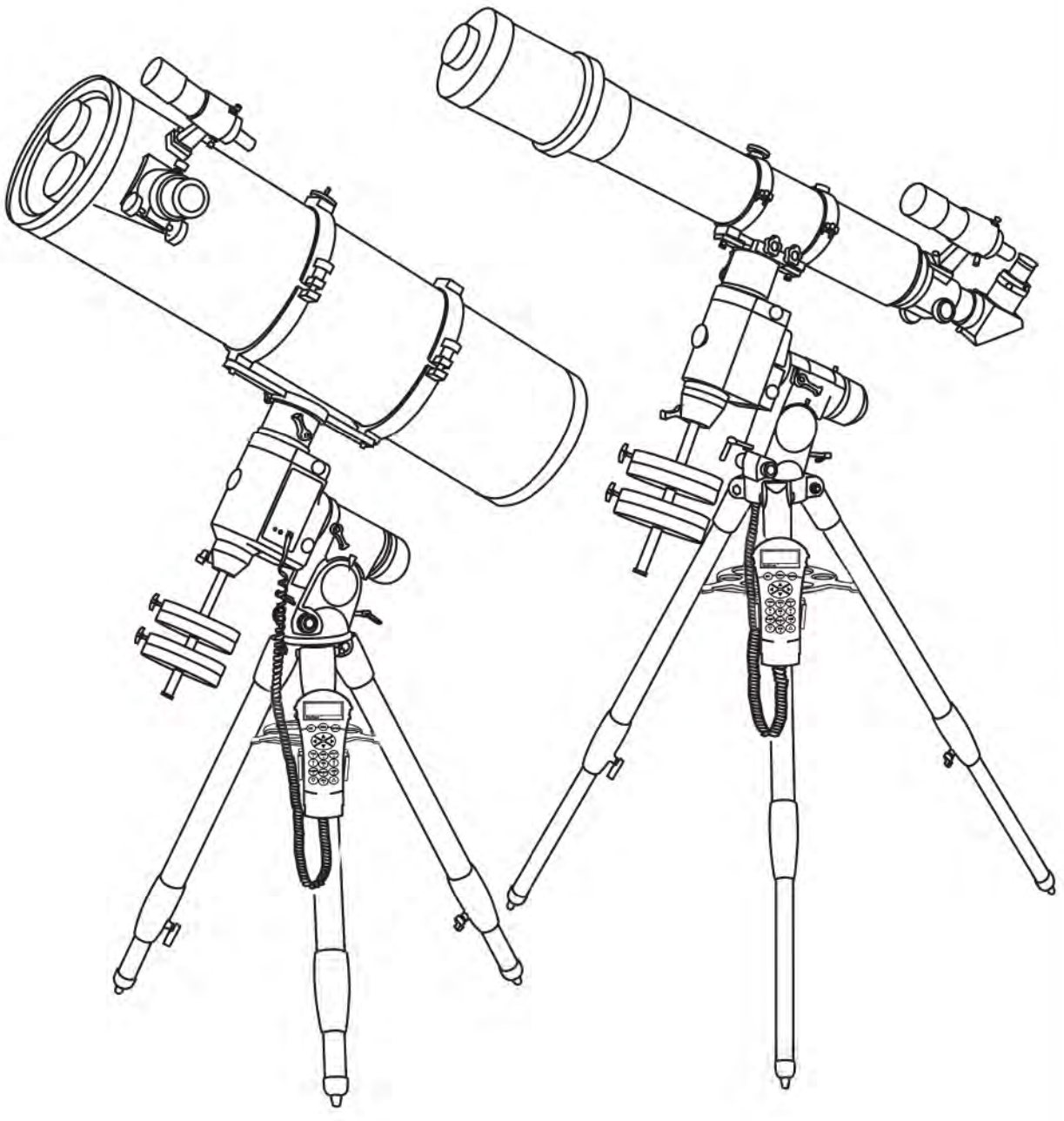
INSTRUCTION MANUAL

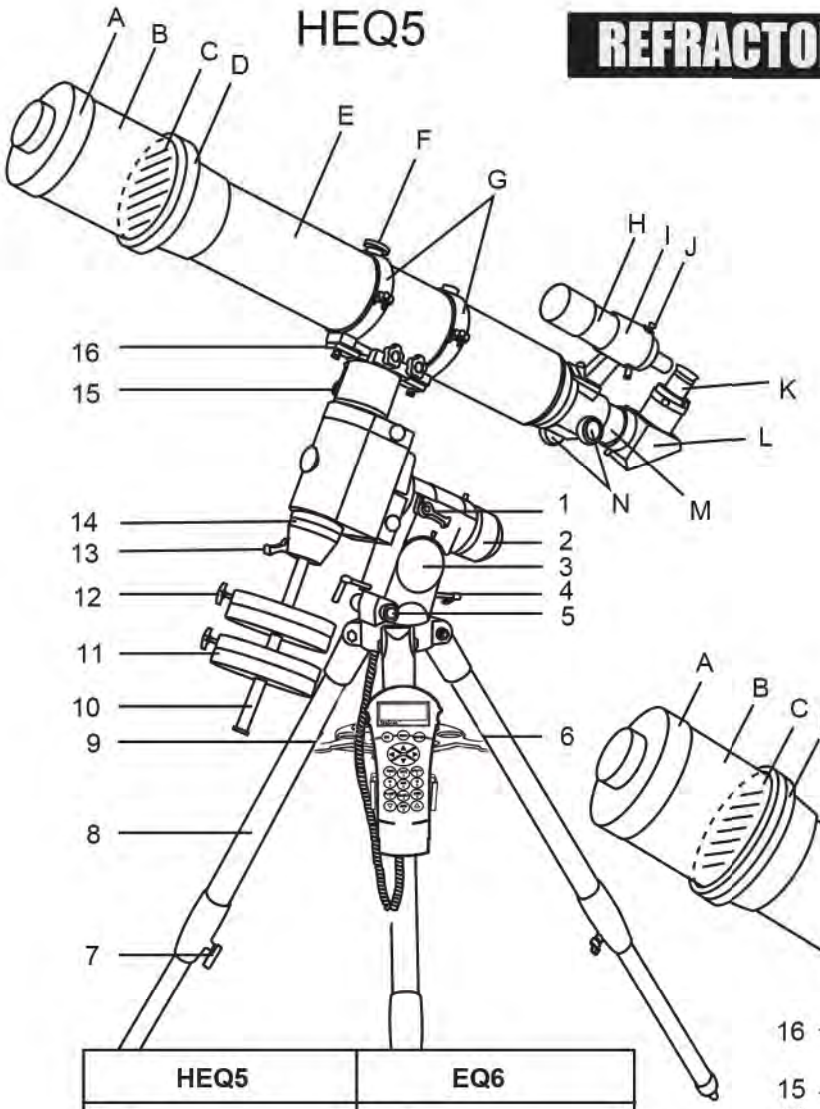
HEQ5/EQ6 MOUNT



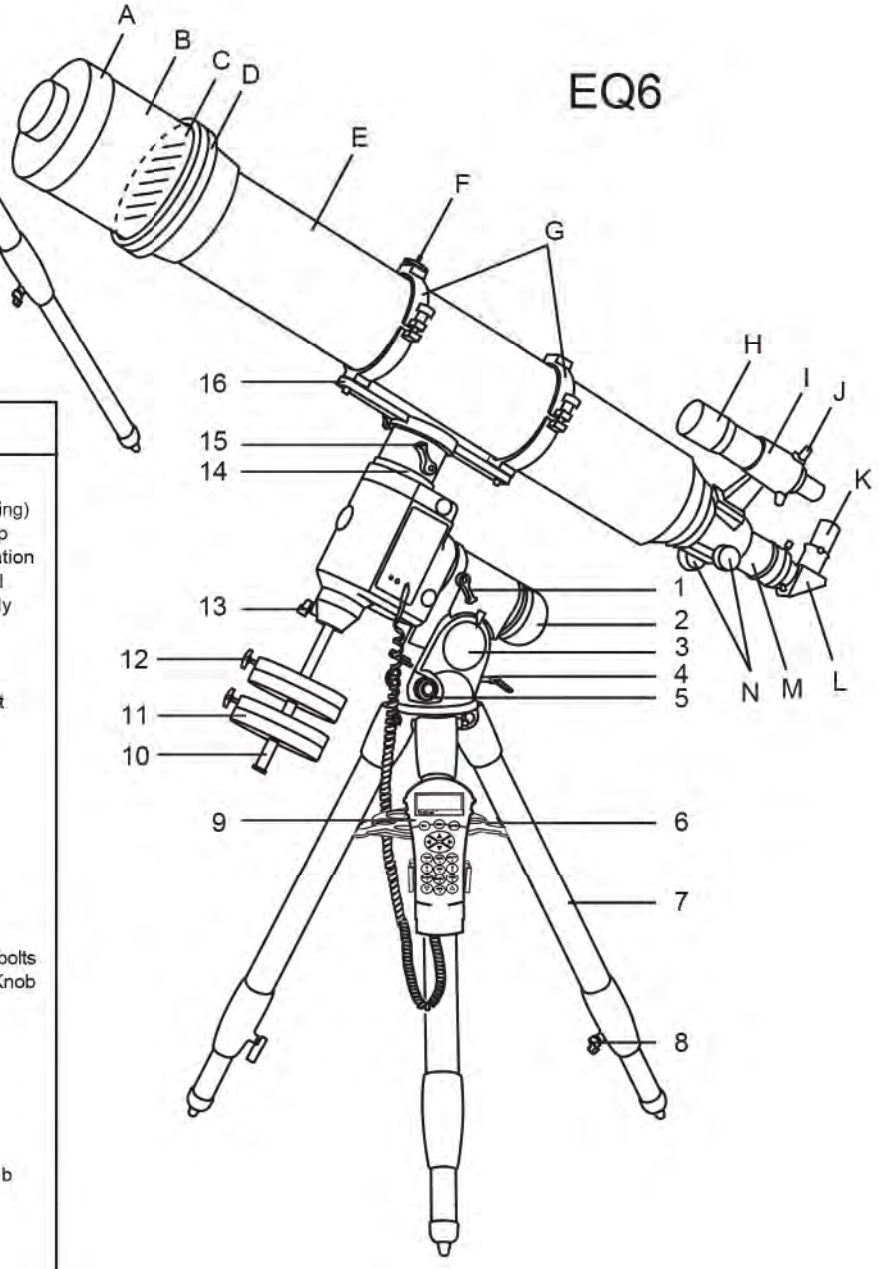
130405V1

HEQ5

REFRACTOR

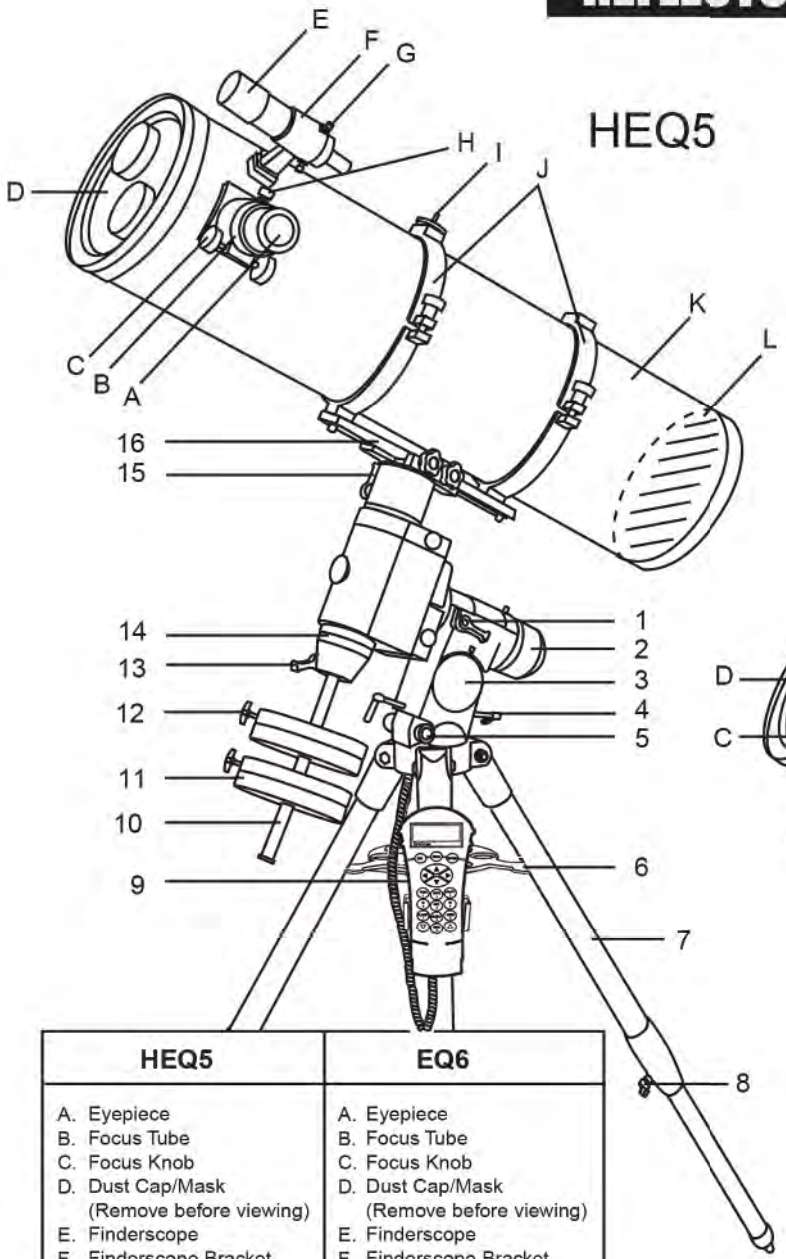


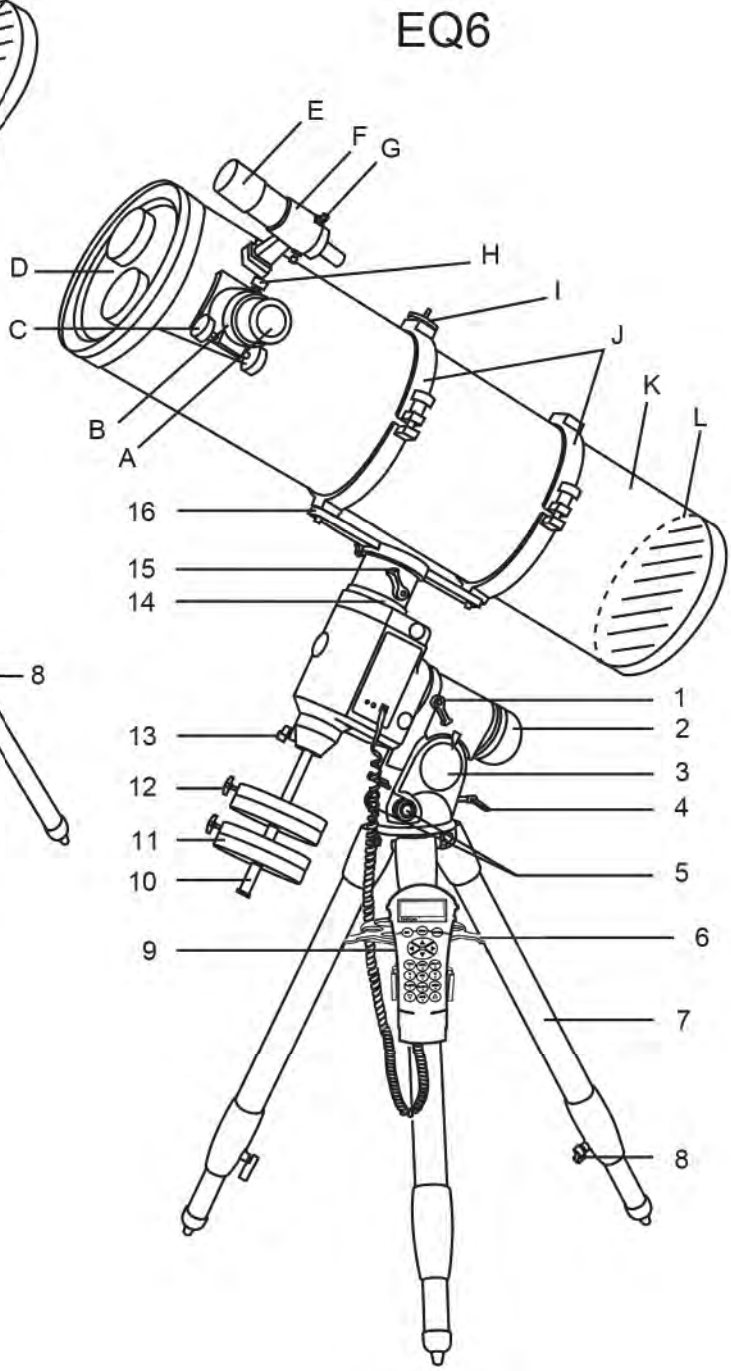
EQ6



HEQ5	EQ6
A. Dust Cap/Mask (Remove before Viewing)	A. Dust Cap/Mask (Remove before Viewing)
B. Sun Shade/Dew Cap	B. Sun Shade/Dew Cap
C. Objective Lens Location	C. Objective Lens Location
D. Adjustable Lens Cell	D. Adjustable Lens Cell
E. Telescope Main Body	E. Telescope Main Body
F. Piggyback Bracket	F. Piggyback Bracket
G. Tube Ring	G. Tube Ring
H. Finderscope	H. Finderscope
I. Finderscope Bracket	I. Finderscope Bracket
J. Alignment Screw	J. Alignment Screw
K. Eyepiece	K. Eyepiece
L. Diagonal	L. Diagonal
M. Focus Tube	M. Focus Tube
N. Focus Knob	N. Focus Knob
1. R.A. Lock Lever	1. R.A. Lock Lever
2. Polarscope Holder (not shown)	2. Polarscope Holder (not shown)
3. Latitude Scale	3. Latitude Scale
4. Altitude Adjustment T-bolts	4. Altitude Adjustment T-bolts
5. Azimuth Adjustment Knob	5. Azimuth Adjustment Knob
6. Accessory Tray	6. Accessory Tray
7. Height Adjustment Clamp	7. Tripod Leg
8. Tripod Leg	8. Height Adjustment Clamp
9. Hand Control	9. Hand Control
10. Counterweight Rod	10. Counterweight Rod
11. Counterweight	11. Counterweight
12. Counterweight Thumb Screw	12. Counterweight Thumb Screw
13. Counterweight Rod Lock Knob	13. Counterweight Rod Lock Knob
14. Dec Setting Circle	14. Dec Setting Circle
15. Dec Lock Lever	15. Dec Lock Lever
16. Mounting Plate	16. Mounting Plate

REFLECTOR





HEQ5	EQ6
A. Eyepiece	A. Eyepiece
B. Focus Tube	B. Focus Tube
C. Focus Knob	C. Focus Knob
D. Dust Cap/Mask (Remove before viewing)	D. Dust Cap/Mask (Remove before viewing)
E. Finderscope	E. Finderscope
F. Finderscope Bracket	F. Finderscope Bracket
G. Alignment Screw	G. Alignment Screw
H. Tension Adjustment Screw	H. Tension Adjustment Screw
I. Piggyback Bracket	I. Piggyback Bracket
J. Tube Rings	J. Tube Rings
K. Telescope Main Body	K. Telescope Main Body
L. Primary Mirror Location	L. Primary Mirror Location
1. R.A. Lock Lever	1. R.A. Lock Lever
2. Polarscope Holder (not shown)	2. Polarscope Holder (not shown)
3. Latitude Scale	3. Latitude Scale
4. Altitude Adjustment T-bolts	4. Altitude Adjustment T-bolts
5. Azimuth Adjustment Knob	5. Azimuth Adjustment Knob
6. Accessory Tray	6. Accessory Tray
7. Tripod Leg	7. Tripod Leg
8. Height Adjustment Clamp	8. Height Adjustment Clamp
9. Hand Control	9. Hand Control
10. Counterweight Rod	10. Counterweight Rod
11. Counterweight	11. Counterweight
12. Counterweight Thumb Screw	12. Counterweight Thumb Screw
13. Counterweight Rod Lock Knob	13. Counterweight Rod Lock Knob
14. Dec Setting Circle	14. Dec Setting Circle
15. Dec Lock Lever	15. Dec Lock Lever
16. Mounting Plate	16. Mounting Plate

TABLE OF CONTENTS

ASSEMBLING YOUR TELESCOPE ---- 5

- Tripod Set Up ---- 5
- Mount Assembly ---- 5
- Telescope Assembly ---- 6
- Finderscope Assembly ---- 6
- Eyepiece Assembly ---- 7
- Hand Control Holder Installation (For SynScan™ Only) ---- 7

OPERATING YOUR TELESCOPE ---- 8

- Aligning the Finderscope ---- 8
- Balancing the Telescope ---- 8
- Operating the Mount Manually ---- 9
- Using the Optional Barlow Lens ---- 10
- Focusing ---- 10
- Polar Alignment ---- 10
- Pointing Your Telescope ---- 14
- Choosing the Appropriate Eyepiece ---- 17

OBSERVING THE SKY ---- 18

PROPER CARE FOR YOUR TELESCOPE ---- 19

- Collimating a Newtonian Reflector ---- 19
- Collimating a Refractor with the Adjustable Objective-Lens Cell ---- 21
- Cleaning Your Telescope ---- 21

APPENDIX A - STANDARD TIME ZONES OF THE WORLD ---- I

APPENDIX B - OPTIONAL ACCESSORIES ---- II

APPENDIX C - RECOMMENDED READING ---- IV

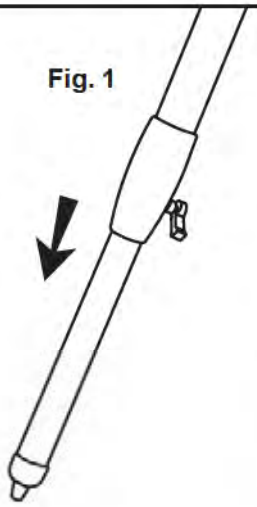
APPENDIX D - GLOSSARY ---- V

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.

ASSEMBLING YOUR TELESCOPE

TRIPOD SET UP

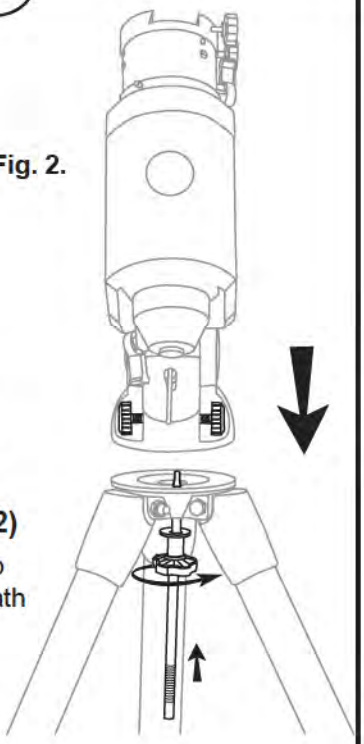
Fig. 1



ASSEMBLING THE TRIPOD LEGS (Fig.1)

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 tripod legs apart to stand the tripod upright.
3) Place a carpenter's level or bubble level on the top of the tripod legs. 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.

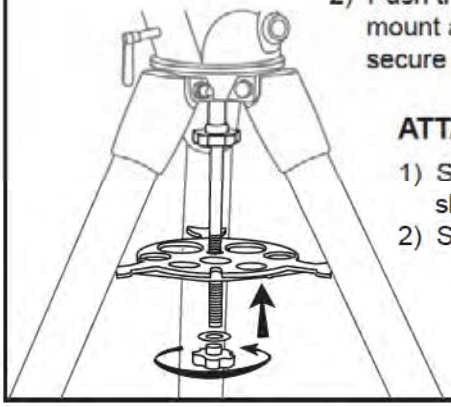
Fig. 2.



ATTACHING MOUNT TO TRIPOD LEGS (Fig. 2)

1) Align metal dowel on the tripod head with the gap between the azimuth adjustment knobs underneath the mount.
2) Push the primary locking shaft up against the mount and turn the knurled knob underneath to secure mount to tripod.

Fig. 3



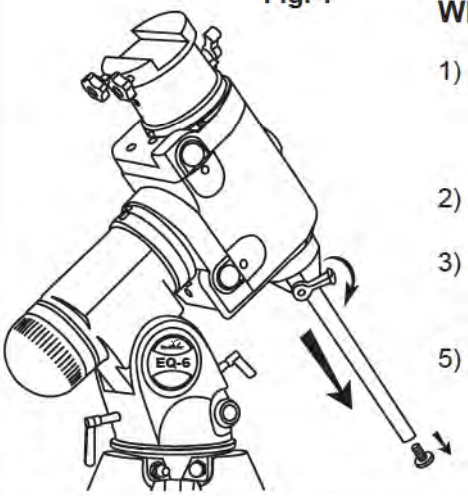
ATTACHING THE ACCESSORY TRAY (Fig. 3)

1) Slide the accessory tray along the primary locking shaft until it pushes against the tripod legs.
2) Secure with the washer and locking knob.

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

MOUNT ASSEMBLY

Fig. 4

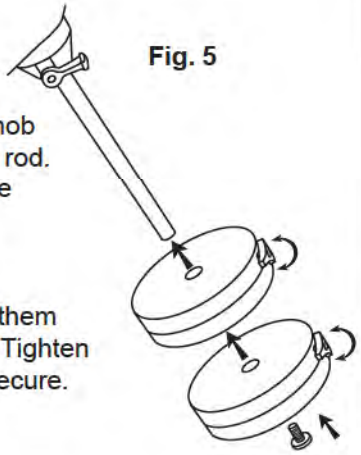


INSTALLING THE COUNTER-WEIGHTS (Fig. 4, 5)

1) Loosen the counterweight rod lock knob and gently pull out the counterweight rod. Re-tighten the lock knob to secure the counterweight rod in place.
2) Unscrew the threaded cap from the end of the counterweight rod.
3) 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.

(diagram applicable to both mounts)

Fig. 5



TELESCOPE ASSEMBLY

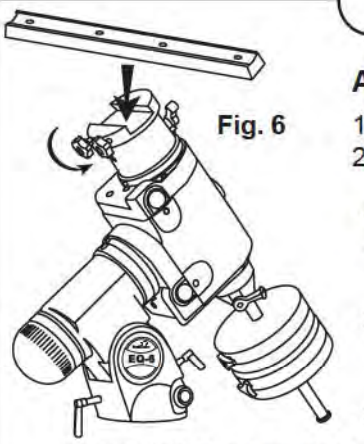


Fig. 6

(diagram applicable to both mounts)

ATTACHING THE MOUNTING PLATE (Fig.6)

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

ATTACHING THE TUBE RINGS (Fig.7)

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.

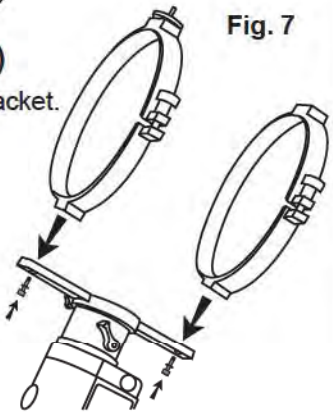


Fig. 7

TELESCOPE ASSEMBLY

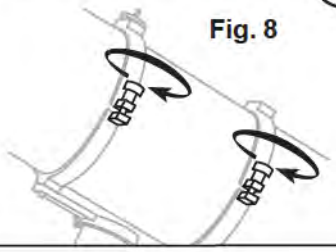


Fig. 8

ATTACHING THE TELESCOPE MAIN TUBE TO THE TUBE RINGS (Fig.8)

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.

FINDERSCOPE ASSEMBLY (for reflectors)

Fig.9

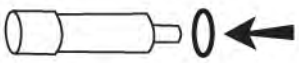
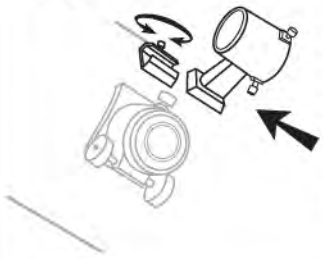


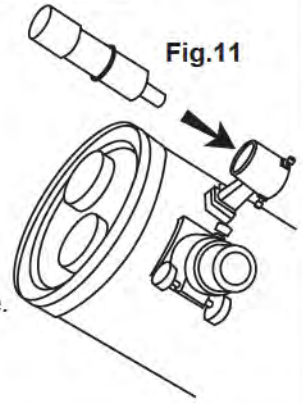
Fig.10



ATTACHING THE FINDERSCOPE BRACKET (Fig. 9,10,11)

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 bracket by sliding it backwards until the rubber o-ring seats in the finderscope mount.

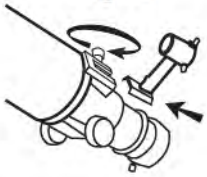
Fig.11



FINDERSCOPE ASSEMBLY (for refractors)

Fig.12

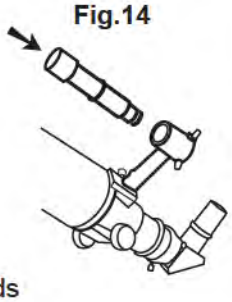
Fig.13



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

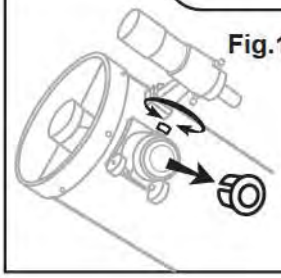
1) Locate the finderscope bracket. Carefully remove the rubber-o-ring from the finderscope bracket.
2) Position the o-ring into the groove located approximately half-way along the finderscope tube.
3) Locate the finderscope optical assembly.
4) Slide the finderscope bracket into the rectangular slot 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 (for reflectors)

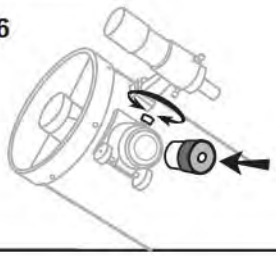
Fig.15



INSERTING THE EYEPIECE (Fig.15, 16)

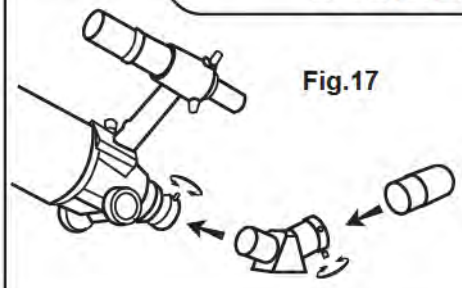
1) Unscrew the thumbscrews on the end of the focus tube to remove the black plastic end-cap.
2) Insert the desired eyepiece and secure it by retightening the thumbscrews.

Fig.16



EYEPIECE ASSEMBLY (for refractors)

Fig.17



INSERTING THE EYEPIECE (Fig.17)

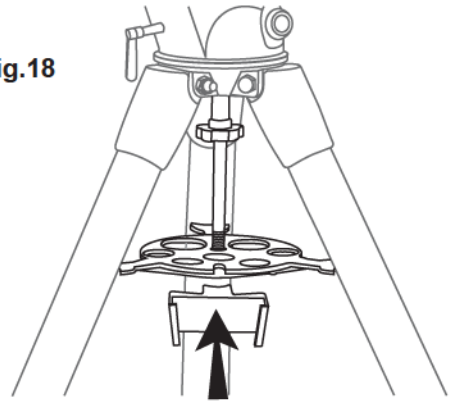
1) Loosen the thumbscrew on the end of the focus tube.
2) Insert the diagonal into the focus tube and re-tighten the thumbscrew to hold the diagonal in place.
3) Loosen the thumbscrews on the diagonal.
4) Insert the desired eyepiece into diagonal and secure by re-tightening the thumbscrews.

HAND CONTROL HOLDER INSTALLATION

INSTALLING THE HAND CONTROL HOLDER (Fig.18) (for SynScan™ only)

Locate the hand control holder. Slide the holder onto the accessory tray as shown in Fig.6.

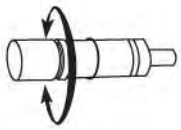
Fig.18



OPERATING YOUR TELESCOPE

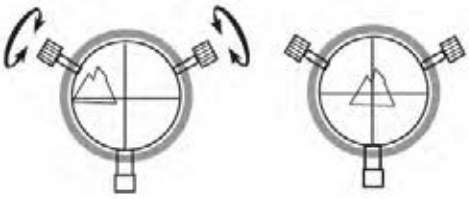
Aligning the finderscope

Fig.a



These fixed magnification scopes mounted on the optical tube are very useful accessories. When they are 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).

Fig.a-1



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.a-1).

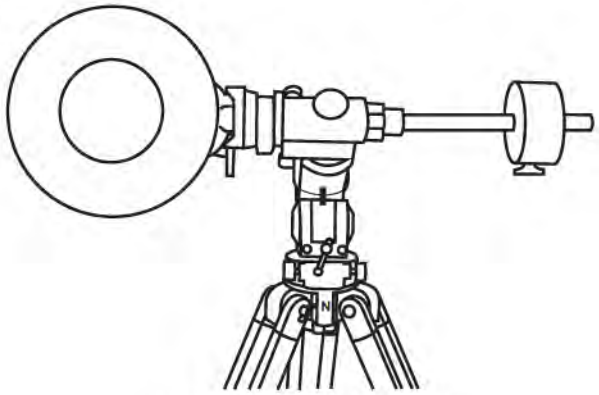
Balancing the telescope

A Telescope should be balanced before each observing session. Balancing reduces stress on the telescope mount and allows for 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) 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.b).
2) Tighten the Dec. lock knob.
3) Move the counterweights along the counterweight rod until the telescope is balanced and remains stationary when released.
4) Tighten the counterweight thumb screws to hold the counterweights in their new position.

Fig.b



(diagram applicable to both mounts)

Dec. Balancing

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.

Operating the mount manually

The HEQ5 and EQ6 mount have controls for both conventional altitude (up-down) and azimuthal (left-right) directions of motion. Use the altitude adjustment T-bolts for altitude adjustments. These allow fine-adjustment for setting the mount to your local latitude. The azimuthal axis is changed by the two azimuth adjustment knobs located near the tripod head. These allow fine-adjustment of azimuth for polar aligning (Fig.c).

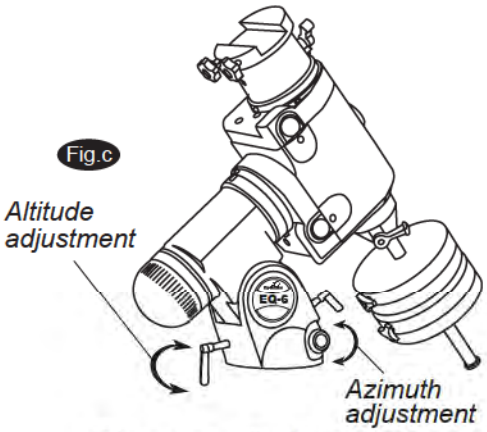
Make sure to loosen one altitude adjustment T-bolt before tightening the other. Over-tightening can cause the bolts to bend or break.

In addition, the HEQ5 and EQ6 mounts have direction controls for polar aligned astronomical observing. These directions use right ascension (east/west) and declination (north/south) axis. There are two options to move the telescope in these directions: For large and quick movement, loosen the R.A. lock level under the R.A. shaft or the Dec. lock level near the top of the mount (Fig.d). For fine adjustments, use the SynTrek™ or SynScan™ hand control.

There are three numerical scales on this mount. The lower scale is used for polar alignment of the telescope to your local latitude. The R.A. (right ascension) scale is measures hour angle and is adjustable to your local meridian. The declination scale is located near the top of the mount (Fig.e).

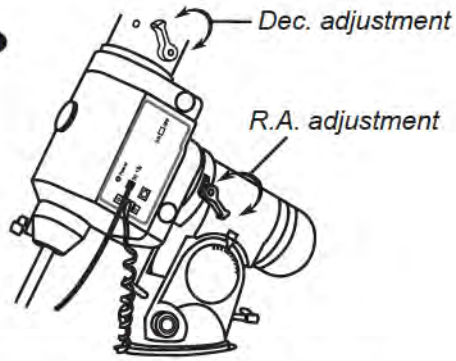
(For SynScan™ Only) Do not adjust the mount manually when under the SynScan™ operation mode. The telescope will have to be returned to the Home Position and initial star alignment will have to be done again.

Fig.c



(Diagram applicable to both mounts)

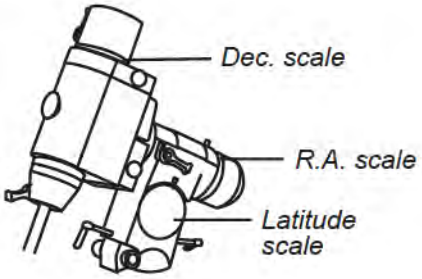
Fig.d



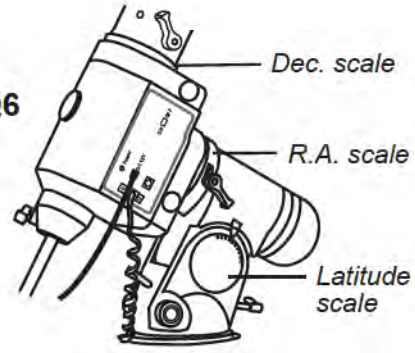
(Diagram applicable to both mounts)

Fig.e

HEQ5



EQ6



Warning Tips Trouble Shooting

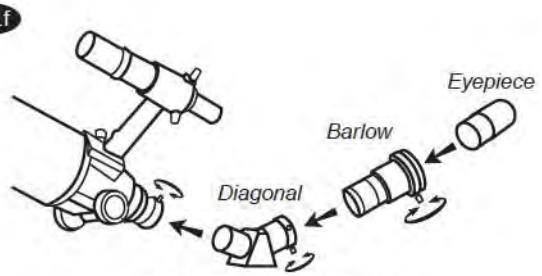
Using the optional Barlow lens

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.

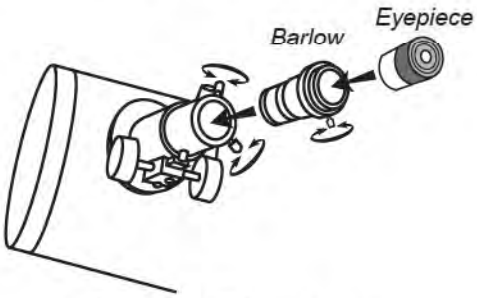
The Barlow is inserted between the focuser and the eyepiece in a reflector, and usually between the diagonal and the eyepiece in a refractor or a maksutov (Fig.f). With some telescopes, it can also be inserted between the focuser and the diagonal, and in this position it gives even greater magnification. 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 outperform a single lens producing the same magnification. However, its greatest value may be that a Barlow can potentially double the number of eyepieces in your collection.

Fig.f



(Refracting Telescopes and Maksutovs)

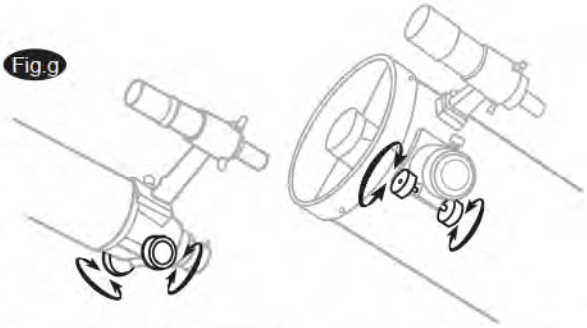


(Reflecting Telescopes)

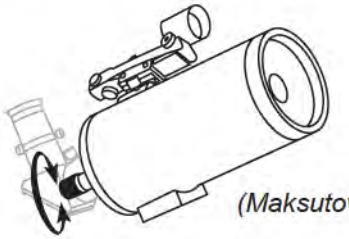
Focusing

Slowly turn the focus knobs under the focuser, one way or the other, until the image in the eyepiece is sharp (Fig.g). 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 have not yet reached outside temperature. Refocusing is almost always necessary when you change an eyepiece or add or remove a Barlow lens. On some focusers, there is a tension adjustment. Over-tighten this may damage the rack and pinion assembly.

Fig.g



(Refracting Telescopes) *(Reflecting Telescopes)*



(Maksutov Telescopes)

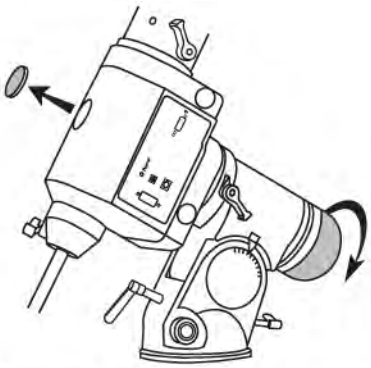
Polar Alignment

Preparing the Mount

This section describes how to achieve a precise polar alignment with your HEQ5/EQ6 mount. To achieve a precise polar alignment it is first necessary to prepare the mount. In the Northern Hemisphere, this includes orienting the polar scope reticule and aligning the polar scope reticule. If you are in the Southern Hemisphere, you only need to align the polar scope reticule. These steps, which only need to be done once, are outlined first.

If you have already prepared your mount then you can skip to the final section entitled "Procedure for Precise Polar Alignment of the HEQ5/EQ6 Mount". If not, follow the steps to prepare your mount for precise polar alignment.

Fig.h



(Diagram applicable to both mounts)

First, remove the caps from the upper and lower ends of the RA axis so you can look into the polar scope (Fig.h). Release the counterweight shaft and rotate the mount in declination axis so that the hole in the shaft is in front of the polar scope. This allows you to see all the way through the RA shaft.

GLOSSARY (Fig.h-1)

Date Scale Indicator
This indicator is used as a reference point when using the Date Scale.

Date Scale
The circular scale surrounding the polar scope eyepiece. On the outer part of the scale you will see months from 1 (January) to 12 (December) with divisions in between them. The longer divisions mark 10-day increments and the short ones 2-day increments. The number of the month appears below the 15th day of that month.

Longitude Scale
The small scale that appears below the Date Scale and is labeled E 20 10 0 10 20 W. Since the Date and Longitude scales are on the same ring, This ring is sometimes referred to as the Date/Longitude scale.

Longitude Index Marker
A small line on the black plastic ring that is next to the Date/Longitude Ring.

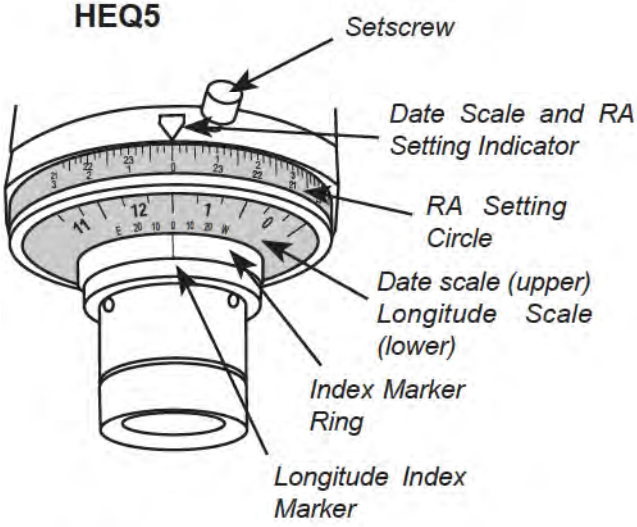
Index Marker Ring
The small black ring with the Index marker on it.

RA Setting Circle
The scale showing hours from 0 to 23. On the HEQ5 it is directly above the Date/Longitude Scale. On the EQ6 it is opposite the end where the polar scope eyepiece is located. If you live in the Northern Hemisphere you will be using the upper scale on the RA Setting Circle. The lower scale is for use in the Southern Hemisphere.

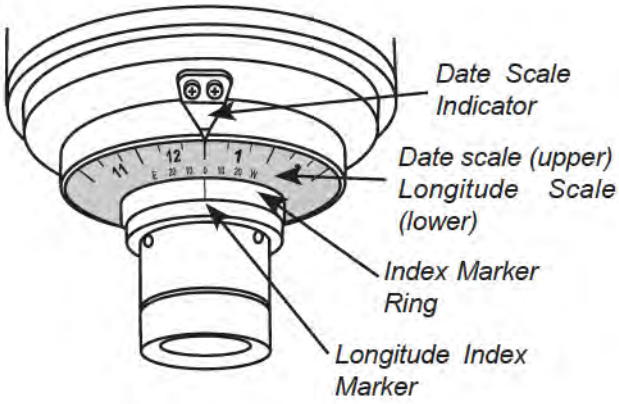
RA Setting Indicator
On the HEQ5 the Date Scale Indicator also acts as the RA Setting indicator. On the EQ6, it is the small triangular indicator next to the RA setting circle.

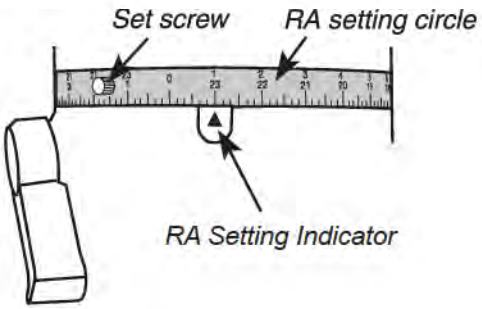
Fig.h-1

HEQ5



EQ6



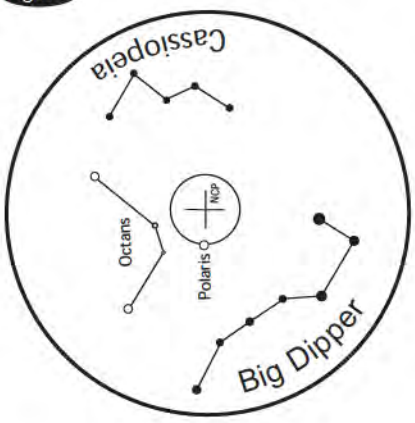


Step 1: Orienting the Polar Scope Reticule

Follow the steps as outlined below to properly orient the reticule inside the polar scope.

1. Unlock the RA axis and rotate it until the reticule pattern shows the Polaris Location Indicator at the very bottom (i.e., the 6 o'clock position - See Figure h-2). Re-lock the RA axis.
2. Loosen the RA setting circle by loosening the setscrews, then turn the setting circle so that its indicator is pointing to zero. Do not rotate the mount in RA, just loosen and move the RA Setting Circle. When done, tighten the setscrews.
3. Now unlock the RA axis and rotate the mount so the Setting Circle indicator points to 1 h 0 m. Use the top scale if you are in the northern hemisphere and the bottom scale if you are in the southern hemisphere. Lock the RA axis.
4. Rotate your Date/Longitude scale so that October 10 lines up with the Date Scale Indicator (i.e., 10th day of month 10).
5. Unlock the RA axis and rotate it back so the RA Setting Indicator points to zero again on the RA Setting Circle scale.
6. Use small flat head screw driver to loosen the setscrew on the Index Marker Ring. Rotate the ring so that the marker is aligned with October 10 on the datescale. Tighten the setscrew to lock the ring in place.

Fig.h-2



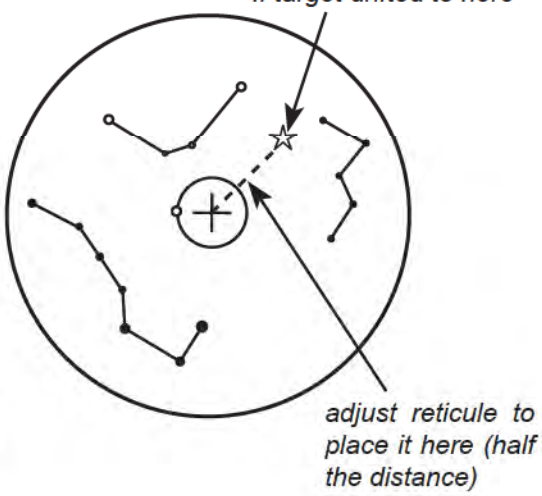
After completing these steps you will have the reticule in the proper orientation.

Step 2: 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 an OTA or counterweights. 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. 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 (See Figure h-3).
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.h-3



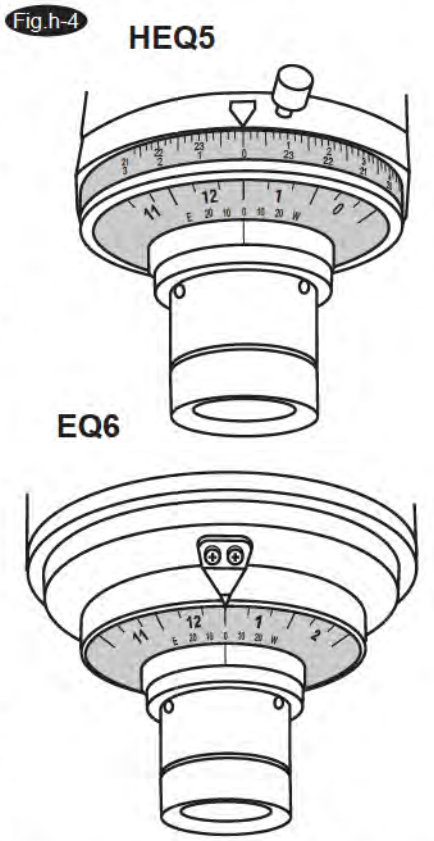
Procedure for Precise Polar Alignment of the HEQ5/EQ6 Mount.

Preliminary Step: Determining the Zero Point on the Longitude Scale

The alignment procedure requires that you set the Longitude scale to "Zero". Depending on where you live, "Zero" can be anyplace between the E and the W on longitude scale, so first you need to determine where zero is for your location. Your Zero point is equal to the difference between your actual longitude and the longitude of the central meridian of your time zone. To calculate the longitude of your central meridian, multiply your time zone offset from Greenwich Mean Time (GMT) by 15.

For example, in Waterloo, Ontario, Canada (Eastern Time) the time zone offset is -5 hours. Ignore the sign and simply multiply 5 x 15 = 75. The longitude of the central meridian for the Eastern Time Zone is 75 degrees west. The actual longitude at the viewing location in Waterloo is 80 degrees 30 minutes West. Ignore the 30 minutes and just use 80 in the equation. Now it's simple, 80-75=5. Since 80 is greater than 75 the result is positive 5. That means Waterloo, Ontario is west of its Central Meridian. In this case, the zero point is at the "5" mark on the W side of the scale. If the location was east of its central meridian the equation would yield a negative value. In that case the E side of the scale should be used.

Fig.h-4

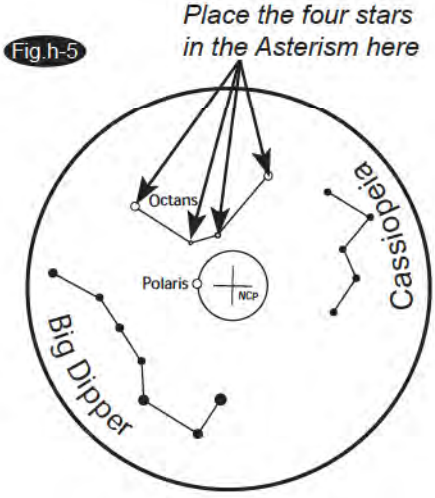


Precise Polar Alignment for the **Northern Hemisphere**:

1. Rotate the RA axis so the Longitude Index Marker (See Figure h-4) lines up with your Date Scale Indicator. Lock the RA axis.
2. Turn the Date/Longitude scale so that your calculated "Zero" point lines up with the Longitude Index Marker.
3. Unlock the RA axis and rotate the mount so the Date Scale Indicator is pointing at the current date. Lock the RA axis.
4. Loosen and move the RA Setting Circle to show the current time. Use the upper portion of the scale for the Northern Hemisphere and the bottom for the Southern hemisphere. Tighten the Setting Circle.
5. Unlock the RA axis and rotate the mount until RA setting circle indicator points at Zero. The reticule is now in the proper orientation.
6. Use the altitude and azimuth adjusters to place Polaris into the small circle on the perimeter of the bigger circle in the polar scope reticule.

The polar alignment is complete. This procedure should get you within a couple of minutes of true north.

Fig.h-5



Precise Polar Alignment for the **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 can be used for Polar Alignment. This procedure can be somewhat difficult in the city because all four of the stars in the Asterism are fainter than Magnitude 5.

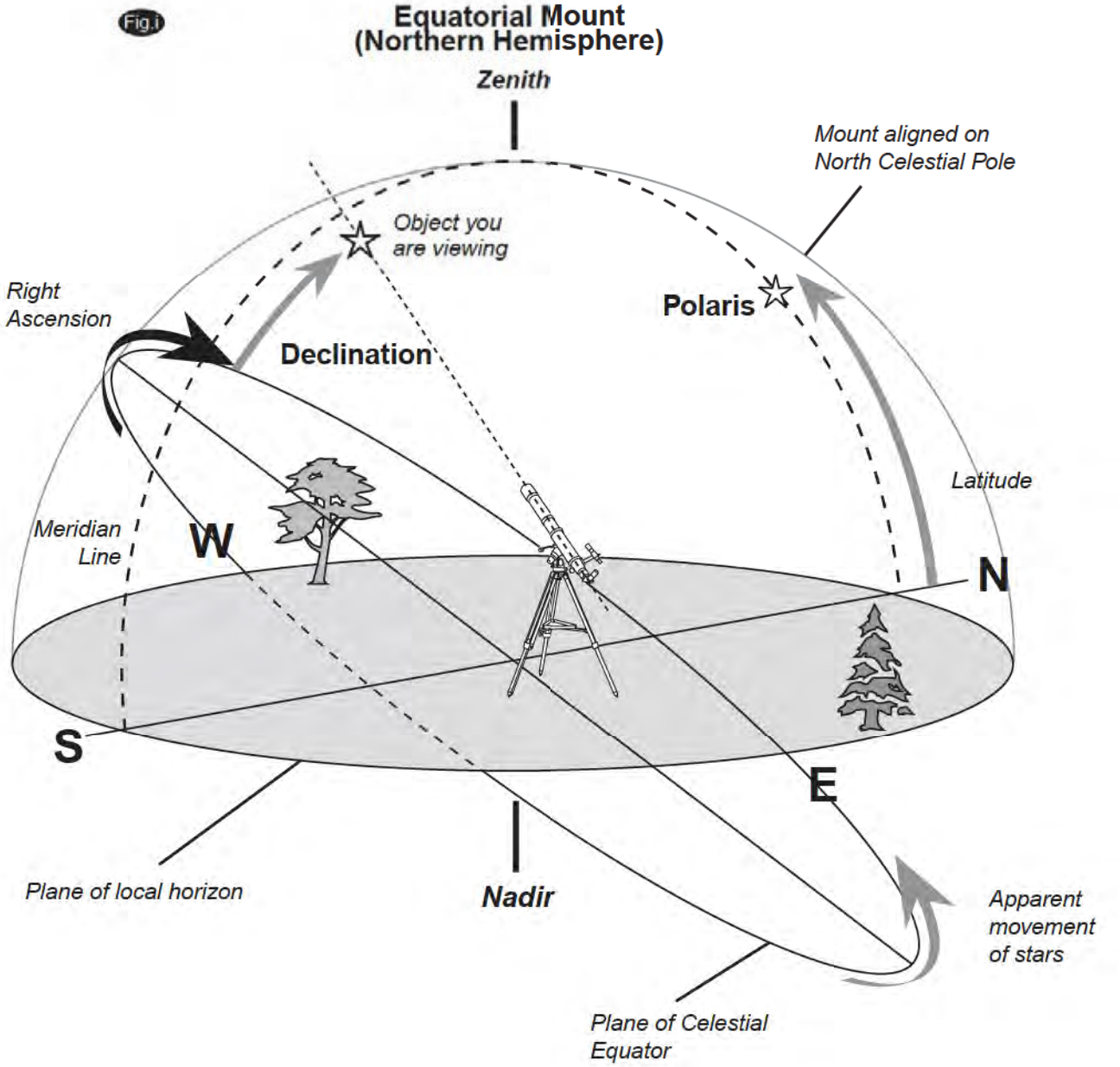
Rotate the telescope in RA axis and/or use the altitude and azimuth adjusters to place the four stars in the Asterism in the four circles (Fig. h-5).

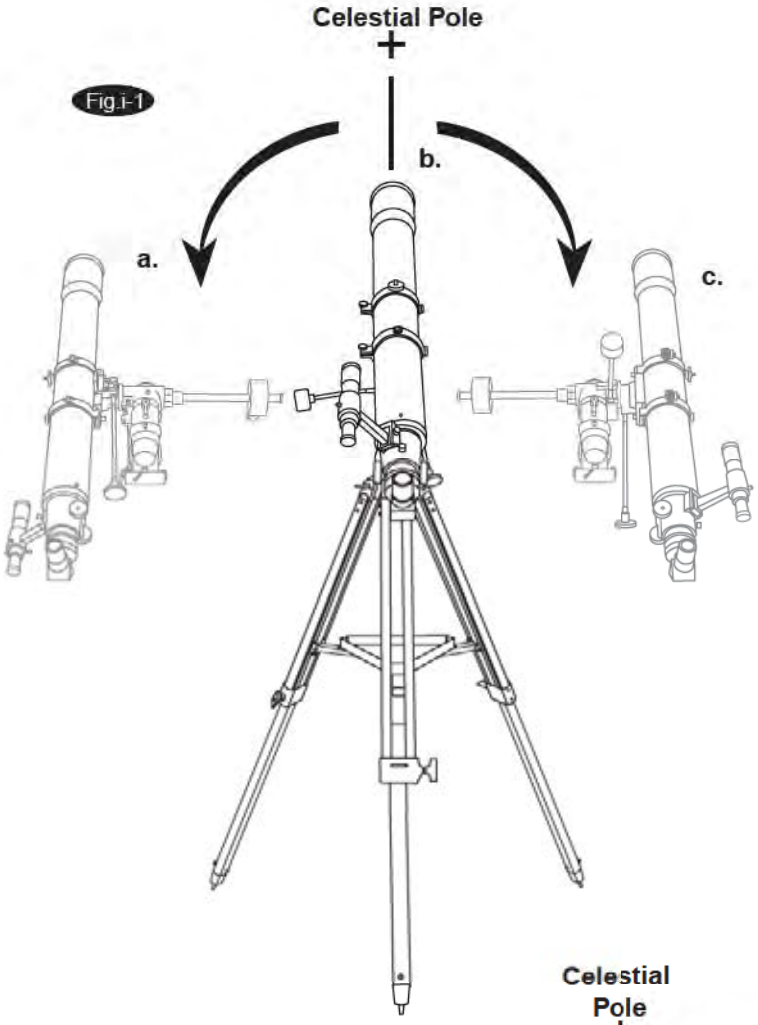
Pointing your telescope

A German Equatorial mount has an adjustment, sometimes called a wedge, which tilts the mount's polar axis so that it points at the appropriate Celestial Pole (NCP or SCP). Once the mount has been polar aligned, it needs to be rotated around only the polar axis to keep an object centred. Do not reposition the mount base or change the latitude setting. The mount has already been correctly aligned for your geographical location (ie. Latitude), and all remaining telescope pointing is done by rotating the optical tube around the polar (R.A.) and declination axes.

A problem for many beginners is recognizing that a polar-aligned equatorial mount acts like an alt-azimuth mount which has been aligned to a celestial pole. The wedge tilts the mount to an angle equal to the observer's Latitude, and therefore it swivels around a plane which parallels the celestial (and Earth's) equator (Fig.i). This is now its "horizon"; but remember that part of the new horizon is usually blocked by the Earth. This new "azimuth" motion is called Right Ascension (R.A). In addition, the mount swivels North(+) and South(-) from the Celestial Equator towards the celestial poles. This plus or minus "altitude" from the celestial equator is called Declination (Dec).

Fig.i



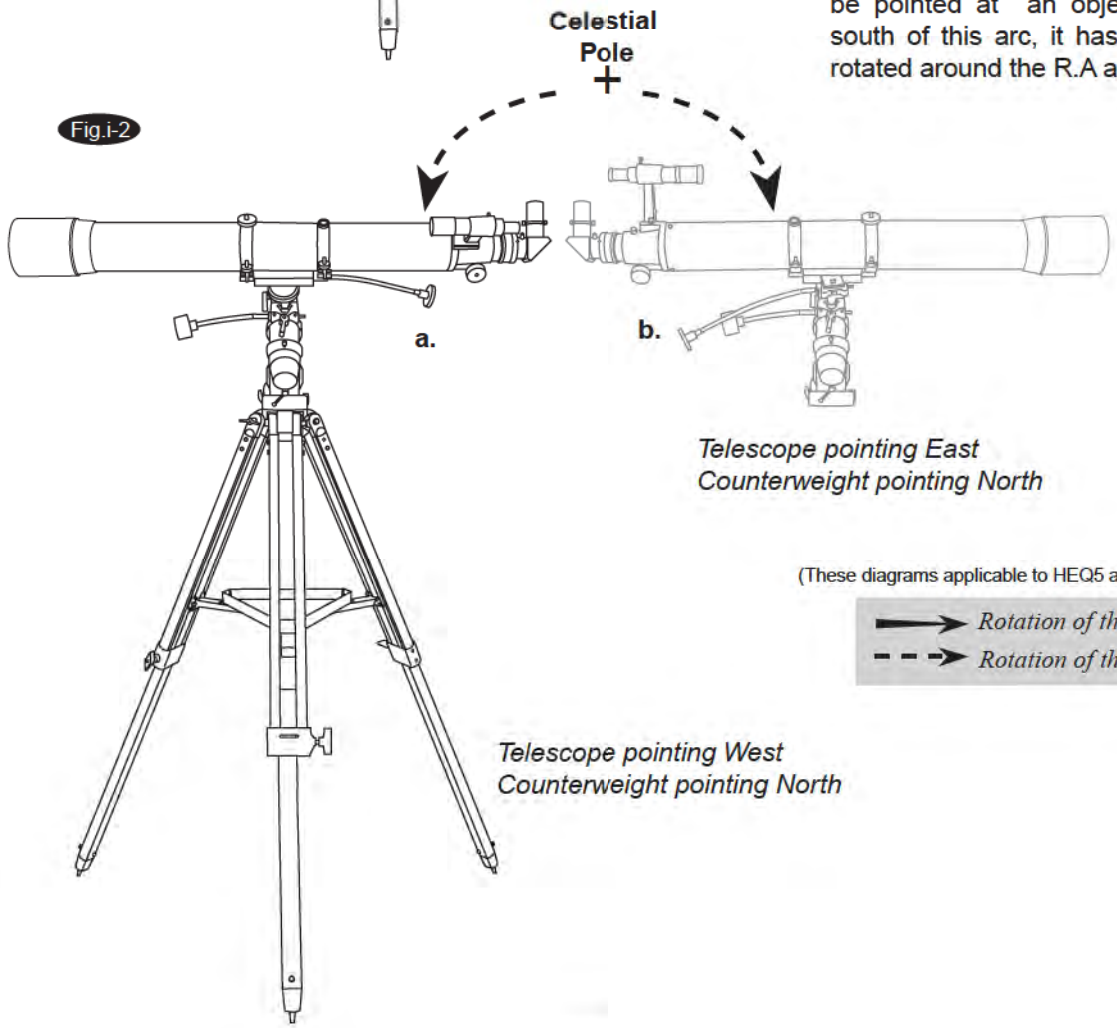


Pointing to the NCP

For the following examples, it is assumed that the observing site is in the Northern Hemisphere. In the first case (Fig.i-1b), the optical tube is pointing to the NCP. This is its probable position following the polar-alignment step. Since the telescope is pointing parallel to the polar axis, it still points to the NCP as it is rotated around that axis counter-clockwise, (Fig.i-1a) or clockwise (Fig.i-1c).

Pointing toward the western or eastern horizon

Now, consider pointing the telescope to the western (Fig.i-2a) or eastern (Fig.i-2b) horizon. If the counterweight is pointing North, the telescope can be swivelled from one horizon to the other around the Dec axis in an arc that passes through the NCP (any Dec arc will pass through the NCP if the mount is polar-aligned). It can be seen then that if the optical tube needs to be pointed at an object north or south of this arc, it has to be also rotated around the R.A axis.



Telescope pointing East
Counterweight pointing North

Telescope pointing West
Counterweight pointing North

(These diagrams applicable to HEQ5 and EQ6 mounts)

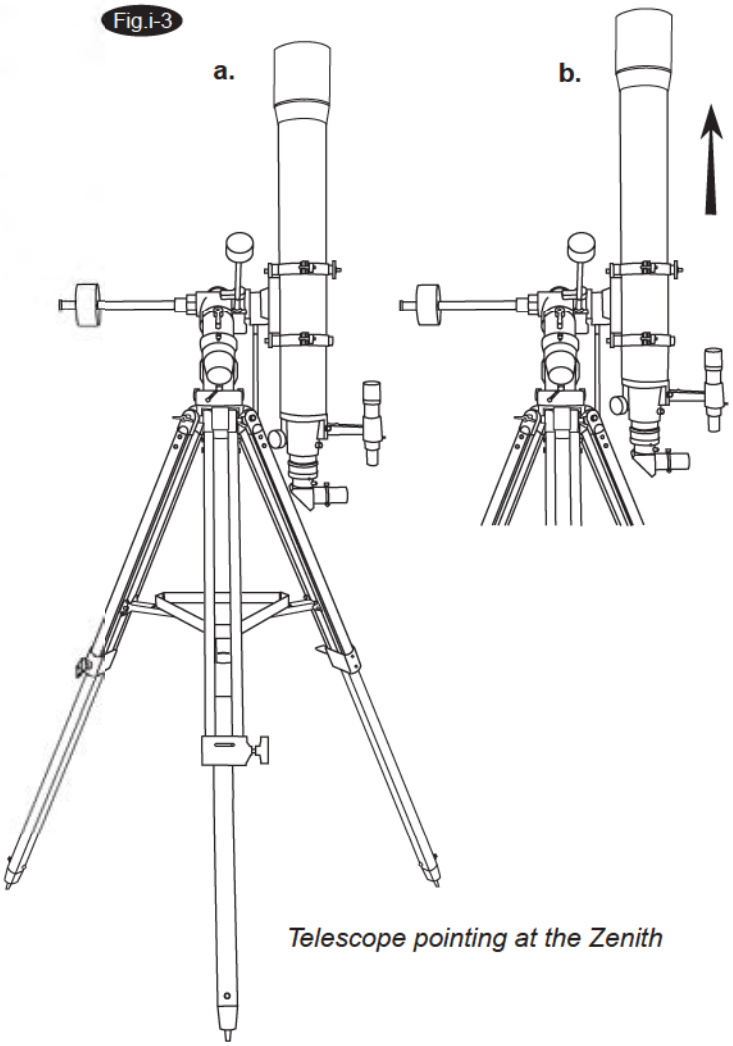
Rotation of the R.A. axis
Rotation of the Dec. axis

Telescopes with long focal lengths often have a "blind spot" when pointing near the zenith, because the eyepiece-end of the optical tube bumps into the mount's legs (Fig.i-3a). To adapt for this, the optical tube can be very carefully slipped up inside the tube rings (Fig.i-3b). This can be done safely because the tube is pointing almost vertically, and therefore moving it does not cause a Dec-balance problem. It is very important to move the tube back to the Dec-balanced position before observing other sky areas.

Something which can be a problem is that the optical tube often rotates so that the eyepiece, finderscope and the focussing knobs are in less convenient positions. The diagonal can be rotated to adjust the eyepiece. However, to adjust the positions of the finderscope and focussing knobs, loosen the tube rings holding the optical tube and gently rotate it. Do this when you are going to view an area for while, but it is inconvenient to do every time you briefly go to a new area.

Finally, there are a few things to consider to ensure that you are comfortable during the viewing session. First is setting the height of the mount above the ground by adjusting the tripod legs. You must consider the height that you want your eyepiece to be, and if possible plan on sitting on a comfortable chair or stool. Very long optical tubes need to be mounted higher or you will end up crouching or lying on the ground when looking at objects near the zenith. On the other hand, a short optical tube can be mounted lower so that there is less movement due to vibration sources, such as wind. This is something that should be decided before going through the effort of polar aligning the mount.

Fig.i-3



Telescope pointing at the Zenith

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.

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

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.j).

Fig.j

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.j-1).

Fig.j-1

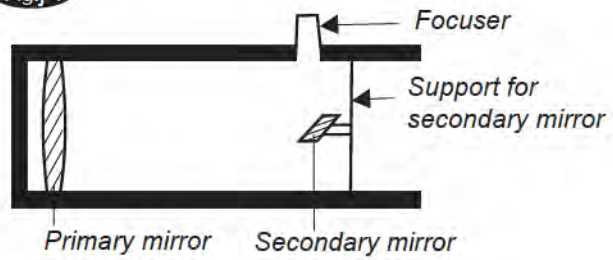
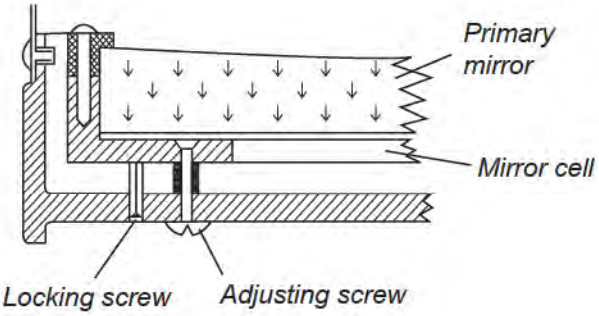


Fig.j-2



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.j-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.j-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.j-3

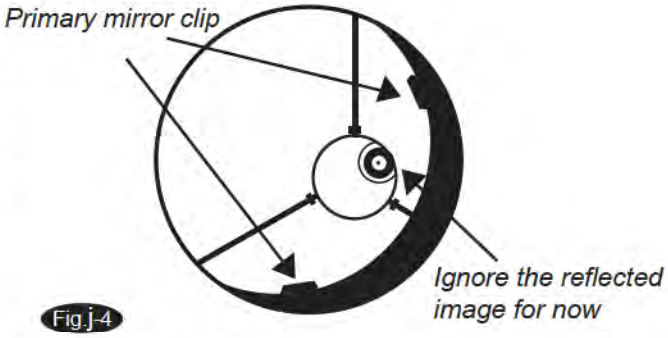
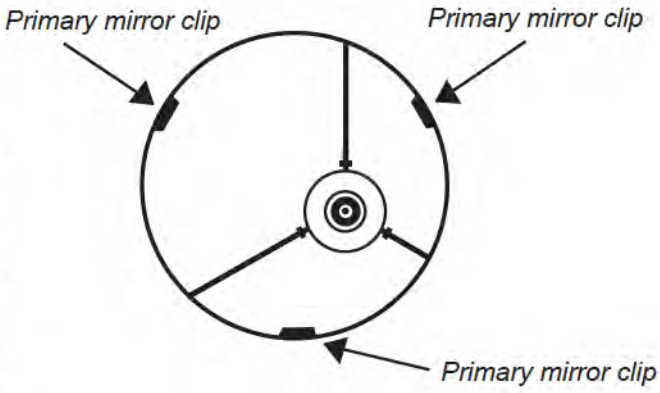


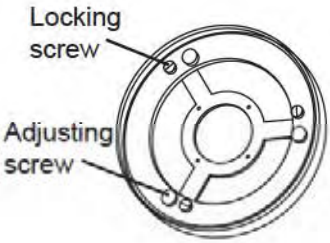
Fig.j-4



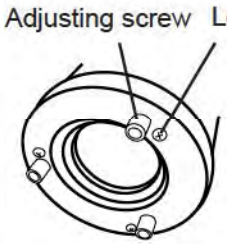
alternately loosen one and then compensate for the slack by tightening the other two. Stop when you see all three mirror clips (Fig.j-4). Make sure that all three small alignment screws are tightened to secure the secondary mirror in place.

Aligning the Primary Mirror

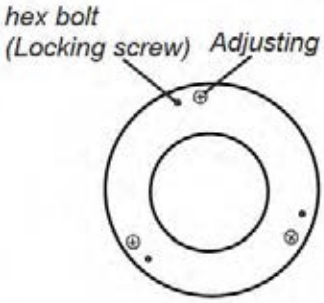
Find the three locking screws at the back of your telescope and loosen them by a few turns.



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.

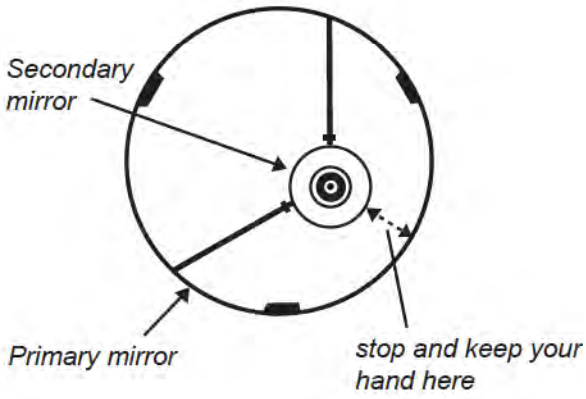


If you see 3 large nuts protruding from the back of your telescope and 3 small Phillip's-head screws besides them, the Phillip's-head screws are the locking screws and the large nuts are the adjusting screws.



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.j-5

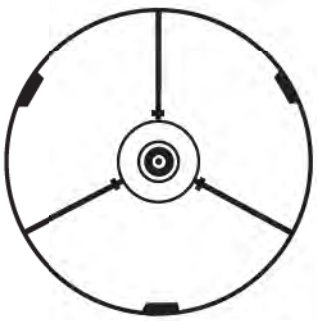


Now run your hand around the front of your telescope keeping your eye to the focuser, you will see the reflected image of your hand. The idea here is to see which way the primary mirror is defected; you do this by stopping at the point where the reflected image of the secondary mirror is closest to the primary mirrors' edge (Fig.j-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.j-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.j-6



Both mirrors aligned with collimating cap in

Both mirrors aligned with eye looking in focuser

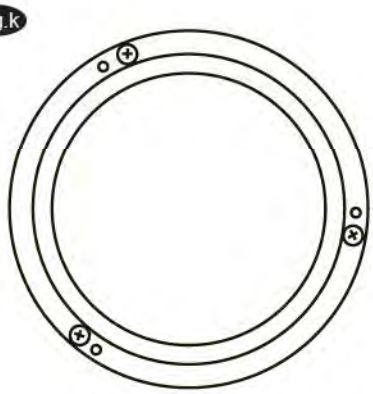
Collimating a refractor with the adjustable objective-lens cell

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.k). The idea is to alternately loosen and tighten each against the other until you have a round star image.

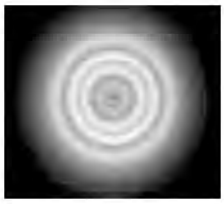
Fig.k



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.k-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.k-2).

Fig.k-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.k-2

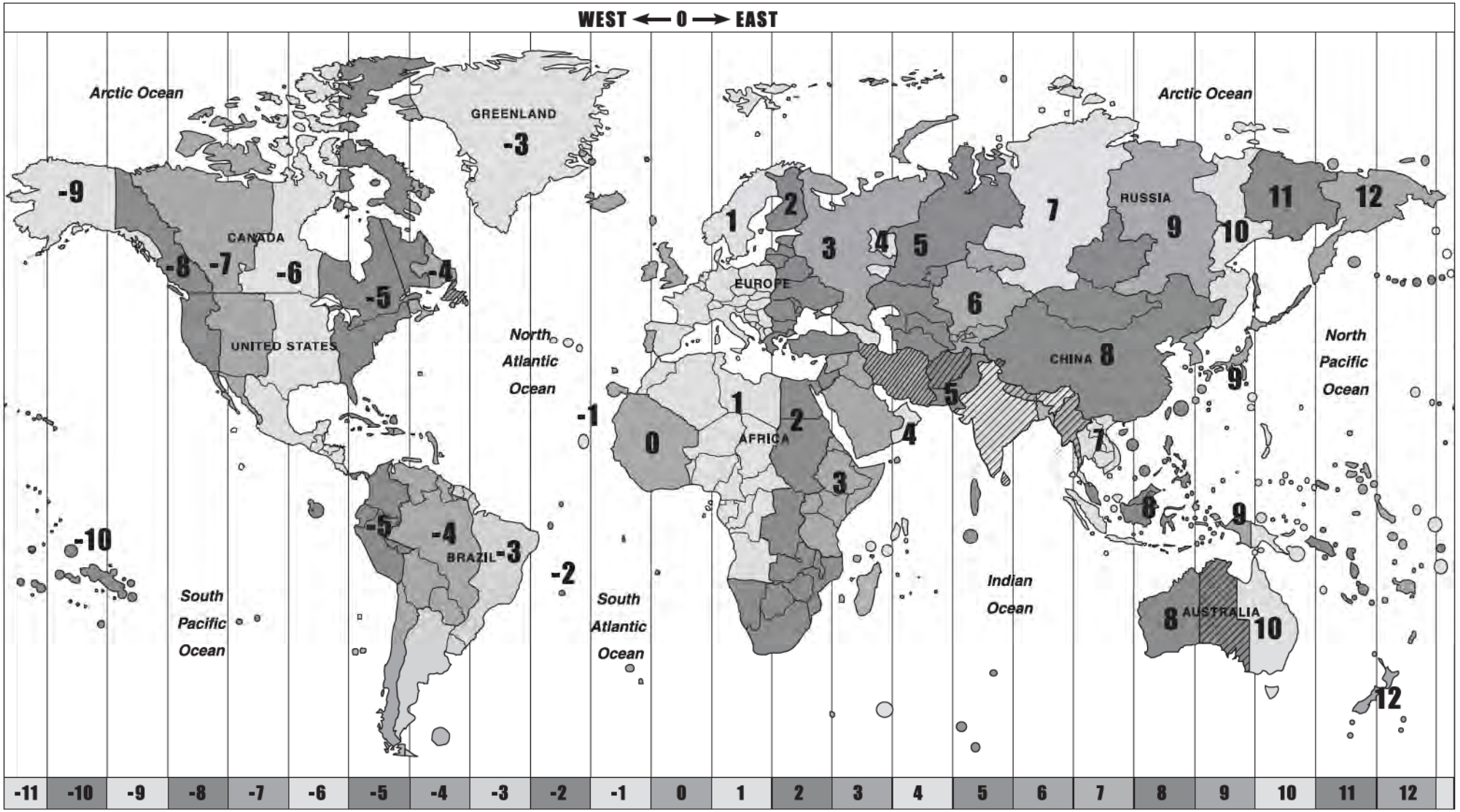
Needs collimation

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- STANDARD TIME ZONES OF THE WORLD



APPENDIX B - OPTIONAL ACCESSORIES

LONG EYE-RELIEF EYEPIECES

These multi-coated eyepieces provide a generous 20mm eye relief, and all focal lengths including the 2mm model feature particularly wide diameter eye lenses for maximum viewing comfort. These eyepieces are especially valuable for spectacle wearers, as the long eye relief allows the entire field to be viewed whilst spectacles are being worn. Soft rubber eyecups are provided for added comfort and to keep out extraneous light.

Available in: 25mm (50º apparent field), 20mm (50º apparent field), 15mm (50º apparent field), 10mm (50º apparent field), 9mm (50º apparent field), 5mm (45º apparent field), 2mm (45º appar ent field).

WIDE-ANGLE EYEPIECES

These ultra-wide angle, multi-Coated eyepieces offer a generous 66º apparent field of view, allowing more sky objects to be viewed at one time. They provide sharp images right across the field. Rubber eyepieces are included for viewing comfort and to exclude extraneous light.

Available in: 20mm (18mm Eye Relief), 15mm (13mm Eye Relief), 9mm (15mm Eye Relief), 6mm (14.8mm Eye Relief).

2" EYEPIECES

These 2"/50.8mm fully multi-coated eyepieces offer exceptional value for the money. They feature long eye relief, a wide field of view and soft rubber eyecups. The multi-coatings ensure maximum light transmission and enhance image contrast.

Available in: 42mm (50º apparent field), 35mm (56º apparent field), 28mm (56º apparent field).

**To be used with telescopes with a 2" focuser.*

2" 90º STAR DIAGONAL

Made to yield maximum astronomical viewing performance, the 2"/50.8mm star diagonal is perfect with telescopes with a 2" focuser and 2" eyepieces. It comes with a 1.25" adapter to accept standard 1.25" eyepieces.

**To be used with telescopes with a 2" focuser.*

8-24 ZOOM EYEPIECE

This 6-element 1.25" zoom eyepiece for astronomical telescope provides the benefits of a continous adjustable focal length for an affordable price. It allows you to find an object at low power, then zoom in until you reach the desired magnification. The fold-down rubber eyecup provide comfortable viewing for eyeglass wearers.

Focal length: 8mm-24mm.
Apparent field: 40º - 60º.
Eye relief: 18mm-15mm.

DUAL LED FLASHLIGHT

This dual purpose flashlight includes two pairs of LED's for instant switch between night vision protecting red light for telescope operation and white light for non-astronomical use. The brightness wheel provides quick and easy intensity adjustment. Battery included.

EQ6 MOUNT EXTENSION

The EQ6 extension tube extends the height of the EQ6 mount so it is easier for observer to look into a long refractor. Installed between the tripod and the mount head, this heavy-duty metal tube gives about 8" in height to the assembly while maintaining the stability of the mount.

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,

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).

APPENDIX D - GLOSSARY

Absolute Magnitude

The apparent brightness a star would have if placed at a distance of 10 parsecs from the earth.

Achromatic Lens
A refractor lens, made of two or sometimes three separate lenses, which has the effect of bringing most of the viewed colours to a sharp focus, thus reducing chromatic aberration.

Alt-azimuth
A simple mount that allows movement in altitude (up and down) and in azimuth (side to side).

Antireflection Coating
A thin layer of film applied to an optical surface that reduces the loss of transmission of light.

Aperture
The diameter of the primary mirror or lens.

Barlow Lens

A "negative" lens which, when placed in front of the eyepiece, increases the focal length and magnification and decreases the field.

Collimation

The process of aligning all the elements of an optical system. Collimation is routinely needed in reflectors, often in Catadioptric systems but seldom in refractors.

Declination

Similar to Latitude on the Earth's surface, it is the distance in degrees North or South of the Celestial Equator (the projection of the Earth's Equator onto the Celestial Sphere). The degrees can be sub-divided into minutes and seconds.

Dew Cap
A tube extending forward from the front lens of a telescope. It prevents dew from forming on the lens as it cools down, and acts as a sunshade to reduce reflections during the day.

Diagonal
A mirror or prism system which changes the angle and orientation of the light rays coming from the telescope to the eyepiece.

Equatorial Mount

A telescope mount with an axis parallel to the axis of the earth. This provides easy tracking of sky objects and for photography when combined with a clock drive.

Eyepiece
Also called an ocular. This is a small tube that contains the lenses needed to bring a telescope's focus to a final image in the eye. Telescopes usually come with at least two eyepieces: one for low power and a second for a higher power view.

Eye Relief
The distance between the eyepiece lens and the position in which the eye must be placed to see through the telescope. Telescope users who wear eyeglasses while observing, appreciate the benefits of longer eye relief.

Exit Pupil
This is the diameter of the beam of light from the eyepiece which reaches the pupil of the eye. It is usually expressed in mm, and determined by dividing the diameter of the primary (in mm) by the Magnification. Knowing this value and the diameter of your dilated pupil allows you to choose the eyepieces which will work best for you with a specific telescope.

Field of View

The maximum view angle of an optical instrument. The number, in degrees, supplied by the manufacturer is the Apparent Field of View. To find the True Field of View (also known as the Actual Field of View), divide the Apparent Field of View by the Magnification.

Finderscope
A low power telescope attached parallel to the main instrument which provides easy object locating and telescope aiming.

Focal Length
The distance of the light path from the objective (primary lens or mirror) to the convergence of the beam. The convergent spot is called the Focus or Focal Point.

Focal Ratio
This is found by dividing an optical system's Focal Length by its Aperture. The resulting value is sometimes called the system's "speed".

Focuser
A device which brings the light rays in a telescope to a precise focus. Common designs include geared (rack-and-pinion), gearless (Crayford- style) and helical.

Lens

A transparent optical element consisting of one or more pieces of glass. A lens has curved surfaces that bring distant light to a focus.

Magnifying Power

The amount by which a system increases the apparent size of objects. Magnification is determined by dividing the Focal Length of the telescope by the Focal Length of the eyepiece.

Mirror
In a telescope, it is a highly polished surface made to reflect light. Primary mirrors are usually made spherical or paraboloidal (parabolic) to focus the light rays.

Objective

The primary or largest element in an optical system; sometimes called the "fixed optics."

Optical Tube Assembly
The housing and optical train of a telescope; not including the mount, diagonal, eyepiece or accessories.

Parabolic Mirror

A parabolic or more accurately a "paraboloidal" mirror, is ground to a shape which brings all incoming light rays to a perfect focus, on axis.

Polar Axis
A telescope mount's axis that is parallel with the earth's axis. With a drive motor, the motion of stars due to the earth's movement can be counteracted so that they remain in the field.

Power
See Magnifying Power.

Prime Focus
The focal point of the objective mirror or lens.

Resolution

The ability of an optical system to reveal details.

Resolving Power
The ability of a telescope to separate closely positioned points.

Right Ascension
Similar to but not the same as Latitude on the Earth's surface. It is the position eastwards from the Vernal Equinox, in 24 one-hour units. The hours can be sub-divided into minutes and seconds.

Setting Circles

Circular scales attached to the telescope. They are marked off in degrees of Declination and hours of Right Ascension. Together, the circles allow the position of a known object to be found by setting the dials to the equatorial coordinates.

True Field of View

How much sky, in angular measure, is available at the eyepiece. It is contrasted with Apparent Field of View, which measures the field of the eyepiece alone.

Wide Angle Eyepiece

An eyepiece with an Apparent field of view of more than 50 degrees.

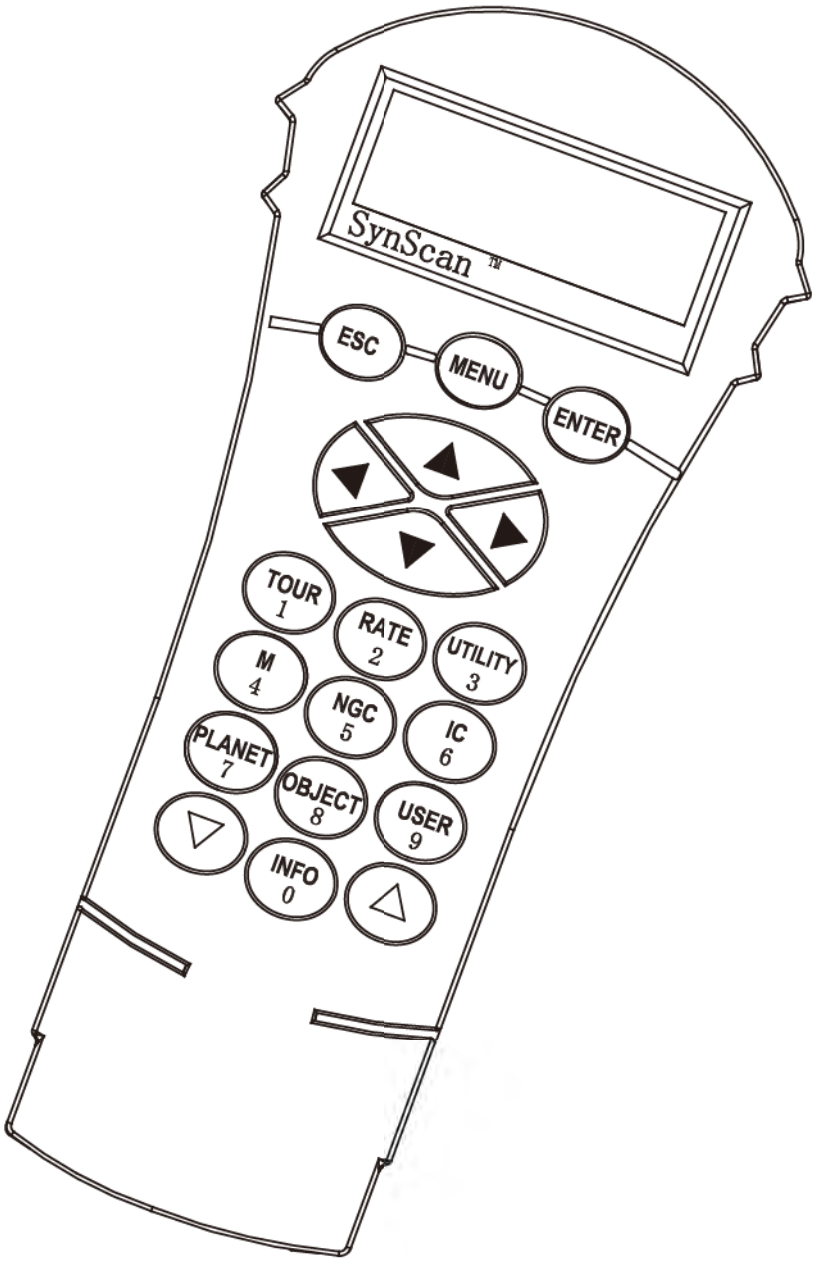
Zoom Eyepiece

An optical system which provides a variable focal length.

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.

INSTRUCTION MANUAL

SynScan™



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CONTENT

Basic Operations

PART I : INTRODUCTION

1.1 Outline and Interface 4
1.2 Connecting to a Telescope Mount 4
1.3 Slew the Mount with the Direction Keys 4
1.4 SynScan Hand control's Operating Modes 5

PART II : INITIALIZATION

2.1 Setup Home Position of the Telescope Mount 7
2.2 Initialize the Hand Control 7

PART III : ALIGNMENT

3.1 Choosing an Alignment Method 10
3.2 Aligning to Alignment Stars 10
3.3 Alignment Method for Equatorial Mounts 10
3.4 Alt-Azimuth Mounts using Brightest Star Alignment Method 11
3.5 Alt-Azimuth Mounts using 2-Star Alignment Method 12
3.6 Tips for Improving Alignment Accuracy 15
3.7 Comparison of Alignment Methods 15

PART IV : SYNSCAN MENU TREE

4.1 Menu Structure 17
4.2 Accessing Menus 18
4.3 Short-cut Keys 18

PART V : LOCATING OBJECTS

5.1 Locating Messier Objects 19
5.2 Locating NGC and IC Objects 20
5.3 Locating Planets and the Moon 20
5.4 Locating Caldwell Objects 20
5.5 Locating SAO Stars 21
5.6 Locating Named Stars, Double Stars, and Variable Stars 21
5.7 Deep Sky Tour 22
5.8 User-Defined Objects 22

Intermediate Operations

PART VI : CONFIGURE THE TELESCOPE MOUNT

6.1 Choosing Tracking Speed 24
6.2 Backlash Compensation 24
6.3 Setting the Slewing Limits 24
6.4 Enable/Disable Auxiliary Encoder 25
6.5 Setting Autoguider Speed 25

PART VII : CONFIGURE THE HAND CONTRL

7.1 Display, Keypad 26
7.2 Alignment Star Filter 26
7.3 Sorting Method of the Alignment Star List 26
7.4 Naming of Stars 26

PART VIII : AUXILIARY FUNCTIONS

8.1 Editing Date, Time, Coordinates, Time Zones, and Daylight Saving Time 27
8.2 Re-aligning the Mount 27
8.3 Show Position 27
8.4 Show Time and Local Sidereal Time 27
8.5 Display Version Information 27
8.6 Display Power Voltage 28
8.7 Display Polaris Position 28
8.8 Display Polar Alignment Error 28
8.9 Changing Polar Scope Illumination Level 28
8.10 Identifying Objects 28
8.11 Synchronizing Encoders 29

Advanced Operations

PART IX : CONNECTING TO A COMPUTER

9.1 Working with Astronomical Applications 30
9.2 PC Direct Mode 30

PART X : UPDATING FIRMWARE

10.1 Hardware Requirements 31
10.2 Preparation 31
10.3 Updating Firmware 31
10.4 Trouble Shooting 32

PART XI : ADVANCED FUNCTIONS

11.1 Parking Telescope 33
11.2 Pointing Accuracy Enhancement 34
11.3 Polar Alignment without Polar Scope 35
11.4 Camera Control 36
11.5 Periodic Error Correction (PEC) for EQ Mount 38
11.6 Calibrating Auto-Home Offset 39

PART XII : USING A SYNSCAN GPS MODULE

12.1 Initialization of the Hand control with a SynScan GPS Module 40
12.2 Checking GPS Information 40

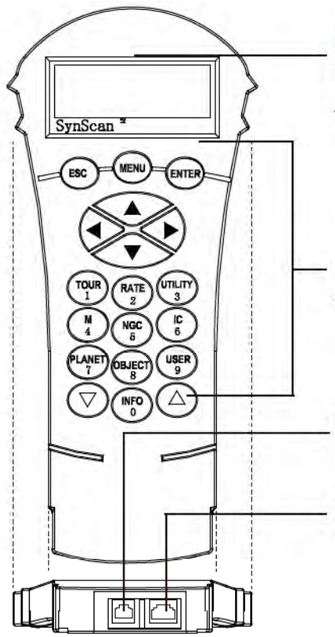
Appendix

APPENDIX I : ELIMINATING CONE ERROR 41
APPENDIX II : SYNSCAN SELF-DIAGNOSIS 42
APPENDIX III : SCHEMATIC OF THE PORTS 43
APPENDIX IV : SPECIFICATIONS 43

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.

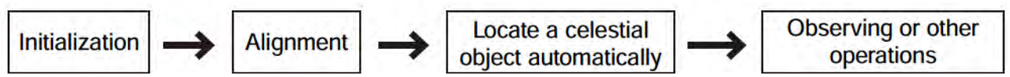


Fig. 1.4a

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:

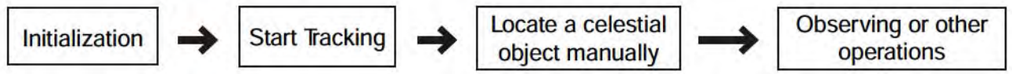


Fig. 1.4b

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.

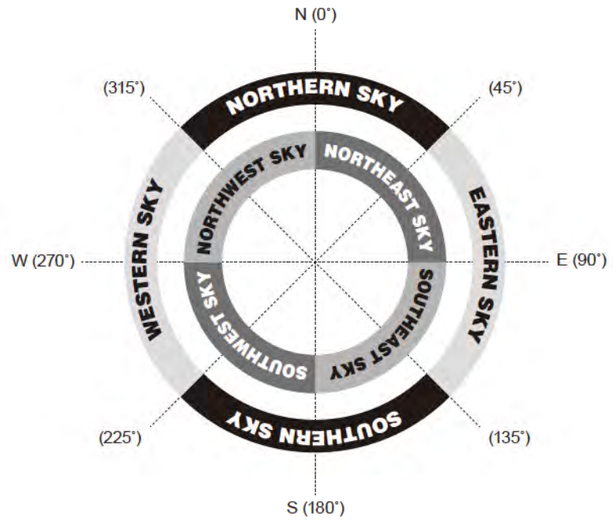


Fig. 3.4a

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.

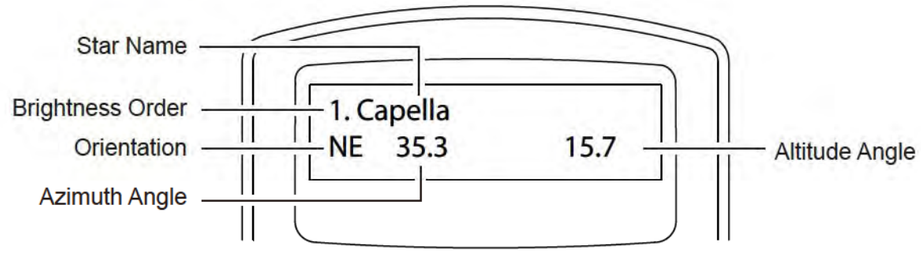


Fig. 3.4b

- 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

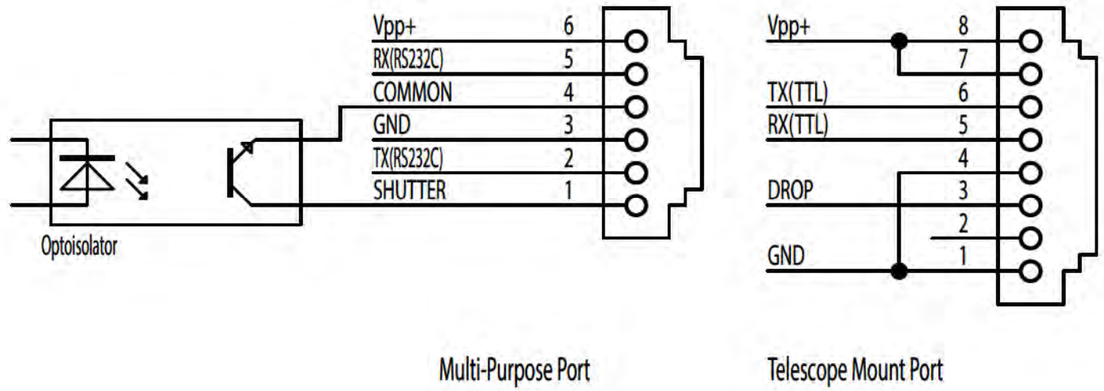
The SynScan hand control contains a built-in self-diagnosis program. To run a full test, users should prepare a "Loop-Test Plug" by referring to Appendix 3 and the following instructions:

- 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



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.