



for Firmware Version 1.11

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1. About the Log file

MGen-3 always logs events happening in the system during the Firmware operation. SD card need to be at the “usable” state, which means it should be formatted to FAT FS format and the HandController (HC) needs to mount and initialize it successfully, then a new log file is created each time the Fw. starts or the card is re-inserted.

Log files are written into the `/MG3/Logs` directory on the card.

After downloading a log file to your local machine using PC App, the file can be found at `<base dir.>/<UID>/SD/MG3/Logs` path, where

`<base dir.>` is the directory chosen in PC App as your “My Folder”,

`<UID>` is the User ID of your HC.

Important notice: MGen-3 uses UTC for the real-time clock. All timestamps and dates used in relation with a log file are meant to be UTC date & time values!

1.1. Naming convention

Log files' names are created as the following:

`<date>_log_<index>.txt`

where

`<date>` is the date (by HC's clock) when the file has been created, the format is: `YYYY-MM-DD` (year, month, day)

`<index>` is the decimal index of the file for the same date, starting from 1 up to 99.

If there were 99 log files present for a date, no new log file will be created.

Example: if you started the Firmware for the 3rd time on the same day (e.g. 14th of may, 2021.), there will be 3 files on the SD card at that time:

<code>2021-05-14_log_1.txt</code>	Already closed.
<code>2021-05-14_log_2.txt</code>	Already closed.
<code>2021-05-14_log_3.txt</code>	Open, being written continuously.

1.2. Behaviour

Only one log file can be opened for logging data at a time. This file is not closed and finalized (flushed to SD card) while the Firmware is running so care must be taken about stopping the Firmware in the normal way: using the "Options/Turn off" screen to stop the Firmware or requesting this through an API call (by some application).

Not closed files may be broken, wrong date/time data set for them and cause FileSystem errors on the SD card. (These errors don't affect present files or files created later but the broken one.) The data content of these broken files are mostly valid until their very end part, though one can't rely on this.

FileSystem errors can be fixed with Windows or other OS, plugging the card in a reader and doing a filesystem check and correction. Currently, the Fw. doesn't offer such.

2. Format specification

Log files are simple ASCII text files, organized table-style. CR+LF newline characters (0x0D + 0x0A) separate between rows and tab characters (0x09) separate between columns in each row of the table.

So a log file can easily be loaded using for example an office tool as text file with the given separators/delimiters or by a program as a simple text parser.

Each row of the Log file contains one “event” logged (until otherwise specified). These events have ID names that differentiate between them.

So the common format of any entry is the following:

DATE **TIME** **ID** **<optional columns>**

- Date (UTC) column has the exact format of **YYYY-MM-DD** (Year, Month, Day).
- Time (UTC) column has the exact format of **HH:MM:SS.LLL** (Hours (24), Minutes, Seconds, milliseconds).
- ID column is a case-sensitive string consisting of two words: a class ID and an entry ID of that class, separated with a space (0x20) character.
- Optional columns' format depend on the ID (type) of the entry.

The sub-sections of this current section of the document will denote the class and entry IDs too to offer easy-to-use direct links from the table of contents.

For better overview, date and time entries will not be noted for the detailed entry descriptions. That first two columns are default for all.

2.1. Log system entries (LOG)

Reserved for informational data of the logging system.

2.1.1. START

LOG START <UID> <Fw.name> <Fw.ver.> <Fw.flags>

When a Log file is created, the first entry is this one showing info of the Firmware that has started to write the Log file.

<UID> The User ID of the HandController.

<Fw.name> Name (description) of the Firmware.

<Fw.ver> Version of the Firmware as the format of **V.SS.P** (main Version, Subversion, Patch number). Digits are hexadecimal!

<Fw.flags> Flags of the Firmware, hexadecimal. This encodes some type info of the Fw., not documented.

2.1.2. STOP

LOG STOP <reason>

Entry for the Log file being closed. This must be the last entry of all Log files.

<reason> The reason as a string to close the Log file. Currently only “system stop” when the Firmware exits.

2.1.3. BUFFERFULL

LOG BUFFERFULL

A special entry indicating that the log buffer (in memory) was full at this time point (because it couldn't be flushed to the SD card for any reason) and so there is a high chance that the log file missed here at least one entry. Parser applications must notice this state of error before continuing analyzing the other entries. There could be from a single missing entry up to a lot of entries of hours of operation.

2.2. Camera events (CAM)

Event class for the used Camera. Anything happening to/by it may generate such an entry.

2.2.1. CONN

CAM CONN <UID> <Fw.name> <Fw.ver.>

When a Camera has been successfully enumerated by the USB host and initialized by the HC, this entry is saved. The data of it are similar to the LOG START log entry but tells info about the Camera's Firmware. (Fw.flags column is missing.)

From this time point there can be other CAM events saved.

2.2.2. DISCONN

CAM DISCONN

The Camera has been disconnected (stopped). This entry indicates that the previously connected Camera is no more available. Can be of any reason, plugging it out from the HC or when the HC powers down the USB host, or even when an USB communication error occurs.

2.2.3. FRAME

CAM FRAME <X drift> <Y drift> <FWHM> <bright>

The entry is saved when there's a new guiding frame available from the Camera. The raw evaluation result data of the guiding frame is saved as this type of entry.

Do not get confused, this entry is generated only when a guiding frame is available, not a single raw frame from the Camera. Guiding frames are calculated by a result of the star search, when there is multistar data available, from which the final guiding frame is calculated. It doesn't matter if the guiding frame contains any star, this entry is saved anyway.

Also, this entry has no connection to autoguiding. Whatever state (on/off) the autoguiding is in, this entry will be saved.

<X drift>	The drift value on the X axis, in pixel units.
<Y drift>	The drift value on the Y axis, in pixel units.
<FWHM>	The measured FWHM value of the star on the gui. frame.
<bright>	The measured brightness value of the star on the gui. frame.

X and Y drift values are relative values to the "autoguiding reference point". This point is not a physical coordinate but a virtual point on a virtual coord. system. As multiple stars are mixed together to form the guiding frame, there's no real coordinate of it, instead the HC will use the position around which the autoguiding will be done. (Dithering will be spread

the current autoguiding center points around this reference point.) So drift values can “step instantly” too if either the autoguiding center point or reference point changes.

Drift values given by this entry are only informational, no real use of them, except to record mount tracking errors etc. (for generating PE curve automatically for example) or to store some kind of “raw positions” of the final guiding star.

The FWHM (Full Width at Half Maximum) value is always given, even if the star shape fitting resulted in “no star” state. This value is valid only if the brightness value is non-zero.

The brightness is a relative measure value of the overall brightness of the (multi)star image. These values can be compared to each other unless the multistar settings change. There is no calculated “real brightness” as it would be way too complex for interpretation.

If this value is zero, the star fitting method treated the fitting as “no star visible”, due to being too sharp (FWHM is very small) or too big and faint.

2.3. Autoguiding entries (AG)

All events happening to/by autoguiding processing will generate this class of events.

2.3.1. NEWREFPT

AG NEWREFPT <X pos.> <Y pos.>

When a new autoguiding reference point is set, this event is logged. X and Y positions are in pixel units and meant to be on a virtual coordinate system, whose origo is defined “as is” (after a star search routine).

2.3.2. NEWPOS

AG NEWPOS <X pos.> <Y pos.>

When a new autoguiding center point (in pixel units) was defined (on the virtual coord.system). This usually happens when the autoguiding was started, the latest known drift will be used as the new autoguiding center point. An active autoguiding will try to hold the guiding star at this point.

Note that the CAM FRAME entries’ drift values are always relative to this autoguiding reference point.

2.3.3. START

AG START <RA mode> <RA P> <RA I> <RA tol.>
<DEC P> <DEC tol.> <foc.len.>

The autoguiding just has been started. (Not right exactly when the user enabled it but when the first guiding frame arrived and was evaluated.) The actual parameters set for the autoguiding is listed as the optional columns.

<RA mode>	“manual” or “auto trim”.
<RA P>	RA guiding’s proportional coefficient.
<RA I>	RA guiding’s integral coefficient. This value being negative (-1) means that the integral component is not enabled.
<RA tol.>	RA guiding’s tolerance value set. (Pixel unit.)
<DEC P>	DEC guiding’s proportional coefficient.
<DEC tol.>	DEC guiding’s tolerance value set. (Pixel unit.)
<foc.len.>	The set focal length value for the guiding optics. (Used for pixel to arcseconds conversion.)

2.3.4. DRIFT

AG DRIFT <RA drift> <DEC drift>

When autoguiding is active and there was a star visible on the guiding frame, the calculated RA and DEC drifts are logged as this. The unit is pixels but the conversion from X/Y to RA/DEC was done using the calibration data.

The autoguiding process uses these drift values as its input data.

The drift values are calculated internally as the following:

$$d_{RA} = (\overline{pos} + \overline{ag_refpt} - \overline{ag_center}) \cdot \overline{cal_{RA}}$$

$$d_{DEC} = (\overline{pos} + \overline{ag_refpt} - \overline{ag_center}) \cdot \overline{cal_{DEC}}$$

where \overline{pos} is a drift vector that CAM FRAME indicates,
 $\overline{ag_refpt}$ is the autoguiding reference point what AG NEWREFPT indicates,
 $\overline{ag_center}$ is the autoguiding center point what AG NEWPOS indicates and
 $\overline{cal_{RA}}$, $\overline{cal_{DEC}}$ are calibration normal vectors that CALIB RESULT indicates.

2.3.5. PULSE

AG PULSE <RA pulse> <DEC pulse>

Right after new drift values were put into the autoguiding processor, the calculated required correction pulse lengths are logged as this. The unit is seconds.

The new pulse length calculated always overrides the current pulse being put out. So if a pulse with 0 length was calculated, the outgoing autoguiding signal (on that axis) was immediately stopped.

Note that this is the theoretical pulse length required. The actual outgoing pulse lengths may be limited by the Camera frame rate too.

The actual outgoing correction signal changes are logged separately as below.

If <DEC pulse> column is a "-" character only, it means that the DEC guiding was disabled. (No DEC calibration vector is defined.)

2.3.6. OUT

AG OUT <RA-> <RA+> <DEC-> <DEC+>

Indicates the change of an autoguider output signal on the ST-4 connector. Each optional column is a string that can be empty meaning that output line is non-signaled, or the string showing the line ("RA-", "RA+" etc.) is signaled. By these entries you can track down what signals were physically present at the HC's ST-4 output connector.

2.3.7. TRIM

AG TRIM <new RA P> <new RA I>

When the “auto trim” mode is active and the autoguider processor made a change of the P and/or I parameters. The new values present in the columns are stored to the variables and autoguiding is carried out using those from that time.

2.4. Dithering entries (DITH)

Events of the dithering unit in the autoguider process.

2.4.1. REQ

DITH REQ <count> <size>

This entry indicates that a dithering was requested. (Can be done by the AutoExposure program or through an API call.)

After this entry there will be an AG NEWPOS entry with the new autoguiding position that the dithering unit calculated. The dithering is now in active state and AG OUT pulses will be calculated and AG OUT signals will follow them. (Dithering is done like normal autoguiding, frame-by-frame but in a specialized calculation mode.)

2.4.2. END

DITH END

Dithering is treated to be finished and mount movement will be stopped. New autoguiding positions (AG NEWPOS) will be measured until the timeout, then guiding will continue at the new position.

2.5. Calibration entries (CALIB)

Events of the Calibration function and data.

2.5.1. START

CALIB START <foc.len.> <ag.speed>

A calibration function has been started with the given starting parameters. “Starting” means that these parameters are only used to speed-up the process. If good parameters are defined for the calibration, it will start using proper amount of correction signal lengths to avoid extra pulses required or overpulsing.

<foc.len.> Reflects the “focal length” variable’s value set on the HC.

<ag.speed> Reflects the “AG speed RA” variable’s value set on the HC.

2.5.2. RESULT

CALIB RESULT <RA dir.X> <RA dir.Y> <RA speed>
 <DEC dir.X> <DEC dir.Y> <DEC speed>

When the Calibration ends successfully, the new calibration data is stored as this entry. Also when an autoguiding has just been started ([AG START](#)), the actual calibration data is logged in the same way just to inform the log file’s parser what vectors the autoguider process is using.

<RA dir.X> <RA dir.Y> The normal vector (unit length) showing the direction of star moving for the RA+ signal.

<RA speed> The speed of the star (in px/s unit) for an RA correction signal.

<DEC dir.X> <DEC dir.Y> The normal vector (unit length) showing the direction of star moving for the DEC+ signal.

<DEC speed> The speed of the star (in px/s unit) for a DEC correction signal.

In the case when the DEC axis was disabled for calibration, the result will contain zero <DEC speed>. Also the normal vector components of DEC could be zeros.

2.5.3. CANCEL

CALIB CANCEL

When the Calibration process has been canceled by the user. The previous calibration data was preserved.

2.5.4. END

CALIB END

When the Calibration process has ended successfully. Before this entry a new calibration result must have been reported into the log file.

2.6. Star Search entries (SS)

Events of the Star Search function and data.

2.6.1. START

```
SS START    <min.gain> <max.gain> <min.expo> <max.expo>
             <prefer>   <goal sat.>
```

A Star Search function has been started with the given input parameters.

<min.gain>	The minimum gain value to be used.
<max.gain>	Same for maximum.
<min.expo>	The minimum exposure time to be used (in ms unit).
<max.expo>	Same for maximum.
<prefer>	A string showing which search way is preferred: "long" exposure time or "short" exposure time.
<goal sat.>	The goal maximum saturation value of a star visible.

Goal saturation is expressed as a byte, so the value of 255 means full saturation (on the 12-bit raw image) is allowed. By default the Firmware uses a value of ca. 71% saturation and so a byte value of 182.

While a Star Search is running, Camera stops taking "guiding frames" periodically and there won't be **CAM FRAME** events logged.

2.6.2. FOUND

```
SS FOUND    <gain>      <expo>      <num stars>
```

The result of the latest frame with the given gain and exposure time.

<gain>	The gain value used to take the frame for searching.
<expo>	The exposure time (ms) used to take the frame for searching.
<num stars>	The number of detected stars on it. These could be used for the multistar guiding.

2.6.3. CANCEL

```
SS CANCEL
```

The Star Search has just been canceled by the user. Previous multistar info is held.

2.6.4. END

SS END <gain> <expo> <num stars>

The Star Search ended with the given gain and exposure time and number of stars used as the input for multistar guiding.

There's no info about the found individual stars (position, FWHM, brightness, used weight for guiding image etc.).

2.7. AutoExposure event entries (EXPO)

Events of the AutoExposure (AE) programs run by the HC.

2.7.1. START

EXPO START <preset>

A single AE program has just been started. The <preset> string shows which program was used: "preset #N" (N is the number of the preset, from 1 to 4.)

2.7.2. STATE

EXPO STATE <state> <time>

The new state of the AE unit.

AE is a simple state machine that changes state by different inputs or by itself. It consumes (at least or exactly) a given amount of time then steps to a new state.

<state> A string showing the new state of the AE unit. Possible values:

IDLE - AE is not running anymore.
WAIT - "wait time" is being timed.
ML - "mirror lockup" is being timed.
EXPO - "exposure time" is being timed.
? - (in case of an error)

<time> The time that the state machine should be spend at this new state.

2.7.3. OUT

EXPO OUT <foc> <exp>

The exposure output (EOS jack) signals have changed to a new state.

<foc> "foc" string if the focus line is active from now, otherwise empty.

<exp> "exp" string if the exposure line is active from now, otherwise empty.

2.7.4. PAUSED

EXPO PAUSED

The user wanted to pause the exposure program previously and now the AE program has reached the state when it can be paused. This time point is in the WAIT state, right before activating the focus line of the output. (That is 0.3 seconds before the exposure line going active.)

2.7.5. CONTINUE

EXPO CONTINUE

The user continued the program from its paused state. This entry can happen only when the AE got in paused state preceding so the EXPO PAUSED entry was present.

2.7.6. STOP

EXPO STOP

The user stopped the program manually. The AE will go to IDLE state immediately.