INSTRUCTION MANUAL

Orion StarShoot™ Compact Astro Tracker

#21192

- **Nightscape Photography**
- **Long-Exposure Astrophotography**
- **Daytime and Nighttime Time-lapse Photography**

Congratulations on your purchase of the Orion StarShoot Compact Astro Tracker (CAT). This palm-sized, high-precision camera tracking module is designed for long exposure astrophotography as well as daytime or nighttime time-lapse photography with a DSLR or mirrorless camera. The StarShoot CAT houses a right ascension DC servo tracking motor with selectable sidereal, solar, and lunar tracking rates. Its small size and light weight make it convenient for taking with you to remote locations. It is Wi-Fi enabled and controlled wirelessly from your smartphone or tablet with the free, downloadable Tracker Console App for Android and iOS platforms. The StarShoot CAT is easy and fun to use, and will add a new dimension to your photographic capabilities!

This instruction manual will help you set up, properly operate, and care for your tracker. Please read the following text thoroughly before getting started.

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Included Components

The StarShoot Compact Astro Tracker basic kit includes the following components (**Figure 1**).

1. Tracker module
2. Polar scope
3. Ball head adapter
4. Polar scope illuminator (two pieces)
5. Panoramic ball head mount
6. CR-2032 3V lithium battery (not shown)
7. 3/8" to ¼" thread insert (removable, comes installed in Tracker module)

Figure 1

WARNING:

• NEVER look at the Sun through the polar scope, even for an instant. Doing so could cause permanent eye damage, even blindness. Do not aim the polar scope at or near the Sun.

• Do not use in the presence of flammable gas, as doing so could result in explosion or fire.

• Keep out of reach of children. Failure to do so could result in injury to the child. This item contains small parts that constitute a choking hazard. Consult a physician immediately if a child swallows any part of this device.

• Do not disassemble this product. Touching the product's internal parts could result in injury. In the event of malfunction, contact Orion Technical Support for assistance.

8. Optional Accessories

The following optional accessories are available for use with the StarShoot CAT:

A. Equatorial base (#4802)

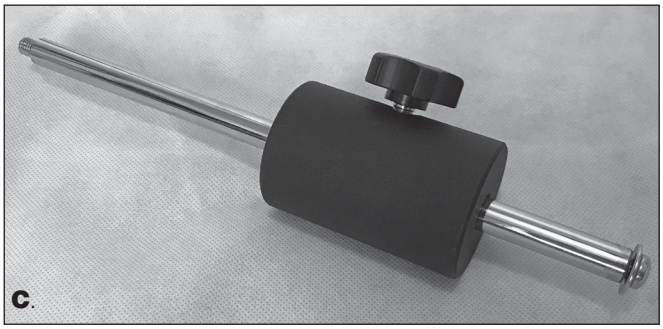
B. Declination bracket (#4803)

C. Counterweight and shaft (#4804)

D. DSLR control cable (SNAP)

- Canon 3-pin plug (#4805)
- Canon 1-pin plug (4808)
- Nikon 1-pin plug (#4806)
- Sony 1-pin plug (#4807)

E. StarBlast AutoTracker Altazimuth Mount Tripod (#8976)



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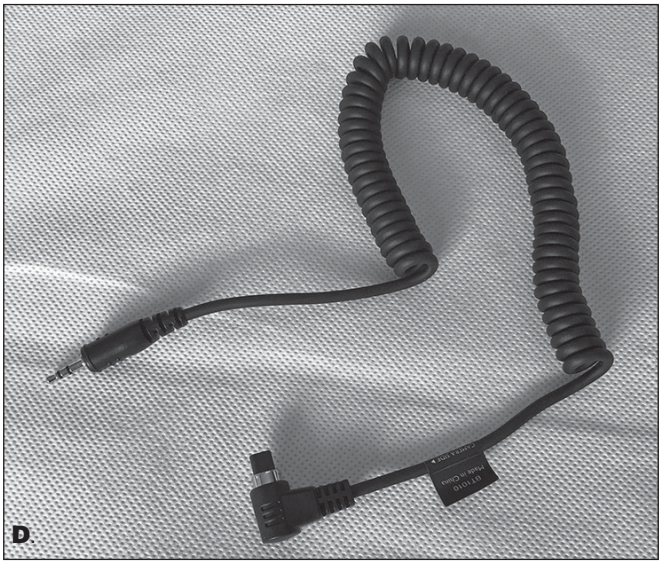

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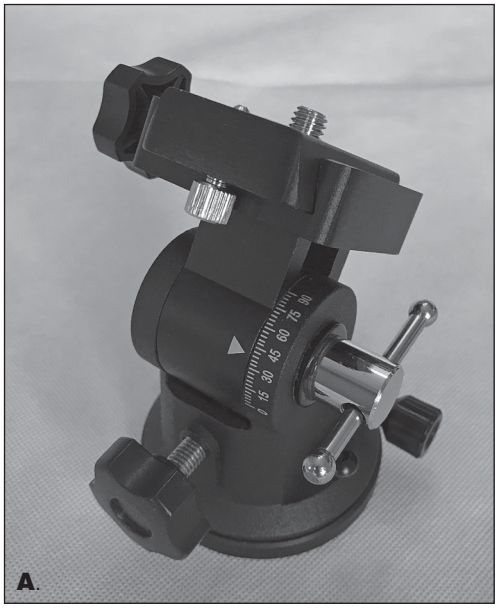

A.

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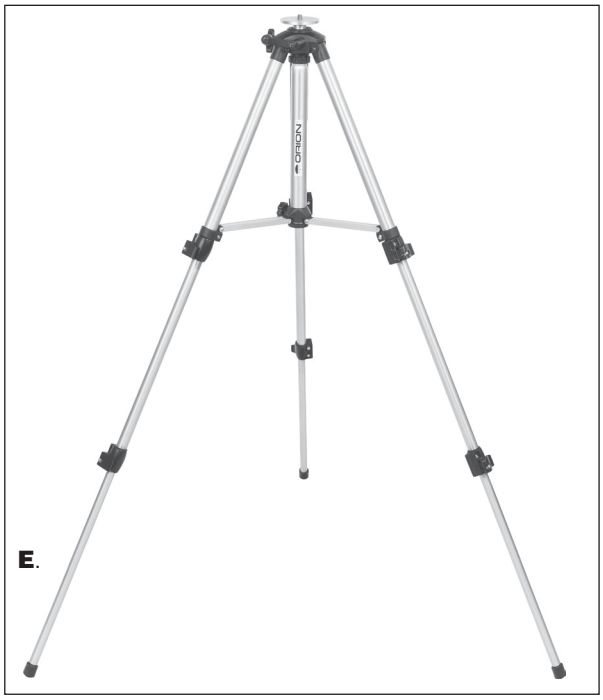


E.

Parts and Features Identification

1. SNAP Port: DSLR shutter control
2. Micro USB Port
3. Dovetail Lock Knob
4. Saddle
5. Saddle Rotation Lock Knob
6. Power Button
7. Power Status LED
8. Wi-Fi Status LED
9. Battery Compartment (2 x AA)
10. Tripod Mounting Disk Retaining Knob
11. Tripod Mounting Disk
12. 3/8" Threaded Side Socket (with 3/8" to 1/4" thread insert installed)

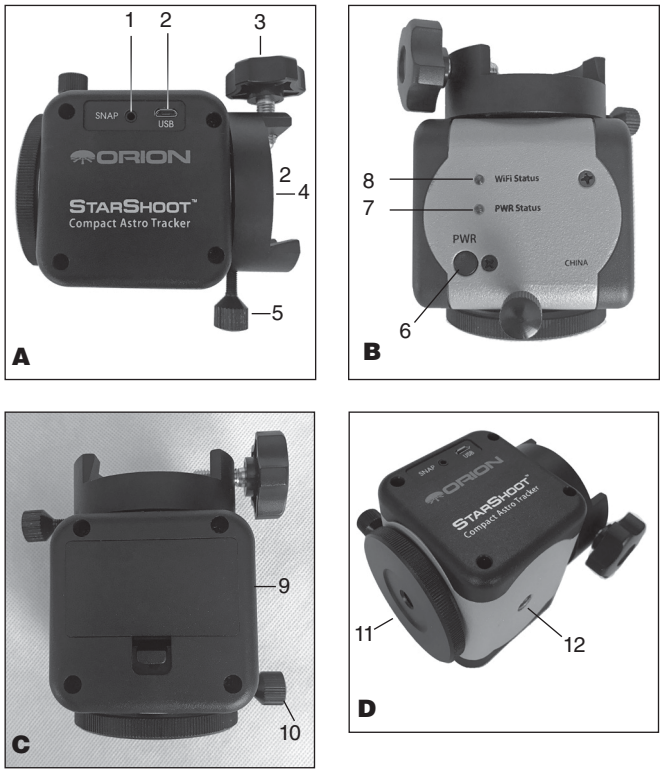


Figure 2. Familiarize yourself with the parts and features of the StarShoot CAT.

Introduction

The StarShoot Compact Astro Tracker (CAT) is a compact, versatile camera tracking module that excels for taking long-exposure night photographs and daytime or nighttime time-lapse videos. For astrophotography, StarShoot CAT's precise sidereal tracking enables long exposures of celestial objects while keeping star images pinpoint sharp. Use StarShoot CAT to capture jaw-dropping Milky Way nightscape shots and panoramic starscapes. Use the timelapse modes to "compress time" by capturing fun daytime time-lapses, or the rising of the Milky Way at night, or the progression of a lunar eclipse. The creative possibilities are endless! And you can do it all from the convenience of your smartphone or tablet running the free Tracker Console app.

Read on to learn how to set up StarShoot CAT for different applications and how to control it using the intuitive Tracker Console app.

Downloading and Installing the Tracker Console App

You will control the StarShoot CAT wirelessly via a Wi-Fi connection from your smartphone or tablet using the free Tracker Console app (**Figure 3**). The app is available for both iOS and Android platforms. Go to the App Store or Google Play, respectively, and search for the Tracker Console app, then download it to your device. Guidelines for use of the app are provided in the relevant sections of this manual.

Figure 3. The Tracker Console app icon

Basic Power-Up, Wi-Fi Connection, and Status LEDs

This section describes the basic power-up and Wi-Fi connection procedures for the StarShoot CAT. Please familiarize yourself with them before moving on to specific uses such as astrophotography, time-lapse, etc.

Power Sources: StarShoot CAT can be powered by two on-board AA type batteries or from a 5V external power source via USB, or from the USB port of a computer. Don't worry about frying the internal electronics by using a 5V power source instead of the 3V (2 x 1.5V) on-board AA batteries: StarShoot CAT has a 5V-to-2.8V DC converter inside.

Power On: Push and hold the PWR (power) button until the red Power LED lights up (**Figure 2B**). The green Wi-Fi LED will start to blink, indicating that the built-in Wi-Fi is activated and ready for connection to your smartphone or tablet.

Connect to Wi-Fi: After power-up, go to "Settings > Wi-Fi" on your phone, find and join the Wi-Fi access point "SynScanWi-Fi_xxxxxx". Start the Tracker Console app and tap the Connect button. Once the Wi-Fi connection is established you can run the Tracker Console app to access its many features. See specific details in the relevant sections.

Power Off: Press and hold the PWR button for about 5 seconds to turn off the power.

Reconnecting the Wi-Fi After a Time-out: In the absence of Wi-Fi traffic the StarShoot CAT's internal Wi-Fi automatically shuts off and the green Wi-Fi indicator light goes out. The default time-out is 10 minutes but you can set it to other values using the Tracker Console app. To resume Wi-Fi, press the PWR button briefly until the green Wi-Fi LED comes back on, then release the PWR button. Re-connect to the Wi-Fi as described above.

Refer to the sidebar below for a detailed description of all status indicators.

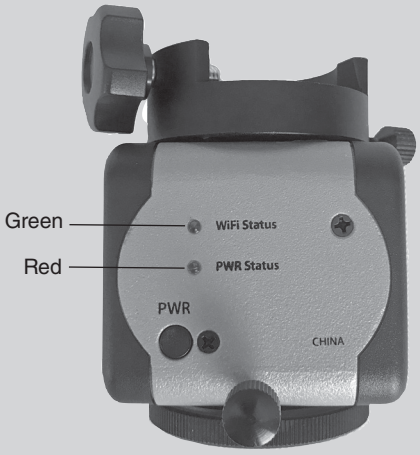
LED Status Indicators

Red LED Off: The power is off.

Red LED Solid On: Power is on and system is normal.

Red LED Slow Blink: Low Battery Level or Firmware Update in Progress. The red LED blinks two times per second when the battery level is lower than 2.3V, or during firmware upgrades.

Red LED Fast Blink: The red LED blinks three times per second to indicate motor speed errors exceeding 5% and/or motor stalls that last over 5 seconds. Speed errors can be caused by overloading the mount and by low battery levels. To correct a speed error reduce the load or supply new batteries. Motor stalls are usually caused by obstructions of the mount so that it cannot rotate. In the case of motor stalls, remove the obstruction, then restart your task.



Green LED Off: Wi-Fi is turned off.

Green LED Blinking: Wi-Fi is activated and ready for connection.

Green LED Solid On: Wi-Fi is connected and Tracker Console app is running.

Time-Lapse Photography with StarShoot CAT

There are three different time-lapse modes to choose from with the StarShoot CAT: *Regular-Exposure Time-Lapse, Long-Exposure Time-Lapse,* and *Astro Time-Lapse.*

Regular-Exposure Time-Lapse mode is for capturing time-lapse videos in daylight or well-lit conditions with short exposures. In this mode, exposure settings are set on your camera itself. The StarShoot CAT pans your camera and sends signals to trigger the shutter as it creates your time-lapse video.

In the *Long-Exposure Time-Lapse* mode StarShoot CAT controls the exposure time instead of your camera doing so. This way you can use exposures that exceed 30 seconds, which are often needed in low light conditions. Whenever you use *Long-Exposure Time-Lapse* mode set your shutter dial on your camera to BULB. If it is not set on BULB mode the camera shutter speed setting will be used instead.

You can make time-lapse videos using StarShoot CAT to control the shutter only (no panning), or to pan continuously while firing the shutter of your camera at intervals set by you. Use the first of these techniques to produce a time-lapse video from a fixed perspective and the second to create a time-lapse video in which the perspective moves – that is, the camera pans -- during the video.

Unlike in *Regular-Exposure Time-Lapse* mode, in *Long-Exposure Time-Lapse mode* rotation stops during the exposures. This enables the camera sensor to capture more of the available light resulting in a better image.

For the A*stro Time-Lapse mode,* the StarShoot CAT tracks the sky to allow amazing videos of celestial vistas.

Note that StarShoot CAT does not generate time-lapse videos for you; it just collects the individual exposures, which must then be combined into a time-lapse video using a third-party software program.

Setting Up for Regular Exposure Time-Lapse and Long Exposure Time-Lapse Operation

Attaching StarShoot CAT to Your Tripod

Set up your tripod and ensure it is stable and set at the desired height. The top of the tripod should be roughly level. For regular-exposure time-lapse photography StarShoot CAT should be mounted directly to the tripod via the tripod's 3/8" threaded post. If your tripod has a pan head or ball head mount attached, it is recommended that you remove it and attach StarShoot CAT directly to the tripod using the 3/8" threaded socket in the knurled Tripod Mounting Disk (**Figure 4**).

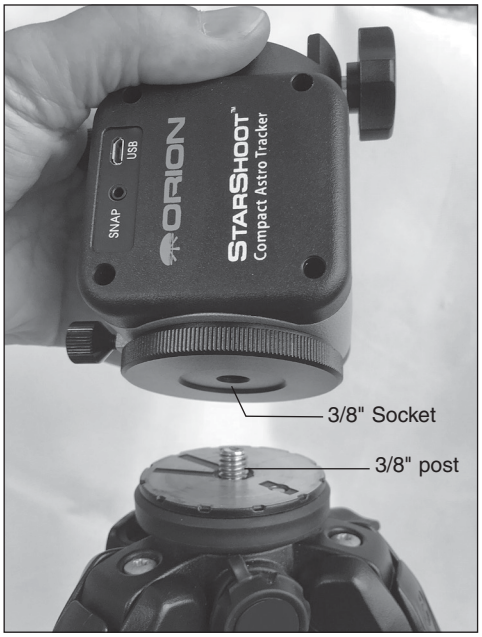


Figure 4

Mounting Your Camera

Now you can attach your camera gear **(Figure 5)**. We recommend attaching the included Ball Head Mount to the StarShoot CAT and attaching your camera to the Ball Head. The Ball Head will give you the ability to aim the camera in any direction, allowing far more flexibility and control when composing your shots. Once your camera is attached to StarShoot CAT, it's time to connect them electronically using the appropriate SNAP Cable (sold separately) for your camera model. One end plugs into the camera's shutter control port and the other into the SNAP port on StarShoot CAT.

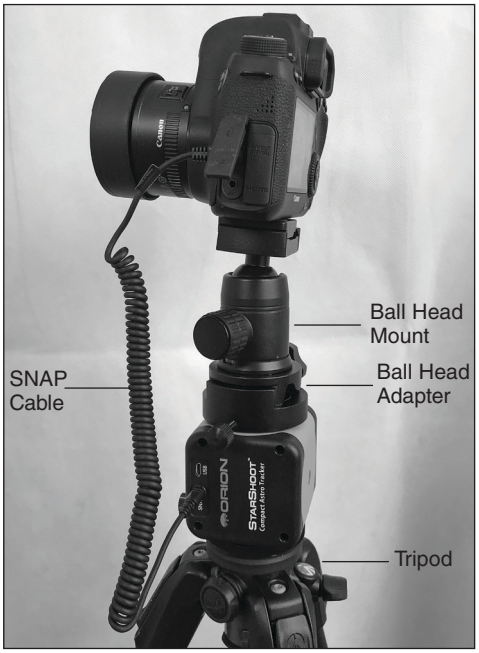


Figure 5

Orion BHM-13 Panoramic Ball Head Mount

A ball head mount is the perfect camera mounting platform because it is easily adjustable, solid when tightened, and allows pointing of the camera in any desirable direction. We recommend using the included Orion BHM-13 Panoramic Ball Head Mount with the StarShoot CAT for all photographic and time-lapse applications except possibly when using the Dec Bracket with its Dec Platform.

The BHM-13 Panoramic Ball Head Mount has a weight capacity of 13.2 lbs. (6 Kg), which well exceeds the load capacity of the StarShoot CAT itself.

To attach the Ball Head Mount to the StarShoot CAT, just thread it onto the 3/8" post of the included Ball Head Adapter via the 3/8" socket on the bottom of the Ball Head Mount. Then slide the Ball Head Adapter into the saddle of the StarShoot CAT and lock it in place with the dovetail lock knob.

Remove the Ball Head Mount's quick release (QR) plate by turning the QR plate lock knob counterclockwise until it stops. Then remove the plate. Attach the QR plate to the bottom of your DSLR camera via the ¼"-20 post until tight. Then place the QR plate back into the saddle of the Ball Head Mount and tighten the QR plate lock knob.

Using the Tracker Console App for Time-Lapse Photography

Now you are ready to start making time-lapse videos using the Tracker Console app on your smartphone or tablet. This section assumes that you have installed the app on your device. If you have not, please refer back to the section titled Downloading and Installing the Tracker Console App on page 4.

Figure 6

Boot up the Tracker Console App. The main screen will be displayed (**Figure 6**). From the main screen, select *Regular-Exposure Time-Lapse* by tapping on it. This is the simplest mode for StarShoot CAT and a good one for helping you get the hang of setting the control parameters.

Regular- and Long-Exposure Time-Lapse Parameters

The parameters for *Regular-Exposure Time-Lapse* and *Long-Exposure Time-Lapse* are identical except for the *Exposure* parameter. On the *Regular Exposure Time-Lapse* screen you cannot change the value for *Exposure*. It is fixed at 0.5 seconds, which is a requirement for StarShoot CAT to provide an adequate signal to control the camera shutter. Note: This 0.5-second period is automatically taken into consideration when the App calculates the *Video Time* Span parameter.

In the *Long-Exposure Time-Lapse* mode the *Exposure* parameter controls the shutter speed setting of your camera and can be set to suit your needs. For night scenes individual exposures may range from a second or two to several minutes. Take some test shots to establish the best settings and exposure for your needs, then enter that value into the *Exposure* parameter field. Again, you must set your camera to BULB mode, otherwise the shutter speed setting on your camera will take precedence over the value in the *Exposure* field.

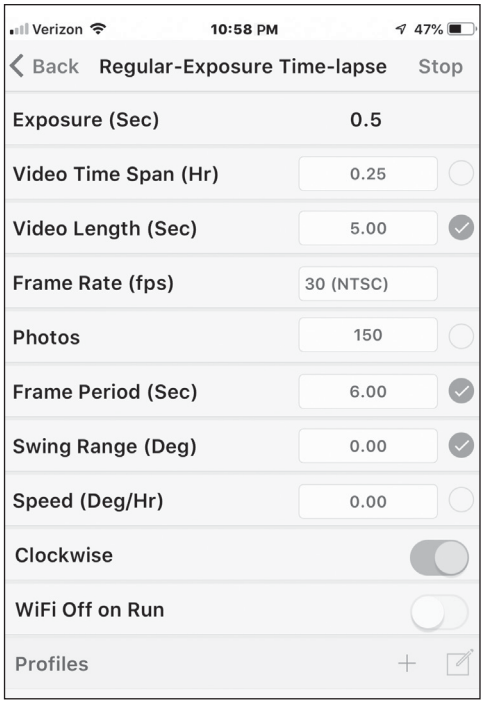


Figure 7

The screen shot in **Figure 7** shows the various parameters that you can set to create your time-lapse video. All of the parameters are explained in detail below.

The simplest way to get started is to set StarShoot CAT up on a tripod and take a static time-lapse video (one that doesn't involve panning). To do this, all you need to know is the time span over which your video will be taken and the desired length of your final video. For instance, if you want to get a time-lapse video covering the last hour leading to sunset, enter a value of 1 for *Video Time Span*. If you want to compress that hour into a 45-second video, set your *Video Length* to 45. It's that easy. The Tracker Console app will calculate the other necessary parameters for you.

Once all of your parameters are set, just tap Run to start the time-lapse sequence. If you are happy with a set of parameters you can save them in a profile to recall again whenever you like.

Time-Lapse Parameter Details

The following is a complete list of the parameters you can set. Note that because several of the parameters are interdependent some may be unavailable at certain times. For instance, when *Frame Rate* and *Video Length* are set you cannot manually choose the number of Photos, as it is calculated for you based on the other two parameters. However, if you deselect

Video Length and set Photos directly, the app will calculate a new value for *Video Length.*

Exposure (Sec): Fixed at 0.5 seconds for *Regular-Exposure Time-Lapse*. For *Long-Exposure Time-Lapse* set this value to suit your exposure requirements. Be sure to set your camera shutter to BULB mode.

Video Time Span (Hr): Set this parameter to the total *Video Time Span* time for your video in hours. For example, if you want your video to cover a span of three hours, set *Video Time* Span to 3. Note that *Video Time* Span does not refer to the length of your video, it refers to the time span over which it is photographed. You set the desired length of your video in the *Video Length parameter.*

Video Length (Sec): Set *Video Length* equal to the desired length of your video in seconds. For a one-minute long video, set *Video Length* to 60.

Frame Rate (fps): Select *NTSC (30 fps)* or *PAL (25 fps)* according to the video standards for your location. You can further adjust the playback speed of your video in your video editing software. In the United States, *NTSC* is the standard.

Photos: This parameter is automatically set by setting *Video Length* and *Frame Rate* using the formula: *Photos = Video Length x Frame Rate*

Frame Period (Sec): You can set the *Frame Period* to select a desired interval between photos taken rather than have it calculated for you based on other parameters. Note that if you set *Photo Interval* and Video Length the app will re-calculate Video Time Span. Anytime you are changing a parameter it is a good idea to check its effects on the other ones.

Swing Range (Deg): Use *Swing Range* to create an interesting swing or pendulum effect for your time-lapse video. When used, StarShoot CAT will pan to the limit of the *Swing Range* that you set, then pan back to your starting point as many times as specified in the *Swing Count* parameter.

For instance, say you have two interesting subjects that you want to feature in your video. Set *Swing Range* to the angle between them and *Swing Count* to 1, then point your camera at the first subject. As the time-lapse video is being recorded, StarShoot CAT will pan from the first subject to the second subject, then stop. By setting *Swing Count* to 2, it will pan to your second object, then back to your first object, then stop. By using *Swing Range* values greater than 1 you can have StarShoot CAT pan back and forth multiple times during the video. Set *Swing Range* to 0 for no panning and to an even number to always end up where you started.

Speed (Deg/Hr): *Speed* determines how quickly StarShoot CAT will pan in degrees per hour. In most cases, you do not need to set this parameter unless you want to control the panning speed but are not concerned with the actual video time span. If you do not want StarShoot CAT to pan in your time-lapse video then set *Speed* to 0.

Clockwise: *ON* will cause StarShoot CAT to rotate left to right (viewing down with the saddle on top). *OFF* will cause StarShoot CAT to rotate right to left.

Wi-Fi Off on Run: When enabled, StarShoot CAT will automatically turn off Wi-Fi at the start of a task to save power. Wi-Fi can be restored at any time by pressing and holding the power button until the green LED Wi-Fi indicator light comes on.

Profiles Save / Edit: To save a profile tap *Save*. To edit or delete a profile tap *Edit*. You can store multiple profiles of your favorite settings for recall at future sessions.

Time-Lapse Progress Screen

Once your tripod, StarShoot CAT, and camera are set up and all of your task parameters are set, just press *Run* to start the task. Your parameter settings will remain in view and Status will appear at the bottom of the screen. To view the task progress tap on *Status*. (See **Figure 8**.)

Pressing *Stop* brings up a confirmation screen; you can cancel the Stop request and resume the task or proceed to end the task at that point.

The *Long-Exposure Time-Lapse* progress screen shows the same information and works in the same manner.

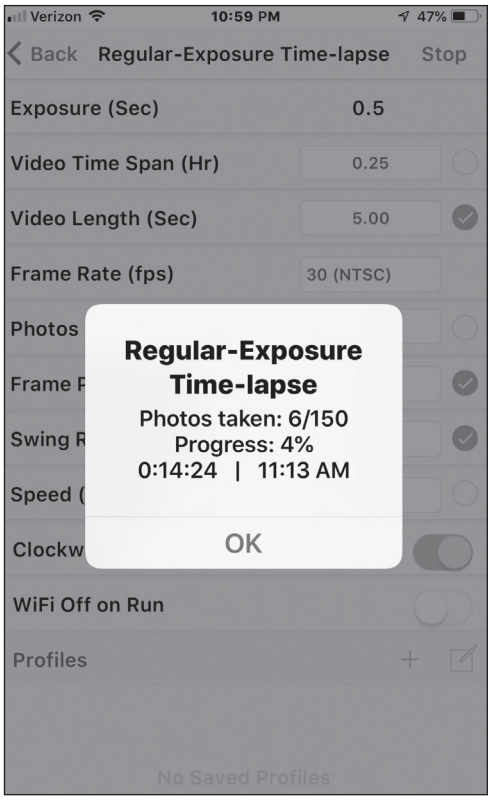


Figure 8

Astro Time-Lapse Using the StarShoot CAT

One of the most powerful features of StarShoot CAT is its ability to create time-lapse videos of celestial vistas. Now you can do this in *Regular-Exposure Time-Lapse* or *Long-Exposure Time-Lapse* mode – for instance, taking a video of the Milky

Way rising or a constellation moving across the sky. But in those modes you are not tracking the sky – and the StarShoot CAT is not polar aligned – therefore you will be limited in the length of exposures you can make before trailing of the stars occurs.

The beauty of the Astro Time-Lapse mode is that it combines StarShoot CAT's astrophotography functions with its time-lapse functions. That means you can take longer exposures without trailing, so instead of a 30-second exposure you can go for 60 or 90 seconds, or whatever you like. Doing so will result in a brighter foreground and greater resolution of the star field or Milky Way. You might wonder that if the StarShoot CAT is tracking the sky, won't the foreground move slightly with each image, causing it to "smear"? Yes, but it's fairly negligible because StarShoot CAT automatically returns to the starting point after each exposure, which keeps the foreground in reasonably sharp focus. Pretty cool!

Note that to capture astronomical time-lapse videos you must polar align StarShoot CAT as described in *Appendix I*. Below are the parameters you can set in the Tracker Console app along with explanations for how they're used to produce astronomical time-lapse videos (**Figure 9**).

Exposure (Sec): *Exposure* should be set to a value that is sufficiently long to record detail in the nighttime sky, which is typically longer than 30 seconds. Be sure that your camera is attached to StarShoot CAT via the SNAP control cable, then set your exposure time in this field. Make sure also to set your camera to BULB mode, otherwise your shutter will close according to whatever shutter speed is selected on your camera.

Video Time Span (Hr): *Video Time Span* refers to the amount of real time (in hours) that will elapse from the start to the end of the recording. *Video Time Span* is affected by Exposure, Photos, *Video Length and Frame Rate*, and will be calculated based on the parameters you set. However, you can also directly set a value for *Video Time Span*. For instance, if you want to follow the Moon for 5 hours to record the stages of a lunar eclipse, you could set *Video Time Span* to 5. Set the length of your desired time-lapse video in *Video Length* and the appropriate frames per second (fps) in Frame Rate. Other related parameters will then be calculated automatically.

Video Length (Sec): Set this parameter to the desired length in seconds of your finished time-lapse video. You can set this parameter directly, or you can allow it to be calculated for you based on the values of other parameters.

Frame Rate: Select *NTSC (30 fps)* or *PAL (25 fps)* according to the video standards for your location. You can further adjust the playback speed of your video in your video editing software.

Photos: Enter the number of exposures you wish to make up your video. It is usually easier to let this field be calculated based on settings for other parameters. For instance, you have more creative control on your time-lapse video by setting the *Video Time Span* and the *Video Length parameters*, and letting the app calculate the number of Photos that will be required.

Tracking Rate: If you are making a time-lapse video of the Moon then select *Lunar*. Otherwise, select *Sidereal*.

Wi-Fi Off on Run: When enabled, StarShoot CAT will automatically turn off Wi-Fi at the start of the task to save power. Wi-Fi can be restored at any time by pressing and holding the power button until the green LED Wi-Fi indicator light comes on.

Profiles Save / Edit: To save a profile tap *Save*. To edit or delete a profile tap *Edit*. You can store multiple profiles of your favorite settings for recall at future sessions. Once your tripod, StarShoot CAT, and camera are set up and all of your task parameters are set, just press *Run* to initiate the task. This will bring up your *Progress Screen*.

Astro Time-Lapse Progress Screen

Once your task has started tap Status to review information regarding the number of photos completed and time remaining **(Figure 10)**.

Night Sky Photography (Astrophotography) with the StarShoot CAT

With the StarShoot CAT you will be able to take stunning photographs of constellations, the Milky Way band, star clusters, galaxies, and gaseous nebulas. But before you do, let's start with why you need a tracking mount in the first place. What benefit does the StarShoot CAT offer for night sky photography, or astrophotography?

The answer is that it solves two problems that you don't encounter in typical, terrestrial types of photography. One is the need to use long exposures (e.g., greater than 30 seconds)

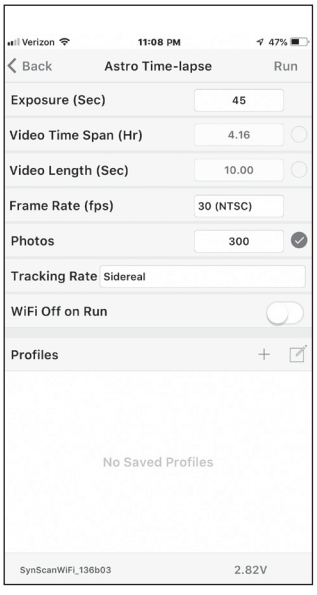


Figure 9

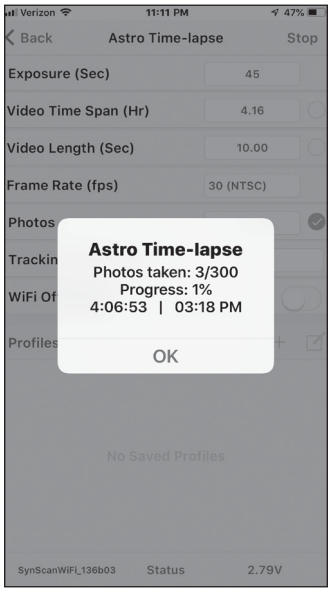


Figure 10

to record dim night sky objects. The second is the need to have the camera follow – or "track" – the sky during the exposure.

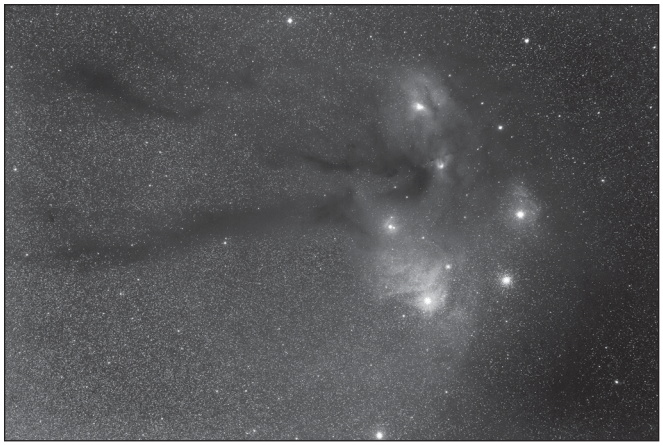


Figure 11. Antares region of Scorpius at 200mm. This is a stack of 30 1-minute exposures tracked with StarShoot CAT.

Why Take Long Exposures?

For night sky photography, you need a sufficiently long exposure for your camera to collect enough light to reveal celestial objects that are much too faint for our eyes to see. Many DSLR cameras can be set to take up to a 30-second exposure, which may be sufficient for shooting some night sky subjects. But you can take an even longer exposure -- like a minute or two, or four! -- by selecting the BULB mode on your camera and using StarShoot CAT's SNAP cable connection to really capture the starfield or celestial object in glorious detail (see **Figure 11**.)

But solving the exposure problem reveals the second problem.

The Need for Tracking

In your now nicely exposed photo, the stars don't look like sharp pinpoints anymore – they're "smeared" into little lines and arcs! This is called trailing, and it becomes more noticeable as the focal length of your lens and/or your exposure time increases.

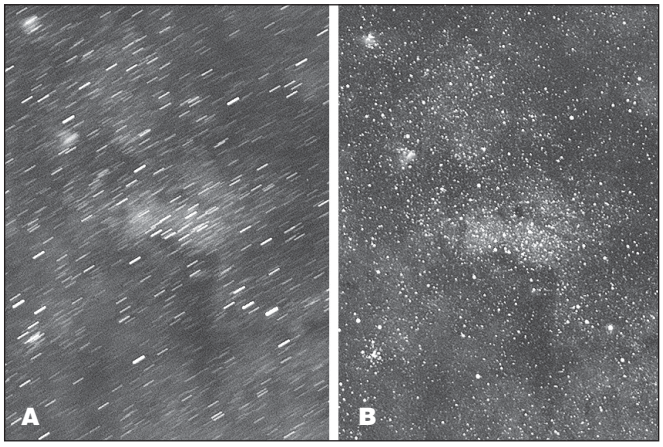


Figure 12. Two 60-second exposures at 24mm. **A)** No tracking – star trailing is evident. **B)** Tracked with StarShoot CAT – stars are sharp.

Star trailing is caused by the rotation of the Earth on its axis. It's the same phenomenon that causes the Sun and Moon to appear to rise and move across the sky and then set every day. The Earth's rotation also causes the stars to move across the sky from east to west over the course of a night. And a camera sitting still on a tripod will, after a relatively short period of time, record that apparent movement of the stars as streaks, or trails. (See **Figure 12A.**)

StarShoot CAT overcomes this problem by moving your camera precisely at the same rate that the Earth is rotating, which negates the effects of that rotation while a long exposure is being made. Such tracking keeps the specific area of the sky you're targeting from moving relative to the camera's sensor, so stars remain pinpoints and everything stays sharp rather than smearing (**Figure 12B**).

So with StarShoot CAT, two of the primary challenges in doing astrophotography are simplified and automated for you. First, StarShoot CAT's camera control function enables you to take exposures longer than 30 seconds in duration. Second, its tracking capability compensates for the Earth's rotation to produce pinpoint star images even with long exposures. As your skill level in night sky photography progresses you can set StarShoot CAT to take multiple, successive images of your subject, then use post-processing techniques like stacking and stretching to produce truly rich, detailed celestial images.

Setting Up for Night Sky Photography

For long exposure night sky photography, or astrophotography, you will need the Equatorial (EQ) Base (sold separately). This will allow you to precisely polar align the StarShoot CAT so that it can track the sky. The polar alignment procedure is described in detail in Appendix I.

To assemble the components of the StarShoot CAT needed for night sky photography, follow these steps:

1. Set up your tripod and ensure it is stable.
2. If you have a pan head or ball mount on the tripod, remove it. Doing so should expose a 3/8" threaded post. Attach the EQ Base to the tripod's 3/8" threaded post via the 3/8-inch threaded mounting hole on the bottom of the EQ Base.
3. Once the EQ Base is securely attached, align the tripod so that the Altitude Adjustment Knob on the EQ Base is facing north.
4. Now, level the tripod as best you can by eye. It is not required that the EQ Base be level for night sky photography, but it makes subsequent adjustments easier.
5. Next, loosen the Altitude Lock Handle a bit, then rotate the Altitude Adjustment Knob until the Altitude Indicator points to your latitude on the Altitude Scale **(Figure 13)**. (The altitude of Polaris above the horizon at your location matches your latitude). If you don't know your latitude you can look it up in the Tracker Console app under Settings: Location (assuming the GPS function of your phone is

enabled), or on the internet. The retighten the Altitude Lock Handle.

6. Next, attach StarShoot CAT to the Dovetail Mounting Plate included with the EQ Base; the 3/8" post of the mounting plate threads into the 3/8" socket in the side of the StarShoot CAT housing. (You will likely have to first remove the 3/8"-to-1/4" thread insert that comes installed in that socket.) Orient the Plate so that the end with the Safety Stop is nearest the StarShoot CAT's Saddle, as shown in **Figure 14**. Use a quarter, a large flat blade screwdriver, or (preferably) the included 4mm Allen wrench to tighten the bolt head on the underside of the Dovetail Mounting Plate.
7. Now slide the Dovetail Mounting Plate into the Saddle of the Equatorial Base, as shown in **Figure 15**, then tighten the Saddle Lock Knob to secure it.

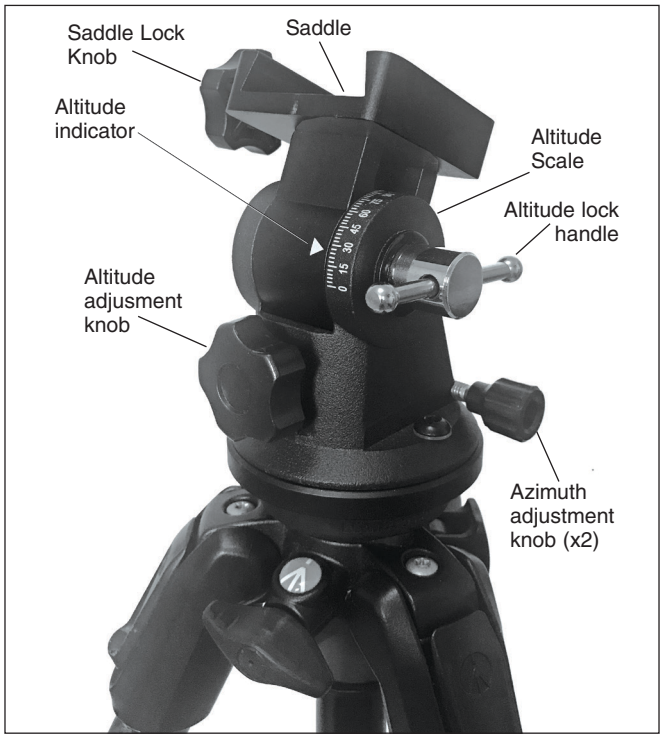


Figure 13

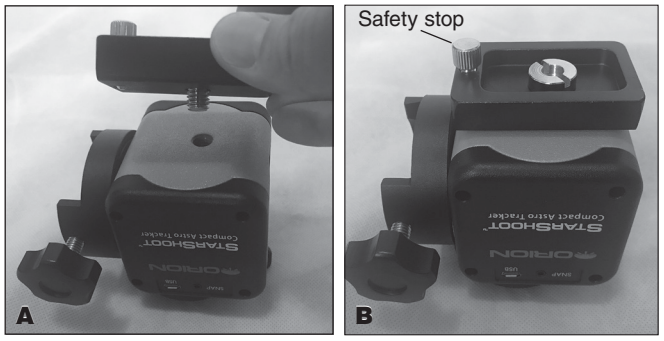


Figure 14

8. Remove the Tripod Mounting Disk from the back of the StarShoot CAT (refer to **Figure 2).** To do this you will need to loosen the Mounting Disk Retaining Knob one full turn or so.
9. Once the plate is removed, fully insert the Polar Scope into the exposed hole (**Figure 16**). It should snap into place.
10. Finally, you will install the Polar Scope Illuminator on the front end of the Polar Scope. First, assemble the grip adapter to the Illuminator as shown in **Figure 17A**. Then fit the grip adapter over the exposed end of the Polar Scope (**17B**).

Connecting the SNAP Camera Control Cable

Make sure you have the correct SNAP camera control cable for your particular camera brand and model. Insert the camera end of the cable into the camera's shutter release port and the 2.5mm mini stereo plug end into the SNAP port on the StarShoot CAT. You're all set!

Polar Alignment

With the StarShoot CAT now assembled for night sky photography, it's time to polar align. Please refer to Appendix I for the detailed procedure.

Figure 15

Figure 16

Figure 17

Installing the Battery in the Polar Scope Illuminator

1. Unthread the knurled battery compartment cap of the Illuminator.

2. Place the 3V CR-2032 lithium battery in the compartment, positive (+) side facing up.

3. Replace the battery compartment cap.

Operating the Polar Scope Illuminator

To turn the Illuminator on, rotate the brightness (MIN/MAX) dial until the red LED bulb lights up. Adjust the brightness of the LED to the desired level between MIN and MAX with the brightness dial. To turn off the Illuminator, turn the brightness dial all the way to the MIN setting. (Note: The ON/OFF dial is for removal/replacement of the threaded battery cover.)

Using the Tracker Console App for Night Sky Photography

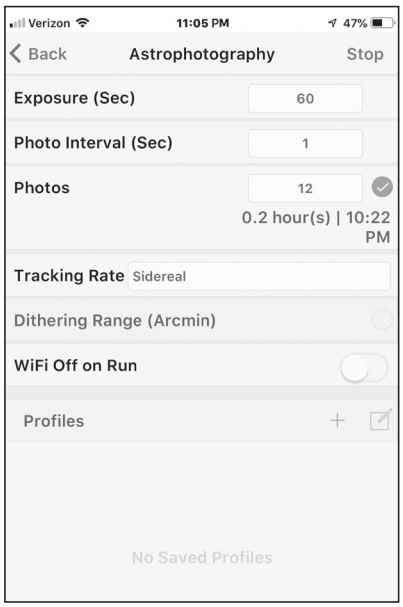


Figure 18

For Astrophotography, or night sky photography, there are only a few parameters that need to be set. These are described below (refer to **Figure 18**):

Exposure (Sec): *Exposure* should be set to a value (in seconds) that is sufficiently long to record detail in the nighttime sky, which is often longer than 30 seconds. Be sure that your camera is attached to StarShoot CAT via the SNAP control cable, then set your exposure time in the Exposure field. Be sure your camera is set to BULB mode, otherwise the shutter will close according to whatever shutter speed is selected on your camera.

Photo Interval (Sec): This is the time in seconds between the end of one exposure and the beginning of the next exposure. StarShoot CAT continues to track the object during the *Photo Interval*, then resumes with the next exposure once the *Photo Interval* has elapsed.

Photos: Enter the number of exposures you wish to capture of the subject. You can combine multiple exposures of an object into a single image in post processing to increase the signal-to-noise ratio. In other words, by digitally "stacking" multiple images of the same target, you will see less noise (graininess) and more detail than can typically be recorded in a single long exposure.

Tracking Rate: The StarShoot CAT can be set to one of three different tracking rates: *Sidereal, Lunar,* or *Solar*. While stars (other than our Sun) and deep-sky objects move at the Sidereal rate, closer objects such as the Moon and Sun move at slightly faster rates. Choose *Sidereal* if you are shooting the Milky Way or a constellation, and *Lunar* if you are tracking the Moon (e.g., to record the stages of a lunar eclipse). *Solar* is reserved for advanced uses where specialized equipment – most notably a protective solar filter -- is being used to photograph the Sun.

Wi-Fi Off on Run: When enabled, StarShoot CAT will automatically turn off Wi-Fi at the start of a task to save power. Wi-Fi can be restored at any time by pressing and holding the power button until the green LED Wi-Fi indicator light comes on. If you encounter any problems, reconnect to StarShoot CAT's network on your device.

Profiles Save / Edit: To save a profile tap *Save*. To edit or delete a profile tap *Edit.* You can store multiple profiles of your favorite settings for recall at future sessions. Once your tripod, StarShoot CAT, and camera gear are set up and all of your task parameters are set, just press Run to initiate the task. This will bring up your *Progress Screen*.

Astrophotography Progress Screen

Any time you have a process running you can view its progress by tapping on Status at the bottom of the parameters screen. This brings up information about number of photos taken, percentage of task complete, etc. The information may vary slightly depending on which function you are currently using.

Manual Control of the StarShoot CAT

Manual Control gives you the ability to nudge your camera, but without touching it directly – a handy feature when you need to tweak your composition to get that perfect shot, or to move

the camera incrementally, without bumping your gear out of alignment.

Go to the Main Menu and tap on *Manual Control*. This will bring up the manual control arrows on either side of an angle given in degrees, minutes, and seconds (**Figure 19**). Tap or touch and hold the arrow symbols to nudge or continuously move StarShoot CAT to the left or right, respectively. Release the arrow symbol to stop StarShoot CAT's movement. The angle you have rotated through will show up between the arrows.

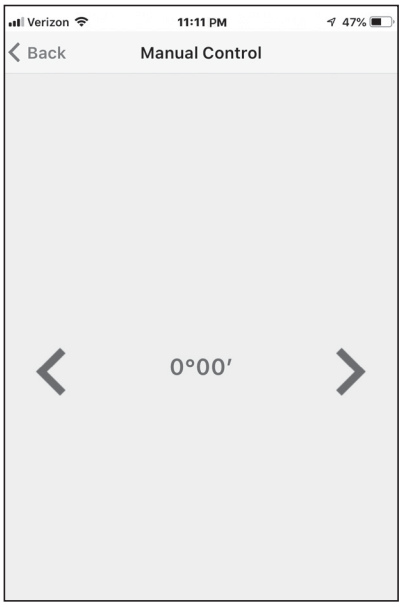


Figure 19

You can also use *Manual Control* to determine the *Swing Range* for your time-lapse video compositions. For instance, say you have two points of interest and want your video to swing from one to the other. Aim your camera at the first point, then Zero the counter. Now, tap and hold the arrow keys until your camera is pointing at your second point of interest. Record the angle that is showing between the arrows and enter it as your *Swing Range* parameter when you are ready to create your time-lapse video.

Reviewing the Settings of the Tracker Console App

Tap on Settings on the home screen to set a variety of device functions as detailed below.

Language: Choose the default language for the Tracker Console.

Night Mode: This mode is designed to help preserve your dark adaptation. Tap and choose *On* or *Auto* to display a black background with red text. Note: if there are any visual astronomers in your vicinity you should set the app to *On* as a courtesy to them.

Location: Tap to get a sub-menu that gives you the option to use the location sensor in your device to set your current longitude and latitude. If the sensor is disabled you can enter the coordinates manually. Location determines the hemisphere you are in and sets the correct rotation direction for *Astrophotography* and *Astro Time-Lapse* functions. It is also used to display the position of Polaris and Octans on the Polar Scope reticle.

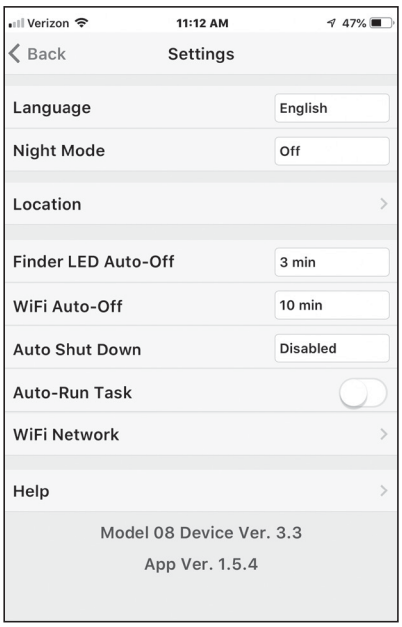


Figure 20

Finder LED Auto-Off: After the selected delay the Polar View Finder LED will automatically turn off. To turn on the LED again just quickly press StarShoot CAT's Power button, or set the LED to on using the Tracker Console.

Wi-Fi Auto-Off: Tap to choose a delay to automatically turn off Wi-Fi to preserve power. Wi-Fi will turn off when no Wi-Fi activity is detected during the *Auto-Off* interval. You can turn it back on by quickly pressing and releasing StarShoot CAT's Power button. Note: Wi-Fi is not needed once parameters for a given task have been set.

Auto Shut Down: To save power StarShoot CAT will automatically turn off after the specified amount of time if no tasks are running and there have been no communications between StarShoot CAT and the Tracker Console app.

Auto-Run Task: If enabled, StarShoot CAT will automatically re-start the previous photography process the next time the power is turned on.

Wi-Fi Network

Tap on *Wi-Fi Network* to bring up the Wi-Fi options as detailed below. You can choose either *Access Point (AP) Mode* or *Station (STA) Mode.* Use AP mode for a basic connection to StarShoot CAT. Use STA mode if you wish to control StarShoot CAT while simultaneously being connected to a wireless network (e.g., for internet access) or want to control StarShoot CAT remotely via the internet. Be sure that you have the correct *STA SSID* and *Password* information. If you enter the incorrect information you may need to reset StarShoot CAT to its factory settings using the procedure outlined on p. 21.

Access Point (AP) Mode: This is the default and simpler mode. In AP mode StarShoot CAT acts as a wireless access point so that you can connect to it via the Tracker Console.

AP Mode SSID: The SSID will automatically appear based on the SSID you entered to make your initial Wi-Fi connection. Select it to connect your device to StarShoot CAT. Before attempting to connect be sure that StarShoot CAT is powered up and the green Wi-Fi light is blinking. The green light signals that StarShoot CAT is ready to make a Wi-Fi connection.

AP Mode Security: Select *Open* if no encryption is to be used. Otherwise, tap on the settings field and choose an encryption type from the list.

Station Mode (STA): Choose this mode if you wish to have internet access while using StarShoot CAT, control StarShoot CAT via the internet, or to save battery power. When you select *STA mode* StarShoot CAT will join an existing Wi-Fi network. To use *STA Mode*, select it, then set the SSID and Password for the network you are joining. When all of your selections are made click on *Apply.* StarShoot CAT will restart and join the network. The new settings will be stored in StarShoot CAT's memory and will remain there until the settings are changed.

STA SSID: Select the network you wish to join and enter the SSID for that network.

STA Password: Enter the *Password* for the network you have selected to join.

STA Use DHCP: Turn this off ONLY if you want to set the IP address manually.

Network Troubleshooting

Re-establish Wi-Fi Connection

The Wi-Fi connection to StarShoot CAT will disconnect if either the SSID or Password is modified. If you lose your Wi-Fi connection please follow the procedures to reconnect your device to StarShoot CAT as outlined on pages 4-5.

Appendix I. Polar Alignment

In order to accurately track the movement of the night sky, the rotation of the camera must occur about an axis that is parallel to Earth's rotational axis. Therefore, the two axes must be aligned with each other before StarShoot CAT's tracking feature is turned on.

Polar Alignment refers to the procedure for aligning StarShoot CAT's rotational axis with the Earth's rotational axis. If we extend Earth's rotational axis out into space it intersects an imaginary point called the Celestial Pole. In the Northern hemisphere that point is called the North Celestial Pole, or NCP. In the Southern hemisphere it is the South Celestial Pole, or SCP.

Because the celestial poles are imaginary points, you can't see them. Fortunately, there are a couple of celestial "landmarks" close to the poles that help us pinpoint them. In the northern hemisphere that landmark is Polaris, the North Star. In the southern hemisphere it is the star Sigma Octantis.

Polar Alignment in the Northern Hemisphere

To successfully polar align the StarShoot CAT in the northern hemisphere, you must perform the procedure at night with an unobstructed view of Polaris. To find Polaris in the sky, look north and locate the pattern of the Big Dipper **(Figure 21)**. The two stars at the end of the "bowl" of the Big Dipper point right to Polaris. If you need help determining which direction is north, you could use your smartphone's compass feature or find a physical compass to point the way.

Assuming you already followed the setup procedure detailed on pages 10-11, the next step is to turn on the Polar Scope Illuminator. A red LED bulb illuminates a reticle inside the Polar Scope (**Figure 22**). Now when you peer into the eyepiece end of the Polar Scope you should see the illuminated reticle pattern. (You can familiarize yourself with the reticle in daytime without the need for the Illuminator.) Adjust the intensity of the Illuminator by turning the brightness (MIN/MAX) dial. You want enough brightness to see the reticle pattern, but not so much that it overpowers your view of Polaris.

Orient the tripod so that the Polar Scope is roughly aimed at Polaris when you "eyeball" it **(Figure 23).** Next, rotate the Polar Scope so that the "0" label on the reticule pattern is at the 12 o'clock position (i.e., at the top, as in **Figure 22**). When positioned correctly the "3" will be seen at the right, "6" and the bottom and "9" to the left. Use the Altitude and Azimuth Adjustment Knobs on the EQ Base to move the Tracker incrementally while viewing through the Polar Scope, until you can see Polaris in the field of view. (For the Azimuth Adjustment Knobs, turn one clockwise and the other counterclockwise the same amount, or vice versa.) It doesn't matter where it is in the field of view at this point; you will make fine adjustments to position Polaris where it needs to be in a moment.

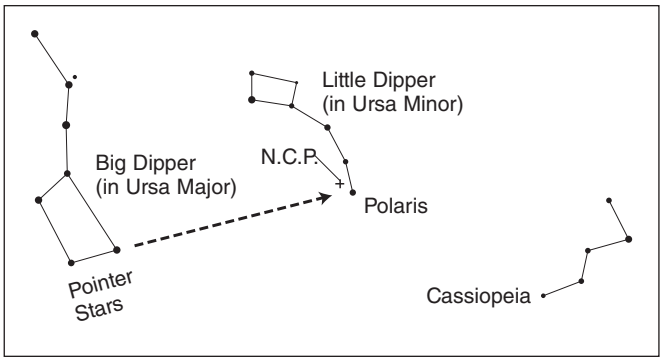


Figure 21

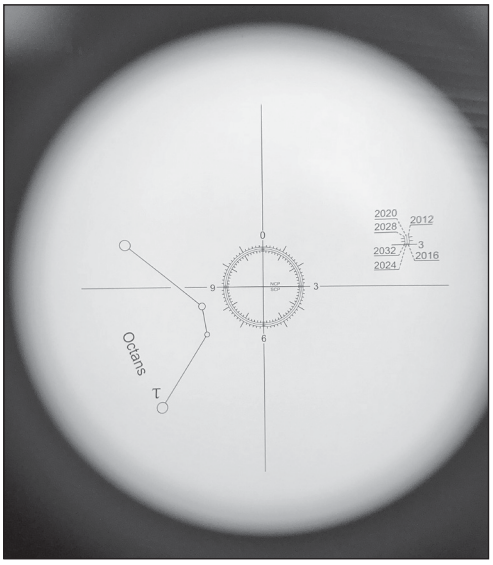


Figure 22

Figure 23

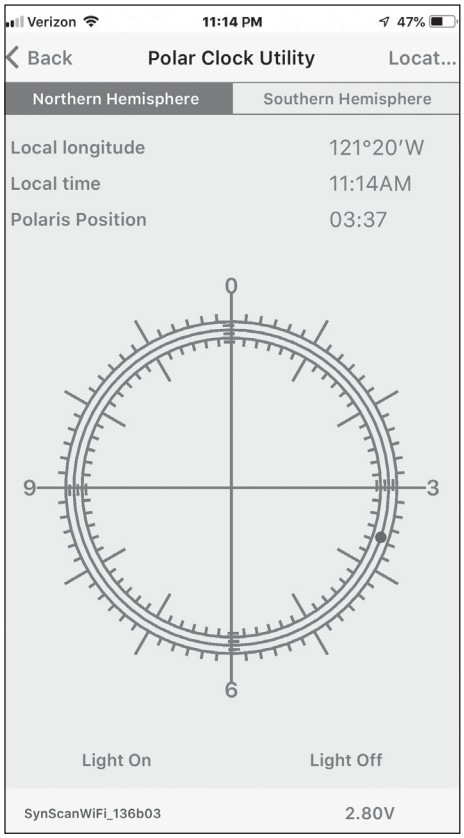


Figure 24

Using the Polar Clock Utility to Nail Your Polar Alignment

Select the Polar Clock Utility in the Main Menu of the Tracker Console app. Tap on Northern Hemisphere if it is not already selected. The app displays a graphic that matches the reticle in the Polar Scope (**Figure 24**). Note the position of the small black dot - it represents Polaris and shows where Polaris should be located relative to the NCP at the current time.

Without moving the tripod itself, turn the Altitude and Azimuth Adjustment Knobs until the position of Polaris in the Polar Scope matches that of the black dot. When it does, you are precisely polar aligned with the NCP (represented by the intersection of the perpendicular lines at the center of the reticle).

Now carefully remove the Polar Scope Illuminator and Polar Scope, making sure that you do not disturb the position of the tripod in doing so. NOTE: You do not have to remove the Polar Scope completely; you can just back it out enough (about ½") so that the end of it does not protrude into the StarShoot CAT's saddle.

Now that the StarShoot CAT is polar aligned, you can go ahead and attach your Ball Head Mount or Declination Bracket, your camera, and the SNAP cable connecting the StarShoot CAT to your camera. NOTE: If you are using the optional Declination Bracket you can perform the polar alignment procedure with all of your gear already mounted. More on that later.

Attaching the Panoramic Ball Head Mount and Camera

The Ball Head Mount will allow you to aim the camera at any area of the sky. Attach the Ball Head Adapter to the bottom of the Ball Head Mount by threading the adapter's 3/8" post into the 3/8" socket in the bottom of the Ball Head Mount until tight. Then slide the Ball Head Adapter into the StarShoot CAT's Saddle and tighten the Saddle Lock Knob (**Figure 25**).

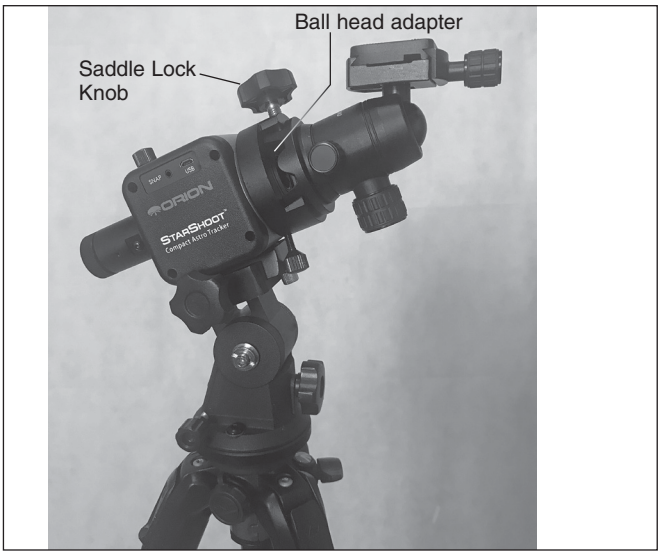


Figure 25

Now remove the quick-release (QR) plate from the Ball Head Mount by loosening the QR plate lock knob as far as it will go. This will allow you to lift the QR plate out. Attach the plate to the bottom of your camera via the ¼"-20 threaded post. Then with the camera attached to the QR plate, re-insert the plate into its saddle and tighten the QR plate lock knob.

Polar Alignment in the Southern Hemisphere

Unfortunately, there are no bright reference stars in the immediate vicinity of the Southern Celestial Pole (SCP), so the polar alignment procedure is a little more involved. However, there is a small group of stars near the SCP that can be seen in your Polar Scope. Once you have this group of stars in view, a precision polar alignment is just as easy to achieve in the Southern Hemisphere as it is in the North, with the aid of the Polar Clock function included in the Tracker Console app.

We'll start with a coarse polar alignment, which is intended to bring a small group of four stars near the SCP into the Polar Scope's field of view. We refer to these stars as the Sigma Octantis group, with Sigma Octantis being the brightest of the four (but still only barely visible with the naked eye under ideal conditions), and always the one that is nearest the SCP. You will use the easily identifiable constellation Crux, also known as the Southern Cross, to point the way.

1. Attach the EQ Base to your tripod via the 3/8" mounting post.
2. Then attach the StarShoot CAT to the EQ Base.
3. Once the EQ Base is securely attached, align the tripod so that the Altitude Adjustment Knob on the EQ Base is facing south.
4. Now, level the tripod as best you can by eye. It is not required that the EQ Base be level for night sky photography, but it makes subsequent adjustments easier.
5. Next, loosen the Altitude Lock Handle a bit (refer to **Figure 13**) then rotate the Altitude Adjustment Knob until the Altitude Indicator points to your latitude on the Altitude Scale. If you don't know your latitude you can look it up in the Tracker Console app under Settings: Location, or on the internet. Then retighten the Altitude Lock Handle.
6. Next, attach StarShoot CAT to the Dovetail Mounting Plate included with the EQ Base; the 3/8" post of the mounting plate threads into the 3/8" hole in the bottom of the StarShoot CAT housing. Orient the Plate so that the end with the Safety Screw is nearest the StarShoot CAT's Saddle, as shown in **Figure 14**. Use a quarter, a large flat blade screwdriver, or (preferably) the included 4mm Allen wrench to tighten the bolt head on the underside of the Dovetail Mounting Plate.
7. Now slide the Dovetail Mounting Plate into the Saddle of the EQ Base, as shown in **Figure 15**, then tighten the Saddle Lock Knob to secure it.
8. Remove the knurled Tripod Mounting Disk from the back of the StarShoot CAT. To do this you will need to loosen the Mounting Disk Retaining Knob one full turn or so. Once the plate is removed, fully insert the Polar Scope into the exposed hole. It should snap into place (**Figure 16**).
9. Now, install the Polar Scope Illuminator on the front end of the Polar Scope as shown in **Figure 17**.
10. Find the Southern Cross (Crux) in the sky, and its brightest star, Acrux. Acrux is considered the "foot" of the cross. Referring to **Figure 26**, draw an imaginary line between the foot of the cross and the "head" of the cross, then extend it another four and a half lengths from Acrux. That is the approximate location of the SCP.
11. Now point your polar scope to that spot. You should be able to see the Sigma Octantis group of four stars in the field of view of the Polar Scope (see **Figure 27**). If you can't, keep making adjustments until you can using the Altitude and Azimuth Adjustment Knobs on the EQ Base. *Be sure the brightness from the Polar Scope Illuminator is not cranked up too high, or it will wash out the view of the Sigma Octantis group of stars.*

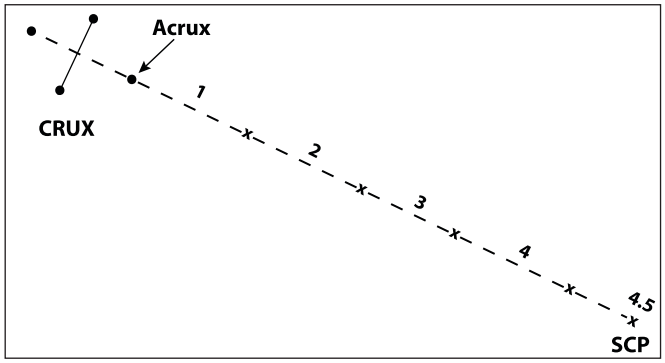


Figure 26

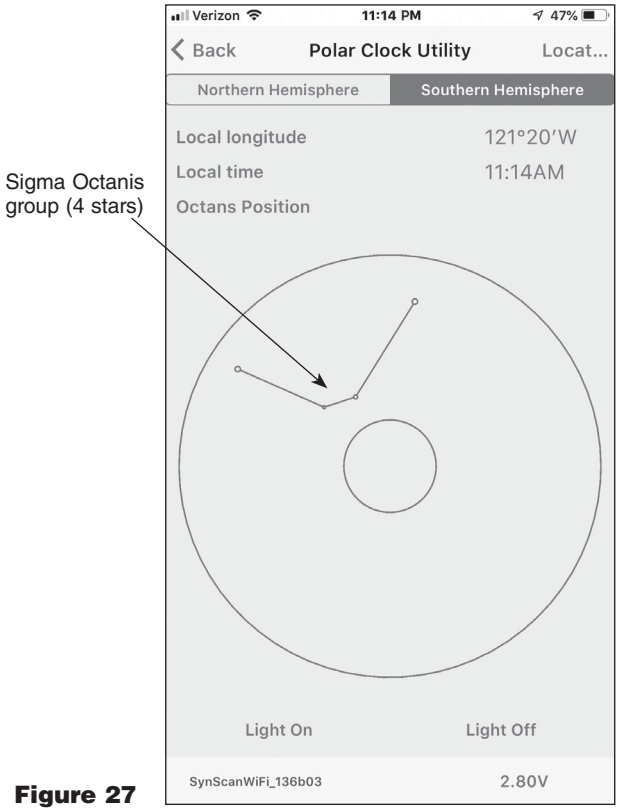


Figure 27

Using the Sigma Octantis Clock Utility

Once you can see the Sigma Octantis group in your Polar Scope field of view you are ready to refine your polar alignment to the SCP.

1. Bring up the Tracker Console app and tap on the Polar Clock Utility.
2. Tap on Southern Hemisphere if it is not already selected. This will bring up a representation of the reticle in your Polar Scope (**Figure 27**).
3. Rotate your Polar Scope to match the view in the Polar Clock utility. That is, rotate it so that the representation of the Sigma Octantis group in your Polar Scope has the same orientation as shown in the Polar Clock utility.
4. Now use the Altitude and Azimuth Adjustment Knobs on the EQ Base to move the EQ Base incrementally while viewing through the Polar Scope, until all four stars of the Sigma Octantis group fall inside the little circles representing them on the Polar Scope's reticle (refer to "Octans" in **Figure 22**). When they do, you are polar aligned on the SCP!

Appendix II. Calibration of the Polar Axis Finder Scope

For accurate polar alignment the Polar Scope's reticle must be aligned exactly with the polar scope's mechanical axis. A simple calibration procedure will ensure that this is the case. But first, check to see whether the Polar Scope requires calibration at all. It may be precisely aligned right out of the box, so do this simple test before attempting the calibration procedure:

1. With your Polar Scope installed in the StarShoot CAT, aim it at a distant object at least 100 yards away. A street light or distant chimney is a good choice.
2. Center the distant target on the intersection of the crosshairs in the Polar Scope reticle.
3. Now rotate the Polar Scope 180 degrees.

If the distant target is still centered on the crosshairs, or if it has barely moved from that point, then YOU DO NOT NEED TO CALIBRATE your polar scope. If the distant target has moved away from the crosshairs significantly, then you should perform the following calibration.

Aligning the Polar Scope Reticle to the Polar Scope Optical Axis

You will need a 1.5 mm Allen wrench to perform the calibration. Refer to **Figures 28** and **29** during this process. The Polar Scope's thin glass reticle is held in place by three small Allen screws around the perimeter of the eyepiece. You should not completely loosen any of these screws as the reticle will lose its support and no longer be adjustable. If this happens you will need to unscrew the eyepiece from the polar scope, manually center the glass reticle as best you can, then reinsert the screw that had lost contact.

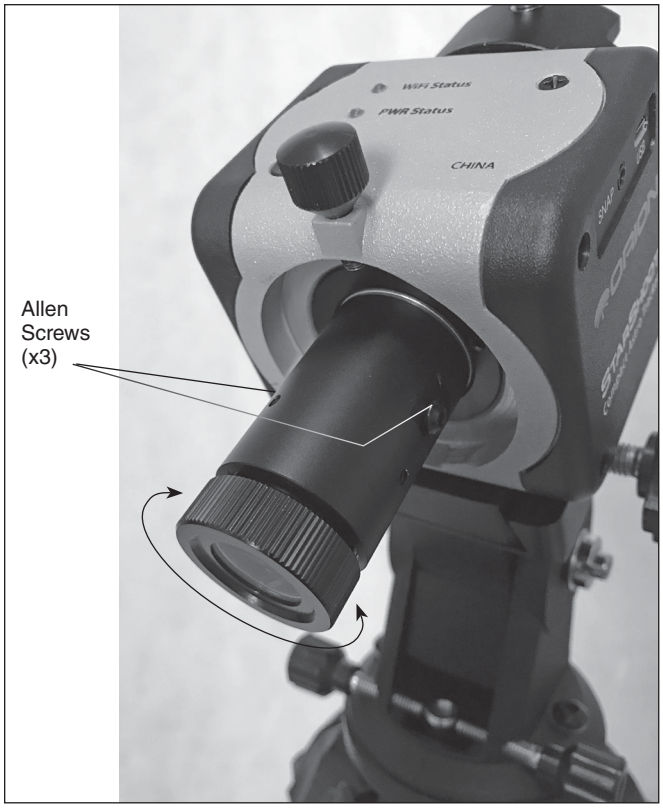


Figure 28

Continuing from Step 3 above, note how far your target moved off the crosshairs. To align the reticle you need to adjust the three small Allen screws (tighten/loosen) so that the target moves one half of the distance back toward the crosshairs.

4. Choose one of the screws and *loosen* it 1/4 turn. Note the movement of the crosshairs. If it moves in the correct direction, tighten the two other screws about 1/4 turn each, then loosen the original screw again.
5. With each loosening of a screw and tightening of the opposing screws the crosshairs will move. Continue until the crosshairs move half way out to the target at its maximum deviated position. Now, gently tighten all three

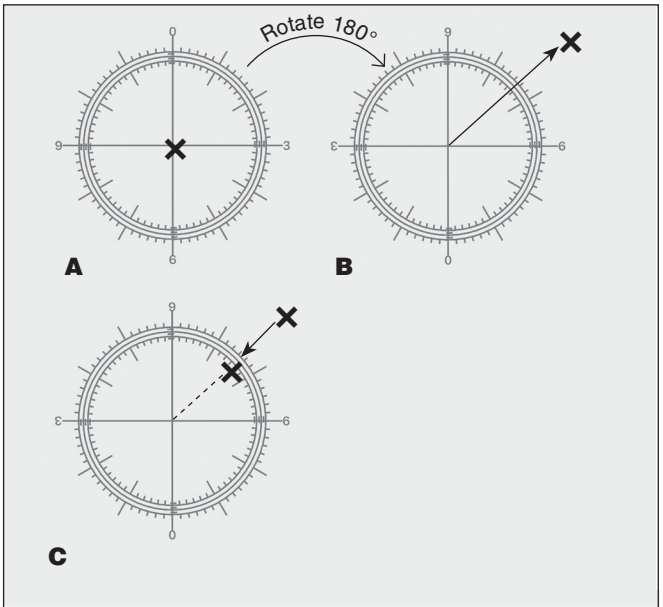


Figure 29. Calibration of the Polar Scope

A. Look into the Polar Scope and, using the EQ Base's Altitude and Azimuth Adjustment Knobs, place a target on the reticle's crosshairs. Make sure the reticle is oriented with "0" at the top as in the illustration.

Now rotate the Polar Scope 180 degrees.

B. The target has moved off of the crosshairs, indicating that the Polar Scope reticle is misaligned. Adjust the reticle using the three Allen screws as described in steps 4 and 5 until the crosshairs move half the distance out to the target (not all the way!).

C. This illustrates the point made in B, that the adjustment should reduce the displaced distance by half. (The crosshairs should move halfway out to the target.)

Now rotate the Polar Scope back to the starting position and repeat A and B. When rotation of the Polar Scope 180 degrees does not result in a significant movement of the target off of the crosshairs, the Polar Scope is calibrated.

Allen screws to secure the reticle. Do not overtighten the screws or you may crack the glass reticle!

6. Now reset the polar scope so “0” is up, and repeat steps 2 and 3. Note the location of your target relative to the crosshairs.
7. If the target has moved off the crosshairs again, repeat steps 4 through 6. Perform the adjustments until the target stays centered on the crosshairs when the Polar Scope is rotated 180 degrees.

Remember:

- First verify that your Polar Scope requires calibration before starting the calibration adjustments!
- When adjusting the Allen screws, always proceed by first loosening one screw, then tightening the other two gently.
- Do not loosen one screw completely or loosen more than one screw at a time as the reticle may lose its support and become nonadjustable.
- To make things easier, perform the calibration during the daytime.

Appendix III. The Optional Equatorial Base

To use the StarShoot CAT for long-exposure astrophotography or astro time-lapse, polar alignment is a must. The optional Equatorial Base accessory (**Figure 30**) enables the fine pointing control required for accurate polar alignment.

The Equatorial (EQ) Base includes the following key parts:

Dovetail Mounting Plate: The removable Dovetail Mounting Plate includes a 3/8" threaded post for attachment of the StarShoot CAT.

Safety Stop: The Safety Stop prevents the StarShoot CAT from slipping out of the saddle of the EQ Base should you let go of it before tightening the Mounting Plate Lock Knob.

Saddle Lock Knob: Secures the Dovetail Mounting Plate in the Saddle.

Azimuth (Horizontal) Adjustment Knobs: These two knobs enable fine pointing of the EQ Base in the left and right (azimuth) directions. Once the azimuth is set, make sure both knobs are lightly tightened.

Altitude (Vertical) Adjustment Knob: This knob enables fine pointing of the EQ Base in the vertical (altitude) direction.

Altitude Scale: This scale indicates the altitude setting of the EQ Base. Note that for polar alignment procedures, the altitude of your Base is equal to the latitude of your observing site.

Appendix IV. The Optional Declination Bracket

The optional Declination (Dec) Bracket (**Figure 31**) provides more convenience and control for mounting your photographic payloads. It gives you finer pointing control for Declination adjustments when StarShoot CAT is used in its polar-aligned

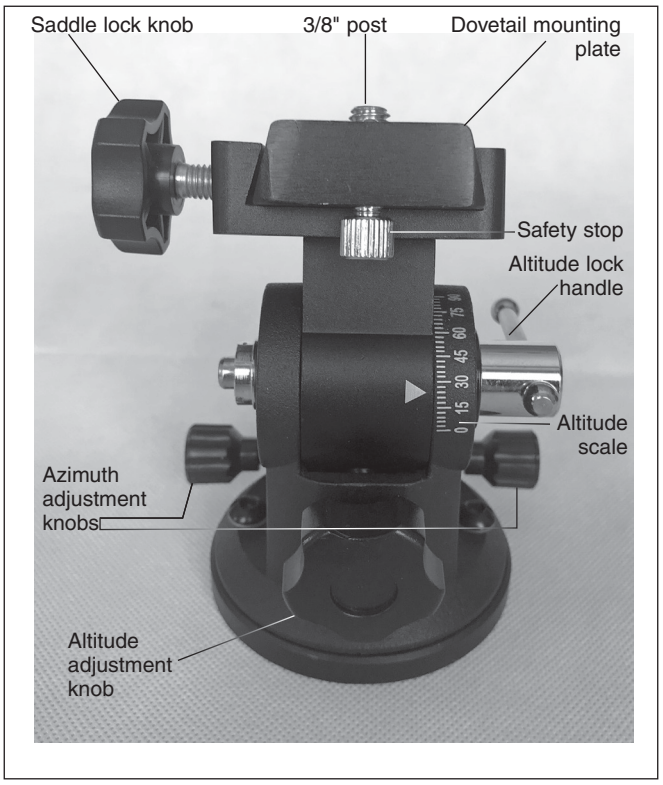


Figure 30

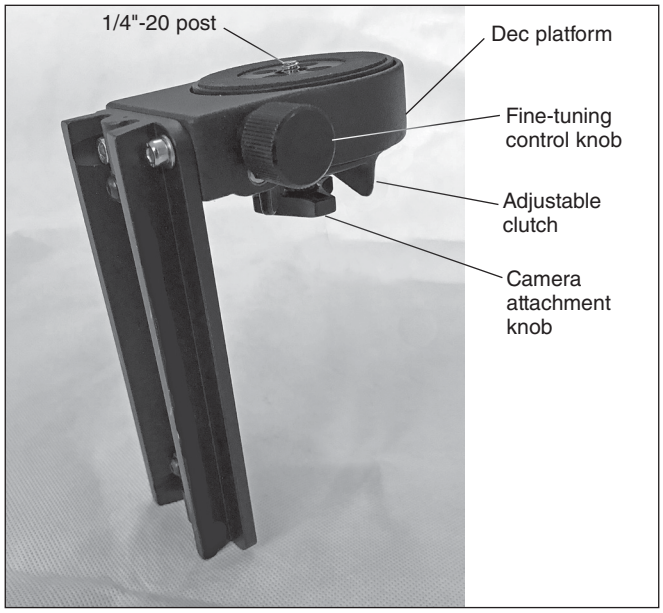


Figure 31

equatorial mode. Use its adjustable clutch to make coarse movements, and its fine-tuning control knob to make incremental movements. The Dec Bracket is a must-have accessory if you are going to use the StarShoot CAT extensively for astrophotography.

One great benefit of the Dec Bracket is that it allows polar alignment with your camera already attached to the StarShoot CAT (**Figure 32**). You do not have to back out or remove the Polar Scope after polar alignment is completed. This way there is less risk of accidentally moving the tripod after completing the polar alignment procedure – for example when attaching the Ball Head Mount or the camera. Any such movement would ruin the polar alignment and require repeating the procedure.

The Declination Bracket also allows the use of heavier camera and lens combinations, because the optional Counterweight and Shaft can be attached to the Declination Bracket to counterbalance the load (**Figure 33A**). Without such counterbalancing a heavy camera could put stress on the StarShoot CAT's motor and result in poor sky tracking. What's more, adding the Counterweight and Shaft increases the StarShoot CAT's payload capacity from 6.6 lbs. to 8.8 lbs.!

You can also remove the Declination Platform to reveal a 3/8" mounting post to which you can attach the Ball Head Mount and camera, if you want more freedom of movement and positioning than is afforded by the Declination Platform (**Figure 33B**). To remove the Declination Platform you will need an Allen wrench to remove the two socket head cap screws that couple it to the dovetail bracket.

Or, leave the Dec Platform in place and attach the Ball Head Mount to it via its ¼"-20 post (**Figure 33C**) (you will need to install a 3/8" to 1/4" thread adapter [sold separately] in the bottom of the Ball Head Mount). This does put the camera up higher, which means you must be sure to counterbalance that load appropriately with the optional Counterweight and Shaft.

Figure 32

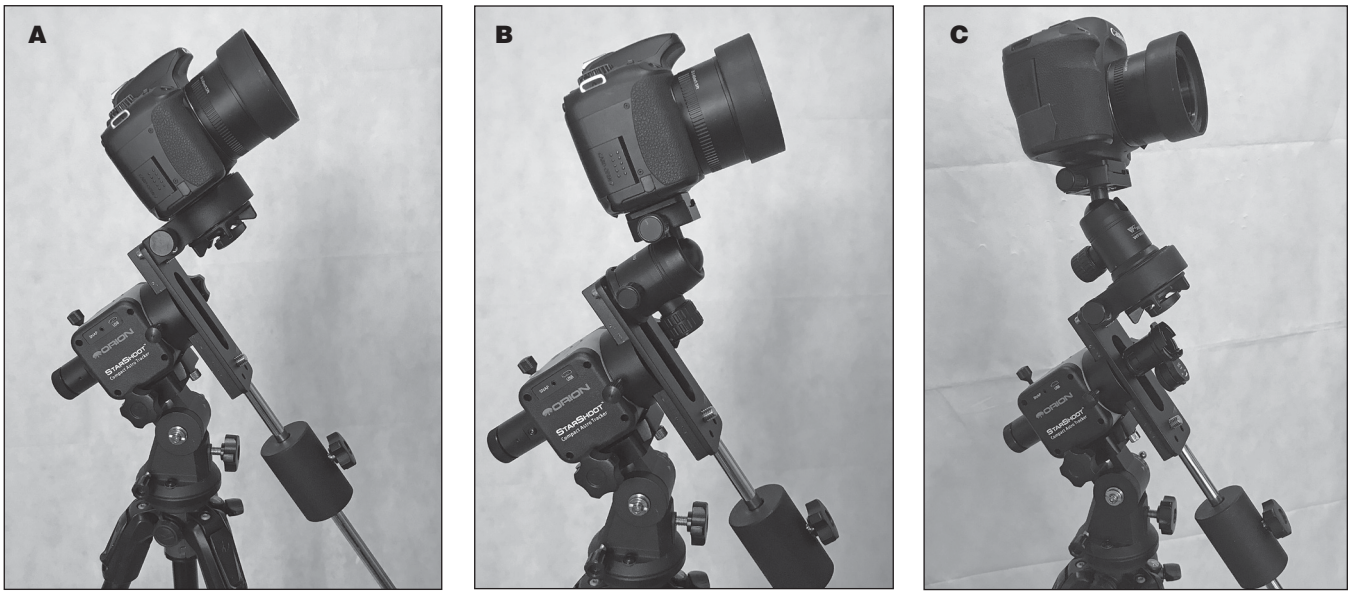


Figure 33. Different ways to use the Declination Bracket with the StarShoot CAT

Attaching the Declination Bracket and Camera

To attach the optional Declination Bracket to the StarShoot CAT just slide it into the StarShoot CAT's saddle, then tighten the Saddle Lock Knob to secure it in place. Then attach your camera to the padded declination platform's ¼"-20 post by turning the Camera Attachment Knob. (Or see above for other mounting options.) Turn the Camera Attachment Knob clockwise to thread the post into the ¼"-20 receptacle on the bottom of your camera until tight.

Appendix V. How to Restore Factory Wi-Fi Settings

Occasionally you may need to reset StarShoot CAT to its factory Wi-Fi settings. For instance, if you have forgotten the Password or are having trouble establishing a W-Fi connection, or if you have accidentally entered any incorrect Wi-Fi settings, you may need to "reboot" StarShoot CAT by restoring the factory defaults. To reset StarShoot CAT to the factory Wi-Fi settings follow the procedures below:

1. Power down StarShoot CAT by holding the PWR button for about 5 seconds. Let go once the red LED goes out.
2. Press and hold the PWR button for about 10 seconds until the red LED starts to blink slowly. This indicates the start of the boot loader mode.
3. The boot loader will restore the factory default with the Wi-Fi SSID set to SynScanWi-Fi_xxxxxx. No password will be required.
4. Power down StarShoot CAT by holding the PWR button for about 5 seconds until the red LED goes out.

The next time you power up StarShoot CAT it will start with the factory Wi-Fi settings.

Note: When the power button is pushed and held for more than 9 seconds, or when a firmware upgrade is to be done, StarShoot CAT will enter boot loader mode and the factory default Wi-Fi settings will be restored. If you were using other than the default settings you will need to go back to the Wi-Fi settings screens in the Tracker Console to re-enter your settings preferences.

Appendix VI. Updating the Firmware

Occasional improvements may be made to StarShoot CAT's firmware. To update the firmware you will need to download the firmware loader program as well as the updated firmware update file. Both are available on Orion's website in the Product Manuals & Video link on the StarShoot CAT's main product page.

Follow the steps below to update the firmware:

1. Go to www.telescope.com and find the page for the StarShoot Compact Astro Tracker. Click on the Manuals & Videos link below the main product image, then click on "Motor Controller Firmware Loader". You will need this program to load your firmware updates.
2. In the same list of files where you found the firmware loader file, find the latest version of StarShoot CAT's firmware and download it to your computer. Place it in the same folder as the firmware loader program.
3. Connect StarShoot CAT to the computer with a micro USB cable. If you have not connected StarShoot CAT to your computer before, wait a few moments for the drivers to load.
4. Press and hold StarShoot CAT's PWR Button to turn on the power.
5. Run the Motor Controller Firmware Loader and select the firmware file you downloaded.
6. Select "auto-detect COM port", then click on "Update". Do NOT turn off the power while updating the firmware. After about 25 seconds, the program will display "Update Complete. Turn off power".
7. If you didn't select "auto-detect COM port", or you have other devices connected to the same computer, please manually enter the COM port for StarShoot CAT as indicated in your Device Manager. Then click on "Update".
8. Press and hold the PWR button for about 5 seconds to turn off the power. The next time you power up StarShoot CAT the new firmware will take effect.

Appendix VII. StarShoot CAT Specifications

Product Type	Ultra compact tracking mount
Regions	Northern and Southern hemispheres
Functions	Astronomical tracking, Camera control, and Time-lapse video
Tracking Modes	Sidereal, 0.5x Sidereal, 2x Sidereal, Solar, Lunar, and Manual
Payload Capacity	Up to 6 lb. 10 oz. (3 kg)
Wheel Gear	36mm dia., 72 teeth, aluminum alloy
Worm Gear	11mm dia., high-tension brass
Motor Drive	Precision DC servo
Wireless Mode	Wi-Fi with selectable modes
Control	Free Tracker Console app for Android and iOS
Polar Scope	~10° FOV, works for polar alignment to NCP and SCP
Power	Internal: 2 x AA batteries (not included); External 5V via micro USB
Operating Time	Up to 24 hours with 2 x AA batteries
Temperature Range	14° ~ 104°F (10° ~ 40°C)
Dimensions	2.75" x 3.9" x 3.0" (70mm x 100mm x 75mm)
Weight	1 lb. 6 oz. (0.71 kg)
Mounting	Dual 3/8" threaded sockets (one has removable 3/8"-to-1/4" adapter installed)

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.

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