NexStar® SE

MODELS #11068 & #11069 (6SE & 8SE)

QUICK SET-UP GUIDE

ENGLISH

Telescope Setup

1

Ensure that all parts of your NexStar 6SE or 8SE telscope are present: fork arm, optical tube, tripod, accessory tray, computerized hand control, 25mm eyepiece, StarPointer red dot finderscope, star diagonal, bubble level.

2

Spread the tripod's legs out and place the tripod on the ground.

3

Remove the leg brace locking knob.

4

Slide the accessory tray onto the threaded rod so that each arm of the tray braces against each tripod leg. Replace and tighten the leg brace locking knob to secure the tray in place.

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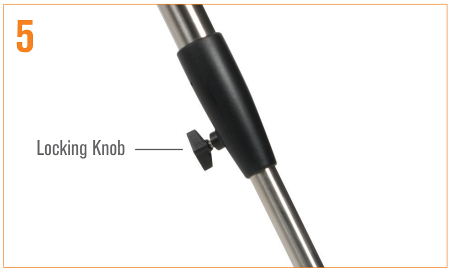


To extend each tripod leg to the desired height, loosen the locking knob, pull the leg section out, and re-tighten the knob.

6

To check that the tripod is level, place the bubble level on top of it. Carefully readjust the height of each leg as needed and then re-check using the level. Remove the level when you are done.

7

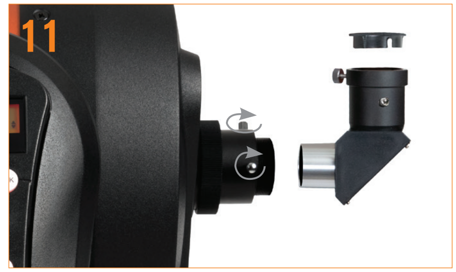
Set the base of the telescope on the tripod head so that the hole in the center of the mount base aligns with the positioning pin on top of the tripod. Rotate the telescope mount so the 3 rubber feet align with the 3 recesses on the tripod mounting plate.

8

Tighten the captive mounting bolts under the tripod head to secure the mount to the tripod.

To adjust the balance or remove the tube from the base, simply loosen the quick-release clamp knob and slide the tube back towards the rear cell of the tube. Hold the tube firmly when mounting or dismounting. Ensure the dovetail clamp is tight before releasing the tube.

Slide the StarPointer red dot finderscope onto mounting bracket. Tighten the screws on side of the finderscope StarPointer to secure it in place. Pull the small plastic tab from under the battery cover to allow the battery to make contact.



Remove the cap on the rear of the telescope. Insert the silver barrel of the star diagonal into the visual back. Tighten the silver set screw to secure.

Insert the silver barrel of the 25mm eyepiece into the star diagonal. Tighten the silver screw to secure.

Remove the battery cover from the center of the base by gently lifting on the round portion of the cover. Insert 8 AA batteries into the holder and reattach the battery cover. Be careful to insert the batteries in the correct polarity.

Turn on the power switch located at the base of the fork arm.

Before you begin viewing, please remember to remove the tube lens cap.

Slowly turn the focus knob until your subject is in sharp focus.

Moving the Telescope

With the telescope powered on, use the hand control directional slew buttons (the arrow keys) to move the scope up, down, left, or right. The altitude axis (up & down) also has a slip clutch that you can move by hand at any time. The azimuth axis (left and right) does not. Forcing the scope left and right without using the hand control can result in damage to the gears.

Aligning the Finderscope

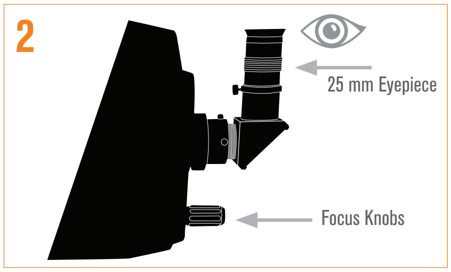
The finder is one of the most important parts of your telescope. It helps you locate objects and center them in the eyepiece. The first time you assemble your telescope, you need to align the finder to the telescope's main optics. It's best to do this during the day*.

***SOLAR WARNING!** Never attempt to view the Sun through any telescope without a proper solar filter!

1

CHOOSE A TARGET
Take the telescope outside during the day and find an easily recognizable object, such as a streetlight, car license plate or sign. The object should be as far away as possible, but at least a quarter mile away.

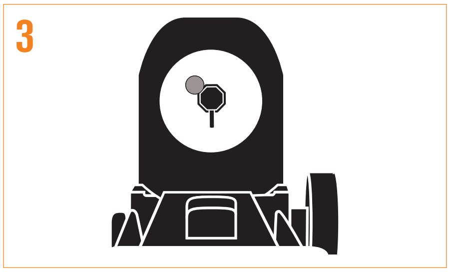
2



CENTER THE TARGET IN THE EYEPIECE
Look through the telescope using your lower powered eyepiece. Move the telescope until the object you chose lies in the center of the view. If the image is blurry, gently turn the focus knobs on either side of the telescope until it comes into sharp focus.

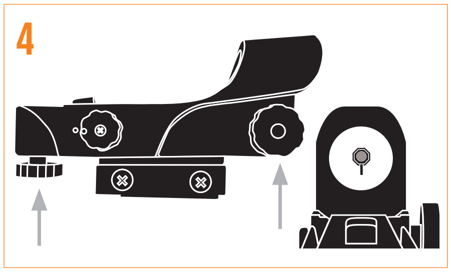
NOTE: The image in your telescope may appear inverted. This is perfectly normal in an astronomical telescope.

3



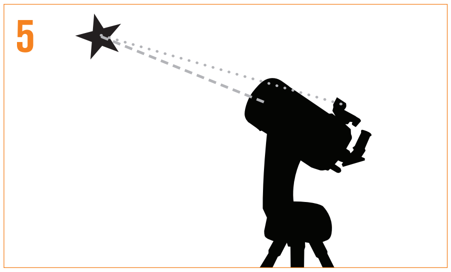
LOOK THROUGH FINDERSCOPE
Once the object is centered in your 25mm eyepiece, look through the finderscope and locate the red dot.

4



ADJUST THE FINDERSCOPE
Without moving the telescope, use the two adjustment knobs to move the finder around until the red dot appears over the same object you are observing in the telescope's 25 mm eyepiece.

5



YOUR FINDERSCOPE IS NOW ALIGNED!
It should not require realignment unless it is bumped or dropped.

Hand Control Guide

Before you can begin using your NexStar 6SE or 8SE, you must set up your computerized hand control and go through the SkyAlign alignment procedure. For the NexStar SE to accurately point to the objects in the sky, it must first be aligned with known positions (stars) in the sky. With this information, the telescope can create a model of the sky, which it uses to locate any object in its database.

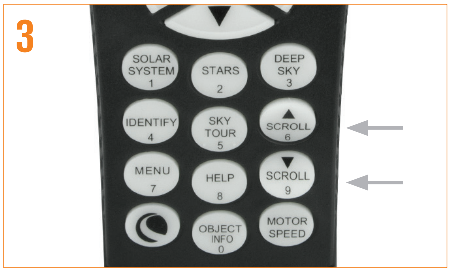
1

The first time you turn on the scope, you will need to select the language. Press the number button corresponding to the language you prefer, and press ENTER.

2

The display reads "NexStar SE Ready." Press ENTER to begin the alignment procedure.

3



Use the SCROLL UP and SCROLL DOWN buttons (located on #6 and #9 keys respectively) to select "SkyAlign" then press ENTER.

4

The hand control will ask you for your observing site location. Use the SCROLL buttons to select "City Database" and press ENTER. Use the SCROLL buttons to see the options and ENTER once you have made your selection. You will select your continent, country, state, and nearest city from the list.

5

Use the numeric keypad enter the current time. Press ENTER to continue. Press UNDO to backspace. If you entered the time in 12-hour format, you will need to select AM or PM.

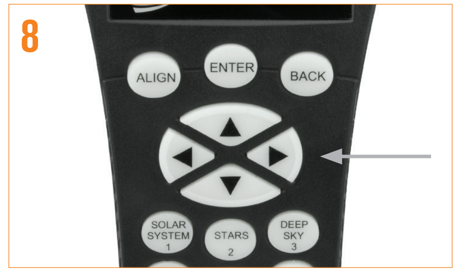
6

Select either Standard Time or Daylight Saving Time, depending on your location or the time of year.

7

Use the numeric keypad enter today's date in MM/DD/YYYY format. Press ENTER to continue.

8



The mount is now ready to be aligned. Use the directional arrow keys on the hand control to slew (move) the telescope towards any bright celestial object in the sky. Center the object in the finderscope and press ENTER. Once the alignment is underway, do not move the scope or tripod by hand. Use only the hand control to move the scope or errors in alignment will occur.

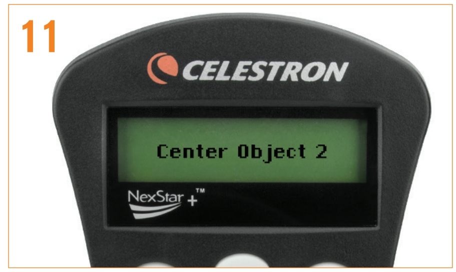
9

If the finderscope has been properly aligned, the alignment star should now be visible in the field of view of the eyepiece.

10

The hand control will prompt you to center the bright alignment star in the center of the eyepiece. Once centered, press ALIGN. This will accept the star as your first alignment position. The motors will automatically slow down to make this easier.

11

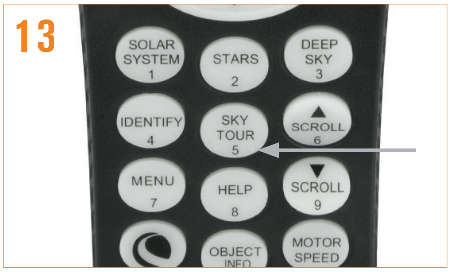


For the second alignment object, choose a bright star or planet as far from the first alignment object as possible. Once again, use the directional arrow buttons to center the object in the finderscope and press ENTER. Once the object is centered in the eyepiece, press ALIGN.

12

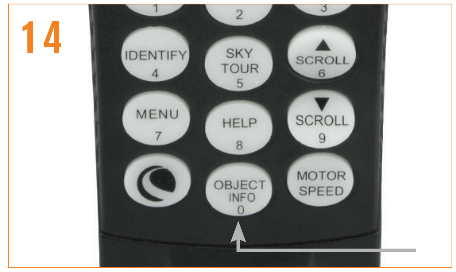
Repeat the process for the third alignment star. When the telescope has been aligned to the final star, the display will read "Match Confirmed." Press UNDO to display the names of the three bright objects you aligned to, or press ENTER to accept these three objects for alignment.

13



Now that your telescope is properly aligned, you are ready to find your first object. Press the SKY TOUR button (keypad #5) on the hand control. The hand control will display a list of objects that are visible, above your horizon, for the date and location you entered.

14



Press OBJECT INFO (keypad #0) to read information about the object. Press the SCROLL DOWN scroll key to display the next object on the list. Press ENTER to automatically slew the scope to the selected target.

⚠ SOLAR WARNING

- Never point telescope directly at the Sun (unless you have an approved solar filter). Permanent and irreversible damage to the camera or optics may result.
- Never leave the telescope unsupervised. Make sure an adult who is familiar with the correct operating procedures is with your telescope at all times, especially when children are present.

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

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Please note that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Product design and specifications are subject to change without prior notification.

This product is designed and intended for use by those 14 years of age and older.

For complete specifications and warranty information, visit: celestron.com/support/warranties

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2835 Columbia Street ▪ Torrance, CA 90503 USA
12-21

CELESTRON®

TELESCOPE BASICS

NexStar® SE

MANUAL

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TELESCOPE BASICS

EYEPIECES & MAGNIFICATION

You may want to purchase additional eyepieces for your NexStar SE telescope. Eyepieces allow you to view a magnified image in your telescope. The smaller the focal length of the eyepiece, the more magnification you will get with your telescope. High power eyepieces make things appear much closer, but have a narrower field of view, meaning you see a smaller amount of sky. This can make it more difficult to locate small objects, such as planets. When first trying to locate an object, use your longest focal length eyepiece (lowest power). This will give the widest field of view possible and will make it much easier to find your target. Once you have the target centered in your eyepiece, you can switch to a high power eyepiece to get a closer view. When you are ready to find another target, switch back to your low power eyepiece.

25 mm eyepiece 10 mm eyepiece

The amount of magnification an eyepiece provides with a given telescope can be calculated using this formula:

$$\text{MAGNIFICATION} = \frac{\text{FOCAL LENGTH OF THE TELESCOPE}}{\text{FOCAL LENGTH OF THE EYEPIECE}}$$

This formula can be used with any new eyepieces you decide to purchase for your telescope.

NOTES ON THE USE OF HIGH MAGNIFICATION

Sometimes local weather conditions can affect how much magnification you can use at any given time. If you look at bright stars with the naked eye and they appear to be twinkling or rapidly changing color, the atmosphere is not stable enough for sharp views under high magnification. On nights like this, the edge of the Moon or planets may appear as if you are viewing them through running water. If this occurs, switch eyepieces to slightly lower magnification and see if the image stabilizes. If it doesn't, increase the focal length (lowering the power) further until the view becomes steady. The stability of images can change from night to night and even hour by hour. For more on the effects on seeing conditions, please see the Tips for Astronomical Observing section (page 8).

FOCUSING

In order to see the sharpest image possible, you need to focus the eyepiece. Focus will depend on many factors, such as distance to your target and the eyepiece you are using, but can also depend on the person looking through the telescope.

While looking through the eyepiece, slowly turn the focusing knobs located below the eyepiece at the base of the focuser. You should see the image go from blurry to sharp. If you keep turning the knob and pass the focus point, the image will become blurry again. Simply turn the knobs back the other way until you find the sharpest image.

What may look focused to you may not be in focus for someone else. If you are sharing an image of the Moon or a planet with someone, don't forget to remind them to refocus the eyepiece so they can see the sharp details that you did.

VIEWING WITH EYEGLASSES

When you look through an eyepiece, your eye must be a specific distance from the top lens of the eyepiece in order to see the full image circle the eyepiece provides. If you are too far away, you will only see the center of the view and the edges are cut off. If you are using an eyepiece with a long eye relief distance, you may be able to view through the eyepiece with your glasses on. To test this, look through the eyepiece with your glasses on, then take them off and look again. If you can see the same field if view with your glasses on, you can view while wearing them. If you notice that the view without your glasses on offers a far larger field of view, you should not wear your glasses when using this eyepiece.

You can always view without your glasses on, but you will need to adjust the focus knobs to compensate for your vision. If you are observing with other people, they may need to readjust the focus when they view through the telescope.

If you suffer from severe astigmatism, the telescope may not focus as sharply as when you are wearing your glasses.

If you are considering the purchase of additional eyepieces for your telescope, you should look at eyepiece designs that offer at least 18 mm of eye relief to give yourself a better chance of observing with your glasses on.

IMAGE ORIENTATION

If you have an astronomical refracting telescope and you were to insert an eyepiece directly into the telescope's focuser, you would see an image that was upside down and mirror reversed. Because observing straight through the telescope can be difficult to use when looking directly overhead, astronomers use a mirror diagonal to make the eyepiece more accessible. The mirror in the diagonal also flips the image so that it is correctly oriented up and down. However, it will still appear backwards left to right. This is perfectly normal.

Optical systems such as spotting scopes and binoculars give a correctly oriented image, but they were designed for terrestrial observing. They use complex sets of prisms that flip the image so that it appears correctly oriented. Astronomers avoid using additional glass elements in the light path such as mirrors or prisms because each time light strikes an optical surface some of the light is absorbed by the glass and is lost to the observer's eye. The prisms in spotting scopes and binoculars will reflect the light path 4 to 5 times before sending it to the eyepiece, losing a little bit more light each time. When looking at faint targets, such as galaxies or nebulae, the astronomer wants his or her eye to capture every photon of light possible to see the faintest detail. This is not a problem for daytime terrestrial telescopes where daylight is plentiful–and nobody wants to see wildlife upside-down or backwards! If you really want to use your scope for terrestrial viewing with a fully corrected image, there are optional prism assemblies available, but check with the manufacturer as not all refractors can reach focus with all erecting prisms.

Newtonian reflector telescopes were also designed for astronomical use and images of terrestrial objects will appear upside-down. Because the design uses two mirrors, the images you see are correct left to right and up and down, but the views are rotated, depending on the angle of the focuser and the ground as well as how you hold your head to the eyepiece. Using a diagonal like the refractor would actually cause more problems by mirror reversing the image and not really correcting the image at all. Unfortunately for Newtonian telescopes, there is no easy way to correct this.

Astronomers don't mind an upside-down view since there is really no up or down in space. It is all a matter of perspective. Because the Earth we live on is roughly shaped like a sphere, a person in Australia looking at the Moon with the naked eye would see it upside-down compared to a person simultaneously observing it from Alaska. They are looking at the same object, but from different perspectives.

Image orientation as seen with the unaided eye & using erecting devices on refractors & Newtonians.

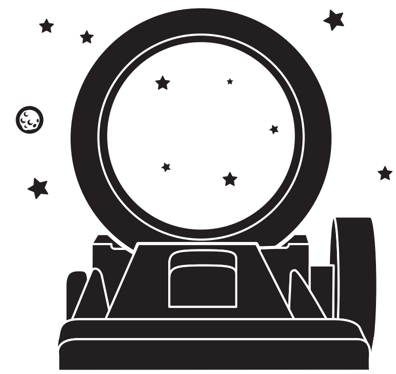
Reversed from left to right, as viewed using a Star Diagonal on a refractor.

Inverted image, normal with Newtonians & as viewed with eyepiece directly in a refractor.

WHAT TO EXPECT WITH YOUR NEW TELESCOPE

APPARENT MOTION OF THE SKY

Unlike fixed targets on the ground, astronomical targets move across the sky. This is caused by Earth's rotation. When you observe a celestial target in your telescope, such as the Moon or planets, it will appear to slowly drift across the field of view of your eyepiece. The higher the magnification of your eyepiece, the faster the object will appear to drift. In order to keep the object centered in the field of view, you will have to nudge the mount in altitude and azimuth. To maximize your viewing time between nudges, watch the target drift across the field of view to see what direction it is heading. Try to position the scope just ahead of it, and then watch as the target drifts into the field of view from one side and exits the other.



MAGNIFICATION AND STARS

Your telescope will magnify objects and make them appear much closer than they are. As you increase magnification on the Moon, you will see details within the craters and mountain ranges. Planets such as Jupiter and Saturn will increase from a small point of light to a noticeable disk. Stars, on the other hand, will not increase in size, no matter how powerful an eyepiece you use. Why? Stars are too far away to be resolved as a sphere. If you could bring them 250 times closer by using a very high power eyepiece, stars would still only appear as a pinpoint of light, even through large professional telescopes. However, your telescope will show you the separation between double stars. Some deep-sky objects, such as the Orion Nebula, may look like stars to the naked eye, but under magnification, it will appears as a large "fuzzy" cloud through your telescope.

RELATIVE BRIGHTNESS OF OBJECTS

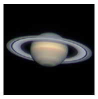
Celestial objects can vary dramatically in brightness. Astronomers use a scale called "apparent magnitude" to compare the relative brightness of these objects. The star Vega, in the constellation Lyra, serves as the baseline to which all other objects are compared. Vega is considered to have a brightness of magnitude 0. Though it may seem counter intuitive, as the brightness of a star or other celestial object increases, its number on the magnitude scale decreases. According to this scale, the Sun has the greatest brightness with a magnitude of -27, while the faintest stars the unaided human eye can detect under perfect dark conditions are magnitude 6.

The limit to what the unaided human eye can see varies depending on the size of your iris (the opening of your eye). The average adult human iris can only open about 7 mm when fully dark-adapted. Astronomers use telescopes with larger apertures to collect more light and focus it to a point that can enter the 7 mm iris of your eye, allowing you to not only see more detail, but fainter detail than you would otherwise. The larger the aperture of your telescope, the more detail you can see.

The first targets you should consider finding are the bright ones. As you gain familiarity with your telescope, you can start looking for fainter objects.

Here are some suggestions on where to start in order of brightness:

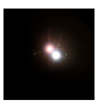
The Moon
Your telescope will reveal excellent detail on the Moon. Try observing the “terminator,” the line of darkness on the edge of the Moon’s disk. Observing along the terminator provides the best detail of craters and other surface features. Try your higher-power eyepiece to see the Moon up close.



The Planets
Saturn and Jupiter are the best planets to observe. You can see the rings around Saturn and the moons of Jupiter through your telescope. During certain times, you can even see the shadow of Jupiter’s moons on Jupiter’s surface. Under good sky conditions you can observe cloud bands on Jupiter.
Venus will not show much surface detail, but you can see the phases from a thin crescent to a thick gibbous as it moves around the Sun.

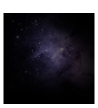
Mars will appear as a ruddy colored disk and, at times, may show a polar cap. The best time to view Mars is when it is closest to Earth (called opposition). Due to the orbits of Earth and Mars, this only happens once every two years, so make sure not to miss it!

Stars
Stars many not look any larger in your telescope, but they can still be interesting targets. Try observing single stars to compare and contrast their varying colors. In the winter skies, the easily recognizable constellation of Orion showcases two of the more extreme examples. Betelgeuse in Orion’s shoulder is very reddish, while Rigel in Orion’s foot is very bluish-white.

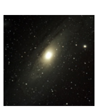


Double Stars
Double stars, which are close pairs of stars, some of which are gravitationally bound, can also offer some beautiful contrast. The star Albireo, which marks the nose of the swan in the constellation Cygnus, is a beautiful example of a bright golden-yellow star with a dimmer blue companion star.

Star Clusters
Star clusters, or loose groups of stars are also beautiful targets. The Pleiades star cluster in the constellation Taurus is a very close group of hot blue stars, visible to the naked eye on a dark night. Your telescope will reveal beautiful gas clouds surrounding the cluster in a low power eyepiece. The Double Cluster in the constellation Perseus, also visible with your low power eyepiece, is composed of two tight knit groups of stars. Another type of cluster is a globular cluster. Its stars are so tightly packed together that it is difficult to differentiate individual stars. The best example of this is the Great Hercules cluster in the constellation Hercules. This type of cluster looks best in very dark skies away from city lights.



Nebulae
Nebulae can be very faint and difficult to see, but there are a few examples that are rewarding even from suburban skies. The Great Orion Nebula in the constellation Orion is very easy to see. It appears as a collection of stars that represent the “sword” hanging from Orion’s belt. In a low power eyepiece, you will see four stars in a trapezoid pattern surrounded by a greenish-blue haze. Inside this vast nebula, new stars are being formed. Under dark skies, this nebula can take up a sizable portion of the eyepiece.



Galaxies
Galaxies are notoriously difficult to track down, because they are extended objects with very low surface brightness. This makes them hard to see unless you are under extremely dark skies, but there is one galaxy that is fairly easy to find. The Great Andromeda Galaxy in the constellation Andromeda can just barely be seen with the unaided eye in dark skies. It can even be seen with 10x50 binoculars from the suburbs. In the eyepiece, you will see an elongated whitish glow, which may stretch across most of the eyepiece field.

SEEING COLOR

When you look at pictures of nebulae in scientific publications you will see lot of red, blue and yellow nebulosity. The view through the eyepiece does not look like this. Keep in mind that these published astroimages are created over long exposure periods. Photographic film and image sensors can collect and store light over time, and are far more sensitive to the many different colors present. Your eye, on the other hand, sees on an instant-by-instant basis and is most sensitive to the green part of the spectrum. This is why most nebulae appear greenish-grey in the eyepiece.

TIPS FOR ASTRONOMICAL OBSERVING

SELECTING AN OBSERVING SITE

If you are going to be observing deep-sky objects, such as galaxies and nebulae, you should consider traveling to a dark sky site away from city lights and upwind of any major source of air pollution, with a relatively unobstructed view of the horizon. Always choose as high an elevation as possible to lower the effects of atmospheric instability and ensure that you are above any ground fog.

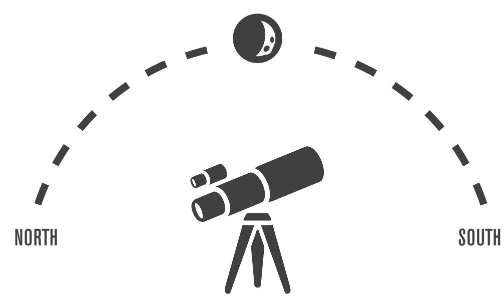
While it can be desirable to take your telescope to a dark sky site, it is not always necessary. If you plan to view the planets, the Moon or even some of the brighter deep-sky objects, your own backyard is a perfect location. Set up the scope out of the direct path of streetlights or house lights to help protect your night vision. Try to avoid observing anything that lies within 5 to 10 degrees over the roof of a building. Roofs absorb heat during the day and radiate this heat out at night, causing a layer of turbulent air directly over the building that can degrade your image.

Observing through a window is not recommended because the window glass will distort images considerably. And an open window can be even worse, because warmer indoor air will escape out the window, causing turbulence. Astronomy is an outdoor activity.

CHOOSING THE BEST TIME TO OBSERVE

Try not to view immediately after sunset. After the Sun goes down, the Earth is still cooling, causing air turbulence. As the night goes on, not only will seeing improve, but air pollution and ground lights will often diminish. Some of the best observing time is often in the early morning hours before dawn.

Objects are best observed as they cross the meridian, the imaginary line that runs from north to south through a point directly over your head. This is the point at which objects reach their highest points in the sky and your telescope is looking through the least amount of atmosphere possible. Objects that are rising or setting near the horizon will suffer more atmospheric turbulence since you are looking through a much longer column of air. It is not always necessary to have cloud-free skies if you are looking at planets or the Moon. Often broken cloud conditions provide excellent seeing.



COOLING THE TELESCOPE

Allowing your telescope to acclimate to outdoor temperatures minimizes heat wave distortion inside the telescope tube. Give your telescope at least 10 minutes to cool down to outside air temperature, or longer if there is a big difference between the temperature of the telescope and the outside air.

ADAPTING YOUR EYES

If you are planning to observe deep sky objects, allow your eyes to fully adapt to the dark by avoiding exposure to white light sources such as flashlights, car headlights, and streetlights. It will take your pupils about 30 minutes to expand to their maximum diameter and build up the levels of optical pigments necessary to see the faint light from a distant target. If you need light to help set up your telescope, try using a red LED flashlight at a low brightness setting and avoid looking straight at the light source.

When observing, it is important to observe with both eyes open. This avoids eye fatigue at the eyepiece. If you find this too distracting, cover the unused eye with your hand or an eye patch. The center of your eye works well in bright daylight, but is the least sensitive part of the eye when trying to see subtle detail at low light levels. When looking in the eyepiece for a faint target, don't look directly at it. Instead look toward the edge of the field of view and the object will appear brighter.

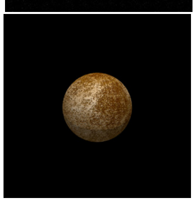
PRACTICE WHAT YOU HAVE LEARNED: **OBSERVING THE PLANETS**

There are five planets that are visible to the naked eye - Mercury, Venus, Mars, Jupiter and Saturn. To the unaided eye, these planets will look similar to stars. Uranus and Neptune are too faint to see with the unaided eye, but in a telescope they will appears as slightly bloated stars. Planets change positions against the background stars on a daily basis. Don't fear, though. With a little preparation and some knowledge of what to expect, you will be able to pick them out of the sky and find them in your telescope quite easily.

First, go online and use your favorite search engine to look for "visible planets." You will find a large number of web sites that offer printable planet finder charts that are good for the current month. These charts will usually specify a time and date to use them. For example, the map may show the sky at 11:00 PM for the beginning of the month, but may also be used at 10:00 for mid-month dates and 9:00PM at the end of the month. Hold the chart over your head and rotate the chart so that the north part of the map is facing north. Match up the brighter stars and constellations shown on the chart with the stars you can actually see and then look for the planets pointed out on the chart.

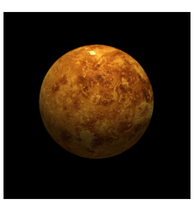
Other web sites may have more accurate interactive star charts. To use these, you need to enter the date, time, and your location and the site will generate a map of the stars with plotted positions of the planets. You can print the charts and take them outside with you when you observe. As with the charts described above, you would need to hold them over your head with north on the map pointing north to use them correctly.

Even though planets move against the stars from day to day, they stay in a very limited strip of sky, called the ecliptic. Planets are usually the brightest objects along the ecliptic.



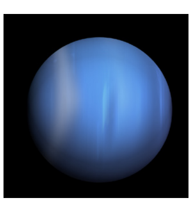
Observing Mercury and Venus

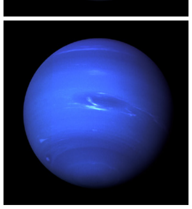
Because Mercury and Venus orbit so close to the Sun, they never appear to stray too far from it in the sky. As a result, these planets are usually seen in the early dawn before sunrise or twilight after sunset. You only have a short time to view these planets before they set below the horizon or the glare from the rising sun swallows them up. Mercury is always so low to the horizon that magnified images will rarely offer more detail than a small ruddy disk. Venus will rise higher and is, at times, brighter than anything in the sky other than the Sun and Moon. It is so bright that many people mistake it for an airplane. Due to the high amount of cloud cover on Venus, you will never see any surface detail, but you can see the planet go through phases like the Moon, from a small crescent to a large gibbous as it circles the Sun. If you view these planets, it is best to do this when the Sun is fully below the horizon to avoid accidentally viewing the Sun through your telescope, which can cause irreversible damage to your eye.



Observing Mars

Mars orbits farther from the Sun than Earth does. During opposition, when the Earth and the planet are closest to each other, the planet will rise at sunset and be visible in the sky all night. Due to the relative speeds of Earth and Mars, Mars only comes into opposition once every two years. Around the time of Mars' opposition, the planet is at its largest and can start to show some subtle detail such as a polar cap and some shading of surface features. At opposition, it is possible to see one of the polar caps with a small telescope.





Observing Uranus and Neptune

Uranus and Neptune are too far away to show any detail. Even under high power, they appear slightly larger than a star, but what is really noticeable about these planets in an eyepiece is their stunning greenish-blue color.

OBSERVING JUPITER

Jupiter and Saturn are, without a doubt, the most beautiful planets to view in any telescope. We'll look at them in more detail. Jupiter is the largest planet in the solar system. It has a very thick atmosphere of gas, but has no discernible solid surface. When we view Jupiter, we can only see the outer layers of its atmosphere, but there are still many wonders to see.

When you look at Jupiter through a telescope, the first thing you'll notice is its size. Jupiter is definitely not a star. Even at low magnification, the planet resolves into a pale tan disk. At higher magnifications you will see that the disk is not perfectly round; it's a little wider in diameter at the equator than measured through the poles. This is caused by Jupiter's high rotational speed, taking just under 10 hours to complete one revolution.

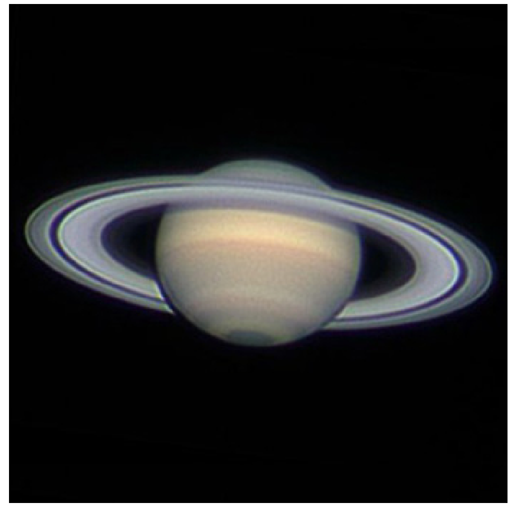
Look carefully at the disk and you will see darker cloud bands crossing the face of the planet, like stripes on a billiard ball. The clouds appear as stripes due to different wind conditions at different latitudes, which can exceed 200 miles per hour (320 km/h). The turbulent areas sandwiched between these layers can create massive storms that force up layers of compounds from the lower atmosphere, which react with sunlight to create the red and brown hues seen in the clouds. Since these interactions are constantly changing, Jupiter will look a bit different each time you view it.

One of the most famous features of Jupiter is the Great Red Spot, a giant storm that is larger than three planet Earths in diameter and has been going strong since it was first recorded in 1831. Similar to the equatorial cloud bands, the color of the Great Red Spot can change. For the past few years, the spot has changed from red to a pale salmon pink, making it a little more difficult for small telescopes to see.

Another fascinating reason to keep your eye on Jupiter is its moons. Jupiter has 67 moons at last count. Unfortunately, only a handful of them can be seen from Earth. When you view Jupiter through the eyepiece, you will see four small star-like objects that appear to the right or left of the planet, forming a rough line with Jupiter's equator. These are the Galilean moons—Io, Europa, Ganymede and Callisto—first discovered by Galileo Galilei in 1610. They were the first celestial objects found to orbit a body other than the Earth or the Sun. Three of these moons are larger than Earth's moon and Ganymede is even larger than the planet Mercury.

These moons orbit Jupiter very quickly. Io takes less than two days to complete one orbit of Jupiter, while Callisto, with the longest orbit of the Galilean moons takes almost 17 days. This is much faster than Earth's moon, which takes close to 28 days to complete one orbit. This means the moons will look different every time you view the planet. Sometimes you will not be able to see all four moons at the same time as one or more of them may be hidden in the planets shadow or behind the planet itself. One of the more special treats you might see is a transit of one of the moons or one of the moon shadows crossing the face of the planet. You can check online for programs that allow you to predict the lunar transits, shadow transits and eclipses of Jupiter's moons so you can plan observing sessions around these special events.

OBSERVING SATURN



Saturn is the second largest planet and a gas giant similar to Jupiter. The planet appears yellowish due to its ammonia-rich upper atmosphere. Like Jupiter, Saturn has very high equatorial winds that can reach 1100 miles per hour (1800 km/h), but it lacks the contrasting dark color bands seen on Jupiter. Sometimes large storms can appear as white spots but can dissipate quickly.

The main thing you notice when you look at Saturn for the first time is its incredible ring system. These rings are primarily made of small particles of ice with traces of rocky material. They extend 75,000 miles (120,700 km) above the planet's equator, but have an average thickness of less than half a mile (0.8 km).

The rings were first glimpsed by Galileo Galilei in 1610 in his early refracting telescope, but he was not able to see them clearly enough to determine what they were. He originally thought Saturn was three bodies orbiting closely but not touching. It was not until 1655, that Christiaan Huygens first described their true nature as a disk surrounding the planet. In 1675, Giovanni Domenico Cassini discovered that this disk around Saturn was actually a series of smaller rings separated by gaps. The largest dark gap in the rings between the bright A and B rings is called the Cassini Division in his honor. This gap spans 3000 miles (4800 km) and is visible in telescopes if the seeing conditions and ring angle are favorable.

Roughly every 15 years, observers on Earth see Saturn's rings completely vanish from sight. Saturn's orbit around the Sun is slightly inclined to Earth's orbit. This means that twice during Saturn's 29.5 year orbit of the Sun, Saturn's rings are viewed edge-on from Earth. Because the rings are so thin, they cannot be seen and all that is visible is the planet itself. The last occurrence of this was September 4, 2009. In the years since, the angle between the Earth and Saturn has opened up, allowing us to see a more of the rings. In 2016, the rings will once again be at their widest before slowly starting to close, disappearing again in 2025.

Saturn has 62 confirmed moons, but only a few are visible in small telescopes. Titan, discovered by Christian Huygens in 1655, is the second largest moon in the solar system. Like Jupiter's Ganymede, it is also larger than the planet Mercury. The next largest moons, Rhea and Iapetus are less than 70% of the size of Titan and may be visible in telescopes as small star-like points of light.

HOW TO FIND DEEP-SKY OBJECTS

You have now viewed the Moon and planets. It's time to take the next step on your journey to the cosmos and look for your first objects beyond our Solar System.

DEEP-SKY OBSERVING EQUIPMENT

Red Flashlight
This is an essential tool for deep-sky astronomy for reading finder charts or star atlases. In order to see the faint light coming from distant objects like nebulae or galaxies, your eyes must be fully dark adapted with your irises fully open to let the most light from your telescope into them. White light from a standard flashlight will cause your irises to close down and it can take up to 30 minutes for your eyes to return to full dark adaptation. Red lights do not have the same effect. We recommend any red LED flashlight that has adjustable brightness output, because even red light, if excessively bright, can affect your night vision. We recommend the Celestron PowerTank Glow 5000. It's the perfect brightness and can also charge your personal electronics.

Planisphere
A planisphere is a special circular star map that will show you the rough placement of constellations over your head, so you can navigate your way across the sky. Unlike charts you can print online, planispheres work at any time of year, not just the date or month you printed it for. The planisphere consists of two round disks joined at the center. The bottom disk has a map of the constellations while the top disk has a window cut into it out showing a portion of the sky map. By turning the inner and outer disks to match your specific date and time, the map will display only those constellations visible to you at that time. This is handy for finding rough locations of bright stars and constellations. Planispheres are available at most bookstores. Be sure to pick one that is designed for your location, as planispheres correspond to geographical latitudes in the Northern or Southern Hemispheres.

Star Atlas
Star atlases are the roadmaps of the sky. Once you have located a constellation with your planisphere, the star atlas will show you a detailed, close-up view of that region of sky showing the stars and deep-sky objects that reside in it. These are available at many telescope retailers or bookstores.

Apps and Programs
There are many smartphone and tablet applications that take the place of planispheres and star maps, including the SkyPortal app from Celestron. These will give digital representations of the night sky on your device, allowing you to go from a wide view to a zoomed-in view with a touch of the screen. Try searching your device's app store to see what's available.

There are also some great astronomical sky simulation programs available for your computer with very detailed on-screen star maps, tools to help you plan an observing session, and printable star maps customized for your time and location. If you recently purchased a Celestron telescope, you should have received a code for a free download of Celestron's Starry Night astronomy software.

STARHOPPING

The easiest way to find your way around the sky is using a technique called "starhopping." To get started, measure the field of view of your finderscope.

Measuring the Field of View of Your Finderscope.

1. Look in the sky and locate a constellation with bright stars. You can use your planisphere to help identify it. Now find the map in your star atlas that shows this constellation.

2. Center your finderscope on any bright star that you can recognize on the star map.

3. Hold your head 12 inches behind the reflective window of your StarPointer finderscope and move the telescope so that the bright star is at the edge of the field if view of the window (it does not matter which direction you pick).

4. Without moving the telescope, look through the finderscope window and locate another star near the opposite edge of the field of view.

5. Locate this second star on the chart. Measure the distance between these two stars on the chart using a ruler. This distance is represents one finderscope field of view on your atlas. You can now use this measurement to locate celestial objects.

Locating Celestial Objects

1. Once you have identified an object you want to find, locate it on your star atlas. Use the map to determine what constellation it lies in and what bright stars are near it.

2. Now use your planisphere to locate the constellation in the sky and try to locate the bright stars you found on the star chart near your target. Move your telescope so that the bright star is centered on red dot of your StarPointer finderscope.

3. Using the scale you just created, find out how many fields of view of the finderscope you need to move and in what direction to go from the bright star to your target. Looking through the finderscope, move the telescope the same number of fields of view and in the same direction as indicated by the map. When you are done, your telescope should be very close to your target.

4. Look through the lowest power eyepiece you have and see if you can see it. If you don't see it, you can start a systematic search of the local area. Look through your eyepiece and slowly move the scope back and forth, up and down. Try not to move more than one field of view of the eyepiece at a time so you don't miss seeing it. Be sure to move slowly and take your time. If you still can't find it, don't worry. Just go back to your bright star and try it again. With a little patience and some practice, you will be able to locate these objects without much trouble.

PRACTICE WHAT YOU HAVE LEARNED: **OBSERVING DOUBLE STARS**

Double Stars

Double stars, or pairs of stars that appear close together in the sky, are rewarding objects to observe. In some cases, these stars are so close together that they appear to the unaided eye as single stars, but under the magnification of a telescope, they resolve into a very closely separated pair. Some of these pairs show a very striking difference in color between the stars. The great thing about double stars is that they are not as affected by light pollution as other deep-sky objects are.

Some double stars will require higher magnifications to cleanly separate the two component stars. Astronomers use special eyepieces with measuring reticles to measure the separation and angle of the two stars. Repeated measurements of the stars' angles over long periods of time show how fast the stars orbit each other.

Star atlases, astronomy programs, and mobile apps will identify double stars using a different symbol than single stars. Use the starhopping method described above to locate these gems of the sky. Here are a few examples of easy to find double stars to get you started.

Observing Albireo

Albireo is one of the most beautiful examples of a double star and, lucky for us, it is very easy to locate. Albireo appears to the naked eye as a single star in the easily recognizable constellation Cygnus the Swan and marks the nose of the celestial bird. What is striking about this double star is the color, a bright yellow star paired with a dimmer blue companion star. This pair has a separation of about 1/1000th of a degree.

Observing Mizar

Mizar is a very easy double star to find, as it is located in the Big Dipper, in the constellation Ursa Major. It is the second star from the end of the handle. Arabic texts suggest that this double star was used as a test of eyesight, as some people can see both component stars without optical aid. They are separated by 1/5th of a degree. The fainter companion star has its own name, Alcor.

Observing Gamma Leonis (Algieba)

Gamma Leonis, also known by the Arabic name Algieba. It is located in the easily recognizable constellation of Leo the Lion, in an asterism called the Sickle of Leo. This group of stars, representing the lion's mane, resembles a backwards question mark with Regulus, the brightest star in the constellation Leo, at the very bottom. Algieba is a very close double star. The most striking feature of this pair is the color differences, with one star being an orange-red and the other being a greenish-yellow. In 2009, astronomers discovered that the primary star in this system, Gamma Leonis 1, has a planetary companion that is almost 9 times more massive than Jupiter. Further data suggests that there may be a second planet orbiting this star with a mass twice that of Jupiter, but further investigation is needed.

PRACTICE WHAT YOU HAVE LEARNED: **OBSERVING STAR CLUSTERS**

Star Clusters

Star clusters are groups of stars that are packed into a small area. Clusters that have loosely distributed stars are called open clusters and can contain hundreds of stars. Clusters that are very tightly packed in a small area are called globular clusters, which can contain hundreds of thousands of stars. For open clusters, you should use low power eyepieces to better frame the cluster. For globular clusters, try low power first, and then boost up to a higher power to try to resolve as many of the stars as possible.

Observing the Pleiades

The Pleiades is an open cluster located in the constellation Taurus the Bull. It is a large open cluster of very bright blue stars and is easily seen with the naked eye. It is only about 400 light years from Earth. This cluster is large and best appreciated with low power eyepieces. This cluster has been recognized and recorded by many cultures all over the world. In Japan, this cluster is known as Subaru and was adopted as the name and logo of the automobile manufacturer.

Observing the Double Cluster

The Double Cluster in the constellation Perseus is a beautiful telescopic object, or more accurately, objects, since there are two distinct open clusters in the same field if view. To the unaided eye, this cluster appears as a fuzzy patch in Perseus, but a small telescope or binoculars resolves this into to open clusters approximately one degree apart. Each cluster contains a few hundred stars. Be sure to use low power eyepieces with this object to get both clusters together, and then switch to higher magnification to inspect each cluster in more detail.

Observing the Hercules Globular Cluster

The Hercules Globular Cluster is the most beautiful example of a globular cluster in the northern skies. It is conveniently located between two bright stars in the constellation Hercules and is just barely visible to the unaided eye on a dark night as a fuzzy star. It can be seen easily in binoculars, but looks better through a telescope using low to moderate magnification. This cluster contains hundreds of thousands of densely packed stars.

PRACTICE WHAT YOU HAVE LEARNED: **OBSERVING NEBULAE**

Nebulae
Nebulae are large clouds of ionized gas or dust that lie in interstellar space.

They can be classified into three basic categories:

Emission Nebula - These nebulae are rich in HII (pronounced H2), or ionized hydrogen. The ionized hydrogen glows as a result of high-energy photons emitted from a nearby massive star. Emission nebulae usually contain star forming regions where the gas clouds coalesce and new stars are born. They can also be found at the other end of a star's life cycle, when a massive dying star sheds it outer layer into space. The gas expands into a spherical cloud and is ionized by the star's exposed core. This special type of emission nebula is called a **planetary nebula**.

Reflection Nebula - These nebulae are often rich in HII, but do not give off light of their own. Instead, these nebulae reflect the light from nearby stars that are not massive enough to excite the ionized gas.

Dark Nebula - These nebulae are clouds of dust and HII, but are not illuminated by close stars. They are only seen because they block the light from stars behind them, creating dark areas in an otherwise bright star field.
Many of these nebulae are very large objects and under dark skies, you may trace them over a sizable percentage of the view in a low power eyepiece. Planetary nebulae are usually small in diameter and will look better using moderate to high power.

Observing the Orion Nebula

The Orion Nebula is a "stellar nursery," a large diffuse HII region where new stars are forming. It is extremely easy to locate, visible to the naked eye as a small fuzzy patch in the constellation of Orion. The nebula appears as a jewel in the sword that hangs from three stars of Orion's belt. This is one deep-sky object that has very high surface brightness and even looks good from suburban skies, though dark skies will show significantly more detail. Use low magnification for this object as it is big and you'll want to see it against the dark backdrop of the surrounding sky. The nebula appears as a faint greenish glow in the eyepiece, with a brighter center portion with a dark gulf on one side. The glow of this emission nebula comes from the star cluster at the center. The four brightest stars in the cluster are known as the Trapezium for the trapezoidal shape they form. Astronomers know that more stars are being formed in this nebula, but they are shrouded from view by the gas and dust.

Observing the Lagoon Nebula
The Lagoon Nebula is another excellent example of an HII star-forming region. Under dark skies, this nebula is just visible to the naked eye in the constellation Sagittarius. In a low power eyepiece, the greenish-gray nebula appears as a star cluster surrounded by an oval shaped glow with a brighter core. This nebula contains a number of Bok globules, dark clouds of gas condensing into new stars.

Observing the Ring Nebula
The Ring Nebula is a planetary nebula that was created when a red giant star, near the end of its life, blew off its outer shell, leaving behind an exposed core that would evolve to a white dwarf star. It is located in the constellation Lyra, between the two naked eye stars representing the base of the lyre and only about 6 degrees from Vega, the second brightest star in the northern hemisphere. The nebula looks like a small blue smoke-ring in lower magnifications. Using magnifications of 100x or more will show a bright edge with a noticeably darker center.

PRACTICE WHAT YOU HAVE LEARNED: **OBSERVING GALAXIES**

Galaxies

A galaxy is an immense system of millions or billions of stars along with gas and dust that are gravitationally bound together. Most galaxies range from 3,000 to 300,000 light years in diameter and are separated from each other by vast distances of millions of light years. If you have gone outside on a dark night and seen the Milky Way stretching across the sky, you are seeing the disk of our galaxy—from the inside. Distant galaxies are very faint can only be seen under dark skies with fully dark-adapted eyes. Most will appear as elongated smudges of light in the eyepiece. To see hints of the delicate spiral structure in most galaxies, you need a very large telescope with a diameter of at least 11 inches (280 mm).

Observing the Andromeda Galaxy

The Andromeda Galaxy is spiral galaxy that lies approximately 2.5 million light years from Earth in the constellation Andromeda. It contains over a trillion stars, double the amount in our own Milky Way galaxy. It is the only distant galaxy visible to the naked eye on a dark, moonless night. The Andromeda Galaxy is currently on a collision course with our Milky Way Galaxy, traveling towards us at close to 200 miles per second (315 km/sec). The collision is expected to occur in about 4 billion years, when both galaxies will possibly merge to form one giant elliptical galaxy.

Because the Andromeda Galaxy is such a large object, it's best viewed using a low power eyepiece. In long exposure images of this galaxy, the galaxy can take up 3 degrees of sky, or 6 times the diameter of the full moon. However, in most telescopes, only the bright central core is visible. When starhopping to this object, you will find the constellation Andromeda does not have many bright stars. An excellent starting point is with the 5 bright stars of the nearby constellation of Cassiopeia, which is shaped like the letter W (or M depending on the season or time of night).

STORAGE, TRANSPORTING AND MAINTENANCE

Your Celestron telescope is a precision instrument and should be kept indoors when not in use. For day-to-day observing, the scope can be left fully set up. Just make sure the covers are in place to prevent dust from entering the telescope tube.

Always carry the telescope from the mount and not from the telescope tube. Most beginner telescopes are the perfect size to take with you on your next camping trip. We recommend packing the scope in its original box to prevent it from being damaged on the way.

Clean the outside of the telescope and mount with a damp cloth. We do not recommend using any solvents or cleaners on the outside of the scope. Never attempt clean the telescope's mirrors. Unlike a bathroom mirror where the reflective surface is behind the glass, the mirrors on your telescopes have a metallic coating on the top surface of the glass. Wiping the mirror can lead to scratches in the surface coating that will affect your image quality far more than a thin layer of dust.

The finderscope lens and eyepieces can be cleaned with optical lens tissues available at most photography supply stores. Eyepieces should be handled with care to avoid touching optical surfaces.

ADDITIONAL RESOURCES

For more information on this product,
please visit the respective product page on **celestron.com**

SOLAR WARNING:
Never attempt to view the Sun through any telescope without a proper solar filter.

Need assistance?
Contact Celestron Technical Support celestron.com/pages/technical-support

celestron.com/pages/warranty

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CELESTRON

celestron.com/pages/technical-support
2835 Columbia Street • Torrance, CA 90503 U.S.A.

NEXSTAR+ HAND CONTROL

Congratulations! You have received a newly upgraded NexStar+ hand control with your telescope.

The NexStar+ hand control features all of the functionality of the older NexStar hand control but offers the following improvements:

- Expandable functionality through the use of the Help and Option buttons (available in future firmware updates)
- LCD is less sensitive to low temperatures
- Directional buttons have raised edges to make them easier to find without looking at the hand control
- Support for faster updating via Celestron's new firmware management software

Below is a brief description of the individual components of NexStar+ hand control.

1. LIQUID CRYSTAL DISPLAY (LCD) WINDOW: Offers improved performance in cold weather and red backlighting for comfortable nighttime viewing of telescope information and scrolling text.

2. ALIGN: Instructs the telescope to begin the default alignment procedure. It is also used to select star or object as an alignment position.

3. DIRECTION KEYS: Allow complete control of your telescope in any direction. Use the direction keys to center objects in the eyepiece or to manually slew your telescope.

4. CATALOG KEYS: Allow direct access to each of the main catalogs in the database of thousands of objects.
Your telescope contains the following catalogs in its database:

- Solar System – All 7 planets in our Solar System plus the Moon, Sun and Pluto
- Stars – Custom lists of all the brightest stars, double stars, variable stars, constellations and asterisms
- Deep Sky – Custom lists of all the best Galaxies, Nebulae and Clusters, as well as the complete Messier and select NGC objects

5. IDENTIFY: Searches your telescope's database and displays the name and offset distances to the nearest matching objects.

6. MENU: Displays setup and utilities functions, such as tracking rate and user defined objects and others.

7. OPTION (CELESTRON LOGO): Works similar to the SHIFT key on a keyboard and can be used in combination with other keys to access more advanced features and functions to be added with later firmware updates.

8. ENTER: Pressing ENTER allows you to select any of your telescope's functions, accept entered parameters and slews the telescope to displayed objects.

9. BACK: Similar to the UNDO button on the original hand control, pressing BACK will take you out of the current menu and display the previous level of the menu path. Press BACK repeatedly to get back to a main menu or use to erase data entered by mistake.

10. SKY TOUR: Activates the tour mode, which seeks out all of the best objects in the sky and automatically slews your telescope to those objects.

11. SCROLL KEYS: Used to scroll UP and DOWN within any of the menu lists. A double arrow symbol on the right side of the LCD indicates that the scroll keys can be used to view additional information. The buttons have an angled shape to make it easier to locate without looking.

12. MOTOR SPEED: Similar to the Rate Button on the original NexStar hand control, it allows you to change the motor's speed when the direction keys are pressed.

13. OBJECT INFO: Displays coordinates and valuable information about objects selected from your telescope's database.

14. RS-232 JACK: For use with computer software programs for point and click slewing capability and updating firmware via PC.

15. HELP MENU: In future firmware updates, this button will offer troubleshooting tips. For your convenience, it currently functions as a shortcut to the Messier Catalog.

NexStar+ NEXSTAR+ HAND CONTROL

SELECTING AN OBJECT

Once the telescope is properly aligned, you can choose an object from any of the catalogs in the NexStar+ hand control's database. The hand control has a key designated for each category of objects in its database; Solar System objects, Stars and Deep Sky objects.

• **Solar System –** The Solar System catalog will display all of the planets (and Moon) in our Solar System that are currently visible in the sky. To allow the Sun to be displayed as an option in the database, see Allow Sun option in the Database Setup section of the manual.
• **Stars –** The Stars catalog displays custom lists of all the brightest stars, double (binary) stars, variable stars, constellations and selected asterisms.
• **Deep Sky –** The Deep Sky catalog displays a list of all of the best Galaxies, Nebulae and Clusters, as well as the complete Messier and select NGC objects. There is also an alphabetical list of all deep sky objects in order by their common name.
Use the SCROLL keys to scroll through the catalogs to find the object you wish to view.
When scrolling through a long list of objects, holding down either the UP or DOWN key will allow you to scroll through the catalog at a rapid speed.

SLEWING TO AN OBJECT

Once the desired object idisplayed on the hand control screen, you have two options:

- Press the **OBJECT INFO Key**. This will give you useful information about the selected object such as magnitude, constellation and extended information about the most popular objects.
  - o Use the **UP/DOWN** arrow buttons to scroll through the displayed object info
  - o Use the **BACK** button to return to the object database

- **Press the ENTER Key.** This will automatically slew the telescope to the coordinates of the object displayed on the hand control. While the telescope is slewing to the object, the user can still access many of the hand control functions (such as displaying information about the object).

NOTE: The Messier, NGC and SAO catalogs require the user to enter a numeric designation. Once you have selected the appropriate catalog button and selected the Messier, NGC or SAO catalog, you will see a flashing cursor indicating you are in numeric entry mode.

Enter the catalog number for the object you want to view. Press **ENTER** to command the telescope to slew to the object, or hold the **OPTION** button (the Celestron logo) and press **OBJECT INFO** to see information about the object you selected.

Caution: Never slew the telescope when someone is looking into the eyepiece. The telescope can move at fast slew speeds and may hit an observer in the eye.

MOTOR SPEED BUTTON

The MOTOR SPEED button, similar to the Rate button on the original NexStar hand control, allows you to instantly change the speed rate of the motors from high speed slew rate to precise guiding rate or anywhere in between. Each rate corresponds to a number on the hand control key pad. The number 9 button is the fastest rate (approximately 3.5° per second, depending on the mount) and is used for slewing between objects and locating alignment stars. The number 1 button on the hand control is the slowest rate (half sidereal) and can be used for accurate centering of objects in the eyepiece.

To change the speed of the motors:

- Press the MOTOR SPEED key on the hand control. The LCD will display the current motor speed
- Press the number on the hand control that corresponds to the desired speed

The hand control has a "double button" feature that allows you to instantly speed up the motors without having to choose a speed. To use this feature, simply press the arrow button that corresponds to the direction that you want to move the telescope. While holding that button down, press the opposite direction button. This will increase the speed to the maximum slew rate.

When using the hand control's up and down direction buttons, the slower slew rates (6 and lower) move the motors in the opposite direction than the faster slew rates (7- 9). This is done so that an object will move in the appropriate direction when looking into the eyepiece (i.e. pressing the **UP** arrow button will move the star upwards in the field of view of the eyepiece). However, if any of the slower slew rates (rate 6 and below) are used to center an object in the StarPointer, you may need to press the opposite directional button to make the telescope move in the correct direction.

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Celestron NexStar+ Hand Control
TROUBLESHOOTING GUIDE

This troubleshooting guide can help you resolve problems related to the Celestron NexStar+ Hand Control. Specifically, if you have a "No Response" error, "BOOT LOADER" error, or the hand control reports the improper telescope model, follow the instructions below to see if you can fix the problem on your own.

POSSIBLE PROBLEMS

PROBLEM #1

"No Response" Errors

The hand control displays No Response errors when plugged into the mount, and the mount is powered on.

- If the hand control displays No Response 16 **OR** No Response 17 (only one of these errors and not both), the problem is with the mount, not the hand control. Contact Celestron Technical Support at celestron.com/pages/technical-support for assistance.

- If the hand control displays **BOTH** No Response 16 and No Response 17, the problem could be with either the mount or the hand control.
    - If your mount has an AUX port(s), try plugging the hand control into the AUX port instead of the HC (hand control) port. If the No Response error goes away, there is a problem with your mount's HC port. You can still use the mount by plugging the hand control into one of the AUX ports.
    - There could be a problem with your power source providing too low voltage or current. Try using a different power source to see if the problem goes away.
    - Updating the hand control firmware with Celestron Firmware Manager may resolve the problem. We'll explain how in the next section.
- If using the Celestron Focus Motor, and the hand control displays No Response 18, then there is an issue with the focus motor not responding or not being detected by the hand control. If this occurs, try using CFM to update the hand control firmware to see if this resolves the issue. We'll explain how to do this in the next section.
    - If updating the hand control firmware does not resolve the No Response 18 error, then there may be a problem with the focus motor's cable or the focus motor itself. In this case, please contact Celestron Technical Support for further assistance.

PROBLEM #2:

Incorrect telescope model shown

The hand control does not display the No Response errors described above, but it does display an incorrect telescope model when plugged into the mount.

- **For EQ mounts,** the hand control displays "NexStar Ready" instead of the model of your EQ mount. If this happens, you will need to change the firmware using Celestron Firmware Manager. We'll explain how in the next section.

- **For AZ mounts,** the hand control displays "Advanced GT" instead of the model of your AZ mount. If this happens, you will need to change the firmware using Celestron Firmware Manager. We'll explain how in the next section.

PROBLEM #3:

BOOT LOADER Errors

Whenever the hand control is in the firmware boot loading mode, then "BOOT LOADER" will appear on the the top line of the LCD. The line below it will provide additional information, common examples include "User keypad request", "CFM request", "Pass Through Engine", and "Invalid Package".

In the case where the hand control is trapped in boot loader mode, for any error message save for "Invalid Package", simply power cycle the hand control to resolve the issue. To do this, the mount should be powered off, and if the hand control is connected to a PC via a cable, it should be physically disconnected from the computer. Then reconnect the hand control to the mount and turn the mount back on.

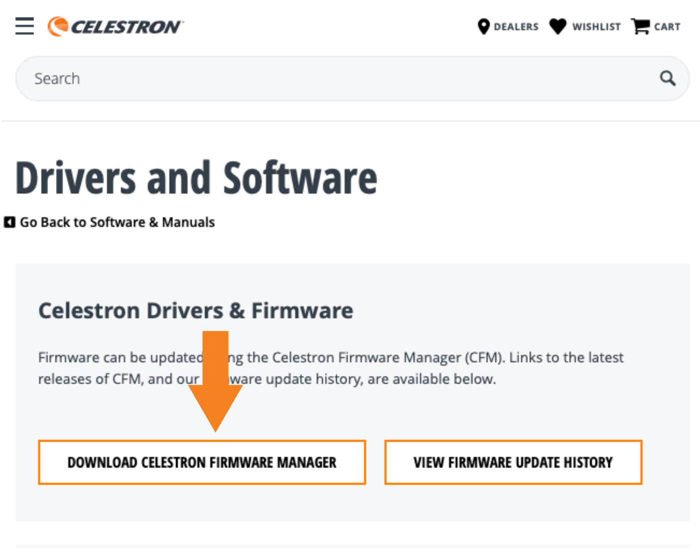
In the case where BOOT LOADER appears on the first line of the LCD and "Invalid Package" appears on the second line of the LCD, you will need to reprogram the hand control with the Celestron Firmware Manager. We'll explain how to do this in the next section.

Using Celestron Firmware Manager (CFM)

TO UPDATE THE NEXSTAR+ HAND CONTROL'S FIRMWARE

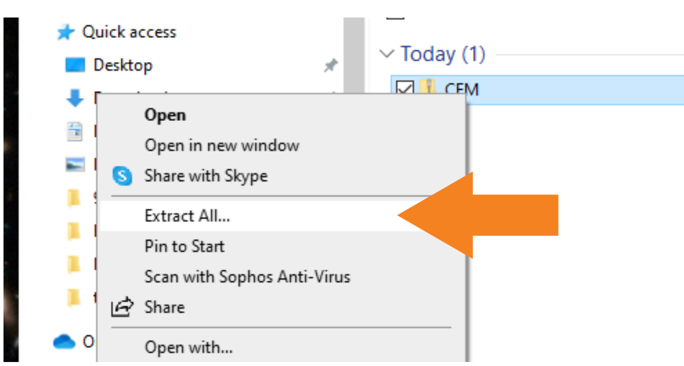
To update your hand control's firmware, you'll need to use Celestron Firmware Manager (CFM).

Visit www.celestron.com/pages/drivers-and-software to download CFM.

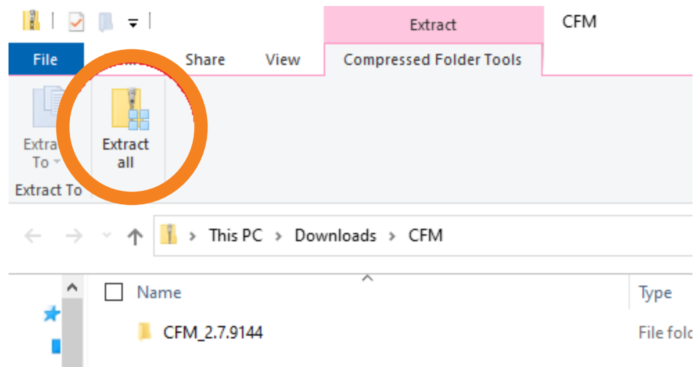


System Requirements:
- Java Runtime Engine (JRE) version 6 (or higher)
- Windows XP or higher
- Mac OS X (10.5) or higher
- Other operating systems should work but are untested

CFM is delivered in a compressed archive (.ZIP) file. CFM will not run from inside a compressed archive. You must extract (unzip) the archive to create an uncompressed folder before running CFM. For convenience, you can create a folder on your Desktop called "CFM" and then extract the files to that folder location. In Windows, right-click on the file and choose Extract. If you double click on the archive, you are not unpacking the archive, just looking inside it.



Alternatively, you can use the "Extract all" from the Compressed Folder Tools menu at the top of the screen.



Next, plug your hand control into your Celestron mount as you usually would and power on the mount. The hand control may report errors as described above. Connect your hand control to your computer.

- For most hand controls, there is a USB port on the bottom of the hand control for computer connection. You will need a USB cable (Type-A to Mini-B, USB 2.0 or greater).

- For older hand controls, there is a 4-pin modular jack on the bottom of the hand control for computer connection. This requires the Celestron #93920 NexStar RS-232 cable, which connects to the hand control and a serial port on your computer. If your computer does not have a serial port, then you will additionally need to purchase a USB-to-serial (RS-232) converter, available from many electronics retailers.

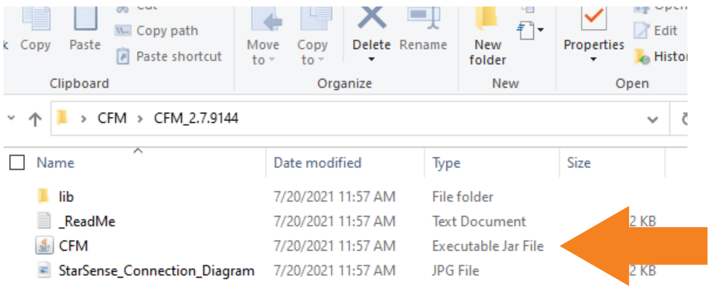
Once connected, the computer should recognize the hand control. If it does not, check your cable connections and try again.

If the hand control is still not recognized, you will need to manually install the required Prolific USB-Serial driver on your computer. In most cases, this driver will be automatically installed, but if using a Mac or an older PC operating system, manual installation may be required. To manually install the driver, click on the appropriate link below, download the .zip archive, extract the files from the .zip, then follow the directions found in the files. Once the driver is installed, the hand control should now be recognized by the computer.

Windows – www.prolific.com.tw/us/showproduct.aspx?p_id=225&pcid=41

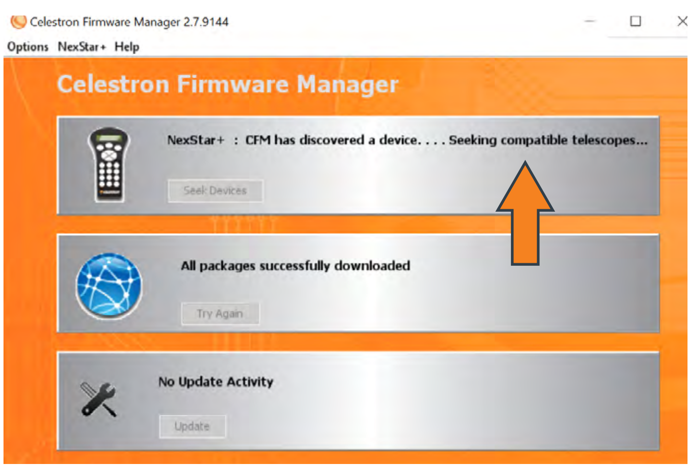
Mac OS – www.prolific.com.tw/us/showproduct.aspx?p_id=229&pcid=41

Open the folder that contains the extracted CFM files and double click the file called CFM.jar (Windows hides the .jar file extension by default).



If the "Can't Find Main Class" error appears, you are using an outdated version of Java, or you are running from inside the compressed archive. If you don't see anything when you start CFM, or you see the splash screen for just a moment before it quits, you have an outdated version of Java.

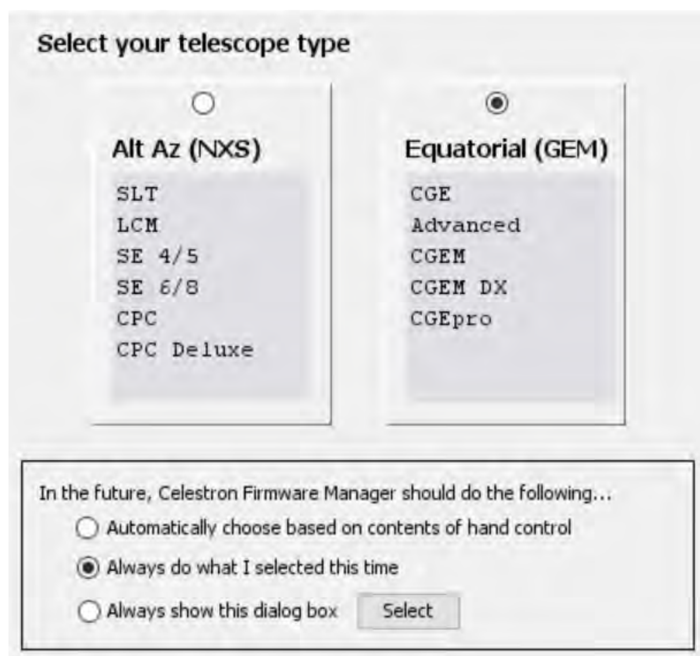
CFM will open and automatically seek any devices connected to the computer. Wait a few seconds, and CFM should discover the hand control.



If CFM does not discover the hand control automatically, check your cable connections and press "Seek Devices" in CFM. When CFM finds the hand control, the hand control will display "BOOT LOADER Serial Pass Through OFF."

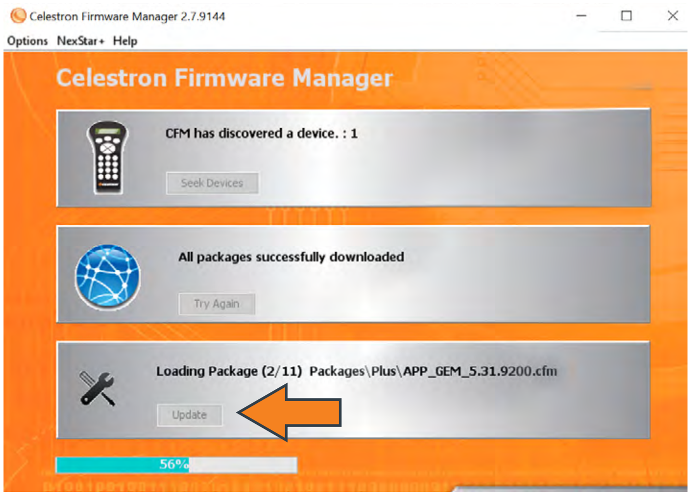
If the incorrect telescope model is displayed on the hand control (Problem #2 above), you can fix this from the NexStar+ menu in the top left of CFM. If the hand control displays No Response 16/17 errors (Problem #1 above), you can skip this step.

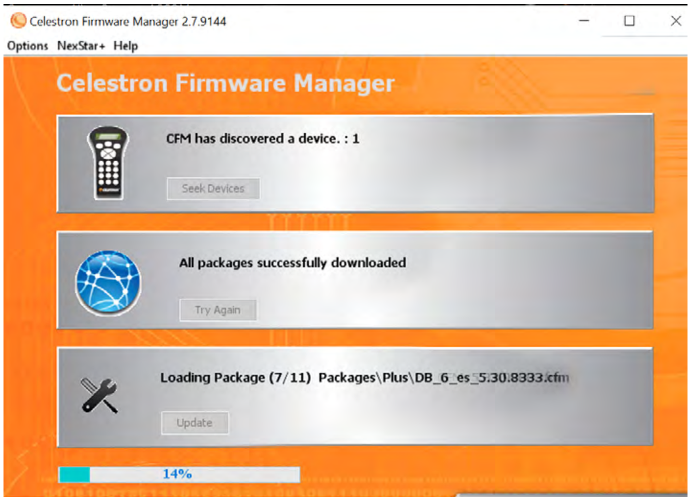
Select "Mount Types" from the menu, and the "Select your telescope type" window appears.



Find your mount and click on the corresponding "Alt Az (NXS)" box or "Equatorial (GEM)" box. Then, click on the "Always do what I selected this time" selection at the bottom of this window. Next, click the Select box at the bottom of the window to confirm your selections, and the window will close.

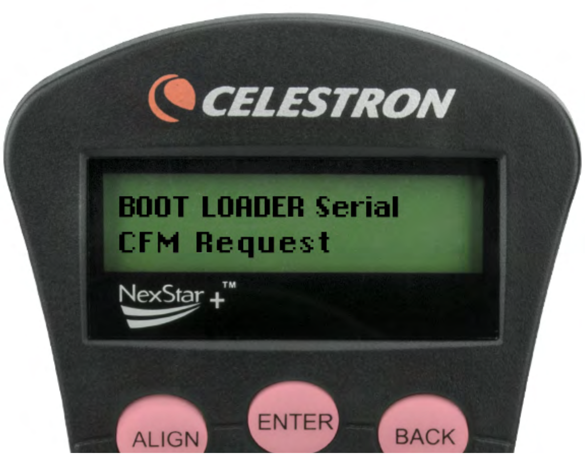
Now, click the "Update" button to begin updating your hand control.



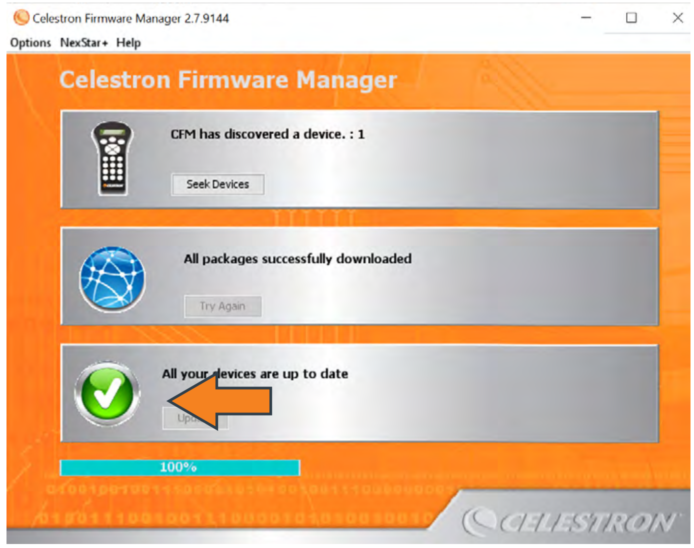


WARNING: Do not disconnect the hand control or power off the computer or mount while the update is in progress!

The hand control will display "BOOT LOADER Serial CFM Request" during the update.



When completed, CFM will report "All your devices are up to date," and a green circle with a checkmark will appear.



Your hand control is now updated.

NOTE: If there were problems during the firmware update, you would need to go through the process again. To do this, first, disconnect the hand control from the computer. Power cycle the mount and reconnect the hand control to the computer. Then click "Seek Devices" in CFM.

Once your hand control's firmware has been updated, you can disconnect the computer cable. Ensure the hand control is still connected to the mount, and power cycle the mount to see if the No Response 16/17 error or incorrect model error goes away. If it does, have fun using your telescope! If it does not, please contact Celestron Technical Support at celestron.com/pages/technical-support for further assistance.

CELESTRON®

INSTRUCTION MANUAL

NexStar® 6SE NexStar® 8SE

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Introduction

Congratulations on your purchase of the Celestron NexStar! The NexStar ushers in a whole new generation of computer automated technology. Simple and friendly to use, the NexStar is up and running after locating just three bright objects. It's the perfect combination of power and portability. If you are new to astronomy, you may wish to start off by using the NexStar's built-in Sky Tour feature, which commands the NexStar to find the most interesting objects in the sky and automatically slews to each one. Or if you are an experienced amateur, you will appreciate the comprehensive database of over 40,000 objects, including customized lists of all the best deep-sky objects, bright double stars and variable stars. No matter at what level you are starting out, the NexStar will unfold for you and your friends all the wonders of the Universe.

Some of the many standard features of the NexStar include:

- Incredible 5°/second slew speed.
- Fully enclosed motors and optical encoders for position location.
- Integrated hand controller – built into the side of the fork arm.
- Storage for programmable user defined objects; and

Many other high performance features!

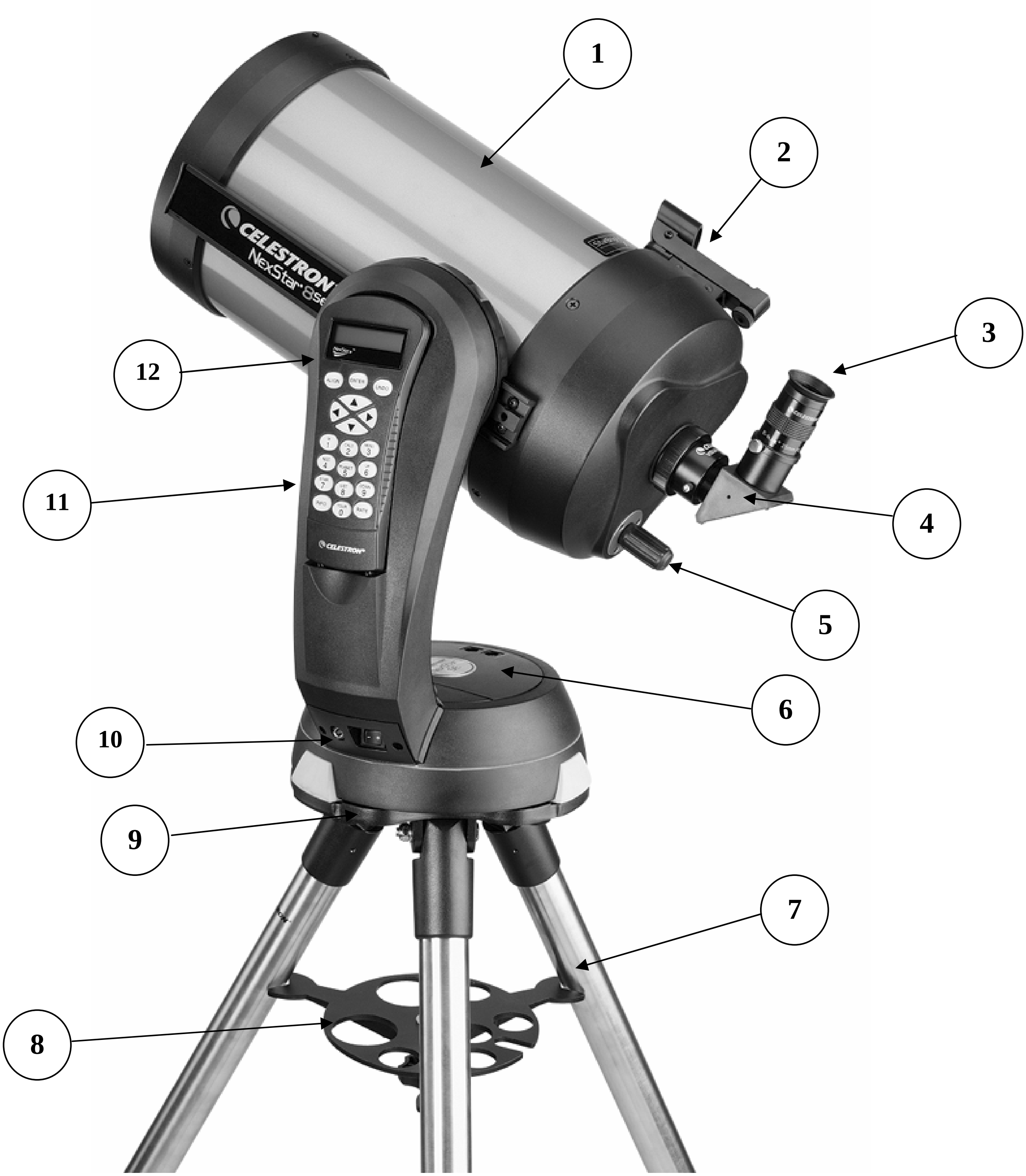
The NexStar's deluxe features combined with Celestron's legendary optical standards give amateur astronomers one of the most sophisticated and easy to use telescopes available on the market today.

Take time to read through this manual before embarking on your journey through the Universe. It may take a few observing sessions to become familiar with your NexStar, so you should keep this manual handy until you have fully mastered your telescope's operation. The NexStar hand control has built-in instructions to guide you through all the alignment procedures needed to have the telescope up and running in minutes. Use this manual in conjunction with the on-screen instructions provided by the hand control. The manual gives detailed information regarding each step as well as needed reference material and helpful hints guaranteed to make your observing experience as simple and pleasurable as possible.

Your NexStar telescope is designed to give you years of fun and rewarding observations. However, there are a few things to consider before using your telescope that will ensure your safety and protect your equipment.

Warning

- **Never look directly at the sun with the naked eye or with a telescope (unless you are using the proper solar filter). Permanent and 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	Optical Tube	7	Tripod
2	Star Pointer Finderscope	8	Accessory Tray / Leg Brace
3	Eyepiece	9	Tilt Wedge Plate
4	Star Diagonal	10	ON/OFF Switch
5	Focuser Knob	11	Hand Control
6	Battery Compartment	12	Liquid Crystal Display

NexStar 8 SE Shown

Assembly

The NexStar 8 comes completely pre-assembled and can be operational in a matter of minutes. The NexStar is conveniently packaged in one reusable shipping carton that contains all of the following accessories:

- 25mm Eyepiece – 1¼"
- Star Diagonal 1¼"
- Star Pointer Finderscope
- Adjustable Steel Tripod
- The Sky™ Level 1 Astronomy Software
- NexRemote telescope control software
- RS232 Cable
- Computerized Hand Control with over 40,000 Object Database

Assembling the NexStar

Start by removing the telescope from its shipping carton and setting the round base on a flat table or surface. It is best to carry the telescope by holding it from the lower portion of the fork arm and from the bottom of the base. Remove all of the accessories from their individual boxes. Remember to save all of the containers so that they can be used to transport the telescope. Before the batteries can be installed, the telescope tube should be positioned horizontal to the ground. To do this, gently rotate the front of the tube upwards until it is level with the ground.

Powering the NexStar

The NexStar can be powered by eight AA batteries (not included), an optional 12v AC adapter or an optional car battery adapter. The battery compartment is located in the center of the telescope's base (see figure 3-1).

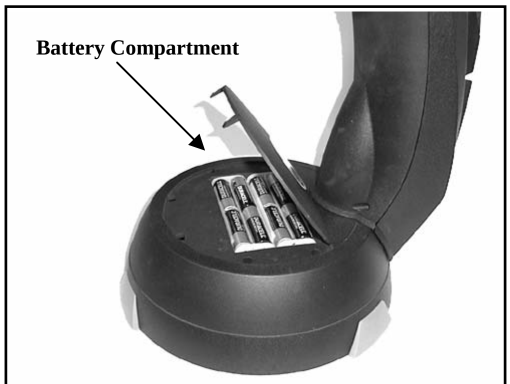


Figure 3-1: The NexStar can be powered with 8 AA batteries.

To power the NexStar with batteries:

1. Remove the battery cover from the center of the base by gently lifting up on the round portion of the cover.

2. Insert the batteries into the battery compartment of the base.

3. Reattach the battery compartment door by gently pushing down on the cover until it snaps into place.

4. Turn on the power to the NexStar by flipping the switch, located at the base of the fork arm, to the "On" position.

The Hand Control

The hand control is located on the side of the fork arm and can be removed and used remotely or used while attached to the fork. The hand control attaches to the fork arm by resting on two posts, located on the bottom of the hand control cradle, and a clip inside the fork arm. To remove the hand control from the fork arm cradle, gently lift the hand control upwards and pull out. To return the hand control into the fork arm, lower the hand control into the cradle so that the two holes in the bottom of the hand control go over the posts on the bottom of the cradle, and the opening in the back of the hand control slides over the clip inside the fork arm.

Once the telescope is powered up, the hand control can be used to move the optical tube in altitude (up and down) and azimuth (side to side). Use the Up arrow directional button to move the telescope tube until it is roughly parallel to the ground. This will make it more convenient to attach the necessary accessories as well as remove the front lens cover and install batteries when they are needed.

You are now ready to attach the included visual accessories onto the telescope optical tube.

The Star Diagonal

The star diagonal diverts the light at a right angle from the light path of the telescope. For astronomical observing, this allows you to observe in positions that are more comfortable than if you were to look straight through. To attach the star diagonal:

1. Turn the thumbscrew on the visual back until its tip no longer extends into (i.e., obstructs) the inner diameter of the visual back.

2. Slide the chrome portion of the star diagonal into the visual back.

3. Tighten the thumbscrew on the visual back to hold the star diagonal in place.

If you wish to change the orientation of the star diagonal, loosen the thumbscrew on the visual back until the star diagonal rotates freely. Rotate the diagonal to the desired position and tighten the thumbscrew.

Figure 3-2 - The visual accessories

The Eyepiece

The eyepiece, or ocular, is the optical element that magnifies the image focused by the telescope. The eyepiece fits into either the visual back directly or the star diagonal. To install the eyepiece:

1. Loosen the thumbscrew on the star diagonal so it does not obstruct the inner diameter of the eyepiece end of the diagonal.

2. Slide the chrome portion of the eyepiece into the star diagonal.

3. Tighten the thumbscrew to hold the eyepiece in place.

To remove the eyepiece, loosen the thumbscrew on the star diagonal and slide the eyepiece out.

Eyepieces are commonly referred to by focal length and barrel diameter. The focal length of each eyepiece is printed on the eyepiece barrel. The longer the focal length (i.e., the larger the number) the lower the eyepiece power or magnification; and the shorter the focal length (i.e., the smaller the number) the higher the magnification. Generally, you will use low-to-moderate power when viewing. For more information on how to determine power, see the section on “Calculating Magnification.”

Barrel diameter is the diameter of the barrel that slides into the star diagonal or visual back. The NexStar uses eyepieces with a standard 1-1/4" barrel diameter.

The Star Pointer Finderscope

The Star Pointer is the quickest and easiest way to point your telescope exactly at a desired object in the sky. It's like having a laser pointer that you can shine directly onto the night sky. The Star Pointer is a zero magnification pointing tool that uses a coated glass window to superimpose the image of a small red dot onto the night sky. While keeping both eyes open when looking through the Star Pointer, simply move your telescope until the red dot, seen through the Star Pointer, merges with the object as seen with your unaided eye. The red dot is produced by a light-emitting diode (LED); it is not a laser beam and will not damage the glass window or your eye. The Star Pointer comes equipped with a variable brightness control, two axes alignment control and a quick-release dovetail mounting bracket. Before the Star Pointer is ready to be used, it must be attached to the telescope tube and properly aligned:

Star Pointer Installation

1. Locate the dovetail mounting bracket on the rear cell of the optical tube.

2. Slide the mounting track at the bottom of the Star Pointer over the dovetail portion of the bracket. It may be necessary to loosen the two screws on the side of the mounting track before sliding it over the dovetail. The end of the Star Pointer with the glass window should be facing out towards the front of the telescope.

3. Tighten the two screws on the side of the mounting track to secure the Star Pointer to the dovetail bracket.

Star Pointer Operation

The star pointer is powered by a long life 3-volt lithium battery (#CR2032) located underneath the front portion of the Star Pointer. Like all finderscopes, the Star Pointer must be properly aligned with the main telescope before it can be used. This is a simple process using the azimuth and altitude control knobs located on the side and bottom of the Star Pointer. The alignment procedure is best done at night since the LED dot will be difficult to see during the day.

1. To turn on the Star Pointer, rotate the variable brightness control (see figure 3-3) clockwise until you here a "click". To increase the brightness level of the red dot, continue rotating the control knob about 180º until it stops. **Remember to remove the plastic cover over the battery, and always turn the power off after you have found an object. This will extend the life of both the battery and the LED.**

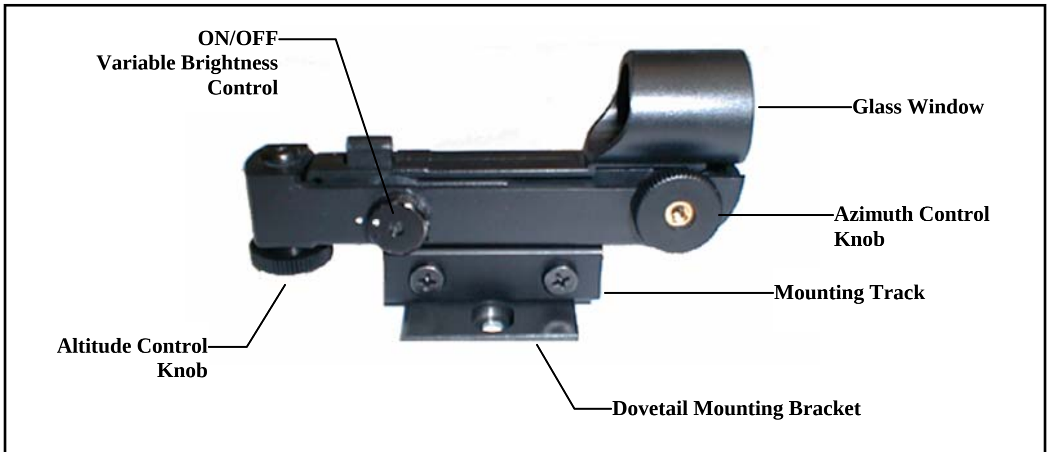


Figure 3-3: The Star Pointer Finderscope with Mounting Bracket

2. Locate a bright star or planet and center it in a low power eyepiece in the main telescope.

3. With both eyes open, look through the glass window at the alignment star.

4. If the Star Pointer is perfectly aligned, you will see the red LED dot overlap the alignment star. If the Star Pointer is not aligned, take notice of where the red dot is relative to the bright star.

5. Without moving the main telescope, turn the Star Pointer's azimuth and altitude alignment controls until the red dot is directly over the alignment star.

If the LED dot is brighter than the alignment star, it may make it difficult to see the star. Turn the variable brightness control counterclockwise, until the red dot is the same brightness as the alignment star. This will make it easier to get an accurate alignment. The Star Pointer is now ready to be used.

Removing the Optical Tube

The NexStar SE dovetailed quick release bracket allows you to adjust the optical tube for proper balancing or remove the tube for safe storage. To adjust or remove the tube from the base, simply loosen the quick release clamp knob (see figure 3-4) and slide the tube back towards the rear cell of the tube.

Figure 3-4

Attaching the NexStar to the Tripod

The Celestron NexStar tripod is a sturdy, heavy duty mount on which to place your NexStar 6/8" telescope. This tripod can go anywhere, from your backyard to a remote observing site. The tripod comes completely assembled and only needs to have the center leg brace / accessory tray put in place.

To set up the tripod:

1. Hold the tripod with the head up, away from the ground.
2. Pull the legs apart until the legs are fully extended and press it down flat against the ground.
3. Place the center leg brace over the center support rod.
4. Tighten with the leg brace locking knob until the leg brace firmly presses out against each leg.
5. The tripod will now stand by itself.

Your tripod has height adjustable legs for proper leveling on all types of surfaces. The tripod also comes with detached bubble level to assist in accurate leveling. To adjust the height and level the tripod:

1. Place the bubble level on the top of the tripod mounting plate.
2. Locate the tightening screw on the bottom of each tripod leg.
3. Rotate the knob counterclockwise until the inside portion of the tripod leg slides out.
4. Extend the center portion of the tripod leg to the desired height making sure that the bubble in the bubble level is centered.
5. Tighten the knob to hold the tripod leg in place.

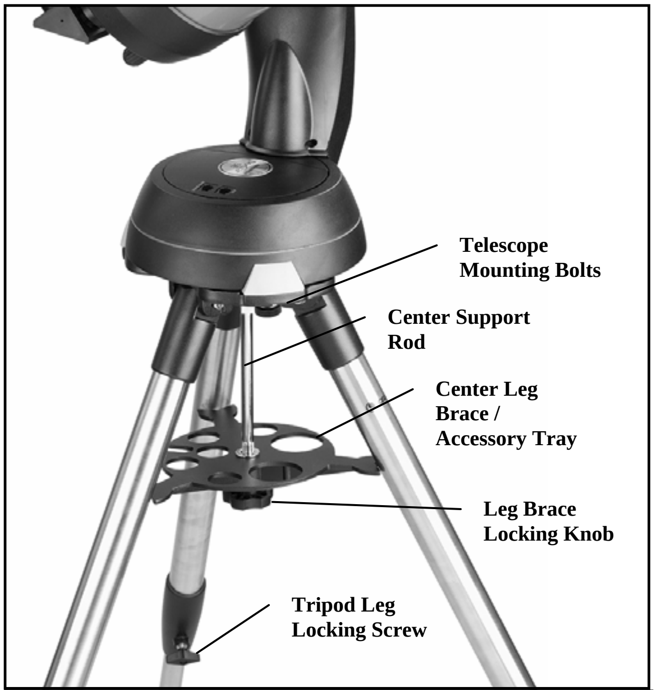


Figure 3-5

To mount the telescope on the tripod:

1. Set the base of the telescope on the tripod mounting plate so that the hole in the center of the base goes over the positioning pin on top of the tilt plate.
2. Rotate the base so the holes under each rubber foot line up with the mounting bolts attached to the tilt plate.
3. Thread in the mounting bolts into each hole of the telescope base.

Your NexStar is now securely attached to the tripod and ready for use.

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Hand Control

The NexStar has a removable hand controller built into the side of the fork arm designed to give you instant access to all the functions the NexStar has to offer. With automatic slewing to 40,000 objects, and common sense menu descriptions, even a beginner can master its variety of features in just a few observing sessions. Below is a brief description of the individual components of the NexStar hand controller:

1. **Liquid Crystal Display (LCD) Window:** Has a dual-line, 16 character display screen that is backlit for comfortable viewing of telescope information and scrolling text.
2. **Align:** Instructs the NexStar to use a selected star or object as an alignment position.
3. **Direction Keys:** Allows complete control of the NexStar in any direction. Use the direction keys to center objects in the StarPointer finderscope and eyepiece.

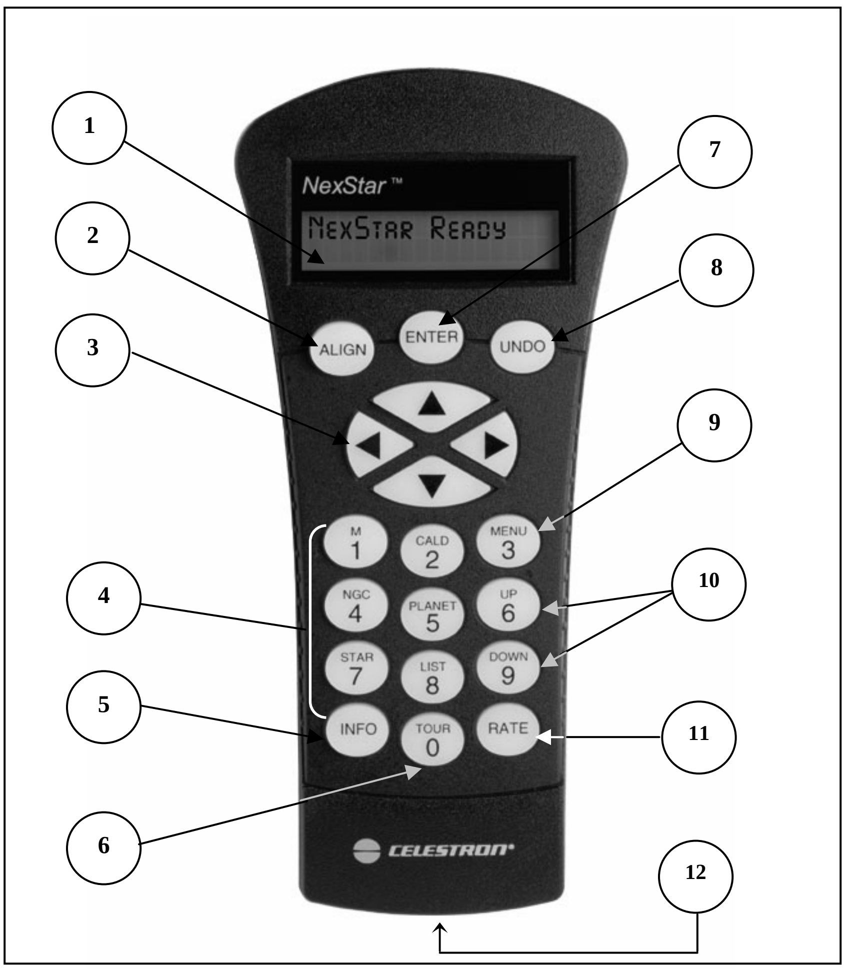


Figure 4-1
The NexStar Hand Control

4. **Catalog Keys:** The NexStar has a key on the hand control to allow direct access to each of the catalogs in its 40,000 object database. The NexStar contains the following catalogs in its database:

Messier – Complete list of all Messier objects.
NGC – Select list of all the deep-sky objects in the Revised New General Catalog.
Caldwell – A combination of the best NGC and IC objects.
Planets - All 8 planets in our Solar System plus the Moon and Sun.
Stars – A compiled list of the brightest stars from the SAO catalog.
List – For quick access, all of the best and most popular objects in the NexStar database have been broken down into lists based on their type and/or common name:

Named Stars	Common name listing of the brightest stars in the sky.
Named Objects	Alphabetical listing of over 50 of the most popular deep sky objects.
Double Stars	Numeric-alphabetical listing of the most visually stunning double, triple and quadruple stars in the sky.
Variable Stars	Select list of the brightest variable stars with the shortest period of changing magnitude.
Asterisms	A unique list of some of the most recognizable star patterns in the sky**.**

5. **Info*:*** Displays coordinates and useful information about objects selected from the NexStar database.
6. **Tour:** Activates the tour mode, which seeks out all the best objects for a given month and automatically slews the NexStar to those objects.
7. **Enter:** Pressing *Enter* allows you to select any of the NexStar functions, accept entered parameters and slew the telescope to displayed objects.
8. **Undo:** *Undo* will take you out of the current menu and display the previous level of the menu path. Press *Undo* repeatedly to get back to a main menu or use it to erase data entered by mistake.
9. **Menu:** Displays the many setup and utilities functions such as tracking rate and user defined objects and many others.
10. **Scroll Keys:** Used to scroll up and down within any of the menu lists. A double arrow symbol on the right side of the LCD indicates that the scroll keys can be used to view additional information.
11. **Rate:** Instantly changes the rate of speed of the motors when the direction buttons are pressed.
12. **RS-232 Jack**: Allows you to interface with a computer and control the NexStar remotely.

Hand Control Operation

This section describes the basic hand control procedures needed to operate the NexStar. These procedures are grouped into three categories: Alignment, Setup and Utilities. The alignment section deals with the initial telescope alignment as well as finding objects in the sky; the setup section discusses changing parameters such as tracking mode and tracking rate; finally, the last section reviews all of the utility functions such as adjusting the telescopes slew limits and backlash compensation.

Alignment Procedure

In order for the NexStar to accurately point to objects in the sky, it must first be aligned to known positions (stars) in the sky. With this information, the telescope can create a model of the sky, which it uses to locate any object with known coordinates. There are many ways to align the NexStar with the sky depending on what information the user is able to provide: **SkyAlign** uses your current date, time and city to create an accurate model of the sky. Then the user can simply point the telescope to any three bright celestial objects to accurately align the telescope with the sky. **Auto Two-Star Align** will ask the user to choose and center the first alignment star, then the NexStar will automatically select and slew to a second star for alignment. **Two-Star Alignment** requires the user to identify and manually slew the telescope to the two alignment stars. **One-Star Align** is the same as Two-Star Align however only requires you to align to one known star. Although not as accurate as the other alignment methods, One-Star Align is the quickest way to find and track bright planets and objects in Altazimuth mode. **Solar System Align** will display a list of visible daytime objects (planets and the moon) available to align the

Definition
"Altazimuth" or "Alt-Az" refers to a type of mounting that allows a telescope to move in both altitude (up and down) and azimuth (left and right) with respect to the ground. This is the simplest form of mounting in which the telescope is attached directly to a tripod.

telescope. Finally, **EQ North and EQ South** alignments are designed to assist you in aligning the NexStar when polar aligned using the tripods built-in wedge. Each alignment method is discussed in detail below.

Sky Align

Sky Align is the easiest way to get your NexStar aligned and ready to observe. Even if you do not know a single star in the sky, the NexStar will have you aligned in minutes by asking for basic information like the date, time and location. Then you simply need to aim the telescope to any three bright celestial objects in the sky. Since Sky Align requires no knowledge of the night sky it is not necessary to know the name of the stars at which you are aiming. You may even select a planet or the moon. The NexStar is then ready to start finding and tracking any of the objects in its object database. Before the telescope is ready to be aligned, it should be set up in an outside location with all accessories (eyepiece, diagonal and finderscope) attached and lens cover removed. Also make sure that the tripod is leveled as described in the Assembly section of the manual. To begin Sky Align:

1. Power on the NexStar by flipping the switch located at the base of the fork are to the "on" position.
2. Press ENTER to choose *Sky Align*. Pressing the ALIGN key will bypass the other alignment options and the scrolling text and automatically begins *Sky Align.*
3. The hand control display will then ask for the following time/site information:

Location - The NexStar will display a list of cities to choose from. Choose the city from the database that is closest to your current observing site. The city you choose will be remembered in the hand controls memory so that it will be automatically displayed the next time an alignment is done. Alternatively, if you know the exact longitude and latitude of your observing site, it can be entered directly into the hand control and remembered for future use as well. To choose a location city:

- ❑ Use the Up and Down scroll keys to choose between *City Database* and *Custom Site*. *City Database* will allow you to select the closest city to your observing site from a list of either international or U.S. location. *Custom Site* allows you to enter the exact longitude and latitude of your observing site. Select *City Database* and press ENTER.
- ❑ The hand control will allow you to choose from either U.S. or international locations. For a listing of U.S. locations by state and then by city, press ENTER while **United States** is displayed. For international locations, use the Up or Down scroll key to select **International** and press ENTER.
- ❑ Use the Up and Down Scroll buttons to choose your current state (or country if International locations was selected) from the alphabetical listing and press ENTER.
- ❑ Use the Up and Down Scroll buttons to choose the closest city to your location from the displayed list and press ENTER.

Time - Enter the current time for your area. You can enter either the local time (i.e. 8:00), or you can enter military time (i.e. 20:00).

- ❑ Select PM or AM. If military time was entered, the hand control will bypass this step.
- ❑ Choose between Standard time or Daylight Savings time. Use the Up and Down scroll buttons (10) to toggle between options.
- ❑ Select the time zone that you are observing from. Again, use the Up and Down buttons (10) to scroll through the choices. For time zone information, refer to the Time Zone map in the appendix of this manual.

Date - Enter the month, day and year of your observing session. The display will read: mm/dd/yy.

Helpful Hints

-If the wrong information has been input into the hand control, the UNDO button will act as a backspace allowing the user to re-enter information.

-The next time that your NexStar is aligned, the hand control will automatically display the last location (either a city or longitude/latitude) that was entered. Press ENTER to accept these parameters if they still apply. Pressing the UNDO button will allow you to go back and select a new city location or longitude/latitude.

4. Use the arrow buttons on the hand control to slew (move) the telescope towards any bright celestial object in the sky. Align the object with the red dot of the finderscope and press ENTER.

5. If the finderscope has been properly aligned with the telescope tube, the alignment star should now be visible inside the field of view of the eyepiece. The hand control will ask that you center the bright alignment star in the center of the eyepiece and press the ALIGN button. This will accept the star as the first alignment position. (There is no need to adjust the slewing rate of the motors after each alignment step. The NexStar automatically selects the best slewing rate for aligning objects in both the finderscope and the eyepiece).

6. For the second alignment object, choose a bright star or planet as far as possible from the first alignment object. Once again use the arrow button to center the object in the finderscope and press ENTER. Then once centered in the eyepiece press the ALIGN button.

7. Repeat the process for the third alignment star. When the telescope has been aligned to the final stars, the display will read "Match Confirmed". Press UNDO to display the names of the three bright objects you aligned to, or press ENTER to accept these three objects for alignment. You are now ready to find your first object.

Tips for Using Sky Align

Remember the following alignment guidelines to make using Sky Align as simple and accurate as possible.

- Be sure to level the tripod before you begin alignment. The time/site information along with a level tripod will help the telescope better predict the available bright stars and planets that are above the horizon.
- Remember to select alignment stars that are as far apart in the sky as possible. For best results make sure that the third alignment star does not lie in a straight line between the first two stars. This may result in a failed alignment.
- Don't worry about confusing planets for stars when selecting alignment objects. SkyAlign works with the four brightest planets (Venus, Jupiter, Saturn and Mars) as well as the Moon. In addition to the planets, the hand control has over 80 bright alignment stars to choose from (down to 2.5 magnitude).
- Rarely SkyAlign will not be able to determine what three alignment objects were centered. This sometime happens when a bright planet or the Moon passes near one of the brighter stars. In situations like these it is best to try to avoid aligning to either object if possible.
- Be sure to center the objects with the same final movements as the direction of the GoTo Approach. For example, if the scope normally finishes a GoTo with the front of the scope moving right and up, you should center all three alignment objects in the eyepiece using the right and up arrow buttons (the up/down arrows reverse at slew rates of 6 or lower). Approaching the star from this direction when looking through the eyepiece will eliminate much of the backlash between the gears and assure the most accurate alignment possible.

Auto Two-Star Align

As with Sky Align, Auto Two-Star Align requires you to enter all the necessary time/site information as before. Once this information is entered, NexStar will prompt you to select and point the telescope at one known star in the sky. The NexStar now has all the information it needs to automatically choose a second star that will assure the best possible alignment. Once selected the telescope will automatically slew to that second alignment star to complete the alignment. With the NexStar set up outside with all accessories attached and the tripod leveled, follow the steps below to align the telescope:

1. Once the NexStar is powered on , Press ENTER to begin alignment.

2. Use the Up and Down scroll keys (10) to select *Auto Two-Star Align* and press ENTER.

3. The hand control will display the last time and location information that was entered into the hand control. Use the Up and Down buttons to scroll through the information. Press ENTER to accept the current information or press UNDO to manually edit the information (see Sky Align section for detailed instruction on entering time/site information).

4. The display will now prompt you to select a bright star from the displayed list on the hand control. Use Up and Down buttons (6 and 9 on the keypad) to scroll to the desired star and then press ENTER.

5. Use the arrow buttons to slew the telescope to the star you selected. Center the star in the finderscope and press ENTER. Finally, center the star in the eyepiece and press ALIGN.

6. Based on this information, the NexStar will automatically display the most suitable second alignment star that is above the horizon. Press ENTER to automatically slew the telescope to the displayed star. If for some reason you do not wish to select this star (perhaps it is behind a tree or building), you can either:

- Press the UNDO button to display the next most suitable star for alignment.
- Use the UP and DOWN scroll buttons to manually select any star you wish from the entire list of available stars.

Once finished slewing, the display will ask you to use the arrow buttons to align the selected star with the red dot of the finderscope. Once centered in the finder, press ENTER. The display will then instruct you to center the star in the field of view of the eyepiece. When the star is centered, press ALIGN to accept this star as your second alignment star. When the telescope has been aligned to both stars the display will read `Align Success`, and you are now ready to find your first object.

Two Star Alignment

With the two-star alignment method, the NexStar requires the user to know the positions of two bright stars in order to accurately align the telescope with the sky and begin finding objects. Here is an overview of the two-star alignment procedure:

1. Once the NexStar is powered on, use the Up and Down scroll keys (10) to select Two-Star Align, and press ENTER.
2. Press ENTER to accept the time/site information displayed on the display, or press UNDO to enter new information.
3. The SELECT STAR 1 message will appear in the top row of the display. Use the Up and Down scroll keys (10) to select the star you wish to use for the first alignment star. Press ENTER.
4. NexStar then asks you to center in the eyepiece the alignment star you selected. Use the direction arrow buttons to slew the telescope to the alignment star and carefully center the star in the finderscope. Press ENTER when centered.
5. Then, center the star in the eyepiece and press ALIGN.

Helpful Hint

In order to accurately center the alignment star in the eyepiece, you may wish to decrease the slew rate of the motors for fine centering. This is done by pressing the RATE key (11) on the hand controller then selecting the number that corresponds to the speed you desire. (9 = fastest , 1 = slowest).

6. NexStar will then ask you to select and center a second alignment star and press the ALIGN key. It is best to choose alignment stars that are a good distance away from one another. Stars that are at least 40º to 60º apart from each other will give you a more accurate alignment than stars that are close to each other.

Once the second star alignment is completed properly, the display will read `Align Successful`, and you should hear the tracking motors turn-on and begin to track.

One-Star Align

One-Star Align requires you to input all the same information as you would for the Two-Star Align procedure. However, instead of slewing to two alignment stars for centering and alignment, the NexStar uses only one star to model the sky based on the information given. This will allow you to roughly slew to the coordinates of bright objects like the moon and planets and gives the NexStar the information needed to track objects in altazimuth in any part of the sky. One-Star Align is not meant to be used to accurately locate small or faint deep-sky objects or to track objects accurately for photography.

To use One-Star Align:

1. Select One-Star Align from the alignment options.
2. Press ENTER to accept the time/site information displayed on the display, or press UNDO to enter new information.
3. The SELECT STAR 1 message will appear in the top row of the display. Use the Up and Down scroll keys (10) to select the star you wish to use for the first alignment star. Press ENTER.
4. NexStar then asks you to center in the eyepiece the alignment star you selected. Use the direction arrow buttons to slew the telescope to the alignment star and carefully center the star in the finderscope. Press ENTER when centered.
5. Then, center the star in the eyepiece and press ALIGN.
6. Once in position, the NexStar will model the sky based on this information and display `Align Successful`.

Note: Once a One-Star Alignment has been done, you can use the Re-alignment feature (later in this section) to improve your telescope's pointing accuracy.

Solar System Align

Solar System Align is designed to provide excellent tracking and GoTo performance by using solar system objects (Sun, Moon and planets) to align the telescope with the sky. Solar System Align is a great way to align your telescope for daytime viewing as well as a quick way to align the telescope for night time observing.

Never look directly at the sun with the naked eye or with a telescope (unless you have the proper solar filter). Permanent and irreversible eye damage may result.

1. Select *Solar System Align* from the alignment options.
2. Press ENTER to accept the time/site information displayed on the display, or press UNDO to enter new information.
3. The SELECT OBJECT message will appear in the top row of the display. Use the Up and Down scroll keys (10) to select the daytime object (planet, moon etc) you wish to align. Press ENTER.
4. NexStar then asks you to center in the eyepiece the alignment object you selected. Use the direction arrow buttons to slew the telescope to the alignment object and carefully center it in the finderscope. Press ENTER when centered.
5. Then, center the object in the eyepiece and press ALIGN.

Once in position, the NexStar will model the sky based on this information and display `Align Successful`.

Tips for Using Solar System Align

- For safety purposes, the Sun will not be displayed in any of the hand control's customer object lists unless it is enabled from the Utilities Menu. To allow the Sun to be displayed on the hand control, do the following:

1. Press the UNDO button until the display reads "NexStar SE"
2. Press the MENU button and use the Up and Down keys to select the *Utilities menu*. Press ENTER.
3. Use the UP and Down keys to select *Sun Menu* and press ENTER.
4. Press ENTER again to allow the Sun to appear on the hand control display.

The Sun can be removed from the display by using the same procedure as above.

To improve the telescope pointing accuracy, you can use the Re-Align feature as described below.

EQ North / EQ South Alignment

EQ North and EQ South Alignments assist the user in aligning the telescope when polar aligned using an optional equatorial wedge. Similar to the Altazimuth alignments described earlier, the EQ alignments gives you the choice of performing an AutoAlign, Two-Star alignment, One-Star alignment or Solar System alignment. For help in polar aligning your NexStar, see the Astronomy Basics section later in the manual.

EQ AutoAlign

The EQ AutoAlign uses all the same time/site information as the Alt-Az alignments, however it also requires you to position the tube so that the altitude index markers are aligned (see figure 4-2), and then rotate the telescope base until the tube is pointed towards the Meridian (see figure 4-3). Based on this information the NexStar will automatically slew to two selected alignment stars to be centered and aligned. To use EQ Auto-Align:

1. Select EQ North or South Align from the alignment options and press ENTER
2. Press ENTER to accept the time/site information displayed on the display, or press UNDO to enter the time/site information manually.
3. Select EQ AutoAlign method and press ENTER
4. With *Set Alt to Index* displayed on the hand control screen, use the up and down arrow buttons to move the telescope tube upwards until the altitude index markers are aligned. The altitude index markers are located at the top of the fork arm. See figure 4-2.
5. When *Find Meridian* is displayed on the hand control screen, use the left and right arrow buttons to move the telescope base until optical tube is pointing towards the Meridian.
6. Based on this information, the NexStar will automatically display the most suitable alignment stars that are above the horizon. Press ENTER to automatically

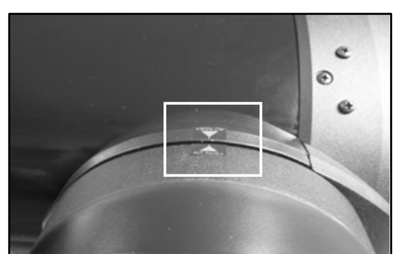


Figure 4-2 - Altitude Index Markers

slew the telescope to the displayed star. If for some reason you do not wish to select one of these stars (perhaps it is behind a tree or building), you can either:

- Press the UNDO button to display the next most suitable star for alignment.
- Use the UP and DOWN scroll buttons to manually select any star you wish from the entire list of available stars.

7. The telescope then asks you to center in the eyepiece the alignment object you selected. Use the direction arrow buttons to slew the telescope to the alignment object and carefully center it in the finderscope. Press ENTER when centered.
8. Then, center the object in the eyepiece and press ALIGN.
9. Once you press the ALIGN button the telescope will automatically slew to a second alignment star. Repeat steps 6 and 7 to complete alignment.

EQ Two-Star Align

The EQ Two-Star Align follows most of the same steps as the Alt-Az Two-Star Align. This alignment method does not require the user to align the altitude index markers or point towards the Meridian, but it does require the user to locate and align the telescope on two bright stars. When selecting alignment stars it is best to choose stars that, a) have a large separation in azimuth and b) both are either positive or negative in declination. Following these two guidelines will result in a more accurate EQ Two-Star alignment.

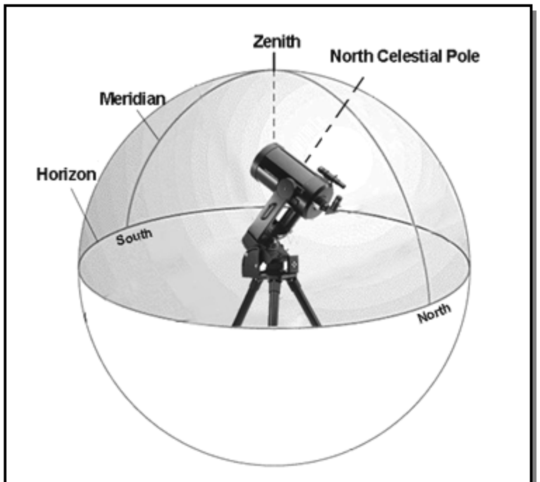


Figure 4-3
The Meridian is an imaginary line in the sky that starts at the North celestial pole and ends at the South celestial pole and passes through the zenith. If you are facing South, the meridian starts from your Southern horizon and passes directly overhead to the North celestial pole.

EQ One-Star Align

EQ One-Star Align operates much the same way as EQ Two-Star Align however it only relies on the alignment of one star to align the telescope. To use EQ One-Star Align follow steps 1 through 7 under the EQ Two-Star Align section.

EQ Solar System Align

This alignment method allows you use only one solar system object to equatorially align the telescope for daytime use. To align your telescope using a solar system object follow steps 1 through 7 under the EQ Two-Star Align section.

Improving Pointing Accuracy

The NexStar SE telescope has several options that allow you to improve the pointing accuracy of your mount in a variety of ways.

Alignment Stars:

Alignment stars allows you to replace any of the original alignment stars with a new star or celestial object. This will improve the pointing accuracy of your telescope without having to re-enter addition information.

To replace an existing alignment star with a new alignment star:

1. Select the desired star (or object) from the database and slew to it.
2. Once centered, press the UNDO button until you are at the main menu.
3. With NexStar SE displayed, press the ALIGN key on the hand control.
4. Use the Up/Down buttons and select the *Alignment S*tars option and press ENTER.
5. The display will then ask you which alignment star you want to replace. Use the UP and Down scroll keys to select the alignment star to be replaced and press ENTER. It is usually best to replace the star closest to the new object. This will space out your alignment stars across the sky.
6. Align the star in the center of the finderscope and press ENTER.
7. Carefully center the object in the center of the eyepiece and press ALIGN

Sync:

The Sync feature can be used to improve pointing accuracy in a specific region of the sky. Sync is a very useful feature especially when used in conjunction with the Constellation tour and Identify feature in which you will be exploring smaller areas of the sky. To Sync on an object:

1. Select the desired star (or object) from the database and slew to it.
2. Once centered, press the UNDO button until you are at the main menu.
3. With NexStar SE displayed, press the ALIGN key on the hand control.
4. Use the Up/Down buttons and select the Sync option and press ENTER.
5. Align the Sync object in the center of the finderscope and press ENTER.
6. Carefully center the object in the center of the eyepiece and press ALIGN.

Your telescope's pointing accuracy will now be improved in that area of the sky.

NOTE: *Sync* can improve your telescope's pointing accuracy over a wide area or over smaller areas of the sky depending on the quality of the initial alignment, as well as where the telescope was pointing when the *Sync* was done.

Undo Sync:

Since doing a Sync can affect your pointing accuracy in other parts of the sky, it may be necessary to 'Un-Sync" your telescope when exploring other parts of the sky. Doing an Undo Sync will restore the pointing of your telescope to its original alignment. Additionally, if you wish to add calibration stars or re-alignment stars you will be asked to do an Undo Sync before you will be able to proceed

Object Catalog

Selecting an Object

Now that the telescope is properly aligned, you can choose an object from any of the catalogs in the NexStar's database. The hand control has a key designated for each of the catalogs in its database. There are two ways to select objects from the database; scrolling through the named object lists and entering object numbers:

- Pressing the LIST key on the hand control will access all objects in the database that have common names or types. Each list is broken down into the following categories: Named Stars, Named Object, Double Stars, Variable Stars and Asterisms. Selecting any one of these options will display an alpha-numeric listing of the objects under that list. Pressing the Up and Down keys (10) allows you to scroll through the catalog to the desired object.
- Pressing any of the catalog keys (M, CALD, NGC, or STAR) will display a blinking cursor below the name of the catalog chosen. Use the numeric key pad to enter the number of any object within these standardized catalogs. For example, to find the Orion Nebula, press the "M" key and enter "042".
- Pressing the PLANET button will allow you to use the UP and DOWN arrow keys to scroll through and select the eight planets as well as the moon.

When scrolling through a long list of objects, holding down either the Up or Down key will allow you to scroll through the catalog at a rapid speed.

When entering the number for a SAO star, you are only required to enter the first four digits of the objects six digit SAO number. Once the first four digits are entered, the hand control will automatically list all the available SAO objects beginning with those numbers. This allows you to scroll through only the SAO stars in the database. For example, in searching for the SAO star 40186 (Capella), the first four digits would be "0401". Entering this number will display the closest match from the SAO stars available in the database. From there you can scroll down the list and select the desired object.

Slewing to an Object

Once the desired object is displayed on the hand control screen, you have two options:

- **Press the INFO Key**. This will give you useful information about the selected object such as magnitude, constellation and fascinating facts about many of the objects.

- **Press the ENTER Key**. This will automatically slew the telescope to the coordinates of the object. While the telescope is slewing to the object, the user can still access many of the hand control functions (such as displaying information about the object).

If you slew to an object that is below the horizon, NexStar will notify you by displaying a message reminding you that you have selected an object outside of your slew limits (see Slew Limits in the Scope Setup section of the manual). Press UNDO to go back and select a new object. Press ENTER to ignore the message and continue the slew. The NexStar hand control will only display objects that are below the horizon if the Filter Limits are set below 0º in altitude. See Filter Limits in the Utility Feature section of the manual for more information on setting the filter limits.

Caution: Never slew the telescope when someone is looking into the eyepiece. The telescope can move at fast slew speeds and may hit an observer in the eye.

Object information can be obtained without having to do a star alignment. After the telescope is powered on, pressing any of the catalog keys allows you to scroll through object lists or enter catalog numbers and view the information about the object as described above.

Finding Planets

The NexStar can locate all 8 of our solar systems planets plus the Sun and Moon. However, the hand control will only display the solar system objects that are above the horizon (or within its filter limits). To locate the planets, press the PLANET key on the hand control. The hand control will display all solar system objects that are above the horizon:

- Use the **Up and Down** keys to select the planet that you wish to observe.
- Press **INFO** to access information on the displayed planet.
- Press **ENTER** to slew to the displayed planet.

To allow the Sun to be displayed as an option in the database, see *Sun Menu* in the Utilities section of the manual.

Tour Mode

The NexStar includes a tour feature which automatically allows the user to choose from a list of interesting objects based on the date and time in which you are observing. The automatic tour will display only those objects that are within your set filter limits. To activate the Tour mode, press the TOUR key on the hand control. The NexStar will display the best objects to observe that are currently in the sky.

- To see information and data about the displayed object, press the INFO key.
- To slew to the object displayed, press ENTER.
- To see the next tour object, press the Down key.

Constellation Tour

In addition to the Tour Mode, the NexStar telescope has a Constellation Tour that allows the user to take a tour of all the best objects within a particular constellation. Selecting *Constellation* from the LIST menu will display all the constellation names that are above the user defined horizon (filter limits). Once a constellation is selected, you can choose from any of the database object catalogs to produce a list of all the available objects in that constellation.

- To see information and data about the displayed object, press the INFO key.
- To slew to the object displayed, press ENTER.
- To see the next tour object, press the Up key.

Direction Buttons

The NexStar has four direction buttons in the center of the hand control which control the telescope motion in altitude (up and down) and azimuth (left and right). The telescope can be controlled at nine different speed rates.

1 = .5x *2 = 1x* *3 = 4x* *4 = 8x* *5 = 16x*	*6 = 64x* *7 = 1º / sec* *8 = 3º / sec* *9 = 5º / sec*
Nine available slew speeds	

Rate Button

Pressing the RATE key (11) allows you to instantly change the speed rate of the motors from high speed slew rate to precise guiding rate or anywhere in between. Each rate corresponds to a number on the hand controller key pad. The number 9 is the fastest rate (5º per second, depending on power source) and is used for slewing between objects and locating alignment stars. The number 1 on the hand control is the slowest rate (.5x sidereal) and can be used for accurate centering of objects in the eyepiece. To change the speed rate of the motors:

- Press the RATE key on the hand control. The LCD will display the current speed rate.
- Press the number on the hand control that corresponds to the desired speed.

The hand control has a "double button" feature that allows you to instantly speed up the motors without having to choose a speed rate. To use this feature, simply press the arrow button that corresponds to the direction that you want to move the telescope. While holding that button down, press the opposite directional button. This will increase the speed to the maximum slew rate.

Setup Procedures

The NexStar contains many user defined setup functions designed to give the user control over the telescopes many advanced fea tures. All of the setup and utility features can be accessed by pressing the MENU key and scrolling through the options:

Tracking Mode - Once the NexStar is aligned the tracking motors will automatically turn on and begin tracking the sky. However, the tracking can be turned off for terrestrial use:

Alt-Az This is the default tracking rate and is used when the telescope is placed on a flat surface or tripod without the use of an equatorial wedge. The telescope must be aligned with two stars before it can track in Alt-Az.

EQ North Used to track the sky when the telescope is polar aligned using an equatorial wedge in the Northern Hemisphere.

EQ South Used to track the sky when the telescope is polar aligned using an equatorial wedge in the Southern Hemisphere.

Off When using the telescope for terrestrial (land) observation, the tracking can be turned off so that the telescope never moves.

Tracking Rate - In addition to being able to move the telescope with the hand control buttons, the NexStar will continually track a celestial object as it moves across the night sky. The tracking rate can be changed depending on what type of object is being observed:

Sidereal This rate compensates for the rotation of the earth by moving the telescope at the same rate as the rotation of the earth, but in the opposite direction. When the telescope is polar aligned, this can be accomplished by moving the telescope in Right Ascension only. When mounted in Alt-Az mode, the telescope must make corrections in both R.A. and declination.

Lunar Used for tracking the moon when observing the lunar landscape.

Solar Used for tracking the Sun when solar observing using a proper solar filter.

View Time-Site - *View Time-Site* will display the last saved time and longitude/latitude entered in the hand control.

User Defined Objects - The NexStar can store over 100 different user defined objects in its memory. The objects can be daytime land objects or an interesting celestial object that you discover that is not included in the regular database. There are several ways to save an object to memory depending on what type of object it is:

Save Sky Object: The NexStar stores celestial objects to its database by saving its right ascension and declination in the sky. This way the same object can be found each time the telescope is aligned. Once a desired object is centered in the eyepiece, simply scroll to the "Save Sky Obj" command and press ENTER. The display will ask you to enter a number between 1-99 to identify the object. Press ENTER again to save this object to the database.

Save Database (Db) Object: This feature allows you to create your own custom tour of database objects by allowing you to record the current position of the telescope and save the name of the object by selecting it from any one of the database catalogs. These objects then can be accessed by selecting *GoTo Sky Object.*

Save Land Object: The NexStar can also be used as a spotting scope on terrestrial objects. Fixed land objects can be stored by saving their altitude and azimuth relative to the location of the telescope at the time of observing. Since these objects are relative to the location of the telescope, they are only valid for that exact location. To save land objects, once again center the desired object in the eyepiece. Scroll down to the "Save Land Obj" command and press ENTER. The display will ask you to enter a number between 1-9 to identify the object. Press ENTER again to save this object to the database.

Enter R.A. - Dec: You can also store a specific set of coordinates for an object just by entering the R.A. and declination for that object. Scroll to the "Enter RA-DEC " command and press ENTER. The display will then ask you to enter first the R.A. and then the declination of the desired object.

GoTo Object: To go to any of the user defined objects stored in the database, scroll down to either GoTo Sky Obj or Goto Land Obj and enter the number of the object you wish to select and press ENTER. NexStar will automatically retrieve and display the coordinates before slewing to the object.

To replace the contents of any of the user defined objects, simply save a new object using one of the existing identification numbers; NexStar will replace the previous user defined object with the current one.

Get RA/DEC - Displays the right ascension and declination for the current position of the telescope.

Goto R.A/ Dec - Allows you to input a specific R.A. and declination and slew to it.

Identify

Identify Mode will search any of the NexStar database catalogs or lists and display the name and offset distances to the nearest matching objects. This feature can serve two purposes. First, it can be used to identify an unknown object in the field of view of your eyepiece. Additionally, *Identify Mode* can be used to find other celestial objects that are close to the objects you are currently observing. For example, if your telescope is pointed at the brightest star in the constellation Lyra, choosing *Identify* and then searching the *Named Star* catalog will no doubt return the star Vega as the star you are observing. However, by selecting *Identify* and searching by the *Named Object* or *Messier* catalogs, the hand control will let you know that the Ring Nebula (M57) is approximately 6° from your current position. Searching the Double Star catalog will reveal that Epsilon Lyrae is only 1° away from Vega. To use the *Identify* feature:

- Press the Menu button and select the Identify option.
- Use the Up/Down scroll keys to select the catalog that you would like to search.
- Press ENTER to begin the search.

Note: Some of the databases contain thousands of objects, and can therefore take a minute or two to return the closest object.

Precise GoTo

The NexStar has a precise goto function that can assist in finding extremely faint objects and centering objects closer to the center of the field of view for high power viewing or astrophotography. Precise Goto automatically searches out the closest bright star to the desired object and asks the user to carefully center it in the eyepiece. The hand control then calculates the small difference between its goto position and its centered position. Using this offset, the telescope will then slew to the desired object with enhanced accuracy. To use Precise Goto:

1. Press the MENU button and use the Up/Down keys to select *Precise Goto*.
   - Choose *Database* to select the object that you want to observe from any of the database catalogs listed
   - Choose *RA/DEC* to enter a set of celestial coordinates that you wish to slew to.
2. Once the desired object is selected, the hand control will search out and display the closest bright star to your desired object. Press ENTER to slew to the bright alignment star.
3. Use the direction buttons to carefully center the alignment star in the eyepiece.

Press ENTER to slew to the desired object.

Scope Setup Features

Setup Time-Site **-** Allows the user to customize the NexStar display by changing time and location parameters (such as time zone and daylight savings).

Anti-backlash – All mechanical gears have a certain amount of backlash or play between the gears. This play is evident by how long it takes for a star to move in the eyepiece when the hand control arrow buttons are pressed (especially when changing directions). The NexStar's anti-backlash feature allows the user to compensate for backlash by inputting a value which quickly rewinds the motors just enough to eliminate the play between gears. The amount of compensation needed depends on the slewing rate selected; the slower the slewing rate the longer it will take for the star to appear to move in the eyepiece. Therefore, the anti-backlash compensation will have to be set higher. You will need to experiment with different values; a value between 20 and 50 is usually best for most visual observing, whereas a higher value may be necessary for photographic guiding. Positive backlash compensation is applied when the mount changes its direction of movement from backwards to forwards. Similarly, negative backlash compensation is applied when the mount changes its direction of movement from forwards to backwards. When tracking is enabled, the mount will be moving in one or both axes in either the positive or negative direction, so backlash compensation will always be applied when a direction button is released and the direction moved is opposite to the direction of travel.

To set the anti-backlash value, scroll down to the anti-backlash option and press ENTER. Enter a value from 0-99 for both azimuth and altitude directions and press ENTER after each one to save these values. NexStar will remember these values and use them each time it is turned on until they are changed.

- **MENU**
  - **SCOPE SETUP**
    - **SETUP TIME-SITE**
    - **ANTI-BACKLASH**
      - *AZM POSITIVE*
      - *AZM NEGATIVE*
      - *ALT POSITIVE*
      - *ALT NEGATIVE*
    - **SLEW LIMITS**
      - *SLEW ALT MAX*
      - *SLEW ALT MIN*
    - **FILTER LIMITS**
      - *ALTMAX IN LIST*
      - *ALTMIN IN LIST*
    - **DIRECTION BUTTONS**
    - **GOTO APPROACH**
      - *AZM APPROACH*
      - *ALT APPROACH*
    - **AUTOGUIDE RATES**
      - *RA RATE*
      - *DEC RATE*
    - **CORDWRAP**
  - **UTILITIES**
    - **GPS ON/OFF**
    - **LIGHT CONTROL**
      - *KEYPAD*
      - *DISPLAY*
    - **FACTORY SETTING**
      - *PRESS UNDO*
      - *PRESS "0"*
    - **VERSION**
    - **GET AXIS POSITION**
    - **GOTO AXIS POSITION**
    - **HIBERNATE**
    - **SUN MENU**
    - **SCROLLING MENU**
    - **CALIBRATE GOTO**
    - **SET MOUNT POSITION**
    - **WEDGE ALIGN**

Slew Limits – Sets the limits in altitude that the telescope can slew without displaying a warning message. The slew limits prevent the telescope tube from slewing to an object below the horizon. The slew limits can be customized depending on your needs. For example, if you would like to slew to an object that is close to the zenith but you have a camera attached that prevents it from pointing straight up, you can set the maximum altitude to 80 or 85 degrees to prevent the tube from ever pointing straight up.

Filter Limits – When an alignment is complete, the NexStar automatically knows which celestial objects are above the horizon. As a result, when scrolling through the database lists (or selecting the Tour function), the NexStar hand control will display only those objects that are known to be above the horizon when you are observing. You can customize the object database by selecting altitude limits that are appropriate for your location and situation. For example, if you are observing from a mountainous location where the horizon is partially obscured, you can set your minimum altitude limit to read +20º. This will make sure that the hand control only displays objects that are higher in altitude than 20º.

Observing Tip!

If you want to explore the entire object database, set the maximum altitude limit to 90º and the minimum limit to –90º. This will display every object in the database lists regardless of whether it is visible in the sky from your location or not.

Direction Buttons –The direction a star moves in the eyepiece varies depending on the accessories being used. This can create confusion when guiding on a star using an off-axis guider versus a straight through guide scope. To compensate for this, the direction of the drive control keys can be changed. To reverse the button logic of the hand control, press the MENU button and select *Direction Buttons* from the Utilities menu. Use the Up/Down arrow keys (10) to select either the Azimuth buttons (left and right) or Altitude buttons (up and down) and press ENTER. Pressing ENTER again will reverse the direction of the hand control buttons from their current state. Direction Buttons will only change the eyepiece rates (rate 1-6) and will not affect the slew rates (rate 7-9).

Goto Approach - lets the user define the direction that the telescope will approach when slewing to an object. This allows the user the ability to minimize the affects of backlash For example, if your telescope is back heavy from using heavy optical or photographic accessories attached to the back, you would want to set your altitude approach to the negative direction. This would ensure that the telescope always approaches an object from the opposite direction as the load pulling on the scope. Similarly, if using the telescope while polar aligned, you would want to set the azimuth approach to the direction that allows the scope to compensate for different load level on the motors and gears when pointing in different parts of the sky.

To change the goto approach direction, simply choose *Goto Approach* from the *Scope Setup* menu, select either Altitude or Azimuth approach, choose positive or negative and press Enter.

Autoguide Rates- Allows the user to set an autoguide rate as a percentage of sidereal rate. This is helpful when calibrating your telescope to a CCD autoguider for long exposure photography.

Cordwrap - – Cord wrap safeguards against the telescope slewing more than 360º in azimuth and wrapping accessory or power cables around the base of the telescope. This is useful any time that cables are plugged into the base of the telescope. By default, the cord wrap feature is turned off when the telescope is aligned in altazimuth and turn on when aligned on a wedge.

Utility Features

Scrolling through the MENU options will also provide access to several advanced utility functions such as anti-backlash compensation and slew limits.

GPS On/Off - Allows you to turn on\off the GPS module when using the optional CN16 GPS accessory. When aligning the telescope, the NexStar still receives information, such as current time, from the optional GPS accessory. If you want to use the hand control database to find the coordinates of a celestial object for a future date you would need to turn the GPS module off in order to manually enter a date and time other than the present.

Light Control – This feature allows you to turn off both the red key pad light and LCD display for daytime use to conserve power and to help preserve your night vision.

Factory Setting – Returns the NexStar hand control to its original factory setting. Parameters such as backlash compensation values, initial date and time, longitude/latitude along with slew and filter limits will be reset. However, stored parameters such as user defined objects will remain saved even when *Factory Settings* is selected. The hand control will ask you to press the "0" key before returning to the factory default setting.

Version - Selecting this option will allow you to see the version number of the hand control software.

Get Axis Position - Displays the relative altitude and azimuth for the current position of the telescope.

Goto Axis Position - Allows you to enter a specific altitude and azimuth position and slew to it.

Hibernate - Hibernate allows the NexStar to be completely powered down and still retain its alignment when turned back on. This not only saves power, but is ideal for those that have their telescopes permanently mounted or leave their telescope in one location for long periods of time. To place your telescope in Hibernate mode:

1. Select Hibernate from the Utility Menu.
2. Move the telescope to a desire position and press ENTER.
3. Power off the telescope. Remember to never move your telescope manually while in Hibernate mode.

Once the telescope is powered on again the display will read Wake Up. After pressing Enter you have the option of scrolling through the time/site information to confirm the current setting. Press ENTER to wake up the telescope.

Helpful Hint

Pressing UNDO at the Wake Up screen allows you to explore many of the features of the hand control without waking the telescope up from hibernate mode. To wake up the telescope after UNDO has been pressed, select Hibernate from the Utility menu and press ENTER. Do not use the direction buttons to move the telescope while in hibernate mode.

Sun Menu

For safety purposes the Sun will not be displayed as a database object unless it is first enabled. The enable the Sun, go to the *Sun Menu* and press ENTER. The Sun will now be displayed in the Planets catalog as can be used as an alignment object when using the Solar System Alignment method. To remove the Sun from displaying on the hand control, once again select the Sun Menu from the Utilities Menu and press ENTER.

Scrolling Menu

This menus allows you to change the rate of speed that the text scrolls across the hand control display.

- Press the Up (number 6) button to increase the speed of the text.
- Press the Down (number 9) button to decrease the speed of the text.

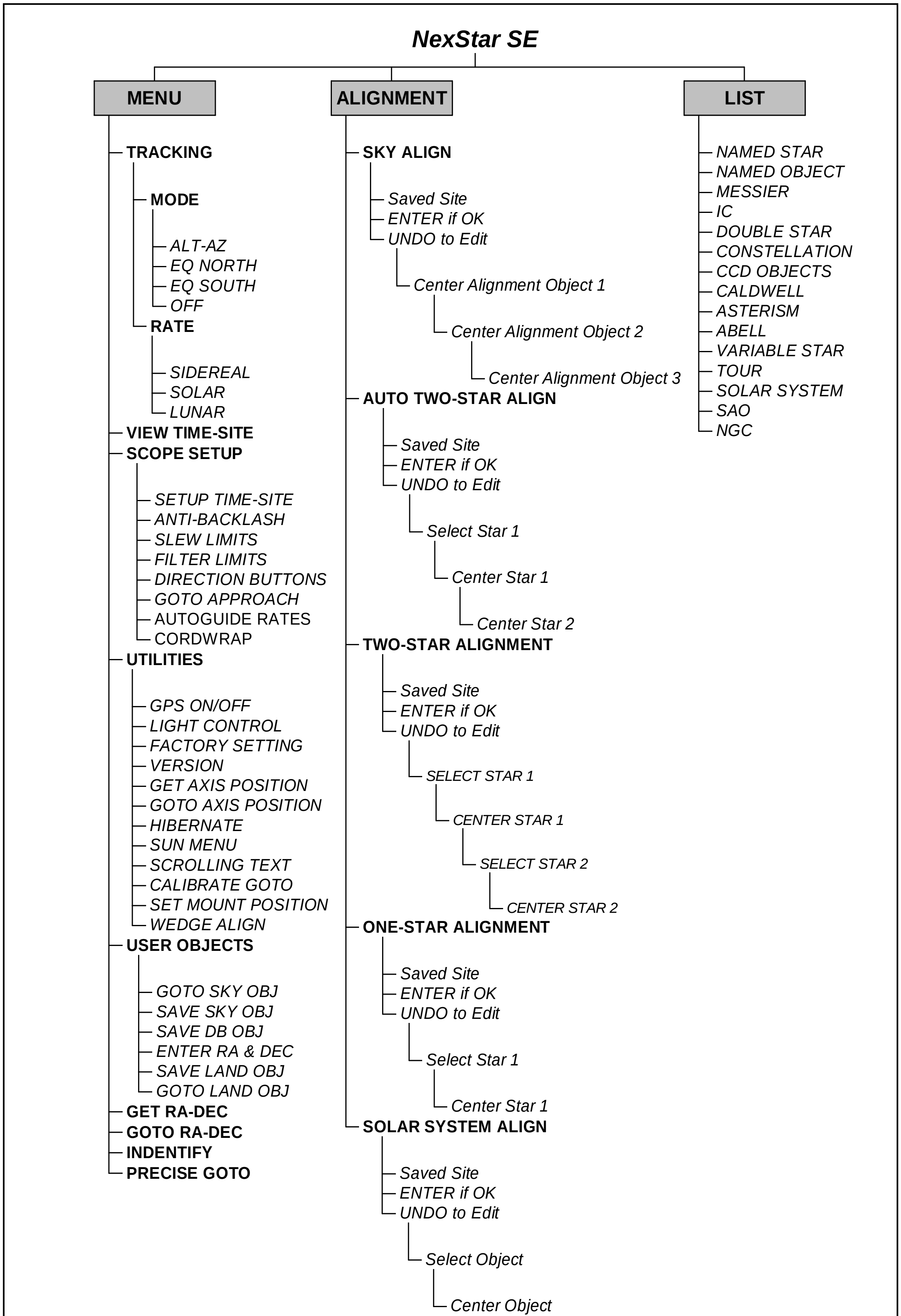
Calibrate Goto

Goto Calibration is a useful tool when attaching heavy visual or photographic accessories to the telescope. Goto Calibration calculates the amount of distance and time it takes for the mount to complete its final slow goto when slewing to an object. Changing the balance of the telescope can prolong the time it takes to complete the final slew. Goto Calibration takes into account any slight imbalances and changes the final goto distance to compensate.

Set Mount Position

The Set Mount Position menu can be used to recover an alignment in cases where the telescope or tripod has been manually moved. For instance, you might use this feature if you needed to adjust the level of the tripod by raising or lowering the tripod legs. After the mount has been moved, simply slew to a bright star and center it up in the eyepiece, then select *Set Mount Position* from the Utilities menu. Since the telescope has been moved, the pointing accuracy will be diminished. But now you can slew to a new set of alignment stars and replace any of the original alignment stars with the new stars. This will help you to avoid having to start the alignment process over from the beginning.

Wedge Align **–** The NexStar has two equatorial alignment modes (one for the northern hemisphere and one for the southern) that will help you to polar align your telescope when using an optional equatorial wedge. See the *Astronomy Basics* section of the manual for more information on the *Wedge Align* feature.



NexStar Menu Tree:
The following figure is a menu tree showing the sub-menus associated with the primary command functions

Telescope Basics

A telescope is an instrument that collects and focuses light. The nature of the optical design determines how the light is focused. Some telescopes, known as refractors, use lenses. Other telescopes, known as reflectors, use mirrors. The Schmidt-Cassegrain optical system (or Schmidt-Cass for short) uses a combination of mirrors and lenses and is referred to as a compound or catadioptric telescope. This unique design offers large-diameter optics while maintaining very short tube lengths, making them extremely portable. The Schmidt-Cassegrain system consists of a zero power corrector plate, a spherical primary mirror, and a secondary mirror. Once light rays enter the optical system, they travel the length of the optical tube three times.

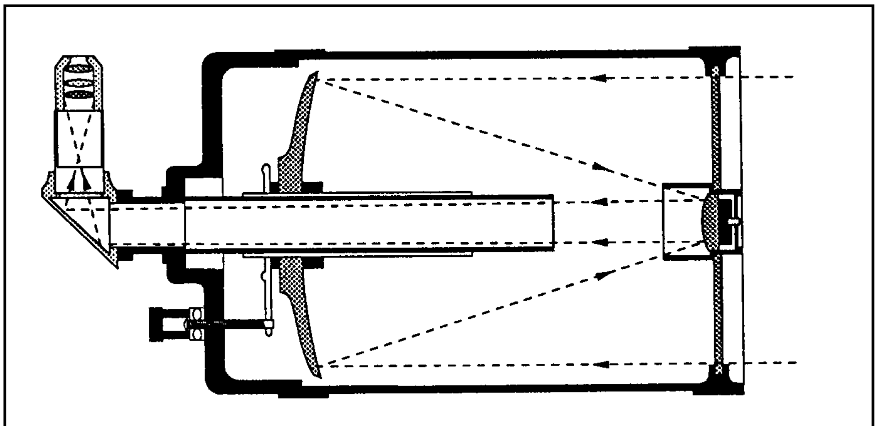


Figure 3-1
A cutaway view of the light path of the Schmidt-Cassegrain optical design

The optics of the NexStar have Starbright XLT coatings - enhanced multi-layer coatings on the primary and secondary mirrors for increased reflectivity and a fully coated corrector for the finest anti-reflection characteristics.

Inside the optical tube, a black tube extends out from the center hole in the primary mirror. This is the primary baffle tube and it prevents stray light from passing through to the eyepiece or camera.

Image Orientation

The image orientation changes depending on how the eyepiece is inserted into the telescope. When using the star diagonal, the image is right-side-up, but reversed from left-to-right (i.e., reverted). If inserting the eyepiece directly into the visual back (i.e., without the star diagonal), the image is upside-down and reversed from left-to-right (i.e., inverted). This is normal for the Schmidt-Cassegrain design.

Actual image orientation as seen with the unaided eye

Reversed from left to right, as viewed with a Star Diagonal

Inverted image, as viewed with the eyepiece directly in telescope

Figure 3-2

Focusing

The NexStar's focusing mechanism controls the primary mirror which is mounted on a ring that slides back and forth on the primary baffle tube. The focusing knob, which moves the primary mirror, is on the rear cell of the telescope just below the star diagonal and eyepiece. Turn the focusing knob until the image is sharp. If the knob will not turn, it has reached the end of its travel on the focusing mechanism. Turn the knob in the opposite direction until the image is sharp. Once an image is in focus, turn the knob clockwise to focus on a closer object and counterclockwise for a more distant object. A single turn of the focusing knob moves the primary mirror only slightly. Therefore, it will take many turns (about 30) to go from close focus (approximately 25 feet) to infinity.

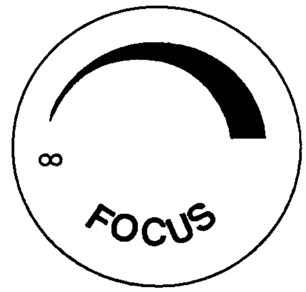


Figure 3-3
The emblem on the end of the focus knob shows the correct rotational direction for focusing the NexStar.

For astronomical viewing, out of focus star images are very diffuse, making them difficult to see. If you turn the focus knob too quickly, you can go right through focus without seeing the image. To avoid this problem, your first astronomical target should be a bright object (like the Moon or a planet) so that the image is visible even when out of focus. Critical focusing is best accomplished when the focusing knob is turned in such a manner that the mirror moves against the pull of gravity. In doing so, any mirror shift is minimized. For astronomical observing, both visually and photographically, this is done by turning the focus knob counterclockwise.

Calculating Magnification

You can change the power of your telescope just by changing the eyepiece (ocular). To determine the magnification of your telescope, simply divide the focal length of the telescope by the focal length of the eyepiece used. In equation format, the formula looks like this:

$$\text{Magnification} = \frac{\text{Focal Length of Telescope (mm)}}{\text{Focal Length of Eyepiece (mm)}}$$

Let's say, for example, you are using the 25mm eyepiece. To determine the magnification you simply divide the focal length of your telescope (the NexStar 8 has a focal length of 2000mm) by the focal length of the eyepiece, 25mm. Dividing 2000 by 25 yields a magnification of 80 power.

Although the power is variable, each instrument under average skies has a limit to the highest useful magnification. The general rule is that 60 power can be used for every inch of aperture. For example, the NexStar 8 is 8" in diameter. Multiplying 8 by 60 gives a maximum useful magnification of 480 power. Although this is the maximum useful magnification, most observing is done in the range of 20 to 35 power for every inch of aperture which is 160 to 280 times for the NexStar 8 telescope.

Determining Field of View

Determining the field of view is important if you want to get an idea of the angular size of the object you are observing. To calculate the actual field of view, divide the apparent field of the eyepiece (supplied by the eyepiece manufacturer) by the magnification. In equation format, the formula looks like this:

$$\text{True Field} = \frac{\text{Apparent Field of Eyepiece}}{\text{Magnification}}$$

As you can see, before determining the field of view, you must calculate the magnification. Using the example in the previous section, we can determine the field of view using the same 25mm eyepiece. The 25mm eyepiece has an apparent field of view of 52°. Divide the 52° by the magnification, which is 80 power. This yields an actual field of view of .65°.

To convert degrees to feet at 1,000 yards, which is more useful for terrestrial observing, simply multiply by 52.5. Continuing with our example, multiply the angular field .65° by 52.5. This produces a linear field width of 34 feet at a distance of one thousand yards. The apparent field of each eyepiece that Celestron manufactures is found in the Celestron Accessory Catalog (#93685).

General Observing Hints

When working with any optical instrument, there are a few things to remember to ensure you get the best possible image.

- Never look through window glass. Glass found in household windows is optically imperfect, and as a result, may vary in thickness from one part of a window to the next. This inconsistency can and will affect the ability to focus your telescope. In most cases you will not be able to achieve a truly sharp image, while in some cases, you may actually see a double image.

- Never look across or over objects that are producing heat waves. This includes asphalt parking lots on hot summer days or building rooftops.

- Hazy skies, fog, and mist can also make it difficult to focus when viewing terrestrially. The amount of detail seen under these conditions is greatly reduced. Also, when photographing under these conditions, the processed film may come out a little grainier than normal with lower contrast and underexposed.

- If you wear corrective lenses (specifically glasses), you may want to remove them when observing with an eyepiece attached to the telescope. When using a camera, however, you should always wear corrective lenses to ensure the sharpest possible focus. If you have astigmatism, corrective lenses must be worn at all times.

Astronomy Basics

Up to this point, this manual covered the assembly and basic operation of your NexStar telescope. However, to understand your telescope more thoroughly , you need to know a little about the night sky. This section deals with observational astronomy in general and includes information on the night sky and polar alignment.

The Celestial Coordinate System

To help find objects in the sky, astronomers use a celestial coordinate system that is similar to our geographical coordinate system here on Earth. The celestial coordinate system has poles, lines of longitude and latitude, and an equator. For the most part, these remain fixed against the background stars.

The celestial equator runs 360 degrees around the Earth and separates the northern celestial hemisphere from the southern. Like the Earth's equator, it bears a reading of zero degrees. On Earth this would be latitude. However, in the sky this is referred to as declination, or DEC for short. Lines of declination are named for their angular distance above and below the celestial equator. The lines are broken down into degrees, minutes of arc, and seconds of arc. Declination readings south of the equator carry a minus sign (-) in front of the coordinate and those north of the celestial equator are either blank (i.e., no designation) or preceded by a plus sign (+).

The celestial equivalent of longitude is called Right Ascension, or R.A. for short. Like the Earth's lines of longitude, they run from pole to pole and are evenly spaced 15 degrees apart. Although the longitude lines are separated by an angular distance, they are also a measure of time. Each line of longitude is one hour apart from the next. Since the Earth rotates once every 24 hours, there are 24 lines total. As a result, the R.A. coordinates are marked off in units of time. It begins with an arbitrary point in the constellation of Pisces designated as 0 hours, 0 minutes, 0 seconds. All other points are designated by how far (i.e., how long) they lag behind this coordinate after it passes overhead moving toward the west.

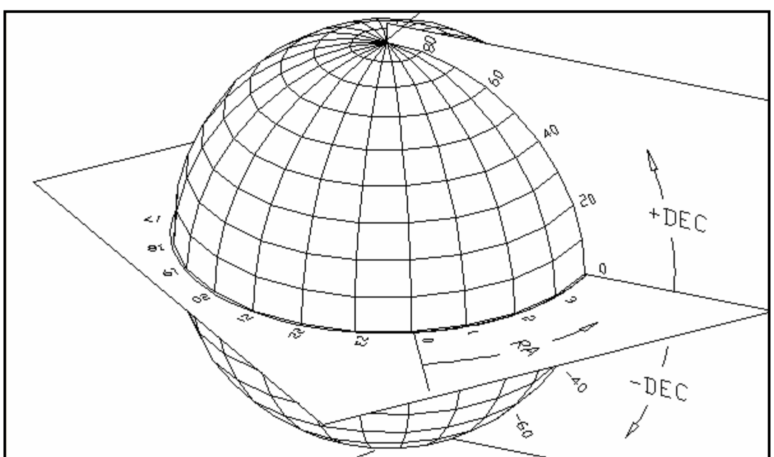


Figure 6-1
The celestial sphere seen from the outside showing R.A. and DEC.

Motion of the Stars

The daily motion of the Sun across the sky is familiar to even the most casual observer. This daily trek is not the Sun moving as early astronomers thought, but the result of the Earth's rotation. The Earth's rotation also causes the stars to do the same, scribing out a large circle as the Earth completes one rotation. The size of the circular path a star follows depends on where it is in the sky. Stars near the celestial equator form the largest circles rising in the east and setting in the west. Moving toward the north celestial pole, the point around which the stars in the northern hemisphere appear to rotate, these circles become smaller. Stars in the mid-celestial latitudes rise in the northeast and set in the northwest. Stars at high celestial latitudes are always above the horizon, and are said to be circumpolar because they never rise and never set. You will never see the stars complete one circle because the sunlight during the day washes out the starlight. However, part of this circular motion of stars in this region of the sky can be seen by setting up a camera on a tripod and opening the shutter for a couple hours. The processed film will reveal semicircles that revolve around the pole. (This description of stellar motions also applies to the southern hemisphere except all stars south of the celestial equator move around the south celestial pole.)

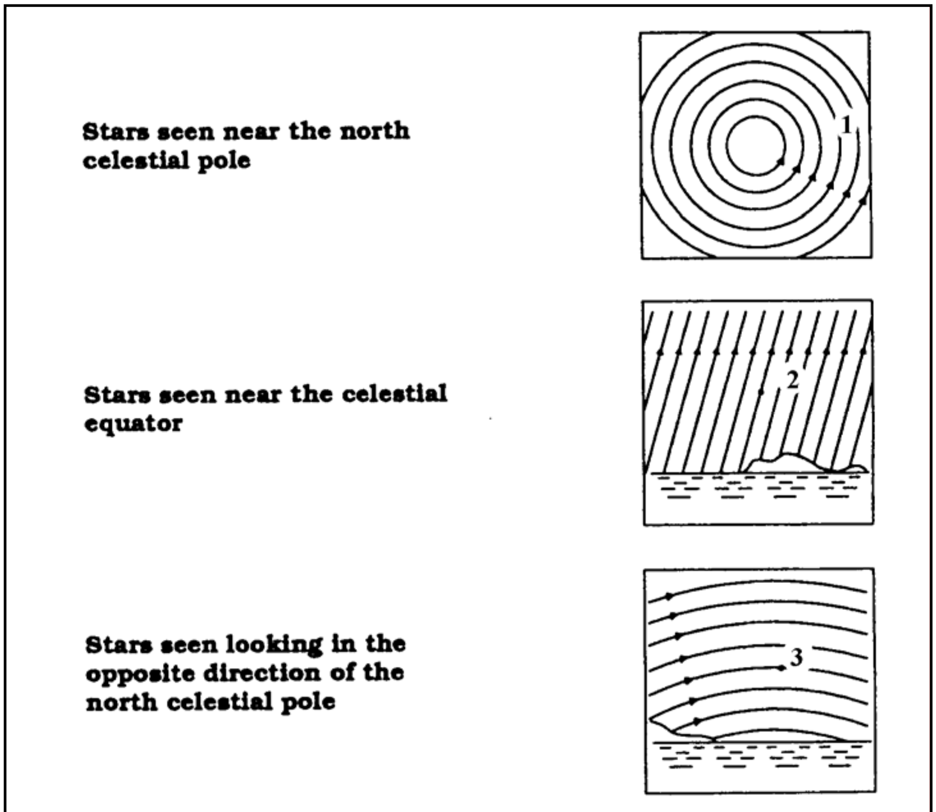


Figure 6-2
All stars appear to rotate around the celestial poles. However, the appearance of this motion varies depending on where you are looking in the sky. Near the north celestial pole the stars scribe out recognizable circles centered on the pole (1). Stars near the celestial equator also follow circular paths around the pole. But, the complete path is interrupted by the horizon. These appear to rise in the east and set in the west (2). Looking toward the opposite pole, stars curve or arc in the opposite direction scribing a circle around the opposite pole (3).

Polar Alignment

Even though the NexStar can precisely track a celestial object while in the Alt-Az position, it is still necessary to align the polar axis of the telescope (the fork arm) to the Earth's axis on rotation in order to attempt long exposure astro photography. This is accomplished by using the built-in wedge attached to the steel tripod. This allows the telescope's tracking motors to rotate the telescope around the celestial pole, the same way as the stars. Without the equatorial wedge, you would notice the stars in the eyepiece would slowly rotate around the center of the field of view. Although this gradual rotation would go unnoticed when viewing with an eyepiece, it would be very noticeable on film.

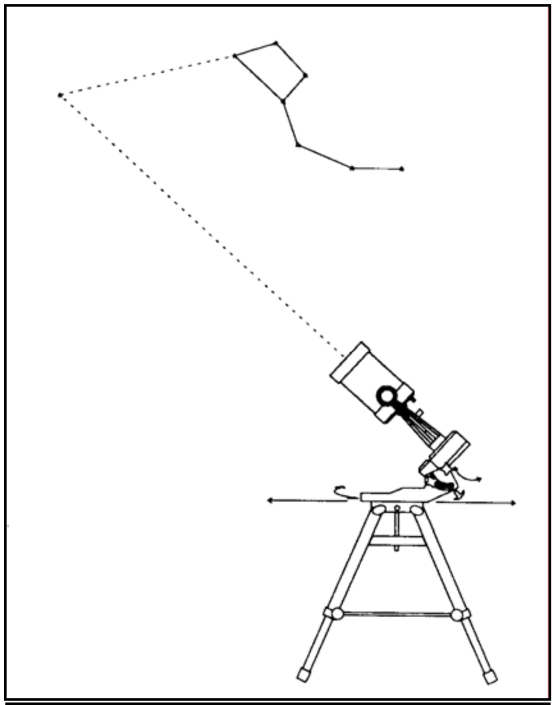


Figure 6-3
This is how the telescope is to be set up for polar alignment. The tube should be parallel to the fork arm which should be pointed to Polaris.

Polar alignment is the process by which the telescope's axis of rotation (called the polar axis) is aligned (made parallel) with the Earth's axis of rotation. Once aligned, a telescope with a clock drive will track the stars as they move across the sky. The result is that objects observed through the telescope appear stationary (i.e., they will not drift out of the field of view). If not using the clock drive, all objects in the sky (day or night) will slowly drift out of the field. This motion is caused by the Earth's rotation.

Definition

The polar axis is the axis around which the telescope rotates when moved in right ascension. This axis points the same direction even when the telescope moves in right ascension and declination.

Polar Alignment (with optional Wedge)

The simplest way to get a basic polar alignment with your NexStar is to angle the tilt plate on the equatorial wedge accessory so that the fork arm (or polar axis) is pointed towards the star Polaris. For help in locating Polaris, refer to the Finding the North Celestial Pole section below. To polar align your NexStar:

1. Position the telescope tripod so that tilt plate hinge is facing towards north.
2. Gently rotate the telescope tube so that it is pointing straight up in the sky.
3. Loosen the Latitude Adjustment Lock on the tripod.
4. Slowly tilt the telescope towards the north until the scale on the Latitude Adjustment Rod is equal to the latitude of your observing location. For example, if using your telescope from Los Angeles, you would set the scale to 34 degrees.

Note: To view your current latitude, select View Time-Site menu feature after completing a successful alignment.

5. Once in position, securely tighten the latitude adjustment lock to hold the telescope in place.

You are now ready to complete an *EQ North (South) Alignment* to begin finding celestial objects and a *Wedge Align* for a more accurate polar alignment.

Wedge Align

The NexStar has two equatorial wedge alignment modes (one for the northern hemisphere and one for the southern) that will help you polar align your telescope when using an optional equatorial wedge. After performing either an EQ AutoAlign or Two-Star Alignment, Wedge Align will slew the telescope to where Polaris should be. By adjusting the tripod's tilt plate to center Polaris in the eyepiece, the fork arm (polar axis) will then be pointing towards the actual North Celestial Pole. Once Wedge Align is complete, you must re-align your telescope using any of the EQ alignment methods. Follow these steps to Wedge Align your telescope in the Northern Hemisphere:

1. With the NexStar set up as described in the section above and roughly positioned towards Polaris, align the telescope using either the EQ AutoAlign or Two-Star Alignment method.

2. Select *Wedge Align* from the Utilities menu and press Enter.

Based on your current alignment, NexStar will slew to where it thinks Polaris should be. Use the tripod's tilt plate adjustment to place Polaris in the center of the eyepiece. Do not use the hand control's direction buttons to position Polaris. Once Polaris is centered in the eyepiece, press ENTER; the polar axis should then be pointed towards the North Celestial Pole.

Photography with the NexStar

After looking at the night sky for a while you may want to try photographing it. In addition to the specific accessories required for celestial photography, there is the need for a camera - but not just any camera. The camera does not have to have many of the features offered on today's state-of-the-art equipment. For example, you don't need auto focus capability or mirror lock up. Here are the mandatory features a camera needs for celestial photography. First, a "B" setting which allows for time exposures. This excludes point and shoot cameras and limits the selection to SLR cameras, the most common type of 35mm camera on the market today.

Second, the "B" or manual setting should NOT run off the battery. Many new electronic cameras use the battery to keep the shutter open during time exposures. Once the batteries are drained, usually after a few minutes, the shutter closes, whether you were finished with the exposure or not. Look for a camera that has a manual shutter when operating in the time exposure mode. Olympus, Nikon, Minolta, Pentax, Canon and others have made such camera bodies.

The camera must have interchangeable lenses so you can attach it to the telescope and so you can use a variety of lenses for piggyback photography. If you can't find a new camera, you can purchase a used camera body that is not 100-percent functional. The light meter, for example, does not have to be operational since you will be determining the exposure length manually.

You also need a cable release with a locking function to hold the shutter open while you do other things. Mechanical and air release models are available.

Attaching a Camera to the NexStar

Attaching a camera to the NexStar requires the use of the optional T-adapter (#93633-A) and a T-ring specific to the brand of camera being used. See *Optional Accessories* section in this manual. To attach the photographic accessories:

1. Remove the visual back from the rear cell .
2. Thread the T-adapter securely onto the rear cell of the telescope.
3. Thread the T-ring onto the exposed end of the T-adapter.
4. Remove any lens from the body of your camera.
5. Attach the camera body to the T-ring by aligning the dot on the side of the T-ring with the dot on the camera body and twisting.

Finding the North Celestial Pole

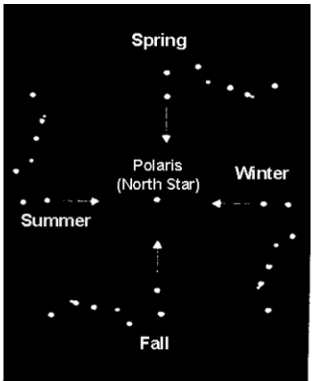


Figure 6-6
The position of the Big Dipper changes throughout the year and the night.

In each hemisphere, there is a point in the sky around which all the other stars appear to rotate. These points are called the celestial poles and are named for the hemisphere in which they reside. For example, in the northern hemisphere all stars move around the north celestial pole. When the telescope's polar axis is pointed at the celestial pole, it is parallel to the Earth's rotational axis.

Many methods of polar alignment require that you know how to find the celestial pole by identifying stars in the area. For those in the northern hemisphere, finding the celestial pole is not too difficult. Fortunately, we have a naked eye star less than a degree away. This star, Polaris, is the end star in the handle of the Little Dipper. Since the Little Dipper (technically called Ursa Minor) is not one of the brightest constellations in the sky, it may be difficult to locate from urban areas. If this is the case, use the two end stars in the bowl of the Big Dipper (the pointer stars). Draw an imaginary line through them toward the Little Dipper. They point to Polaris (see Figure 6-6). The position of the Big Dipper changes during the year and throughout the course of the night (see Figure 6-6). When the Big Dipper is low in the sky (i.e., near the horizon), it may be difficult to locate. During these times, look for Cassiopeia (see Figure 6-6). Observers in the southern hemisphere are not as fortunate as those in the northern hemisphere. The stars around the south celestial pole are not nearly as bright as those around the north. The closest star that is relatively bright is Sigma Octantis. This star is just within naked eye limit (magnitude 5.5) and lies about 59 arc minutes from the pole.

Definition *The north celestial pole is the point in the northern hemisphere around which all stars appear to rotate. The counterpart in the southern hemisphere is referred to as the south celestial pole.*

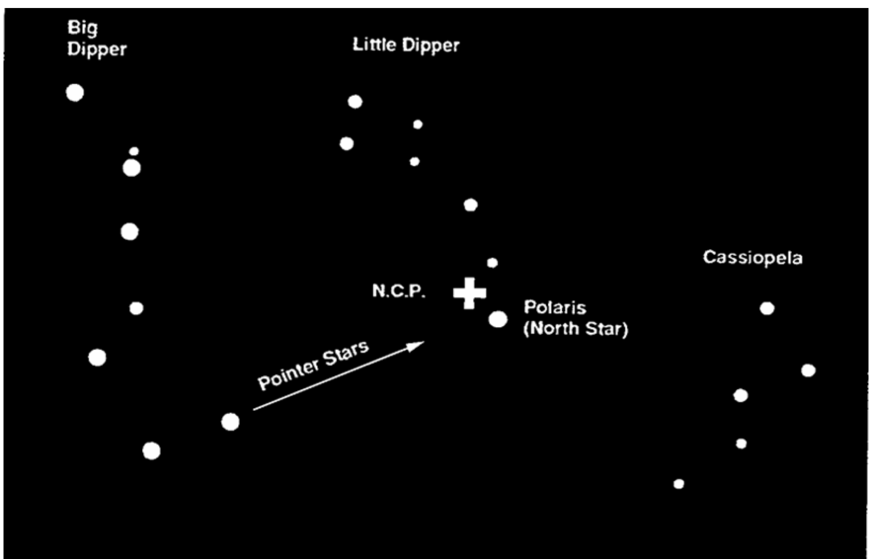


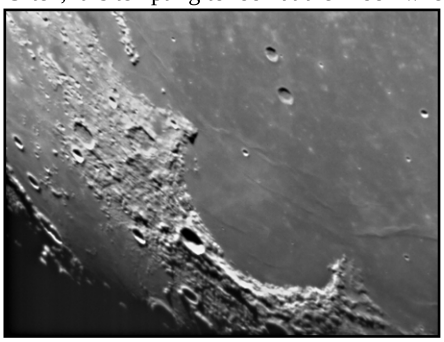
Figure 6-7
The two stars in the front of the bowl of the Big Dipper point to Polaris which is less than one degree from the true (north) celestial pole. Cassiopeia, the "W" shaped constellation, is on the opposite side of the pole from the Big Dipper. The North Celestial Pole (N.C.P.) is marked by the "+" sign.

Celestial Observing

With your telescope set up, you are ready to use it for observing. This section covers visual observing hints for both solar system and deep sky objects as well as general observing conditions which will affect your ability to observe.

Observing the Moon

Often, it is tempting to look at the Moon when it is full. At this time, the face we see is fully illuminated and its light can be overpowering. In addition, little or no contrast can be seen during this phase.



One of the best times to observe the Moon is during its partial phases (around the time of first or third quarter). Long shadows reveal a great amount of detail on the lunar surface. At low power you will be able to see most of the lunar disk at one time. Change to higher power (magnification) to focus in on a smaller area. Choose the *lunar* tracking rate from the NexStar's MENU tracking rate options to keep the moon centered in the eyepiece even at high magnifications.

Lunar Observing Hints

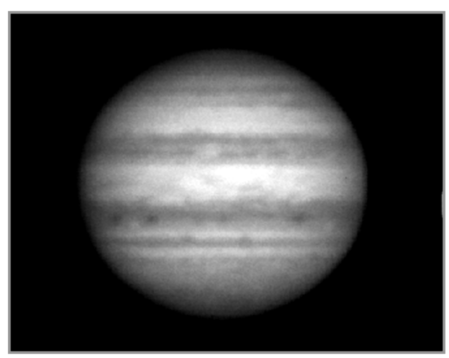
- To increase contrast and bring out detail on the lunar surface, use filters. A yellow filter works well at improving contrast while a neutral density or polarizing filter will reduce overall surface brightness and glare.

Observing the Planets

Other fascinating targets include the five naked eye planets. You can see Venus go through its lunar-like phases. Mars can reveal a host of surface detail and one, if not both, of its polar caps. You will be able to see the cloud belts of Jupiter and the great Red Spot (if it is visible at the time you are observing). In addition, you will also be able to see the moons of Jupiter as they orbit the giant planet. Saturn, with its beautiful rings, is easily visible at moderate power.

Planetary Observing Hints

- Remember that atmospheric conditions are usually the limiting factor on how much planetary detail will be visible. So, avoid observing the planets when they are low on the horizon or when they are directly over a source of radiating heat, such as a rooftop or chimney. See the "*Seeing Conditions*" section later in this section.
- To increase contrast and bring out detail on the planetary surface, try using Celestron eyepiece filters.



Observing the Sun

Although overlooked by many amateur astronomers, solar observation is both rewarding and fun. However, because the Sun is so bright, special precautions must be taken when observing our star so as not to damage your eyes or your telescope.

Never project an image of the Sun through the telescope. Because of the folded optical design, tremendous heat build-up will result inside the optical tube. This can damage the telescope and/or any accessories attached to the telescope.

For safe solar viewing, use a Celestron solar filter (see *Optional Accessories* section of manual) that reduces the intensity of the Sun's light, making it safe to view. With a filter you can see sunspots as they move across the solar disk and faculae, which are bright patches seen near the Sun's edge.

Solar Observing Hints

- The best time to observe the Sun is in the early morning or late afternoon when the air is cooler.
- To center the Sun without looking into the eyepiece, watch the shadow of the telescope tube until it forms a circular shadow.
- To ensure accurate tracking, be sure to select solar tracking rate.

Observing Deep Sky Objects

Deep-sky objects are simply those objects outside the boundaries of our solar system. They include star clusters, planetary nebulae, diffuse nebulae, double stars and other galaxies outside our own Milky Way. Most deep-sky objects have a large angular size. Therefore, low-to-moderate power is all you need to see them. Visually, they are too faint to reveal any of the color seen in long exposure photographs. Instead, they appear black and white. And, because of their low surface brightness, they should be observed from a dark-sky location. Light pollution around large urban areas washes out most nebulae making them difficult, if not impossible, to observe. Light Pollution Reduction filters help reduce the background sky brightness, thus increasing contrast.

Seeing Conditions

Viewing conditions affect what you can see through your telescope during an observing session. Conditions include transparency, sky illumination, and seeing. Understanding viewing conditions and the effect they have on observing will help you get the most out of your telescope.

Transparency

Transparency is the clarity of the atmosphere which is affected by clouds, moisture, and other airborne particles. Thick cumulus clouds are completely opaque while cirrus can be thin, allowing the light from the brightest stars through. Hazy skies absorb more light than clear skies making fainter objects harder to see and reducing contrast on brighter objects. Aerosols ejected into the upper atmosphere from volcanic eruptions also affect transparency. Ideal conditions are when the night sky is inky black.

Sky Illumination

General sky brightening caused by the Moon, aurorae, natural airglow, and light pollution greatly affect transparency. While not a problem for the brighter stars and planets, bright skies reduce the contrast of extended nebulae making them difficult, if not impossible, to see. To maximize your observing, limit deep sky viewing to moonless nights far from the light polluted skies found around major urban areas. LPR filters enhance deep sky viewing from light polluted areas by blocking unwanted light while transmitting light from certain deep sky objects. You can, on the other hand, observe planets and stars from light polluted areas or when the Moon is out.

Seeing

Seeing conditions refers to the stability of the atmosphere and directly affects the amount of fine detail seen in extended objects. The air in our atmosphere acts as a lens which bends and distorts incoming light rays. The amount of bending depends on air density. Varying temperature layers have different densities and, therefore, bend light differently. Light rays from the same object arrive slightly displaced creating an imperfect or smeared image. These atmospheric disturbances vary from time-to-time and place-to-place. The size of the air parcels compared to your aperture determines the "seeing" quality. Under good seeing conditions, fine detail is visible on the brighter planets like Jupiter and Mars, and stars are pinpoint images. Under poor seeing conditions, images are blurred and stars appear as blobs.

The conditions described here apply to both visual and photographic observations.

Figure 7-1
Seeing conditions directly affect image quality. These drawings represent a point source (i.e., star) under bad seeing conditions (left) to excellent conditions (right). Most often, seeing conditions produce images that lie some where between these two extremes.

Telescope Maintenance

While your NexStar telescope requires little maintenance, there are a few things to remember that will ensure your telescope performs at its best.

Care and Cleaning of the Optics

Occasionally, dust and/or moisture may build up on the corrector plate of your telescope. Special care should be taken when cleaning any instrument so as not to damage the optics.

If dust has built up on the corrector plate, remove it with a brush (made of camel's hair) or a can of pressurized air. Spray at an angle to the lens for approximately two to four seconds. Then, use an optical cleaning solution and white tissue paper to remove any remaining debris. Apply the solution to the tissue and then apply the tissue paper to the lens. Low pressure strokes should go from the center of the corrector to the outer portion. **Do NOT rub in circles!**

You can use a commercially made lens cleaner or mix your own. A good cleaning solution is isopropyl alcohol mixed with distilled water. The solution should be 60% isopropyl alcohol and 40% distilled water. Or, liquid dish soap diluted with water (a couple of drops per one quart of water) can be used.

Occasionally, you may experience dew build-up on the corrector plate of your telescope during an observing session. If you want to continue observing, the dew must be removed, either with a hair dryer (on low setting) or by pointing the telescope at the ground until the dew has evaporated.

If moisture condenses on the inside of the corrector, remove the accessories from the rear cell of the telescope. Place the telescope in a dust-free environment and point it down. This will remove the moisture from the telescope tube.

To minimize the need to clean your telescope, replace all lens covers once you have finished using it. Since the rear cell is NOT sealed, the cover should be placed over the opening when not in use. This will prevent contaminants from entering the optical tube.

Internal adjustments and cleaning should be done only by the Celestron repair department. If your telescope is in need of internal cleaning, please call the factory for a return authorization number and price quote.

Figure 8-1
The three collimation screws are located on the secondary mirror holder in the center of the corrector plate.

Collimation

The optical performance of your NexStar telescope is directly related to its collimation, that is the alignment of its optical system. Your NexStar was collimated at the factory after it was completely assembled. However, if the telescope is dropped or jarred severely during transport, it may have to be collimated. The only optical element that may need to be adjusted, or is possible, is the tilt of the secondary mirror.

To check the collimation of your telescope you will need a light source. A bright star near the zenith is ideal since there is a minimal amount of atmospheric distortion. Make sure that tracking is on so that you won't have to manually track the star. Or, if you do not want to power up your telescope, you can use Polaris. Its position relative to the celestial pole means that it moves very little thus eliminating the need to manually track it.

Before you begin the collimation process, be sure that your telescope is in thermal equilibrium with the surroundings. Allow 45 minutes for the telescope to reach equilibrium if you move it between large temperature extremes.

To verify collimation, view a star near the zenith. Use a medium to high power ocular — 12mm to 6mm focal length. It is important to center a star in the center of the field to judge collimation. Slowly cross in and out of focus and judge the symmetry of the star. If you see a systematic skewing of the star to one side, then recollimation is needed.

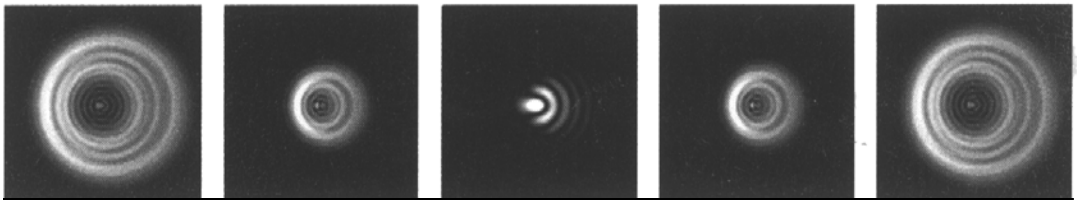


Figure 8-2 -- Even though the star pattern appears the same on both sides of focus, they are asymmetric. The dark obstruction is skewed off to the left side of the diffraction pattern indicating poor collimation.

To accomplish this, you need to tighten the secondary collimation screw(s) that move the star across the field toward the direction of the skewed light. These screws are located in the secondary mirror holder (see figure 8-1). To access the collimation screws you will need to remove the cap that covers the secondary mirror holder. To remove the cap, gently slide a flat head screwdriver underneath one end of the cap and twist the screwdriver. Slide the screwdriver underneath the other side of the cap and twist until the cap comes off. Make only small 1/6 to 1/8 adjustments to the collimation screws and re-center the star by moving the scope before making any improvements or before making further adjustments.

To make collimation a simple procedure, follow these easy steps:

1. While looking through a medium to high power eyepiece, de-focus a bright star until a ring pattern with a dark shadow appears (see figure 8-2). Center the de-focused star and notice in which direction the central shadow is skewed.

2. Place your finger along the edge of the front cell of the telescope (be careful not to touch the corrector plate), pointing towards the collimation screws. The shadow of your finger should be visible when looking into the eyepiece. Rotate your finger around the tube edge until its shadow is seen closest to the narrowest portion of the rings (i.e. the same direction in which the central shadow is skewed).

3. Locate the collimation screw closest to where your finger is positioned. This will be the collimation screw you will need to adjust first. (If your finger is positioned exactly between two of the collimation screws, then you will need to adjust the screw opposite where your finger is located).

4. Use the hand control buttons to move the de-focused star image to the edge of the field of view, in the same direction that the central obstruction of the star image is skewed.

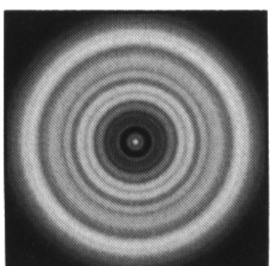


Figure 7-3
A collimated telescope should appear symmetrical with the central obstruction centered in the star's diffraction pattern.

5. While looking through the eyepiece, use an Allen wrench to turn the collimation screw you located in step 2 and 3. Usually a tenth of a turn is enough to notice a change in collimation. If the star image moves out of the field of view in the direction that the central shadow is skewed, than you are turning the collimation screw the wrong way. Turn the screw in the opposite direction, so that the star image is moving towards the center of the field of view.

6. If while turning you notice that the screws get very loose, then simply tighten the other two screws by the same amount. Conversely, if the collimation screw gets too tight, then loosen the other two screws by the same amount.

7. Once the star image is in the center of the field of view, check to see if the rings are concentric. If the central obstruction is still skewed in the same direction, then continue turning the screw(s) in the same direction. If you find that the ring pattern is skewed in a different direction, than simply repeat steps 2 through 6 as described above for the new direction.

Perfect collimation will yield a star image very symmetrical just inside and outside of focus. In addition, perfect collimation delivers the optimal optical performance specifications that your telescope is built to achieve.

If seeing (i.e., air steadiness) is turbulent, collimation is difficult to judge. Wait until a better night if it is turbulent or aim to a steadier part of the sky. A steadier part of the sky is judged by steady versus twinkling stars.

Optional Accessories

You will find that additional accessories enhance your viewing pleasure and expand the usefulness of your telescope. For ease of reference, all the accessories are listed in alphabetical order.

Adapter, Car Battery (#18769) - Celestron offers the Car Battery Adapter that allows you to run the NexStar drive off an external power source. The adapter attaches to the cigarette lighter of your car, truck, van, or motorcycle.

Barlow Lens - A Barlow lens is a negative lens that increases the focal length of a telescope. Used with any eyepiece, it doubles the magnification of that eyepiece. Celestron offers two Barlow lens in the 1-1/4" size for the NexStar. The 2x Ultima Barlow (#93506) is a compact triplet design that is fully multicoated for maximum light transmission and parfocal when used with the Ultima eyepieces. Model #93507 is a compact achromatic Barlow lens that is under three inches long and weighs only 4 oz. It works very well with all Celestron eyepieces.

Diagonal, 45 degree, erect image (#94112-A) – This design allows you to look into the telescope at a 45° angle, at images that are oriented properly, meaning the image is upright and correct from left to right.

Eyepieces - Like telescopes, eyepieces come in a variety of designs. Each design has its own advantages. For the 1-1/4" barrel diameter there are three different eyepiece designs available:

- **OMNI Plössl -** Plössl eyepieces have a 4-element lens designed for low-to-high power observing. The Plössls offer razor sharp views across the entire field, even at the edges! In the 1-1/4" barrel diameter, they are available in the following focal lengths: 4mm, 6mm, 9mm, 12.5mm, 15mm, 20mm, 25mm, 32mm and 40mm.

- **X-Cel -** This 6 element design allows each X-Cel Eyepiece to have 20mm of eye relief, 55° field of view and more than 25mm of lens aperture (even with the 2.3mm). In order to maintain razor sharp, color corrected images across its 50° field of view, extra-low dispersion glass is used for the most highly curved optical elements. The excellent refractive properties of these high grade optical elements, make the X-Cel line especially well suited for high magnification planetary viewing where sharp, color-free views are most appreciated. X-Cel eyepieces come in the following focal lengths: 2.3mm, 5mm, 8mm, 10mm, 12.5mm, 18mm, 21mm, 25mm.

- **Ultima -** Ultima is not really a design, but a trade name for our 5-element, wide field eyepieces. In the 1-1/4" barrel diameter, they are available in the following focal lengths: 5mm, 7.5mm, 10mm 12.5mm, 18mm, 30mm, 35mm, and 42mm. These eyepieces are all parfocal.

Exotherm, Hand Warmer- (#93504) - Perfect for chilly evenings of star gazing, the Exotherm Hand Warmer is convenient, reusable and provides up to one hour of instant heat.

Filters, Eyepiece - To enhance your visual observations of solar system objects, Celestron offers a wide range of colored eyepiece filter sets that thread into the 1-1/4" oculars. Available sets are:
#94119-10 – Orange, Light Blue, ND13%T, Polarizing (#s 21, 80A, 15, Polarizing)
#94119-20 - Deep Yellow, Red, Light Green, ND25% T (#s 12, 25, 56, 96ND-25)
#94119-30 - Light Red, Blue, Green, ND50% T (#s 23A, 38A, 58, 96ND-50)
#94119-40 - Yellow, Deep Yellow, Violet, Pale Blue (#s 8, 96ND-13, 47, 82A)

Night Vision Flashlight - (#93588) - Celestron's premium model for astronomy, using two red LED's to preserve night vision better than red filters or other devices. Brightness is adjustable. Operates on a single 9 volt battery (included).

Light Pollution Reduction (LPR) Filter - These filters are designed to enhance your views of deep sky astronomical objects when viewed from urban areas. LPR Filters selectively reduce the transmission of certain wavelengths of light, specifically those produced by artificial lights. This includes mercury and high and low pressure sodium vapor lights. In addition, they also block unwanted natural light (sky glow) caused by neutral oxygen emission in our atmosphere. Celestron offers a model for 1-1/4" eyepieces (#94126A).

Moon Filter (#94119-A) - Celestron's Moon Filter is an economical eyepiece filter for reducing the brightness of the moon and improving contrast, so greater detail can be observed on the lunar surface. The clear aperture is 21mm and the transmission is about 18%.

Polarizing Filter Set (#93608) - The polarizing filter set limits the transmission of light to a specific plane, thus increasing contrast between various objects. This is used primarily for terrestrial, lunar and planetary observing.

PowerTank (#18774) – 12v 7Amp hour rechargeable power supply. Comes with two 12v output cigarette outlets, built-in red flash light , Halogen emergency spotlight. AC adapter and cigarette lighter adapter included.

Sky Maps (#93722) - Celestron Sky Maps are the ideal teaching guide for learning the night sky. You wouldn't set off on a road trip without a road map, and you don't need to try to navigate the night sky without a map either. Even if you already know your way around the major constellations, these maps can help you locate all kinds of fascinating objects.

Solar Filter 8" (#94128) - The AstroSolar® filter is a safe and durable filter that covers the front opening of the telescope. View sunspots and other solar features using this double-sided metal coated filter for uniform density and good color balance across the entire field. The Sun offers constant changes and will keep your observing interesting and fun.

T-Adapter (#93633-A) - T-Adapter (with additional T-Ring) allows you to attach your SLR camera to the rear cell of your Celestron NexStar. This turns your NexStar into a 1250mm telephoto lens perfect for terrestrial photography and short exposure lunar and filtered solar photography.

T-Ring - The T-Ring couples your 35mm SLR camera body to the T-Adapter. This accessory is mandatory if you want to do photography through the telescope. Each camera make (i.e., Minolta, Nikon, Pentax, etc.) has its own unique mount and therefore, its own T-Ring. Celestron has 8 different models for 35mm cameras.

Vibration Suppression Pads (#93503) - These pads rest between the ground and tripod feet of your telescope. They reduce the amplitude and vibration time of your telescope when shaken by the wind or an accidental bump. This accessory is a must for long exposure prime focus photography.

Wedge, NexStar 6/8 (#93658) - Upgrade your NexStar 6SE or 8SE with this wedge for long exposure astrophotography. With built-in azimuth and altitude adjustment controls for easy polar alignment, this wedge has a 25-90° latitude range

A full description of all Celestron accessories can be found in the Celestron Accessory Catalog (#93685).

Appendix A - Technical Specifications

Optical Specification

	NexStar 6SE (#11068)	NexStar 8SE (#11069)
Design	Schmidt Cassegrain Optical Design	Schmidt Cassegrain Optical Design
Aperture	6 inches (150mm)	8 inches (200mm)
Focal Length	60 inches (1500mm)	80 inches (2032mm)
F/ratio of the Optical System	10	10
Primary Mirror: Diameter Coatings	150mm Starbright XLT®	100mm Starbright XLT®
Secondary Mirror Spot Size Secondary Obstruction	2.2" 37% by diameter; 14% by area	2.5" 35% by diameter; 12% by area
Corrector Plate: Material Coatings	Optical Quality Crown Glass Starbright XLT®	Optical Quality Crown Glass Starbright XLT®
Highest Useful Magnification	354x	480x
Lowest Useful Magnification (7mm exit pupil)	21x	29x
Resolution: Rayleigh Criterion Dawes Limit	.92 arc seconds .77 arc seconds	.68 arc seconds .57 arc seconds
Light Gathering Power	459x unaided eye	843x unaided eye
Near Focus standard eyepiece or camera	~ 20 feet	~ 25 feet
Field of View: Standard Eyepiece	.8º	.64º
Linear Field of View (at 1000 yds)	42 feet	33.6 feet
Magnification: Standard Eyepiece	60x	81x
Optical Tube Length	16 inches	17 inches
Weight of Telescope	21 Lbs.	24 Lbs.
Weight of Tripod	9 lbs	9 lbs

Electronic Specifications

Input Voltage	12 V DC Nominal
Batteries Required	8 AA Alkaline
Power Supply Requirements	12 VDC-750 mA (Tip positive)

Mechanical Specifications

Motor: Type Resolution	DC Servo motors with encoders, both axes .26 arc sec
Slew speeds	Nine slew speeds: 5º /sec, 3º /sec, 1º/sec, .5/sec, 32x, 16x, 8x, 4x, 2x
Hand Control	Double line, 16 character Liquid Crystal Display 19 fiber optic backlit LED buttons
Fork Arm	Cast aluminum, with integrated hand control receptacle

Software Specifications

Software Precision	16 bit, 20 arc sec. calculations
Ports	RS-232 communication port on hand control
Tracking Rates	Sidereal, Solar, Lunar and King
Tracking Modes	Alt-Az, EQ North & EQ South
Alignment Procedures	SkyAlign, Auto Two-Star, Two-Star, One-Star, Solar System Align
Database	200 user defined programmable object. Enhanced information on over 200 objects
Total Object Database	**+40,000**

Appendix B - Glossary of Terms

A-

Absolute magnitude	The apparent magnitude that a star would have if it were observed from a standard distance of 10 parsecs, or 32.6 light-years. The absolute magnitude of the Sun is 4.8. at a distance of 10 parsecs, it would just be visible on Earth on a clear moonless night away from surface light.
Airy disk	The apparent size of a star's disk produced even by a perfect optical system. Since the star can never be focused perfectly, 84 per cent of the light will concentrate into a single disk, and 16 per cent into a system of surrounding rings.
Alt-Azimuth Mounting	A telescope mounting using two independent rotation axis allowing movement of the instrument in Altitude and Azimuth.
Altitude	In astronomy, the altitude of a celestial object is its Angular Distance above or below the celestial horizon.
Aperture	the diameter of a telescope's primary lens or mirror; the larger the aperture, the greater the telescope's light-gathering power.
Apparent Magnitude	A measure of the relative brightness of a star or other celestial object as perceived by an observer on Earth.
Arcminute	A unit of angular size equal to 1/60 of a degree.
Arcsecond	A unit of angular size equal to 1/3,600 of a degree (or 1/60 of an arcminute).
Asterism	A small unofficial grouping of stars in the night sky.
Asteroid	A small, rocky body that orbits a star.
Astrology	The pseudoscientific belief that the positions of stars and planets exert an influence on human affairs; astrology has nothing in common with astronomy
Astronomical unit (AU)	The distance between the Earth and the Sun. It is equal to 149,597,900 km., usually rounded off to 150,000,000 km.
Aurora	The emission of light when charged particles from the solar wind slams into and excites atoms and molecules in a planet's upper atmosphere.
Azimuth	The angular distance of an object eastwards along the horizon, measured from due north, between the astronomical meridian (the vertical line passing through the center of the sky and the north and south points on the horizon) and the vertical line containing the celestial body whose position is to be measured. .

B -

Binary Stars	Binary (Double) stars are pairs of stars that, because of their mutual gravitational attraction, orbit around a common Center of Mass. If a group of three or more stars revolve around one another, it is called a multiple system. It is believed that approximately 50 percent of all stars belong to binary or multiple systems. Systems with individual components that can be seen separately by a telescope are called visual binaries or visual multiples. The nearest "star" to our solar system, Alpha Centauri, is actually our nearest example of a multiple star system, it consists of three stars, two very similar to our Sun and one dim, small, red star orbiting around one another.

C -

Celestial Equator	The projection of the Earth's equator on to the celestial sphere. It divides the sky into two equal hemispheres.
Celestial pole	The imaginary projection of Earth's rotational axis north or south pole onto the celestial sphere.
Celestial Sphere	An imaginary sphere surrounding the Earth, concentric with the Earth's center.
Collimation	The act of putting a telescope's optics into perfect alignment.

D -

Declination (DEC)	The angular distance of a celestial body north or south of the celestial equator. It may be said to correspond to latitude on the surface of the Earth.

E -

Ecliptic	The projection of the Earth's orbit on to the celestial sphere. It may also be defined as "the apparent yearly path of the Sun against the stars".
Equatorial mount	A telescope mounting in which the instrument is set upon an axis which is parallel to the axis of the Earth; the angle of the axis must be equal to the observer's latitude.

F -

Focal length — The distance between a lens (or mirror) and the point at which the image of an object at infinity is brought to focus. The focal length divided by the aperture of the mirror or lens is termed the focal ratio.

J -

Jovian Planets — Any of the four gas giant planets that are at a greater distance form the sun than the terrestrial planets.

K -

Kuiper Belt — A region beyond the orbit of Neptune extending to about 1000 AU which is a source of many short period comets.

L -

Light-Year (ly) — A light-year is the distance light traverses in a vacuum in one year at the speed of 299,792 km/ sec. With 31,557,600 seconds in a year, the light-year equals a distance of 9.46 X 1 trillion km (5.87 X 1 trillion mi).

M -

Magnitude — Magnitude is a measure of the brightness of a celestial body. The brightest stars are assigned magnitude 1 and those increasingly fainter from 2 down to magnitude 5. The faintest star that can be seen without a telescope is about magnitude 6. Each magnitude step corresponds to a ratio of 2.5 in brightness. Thus a star of magnitude 1 is 2.5 times brighter than a star of magnitude 2, and 100 times brighter than a magnitude 5 star. The brightest star, Sirius, has an apparent magnitude of -1.6, the full moon is -12.7, and the Sun's brightness, expressed on a magnitude scale, is -26.78. The zero point of the apparent magnitude scale is arbitrary.

Meridian — A reference line in the sky that starts at the North celestial pole and ends at the South celestial pole and passes through the zenith. If you are facing South, the meridian starts from your Southern horizon and passes directly overhead to the North celestial pole.

Messier — A French astronomer in the late 1700’s who was primarily looking for comets. Comets are hazy diffuse objects and so Messier cataloged objects that were not comets to help his search. This catalog became the Messier Catalog, M1 through M110.

N -

Nebula — Interstellar cloud of gas and dust. Also refers to any celestial object that has a cloudy appearance.

North Celestial Pole — The point in the Northern hemisphere around which all the stars appear to rotate. This is caused by the fact that the Earth is rotating on an axis that passes through the North and South celestial poles. The star Polaris lies less than a degree from this point and is therefore referred to as the "Pole Star".

Nova — Although Latin for "new" it denotes a star that suddenly becomes explosively bright at the end of its life cycle.

O -

Open Cluster — One of the groupings of stars that are concentrated along the plane of the Milky Way. Most have an asymmetrical appearance and are loosely assembled. They contain from a dozen to many hundreds of stars.

P -

Parallax — Parallax is the difference in the apparent position of an object against a background when viewed by an observer from two different locations. These positions and the actual position of the object form a triangle from which the apex angle (the parallax) and the distance of the object can be determined if the length of the baseline between the observing positions is known and the angular direction of the object from each position at the ends of the baseline has been measured. The traditional method in astronomy of determining the distance to a celestial object is to measure its parallax.

Parfocal — Refers to a group of eyepieces that all require the same distance from the focal plane of the telescope to be in focus. This means when you focus one parfocal eyepiece all the other parfocal eyepieces, in a particular line of eyepieces, will be in focus.

Parsec — The distance at which a star would show parallax of one second of arc. It is equal to 3.26 light-years, 206,265 astronomical units, or 30,8000,000,000,000 km. (Apart from the Sun, no star lies within one parsec of us.)

Point Source — An object which cannot be resolved into an image because it to too far away or too small is considered a point source. A planet is far away but it can be resolved as a disk. Most stars cannot be resolved as disks, they are too far away.

R -

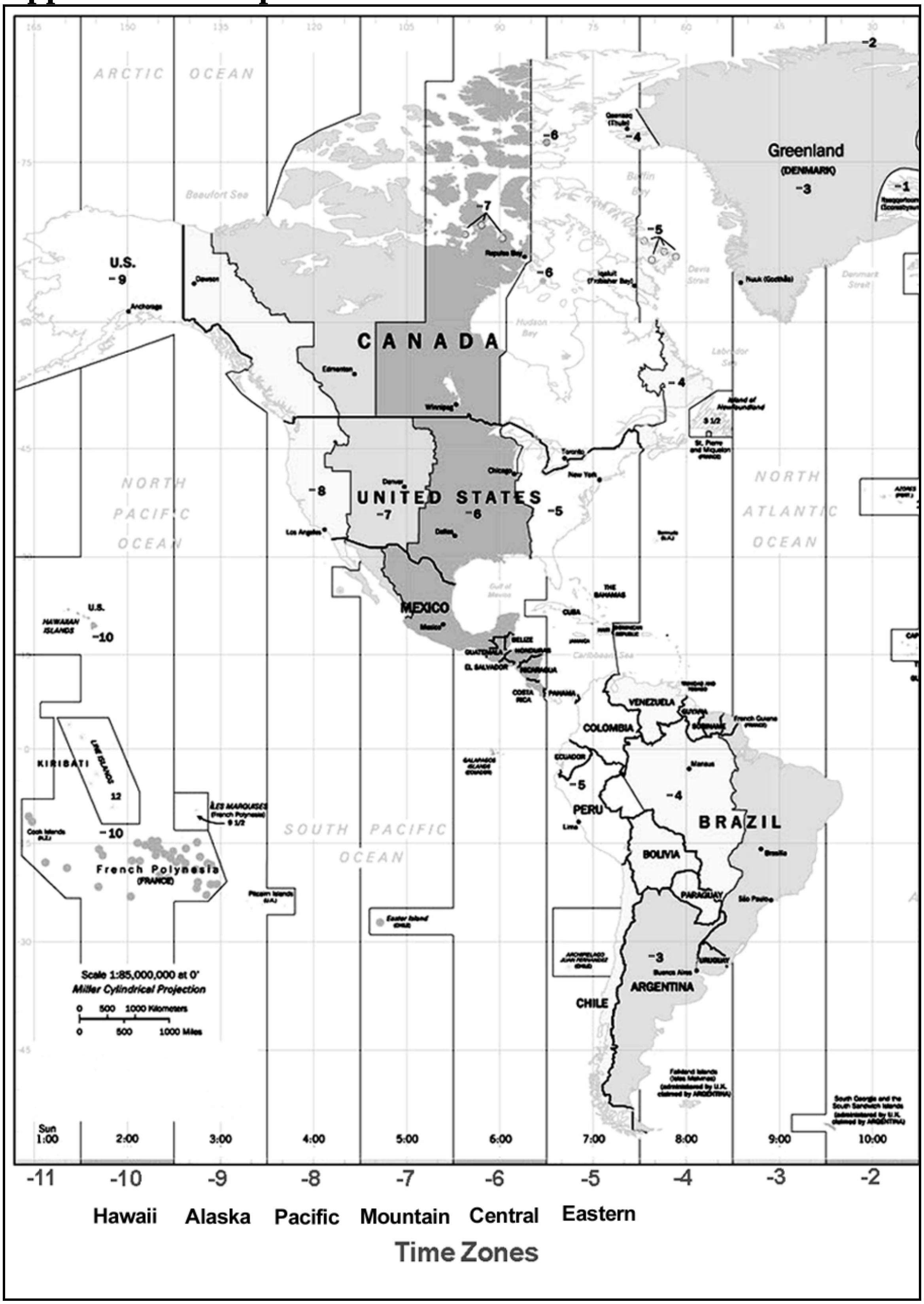
Reflector — A telescope in which the light is collected by means of a mirror.

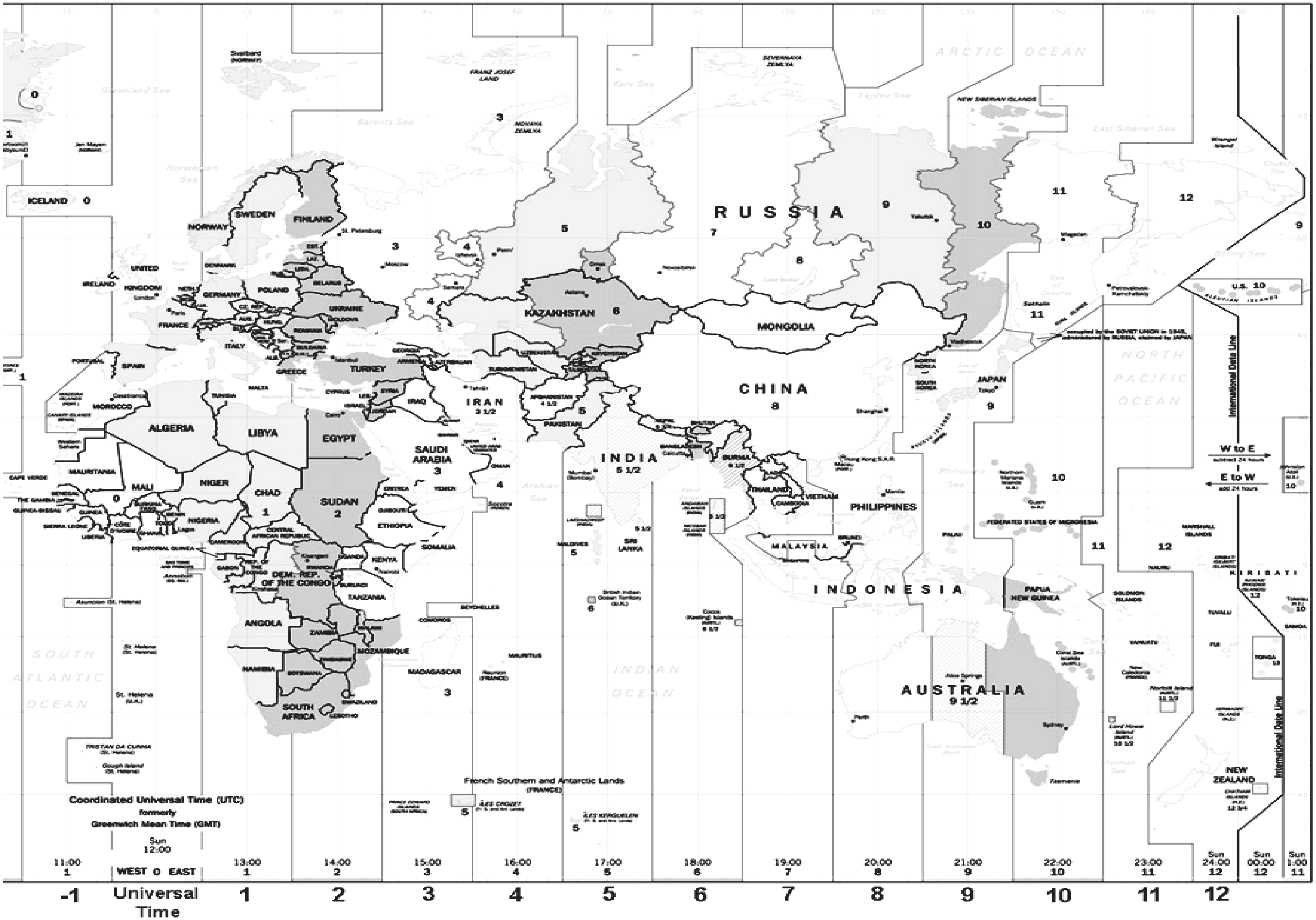
Resolution	The minimum detectable angle an optical system can detect. Because of diffraction, there is a limit to the minimum angle, resolution. The larger the aperture, the better the resolution.
Right Ascension: (RA)	The angular distance of a celestial object measured in hours, minutes, and seconds along the Celestial Equator eastward from the Vernal Equinox.
S -	
Sidereal Rate	This is the angular speed at which the Earth is rotating. Telescope tracking motors drive the telescope at this rate. The rate is 15 arc seconds per second or 15 degrees per hour.
T -	
Terminator	The boundary line between the light and dark portion of the moon or a planet.
U -	
Universe	The totality of astronomical things, events, relations and energies capable of being described objectively.
V -	
Variable Star	A star whose brightness varies over time due to either inherent properties of the star or something eclipsing or obscuring the brightness of the star.
W -	
Waning Moon	The period of the moon's cycle between full and new, when its illuminated portion is decreasing.
Waxing Moon	The period of the moon's cycle between new and full, when its illuminated portion is increasing.
Z -	
Zenith	The point on the Celestial Sphere directly above the observer.
Zodiac	The zodiac is the portion of the Celestial Sphere that lies within 8 degrees on either side of the Ecliptic. The apparent paths of the Sun, the Moon, and the planets, with the exception of some portions of the path of Pluto, lie within this band. Twelve divisions, or signs, each 30 degrees in width, comprise the zodiac. These signs coincided with the zodiacal constellations about 2,000 years ago. Because of the Precession of the Earth's axis, the Vernal Equinox has moved westward by about 30 degrees since that time; the signs have moved with it and thus no longer coincide with the constellations.

Appendix C - RS-232 Connection

Using the included NexRemote software you can control your NexStar telescope with a computer via the RS-232 port located on the computerized hand control and using the RS-232 cable . For information about using NexRemote to control your telescope, refer to the help files located on the disk. In addition to NexRemote, the telescope can be controlled using other popular astronomy software programs.

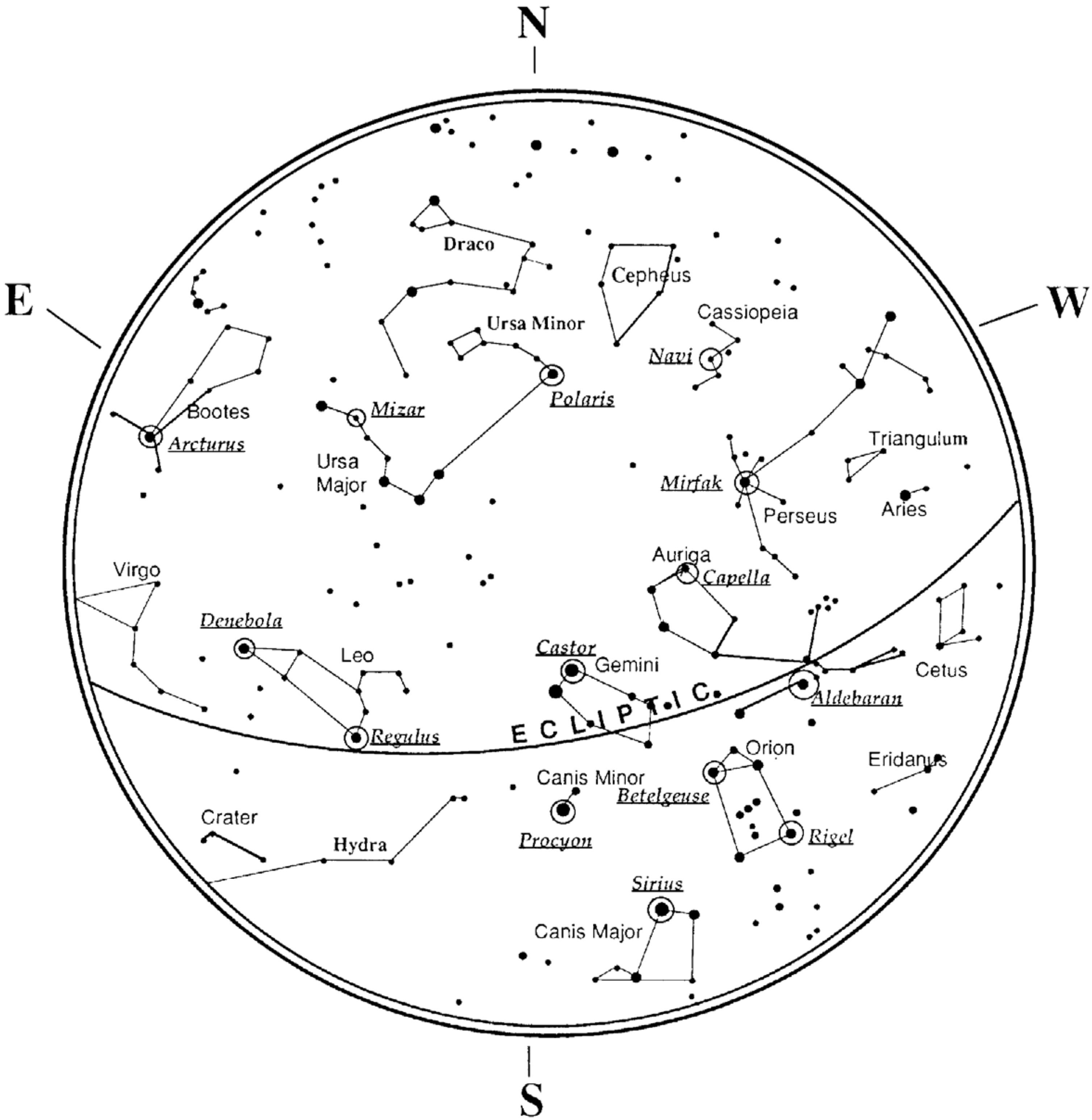
Appendix D – Maps of Time Zones



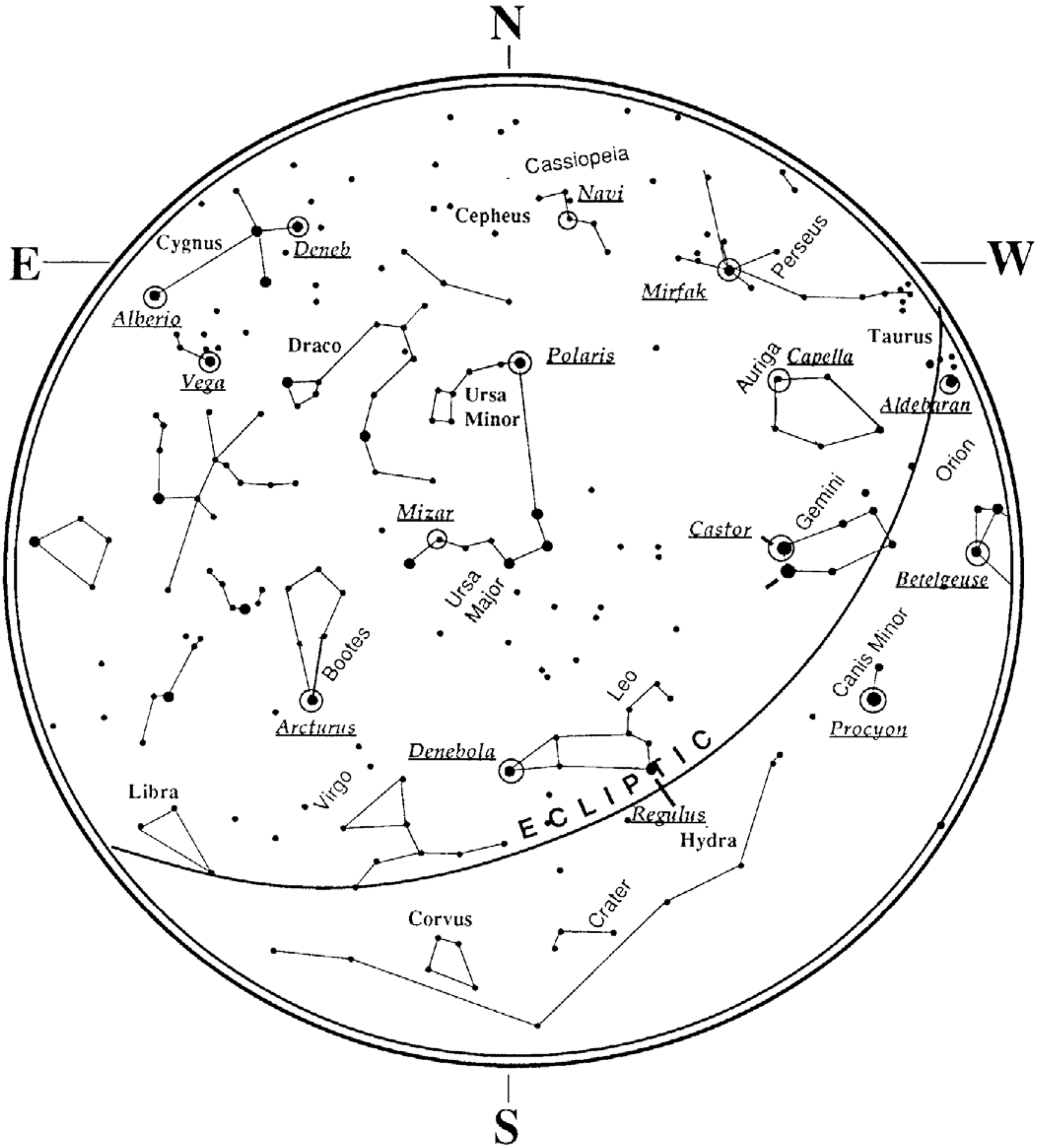

RUSSIA
CHINA
MONGOLIA
KAZAKHSTAN
INDIA
5 1/2
IRAN
3 1/2
SAUDI ARABIA
JAPAN
PHILIPPINES
INDONESIA
AUSTRALIA
9 1/2
NEW ZEALAND
PAPUA NEW GUINEA
MALAYSIA
PAKISTAN
SUDAN
EGYPT
LIBYA
ALGERIA
NIGER
CHAD
MALI
MAURITANIA
NIGERIA
ETHIOPIA
KENYA
TANZANIA
DEM. REP. OF THE CONGO
ANGOLA
NAMIBIA
SOUTH AFRICA
MOZAMBIQUE
MADAGASCAR
TURKEY
UKRAINE
POLAND
GERMANY
FRANCE
SPAIN
ITALY
NORWAY
SWEDEN
FINLAND
ICELAND 0
UNITED KINGDOM
IRELAND
International Date Line
W to E
subtract 24 hours
E to W
add 24 hours
ARCTIC OCEAN
NORTH PACIFIC OCEAN
INDIAN OCEAN
SOUTH ATLANTIC OCEAN
French Southern and Antarctic Lands (FRANCE)
Coordinated Universal Time (UTC)
formerly
Greenwich Mean Time (GMT)
Sun 12:00
WEST 0 EAST
11:00 1
13:00 1
14:00 2
15:00 3
16:00 4
17:00 5
18:00 6
19:00 7
20:00 8
21:00 9
22:00 10
23:00 11
Sun 24:00 12
Sun 00:00 12
Sun 1:00 11
-1
Universal Time
1
2
3
4
5
6
7
8
9
10
11
12

Time Zones

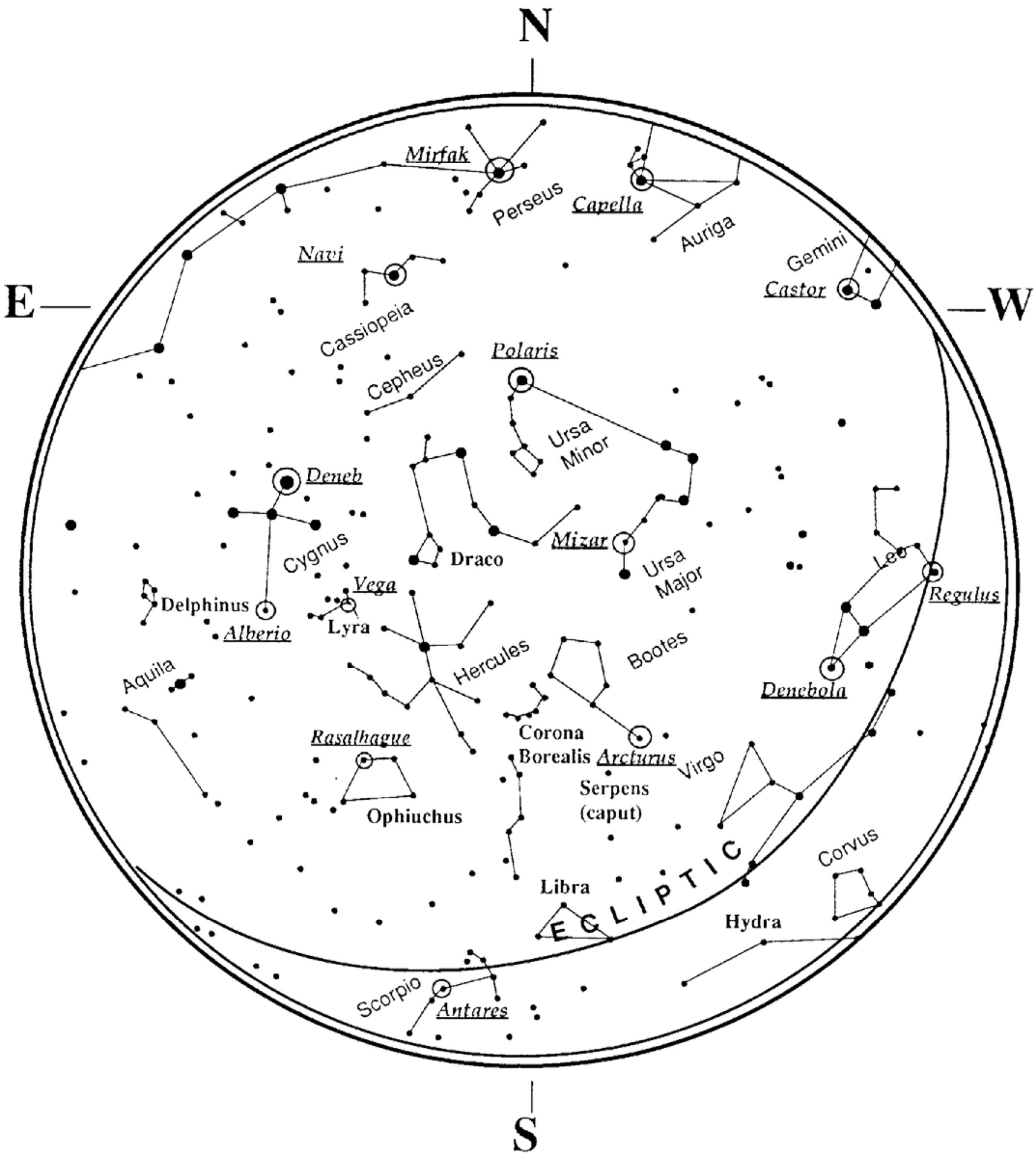
January - February Sky



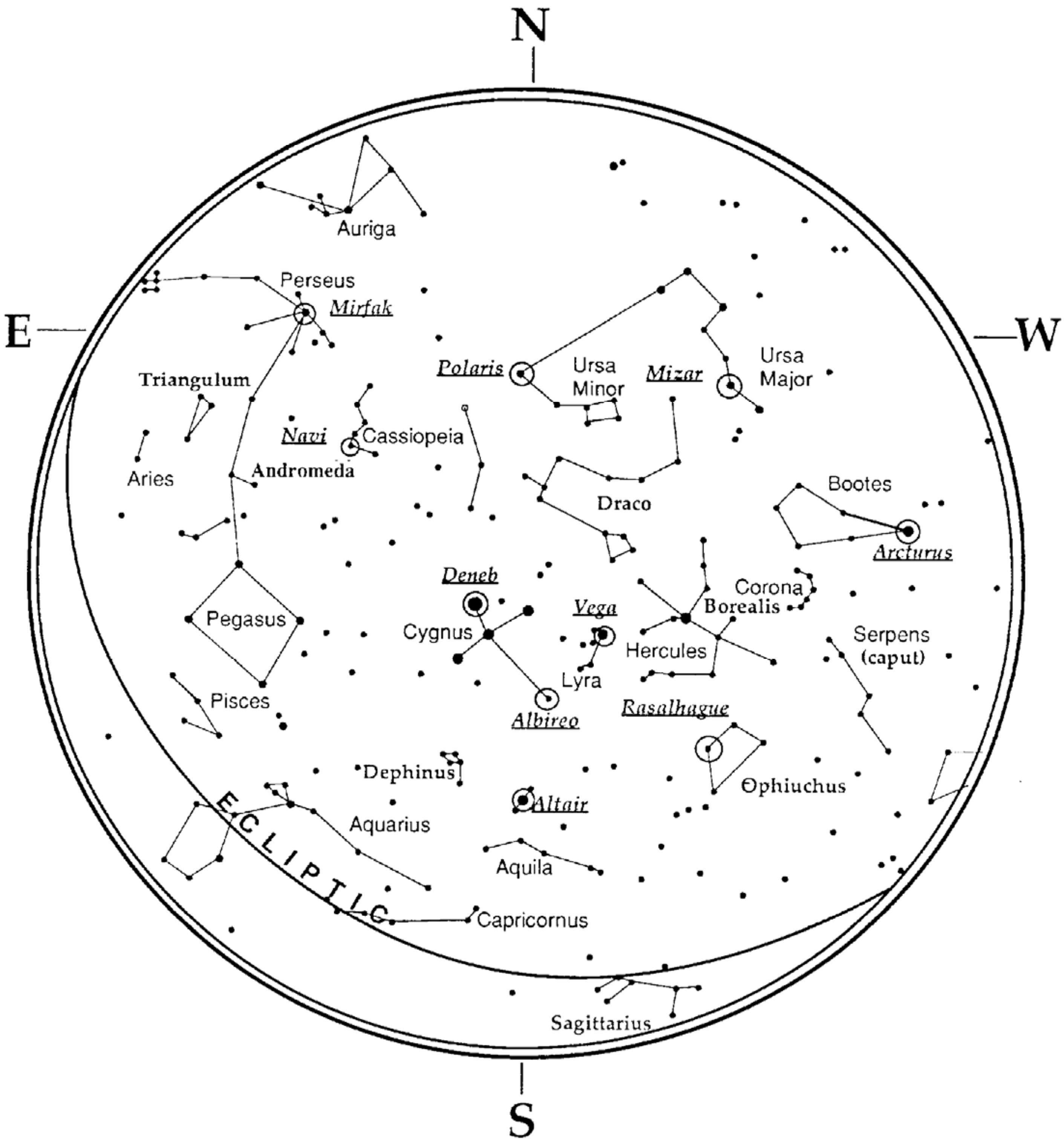
March - April Sky



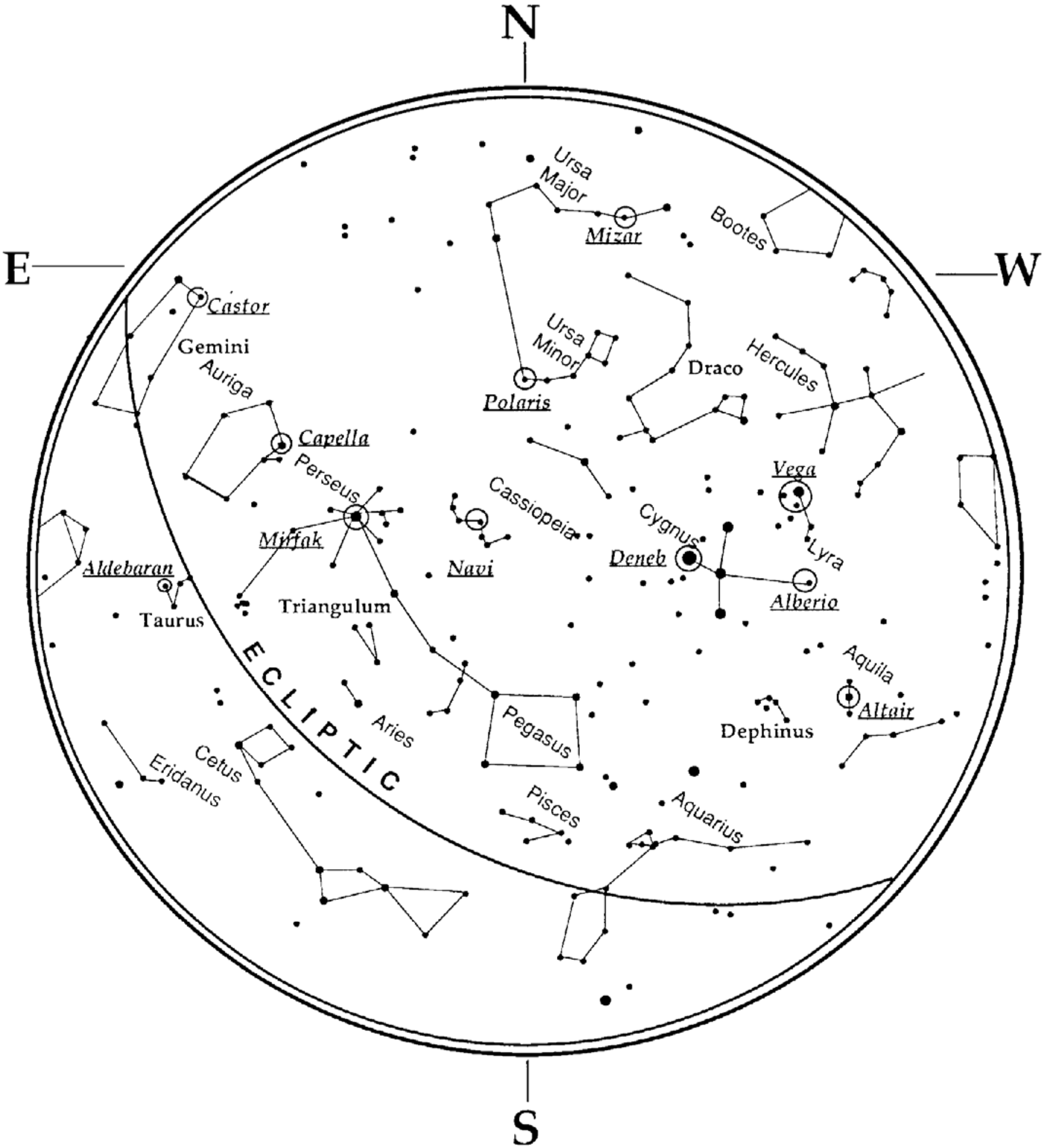
May - June Sky


N
E
W
S
Mirfak
Perseus
Capella
Auriga
Gemini
Castor
Navi
Cassiopeia
Cepheus
Polaris
Ursa Minor
Deneb
Cygnus
Draco
Mizar
Ursa Major
Delphinus
Alberio
Vega
Lyra
Leo
Regulus
Hercules
Bootes
Aquila
Denebola
Corona Borealis
Arcturus
Virgo
Rasalhague
Serpens (caput)
Ophiuchus
Libra
ECLIPTIC
Corvus
Hydra
Scorpio
Antares

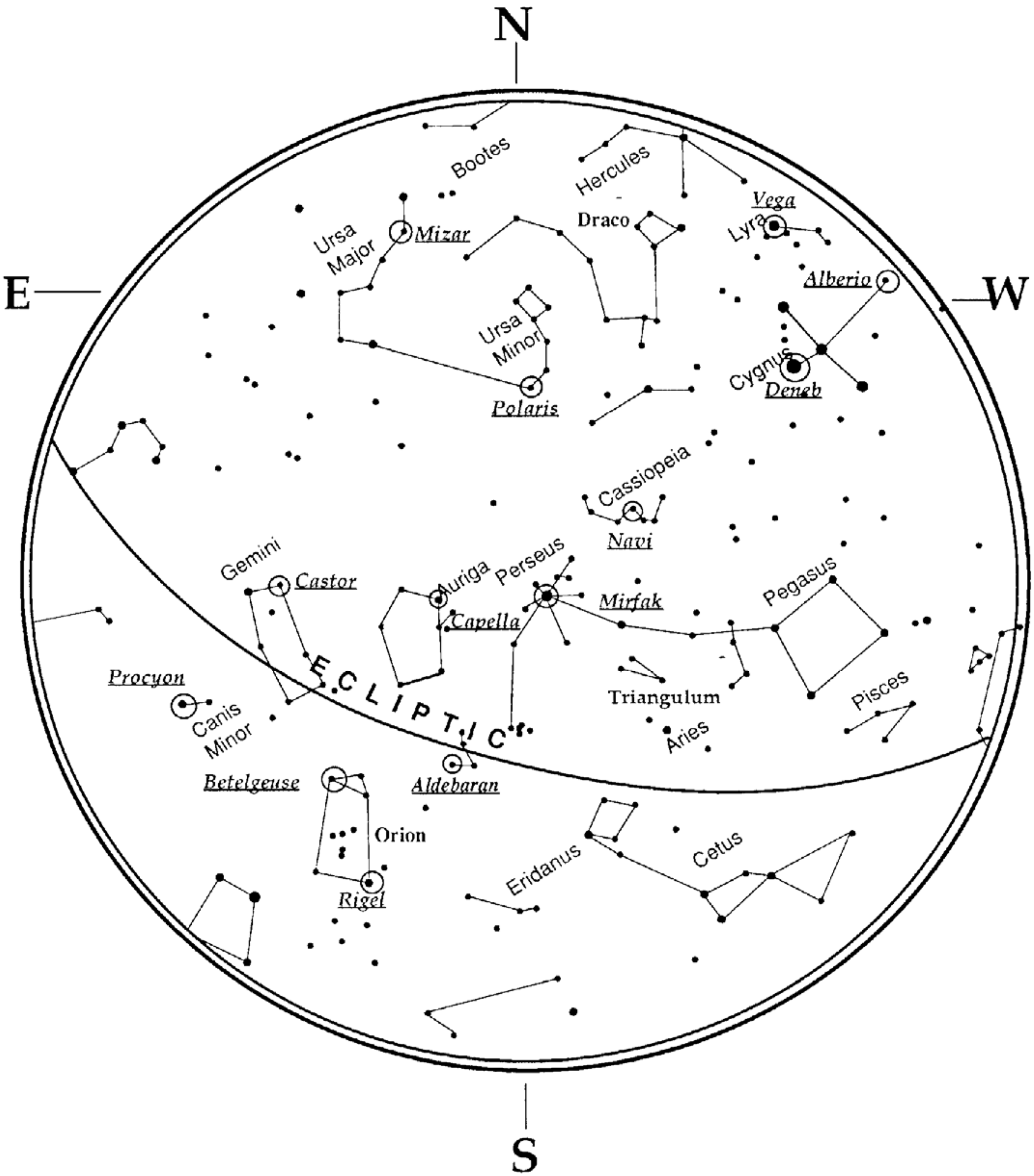
July - August Sky



September - October Sky



November - December Sky



CELESTRON TWO YEAR WARRANTY

A. Celestron warrants this telescope to be free from defects in materials and workmanship for two years. Celestron will repair or replace such product or part thereof which, upon inspection by Celestron, is found to be defective in materials or workmanship. As a condition to the obligation of Celestron to repair or replace such product, the product must be returned to Celestron together with proof-of-purchase satisfactory to Celestron.

B. The Proper Return Authorization Number must be obtained from Celestron in advance of return. Call Celestron at (310) 328-9560 to receive the number to be displayed on the outside of your shipping container.

All returns must be accompanied by a written statement setting forth the name, address, and daytime telephone number of the owner, together with a brief description of any claimed defects. Parts or product for which replacement is made shall become the property of Celestron.

The customer shall be responsible for all costs of transportation and insurance, both to and from the factory of Celestron, and shall be required to prepay such costs.

Celestron shall use reasonable efforts to repair or replace any telescope covered by this warranty within thirty days of receipt. In the event repair or replacement shall require more than thirty days, Celestron shall notify the customer accordingly. Celestron reserves the right to replace any product which has been discontinued from its product line with a new product of comparable value and function.

This warranty shall be void and of no force of effect in the event a covered product has been modified in design or function, or subjected to abuse, misuse, mishandling or unauthorized repair. Further, product malfunction or deterioration due to normal wear is not covered by this warranty.

CELESTRON DISCLAIMS ANY WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY OF FITNESS FOR A PARTICULAR USE, EXCEPT AS EXPRESSLY SET FORTH HEREIN.

THE SOLE OBLIGATION OF CELESTRON UNDER THIS LIMITED WARRANTY SHALL BE TO REPAIR OR REPLACE THE COVERED PRODUCT, IN ACCORDANCE WITH THE TERMS SET FORTH HEREIN. CELESTRON EXPRESSLY DISCLAIMS ANY LOST PROFITS, GENERAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES WHICH MAY RESULT FROM BREACH OF ANY WARRANTY, OR ARISING OUT OF THE USE OR INABILITY TO USE ANY CELESTRON PRODUCT. ANY WARRANTIES WHICH ARE IMPLIED AND WHICH CANNOT BE DISCLAIMED SHALL BE LIMITED IN DURATION TO A TERM OF TWO YEARS FROM THE DATE OF ORIGINAL RETAIL PURCHASE.

Some states do not allow the exclusion or limitation of incidental or consequential damages or limitation on how long an implied warranty lasts, so the above limitations and exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Celestron reserves the right to modify or discontinue, without prior notice to you, any model or style telescope.

If warranty problems arise, or if you need assistance in using your telescope contact:

Celestron
Customer Service Department
2835 Columbia Street
Torrance, CA 90503
Tel. (310) 328-9560
Fax. (310) 212-5835
Monday-Friday 8AM-4PM PST

This warranty supersedes all other product warranties.

NOTE: This warranty is valid to U.S.A. and Canadian customers who have purchased this product from an Authorized Celestron Dealer in the U.S.A. or Canada. Warranty outside the U.S.A. and Canada is valid only to customers who purchased from a Celestron Distributor or Authorized Celestron Dealer in the specific country and please contact them for any warranty service.

Celestron
2835 Columbia Street
Torrance, CA 90503
Tel. (310) 328-9560
Fax. (310) 212-5835
Web site at http//www.celestron.com

(Products or instructions may change
without notice or obligation.)

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

#11068-INST
Printed in China
$10.00
06-06

NEXSTAR SE SERIES ADDITIONAL SPECIFICATIONS

6/8SE TRIPOD

- Tripod spread in low position is ≈ 26”
- Tripod spread in high position is ≈ 42.5”
- Tripod height in the low position is ≈ 24.5”
- Tripod height in the high position is ≈ 42”

Both the NexStar 4/5SE and 6/8SE tripods have the same collapsed length of ≈ 27”. This is good to know for packing it as baggage on trips. The length of the NexStar 6/8SE tripod with legs extended is ≈ 47”.

Mount clearance: Distance between the top of the mount base (battery compartment lid) to the center of the dovetail clamp (altitude bolt axis).

- NexStar 4/5SE clearance is ≈ 8.25”
- 6/8SE clearance is ≈ 10”
- Pointed at zenith, the 8SE OTA has 4.5” from the back of the mirror cell to the top of the mount base (battery compartment lid), about 4” from the back of the baffle nut to the mount base top and about 3” from the tip of the focus knob to the mount base top. This is enough distance to use the visual back, 1.25” Star Diagonal and a 1.25” eyepiece to view the zenith. It is not enough distance to accommodate larger accessories or SLR cameras attached to the scope.
- The respective distances for the 6SE OTA are ≈ 5.5”, 5”, and 4”
- The focuser mechanism back plate screws (3) are M3x8”

THE 4/5SE SPUR GEAR SPECS ARE:

- Module is 0.5”
- Number of teeth is 16
- Pressure angel is 20°
- Pitch diameter is 8 mm

Schmidt-Cassegrain
Optical Tube Assembly

Instruction Manual

C8 ● C9.25 ● C11 ● C14

A telescope is an instrument that collects and focuses light. The nature of the optical design determines how the light is focused. Some telescopes, known as refractors, use lenses. Other telescopes, known as reflectors, use mirrors. The Schmidt-Cassegrain optical system (or Schmidt-Cass for short) uses a combination of mirrors and lenses and is referred to as a compound or catadioptric telescope. This unique design offers large-diameter optics while maintaining very short tube lengths, making them extremely portable. The Schmidt-Cassegrain system consists of a zero power corrector plate, a spherical primary mirror, and a secondary mirror. Once light rays enter the optical system, they travel the length of the optical tube three times.

The optics of the Celestron Schmidt-Cassegrain telescopes have Starbright® coatings - enhanced multi-layer coatings on the primary and secondary mirrors for increased reflectivity and a fully coated corrector for the finest anti-reflection characteristics.

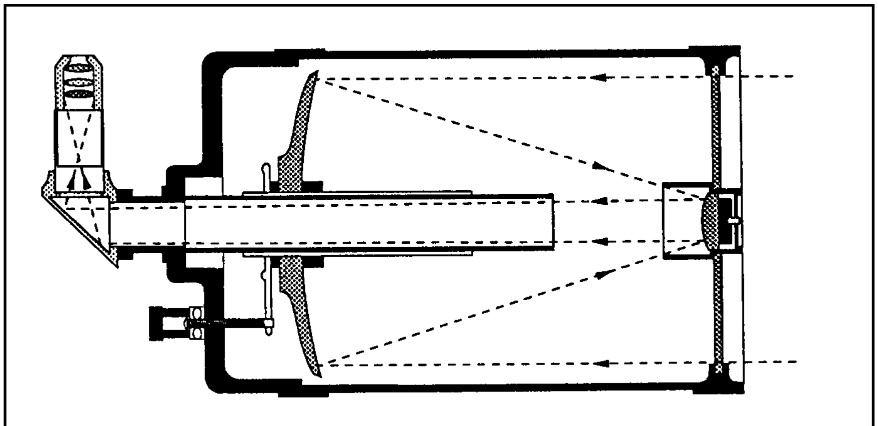


Figure 1-1
A cutaway view of the light path of the Schmidt-Cassegrain optical design

	8" OTA	8" OTA-CF	9.25" OTA	9.25" OTA-CF	11" OTA	11" OTA-CF	14" OTA	14" OTA
Part Number	**91024**	**91023**	**91027**	**91026**	**91036**	**91035**	**91037**	**91038-XLT**
Focal Length	2032mm F/10	2032mm F/10	2350mm F/10	2350mm F/10	2800mm F/10	2800mm F/10	3910mm F/11	3910mm F/11
Eyepiece	25mm – 1.25" (81x)	25mm - 1.25" (81x)	25mm - 1.25" (94x)	25mm - 1.25" (94x)	40mm - 1.25" (70x)	40mm - 1.25" (70x)	40mm - 2" (98x)	40mm - 2" (98x)
Star Diagonal	90° - 1.25"	90° - 1.25"	90° - 1.25"	90° - 1.25"	90° - 1.25"	90° - 1.25"	90° - 2"	90° - 2"
Finderscope	6x30	6x30	6x30	6x30	9x50	9x50	9x50	9x50
Optical Tube	Aluminum	Carbon Fiber	Aluminum	Carbon Fiber	Aluminum	Carbon Fiber	Aluminum	Aluminum
Fastar Compatible	No	Yes	No	No	No	No	No	Yes

Attaching the Visual Back

The visual back is the accessory that allows you to attach all visual accessories to the telescope. The 8", 9.25" and 11" optical tubes come with the visual back installed. The 14" OTA comes with a thread on 2" star diagonal instead of a visual back. If it is not already on the tube it can be attached as follows:

1. Remove the rubber cover on the rear cell.

2. Place the knurled slip ring on the visual back over the threads on the rear cell (Fig 1-2).

3. Hold the visual back with the set screw in a convenient position and rotate the knurled slip ring clockwise until tight.

Once this is done, you are ready to attach other accessories, such as eyepieces, diagonal prisms, etc.

If you want to remove the visual back, rotate the slip ring counterclockwise until it is free of the rear cell.

Installing the Star Diagonal

The star diagonal is a prism that diverts the light at a right angle to the light path of the telescope. This allows you to observe in positions that are physically more comfortable than if you looked straight through.

To attach the star diagonal onto the 8", 9.25" and 11" optical tubes:

1. Turn the set screw on the visual back until its tip no longer extends into (i.e., obstructs) the inner diameter of the visual back.

2. Slide the chrome portion of the star diagonal into the visual back.

3. Tighten the set screw on the visual back to hold the star diagonal in place.

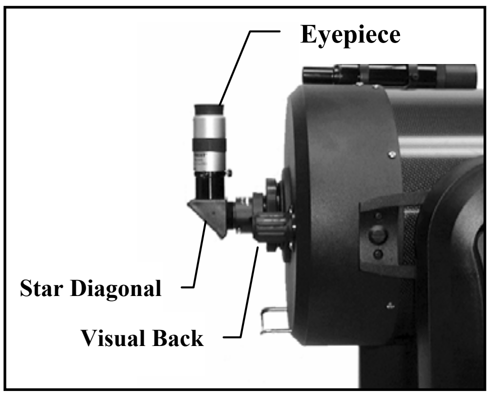


Figure 1-2 – 8", 9.25" and 11" Rear Cell

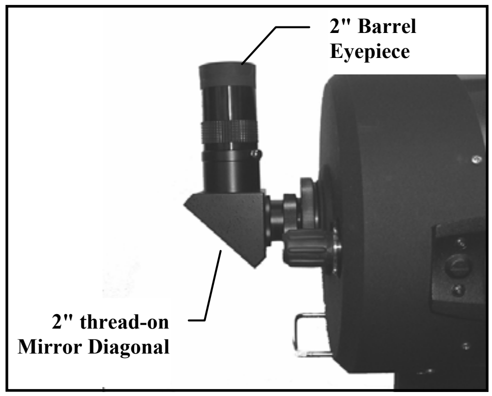


Figure 1-3 – 14" Rear Cell

The 14" OTA comes with a 2" mirror diagonal that attaches directly onto the rear threads of the optical tube. See figure 1-3.

If you wish to change the orientation of the star diagonal, loosen the set screw on the visual back until the star diagonal rotates freely. Rotate the diagonal to the desired position and tighten the set screw.

Installing the Eyepiece

The eyepiece, or ocular, is an optical element that magnifies the image focused by the telescope. The eyepiece fits into either the visual back directly or the star diagonal. To install an eyepiece:

1. Loosen the set screw on the star diagonal until the tip no longer extends into the inner diameter of the eyepiece end of the diagonal.

2. Slide the chrome portion of the eyepiece into the star diagonal.

3. Tighten the set screw on the star diagonal to hold the eyepiece in place.

To remove the eyepiece, loosen the set screw on the star diagonal and slide the eyepiece out. You can replace it with another eyepiece (purchased separately).

Eyepieces are commonly referred to by focal length and barrel diameter. The focal length of each eyepiece is printed on the eyepiece barrel. The longer the focal length (i.e., the larger the number) the lower the eyepiece power and the shorter the focal length (i.e., the smaller the number) the higher the magnification. Generally, you will use low-to-moderate power when viewing. For more information on how to determine power, see the section on "Calculating Magnification."

Installing the Finderscope

The Celestron tube assembly come with a finderscope used to help you locate and center objects in the main field of your telescope. To accomplish this, the finder has a built-in cross-hair reticle that shows the optical center of the finderscope.

Start by removing the finder and hardware from the plastic wrapper. Included are the following:

• Finderscope
• Finder Bracket
• Rubber O-ring
• Three Nylon Tipped Thumbscrews (10-24x1/2")
• Two Phillips Head Screws (8-32x1/2" or 10-24x1/2")

To install the finderscope:

1. Attach the bracket to the optical tube. To do this, place the curved portion of the bracket with the slot over the two holes in the rear cell. The bracket should be oriented so that the rings that hold the finder are over the telescope tube, not the rear cell (see Fig 1-4). Start threading the screws in by hand and tighten fully with an Allen wrench.

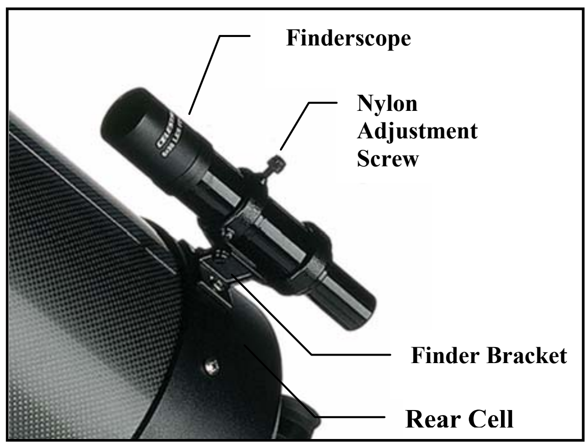


Figure 1-4

2. Partially thread-in the three nylon-tipped thumbscrews that hold the finder in place inside the bracket. Tighten the screws until the nylon heads are flush with the inner diameter of the bracket ring. Do NOT thread them in completely or they will interfere with the placement of the finder. (Having the screws in place when the finder is installed will be easier than trying to insert the screws after the finder has been installed.)

3. Slide the rubber O-ring over the back of the finder (it will NOT fit over the objective end of the finder). It may need to be stretched a little. Once on the main body of the finder, slide it up about one inch from the end of the finder.

4. Rotate the finder until one cross hair is parallel to the R.A. axis and the other is parallel to the DEC axis.

5. Slide the eyepiece end of the finder into the front of the bracket.

6. Slightly tighten the three nylon tipped thumbscrews on the front ring of the bracket to hold the finder in place.

7. Once on, push the finder back until the O-ring is snug inside the back ring of the finder bracket.

8. Hand tighten the three nylon tipped thumbscrews until snug.

Aligning the Finderscope

Accurate alignment of the finder makes it easy to find objects with the telescope, especially celestial objects. To make aligning the finder as easy as possible, this procedure should be done in the daytime when it is easy to find and identify objects. The finderscope has three adjustment screws that put pressure on the finderscope while adjusting the finder horizontally and vertically. To align the finder:

1 Choose a target that is in excess of one mile away. This eliminates any possible parallax effect between the telescope and finder.

2 Release the altitude and azimuth clamps and point the telescope at your target.

3 Center your target in the main optics of the telescope. You may have to move the telescope slightly to center it.

4 Adjust the screw on the finder bracket that is on the right (when looking through the finder) until the crosshairs are centered horizontally on the target seen through the telescope.

5 Adjust the screw on the top of the finder bracket until the crosshairs are centered vertically on the target seen through the telescope.

Image orientation through the finder is inverted (i.e., upside down and backwards left-to-right). This is normal for any finder that is used straight-through. Because of this, it may take a few minutes to familiarize yourself with the directional change each screw makes on the finder.

Focusing

The Schmidt-Cassegrain focusing mechanism controls the primary mirror which is mounted on a ring that slides back and forth on the primary baffle tube. The focusing knob, which moves the primary mirror, is on the rear cell of the telescope just below the star diagonal and eyepiece. Turn the focusing knob until the image is sharp. If the knob will not turn, it has reached the end of its travel on the focusing mechanism. Turn the knob in the opposite direction until the image is sharp. Once an image is in focus, turn the knob clockwise to focus on a closer object and counterclockwise for a more distant object. A single turn of the focusing knob moves the primary mirror only slightly. Therefore, it will take many turns (about 30) to go from close focus to infinity.

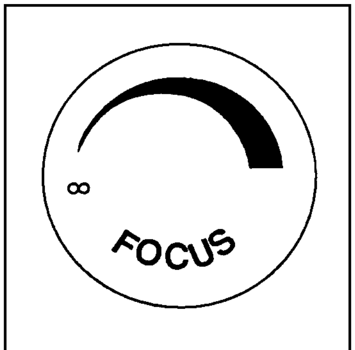


Figure 1-5
The emblem on the end of the focus knob shows the correct rotational direction for focusing your telescope.

For astronomical viewing, out of focus star images are very diffuse, making them difficult to see. If you turn the focus knob too quickly, you can go right through focus without seeing the image. To avoid this problem, your first astronomical target should be a bright object (like the Moon or a planet) so that the image is visible even when out of focus. Critical focusing is best accomplished when the focusing knob is turned in such a manner that the mirror moves against the pull of gravity. In doing so, any mirror shift is minimized. For astronomical observing, both visually and photographically, this is done by turning the focus knob counterclockwise.

C14 Users: *Before turning the focus knob, remember to lossen to two mirror locking knobs located on the rear cell of the telescope. These knobs connect a screw to the primary mirror mounting plate and prevent the mirror from moving when locked down. These screws should be locked down when transporting the telescope.*

Image Orientation

The image orientation changes depending on how the eyepiece is inserted into the telescope. When using the star diagonal, the image is right-side-up, but reversed from left-to-right (i.e., mirror image). If inserting the eyepiece directly into the visual back (i.e., without the star diagonal), the image is upside-down and reversed from left-to-right (i.e., inverted). This is normal for the Schmidt-Cassegrain design.

Actual image orientation as seen with the unaided eye

Reversed from left to right, as viewed with a Star Diagonal

Inverted image, as viewed with the eyepiece directly in telescope

Figure 1-6

Calculating Magnification

You can change the power of your telescope just by changing the eyepiece (ocular). To determine the magnification of your telescope, simply divide the focal length of the telescope by the focal length of the eyepiece used. In equation format, the formula looks like this:

$$\text{Magnification} = \frac{\text{Focal Length of Telescope (mm)}}{\text{Focal Length of Eyepiece (mm)}}$$

Let's say, for example, you are using the 40mm Plossl eyepiece. To determine the magnification you simply divide the focal length of your telescope (the C8 OTA for example has a focal length of 2032mm) by the focal length of the eyepiece, 40mm. Dividing 2032 by 40 yields a magnification of 51 power.

Although the power is variable, each instrument under average skies has a limit to the highest useful magnification. The general rule is that 60 power can be used for every inch of aperture. For example, the C8 is 8 inches in diameter. Multiplying 8 by 60 gives a maximum useful magnification of 480 power. Although this is the maximum useful magnification, most observing is done in the range of 20 to 35 power for every inch of aperture which is 160 to 280 times for the C8 telescope.

Determining Field of View

Determining the field of view is important if you want to get an idea of the angular size of the object you are observing. To calculate the actual field of view, divide the apparent field of the eyepiece (supplied by the eyepiece manufacturer) by the magnification. In equation format, the formula looks like this:

$$\text{True Field} = \frac{\text{Apparent Field of Eyepiece}}{\text{Magnification}}$$

As you can see, before determining the field of view, you must calculate the magnification. Using the example in the previous section, we can determine the field of view using the same 40mm eyepiece. The 40mm Plossl eyepiece has an apparent field of view of 46°. Divide the 46° by the magnification, which is 51 power. This yields an actual field of .9°, or nearly a full degree.

To convert degrees to feet at 1,000 yards, which is more useful for terrestrial observing, simply multiply by 52.5. Continuing with our example, multiply the angular field .9° by 52.5. This produces a linear field width of 47 feet at a distance of one thousand yards. The apparent field of each eyepiece that Celestron manufactures is found in the Celestron Accessory Catalog (#93685).

Fastar Lens Assembly Option – Using your CGE telescope at f/2 with optional Fastar Lens Assembly

Some C8 and C14 optical tubes are equipped with a removable secondary mirror (see Table 1-1) that allows you to convert your f/10 telescope into an f/2 imaging system capable of exposure times 25 times shorter than those needed with a f/10 system! With the optional Fastar lens assembly you can easily convert your Fastar compatible telescope to f/2 prime focus use in a matter of seconds.

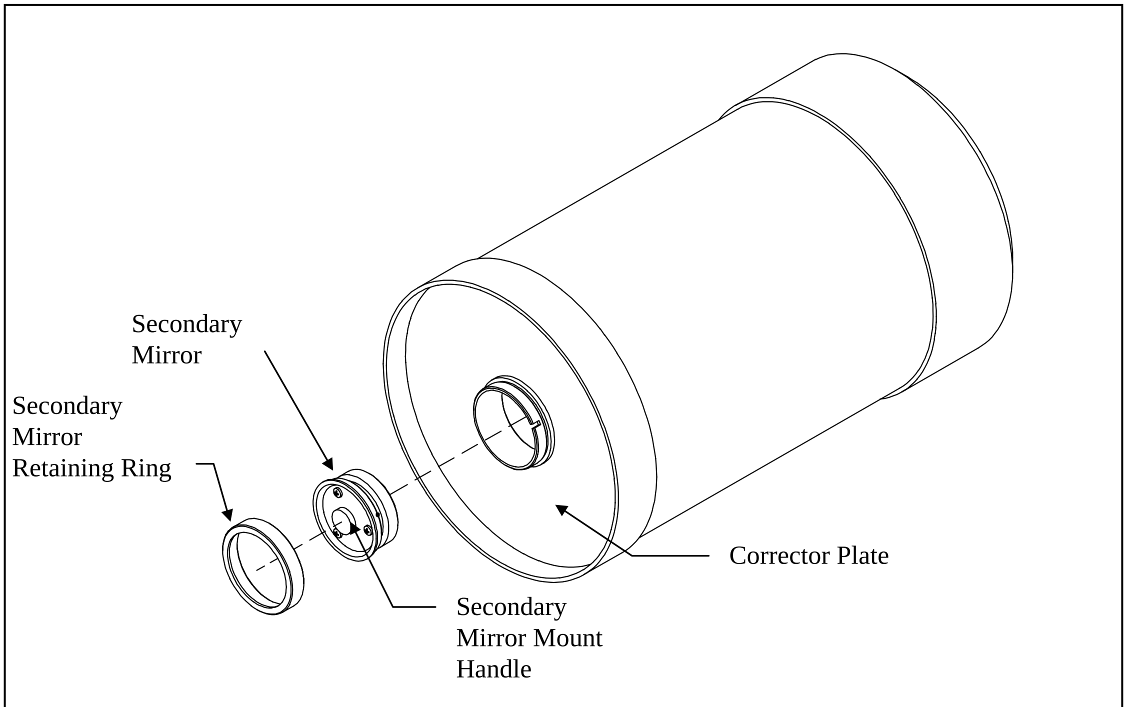


Figure 1-7 - The Fastar Compatible Optical System

The Fastar compatible CGE telescope's versatility allows it to be used in many different f-number configurations for CCD imaging. It can be used at f/2 (with optional Fastar Lens Assembly), f/6.3 (with the optional Reducer/Corrector), f/10, and f/20 (with the optional 2x Barlow) making it the most versatile imaging system available today. This makes the system ideal for imaging deep-sky objects as well as planetary detail. Described below is the configuration of each F-number and the type of object best suited to that kind of imaging.

The above figure shows how the secondary mirror is removed when using the optional CCD camera at f/2 and the Fastar Lens Assembly.

Warning: The secondary mirror should never be removed unless installing the optional Fastar Lens Assembly. Adjustments to collimation can easily be made by turning the screws on the top of the secondary mirror mount without ever having to remove the secondary mirror (see Telescope Maintenance section of this manual).

The F/# stands for the ratio between the focal length and the diameter of the light gathering element. A C8 optical tube has a focal length of 80 inches and a diameter of 8 inches. This makes the system an f/10, (focal length divided by diameter). However, the C14 optical tube has a 154 inch focal length with a F-ratio of f/11. When the secondary is removed and the CCD camera is placed at the Fastar position, the system becomes f/2, this is a unique feature to some Celestron telescopes (see figures below).

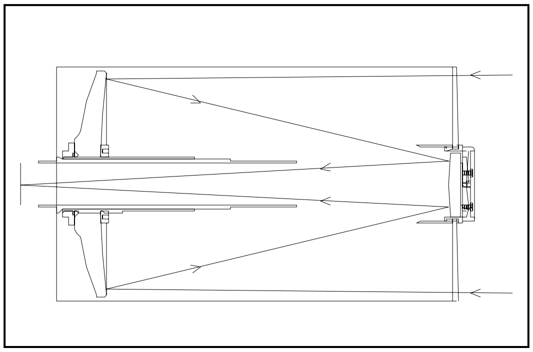


Figure 1-8

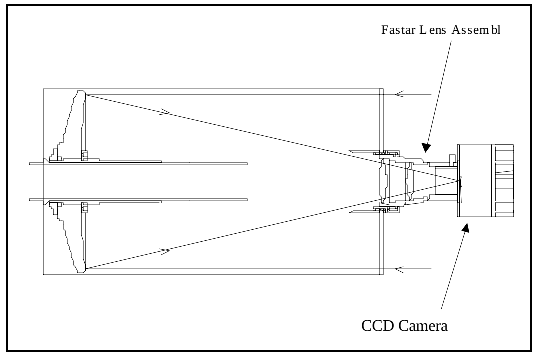


Figure 1-9

The key factors for good CCD imaging are; exposure time, field-of-view, image size, and pixel resolution. As the F/# goes down (or gets faster), the exposure times needed decreases, the field-of-view-increases, but the image scale of the object gets smaller. What is the difference between f/2 and f/10? F/2 has 1/5 the focal length of f/10. That makes the exposure time needed about 25 times shorter than at f/10, the field of view 5 times larger and the object size 1/5 compared to that of f/10. (see Table below)

	Telescope Model	**Standard Cassegrain f/10**	**With Reducer/Corrector f/6.3**	**With Fastar Lens Accessory f/2**
FOCAL LENGTH & SPEED	CGE 800	80" (2032mm)	50.4" (1280mm)	16" (406.4mm)
	CGE 1400	154" (3910mm)	88.2" (2239mm)	29.4" (746mm)
ST 237 F.O.V.*	CGE 800	8 x 6.1 (arc min)	12.6 x 9.7 (arc min)	40 x 30 (arc min)
	CGE 1400	4 x 3 (arc min)	7 x 5.5 (arc min)	22 x 17 (arc min)

* Field of view calculated using SBIG ST 237 CCD camera with 4.7mm x 3.6mm chip.

Table 1-2

Care and Cleaning of the Optics

Occasionally, dust and/or moisture may build up on the corrector plate of your telescope. Special care should be taken when cleaning any instrument so as not to damage the optics.

If dust has built up on the corrector plate, remove it with a brush (made of camel's hair) or a can of pressurized air. Spray at an angle to the lens for approximately two to four seconds. Then, use an optical cleaning solution and white tissue paper to remove any remaining debris. Apply the solution to the tissue and then apply the tissue paper to the lens. Low pressure strokes should go from the center of the corrector to the outer portion. **Do NOT rub in circles!**

You can use a commercially made lens cleaner or mix your own. A good cleaning solution is isopropyl alcohol mixed with distilled water. The solution should be 60% isopropyl alcohol and 40% distilled water. Or, liquid dish soap diluted with water (a couple of drops per one quart of water) can be used.

Occasionally, you may experience dew build-up on the corrector plate of your telescope during an observing session. If you want to continue observing, the dew must be removed, either with a hair dryer (on low setting) or by pointing the telescope at the ground until the dew has evaporated.

If moisture condenses on the inside of the corrector, remove the accessories from the rear cell of the telescope. Place the telescope in a dust-free environment and point it down. This will remove the moisture from the telescope tube.

To minimize the need to clean your telescope, replace all lens covers once you have finished using it. Since the rear cell is NOT sealed, the cover should be placed over the opening when not in use. This will prevent contaminants from entering the optical tube.

Internal adjustments and cleaning should be done only by the Celestron repair department. If your telescope is in need of internal cleaning, please call the factory for a return authorization number and price quote.

Collimation

The optical performance of your telescope is directly related to its collimation, that is the alignment of its optical system. Your telescope was collimated at the factory after it was completely assembled. However, if the telescope is dropped or jarred severely during transport, it may have to be collimated. The only optical element that may need to be adjusted, or is possible, is the tilt of the secondary mirror.

Figure 1-10
The three collimation screws are located on the front of the secondary mirror housing.

To check the collimation of your telescope you will need a light source. A bright star near the zenith is ideal since there is a minimal amount of atmospheric distortion. Make sure that tracking is on so that you won't have to manually track the star. Or, if you do not want to power up your telescope, you can use Polaris. Its position relative to the celestial pole means that it moves very little thus eliminating the need to manually track it.

Before you begin the collimation process, be sure that your telescope is in thermal equilibrium with the surroundings. Allow 45 minutes for the telescope to reach equilibrium if you move it between large temperature extremes.

To verify collimation, view a star near the zenith. Use a medium to high power ocular — 12mm to 6mm focal length. It is important to center a star in the center of the field to judge collimation. Slowly cross in and out of focus and judge the symmetry of the star. If you see a systematic skewing of the star to one side, then re-collimation is needed.

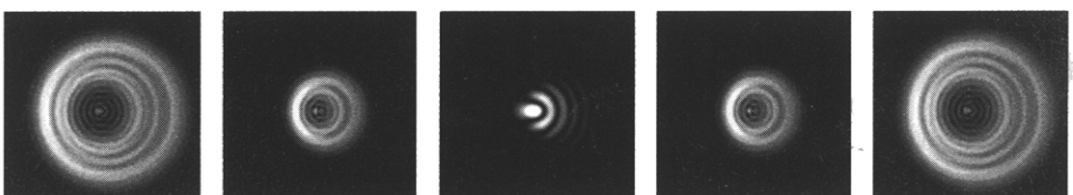


Figure 1-11 -- Even though the star pattern appears the same on both sides of focus, they are asymmetric. The dark obstruction is skewed off to the left side of the diffraction pattern indicating poor collimation.

To accomplish this, you need to tighten the secondary collimation screw(s) that move the star across the field toward the direction of the skewed light. These screws are located in the secondary mirror holder (see figure 1-10). Make only small 1/6 to 1/8 adjustments to the collimation screws and re-center the star by moving the scope before making any improvements or before making further adjustments.

To make collimation a simple procedure, follow these easy steps:

1. While looking through a medium to high power eyepiece, de-focus a bright star until a ring pattern with a dark shadow appears (see figure 1-11). Center the de-focused star and notice in which direction the central shadow is skewed.

2. Place your finger along the edge of the front cell of the telescope (be careful not to touch the corrector plate), pointing towards the collimation screws. The shadow of your finger should be visible when looking into the eyepiece. Rotate your finger around the tube edge until its shadow is seen closest to the narrowest portion of the rings (i.e. the same direction in which the central shadow is skewed).

3. Locate the collimation screw closest to where your finger is positioned. This will be the collimation screw you will need to adjust first. (If your finger is positioned exactly between two of the collimation screws, then you will need to adjust the screw opposite where your finger is located).

4. Use the hand control buttons to move the de-focused star image to the edge of the field of view, in the same direction that the central obstruction of the star image is skewed.

5. While looking through the eyepiece, use an Allen wrench to turn the collimation screw you located in step 2 and 3. Usually a tenth of a turn is enough to notice a change in collimation. If the star image moves out of the field of view in the direction that the central shadow is skewed, than you are turning the collimation screw the wrong way. Turn the screw in the opposite direction, so that the star image is moving towards the center of the field of view.

6. If while turning you notice that the screws get very loose, then simply tighten the other two screws by the same amount. Conversely, if the collimation screw gets too tight, then loosen the other two screws by the same amount.

7. Once the star image is in the center of the field of view, check to see if the rings are concentric. If the central obstruction is still skewed in the same direction, then continue turning the screw(s) in the same direction. If you find that the ring pattern is skewed in a different direction, than simply repeat steps 2 through 6 as described above for the new direction.

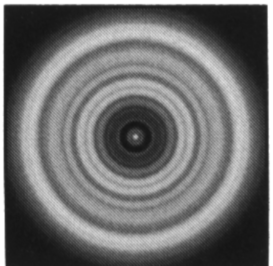


Figure1-12
A collimated telescope should appear symmetrical with the central obstruction centered in the star's diffraction pattern.

Perfect collimation will yield a star image very symmetrical just inside and outside of focus. In addition, perfect collimation delivers the optimal optical performance specifications that your telescope is built to achieve.

If seeing (i.e., air steadiness) is turbulent, collimation is difficult to judge. Wait until a better night if it is turbulent or aim to a steadier part of the sky. A steadier part of the sky is judged by steady versus twinkling stars.

CELESTRON TWO YEAR WARRANTY

A. Celestron warrants this telescope to be free from defects in materials and workmanship for two years. Celestron will repair or replace such product or part thereof which, upon inspection by Celestron, is found to be defective in materials or workmanship. As a condition to the obligation of Celestron to repair or replace such product, the product must be returned to Celestron together with proof-of-purchase satisfactory to Celestron.

B. The Proper Return Authorization Number must be obtained from Celestron in advance of return. Call Celestron at (310) 328-9560 to receive the number to be displayed on the outside of your shipping container.

All returns must be accompanied by a written statement setting forth the name, address, and daytime telephone number of the owner, together with a brief description of any claimed defects. Parts or product for which replacement is made shall become the property of Celestron.

The customer shall be responsible for all costs of transportation and insurance, both to and from the factory of Celestron, and shall be required to prepay such costs.

Celestron shall use reasonable efforts to repair or replace any telescope covered by this warranty within thirty days of receipt. In the event repair or replacement shall require more than thirty days, Celestron shall notify the customer accordingly. Celestron reserves the right to replace any product which has been discontinued from its product line with a new product of comparable value and function.

This warranty shall be void and of no force of effect in the event a covered product has been modified in design or function, or subjected to abuse, misuse, mishandling or unauthorized repair. Further, product malfunction or deterioration due to normal wear is not covered by this warranty.

CELESTRON DISCLAIMS ANY WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY OF FITNESS FOR A PARTICULAR USE, EXCEPT AS EXPRESSLY SET FORTH HEREIN.

THE SOLE OBLIGATION OF CELESTRON UNDER THIS LIMITED WARRANTY SHALL BE TO REPAIR OR REPLACE THE COVERED PRODUCT, IN ACCORDANCE WITH THE TERMS SET FORTH HEREIN. CELESTRON EXPRESSLY DISCLAIMS ANY LOST PROFITS, GENERAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES WHICH MAY RESULT FROM BREACH OF ANY WARRANTY, OR ARISING OUT OF THE USE OR INABILITY TO USE ANY CELESTRON PRODUCT. ANY WARRANTIES WHICH ARE IMPLIED AND WHICH CANNOT BE DISCLAIMED SHALL BE LIMITED IN DURATION TO A TERM OF TWO YEARS FROM THE DATE OF ORIGINAL RETAIL PURCHASE.

Some states do not allow the exclusion or limitation of incidental or consequential damages or limitation on how long an implied warranty lasts, so the above limitations and exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Celestron reserves the right to modify or discontinue, without prior notice to you, any model or style telescope.

If warranty problems arise, or if you need assistance in using your telescope contact:

Celestron
Customer Service Department
2835 Columbia Street
Torrance, CA 90503
Tel. (310) 328-9560
Fax. (310) 212-5835
Monday-Friday 8AM-4PM PST

This warranty supersedes all other product warranties.

NOTE: This warranty is valid to U.S.A. and Canadian customers who have purchased this product from an Authorized Celestron Dealer in the U.S.A. or Canada. Warranty outside the U.S.A. and Canada is valid only to customers who purchased from a Celestron Distributor or Authorized Celestron Dealer in the specific country and please contact them for any warranty service.

Celestron
2835 Columbia Street
Torrance, CA 90503
Tel. (310) 328-9560
Fax. (310) 212-5835
Web site at http//www.celestron.com

(Products or instructions may change
without notice or obligation.)

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$10.00
05-05

TELESCOPE MAINTENANCE

ENGLISH

While your telescope requires little maintenance, there are a few things to remember that will ensure your telescope performs at its best. Each optical design type has special collimation instructions described below. **Many lower cost Refractor and/or Newtonian telescopes do not have the capability of collimation and thus you only need to refer to the care and cleaning of the optics information.** The collimation instructions show images of typical Celestron telescopes, and your telescope may be somewhat different, but the overall functions/methods are similar.

CARE AND CLEANING OF THE OPTICS

Occasionally dust and/or moisture may build up on the objective lens, the corrector plate, or primary mirror depending on which type of telescope you have. Special care should be taken when cleaning any instrument so as not to damage the optics.

If dust has built up on the optics, remove it with a brush (made of camel's hair) or a can of pressurized air (spray at an angle to the glass surface for approximately two to four seconds). Then, use an optical cleaning solution and white tissue paper to remove any remaining debris. Apply the solution to the tissue and then apply the tissue paper to the optics. Low pressure strokes should go from the center of the lens (or mirror) to the outer portion. **DO NOT rub in circles!**

You can use a commercially made lens cleaner or mix your own. A good cleaning solution is isopropyl alcohol mixed with distilled water. The solution should be 60% isopropyl alcohol and 40% distilled water. Or, liquid dish soap diluted with water (a couple of drops per one quart of water) can be used.

Occasionally, you may experience dew build-up on the optics of your telescope during an observing session. If you want to continue observing, the dew must be removed, either with a hair dryer (on low setting) or by pointing the telescope at the ground until the dew has evaporated.

If moisture condenses on the inside of the optics, remove the accessories from the telescope. Place the telescope in a dust-free environment and point it down. This will remove the moisture from the telescope tube.

To minimize the need to clean your telescope, replace all lens covers once you have finished using it. Since the cells are NOT sealed, the covers should be placed over the openings when not in use. This will prevent contaminants from entering the optical tube.

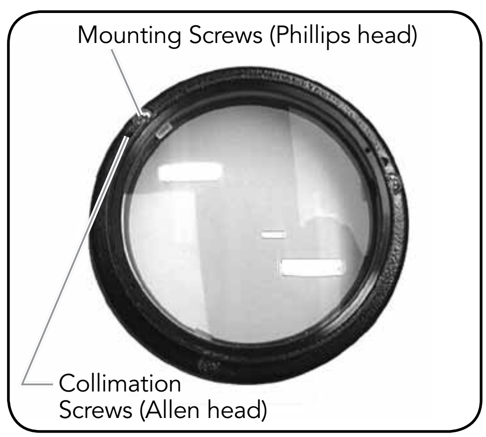
Internal adjustments and cleaning should be done only by the Celestron repair department or a qualified Celestron dealer.

COLLIMATION OF REFRACTORS

Be sure to completely read carefully before attempting collimation. Collimation is the process of aligning the optical axis of each optical element with each other and with the mechanical axis of the telescope tube. For a refractor telescope design, this means aligning the optical axis of the objective lens with the optical axis of the eyepiece on the rear end of the tube. Your refractor was properly aligned at the factory. However, extremely rough handling while traveling may eventually alter the alignment of the lens. Your refractor telescope may come with an adjustable objective lens housing to assist in the alignment of the optical axis. It is rare that collimation would be necessary, and if your telescope does not have collimation adjustment screws, you may have to send it to the factory for alignment.

To determine whether or not re-collimation is necessary, the telescope should be set up outside at night. It should be a still night and one in which you have let the telescope sit outside for 15 to 30 minutes before attempting collimation. You should also wait for a night with good seeing conditions and avoid looking over anything that produces heat waves (i.e., roof tops, car hoods, etc.).

Pick a bright star and center it in the field of the telescope. Study the image of the star while racking it in and out of focus using an eyepiece that yields 30 to 60 power for every inch of aperture. If an unsymmetrical focus pattern is present, then collimation is necessary. (If the telescope is properly collimated, the out of focus star image will appear as a concentric ring pattern similar to that shown).



OBJECTIVE LENS HOUSING (WITH LENS SHADE REMOVED) SHOW MOUNTING AND COLLIMATION SCREWS.

To collimate, the telescope should be on either a motor driven (i.e., tracking) equatorial mount that is approximately polar aligned or pointed at a stationary star without the motor drive running. Polaris, the North Star, is the perfect collimation star for northern hemisphere observers since it appears motionless against the background sky long enough to perform the collimation procedure. Polaris is the last star in the handle of the Little Dipper (Ursa Minor), and its distance above the northern horizon is always equal to your latitude angle.

Prior to collimating, locate the three (3) mounting screws on the objective lens housing on the front of the tube. (These screws attach the objective lens housing to the main tube and should not be removed). It may be necessary to remove the lens shade from the front of the tube to allow easy access to the collimation screws. Next to each mounting screw is a shorter Allen screw (collimation screw) that pushes against the optical tube to pivot the objective lens housing. In order to make an adjustment, the mounting screw is loosened while the Allen screw is turned in or out. Then, the mounting screw is tightened. Only one of the three (3) sets is adjusted at a time. Normally motions on the order of 1/8 turn will make a difference, with only about 1/2 to 3/4 turn being the maximum required. **DO NOT remove or back out the mounting screws more than one (1) to two (2) turns!**

With Polaris or another bright star centered in the field of view, focus with your highest power eyepiece (i.e., one with the shortest focal length). This includes eyepieces in the 4 mm to 6 mm range. The star should be well centered in the field of view of the eyepiece. It may be helpful for two people working together, while one views and instructs the other which screws are correctly turned and by how much. Start by loosening one Phillips head (mounting) screw about 1 turn and advancing the Allen screw to see if the motion is correct. If not, undo the step and try another set of screws.

After making the first adjustment, it is necessary to re-aim the telescope tube to center the star again in the field of view. It can then be judged for symmetry by going just inside and outside of exact focus and noting the star's pattern. Improvement should be seen if the proper adjustments are made. Since three (3) sets of screws are present, it may be necessary to move at least two (2) sets of screws to achieve the necessary lens movement. **DO NOT over tighten the outer mounting screws!**

Once in collimation, your telescope should not need additional collimation unless the telescope has been bumped or jarred severely.

A COLLIMATED TELESCOPE SHOULD APPEAR AS A SYMMETRICAL RING PAT TERN SIMILAR TO THE DIFFRACTION DISK SEEN HERE.

Refractor Collimating Eyepiece — Some refractors include a collimating eyepiece (if not, you should consider purchasing one from a dealer) that can help you to roughly check the alignment of your telescope in the daytime. The collimating eyepiece has a pinhole site that helps you determine if the optics are properly aligned with the tube. With the focuser racked in all the way and the diagonal removed, place the collimating eyepiece inside the focuser tube. If the telescope is properly collimated, you should be able to see the entire edge of the objective lens when looking through the pin hole. If the objective lens appears oval, then it may be necessary to collimate the telescope as described above.

Refractor Collimating Eyepiece- Some refractors include a collimating eyepiece (if not, you should consider purchasing one from a dealer) that can help you to roughly check the alignment of your telescope in the daytime. The collimating eyepiece has a pinhole site that helps you determine if the optics are properly aligned with the tube. With the focuser racked in all the way and the diagonal removed, place the collimating eyepiece inside the focuser tube. If the telescope is properly collimated, you should be able to see the entire edge of the objective lens when looking through the pin hole. If the objective lens appears oval, then it may be necessary to collimate the telescope as described above.

Collimation of a Schmidt-Cassegrain

The optical performance of your telescope is directly related to its collimation, the alignment of its optical system. Your telescope was collimated at the factory after it was completely assembled. However, if the telescope is dropped or jarred severely during transport, it may have to be collimated. The only optical element that may need to be adjusted, or is possible, is the tilt of the secondary mirror.

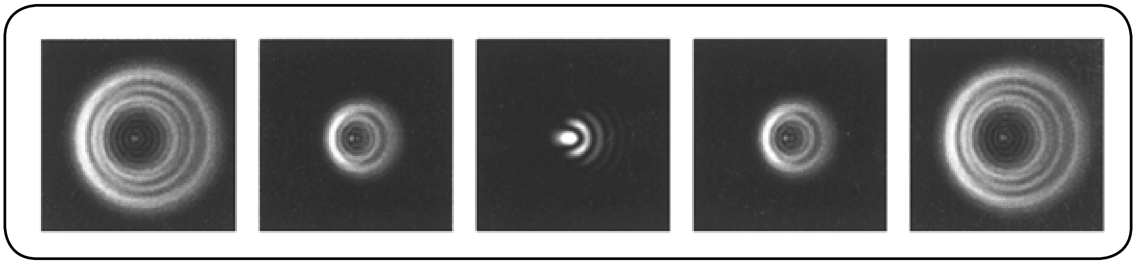
To check the collimation of your telescope you will need a light source. A bright star near the zenith is ideal since there is a minimal amount of atmospheric distortion. Make sure that tracking (with an optional motor drive) is on so that you won't have to manually track the star. Or, if you do not want to power up your telescope, you can use Polaris. Its position relative to the celestial pole means that it moves very little thus eliminating the need to manually track it.

Before you begin the collimation process, be sure that your telescope is in thermal equilibrium with the surroundings. Allow 45 minutes for the telescope to reach equilibrium if you move between large temperature extremes.

To verify collimation, view a star near the zenith. Use a medium to high power ocular — 12 mm to 6 mm focal length. It is important to center a star in the center of the field to judge collimation. Slowly cross in and out of focus and judge the symmetry of the star. If you see a systematic skewing of the star to one side, then re-collimation is needed.

THE THREE COLLIMATION SCREWS ARE LOCATED ON THE FRONT OF THE SECONDARY MIRROR HOUSING.

To accomplish this, you need to tighten the secondary collimation screw(s) that move the star across the field toward the direction of the skewed light. These screws are located in the secondary mirror holder. Make only small 1/6 to 1/8 adjustments to the collimation screws and re-center the star by moving the scope before making any improvements or before making further adjustments.



Even though the star pattern appears the same on both sides of focus, they are asymmetric. The dark obstruction is skewed off to the left side of the diffraction pattern indicating poor collimation.

To make collimation a simple procedure, follow these easy steps:

1. While looking through a medium to high power eyepiece, de-focus a bright star until a ring pattern with a dark shadow appears. Center the de-focused star and notice in which direction the central shadow is skewed.
2. Place your finger along the edge of the front cell of the telescope (be careful not to touch the corrector plate), pointing towards the collimation screws. The shadow of your finger should be visible when looking into the eyepiece. Rotate your finger around the tube edge until its shadow is seen closest to the narrowest portion of the rings (i.e. the same direction in which the central shadow is skewed).
3. Locate the collimation screw closest to where your finger is positioned. This will be the collimation screw you will need to adjust first. (If your finger is positioned exactly between two of the collimation screws, then you will need to adjust the screw opposite where your finger is located).
4. Use the hand control buttons to move the de-focused star image to the edge of the field of view, in the same direction that the central obstruction of the star image is skewed.
5. While looking through the eyepiece, use an Allen wrench or Phillips screwdriver to turn the collimation screw you located in step 2 and 3. Usually a tenth of a turn is enough to notice a change in collimation. If the star image moves out of the field of view in the direction that the central shadow is skewed, than you are turning the collimation screw the wrong way. Turn the screw in the opposite direction, so that the star image is moving towards the center of the field of view.
6. While turning, if you notice that the screws get very loose, then simply tighten the other two screws by the same amount. Conversely, if the collimation screw gets too tight, then loosen the other two screws by the same amount.
7. Once the star image is in the center of the field of view, check to see if the rings are concentric. If the central obstruction is still skewed in the same direction, then continue turning the screw(s) in the same direction. If you find that the ring pattern is skewed in a different direction, than simply repeat steps 2 through 6 as above for the new direction.

Perfect collimation will yield a star image very symmetrical just inside and outside of focus. In addition, perfect collimation delivers the optimal optical performance specifications that your telescope is built to achieve.

If seeing (i.e., air steadiness) is turbulent, collimation is difficult to judge. Wait until a better night if it is turbulent or aim to a steadier part of the sky. A steadier part of the sky is judged by steady versus twinkling stars.

A collimated telescope should appear symmetrical with the central obstruction centered in the star's diffraction pattern.

Collimation of a Newtonian

The optical performance of most Newtonian reflecting telescopes can be optimized by re-collimating (aligning) the telescope's optics, as needed. To collimate the telescope simply means to bring its optical elements into balance. Poor collimation will result in optical aberrations and distortions.

Before collimating your telescope, take time to familiarize yourself with all its components. The primary mirror is the large mirror at the back end of the telescope tube. This mirror is adjusted by loosening and tightening the three screws, placed 120 degrees apart, at the end of the telescope tube. The secondary mirror (the small, elliptical mirror under the focuser, in the front of the tube) also has three adjustment screws.

Aligning the Secondary Mirror

The following describes the procedure for daytime collimation of your telescope using an optional Newtonian Collimation Tool/Cap available from many telescope dealers. To collimate the telescope without the Collimation Tool, read the following section on night time star collimation. For very precise collimation, the optional Collimation Eyepiece 1 1/4" (# 94182) is offered.

To determine if your telescope needs collimation, first point your telescope toward a bright wall or blue sky outside.

Never look directly at the Sun with the naked eye or with a telescope (unless you have the proper solar filter). Permanent and irreversible eye damage may result.

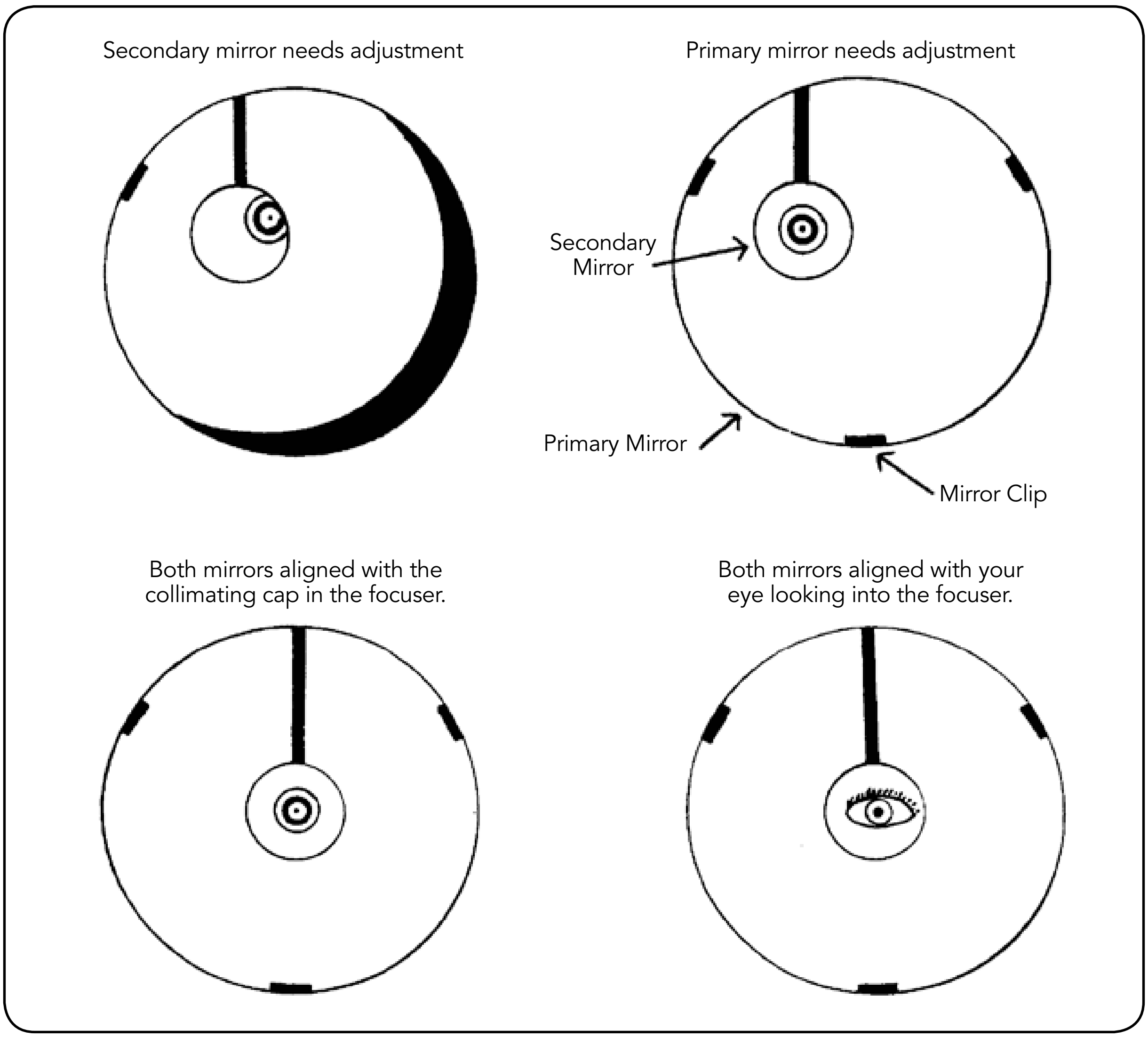
If you have an eyepiece in the focuser, remove it. Rack the focuser tube in completely, using the focusing knobs, until its silver tube is no longer visible. You will be looking through the focuser at a reflection of the secondary mirror, projected from the primary mirror. During this step, ignore the silhouetted reflection from the primary mirror. Insert the collimating cap into the focuser and look through it. With the focus pulled in all the way, you should be able to see the entire primary mirror reflected in the secondary mirror. If the primary mirror is not centered in the secondary mirror, adjust the secondary mirror screws by alternately tightening and loosening them until the periphery of the primary mirror is centered in your view. DO NOT loosen or tighten the center screw in the secondary mirror support, because it maintains proper mirror position.

Aligning the Primary Mirror

Now adjust the primary mirror screws to re-center the reflection of the small secondary mirror, so it's silhouetted against the view of the primary. As you look into the focuser, silhouettes of the mirrors should look concentric. Repeat steps one and two until you have achieved this.

Remove the collimating cap and look into the focuser, where you should see the reflection of your eye in the secondary mirror.

Newtonian collimation views as seen through the focuser using a collimation tool /cap



Night Time Star Collimating

After successfully completing daytime collimation, night time star collimation can be done by closely adjusting the primary mirror while the telescope tube is on its mount and pointing at a bright star. The telescope should be set up at night and a star's image should be studied at medium to high power (30-60 power per inch of aperture). If a non-symmetrical focus pattern is present, then it may be possible to correct this by re-collimating only the primary mirror.

Procedure — Please read this section completely before beginning.

To star collimate in the Northern Hemisphere, point at a stationary star like the North Star (Polaris). It can be found in the northern sky, at a distance above the horizon equal to your latitude. It's also the end star in the handle of the Little Dipper. Polaris is not the brightest star in the sky and may even appear dim, depending upon your sky conditions. ***If you are in the Southern Hemisphere, point at the star Sigma Octantis.***

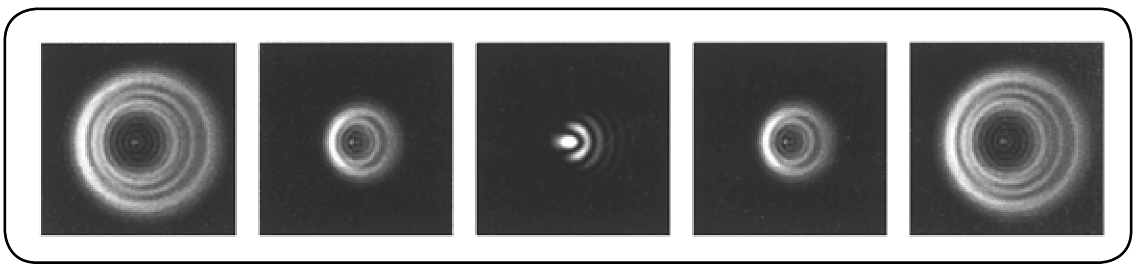
The three collimation screws are located on the front of the secondary mirror housing.

Prior to re-collimating the primary mirror, locate the collimation screws on the rear of the telescope tube. The rear cell has three large thumbscrews which are used for collimation and three small thumbscrews which are used to lock the mirror in place. The collimation screws tilt the primary mirror. You will start by loosening the small locking screws a few turns each. Normally, motions on the order of a 1/8 turn will make a difference, with approximately a 1/2 to 3/4 turn being the maximum required for the large collimation screws. Turn one collimation screw at a time and with a collimation tool or eyepiece, see how the collimation is affected (see the paragraph below). It will take some experimenting, but you will eventually get the centering you desire.

It is best to use the optional collimation tool or collimating eyepiece. Look into the focuser and notice if the secondary reflection has moved closer to the center of the primary mirror.

With Polaris or a bright star centered within the field of view, focus with either the standard ocular or your highest power ocular, i.e., the shortest focal length in mm, such as a 6 mm or 4 mm. Another option is to use a longer focal length ocular with a Barlow lens. When a star is in focus it should look like a sharp pinpoint of light. If, when focusing on the star, it is irregular in shape or appears to have a flare of light at its edge, this means your mirrors aren't in alignment. If you notice the appearance of a flare of light from the star that remains stable in location, just as you go in and out of exact focus, then re-collimation will help sharpen the image.

When satisfied with the collimation, tighten the small locking screws.



Even though the star pattern appears the same on both sides of focus, they are asymmetric. The dark obstruction is skewed off to the left side of the diffraction pattern indicating poor collimation.

Take note of the direction the light appears to flare. For example, if it appears to flare toward the three o'clock position in the field of view, then you must move whichever screw or combination of collimation screws necessary to move the star's image toward the direction of the flaring. In this example, you would want to move the image of the star in your eyepiece, by adjusting the collimation screws, toward the three o'clock position in the field of view. It may only be necessary to adjust a screw enough to move the star's image from the center of the field of view to about halfway, or less, toward the field's edge (when using a high power ocular).

Collimation adjustments are best made while viewing the star's position in the field of view and turning the adjustment screws simultaneously. This way, you can see exactly which way the movement occurs. It may be helpful to have two people working together: one viewing and instructing which screws to turn and by how much, while the other performing the adjustments.

IMPORTANT: After making the first, or each adjustment, it is necessary to re-aim the telescope tube to re-center the star again in the center of the field of view. The star image can then be judged for symmetry by going just inside and outside of exact focus and noting the star's pattern. Improvement should be seen if the proper adjustments are made. Since three screws are present, it may be necessary to move at least two of them to achieve the necessary mirror movement.

A collimated telescope should appear as a symmetrical ring pat tern similar to the diffraction disk seen here.

SCT & EdgeHD Collimation Guide

To get the best performance from your Schmidt-Cassegrain (SCT) or EdgeHD telescope, its optics must be collimated–properly aligned within the telescope. Your telescope was collimated at the factory when it was assembled, and its collimation was QA-checked before it was shipped. However, if the telescope has been dropped or jarred during transport or has undergone considerable temperature changes, it may need to be re-collimated.

You can achieve correct collimation by adjusting the tilt of the secondary mirror housed at the center of the Schmidt corrector (see **Figure 1**). This is the only adjustment available to the end user and should be the only adjustment required to bring the telescope's optics into excellent collimation.

NOTE: Do not attempt to make adjustments to the Schmidt corrector's orientation or positioning. Doing so will likely degrade collimation and optical performance and may require return to Celestron to achieve proper optical alignment.

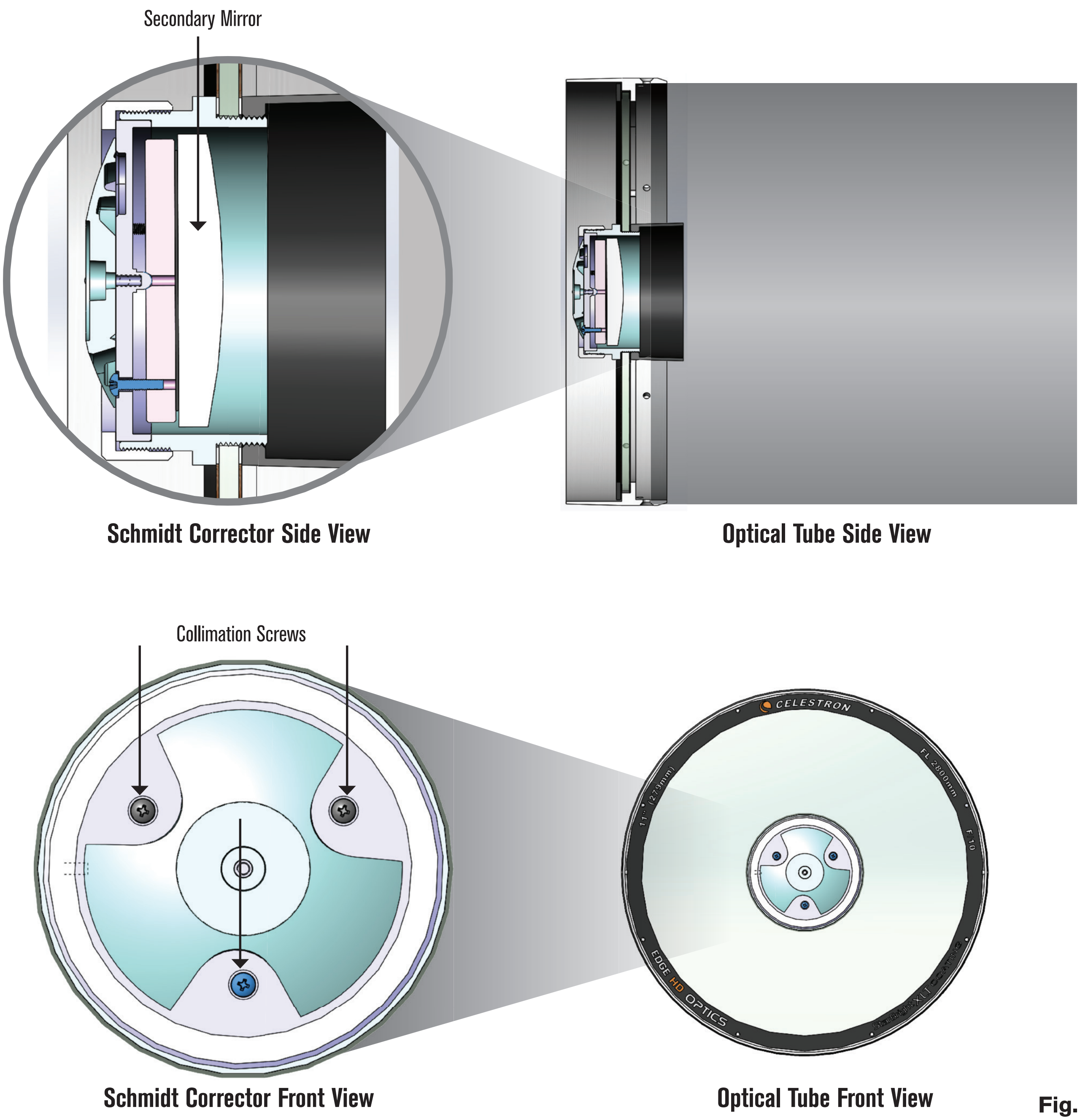


Fig. 1

CHECKING COLLIMATION – HOW DO I KNOW IF MY OPTICS NEED ADJUSTMENT?

Checking optical collimation is quick and easy. We recommend taking a few moments to check collimation before each observing session. To do this, you'll need to examine a star image through the telescope's eyepiece.

1. To begin, set up your telescope as you normally would for an observing session. Connect a higher power eyepiece (ideally, 10mm focal length or less). Before you begin, be sure that your telescope is in thermal equilibrium with its surroundings. Allow 45 minutes for the telescope to reach equilibrium if you move it between large temperature extremes, like from a heated car or house into the cold night air.

2. Choose a star at least 20 degrees above the horizon to minimize the effect of atmospheric seeing conditions and slew the telescope to it. Center the star in the field of view.

3 Defocus the telescope by about one turn of the focus knob until the star image appears doughnut shaped. There will be brighter rings of light surrounded by a dark hole (i.e. the shadow from the secondary obstruction) in the center (see **Figure 2**). If the telescope is collimated, the hole should appear centered relative to the rings. If the hole is not centered, then adjustment to the collimation is needed (see **Figure 3**).

4. Next, check the other side of focus by reversing direction of the focus knob so that the centered star is focused and then defocused again. The hole should still be centered in the rings. If it isn't, some collimation adjustment is needed.

If you are unsure if the telescope needs adjustment or not, the collimation is likely OK. In this case, it's best not to make any adjustments, as doing so can easily make the collimation worse, not better.

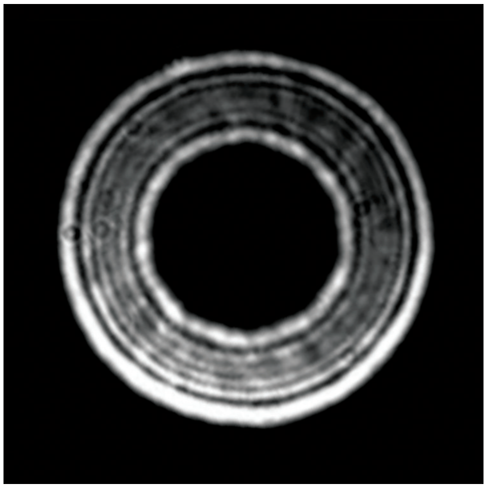


Fig. 2 Out of focus star with proper collimation

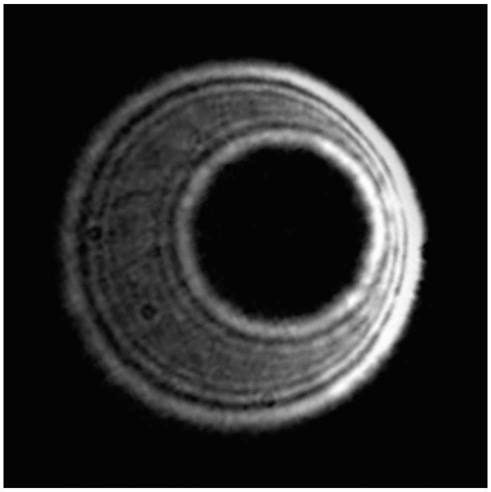


Fig. 3 Out of focus star with collimation needed

COLLIMATION SETUP

As you did when checking collimation, make sure your system is acclimatized to the outside temperature before you begin the collimation process.

To collimate your SCT or EdgeHD, you will need a pinpoint light source. A bright star works great. A bright star near the zenith is ideal since there is minimal atmospheric distortion in that part of the sky. Make sure that your mount's tracking is turned on, so the star won't drift as you are making collimation adjustments. Or, if you are using a roughly polar aligned equatorial mount and you do not want to power up your telescope, you can choose Polaris as your collimation star. Its position relative to the celestial pole means that it moves very little, eliminating the need to track it.

If seeing conditions (i.e. air steadiness) are turbulent, collimation will be difficult to judge (see **Figure 4**). This is because the extra-focal diffraction patterns that need to be evaluated will be smeared and blurred. Wait until a better night if it is turbulent or aim to a steadier part of the sky. Look for a part of the sky with steady—not twinkling—stars. If stars are twinkling, then conditions are poor, and it may be hard to achieve proper collimation. If seeing conditions are good (see **Figure 5**), you can use a high-powered eyepiece (i.e. focal length less than 10mm) to achieve the most precise optical alignment. If seeing conditions are ideal, use an eyepiece with even more magnification (i.e. focal length between 2.3mm and 7mm) for the best results.

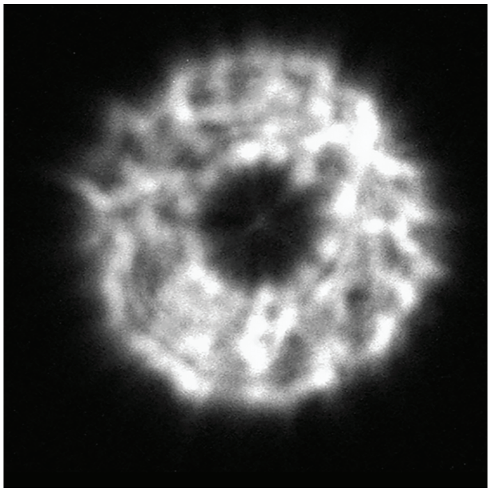


Fig. 4 Out of focus star under turbulent conditions

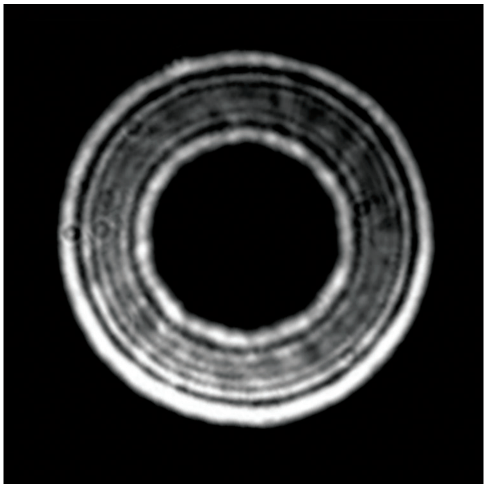


Fig. 5 Out of focus star under good seeing conditions

Next, if you have one attached, remove the dew shield from your telescope. This will provide best access to the collimation screws.

NOTE: If you are outside in heavy dew conditions when attempting to collimate, you may need to consider using an optional dew heater system; this will prevent dew from forming on the Schmidt corrector while you adjust collimation.

When connecting the eyepiece to the telescope, make sure all thumbscrews are firmly tightened, as this helps ensure the eyepiece is best mechanically aligned with the optical axis. Also, make sure the retaining ring that connects the visual back to the rear cell of the telescope is securely tightened. If you will be subsequently using the telescope for imaging with a camera, consider collimating the telescope with the eyepiece inserted directly into the visual back, without a diagonal in place. Doing so will remove any source of alignment error which may arise from the diagonal itself.

After making each collimation adjustment, you will need to re-center the bright star in the eyepiece. If using a computerized mount, you should use your telescope's hand control to move the telescope (use a slow speed rate) and re-center the star. So, make sure the hand control is in a handy location nearby.

COLLIMATION PROCESS

To collimate your telescope, you'll use a Phillips-head screwdriver to make adjustments to the collimation screws on the back of the secondary mirror assembly. These three screws are clearly visible when looking at the front of most telescopes (see **Figure 6**).

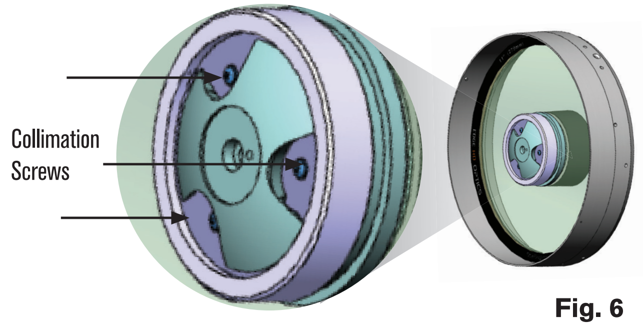


Fig. 6

Some older SCT telescopes have an orange cap that covers the collimation screws (see **Figure 7**). Carefully use a flat-head instrument or other tool to pry the cap off. There are a couple of tabs on the plastic cap that connect it to the rear of the secondary mirror assembly. Once the cover is removed, it's easy to see and access the three collimation screws.

Fig. 7

There are three collimation screws; each can be adjusted to change the tilt of the secondary mirror. All three screws provide a "tip/tilt" adjustment system, if you loosen one screw, then the other two screws should be tightened. Conversely, if you tighten one screw, then the other two screws should be slightly loosened (see **Figure 8**). In practice, since each screw will only be loosened or tightened by a very small amount at a time, it is not necessary to adjust all three screws at once, as there is some flex in the mechanical assembly. However, if you do tighten (or loosen) one of the screws by a significant amount, then the other two screws will need to be loosened (or tightened) at some point in order to provide the proper screw tension.

WARNING: When using the screwdriver to make adjustments to the collimation screws, stay focused and be careful not to inadvertently scratch the Schmidt corrector. Use a red-light flashlight, if needed, to illuminate the collimation screws so you can make sure you put the screwdriver tip in the head of the intended screw.

The goal of making adjustments to the collimation screws is to center the central shadow (i.e. the hole) in the defocused star image. Make only small 1/10th-of-a-turn adjustments at most to each of the collimation screws.

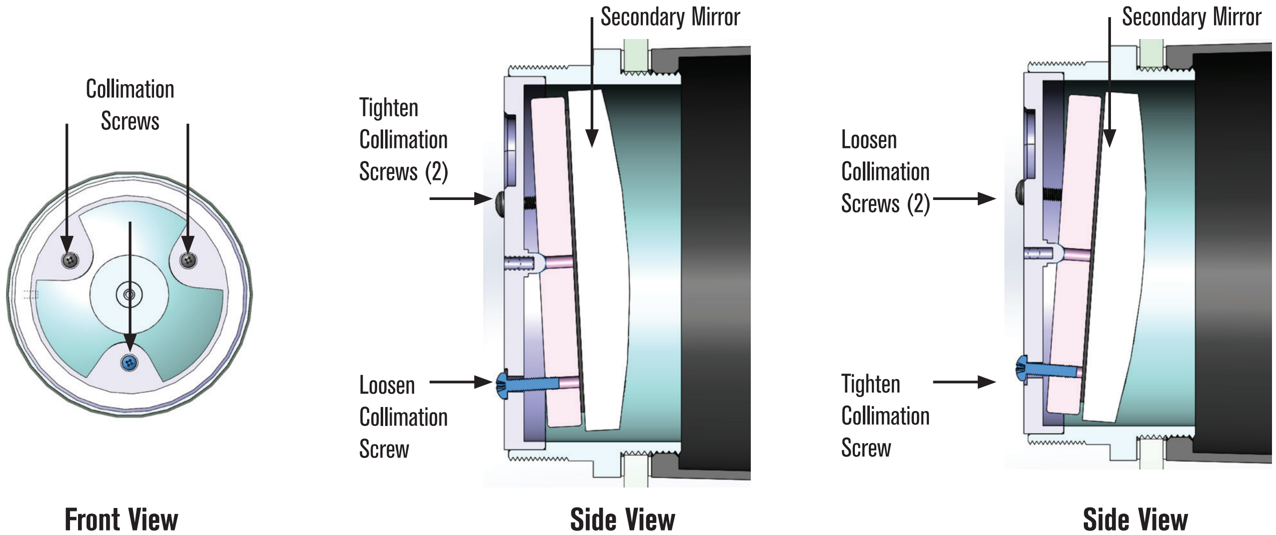
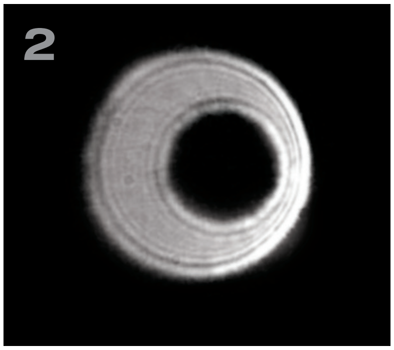


Fig. 8

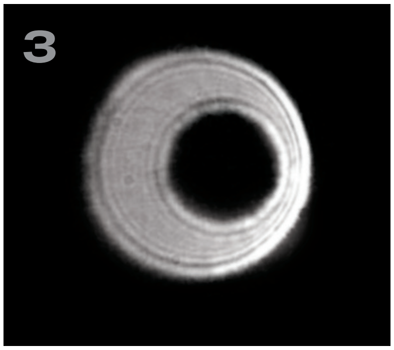
Be sure to re-center the star in the eyepiece's field of view by moving the telescope on its mount after making any adjustments to the collimation screws. If the star is not centered in the field of view, interpretation of the defocused star images will not be accurate to determine proper collimation. As discussed previously, using shorter focal length eyepieces will increase magnification and improve the centering precision of the star within the field of view of the eyepiece.

To collimate the SCT or EdgeHD, follow these steps:

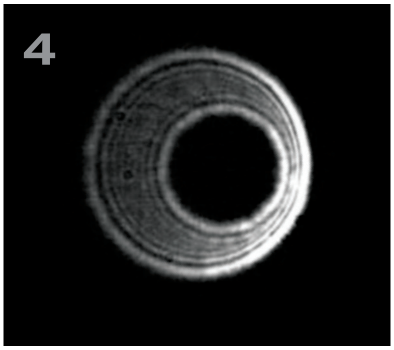
1. Center the bright star in the eyepiece's field of view. Insert the highest power eyepiece that can be used with good results under current seeing conditions.



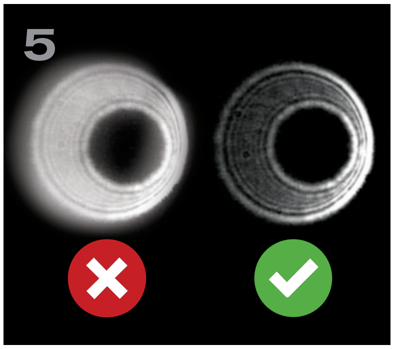
2. Defocus the star until you can see a dark "hole" in the center (i.e. the shadow of the secondary mirror) and 2-4 diffraction rings of light around it. If you defocus the star too much, it may be difficult to determine precise collimation, and it will also become dimmer and harder to see. If you defocus the star too little, you won't be able to distinctly see the hole and rings.



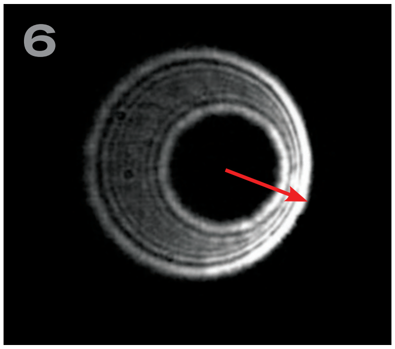
3. Inspect the out-of-focus ("extra-focal") diffraction pattern.



4. Next, turn the focus knob in the opposite direction. This will cause the image to pass through focus and become defocused on the other side of focus. Again, defocus the image until you can see the central hole and 2-4 rings of light around it.

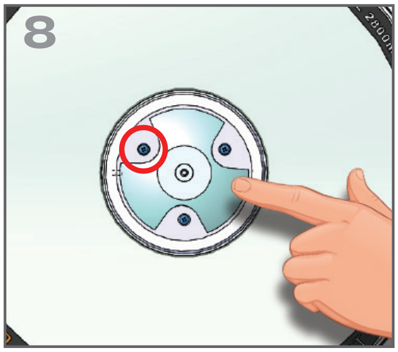


5. Inspect the extra-focal diffraction pattern on the other side of focus to see if one side of focus provides a slightly better appearance of the light and dark diffraction rings. Whichever side of focus has clearer light and dark diffraction rings should be used for collimation purposes.

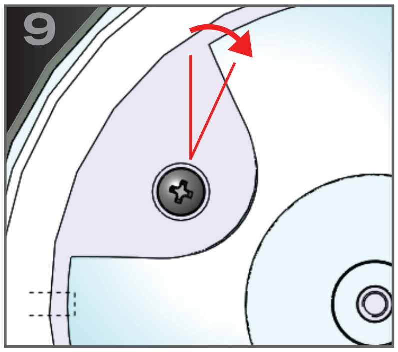


6. Make sure the star is still centered in the eyepiece's field of view. Note the direction in which the central shadow and the diffraction inner bright ring are skewed relative to the bright outer diffraction ring

7. Place your finger along the edge of the front cell of the telescope pointing towards the collimation screws, taking care not to touch the Schmidt corrector. The shadow of your finger should be visible when looking at the extra-focal diffraction pattern in the eyepiece. Rotate your finger around the tube edge until its shadow is closest to the narrowest portion of the rings (i.e. the same direction in which the central shadow is skewed)

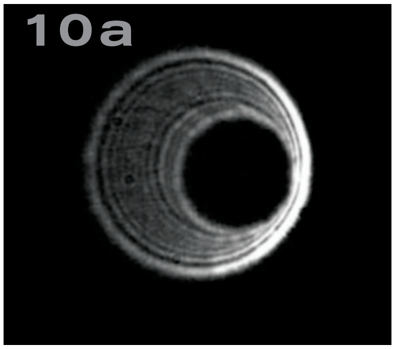


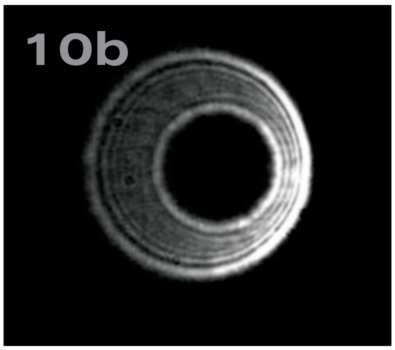
8. Locate the collimation screw closest to where your finger is pointing. This is the collimation screw you should adjust first. If your finger is pointing exactly between two collimation screws, adjust the one that is further away from your finger.



9. Use the screwdriver to turn the collimation screw identified in Step 8. Very slightly tighten the screw. Usually, 1/10th of a turn of the screw is enough to notice a change in collimation. Then, look in the eyepiece and re-center the star in the field of view by moving the telescope mount. Use a slow speed rate to do this, as the field of view will be quite narrow.

NOTE: If you turn the collimation screw too much, the star may no longer appear in the field of view, especially if you are using a very short focal length eyepiece. If this occurs, use the telescope's finderscope to find and re-center the star. Make only very small adjustments to each collimation screw, and the star should always appear somewhere in the field of the eyepiece before re-centering.





10. Confirm that the diffraction pattern's central shadow and inner bright ring have moved closer to the center relative to the bright outer ring.

a. If the central shadow and inner ring are now further de-centered, try loosening the collimation screw instead of tightening it. Remember to re-center the star in the field of view after each adjustment.

b. If the central shadow and inner ring have moved closer, continue to make adjustments in the same way until the shadow and inner ring are as centered as they can get using that collimation screw. Remember to re-center the star in the field of view after making each adjustment.

NOTE: If you notice while making adjustments that one of the collimation screws becomes very tight, slightly loosen the other two collimation screws by an equal amount. This will relieve pressure on the screw that was tight, and you should be able to continue to make adjustments by tightening the screw. Conversely, if you notice that the collimation screw becomes too loose when loosening it, tighten the other two screws (refer to **Figure 8**).

11. If the central shadow and inner ring are still not centered relative to the outer ring when centered in the field of view, you will need to make adjustments to one of the other collimation screws. Go back to Step 6 and repeat the process. This time, you will make adjustments to a different collimation screw.

Proper Collimation

You have achieved proper collimation when the central shadow and the bright inner diffraction ring are concentric with the bright outer diffraction ring, and the thin concentric dark ring (in between these two bright rings) extinguishes uniformly and simultaneously as you slowly pass through focus (see **Figure 9**). Proper collimation yields a star image diffraction pattern that is concentrically similar just inside and outside of focus. In addition, proper collimation delivers the optimal optical performance specifications that your telescope is built to achieve.

Fig. 9

WARNING: If you cannot collimate your SCT or EdgeHD using the collimation screws, do not attempt to make any other adjustments to the optics or mechanics of the telescope! Doing so will not only likely put your telescope further out of alignment, it will also void your warranty. Instead, contact Celestron Technical Support by submitting a ticket here: celestron.com/pages/technical-support. Your telescope may need to be returned to Celestron for warranty evaluation (or paid repair, if the warranty has expired).

CONCLUSION

Collimating your telescope is an important part of ensuring its best performance and best images. While you should quickly check your telescope's collimation before each observing session, it is unlikely that collimation adjustments will be required on a regular basis. The exception would be in cases when the telescope is transported and not well-secured during a bumpy ride.

Collimation is not necessarily difficult to do but requires some learning and some patience. After adjusting your telescope's collimation a few times, you'll get the hang of it. The process will become easier and less time-consuming. Good luck and clear skies!

CELESTRON

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2835 Columbia Street • Torrance, CA 90503 U.S.A.

0820

NexStar Communication Protocol

This document describes the serial commands supported by the Celestron NexStar hand control. This information applies to the NexStar GPS, NexStar GPS-SA, NexStar iSeries, NexStar SE Series, NexStar GT, CPC, SLT, Advanced-GT, and CGE mounts.

Communication to the hand control is 9600 bits/sec, no parity and one stop bit via the RS-232 port on the base of the hand control.

Note: the GT hand control prior to version 104.0 should be treated as version 1.2 in the tables below. Version 104.0 should be treated as version 4.03.

Get Position Commands

The following commands retrieve the position of the telescope in either RA/DEC or AZM-ALT coordinates.

The position is returned as a hexadecimal value that represents the fraction of a revolution around the axis. Two examples are given below:

- If the Get RA/DEC command returns 34AB,12CE then the DEC value is 12CE in hexadecimal. As a percentage of a revolution, this is 4814/65536 = 0.07346. To calculate degrees, simply multiply by 360, giving a value of 26.4441 degrees.
- If the precise GET AZM-ALT command returns 12AB0500,40000500 then the AZM value is 12AB0500 in hexadecimal. As a percentage of a revolution, this is 313197824/4294967296 = 0.0729 or 26.252 degrees.

The standard commands offer a precision of 1/65536 * 360 * 60 * 60 = about 19.8 arcseconds per unit while the precise commands offer a precision of 1/16777216 * 360 * 60 * 60 = about 0.08 arcseconds per unit (only the upper 24 bits are used).

Note: if the telescope has not been aligned, the RA/DEC values will not be meaningful and the AZM-ALT values will be relative to where the telescope was powered on. After alignment, RA/DEC values will reflect the actual sky, azimuth will be indexed to North equals 0 and altitude will be indexed with 0 equal to the orientation where the optical tube is perpendicular to the azimuth axis.

Command Function	**PC Command**	**Hand Control Response**	**Applies to Versions**
Get RA/DEC	"E"	"34AB,12CE#"	1.2+
Get precise RA/DEC	"e"	"34AB0500,12CE0500#"	1.6+
Get AZM-ALT	"Z"	"12AB,4000#"	1.2+
Get precise AZM-ALT	"z"	"12AB0500,40000500#"	2.2+

GOTO Commands

The following commands direct the telescope to GOTO a specified RA/DEC or AZM-ALT position. As with the Get Position commands, the values are in hexadecimal and represent the fraction of a rotation around the axis.

Note: GOTO RA/DEC commands will not work unless the telescope is aligned.

Command Function	**PC Command**	**Hand Control Response**	**Applies to Versions**
GOTO RA/DEC	"R34AB,12CE"	"#"	1.2+
GOTO precise RA/DEC	"r34AB0500,12CE0500"	"#"	1.6+
GOTO AZM-ALT	"B12AB,4000"	"#"	1.2+

GOTO precise AZM-ALT	"b12AB0500,40000500"	"#"	2.2+

Sync

To Sync to an object via serial commands, the user should center a known object in an eyepiece. Then the Sync serial command should be sent, using the celestial coordinates (RA and DEC) for that object. This causes future GOTO or Get Position commands to use coordinates relative to the Sync'd position, improving pointing accuracy to nearby objects. (we probably don't need to mention "from the planetarium package" since it also improves pointing accuracy if they GoTo objects via the hand control.) The format for the RA/DEC positions in the Sync command is identical to the GOTO RA/Dec command.

Command Function	**PC Command**	**Hand Control Response**	**Applies to Versions**
Sync RA/DEC	"S34AB,12CE"	"#"	4.10+
Sync precise RA/DEC	"s34AB0500,12CE0500"	"#"	4.10+

Tracking Commands

The following commands retrieve or set the tracking mode.

Depending on the mount type, following tracking modes are available:
0 = Off
1 = Alt/Az
2 = EQ North
3 = EQ South

Note: On the CGE and Advanced GT hand control versions 3.01 through 3.04 the value for EQ North is 1 and EQ South is 2. This has been corrected to match the other models in current hand control versions.

Command Function	**PC Command**	**Hand Control Response**	**Applies to Versions**
Get Tracking Mode	"t"	chr(mode) & "#"	2.3+
Set Tracking Mode	"T" & chr(mode)	"#"	1.6+

Slewing Commands

The following commands allow you to slew (move) the telescope at fixed or variable rates.

For **variable rates**, multiply the desired rate by 4 and then separate it into a high and low byte. For example if the desired tracking rate is 150 arcseconds/second, then:
trackRateHigh = (150 * 4) \ 256 = 2, and
trackRateLow = (150 * 4) mod 256 = 88

For **fixed rates**, simply use a value from 1-9 (or 0 to stop) to mimic the equivalent hand control rates.

Note: in most configurations, issuing the slew commands will override (or conflict with) the tracking mode of the mount. Hence it is always best to disable tracking first using the **Tracking Commands**, issue the slew command, then re-enable tracking. The main exception to this is when tracking equatorially - the **fixed rate** slews at 1 or 2 will not override tracking. This can be useful to simulate autoguiding.

Note: on GT models, the fixed rate slews at rate 9 move at 3 degrees per second instead of the maximum rate.

Command Function	PC Command	Hand Control Response	Applies to Versions
Variable rate Azm (or RA) slew in positive direction	“P” & chr(3) & chr(16) & chr(6) & chr(trackRateHigh) & chr(trackRateLow) & chr(0) & chr(0)	“#”	1.6+
Variable rate Azm (or RA) slew in negative direction	“P” & chr(3) & chr(16) & chr(7) & chr(trackRateHigh) & chr(trackRateLow) & chr(0) & chr(0)	“#”	1.6+
Variable rate Alt (or Dec) slew in positive direction	“P” & chr(3) & chr(17) & chr(6) & chr(trackRateHigh) & chr(trackRateLow) & chr(0) & chr(0)	“#”	1.6+
Variable rate Alt (or Dec) slew in negative direction	“P” & chr(3) & chr(17) & chr(7) & chr(trackRateHigh) & chr(trackRateLow) & chr(0) & chr(0)	“#”	1.6+
Fixed rate Azm (or RA) slew in positive direction	“P” & chr(2) & chr(16) & chr(36) & chr(rate) & chr(0) & chr(0) & chr(0)	“#”	1.6+
Fixed rate Azm (or RA) slew in negative direction	“P” & chr(2) & chr(16) & chr(37) & chr(rate) & chr(0) & chr(0) & chr(0)	“#”	1.6+
Fixed rate Alt (or DEC)	“P” &	“#”	1.6+

slew in positive direction	chr(2) & chr(17) & chr(36) & chr(rate) & chr(0) & chr(0) & chr(0)		
Fixed rate ALT (or DEC) slew in negative direction	“P” & chr(2) & chr(17) & chr(37) & chr(rate) & chr(0) & chr(0) & chr(0)	“#”	1.6+

Time/Location Commands (Hand Control)

The following commands set the time and location in the hand control.

The format of the location commands is: ABCDEFGH, where:
A is the number of degrees of latitude.
B is the number of minutes of latitude.
C is the number of seconds of latitude.
D is 0 for north and 1 for south.
E is the number of degrees of longitude.
F is the number of minutes of longitude.
G is the number of seconds of longitude.
H is 0 for east and 1 for west.

For example, to set the location to 118°20’17” W, 33°50’41” N, you would send (note that latitude is before longitude):
“W” & chr(33) & chr(50) & chr(41) & chr(0) & chr(118) & chr(20) & chr(17) & chr(1)

The format of the time commands is: QRSTUVWX, where:
Q is the hour (24 hour clock).
R is the minutes.
S is the seconds.
T is the month.
U is the day.
V is the year (century assumed as 20).
W is the offset from GMT for the time zone. **Note**: if zone is negative, use 256-zone.
X is 1 to enable Daylight Savings and 0 for Standard Time.

For example, to set the time to 3:26:00PM on April 6, 2005 in the Eastern time zone (-5 UTC: 256-5 = 251) you would send:
“H” & chr(15) & chr(26) & chr(0) & chr(4) & chr(6) & chr(5) & chr(251) & chr(1)

Note: All values are sent in binary format, not ASCII.

Note: The Get commands do **not** retrieve the time and location from the GPS unit (if one is present). The time and location are retrieved from the hand control. You must first enter the View Time/Site menu to update the hand control time if you want the time from the GPS or, use the GPS Commands in the next section.

Command Function	**PC Command**	**Hand Control**	**Applies to Versions**

		Response	
Get Location	"w"	chr(A) & chr(B) & chr(C) & chr(D) & chr(E) & chr(F) & chr(G) & chr(H) & "#"	2.3+
Set Location	"W" & chr(A) & chr(B) & chr(C) & chr(D) & chr(E) & chr(F) & chr(G) & chr(H)	"#"	2.3+
Get Time	"h"	chr(Q) & chr(R) & chr(S) & chr(T) & chr(U) & chr(V) & chr(W) & chr(X) & "#"	2.3+
Set Time	"H" & chr(Q) & chr(R) & chr(S) & chr(T) & chr(U) & chr(V) & chr(W) & chr(X)	"#"	2.3+

GPS Commands

The following table shows various commands that can be sent to a GPS unit. Note: all units of time are in UT.

Command Function	**PC Command**	**Hand Control Response**	**Applies to Versions**
Is GPS Linked? X > 0 if linked, 0 if not linked	"P" & chr(1) & chr(176) & chr(55) & chr(0) & chr(0) & chr(0) & chr(1)	chr(x) & "#"	1.6+
Get Latitude ((x*65536)+(y*256)+z)/(2	"P" & chr(1) & chr(176) &	chr(x) & chr(y) & chr(z) &	1.6+

^24) is a fraction of a rotation. To convert to degrees, multiply by 360.	chr(1) & chr(0) & chr(0) & chr(0) & chr(3)	“#”	
Get Longitude ((x*65536)+(y*256)+z)/(2^24) is a fraction of a rotation. To convert to degrees, multiply by 360.	“P” & chr(1) & chr(176) & chr(2) & chr(0) & chr(0) & chr(0) & chr(3)	chr(x) & chr(y) & chr(z) & “#”	1.6+
Get Date x is month (1-12) y is day (1-31)	“P” & chr(1) & chr(176) & chr(3) & chr(0) & chr(0) & chr(0) & chr(2)	chr(x) & chr(y) & “#”	1.6+
Get Year (x * 256) + y = year	“P” & chr(1) & chr(176) & chr(4) & chr(0) & chr(0) & chr(0) & chr(2)	chr(x) & chr(y) & “#”	1.6+
Get Time x is the hours y is the minutes z is the seconds	“P” & chr(1) & chr(176) & chr(51) & chr(0) & chr(0) & chr(0) & chr(3)	chr(x) & chr(y) & chr(z) & “#”	1.6+

RTC Commands

The following table shows various RTC commands on the CGE mount.

Command Function	**PC Command**	**Hand Control Response**	**Applies to Versions**
Get Date x is month (1-12) y is day (1-31)	“P” & chr(1) & chr(178) & chr(3) & chr(0) & chr(0) & chr(0) &	chr(x) & chr(y) & “#”	1.6+

	chr(2)		
Get Year (x * 256) + y = year	"P" & chr(1) & chr(178) & chr(4) & chr(0) & chr(0) & chr(0) & chr(2)	chr(x) & chr(y) & "#"	1.6+
Get Time x is the hours y is the minutes z is the seconds	"P" & chr(1) & chr(178) & chr(51) & chr(0) & chr(0) & chr(0) & chr(3)	chr(x) & chr(y) & chr(z) & "#"	1.6+
Set Date x is month (1-12) y is day (1-31)	"P" & chr(3) & chr(178) & chr(131) & chr(x) & chr(y) & chr(0) & chr(0)	"#"	3.01+
Set Year (x * 256) + y = year	"P" & chr(3) & chr(178) & chr(132) & chr(x) & chr(y) & chr(0) & chr(0)	"#"	3.01+
Set Time x is the hours y is the minutes z is the seconds	"P" & chr(4) & chr(178) & chr(179) & chr(x) & chr(y) & chr(z) & chr(0)	"#"	3.01+

Miscellaneous Commands

Command Function	**PC Command**	**Hand Control Response**	**Applies to Versions**
Get Version	"V"	chr(major) & chr(minor) & "#"	1.2+

Get Device Version Devices include: 16 = AZM/RA Motor 17 = ALT/DEC Motor 176 = GPS Unit 178 = RTC (CGE only)	“P” & chr(1) & chr(dev) & chr(254) & chr(0) & chr(0) & chr(0) & chr(2)	chr(major) & chr(minor) & “#”	1.6+
Get Model 1 = GPS Series 3 = i-Series 4 = i-Series SE 5 = CGE 6 = Advanced GT 7 = SLT 9 = CPC 10 = GT 11 = 4/5 SE 12 = 6/8 SE	“m”	chr(model) & “#”	2.2+
Echo - useful to check communication	“K” & chr(x)	chr(x) & “#”	1.2+
Is Alignment Complete? - align=1 if aligned and 0 if not	“J”	chr(align) & #	1.2+
Is GOTO in Progress? - Response is **ASCII** “0” or “1”	“L”	prog & “#”	1.2+
Cancel GOTO	“M”	“#”	1.2+

Developer Notes

Timeouts

If the hand control is sent a command that requires it to communicate with another device, then the hand control will make multiple attempts to get the message through in the event of communications problems. Examples include “Get Position” commands, “GOTO in Progress” commands, etc.
Software drivers should be prepared to wait up to 3.5s (worst case scenario) for a hand control response. If serial commands are “blindly” sent without waiting for a response, then some commands may be dropped or the software driver could see responses that are for earlier commands.

Pass-through Commands with No Response

Commands that start with ‘P’ are special pass-through commands that communicate with a specific telescope device. For instance, the Slew commands talk directly to the motor control. If a ‘P’ command is sent but no response is returned (because the device is not there or the command is unknown or there was a communication problem) then one extra data byte is returned before the ‘#’ terminating character and any returned data is garbage. This is done to give software drivers a flag that something went wrong so appropriate action can be taken. It is particularly useful if you want to check for the existence of a device: for instance, check the time from the GPS unit, and look for an error response. Software drivers should check for the ‘#’ termination character and if it is a different character then the next character (hopefully ‘#’) should be consumed and any command-specific handling should be done.

CELESTRON

CPWI

TELESCOPE CONTROL SOFTWARE

INSTRUCTION MANUAL

Table of Contents

Introduction

Welcome to Celestron PWI (CPWI)! This program allows you to align your Celestron computerized mount, slew to celestial objects, and access many other features directly from your computer. CPWI is equipped with a planetarium SkyViewer, which makes it easy to search for objects and navigate the night sky. You can also use the software to align the mount using the optional StarSense AutoAlign accessory, and even perform an All-Star Polar Alignment directly within CPWI.

Before you get started, please review the PC System Requirements and list of Compatible Celestron Mounts below to ensure your equipment is compatible with CPWI.

PC System Requirements

- Windows 7, 8, or 10 operating system
- PC equipped with USB 2.0 or 3.0 Type A ports (only for cable connection). All of these cables are generic and can be purchased from any supplier. Choose the cable that corresponds best with your mount from the options below.

    1. **For CGX and CGX-L mounts:** USB 2.0 cable (male type A to male type B)
    2. **For telescopes with the newer NexStar+ or StarSense hand controls with a Mini USB port at the bottom:** Mini USB 2.0 cable (male type A to male Mini-B)
    3. **For older NexStar+ or StarSense hand controls with a serial port at the bottom:** USB to serial (male type A to female RS-232 | male RS-232 to serial)

    NOTE: The RS-232 cables can be found on the Celestron website. Search for item #18775 and item #93920. This option requires a two cable connection.

- An internet connection is required to enable location settings and the online object database, or to auto-update drivers for the cables mentioned above
- 24 MB of hard drive storage and 100 MB of memory
- Screen resolution of 1024 x 768 or higher is recommended
- A wireless network connection (i.e. WiFi) signal if you are using a WiFi-enabled telescope or connecting via the SkyPortal WiFi Module #93973

Compatible Celestron Mounts

CPWI is compatible with all new Celestron computerized telescopes equipped with the NexStar+ hand control, StarSense hand control, or integrated WiFi (such as NexStar Evolution and Astro Fi). Please see the full list of compatible telescope mounts below to confirm your mount is compatible with CPWI.

- Advanced GT
- Advanced VX
- Astro Fi
- CGE
- CGE PRO
- CGEM
- CGEM II
- CGEM DX
- CGX
- CGX-L
- CPC
- CPC Deluxe
- LCM
- NexStar Evolution
- NexStar SE
- NexStar SLT
- SkyProdigy

Optional Accessories

- SkyPortal WiFi Module
- StarSense AutoAlign
- SkySync GPS
- Celestron Focus Motor
- Autoguider for PEC training

NOTE: Some Celestron mounts may not have enough AUX ports to accommodate these optional accessories. If you need additional AUX ports, please see item #93919 Aux Port Splitter on the Celestron.com website. Do not connect multiple AUX Splitters to each other, as resistance and power loss may result, which will impact the performance of the mount and the connected accessories.

Installing the Software

1. On the Celestron PWI webpage, find and select the "Download CPWI Software HERE" hyperlink to begin downloading CPWI.

2. Open the Setup_CPWI.exe download file and follow the onscreen steps.

3. Run the application and proceed to install CPWI.

Telescope Setup with an EQ Mount

If you are using an equatorial mount, the mount's RA and Dec axes should be at the index marks or homed, depending on your mount, and roughly polar aligned prior to using the CPWI software. Once roughly polar aligned, you can begin aligning the telescope. Once the alignment is complete, you can use All-Star Polar Alignment (ASPA) to accurately polar align the mount. Later in this manual, you'll find detailed instructions on ASPA.

Telescope Setup with an Alt/Az Mount

The optical tube on your Alt/Az telescope should be roughly level to the ground pointing due north.

NOTE: All users should point the telescope north, regardless of whether they are in the Northern or Southern Hemisphere.

For Northern and Southern Hemisphere users

Telescope Setup with an Alt/Az Mount on a Wedge

If you are using an Alt/Az mount with an equatorial wedge, the optical tube must be at the altitude index mark pointing south if you are in the Northern Hemisphere. If you are in the Southern Hemisphere, your optical tube should be at the index mark pointing north. Be sure you have the mount roughly polar aligned before starting an alignment in CPWI.

Northern Hemisphere

Southern Hemisphere

Connecting your Computer to your Mount

There are three ways you can connect your computer to your mount.

1. Connecting via USB (CGX / CGX-L mounts only)

You will need a USB 2.0 Male Type A to Male Type B cable. Plug the Male Type A connector into the computer and plug in the Male Type B connector into the USB port on the mount.

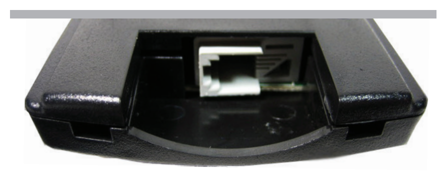
NOTE: USB 3.0 Type B cables are **NOT** compatible with CGX mounts; the 3.0 Type B connector is bigger and will not physically plug into the mount.

NOTE: If you are using the optional Celestron Focus Motor and it is connected to the mount's AUX port, then it is possible to connect via USB to the mount through the focus motor's USB port.

2. Connecting via Hand Control

You can connect to the mount using the port at the bottom of the Celestron hand control. Newer NexStar+ and StarSense hand controls have a Mini USB port at the bottom, while older NexStar+ and StarSense hand controls have a serial port at the bottom.

i. For newer hand controls with Mini USB port, you will need a Mini USB cable (Male Type A to Male Mini B).



ii. Older hand controls with serial port will need the RS-232 cable combination listed in the system requirements above. Connect the RS-232 ports together from each cable, then take the USB end of the cable and plug it into the computer. Next, take the serial end of the cable and plug it into the bottom of the hand control.

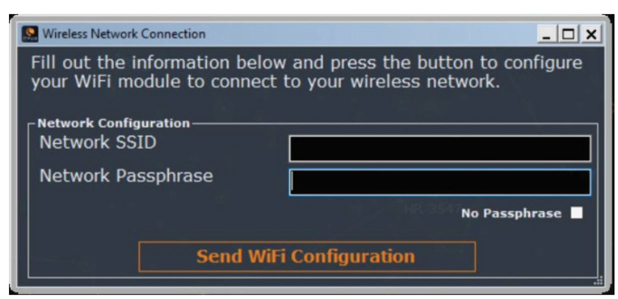
3. Connecting via WiFi

If you are using the SkyPortal WiFi module or if your mount has internal WiFi, there are two ways you can connect via WiFi: Direct Connect mode or Access Point mode. Direct Connect mode is meant for close range wireless control. This is only ideal if you are physically near the telescope with your computer (within 10-20 feet). Access Point mode is meant for remote wireless control. This is useful for backyard or remote observatories where the direct wireless connection won't suffice for a long-range WiFi connection. Unlike Direct Connect mode, Access Point mode allows you to connect to the internet and use CPWI to wirelessly control your telescope at the same time.

If your mount does not have integrated WiFi, start by plugging the SkyPortal WiFi module into an AUX port on the mount. If you are using a Celestron mount with WiFi, the module is not needed.

Direct Connect – Set the WiFi module switch to the Direct Connect position. Go to the wireless network settings on your computer and connect to the WiFi module. It will be identified as "Celestron-___". Once connected, you are ready to open CPWI and connect to the WiFi module directly.

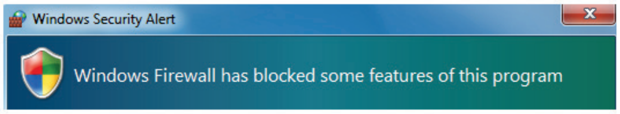
Access Point – To use access mode, you will first need to connect to the WiFi module in Direct Connect mode to enter your home network SSID and password. To do this, first, set the WiFi module switch to the Direct Connect position. Go to the wireless network settings on your computer and connect to the WiFi module. It will be identified as "Celestron-___". Once connected, open CPWI, and select "Start" from the opening screen. Next, go to the Utilities menu on the left side of the screen, and select "WiFi WLAN Config...". A pop-up window will appear, and you can enter your home network SSID and password here. When completed, press "Send WiFi Configuration", and this data will be stored in the WiFi module.



Next, set the WiFi module switch to the Access Point position. Power the module off, then on again. Go to the wireless network settings on your computer and connect to your home network. You are now ready to open CPWI and connect to the WiFi module through your home network.

NOTE: Please refer to your Celestron telescope or WiFi module manual for more information on Direct Connect and Access Point switch position.

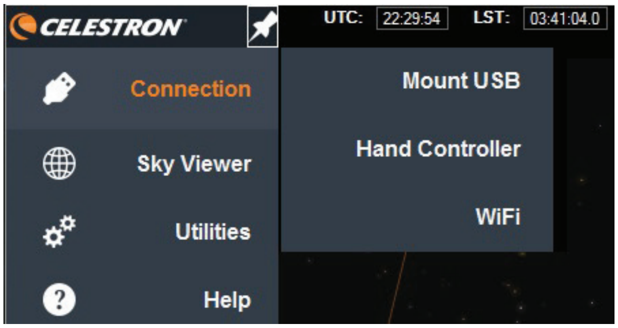
NOTE: For Access Point WiFi connection, you will get a warning from Windows Defender Firewall about some features being blocked for CPWI. To allow Access Point to work, you will need to select all the networks. Make sure the "public networks" and "private networks" boxes are checked. If "domain networks" appears, make sure that box is checked as well, then select "Allow Access".



Connecting CPWI to your Mount

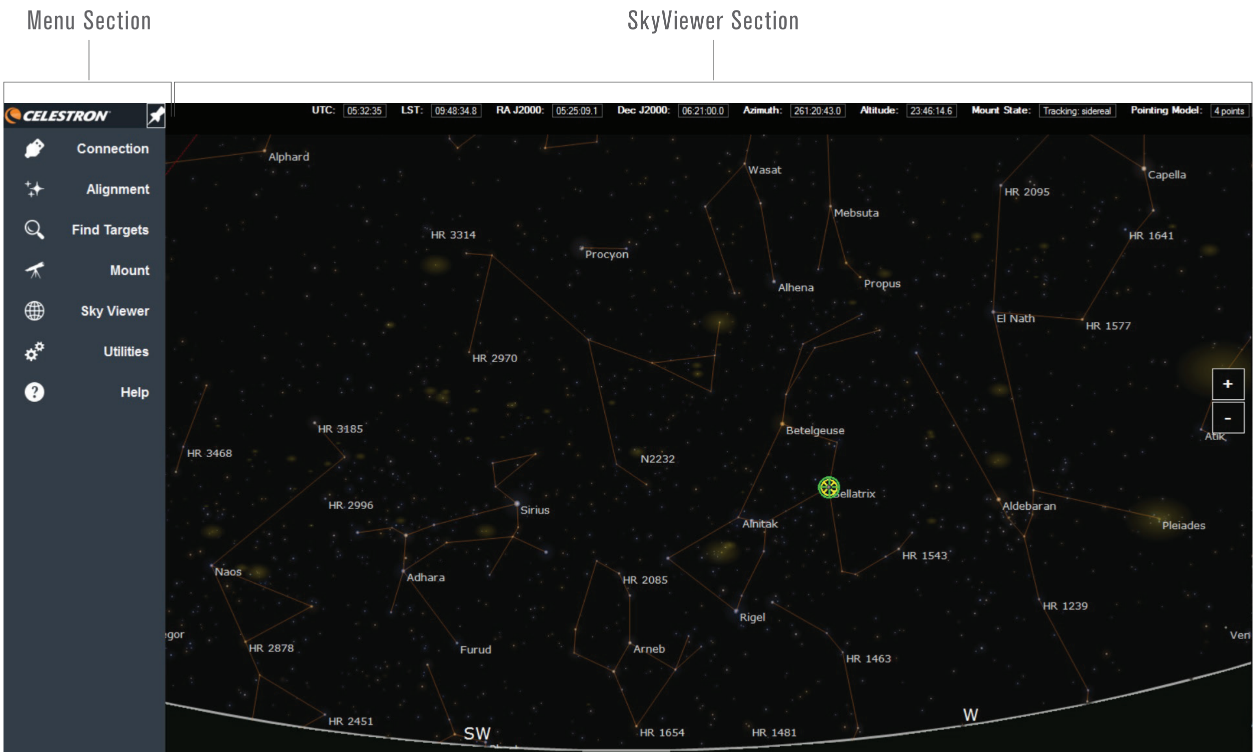
When you first open CPWI, an introduction window will pop up. Select "Start," and CWPI will appear on screen.

You'll find the connection options in the Connection selection in the Menu. If you are connecting directly to the mount's PC port (CGX and CGX-L only), select "Mount USB." If you are connecting to the mount through its hand control, select "Hand Controller." If you are connecting via WiFi, select "WiFi." CPWI should connect to your mount. You are now ready for alignment with the night sky.



CPWI Overview

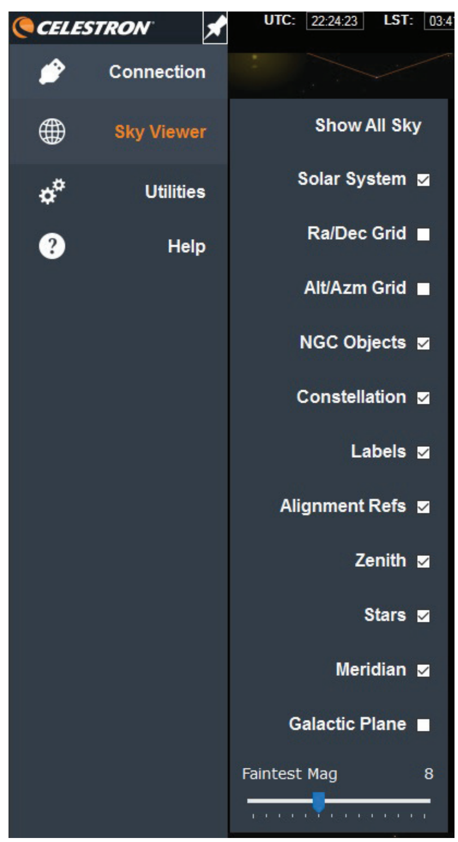
When you open CPWI, there are two main sections you can control, the SkyViewer Section and the Menu Section.



1. SkyViewer Section

In the **SkyViewer** section, shown in the screenshot above, you can use your cursor to click and drag the model of the night sky to move it and see what stars are currently visible. This is also where you can manually search for stars, deep sky objects, or constellations. Zoom in or out of the SkyViewer by scrolling the mouse or selecting the + or – buttons on the right side of the screen. Select an object by clicking on it.

In the top left corner of the program, locate the "SkyViewer" drop-down menu. Here is where you can enable, disable, or adjust certain features that will be displayed in the SkyViewer. You can adjust SkyViewer to only show specific types of celestial objects, or you can choose to show them all.



2. Menu Section

The **Menu** section is on the left-hand side of the screen. There are initially four sub-menus:

Connection - This is where you start to establish a connection between CPWI and your telescope mount.
SkyViewer - As mentioned previously, this is where you can adjust the display parameters of the SkyViewer.
Utilities - This provides access to advanced functionality.

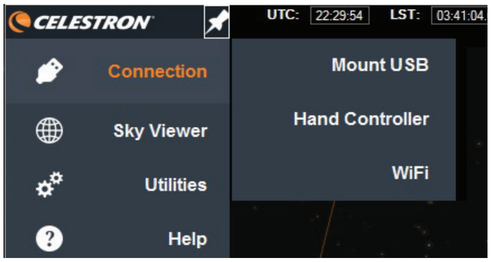
Help - This provides help with understanding the pointing model details and also provides detailed version history information.

Use the pin icon (located above the Menu section) to hide the Menu. To have the Menu reappear, click on the edge of the pin icon that can still be seen on screen.

At the top of the screen, you will find the Data bar. This section displays current information at a glance, including universal time (UTC), local time (LST), pointing coordinates (in RA/Dec and Alt/Az coordinates), mount status, and number of alignment references in the pointing model.

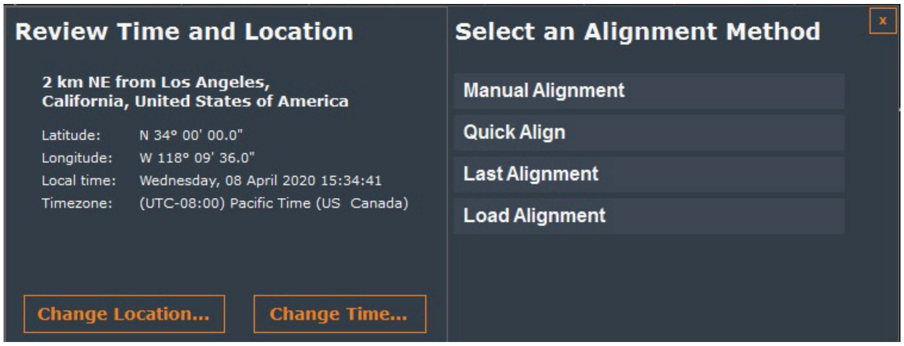
Aligning the Mount

First, connect to the telescope mount using any one of the connection methods previously outlined. If you have other Celestron accessories you want to use with the mount that work with CPWI, they must be connected to an AUX port prior to powering on the mount. (More on using these optional accessories appears later in the manual.) Select a connection option–USB (CGX and CGX-L mounts only), hand control, or WiFi–and the Select an Alignment Method window will appear.



Before beginning an alignment, check the information in the Alignment Method pop-up window to make sure it matches your current observing time and location.

If you need to edit your location, select Change Location. A Location Settings window will pop up. You can either manually enter your location or use Google Maps to get your exact GPS coordinates. Using Google Maps requires an internet connection. If you are connecting to your telescope via WiFi in Direct Connect mode, you will not be able to use this feature.



If you use Google Maps, simply select a location on the map and a pop-up window will provide you with the coordinates. You can then send the coordinates to CPWI.

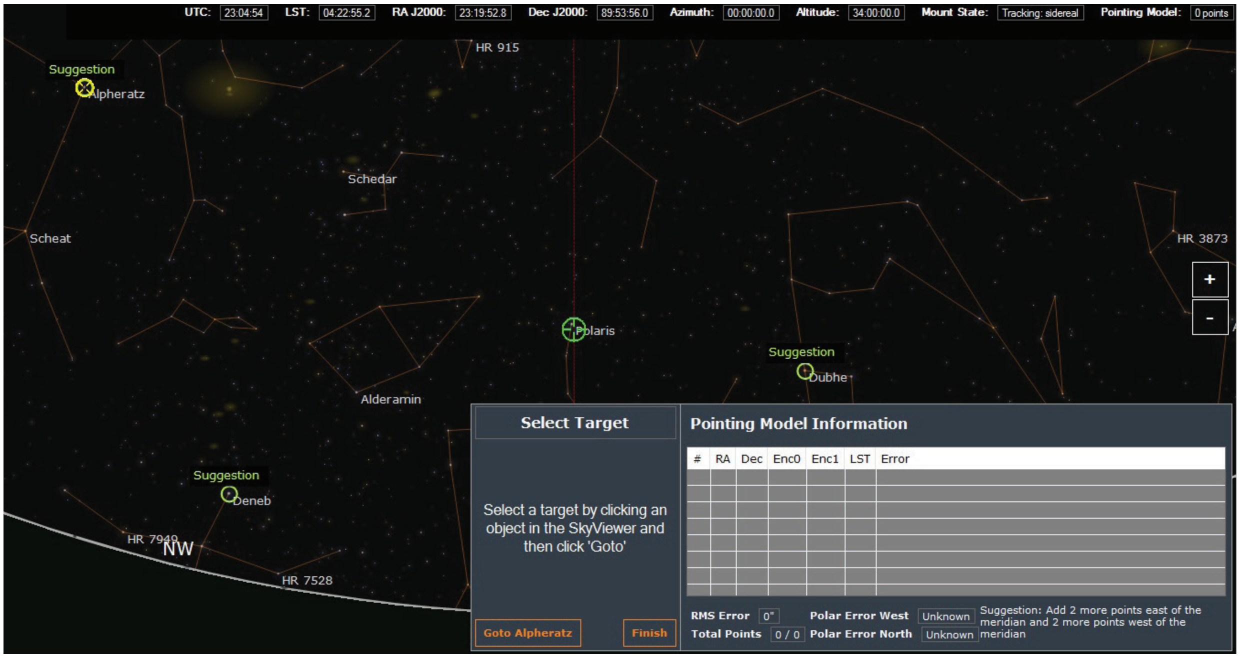
The time is pulled from your computer and shouldn't need to be changed, unless your computer's time is wrong. If needed, update it to correct the time for CPWI by selecting Change Time.

If you are manually searching for a location within CPWI's database and your local city does not show up, use the next closest city in the database. We recommend acquiring GPS coordinates in advance whenever possible.

After checking your time and location settings, select "Manual Alignment" from the Alignment Methods. If your mount has manual clutch knobs, make sure they are locked prior to alignment; if you subsequently loosen the manual clutch knobs, the mount will lose its alignment and will need to be re-aligned.

If your mount has home switches, a Home Switches box will pop up and allow you to begin by slewing the mount to its home position.

If you have an AZ mount, then there will be a "Wedge Enabled" checkbox. If you have your AZ mount on an equatorial wedge, make sure this option is selected.

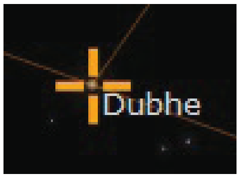


Select a star on the screen by clicking it. CPWI will highlight bright alignment stars that are well-positioned in the sky as suggestions, but you can choose any star that you can easily identify in the sky. Next, click GoTo on the Select Target screen. The mount will automatically slew toward the selected object. If you polar aligned your EQ mount (or AZ mount with EQ wedge) or started in the "level-North" position for your AZ mount, then the telescope should point close to the selected object. Otherwise, the telescope will likely not be pointing near the selected object.

Next, use the manual Slew Controls to center the selected object in the telescope's field of view.

Adjust the RATE for different motor speeds. Rates 1-6 are useful for centering in the telescope and finderscope. Rates 6-9 are useful for high-speed slewing and aren't recommended for centering. Selecting the dots in the corners of the Slew Controls will slew both axes at the same time. Also, when the Slew Controls window is on screen and selected, you can use the arrow keys on your keyboard to slew the telescope.

Centering objects will be easiest if you first center them in your (aligned) finderscope, and then center them in your telescope's field of view. Once the object is centered in the telescope's field of view, press "Centered" in the Center Target window. The object will now become an alignment point for the mount model created by CPWI, and you will see this indicated as a "1" in "Pointing Model" in the Data bar at the top of the screen. The object location in the SkyViewer will also now be marked with a cross, this indicates that the object has been used as an alignment reference.

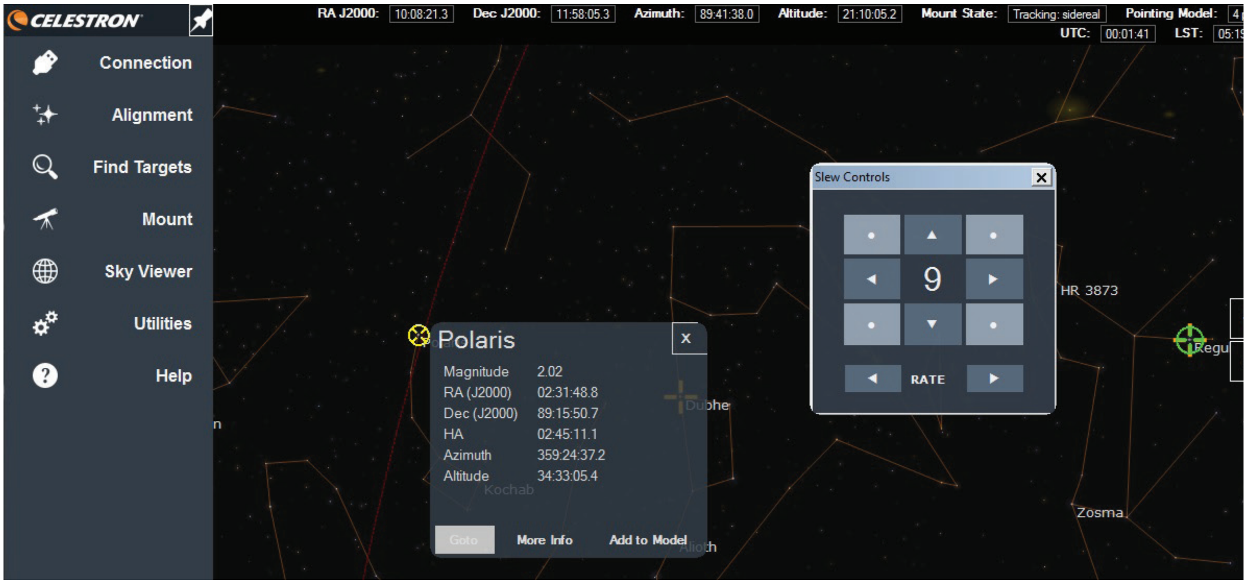


You will then be prompted to select another object in the SkyViewer, and you will repeat the process of selecting an object, having the telescope GoTo the object's approximate position, and using the Slew Controls to center the object in the telescope's field of view.

IMPORTANT NOTE: Whenever you center an object for alignment, make sure to always use the Up and Right direction buttons for the final slew commands. This will minimize the effect of gear backlash to obtain the most accurate mount model.

To get a good mount model, we recommend using at least 4 alignment points, with each point in a different quadrant of the sky. Use CPWI's suggested alignment stars to get a good selection of stars across the sky. After you have aligned on 4 stars, click "Finish" in the Select Target window.

You can add additional alignment references at any time by clicking on a star, selecting GoTo from the object's pop-up window, centering it in the telescope's field of view using the manual Slew Controls, and then selecting "Add to Model" from the object's pop-up window.



You can also add additional alignment points by selecting "Add Reference(s)" from the Alignment section in the Menu on the left.

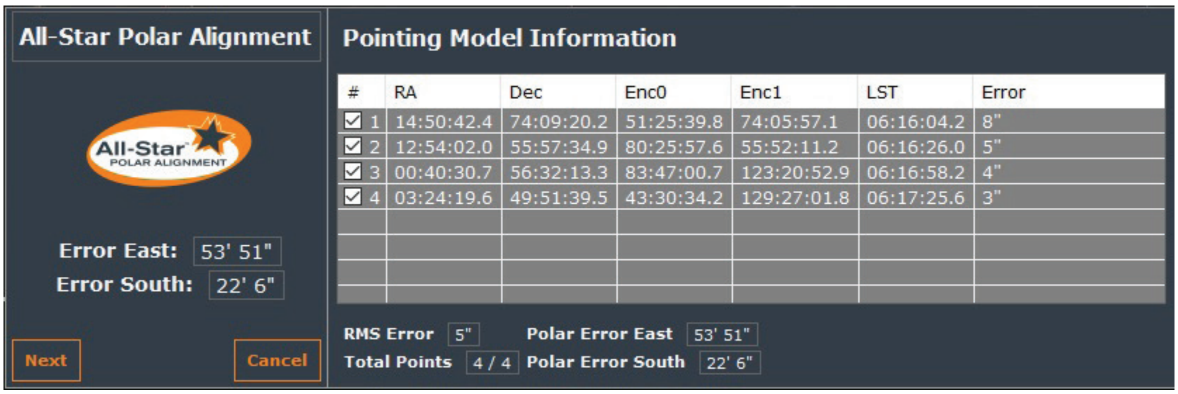
If you are using an AZ mount and have completed the alignment, you are ready to use CPWI. If you are using an EQ mount (or AZ mount on an EQ wedge) and have completed the alignment, we recommend completing an All-Star Polar Alignment for final setup.

All-Star Polar Alignment (ASPA) for EQ Setups

CPWI and the mount are now aligned to the night sky, but the EQ mount may not be accurately polar aligned. Celestron's proprietary All-Star Polar Alignment procedure (ASPA) can help correct equatorial mount's polar alignment quickly and easily. To perform an ASPA in CPWI, you must have at least 3 alignment points in your alignment model.(In the Data bar at the top of the screen, "Pointing Model" should indicate at least 3 points.)

After a successful 3-point (or more) alignment is completed, CPWI will automatically ask if you want to perform an All-Star Polar Alignment. Otherwise, you can select "Perform ASPA" from the Alignment section in the Menu. You will receive a notification if you need more alignment points to complete an ASPA.

Once you select All-Star Polar Alignment, you will see the All-Star Polar Alignment window.



Your polar alignment error will be displayed. Take note of the displayed error if needed, then click Next.

Select a star for ASPA from the SkyViewer. If you are in the Northern Hemisphere, you should select a star on the southern horizon. Southern Hemisphere users should select stars on the northern horizon. Do not use any stars directly overhead near zenith, directly east or west at any elevation above the horizon, or near the North Pole for Northern Hemisphere users or South Pole for Southern Hemisphere users. Once you have found a star for ASPA, select it, then select GoTo in the ASPA pop-up window.

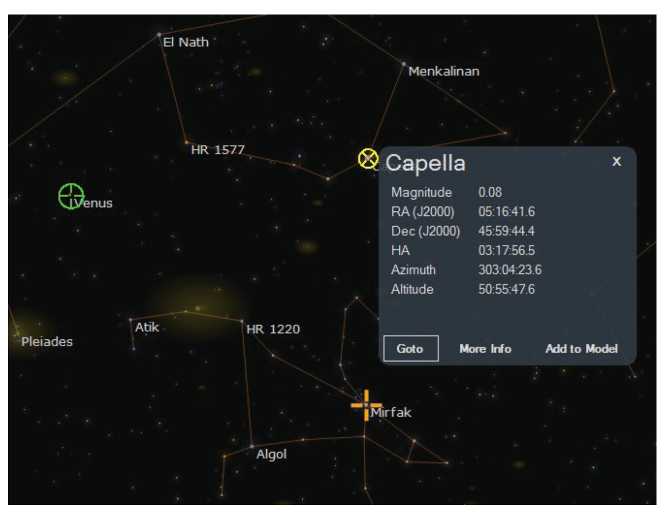
Center the selected star in the eyepiece (or camera) using the onscreen slew controls. Once the star is centered in the field of view, press the "Centered" box in the ASPA window. (NOTE: Remember to finish centering with the UP and RIGHT direction keys for best polar alignment accuracy.) The mount will then slew to the position the star should be if the mount were perfectly polar aligned. If the mount is very far from being polar aligned, then the star may no longer even be in the field of view! In this case, you will need to use the finderscope to find the star. Now, use the mount's altitude and azimuth polar alignment adjustment knobs to re-center the star in the eyepiece's field of view.

Polar alignment is now complete. If you want to check your results, re-align the mount in CPWI by selecting Delete Alignment from the Alignment section of the Menu, then select Perform Alignment. After realigning, check your polar align error by performing ASPA again to review your results. At this point, you can either exit ASPA and start using CPWI, or perform another ASPA if you'd like. The second time you do an ASPA, the mount's polar alignment adjustment knobs should need minimal—if any—adjustment.

Once you have completed one ASPA after initial Alignment, you are ready to use CPWI to control your Celestron telescope.

Slewing to an Object

To select your desired object in the SkyViewer, use your cursor to click and drag to navigate the planetarium. Once you find the object you want to slew to, click on it. A Target window will pop up. Select GoTo. The telescope will then slew to the object you have chosen. The object should be in the field of view of the telescope.

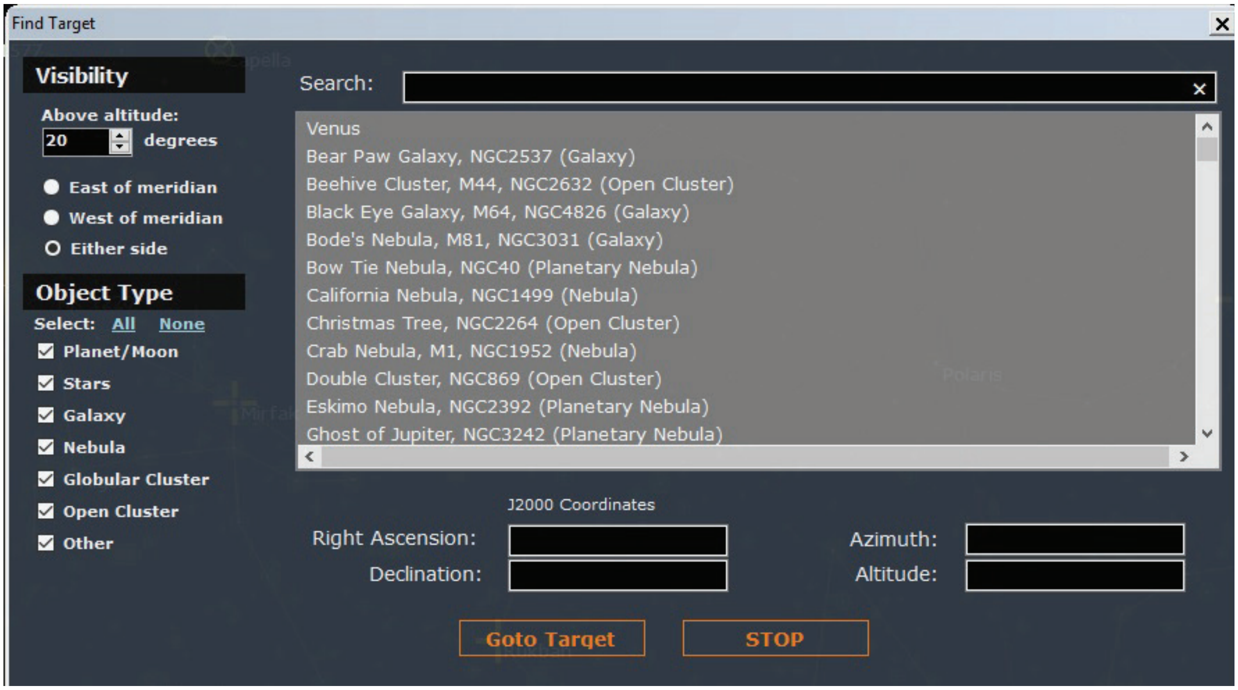


When you select an object in the SkyViewer, you also have the option to select Info. If you are connected to the internet, clicking Info will take you online to where you can learn more information about the object. If you are connected via WiFi in direct connect mode, you will not be able to use this feature, since your computer is connected directly to the WiFi module.

The telescope's current position is indicated by the green crosshair in the SkyViewer. Slewing the telescope in CPWI will move the green crosshair in real time as you slew. When you make a selection in the SkyViewer, a yellow crosshair will appear over the object.

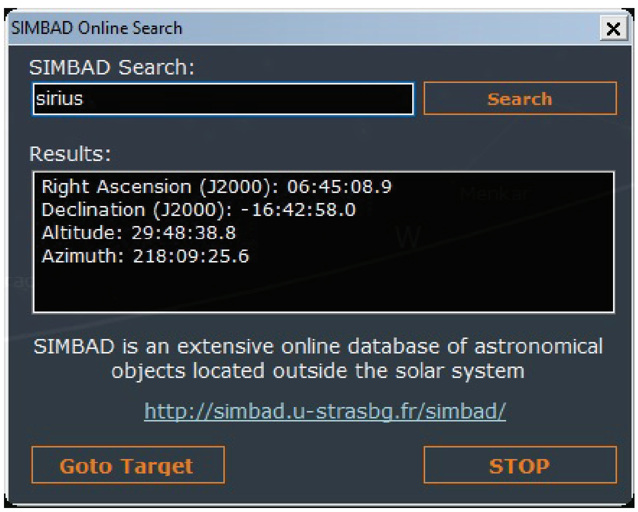
Finding Targets

You can also search for objects using the Find Targets selection from the Menu. Selecting "Local Database" will bring up the Find Target window.



You can use the Visibility and Object Type filters on the left side of the window to narrow down the list of objects to choose from. You can select an object by choosing it from the list. Alternatively, you can search for objects in the list by name by using the Search bar at the top of the screen. (Tip: If using the Search bar, make sure all the Object Type boxes are selected. Otherwise, your object may not appear if it is an excluded object type.) The RA/Dec and Alt/Az coordinates for the selected object will be displayed in the window. To slew the telescope to the selected object, select GoTo Target. To abort the slew and stop the mount, press STOP.

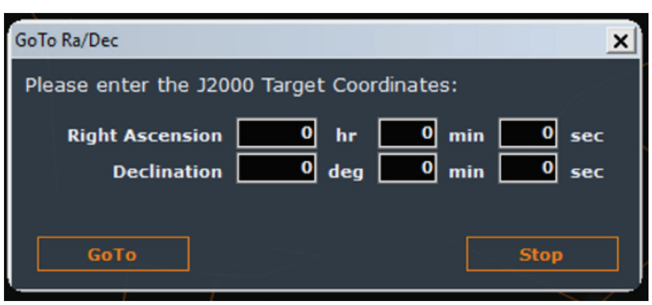
If you select "SIMBAD Online" from the Find Targets section of the Menu, then the SIMBAD Online Search window will appear.



Using the SIMBAD Online Search window requires an internet connection. If you are connected to the mount via WiFi direct connection (rather than networked in "access point mode"), you won't be able to use the SIMBAD Online Search functionality.

Type the name of any object in the SIMBAD Search field, and press Search. If a result is found, it will be displayed. You can then slew directly to the object's location (if above the horizon) by pressing GoTo Target. If you want to abort the slew in-progress, press STOP. The mount will stop moving.

If you already know the RA/Dec coordinates of the target you are trying to find, you can enter in the coordinates directly by choosing "GoTo RA/Dec" from the Find Targets section of the Menu. Once the coordinates are entered into the Go To Ra/Dec window that appears, simply click "GoTo", and CPWI will slew the telescope so it is pointed at the entered coordinates. Click "Stop" to abort a slew in progress.



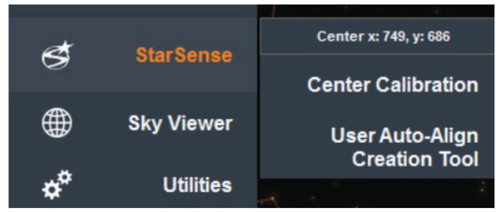
Aligning with the StarSense AutoAlign Accessory

Before you begin, attach the StarSense camera to the telescope tube. See the StarSense AutoAlign manual for more information on how to do this. Attach the AUX cable from the StarSense camera to an AUX port on your Celestron mount.

Make sure you have everything connected to the appropriate AUX ports before powering on the mount.

- If you are connecting via USB (CGX and CGX-L mounts only), simply plug in the USB Type B 2.0 cable from your PC to the mount, with the StarSense camera connected to an AUX port.
- If you are connecting via hand control, plug the StarSense hand control into an AUX port on the mount and plug in the appropriate cables, previously outlined in the manual, from your PC to your hand control.
- If you are connecting via WiFi, plug in the SkyPortal WiFi module if your mount does not have internal WiFi. Make sure the WiFi switch is in the correct position, as previously outlined in this manual.

After CPWI is opened and connected to the mount, CPWI will automatically search for the StarSense AutoAlign accessory. Once found, you will see the StarSense selection in the Menu:



Before aligning using StarSense, the StarSense camera must be calibrated to the telescope optical tube.

Calibrating the StarSense

Calibration aligns the center of the StarSense camera's field of view with the center of the telescope's field of view. This usually only needs to be done once, unless the telescope is handled roughly during transportation. If you have previously center calibrated the StarSense camera to your telescope using the hand control or the SkyPortal app, you don't need to do it again with CPWI.

Before initiating a StarSense center calibration, make sure you have the mount homed or at index marks. Alt/Az mounts should be pointing roughly North with the optical tube level, and EQ mounts should be roughly polar aligned. Next, select "Center Calibration" from the StarSense section in the Menu.

You will be prompted to select a star in the SkyViewer, and then GoTo the star. Then, use the onscreen slew controls to center the star in the telescope's eyepiece. If the star is not in the telescope's field of view, use the telescope's finderscope to find and center the star in the telescope.

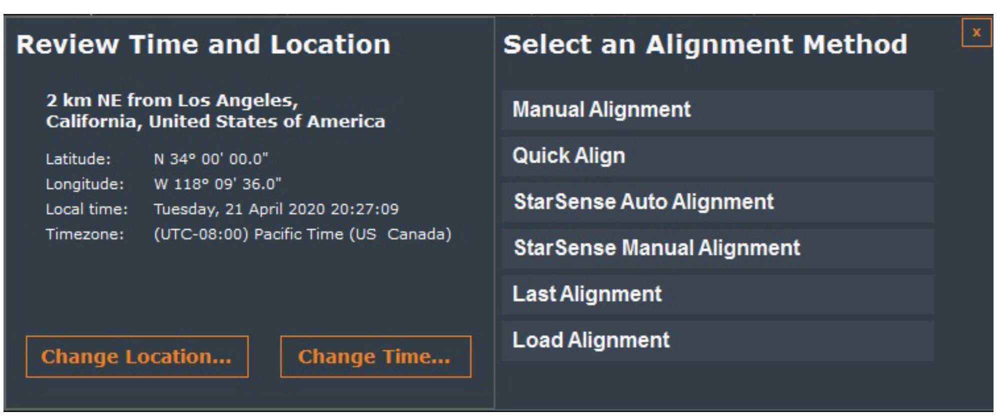
NOTE: It is highly recommended that you use an aligned finderscope during this step, since the mount is not yet accurately aligned to the sky.

Remember to use the UP and RIGHT slew commands to finish centering the star to provide the best pointing accuracy.

Once the star is centered in the telescope's field of view, click "Centered" in the Center Target window. The StarSense camera will then take an image of that section of the sky to determine its position and the position of the centered star. If the calibration is successful, the Calibration window will notify that the calibration was successful. If the calibration is not successful, you will be prompted to select another star to begin the center calibration process again.

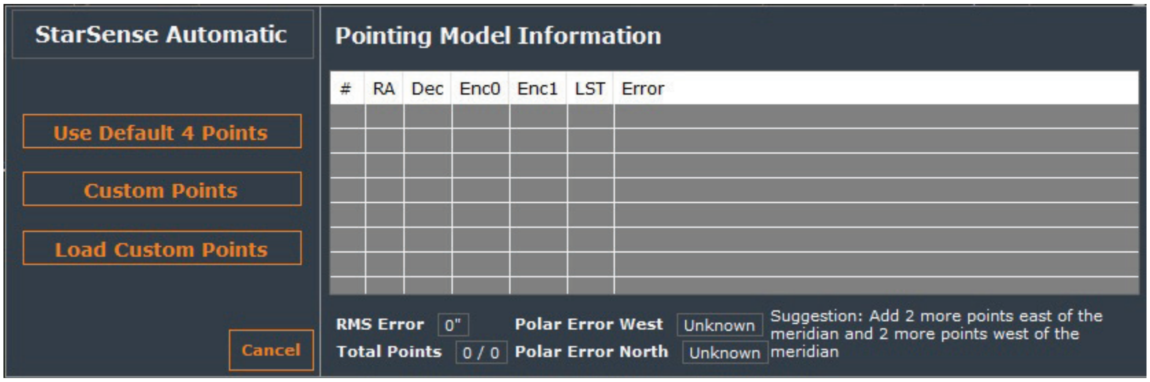
StarSense Auto Alignment

Once the StarSense camera is center calibrated to the telescope, you're now ready to perform a StarSense automatic alignment. Select "Perform Alignment" from the Alignment selection in the Menu. When StarSense is connected, you'll notice two additional alignment methods in the "Select an Alignment Method" pop-up window: StarSense Auto Alignment and StarSense Manual Alignment.



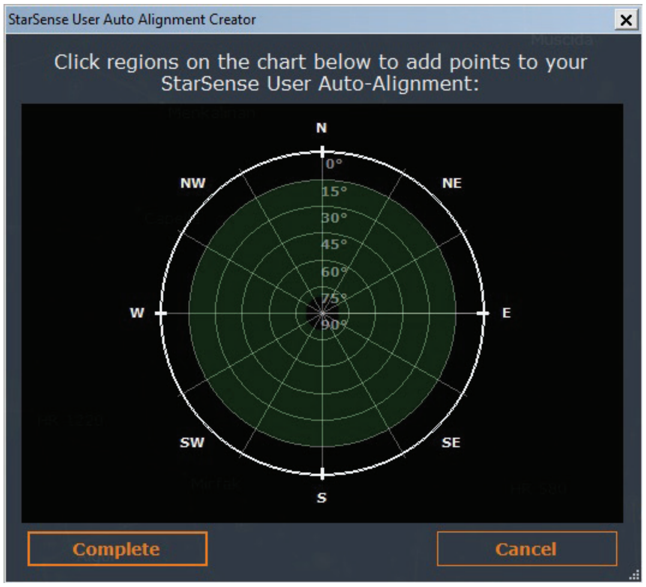
Select "StarSense Auto Alignment". If the mount has home switches or sensors, CPWI will automatically move the mount to the home position. Otherwise, make sure you have the mount homed or at index marks. Alt/Az mounts should be pointing roughly north with the optical tube level, and EQ mounts should be roughly polar aligned.

If you have not yet calibrated the StarSense camera, you can click “Calibrate” in the StarSense Automatic window. Otherwise, click “Ready”, and the following options will appear:



Select “Use Default 4 Points,” and the StarSense Auto Alignment process will begin. The mount will then automatically slew around the sky. The StarSense camera will capture 4 images in different areas of the sky to complete the alignment. This takes two to three minutes. If there are parts of the sky where the StarSense camera’s view is obstructed (i.e. by nearby objects like buildings or trees), StarSense will continue to slew around the sky until it can capture at least 4 images of clear sky. Once completed, you will receive an “Alignment Complete!” message, and you are now aligned and ready to observe using CPWI.

If you want to choose where in the sky the mount will slew to obtain alignment references, select “Custom Points”. This also allows more than 4 alignment points to be used in the Auto-Alignment. Once selected, the StarSense User Auto Alignment Creator window will appear.



Use this window to select regions of sky that have a clear view from your location. 0° denotes the horizon, while 90° is zenith. Select at least 4 points. You can choose more than 4 points; this will add additional alignment references to the mount model. More reference points will provide better pointing (and tracking) accuracy across the entire sky but will take more time to complete. There will generally be little benefit from selecting more than 10 alignment points. After you have selected the alignment points, select “Complete.” A pop-up window will appear and ask if you want to save your user auto-alignment references points. Select “Yes” if you want to use the chosen alignment points for future use, and you’ll be prompted for a file location on your computer to save the file. You can use this file later by selecting “Load Custom Points” from the StarSense Automatic window.

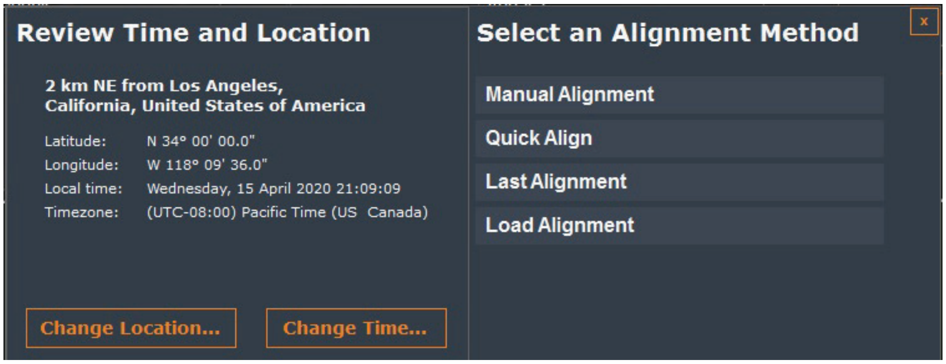
StarSense Manual Alignment

StarSense Auto Alignment is about as hands-off as it gets, but it also has its limitations. Depending on your location, sections of the sky may be blocked by a tree, building, or mountaintop. StarSense is unaware of these natural limitations and may slew to sections of the sky that are obstructed from the StarSense camera’s field of view. This is OK because StarSense will automatically keep scanning the sky until it finds a clear view, but it causes the alignment to take longer. To speed up the process, consider using StarSense Manual Alignment if your observing location has many areas of obstructed sky.

You can perform a StarSense Manual Alignment by selecting “Perform Alignment” from the Alignment section of the Menu, and then selecting “StarSense Manual Alignment” from the Select an Alignment Method window. If the mount has home switches or sensors, CPWI will automatically move the mount to the home position. Otherwise, make sure you have the mount homed or at index marks. Alt/Az mounts should be pointing roughly north with the optical tube level, and EQ mounts should be roughly polar aligned. If you have not yet calibrated the StarSense camera, you can click “Calibrate” in the StarSense Automatic window. Otherwise, click “Ready,” and the Select Capture Point window will appear along with the Slew Controls window. Now, use the slew controls to manually slew the mount to a region of sky that has a clear view from your location. Then, click “Solve Here” from the Select Capture Point window. The StarSense camera will take an image and plate-solve it to create an alignment point. Repeat this process at least 3 additional times to obtain at least 4 alignment points. The telescope is now aligned and ready to be used with CPWI. You can repeat this process more than 4 times to obtain even greater pointing accuracy. For best results across the entire sky, use alignment points that are widely spaced apart.

Other Alignment Methods

After initially connecting the mount to CPWI, the Select an Alignment Method window appears. The Manual Alignment selection has been discussed previously in this manual. Here, we will review the other alignment methods that can be selected from this window.



Quick Align (EQ mounts only)

This is a "zero star" alignment – this alignment method relies on the accurate initial positioning of the mount. The EQ mount must be in the "home" position (i.e. counterweight shaft pointing straight down with the telescope tube parallel to the RA axis) and must be accurately polar aligned.

This alignment method is typically used for telescopes that are housed in an observatory, where the polar alignment is accurate and the mount is not moved. If the mount has home sensors, like the CGX and CGX-L mounts, then you can use this option for a remote alignment. Otherwise, you will typically find better pointing accuracy using the Manual Alignment selection.

Last Alignment

After you perform a manual alignment, the data is automatically saved. If you have not moved the mount since the last time you used it, you can select "Last Alignment", and CPWI will use the data from the previous manual alignment. Then, to have an accurate alignment to the current night sky, all you need to do is select "Sync on Object" from the Alignment section of the Menu. The Select Target window will appear. Select an object in the SkyViewer, GoTo the object, center it with the onscreen slew controls, then click "Centered." The last alignment should now be accurate to the sky.

Load Alignment

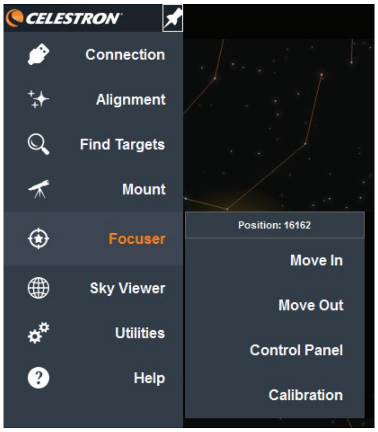
You can save a manual alignment by selecting "Save Alignment" from the Alignment section of the Menu. If you have saved an alignment previously, then you can use it by choosing "Load Alignment" from the Alignment Methods. The mount will need to be in the home position initially. If you have an EQ mount with home switches, like the CGX or CGX-L, the mount can be automatically slewed to the home position. You will be asked for the file location of the saved alignment. Once the alignment is loaded, you will be prompted to sync on a star. The Select Target window will appear. Select an object in the SkyViewer, GoTo the object, center it with the onscreen slew controls, then click "Centered." The loaded alignment should now be accurate to the current sky.

Using the Celestron Focus Motor

With the Celestron Focus Motor attached to your Celestron telescope and connected to an AUX port on the mount, connect to CPWI. CPWI will automatically search for the Celestron Focus Motor. Once found, you will now see the Focuser section in the Menu:

If you have not yet calibrated the Celestron Focus Motor to your telescope optical tube, start by selecting "Calibration" from the Focuser section in the Menu.

NOTE: If you have already calibrated the Focus Motor using the hand control, you don't need to do it again when using CPWI.

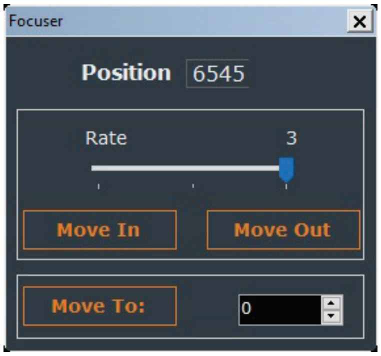


Then, click "Begin" from the Focuser Calibration pop-up window. The calibration process finds the inward and outward limits to the focuser mechanical travel and provides indexing so you can return to specific focuser positions. (The inward focus limit is index mark "0," and each CCW rotation of the focuser knob adds 1000 counts.) The calibration process takes several minutes to complete, as the Focus Motor needs to move through the entire range of focuser motion. Click "Force Stop" to abort the Focus Motor calibration process, if needed.

Once calibration is complete, you can find the current focuser position at the top of the Focuser selection from the Menu. The motor will now stop before it reaches the inward and outward limits of focuser travel. Recalibrating your Celestron Focus Motor is required any time you remove it from the telescope optical tube.

For quick focusing, you can use the "Move In" and "Move Out" commands from the Focuser section in the Menu. Selecting "Move In" will move the primary mirror away from the Schmidt corrector at the fastest rate (rate 3), while selecting "Move Out" will move the primary mirror toward the Schmidt corrector at the fastest rate. You can monitor the focuser index position just above the "Move In" and "Move Out" commands to determine where you currently are in the focuser's travel range.

For most precise focusing, select "Control Panel" from the Focuser section in the Menu. The Focuser pop-up window will appear.



Use the Rate slider to select the Focus Motor speed rate. Selecting rate 1 rotates the focus knob at 8°/second, rate 2 rotates the focus knob at 32°/second, and rate 3 rotates the focus knob at 128°/second. Choose rate 1 for fine focusing. To move the focuser inwards (i.e. primary mirror moves away from Schmidt corrector), click "Move In." To move the focuser outwards (i.e. primary moves towards the Schmidt corrector), click "Move Out." You can monitor the current focuser index position in the Focuser pop-up window. To return to a specific focuser index position, enter the position into the box on the bottom right of the window, and then click "Move To." This is convenient if you already know the specific focuser index position that focuses your setup. The next time you observe, you can enter this focuser position, click "Move To," and the telescope should be in good focus.

Refer to the online instruction manual at celestron.com for more information on the Celestron Focus Motor.

Using a Celestron GPS Accessory

With the Celestron SkySync GPS (or the older CN16 GPS) accessory connected to an AUX port on the mount, connect to CPWI. CPWI will automatically search for the GPS accessory. Once found, you will see the GPS section in the Menu. Once the GPS accessory satellite links and is ready to be used, select GPS, and you will be able to see your latitude and longitude coordinates as reported by the GPS accessory. CPWI will now use the location data provided by the GPS accessory. You can see this information when you perform an alignment in the "Review Time and Location" area of the Select an Alignment Method window. To disable the use of the GPS location data for the alignment, deselect the "Enable GPS" checkbox in the "Review Time and Location" area.

Menu Options

In this section, we will review the more detailed functionality that can be accessed from the different sections of the Menu on the left side of the screen once connected to the mount.

Connection

This is where it all starts. Select "Mount USB," "Hand Controller," or "WiFi" as indicated previously in this manual to connect CPWI to the mount and start an observing session. Once connected, you can select "Disconnect" to disconnect CPWI from your mount.

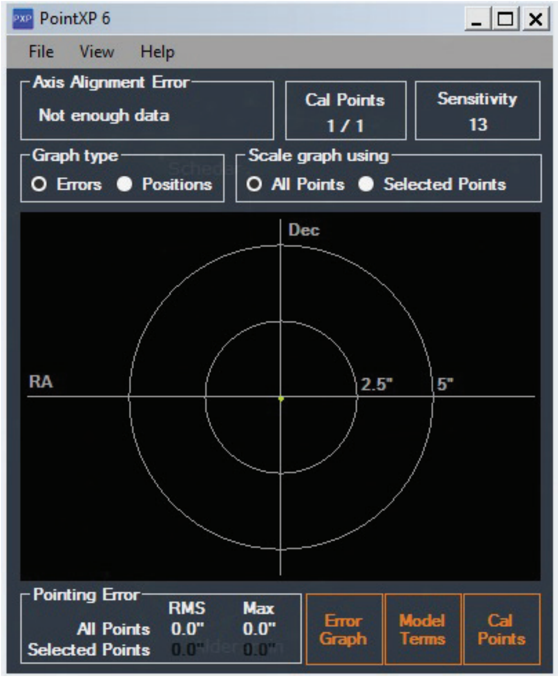
Alignment

View Pointing Model – Selecting this will open up the PointXP 6 window.

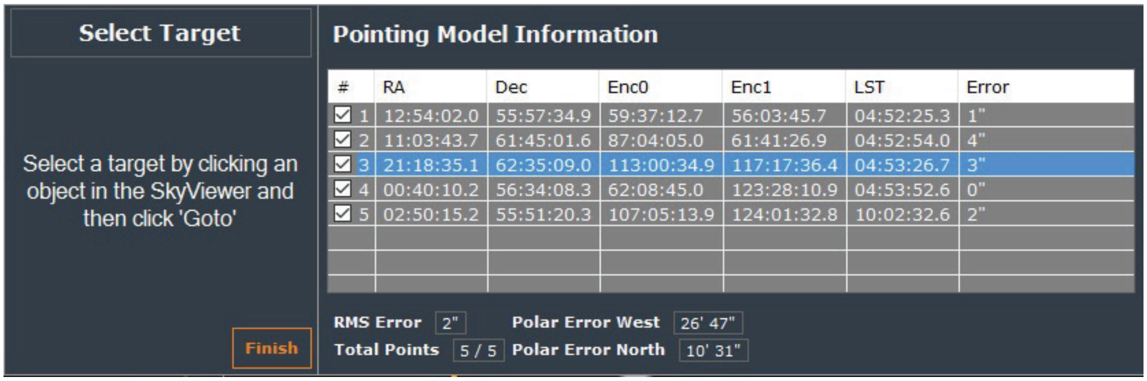
Here you can find detailed information about the current mount alignment model. For a detailed YouTube video discussion of this window, refer to the Pointing Model Help in the Help section of the Menu (requires internet connection). You can also access this video by selecting Help from the options at the top of the PointXP 6 window. For a simplified user interface to the current mount alignment model, select "Add Reference(s)" from the Alignment section of the Menu (see below).

Perform ASPA - Discussed previously in this manual, this selection achieves accurate polar aligning of EQ mounts (including AZ mounts on EQ wedges).

Add References - Allows additional alignment reference points to be added to the mount model. If you notice your mount's pointing accuracy is not quite as accurate as you would like in certain areas of the sky, add a pointing reference (i.e. star) in that area of sky to increase pointing accuracy. You can also add any object to the mount model by clicking on it in the SkyViewer and then clicking "Add to Model" from the object information pop-up window.



When Add References is selected, the Pointing Model Information window will appear.



Each alignment reference currently in the mount model will be displayed. Besides adding additional alignment references to the mount model to increase accuracy, you can also try disabling any alignment points currently in the model that appear to be creating significant error. Do this by unchecking the checkbox to the left of each alignment reference. You can then look at the RMS Error displayed at the bottom of the window; if the number gets smaller, then disabling that alignment reference helped the model.

NOTE: For EQ mounts, if disabling an alignment reference leaves less than two alignment references on one side of the meridian, the Pointing Model Information box will recommend using another alignment reference on that side of the meridian.

You can also see the polar alignment error calculated from the mount model at the bottom of the window. If the polar alignment error is more than a couple of arcminutes, considering using the “Perform ASPA” option in the Alignment section of the Menu. If StarSense AutoAlign is connected, selecting Add References will also initiate a StarSense manual alignment. Follow the onscreen instructions in the “Select Capture Point” section of the Pointing Model Information window.”

Sync on Object – This short procedure is required after a “Load Alignment” and “Last Alignment.” Refer to “Load Alignment” and “Last Alignment” under the “Other Alignment Methods” section of this manual.

Save Alignment - Allows you to save an alignment to a file location on your computer so that it can be loaded in the future using the “Load Alignment” alignment method option.

Save Alignment and Park Mount – Automatically saves the current alignment (same as “Last Alignment”) and prompts to slew the mount to a “park” position so the mount can be powered off in that position. You can then slew the mount using the onscreen slew controls to any preferred position, then disconnect the mount when instructed by CPWI. CPWI will remember the previous park position, and you can choose to automatically slew to this same park position the next time the mount is parked. (The initial default park position for EQ mounts is with the OTA on the east side of the mount pointing downwards. For AZ mounts, the initial default park position is with the OTA level and pointing North.) Save Alignment and Park Mount is typically performed when the telescope system is in a permanent or semi-permanent installation, like a backyard observatory. This way, the telescope can be stored in a preferred position, and still be aligned the next time it is used. The next time CPWI is connected it will automatically ask to “Un-Park” the mount, and the mount will be ready to be used. (NOTE: You are not required to Sync on Object after un-parking the mount.)

Delete Alignment - Deletes the current alignment. To use the mount after deleting the alignment, a new alignment will need to be performed or loaded.

Find Targets

The functionality for this section was discussed previously in this manual.

Mount

Stop Mount - Selecting this option stops the mount from moving. This can be very useful in preventing crashes, if you see the telescope is going to slew into something.

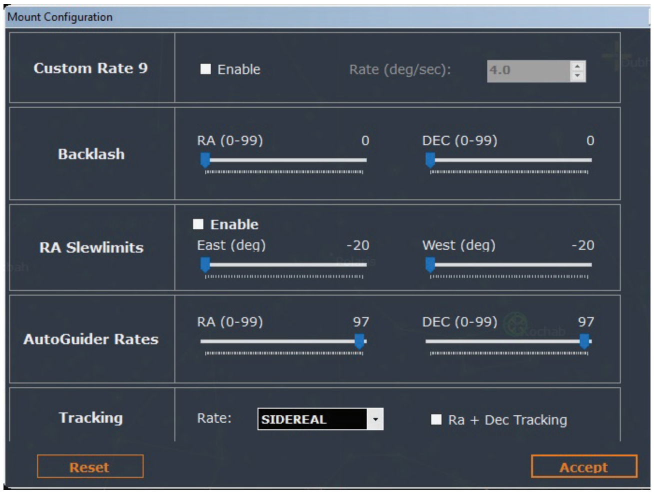
Slew Controls - This selection quickly displays the manual slew controls on screen.

Configure Mount – This selection allows changing various mount parameters. After making changes here, click “Accept” to save the changes. To return to previous settings, click “Reset.”

- **Custom Rate 9** -This selection allows you to vary the speed rate for the fastest slew rate (i.e. Rate 9).

NOTE: Setting Rate 9 above the default setting may cause a decrease in motor performance for some setups.

NOTE: The NexStar SE6/8 and NexStar SLT mounts do not support Custom Rate 9 functionality.



• **Backlash -** This selection allows you to set the backlash compensation for each of the mount's axes of motion. Mechanical gears have a certain amount of backlash or play between the gears. This play is evident in the amount of time it takes for a star to move in the eyepiece when reversing slew directions. The amount of gear backlash is constant, so with the slower slewing rates, it will take longer for the star to move in the eyepiece when reversing directions. CPWI's anti-backlash feature allows you to compensate for backlash by inputting a value that quickly rewinds the motors just enough to eliminate the play between gears. The amount of gear backlash is different in each mount, so you will need to experiment to determine the best value for your mount. Most mounts work best with values between 30 and 70. It is generally better to have a value that is too small than too large. If the value is too large, you will see the object overshoot when you change directions, which will make it hard to center objects in the field of view.

NOTE: Gear backlash compensation is only recommended for visual use and may be counterproductive when used during astrophotography. When tracking is enabled, the mount will be moving in one or both axes. Pressing a direction button opposite to the direction of tracking will cause the gear backlash compensation to activate twice; once when you push the direction button, and again when you release it and tracking resumes.)

To set the anti-backlash value, enter a value from 0-99 for both RA and Dec (or AZ and ALT). CPWI will remember these values and use them each time you turn the telescope on until the values are changed. If you do not want to use any backlash compensation, make sure the value for each axis is 0.

• **RA Slewlimits (EQ mounts only)** – This selection allows you to set how far beyond, or how far before, the meridian the mount will slew in RA before requiring a meridian flip. This functionality is especially useful during astroimaging, as you may want to track an object through the meridian for as long as your mount allows before performing a flip. To use the RA Slewlimits, first select the "Enable" checkbox, then set the limits for East of the meridian and West of the meridian. Negative numbers indicate the number of degrees past the meridian. The limit is -20° since most Celestron EQ mounts cannot slew further than 20° past the meridian due to mechanical limitations. A positive number indicates a meridian flip will occur before the mount reaches the meridian. +40° before the meridian is the maximum value allowed. (NOTE: It is important to know the mechanical limits to motion past the meridian for your mount before these limits are entered, otherwise you may reach the mechanical limit before the software slew limit, which may cause you to need to realign the mount.) (NOTE: AZ mounts on EQ wedges do not have a limitation on how far past the meridian they can slew.)

• **Altitude Slewlimits (AZ mounts only)** – This selection allows you to the define the allowable slew range in the altitude axis. This can be useful for preventing accessories attached to the rear cell of the mount from hitting the base of the mount when the telescope is pointing straight up. To use the altitude slewlimits, first check the "Enable" box. Then, set the lower limit and upper limit to the altitude slew range (0° is the horizon, 90° is zenith).

• **AutoGuider Rates** – This selection allows you to set the autoguiding rate as a percentage of sidereal rate. This is helpful when calibrating your telescope to an autoguiding camera for long exposure astroimaging.

• **Tracking** – Choose from sidereal, solar, or lunar rates. The current tracking rate selected will appear in the "Mount State" section of the Data bar at the top of the screen. For EQ mounts, you can also activate tracking in both axes by selecting the "Ra + Dec Tracking" checkbox. This can be useful to use if your polar alignment isn't very good.

• **PEC** – Enables PEC playback for mounts that support it. (See Train PEC below.)

• **Meridian Sweep (EQ mounts only)** - This function instructs the mount how to respond to GoTo commands when slewing to objects that are near the meridian. It can be used to prevent unwanted meridian flips. Meridian Sweep allows the telescope tube to remain on a desired side of the mount after slewing to the object. (NOTE: If the RA Slewlimits are enabled, they will provide a limit to how far past the meridian the mount can go until a meridian flip is performed.) (NOTE: AZ mounts on an equatorial wedge do not require this function, as they do not need to perform a meridian flip.)

Once enabled by selecting the "Enable" checkbox, there are three options:

- **Favor East** – If the target object is accessible from both sides of the mount, selecting "Favor East" instructs the mount to GoTo to the object as if it were on the east side of the meridian. The optical tube will then be positioned on the west side of the mount and pointing east.
- **Favor West** – If the target object is accessible from both sides of the mount, selecting "Favor West" instructs the mount to GoTo to the object as if it were on the west side of the meridian. The optical tube will then be positioned on the east side of the mount and pointing west.
- **Favor Current** – Selecting "Favor Current" instructs the mount to favor whichever side the mount is currently on when slewing to objects close to the meridian.

The "Angle" selection box allows you to choose how far past the meridian the mount can slew during a GoTo command before the meridian flip is performed. Make sure the number you enter in this box is less than any negative slew limit if RA Slewlimits are enabled. If RA Slewlimits are not enabled, then make sure the "Angle" is less than the number of degrees that your mount can move past the meridian before mechanical interferences occur.

• **GoTo Approach Direction** – Use this setting to change the direction of the mount's final approach when slewing to an object. You can change the approach direction for each axis of the mount. For EQ mounts, RA positive means the mount approaches from east to west, while RA negative means the mount approaches west to east. DEC positive means the mount approaches from south to north, while DEC negative means the mount approaches from north to south.

For AZ mounts, azimuth positive means the mount approaches from clockwise, while azimuth negative means the mount approaches from counter-clockwise. Altitude positive means the mount approaches down to up, while altitude negative means the mount approaches up to down.

This functionality allows you to minimize the effects of backlash. For example, for AZ mounts, if your telescope is back heavy from using heavy optical or photographic accessories, you would want to set your altitude approach to the negative direction. This would ensure that the telescope always approaches an object from the direction opposite the load pulling on the scope.

- **Cordwrap (AZ mounts only)** – This function prevents the power cable from wrapping around the mount when slewing in azimuth. When "Enable Cordwrap Here" is clicked, the cordwrap position will be set at 180° away in azimuth from the current mount position. The mount will not slew past the cordwrap position in one direction, rather it will reverse direction and approach the object from "the long way around" in azimuth to prevent the power cable from wrapping around the mount. To disable the cordwrap functionality, click "Disable Cordwrap".

Train PEC - Errors are inherent in all worm gears. Periodic Error Correction (PEC) improves the tracking accuracy of the RA motor drive by reducing the amplitude of your mount's particular worm gear errors. Not all Celestron mounts support PEC. Train PEC will not appear as a selection if your mount doesn't support it.

Using PEC is a three-step process. First, the mount needs to find the worm gear "index position" so it has a starting point reference when playing back the recorded error. Next, you must autoguide your mount's tracking using an autoguiding camera (i.e. an "autoguider") for at least 10 minutes – about the time it takes for a full rotation of the worm gear. During this time, the mount records the corrections made by the autoguider; this is the "Train PEC" process. This "teaches" the periodic error characteristics of the worm gear to the mount. The periodic error of the worm gear drive is then stored in memory. The final step is to playback the periodic error corrections made during the training process during regular tracking. This will greatly reduce the overall tracking error in the system. PEC is intended for advanced astrophotography and will still usually require autoguiding during imaging when used. However, the autoguider will no longer need to make large amplitude tracking error corrections, ensuring pinpoint stars in the final image.

To train PEC, first make sure the telescope has been accurately polar aligned. We recommend using the All-Star Polar Alignment (ASPA) functionality described earlier in this manual. Once polar aligned, follow these steps:

1. Find a bright star relatively close to the object you want to image.

2. Insert the autoguiding camera into the eyepiece holder of your telescope and connect the camera to your computer. Orient the autoguider so that one axis of the sensor is parallel to the declination axis while the other is parallel to the R.A. axis.

3. Focus the telescope so the stars in the autoguider are in sharp focus on your computer screen.

4. Connect the autoguider's guiding output port to the autoguider port on the mount's electronics panel using an ST-4 compatible autoguider cable.

5. Confirm that the autoguider is working to guide the mount.

6. To begin recording the drive's periodic error, select "Train PEC" from the Utilities section of the Menu. Click on "Begin PEC Training." The first time each observing session that PEC training or playback is selected, the worm gear must first rotate to its index position. If the worm gear rotation moves your guide star outside the field of view of the autoguider, the guide star will need to be re-centered before the recording begins. In some instances, it may be necessary to restart PEC recording after the worm gear has found its index. Do this by clicking "Cancel PEC Training" and then click on "Begin PEC Training" again.

7. After 10 minutes, PEC Training will automatically stop recording. PEC will now be active (i.e. PEC playback is now on). Click on "No, Stop training PEC" in the pop-up window to finish. If you would like to redo the PEC Training, click on "Yes, Stop PEC Playback." You can repeat the entire process; the previously recorded PEC data will be replaced with the new PEC data.

You are now ready to image using PEC. If you would like to disable PEC playback, then "Configure Mount" from the Mount section of the Menu and deselect the "Enable PEC playback" box in the PEC area of the Mount Configuration window. Does the PEC function make unguided astroimaging possible? Yes and no. For shorter exposures with shorter focal length telescopes, the answer is yes. However, even with PEC, autoguiding is still mandatory for long exposure deep sky astroimaging with longer focal length telescopes.

GoTo Home – For mounts that have home position sensors, like the CGX and CGX-L mounts, selecting this automatically slews the mount to the home position.

Disable Tracking – Selecting this option turns off tracking. Once turned off, it will state "Stopped" in the Mount State section of the Data bar at the top of the screen. To turn tracking back on, select Enable Tracking.

SkyViewer

The functionality for this selection was discussed previously in this manual. Please see page 6.

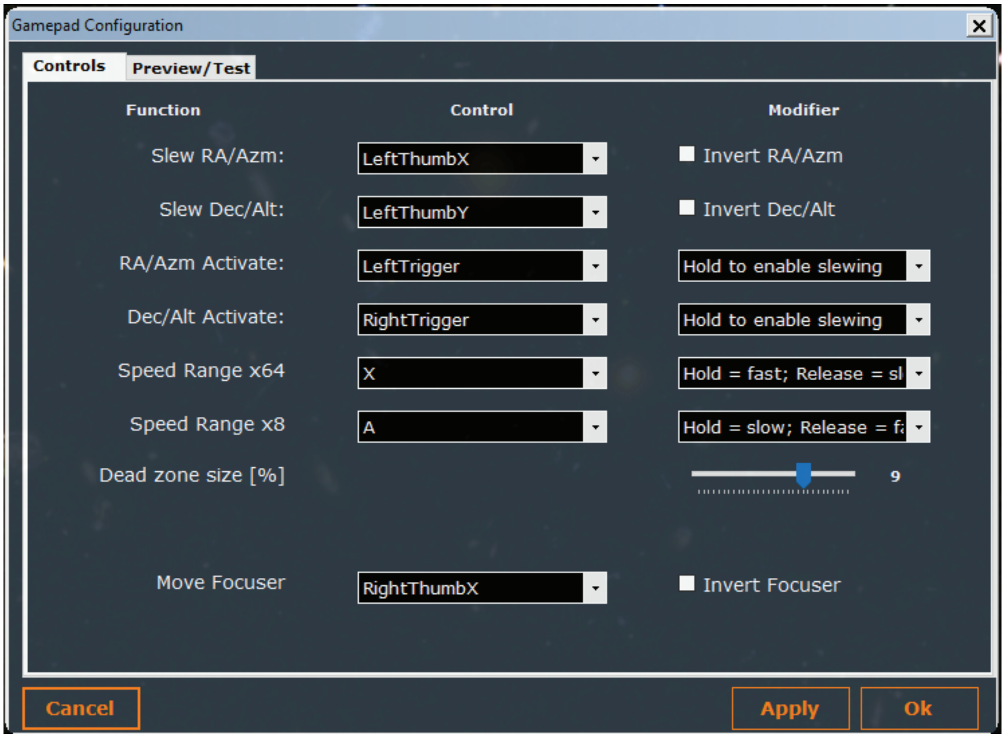
Utilities

Connect StarSense – Prompts CPWI to find and connect to the StarSense AutoAlign accessory. If the StarSense camera is already connected to the mount upon initial connection to CPWI, this command is not necessary since CPWI will automatically find and connect to StarSense AutoAlign.

Connect Focuser– Prompts CPWI to find and connect to the Celestron Focus Motor. If the Celestron Focus Motor is already connected to the mount upon initial connection to CPWI, this command is not necessary since CPWI will automatically find and connect to the focus motor.

Connect GPS – Prompts CPWI to find and connect to the Celestron SkySync GPS (or the older CN16 GPS). If the Celestron GPS accessory is already connected to the mount upon initial connection to CPWI, this command is not necessary since CPWI will automatically find and connect to the GPS accessory.

Gamepad Setup–– If you have a PC Gamepad that supports XInput, then you can use it to control the mount. You can also use it to control the optional Celestron Focus Motor. Selecting "Gamepad Setup" will cause the Gamepad Configuration window to appear.



Use the drop-down menu under the Control column to define how each function is controlled by the Gamepad. For the "Slew RA/Azm", "Slew Dec/Alt", and "Move Focuser" functions, these will typically be controlled by the Gamepad joysticks. If you want to reverse the directions of the joysticks for any of these commands, select the "Invert" checkbox in the Modifier column. For the "RA/Azm Activate" and "Dec/Alt" Activate" functions, these will typically be controlled by the Gamepad buttons (or triggers). These "activate" controls only allow the joysticks to work to slew the mount when the button is pressed, this prevents any accidental slewing if the joysticks are accidentally moved. In the Modifier column, you can use the drop-down menu to reverse the polarity of the buttons – the mount will only move if the buttons are not pressed. Mouse over each selection in the window for more information.

There is one base speed range and two Speed Range "boost" functions which boost the range by 8x and/or 64x respectively. These boost functions can work in tandem, and by default both speed boosts are active when the buttons are released and deactivated when you press the buttons. The polarity of these buttons can be reversed using the selections in the Modifier column. This allows you to choose any of the four overlapping ranges as the "preferred" range that operates when no button is pressed. The table below indicates the speed ranges and the equivalent hand control MOTOR SPEED rates.

	Speed Range	Hand Control Motor Speed Equivalent
Base	1 arcsec/sec to 1 arcmin/sec	rate 0 to rate 3
x8 Active	8 arcsec/sec to 8 arcmin/sec	rate 1 to rate 5
x64 Active	1 arcsec/sec to 1 deg/sec	rate 3 to rate 7
x8 Active and x64 Active	1 arcsec/sec to 4 deg/sec*	rate 5 to rate 9*

* up to max speed of mount

Most consumer-grade joysticks do not return to exactly zero when they are released. It is therefore common for control software to ignore inputs less than a certain value. This region is the "dead zone" and is defined in CPWI as a percentage deflection of the joystick. Below this setting, inputs will be ignored and treated as zero deflection. The default setting is 10%; if you find that your mount has a tendency to keep slewing after you release the joystick, then you should increase the "Dead zone size" setting. (Note: The Preview / Test tab shows the percentage reading from the joystick after the dead zone correction has been applied, this number should always return to zero when you release the joystick.)

Once you have configured the Gamepad, click "Apply".

At the top of the Gamepad Configuration window you will see a Preview/Test tab. Selecting this tab will allow you to check the functionality of your Gamepad by confirming its commands are being received by CPWI.

WiFi WLAN Config - This is used to establish a WiFi connection in "access point" mode. This is described in the "Connecting CPWI to Your Mount" section of this manual.

Hot Keys - Selecting this makes the Hot Keys window appear. This gives a handy primer for all the hot key combinations available in CPWI.

Hot Keys

Keys	Command
Up	Slew up
Down	Slew down
Left	Slew left
Right	Slew right
D9	Set Rate to 9
D8	Set Rate to 8
D7	Set Rate to 7
D6	Set Rate to 6
D5	Set Rate to 5
D4	Set Rate to 4
D3	Set Rate to 3
D2	Set Rate to 2
D1	Set Rate to 1
S	Stop Mount
Z	Focuser move out
X	Focuser move in
D3 + CTRL	Focuser Rate 3
D2 + CTRL	Focuser Rate 2
D1 + CTRL	Focuser Rate 1

Help

Pointing Model Help - If you are connected to the internet, selecting this will bring up a YouTube video that provides a detailed primer for the mount modeling used in CPWI. It also gives detailed descriptions of the options found in the PointXP 6 window.

Version History – Selecting this will provide detailed release notes for each version release of CPWI.

About – Selecting this gives the version number of current CPWI version installed and also gives credits and acknowledgments.

ASCOM Commands Through CPWI

CPWI supports ASCOM commands from third-party software to control the connected Celestron mount and Celestron Focus Motor. This is done with custom ASCOM drivers built into CPWI. To use CPWI's ASCOM drivers, first connect CPWI to your mount (and focus motor) as you normally would. Then, from the third-party software, select "CPWI" or "CPWI Focuser" to connect to the mount or focus motor through CPWI.

NOTE: The CPWI ASCOM drivers are automatically installed during CPWI software installation if and only if the ASCOM platform is already installed on the PC. So, install the ASCOM platform on your PC before you install CPWI, or else it will not work. The ASCOM platform download can be found at https://ascom-standards.org/Downloads/Index.htm .

Celestron PWI was co-developed by PlaneWave Instruments and Celestron.
Please check the CPWI support page for any changes or updates to the CPWI software.

Additional Resources

What is backlash and how can I adjust it?

Backlash is play in the drive gears. All telescopes have some backlash, as gears cannot be too tight, preventing the motors from turning. Backlash causes the delay in scope movement when using the direction arrows on the hand control. It is especially a problem when moving in the direction opposite the scope's tracking, when the lag before the scope moves can be on the order of 10 seconds if the backlash is bad.

The goal is to minimize backlash, and the good news is your Celestron scope's control firmware lets you to do this by rewinding the motors enough to eliminate the gear play when the arrow is pressed and winding it back the other direction when the arrow is released to make the gears re-engage and go back to smooth tracking.

Positive backlash compensation is applied when the mount changes its direction of movement from backwards to forwards. Negative backlash compensation is applied when the mount changes its direction of movement from forwards to backwards. When tracking is enabled, the mount will be moving in one or both axes in either the positive or negative direction, so backlash compensation will always be applied when a direction button is released and the direction moved is opposite to the direction of travel. The amount needed will depend on the slew rate; slower slews will be more sluggish and will need higher values. Visual work will be less demanding and won't need as high values as guiding for astroimaging.

One general tip: Always use the up-and-right for final alignment to match the direction the scope will use to approach an object during a goto. This helps to reduce the backlash inherent in any system and improves goto and tracking accuracy.

I'm experiencing motion to the east after slews with my Celestron Alt-Az GoTo mount. Is this backlash, and how do I correct it?

Yes, it is classic gear backlash. Gear backlash will often show up on the AZ axis at rates above rate 2 when moving east.

Here's how to fix this issue:

1. Start by properly aligning the mount so it will be tracking.
2. Set the anti-backlash correction (under Scope Setup) for the AZ axis' negative direction to 99, its highest value. (In the Southern Hemisphere use the positive direction; the instructions below are for the Northern Hemisphere.)
3. Point the scope to a spot near the meridian and near the celestial equator. Set the motor speed to rate 3 (or higher). You should now see the following behavior.
4. When you slew left, the telescope will move east and you will see the field of view moving eastwards through the eyepiece (assuming either an inverted or mirror-reversed view). Be sure to move at least 10 arc-minutes eastward at rate 3 (or higher) before releasing the button. When you release the button, the motor will ramp to a stop and the tracking will engage. Just before the motor changes direction, the anti-backlash will kick in briefly and drive through the gear backlash. Because 99 is probably too high a setting, you will overshoot the backlash and the field of view will jump to the west slightly before tracking engages. Once tracking engages, the field of view will be constant in the eyepiece.
5. Adjust the anti-backlash correction for AZ negative to 50. Again, slew the mount eastward at rate 3 or higher for at least 10 arc-minutes. If the new value for AZ negative is too low, then not all the gear backlash will be corrected. The remaining backlash will be used by the motor after the tracking is engaged in the field of view will appear to briefly continue to move eastwards at sidereal speed. If the new value is still too high, then the gear backlash will be overcorrected and the field of view will again jump to the west after releasing the button, stabilizing once tracking engages.
6. Continue to adjust the backlash setting until there is no visible westward overcorrection. Some users prefer a small amount of under correction but this is a matter of taste. When you are satisfied with the value of the AZ negative correction, set the AZ positive correction to the same value.

You can also configure the anti-backlash settings during the day on land objects. What you see in the eyepiece will be slightly different, but the basic principle is the same. Slew the mount a significant distance in one direction (at least two times the size of the backlash of the mount) and then release the slew button. Adjust the backlash setting as high as possible until you see over correction, and then come back down until the overcorrection goes away.

When you are done with the AZ axis, consider setting up the ALT axis as well. You can start with whatever value you found worked for AZ.

ALIGNMENT

Choose the "Auto Two Star" method. (This method appears by concensus, to be the most reliable).

Thus with your 'scope tube pointing North and with the mount arm on your left as you stand behind the instrument. Switch on your 'scope and enter all relevant data, Time, Date etc.

Irrespective of what your hand controller offers, choose Polaris as your first star. (assuming you can see it). If it is not the first star on offer, you will need to toggle either the 6 or 9 buttons to produce it on screen.

Now locate it in your finder and, having done so, press "Enter". You should now see it in your eyepiece, (a 25mm will be quite sufficient), although it may not be in focus.

Keep it defocused so that it looks rather like a large doughnut. This shape allows you to centralize it in your eyepiece far more easily since your eye is very susceptible to the concentricity of rings.

Thus, by comparing the position of the doughnut with the edge of the field of view, you should be able to center it very accurately.

However, the doughnut may not be in the center to start with. No matter ! Using the direction buttons on the hand controller, move it to the bottom left quadrant of your eyepiece.

Now from this position, move it right and upward to centralize. If you overshoot, take it back to the bottom left quadrant and begin again. When you are satisfied that you have it centralized it, press "Align" and you will be offered your second alignment star.

This star should be between 30 and 70 degrees in altitude and at least 90 degrees from your first choice; Polaris.

Let's assume it has chosen or that you have chosen Altair.

Press "Enter" and your 'scope will automatically slew to this star. If it "lands" nowhere in the vicinity of Altair you will know immediately that something is wrong, but all being well it should be near. Now merely go through the same procedure as you did when aligning Polaris and you should have a good alignment.

GoTo and tracking performance

If your alignment has been successful, any object you "GoTo" should be within the field of view of a 25mm eyepiece although not necessarily in its center. Thus if you wish to bring it to center, (as is normal), use the same movement (bottom left to the right and up) as used when you aligned, to do so.

There is a caveat however:

This procedure should keep your 'scope tracking well when operating between North and South through East but you may find that objects may begin to slip from the field of view in very short time when operating the 'scope between South and North through West. If this occurs, simply align or realign the "slipping" object by placing it in the UPPER left quadrant of the eyepiece and recentralizing it by moving it to the right and DOWN.