INSTRUCTION MANUAL

Orion Atlas™ Pro AZ/EQ-G GoTo Mount

#10010

TELESCOPES & BINOCULARS

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Figure 1. The Atlas Pro AZ/EQ-G mount

Congratulations on your purchase of the Orion Atlas Pro AZ/EQ-G GoTo Mount. Designed for use in either alt-azimuth or equatorial modes, this versatile, precision GoTo mount provides a stable, high-performance platform for astronomical observing or astrophotography. These instructions will help you set up and properly use your new mount. Please read them over thoroughly before getting started.

1. Unpacking

The entire mount will arrive in two boxes, one containing the tripod and counterweights, the other containing the mount head and hand controller. Be careful unpacking the boxes. We recommend keeping the boxes and original packaging. In the event that the mount needs to be shipped to another location, or returned to Orion for warranty repair, having the proper packaging will ensure that your mount will survive the journey intact.

Make sure all the parts in **Figure 2** are present. Be sure to check the boxes thoroughly, as some parts are small. If anything appears to be missing or damaged, immediately call Orion Customer Support (800-676-1343) or email support@telescope.com for assistance.

WARNING:

- ***Never look directly at the Sun with the naked eye or with a telescope – unless you have a proper solar filter installed over the front of the telescope! Otherwise, permanent, irreversible eye damage may result.***
- ***Never use your telescope to project an image of the Sun onto any surface. Internal heat build-up can damage the telescope and any accessories attached to it.***
- ***Never use an eyepiece solar filter or a Herschel wedge. Internal heat build-up inside the telescope can cause these devices to crack or break, allowing unfiltered sunlight to pass through to the eye.***
- ***Never leave the telescope unsupervised, either when children are present or adults who may not be familiar with the correct operating procedures of your telescope.***

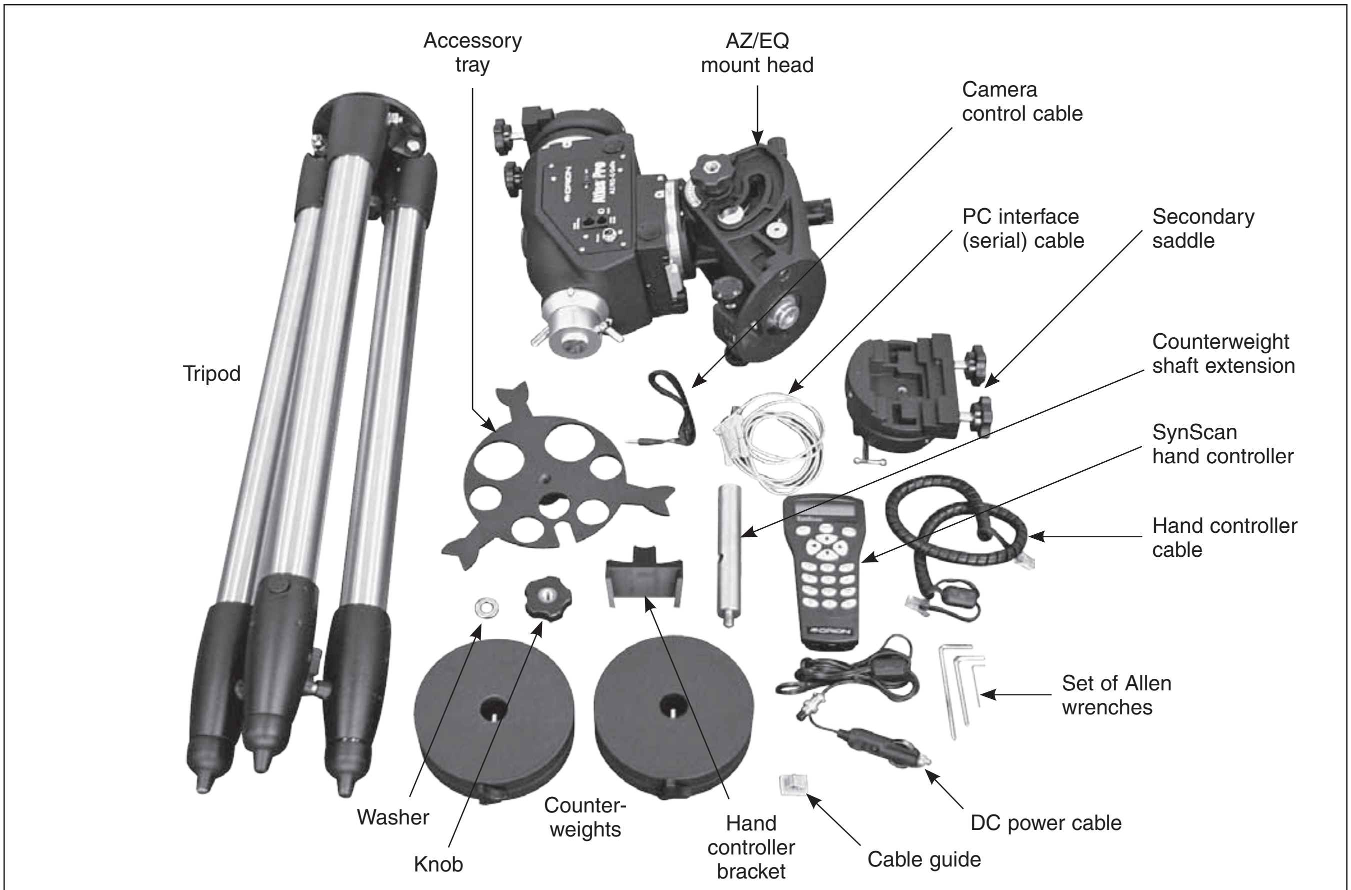

Figure 2. Components included with the Atlas Pro

Table of Contents

2. Setting Up the Atlas Pro AZ/EQ-G Mount

2.1 Setting Up the Tripod and Mount Head

1. Stand the tripod upright and spread the legs out as far as they will go. Make certain that the leg lock levers are tightened. Keep the tripod legs at their shortest (fully retracted) length, for now; you can extend them to a more desirable length later, after the mount is fully assembled.
2. Loosen the two azimuth adjustment knobs on the mount head until there is ½" or more of space between the two azimuth adjustment bolts **(Figure 3a).** Then place the mount on the tripod, aligning the metal post on the tripod with the gap between the two azimuth adjustment knobs **(Figure 3b).**
3. Once the mount is seated, slightly tighten the two azimuth adjustment knobs.
4. Thread the center support shaft up through the tripod top and into the bottom of the mount head until tight. Use the upper knob on the center support shaft to do this. The mount head should now be firmly connected to the tripod.

2.2 Attaching the Accessory Tray/Spreader and the Hand Controller Holder

1. Remove the knob and washer from the bottom of the center support shaft. Slide the tripod support tray up the bottom of the shaft until the three tray arms are touching the legs of the tripod. The flat side of the support tray should be facing up. Make sure the “V” of each tray arm is against a tripod leg. Place the washer on the center support shaft against the tray, and follow it by threading the knob all the way up the center support shaft until it is tight against the tray **(Figure 4).** The tripod support tray provides additional stability for the tripod, and holds up to five 1.25" eyepieces and two 2" eyepieces.
2. Using the bubble level on the mount **(Figure 5)**, level the mount by adjusting the length of the tripod legs as needed.
3. Insert the hand controller holder into the U-shaped slot on the accessory tray/spreader **(Figure 6).**

Warning: The accessory tray/spreader will ensure the tripod legs remain firmly expanded, which will prevent the tripod from accidentally toppling over. When using the Atlas Pro mount, it is important to always install the accessory tray/spreader before attaching the telescope.

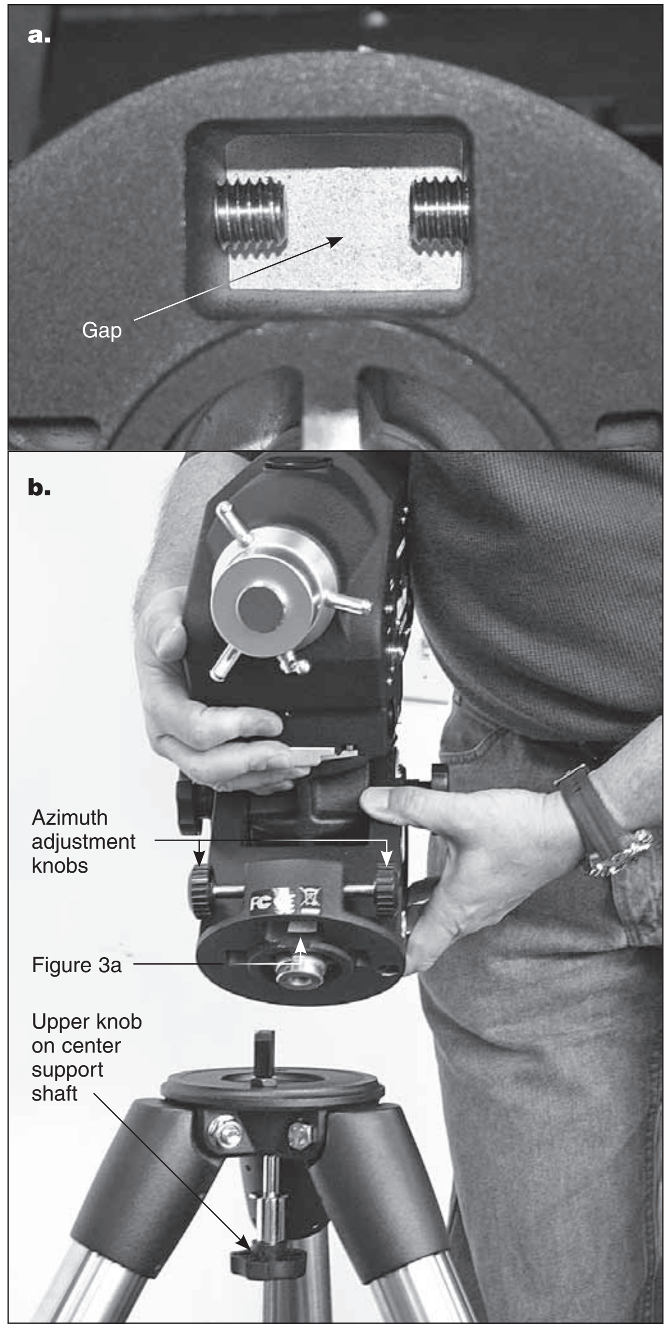

Figure 3. a) Loosen the azimuth adjustment bolts to create at least a ½" gap. **b)** Orient the mount head so that the gap aligns with the metal post on the tripod.

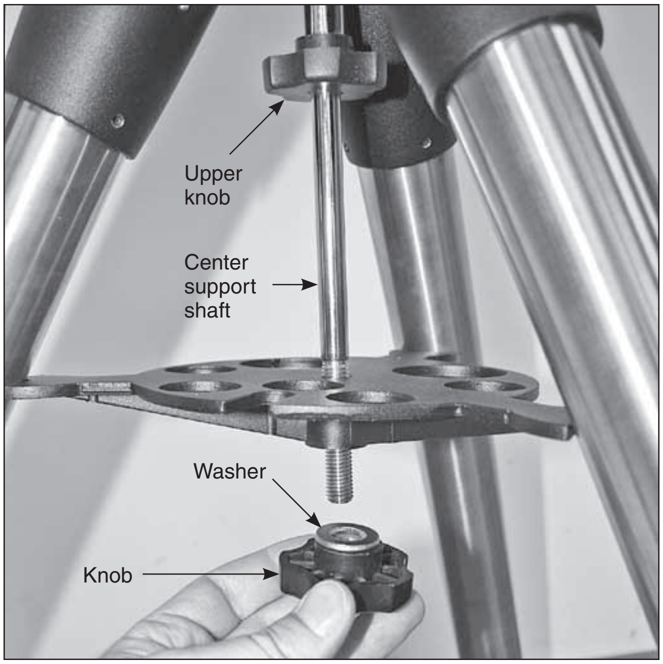

Figure 4. Installing the tripod leg spreader, which doubles as an eyepiece/accessory tray.

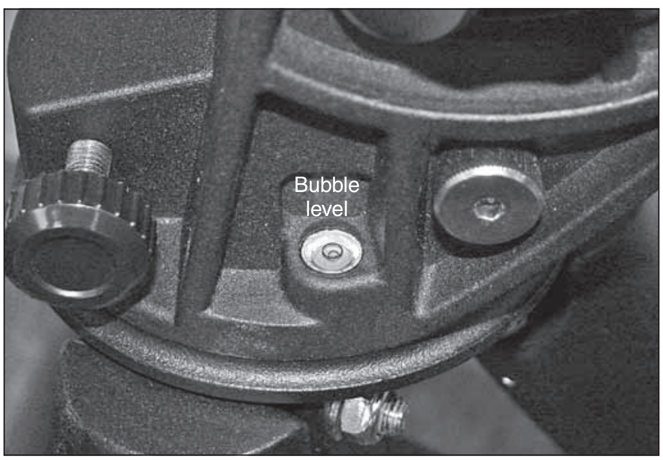

Figure 5. The bubble level at the base of the mount head makes leveling the mount easy.

2.3 Attaching the Counterweights

Always attach the counterweight(s) *before* installing your telescope on the mount!

1. Loosen the T-bolt for locking the counterweight shaft **(Figure 7a)** and fully extend the shaft. Re-tighten the T-bolt to secure the shaft in place **(Figure 7b).**

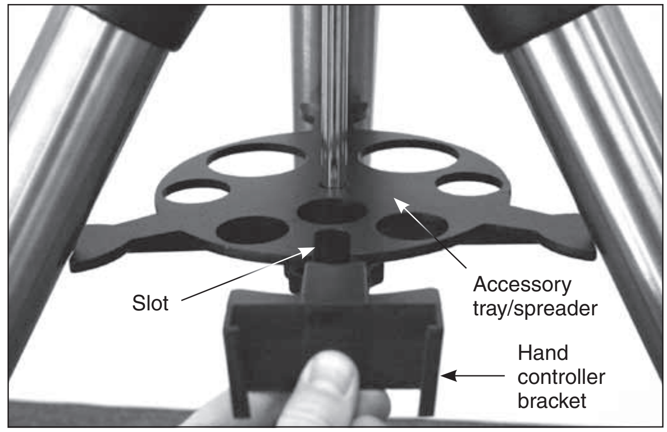

Figure 6. Hand controller bracket snaps into the slot in the accessory tray.

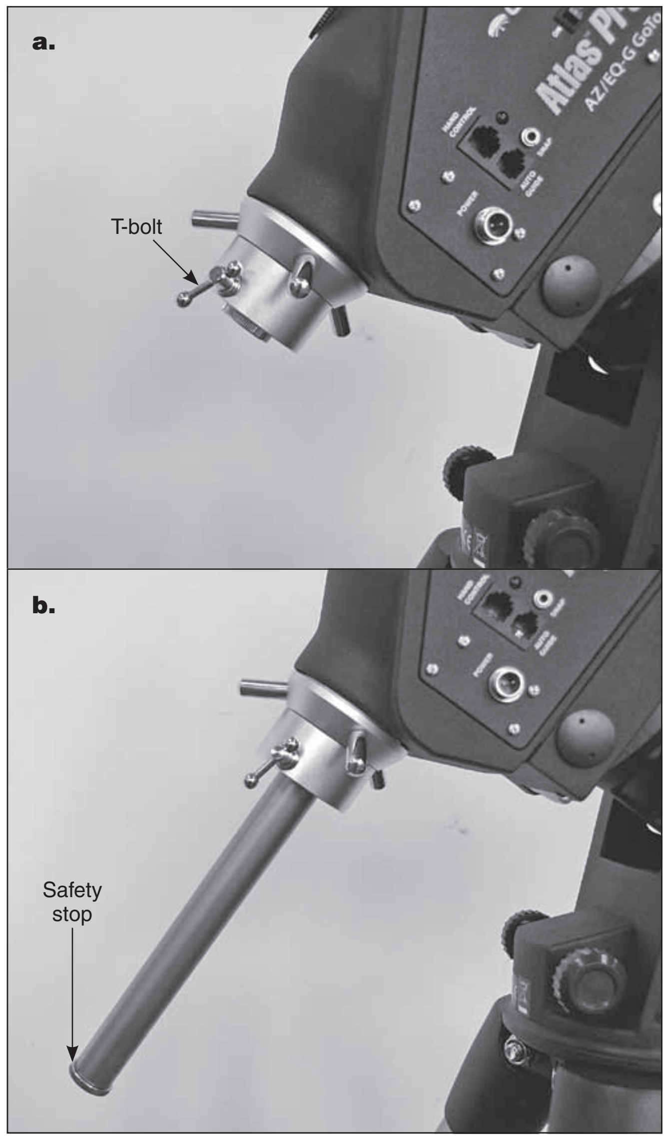

Figure 7. a) Counterweight shaft retracted.
b) Counterweight shaft extended.

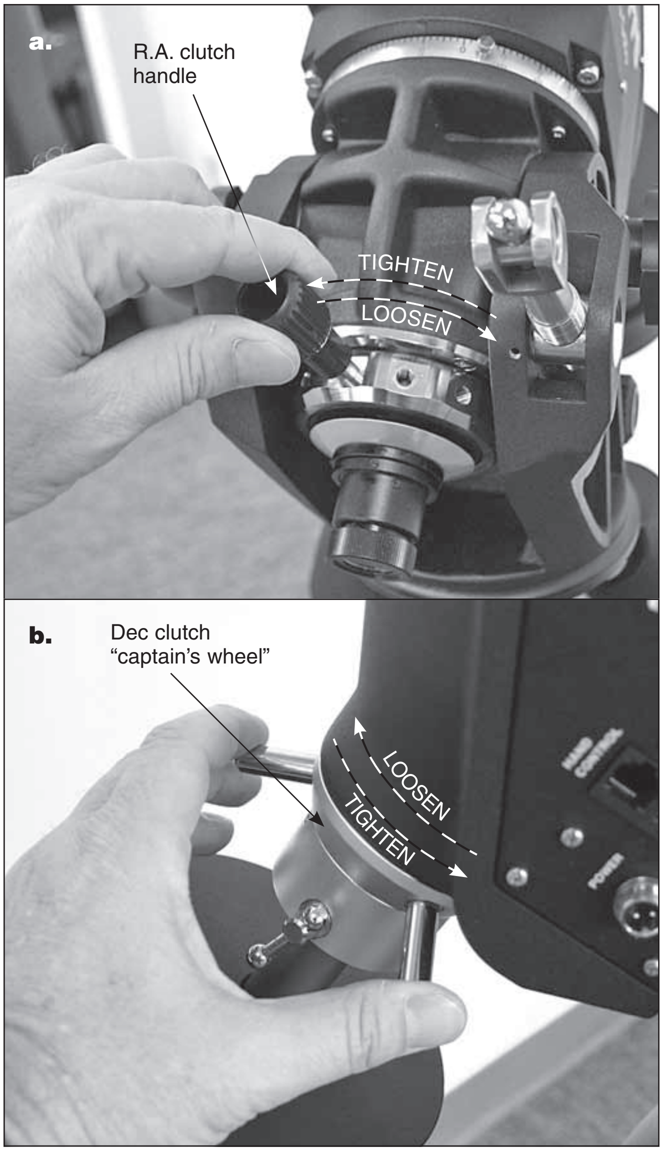

Figure 8. a) Right ascension clutch. The handle can be placed in an adjacent hole if needed. **b)** Declination clutch.

2. Loosen the right ascension (R.A.) clutch with the handle **(Figure 8a)**, and rotate the R.A. axis until the counterweight shaft is pointing toward the ground, as in **Figure 7b**.
3. Remove the knurled "toe saver" safety stop (**Figure 7b**) from the end of the counterweight shaft.
4. The Atlas Pro mount comes with a 150mm counterweight shaft extension **(Figure 9)**, which can be installed at this point if necessary for balancing heavier payloads. Ensure that the extension is tightly secured before installing counterweights.
5. Loosen the counterweight's lock knob and slide one or more counterweights onto the counterweight shaft as needed to balance your instrument. (See **Section 2.5** for details on how to balance the telescope.) Retighten the lock knob to secure the counterweight on the shaft.

Figure 9. The included 150mm counterweight shaft threads into the bottom of the main shaft.

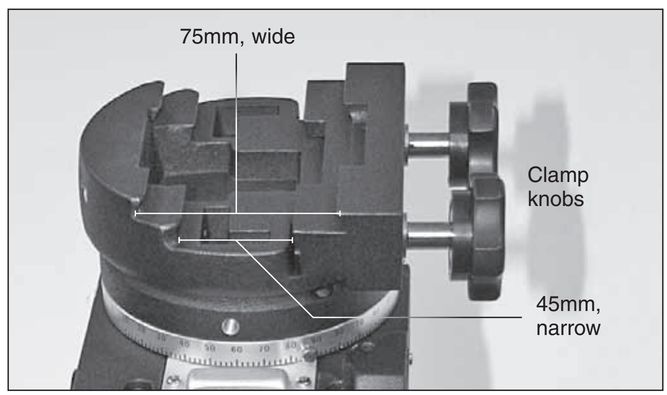

Figure 10. The primary dual-width saddle accommodates narrow or wide dovetail plates.

6. Replace the safety stop on the end of the counterweight shaft. The safety stop prevents the counterweights from falling on your foot if the lock knobs come loose.

2.4 Installing a Telescope on the Mount

The Atlas Pro mount is designed to hold a telescope payload of up to 44 lbs. For heavier telescopes, the mount may not provide sufficient stability for steady imaging.

1. Before installing a telescope, be sure that:
   - The counterweight shaft is pointing toward the ground.
   - The counterweights are installed on the counterweight shaft and have been moved to the bottom end of the shaft.
   - The R.A. axis is secured by tightening the R.A. clutch.
2. Loosen the two clamp knobs on the primary dual-width saddle plate **(Figure 10)** until the width of one of the

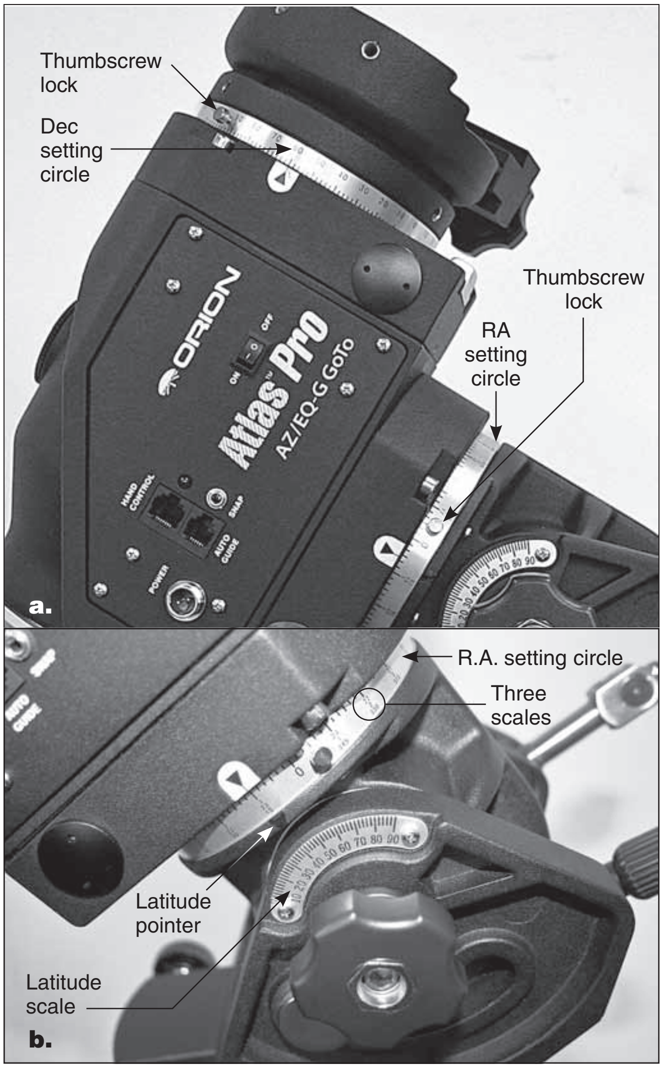

Figure 11. a) R.A. and Dec. setting circles. **b)** The RA setting circle features three stacked numbers: top number is R.A. in EQ mode in Southern hemisphere; middle number is R.A. in EQ mode in Northern hemisphere; bottom number is azimuth angle in Alt-azimuth mode. The latitude scale and pointer are used to set the R.A. axis elevation to the latitude of your observing/imaging location.

dovetail grooves is slightly wider than the width of the dovetail bar on your telescope or telescope tube rings.

3. While holding the telescope, seat the dovetail bar of the telescope into the proper groove of the saddle. The lower groove is for a “narrow” (Vixen style), 45mm width dovetail bar and the upper groove is for a “wide” (Losmandy style), 75mm bar. Then tighten the two clamp knobs to secure the dovetail bar in the saddle.

Warning: Keep supporting the telescope until you are sure it has been firmly attached to the saddle!

2.5 Balancing the Telescope

To minimize stress on the motor drive system and ensure smooth, accurate movement of a telescope on both axes of the mount, it is imperative that the optical tube be properly balanced. We will first balance the telescope with respect to the right ascension (R.A.) axis, then the declination (Dec.) axis, in the equatorial mode.

1. Keeping one hand on the telescope optical tube, loosen the R.A. clutch **(Figure 8a)**. Make sure the Dec. clutch “captain’s wheel” **(Figure 8b)** is tightened, for now. The telescope should now be able to rotate freely about the R.A. axis. Rotate it until the counterweight shaft is parallel to the ground (i.e., horizontal).
2. Now loosen the counterweight lock knob and slide the weight(s) along the shaft until it exactly counterbalances the telescope. That’s the point at which the shaft remains horizontal even when you let go with both hands. Once balance is achieved, retighten the counterweight lock knobs.
3. To balance the telescope on the Dec. axis, first tighten the R.A. clutch, with the counterweight shaft still in the horizontal position. Then with one hand on the telescope optical tube, loosen the Dec. clutch and check for any rotation. If there is some, adjust the telescope forward or back in the saddle or in its tube rings until it remains horizontal when you carefully let go of it.

The telescope is now balanced on both axes. When you loosen the clutch on one or both axes and manually point the telescope, it should move without resistance and should not drift from where you point it.

3. Using the Atlas Pro AZ/EQ-G Mount

3.1 Manually Rotating the Mount

The mount can be moved manually by simply loosening the R.A. and Dec clutches and pointing the telescope to the desired location. Both the R.A. and Dec. clutches should be tightened when driving the mount with the internal motors.

3.2 Using the Setting Circles

As indicated in **Figure 11a**, the Atlas Pro features right ascension and declination setting circles. Most users of a GoTo telescope will not have a need to use setting circles, but if you should, here’s how:

1. Before using the setting circles, they will need to be calibrated. Point the telescope toward a known object whose coordinates you have looked up (R.A.-Dec. coordinates or azimuth-altitude coordinates). Loosen the two locking thumbscrews on the setting circles and turn them so the coordinate values line up with the arrows on both the R.A. and Dec. setting circles, then retighten the locking screws.
2. Once the setting circles are calibrated, the mount can be moved either electronically or manually to specified coordinates by referring to the setting circle readings.
3. The R.A. setting circle features three different scales **(Figure 11b)**: the upper scale is used to indicate the right ascension in Equatorial mode when mount is operating

in the Southern Hemisphere; the middle scale is used to indicate the right ascension in Equatorial mode when operating in the Northern Hemisphere; the lower scale is used to indicate the azimuth angle when operating in Alt-azimuth mode.

4. The Dec. setting circle is divided into four quadrants of 90-degrees, used to indicate the declination (when mount is operating in Equatorial mode) or altitude angle (when operating in Alt-azimuth mode). Users should use the proper segment when calibrating the Dec. setting circle.

3.3 Adjusting the R.A. Axis Elevation (Latitude)

1. Loosen the two altitude lock knobs located on the sides of the mount **(Figure 12)**.
2. Locate the altitude jackscrew **(Figure 13)** and extend its retracted handle. Use it to turn the jackscrew to set the R.A. axis elevation to your location's latitude. Refer to the latitude scale and pointer on the left side of the mount **(Figure 11b).** (If you don't know your latitude, consult a geographical atlas or look it up on the internet.) For example, if your latitude is 35° North, set the pointer to 35. The latitude setting should not have to be adjusted again unless you move to a different viewing location some distance away.
3. Stow the handle back in the jackscrew after the adjustment, then tighten the two altitude lock knobs.

Note: It is normal to have slight elevation play on the Atlas Pro AZ/EQ-G mount. The mount depends on the gravity of its payload and its own weight to stay firm. Because of this, it is recommended to end the elevation adjustment with an upward movement. Whenever there is an upward over-adjustment, lower the elevation first, and then crank the mount upward again.

3.4 Setting the Mount to Alt-azimuth Mode

1. Loosen the two altitude lock knobs **(Figure 12)**.
2. Remove the two knurled knobs from the left side of the mount **(Figure 14a).** Put the shorter one into the lower screw hole; keep the longer one for later usage. Notice the "Alt-azimuth mode lock hole" in the R.A. axis housing. You will align that hole with the screw hole to its left when you orient the mount head in the alt-azimuth position in the next step.
3. Now crank up the R.A. axis with the jackscrew until it reaches approximately 88 degrees elevation, at which point the jackscrew will disengage entirely. Lift the

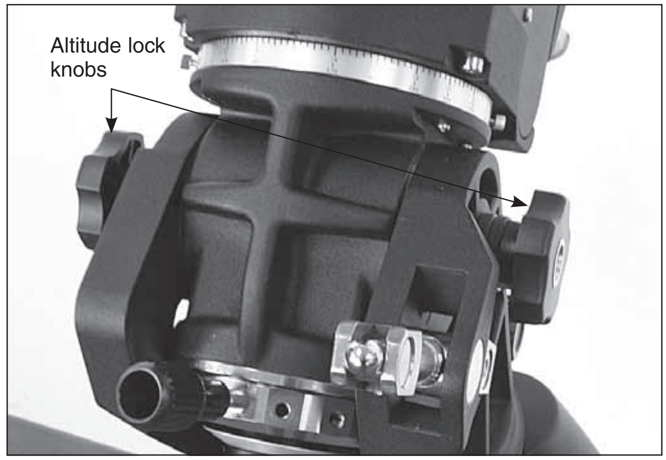

Figure 12. The dual altitude lock knobs.

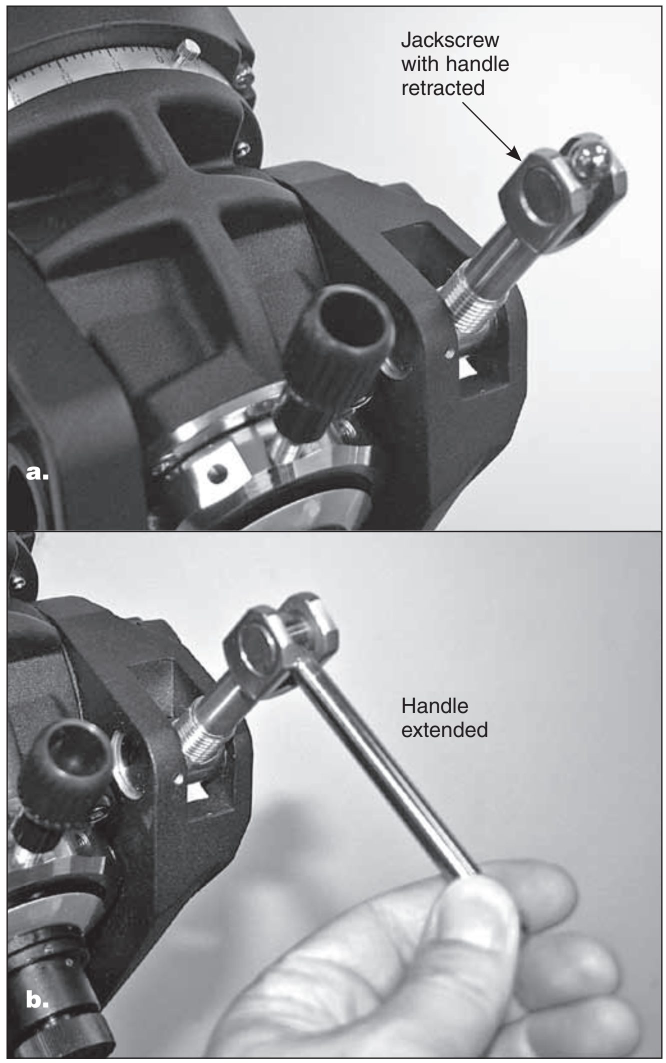

Figure 13. The altitude jackscrew with handle **a)** retracted, and **b)** extended for turning.

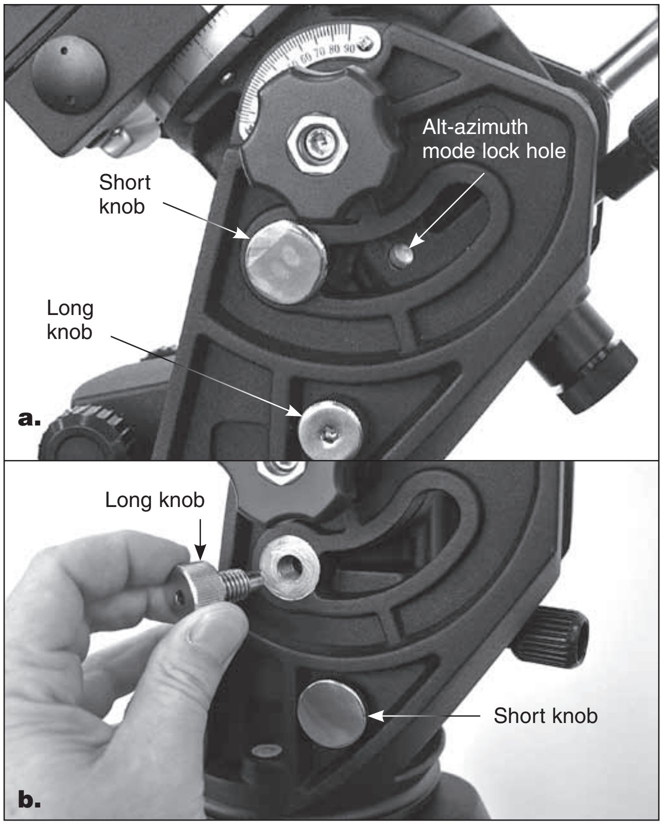

Figure 14. a) The two knurled knobs appear as shown in EQ mode. **b)** To use the mount in Alt-azimuth mode, the knob positions should be switched.

counterweight shaft to align the alt-azimuth mode lock hole with the upper screw hole on the left side, then insert the longer knurled knob to connect these two holes **(Figure 14b)** and tighten it with the included 5mm Allen wrench.

4. Retighten the two altitude lock knobs. **Figure 15** shows the mount set in Alt-azimuth mode, with one counterweight installed.
5. To restore the mount to Equatorial mode, loosen the two altitude lock knobs first, then remove and exchange the two knurled knobs on the left side of the mount. While holding the counterweight shaft, slowly lower the R.A. axis until the latitude jackscrew starts to engage. Then turn the jackscrew counterclockwise with the handle to lower the elevation to the desired angle.

Figure 15. Single scope mount setup in Alt-Azimuth mode, with one counterweight added.

Note:

- When setting the mount to Equatorial mode, the longer knurled knob on the left side of the mount must first be moved to the lower threaded hole on the same side, otherwise the mount may be damaged when cranking the R.A. axis down.
- In Alt-azimuth mode with one telescope mounted, the telescope should be positioned such that it is on the right-hand side of the mount when viewed from behind the mount. The counterweight shaft should be extended to the left.
- When switching between Alt-azimuth and Equatorial modes, be sure to remove the telescope (first) and all counterweights (after scope has been removed) from the mount first to avoid damage to the mount's latitude adjustment mechanisms.
- It may be more difficult to balance the R.A. (or Azimuth) axis in Alt-azimuth mode. Here are the balancing steps recommended for Alt-azimuth mode:
    - **Balance** the payload and counterweights in equatorial mode and mark the position of the counterweights.
    - **Unload** the payload and counterweights to set the mount in Alt-azimuth mode.
    - **Re-load** the mount again by installing the counterweights at the marked position.

3.5 Mounting a Second Telescope (Alt-azimuth mode only)

The secondary telescope saddle (included) can be installed at the end of the Atlas Pro mount's counterweight shaft to mount a second telescope.

1. Slide the counterweight shaft out and rotate it so the flat strip at the end of the shaft is facing up, then lock the shaft with the T-bolt.
2. Loosen the Allen screw on the secondary saddle's silver coupler ring and push the saddle onto the counterweight shaft, as shown in **(Figure 16a)**. Align the Allen screw with the flat strip on the counterweight shaft.
3. Use a 5mm Allen wrench to secure the saddle to the counterweight shaft with the Allen screw in the center of the saddle **(Figure 16b)**. Also tighten the Allen screw on the coupler ring with the same wrench **(Figure 16c)**.
4. Tighten the Dec. clutch, and then install the second telescope on the secondary saddle. The second telescope and its saddle should be situated to the left of the mount when the telescope points forward.
5. Loosen the counterweight shaft's locking T-bolt to test the balance of the second telescope. Adjust the positioning of the telescope in its tube rings or the dovetail bar's position in the groove of the saddle until the telescope is balanced. Then retighten the T-bolt.
6. Loosen the Dec. clutch to check the balance of the telescope mounted on the primary saddle. Make any adjustments needed, then retighten the Dec. clutch.
7. Loosen the counterweight shaft's locking T-bolt and rotate the second telescope until it points in the same direction as the main telescope. Lock the T-bolt again.
8. Aim the main telescope at a distant object, and then adjust the two vertical-adjustment T-bolts on the secondary saddle **(Figure 16c)** to point the secondary telescope to the same vertical level.

Figure 17 shows the mount in Alt-azimuth mode with the secondary saddle installed.

Note:

- Use the secondary saddle only when the Atlas Pro mount is configured in Alt-azimuth mode.
- There is no mechanism on both the primary saddle and the secondary saddle for aligning the two telescopes in the azimuth direction.
- The 150mm counterweight shaft extension cannot be used with the secondary saddle.

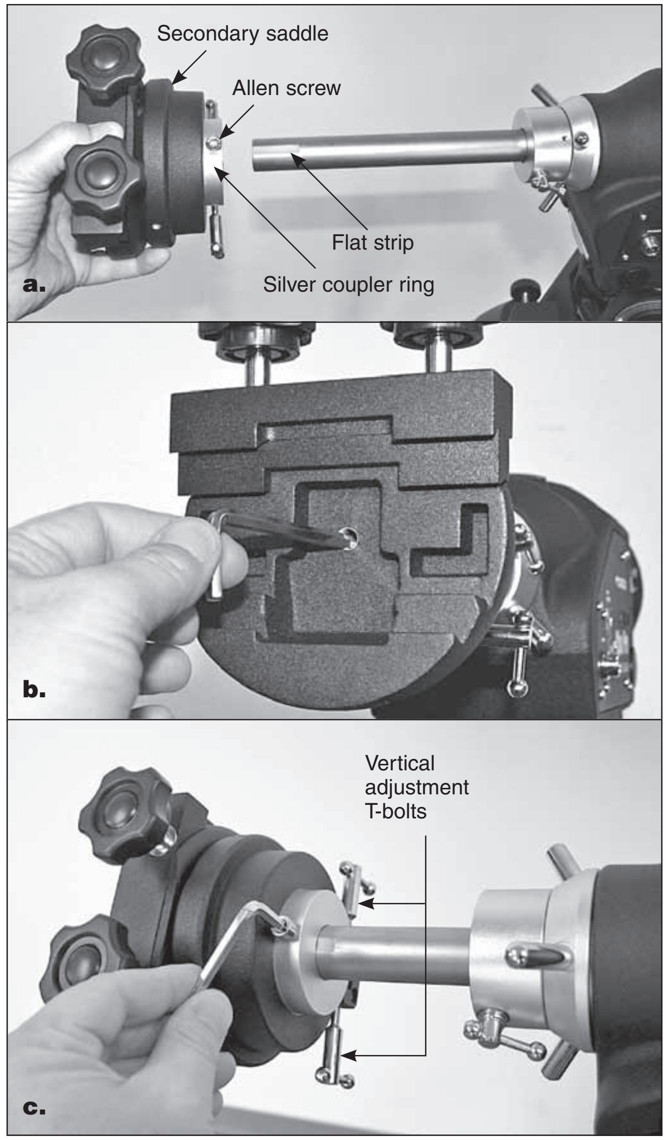

Figure 16. a) For mounting a second telescope in Altazimuth mode, a secondary saddle is installed on the counterweight shaft. **b)** Be sure to tighten the screw running through center of the secondary saddle. **c)** Finally, tighten the socket head screw on the saddle's silver collar.

Figure 17. The mount is now ready to accept two telescopes in Altazimuth mode.

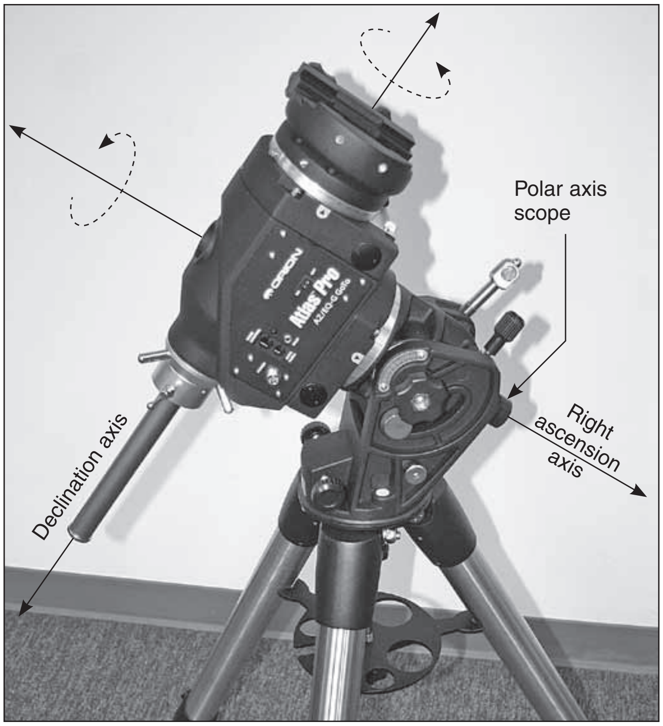

Figure 18. The R.A. and Dec. axes of the Atlas Pro AZ/EQ-G mount.

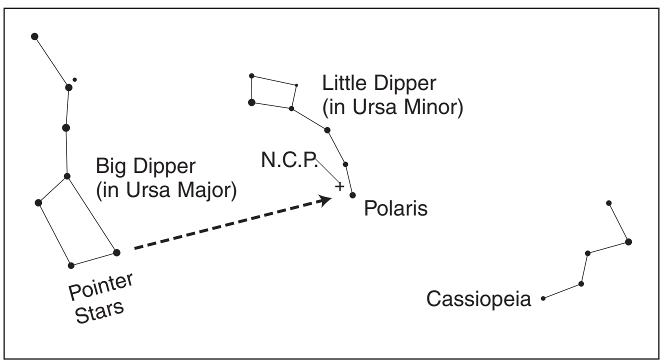

Figure 19. Polaris is easy to find in the northern sky by extending an imaginary line from the two "pointer stars" of the Big Dipper. Polaris lies within 1 degree of the north celestial pole (NCP).

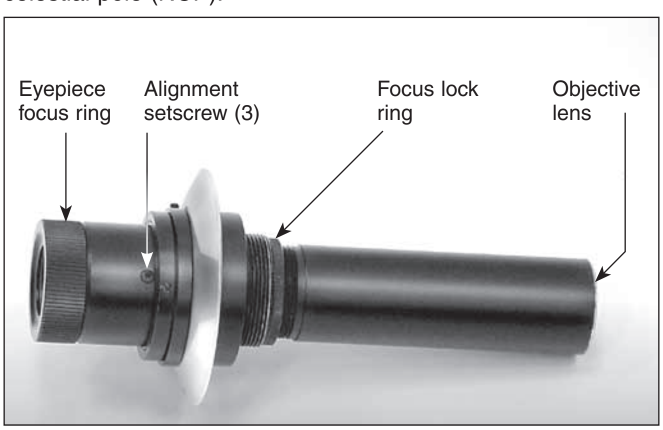

Figure 20. The polar axis finder scope, which comes preinstalled in the mount.

4. Polar Alignment

4.1 What Is It?

When you look at the night sky, you no doubt have noticed that the stars appear to move slowly from east to west over time. That motion is actually caused by the Earth's rotation (from west to east). An equatorial mount is designed to compensate for that motion, allowing you to easily "track" the movement of astronomical objects, thereby keeping them from drifting out of your telescope's field of view while you're observing or imaging.

This "tracking" is accomplished by slowly rotating the telescope on its right ascension (R.A.) axis **(Figure 18)**, using the built in motor drive. But first the R.A. axis of the mount must be aligned with the Earth's rotational (polar) axis—a process called polar alignment.

For Northern Hemisphere operation, approximate polar alignment is achieved by pointing the mount's right ascension axis at the North Star, or Polaris. It lies within 1° of the north celestial pole (NCP), which is an extension of the Earth's rotational axis out into space. Stars in the Northern Hemisphere appear to revolve around the NCP.

To find Polaris in the sky, look north and locate the pattern of the Big Dipper **(Figure 19)**. The two stars at the end of the "bowl" of the Big Dipper point in the general direction of Polaris.

Observers in the Southern Hemisphere aren't so fortunate to have a bright star so near the south celestial pole (SCP). The star Sigma Octantis lies about 1° from the SCP, but it is barely visible with the naked eye (magnitude 5.5).

4.2 The Polar Axis Finder Scope

The Atlas Pro mount comes with a polar axis finder scope **(Figure 20)** housed inside the right ascension axis of the mount. When properly aligned and used, it makes accurate polar alignment quick and easy to do. The polar scope included with the Atlas Pro mount can be used for polar alignment in the Northern or Southern Hemispheres. That is, the polar scope's reticle graphic has reference stars that are useful for aligning in either hemisphere. Remove the cap from the eyepiece of the polar scope to view through it.

4.3 Aligning the Polar Axis Scope to the R.A. Axis

Before using the polar scope for polar alignment, the polar scope itself must be aligned to the mount's R.A. axis. The reticle of the polar axis finder scope has a tiny star map printed on it that makes precise polar alignment quick and easy **(Figure 21)**. At the center of the reticle is a cross, which you'll use in the procedure below to align the polar scope to the R.A. axis.

1. Loosen the Dec. clutch wheel and rotate the optical tube about the declination axis until you have a clear view through the polar axis finder scope **(Figure 22)**. Then retighten the Dec. clutch.
2. Look through the polar scope at a distant object (during the day) or at Polaris (at night) and center it on the cross in the middle of the reticle. You may need to adjust the latitude jackscrew and azimuth adjustment knobs of the mount and the tripod position to do this. Focus the polar scope by rotating its eyepiece.
3. Rotate the mount 180° about the R.A. axis. It may be convenient to remove the optical tube and counterweights before doing this. If the object remains centered on the center cross of the reticle after the rotation, then the polar scope is properly aligned to the R.A. axis and no adjustment is needed.
4. If the target deviated from the cross, then use a 1.5mm Allen wrench to adjust the three small Allen screws on the polar scope **(Figure 23a)** to move the target *half the distance* back to the cross **(Figure 23b).** Then you will re-center the object on the cross as in step 2 using the mount's azimuth adjustment knobs and the latitude jackscrew.
5. Repeat steps 2 to 4 until the object stays centered on the cross of the reticle when rotating the mount on the R.A. axis.

Note:

- When adjusting the Allen screws, loosen one screw only ¼ of a turn, and then tighten the other two.
- Do not over tighten the Allen screws as it might damage the reticle plate in the polar scope.
- Do not loosen one screw completely or loosen more than one screw at a time, or the reticle plate in the polar scope will be disengaged and further adjustment is impossible.
- If the reticle plate does disengage, remove the polar scope's eyepiece by turning the knurled ring counterclockwise and engage the reticle plate again.

4.4 Polar Alignment Using the Polar Scope

1. Set up the Atlas Pro mount. It is recommended to load the mount with the counterweights and telescope (in that order!) and level the mount prior to polar alignment.
2. Move the tripod so the telescope tube and right ascension axis point roughly at Polaris (for Northern Hemisphere) or toward the four dim stars (approx magnitude 5 or 6) of Octans (for Southern Hemisphere). You may need to adjust the altitude and azimuth adjustments to accomplish this.
3. Loosen the Dec. clutch wheel and rotate the optical tube about the declination axis until you have a clear view through the polar axis finder scope **(Figure 22).** Then retighten the Dec. clutch.

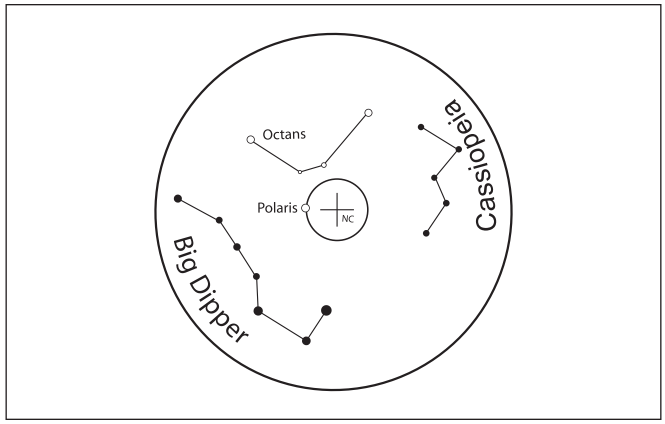

Figure 21. The reticle of the polar axis scope shows the positions of the Big Dipper and Cassiopeia relative to Polaris and the north celestial pole (NCP). For southern hemisphere users, four stars of the constellation Octans are depicted.

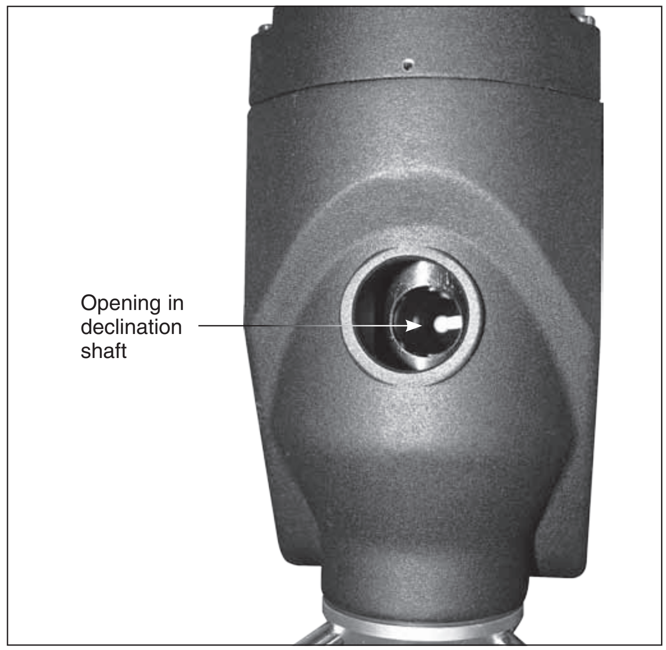

Figure 22. To view through the polar scope, rotate the Dec. axis of the mount until the opening in the Dec. shaft lines up with the opening in the mount housing.

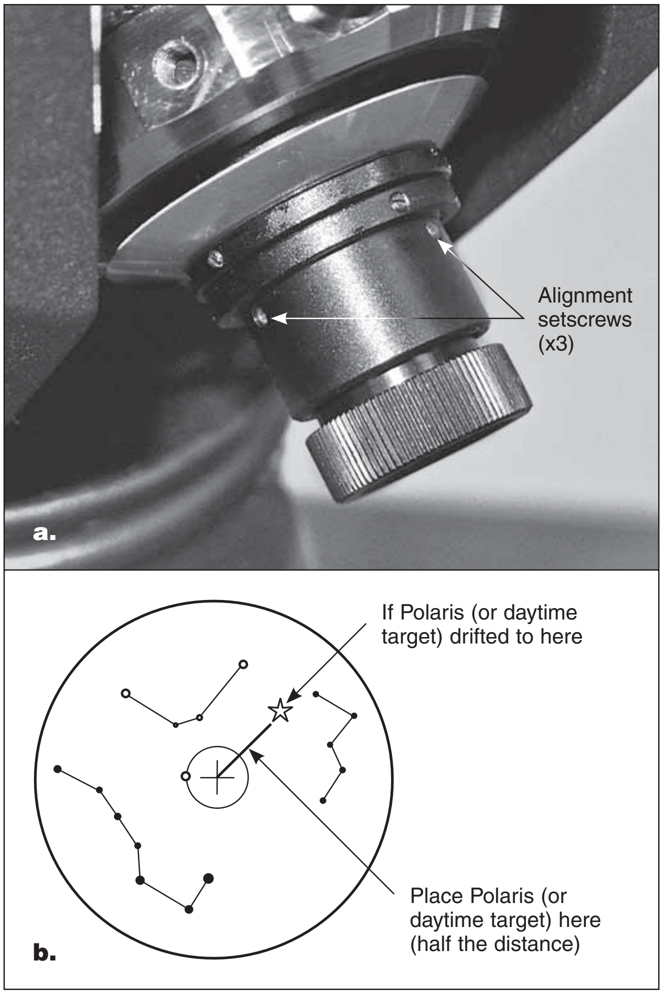

Figure 23. a) The polar axis scope has three alignment setscrews located near the eyepiece. **b)** After centering a distant target and rotating the mount 180 degrees in R.A., adjust the three alignment setscrews to move the target half the distance back to the center cross. Then use the mount's latitude jackscrew and azimuth adjustment knobs to recenter the target.

4. Turn on the power to the mount to illuminate the polar scope. The reticle pattern **(Figure 21)** should now be visible in the polar scope. If the image appears blurred, rotate the polar scope's knurled eyepiece to focus it.

Note: The red illumination of the polar scope reticle is adjustable from 100% to 0% brightness. The default illumination is 100%, which may be too bright for readily seeing Polaris and surrounding stars. To reduce the brightness, access the menu "UTILITY \ Polar Scope LED" and press the ENTER key. Use the Left direction key to reduce the illumination to the desired level (probably 10% or less), then press the ENTER key to set it.

5. Now, sight Polaris in the polar axis finder scope. If it's not in the field of view, move the mount left or right using the azimuth adjustment knobs, and adjust the altitude up or down using the jackscrew until Polaris is visible in the polar scope.
6. Note the constellation Cassiopeia and the Big Dipper in the reticle. They do not appear in scale, but they indicate the general positions of Cassiopeia and the Big Dipper relative to the NCP in the sky. Rotate the reticle so the star patterns depicted match their current orientation in the sky when viewed with the naked eye. To do this, release the R.A. clutch and rotate the main telescope around the R.A. axis until the reticle is oriented with sky. For larger optical tubes, you may need to remove the tube from the mount to prevent it from bumping into the mount during this procedure.
7. Now use the azimuth adjustment knobs and the latitude jackscrew on the mount to position Polaris inside the tiny circle on the finder's reticle. You must first loosen – only very slightly! – the knob underneath the mount head on the center support shaft to use the azimuth adjustment knobs. Once Polaris is properly positioned within the reticle, you are precisely polar aligned. Retighten the knob under the mount and lightly tighten the altitude lock knobs on the sides of the mount.

Polar Alignment in Southern Hemisphere: In the field of view of the polar scope, locate the four dim stars that form the pattern labeled "Octans," which lie near the South Celestial Pole. Loosen the R.A. clutch and rotate the R.A. axis to align the orientation of the "Octans" graphic to the same four stars in the actual sky. Then use the altitude jackscrew and the azimuth adjustment knobs to move the four stars into the four small circles of the Octans graphic on the reticle. With that, the mount is now polar aligned for Southern Hemisphere viewing.

4.5 Another Way to Determine Position of Polaris on Reticle

At the end of the initialization of the SynScan hand controller, after entering the proper local longitude, latitude, date, time, and daylight-saving time setting, the SynScan hand controller will display the message: "Polaris Position in P.Scope=HH:MM". Imagine the larger circle in **Figure 21** as a clock's face with 12:00 at the top, with the current time pointing to the "HH:MM". The orientation of the *hour hand* of the clock represents the orientation of Polaris in the polar scope. Place Polaris at the same orientation on the reticle's large circle to finish the polar alignment.

Note: From this point on in your observing or imaging session, you should not make any further adjustments to the azimuth or the latitude of the mount, nor should you move the tripod. Doing so will disrupt the polar alignment. The telescope should be moved only about its right ascension and declination axes.

5. Drive Panel Interface

5.1 Drive Panel
The drive panel of the Atlas Pro AZ/EQ-G is shown in **Figure 24.**

5.2 Panel Interface Components:
POWER: This is a threaded 12V DC power input jack that provides a secure connection to the power source. The 12V DC "cigarette lighter" power cable provided with the mount has a matching threaded connector for the input jack.

HAND CONTROL: This RJ-45 8-pin jack is for connecting the coil cable of the SynScan hand controller.

AUTO GUIDE: A 6-pin RJ-12 jack is for connecting an autoguider. It is compatible with any autoguider with a ST-4 type interface.

SNAP: This 2.5mm stereo jack allows connection to a camera's shutter control port. The SynScan hand controller can control a camera to take pictures automatically via this interface. The camera control cable included with the Atlas Pro mount is compatible with select Canon EOS series DSLR cameras. It has a right angle 2.5mm stereo plug on one end for connection to the drive panel and a straight 2.5mm plug on the other end for connection to the camera. Cables for other cameras can be sourced optionally or custom made.

ON/OFF Switch: Turns on and off the power to the mount and hand controller.

Power LED: The power LED serves as a power-on indicator and provides other status information:

1. *Steady on:* Power voltage is normal.
2. *Slow flashing:* Power voltage is low; continuing to operate the mount may damage the battery (if a 12V lead-acid battery is in use).
3. *Fast flashing:* Power voltage is extremely low; continuing to operate the mount may damage the battery and the motor controller in the mount.
4. *Intermittent single flash:* The PPEC training routine has been triggered, but the controller board in the mount has not received the worm index signal and the PE correction recording has not started yet.
5. *Intermittent double flash:* The PPEC training routine has been started and the controller board in the mount has received the worm index signal and started to record the PE correction. When the intermittent double flash stops, it means the PPEC training has finished.
6. *Intermittent triple flash:* Sidereal tracking with PEC is now enabled.

5.3 Pinout of the Interfaces
A schematic diagram of the drive panel port circuitry is shown in **Figure 25**.

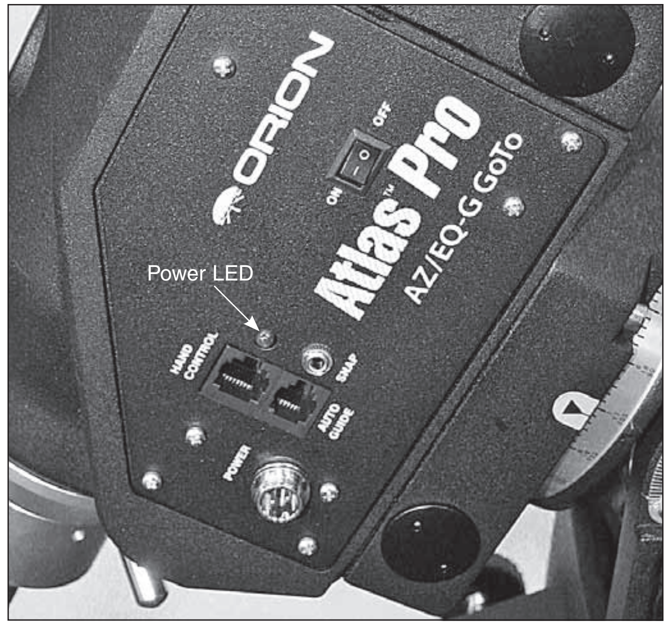

Figure 24. The drive panel of the Atlas Pro AZ/EQ-G

Note:

- The SNAP port provides two trigger signals to the stereo plug. The signal to the head of the plug is issued slightly later than the signal to the ring of the plug.
- For a camera that needs only a shutter-release signal, either trigger signal will work. For a camera that requires a "Focus" signal ahead of the shutter-release signal, both signals will be utilized.

5.4 Attaching the SynScan GoTo Hand Controller
The coil cable for the SynScan hand controller has RJ-45 connectors on each end. Plug one connector into the Hand Control port of the drive panel and the other connector into the RJ-45 port on the bottom of the SynScan controller **(Figure 26)**. Push the connector into the port until it clicks into place.

The smaller modular port next to the RJ-45 port on the hand controller enables serial communication between the Atlas Pro mount and a computer running astronomy software such as Starry Night Pro. For that you will need the RS-232 computer interface cable that was included with the mount. If your computer does not have an RS-232 port, you will also need a USB-to-serial adapter. Check telescope.com for an available adapter.

The 12V DC power jack on the hand controller is used only for updating the firmware in the hand controller or for browsing the object database without connecting to the telescope mount. Do not connect the hand controller to a power source when using the mount for normal operation!

5.5 Power Supply Requirements
The Atlas Pro AZ/EQ-G should be powered by a 12V DC or AC-to-DC power supply with a *3-amp* or higher output current rating. (A 2A AC adapter of the type recommended for the Atlas EQ-G mount will not work for the Atlas Pro.)

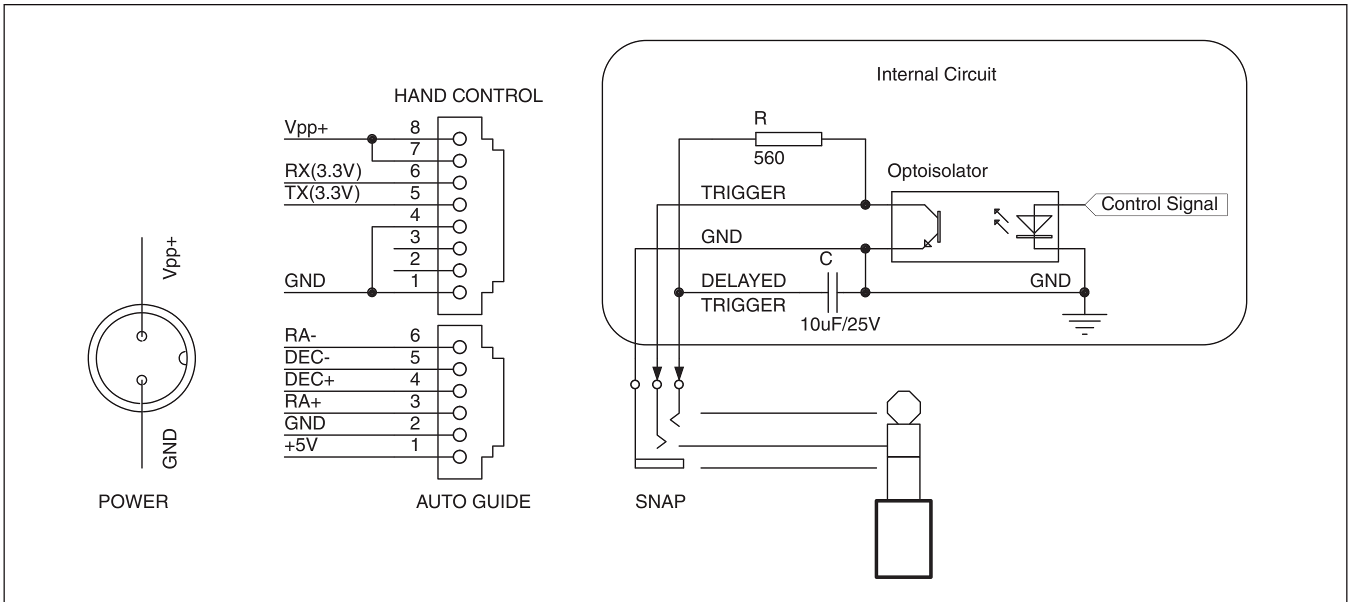

Figure 25. Schematic diagram of the drive panel port circuitry.

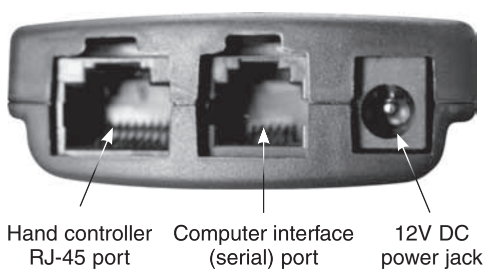

Figure 26. SynScan hand controller ports.

- Output Voltage: DC 11V (minimum) to DC 16V (maximum). Voltage not in this range could cause permanent damage to the motor controller board or the hand controller.
- Output Current: 4A for power supply with 11V output voltage, 2.5A for power supply with 16V output voltage.
- Do not use an unregulated AC-to-DC adapter. When choosing an AC adapter, it is recommended to use a switching power supply with 15V output voltage and at least 3A output current.
- If the power voltage is too low, the motor controller will stop the motors automatically.

6. Other Atlas Pro AZ/EQ-G Features

6.6 Auxiliary Encoder Function

The Atlas Pro mount is equipped with auxiliary encoders on both the R.A. axis and Dec. axis. These enable the mount to continue tracking even when a user unlocks the clutches and manually rotates the mount in R.A. and Dec. With this feature, you can manually operate the mount any time without worrying about losing the mount's alignment status. When you want to operate the mount with the SynScan hand controller again, no re-alignment is required; all that is needed is to re-lock the clutches. This feature can be enabled or disabled in the SynScan hand controller.

6.7 Permanent Periodic Error Correction

The Atlas Pro mount is equipped with an index on its R.A. worm, thus the motor controller can keep tracking the current position of the worm. After a proper PEC training routine, in which the training data is stored in the motor controller permanently, a user can start the periodic error correction (PEC) at any time to improve the tracking performance for astrophotography. A training process is not required in the next observing session (assuming that the polar alignment is always accurate), thus this is a Permanent Period Error Correction (PPEC). A user can train the mount by guiding either manually or electronically with auto-guiding. For detailed instructions, please refer to the relevant section in the SynScan hand controller instruction manual.

6.8 Batch Exposure Function

The Atlas Pro mount is equipped with a SNAP port that can control the shutter of a DSLR camera (see **Figure 24**). Working with the SynScan hand controller's "Camera Control" function, you can set the number of exposures and exposure duration for up to eight different sets of exposures. There is a 2-second delay between exposures (or longer depending on your camera's image download time). For detailed information, refer to the SynScan hand controller instruction manual.

Specifications

Product name	Atlas Pro AZ/EQ-G Mount
Mount type	German equatorial / Alt-azimuth dual mode
Payload (Counterwts. excl.)	44 lbs. (20kg)
Saddle type	Dual wide (Losmandy) and narrow (Vixen)
Latitude adjustment range	10° - 75°, 90°
Azimuth adjustment range	About ±9°
Counterweight	11 lbs. (5kg) each (x2)
Tripod	2-inch stainless steel, 16.5 lbs. (7.5kg)
Counterweight shaft	25mm Diameter, length 202mm + 150mm extension
Power requirement	DC11~16V 4A
Motors	1.8° Hybrid stepper motor
Transmission	180:1 Worm drive + 48:12 timing belt drive + 64 micro-step/1.8° stepper motor drive
Gear ratio	720
Resolution	9,216,000 Counts/rev., approx. 0.14 arc-second
Maximum slewing speed	4.2 degrees/second
Tracking rates	Sidereal, solar, lunar
Tracking modes	Alt-azimuth or Equatorial mode
Autoguiding speeds	0.125X, 0.25X, 0.5X, 0.75X, 1X
PEC	100 segments permanent PEC
Polar axis scope	Northern or Southern hemisphere, illuminated
Hand controller	SynScan
Database	42,000+ objects
Celestial object catalogs	Messier, NGC, IC, SAO, Caldwell, Double Star, Variable star, Named stars, Planets
Pointing accuracy	Up to 5 arc-minutes (RMS)
Resolution of aux. R.A./Dec.axis encoders	6356 Counts/rev., approx. 3.4 arc-minutes
Weight (Tripod excluded)	34 lbs. (15.4kg)

One-Year Limited Warranty

The Atlas Pro AZ/EQ-G Mount 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 to: Orion Warranty Repair, 89 Hangar Way, Watsonville, CA 95076. Proof of purchase (such as a copy of the original receipt) 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: Orion Customer Service (800) 676-1343; support@telescope.com.

Orion Telescopes & Binoculars

89 Hangar Way, Watsonville CA 95076

Customer Support Help Line (800) 676-1343 • Day or Evening

INSTRUCTION MANUAL

SynScan V4 GoTo Hand Controller

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Corporate Offices:
89 Hangar Way, Watsonville CA 95076 - USA

IN 526 Rev. A 03/14

Table of Contents

WARNING:

- ***Never look directly at the Sun with the naked eye or with a telescope – unless you have a proper solar filter installed over the front of the telescope! Otherwise, permanent, irreversible eye damage may result.***
- ***Never use your telescope to project an image of the Sun onto any surface. Internal heat build-up can damage the telescope and any accessories attached to it.***
- ***Never use an eyepiece solar filter or a Herschel wedge. Internal heat build-up inside the telescope can cause these devices to crack or break, allowing unfiltered sunlight to pass through to the eye.***
- ***Never leave the telescope unsupervised, either when children are present or adults who may not be familiar with the correct operating procedures of your telescope.***

1. Overview and Operating Modes

The SynScan V4 GoTo hand controller provides easy, computerized location of thousands of night sky objects – planets, nebulas, star clusters, galaxies, and more for viewing through your telescope. The SynScan hand controller, combined with the optical encoders and electronic drive motors of your GoTo mount, allow you to automatically point your telescope to a specific object, or tour the skies with push-button simplicity. The user-friendly menus allow automatic slewing to over 42,000 objects and stars. Even inexperienced astronomers will quickly master SynScan's intuitive features and functionality.

1.1 Keypad Layout and Connection Ports

The hand controller's two-line liquid crystal display (LCD) is backlit for comfortable viewing. The contrast of the text and the brightness of the red backlight are both adjustable.

There are four categories of control keys on the hand controller **(Figure 1a)**:

1. Mode keys
2. Direction keys
3. Scroll keys
4. Dual Purpose keys

Mode Keys

The three mode keys are ESC, MENU, and ENTER.

- ESC is used to escape from a certain command or go back a level in the menu tree.
- MENU is a quick hot key that takes you to the SETUP menu.
- ENTER is used to select the functions and submenus in the menu tree, and to confirm certain functional operations.

Direction Keys

The direction keys (Up, Down, Left, Right) allow the user to have complete control of the mount at almost any step in operation. These controls are locked out when the telescope is slewing to an object. The direction keys are very helpful when initially aligning the mount, centering objects in the eyepiece field of view, slewing, and manually guiding. The left and right direction keys can also be used to move the text cursor when entering data on the hand controller.

Scroll Keys

The Up and Down scroll keys allow you to scroll up and down within the menu tree or selections displayed on the hand controller screen.

Dual Purpose (Shortcut) Keys

The dual purpose keys serve two distinct purposes. They are used for data entry and as quick-reference (shortcut) keys.

- TOUR: Access the "Deep Sky Tour" function. Takes you on a preset tour of the best night sky objects visible

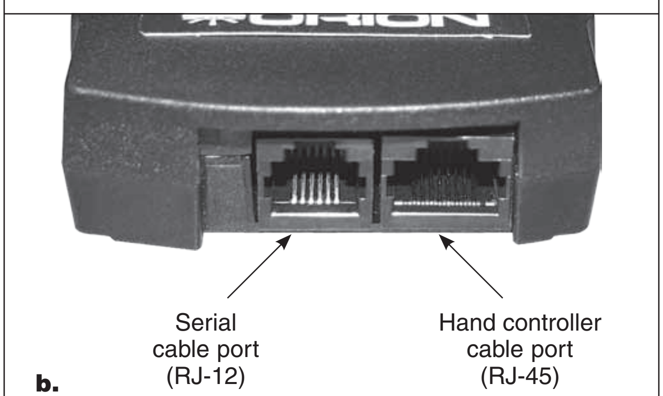


Figure 1. a) The SynScan GoTo hand controller, **b)** Hand controller cable and serial cable ports on the bottom end of the controller

- RATE: Changes the slew speed controlled by the directional keys. There are 10 slew speeds to choose from, with 0 being the slowest and 9 being the fastest.
- UTILITY: Access to the UTILITY FUNCTION menu. Displays functions such as "Show Position", "Show Information," etc.

- USER: Access to the OBJECT LIST submenu. Gives access to up to 25 user-defined coordinates
- ID: Access to the “Identify” function. Identifies the object the mount is currently pointing to.
- M: Access to the “Messier Catalog” submenu of 109 Messier objects.
- NGC: Access to the “NGC Catalog” submenu.
- IC: Access to the “IC Catalog” submenu.
- PLANET: Access to “SOLAR SYSTEM” objects.
- OBJECT: Access to the “OBJECT LIST” menu.

To connect the SynScan V4 hand controller to your mount, plug the 8-pin RJ-45 connector of the coil cable that came with your SynScan into the corresponding port on the bottom of the hand controller (**Figure 1b**), and plug the other end of the cable into the port on the mount’s drive panel. The table below lists the “Hand Control” ports on different Orion GoTo mounts.

Mount Model	Hand Controller Port	“Hand Control” Port on Mount
Atlas EQ-G	8-pin RJ-45	DB-9 (F)
SkyView Pro GoTo, Sirius EQ-G, Atlas Pro AZ/EQ-G, HDX110 EQ-G		8-pin RJ-45
SkyQuest GoTo Dobsonians, all other Orion alt-azimuth mounts		6-pin RJ-12

Plug the coil cable’s RJ-45 connector into the mount. The smaller modular jack on the bottom of the hand controller is used for serial (RS-232) communications between the SynScan and a computer equipped with astronomy software such as Starry Night Pro (see **Section 7: Connecting SynScan to a Computer**). A serial cable was included with your Orion GoTo mount or telescope.

1.2 Slewing with the Direction Keys

The four large direction keys (**Figure 1a**) allow the mount to be slewed electronically as follows:

- The Left and Right keys control the movements of the Right Ascension (R.A.) axis (for an equatorial mount or mode) or the azimuth axis (for an Alt-azimuth mount or mode).
- The Up and Down keys control the movements of the Declination (Dec.) axis (for an equatorial mount or mode) or altitude axis (for an Alt-azimuth mount or mode).
- Pressing the “RATE” key will enable the slewing speed to be selected or changed:
    - The LCD screen will display “Set Speed,” followed by the current speed as “Rate = *X’”.
    - Press a number between “0” and “9” to select a new speed.
    - Press the ENTER key to return to the previous display.
    - If you do not press the ENTER button, you can continue to change the speed while using the direction keys to slew the mount.
    - If there is no keypad operation in 5 seconds, the most recent speed will be kept and the LCD display will return to its previous content.

The following table lists the available slewing speeds:

Rate No.	0	1	2	3	4
Speed *1	0.5X*2	1X*3	8X	16X	32X

Rate No.	5	6	7	8	9
Speed *1	64X	128X	400X	600X	Max*4

- Rates 7, 8, and 9 are used for fast slewing of the mount.
- Rates 5 and 6 are primarily used to move a target within the field of view of a finder scope.
- Rates 2, 3, and 4 are slower rates useful for moving a target in the field of view of an eyepiece.
- Rates 0 and 1 are the slowest rates, ideal for centering an object in a high-power eyepiece, or for manual guiding.

Note:

*1: Speed is represented as multiples of the sidereal rate (Earth’s rotation speed)

*2, *3: For Equatorial mounts, the speed is the drift speed of an object in the FOV with tracking turned on; it is not the axis’s rotation speed.

*4: Maximum speed varies on different mounts. For most Orion mounts, it is higher than 800X (3.4 degrees/sec).

1.3 SynScan Operating Modes

The SynScan V4 hand controller has two operating modes to choose from: Full Feature Mode and Easy Tracking Mode.

1. Full Feature Mode

Full Feature mode is the most commonly employed mode of operation. In this mode the hand controller must be connected to an Orion GoTo telescope mount. After turning on the power to the mount, an “Initialization” routine for the hand controller must be performed, followed by a GoTo “Alignment” routine, which precisely orients the mount with the coordinate grid of the sky. Only after the “Alignment” is done can the SynScan hand controller’s GoTo function be used to accurately pinpoint celestial objects.

A flowchart of the “Full Feature” operation is shown here:

Initialization → Alignment → Locate a celestial object automatically → Observing or other operations

2. Easy Tracking Mode

The Easy Tracking mode is suitable for quick setup for visual observing of brighter celestial objects, such as planets, the Moon, or the Sun. If the user does not turn on the tracking function, the Easy Tracking mode can also be used for observing terrestrial objects.

In Easy Tracking mode, the hand controller must be connected to an Orion GoTo telescope mount. The mount must be set in a proper “Home Position” (refer to **Section 2.1** for details) before turning on the power. After turning on the power to the mount, you’ll complete an “Initialization” routine on the hand controller. Then you can choose to skip the “Alignment” routine and start the tracking function directly (refer to **Section 5.4** for selecting the tracking rate). Users will need to locate a celestial object in the sky, and then use the hand controller to manually point the telescope to the target. The object locating function may still be used but it will not yield a highly accurate result.

A flow chart of the “Easy Tracking” operation is shown here:

Initialization → Start Tracking → Locate a celestial object automatically → Observing or other operations

2. Initialization

2.1 Setting the Mount’s Home Position

Before powering on the telescope mount, it should be set to the “home position.” The home position is different for equatorial and alt-azimuth mounts.

1. Home Position of an Equatorial Mount

- Level the tripod head.
- Point the R.A. axis toward the North Celestial Pole (in Northern Hemisphere) or the South Celestial Pole (in Southern Hemisphere).
- Orient the counterweight shaft so it points downward.
- Point the telescope in the general direction of the North Celestial Pole (in Northern Hemisphere) or the South Celestial Pole (in Southern Hemisphere).

2. Home Position of an Alt-azimuth Mount

To operate the SynScan hand controller in “Full Feature” mode, no particular home position is required.

To operate the SynScan in “Easy Tracking” mode:

- Level the mount base.
- Level the telescope’s tube (parallel to ground) and point it toward true North (not magnetic North).

2.2 Initializing the Hand Controller

Once the mount has been set to the home position, turn the mount’s power switch to ON and start the initialization process via the SynScan hand controller.

1. Selecting the Operating Mode of the Mount

A SynScan V4 hand controller with firmware version 4.05.06 or later supports both an equatorial mount and an alt-azimuth mount. It automatically detects the model of the mount to which it connects and selects the appropriate operation mode accordingly.

For an Equatorial/Alt-azimuth dual-mode mount, such as the Orion Atlas Pro AZ/EQ-G, the SynScan hand controller will request that the user select the operating mode you wish to use:

- The LCD screen will display “Operating Mode” in the first line.
- Use the scrolling keys at the bottom left and right of the keypad to choose Equatorial mode (EQ Mode) or Alt-azimuth mode (AZ Mode).
- Press ENTER to confirm the selection.

2. Firmware Version Display

The hand controller will display the firmware version.

- Press ENTER to proceed to the next step. Press ESC to return to the previous step.
- You can slew the mount with the direction keys at this step.

3. Solar Warning Message

The hand controller will scroll a warning message about the dangers of viewing the Sun with a telescope without a properly fitted solar filter.

- Press ENTER to confirm you have read the warning messages and proceed to the next step. Press ESC to return to the previous (firmware version display) step.
- You can slew the mount with the direction keys at this step.

4. Auto-homing (HDX110 EQ-G Mount only)

The “Auto-Homing” feature automatically establishes a home position for the telescope. This capability applies only to mounts equipped with the Auto-homing feature, such as the Orion HDX110 EQ-G mount. Here’s the procedure:

- The LCD screen will display “Auto-Home?” in the first line, and display “1) YES 2) NO” in the second line.
- Press “2” to skip this step and proceed to the next step, or …
- Press “1” to start the auto-homing routine on the mount. Once completed, the screen will display “Home Position Established.” Press ENTER to proceed to the next step.
- During the auto-homing routine, pressing the ESC key will stop the mount’s movement. The screen will display “Home Position NOT Established.” Press ENTER to proceed to the next step.

5. Entering Data About the Observing Site, Time, and Date

Geographic Coordinates

The LCD screen will display “Set Longitude:” on the first line and the longitude values on the second line.

- Enter the telescope’s current longitudinal location using the numeric keypad and scroll buttons. If you do not know the longitude coordinate of your viewing location, consult an atlas or look them up on the internet (i.e., search “[your location] coordinates”).
- Use the scroll keys to toggle between E and W.
- Press ENTER to confirm the entered coordinates and proceed to the next step.

The LCD screen will then display “Set Latitude:” on the first line and the latitude values on the second line.

- Enter the telescope’s current latitudinal location using the numeric keypad and scroll buttons. If you do not know the latitude coordinate of your viewing location, consult an atlas or look them up on the internet (i.e., search “[your location] coordinates”).
- Use the scroll keys to toggle between N and S.
- Press ENTER to confirm the entered coordinates and proceed to the next step.

Note: Latitude and longitude coordinates must be entered in degrees and arcminutes. If your atlas or other reference source provides coordinates in decimal values (i.e., latitude = 36.95 N), you must convert that into degrees (°) and arcminutes (‘), i.e., latitude 36.95 N = latitude 36°57’ N. There are 60 arcminutes in 1 degree.

Time Zone

The LCD screen will display “Set Time Zone” on the first line and the current time zone on the second line.

- Enter the time zone in which you are observing in hours (see **Appendix A**), using the scroll keys and numeric keypad. Use the scroll keys to change the “+” or “-” sign. The “+” sign is used for time zones in the Eastern Hemisphere (Europe, Africa, Asia, Oceania), while the “-” sign is used for time zones in the Western Hemisphere (North and South America). So for California the time zone would be entered as -08:00.
- Press ENTER to confirm your choice and proceed to the next step.

Date, Time, Daylight Saving Time

- Enter the date in the format mm/dd/yyyy using the numeric keypad. Press ENTER to confirm your choice.
- Enter your current local time using the 24 hour time mode (e.g., 2:00 p.m. = 14:00). Press ENTER to view the time you entered. If the time is incorrect, press ESC to go back to the previous screen. If the time is correct, press ENTER again to proceed to the next step.
- When “Daylight Saving?” is displayed, use the scroll keys to select “Yes” or “No”. “YES” indicates the time entered in the previous step is Daylight Saving time, while “NO” indicates the time entered is Standard time.
- Press the ENTER key to confirm and proceed to the next step

6. Display Position of Polaris Relative to NCP

This step applies to an equatorial mount (or mode) only. It specifies the orientation of the north star, Polaris, relative to the north celestial pole (NCP) in the polar scope’s field of view.

- The LCD screen will display “Polaris Position in P.Scope = HH:MM”. When using a polar scope to do the polar alignment, user can imagine the large circle in the FOV of a polar-scope as a clock’s face with 12:00 at the top, and put the Polaris at the “HH:MM” position of the large circle. Press ENTER to confirm and proceed to the next step. Press ESC to return to the previous step.
- The LCD screen will display “Hour Angle of Polaris = HH:MM”. Press ENTER to confirm and proceed to the next step. Press ESC to return to the previous step.

7. Starting GoTo Alignment

For this, the last step in the hand controller’s initialization process, the screen will display “Begin Alignment?” and ask you to select 1) YES or 2) NO.

Press “1” to start the alignment process.

The SynScan hand controller will operate in Full Feature mode (refer to **Section 1.4**) after the alignment.

Press “2” to skip the alignment process.

The SynScan hand controller will enter standby mode.

- You can start the tracking functions (refer to **Section 5.4**), or use the GoTo function (see **Section 4**) to roughly locate celestial objects. For either operation the SynScan hand controller will employ the Easy Tracking mode (refer to **Section 1.3 Step 2**).
- You can also start an alignment process to operate the SynScan hand controller in Full Feature mode.
- You may slew the mount with the direction keys to point the telescope to terrestrial targets for observing. The “User-Defined Objects” function (refer to **Section 4.6**) of the SynScan hand controller is a useful tool for terrestrial observing.

3. GoTo Star Alignment

In order for your GoTo telescope to accurately locate and point to objects in the sky, it must first be aligned on known positions (stars) in the sky. With the supplied information, the mount can replicate a model of the sky and the movements of astronomical objects. We’re not talking about polar alignment here; that should be done prior to the GoTo alignment procedure (consult the manual for your specific mount or telescope.)

Note: For best results, consider using an illuminated reticle (crosshair) eyepiece to aid in the precise centering of stars in the telescope’s field of view (FOV) during the alignment process. And before performing any of the alignment methods, be sure that your finder scope is precisely aligned with the telescope tube.

3.1 Choosing an Alignment Method

At the beginning of the alignment process, you will use the scroll keys to choose an alignment method. The available alignment methods differ between the mount types:

- For an equatorial mount, the choices are 1-Star Alignment (1-Star Align.), 2-Star Alignment (2-Star Align.) or 3-Star Alignment (3-Star Align.).
- For an alt-azimuth mount, the choices are Brightest Star Alignment (Brightest Star) or 2-Star Alignment (2-Star Align.).
- Select one and press ENTER to proceed to the next step.

Note: For a detailed description and comparison of each alignment method, please refer to **Section 3.6**.

3.2 Choosing the Alignment Star(s)

In this step, you will be asked to choose one or multiple alignment stars from a list provided by the SynScan hand controller, and then control the mount to center the star(s) in the field of view of the telescope’s eyepiece. The SynScan hand controller will then use the data collected in this process to calculate the mount’s orientation relative to the sky coordinates.

The steps for aligning on alignment stars may differ depending on the type of mount used, as well as the chosen alignment method. Please refer to the relevant section for your mount:

- 3.3 Alignment Methods for Equatorial Mounts
- 3.4 Alignment Methods for Alt-azimuth Mounts

3.3 Alignment Methods for Equatorial Mounts

If you are using the GoTo controller for the first time, we recommend you begin with the 3-star alignment. In most cases, a 3-star alignment produces the most accurate alignment of the three possible methods. A 1-star alignment is the least accurate but may be sufficient for casual observing.

3-Star Alignment

1. At the prompt of "Choose 1st Star," use the scroll keys to browse through a list of star names and choose one you're familiar with. Press ENTER. The mount will then automatically slew the telescope toward that star.
2. After the mount stops, the hand controller will display "Use arrow buttons Ctr. To eyepiece." The mount's tracking function is also automatically turned on to prevent the target star from drifting in the FOV of the telescope.
3. Now use the direction keys to move the telescope to center the star in the FOV of the finder scope.
4. Then look in the eyepiece and move the telescope (using the directional keys) so that the chosen star is centered in the field of view of the telescope eyepiece.
5. Press ENTER to confirm the star is centered.

Note: Generally, a slew rate of 5 or 6 is best for centering the star in the finder scope, and a rate of 2 or 3 works best for centering the star in the telescope's eyepiece. The slewing speed can be adjusted by pressing the RATE/2 key. Choose a desired rate between 0 (slowest) and 9 (fastest).

6. You will then be prompted to choose a 2nd alignment star. Choose a star using the scroll buttons and press ENTER to confirm your choice. Repeat the centering procedure for the second alignment star using the direction buttons and press ENTER to confirm alignment.
7. The controller will provide a list of stars that can be used as the third alignment star. Choose a star using the scroll buttons and press ENTER to confirm your choice. Once again, repeat the centering procedure for the third alignment star and press ENTER to confirm alignment.
8. Once the three alignment stars have been entered and alignment is completed, the hand controller will display "Alignment Successful." Press ENTER to access the Main Menu.
9. If "Alignment Failed" is displayed, the alignment procedure must be performed again. To do this, turn the mount's power switch off, then on again.

2-Star Alignment

Two-star alignment requires only two alignment stars but may produce lesser pointing accuracy than the three-star alignment.

1. From the alignment prompt, select "2-Star Align" using the scroll buttons. Press ENTER to confirm your choice.
2. The hand controller will provide a list of stars available in your current sky for you to choose as the first alignment star. Use the same procedure as described for the 3-star alignment to center the first and second star in the finder scope, then in the telescope's eyepiece. Once the two alignment stars have been entered and alignment is complete, the hand controller will display "Alignment Successful."
3. If "Alignment Failed" is displayed, the alignment procedure must be performed again. To do this, turn the mount's power switch off, then on again.

1-Star Alignment

One-star alignment is the simplest and quickest alignment method, as only one alignment star is required. Due to minimal data input, however, a one-star alignment will not yield optimal results unless polar alignment is very accurate, and any cone error is minimized (see **Appendix C**).

1. Access the alignment screen and select "1-Star Align" using the scroll buttons. Press ENTER to confirm your choice.
2. The hand controller will provide a list of stars available in your current sky for you to choose as the alignment star. Use the same procedure as described for the 3-star alignment to center the first (and only) star in the finder scope, then in the telescope's eyepiece. Once the alignment star has been entered and alignment is complete, the hand controller will display "Alignment Successful."
3. If "Alignment Failed" is displayed, the alignment procedure must be performed again. To do this, turn the mount's power switch off, then on again.

Cancellation During Alignment Process

1. While the mount is slewing during the alignment, you may press the ESC key to stop the mount. The hand controller screen will display "MOUNT STOPPED. Press any key…"
2. Press any key and the SynScan hand controller will display "Exit Alignment? 1) YES 2) NO." Press key 1 to exit the alignment process; press key 2 to go back to choose an alignment star.

3.4 Alignment Methods for Alt-azimuth Mounts

There are two methods for aligning in Alt-azimuth mode, and they are very similar: Brightest Star Alignment and 2-Star Alignment. Both actually involve identifying and pointing the telescope to two different bright stars in the night sky. Both alignment methods provide the same level of precision. The only difference is that for the Brightest Star alignment, the hand controller will prompt you to select the first alignment star from a directional region of the sky and will provide a short list of the brightest stars in that region. With the 2-Star alignment procedure the list of eligible stars is not grouped by region of sky.

For the novice stargazer unfamiliar with the night sky or the names of brighter stars, some might find the Brightest Star Alignment to be the easier of the two methods. The 2-Star method is for users who know the names of at least some stars in the night sky. To assist you in performing the alignment by either method, we have included in **Appendix G** a set of star charts with the names of some bright stars indicated for easy reference.

Rules for choosing alignment stars:

- It is recommended that the two alignment stars be 15-60 degrees above the horizon and their altitudes differ by 10-30 degrees.
- The two alignment stars should be separated by 45-135 degrees in azimuth, preferably around 90 degrees.

Note: Before performing either of the alignment methods, be sure that the finder scope or reflex sight is precisely aligned with the telescope tube.

Brightest Star Alignment

Aligning the 1st Star

1. Select "Brightest Star" as your Alignment Method. Press ENTER.
2. The hand controller will prompt you to "Select Region." Referring to **Figure 2**, choose the region that corresponds with where you see the brightest star in the sky. It may be helpful to have a compass for reference during this process. There are eight overlapping regions to choose from, each covers a 90-degree span in azimuth. The direction you choose will only affect your alignment star selection; you will still be able to choose objects to view across the entire sky once the alignment is complete.
3. After you have selected the region of the sky containing the brightest star, the hand controller will generate a list of the brightest stars in that region sorted by the brightness of the star, with the brightest stars at the top of the list. Only stars brighter than magnitude 1.5 will appear in the list. If there is no star brighter than magnitude 1.5 in the selected region, the hand controller will display "No object found in this region." Press ENTER or ESC and select another region of sky.
4. Now, use the Scroll keys to scroll through the list of bright stars. There will only be a few stars, at most, on the list, and sometimes only one star will be on the list. The hand controller will display the name of the star on the first line, and the approximate position of the star (based on the time and date entered during the initial setup) on the second line **(Figure 3)**. The first coordinate on the second line is an E-W coordinate (azimuth angle), and the second coordinate indicates degrees above the horizon.

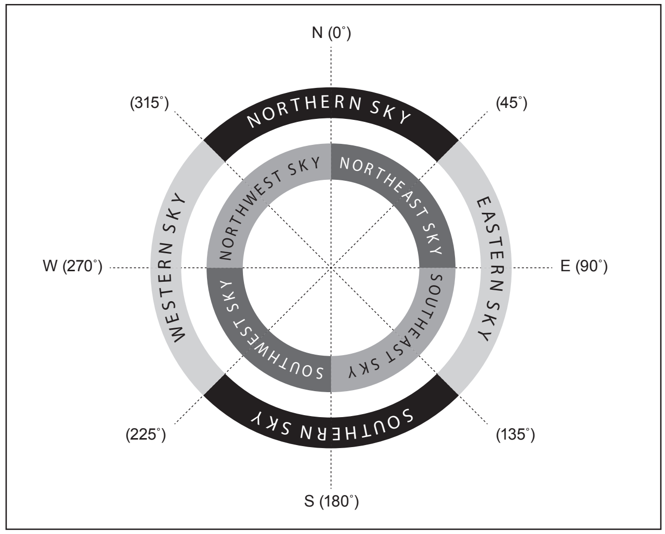


Figure 2. Directional regions of the sky used in the "Brightest Star" alignment method.

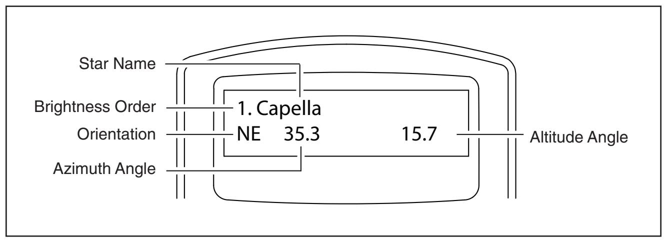


Figure 3. Alignment star information displayed on LCD.

These coordinates provide a simple way to identify the bright star you have chosen. When you are confident the hand controller is displaying the name of the bright star you wish to align on, press ENTER.

5. The mount will NOT slew to the selected bright star automatically. Instead, the screen will display "Point scope to RR ZZ.Z° TT.T° ," where RR is the region (e.g., NE, SW, etc.) ZZ.Z is the azimuth angle in degrees, and TT.T is the altitude in degrees. Use the direction keys to move the mount and point the telescope to the 1st alignment star selected in the previous step. Center the 1st alignment star in the FOV of the finder scope or the red dot finder, and then press ENTER to proceed to the next step.

If the mount has clutches on its axes, you can loosen the clutches to move the mount manually to point the telescope to the target.

Note: Generally, a slewing rate of 5 or 6 is best for centering the star in the finder scope, and a rate of 2 or 3 works best for centering the star in the telescope's eyepiece. The slewing speed can be adjusted by pressing the RATE/2 key. Choose a desired rate between 0 (slowest) and 9 (fastest).

6. Now the screen will display "Ctr. to eyepiece" and the name of the selected 1st alignment star. Use the direction keys to center it in the telescope's eyepiece and then press ENTER.

Aligning the 2nd Star

7. If the first alignment star is not a planet, the LCD screen will display "Choose 2nd Star"; otherwise, it will display "Choose 1st Star."
8. Scroll through the list using the Scroll keys and refer to the appropriate star chart in the back of this manual to choose a second alignment star. Ideally, you want this star to be about 60 degrees (i.e., about six fist-widths held at arm's length) away from the first alignment star in azimuth, and preferably at roughly the same altitude. The more distance between the two alignment stars, the better accuracy the alignment will produce. Once you've selected a second alignment star, press ENTER. The mount will now automatically slew to the selected star, which should land in or near the field of view of your finder scope.
9. After the mount stops, the hand controller will display the name of the selected star on line 1 and "Ctr. to eyepiece" on line 2. After you've centered it in the telescope's eyepiece (or first in the finder scope, if the star is not visible in the eyepiece field of view), press ENTER.

- If the first alignment star was not a planet, the SynScan hand controller will now display "Alignment Successful." Press ENTER to complete the alignment process.
- If the first alignment star was a planet, the SynScan hand controller will display "Choose 2nd Star." Repeat from Step 2 to complete the alignment process.
- If the message "Alignment Failed" displays, it usually means the star positions do not correspond with the location and date/time information input during setup. Please check your user initialization settings before starting again.

Cancellation During Alignment Process

1. While the mount is slewing during the alignment, you may press the ESC key to stop the mount. The hand controller screen will display "MOUNT STOPPED!! Press any key."
2. Press any key and the SynScan hand controller will display "Exit Alignment? 1) YES 2) NO." Press key 1 to exit the alignment process; press key 2 to start the alignment process over.

2-Star Alignment

To perform the 2-star alignment, follow the same steps described for the Brightest Star alignment, except that the hand controller will not prompt you to select a directional region for a bright star. Instead, you'll be presented with a list of stars available in your current sky to choose from, for each of the two alignment stars.

3.5 Tips for Improving Alignment Accuracy

Eyepiece

- Use a reticle eyepiece to ensure accurate centering of your alignment objects. If a reticle eyepiece is not available, try to use an eyepiece with longer focal length to yield a smaller FOV. You can also try de-focusing the star image to obtain a large star disk in the FOV. Centering the star disk in the FOV is easier than centering a pinpoint star, in the absence of a reticle eyepiece.
- During the alignment process, avoid changing or rotating the eyepiece and the diagonal (if one is used).

Mechanical Backlash

All mounts have some amount of mechanical backlash on both axes. To avoid introducing alignment error from backlash, keep the following rules in mind:

- When centering an alignment star in the eyepiece, the operation should always end by using the UP and RIGHT direction keys to move the axes.
- If there is overshoot when centering an alignment star in the eyepiece with UP and RIGHT keys, use the LEFT or DOWN keys to pull the star back to the edge of the FOV and then use the RIGHT and UP keys to center the star again.

Alignment Star Selection

The choice of alignment stars can also impact the alignment accuracy. Please refer to earlier parts of **Section 3** on suggestions for choosing alignment stars for various mounts and alignment methods.

3.6 Comparison of Alignment Methods (Equatorial Mount/Mode)

1-Star Alignment

Advantage: Quickest alignment.

Preconditions:

- An accurate polar alignment for the mount.
- Small cone error in the telescope-mount setup.
- If the cone error is large, there will be noticeable offset in the R.A. when the SynScan hand controller locates an object that is:
  - On the other side of the meridian from the alignment star.
  - Deviated significantly in declination from the alignment star.

Rules for choosing an alignment star:

- Choose an alignment star with smaller declination. It will help to obtain higher resolution in R.A. movement in the telescope's eyepiece.
- If there is cone error in the telescope-mount setup or if you are unsure about it, choose an alignment star that is close to the object(s) to be observed.

2-Star Alignment

Advantage: For visual observing, the mount does not need to be polar-aligned accurately.

Preconditions: Small cone error in the telescope-mount setup.

Rules for choosing alignment stars:

- The deviation in R.A. of the two alignment stars should not be too small or too close to 12 hours, i.e., 180 degrees; the recommended deviation is between 3 and 9 hours, i.e., between 45 and 135 degrees.

- If there is cone error in the telescope-mount setup or if you are unsure about it, choose two alignment stars that are on the same side of the meridian. The absolute values of the two alignment stars' declination should be between 10 to 30 degrees.

Note: If the polar alignment of the mount is good, it is not necessary to choose "2-Star alignment" to align the mount; use "1-star alignment" instead.

3-Star Alignment
Advantages:

- Good pointing accuracy; even if the telescope-mount system has cone error.
- For visual observing, the mount does not need to be accurately polar-aligned.

Preconditions: The skies on both sides of the meridian are clear of obstructions.

Rules for choosing alignment stars:

- The three alignment stars should be spread out on both sides of the meridian.
- For the two alignment stars on the same side of the meridian, they should differ in R.A. by greater than 3 hours, i.e., 45 degrees apart in RA, and the absolute value of the difference of the two alignment stars' declination should be between 10 and 30 degrees ($10° < |Dec1 – Dec2| < 30°$).
- If there is cone error in the telescope-mount setup or you are unsure about it, don't choose alignment stars that all have small declinations (close to Dec. = 0).

Note: If you are sure that there is no (or very small) cone error in the telescope-mount system, then it is not necessary to choose the "3-star alignment" to align the mount. Use "1-star alignment" or "2-star alignment" instead.

4. Locating Objects

Users can access several popular celestial object catalogs stored in the SynScan hand controller and command the telescope mount to locate a specific object in the catalogs. The object location function is available for either "Full Feature" mode (**Section 1.3 Step 1**) or "Easy Tracking" mode (**Section 1.3 Step 2**) of the mount.

The SynScan hand controller boasts a vast database of over 42,000 objects and stars. Once the telescope has been GoTo aligned, you can access and view the thousands of objects in the SynScan database. The database contains the following catalogs:

Named Star: A list of 100 popular, known stars

Solar System: The other 8 planets of our solar system and Earth's Moon

NGC: 7,840 of the brightest deep-sky objects from the Revised New General Catalog

IC: 5,386 of standard stars and deep sky objects from the Indexed Catalog

Messier: Complete list of 110 Messier objects

Caldwell: Complete list of 109 Caldwell objects

SAO Catalog: The SAO star catalog in the SynScan hand controller is a small sub-set of the 259,000-star SAO catalog, containing only stars brighter than magnitude 8

Double Star: Includes 55 of the best double stars to view

Variable Star: Includes 20 of the most famous variable stars

User Object: Up to 25 objects can be saved in the User-Defined database

Deep-Sky Tour: Takes you on a preset tour across the night sky, stopping at the brightest and most beautiful objects visible in your sky at the current time/date

4.1 Messier, NGC, IC, and Caldwell Objects

1. Press the M, NGC, or IC shortcut key on the hand controller, or press the OBJECT key. For Caldwell objects, there is no shortcut key so press the OBJECT key and scroll until "Caldwell Catalog" is displayed, then press ENTER.
2. Enter the 3-digit (for Messier or Caldwell) or 4-digit catalog number of the object you wish to target.
   - Messier objects are numbered from 1 through 110.
   - NGC objects are numbered from 1 through 7840.
   - IC objects are numbered from 1 through 5386.
   - Caldwell objects are numbered from 1 through 109.
3. If the selected object is below the horizon at this time, the SynScan hand controller will display "Below horizon" for 2 seconds; otherwise, it will display the object's current azimuth and altitude.
4. By using the scroll keys, you can browse the following information of the object: J2000 celestial coordinates, magnitude (MAG=), rising time (Rise:), transit time (Transit:), setting time (Set:), size (Size=) and associated constellation (Constellation:).
5. Press the ENTER key to proceed to the next step. The screen will display "View Object?"
6. Press the ENTER key to slew the mount toward the target (or press the ESC key to return to the previous step). When the mount stops, the SynScan hand controller will beep and then return to the previous step. The mount will also automatically start tracking the object.
7. You can press the ESC key to stop the mount if needed. The screen will display "MOUNT STOPPED!! Press any key." Then press any key to return to the previous step.

Note: The mount will not slew if:

- The object is below the horizon.
- On an alt-azimuth mount, the object's altitude exceeds the limit set by the hand controller. (The screen will display "Target over slew limit" in this case.) See **Section 5.6** for more on altitude slew limits.

4.2 Planets and the Moon

1. Press the "PLANET" shortcut key. The screen will display "Solar System" in the top row.
2. Use the scroll keys to browse through the list of entries, which includes Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto (Yes, we know, it's no longer officially a planet!), and the Moon. Choose one and press ENTER.
3. If the selected object is currently below the horizon, the message "Below horizon" will display for 2 seconds; otherwise, you will see the object's current azimuth and altitude.
4. Using the scroll keys, you can browse the following information of the object: current RA and Dec coordinates, rise time (Rise:), transit time (Transit:), set time (Set:), and the common name of the object. Press ENTER to proceed to the next step.
5. To slew to the object, follow the same process described for the Messier, NGC, IC, and Caldwell Objects in **Section 4.1** above.

4.3 Named Stars, Double Stars, and Variable Stars

1. Press the "OBJECT" shortcut key. Use the two scroll keys to browse the list until "Named Star," "Double Stars," or "Variable Stars" is displayed, and then press the ENTER key to select the desired option.
2. Once inside, use the two scroll keys to find the desired object in the list of star names. Press the ENTER key to confirm the selection.
3. To slew to an object you will use the same basic procedure as for the other objects above (see **Section 4.1**).

Note: The data for the separation angle (Separation:) and the position angle (Position Angle:) are provided for double stars, and the maximum magnitude (Max.MAG=), minimum magnitude (Min.MAG=), and period of variation (Period=) are provided for variable stars.

4.4 SAO Stars

1. Press the "OBJECT" shortcut key and use the two scroll keys to find "SAO Catalog," then press ENTER.
2. Enter the 4 left-most digits of the 6-digit SAO number (e.g., "SAO 0238xx"). Press ENTER, then the hand controller will find the first SAO number in the database that matches the four left-most digits entered (e.g., "SAO 023801").
3. Use the scroll keys to change the last two digits until the screen displays the desired SAO index number. Press the ENTER key to confirm the input. (e.g., "SAO 023825").

Note: The SAO catalog in the SynScan hand controller is a sub-set of the SAO catalog. It only contains stars brighter than magnitude 8.

4. To slew to a star you will use the same procedure as for the other objects above (see **Section 4.1**).

4.5 Deep Sky Tour

The SynScan V4 hand controller enables you to take a tour of the best deep-sky objects visible in the current sky from your location. You can select them one by one and command the SynScan hand controller to automatically point the telescope to each object for viewing. This is the "Deep Sky Tour" function.

1. Press the "TOUR" shortcut key. The screen will display "Deep Sky Tour" in the top row. Use the two scroll keys to browse through a list of the deep-sky objects and press ENTER to pick one.
2. The screen will display the catalog to which the object belongs as well as its catalog number in the top row. The object's current azimuth and altitude will be displayed in the bottom row.
3. Use the scroll keys to browse the object's current celestial coordinates, magnitude (MAG=), rise time (Rise:), transit time (Transit:), set time (Set:), size (Size=), and associated constellation (Constellation:).
4. Press ENTER to proceed to the next step.
5. **Go To the Object:** Slewing to an object involves the same procedure as described for the other objects above (see **Section 4.1**).

4.6 User-Defined Objects

The SynScan hand controller allows you to save up to 25 objects in the User-Defined database. You can save currently unknown objects, unidentifiable objects, current comet and/or asteroid positions, or you can make a custom list of your favorite objects to view.

Defining and saving an object to the database

1. Press the "USER" shortcut key. The screen will display "User Object".
2. Press the scroll keys until "New Object" is displayed on the screen, then press the ENTER key. The screen will display "Coord. Type 1) RA-DEC 2) Mount." Press "1" to enter R.A./Dec. coordinates for a celestial object; press "2" to enter Alt-azimuth coordinates for a land object. If "RA-DEC" is chosen, the screen will display the coordinates to which the telescope is currently pointing. If "Mount" is chosen, the screen will display the coordinates of the mount's two axes. The first number is the coordinates of the R.A. or azimuth axis, while the second number is the coordinates of the Dec. or altitude axis.
3. Edit the coordinates using the numeric keys and scroll keys. Press ENTER to save the chosen setting.
4. The screen will display "Save?" Press the ENTER key to start saving the coordinates. (Or press the ESC key to proceed to the next step without saving the coordinates.)
5. The hand controller will prompt you to choose a storage space index number between 1 and 25 for your chosen object. Select the number you wish to represent the coordinates, using the scroll buttons. Press ENTER to confirm.

6. Once the object coordinates are represented by a number, the hand controller will display “View Object?” Press ENTER to slew the telescope to the coordinates. Press ESC to exit.

Selecting a user defined object

1. Press the USER shortcut key. The screen will display “User Object / Recall Object”. Press ENTER.
2. Use the scroll keys to browse through the list of pre-defined objects indexed from 1 to 25. Select the number representing the object you wish to view, then press ENTER to display the object’s coordinates. Press the ENTER key again to proceed.
3. The screen will now display “View Object?” Press ENTER to slew the telescope to the selected object. Press ESC to exit.

5. Configuring Hand Controller and Mount Settings

The MENU and UTILITY shortcut keys are the entry points for configuring many aspects of the mount and hand controller. The different types of functions available are listed below, along with their respective purposes. Press the MENU or UTILITY keys, as directed below, to access them.

5.1 Date, Time, Site, Time Zone, and Daylight Saving Time

- Date – Allows you to change the date entered at the initial setup.
- Time – Allows you to change the current time.
- Observation Site – Allows you to change the current location settings.
- Daylight Saving – Allows you to change the Daylight Saving option.
- Alignment – Allows you to re-perform the 1-star, 2-star, or 3-star alignment for GoTo operation at any time without restarting the mount (see **Section 5.10**).

5.2 Hand Controller Display and Keypad Settings

1. Access “MENU \ Handset Setting” and press the ENTER key.
2. Use the scroll keys to select “LCD Contrast,” then use the left/right direction keys to adjust the contrast of the LCD text characters.
3. Use the scroll keys to select “LED Backlight,” then use the left/right direction keys to adjust the LED brightness of the hand controller keys (buttons).
4. Use the scroll keys to select “LCD Backlight,” then use the left/right direction keys to adjust the brightness of the LCD screen’s backlight.
5. Press ESC to exit the adjustment.

5.3 Backlash Compensation

Backlash is a delay in motorized motion of the mount due to slack between gears. This delay, or hesitation, is experienced when the slewing direction is reversed on one or both axes of motion using the direction keys on the hand controller. So when you’re looking at an object in the eyepiece, it will not move immediately upon pressing a direction key – there will be a lag time.

The SynScan hand controller can compensate for backlash by commanding the mount to slew at a higher speed for a specific amount of distance when the user reverses direction with the direction keys. With such backlash compensation you’ll get a faster response from the mount.

This function allows you to insert a value for each axis to compensate for slewing backlash experienced on that axis. For improved pointing accuracy, it is important that the backlash value is set to be equal or greater than the actual amount of backlash between the gears. If the actual amount of backlash is unknown, we recommend that you set the value to 5000 (approximately equivalent to 0.2°). First set the value for R.A. backlash, then press ENTER to set the value for DEC.

1. Access “MENU / Backlash” and press the ENTER key.
2. The screen will display “Azm = X°XX'XX" ” or “RA = X°XX'XX" ”. Use the Left/Right keys to move the cursor and use the numeric keys to fill in a number at the cursor position to input the amount of backlash in the azimuth or R.A. axis. Press the ENTER key to finish the input and proceed to the next step.
3. The screen will display “Alt = X°XX'XX" ” or “Dec = X°XX'XX" ”. Fill in the amount of backlash in the altitude axis or Dec. axis and then press the ENTER key.

Notes:

- Set the backlash value to 0 for an axis to disable backlash compensation for that axis.
- Backlash compensation is only active for computerized GoTo slewing, not for manual slewing with the direction buttons.

5.4 Tracking Rate

The mount can track at several different rates, which you select depending on the type of object(s) you’ll be observing or photographing.

1. Access “MENU \ Tracking” and press the ENTER key.
2. Use the scroll keys to browse the various options, and press the ENTER key to pick one.
   - *Sidereal Rate:* ***This is the default tracking rate.*** Activates tracking at sidereal rate (R.A. tracking) for observing/photographing stars, deep-sky objects, and planets.
   - *Lunar Rate:* Activates tracking at lunar rate (R.A. tracking) for observing/photographing the Moon.
   - *Solar Rate:* Activates tracking at solar rate (R.A. tracking) for observing/photographing the Sun.

- *PEC + Sidereal Rate:* Activates sidereal rate tracking and turns on Periodic Error Correction (PEC). Applies to equatorial mounts/mode only.
- *Stop Tracking:* Turns off the tracking function.

Note: You can turn on the tracking without performing a star alignment procedure. In this case, the polar alignment should be rather accurate for an equatorial mount; and the mount must be set up to the proper home position before turning on the power (refer to **Section 2.1**).

5.5 Autoguide Speed

For astronomical imaging, some Orion equatorial mounts or dual equatorial/alt-azimuth mounts have a designated autoguider interface. The pin-outs on the 6-pin modular connector are ST-4 compatible and can be used with most autoguiding cameras currently available. The guiding speed can be adjusted using the Auto Guide Speed function in the Setup Menu.

1. Access “MENU \ Auto Guide Speed” and press the ENTER key.
2. Use the scroll keys to choose one of the following guiding speeds: 0.125X, 0.25X, 0.5X, 0.75X, or 1X, and then press the ENTER key. The default autoguiding speed is 0.5X.

5.6 Altitude Axis (Elevation) Slew Limits

Some alt-azimuth mounts have limited slewing range on their altitude axis, or users may need to set slewing limits for some equatorial mounts. Users can set the upper or lower altitude limit for such mounts.

- When you select an object whose altitude exceeds the altitude limits of an alt-azimuth mount, or the elevation slewing limit of an equatorial mount, the SynScan hand controller will display “Target is over slew limits!!” and will not initiate slewing.
- When you use the Up or Down direction keys to slew the altitude axis to exceed the altitude limits of an Alt-azimuth mount, the SynScan hand controller will automatically stop the altitude axis and display “Over slew limit. Slewing stopped!” In this case you have to press any key and the SynScan controller will bring the altitude axis back.

Follow these steps to set the altitude slewing limits:

1. Access “MENU \ Elevation Limits”, and press the ENTER key.
2. Use the scroll keys to choose options “Enable” or “Disable,” then press the ENTER key to confirm.
3. If “Disable” is chosen, the SynScan hand controller will turn off the altitude limit.
4. If “Enable” is chosen, the SynScan hand controller will turn on the altitude limit, and you can input the upper and lower limits as follows:
   - The screen will display “Set Elev. Limits:” in the top row, and “Upper=+XXX. X°” in the bottom row. Use the Left/Right keys to move the cursor and use the numeric keys to fill the upper limits. The leading sign can be changed with the scroll keys. Press the ENTER key to end the input and proceed.
   - The screen will display “Lower=+XXX. X°” at the bottom row; fill in the data in a similar way.

5.7 Enable/Disable Auxiliary Encoder

Some Orion telescopes and mounts are equipped with auxiliary encoders on their primary axes to support manually moving the scope without upsetting the mount’s GoTo alignment status. Users may turn off the auxiliary encoder to obtain the best pointing accuracy. The auxiliary encoder can be turned on again at any time for manually moving the mount.

1. Access “MENU \ Auxiliary Encoder” menu and press the ENTER key.
2. Use the scroll keys to select between “Enable” or “Disable” and press the ENTER key.

Note: After re-enabling the auxiliary encoders, it is recommended to use the direction keys to move both axes a bit before commanding the hand controller to locate an object.

Note: For some Orion mounts, which are not equipped with auxiliary encoders, when accessing the Auxiliary Encoder, the hand controller display will show “Not available!” and return to the previous step.

5.8 Alignment Star Filter

Not all combinations of alignment stars are good for a 2-star alignment or 3-star alignment. The SynScan hand controller uses a built-in advanced alignment star filter to show only the stars that are suitable to work with the 1st or 2nd alignment star(s), when asking the user to choose the 2nd or 3rd alignment star. This helps to improve the success rate of the alignment.

Some advanced users or those who have limited sky visibility can turn on/off this advance filter with the following steps:

1. Access “MENU \ Alignment Stars \ Adv. Filter” and press the ENTER key.
2. Use the scroll keys to choose “OFF” and then press the ENTER key to disable the filter.
3. Use the scroll keys to choose “ON” and then press the ENTER key to enable the filter.

Note: Even if the advanced filter function is turned off, the SynScan hand controller will still apply the following rules to generate the list of alignment stars:

- The alignment star’s altitude must be above 15 degrees.
- For an equatorial mount or mode, the alignment star’s declination must be between -75 and +75 degrees.
- For an alt-azimuth mount or mode, the alignment star’s altitude must be below 75 degrees or within the altitude limits defined by the user (**Section 5.6**).

5.9 Sorting Method of Alignment Stars

1. Access “MENU \ Alignment Stars \ Sort by” and press the ENTER key.

2. Use the scroll keys to select “Magnitude” or “Alphabet” and the press the ENTER key to sort the list accordingly.

5.10 Naming of Stars

1. Access “MENU \ Alignment Stars \ Set Star Name” and press the ENTER key.
2. Use the scroll keys to choose between “Common Name” and “Bayer Designation”, press the ENTER key to confirm.

5.11 Re-aligning the Mount

You can execute a 1-star alignment, 2-star alignment, or 3-star alignment at any time without restarting the mount.

1. Access “MENU \ Alignment” and then press the ENTER key.
2. Use the scroll keys to select an alignment method and press the ENTER key to start the alignment process. For detailed instructions on alignment, please refer to Section 3.

5.12 Show Position

This function displays the coordinates of the point in the sky at which the telescope is aimed. Access the menu “UTILITY FUNCTION \ Show Position” and press the ENTER key.

Use the scroll keys to choose one of the following coordinate types:

- *Dec/RA:* Displays the current equatorial coordinates of the telescope.
- *Alt/Azm:* Displays the current altitude and azimuth coordinates of the telescope.
- *Ax1/Ax2:* Displays the current coordinates of the mount. Ax1 is the position of the declination or altitude axis, and Ax2 is the position of the R.A. or azimuth axis.

Note: You can use the direction keys to slew the mount to specific coordinates by referring to the real-time coordinates display.

5.13 Show Time and Local Sidereal Time

To display the current local sidereal time (LST) and the local time, access the menu “UTILITY FUNCTION \ Show Information \ Time” and press the ENTER key.

5.14 Display Version Information

Access the menu “UTILITY FUNCTION \ Show Information \ Version” and press the ENTER key, and then use the scroll keys to browse through the following information. Press the ESC key to exit.

- *H.C. Firmware:* The firmware version of the SynScan hand controller.
- *Database:* The database version of the SynScan hand controller
- *H.C. Hardware:* The hardware version of the SynScan hand controller.
- *Motor Controller:* The firmware version of the mount’s internal motor controller board.
- *H.C. Serial No.:* The serial number of the SynScan hand controller.

5.15 Display Power Voltage

To display the voltage of the power supply used to power the telescope or mount, go to “UTILITY FUNCTION \ Show Information \ Power Voltage” and press the ENTER key.

5.16 Display Polaris Position

This function can aid in achieving an accurate polar alignment when using the mount’s polar axis finder scope. Imagine the large circle around the celestial pole (cross in center) in the polar scope’s field of view as a clock’s face, with 12:00 at the top, and put Polaris at the “HH:MM” position of the large circle.

1. To do this, access the menu “UTILITY FUNCTION \ Show Information \ Polaris Pos.” and press the ENTER key. The screen will display “Polaris Position in P.Scope = HH:MM.” Use the scroll keys to display “Polaris HA = HH:MM”, where HA stands for Hour Angle. Press the ESC key to exit.

5.17 Display Polar Alignment Error

Checking the polar alignment error will tell you how accurate your polar alignment is, which will allow you to decide if you should perform the polar alignment procedure again or if it’s “good enough” for your purpose.

1. Access the menu “UTILITY FUNCTION \ Show Information \ Polar Align. Error” and press the ENTER key. The screen will display “Mel=+DDD°MM'SS" Maz=+DDD°MM'SS" ”. The “Mel” value is the polar alignment offset in elevation, and the “Maz” value is the polar alignment offset in azimuth. The data is valid only after a 2-star or 3-star GoTo alignment.

5.18 Changing Polar Scope Illumination Level

This function applies only to certain Orion mounts that are equipped with a variable-brightness polar scope illuminator.

1. Access the menu “UTILITY FUNCTION \ Polar Scope LED” and press the ENTER key.
2. Use the Left/Right direction keys to adjust the illumination level. Press the ENTER key to confirm and exit.

6. Advanced Functions

6.1 Identifying Objects

After aligning the mount for GoTo operation, the SynScan hand controller can be used to identify any object at which the telescope is pointing.

1. Center the object to be identified in the telescope’s eyepiece.
2. Press the “ID” shortcut key. The screen will display “Identify: Searching…”. The SynScan hand controller will look up the named stars, planets, Messier objects, NGC objects, and IC objects within a 5 degrees range of the object centered in the eyepiece.

3. The screen will display “No object found” if the SynScan hand controller cannot identify the object.
4. If an object is found within the 5-degree range, the screen will display the object’s name in the top row, and the deviation from the object in the center of the eyepiece.
5. If multiple objects are found, use the scroll keys to browse through the list of identified objects.
6. Press the ENTER key to select an identified object and then use the scroll keys to read its data, such as the J2000 celestial coordinates, magnitude (MAG=), rising time (Rise:), transit time (Transit:), setting time (Set:), size (Size=), associated constellation (Constellation:), etc.
7. Press the ESC key to exit.

6.2 Synchronizing Encoders

For telescopes or mounts that are not equipped with auxiliary encoders, if the mount loses the correct position of either of its two axes – for example, if an axis is manually moved – the pointing accuracy will be compromised when the SynScan hand controller tries to locate an object.

Providing the base of the mount or its tripod was not moved, you can recover the pointing accuracy with the “Synchronize Encoder” operation.

1. Access “MENU \ Sync. Encoder” and press the ENTER key.
2. Use the scroll keys to select an alignment star and press the ENTER key. The mount will point the telescope toward the alignment star.
3. After the mount has stopped, use the direction keys to center the alignment star in the eyepiece, then press the ENTER key to confirm.
4. The SynScan hand controller will display “Sync Encoder Completed.” Press any key to exit.

6.3 Parking the Telescope

If the mount has not been moved after an observing session, you can “park” the telescope to keep the alignment data, PAE data, and PEC data, and start your next observing session without having to redo the GoTo alignment and calibration.

Parking

1. Access the menu “UTILITY FUNCTION \ Park Scope” and press the ENTER key.
2. The screen will display “Park to…” Use the scroll keys to choose one of the following parking positions and press the ENTER key.
   - *Home Position:* Park the telescope in the Home Position (refer to **Section 2.1**).
   - *Current Pos.:* Park the telescope in its current position.
   - *Custom Position:* Park in the same position you used after the previous observing session.
3. The mount will slew to the parking position (except parking at the current position). When the mount stops the screen will display “Position saved. Turn off power”.
4. You may now turn off power to the mount, or press the ESC key to cancel parking.

Resuming from Parked Position

1. Turn on power to the mount.
2. Pass through the initial steps.
3. When the screen displays “Start from Park? 1) Yes 2) No”:
   - Press “1” to resume operation of the mount from the parked status. After the regular initialization steps, the SynScan hand controller will be ready for full feature operation like in the previous observing session.
   - Press “2” to abandon the previous saved park position and alignment data and start a regular observing session.

6.4 Pointing Accuracy Enhancement (PAE)

The pointing accuracy enhancement (PAE) function enables the telescope mount to achieve enhanced pointing accuracy in specific areas of the sky.

After a 1-star, 2-Star or 3-star alignment, the telescope mount might still have a small pointing error due to many factors, such as the flexure of the telescope, atmospheric refraction, or other mechanical issues. The amount of pointing error may vary in different portions of the sky.

The SynScan hand controller divides the sky into 85 small zones, and you can calibrate the pointing error for each of these zones. The next time the SynScan controller tries to locate an object in the calibrated zone (or a zone nearby), it will automatically apply the recorded calibration data to compensate for the pointing error. This function is useful for locating faint deep sky objects, and it is also helpful to obtain consistent pointing accuracy for a permanent observatory.

Perform the following procedure to use the PAE function:

1. Perform a 1-star alignment, 2-star alignment, or a 3-star alignment.
2. Choose a bright star near the area of interest in the night sky. Consult a star map or software program to choose the star, if necessary.
3. Find this reference star in the hand controller’s object database (Named Stars) and press ENTER to select the star. Press ENTER again, and the LCD will ask “View Object?” Press ENTER to issue a command to the mount to go to the star. If the mount is under the control of a computer running planetarium software, click on the star to slew the mount to it.
4. Use the direction keys to accurately center the star in a high-powered eyepiece (10mm or less focal length), or preferably, an illuminated reticle eyepiece. Remember to end the centering operation by pressing the Right and Up direction keys together.

5. Use one of the following operations to start the PAE calibration:
   - Press the “UTILITY” shortcut key, access the sub-menu “PAE \ PAE Correction,” then press the ENTER key.
   - Or, press and hold the ESC key for 2 seconds.
6. The LCD screen will read “Recentering Obj.:” in the first row, and the name of the reference star in the second row. (If the GoTo command was sent by a computer running planetarium software, the LCD will read “The last target” instead of the star’s name.)
7. Make sure the chosen star is still centered in the eyepiece (center it again if needed, as in Step 4), and press the ENTER key.

After the PAE function is performed, the hand controller will recalculate its model of the sky. The pointing accuracy in the area of sky around the chosen bright star should now be improved. To improve pointing accuracy in another region of the sky, perform the PAE function again, this time choosing a bright star in the new region of interest.

Note: Whenever the SynScan hand controller locates an object, it will automatically check whether PAE calibration data is available, and apply the compensation accordingly. No manual intervention is required. If more than one PAE calibration is performed in the same zone, the previous calibration data will be overwritten.

You can access the menu “UTILITY FUNCTION / PAE / Clear PAE data” to clear all PAE calibration data. The PAE calibration data will be automatically cleared after a 1-star alignment, 2-star alignment, or 3-star alignment.

Note: If the mount is “parked” before it is powered off, the star alignments and PAE corrections will remain stored in the hand controller. As long as the mount is not moved once parked, the alignment will not need to be performed again when it is subsequently powered on.

6.5 Camera Control

The SynScan hand controller can control a DSLR camera to do astrophotography. It can accept eight different sets of exposure parameters, and then control the camera to take the exposure sets without manual intervention.

To use the camera control function, the camera must be equipped with a shutter release control port and be set to the “Bulb” exposure mode.

Connecting the Camera

1. **Using the SNAP port on the telescope mount:** Select Orion equatorial mounts, such as the Atlas Pro AZ/EQ-G and HDX110 EQ-G, are equipped with a SNAP port on the drive panel. You’ll need an appropriate shutter control cable to connect your DSLR camera to the 2.5mm SNAP port.
2. **Using the serial port on the SynScan hand controller:** The SynScan hand controller uses 2 pins (The SHUTTER and COMMON pins in the diagram of **Appendix E** of its serial port to control the shutter release of a DSLR camera. Use a proper shutter control cable to connect the SynScan hand controller and a camera.

Set Up Control Parameters

1. Press the “UTILITY” shortcut key, access the sub-menu “Camera Control \ Configuration” and press the ENTER key.
2. Edit the “interval” time; that is, the time between each exposure (in MM:SS format) and press the ENTER key.
3. Use the scroll keys to browse through the list of 8 groups of parameters. A sample screen-shot is shown here:

```
Select a Group
1. mm:ss X 000
```

The first number (“1”) is the index number of this set; the “mm:ss” data is the exposure time in minutes and seconds; and the last 3 digits are the number of frames to be shot, up to 999. Press the ENTER key to pick a group and proceed to the next step.

4. The first row of the screenshot below indicates the index number of the set being edited. The second row shows the exposure time of this group.

```
Edit Group#1
Exposure mm:ss
```

   - Use the numeric keys to enter the exposure time, then press the ENTER key.
   - Now the screen is changed to set the number of frames to be shot for this set, as shown below. Use the numeric keys to enter the number of frames after the word “Repeats” and press ENTER.

```
Edit Group#1
Repeats 000
```

   - The SynScan hand controller will return to Step 2, where you can enter another set of exposures, if desired.

Note: To disable an exposure set, set either the “Exposure” or the “Repeats” parameter to 0.

5. After setting the parameters for your exposure set(s), press the ESC key to exit the configuration process.

Batch Exposure

1. Set the camera to “Bulb” exposure mode.
2. Press the “UTILITY” shortcut key, access to the sub-menu “Camera Control \ Shoot,” and press the ENTER key.
3. The SynScan hand controller will start the first exposure set and display the progress data on the screen. A sample screenshot is shown below:

```
Shooting#1: 003
Released mm:ss
```

- The top row shows the set index and the number of frames pending.
- The bottom row shows the remaining exposure time of the current frame.
- At the end of each frame, the SynScan hand controller will give a beep and wait for the pre-set time interval before the next exposure.

4. During the exposure, you can press the ESC key to suspend the operation. The screen will display "Shoot Suspended. 1) Resume 2) Exit." Press the "1" key to resume the exposures or press "2" to exit.

```
Shoot Suspended
1) Resume 2) Exit
```

6.6 Periodic Error Correction (PEC) for EQ Mount

Almost all equatorial mounts that use worm gears have a periodic tracking error, which is due to slight eccentricities and misalignments in the gears. Periodic error is not critical for visual observing but might lower the image quality in long-exposure astrophotography if not minimized. The SynScan hand controller has a periodic error correction (PEC) function to improve the tracking performance for astrophotography. The PEC training function provides a correction to reduce the amplitude of the worm gear errors. By recording the guiding actions over one full worm gear cycle, SynScan can then "play back" those actions with each subsequent worm cycle to compensate for drifting in the R.A. sidereal tracking caused by periodic error.

Orion equatorial mounts feature two different types of PEC, depending on the model of the mount. One type is software-based PEC (SPEC), which applies to Orion's SkyView Pro GoTo, Sirius EQ-G, and Atlas EQ-G mounts. The other type is permanent PEC (PPEC), which comes standard with the Atlas Pro AZ/EQ-G and HDX110 EQ-G mounts. The SynScan hand controller detects the mount model and chooses the appropriate PEC algorithm.

Note: PEC training is recommended for advanced users with interest in long-exposure astrophotography only. Careful guiding is required. Standard sidereal tracking is sufficient for casual visual applications, and PEC training is not required.

PEC Training

For mounts that support standard, or software-based PEC, such as the Sirius EQ-G and Atlas EQ-G, you'll need to manually (visually) guide for at least one full worm cycle using an illuminated reticle eyepiece capable of producing at least 300X magnification with your telescope. For best results, the true field of view should not exceed 10 arcminutes.

For mounts that support PPEC, such as the Atlas Pro AZ/EQ-G and HDX110 EQ-G mounts, an autoguiding camera can be used instead of manual guiding for the PEC training process. In such cases, it is recommended to turn on the autoguider for at least one minute before starting the PEC training process. The total time for the PEC training of these mounts can be as long as two cycles of the period error.

The following step-by-step procedure below describes how to perform the PEC training function manually, using an illuminated reticle eyepiece.

1. Perform an accurate polar alignment, then perform a GoTo star alignment.
2. Then choose a star close to the celestial equator, i.e., with a small Dec. value (Dec. between +10° and –10°). This object will be used as the guide star. Point the telescope toward it and start the mount tracking.
3. Rotate the reticle eyepiece in the focuser (or diagonal) until the R.A. movement of the star (i.e., its movement when you press the Left or Right direction button) runs parallel to one set of the illuminated crosshairs. Then center the star on the crosshairs of the eyepiece's reticle.
4. Access the menu "UTILITY FUNCTION \ PEC Training" and press the ENTER key. The screen will display "Select Speed: 1) 0.125X 2) 0.25X." This is the speed used to move the star in the FOV of the telescope when you press the Left or Right direction key on the SynScan hand controller. **Choosing a 0.125X sidereal rate is recommended for a longer focal length telescope, and a 0.25X sidereal rate is recommended for a shorter focal length telescope.** Press the "1" or "2" key to make a selection and proceed to the next step.
5. The screen will display the elapsed time once the guide speed has been selected, indicating that the recording of the guiding actions has begun. Use the Left and Right direction keys to control the mount and keep the star centered in the reticle eyepiece until the PEC training time is up and the SynScan hand controller stops displaying the time. (If the star drifts in declination, it doesn't matter. PEC is only concerned with corrections of movement in R.A.) The total time for this training process depends on your particular mount model, but it will be at least several minutes. Pressing ESC will immediately stop the recording and exit from the PEC training function.

PEC Replay

Once PEC training is completed, PEC tracking can be turned on by accessing "MENU \ Tracking \ PEC+Sidereal," then press the ENTER key to start the PEC replay. The SynScan will play back the guiding corrections you made during the PEC training cycle to compensate for the periodic error.

Notes:

- The PEC + Sidereal tracking rate will be accurate only after at least one full cycle of PEC training is performed.
- After turning on the PEC + Sidereal replay, wait for at least one worm cycle before taking a picture.
- To re-use the PEC data on a mount that supports SPEC, users should "park" the telescope before shutting off power (refer to **Section 6.3**). This stipulation does not apply to mounts that support PPEC.

6.7 Calibrating Auto-Home Offset

The Orion HDX110 EQ-G mount has an Auto-Home function that can automatically set the mount to a standard home position after turning on the power. The offset of the home position can be calibrated and compensated with the following procedure:

1. Accurately polar-align the HDX mount.
2. Turn off the power, then turn it on again, and then initialize the hand controller.
3. When the SynScan hand controller displays "Auto-Home?," press the "1" key to execute the auto-home process.
4. Finish the subsequent initialization steps.
5. At the end of the initialization, choose 1-star alignment to align the mount.
6. At the end of the 1-star alignment, the hand controller will ask "Update H.P.O? 1) No 2) Yes" ("H.P.O." stands for Home Position Offset).
   - Press "1" to keep the original Home Position Offset.
   - Press "2" to use the results obtained from the 1-star alignment to calibrate the home position offset.

6.8 Polar Alignment without Polar Scope

Polar alignment of your mount by means of the polar-axis scope is covered in the instruction manual for the mount.

However, there is another, more accurate way to polar align. This software-based polar alignment routine can be performed without use of the polar-axis scope. You will need to use a reticle eyepiece for this procedure to ensure precise centering of the stars in the eyepiece field of view.

1. Complete a 2-star alignment or 3-star alignment. At the end of the alignment, the SynScan hand controller will display the polar alignment error in altitude (Maz) and azimuth (Mel) (refer to **Section 5.17**). Based on the error given, you can decide whether it will be necessary to adjust the polar alignment.
2. Press the "MENU" shortcut key, and then access to sub-menu "Alignment\Polar Alignment". Press the ENTER key to proceed to the next step.
3. The screen will display "Select a Star".
   - Use the scroll keys to browse through a list of star names and press the ENTER key to pick one as the reference star for polar alignment.
   - The mount will start slewing to point the telescope to the reference star.
4. Use the direction keys to center the reference star in the eyepiece of the telescope after the mount stops slewing. Remember to end the centering operation with Up and Right direction keys. Press the ENTER key to proceed to the next step.
5. The screen will now display the polar alignment error in altitude (Mel=dd°mm'ss"). You can then use the data to determine whether or not to adjust the altitude of the R.A. axis. Press the ENTER key again to proceed to the next step.
6. The mount will slew to a new position. When it stops, the screen will display "Adjust Altitude:" By using ONLY the altitude adjustment mechanism of the mount (DO NOT touch the azimuth adjustment mechanism and DO NOT use the direction keys on the hand controller), bring the reference star back to the closest point to the center of the FOV of the telescope's eyepiece. Remember the reference star's position in the eyepiece for later adjustment. Press the ENTER key to confirm the centering operation.
7. The screen will now display the polar alignment error in azimuth (Maz=dd°mm'ss"). You can then use the data to determine whether or not to adjust the azimuth of the mount. Press the ENTER key again to proceed to the next step.
8. The mount will slew to a new position. When it stops, the screen will display "Adjust Azimuth:" By using ONLY the azimuth adjustment mechanism of the mount (DO NOT touch the altitude adjustment mechanism, DO NOT use the direction keys on the hand controller), bring the reference star back to the closest point to the previous position (at the end of **Step 6**). Press the ENTER key to confirm the centering operation.
9. The screen will display the polar alignment error again, press the ENTER button to end the polar alignment process. It should be an improvement over what was given in **Step 1**.
10. Go back to the "Alignment" menu on the SynScan hand controller and execute another 2-Star or 3-Star alignment, and then check the polar alignment error data reported at the end of the 2-star alignment or 3-star alignment. Repeat **Step 2** to **Step 8** until the error is small enough to be acceptable. Generally, you can expect to get up to 1 arc-minute polar alignment accuracy after repeating this polar alignment process 2 or 3 times.

7. Connecting SynScan to a Computer

7.1 Working with Astronomical Software Programs

The SynScan V4 hand controller can communicate with a computer via the RS-232 port at the bottom of the controller (**Figure 1b**). In this way you can use many commercially available planetarium software programs to control your GoTo telescope or mount, essentially bypassing the hand controller's interface. The computer must have an RS-232C serial port; otherwise, an optional USB-to-Serial adapter is required. Connect the SynScan hand controller to the computer (or USB-to-serial adapter) with the RJ-12 to DB-9 serial cable supplied with your telescope or mount.

7.2 PC Direct Mode

PC Direct Mode is a special mode for the SynScan hand controller to work with a PC. Under this mode, the hand controller becomes a repeater between the PC and the motor controller inside the telescope mount. The application running on the PC controls the motor controller directly.

Currently, the PC direct mode is mainly used to update the motor controller's firmware.

1. Access the menu "UTILITY FUNCTION \ PC Direct Mode" and press the ENTER key. The screen will display "PC Direct Mode \ Press ESC to exit."
2. Press and hold the ESC key for more than 1 second to exit PC Direct Mode.

You can still use the direction keys to move the telescope mount.

8. Updating Firmware

8.1 Hardware Requirements

- A SynScan V4 hand controller with firmware version 3.0 or later.
- A computer running Windows (Win 95 or later).
- An RS-232C serial port on the computer, or a USB-to-Serial adapter.
- The PC interface cable (DB-9 to RJ-12, typically), which is usually included with a GoTo telescope or mount.
- A 12V DC power supply or battery.

8.2 Preparation

1. Create a new folder in the computer (for example, C:\SynScan) to save relevant files.
2. Download the "SynScan Firmware Loader" application package from www.OrionTelescopes.com and extract the file "SynScanFirmwareLoader.exe" to the above folder.
3. Download the latest firmware package and extract the ".SSF" file to the above folder.

8.3 Updating Firmware

1. Connect the computer and the SynScan hand controller with the PC interface cable.
2. Press and hold the "0" and "8" keys simultaneously, and then power on the hand controller. The hand controller will display "SynScan Update" on the screen. Release the "0" and "8" keys.
3. On the computer, run the SynScanFirmwareLoader.exe file. An application window is shown in **Figure 4**.
   - Use the "Browse" button to load the latest firmware file (".SSF" file).
   - Check the "Enforce database update" to enforce updating the hand controller's database. Or uncheck it to let the application determine whether an update is needed.

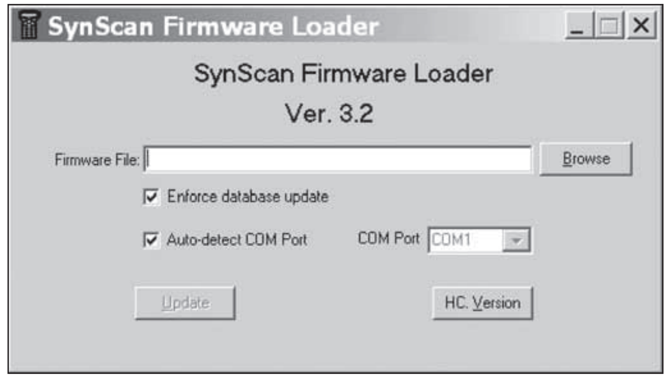


Figure 4. Application window for SynScan firmware loader.

   - Check the "Auto-detect COM port" to let the application detect the proper serial port that will connect to the SynScan hand controller. Or uncheck it to manually choose the COM port. Select one from the "COM port" drop-down list.
   - Click the "HC Version" button to check the versions of the hardware, firmware, and database.
   - Click the "Update" button to start loading the firmware to the SynScan hand controller.
4. After the loading starts, the application will display a percentage number at the bottom of the window to show the progress.
5. Once update is complete, the application will display a green bar with "Update Complete" at the bottom of the window.

8.4 Troubleshooting

1. If a window pops up and displays the message: "Cannot connect to a SynScan hand control" after clicking the "Update" button or the "H.C. Version" button, close the message window and click the "Update" button or the "H.C. Version" button to try again. If the application displays the message again, check the cable connections and ensure the USB-to-Serial port adapter is working, and that you have the proper drivers installed for it on your computer.
2. If the firmware update fails, the SynScan Firmware Loader will pop up a window with message "Firmware update failed. Cycle power to SynScan and try again!" Close the window and power off the hand controller. Then repeat the firmware update process again.
3. If the update process failed in the middle of updating, try to press the SETUP button on the SynScan hand controller to use other communication speeds: "Mi" (medium speed) or "Lo" (low speed).

9. Using a SynScan GPS Module

The optional SynScan GPS module automatically acquires accurate local geographical coordinates and local time, obviating the need for the user to input the data themselves. The GPS data helps to improve the accuracy of the GoTo alignment and the polar alignment.

9.1 Initialization of Hand Controller with SynScan GPS Module

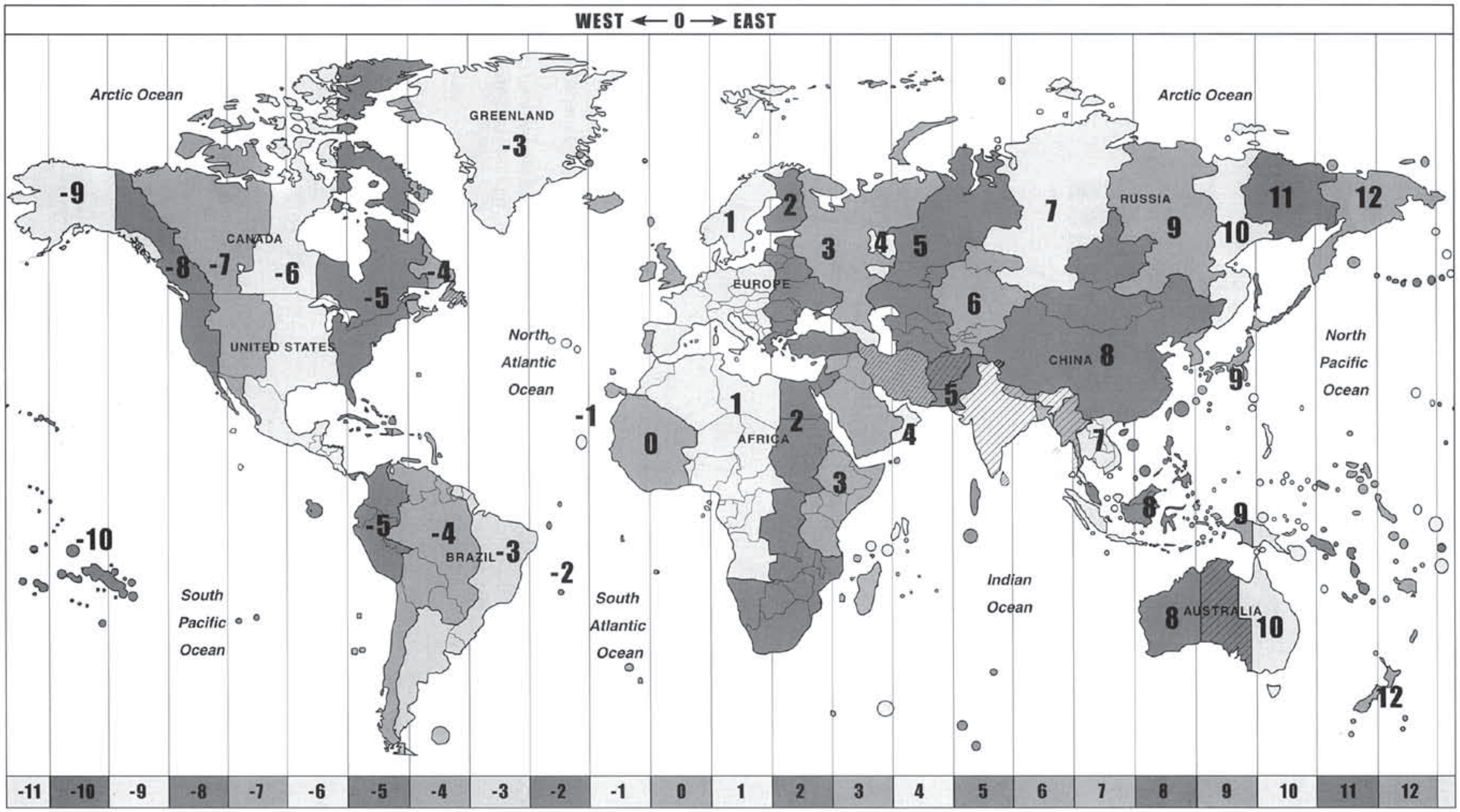
The initialization process of the SynScan hand controller with a SynScan GPS adapter differs from the standard initialization process.

1. Plug the SynScan GPS module into the serial port located at the bottom center of the SynScan hand controller. Place the GPS module on a horizontal surface and turn on the power of the mount.
2. If the SynScan hand controller detects the connection of a GPS module, it will ask for the local time zone:
   - Use the left and right direction keys to move the cursor on the screen.
   - Use the scroll keys to change the sign for the time zone. Use "-" for the time zones in the Western Hemi-sphere and "+" for the time zones in the Eastern Hemisphere.
   - Use the numeric keys to fill the time zone value in ±hh:mm format.
   - Press ENTER to confirm and proceed.
3. The hand controller will then ask whether to use Daylight Saving Time. Use the scroll keys to select "YES" and "NO" and press the ENTER key.
4. The screen will now display "GPS fixing…" This means that the GPS module is trying to fix on the GPS satellites.
5. After the SynScan GPS module fixes on the satellites, the SynScan hand controller will continue the initialization process.

9.2 Checking GPS Information

1. Plug the SynScan GPS module into the RJ-12 serial port located at the bottom center of the SynScan hand controller. Place the GPS module on a horizontal surface.
2. Access the menu "UTILITY FUNCTION \ GPS" and press the ENTER key.
3. The screen will now display "GPS fixing…" as the GPS module is attempting to fix on the GPS satellites.
4. After the SynScan GPS module fixes on the satellites, the screen will display "GPS Information:" Use the scroll keys to browse through the following information. Press the ESC key to exit.
   - M.O.V: Local magnetic declination
   - Lat: Local latitude
   - Lo: Local longitude
   - Date: Local date
   - UT: Universal Time (Greenwich Mean Time)
   - LT: Local time
   - TimeZone: Local time zone
   - LST: Local sidereal time
   - Elevation: Local elevation
   - Quality: Quality of GPS fixing
   - Number of SV: Number of GPS satellites in view
   - SV (fixed) Nr: Number of GPS satellites fixed on

Appendix A: Standard Time Zones of the World



Appendix B: SynScan Menu Tree

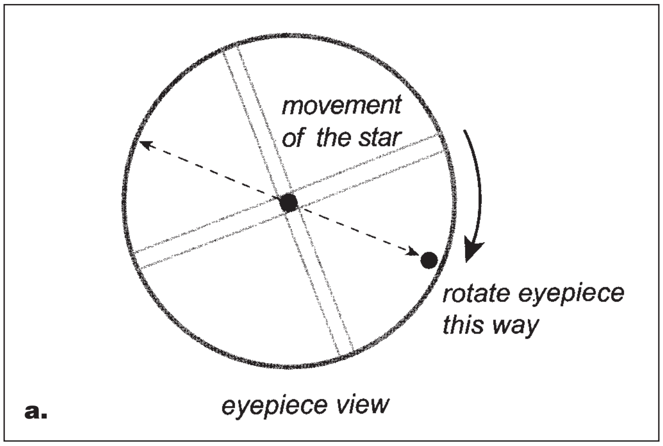
Accessing Menus

The SynScan hand controller's menu is only accessible after the initialization, or after the GoTo alignment routine is completed (if it is chosen at startup). You can use the ESC key, the ENTER key, and the two scrolling keys to access the menu.

- **SETUP MODE**
  - **Date**
  - **Time**
  - **Observ. Site**
  - **Daylight Saving**
  - **Alignment**
    - *1-Star Align.* [#]
    - *2-Star Align.*
    - *3-Star Align.* [#]
    - *Brightest Star* [^]
    - *Polar Align* [#*]
  - **Alignment Stars**
    - *Set Star Name*
    - *Adv. Filter*
    - *Sort By*
  - **Backlash**
  - **Tracking**
  - **Auto Guide Speed** [#]
  - **Elevation Limits** [^]
  - **Auxiliary Encoder** [+]
  - **Sync. Encoder**
  - **Handset Setting**
  - **Factory Setting**
- **UTILITY FUNC.**
  - **Show Position**
  - **Show Information**
    - *Time*
    - *Version*
    - *Power Voltage*
    - *Polaris Position*
    - *Polar Align. Error* [#]
  - **Identify**
  - **Park Scope**
    - *Home Position*
    - *Current Pos.*
    - *Custom Pos.*
  - **PAE**
    - *PAE Correction*
    - *Clear PAE Data*
  - **GPS**
  - **PC Direct Mode**
  - **Polar Scope LED** [#+]
  - **PEC Training** [#+]
  - **Camera Control** [#+]
- **OBJECT LIST**
  - **Named Star**
  - **Solar System**
  - **NGC Catalog**
  - **IC Catalog**
  - **Messier Catalog**
  - **Caldwell Catalog**
  - **SAO Catalog**
  - **Double Star**
  - **Variable Star**
  - **User Object**
    - *Recall Object*
    - *New Object*
  - **Deep Sky Tour**

Note:

Applicable to Equatorial mounts
^ Applicable to Altazimuth mounts
+ Applicable only to certain types of mounts and motor controllers.
* Only available after 2-star or 3-star alignment is performed.



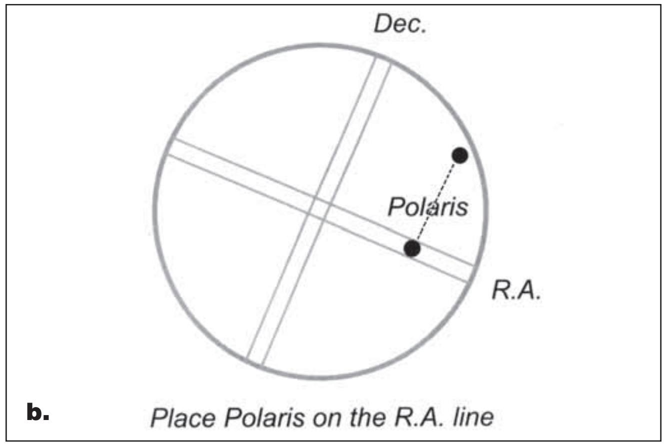


Figure 5. a) Aligning the R.A. motion of the star with the crosshairs of a reticle eyepiece. **b)** Adjust the telescope in Dec. (with the hand controller) to place the star on the R.A. crosshair.

Appendix C: Eliminating Cone Error

A telescope exhibits cone error if the telescope tube's optical axis is not perpendicular to the equatorial mount's Dec. axis. Such cone error can reduce the pointing accuracy of the mount and the accuracy of the polar alignment. A 3-star GoTo alignment automatically compensates for some of the "cone" error, but pointing accuracy will be optimized by mechanically minimizing the cone error. The following calibration procedure should be performed before the initial use of the telescope and periodically thereafter to ensure peak accuracy.

Testing for Cone Error

This test is performed at night using two bright stars located on opposite sides of the meridian.

1. Confirm that the telescope is properly polar-aligned.
2. Perform a 2-star GoTo alignment. The alignment stars should be located on the same side of the meridian and their declination deviation should be within 10 to 30 degrees.
3. Use the SynScan hand controller to locate a few objects on the same side of the meridian as the alignment stars. The pointing accuracy should be quite good.
4. Then use the SynScan hand controller to locate a few objects on the other side of the meridian.
   - If the pointing accuracy is still good, then the mount system has small or no cone error.
   - If the pointing accuracy becomes poor on the opposite side of the meridian from the alignment stars, and most of the error is on the R.A. axis (that is, the object can be brought back to the center of the eyepiece using the left or right direction keys), it means that the cone error of the telescope-mount system is quite large.

Eliminating Cone Error

1. Insert an illuminated reticle eyepiece into the focuser (or diagonal) of the telescope. Confirm that the telescope is properly set up and balanced, and that the finder scope is aligned with the optical tube of the telescope.

   Note: **Steps 2** to **4** are to identify R.A. and Dec. movements of stars in the reticle eyepiece. If you are already familiar with the movements, proceed to **Step 5**.
2. Find a bright star and position the telescope so the star is centered in the eyepiece field of view.
3. Look into the eyepiece. Move the telescope about the R.A. axis using the R.A. direction buttons on the hand controller while carefully observing the movement of the star.
4. Keep moving the telescope about the R.A. axis back and forth to keep the star within the eyepiece field of view. Rotate the eyepiece in the focuser (or diagonal) until the movement of the star becomes parallel to one of the illuminated crosshairs **(Figure 5a)**. This crosshair will represent R.A. movement in the course of this procedure, and the perpendicular crosshair will represent Dec. movement. Tighten the set screws to secure the eyepiece in position.
5. Point the telescope North and set the latitude scale to your local latitude using the altitude adjustment knobs on your mount. Alternatively, place Polaris in the polar axis finder scope if your polar axis finder scope is accurately aligned with the mount.

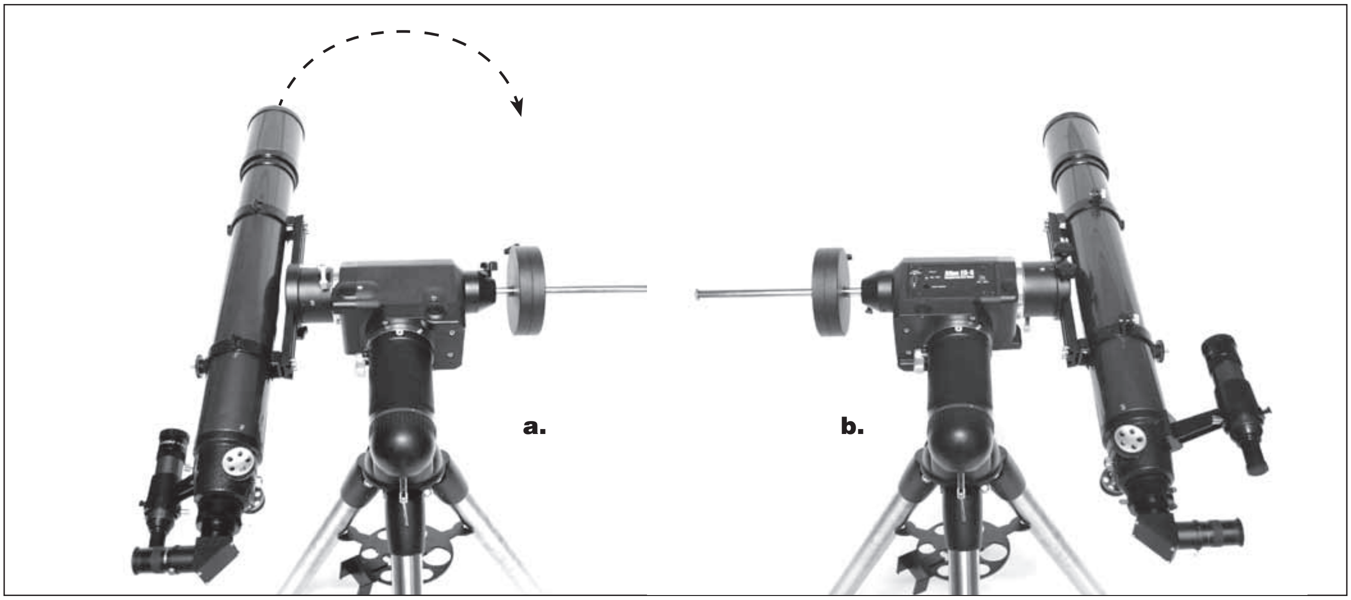


Figure 6. a) The counterweight shaft is horizontal and the telescope is pointed north. **b)** Rotate the mount 180 degrees about the RA axis.

6. Loosen the R.A. clutch and rotate the telescope about the R.A. axis until the counterweight shaft is parallel to the ground, i.e., horizontal (as shown in **Figure 6a**).
7. Using the Dec. direction buttons on the hand controller, adjust the telescope in Dec. so Polaris lies on the R.A. crosshairs of the illuminated reticle eyepiece **(Figure 5b).**
8. Without moving the R.A. axis, adjust the azimuth adjustment knobs on the mount to place Polaris in the center of the eyepiece field of view. Adjustment in Dec. axis using the hand controller may be necessary.
9. Rotate the R.A. axis 180 degrees **(Figure 6b)**. The counterweight shaft should be leveled and pointed to the other side of the mount. If Polaris can be placed at the center of the eyepiece by rotating the Dec. axis only, it means the cone error is small and no further adjustment is needed; otherwise, continue with the following steps.
10. Rotate the Dec. axis to bring Polaris as close as possible to the center of the finder scope or the telescope's eyepiece.
11. Carefully nudge the telescope in a HORIZONTAL motion while observing the movement of Polaris in the eyepiece field of view **(Figure 7).** Determine which – left or right – direction brings Polaris closer to the center of the eyepiece. This will reveal the direction in which you should adjust the telescope on the saddle or the mounting bar to reduce the cone error.

Figure 7. Gently push the telescope horizontally to determine the direction of optical axis offset.

12. Use a shim (or other method) on the proper side of the saddle or mounting bar to raise the telescope slightly. Look into the eyepiece while applying the shim, if possible. Reduce the distance between Polaris and the center of the eyepiece by HALF (not all the way!).
13. Repeat Steps 8 and 9 to check whether the cone error is now acceptable. Repeat Steps 10, 11, and 12 if necessary until Polaris remains in the center of the eyepiece field of view, or moves slightly around the center, when the mount is rotated about the R.A. axis.

    Note: This adjustment can be done in the daytime by targeting a distant, small object – at least ¼ mile away – instead of Polaris.

Appendix D: SynScan Self-Diagnosis

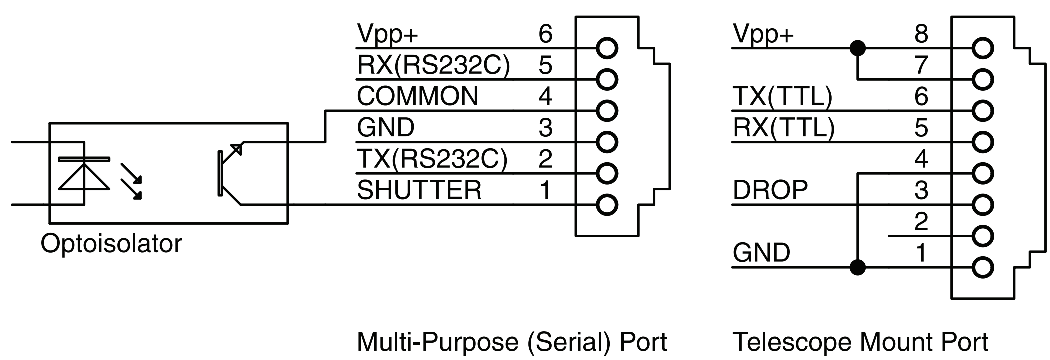
The SynScan hand controller contains a built-in self-diagnosis program. To run a full test, you first need to make a "Loop-Test Plug" by referring to **Appendix E** and the following instructions:

- Short the pin-2 (TX_RS232C) and pin-5 (RX_RS232C) of an RJ-12 plug.

Here are the diagnosis steps:

1. Insert the two "Loop-Test Plugs" into the corresponding ports of the SynScan hand controller.
2. Press the "2" and "5" keys simultaneously and power on the hand controller.
3. The hand controller will display "SynScan B.I.T." for a short time.
4. The LCD screen will go black and then clear for a while for the purpose of checking the LCD display.
5. If there is any problem with the RS-232C function of the serial port (the RJ-12 outlet) or there is no Loop-Test Plug connected to the serial port, the screen will display "COM1 ERROR." Press ENTER to continue.
6. If there is any problem with the hand controller port or there is no Loop-Test Plug inserted in that port (the RJ-45 outlet), the screen will display "COM2 ERROR". Press ENTER to continue.
7. If everything is fine, the test will proceed to Step 8; Otherwise, the SynScan hand controller will show "EEPROM ERROR" or "Flash ERROR." Press ENTER to continue in that case.
8. Check keypad and other features:
    - The screen will display "Key=" in the top row. If a key is pressed, the name of the key will be displayed.
    - The power voltage will be displayed on the bottom row of the screen.

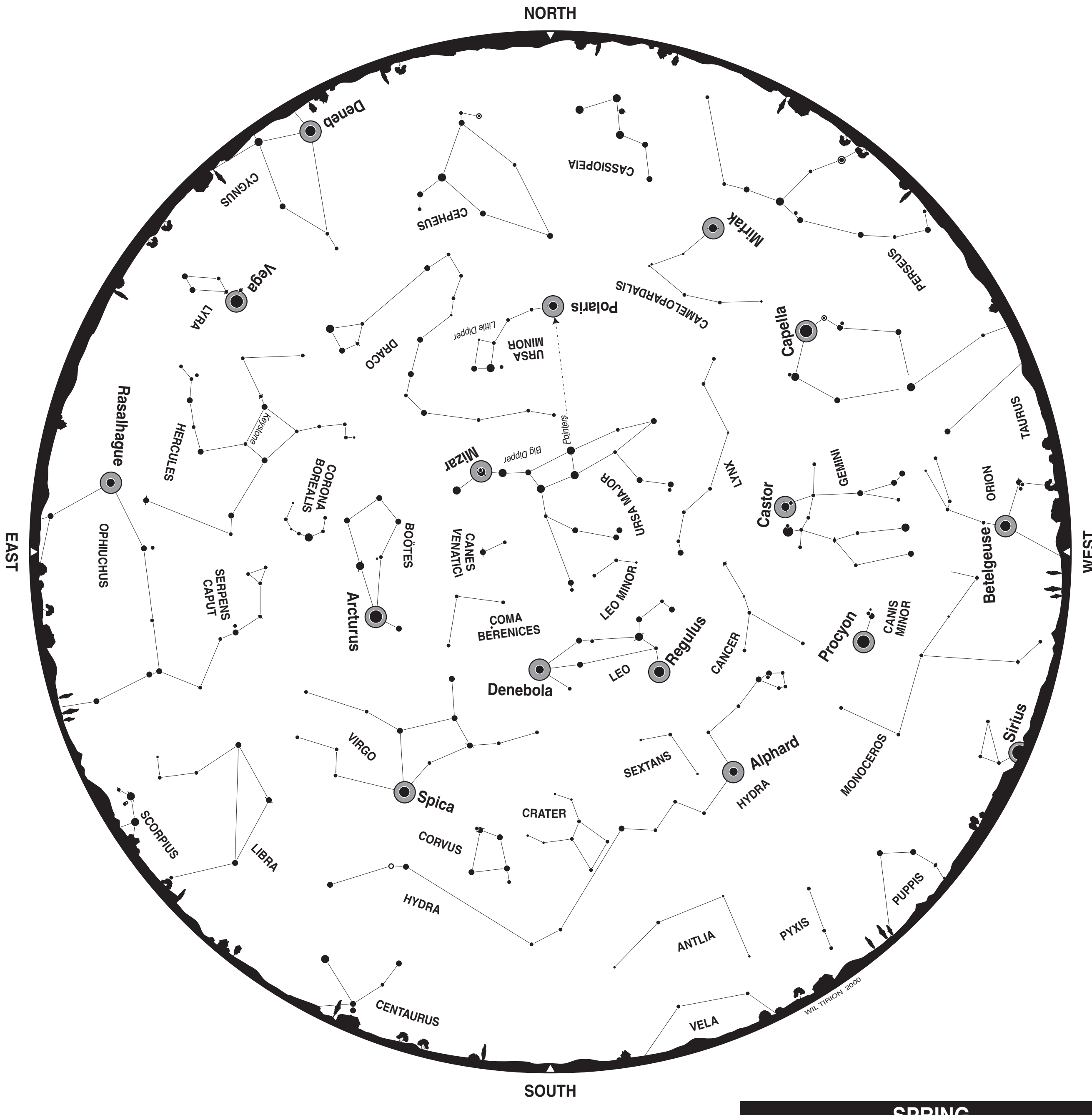
Appendix E: Schematic of the Ports



Appendix F: Specifications

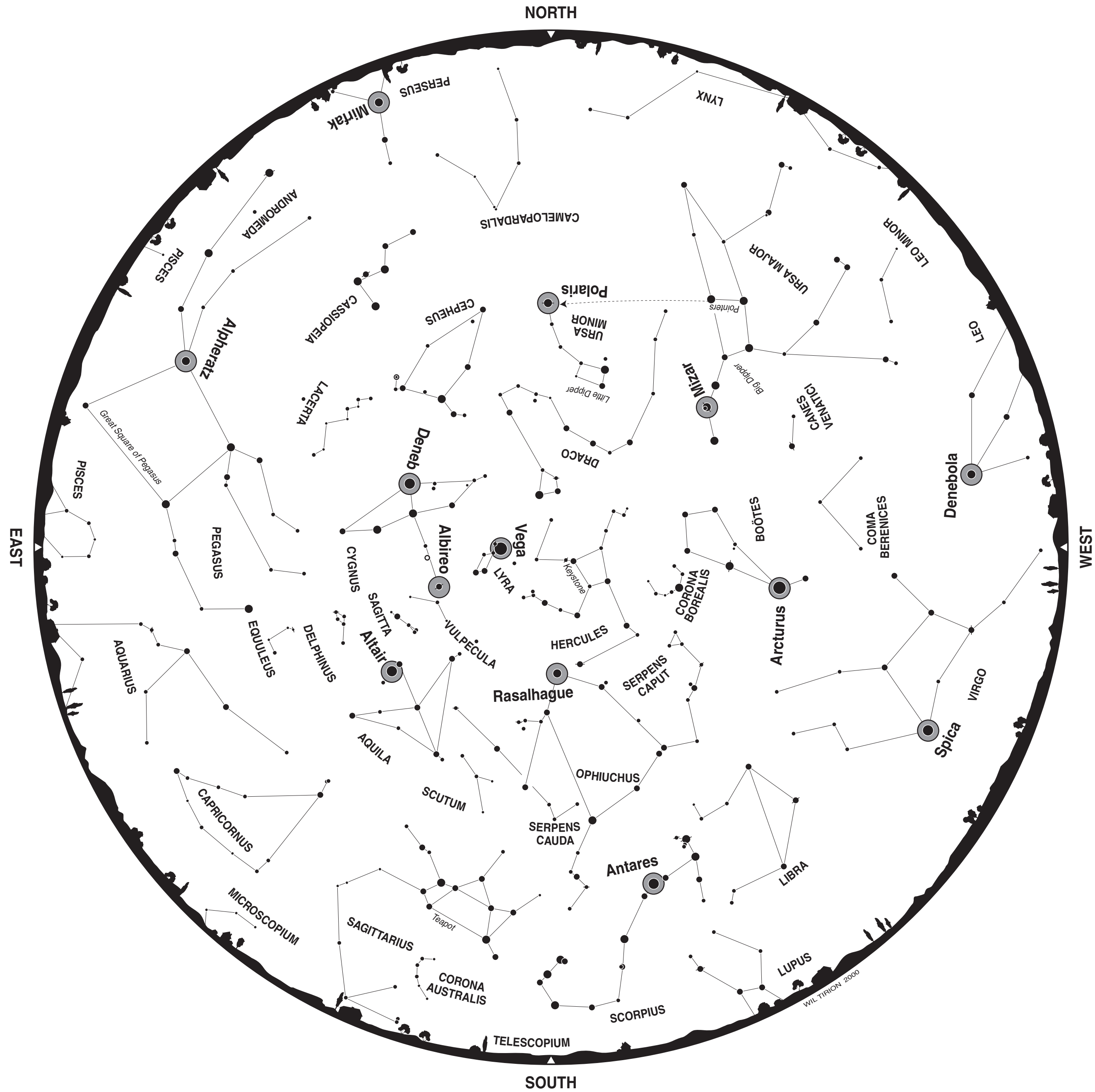
Supported Modes	Equatorial and Alt-azimuth
Object Catalog	Messier, NGC, IC, SAO, Caldwell, Double Star, Variable Star, Named Star, Planets
Pointing Accuracy	Up to 5 arc-minutes RMS
Tracking Rate	Sidereal Rate, Solar Rate, Lunar Rate
PEC	SPEC or PPEC
Database	42000+ Objects
LCD	18 Characters x 2 Lines Adjustable Contrast and Backlight
Keypad	Rubber, Adjustable backlight
GPS	SynScan GPS Modular (Optional)
PC Connection	RS-232C, 9600bps, No parity check, 8 data bits, 1 start bit, 1 stop bit
Power Supply	DC 12V, 100mA
Power output on serial port	Power Supply Voltage - 0.7V Maximum 100mA current output

Appendix G: Star Charts



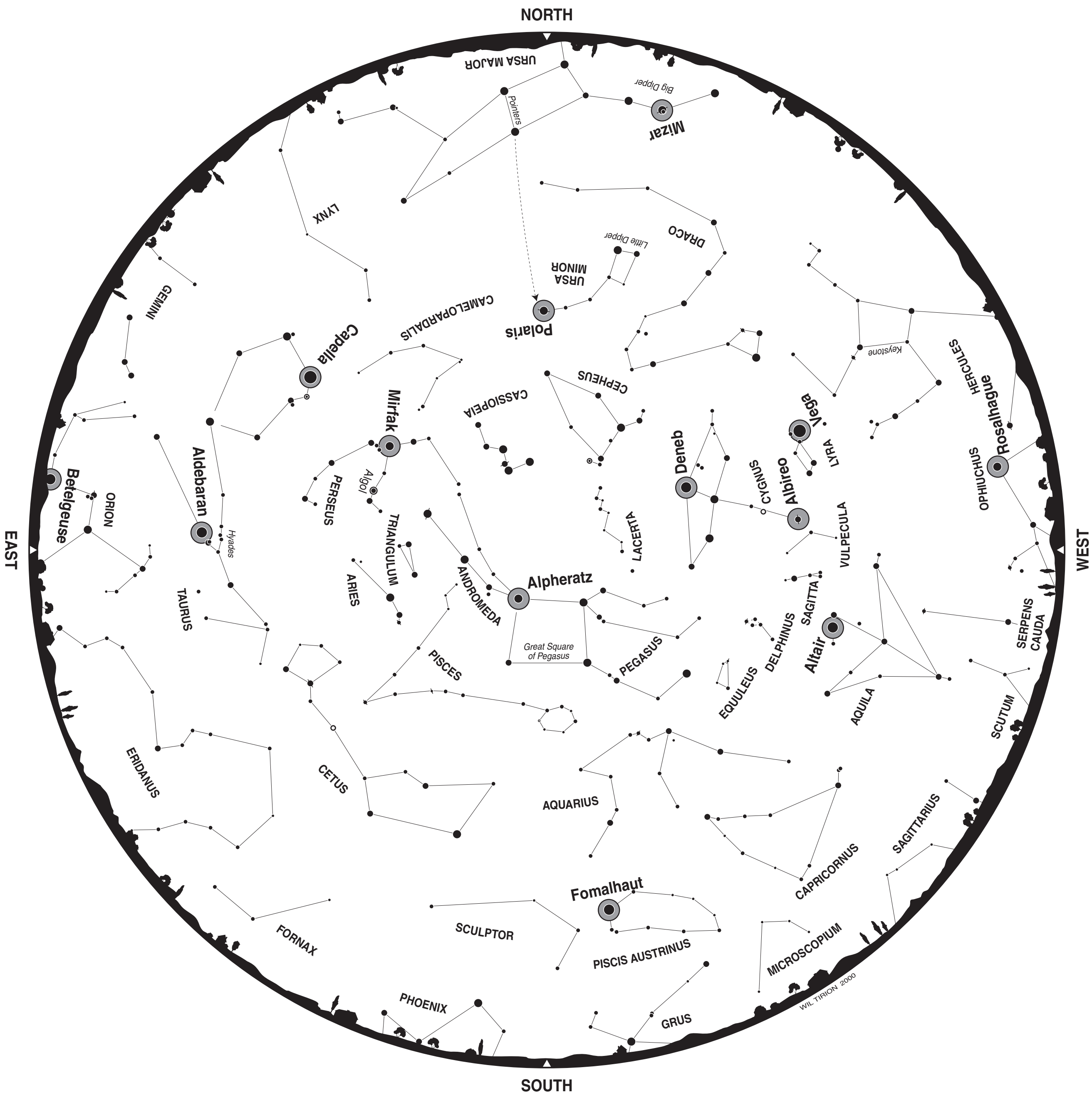
SPRING	
Early March	1:00 AM
Late March	12:00 AM
Early April	12:00 AM*
Late April	11:00 PM*
Early May	10:00 PM*
Late May	9:00 PM*
Early June	8:00 PM (dusk)*

***Daylight saving time**



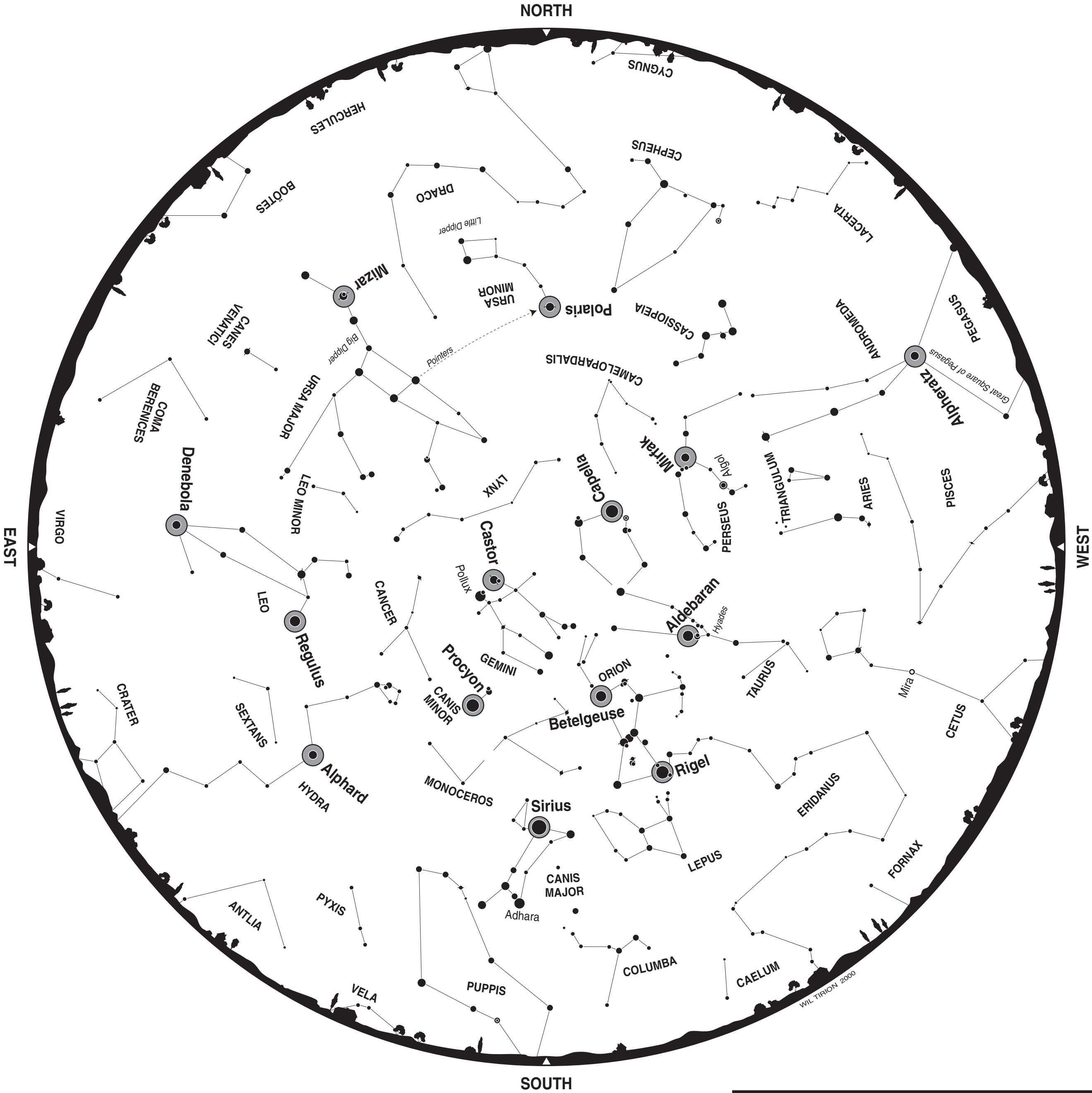
SUMMER	
Early June	2:00 AM*
Late June	1:00 AM*
Early July	12:00 AM*
Late July	11:00 PM*
Early August	10:00 PM*
Late August	9:00 PM*
Early September	8:00 PM (dusk)*

***Daylight saving time**



AUTUMN	
Early September	2:00 AM*
Late September	1:00 AM*
Early October	12:00 AM*
Late October	11:00 PM*
Early November	9:00 PM
Late November	8:00 PM
Early December	7:00 PM

***Daylight saving time**



WINTER	
Early December	2:00 AM
Late December	1:00 AM
Early January	12:00 AM
Late January	11:00 PM
Early February	10:00 PM
Late February	9:00 PM
Early March	8:00 PM

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.**

Orion Telescopes & Binoculars

Corporate Offices: 89 Hangar Way, Watsonville CA 95076 - USA

Customer Support: **www.OrionTelescopes.com/contactus**

INSTRUCTION MANUAL

Orion 8" and 10" f/3.9 Newtonian Astrographs

#8297 8" f/3.9, #8296 10" f/3.9

#8296

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IN 406 Rev. A 07/11

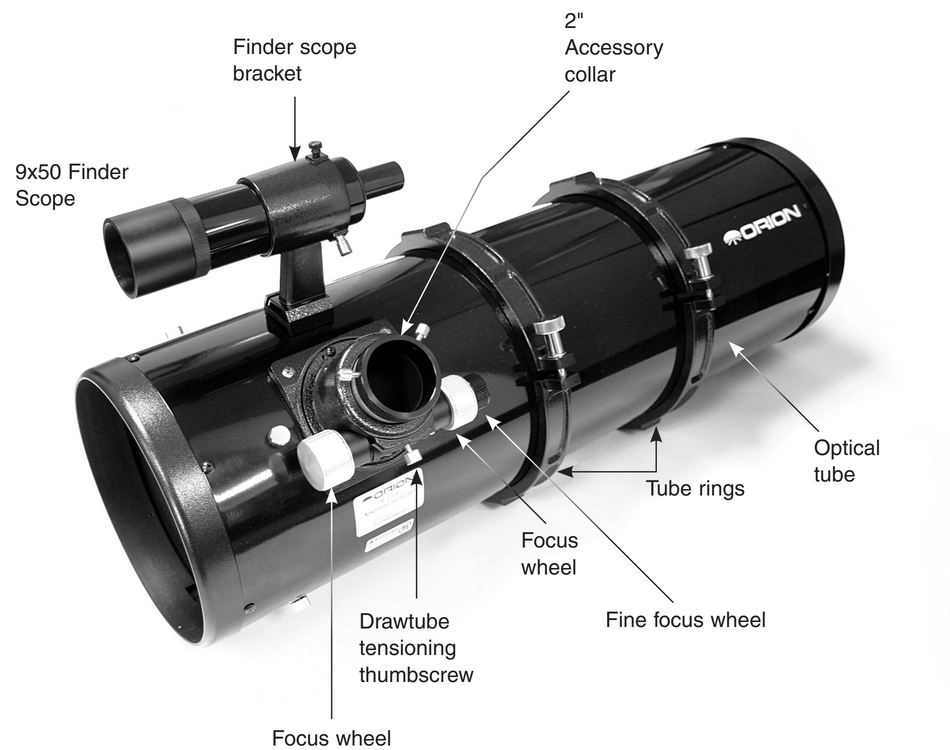

Figure 1. The Orion 8" f/3.9 Newtonian Astrograph

Congratulations on your purchase of an Orion f/3.9 Newtonian Astrograph! These powerful imaging telescopes feature “fast,” high-quality parabolic optics, a 2" dual-speed Crayford focuser, and excellent mechanical construction with some special features. Optimized for astrophotography with DSLR and astronomical CCD imaging cameras, our f/3.9 Newtonian Astrographs are capable of delivering breathtaking imaging performance – for beginning to advanced astrophotographers.

This instruction manual covers both the 8" and 10" models of f/3.9 Newtonian astrograph. Although they differ in aperture and focal length, physical size, and weight, they are otherwise very similar in mechanical construction and features. So we will use the 8" model to illustrate the features of both astrographs. Any exceptions related to the 10" model will be noted.

This instruction manual will help you to set up and properly use your telescope. Please read it through completely before attempting to use the scope and its included accessories.

WARNING: Never look directly at the Sun through your telescope or its finder scope – even for an instant – without a professionally made solar filter that completely covers the front of the instrument, or permanent eye damage could result. Young children should use this telescope only with adult supervision.

Parts List

- Optical tube assembly
- Optical tube dust cap
- 1.25" eyepiece holder
- 9x50 finder scope with bracket
- Pair of hinged tube rings
- 2" thread-on extension adapter, 30mm
- 2" slip-on extrension adapter, 36mm
- Quick collimation cap
- Cooling accelerator fan and battery holder (batteries not included)
- Starry Night Special Edition CD-ROM and StarTheater DVD

We recommend keeping all of the original packaging. In the unlikely event you should need to ship the telescope back to Orion for warranty repair service, you should use the original

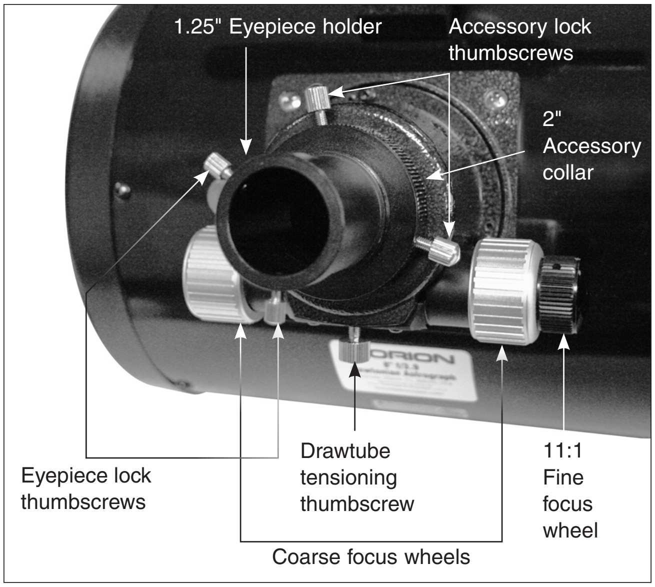

Figure 2. The 2" dual-speed (11:1) Crayford focuser

packaging to ensure the telescope stays intact during shipping. Take a moment to inspect the telescope and all of its parts.

Before proceeding with the instructions, refer to Figure 1 to familiarize yourself with some of the features and components of the telescope.

1. Getting Started

The telescope arrives nearly fully assembled from the factory, with optics installed, in a single shipping box. The optics were collimated at the factory, however you should check the collimation prior to first use (see "Collimating the Optics"), as it's not uncommon for Newtonian optics to get bumped slightly out of collimation in the delivery process. Likely only a minor adjustment, if any, may be necessary.

Attaching the Telescope to a Mount

The f/3.9 Newtonian Astrographs each come with a pair of hinged, felt-lined tube rings to hold the optical tube assembly (OTA) on a mount. Each ring has a flat boss on opposing sides. Both bosses have a ¼"-20 threaded hole in the center. One tube ring has a piggyback camera adapter mounted on one of the bosses, which can be used to mount a camera for piggyback astrophotography. That adapter can be removed if you wish to attach an optional dovetail plate to the top of the tube rings for mounting a piggybacked guide scope.

The tube rings should be attached to a dovetail mounting plate (sold separately) compatible with your mount's equatorial head. Balancing the telescope is achieved by sliding the dovetail mounting plate forward or backward within the mount's dovetail saddle. You can also move the telescope forward or backward within the tube rings. To do so, loosen the tube ring clamps slightly and slide the telescope tube forward or backward as needed to reach optimum balance, then retighten the clamps. Rotating the telescope to achieve a comfortable eyepiece or camera angle is done in the same fashion. Simply loosen the tube ring clamps just enough to allow the optical tube to rotate within the tube rings. Retighten the tube ring clamps securely once you have reached the desired eyepiece or camera orientation.

2" Dual-Speed Crayford Focuser

The f/3.9 Newtonian Astrograph features an all-metal, 2" dual-speed (11:1) Crayford-type focuser **(Figure 2)**, which allows very precise, fine focusing. A reinforcing plate inside the optical tube just under the focuser provides added rigidity, minimizing any "flexing" of the focuser housing on the tube due to the weight and moment arm of the imaging camera. If the drawtube slips under the weight of your imaging system or heavy visual accessories, simply increase the drawtube tension by gently tightening the drawtube tensioning thumbscrew as needed.

The smooth focus motion and fine-focus wheel allow precision adjustments for critical focusing of eyepieces and cameras. Once focus is reached, you can lock the drawtube in place by tightening the drawtube tensioning thumbscrew.

The focuser drawtube has a 2" collar on the end of it, with two thumbscrews, for attachment of 2" accessories. The telescope ships with a 1.25" eyepiece holder inserted into the 2" collar.

The focuser drawtube has 38mm of travel.

Fine Focus

The dual-speed Crayford focuser features both coarse and fine focusing wheels. The two large, silver-colored wheels are for coarse focusing. The small black wheel next to the right-hand large focus wheel allows ultra-precise focus adjustment at a gear ratio of 11:1, meaning eleven turns of the fine focus wheel equals one turn of the large focus wheel.

Use the large focus wheels to achieve rough focus on your target object, then use the fine focus wheel to home in on the exact focus point. You will be amazed at the amount of detail that careful fine focus adjustment brings in to view on targets such as the lunar surface, planets, double stars, and other celestial objects.

Focuser Reinforcing Plate

You'll notice that on the inside of the optical tube directly under the focuser is a steel reinforcing plate. This plate was added to provide extra rigidity to the interface between the focuser and tube, to minimize the possibility of flexure at that interface due to the weight of the imaging camera and its positional moment arm. Such flexure could cause undesirable distortion in long-exposure astrophotographic images. This reinforcing plate allows use of heavier cameras while minimizing the risk of flexure between the focuser base and tube. It is a design enhancement that other, similar scopes on the market do not have.

Attaching the Finder Scope

The included 9x50 crosshair finder scope **(Figure 3a)** is useful for locating objects in the sky and centering them in the main telescope's field of view.

To install it, first remove the O-ring from the bracket and place it over the body of the finder scope until it seats in the narrow groove near the middle of the finder. Unthread the two black nylon alignment screws on the bracket until the screw ends are flush with the inside surface of the bracket. Slide the eyepiece end (narrow end) of the finder scope into the end of the bracket's cylinder opposite the alignment screws while pulling the chrome, spring-loaded tensioning pin on the bracket with your fingers **(Figure 3b)**. Push the finder scope through the bracket until the O-ring seats just inside the front opening. Release the tensioner and tighten the two black nylon screws a couple of turns each to secure the finder scope in place. The tips of the tensioner and nylon screws should seat into the wide groove on the finder scope's body.

Now slide the foot of the finder scope bracket into the dovetail base on the main telescope. You'll first have to back out the thumbscrew lock on the dovetail base a few turns to allow the bracket to slide in. Once the bracket is inserted, tighten the thumbscrew lock.

Aligning the Finder Scope

The finder scope and the main telescope must be aligned so they point to exactly the same spot in the sky. Alignment is easiest to do in daylight. First, insert an eyepiece (a crosshair eyepiece is best) into the eyepiece holder in the telescope's focuser. Point the telescope at an object such as the top of a telephone pole or a street sign that is at least a quarter-mile away. Move the telescope so the target object appears in the very center of the field of view when you look into the eyepiece.

Now look through the finder scope. Is the object centered in the finder scope's field of view? If not, hopefully it will be visible somewhere in the field of view, so that only a minor adjustment of the finder scope's two alignment screws will be needed to center it. Otherwise you'll have to make coarser adjustments to redirect the aim of the finder scope.

Once the target object is centered on the crosshairs of the finder scope, look again in the telescope's eyepiece and see if it is still centered there as well. If it isn't, repeat the entire process, making sure not to move the telescope while adjusting the alignment of the finder scope. When the target object is centered on the crosshairs of the finder scope and in the telescope's eyepiece, the finder scope is aligned and ready to be used for locating objects.

The finder scope alignment should be checked before every imaging or observing session. This can easily be done at night, before viewing through the telescope. Choose any bright star or planet, center the object in the telescope eyepiece, and then adjust the bracket's alignment screws until the star or planet is also centered on the finder's crosshairs.

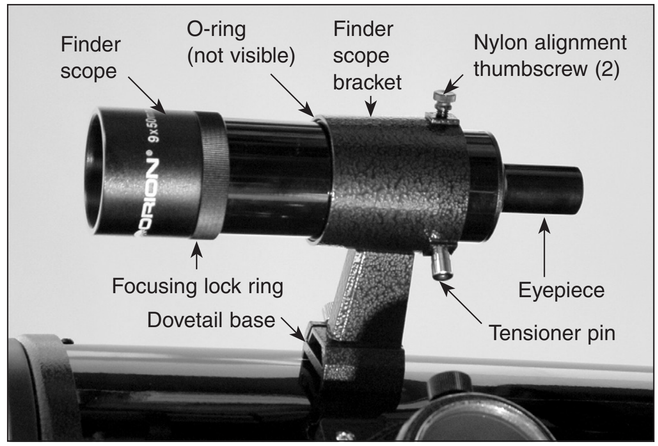

Figure 3a. The 9x50 finder scope and bracket

Figure 3b. Pull back the spring tensioning pin and slide the finder scope into its bracket until the O-ring is seated in the bracket ring.

Focusing the Finder Scope

If the image in the finder scope appears out of focus, you will need to refocus the finder scope for your vision. First, loosen the lock ring located behind the objective lens cell on the body of the finder scope **(Figure 3a)**. Back the lock ring off by a few turns. Then refocus the finder scope on a distant object by rotating the objective lens cell clockwise or counterclockwise. Once the image appears sharp, retighten the lock ring behind the objective lens cell. The finder scope's focus should not need to be adjusted again.

2. Operating Your Orion f/3.9 Newtonian Astrograph

Your Orion f/3.9 Newtonian Astrograph is designed primarily for astro-imaging, but it makes a fine visual instrument as well. For visual use, we recommend using high-quality eyepieces to take full advantage of the instrument's exceptional optical quality. For imaging applications, the telescope is optimized for use with an APS-C or smaller size sensor, found in such cameras as the Orion StarShoot™ Pro, Orion Parsec™, and many DSLRs.

Cooling the Telescope

All optical instruments need time to reach "thermal equilibrium." The bigger the instrument and the larger the temperature change, the more time is needed. Allow at least 30 minutes for your telescope to cool to the temperature outdoors. In very cold climates (below freezing), it is essential to store the telescope as cold as possible. If it has to adjust to more than a 40°F temperature change, allow at least one hour. You can use the telescope while it's cooling down, just note that you may see "tube currents," which interfere with the telescope's ability to resolve a sharp image. Tube currents are essentially heat waves exiting both the optical components (such as the primary mirror) and the telescope itself. The effect seen through the eyepiece is much like looking above a hot surface or fire.

Mirror Cooling Fan

Your f/3.9 Newtonian Astrograph comes with a cooling fan that attaches to the rear of the primary mirror cell. Using the fan reduces the amount of time required for the primary mirror to reach thermal equilibrium with the ambient air. The fan is powered by 12-volts DC. The included battery holder holds eight D-cell alkaline batteries (not included). Alternatively, the fan can be powered by a 12-volt DC field battery, such as the Orion Dynamo Pro.

Fan Installation

1. Place the fan on the rear of the mirror cell of the telescope and line up the holes in the fan with the threaded holes in the mirror cell. Make certain the label on the fan is facing the primary mirror.
2. Place the fan cover (wire grille) over the fan so the holes in its corners line up with the holes in the fan and mirror cell (**Figure 4a**). The fan cover should be oriented so that its corners seat flush onto the fan.
3. Thread a screw, with a washer attached, through the fan cover and fan and into the mirror cell **(Figure 4b).** Firmly tighten the screw, but be careful not to overtighten and strip the threads. Repeat this for the other three screws (and washers).
4. Insert eight D-cell batteries (not included) into the battery pack. Orient the batteries as shown on the plastic battery holder.
5. Plug the cord from the battery pack into the fan. The fan should begin rotating. If it doesn't, check the connections and orientation of the batteries and try again. To turn the fan off, unplug the cord from the fan.

Using the Cooling Fan

The cooling fan should be turned on as soon as the telescope is brought outdoors prior to your imaging or observing session. It should run for approximately 15-30 minutes to properly cool down the telescope. When the telescope is in use, the fan should be turned off. This is because even though it runs free from vibration, the air currents it generates in the optical tube will degrade image quality. Once the mirror has cooled to the outdoor ambient temperature, the fan will likely not be needed again for that session.

Figure 4a. Line-up the holes in the fan and fan cover with the holes in the rear of the primary mirror cell.

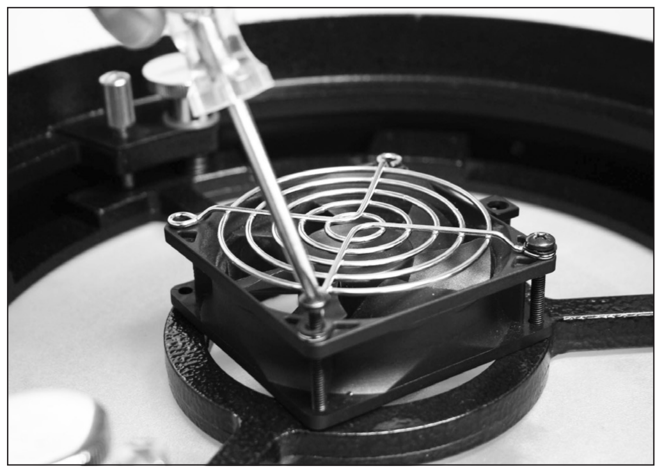

Figure 4b. Attaching the fan to the mirror cell.

Imaging with the f/3.9 Newtonian Astrograph

This instrument has fast f/3.9 parabolic optics, which produce bright images and allow short exposure times. Fast optics also inherently produce some coma, or distortion of star images toward the periphery of the field of view. Therefore, to achieve the best possible images, we highly recommend use of a coma corrector (sold separately) designed for use with f/4 Newtonians, or for a range of focal ratios that includes f/4.

Many common coma correctors have a 2" diameter housing and T-threads for attachment to a camera. Typically, the coma corrector is attached to the front of the camera body via its T-threads (for DSLRs, to a compatible T-ring), then inserted into the 2" accessory collar of the focuser drawtube. Use of a coma corrector will allow you to utilize the entire imaging area of your camera without the need to crop the edges of your astro-images due to optical distortion. Check Orion's website for compatible coma correctors.

Attaching a CCD Camera

The Orion f/3.9 Newtonian Astrographs are equipped to accept CCD cameras with a 2" nosepiece, or a 2" coma corrector in place of the nosepiece, which slides directly into the telescope's focuser like an eyepiece **(Figure 5).** The 2" nosepiece is secured with the two thumbscrew locks. If your CCD imager does not include a compatible 2" nosepiece, or if you wish to utilize the camera's T-threads without a coma corrector, a zero-profile prime focus camera adapter is required (available from Orion). The zero-profile adapter has male T-threads that couple to the female T-threads of your camera.

Note that, depending on your CCD camera's specifications, you may need to add T-thread spacer rings between the coma corrector and the CCD camera, to achieve the necessary critical distance between the coma corrector's rear lens element and the camera's imaging sensor.

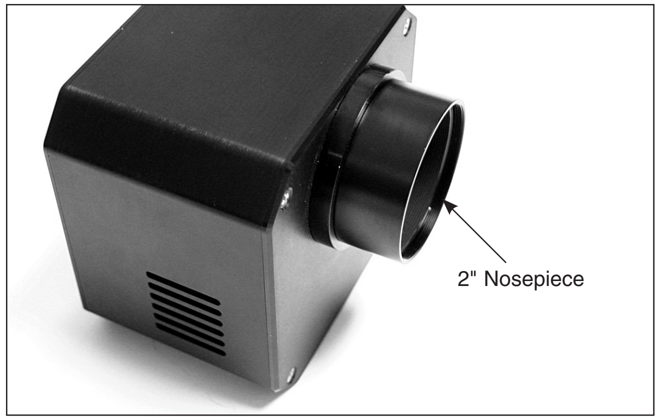

Figure 5. The Orion Parsec 8300 CCD camera, with 2" zero-profile adapter (nosepiece), which is included with the camera.

Attaching a DSLR Camera

To attach a DSLR camera, you will need the appropriate T-ring for the make and model of your camera. If you do not plan to use a coma corrector, then you will need a zero-profile prime focus camera adapter (available from Orion). Simply attach the T-ring to the camera body and thread the zero-profile camera adapter into the T-ring. Then insert the barrel of the camera adapter into the focuser's 2" accessory collar and secure it with the two thumbscrew locks **(Figure 6)**.

To use a coma corrector, thread it into the T-ring attached to your DSLR camera body, then insert the coma corrector housing into the focuser through the 2" accessory collar and tighten the two locking thumbscrews on the collar to secure the camera in place.

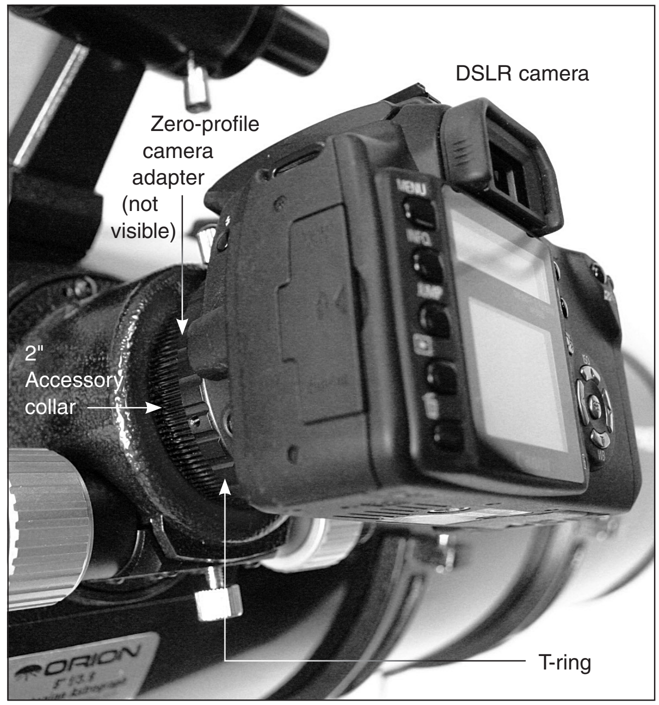

Figure 6. Attachment of a DSLR camera requires a T-ring for the particular camera model and a T-adapter, such as the Orion Zero-Profile Prime Focus Camera Adapter, which fits into the 2" accessory collar.

Removing the Piggyback Camera Adapter from the Tube Ring

If you want to install an optional mounting plate atop the tube rings for piggyback attachment of a guide scope, you'll need to remove the piggyback camera adapter first. To do so, first remove the tube ring from the telescope. Then unthread the plastic ring from the threaded bolt. Peel back the felt lining on the inside surface of the tube ring where the bolt is located; peel it back just enough so that you can access the bolt head with a screwdriver. Using a Phillips screwdriver, remove the bolt from the ring. Now, replace the adhesive felt over the area where the bolt head was. Now the rings are ready to accommodate a mounting plate for your piggyback guide scope assembly.

The Orion f/3.9 Newtonian Astrographs were designed with a couple of special enhancements to maximize the contrast of your astrophotographs and visual images. One is the inclusion of multiple baffle rings on the interior of the optical tube. The 8" model has 9 baffle rings and the 10" model has 13. These baffle rings block the transmission of off-axis light through the optical tube, which could reduce image contrast. The other contrast-enhancing feature is the extended length of the opti-

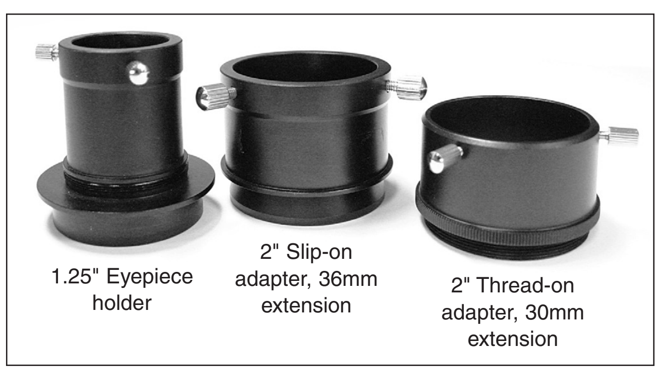

Figure 7. The 1.25" eyepiece holder and two 2" extension adapters included with the 8" and 10" f/3.9 Newtonian Astrographs.

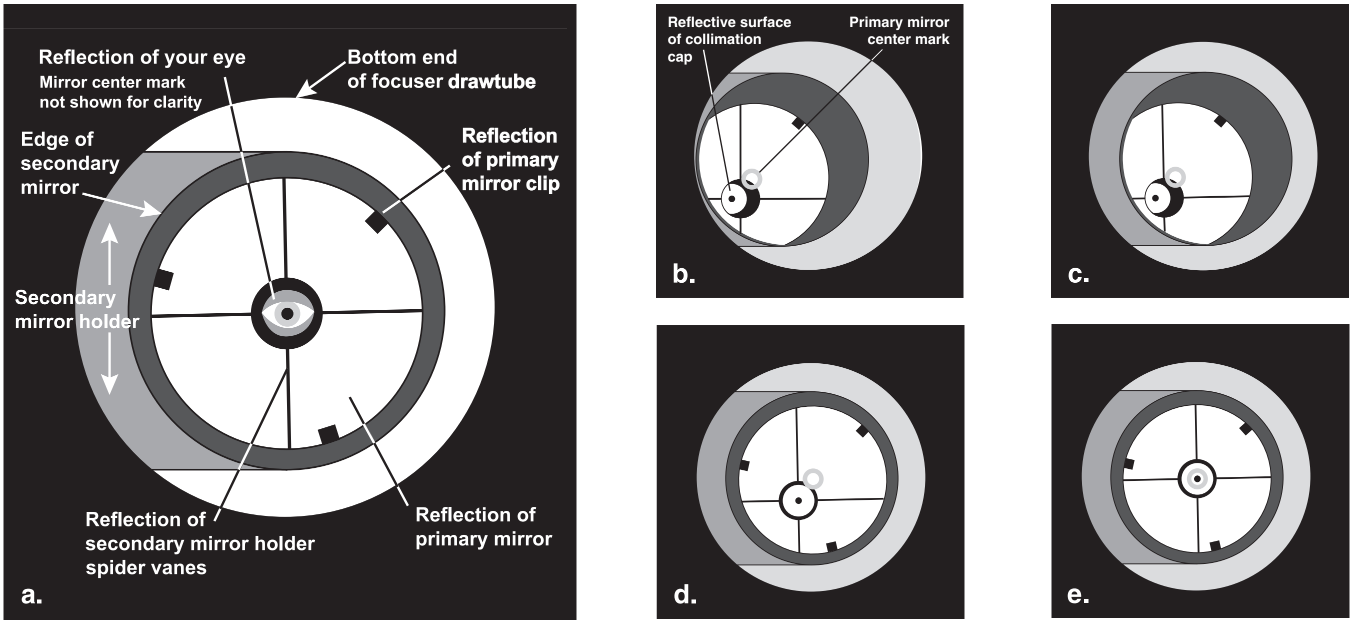

Figure 8. Collimating the optics. **(a)** When the mirrors are properly aligned, the view down the focuser drawtube should look like this. **(b)** With the collimation cap in place, if the optics are out of alignment, the view might look something like this. **(c)** Here, the secondary mirror is centered under the focuser, but it needs to be adjusted (tilted) so that the entire primary mirror is visible. **(d)** The secondary mirror is correctly aligned, but the primary mirror still needs adjustment. When the primary mirror is correctly aligned, the center "dot" of the collimation cap will be centered, as in **(e)**.

cal tube in front of the focuser. Both the 8" and 10" models have added length in front of the focuser, compared to a standard Newtonian, to prevent any possibility of incoming light from impinging directly on the secondary mirror or entering the focuser drawtube. The baffle rings and the interior of the optical tube are both painted flat black to further absorb stray light. These enhancements ensure the best possible contrast when observing and photographing faint celestial objects.

Visual Observing with the f/3.9 Newtonian Astrograph

The 8" and 10" f/3.9 Newtonian Astrographs are optimized for photographic imaging, but they can also be used of visual observing of ccelestial objects. (Because the field of view in a Newtonian reflector is rotated from right-side-up, this type of telescope is not recommended for terrestrial observing.) The tall 1.25" eyepiece holder adapter that comes installed in the focuser from the factory should allow you to achieve focus with most 1.25" telescope eyepieces **(Figure 7).**

For 2" eyepieces, you will likely have to use a 2" extension adapter to achieve focus with a 2" eyepiece. Two such adapters are included with your telescope **(Figure 7)**. One is a thread-on adapter that adds 30mm of extension, the other is a slip-in adapter that adds 36mm of extension. You may need one or the other adapter depending on the amount of extension required for your eyepiece.

To install the thread-on 2" extension, first remove the 2" accessory collar on the focuser drawtube by turning it counterclockwise until it comes off. Then thread the 2" extension adapter onto the focuser drawtube until tight. Insert a 2" eyepiece into the extension adapter and secure with the two thumbscrews. To install the slip-in 2" extension adapter, just insert its tapered base into the 2" accessory collar of the focuser, then tighten the two locking thumbscrews to secure the adapter in place.

Collimating the Optics (Aligning the Mirrors)

Collimating is the process of adjusting the mirrors so they are aligned with one another. Precise collimation of the optics is especially critical for fast Newtonian optics such as in the f/3.9 astrographs. If the mirrors are even slightly misaligned, image quality will suffer. So you should check the collimation before every observing or imaging session, to make sure it is dead-on. The process of collimation is a relatively easy and can be done in daylight or darkness.

Your telescope's optics were collimated at the factory, and should not need much adjustment unless the telescope was handled roughly in transit. To check collimation, remove the eyepiece and look down the focuser drawtube. You should see the secondary mirror centered in the drawtube, as well as the reflection of the primary mirror centered in the secondary mirror, and the reflection of the secondary mirror (and your eye) centered in the reflection of the primary mirror, as in **Figure 8a.** If anything is off-center, proceed with the following collimating procedure.

The Collimation Cap

Your f/3.9 Newtonian Astrograph comes with a “quick collimation cap” **(Figure 9)**. This is a simple cap that fits on the focuser drawtube like a dust cap, but has a tiny hole in the center and a reflective inner surface. The collimation cap helps center your eye over the focuser drawtube so that aligning the optical components is easier to achieve. The reflective surface provides a distinct visual reference that is helpful in centering the primary and secondary mirror reflections. **Figures 8b through 8e** assume that you have the collimation cap in place.

We strongly recommend the use of a laser collimating tool such as the Orion LaserMate Deluxe or LaserMate Pro to aid in collimating the optics. A laser collimator will ensure a more precise collimation than you can usually achieve with the included collimation cap. With fast optics like those of the f/3.9 Newtonian Astrographs, getting a very precise collimation is critical for obtaining the sharpest, crispest images, so a laser collimator is a worthwhile (and small) investment. However, for the purposes of this instruction, we’ll assume that you don’t (yet) have a laser collimator, and that you’ll be using the supplied collimation cap.

The Primary Mirror Center Mark

You’ll notice that the primary mirror of your f/3.9 Newtonian Astrograph has a tiny ring (sticker) marking its center. This “center mark” allows you to achieve a very precise collimation of the primary mirror; you don’t have to guess where the exact center of the mirror is.

NOTE: ***The center ring sticker need not ever be removed from the primary mirror. Because it lies directly in the shadow of the secondary mirror, its presence in no way adversely affects the optical performance of the telescope or the image quality. That might seem counter-intuitive, but it’s true!***

Preparing the Telescope for Collimation

Once you get the hang of collimating, you will be able to do it quickly even in the dark. If you’re new to It, it is best to collimate in daylight, preferably in a brightly lit room and with the scope aimed at a light-colored wall. It is recommended that the telescope tube be oriented horizontally. This will prevent any parts from the secondary mirror from falling down onto the primary mirror and causing damage if something comes loose while you are making adjustments. Place a sheet of white paper inside the optical tube directly opposite the focuser (**Figure 10**). The paper will provide a bright “background” when viewing into the focuser during collimation.

Aligning the Secondary Mirror

To adjust the secondary mirror collimation, you will need both a small and a large Phillips screwdriver.

You will need to check, and adjust if necessary, four aspects of the secondary mirror’s alignment:

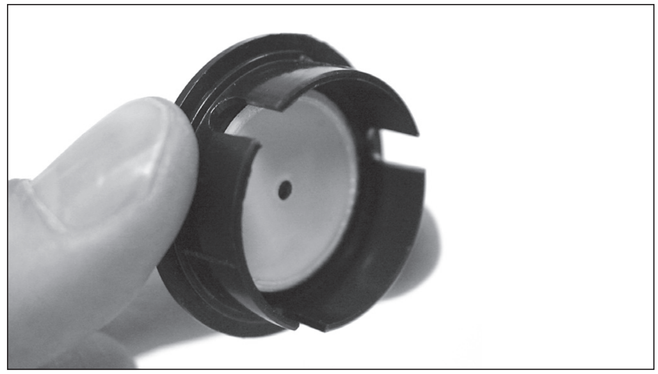

Figure 9. The quick collimation cap, which features an inner reflective surface, helps in centering reflections of the optics in the focuser during the collimation process.

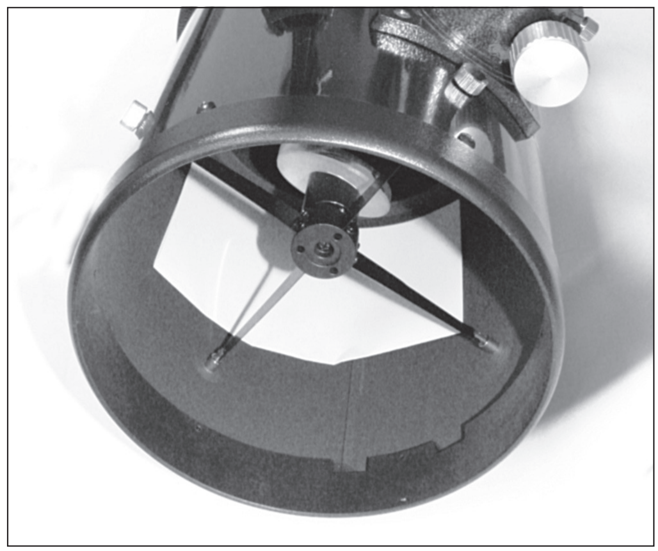

Figure 10. Placing a piece of white paper inside the optical tube opposite the focuser provides a bright background when viewing into the focuser.

1. The secondary mirror’s axial position
2. The secondary mirror’s radial position
3. The secondary mirror’s rotational position
4. The secondary mirror’s tilt

The first three will probably only need to be checked and (possibly) adjusted once. Chances are, however, that they are set correctly from the factory and will not need any adjusting. *We recommend that you do not make the adjustments in 1 to 3 above unless you first determine that they absolutely need it!* It is usually only the secondary mirror’s tilt that will need to be adjusted occasionally.

Adjusting the Secondary Mirror’s Axial Position

With the collimating cap in place, look through the hole in the cap at the secondary (diagonal) mirror. Ignore the reflections

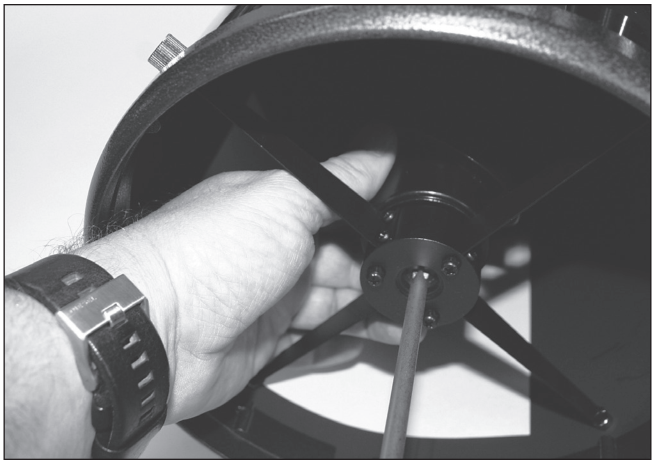

Figure 11. To center the secondary mirror axially under the focuser, hold the secondary mirror holder in place with your fingers while adjusting the center screw with a large Phillips-head screwdriver. Later you will adjust the tilt of the secondary mirror by turning the three small set screws that surround the large center screw.

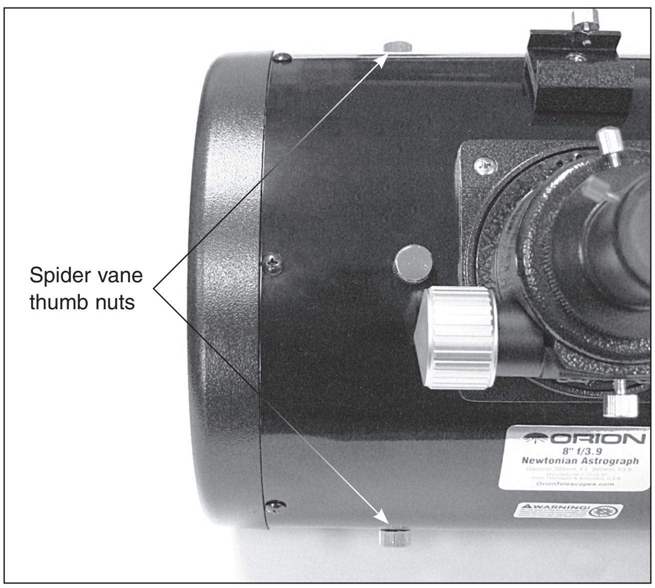

Figure 12. To center the secondary mirror radially in the focuser drawtube, make adjustments to the two knurled spider vane thumbscrews that are perpendicular to the focuser.

for the time being. The secondary mirror itself should be centered in the focuser drawtube. If it is off-center along the axis of the telescope, i.e., positioned too far toward the front opening or toward the rear of the telescope**,** as it is in **Figure 8b**, you will have to adjust the mirror's axial position.

To do so, use a small Phillips screwdriver to loosen the three small alignment set screws in the center hub of the 4-vane spider several turns. Now, grasp the mirror holder (the cylinder that is attached to the back of the secondary mirror itself) with one hand while turning the center screw with a large Phillips head screwdriver with your other hand **(Figure 11)**. Turning the screw clockwise will move the secondary mirror toward the front opening of the optical tube, while turning the screw counter-clockwise will move the secondary mirror toward the primary mirror. When the secondary mirror is centered axially in the focuser drawtube, rotate the secondary mirror holder until the reflection of the primary mirror is as centered in the secondary mirror as possible. It may not be perfectly centered, but that is fine for now. Then, tighten the three small alignment set screws equally to secure the secondary mirror in that position.

Adjusting the Secondary Mirror's Radial Position

Like the axial position, the secondary mirror's radial position was set at the factory and will probably not need any adjusting, or if it does, you'll typically need to do it only once.

By "radial position" we mean the position of the secondary mirror along the axis perpendicular to the focuser drawtube, as shown in **Figure 12**. This position is changed by adjusting two of the spider vane thumb nuts, as shown. Loosen one thumb nut, then tighten the opposite one until the secondary mirror is centered radially in the drawtube. Do not loosen the thumb nuts too much, to avoid having them completely unthread from the ends of the spider vanes. Also, when making this adjustment, be careful not to stress the spider vanes or they could bend.

Adjusting the Secondary Mirror's Rotational Position

The secondary mirror should face the focuser squarely. If the mirror appears to be rotated away from the focuser, the mirror's rotational position will need to be adjusted. Again, this adjustment will rarely, if ever, need to be done.

Grip the sides of the secondary mirror holder with your fingers. Then, using a large Phillips screwdriver, loosen the center screw in the secondary mirror holder about a quarter of a turn only (counterclockwise). That should be enough to free up the secondary mirror to rotate slightly in either direction. Look into the collimation cap and rotate the mirror slightly in each direction to get an idea of how it affects the view of the secondary mirror. Now rotate the mirror as needed so that it precisely faces the focuser. Hold the mirror holder stationary in that position while turning the center screw clockwise until it is just tight (do not over-tighten). Sometimes the mirror may rotate slightly when tightening the screw, so keep at it until the mirror faces the focuser squarely and is secured in place.

Adjusting the Secondary Mirror's Tilt

Finally, the tilt of the secondary mirror may occasionally require adjustment. If the entire primary mirror reflection is not visible in the secondary mirror when using the collimation cap, as in **Figure 8c**, you will need to adjust the tilt of the secondary mirror. Using a 2mm Allen wrench, first loosen one

Figure 13. The tilt of the secondary mirror is adjusted with a 2mm Allen wrench on the three setscrews surrounding the center Phillips-head bolt.

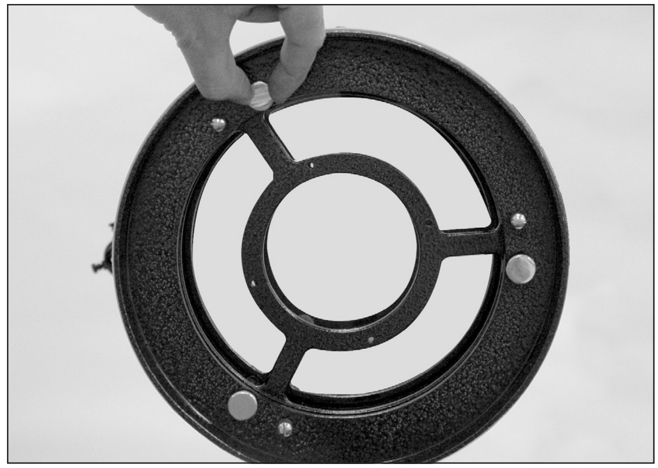

Figure 14. The tilt of the primary mirror is adjusted by turning one or more of the three large, spring-loaded collimation knobs. The three thinner thumbscrews lock the primary mirror in place.

of the three alignment set screws by, say, one full turn, and then tighten the other two to take up the slack **(Figure 13).** Do not loosen the center screw during this process. The goal is to center the primary mirror reflection in the secondary mirror, as in **Figure 8d**. When it is centered, you're done adjusting the secondary mirror. Don't worry that the reflection of the secondary mirror (the dark circle with the four spider vanes adjoining it) is off-center, since that adjustment is made when aligning the primary mirror in the next step.

Aligning the Primary Mirror

The final collimation adjustment is made to the primary mirror. It will need adjustment if, as in **Figure 8d**, the secondary mirror is centered under the focuser and the reflection of the primary mirror is centered in the secondary mirror, but the reflection of the secondary mirror (dark circle containing the light reflective surface and center black "dot" of the collimation cap) is off-center.

The tilt of the primary mirror is adjusted with three spring-loaded collimation knobs on the back end of the optical tube (bottom of the primary mirror cell); these are the larger knobs **(Figure 14).** The other three smaller thumbscrews lock the mirror's position in place; these thumbscrews must be loosened before any collimation adjustments can be made to the primary mirror.

To adjust the primary mirror's tilt, first loosen all three locking (thin) thumbscrews by turning them counterclockwise a couple of turns each. Now, while looking into the focuser through the collimation cap, turn one of the larger collimation knobs a half turn or so in either direction and see if the secondary mirror reflection moves closer to the center of the primary. That is, does the "dot" of the collimation cap appear to move closer to the ring on the center of the primary mirror? If it does, great, keep going until you get it as close as you can. If it doesn't, try turning the collimation knob in the opposite direction. If turning the one knob does not seem to bring the dot closer to the ring, try using one of the other collimation knobs. It will take some trial-and-error using all three collimation knobs to properly align the primary mirror. Over time you will get the feel for which collimation knobs to turn to move the image in a given direction.

When you have the dot centered as much as possible in the ring, your primary mirror is collimated. Now lightly tighten the three locking thumbscrews to secure the primary mirror in place.

The view through the collimation cap should now resemble **Figure 8e**. A simple star test will indicate how well the telescope optics are collimated.

Star-Testing the Telescope

When it is dark, point the telescope at a bright star and accurately center it in the eyepiece's field of view. (To achieve focus with an eyepiece, you will likely have to use the included 35mm extension adapter, as described previously.) Slowly de-focus the image with the focusing knob. If the telescope is correctly collimated, the expanding disk should be a perfect circle **(Figure 15)**. If the image is unsymmetrical, the scope is out of collimation. The dark shadow cast by the secondary mirror should appear in the very center of the out-of-focus circle, like the hole in a donut. If the "hole" appears off-center, the telescope is out of collimation.

If you try the star test and the bright star you have selected is not accurately centered in the eyepiece, the optics will always appear out of collimation, even though they may be perfectly aligned. It is critical to keep the star centered, so over time you will need to make slight corrections to the telescope's position in order to account for the sky's apparent motion. Point the telescope at Polaris (the north star) if you do not have a mount that tracks.

3. Care & Maintenance

Give your telescope reasonable care and it will last a lifetime. When not in use, keep its dust cover on as well as the dust

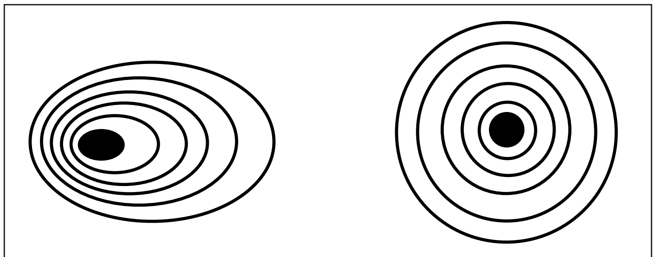

Figure 15. A star test will determine if the telescope's optics are properly collimated. A defocused view of a bright star through the eyepiece should appear as illustrated on the right if the optics are perfectly collimated. If the circle is unsymmetrical, as illustrated on the left, the optics need alignment.

cap on the eyepiece opening. Keep the telescope inside the hard storage carrying case when not in use. Store it indoors or in a dry garage. Do not leave the telescope outside except when using it. The optical tube is aluminum and has a smooth anodized surface that should resist scratches and smudges. If a scratch does appear on the tube, it will not harm the telescope. Smudges on the tube can be wiped off with standard household cleaners such as Windex or Formula 409.

Cleaning Mirrors

In general, your telescope's mirrors will only need to be cleaned very infrequently, if ever. Covering the front opening of the telescope with the dust cover when it is not in use will prevent dust from accumulating on the mirrors. Keeping the dust cap on the focuser's 1.25" opening is also a good idea. Improper cleaning can scratch the mirror coatings, so the fewer times you have to clean the mirrors, the better. Small specks of dust or flecks of paint have virtually no effect on the visual or imaging performance of the telescope.

The large primary mirror and the elliptical secondary mirror of your telescope are front-surface aluminized and over-coated with hard silicon dioxide, which prevents the aluminum from oxidizing. These coatings normally last through many years of use before requiring re-coating.

To clean the secondary mirror, first remove it from the telescope. Do this by keeping the secondary mirror holder stationary while completely unthreading the Phillips-head screw in the center hub of the spider vane assembly **(see Figure 11)**. Do not touch the mirror surface when doing this. Once the Phillips-head screw is unthreaded, the secondary mirror and its holder can be removed from the telescope. The secondary mirror does not need to be removed from its holder for cleaning. Then follow the same procedure described below for cleaning the primary mirror.

To clean the primary mirror, first carefully remove the mirror cell from the telescope. To do so you must remove the screws that attach the primary mirror cell and end ring to the tube **(Figure 16)**. Then pull the cell away from the tube. You will notice the primary mirror is held in the mirror cell with three clips held by two screws each. Loosen the screws and remove the clips.

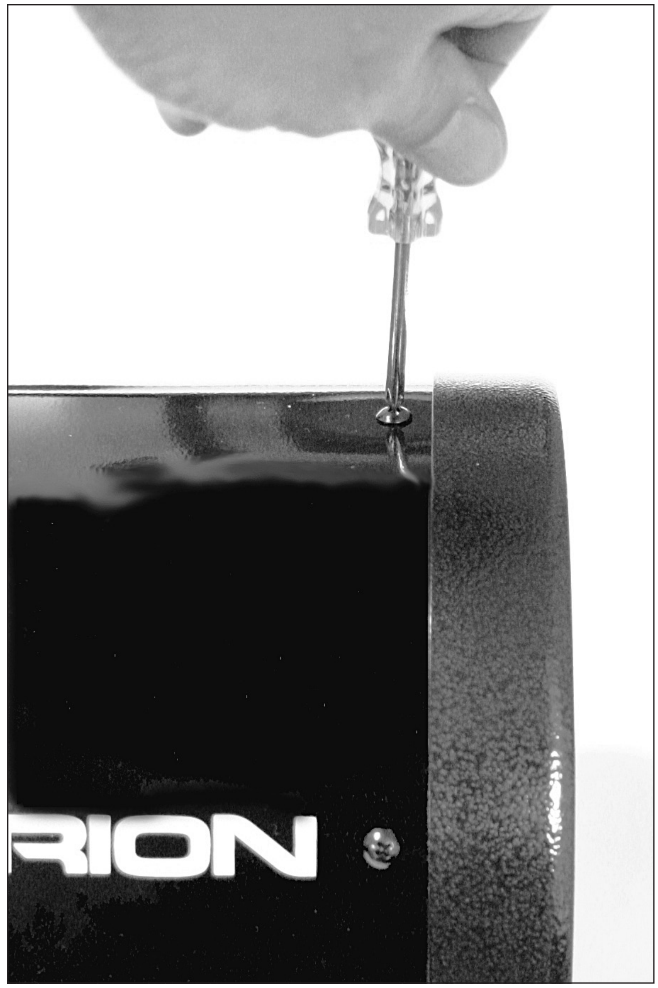

Figure 16. To clean the primary mirror, it must first be removed from the telescope tube. To do so, remove the Phillips-head screws that fasten the rear cell and end ring to the telescope tube. Then separate the cell from the tube.

You may now remove the primary mirror from its cell. Do not touch the surface of the mirror with your fingers. Lift the mirror carefully by the edges. Set the mirror on a clean soft towel. Fill a clean sink or large bucket with room temperature water, a few drops of liquid dishwashing detergent, and if possible, a capful of 100% isopropyl alcohol. Submerge the mirror (aluminized surface facing up) in the water and let it soak for a few minutes (or hours if it's a very dirty mirror). Wipe the mirror under water with clean cotton balls, using extremely light pressure and stroking in straight lines across the mirror surface. Use one ball for each wipe across the mirror. Then rinse the mirror under a stream of lukewarm water. Any particles on the surface can be swabbed gently with a series of cotton balls, each used just one time. Dry the mirror surface with a stream of air (a "blower bulb" works great). Cover the mirror surface with tissue, and leave the mirror in a warm area until it is completely dry before replacing it in the mirror cell. Then reinstall the mirror cell in the telescope optical tube with the six screws.

4. Specifications

Orion 8" f/3.9 Newtonian Astrograph

Optical configuration:	Newtonian reflector
Aperture:	203mm
Focal length:	800mm
Focal ratio:	f/3.9
Primary mirror:	Low thermal expansion optical glass, parabolic figure
Mirror coatings:	Enhanced aluminum (94% reflectivity) with SiO_2 overcoat
Secondary mirror minor axis:	70mm
Focuser:	Dual-speed (11:1) 2" Crayford, accepts 2" accessories
Drawtube travel:	38mm
Optical tube:	Rolled steel, gloss enamel exterior finish
Tube baffles:	9
Weight:	17.5 lbs. – without tube rings, fan, finder scope, 1.25" eyepiece holder 21.6 lbs. – with tube rings, finder scope, 1.25" eyepiece holder
Length:	30.25"
Tube rings:	Included, hinged, felt-lined
Finder Scope:	9x50, with spring-loaded X-Y dovetail bracket
2" Extension adapters:	30mm and 36mm extension length

Orion 10" f/3.9 Newtonian Astrograph

Optical configuration:	Newtonian reflector
Aperture:	254mm
Focal length:	1000mm
Focal ratio:	f/3.9
Primary mirror:	Low thermal expansion optical glass, parabolic figure
Mirror coatings:	Enhanced aluminum (94% reflectivity) with SiO2 overcoat
Secondary mirror minor axis:	82mm
Focuser:	Dual-speed (11:1) 2" Crayford, accepts 2" accessories
Drawtube travel:	38mm
Optical tube:	Rolled steel, gloss enamel exterior finish
Tube baffles:	13
Weight:	25.5 lbs. – without tube rings, fan, finder scope, 1.25" eyepiece holder 30.2 lbs. – with tube rings, finder scope, 1.25" eyepiece holder
Length:	38.6"
Tube rings:	Included, hinged, felt-lined
Finder Scope:	9x50, with spring-loaded X-Y dovetail bracket
2" Extension adapters:	30mm and 36mm extension length

One-Year Limited Warranty

The Orion 8" and 10" f/3.9 Newtonian Astrographs are 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 to: Orion Warranty Repair, 89 Hangar Way, Watsonville, CA 95076. Proof of purchase (such as a copy of the original receipt) 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: Orion Customer Service (800) 676-1343; support@telescope.com.

Orion Telescopes & Binoculars
OrionTelescopes.com

89 Hangar Way, Watsonville CA 95076

Customer Support Help Line (800) 676-1343