

English manual version 1.01

By Tommy Nawratil



Many thanks for purchasing the MGEN-3!

The Lacerta MGEN-3 is the new generation of the proven MGEN-2 autoguider. It contains new and important improvements like multistar guiding, self-parameterizing and an easy one push autoguiding start feature. Less hassle and more precision was our goal. The MGEN-3 can be used as a stand-alone guider, includes a timer for DSLR and similar cameras, or it can be controlled remotely via USB access. It can be connected via Ascom to various programs for synchronizing with CCD/CMOS cameras when dithering is needed (in progress, mgen.app will soon be released).

It combines a number of well established and some innovative features:

- programmed directly on the microprocessor, thus not relying on a non-astro operating system
- direct USB access, usually with automatic driver installation. Powered via 5V USB port
- increased sensitivity via optimized dark frame calibration
- multistar guiding (up to 100 stars, auto selection and weighting)
- self-optimizing and adjusting to changing conditions (A.I.)
- extreme subpixel precision not affected by seeing variations
- one push mode for fast autoguiding start
- dithering after a specified number of exposures (can be combined with Lacerta Motorfocus)
- DSLR/DSLM timer integrated, various modes can be controlled fully either standalone OR remotely ASCOM compatible via mgen.app – visit <https://mgen.app>
- north polar alignment via digital Scheiner method

Development:

With firmware version 1.00 the MGEN-3 has about the same functionality as the MGEN-2, but has some important improvements. Numerous other features are in planning, such as platesolving and related features (micro GoTo via ST4, polar alignment, etc). There is an onboard WiFi module that will allow wireless connection to PCs or mobile phones and apps, adaptive optics, measuring of field rotation and derotator, and more. Please send us your ideas. Suggestions are always welcome.

Contents of the box:



- MGEN-3 Handbox
- MGEN-3 Camera (with M28.5x0.6 1.25" filter thread)
- Adapter Nr.2 for camera thread to T2
- Adapter Nr.1 for camera thread to 1,25" barrel (31.7mm) with filter thread
- 2x USB cables
- ST4 guiding cable
- 4GB SD card

Connecting the Camera to the guidescope:

The camera is extra lightweight (40grams) and designed to fit any guidescope. The camera body has the M28x0.6 common 1.25" filter thread. There is a screw-on barrel that can be used for fitting it to 1.25" focusers. A second adapter can be used to fit the camera to T2 threads. With the T2 adapter the backfocus is 9mm. See the various possibilities here:



Connection ports of MGEN-3:



Power: The MGEN-3 is powered via the USB port on the bottom right of the handbox (see picture). You may use a normal mobile phone wall adapter, a power bank or a USB port on your PC. The current drawn is typically about 240mA/1.2W.

The MGEN-3 can be used standalone or remotely via USB, using a Windows app that you can download to your PC. We have set up an **MGEN-3 specific Support Website** and invite you to visit it and register your device. You will get the firmware upgrades free for a year (extensions will be possible for a minor contribution), and all the accompanying apps, manuals and videos are available there.

<https://support.mgen-autoguider.com/>

Manuals and apps are also free to download at the MGEN-3 product website at lacerta-optics.com
<https://lacerta-optics.com/MGEN-3#nav-support>

accompanying apps for the MGEN-3

- virtual interface for full control via PC
- Sky Emulator for getting to know the functions indoors via PC
- Text Editor for translating the menu language

Comments and howtos for the apps can be found as readme files in the zip Files to download.

the Windows driver (FTDI)

In order to communicate with your PC it is necessary to have a driver installed. In most cases this will happen automatically if you are connected to the network. If your MGEN-3 is not properly recognized, please download the setup.exe file from here and install it (available to the right under comments)

<https://www.ftdichip.com/Drivers/D2XX.htm>

The MGEN-3 is an easy guider – Guiding at the push of a button

Connect the hand controller to the camera via the USB cable, and to your mount's ST4 port via the ST4 cable (both provided). Power your MGEN-3 via the second smaller USB port (bottom right on the handbox), using the second included USB cable (normal 5V USB power). You can use a mobile phone wall adapter, a power bank or a USB port on a PC.



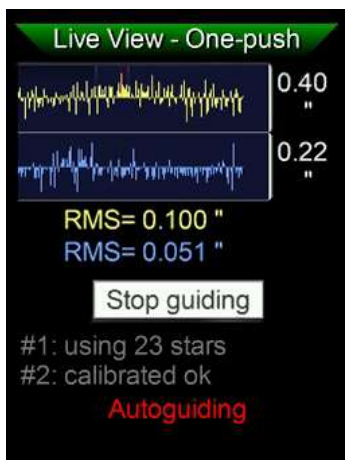
A short press of the **ESC** button turns on the MGEN-3, and after the splash screen the **One push** screen is displayed. What you see here is a live picture from the camera, containing stars. It's a black and white picture because the MGEN-3 camera has a very sensitive monochrome sensor.

Right below the screen there is a button, **Start guiding**



To set the cursor on **Start guiding**, push the **DOWN ▼** directional button, and then press **SET** (from firmware 1.01 the cursor will be on **Start guiding** by default).

The MGEN-3 automatically starts a **star search**, identifying and selecting many stars, goes through the **calibration** procedure with your mount (already tracking), and **autoguiding** will be started immediately.



The live picture is then replaced by the guide graph, and at the bottom, **Autoguiding** is displayed in red blinking letters. You may now start the exposure sequence with your camera.

The MGEN-3 will monitor the guiding, create its internal statistics and optimize the guiding values by itself. The multistar feature greatly reduces seeing effects on the guiding, and helps to get not only rounder, but also smaller stars in your pictures.

This one push autoguiding saves a lot of time! No need to check pictures, select proper guide stars, calibrate, change screens and press lots of buttons to take the same necessary steps every single time.

First though, some preliminary steps need to be taken, like focusing your guidescope, setting some basic values, and getting to know your MGEN-3. We will now guide you through these steps.

Interface, menu and operating the MGEN-3

The MGEN-3's menu is divided into four main groups, dropdown menus containing several entries. Using the directional buttons **UP ▲** and **DOWN ▼** the cursor can be shifted through these items, while using **LEFT ◀** and **RIGHT ▶** the main groups can be selected. To enter a page use the **SET** button, and to leave it for the main menu use the **ESC** button.

The four main menus are:



DSLRL Timer - here you find the exposure control for DSLRs and related cameras. Different sequences can be programmed. For now we offer four presets that can be edited according to your needs.



Live picture of the MGEN-3 camera, its settings and exposure time, and some related functions, as well as the one-push guiding page.



Autoguiding and related functions, like calibration, dithering and more (see page 16)



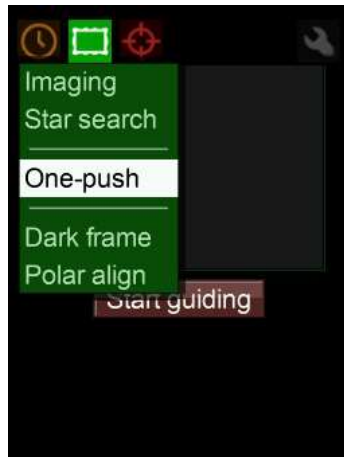
Options: Settings of the display, day/night modes, colors, languages, SD card, system and boot for firmware upload, and switch off. The ID number of your device used for registration can be found under System.

There is a shortcut to switch between pages directly: On any particular page, press and hold **ESC**. On the bottom a line appears ◀ change page ▶ and by pushing **LEFT ◀** or **RIGHT ▶** one can enter the adjacent pages.

Basic steps for using the MGEN-3 for the first time

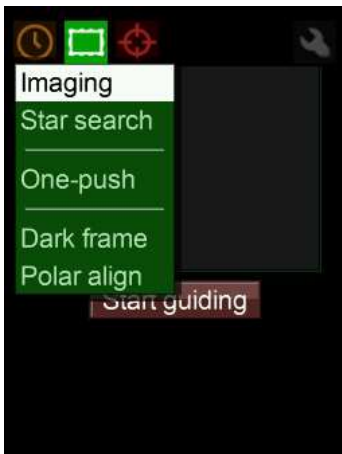
To use the MGEN-3 you need to attach the camera firmly to a guidescope and focus it. You may connect to any scope, but we recommend using a small 30mm or 50mm guidescope. This allows for a bigger field of view, and the subpixel precision of MGEN-3 is so great that it can accommodate practically any focal length. To achieve focus you can use the stars, but its also possible to do it in the daylight aiming at a very distant object (you will need to lower the gain and exposure time for this).

In order to focus the guide scope accurately you must switch to the live-view window where you can also make certain adjustments if necessary. You can zoom in to get a close view. First, press **ESC** to leave the one push page and enter the main menu:



Here you can shift the cursor by pressing the directional buttons **UP ▲** and **DOWN ▼**. By **LEFT ◀** and **RIGHT ▶** you can change to other main menus.

For focusing we choose Imaging, and by pressing **SET** you enter the Live View-Imaging page:



On the Imaging page we find some values that need to be adjusted, and we can also zoom into the picture to get a much closer view of a star.

gain means the amplification of the signal coming from the sensor (recommended: 9).

view gain is the extra amplification used just for the display (8x recommended).

expo. is the exposure time of the image (1000ms recommended for night sky, during daylight around 5ms)

average: Here, three modes are available that determine how the picture is calculated if the zoom factor is less than 1:1. Leave it at average.

Editing numbers on the MGEN-3

To begin with the cursor rests on the live image, and by pressing **DOWN** ▼ twice it can be shifted onto...

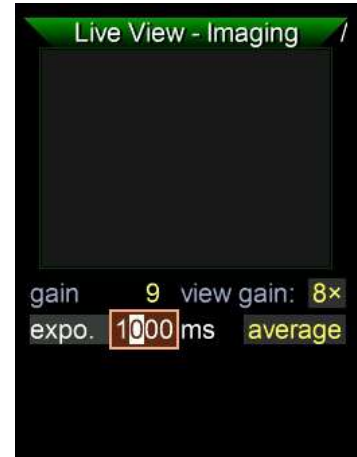
the value for the expo time:



press **SET** to activate:



press **LEFT** to move cursor:



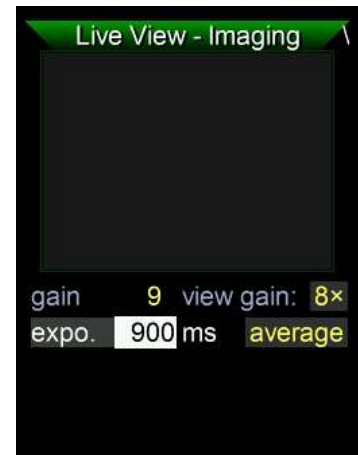
UP increases the number



DOWN decreases the number



and press **SET** to confirm



For finding focus it is helpful to estimate where to place the sensor of the MGEN-3 camera, especially if you need to use adapters. If you know the focal length of your guidescope, measure that distance from the lens backwards to find the approximate position. Another way is to point the guidescope at the moon, take a sheet of paper and move it back and forth behind the focuser until you find the spot where the moon is smallest. Place the sensor near that point.

With the default setting the camera is sensitive enough that you will probably already see some defocused star disks. Now you just need to focus your guidescope to make these disks as small as possible.

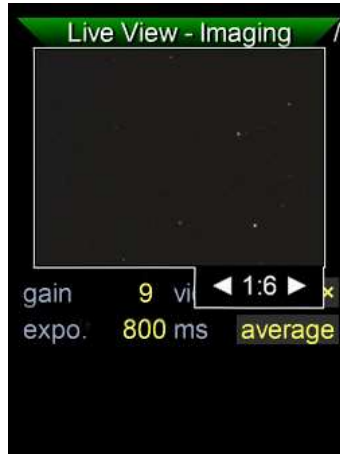
Zoom mode

Once you have achieved focus this way, you can use the zoom function to zoom into the picture for more precise focusing. Move the cursor back onto the live image and press SET to enter zoom view.

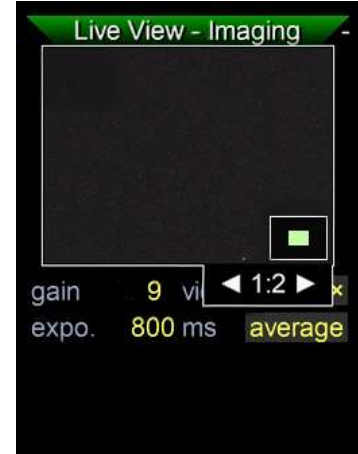
SET: enter zoom view



press and hold ESC,
the zoom factor shows up

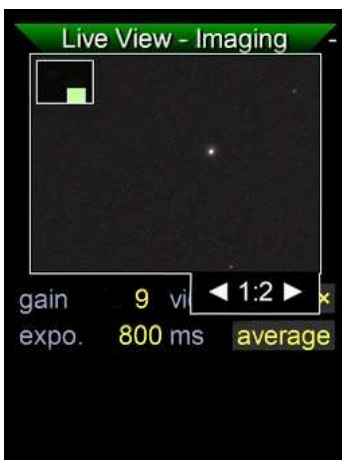


press RIGHT to
zoom in

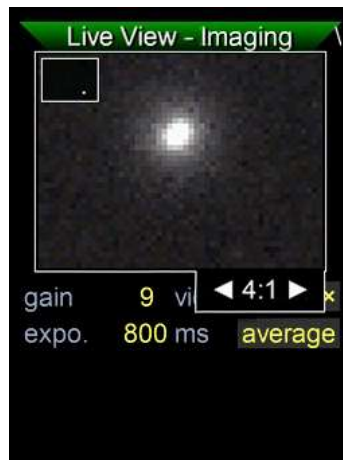


The small green area that shows up depicts the size and position of the field on the sensor.

Release ESC, and by using the
arrow buttons move the
selection box across the sensor.



Center on a brighter star.
By using ESC+RIGHT you
can zoom in up to 4:1



When done, zoom out by
pressing ESC+LEFT and
exit zoom view by SET



At this high zoom level (4:1 = 400%) it is easy to focus quickly and precisely!



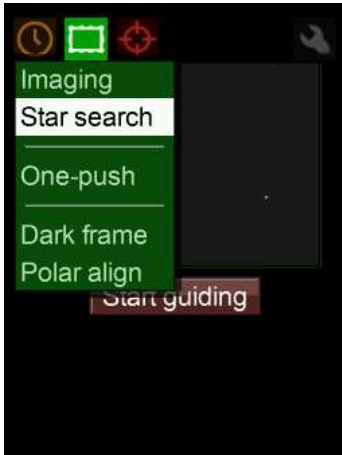
Note #1: You may also use a daytime target far in the distance for focusing. That way you save time under the stars. But you will need to adjust certain values to compensate for the much brighter daylight. See photo.

Note #2: After focusing, do not remove the MGEN-3 camera from your guidescope. That way there will be no need to focus it again.

Star search is the next item after Imaging.

It is helpful to take a moment to have a look, check the settings and get to know what they do. These values are important, because they are also applied when doing a star search via the one push screen.

Select and press **SET**



to enter the Star search page



Again the live image is displayed. You could even use the zoom function, but this page is actually used primarily to set the basic values for the automated star search.

Gain interval: Sets the range for the sensor amplifier used by the automated star search. If the full range 0-9 is set, Star search will use lower values if brighter stars are in the field. Brighter stars have a better signal to noise ratio, and the dimmest stars will be excluded. But a star that is too bright will also be excluded as it tends to dominate the combined multistar. If there are only dimmer stars in the field, Star search will use the full range and include more stars to compensate. Star search also does the calculation to create the multistar from all the stars found. Brighter stars get more weight than dimmer stars. We recommend leaving the gain interval at the default 0-9, but you may want to try manually and explore the effects. If there are lots of stars in the field and Star search catches the maximum 100 stars, you may try to lower the range, even down to 0-0 to find only the brighter stars. The MGEN-3 allows for full manual control.

Exposure interval: Here a range must also be set. The auto Star search then tries different exposure times from this range to find the proper exposure time best suited to the star field. Brighter stars will lead to shorter exposure time and vice versa. The time found here will also be used in autoguiding, and is the time interval when corrections are sent to the mount. If you own a mount with a less steep periodical error, corrections are less often necessary and you may allow for a longer time interval (up to 4000ms). If you use an active optics mirror you can use an extremely short interval (down to 1ms). Usual mechanical mounts cannot react this fast, and for them we recommend using a range of 800-1500ms (default values).

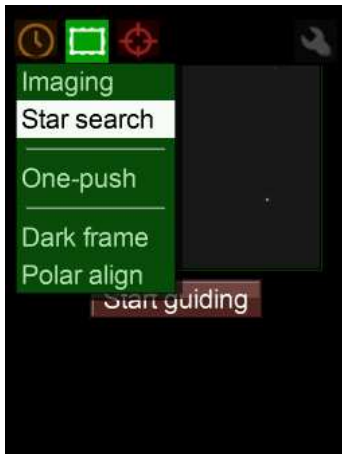
If you start a star search here, a few different exposure times are tried and you will see the numbers briefly showing up. When a suitable time is found and the stars are selected, Star search automatically switches to the star selection screen. This is for manual use and will be discussed later on. You have to go back to Star search to see that the found and selected stars are marked by small green squares that represent the readout areas the camera transmits to the controller. The determined exposure time can be seen in the Imaging page.

This exposure time also serves as a base for setting up the MGEN-3's internal statistics. It is permanently measuring the deviations and associates them with the correction pulses, and gets to know how the mount is functioning (PE, etc). It always tries to minimize deviations and tweaks the

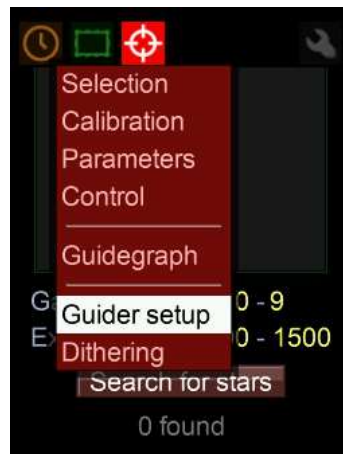
guiding parameters accordingly on its own. If conditions change, it will go with them and adjust the values accordingly. At the start of the next session, the last values used will be recalled and be used as the new starting point, and they will then be constantly modified according to the conditions.

These values are to be set in the **Guider Setup**:

Call up the menu by **ESC**



by **RIGHT** ► switch to the neighboring menu and choose Guider setup



...and then enter by **SET**



Check if the default values fit or need to be corrected for your setup. A 50mm finder usually has a focal length of 180mm, and a 30mm finder is usually 120mm. A Synta 50mm ED finder has 240mm.

The autoguiding speed is usually 0.50x sidereal rate.

The MGEN-3 uses the focal length value for making calculations displayed in arc seconds, for example FWHM or rms deviation. Its useful to have them displayed this way in order to compare with different setups and have them related to a known angle unit. Therefore we recommend to have Display arcsec. checked.

Note #1: The values actually used for guiding are determined only in the calibration process, so the numbers set here only help to avoid movements that are too large or too small, and the calibration will be very quick and successful.

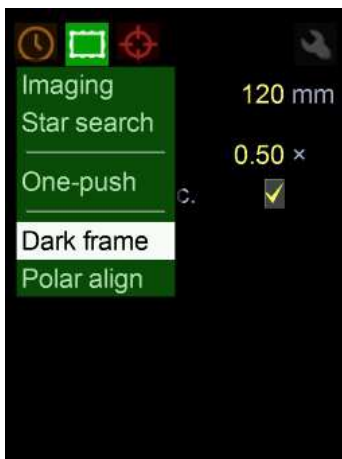
Note #2: These numbers are saved and only need to be set the first time you use it, as long as you do not change your setup.

Darkframe acquisition:

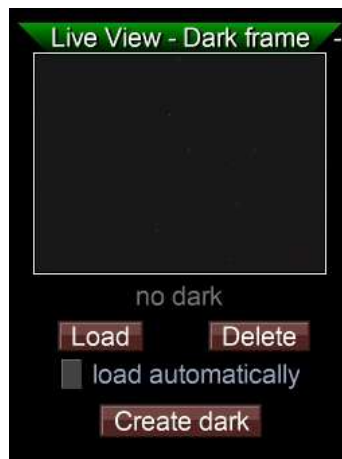
As with any camera, the MGEN-3 sensor will show some artifacts like hot and cold pixels, dark current, etc. For enhanced sensitivity and functionality, it is good to correct for these using correction frames. We call it Darkframe for simplicity, but there is more going on internally (optimized Dark, Bias, scaling, and overscan correction).

Acquiring a set of dark frames is very easy; just make sure that absolutely no light reaches the sensor. Covering it by hand in daytime, even indoors, is not sufficient. Do it at night, and make sure it is totally dark!

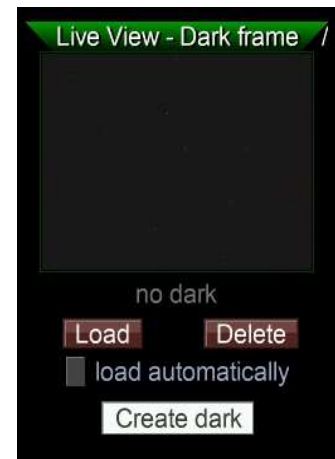
choose **Dark frame** in the menu



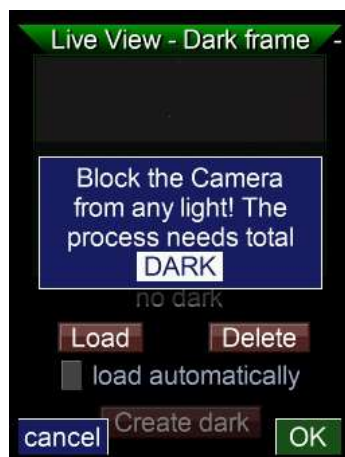
enter by **SET**



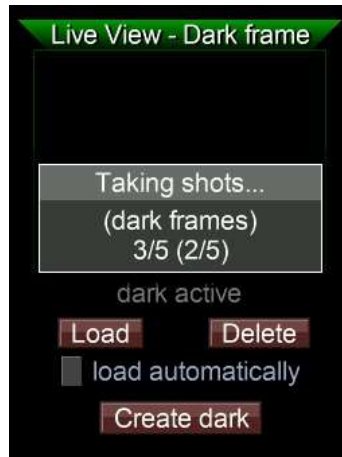
cursor on **create** + **SET**



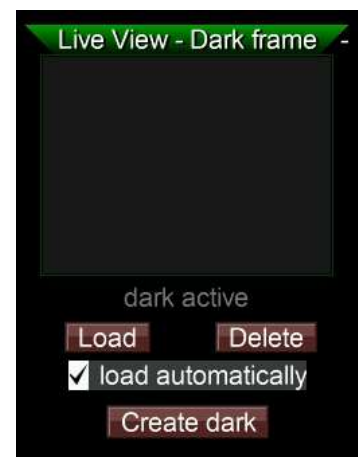
obey warning + **ok**



wait until done...



and check **load automatically**



The corrections are applied, **dark active** is displayed and the file is saved onto the SD card. If there is no SD card in the slot, there is a warning, but the corrections remain active until shutdown.

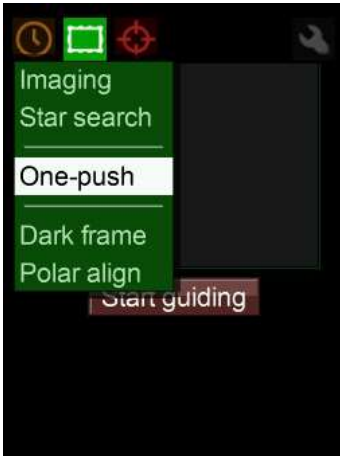
Note: Make sure to check **load automatically**, the correction file will be auto loaded every time the MGEN-3 is switched on.

After these preparations that only need to be done once before first use are completed, the MGEN-3 is fully trained to do its job. From now on you may start autoguiding right from the startup screen by one push of a button!

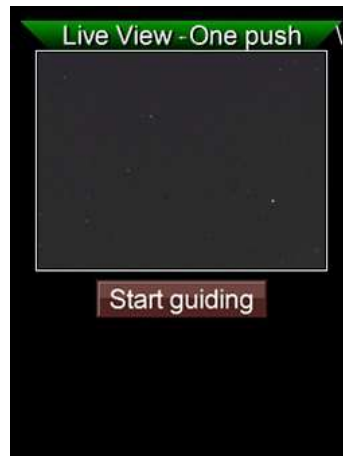
One-push – start autoguiding

After starting up the MGEN-3 the one-push page appears automatically, also showing the image from the camera. Move the cursor to **Start guiding** if it is not already there, and press SET. From the menu you can enter this page at anytime:

Select **One-push**



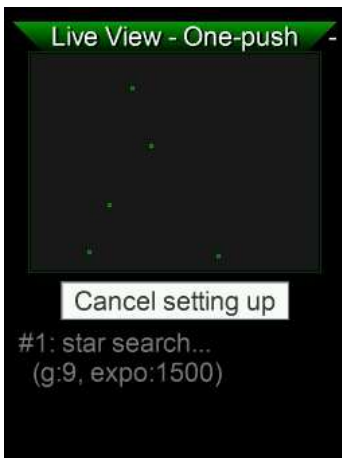
and enter by **SET**



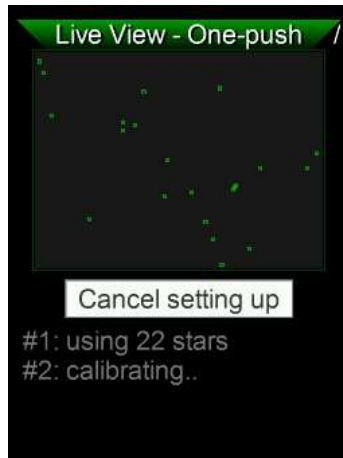
cursor on **Start guiding**+ **SET**



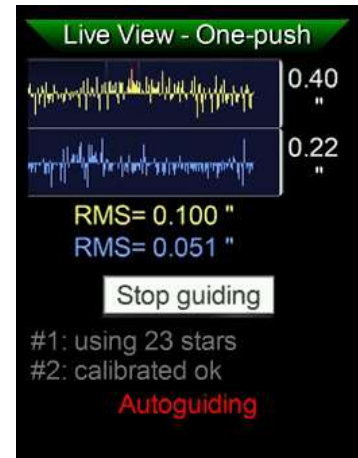
now the auto sequence takes over:
stars are being searched for...



...calibration takes place....



...and autoguiding is started



The live image is replaced by the guide graph, showing the progress of the autoguiding and displaying the rms deviations. You may also stop and resume guiding from here. If a new starfield is detected, a new star search and calibration takes place automatically. If detection fails, you may go to the Star search page and start the Star search there manually. Normally, the whole one-push sequence from start to autoguiding takes only about 30 seconds, no more.

The one-push feature helps greatly in atomizing the sequence of steps, but if you prefer, the MGEN-3 also allows for full manual or semi-manual control. The functions will be explained in detail in following chapters. But before that let's take a look at the DSLR timer and at dithering in order to have everything you need for your astrophotography session clearly understood.

Note: At the end of this manual you will find some important additional hints for a successful guiding.



DSLR exposure control

The MGEN-3 has a fully functional, on board remote timer. Using a proper cable for the camera model, your DSLR can be connected to the socket on the bottom of the handbox. Canon, Nikon, Pentax, many Sony and other cameras can thus be controlled via cable.

The exposure control is the menu furthest to the left . In the beginning, there is only one entry here, called Single.

enter by **SET**



program the timer



after starting, the remaining time is counted down



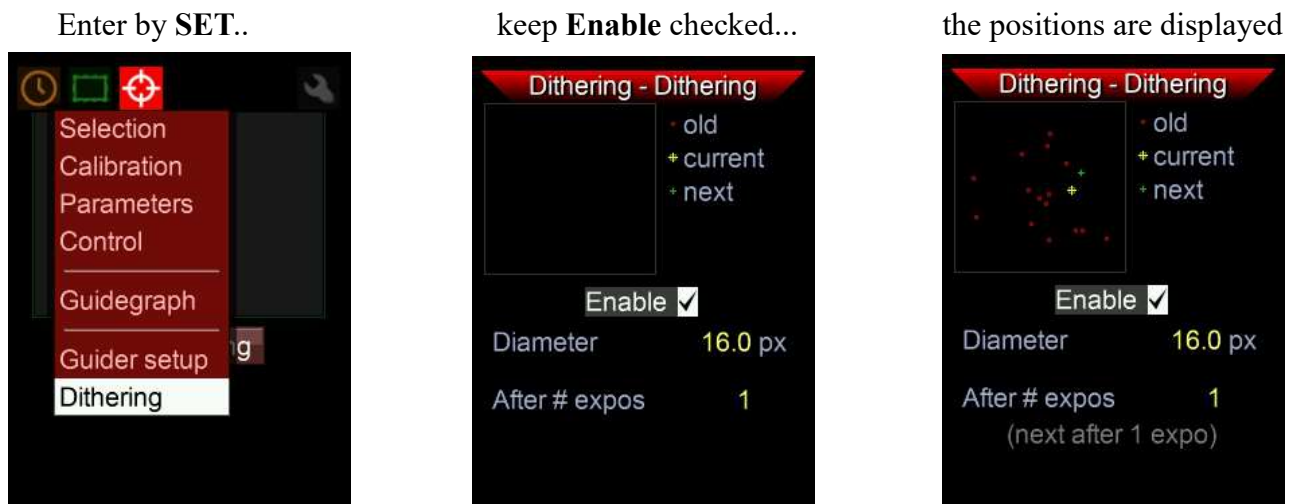
You can pause and restart the exposure sequence at any time. Two signals are sent to the DSLR: First, the focus signal (like half pressing the exposure button) and ESC lights up, then the shutter release signal and SET also lights up. If you want to use mirror lock, you need to activate it in the DSLR. The value 0.0s means no mirror lock. We do not recommend mirror lock with long exposure times. Mirror shake is more of a problem with very short exposures.

There are currently four presets that can all be programmed individually. More functions and combinations will follow (for example HDR sequences, and more).

Note: The waiting time should be at least as long you DSLR needs to save the individual exposures and to be ready for the next one. We do not recommend less than 3 seconds. Below 0.4 seconds no shutter signal is transmitted.

Dithering 1 (basics)

Dithering means randomly shifting the guide star a short distance between the DSLR exposures. That way, hot and cold pixels, and even some of the pattern of the dark current imprinted on every frame can be practically eliminated during stacking of the frames, and a much cleaner master frame can be obtained. Stacking registers the frames according to the star positions, and hot pixels will have different positions relative to the stars when the camera is shifted – and they thus become outliers in the calculation. No more “walking noise” effect. Dithering is one of the main building blocks of modern astrophotography.



If enabled, the MGEN-3 will shift the guide star automatically a little bit after the specified number of exposures. You can observe the shifting on the active LEDs of the directional buttons when the ST4 output is activated immediately after the DSLR exposure has ended.

We recommend to keep dithering enabled. The diameter specifies the area the multistar is shifted around the original position, and it can be set up to 99.9 pixels. With a standard setup, 10-15 pixels are sufficient.

With a ratio of about 5:1 between the focal length of guide scope and the main scope, that is equivalent to 50-75 pixels on the DSLR (if the pixel pitch is same as the MGEN-3, 3.75 μ m). With very short focal lengths you may increase this value a bit.

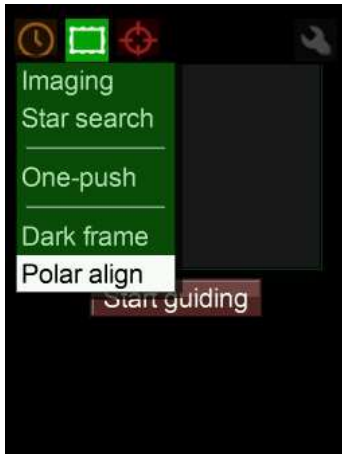
If you make very many exposures, you may choose not to dither after every picture, but at longer intervals. It saves time (dithering takes a few seconds), but you won't lose the effect.

More on dithering with the MGEN-3 below in Dithering 2, (page 21).

Polar alignment via the digital Scheiner method (measured drifts)

With polar alignment following the Scheiner method, the drift of a star is measured when the RA axis is not pointed precisely at the pole. From the measured drift rate the misalignment is calculated and displayed. Two star positions are needed: A star close to the meridian and near the equator is chosen for correcting azimuth (left-right), and a star either deep in the west or east, also near the equator, for correcting the pole height (up-down) of the mount. This 2 step method is very precise, and does not need the pole itself to be in view. With the multistar feature of the MGEN-3 the influence of seeing is greatly reduced, leading to good results in a very short time.

Enter by **SET...**



the Polar align page



Polar aligning a mount usually is done before autoguiding, so after startup you can switch directly to this page. Set the focal length of your guidescope, if not already done. We recommend to start with a star near the meridian. That helps later on to eliminate the height error as the azimuth is already fine tuned).

Aligning **Azimuth** - step by step:

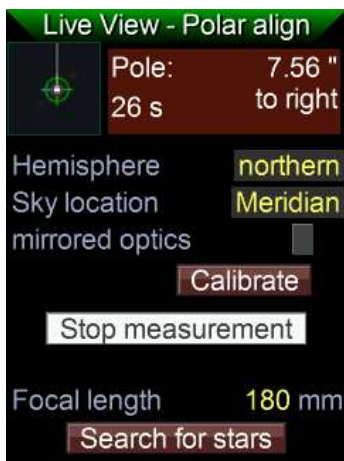
- Set your mount to track with sidereal rate
- do a star search (at bottom of this page). The multistar will appear in the small window, marked by a green circle
- set the hemisphere of your location (northern or southern)
- set Sky location, where the guidescope is pointed (here Meridian)
- if the image is mirrored, (e.g. OAG), and if you use an uneven number of mirrors set a checkmark after **mirrored optics**
- press **calibrate**. The MGEN-3 needs to know how the pixel rows of its camera are related to the mounts axes. This is done by this small calibration routine. You only need to do it once at the beginning of every polar alignment session.



A box pops up. Simply follow the instructions. Your mounts RA axis needs to be slowly moved a little eastwards. You may use the **RIGHT** (or **LEFT**) button on the MGEN-3 to manually send the respective ST4 signal, or you can stop tracking for a few seconds, and then press OK. A little line appears, stretching from the multistar pointing to the pole.

When done, press **SET** (OK). The MGEN-3 now knows how it is aligned to the axes of your mount.

- Now press **start measurement**.



After a few seconds, results appear that are continuously updated as time goes on. The deviation is displayed in size and direction. Wait for about 30 seconds until the number gains stability, stop the measurement and correct the azimuth of your mount. If the pole is to the right, your pole block must also be turned to the right, (clockwise, as seen from above).

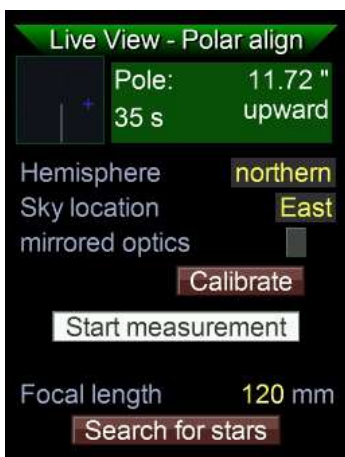
To estimate how much you need to turn your mount, switch to the Imaging page. If the measurement is still running, it will be stopped automatically. If you have a focal length of 180mm, the width of the image is about 1,5 degrees, with 120mm, it is about 2,3 degrees. Move your mount until the stars on the screen have moved the measured distance.

If the correction is done, start another star search on the polar align screen and repeat the procedure to fine tune. With small deviations, there is no need to switch to the Imaging page. Watch the movement here. If the star moves out of the window, do a new star search.

If the measured deviations are fluctuating for a few arc minutes around Zero, the azimuth of your mount is aligned with sufficient accuracy. You may notice some long term variations, these are effects of periodical error and other things. Do not overdo fine tuning, as it is not necessary if you are using an autoguider.

aligning the **polar height**:

- choose a starfield deep in the east or west (near equator if possible)
- set Sky location accordingly
- start a star search
- start the measurement



After some seconds results appear that are continuously updated as time goes on. The deviation is displayed in size and direction. Wait for about 30 seconds until the number gains stability, stop the measurement and correct the polar height of your mount. Pole upwards means, your RA axis needs to be set steeper, away from the horizon.

To estimate how much you need to turn your mount, switch to the Imaging page. If the measurement is still running, it will be stopped automatically. If you have a focal length of 180mm, the width of the image is about 1,5 degrees, with 120mm, it is about 2,3 degrees. Move your mount until the stars on the screen have moved the measured distance.

If the correction is done, start another star search on the polar align screen and repeat the process to fine tune.

If the measured deviations are fluctuating for a few arc minutes around Zero, the polar height of your mount is aligned with sufficient accuracy. Again, do not overdo fine tuning as it is not necessary if you are using an autoguider. With the azimuth and polar height set, your mount is properly aligned.

Note: The precision of polar alignment with an autoguider does not need to be better than 5-10 arc minutes, if the guide star is in the field you are photographing. The guider will correct for residuals effectively enough. Overdoing the fine tuning is a waste of precious time under the sky.



Autoguiding menu and related functions

In this menu section you find functions essential to autoguiding listed in proper succession, and you can set parameters manually. The parameters set here are also used by the one-push process, so you may do some refinements for your particular setup and benefit from using them later during one-push guiding. If you use Star search instead of the one-push function, after completion, the MGEN-3 switches automatically to Star Selection.

Guiding – Selection

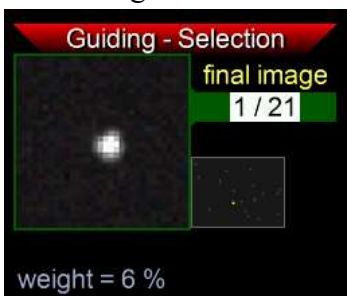
The MGEN-3 measures and weights every star found in Star search, and combines them accordingly into a multistar or master guide star. Stars with a bad signal/noise ratio or very bright stars that would be too dominant are excluded automatically. This auto selection process is quite effective and reliable in most cases.



To provide manual control over this process, there is the possibility to check the found stars one by one and deactivate or reactivate them before they are combined into the multistar. If there are doubtful stars, artifacts or otherwise unwanted stars, they can be rejected. Single problem cases will not noticeably influence the multistar, but here is room to experiment if you wish to.

After Star search, the star selection appears automatically, showing the calculated multistar in the small window, centered in the green circle and cross, and its FWHM is displayed in pixels. The size of the green circle is 4x FWHM. You may also use this window for focusing the guidescope. It can be called up by setting the cursor on **final image** and pressing **SET**.

Note: The auto star search tries to have the multistar within a certain FWHM range. With very short focal length guidescopes it can happen that the FWHM drops below 1.5 pixels. That would start to influence the sub-pixel precision, as fractions can not be measured that precisely. In such cases it is recommended to have the focus of the guidescope a little soft. A value exceeding 3 pixels is considered unnecessarily large, and it is of course a function of the focal length combined with seeing.

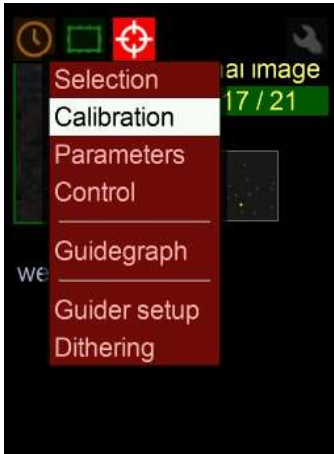


If the cursor is set to the star number and **SET** is pressed, the image of the respective star is displayed (here star 1 from 21), and the weight for its contribution to the multistar. The smaller window shows its position on the sensor.

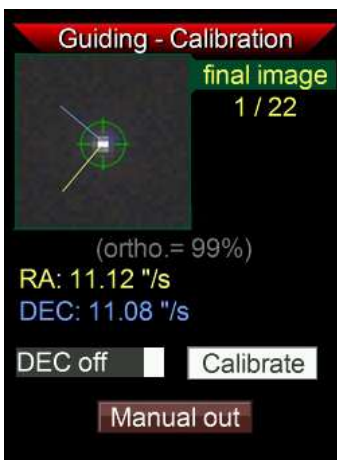


Using the buttons **LEFT** and **RIGHT** the stars can be called up one by one, and deactivated or reactivated by pressing **SET**. A deactivated star is shown against red and is ignored, and its weight is set to 0%.

Guiding – Calibration



During Calibration the MGEN-3 measures the movements of the multistar, and ST4 signals are transmitted to each of the four direction controls. This is to determine the length and direction of the ST4 signals to be sent in order to achieve the necessary correction and restore the multistar to its reference position. Because of the many stars used, the needed calibration movements are shorter and faster than is usually the case. Setting correct values in the Guider Setup menu helps in calibrating quickly and precisely.



Set the cursor on **Calibrate** and start calibration by pressing **SET**. The sequence takes a few seconds and ends displaying some results. First, the orthogonality of the DEC and RA movements, and the respective speed the multistar movements in each axis.

It is good to have a look at these results. They tell you if the mount reacts precisely to the correction signals. The DEC speed is typical for the setup and stays the same everywhere in the whole sky, but the RA speed gets smaller and smaller as you approach the pole (cosinus DEC function). If a speed value looks improbable, check for connectivity. Orthogonality is influenced mostly by random backlash that occurs during the test of the other axis. 80% is already acceptable, but values over 90% would be preferred.

With **DEC off** checked, calibration will not take place in DEC. Important for RA only mounts.

Note: While calibrating, watch the directional buttons. They light up one by one, while the respective ST4 signal is transmitted to the different direction controllers. The sequence of output is DEC ▼, DEC ▲, RA ►, RA ◀. If calibrating in one direction takes unusually long, it is a hint that something is wrong. It could be, for example, a contact problem, or excess backlash in the mount.

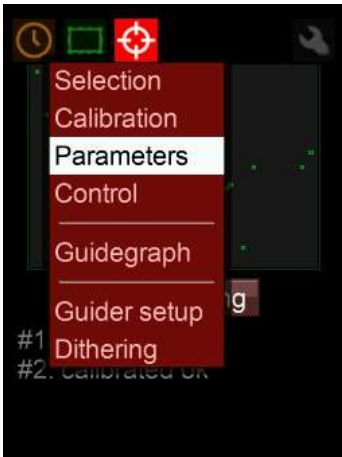


At the bottom of the page there is the **Manual out** button. This is an important tool to check the connection to the mount. Set the cursor and press SET, a box appears telling you to now transmit the ST4 signals by pressing the directional buttons. Check if the multistar moves when you output the signals manually. Exit this mode by pressing **ESC (OK)**.

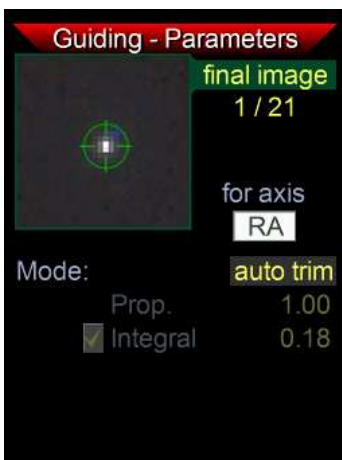
You do not need stars to do this test: In daytime, set your mount to tracking, and enter calibration/manual mode without having a star. Then transmit the signals one by one and listen to the sound of the motors. Listen if anything changes when you press the buttons. It helps to have an ear in contact with the mount's head for this. All four direction commands must respond, otherwise there is a problem.

Note: With mounts that show some backlash, it is not good to balance the scope perfectly, but to try to have a little bias. The weight pulls the tooth of the gear always on the same side of the worm, and backlash is effectively eliminated. Do that with both axes. Especially the DEC tends to start floating randomly if the scope points near the zenith.

Guiding - Parameters



The guiding parameters are values basic to guiding. Measured deviations of the multistar must be converted into correction signals, and how the MGEN-3 does that can be adjusted here. The default values are configured to work well in most situations, but with the MGEN-3 it is also possible to fully control the algorithm manually. The values chosen here apply also in one-push autoguiding.



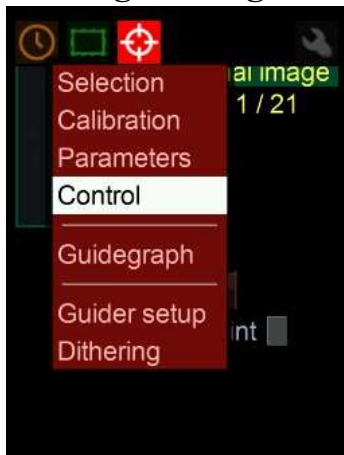
The RA and DEC axis are to be selected separately. First shown here is the **RA** display. Two modes are available, auto trim and manual. With **auto trim**, the self-parameterizing algorithm always seeks to minimize deviations by itself. So the values are grayed out. With **manual**, you can set proportional and integral values. It functions in essence like a PI control loop. Proportional corrects the measured deviation linearly, while integral is a longtime correction supplement derived from internal statistics. The interplay between them is the crucial factor to minimize deviations. Tolerance allows for some deviations before the system reacts and buffers overreaction. For advanced users only!



On the DEC page the standard mode is currently **manual** only. The DEC shows neither periodic error nor overtones, but static drifts or erratic movements. So an integral term does not make much sense. Instead, a value of 0.8 for proportional will suit most situations. In the case of overreaction you may lower this value to avoid oscillation of the mount. The tolerance can be left at 0.00, or increased if corrections in the DEC axis need to be dampened. For advanced users only!

More possibilities like deactivating one guiding direction, and self-optimization here also will soon follow.

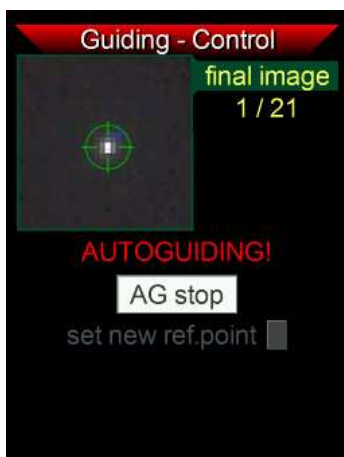
Guiding – Autoguiding Control



The next page is called Control



This is the place to start autoguiding manually (**SET**), or stop autoguiding (again **SET**)

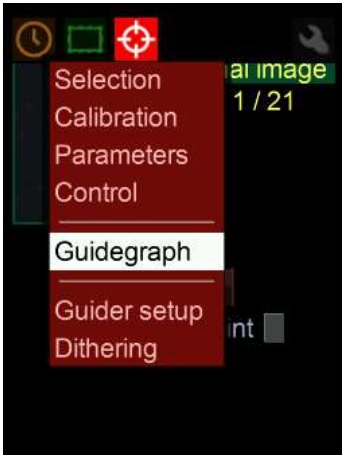


When autoguiding is started, **AUTOGUIDING!** appears and blinks, and a red cross marks the set point where the star should be kept.

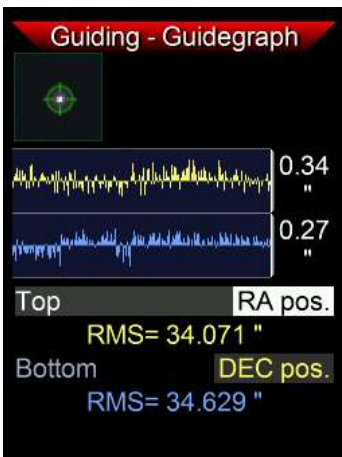
The reference point is used only during dithering. If autoguiding is stopped and the guide star shifted, and the new position will be used as the new reference point, mark the **set new ref. point** checkbox. Otherwise the MGEN-3 will inevitably move the guide star to the old position, if autoguiding is re-started.

When dithering occurs, you see an interesting interplay: The position of the multistar at the start of autoguiding is marked by a blue cross, the new position calculated during dithering will be marked by a red cross, and the multistar (marked by the green circle) is moved there, and autoguiding is then resumed.

Guiding – Guidegraph



Below Control in the menu you find the page to observe the guidegraphs.



By default you see the positions of the multistar displayed, showing the deviations from the zero line. RA is the upper, DEC the lower graph. The graph is updated every guide cycle and shows about the last 220 positions.

To the right of the curves their scale is displayed. It is the size of the vertical white line. The standard deviation rms summarized from the curve is displayed below the curves.

If a measurement is considered to be a bad one, a red line is inserted into the graph, and this position is ignored for guiding. This happens if clouds obscure the stars, or for other reasons.



If the cursor is on **RA pos.**, you may press **SET** and a box pops up. Here you can choose what kind of graph should be displayed – correction means the length of the respective AG signals, and tracking error are the summarized corrections.

These choices can also be made for the lower graph.

The same graph selection will be also displayed at the one-push page, after autoguiding is started.

Guiding – Guider Setup

As already discussed on page 10, the focal length of the guidescope, the autoguiding speed of the mount and the display arc seconds are to be set here.

Dithering 2 – supplement

The basic settings have already been discussed on page 14. Here is some additional information.

Dithering shifts around the guide star in a random way, but not further and further away from the initial position of the first exposure, rather it stays in its vicinity. The size of this area is controlled by the dither diameter (in pixels of the MGEN-3 camera). If it is necessary to choose another position as a reference, go to the Control page and check the **new reference pos.** box. The new positions calculated during dithering will now be spread around the new initial position.



In the box in the upper left there is a graphic display: The previous positions are represented by little red crosses, the actual position by a yellow one, and the next calculated position by a green one. As dithering progresses, a little cloud of red crosses is built up showing the distribution of the points.



Options menu

Adjustments for Display, light and colors, language, SD card, Boot mode for updating the firmware, and switch off the MGEN-3

Options – Display



Backlight of the Display and the button LEDs:

LCD: backlight strength of the display

ESC and SET: active (DSLR exposure signals) and inactive directional buttons: active (ST4 signal output) and inactive



For **ESC** and **SET** buttons, 3 colors can be selected

Options – Colors

Day and night modes can be selected and adjusted in strength

Color filter modes and strength



3 color modes



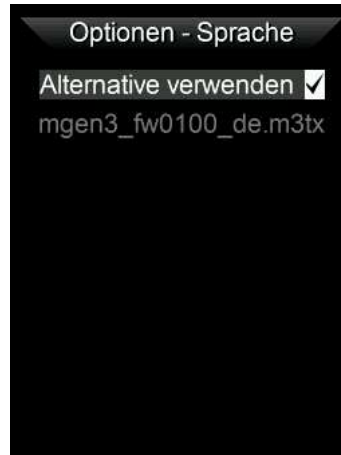
the amber filter mode



Options – Language

The basic menu language of the MGEN-3 is English. Here alternative languages can be selected, if the respective language file (m3tx extension) is found in the “Text” folder on the SD card.

For now English (native) and German is available. Japanese will follow soon. Set the checkmark and the **alternative** language will be used.



There is a special translation app, that allows translating the menu texts into any language and font and save it as a m3tx file. The Text Editor is available on the MGEN-3 support site:

<https://support.mgen-autoguider.com/>

Options – Date and Time



The MGEN-3 has a real-time clock built in, that is powered by an internal battery and continues even after shutting down.

Format is YYYY MM DD

If needed, you can set the time here.

Options – System

Some information is shown here, and the managing of the SD card.

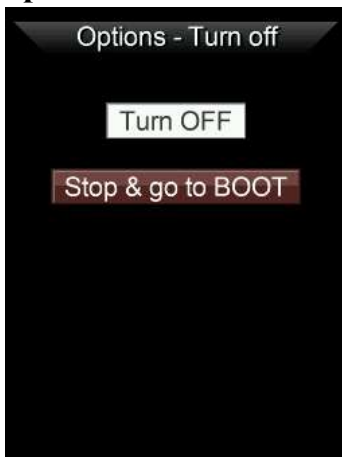


The ID number you need to register your MGEN-3 on the support site.
The version number of the currently installed firmware.

Information about the SD card status (ready, no card, unformatted).
Formatting the SD card will also generate the folders needed for the Guide log, Darkframe and language file. Up to 32GB cards are supported. The guide log will be written while the MGEN-3 is autoguiding, and the file is saved into the Log folder on the SD card. Currently it is only possible to access the SD card on a PC.

Factory reset will set all values to default. Use it if you get lost by unknown manual adjustments. Useful e.g. for Clubs where members often set special values and just leave them active.

Options – Turn off / Boot



Here is the switch to properly turn off the MGEN-3.

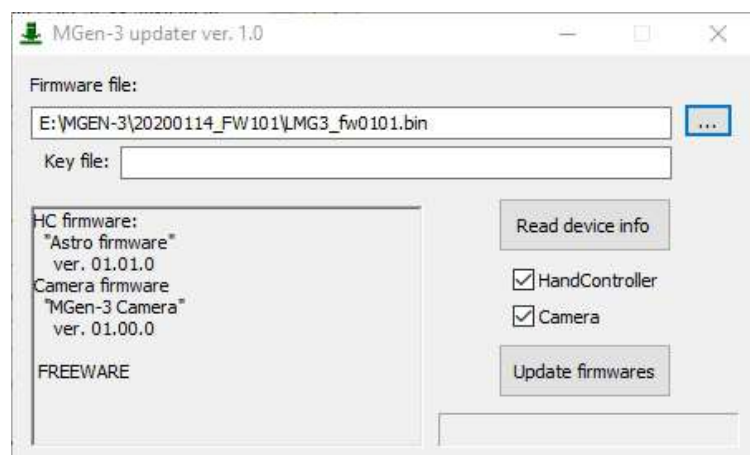
It is important to shut down all processes, and close + save the Guide log file on the SD card. Without proper shutdown, the Guide log file will not be written properly and may be inaccessible.

The Boot mode, which is important for installing new MGEN-3 firmware files, can be called up here.



Firmware update – check MGEN-3's support site for updates!
<https://support.mgen-autoguider.com/>

Enter Boot mode to have the MGEN-3 ready for loading new firmware. The camera must be connected and updated as well. Start the update using the Updater App found at the support site. Use keyfile when asked for. After updating, you may start the new firmware or turn the MGEN-3 off from here.



MGEN-3 technical details

The Hand Controller

The handbox itself is a special platform running a custom OS on microcontroller level, and is kept simple for reliability. The Firmware on the HC is upgradeable.

The HC consists of the following components:

- Powerful 32-bit CPU with 64MB of RAM
- big, color LCD display
- six back-lit control buttons
- one USB device interface to allow control by a PC
- one USB 2.0 host interface for the Camera
- one MicroSD card slot
- one WiFi 802.11 b/g/n module embedded
- ST-4 output port (optocoupled)
- exposure (DSLR) control output port (optocoupled) auxiliary low speed I/O or communication port (optocoupled)
- real-time clock with battery

The HC is powered through the USB device interface (USB B mini 5-pin type connector).

the Camera

The Camera is a special type of raw USB 2.0 Camera designed to be used with the MGEN-3 HC. The shape enables use in any optical system and the backfocus is purposely kept very short. The aluminum case acts as a passive cooling element, conducting heat directly off of the image sensor and from other internal parts.

Firmware releases for the MGEN-3 also contain the required Firmware versions for this Camera.

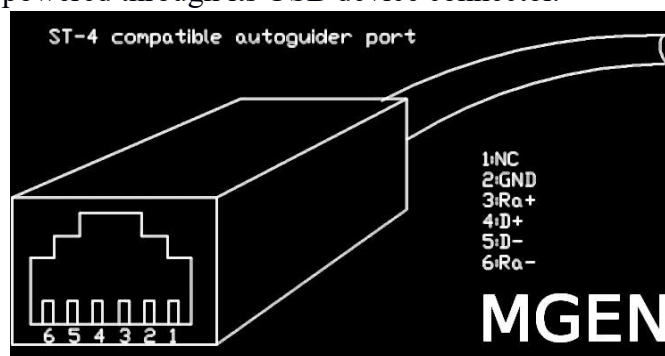
Special features of the Camera:

- raw 12-bit image
- well buffered data transfer to avoid bad/missing frames
- optical dark pixel area allows the use of optimized dark correction
- (multi-crop image transfer for high-speed, multi-zone imaging)

The image sensor used in the Camera is the monochrome version of the AR0130CS:

- 3.75 μm pixel size
- 1288 x 968 active pixel area (4.8 x 3.6 mm)
- Quantum Efficiency is almost 80% near 570 nm
- typical read noise is 4 e- at max. gain

The Camera is powered through its USB device connector.



Change log for FW 1.01

- some bug fixes (guide log written now)
- DEC off added at calibration
- at startup, the cursor is set to “Start guiding”

Hints to a successful Guiding

We know from experience about some of the more frequent guiding problems. Here are a few hints to get things right:

- unbalancing the mount. With mounts that show some backlash, there is a gap between the gear and the worm. To avoid having the mount “floating” in that gap apply a healthy dose of unbalance. On the RA its easy to shift the counterweight, so you have more weight toward the east (preferably, the worm should push the gear). But it is even more important in DEC, as there is no constant pushing movement and the directions may change. Place a small weight in a place so that the DEC axis is always pulled toward one side, e.g. in the direction of the knobs of the tube rings.
- Mounting the guidescope: Make sure there is direct and firm contact with the telescope, i.e. clamp it strongly in the finder shoe. Mounting it on the tube rings could be a problem, as there usually is flexible material inside the rings. It could lead to a shift between guider and main camera.
- Fix your cables: While tracking across the sky, the cables are moving and can become taught, and wind gusts may rattle them.
- Starfield of the guidescope: The guidescope should be parallel to your main optics, so the starfield it “sees” is in the same position that your main camera sees. That helps avoiding field rotation by rough north alignment.
- If guiding is strange or your mount does not react as expected, read the calibration chapter. There you will find important hints to pinpoint the problem.
- Near the celestial pole, guiding gets increasingly difficult as the real movement of the RA axis is very small next to the poles (cosinus DEC function). For guiding near the pole, as an exception it is advisable to point the guidescope a little bit away toward the equator. Do not test guiding near the Polestar, choose a star field near the celestial equator!

This manual will be extended and updated.

We wish you success and happy tracking with the MGEN-3, and clear skies!
Your Lacerta Team

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