iOptron®

GoToNova® Dual Axis GOTO Kit

Instruction Manual

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WARNING!

Never use a telescope to look at the Sun without a proper solar filter!
Looking at or near the Sun will cause instant and irreversible damage to your eye.
Children should always have adult supervision while observing.

1. Overview

This iOptron® GoToNova® dual axis GOTO upgrading kit helps you upgrade your existing German equatorial mount to a computerized mount with GOTO function. This kit is perfect for people who are interested in Do-It-Yourself (DIY). After simple and easy to follow installation steps, you will be able to explore the sky with the hand controller (HC). You can also expand the functionalities by connecting the mount with your laptop computer.

The GoToNova® dual axis GOTO upgrading kit is available for the EQ5-like mounts (144 teeth). The kit is compatible with the following mounts: EQ5, Vixen Great Polaris (GP), Orion SkyView Pro, Celestron CG-5, Meade LDX55/LDX75 and Astro-5. The kit may also be used on the older Vixen Super Polaris (SP) with some more modification to the housing.

You can further upgrade your telescope system with optional GPS module and ST-4 autoguiding adapter from iOptron.

Features:
- DC servomotor with high accuracy optical encoder
- Precision engineered spur gear
- 8401 hand controller with USB port for firmware upgrade and computer control
- The largest LCD screen on the market with 8 lines and 21-characters with backlit
- 130,000 object database with 256 user-defined objects
- 9-speed motor control
- HBX ports for iOptron auxiliary components
- GPS-compatible with optional GPS module (#8411)
- ST-4 autoguide compatible with optional ST-4 autoguiding adapter (#8427)
- LED socket for LED illumination on polar scope, finder scope or eyepiece
- Comes standard with: installation tools, 12V DC car plug adaptor and USB cable

Contents:[1]

Figure 1. Contents in a GoToNova® kit package

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[1] Contents may vary without notice.

- 1x GOTONOVA 8401 hand controller
- 1x right ascension (R.A.) motor assembly
- 1x declination (DEC) motor assembly
- 2x coiled cables with RJ-11 connectors
- 2x metal spur gears
- 1x short 5mm Allen head bolt for DEC motor installation
- 1x long 5mm Allen head bolt for R.A. motor installation
- 1x 5mm Allen wrench
- 1x 1.5mm Allen wrench
- 1x USB cable
- 1x 12VDC cigarette lighter adapter

Figure 2. DEC (left) and R.A. (right) unit

Shown in Figure 2 are the DEC and R.A. motor units. The RA motor assembly has an ON/OFF power switch, a 12V power inlet, a power LED indicator and three connectors named PORT A. The DEC motor assembly has two cable connectors named PORT B and a LED socket for LED illumination on polar scope, finder scope or eyepiece (center positive). All the ports are exchangeable. You may plug the GoToNova 8401 hand controller and iOptron accessories into any available port.

2. GoToNova® Dual Axis GOTO Kit Installation

If you currently own an EQ5-type non-computerized mount that has dual-axis or single-axis drives, they will need to be removed before installing the GOTO kit. Just remove the cover from each motor, then the one 5mm bolt that holds each motor in place, and you're ready to go. Remove the old spur gear as well.

Install the included spur gears onto the ends of the R.A. and DEC axis worm shafts. Shown in Figure 3 and Figure 4 are R.A. and DEC motor assembly hosts after the old drivers are removed and the new spur gears are installed. **Please make sure the gear is mounted in a way that the step side faces outside.**

Figure 3. R.A. unit host

Figure 4. DEC unit host

Remove 2 small black Phillips screws on the R.A. unit. Take the plastic cover off. **Be careful with the optical encoder and wheel.**

Slide the R.A. motor assembly into mount's hosting place, as shown in Figure 5. The R.A. unit is held in place with the long 5mm Allen-head bolt. It is inserted through the hole in the altitude adjuster of the mount (Figure 6). If there is not enough clearance, you may need lower the mount in altitude using the altitude adjustment screws.
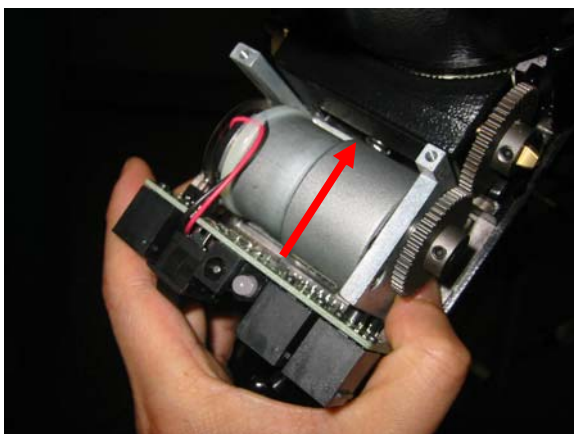
Figure 5. Install R.A. unit
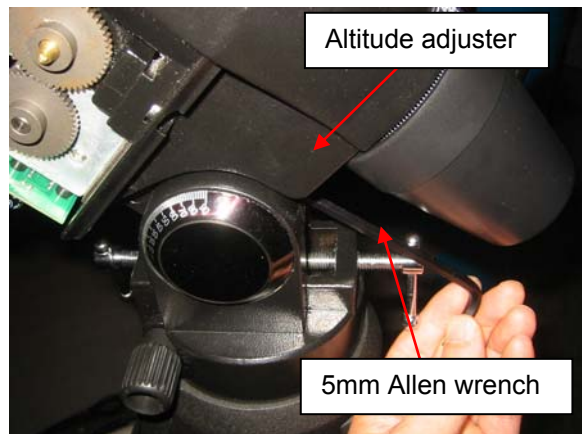
Figure 6. Lock the R.A. unit

Screw the 5mm bolt into the corresponding hole on the R.A. unit mounting plate. Adjust the position of the unit to mesh and align the gears, as indicated in Figure 7. Make sure that the

R.A. motor unit is correctly positioned with the two spur gears parallel and their teeth are not meshing too tightly. If they are too tight, you will stress the motor and shorten its life. If they are too loose, there will be excess backlashes. You need 1.5mm Allen wrench to adjust the spur gear. Tighten the bolt.
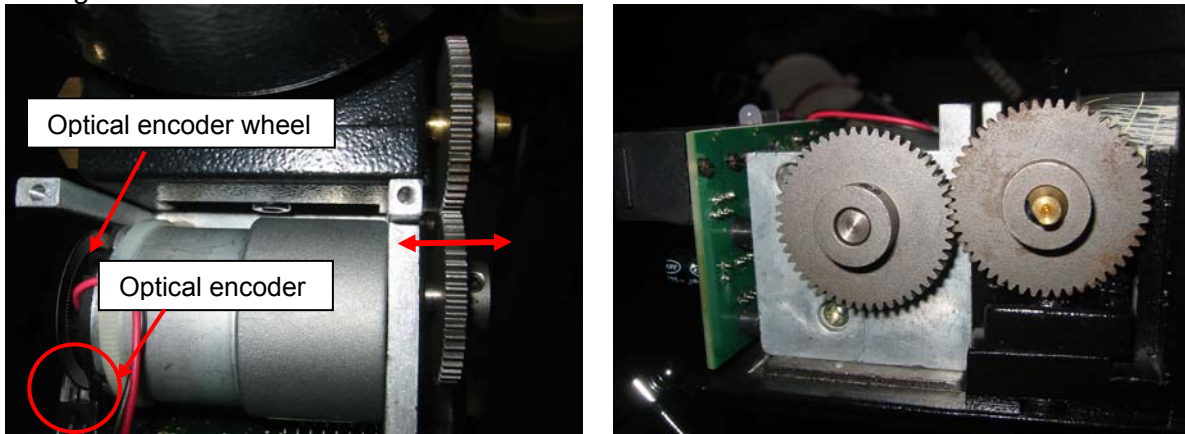
Figure 7. Spur gear alignment

Take the plastic cover off the DEC motor assembly. Attach the unit onto the DEC host. Adjust the spur gears mesh and secure the DEC unit using the short 5mm Allen-head screw.
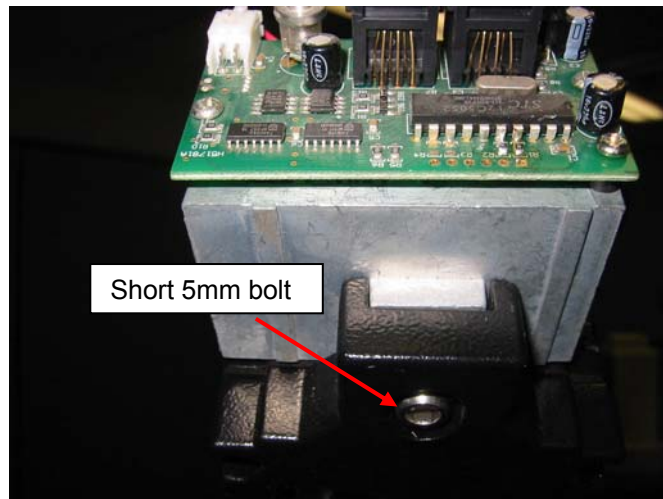
Figure 8. Install DEC motor unit

Before putting the cover on the R.A. or DEC motor assembly, ensure that the optical encoder and encoder wheel (Figure 7) on the end of the unit are free of any grease, dust and debris. Anything on the optical encoder could cause missed signal count and will ultimately affect the GOTO and tracking accuracy of your instrument.

Check the R.A. and DEC units before replacing the covers. Plug one end of a supplied RJ-11 coiled cable into any one of Port A on the R.A. unit and the other end of the cable into one of Port B on the DEC unit to connect the R.A. and DEC units. Plug one end of the other RJ-11 coiled cable into the HBX port of 8401 hand controller (HC) and the other end of the cable into any available port on R.A or DEC unit. Connect the mount to a 12V DC power supply or an

AC adapter. Turn the mount on. The power indicator will turn green. Press the arrow key to turn the R.A. or DEC motor to check if the gears are wobbling or mount is rotating smoothly. Turn off the power and readjust the gear meshing and positioning if needed.

You may put small amount of grease to the teeth of the meshing spur gears. Slide the plastic cover onto the R.A. unit. Ensure that the switch and connecting sockets slide into their respective holes in the case. Use two of the small Phillips screws supplied to seal the enclosure. Reinstall the DEC cover accordingly.

Now you have successfully converted a non-computerized mount into an state-of-the-art GOTO system!

3. GoToNova® 8401 Hand Controller

Figure 9. GoToNova® 8401 Hand Controller

GoToNova 8401 hand controller (HC) is the standard controller for a GoToNova dual axis GOTO kit, as shown in Figure 9.

3.1. Key Description

- MENU: Press "MENU" to enter the Main Menu.
- BACK: Move back to the previous screen, or end/cancel current operation, such as slewing.
- ENTER: Confirm an input, go to the next menu, select a choice, or slew the telescope to a selected object.
- Arrow (▲▼►◄): Press ▲▼ buttons to move a telescope along the DEC direction, ►◄ to move a telescope along the RA direction. Brows the menu or move the cursor in operating menu.

- Number Keys: Input numerical values. Also used to adjust speeds (1: 1X; 2: 2X; 3: 8X; 4: 16X; 5: 64X; 6: 128X; 7: 256X; 8: 512X; 9: MAX)
- Light Key(☼): Turns on/off the red LED reading light on the back of the controller.
- ? Key: For help or extra information.
- STOP/0 Key: Stop/Start tracking.
- HBX (Handbox) port: connect the HC to the mount using a 6-wire RJ-11 cable.
- USB port: connect the HC to a Computer via a USB cable.

3.2. The LCD Screen

The 8401 HC is designed to use for both iOptron's equatorial (EQ) mount, such as the SmartStar®-PR GOTO German equatorial mount and the GoToNova GOTO Kit, and AltAzimuth (A/A) mount, which includes all SmartStar® GOTO mounts and telescopes. It consists of a large 8-line LCD screen, which displays all the information as shown in Figure 10. The user interface is simple and easy to learn.
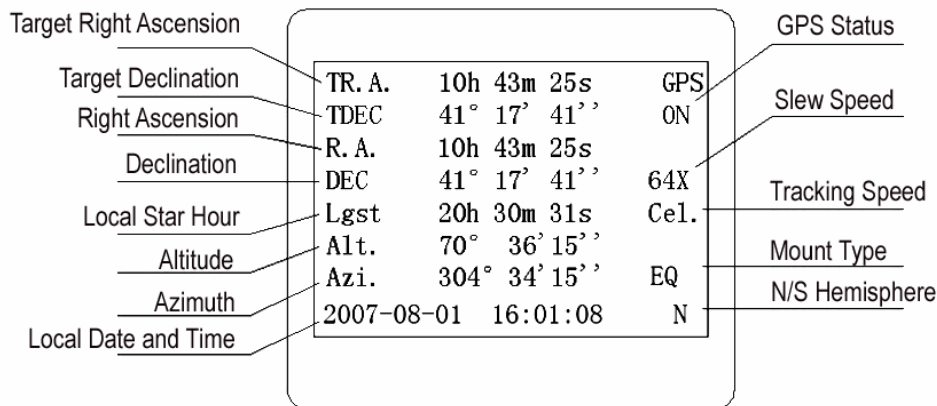
Figure 10. 8401 HC LCD Information Screen

- GPS status: When the power is turned on, it shows "GPS ON", which means a GPS receiver is connected, if there is a GPS receiver. When the GPS receiver finds the satellite and receives GPS signal, it shows "GPS OK". The "GPS OK" may turn off after few minutes.
- Slew speed: It has 9 speeds: 1X, 2X, 8X, 16X, 64X, 128X, 256X(1º/sec), 512X(2º/sec), MAX(~4º/sec).
- Tracking speed: It has 4 speeds: Cel (celestial), Sol (Solar), Lun (Lunar), Def (user defined)
- Mount Type: EQ is equatorial and A/A altazimuth.

3.3. Connection to a Computer

The GoToNova hand controller has a USB port which can be connected to a computer for firmware upgrade and computer control the mount. A USB2COM driver is needed to simulate the USB port to a RS-232 serial port. (see Appendix D)

The iOptron mounts may be controlled by a number of popular astronomy software programs. For astronomy software that does not have an embedded iOptron mount driver, an ASCOM driver and related platform are needed. Please refer to Appendix F for more information.

4. Getting Started

In order to experience the full GOTO capability of GoToNova technology, it is very important to set up the mount correctly before observation.

4.1. Setting Up the EQ5 Mount

It is assumed that you are familiar with the EQ5-type mount set up, telescope balancing, and polar alignment. The most important position is its **Park Position.** The mount has to be at this position every time the mount is setting up to ensure the GOTO performance.

The Park Position of an EQ mount is when the mount is Polar aligned. The important detail is:

- The north-facing tripod leg (the one underneath the tripod alignment peg) is facing north;
- The counterweight shaft is pointing straight down, in line with the north-facing tripod leg;
- The edge of the dovetail saddle is parallel to the polar axis, with DEC motor unit on the east side of the mount;
- The R.A. axis is pointing to North and inclined at an angle above the horizon equal in magnitude to your latitude; and
- The optical axis of the telescope is parallel to the polar axis and is on top the mount, as shown in Figure 11.

After the mount is set up, connect the R.A. motor unit and DEC unit with one coiled cable. Connect the 8401 HC to the mount (Port A or Port B). Connect the 12V DC power to the R.A. unit. Turn the mount on by press the power switch.

Figure 11. Park position

4.2. Setting Up the Hand Controller

The mount needs to have correct date, time and site information before it can perform GOTO correctly. The 8401 HC has a backup battery to remember the date and time between the sessions. The site information includes longitude, latitude and time zone offset, will be stored in HC flash memory until you change them.

If your GoToNova kit equipped with an optional GPS receiver (#8411), the hand controller will receive the local time, longitude and latitude information from satellites after the link is established. A clear sky outside is needed for the GPS to establish its link with the satellites. *However, manual input is still needed for time zone and Daylight Saving setting.*

4.2.1. Set Up Local Time

Press MENU button, from the main menu, scroll down and select "*Set up controller*"

```
Select and Slew
Sync. to Target
Electronic Focuser
Set Up Controller
Align
Set Up Tracking
User Objects
Auto Guide
```

Press ENTER. Select "*Set Up Local Time*"

```
Set Up Local Time
Set Up Site
Set N/S Hemisphere
Set Display Contrast
Set Eyepiece Light
Set Backlight
Set Snti-backlash
Set Key Beep
```

Press ENTER. The "*Set Local Time*" screen will show:

```
Set Local Time:

2009-06-01 11:55:09
Daylight Saving Time Y
```

Use ◄ or ► key to move the cursor and number keys to enter the number. Use the ▲ or ▼ button to toggle between "Y" and "N" of Daylight Saving Time. Press ENTER to go back the previous screen.

4.2.2. Set Up Site Info

Scroll down and select "*Set up site*"

```
Set up Local Time
Set up site
Set N/S hemisphere
Set display contrast
Set Eyepiece light
Set Backlight
Set anti-backlash
Set Key Beep
```

Press ENTER. "W/E" means western/eastern hemisphere; "N/S" means northern/southern hemisphere; "d" means degree; "m" means minute; and "s" means second.

```
Set up site info:
Longitude:
      W071d27m47s
Latitude:
      N42d15m40s
300  Min.  behind    UT
```

Press ◄ or ► key to move the cursor and ▲ or ▼ key to toggle between "W" and "E", "N" and "S", using number keys to change the numbers. It is always a good idea to do your home work to get the GPS coordinates before traveling to a new observation site.

The site coordinates information can be found from GPS navigator, smart phone or internet. You may also find it from *Support* section in iOptron website, under *Controller Set-up* (http://www.ioptron.com/support.cfm?module=faq#).By entering the city name or address, you can find its latitude and longitude. In case you only find the site information in decimal format you can convert them into d:m:s format by multiplying the decimal numbers by 60. For example, N47.53 can be changed to N47°31'48": 47.53° = 47° +0.53°, 0.53°=0.53x60'=31.8', 0.8'=0.8x60"=48". Therefore, 47.53°=47°31'48" or 47d31m48s.

Press ◄ or ► key, move the cursor to the bottom of the screen to set the time zone information (add or subtract 60 minutes per time zone). Enter minutes "***ahead of***" or "***behind***" UT (universal time).

- Boston is 300 minutes "behind" UT
- Los Angeles is 480 minutes "behind" UT
- Rome is 60 minutes "ahead of" UT
- Beijing is 480 minutes "ahead of" UT
- Sydney is 600 minutes "ahead of" UT

All the time zones in North America are *behind* UT, as shown in the following table. So make sure it shows "behind" instead of "ahead of" UT.

Time Zone	Hawaii	Alaska	Pacific	Mountain	Central	Eastern
Hour behind UT	-10	-9	-8	-7	-6	-5
Enter Minutes	600	540	480	420	360	300

To adjust minutes, move the cursor to each digit and use the number keys to input number directly. To change the "***behind***" or "***ahead of***" UT, move the cursor to "***ahead of***" and

use ▲ or ▼ key to toggle between "**behind**" and "**ahead of**". When the number is correct, press ENTER and go back to the previous screen.

For other parts of the world you can find your "time zone" information from iOptron website (http://www.ioptron.com/support.cfm?module=faq#). **DO NOT COUNT DAYLIGHT SAVING TIME.**

4.2.3. Set Mount Type

The 8401 HC will automatic detect the mount type as EQ. You may also manually select if from "**Set Mount Type**" menu. Scroll down and select "**Set Mount Type**",

```
Set up site
Set N/S hemisphere
Set display contrast
Set Eyepiece light
Set Backlight
Set anti-backlash
Set Key Beep
Set Mount Type
```

Press Enter.

```
Equatorial Mount
Alt/Azi Mount
```

Select Equatorial mount and press ENTER to go back the previous screen.

4.2.4. Set N/S Hemisphere

If the polar axis is aligned to North Celestial Pole, then set the mount to Northern Hemisphere. If the polar axis is pointing to South Celestial pole, set the mount to Southern Hemisphere.

```
Set up Local Time
Set up Observ. site
Set N/S hemisphere
Set display contrast
Set Eyepiece light
Set Backlight
Set anti-backlash
Set Key Beep
```

Press Enter.

```
North hemisphere
South hemisphere
```

Select North Hemisphere if you are located in US and press ENTER to go back to the previous screen.

4.2.5. Initial Star Alignment

A simple star alignment/synchronization can be performed to improve the GOTO accuracy.

To perform "***One Star Align***," press MENU button, scroll down to "***Align***", select "***One Star Align***" and press ENTER. The screen will display a list of bright objects for you to select from. Select an object using ▲ or ▼ key. Then press ENTER. After the mount slews to the target, use the arrow keys to center it in your eyepiece. Then press ENTER.

An alternate way is to perform "***Sync to Target***." Press the MENU button, select "***Select and Slew***" and press ENTER. Browse over the catalogs and select an object, such as "***Stars***" →"***Named stars***" →***140 (Polaris)***, and press ENTER. After the mount slews to Polaris, press the MENU button, scroll down to "***Sync. To Target***", follow the on-screen instruction to center Polaris and press ENTER. You may need to use the number keys to change the slewing speed to make the centering procedure easier.

4.2.6. Go to the Moon

After performing these set-ups the mount is ready to GOTO and track objects. One of the most common objects is the Moon.

To slew to the Moon press the MENU button. Select "***Select and Slew***" by pressing the ENTER button. Select "***Planets, Sun, Moon***", and use the ▲ or ▼ buttons to select Moon. Press ENTER. The telescope will automatically slew to the Moon and lock on it. It will automatically begin to track once it locks on. If the Moon is not centered in your eyepiece, use the arrow keys to center the Moon. Or for better performance use "***Sync to Target***."

4.3. Turn Off the Mount

When you have finished your observation, it is recommended that you return the mount to Park Position before powering down. This will ensure that there is no need for you to perform the initial setup again when you power up the mount subsequently, if the mount is not moved. To return the mount to its Park Position, press the MENU button, scroll down to "***To Park Position"*** and press ENTER. Once the telescope returns to Park Position turn the power off.

5. Use the Hand Controller

5.1. Manual Operation of a Telescope

You may observe land and astronomical objects using 8401 HC's arrow keys.

After the telescope was assembled, flip the I/O switch on the telescope mount to turn on the mount. Use ►,◄,▼ or ▲ buttons to point the telescope to the desired object. You may need to use the number keys to change the slewing speed. Simply press a number while slewing to change the slew speed.

5.2. Select and Slew

Press the MENU button. From the main menu, select "**Select and Slew**." Select an object that you would like to observe and press the ENTER key.

The GoToNova® 8401 hand controller has a database of about 130,000 objects. Use the ► or ◄ buttons to move the cursor and the ▼▲ buttons to change the individual number. The check mark (√) indicates the object is above the horizon, and a cross mark (X) means it is below the horizon. In some catalogs those stars below the horizon will not display on the hand controller.

5.2.1. Planets, Sun, Moon

There are 10 objects in the Solar system catalog.

5.2.2. Deep sky objects

This menu includes objects outside our Solar system such as galaxies, star clusters, quasars, and nebulae.

- Named Deep Sky Objects: consists of 60 deep sky objects with their common names. A list of named deep sky objects is attached in Appendix C.

- Messier Catalog: consists of all 110 objects.

- NGC IC Catalog: consists of 7840 objects in NGC catalog and 5386 objects in IC catalog. To select an object from NGC or IC catalog, move the cursor to NGC, using▲ or ▼ button to toggle between NGC and IC. Then move the cursor to numerical position and use the number button to select the object.

- UGC Catalog: consists of 12939 objects.

- MCG Catalog: consists of 29004 objects. They are listed numerically from MCG+15 to MCG-05.

- Caldwell Catalog: consists of 109 objects.

- Abell Catalog: consists of 2712 objects.

- Herschel Catalog: consists of 400 objects.

5.2.3. Comets

This catalog contains up to 190 comets. This database is customer upgradeable.

5.2.4. Asteroids

This catalog contains up to 4096 asteroids. This database is customer upgradeable.

5.2.5. Stars:

- Named Stars: consists of 191 stars with their common names. They are listed alphabetically. A list is attached in Appendix C.

- Double Stars: consists of 40 double stars. A list is attached in Appendix C.

- GCVS Variable Stars: consists of 38624 GCVS variable stars. They are listed numerically.

- SAO Catalog: consists of 26584 SAO catalog objects. They are listed numerically.

5.2.6. Constellations

This catalog consists of 88 modern constellations with their names. They are listed alphabetically. A list is attached in Appendix C.

5.2.7. User Objects

This catalog can consist up to 256 user predefined objects. These objects need to be entered before they can be selected for slewing.

5.2.8. Enter R.A. DEC

Here you can go to a target by entering its R.A. and DEC numbers.

5.3. Sync to Target

This operation will match the telescope's current coordinates to Target Right Ascension and Declination. After slew to an object, press MENU—then scroll to "*Sync to Target*" and press ENTER. Follow the screen to do the sync. Using this function will re-calibrate the computer to the selected object. Multiple syncs can be performed if needed.

"*Sync to Target*" will only work after "*Select and slew*" is performed. Otherwise, the system may perform incorrectly. You can change the slewing speed to make the centering procedure easier. Simply press a number (1 through 9) to change the speed. The default slew speed is 64X.

"*Sync to Target*" does the same thing as one star alignment except that you choose the object to "sync" to. One star alignment chooses the star/object for you.

5.4. Electric Focuser

Reserved for iOptron accessories.

5.5. Set Up Controller

5.5.1. Set Up Local Time

Please refer to 4.2.1.

5.5.2. Set Up Site

Please refer to 4.2.2.

5.5.3. Set N/S Hemisphere

Please refer to 4.2.4.

5.5.4. Set Display Contrast

Use arrow keys to adjust LCD display contrast.

5.5.5. Set Eyepiece Light

If you have an illuminated-reticule eyepiece or illuminated polar scope, and it is supported by GoToNova hand controller-- use this option to adjust the light intensity.

5.5.6. Set Backlight

Adjust LCD and keypad backlight.

5.5.7. Set Anti-backlash

All mechanical gears have a certain amount of backlash or play between the gears. This play is evident by how long it takes for a star to move in the eyepiece when the hand control arrow buttons are pressed (especially when changing directions). The GoToNova anti-backlash feature allows the user to compensate for backlash by inputting a value which quickly rewinds the motors just enough to eliminate the play between gears. The amount of compensation needed depends on the slewing rate selected; the slower the slewing rate the longer it will take for the star to appear to move in the eyepiece. You will need to experiment with different values (from 0-2000 steps, each step equals to 1.5 arc sec). A value between 100 and 200 is usually best for most visual observing, whereas a higher value may be necessary for photographic guiding.

While viewing an object in the eyepiece, observe the responsiveness of each of the four arrow buttons. Note which directions you see a pause in the star movement after the button has been pressed. Working one axis at a time, adjust the backlash settings high enough to cause immediate movement without resulting in a pronounced jump when pressing or releasing the button. The hand controller will remember these values and use them each time it is turned on until they are changed. For an Alt/Azi operation, 0 step is suggested for both R.A. and DEC anti-backlash. For an EQ mount, the default setting is 150 for both DEC and R.A.

To set the anti-backlash value, select the "**Set Up Controller**" menu and scroll down to the "**Set anti-backlash**" option and press ENTER.

```
Set up Local Time
Set up site
Set N/S hemisphere
Set display contrast
Set Eyepiece light
Set Backlight
Set anti-backlash
Set Key Beep
```

Press ENTER. A R.A. anti-backlash will display:

```
R.A. anti-backlash:
          0150    steps

   One step equals to
      1.5 arc second.
```

To adjust steps, move the cursor to each digit and use the number key to input number directly. Press ENTER, a DEC anti-backlash will display:

```
DEC anti-backlash:
          0150    steps

   One step equals to
      1.5 arc second.
```

Move the cursor to each digit and use the number key to set the anti-backlash. Press ENTER to go back the previous screen.

Press BACK button to go back to main menu.

5.5.8. Set Key Beep

Turn the key beep on/off.

5.5.9. Set Mount Type

The HC will detect and automatic set the mount as Equatorial Mount.

5.5.10. Reset All

Reset all settings to factory default data.

5.5.11. Update Firmware

Firmware updating using iOptron Downloader through USB port on hand controller. (Refer to Appendix E.)

5.5.12. Set gear ratio

Reserved for future products.

5.5.13. Set Language

Select hand controller language.

5.6. Align

This function is used for aligning the telescope. In addition to "*Easy One Star Align*," the system also provides "*One Star Align"*, "*Two Star Align*" and "*Three Star Align*". **The mount has to be at Park Position before performs any alignment procedure.**

5.6.1. Easy One Star Align

Press MENU button, scroll down to "*Align*", select "*Easy One Star Align*" and press ENTER. The screen will list three bright objects for you to select from (ex. Moon, Jupiter, Venus). Select an object using ▲ or ▼ key. Then press ENTER. Next use the arrow keys to slew to the object until it is centered in your eyepiece. Then press ENTER.

You may need to use the number keys to change the slewing speed to make the centering procedure easier.

5.6.2. One Star Align

From the main menu select "*Align*". Select "*One Star Align*". Use ▲ and ▼ buttons to select a star and press ENTER. A list of align planets or stars that are above the horizon is computed based on your local time and location. Use arrow buttons to move the telescope and center the star in your eyepiece. You can use the number buttons to change the slew speed.

Press ENTER when finished. If your setup is leveled well, one star alignment should be sufficient for good GOTO accuracy. To increase the accuracy you may choose to do two star alignment.

5.6.3. Two Star Align

Two star alignment will increase the GOTO accuracy of the mount. It is suggested to do two star alignment after one star alignment. Two star alignment requires a wider view of the sky, since the two align stars need to be far apart. Select "Two Star Align" in the Align menu. When you finish the first star, the system will prompt you to choose the second star. If the star you choose is too close to the first one, the system will let you choose another one. When you are aligned with the second star, two star alignment is finished. You can reject the suggested star if it is blocked by the tree or behind the house.

"*Two Star Align*" results will be overridden if "*One Star Align*" or "*Sync. to Target*" is performed after "*Two Star Align*."

5.6.4. Three-Star Align

Three-star alignment procedure will reduce the so-called "*corn error*" of an EQ mount. Before GoToNova can find anything for you it needs to establish that the Park Position of your mount's polar axis is indeed pointing at the north celestial pole. Furthermore, every mount's accuracy of construction varies somewhat, so the optical axis of the telescope may not be perpendicular to the declination axis or, more rarely, the polar axis may not be at right angles to the declination axis. These small errors (known collectively as the cone error) can make a big difference to the GOTO performance of your mount, so it pays to understand the implications.

From the main menu select "*Align*". Select "*Three Star Align*". GoToNova will then present you with the name of a suggested alignment star. If this star is hidden by a tree or building, press the down arrow to advance through the list in alphabetical order until you find a star that is visible. Press ENTER and the mount will slew to where it thinks the star you have selected lies, beeping once it has finished moving. Most likely, the scope won't be pointing exactly at the star, so use the up, down, left or right arrows to centre the star — first in the finder, then in the eyepiece. Once you are done, press ENTER and the next alignment star will be selected. Repeat this process until you have selected all three stars whereupon GoToNova will compute the polar axis positioning error of your mount and display it. For a better result, select three stars located in the different part of the sky.

Press BACK and you will return to the display.

5.6.5. Dis R.A axis error

This displays the celestial pole pointing error after two star or three star alignment. When the HC shows for example:

7.5" lower

4.3" east,

it means the polar axis of the mount is pointing lower and to the east. Pointing error is zero when you power on the mount (unless you "**Park Telescope**" before powering off.)

5.6.6. Test Anti-backlash

Not supported.

5.6.7. Polaris Position

Polaris is NOT at the exact point of the Polar Axis. This shows the offset (about 40 min) between the Polaris and the actual Celestial Pole (Polar Axis), as well as the direction of the Polaris to the Polar Axis at the observing location. For a precise polar alignment, this offset needs to be taken into account. In order to use this function, a better mount with suitable polar scope is needed.

5.7. PEC Option

Periodic Error Correction (PEC) is a system that improves the tracking accuracy of the drive by reducing the number of user corrections needed to keep a guide star centered in the eyepiece. PEC is designed to improve photographic quality by reducing the amplitude of the worm errors. Using the PEC function is a three-step process. First, the GoToNova needs to know the current position of its worm gear so that it has a reference when playing back the recorded error. Next, you must guide the mount for 800 seconds during which time the system records the correction you make. This "teaches" the PEC program the characteristics of the worm. The periodic error of the worm gear drive will be stored and used to correct periodic error. The last step is to play back the corrections you made during the recording phase. Keep in mind that PEC only works well for a mount that the error is "periodic".

After PEC is recorded, a "PEC" indicator will be displayed on the LCD screen when the hand controller is playing back the PEC.

5.8. Set Up Tracking

A user can set up tracking in the main menu by selecting "**Set up tracking**". Then the user can select "**Sidereal speed", "Solar speed", "Lunar speed",** and "**User defined speed**". For "**User defined speed**" this can be adjusted from 91% to 109% of sidereal speed by pressing the ▲or ▼ buttons.

5.9. User Objects

Besides various star lists available in the hand controller --you can add, edit or delete your own user-defined objects. All data you enter is supposedly J2000.0 epoch.

5.10. Auto Guide

This is an advanced function for autoguiding when a guiding camera is equipped. The GoToNova supports autoguiding through ASCOM protocol or an ST-4 guiding camera (an extra ST-4 to HBX adapter is needed). Please follow the guiding software for detailed instructions.

5.11. Park Scope

This procedure only needs to be done if you are turning off the GoToNova kit and do not move your telescope mount after the mount is powered off. Celestial pole pointing error will be stored to flash memory and recalled when you power on again.

TO move the mount to its Park Position, please use "***To Park Position***".

5.12. To Park Position

This moves your telescope to park position. When power is turned on--the mount assumes the physical position is the park position. This is its reference point for all other objects.

6. Maintenance and Servicing

6.1. Maintenance

The GoToNova kit is designed to be maintenance free. Do not overload the mount. Do not drop the mount, this will damage the kit or degrade the GOTO tracking accuracy permanently. Do not drop the hand controller. Do not connect other accessories to the hand controller. Only use iOptron supplied coiled cables and USB cables. Use a wet cloth to clean the mount and hand controller. Do not use solvent.

6.2. iOptron Customer Service

If you have a question concerning your products, contact the iOptron Customer Service Department. Customer Service hours are 9:00 AM to 5:00 PM, Eastern Time, Monday through Friday. In the unlikely event that the kit or hand controller requires factory servicing or repairs, write or call the iOptron Customer Service Department first to receive an RMA# before returning the telescope to the factory. Please provide details as to the nature of the problem as well as your name, address, and daytime telephone number. We have found that most problems can be resolved by e-mail or telephone. So please contact iOptron first to avoid returning the telescope for repair. It is strongly suggested that to send technical questions to support@ioptron.com. Call toll free in the U.S. 866.399.4587 or 1.781.569.0200.

Appendix A. Technical Specifications

Product Name	GoToNova® dual motor GOTO kit (DIY)
Motor	DC servomotor with optical encoder
Resolution	0.375 arc second
Control Speed	9 speed (1×,2×,8×,16×,64×,128×,256×,512×,MAX)
GOTO system	GoToNova®
Processor	32bit ARM
Hand controller	GoToNova® 8401
Object Database	130,000
LCD Display	8 line, 21 character with LED backlit
Tracking Control	Automatic
Tracking Speed	celestial, solar, lunar and user defined
GPS	Optional 32 channel GPS receiver (#8411)
Power Consumption	0.2A(Tracking), 1A(Slew)
Power Requirement	12V DC(11 ~ 15V), 2Amp, center positive
USB Port	Yes (on hand controller)
ST-4 autoguiding Port	Yes (with optional ST-4 adapter #8427)
LED reticle connector	Yes
Operation Temperature	0ºC ~ 40ºC
Firmware Upgrade	Yes
PC Computer Control	Yes (ASCOM)
Warranty	One year

Appendix B. GoToNova® 8401 HC MENU STRUCTURE

MENU
- Select and Slew
  - Planets, Sun, Moon
    - Mercury
    - Venus
    - Mars
    - Jupiter
    - Saturn
    - Uranus
    - Neptune
    - Pluto
    - Sun
    - Moon
  - Deep Sky Objects
    - Named Deepsky Object
    - Messier Catalog
    - NGC IC Catalog
    - UGC Catalog
    - MCG Catalog
    - Caldwell Catalog
    - Abell Catalog
    - Herschel Catalog
  - Comets
  - Asteroids
  - Stars
    - Named Stars
    - Double Stars
    - GCVS Variable Stars
    - SAO Catalog
  - Constellations
  - User Objects
  - Enter R.A. and DEC
- Sync. To Target
- Electric Focuser
  - Focus
  - Set Anti-backlash

Set Up Controller
- Set Up Local Time
- Set Up Site
- Set N/S Hemisphere
- Set Display Contrast
- Set Eyepiece Light
- Set Backlight
- Set Anti-backslash
- Set Key Beep
- Set Mount Type
- Reset All
- Upgrade Firmware
- Set Gear Ratio
- Set Language

Align
- Easy One Star Align
- One Star Align
- Two Star Align
- Three Star Align
- Disp. R.A. Axis Error
- Test Anti-backslash
- Polaris Position

PEC Option
- PEC Play Back
- Record PEC
- Delete PEC Record

Set Up Tracking
- Sidereal Speed
- Solar Speed
- Lunar Speed
- User Defined Speed

User Objects
- Add A New Record
- Modify Records
- Delete One Record
- Erase All Records

Auto Guide

Park Scope

To Park Position

Appendix C. GoToNova® Star List

GoToNova Deep Sky Object List

ID No.	OBJECT	NGC #	Messier #	IC#	A(Abell)	U(UGC)
1	Andromeda Galaxy	224	31			
2	Barnards Galaxy	6822				
3	Beehive Cluster	2632	44			
4	Blackeye Galaxy	4926	64			
5	Blinking Planetary Nebula	6826				
6	Blue Flash Nebula	6905				
7	Blue Planetary	3918				
8	Blue Snowball Nebula	7662				
9	Box Nebula	6309				
10	Bubble Nebula	7635				
11	Bipolar Nebula	6302				
12	Butterfly Cluster	6405	6			
13	California Nebula	1499				
14	Cat's Eye Nebula	6543				
15	Cocoon Nebula			5146		
16	Cone Nebula	2264				
17	Cork Nebula	650-51	76			
18	Crab Nebula	1952	1			
19	Crescent Nebula	6888				
20	Draco Dwarf					10822
21	Duck Nebula	2359				
22	Dumbbell Nebula	6853	27			
23	Eagle Nebula		16			
24	Eight-Burst Nebula	3132				
25	Eskimo Nebula	2392				
26	Flaming Star Nebula			405		
27	Ghost of Jupiter	3242				
28	Great Cluster	6205	13			
29	Helix Nebula	7293				
30	Hercules Galaxy Cluster				2151	
31	Hind's Variable Nebula	1555				
32	Hubble's Variable Nebula	2261				
33	Integral Sign Galaxy					3697
34	Jewel Box Cluster	4755				

#	Name					
35	Keyhole Nebula	3372				
36	Lagoon Nebula	6523	8			
37	Little Gem	6445				
38	Little Gem Nebula	6818				
39	Little Ghost Nebula	6369				
40	North American Nebula	7000				
41	Omega Nebula	6618	17			
42	Orion Nebula	1976	42			
43	Owl Nebula	3587	97			
44	Pelican Nebula			5070		
45	Phantom Streak Nebula	6741				
46	Pinwheel Galaxy	598	33			
47	Pleiades		45			
48	Ring Nebula	6720	57			
49	Ring Tail Galaxy	4038				
50	Rosette Nebula	2237				
51	Saturn Nebula	7009				
52	Sextans B Dwarf					5373
53	Small Magellanic Cloud	292				
54	Sombrero Galaxy	4594	104			
55	Spindle Galaxy	3115				
56	Tank Track Nebula	2024				
57	Trifid Nebula	6514	20			
58	Ursa Minor Dwarf					9749
59	Whirlpool Galaxy	5194	51			
60	Wild Duck Cluster	6705	11			

Messier
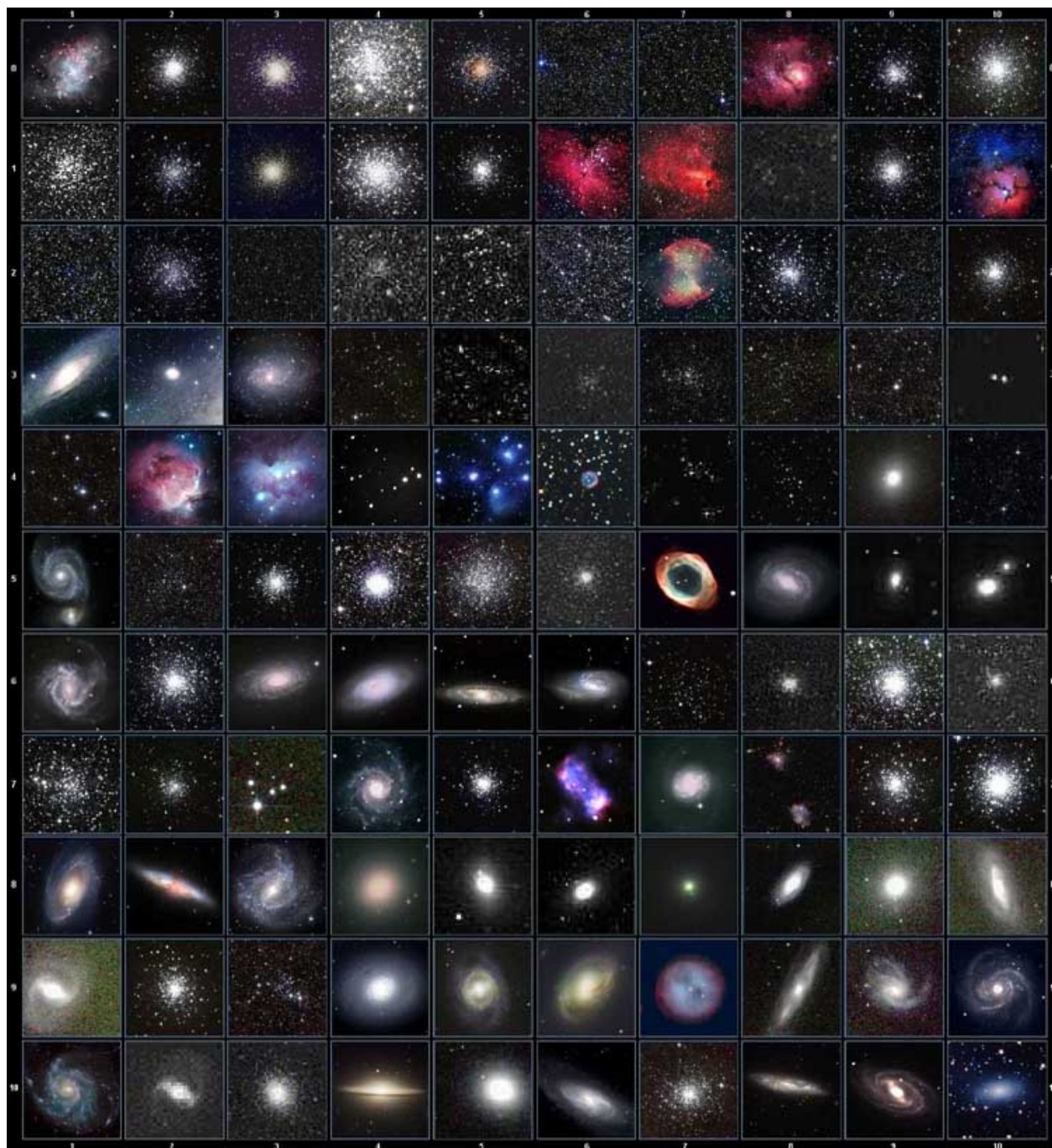
This table is licensed under the GNU Free Documentation License. It uses material from the Wikipedia article List of Messier objects

Modern Constellations

No.	Constellation	Abbreviation	No.	Constellation	Abbreviation
1	Andromeda	And	45	Lacerta	Lac
2	Antlia	Ant	46	Leo	Leo
3	Apus	Aps	47	Leo Minor	LMi
4	Aquarius	Aqr	48	Lepus	Lep
5	Aquila	Aql	49	Libra	Lib
6	Ara	Ara	50	Lupus	Lup
7	Aries	Ari	51	Lynx	Lyn
8	Auriga	Aur	52	Lyra	Lyr
9	Boötes	Boo	53	Mensa	Men
10	Caelum	Cae	54	Microscopium	Mic
11	Camelopardalis	Cam	55	Monoceros	Mon
12	Cancer	Cnc	56	Musca	Mus
13	Canes Venatici	CVn	57	Norma	Nor
14	Canis Major	CMa	58	Octans	Oct
15	Canis Minor	CMi	59	Ophiuchus	Oph
16	Capricornus	Cap	60	Orion	Ori
17	Carina	Car	61	Pavo	Pav
18	Cassiopeia	Cas	62	Pegasus	Peg
19	Centaurus	Cen	63	Perseus	Per
20	Cepheus	Cep	64	Phoenix	Phe
21	Cetus	Cet	65	Pictor	Pic
22	Chamaeleon	Cha	66	Pisces	Psc
23	Circinus	Cir	67	Piscis Austrinus	PsA
24	Columba	Col	68	Puppis	Pup
25	Coma Berenices	Com	69	Pyxis	Pyx
26	Corona Australis	CrA	70	Reticulum	Ret
27	Corona Borealis	CrB	71	Sagitta	Sge
28	Corvus	Crv	72	Sagittarius	Sgr
29	Crater	Crt	73	Scorpius	Sco
30	Crux	Cru	74	Sculptor	Scl
31	Cygnus	Cyg	75	Scutum	Sct
32	Delphinus	Del	76	Serpens	Ser
33	Dorado	Dor	77	Sextans	Sex
34	Draco	Dra	78	Taurus	Tau
35	Equuleus	Equ	79	Telescopium	Tel
36	Eridanus	Eri	80	Triangulum	Tri
37	Fornax	For	81	Triangulum Australe	TrA
38	Gemini	Gem	82	Tucana	Tuc
39	Grus	Gru	83	Ursa Major	UMa
40	Hercules	Her	84	Ursa Minor	UMi
41	Horologium	Hor	85	Vela	Vel
42	Hydra	Hya	86	Virgo	Vir
43	Hydrus	Hyi	87	Volans	Vol
44	Indus	Ind	88	Vulpecula	Vul

GoToNova Named Star List

001 Acamar	049 Ascella	097 Kaus Australis	145 Rassalas
002 Achernar	050 Asellus Australis	098 Kaus Borealis	146 Rasagethi
003 Acrux	051 Asellus Borealis	099 Kaus Media	147 Rasalhague
004 Acubens	052 Aspidiske	100 Keid	148 Rastaba
005 Adhafera	053 Atik	101 Kitalpha	149 Regulus
006 Adhara	054 Atlas	102 Kochab	150 Rigel
007 Al Na'ir	055 Atria	103 Kornephoros	151 Rigel Kentaurus
008 Albali	056 Avoir	104 Kurhah	152 Ruchbah
009 Alberio	057 Azha	105 Lesath	153 Rukbat
010 Alchibar	058 Baten Kaitos	106 Maia	154 Sabik
011 Alcor	059 Beid	107 Marfik	155 Sadachbia
012 Alcyone	060 Bellatrix	108 Markab	156 Sadalbari
013 Aldebaran	061 Betelgeuse	109 Matar	157 Sadalmelik
014 Alderamin	062 Biham	110 Mebsuta	158 Sadalsuud
015 Alfirk	063 Canopus	111 Megrez	159 Sadr
016 Algedi	064 Capella	112 Meissa	160 Saiph
017 Algenib	065 Caph	113 Mekbuda	161 Scheat
018 Algiebra	066 Castor	114 Menkalinan	162 Schedar
019 Algol	067 Celabrai	115 Menkar	163 Seginus
020 Algorab	068 Celaeno	116 Menkent	164 Shaula
021 Alhena	069 Chara	117 Menkib	165 Sheiak
022 Alioth	070 Chertan	118 Merak	166 Sheratan
023 Alkaid	071 Cor Caroli	119 Merope	167 Sirius
024 Alkalurops	072 Cursa	120 Mesartim	168 Skat
025 Alkes	073 Dabih	121 Miaplacidus	169 Spica
026 Almach	074 Deneb	122 Mintaka	170 Sterope
027 Alnasl	075 Deneb Algedi	123 Mira	171 Sulafat
028 Alnilam	076 Deneb Kaitos	124 Mirach	172 Syrma
029 Alnitak	077 Denebola	125 Mirfak	173 Talitha
030 Alphard	078 Dubhe	126 Mirzam	174 Tania Australis
031 Alphecca	079 Edasich	127 Mizar	175 Tania Borealis
032 Alpheratz	080 Electra	128 Muphrid	176 Tarazed
033 Alrakis	081 Elnath	129 Muscida	177 Taygeta
034 Alrescha	082 Eltanin	130 Nashira	178 Thuban
035 Alshain	083 Enif	131 Nekkar	179 Unukalhai
036 Altair	084 Errai	132 Nihal	180 Vega
037 Altais	085 Fomalhaut	133 Nunki	181 Vindemiatrix
038 Alterf	086 Furud	134 Nusakan	182 Wasat
039 Aludra	087 Gacrux	135 Peacock	183 Wazn
040 Alula Australis	088 Giausar	136 Phact	184 Yed Posterior
041 Alula Borealis	089 Gienah	137 Phecda	185 Yed Prior
042 Alya	090 Gomeisa	138 Pherkad	186 Zaniah
043 Ancha	091 Graffias	139 Pleione	187 Zaurak
044 Ankaa	092 Groombridge 1830	140 Polaris	188 Zavijava
045 Antares	093 Grumium	141 Pollux	189 Zosma
046 Arcturus	094 Hamal	142 Porrima	190 Zubenelgenubi
047 Arkab	095 Homan	143 Procyon	191 Zubeneschamali
048 Arneb	096 Izar	144 Propus	

GoToNova Double Star List

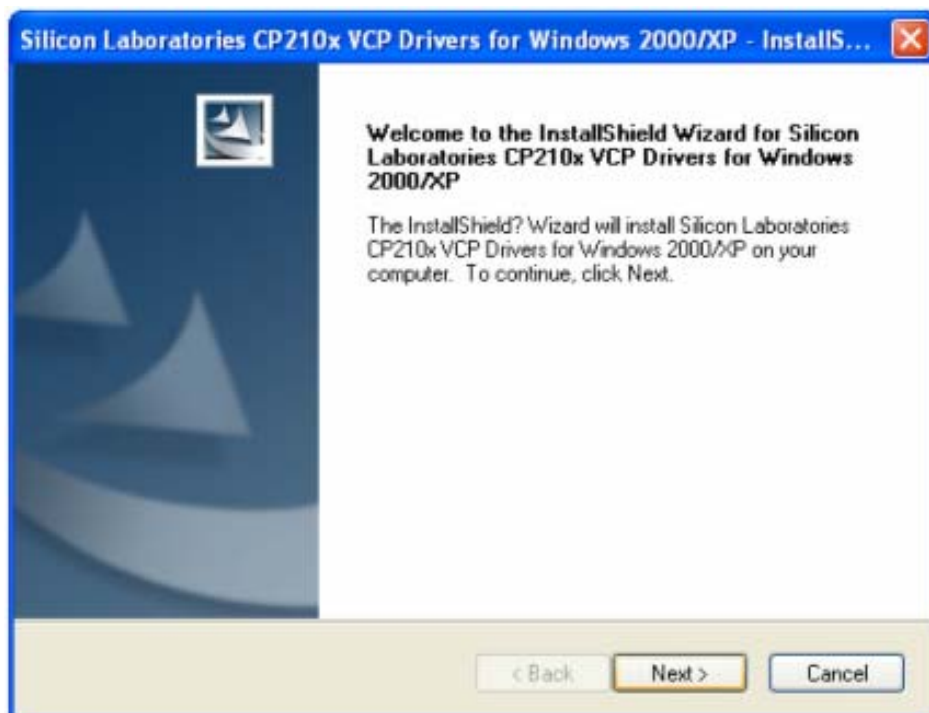| No.	Object	Const	SAO	Name
1	Eta	Cas	21732	Achird
2	Alpha	Psc	110291	Alrisha
3	Theta	Per	38288	
4	Alpha	For	168373	Fornacis
5	Alpha	Aur	40186	Capella
6	Sigma	Ori	132406	
7	Mu	Ori	113389	
8	Alpha	CMa	151881	Sirius
9	Delta	Gem	79294	Wasat
10	Alpha	Gem	60198	Castor
11	Alpha	CMi	115756	
12	Epsilon	Hya	117112	
13	HR 3579		42642	
14	Kapa	UMa	42661	
15	Psi	Vel	221234	
16	Gamma	Leo	81298	Algieba
17	HR 4167		222199	
18	Mu	Vel	222321	
19	Alpha	UMa	15384	Dubhe
20	Zeta	UMa	28737	Mizar
21	Iota	Leo	99587	
22	Gamma	Cen	223603	
23	Gamma	Vir	138917	Porrima
24	Beta	Mus	252019	
25	HR 5089		204545	
26	Alpha	Cen	252838	
27	Zeta	Boo	101145	
28	Gamma	Lup	225938	
29	Gamma	CrA	83958	
30	Xi	Sco	159665	
31	Alpha	Sco	184415	Antares
32	Lambda	Oph	121658	Marfic
33	Zeta	Her	65485	
34	Eta	Oph	160332	Sabik
35	70	Oph	123107	
36	Zeta	Sgr	187600	Ascella
37	Delta	Cyg	48796	
38	Beta	Del	106316	Rotanev
39	Tau	Cyg	71121	
40	Epsilon	Lyr	67310	double double

Appendix D. Set Up USB-PC Connection

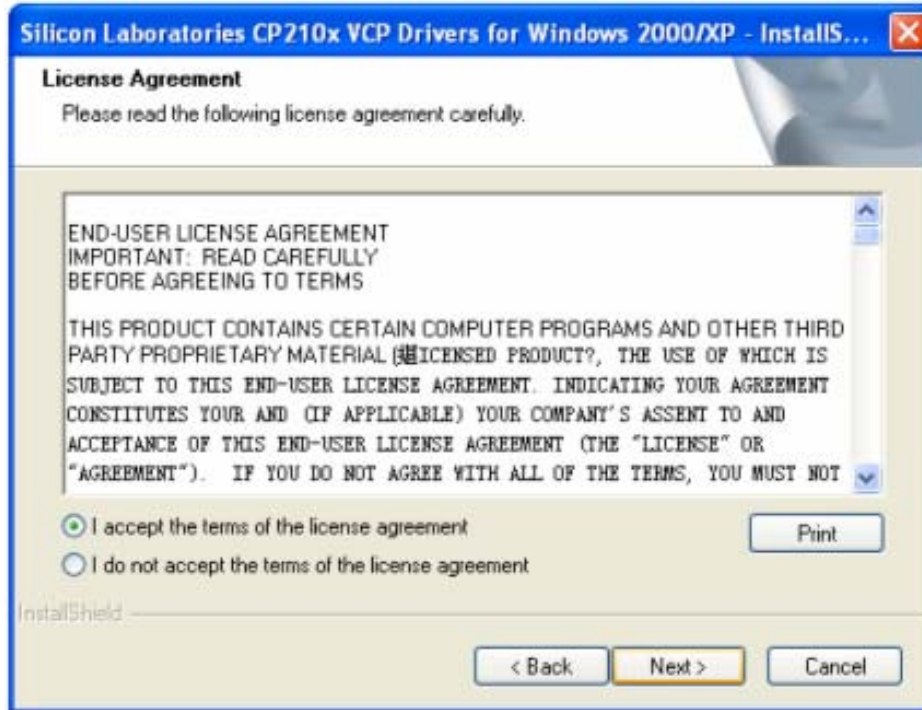**The example shown is using a PC with windows XP operation system.**

1. **Download USB2COM driver (cp210x.zip file for 8401) from iOptron Website**
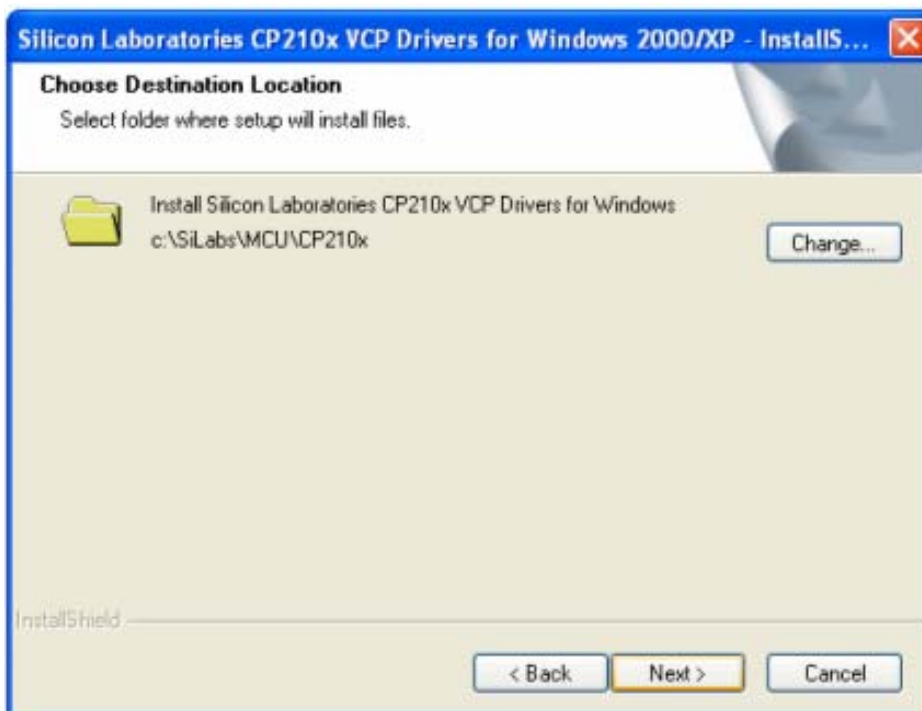
2. **Install cp210x(usb2com) driver**
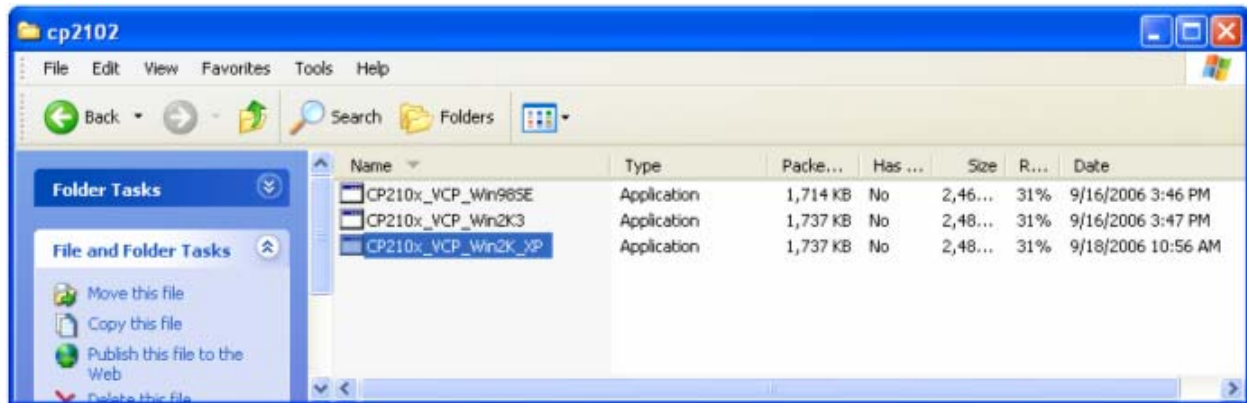
Choose the appropriate driver for your OS. In this case is a Windows XP operation system. Double click on it, and you will see:


Click "Next".

Silicon Laboratories CP210x VCP Drivers for Windows 2000/XP - InstallS...

License Agreement
Please read the following license agreement carefully.

> END-USER LICENSE AGREEMENT
> IMPORTANT: READ CAREFULLY
> BEFORE AGREEING TO TERMS
>
> THIS PRODUCT CONTAINS CERTAIN COMPUTER PROGRAMS AND OTHER THIRD
> PARTY PROPRIETARY MATERIAL (鏈ICENSED PRODUCT?, THE USE OF WHICH IS
> SUBJECT TO THIS END-USER LICENSE AGREEMENT. INDICATING YOUR AGREEMENT
> CONSTITUTES YOUR AND (IF APPLICABLE) YOUR COMPANY'S ASSENT TO AND
> ACCEPTANCE OF THIS END-USER LICENSE AGREEMENT (THE "LICENSE" OR
> "AGREEMENT"). IF YOU DO NOT AGREE WITH ALL OF THE TERMS, YOU MUST NOT

⦿ I accept the terms of the license agreement   [Print]
◯ I do not accept the terms of the license agreement

InstallShield

[< Back]   [Next >]   [Cancel]

Select "I accept the terms of license agreement", and click "Next"

Silicon Laboratories CP210x VCP Drivers for Windows 2000/XP - InstallS...

Choose Destination Location
Select folder where setup will install files.

Install Silicon Laboratories CP210x VCP Drivers for Windows
c:\SiLabs\MCU\CP210x   [Change...]

InstallShield

[< Back]   [Next >]   [Cancel]

Using the default installation path, c:\SiLabs\MCU\CP210x, or specify your own path by click "Change". Click "Next". Then click "Install".
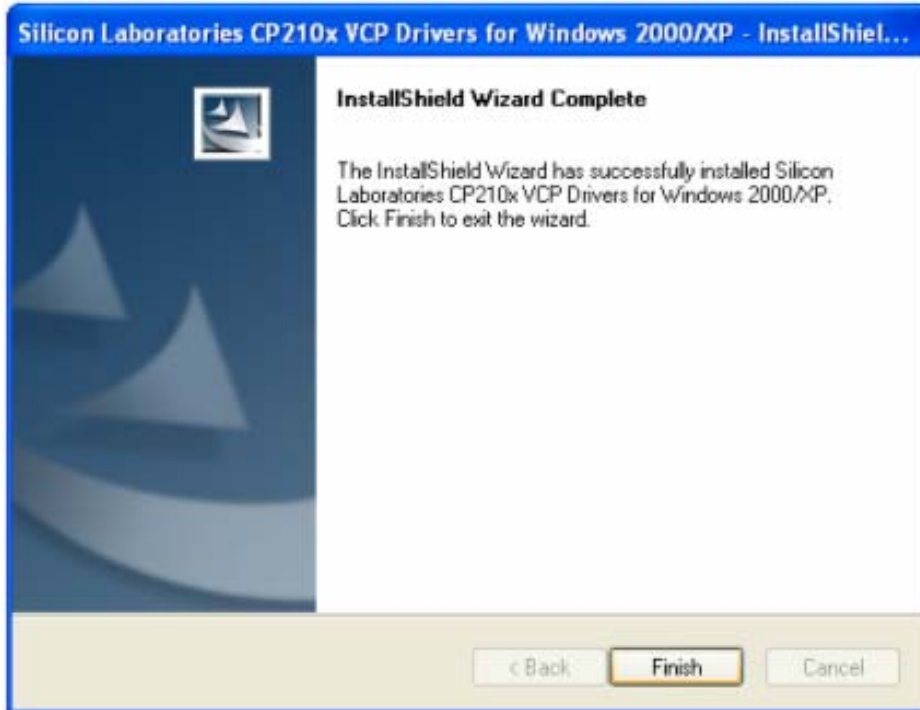
When finished installation, click "Finish"

3. **Plug the USB cable to the USB port on your PC, plug the other end of the USB cable to hand controller. Turn on the power on the mount.**

4. **Install the Hardware**
The computer will find a new hardware and show the following screen
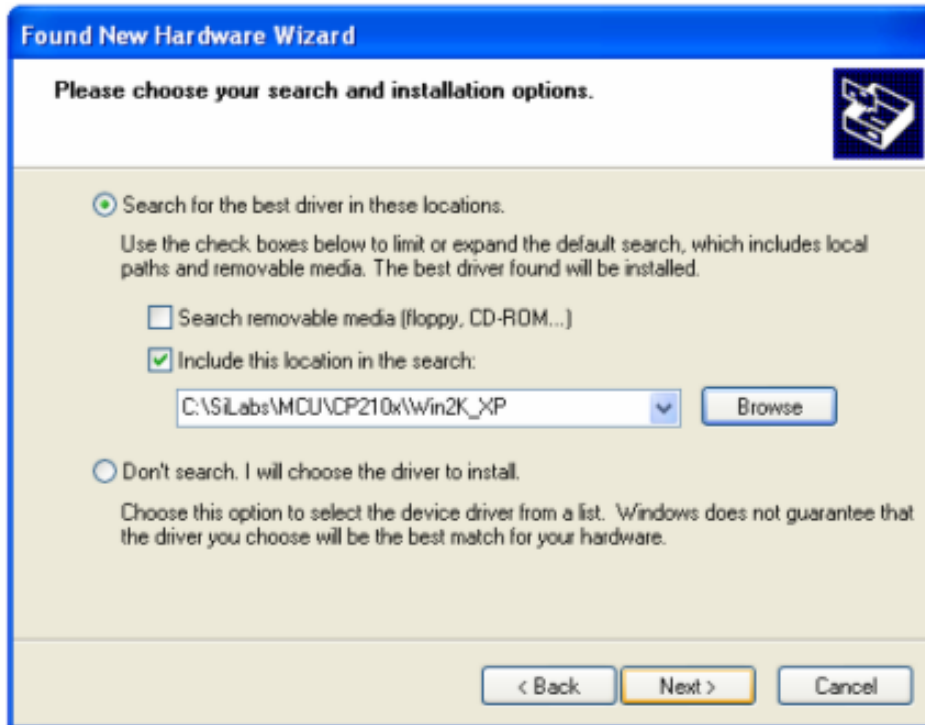

Select "No, not this time" and click "Next".
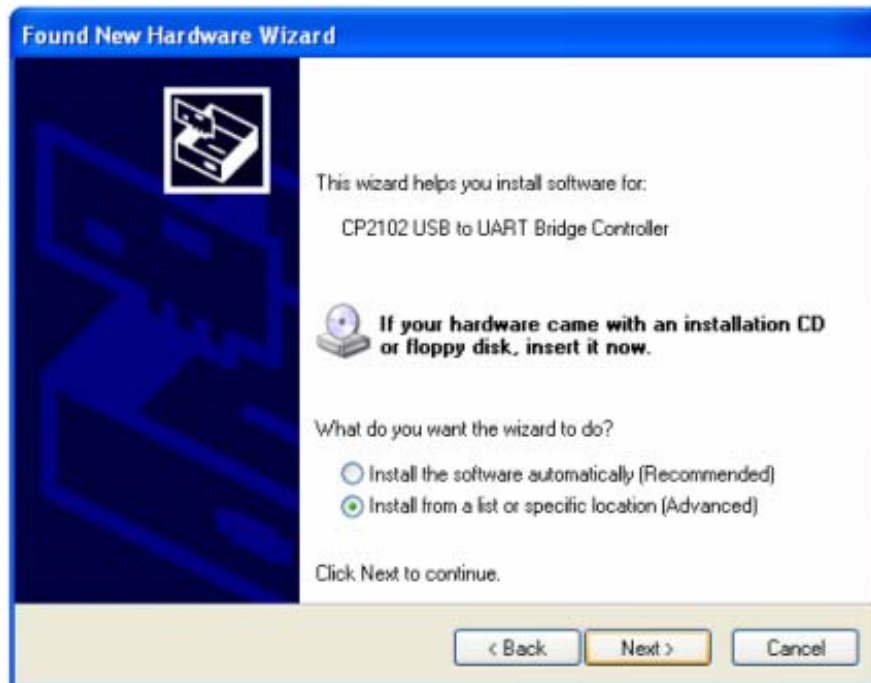
Select "Install from a list or specific location" and click "Next".
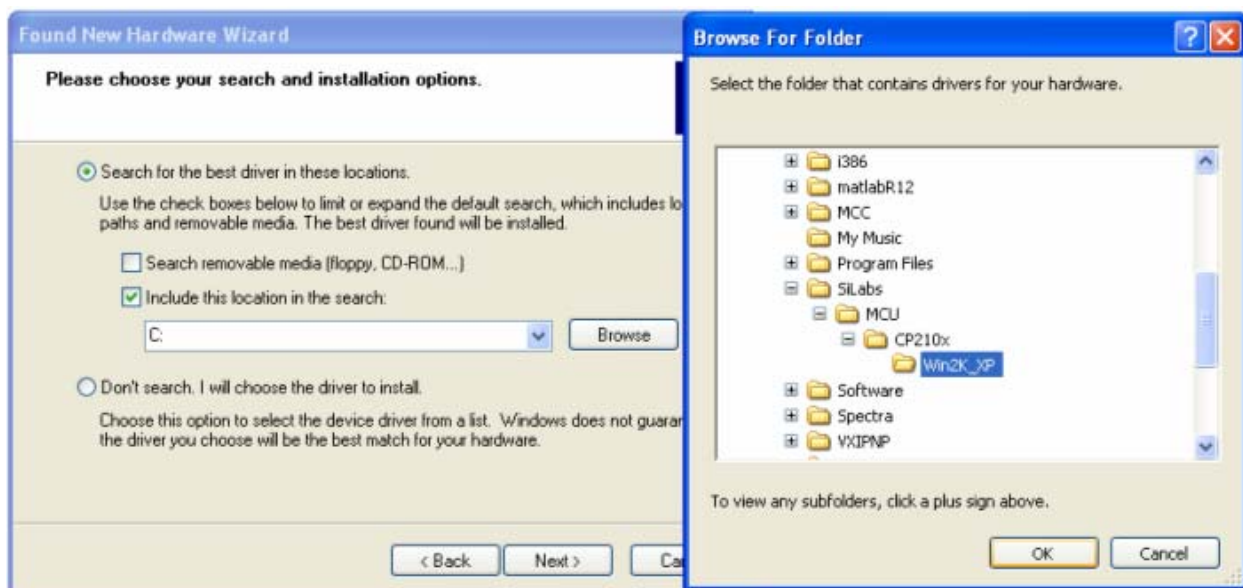
Select "Search for the best driver in these locations," and check "Include this location in the search."

Click on "Browse" and select the cp210x driver from directory
c:\SiLabs\MCU\CP210x\Win2K_XP, click OK.

Click "Next". The computer will start to install the driver for the USB2COM. When the installation is done, click "Finish".

If the computer shows "find a new hardware" screen again, just repeat the steps in this section again.

Now your computer should be ready for Firmware Upgrading; computer communication with the mount via ASCOM platform; and planetarium software applications. However, you need to find assigned COM port number for the USB connection. To do so, right click "My Computer", and click "Properties"

Click "Hardware", click "Device Manager"
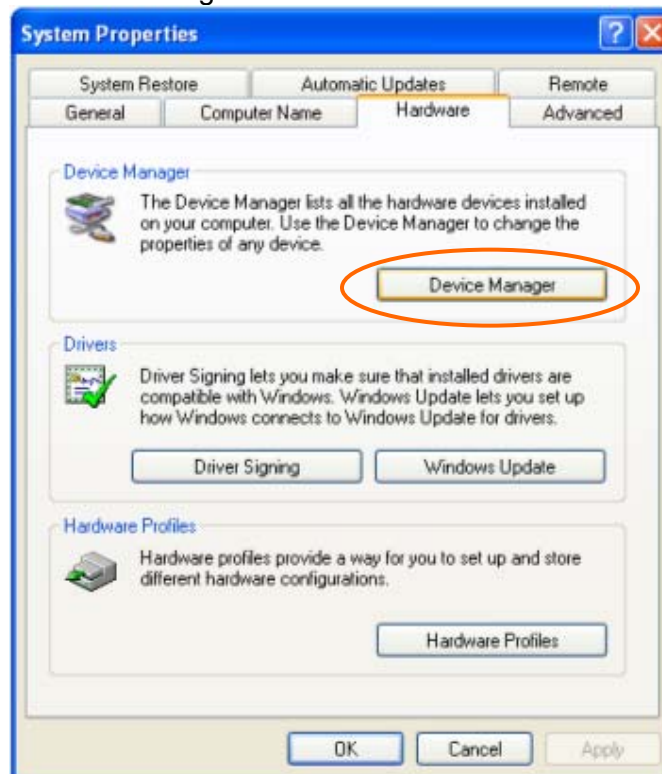
Double click on "Ports (COM & LPT)". Find the COM number and write it down (in the following figure, it is COM4)
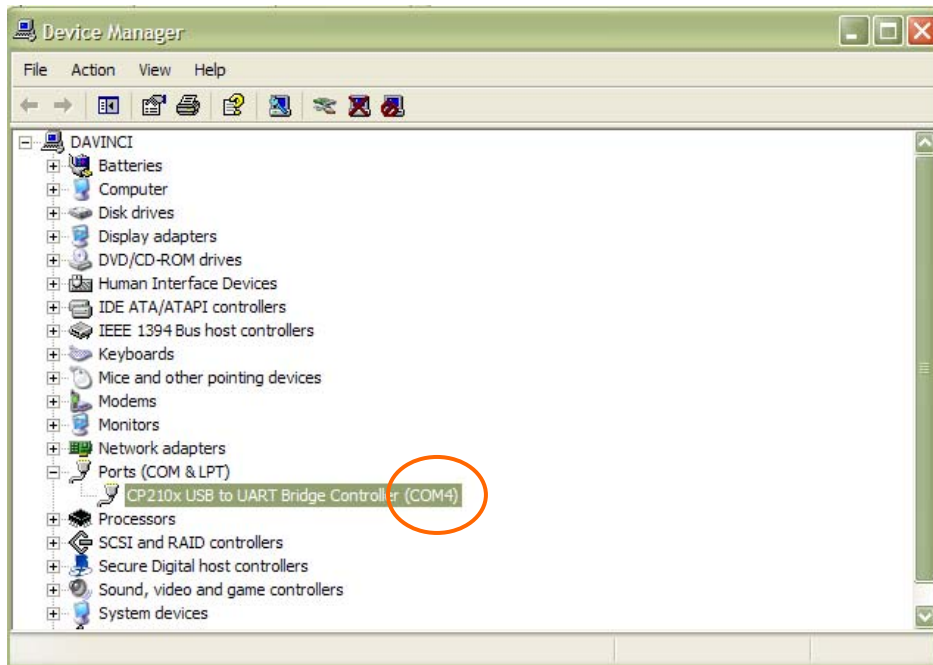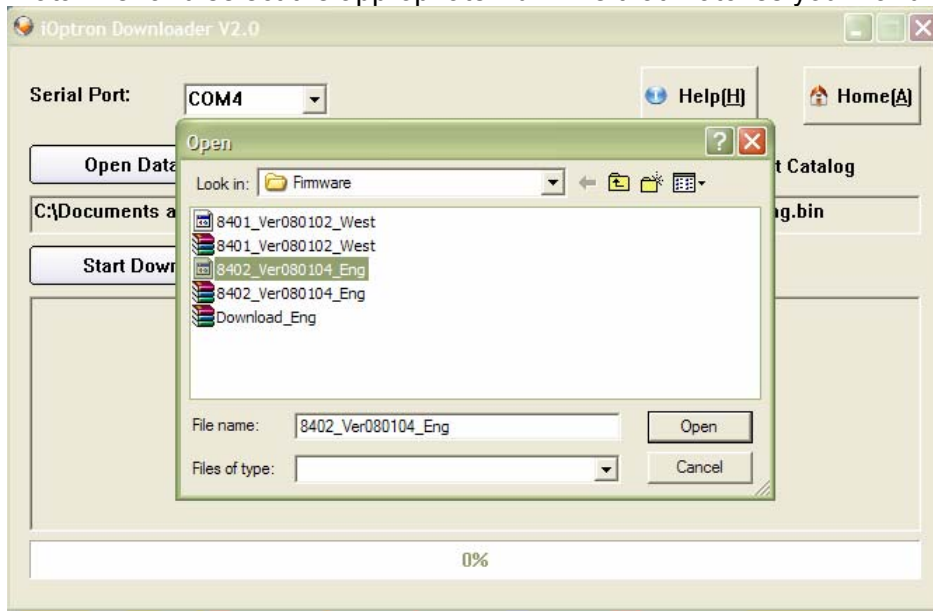
Appendix E. Firmware Upgrade

1. **Download and install Firmware Downloader from iOptron Website**

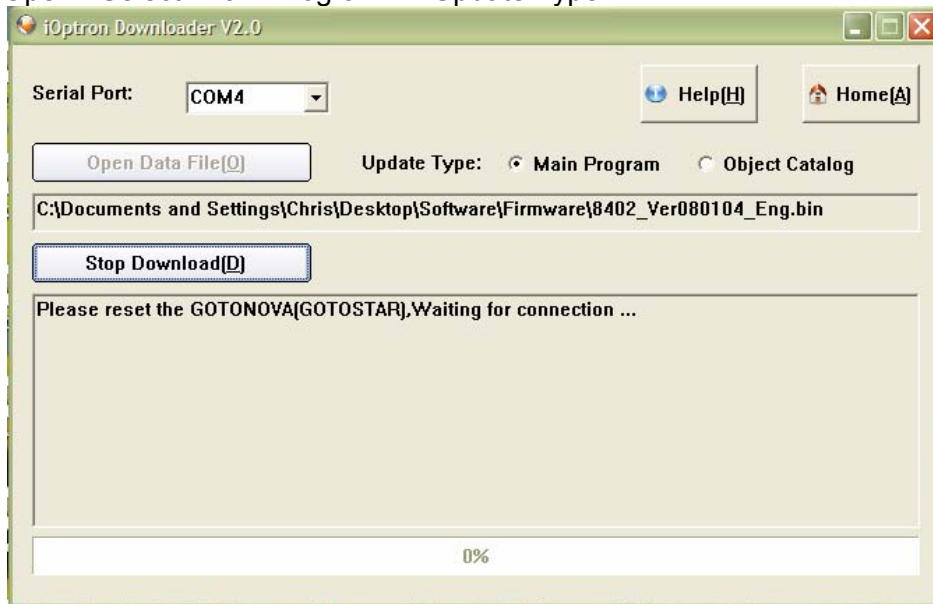2. **Double click and open "iOptron Downloader"**
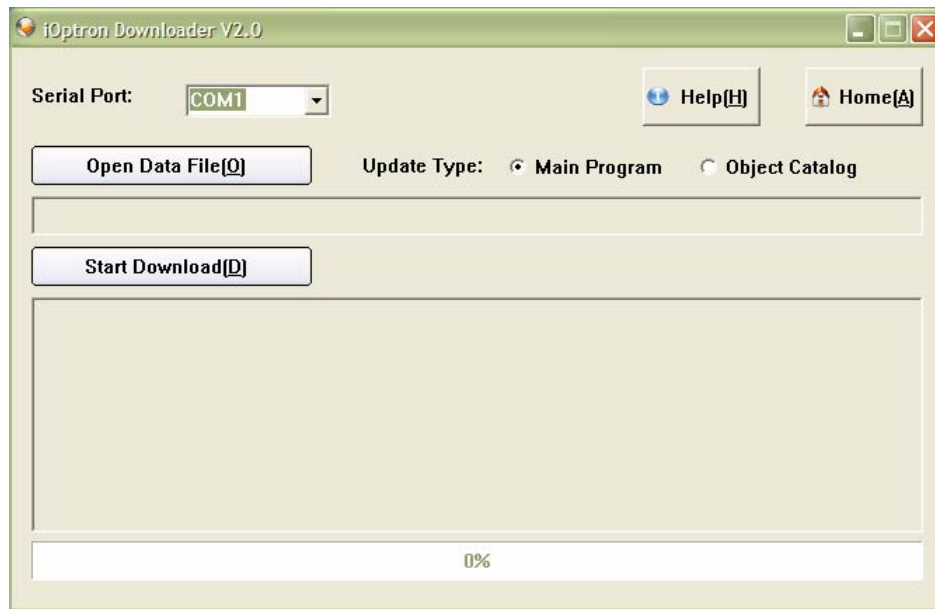
On the interface, select appropriate port using pull-down menu (in this case, COM4):
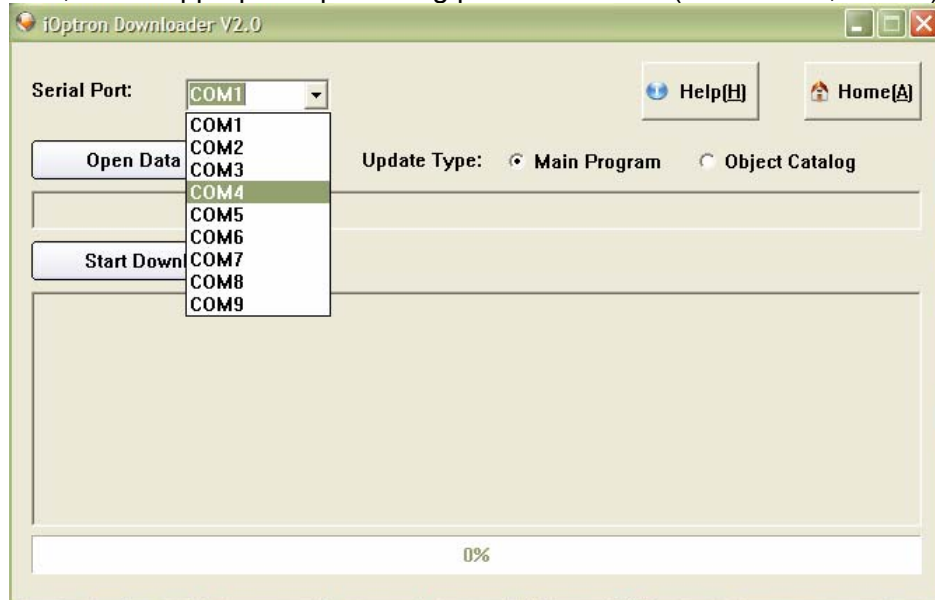
Click "Open Data File" and select the appropriate ".bin" file that matches your hand controller.

Then click "Open". Select "Main Program" in Update Type.

Click "Start Download"
It shows "Please reset GoToNova[GOTOSTAR], waiting for connection…"

On the hand controller, press "MENU", and using ▼▲ scroll to select "Set u controller", press "ENTER", then select "Upgrade firmware", press "ENTER" and the upgrade will start.
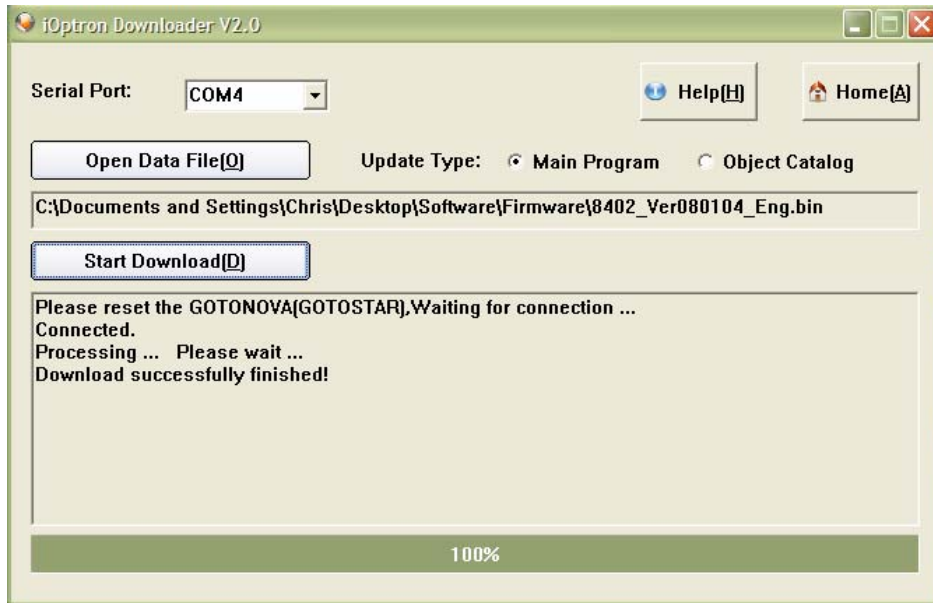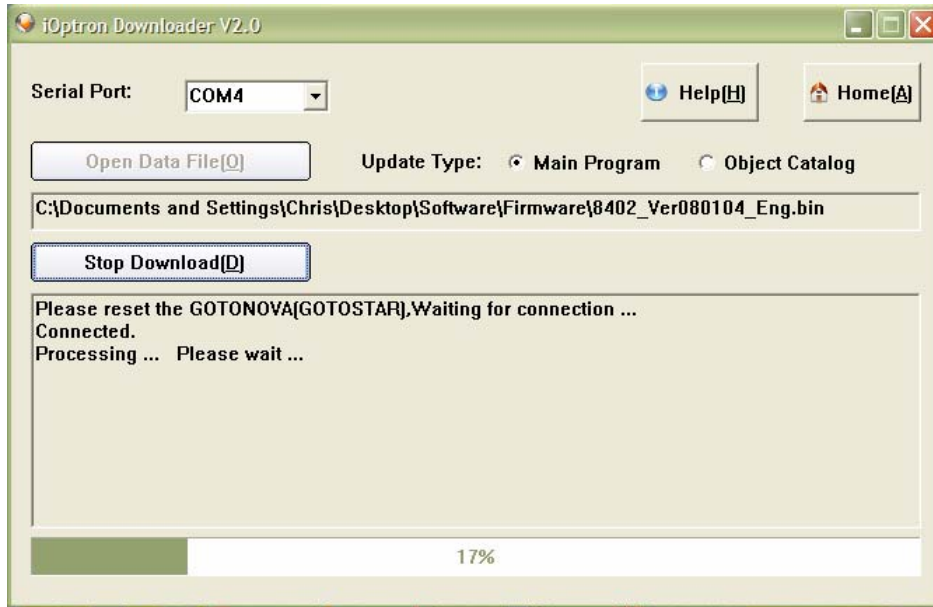
The upgrade is completed. Turn your mount power off then on again.

Typical Errors:
1. Invalid Port Number: in Device Manager: make sure you have the correct COM port number for CP210x.
2. Wrong downloader: you should use iOptron Downloader instead of the Flash Downloader.
3. Use cp210x driver provided by iOptron. The newest version from SiLab may not work properly for iOptron's hand controller.
4. Screen is now blank: wrong ".bin" file: make sure you have the correct ".bin" file for firmware upgrade. Follow iOptron online FAQ, *"What can I do if the firmware upgrade was interrupted, or after download the screen is blank or does not respond?"* to reset your hand controller (http://www.ioptron.com/support.aspx?catalog=26).

Appendix F. Use a PC to Control an iOptron Mount

In general you need the followings to use a PC to control an iOptron mount:

1. A GoToNova Hand Controller with USB port, such as 8402 or 8401 Hand Controller;

2. Download USB2COM driver from iOptron website http://www.ioptron.com, click on **Support**, select **GoToNova Hand Controllers**.
   - For 8401, 8402 hand controller, download cp2102.zip or CP210x VCP driver depends on your windows operation system;
   - For 8402G hand controller, download PL-2303 VCP driver

3. Install USB2COM to establish the connection between the mount and the PC;

4. Download and install ASCOMPlatform5b.msi from http://www.ascom-standards.org/

5. Download and install ASCOMPlatform5.5.1 Update from http://www.ascom-standards.org/.

6. Download and install iOptron Telescope ASCOM drive 1.03b from iOptron website, click on **Support**, select **ASCOM Driver**.
   - Please remove previous installed iOptron ASCOM driver before installation
   - If your computer does not have a Visual C++ 2008 SP1 Redistribute, which gave an error message during ASCOM installation, you need download and install one from http://download.microsoft.com/download/d/d/9/dd9a82d0-52ef-40db-8dab-795376989c03/vcredist_x86.exe.

7. Planetarium software support ASCOM protocol. Follow software instruction to select iOptron Telescope.

Not all the function from a planetarium software may be supported. Some companies have integrated iOptron's products into their planetarium software, such as Voyage and The Sky X Pro. Therefore, an ASCOM plug-in will not be needed. Most planetarium software can be used to control iOptron's product via ASCOM.