

INSTRUCTION MANUAL

Orion® StarShoot Solitaire™ AutoGuider #52074



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Figure 1.

Welcome to a world of astro-imaging with trouble-free automatic guiding! Your Orion StarShoot Solitaire AutoGuider 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 Solitaire operates completely independently and does not require an external PC or laptop. The tracking corrections made by the Solitaire 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.

1. Getting Started

Please take a moment to look over your new Solitaire and become familiar with the different components, as well as the required telescope equipment to start autoguiding.

Parts List (Figure 1)

- A. Control paddle
 - B. Camera head
 - C. 9mm Parfocal eyepiece
 - D. 10' Power cable
 - E. 7' Camera cable (to control paddle)
 - F. 7' Autoguide cable (control paddle to mount's port)
- Carrying case (not shown)

Imaging System Requirements

You must have the equipment necessary to begin autoguiding and take long exposure deep space images. Please confirm that you have the following three essential equipment items before proceeding.

1) 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.

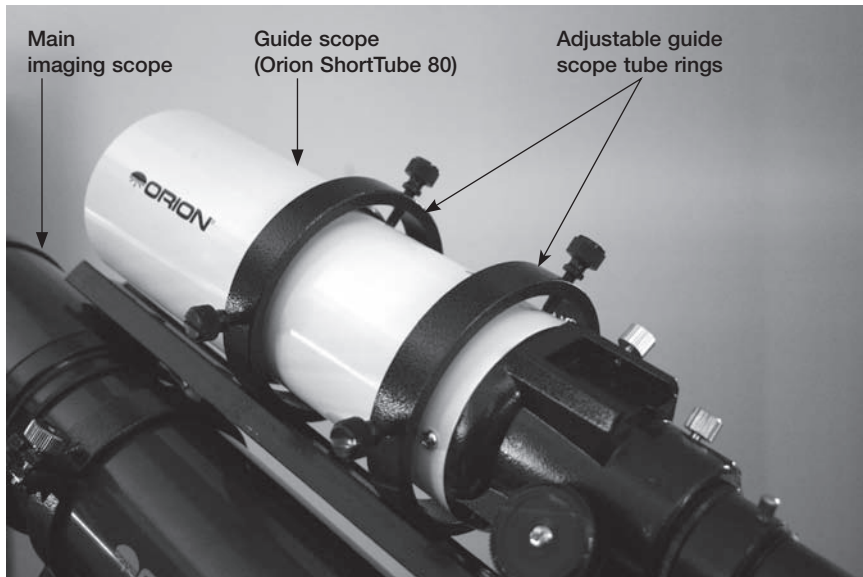


Figure 2. Adjustable guide scope tube rings allow you to adjust the position of the guide scope without moving the main imaging scope.

2) 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.

Alternatively, the Orion X-Y Guidestar Finder can be used instead of adjustable guide scope rings. The X-Y Guidestar Finder moves the autoguider laterally in the focuser and imaging plane to find a guide star.

Because of the high resolution and accuracy of the Solitaire, 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.

Note: Most refractor guide scopes will need an extension tube to reach focus with the StarShoot Solitaire. A diagonal is an acceptable alternative to an extension tube, but not preferred.



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

An alternative to using a separate guide scope is an off-axis guider. An 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 most commonly used in catadioptric telescopes, such as Schmidt-Cassegrains or Maksutov-Cassegrains.

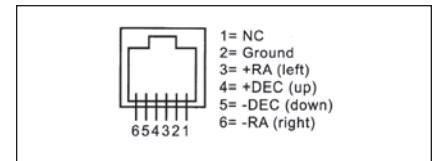


Figure 3b. This is the autoguider port pin diagram for the ST-4 compatible mounts.

3) Mount

An equatorial mount with dual axis motors and a RJ-12 autoguider port is required. Just about any equatorial mount equipped with an autoguider port will work with the Solitaire (Figure 3a). The Solitaire 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 autoguider port. For short exposure deep space photography (typically 45 seconds or less) the Solitaire 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. An equatorial mount will yield the best overall performance for guided deep space astrophotography.

Quick Start Guide

Thanks to its ease of use, you can hook up your StarShoot Solitaire and be ready within minutes. Once your imaging rig has been set up, polar aligned and carefully balanced, here are the main steps to follow:

1. Make all the necessary connections:
 - a. Attach the camera to the guide scope, carefully locking the setscrews.
 - b. Connect the Control Paddle to both the camera head and the mount's ST-4 port using the appropriate RJ cables.
 - c. Connect the Control Paddle to a 12V DC power supply.
2. Turn the camera on.
3. Search for a suitable guide star
4. Focus with the special parfocal eyepiece (*)
5. Calibrate the mount (*)
6. Set the camera's advanced options (*)
7. Start autoguiding.

(*) *The steps marked with a star, such as focusing and calibration, may not always be necessary. Please consult Section 4 ("Tips and Tricks") for details. Refer to Section 2 "Using the StarShoot Solitaire" for a more detailed operating procedure.*

2. Using the StarShoot Solitaire

The StarShoot Solitaire's control paddle features a wide pixel matrix screen, whose colors (red pixels on a black background) and brightness do not compromise the eye's delicate adaptation to darkness.

The bottom of the screen can have up to three different options, which can be activated by pressing the corresponding button on the control paddle (from left to right).

1. Connect the power supply to the provided 12VDC power cable and plug it into the Solitaire's control paddle.
2. Connect the camera head to the control paddle, then connect the control paddle to the mount's autoguide port using the provided cables.
3. Turn the camera on by pressing and holding the central button until the screen lights up; shortly thereafter, the message **YOUR STARSHOOT IS READY** will appear. Press **OK** to go to the first user screen (Figure 4):



Figure 4. This screen appears after the Solitaire is powered on.

At any time when in this screen (Figure 4), you can turn off the camera by pressing and holding the left button (**OFF**).

4. Select **BASIC** to access the **MENU BASIC** screen (Figure 6).

Selecting **OPTION** enables you to adjust the display and keyboard **BACKLIGHT DISPLAY** level and the **BUZZER** volume (Figure 5a and 5b).



Figure 5a. This screen enables you to adjust the **BACKLIGHT DISPLAY**.

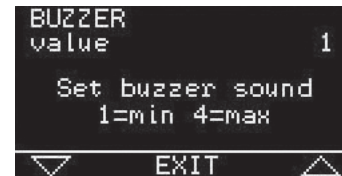


Figure 5b. This screen enables you to adjust the **BUZZER** volume.

You can adjust both the brightness and the buzzer volume with the arrow keys on the control paddle: four levels are available, from 1 (minimum) to 4 (maximum). When you have completed making your adjustments, select **EXIT** (Figure 5b) to return to the **MENU BASIC** screen.

5. Find and center a guide star with moderate brightness using a wide angle eyepiece, then replace the wide angle eyepiece with the provided 9mm parfocal eyepiece. Focus on the guide star as precisely as possible. Once focused, replace the eyepiece with the camera head and the star should already be in focus with the camera.



Figure 6.

- Select **FOCUS**, and the StarShoot Solitaire will automatically scan the whole frame for the guide star (Figure 7)

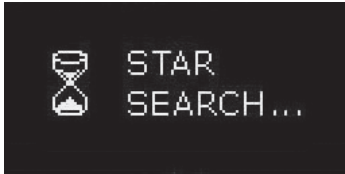


Figure 7. The **STAR SEARCH** feature looks for the star you have previously centered using the parfocal eyepiece.

After a moment (the actual duration of the search will vary), the StarShoot Solitaire will inform you of the outcome with a simple message: “**STAR FOUND!**” or “**STAR NOT FOUND!**” (Figure 8a and 8b)

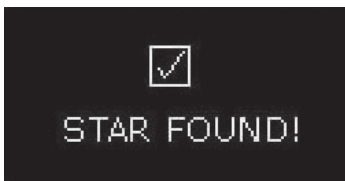


Figure 8a. The Solitaire has successfully found the guide star.

Figure 8b. The Solitaire has failed to find the guide star.

If the guide star was not found, the Solitaire automatically goes back to the **MENU BASIC** screen. If this happens, please select a brighter guide star and try again. If the star is found, the Solitaire proceeds to the **FOCUS STAR / OFFSET X/Y** screen (Figure 9).

- Inspect the **FOCUS STAR / OFFSET X/Y** screen to check the guide star focus quality displayed as a number in the upper right corner, and relative guide star position on the detector displayed as a “+” in the rectangular box. The lower the number, the better the focus. A properly focused star should be 3 to 8 pixels wide according to the brightness and air turbulence.



Figure 9. This screen displays the guide star focus quality and its relative location on the camera’s detector.

Note: If the star is too close to the sensor’s edges ($\pm 82/\pm 46$), you can try to center it by CAREFULLY moving the mount along the four directions with the drive keypad at guiding speed.

If the star is thrown off the active area, it will be lost (**STAR LOST!** message pops up) and you will have to start over with focusing.

- Once the guide star has been centered and focused, select **CALIBR** to get to the **STATUS CALIBRATING** screen (Figure 10). Press **OK** to start calibrating the mount.

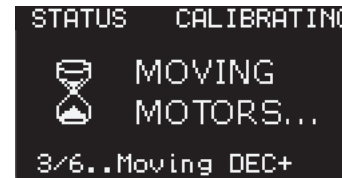


Figure 10. This status screen appears during the mount calibration.

The calibration process can last up to a few minutes. Upon completion, the new calibration parameters are automatically saved into the camera’s non-volatile memory (Figure 11a). If you want to reuse the parameters from last calibration, choose **LOAD** from the focusing menu. (Please see Section 4 “Tips and Tricks – Mount Calibration”)

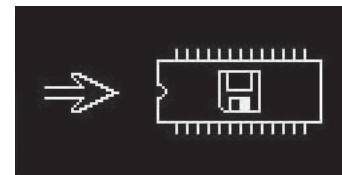


Figure 11a. The completed calibration is automatically saved to be used later if desired.

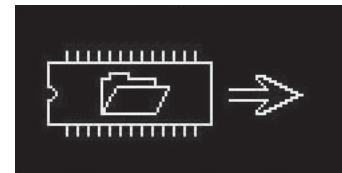


Figure 11b. Select **LOAD** in the **FOCUS STAR / OFFSET X/Y** screen to load the stored calibration settings.

- When calibration is complete, the **STATUS READY** screen will appear (Figure 12a). The tracking error graph appears for the X and Y axis. The X and Y tracking error graph displays real-time guiding corrections issued to the mount.

Select **START** to begin autoguiding. The StarShoot Solitaire is now guiding for you! The **STATUS GUIDING** window will appear (Figure 12b). You can interrupt the autoguiding process by pressing **STOP** at any time, while **EXIT** will take you back to the basic settings screen.



Figure 12a. Once calibration is complete, the **STATUS READY** screen appears with a tracking error graph.



Figure 12b. Select **START** to begin autoguiding. The tracking error graph will display during autoguiding.

At times the guide star may be lost (1 beep per second and **STAR LOST**). This can be due to a number of different reasons, e.g. because the sky has clouded over, the optics have dewed up, or the star has been thrown off the field of view by a wind gust or even because the telescope has been touched. If the star remains invisible for up to 30 seconds, the camera will still be able to resume autoguiding; otherwise, the current session is aborted and the execution flow goes back to the **MENU BASIC** screen to search for a new guide star.

Adjusting the Aggressiveness

The default settings in the Solitaire should provide good results with most imaging setups. However, you can optionally adjust the aggressiveness settings to optimize your particular setup, if needed.

1. Select **ADVAN** when in the **STATUS READY** screen, and you will be prompted with the **MENU ADVANCED** screen (Figure 13)



Figure 13.

2. Select **AGGRESS X** to come to the first **AGGRESSIVENESS** screen for **X** (Figure 14a).

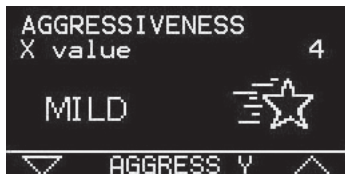


Figure 14a. The **AGGRESSIVENESS** screen for **X**.

Select the corresponding up/down buttons that match the screen to adjust the X value aggressiveness.

3. Now select **AGGRESS Y** to come to the second **AGGRESSIVENESS** screen for **Y** (Figure 14b). Select the corresponding up/down buttons that match the screen to adjust the X value aggressiveness.

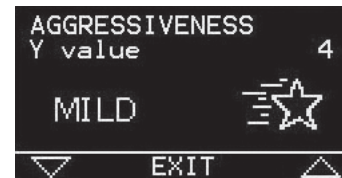


Figure 14b. The **AGGRESSIVENESS** screen for **Y**.

The aggressiveness in both axes can range from 1 to 6 (1-2=LOW, 3-4=MILD, 5-6=HIGH) and expresses the degree of reactivity of corrections. A high value will urge the camera to immediately correct for the slightest displacement, whereas a low value will yield a much smoother behavior. Please see Section 4. "Tips and Tricks – Mount Calibration" for more information.

3. Troubleshooting

The StarShoot Solitaire is very simple and intuitive to use. However, as with any imaging setup, you may encounter difficulty while autoguiding and taking long exposure astro-images. The following are some error messages which could potentially occur during setup or while autoguiding.

Error Messages

> **STAR LOST!** – This message is also accompanied with an audible beep once per second, for up to 30 seconds until the star is found again. This message may occur if:

- Clouds are rolling in (during **AUTOGUIDING READY** and **GUIDING**).
- Dew forms on the guidescope objective (during **AUTOGUIDING READY** and **GUIDING**).
- The guiding speed is too fast (during **MOVING MOTORS...**).
- The mount does not move (during **MOVING MOTORS...**).

If the mount is not moving, check the autoguider cable connection to your mount. If the autoguiding corrections appear to be too large, decrease the autoguide speed in your mount's settings.

> **STAR NOT FOUND!** – This message may occur when the StarShoot Solitaire camera cannot find a suitable star after **STAR SEARCH...** command.

> **COMMUNICATION ERROR!** – The following message is displayed if the cable connecting the CPU and the camera head gets accidentally disconnected, or in case of problems with the electrical connections or the power supply.

4. Tips and Tricks

Choosing a Suitable Guide Scope

Thanks to its sub-pixel guiding accuracy, the StarShoot Solitaire does not require telescopes with a very long focal length or large aperture. As a rule of thumb, when imaging with digital SLRs or CCDs (pixel size between 5 and 8 microns), in general the guide scope should have at least about half of the focal length of the imaging scope. We recommend using refractors instead of slow catadioptric reflectors (e.g. Schmidt & Maksutov-Cassegrains with f/ ratio of 10 and upwards), since focusing by movable primary mirror can easily lead to exposure trailing even if the tracking performance looks apparently good. Moreover, there are cases where high magnification is not always an advantage, due to lower brightness and increased sensitivity to atmospheric turbulence (seeing).

Guiding Speed Adjustment

The StarShoot Solitaire automatically adjusts the exposure time according to the guide star's brightness: shorter for bright stars, longer for dim ones. This also affects the frequency of corrections to the mount: bright stars allow for continuous position control, which also ensures that all sorts of tracking errors, including the component resulting from periodic error and atmospheric turbulence, will be easily guided out. Bright stars are best to compensate for the most erratic periodic errors, or with guide scopes having a shorter focal length than that of the main optics. In this case, we advise using a moderate guiding speed (0.15 - 0.5X) with HIGH aggressiveness.

On the other hand, fainter stars imply a less frequent correction of tracking errors: this makes them not as suitable for mounts with an irregular periodic error. However, long exposure times required by faint stars could come in handy to minimize the influence of bad seeing. Here we suggest a very low guiding speed, best if no higher than 0.25X with MILD aggressiveness.

Medium brightness stars (visual magnitude between 3 and 6) generally yield best performance.

Search for a Suitable Guide Star

Note: The telescope must not be touched during calibration, otherwise the relevant parameters can not be calculated correctly. During calibration and autoguiding it is also important not to place the control paddle in your hand or the camera could move. Instead, place the control paddle on a secure surface such as a tripod accessory tray.

If the search for the guide star fails, you can manually move the guide scope looking for a brighter star. If the camera does not manage to find a sufficiently bright star, a position-adjustable guide scope will help. If you are using an off-axis guider, the pick-off prism and tube can be moved and/or rotated to find a brighter star.

Mount Calibration

Note: The telescope must not be touched during calibration, otherwise the relevant parameters may not be calculated correctly. Please also ensure that the control paddle is not moved during calibration!

Once calibration is complete, the parameters are permanently stored into the StarShoot Solitaire's internal memory for later use, provided that the following precautions are taken into account:

- Always guide on stars lying in the same side of the sky (with respect to the local meridian) as where the calibration was performed. For example, if you calibrated east of the meridian, you should choose a guide star east of the meridian.
- Do not remove and reinstall the camera on the guide scope after calibration, or your calibration settings will be compromised.
- Do not move or rotate the camera after calibration, or that too will compromise your calibration settings.

If any of these things are done, the mount must be calibrated again.

It might take a relatively long time for the calibration process to finish, especially with short focal length guide scopes (under 500 mm).

It is also advisable not to use too dim a star for calibration, otherwise just a few thin clouds or a little dew on the lenses could cause the star to be lost and jeopardize the final result of this important process.

Autoguiding and Aggressiveness

The higher the aggressiveness, the larger and more rapid the corrections to the mount are. So if the aggressiveness is set to **HIGH**, the autoguider corrects for nearly all of the guide star movement that deviates from its position. Ideally, this should result in perfect tracking. But other factors like mount vibration, wind, and poor seeing can make the autoguider "chase" the guide star movement under high aggressiveness. So depending on your mount, guidescope and outdoor conditions, you may need to adjust the aggressiveness accordingly.

HIGH values are suitable when using small refractors featuring a focal length 1,5-2 times smaller than the main instrument. **MILD** values are for guide scopes of about the same focal length and **LOW** ones are best in case of very long guide scopes or off axis guiding (typically SCTs).

During autoguiding, the tracking error graph for X and Y should stay as smooth (straight) as possible. It is advisable to start off with default values for aggressiveness and guiding speed. Later, if needed, both parameters can be fine tuned to achieve the best possible setting between your StarShoot Solitaire and your telescope.

If the tracking error graph is showing significant movement in both the X and Y axis, the autoguider is likely overcorrecting, and the guiding speed should be

decreased until the oscillation decreases to show as little movement as possible. It's still typical to see some oscillation across the zero line is acceptable since both graphs depict the offset between two consecutive exposures with a 2X scale. So, two pixels on the tracking graph are actually equivalent to one single pixel on the detector. If the oscillation continues even with the guiding speed at its lowest possible value, the aggressiveness has to be decreased.

If you see constant movement in one direction of X and/or Y, the mount is likely under correcting. The guiding speed has to be slowly increased until the constant guiding corrections calm down. If no improvement is seen even with the guiding speed at its highest value, the aggressiveness must be increased.

On nights with bad seeing, and especially with long focal length guide scopes, it could be worthwhile to slightly defocus the guide star, so that the effect of high-frequency twinkling is mitigated somewhat and the camera won't try to "guide the seeing out".

Note: Your imaging setup including polar alignment, mount balancing, quality and solidity of all the mechanical supports and adapters are critically important to achieve round stars and well-tracked exposures! Sometimes trailing due to differential flexure can ruin your pictures even with apparently smooth tracking.

5. Specifications

Camera

Sensor	Mono 1/3" Aptina MT9V032
Sensor resolution	752x480, 6µm square pixels
Exposure time range	Auto, 0.001 - 2 seconds
Housing	Aluminium, with polycarbonate lid
Nosepiece	Standard 1.25-inch (31.8mm) with filter thread
Connectors	8-pin RJ45
Size and weight	65mm x 50mm, Weight: 110g (3.8 oz.)

Control Paddle

Display	2.5-inch red graphical LCD, 128x64 pixel resolution
Connectors	8 pin RJ45, 12VDC jack, 6 pin RJ12 pin
Size and weight	55mm x 96mm x 28mm, 220g (7.7 oz.)
Power requirements	6-14VDC, 110mA

Features

- Automatic guide star search
- Real-time monitoring of guide star position and focus
- Automatic axis calibration with permanent storage of parameters
- Adjustable display red backlight and buzzer volume
- Adjustable dual-axis aggressiveness
- High-precision 0.5 subpixel autoguiding

Two-Year Limited Warranty

This Orion StarShoot Solitaire AutoGuider is warranted against defects in materials or workmanship for a period of two years 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 to: Orion Warranty Repair, 89 Hangar Way, Watsonville, CA 95076. If the product is not registered, proof of purchase (such as a copy of the original invoice) is required.

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, and you may also have other rights, which vary from state to state. For further warranty service information, contact: Customer Service Department, Orion Telescopes & Binoculars, 89 Hangar Way, Watsonville, CA 95076; (800) 676-1343.



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