



**iEFIS G4 Boot, update and backup/restore system**

## General

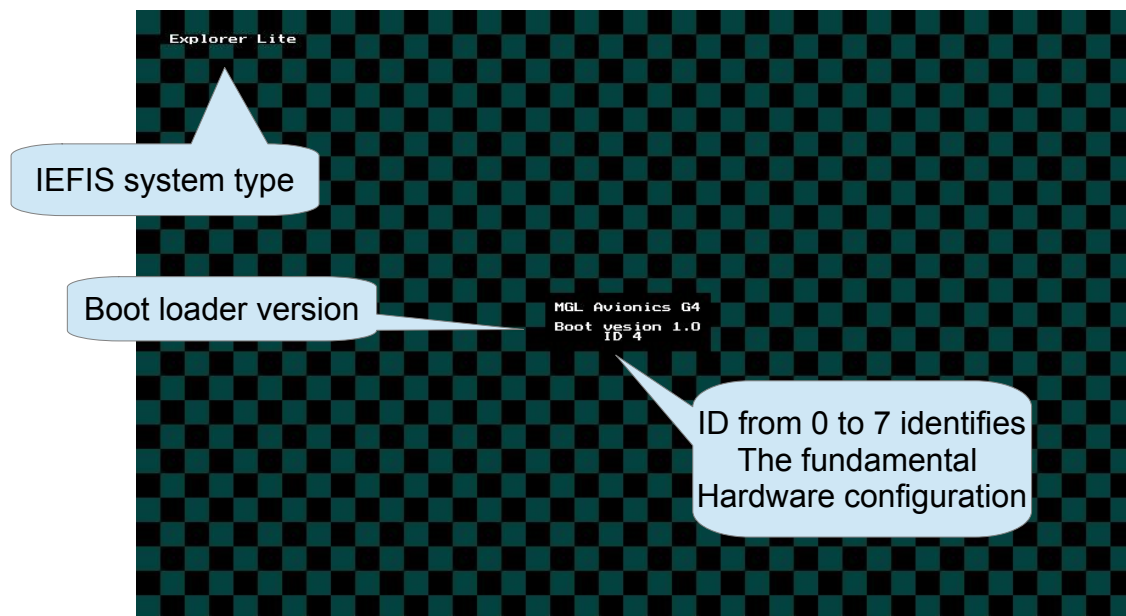
On power up the iEFIS G4 system first activates a boot loader. The boot loader's main purpose is to perform basic system startup and initialization and then load the Linux operating system.

In case of the iEFIS system the boot loader has been extended to include functions to update the EFIS firmware, perform backups and restore and it can also perform major system updates that involve updating the Linux operating system itself and restructure the internal file system.

During normal system operation the boot loader screen shows for a few seconds and is then replaced with the running EFIS firmware.

During startup the boot process can be stopped by the user by pressing the right lower rotary control while applying power to the system. In case of systems operating in portrait mode you press the left rotary control.

Note: The text showing in the boot loader screens will always be in landscape mode even if the EFIS is used in portrait mode.



ID 0-3 = Native G4 motherboard

ID 4-7 = Classic motherboard with G4 adaptor

## Updating the G4 iEFIS firmware

The entire EFIS firmware including built-in screen designs is a single file.

The filename is “exp4” (without the quotes).

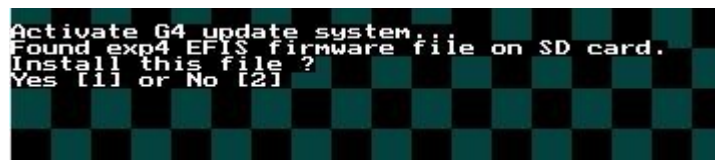
The latest firmware file can be downloaded from [www.MGLAvionics.co.za](http://www.MGLAvionics.co.za) on the G4 firmware page.

Copy the exp4 file onto the root folder of a SD Micro card. The card must be formatted using standard FAT32. It is currently not possible to use the later ExFat format as this is not supported by the Linux boot loader.

Insert the card into the SD slot of your EFIS.

Switch on the EFIS while holding down the “Page” rotary control (bottom right in landscape or bottom left in Portrait mode).

The boot process will be interrupted and you will be presented with the following display:



```
Activate G4 update system.
Found exp4 EFIS firmware file on SD card.
Install this file?
Yes [1] or No [2]
```

Interaction with the boot system is done using the Rotary controls as buttons – simply push the control into its indent.

The rotary controls are labeled from 1 to 4 or 1 to 5 depending on the EFIS model.



Press Rotary control [1] to update the iEFIS firmware.

This takes about 2 to 3 seconds.

The boot system will first check the file to make sure it is valid and not corrupted or truncated.

If there is an issue you will be presented with one of the following messages:

“File size error. Expected 3812346 got 34562 bytes”

“File check error. Expected ACE341F2 got 5D2042EF”

If it is not possible to copy the file either due to a problem with your SD card or the internal disk you will get “File or process error”. If it is not possible to read the SD card you may get “Cannot open root folder on SD card”

If the firmware update was successful you get:

```
Activate G4 update system...
Found exp4 EFIS firmware file on SD card.
Install this file ?
Yes [1] or No [2]
Press any rotary knob to continue...
```

What it does: The file “exp4” is copied from your SD card to the internal disk into the folder /efis

After you pressed a rotary control:

```
Activate G4 update system...
Found exp4 EFIS firmware file on SD card.
Install this file ?
Yes [1] or No [2]
Press any rotary knob to continue...
No install scripts found, remove SD card to boot
Press [1] for options
```

If you would like to continue booting simply remove the SD card.

You can also access the options menu from here.

The options menu is also available if you enter the update system and there is no SD card inserted or there is no “exp4” file on the SD card.

## The Options menu



The options menu is accessible after applying power with the page rotary control held down (pressed in). It is also available after performing a EFIS firmware update as detailed in the last chapter.

### [1] Backup system image to external SD card

This function allows you to make a complete backup of the internal disk (Clone). This is a system image in other words a sector by sector copy. For this you need a minimum of a 16GByte SD Micro card. You can use a larger card including XC cards in excess of 32 Gbytes.

You will be prompted to insert the target card. Note that any data on that card will be lost so make sure you have the correct card.

The system will perform some checks and then advise you on the time this will take. It tends to be around 70 minutes so make sure your aircraft battery is on a charger.

The resulting SD card is a fully bootable card – in other words it is a true backup that can be used to replace the internal disk if that becomes necessary.

This card can also boot from the external SD card slot – the system will first check to see if there is a valid bootable card in the external SD card slot before using the internal card.

Note that on physically larger systems it will take longer to boot from the external card as the speed is reduced due to longer data lines from the internal processor.

Note: Regardless of the size of the SD card (minimum 16GBytes) any created card will always be modified to look like a 16GByte card – any additional space on the card remains unused.

The system will report on progress during the cloning and advise on any errors – if a read or write fails it will be reattempted up to 10 times and if that works the cloning will continue.

“ Copied 8743 MBytes. 50% Retry: 0/0” – the retry field list read/write retry counts.

After completion you will be offered to verify the newly created card. Note that this also takes a similar amount of time.

You can cancel the clone or verify at any time.

### [2] Restore system image from external SD card

This function is a reverse of the above. It allows you to copy a backup made using the above method onto a fresh SD card installed internally or overwrite the existing system with your backup.

### [3] Internal SD basic checks

This function can be used to check the currently installed SD card to make sure the basics are working.

The following checks are made:

- 1) The card is readable
- 2) It contains 4 partitions or more
- 3) Partition 1 and 2 are binary and contain the primary bootloader (partition 2 is a backup)
- 4) Partition 3 contains the u-boot secondary boot loader (and the code running this)
- 5) SD card has the correct minimum size
- 6) The folder /efis exists and can be accessed
- 7) The EFIS firmware file exists and can be verified to be correct

[4] Continue booting

Load Linux operating system and start it – once completed a Linux script will attempt to find the exp4 file, load and start it. If Linux cannot find the file it will display a message on the screen saying so.

## **The boot process**

After application of power the processor loads the first level (primary boot) from an internal flash memory on the G4 CPU card and executes it.

The primary boot system's main task is to initialize the internal dynamic memory device on the G4 card. Once done it loads the secondary boot loader also from the Flash memory chip. This is the u-boot system which is one of the most popular Linux boot loaders. U-boot has been modified to include the MGL G4 functions described in this document.

U-boot attempts to find a bootable Linux system on the external SD card slot. If it does not find this it locates the Linux kernel on the internal SD card, loads and starts it.

Booting from the external SD card allows for a simple verification of any clones made using the cloning function described in this document.

A custom script located in /etc/init.d is executed after the Linux kernel has started. This script attempts to find the EFIS exp4 file and if found executes it.

The primary and secondary boot loaders are also found on the internal SD card but not normally used. They can be copied to the internal flash memory using a premade script. The script is called "mkspinorboot" and is located in /bin

## **The factory image**

From the MGL Avionics website you can download the file "SDCard.img" from the G4 firmware page. This is the original system every G4 starts with. It is about 3.6GBytes in size.

This file is written to a blank SD card using an application that can do a sector by sector copy. For windows one such free application is WinImage32 and another nice one is Balena-Etcher.

On a Linux system you can use "dd" or Balena-Etcher Linux edition.

Once you have created the SD card from this image the SD card contains a full Linux and EFIS system with the basic files – all the terrain data, vector map and a few other files. The exp4 file however is missing.

This card is now inserted into the internal SD card slot.

There are three solder links on the G4 CPU card marked B0, B1 and B2.

Normally only B0 is closed. In this case the CPU will boot from the internal flash memory chip also on the G4 board (it's the 8 pin IC next to the CPU chip).

If B2 is also closed (B0,B2 closed, B1 open). The CPU will boot from the internal SD card (not the external SD card slot).

This is normally only done once at the factory as initially there are no boot loaders in the flash memory chip.

Regardless of the source of the boot code (flash or SD card) – once the image is started for the first time a script is executed that takes a few minutes to complete. You should see a message on the screen stating “Resizesfs2” and a version number. Wait until this changes to “cannot find exp4 EFIS Executable file”.

The first thing that will happen is the partition size containing the EFIS application and Linux will be changed to a size about 15GBytes (even if the SD card is larger). After that the file system needs to be resized to fit the new partition size (this takes a few minutes). The EXT4 journaling file system is used here.

The primary and secondary boot loaders are then copied from the SD card to the flash memory.

The next step is creating the EFIS folders and then moving the various EFIS related files into their target folders. This has to be done this way as the folders are created case insensitive and this is only possible with empty folders.

Once this is completed the script file that has been performing these tasks self-destructs and the system is ready for use. The next step would be to install the current exp4 file to run the EFIS.

Note: if this process fails – usually the culprit is a bad SDCard.img to SD Card transfer that has not completed or there are sector errors on the SD card.