INSTRUCTION MANUAL

Orion® StarShoot™ Mini G Series CMOS Cameras

#51883 Mini 6.3 Color
#51884 Mini 6.3 Mono
#51359 Mini 1.2mp Color
#54292 Mini 2mp Mono Autoguider

#51883

Welcome to the exciting world of astro-imaging. Your new StarShoot™ Mini CMOS Imaging Camera is capable of capturing professional quality astro-images of many of your favorite celestial objects, or be used as an autoguider to accurately lock onto stars and improve the tracking performance of your mount during a long exposure photograph with another camera. Please read this instruction manual before attempting to use the camera or install the needed software. This manual covers installation of your camera along with basic functions of acquiring images using the included software, as well as autoguiding using PHD2. To get the most out of your camera using 3rd party dedicated astronomy apps coupled with the universal ASCOM driver for the G Series Camera, please consult the software help files and manuals included with the individual software packages available on the market. Some of our favorite programs are mentioned below.

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A N   E M P L O Y E E - O W N E D   C O M P A N Y

1. The StarShoot Mini CMOS camera

The StarShoot Mini cameras are lower cost alternatives to the larger StarShoot G10 and above cameras. They are not cooled which means that while the inherent noise will be a small bit higher, the size, cost, and power requirements are considerably reduced. The StarShoot Mini 6.3mp cameras are based around the Sony IMX 178 CMOS chip, and excel at planetary imaging because of the super-fast USB 3.0 port frame rates and the tiny 2.4 micron pixels. The StarShoot 2mp Mono Autoguider includes the Sony IMX 290 sensor, as well as a USB 2.0 port. In addition, they are capable of deepsky imaging with exposures up to 1000 seconds. They also feature a standard SBIG autoguider port, so they can be used as a very sensitive autoguider while imaging through a separate camera. For the most sensitive guiding, the Mini 2.0mp or the mono version of the 6.3mp is recommended. Autoguiding can be done with the SS 6.3mp Color version, but sensitivity is always higher with a mono sensor. The Mini cameras are powered fully via the USB port on your computer. No separate power source is necessary.

Figure 1. The back panel of the StarShoot Mini 6.3mp camera. Note the 2mp Autoguider includes a USB 2.0 port

Figure 2. The included parts of the StarShoot Mini.

Parts List
- StarShoot Mini camera
- 1.25" nosepiece
- USB cable
- SBIG guide cable

Telescope
The StarShoot Mini can be used with most all telescopes on the market. The Mini cameras slip into a 1.25" focuser, or can thread directly to male c-mount threads. Caution: Be sure to always firmly tighten the thumbscrew(s) that secure the camera in the telescope focuser, or it could fall out and onto the ground! The camera comes with a 1.25" c-mount threaded nosepiece (**Figure 2**) which should be used when slipping the camera into a 1.25" focuser (or 2" focuser with a 1.25" stepdown adapter). To utilize the c-mount threads, do not use the 1.25" nosepiece, and thread the camera directly onto the c-mount threads.

Back-focus Requirement
The StarShoot mini cameras feature a backfocus of 17.5mm from the front c-mount threads. This means that when threaded onto a c-mount device, the sensor sits 17.5mm back from that threaded connection. However, when slipped all the way into a 1.25" focuser instead of using the threads, the sensor sits 10.5mm IN FRONT of the lip where the 1.25" diameter section of the camera ends. So slipping into a 1.25" focuser means the camera has a 10.5mm FORWARD focus requirement. This information may be useful when determining rough focus positions for different camera/telescope configurations.

2. Software and Hardware Installation

The software and driver must first be downloaded from the Orion website before plugging in the camera. Please go to: www.telescope.com/Gseries to download all the relevant software for your camera. Downloadable files include:

- **StarShoot Image Capture:** basic camera control program
- G series direct driver: for DirectShow applications
- G series ASCOM driver: for camera control in 3rd part astroimaging software.

Note it is HIGHLY recommended to install the ASCOM platform and download the G series ASCOM driver to use with the camera. Dedicated 3rd party camera control programs are available online which will unlock the full astro-imaging potential of the camera. To install the ASCOM platform, visit www.ascom-standards.org and click the download button. Don't forget to also install the G series ASCOM driver from Orion's website **AFTER** you install the main ASCOM platform. When connecting to the camera in a 3rd party program using ASCOM, choose "ASCOM StarShootG camera" from the camera selection menu, and then the camera should appear in the ASCOM camera selection window if the driver is properly installed and the camera connected. Note the same driver for all the Orion StarShoot Blue series cameras is the same, and you may have multiple cameras listed if you also have a larger

cooled StarShoot G series camera connected at the same time. Be sure to connect to the appropriate camera in your software.

1. Download all relevant files from the Camera support/ download page

2. Double-click on the install .exe for the Image Capture program, the driver, and the ASCOM driver, and follow the onscreen directions for installation. Do not plug the camera in until the drivers have been installed for the camera

3. Once the driver and software has been installed, plug the camera into an available USB port

4. Windows will take a moment to recognize the USB device plugged in, and once that is complete, you can open up the StarShoot Image Capture program to connect to the camera

Hardware setup

Now that the camera drivers and software are installed, it's time to connect the camera to the telescope, and open up the software. Install the camera into your focuser and connect the USB cable from the camera to an available USB port on the computer. The StarShoot 6.3mp works best when plugged into a USB 3.0 port, as the frame rate will be much higher. It will still work in a USB 2.0 port, but with a reduced framerate.

Focusing the camera for the first time can be tricky, since the camera may focus at a completely different place from where an eyepiece focuses. It is recommended that you first center a bright star in a 25mm eyepiece before attaching the camera, to be sure the camera is centered on the star. Even very far out of focus, you should be able to see a fat disk (the out-of-focus star), to determine which way to turn the focus knob to bring the star down to a focused point.

Software

The next section will document connecting to the camera and basic image downloads. The included software will run the basic astro-imaging steps including image download, exposure controls and such, but please note that this software only touches on the basic functions of acquiring astro images. To get the best results with more advanced processes such as stacking multiple long exposures together to reduce noise, manual dark frame subtractions, flat field and dark frame stacking for smoother calibration frames, and other processes, it is HIGHLY recommended to control the camera with an ASCOM compatible capture program. Some are free on the web, others are paid, but there is a vast array of programs available that will be compatible with the camera. Here are some of our favorites:

DeepSkyStacker: *http://deepskystacker.free.fr/* - Excellent free program for pre-processing that simplifies the alignment and stacking of your images. Automatically monitors a directory where images are saved, and processes on the fly. Add all the calibration frames, including darks, flats, biases, and step back while the software does the rest giving you output ready for post processing in programs such as PhotoShop.

RegiStax: *www.astronomie.be/registax/* - Excellent free program for aligning, stacking and processing of AVI video files, ideal for capturing lunar and planetary video, splitting the video into individual frames, analyzing each frame and aligning/stacking/ processing the best ones for pulling out fine details.

SharpCap: *sharpcap.co.uk* – Free camera control and capture program. Features include video and long exposure control, flat field and dark frame subtractions, histogram control, excellent focus assist routines including Bahtinov mask overlays and FWHM measurements, and MUCH more!

Sequence Generator Pro: *mainsequencesoftware.com* – free 45 day trial. Excellent Image Capture suite to control all aspects of your setup. Create sequences of exposures of different lengths, control a Go-To mount for automatic pointing and auto-centering in any part of the image, auto v-curve focusing with a compatible electronic focuser (without having to re-center to a target star), autoguider control, and a host of other features.

Nebulosity: *stark-labs.com* – free demo available to try. Powerful, yet very easy to use image capture and processing program. Excellent processing routines such as aligning/stacking and dark/ flat/bias handling. An excellent choice for the beginning astro-photographer getting into processing, yet will carry over for more advanced users as well.

N.I.N.A: *https://nighttime-imaging.eu/* – free open source image capture suite designed to control all aspects of your setup. Very customizable, and with very frequent update cycles which bring new features to the platform.

PHD2 Guiding: *openphdguiding.org* – The gold standard open source (and free!) software for using your StarShoot Mini as an autoguider. Built in wizards to fine tune the guiding, and now with the ability to guide on multiple stars in the image.

Note: if you wish to skip using StarShoot Image capture, and only use your camera as an autoguider, review the following sections for focus, but skip forward to the Autoguiding section for more details.

3. Orion StarShoot Image Capture

Plug the camera into a free USB port in your computer. When you open Orion Starshoot Image Capture, you'll be presented with the main preview window on the right, and the control options on the left-hand side. (**Figure 3a**). On the top of the left-hand side, click the camera name to start a video preview (**Figure 3b**). Scrolling down the left-hand side, you'll find all the controls for operating the camera. The primary window to control the exposure and to use first is the Capture and Resolution window (**Figure 4**). In this window, you can set either video or still image mode (trigger mode), as well as set the resolution and gain of the camera and set single, looping, or sequence shots to be saved automatically in a chosen directory.

Scrolling down further along the left side, you'll find windows for other camera attributes including bit depth (always choose the highest bit depth to get the most detail and quality out of the image), binning control (1x1 is full camera resolution) and histogram. There are other windows present, but the ones listed above are the most important ones when taking your first image.
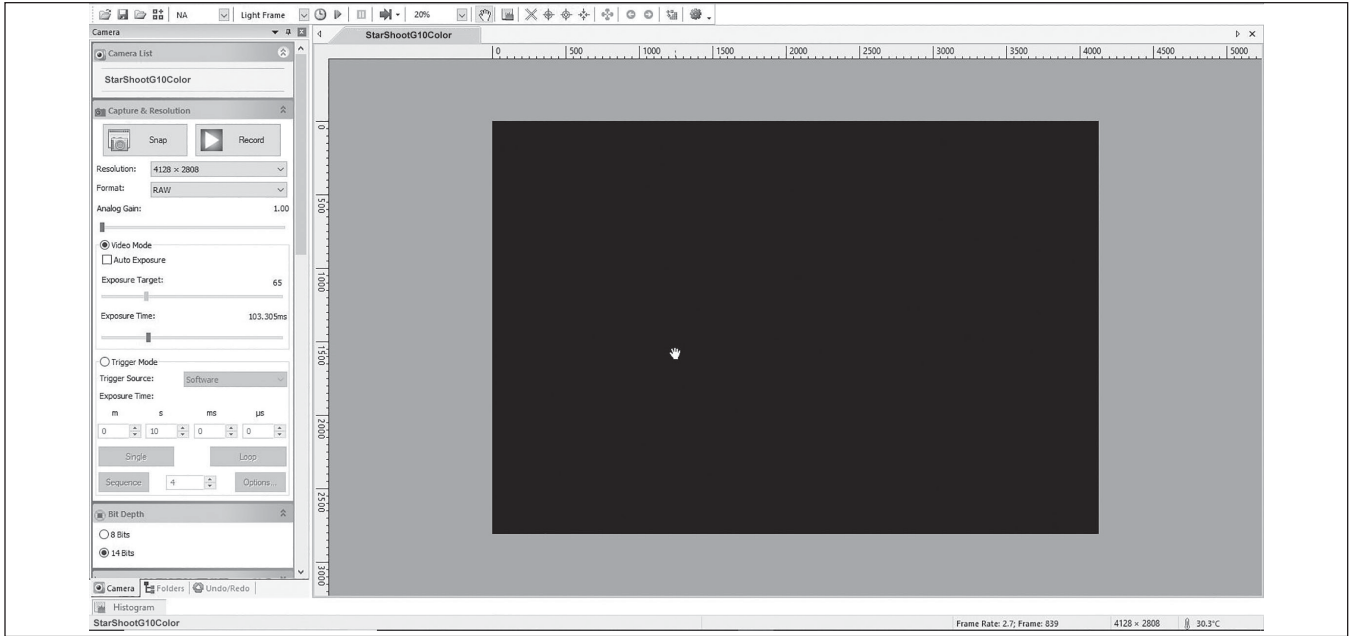
Figure 3a. Primary software screen.
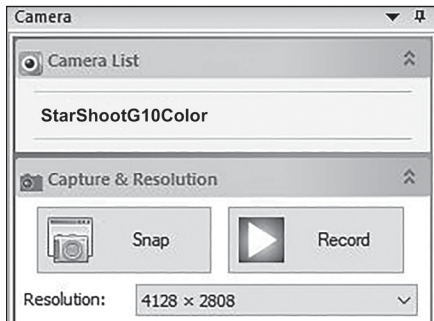
Figure 3b. Camera model – click this text to connect to the camera and start the preview.
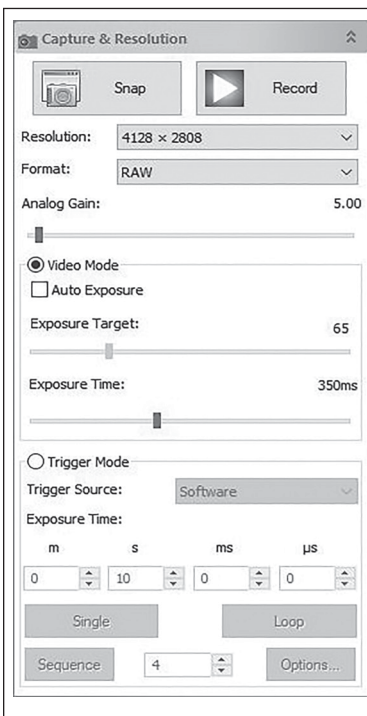
Figure 4. The Capture and Resolution window pane.

Some windows are not applicable to astro-imaging, and can be shut off by going into the Options>preferences menu.

To take your first image, focus must be achieved. With a CMOS camera, one of the quickest and easiest ways to focus is to point the camera at a bright star, and choose a fast video frame rate with higher gain settings so you can watch the star in real time, and focus until the star becomes a point.

Focusing

1. Make sure the camera is in preview mode – if not, click the camera name in the top left window, to turn on streaming preview mode.

2. In the Capture and Resolution window **(Figure 4)**, set the resolution to full, the gain to somewhere in the middle of the slider, and the exposure to video mode with "auto exposure" unchecked, and an exposure time to somewhere around 200-500 milliseconds. This should provide you with several frames per second, enough to see a real time focus preview.

3. This should be good enough to see a bright star like Vega, provided it's in the field of view, and relatively close to focus. If you see nothing, but are sure the star is in the center of the field, adjust your focus in and out because a very out of focus star will spread out and become quite dim.

4. Once you acquire the star, center it, and focus until it looks like a tiny point. At this point you are probably over exposing the star, and can back off on the exposure time and gain settings. If the star is in the middle of the field, you can also reduce the resolution setting on the chip, in order to speed up the frame rate, to get a super responsive live focus. Readjust focus until the star is as tiny as possible. At this point, everything including the moon and a distant galaxy will be in focus.

5. If you wish to fine tune the focus further, a Bahtinov mask is an ideal method of focusing with Orion StarShoot Capture, as it is quite an accurate method using medium brightness stars. Contact Orion or search for Bahtinov mask on *www.telescope.com* for more details, and to purchase a Bahtinov mask for your specific telescope.

Your First Lunar/Planetary Image

The moon is perhaps the easiest object to get your first image, as it is very bright, and easy to find. Planets are also easier than nebulae to capture, since you'll be streaming a video file, and can use programs such as Registax to process the video file.

1. Go to the Options menu, click preferences, and under the Record heading, choose a directory location for your saved files, naming convention of your choice, and make sure the file type is set to AVI.

2. In the Capture and Resolution window pane, check Video Mode, uncheck auto exposure, and use the Exposure Time slider to find an exposure that looks good. Planets do well with lots of short exposures, so if the exposure time is too long, experiment with raising the gain, and lowering the exposure value.

3. When ready to record, press the record button and press it again when your video is the desired length. In the Options menu, under Record preferences, you can set limits to time of the video, as well as number of frames.

4. You can then load your AVI file into a 3rd party program such as RegiStax, in order to process the lunar or planetary details present in the video file.

Auto Exposure can be used if desired, but manually adjusting the exposure values provides the best control over the image. Check the "Auto Exposure box, and drag the box over an area you wish the system to measure. You can resize the box accordingly. Then set the Exposure Target, and the system will try to keep the exposure close to that target exposure value by adjusting the exposure time automatically.

Imaging with a Mono camera

One shot color cameras are relatively easy to get a final image from because there is less processing involved. But color chip cameras suffer from less sensitivity to light than a monochrome camera does. The reason is due to the Bayer Matrix over the chip. The pixels are arranged in squares of alternating colors (for example -- an RGGB arrangement in the SS 6.3mp Color). This means that for every four pixels in a square, only one of them is sensitive to red light, and only one to blue. But in a monochrome chip, every pixel sees ALL of the photons of light across the visible spectrum. The result is a much more sensitive chip. This is much more versatile, because you can put any kind of filter in front of the camera, depending on the wavelength of light you want to capture. You may also wish to consider a filter wheel to simplify the process of switching filters between exposures.

Conversion Gain

Along the left hand pane is a window for conversion gain, and options (if your specific camera supports both options) for LCG and HCG -- low and high options. LCG provides the largest dynamic range in your images at the expense of a bit more noise. HCG can lower the noise at the expense of compressing the dynamic range. When in doubt, start in LCG mode, and your images will turn out fine. But if you are autoguiding, and do not care about lower dynamic range, switching to HCG and raising the gain a few points will help pull out some fainter guide stars from the background noise. The ASCOM driver also includes LCG/HCG settings when in 3rd party control programs

ASCOM Driver

The ASCOM driver allows the camera to be used with any of the programs listed above, along with any others that support ASCOM cameras. Please download the ASCOM platform from **ascom-standards.org** first and then make sure to install the camera ASCOM driver from Orion's website. When in 3rd party camera control programs, the camera gain settings can be controlled in the ASCOM setting window for the camera. Open the ASCOM camera settings, adjust the gain, and experiment with exposures as detailed above. One last thing to note, some programs may use a percentage for gain, others may use the actual gain numbers. If the gain range is 0-100, it's using a percentage of total gain.

4. Using the SS Mini as an Autoguider

The StarShoot Mini cameras have the ability to act as an autoguider to correct for small imperfections in the mount's tracking quality. These imperfections can arise from various sources including periodic error due to the nature of the gearing, and poor polar alignment which causes a slow drift of the image. Autoguiding is essential for any long exposure image of the sky, especially at longer focal lengths.

Mount

An equatorial mount with dual axis motors and an RJ-12 autoguide port is required. Just about any equatorial mount equipped with an autoguide port will work with the StarShoot Mini. The Mini is "ST-4" compatible which uses the same pin out configuration as the first generation CCD autoguiders. Most computerized goto mounts also have this autoguide port. For short exposure deep space photography (typically 45 seconds or less) the StarShoot Mini can successfully guide with a computerized altitude-azimuth or fork mounted telescope (as long as it includes an autoguide port), popular among computerized Schmidt-Cassegrain telescopes.

However, guided exposures longer than one minute in an altitude-azimuth mount will cause field rotation to occur in the image, so an EQ mount is recommended instead.

PHD2 Guiding Software

The SS Mini along with the use of PHD2 Guiding (Push Here Dummy) software makes the task of autoguiding simple and easy to setup. The latest version of PHD2 can be found at:

https://openphdguiding.org/

Also, before setting up the StarShoot Mini as an Autoguider, make sure you have downloaded and installed the ASCOM Platform (located at **ascom-standards.org**), followed by the StarShoot ASCOM driver (available on the Orion support page for your camera). PLEASE make sure to install the ASCOM platform BEFORE you install the ASCOM camera driver, otherwise Windows will return an error because it cannot find the proper ASCOM directories to install this driver.

The calibration and guiding is automatic once you initially find and focus a guide star. Your telescope must first be prepared for astro-imaging. Make sure your mount is polar aligned well. Your guide scope should be securely attached to your main imaging scope; or if you are using a Schmidt-Cassegrain, the off-axis guider and main camera should already be attached to the telescope.

PHD2 Settings

PHD2 has a detailed help file, a setup wizard, and a very active online forum. But a few initial settings will help get the StarShoot Mini up and running quickly as a guider. First connect the StarShoot Mini to your guidescope (see below for some sample connection types), attaching the USB cable between the camera and the computer. Then connect the ST-4 phone cable between the camera and the autoguider port on your mount. You are now

Figure 5. The USB and autoguide ports of the StarShoot Mini Autoguider.

ready to connect to the system in PHD2:

1. Click the 'Connect Equipment' button in PHD2 to bring up the Camera and mount selection dialog box (**Figure 6**). For 'Camera' choose 'ASCOM StarShootG Camera Driver' from the pulldown list, and for Mount, choose 'On Camera'. It is important to pick this selection as this is what allows guiding corrections via the ST-4 cable from the autoguider to the mount. Optionally, if you also have your mount connected via USB to the computer via an ASCOM driver, you can choose the ASCOM mount driver under the 'Aux mount' selection to provide PHD2 with pointing data from your mount (this can be helpful when moving to different objects so you do not have to redo the guide calibration routine.

2. Click the little toolbox button next to the Connect button to bring up the ASCOM properties for your camera (**Figure 7**). Make sure in this window you are choosing the correct

camera (if you have two Orion cameras attached, one to guide and one to image with, both may show up in this list – make sure you have selected the autoguider). Choose the highest bit depth, and Gain can also be adjusted, but it is recommended to keep it between 0-10. Click 'ok' to go back to the Equipment chooser, and then click 'Connect All'

3. Choose an exposure time (usually 2-4 seconds is appropriate) and then click 'Begin Looping Exposures' to fine tune the focus and choose a guiding star. You can also adjust the Screen Gamma slider to show fainter background stars.

4. Refer to the PHD2 instructions for detailed setup and use of the program.

### Attaching the SS Mini to guidescopes.

The StarShoot Mini features a 1.25" nosepiece to allow it to attach to most all focusers. In addition, there is a female C-mount cut into the front housing for direct thread-on connections. The imaging sensor is approximately 17.5mm behind the front C-mount threads, and 10.5mm in front of the back lip of the 1.25" section of the body.

To attach the SS Mini to the #52053 Orion 30mm Ultra-Mini Guide Scope, remove the thin black 5mm CS mount ring spacer from the 30mm guidescope, and thread the SS Mini directly to the C-mount threads. Pre-focus the 30mm until there is a gap of approximately 2mm in the focus threads, and the camera will be very close to focus (**Figure 8**).

To attach the SS Mini to the #13008 60mm Multi Use Guidescope, first install the 1.25" nosepiece on the end of the camera's C-mount threads. Extend the Guidescope's drawtube out to its full length (~35 on the laser engraved drawtube scale) and then insert the camera with approximately 6mm (0.25") of the camera's 1.25" body sticking out of the focuser (**Figure 9**). It is ok to not bottom out the camera when inserting into a focuser – the setscrews on the guidescope will securely hold the camera in place. Fine tune the focus with the helical section to achieve precise focus, sliding the camera in and out of the focuser slightly if extra travel is necessary.
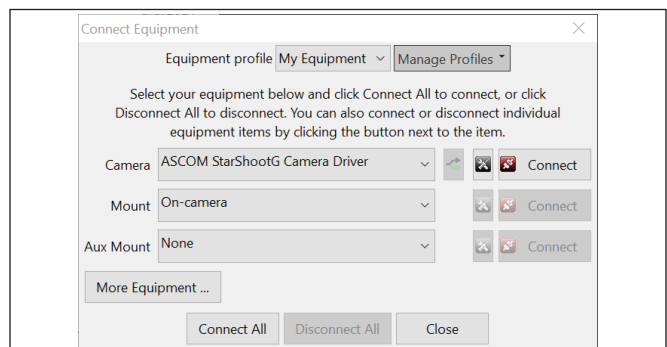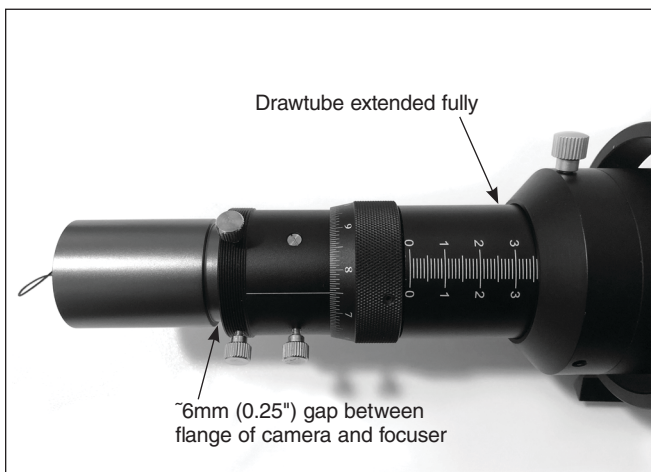

Figure 6. The Connect Equipment window.
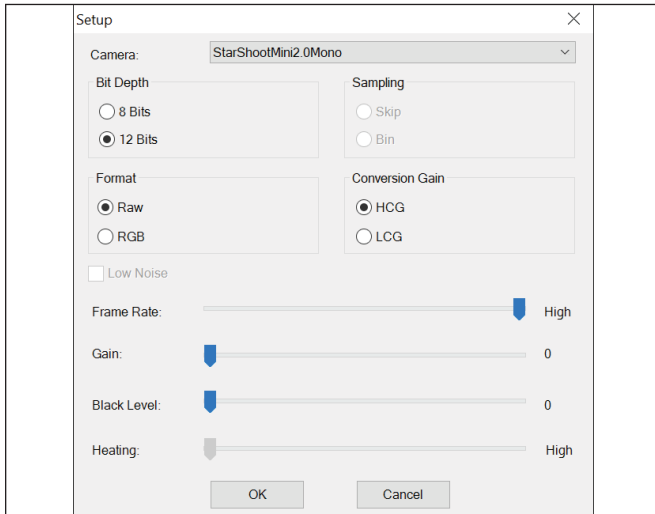
Figure 7. The ASCOM camera setup window.
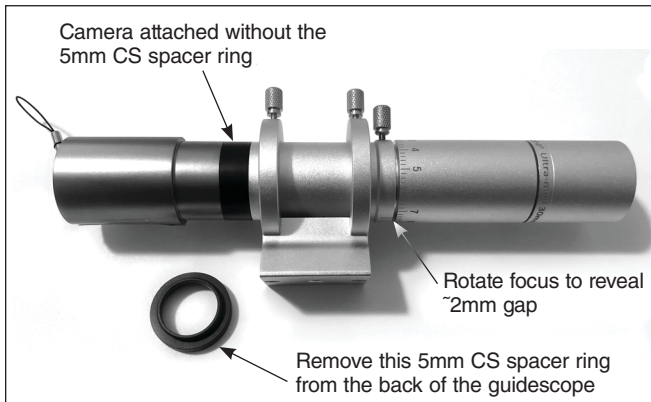
Figure 8. Rough focus position for the 30mm Ultra Mini Guidescope.

Figure 9. Rough focus position for the 60mm Multi Use Guidescope.

Specifications

StarShoot Mini 6.3mp cameras

Sensor:	IMX 178 (Color and Mono)
Resolution:	Up to 3040 x 2048
Pixel Size:	2.4 microns
Diagonal Size of chip:	8.86 mm
Bayer Matrix Pattern:	RGGB arrangement
Exposure Range:	0.244ms – 1000s
Partial frame download:	Region of interest and Sub-frame download supported
Binning:	1x1, 2x2
ADC:	14 bit
QE peak:	78%
Read Noise:	1.4e – 2.2e (depending on gain setting)
Interface:	USB3.0
Front Nosepiece threads:	C-mount
CMOS chip window:	IR blocking 380-690nm bandpass (Color version), AR coated, non IR blocking, 350-1050nm bandpass (Mono version).
Dimension:	72.4mm x 37mm
Weight:	61g
Camera power:	DC 5v from PC USB port

StarShoot Mini 2.0mp Mono Autoguider

Sensor:	IMX 290 (Mono)
Resolution:	1920 x 1080
Pixel Size:	2.9 microns
Diagonal Size of chip:	6.4 mm
Exposure Range:	0.105ms – 1000s
Partial frame download:	Region of interest and Sub-frame download supported
Binning:	Hardware: 1x1
ADC:	12 bit
QE peak:	80%
Interface:	USB2.0
Front Nosepiece threads:	C-mount
CMOS chip window:	AR coated, non IR blocking, 400-1050nm bandpass
Dimension:	72.4mm x 37mm
Weight:	68g
Camera power:	DC 5v from PC USB port

StarShoot Mini 1.2mp Camera

Sensor:	IMX 225 (C)
Resolution:	1280 x 960
Pixel Size:	3.75 microns
Diagonal Size of chip:	6 mm
Bayer Matrix pattern	RGGB arrangement
Exposure Range:	0.135ms – 1000s
Partial frame download:	Region of interest and Sub-frame download supported
Binning:	1x1, 2x2
ADC:	12 bit
QE peak:	TBD
Interface:	USB2.0
Front Nosepiece threads:	C-mount
CMOS chip window:	AR coated, non IR blocking, 400-1000nm bandpass
Dimension:	67mm x 37mm
Weight:	66g
Camera power:	DC 5v from USB port

One-Year Limited Warranty

This Orion product is warranted against defects in materials or workmanship for a period of one year from the date of purchase. This warranty is for the benefit of the original retail purchaser only. During this warranty period Orion Telescopes & Binoculars will repair or replace, at Orion's option, any warranted instrument that proves to be defective, provided it is returned postage paid. Proof of purchase (such as a copy of the original receipt) is required. This warranty is only valid in the country of purchase.

This warranty does not apply if, in Orion's judgment, the instrument has been abused, mishandled, or modified, nor does it apply to normal wear and tear. This warranty gives you specific legal rights. It is not intended to remove or restrict your other legal rights under applicable local consumer law; your state or national statutory consumer rights governing the sale of consumer goods remain fully applicable.

For further warranty information, please visit www.OrionTelescopes.com/warranty.