



# Sky Commander XP4 User's Manual

Rev 4.1

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# 1 Introduction

Thank you for buying the Sky CommanderXP4 telescope computer system. You have made an excellent choice. If you have not already used a computer equipped telescope, you are in for a pleasant experience that may change forever the way you observe.

XP4 was designed especially for those amateurs who would like to be able to locate and observe celestial objects fast and easily. With the aid of Sky Commander XP4 more time can be spent at the eyepiece and less time at the finder scope and sky atlas. Objects are located by entering their catalog number using push buttons. A liquid crystal display shows you the scope's position and lets you 'zero in' to objects. With a little practice you can locate even the hardest to find objects in seconds. You will find that operating the unit is next to intuitive. This and other exciting features described in this manual will help make your nights out under the stars more enjoyable than ever.

## 1.1 XP4 New Features

XP4 builds on the tradition of the original Sky Commander and adds new capability.

- New custom ABS plastic enclosure for durability and easier battery replacement.
- 4X Memory Size – plenty of room for operating program and 30,000+ database objects.
- Flash Memory – Upgrade software and manage database through your PC with Windows based utility program.
- Four independent setups for multiple scopes.
- Additional Catalog Types – Named object catalogs for deep sky and stars are now supported. Also a Bayer (Greek letter + number) star catalog is available.
- Users can select from a list of available catalogs and load only those that are of interest.
- Users can create their own catalogs using Microsoft Excel spreadsheet.
- Support for third party drive systems such as ServoCat and SiTech in addition to the Sky Engineering Sky Tracker™.

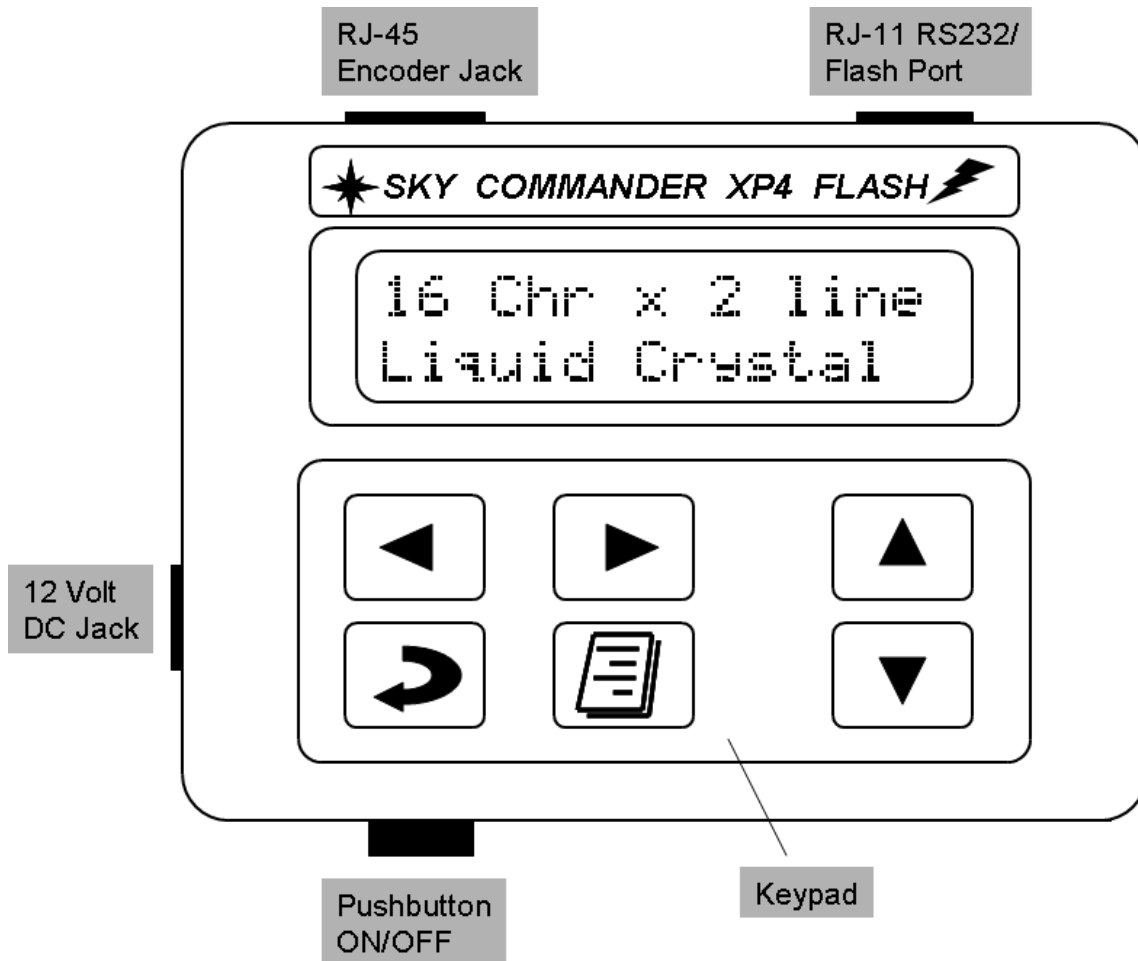
In the original Sky Commander program and database changes were done by replacing an EPROM (Electrically Programmable Read Only Memory) device. This required the unit to be opened and was not convenient. XP4 introduces flash memory which can be updated without opening the box. Simply connect it to your PC and run an upgrade utility.

## 1.2 About this Manual

This manual contains everything you need to know to start using Sky Commander XP4. Parts of the manual are written as a tutorial to help you get familiar with operating the unit. Every feature is described using examples.

### 1.3 Familiarization

Figure 1 shows the Sky Commander computer. The ON-OFF pushbutton switch is located on the left front of the box. A power jack is available for powering the unit from external 12 volt DC. The unit also operates from an internal 9 volt battery. A six button keypad is used to make selections, navigate menus, etc. Optical encoders for sensing scope motion attach by cable to an 8 pin modular jack (RJ45). A second 6 pin modular jack is used for RS-232 communications to a host PC. It is also used for installing upgrades and changes to the database.



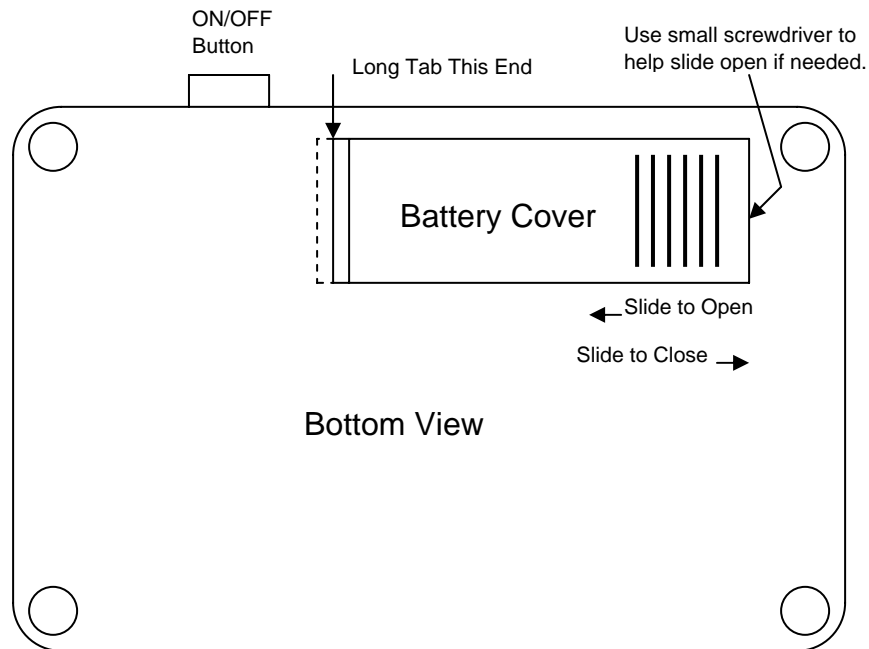
**Figure 1 Sky Commander XP4 Computer**

The display is 32 character (2 lines of 16 characters) dot matrix LCD (Liquid Crystal Display). It is illuminated with an adjustable yellow-green LED backlight.

## 1.4 Battery Replacement

The unit has an internal compartment for a 9 volt alkaline battery. When replacement is required, follow the steps outlined below:

- 1) On the bottom of the unit you will find a slide cover. Push in the direction shown in order to open the battery compartment. If the slide is hard to move, a coin or small screwdriver blade may be used at the point indicated.
- 2) Remove the battery and attach a new one.
- 3) When replacing the battery, insert the wire lead side first (wire goes under battery, not next to cover).
- 4) Replace the plastic slide cover. The end of the cover with the long tab goes to the end of the opening nearest the ON-OFF button. Slide the cover to the closed position.



**Figure 2 Battery Installation**

## 1.5 External 12 Volt Operation

The unit will operate on external 12 volt DC power. The power jack is on the left side. It is a standard 2.1mm ID, 5.5mm OD type. The center contact is positive polarity.

**WARNING** – Use only regulated 12 volt DC power supply or 12 volt battery for external power. A regulated AC to DC adapter for this purpose is available as part number PWR-AC-1210. Use of unregulated adapters will void warrantee

External power must be used in cold weather, 10 degrees C and below. It powers a heater to keep the liquid crystal display operating normally. Without the heater, the display response can be very slow, making it difficult to use.

External power is also very useful when using the 'Fast track' feature. When Fast Track is on, the unit will draw an extra 50 to 100 mA depending on the encoder type and resolution. This will run down an internal 9 volt battery (300 to 400 mAH) quickly.



It is not necessary to use an internal 9 volt battery when operating from external power. You can leave the internal 9 volt battery installed however. It will not damage the unit.

## 2 Unit Setup

This chapter deals with getting the unit setup for your particular telescope. If you purchased the unit along with the telescope, the dealer may already have done these steps for you.

### 2.1 Setup Menu




The purpose of the Setup Menu is to make changes to various parameters such as encoder resolution, i.e. steps per revolution, etc.





Enter the setup menu by starting with the unit off. With both the  and  buttons pressed at the same time, turn the unit on. You will see copyright and version display for two seconds, then the following:

```
Select Setup  
[1] 2 3 4
```

Four independent setups can be selected. These are intended to accommodate multiple telescope, i.e. you can configure up to four telescopes, each with different encoder settings. When changing the unit from one scope to another, it is only necessary to select the preconfigured setup.

**Helpful hint** - most users will have just one telescope, so leave the setup selection to [1].

Use  and  buttons to change the selection (indicated with brackets). Press  to make the selection current, i.e. this is the setup that will be used when the unit is turned on for normal operation.

With the brackets indicating which setup you wish to view or make changes to, press  to see the first item.  and  let you navigate through the list of items that can be changed. When changing an item remember to press  to save it, otherwise the change will not take effect.

- **Scope Mount** – Select Fork, Dobsonian, or German Eq. Dobsonian should be selected for any Alt-Az type mount.
- **Hemisphere** – Select the hemisphere where you will be operating the scope.



- **RA Direction** – This is the direction for the RA or Azimuth encoder. The direction, Normal or Reverse, will be determined by doing a simple test with the scope. The default, Normal is the one that is most typical for most Dobsonian scopes. See directions for determining this setting for [DOB](#), [Fork](#), or [German Eq](#).
- **Dec Direction** – This is the direction for the Declination or Elevation encoder. The direction, Normal or Reverse, will be determined by doing a simple test with the scope. The default, Normal is the one that is most typical for most Dobsonian scopes.
- **RA Encoder Res** – This is the number of counts of the encoder per revolution of the telescope RA or Azimuth axis. Typical values are 4000, 4096, 8000, 8192, 10000, etc.
- **Dec Encoder Res** – This is the number of counts of the encoder per revolution of the telescope Declination or Elevation axis. Typical values are 4000, 4096, 8000, 8192, 10000, etc.

**Important Note:** The resolution numbers entered represent the counts per revolution of the telescope. For instance, if an 8192 step encoder is used for azimuth and 4096 step encoder is used for elevation, then you must enter those numbers. Any gearing or pulley ratio must be taken into account. If a 2048 step encoder is geared 2:1, then enter 4096.

- **Fast Track ON/OFF** – The Fast Track feature helps the Sky Commander keep up with fast motion when using higher resolution encoders, 8192 and up. By default it is OFF. Setting to 12V will turn on fast track automatically when external 12 volts is detected. The ON selection will force it on all the time. Note: having Fast Track on uses more power from the battery, so if only internal battery is used, the battery will not last nearly as long.
- **Sidereal Clock** – This selection should always be ON, unless the scope is a Dobsonian on a motorized equatorial platform. In this case it should be OFF.
- **RS232 Baud Rate** – The default is 9600 bits per second. Lower values can also be selected.
- **SiTech Mode** – The Default is OFF. It should only be turned ON when using the Sidereal Technology Alt-Az drive system.

## 2.2 Determining Encoder Parameters

In the previous section you learned how to enter and save setup parameters, including those for the telescope encoders. Unless the telescope manufacturer sets these for you, you will need to set them yourself. Failure to do this will result in very large pointing errors when you attempt to use it for the first time.

### 2.2.1 Encoder Resolution

Encoder Resolution refers to the smallest angular movement of the encoder shaft that can be detected. It is normally specified as the number of **steps** per revolution. Frequently however the number printed on the encoder itself represents the number of **pulses** per revolution. There is a direct relationship between pulses and steps; there are four steps per pulse.

Example: if the encoder is marked 'S2-1000', the 1000 number refers to pulses and the number of steps is 4000.


Moreover, if the mechanical coupling between the encoder and telescope axis includes any gearing or pulley ratio, then that ratio must be taken into account when setting the resolutions in the setup menu.

Determine the number of steps per revolution of the telescope on each axis and enter those numbers through the [Setup Menu](#).

### 2.2.2 Encoder Direction – Dobsonian (Alt-Az)

Sky Commander detects motion and direction of telescope movement through the encoders, but it does not know the sense of direction with respect to up/down, or left/right. You will determine that sense of direction and enter it through the [Setup Menu](#).

For the purpose of doing the following test, put the unit into 'FORK' mode. See [Setup Menu](#) for instructions on how to do that. When you are finished with the test, you will return to 'DOB' mode.

With the encoder cable plugged into the Sky Commander, turn it on. Press  in response to the 'Set Date' prompt. It is not necessary to set the date at this time. Wait until 'Calculating Planets' is finished. You will be prompted to select 1 or 2 star

alignment. Press  to select 1 star.

Position the scope in elevation to just above horizontal. Use  and  to select

a star near the equator like *Aldebaran* which is about +16 degrees declination. Press



when you see it displayed. The display should look similar to the following:

```
04h 36m +16.6
Mes_0001  ✧  TAU
```

Move the scope up toward the zenith. The numbers of declination should increase. If they decrease instead, just note it and proceed.

Now move the scope in the counter-clockwise direction. The numbers of RA should increase.

If either declination or RA directions are incorrect, go into the [Setup Menu](#) and change the direction from Normal to Reverse or visa versa.


Repeat the steps above to verify that the changes you made took effect, then return the scope mount setting to 'DOB'.

### 2.2.3 Encoder Direction – Fork Mount



Sky Commander detects motion and direction of telescope movement through the encoders, but it does not know the sense of direction with respect to North/South, or East/West. You will determine that sense of direction and enter it through the [Setup Menu](#).

The Sky Commander should already be setup for operation in 'FORK' mode. If not, then follow directions in the section [Setup Menu](#).

Identify the side of the fork that will normally be facing up during alignment and use. This is the side that is up when the scope is pointing to an object on the meridian. Be sure to use this side during the following test and during star alignment.

With the encoder cable plugged into the Sky Commander, turn it on. Press  in response to the 'Set Date' prompt. It is not necessary to set the date at this time. Wait until 'Calculating Planets' is finished. You will be prompted to select 1 or 2 star

alignment. Press  to select 1 star.

Position the scope in declination near the equator. Use  and  to select a star also near the equator like *Aldebaran* which is about +16 degrees declination. Press



when you see it displayed. The display should look similar to the following:

```
04h 36m +16.6
Mes_0001  ✧  TAU
```


Move the scope in the northerly direction. The numbers of declination should increase. If they decrease instead, just note it and proceed. Now move the scope in the easterly direction. The numbers of RA should increase.

If either declination or RA directions are incorrect, go into the [Setup Menu](#) and change the direction from Normal to Reverse or visa versa.

### 2.2.4 Encoder Direction – German Equatorial

Sky Commander detects motion and direction of telescope movement through the encoders, but it does not know the sense of direction with respect to North/South, or East/West. You will determine that sense of direction and enter it through the [Setup Menu](#).

The Sky Commander should already be setup for operation in 'GERMN' mode. If not, follow directions in the section [Setup Menu](#).

With the encoder cable plugged into the Sky Commander, turn it on. Press  in response to the 'Set Date' prompt. It is not necessary to set the date at this time. Wait until 'Calculating Planets' is finished. You will be prompted to select 1 or 2 star

alignment. Press  to select 1 star.

Position the scope in declination near the equator, and near the eastern horizon in

RA. Use  and  to select a star also near the equator like *Aldebaran* which is

about +16 degrees declination. Press  when you see it displayed. The display should look similar to the following:

```
04h 36m +16.6
Mes_0001  ✧  TAU
```

Move the scope in the northerly direction. The numbers of declination should increase. If they decrease instead, just note it and proceed. Now move the scope in the easterly (down toward horizon) direction. The numbers of RA should increase.






If either declination or RA directions are incorrect, go into the [Setup Menu](#) and change the direction from Normal to Reverse or visa versa.

## 3 Star Alignment

Each time Sky Commander is turned on, you must go through an alignment procedure so the computer has an orientation to the sky. Sky Commander XP4 supports two alignment methods, 1-Star and 2-Star. The procedure you use depends on the type of mounting your scope has and the accuracy to which it is polar aligned. If the scope is very well polar aligned, only one alignment star is needed. However, if polar alignment is only rough or the scope is Dobsonian type or Alt-Azimuth, then two stars are needed. Note that anytime polar alignment is in question a 2-Star alignment can be done.

### 3.1 Polar Aligned Scopes

This section describes the 1-Star alignment that can be used on mounts that have been well polar aligned. The 1-Star alignment is the easier of the two procedures since it requires only one sighting. The positioning accuracy of your system however will depend on the accuracy of the polar alignment.


After turning on, select 1-Star alignment with the  button. The display will show **'Sight 1st Star'** on the top line. The bottom line will show the name of one of 40 alignment stars along with its magnitude.  or  buttons let you select the star you are going to use. If you have a German Equatorial (NOT FORK) mount and you want to use a star in the western sky, use the  or  buttons to change the display to **'Sight 2nd Star'**. For fork mounts leave the display at **'Sight 1st Star'** for any alignment star, East or West of the meridian.


Sight the star with your scope. Get it as close to center of field as possible. When the star is centered, press ENTER. This completes the alignment procedure, and the Sky Commander enters operating mode.

### 3.2 Dobsonian (Alt-Azimuth) Scopes

To use Sky Commander with a Dobsonian (Alt-Azimuth) scope, a 2-Star alignment must be done every time the unit is turned on. The stars should not be too close to the zenith or horizon. +10 to +60 degrees elevation is preferable. They should be separated in azimuth at least 90 degrees; the more separation, the better.

Two star alignment begins with the 'Sight 1st Star' prompt. Use  and

 buttons to select the first star. The first one in the list is Polaris. This is usually a good star for northern hemisphere users.


Sight the star with the scope. Be as accurate as possible. Press  when you have the star sighted.




The display will now prompt with 'Sight 2nd Star'. Select the next star from the list.


Note: The Sky Commander will allow you to select any of the available alignment stars. It is up to you to choose ones that are suitable. Suggestion: Mark the stars on a planisphere for a handy reference. Also choose your alignment stars ahead of time.

Sight this star just like the first, then press ENTER. You have just completed the alignment procedure. The Sky Commander enters operating mode.


### **3.3 Fork 2-Star Alignment**

When you are prompted for 1 or 2-star alignment, select 2-star with . You will be prompted to set the scope to +90 degrees. This means relative to the scope, not the sky. The optical tube should be oriented parallel to the fork arms. The positioning is not very critical, within a degree is fine.




Next you will be prompted to sight the 1st star. Use  and  buttons to select a convenient star on the eastern side of the meridian. Get the star sighted accurately in the scope and press . Now you will be prompted for the 2nd star. Choose one on the western side of the meridian (preferably at least 90 degrees from the first).


Again, sight the star and press . This completes the alignment procedure, and the Sky Commander enters operating mode.

### 3.4 German Equatorial 2-Star Alignment

When you are prompted for 1 or 2-star alignment, select 2-star with . You will be prompted to set the scope to +90 degrees. This means relative to the scope, not the sky. The optical tube should be oriented parallel to the polar shaft of the mount.

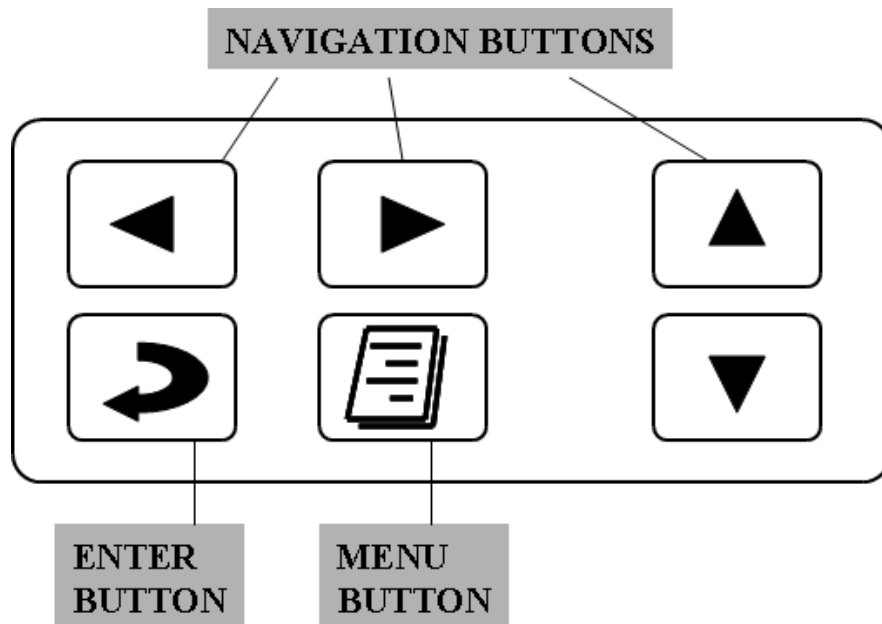
Note: This setting must be accurate. See the appendix describing the method for determining the +90 degree position for a German Equatorial.

Next you will be prompted to sight the 1st star. Use  and  buttons to select a convenient star on the eastern side of the meridian. Get the star sighted accurately in the scope and press . Now you will be prompted for the 2nd star. Choose one on the western side of the meridian (preferably at least 90 degrees from the first).

Again, sight the star and press . This completes the alignment procedure, and the Sky Commander enters operating mode.

## 4 Sky Commander Operation

All of the Sky Commander functions are accessible through the six button keypad array on the front panel. The buttons are arranged in such a way to make them easily located by feel. The four arrow buttons are for navigating menus and scrolling lists. The remaining two buttons are ENTER, for making selections and MENU, for accessing the menu controls.



**Figure 3 - Keypad Buttons**

In normal operation the buttons are pressed and quickly released, like dialing on a touch-tone phone. If the buttons are held down for more than about a second however, multiple presses of the button are generated. This can be convenient for scrolling through long lists.

### 4.1 Setting the Date

The date displayed each time you turn on the Sky Commander is not driven by a 'real time' clock as in a desktop PC. You are able to change and save it as described below however. Setting the date is optional; it is used only for the calculation of planet positions and has no effect on alignment or location of other objects.

Change the date by moving the cursor with and scrolling the month, day and year with or . Press to save the date and proceed to [Star Alignment](#).





## 4.2 Basics of Object Location



After performing [Star Alignment](#), Sky Commander is ready to guide you to any of thousands of database objects. This section will take you through the basic steps of locating an astronomical object.

Note: The Sky Commander database can be customized in terms of catalog selection and arrangement. For the purpose of describing basic operation, an example will be used. It is assumed that the Messier catalog is loaded and it is the first one in the list of catalogs. See [Catalog Selection](#) for details.


Assume the star Betelgeuse has been used for alignment (second star in the case of 2-star alignment). The display will look similar to the following:

```
05h 55m +07.4
Mes_0001  ✧  TAU
```

Line 1 of the display shows the telescope position in RA and declination. Line 2 shows catalog, object number, and constellation. The object shown is the default one, i.e. Messier, 'Mes' is the first catalog, and Messier 1 is the first object in the Messier catalog. The displayed object is referred to as the **current** object. Notice the underscore symbol, '\_' on line 2 between the catalog name and number. This is the **cursor** symbol and is used to aid in navigating catalogs, menus, etc. The cursor may be moved using  and  buttons. The cursor position shown is the **home** position. It is normally in this position unless you are in the process of making a catalog selection.

In this example, M42 the Orion Nebula will be located. The first step is to change the current object to Mes 0042. Move the cursor under the third zero and use  to change it to '4'. Now move the cursor under the 1, and change it to 2. Now press  to make the selection current. Notice the cursor returns to home position. M42 is now current and the display looks like:

```
05h 55m +07.4
Mes_0042  ✧  ORI
```

The top line of the display is still showing telescope absolute position. Change it to relative position by pressing  once. The display will change to:

```
* ↗344.6 ↘ 01.7  
Mes_0042   ✧   ORI
```

The asterisk, \* symbol on the top left indicates the display is showing telescope *relative* position, i.e. the difference between telescope absolute position and object position. Arrows on the top are an indication of which way to move the scope to get to the object. Numbers indicate degrees of displacement.

Note: this example is for Alt-Azimuth (Dobsonian) – if the scope is Fork or German Eq, the top line will look like -

```
* 00h 20m +12.8
```

indicating hours and minutes of RA displacement, and degrees of declination displacement.


You will now move the telescope in azimuth (RA for polar type mounts) and elevation (declination for polar type mounts) to the target object, M42. The right pointing arrow indicates you should move clockwise in azimuth. The down pointing arrow indicates you should move down in elevation. As you move the scope the numbers change. For azimuth, the starting number is greater than 180 degrees, so they increment toward 360 degrees (same as zero) as you get closer to the target. For elevation, the numbers decrease to zero as you get closer. Move the scope until both displacements are zero:

```
* ↗000.0 ↘ 00.0  
Mes_0042   ✧   ORI
```


The telescope is now pointing at the target object. If you find that it is not, repeat the alignment procedure (turn power off and on to reset). If there is still a problem, see the section in this manual titled [Troubleshooting](#).

### 4.3 Catalog Selection




In the last section you learned the basics of object location. The example used the Messier catalog, but Sky Commander can hold many more catalogs, up to 32 including Planet and Special Object catalogs which you will learn about later.

To select other catalogs, move the cursor under the catalog name using the  button as shown below:

```
      05h 55m +07.4  
Mes 0042  ✧  ORI
```

Now use  button to change to the next catalog, in this example the NGC catalog

```
      05h 55m +07.4  
NGC 0001  ✧  PEG
```

Pressing  always returns the cursor to home position and makes the displayed object current. With the cursor under the catalog name, use  and  buttons to see other catalogs that make up the database.

The following table is a list of catalogs available at the time of writing this manual. Updated catalogs, when available can be found at <http://www.skyeng.com> .

Abbreviation	Catalog Name	Brief Description	Number
Mes	Messier	The famous catalog of Charles Messier	110
NGC	New General Catalog	Entire NGC Catalog	7800
NDS	Named Deep Sky	Various types of deep sky objects by common name	135
NST	Named Star	Stars by common name	142
Dbl	Double Stars	600 best double stars provided by Saguaro Astronomy Club	600
Byr	Bayer Stars	Stars by Greek letter and number	1500
APN	Abell Planetary Nebula	Large but very faint planetary nebula cataloged by George Abell in 1966.	86
Arp	Arp Peculiar Galaxies	Complete catalog of Dr Halton C. Arp	338
Brd	Barnard	Dark nebula	159
Hr4	Herschel 400	Herschel 400 listed by NGC number	400
HIC	Hickson Galaxy Clusters	A catalog of compact galaxy clusters	100
IC	Index Catalog	Entire Index Catalog	5250
Brk	Berkley	Open Clusters	86
Cr	Collinder	Open Clusters	71
Trm	Trumpler	Open Clusters	34
S	Special Objects	User entered coordinates	74
PLN	Planets	All observable planets	8

**Table 1 - Installed Catalogs**

## 4.4 Catalog Types




The way that you access objects within a given catalog depends on the type.

- Numbered
- Named
- Named with Constellation



### 4.4.1 Numbered Catalogs




A four digit number appears to the right of the catalog name. The constellation name appears to the far right -

```
* #000.0 ↓ 00.0  
NGC 4594 ◊ VIR  
                    
```

The cursor can be placed under each digit and the  and  buttons are used to change them. Pressing  causes the entered object to become current. If an invalid number is accidentally entered, an error message is displayed and the display reverts to the previously selected object.

## Object Not Found




The cursor may be moved under the constellation name. The constellation can be changed with the  and  buttons. Note: Only constellations that contain objects within the current catalog (and the object meets [Limit Magnitude](#) criteria) will be selectable.

Having selected a constellation, objects of the current catalog can be browsed by placing the cursor under the  symbol. As the  and  buttons are pressed, first a brief object description appears, then the object number. The description helps the user decide whether or not it is of interest. See [Scroll by Constellation and Catalog](#)

### 4.4.2 Named Catalogs

There are two catalogs, namely NDS (Named Deep Sky) and NST (Named Star) which allow the user to select in alphabetical order the common name of an object.

```
* #000.0 ↓ 00.0  
NST Acamar  
                    
```

When the cursor is moved under the first letter of the object name, the  and  buttons let you increment or decrement to the next letter. You can move quickly to the first letter of the name you are trying to locate. Move the cursor once more to the right and then scroll to the exact name you want. In this example, press  several times to get from 'Acamar' to 'Alberio'.




```
* #000.0 ↓ 00.0  
NST Alberio  
                    
```

Press  to make the object current.


#### 4.4.3 Named with Constellation Catalogs

The Double Star Catalog in particular is organized by name and constellation.



```
  * #000.0 + 00.0  
Db1 0Σ 514   AND
```

Positioning the cursor under the name lets you scroll through all the double stars in the current constellation, Andromeda in this case. To get to a different constellation, just move the cursor under the first letter of the constellation name. Scroll to the constellation with the  and  buttons. Move the cursor back under the double star name to continue with your search. Press  to make the object current.

## 5 Operating Menus

More advanced control over operating features, parameters and settings is accomplished through the Operating Menus. To access the operating menus, press the  button once. You will see the first menu item –




```
Search-ID ON-OFF
*   on   OFF   *
```

Use the  and  buttons to get to other menu items. There are eight of them.





- Search & ID
- Limit Search Magnitude
- LCD Intensity
- Favorite List On-Off
- Purge Favorite List
- Battery Monitor
- Realign on Object
- Equatorial Table Reset (appears only when sidereal clock is off)

Exit the operating menus by pressing  once more.

### 5.1 Search & Identify Menu

Use  and  buttons to turn this feature On or Off. See [Search & Identify](#) for description of this feature. Press  to return to operating mode.

### 5.2 Limit Magnitude Menu

Use  and  buttons to increment or decrement the limiting magnitude. Objects dimmer than this setting will not be displayed during object scrolling operations, or Search & ID mode. Press  to permanently save the setting. You do not necessarily need to save; the setting will still be in effect until the unit is turned off, even if it is not saved. Press  to return to operating mode.

Note – a unique Limit Magnitude value is saved for each scope defined in the setup parameters. There are four of them. See [Setup Menu](#). Example – you can set Limit Mag to 13 for your 16" dob, and 10 for your 4" refractor. When you change from one scope to the other, the correct Limit Mag will used.

### 5.3 LCD Intensity Menu

Use ◀ and ▶ buttons to select the desired display brightness, LOW, MEDIUM or HIGH. Press ↻ to permanently save the setting. Press ☰ to return to operating mode.

### 5.4 Favorite List Menu

Use ◀ and ▶ buttons to turn the list On or Off. See [Favorite Objects List](#) for information on this special mode. Press ☰ to return to operating mode.

### 5.5 Purge Favorite List Menu

If the 'Favorite List' gets cluttered, or corrupted, or you just want to start over, select YES, using the ◀ button and ↻ button. The Favorite list will be erased. Press ☰ to return to operating mode.

### 5.6 Battery Monitor Menu

A bar is displayed on the bottom line -

```
E  _BATTERY+  F
|||||
```

The farther the bar extends to the right, the higher the charge of the battery. Full indicates 9 volts or more, Empty is about 6 volts.

### 5.7 Realign on Object Menu

While in operating mode, pointing accuracy can sometimes be improved by sighting on a known database object and executing a 'Realign'. For Dobsonian (Alt-Az) scopes, avoid realigning on objects higher than about 60 degrees, i.e. use the same criteria for selecting the realign object as you use to select the initial alignment stars.

Be sure the object is current on the display and center it in the eyepiece. Go to the 'Realign on Obj' menu and press ↻. Sky Commander will automatically exit the menu display. The offset should now be zero on each axis –

```
* #000.0 + 00.0
Mes_0042  ✧  ORI
```

If the offset is not exactly zero, you can execute the realign command once more. See section titled [Realignment on Database Objects](#)





## 5.8 Equatorial Table Reset Menu


If your scope is a Dobsonian and you are using an equatorial table, you will need to use the Table Reset menu. It allows you to reestablish alignment after physically resetting the table. You do not have to do another star alignment. Use the following setup and alignment procedure:


1. Polar align the table as accurately as possible.
2. Sidereal clock must be turned off. See [Setup Menu](#).
3. When you are ready to do the initial 2-star alignment, turn the table on and then bring it to the reset position. At the same time turn the Sky Commander on. These two operations should be done simultaneously or as nearly so as possible. The table must be running during alignment, and must not slip. Perform the 2-star alignment (see [Alt-Az Alignment](#)). You are now ready to observe.
4. To assure accuracy of the setting circles, leave the table running.
5. At some point it will be necessary to reset the table. When you are ready to do this, perform the following steps:

Press:  to get to menu screens

 or  to get to Equatorial Table Reset.

Bring table back to reset position. The table must be running.



Press  immediately.

Press  to return to normal operation.


Important Note: if you suddenly encounter poor pointing accuracy during operation, the table may have slipped. If this happens, there is no need to do another two star alignment, simply reset the table as described above. Do not use the 'Realign to Object' function until you have eliminated table slippage as the cause of pointing error.

## 6 Operating Features


### 6.1 Display Object Information

While the cursor is in 'Home' position, pressing  will display basic information about the current object. For instance, go to the Messier catalog, 'Mes'. Change the number to 0027 and press  to make it current.

```
Mes_0027  ♦  UUL
```

The cursor reverts back to home position. Now press  to display information –

```
Planet. Neb +07.3
```

M27 is a planetary nebula of magnitude 7.3. Press  again, and the display goes back to showing the object catalog and number again.

Information about double stars is different. Example, select the double star catalog 'Db1' and scroll to the constellation of Andromeda, 'AND'. With the cursor under the star name, scroll to -

```
Db1 03 514  AND
```

Press  to make it current, then press  to show the information -

```
7.1/ 9.5  005"
```

The double star is primary magnitude 7.1, secondary magnitude 9.5 and 5 arc second separation.

For other star catalogs, such as Named Star (NST) and Bayer Star (Byr), the star magnitude and spectral type is displayed –

Example, for 

```
Byr_ALPHA  AND
```

, the following info is displayed –

```
2.1/  B8/
```

Alpha Andromeda (Alpheratz) is a 2.1 magnitude star of spectral type B8.

## 6.2 Search & Identify

Sky Commander has the ability to identify objects you come across while panning the scope. Enable Search & ID through the Operating Menu – see [Search & Identify Menu](#).

As you move the scope, any object brighter than the [Limit Magnitude](#), which is within a .5 degree circle is displayed. If multiple objects qualify, the closest one is displayed.

While Search & ID mode is on, an 'S' is displayed in the upper left of the display as a reminder to the user –

```
S* 4000.3 † 00.2  
Mes_0001  ⬠  UMA
```


All loaded catalogs except 'Special Objects' and Planets are searched.



If no object is found meeting the criteria, the following message is displayed –

```
Searching Data
```

Power consumption is slightly higher while in Search & ID mode.

## 6.3 Scroll by Constellation and Catalog

You may have noticed the diamond symbol,  that appears with most catalogs. Positioning the cursor under the diamond allows you to browse through objects in the current catalog that are also in the current constellation (shown to right of diamond).

While the cursor is under the diamond, use the  and  buttons to scroll through the list. The description of each object is displayed briefly before the display reverts to showing the object number. This gives you the ability to quickly sort objects such as bright galaxies, clusters, etc.

**Note** - the objects displayed while in this mode are limited to those brighter than the [Limit Magnitude](#).

**Example:** Make the NGC catalog current and move the cursor under the diamond. The default constellation is Pegasus because NGC 0001 is in that constellation.

```
NGC 0001  ⬠  PEG  
           ─
```

Use the  and  buttons to browse the NGCs of Pegasus. Notice there are many dim galaxies, but also a few bright ones. For instance, as you scroll, you may see –

Galaxy                    +10.6

10.6 is the magnitude. The display then reverts to showing the object number –

NGC 7814    ✧    PEG

To move to a different constellation, simply move the cursor under the constellation name (far right bottom line) and use the  and  buttons to select a new one.

**Note** – if a constellation does not contain objects of the current catalog, it will not be selectable.

With the cursor under 'PEG', press  twice to get to the constellation Orion (ORI)

NGC 1661    ✧    ORI


Again, move the cursor under the diamond and scroll with  and  buttons. Notice there are many bright nebulas and clusters to choose from. You may see something like –

Open Clstr    +04.2



Then the display reverts to –

NGC 1981    ✧    ORI

## 6.4 Favorite Objects List

Objects from the internal database can be marked as 'Favorite' and put into a list for quick reference. Another possible use is to record your evenings observations. When the cursor is in the home position on the bottom line of the display, pressing  will cause the following prompt –

```
Add to Fav List?
*   yes  NO   *
```



If you wish to add the object to the favorite list, move the cursor under YES, and press . Otherwise just press  and the object will not be saved. A maximum of 73 objects can be saved to the favorite list.

If you try to save more than the maximum, an error message is displayed –

```
Fav List Full
```

Also, if the object is already in the list, you will see –



```
Already in List
```

When you want to access an object that was stored in the favorite list, the list must be turned on. Go to the operating menus (  ) and index to the 'Favorite List' menu. See [Favorite List Menu](#). Turn on the list by moving the cursor under ON, then press  again to exit menus. If you forgot to put any objects into the list, the following error message is displayed –


```
Fav List Empty
```

Otherwise you should see something like the following –



```
F*  4038.1  +  15.7
Mes__0021  *  SGR
```

The 'F' on the top line indicates that the 'Favorite' list is active. In this example, M21 is in the list. Other favorites are accessed using the  and  buttons. While the

list is active, these buttons are dedicated to scrolling the list.

While the list is in use, objects may be deleted. Press  and the following prompt is displayed –



```
Del Fav List ?
*      yes  NO      *
```

Move the cursor under YES and then press  to delete it. Otherwise just press  and it will not be deleted.



To delete the entire favorite list, see operating menu item - [Purge Favorite List Menu](#).




## 6.5 Special Object List



You may wish to reference object coordinates other than those included in the catalogs. The Special Object list provides an easy way to do just that. You can enter up to 59 coordinates by Right Ascension and declination. This can be done either through the keypad on the Sky Commander or through a PC program via the RS232 port. See Load Special Object Coordinates Command in [Appendix B](#).

To see the Special Object list, move the cursor under the catalog name and use  or  to get to the catalog named with a single 'S' as shown below –

```
      05h 14m -08.2  
S 00 00h00m+00.0
```

The two digits following 'S' are object index. Put the cursor under the first digit and use  or  to scroll the list. The index range is 00 to 58. There is also a '99' index which is explained below.

Return to index '00' and then move the cursor under the first digit of RA hours. Use  or  to change this digit then move to the next digit, changing it as well. Continue to move the cursor to the right, changing digits as desired. When you are done entering the special object coordinates, press  to save it in EEPROM memory. The information will be retained even after turning the Sky Commander off.

Special objects are located just as other catalog objects, i.e. with the cursor in home position, the  button toggles on and off the  so you can 'zero in' to the target.




Entering of object information other than coordinates is not supported, so it is a good idea to keep your own list with that type of information.

Special object coordinates can also be uploaded from a PC program using the RS232 port. See Appendix B for information on serial protocol.



Special object '99' is to be used by PC software to upload coordinates 'On the Fly'. It is not saved in EEPROM, so any changes to it through the keypad or PC will be lost after the Sky Commander is turned off.

## 6.6 The Planet Catalog

The planet catalog is a bit different than the other catalogs because the positions are calculated during initialization when the Sky Commander is turned on. Positions are based on the date that the user enters. Since there is no time entry other than date, it is best to set the date one day ahead – i.e. if it is the evening of June 1<sup>st</sup>, set the date to June 2<sup>nd</sup>. The reason is that the calculations assume 0 hours universal time for the given date. For instance, in early evening (US) the time is much closer to 0 hours UT of the following day than it is to 0 hours UT of the present day.


Press  button to move the cursor under the catalog name and then index to the PLN catalog using the  and  buttons. The display should look something like

```
* #032.1 + 19.3  
PLN_ Mercury
```

Now move the cursor over by the planet name with the  button and index to a different planet with the  and  buttons.  returns the cursor to home position.

## 6.7 Standby Mode

During an observing session there will be times when you are not actively using the Sky Commander. It is a good idea to put the unit into standby to save battery power and turn out the display backlight. Standby is activated by a quick double press of the

 button. The display shows –

```
Standby Mode
```

and the backlight goes out. While in standby, encoder alignment is maintained, even if the scope moves. Press any button to return the unit to normal operation.

## 6.8 Use with Equatorial Table

An equatorial table is one way to give Dobsonian scopes tracking ability. The scope is mounted atop the table which is driven with a clock drive. When properly polar aligned, the table cancels out the motion of the earth, thus making all celestial objects stationary in the eyepiece.



In the normal case (no table), Sky Commander uses an internal sidereal clock to keep pace with the apparent motion of the sky. When used with a table, it is only necessary to turn the clock off. See 'Sidereal Clock' under - [Setup Menu](#) . Also see [Equatorial Table Reset Menu](#)

### 6.8.1 2-Star Alignment with EQ Table

Even though the table is 'equatorial', it is still necessary to perform a 2-star alignment since the scope is moving on axes which are not polar. When doing the alignment it is necessary to follow the steps below –

- The table must be well polar aligned.
- Sky Commander sidereal clock is turned off.
- Turn the table on and bring it to the mechanical start position. At the same time turn the Sky Commander on. These two operations should be done simultaneously or as nearly so as possible. Perform the 2-star alignment.
- During the alignment procedure the table must not slip. If it does slip, you must start over.




The equatorial table must continue to run and must not slip during the observing period. If however, the table stops, or slips, it is NOT necessary to repeat the two star alignment. If this happens, just perform the table reset procedure described below.

### 6.8.2 Equatorial Table Reset

When it becomes necessary to do a mechanical reset of the table, or the table stops or slips, do the following –

- Go to the operating menu item - [Equatorial Table Reset Menu](#). It looks like –

```
Equatorial Table  
Reset (Press E)
```

- Before pressing the  button, bring the table back to the mechanical start position (table running). Press  to coincide in time with the starting of the table from the start position. Press  to return to normal operation. Alignment and accuracy will be restored.

<p><b>Note</b> – 'Equatorial Table Reset' appears in the list of menu items <u>only</u> when the <u>sidereal clock</u> is turned <u>off</u>, as it must be for using the Sky Commander XP4 on an equatorial table.</p>
--

## 6.9 Realignment on Database Objects

For various reasons, pointing accuracy may not always be as good as it should be. The 'Realign on Object' feature can help correct that condition. By carefully centering a database object in the eyepiece and then telling the Sky Commander to realign to it, a poor alignment can be improved. First, make sure the object you are aligning to is the same one showing on the Sky Commander display.

Press:  to get to menu items, then  or  to get to 'Realign on Obj' menu.

Center the object in the eyepiece.

Press  to complete the realign function.




'OK' is displayed briefly before normal operating mode is resumed.

**Note** – When selecting an object for realign, use the same criteria as you do when selecting initial alignment stars, i.e. not too close to the zenith for Dobsonian scopes, or not near the celestial poles for polar aligned scopes.

## 6.10 Sidereal Clock

Sky Commander has a built in clock to keep pace with the apparent motion of the sky. For most scopes and mountings, the Sidereal Clock should be **ON**. Only when using a Dobsonian scope with an equatorial table, should it be turned **OFF**. See the section [Setup Menu](#) for instructions on navigating to this menu item. It appears as follows –

```
Sidereal Clock
*   ON   off   *
    
```

Select the desired setting using  or  button, then press  to save.

## 7 Alignment Stars

Alignment Stars for use in Northern Hemisphere								
Star Name	Common Name	RA (2000)			Declination (2000)			Visual Magnitude
		Hours	Min	Sec	Deg	Min	Sec	
Alpha UMi	Polaris	2	31	50	89	15	50	2
Alpha CAS	Schedar	0	40	30	56	32	15	2.2
Beta CET	Deneb Kaitos	0	43	35	-17	59	12	2
Beta AND	Mirach	1	9	44	35	37	14	2.1
Alpha ARI	Hamal	2	7	10	23	27	45	2
Beta PER	Algol	3	8	10	40	57	21	2.1
Alpha PER	Mirfak	3	24	19	49	51	40	1.8
Gamma ERI	Zaurak	3	58	2	-13	30	31	3
Alpha TAU	Albedaran	4	35	55	16	30	33	0.9
Beta ORI	Rigel	5	14	32	-8	12	6	0.1
Alpha AUR	Capella	5	16	41	45	59	53	0.1
Alpha ORI	Betelgeuse	5	55	10	7	24	26	0.5
Alpha CMa	Sirius	6	45	9	-16	42	58	-1.5
Alpha CMi	Procyon	7	39	18	5	13	30	0.4
Beta GEM	Pollux	7	45	19	28	1	34	1.1
Iota UMa	Talitha	8	59	12	48	2	29	3.1
Alpha HYA	Alphard	9	27	35	-8	39	31	2
Alpha LEO	Regulus	10	8	22	11	58	2	1.4
Lambda UMa	Tania Borealis	10	17	6	42	54	52	3.5
Delta LEO	Zosma	11	14	6	20	31	25	2.6
Gamma UMa	Phecda	11	53	50	53	41	41	2.4
Alpha2 CVn	Cor Caroli	12	56	2	38	19	6	2.9
Alpha VIR	Spica	13	25	12	-11	9	41	1
Eta UMa	Alkaid	13	47	32	49	18	48	1.9
Alpha BOO	Arcturus	14	15	40	19	10	57	0
Beta BOO	Nekkar	15	1	57	40	23	26	3.5
Beta LIB	Zubeneschamali	15	17	0	-9	22	58	2.6
Alpha SCO	Antares	16	29	24	-26	25	55	1
Zeta HER		16	41	17	31	36	10	2.8
Alpha OPH	Rasalhague	17	34	56	12	33	36	2.1
Alpha LYR	Vega	18	36	56	38	47	1	0
Alpha AQL	Altair	19	50	47	8	52	6	0.8
Gamma CYG	Sadr	20	22	14	40	15	24	2.2
Alpha CYG	Deneb	20	41	26	45	16	49	1.3
Epsilon PEG	Enif	21	44	11	9	52	30	2.4
Eta PEG	Matar	22	43	0	30	13	17	2.9
Alpha PSA	Fomalhaut	22	57	39	-29	37	20	1.2

## 8 XP4 Specifications


<b>PARAMETER</b>	<b>CONDITIONS</b>	<b>SPECIFICATION</b>
Operating Voltage	9 volt Internal Battery	5.5 volts Minimum
	External DC Supply	11 v Min, 13.8v Max
Supply Current	Internal 9v battery, Fast Track off.	10 mA typical
	External DC Supply, Fast Track on, 4000 step encoders	90 mA typical
	External DC Supply, display heater on	Additional 120mA
Battery Life	Internal 9v battery, Fast Track off.	30 Hours with typical use
DC Power Jack		2.1mm ID, 5.5mm OD power jack, center positive.
Encoder Type		Optical Rotary, US Digital type S1 and S2
Max Rotational Speed	Fast Track Off	1200 steps / sec Max.
	Fast Track On	2000 steps / sec Max.
Encoder Resolution	Includes any gearing ratio	32767 (2 <sup>15</sup> -1) Max
Operating Temp	Internal 9v battery, no heater.	+10C to 50C
	External DC Supply with heater on	-25C to 50C
Displayed Resolution	RA - Declination mode	1 min RA, .1 deg declination.
	Alt - Azimuth Mode	.1 deg Azimuth, .1 deg elevation
Display Type		2x16 char high contrast super twist LCD, yellow/green backlight. Adjustable intensity.
Serial Port		300 to 9600 baud 1 start bit, 8 data bits, no parity, 1 stop bit.

## 9 Troubleshooting

Your Sky Commander computer was checked out fully before shipping. Should you experience difficulty, please refer to the following trouble chart before calling for assistance.

<b>TROUBLE</b>	<b>CORRECTIVE ACTION</b>
No display indication when unit is turned on.	Check internal battery and connection. Try external 12V power.
No display backlight visible.	Adjust intensity with keypad. Light is intentionally dim for night use.
Either RA or dec readout does not change when scope is moved.	Check connections to encoder. Inspect contacts of encoder jack on Sky Commander unit. Look for bent or out of place pins. Inspect encoder cable ends closely. Damaged ends can cause bad electrical contact. Try switching encoders to isolate problem, i.e. determine if problem is encoder or cable or unit.
Objects cannot be found	Check direction and resolution settings for each encoder. Objects may be too dim. Be sure to correctly identify alignment stars.
Position accuracy poor	Check resolution setting for each encoder. Check centering of encoders. Check orthogonality of axes and optical collimation. Center alignment stars accurately.
Other position accuracy problems	Perform 360 degree rotation test (see below).
Position accuracy degrades with time.	Check that the sidereal clock is turned on. Check encoders to make sure they are not slipping. Do not move scope too fast.
RA or Azimuth reading seems to stop counting when turning scope counter-clockwise, but may be OK in clockwise direction.	Azimuth pivot pin may not be tightly secured to ground board. Retighten. Pivot pin may be binding if not mounted perpendicular. Pivot pin may be too short, causing binding. Try to remount. Use lubricant on pin/bushing if necessary.
Unit does not work when used with Sky Tracker Dobsonian drive system	Check connection between Sky Commander and Sky Tracker box. Make sure Sky Commander RS232 baud rate is set to 9600.

**360 Degree Rotation Test** - Do this test if you cannot find any mechanical or electrical connection problems with the encoders. It is not necessary to have the scope outside to do this test.

- 1) Put the unit into FORK mode and turn OFF sidereal clock (see [Setup Menu](#)). These settings are only for the test. Remember to restore the original settings after the test is done.
- 2) Turn the unit on and position the (Dob) scope roughly horizontal. When prompted for 1 or 2 star alignment, select 1 star.
- 3) Select a star near the equator like Betelgeuse (+7.5 North) and press  to align on it.
- 4) Establish a mechanical reference point in azimuth. This can be any fixed object in the room. Move the scope to the reference position and note the azimuth (or RA) number on the display.
- 5) Move the scope as you would normally in azimuth, making several complete rotations, first in clockwise direction and then counter clockwise direction. If you move slightly in elevation, it is OK. Each time the scope comes to the reference point, note the number displayed. It should always be the same as the first reading. This completes the azimuth test.
- 6) Move the scope in elevation to its lowest point. There should be some kind of mechanical stop. Note the elevation (declination) number. Now move to the zenith stop point and note that number. The two numbers should be roughly 90 degrees apart allowing for the fact the mechanical stops may not be exactly 90 degrees apart. Also allow for negative numbers at the horizontal position and overshooting +90 degree reading at the vertical position.
- 7) Move the scope in elevation between the two stops and note that the readout returns to the recorded numbers at the stop points. This completes the elevation test.

**Technical Assistance**

Technical assistance is available to all customers free of charge. Normal business hours are from 7:00 PM to 10:00 PM EST Mon-Sat. Leave message if necessary.

By Phone – **(954)345-8726**

E-Mail – [skycomm@att.net](mailto:skycomm@att.net)

Web Site – <http://www.skyeng.com>

Orders and other correspondence:

**Sky Engineering Inc  
4613 N University Drive  
#351  
Coral Springs, FL 33067**

# Appendix A

## Method of Determining 90 Degree Setting for GE Mounts

The advantage of the 2-star alignment is in not having to be polar align. Whenever a 2-star alignment is done, the user is required to orient the scope to '+90 degree declination' (except for Dobsonians). It is important to understand that this position is relative to the telescope itself and not the sky. The 90 degree position is achieved by having the optical axis of the scope parallel to the scope's polar axis.

The Sky Commander computer uses a unique Auto-Lock method whereby the +90 degree point is found by computation based on the sighting of the two alignment stars. You are only required to set the position to within about a degree or so. Thus, one opportunity for error is eliminated. Auto-Lock applies only to fork mounted scopes. It does not apply to German equatorials. This means that the +90 degree setting must be done with some precision for a German equatorial.

Fortunately there is an easy method to locate the +90 degree point on a German equatorial. Perform the following steps:

- 1) Collimate the telescope as accurately as possible.
- 2) Position the scope with the polar axis pointed toward Polaris (not the actual celestial pole). Polaris is used because is relatively stationary.
- 3) Put the scope in top position (dec axis vertical as viewed from front). Adjust the elevation of the mount so that Polaris passes through the center of field as the scope is moved left and right on the dec axis. Use a medium power eyepiece (preferably one with an illuminated reticle).
- 4) Now put the scope in side position (dec axis horizontal) on the west side of the mount. Adjust the mount left and right until Polaris moves through the center of field as the scope is moved up and down on the dec axis.
- 5) Flip the scope to the opposite side of the mount (dec axis again horizontal). See how close Polaris comes to center of field as you sweep on the dec axis.
- 6) If Polaris cannot be centered, it means that the optical axis is not square with the dec axis. Shim the optical tube as required to correct the error. Take up just half the error as seen in the eyepiece, otherwise you will be off in opposite direction when you flip the scope to the other side. You will have to make a small azimuth adjustment as well each time you adjust the shim. Repeat steps 4-6 until Polaris is centered on both sides of the mount.
- 7) Bring the scope to top position once more. Move on the dec axis to bring Polaris to



the center of field. If it is a little high or low, don't worry but make sure it is centered left to right.

8) Now adjust the mechanical declination setting circle to exactly 90 degrees and lock it down well. If there is no mechanical setting circle, some means should be employed to locate this exact position when it is needed.

# Appendix B

## RS-232 Serial Port

The serial port is used for communications with a PC during normal use and also for the purpose of flash memory upgrade.

- **Connector and Pin Assignment**

The serial port is located on the rear panel of the unit. It is a 6-pin RJ11 type modular jack .

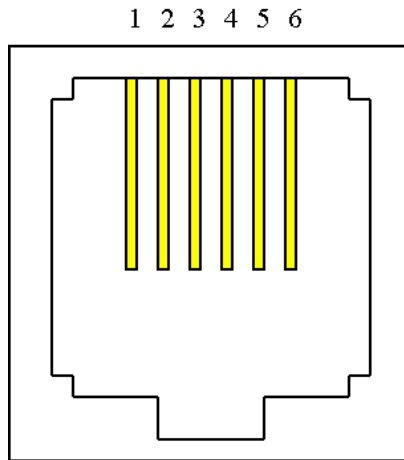


Figure 4 - RS232 Serial Port

Pin functions are as follows:

RJ11 Pin	DB9 Pin	Function
1	NC	Used for flash upgrade, do not use in normal operation
2	5	Ground
3	NC	Alternate 12V Power input for Sky Commander
4	2	Data from Sky Commander to PC
5	3	Data from PC to Sky Commander
6	NC	Used for flash upgrade, do not use in normal operation

DB9 pins refer to the serial connector of a Personal Computer. Note – PCs that do not have serial ports can use USB to serial (COM port) adapter cables.

A number of commercially available programs for the PC will communicate with the Sky Commander. These programs allow you to display a section of the sky centered on the position of the telescope. This can be convenient when hopping from one object to others nearby.

- **Line Settings**

When connecting with a PC, use the following line settings –

- 1 start bit
- 8 data bits
- No parity
- 1 stop bit
- Flow Control - None

Available baud rate settings are 300, 600, 1200, 2400, 4800, and 9600 bits per second. See section [Setup Menu](#) for information on how to set the Sky Commander baud rate. This rate must match the rate selected on the PC.

- **Command Protocol**

Some users may wish to write their own programs to interface with Sky Commander. For this you will need to understand the data format that is used. This section describes the various commands.

- **Request Position Command '0X0D'**

Whenever the program needs updated coordinates it sends a carriage return character (hexadecimal 0D) to the Sky Commander. The program will then receive a 16 character ASCII string. The format is as follows:

- [1] space
- [2,3] integer part of RA hours
- [4] fixed decimal point
- [5-7] fractional part of hours
- [8] space
- [9] + or - for declination
- [10,11] integer part of declination
- [12] fixed decimal point
- [13-15] fractional part of declination
- [16] NULL character to terminate string

Example: `_12.345_+67.890` (underscore represents a space character, 0X20).

The fractional part of the number is treated as a fractional part of an hour, e.g. 4.25 is 4 hours 15 minutes. The same applies to declination.

Most programming languages provide an easy means to convert the string to floating point variables.

- **Load Special Object Coordinates Command**

Coordinates of special objects can be uploaded to the Sky Commander from a PC using the following command:

**Lxx\_hh.hhh\_+dd.ddd[CR]**

- xx=special object ID number (00 through 58 and 99 valid)
- '\_' = space character.
- hh.hhh= RA hour and fractional part thereof.
- +dd.ddd= Declination (with sign) and fractional part.
- [CR] = carriage return character.

Sky Commander will respond with ASCII 'A' for acknowledge. For object IDs 00 through 58, the coordinates are stored in EEPROM (Electrically Erasable Programmable Read Only Memory) and are permanent until overwritten. If object ID number 99 is used, the data is stored in RAM (Random Access Memory) and is only valid until the unit is turned off.

- **Read Special Object Coordinates Command**

To read back special object coordinates stored in the Sky Commander, use the following command:

**?xx** where xx=special object ID number (00 through 58 valid).

Sky Commander will respond with: hh.hhh +dd.ddd[CR].

- **Object Offset Command ASCII 'O'**

Azimuth and elevation offsets (distance to current object) can be obtained with the single character 'O' command. This is useful when the telescope is to slew automatically to the current object.

Sky Commander responds with eight binary bytes (not ASCII). The bytes represent two floating point numbers. The first number is the elevation offset, +=Go Up. The second of the two numbers is the azimuth offset, +=Go CCW. Both numbers are in units of degrees. See section [Floating Point Format](#) below for a full description.

- **Drive Rates Command ASCII 'R'**

Sky Commander calculates the azimuth and elevation drive rates required to track an object. The single letter 'R' command is used.

Sky Commander responds with eight binary bytes representing two floating point numbers. The first number is the elevation rate and the second is the azimuth rate. Positive numbers indicate the telescope should move UP (for elevation) or go CCW (for azimuth). Units are in degrees/minute.

- **Field Rotation Command ASCII 'F'**

While tracking an object in azimuth and elevation, the field will rotate slowly, limiting photographic exposure times. The rate of rotation depends on where the telescope is pointing. Sky Commander calculates and reports field rotation in response to the 'F' command.

A single floating point number, four binary bytes is returned. The sign is arbitrary since the number of mirrors in the optical system will affect the direction of rotation. Units are in degrees/minute.

- **Floating Point Format**

Numbers that are returned in response to various commands are expressed in IEEE floating point format as described below:

Each number consists of four bytes (32 bits) with the most significant byte sent first. The bits are assigned the following meaning:

- 31: sign of mantissa, 1=negative.
- 30-23: exponent, biased by 128.
- 22-0: mantissa, 24 bits, MSB hidden and always=1.

The mantissa is normalized, 24 bits with the MSB hidden. The MSB is always assumed to be 1, therefore only 23 bits are needed to store the mantissa. The exponent is biased by 128; i.e. a 128 value represents an exponent of zero. A 129 value is an exponent of 1. Example: if the exponent has a 131 value (+3), the number is  $2^3 * (\text{mantissa})$ . The mantissa is always less than one, and greater than or equal to 1/2.

The number zero is stored as four zero bytes.

# Appendix C

## Encoder Jack

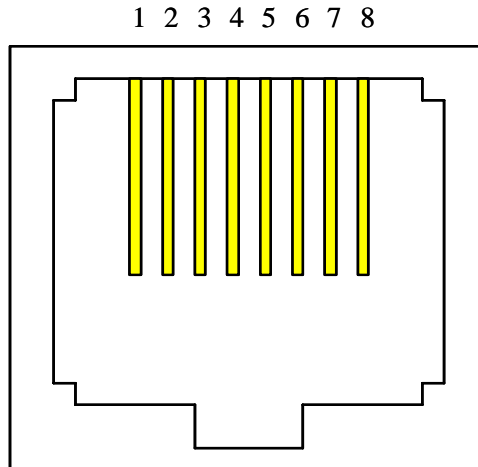


Figure 5 - RJ45 Encoder Jack

RJ45 Pin	Function
1	Azimuth (or RA) Channel B Signal
2	Azimuth Encoder +5V Power
3	Azimuth Channel A Signal
4	Ground
5	Elevation (or Declination) Channel B Signal
6	Elevation Encoder +5V Power
7	Elevation Channel A Signal
8	Ground

# Appendix D

## A Discussion of Pointing Accuracy

You have purchased a sophisticated computer system with high resolution motion encoders. You would hope to be able to pinpoint objects with it when you 'zero-in'. Still, you may find that for one reason or another, there are inaccuracies in pointing. Even after carefully following alignment procedures you still have to fish around a little to find the object. This section is a discussion of factors that influence pointing accuracy.

To start with, consider the telescope itself. Whether it has an equatorial mount or an alt-azimuth, it moves on two axes. Ideally, these axes are orthogonal or perpendicular to each other. The reason for this stems from the fact that celestial coordinates are based on a polar system that is orthogonal in itself. An equatorial telescope can never be truly polar aligned unless its axes are orthogonal. While alt-azimuth telescopes are never physically polar aligned, it is nonetheless important to have orthogonality where digital setting circles are concerned. All of the calculations done in the Sky Commander computer are based on orthogonal coordinates.

The effect of not having orthogonality is that the computer receives slightly distorted position information. Even though the encoders are installed perfectly and give the exact angular position of each shaft or axis, if the axes are not orthogonal, the computed position may not match the true position, hence a pointing error.

Besides the problem of orthogonality between the two main axes, there is the question of orthogonality between the declination (or elevation) axis and the scope's optical axis. This likewise can cause pointing errors with an effect similar to that noted above. The two misalignments though independent of each other can be difficult to distinguish when trying to correct. Always collimate the tube assembly before trying to 'square' it with the declination (or elevation) axis.

Dobsonian telescopes in particular can exhibit a 'wobbling' of the azimuth axis caused by non-flatness of the bottom of the rocker box. It is not difficult to understand how this can contribute to pointing errors. It can easily be checked with a straightedge.

If either of the two encoders is mounted off the center of rotation there will be some error, for instance if the elevation encoder on a Dobsonian is not mounted in the center of the bearing disk, an error due to 'runout' is experienced.

The encoders themselves have a certain angular resolution. This is the smallest movement that can be detected. Resolution itself is a source of error when aligning and in normal use. Though small, it can add to other errors.

Always take time to center alignment stars in the eyepiece. This obvious source of error should not be overlooked. Remember the axiom sometimes referred to as GIGO or

'Garbage In Garbage Out'. Whenever a computer is given erroneous data input, you can expect erroneous data output.

The computer itself contributes little if any error. All calculations are done in single precision floating point with six or seven digit accuracy, more than is required. Star and deep sky object coordinates are stored in the computer's memory to the nearest .01 degree.

Remember that you can use the 'Realign on Object' feature to improve pointing accuracy. See [Realignment on Database Objects](#).



## Appendix E

### Installing the ALT-AZ-1000 Kit



Figure 6 - Dob Kit (encoders not included)

**Important Note:** Before performing the following procedure, make certain that there is at least 1-3/8" clearance between the inside bottom surface of the rocker box and the front bottom corner of the mirror box as it swings past the rocker box center (pivot point). Insufficient clearance will result in damage to the azimuth encoder.

#### Azimuth:

1. Cut a 1-1/4" hole in the bottom center of the rocker box. A hole saw works very well for this operation. One can be obtained at almost any hardware store for about five dollars. If a hole already exists, it is a good idea to plug it up first with a piece of wood dowel so that the hole saw has something to keep it centered. Try to keep the drill as

perpendicular as possible to the wood surface. Exact centering is not critical.

2. Press the 1" bronze bushing (1-1/4" OD) into the hole from the top. DO NOT hit it directly with a hammer since it will deform easily. If it will not press in by hand, use a piece of rough sandpaper or a rasp to enlarge the hole slightly. If the bushing is loose in the hole, use some quick set epoxy. Be sure that the flange of the bushing is resting flat on the wood surface as the epoxy sets up.

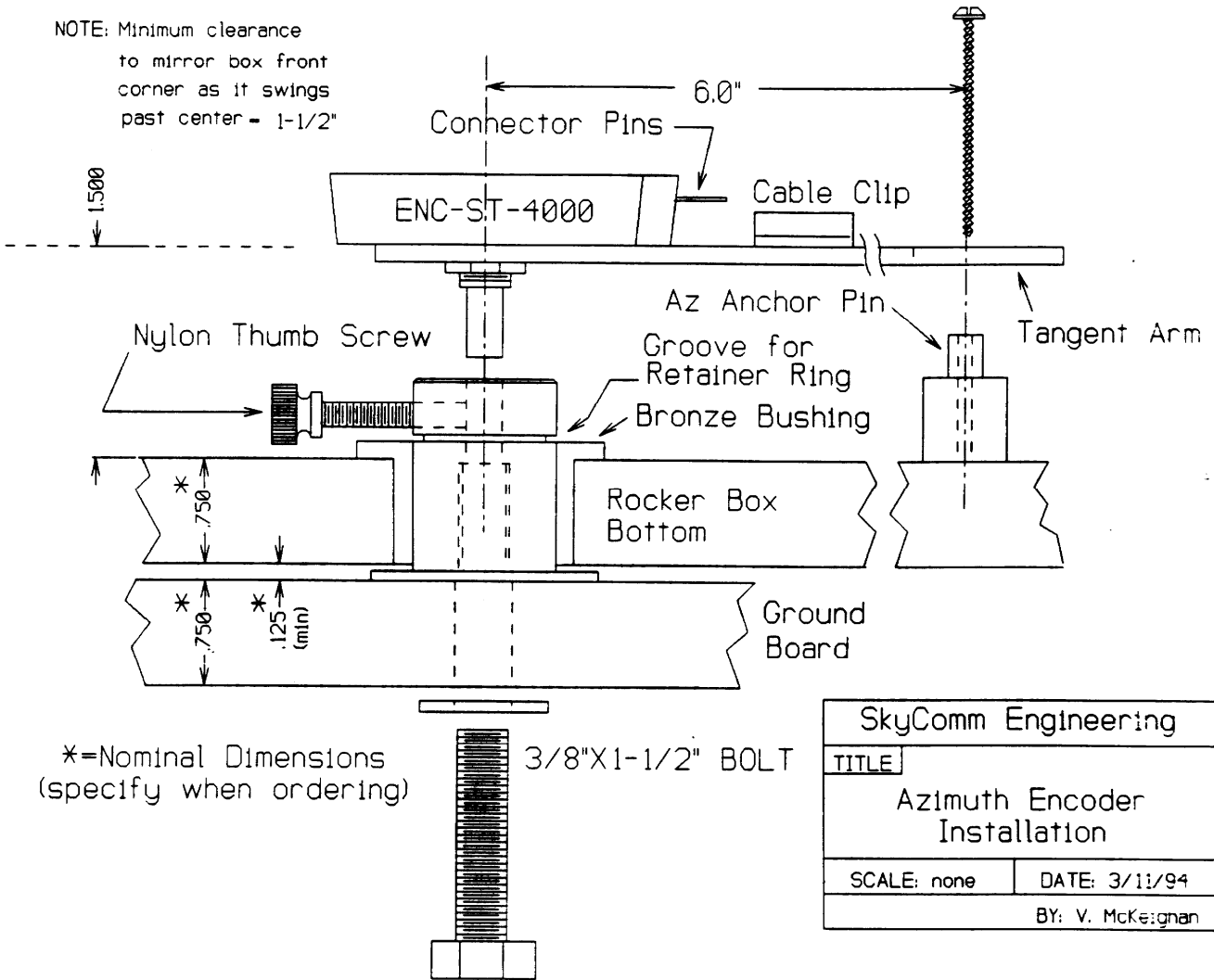
3. Mount the 1" diameter pivot pin as shown in the drawing. Drill a 3/8" hole in the center of the ground board (centering not very critical). Use the smaller flat washer under the head of the 3/8"-16 x 1-1/2" bolt. Pass the bolt through the hole from the bottom. Put the larger flat washer over the end of the bolt and then thread on the 1" diameter pivot pin. Tighten until snug.

4. Assemble the rocker box and ground board. Slide the spring retainer ring into the groove of the pivot pin if you wish to always keep the rocker box and ground board together. The ring can be removed later if necessary.

5. Mount the azimuth anchor pin to the inside bottom of the rocker box at a place six inches from the pivot point and in the direction that you will dress the azimuth encoder cable.

6. Start the 10-32 nylon thumb screw into the side of the 1" pivot pin. Take the azimuth encoder/tangent arm assembly (the shorter of the two) and insert the 1/4" dia encoder shaft into the end of the pivot pin. At the same time slide the forked end of the tangent arm over the anchor pin. Make sure that the encoder shaft is all the way into the hole of the pivot pin. Tighten the nylon thumb screw lightly.

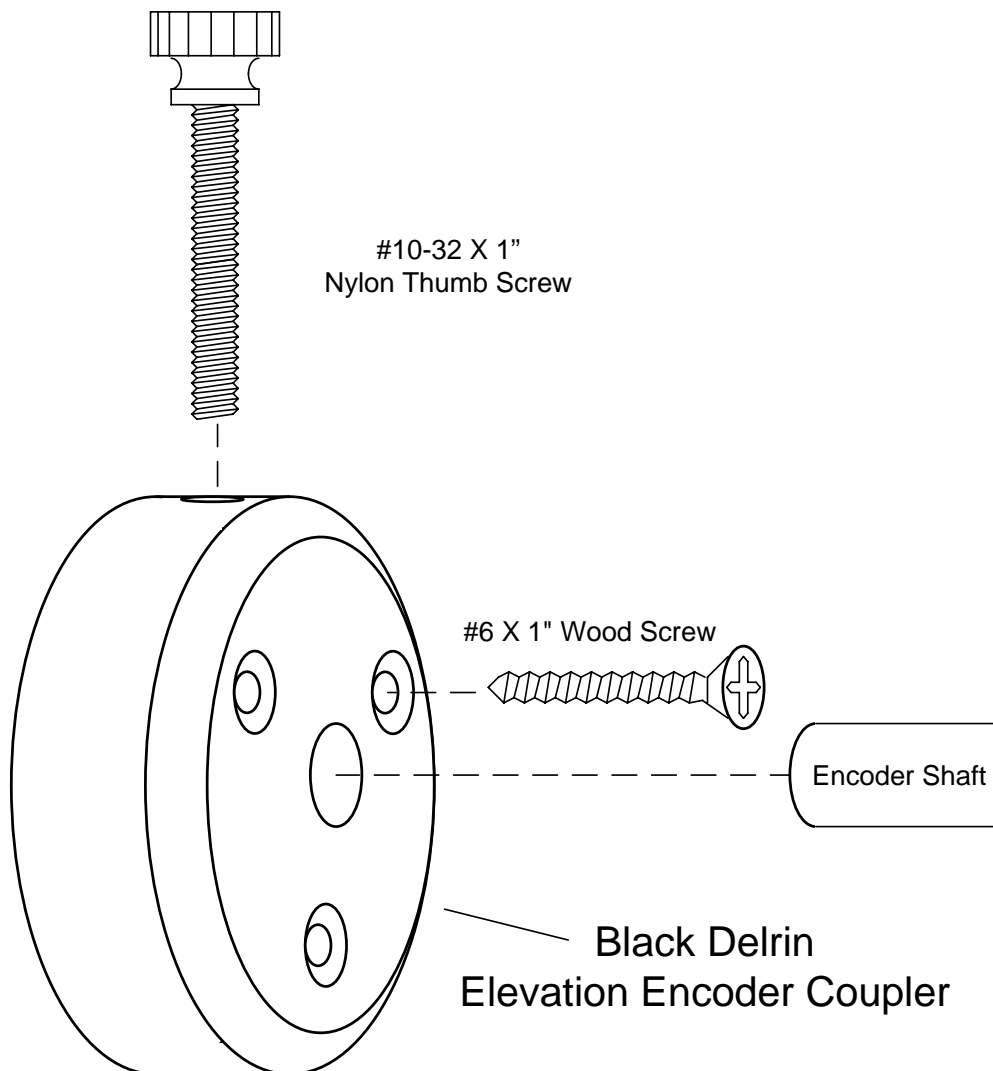
7. Find the end of the azimuth encoder cable (longer of the two cables). Plug the cable into the RJ11 jack on the tangent arm. This completes the installation of the azimuth encoder.



**Figure 7 - Azimuth Encoder Mounting**

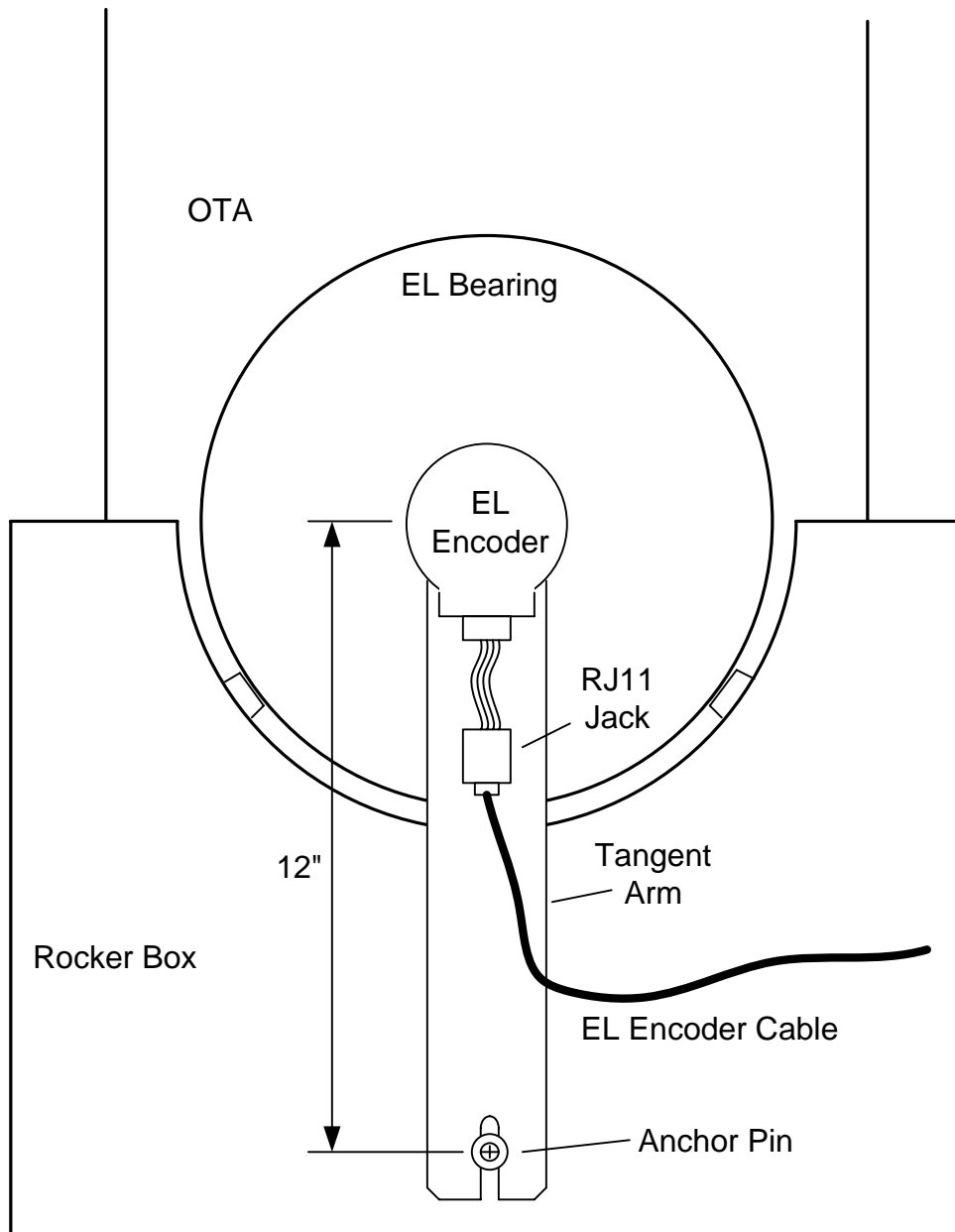
**Elevation:**

1. Mount the elevation encoder coupler to one of the side bearings with three #6 X 1" stainless steel wood screws. Use care to center the coupler. An off-center coupler could result in degraded pointing accuracy
  
2. Mount the elevation anchor pin to the side of the rocker box. Drill a small pilot hole for the #4 wood screw at a point 12" from the center of the encoder coupler. The hole may be straight down from the center, or on an angle, as required. Use the #4 stainless steel washer under the screw head to prevent the slotted end of the encoder arm from slipping off the anchor pin.



**Figure 8 - Elevation Encoder Mounting**

3. Install the elevation encoder/tangent arm assembly by sliding the slotted end over the anchor pin and then inserting the 1/4" shaft of the encoder into the hole in the coupler. Tighten the nylon thumb screw.
4. Find the end of the elevation encoder cable (shorter of the two cables). Plug it into the RJ11 jack on the elevation tangent arm. This completes the installation of the elevation encoder.



**Figure 9 – Mounting of Elevation Encoder Arm**

## **1-Year Warranty**

The Sky Commander XP4 is warranted for a period of 1 year from date of purchase. If the unit or encoders or associated parts fail due to defective material or workmanship, the unit or parts will be repaired or replaced free of charge. The unit or parts will be shipped free of charge one way. Damage done by incorrect installation or abuse is not covered by this warranty.