

# INSTRUCTION MANUAL

## Orion® StarShoot™ AutoGuider

#52064



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Welcome to a world of astro-imaging with trouble-free automatic guiding! Your StarShoot AutoGuider (SSAG) automatically fixes on a star and sends tracking corrections to your mount to enable perfectly round stars in your astro-images. Autoguiding is an immense help for your astro-imaging productivity. The SSAG enables your telescope to precisely track the apparent movement of the night sky without the need for you to monitor your telescope setup every second. The tracking corrections made by the SSAG will compensate for mechanical imperfections inherent in all telescope mounts. This essential astro-imaging tool allows you to relax under the stars while your telescope tracks and takes images.

## Parts List

- StarShoot AutoGuider
- 10' USB Cable
- 6' autoguide interface cable
- CD-ROM

## System Requirements

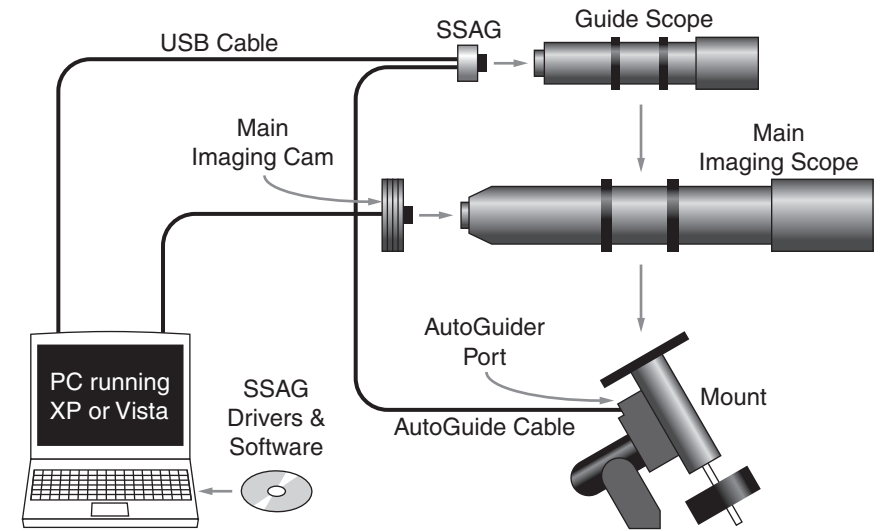
### [Quick setup diagram (Figure 1a & 1b)]

#### Primary Telescope/Main Imaging Scope

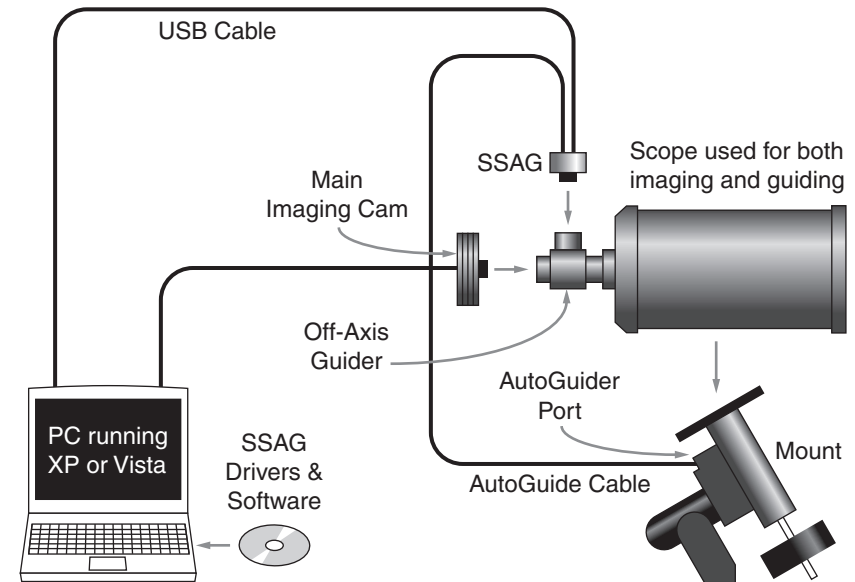
Your main imaging scope will be used with your main astro-imaging camera. The main imaging scope can be virtually any scope suitable for your CCD or DSLR camera.

#### Guide Scope

You will need an additional telescope for guiding, referred to as a guide scope. The guide scope is mounted on top of, or beside the main imaging scope. Adjustable guide scope tube rings (available from Orion) are recommended and allow you to move the guide scope around without moving the main imaging scope (Figure 2). The guide scope is adjusted in the same fashion as a finder scope.



**Figure 1a.** A traditional imaging setup contains a main imaging scope and separate guide scope. The SSAG interfaces with your computer via the USB cable, and connects to your mount's autoguide port via the autoguide cable.



**Figure 1b.** Cassegrain style telescopes can be used with an off-axis guider. This allows both the main imaging camera and autoguiding to use the same telescope.



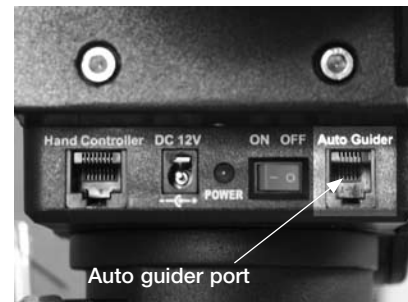
**Figure 2.** Adjustable guide scope tube rings allow you to adjust the position of the guide scope without moving the main imaging scope.

Because of the high resolution and accuracy of the SSAG, you do not need a large guide scope; any small refractor will serve well for this purpose. Separate refractor optical tube assemblies, such as the Orion Short Tube 80, make excellent guide scopes.

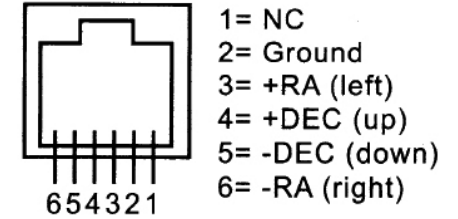
The only exception to using a guide scope is to use an off-axis guider, which is typically made for Schmidt-Cassegrain telescopes (Figure 1b). The off-axis guider uses a prism to intercept a small portion of the light path in front of the camera, thus allowing the camera and guider to use the same telescope. Off-axis guiders require a large amount of inward focus travel which is why they are generally only suitable for Schmidt-Cassegrain telescopes.

### Mount

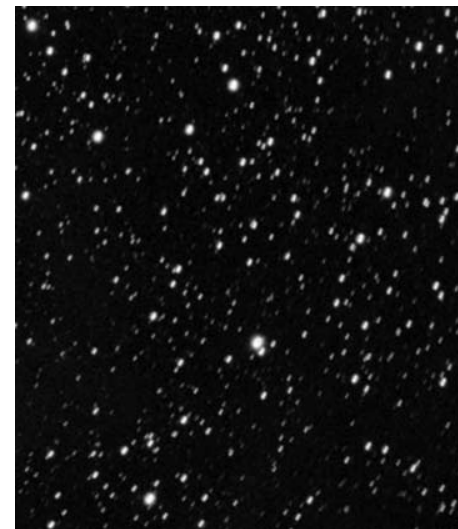
An equatorial mount with dual axis motors and a RJ-12 autoguide port is required. Just about any equatorial mount equipped with an autoguide port will work with the SSAG (Figure 3a). The SSAG is "ST-4" compatible which uses the same pin out configuration as the first generation CCD autoguiders (Figure 3b). Most computerized goto mounts also have this autoguide port. For short exposure deep space photography (typically 45 seconds or less) the SSAG can successfully guide with a computerized altitude-azimuth or fork mounted telescope, 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 (Figure 4). An equatorial mount will yield the best overall performance for guided deep space astrophotography.



**Figure 3a.** The SSAG works with any mount equipped with an ST-4 compatible autoguide port, shown here on the Sirius EQ-G mount.



**Figure 3b.** This is the pin diagram for the SSAG and ST-4 compatible mounts.



**Figure 4.** Field Rotation occurs in long exposure images taken with an altitude-azimuth mount or poorly polar aligned equatorial mount.

### Computer

The SSAG requires a PC running Windows XP or Vista. For astro-imaging in the field at night, a laptop computer is highly recommended.

The computer hardware should have at least the following:

- Pentium™ Processor
- 128MB RAM
- Disk Space – 50MB, 100MB or more is recommended
- Video Display – 800 X 600, 16-bit color or higher, 1024 x 768 or higher is recommended
- Mouse
- USB High Speed 2.0 port

## Software and Driver Installation

Before the camera can be used, software and camera drivers must be installed onto your computer. Turn on your computer and allow the Windows operating system to load as normal. Insert the included CD-ROM into your computer's CD-ROM drive, and the Launcher will appear (Figure 5). This allows you to install the PHD Guiding software. Do not connect the camera to your computer before you have installed the software.



**Figure 5.** The launcher offers an easy way to start installing the camera and software.

### Software Installation

1. Insert the CD-ROM and wait for the **Launcher** window to appear. If you are using Windows Vista, the **AutoPlay** window will appear first, then select **Run Opener.exe**.
2. When the launcher appears, select **Install PHD Guide**.
3. Read the license agreement and select **I accept the agreement** if you agree with the terms. Follow the prompts to complete the software installation.

### Installing the camera using a Windows XP computer:

1. Insert the CD-ROM and wait for the launcher window to appear.
2. When the launcher appears, select **Install Drivers**. Do not plug the camera in before loading the drivers.

3. Once the drivers have been installed, connect the SSAG to your computer's USB port.
4. In Windows XP a **Found New Hardware Wizard** appears (Figure 6).



**Figure 6.** In Windows XP the Found New Hardware Wizard appears when you first plug the SSAG into your USB port.

5. Windows will ask if you want to search for drivers and updates online. Select **No, not this time** and click **Next**.
6. Next, choose **Install the software automatically**.
7. Windows will note that the driver has not passed Windows Logo testing. This is normal. Click the **Continue Anyway** button. When the Wizard has completed, click the **Finish** button.
8. You will immediately be prompted with a **Found New Hardware Wizard** again. This time the camera firmware will be installed. Make the same selections again in the Wizard, **No, not this time**, click **Next**, and choose **Install the software automatically**. The camera is now installed on your computer and the red LED on the camera should be on.

## Installing the camera using a Windows Vista computer:

1. Insert the CD-ROM and wait for the AutoPlay window to appear. Load Run Opener.exe. (Figure 7)



**Figure 7.** In Windows Vista the AutoPlay screen appears when you insert the CD-ROM into your computer. Select Run Opener.exe when prompted with this screen.

2. Select **Install Drivers**. Follow the prompts in the install screen to complete the driver installation.
3. Windows will note that the driver has not passed Windows Logo testing. This is normal. Click the **Continue Anyway** button. When the Wizard has completed, click the **Finish** button.
4. Once the drivers have been installed, connect the SSAG to your computer's USB port.
5. Windows Vista will automatically detect the camera and install the device for you. Wait for the dialog box in the taskbar to say **Device Installed Successfully**. The camera is now installed on your computer and the red LED on the camera should be on.

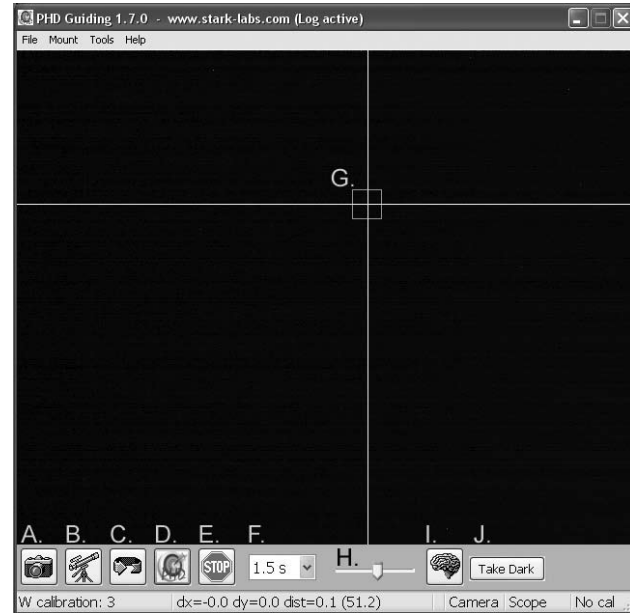
## Getting Started During the Day

We recommend using the SSAG for the first time during the day. This way, you can become familiar with the basic camera functions without having to stumble around in the dark. Setup your telescope and mount so the optical tube is pointing at an object that is at least a couple of hundred feet away. Insert an eyepiece and focus as you normally would.

*Note: Under normal use the SSAG is coupled to a separate guide scope which is mounted or piggy-backed onto the imaging scope. For initial setup during the day, you do not need to have both telescopes setup, but you should use the same guide scope you intend to use later at night.*

First let's explore the interface of PHD Guiding. PHD Guiding makes the task of autoguiding very easy and the setup can be accomplished in minutes.

## PHD Guiding Screen Layout



**A. Connect to Camera:** Selects and connects to the autoguider camera. Choose the StarShoot AutoGuider or the older StarShoot DSCI camera



**B. Connect to Telescope:** This command connects the SSAG to your mount. To connect the SSAG to your mount, go to the **Mount** menu and select **On-camera**, then click this icon.



**C. Looping Exposures:** Takes continuous exposures for acquiring and focusing the guide star.



**D. PHD Guide:** Automatically calibrates and guides. Once your guide star is found and focused, simply click on the star and click PHD Guide. The rest is automatic!



**E. Stop:** Stops either calibrating, guiding, or looping exposures.



**F. Exposure Selection:** Choose from 14 different exposure times for the camera.



**G. Guide Star Box:** When a guide star is selected, a green box appears around it. PHD Guiding will display the pixel coordinates of the star in the lower left screen. When the calibration routine starts, yellow crosshairs are displayed around the box. When the autoguiding begins, the crosshairs turn green. This box does not appear until a guide star has been selected. (See “Start Autoguiding”)



**H. Gamma Adjustment:** Adjust the apparent screen brightness level in the image by moving the slider bar left (brighter) or right (fainter).



**I. Advanced Parameters:** Control the camera and guiding routine settings. You do not typically have to adjust the advanced parameters. For very bright guide stars, or for daytime testing, the camera gain can be adjusted in this menu. (See “Advanced Autoguider Settings” for more detail about this menu.)



**J. Take Dark Frame:** Captures and internally saves a dark frame that is automatically subtracted from future exposures. Taking a dark frame is optional and not required for normal use. See “Dark Frames and Noise Reduction” for more information.

Since the SSAG camera is so sensitive to light, you will need to reduce the gain of the camera to effectively use it during the day.

1. Plug the SSAG into your computer's USB port.
2. Insert the SSAG into the 1.25" eyepiece holder on your guide scope.
3. Open PHD Guiding and select the **Connect to Camera** icon.
4. Click on **Advanced Parameters** (the brain icon) and locate the Camera gain (%) field.
5. Adjust the **Camera gain (%)** to **5%** and click **Done**.

*Note: The default camera gain is 95%. After you are done using the camera during the day, change the gain back to 95% to retain the high sensitivity of the camera.*

6. In the **Exposure Selection** pull down menu, select **0.05 s**.
7. Click the **Looping Exposures** icon to begin taking continuous pictures.
8. Gradually move the telescope focus inward until you get a sharp image on your computer screen (Figure 8). The SSAG focuses approximately 15mm inward from a standard 1.25" eyepiece. On most refractors, a 1.25" extension tube (available from Orion) is usually needed to reach focus. Alternatively, you can use a star diagonal. Note the approximate position of your focuser where the SSAG reached focus on your guidescope to make the same task at night much easier.
9. Experiment with the **Gamma Adjustment** as needed to see a high contrast image. The **Gamma Adjustment** during the day will likely need to be different at night, but you should become familiar with this adjustment before you setup at night.



**Figure 8.** Gradually move the focuser inward until you have a clear daytime image on your computer screen.

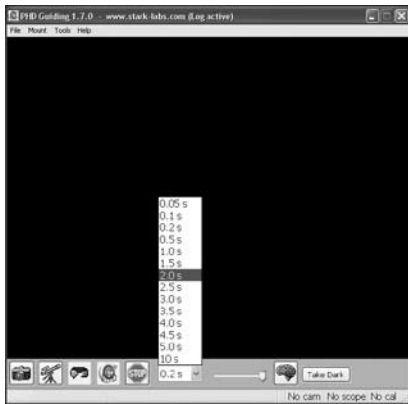
## Start Autoguiding

The SSAG with the use of PHD Guiding software makes the task of autoguiding simple and easy to setup. 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.

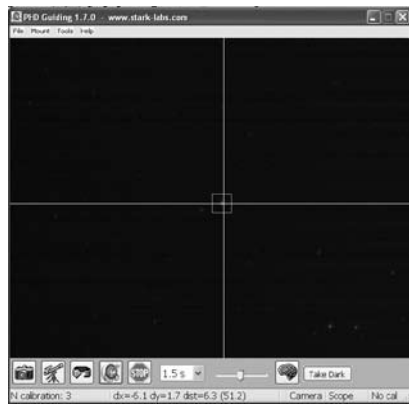
*Note: Autoguiding can correct for a mount that is poorly polar aligned. However the image will be harder to initially locate and center since it will still drift away from the camera's field of view. Additionally, guiding with a poor polar alignment will eventually cause field rotation in a long exposure image.*

1. Locate, center and focus the celestial object you wish to image with your CCD or DSLR camera in your main imaging scope. Once you have centered the desired object, it is important to make sure the tracking on your mount is engaged so you don't lose the object before the guiding starts.
2. Using a low power 1.25" eyepiece, locate and center a fairly bright star in your guide scope. Do not move the main imaging scope or your object will be lost! As stated in “System Requirements”, we recommend using adjustable guide scope tube rings to allow independent movement of the guide scope.
3. Remove the eyepiece and insert the SSAG into your guide scope.
4. Plug the SSAG into your computer's USB port and connect the autoguider cable from the SSAG to your mount's autoguide port. Load PHD Guiding on your computer.
5. Click the **Connect to Camera** icon and select the **StarShoot AutoGuider**.
6. In the **Exposure Selection** pull down menu, select **2.0 s** (Figure 9).

7. Click on the **Looping Exposures** icon to begin continuously taking pictures.
8. Gradually move the focus inward on your guide scope until you see the star come into focus. As you get close to focused, the camera may start detecting several faint background stars.
9. Once you have reached focus and you can see at least one clearly defined star, click the **Stop** icon.
10. Click on the star you want to guide on. A green guide star box should appear around the star you selected. In the lower left screen, the pixel coordinates of the star is displayed. If the guide star box is yellow, a message appears at the bottom of the screen **LOW SNR**. If you see this message, you need to select a brighter star. Increase the exposure time if necessary.



**Figure 9.** Select 2.0 s in PHD Guiding to set the exposure time to 2 seconds.



**Figure 10.** Yellow crosshairs appear once the calibration begins. The process is automatic. The crosshairs turn green when guiding begins.

11. Go to the **Mount** menu and make sure **On-camera** is selected. Click on the **Connect to Telescope** icon.
12. Click the **PHD Guide** icon and the calibration will begin (Figure 10). The rest is automatic! Yellow crosshairs are displayed around the guide star box when the calibration starts. The calibration is automatic and takes a few minutes. When the calibration is complete, the autoguiding begins automatically and the crosshairs turn green. You are now ready to take astro-images with precise tracking!

*Note: Be patient while PHD Guiding completes the calibration. The telescope cannot be disturbed during the calibration process. It is just as critical not to touch the telescope during calibration as it is when exposing an astro-image. The calibration ensures that the AutoGuider knows the movements and tracking behaviors of your mount.*

## Dark Frames and Noise Reduction

All CCD and CMOS cameras have inherent noise which becomes more apparent with longer exposure images. If you require taking longer exposures (typically longer than 3 seconds) you may start to see vertical lines and bright dots (hot pixels). There are several ways to reduce the amount of noise seen in your guiding images. You will get the best guiding performance when your image background looks smooth and black. The **Gamma Adjustment** will help clip the low level background noise by adjusting the slider bar left or right as needed. You can also reduce the camera **Gain** or enable **Noise Reduction** (see "Advanced Autoguider Settings"). **Take Dark** saves a dark frame which is subtracted from your guiding images to remove most of the noise. Dark frames are images taken with the camera capped from incoming light, revealing only the camera noise in the image. This noise is subtracted from a "light frame" which is the image you want to see from the camera.

To take the dark frame:

1. Cap the objective of your guide scope.
2. Keep the **Exposure Selection** set to the same time you wish to use for guiding. For example, if you choose **2.0 s**, then you must keep this exposure time while guiding for the dark frame to be effective.
3. Click **Take Dark**.
4. Remove the cap from your guide scope and resume taking pictures or guiding. PHD Guide will automatically subtract the dark frames from all of your exposures. To remove the dark frame, go to **Tools** and select **Erase Dark Frame**.

## Advanced Autoguider Settings

The **Advanced Parameters** (the brain icon) in PHD Guide allows you to change several settings to better customize the guiding performance of your SSAG. Under normal use, you should not have to make any major adjustments to the **Advanced Parameters**. All of the calibration and autoguiding is done automatically simply by pressing the **PHD Guide** icon. However the following settings can be adjusted to cater to your specific guiding setup:



### Advanced Parameters

**R.A. Aggressiveness:** Adjusts the percentage of R.A. correction per step. The default value is 100, meaning that the guider will move the full distance of the correction. If the seeing conditions are not steady, the aggressiveness can be turned down to smooth out the quick movements and reduce the correctional movement.

**R.A. Hysteresis:** Implements a percentage of the previous averaged tracking corrections to the current tracking corrections. This setting can be useful if you are experiencing some wind or severe periodic error, since the guider will partially

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ignore some of the radical movements and repeat a percentage of the previous tracking corrections.

**Dec Guide Mode:** This setting should not be changed under normal use. You can optionally disable dec guiding, or limit which direction the guider will allow dec to be corrected on (north or south). The default setting automatically finds which side dec is drifting (north or south).

**Dec Algorithm:** Ideally corrections made in declination should only be one consistent direction, usually based on how well the mount is polar aligned. The **Dec Algorithm** takes this into account and attempts to keep the declination tracking consistent. Choose **Resist switching** or **Lowpass filter** which are algorithms that try to keep dec on one side of drift, or average the corrections made in dec.

**Calibration Step:** Adjusts how long each guide pulse is during calibration. The default is 500 milliseconds. The calibration step can be increased to provide a better sample of movement. However, if the calibration step is increased too much, the guide star will move out of the camera's field of view during calibration.

**Min. Motion:** Number of pixels the star must move before PHD will make a guiding correction. The default is 0.25 pixels.

**Search Region:** The area in pixels that the guide star is searched for and looked at. The default is 15x15 pixels. Under normal use, this setting should not be changed.

**Noise Reduction:** Choose from 2x2 mean or 3x3 median to smooth out noise and blur out hot pixels.

**Time Lapse:** This setting optionally sets a delay between each guiding correction. For mounts that track exceptionally well, you can add a delay between each correction.

**Gain:** The gain adjusts the camera's internal brightness level and sensitivity. The default is 95%. If you are experiencing excessive noise or hot pixels, you can reduce the gain. The camera remains very sensitive as low as 50% gain. If you are guiding on a very bright guide star, you can afford to turn down the gain and further decrease the noise in your image.

**Force Calibration:** Enabling this setting makes PHD Guide calibrate every time a new star is chosen. If you move your telescope to another object in the sky, you will need to recalibrate the autoguider. The default has this setting enabled.

**Log Info:** You can log all actions into a text file saved in the PHD directory.

**Disable Guide Output:** This setting deliberately shuts off the autoguider output for potential troubleshooting measures.

## Tips & Tricks

If all conditions are ideal, and your tracking is superb, you typically do not have to alter any of the camera's default settings. However, if your setup is tracking much worse than usual (such as a night with high wind or poor seeing), you may need to customize your settings to better adapt to the current conditions in the field.

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Reduce the R.A. **Aggressiveness** in the **Advanced Parameters** menu to better stabilize the guiding during bad seeing or wind gusts. You may also want to decrease the **R.A. Aggressiveness** if your guiding exposures/corrections are set very quickly (less than 1 second). If the guider sends several corrections per second to the mount, the mount's movement may osculate due to the response time of your mount. Additionally the varying seeing conditions makes the star appear to jump around rapidly and cause the guider to make unnecessary corrections, sometimes referred to as "chasing the seeing". If seeing is poor, keep the guiding correction intervals/exposures to 1 second or more. For most guide scopes, we recommend setting the autoguide exposures between 1-4 seconds for best results.

## Polar Alignment

A good polar alignment of your EQ mount is of critical importance for long-exposure imaging. Inaccurate polar alignment leads to field rotation, even with the autoguider tracking. If your equatorial mount uses a polar axis finder scope, we highly recommend utilizing it for polar alignment. If not, a technique known as the "drift method" of polar alignment has been used for many years, and can achieve an extremely accurate polar alignment. Unfortunately it is very time consuming, since the drift of a star over time must be observed. The basic idea is to let the telescope mount track while watching a star to see which way the star drifts. Note the direction of the drift, and correct by moving the mount in the appropriate direction.

To perform the drift method of polar alignment:

1. Roughly polar align your mount by pointing the R.A. axis of the mount at Polaris (the NorthStar).
2. Find a bright star near the meridian (the imaginary line running north-to-south through zenith) and near the celestial equator (zero degrees declination). Point the telescope at this star, and center it in an illuminated reticle eyepiece (available from Orion). If you don't have an illuminated reticle eyepiece, use your highest-magnification eyepiece.
3. Determine which way is north and south in the eyepiece by moving the telescope tube slightly north and south.
4. Now, let the mount's motor drive run for about five minutes. The star will begin to drift north or south. Ignore any east-to-west movement.
5. If the star drifts north, the telescope mount is pointing too far west. If the star drifts south, the telescope mount is pointing too far east. Determine which way the star drifted and make the appropriate correction to the azimuth position of the mount. Rotate the entire mount (and tripod) slightly east or west as needed or use the azimuth adjustment knobs (if your mount has them) to make fine adjustments to the mount's position.
6. Next, point the telescope at a bright star near the eastern horizon and near the celestial equator (Dec. = 0).

- Let the telescope track for at least five minutes, and the star should begin to drift north or south.
- If the star drifts south, the telescope mount is pointed too low. If the star drifts north the telescope mount is pointed too high. Observe the drift and make the appropriate correction to the mount's altitude (or latitude); most mounts have some sort of fine adjustment for this.

Repeat the entire procedure until the star does not drift significantly north or south in the eyepiece after a few minutes. When this is accomplished, you are very accurately polar aligned. Autoguiding on a well polar aligned mount will yield the best results for your images. The fewer tracking corrections that have to be made, the better your images will be.

### Differential Tube Flexure

A common obstacle in guiding with a separate guide scope and imaging scope is differential tube flexure, the unwanted movement of a guide scope in relation to the main imaging scope. If any part between the autoguider and imager moves or flexes during the exposure, then the resulting image will have oblong stars which gives the appearance of poor tracking. There are a few basic measures to ensure your guide scope is securely in place:

- If your guide scope has a focus lock, firmly tighten the focus lock thumb screw after you have focused on your guide star.
- If you are using adjustable guide scope tube rings, make sure all thumb screws are firmly tightened against the guide scope tube.
- The guide scope tube rings and mounting plate should be tightened very securely against the main imaging scope. Check for any visual flexure or movement by gently pressing against the guide scope.
- The focuser and tube rings on the main imaging scope should also be firmly in place. It is not uncommon for screws and bolts to come loose after a few usages; so they should be checked before each imaging session.

### Cabling

The SSAG uses only two light-weight cables; a USB cable and the autoguide cable. Keep an eye on the cables as you move the scope around. If there is any stress on the cables, your tracking may be affected.

Some imaging cameras use heavy-duty cables with significant weight. These cables can contribute to differential tube flexure. If you are getting images with oblong stars and your tracking appears to be good otherwise, try tying any heavy cables to a secure location on your mount. It does not take much resistance against the autoguider or imager to create poor tracking.

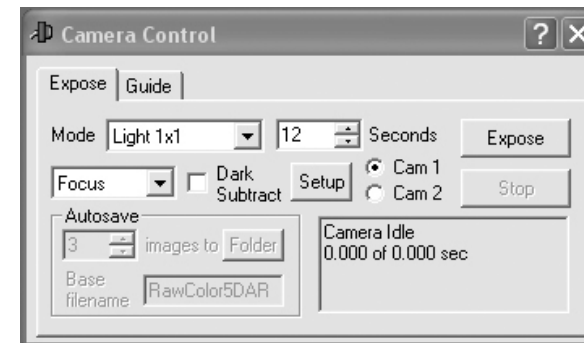
### USB Extension Cable

In many instances, it is likely a longer cable for the SSAG will be needed in order to comfortably setup the telescope, camera, and computer. We recommend purchasing a 10' USB extension cable if you need more cord length (available from Orion).

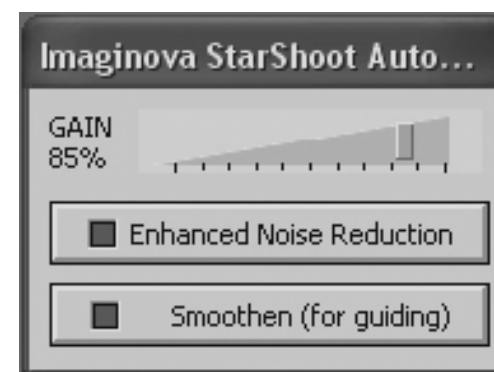
## Using the SSAG with MaxIm DL Essentials

For StarShoot Deep Space Imaging Camera users MaxIm DL Essentials version 1.08 and later supports the use of the SSAG. You can simultaneously operate the StarShoot AutoGuider and StarShoot Deep Space Imager at the same time.

- Plug the SSAG and the SSDSCI/SSDSMI (II) into the USB ports on your computer.
- Load MaxIm DL Essentials. The **Camera Control** window should have an option to select **Cam 1** or **Cam 2** (Figure 11). You will also notice the **Imaginova StarShoot AutoGuider** window appear in the center of the screen (Figure 12). This window allows you to adjust the camera gain and optionally enable noise reduction.

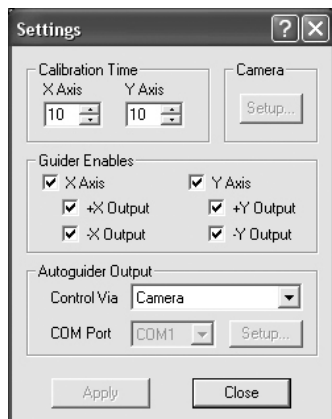


**Figure 11.** Cam 1 / Cam 2 camera control window in MaxIm DLE



**Figure 12.** MaxIm DLE AutoGuider window allows you to adjust the camera gain and optionally enable noise reduction to smooth out the background noise.

- Determine which camera the SSAG is, **Cam 1** or **Cam 2**. This is done by taking a 1 second exposure in each camera. The camera that has the larger 1280x1024 image is the SSAG.
- Click the **Autoguide** tab in the camera control window. Select the camera that corresponds to the SSAG.
- Click the **Settings** button.
- Maxim DL Essentials needs to know how fast the telescope moves in right ascension (R.A.) and declination (Dec.) when the autoguider commands are issued. To do this, the software will Calibrate the mount by moving it back and forth on each axis. The **Calibration Time** determines how long it activates the motors each time. The default value is 10 seconds. Make sure all of the **Guider Enables** boxes are checked (Figure 13).



**Figure 13.** The autoguide **Settings** window controls the **Calibration Time** in each axis, movement in both axis, and the **Autoguider Output** connection to your mount.

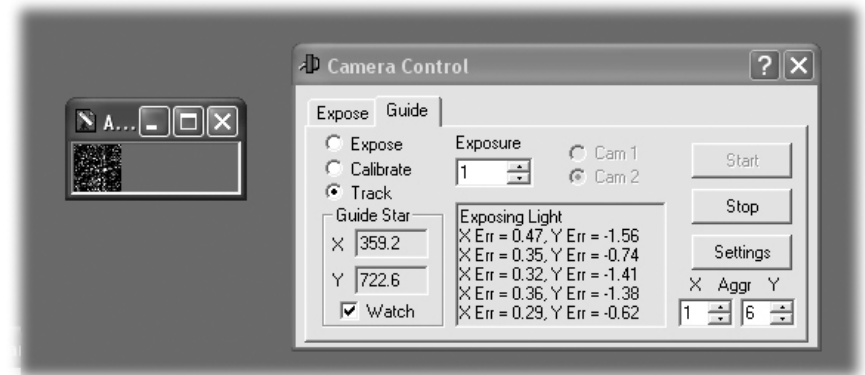
- For **Autoguider Output**, set **Control Via** to **Camera**.
- Click **Apply**. You can leave this dialog box open, or **Close** it if you wish. On the **Guide** tab, set to **Expose**, and click the **Start** button. A single image will be taken. Ensure that a well-focused bright star (near the actual object to be imaged) appears in the image. If not, adjust the guide scope and try again. Make sure the star is not close to the edge of the camera's field of view or it may drift out during calibration.

*Note: The algorithm can be confused if another star appears in the frame; to minimize this risk, calibrate on an isolated bright star.*

- Now, set to **Calibrate**, and click the **Start** button. A series of five exposures will be taken; each time the telescope will be moved slightly. If the telescope does not move, check the **Settings**.
- The star should move in an "L" shape. If it does not move enough, a warning message will appear. The recorded positions will be displayed in the scrolling log, along with any error messages.

*Note: If the star does not move far enough, or moves too far (i.e. the star leaves the field), the duration of the calibration move commands can be adjusted by clicking the **Settings** command and changing the **Calibration Time** fields (measured in seconds). A longer calibration time will increase the motion of the star; a shorter time will decrease the motion. Typical values range from five to ten seconds, depending on the correction speed, focal length, and pixel size.*

- Once you have successfully calibrated, switch to the **Track** mode. Click **Start**, and watch the star. It should move to the center of the small track box, and whenever it drifts off it should be pulled back again. Also the tracking errors will be displayed in the scrolling log (Figure 14).



**Figure 14.** Autoguiding in MaxIm DL displays the guide star in a small window with the **Watch** box enabled. The tracking corrections are also displayed in the **Camera Control** window.

- If the star bounces back and forth, reduce the aggressiveness for that axis. If it corrects too slowly, increase the aggressiveness. Changes to the aggressiveness settings take effect immediately.

## Care and Maintenance

When the SSAG is not in use, the cover cap should be replaced on the end of the nosepiece. This prevents dust from accumulating on the SSAG's optical window. The optical window should only be cleaned if significant dust builds up for if the window is touched. Any quality optical lens cleaning tissue and optical lens cleaning fluid specifically designed for multi-coated optics can be used to clean the glass surface of the SSAG's optical window. Never use regular glass cleaner or cleaning fluid designed for eyeglasses. Before cleaning with fluid and tissue, blow any loose particle off the surface with a blower bulb or compressed air. Then apply some cleaning fluid to a tissue, never directly on the optics. Wipe the optical surface gently in a circular motion, then remove any excess fluid with a fresh lens tissue. Use caution, rubbing too hard may cause scratches.

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## Specifications

Camera Sensor:	Monochrome CMOS Micron MT9M001
Sensor format:	1/2"
Pixel array:	1280 x 1024 (1.3Mp)
Pixel Size:	5.2μ x 5.2μ
Exposure Range:	0.05 seconds to 10 seconds
A/D Conversion:	8 bit
Thermoelectric cooling:	No
IR-cut filter:	No
Mounting:	1.25" nose piece or t-thread
Weight (oz.):	4.4
Dimensions:	2.5" wide x 2.35" long
Mount connection:	Via RJ-12 modular jack (6-pin)
Autoguide commands:	"ST-4" output

*This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.*

*Changes of modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.*

*Note: This equipment has been tested and found to comply with the limits for Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

*Reorient or relocate the receiving antenna.*

*Increase the separation between the equipment and receiver.*

*Connect the equipment into an output on a circuit different from that to which the receiver is connected.*

*Consult the dealer or an experienced radio/TV technician for help.*

*A shielded cable must be used when connecting a peripheral to the serial ports.*



