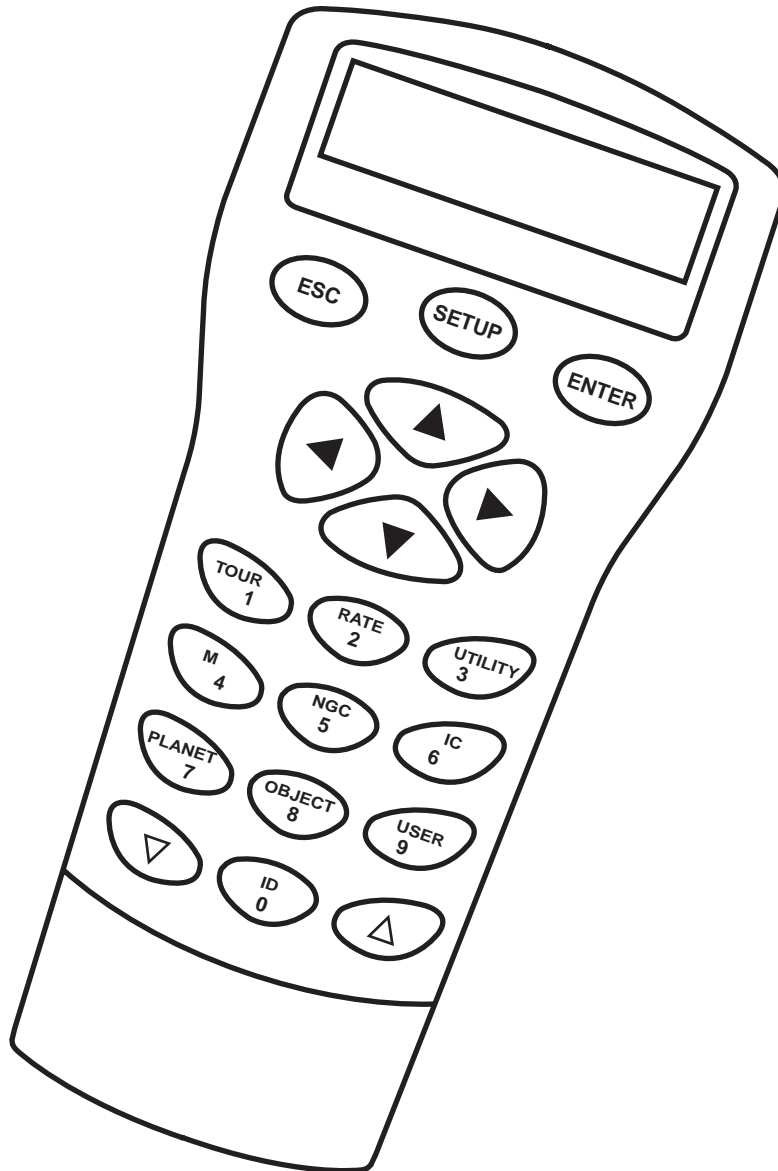


# INSTRUCTION MANUAL

**SynScan™**



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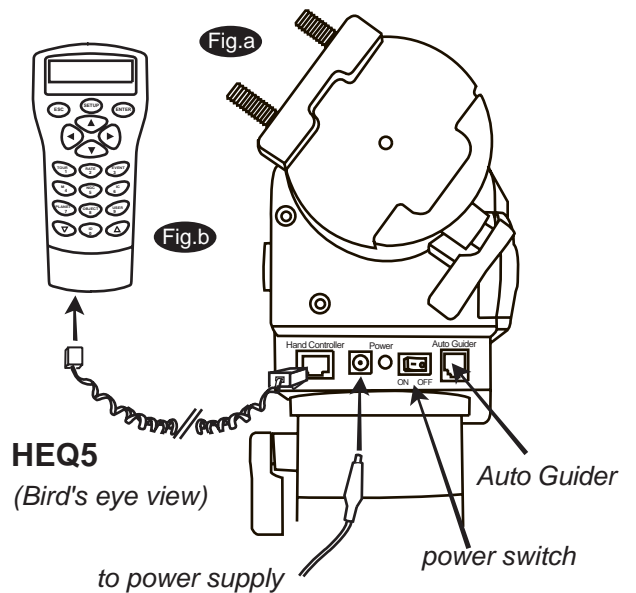


NEVER USE YOUR TELESCOPE TO LOOK DIRECTLY AT THE SUN. PERMANENT EYE DAMAGE WILL RESULT. USE A PROPER SOLAR FILTER FIRMLY MOUNTED ON THE FRONT OF THE TELESCOPE FOR VIEWING THE SUN. WHEN OBSERVING THE SUN, PLACE A DUST CAP OVER YOUR FINDERSCOPE OR REMOVE IT TO PROTECT YOU FROM ACCIDENTAL EXPOSURE. NEVER 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.

# THE SynScan™

## Introduction to the SynScan™

The SynScan™ is a precision-engineered instrument that will allow you to easily find and enjoy viewing night sky treasures, such as planets, nebulae, star clusters, galaxies and much more. The hand control allows you to point your telescope at a specific object or even tour the skies at the touch of a button. The user friendly menu system allows automatic slewing to over 13,400 objects. Even an inexperienced astronomer can master its variety of features in a few observing sessions. Below is a brief description of the individual components of the SynScan™ hand controller.

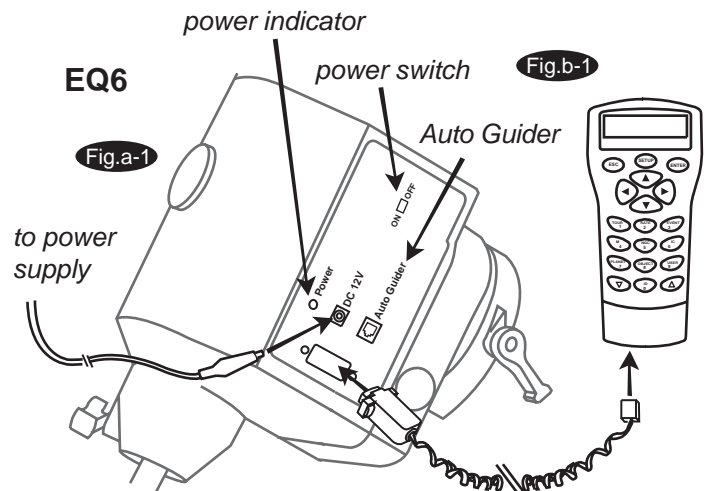


## Powering the SynScan™

The SynScan™ should be powered by 11-15V DC power supply (tip-positive) capable of producing continuous current of minimum 2 amps. Correctly plug the power cord into the 12V DC socket on the the mount (See Fig.a and b for HEQ5 mount, Fig.a-1 and b-1 for EQ6 mount). Flip the Power Switch to the "on" position to turn on the power.

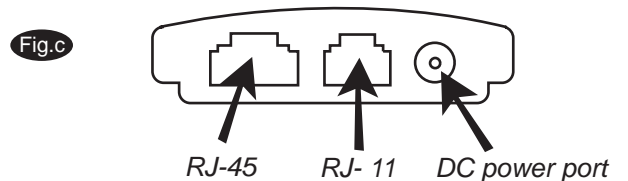


The power indicator will flash when the power is low. Continue to use the battery at this point may damage the battery. The power indicator will flash rapidly when the power is extremely low. Continuing to use the same battery may damage the SynScan system.



## SynScan™ Hand Control

The SynScan™ hand control cable for the HEQ5 has a RJ-45 connector on both ends. Plug one end into the hand control (Fig.c) and the other into the outlet on the mount (Fig.b). Push the connector into the outlet until it clicks into place. The SynScan™ cable for the EQ6 mount has a RJ-45 connector on one end and DB9 on the other. Plug the RJ-45 connector into the hand control (Fig.c). Push the connector into the outlet until it clicks into place. Plug the DB9 connector into the outlet on the mount. Tighten the screws to secure the connector in place (Fig.a-1). The RJ-11 4-pin port is used for RS-232 communications between the SynScan™ and a computer (see "Linking with a Computer"). The DC power port allows independent use of the SynScan™ hand control for users who wish to browse the database without connecting to the telescope (Fig.c).



The DC power port on the hand control is for hand control stand-alone applications only. For telescope applications, use the 12V DC outlet on the mount.

The SynScan™ Hand Control allows direct access to all the motion controls of the telescope and a database with a range of preset objects. The Hand Control comes with a dual-line, 16 character display screen that is backlit for comfortable viewing of the telescope information and scrolling text. To explore the many functions that the SynScan™ has to offer, there are 4 main categories of control on the Hand Control (Fig.d):

### Mode keys

The mode keys are located near the top, close to the LCD display. They include the *ESC*, *ENTER*, and *SETUP* keys:

**ESC** key is used to escape from a certain command or to go back a level in the menu tree.

**ENTER** key is used to select the functions and submenus in the menu tree, and to confirm certain functional operations.

**SETUP** key is a quick hot key that takes you to the Setup submenu.

### Directional keys

The directional keys allow complete control of the telescope at almost any step in the SynScan's operation. These controls are locked out when the telescope is slewing to an object. They are normally used to initially align, center objects in the eyepiece, and manual guiding. The left and right directional keys can also be used to move the text cursor when entering data to the hand control.

### Scroll Keys (Fig.e)

The up and down scroll keys allow you to scroll up and down within the menu tree or selections.

### Dual Purpose keys

These keys range from the middle to the bottom of the hand control. They serve two distinct purposes — data entry and quick reference hot keys.

**TOUR** key (Fig.f) takes you on a preset tour across the sky you are currently under.

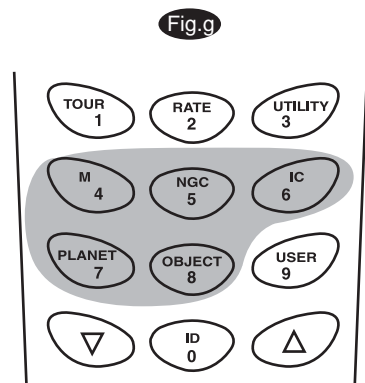
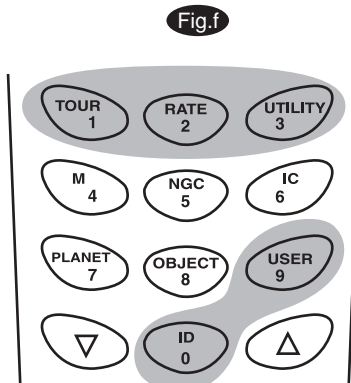
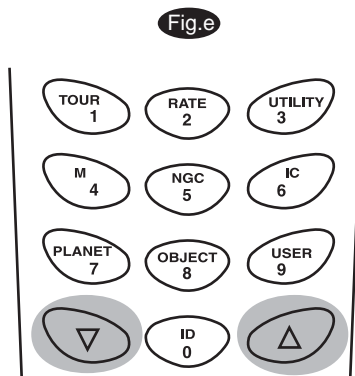
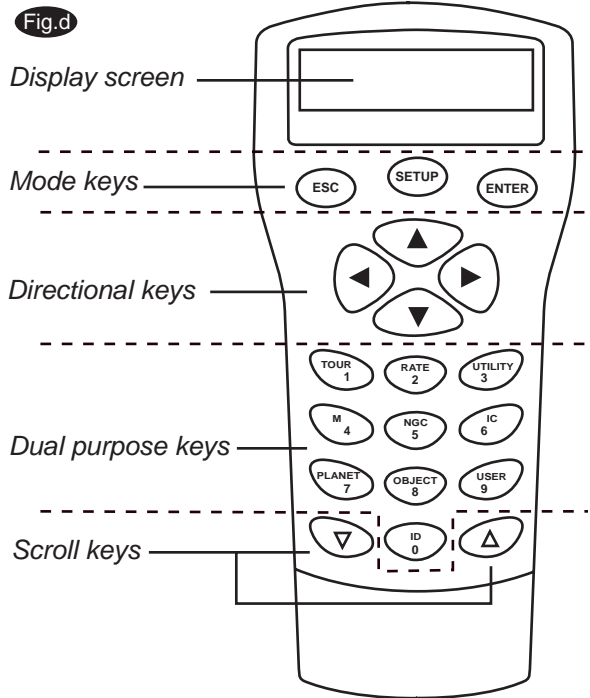
**RATE** key (Fig.f) changes the speed rate of the motors when the direction keys are pressed. There are 10 speeds to choose from: 0 (slowest) to 9 (fastest).

**UTILITY** key (Fig.f) shows functions such as Show Position, Display Time...etc.

**USER** key (Fig.f) gives access to up to 25 user-defined coordinates.

**ID** key (Fig.f) identifies the object the telescope is currently pointing to.

**NGC, IC, M, PLANET, and OBJECT** keys (Fig.g) allow direct access to SynScan™ database of over 13,400 objects.

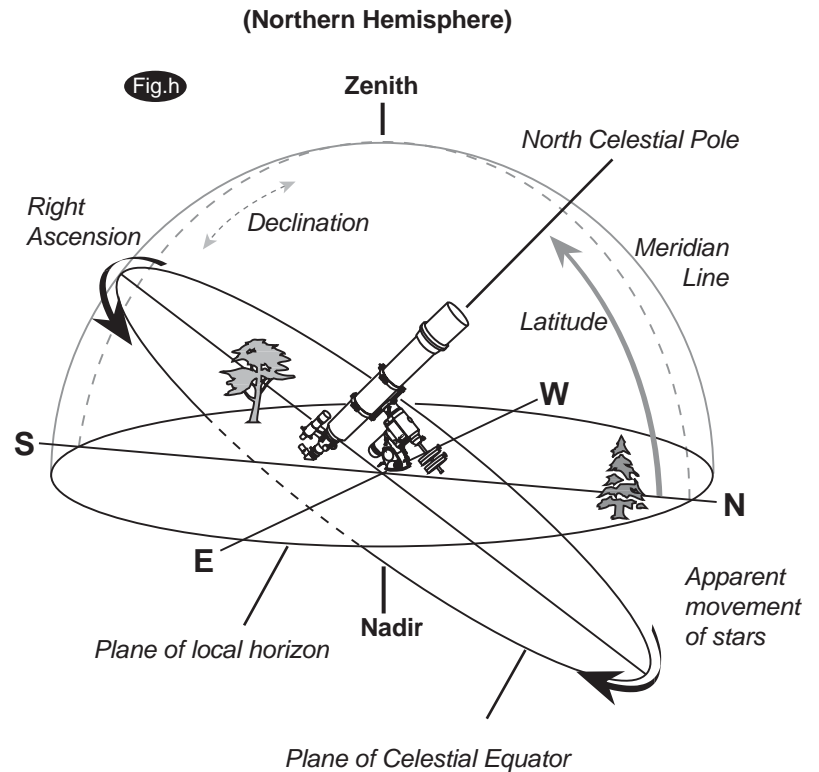


# HAND CONTROL OPERATION

This section provides a step-by-step procedure on how to operate your SynScan™ hand control.

## Initial Setup

1. Perform the Polar alignment using the polarscope.
2. Point the telescope roughly to the North Celestial Pole (or Polaris) if you are in the Northern Hemisphere. Point to the South Celestial Pole if in Southern Hemisphere. Make sure the counterweight rod is pointed down as seen in Fig.h. This will be the home position of the telescope.
3. Flip the Power Switch on the mount to the "ON" position to turn on the power.
4. The initial screen displayed on the hand control is the Version Screen. Press *ENTER* to proceed.
5. The hand control will display "Begin Alignment?" Press *ENTER* to proceed to the alignment procedure. Press *ESC* will exit to the main menu (see SynScan™ Menu Tree).



The hand control's red light will become dimmer and the key pads will turn off if idle for 30 seconds. Pressing any key turns it back on.

6. Enter the telescope's current latitudinal and longitudinal position using the numeric keypad. First enter the longitudinal coordinate, followed by the latitudinal coordinate.
7. Use the scroll keys to choose between W or E, and N or S. Pressing the left or right directional keys will move the cursor to the previous or next number. Press *ENTER* to confirm.
8. Enter your current time zone in hours (see Appendix B), using the scroll keys and numeric key pad (+ for East, - for West). Press *ENTER* to confirm.
9. Enter the date in the following format mm/dd/yyyy using the numeric keypad. Press *ENTER* to confirm.
10. Enter your current local time using the 24 hr time mode (e.g. 2:00PM=14:00). Press *ENTER* to view the time you entered. If it is incorrect, press *ESC* to go back to the previous screen. If correct, press *ENTER* again to proceed to the daylight saving setting.
11. Press *ENTER* if you are currently on Daylight Savings time. Using the scroll key to scroll down to "NO" and press *ENTER* if you are on regular time.
12. After setting the daylight saving, SynScan™ will take you to the alignment menu.



If a mistake was entered into the SynScan™ hand control, press the *ESC* key to go back to the previous menu, and press *ENTER* to start again.

# Star Alignment

In order for the SynScan™ to correctly point to objects in the sky, it must first be aligned to one to three known positions (stars) in the sky. As the Earth rotates on its axis every 24 hours, astronomical objects appear to move through the sky following an arc. With the supplied information, the telescope can replicate a model of the sky and the movements of astronomical objects.

There are three ways to align the SynScan™ depending on your demand for accuracy. If you are using the SynScan™ for the first time, we recommend that you begin with the Three Star Alignment. In most cases, this produces the most accurate alignment among the three methods. Before performing any of the alignment methods, be sure that your finderscope is well aligned with the telescope tube. Below describes a step-by-step procedure on how to perform the Three Star Alignment:

## Three-Star Alignment

1. In the alignment screen, select 3-Star Align using the scroll keys. Press *ENTER* to confirm.
2. The SynScan™ will provide a list of stars available in your current sky for you to choose as the first alignment star. Using the scroll keys, choose a star you are most familiar with and press *ENTER*. The telescope will start slewing towards it. When the telescope stops slewing, adjust its position with the directional keys until the star is centered on the crosshairs in the finder scope. Now look through the eyepiece and adjust the telescope so that the object is centered in the field of view of the eyepiece. Press *ENTER* to confirm.



The slewing speed can be adjusted by pressing on the *RATE* button. Then choose a number between 0 (slowest) - 9 (fastest).



SynScan™ will beep once when it has finished slewing to an object. Do not try to adjust the telescope before you hear the beep. SynScan™ will only respond to the *ESC* key while slewing.

3. SynScan™ will provide a list of objects for the second alignment star. Choose a star using the scroll keys and press *ENTER*. Repeat the centering procedure for the second star and press *ENTER* to confirm.
4. SynScan™ will once again provide a list of objects for the third alignment star. Choose a star from the list and press *ENTER*. Once again, repeat the centering procedure for the third alignment star.
5. Once completed, SynScan™ will display "Alignment Successful".

## Two-Star Alignment

Two-Star Alignment requires only two alignment stars but may produce lesser pointing accuracy than the Three-Star Alignment. Below describes a step-by-step procedure on how to perform the Two-Star Alignment:

1. In the alignment screen, select 2-Star Align using the scroll keys. Press *ENTER* to confirm.
2. The SynScan™ will provide a list of stars available in your current sky for you to choose as the first alignment star. Using the scroll keys, choose a star you are most familiar with and press *ENTER*. The telescope will start slewing towards it. When the telescope stops slewing, adjust its position with the directional keys until the star is centered on the crosshairs in the finder scope. Now look through the eyepiece and adjust the telescope so that the object is centered in the field of view of the eyepiece. Press *ENTER* to confirm.
3. SynScan™ will provide a list of objects for the second alignment star. Choose a star using the scroll keys and press *ENTER*. Repeat the centering procedure for the second star and press *ENTER* to confirm.
4. Once completed, SynScan™ will display "Alignment Successful".

## One-Star Alignment

One-Star Alignment is the easiest and quickest alignment method. It requires only one alignment star. Below describes a step-by-step procedure on how to perform the One-Star Alignment:

1. Make sure the telescope has been polar aligned.
2. In the alignment screen, select *1-Star Align* using the scroll keys. Press *ENTER* to confirm.
3. The SynScan™ will provide a list of stars available in your current sky for alignment. Using the scroll keys, choose a star you are most familiar with and press *ENTER*. When the telescope stops slewing, adjust its position with the directional keys until the star is centered on the crosshairs in the finderscope. Now look through the eyepiece and adjust the telescope so that the object is centred in the field of view of the eyepiece. Press *ENTER* to confirm.
4. Once completed, SynScan™ will display "*Alignment Successful*".



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# OBJECT CATALOGUE

## Object database in the SynScan™

The SynScan™ comes with a vast database with over 13,400 object coordinates and information all available in the palm of your hand. The database contains the following catalogues:

- Solar System** - The other 8 planets of our solar system, plus the Moon.
- Named Star** - A list of 100 best known stars from the SynScan™ database.
- \*NGC** - 7,840 of the brightest deep sky objects from the Revised New General Catalogue.
- IC** - 5,386 of standard stars and deep sky objects from the Indexed Catalogue.
- Messier** - Complete list of 110 Messier objects.
- Others** - There are also Single Stars, Double Stars, Globular Clusters, Uncertain Stars, Galaxies, Clusters, Nebulea, Reflection Nebulea, Planetary Nebulea, and Open Clusters.

## Selecting an Object

Once the telescope has been aligned, you can now access and view the 13,400 different objects in the SynScan™ database. There are three methods of selecting a celestial object to view:

### SHORTCUT KEYS

(Fig.i)

**TOUR** - Takes you on a preset tour across your current sky. It will automatically choose from the database the brightest and most beautiful deep-sky objects for your viewing pleasure. Use the down scroll key to view through the deep sky objects. Choose the desired object by pressing *ENTER*. It will show the coordinate of the chosen object. Pressing *ENTER* once more will cause the telescope to slew to the object.

**M, NGC, IC** - These shortcut keys give you access to the most popular celestial catalogues to date. Each Catalogue has a set number of objects to choose from. Use the numeric keys to select an object by entering its number. Pressing *ENTER* will display its coordinate. Primary information such as size, magnitude, and constellation are obtained by pressing the scroll keys. Pressing *ENTER* once more will cause the telescope to slew to the object.

**PLANET** - This shortcut key takes you straight to the Planets sub menu in the database. Use the scroll keys to scroll through the list of planets in our solar system. Press *ENTER* to view its coordinates, and *ENTER* once more to slew to the planet.

**USER** - This will take you to the database that you have defined for yourself. You can enter a new location or recall the objects that have been previously saved (see Using the User Defined Database).

### OBJECT KEY

(Fig.j)

The **OBJECT** key takes you to the Objects Catalogue, where you have complete access to over 13,400 celestial objects in the database. (See Object database in the SynScan™ and the menu tree.)

### MENU

(Fig.k)

In the Main Menu, scroll down to **OBJECT CATALOGUE** and press *ENTER*. Similar to the **OBJECT** key, this gives you the complete access to all 13,400 celestial objects in the database. (See Object database in the SynScan™ and the menu tree.)

Fig.i

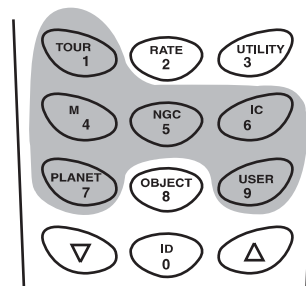


Fig.j

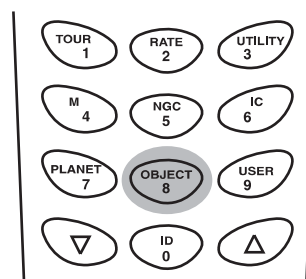
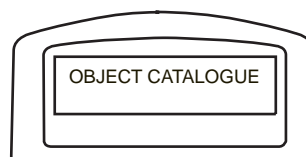


Fig.k



\*NGC 2000.0 database, edited by Roger W. Sinnott, copyright by Sky Publishing Corporation. Used with permission.



# OTHER FEATURES

## Utility Functions

Utility Functions are useful tools that provide simple, one-step processes to your SynScan™:

- Show Position** - This displays the coordinates of the location where the telescope is currently pointing.
- Display Time** - This displays the local time and local Sidereal time.
- Park Scope** - This moves the telescope to the Home position.
- RS-232 mode** - This allows linking to a computer. (See "Linking with a Computer".)
- PEC Training** - See Appendix D for information.

## Setup Functions

The Setup functions allow you to change any system variable or information regarding location, time, date, and alignment configurations. To access the Setup Functions, either press *SETUP* key on the key pad or scroll to *SETUP* under menu option using the scroll keys. Below lists the different types of functions available to you, and their purposes.

- Date** - Allows you to change the date entered at the initial setup.
- Time** - Allows you to change the current time.
- Observing site** - Allows you to change the current location.
- Daylight Savings** - Allows you to change the Daylight Savings option.
- Alignment** - Allows you to perform the star alignment. (See "Alignment".)
- Set Backlash** - This feature allows you to insert a value for each axis to compensate for its backlash. For better pointing accuracy, it is important that the backlash value is set to be equal or greater than the real amount of backlash between the gears. If the real amount of backlash is unknown, we recommend that you set the value to 5000 (equivalent to approx. 0.2°). First set the value for R.A. Press *ENTER* to proceed to Dec.
- Set Tracking**
  - Sid. Rate: This activates tracking in Sidereal rate (R.A. Tracking).
  - Lunar Rate: This activates tracking in Lunar rate (R.A. Tracking).
  - Solar Rate: This activates tracking in Solar rate (R.A. Tracking).
  - PEC + Sidereal Rate: Sidereal rate with Periodic Error Compensation.
  - Stop Tracking: This stops the tracking instantly.
- Auto Guide Speed** - When using an autoguider, this sets the guiding speed to 1X, 0.75X, 0.5X, or 0.25X sidereal rate.

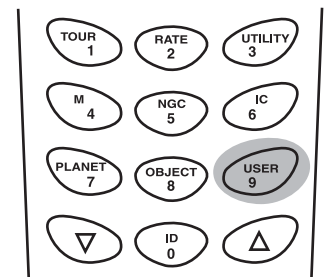
## Using the User Defined Database

SynScan™ allows you to save up to 25 objects in the user defined database.

### Saving an object to the database

1. Press the *USER* key (Fig.I) or select *USER DEFINED* under the object catalogue. Press *ENTER*.
2. Choose *INPUT COORDINATE* and press *ENTER* to confirm.
3. You can choose to enter the location by its R.A. and Dec., or telescope altitude and azimuth coordinates. Press 1 (R.A. and Dec.) or 2 (Alt-Azimuth) to make your selection. By default SynScan will display the current R.A./Dec or Alt/Az coordinates. Change the coordinates using the numeric keypad and scroll keys. Press *ENTER* to save.
4. The SynScan™ will ask you to choose a number between 1 to 25. Select the number you wish to represent the coordinate, using the scroll keys. Press *ENTER* to confirm.
5. Once a number is given to the coordinate, the hand control will display "View Object?". Pressing *ENTER* will cause the telescope to slew to the coordinate. Press *ESC* to exit.

Fig.I



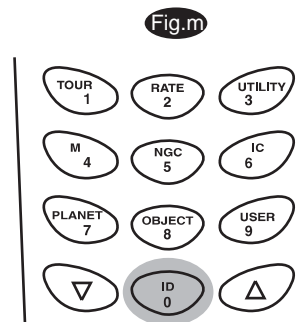
## Selecting a user defined object

1. Press the *USER* key or select *USER DEFINED* under the object catalogue. Press *ENTER*.
2. Choose *RECALL OBJECT* and press *ENTER* to confirm.
3. Select the number representing the object you wish to view, using the scroll keys. Pressing *ENTER* will show its coordinate. Press *ENTER* again to choose the object.
4. The SynScan™ will display "View Object?". Pressing *ENTER* will cause the telescope to slew to the coordinate. Press *ESC* to exit.

## Identifying an Unknown Object

SynScan™ has the ability to identify the unknown object the telescope is currently pointing at. To do so, simply:

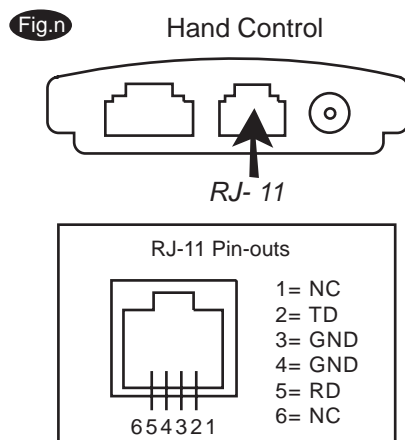
1. Press the *ID* key (Fig.m) or scroll down to *IDENTIFY* in the main menu and press *ENTER* to identify the object.
2. If it is a truly unknown object, the hand control will take you back to the *IDENTIFY* menu.
3. Press *ESC* to exit from this function.



## Linking with A Computer

Another feature of the SynScan™ is the ability to connect to a computer via a serial cable. Many commercially available planetarium softwares can be used to control the SynScan™. Look for softwares compatible with NexStar5. Below describes the procedure on how to connect and disconnect the SynScan™ to a computer:

1. Make sure that the telescope has been aligned.
2. Connect the RS-232 cable to the RJ-11 connector on the hand control and to the COM-port of your computer (Fig.n).
3. On your SynScan™ hand control, select RS232 under the *UTILITIES* menu. Press *ENTER* to go to RS-232 mode.
4. In the planetarium software of your choice, choose "Celestron NexStar5" in the driver setup and follow the instructions provided by your program to establish the connection to the telescope. The SynScan™ should be under the full control of your computer once the connection is successfully established.



## Disconnecting from the computer

1. Follow the instructions provided by your software to close the connection to the telescope.
2. On the SynScan™ hand control, press *ESC* to resume normal hand control operations.



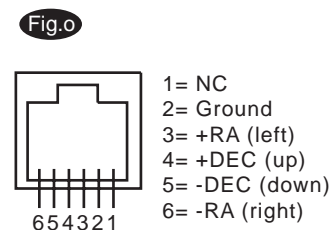
See Appendix C for more information on RS-232 connection.



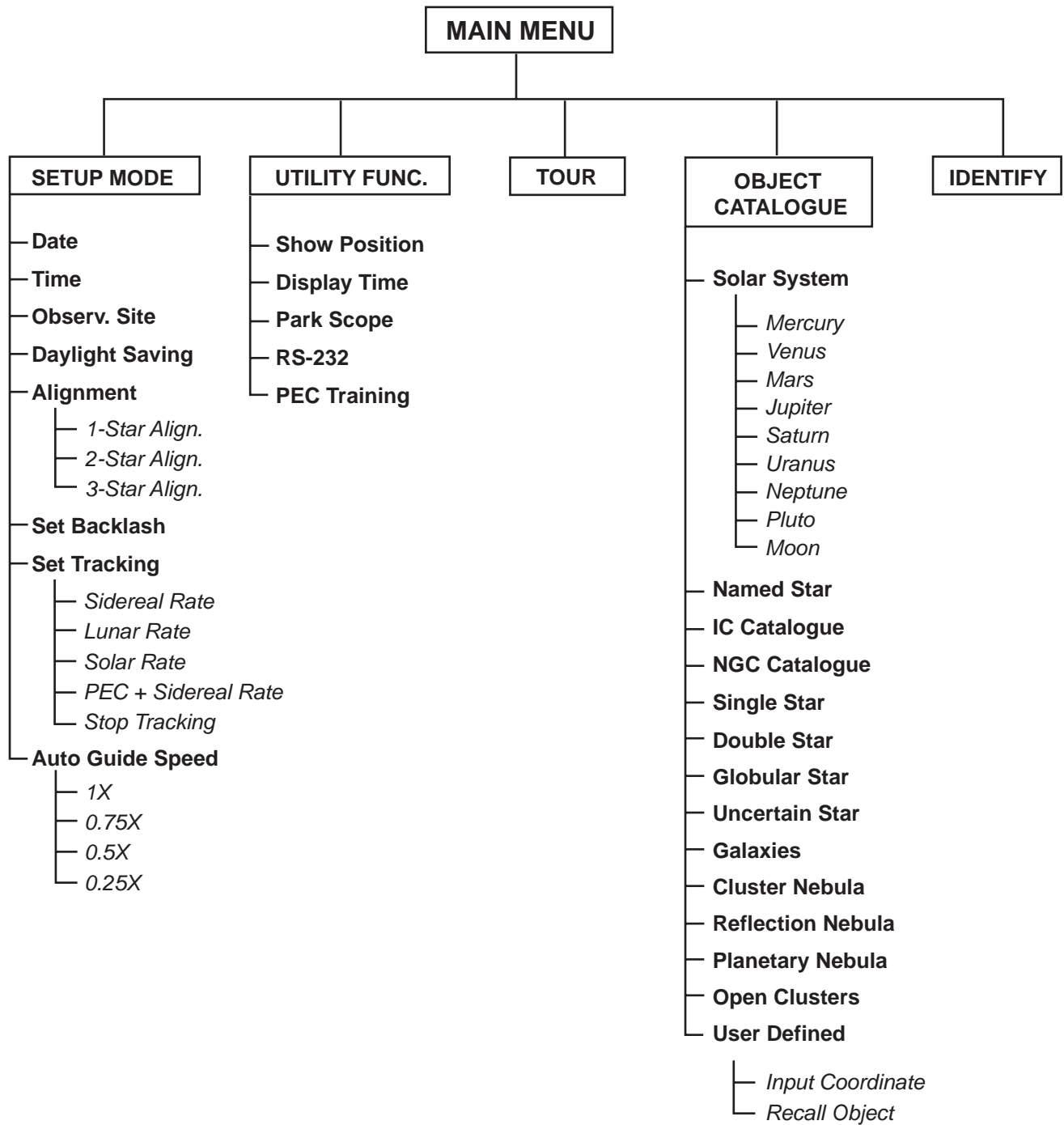
Do not disengage the SynScan™ unit before you disengage the program. Doing so may cause some programs to freeze.

## Auto Guiding

The SynScan™ has a designated autoguider interface on the mount for use with an auto guider (see Fig.a, a-1). The pin-outs on the 6 pin modular connector is ST-4 compatible and can be used for most autoguiders on the market. Refer to Fig.o when connecting the autoguider cable to the SynScan™ and calibrating the autoguider. Relay box can be added for extra protection. Note that the four inputs are active-low, with internal pull-ups. Guiding speed can be adjusted using the Auto Guide Speed function in the Setup Menu.



# SynScan™ MENU TREE



# TECHNICAL SPECIFICATIONS

## SynScan™ SPECIFICATIONS

Power Supply:	11 to 15 V DC 2Amp (Tip positive)
Motor type and resolution:	Microstep driven 1.8° stepper motors. Resolution: 0.144 arc sec (or 9,024,000 steps/rev.)
Slew speeds:	Rate 0 = 0.5X Rate 1 = 1X Rate 2 = 8X Rate 3 = 16X Rate 4 = 32X Rate 5 = 64X Rate 6 = 400X Rate 7 = 500X Rate 8 = 600X Rate 9 = 800X
Gear Ratio:	705
Tracking Rates:	Sidereal, Lunar, Solar
Tracking Modes:	R.A. tracking
Alignment Method:	One-Star Alignment, Two-Star Alignment, Three-Star Alignment
Database:	25 user defined objects. Complete M, NGC, and IC catalogues, Total 13,436 objects
Pointing Accuracy:	Up to 1 arc min

# APPENDIX A - ENHANCING THE PRECISION

Generally speaking the SynScan™ produces pointing and tracking accuracies adequate for most applications. However, if higher precision is required, for example for astro-photography, accurate polar alignment and "cone" error calibration may be required. See the manual for HEQ5 and EQ6 mount for information on accurate polar alignment using the polarscope.

## Cone Error Calibration

"Cone" error is a common inaccuracy found on all German equatorial mounts. It is a result from the optical axis not being aligned to the R.A. axis of the mount. This affects the pointing accuracy of the SynScan™. Three-Star Alignment automatically compensates for the "Cone" error. If you choose One-Star or Two-Star Alignment method, you will need to perform manual mount calibration to eliminate the "cone" error. The following calibration procedure should be performed before the initial use of the telescope and periodically thereafter to ensure the accuracy.

### Testing for Cone Error

This test is done at night using two bright stars located on the opposite side of the sky. Make sure the telescope is properly polar-aligned using the polarscope. Perform the One-star Alignment using an eastern star as the alignment star (see One-star Alignment). After the star alignment, choose a bright star on the western sky from the SynScan™ object database and have the telescope slew to the star. If the optical axis is perfectly aligned to the R.A. axis, the telescope will accurately put the star in the center of the eyepiece. In this case, there is no "cone" error in your telescope setup and you will not need to perform the calibration. It is acceptable if the star is slightly off-center as long as it is in the eyepiece view and close to the center. Many factors determine the pointing accuracy of the SynScan™, for example incorrect star alignment, R.A. or Dec lock knob being loose, or "cone" error. If your telescope puts the star outside the eyepiece view, you need to first determine whether it is "cone" error that causes the pointing inaccuracy. To find out, simply move the telescope in R.A. axis by pressing the Left or Right direction key. If the star can be moved into the eyepiece view without adjusting the Dec axis, it is likely that "cone" error exists in your telescope setup.

### Calibration Procedure

1. Insert the illuminated reticle eyepiece. Make sure that the telescope is properly set up and balanced, and the finderscope is perfectly aligned with the telescope tube.



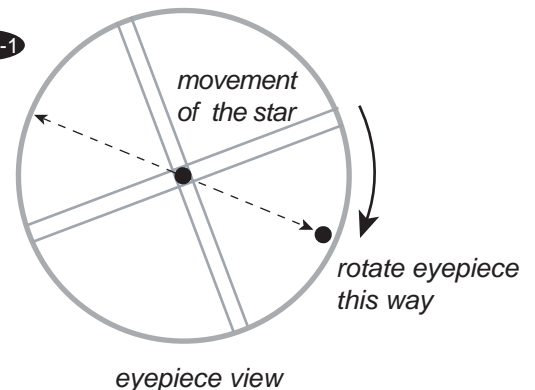
Required accessory: Illuminated reticle eyepiece with double crossline pattern. Depending on the design of your mounting plate (dovetail bar), modifications may be required. (See step 10 for the required mechanism on the mounting plate.)



Step 2 to 4 is to identify R.A. and Dec movements in the reticle eyepiece. If you are already familiar with the movements, you may skip to step 5.

2. Find any bright star and place it in the center of the eyepiece view.
3. Look into the eyepiece. Move the telescope in R.A. axis using the R.A. direction keys on the hand control while carefully observing the movement of the star.
4. Keep moving the telescope in R.A. axis back and forth to keep the star within the eyepiece view. Rotate the eyepiece until the movement of the star becomes parallel to (or matches) any set of the lines (Fig.A-1). This set of lines will represent R.A. movement in the course of this procedure, and the perpendicular lines will represent Dec movement. Tighten the set screws to secure the eyepiece in place. Make sure that the eyepiece will remain stationary when the telescope is being rotated .

Fig.A-1



5. Point the telescope to North and set the latitude scale to your local latitude using the altitude adjustment T-bolts, or place Polaris on the crosshair of the polarscope if your polarscope is perfectly aligned with the rotation axis of the mount.
6. Loosen the R.A. lock knob and rotate the telescope around the R.A. axis until the counterweight shaft is parallel to the ground. (Fig.A-2)
7. Using the Dec direction key on the hand control, adjust the telescope in Dec so Polaris sits on the R.A. lines of the reticle eyepiece (Fig.A-3).
8. Without moving the R.A. axis, adjust the azimuth control knobs to bring Polaris to the center of the eyepiece (Fig.A-4). Adjustment in Dec axis using the hand control may be necessary.

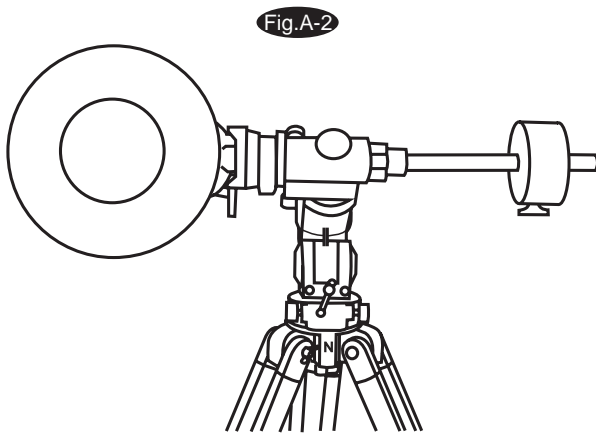


Fig.A-2

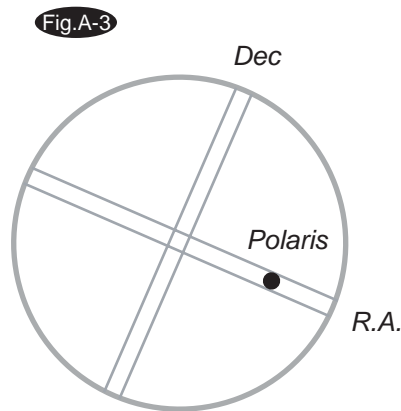


Fig.A-3

Place Polaris on the R.A. line

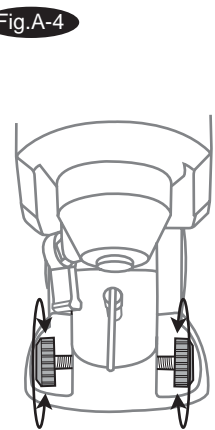


Fig.A-4

9. Loosen the R.A. lock knob and carefully rotate the telescope 180° in R.A. axis. (Fig.A-5). This should be done as accurate as possible using the R.A. setting circle.
10. Once again, adjust the telescope in Dec so Polaris sits on the R.A. lines of the reticle eyepiece (see Fig.A-3).
11. Now take a closer look at the mounting plate underneath the telescope tube. There should be a set of screws on each end, next to the tube ring locking screws (Fig.A-6). (If your mounting plate does not have these screws or screw holes, you will need to make modification to the plate.)

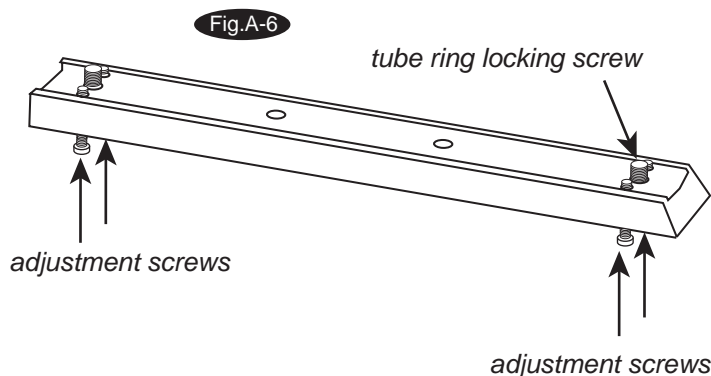


Fig.A-6

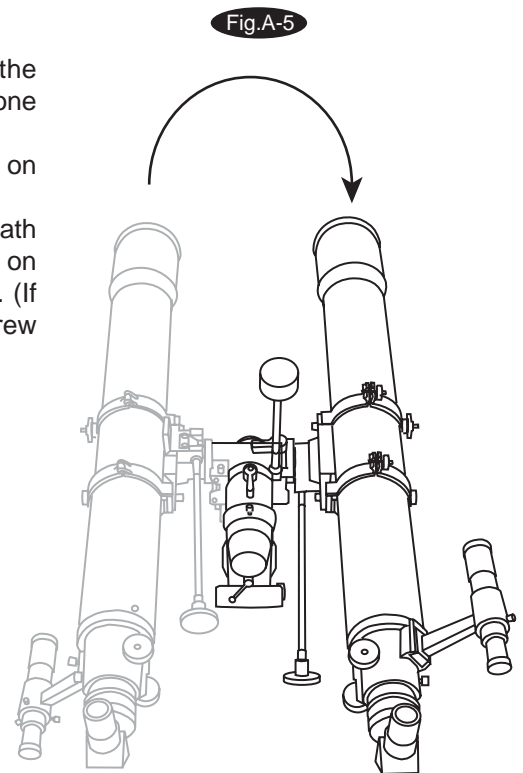
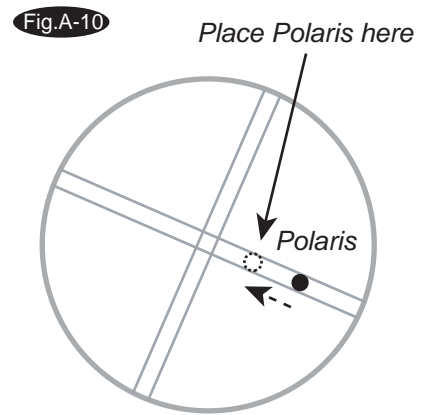
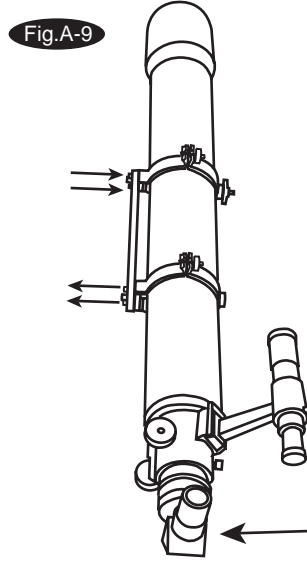
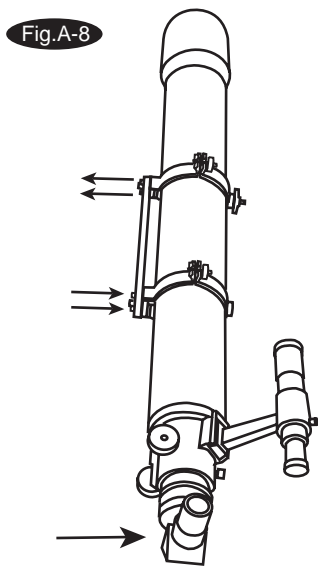
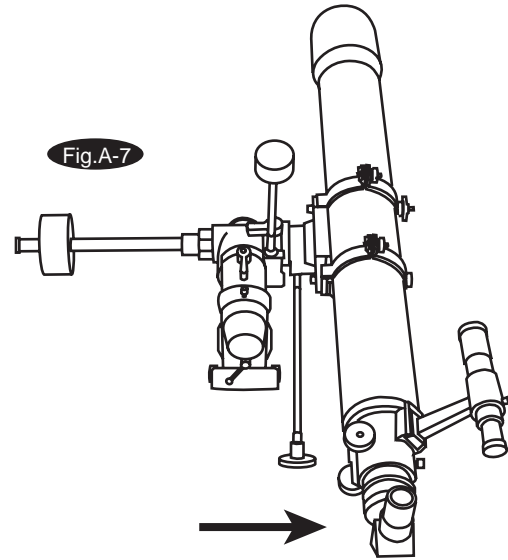



Fig.A-5

12. Carefully nudge the telescope in horizontal motion using only one finger while observing the movement of Polaris through the eyepiece (Fig.A-7). This is to determine which direction (left or right) moves Polaris closer to the center of the eyepiece.
13. Next step is to adjust the adjustment screws on the mounting plate according to your finding from step 12. If Polaris moves toward the center when the telescope is nudged toward your right hand side, You will need to loosen the adjustment screws near the front of the tube and tighten the ones closer to the back of the tube (Fig.A-8), and vice versa (Fig.A-9). Look into the eyepiece. Adjust the screws just enough to place Polaris **HALF** the distance back to the center (Fig.A-10).



14. Repeat step 7 to 13 until Polaris remains in the center of the eyepiece, or moves slightly around the center, when the mount is rotate about the R.A. axis.

 This calibration method can be applied on both refracting and reflecting telescopes. Optical path of different telescope designs does not affect how the telescope tube and tube rings should be adjusted on the mounting plate.

# APPENDIX B - PERIODIC ERROR CORRECTION

Periodic Errors are found in almost all worm gears due to slight eccentricities and misalignments. The PEC (Periodic Error Correction) Training function provides a manual correcting method to reduce the amplitude of the worm errors. By recording a full cycle of guiding actions versus motor shaft angle, SynScan™ can work to compensate for the drifting in the RA sidereal tracking caused by the periodic errors. Below describes a step-by-step procedure on how to perform the PEC:



PEC Training function is recommended for advanced users interested in long-exposure astrophotography only. Careful guiding is required. Regular sidereal tracking is adequate for all casual visual use of the SynScan™ and PEC Training is not required.



Required accessory: Illuminated reticle eyepiece with double crossline pattern capable of producing at least 300X magnification in combination with your telescope. The true field of view should not exceed 10 arc min. See Choosing the appropriate eyepiece for more information on calculating the field of view.

## PEC Training

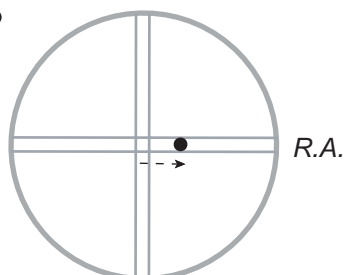
1. Perform the accurate Polar Alignment method (see HEQ5/EQ6 manual).
2. Slew or manually point the telescope to a star with smaller DEC coordinate. This object will be used as the guide star.
3. Activate Sidereal Tracking from the Setup Menu (see Setup Functions). Once the tracking has started, press ESC to go back to the Setup Menu.
4. Rotate the reticle eyepiece until one set of the lines becomes parallel to (or matches) the R.A. movement of the telescope (see step 2 to 4 of the Cone Error Calibration for more information on how this is done.)
5. Move the guide star back at the center of the eyepiece view using the direction keys.
6. On the hand control, select PEC Training in the Utility Functions and press ENTER.



Utility Functions can be easily accessed by pressing the UTILITY quick reference hotkey on the keypad.

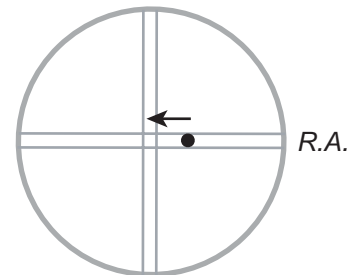
7. Select the R.A. guide speed for the PEC training.
8. The SynScan™ hand control will display the current time once the guide speed is selected, indicating that the recording has begun.
9. Using the LEFT or RIGHT direction key only, move the telescope so the guide star remains at the center of the eyepiece view (Fig.D, D-1). Repeat whenever necessary.

Fig.D



*The Guide star drifts away from the center*

Fig.D-1



*Adjust the telescope to move the guide star back to the center*



10. For 8 minutes (10 minutes and 30 seconds for HEQ5), the EQ6 SynScan™ hand control records the manual guiding actions in order to characterize the periodic errors. Pressing ESC will stop the recording immediately and exit from the PEC training function.



Guiding actions are recorded even when the PEC training is stopped midway. In this case, the PEC+Sidereal tracking will not be accurate until a full cycle of the PEC training is performed.

11. The SynScan™ will beep and display "Record completed" when the training time is up. Press any key to exit from the PEC training.

### **Play back the PEC record**

PEC tracking can be activated under the Setup Menu or pressing the SETUP quick reference hotkey on the keypad when needed. In the Setup Menu, choose Set Tracking, then PEC+Sidereal. SynScan™ will play back the corrections you made during the PEC training cycle and start tracking with periodic error compensated.



The SynScan™ will continue to track in the PEC+Sidereal mode until another tracking mode is selected. If the power is turned off while the SynScan™ is under the PEC+Sidereal mode, the hand control loses synchronization with the R.A. worm gear and the PEC Training will have to be performed again when the power is turned back on. To avoid this, be sure to return the telescope to its home position by selecting *PARK SCOPE* under the *UTILITY FUNCTIONS* before turning off the power.

# APPENDIX C - RS-232 CONNECTION

The SynScan™ hand control must be set to RS-232 mode in order to establish a RS-232 connection with a PC. Under the *UTILITIES* menu in the SynScan™ hand control, select *RS232* and press *ENTER* will launch the RS-232 mode. Once in the RS-232 mode, the SynScan™ hand control will communicate with the PC at 9600 bits/sec, no parity and stop bit. All angles are communicated with 16 bit numbers.

## INITIALIZATION

1. PC sends one byte (63 = ASCII "?") to check whether the SynScan™ is ready.
2. SynScan™ responds with one byte (35 = ASCII "#") when SynScan™ is ready to respond.



All INITIALIZATION steps are recommended but not necessary.

## GoTo R.A.-Dec positions

1. INITIALIZATION
2. PC sends (82 = ASCII "R")
3. PC sends the R.A. high byte, RA low byte, Dec high byte, Dec low byte.
4. When the scope is finished slewing, it will send back a "@"

## GoTo Alt-Az positions

1. INITIALIZATION
2. PC sends (65 = ASCII "A")
3. PC sends the Azm high byte, Azm low byte, Alt high byte, Alt low byte.
4. When the scope is finished slewing, it will send back a "@"

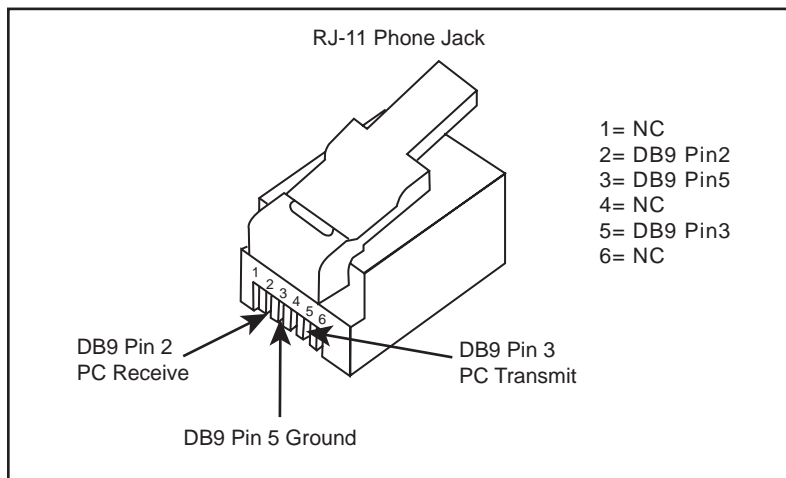
## Get R.A.-Dec positions

1. INITIALIZATION
2. PC sends (69 = ASCII "E")
3. SynScan™ sends the R.A. high byte, RA low byte, Dec high byte, Dec low byte

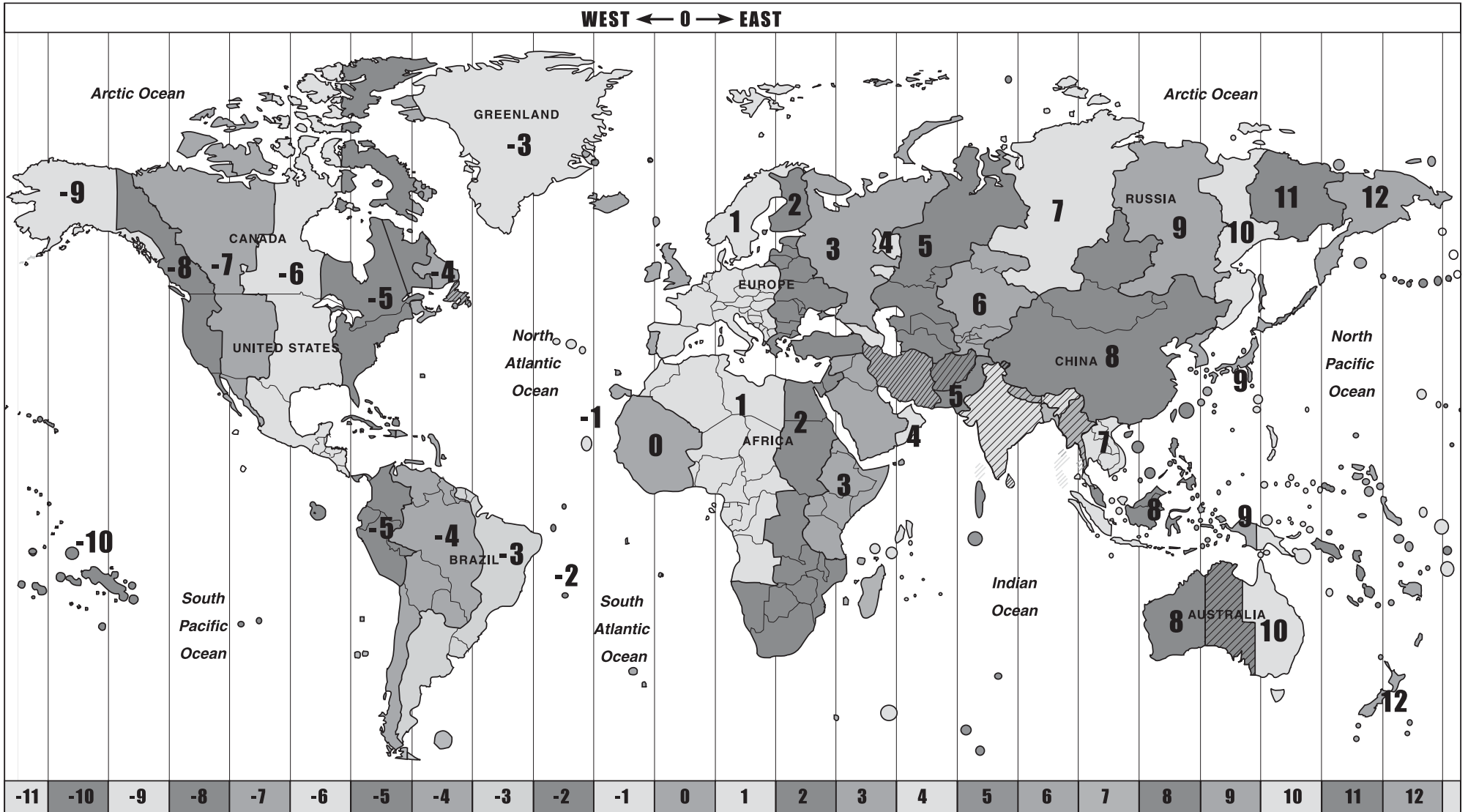
## Get Alt-Az positions

1. INITIALIZATION
2. PC sends (90 = ASCII "Z")
3. SynScan™ sends the Azm high byte, Azm low byte, Alt high byte, Alt low byte.

## Physical Connection Diagram



# APPENDIX D - STANDARD TIME ZONES OF THE WORLD



# 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.