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1 Introduction

Thank you for buying the Sky Commander XP4 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.

![Battery Installation Diagram](image)

**Figure 2 Battery Installation**
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 \[\text{ }\] 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 \[\text{ }\] to select 1 star.

Position the scope in elevation to just above horizontal. Use \[\text{ }\] and \[\text{ }\] to select
a star near the equator like *Aldebaran* which is about +16 degrees declination. Press \[\rightarrow\] when you see it displayed. The display should look similar to the following:

\[
04h\ 36m\ +16.6 \\
Mes_\_0001\  \circ\ \ Tau
\]

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 \[\rightarrow\] 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 \[\uparrow\] to select 1 star.

Position the scope in declination near the equator. Use \[\uparrow\] and \[\downarrow\] to select a star also near the equator like *Aldebaran* which is about +16 degrees declination. Press \[\rightarrow\] when you see it displayed. The display should look similar to the following:
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 \( \rightarrow \) 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 \( \uparrow \) to select 1 star.

Position the scope in declination near the equator, and near the eastern horizon in RA. Use \( \uparrow \) and \( \downarrow \) to select a star also near the equator like Aldebaran which is about +16 degrees declination. Press \( \rightarrow \) when you see it displayed. The display should look similar to the following:

\[
04h 36m +16.6 \\
Mes_0001 \rightarrow TAU
\]

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 \( \downarrow \). 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 \( \uparrow \) and \( \downarrow \) buttons to select a convenient star on the eastern side of the meridian. Get the star sighted accurately in the scope and press \( \rightarrow \). 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 \( \rightarrow \). 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.

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 \text{\textarrowleft} and scrolling the month, day and year with \text{\textarrowup} or \text{\textarrowdown}. Press \text{\textarrowright} to save the date and proceed to \textit{Star Alignment}. 

\begin{figure}
\centering
\includegraphics[width=0.7\textwidth]{keypad_buttons.png}
\caption{Keypad Buttons}
\end{figure}
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  â  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 [left] and [right] 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 [up] to change it to ‘4’. Now move the cursor under the 1, and change it to 2. Now press [enter] 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  â  ORI
```

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

\[ \ast \ 00h \ 20m \ +12.8 \]

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:

\[ \ast \ 000.0 \ 00.0 \]

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:

\[
\begin{array}{c}
05\text{h } 55\text{m } +07.4 \\
\text{Mes } 0042 \quad \odot \quad \text{ORI}
\end{array}
\]

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

\[
\begin{array}{c}
05\text{h } 55\text{m } +07.4 \\
\text{NGC } 0001 \quad \odot \quad \text{PEG}
\end{array}
\]

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](http://www.skyeng.com).

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

**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 -
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.

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 AcaMar

* ›000.0 ↓ 00.0
   NST Alberio
Press $\rightarrow$ to make the object current.

4.4.3 Named with Constellation Catalogs

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

$$* \uparrow 000.0 \downarrow 00.0$$

Db1 $\Omega$ 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 $\uparrow$ and $\downarrow$ buttons. Move the cursor back under the double star name to continue with your search. Press $\rightarrow$ 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 \( \text{<} \) and \( \text{>} \) buttons to select the desired display brightness, LOW, MEDIUM or HIGH. Press \( \text{<} \) to permanently save the setting. Press \( \text{<} \) to return to operating mode.

5.4 Favorite List Menu

Use \( \text{<} \) and \( \text{>} \) buttons to turn the list On or Off. See Favorite Objects List for information on this special mode. Press \( \text{<} \) 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 \( \text{<} \) button and \( \text{>} \) button. The Favorite list will be erased. Press \( \text{<} \) to return to operating mode.

5.6 Battery Monitor Menu

A bar is displayed on the bottom line -

\[
\begin{array}{c}
E \quad \text{-} \\
\text{BATTERY}+ \\
F \\
\end{array}
\]

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 \( \text{<} \). Sky Commander will automatically exit the menu display. The offset should now be zero on each axis –

\[
\begin{array}{c}
* \downarrow 000.0 \uparrow 00.0 \\
Mes_0042 \diamond ORI \\
\end{array}
\]

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: \[\text{ to get to menu screens}\] \\[\text{ or }\] \\[\text{ to get to Equatorial Table Reset.}\]

   Bring table back to reset position. The table must be running.
   Press \[\text{ immediately.}\]
   Press \[\text{ to return to normal operation.}\]

   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 \( \downarrow \) will display basic information about the current object. For instance, go to the Messier catalog, ‘Mes’. Change the number to 0027 and press \( \rightarrow \) to make it current.

\[
\text{Mes}_{0027} \rightarrow \text{VUL}
\]

The cursor reverts back to home position. Now press \( \downarrow \) to display information –

\[
\text{Planet Neb} +07.3
\]

M27 is a planetary nebula of magnitude 7.3. Press \( \downarrow \) 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 ‘Dbl’ and scroll to the constellation of Andromeda, ‘AND’. With the cursor under the star name, scroll to -

\[
\text{Dbl}_0 \Sigma 5_{14} \rightarrow \text{AND}
\]

Press \( \rightarrow \) to make it current, then press \( \downarrow \) to show the information -

\[
7.1/9.5 \space 005''
\]

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 \( \text{Byr}_{\text{ALPHA}} \rightarrow \text{AND} \), the following info is displayed –

\[
2.1/\text{B8/}
\]

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 –

\[ S* \ 000.3 \uparrow 00.2 \]
\[ Mes_0081 \diamond UMA \]

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, \( \diamond \) 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 \( \uparrow \) and \( \downarrow \) 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.

\[ NGC \ 0001 \diamond PEG \]
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 nebulae 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 \( \rightarrow \) will cause the following prompt –

```
Add to Fav List?
\( \downarrow \) yes \( \uparrow \) NO
```

If you wish to add the object to the favorite list, move the cursor under YES, and press \( \rightarrow \). Otherwise just press \( \rightarrow \) 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 (\( \rightarrow \)) and index to the ‘Favorite List’ menu. See **Favorite List Menu**. Turn on the list by moving the cursor under ON, then press \( \rightarrow \) 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*  \#038.1 + 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 \( \rightarrow \) and \( \rightarrow \) 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\textsuperscript{st}, set the date to June 2\textsuperscript{nd}. 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 $\leftarrow$ button to move the cursor under the catalog name and then index to the PLN catalog using the $\uparrow$ and $\downarrow$ buttons. The display should look something like

* $\#032.1 \downarrow 19.3$
PLN_ Mercury

Now move the cursor over by the planet name with the $\rightarrow$ button and index to a different planet with the $\uparrow$ and $\downarrow$ buttons. $\rightarrow$ 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 $\rightarrow$ 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.

Note – ‘Equatorial Table Reset’ appears in the list of menu items only when the sidereal clock is turned off, as it must be for using the Sky Commander XP4 on an equatorial table.
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

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha UMi</td>
<td>Polaris</td>
<td>2 31 50</td>
<td>89 15 50</td>
<td>2</td>
</tr>
<tr>
<td>Alpha CAS</td>
<td>Schedar</td>
<td>0 40 30</td>
<td>56 32 15</td>
<td>2.2</td>
</tr>
<tr>
<td>Beta CET</td>
<td>Deneb Kaitos</td>
<td>0 43 35</td>
<td>-17 59 12</td>
<td>2</td>
</tr>
<tr>
<td>Beta AND</td>
<td>Mirach</td>
<td>1 9 44</td>
<td>35 37 14</td>
<td>2.1</td>
</tr>
<tr>
<td>Alpha ARI</td>
<td>Hamal</td>
<td>2 7 10</td>
<td>23 27 45</td>
<td>2</td>
</tr>
<tr>
<td>Beta PER</td>
<td>Algal</td>
<td>3 8 10</td>
<td>40 57 21</td>
<td>2.1</td>
</tr>
<tr>
<td>Alpha PER</td>
<td>Mirfak</td>
<td>3 24 19</td>
<td>49 51 40</td>
<td>1.8</td>
</tr>
<tr>
<td>Gamma ERI</td>
<td>Zaurak</td>
<td>3 58 2</td>
<td>-13 30 31</td>
<td>3</td>
</tr>
<tr>
<td>Alpha TAU</td>
<td>Albedaran</td>
<td>4 35 55</td>
<td>16 30 33</td>
<td>0.9</td>
</tr>
<tr>
<td>Beta ORI</td>
<td>Rigel</td>
<td>5 14 32</td>
<td>-8 12 6</td>
<td>0.1</td>
</tr>
<tr>
<td>Alpha AUR</td>
<td>Capella</td>
<td>5 16 41</td>
<td>45 59 53</td>
<td>0.1</td>
</tr>
<tr>
<td>Alpha ORI</td>
<td>Betelgeuse</td>
<td>5 55 10</td>
<td>7 24 26</td>
<td>0.5</td>
</tr>
<tr>
<td>Alpha CMa</td>
<td>Sirius</td>
<td>6 45 9</td>
<td>-16 42 58</td>
<td>-1.5</td>
</tr>
<tr>
<td>Alpha CMi</td>
<td>Procyon</td>
<td>7 39 18</td>
<td>5 13 30</td>
<td>0.4</td>
</tr>
<tr>
<td>Beta GEM</td>
<td>Pollux</td>
<td>7 45 19</td>
<td>28 1 34</td>
<td>1.1</td>
</tr>
<tr>
<td>Iota UMa</td>
<td>Talitha</td>
<td>8 59 12</td>
<td>48 2 29</td>
<td>3.1</td>
</tr>
<tr>
<td>Alpha HYA</td>
<td>Alphard</td>
<td>9 27 35</td>
<td>-8 39 31</td>
<td>2</td>
</tr>
<tr>
<td>Alpha LEO</td>
<td>Regulus</td>
<td>10 8 22</td>
<td>11 58 2</td>
<td>1.4</td>
</tr>
<tr>
<td>Lambda UMa</td>
<td>Tania Borealis</td>
<td>10 17 6</td>
<td>42 54 52</td>
<td>3.5</td>
</tr>
<tr>
<td>Delta LEO</td>
<td>Zosma</td>
<td>11 14 6</td>
<td>20 31 25</td>
<td>2.6</td>
</tr>
<tr>
<td>Gamma UMa</td>
<td>Phceda</td>
<td>11 53 50</td>
<td>53 41 41</td>
<td>2.4</td>
</tr>
<tr>
<td>Alpha2 CVn</td>
<td>Cor Caroli</td>
<td>12 56 2</td>
<td>38 19 6</td>
<td>2.9</td>
</tr>
<tr>
<td>Alpha VIR</td>
<td>Spica</td>
<td>13 25 12</td>
<td>-11 9 41</td>
<td>1</td>
</tr>
<tr>
<td>Nu UMa</td>
<td>Alkaid</td>
<td>13 47 32</td>
<td>49 18 48</td>
<td>1.9</td>
</tr>
<tr>
<td>Alpha BOO</td>
<td>Arcturus</td>
<td>14 15 40</td>
<td>19 10 57</td>
<td>0</td>
</tr>
<tr>
<td>Beta BOO</td>
<td>Nekkar</td>
<td>15 1 57</td>
<td>40 23 26</td>
<td>3.5</td>
</tr>
<tr>
<td>Beta LIB</td>
<td>Zubeneschamali</td>
<td>15 17 0</td>
<td>-9 22 58</td>
<td>2.6</td>
</tr>
<tr>
<td>Alpha SCO</td>
<td>Antares</td>
<td>16 29 24</td>
<td>-26 25 55</td>
<td>1</td>
</tr>
<tr>
<td>Zeta HER</td>
<td></td>
<td>16 41 17</td>
<td>31 36 10</td>
<td>2.8</td>
</tr>
<tr>
<td>Alpha OPH</td>
<td>Rasalhague</td>
<td>17 34 56</td>
<td>12 33 36</td>
<td>2.1</td>
</tr>
<tr>
<td>Alpha Lyr</td>
<td>Vega</td>
<td>18 36 56</td>
<td>38 47 1</td>
<td>0</td>
</tr>
<tr>
<td>Alpha AQL</td>
<td>Altair</td>
<td>19 50 47</td>
<td>8 52 6</td>
<td>0.8</td>
</tr>
<tr>
<td>Gamma CYG</td>
<td>Sadr</td>
<td>20 22 14</td>
<td>40 15 24</td>
<td>2.2</td>
</tr>
<tr>
<td>Alpha CYG</td>
<td>Deneb</td>
<td>20 41 26</td>
<td>45 16 49</td>
<td>1.3</td>
</tr>
<tr>
<td>Epsilon PEG</td>
<td>Enif</td>
<td>21 44 11</td>
<td>9 52 30</td>
<td>2.4</td>
</tr>
<tr>
<td>Eta PEG</td>
<td>Matar</td>
<td>22 43 0</td>
<td>30 13 17</td>
<td>2.9</td>
</tr>
<tr>
<td>Alpha PSA</td>
<td>Fomalhaut</td>
<td>22 57 39</td>
<td>-29 37 20</td>
<td>1.2</td>
</tr>
</tbody>
</table>
# 8 XP4 Specifications

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

<table>
<thead>
<tr>
<th>TROUBLE</th>
<th>CORRECTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>No display indication when unit is turned on.</td>
<td>Check internal battery and connection. Try external 12V power.</td>
</tr>
<tr>
<td>No display backlight visible.</td>
<td>Adjust intensity with keypad. Light is intentionally dim for night use.</td>
</tr>
<tr>
<td>Either RA or dec readout does not change when scope is moved.</td>
<td>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.</td>
</tr>
<tr>
<td>Objects cannot be found</td>
<td>Check direction and resolution settings for each encoder. Objects may be too dim. Be sure to correctly identify alignment stars.</td>
</tr>
<tr>
<td>Position accuracy poor</td>
<td>Check resolution setting for each encoder. Check centering of encoders. Check orthogonality of axes and optical collimation. Center alignment stars accurately.</td>
</tr>
<tr>
<td>Position accuracy degrades with time.</td>
<td>Check that the sidereal clock is turned on. Check encoders to make sure they are not slipping. Do not move scope too fast.</td>
</tr>
<tr>
<td>RA or Azimuth reading seems to stop counting when turning scope counter-clockwise, but may be OK in clockwise direction.</td>
<td>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.</td>
</tr>
<tr>
<td>Unit does not work when used with Sky Tracker Dobsonian drive system</td>
<td>Check connection between Sky Commander and Sky Tracker box. Make sure Sky Commander RS232 baud rate is set to 9600.</td>
</tr>
</tbody>
</table>
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

Web Site – http://www.skyeng.com

Orders and other correspondence:

Sky Engineering Inc
4630 N University Drive
PMB 329
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.

![Diagram of RS-232 Serial Port]

Pin functions are as follows:

<table>
<thead>
<tr>
<th>RJ11 Pin</th>
<th>DB9 Pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
<td>Used for flash upgrade, do not use in normal operation</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>Ground</td>
</tr>
<tr>
<td>3</td>
<td>NC</td>
<td>Alternate 12V Power input for Sky Commander</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>Data from Sky Commander to PC</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>Data from PC to Sky Commander</td>
</tr>
<tr>
<td>6</td>
<td>NC</td>
<td>Used for flash upgrade, do not use in normal operation</td>
</tr>
</tbody>
</table>

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:

\[
\text{Lxx\_hh\_hhh\_+dd\_ddd[CR]}
\]

- \(xx\) = 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:

\[
?xx \quad \text{where } xx = \text{special object ID number (00 through 58 valid)}.
\]

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 $2^3 \times$ (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

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 D

AstroSystems TeleKit and flush sided telescopes with AstroSystems Hardware kit

Components List

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sky Commander Computer</td>
</tr>
<tr>
<td>2</td>
<td>Encoders</td>
</tr>
<tr>
<td>1</td>
<td>Instruction Manual</td>
</tr>
<tr>
<td>1</td>
<td>Cable set</td>
</tr>
<tr>
<td>1</td>
<td>Altitude bar w/ thumbscrew</td>
</tr>
<tr>
<td>1</td>
<td>Encoder nut</td>
</tr>
<tr>
<td>1</td>
<td>Encoder washer</td>
</tr>
<tr>
<td>1</td>
<td>Az. bracket screw #10 x 1/2&quot;</td>
</tr>
<tr>
<td>1</td>
<td>Azimuth encoder bracket</td>
</tr>
<tr>
<td>2</td>
<td>#8 Washers</td>
</tr>
<tr>
<td>1</td>
<td>Altitude pin 1/4&quot; x 5/8&quot;</td>
</tr>
<tr>
<td>3</td>
<td>Wire guide screws #10 x 1/2&quot;</td>
</tr>
<tr>
<td>3</td>
<td>Wire guides</td>
</tr>
<tr>
<td>4&quot;</td>
<td>Velcro tape</td>
</tr>
<tr>
<td>6&quot;</td>
<td>Two sided tape</td>
</tr>
</tbody>
</table>

Altitude Encoder Installation - TeleKit

The first step is to install the altitude encoder in the cut-out of the altitude Bearing. It is helpful to pencil a circle the size of the encoder body to center the encoder. The top edge of the altitude bearing is at the centerline. Apply double sided foam tape to the back of the encoder and carefully position the encoder in the center of the Altitude Bearing (#1). Be sure to orient the plug for enough clearance to insert the phone jack. Slide the altitude bar over the shaft of the encoder and tighten the thumbscrew (#2). Mark the approximate center of the slot on the side of the rocker box and then remove the connecting bar. Drill the rocker box with a 7/64" bit 5/8" deep. Place a #8 washer on the #8 x 1.25" screw, then the aluminum sleeve, then another #8 flat washer over the screw. This keeps the sleeve from compressing the rocker box. Install the screw in the rocker box (#3) and reinstall the altitude bar. The slot in the bottom of the altitude bar prevents any eccentricity of the encoder from stressing the encoder shaft while still holding the shaft stationary relative to the body when rotated.

Altitude Encoder Installation - Most Alt-Az Mounts - "DOB's"

The first step is to install the altitude encoder at the center of the altitude bearing with the encoder shaft pointing out, or away from the telescope (see illustration, Page 28 on right). It may be necessary to build-up the center of the bearing with a wood or metal plate to allow the encoder body to be mounted at the center of rotation. On telescopes that do not have a solid altitude bearing a mounting plate can be fashioned to mount to the mirror box and project to the center of rotation. It is also necessary to position the encoder far enough away from the side of the telescope to clear any hardware, such as external truss clamps, avoiding any interference with the altitude bar. Apply double sided foam tape to the back of the encoder and carefully position the encoder at the center of altitude rotation.
Slide the altitude bar over the shaft of the encoder and tighten the thumbscrew. Mark the approximate center of the slot on the side of the Rocker Box and then remove the altitude bar. The altitude bar can be oriented at any angle that allows the slot to meet the rocker box. Most prefer vertical placement.

Drill the Rocker Box with a 7/64" bit 5/8" deep. Place a #8 washer on the #8 x 1.25" screw, then the aluminum sleeve, then another #8 flat washer over the screw. The washers keep the sleeve from compressing the rocker box. Install the screw in the Rocker Box and reinstall the altitude bar. The slot in the bottom of the altitude bar prevents any eccentricity of the encoder from stressing the encoder shaft while still holding the shaft stationary relative to the body when rotated.

**Azimuth Encoder Installation**
The bracket is slipped on the threaded portion of the encoder and fastened with the nut and star washer. The encoder shaft is then inserted into the pivot bolt and fastened by tightening the set screw in the pivot bolt. If your pivot bolt is not drilled for the encoder shaft you will need to have it modified or replace with the Astrosystems Pivot Kit. Mark and drill the hole in the bottom of the Rocker Box with a 1/8" bit 1/2" deep. Install the #10 x 1/2" screw through the hole in the bracket. You can dust the bracket with flat black paint to complete the azimuth encoder installation.

**Wiring**
The wires from the altitude encoder can be run inside the mirror box by looping the wire over the top of the altitude bearing. The wire from the azimuth encoder can be run inside the mirror box, just provide enough slack so that the telescope can move freely from horizon to zenith.

If the computer is mounted on the upper cage, the wires can be wrapped around a truss and then covered by the shroud. Use the wire guides provided to route the wires. The use of Velcro makes the computer easy to remove for storage.

The computer can also be attached to the mirror box by Velcro or a wood bracket available from **AstroSystems** and oriented so the display faces toward the focuser. Some find this a more convenient location by simplifying the wiring and keeping the weight off the cage and the display light away from the eyepiece.
Encoder Installation – Obsession Style Hardware – Set 2

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Altitude encoder tangent arm</td>
<td></td>
<td>1 Altitude encoder mounting bracket</td>
</tr>
<tr>
<td>1 Azimuth encoder tangent arm</td>
<td></td>
<td>2 Encoder nut/washer</td>
</tr>
<tr>
<td>2 Thread inserts #8-32 brass</td>
<td></td>
<td>2 Thumbscrews #8-32 x 1/2&quot; brass</td>
</tr>
<tr>
<td>4 Mount screws #8 x 5/8&quot;</td>
<td></td>
<td>1 Connector mount nut 1/4&quot;-20</td>
</tr>
<tr>
<td>1 Altitude encoder connector</td>
<td></td>
<td>3/4&quot; dia. x 3/4&quot; w/ set and thumbscrew</td>
</tr>
<tr>
<td>1 Connector mount bolt</td>
<td></td>
<td>1/4-20 x 1/2&quot; (20&quot;-25&quot; telescopes)</td>
</tr>
<tr>
<td>1 Connector mount bolt</td>
<td></td>
<td>1/4-20 x 1.75&quot; (12.5&quot;-18&quot;)</td>
</tr>
</tbody>
</table>

Hardware – Azimuth Encoder

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Azimuth bracket screw #10 x 1/2&quot;</td>
<td></td>
<td>3 Wire guide screws #10 x 1/2&quot;</td>
</tr>
<tr>
<td>1 Azimuth bracket washer #10</td>
<td></td>
<td>3 Wire guides Black Nylon</td>
</tr>
</tbody>
</table>

Altitude Encoder Installation

The altitude encoder can be mounted on either side of the telescope since the direction relative to the computer is programmed in by the operator. However, the cable length will usually require the altitude encoder installation is done on the same side of the telescope as you observe. The first step is to mark and drill the holes for mounting the altitude encoder bracket on the altitude bearing. Find the center of the altitude bearing by measuring along its top side. Mark this in pencil along the top edge. On telescopes that have an arc as the altitude bearing (12.5" – 18") without a top edge, the altitude encoder bracket is mounted directly to the mirror box side. In this case the longer screw (1/4"-20 x 1.75") is used to keep the tangent arm spaced far enough from the telescope to avoid contact with the clamp blocks.
Obsession Style Hardware Installation – set #2 (cont.)

The other end of the altitude tangent arm is attached to the rocker box with two thumb screws. These are threaded into brass thread inserts. The tangent arm can be oriented vertically or angled for a lower visual impact. Slide the tangent arm on the encoder and rotate to the desired position. Mark the rocker box at the center of the two slots. Drill a 17/64" hole at both positions 1/2" deep. Put a small amount of waterproof wood glue or epoxy in the hole and using a slot screwdriver, turn the inserts in flush. When dry, attach the tangent arm but leave the brass thumbscrews slightly loose so the tangent arm is held rotationally but allows a small amount of back and forth movement to compensate for eccentricity without stressing the encoder.

Azimuth Encoder Installation

If your telescope does not have a azimuth pivot bolt with a 1/4" hole in it’s center, then you will need to replace your current bolt with one that is drilled. The standard pivot bolt supplied will have a plastic sleeve that allows a press fit of the encoder shaft. The bracket is slipped on the threaded portion of the encoder and fastened with the nut and star washer. The encoder shaft is then inserted into the pivot bolt. Mark the hole position on the other end and drill the hole in the bottom of the Rocker Box with a 1/8" bit 1/2" deep. Install the #10 x 1/2" screw through the hole in the bracket. Slide a small piece of paper under the edge of the washer and tighten the screw so the paper can still be removed. This holds the encoder bracket rotationally but allows a small amount of back and forth movement to compensate for eccentricity or side play without stressing the encoder. You can dust the bracket with flat black paint to complete the encoder installation.
Appendix C

Quick DOB setup

The following instructions are to quickly setup a DOB mount. Detailed instructions are on pages 4-8.

Turn the unit on holding both the up and down arrow keys down. The first prompt is "Select setup [1] [2] [3] [4]", choose a number with the right arrow and press enter to save and move to the next prompt with the down arrow key.

The next prompt is "Scope Mount?", select DOB. Press enter to save and move to the next prompt with the down arrow key.

The next prompt is "Set Hemisphere", select North or South depending on which hemisphere you live within. Press enter to save and move to the next prompt with the down arrow key.

The next prompt is for "RA direction". With a DOB (Altitude - Azimuth) this corresponds to Azimuth movement. Set this at NORM (normal) if the Azimuth encoder shaft points down when mounted (most cases), and to REV (reversed) if the encoder is mounted with the shaft pointing up. Press enter to save and move to the next prompt with the down arrow key.

The next prompt is for "Dec. direction". With a DOB (Alt. - Az.) this corresponds to Altitude movement. Point the telescope down and stand in front of the telescope. Looking down toward the primary mirror, determine if the encoder is on the left or right side of the telescope. If the encoder is on the right side of the telescope, set the unit to REV. If the encoder is on the left side, set the unit to NORM. This assumes that the encoder shaft is pointing away from the telescope, as with the Astrosystems TeleKit. Reverse this direction if the encoder is mounted with the shaft facing the telescope, as with the Obsession mounting hardware.

1-Year Warranty

The Sky Commander XP4 is warranted for a period of one year from date of purchase. If the unit or encoders or cabling fail due to defective materials 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.