Telescope Control Issues with TheSky and Telescopes That Use The LX200 Protocol

This document describes many fundamental issues when controlling robotic telescopes that use the LX200 protocol with TheSky Astronomy Software. These telescopes include:

- All LX200 model telescopes from Meade Instruments
- The SkySensor 2000 from Vixen
- The Gemini control system from Losmandy Astronomical Products
- Astro-Physics GTO telescope mounts that use a "hybrid" LX200 protocol

TheSky and the LX200 Interface

Understanding the interface between TheSky and telescopes that use the LX200 protocol can aid when troubleshooting problems. The interaction is straightforward. When a "Slew" command is issued from TheSky, the *right ascension and declination* coordinates displayed in the Object Information dialog box are sent to the telescope through the serial port.
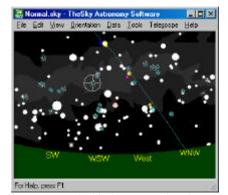

Figure 1 — TheSky's screen showing the telescope cross hairs.
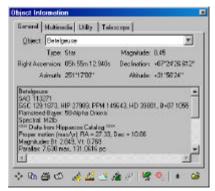

Figure 2 — The Object Information dialog box for the star Betelgeuse.

Whether or not the telescope *actually arrives* at the precise coordinates issued by TheSky is *completely dependent on the telescope*. No telescope points perfectly, so chances are the telescope is not actually pointing at the destination coordinates. And TheSky merely reflects the coordinates reported from the telescope.

In addition, TheSky does not use the telescope's built-in databases for positional information when slewing the telescope. TheSky obtains its positional data from other catalogs (Hipparcos/Tycho, GSC, PCG, NGC, etc.) then sends the right ascension and declination coordinates to the telescope.

A Slewing Test

Suppose, for example, you wish to slew to the Whirlpool Galaxy, M51. First, establish a link with the telescope as described in TheSky's manual. In TheSky, click **Edit | Find**. In the Find dialog box, type M51 and then click **Find**. TheSky now displays the following information in the Object Information dialog box:
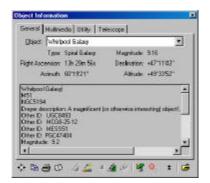
Figure 3 — M51's Object Information

Here's the complete Information on M51:

Whirlpool Galaxy
M51
NGC5194
Dreyer description: A magnificent (or otherwise interesting) object!, great spiral nebula M51.
Other ID: UGC8493
Other ID: MCG8-25-12
Other ID: MESS51
Other ID: PGC47404
Magnitude: 9.2
RA: 13h 29m 56.4s Dec: +47°11'43"
RA: 13h 29m 53.3s Dec: +47°11'48" (Epoch 2000)
Azm: 60°19'21" Alt: +49°33'52"
Rise: 08:47 Transit: 19:11 Set: 05:39
Size:11.1' x 6.9'
Position Angle: 162.0
Hour angle: -03h 44m 03.3s   Air mass: 1.31
From Betelgeuse:
 Angular separation: 100°08'18"
 Position angle: +39°13'

Click the **Slew To** button to actually move the telescope to these coordinates. After the LX200 has slewed to the object, verify that the coordinates reported by the hand paddle exactly match those displayed in the Object Information dialog box. If the coordinates do not match, there is a problem. Check the telescope's initialization settings (location, date, time, time zone, etc.) and make sure the *Long Format Mode* is turned on (see "What is the Long Format Mode?" for details.

To compare the coordinates that TheSky computes against those of the LX200, do the following: Find M51 in the LX200 hand controller's database and look at its right ascension and declination coordinates. Compare these coordinates with TheSky's. They should match within a few arcseconds when the Long Format Mode is turned on.

Here is a second telescope pointing "litmus" test. Use the LX200 hand paddle to issue the slew to command to M51. Make a note of where the object falls in the eyepiece. Now slew to M51 from TheSky. The telescope should not move significantly.

Yet Another Comparison of Coordinates
Click **Edit | Find | M51** and then slew the telescope to this object. After TheSky reports the telescope has completed the slew, (regardless of whether or not M51 is actually centered in the field or even within the eyepiece), check the coordinates in the LX200 hand paddle. The hand paddle's coordinates should be identical to the coordinates in the Object Information dialog box, indicating that the telescope "thinks" it is now on the object. Remember, TheSky very accurately "tells" the telescope where it is supposed to go.

What is the Long Format Mode?

The Long Format Mode is an option in LX200 control systems that have High Precision Pointing and this option can be turned on and off by the user. It is off by default and must be turned on each time the telescope is turned on. With the Long Format Mode turned on, positional data is sent to, or received from, the telescope to the nearest arcsecond in the following format:

```
HH:MM:SS
DD:MM:SS
```

Where HH are hours, MM are minutes, and SS are seconds of right ascension and DD are degrees, MM are minutes and SS are seconds of declination.

With the Long Format Mode turned off, positional data is sent or received to the nearest arcminute: (`HH:MM` and `DD:MM`).

You must manually turn on Long Format Mode option every time the telescope is turned on. (Due to limitations of the telescopes' firmware, there is no way to determine if the Long Format Mode is currently turned on or off.) LX200 owners should note that the Long Format Mode is *not* the same as the High Precision Pointing mode. See the LX200 manual for complete details on the differences between these two options.

Setting the Long Format Mode Using TheSky

The Long Format Mode can be set using TheSky Astronomy Software as described below.

1. Make sure your telescope is turned on and initialized.
2. From TheSky, click **Telescope | Link | Establish**.
3. Click **Telescope | Options** | **Initialize**.
4. On the Initialize dialog box, mark the **Use Long Format** option and then click **OK**.
5. In order for this change to take affect, click **Telescope | Link | Terminate** and then **Telescope | Link | Establish**.

Or,
1. Make sure your telescope is turned on and initialized.
2. From TheSky, click **Telescope | Link | Establish**. This will show the telescope's current position on the Virtual Sky.
3. Click **Telescope | Options** | **Terminal**.
4. On the Terminal dialog box, in the **Command** text box, type the following text: `:U#`
5. Click **Send**.

The text "No response" will be displayed in the Response text box when setting this option. The LX200 is now in the Long Format Mode.

Hint: Make sure that you only click **Send** once. Clicking it twice will turn the Long Format Mode off! If you accidentally click **Send** twice, power off the LX200, and then turn it back on. The telescope always starts with the Long Format Mode off.

Limitations of the LX200 protocol with the Long Format Mode Off

The coordinates reported by TheSky are slightly more accurate than the coordinates reported by the LX200. TheSky additionally compensates for such factors as nutation, abberation, and precession. TheSky's stellar and non-stellar object's positions, therefore, are accurate to about one arcsecond.

Catalog Errors

Another factor that might cause confusion when attempting to slew a telescope to a known object is errors in the celestial catalogs used by TheSky. Catalog positional errors can be as much as several arcseconds to several arcminutes. An interesting article entitled "Understanding Catalog Capriciousness" (page 91) in the

April 1997 issue of *Sky & Telescope* magazine addresses catalog errors. This is an eye-opening synopsis of how and why some of the objects plotted in TheSky are not correct. The article is available at the following URL:

http://www.bisque.com/thesky/tom/catalogs.htm

Refraction

LX200 model telescopes compute refraction internally. Therefore, TheSky does not include refraction when sending coordinates to the telescope.

Miscellaneous Initialization Issues

Always make sure that the location, date, time and time zone in TheSky are accurate before connecting to the LX200. You can optionally transfer the necessary initialization information to the LX200 from TheSky to update the telescope settings for these parameters. The LX200 is a poor timekeeper, and cannot automatically compensate for events like daylight saving time.

Two-Star Alignment

Software Bisque recommends using the LX200's built-in two star alignment procedure for initializing the telescope. This procedure is easier than accurately setting the time, date, and location that is required with the one star alignment mode. Typically, this procedure achieves better synchronization results.

Using TPoint for Windows and an LX200

If a TPoint model is created when the Long Format Mode turned off, the best possible pointing accuracy is around one arcminute. This severely limits TPoint's ability to correct the telescope's pointing.

Start a new TPoint model from scratch with the LX200 in the Long Format Mode as described above.

To get the most out of TPoint you will need a very high resolution closed loop encoder system yielding about 1 arcsecond or better resolution, like an LX200. TPoint is not intended to be used with "low" resolution systems that use standard encoders (ranging from 2000 encoder tics per revolution to 10,000 tics per revolution).

For a definition of RMS pointing please visit here our web page at
http://www.bisque.com/products/paramount/Pmntfaqs.asp

For a complete synopsis of telescope pointing issues and TPoint, visit the TPoint author's home page at
http://www.tpsoft.demon.co.uk.