaker software package. Degree tile based raster map file format for seamless map coverage
- Moving map support for vector based database format, in combination with raster image backdrop maps or terrain elevation data
- Install both raster and vector maps for a given area and switch between the two at any time
- Sensor fusion navigation concept. Use and switch between a multitude of navigation

systems with ease:

  - +/-150 analog input CDI/GSI external GPS/VOR/ILS
  - ARINC 429 based external GPS/VOR/ILS
  - RS232 based external GPS/VOR/ILS Nav radios
  - GVOR (GPS only implementation of VOR – no nav radio required)
  - GLS (GPS only implementation of ILS)
  - Heading and altitude bugs
- 3D Highway in the sky navigation (HITS)
- 3D runway depiction with runways defined in airport data base
- 3D GLS approach using HITS technology to show glide slope to threshold in 3D
- Terrain awareness monitoring (TAWS)
- Forward looking 3D terrain geographically aligned mesh views
- Airspace monitoring and alerts
- Comprehensive, graphical weight and balance calculator, highly customizable
- Traffic monitoring with visual map displays and audio alerts
  - TCAS via high speed ARINC 429 (ARINC 735 compatible)
  - TIS via high speed ARINC 429 (ARINC 735 compatible)
  - PCAS using XRX passive transponder signal monitoring via RS232
  - FLARM active short range transponder based traffic monitoring via RS232
- Autopilot interface via RS232 NMEA and ARINC 429 (GPS steering). Ability to use currently selected CDI/GSI source in GPS NMEA messages allowing GPS enabled autopilots to follow VOR, ILS (Localizer and glide slope) including GPS based VOR and ILS emulations.
- Highly flexible setup options specifying operational details of almost any conceivable item in the system including user defined screen designs (using EFIS simulator and screen designer). Highly flexible engine monitoring giving ability to monitor any power plant in existence including but not limited to: Piston engines – two, four stroke including heavy fuel engines. Turbine engines including jet engines.

GPS navigation system

EFIS contains a built in GPS receiver with an external, active antenna.
The GPS system is of highest, state of the art quality and provides the following features:

- Antaris-4 GPS engine optimized for operation under compromised conditions such as limited satellite visibility and multipath reception

- 16 channels with 8192 search bins for very fast time to first fix
- Up to 4 position fixes per second
- SBAS support (WAAS and EGNOS)
- RAIM with FDE (fault detection and exclusion)

Principles of GPS SBAS operation

EFISs SBAS (Satellite based augmentation system) supports WAAS (Wide area augmentation system) and EGNOS (European Geostationary navigation overlay system).

Implementation conforms to RTCA/DO-229C, class beta-1 equipment, timeouts as per en-route case.

SBAS is used to improve the accuracy of the navigation solution by providing the GPS receiver information on current errors so these can be corrected for. SBAS is not available globally but depends on coverage by additional satellite systems.

EFIS provides a GPS setup where SBAS can be switched off if required.

Principles of GPS RAIM operation

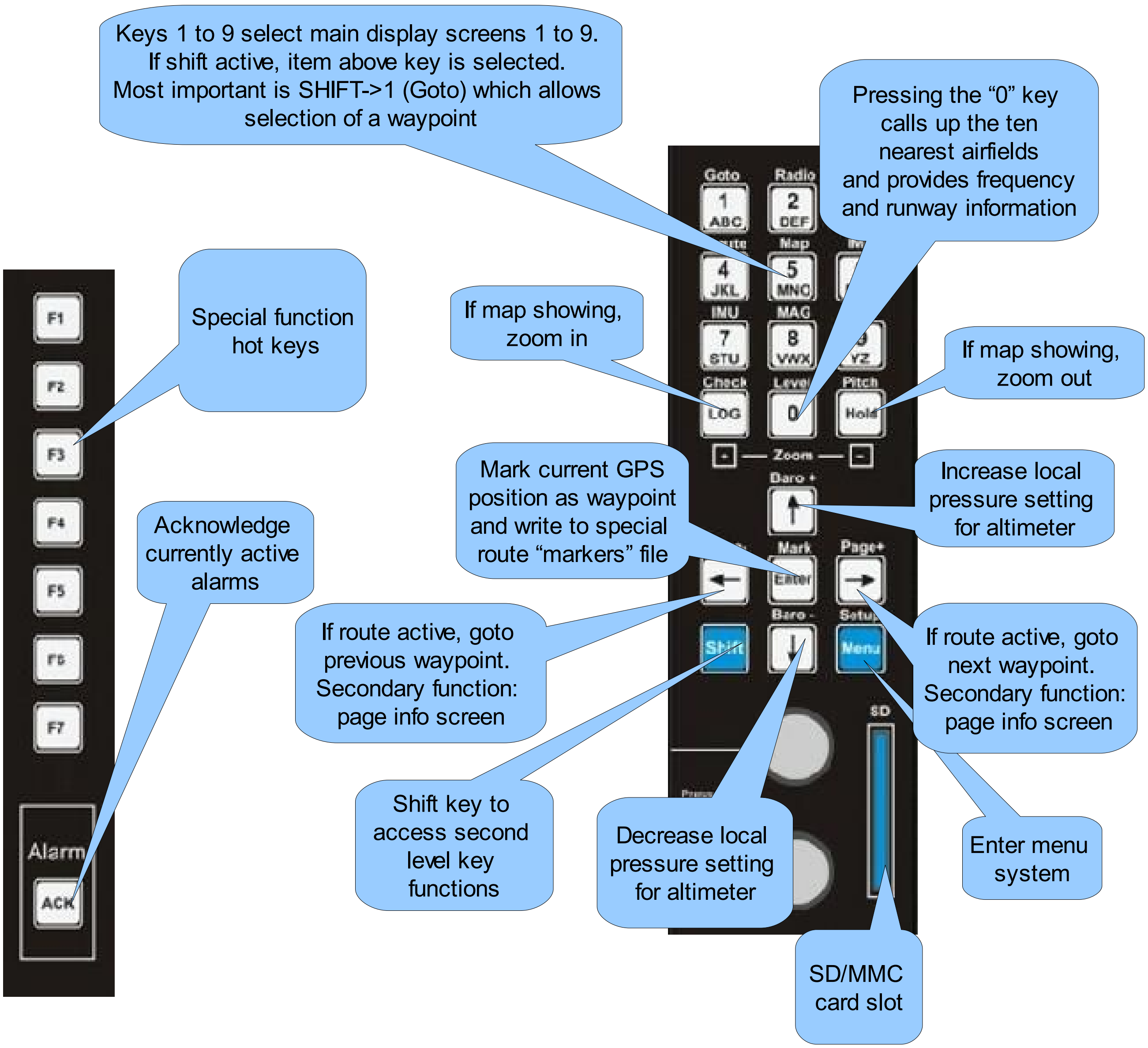
RAIM is a system used to improve GPS integrity with respect to incorrect or corrupted signals transmitted by GPS satellites. The RAIM system employed follows common guidelines as set out for TSO'd GPS receivers:

Four or more satellites are required for a 3D fix. If a minimum of five satellites are available for a navigation solution a bad satellite can be detected. If a minimum of six satellites are available a bad satellite can be detected and eliminated from the solution (FDE) .

In EFIS, RAIM is always enabled and is subject to operation based on acceptable DOP geometry and sufficient satellite visibility.

Using the EFIS keypad

The intention behind keypad usage is to minimize pilot interaction with the EFIS during flight. For this reason, key presses are kept to a minimum and functions are arranged such that access is fast and uncomplicated. The graphic below shows basic key usage whenever one of the nine main display screens is showing. The only time this schema does not apply is when you have activated one of the menus.



Items on the main screen

Your EFIS supports up to nine screens. Each of these screens is fully user programmable, if desired starting from a blank screen. This is done using the Windows PC based EFIS screen designer and simulator. Using this program, you can choose from hundreds of instruments and display items and arrange these as you require, influencing operational details, appearance and size. You may also modify the pre-made screens that the EFIS ships with to change them to your requirements.

Typically, one of your first tasks is to design your engine monitoring requirement. This is usually done by modifying the standard engine monitoring part of a supplied default screen. For example, you may need to modify the number of EGT and CHT channels, perhaps add a second fuel tank level monitor. You can also select from a number of pre-made engine monitoring screens found on your EFIS DVD.

Screen file organization

Each screen may be built up from up to three separate areas. These are referred to as “Flight”, “Engine” and “Info” Each screen may have all of these or none (in which case the screen is blank). Each screen may have up to six info areas which can be paged using the left/right arrow keys. At a minimum, a screen has a single area. This may be any type. Despite the naming of the areas, any area may contain any possible instrument or display item for unlimited flexibility.

The term “area” is used loosely. While the standard screens split the display into areas, this is completely arbitrary and areas may overlap in any way you like.

Example, standard screen

This is the standard EFIS screen used as screen 1 as shipped with a new EFIS. Please note that it is possible for a distributor or aircraft installer to change or modify this as may be required.

Each of the three areas is defined in a single, small file created by the EFIS screen designer. The file contains descriptors for each item contained in this part of the screen. Such a descriptor may for example define a circular (arc) indicator of a certain size and configuration and attached to a certain value, for example oil temperature.

Designing or modifying screens is a simple process that is quick and easy, no specialist programming knowledge is required but it does require that you have a good idea what you want your EFIS to display !

Flight area
Filename: Flight1.efm

Info area
Filename: Info1a.eim

Engine area
Filename: Engine1.eem

Copying screen designs from one of the 9 possible screens to another is a simple matter of renaming the screen files. For example, to copy the engine part of the above screen to screen number 5, copy the file Engine1.eem to Engine5.eem.

Organization of screen files

Screen files contain information describing position and attributes of the instruments and display items they contain.

The filename of a screen file dictates which of the display screens the file will be used on. By renaming the file, you can move the file to another screen.

In keeping with the three possible areas per screen, the filenames are called “FlightN.efm”, “EngineN.eem” and “InfoNM.eim”. Replace “N” with a number 1-9 to indicate the screen to use for the file. For the info file replace “M” with a,b,c,d,e or f to indicate the info file sequence (you can have up to six info areas per screen).

Screen file locations on disk:

Screen files located on the internal solid state disk reside in the “Screens” folder. This folder includes all screen files and the splash screen.

If an external SD card system is used, all screen files are located on the SD card root folder. If SD card is used to hold the system, no folders are used, all files are installed in the root.

Enigma does not implement folders. All internal files reside in the root folder.

EFIS built in disk drives

Your EFIS has two built in disk drives. Both are solid state disks without moving parts. The disks differ in storage technology and are used accordingly. Further to this, the SD/MMC card represents a further removable disk.

Disk C: SD/MMC card slot

Disk D: 2 Mbyte battery backed RAM disk, unlimited write cycles. Enigma: 1MByte Disk.

Disk E: High speed Compact Flash drive. Typical capacity: 1GByte. Larger capacities are supported if required. Please see section on compatible Flash Drives and formating of these drives for use with EFIS.
Note: Enigma does not have an internal CF drive. It uses the SD card Disk C for storage of large files such as maps. Disk E does not exist on Enigma.

Disk F: USB Flash drive. Future use, not supported with current software release.

EFIS uses the Flash disk to store the following files:

- Flight*.efm -Enigma format screen file (Screen folder)
- Engine*.eem -Enigma format screen file (Screen folder)
- Info*.eim -Enigma format screen file (Screen folder)
- Waypoint.ewd -Enigma format supplementary waypoint file (Navdata folder)

- Navidata.ewd -Enigma format Navigation database file (Navdata folder)
- Splash.mif -Graphic file for startup image (splash screen - Screen folder)
- MAPINDEX.MM0 -Raster map index file. (Maps folder)
- raster map files -Files similar to “N45W110B.M42 – (Maps folder)
- VMAP.EVD -World vector base map file – (Maps folder)
- *.DEM -GTOPO30 terrain data files – (Terrain folder)
- WB.DEF -Weight and balance definition file. (Other folder)
- WB.MIF -Weight and balance aircraft image. (Other folder)
- ACLSYMBL.MIF -Optional aircraft symbol for moving map large (Screen folder)
- ACSSYMBL.MIF -Optional aircraft symbol for moving map small (Screen folder)

EFIS uses the RAM disk to store the following files

- *.ert -Enigma route files (may be imported from SD card)
- Markers.ert -Special route file to store GPS positions “marker function”
- Fltlog.dat -contains up to 1000 entries of a flight folio style flight log.
- *.ecl -EFIS checklist files. RAM drive.

EFIS uses the SD/MMC card to store the following files

- Enigma.rec -Enigma “black box” data recording file

Note: The SD/MMC card may contain all of the files that are normally installed on the internal solid state disk in the root folder together with the external system file “Odyssey.emb”. If such an SD card is inserted on startup of the system, regardless of the state of the internal solid state drive, the contents of the SD card govern the software that will be loaded and executed (Odyssey.emb file contains both FlightOps operating system as well as the EFIS application). If the Odyssey.emb system is in operation, all files on the internal solid state disk are ignored and relevant files will be loaded from the SD card.

This is the normal mode of operation if the internal solid state drive is not inserted or not functional or a new system is being tested without the currently installed system requiring alterations.

Note: Enigma does not use emb files as it does not execute from an internal disk.

Obtaining and using navigation data

Your EFIS system requires a navigation database in order to fully function. The navigation database may contain items such as Waypoints, Airport information and runway information, navigation beacons, reporting points and airspace information amongst other items.

The EFIS supports two sources of data: The first and most important is the **Navidata.ewd** file. This file contains comprehensive navigation data and you will probably frequently use a new file as new navigation data is issued.

The second file that can be used optionally is the **Waypoint.ewd** file. This file contains supplementary waypoints in case you are using a subscription service for your data and you are not able to add your own, private waypoints. In this case you can create and maintain the **Waypoint.ewd** file either in the EFIS or using the Enigma Flight Planner Windows application program (free download from www.MGLAvionics.co.za).

Sources of navigation data

The EFIS supports navigation data from several sources. You can use one source at a time.

Open navigation data

This data is maintained by yourself using the Enigma Flight Planner program. Waypoint and airport data can be obtained for many areas of the World through the free service provided at www.navaid.com web site. Download data for your region in GPX format. This can be imported into the Enigma Flight Planner program. Airspace data is available for free download from the MGL Avionics data server at www.MGLAvionics.com. Download the airspaces for your region (a file named airspace.evd) and place this file into your Enigma Flight Planner "Data" folder. Once you have imported the GPX data and have created the waypoint and airport database you can export all of the information (including the airspaces) to a **Navidata.ewd** file.

Enigma Flight Planner is being extended to be able to import navigation data from additional sources.

Pocket FMS navigation database

PocketFMS provides a subscription service via their website at www.PocketFMS.com. A free Windows Flight Planning program can be downloaded and this will download navigation data such as waypoints, airport and runway information, airspaces and airport Notams. This information can be exported to a **Navidata.ewd** file. PocketFMS supports user contributed data including private airfield information and other data and features a 2 hour update cycle. PocketFMS is a good choice for subscription data for VFR and private/sport flying.

Jeppesen Navdata®

Jeppesen provides professional level navigation data which includes items such as SIDS, STARS and Holds over and above the normal VFR based information. Data is available on a 28 day update cycle via download from Jeppesen in Navidata format.

Jeppesen Navdata® is a subscription service that also allows lower cost single data downloads. Please visit the Jeppesen website at www.Jeppesen.com for more information.

Jeppesen Navdata® is the choice for professional level flight operations and it may be used in the Enigma Flight Planning program as database for flight planning and route creation.

Using the Navidata.ewd database

Place the **Navidata.ewd** file onto your SD card. Often this is the only task required – insert the card into your instrument and the database will be immediately loaded and used.

You can also install the **Navidata.ewd** file onto the EFIS's internal disk. On Enigma instruments you have around 5MBytes of space available (Early versions of Enigma may have less space). Odyssey and related instruments have a large amount of disk space available that should be more than enough for even the largest navidata files.

We recommend that you install the navidata onto the internal disk and then delete the navidata file from the SD card or use a seperate card to transfer the navidata file to your instrument.

The EFIS will always attempt to use a navidata database on the SD card if it is available. If it is not, it will try and use the internal database (if one has been installed).

Upgrading from older systems

Older application software versions of Enigma and Odyssey systems used a three way file system for the database. These files are Waypoint.ewd, Airports.ewd and Airspace.evd.

If you upgrade to Enigma 1.1.0.0 or later or Odyssey Beta 0.1.1.0 or later and you are using the old database system, please delete the three files before you start using the navidata.ewd file. You will find these files on the Enigma Flash disk or in the Odyssey “Navdata” folder on the internal solid state disk. Use the File manager on Menu level 2 (second page) to perform this task.

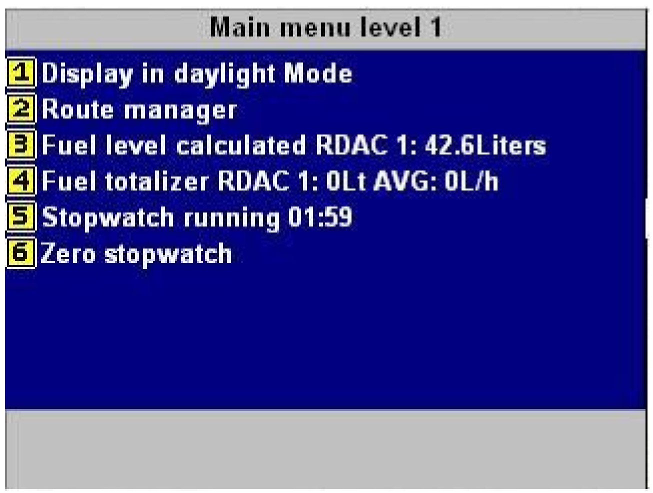
The EFIS menu system

Your EFIS features an extensive menu system that is easy to quick to navigate. Everything is logically grouped by function.

Menu functions between Enigma and Odyssey based EFIS systems are nearly identical. Items not supported are not shown in the Enigma system.

The EFIS has a two level menu system. From a main display screen, pressing Setup Menu enters the first menu level, pressing it again enters the second menu level which contains all of the setup functions. Finally, pressing the menu button again will return to the currently active display screen.

EFIS menu level 1



Display in .... mode

Select day or night mode for the display. You can setup the display backlight level for each mode in screen setup.

Start/end flight

If your system is setup for manual flight logging, this is where you start and end a flight for logging purposes. Note: we recommend you use the system in automatic flight detect mode. If you are using automatic flight detect, this menu entry will not show. Select automatic flight detect in operations setup.

Route Manager

This enters the route manager function. Here you can create new routes, edit or delete existing routes. Note that you can also use routes created by the Windows PC based Enigma Flight Planner software. Flight Planner can also import routes in various formates created by other flight planning software packages.

Please note that a special route file is reserved. This is the file “markers.rte”. This file is created automatically if it does not exist. It contains, in order, any waypoints you created using the “marker” function (Enter button, when a main display is showing).

Also note, that the “goto” function allows you to pick waypoints not only from the waypoint file but also from any route.

Fuel level calculated

Here you can enter the fuel level for a calculated (virtual tank). This requires that you have a fuel flow sender fitted and operational.

If you have two RDAC units, you can have two virtual tanks. Enable the second RDAC in engine setup. If you don't have the second RDAC enabled, the entry for the second RDAC calculated fuel level will not show.

Fuel totalizer...

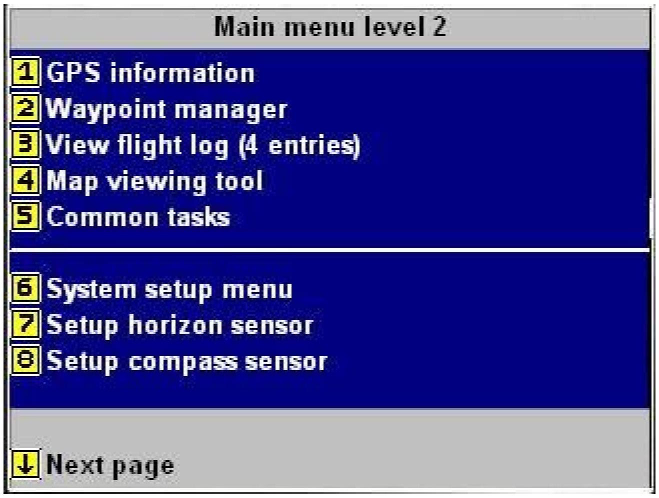
This function shows your total accumulated fuel usage since you last reset this value. The value can reset automatically at the start of a flight (operations setup) but you can reset the value at any time using this function. Further to this, the average fuel burn is calculated and shown. Average fuel burn is calculated using accumulated fuel flow and engine running time.

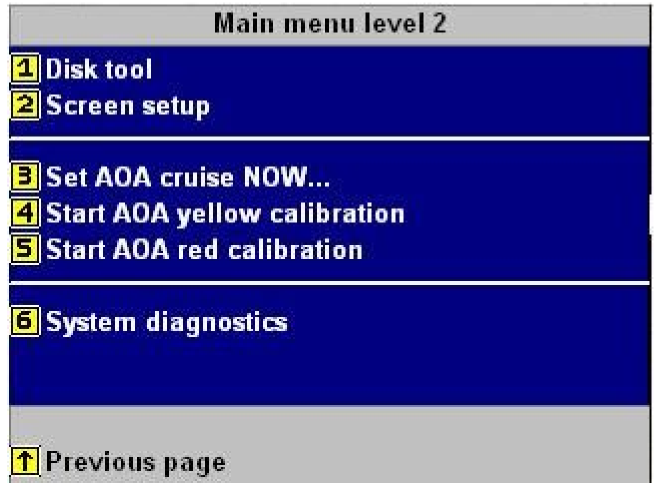
This function has an entry for each RDAC flow sender. If you do not have the second RDAC enabled the entry for the second RDAC will not show. Enable in engine setup.

Stopwatch

Here you can start or stop the built in stopwatch. You can zero the stopwatch at any time. The stopwatch is a standard EFIS component that can be placed on any screen as desired. It is common to place the stopwatch on one of the info screens.

EFIS menu level 2





GPS Information

Enter the GPS information display. Here you will find detailed information on the current GPS satellite status and diagnostics. You can also obtain sunrise and sunset times for the current date at your exact location if you have a GPS position fix.

Waypoint manager

Enter the extensive waypoint management system. Here you can view, add, delete and modify existing waypoints in the Waypoint.ewd file.

View flight log

View the flight folio flight log. This contains details of your last 1000 flights. The flightlog is stored on the RAM drive as file Fltlog.dat. Copy this file to the SD card using the disk tool if you would like to copy the flight details to the EFIS flight log program on your PC.

Map viewing tool

This tool allows you to view any available area of your maps.

Common tasks

This contains a selection of common tasks used during setup of your system.

Install tasks

This contains a selection of automated installation tasks to simplify common installation tasks such as installing waypoints, maps etc. These functions allow you to transfer files from the SD/MMC card to the internal solid state disk into the correct folder locations in an automated fashion.

System setup menu

This enters the extensive system setup menu system. This is where you setup operational details of your system.

Setup horizon sensor

Here you will find functions to setup the horizon system (AHRS or ARS). Functions in here may vary with the type of horizon system connected.

Setup compass sensor

Here you will find functions to setup your magnetic compass system.

Disk Tool

Here you will find a collection of disk related functions such as copying files or formating the internal RAM and Flash disk.

Screen setup

Setup day and night modes for the display screen.

AOA calibration items

Refer to separate AOA section in this manual.

System Diagnostics

This enters a low level system diagnostics screen that allows hardware trouble shooting. Here you can monitor raw data from the RDAC units which is helpful with detecting probe/sender problems.

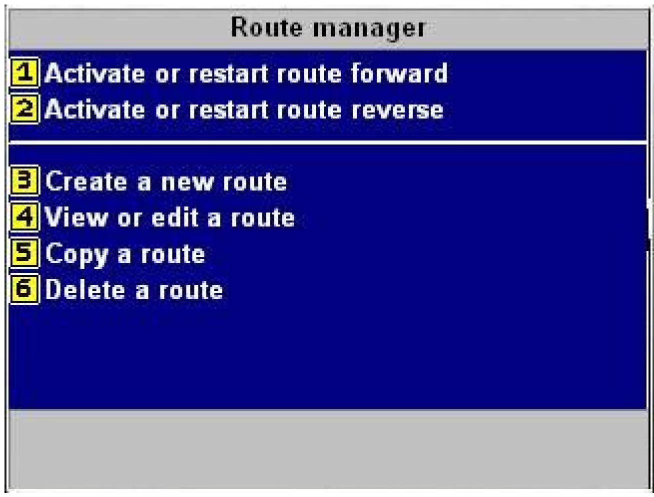
ARINC 429 diagnostics

This contains a ARINC 429 monitor system allowing you to view selected ARINC 429 labels received on any of the built bin ARINC 429 RX channels.

The Route Manager

The route manager is your central access point for creating new routes or editing existing routes. Here you also activate or stop a route.

Please note that you can access the route manager either directly via SHIFT-4 or via level 1 menu.



A route is a collection of waypoints. You need at least one waypoint for a route but in practical cases a route has several waypoints. Waypoints are placed into the route in order of travel from first to last waypoint. Routes are stored on your RAM drive and have a 1-8 character name and the extention “.rte”.

Routes can be activated in forward or reverse mode.

Routes imported via the GPX file format or RTE format may have longer names with up to 30 characters, locally created routes are limited to 8 characters.

Activate or restart route forward

This function allows you to select an existing route and activate it in the forward direction. If the route is already active, you can restart the route.

Activate or restart route reverse

This function allows you to select an existing route and activate it in the reverse direction. If the route is already active, you can restart the route.

Create a new route

Create a new, empty route. You will be prompted for the route filename. The new route will be stored on the RAM drive.

View of edit a route

This function allows you to view or edit an existing route. Here you can add waypoints, modify or delete them.

Copy a route

Create a duplicate of an existing route under a new name. One reason you may want to do this is to create a new route using an existing one as a base, perhaps with an additional waypoint.

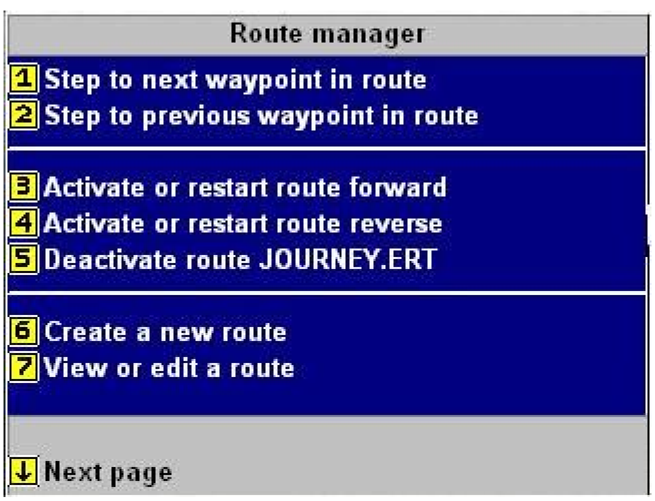
Delete a route

Delete an existing route.

Operating an active route

The image below shows the route manager with a route activated. The name of the activated route is "JOURNEY" and the corresponding route file is "Journey.rte" on the RAM drive.

You can step forwards and backwards through the route waypoints. Please note that you can also do so from any main screen using the left and right arrow buttons.

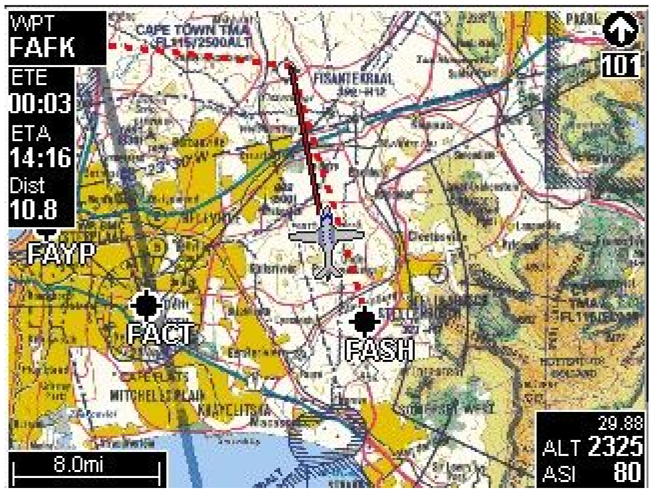


In most cases you will use manual route advance. You may also set your EFIS to advance to the next waypoint automatically. You should also setup the waypoint intercept radius. The EFIS will consider the waypoint reached when arriving inside the waypoint intercept radius. Set these options in the navigation setup menu.

When you are finished with a route, you can deactivate it.

Routes remain active until the last waypoint has been reached or until deactivation. Routes will remain active even if you remove power to your instrument. If a route is active, selecting the Goto function or activating a GLS approach (either direct or via intercept) will immediately deactivate the route.

Routes on the moving map



On the moving map the current route leg and next leg (if applicable) are shown as bold red, dotted line. The above image shows a typical view. We have a route leg from FASH to Fisantekraal with the next leg in the route slightly north of west.

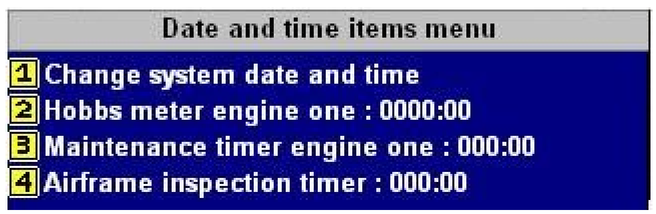
If you have set automatic route advance, as your distance to the next route point decreases to below the Waypoint intercept distance (set this in the Navigation setup, usually 2 miles), you will hear the message ”waypoint arrival” if your intercom system is connected to the EFIS audio output. At the same time a message appears showing the name of the next waypoint which is now activated. The red dotted line moves to show the new “current” leg and next leg (if possible).

Please note that you can, at any time, step forward or backwards through the route by pressing the right or left arrow buttons.

The system setup menu

The system setup menu is your most important and also most extensive menu system. Here you specify in detail how your system will operate. You will select units of measure, engine monitoring parameters, navigation related setups and many items more.

Here you set your local time and date (The EFIS's built in “real time clock”) and also your engine hobbs meter and maintenance timers. If you have a second RDAC enabled you will have two hobbs and maintenance timers.

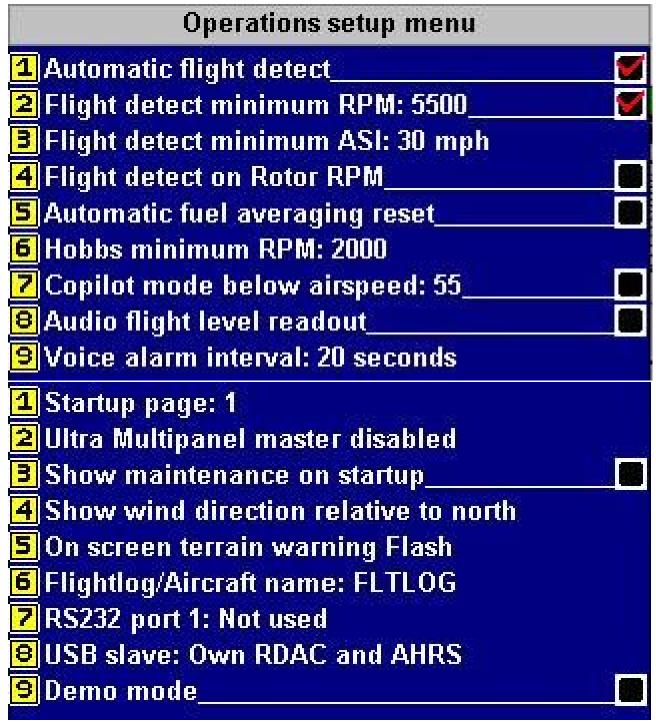


Select the units of measure for your various readouts. For example you can select to have your altitude readout in meters or feet.

Operations setup menu

The operations setup menu is one of the most extensive and important setup menus.

The items in this menu are descripted in the following section.



Automatic flight detect

Select if you want your instrument to detect start of flight automatically. This is used to start and stop flight log recording. If this is not selected you will find an entry in main menu level 1 to manually start and stop flight log recording. The recommendation is to select flight data recording automatic.

Note: Once flight logging has started the flight timer item on any screen that has this item will flash to indicate that flight logging is active.

Flight detect minimum RPM

Set the minimum RPM that must be measured for automatic flight logging to detect start of a flight. This would be a high RPM value, typically 90% of your maximum take-off RPM. Once flight logging has started, this RPM value is no longer of any consequence, RPM is ignored.

Flight detect minimum ASI

Set the minimum indicated airspeed value above which a flight is considered "active". Once the airspeed falls below this value for 15 seconds or longer, the flight is considered ended.

Flight detect on Rotor RPM

This is for Rotor craft only. Allow flight detection on Rotor RPM. In this case ASI is not used to detect a flight.

Automatic fuel averaging reset

Reset the fuel averaging every time a new flight starts.

Hobbs minimum RPM

Set the minimum RPM required to enable the HOBBS meter. If RPM is below this value, the HOBBS meter does not accumulate time.

Copilot mode below airspeed

Select the maximum airspeed for the copilot mode to be active. Any airspeed below or equal to this airspeed activates the copilot mode. Copilot mode reads out your airspeed if you have your instrument connected to your sound/intercom system.

Audio flight level readout

Select if you would like your instrument to read out flight level changes. This requires your instrument to be connected to your sound/intercom system.

Flight levels will be read out in 500 ft increments even if you have selected meters as altitude units.

Voice alarm interval

Select the repetition rate for voice alarm readouts. Any active alarm will result in a voice annunciation in the selected interval.

Startup page

Select the startup page for your instrument.

Ultra master panel enable

If you have a Stratomaster Ultra HXL instrument as secondary panel, you can connect it to your instrument via an airtalk link and run it as a “slave”.

You may also want to enable this communications protocol if you want to record flight data using equipment provided for this purpose by other companies.

Show maintenance on startup

Select if you would like to have your instrument show your current maintenance and airframe timers on startup.

You can view these timers at any other time in the “common tasks” menu.

Show wind direction...

Select if you would like to show the wind direction arrow relative to north (as viewed on a map) or relative to your aircrafts heading.

On screen terrain warning flash

Select if you would like to enable the TWAS on screen flash warning system. This pertains to moving map views. Any area on your current map view that requires warning relative to TAWS rules will flash yellow (within 1000 ft of current altitude) or red (at or above current altitude).

Flight log/Aircraft name

Enter a file name for your flight log. When you export your flight log to SD card it will be given the name you enter here. A good name would be your aircrafts registration.

The export function for the flight log is in the “common tasks” menu.

RS232 port 1,3,4,5...

Select how your RS232 port 1, 3, 4 or 5 should be used. Ports 3-5 require a communications extender component (optional item).

Port 2 is reserved for NMEA/GPS.

Options are:

- Not used
- SL40 COMM radio
- SL30 NAV/COMM radio
- XCOM COMM radio
- Filser COMM radio
- MGL COMM radio
- MGL NAV/COMM radio
- XRX PCAS Traffic system
- FLARM Traffic system

USB Slave

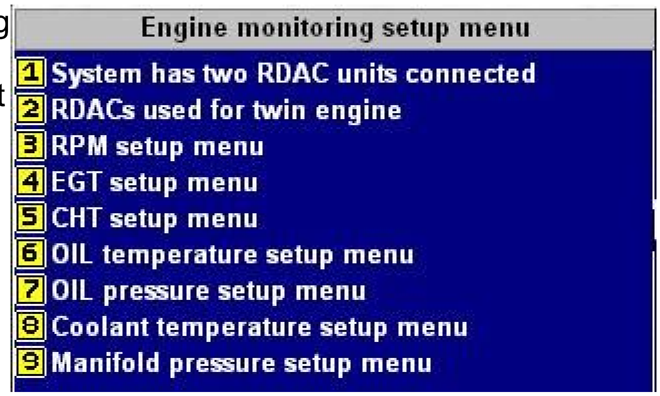
If you have a muti panel system and this is a slave instrument, please select how the slave instrument should use RDAC and attitude sensors if these are connected to the slave. If these are not selected for local use, data for these items will be obtained from the master panel.

Demo mode

The last item in the operations setup is the “demo mode” selection. Here you can place EFIS into a “demo” mode. EFIS will create engine and flight data as if the instrument is actually flying complete with moving artificial horizon. The demo mode is usually used to test indications after a screen display or setups have been changed without the need to actually fly the aircraft.

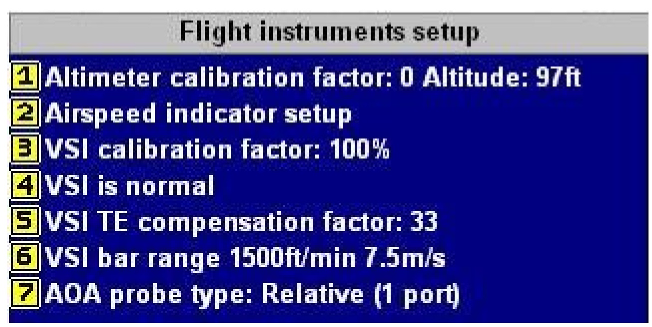
Engine monitoring setup

This enters an extensive menu system allowing you to specify in great detail how your engine is to be monitored. For example, you will select what temperature ranges to use for your EGT probes (Exhaust Gas Temperature).

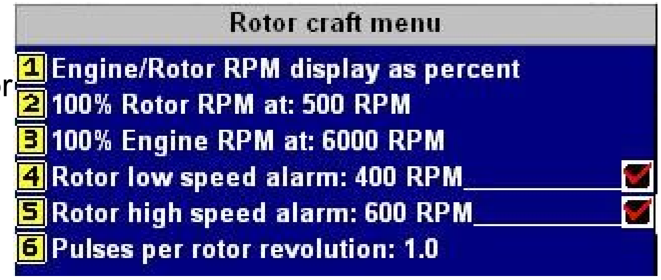


Here you calibrate your fuel flow senders, calibrate your fuel tank level senders and specify how your system is to calculate fuel endurance and range.

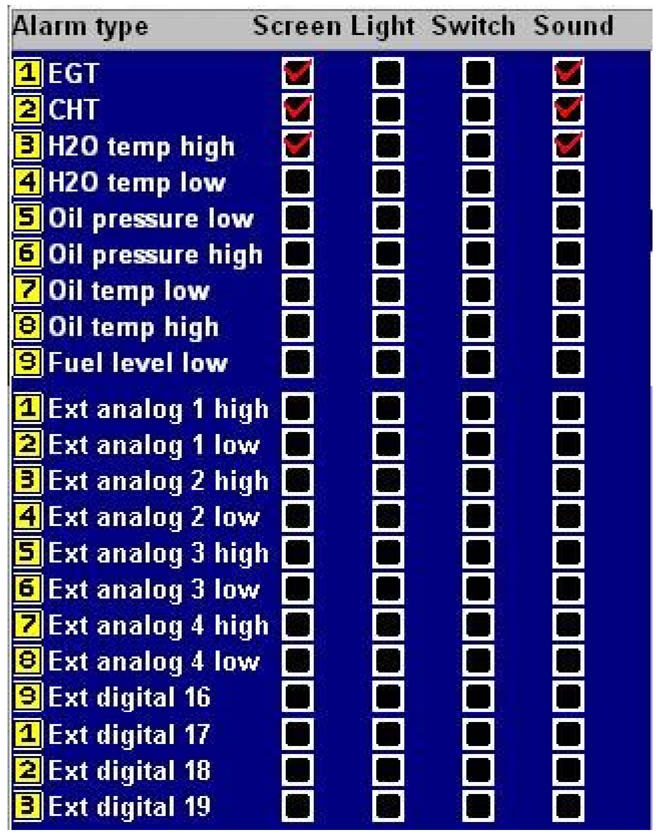
Setup and calibrate your various primary flight instruments such as altimeter and airspeed indicator.

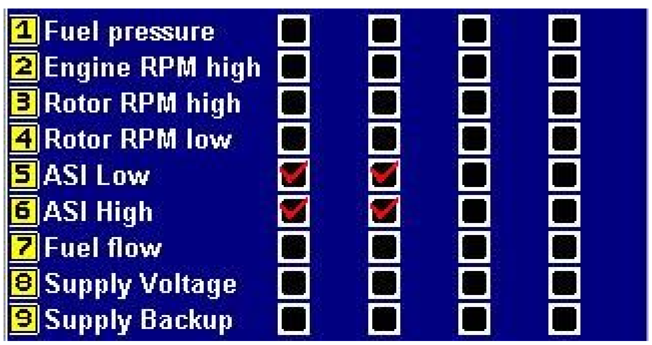


Setup your rotor craft related instruments. If you do not have a rotor craft, you can safely ignore this menu. In this case, make sure Rotor speed alarms are disabled.



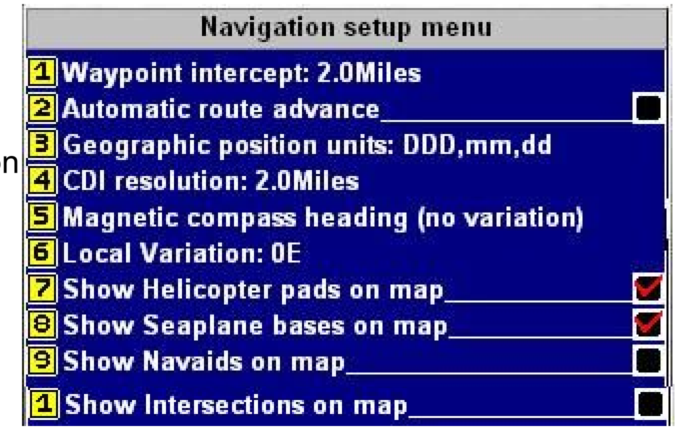
This important menu allows you to specify how each alarm in the system is to operate. You also select here any voice audio words and phrases to play if a corresponding alarm is active.



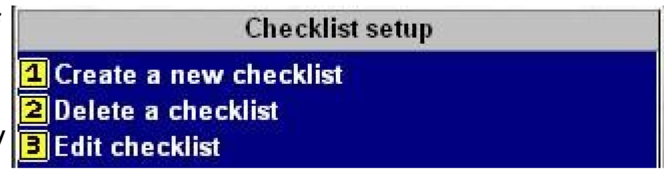


“Ext” alarms refer to alarms that can be setup using the optional I/O extender module.

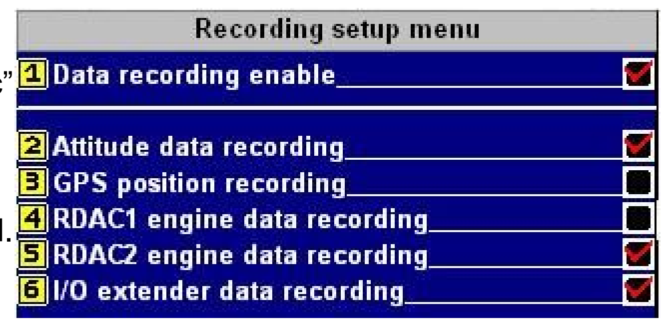
Here you specify items related to navigation, for example which waypoint types to display on your maps.



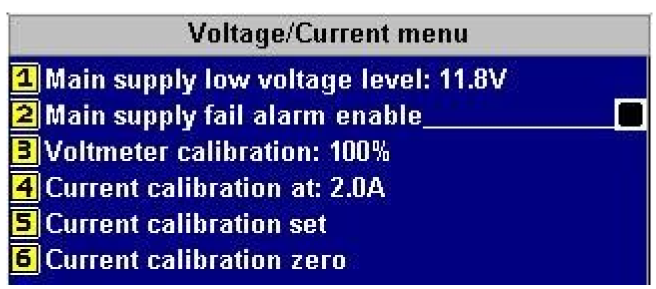
Here you create checklists such as pre-takeoff or pre-startup checklists. You can create a large number of checklists if required, each with a name. Checklists are activated from any main screen using SHIFT-LOG (“Check” on top of button). Checklists are stored on your RAM drive.



Select items to record “black box” style onto a SD card. Recordings are made on a preconfigured recording file called “Enigma.rec” located on the SD card. This file is created by the PC based EFIS simulator and screen designer. You can choose the size of this file and by this how long a recording can be stored. The duration of recording is also influenced by which items you want to record.



In this menu you can setup your voltage and current monitoring system. Current monitoring is available if you have the optional I/O Extender module or dedicated current monitoring module.



Main supply low voltage level specifies the voltage below which the “Low voltage alarm” is activated. Note that you still need to enable this alarm in the “Alarm setup and routing” if you want to use this alarm.

Main supply fail alarm enable will activate an alarm if the system changes over to a connected backup battery due to failure of the main supply. Note that you need to enable this alarm in the Alarm Setup and Routing menu.

Calibrating the current monitoring system

The EFIS's current monitoring system is based on the traditional current shunt. The system is based on standard 50mV shunts. You enter the amperage of the shunt. A typical value for a 50mV shunt is 50A. Other popular shunt values are 20A and 100A. The value specifies the current required to achieve a 50mV voltage drop across the shunt.

You can use standard current shunts or you can make your own using a length of copper cable.

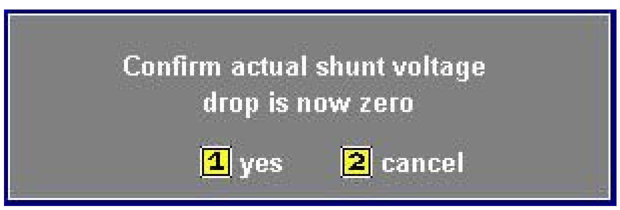
We recommend that you wire your system such that any current to a electric starter motor or similar high current device that is not used continuously is not routed through the shunt. Battery charge currents and currents to normal electrical users (lights, radios, avionics etc) should go through your shunt. Please view the installation manual for circuit diagrams.

The current calibration functions can only be used if you have a current monitoring device attached. The calibration is performed as follows:

Setting the "zero current calibration point"

Remove one current shunt connection and join it with the other connection. This ensures that both current shunt connections see exactly the same voltage. They MUST remain connected to the positive supply rail.

When this is done, select the "Current calibration zero" function.



This sets the zero current calibration point. This is stored in the current monitoring device, not in your EFIS.

Setting the current calibration

Enter the current your shunt will be passing with a voltage drop of 50mV. Standard shunts are based on a 50mV voltage drop.

System initialization menu

Here you can set your EFIS to factory default setting, execute automated setup scripts or load a sound file.

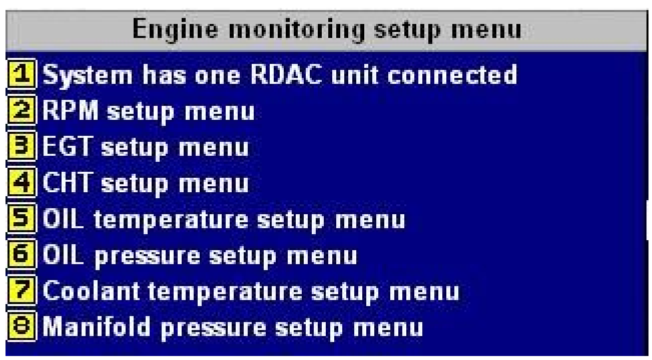
The most important function in this menu is the zero function for ASI, VSI and AOA sensors. You will use this function should any of your sensors ever drift out of “zero”. For example, assume your vertical speed sensor is giving a small, constant reading when it should be reading “zero”.

Executing a script file can be used to setup your EFIS from a preprepared script created using the EFIS Screen Designer and Simulator program. This function is also available from the “Install Tasks” menu. Scripts can be used to easily copy an entire setup, including screen designs to an EFIS instrument.

Script library files have the file extension “.ESL”

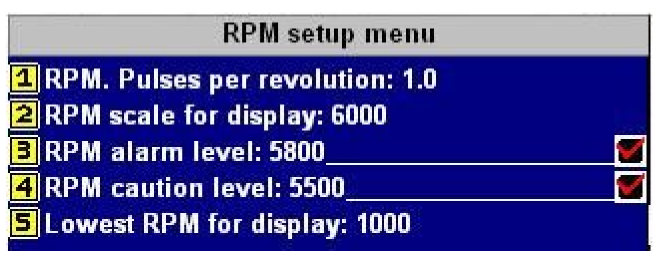
Engine monitoring setup menu

This is the menu used to customize engine monitoring to your requirements.



RPM setup menu

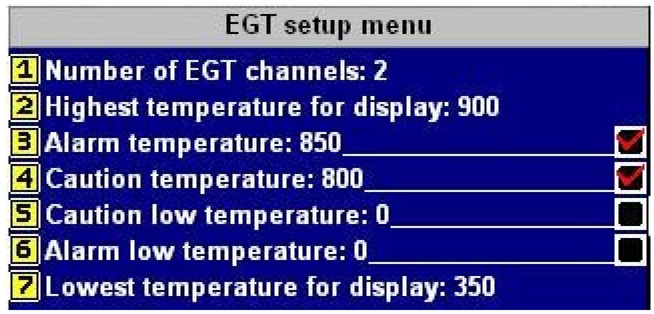
Here you setup your engine RPM monitoring. The most important setting is the number of pulses to count per engine revolution. For example, Rotax 912 engines generate 1 pulse per revolution, Rotax 503 and 582 engines produce 6 pulses per revolution (DCDI versions). Most four cylinder, four stroke engines produce two pulses per revolution. This setup allows you to enter fractions as



well to cater for unusual engines such as three cylinder engines.

EGT setup menu

Select the number of EGT channels you want to use. Also, set your temperature limits to use for display and alarms. Alarms can be enabled or disabled here.



Please take note on the channel allocations for EGT and CHT probes as outlined here:

Using the EGT and CHT setup menu, select the number of EGT and CHT channels you will be using. EGT channels always start from RDAC TC1 and are followed by the CHT channels. For example, assume you are using two EGT and two CHT channels. On the RDAC you will use the following allocation:

TC1 - EGT 1

TC2 - EGT 2

TC3 - CHT 1

TC4 - CHT 2

If you have a second RDAC connected and have twin engine monitoring selected, then the second RDAC follows the same channel allocation as the first for the second engine.

If you have a second RDAC connected but have single engine monitoring selected, the second RDAC acts as extension to the first RDAC and channels follow in logical order. For example consider the following:

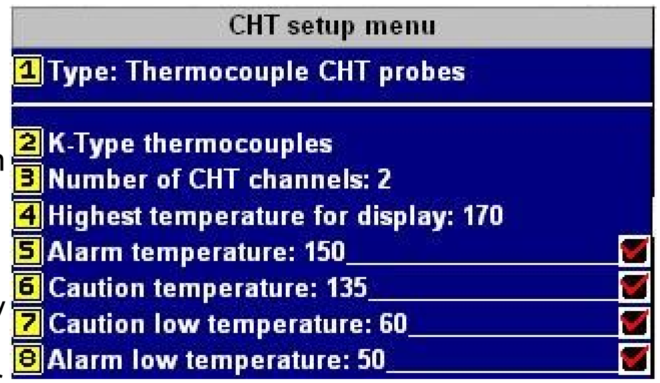
You are using two 12 channel RDAC units to monitor a eight cylinder engine and want 8 EGT and 8 CHT channels. RDAC one channels TC1 to TC8 will be EGT channels 1 to 8. TC9 to TC 12 will be CHT 1 to 4. On the second RDAC, you will use TC1 to TC4 for CHT 4 to 8. TC5 to TC12 will remain unused.

Setting number of channels in the EGT and CHT setup is relevant mostly for the "scanning" and "highest value" readouts. When designing your screen layout using the EFIS simulator and screen designer, you must allocate any graphic bargraph displays to their respective channels on the RDAC units. If you do not do this, your graphic displays and numeric readouts may not show the same channels. If you are using a screen layout designed by somebody else (for example your aircraft manufacturer), obtain relevant information on the channel allocations from them or alternatively, load your screens into the simulator and screen designer and find out what channels have been allocated.

CHT setup menu

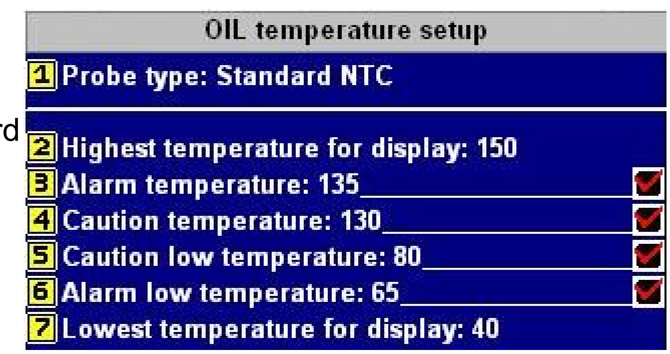
In this menu you setup your CHT monitoring

Please also note the section on EGT/CHT channel allocation as described in the EGT setup menu.



CHT probe types may be K-type thermocouples or J-type thermocouples. In addition it is possible to select Rotax 912 CHT monitoring. Rotax 912/914 engines use two oil temperature senders to monitor temperature in each bank of cylinders. If you select Rotax NTC probes, the number of CHT channels is automatically fixed to 2 channels. Please note that it is still required to set any graphic display such as bargraph CHT displays to the Rotax CHT mode so these bargraphs will obtain their display values from the correct source. This selection is done using the EFIS simulator and screen designer.

Oil temperature setup menu

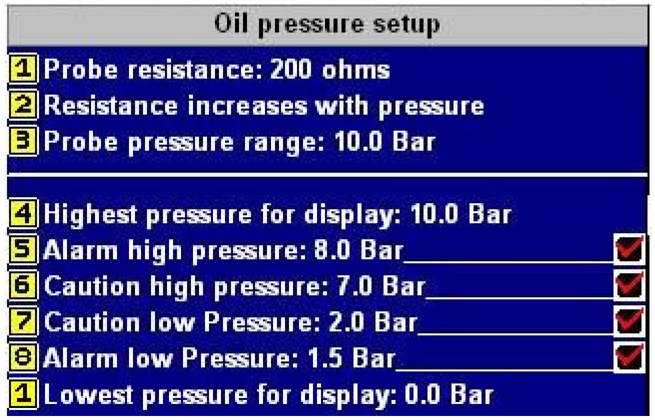


In this menu you select relevant options and setups for your oil temperature monitoring. Most applications would use the Standard NTC probe which is equivalent to the standard VDO oil temperature sender, also used on Rotax 912/914 engines.

Oil pressure setup menu

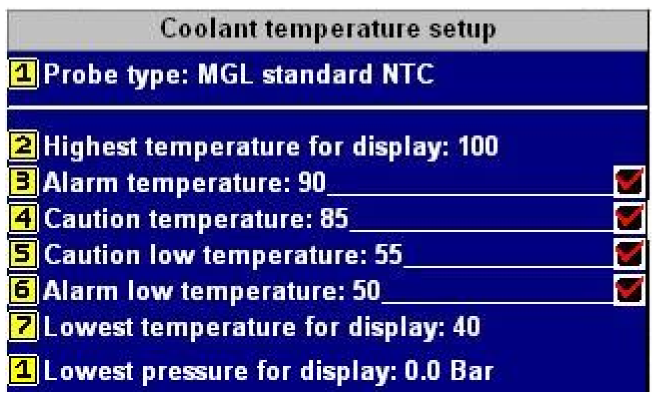
In this menu you select options and settings for your oil pressure sender.

Select the nominal probe resistance at full range pressure (most senders are 200 or 400 ohms). Most senders will increase resistance as pressure increases but there are some types which work "in reverse". Finally, set the full range pressure for the probe. Most probes are either 5 or 10 bar types.



Coolant temperature setup menu

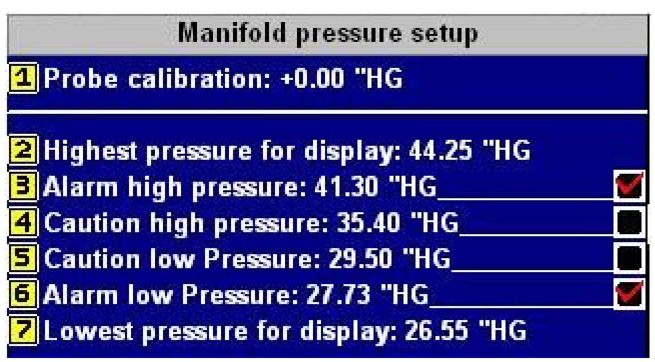
Select options for your coolant temperature monitoring. Please note that it is possible to use the coolant temperature monitoring not just for the traditional water temperature on water cooled engines but you can use this channel also for a second oil temperature monitoring channel, perhaps for a gearbox oil temperature.



Manifold pressure setup menu

Should you be using a RDAC engine monitor module with a built in manifold pressure sender you can use this menu to select your display ranges.

The sender in the RDAC is uncalibrated and if you would like a very accurate display, you can finely calibrate the sender using the probe calibration. You need a reference such as the barometer readout that is provided by EFIS (the barometer can be placed on an info



display). Compare the MAP reading with the barometer and adjust the MAP until it reads exactly the same pressure as the barometer which on EFIS shows actual ambient pressure.

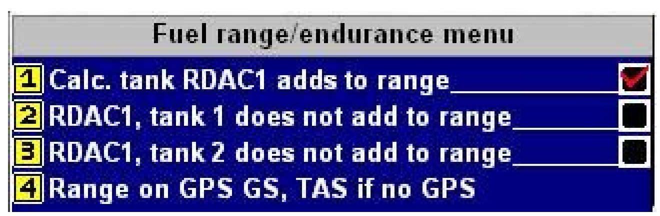
Fuel related setup menu

In this menu you select various options and calibrations for your fuel tank levels and fuel flows. You can have two physical fuel tanks per connected RDAC unit (each with a level sender) for a total of four tanks. In addition, you can use a further two virtual tanks. These are tanks that show you a fuel level based on your input, subtracting fuel level based on the fuel flow reported from fuel flow senders. You may have one virtual tank per RDAC.

Virtual tanks may be used to show the same levels as a physical tank (as secondary check on the fuel level of that tank) or they may show additional tanks as you require. We recommend that virtual tanks should always have a secondary fuel level indication which could be something as simple as a sight gage. Remember that virtual fuel level is subject to errors originating from incorrect starting values as well as incorrect calibration of the flow senders or under reading of flow caused by mechanical reasons.

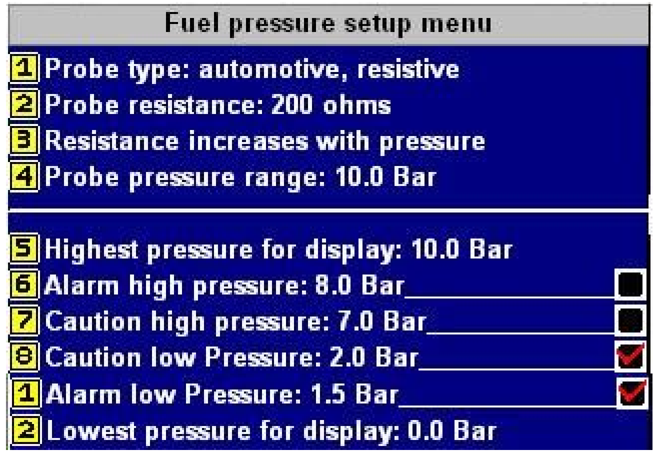
Fuel range/endurance setup

Here you select which fuel tank levels your instrument should consider for range and endurance calculations. You also select options on how to use sources of speed needed for the range calculation.

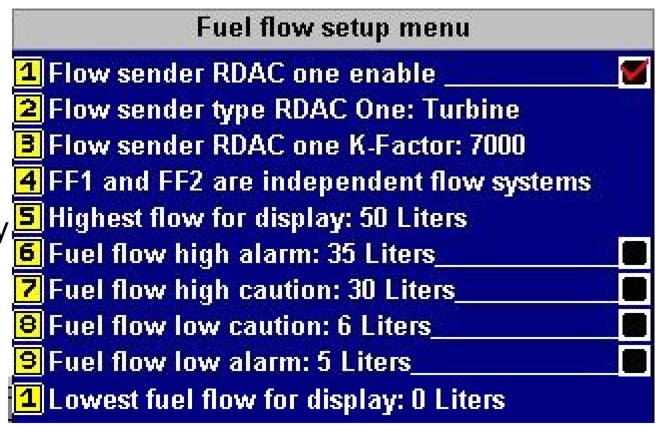


Fuel pressure setup menu

Here you select options for your fuel pressure monitoring. If you have two RDAC units connected, these settings apply to both possible fuel pressure senders and readouts.



Fuel flow setup menu



Here you select options and calibrations for your fuel flow senders. Of importance are flow sender type and K-Factor.

Type: Turbine. The K-Factor specifies how many pulses your flow sender creates for every one liter of liquid passing through it. Adjust this value according to the flow sender manufacturers specifications. You can also adjust this value to calibrate your flow sender. If you find that your flow sender is reading slightly low, decrease the K-factor, if it is slightly high, increase the factor. If your reading is incorrect by a large amount, do NOT attempt to fix the problem by modifying the K-Factor by a large amount. You have a problem that is causing the flow sender to produce incorrect readings. Fix the problem before adjusting the K-Factor.

Type InjectorH or InjectorL. In this case your RDAC flow sender input is connected to the switched side of your fuel injector and is monitoring the opening/closing time durations of the injector to derive fuel flow. In this case the K-Factor is used to bring the reading to a correct value. The actual value will differ depending on number of injectors, fuel pressure, and injector jet size. We suggest you start with a K-factor value of about 1500 and adjust this until your flow reading matches reality.

Differential flow measurement

The instrument is capable of differential fuel flow measurement using two fuel flow senders. In this case two RDAC units are required to be connected (RDAC 1 and RDAC 2). It is not required to enable RDAC 2 in the engine monitoring setup if this is not required (for example, you are using a second RDAC **only** for a second fuel flow sender).

If this option is selected, Fuel flow senders one and two are two independent flow monitoring systems and each can be used for one of two virtual, calculated fuel tanks.

If this option is selected, all Fuel Flow 2 functions related to virtual tank levels are disabled. The flow sender connected to RDAC 2 is used to subtract from the flow sender reading of the flow sender connected to RDAC 1.

The fuel flow reading “Fuel flow 1” is calculated as Fuel Flow RDAC 1 minus Fuel Flow RDAC 2. If the result of this calculation results in a negative value, the Fuel Flow for RDAC 1 will read zero.

Differential fuel flows are mostly used with fuel injection systems. In these cases, often a fairly high return flow to the tank in present requiring the use of two flow senders. Due to a accumulation of measurement inaccuracies, this tends to work well only with fairly high fuel flows that fall well into the flow range of the flow senders used.

If you have a fuel injection system using electronic injectors, we strongly recommend using the fuel injection monitoring capability of the system instead.

Calibration of a differential flow system.

Create your self a screen using the screen designer that shows fuel flow from both RDACs. Set the two flow senders to be normal, independent systems.

You can now monitor the two fuel flow readings and the difference between the two would be your differential flow that is consumed by the engine. We strongly recommend using two fuel flow senders of identical manufacturer and type. Calibrate the K-Factor of both senders so they will always be equal until you have the correct flow differential indicated.

Example: The two K-Factors are set to 7000. The measured differential flow is 30 liters/hour. The forward flow is 100 liters/hour and the return flow is 70 liters/hour.

By performing a test you find the actual flow is 27 liters/hour. This means we are over reading by 10% (3 liters/hour).

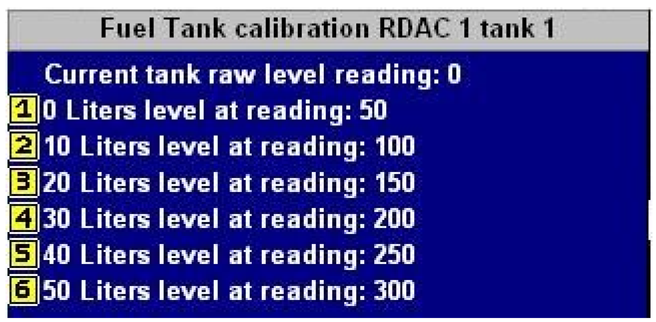
Correct the K-Factor as follows: Increase the K-Factor on both senders by 10%, I.e. They will now both be set at 7700. After this, sender one will read 90 liters/hour and sender two will read 63 liters/hour. The differential is now 27 liters/hour, our desired reading.

Fuel tank setup menu

This menu is used to set the capacity of your fuel tanks. Calculated tank refers to virtual tanks based on fuel flow only. Here you also set the fuel level alarm values and you can enable/disable every these alarms individually for every tank.

Physical fuel tanks have a level sender connected to the RDAC fuel level inputs. These senders are mostly resistive types but sometimes capacitive senders are used. Note that capacitive senders may be sensitive to fuel types used and may read incorrectly if a different type of fuel is used. Fuel tank level calibration is described in the next section.

Fuel tank calibration



Your EFIS supports a six point calibration system for fuel tank senders. Once you have set the size of the tank, the tank is split into six calibration points, evenly spaced from 0 to the full level.

This calibration shows you the current reading obtained from the level sender. The reading can be from 0 to 4095. A reading of zero means that the fuel level input of the RDAC is at zero volts, while a reading of 4095 is equivalent to 5V. Important is that the reading changes with your fuel level **in a repeatable and reliable way.** The EFIS does not mind if the reading increases or decreases with fuel level, as long as it does so in a meaningful way.

Calibration is performed by starting with an empty tank and then moving the current reading into the calibration point. You can copy the current reading into the relevant slot or you can enter the value directly (for example you may have valid values from another aircraft that is constructed identical and want to use the calibration from that aircraft as starting point). Note that it is possible to construct a script file that you can execute on any EFIS to set these values (as any other setting) if you are a producer of aircraft and want to copy settings to aircraft quickly.

We recommend that you use a “silent” reserve level. For example assume you have a tank that holds 100 liters. We recommend that you set the tank size as 90 liters and start your zero level calibration with 10 liters of fuel already in the tank. Of course you can decide on your own preferred reserve levels.

Flight instruments setup

This menu contains the settings and user calibrations for the altimeter, airspeed indicator, vertical speed indicator and angle of attack indicator.

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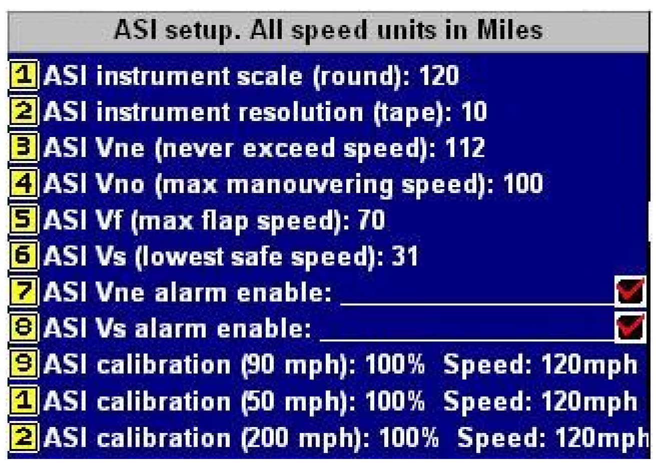
Altimeter calibration factor

This function allows to to calibrate your altimeter if you find it has a slight error. Each count corresponds to about 7ft of altitude at sea level. You can view the current altitude readout.

Please note: This is NOT the local barometric setting that air traffic control will give you. This setting is used after you have obtained the local barometric setting and are certain of its accuracy. Enter the local barometric setting using the Up/Down arrows from any main display that contains a barometric local pressure readout. If you have a residual error after you have done this, you can use this function to cancel out the error. Factors entered here will normally be very small. A positive number decreases your altitude, a negative number increases it.

Airspeed indicator setup



Here you enter various options for your airspeed indicator. Of importance are the V-speeds that determine the position of your colored arcs or bands on your airspeed indicator.

You can also enter three airspeed calibration values (in percent of a nominal 100% value). The “90 mph” value applies to all airspeeds. The “50 mph” and “200 mph” values are scaled relative to the 90 mph value depending on your current airspeed.

Example: Your 50 mph factor is 120%, your 90 mph is 100% and your 200 mph is 90%. With this setting, your airspeed will readout according to factory calibration at 90 mph, it will read 5% less at 145mph, 10% less at 200 mph and 15% less at 255mph. At 70mph airspeed will read 10% higher, at 50mph 20% higher and at 30mph it will be 30% higher.

Using these three calibration values, you can cancel out errors caused by airflow variations around your aircraft at various speeds. However, we recommend that the best way to obtain a good and accurate reading is to install your pitot tube and static ports in a good location. With a good location, there is barely a need for further calibration. We recognize that this is not always practical or possible and thus have given you the option to use non-linear calibration using these three settings.

VSI related items

These settings allow you to specify options and calibrate the vario quality VSI indicator.

Setting the calibration factor involves putting your aircraft into a constant climb or glide during a calm day (i.e. No turbulence). Here is an example of how to do this:

I am flying at 8500ft. I cut the throttle and put the aircraft into a stable glide. I note the sink at an indicated -500ft/min and can keep this constant. As I descend through 8000ft, I take note of the second hand of my watch. I keep descending for exactly one minute at the constant 500ft/min sink. At the end of the minute I take note of my altitude readout. It should be 7500 ft exactly if my VSI was correct and I did not change my rate of sink during the minute. Assume that the altitude is reflected as 7400 ft. This means my VSI has been under reading by 20%. Enter a VSI calibration of 120% and you are done.

Mostly for glider use, the VSI can be total energy compensated. This attempts to use changes in airspeed to compensate and oppose VSI readings such that the VSI will not respond to “stick thermals” but only to actual lift or sink caused by airflow and thermal activity. Enter a compensation factor value that will result on your aircraft in zero VSI activity if you push the stick forward or pull back. You need to do this on a calm day with no thermal activity. The factor for your aircraft is found by experimentation.

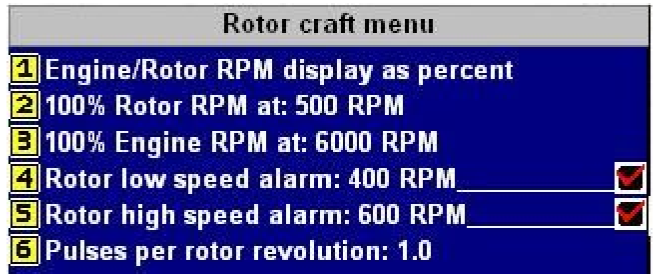
Select a VSI bargraph range suitable for the maximum climb/sink rate of your aircraft. Most light aircraft will probably select a 1500ft/min range.

AOA probe type

Select the kind of AOA probe you are using (if any). Your EFIS supports fully differential AOA probes (such as can be fitted directly into the leading edge of a wing or as stand-alone) as well as the simpler single port devices (which use static pressure as “balance”). See the discussion on probe types and calibration elsewhere in this manual.

Rotor craft menu

Using this menu, select options for the rotor craft display as well as rotor speed alarm limits. You also need to set the number of pulses generated by your rotor RPM sensor for every revolution of the rotor. If your instrument is not fitted to a rotor craft, please disable the rotor speed alarms.



Alarm setup and routing

This important menu is used to select which alarm indications to use for every of the available alarm sources.

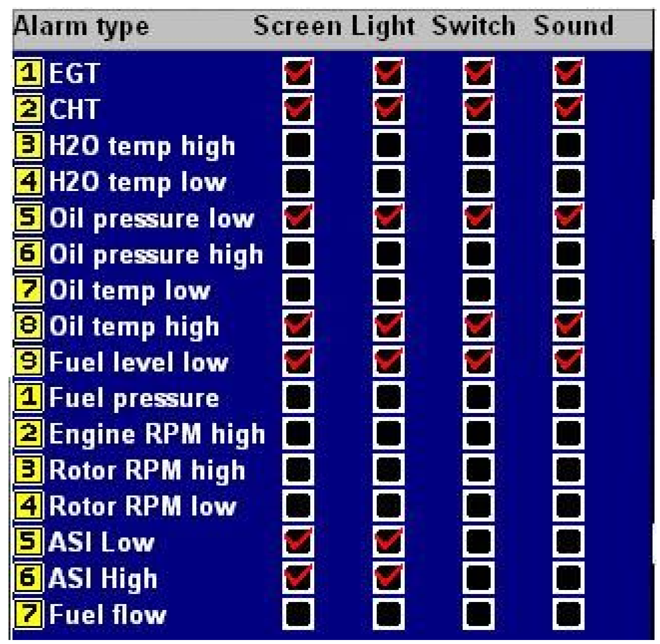
You also select which sounds to synthesize for each alarm. Normally these sounds will be actual voice recordings specifying the type of alarm that is active.

Screen – alarm flashes a message on the screen.

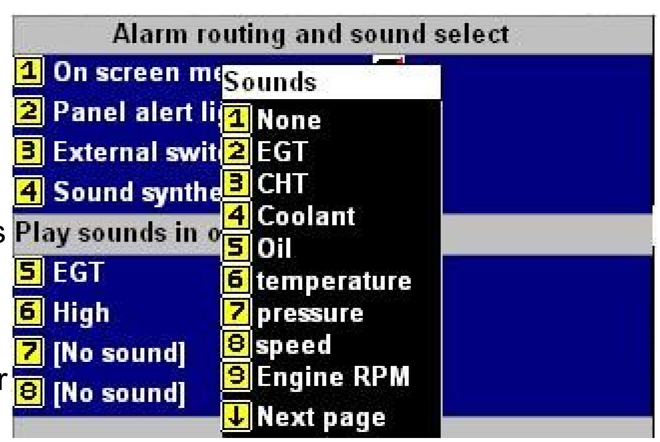
Light – alarm switches the flashing panel alert light on

Switch – alarm activates the externally available alarm switch (this can be used to sound a buzzer or switch a light)

Sound – alarm will synthesize a sound that can be injected into an aircraft intercom system or drive a speaker (The EFIS provides suitable outputs for both).



The image on the right shows selection of sounds to play for an alarm (in this case EGT alarm). Up to four sounds can be combined per alarm. Normally each sound is a word or phrase. Sounds can be recorded by the user to support different languages. Use the Enigma sound recorder software package to easily create a sound file for your EFIS.



Setup navigation

This menu is used to select options for your navigation.

Waypoint intercept – Radius around a waypoint you have selected as “goto” or as next waypoint in a route. Once you are inside the radius your EFIS will consider that you have arrived at your waypoint. This will be announced by voice and screen message.

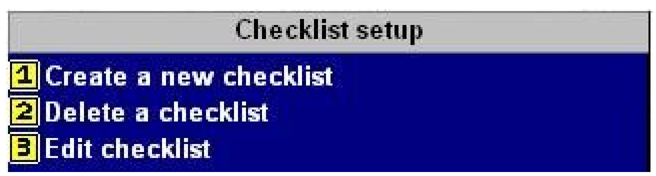
You can cause the EFIS to advance to the next waypoint in a route once you arrive at a route waypoint.

Magnetic variation for your location is automatically calculated for your current location using a comprehensive model of the Earth magnetic field and how it changes with time. For magnetic variation to be correct, it is important that you enter the correct time and date into your EFIS (time and date setup).

Magnetic variation is required in order for the wind speed and direction calculations to return a meaningful result. You also need a compass connected that is giving you a reasonably accurate heading.

Checklist setup

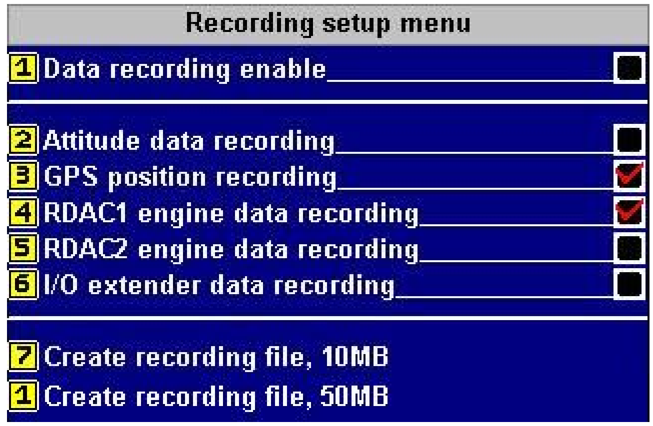
This menu allows you to create and edit checklists. Checklists are typically pre-startup and pre-takeoff checklists.



Each checklist may contain up to 32 entries. Each entry is a short line of text specifying the item to be checked. Checklists can also be created on any PC using Notepad or similar ASCII text editor. Files have a filename up to eight characters long and use the extention “.ecl”, for example “takeoff.ecl”.

Checklists can be activated and deactivated from any main display screen by selecting “Shift-Check”.

Recording setup menu



The EFIS supports “black box” style flight data recording directly onto an inserted SD card.

Here you select which item groups to record. In order to record RDAC 2 data, RDAC 2 must be connected and enabled in the engine monitoring setup.

Recordings are written to the file “Enigma.rec”.The filesize of this file and the options you select here determine the duration of recording. Please note that your instrument does not create this file automatically. You need to create a recording file called “Enigma.rec” using the EFIS simulator and screen designer. Here you decide on the file size. You then copy the file onto the SD card so your instrument can use it for recording.

Alternatively you can create two default sizes of recording file using your EFIS. As a rule of thumb, you can work on about 1 MB per hour for an average system setup. Writing the recording file onto the SD may take some time to complete depending on the maximum write speed of your SD card. Make sure the cards “write protect” tab is in the “off” position. No writing to card is possible if the “write protect is active”.

The reason behind the fixed file size of the recording file has to do with limited write cycles of the SD card and the instability of the MS-DOS file system. With a fixed file size, the EFIS never has to write to either the directory structure or FAT tables of the SD card eliminating wear of the card or possible data corruption.

Once the recording file has been filled, the recording continues at the start of the file again, overwriting the oldest data in the file.

The EFIS records all available data for each selected category once per second.

System initialization menu

This menu is seldom accessed by the user.

The most important function is the “zero ASI,VSI and AOA” sensors. This allows you to reset the sensors to their initial calibrated states. For this the aircraft must be stationary and not exposed to any ambient pressure fluctuations such as caused by wind (even if the aircraft is in a closed hangar).

You will use this function if you find that your airspeed indicator is showing a small, permanent reading or your VSI is showing a climb or sink when ambient pressure is constant.

We find the sensors seldom drift by much during aging but it is usually a good idea to perform this function once a year or when the need arises.

Set configuration to factory default

This will reset all your settings with the exception of critical sensor calibrations to a default state. Only use this function to restore an instrument that has suffered from serious corruption of settings.

Execute script library /Load sound file

These functions are also available in the “common tasks menu” and are described there. They are used to automate complex setups using preconfigured setup files.

Ambient temperature calibration

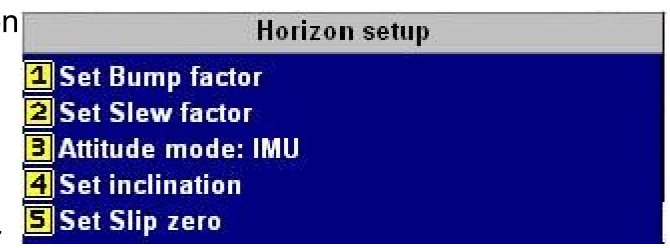
This function allows you to calibrate your ambient temperature probe. You add or subtract an offset measured in degrees Celcius.

ALT/ASI factory calib...

This is where the factory calibration values for your EFIS are entered. These factors should correspond to the values given in your calibration certificate.

Horizon setup

Various setups related to your artificial horizon sensor. Please see documentation for your sensor for details.

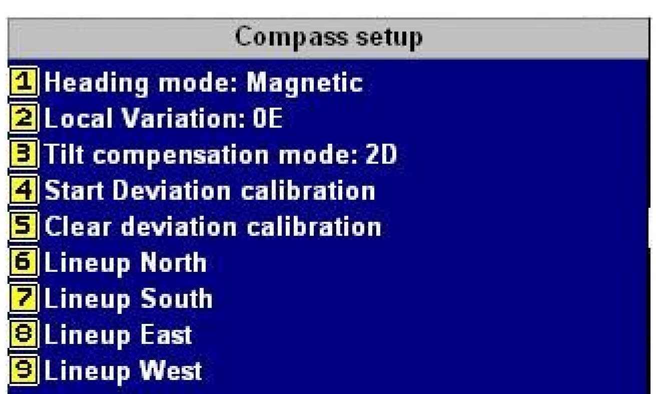


Set slip zero – this function allows you to set your slip indicator to exactly zero even if your aircraft tends to fly slightly wing down. The procedure is to place the aircraft in a stable, straight and level attitude during calm flight conditions and then select this function.

To cancel the correction, place your sensor absolutely horizontal (use a spirit level) and select the function again.

Compass setup

Select heading mode (true or magnetic heading) and enter local variation (also accessible from navigation menu).



Tilt compensation modes depend on your sensor type. 2D mode is for a simple X/Y axis sensor, 3D modes use accelerometer or gyro based tilt compensation as available.

For deviation compensation follow instructions for sensor.

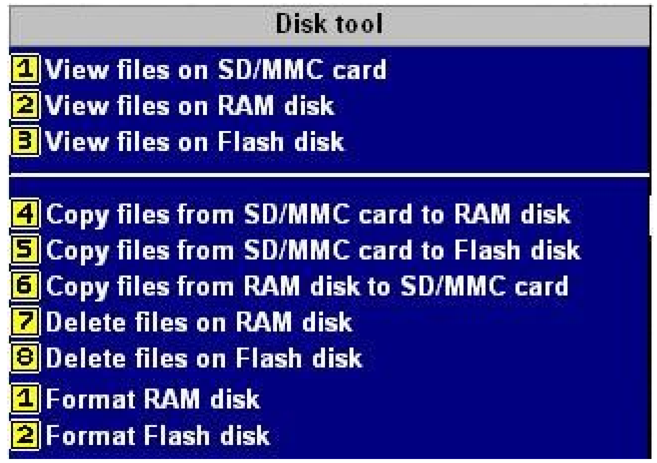
A note on deviation compensation: Only perform deviation compensation if deviation errors are relatively small (not more than 10 degrees). If your errors are larger, find a better location for the compass in your aircraft !

The lineup functions can be used after deviation compensation leaves small errors to exactly cancel out remaining deviation on the major cardinal headings. Obviously, you will need a good reference compass to lineup your aircraft for for this.

Please note: For the wind direction and speed indicator to work correctly, heading information from the compass needs to be accurate. Further to this, you need to enter the correct magnetic variation for your location. The wind calculations require true compass heading. You do not have to set the heading mode to true for this, the wind calculations will use true heading based on your supplied variation information automatically.

Disk tool

The disk tool allows you to copy individual files and maintain your EFIS internal disks. Typical uses are:



- Copy individual screen files from SD card to flash drive
- Copy checklist files from SD card to RAM drive
- Copy route files from SD card to RAM drive
- Copy special route file “markers.ert” from RAM drive to SD card for extracting your waypoint markers to the EFIS Flight planner program.

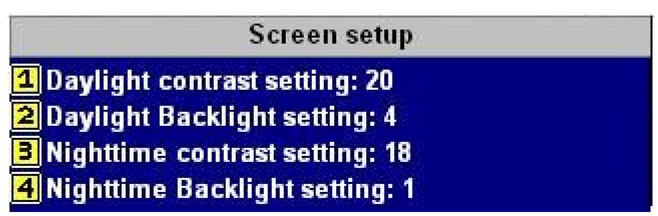
You can format both RAM drive and Flash drive if for some reason they have been corrupted. After formatting the Flash drive you need to reinstall screen files, waypoint and abbreviated airport information file.

After formatting the RAM drive you need to reinstall route files and checklist files.

We recommend that you periodically copy any files that may have changed to SD card for backup. Waypoint files, if you have edited or added any waypoints on the instrument itself should be backed up. The same goes for any route files you have created on your EFIS including the “markers.ert” file.

Screen setup

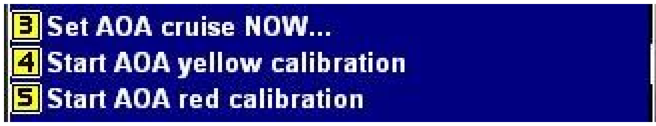
This menu allows you to setup backlight and contrast (vertical viewing angle) for daylight and night operations.



Note: if your instrument is fitted with a TFT display, contrast settings do not have any function.

Backlight level settings have a significant effect on power consumption of your instrument. Do not use a backlight setting higher than what is required in your aircraft for best display quality.

Calibrating the AOA sensor



The EFIS supports two pressure based methods for measuring angle of attack. You select the method you are using in “Instruments setup”.

Set AOA cruise NOW...

This menu item will only show if you have a single port AOA sensor selected (relative sensor mode, setup in “Instruments setup”).

The single port sensor measures a pressure relative to static pressure and needs to have a “zero” reference. This is done at any time in flight, usually before AOA Yellow or Red calibration is done. The procedure is simple: Fly straight and level at a high cruise speed below your VNE. The idea is to fly with a low angle-of-attack. When this is achieved, select the “Set AOA cruise NOW...”. Your EFIS will make a snapshot measurement of AOA and Pitot tube pressures and use the ratio of the two as AOA zero indication. Any AOA higher than this will result in your AOA indicator rising.

Start AOA yellow calibration

This is the main calibration function for your AOA yellow region. You calibrate the top end of the green region which is your clean stall (flaps,gear retracted).

When safe to do so fly the aircraft to the beginning of the clean configuration stall buffet. Do not actually stall the aircraft. For example, if your aircraft wants to break into the stall at 50 mph, you should slow down to perhaps 53 mph. Once completed you should end the yellow calibration in flight. If in doubt, please have a second pilot assist if at all possible.

This calibration sets the AOA indicator to the border between Green and Yellow areas.

Start AOA red calibration

This is the main calibration function for your AOA red region. You calibrate the top end of the yellow region which is your landing configuration stall (full flaps, gear out).

When safe to do so fly the aircraft to the beginning of the landing configuration stall buffet. Do not actually stall the aircraft. For example, if your aircraft wants to break into the stall at 50 mph, you should slow down to perhaps 53 mph. Once completed you can end the AOA red calibration.

This calibration sets the AOA indicator to the border between Yellow and Red areas.

Testing AOA calibration

Verify that the AOA indicator reads zero with the aircraft stationary. When in flight with a dual port AOA probe, you should find the indicator roughly in the bottom third to center of the green area. With a single port probe the indicator will be towards the lower end of the green area during normal cruise. Your aircraft should enter the stalling regime when the indicator crosses into the yellow area. In landing configuration with full flaps your aircraft should stall when crossing from yellow to red.

The AOA calibration can be repeated as often as you like should it not operate as you expect. Some sensitivity towards AOA probe types and placement exists, so sometimes a little experimentation is required for optimum results.

For usage of the angle of attack indicator, refer to your aircraft manufacturer recommendations.

A correctly used AOA indication can significantly increase flight safety during times of reduced airspeed such as during landings or during steeply banked turns. AOA shows actual angle of attack and is completely independent of aircraft weight and density altitude. Your wing will always stall at the same angle of attack in a given configuration. The EFIS will issue a single voice warning “Angle, Angle” whenever you pass close to the green-yellow border and again close to the yellow-red border.

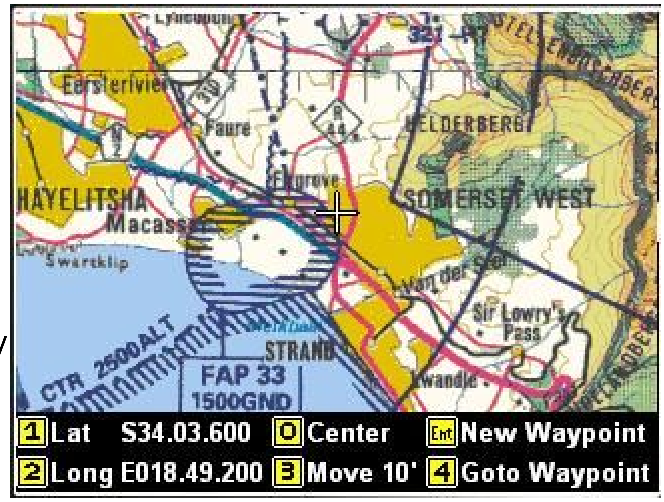
During a typical landing at slowest speeds you would perhaps get “Angle, Angle” just before you drop to landing configuration flaps. In this configuration another “Angle, Angle” will put you dangerously close to full flap stall. Push the stick forward immediately and increase engine power if required to prevent altitude loss.

We recommend that you practice AOA based flying with a flight instructor at a safe altitude in a way that an inadvertent stall will not put aircraft or occupants in any danger.

Verify that the AOA indicator works as expected after installation of a AOA probe and consequent calibration. Test the AOA frequently by flying close to the stall break and verifying correct AOA display. Recognize that a AOA probe that is impeded with insects, leaky plumbing or incorrect alignment will not work as expected.

Map viewer

The EFIS's map viewer is used to view any area of your available maps regardless of your current position or GPS status. The intention is to allow you to check any area for flight planning purposes or even create new waypoints directly from locations on the map.



Please note that it is the pilots responsibility to independently verify the accuracy and currency of any provided mapping or waypoint and airfield data. MGL Avionics and their appointed distributors cannot be held responsible for incorrect or outdated information as all information is provided by third parties and this is passed on in good faith.

The map viewer can show raster maps (maps created from an image such as scanned paper maps) or vector maps (draw maps from your EFIS's World wide vector map database).

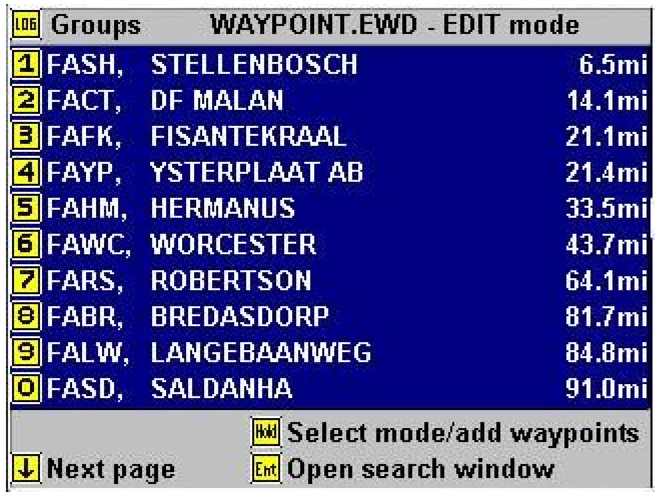
Switch between map styles at any time pressing “SHIFT” followed by “5” (SHIFT+Map).

<u>Always verify accuracy and currency of any data provided, regardless of source.</u>

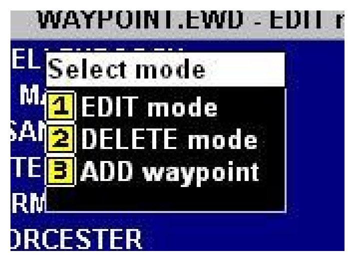
Waypoint manager

The EFIS waypoint manager is your tool to add, delete or edit waypoints in your Waypoint.ewd file on your flash drive.

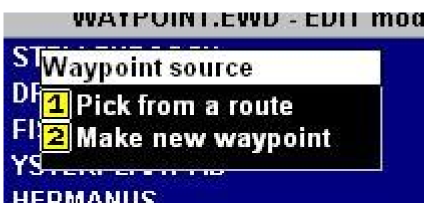
If a geographic position is known, waypoints are sorted in order of distance from you. As the EFIS can maintain up to 50.000 waypoints, a search facility is included which allows you to quickly locate any waypoint by specifying part of either the short or long waypoint name.



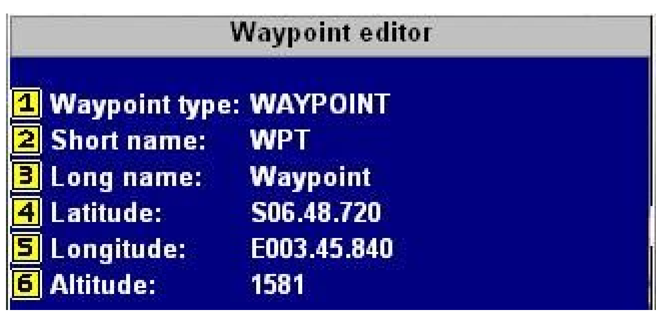
Selecting "Log" allows you to select which types of waypoints to include or exclude from your current editing session.



Pressing "Hold" will allow you to choose if you want to switch from the default "edit" mode to "delete" mode or if you would like to add a new waypoint.



Selecting "add" asks if you would like to pick an existing waypoint from a route (for example the "markers" file) or if you want to create a new waypoint.



Whether adding a new waypoint or editing an existing waypoint, you will be presented with the waypoint editor on the right.

Here you select type of waypoint, can edit the position, names and altitude (or frequency if a navaid)

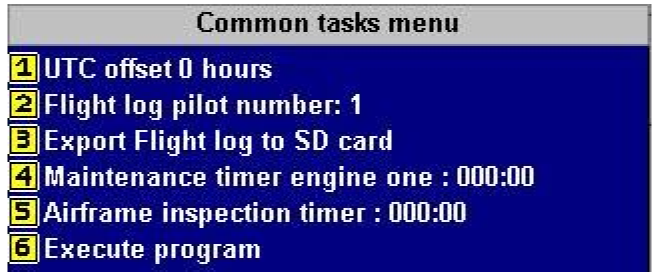
Searching for a waypoint may be done by seaching short or long names. Enter the first characters of the name and all matching names will be found and presented as shown in the example to the right. Close the search window if you can see the waypoint you are looking for. You can then select it as normal.

Tip: Waypoints created on the fly using the “mark” function are stored in order of creation in the route file “markers.ert” located on your RAM drive. You can add waypoints from the markers route file (or any other route file) by selecting “pick from a route” and then selecting the desired route name.

Recommendation: Try not to use a waypoint file with too many waypoints. While the EFIS does support up to 50.000 waypoints in the waypoint file, search for waypoints will slow down as the complete list might be searched every time you add a new search character. The EFIS only dedicates a relatively small part of its processing power to this as most of the available CPU time is dedicated to managing the hundreds of individual tasks that are required to operate a full EFIS system. Large waypoint files do not have any other noticeable affect on performance.

Common tasks menu

Grouped in the common tasks menu are items and functions that you might need relatively often for system maintenance purposes.



UTC offset...

Enter the UTC hour offset for your location. For example South Africa has a offset of UTC+2 hours. This information will be used by the EFIS to show UTC time in the absence of a valid GPS signal. If a valid GPS signal can be received, your EFIS will show the UTC time as obtained from the constellation of GPS satellites.

Flight log pilot number..

Select a pilot number under which the next flights will be logged. Every flight entry in the flight log has a pilot number associated to it.

Export Flight log to SD card

Copy your current flight log (Flight folio log) to SD card for import into your Enigma Flight Planner. You can view your flight log in Flight Planner, edit it and print it.

Maintenance timer engine 1 / engine 2

These timers allow you to keep track of engine maintenance intervals. Set the timer when you have serviced your engine. When you start your EFIS, the remaining time is shown (enable this in operations setup if required). A typical time might be 50 hours.

If you have RDAC 2 enabled (engine setup), maintenance timer 2 will show.

Airframe inspection timer

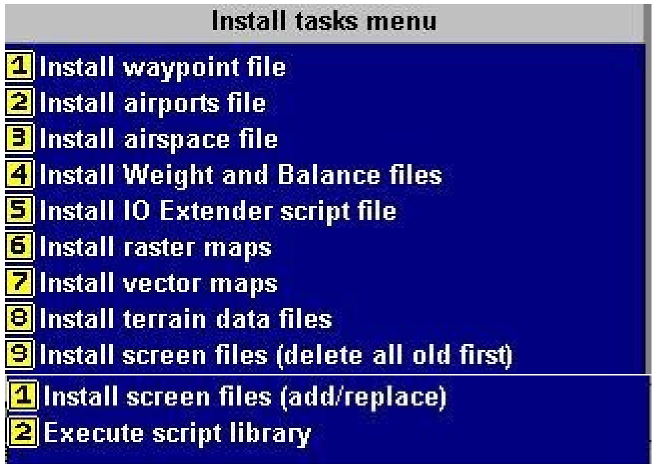
This timer operates similar to the engine maintenance timers but is based on flight time. You might use it to schedule thorough airframe checks at intervals, perhaps every 25 or 50 hours.

Execute program

This function is currently not fully implemented (check for updates for your EFIS). This function is intended mainly to allow execution of “once off” programs such as programs to update peripherals like AHRS sensors with latest software but may be expanded to other functionality as well.

Install Tasks menu

This important menu combines several often used install tasks. Functions here typically copy new data or map files from your SD/MMC card and install these at their correct locations and also ensuring that the system takes notice of any changes.



Install waypoint file

This function will install a waypoint file (waypoint.ewd) located on the SD card. The EFIS will check for available disk space, delete the old waypoint file and then copy the new file. The remainder of the system will be notified that a new waypoint file has been installed so transition to the new file can be established without glitches.

Install Weight and Balance files

Use this function to copy the files WB.DEF and WB.MIF from your SD/MMC card to the internal solid state disk. WB.DEF is created in your Enigma Flight Planner program and contains the definitions (weights and moment arms) for your aircraft. WB.MIF contains an image of your aircraft for Weight and Balance location identification. This image is created using a standard image editing program (such as Windows Paint) and converted to MIF format using the Enigma BMP to MIF conversion program.

Install I/O Extender script file

Use this function to install the I/O Extender script file created with the I/O Extender script file editor. I/O Extender script files are used to add automation and alarm monitoring functionality to an I/O Extender.

Install raster maps

Use this function to install raster maps from your SD/MMC card to your internal solid state disk. These raster files consist of a single file MAPINDEX.MM0 plus one or more raster files in the form N45W112B.M42 or similar.

Please note: Raster map files can be very large. The process of copying these files may take several minutes to several tens of minutes depending on the size of your files and the write speed of your solid state disk. Solid state Flash disks have slow write speeds.

Install Vector maps

Use this function to install the World vector base map “VMAP.EVD”. This file contains vector map definitions for urban areas, roads, rivers, water bodies, borders, etc.

Installing this file may take several minutes depending on its size.

Install terrain data files

Use this function to install terrain data files. These are large files about 54MBytes each. Installation of these files may take several tens of minutes depending on how many of these files you need to install to cover your area (For example North America typically requires four of these files).

Install screen files (delete all old first)

If you have a set of screen files on your SD card (flight1..9.efm, engine1..9.eem, infoa..e/1..9.eim), this function will install these files after deleting all other screen files first.

You will use this function to install a complete new set of screen files.

Install screen files (add/replace)

If you have a set of screen files on your SD card (flight1..9.efm, engine1..9.eem, infoa..e/1..9.eim), this function will install these files after deleting any existing with the same name first. This will not affect any other installed screen files, only the ones you are replacing.

Execute script library

This function allows you to execute a script library file.

A script library file is created by the the EFIS Screen designer and simulator. It is used to copy all screen files, sound file, and all setups from the simulator to the real instrument in one easy step.

Script libraries are the fastest and easiest way to setup an EFIS after you have designed your screens and tested your setups on the simulator.

GPS Navigation in practice

The EFIS provides you will two principal levels of navigation: “Goto” and “Route” navigation.

You use the “goto” navigation function at any time to select a waypoint you wish to fly to. Waypoints may be any defined waypoint in the waypoint file “Waypoint.ewd” as installed on your EFIS, or you can choose any waypoint from any route file you may have on your system including the “markers.ert” special route file.

Once you select a “goto”, the EFIS creates a single route leg from your current position to the waypoint you have selected. From this point onwards, the CDI indications work just as if you would be navigating a route leg, showing any deviation from the straight line between start and destination of your “goto” leg.

From any of the nine main screens, press SHIFT and then “1”. The “1” button has the word “goto” written above it. This will lead you to the waypoint selection menu.

Press “LOG” to select waypoint types to include or exclude from the list. The “Enter” button can be used to search for a waypoint (for details on this, view the section on the waypoint manager). Pressing the “left arrow” button allows you to pick a route and then you can select a waypoint from that route. Please note, when you are viewing the waypoint list, the screen background is blue.

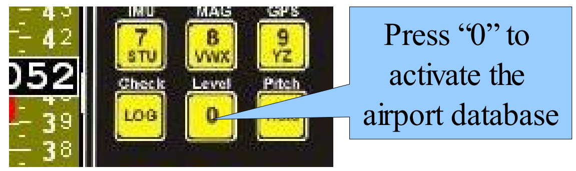
If you are picking a waypoint from a route, the background is green.

Using the Airport database

The EFIS supports both a waypoint as well as a airport database. These are two separate databases with the provision that every airport in the airport database must also have a corresponding entry in the waypoint database.

Waypoint and airport databases are maintained by the EFIS FlightPlanner program and are imported into EFIS using the waypoint and airport import functions in the common functions menu.

Activation of the airport database is always done from any main display by pressing the “0” button



Activation of the airport database leads to the display of short information for the closest 8 airports to your current location:

Each entry shows an arrow indicating which direction to fly relative to your current heading to intercept the airport. If the arrow points straight ahead, continue your current track.

Next is the distance to the airport (using distance units as selected for your instrument in “units setup”).

Next, an approach, tower or unicom frequency is shown if defined in your airport database. If no frequency is defined, “No Freq” is shown.

This is followed by a primary and, if available, a secondary runway designation.

Selecting any of the eight airports results in the following display:

Shown are all defined frequencies for your selected airport (and the nominal airport altitude above MSL). If you have a compatible communications radio connected to your EFIS, selecting any of the frequencies will set your radio to that frequency.

Next, the defined runways are shown with designation, surface type (Asphalt in this example), length and width. If your database defines precision GPS approach data for the runway, selecting the runway will lead to the EFIS asking which direction your would like to land on the runway and after you have chosen, the EFIS will guide you to an intercept point where you can turn onto the runway heading and, using your preferred glide slope that your have setup, will guide you to the threshold of the runway. If your area has WAAS or equivalent support compatible with the GPS receiver in your EFIS, accuracies up to 3 feet can be obtained provided your airport data has the required accuracy. Without WAAS, accuracy is typically 15-50 ft depending on the current satellite constellation and visibility to your GPS receiver.

If your database does not contain GPS approach data “NO APP” is shown.

Please note that the EFISs approach assistance is not intended to be used in zero visibility conditions as neither database information nor GPS can be relied upon as sole means of navigation. For example, GPS may be subject to outages from many causes.

USE GPS AIDED APPROACHES ONLY WITH A GOOD GPS ANTENNA INSTALLATION AND AFTER VERIFICATION THAT THE DATABASE HAS ACCURATE INFORMATION. ALWAYS HAVE AN ALTERATIVE SOURCE OF NAVIGATION INFORMATION AND CROSS CHECK.

As alternative to GPS approaches you can perform a “Goto” to this airport similar to using a “Goto” with any normal waypoint.

Using the Airport browser

Pressing “9” from the closest airports selection will open the airport browser. Here you can page through all available airports in the order they are defined in your airport database. You can select any airport and proceed as with selection of one of the closest airports.

You can search for an airport by pressing “LOG”. This presents you with an entry field where you can enter the desired airport designator, for example “KLAX” for Los Angles international airport. If the airport exists in the database, you will be presented with the airport details.

Using the airports database with an active route

If you have a route activated, pressing “0” will show you the airports contained in your route starting from your current leg, in order of legs (this depends if you started the route forward or backwards). Any waypoints other than airports contained in your route are not shown.

Should you have a route active but would prefer to view the list of nearest airports, press “Switch to nearest airports”.

Selecting any of the airports will show you the airport details. Should you select “goto this airport” from within the airport detail view, you will cancel your current route.

Note: EFIS routes are completely independent from any waypoint or airport databases. Should your route contain airports that are not defined in your airport database, this will not affect the operation of the route but in the above route airports view, missing airports will not be shown.

Notes on usage of the airport database

Your airport database is somewhat reliant on your waypoint database.

While you are flying, the EFIS continuously sorts your waypoint list in the background by distance from your current location. This is required so that your moving map drawing does not have to search through the entire waypoint database (which could be very large) in order to find out which waypoint icons need drawing on your currently visible map.

Also, when you perform a “Goto” you immediately see waypoints sorted by distance.

When you activate the airport database, your EFIS searches from your closest waypoints and identifies the eight closest waypoints containing airports or airfields. These are then searched for in the airport database. The EFIS will try to find at least eight airports that are contained in your airport database.

Airports and waypoints are matched by the short waypoint name.

If you do not have a waypoint database installed that contains the airports in the airport database, the EFIS cannot perform the closest airport search and you will need to use the airport browser.

Location and installation of the Airport database

The airport database forms part of the Navidata.ewd file. In Enigma this file resides either on the internal flash drive (copied there using the “Install navidata” menu function) or it can remain on the SD card.

On Odyssey, Voyager and Explorer EFIS systems the navidata database file can be installed into the Navdata folder or it can reside on the SD card.

Navidata files residing on the SD card will be loaded in preference to internal installed navidata databases.

Sensor fusion navigation

The EFIS provides a comprehensive navigation system that is exceptionally flexible and powerful while at the same time easy to use.

The EFIS allows using a large number of external as well as internal navigation sources. In order to make it possible to use such a large number of divergent navigation systems and sources, the EFIS includes a Sensor Fusion navigation engine.

Sensor fusion allows the selection of a navigation source for navigation, interprets this source in a consistent fashion for display on HSI and GSI indicators and provides the navigation information to autopilots.

Navigation sources

The EFIS supports the following inputs to the navigation system:

- Analog inputs (+/-150mV)

  The EFIS provides 4 analog +/-150mV inputs compatible with many navigation radios. Input 1 is used for HSI, input 2 for GSI, input 3 is used to provide a “valid” indication for input 1 and input 4 provides the “valid” indication for input 2.

  If analog inputs are selected as navigation source, no radial information is available if the source is a VOR receiver. The sensor fusion engine will track the HSI. For this to be possible, it is required to manually fly an intercept to the desired radial before activating the autopilot to then track the HSI.

- ARINC 429 inputs 1 to 3

  The three ARINC inputs can each connect to a different navigation source. These can be VOR receivers or ILS/GS receivers or combinations thereof. VOR receivers provide radial information allowing autopilot intercept and tracking of a radials. ILS localizer intercept and tracking is supported as is glide slope intercept and tracking.

  Note: ARINC channel 2 is a high speed channel intended for connection of TCAS/TIS systems, however, if the required navigation labels are present at this input, they can be used for navigation.

- Serial NAV radio on RS232 input 1

  The EFIS supports a GARMIN SL30 NAV/COM or a MGL NAV/COM radio connected to RS232 input 1. Both radios provide full VOR and ILS/GS functionality and can be used for autopilot intercept and tracking of radials as well as ILS localizers and glide slopes.

- GVOR – Simulated VOR using GPS and navigation database

  The built in GVOR system of the EFIS can be used just like a “real” VOR and this can be used as source for an autopilot.

- GLS – Simulated ILS and glide slope

The built in GLS functionality can be used to intercept and track a GPS simulated ILS localizer and glide slope. This can be used in conjunction with the GLS intercept. With this a connected autopilot will first intercept a point along the extended centerline of the desired runway before turning finals and switching to the simulated localizer and glideslope intercept and tracking.

- GPS waypoint and route navigation

  Activating a “goto” to a waypoint (waypoints, airfields, navigation beacons, etc) will cause a connected autopilot to track to the destination.

  Activating a route (flightplan) will cause the autopilot to execute tracking of each leg of the route. Normal “forward” and “backward” controls by the pilot to select the desired leg of the route should be executed before activating the autopilot.

  If GPS steering is enabled, the sensor fusion engine will execute smooth course changes onto the new heading slightly before the end of a leg has been reached. This may result in waypoints not being overflown.

  GPS navigation may include “altitude change waypoints”. If such a waypoint is reached the autopilot, if it is capable of changing altitude, will initiate a climb or descent. Please note that you should set the desired climb and descent rates in the Navigation setup to be compatible with your aircraft and flight profiles.

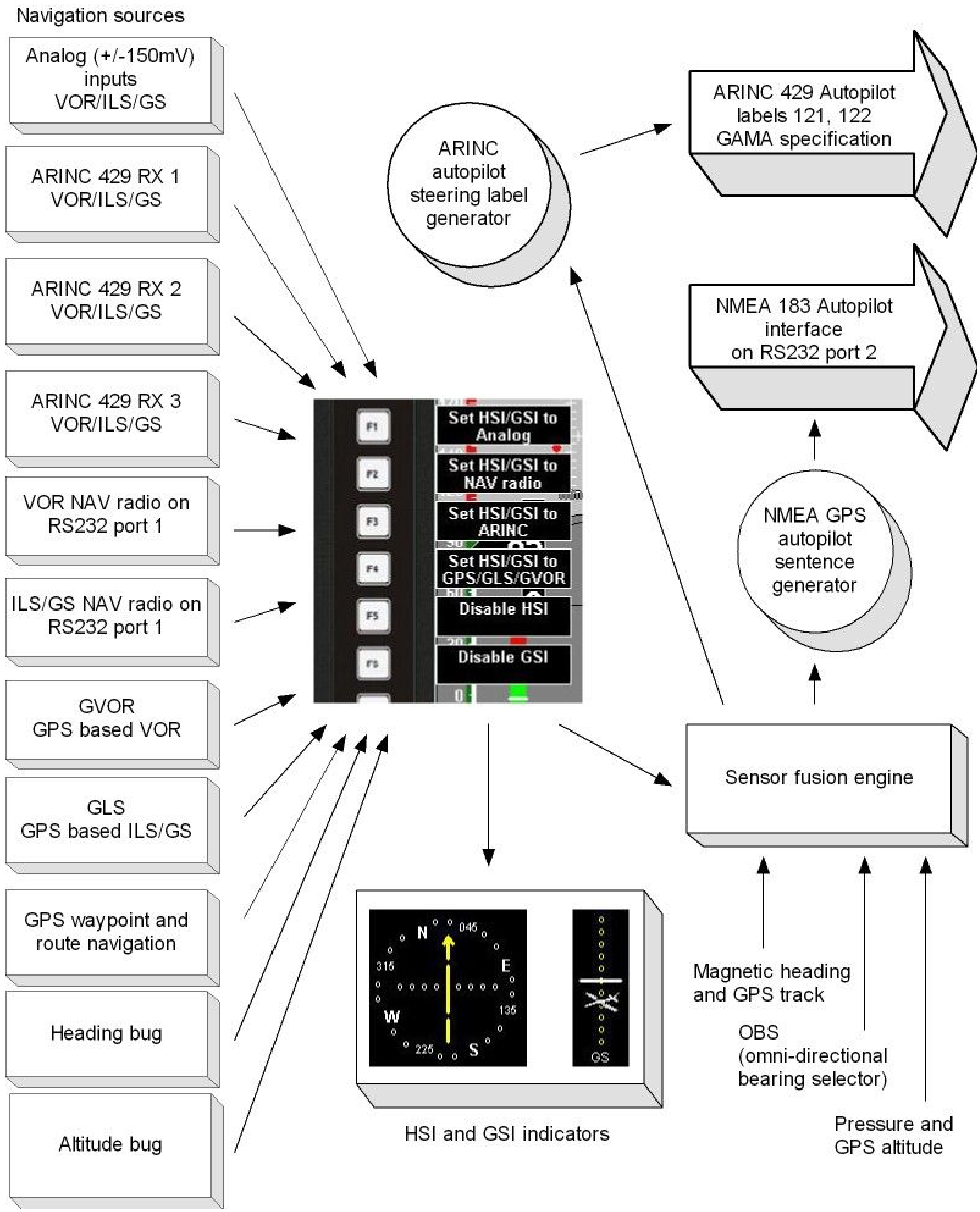
- Heading bug

  If the heading bug is activated as navigation source, selecting a heading will cause the autopilot to follow this heading. Note that in this case CDI (course deviation indication) does not apply. The autopilot steers the heading regardless of resulting ground track.

- Altitude bug

  If your autopilot is able to change altitude, the sensor fusion engine will track the altitude based on the heading bug as target altitude. Please note that you should set the desired climb and descent rates in the Navigation setup to be compatible with your aircraft and flight profiles.

The following page gives a graphic overview of the EFIS sensor fusion navigation system.


Navigation sources
Analog (+/-150mV) inputs VOR/ILS/GS
ARINC 429 RX 1 VOR/ILS/GS
ARINC 429 RX 2 VOR/ILS/GS
ARINC 429 RX 3 VOR/ILS/GS
VOR NAV radio on RS232 port 1
ILS/GS NAV radio on RS232 port 1
GVOR GPS based VOR
GLS GPS based ILS/GS
GPS waypoint and route navigation
Heading bug
Altitude bug
ARINC autopilot steering label generator
ARINC 429 Autopilot labels 121, 122 GAMA specification
NMEA 183 Autopilot interface on RS232 port 2
NMEA GPS autopilot sentence generator
Set HSI/GSI to Analog
Set HSI/GSI to NAV radio
Set HSI/GSI to ARINC
Set HSI/GSI to GPS/GLS/GVOR
Disable HSI
Disable GSI
Sensor fusion engine
Magnetic heading and GPS track
OBS (omni-directional bearing selector)
Pressure and GPS altitude
HSI and GSI indicators

Using the sensor fusion navigation system

The EFIS navigation system is very simple to use, despite its many options.

Using the function keys on the left side of the screen, simply select the desired navigation source. The selected source will be shown above the HSI or GSI display (as applicable).

External navigation sources will of course depend on what you have installed in your aircraft. Sources that are not used should be disabled in the HSI and GSI setup menu so they will not appear in the selection.

If a valid signal is present at the source, the HSI and GSI indicators will activate. At the same time the autopilot will receive instructions to track HSI and GSI using additional bearing information where available and required.

Example HSI and GSI display during a GLS approach onto a runway. The OBS has been set automatically as the runway heading is known. This display shows us that we are slightly to the left of the centerline while crabbing to the right. We are also a little below the glide slope.

A small text field above the HSI shows “GLS” to indicate the selected navigation source for the HSI display and autopilot.

The autopilot interfaces

The EFIS supports two autopilot interfaces. The first is a GPS bases system using NMEA sentences on serial RS232 port 1. The second interface is via the ARINC 429 TX channel.

These two interfaces are very different in their capabilities and options:

- NMEA on RS232 port 1

  NMEA autopilot sentences where designed specifically for GPS route and waypoint navigation. The EFIS's sensor fusion engine uses these sentences for VOR, ILS and heading bug navigation by generating appropriate data fields within the sentences that in effect emulate GPS navigation without a GPS navigation source.

  A newly defined VNAV sentence is also available and may be used by newer generation autopilots that understand this sentence for vertical navigation.

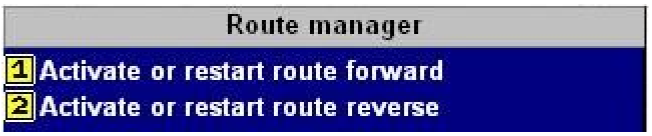
- ARINC 429 TX (Normal speed, 12500 bits/second)

  ARINC autopilot navigation is relatively primitive. It consists of just two labels that instruct the autopilot to bank left or right at a given angle or fly up or down at an angle. Of course this means that the sensor fusion engine needs to be more involved in the actual flying of the aircraft as it needs to work out optimum bank angles to intercept and track a given course or ground track.

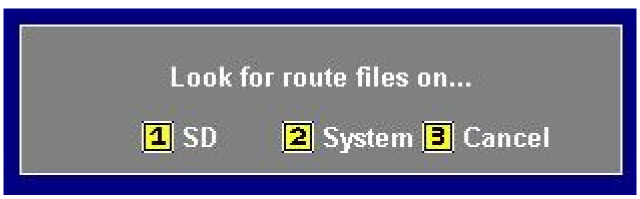
Some autopilots allow connection of NMEA and ARINC at the same time. Often these will use the NMEA for horizontal, GPS based navigaton while using the ARINC for VOR/ILS navigation and vertical navigation (altitude bug, route navigation or glide slope).

Navigation using routes

To activate a route, press “SHIFT” and then “4” (it has “route” written above the button). You will be presented with the route manager menu. You can also activate the route manager by going through the menus.



Select if you would like to fly your route in forward (first entry to last entry) or reverse direction (last entry to first entry).

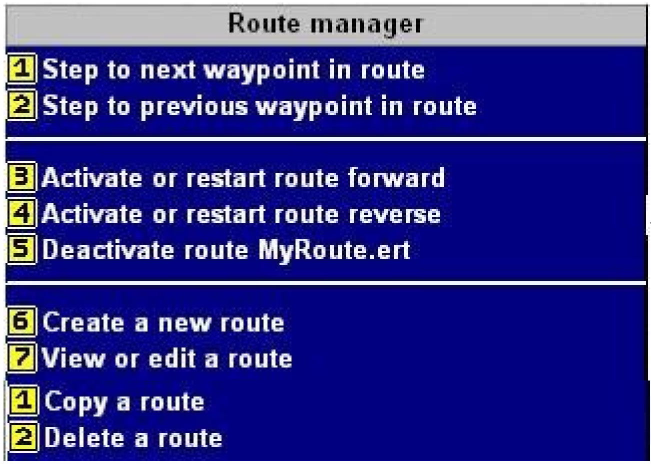


Select if you would like to fly a route stored on your SD card or one that has already been copied to your internal RAM drive.

Now select the route to fly.

Note: If you select a route from the SD card, it will be copied to the RAM drive for you and executed from there. If you would like to start this route again later, you can select it from the RAM drive as it exists there already.

The EFIS is now navigating to the first route waypoint and the route manager now looks like this:



You can move forward or backwards in the currently activated route or end the route at any time.

You may also move forward and backward in a route by using the left and right arrow buttons from any main display screen.

Note on the operation of the left/right arrow buttons:

If no route is active, the buttons are used directly to switch between info screens if your current screen has multiple info screens defined.

If a route is active, the buttons are used to move forwards and backwards through your route. In this case, using SHIFT with the two arrow buttons will page between the info screens.

Use “System setup” and then “setup Navigation” to set your waypoint intercept radius and automatic route advance option.

When your distance to your target waypoint is closer or equal to the waypoint intercept radius, The EFIS will consider that you have arrived at your waypoint. A message telling you that you have arrived will be shown on your screen and if you have your audio system connected to the EFIS the waypoint arrival voice alert will sound.

If you have the automatic route advance option selected, the EFIS will at this point automatically select the next waypoint in your route if there are any remaining.

CDI and goto displays

This image shows the two types of GPS based CDI displays supported with the current version of the EFIS. The top display is a true CDI which in this case is telling you that you are about 2 miles to the left of the desired track and you should steer right to intercept the track.

The second option is a combination of compass rose, direction to waypoint and CDI. We refer to this instrument as a "HSI" or horizontal situation indicator. In this case the "HSI" is telling you that your heading is due north, that your heading is slightly to the left of your destination (you should turn right a little to get the arrow to point up (which means destination is straight ahead). The CDI is telling you that you are about 2 miles to the left of the desired track and should steer right to intercept.

Use "System setup" and then "setup Navigation" to set your desired CDI resolution.

A second, similar CDI "rose" exists in your EFIS screen design and referred as NAV HSI. The NAV HSI can also display CDI from VOR and ILS localizers.

This image shows an alternative navigation instrument created with two components, the small compass rose and a heading error set to show "track error".

It will show heading (which could be GPS or compass heading, depending on how your screen design has been set up) and the arrow points to the direction to fly in order to intercept the next waypoint. If the arrow points straight up, your waypoint is dead ahead.

Highway in the sky (HITS) navigation

Your EFIS implements a sophisticated 3D graphics engine that is able to translate points of real geographic coordinates and elevations or altitudes into corresponding locations on the EFIS display taking the current aircraft attitude into account as well.

HITS navigation is available on any horizon display as overlay and is active whenever you perform a “goto” to a waypoint or activate a route.

HITS is a GPS based navigation system. It does not work with VOR based navigation. However, it can be used in parallel with VOR navigation which works using a CDI display.

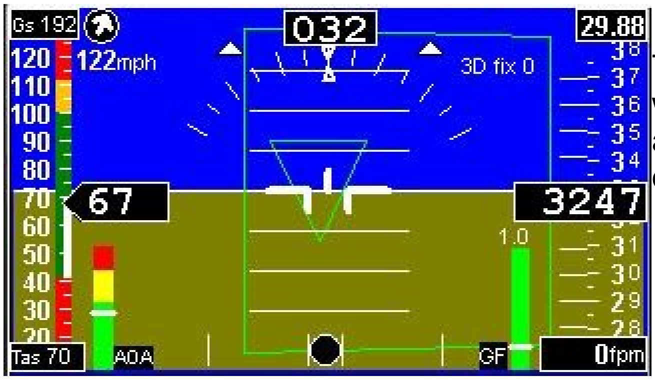
Depending on your setup preferences, HITS can also take your current altitude into account, relative to the Highway in the sky and the Image on the screen behaves accordingly.

This image shows a typical Highway in the sky (HITS) display. The desired flight path should go directly through the center of the green boxes. In this image, the aircraft is to the left of the desired track and too low. We can also see that at the current heading, we will be intercepting the track soon but we should also climb to intercept the desired altitude.

The picture on the right shows the view on the Highway in the sky when we are on track and at the correct altitude. The green boxes of the Highway in the sky form a tunnel. As long as we fly along the tunnel we are on track, at the correct heading and correct altitude.

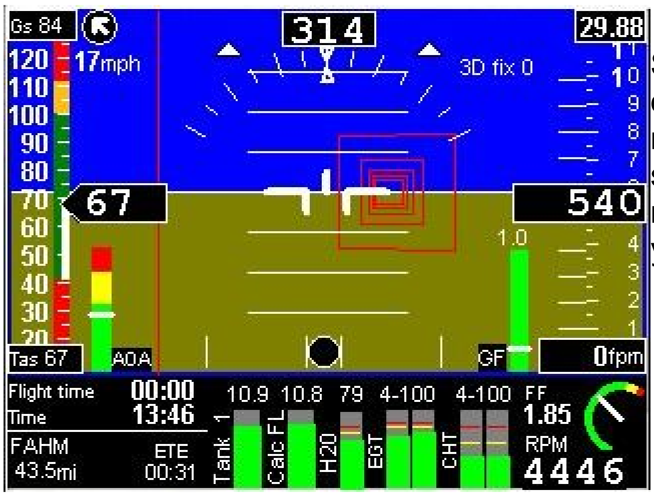
This image also shows the last “box” to be a triangle. This is the end of the track, the location of the current waypoint.

Highway in the sky – arriving at the waypoint



The last highway box is located right at your waypoint. This is drawn as a triangle with the apex downwards pointing to the exact location of the waypoint geographic coordinates.

Highway in the sky – going the wrong way



Should your heading be more than +/-90 degrees from the desired heading to reach the next waypoint, the highway is drawn in red as shown in the picture on the left. You need to reverse course as you are flying away from your target.

Highway in the sky – details and setup.

Your EFIS implements a “real” highway in the sky. When you activate GPS navigation to a waypoint, the EFIS calculates the exact geographic coordinates and altitudes of each box corner. Boxes are placed certain distances apart, starting at the target waypoint. If your distance units are set to Kilometers, the boxes are spaced 2.5Km apart. 2 statute miles or 2 nautical miles for the other options.

Because of this, the boxes will not move if you are not moving. However, if you are moving towards the boxes, they will appear to move towards you, at a rate that depends on your speed.

A minimum amount of setup is required to operate your HITS.

You can enable or disable the Highway in the sky display (it is shown as overlay in any horizon display).

You can choose the size of the highway in the sky boxes. Normally we suggest to use 1000 feet (1000 feet width and 1000 feet altitude). You may select different sizes if you wish.

You can select to have your HITS sensitive to your current altitude. In this case the HITS boxes will seem to lower or raise relative to your current altitude. This is used as an easy way to fly a given altitude.

If you leave this box unchecked, HITS boxes will always show at your current altitude.

Setting HITS altitude to fly

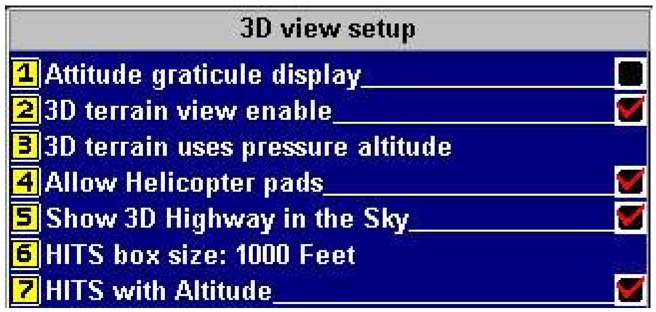
If you have “HITS with Altitude” checked in navigation setup, the desired altitude is selected when you perform a “GOTO” waypoint. The EFIS assumes that you want to continue on your current altitude.

You can update this altitude at any time to your current altitude by selecting the “Set HITS to current altitude” function which appears in the menu whenever a track is active.

If you are activating or flying a route you need to set the desired altitude using the above function whenever you would like to change cruising altitudes.

Forward looking 3D terrain and airport views

Accessible from Main menu level 2, you have the 3D setup menu:



Attitude graticule display

If you have an artificial horizon sensor connected, it is recommended to select this box. This will enable the horizon graticule lines. It will also result in your horizon screen drawn in gray if no information is received from your horizon sensor.

If you are not using a horizon sensor, leave this block unchecked. This will result in the horizon always drawn in sky/ground colors and the horizon graticule lines will not show. This setup still allows you the full abilities of the 3D terrain view, HITS navigation and 3D runways.

3D terrain view enable

Select this box if you want the 3D terrain view displayed. Note that in order for 3D terrain to show, you need terrain data files on your SD/MMC card for your location and a valid GPS position. Terrain will not show if your GPS is not currently receiving a valid fix.

Allow helicopter pads

Deselect this item if you are flying an aircraft that cannot make use of helicopter landing pads. This will avoid the EFIS using up the airport cache for helipads if you are flying in an area that has many helicopter landing pads (this can prevent the EFIS from showing runways until you are close to the runway).

3D terrain uses...

Select if you would like to use pressure altitude (subject to your local Baro setting) or GPS derived altitude as reference for the 3D view (this governs the “height” of the view). If you select GPS and no 3D fix can be obtained, pressure altitude is used.

We recommend to use pressure altitude as bad satellite visibility or unsuitable constellations may result occasionally in fairly large errors in altitude calculated by the GPS system.

Items related to HITS (Highway in the Sky) are described on page .

3D terrain – how it works

Somewhere in the Southern French Alps

The EFIS's 3D terrain feature is available if you have terrain data in GTOPO30 or STRM30 format loaded for your location on your SD card. Terrain files covering the entire Earth are available for free download from the MGL Avionics data download website. Follow the relevant links on www.MGLAvionics.co.za.

These files are also found on your EFIS DVD.

Terrain is drawn in form of a terrain mesh derived from this data. Each crossing of two lines on the terrain image corresponds to one data point in the source data. Each square is approximately 1 square KM or 1/120th of latitude and 1/120th of longitude exactly.

The EFIS constantly maintains a representation of the terrain up to about 60 KM in the direction you are flying. If you are flying towards mountains not yet in this range, the mountains will not show. As you get closer, you will start seeing the mountains build on the image.

If you are flying much higher than the terrain, you can easily see the limits of the terrain as currently represented in your EFIS as shown on the above image. Any area that does not yet have terrain representation (as you are too far away) is shown in green.

3D airports/runways

If you have airports data installed on your internal solid state disk, The EFIS will draw runways in 3D when you get within range of an airport.

The EFIS continuously scans the data for runways and helicopter bases that are close to you. The two closest airports are considered. If you are flying a 3 axis aircraft that is not able to consider helipads, deselect the "allow helipads" entry in the 3D setup. This will make sure that you will be presented with runways only if you are in an area that has many helicopter landing pads.

The EFIS will show vital approach information as follows:

a) The airport code (usually FAA code).

b) distance to go

c) time to go assuming you proceed to the airfield in the shortest distance

As you get closer than about 10 miles to the airport, runway designations appear "floating" above the runway thresholds. This allows you an early orientation towards the airport layout and runways.

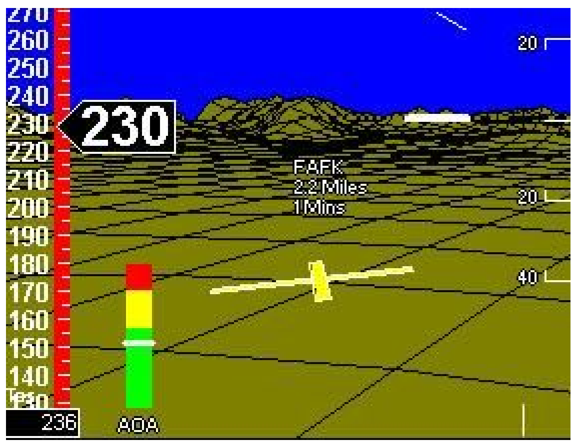
The EFIS will consider up to five runways per airport. If an airport has more than five runways defined in the database, the first five will be used. Helipads, if defined as part of a normal airport will be shown as well.

Runways can appear in one of two colors. This is very significant.

Blue runways: The runway is drawn using GLS runway data. This specifies actual geographic positions of runway thresholds and elevations. This data is accurate (providing of course that it has been defined accurately in the database). You can consider using the image on the screen to give you initial approach guidance in bad visibility.

Yellow runways: The runway is defined only by means of runway designations. The airport is defined using a single geographic location. In this case, the EFIS uses the runway designations and length and width (if defined) of the runways together with the local magnetic variation to derive actual true runway headings. The position as defined for the airport is taken as the center of the runway. If more than one runway is defined, they will be drawn with their centers overlapping in a single location.

Yellow runways may or may not show actual airport layouts but will give a reasonable overview. Yellow runways cannot be used as target for a GPS aided approach (GLS approach).



Traffic monitoring

The EFIS can be connected to a variety of traffic monitoring sources:

TCAS

TCAS is based on active transponder interrogation. If you have a TCAS compatible system, your can connect it to the EFIS via high speed ARINC RX channel 2.

TCAS allows for reporting of up to 30 intruders with range, bearing and altitude information.

The EFIS will track intruders and draw the flight path of the intruders.

TIS

TIS is available at selected airports, currently in the United States only. TIS requires use of a mode-S transponder that can receive TIS transmissions. If you have a TIS compatible transponder, connect it to high speed ARINC RX channel 2.

TIS allows for reporting of up to 30 intruders (possibly limited by the transponder to a lower number) with range, bearing and altitude information.

The EFIS will track intruders and draw the flight path of the intruders.

XRX PCAS

PCAS is a passive, transponder based system. PCAS can report up to three intruders with range, bearing and altitude information. Please note that passive systems may have reduced accuracy, in particular bearing to intruder. Bearing errors of up to +/-45 degrees may be possible. Location of an intruder as shown by the EFIS must be interpreted as an estimate only. Please view the documentation of your PCAS system for specifics.

Due to unreliable bearing information the EFIS will not draw the track of an intruder.

FLARM

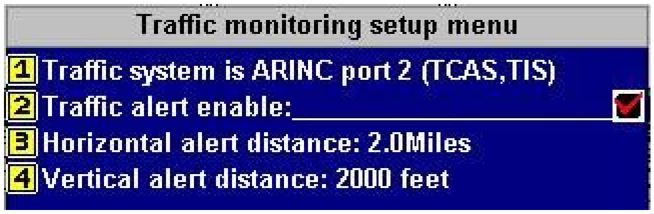
FLARM is a low cost, short range active transponder based system. It does not use or require normal mode-A,C or E aircraft transponders or primary radar stations.

FLARM is based on GPS position reported by other FLARM equipped aircraft.

Up to three intruders can be reported.

The EFIS will track intruders and draw the flight path of the intruders.

Setting up the traffic monitoring system



Using the provided menu in the System Setup menu, select the desired source for traffic monitoring. You can select multiple sources such as TCAS/TIS and FLARM or TCAS/TIS and PCAS.

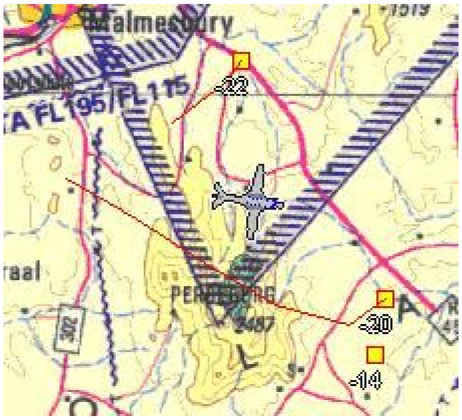
If you select PCAS or FLARM, you must also enable the RS232 port 1 setup for the chosen source:

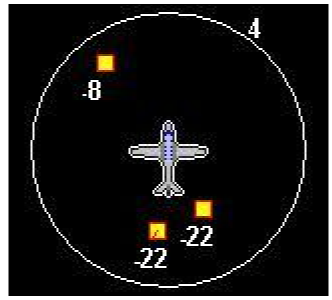
The serial port selection is performed in the System Operations setup menu.

If you have the optional USB communications extender installed, external serial ports 2,3 or 5 can also be used for traffic monitoring systems.

Display of traffic

Traffic can be displayed either on any moving map display or the navigator display.





Traffic is displayed as a small yellow square with red border and can be trailed by a red flight path if previous history of this intruder is available. Underneath the intruder the relative altitude is displayed in steps of 100 ft. Negative values mean the intruder is below your altitude while positive numbers show intruders above your flight altitude.

Please be aware that altitudes reported by traffic monitoring systems may lack absolute accuracy and thus must always be interpreted as estimates. It is possible that an intruder is reported at an altitude below yours while it is actually above.

Altitudes reported are based on transponder responses relative to your pressure altitude at 1013.25 mB or 29.92"Hg. In case of FLARM, altitudes are based on GPS derived altitude.

Traffic alerts

If you have traffic alerts enabled, any traffic that is at less than your defined horizontal alert distance and within your vertical alert distance will activate an on-screen warning message that is also coupled to your audio output. If you are using a standard sound file the message reads in the well known format:

"Traffic 2 o'clock high"

Traffic is reported as 1-12 o'clock relative bearing from your aircrafts nose with 12 o'clock being straight ahead.

Traffic may be "high" or "low" or at the same level in which case the word "high" or "low" is omitted.

Testing the traffic system

If you have a PC or laptop computer with the EFIS Screen Designer and Simulator installed and your system is fitted with a serial port you can simulate a real XRX PCAS or FLARM traffic system. Consider a USB to serial adapter if your laptop does not have a serial port built in.

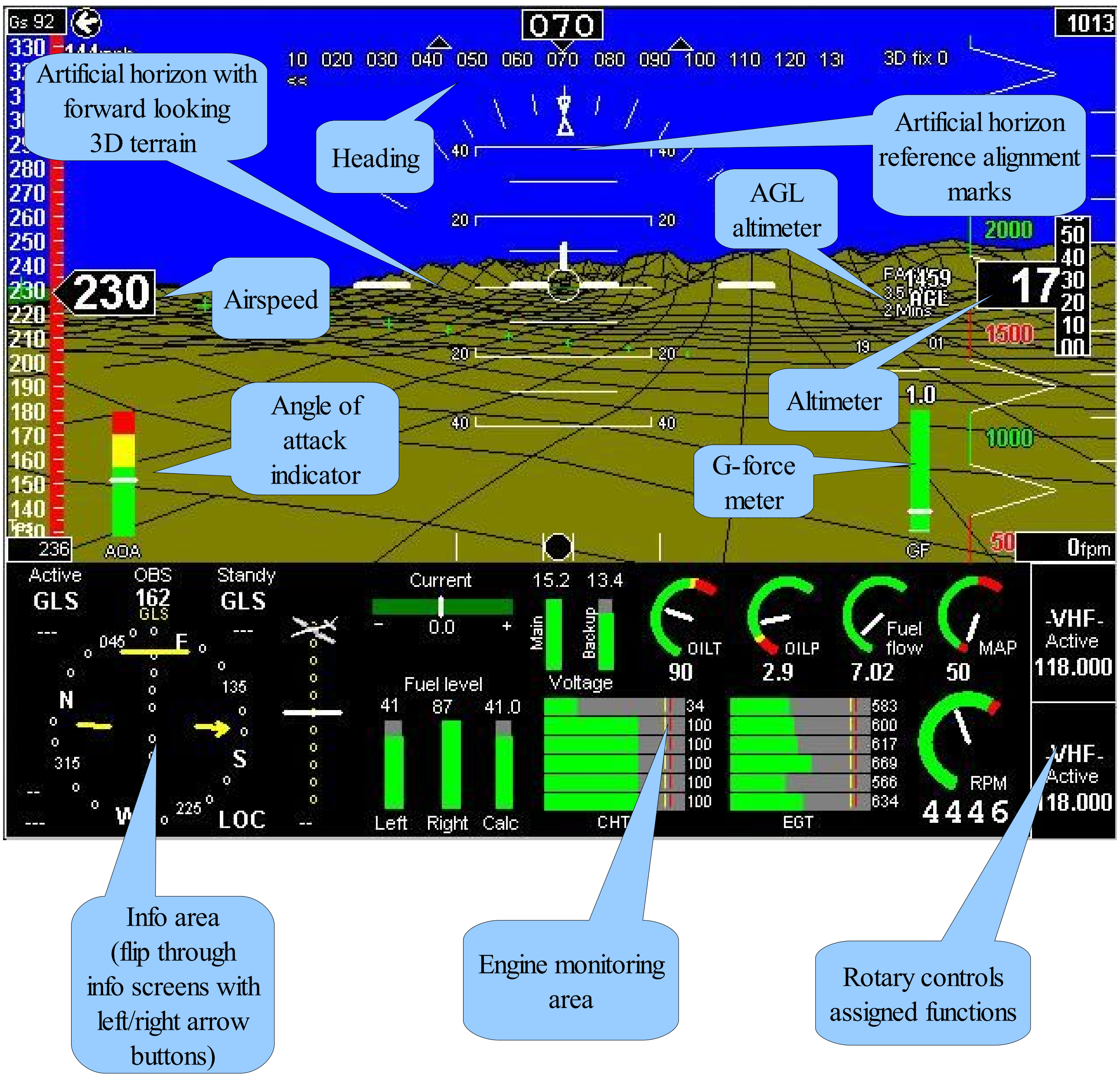
Enable the serial port device simulator and select the required system. Traffic will be simulated automatically.

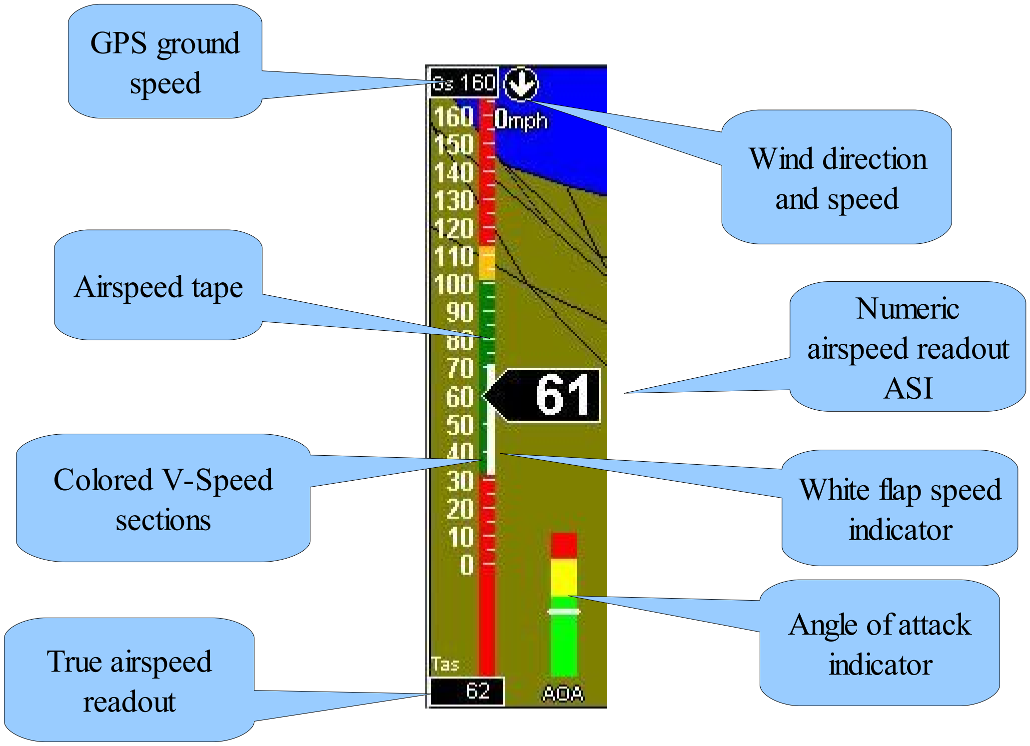
Traffic via the ARINC interface cannot be simulated directly via the PC. Please check for updates to the EFIS firmware and Simulator as we are planning ARINC simulation via a standard RS232 port for ease of testing.

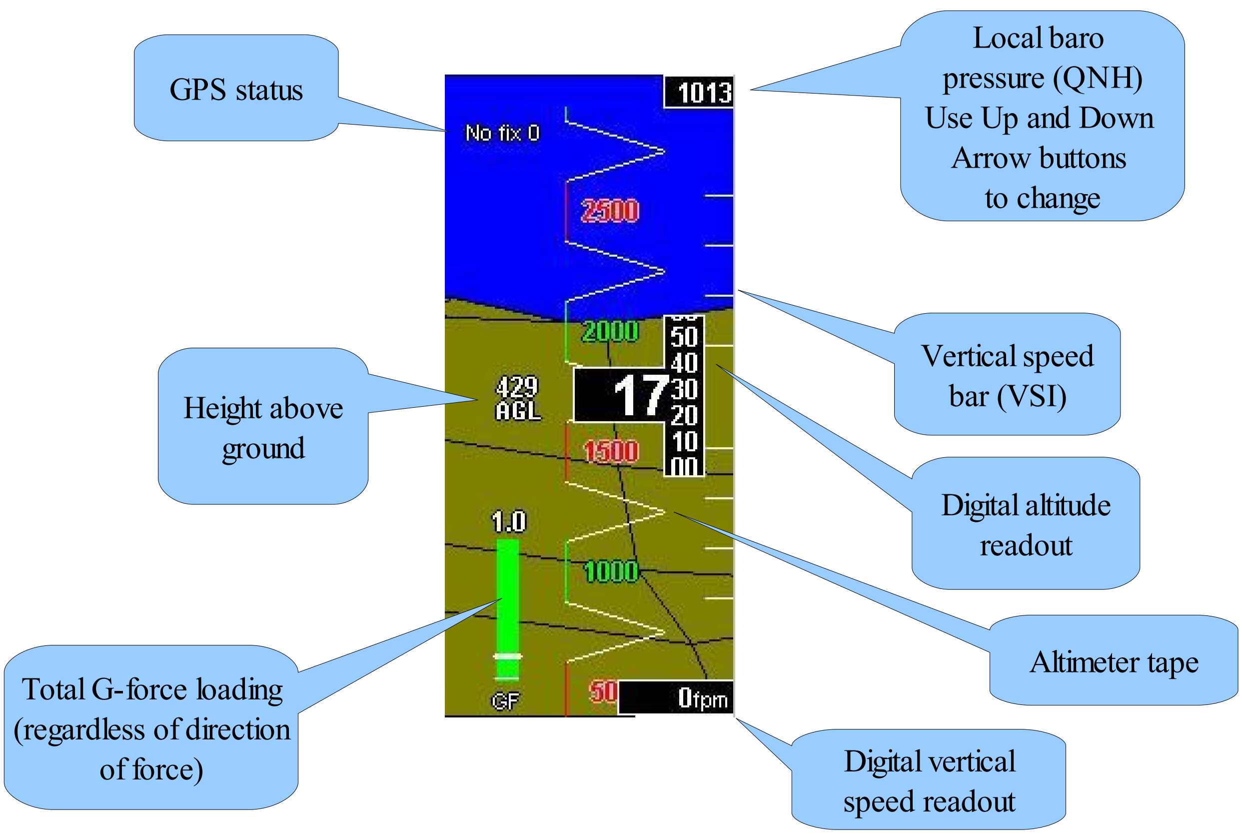
The standard screens in detail

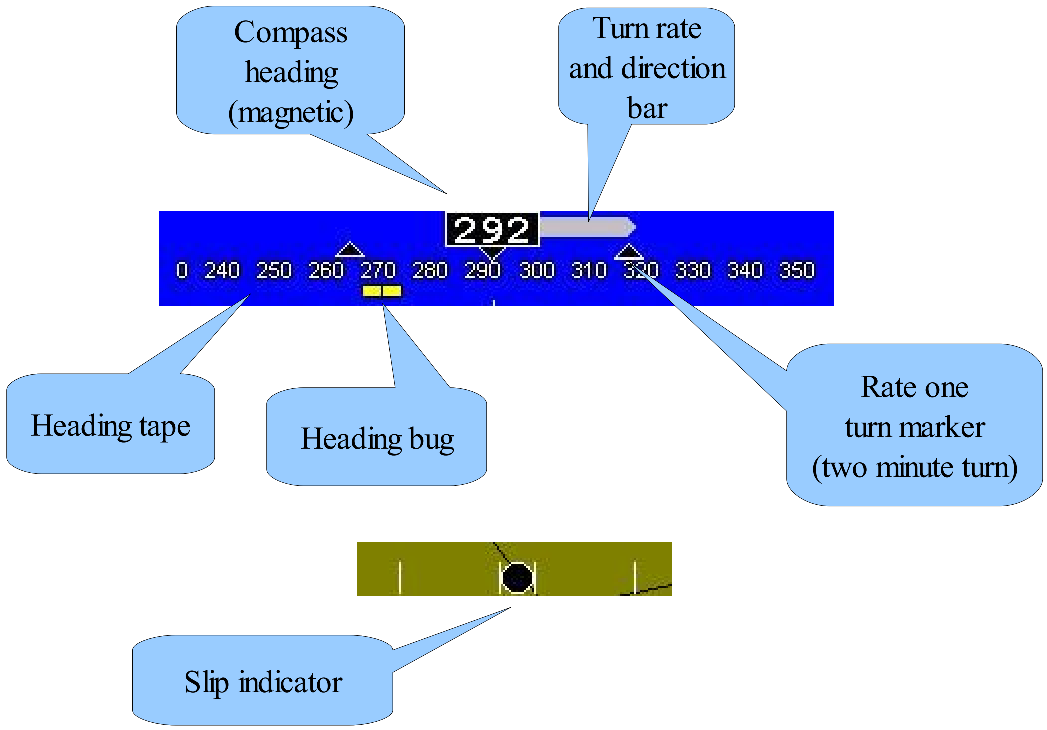
The IFR screen

Standard screen 1 is a IFR screen to be used with artificial horizon sensor and a compass. Engine monitoring section differs depending on the engine type selected.

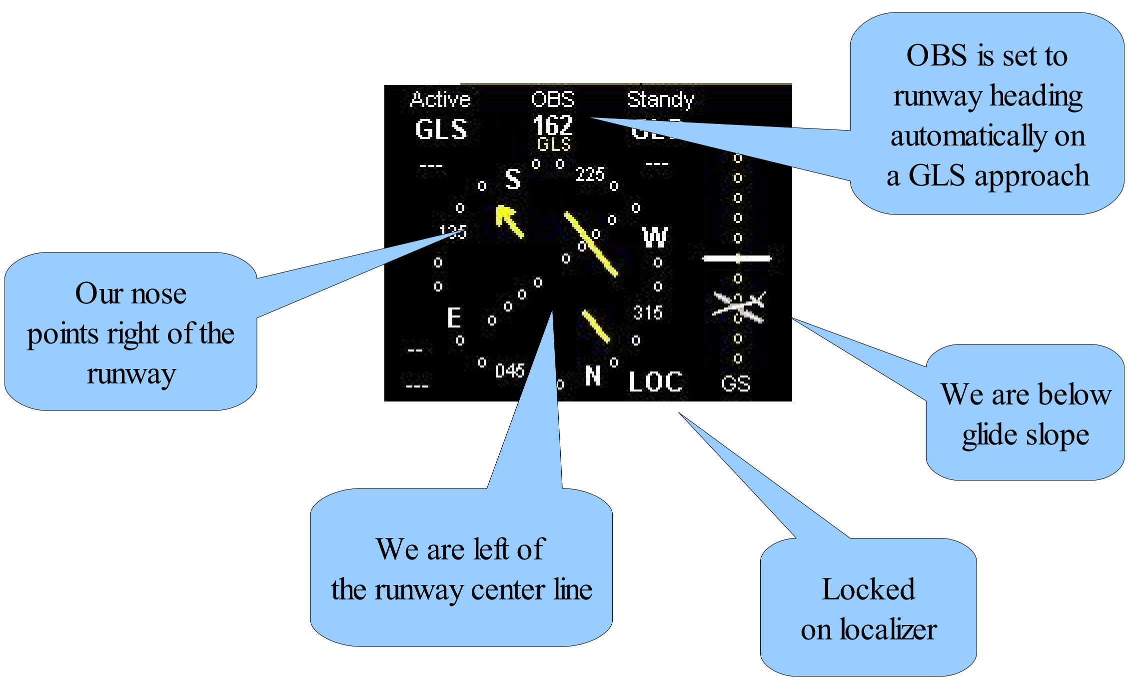



GPS ground speed
Wind direction and speed
Airspeed tape
Numeric airspeed readout ASI
Colored V-Speed sections
White flap speed indicator
Angle of attack indicator
True airspeed readout
Gs 160
0mph
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
61
Tas
62
AOA

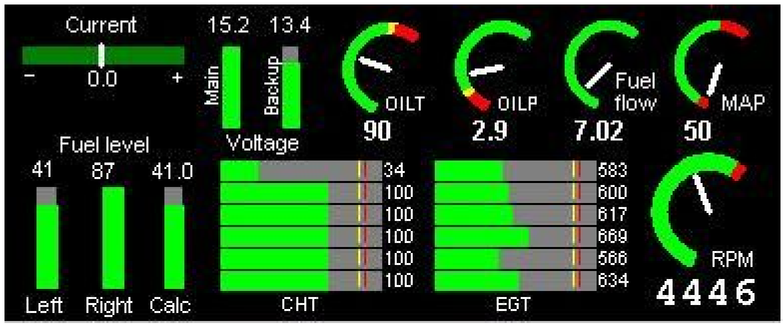

GPS status
Local baro pressure (QNH) Use Up and Down Arrow buttons to change
Vertical speed bar (VSI)
Height above ground
Digital altitude readout
Altimeter tape
Total G-force loading (regardless of direction of force)
Digital vertical speed readout
1013
No fix 0
2500
2000
429 AGL
17
50
40
30
20
10
00
1500
1.0
1000
GF
50
0fpm



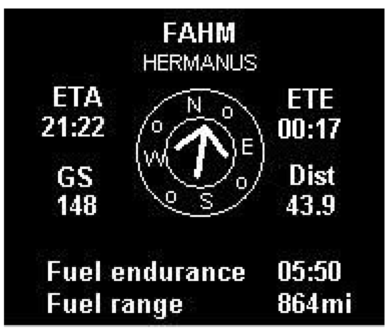
Info screen area showing HSI and glide slope indicator (currently flying a GLS approach)



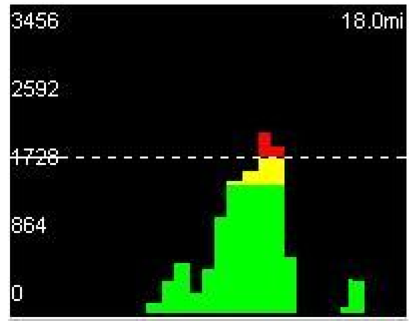
Engine area, here showing a typical 6 cylinder setup with two fuel tanks



Other standard info screens (choose info screen by paging with the left/right arrow buttons).



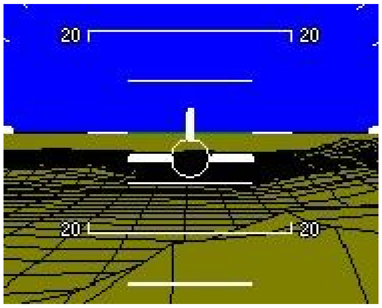
Typical GPS navigator screen



Forward looking terrain profile.
Change scale using zoom keys

General info screen

Velocity vector



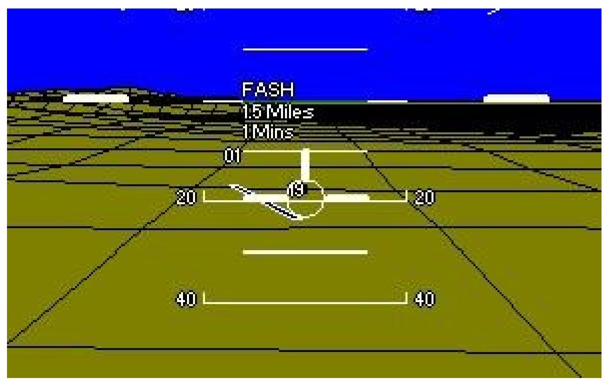
Velocity vector showing a descent at a 5 degree angle

By default, the synthetic vision display is aligned to your ground track as reported by the GPS navigation system. This means that the center of the display is where you are going. If you are approaching a runway and it is located at the center of the screen, this is where you will be flying to.

The airplane symbol can move up and down indicating true angle of descent and ascent. Combined with the synthetic vision, this can be used to adjust the glide slope when approaching a runway:

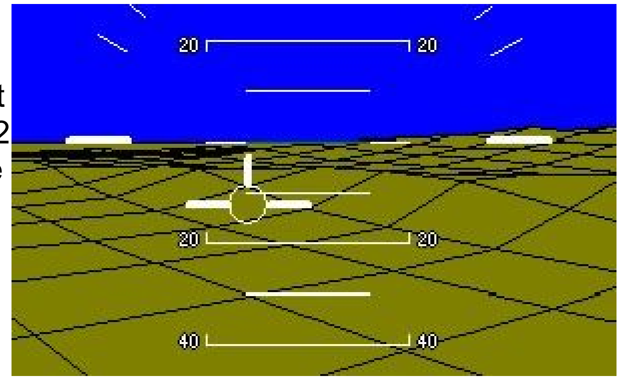
This image shows a steep, almost 20 degree approach to a runway which would place us about 1/3 down the runway if we maintain speed and angle. We would also need to adjust our heading very slightly to the left to intercept the runway perfectly.

Note that our attitude is level.

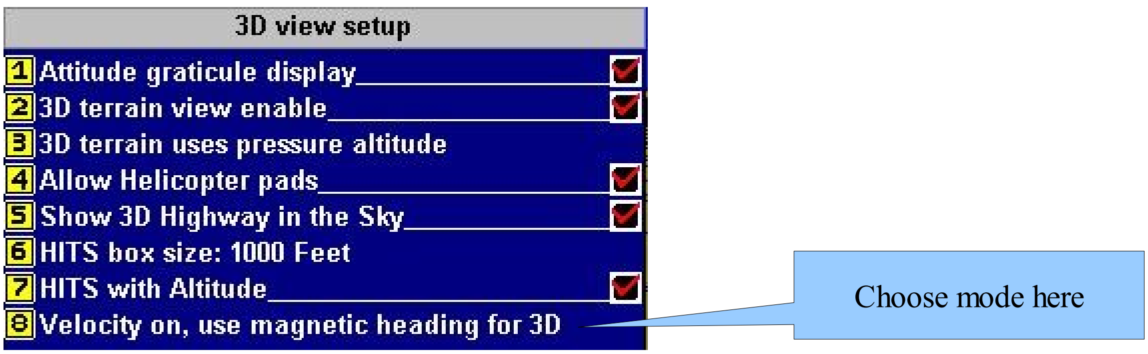


As an alternative, the synthetic vision may be based on magnetic (compass) heading. In this case, the airplane symbol may move left or right, depending on the angle between magnetic heading and ground track. This would approximate what you where seeing out of the window. If you where to approach a runway in a cross wind and would be flying at a crab angle to maintain center line, the runway will appear to the side of the image. As long as you maintain the velocity vector (airplane symbol) on the runway threshold – you will get there.

This is a typical image that you may see if the synthetic vision system is set to use magnetic heading. In this case our ground track is to the left of our heading and we are descending at about 12 degrees angle in level attitude. The position of the airplane symbol tells us where the current track and vertical angle of the aircraft would take us if we maintain it.



Choosing the mode of operation of the velocity vector and synthetic vision heading mode is done in the 3D setup menu (second page of Menu level 2).



Mode options are:

1) Velocity on, use magnetic heading for 3D.
2) Velocity on, use GPS ground track for 3D.
3) Velocity off, use magnetic heading for 3D.
4) Velocity off, use GPS ground track for 3D.

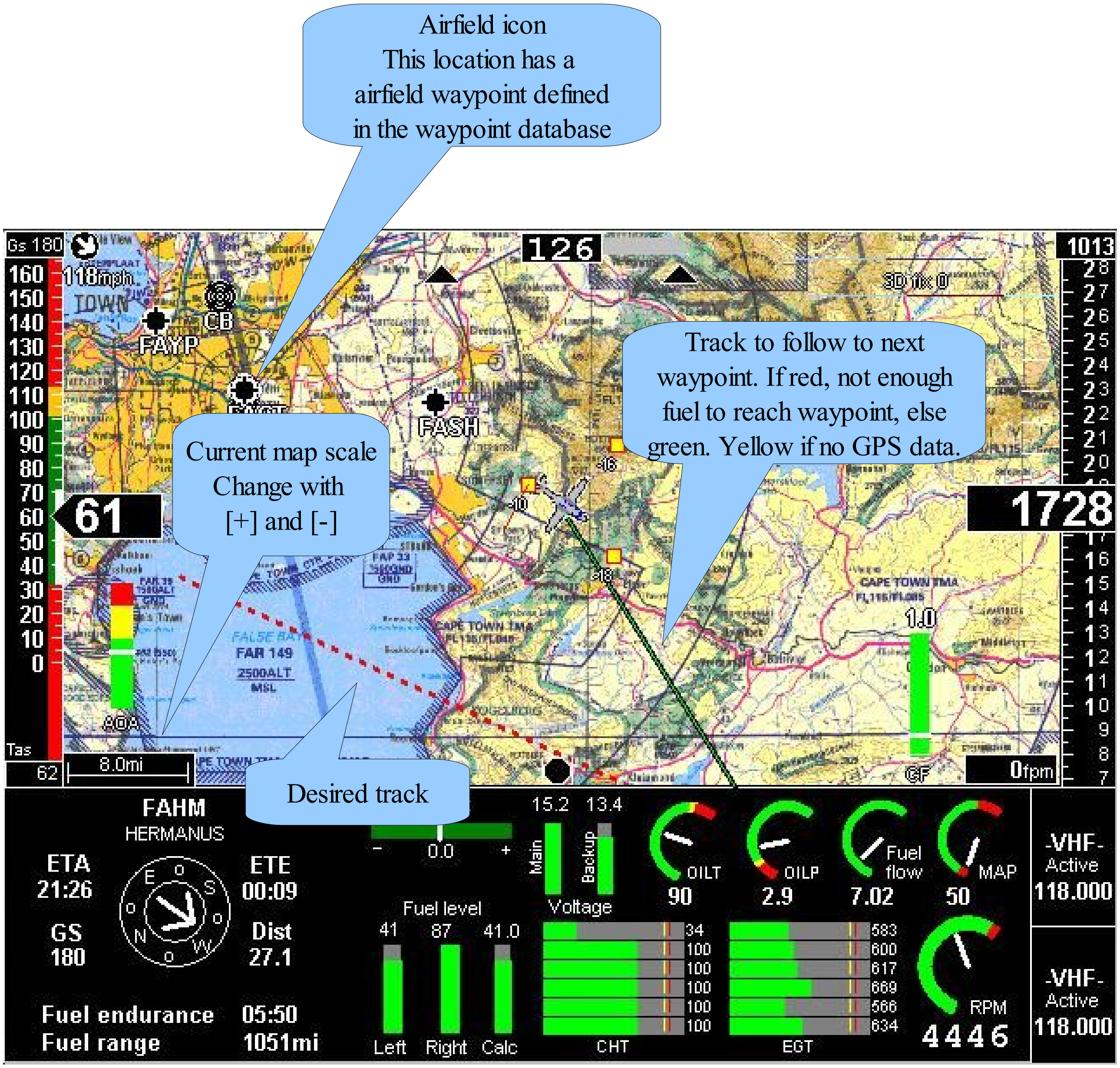
If you select magnetic heading for the synthetic vision view you require both AHRS and compass sensors connected. Your instrument needs a gyro stabilized compass heading to be able to show correct headings during turns in this case. This will not work if you have only a compass sensor connected.

We recommend using GPS ground track – in our opinion this provides the best functionality as with magnetic heading items on the screen (including Highway in the sky) will not appear centered if you are on track if you are flying in a crosswind.

The airplane symbol will appear in red if velocity vector is “on” but no GPS position/track can be obtained. The symbol will center in the horizon graticule in this case.

Navigation / moving map screen

This screen combines a large moving map navigator with all standard primary flight information instruments.



This image shows three intruders from a traffic monitoring system such as TCAS. The traffic is shown with relative altitudes in steps of 100 feet.

Note: Raster Maps are created by the Enigma Mapmaker program from BMP or JPG raster image map sources. Vector maps are “drawn” maps using a vector database for your area. Raster map files created by Mapmaker or vector maps are installed onto the internal solid state disk into the “maps” folder.

You can use both Raster as well as vector maps at the same time in the EFIS. Switch between Raster and vector maps using “SHIFT” followed by “5” at any time from any main screen (SHIFT+Map).

Duration of map zoom (redraw after pressing the [+] or [-] zoom buttons) varies from about 0.5 seconds to 2.5 seconds depending on various factors like zoom level, size of source maps, number of map files needed to collect map data compression level of source data etc.

During zoom processing all other EFIS functions remain fully functional.

Navigator screen

The third standard screen introduces the navigator component combined with a smaller 3D forward looking terrain / horizon component and the standard engine and info screens.

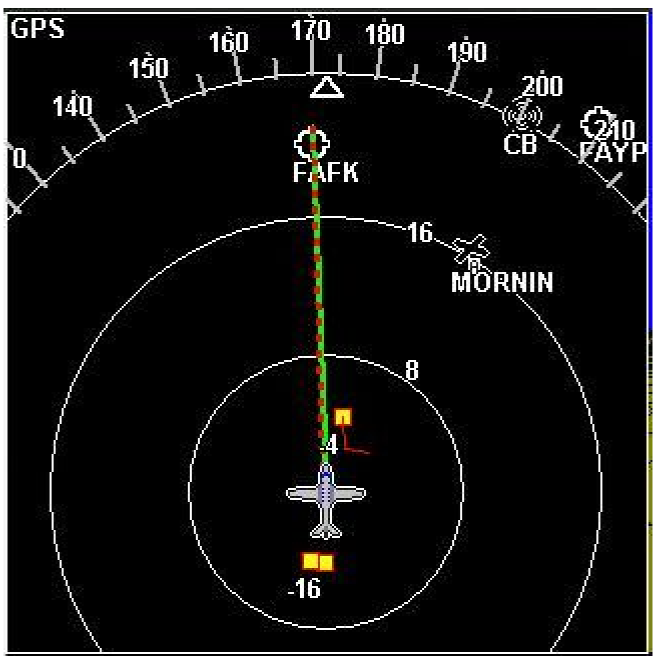
The navigator component

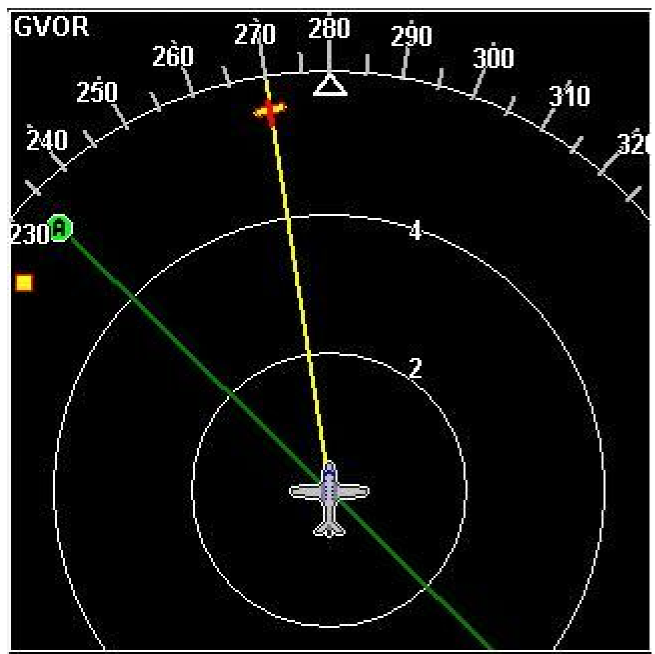
The navigator provides a track-up display of your flight path. The navigator works in either GPS navigation mode or VOR navigation mode. If GPS and VOR navigation is active at the same time, the navigator defaults to GPS mode.

Symbols displayed are those in your Waypoint database and include simple waypoints, airfields, navigation beacons, intersections and reporting points.

Further to this, if you have a traffic monitoring and alerting system installed (TCAS, TIS, PCAS or FLARM) reported traffic will be shown relative to your position. Numerics displayed with each traffic item relates to the relative altitude of the intruder in 100's of feet. Positive values relate to an intruder above your altitude while negative values are below your altitude.

Please note that the position and altitude as displayed is derived from your traffic monitoring system and may be subject to errors. Traffic monitoring systems do not replace traditional methods of visual lookout and air traffic control.





GPS navigator mode

During active GPS navigation (active “Goto” or active route navigation), track to the next waypoint is shown in either yellow red or green as a solid line. Yellow means that fuel endurance cannot be determined while red means that not enough fuel is available to reach your destination. Green means fuel quantity is sufficient. The desired track to fly is shown as a red dotted line. In case of route navigation the next route leg will be shown as a red dotted line as well.

VOR navigator mode

If GPS navigation is not active and VOR navigation is active, the radial to the selected station is shown in a green, solid line. The “paddle” at the end of the green line shows the direction to the selected VOR station.

The currently selected OBS track is shown as a yellow line.

VOR navigation using the VOR navigator requires selection of a VOR source that provides information on the current radial.

Should you choose the external analog +/-150mV analog inputs as VOR source, the navigator is not able to provide information on your radial. In this case you can only use the CDI.

Navigator range rings and range selection

Similar to the GPS moving map, selection of zoom is done using the [+] and [-] keys (keys are marked LOG and HOLD).

Range rings and scale is chosen depending on current zoom factor (which is shared with moving maps) and your chosen units of distance.

Using the moving map

One of the most significant components of your EFIS system is the GPS based moving map system.

A typical raster map image. The source of the image is a scanned aviation chart that has been converted to Enigma raster map format by the free Enigma Mapmaker program (available for download from the MGL Avionics website).

The EFIS may be used with two completely different moving map systems and you may use both of these systems at the same time in your system

The first system is a **raster image map** based system. Raster maps are often scanned images of paper maps that have been converted to Enigma format. The EFIS is fully Enigma format compatible and can use any raster maps intended for the Enigma system.

You can convert any map image that is available in digital format such as Windows BMP or JPEG format for use with your EFIS using the freely available conversion program “Enigma mapmaker” that is on your EFIS DVD or you can download the latest version from the MGL Avionics website.

The second map system is a **vector map system**. Enigma format vector maps consist of single files covering a region or continent. These maps tend to be more sparse compared to raster image maps and contain roads, rivers, places of interest, urban areas, railway lines, power lines and water bodies. The EFIS combines these maps with a topographical background created from terrain elevation data (the same data also used for your 3D terrain views and TAWS system) as well as airspace information from your navidata.ewd file.

One of the map viewing options (accessible via SHIFT+5) allows you to switch of the topographical background if you prefer.

Using the Enigma Vector map editor you can edit existing vector map files (for example you may want to add a road that is missing in the data) or you can create new vector maps from scratch. The Enigma Vector map editor is included on your EFIS DVD and can also be downloaded from the MGL Avionics website.

Raster map files

Enigma format raster maps are stored as files and contain a selection of “degree tiles”. All Enigma maps are based on the degree tile idea and the degree tile is a 1 degree x 1 degree section of a map. This forms the smallest map unit available in Enigma. An Enigma map file typically contains multiple tiles. Each map file can contain tiles at resolutions ranging from a low 150x150 pixels (at the equator) to a high 2400x2400 pixels.

A sample map file name may be **“S29E020b.M42”**. This means that the map file contains 4 degree tiles horizontal and two tiles vertical for a total of 8 tiles. The resolution of the tiles is 1200x1200 pixels (at the equator) and that the top left degree boundary is located at South 29 degrees and East 20 degrees.

Depending on the amount of maps required to cover your flying area, you would typically need perhaps 10-100 of these map files. The EFIS does not address the maps by filename directly but uses another file created by **MapMaker**, the file **“MapIndex.MM0”**. This file contains an index to every degree tile in your mapping system and informs the EFIS of its location inside the relevant file. This way the EFIS does not have to continuously search through the directories of your solid state hard drive for relevant files, it only needs to read the index file.

Map files are stored internally on your EFIS solid state disk in the **“maps”** folder.

They can easily be transferred from SD card by using the relevant **“Install Tasks menu” -> “Install Raster maps”** function.

This function copies any raster map files and the **MapIndex.MM0 file** from SD card to the internal **Maps** folder.

Please note that this function may take some time to execute due to the relatively slow write speeds of Flash memory and large file sizes.

Using moving maps with the EFIS simulator

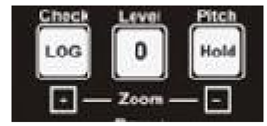
When you create your maps or want to try out maps you have obtained elsewhere, use the simulator. You will find it has a folder called “MMC”. This folder represents a “simulated” SD or MMC card. Simply copy your map files and the matching index file into this folder and proceed on the simulator as you would with the real instrument. Choose **“Install Tasks”** and then select **“Install Raster Maps”.**

If you are using vector maps, copy the VMAP.EVD file for your area into the MMC folder. Install this using **“Install Tasks” -> “Install vector map”**.

You can switch between raster and vector maps if you have both installed using SHIFT+5 from any main screen.

Use the "GPS simulator" to enter a position on the map you would like to test and you should be able to view it on any screen that has a moving map image component installed.

Interacting with the moving map



Normally, the only interaction with the moving map is changing the zoom level. This is done simply by pressing "LOG" or "HOLD" (Note the [+] and [-] legends) to zoom into and out of the map. You have a total of 5 zoom levels available.

Using the maps in innovative ways

As you can use any image as a bases for maps, it becomes possible to easily create modified maps for specific tasks such as competition flying. You can even use a sketch on a sheet of paper that you scan into your PC – as long as you tell Mapmaker where the degree tile boundaries are, you can use it. There is not need for you to draw accurately using a specific map projection (such as Mercator for example). Mapmaker will figure it out and scale and rotate your sketch to perfection !

EFIS Moving map options

The EFIS supports two fundamentally different forms of digital maps. Raster maps and vector maps. A raster map is a digital image. Any image could be used, even if it is not a map at all. Enigma Mapmaker provides the means to convert any digital raster image into a map file usable with the EFIS.
Vector maps do not contain images but rather a list of instructions, perhaps with added data and descriptions. These instructions may be something as simple as drawing a line between two geographic points or an instruction to draw a shape in a particular location and color.

Each of these map types has advantages and disadvantages.

Raster maps are easy to create and use with the EFIS and can provide a simple means of covering areas not covered in other data formats or creating customized maps, for example for competition flying. Raster maps tend to create large file sizes and require a large amount of processing in order to read and scale them to create the final target image.

Vector maps tend to have less information compared to raster maps but the information can be better used by the EFIS. For example, a vector file may include airspace boundary information that the EFIS can use to warn you if you cross such a boundary.

Vector maps

Your EFIS can use vector maps that are provided by MGL Avionics and can be obtained via free download from the Stratomaster data download website (view website at www.MGLAvionics.com for a link to the data download website.

Vector maps are referred to as “Base maps”. A vector map resides in a single file called “VMAP.EVD”. Maps are provided to cover the World except Antarctica. Vector maps contain the following information: Urban areas coverage, Towns and places, primary and secondary roads, rivers, railway lines, power lines, inland water bodies (perennial and non-perennial like dry pans), borders, coastal lines etc.

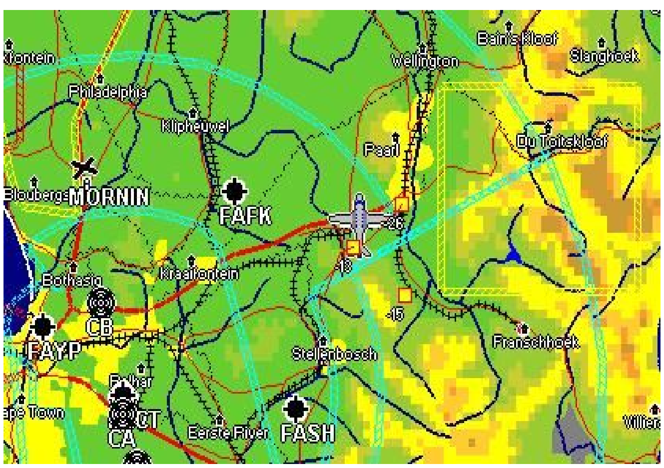
Vector maps can be downloaded for 9 regions:

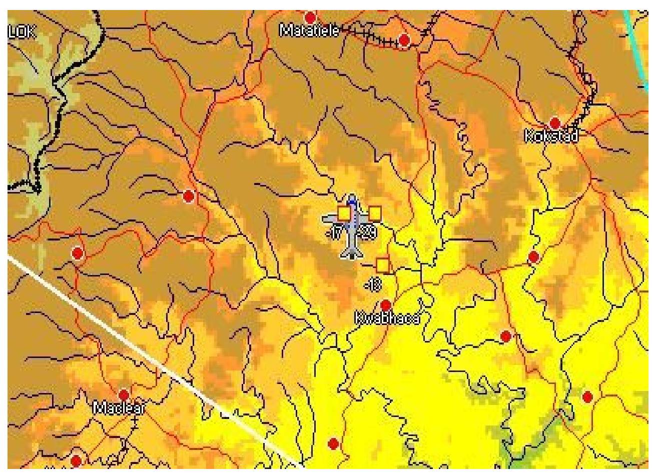
North, Central and South America

Europe, Northern Africa and Mediterranean and Southern Africa

Russia and China, Asia and Australia/New Zealand

Vector maps form one of three parts for your visual vector map in the EFIS. Combine the vector map with Airspace data and terrain data for a full system.





Examples of vector map images. Vector maps can reduce detail as you zoom out to prevent “clutter” which can render raster maps problematic at low zoom levels. As you zoom in, more detail can appear. The above examples are using the vector map “VMAP.EVD” to create the towns, roads etc. The topographical background is created from the terrain data files (DEM files from GTOP30 datasets). Airspaces are drawn from the airspace vector database (Navidata.ewd file). Finally the maps are each showing a single airfield from the Navidata.ewd database or they may be contained in the supplementary waypoint database Waypoints.ewd.

Note that you switch between raster and vector maps using SHIFT+5 from any main screen.

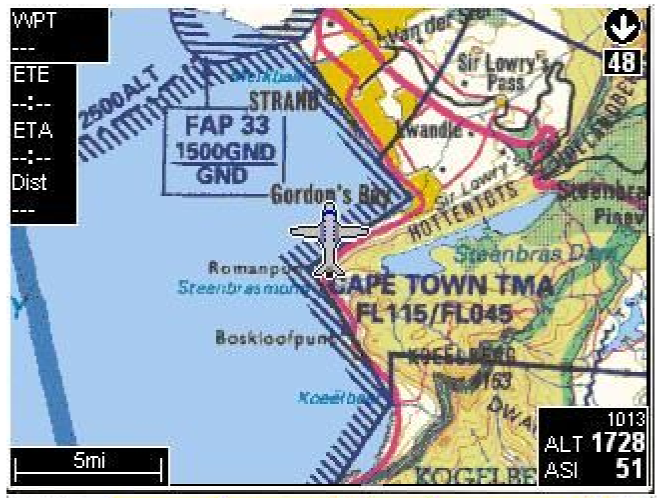
Map Orientations

Images shown here are taken from the Enigma system as they are smaller and easier used in a manual. The same principles apply for the EFIS system.

The EFIS can provide you with either “north up” or “track up” map displays. You select this in the “navigation setup”.

Map mode option:
North up.

This is usually the preferred way to display raster maps that contain writing. The aircraft symbol in the center rotates based on true heading derived from the GPS ground track.



Map mode option:
Track up.

This is the most popular mode for using vector maps. The aircraft symbol remains pointing up while the map image rotates underneath.

Note: You change between raster and vector modes by using SHIFT+5 from any main screen. First press “SHIFT” and then “5” (map).

If you do not have map coverage for a certain area in the chosen format, you will get a black background. Airpaces and waypoints may still show if you have them defined in your database for the current area.

Setting up your vector mapping system

For a fully functional vector map system you require:

Terrain data for your area. See detail on terrain data functionality in this manual. The terrain data file(s) reside on your Solid State disk in the **“Terrain”** folder.

Airspace vector data. This data is contained in the Navidata.ewd file together with airports, waypoint and other navigation information.

Vector base map data file. This file has a file name of “VMAP.evd” and resides on your Solid State disk in the **“Maps”** folder. This file contains map drawing information for towns, cities, urban areas, roads, railway lines, rivers, lakes and other items. Be sure to install a vector base map file that covers your intended area of operations. Base map files are provided for nine different areas covering the World.

Waypoints. Waypoints are contained in two data sources. The standard Enigma waypoint.ewd contains supplementary waypoints and is optional. The navidata.ewd database file contains waypoints as exported from your navigation database source such as PocketFMS, Jeppesen or the Enigma Flight Planner tool.

EFIS internal Solid State disk organization.

The Solid state disk is organized into the following folders. The folders are fixed and created automatically after you format the Solid State disk. A format facility is available in the **“File manager”.**

- Screens

  This folder contains your screen definition files and also the splash screen.

- Navdata

  Contains Waypoint.ewd and Navidata.ewd files

- Maps

  Contains raster map files and VMAP.evd vector map file

- Terrain

  Contains terrain GTOPO30 DEM files

- Other

  Contains weight&balance definition and image files

A standard EFIS ships with a 1GByte high speed Compact Flash card used as Solid State disk. The cards are selected by MGL Avionics after intensive testing to ensure performance and reliability requirements are met.

It is possible to replace these cards should this be required, The following minimum criteria must be met by the replacement card:

- Size must be either 1, 2 or 4 Gbyte. Other sizes are not supported. A 4GByte card is large enough to store all the World's data. A 1GByte card is large enough to store all of Northern America.

- The card must be able to support PIO mode 4 data transfers on a 16 bit bus
- A minimum speed of 80X must be supported. Please be aware that many cards may claim these speeds or even faster speeds but cannot sustain these speeds.
- A read or write cycle may not exceed 120nS cycle time.
- The card must support multi sector reads and writes.
- Cards must support ECC error detection and correction.
- As a rule of thumb, cards made for professional SLR digital camera use tend to be good choices for EFIS.
- MGL Avionics does not guarantee reliable operation with cards that have not been approved for use by MGL Avionics.

Windspeed and direction components

This wind indicator has been built with three components: Small Arrow heading indicator set to “wind direction”, Wind speed text component and speed units text component.

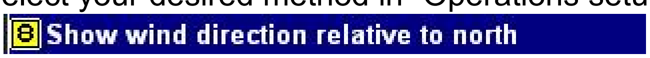
If your EFIS has access to compass sensor data and you have a valid GPS ground track, it can display wind direction and velocity.

For this to be possible, the following conditions need to be met:

Your magnetic compass heading needs to be reasonably accurate. Your systems date must be correctly entered, in particular the year. This information is required so the EFIS can calculate the correct magnetic variation for your area.

Wind direction can be displayed either relative to north (map view) or relative to your current heading, whichever you prefer. If the wind direction is shown relative to your heading then the arrow effectively points the way the wind is blowing relative to the direction your nose is pointing.

Select your desired method in “Operations setup”



The EFIS uses the angle difference between your aircrafts ground track (GPS derived) and the magnetic heading (from the compass) to work out your “crab angle”. The crab angle together with differences in ground speed (GPS derived) and true airspeed allow calculation of wind speed and direction.

If either airspeed or magnetic heading is incorrect, this function will return incorrect results.

EFIS terrain awareness and warning system (TAWS)

The EFIS includes terrain elevation awareness based on the standard GTOPO30 file format which is also used by the SRTM30 data format. GTOPO is based on a combination or surveys from various sources while SRTM is based on the Shuttle radar terrain mission.

The data is World Wide and based on 30 arc-second samples giving an approximate 1 square KM resolution. This resolution is ideal for aviation use and results in a manageable data size.

STRM data tends to be more accurate and of higher resolution but covers only the area from N60 degrees to S60 degrees latitude.

Data can be downloaded from the Internet from various sources.

SRTM30 data is available from: ftp://e0srp01u.ecs.nasa.gov/srtm

We recommend to download "version 2" of this data as it has been substantially edited to remove issues related to the original data.

GTOPO30 data is available from http://edcdaac.usgs.gov/gtopo30/gtopo30.html

Please check to see if your CD/DVD that was included with your EFIS contains this data. Your local distributor or dealer may have included the data for your location.
Should the above links not be functional, please use a search engine such as Google to locate current download sites. Search terms of "SRTM30" or "GTOPO30" should result in an easy location.

The data is organized in "tiles". Each tile spans 40 degrees longitude and 50 degrees latitude. Each tile is a zip file that contains several files. From this zip file, extract the file ending with the extension ".DEM". Each *.DEM file is exactly 57.600.000 bytes in size (about 55MBytes). You do not need to copy any other files from the ZIP library to your SD card.

Install all the DEM files required to cover your flying area using the Install Tasks menu. There is no further setup required to enable basic terrain awareness. Please note that it may take a few minutes to copy the files to your SD card due to the limited write speeds of these cards.

The FAA mandates certain ways terrain information has to be presented to the pilot. The EFIS largely follows this but does deviate where we have found this to be of value for the kind of aircraft that would use an EFIS system.

The EFIS distinguishes between terrain awareness and terrain warning as two different functions.

Terrain awareness

Terrain awareness results in the display of terrain data similar to the form mandated by the FAA as shown in the above image. Any area that is yellow includes terrain with an elevation of 1000 ft (300 meters) or less below your aircrafts current altitude. Any area shown in red is at or above your current flight altitude.

On the map, the terrain data overlay is shown for ½ second every two seconds. This allows the underlying map detail to remain fully usable.

The EFIS uses elevation obtained from your GPS for terrain purposes if your GPS is in 3D mode. If your GPS is operating in 2D mode due to lack of satellite visibility, your pressure altitude is used instead.

As an added safety precaution we decided to add 30 ft (about 10 meters) to the elevation data as presented in the terrain data file.

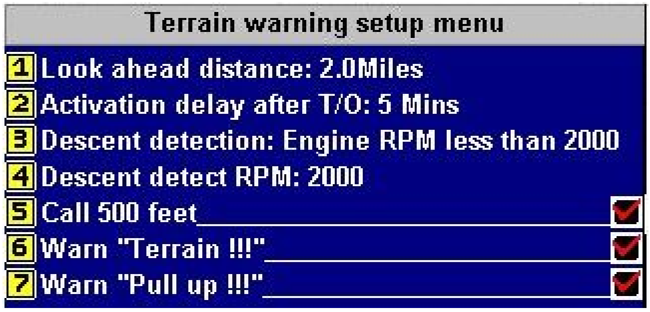
If no GPS position is available, the terrain functionality is disabled.

Terrain warning

Terrain warning is based on the terrain data in the direction you are flying (GPS ground track, not heading). The EFIS will “look ahead” a certain distance that you can decide and give you warnings on the screen as well as through the audio channel of terrain ahead.

If terrain ahead within your look ahead limit is “yellow”, you will get the “Terrain !!” warning. This warning will be repeated every 30 seconds. You can disable the terrain warning feature outright or you can acknowledge by pressing the “ACK” button which will silence this alarm until the next transition from “no terrain alarm” to “terrain alarm”.

If terrain ahead within your look ahead includes a “red” area you will get the “Terrain, pullup !!” warning every 10 seconds. As with the “yellow” warning you can disable this function or



Acknowledge it to silence the warning.

Terrain warning setup

The terrain warning setup menu as shown above is used to customize the terrain system to your preference.

Look ahead distance...

Enter the distance the EFIS should look ahead on your current ground track for terrain. Choose a figure that is related to your aircrafts flying speed. If you enter a large distance you will get terrain warnings very early if you have a slow aircraft. 2 miles (about 3.2Km) is perhaps a good distance for most applications.

Activation delay after T/O...

Enter, in minutes, how long the terrain warning system should remain disabled after your take-off (start of new flight). Start of flight detection is either automatic (based typically on airspeed and engine RPM) or manual where you start and stop flights. You select this in the operations setup menu.

Descent detection...

Select how your EFIS should detect a normal descent. Once in descent mode, terrain warning is disabled and the EFIS will call the 500 ft altitude above ground if that function is enabled. Descent mode will prevent unnecessary terrain warnings when you get ready to land your aircraft.

1. Screen marker. If you have a screen defined that includes a “Descent” component and you switch to that screen (perhaps your dedicated “landing” screen), then you place the EFIS's terrain warning in descent mode.
2. Engine RPM. If you select this mode, then the EFIS will be in descent mode whenever RPM on RDAC 1 is below your set limit. An internal 5 second time filter is used to prevent unnecessary switching between descent and normal terrain warning modes.
3. External contact. If you do not have a rotor craft, the rotor RPM input on the back of

your EFIS can be used as “landing mode” indicator which can place your terrain warning system into descent mode. Typically, you would use a contact on your retractable gear or flap lever to indicate to your system that you are in descent mode. For normal mode, the voltage at the external input should be zero (or left unconnected), for descent mode, the voltage should be 5V or higher. Your switch should typically be wired from the Rotor RPM/External contact input to your +12V supply (also accessible on the Rotor RPM terminal block) and the contact should be closed when in descent mode.
A recommended switch is a magnetic reed switch as often used in alarm systems to detect open doors or windows.

Call 500 feet

Enable this function if you want the EFIS to call out 500 feet in descent mode. The call out is both a screen display message as well as the “call 500” voice phrase.

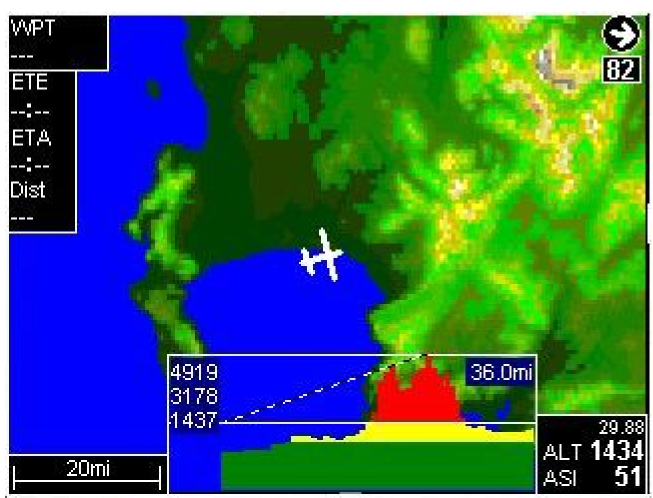
Warn Terrain, Warn Pullup

Enable/disable the terrain warning (Terrain in flight path below 1000 ft altitude) and/or terrain pullup warning (terrain at or higher than current altitude ahead).

Tips on using the terrain warning system

When you practice circuits or want to do some low flying in VFR conditions, switch the terrain warning system off.
Never rely only on your terrain data. Your data may be incorrect or elevations not represented accurately. The EFISs terrain system is intended for VFR reference only.

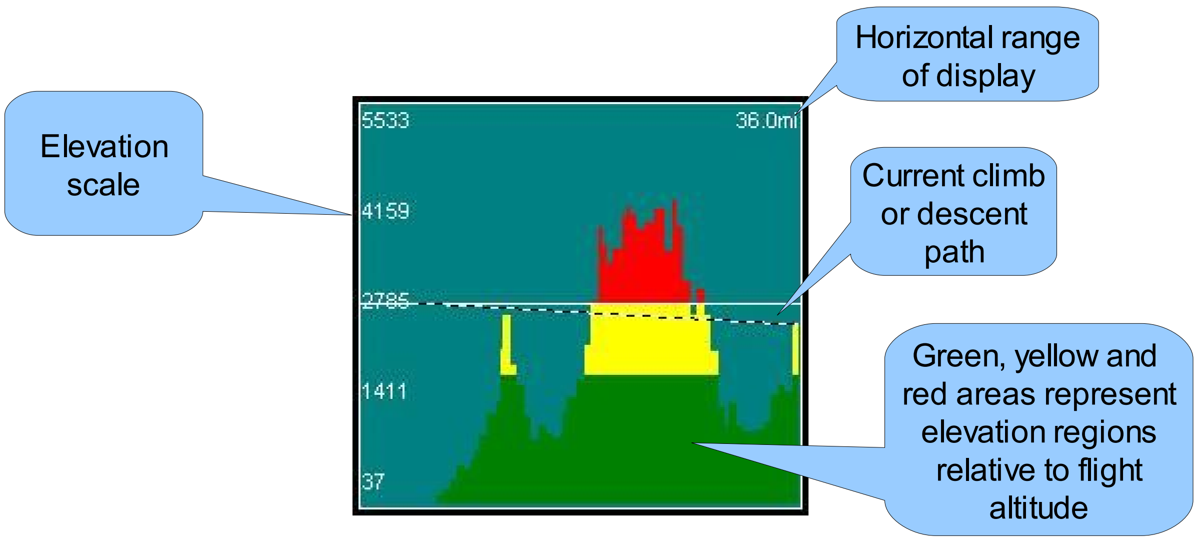
Topographical moving map background



In the absence of raster image maps, the EFIS can use terrain data to create topographical maps using shades of color to indicate ground elevation. A typical image this creates is shown above of the Cape Town area, where your EFIS instrument has been developed. No particular setup is required. If your SD does not contain any raster map data for the area under consideration but terrain data is available, the terrain data will be used automatically.

Terrain look ahead visual component

The terrain profiles overlays the image with a dashed line representing your current descent or climb angle relative to the terrain displayed.



Ground elevation at or above your current flight altitude is shown in red. The elevation from your current flight altitude to 1000 feet (300 meters) below it is shown in yellow.

The dashed line is based on your current altitude, current vertical speed as obtained from your VSI and the ground speed as obtained from your GPS. Using ground speed means that this indication takes into account any winds aloft that are currently affecting your climb or descent angle.

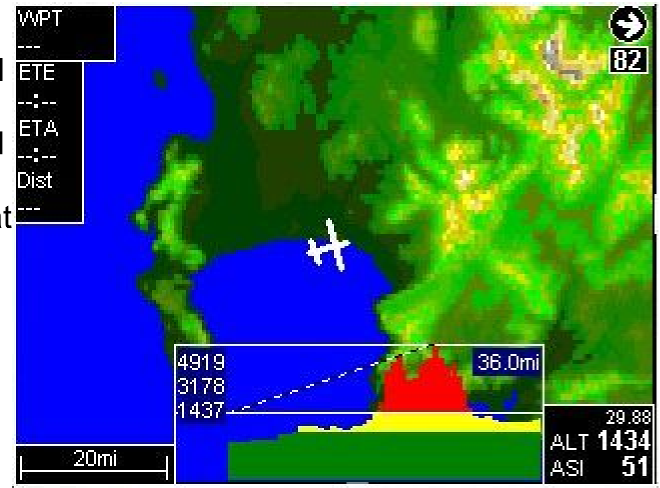
The terrain profile is based on your current ground track as obtained from your GPS. Please note that may differ from your heading which is the way your aircraft is pointing due to crosswind effects.

Flight altitude for terrain purposes is obtained from the GPS is the GPS is operating in 3D mode. Should the GPS be operating in 2D mode due to lack of visible satellites, the EFIS will use the altitude as obtained from your altimeter, taking your local barometric pressure setting (QNH) into account.

The terrain look ahead does not show any information if you do not presently have a valid GPS position.

The terrain look ahead indication is used to set a suitable climb power if you need to get over a terrain obstacle or can be used to judge if you will clear terrain ahead if you are gliding. As with any such information, be aware that flight conditions may change due to various reasons so the pilot in command has to use this information with due caution.

Example terrain lookahead display



The image on the right shows a typical vertical situation. The aircraft is heading towards a mountain range approximately 18 miles ahead (half of the 36 miles range in the display). The aircraft is climbing and the indicator shows that should this rate of climb be maintained, the aircraft will just clear both the first and second mountain peaks. The indication agrees with the terrain ahead shown in the moving map display. The current altitude is 1434 feet and the highest peak is at 4919 feet if the aircraft continues on this ground track.

COM radio interface

If you have one of the following VHF radios you can select the VHF communications frequency directly from your EFIS airports database.

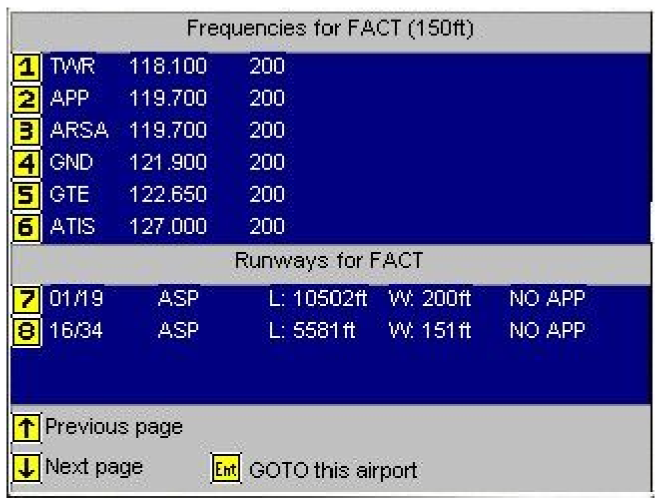
- **Garmin/Apollo SL30 NAV/COM radio**
- **Garmin/Apollo SL40 COM radio**
- **XCOM 760**
- **Filser VHF radios with RS232 port**
- **MGL Avionics VHF COM radio**
- **MGL Avionics NAV/COM radio**

Before you can operate any of these radios, ensure that the radio is correctly wired to RS232 port 1 and select the radio type you are using in “Operations setup”.

Press “0” from any main screen and select the airport from the list of closest airports to your current location or use the airports browser.

If your airports database has information on frequencies for the selected airport, these are shown in a list like the one shown here for Cape Town International.

Press the button indicated next to the desired frequency to select it in your COM radio.



Note: All selections will be done to the active frequency in cases where the radio supports both active and standby frequencies. Each time you press a frequency selection button, the corresponding selection message is sent to the radio.

Using the “Radio” page to set frequencies not related to an airport.

Pressing “SHIFT”+”2” (Radio) shows the Radio page. Here you can place up to 10 radio frequencies for quick select. Typically, you would have area frequencies on this page.

Frequencies and description are stored in a simple text file that you can create yourself (using Notepad or similar) with a filename of "radio.txt". Please use a simple text editor to create a normal ASCII text file. Do not use files created by Word processing applications unless they can export to a simple text file.

Example radio.txt file:

Use the text between the dashed lines, don't include the dashed lines.

;Example frequency list for SHIFT+Radio function
;First entry is frequency in MHZ in the following formats
;123
;123.0
;123.5
;123.45
;123.425
;This can be followed by a space and then text up to 30 characters for a descriptor
;Lines starting with a ";" are comments (like this line)
;You can enter up to 10 frequencies

124.8 VFR below 1500 AGL
124.4 General flying area
123.45 Chat frequency

Copy the file onto your internal solid state disk using the "File manager". Copy the file into the “Other” folder.
If you have a compatible radio, you can set the active frequency directly from the radio page.
If you don't have a compatible radio, it's still useful if you need to look up a frequency.

VOR/ILS interface

If you have a Garmin/Apollo SL30 NAV/COM radio connected, you can use your EFIS VOR and ILS components.

Ensure the RS232 port 1 is correctly wired to your SL30 radio and select the SL30 radio in the RS232 interface selection in the operations setup.

The EFIS will display information from the SL30 and you can use the waypoint database to select VOR or ILS localizer beacons.

To select a VOR/ILS beacon, press SHIFT followed by “NAV” (button 3). A screen similar to the following will appear:

The list contains all navaids in your waypoint database that are marked as usable for VOR or ILS (localizer and glideslope) use.

The items are shown in order of distance from your current location so the required station will likely be within the first pages even if you have a large database.

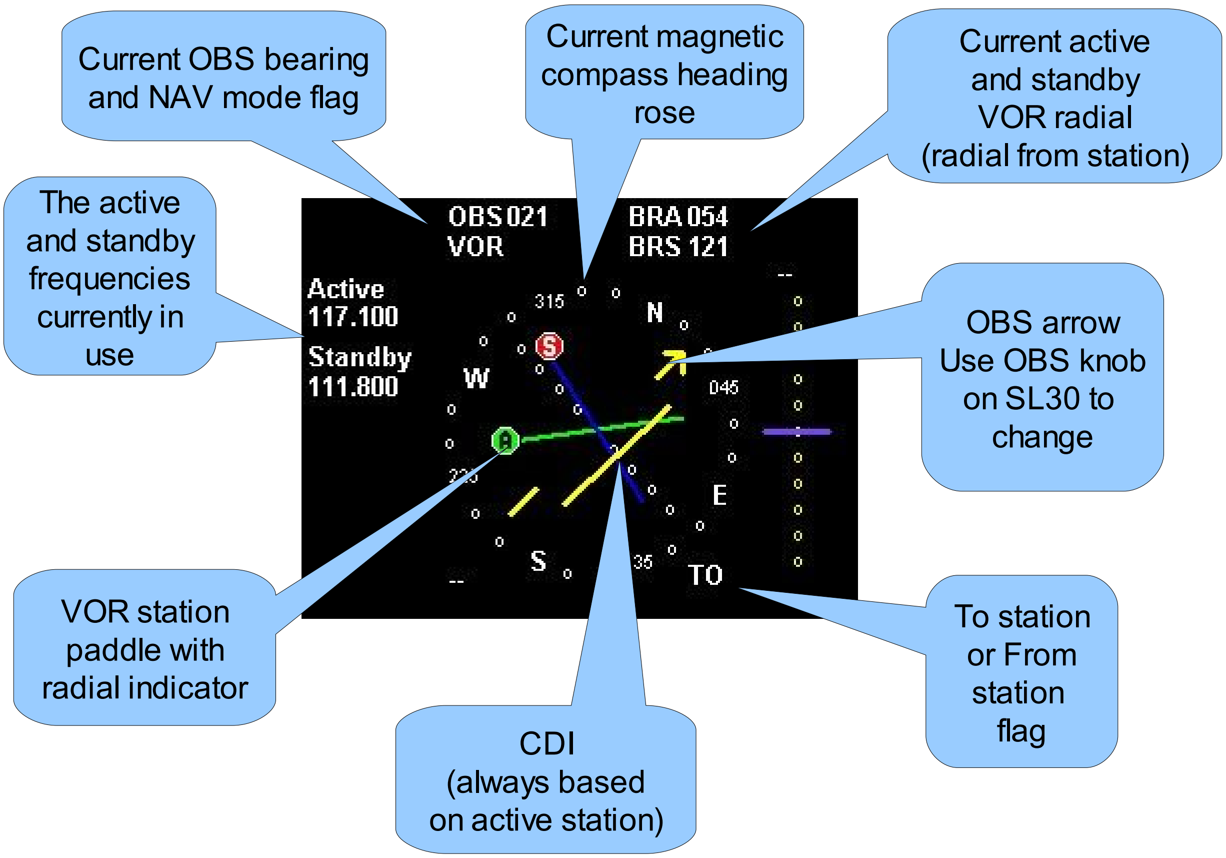
Note that you can select is you want to set the primary (active) or secondary (standby) channel. The default is the primary channel. Change this selection before you select the station.

Once you select the station, the frequency associated with that station will be sent to the NAV/COM radio and you will return to the main screen.

NAV and ILS visual screen components

The EFIS provides a NAV display and a separate Glide slope component. The NAV display will be used for both VOR as well as ILS (Localizer).
Depending on the options chosen in your screen setup, the NAV display will operate as GPS waypoint navigator if no radio NAV is active.

The following illustration shows all the VOR components and a standard glide slope display. Note that there are alternative glide slope displays that may be more suitable for your screen layout.

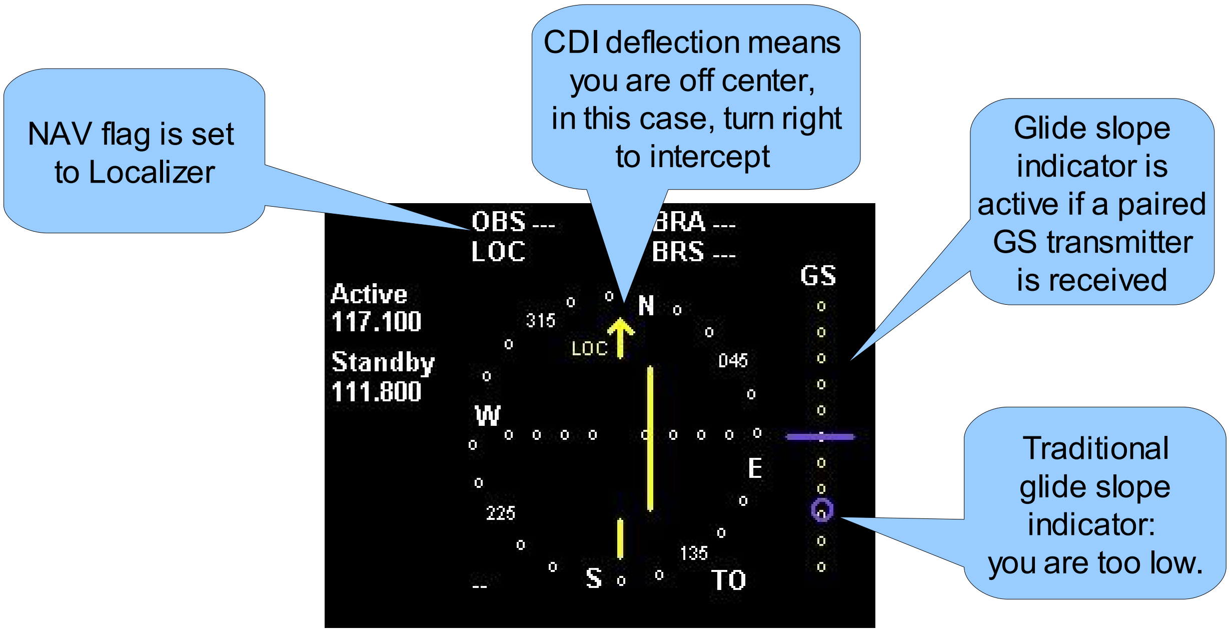


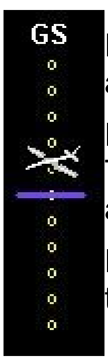
The OBS knob on the SL30 radio is used to set the OBS arrow to the desired radial of the active VOR station. The CDI indicator shows you if you have intercepted the radial – this occurs if the CDI is centered with the OBS arrow. If you maintain a centered needle the needle will point up (you are moving towards the station on the selected OBS radial) or down (you are moving away from the station on the selected radial).

As further aid, the radials and relative locations of active and standby VOR stations are shown as paddles. The paddle is the location of the station relative to your current location and the arm of the paddle is the radial you are on. In the above case, 050 and 129 degrees respectively.

The TO/FROM flag informs you if you are moving towards the station or away from it. If you are directly above the station (cone of uncertainty) the indication will be “--”.

If your SL30 is tuned to a localizer station, the NAV components behave as follows:





Further the the above traditional glide slope indication, your screen setup can be adjusted to show the “modified” glide slope indicator shown on the left.

In this case, a small aircraft symbol indicates your height relative to the glide slope. This is more intuitive but non standard so be careful if other pilots will use your aircraft.

In this example image, the aircraft is a little too high, reduce power or increase drag to intercept the glide slope.

Typical VOR and ILS screen displays

The above image shows a typical implemented VOR display, fully active. Note that a thin, light blue line is drawn as well, this is the current ground track as indicated by the GPS. It shows quite a deviation from the heading which can be expected noting that we have a very strong 85 mph wind blowing from the left in this example.

The above screen shows the active NAV channel tuned to a localizer station. In this case we are to the left of the runway centerline and should adjust to the right to intercept. Note the third form of available glide slope indication. This display has the aircraft symbol move from the top right (very high) to the bottom left (very low) of the indicator. If you keep the aircraft exactly centered on the cross hair, you will be exactly on the glide slope.

The above display shows that we are quite high on our approach.

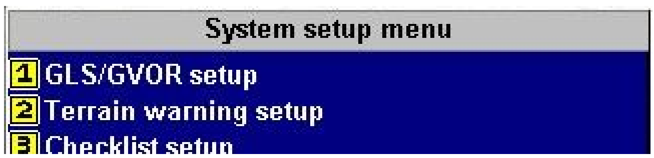
EFIS GLS and GVOR functions

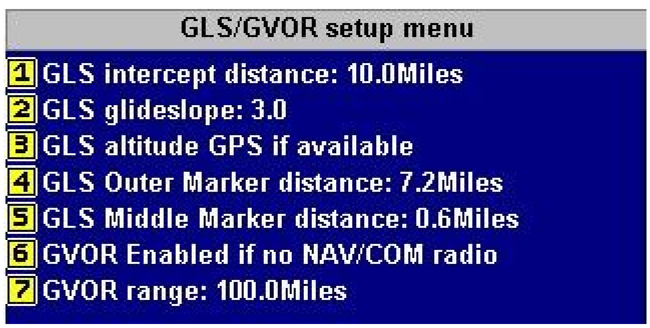
The EFIS contains two comprehensive functional modules to emulate ILS (Localizer and Glide slope) as well as conventional VOR navigation using the built in GPS plus information available in the EFIS databases.

This allows use of the EFIS for both ILS and VOR training without the need to connect an expensive NAV radio system. Further to this it allows ILS training at any airfield, even if no conventional ILS system is installed.

GLS/GVOR setup

GLS/GVOR setup can be reached in the system setup menu.





GLS Intercept distance

GLS approaches can be flown either direct to a particular runway or via an intercept point along the runway centerline. Enter the distance you would like this intercept point to be from the runway threshold. Note: For small aircraft at small runways we recommend a distance of about 3 miles.

GLS glideslope

Enter the desired glide slope angle. Standard glide slope angles for ILS systems are 3 degrees but can vary from about 2.5 to 3.5 degrees.

GLS altitude mode

Altitude for calculation of your glide slope to the threshold can be based on GPS or pressure altitude. You have the option of forcing the altitude to pressure altitude (this means your local pressure setting must be correct to correctly intercept the runway threshold) or you can specify GPS altitude. Note that altitude derived from GPS may not be available at all times if your current visible satellites do not allow it. In this case the EFIS will default to pressure altitude to cover GPS outages.

GLS outer marker distance

Enter the distance for the outer marker. This is normally 7.2 miles from the threshold but if you are practicing with a small aircraft at a small field, we recommend a distance of perhaps 2.5 miles. This distance should be less than the intercept distance.

When you fly over the emulated outer marker, the EFIS will sound the appropriate morse code sequence and flash a message with a blue background.

Note that with the emulated marker beacon, only the distance counts, the marker will sound even if you are severely off the centerline.

GLS middle marker distance

Enter the distance for the middle marker. This is normally 0.6 miles from the threshold.

When you fly over the emulated middle marker, the EFIS will sound the appropriate morse code sequence and flash a message with a yellow background.

Note that with the emulated marker beacon, only the distance counts, the marker will sound even if you are severely off the centerline.

GVOR Enabled...

Here you can enable or disable the GPS derived VOR emulation. Note: If you have a NAV radio connected, GVOR cannot be used. All VOR navigation will be performed using data provided by the NAV radio. Tip: Enable the GVOR and switch the NAV radio off if you want to practice using the GVOR system.

GVOR Range...

Enter the range you would like the emulated VOR beacon to have. A value of about 60-120 miles reflects the performance of most VOR beacons well. If you are outside the range, the EFIS will not “receive” the emulated VOR beacon.

Using GLS

GLS is the GPS based implementation of a standard beacon based ILS (instrument Landing System). It consists of several parts:

1) Localizer. This gives you an indication if you are left, right or aligned with the runway centerline.
2) Glide slope. This gives you an indication if you are above, below or aligned with the

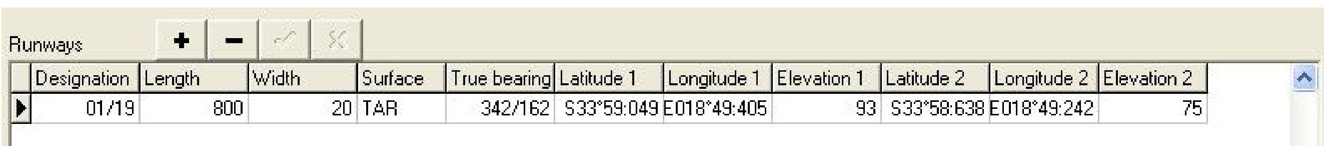
glide slope to the runway threshold (normally a 3 degree slope).

3) Marker beacons. Three marker beacons called outer, middle and inner marker provide visual and audio signals indicating points along the glide slope. The EFIS implements the outer marker (normally about 7.2 Km from the threshold) and middle marker (normally about 1050 meters from the threshold). The glide slope normally intersects the runway about 300 meters after the threshold.

GLS data

GLS data is imported and maintained using the Enigma FlightPlanner program. Not all airfields may have the required data included. You can add the data yourself if you have a good GPS receiver or are in a position to use the GPS receiver in your EFIS to obtain the required data.

Sample GLS runway definition from Enigma FlightPlanner:



Designation	Length	Width	Surface	True bearing	Latitude 1	Longitude 1	Elevation 1	Latitude 2	Longitude 2	Elevation 2
01/19	800	20	TAR	342/162	S33°59:049	E018°49:405	93	S33°58:638	E018°49:242	75

GLS data is enabled for this runway by entering the TRUE bearing of the runway headings. Note that the bearings may deviate from the centerline in cases where obstacles or noise abatement procedures prevent an aligned approach. Bearings may deviate from each others reciprocal by up to +/-60 degrees. In the above example, the bearings are aligned with the runway and are 180 degrees apart. Note that the bearings may be different from the runway designation headings. In the above case a magnetic variation of 24 degrees West is present at the location. The bearings have been obtained by walking along the middle line of the runway using a hand-held GPS receiver set to “true heading”.

Next, the two glide slope intercept points are measured. We need exact latitude, longitude and elevation. We first enter latitude1, longitude1 before latitude2 and longitude2 as the latter is a relative measure to the first in the database. The first position refers to the first runway heading (01 in this case) and the second position refers to the second runway heading (19 in this case).

Glide slope intercept points for ILS systems are normally about 300 meters from the threshold. This may be impractical for many smaller runways and a location closer to the threshold may be chosen.

GLS onto this runway is disabled in the database by entering a “-” as bearing.

Important note: Should you be using a handheld GPS to find position and elevation of a runway threshold, please ensure that your GPS uses the WSG84 geodetic datum. This is the datum used by your EFIS GPS.

Using GLS

To activate a GLS approach, press “0” from any EFIS instrument display page and choose one of the nearest airfields in the list or use the airfield browser.

Here we have chosen the airfield whose GLS runway definition is described above.

Note that the runway is marked with “GLS” to show that GLS data is available for this runway. Press the numeric next to the desired runway to activate the GLS selection page.

Choose the runway you want to fly the GLS approach on. You can choose to activate directly onto the runway threshold or go via the intercept point first. The intercept point would be somewhere along the runway centerline at a distance you can specify in the GLS/GVOR setup.

Once you have selected a GLS approach you can change at any time by reselecting another runway or changing from intercept point to threshold.

Note: once you have activated GLS either direct or via intercept you can use the left and right arrow keys to change between the two at any time.

If you are flying via the intercept, the intercept point is reached by following normal “goto” waypoint indicators as setup on your screens. When you get to within 0.2 miles of the intercept point, the EFIS will automatically change to the direct approach to the threshold.

Direct or intercept points appear as “next” waypoint. Any active routes or active waypoints are canceled when you activate a GLS approach.

You can cancel a GLS approach at any time. A function to do this appears in the main menu if a GLS approach is active. You can also cancel a GLS approach by performing a “goto waypoint” or activating a route.

GLS approaches use the same indications as an ILS approach using a NAV radio. Mode indicators will read “GLS” instead of “ILS”.

Note that GLS is intended as a daytime, VFR only training aid. While the built in WAAS enabled GPS is capable of performing category III ILS approaches in areas covered by WAAS, this is not the intention.

Uses for GLS

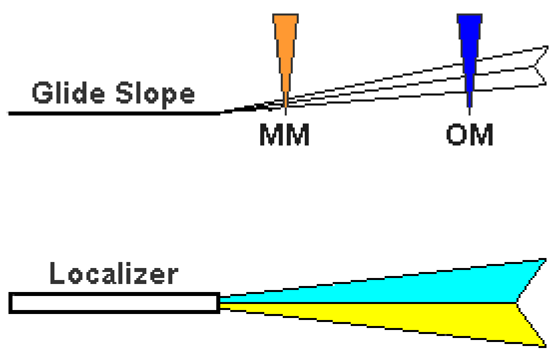
GLS is intended as ILS training aid and to enable the casual pilot to learn about ILS at his own home strip. As general approach training aid, it is also excellent in aiding the student pilot to better judge his approaches in particular to the approach angle (glide slope).

As advanced ILS training aid, GLS can be used in an instructor/student environment in a number of ways. Here are some suggestions:

Use GLS to practice ILS approaches at remote runways that do not have facilities or approach fees. This also aids in being able to shoot more approaches in a given amount of time due to less traffic.

Use GLS to practice “under the hood” approaches without the need for a hood. Here is how it works: The instructor prepares a number of “ghost” runways using Enigma Flightplanner. These runways don't exist and are in fact locations of some feature on a field for example. Perhaps a bush. The instructor knows the location of the “runway” but the student does not. The student flies his ILS approach using GLS while the instructor is able to judge how things are progressing by looking out the window.

Use GLS to practice ILS approaches at any airfield that has GLS runway information. Keep your instrument rating in practice without the need of a real ILS equipped runway.



Graphic showing typical ILS approach path.

Localizer gives you a +/- 4 degree left/right deviation indication for full scale deflection of the CDI. Glide slope gives you a +/- 1.4 degrees up/down deviation indication for full scale deflection. MM and OM refer to locations of middle market and outer marker beacons.

Flying a GLS approach via intercept

After activation of your GLS onto the desired runway, use normal GPS navigation indications to fly to your intercept point. It appears as a normal waypoint. You should aim to be around 1000 to 2000 ft above threshold elevation when reaching the intercept point. When you reach the intercept point, the EFIS sounds the message "GLS intercept" and flashes the message "Intercept arrival". You don't have to do anything at this point, the EFIS will now activate GLS onto the selected runway and the runway threshold is your next waypoint. At this time you can change to the ILS screen and follow the indicators.

Typically you will be a little left or right of the centerline and too low at this point. Maintain altitude if possible and correct your aircrafts approach until you are following the centerline and the localizer indication is centered. Maintain this throughout the approach. At some point you will see the glideslope indicator moving. When you have intercepted the glideslope, the glideslope indicator will be centered. Maintain the glideslope indicator by adjusting power. Do not chase the glideslope by lowering or raising the aircrafts nose. Adjust power as is required to remain on the glideslope and use attitude to adjust your airspeed. You should be able to ride the glideslope down to the threshold.

If your GLS is properly setup, you will first hear the sound of the outer marker beacon and get a blue message "Outer marker" on the screen typically 4.5 miles from the threshold. When you hear the sound of the middle marker and see the yellow message "middle marker" you are about 0.3 miles from the threshold and should be able to continue a visual approach and landing.

Please note that you must check your EFIS GLS settings and set marker beacon distances as you would like to use them, similar you need to set distance to intercept point and glide slope (normally 3 degrees). These items can be changed to customize your EFIS for a particular airfield. For example, you might be flying a small aircraft at a small field and do not want to use the large distances normally associated with ILS approaches for your training.

Please note that the GLS system is intended as a ILS training aid in daytime VFR (visual flight rules) conditions only. It is not approved for actual ILS replacement.

Flying a GLS approach direct

Activate the GLS direct approach if you are within a +/- 45 degree arc from the centerline of the desired runway. Making a GLS approach from a larger angle or onto the reciprocal runway heading is meaningless.

Once activated, follow the ILS localizer and glideslope indicators as described above "flying GPL via intercept".

Differences between GLS and a normal ILS approach using NAV radio.

GLS does not follow a radio beam. It uses GPS. GPS reception can be lost or compromised at any time. Ensure that your installation is good and that your antenna has an unobstructed view on the sky so best possible accuracy can be obtained.

Abandon your GLS approach if you get the message “GPS not available” on your screen.

Marker beacons on a real ILS can only be received within a +/- 4 degree approach path. GLS marker beacons describe a circle around the threshold and can be received anywhere you cross that circle.

A real ILS Localizer and glideslope can only be received on a relatively narrow beam from the runway centerline. By contrast, GLS works all around the airfield, even if approaching from the wrong direction (but the indications will not be very useful).

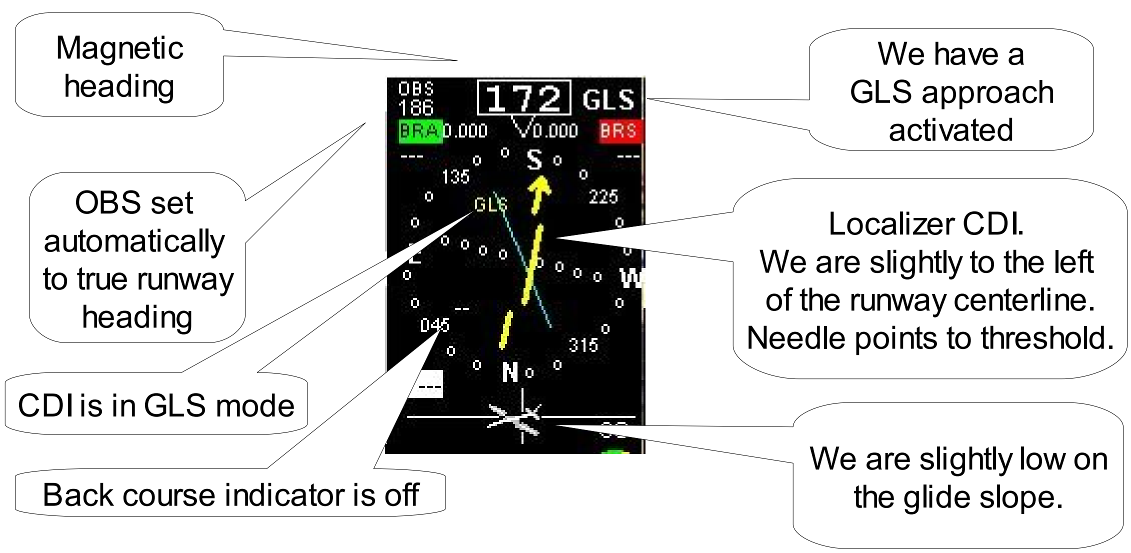
GLS localizer and glideslope works from vast distances from the threshold – you can line up on a runway in California from a location in China but can't use the glideslope unless you can fly in a high orbit around the Earth. Real ILS has a limited range. On the other hand, you could probably use your EFIS to land a Space Shuttle.

Back course

The EFIS's GLS implements back course functionality.
Many radio based ILS systems provide a localizer beam in the opposite direction of the runway heading (i.e. Take-off heading). This can be used as localizer should you perform a missed approach or just need to fly out keeping onto the runway centerline.

If your screen as a back course marker added (Special text component), the lettering “BC” will appear. Please note that unlike a traditional needle based ILS localizer indication, you do not need to reverse the indication. The EFIS has already done this for you. The CDI indication is thus exactly the same as during the landing approach.

Typical GLS approach ILS and Glide slope display



The above display is taken from an approach onto Runway 19. The actual magnetic heading is 186 degrees. The OBS is set automatically to this when you select the GLS approach. The true heading in the airport database for this runway is 162 degrees and the variation is 24 degrees west which gives 184 magnetic. The runway threshold is also set as “goto waypoint” so we know how far we are from the threshold if we look at a GPS distance to waypoint readout. This display tells us that we are slightly to the left of the centerline and should turn right. We are almost perfectly on the glide slope, perhaps a little low but not much.

The blue line is our GPS ground track and it is telling us that we are currently worsening our localizer situation and moving further to the left of the runway.

In order to have a valid ILS / Glide slope display we should be within a +/- 30 degree cone of the runway centerline.

The GLS is canceled if we land (automatic flight detect active or we manually end a flight).

We can also cancel a GLS at any time by selecting the relevant menu function – this only appears is a GLS is in progress.

Messages and sounds related to GLS

If you have your EFIS connected to your intercom system the following sounds or phrases will be available:

“GLS Intercept” - Sound and screen. You are flying a GLS via intercept and have arrived withing a 0.5 mile radius of the Intercept point. From here you will turn onto the runway heading.

“GLS Lock” - Sound only. GLS is active and you are within a +/-30 degree cone of the runway centerline. You are “receiving localizer and glide slope”.

“GLS Alert” - Sound only. GLS is active and you are more than +/-30 degrees cone from the runway centerline after having locked on. This sound will be suppressed if you are closer to 0.15 miles from the GLS touchdown point.

“Outer marker” - Sound and Screen. Morse code indicator. Activates once if you fly over a location along the centerline within the +/-30 degree cone. You define the distance of this location from the touchdown point in the GLS setup.

“Middle marker” - Sound and Screen. Morse code indicator. Activates once if you fly over a location along the centerline within the +/-30 degree cone. You define the distance of this location from the touchdown point in the GLS setup.

Related to this is the message “GPS Fail” which is Screen and sound. If you get this message during a GLS approach, you no longer are receiving a valid GPS position and heading information. Abandon your approach immediately if you have passed the middle marker and do not have a runway visual, otherwise wait 5 to 10 seconds to give the GPS time to re-acquire. If this fails, abandon the GPS approach.

Please note that you can record your own sounds and phrases assigned to these functions using the Enigma Sound application program for Windows.

GLS using 3D glideslope and 3D runway depiction.

If you have HITS (Highway in the sky) enabled for your horizon display (enable in navigation setup), the EFIS will draw a 3D outline of your currently selected GLS runway and will draw a 3D glide slope display using green crosses. When you align the crosses you are aligned and on the glide slope.

The above image shows a GLS approach onto runway 19 at FASH (Stellenbosch airfield near Cape Town, South Africa).
The aircraft is a little to the right of the ideal glide slope (set to 3 degrees in this case) and too high. The crosses are spaced about 0.3 miles apart which agrees with the distance to go display of 1.0 miles.

This display is a very good alternative to the more common “needle” ILS displays and gives the pilot an excellent view on the approach. Looking out the window, the real runway would present itself exactly like the one shown on the screen.

Note: This display is dependent on the accuracy of the runway data in your airports database (see section on GLS on how to view/edit this data).

It is important that your GPS is performing well and has a good sky view with good satellite constellation for maximum possible accuracy, in particular during the final part of the approach.
Note that during the approach, you can select the GLS to rely on altitude from your altimeter, rather than from the GPS which may contain a significant error if you have a poor GPS solution. Select this in the GLS/GVOR setup.

Successful and reliable use of this feature requires a good GPS antenna installation and no interference from electrical sources such as engine ignition systems.

Using GVOR

GVOR implements a dual VOR using GPS to simulate VOR beacons. The VOR system consists of a primary and standby system. Most of the time, the primary system is used.

GVOR works exactly like a real NAV radio based VOR. The EFIS knows the geographical location of a chosen VOR station as well as the magnetic variation at that location and can hence simulate the VOR radials exactly.

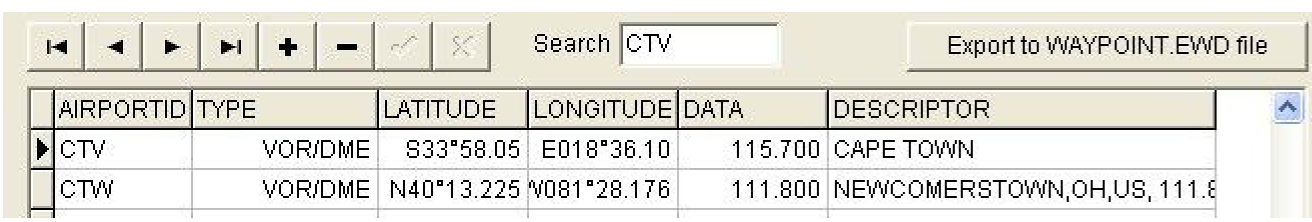
GVOR is indicated by using the letters GVR in the mode indicators.

To activate a GVOR, a connected NAV radio (if any) must be switched off and the GVOR system must be enabled in the GVOR setup. Also ensure that the GVOR beacon range is setup to your liking.

Activation of the GVOR is done in exactly the same way as if you would have a NAV radio connected. Press SHIFT+NAV to select the VOR beacon selection page:

If not already done, first choose the required OBS heading by pressing "LOG". Then select the desired beacon after having ensured selection of either primary or standby VOR.

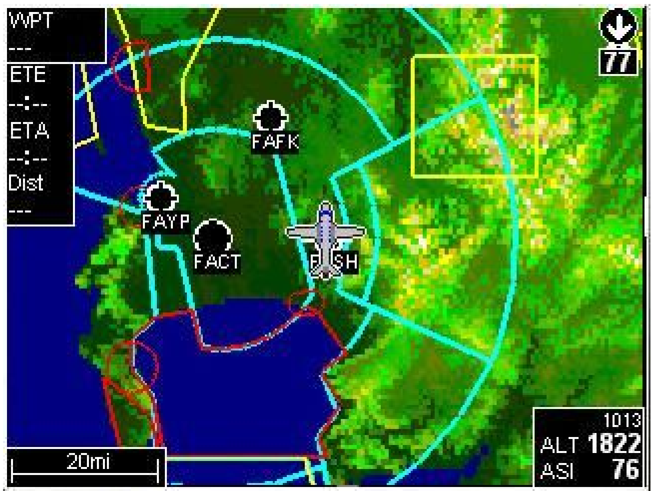
VOR beacon definitions in Enigma FlightPlanner Waypoint editor. For GVOR to work correctly, latitude and longitude of the beacon must be correct.



VOR navigation is done on the primary VOR station in most cases. If you select a standby station within range and no primary station is selected or the primary station is not in range but the standby is, the EFIS will switch to the standby station for navigation displays.

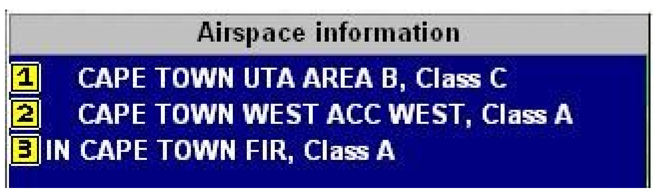
EFIS airspace awareness

If you have installed a suitable airspace definition file (“Navidata.ewd”) onto your internal solid state disk, the EFIS will use this file to draw airspaces onto your vector maps (if you are using vector maps) and will use the information in this file to monitor your aircrafts position relative to the defined airspaces.



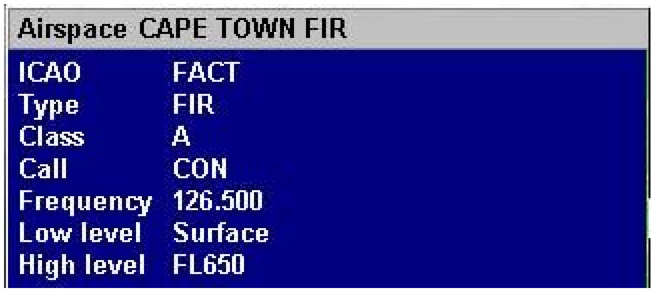
This image shows the airspaces around the Cape Town / South Africa area. FACT is Cape Town International airport. Boundaries in light blue refer to controlled airspaces, yellow defines special use airspaces, red is restricted or prohibited.

To find out information on the airspaces that could currently concern your position, press Shift +IMS. This shows the airspace information screen:



This display shows you all airspaces that your aircraft is currently flying in, under or over. If you are in a particular airspace considering your current altitude, the word “IN” appears in front of the airspace name.

To find our more information on any one of these airspaces, press the button marker, for example, using the above display you will get the following if “3” is pressed.



Setting up airspace monitoring

In “navigation setup”, enable or disable airspace monitoring. Even if you disable monitoring, airspace data will still be used for vector map drawing (if you are using vector maps).

You have the option of being notified if you leave an airspace.

Airspace notifications come in two forms – on screen messages which are always enabled if you have airspace alerts enabled and audio alerts.

The audio alert, if enabled, repeats the “airspace” phrase or message as defined in your audio file twice.

About altitudes for airspace monitoring.

The EFIS uses pressure altitude for airspace monitoring at all times (GPS is not technically permitted to be used for aviation altitude purposes).

Altitude will be pressure altitude corrected for local barometric pressure (QNH, local pressure setting) for all airspace vertical limits defined as AMSL, above Surface, above Ground. Altitude assuming a pressure of 1013mB (29.9”Hg) will be used regardless of your local pressure setting for airspace vertical limits defined as flight levels.

A particular difficulty arises with airspace definitions where the vertical limit(s) are defined relative to ground or surface. If no terrain data is available to the system, it is not possible for the EFIS to tell you if you are within such an airspace. The EFIS can only monitor the outside horizontal perimeter of the airspace. In this case, the EFIS will alert you as you cross the airspace boundary regardless of your current altitude. If terrain data is available for your current location, the EFIS will use this to work out your “above ground” altitude but will always use pressure altitude to do so. This requires that your local pressure altitude is set correctly.

Airspace monitoring limitations

Airspace monitoring relies on accuracy of the provided data. This data may be incomplete, contain errors or be out of date.

The EFIS airspace monitoring and alerting may only be used as a supplement to normal aeronautical navigation practices, never as replacement.

The pilot in command of the aircraft has to obtain latest information relevant for his flight before commencing aircraft operations and is required to cross check airspace data for accuracy.

This should be done using a suitable application. Use the PocketFMS flight planning tool for navidata exported from this application.

For user maintained data using the Enigma Flight Planner, use the Enigma Flight Planner.

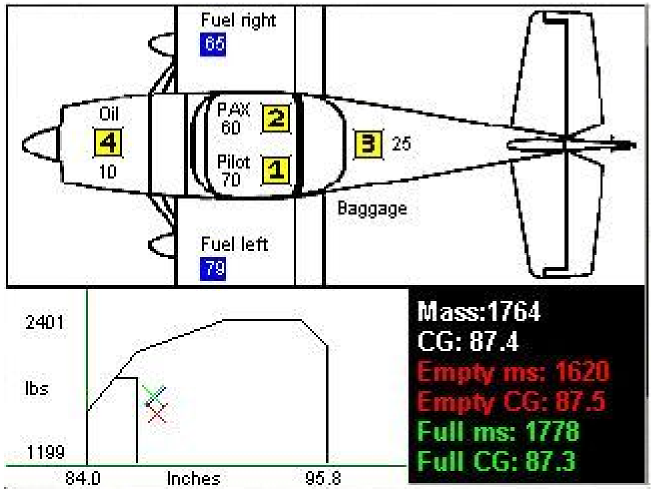
For Jeppesen Navdata, use the Enigma Flight Planner after performing an import of the Jeppesen Navdata.

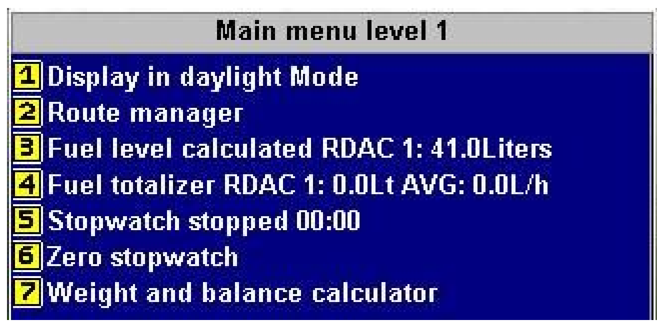
Under no circumstances will MGL Avionics accept liability for any provided data. This data is provided in good faith but does not originate at MGL Avionics, nor does MGL Avionics exercise any control over this data.

The pilot in command of the aircraft uses the provided data at own risk.

Weight and Balance calculator

The EFIS contains a graphical weight and balance calculator that you can customize to suit your aircraft.





The weight and balance calculator can be accessed from the main menu level 1 if a Weight and Balance definition file has been installed on your internal solid state disk (into folder “Other”). This file is created by the Weight and Balance definition window of your EFIS Simulator and Screen designer program. The filename is WB.DEF. A further file called WB.MIF can be created that contains the background image to be used by the Weight and Balance calculator. This process is described further on in this chapter.

The Weight and Balance display allows you to enter weights that do not change in flight, for example passenger and baggage as well as fuel tanks related directly to the 6 possible fuel tanks that your EFIS can monitor (4 physical tanks and 2 calculated tanks if you have two RDACs connected). In case of these fuel tanks, weights and balance will be calculated using current fuel levels, zero fuel level (in RED color) and full fuel level (in GREEN color).

The location of these points will also be shown in their relevant colors on the weight and balance graph to the left of the readout.

The EFIS will remember your last entries for the fixed weight fields if you switch your instrument off. If this data reverts to zero on restart, your memory backup battery needs to be changed. This battery is of type CR2032 (a common calculator type battery) located in a holder on the rear of your instrument. It should be replaced every year.

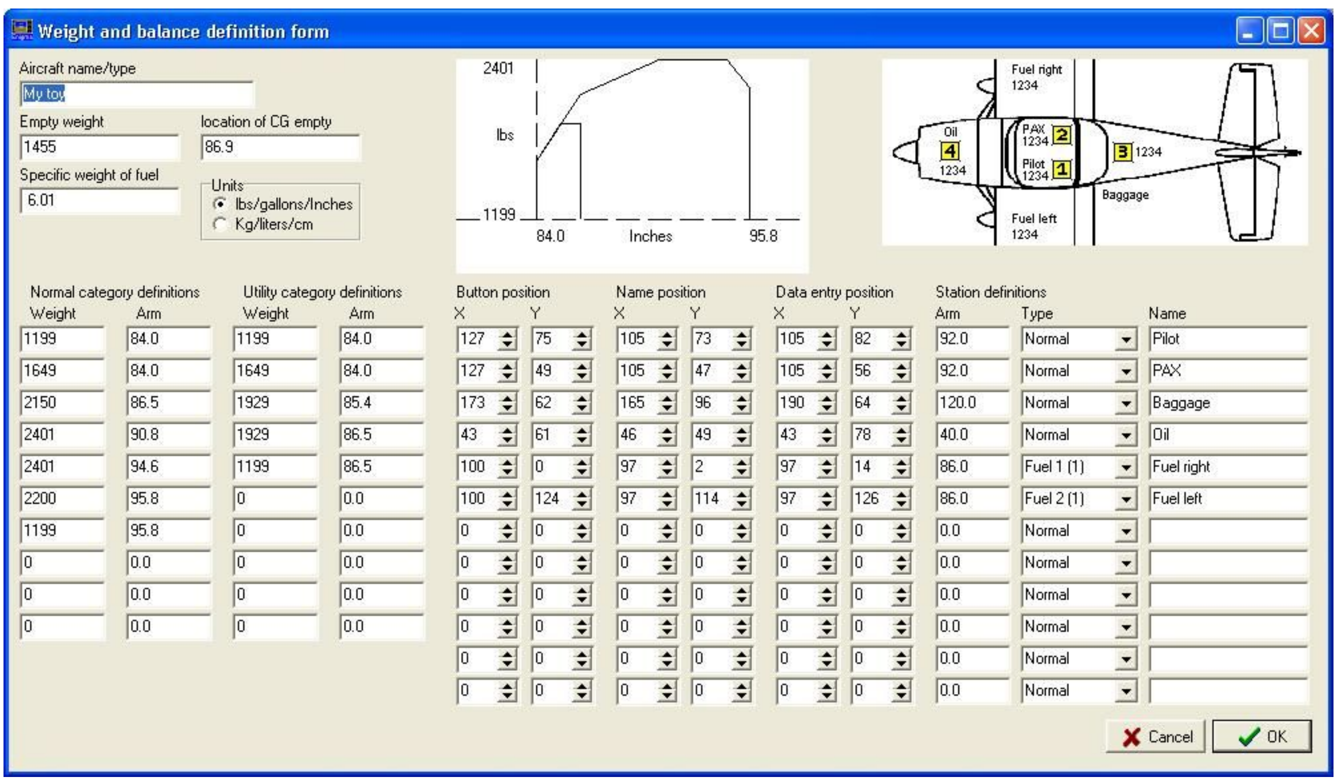
Defining the Weight and balance details for your aircraft

The weight and balance definition form is found under the W&B tag on your EFIS Screen Designer and Simulator program. Here you define the specifics for your aircraft. Once you have completed your entry, a file called “WB.DEF” is created in your Flash folder of your currently loaded project. You install this file onto your EFIS instrument either by using the provided function in “install tasks” (Main menu level 2) or by copying this file yourself to the internal solid state disk (folder “other”). Note that a second file is used for the aircraft backdrop image. This file is called “WB.MIF” and is converted from a standard Windows BMP image file using the EnigmaBMPtoMIF converter program (Download this program from our website www.MGLAvionics.co.za if you do not have it already).

The size of your image file must be 320 pixels wide and 140 pixels high. A typical program you can use to make such an image is the Windows Paintbox program that is standard in every Windows installation.

Once you have converted the BMP image file using EnigmaBMPToMIF, make sure it is called WB.MIF and copy it to the Flash folder of your current project. DO NOT RENAME THE BMP FILE TO WB.MIF – you MUST use the converter.

We recommend that you first create or obtain a suitable image for your aircraft before defining button and field locations. If you do not want to use a background image, you can still use the W&B functions. In this case place the buttons and fields at locations you prefer.



Normal category definitions Weight	Arm	Utility category definitions Weight	Arm	Button position X	Y	Name position X	Y	Data entry position X	Y	Station definitions Arm	Type	Name
1199	84.0	1199	84.0	127	75	105	73	105	82	92.0	Normal	Pilot
1649	84.0	1649	84.0	127	49	105	47	105	56	92.0	Normal	PAX
2150	86.5	1929	85.4	173	62	165	96	190	64	120.0	Normal	Baggage
2401	90.8	1929	86.5	43	61	46	49	43	78	40.0	Normal	Oil
2401	94.6	1199	86.5	100	0	97	2	97	14	86.0	Fuel 1 (1)	Fuel right
2200	95.8	0	0.0	100	124	97	114	97	126	86.0	Fuel 2 (1)	Fuel left
1199	95.8	0	0.0	0	0	0	0	0	0	0.0	Normal	
0	0.0	0	0.0	0	0	0	0	0	0	0.0	Normal	
0	0.0	0	0.0	0	0	0	0	0	0	0.0	Normal	
0	0.0	0	0.0	0	0	0	0	0	0	0.0	Normal	
				0	0	0	0	0	0	0.0	Normal	
				0	0	0	0	0	0	0.0	Normal	

You may give your aircraft definition a name.

Before you enter any data, select if you prefer the U.S. System of measurements or would rather use the metric system. If you have U.S. selected, all weights are in lbs and all arm distances are in inches with one decimal. Fuel quantity is in gallons. If you have selected metric units then you will work in Kg, cm and liters. Note that even with cm you must enter one decimal for every arm measurement.

All arms are distances from a common reference point usually close to the aircrafts nose.

You must define the empty weight and arm of your aircraft as defined in your aircrafts manual.

Then you need to define the points of your allowable CG limits. You can use two graphs that may overlap. These are referred to as normal and utility category. The utility category is usually used to define a stricter CG and weight range for example for use during aerobatics.

Each graph may contain up to 10 points. Most applications will use between 4 and 6 points per graph. Unused points must be set to “0”.

As you edit a point, you will immediately see the graph displayed updated to reflect the change. Ensure that the result, when done, is exactly like that required for your aircraft. If this is not possible (for example you need more than 10 points) create a graph that will entirely lie inside the allowable range (i.e will at all points be within safe limits).

If you don't need the second graph, enter “0” for all points.

On the right side of the definition form, you can create up to 12 stations that will be taken into account during the weight and balance calculation.

Note that these stations may have different types:

Normal: This point requires the pilot to enter a weight.

Fuel 1 (1) Physical fuel tank 1, RDAC 1

Fuel 2 (1) Physical fuel tank 2, RDAC 1

Fuel C (1) Calculated fuel tank 1, RDAC 1 (fuel flow related virtual tank)

Fuel 1 (2) Physical fuel tank 1, RDAC 2

Fuel 2 (2) Physical fuel tank 2, RDAC 2

Fuel C (2) Calculated fuel tank 1, RDAC 2 (fuel flow related virtual tank)

Fuel AUX Auxiliary fuel tank. This is a fuel tank where the amount of fuel has to be entered by the pilot as it is not connected to any EFIS sensors.

If a point is of type “Normal” or “Fuel AUX”, then you need to place a button on the data entry window. Simply enter the coordinates where you would like to place the button. Valid values are X: 1 to 300, Y: 0 to 124.

Setting X of the button to zero disables the station.

Further entries are available for a label (name) of the station as well as location of the data display and location of the label itself.

Installing the finished Weight and Balance definition into your EFIS

If you have completed your weight and balance definition, you need to copy the file "WB.DEF" which you will find in your projects Flash folder together with the file "WB.MIF" that contains the aircraft image to your SD or MMC card.

Insert the card into your EFIS and then select "Install Tasks" from the main menu level 2.

In "Install Tassk" select "Install Weight and Balance files".

Provided you have sufficient disk space on your internal solid state drive the files will be copied and your Weight and Balance calculator is ready for use.

Considerations when using the Weight and Balance calculator

When using calculated tanks based on fuel flow, ensure that you have entered the currently loaded fuel quantity before entering the Weight and Balance calculator.

The units of measure used in the Weight and Balance calculator are independent from any of your local settings in the EFIS. The units are dictated by the Weight and Balance definition form and will usually be chosen to agree with the units used in your aircrafts manual.

Be very aware of this if your Weight and Balance calculations are in U.S. units of measure while you operate the remainder of your EFIS in a metric system.

Magnetic variation

The EFIS contains a sophisticated model of the Earth magnetic field and how it changes over time.

The EFIS uses this to calculate the magnetic variation at your location. For this to be possible, the EFIS needs to know the location and the date.

The location will be known when your GPS receiver is able to find a position and as the position changes, so will the EFIS recalculate variation. You however need to enter the date (and time) into the EFIS using the Set date/time function in System Setup.

Should for some reason your GPS receiver not be able to obtain a position, you can still have the EFIS calculate variation. Use the map viewer function to enter lat and long of your position and the EFIS will use this if no GPS is available.

Magnetic variation is required in order for the wind speed and direction calculations to return a meaningful result. You also need a compass connected that is giving you a reasonably accurate heading for this to work satisfactory.

EFIS ARINC 429 interfaces

The EFIS provides three ARINC receivers and one ARINC transmitter. For normally configured systems the ARINC transmitter is set to Normal speed, ARINC receive channels 1 and 3 are normal speed while ARINC receive channel 2 is high speed.

For details on the ARINC429 format please view the ARINC 429 specification document. Due to copyright reasons we cannot reproduce these details here.

EFIS ARINC 429 transmit (Normal speed)

The ARINC transmit channel is mainly intended to provide an interface to suitable ARINC enabled autopilots. The following labels are transmitted:

Label 100. ID 2, 11. 250mS

Magnetic selected Course.

This is the magnetic course selected at time of activation of a GPS “goto” or route leg. The label is flagged “not valid” in modes of navigation where a fixed ground track is not available.

Label 117G. ID 2. 100mS

Vertical deviation.
This label is sent whenever the altitude bug is active. This is also the case during execution of a flight plan that includes altitude directives.

Label 121. ID 2. 100mS

Horizontal command to autopilot.

This label is the “roll” command to the autopilot. The EFIS produces a roll command up to 30 degrees left or right based on which type of navigation source is selected. Roll angle is modulated such to provide both track intercept as well as tracking.

Label 122G. ID 2. 100mS

Vertical command to autopilot.

This label provides a pitch angle command up or down in order to track altitude. Sources include the altitude bug and route navigation.
Permitted angles depend on navigation source. Angles of up to 5 degrees will be commanded.

Label 320. ID 2. 50mS

Magnetic heading

Magnetic heading as derived from a magnetic compass connected to the EFIS.

Label 324. ID 4,5. 20mS

Pitch Angle AHRS

This is the pitch angle as derived from the AHRS connected to the EFIS. Please note: Angles up to 90 degrees are possible. ARINC documentation allows up to 180 degrees. This is not possible.

Label 325. ID 4.5. 20mS

Roll Angle AHRS

Roll angle as derived from the AHRS connected to the EFIS. Angles 0-180 degrees left and right roll.

ARINC 429 receive channels 1 and 3 (Normal speed)

ARINC receive on these channels may accept any label. Labels not expected are ignored by the system.

Label 173. Localizer deviation

Label 174. Glideslope deviation

Label 222. VOR omnibearing

Label 34. VOR/ILS frequency

Label 33. ILS frequency

Label 114. Desired track

Label 115. Waypoint bearing

Label 116. Cross track distance

Label 117. Vertical deviation

Label 310. Present position latitude

Label 311. Present position longitude

Label 312. Ground Speed

Label 313. Ground track

ARINC 429 receive channel 2 (High speed)

This ARINC receive channel is intended to be used with TIS and TCAS or similar traffic monitoring systems and as a consequence implements ARINC 735 labels.

However, all of the ARINC labels that can be received on other ARINC channels can also be received on this channel.

ARINC 735 labels

Label 357 (RTS/ETX)

Label 130 intruder range

Label 131 intruder altitude

Label 132 intruder bearing

The ARINC 735 intruder file may contain up to 30 intruders as per specification.

EFIS ARINC 429 implementation

The EFIS follows ARINC 429P1 specifications with the following exceptions:

Transmitter output impedance is higher than specified. This means fewer receivers should be connected. The EFIS will drive up to 10 receivers. In typical installations one or two receivers are connected.

Transmitter output slew rate. The slew rate conforms to ARINC429P1 high speed transmit. This slew rate is also used with low speed transmit. This has no bearing on functionality of a low speed transmitter.

SDI fields on all transmissions are set to “zero”.

Inter-label spacing is 4 bit times minimum.

High speed 100KBits/second.

Low speed 12.5KBits/second.

EFIS multipanel operation

The EFIS contains comprehensive multi panel operation options. These include using the EFIS with a low cost Stratomaster Ultra EFIS as well as using the EFIS in a typical master/slave arrangement with two or more panels. This includes operation with EFIS compatible devices such as PC based flight simulators and other EFIS systems that are communications compatible with your EFIS.

Operating EFIS as master to an Ultra Slave

One EFIS may be master to one or more Ultra slaves. The Ultra slave is connected to the master EFIS via airtalk link. The Ultra must be setup as airtalk slave with multi panel mode enabled (Ultra mode setup menu).

The EFIS needs to have Ultra Multipanel enabled. This results in regular transmission of EFIS sensor data on the airtalk link.

Note: Some 3rd party applications may use EFIS sensor data from the airtalk link in which case you need to enable the Ultra Multipanel master.

Operating an EFIS multipanel system

You may connect two or more EFIS systems to form a multipanel system using the USB connections available on the rear of your EFIS.

You use a standard USB host to device cable (available in any computer retail shop). These cables are often sold as USB printer cables. You need a standard type with a “A” host connector and “B” device connector.

Your EFIS is fitted with two host ports and one device port. You assign the EFIS master by plugging the USB cable into any of the host connectors. The device side connector plugs into your assigned EFIS slave. There is no further setup required to enable or assign master/slave operations.

The only setup option you have refers to the EFIS slave (the device you plugged the USB device side connector into).

You can select one of four options for slave operation:

1) USB Slave: Own RDAC and AHRS
2) USB Slave: Own RDAC, master AHRS
3) USB Slave: Master RDAC, own AHRS
4) USB Slave: Master RDAC, master AHRS

In most cases you will select to use master RDAC and master AHRS. This means that your Slave EFIS will obtain all the sensor data from the master.

EFIS master/slave operation – how does it work ?

In a typical system, you may have one EFIS master and one EFIS slave.

Each EFIS will be fully wired to a common RDAC and a common AHRS system (horizon and compass via the airtalk). Each EFIS will also have its own GPS antenna connected.

This means, if the two EFISs are not connected via the USB link, you have two fully independent, fully operational EFIS systems.

Due to the connection of the USB link, you cause automatic master/slave operation. The slave will ignore all its own sensors and use the following data from the master:

a) Altimeter, ASI, VSI, AOA, ambient temperature etc.

b) Both RDAC units and all connected sensors

c) All GPS and related data (position, velocity, heading etc)

d) All AHRS data (attitude and heading, compass)

Should the data link from the master fail for whatever reason, the slave will revert to its own sensors within two seconds of failure. This is why it is important that the slave is fully wired to the RDAC(s) and AHRS sensors.

Should the slave be fitted with its own RDAC and AHRS for redundancy or other reasons, you can select to use the private sensors and ignore the master data for these items (as explained above).

EFIS<->Enigma master/slave actions

In an EFIS and/or Enigma master/slave system the following user actions are propagated between systems:

1) Change of local pressure setting (Baro+, Baro-)
2) Acknowledgment of alarm (Pressing of “Ack” button)
3) Goto Waypoint (other system receives current waypoint information)
4) Activate GLS (other system receives all information related to active GLS)
5) Navigate with route (other system receives current waypoint information)

Should a route be activated on either master or slave system, the other system will follow by means of performing an equivalent “goto waypoint” for every leg. It is not required that the other system(s) have a WAYPOINT.EWD file loaded as all information required to navigate to the next waypoint is transferred.

Should one system activate a GLS approach the other system will follow. All information related to the approach is transferred, the target system does not require a loaded navidata database file.

EFIS master/slave system setup

It is typical but not mandatory that the EFIS systems would be setup to be identical. This means you install the same screens and perform the same setups. This is easily achieved automatically by executing a Script Library file created using the EFIS Screen Designer and simulator on both systems.

Ensure that you have all relevant engine parameter setups identical on both systems unless there is a good reason why they should be different.

Consider selecting different startup screens (selected in operations setup) for different EFIS instruments. For example you might choose to start the main system with a primary flight display, the second system with a navigation/moving map display and even a third system with an engine monitoring display.

If you are using three EFIS systems, be sure to plug two slaves into the two host USB ports of the master. Daisy-chaining (I.e. From one USB host to another USB slave and that slaves Host to another slave) does not work.

Setting up your SD/MMC cards for use with a master/slave system

An ordinary master/slave setup would require that each system has its own SD/MMC card loaded with everything needed to maintain a fully functional system in case of a master system failure. This is easily achieved by ensuring that each card is an exact copy of the other.

The USB link does not transfer mapping information due to the large amount of data involved and the need for the slave system to be independent. It is thus recommended that your slave system has its own copy of any maps you are using on your master system.
We also recommend that you install waypoints and airports files on all systems and keep them synchronized when you update these files.

USB cable notes

Be careful when you select and wire USB cables. USB cables can radiate EMI if proper wiring and installation techniques are not followed. This can lead to interference on your communications radios.

USB cables containing EMI suppression ferrites on both ends are preferred. Expensive braided or gold plated USB cables are not going to improve anything – they have no advantage.

If your cables are too long, coil them and flatten the coil. Do not allow a round coil – this acts as transmitting/receiving magnetic antenna.

EFIS master/slave and the sound system

Most master/slave systems will probably only wire in the master system into the aircrafts intercom so that voice alerts can be heard by the pilot.

It is possible to wire in the slave system if your audio panel supports multiple inputs and it is possible to switch the slave input off until it is needed.

Tip: If your sound system does not have a disable for the audio input, consider a switch in series with the audio output of your instrument, this way you can switch off the voice/sound generation when you do not need it.

EFIS multi boot system

This text refers only to Odyssey, Voyager and Explorer instruments. Enigma is not required to "multi boot" due to a different system.

The EFIS can boot in a variety of ways. Booting refers to the source of the FlightOps operating system and the EFIS application program and mechanism of transferring these into system memory.

Normal system

The file **Odyssey.bin** is copied by the EFIS primary boot loader from SD card to the root folder of the internal Solid State disk whenever the boot loader finds this file on the SD card and determines that it is different to the file located on your internal Solid State disk.

Note that no version check is done. You can go forwards AND backwards in software version numbers as you desire. The file is checked for physical differences (file contents and size).

If no further bootable files are found on the SD card, the **Odyssey.bin** file is loaded from your internal Solid State disk and transferred into system memory. Once this is complete, the code is checked for errors. If the file is in any way corrupted, the system will stop with an error message.

If the code is good, FlightOps is started. As part of the startup the section of memory that holds executable code is protected from any future unauthorized write access to prevent accidental corruption of the code.

External system boot

It is possible to create a fully functional system on an SD card that will be used instead of any files on the internal Solid State disk. This can also be used as "Emergency system" if for some reason the internal Solid State disk is not operational. The external boot works even if the internal Solid State disk is removed from the system.

To create an external boot system, copy ALL the files you would normally install onto your Solid State disk onto the SD card root folder. Do not use any folders on the SD card (unless they are not related to the EFIS).

Copy all your screen files, maps, waypoints and airport data and anything else you may need on your system (for example the weight&balance files).

Finally, copy the **Odyssey.bin** file that you want to use as external system onto the SD card. However, rename the file to **Odyssey.emb**. You should not have a **Odyssey.bin** filename on this card.

If the EFIS primary boot system finds the **Odyssey.emb** file on your SD card, it will be loaded into memory and executed the same way as normal system startup, however, the internal solid state disk is ignored for all operations and is not available in the File manager.

All files required by the system will be read from SD card.

Note that some operations may be slightly slower when operating from SD card due to lower data transfer rates. However, the difference is not very noticeable due to the efficient file system employed in FlightOps.

Test your SD card for clean startup when the EFIS is powered up with the card inserted. Some older or non-compatible cards may not start up cleanly. If you have such a card, the recommended remedy is to get another from a different card maker.

Use ordinary SD cards. Do not use “high speed” cards. We find that many of these so-called “high-speed” cards are no faster than ordinary cards and often inferior.

External boot using internal solid state disk

If you place a renamed **Odyssey.bin** file as **Odyssey.exb** onto the SD card and the SD card is inserted at power up, the **Odyssey.exb** file will be loaded into memory and executed instead of the **Odyssey.bin** file from the internal Solid State disk (if the file **Odyssey.bin** exists).

Unlike the **Odyssey.emb** boot described above, the **Odyssey.exb** boot will use the internal Solid State disk for all file access as in a normal system.

Deleting the Odyssey.bin file from the internal Solid State disk

Using the file manager, it is possible to delete the **Odyssey.bin** file on the internal Solid State disk. You will be warned that this will result in the next startup of the system failing and you will be required to reload the **Odyssey.bin** file or use any of the alternative boot methods to start a system.

This is similar to formating the internal Solid State disk, except that you will have to reinstall all the files required for your system (maps, waypoint and navidata files etc).

Installing your first system

One of the first tasks you will be faced with is a first system installation. You will have received your EFIS with a few default screens installed.

Most likely, the immediate requirement will be to modify the engine screens to suit your application.

After this, you will want to install supplementary waypoints and the navidata files.

You then will install maps and perhaps weight and balance files.

Here is a step by step guide to how this could be done:

Step 1

Install and run the EFIS simulator and screen designer.

From the available projects, open a project that matches your engine monitoring needs as close as possible. Check your engine parameters in the Engine setup menus, for example EGT temperature ranges, number of channels etc.

Using the screen designer, modify the engine screens to suit your requirements.

Have a look at the document “Enigma alteration guide” available from the MGL Avionics Website to get started if you are unsure of how to proceed.

When you are satisfied that your simulated EFIS behaves as you require, create a “batch library from current setup” - Project menu. This creates a single file containing all your screens, setups and, optionally, sound and weight and balance definitions (which you can also create in the simulator).

Give your batch file a suitable name and copy to your SD card (root folder).

Step 2

In the EFIS, go to the “Install tasks menu” and go to the second page. Here you will find a function “Execute script library”. Insert your SD card with your batch library file and select it.

Your EFIS will install your screen files, any other files in the library, install a new sound file if it was included and update all your settings.

Step 3

Prepare your first navidata database file. Navidata can be obtained from PocketFMS (www.PocketFMS.com), Jeppesen Navdata (www.Jeppesen.com) or you can create your own using the Enigma Flight Planner program.

PocketFMS and Jeppesen provide data using a subscription service while data created in Enigma Flight Planner is free.

Basic instructions for Enigma Flight Planner:

Download airport and navigation beacon information from www.navaid.com. Choose the GPX file format.

Download airspace data from www.MGLAvionics.com for your region. You will extract a file called airspace.evd. Copy this file to your Enigma Flight Planner "Data" folder.

Import the GPX file into your Enigma FlightPlanner. This will create two databases that you can view and edit. The first is the waypoints database, the second is the airports database.

You can add waypoints and airfields as you require.

When you are done, export using the Navidata file export. Do not use the exports to Waypoint.ewd or export to Airports.ewd – these files are no longer used.

Copy the navidata.ewd file from your Enigma Flight Planner "Export" folder to your SD card.

Basic instructions if you are using a navidata file from a subscription service:

Use Enigma Flight Planner to create "supplementary" waypoints – these would typically be a collection of private waypoints that you would not find in the subscription data. Export these to the file "Waypoint.ewd" from the waypoints database. Note: This step is optional, you do not require to have the waypoint.ewd file on hand.

Step 4

In EFIS, go to the "Install tasks menu" and choose "Install waypoints" (if you have any supplementary waypoints defined) and then "Install Navidata".

Note for Enigma: If your Navidata file is too large for installation, leave it on the SD card. Enigma will use it from the card.

Tip: consider creating a smaller navidata file for installation into Enigma if your data source allows this. This way you can still use a smaller selection of data in case you forget your SD card at home. Enigma will use the navidata on the SD card if one exists, even if a navidata file has been installed internally.

Step 5

From the EFIS DVD, copy the terrain data install file for your area onto your PC into a temporary folder and execute the file. This will install one or more files with a ".DEM" file extention. These files are quite big, over 50MBytes each.

Copy the DEM files to your SD card.

Step 6

In EFIS, go to the "Install tasks menu" and choose "Install terrain data". Due to the size of these files, this may take a few minutes.

Note: This step is not required for Enigma. Leave the DEM files on the SD card.

Step 7

From the EFIS DVD, copy the vector map data install file for your area onto your PC into a temporary folder and execute the file. This will install a file called VMAP.evd. Copy this file to your SD card.

Step 8

In EFIS, go to the “Install tasks menu” and choose “Install vector map”. This may take a short while depending on the size of the VMAP.EVD file for your area.

Note: This step is not required for Enigma. Leave the VMAP.EVD file on the SD card.

Step 9

Check your EFIS DVD for any raster map files for your area. If you have the Southern Africa DVD, Raster map files are included for the Southern Africa area. For other areas check with your local distributor if raster maps are available.

Tip: you can convert your own paper or digital format maps (if they are in BMP ot JPG format) into raster maps for your EFIS using the “Enigma Mapmaker” program on your EFIS DVD (or download the latest version from the MGL Avionics website).

Copy all raster map files AND the Mapindex.MM0 file onto your SD card.

Raster map files have names similar to “**N33W093b.M34**”.

Step 10

In EFIS, go to the “Install tasks menu” and choose “Install raster maps”. This may take a few minutes as raster map files tend to be large.

Note: This step is not required for Enigma. Leave the raster map files on the SD card.

Other steps

Once you are comfortable with your setups, you will possibly install more advanced items like weight and balance files – these contain an image of your aircraft that you can create in a basic drawing program such as Microsoft Windows paint. Perhaps you have an I/O extender and have created an I/O extender script file for advanced functionality (see the I/O extender manual for details on this).

Installation steps in general

The above is just an example, the steps do not have to be followed in any particular order and you can easily combine steps.

For example, consider first creating all the files required and copy them to your SD card and then install the files one after the other in EFIS to save time.

Note: The following does not apply to the Enigma EFIS.

Keep your SD card as emergency boot system by copying a renamed “Odyssey.bin” as “Odyssey.emb” onto the card. You will be able to run your system from the SD card should anything happen to your internal Solid State disk.

Make a second copy of this card but with the Odyssey.bin in the original name – should you ever need to reinstall anything, you will have everything readily available. You will probably use this second card to transfer new versions of your data files (perhaps you added some new waypoints) or you downloaded a new version of Odyssey.bin itself (keep looking out for new versions of Odyssey.bin on the MGL Avionics website – new functions and features are being added all the time to Odyssey and you can expect new versions every 4 weeks or so. All updates are free of charge and they are easy to do).

For Enigma systems, keep checking for updates to the file Enigma.bin on the www.MGLAvionics.co.za website.

Enigma/EFIS hardware extenders

The EFIS's hardware I/O capabilities can be extended using the following devices:

Airtalk I/O Extender

This small unit extends the EFIS with up to 19 digital inputs, 8 digital outputs, 7 analog inputs and a bidirectional current sensing system (intended to show battery charge/discharge current rates).

The digital inputs are 12V compatible and can be used to create passive indicators (such as door open/closed, gear up/down etc) as well as alarms upon activation. The inputs can also be used as remote controls for the EFIS remote control popup menu which allows control over vital functions using just three (or four) buttons (perhaps mounted on a joystick).

Four of the available digital inputs can be used to activate standard EFIS alarms (subject to normal EFIS alarm routing)

Digital outputs are current sink outputs which can be used to control alarm annunciator panels, grouping classes of alarms (for example fuel level alarms) to an output. These outputs can be further used in a form of automation where you can program digital outputs to respond to analog input values (for example, switch on a fan if a certain level output from a temperature sender is received).

Analog inputs are 12V inputs used to measure a voltage level from 0V to 12V. This can for example be created by a linear potentiometer coupled to a flap lever. Typical uses are: Flap and trim position indicators, fuel and oil level indicators.

Analog inputs can be associated with any EFIS analog display instrument (bargraph etc) complete with upper and lower warning and alarm limits.

The I/O extender ships with a graphic configuration utility that allows simple configuration of the functions required for the application. This exports a single script file which can be installed into the EFIS (Install Tasks menu).

User manual for the I/O Extender is a separate document to this one.

Airtalk Current Monitor

This small device extracts the current monitoring circuit of the I/O extender for applications requiring measurement of battery charge/discharge currents without needing any of the other functionality of the I/O Extender.

USB Communications server

This USB device extends your EFIS with an additional 3 RS232 serial ports, 3 ARINC 429 receivers, 1 ARINC 429 transmitter, CAN interface (used with many engine control units) and two USB host ports (usable as HUB for EFIS dedicated USB functions).

The USB communications server also acts as image processing and server for externally acquired images such as from weather data steams (WX satellite data) and camera images including IR cameras.

User manual for the USB communications server is a separate document to this one.

EFIS trouble shooting

This chapter contains information on common issues related to the EFIS installations

Difficulty setting up CHT channels

Selecting CHT channels requires choosing between the Rotax 912 CHT mode which uses two NTC type oil temperature senders and the more common thermocouple types which tend to get used as rings under spark plugs or similar arrangements.

If you would like to use thermocouples FIRST select thermocouple sender types in the engine monitor setup -> CHT setup. THEN you can use the EFIS Screen designer to assign CHT thermocouple types and assign TC channel numbers using the channel override.

Ensure that both the EFIS CHT setup and the indicator type used (bargraph etc) are set to the same type of CHT senders (thermocouple or Rotax 912) or else your CHT system will not operate correctly.

EFIS software and hardware updates

The Enigma series EFIS is a dynamic development that is ongoing and continuous. Providing the ability to update existing systems is very close to our heart at MGL Avionics.

Software updates

Software updates are very easy to install into your EFIS. Simply download the update from our Website on the EFIS page. You will download a file called “xxx.bin” where “xxx” is either Enigma or Odyssey. The Odyssey update file is used on any Odyssey, Voyager or Explorer instrument while the Enigma file is used on the Enigma instrument.

Copy the update file onto your SD card, insert into your EFIS and switch on. The EFIS will take care of the rest and update all parts of your software as required. The single update file can update your coprocessor(s) software, FlightOps operating system and the EFIS application itself.

Please note that if your primary coprocessor requires updating, the screen may turn dark for up to a minute as the primary coprocessor is reprogrammed. Some updates require that the display backlight is switched off.

Hardware updates

We designed the EFIS such that the main processor and memory subsystem forms a single, replaceable module. Should technology advance and we can offer additional processing power to take advantage of new features, perhaps requiring more memory, it becomes possible to upgrade your EFIS by replacing a single module. This allows you to follow the EFIS development into the future at minimal cost.

You can perform the upgrade yourself if you are technically minded or you can contact your MGL Avionics distributor for assistance.