

# IEFIS alteration guide



This document details how to modify existing screens or create new ones using the iEFIS screen designer.

This guide is applicable for the following products:

- iEFIS Discovery (unreleased product)
- iEFIS Explorer
- iEFIS Challenger
- iEFIS Discovery light
- iEFIS Explorer light
- iEFIS Challenger light
- iEFIS MX1

Document dated December 6<sup>h</sup> 2018

# Table of Contents

General.....	4
The file manager.....	5
My first screen.....	9
Disabling/Enabling a screen.....	18
Using a built in screen selection as a base for a custom design.....	19
Screen layers.....	20
Getting your screens into the real EFIS.....	21
Performance considerations.....	22
Using the screen draw timers.....	23
Reliability considerations.....	25
The item library.....	25
Text items tab.....	25
Text: Special Item.....	25
Units text.....	28
Universal Text item.....	29
Complex Items tab.....	29
VSI History display.....	30
Terrain look ahead.....	30
Analog inputs XY display.....	30
Tape roller item.....	30
Carb temperature monitor.....	30
CDI/HSI XY display.....	31
MGL ADSB.....	31
MGL VHF COM Radio.....	31
MGL Transponder.....	31
MGL Autopilot.....	31
iBOX status.....	31
MGL NAV Radio.....	31
MGL GPS.....	31
Waypoint status.....	31
Instruments tab.....	32
Altimeter, analog.....	32
Airspeed, analog.....	32
VSI, analog.....	33
Bargraph, Bug bargraph, Line bargraph.....	33
Analog meter (roundel).....	34
Horizon.....	35
GPS Moving map.....	36
Wind Vector.....	38
Heading indication.....	38
Slip indicator.....	38
Altimeter tape.....	38
Airspeed tape.....	39
Heading tape.....	39
VSI bargraph.....	39

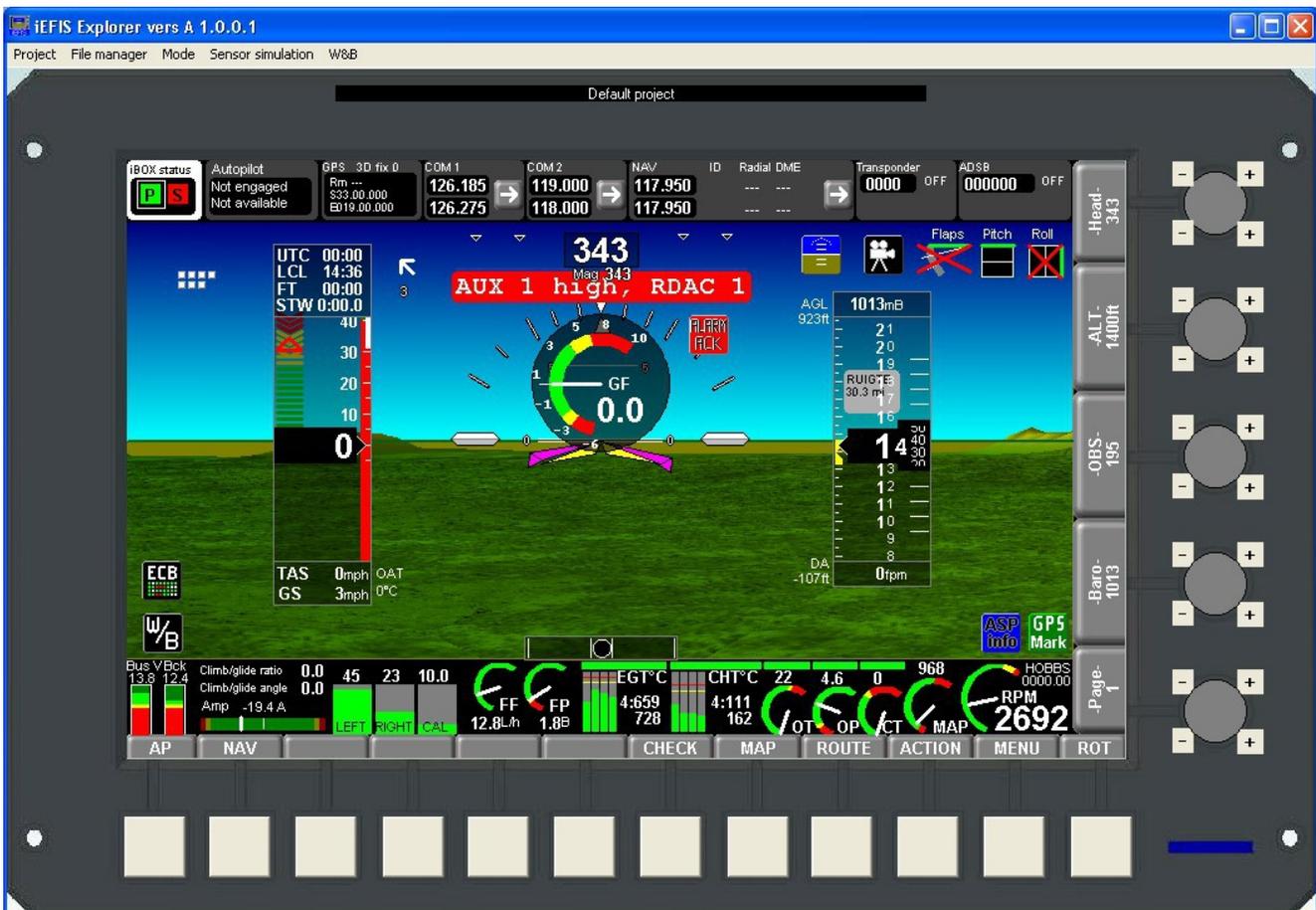
Turn rate bargraph.....	39
CDI.....	39
Analog meter (ARC).....	39
NAV HSI .....	41
NAV GSI.....	42
Simple attitude display.....	43
Angle of attack (AOA).....	43
Airspace look ahead component.....	43
Turn component.....	43
Status/Control tab.....	44
General tab.....	44
Drawing primitives.....	44
Bug indicator.....	45
Screen function marker.....	45
Info screen timer.....	45
Conditional skip items.....	45
Background image.....	45
Analog state indicator.....	46
Video input.....	46
ECB (Circuit breaker).....	46
Functional icon.....	46
Touch area.....	46
Simple status indicator.....	47
Background copy.....	47
The Default file system (advanced users).....	48
Selecting default screen files to edit.....	50
Making the Dfile.bin file.....	51
The “modes.txt” file.....	52
Relocatable modules.....	55

## General

This document assumes that you have downloaded the ExplorerSimulator.exe file from [www.MGLAvionics.co.za](http://www.MGLAvionics.co.za) and run this program resulting in a working installation of the Screen Designer on your Windows PC.

The Screen Designer and Simulator is very nearly identical to the actual instrument in operation so just about anything you can do to the real instrument you can do to the simulator.

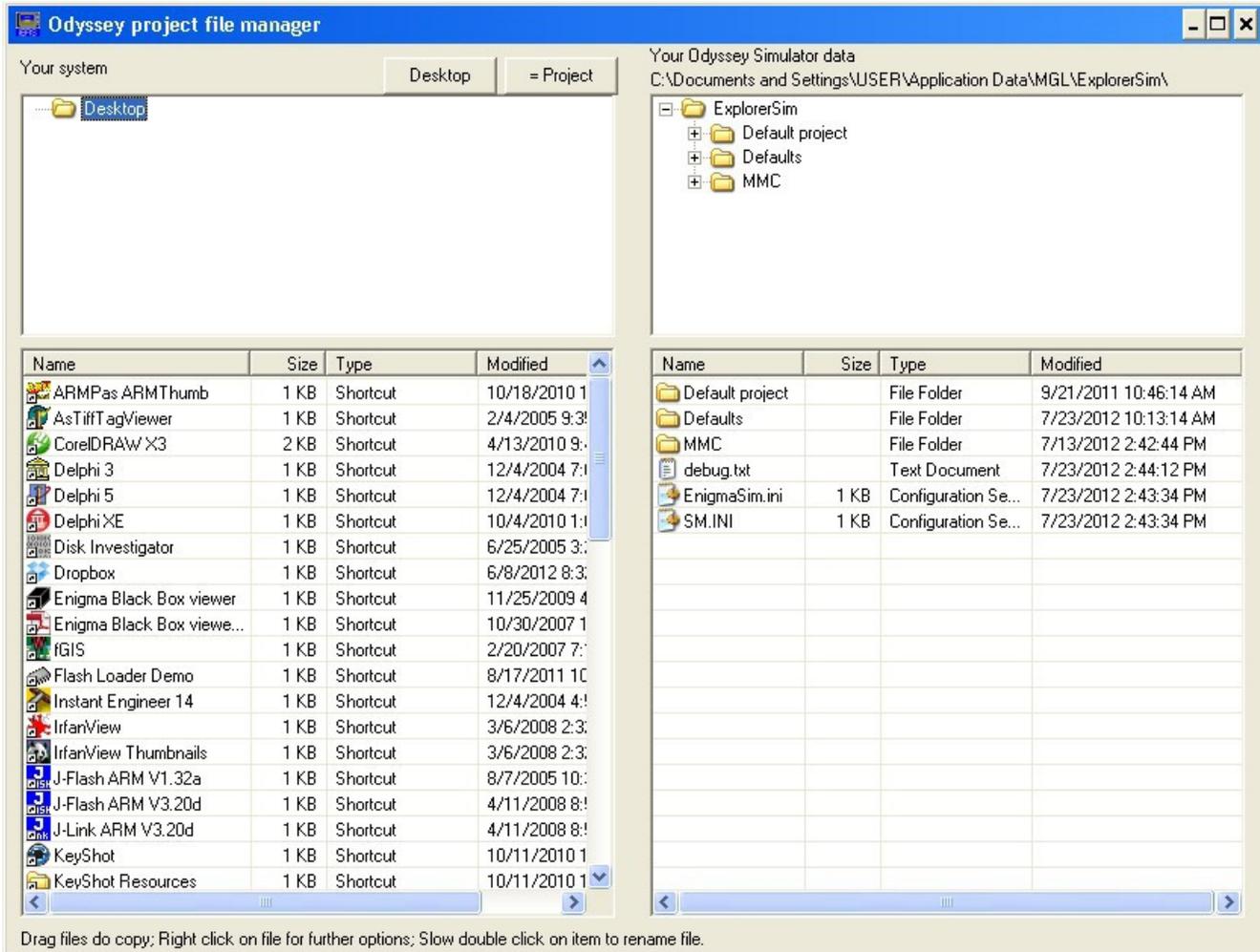
Certain peripherals such as Engine monitoring or an AHRS, even a GPS will be missing. These items have been added to the "sensor simulator".



The above image shows the simulator running on a Windows PC. It has a GPS position set using the GPS simulator and also has terrain data installed.

# The file manager

It makes sense to look at how files are organized for the simulator. Not surprisingly, the real instrument and the simulator shares a similar structure. The Simulator includes a handy file manager:



The file manager uses the right hand side to show your simulators file area in your Windows users “roaming” area. Depending on your Windows settings, this folder may be hidden from you but you can always access it using the file manager.

The top section shows your folder tree and the bottom section shows files in that folder.

The left hand side shows “the rest” of your PC and you can navigate here to any other part of your PC. There are also quick ways to set the left hand side to your “Desktop” or to the current simulator project (handy if you want to copy files within your project).

Clicking on the “Desktop” button gives you access to external drives such as SD card readers which you will use to transfer files to your real EFIS.

You can “right click” on files for options on what you can do and you can simply drag files

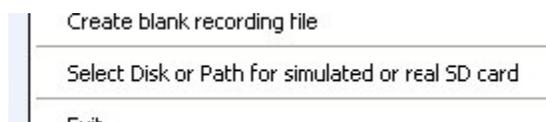
between the left and right sides of the file manager.

Let's have a closer look here:



The MMC folder is a simulation of the EFIS's SD card slot. Any files placed in here look to the EFIS as if they are on the EFIS SD card.

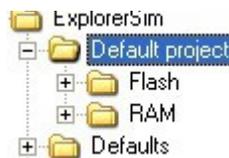
Note: You can also direct the simulator directly to a real SD card in a SD card reader attached to your PC:



If you select a path here it will no longer use the “MMC” folder in your roaming directory (unless of course you point it back to that location).

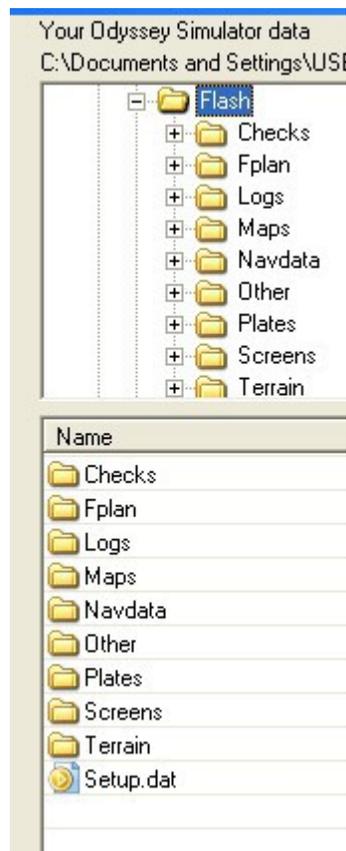
The “defaults” folder contains all of the default screen designs. There are a lot of them but you will almost never interact with the contents of this folder directly so you can ignore it.

The “Default project” is your normal project that you work with. Open this folder so we can see what is inside:



There are two more folders. One is called “RAM”. This represents a small “RAM” disk that is currently unused in the iEFIS so we can ignore this.

The “Flash” folder is more interesting – this is a direct representation of your EFIS's real internal disk drive (It is a SD card that is built into your EFIS).



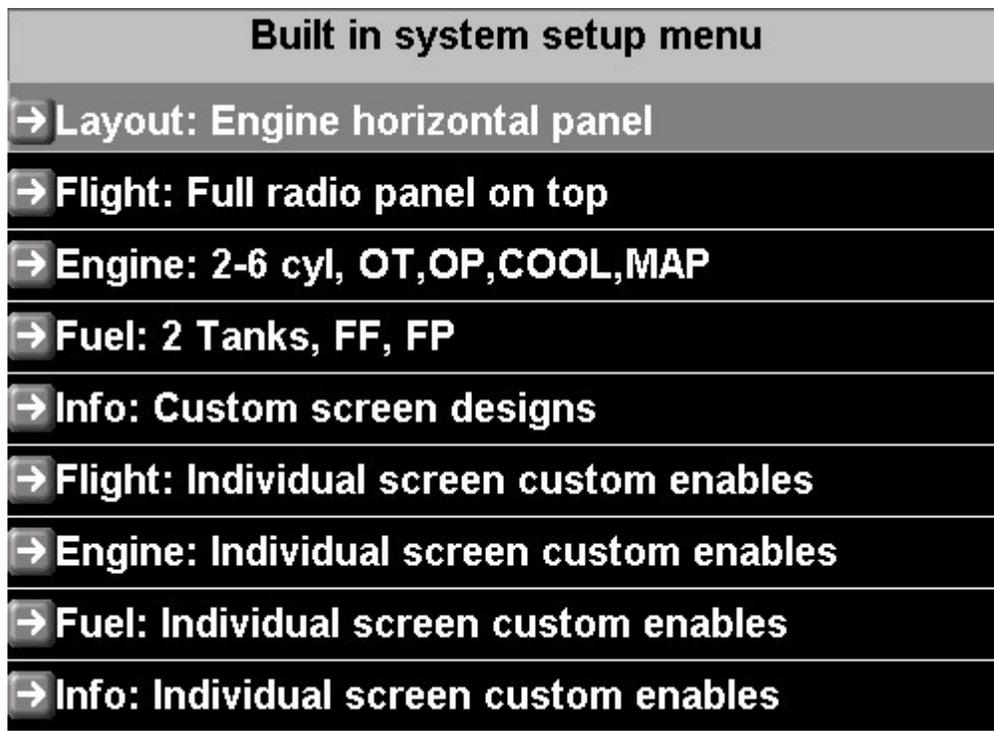
You will notice a number of folders – If you have a look in your real EFIS's file manager (in the menu) and open the internal SSD drive – you will find exactly the same folders.

For purposes of designing screens we are interested in only one folder – the “Screens” folder. If you open it before doing any work, you will notice it is empty. All the screens you see on your EFIS are “Built in” - but the good news is that you can “extract” them in order to use them as a base for your own creations.

You can also create screens or parts of screens “from scratch”.

How does the EFIS know when to use a built in screen and when to use your screen ? You tell it using the setup functions provided in the system setup menu:





Here you tell the system when to use a built in screen and when to use your custom designed screens.

Lets have a look at how a screen is made up:

Each screen may have up to four files. These files are called "Screen design files" and have the file extention ".sdf".

The filenames are "FlightN","EngineN","FuelN" and "InfoNA". Replace the "N" with a number from 1 to 9. You guessed it: Those are the page numbers and we can have up to 9 pages. The "info" page can have up to 10 individual files for each page – simply replace the last character ("A" in this example) with the letter "A" to "J".

The menu page is a separate page in the iEFIS system. Here you replace the page number with the letter "M".

Screen design files contain anything from zero to many hundred individual items that make up a screen. Despite the names given, any screen file may contain any item. You can put a Engine related item into the Flight screen if you like to do so. The file names are just for your convenience – it makes sense to group things.

Using the "Built in system setup menu" you can select from the provided, "built-in" screen sections. Each of these sections may be set to "custom". In that case you will provide that section for each page.

You can also select each section for each page individually to "custom" if you prefer.

## My first screen

OK, lets get serious. Using the “Built in system setup menu” select the following:

- Layout: Engine vertical panel
- Flight: Full radio panel on top
- Engine: Custom screen designs
- Fuel: 2 Tanks, FF, FP
- Info: Standard info pages

Note we have selected the “Engine” as custom screen design.

We are going to do out own engine screen. No reason to start simple. The process is easy.

Now get out of the menu and you should see:

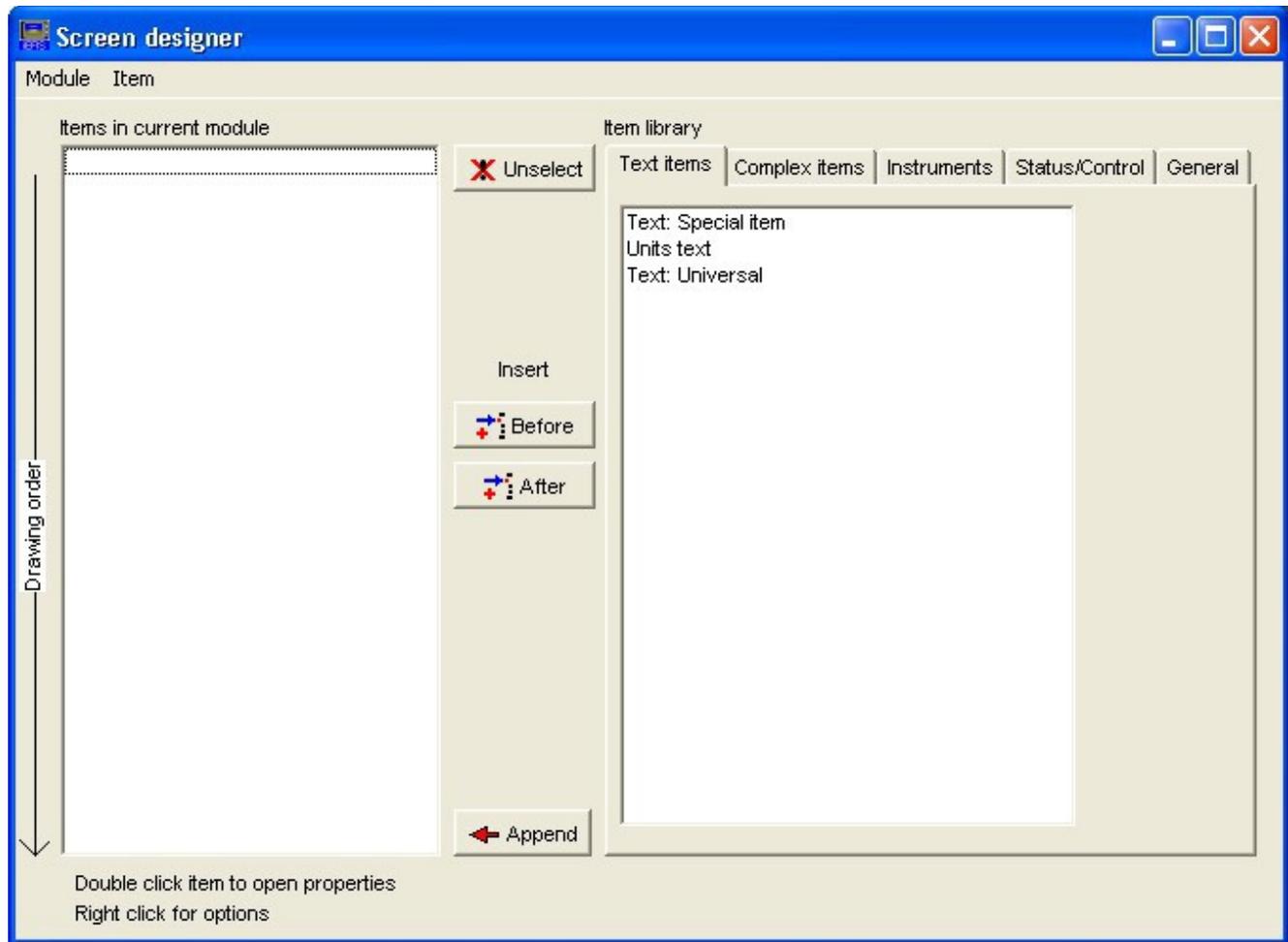


The area that used to show the engine is now blank – it is waiting for us to do something with it.

From the Windows Menu on the Simulator choose “Mode”:



Choose: "Design"...



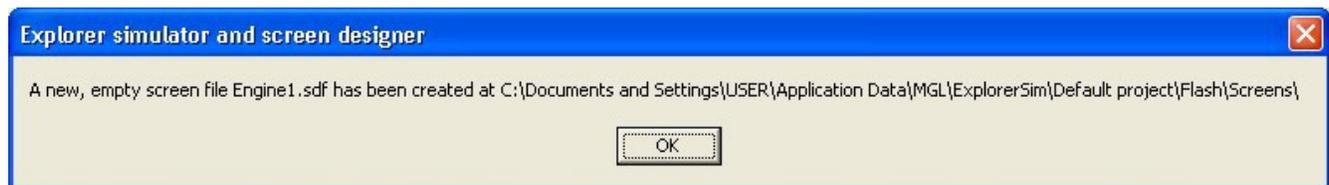
This is the "screen" designer we have been waiting for...

You have a library of items on the right that we can choose from and the left side shows a list of items in our selected screen file. These items are drawn from top to bottom. Drawing order is important – it allows us to do some nice things like putting a background behind an item.

Before we can add items we need a screen file – lets create one. Click on "Module"...



Select "Design custom Engine module".



Great, note where the file has been created – right where we want it, inside the “Screens” folder of our current project.

Now it is time to add some items to our drawing list. We note that our engine section was to the left of the screen so lets make a nice RPM display.

We are going to “play a bit” – just to show how to do things:

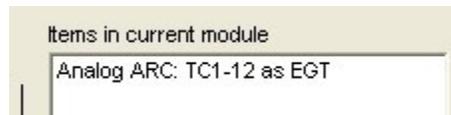
Select the “Instruments tab” and then click on the “Analog meter (ARC)” so it has a blue background.



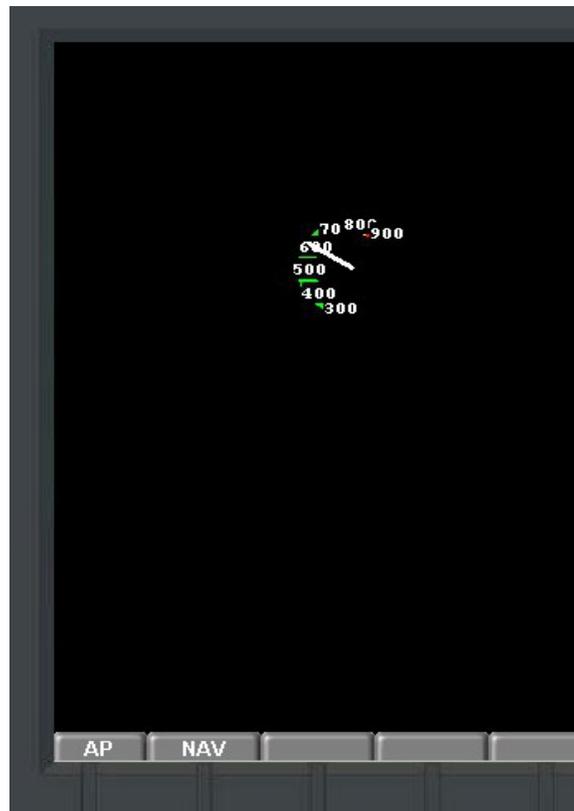
Now click the “Append” button (or you can just “double click” the Analog meter item).



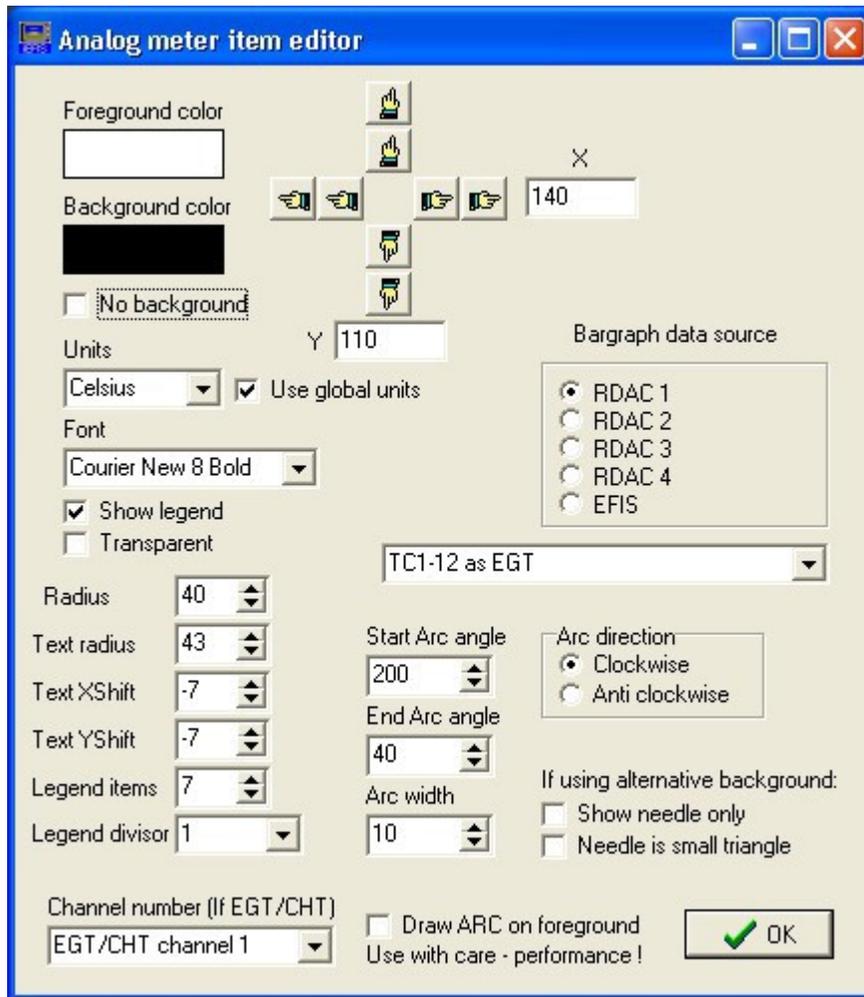
Your items list now looks like



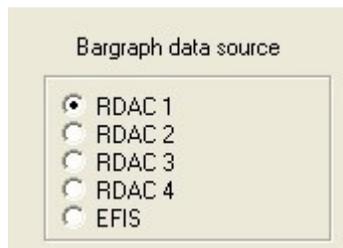
And your screen:



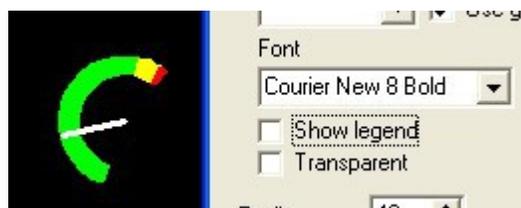
Right – close but not exactly what we had in mind. No problem – let's fix it: Double click on the item in the drawing list to open its property editor:



The first thing we want to change is the data source. We want RPM from RDAC number 1.



and:



Uncheck "Show Legend". Starting tool like what we want ?

We can set start and end angles of our ARC and choose the thickness, we can also set the size. Lets make it nice and big and make the ARC horizontal:

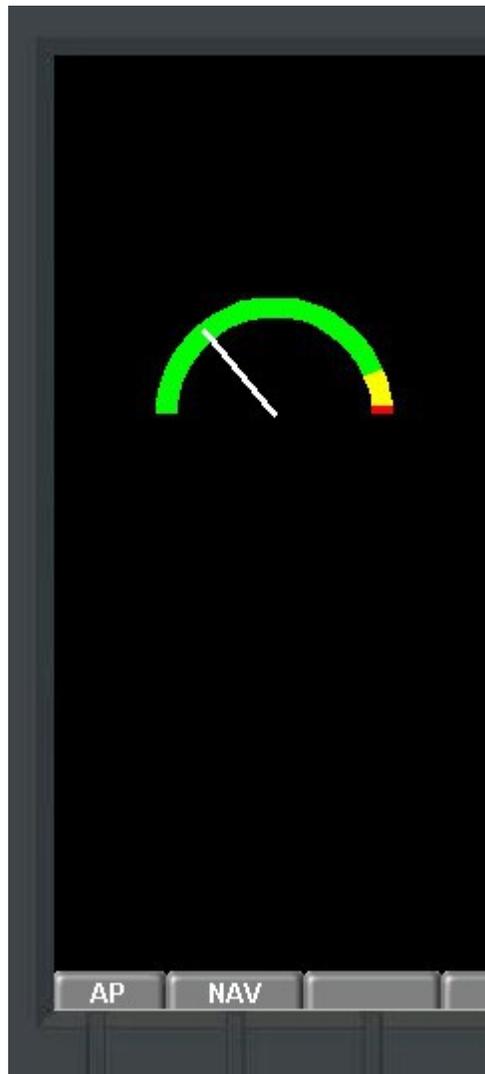
Set the “Start angle” to 270 degrees and the “End Angle” to 90 degrees.

Set the “Radius” to 70.

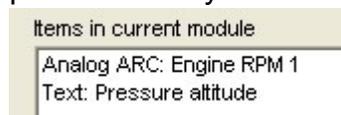
Move the ARC to the left using the move buttons. There are two sets – the inner moves very fine in one pixel steps – the outer moves in steps of ten pixels.

Done ?

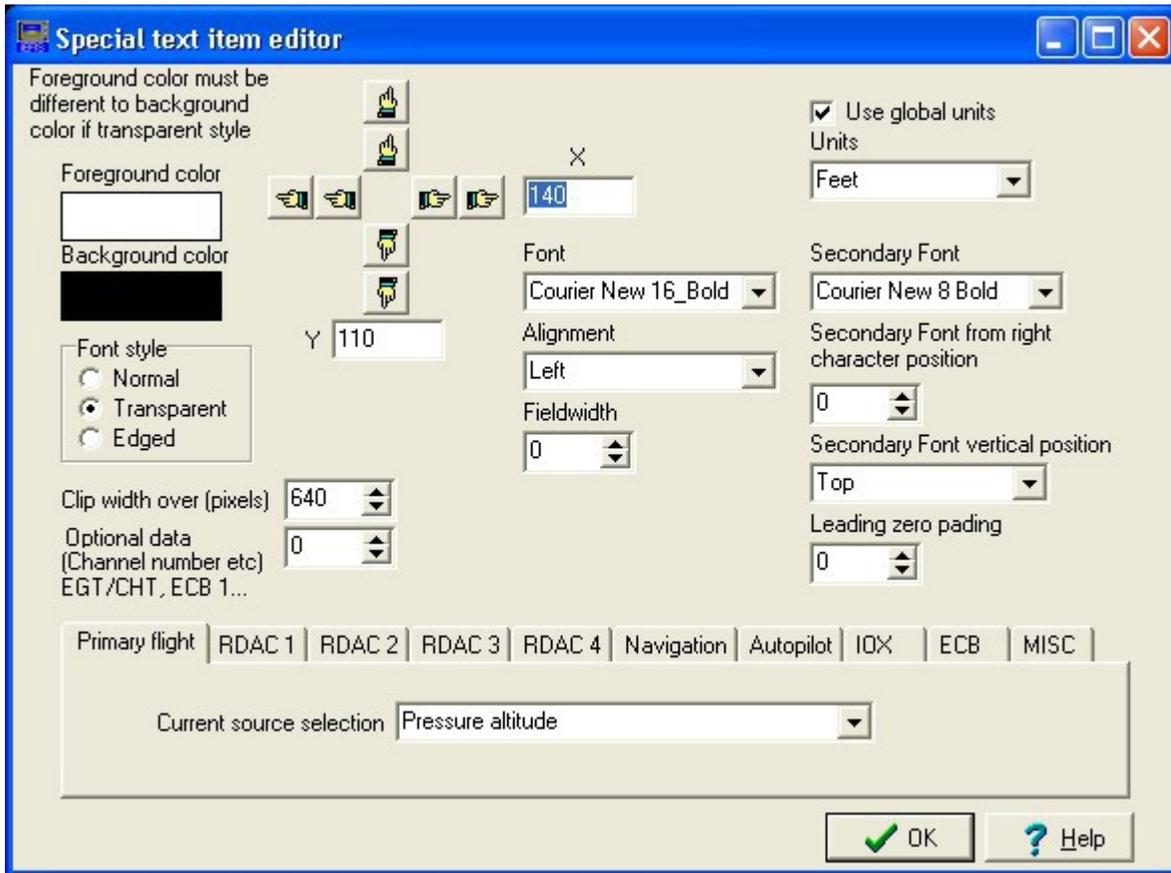
Close the property editor. You should have something like this:



Right – we need a numeric readout for the RPM. Using the same procedure as you used for the ARC, add a “special text item” from the “Text items”:



You guessed the next step: Double click the special text item to bring up the property editor:



OK, lets let this one sink in a bit. You will use this one a lot.

“Special Text” refers to a text based items where the EFIS decides on what that text is.

Using the tabs select “RDAC1” and then RPM 1



Now select the Font as “Arial 20 Bold” and Edged. Leave the colors at a white foreground and black background. The Edged font draws a line around the characters in the background color – we will use that soon...

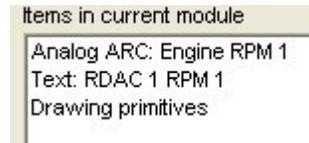
Select “centered” alignment – this way the text will grow left and right as the number changes width. Now move the number below the RPM ARC and close the property editor.

You should have:

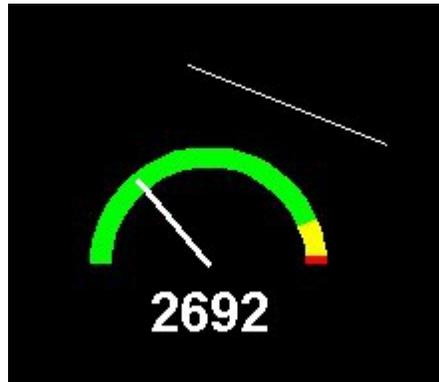


OK, this is starting to look nice.

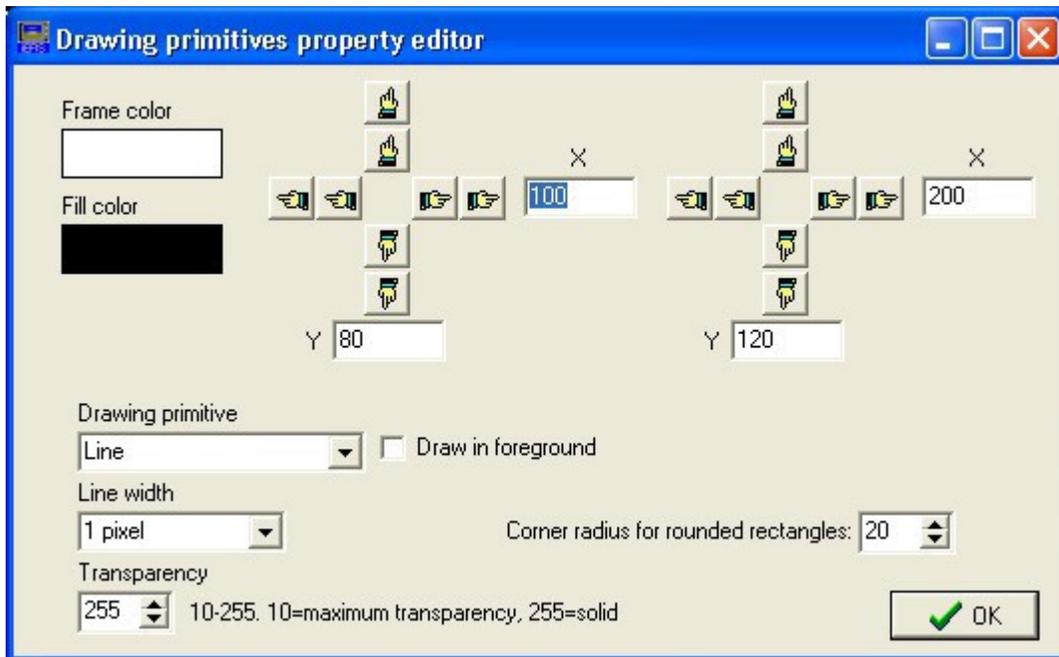
Let us give it a nice frame background with rounded edges. Choose “drawing primitives” from the “general” tab in the designer and add it to the list.



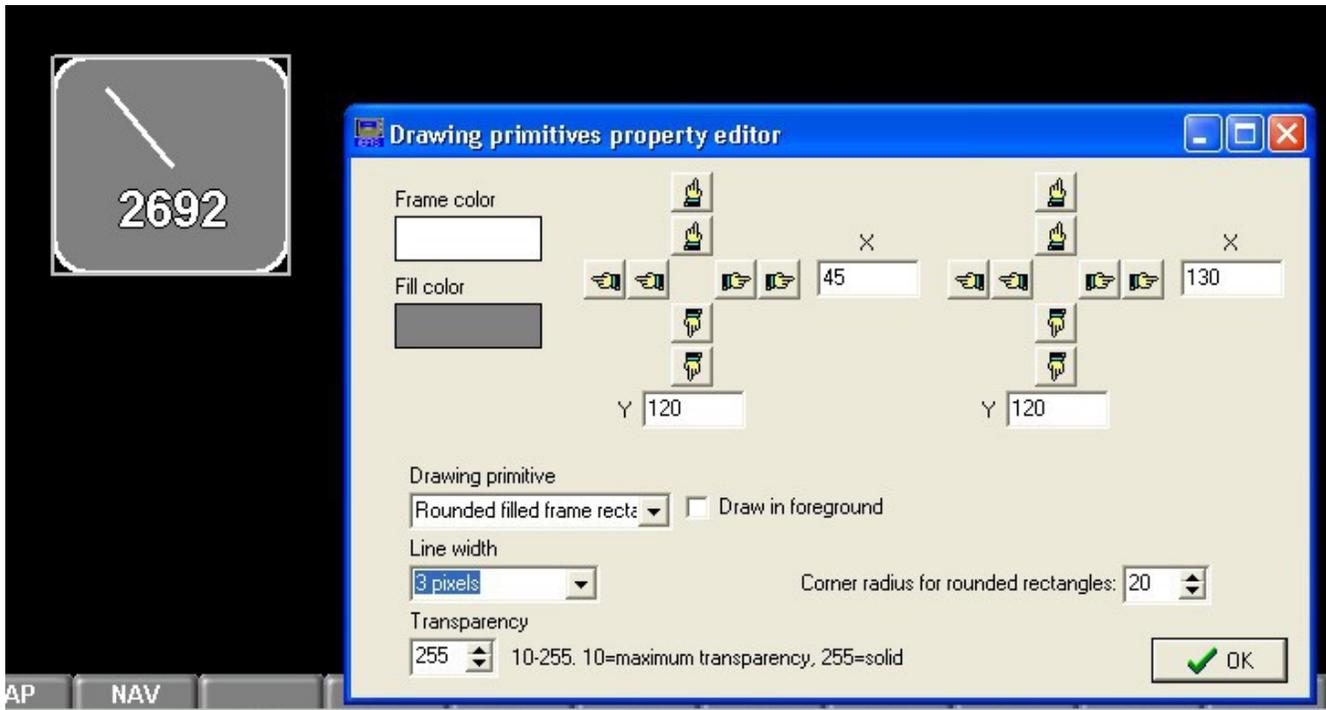
However, the screen now looks like:



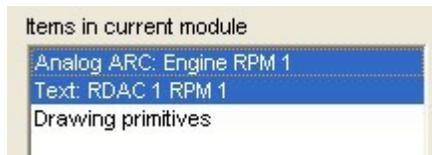
Double click the drawing primitives item in the list to bring up the property editor:



Select “Rounded filled frame rectangle”. Select the colors as given below and move the rectangle over our instrument.



What happened to the ARC ? It got overdrawn by the rectangle as it is later in the list as the ARC. How do we fix that ?



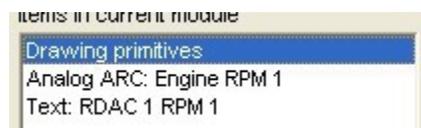
We need to move things around. Highlight the two entries we want to move down (which means the “drawing primitives” will be the first item when it is done).

Use the CTRL and SHIFT keys together with your mouse clicks to select more than one item.

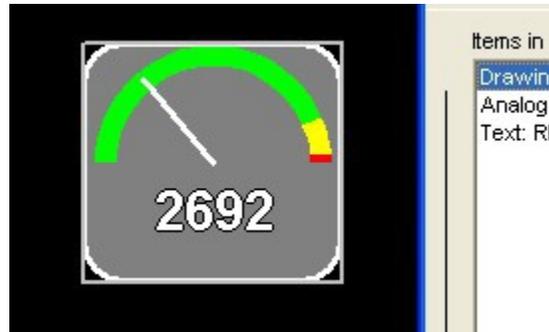
When done, right click on the items:



Some interesting functions here – “Move down” seems a good one for now:



And the screen now looks like this:



Hmm, almost good. The gray rectangle needs to move up a bit. Click the rectangle until its outer borders are flashing slowly – this is a way to select an item in the drawing list when it starts to get busy – you can click on any item to select multiple items.

It may seem confusing at first – but there is a method here. If you click on the RPM number – it may select the drawing primitive since it is also at the same location – no matter keep clicking – it will select/unselect anything that applies for the location until you are happy with the selection.

Close the screen designer. You should have your first partial screen design.

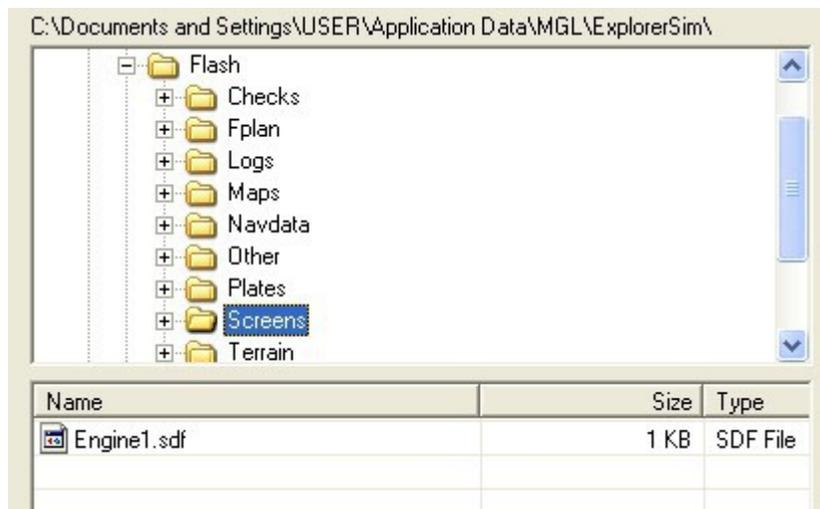
Keep moving between the final screen and the designer until you are happy. Tip: There is a “construction rectangle” as option in the Drawing primitives. It is a rectangle that is visible only in the screen designer. It helps you to partition areas of the screen and makes it easier to position things.



You never need to save screen files – they are saved automatically as you edit them.

If required copy your existing screen files in the screens folder to a safe backup.

OK up to here ? Congratulations – you have done your first screen design. Yes, it is a simple one but you have learned a few vital skills. You are aware of drawing order and you can position items where you want them and set various options for that item.



Going back to the file manager - open the screens folder of your project. You have created a file called “Engine1.sdf”.

So this would be for page 1. You could simple copy the file as “Engine2.sdf” and it would work for page 2 as well.

Or you could rename it rather than copy it if you just want it to appear on a different page. Double click the file name slowly (click – pause -click) and you can then type in a new name.

#### **Notes:**

While the screen designer is active, you cannot change pages.

Closing the screen designer saves your currently editing screen section file.

## **Disabling/Enabling a screen**

The EFIS system supports 9 screens numbered 1 to 9. The EFIS will display any screen that has a corresponding “Flight” file. If there is no “Flight” file for a particular screen, that screen does not exist even if you have Engine, Fuel or Info parts.

If you would like to build a screen that for example only has the Engine part, simply create an empty Flight file for that page. If the Flight file for that page exists (even if the file is empty) the screen will be loaded.

Example: You would like to create a custom design that only has a single page 1: Remove all Flight files for pages 2 to 9.

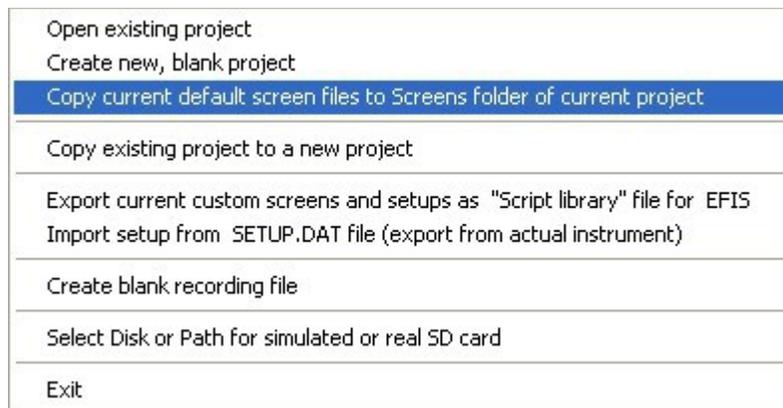
## Using a built in screen selection as a base for a custom design

In many cases you may want to use an existing, built-in screen design as a base with for a complete custom design or just a partial custom design – for example, you may just want to change the Engine or Fuel part of the screen.

The process starts by extracting the screens to the screens folder.

You may want to create a fresh, new project for this or you can use the default project if you are not planning on using it any other way.

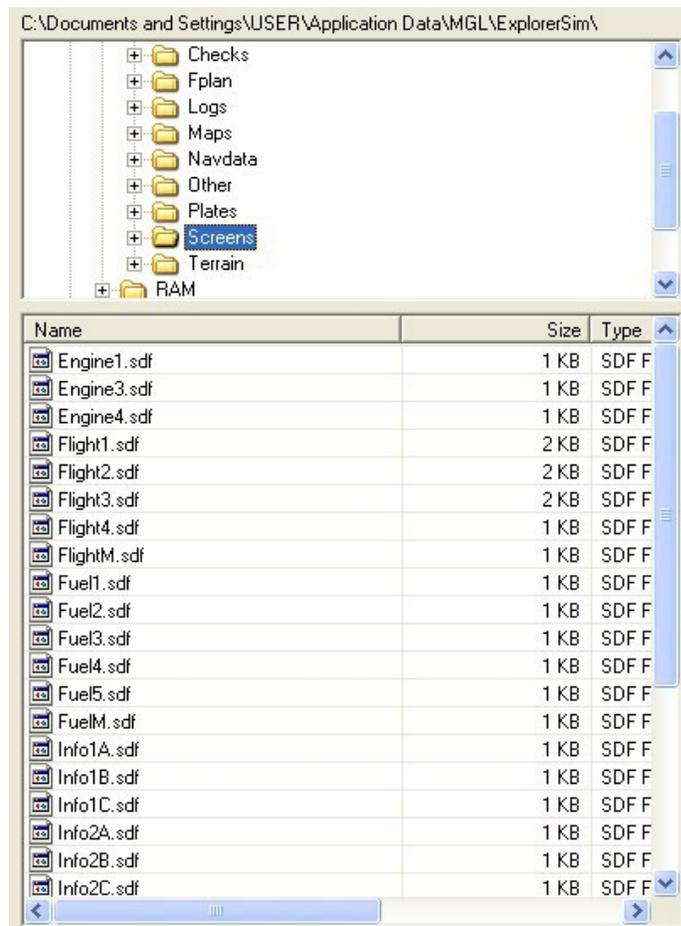
Use the file manager to delete all files in the current screens folder of the current project. You do not have to do this but it is recommended that you start with an empty screens folder.



First ensure that you have selected the required built in screens you need – switch through the various pages and select, if required from the Built in setups menu.

You will export the screens of all pages that you see in the current project.

Once you have done this, you will find the extracted screens in the screens folder of the current project. Any screen files that were there before with the same names will have been overwritten.



You can now use the screen designer to view or change any of these files in the manner you are already familiar with. Note: you always edit the page you are viewing.

## Screen layers

The screen consists of two layers – a background and a foreground layer. What does this mean?

Let us take a look at how the EFIS draws screens. It needs to draw a lot of screens as things change all the time. As a result it draws a complete screen with all the items many times a second – typically up to 20 times or more depending on the system.

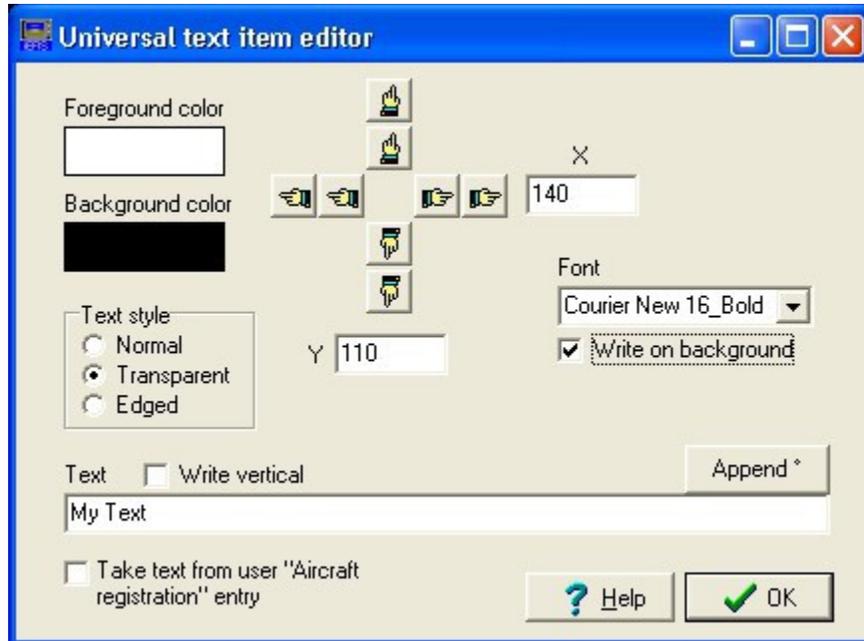
Every time it starts a new screen it needs to start with a black screen with nothing on it – or does it? Well, some items do not change. For example, the ARC we used in the previous example never changes – why draw it every time – it costs valuable processor time to do this.

The answer is to have two screen layers. The background layer contains all the items that do not change or do not change often – for example the moving map is drawn on the background and only re-drawn if the map changes in any way.

The drawing sequence thus starts by copying the background (with all the fixed items) onto the new screen and then drawing all the “foreground” items.

You will notice that many items have a checkbox where you need to specify where the item

has to be drawn:



Here for example we have the “Universal text” item. This is used to supply text to the screen that you specify. For the above example you might want to put the letters “RPM” next to the readout. This would never change so it makes sense to place this on the background – be sure to check the box as shown here.

Please make sure you place every item that can go onto the background onto the background – this enhances drawing performance considerably and results in a responsive system.

Sometimes it is not possible to place an item onto the background. For example – you might place the “horizon” component which may occupy a large part of the screen – this uses mostly the foreground for drawing so it would cover up the background. If you want to place a text item on top of something like this it needs to go on the foreground AND follow the item so it gets drawn afterwards.

## Getting your screens into the real EFIS

You have finished your screen design and now you need to get the new screens into your EFIS. You know the screens are located in the screens folder so one way would be to copy them onto an SD micro card (use the root folder) and then insert the card into your EFIS.

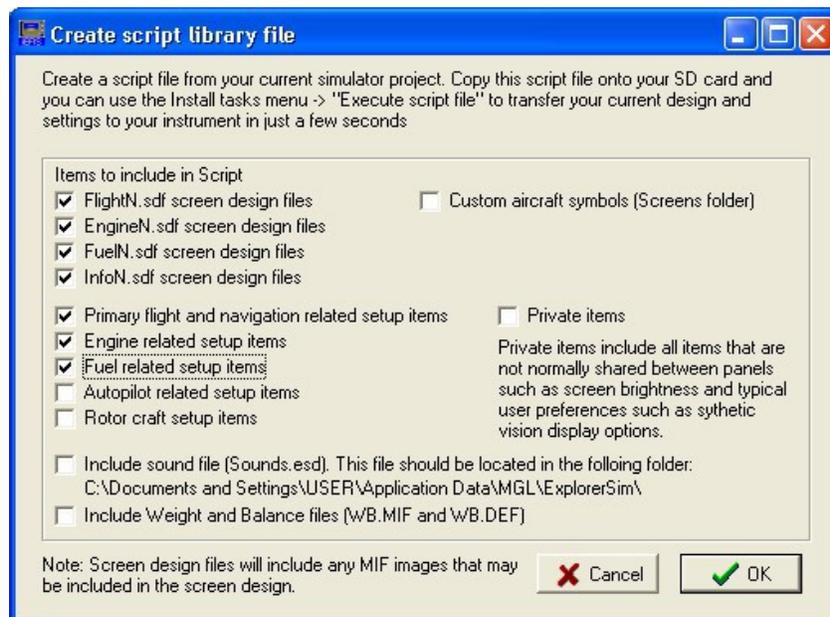
Use the file manager in the EFIS to copy the files to your screens folder in the EFIS. Do not forget to select the custom screen options in the EFIS to match the ones in your simulator.

You can also use the “install screen files” function in the EFIS installation tasks menu. It is just a quicker way than using the file manager.

You can also create a “script file” in the simulator.

Open existing project	
Create new, blank project	
Copy current default screen files to Screens folder of current project	
<hr/>	
Copy existing project to a new project	
<hr/>	
Export current custom screens and setups as "Script library" file for EFIS	
Import setup from SETUP.DAT file (export from actual instrument)	
<hr/>	
Create blank recording file	
<hr/>	
Select Disk or Path for simulated or real SD card	
<hr/>	
Exit	

This opens:



Select options as needed. This function creates a single file containing all your custom screens (as selected) but is also used to transfer all setup settings such as engine monitoring parameters.

The single file created effectively contains a copy of your current simulator excluding any map or navigation data files etc.

This file can be executed in the installation tasks menu "Execute script library". It provides a fast and convenient method to transfer complete systems.

## Performance considerations

Screen drawing performance is under control of the screen designer. The more items you have to draw, the longer it takes. The more pixels an item has, the longer it takes to draw this item.

As some of the built in screens show, you can place a lot of items on the screen – as long as

you are careful.

For example – you could place many large filled rectangles on the screen – all covering the entire screen and each other.

You would quickly overwhelm the drawing engine by forcing it to draw more pixels that is possible given the available time.

The peak drawing performance for certain operations is about 100 million pixels per second but a more realistic figure would be perhaps 25-50 million pixels given processing requirements in a typical setup.

Divide this by 10 complete redraws per second and you will have 2.5 million pixels per draw or 1.25 million pixels for 20 complete redraws.

Further hits on the available memory bandwidth of the graphics engine are caused by the video inputs (if you have a camera connected) – this can add at least 25% additional overhead.

The complete video memory has to be read out to the LCD display around 50-60 times per second (the screen refresh rate). For an Explorer system this means a data transfer rate of around 40 MegaBytes per second, almost double that for a Challenger system.

A screen has 384.000 pixels for Discovery and Explorer, Challenger has 786.432.

The bottom line is: You have a good performance margin but you also have the power to use up this margin by a less than good screen design. Please be sensible.

Should you be on the borderline of exceeding the available performance you will notice this as the screen seems to be delayed – the drawing is falling behind. You notice this for example by changing a screen – the change is not instant – it seems delayed.

### ***Using the screen draw timers***

From version 1.0.1.4 the iEFIS includes two performance related times to allow close monitoring of screen drawing performance. The timers display can be activated in the “operations setup menu”. The setting is transient and will revert to “off” on the next system restart.



Drawing is done using two devices. The first is the main CPU which decides what to draw. Things like 3D transformations and clipping are done in the main CPU so you will find the CPU showing a fairly high load when showing a 3D view (This is fairly constant regardless of size of the image).

The second timer shows the actual time the GPU takes to perform the drawing of the page to completion. This is strictly speaking not only drawing time as this time includes some unused periods where the GPU is waiting for data from the CPU.

Times are expressed in a percentage of the available time.

The maximum allowable time for the CPU should not exceed 70% to reserve sufficient CPU time for other tasks the system needs to perform. Occasional excursions above this limit are acceptable.

The GPU can be loaded up to 100% as it does not perform any tasks beyond drawing, however it is advised to keep the time to a maximum of 80% to avoid latency issues of the display. The GPU drawing time is almost directly related to the amount of pixels that need to be accessed. Keep in mind that many operations require multiple accesses to the same pixel.

## Reliability considerations

You have a lot of power when it comes to designing screens. In order to reduce the amount of parameter checking the system assumes that the screen designer does a good job. Checking every parameter like size and position for every item during operation takes CPU cycles that are better spent elsewhere as the screen design is supposed to be “correct by design”.

Please take care of screen borders. Do not allow any of your screen items to overlap any screen boundary. In some cases this could lead to the overwriting of adjacent memory and malfunction of the system.

## The item library

The item library contains all of the individual items that you can drop onto the screen and configure to your needs.

You can place multiple items of the same type onto the screen (for example text items) but some items may only have a single copy on the screen, for example a moving map.

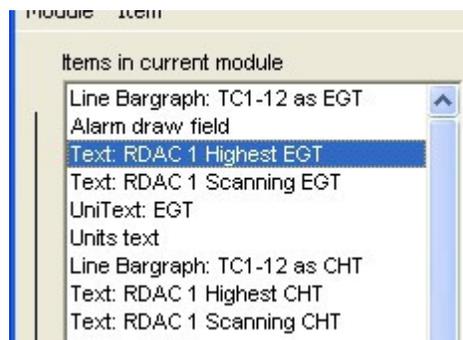
All items have a “property editor” that you can access by double-clicking on the item in the left drawing order module list.

Only one property editor can be open at any time.

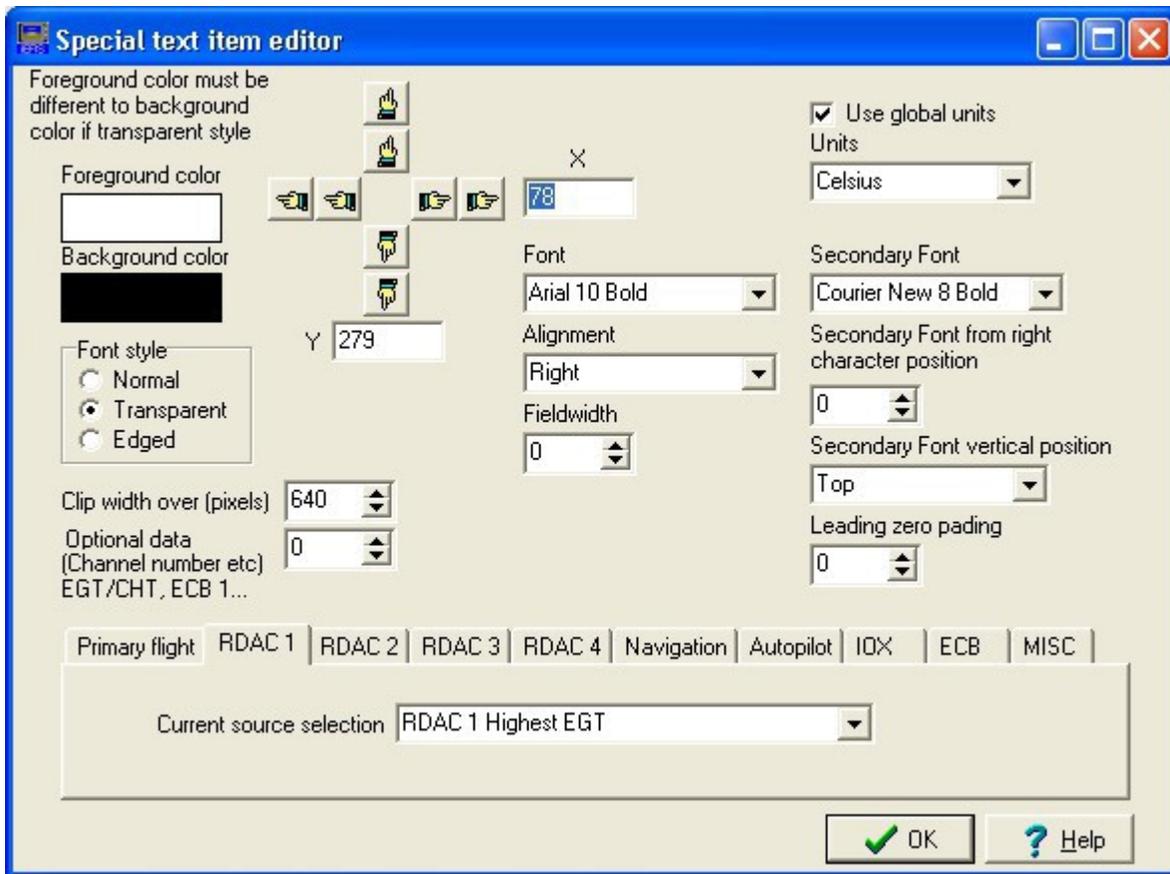
## Text items tab

As the name suggests, here we find the items that result in text on the screen. There are only three entries here but the first one, “Special Item” packs a punch.

### ***Text: Special Item***



The special text item is one of the most complex items. Essentially, it allows you to place a text item on the screen, choose the font and colors – and the EFIS supplies the text. You pick from a range of options what the source of the text is.



Looking at the special text item property editor, at the bottom you have a tabbed selection where you can select the type of text you need. You will find there are many different types of text items available.

You can choose the font and the alignment. Alignment tells the EFIS where the position of the text is – the left, right or center of the text. This allows you to cause the text to grow to the left, right or remain centered (growing to the left and right).

You have two colors available for the font and three font styles:

Normal: The character is drawn as a block. Both foreground and background colors are used.



Transparent: The background color is not used and the character appears “transparent”.



Edged: A thin line is drawn around the border of the text in the background color. This makes it easier to see if the text is drawn over a busy background.

1434

1434

Performance considerations: Transparent text is the fastest to draw as it needs the smallest amount of memory write cycles, Edged is the slowest and needs more processing time.

You can optionally clip excessive width of the text by selecting the number of pixels (from the left) that you are interested in – you can use this to drop a few digits on a number for example.

You can select a secondary font that will be applied starting at a certain position in the text – perhaps you have a numeric value and you want the last few digits smaller. You can supply a vertical alignment for these digits and to complete this you can add a few leading zeros to numerical values.

Example showing secondary font from right character position 2 and leading zero padding at 5, secondary font at top.

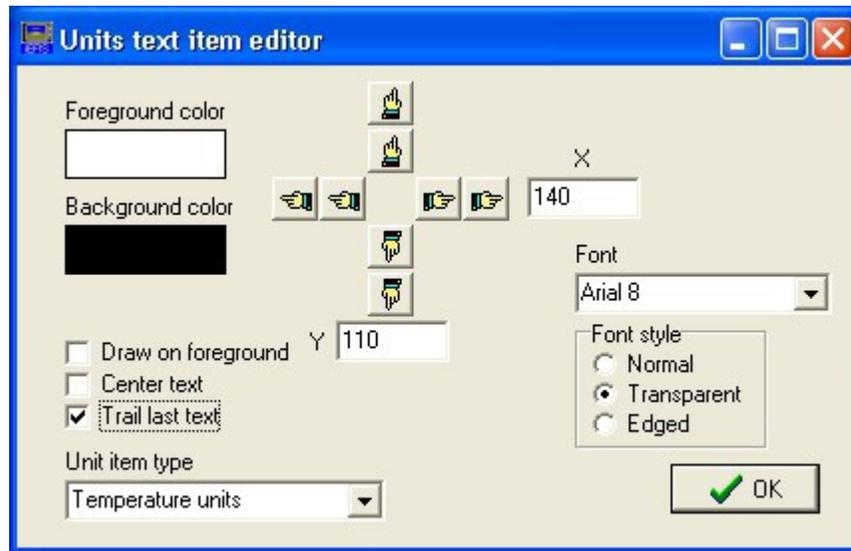
014<sup>34</sup>

Note the box that says “Use global units”.

If this box is ticked, any numeric text item that is subject to translation into different kinds of units (Celsius or Fahrenheit for example) will be determined by the user via selection in the “Units setup menu” in the “System setup”. If you uncheck this box you can fix the units for this text item at design time and the user cannot change it. You can use this for example to create a temperature display that is fixed in Fahrenheit and another that the user can select the units.

Some items may need a “channel” selection – for example EGT or ECB where there are more than one source for the item.

## Units text



This text item is used to show the current selected numeric units for every category – for example “Temperature” or “Liquid quantity”.

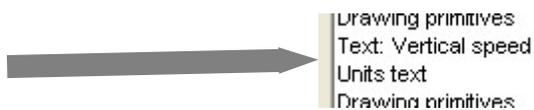
The units can be set to “trail” the last text item (which would be a “special text” item).

In this case, you still decide on the vertical position, just as before but the horizontal position is locked to the end of the last special text item.

Note that you have to be aware of the “Draw on foreground” option.

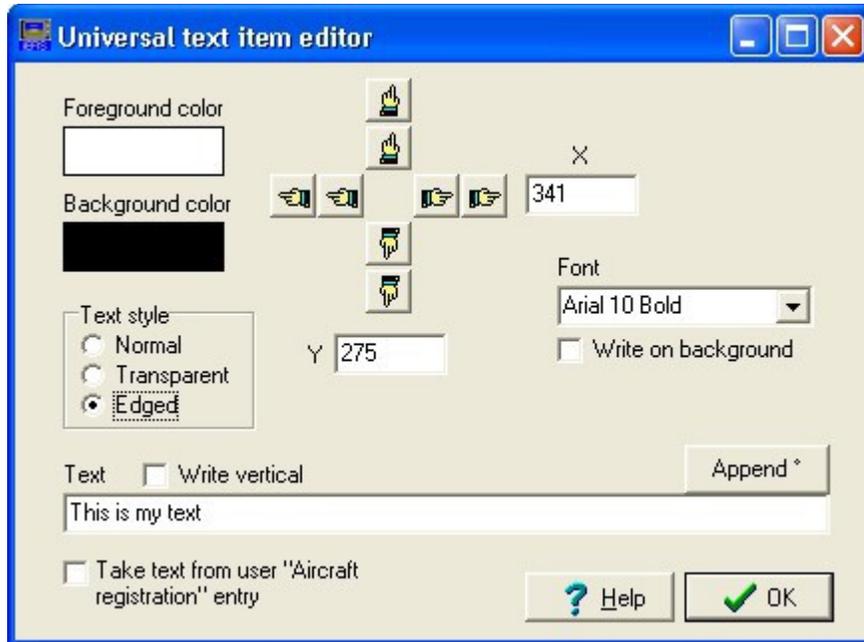
If you would like to just display a static temperature units field (perhaps for a group of instruments) do this on the background (it will be redrawn if the user changes units).

If you want the units to trail the last special text item, ensure that the units is drawn on the foreground or else it does not know where the text item ends.

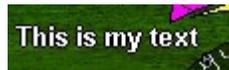


Example of “Units text” following a “special text” item.

## Universal Text item



This item allows you to place any fixed text onto the screen as shown with this example.

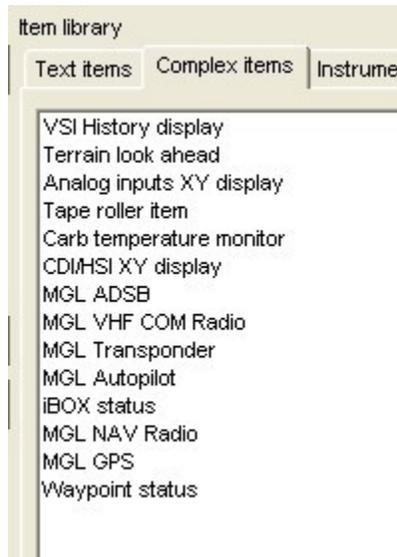


Text can also be added vertically (rotated 90 degrees to the left). Text can be on the background layer (if possible, better for drawing performance) or on the foreground layer if there is something that would otherwise obscure it.

There is also an option to take the text from the user supplied aircraft registration number (This is one of the setup items in the "Operations setup menu").

## Complex Items tab

The "complex items" tab in the screen designer reveals this list:



Here we find items that are far more functional - often very complex. These are “pre-made” items sometimes consisting of many parts. You can view them perhaps as “macro” items.

### ***VSI History display***

Interesting mostly for glider applications this shows a rectangular area showing the VSI as a moving graph for the last minute. This shows very nicely how vertical speed is trending.

### ***Terrain look ahead***

This shows a rectangular area with a vertical depiction of terrain ahead of you together with a line representing the current climb or descent angle – this makes it easy to judge if you are going to clear terrain ahead.

### ***Analog inputs XY display***

This allows you to create a X/Y display attached to two analog input channels.

### ***Tape roller item***

This allows you to create airspeed and altitude “roller items” where the last digits move in “tape” fashion.

### ***Carb temperature monitor***

This is a warning display that can be activated depending on measured temperature. Usually measured at the caburetor.

## ***CDI/HSI XY display***

This item allows you to create a X/Y display attached to both the HSI and GSI navigation inputs. This gives you horizontal and vertical guidance in a single item.

## ***MGL ADSB***

This is a two part component and has two positions, one for each part.

A smaller status display which is normally permanently visible is augmented by a larger control pop-up that can be activated by the user.

The smaller status display can be drawn on the background or foreground. It is preferable to design the screen so the status is drawn on the background for drawing performance purposes.

This item is largely “fixed function” with few designer setups needed.

## ***MGL VHF COM Radio***

See MGL ADSB.

## ***MGL Transponder***

See MGL ADSB.

## ***MGL Autopilot***

See MGL ADSB.

## ***iBOX status***

See MGL ADSB.

## ***MGL NAV Radio***

See MGL ADSB.

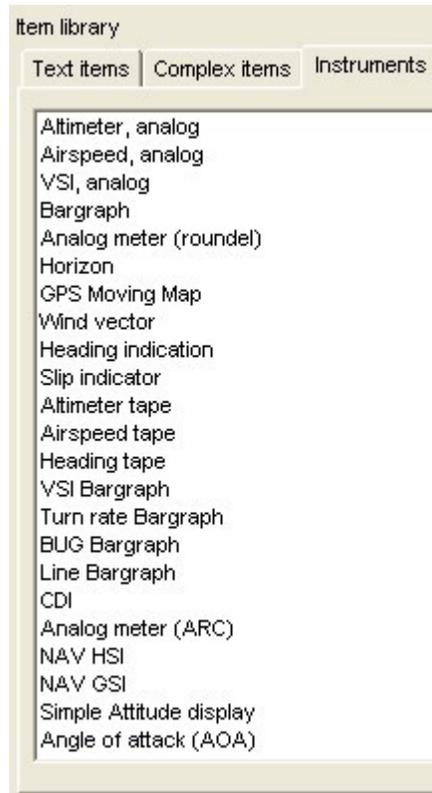
## ***MGL GPS***

See MGL ADSB.

## ***Waypoint status***

See MGL ADSB.

## Instruments tab



This is the largest of the designer item library tags and contains all of the available instrument displays. Some of the items like “Horizon” and “Moving map” are quite complex but are effectively still instruments so they are included here.

Note: the following items may only have a single copy per page:

Horizon

GPS Moving map

### ***Altimeter, analog***

This item is rarely used. It provides a depiction of a simple analog altimeter.

This item can be set to draw the needles only which makes it an option to be used if you provide a background image of an altimeter using the background image item.

### ***Airspeed, analog***

This item is rarely used. It provides a depiction of a simple analog airspeed indicator.

This item can be set to draw the needle only which makes it an option to be used if you provide a background image of an airspeed indicator using the background image item.

Note that air speed indicator range is setup in the instruments setup menu.

## **VSI, analog**

This item is rarely used. It provides a depiction of a simple analog vertical speed indicator.

This item can be set to draw the needle only which makes it an option to be used if you provide a background image of a vertical speed indicator using the background image item.

Note that VSI range is a setup item in the instruments setup menu.

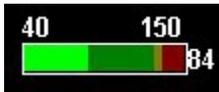
## **Bargraph, Bug bargraph, Line bargraph**

These three items are very similar. They provide different versions of a bar graph that can be attached to a number of data sources. These items are mostly used with engine and fuel monitoring items.

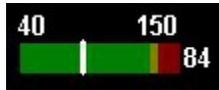
For EGT and CHT, they can display multiple channels as setup in the RDAC TC setup menu.

You specify width, height, horizontal or vertical orientation. You can have them with numeric readouts or you could provide readouts separately using special text items.

For EGT and CHT the width specifies the total width for all channels, for other items it is the width for the single bar graph. This makes it possible to assign a fixed area for the EGT/CHT in your screen design and the EFIS will scale the width of the individual bars to fit depending on the number of channels enabled.



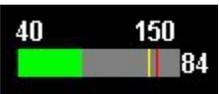
Standard bargraph, horizontal with legend and readout



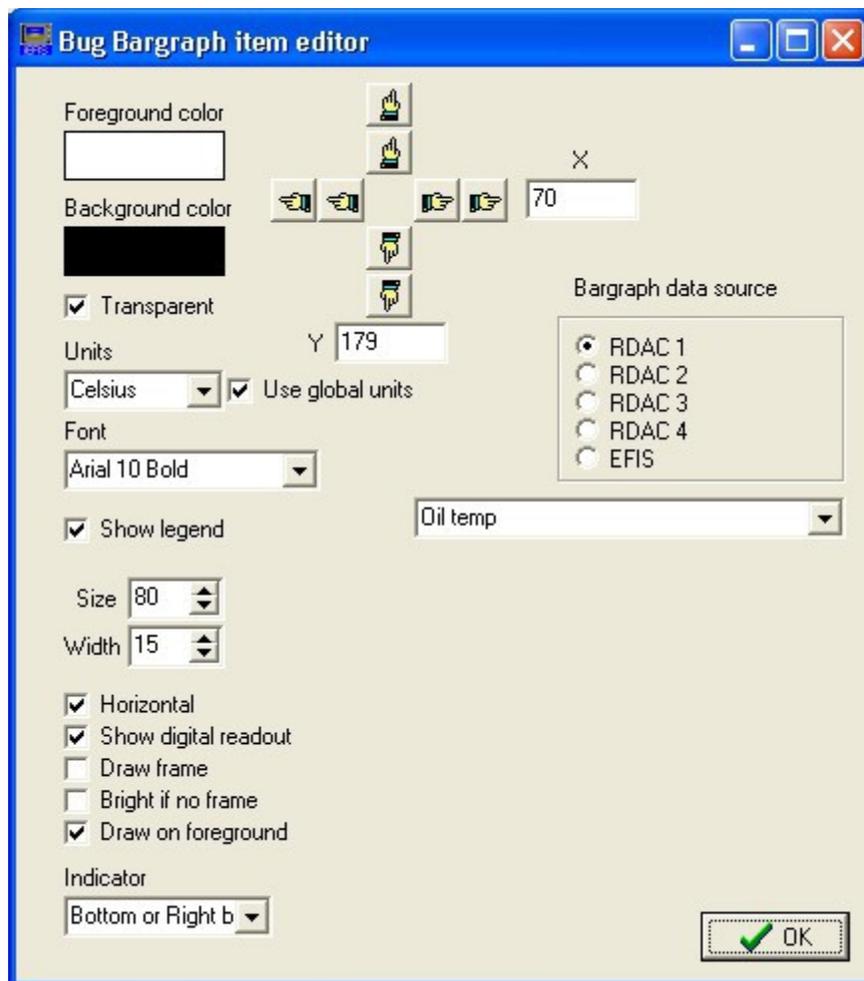
Bug bargraph with line indicator, horizontal with legend and readout



Bug bargraph with bottom bug indicator, horizontal with legend and readout



Line bargraph horizontal with legend and readout



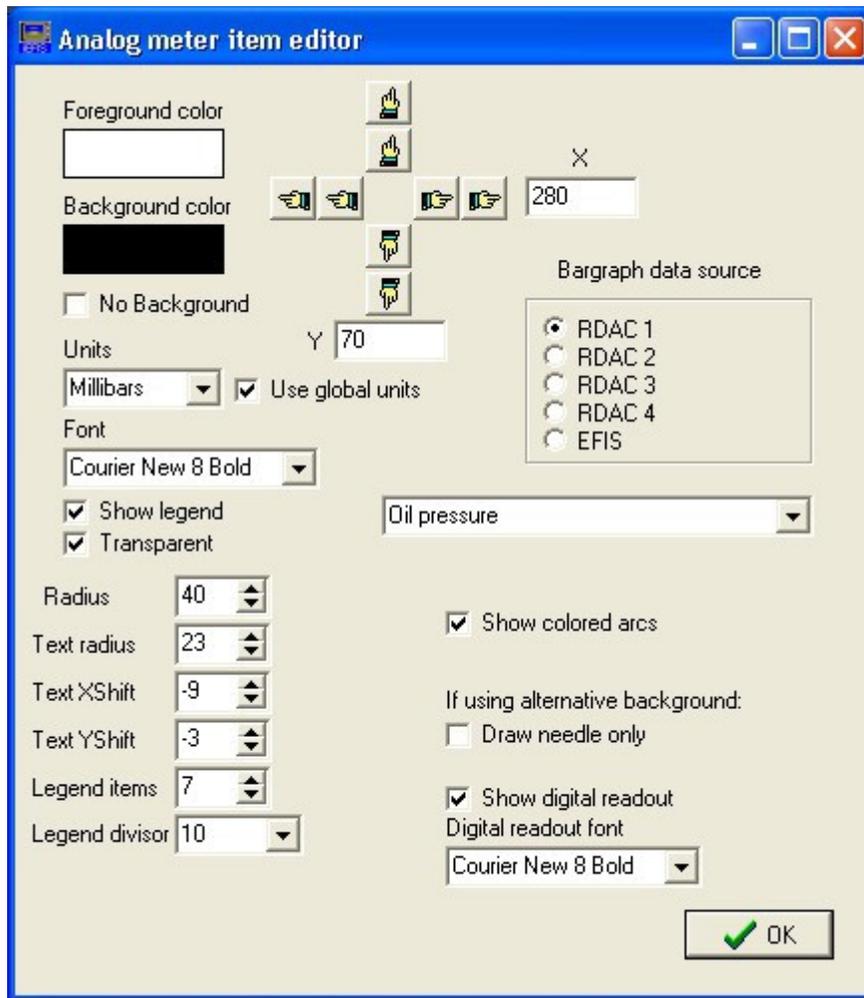
bargraph property editor – here showing the bug bargraph version – others are similar.

Note that you can draw the bar on the background or foreground. It is recommend to draw on the background which will draw the permanent part of the bargraph on the background layer to enhance drawing performance. Choose the foreground only if you have to draw on top of another foreground component like the horizon which obscures the background.

Global units is relevant if you are using the digital readouts. Units will either be set from global choices made by the user or you can fix this in the designer.

### ***Analog meter (roundel)***

This is a fairly old item originating from early versions of the MGL Enigma EFIS but has been left in the designer as it may still prove useful. It has effectively been replaced by the “Analog Meter (ARC)” which is more flexible,



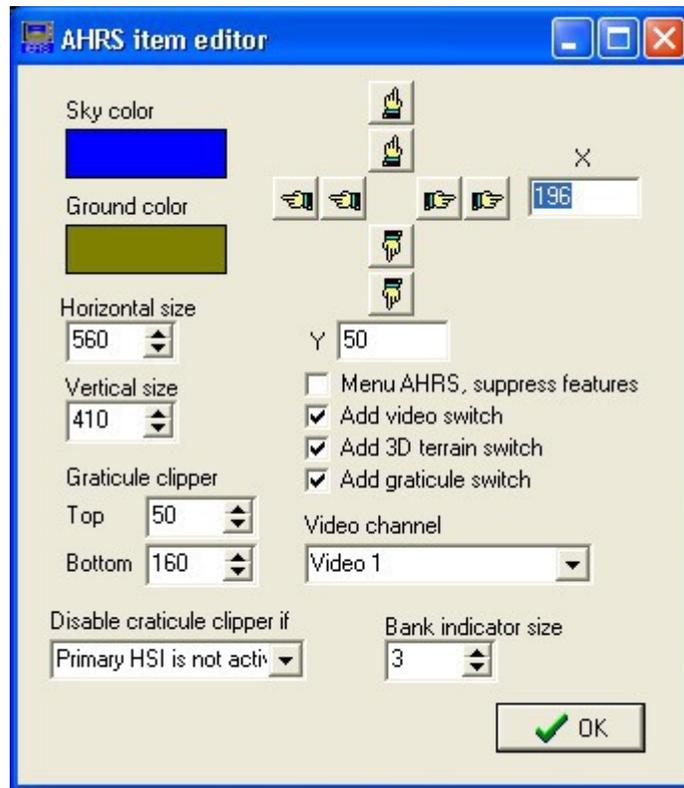
The “roundel's” property editor.

Note that it can be drawn showing the needle only making it suitable for use with an alternative background provided by the “Background image” item.

This item can show the legend and there are some options here. Note that the legend has its own radius setting and can be shifted in the X and Y axis to allow a better fit as numbers tend to grow in width as they progress around the circle. You can specify how many legend items you want and can apply a divisor.

## **Horizon**

The horizon is perhaps the most important single item in the designer and it will be included on many pages.



Select the Video channel to be used in case of a forward looking infrared camera being attached. This can then be enabled by the user as background to the AHRS for night vision operations.

Sky and ground color apply if synthetic vision is switched off.

Graticule clipper allows to clip the graticule to vertical limits and you can qualify this. Typically this is done if you have a HSI in the lower half of the horizon display showing and do not want the pitch ladder to interfere.

You can select the size of the bank indicator to suit the overall size of the horizon image.

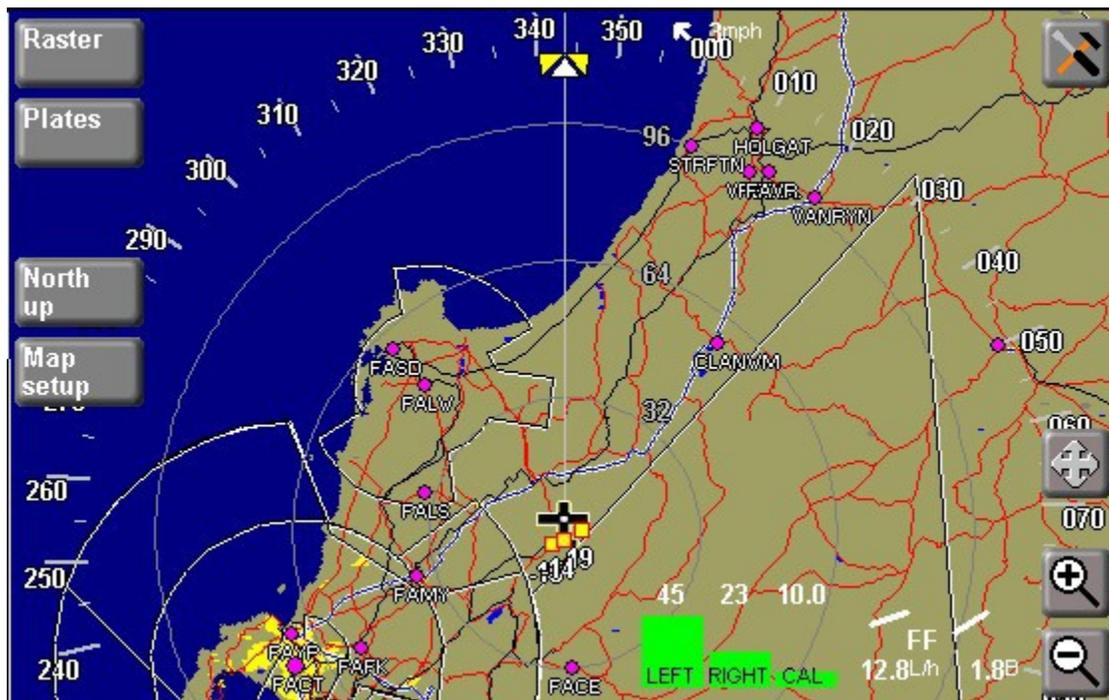
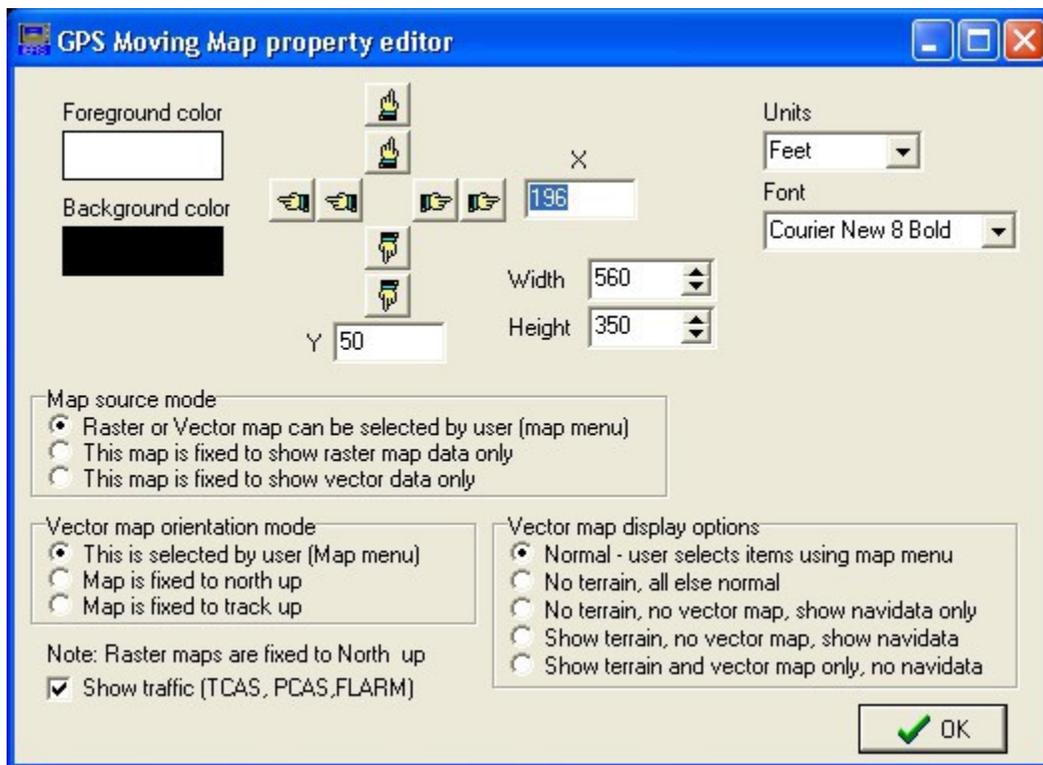
You can decide which “switch” features to enable for user control.

“Menu AHRS, suppress features” is not current used in the iEFIS but it is recommended to leave this box unchecked for future compatibility.

Please do not forget to add a “AHRS functional icon” to your screen to give the user the ability to control the display.

## ***GPS Moving map***

The GPS moving map item is one of the more complex features of the system but still simple to use from a screen design point of view.



Some of the display options in the property editor are not current applicable to the iEFIS and should be ignored.

When you size your moving map and perhaps add items over the map such as icons – please

be aware that the map has “built in” touch icons and buttons as shown in this image. Be sure that your own additions do not interfere with those of the map.

### ***Wind Vector***

This draws a arrow that shows wind direction either relative to true north or relative to the aircraft's heading depending on the users selection in the operations menu.

Note: The Wind vector requires the following input data:

- GPS ground speed
- True air speed
- GPS ground track (magnetic)
- Magnetic heading from compass
- Correct date (at least the correct year)
- GPS position

The formula works be first computing magnetic variation based on the position and then year. From this magnetic ground track can be calculated.

This is compared with the aircraft's magnetic heading. The difference is the “crab angle”.

Further to this, it needs the difference between ground and true air speed.

Wind speed and direction calculations rely on straight and level flight with the aircraft flying wings level (not side slipping causing the nose to point in a different direction to the track).

Of all the factors involved – the magnetic heading from the compass is usually the culprit if calculations throw the wrong result. Correct installation of the compass and calibration is very important. The EFIS has a built in diagnostics for this to be able to locate any problem areas.

### ***Heading indication***

This item provides a number of displays like arrows and compass roses and various heading information sources.

### ***Slip indicator***

Slip indicator attached to the AHRS lateral acceleration sensor.

### ***Altimeter tape***

This provides two basic types of a altimeter tape. You have a number of choices for altimeter bugs and can scale many items to suit.

In most cases a simple, transparent tape is used with a semi transparent background made with a drawing primitive.

The tape is usually augmented by a digital altitude readout in the center.

## ***Airspeed tape***

The airspeed tape is often used with a semi transparent background made with a drawing primitive.

The airspeed tape is usually augmented by a digital airspeed readout in the center.

## ***Heading tape***



This adds a heading tape, usually used at the top of the display. You can choose fonts and colors and can add a heading bug. You can choose from different kinds of heading sources. Consider adding a digital readout of the chosen heading source in the center of your tape.

## ***VSI bargraph***

This bargraph comes in two forms – a down and a up pointing closed arrow. Either one is active depending on your current vertical speed and vertical direction.

You can enable a graticule for the bar.

The range of the bargraph is chosen by the user in the instruments setup menu.

Consider adding a digital readout of the current vertical speed using a special text item.

## ***Turn rate bargraph***

This bargraph come in two forms – a left and a right arrow or bar. This shows the direction of turn and the magnitude.

Tip: when the screen designer is active the bars flick between a rate 1 and a rate 2 turn. Use this to place markers on your screen design at these points. Suitable markers could be a few small bugs or something you make up using the drawing primitives.

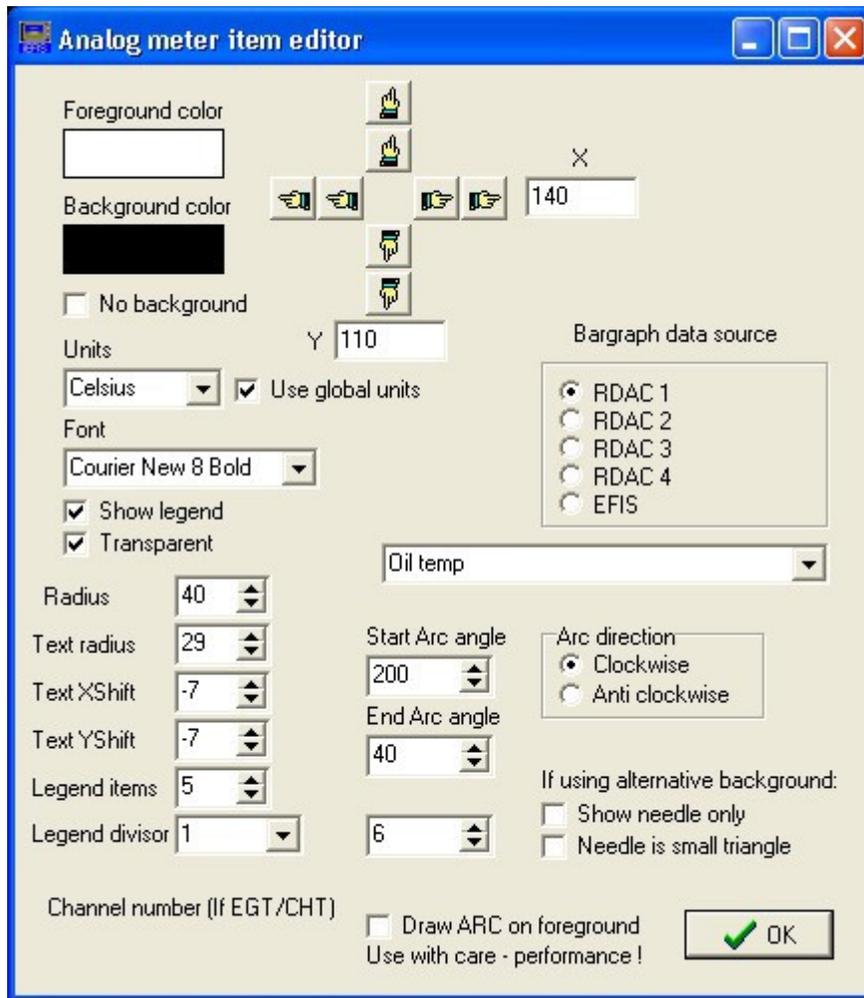
## ***CDI***

This places a CDI (course deviation indicator) on your screen. This is mostly superseded by the HSI item.

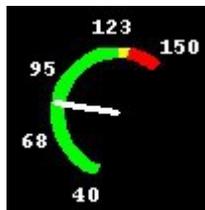
You have a few options such as size and legend readouts and position.

## ***Analog meter (ARC)***

This is one of the more interesting items. You can create a ARC indicator with a needle or small triangle indicator. The needle can move clockwise or anti clockwise and the ARC can start and end at any angle you choose. This makes it well suited to a range of indications, mostly related to engine monitoring.



The ARC property editor and the resultant display:



ARCs are very useful and you can configure them in many ways. You can also use them “needle only” if you are going to provide your own background image.

If you select EGT or CHT then you can select the channel number to be connected to your ARC. Legend and divisor works the same as it does with the “Roundel” item. Note that the text radius is “inverted” the radius increases as the number decreases.

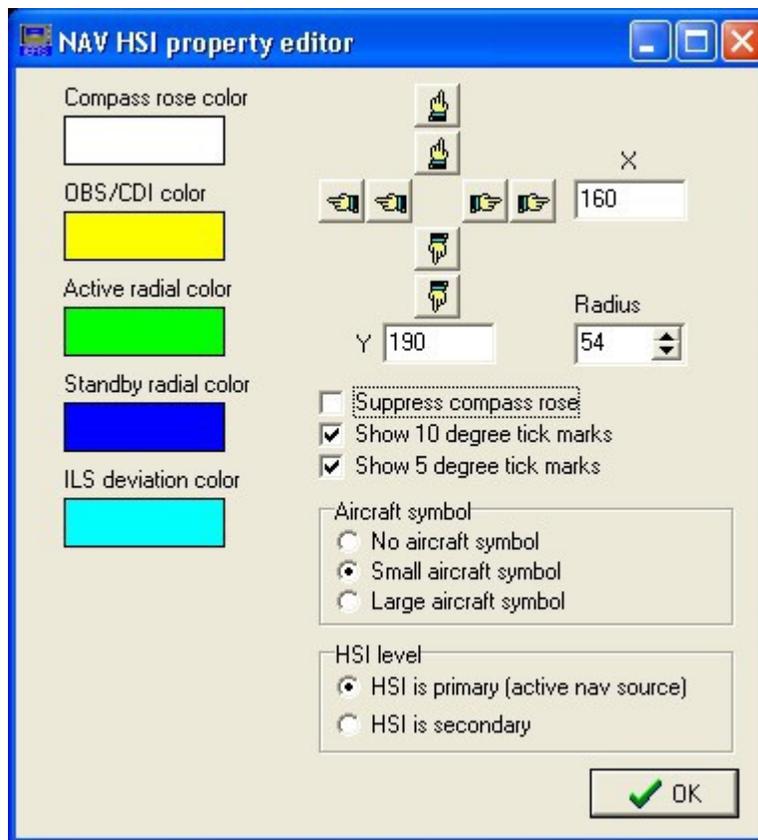
Tip: The clockwise/anti clockwise option makes the ARC component very well suited to opposing displays such as engine and rotor RPM for a helicopter.

## NAV HSI

The horizontal situation indicator is the primary navigation indication for the EFIS.



It shows heading, track deviation and direction to the destination.



You have various options affecting the display. The HSI also shows VOR radials.

Select "HSI is primary". The EFIS has a dual navigation system however, at this point only the primary is enabled.

## NAV GSI

The GSI is essentially your vertical guidance. It shows if you are above or below the target altitude and is also applicable for glide slope.

The EFIS offers a few display options:



The traditional vertical guidance display. The circle moves above and below the marker. The circle represents the target altitude.



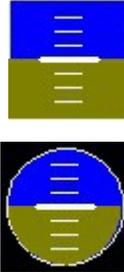
This is the modified display. In this case a airplane symbol is used and the center line represents the target altitude. This tends to be a more logical depiction but is not "aviation standard".



You can select a "horizontal" GSI. Here the aircraft symbol moves up and down but also left and right to make maximum use of available space. This is a good display if you are constrained for space.

## ***Simple attitude display***

This allows you to place a simple attitude display either in a rectangular or circular form.



## ***Angle of attack (AOA)***



The angle of attack or reserve lift indicator provides an alternative AOA display. You can use a bar graph or an ARC as AOA as well.

This indicator works by removing bars from the bottom as angle of attack increases. Your clean stall occurs as you run out of green bars. The landing configuration stall would occur as you run out of yellow bars.

AOA functionality is subject to installation and configuration of suitable pressure ports and it requires a calibration flight.

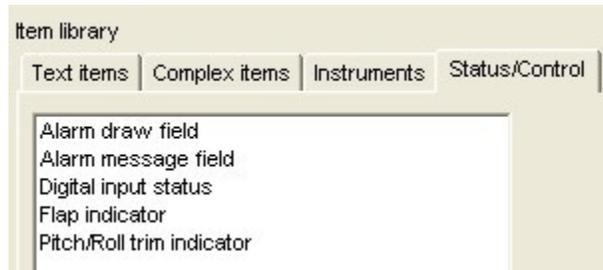
## ***Airspace look ahead component***

This component implements the vertical look ahead view of airspaces and information.

## ***Turn component***

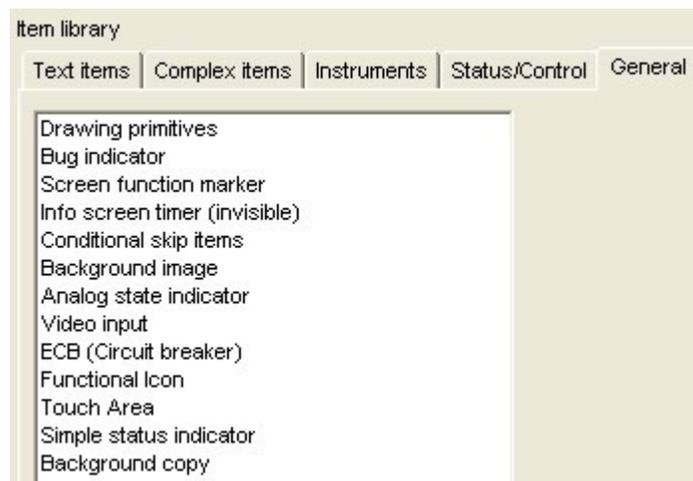
This component displays a turn coordinator (when used with a slip indicator). It implements the traditional mechanical gyro based look of the airplane and is suitable for use in traditional panel simulations.

## Status/Control tab



This screen designer library tag contains status and control items. Items such as the Flap indicator can be a status display and control at the same time.

## General tab



This screen designer tab contains items that do not fit into any of the other tabs.

### ***Drawing primitives***

This is a collection of passive drawing items like lines, circles and rectangles.

Rectangles with rounded corners are supported as are filled items. Filled items are filled with a color and can be given transparency. This makes them well suited as background enhancers for displays, still allowing the background to show through.

One item is a “construction rectangle”. This is a non-drawing item and only shows if the screen designer is active. It allows you to mark an area for your screen section. This makes it easier to design a section without causing accidental overlaps. These rectangles are typically used for engine, fuel and info areas of the screen.

Primitives that are filled impact on the drawing performance and should be handled with care. Filled, rounded rectangles require the highest amount of processing and have the highest

impact on performance so please use them with care.

### ***Bug indicator***

This is a simple, sizable triangle that can point in one of four directions. Often used with turn rate bars to mark rate 1 and rate 2 turns.

### ***Screen function marker***

This is an invisible component. It can flag a special purpose screen. For example it can flag a screen used for “landing” that will automatically suppress terrain warnings.

### ***Info screen timer***

This invisible component can be used to automatically page the info section of a screen. You can select the page interval in seconds.

### ***Conditional skip items***

This is an invisible component that can be used to skip a number of following items so they will not be drawn. A large range of skip conditions can be selected. For example you might want to skip drawing of a compass heading readout if there is no compass connected.

```
Conditional skip 2 item(s)
UniText: Mag
Text: Compass Heading
```

### ***Background image***

This allows you to load a image in MIF format into the background at a specific location. Interesting uses of this item are:

A picture of an engine with temperature readouts on the cylinders

Backgrounds to analog dials using the ARC instrument. This instrument can be set to draw only the needle so you can create your own, attractive looking background.

MIF files are created by translating ordinary Windows BMP files into MIF format using the provided utility from MGL. It is available from the EFIS tools page at [www.MGLAvionics.co.za](http://www.MGLAvionics.co.za).

BMP files can be created using most drawing programs.

When you create your BMP image, be aware of the number of pixels horizontally and vertically of your image. This should match whatever region you want the image to occupy on the actual EFIS screen so you need to create the image at the correct resolution and size.

## ***Analog state indicator***

This creates a rectangular or circular area on your screen matching the alarm/caution state of the underlying data source. It will flash red if there is an alarm active that is not acknowledged. Steady red if no alarm enabled or it has been acknowledged and the alarm condition is active.

It will be yellow in the caution state or green if not in caution or alarm range.

This item can be used as background to other readouts or to enhance alarm status visibility.

## ***Video input***

This item allows you to create a video display area on your page. You can set the size of the area and if the graphics should overlay the video or if the video should be on top of any drawing. You can also crop the video image if you only want a part of it to show. Video source are individually enabled and selected by the user (Video setup menu) and video icon control.

Be sure to add a video icon (functional icons item) to your screen so the user can select video sources.

## ***ECB (Circuit breaker)***

This allows you to create a visible circuit breaker status on the screen and assign colors to the various states (On, OFF, Fault).

Suggestion:

Use these indicators as small square blocks arranged in an array depending on circuit breaker configuration in your aircraft. This allows you to create a small ECB status display showing every breaker in a very small screen area without wasting a lot of space.

Be sure to include the ECB functional icon so the user can control/view the circuit breakers.

## ***Functional icon***

This item allows you to place a number of small “functional icons”. These are touch sensitive icons. For example there is an icon that allows you to open the “Direct-to” GPS navigation function.

Functional icons can be “hidden”. They will show if the “reveal icon” is touched. The reveal icon is itself a functional icon (but always visible if placed).

Icons can also be revealed if a route (flightplan) is active. This is usually reserved for the icons used to step forwards/backwards in the route.

## ***Touch area***

This is similar to the functional icons but invisible and has a user defined size. This is for example used to create areas in the info section of a page allowing the user to page between info sections.

### ***Simple status indicator***

This is a rectangular or circular indicator where you can define the size. The color is either red or green. It is attached to one of many external sources and is intended to show if external equipment is connected, for example a COM radio.

### ***Background copy***

This item can be used to copy a section of the background image onto the foreground. One such use is to create a small moving map image (which draws on the background) and effectively show it as a cutout on the horizon image which would otherwise obscure the background.

Note that this is performance sensitive as this is a real copy operation so should only be used on relatively small areas.

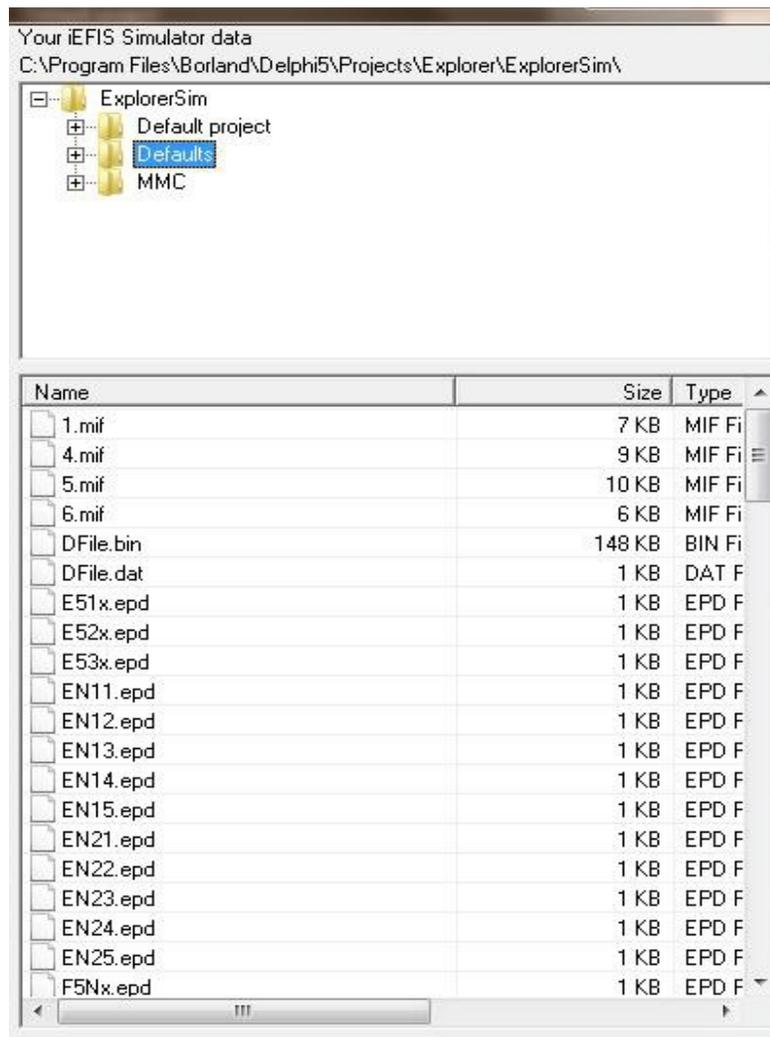
## The Default file system (advanced users)

The defaults folder contains the screen files that are “built-in” to the system. These are ordinary screen files that are 100% identical to the custom screen files the user can create himself using the screen designer. Filenames however are different according to a carefully crafted scheme allowing the EFIS to select from a screen file library according to user preferences.

In the real EFIS this defaults folder is contained as part of the binary.

It is possible to create your own defaults system. In this case you will be editing the screen files in the Defaults folder. You may also edit the contents of the file “modes.txt” which is used to create the menu entries in the System defaults setup menu that the user will use to select his screen layout defaults.

Once you have completed your defaults screen design, the folder can be extracted to a single file called “Dfile.bin” - this will contain all of the screen files in the defaults folder, any MIF image files and the “modes.txt” file. This file can be placed into the EFIS systems “Screens” folder. If the EFIS finds this file it will use it instead of its default file system in the binary.



The names here refer to the flight, engine, fuel and info file names as used with the various user selectable screen options. All screen filenames end in "epd". "MIF" files contain images that some screen files may need as background images.

The first character(s) of the file name determines the file type:

F Flight  
E Engine  
L Fuel  
I Info

MF1 Menu Flight (only one subtype currently used)  
MEn Menu Engine (where n=1-9 subtype, typically engine type)  
MLn Menu Fuel (where n=1-9 fuel system type)  
(Menu does not use info screens)

For Flight, Engine, Fuel the following convention is used

FPLM.epd  
EPLM.epd  
LPLM.epd

Where:

P = page 1 to 9 or N=any page.

L = layout number 1 to 9 as defined in modes.txt file (horizontal, vertical, no engine or whatever is defined in modes.txt)

M = Mode 1 to 9 as defined in modes.txt file. May also be lower case "x" which means currently selected mode.

The mode is "full radio panel... etc", "engine type", "fuel type", etc as defined in "modes.txt" file.

For Info a similar convention is used:

IPLMA.epd

Where:

P = page 1 to 9 or N=any page.

L = layout number 1 to 9 as defined in modes.txt file (horizontal, vertical, no engine or whatever is defined in modes.txt). May be "N" for "any layout".

M = Mode 1 to 9 as defined in modes.txt file.

A = Info screen sub mode A to J. May also be "N" for "any sub mode". This can be used to create a single "blank" info file like I1N1N.epd

Examples:

(if used on Explorer with standard modes.txt file)

F111.epd - Flight, page 1, layout 1 (horizontal), mode 1 (full radio panel on top)

EN15.epd - Engine, Any page, layout 1 (horizontal), mode 5 (2-6 cyl, OT,OP,COOL,MAP)

F5Nx.epd - Flight, Page 5, Any layout, mode as selected (so this file will be used regardless of selected mode)

IN21A.epd - Info, Any page, Layout 2 (vertical), Mode 1 (only 1 mode defined currently), sub mode "A"

System searches for files in a specific order to make this work - first it searches for names with page numbers and exact specifics (modes etc), if that can't be found then it looks for other options. Please note that not every possible combination of name options will be searched for. Please see the search order below for valid combinations.

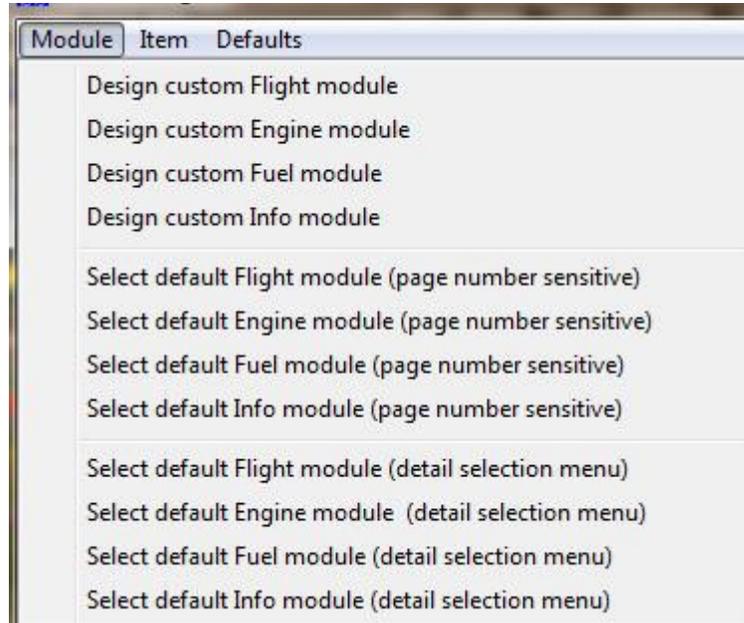
The search order for Flight, Engine and Fuel screen files is:

- 1) Selected page, Selected Layout, Selected mode
- 2) Selected page, Selected Layout, Any mode ("x")
- 3) Selected page, Any Layout ("N"), Any mode ("x')
- 4) Any page ("N"), Selected Layout, Selected mode

The search order for Info screens is:

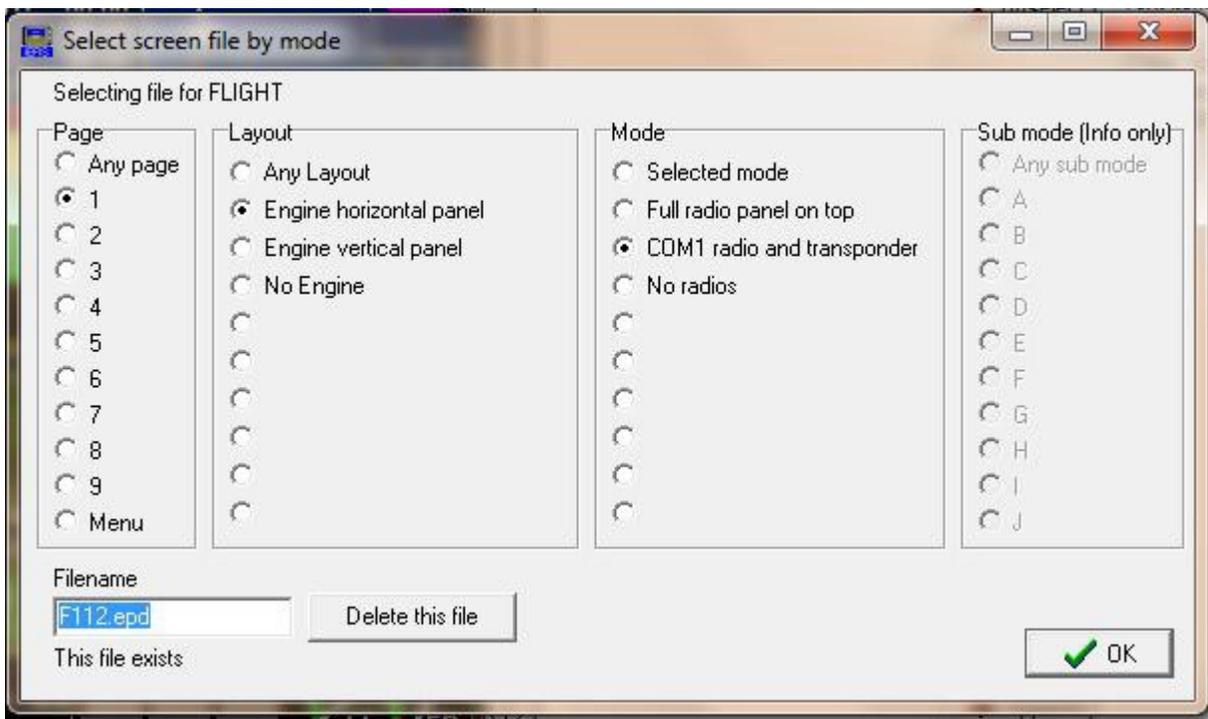
- 1) Selected Page, Selected Layout, Selected mode, Info type ("A"- "J")
- 2) Selected Page, Any Layout ("N"), Selected mode, Info type ("A"- "J")
- 3) Selected Page, Any Layout ("N"), Selected mode, Any info type ("N")
- 4) Any Page ("N"), Selected Layout, Selected mode, Info type ("A"- "J")

### **Selecting default screen files to edit**



Select "page number sensitive" to edit the currently showing screen file in the designer. This file is subject to the search order explained above.

Use the "detail selection menu" to specify an exact file, even if it does not yet exist:

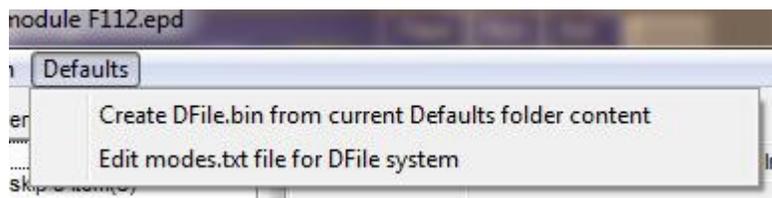


This dialog allows you to easily specify the screen file name for a particular combination of page, layout and mode selections. Please be aware that not all combinations are supported. Please also keep the search order specification in mind (as explained in the previous chapter). Combinations that are not searched for will not be loaded.

The Filename field is read only – this shows you the filename as currently assembled and it also shows you if this file name exists. You may also delete the file if you need to do so (careful, ensure you have a backup – there is no recourse if the file is gone, you will be asked to confirm before the file is deleted).

### ***Making the Dfile.bin file***

Once you are satisfied with your default file system it is time to create the Dfile.bin file. This file is created from the contents of your defaults folder. It includes all screen files, MIF files and the “modes.txt” file. The Dfile.bin file is essentially a virtual disk.

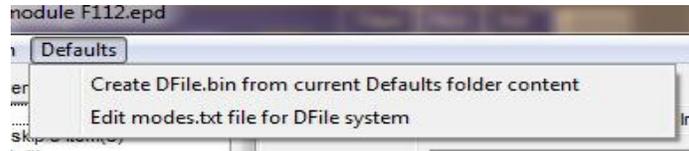


Simply click the option to create the Dfile.bin file. It will be located in the Defaults folder.

You can distribute the Dfile.bin file. This needs to be copied to the “screens” folder of the EFIS and on next restart it will then use that file instead of its own defaults folder which is built into the executable.

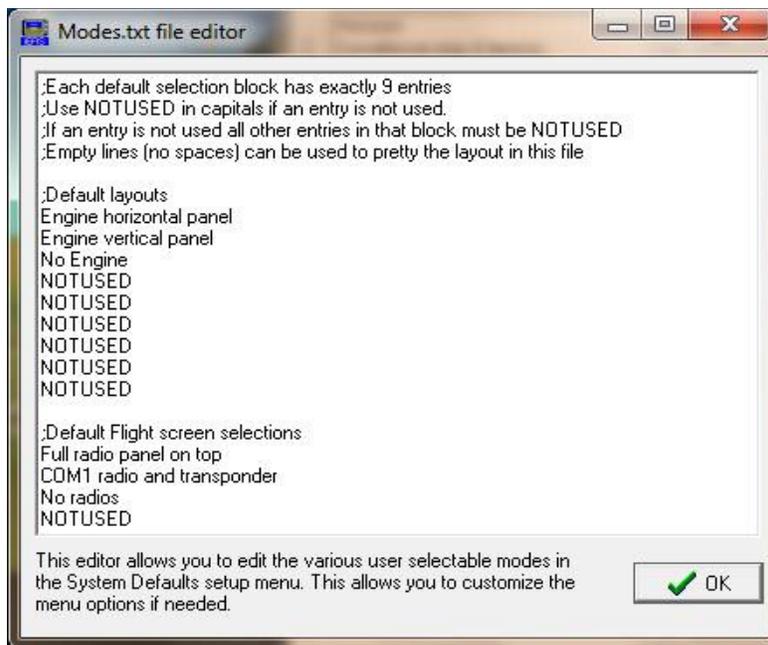
## **The “modes.txt” file**

The “modes.txt” file is a simple ASCII text file such as you can create with Notepad in windows. Your installation will contain such a file. The Screen designer contains a dedicated editor for this file but you can use any tool to edit it.

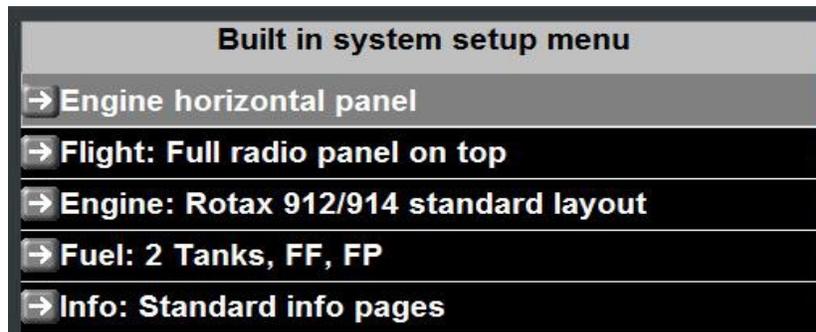


The contents of the “modes.txt” file determines the contents of the menu in the Standard System selection menu in the EFIS. This means that you are able to customize the EFIS defaults system almost completely if you require this.

The “modes.txt” file editor



results in:



**Warning:**

The DFile system is not intended to create a single screen file system for many different applications. The limit of the number of files you may have in a DFile is 255.

When you create the DFile system, ensure there are no unused files in your Defaults folder and that the folder includes only the files you need (including the modes.txt file). The system will attempt to include all files into the DFile that it finds in your Defaults folder.

If you need a DFile system for many different applications (for example Fixed Wing, Gliders, Helicopters,...) consider creating a DFile for each of these.

To make this easier, simply install several copies of the simulator in different folders so you have a dedicated system for each application.

Also try and make use of the systems ability to share identical files between different screens to cut down on the number of individual screen files needed.

## Relocatable modules

From version 1.4.0.3 of the G3 firmware an additional way of adding items to a screen has been introduced.

This allows adding any combination of ordinary screen items into an arbitrary named file and then adding this to the display screens at positions determined by the contents of a text file.

The text file is called “modules.txt” and should be located in the screens folder together with any screen file “modules” it references.

The modules.txt file can be created with any basic text editor (such as notepad in Windows) or it can be created using the iEFIS with its built in text editor: System Setup Menu → Text editor related functions.

The format of the text file is simple: One line refers to a single module file, which pages you would like to use the module and where on the page to place the module.

### Example:

File Modules.txt contents: (This line is not part of the text)

```
ALTTracker.MOD 1,100,200,V 2,300,100,V
```

```
“My module.mod” 4,250,125,V
```

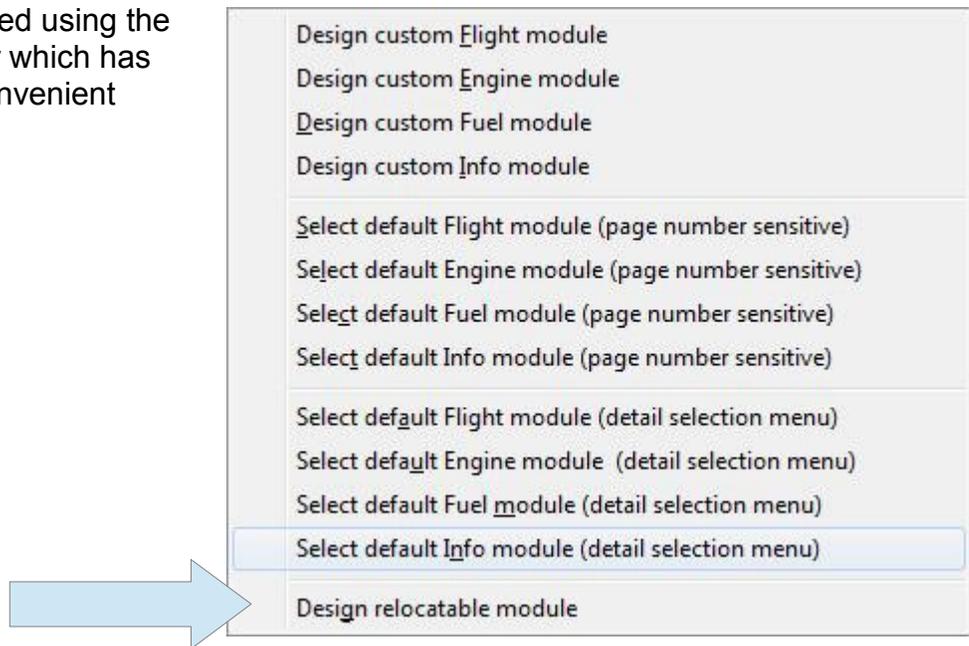
Each line starts with the name of the module file. If your file name includes spaces then you must enclose the file name with double quotes as shown in the second line.

This is followed by one or more number groups which are separated by spaces.

Each group consists of the page number (1 to 9 are valid here) followed by the X and then the Y coordinate of where you want to place the module. The coordinates are in pixels and 0,0 refers to the top left corner of the display.

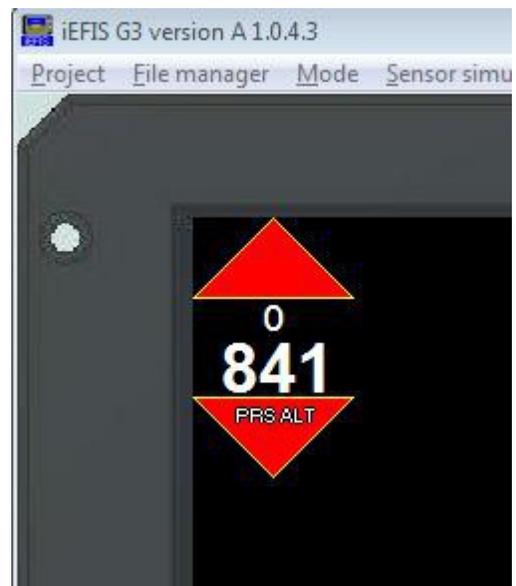
This is followed by a further character specifying how to use the module. For the first release the letter “V” for “Visible” is the only option.

Modules should be created using the ordinary screen designer which has been extended with a convenient function for this:



Modules should be designed such that they contain a single function (possibly implemented with multiple screen items).

Modules should be designed such that they align with the top left edge of the display (X/Y location 0/0) as shown on the right.



The location of any item will be added to the X/Y coordinates as given in the modules.txt file allowing the module to be placed anywhere on the screen.

X/Y coordinates given in the modules.txt file cannot be negative values so it is important to align your design properly or else it may be impossible to align it in the final position should the user choose a location that is more left or up than your design.

Relocatable modules are ordinary screen files so you can rename screen files and put them into modules should you like to do that.

Relocatable modules are loaded after all ordinary screen files have been loaded so they get drawn last and can overwrite underlying items.

In order for the EFIS to recognize the existence of a screen for purposes of being able to switch to that screen it must have a screen called FlightN.sdf (with "N" being the screen number from 1 to 9). This screen may be empty (contains no visible items).

You can create an empty screen file simply by using the relocatable modules function in the screen designer (you can create any filename you like).

While you may use any valid filename for a relocatable module, the recommendation is to use the ".mod" file extension. Note that filenames should not be longer than 31 characters and the file extension must not be longer than three characters. Long filenames under the FAT filesystems are relatively slow and inefficient and the recommendation is to use a maximum of 8 characters plus "." and three character file extension for the filename for a minor speed boost on file loading.

As with any screen design – please take consideration of the fact that items need to be drawn at high frame rates. Excessive drawing can affect performance of the EFIS negatively. Make use of the screen draw timer facility (Operations setup menu) to measure the load on the system your screen design imparts.