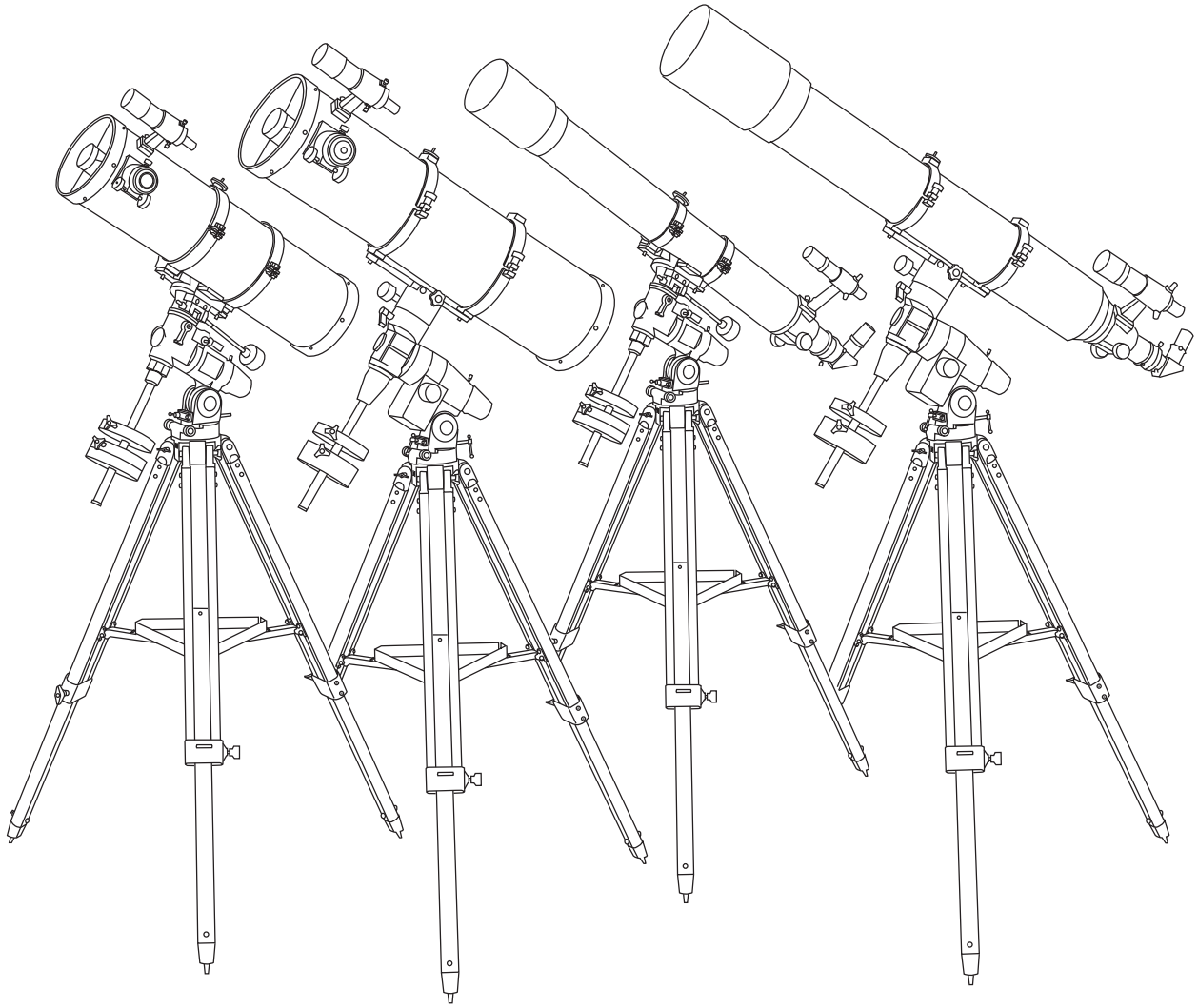
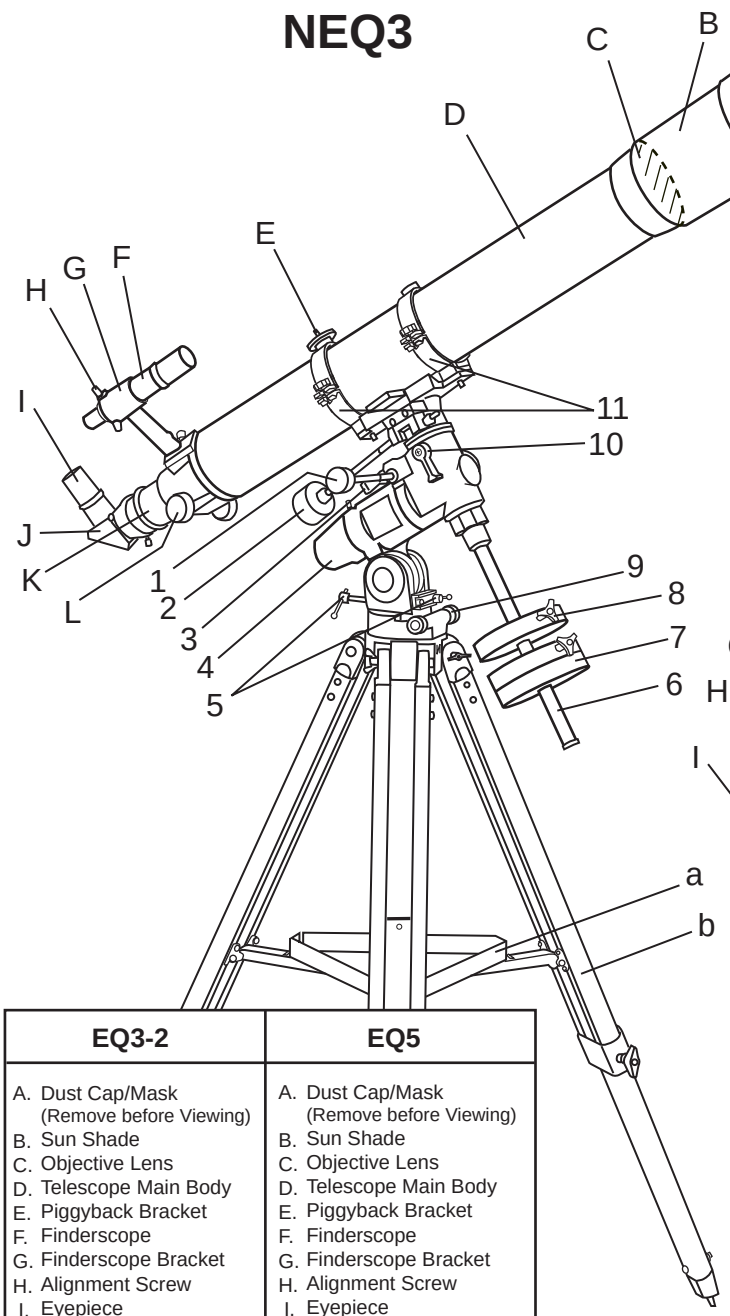
INSTRUCTION MANUAL

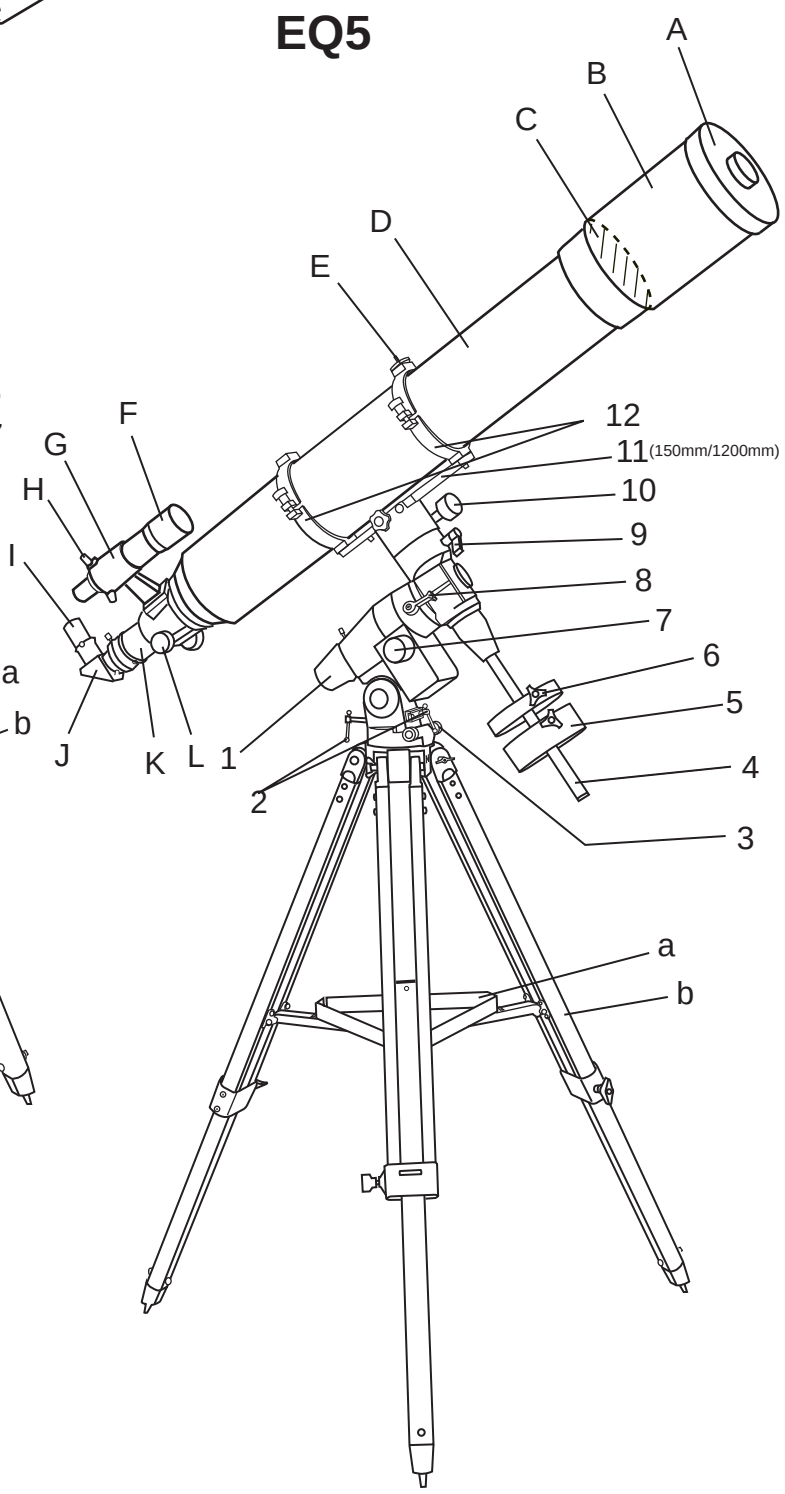
Telescopes with NEQ3 & EQ5 Mount



031007V3

REFRACTOR

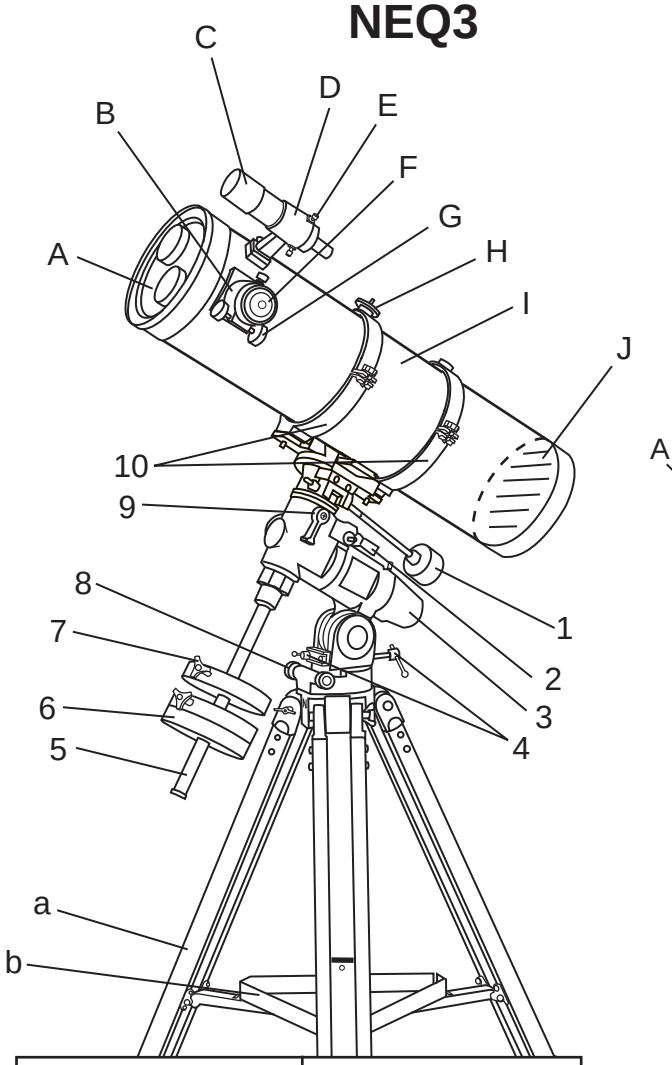




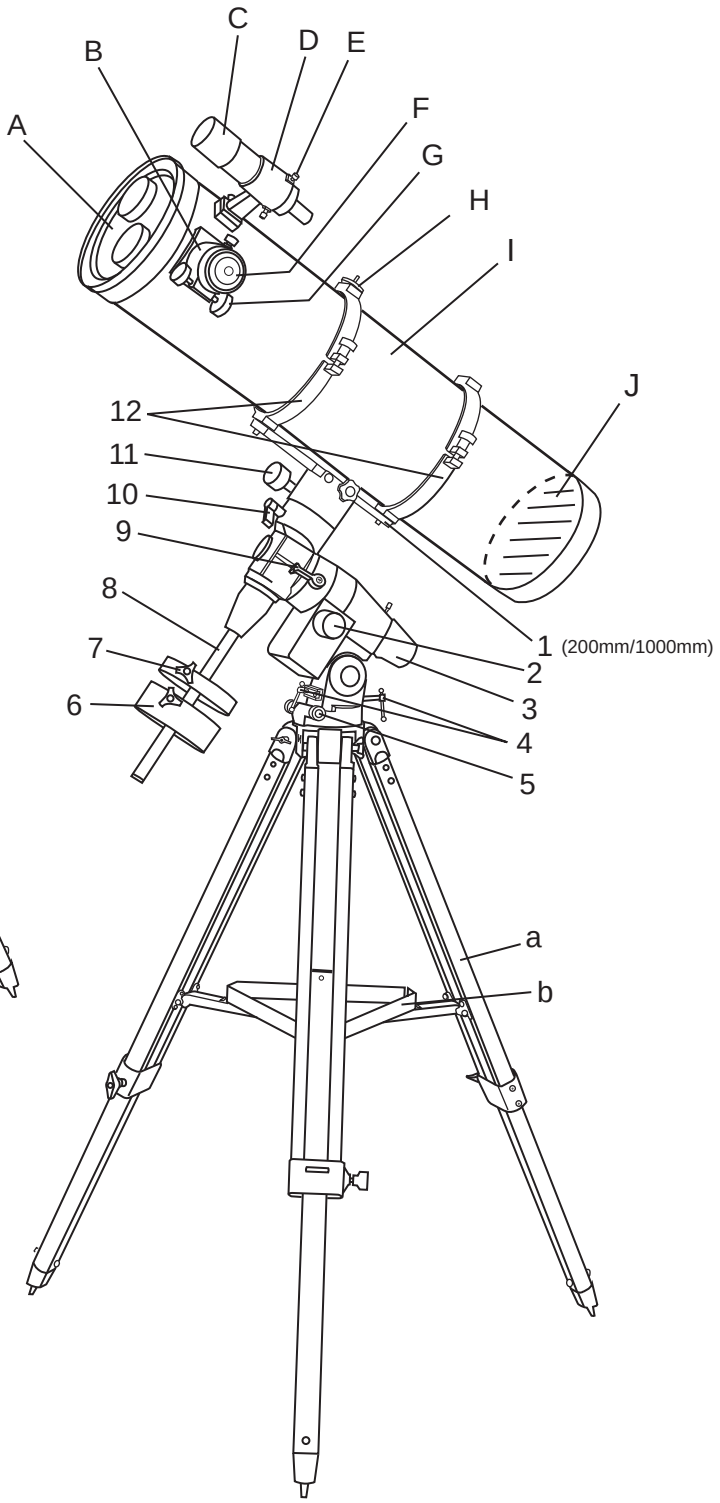
EQ3-2	EQ5
A. Dust Cap/Mask (Remove before Viewing)	A. Dust Cap/Mask (Remove before Viewing)
B. Sun Shade	B. Sun Shade
C. Objective Lens	C. Objective Lens
D. Telescope Main Body	D. Telescope Main Body
E. Piggyback Bracket	E. Piggyback Bracket
F. Finderscope	F. Finderscope
G. Finderscope Bracket	G. Finderscope Bracket
H. Alignment Screw	H. Alignment Screw
I. Eyepiece	I. Eyepiece
J. Diagonal	J. Diagonal
K. Focus Tube	K. Focus Tube
L. Focus Knob	L. Focus Knob
1. R.A. Flexible Control Cable	1. Polarscope Holder (not shown)
2. Dec. Flexible Control Cable	2. Altitude Adjustment T-bolts
3. R.A. Lock knob	3. Azimuth Adjustment Knob
4. Polarscope Holder (not shown)	4. Counterweight Rod
5. Altitude Adjustment T-bolts	5. Counterweight
6. Counterweight Rod	6. Counerweight Thumb Screw
7. Counterweight	7. R.A. Control Knob
8. Counterweight Thumb Screw	8. R.A. Lock Knob
9. Azimuth Adjustment Knob	9. Dec. Lock Knob
10. Dec. Lock Knob	10. Dec. Control Knob
11. Tube Rings	11. Mounting Plate (150mm/1200mm)
	12. Tube RIngs
a. Accessory Tray	a. Accessory Tray
b. Tripod Leg	b. Tripod Leg

REFLECTOR

NEQ3

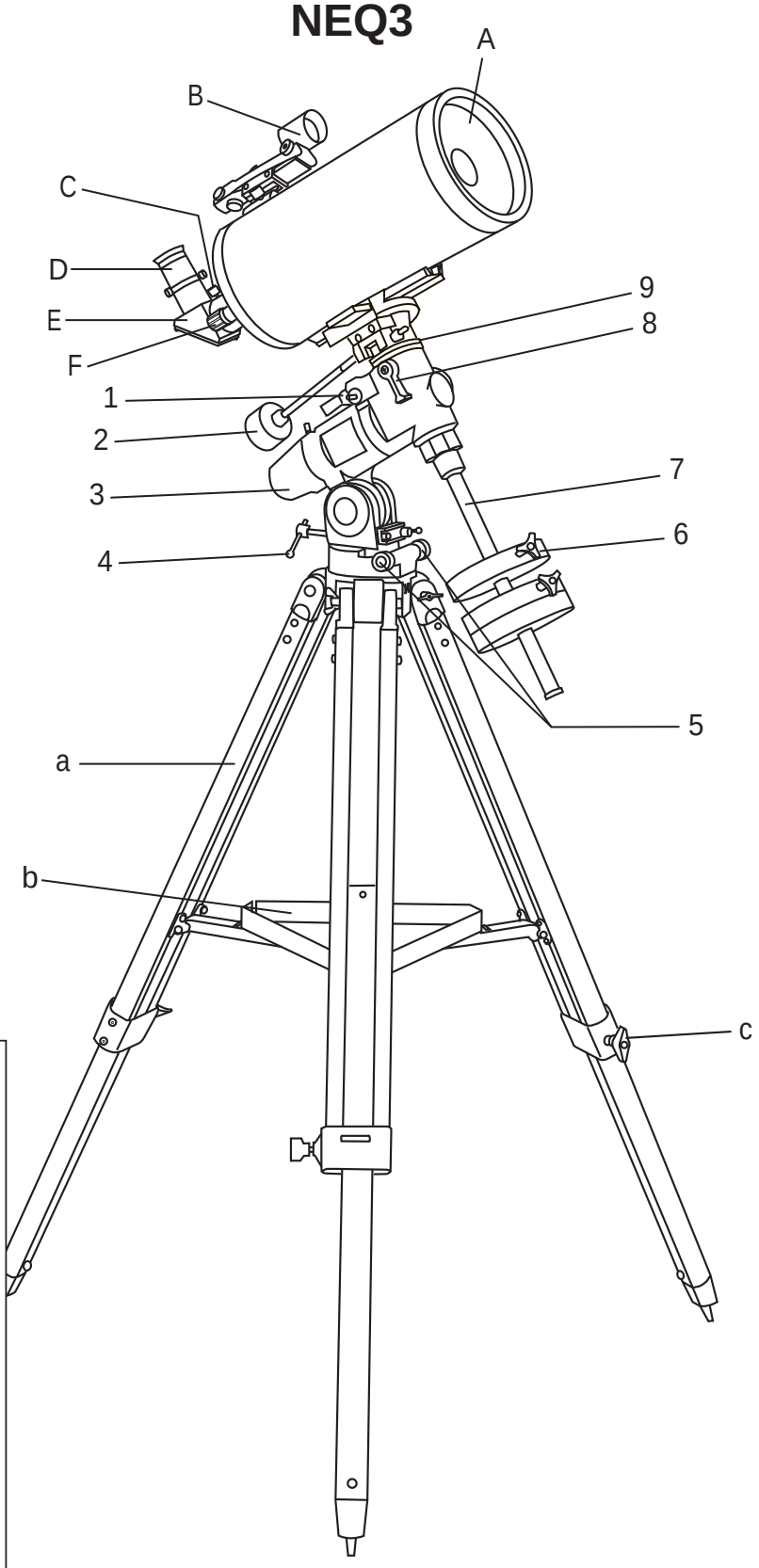


EQ5



EQ3-2	EQ5
A. Dust Cap/Mask (Remove before Viewing) B. Focus Tube C. Finderscope D. Finderscope Bracket E. Finderscope Adjustment Screws F. Eyepiece G. Focus Knob H. Piggyback Bracket I. Telescope Main Body J. Primary Mirror Position 1. Dec. Flexible Control Cable 2. R.A. Lock Knob 3. Polarscope Holder (not shown) 4. Altitude Adjustment T-bolts 5. Counterweight Rod 6. Counterweight 7. Counterweight Thumb Screw 8. Azimuth Adjustment Knob 9. Dec. Lock Knob 10. Tube Rings a. Tripod Leg b. Accessory Tray	A. Dust Cap/Mask (Remove before Viewing) B. Focus Tube C. Finderscope D. Finderscope Bracket E. Finderscope Adjustment Screws F. Eyepiece G. Focus Knob H. Piggyback Bracket I. Telescope Main Body J. Primary Mirror Position 1. Mounting Plate (200mm/1000mm) 2. R.A. Control Knob 3. Polorscope Holder (not shown) 4. Altitude Adjustment T-bolts 5. Azimuth Adjustment Knob 6. Counterweight 7. Counterweight Thumb Screw 8. Counterweight Rod 9. R.A. Lock Knob 10. Dec. Lock Knob 11. Dec. Control Knob 12. Tube Rings a. Tripod Leg b. Accessory Tray

NEQ3



A. Dust Cap (not shown, remove before Viewing)
B. Red Dot Finder
C. Focus Locking Screw
D. Eyepiece
E. Diagonal
F. Focusing Knob

1. R.A Lock Knob
2. Dec Flexible Control Cable
3. Polarscope Holder/ Polarscope (not shown, optional)
4. Altitude Adjustment T-bolt
5. Azimuth Adjustment Knobs
6. Counterweight Locking Thumb Screw
7. Counterweight Rod
8. Dec Lock Knob
9. Dec Setting Circle

a. Tripod Leg
b. Accessory Tray
c. Height Adjustment Clamp

TABLE OF CONTENTS

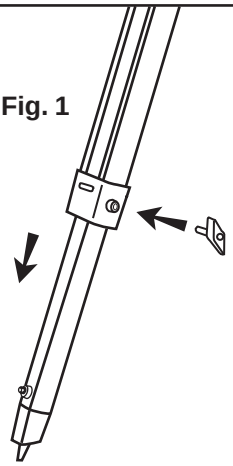
Before you begin

This instruction manual is applicable to all the models with the EQ3-2 or EQ5 mount. Take a moment to find the model closest to your telescope on p.2 p.3, and p4. Follow the instructions for your specific model in the manual. Read the entire instructions carefully before beginning. Your telescope should be assembled during daylight hours. Choose a large, open area to work to allow room for all parts to be unpacked.

FOR NEQ3 MOUNT

TRIPOD SET UP

Fig. 1



ADJUSTING THE TRIPOD LEGS (Fig.18)

1) Slowly loosen the height adjustment clamp and gently pull out the lower section of each tripod leg. Tighten the clamps to hold the legs in place.
2) Spread the legs apart to stand the tripod upright.
3) Adjust the height of each tripod leg until the tripod head is properly leveled. Note that the tripod legs may not be at same length when the equatorial mount is level. Do not over tighten the clamps.

ATTACHING THE ACCESSORY TRAY (Fig.2)

1) Place the accessory tray on top of the bracket, and secure with the locking thumb screws from underneath.

ATTACHING THE MOUNT TO THE TRIPOD (Fig.3)

1) Align metal dowel on the tripod head with the gap between the azimuthal adjustment knobs underneath the mount. Tighten the knurled knob underneath the tripod head to secure mount to tripod.

Note: Loosen the azimuthal adjustment knobs if mount does not fit into tripod head completely. Retighten knobs to secure.

Fig. 2

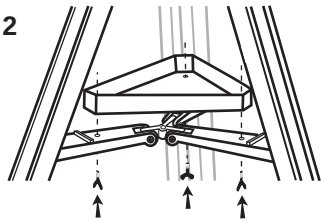
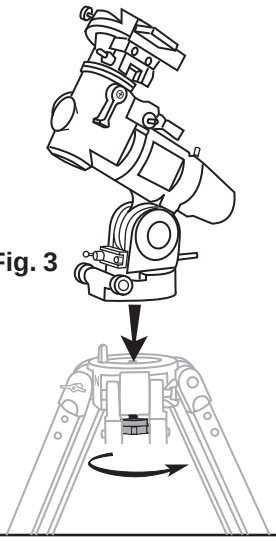
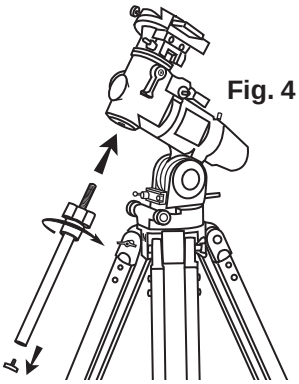


Fig. 3



TELESCOPE ASSEMBLY

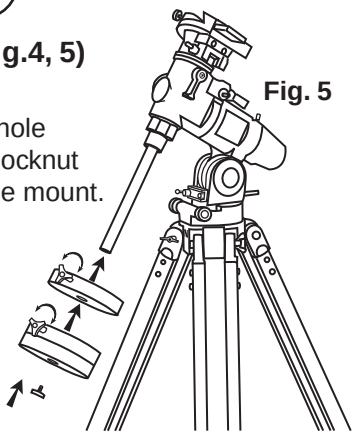
Fig. 4

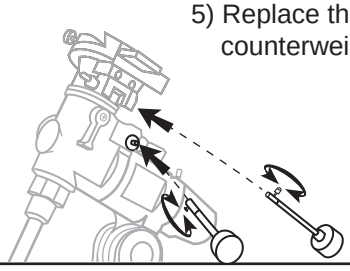


INSTALLING THE COUNTERWEIGHT(S) (Fig.4, 5)

1) Locate the counterweight rod.
2) Screw the counterweight rod into the threaded hole on the end of the declination shaft. Tighten the locknut on counterweight rod until it is locked against the mount.
3) Unscrew the threaded cap from the end of the counterweight rod.
4) Locate the counterweight(s) and slide them halfway along the counterweight rod. Tighten the counterweight thumbscrews to secure.
5) Replace the cap on the end of the counterweight rod.

Fig. 5

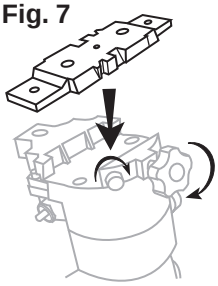




INSTALLING THE CONTROL CABLES (Fig.6)

1) Slide the sleeve end of the cable over the nipple on the end of the worm gear. Secure the cable by tightening the set screw against the flat surface of the nipple.

Fig. 7



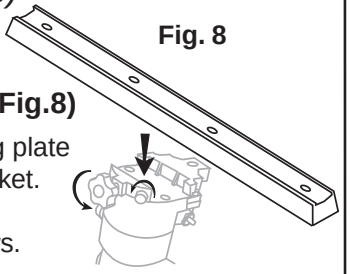
(short mounting plate)

ATTACHING THE MOUNTING PLATE (Fig.7)

1) Align the screws with the grooves on the side of the mounting bar. Position the mounting plate on the mounting bracket.
2) Secure by tightening the two locking screws.

(long mounting plate)

Fig. 8



ATTACHING THE MOUNTING PLATE (Fig.8)

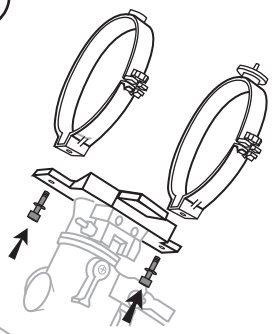
1) Position the mounting plate on the mounting bracket.
2) Secure by tightening the two locking screws.

TELESCOPE ASSEMBLY

ATTACHING THE TUBE RINGS TO THE MOUNT (Fig.9)

1) Remove the telescope tube assembly from its plastic packaging.
2) Remove the tube rings from the telescope by releasing their thumb nuts and opening their hinges.
3) Using the bolts provided, fasten the tube rings to the mount with the 10mm wrench provided.

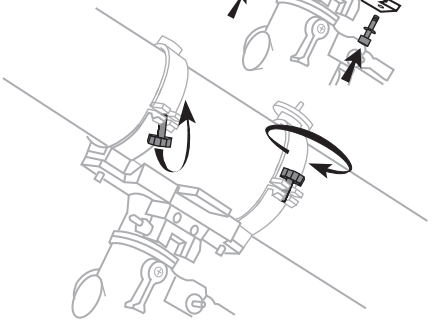
Fig.9



ATTACHING THE TELESCOPE MAIN TUBE TO THE TUBE RINGS (Fig.10)

1) Remove the telescope tube from the paper covering.
2) Find the center of balance of the telescope tube. Place this in between the two tube rings. Close the hinges around the telescope and fasten securely by tightening the thumb nuts. Do not over tighten.

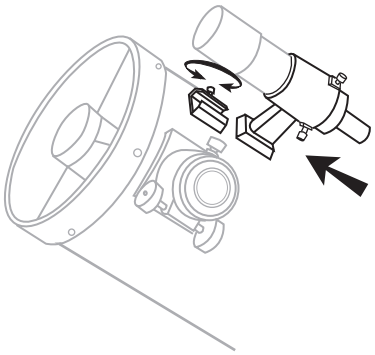
Fig.10



FINDERSCOPE/RED DOT FINDER ASSEMBLY

(reflector and Maksutov)

Fig.11



ATTACHING THE FINDERSCOPE BRACKET/RED DOT FINDER (Fig.11)

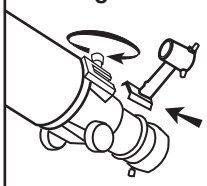
1) Locate the finderscope optical assembly or Red Dot Finder.
2) Slide the finderscope bracket/Red Dot Finder into the rectangular slot and tighten the screw to hold the mount in place.

(refractor)

Fig.12

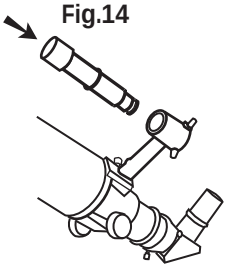
ATTACHING THE FINDERSCOPE (Fig.12, 13, 14)

Fig.13



1) Locate the finderscope bracket. Carefully remove the rubber-o-ring from the finderscope bracket.
2) Position the o-ring into the groove located approximately half-way along the finderscope tube.
3) Locate the finderscope optical assembly.
4) Slide the finderscope bracket into the rectangular slot and tighten the screw to hold the mount in place.
5) Position the finderscope into its mount by sliding it backwards until the rubber o-ring seats in the finderscope mount.

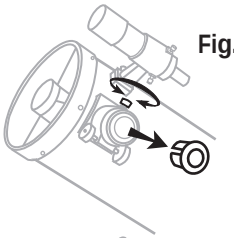
Fig.14



EYEPIECE ASSEMBLY

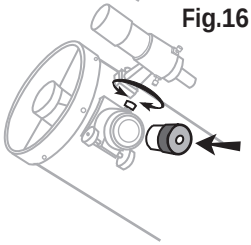
(reflector)

Fig.15



INSERTING THE EYEPIECE (Fig.15, 16)

Fig.16



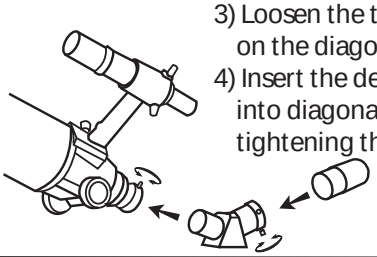
1) Unscrew the thumbscrews on the end of the focus tube to remove the black plastic end-cap.
2) Insert the desired eyepiece and secure it by retightening the thumbscrews.

(refractor and Maksutov)

INSERTING THE EYEPIECE (Fig.17)

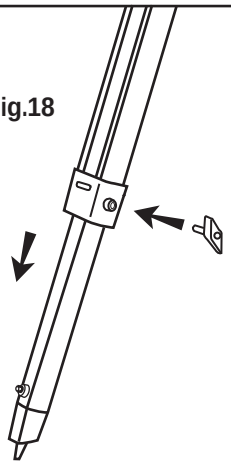
1) Loosen the thumbscrew on the end of the focus tube.
2) Insert the diagonal into the focus tube and re-tighten the thumbscrew to hold the diagonal in place.
3) Loosen the thumbscrews on the diagonal.
4) Insert the desired eyepiece into diagonal and secure by re-tightening the thumbscrews.

Fig.17



TRIPOD SET UP

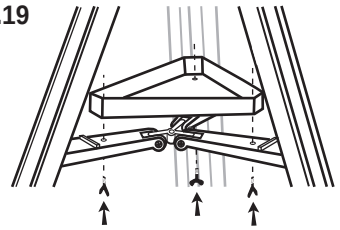
Fig.18



ADJUSTING THE TRIPOD LEGS (Fig.18)

1) Slowly loosen the height adjustment clamp and gently pull out the lower section of each tripod leg. Tighten the clamps to hold the legs in place.
2) Spread the legs apart to stand the tripod upright.
3) Adjust the height of each tripod leg until the tripod head is properly leveled. Note that the tripod legs may not be at same length when the equatorial mount is level. Do not over tighten the clamps.

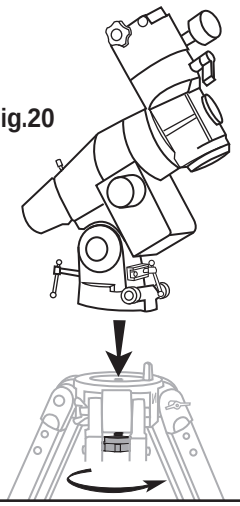
Fig.19



ATTACHING THE ACCESSORY TRAY (Fig.19)

1) Place th e accessory tray on top of the bracket, and secure with the locking thumb screws from underneath.

Fig.20



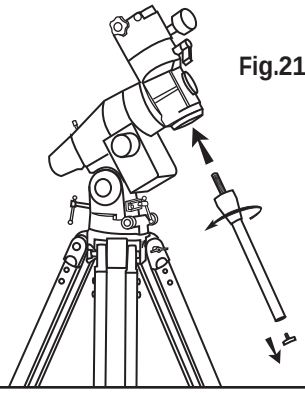
ATTACHING MOUNT TO TRIPOD (Fig.20)

1) Align metal dowel on the tripod head with the gap between the azimuthal adjustment knobs underneath the mount. Tighten the knurled knob underneath the tripod head to secure mount to tripod.

Note: Loosen the azimuthal adjustment knobs if mount does not t into tripod head completely. Retighten knobs to secure.

TELESCOPE ASSEMBLY

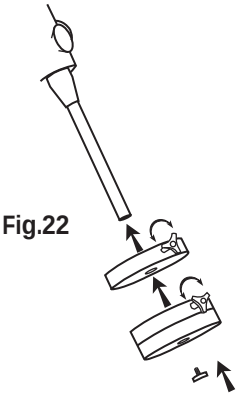
Fig.21



INSTALLING COUNTERWEIGHT (Fig.21, 22)

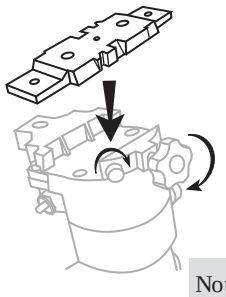
1) Locate counterweight rod.
2) Screw counterweight rod into threaded hole on the end of the declination shaft. Tighten locknut on the counterweight rod until it is locked against the mount.
3) Unscrew the threaded cap from the end of the counterweight rod.
4) Locate the counterweights and slide them halfway along the counterweight rod. Tighten the counterweight thumb screws to secure.
5) Replace the cap on the end of the counterweight rod.

Fig.22



(short mounting plate)

Fig.23



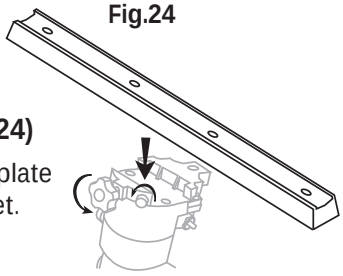
ATTACHING THE MOUNTING PLATE (Fig.23)

1) Position the mounting plate on the mounting bracket.
2) Secure by tightening the two locking screws.

Note: The screws should align with the grooves in the side of the mounting bar.

(long mounting plate)

Fig.24



ATTACHING THE MOUNTING PLATE (Fig.24)

1) Position the mounting plate on the mounting bracket.
2) Secure by tightening the two locking screws.

TELESCOPE ASSEMBLY

ATTACHING THE TUBE RINGS TO THE MOUNT(Fig.25)

1) Remove the telescope tube assembly from its plastic packaging.
2) Remove the tube rings from the telescope by releasing their thumb nuts and opening their hinges.
3) Using the bolts provided, fasten the tube rings to the mount with the 10mm wrench provided.

ATTACHING THE TELESCOPE MAIN TUBE TO THE TUBE RINGS (Fig.26)

1) Remove the telescope tube from the paper covering.
2) Find the center of balance of the telescope tube. Place this in between the two tube rings. Close the hinges around the telescope and fasten securely by tightening the thumb nuts.

Fig.25

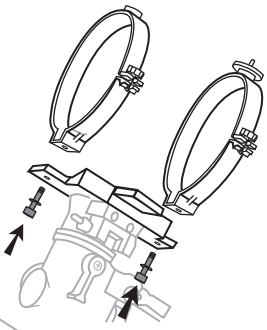
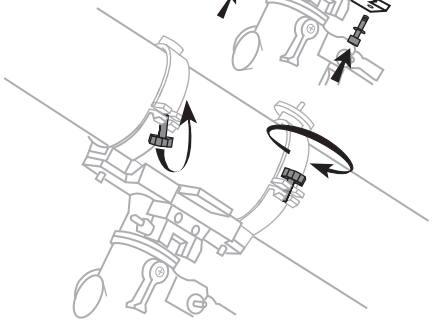


Fig.26



FINDERSCOPE ASSEMBLY

(re ector)

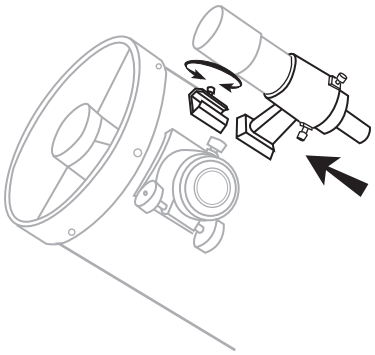


Fig.27

ATTACHING THE FINDERSCOPE BRACKET (Fig.27)

1) Locate the nderscope optical assembly.
2) Slide the nderscope bracket into the rectangular slot and tighten the screw to hold the mount in place.

(refractor)

Fig.28

Fig.29

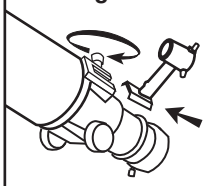
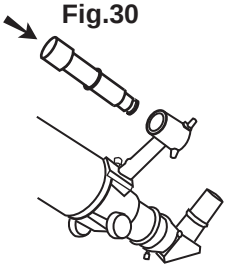


Fig.30

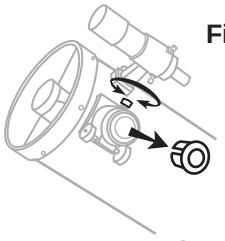


ATTACHING THE FINDER-SCOPE (Fig.28, 29, 30)

1) Locate the nderscope bracket. Carefully remove the rubber-o-ring from the nderscope bracket.
2) Position the o-ring into the groove located approximately half-way along the nderscope tube.
3) Locate the nderscope optical assembly.
4) Slide the nderscope bracket into the rectangular slot and tighten the screw to hold the mount in place.
5) Position the nderscope into its mount by sliding it backwards until the rubber o-ring seats in the nderscope mount.

EYEPIECE ASSEMBLY

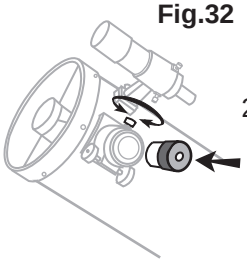
Fig.31



(re ector)

INSERTING THE EYEPIECE (Fig.31, 32)

Fig.32



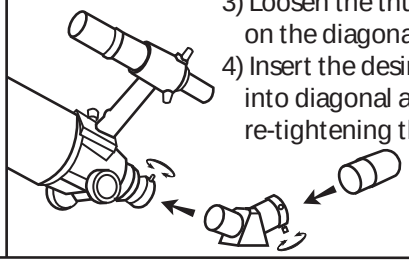
1) Unscrew the thumbscrews on the end of the focus tube to remove the black plastic end-cap.
2) Re-tighten thumb screws to hold the eyepiece in place.

(refractor)

INSERTING THE EYEPIECE (Fig.33)

1) Loosen the thumbscrew on the end of the focus tube.
2) Insert the diagonal into the focus tube and re-tighten thumbscrew to hold the diagonal in place.
3) Loosen the thumbscrews on the diagonal.
4) Insert the desired eyepiece into diagonal and secure by re-tightening the thumbscrews.

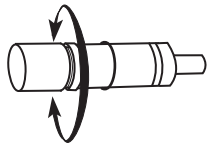
Fig.33



OPERATING YOUR TELESCOPE

Aligning the Finderscope

Fig.a



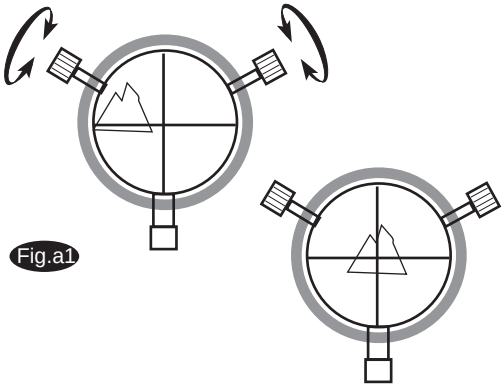


Fig.a1

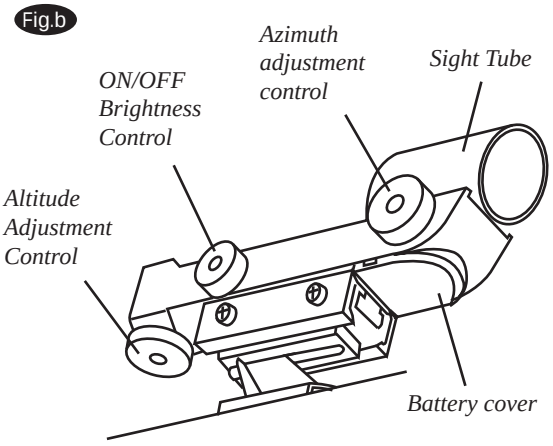
The finderscope (optical or red dot) is a very useful accessory that is included with your telescope. When the finderscope is correctly aligned with the telescope, objects can be quickly located and brought to the centre of the field. Alignment is best done outdoors in day light when it's easier to locate objects. If it is necessary to refocus your finderscope, sight on an object that is at least 500 yards (metres) away. Loosen the locking ring by unscrewing it back towards the bracket. The front lens holder can now be turned in and out to focus. When focus is reached, lock it in position with the locking ring (Fig.a).

1) Choose a distant object that is at least 500 yards away and point the main telescope at the object. Adjust the telescope so that the object is in the centre of the view in your eyepiece.
2) Check the finderscope to see if the object centred in the main telescope view is centred on the crosshairs.
3) Adjust the two small screws to centre the finderscope crosshairs on the object (Fig.a1).

Using the Red Dot Finderscope

The Red Dot Finder 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. The Red Dot Finder is equipped with a variable brightness control, azimuth adjustment control, and altitude adjustment control (Fig.b). The Red Dot Finder is powered by a 3-volt lithium battery located underneath at the front. To use the Finder, simply look through the sight tube and move your telescope until the red dot merges with the object. Make sure to keep both eyes open when sighting.

Fig.b

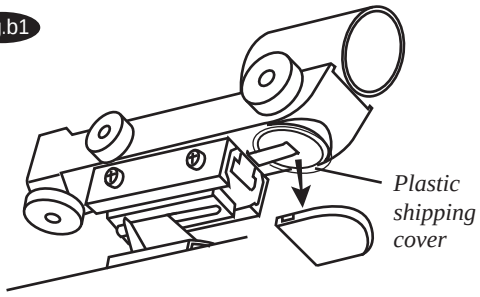


Aligning the Red Dot Finder

Like all finderscopes, the Red Dot Finder must be properly aligned with the main telescope before use. This is a simple process using the azimuth and altitude control knobs.

1) Open the battery cover by pulling it down (you can gently pry at the 2 small slots) and remove the plastic shipping cover over the battery (Fig.b1).
2) Turn on the Red Dot Finder by rotating the variable brightness control clockwise until you hear a "click". Continue rotating the control knob to increase the brightness level.
3) Insert a low power eyepiece into the telescope's focuser. Locate a bright object and position the telescope so that the object is in the centre of the field of view.
4) With both eyes open, look through the sight tube at the object. If the red dot overlaps the object, your Red Dot Finder is perfectly aligned. If not, turn its azimuth and altitude adjustment controls until the red dot is merged with the object.

Fig.b1



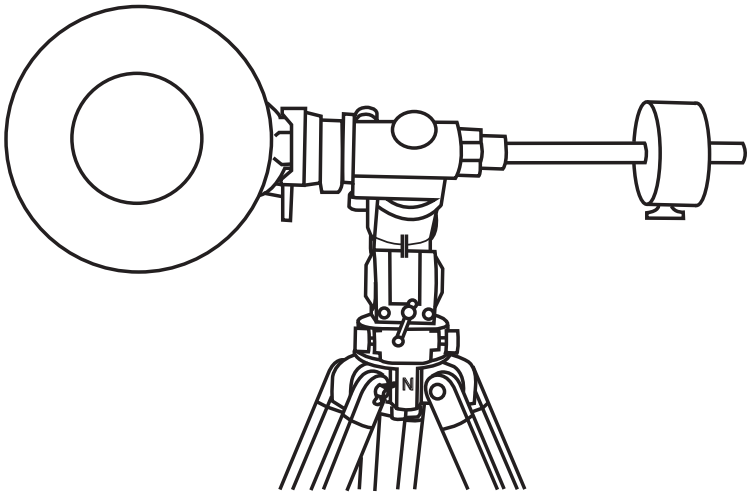
Balancing the telescope

A Telescope should be balanced before each observing session. Balancing reduces stress on the telescope mount and allows precise control of micro-adjustment. A balanced telescope is specially critical when using the optional clock drive for astrophotography. The telescope should be balanced after all accessories (eyepiece, camera, etc.) have been attached. Before balancing your telescope, make sure that your tripod is balanced and on a stable surface. For photography, point the telescope in the direction you will be taking photos before performing the balancing steps.

R.A. Balancing

1) For best results, adjust the altitude of the mount to between 15º and 30º if possible, by using the altitude adjustment T-bolt.
2) Slowly unlock the R.A. and Dec. lock knobs. Rotate the telescope until both the optical tube and the counterweight rod are horizontal to the ground, and the telescope tube is to the side of the mount (Fig.c).
3) Tighten the Dec. lock knob.
4) Move the counterweight(s) along the counterweight rod until the telescope is balanced and remains stationary when released.
5) Tighten the counterweight thumb screws to hold counterweight(s) in their new position.

Fig.c



Dec. Balancing

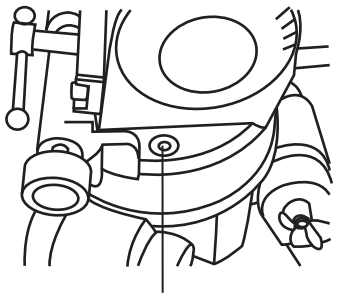
All accessories should be attached to the telescope before balancing around the declination axis. The R.A. balancing should be done before proceeding with Dec. balancing.

1) For best results, adjust the altitude of the mount to between 60º and 75º if possible.
2) Release the R.A. lock knob and rotate around the R.A. axis so that the counterweight rod is in a horizontal position. Tighten the R.A. lock knob.
3) Unlock the Dec. lock knob and rotate the telescope tube until it is parallel to the ground.
4) Slowly release the telescope and determine in which direction it rotates. Loosen the telescope tube rings and slide the telescope tube forward or backward in the rings until it is balanced.
5) Once the telescope no longer rotates from its parallel starting position, re-tighten the tube rings and the Dec. lock knob. Reset the altitude axis to your local latitude.

Using the leveling bubble

For best telescope performance, the equatorial mount should be properly leveled. A level tripod allows easier fine adjustment of controls and better weight distribution. This equatorial mount includes a small leveling bubble near its base (Fig.d). Adjust the height of each tripod leg until the bubble appears in the center of the circle. Note that the tripod legs may not be at same length when the equatorial mount is level.

Fig.d



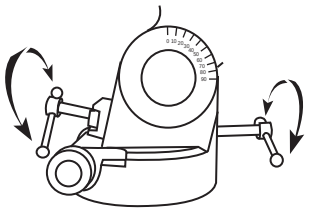
Leveling bubble

Operating the NEQ3 mount

The NEQ3 mount has controls for both conventional altitude (up-down) and azimuth (left-right) directions of motion. These two adjustments are suggested for large direction changes and for terrestrial viewing. The two azimuth adjustment knobs located near the tripod head allow fine-adjustment of azimuth for polar alignment. Use the altitude adjustment T-bolts for altitude adjustments. These allow fine-adjustment for setting the mount to your local latitude. (Fig.e).

In addition, this mount has Right Ascension (hour angle) and Declination direction controls for polar-aligned astronomical observing. Loosen the lock knobs to make large direction changes. Use the control cables for fine adjustment after the lock knobs have both been locked (Fig.e1). An additional scale is included for the altitude axis. This allows polar alignment for your local latitude. (Fig.e2)

Fig.e2



Latitude scale

Operating the EQ5 mount

The EQ5 mount has controls for both conventional altitude (up-down) and azimuth (left-right) directions of motion. These two adjustments are suggested for large direction changes and for terrestrial viewing. The two azimuth adjustment knobs located near the tripod head allow fine-adjustment of azimuth for polar alignment. Use the altitude adjustment T-bolts for altitude adjustments. These allow fine-adjustment for setting the mount to your local latitude. (Fig.f).

In addition, this mount has Right Ascension (hour angle) and declination direction controls for polar-aligned astronomical observing. Loosen the lock knobs to make large direction changes. Use the control cables for fine adjustment after the lock knobs have both been locked (Fig.f1). An additional scale is included for the altitude axis. This allows polar alignment for your local latitude. (Fig.e2)

Fig.e

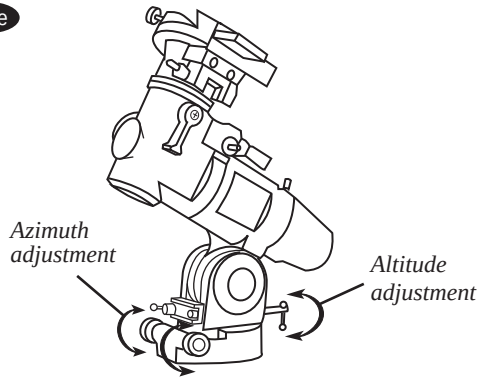


Fig.e1

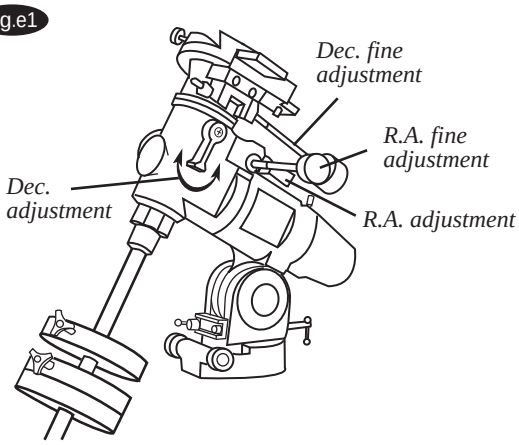


Fig.f

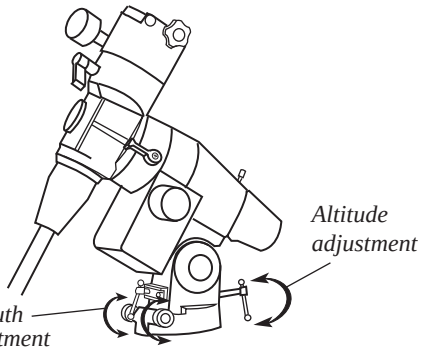
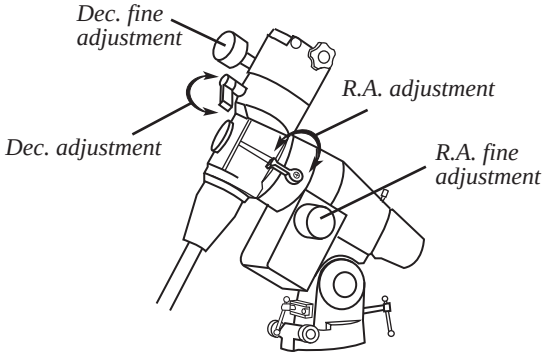


Fig.f1



Using the Barlow lens (optional)

A Barlow is a negative lens which increases the magnifying power of an eyepiece, while reducing the field of view. It expands the cone of the focussed light before it reaches the focal point, so that the telescope's focal length appears longer to the eyepiece.

The Barlow is inserted between the focuser and the eyepiece in a reflector, and usually between the diagonal and the eyepiece in a refractor or a maksutov (Fig.g). With some telescopes, it can also be inserted between the focuser and the diagonal, and in this position it gives even greater magnification. For example, a 2X Barlow when inserted after the diagonal can become 3X when placed in front of the diagonal.

In addition to increasing magnification, the benefits of using a Barlow lens include improved eye relief, and reduced spherical aberration in the eyepiece. For this reason, a Barlow plus a lens often outperforms a single lens producing the same magnification. However, its greatest value may be that a Barlow effectively doubles the number of eyepieces in your collection.

Focusing

Slowly turn the focus knobs under the focuser, one way or the other, until the image in the eyepiece is sharp (Fig.h). The image usually has to be finely refocused over time, due to small variations caused by temperature changes, flexures, etc. This often happens with short focal ratio telescopes, particularly when they haven't yet reached outside temperature. Refocusing is almost always necessary when you change an eyepiece or add or remove a Barlow lens.

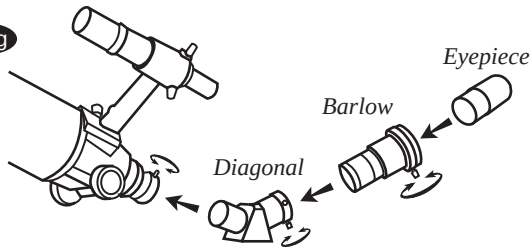
Polar Alignment for Visual Use

Tracking of celestial objects can be simplified by performing a procedure known as a polar alignment. For visual use the procedure does not require high precision. For satisfactory results all you need to do is point your mount at Polaris, the North Star.

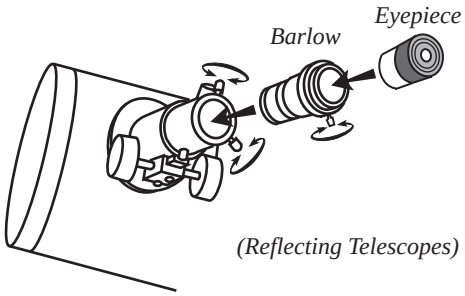
To point at Polaris, start by aiming the north leg of the tripod north. Next, adjust the altitude angle of the mount so that you can see Polaris through the polar axis view port.

Note that the proper altitude angle is equal to your local latitude. If you know your local latitude simply adjust the front and back latitude adjustment bolts until the indicator points to your local latitude on the scale. Fig. j. To find your local latitude you can consult a road map, call your airport, or look it up on the Internet.

Fig.g



(Refracting Telescopes and Maksutovs)



(Reflecting Telescopes)

Fig.h

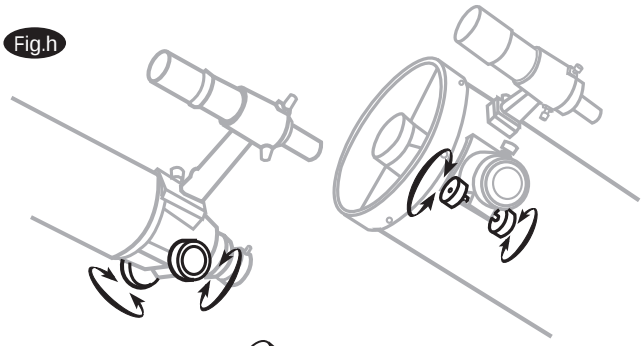
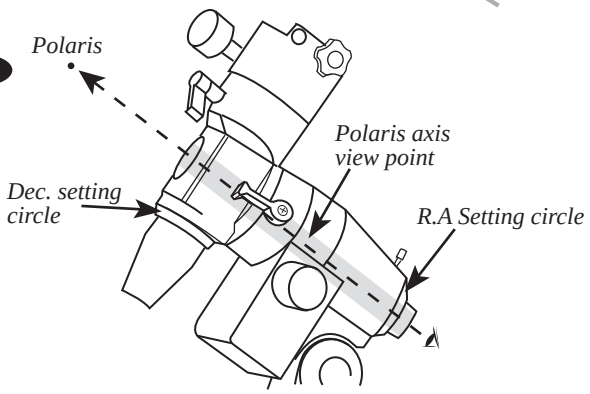
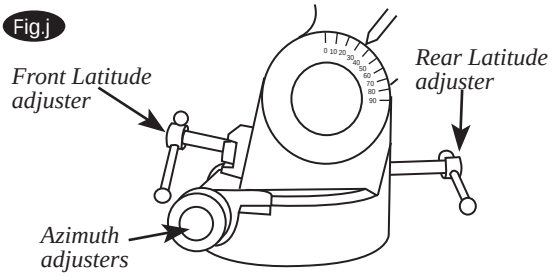


Fig.i



If you can see Polaris through your polar scope view port, you are polar aligned sufficiently for most visual applications.

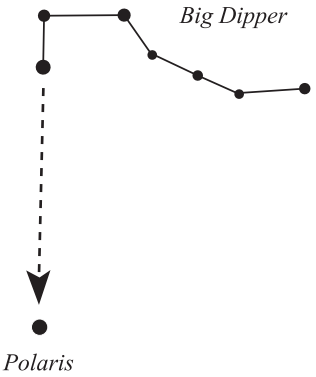
Fig.j



These are the main controls for adjusting the position of your mount to aim it at Polaris. Here, the latitude is set to approximately 40 degrees. East/west adjustments are made with the Azimuth adjusters.Up/down adjustments are made with the Latitude adjusters.

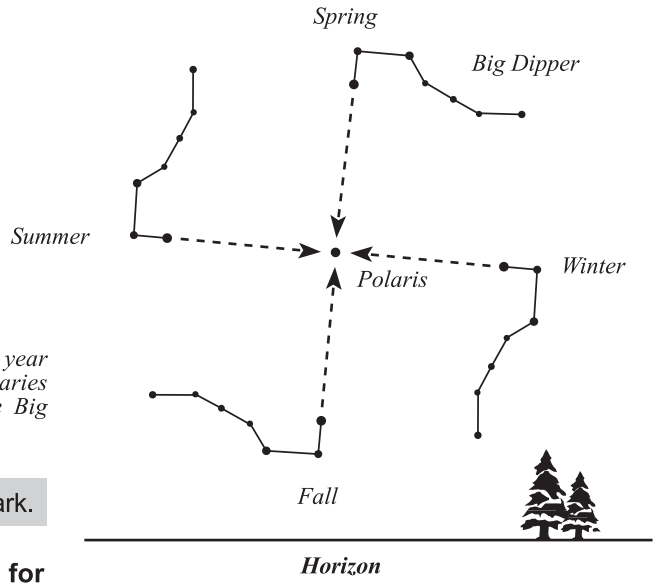
If you cannot find your local latitude, then you can simply adjust the altitude of the polar axis until you can see Polaris through the view port. If you are not sure where to find Polaris, then review Figure k.

If you do know how to find Polaris, then you can skip to the summary of steps for polar aligning. Remember, as long as you place Polaris somewhere near the center of polar axis view port you will have an adequate polar alignment for most visual applications.



The Big Dipper conveniently points at Polaris, the North Star all year round for northern observers, but its orientation just after dark varies with the season. Use the right hand figure to help you find the Big Dipper (and Polaris) any time of year.

Fig.k



Positions shown are approximate for just after dark.

Summary of Steps for Simplified Polar Alignment for Casual Observing

1) Assemble your tripod and mount and place them so that the tripod is level and the polar axis of the mount is pointing north. Remove the front and rear dust caps from the polar axis view port.

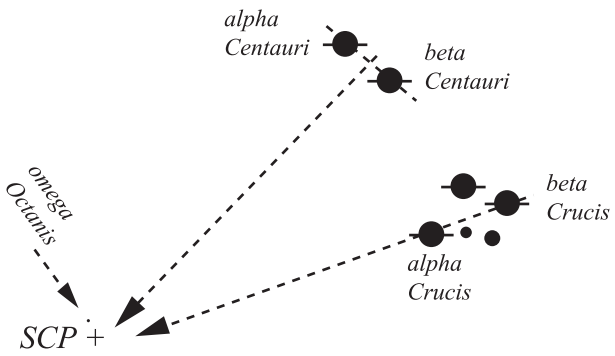
2) Adjust the altitude of your mount using the front and rear altitude adjustment bolts until the altitude indicator matches your local latitude.

3) From behind the mount, look through the polar axis view port and spot Polaris. Use the azimuth and altitude adjustment bolts to place Polaris near the center of the polar axis view port.

Southern Hemisphere

In the Southern Hemisphere you must align the mount to the SCP by locating its position with star patterns, without the convenience of a nearby bright star. The closest star is the faint 5.5-mag. Sigma Octanis which is about one degree away. Two sets of pointers which help to locate the SCP are alpha and beta Crucis (in the Southern Cross) and a pointer running at a right angle to a line connecting alpha and beta Centauri (Fig.l)

Fig.l

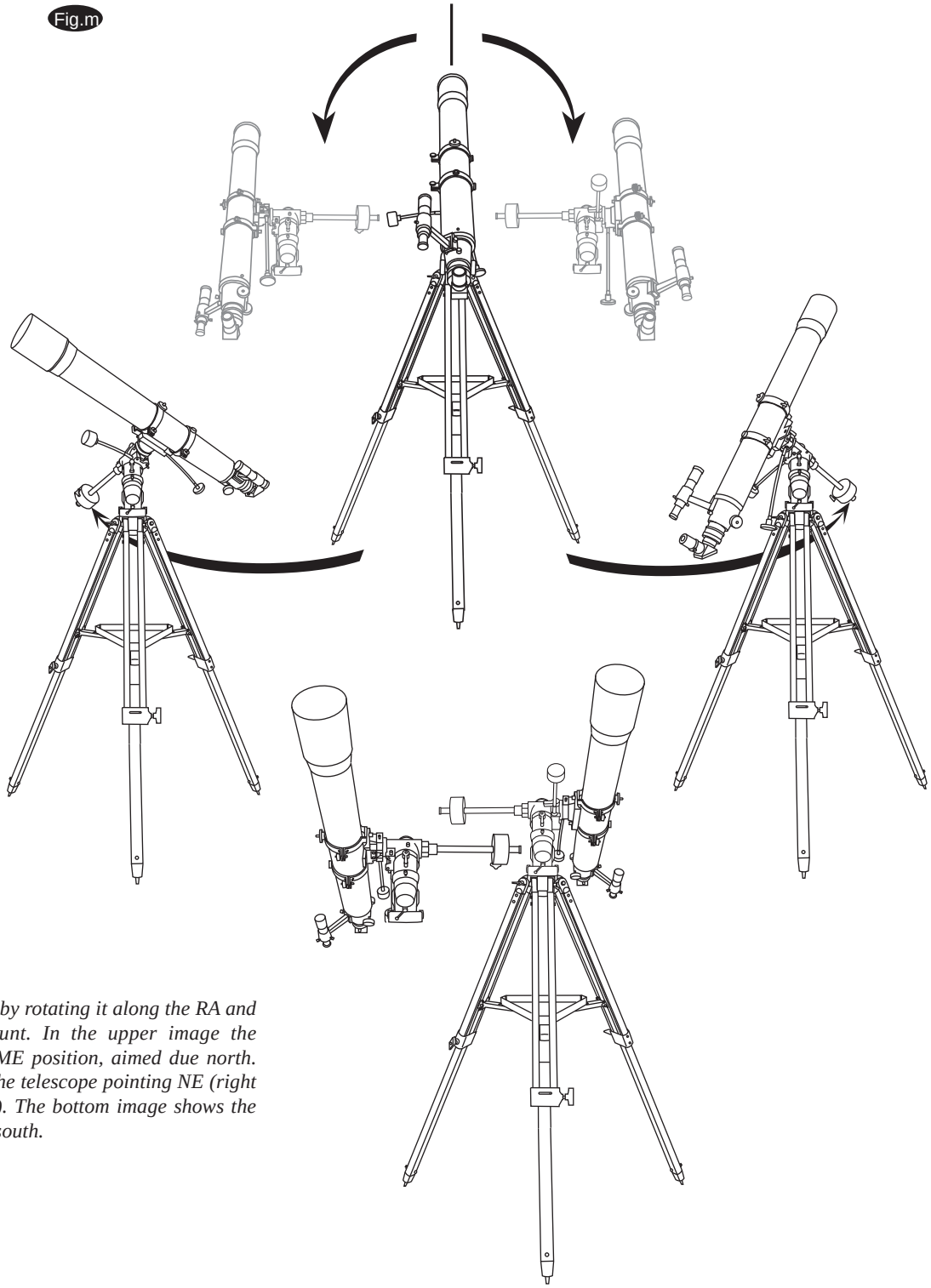


Pointing Your Telescope

Now that your mount is polar-aligned you'll want to point it to various locations in the sky. In the HOME position, your mount and telescope both point north in the direction of Polaris, the North Star. To point south you cannot simply rotate the telescope around the Dec axis, or you will end up pointing at the ground. To point south you must rotate the mount in both RA and in Dec.

Keep in mind that the counterweight(s) will always be placed on the side that the telescope is pointing to. So, if you are looking at an object in the west, the counterweight(s) will be on the west side of the mount. If you are looking to the east, they will be on the east side of the mount.

Fig.m



You aim your telescope by rotating it along the RA and Dec axes of your mount. In the upper image the telescope is in the HOME position, aimed due north. The side images show the telescope pointing NE (right side) and SW (left side). The bottom image shows the telescope pointing due south.

After pointing at an object and tracking it for a while you may find the counterweight(s) rise above the point of being parallel to the ground. If so, it is time to perform a meridian flip. This is necessary to prevent your telescope from eventually colliding with the mount or tripod.

To do a meridian flip, rotate your telescope 180 degrees in Dec and lock the Dec axis. Now, rotate your mount 12H in RA and lock the RA axis. Using the setting circles to assist you will help you do this more accurately.

When finished you should be pointing at the same object you were pointing at before, but from the opposite side of your mount. Don't forget to adjust your RA setting circles back to the coordinates of your object. Lock the setscrew when done.

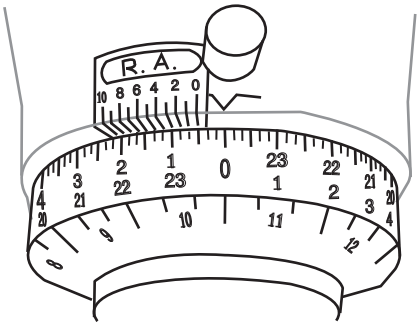
Using the Setting Circles

Now it is time to learn what those numbered dials are for! The dials are called setting circles and they can be used to help you find objects in the sky simply by dialing in a set of coordinates.

All objects in the sky have assigned coordinates labeled Right Ascension (RA for short) and Declination (Dec for short). The RA axis follows east/west movement of the sky and is the primary axis. By periodically rotating the RA axis you are able to follow the apparent motion of the sky and keep objects centered in your eyepiece. This is called tracking.

The Dec axis is for north/south positions. It is primarily used for finding objects, not for tracking them. It is normal, however, to make occasional adjustments to the Dec axis as well. The better your polar alignment, the fewer Dec adjustments you will need to make.

Fig.n



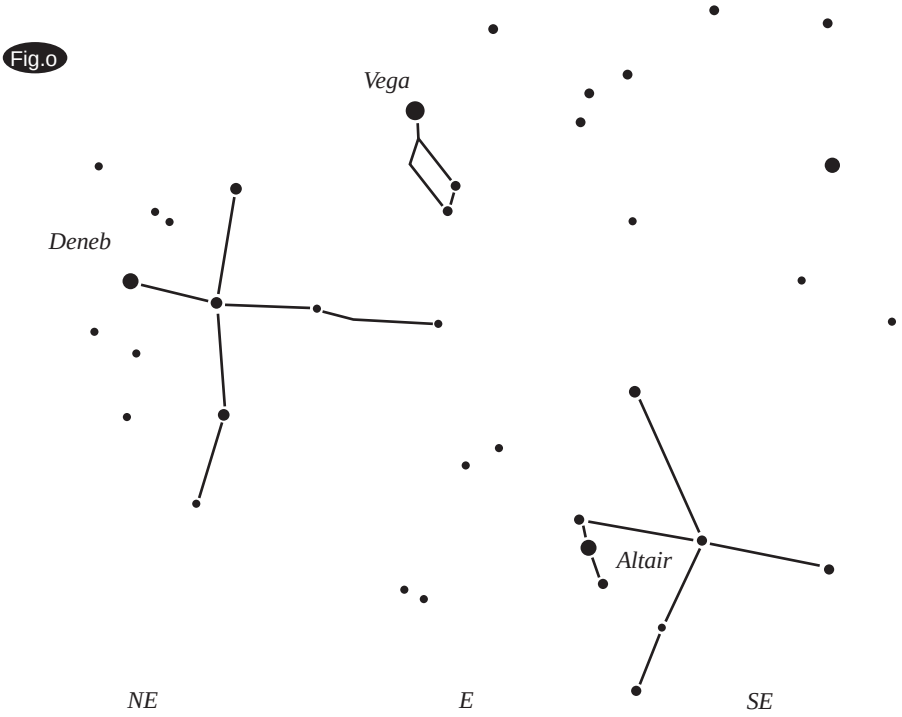
The RA setting circle is numbered from 1 to 24 in 10 minute increments. The example above shows the mount is set to the RA coordinates of 8h 20m. The lower scale marked 1 to 12 is the date scale. The upper scale is the RA minute scale. Both of these can be ignored when using the setting circle scale for finding objects.

First you need to calibrate the RA axis (Fig.n). To do this align your telescope to an object with known coordinates and then rotate the RA setting circle to show those coordinates. Leave the setscrew unlocked at this point. Your Dec scale is factory set and does not need to be calibrated in this way. Once you are aimed at the known object the Dec scale should have the correct coordinate reading.

Now as you rotate the scope in RA and Dec, the setting circle values change. So, to find a specific object, you simply turn both the axes until the designated coordinates line up with the pointers on the respective scales. After finding the object, centre it in your eyepiece, then lock the RA set screw securely. This will prevent the RA setting from incrementing as the telescope tracks the object. You only want the RA setting circle to rotate with the mount when you are locating objects, not when tracking them.

Let's do an example. During summer nights the star Vega shines brightly overhead (Fig.0). Vega is easy to find because it is so much brighter than any other stars in its general vicinity. It's easiest to find Vega by spotting the Summer Triangle. This is a trio of bright stars in the eastern sky consisting of Deneb (Cygnus), Altair (Aquila) and Vega (Lyra). Vega is the westernmost of the three stars. It will be highest overhead of the three for northern observers. Find Vega and centre it in your eyepiece.

Fig.o



Vega is the brightest star in the Summer Triangle, which consists of Deneb (Cygnus), Altair(Aquila) and Vega (Lyra). In this image Vega is at the top. In the sky when facing east it will be the highest of the three stars with Deneb to its left (north) and Altair to its lower right (south).

Vega has the coordinates RA 18h 37m. With Vega centered in your eyepiece loosen the RA setting circle setscrew and rotate the scale until it reads 18h 36m. (If you are in the Northern hemisphere use the top row of numbers. If you are in the Southern hemisphere use the lower set of numbers.)

To do this turn the RA dial until 18 is lined up with the indicator. The small divisions are set at 10 minutes each, so rotate another 3 divisions past 18h in the direction of 19h. This puts you at 18h 30m. Since you are aiming for 18:36, rotate about half of one more division. That will put you approximately at 18:35, and that is close enough for visual purposes.

Now look at the Dec scale. It should be pointing at 39 degrees, which is the Declination of Vega. If it is not, loosen the Allen screw on the Dec scale and rotate the scale until it reads 39 degrees. Retighten the Allen screw when you are done. This will be the only time you will ever need to adjust the Dec scale.

Your mount is now calibrated on Vega and ready to point at other objects using the setting circles. Let's try it out.

The interesting Ring Nebula (M57) is nearby at: RA 18h 52m and Dec 33 degrees. Unlock the RA scale set screw, then unlock the RA axis and rotate the mount until the scale reads 18h 52m. Lock the RA axis but don't tighten the RA setscrew just yet. Now unlock the Dec axis and rotate the telescope until the Dec axis pointer is at 33 on the scale. Lock your Dec axis.

When you look through a low power eyepiece you should be able to detect the Ring Nebula in the field of view. Use your slow motion controls to centre it, then lock the RA setscrew by tightening it fully. When you are ready to move on to the next object, unlock the RA set screw, then rotate the RA and Dec axes until you arrive at the desired coordinates.

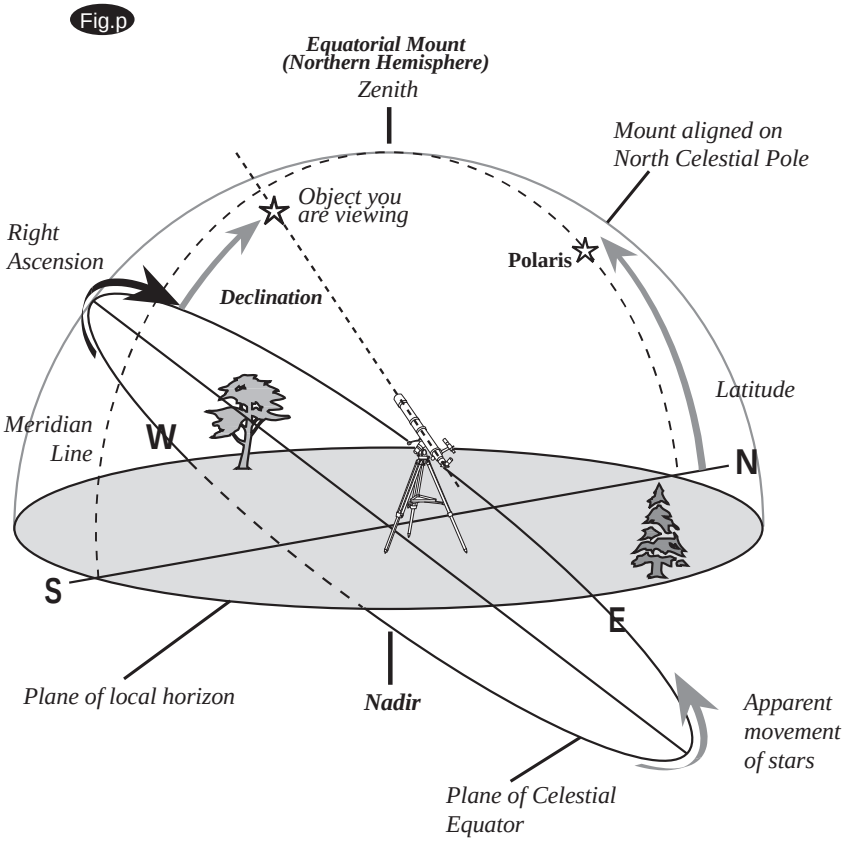
Meridian Flips

The meridian is an imaginary line that runs directly overhead from north to south and divides the sky into east and west (Fig.p). You will find that any moves of the telescope that cause you to cross the meridian will invalidate your setting circles. If you switch from pointing in the eastern sky to an object in the western sky (or visa versa) you will need to perform a meridian flip and manually reset your RA setting circle.

The procedure for doing a meridian flip is described in the section on pointing your telescope. If you do a meridian flip and end up pointing at the same object you had been viewing before, don't forget to reset the RA setting circle to that object's coordinates. If you do a meridian flip and point at a new object, be sure to put its coordinates on the RA setting circle. As always, lock down the RA set screw when switching from finding
objects to tracking them.

It is a good idea to plan your observing so that multiple objects in the west are viewed in sequence before viewing objects in the east. When viewing multiple objects on the same side of the sky you do not need to reset your RA setting circle as often. Why start in the west? We recommend this simply because objects in the western sky will set earlier than objects in the eastern sky. If you leave them to last, they may set before you find them!

Fig.p



Choosing the appropriate eyepiece

Calculating the magnification (power)

The magnification produced by a telescope is determined by the focal length of the eyepiece that is used with it. To determine a magnification for your telescope, divide its focal length by the focal length of the eyepieces you are going to use. For example, a 10mm focal length eyepiece will give 80X magnification with an 800mm focal length telescope.

$$\text{magnification} = \frac{\text{Focal length of the telescope}}{\text{Focal length of the eyepiece}} = \frac{800\text{mm}}{10\text{mm}} = 80\text{X}$$

When you are looking at astronomical objects, you are looking through a column of air that reaches to the edge of space and that column seldom stays still. Similarly, when viewing over land you are often looking through heat waves radiating from the ground, house, buildings, etc. Your telescope may be able to give very high magnification but what you end up magnifying is all the turbulence between the telescope and the subject. A good rule of thumb is that the usable magnification of a telescope is about 2X per mm of aperture under good conditions.

Calculating the field of view

The size of the view that you see through your telescope is called the true (or actual) field of view and it is determined by the design of the eyepiece. Every eyepiece has a value, called the apparent field of view, which is supplied by the manufacturer. Field of view is usually measured in degrees and/or arc-minutes (there are 60 arc-minutes in a degree). The true field of view produced by your telescope is calculated by dividing the eyepiece's apparent field of view by the magnification that you previously calculated for the combination. Using the figures in the previous magnification example, if your 10mm eyepiece has an apparent field of view of 52 degrees, then the true field of view is 0.65 degrees or 39 arc-minutes.

$$\text{True Field of View} = \frac{\text{Apparent Field of View}}{\text{Magnification}} = \frac{52°}{80\text{X}} = 0.65°$$

To put this in perspective, the moon is about 0.5° or 30 arc-minutes in diameter, so this combination would be fine for viewing the whole moon with a little room to spare. Remember, too much magnification and too small a field of view can make it very hard to find things. It is usually best to start at a lower magnification with its wider field and then increase the magnification when you have found what you are looking for. First find the moon then look at the shadows in the craters!

Calculating the exit pupil

The Exit Pupil is the diameter (in mm) of the narrowest point of the cone of light leaving your telescope. Knowing this value for a telescope-eyepiece combination tells you whether your eye is receiving all of the light that your primary lens or mirror is providing. The average person has a fully dilated pupil diameter of about 7mm. This value, varies a bit from person to person, is less until your eyes become fully dark adapted and decreases as you get older. To determine an exit pupil, you divide the diameter of the primary of your telescope (in mm) by the magnification.

$$\text{Exit Pupil} = \frac{\text{Diameter of Primary mirror in mm}}{\text{Magnification}}$$

For example, a 200mm f/5 telescope with a 40mm eyepiece produces a magnification of 25x and an exit pupil of 8mm. This combination can probably be used by a young person but would not be of much value to a senior. The same telescope used with a 32mm eyepiece gives a magnification of about 31x and an exit pupil of 6.4mm which should be fine for most dark adapted eyes. In contrast, a 200mm f/10 telescope with the 40mm eyepiece gives a magnification of 50x and an exit pupil of 4mm, which is fine for everyone.

OBSERVING THE SKY

Sky conditions

Sky conditions are usually defined by two atmospheric characteristics, seeing, or the steadiness of the air, and transparency, light scattering due to the amount of water vapour and particulate material in the air. When you observe the Moon and the planets, and they appear as though water is running over them, you probably have bad "seeing" because you are observing through turbulent air. In conditions of good "seeing", the stars appear steady, without twinkling, when you look at them with unassisted eyes (without a telescope). Ideal "transparency" is when the sky is inky black and the air is unpolluted.

Selecting an observing site

Travel to the best site that is reasonably accessible. It should be away from city lights, and upwind from any source of air pollution. Always choose as high an elevation as possible; this will get you above some of the lights and pollution and will ensure that you aren't in any ground fog. Sometimes low fog banks help to block light pollution if you get above them. Try to have a dark, unobstructed view of the horizon, especially the southern horizon if you are in the Northern Hemisphere and vice versa. However, remember that the darkest sky is usually at the "Zenith", directly above your head. It is the shortest path through the atmosphere. Do not try to observe any object when the light path passes near any protrusion on the ground. Even extremely light winds can cause major air turbulence as they flow over the top of a building or wall.

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 which also affects images. Astronomy is an outdoor activity.

Choosing the best time to observe

The best conditions will have still air, and obviously, a clear view of the sky. It is not necessary that the sky be cloud-free. Often broken cloud conditions provide excellent seeing. Do not 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. Objects are best observed as they cross the meridian, which is an imaginary line that runs through the Zenith, due North-South. This is the point at which objects reach their highest points in the sky. Observing at this time reduces bad atmospheric effects. When observing near the horizon, you look through lots of atmosphere, complete with turbulence, dust particles and increased light pollution.

Cooling the telescope

Telescopes require time to cool down to outside air temperature. This may take longer if there is a big difference between the temperature of the telescope and the outside air. This minimizes heat wave distortion inside telescope tube (tube currents). A rule of thumb is to allow 5 minutes per inch of aperture. For example, a 4 inch refractor would require at least 20 minutes, but an 8" reflector would require at least 40 minutes to cool off to outside conditions. Tip: use this time for polar alignment.

Adapting your eyes

Do not expose your eyes to anything except red light for 30 minutes prior to observing. This allows your pupils to expand to their maximum diameter and build up the levels of optical pigments, which are rapidly lost if exposed to bright light. It is important to observe with both eyes open. This avoids fatigue at the eyepiece. If you find this too distracting, cover the non-used eye with your hand or an eye patch. Use averted vision on faint objects: The center of your eye is the least sensitive to low light levels. When viewing a faint object, don't look directly at it. Instead, look slightly to the side, and the object will appear brighter.

PROPER CARE FOR YOUR TELESCOPE

Collimating a Newtonian reflector

Collimation is the process of aligning the mirrors of your telescope so that they work in concert with each other to deliver properly focused light to your eyepiece. By observing out-of-focus star images, you can test whether your telescope's optics are aligned. Place a star in the centre of the field of view and move the focuser so that the image is slightly out of focus. If the seeing conditions are good, you will see a central circle of light (the Airy disc) surrounded by a number of diffraction rings. If the rings are symmetrical about the Airy disc, the telescope's optics are correctly collimated (Fig.q).

Fig.q

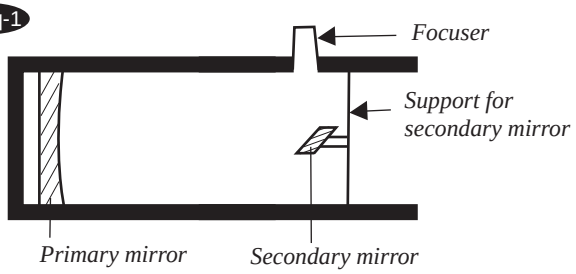
Correctly aligned *Needs collimation*

If you do not have a collimating tool, we suggest that you make a "collimating cap" out of a plastic 35mm film canister (black with gray lid). Drill or punch a small pinhole in the exact center of the lid and cut off the bottom of the canister. This device will keep your eye centered of the focuser tube. Insert the collimating cap into the focuser in place of a regular eyepiece.

Collimation is a painless process and works like this:

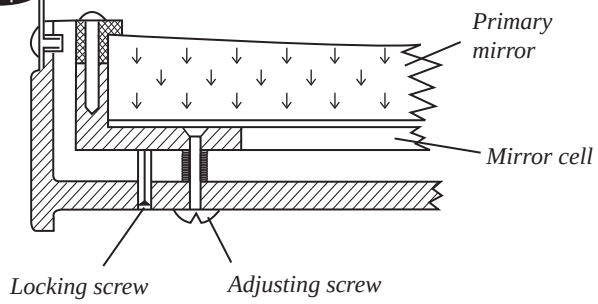
Pull off the lens cap which covers the front of the telescope and look down the optical tube. At the bottom you will see the primary mirror held in place by three clips 120º apart, and at the top the small oval secondary mirror held in a support and tilted 45º toward the focuser outside the tube wall (Fig.q-1).

Fig.q-1



The secondary mirror is aligned by adjusting the three smaller screws surrounding the central bolt. The primary mirror is adjusted by the three adjusting screws at the back of your scope. The three locking screws beside them serve to hold the mirror in place after collimation. (Fig.q-2)

Fig.q-2



Aligning the Secondary Mirror

Point the telescope at a lit wall and insert the collimating cap into the focuser in place of a regular eyepiece. Look into the focuser through your collimating cap. You may have to twist the focus knob a few turns until the reflected image of the focuser is out of your view. Note: keep your eye against the back of the focus tube if collimating without a collimating cap. Ignore the reflected image of the collimating cap or your eye for now, instead look for the three clips holding the primary mirror in place. If you can't see them (Fig.q-3), it means that you will have to adjust the three bolts on the top of the secondary mirror holder, with possibly an Allen wrench or Phillip's screwdriver. You will have to

Fig.q-3

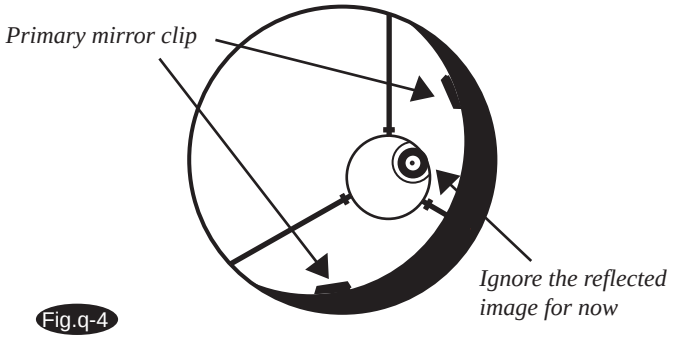
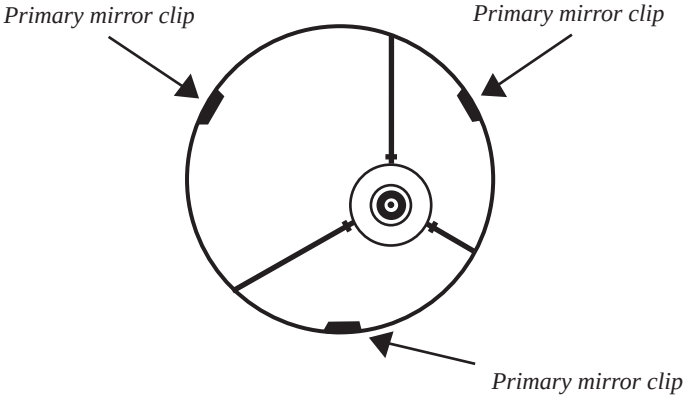


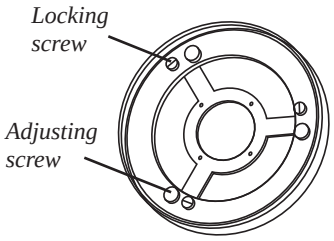
Fig.q-4



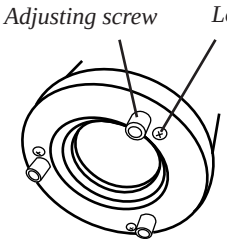
alternately loosen one and then compensate for the slack by tightening the other two. Stop when you see all three mirror clips (Fig.q-4). Make sure that all three small alignment screws are tightened to secure the secondary mirror in place.

Aligning the Primary Mirror

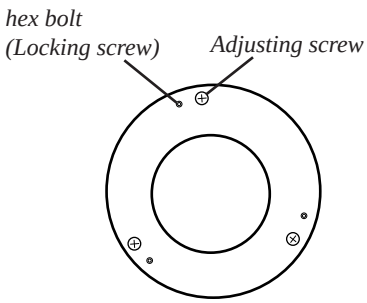
Find the three locking screws at the back of your telescope and loosen them by a few turns.



If you see 3 flat headed screws and 3 thumbscrews, the flat headed screws are the adjusting screws and the thumbscrews are the locking screws.

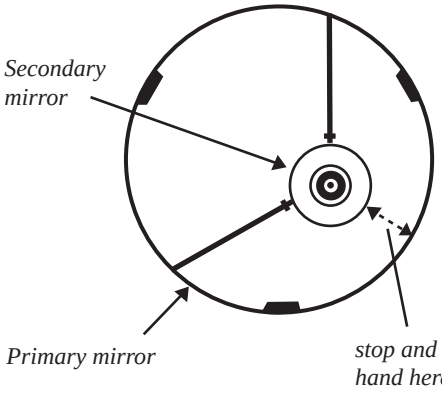


If you see 3 large nuts protruding from the back of your telescope and 3 small Phillip's-head screws besides them, the Phillip's-head screws are the locking screws and the large nuts are the adjusting screws.



If you see 3 hex bolts and 3 Phillip's head screws, the hex bolts are the locking screws and the Phillip's-head screws are the adjusting screws. You will need an Allen wrench to adjust the locking screws.

Fig.q-5

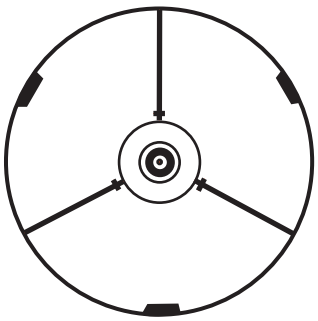


Now run your hand around the front of your telescope keeping your eye to the focuser, you will see the reflected image of your hand. The idea here is to see which way the primary mirror is defected; you do this by stopping at the point where the reflected image of the secondary mirror is closest to the primary mirrors' edge (Fig.q-5).

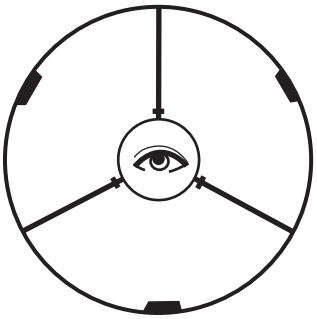
When you get to that point, stop and keep your hand there while looking at the back end of your telescope, is there an adjusting screw there? If there is you will want to loosen it (turn the screw to the left) to bring the mirror away from that point. If there isn't an adjusting screw there, then go across to the other side and tighten the adjusting screw on the other side. This will gradually bring the mirror into line until it looks like Fig.q-6. (It helps to have a friend to help for primary mirror collimation. Have your partner adjust the adjusting screws according to your directions while you look in the focuser.)

After dark go out and point your telescope at Polaris, the North Star. With an eyepiece in the focuser, take the image out of focus. You will see the same image only now, it will be illuminated by starlight. If necessary, repeat the collimating process only keep the star centered while tweaking the mirror.

Fig.q-6



Both mirrors aligned with collimating cap in



Both mirrors aligned with eye looking in focuser

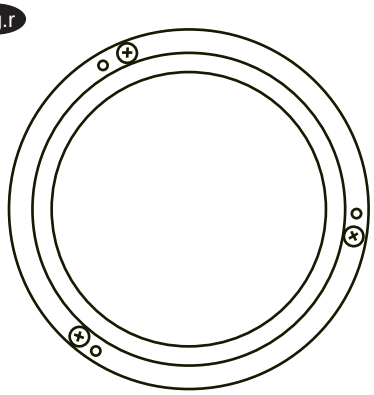
Collimating a refractor with the adjustable objective-lens cell

Collimation is the process of aligning the lenses of your telescope so that the light they collect will focus at the right spot at the back of your telescope for your eyepieces to work.

Collimation is a simple process and works like this:

Pull off the dew cap at the front of your telescope and look into the scope. The pair of lenses are held in a cell by a threaded ring. This cell is held in place by three pairs of screws spaced 120 degrees apart. The larger Phillip's head screws actually hold the cell on, while the smaller, buried Allen screws push against a ledge at the front of the tube and allow the cell to tilt slightly, by tension against the Phillips screws (Fig.r). The idea is to alternately loosen and tighten each against the other until you have a round star image.

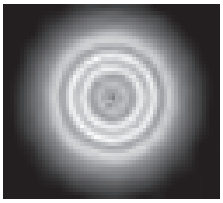
Fig.r



There are a number of devices available for collimation. One of the best is your eyepiece and Polaris. For this purpose it is best that your telescope not be polar aligned, in fact point the mount head due east or west.

Use your lowest power (largest number) eyepiece to acquire Polaris, place it in the center of the eypepiece view. Now switch to your next higher power eyepiece, while keeping the image centered. The in-focus star image will have a bright innermost point, a slightly fainter inner ring and a fainter still outer ring that is hard to see (Fig.r-1). If it doesn't look like this, or you can't reach focus then start with: take out your star diagonal and look at the image slightly out of focus, this will allow you to gauge the deflection. A typical off-collimation image will have a bright spot off to one side when you bring the focus out (Fig.r-2).

Fig.r-1



Correctly aligned

The actual process is to slightly loosen the pair on the side the deflection is, slacken the Allen head screws then tighten the Phillip's head screws against them again. Check the star image again after moving it into the centre of the eyepiece. If you find your image getting worse, then go the other way, or slacken the other two Allen screws a little. Once you have a round star image you are set.

Fig.r-2

Needs collimation

It helps to have a friend to help with the collimation. Have your partner adjust the screws according to your directions while you look in the eyepiece.

Cleaning your telescope

Replace the dust cap over the end of the telescope whenever it is not in use. This prevents dust from settling on the mirror or lens surfaces. Do not clean the mirror or lens unless you are familiar with optical surfaces. Clean the finderscope and eyepieces with special lens paper only. Eyepieces should be handled with care, avoid touching optical surfaces.

APPENDIX A - PRECISE POLAR ALIGNMENT FOR NORTHERN HEMISPHERE

When your equatorial mount is polar-aligned it is able track the sky easily and hold targets in the eyepiece with just occasional adjustments to the RA control cable. If your mount is motorized it can hold objects in the eyepiece almost indefinitely. An accurate polar alignment also greatly reduces the number of guiding corrections that are needed during long exposure astrophotography.

However, for all but the most critical photographic applications, your polar alignment does not need to be perfect. Your mount will provide excellent performance even if there is some error in the polar alignment. SkyWatcher has developed user-friendly equipment and procedures to minimize such errors, and this makes an adequate polar alignment easy to accomplish.

PREPARING THE MOUNT

Aligning the polar scope reticule

The polar scope needs to be aligned with the polar axis of your mount. The steps below tell you how to perform this alignment. Note, you can do this procedure at night while pointing at Polaris. However, it is probably easier to do it in the daytime using a distant point as your target (e.g, a street light a couple of hundred yards away). If doing the procedure during the day, you might find it convenient to set your altitude to near parallel with the ground to put the eyepiece of the polar scope into a comfortable position. Just be sure to leave room to make vertical adjustments in both directions. Also, do this procedure without a telescope or counterweights attached. It will make turning the mount a lot simpler.

1. Locate a distant object and place it under the cross at the centre of the polarscope reticule.
2. Rotate the mount in RA 180 degrees (i.e., 12 hours on the RA setting circle).
3. Note the displacement of your target from the centre of the crosshairs (Fig.s-1). If it is not displaced at all, it means your polar scope reticule is already properly aligned and you don't need to do any more. If it is displaced, continue with the next step of the alignment procedure.
4. Use the three adjustment screws on the polar scope to move the reticule so that exactly one-half of the displacement is corrected for. For example, if the displacement were about half an inch in the direction of 1 o'clock, then you would adjust the cross at the centre of the reticule to go half the distance in that direction (Figure s-2).
5. Now continue to move the cross using the altitude and azimuth adjusters on the mount. When the target is back under the cross, go back to step 2, but this time rotate the mount 180 degrees in the opposite direction. If you still get displacement of the target, repeat steps 3-5.

Fig.s-1

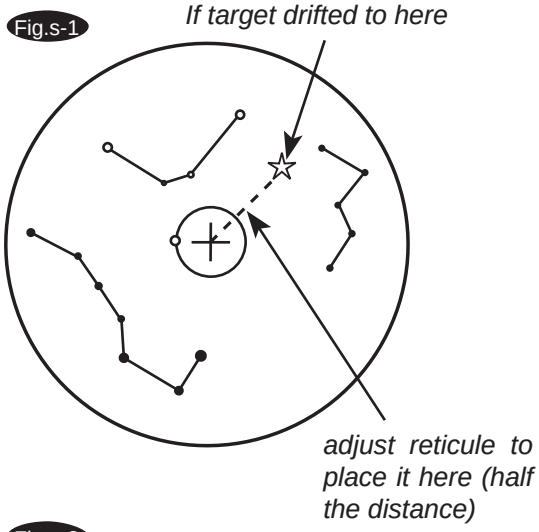
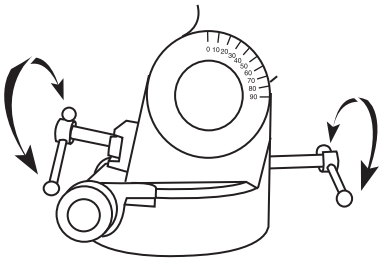


Fig.s-2



Setting your latitude

One bolt should always be loose when doing adjustments. Gently tighten both bolts when your adjustment is complete.

Remove the caps from the upper and lower ends of the RA axis so you can look into the polar scope. Adjust the north and south T-bolts on the mount so the latitude indicator points to your local latitude (Fig.2). Look through the polar scope and adjust the azimuth and altitude controls as needed so that Polaris appears in the view of the polar scope. Once you see it you can use one of the simplified procedures below to place Polaris at the correct position for an accurate polar alignment.

SIMPLIFIED POLAR ALIGNMENT PROCEDURES

The NEQ3 and EQ5 mounts have specially designed reticule patterns and simplified procedures to make polar aligning your mount very simple. In fact, if you purchased a SynScan equipped mount you can perform an extremely accurate polar alignment in less than two minutes! See the SynScan User manual for details.

If you do not have a SynScan mount you can still get a very good alignment without much bother. The two simple procedures detailed below work equally well. Use whichever one you like best.

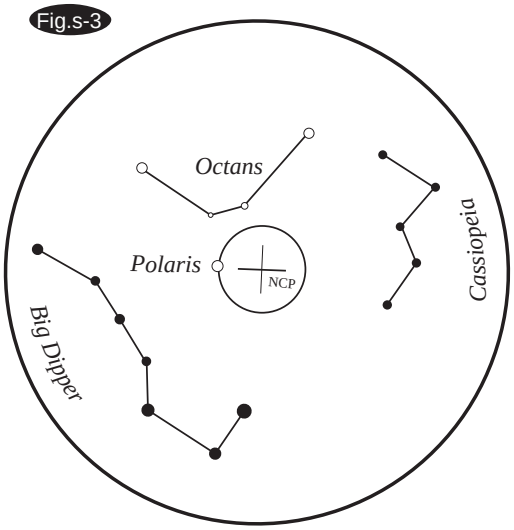
Pattern-based method

Northern Hemisphere - Identify the Big Dipper pattern in the constellation Ursa Major, or find the constellation Cassiopeia in the night sky. In spring and summer, the Big Dipper will be higher in the sky and easier to find. In fall and winter, Cassiopeia may be easier to use.

The patterns for both are etched on your polar scope reticule (Fig.S-3). Simply rotate your mount in RA until one of the patterns matches its actual orientation in the sky. Lock the RA axis. Now the small circle on the perimeter of the larger circle is in the correct position for locating Polaris.

Next, use your azimuth and altitude adjustment controls to place Polaris inside the small circle. Tighten your azimuth and altitude knobs, then tighten your locking shaft bolt to secure the mount to the tripod and you are done.

Fig.s-3



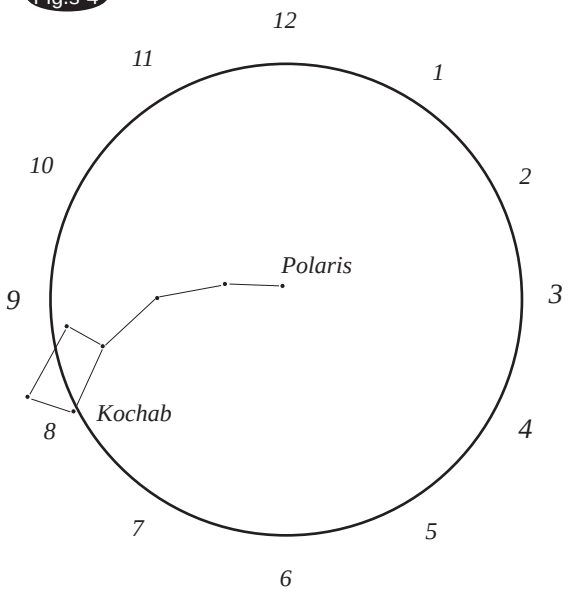
Pattern-based method

Kochab is the brightest star in the bucket portion of the Little Dipper (Fig.S-4). It also happens to form a line with Polaris and the North Celestial Pole (NCP) - the point in space at which you want to aim your polar axis to achieve an accurate polar alignment. Kochab rotates around the NCP the way the hour hand rotates around a clock face, but it takes Kochab nearly 24 hours to make one revolution. We can use this behavior to help us achieve an accurate polar alignment quickly and simply.

First, identify the bright star Kochab in the bucket of the Little Dipper. Now look at Polaris and imagine it is the center of a clock face. Take note of what “time” Kochab appears. For example, if Kochab were directly to the right of Polaris, it would be at 3 o’clock. In the figure above, it is at about 8:00.

Now look into your polar scope. Rotate your mount in RA to place the Polaris indicator circle at the time indicated by Kochab clock method. Then, use your altitude and azimuth adjustment controls to put Polaris inside the circle. Tighten your controls and your locking shaft bolt and you are done.

Fig.s-4



Kochab is the brightest star in the bucket of the Little Dipper. Other stars in the region are quite dim and are not drawn here.

Southern Hemisphere

There is a 4-star pattern in the polar scope, which resembles the bucket of the Big Dipper. In the Southern Hemisphere, there is an Asterism in Octans, which has this shape. By rotating the R.A. axis and by adjusting the altitude and azimuth of the mount, the four stars in the Asterism can be placed in the circles in the Pole Finder. This procedure can be somewhat difficult in the city because all four of these stars are fainter than Magnitude 5.

APPENDIX B - OPTIONAL ACCESSORIES

NEQ3 & EQ5 SYNSCAN

Sky-Watcher offers simple solutions for users who would like to attach their smaller telescope to a convenient computerized system but do not wish to deal with the weight of the HEQ5 or EQ6 mount. The NEQ3 and EQ5 SynScan mounts use the same Go-To system found in the HEQ5 and EQ6 Pro mounts. It allows you to point the telescope at a specific object or even tour the skies at the touch of a button.

DUAL AXIS MOTOR DRIVES

The EQ3 dual axis motor drives precisely control the telescopes' tracking speed to compensate for the earth's rotation. Available in 2x, 4x, and 8x speeds through the Hand Controller. These DC motor drives run on 4 "D" cell batteries (not included). Motors for both axes, clutches, cables, hand controller, and battery case are included.

SINGLE AXIS MOTOR DRIVE

These single axis (R.A.) DC motor drives are powered by 4 "D" cell batteries (not included). A set of batteries will allow several nights of observing. 2x and 8x tracking speeds (2x and 4x for EQ1 model) are available through the hand controller. Motor, hand controller, and battery case are included.

COLLIMATING EYEPIECE

The Sky-Watcher Collimation Eyepiece is ideal for precise collimation of Newtonians and refractors with an adjustable lenscells. This special eyepiece fits into 1¼" focusers or diagonals. Alignment is easy using the small opening on one end and thin crosshairs at the other end.

WIDE-ANGLE EYEPIECES

These Sky-Watcher Wide Angle Eyepieces offer a generous 66° apparent field of view, allowing more sky to be viewed at one time. They provide sharp image right across the field. The rubber eyecups are included for viewing comfort and to keep out extraneous light.
Focal Lengths: 20mm, 15mm, 9mm, 6mm
Eyepiece Barrels: 1.25"
Eye-relief: 14.8mm (W6), 15mm (W9), 13mm (W15), 18mm (W20)

DUAL FLASHLIGHT

These multipurpose flashlights provide instant switch between the night vision protecting red light and regular white light. A convenient control wheel is available for brightness adjustment.

APPENDIX C - RECOMMENDED READING

Amateur Astronomy

Beginner's Guide to Amateur Astronomy: An Owner's Manual for the Night Sky by David J. Eicher and, Michael Emmerich (Kalmbach Publishing Co., Books Division, Waukesha, WI, 1993).

NightWatch: A Practical Guide to Viewing the Universe by Terence Dickinson, (Firefly Books, Willowdale, ON, Canada, 3rd edition, 1999).

Star Testing Astronomical Telescopes by Harold Richard Suiter, (Willmann-Bell, Inc., Richmond, VA, 1994).

Star Ware: The Amateur Astronomer's Ultimate Guide to Choosing, Buying, and Using Telescopes and Accessories by Philip S. Harrington (John Wiley & Sons, New York, 1998).

The Backyard Astronomer's Guide by Terence Dickinson and Alan Dyer (Firefly Books Ltd., Willowdale, ON, Canada, revised edition, 1994).

The Beginner's Observing Guide: An Introduction to the Night Sky for the Novice Stargazer by Leo Enright, (The Royal Astronomical Society of Canada, Toronto, ON, Canada, 1999).

The Deep Sky: An Introduction by Philip S. Harrington (Sky Publishing Corporation, Cambridge, MA, Sky & Telescope Observer's Guides Series, ed. Leif J. Robinson, 1997).

The Universe from Your Backyard: A Guide to Deep Sky Objects by David J. Eicher (Kalmbach Publishing Co., Books Division, Waukesha, WI, 1988).

Turn Left at Orion: A Hundred Night Sky Objects to See in a Small Telescope--and how to Find Them by Guy J. Consolmagno and Dan M. Davis, (Cambridge University Press, New York, 3rd edition, 2000)

Astro-photography

The Great Atlas of the Stars by Serge Brunier, Constellation photography by Akira Fujii (Firefly Books; Willowdale, ON, Canada 2001).

A Manual Of Advanced Celestial Photography by Brad D. Wallis and Robert W. Provin (Cambridge University Press; New York; 1984).

Astrophotography An Introduction by H.J.P. Arnold (Sky Publishing Corp., Cambridge, MA,Sky & Telescope Observer's Guides Series, ed. Leif J. Robinson, 1995).

Astrophotography for the Amateur by Michael Covington (Cambridge University Press, Cambridge, UK, 2nd edition,1999).

Splendors of the Universe: A Practical Guide to Photographing the Night Sky by Terence Dickinson and Jack Newton (Firefly Books, Willowdale, ON, Canada, 1997).

Wide-Field Astrophotography by Robert Reeves (Willmann-Bell, Inc., Richmond, VA, 2000).

Observational References

A Field Guide to the Stars and Planets by Jay M. Pasachoff, (Houghton Mifflin Company, 1999).

Atlas of the Moon by Antonín Rükl (Kalmbach Publishing Co., Books Division, Waukesha, WI, 1993).

Burnham's Celestial Handbook: An Observer's Guide to the Universe Beyond the Solar System by Robert Burnham (Dover Publications, New York; 3- volume set, 1978).

Observer's Handbook by The Royal Astronomical Society of Canada, (University of Toronto Press, Toronto, ON, Canada, published annually).

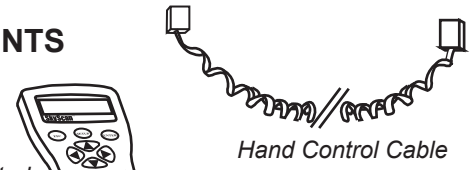
Sky Atlas 2000.0 by Wil Tirion and Roger W. Sinnott (Sky Publishing Corp., Cambridge, MA, 2nd edition, 1998).

CAUTION!

NEVER USE YOUR TELESCOPE TO LOOK DIRECTLY AT THE SUN. PERMANENT EYE DAMAGE WILL RESULT. USE A PROPER SOLAR FILTER FIRMLY MOUNTED ON THE FRONT OF THE TELESCOPE FOR VIEWING THE SUN. WHEN OBSERVING THE SUN, PLACE A DUST CAP OVER YOUR FINDERSCOPE OR REMOVE IT TO PROTECT YOU FROM ACCIDENTAL EXPOSURE. NEVER USE AN EYEPIECE-TYPE SOLAR FILTER AND NEVER USE YOUR TELESCOPE TO PROJECT SUNLIGHT ONTO ANOTHER SURFACE, THE INTERNAL HEAT BUILD-UP WILL DAMAGE THE TELESCOPE OPTICAL ELEMENTS.

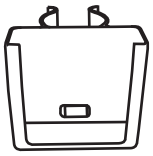
EQ3 SynScan INSTALLATION

CONTENTS

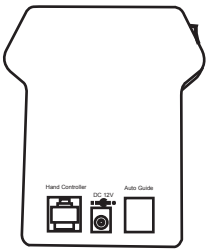


Hand Control Cable

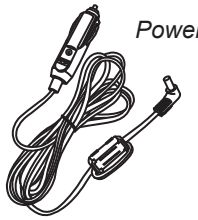
Hand Control



Motor Controller holder



Motor Controller



Power Cord

Motor Cables

Hand Control Holder

SETTING UP

1) Locate the hand control holder. Slide the holder onto the accessory tray as shown in Fig.1.
2) Point the mount to the North, or South in the Southern Hemisphere. Clip the motor controller holder onto the leg that's on the right hand side of the mount, as seen in Fig.2.
3) Slide the motor controller into the holder, as seen in Fig.3
4) Rotate the mount in Dec axis so that the Dec motor is on the same side of the receptacles of the mount, as seen in Fig.4.

To avoid potential electronic-magnetic interference to other devices, the motor controller holder must be clipped firmly onto the stainless leg and the motor

CONNECTING THE CABLES

5) Locate the short motor cable. Plug one end of the cable into the receptacle labeled "Dec.IN", and the other into the the receptacle labeled "Dec. OUT" on the mount. (Fig.5)
6) Locate the long motor cable. Plug one end of the cable into the motor controller and the other into the receptacle labeled "R.A. IN" on the mount. (Fig.6)
7) The hand control cable has a RJ-45 connector on both ends. Plug one end into the hand control and the other into the outlet on the motor controller.
8) Locate the power cord. Make sure that the power switch on the motor controller is OFF. Plug the cigarette lighter end of the cable into the battery and the other into the motor controller.

Fig.1

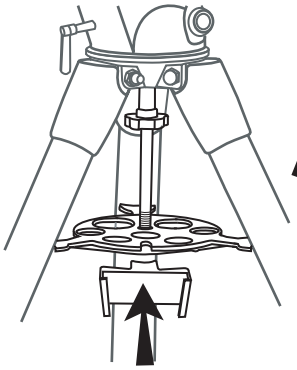


Fig.2

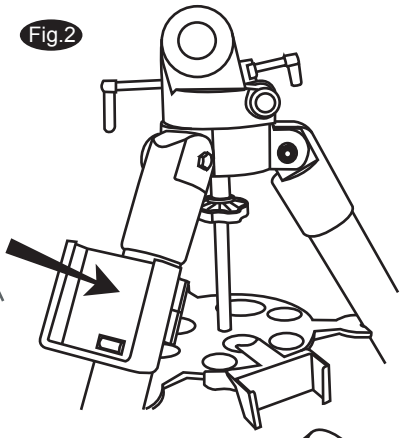


Fig.3

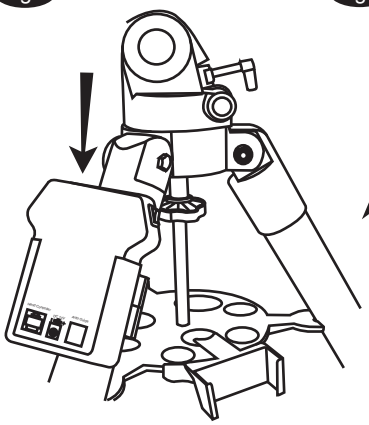


Fig.4

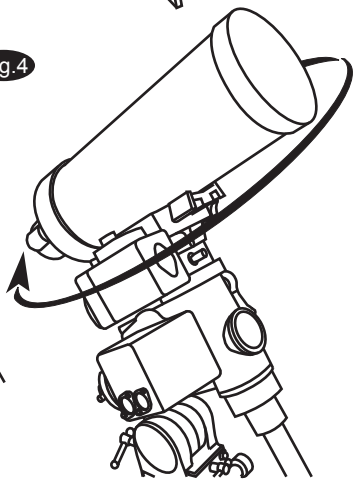


Fig.5

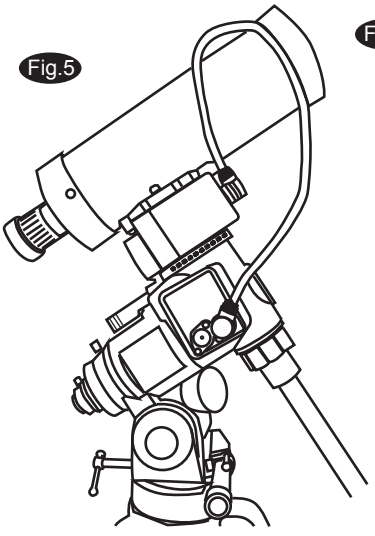
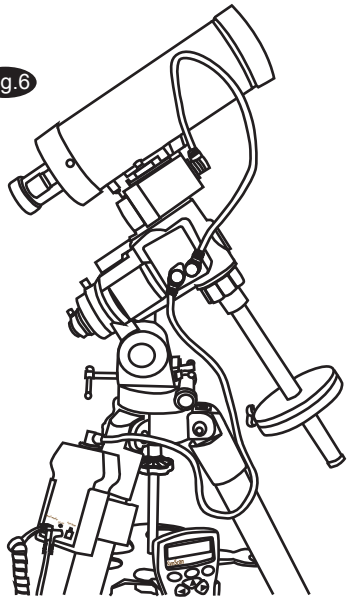
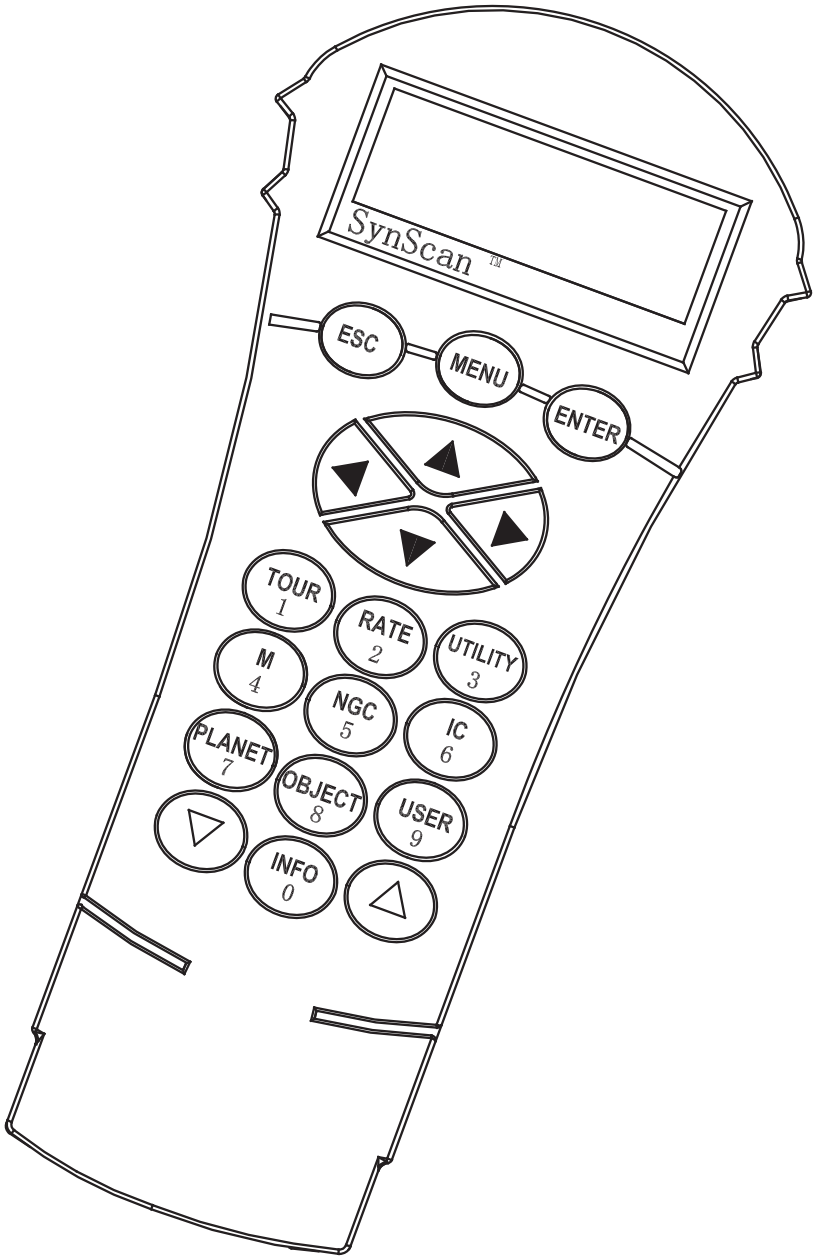


Fig.6



INSTRUCTION MANUAL

SynScan™



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CONTENT

Basic Operations

Intermediate Operations

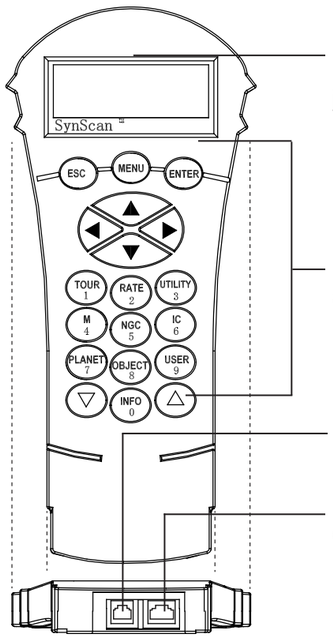
Advanced Operations

Appendix

PART I : INTRODUCTION

1.1 Outline and Interface

A SynScan hand control and its interfaces are shown in Fig. 1.1



LCD Display Screen: It can display two lines of text, 18 characters per line. The contrast and the brightness of the red backlight are adjustable.

Buttons: ESC, MENU, ENTER, directional, number/shortcut keys, and scroll keys.

Multi-Purpose Port: Connects to an external device such as a computer, a GPS module, a camera, etc.

Mount Port: Connects to a Sky-Watcher telescope mount. The hand control can get power supply from the mount via this port.

Fig. 1.1

1.2 Connecting to a Telescope Mount

Connect the 8-pin (RJ-45) “Mount” port of the hand control to the “Hand Control” port on a Sky-Watcher mount using an appropriate cable. The table below lists the “Hand Control” ports on different Sky-Watcher mounts.

Mount Model	Hand control Port	“Hand Control” Port on Mount
EQ6 Pro	8-pin RJ-45	D-sub 9 Male
HEQ5 Pro, EQ5 Pro, EQ3 Pro, AZ-EQ6 GT, EQ8		8-pin RJ-45
All Alt-azimuth mounts		6-pin RJ-12

1.3 Slew the Mount with the Direction Keys

In many situations, users need to slew the mount at different speeds with the directional keys. Here are the guides for this operation:

- The left and right keys are used to control the movements of the Right Ascension (R.A.) axis (for an equatorial mount) or the azimuth axis (for an Alt-azimuth mount).
- The up and down keys are used to control the movements of the Declination (Dec.) axis (for an equatorial mount) or altitude axis (for an Alt-azimuth mount).
- In most cases, pressing the “RATE/2” key will invoke the operation of choosing a slewing speed:
  - » The LCD screen will display “Set Speed”, followed by the current speed as “Rate = *x”.
  - » Press a number between “0” and “9” to select a new speed.
  - » Press the ENTER key to return to the previous display.
  - » If the user does not press the ENTER button, he/she can continue to change the speed while using the direction keys to slew the mount.
  - » If there is no keypad operation in 5 seconds, the most recent speed will be kept and the LCD display will return to the previous ones.
- The following table lists the available speeds:

Rate	0	1	2	3	4	5	6	7	8	9
Speed *1	0.5X*2	1X*3	8X	16X	32X	64X	128X	400X	600X	Max*4

- Rate 7/8/9 is primarily used to quickly slew a mount.
- Rate 5/6 is primarily used to move a target in the field of view of a finder scope.
- Rate 2/3/4 is primarily used to move a target in the field of view of an eyepiece.
- Rate 0/1 is used to move a target in the field of view in high magnification observations, or manual-guiding.

Note:

*1: Speed is represented as multiples of the Earth’s rotation speed.

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

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

1.4 SynScan Hand control’s Operating Mode

The SynScan hand control has 2 operating modes: **Full Feature Mode** and **Easy Tracking Mode**.

1. **Full Feature Mode:**

The flow chart of the “Full Feature” operation is shown in Fig. 1.4a.

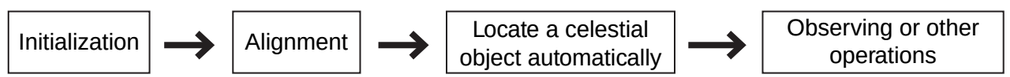


Fig. 1.4a

In Full Feature mode, the hand control must connect to a Sky-Watcher telescope mount. After turning on the power to the mount, the hand control must complete an “Initialization” routine, followed by an “Alignment” routine which establishes a model to transform the coordinates of the mount and the coordinates of the sky. Only after the “Alignment” is done can the SynScan hand control’s high precsion “GOTO” function be used to locate a celestial object.

The Full Feature mode is the most commonly used mode of operation.

2. **Easy Tracking Mode:**

The flow chart of the “Easy Tracking” operation is shown below:

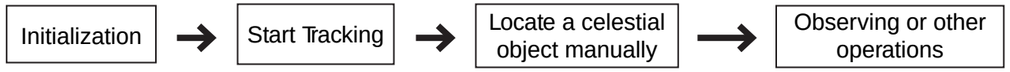


Fig. 1.4b

In Easy Tracking mode, the hand control also needs to connect to a Sky-Watcher telescope mount. The mount must be setup at a proper “Home Position” (refer to Section 2.1 for details) before turning on the power. After turning on the power of the mount, the hand control must complete an “Initialization” routine. Then the user can choose to skip the “Alignment” routine and start the tracking function directly (refer to Section 6.1 “Choosing Tracking Speed”). Users will need to locate a celestial object in the sky, and then use the hand control to manually point the telescope to the target. The object locating function may still be used but it can only give a rough result.

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

PART II : INITIALIZATION

2.1 Setup Home Position of the Telescope Mount

Before powering on the telescope mount, it should be setup to a particular home position. The home position differs between an equatorial mount and an Alt-azimuth mount.

1. Home Position of an Equatorial Mount:
   - Tripod head is leveled.
   - R.A. axis points towards the Northern Celestial Pole (in Northern Hemisphere) or the Southern Celestial Pole (in Southern Hemisphere).
   - Counterweight rod is at its lowest position.
   - The telescope points towards the Northern Celestial Pole (in Northern Hemisphere) or the Southern Celestial Pole (in Southern Hemisphere).

2. Home Position of an Alt-azimuth Mount:
   To operate the SynScan hand control in “**Full Feature**” mode, no particular home position is required.
   To operate the SynScan hand control in “Easy Tracking” mode, the mount should be setup as close to home position as possible, according to the following instuctions:
   - Mount base is leveled.
   - The telescope’s tube is leveled and points towards the true North (note: not magnetic North).

2.2 Initialize the Hand Control

Once the mount has been setup to the home position, the user can turn on the power to the mount and start the initialization process on the SynScan hand control. The following is the steps:

1. **Selecting the Operation Mode of the Mount**
   A SynScan hand control with a firmware version 4.05.06 or later supports both an equatorial mount and an alt-azimuth mount. It is able to detect the model of the mount to which it connects and select the appropriate operation mode accordingly.

   For an equatorial/Alt-azimuth dual-mode mount, such as the AZ-EQ6 GT mount, the SynScan hand control will require the user to choose the mount’s operating mode.

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

2. **Firmware Version Display**
   The hand control will display the firmware version.
   - Press **ENTER** to proceed to the next step. Press **ESC** to return to the previous step.
   - Users can slew the mount with direction keys in this step.

3. **Warning Message Confirmation**

The hand control will display a warning message about the dangers of viewing the sun with a telescope.

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

4. **Auto-homing (EQ8 Only)**

This step only applies to a mount with Auto-homing feature (such as the Sky-Watcher EQ8 Equatorial mount).

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

5. **Setting Information of the Observing Site**

Geographic Coordinates

The LCD screen will display "**Set Longitude**" or "**Set Latitude**" in the first line, and display longitude and latitude in the second line.

- Press the numeric keys at the cursor position to fill the longitude or latitude digits.
- Use the scroll keys to change east/west longitude or north/south latitude when the cursor blinks on the corresponding characters (**E/W** for longitude, **N/S** for latitude).
- Use the **Left** and **Right** direction keys to move the cursor.
- Press the **ENTER** key to confirm the input and proceed to the next step.
- Press the **ESC** key to return to the previous.

Time Zone

The LCD screen will display "**Set Time Zone**" in the first line, and display the current time zone in the second line.

- Use the scroll keys to change the leading "**+**" or "**-**" sign when the cursor is on it. The "**+**" sign is used for time zones in the Eastern Hemisphere (Europe, Africa, Asia, Oceania), while the "**-**" sign is used for time zones in the Western Hemisphere (North and South America).
- Press the numeric keys at the cursor position to fill the time zone digits.
- Press the **ENTER** key to confirm the input and proceed to the next step.
- Press the **ESC** key to return to the previous step.

Date, Time, Daylight Saving Time

- When "**Date: mm/dd/yyyy**" is displayed, enter the current date in the indicated **mm/dd/yyyy** format (i.e. **10/24/2012** for Oct.24,2012); press the **ENTER** key to confirm and proceed to the next step. Press the **ESC** key to return to the "**Geographic Coordinates**" step.
- When "**Enter Time**" is displayed, enter the current local time in 24-hour format. (i.e. **18:30:00** for 6:30pm). Press the **ENTER** key to display the entered time in 12-hour format. Press the **ENTER** key again to confirm and proceed to the next step. Press the **ESC** key to return to the previous step.
- When "**Daylight Saving?**" is displayed, use the scroll keys to select "**Yes**" or "**No**". "**YES**" indicates the time entered in the previous step is daylight saving time, while "**NO**" indicates the time entered is in standard time. Press the **ENTER** key to confirm and proceed to the next step. Press the **ESC** key to return to the previous step.

6. **Display Polaris Position**

This step applies to an equatorial mount only.

- The LCD screen will display "**Polaris Position in P.Scope = HH:MM**". It tells the orientation of Polaris in the polar-scope's FOV. User can imagine the large circle in the FOV of a polar-scope as a clock's face with 12:00 at the top, and put Polaris at the "HH:MM" position of the large circle when using a polar-scope to do the polar alignment. Press **ENTER** key to confirm and proceed to the next step. Press **ESC** key to return to the previous step.
- The LCD screen will display "Hour Angle of Polaris = HH:MM". Press ENTER key to confirm and proceed to the next step. Press ESC key to return to the previous step.

7. **Starting Mount Alignment**

This is the last step in the hand control's initialization process. The screen will display "**Begin Alignment? 1) YES 2) NO**" to ask the user to make a choice:

Press "**1**" to start the alignment process

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

Press "**2**" to skip the alignment process.

The SynScan hand control will enter standby mode.

- Users may start the tracking functions (refer to Section 6.1), or use the GOTO function (refer to **PART V**) to roughly locate celestial objects. Both operations will let the SynScan hand control work in the Easy Tracking mode (refer to Section 1.4 Step 2).
- Users can also start an alignment process (refer to Section 8.2) to let the SynScan hand control operate in Full Feature mode.
- Users may slew the mount with the direction keys to point the telescope to terrestrial targets for observing. The "**User-Defined Objects**" function (refer to Section 5.8) of the SynScan hand control is a useful tool for terrestrial observing.

PART III : ALIGNMENT

3.1 Choosing an Alignment Method

At the beginning of the alignment process, users are asked to choose an alignment method. The available alignment methods differ between the mount types, as listed below:

- For an equatorial mount: **1-Start Alignment** (1-Star Align.), **2-Star Alignment** (2-Star Align.) or **3-Star Alignment** (3-Star Align.)
- For an alt-azimuth mount: **Brightest Star Alignment** (Brightest Star) or **2-Star Alignment** (2-Star Align.)

Note: For a detailed description and comparison of each alignment method, please refer to Section 3.7.

Operation:

- The LCD screen displays "Alignment:" in the first line.
- Use the two scrolling keys to select an alignment method in the second line of the LCD screen.
- Press ENTER to confirm selection and proceed to the next step (Section 3.2).
- Press ESC to skip the alignment process and enter standby mode.

3.2 Aligning to Alignment Stars

In this step, user will be asked to choose one or multiple alignment stars from a list provided by the SynScan hand control, and then control the mount to center the star(s) in the FOV of the telescope's eyepiece. The SynScan hand control will then use the data collected in this process to transform between the mount coordinates and the sky coordinates.

The operating steps of aligning to alignment stars may differ depending on the type of mount used, as well as the chosen alignment method. Users should read the following section which meets your mount and alignment method:

- Section 3.3: Alignment Method for Equatorial mounts.
- Section 3.4: Alt-azimuth mounts using the Brightest Star Alignment method.
- Section 3.5: Alt-azimuth mounts using the 2-Star Alignment method.

3.3 Alignment Method for Equatorial Mounts

Aligning the 1st Star:

1. The LCD screen displays "Choose 1st Star" in the first line. Use the scrolling keys to browse through a list of star names and Press ENTER key to pick the one on the screen as the 1st alignment star. The mount will then automatically slew and point the telescope towards the 1st alignment star in the sky.
2. After the mount stops, the hand control will display "Use arrow buttons Ctr. to eyepiece..". Now the telescope should point rather closely to the 1st alignment star (generally, in the FOV of the finder scope), and the mount's tracking function is also turned on by the hand control to prevent the objects drift in the FOV of the telescope.

3. Now users can use the direction keys to move the telescope to align with the 1st alignment star. That is, center the 1st alignment star in the FOV of the finder scope, and then center it in the FOV of the telescope's eyepiece; press ENTER key to confirm centering of the star and proceed to the next step. Generally, users can use Rate 5 or 6 to center the star in the finder scope and use Rate 2 or 3 to center the star in the telescope's eyepiece.
4. If the user has chosen 1-Star Alignment method before, the SynScan hand control will now display "Alignment Successful". Press ENTER to complete the alignment process.
5. If the user has chosen 2-Star Alignment or 3-Star Alignment before, the SynScan hand control will then proceed to the next step.

Aligning the 2nd Star:

1. Again, the SynScan hand control asks the user to choose and align a 2nd alignment star. The operation is the same as that of aligning the 1st alignment star.
2. If the user has chosen 2-Star Alignment before, the SynScan hand control will display "Alignment Successful" after confirmation of centering the 2nd alignment star.
3. Two seconds later, the LCD screen will display the polar-alignment offset of the mount. The "Mel" value is the offset in elevation, and the "Maz" value is the offset in azimuth.
4. If the user has chosen 3-Star Alignment before, the SynScan hand control will then proceed to the next step.

Selecting and Aligning the 3rd Star:

The operation is the same as that of *Aligning the 2nd Star.*

Cancellation During Aligning Process:

1. While the mount is slewing during the alignment, users may press the ESC key to stop the mount. The hand control screen will display "MOUNT STOPPED!!. Press any key…"
2. Press any key and the SynScan hand control will ask the user to select another alignment star.
3. Press the ESC key again, the LCD screen will display "Exit Alignment? 1) YES 2) NO". Press key 1 to exit the alignment process; press key 2 to go back to choose an alignment star.

3.4 Alt-Azimuth Mounts using *Brightest Star Alignment Method*

Aligning the 1st Star:

1. Find the brightest stars in the current sky with naked eyes, and estimate its horizontal region (orientation).
2. The hand control displays "Select Region". Use the scroll keys to pick one of the eight regions shown in Fig 3.4a, which matches the horizontal region of the brightest star. Press ENTER to confirm selection and proceed to the next step.

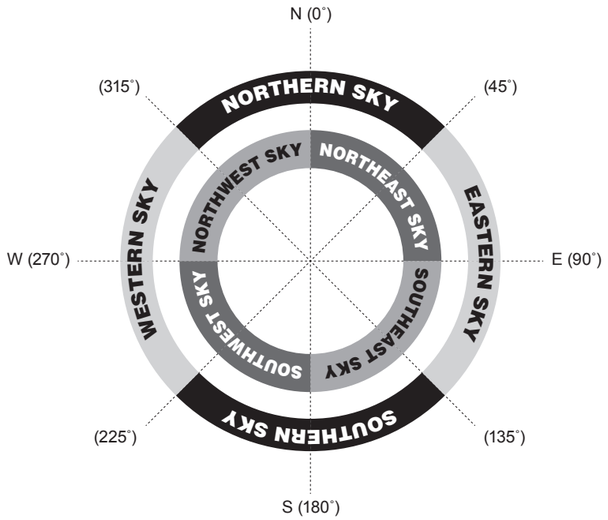


Fig. 3.4a

3. The hand control will generate a list of the bright stars within the selected horizontal region. The list is sorted by the brightness of the star and with the brightest stars at the top of the list. Users can use the scroll keys to browse the list. An example of the screen display is shown in Fig. 3.4b.

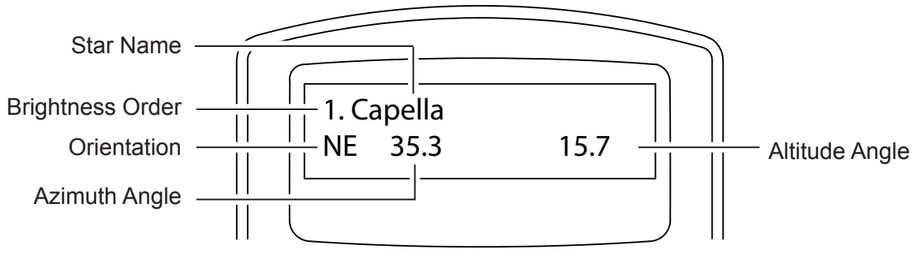


Fig. 3.4b

- Only stars brighter than magnitude 1.5 will appear in the list. If there is no star brighter than magnitude 1.5 in the selected region, the hand control will display "**No object found in this region**."
- If multiple bright stars appear in the list, users can identify the names of the stars in the real sky by matching the azimuth, altitude and magnitude provided by the SynScan hand control.
- Pick one of the star(s) (Generally the brightest one) as the 1st alignment star and press **ENTER** key to proceed to the next step. Press the **ESC** key to return to the previous step ("**Select Region**").

4. Now the screen will display "**Point scope to RR ZZ.Z′ TT.T′** ", which means point the telescope to RR region, the exact azimuth is ZZ.Z degree and the exact altitude is TT.T degree. Users can use the direction keys on the SynScan hand control to move the mount and point the telescope to the 1st alignment star selected in the previous step. Center the 1st alignment star in the FOV of the finder scope or the red dot finder, and then press **ENTER** key to proceed to the next step.

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

5. Now the screen will display "**Ctr. to eyepiece..**" and the name of the selected 1st alignment star. The star should have been in the FOV of the telescope. User can use the direction keys to center it in the eyepiece and then press the **ENTER** key to proceed to the next step.

Aligning the 2nd Star:

1. If the 1st alignment star is not a planet, the LCD screen will display "**Choose 2nd Star**"; otherwise, it will display "**Choose 1st Star**".
2. Use the scrolling keys to browse through a list of star names and press **ENTER** key to pick the one on the screen as the 2nd alignment star. The mount will then automatically slew and point the telescope towards the 2nd alignment star in the sky.
3. After the mount stops, the hand control will display the name of the selected 1st star on line 1 and "Ctr. to eyepiece.." on line 2. Now the telescope should point rather closely to the 2nd alignment star (generally, in the FOV of the finder scope).
4. Now users can use the direction keys to move the telescope to align with the 2nd alignment star. That is, center the 2nd alignment star in the FOV of the finder scope, and then center it in the FOV of the telescope's eyepiece. Press **ENTER** key to confirm the centering of the star and proceed to the next step. Generally, users can use Rate 5 or 6 to center the star in finder scope and use Rate 2 or 3 to center the star in the telescope's eyepiece.
5. If the 1st alignment star is *not* a planet, the SynScan hand control will now display "**Alignment Successful**". Press **ENTER** to complete the alignment process.
6. If the 1st alignment star is a planet, the SynScan hand control will display "**Choose 2nd Star**". Repeat from Step 2 to complete the alignment process.

Cancellation During Aligning Process:

1. While the mount is slewing in alignment process, users may press the **ESC** key to stop the mount. The hand control screen will display "**MOUNT STOPPED. Press any key…**"
2. Press any key and the SynScan hand control will ask the user to select another alignment star.
3. Press the **ESC** key again; the LCD screen will display "**Exit Alignment? 1) YES 2) NO**". Press key **1** to exit the alignment process; press key **2** to go back to choose an alignment star.

3.5 Alt-Azimuth Mounts using *2-Star Alignment Method*

Aligning the 1st Star:

1. The LCD screen displays "Choose 1st Star" in the first line. Use the scrolling keys to browse through a list of star names and Press ENTER key to pick the one on the screen as the 1st alignment star.
2. Now the screen will display "Point scope to ZZZ zz.z' sTT tt.t' ", which means point the telescope to the direction whose azimuth is ZZZ degree, zz.z minutes and whose altitude is sTT degree, tt.t minutes. This is also the direction of the selected 1st alignment star. Users can use the direction keys on the SynScan hand control to move the mount to point the telescope to the star and center the star in the FOV of the finder scope or the red dot finder, and then press ENTER key to proceed to the next step.

   If the telescope has clutches on its axes, user can loosen the clutches to move the mount manually to point the telescope to the target.
3. Now the screen will display "Ctr. to eyepiece.." and the name of the selected 1st alignment star. The star should have been in the FOV of the telescope. User can use the direction keys to center it in the eyepiece and then press the ENTER key to proceed to the next step.

Aligning the 2nd Star:

1. The LCD screen displays "Choose 2nd Star". Use the scrolling keys to browse through a list of star names and Press ENTER key to pick the one on the screen as the 2nd alignment star. The mount will then automatically slew and point the telescope towards the 2nd alignment star in the sky.
2. After the mount stops, the hand control will display the name of the selected 2nd alignment star and "**Ctr. to eyepiece..**". The telescope should point rather closely to the 2nd alignment star (generally, in the FOV of the finder scope.)
3. Now users can use the direction keys to move the telescope to align with the 2nd alignment star. To align, center the 2nd alignment star in the FOV of the finder scope, and then center it in the FOV of the telescope's eyepiece. Press ENTER key to confirm centering of the star and proceed to the next step. Generally, users can use Rate 5 or 6 to center the star in finder scope and use Rate 2 or 3 to center the star in the telescope's eyepiece.
4. The SynScan hand control will now display "Alignment Successful". Press ENTER to complete the alignment process.

Cancellation During Aligning Process:

1. While the mount is slewing during alignment, users may press the ESC key to stop the mount. The hand control screen will display "MOUNT STOPPED!! Press any key…"
2. Press any key and the SynScan hand control will ask the user to select another alignment star.
3. Press the ESC key again; the LCD screen will display "Exit Alignment? 1) YES 2) NO". Press key 1 to exit the alignment process; press key 2 to go back to choose an alignment star.

3.6 Tips for Improving Alignment Accuracy

Eyepiece

It is very important to put the alignment stars at the center (or the same spot) of the FOV of the telescope's eyepiece during the alignment process. Thus,

- It is recommended that a reticle eyepiece is used for alignment.
- If a reticle eyepiece is not available, try to use an eyepiece with shorter focal length to yield a smaller FOV. Users can defocus the telescope to obtain a large star disk in the FOV. Centering the star disk in the FOV is easier than centering a sharp star.
- During the alignment process, avoid changing or rotating the eyepiece and the diagonal mirror.

Mechanical Backlash

All mounts have more or less mechanical backlash on both axes. To avoid introducing alignment error from backlash, users should keep the following rules in mind:

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

Alignment Stars Selection

The choice of alignment stars might also impact the alignment accuracy. Please refer to Section 3.7 on the rules of choosing alignment stars for various mounts and alignment methods.

3.7 Comparison of Alignment Methods

1. **Equatorial Mount with 1-Star Alignment:**

   Advantage: Quickest alignment.

   Preconditions:

   - An accurate polar alignment for the mount.
   - Small cone error in the telescope-mount setup.

     If the cone error is large, there will be noticeable offset in the R.A. when the SynScan hand control locates an object that is:

     » On the other side of the meridian from the alignment star
     » Deviated significantly with the alignment star in declination.

   Rules for choosing an alignment star:

   - Choose an alignment star with smaller declination. It will help to obtain higher resolution in R.A. movement in the telescope's eyepiece.
   - If there is cone error in the telescope-mount setup or if users are not sure about it, it is recommended to choose an alignment star that is close to the object(s) to be observed.

2. **Equatorial Mount with 2-Star Alignment:**

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

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

Rules for choosing alignment stars:

- The deviation in R.A. of the two alignment stars should not be too small or too close to 12 hours; the recommended deviation is between 3 hours and 9 hours.
- If there is cone error in the telescope-mount setup or if users are not sure about it, it is recommended to choose two alignment stars that are on the same side of the meridian. The absolute values of the two alignment stars' declination should better deviate between 10 to 30 degrees.

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

3. **Equatorial Mount with 3-Star Alignment:**

Advantages:

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

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

Rules for choosing alignment stars:

- The 3 alignment stars should be spread out on both sides of the meridian.
- For the two alignment star on the same side of the meridian, the deviation in their R.A. should be greater than 3 hours, and the absolute value of the difference of the two alignment stars' declination should be between 10 to 30 degrees.
  (10° < |Dec1 – Dec2| < 30°)
- If there is cone error in the telescope-mount setup or users are not sure about it, avoid the situation that all 3 alignment stars have small declination (close to the celestial equator).

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

4. **Alt-azimuth Mount:**

The "Brightest Star Alignment" is designed for entry level users who cannot identify stars in the night sky, and the "2-Star alignment" is for users who know the names of the stars in the night sky. Both alignment methods provide the same level of precision.

Rules for choosing alignment stars:

- It is recommended that the altitude of the two alignment stars are between 15 and 60 degrees and the deviation of altitude is between 10 and 30 degrees.
- The azimuth deviation of the two alignment stars can be between 45 and 135 degrees, it is best to be close to 90 degrees.

PART IV : SYNSCAN MENU TREE

4.1 Menu Structure

The SynScan hand control uses menu tree to organize its various functions. The following table shows the menu tree:

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

Note:

Applicable to Equatorial mounts

^ Applicable to Alt-azimuth mounts

***** Only available after 2-star or 3-star alignment is performed

+ Applicable only to certain types of mounts and motor controllers.

4.2 Accessing Menus

The SynScan hand control's menu is only accessible after the initialization, or after the star alignment routine is completed (If it is chosen to start). Users can use the **ESC** key, the **ENTER** key, and the two scrolling keys to access the menu.

The functions of these keys are:

- **ESC** key: Used to return to the previous menu or to exit the current operation. Press the **ESC** key for several times to go back to the top level of the menu structure.
- **ENTER** key: Used to enter a sub-menu or to start the operation of the end level menu.
- **Scroll keys**: Used to scroll within the same level sub-menu.

4.3 Short-cut Keys

The SynScan hand control provides short-cut keys for accessing the most commonly used sub-menu. The short-cut keys may only be used while the hand control is in stand-by mode, that is, the SynScan hand control is not executing a specific operation. Users can always press the **ESC** key to quit the current operation if the short-cut keys are not accessible.

Here is the list of the short-cut keys and their functions:

- **MENU:** Access to the "**SETUP**" sub-menu.
- **TOUR:** Access to the "**Deep Sky Tour**" function.
- **UTILITY:** Access to the "**UTILITY FUNCTION**" sub-menu.
- **M:** Access to the "**Messier Catalog**" sub-menu.
- **NGC:** Access to the "**NGC Catalog**" sub-menu.
- **IC:** Access to the "**IC Catalog**" sub-menu.
- **PLANET:** Access to "**SOLAR SYSTEM**".
- **OBJECT:** Access to the "**OBJECT LIST**" menu and stay at the "**Named Star**" sub-menu.
- **USER:** Access to the "**USER OBJECT**" sub-menu.
- **ID:** Access to the "**Identify**" function.

PART V : LOCATING OBJECTS

Users can access several popular celestial object catalogs stored in the SynScan hand control and control the telescope mount to locate a specific object in the catalogs. The object location function is available for either "Full Feature" mode (Section 1.4 Step 1) or "Easy Tracking" mode (Section 1.4 Step 2) of the mount.

5.1 Locating Messier Objects

1. **Choosing an Object:**

   Press the "**M**" shortcut key on the SynScan hand control. The screen will display "**Messier Catalog / Messier =**" to wait for input of the 3 digits Messier index number which is between 1 and 110.

   - Use the number keys on the keypad to enter a number at the cursor position.
   - Use the left or right direction keys to move the cursor.
   - A 3-digit number starting with a 0 is acceptable. Ex. 001 = 01 = 1
   - Press **ENTER** key to proceed to the next step.

2. **View Information on the Object:**

   - If the selected object is below the horizon at this time, the SynScan hand control will display "**Below horizon**" for 2 seconds; otherwise, it will display the object's current azimuth and altitude.
   - By using the scroll keys, users can browse the following information of the object: Current celestial coordinates, J2000 celestial coordinates, magnitude (MAG=), rising time (Rise:), transit time (Transit:), setting time (Set:), size (Size=), associated constellation (Constellation:) and common name of the object (Object Name) etc.
   - Press **ENTER** key to proceed to the next step.

3. **Locate the Object:**

   The screen will display "**View Object?**"

   - Press the **ESC** key to return to the previous step.
   - Press the **ENTER** key to have the mount slew towards the target. When the mount stops, the SynScan hand control will return to the previous step. The mount will also automatically start tracking the object.
   - Users can press the **ESC** key to stop the mount. The screen will display "**MOUNT STOPPED!! Press any key…**". Users can press any key to return to the previous step.

   Note: The mount will not slew if:

   » The object is below the horizon; or

   » On an alt-azimuth mount, the object's altitude exceeds the limit set by the hand control (Section 11.3). (The screen will display "**Target over slew limit**" in this case.)

5.2 Locating NGC and IC Objects

The process for locating NGC or IC objects is similar to that for locating Messier objects (Section 5.1), with the following differences:

- Press the "NGC" shortcut key to access the NGC catalog. The screen will display "NGC Catalog / NGC =". The NGC catalog index number ranges from 1 to 7840.
- Press the "IC" shortcut key to access the IC catalog. The screen will display "IC Catalog / IC =". The IC catalog index number ranges from 1 to 5386.

5.3 Locating Planets and the Moon

1. **Choosing an Object:**
   Press the "PLANET" shortcut key. The screen will display "SOLAR SYSTEM" in the top row. Use the two scrolling keys to browse through a list of star names in the bottom row, which includes Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto, and the Moon. Press ENTER key to pick one of the targets.
2. **View Information on the Object:**
   - If the selected object is below the horizon at this time, the SynScan hand control will display "Below horizon" for 2 seconds; otherwise, it will display the object's current azimuth and altitude.
   - By using the scroll keys, users can browse the following information of the object: current celestial coordinates, rise time (Rise:), transit time (Transit:), set time (Set:) , and the common name of the object.
   - Press ENTER key to proceed to the next step.
3. **Locate the Object:**
   - The operation is similar to that for locating Messier objects; refer to Section 5.1 for details.

5.4 Locating Caldwell Objects

1. **Choosing an Object:**
   Press the "OBJECT" shortcut key. The screen will display "OBJECT LIST" in the top row. Use the two scroll keys to browse the list until "Caldwell Catalog" is displayed, and then press the ENTER key. The screen will then display "Caldwell Catalog / Cald. #=" for a 3-digit Caldwell index number between 1 and 109 to be entered in.
2. **View Information on the Object:**
   - The operation is similar to that of locating Messier objects; refer to Section 5.1 for details.
3. **Locate the Object:**
   - The operation is similar to that of locating Messier objects; refer to Section 5.1 for details.

5.5 Locating SAO Stars

1. **Choosing an Object:**
   Press the "OBJECT" shortcut key. The screen will display "OBJECT LIST" in the top row. Use the two scrolling keys to browse the list until "SAO Catalog" is displayed, and then press the ENTER key. The screen will then display "SAO Catalog / SAO 0000xx" to wait for input of the 4 left-most digits of the 6 digits SAO index number (i.e. "SAO 0238xx"). Press ENTER key and then the hand control will find the first SAO number in the database that matches the 4 left-most digits entered (i.e. "SAO 023801")

   Use the scroll keys to change the last 2 digits until the screen displays the desired SAO index number. Press the ENTER key to confirm the input. (i.e. "SAO 023825")

   Note: The SAO catalog in the SynScan hand control is a sub-set of the SAO catalog. It only contains stars brighter than magnitude 8.
2. **View Information on the Object:**
   - The operation is similar to that of locating Messier objects; refer to Section 5.1 for details.
3. **Locate the Object:**
   - The operation is similar to that of locating Messier objects; refer to Section 5.1 for details.

5.6 Locating Named Stars, Double Stars, and Variable Stars

1. **Choosing an Object:**
   Press the "OBJECT" shortcut key. The screen will then display "OBJECT LIST" on the top row. Use the two scroll keys to browse the list until "Named Star", "Double Stars" or "Variable Stars" is displayed, and then press the ENTER key to select the desired option. Once inside, use the two scroll keys to go through and find the desired object in the list of star names.
   Press the ENTER key to confirm the selection.
   Note: For Named Stars, the SynScan hand control can display the common name or Bayer designation.Refer to Section 7.4 for details.
2. **View Information on the Object:**
   - The operation is similar to that of locating Messier objects; refer to Section 5.1 for details.
   - For named stars, Distance to Earth in light years(**DIST.**), Spectral type, Bayer Designated name, catalog(SAO, HIP, HD) number are provided.
   - For double stars, the separation angle (Separation:) and the position angle (Position Angle) are provided.
   - For varialble stars, the separation angle (Separation:) and the position angle (Position Angle) are provided.

3. **Locate the Object:**
   - The operation is similar to that of locating Messier objects; refer to Section 5.1 for details.

5.7 Deep Sky Tour

The SynScan hand control can generate a list of the most famous deep sky objects which appear in the current sky. Users can pick them one by one and the SynScan hand control can point the telescope to them for observing automatically. This is the "**Deep Sky Tour**" function.

1. **Choosing an Object:**

   Press the "**TOUR**" shortcut key. The screen will display "**Deep Sky Tour**" in the top row. User can use the two scroll keys to browse through a list of the common names of the deep sky objects and can press **ENTER** key to pick one of them.

2. **View Information on the Object:**
   - The screen will display the catalog to which the deep sky object belongs, as well as its catalog index number in the top row. The object's current azimuth and altitude will be displayed in the bottom row.
   - Use the scroll keys to browse the object's J2000 celestial coordinates, magnitude (**MAG=**), rise time (**Rise:**), transit time (**Transit:**), set time (**Set:**), size (**size=**), and associated constellation (**Constellation:**).
   - Press **ENTER** key to proceed to the next step.

3. **Locate the Object:**
   - The operation is similar to that of locating Messier objects; refer to Section 5.1 for details.

5.8 User Defined Objects

Users can define up to 25 objects for observing.

Defining New Objects:

1. Press the "**USER**" shortcut key. The screen will display "**USER OBJECT**". Press the scroll keys until "**New Object**" is displayed on the screen, then press the **ENTER** key.
2. The screen will display "**Coord. Type 1)RA-Dec 2)Mount**". Press "**1**" to enter R.A./Dec. coordinates for a celestial object; press "**2**" to enter coordinates for a land object.

   - **If the "R.A.-Dec." coordinates is chosen**: The screen will display the coordinates to which the telescope is pointing to at the moment.
   - **If the "Mount" coordinates is chosen**: The screen will display the coordinates of the mount's two axes. The first number is the coordinates of the R.A. axis or azimuth axis, while the second number is the coordinates of the Dec. axis or altitude axis.
3. Use the left and right direction keys to move the cursor and the numeric keys to edit the coordinates. The scroll keys can be used to change the sign of the declination coordinates or the altitude coordinates. Press the **ENTER** key after editing.
4. The screen will display "**Save?**".
   - Press the **ESC** key to proceed to the next step without saving the coordinates.
   - Press the **ENTER** key again to start saving the coordinates. Users should use the scroll keys to select a storage space index number between 1 and 25 and press the **ENTER** key to save the new coordinates.
5. The screen will now display "**View Object?**".
   - Press **ENTER** to slew the mount towards the coordinates entered.
   - Press **ESC** to exit without moving the mount.

Recalling Objects:

1. Press the "**USER**" shortcut key. The screen will display "**USER OBJECT / Recall Object**". Press the **ENTER** key.
2. Use the scroll keys to browse through a pre-defined objects list which is indexed from 1 to 25, and then press **ENTER**. If the selected object has not been defined before, the SynScan hand control will stay at this step for the choosing of another object; otherwise, it will proceed to the next step.
3. The screen will display the coordinates of the selected object. Press the **ENTER** key again to proceed.
4. The screen will now display "**View Object?**"
   - Press **ENTER** to have the mount start slewing towards the selected object. If the object is a celestial object, the mount will start tracking the object automatically after it finishes slewing.
   - Press **ESC** to exit.

PART VI : CONFIGURE THE TELESCOPE MOUNT

6.1 Choosing Tracking Speed

1. Access the menu "SETUP\Tracking" and press the ENTER key.
2. Use the scroll keys to browse through the following options, and press the ENTER key to pick one.
   - Sidereal Rate: Enables the mount to track celestial objects at the sidereal rate for observing the stars, deep sky objects, and planets.
   - Lunar Rate: Enables the mount to track at the lunar rate for observing the Moon.
   - Solar Rate: Enables the mount to track at the solar rate for observing the Sun.
   - Stop Tracking: Stops the mount.
   - PEC+Sidereal: Enables the mount to track at the sidereal rate and turns on the periodic error correction (PEC) function. Applies to equatorial mounts only.

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

6.2 Backlash Compensation

If there is backlash in the motor driving system, users might see a lag when moving an object in the FOV of the telescope with the direction keys. The SynScan hand control can control the mount to slew with higher speeds for a specific amount of distance when the user reverses the moving direction of an axis with opposite direction keys. Such backlash compensation function helps the user get faster response from the mount.

Users should input the amount of the backlash of both axes of the mount as follows:

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

Note: Set the backlash value to 0 for an axis to disable backlash compensation for that axis.

6.3 Setting the Elevation Slewing Limits

Some telescope mounts have limited slewing range in elevation. Users can set the upper and lower limits for such mounts.

- When a user asks the SynScan hand control to locate an object whose elevation exceeds the limits, the SynScan hand control will display "Target is over slew limits!!" and will not start the mount slewing.

- When a user uses the direction keys to slew the mount passing the limits, the SynScan hand control will automatically stop the slewing and display "Over slew limit. Slewing stop!". User has to press any key and the SynScan controller will bring the altitude axis back.

The following are the steps to set the altitude slewing limits:

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

6.4 Enable/Disable Auxiliary Encoder

Some Sky-Watcher's mounts are equipped with auxiliary encoders on their primary axes to support manually rotating the axes without worrying about losing the mount's alignment status. Users may turn off the auxiliary encoder to obtain the best pointing accuracy. The auxiliary encoder can be turned on again at any time for manually moving the mount.

1. Access the menu "SETUP\Aux. Encoder" and press the ENTER key.
2. Use the scroll keys to select between "Enable" or "Disable" and press the ENTER key.

Note:
- After re-enabling the auxiliary encoders, it is recommended to use the direction keys to move both axes for a little bit before asking the hand control to locate an object.
- For a mounts which does not have auxiliary encoders, the hand control will display "Not availiable !"

6.5 Setting Autoguider Speed

For an equatorial mount with an autoguider port, the SynScan hand control can change the guiding speed of the port.

1. Access the menu "SETUP \ Auto Guide Speed>" and press the ENTER key.
2. Use the scroll keys to choose one of the following guiding speeds list: 0.125X, 0.25X, 0.5X, 0.75X, 1X, and then press the ENTER key.

PART VII : CONFIGURE THE HAND CONTROL

7.1 Display and Keypad

1. Access the menu "**Setup \ Handset Setting**" and press the **ENTER** key.
2. Use the scroll keys to select "**LCD Contrast**"; then use the left/right direction keys to adjust the contrast of the LCD screen.
3. Use the scroll keys to select "**LED Backlight**"; then use the left/right direction keys to adjust the brightness of the keypad's LED backlight.
4. Use the scroll keys to select "**LCD Backlight**"; then use the left/right direction keys to adjust the brightness of the LCD screen's backlight.
5. Press **ESC** to exit the adjustment.

7.2 Alignment Star Filter

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

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

1. Access the menu "**Setup \ Alignment Stars \ Adv. Filter**" and press the **ENTER** key.
2. Use the scroll keys to choose "**OFF**" and then press the **ENTER** key to disable the filter.
3. Use the scroll keys to choose "**ON**" and then press the **ENTER** key to enable the filter.

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

- The alignment star's altitude must be above 15 degrees.
- For an equatorial mount, the alignment star's declination must be between -75 and +75 degrees.
- For an alt-azimuth mount, the alignment star's altitude must be below 75 degrees or within the altitude limits defined by the user (Section 6.3).

7.3 Sorting Method of the Alignment Star List

1. Access the menu "**Setup \ Alignment Stars \ Sort by**" and press the **ENTER** key.
2. Use the scroll keys to select "**Magnitude**" and press the **ENTER** key to sort the list by magnitude (from the brightest to the faintest).
3. Use the scroll keys to select "**Alphabet**" and the press the **ENTER** key to sort the list alphabetically.

7.4 Naming of Stars

1. Access the menu "**Setup \ Alignment Stars \ Set Star Name**" and press the **ENTER** key.
2. Use the scroll keys to choose between "**Common Name**" and "**Bayer Designation**", press the **ENTER** key to confirm.

PART VIII : AUXILIARY FUNCTIONS

8.1 Editing Date, Time, Coordinates, Time Zones, and Daylight Saving Time

1. Press the "**MENU**" shortcut key.
2. Use the scroll keys to select "**Date**" and press the **ENTER** key to edit the date. Press the **ENTER** key to apply change, or press the **ESC** key to exit. (Note: The setting of the date is in mm/dd/yyyy format, i.e. 10/24/2012)
3. Use the scroll keys to select "**Time**" and press the **ENTER** key to edit the time. Press the **ENTER** key to apply change, or press the **ESC** key to exit. (Note: The setting of the time is in 24 hours format, i.e. 18:30:00 is entered for 6:30pm.)
4. Use the scroll keys to select "**Observation Site**" and press the **ENTER** key to edit the geographic coordinates. Press the **ENTER** key to apply the change or press the **ESC** key to exit. Edit the time zone. Press the **ENTER** key to apply change or press the **ESC** key to exit.
5. Use the scroll keys to select "**Daylight Saving**" and press the **ENTER** key, and then use the scroll keys to select between "**Yes**" and "**No**". Press **ENTER** to apply change.

Note: refer to Step 5 in Section 2.2 for detailed input instructions.

8.2 Re-aligning the Mount

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

1. Access the menu "**SETUP \ Alignment**" and then press the **ENTER** key.
2. Use the scroll keys to select an alignment method and press the **ENTER** key to start the alignment process. For detailed instructions on alignment, please refer to **PART III**.

8.3 Show Position

1. Access the menu "**UTILITY FUNCTION \ Show Position**" and press the **ENTER** key.
2. Use the scroll keys to switch between the following coordinates:
   - **Dec/RA**: Displays the current celestial coordinates of the telescope.
   - **Alt/Azm**: Displays the current horizontal coordinates of the telescope.
   - **Ax1/Ax2**: Displays the current coordinates of the mount. **Ax1** is the position of the declination or altitude axis, and **Ax2** is the position of the R.A. or azimuth axis.

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

8.4 Show Time and Local Sidereal Time

Access the menu "**UTILITY FUNCTION \ Show Information \ Time**" and press the **ENTER** key to display the current local time and the local sidereal time. Press the **ESC** key to exit.

8.5 Display Version Information

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

- **H.C. Firmware:** The firmware version of the SynScan hand control.
- **Database:** The database version of the SynScan hand control
- **H.C. Hardware:** The hardware version of the SynScan hand control.
- **Motor Controller:** The firmware version of the motor controller of the mount.
- **H.C. Serial #:** The serial number of the SynScan hand control.

8.6 Display Power Voltage

Access the menu "**UTILITY FUNCTION \ Show Information \ Power Voltage**" and press the **ENTER** key to display the power voltage applied to the mount. Press the **ESC** key to exit.

8.7 Display Polaris Position

Access the menu "**UTILITY FUNCTION \ Show Information \ Polaris Pos.**" and press the **ENTER** key, and then use the scroll keys to switch the screen display between "**Polaris Position in P. Scope = HH:MM**". and "Hour Angle of Polaris = HH:MM". Press the **ESC** key to exit.

8.8 Display Polar Alignment Error

Access the menu "**UTILITY FUNCTION \ Show Information \ P.A Error**" and press the **ENTER** key. The screen will display "**Mel=+DDD°MM′SS Maz=+DDD°MM′SS**". The "**Mel**" value is the polar alignment offset in elevation, and the "**Maz**" value is the polar alignment offset in azimuth. These data is valid only after a 2-star alignment or a 3-star alignment.

8.9 Changing Polar Scope Illumination Level

This function applies only to certain Sky-Watcher's equatorial mounts that are equipped with a polar scope illuminator.

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

8.10 Identifying Objects

After aligning the mount, the SynScan hand control can be used to identify the object to which the telescope is pointing.

1. Center the object to be identified in the telescope's eyepiece.

2. Press the "**ID**" shortcut key. The screen will display "**Identify: Searching…**". The SynScan hand control will look up the named stars, planets, Messier objects, NGC objects, and IC objects within a 5 degrees range centered by the object in the eyepiece.
3. The screen will display "**No object found**" if the SynScan hand control cannot identify the object.
4. If an object is found within the 5 degree range, then the screen will display the object's name in the top row, and the deviation from the object to the center of the eyepiece.
5. If multiple objects are found, use the scroll keys to browse through the list of identified objects.
6. Press the **ENTER** key to select an identified object and then use the scroll keys to read its data, such as the J2000 celestial coordinates, magnitude (**MAG=**), rising time (**Rise:**), transit time (**Transit:**), setting time (**Set:**), size (**Size=**) and associated constellation (**Constellation:**), etc.
7. Press the **ESC** key to exit.

8.11 Synchronizing Encoders

If the mount lost the correct position of any of its two axes; for example, the axis is manually moved, the pointing accuracy will be poor when the SynScan hand control tries to locate an object.

Providing the base of the mount is not moved, users can recover the pointing accuracy with the "**Synchronize Encoder**" operation:

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

PART IX : CONNECTING TO A COMPUTER

9.1 Working with Astronomical Applications

After the SynScan hand control is initialized, it can communicate with a computer via the RS-232C connection on its multi-purpose port. The computer must have a RS-232C serial port; otherwise, a USB-to-Serial adapter is required. Connect the SynScan hand control and the serial port with the PC-Link cable (the RJ-12 to D-Sub 9 cable) which comes with the telescope mount.

The most popular astronomical applications which can work with the SynScan hand control are:

- Planetarium Applications: Users can click on an object on the sky map to command the telescope to point to the object.
- Autoguider Applications: Corrects minor tracking error dynamically for long exposure astrophotography.

Note: The SynScan hand control cannot work with the above application when it is in the following status:

- When checking GPS information (Section 12.2).
- During the PEC training process.
- When working in PC Direct mode (Section 9.2).

9.2 PC Direct Mode

PC Direct Mode is a special mode for the SynScan hand control to work with a PC. Under this mode, the SynScan hand control still uses the same hardware connection as described in Section 9.1, but the SynScan hand control becomes a repeater between the PC and the motor controller in the telescope mount. The application running on the PC controls the motor controller directly.

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

- Access the menu "**UTILITY FUNCTION \ PC Direct Mode**" and press the **ENTER** key. The screen will display "**PC Direct Mode\Press ESC to exit**".
- Press and hold the **ESC** key more than 1 second to exit **PC Direct Mode**.
- Users can still use the direction keys to move the telescope mount.

PART X : UPDATING FIRMWARE

10.1 Hardware Requirements

1. A SynScan hand control with firmware version 3.0 or above.
2. A computer running Windows 95 or a later version.
3. A RS-232C serial port on the computer, or a USB-to-Serial adaptor.
4. The PC-Link cable (D-Sub9 to RJ-12) which comes with the mount.

10.2 Preparation

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

10.3 Updating Firmware

1. Connect the computer and the SynScan hand control with the PC-Link cable.
2. Connect the hand control to the telescope mount.
3. Press and hold the "**0**" and "**8**" keys simultaneously, and then turn on power of the mount. The hand control will display "**SynScan Update**" on the screen. Release the "**0**" and "**8**" keys.
4. On the computer, run the **SynScanFirmwareLoader.exe**. An application window is show in Fig 10.3a.

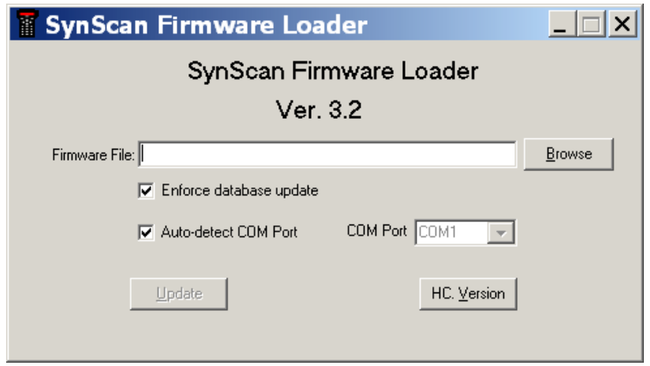


Fig. 10.3a

- Use the "**Browse**" button to load the latest firmware file ("**.SSF**" file)
- Check the "**Enforce database update**" to enforce updating the hand control's database. Clear it to let the application determine whether it is necessary to update the database.

- Check the "**Auto-detect COM port**" to let the application detect the proper serial port that will connect to the SynScan hand control. Clear it to manually choose the COM Port and select a serial port from the "**COM port**" drop-down list.
- Click the "**HC Version**" button to check the versions of the hardware, firmware, and database.
- Click the "**Update**" button to start loading the firmware to the SynScan hand control.

4. After the loading starts, the application will display a percentage number at the bottom of the windows to show the progress.
5. Once update is complete, the application will display a green bar with "**Update Complete**" at the bottom of the window.

10.4 Troubleshooting

1. If a window pops up and displays the message: "**Cannot connect to a SynScan hand control**" after clicking the "**Update**" button or the "**H.C. Version**" button, close the message window and click the "**Update**" button or the "**H.C. Version**" button to try again. If the application displays the message again, check the cable connections and ensure the USB-to-Serial Port adaptor is working.
2. If the firmware update fails, the SynScan Firmware Loader will pop up a window with message "**Firmware update failed. Cycle power to SynScan and try again!**". Close the window and power off the hand control. Then repeat the firmware update process again.
3. If the update process failed in the middle of updating, try to press the **SETUP** button on the SynScan hand control to use other communication speeds: "**Mi**" or "**Lo.**"
   - **Mi** - Medium speed
   - **Lo** - Low speed

PART XI : ADVANCED FUNCTIONS

11.1 Parking Telescope

If the mount of the telescope have not been moved after an observing session, the user can park the telescope to keep the alignment data, PAE data and PEC data, and start observing in the next session without redoing the alignment and calibration.

Parking

1. Access the menu "**UTILITY FUNCTION\Park Scope**" and press the **ENTER** key.
2. The screen will display "**Park to…**". Use the scroll keys to choose one from the following parking position and press the **ENTER** key.
   - **Home Position:** Park the telescope to the Home Position (Refer to section 2.2.1).
   - **Current Pos.:** Park the telescope at the current position.
   - **Custom Position:** Park at the previous parking position which is used in the previous o serving session.
3. The mount will slew to the parking position (except parking at the current position). When the mount stops, the screen will display "**Position saved. Turn off power**".
4. Users may now turn off power to the mount, or press the ESC key to cancel parking.

Resuming

- Turn on power to the mount.
- Pass through the initial steps.
- When the screen will display "**Start from park? 1) Yes 2)No**",
  - » Press "**1**" key to resume the mount from the parking status. After the regular initialization steps, the SynScan hand control will be ready for full feature operation like the previous observing session.
  - » Press "**2**" key to abandon the previous saved parked position and alignment data and start a regular observing session.

11.2 Pointing Accuracy Enhancement

The pointing accuracy enhancement (PAE) function enables the telescope mount to obtain enhanced pointing accuracy in specific small areas.

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

The SynScan hand control divides the sky into 85 small zones, and users can calibrate the pointing error for each of these zones. The next time that the SynScan controller tries to locate an object in the calibrated zone (or a zone nearby), it will automatically apply the recorded calibration data to compensate the pointing error.

This function is useful for locating faint deep sky objects, and it is also helpful for obtaining consistent pointing accuracy for a permanent observatory.

Here are the instructions on using the PAE function:

1. Perform a 1-star alignment, 2-star alignment, or a 3-star alignment.
2. Choose a celestial object in a zone of interest as reference by referring to a sky map or planetarium software. In general, it is a rather bright star, but users can also use other objects. Use the SynScan hand control to control the mount to point the telescope to the reference object.
3. Use one of the following operations to start the PAE calibration:
   - Press the "**UTILITY**" shortcut key, access to sub-menu "**PAE\PAE Correction**", and then press the **ENTER** key.
   - Press and hold the **ESC** key for two seconds.
4. The screen will display "**Re-centering Obj.:**" in the first row, and display the name of the reference object in the bottom row. (If the last object is launched from a PC, then instead of the name of the reference object, it will display "**The last target**".) Now use the direction keys of the hand control to center the object in the telescope's FOV, and then press **ENTER** to confirm. Remember to end the centering operation by pressing the **Right** and **Up** direction keys together.
5. Repeat Step 2 to 5 for viewing different portions of the sky.

Note:

- Whenever the SynScan hand control locates an object, it will automatically check whether a PAE calibration data is available, and apply the compensation accordingly. No manual intervention is required.
- If multiply PAE calibration is performed in the same zone, the previous calibration data will be overwritten.
- Users can access the menu "**UTILITY FUNCTION > PAE > Clear PAE data**" to clear all PAE calibration data.
- The PAE calibration data will be automatically cleared after a **1-star alignment**, **2-star alignment** or **3-star alignment**.

11.3 Polar Alignment without Polar Scope

The polar alignment function can help users to polar align an equatorial mount accurately.

Here are the operating instructions:

1. Complete a 2-star alignment or a 3-star alignment. At the end of the alignment, the SynScan hand control will display the polar alignment error (refer to Section 3.3). Users can use the data to determine whether it is necessary to adjust the polar alignment.
2. Press the "**MENU**" shortcut key, and then access to sub-menu "**Alignment\Polar Alignment**", press the **ENTER** key to proceed to the next step.
3. The screen will display "**Select a Star**".
   - Use the scroll keys to browse through a list of star names and press the **ENTER** key to pick one as the reference star for polar alignment.
   - The mount will start slewing to point the telescope to the reference star.
4. Use the direction keys to center the reference star in the eyepiece of the telescope after the mount stops slewing. Remember to end the centering operation with **Up** and **Right** direction keys. Press the **ENTER** key to proceed to the next step.
5. The screen will now display the polar alignment error in altitude (Mel=dd°mm'ss"). Users can then use the data to determine whether or not to adjust the altitude of the R.A. axis in the next step. Press the ENTER key to proceed.
6. The mount will slew to a new position. When it stops, the screen will display "Adjust Altitude:". By using ONLY the altitude control of the mount (do not touch the azimuth control), bring the reference star back to the closest point to the center of the FOV of the telescope's eyepiece. Remember the reference star's current position in the eyepiece for later adjustment. Press the ENTER key to confirm the centering operation.
7. The screen will now display the polar alignment error. Users can then use the data to determine whether or not to adjust the azimuth of the mount in the next step. Press the ENTER key again to proceed to the next step.
8. The mount will slew to a new position. When it stops, the screen will display "Adjust Azimuth:" By using ONLY the azimuth control of the mount (do not touch the altitude control), bring the reference star back to the closest point to the previous position (at the end of Step 6). Press the ENTER key to confirm the centering operation.
9. The screen will display the polar alignment error again, press the ENTER button to end the polar alignment process.
10. Go back to the "**Alignment**" menu on the SynScan hand control and execute another 2-Star or 3-Star alignment, and then check the polar alignment error data reported at the end of the 2-star alignment or 3-star alignment. Repeat Step 2 to Step 9 until the error is small enough and acceptable. Generally, users can get up to 1 arc-minute polar alignment accuracy after repeating this polar alignment process 2 or 3 times.

Note:

- Users can press the **ESC** key at any time during the polar alignment process to exit.

- The initial polar alignment should not be too far off to avoid the polar alignment error in azimuth exceeding the adjustment range of the mount.
- It is necessary to use a reticle eyepiece in the 2-Star alignment, 3-star alignment and polar alignment process.
- Generally, the cone error in a telescope-mount setup might reduce the accuracy of this polar alignment process. Therefore, it is recommended to reduce or eliminate the cone error before the polar alignment process (Refer to **APPENDIX 1 : ELIMINATING CONE ERROR ON EQUATORIAL MOUNTS**).
- It is recommended that the user verifies the accuracy of the **2-star alignment** or **3-star alignment** before starting the polar alignment process by locating several objects in different areas of the sky. If the pointing accuracy is low, try to use another set of alignment stars for the **2-star** or **3-star alignment** process.

11.4 Camera Control

The SynScan hand control can control a DSLR camera to do astrophotography. It can accept 8 groups of "Exposures Time - Frames" parameters, and then controls the camera to take batch exposures without manual intervention.

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

Connecting the Camera

1. **Using the SNAP port on the telescope mount:**
   Several Sky-Watcher's equatorial mounts (such as the AZ-EQ6 GT and the EQ8) are equipped with a SNAP port. Users can use a proper shutter release control cable to connect this port to the same port on the camera.
2. **Using the multi-purpose port on the SynScan hand control:**
   The SynScan hand control uses 2 pins (The SHUTTER and COMMON pins in the diagram of Appendix 3) of its multi-purpose port to control the shutter release of a DSLR camera. Users may use a proper shutter release cable to connect the SynScan hand control and a camera.

Setup Control Parameters

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

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

The leading number ("1") is the index number of this group; the "mm:ss" data is the exposure time in minutes and seconds; and the ending 3 digits number is the frames to be shot. Press the ENTER key to pick a group and proceed to the next step.

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

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

- Use the left and right keys to move the cursor and use the numeric keys to fill the digits with the cursor. Press the ENTER key to end setting the exposure time.
- Now the screen is changed to set the frames to be shot for this group, as shown below. Use the left and right keys to move the cursor and use the numeric keys to fill in the digits with the cursor. Press the ENTER key to end setting the frames.

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

- The SynScan hand control will return to the status of Step 2 for users to choose and edit another group of parameters.

Note: To disable a group, set either the "Exposure" or the "Repeats" parameters to 0.

4. After setting all groups of the parameters, press the ESC key to exit the configuration process.

Batch Exposure

1. Set the camera to bulb exposure mode.
2. Press the "UTILITY" shortcut key, access to the sub-menu "Camera Control \ Shoot", and press the Enter key.
3. The SynScan hand control will start to take batch exposure and display the progress data on the screen, a sample screenshot is shown below:

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

- The top row shows the group index and the frames pending.
- The bottom row shows the remaining exposure time of the current frame.
- At the end of each frame, the SynScan hand control will wait for the preset interval before the next exposure.

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

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

11.5 Periodic Error Correction (PEC) for EQ Mount

The periodic error correction function applies to an equatorial mount only.

All equatorial mount has periodic tracking error which is not critical for visual observing but might lower the picture quality of long exposure astrophotography. The SynScan hand control has the periodic error correction (PEC) function to improve the tracking performance for astrophotography.

Depending on the model of the equatorial mount, there are two types of PEC. One is software based PEC (SPEC), which applies to Sky-Watcher's EQ3/EQ5/HEQ5/EQ6 Pro mount. The other is permanent PEC (PPEC), which applies to Sky-Watcher's AZ-EQ6 GT mount and EQ8 mount. The SynScan hand control can detect the mount model and choose the corresponding PEC algorithm.

The PEC function is a training-replay process.

PEC Training:

1. Polar align the equatorial mount accurately, and then perform a star alignment.
2. Choose a star close to the celestial equator, point the telescope towards it and start the mount tracking. Center the star in the telescope's eyepiece.
3. Access the menu "**UTILITY FUNCTION\PEC Training**" and press the **ENTER** key, the screen will display "**Select Speed: 1)0.125X 2)0.25X**". This is the speed used to adjust the position of the star in the FOV of the telescope when a user presses the **Left** or **Right** direction key on the SynScan hand control. Choosing a 0.125X sidereal rate is recommended for a smaller FOV of telescope, and a 0.25X sidereal rate is recommended for a wider FOV of telescope. Press the "**1**" or "**2**" key to make a selection and proceed to the next step.
4. The screen will display the elapsed time. Use the **Left** and **Right** direction keys to control the mount and keep the star at the same spot in the FOV of the telescope until the SynScan hand control stops displaying the time. The total time for this training process depends on mount models.

PEC Replay

Once PEC training is completed, access the menu "**Setup\Tracking\PEC+Sidereal**" and press the **ENTER** key to start the PEC replay, that is, start to compensate the period error. Choosing other items in the menu "**Setup\Tracking**" will turn off the PEC.

Notes:

- It is recommended to use a high-power telescope and a reticle eyepiece for the PEC training. A digital eyepiece with a computer is preferred.
- For the equatorial mounts that support PPEC (such as the AZ-EQ6 GT and EQ8 mounts), an autoguider can be used to replace manual guiding in PEC training process. In such cases, it is recommended to turn on the autoguiding for at least one minute before starting the PEC training process. The total time for the PEC training of these mount can be as long as two cycles of the period error.

1. PEC can only compensate tracking errors on the R.A. axis. Therefore, a precise polar alignment is still required to track minor errors on the Dec. axis.
2. After turning on the PEC replay, it is recommended to wait for at least one cycle time of the period error before taking a picture.
3. To re-use the PEC data on a mount which supports SPEC, users should park the telescope before shutting off power (refer to Section 11.1). This limitation does not apply to the mounts which support PPEC.

11.6 Calibrating Auto-Home Offset

Some Sky-Watcher's equatorial mounts (ex. the EQ 8 mount) has the Auto-Home function which can set the mount to a standard home position after turning on the power.

The offset of the home position can be calibrated and compensated with the following procedures:

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

PART XII : USING A SYNSCAN GPS MODULE

Users may purchase a SynScan GPS module to acquire accurate local geographical coordinates and local time; it will help improve the accuracy of the mount alignment and the polar alignment.

12.1 Initialization of the Hand control with a SynScan GPS Module

The initialization process of the SynScan hand control with a SynScan GPS plug-in differs from a regular one.

1. Plug the SynScan GPS module into the multi-purpose port (the 6 pins RJ-12 port) located at the bottom center of the SynScan hand control. Place the GPS module on a horizontal surface and turn on the power of the mount.
2. If the SynScan hand control detects the connection of a GPS module, it will ask for the local time zone:
   - Use the left and right direction keys to move the cursor on the screen.
   - Use the scroll keys to change or switch the sign for the time zone. Use "**+**" for the time zones in the Eastern Hemisphere, use "**-**" for the time zones in the Western Hemisphere.
   - Use the numeric keys to fill the time zone value in **±hh:mm** format.
   - Press **ENTER** to confirm and proceed.
3. The hand control will then ask the user whether to use the Daylight Saving Time. Use the scroll keys to select between "**YES**" and "**NO**" and press the **ENTER** key to confirm and proceed.
4. The screen will now display "**GPS fixing…**". It means that the GPS module is trying to fix to the GPS satellites.
5. After the SynScan GPS module fixes to the satellites, the SynScan hand control will continue the initialization process.

12.2 Checking GPS Information

1. Plug the SynScan GPS module into the multi-purpose port (the 6 pins RJ-12 port) located at the bottom center of the SynScan hand control. Place the GPS module on a horizontal surface.
2. Access the menu "**UTILITY FUNCTION \ GPS**" in the menu and press the **ENTER** key.
3. The screen will now display "**GPS fixing…**". It means that the GPS module is trying to fix to the GPS satellites.
4. After the SynScan GPS module fixes to the satellites, the screen will display "**GPS Information:**". Use scroll keys to browse through the following information. Press the **ESC** key to exit.
   - **M.O.V:** Local magnetic declination
   - **Lat:** Local latitude
   - **Lo:** Local longitude
   - **Date**: Local date
   - **UT:** Greenwich Mean Time
   - **LT:** Local time
   - **TimeZone:** Local time zone
   - **LST:** Local sidereal time
   - **Elevation:** Local elevation
   - **Quality:** Quality of GPS fixing
   - **Number of SV:** Number of GPS satellites in view
   - **SV(fix) Nr:** Number of GPS satellites fixed

APPENDIX I : ELIMINATING CONE ERROR

If the telescope's optical axis is not perpendicular to the declination axis of the equatorial mount, then there is cone error in the telescope-mount system. The cone error might lower the accuracy of locating an object or the accuracy of the Polar-Alignment process.

Testing for Cone Error

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

Eliminating Cone Error

1. Rotate the R.A. axis to level the counterweight shaft.
2. Center the Polaris in the polar scope.
3. Point the telescope to the Polaris, rotate the Dec. axis to bring the Polaris as close as possible to the center of the finder scope or the telescope's eyepiece.
4. Fine tune the azimuth and latitude of the mount to center the Polaris in the telescope's eyepiece.
5. Rotate the R.A. axis 180 degrees. (the counterweight shaft should be leveled and pointed to the other side of the mount). If the Polaris can be put to the center of the eyepiece by rotating the Dec. axis only, it means the cone error is small and no further adjustment is needed; otherwise, continue to the following steps.
6. Rotate the Dec. axis to bring the Polaris as close as possible to the center of the finder scope or the telescope's eyepiece.
7. Slightly push the eyepiece end of the telescope in a HORIZONTAL direction while looking into the eyepiece, find the direction which will bring the Polaris closer to the center of the eyepiece. In this way, a user can determine the direction in which he/she should re-position the telescope on the saddle or the mounting bar to reduce the cone error.
8. Use a shim (or other method) on the proper side of the saddle or the mounting bar to raise the telescope. Look into the eyepiece while applying the shim. Reduce the deviation between the Polaris and center of the eyepiece to HALF.
9. Repeat Steps 4 and 5 to check whether the cone error is acceptable, repeat Steps 6, 7 and 8 if necessary.

Tips:

- It is recommended to use a reticle eyepiece and align the track of the Dec. movement with one of the lines of the reticle.
- This adjustment can be done in day time by using a distant point object to replace the Polaris.

APPENDIX II : SYNSCAN SELF-DIAGNOSIS

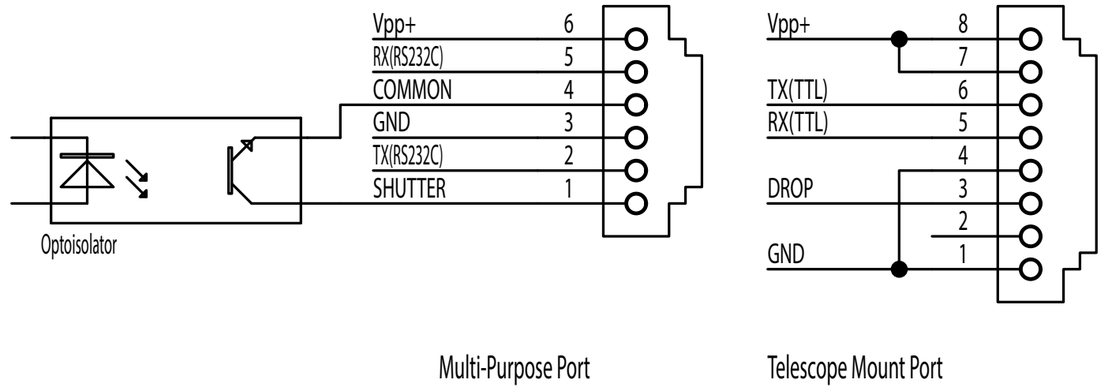
The SynScan hand control contains a built-in self-diagnosis program. To run a full test, users should prepare a “Loop-Test Plug” by referring to Appendix 3 and the following instructions:

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

Here are the diagnosis steps:

1. Insert the “Loop-Test Plug” to the RJ-12 port of the SynScan hand control.
2. Press “**2**” and “**5**” simultaneously and power on the hand control.
3. The hand control will display “**SynScan B.I.T.**” for a short time.
4. The LCD will display “LCD CONTRAST x-yy“, press ENTER button to continue.
5. The LCD screen will become fully black and then fully clear for a while for the purpose of checking the LCD display.
6. If there is any problem for the RS-232C function on multi-purpose port (the RJ-12 outlet) or no Loop-Test Plug connected to the multi-purpose port, the screen will display “**COM1 ERROR**”. Press **ENTER** to continue.
7. Ignore “**COM2 ERROR**” message and press **ENTER** to continue.
8. If everything is fine, the testing will go to Step 9; Otherwise, the SynScan hand control will show “**EEPROM ERROR**” or “**Flash ERROR**”. Press **ENTER** to continue in such case.
9. Check keypad and other features:
   - The screen will display “**Key=**” in the top row. If a key is pressed, the name of the key will be displayed.
   - The power voltage will be displayed on the bottom row of the screen.

APPENDIX III : SCHEMATIC OF THE PORTS



Multi-Purpose Port

Telescope Mount Port

APPENDIX IV : SPECIFICATIONS

Supported Mount	EQ Mount and Alt-Az Mount
Object Catalog	Messier, NGC, IC, SAO, Caldwell, Double Star, Variable Star, Named Star, Planets
Pointing Accuracy	Up to 5 arc-minutes RMS
Tracking Rate	Sidereal Rate, Solar Rate, Lunar Rate
PEC	SPEC or PPEC
Database	42000+ Objects
LCD	18 Characters X 2 Lines Adjustable Contrast and Backlight
Keypad	Rubber, Adjustable backlight
GPS	SynScan GPS Modular (Optional)
PC Connection	RS-232C, 9600bps, No parity check, 8 data bits, 1 start bit, 1 stop bit
Power Supply	DC 7.5 to 12V, 100mA
Power output on Multi-purpose port	Power Supply Voltage - 0.7V Maximum 100mA current output

SynScan™

NEVER USE YOUR TELESCOPE TO LOOK DIRECTLY AT THE SUN. PERMANENT EYE DAMAGE WILL RESULT. USE A PROPER SOLAR FILTER FIRMLY MOUNTED ON THE FRONT OF THE TELESCOPE FOR VIEWING THE SUN. WHEN OBSERVING THE SUN, PLACE A DUST CAP OVER YOUR FINDERSCOPE OR REMOVE IT TO PROTECT YOU FROM ACCIDENTAL EXPOSURE. NEVER USE AN EYEPIECE-TYPE SOLAR FILTER AND NEVER USE YOUR TELESCOPE TO PROJECT SUNLIGHT ONTO ANOTHER SURFACE, THE INTERNAL HEAT BUILD-UP WILL DAMAGE THE TELESCOPE OPTICAL ELEMENTS.