



iOptron[®] CEM60 Center-Balanced Equatorial Mount

Instruction Manual

Product #7200 and #7201



Please read the included CEM60 Quick Setup Guide (QSG) BEFORE taking the mount out of the case!

This product is a precision instrument and uses a magnetic gear meshing mechanism. Please read the included QSG before assembling the mount. Please read the entire Instruction Manual before operating the mount.

You must hold the mount firmly when disengaging or adjusting the gear switches. Otherwise personal injury and/or equipment damage may occur. Any worm system damage due to improper gear meshing/slippage will not be covered by iOptron's limited warranty.

If you have any questions please contact us at support@ioptron.com



WARNING!

***NEVER USE A TELESCOPE TO LOOK AT THE SUN WITHOUT A PROPER FILTER!
Looking at or near the Sun will cause instant and irreversible damage to your eye.
Children should always have adult supervision while using a telescope.***

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1. CEM60 Introduction

Welcome to a new type of equatorial mount – the iOptron® Center-Balanced Equatorial Mount, or CEM! Its unique design puts the payload at the center of gravity providing greater natural stability. This means the mount is extremely light compared to its maximum payload – resulting in an observatory class mount that is portable enough for easy transportation and set-up at a remote site. The adjustable counterweight bar prevents the counterweight from getting in the way of the tripod or pier when operating at a low latitude location. Polar aligning is quick and accessible all the time since the polar scope is not blocked by the declination shaft.

The CEM60™ mount is equipped with the most advanced GOTO NOVA® GOTO technology, making it one of the most powerful and accurate GOTO mounts available. The Go2Nova® 8407+ hand controller has a database of over 300,000 objects making it easy to locate even the faintest celestial objects. Other features include a magnetically loaded gear system to dramatically reduce backlash, gear switches on both R.A. and DEC axes, a screw/worm type latitude adjuster for precision polar alignment and a built-in cable management system which can be customized by the user.

Features:

- A new design, center-balanced equatorial mount (CEM) for maximum payload capacity and minimum mount weight
- High precision tracking mount ideal for both visual observers and astrophotographers
- Patent pending non-contact magnetically loaded gear system
- Payload of 60 lbs (27.2 kg) with mount-only weight of 27 lbs (12.3 kg)
- Gear switches on both R.A. and DEC axes for easy balancing
- Adjustable counterweight shaft for low latitude operation
- Screw/worm type latitude adjuster for precision adjustments when polar aligning
- Milling machine tooling vise type latitude bearing and lock system for rock solid positioning
- Azimuth fine adjusters for easy azimuth adjustment
- Precision stepper motor with 0.06 arcsec accuracy for precise GOTO and accurate tracking
- Permanent periodic error correction (PPEC) (#7200) or Real-time periodic error correction (RPEC) (#7201)
- iOptron AccuAlign™ calibrated polar scope with illuminated reticle and easy polar alignment procedure for fast and accurate polar alignment
- Polar alignment routine for those who can't see the Pole Star
- AutoZero™ technology for mount remote operation
- Go2Nova® 8407+ controller with advanced GOTO NOVA® GOTO Technology, built-in heater, and red LED reading light
- Integrated ST-4 compatible autoguiding port
- Built-in 32-channel Global Positioning System (GPS)
- Built-in cable management system which can be user customized
- Spring loaded dual saddle compatible with Vixen/Losmandy style dovetail bars
- 150mm base size to match optional 2 inch heavy-duty stainless steel tripod (8kg), pier or tri-pier
- Optional PowerWeight™ rechargeable battery pack

2. CEM60 Overview

2.1. Parts List¹

SHIPPING CONTENTS

Your new CEM60 mount comes in two shipping boxes. One box contains either a CEM60 (#7200) or CEM60-EC (#7201) mount head, hand controller, counterweight shaft, and accessories enclosed in a sturdy aluminum carry case. The other box contains a 21lb (9.5kg) counterweight. The contents are:

- iOptron® CEM60 telescope mount (#7200, with silver adjustment knobs) or iOptron® CEM60-EC mount (#7201, high precision model with red adjustment knobs)
- Go2Nova® 8407+ Hand Controller
- One 21lb (9.5 kg) counterweight
- Stainless steel counterweight shaft
- Polar scope with LED illuminated reticle and reticle power cable
- AC adapter (100V-240V)
- Hand Controller Cable (6P6C RJ11 to RJ11, straight wired)
- Serial cable (RS232 to RJ9)
- DC power cable for standard 12v car power socket
- Aluminum carrying case
- Quick Start Guide

OPTIONAL PARTS

- 2" tripod (#8021ACC)
- 42 inch pier (#8033) /48 inch pier (#8030)
- Tri-Pier (#8034)
- MiniPier (#8032)
- StarFi wireless adapter (#8434)
- USB to RS232 Converter with FTDI chipset (#8435)
- PowerWeight™ rechargeable counterweight battery (#8128)

ONLINE RESOURCES *(click on the "Support" menu at www.iOptron.com)*

- Quick Start Guide
- This instructional manual
- Tips for set up
- Hand controller and mount firmware upgrades (check online for latest version)
- iOptron ASCOM driver
- Reviews and feedback from other customers
- Accessories

¹ US market only. Actual contents may vary.

2.2. Identification of Parts

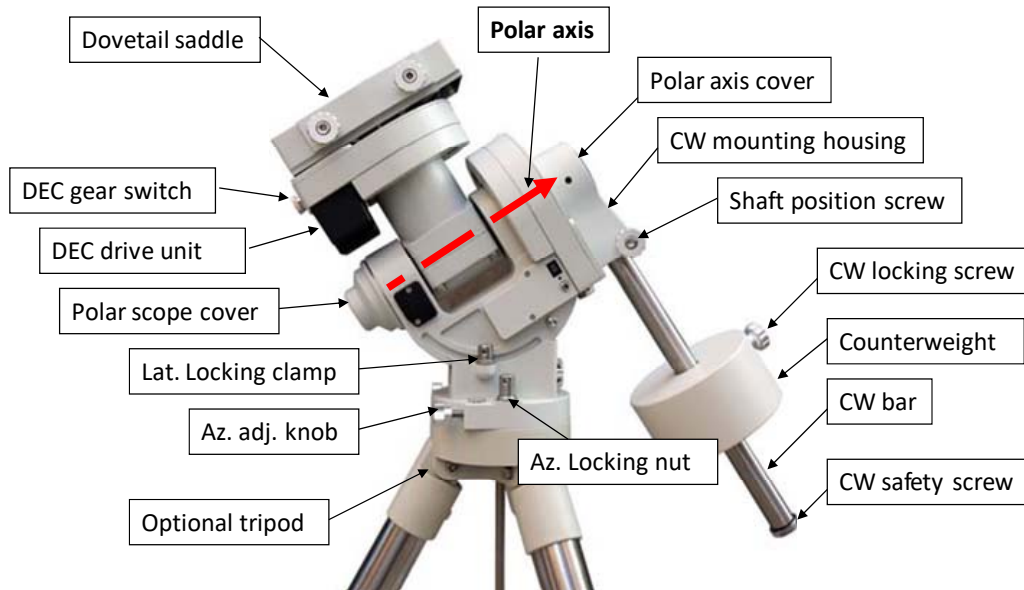


Figure 1. CEM60 mount assembly

2.3. CEM60 Mount Ports

Ports on the mount



Figure 2. Ports on a CEM60 mount

- I/O: Power Switch
- DC 12V: DC power socket to power the mount (2.1mmX5.5mm, center positive)
- PORT: Auxiliary port for connecting to other iOptron accessories, such as an electronic focuser or for observatory dome control. **DO NOT** plug your ST-4 guiding camera cable into this port as it may damage the mount or guide camera electronics.
- HBX (Hand Box): For connecting to an 8407+ Hand Controller
- GUIDE: ST-4 compatible autoguiding port
- RS232: Serial port for mount-computer control and firmware upgrade

On DEC unit:

- Reticle: Power supply for the polar scope illuminated reticle LED, or illuminated eyepiece (1.3mmX3.5mm, center positive)



Figure 3. Polar scope reticle power socket on DEC unit

2.4. CEM60 Gear Switches

The CEM gear system utilizes a magnetic force system for optimal gear meshing. Fully turn the Gear Switch *clockwise* to disengage the worm from the worm wheel. Turn the Gear Switch *counterclockwise* to engage the worm to worm wheel, as indicated on the mount. The Gear Switch **MUST NOT** be left in a position that is in between the Engaged and Disengaged positions. Setting the Gear Switch in between states may damage the worm or worm wheel.



WARNING: Never disengage or adjust the Gear Switches without holding the mount firmly! Otherwise personal injury and/or equipment damage may occur.



Figure 4. CEM60 R.A. (left) and DEC (right) gear switches

2.5. CEM60 Cable Management

The CEM60 mount has a pre-wired Cable Management Panel that allows the user to connect their accessories and imaging equipment without cables tangling or snagging when the mount is slewing or tracking. As shown in Figure 5, the Cable Management Panel has the following connections:

- 2X 12V power outlets (2.1mmX5.5mm, center positive) for powering accessories such as CCD cameras, filter wheels, or electric focusers
- 4X USB 2.0 ports with standard type A connectors for connecting accessories
- 1X 6P6C port which can be used to bridge the guiding port or accessories with a 6P6C/6P4C plug

The USB hub is non-powered and will draw power from the source USB port (for example computer USB port). Therefore, the number of usable USB ports might be limited, depending on the power consumption of the accessories.

The ports on the Cable Management Panel are connected to the Input Panel located next to the polar scope, as shown in Figure 6.

- 1X 12V power input (2.5mmX5.5mm, 5A max.)
- 1x USB 2.0 port with a standard type B connector
- 1X 6P6C port

Owners that would like to wire their own cables can remove the dovetail saddle, remove the polar scope and run cables through the polar scope aperture, soldering the cables onto the cable management panel. When reinstalling the dovetail saddle, make sure that the Stop Post and the arrow is pointed to the front of the mount as shown in Figure 7.

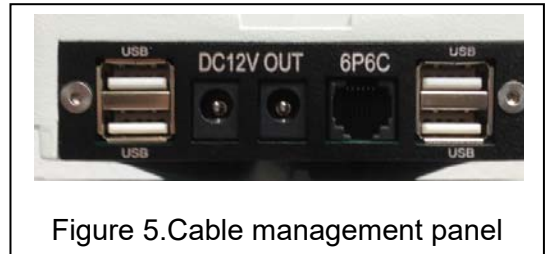


Figure 5. Cable management panel

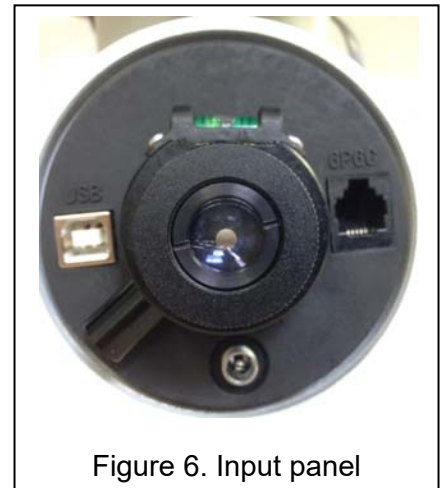


Figure 6. Input panel

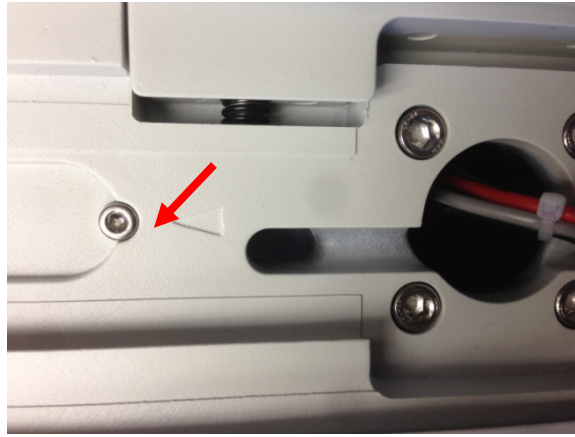


Figure 7. Stop Post on dovetail saddle

2.6. Go2Nova[®] 8407+ Hand Controller



Figure 8. Go2Nova[®] 8407+ hand controller

The Go2Nova[®] 8407+ hand controller (HC) shown in Figure 8 is the standard controller used on the CEM60 mount. It has an integrated heater that ensures the LCD display will work at the temperature as low as -20°C(-4°F). It has a large LCD screen, function, direction, and number keys on the front; a red LED reading light on the back; and a HBX (6-pin) and a serial port (4-pin) at the bottom.

2.6.1. Key Description

- MENU Key: Press “MENU” to enter the Main Menu.

- BACK Key: Move back to the previous screen, or end/cancel current operation, such as slewing.
- ENTER Key: Confirm an input, go to the next menu, select a choice, or slew the telescope to a selected object.
- Arrow (▲▼◀▶) Keys: The arrow keys are used to control the movement of DEC and R.A. axes. Press and hold ▲(DEC+),▼(DEC-) buttons to move a telescope along the DEC direction, ◀(R.A.+), ▶(R.A.-) to move a telescope along the R.A. direction. They are also used to browse the menu or move the cursor while in the menu. Press and holding an arrow key for a fast scrolling.
- 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.
- Help (?) Key: Identify and display bright stars or objects that the telescope is pointing to.
- STOP/0 Key: Stop the mount during GOTO. Also toggling between starting and stopping tracking.
- HBX (Handbox) port: connect the HC to the CEM60 mount using a 6P6C RJ11 cable.
- Serial port: connect the HC to a computer via a RS232 to 4P4C RJ9 cable. The pin-out of the serial port is shown in Figure 9.

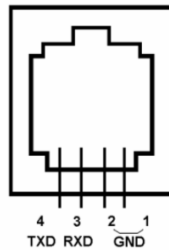


Figure 9. Serial port pin-out on an 8407+ hand controller

2.6.2. The LCD Screen

The 8407+ HC has a large 8-line, 21-character per line, LCD screen which displays information on the status of the mount as shown in Figure 10. The user interface is simple and easy to operate.

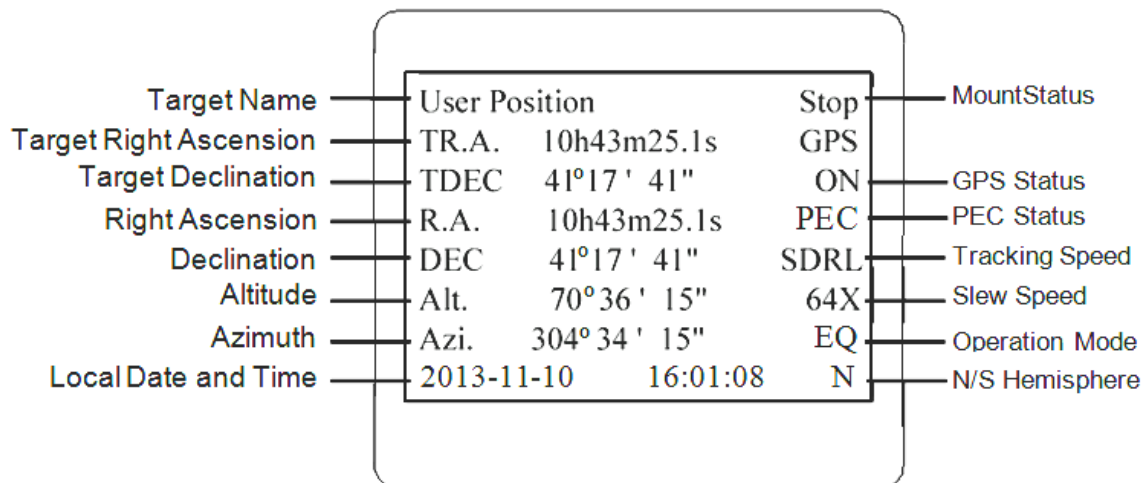


Figure 10. 8407+ HC LCD Information Screen

1. Target Name/Mount Position: displays the name of the target that telescope is currently pointed to or the current mount position.
 - Zero Position: The reference position for GOTO. The mount can move to Zero Position using "Goto Zero Position" or "Search Zero Position" command;

- User Position: The mount is pointed to a user defined position, which could be a particular celestial object or simply a position determined by pressing an arrow key;
 - An object name, such as “Mercury” or “Andromeda Galaxy”: Name of the star or celestial object that the mount is currently slewing to or tracking.
2. Target R.A.: Right Ascension (R.A.) of the target object.
 3. Target Declination: Declination (DEC) of the target object.
 4. Right Ascension: Current R.A. of the telescope.
 5. Declination: Current DEC of the telescope.
 6. Altitude: Altitude of the telescope (degrees vertical from the local horizon - zenith is 90°).
 7. Azimuth: Azimuth of the telescope (north is 0°, east is 90°, south is 180°, and west is 270°).
 8. Local Date and Time: displays the local time in a format of YY-MM-DD HH:MM:SS.
 9. Mount Status: Displays the current operational status of the mount.
 - Stop: mount is not moving;
 - Slew: mount is moving with an arrow key is pressed or a GOTO command, such as “**Select and Slew**” or “**Goto Zero Position**”;
 - Tracking: mount is at a tracking status.
 10. GPS status: When the power is turned on, the initial GPS status will be “GPS ON”, which means that the mount is connected to its GPS receiver and is seeking a satellite signal. When the GPS receiver finds the satellites and receives the GPS signal the status will change to “GPS OK”.
 11. PEC status: Display of “PEC” here Indicates the Periodic Error Correction playback is turned on. Default is off.
 12. Tracking speed: Displays the current tracking rate of the mount.
 - SDRL: mount is tracking at sidereal speed;
 - Solar: mount is tracking at solar speed;
 - Lunar: mount is tracking at lunar speed;
 - King: mount is tracking at king speed;
 - CSTM: mount is tracking at a custom, user-defined speed.
 13. Slew speed: The mount has 9 slew speeds: 1X, 2X, 8X, 16X, 64X, 128X, 256X, 512X, MAX (~3.75°/sec).
 14. Operation Mode: EQ indicates that the mount is operating in an equatorial mode.

2.7. Bench Testing the Mount

The counterweight shaft is designed to counter balance the mount’s own weight. It is recommended that the CW shaft is installed when testing the mount’s function, as shown in Figure 11.



Figure 11. Setup for initial mount testing

Slewing the mount without the CW shaft installed, as shown in the image on the left of Figure 12, is not recommended. **NEVER** operate the mount with only the counterweight or OTA on it, as shown in the image on the right of Figure 12. It will damage the precision engineering of the mount drive system.



Figure 12. **Do not** operate the mount with an unbalanced load, for instance with a counterweight installed without an OTA, as shown above, or vice versa

3. CEM60 Mount Assembly

3.1. Introduction

Congratulations! You have just purchased a new design of telescope mount that has a class leading payload capacity for its weight and is capable of high precision tracking. This makes the CEM60 a superb choice for observational astronomy and astrophotography whether permanently mounted on a pier, in an observatory, or as part of a portable setup for use in your backyard, at dark sky sites, and at star parties.

In order for you to get the optimum performance from the mount and your optical tube assembly (OTA) combination, you must assemble and set up the mount correctly.

The following basic principles are included to help you understand the fundamental concepts of telescope mounts before the specific details of the CEM60 mount are covered.

Telescope mounts are either equatorial or altitude-azimuth (Alt-Az). Both types of mount rotate the OTA around two perpendicular axes to point to a desired object in the night sky.

An Alt-Az is a simple mount that has a horizontal axis to provide vertical (altitude) OTA movement from the local horizon and a vertical axis to provide horizontal (azimuth) OTA movement and is therefore able to point at any part of the sky. In order to track an object across the sky, an Alt-Az mount has to continually move the OTA in both axes. This can provide tracking that is good enough for visual observing and short exposure photography. However, the mechanics of this system are such that an OTA carried by an Alt-Az mount will suffer from field rotation where stars will appear to rotate about the point being tracked forming arcs. As such Alt-Az mounts are not suitable for long exposure astrophotography which is needed to capture faint deep sky objects.

An equatorial mount has an axis, called the right ascension (R.A.) axis, aligned with the celestial North Pole (CNP) in northern latitudes, or the celestial South Pole (CSP) in the Southern Hemisphere. Equatorial mounts counteract the rotation of the Earth by driving the R.A. axis in the opposite direction thus tracking celestial objects as they appear to move across the sky. Once the mount has been accurately aligned to the celestial pole, only movement of the R.A. axis is required for accurate tracking and this design does not suffer from field rotation. R.A. is the celestial equivalent of longitude and is the angular distance measured eastward along the celestial equator as measured from a zero reference point (the vernal equinox). A second axis perpendicular to the R.A., the declination axis (DEC), provides elevation relative to the celestial equator.

As mentioned above, in order to track celestial objects the R.A. axis of an equatorial mount must be accurately aligned with the celestial pole. Your new iOptron mount comes equipped with features that make accurate alignment quick and easy. The CEM60 includes mechanical adjusters that move the mount in altitude and azimuth in order to align the R.A. axis, also known as the mount's Polar Axis, with the celestial pole. These adjustments do not involve any rotation of the mount's R.A. or DEC axes and can be performed without the OTA installed. The first step is to make an approximate azimuth alignment of the mount's Polar Axis by roughly aligning the R.A. axis to a reference point toward True North (or True South if in the Southern Hemisphere). A compass can be used for this initial azimuth alignment but you must allow for the variation between True and Magnetic North/South at your location. Precise horizontal alignment of the Polar Axis is accomplished with the azimuth adjustment bolts on the mount. The second step is to adjust the Polar Axis vertically (altitude) above the horizon by setting the observer's latitude on the provided latitude scale. This procedure is based on the fundamental geometry of the Earth's coordinate system in conjunction with the concept of the celestial sphere. You can verify this by visualizing yourself at the North Pole (latitude $N90^\circ$) in which case Polaris will be 90° from the horizon, or directly overhead. These steps will place the Polar Axis very close to the celestial pole. The accuracy of both of the above adjustments can be enhanced by the use of the incorporated polar scope, which sits in an opening along the R.A. axis and allows direct viewing of the pole. In order to get the most out of your equatorial mount it is essential to understand the concept of polar alignment and how the equatorial mount helps you establish and maintain a true Polar Axis alignment. Now you are ready to set up the GOTO functionality of the CEM60 – which gives access to more than 300,000


celestial objects – by performing star alignments using the equatorial mount’s electronic controller, and enjoy the night sky.

The CEM60 mount is a next-generation equatorial mount that provides the precision alignment capabilities required for today’s complete astronomy solution. The following sections of this manual provide the detailed steps required to successfully set up and operate the CEM60 mount.

3.2. CEM60 Mount Assembly

NOTE: The CEM60 mount is a precision astronomical instrument. It is highly recommended that you read this entire manual and become familiar with the nomenclature and function of all components before starting assembly.

 **WARNING:** DO NOT rock the counterweight shaft rigorously. This may damage the worm/drive gear system and such damage will not be covered by warranty.

 **WARNING:** The Gear Switch will allow you to achieve the most precise weight balance. This also means the mount and OTA will swing FREELY when the Gear Switch is disengaged. Always firmly hold the OTA or mount when releasing a Gear Switch or adjusting gear tension.

STEP 1. Removing the Mount from the Carrying Case

The mount is shipped with the R.A. Gear Switch disengaged. ALWAYS turn the Gear Switch *counterclockwise* to fully engage the Gear Switch before removing the mount from the carrying case (Figure 13).

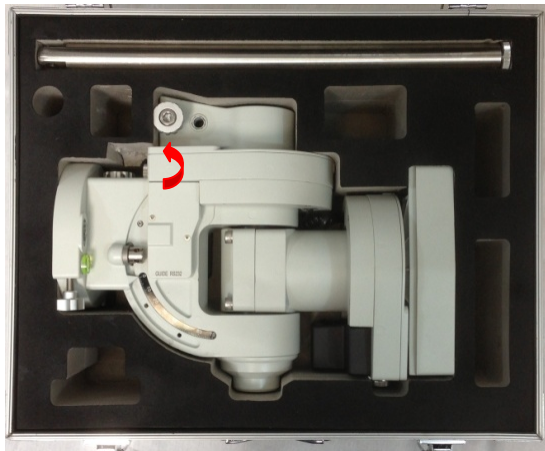


Figure 13. Engage the Gear Switches before removing the mount from the carrying case



Figure 14. Stainless steel lever

The CEM60 mount comes with a stainless steel lever which can be unthreaded from the mount (Figure 14) and can be used to tighten down mounting studs and locking clamps/nuts.

STEP 2. Attaching the Mount

The mount has a 150mm diameter base which can be mounted onto an optional iOptron 2” tripod or pier. If you have your own tripod/pier, make sure it has two M8 threaded holes separated by 130mm with a $\Phi 12\text{mm} \times 15\text{mm}$ center stud.

There are two sets of mounting studs and azimuth locking nuts. Thread the two studs onto an iOptron tripod or pier (if you are using one). Remove the alignment peg from the tripod/pier if it comes with one.

Use the pair of mounting holes that are closest to the edge and thread on the studs. Use the stainless steel lever to tighten the mounting studs. Make sure that the two studs are aligned east-west by rotating the tripod or pier.

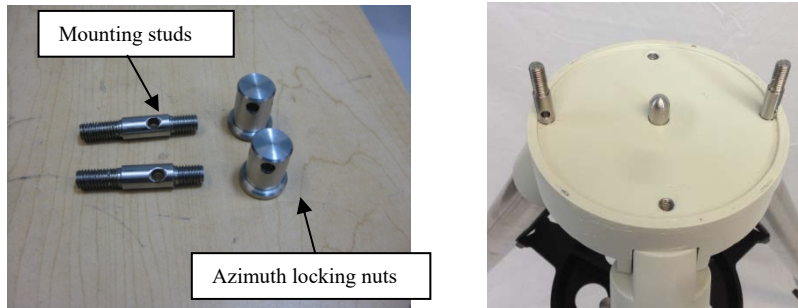


Figure 15. Mounting studs and locking nuts

Back out the azimuth adjustment knobs to make enough room to prevent them from blocking the mounting studs. Put the mount head onto the tripod, making sure that the mount head is facing north (or south if operating in the Southern Hemisphere). Install the washer (optional) and thread the azimuth locking nuts onto the mounting studs, hand tightening them. Adjust the tripod/pier to level the mount.

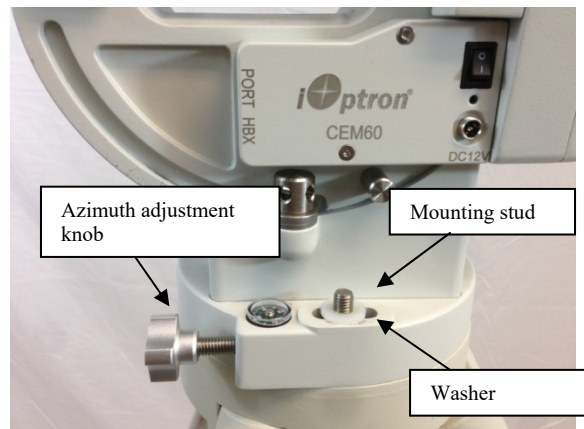


Figure 16. Attaching the mount

STEP 3. Setting the Latitude

This step requires you to know the latitude of your current location. This can be found from your 8407+ hand controller after the embedded GPS receives the signal from the satellites. It can also be easily found on the Internet, using a GPS satellite-navigation system, or a GPS capable cell phone. You will have to change this latitude setting every time you significantly change your night sky viewing location. Note that this setting directly affects the mount's GOTO accuracy.

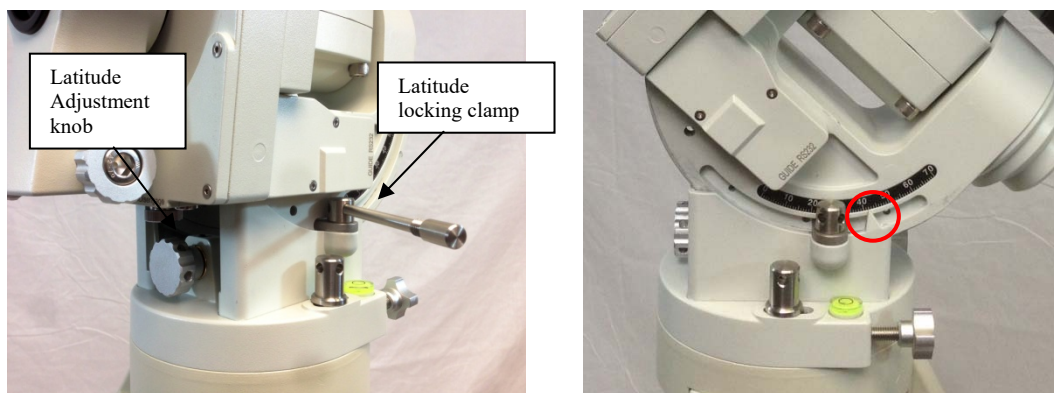


Figure 17. Setting the latitude

Slightly loosen the Latitude Locking Clamps. Turn the Latitude Adjustment Knob until the arrow points to your current latitude on the Latitude Scale. Tighten the Latitude Locking Clamps when done.

At this point, with the mount leveled and pointed north (or south in the Southern Hemisphere), and the latitude set, the Polar Axis (R.A. axis) should be pointing very close to the celestial pole. This alignment accuracy will be sufficient for visual tracking and short exposure, short focal length astrophotography (for example piggy-back mounting a camera on top of the OTA).

STEP 4. Installing the Counterweight (CW) Shaft

DO NOT rock the counterweight shaft rigorously. It may damage the worm system.

There are three screws on CEM60 CW Mounting Housing: A Shaft Locking Screw, a Shaft Position Screw on the other side, and a Low-Latitude Set Screw.

To install the CW shaft:

- (1) Remove the CW Shaft Locking Screw from the CW Mounting Housing and back out the CW Shaft Position Screw to make room for the CW shaft;
- (2) Insert the CW Shaft into the CW Mounting Housing. Make sure the rounded top of the shaft is fully engaged in the slot;
- (3) Insert the CW Shaft Locking Screw into the **TOP** hole and thread it onto the CW shaft;
- (4) Tighten the CW Shaft Position Screw.

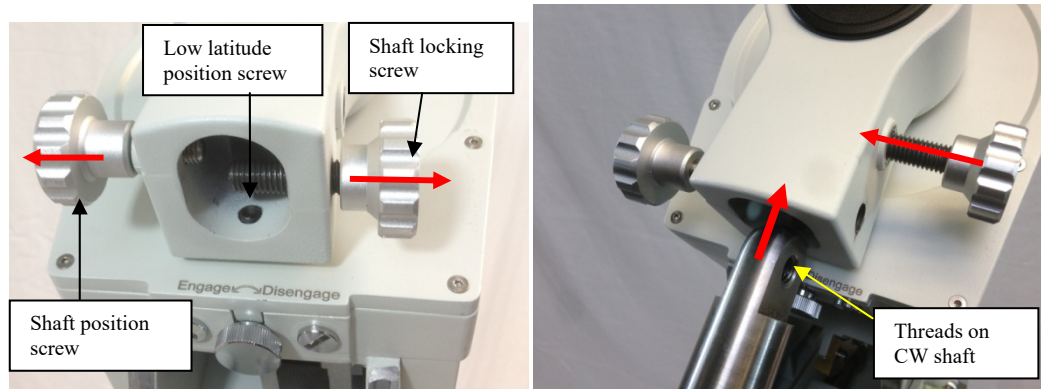


Figure 18. Install the counterweight shaft

If your CW shaft system is a two part configuration, it comes with preinstalled top part of the shaft. Just simply thread the CW shaft onto it.

All three screws, the Shaft Locking Screw, the Shaft Position Screw and the Low-Latitude Set Screw, are preinstalled. You need wrenches to adjust them.



Figure 19. Install counterweight shaft for a two part configuration

At very low-latitudes (<math><10^\circ</math>), turn the Low Latitude Position Screw (a hex head set screw) further into the CW Mounting Housing to ensure that the CW does not foul your tripod/pier. Then tighten the CW Shaft Positioning Screw and Shaft Locking Screw.



Figure 20. Tilt the counterweight shaft for low altitude



Figure 21. Install the counterweight

STEP 5. Installing the Counterweight(s)

Before installing the counterweight, make sure that both R.A. and DEC Gear Switches are fully engaged to avoid sudden mount movements which could cause injury and/or damage the mount gear system and your equipment.

Make sure the mount is at the zero position (i.e. counterweight shaft is pointing to the ground) when installing the counterweight.

Disengage the R.A. Gear Switch to set the R.A. axis free before loading the CW. Remove the CW Safety Cap at the end of the CW Shaft. Guide the CW over the shaft and tighten the CW Locking Screw to hold the CW in place. Always place the Safety Cap back onto the shaft prior to use to prevent personal injury and/or equipment damage. Engage the R.A. Gear Switch again.



WARNING: The mount should always be kept in the zero position while it is being loaded with CWs and payload.



WARNING: The zero position is the only safe position the mount should stay in unless it is balanced.

STEP 6. Balancing the Payload

After attaching the scope and accessories, the mount head assembly must be balanced in both the R.A. and DEC axes to ensure minimum stress on the mount drive mechanism.



WARNING: The telescope will swing freely when the R.A. or DEC Gear Switch is disengaged. Always hold on to the telescope assembly before releasing the Gear Switches to prevent it from swinging, which can cause personal injury and/or equipment damage.

The CEM gear system utilizes a magnetic force system for optimal gear meshing. Fully turn the Gear Switch *clockwise* to disengage the worm from the worm wheel. Turn the Gear Switch *counterclockwise* to engage the worm to worm wheel, as indicated on the mount. You may feel a “click” when the gear meshed.

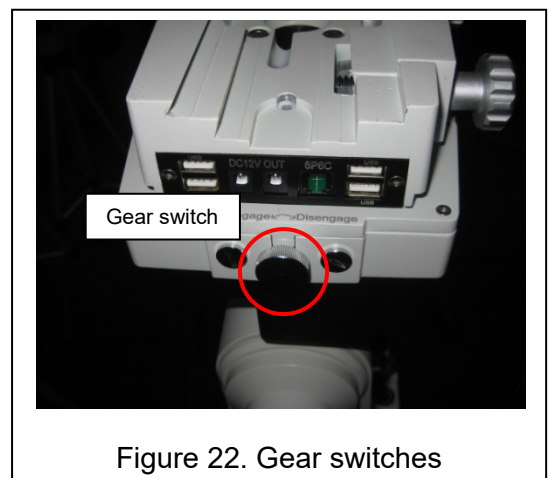


Figure 22. Gear switches



WARNING: The balancing process **MUST** be done with the Gear Switch in the Disengaged position! Otherwise it might damage the worm system.

With the corresponding Gear Switch disengaged, balance the assembly in R.A. axis by moving CW along its shaft. Balance in DEC axis by moving the scope, with any accessories already attached, back and forth in the mount saddle or within the scope mounting rings.

Only balance one axis at a time and start with the DEC axis first. Double check the mount to make sure both the R.A. and DEC axes are balanced.

Return the mount to the Zero Position after balancing, i.e. with the CW Shaft pointing to the ground and the telescope aperture at its highest position.

STEP 7. Connecting Cables

Plug in a 12V DC power supply to the DC12V POWER socket. Connect the Go2Nova® 8407+ Hand Controller to the HBX port on the mount side panel.

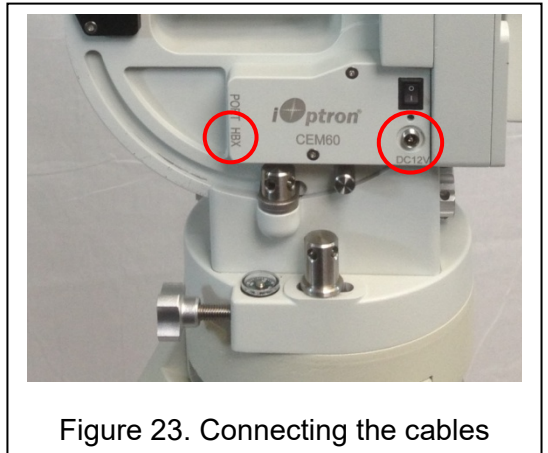


Figure 23. Connecting the cables

STEP 8. Setting Gear Switch Position

Set both Gear Switches to engaged positions after balancing the mount. To make sure the gears are meshed properly, gently turn the Gear Switch counterclockwise until you just feel the stop, but never over tightening. More adjustment may be needed as described below.

Turn the mount power on. Press 9 button on hand controller to change the slew speed to MAX. Press the arrow button to check the gear meshing. If the mount motor has “grinding” sound (which is not harmful) while slewing, the gear switch is too tight. Release 1/16 to 1/8 turn and check it again. If there is excess play in either RA or DEC axis, the gear and worm is not properly meshed. Turn the Gear Switch more counterclockwise. You may need to readjust the Gear Switch for different payload.

STEP 9. Setting up the Hand Controller

The CEM60 mount is equipped with a GPS receiver which will receive the time, longitude and latitude information for your current location from satellites after a link is established. However, there are still some parameters which need to be entered to reflect your location, such as time zone information and whether daylight saving time is currently in effect. This information will be stored in the hand controller memory along with longitude and latitude coordinates until they need to be updated.

A clear sky and open space outside is needed for the GPS to establish a link with the satellites. The GPS is installed on the side of the mount and is protected with a black plastic cover. If the GPS module has difficulty receiving the satellite signal, you may rotate the R.A. axis to one side so that the GPS module is not obscured from the satellites by the mount head or OTA.

To set up the controller, press **MENU** =>“**Settings**”:

```
Select and Slew
Sync. to Target
Alignment
Settings
Electric Focuser
PEC Options
Park Telescope
Edit User Objects
```

Press **ENTER** and select “**Set Time & Site**”

```

Set Time & Site
Set Display and Beep
Set Guiding Rate
Set Tracking Rate
Set Parking Position
Meridian Treatment
Tracking Below Horizon
Set Eyepiece Light

```

Press **ENTER**. A time and site information screen will be displayed:

```

2014-03-09 10:19:18
Daylight Saving Time    Y
UTC -300 Minute(s)

Longitude:W071d08m50s
Latitude:  N42d30m32s

Northern Hemisphere

```

Set Local Time

The time will be updated automatically when the GPS receiver has established its link with the GPS satellites. In the event that the GPS module is unable to establish a link to the satellites, local time can be entered manually. Use the ◀ or ▶ key to move the cursor █ and use the number keys to change the numbers. Use the ▲ or ▼ button to toggle between “Y” and “N” for Daylight Saving Time, or “+” and “-” for UTC (Coordinated Universal Time) setting. Hold the arrow key to fast forward or rewind the cursor.

In order to make the Hand Controller reflect your correct local time, **time zone information has to be entered**. Press the ◀ or ▶ key, move the cursor to the third line “**UTC -300 Minute(s)**” to set the time zone information (add or subtract 60 minutes per time zone). For example:

- Boston is “UTC -300 minutes”
- Los Angeles is “UTC -480 minutes”
- Rome is “UTC +60 minutes”
- Beijing is “UTC +480 minutes”
- Sydney is “UTC +600 minutes”

All the time zones in North America are “UTC -”, as shown in the following table, so ensure the display shows “**UTC -**” instead of “**UTC +**” if in North or South America.

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

To adjust minutes, move the cursor to each digit and use the number keys to input the number directly. Use ▲ or ▼ key to toggle between “+” and “-”. When the time one information entered is correct, press ENTER and go back to the previous screen. **Note that fractional time zones can be entered.**

Do not manually add or subtract an hour from displayed time to reflect Daylight Saving Time (DST). Only select “Y” after DST begins.

For other parts of the world you can find your “time zone” information from internet.

Set Observation Site Coordinates

The third and fourth lines display the longitude and latitude coordinates respectively. The longitude and latitude coordinates will be automatically updated when the GPS picks up a satellite signal. “W/E”

means Western/Eastern Hemisphere; “N/S” means Northern/Southern Hemisphere; “d” means degree; “m” means minute; and “s” means second.

If, for any reason, your GPS does not pick up the satellite signal, you can manually enter your longitude and latitude coordinates. Press the ◀ or ▶ key to move the cursor, use the ▲ or ▼ key to toggle between “W” and “E”, and “N” and “S”, and use the number keys to change the numbers. It is always a good idea to do your homework and get longitude and latitude coordinates before traveling to a new observation site.

The site coordinates information can be found from your smart phone, GPS receiver or via the internet. Site information in decimal format can be converted into d:m:s format by multiplying the decimal numbers by 60. For example, N47.53 can be changed to N47°31'48": $47.53^\circ = 47^\circ + 0.53^\circ$, $0.53^\circ = 0.53 \times 60' = 31.8'$, $0.8' = 0.8 \times 60'' = 48''$. Therefore, $47.53^\circ = 47^\circ 31' 48''$ or 47d31m48s.

Select N/S Hemisphere

If the polar axis is aligned to the North Celestial Pole, then set the mount to Northern Hemisphere. If the polar axis is pointing to the South Celestial Pole, set the mount to Southern Hemisphere. Press the ◀ or ▶ key to move the cursor and use the ▲ or ▼ key to toggle between “Northern Hemisphere” and “Southern Hemisphere”.

As an example, select Northern Hemisphere if you are located in US and press **ENTER** to go back to the main menu.

The time and site information will be stored inside the hand controller’s memory chip. If you are not traveling to another observation site, they do not need to be changed.

Check the Hand Controller Battery



The hand controller has a real time clock which should display the correct time every time the mount is turned on. If the time is incorrect, please check the battery inside the hand controller and replace it if required. The battery is a 3V, CR1220 button battery.

STEP 10. Performing Polar Alignment

One of the CEM60’s unique features is that the polar scope can be used at anytime as it is not blocked by DEC axle as is the case in a German Equatorial Mount. This makes it possible to adjust the polar alignment while the mount is tracking.

In order for an equatorial mount to track properly, it has to be accurately polar aligned.

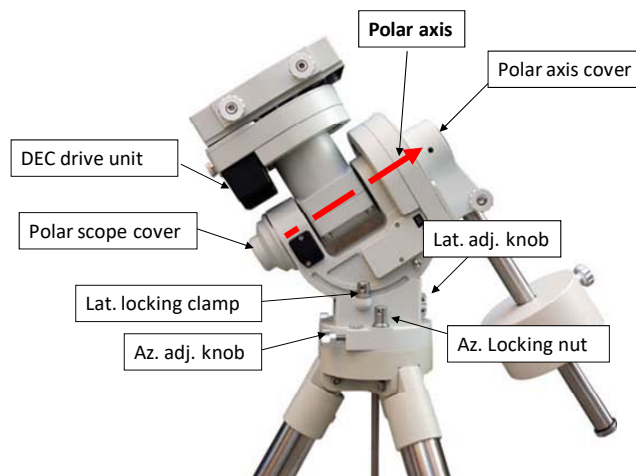


Figure 24. Polar alignment

As indicated in Figure 25, the Polar Scope reticle has been divided into 12 hours along the angular direction with half-hour tics. (**Note: the sub-tics might be in half-hour or 20 minutes.**) There are 6 concentric circles in 2 groups of 3 marked from 36' to 44' and 60' to 70', respectively. The 36' to 44' concentric circles are used for polar alignment in the Northern Hemisphere using Polaris, while the 60' to 70' circles are used for polar alignment in Southern Hemisphere using Sigma Octantis.

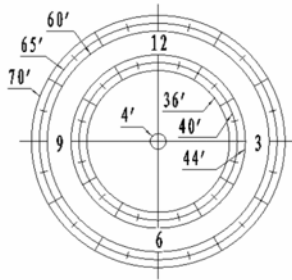


Figure 25. Polar Scope



Figure 26. Polar Scope LED

Quick Polar Alignment

- (1) Level the CEM60 mount and set it to the Zero Position. Make sure the telescope optical axis is parallel to the polar axis (R.A. axis) of the mount. If using a finder scope, adjust it to be parallel to the telescope optical axis. Remove both the Polar Axis Cover and Polar Scope Cover.
- (2) Connect one end of the polar scope power cable to the illumination LED (Figure 26) and the other end to the Reticle socket located next to DEC motor unit (Figure 3). Turn the mount power on. Use the Hand Controller (“Settings” => “Set Eyepiece Light”) to set the illumination intensity.
- (3) Adjust the polar scope dial to ensure that 12 o'clock is at the top. You may also use the bubble level indicator if there is one.
- (4) Use the Hand Controller (MENU => “Alignment” => “Pole Star Position”) to display the current position of Polaris on the LCD screen, as indicated in the left side of the figure below. For example, on May 30, 2010, 20:00:00 in Boston, United States (Lat.N42°30'32” and Long.W71°08'50”, 300 min behind UT, DST set to Y), the Polaris Position is 1hr 26.8m and r = 41.5m.
- (5) Look through the polar scope to find the Polaris. Use the Azimuth and Latitude Adjustment Knobs to adjust the mount in both directions and put the Polaris in the same position on the Polar Scope reticle as indicated on the HC display screen. In this case, Polaris will be located at a radius of 41.5 minutes and an angle of 1 hour 26.8 minutes, as shown In Figure 27 (b).

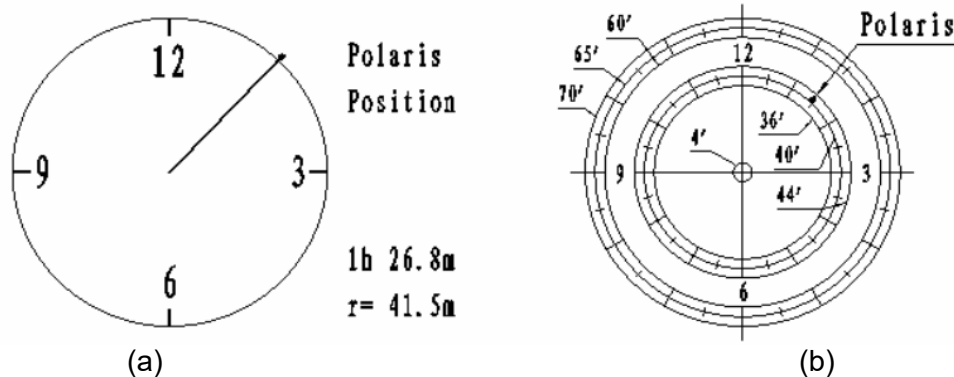


Figure 27. Polaris Position shown on HC (a) and where to put on polar scope reticle (b)

NOTE: If you are located in the Southern Hemisphere, Sigma Octantis will be chosen for Polar Alignment. For example, on May 20, 2010, 20:00:00 in Sydney, Australia (Lat. S33°51'36" and Long.E151°12'40"), 600 min ahead of UT, the position of Sigma Octantis is located at a radius of 64.4 minutes and an angle of 1hour21.8minutes..

BrightStar Polar Alignment

When the pole star is not in sight, you may use two bright stars with Polar Iterate Align to do the polar alignment.

- (1) Level the mount and set it to the Zero Position. Align the telescope to the R.A. axis of the mount. If a finder scope is used, adjust it to be parallel to the telescope optical axis.
- (2) Use the HC (**MENU** => "**Alignment**" => "**Polar Iterate Align**") to display the azimuth and altitude position of several bright stars near the meridian. Select one that is visible at a high altitude as Alignment Star A. Follow the HC instruction to move Alignment Star A to the center of the eyepiece using a combination of the Latitude Adjustment Knob and the "◀" or "▶" buttons. Press **ENTER** to confirm when the star is centered. Next, select a bright star that is close to the horizon as Alignment Star B. Center it using the Azimuth Adjustment Knob and the "◀" or "▶" button (*the "▲" and "▼" buttons are not used here*). Press **ENTER** to confirm the settings.
- (3) The telescope will now slew back to Alignment Star A. Repeat the steps above. The iteration can be stopped when it is determined that the alignment error has been minimized. Press the **BACK** button to exit the alignment procedure.

NOTE: It is highly recommended to use an eyepiece with an illuminated crosshair for accurate centering.

NOTE: The movement of the alignment star in your eyepiece may not be perpendicular depending on its location in the sky.

STEP 11. Returning the Mount to Zero Position

After polar alignment and balancing OTA, return the mount to the Zero Position, as shown in Figure 28. The Zero Position is achieved when the CW shaft is pointing towards the ground, with the OTA/dovetail at its highest position, its axis parallel to the polar axis, and the OTA pointing to the Celestial Pole. Press **MENU** => "**Zero Position**" => "**Goto Zero Position**", or **MENU** => "**Zero Position**" => "**Search Zero Position**". When the mount stopped, loosen the DEC and R.A. Gear Switches in turn to adjust the mount to the Zero Position. Engage the clutches after each adjustment.

Please set the zero position if it is the first time using the mount, or the firmware just being updated.



Figure 28. Zero Position

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 the Mount and Performing Polar Alignment

Assemble your CEM60 mount according to Section 3.2. Make sure the mount is leveled. Turn the mount power switch on. When the GPS receiver is connected to satellites, the hand controller LCD will display GPS OK and the mount will have the correct time and site information (this can also be entered manually as previously described). Mount an OTA and accessories, and carefully balance the mount on both R.A. and DEC axes. Polar align the mount using either the **Quick Polar Alignment** or **BrightStar Polar Alignment Procedure**.

After the mount is powered on, perform **MENU** => "**Zero Position**" => "**Goto Zero Position**" to check the Zero Position, i.e. with the counterweight shaft pointing to ground, OTA at the highest position with its axis parallel to the polar axis and the telescope pointing to the Celestial Pole. If the mount is not at the Zero Position, release the Gear Switches to adjust the mount to approximately the Zero Position.

The exception is when the mount is switched on after it was parked before powering off (**MENU** => "**Telescope Motion**" => "**Park Scope**")

4.2. Manual Operation of the Mount

The mount can now be used to observe astronomical objects using the HC. Use the arrow keys (▶, ◀, ▼, and ▲) to point the telescope to the desired part of the sky. Use the number keys to change the slewing speed. Press the **STOP/0** button to start tracking.

4.3. One Star Alignment

After the mount set up, perform a "**One Star Align**" to correct the Zero Position discrepancy, or linear error.

Press **MENU** => "**Alignment**" => "**One Star Align**" to perform "**One Star Align.**" The hand controller will display a alignment star. Select a different star using the ▲ or ▼ keys. Then press **ENTER**. After the mount slews to the target, use the arrow keys to center it in your eyepiece. Then press **ENTER**. (More details on the alignment function are given in section 5.3)

4.4. GOTO the Moon and Other Objects

Now the mount is ready for GOTO operation which, using advanced GOTONOVA[®] technology, will automatically slew to, and track, a huge range of celestial targets. We will use the Moon as an example.

Press **MENU** => "**Select and Slew**". Select a category, in this example "**Solar System**", and then select an object of interest, in this case "**Moon**". Press **ENTER** and the telescope will slew to the moon and automatically start tracking. If the target is not centered in your eyepiece, use the arrow keys to center it. Then use **MENU** => "**Sync to Target**" for better performance.

4.5. Star Identification Function

The 8407+ hand controller has a star identification function. After setting the correct local time and location and completing polar alignment, slew the telescope to a bright star manually or using the

GOTO function. Press the Help(?) key to identify the star that the telescope is pointing to, as well as nearby bright stars if there is any.

4.6. Turning Off the Mount

When you have finished your observation, simply turn the mount power off and disassemble the mount and tripod.

If the mount is set up on a pier or inside an observatory, it is recommended that you return the mount to the Zero Position or park the telescope. This will ensure that there is no need for you to perform the initial setup again when you power on the mount subsequently so long as the mount has not been moved from the parked position.

4.7. Putting the Mount Back into the Carrying Case

Make sure that the Gear Switches are fully engaged before removing the mount from the tripod or pier. Lay the mount into the carrying case. **Turn the R.A. Gear Switch *clockwise* all the way in to disengage the gear system for transportation.**

5. Complete Functions of Go2Nova® 8407+ Hand Controller

5.1. 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 Go2Nova® 8407+ hand controller has a database of around 358,000 objects. Use the ► or ◀ buttons to move the cursor. Use the number buttons to enter a number, or the ▼ or ▲ buttons to change a number. Hold a button to fast scroll through the list. The “◊” symbol indicates that the object is above the horizon, and the “◌” symbol means it is below the horizon. In some catalogs the stars below the horizon will not be displayed on the hand controller.

5.1.1. Solar System

There are 9 objects in the Solar System catalog.

5.1.2. Deep Sky Objects

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

- Named Objects: consists of 60 popular deep sky objects with their common names. A list of named deep sky objects is included in Appendix E.
- Messier Catalog: consists of all 110 Messier objects.
- NGC Catalog: consists of 7,840 objects.
- IC Catalog: consists of 5,386 objects.
- UGC Catalog: consists of 12,921 objects.
- MCG Catalog: consists of 30,642 objects.
- Caldwell Catalog: consists of 109 objects.
- Abell Catalog: consists of 4,076 objects.
- Herschel Catalog: consists of 400 objects.

5.1.3. Stars

- Named Stars: consists of 195 stars with their common names. They are listed alphabetically; a list is included in Appendix E.
- Binary Stars: consists of 210 binary stars; a list is attached in Appendix E.
- GCVS: consists of 38,528 variable stars in the catalog.
- SAO Catalog: consists of 258,997 SAO catalog objects; they are listed numerically.

5.1.4. Comets

This catalog contains 15 comets.

5.1.5. Asteroids

This catalog contains 116 asteroids.

5.1.6. Constellations

This catalog consists of 88 modern constellations. They are listed alphabetically; a list is attached in Appendix E.

5.1.7. Custom Objects

This allows the storage of up to 60 user-defined objects, including comets.

5.1.8. Customer R.A. and DEC

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

5.2. Sync to Target

This operation will match the telescope's current coordinates to the Target Right Ascension and Declination. It can be used to correct GOTO pointing error. After slewing to an object, press **MENU** - then scroll to "**Sync to Target**" and press **ENTER**. Follow the screen to perform the sync. Using this function will re-align the telescope to the selected object. Multiple syncs can be performed if needed. This operation is useful to find a faint star or nebula near a bright star.

"**Sync to Target**" will only work after "**Select and Slew**" is performed. You can change the slew rate to make the centering procedure easier. Simply press a number (1 through 9) key to change the speed. The default slew rate is 64x.

"**Sync to Target**" will improve the local GOTO accuracy near by the synced star, which is useful for finding a faint object nearby.

5.3. Alignment

This function is used for aligning the telescope to the celestial pole and to create a sky model to calibrate the mount's GOTONOVA[®] functionality.

The hand controller provides two polar alignment methods. "**Polar Iterate Align**" uses a set of 2 bright stars for polar alignment providing a viable polar alignment approach for those who can't see the pole. The "**Two Star Polar Align**" is used to refine the polar alignment using the AccuAlign[™] polar scope.

The system provides three alignment methods to calibrate the mount's GOTO function: "**Solar System Align**", "**One Star Align**", and "**Three Star Align**". The mount has to be at Zero Position before performing any alignment.

5.3.1. Pole Star Position

This function displays the position of the Pole Star for **Quick Polar Alignment** using the iOptron[®] AccuAlign[™] polar scope. In the Northern Hemisphere the position of Polaris is displayed, while in the Southern Hemisphere the position of Sigma Octantis is shown.

5.3.2. One Star Alignment

Press **MENU** => "**Alignment**" => "**One Star Align**". A list of alignment stars that are above the horizon is computed based on your local time and location. With the mount in the Zero Position, use the ▲ and ▼ buttons to select a star and press **ENTER**. Center the target in your eyepiece using the arrow keys. Press **ENTER** when finished. If your mount is set up correctly and polar aligned, one star alignment should be sufficient for good GoTo accuracy. To increase the pointing accuracy over the sky, you may choose to do a three star alignment.

5.3.3. Two Star Polar Align

Two Star Polar Align can improve the accuracy of the mount's polar alignment. Press **MENU** => "**Alignment**" => "**Two Star Polar Align**." A list of alignment stars that are above the horizon is computed based on your local time and location. With the mount at the Zero Position, use the ▲ and ▼ buttons to select the first alignment star and press **ENTER**. Center the target in your eyepiece using the

arrow keys after the mount slews to it. Press **ENTER** when finished. The hand controller will prompt you to choose a second star. After centering the second star, the two-star alignment is finished.

After the two-star alignment, the altitude and azimuth errors will be displayed. This number can be used to fine tune the Quick Polar Alignment.

For example, if the screen shows 7.5" low and 4.3" east, it means that THE MOUNT axis is pointing low and to the east of the Celestial Pole.

5.3.4. Three Star Align

The three-star alignment will further determine the cone error between the OTA and mount axis. The system will use these data to calculate the goto model. If the cone error is big enough, it is suggested to shim the OTA in DEC to minimize it.

Press **MENU** => "**Alignment**" => "**Three Star Align**." A list of alignment stars that are above the horizon is computed based on your local time and location. With the mount at the Zero Position, use the **▲** and **▼** buttons to select the first alignment star and press **ENTER**. Center the target in your eyepiece using the arrow keys. Press **ENTER** when finished. The hand controller will prompt you to choose a second star. Select third star after the mount aligned to the second star.

The system will display the pointing and cone errors after the three star alignment accepted. The system will update the pointing model accordingly.

5.3.5. Solar System Align

This function uses a planet or the moon as an alignment object. Press **MENU** => "**Alignment**" => "**Solar System Align**" for a list of available alignment objects.

5.3.6. Polar Iterate Align

This alignment method allows you to polar align the mount even if you cannot view the Celestial Pole. Press the **MENU** button, then select "**Alignment**" and "**Polar Iterate Align**". The HC will display a list of bright alignment stars near the meridian as Alignment Star A. Follow the HC instructions to move Alignment Star A to the center of the eyepiece using a combination of the Latitude Adjustment Knob and the "**◀**" and "**▶**" buttons. Press **ENTER** to confirm the settings. Next, select a bright star that is close to the horizon as Alignment Star B. Center it using the Azimuth Adjustment Knobs and the "**◀**" and "**▶**" buttons (*the "**▲**" and "**▼**" buttons will not function*). Press **ENTER** to confirm the settings.

The telescope will now slew back to Alignment Star A to repeat the above steps. The iteration can be stopped when it is determined that the alignment error has been minimized. Press the **BACK** button to exit the alignment procedure.

NOTE: It is highly recommended to use an eyepiece with illuminated crosshairs for accurate centering.

NOTE: The movement of the alignment star in your eyepiece may not be perpendicular depending on its location in the sky.

5.3.7. View Model Error

This will display linear RA error, linear DEC error, polar misalignment, non-perpendicular between OTA and DEC, and non-perpendicular between HA and DEC.

5.3.8. Clear Alignment Data

This will clear all alignment data created during one star, two star or three star alignment process.

5.4. Settings

5.4.1. Set Time and Site

Refer to STEP 8 in Section 3.2.

5.4.2. Set Beep

The Hand Controller allows a user to turn off the beep partially, or even go to a silent mode. To change this setting press “**MENU =>Settings =>Set Beep**”,

```
Set Up Time and Site
Set Beep
Set Display
Set Guiding Rate
Set Tracking Rate
Set Parking Position
Meridian Treatment
Tracking Below Horizon
```

Select one of three available modes:

- “**Always On**” – a beep will be heard on each button operation or mount movement;
- “**On but Keyboard**” – a beep will be heard only when the mount is slewing to the object or there is a warning message;
- “**Always Off**” – all sounds will be turned off, including the SUN warning message.

5.4.3. Set Display

Press “**MENU =>Settings =>Set Display**”,

```
Set Up Time and Site
Set Beep
Set Display
Set Guiding Rate
Set Tracking Rate
Set Parking Position
Meridian Treatment
Tracking Below Horizon
```

Use the arrow keys to adjust LCD display contrast, LCD backlight intensity, and keypad’s backlight intensity.

5.4.4. Set Guiding Rate

This is an advanced function for autoguiding when a guiding camera is utilized either via a Guide Port or using the ASCOM protocol. Before autoguiding align the polar axis carefully. Select an appropriate guiding speed. The suppositional guiding speed can be selected from $\pm 0.10X$ to $\pm 0.90X$ sidereal rate. Follow the instructions of your autoguiding software for detailed operation.

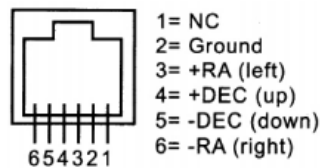


Figure 29. Guide port pin-out

The guide port wiring is shown in Figure 29, which has same pin-out as that from Celestron / Starlight Xpress / Orion Mount / Orion Autoguider/ QHY5 autoguider.

If you have an autoguider which has a pin-out which is the same as the ST-I from SBIG, such as Meade/ Losmandy/ Takahashi/ Vixen, make sure a proper guiding cable is used. Refer to your guiding camera and guiding software for detailed operation.



WARNING: DO NOT plug your ST-4 guiding camera cable into the iOptron port or HBX port. It may damage the mount or guiding camera electronics.

5.4.5. Set Tracking Rate

You can set up the mount tracking rate by selecting “**Set Tracking Rate**”. Then the user can select “**Sidereal Rate**”, “**Lunar Rate**”, “**Solar Rate**”, “**King Rate**”, and “**User Defined Speed**”. The “User defined speed” can be adjusted from 0.9900X to 1.0100X of sidereal.

5.4.6. Set Parking Position

You may park the telescope before powering off the mount. This is very useful if the mount is on a permanent pier or the mount will not be moved in between observation sessions. The mount will keep all the alignment info and reference points.

There are four parking positions. “**Default Horizon Pos.**” will park the scope horizontally on the right side of the mount. “**Default Zenith Pos.**” will park the scope vertically on the right side of the mount. “**Current Position**” will park the scope at its current position. Alternatively, you can enter any altitude and azimuth combination for “**Custom Parking Pos.**”. When the mount is turned on, it will use the last parking position setting as the default setting.

5.4.7. Meridian Treatment

This function tells the mount what to do when it tracks past the meridian. You can tell the mount if it needs a meridian flip and when to do it.

- “**Set Position Limit**” will tell the mount when to stop tracking or to do a meridian flip. The limit can be set at from 0° to 15° (1 hour) pass meridian for Northern Hemisphere and 0° to 10° for Southern Hemisphere.
- “**Set Behavior**” will tell the mount if a meridian flip will be performed.

5.4.8. Track Below Horizon

This function allows the mount to keep tracking an object even if it is below the horizon but can still be seen, for example from an elevated observation site, such as a hill. The power on default is **Forbidden**. One can turn it on when needed.

5.4.9. Set Eyepiece Light

Use this function to adjust the light intensity of the CEM60 illuminated polar scope. If you have an illuminated-reticule eyepiece and has the same socket size, you may use this option to adjust its light intensity.

5.4.10. HBX Heating OFF/ON

Turn on/off the controller LCD back heater. When “**Heating Controller**” is set to **ON**, the heater will automatically be turned on when the ambient temperature reaches 0°C (32°F) and shut off at 10°C.

5.4.11. Set RA Guiding

The function is for the EC version of the CEM60 only. You can turn off R.A. guiding by selecting “**Filter R.A. Guiding**” to allow the high precision encoder to correct the tracking error, or turn the R.A. guiding

on by selecting “**Allow RA Guiding**” to allow the mount to receive guiding corrections from the guiding software.

5.5. Electric Focuser

This function controls an iOptron electric focuser.

5.6. PEC Option

This function only works for the standard CEM60 mount.

5.6.1. PEC Playback

You can turn “**PEC Playback On**” to improve tracking accuracy which is especially useful for long exposure astrophotography. The default status is “**PEC Playback Off**” when the mount is turned on.

5.6.2. Record PEC

All equatorial mounts have a small variation in the worm gears which may be corrected by using Period Error Correction or PEC. PEC is a system which improves the tracking accuracy of the mount by compensating for variations in the worm gear and is especially useful when doing astrophotography without autoguiding. Because the variations are regular, it is possible to record the corrections required to cancel out the worm gear variations and to play them back to correct the periodic error caused by the variations.

In order to use the PEC function, the Go2Nova[®] hand controller first needs to record the periodic error. The periodic error of the worm gear drive will be used to correct periodic error.

We recommend using a guiding camera to record the PE with autoguiding. Here’s how to use the PEC function:

1. Setup the mount with a telescope in autoguiding configuration by connecting a guiding camera via the mount’s Guide Port or using the ASCOM protocol;
2. Select “**MENU=>Settings => Set Guiding Rates**”. Set a guiding speed from 0.10X to 0.90X. The default setting is 0.25X;
3. Then press the **BACK** button and select “**PEC Option**” from the menu. Use the **▲** and **▼** scroll buttons to display the “**Record PEC**” option and press **ENTER** to start recording the periodic error.
4. It takes the worm gear 300 seconds to make one complete revolution. After 300 seconds PEC will automatically stop recording. The PEC value will be permanently stored inside PEC chip on R.A. motor drive until a new data are recorded.
5. If you want to re-record the periodic error, select “**Record PEC**” and repeat the recording processes again. The previously recorded information will be replaced with the current information.

5.6.3. PEC Data Integrity

This function will check the recorded PEC data integrity.

5.7. Park Telescope

This function parks the scope to one of four preset park positions.

5.8. Edit User Objects

Besides various star lists available in the hand controller, you can add, edit or delete your own user-defined objects. This is especially useful for newly found comets. You can also add your favorite observation object into the user object list for easy sky surfing. Up to 60 comets and other user objects can be stored.

5.8.1. Enter a New Comet

Press “**MENU =>Edit User Objects**” to set user objects.

```
User Defined Comet
Other Objects
```

Select “**User Defined Comet**” to add/browse/delete the user-defined comet list. Find the orbit parameters of a comet in the SkyMap format. For example, the C/2012 ISON has an orbit parameter:

No.	Name	Year	M	Day	q	e	ω	Ω	I	H	G
C/2012	S1 ISON	2013	11	28.7960	0.0125050	1.0000030	345.5088	295.7379	61.8570	6.0	4.0

Select “**Add a New Comet**” to add a new one:

```
Add a New Comet
Browse Comets
Delete a Comet
Delete All Comets
```

The hand controller will display the parameter entry screen:

```
Enter Comet Parameter
Date: 0000-00-00.0000
q: 0.000000
e: 0.000000
 $\omega$ : 000.0000
 $\Omega$ : 000.0000
i: 000.0000
```

Enter the parameters using the arrow buttons and number keys. Press **ENTER** and a confirmation screen will be displayed. Press **ENTER** again to store the object under the assigned user object number, or press **BACK** button to cancel.

5.8.2. Enter Other Objects or Observation List

Press “**MENU =>Edit User Objects**” to set user objects.

```
User Defined Comet
Other Objects
```

Select “**Other Objects**” to enter you own object:

```
Add a New Object
Browse Objects
Delete One Object
Delete All Objects
```

Select **“Add a New Object”**. A screen will be displayed asking you to **Enter R.A. and DEC coordinates**:

```
Enter R.A. and DEC
R.A.: 00h00m00s
DEC: +00d00m00s
```

You may enter the R.A. and DEC coordinates of the object you want to store, and press **ENTER** to confirm.

A more useful application of this function is to store your favorite viewing objects before heading to the field. When the **“Enter R.A. and DEC”** screen appears, press the **MENU** button. It brings up the catalogs that you can select the object from. Follow the screen instructions to add your favorite objects. Press **BACK** button to go back one level.

Press the **BACK** button to go back to the object entry submenu. You may review the records or delete those that are no longer wanted. Press the **BACK** button to finish the operation. Now you can slew to your favorite stars from **“Custom Objects”** catalog using **“Select and Slew.”**

5.9. Firmware Information

This option will display the mount type, firmware version information for the hand controller (HC), Main board (Main), R.A. board (RA), and DEC board (DEC).

5.10. Zero Position

5.10.1. Goto Zero Position

This moves your telescope to its Zero Position.

5.10.2. Set Zero Position

This set the Zero Position for the firmware.

The Zero Position reference will be an undefined value after firmware upgrade, or it may lost during power outage or HC battery replacement. You can use this function to set the zero position reference.

Press the **ENTER** after moving the mount to Zero Position either manually or with the hand controller.

5.10.3. Search Zero Pos.

In the event of power failure, the mount will lose all its alignment information. This can be very troublesome if the mount is being operated from a remote observation site and is controlled via the internet. To counter this, the CEM60 has been equipped with a function that can find the Zero Position for an initial mount set up.

Select **“Search Zero Pos.”** and the mount will start to slew slowly and find the R.A. and DEC position to set the mount to the Zero Position. When the mount has found the Zero Position, the HC will ask if you want to calibrate the Zero Position. Press **ENTER** to confirm. The mount will then provide a list of bright stars for you to perform alignment. This will correct any discrepancy in the Zero Position. Alternatively, press **BACK** to cancel.

6. Maintenance and Servicing

6.1. Maintenance

The CEM60 mount is designed to be maintenance free. Do not overload the mount. Do not drop the mount as this will damage the mount and / or permanently degrade GoTo performance and tracking accuracy. Use a wet cloth to clean the mount and hand controller. Do not use solvent.

If your mount is not to be used for an extended period, dismount the OTAs and counterweight(s).

6.2. iOptron Customer Service

If you have any question concerning your CEM60 mount contact iOptron Customer Service Department. Customer Service hours are from 9:00 AM to 5:00 PM, Eastern Time, Monday through Friday. In the event that the CEM60 requires factory servicing or repairing, write or call iOptron Customer Service Department first to receive an RMA# before returning the mount to the factory. Please provide details as to the nature of the problem as well as your name, address, e-mail address, purchase information and daytime telephone number. We have found that most problems can be resolved by e-mails or telephone calls, so please contact iOptron first to avoid returning the mount for repair.

It is strongly suggested that to send technical questions to support@ioptron.com. Call in the U.S. 1.781.569.0200.

6.3. Product End of Life Disposal Instructions



This electronic product is subject to disposal and recycling regulations that vary by country and region. It is your responsibility to recycle your electronic equipment per your local environmental laws and regulations to ensure that it will be recycled in a manner that protects human health and the environment. To find out where you can drop off your waste equipment for recycling, please contact your local waste recycle/disposal service or the product representative.

6.4. Battery Replacement and Disposal Instructions

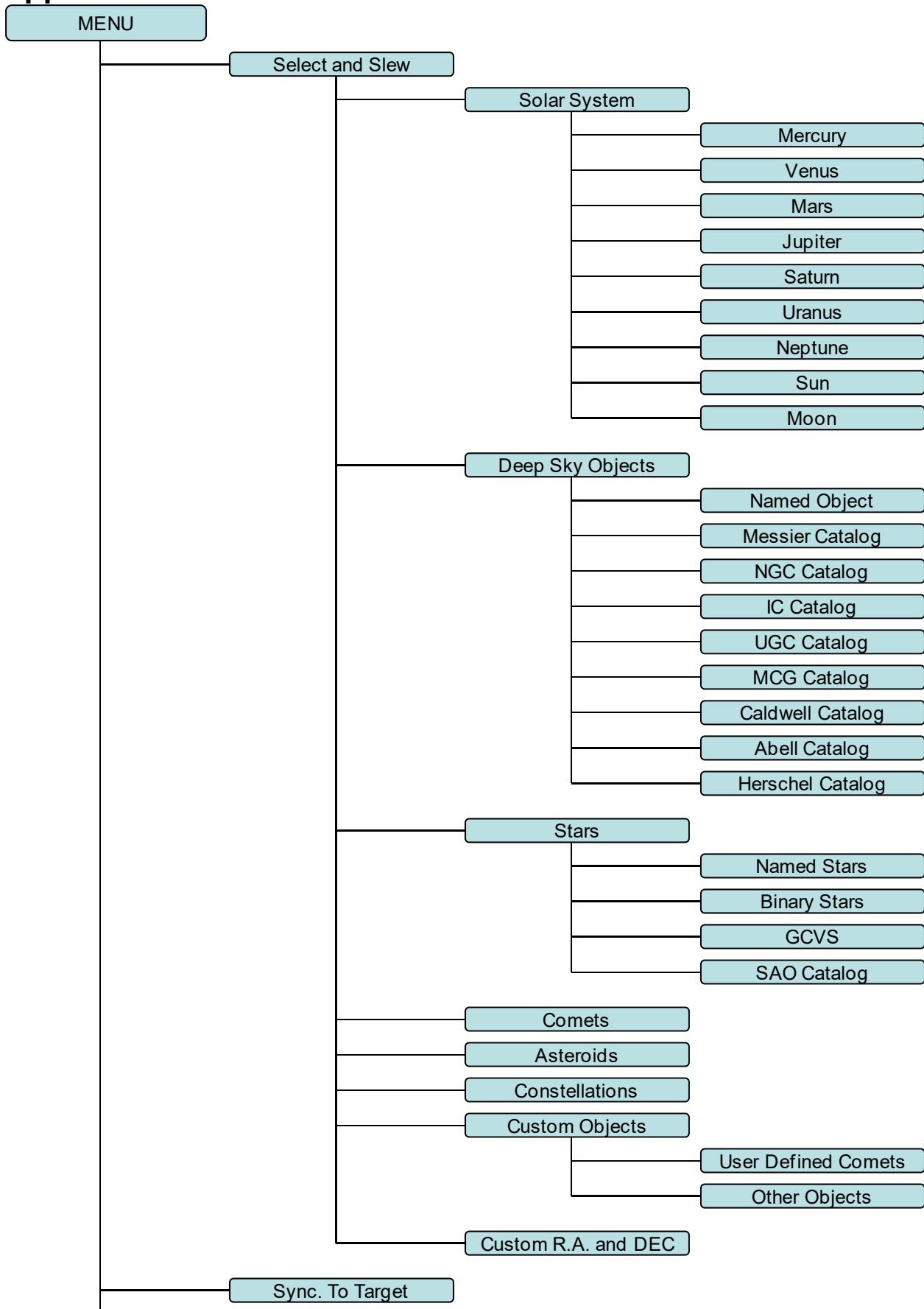


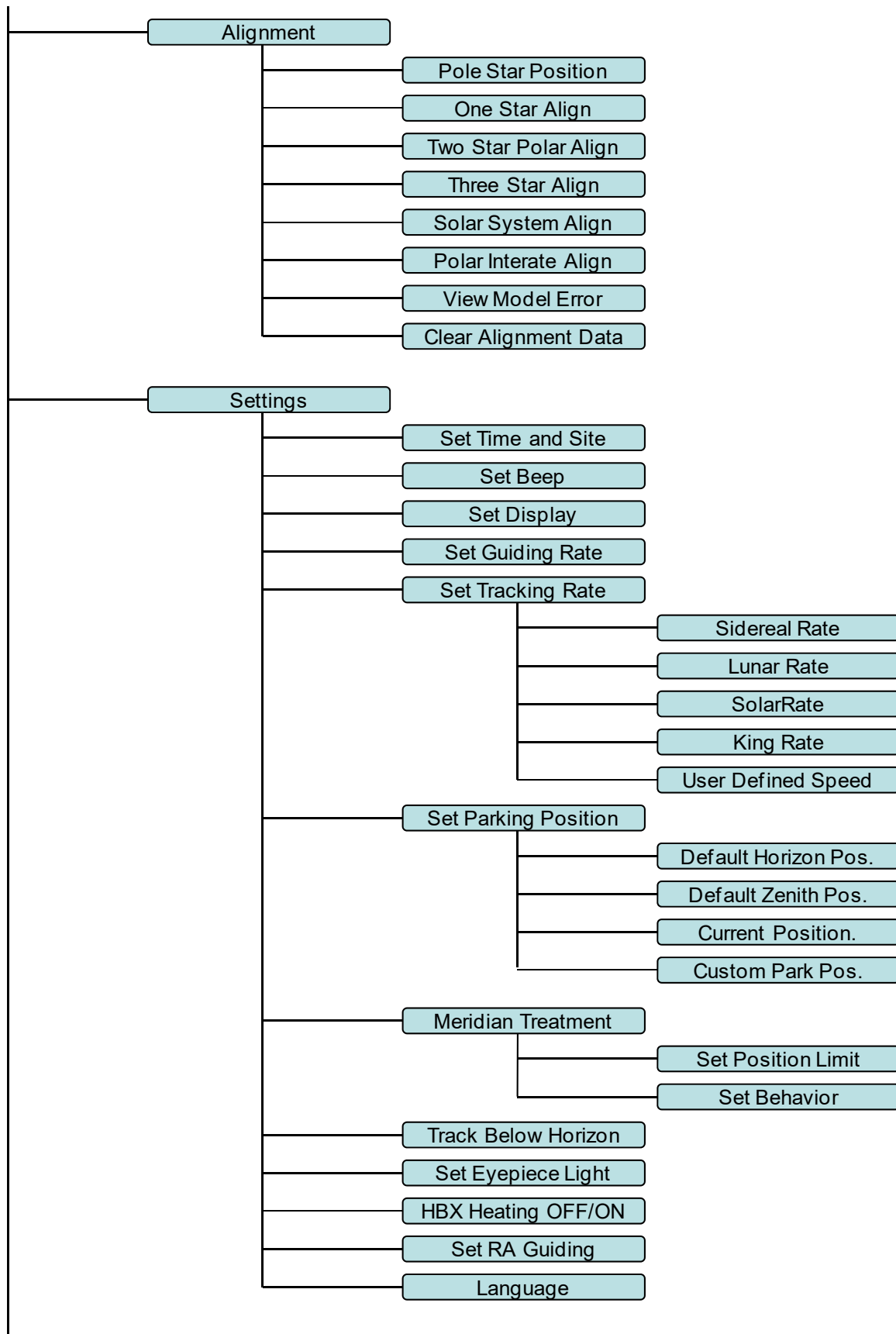
Battery Disposal: Batteries contain chemicals that, if released, may affect the environment and human health. Batteries should be collected separately for recycling, and recycled at a local hazardous material disposal location adhering to your country and local government regulations. To find out where you can drop off your waste battery for recycling, please contact your local waste disposal service or the product representative.

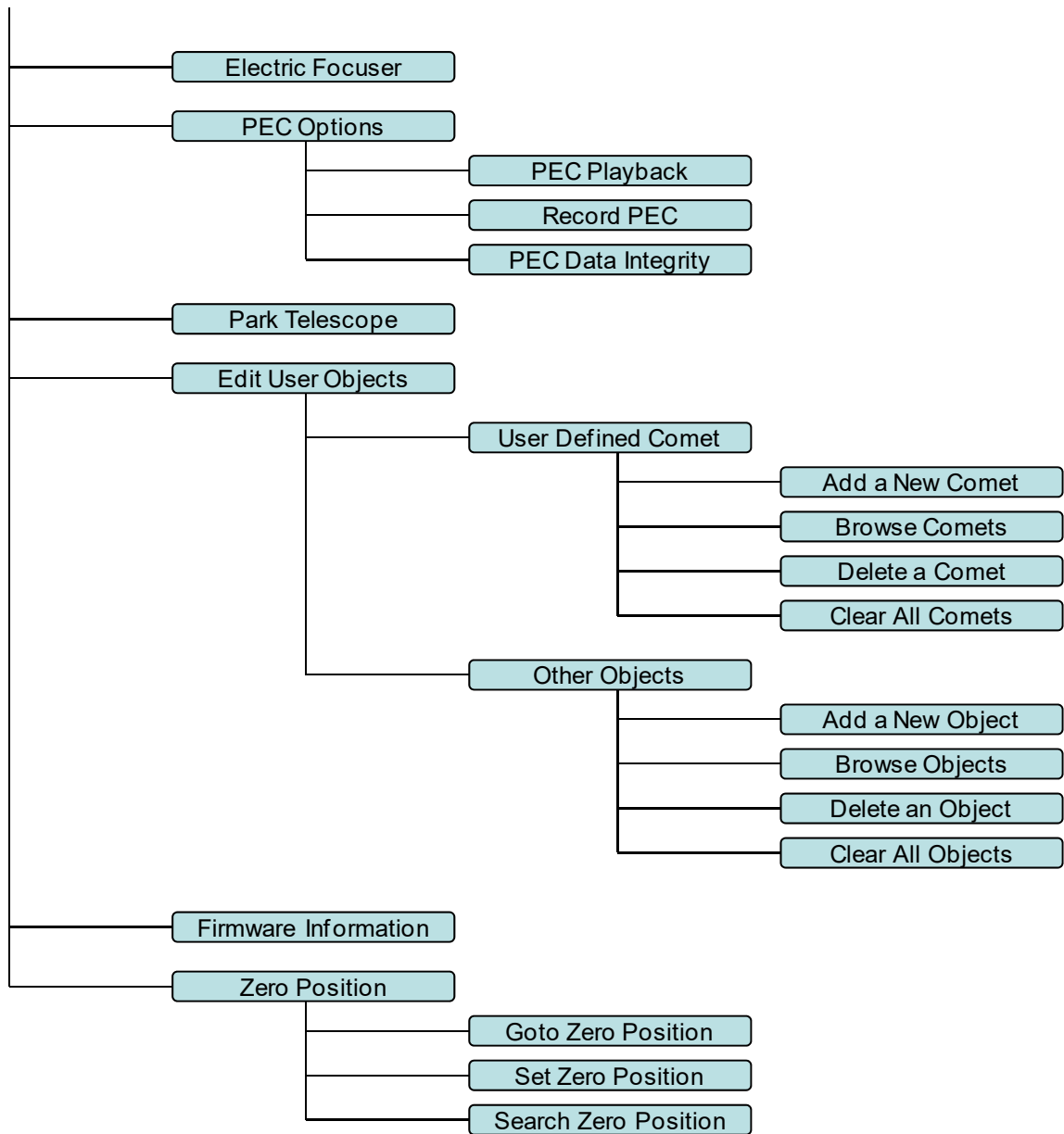
Appendix A. Technical Specifications

Mount	Center-balanced Equatorial Mount (CEM)
Payload	60 lb (27.2kg), exclude counterweight
Mount weight	27 lb (12.3kg)
Payload/Mount weight ratio	2.22:1
Material	All metal (except GPS cover)
Latitude adjustment range	0°~ 70°
Azimuth adjustment range	± 8°
Right Ascension worm wheel	Φ146mm, 288 tooth aluminum
Declination worm wheel	Φ146mm, 288 teeth aluminum
PEC	PPEC/Real time PEC
PE	~±5 arcsec p-p (#7200) or <0.5 arcsec RMS for 5 min (#7201)
Counterweight shaft	Φ28x 450 mm Stainless Steel
Counterweight	21 lb (9.5 kg)
Mount base size	Φ150 mm
Motor drive	Stepper motor
Resolution	0.06 arc seconds
Slew speed	1x,2x,8x,16x,64x,128x,256x,512x,MAX(~3.75°/sec)
Power consumption	0.6A(Tracking), 1.1A(GOTO)
Power requirement	12V DC 2A
AC adapter	100V ~ 240V (included)
Polar Scope	AccuAlign™ dark field illuminated, 2 arc min
Level indicator	Level bubble
Dovetail saddle	8" Losmandy/Vixen dual saddle
Hand Controller	Go2Nova® 8407+,359,000 objects database, star recognition
Meridian treatment	Stop (0-15° pass), auto flip
GPS	Internal 32-channel GPS
Autoguide port	ST-4
Communication port	Serial Port
PC computer control	Yes (ASCOM)
Cable management	4X USB, 2X DC12V (MAX 5A), 6P6C
Operation temperature	-20°C ~ +45°C
Tripod	Optional 2 "tripod Stainless Steel(8kg)/Pier (10kg)
Warranty	Two year limited

Appendix B. Go2Nova[®] 8407+ HC MENU STRUCTURE







Appendix C. Firmware Upgrade

The firmware in the 8407+ Hand Controller and control boards can be upgraded by the customer. Please check iOptron's website, www.iOptron.com, under Support Directory/CEM Mounts, select CEM60 for details.

Appendix D. Computer Control a CEM60 Mount

The CEM60 mount can be controlled by a SmartPhone, a Pad or a computer. It is supported by two types of computer connections:

- Connect to a computer via RS232 serial port. An optional RS232 to USB adapter (iOptron part #8435) is needed if your computer does not have a serial port, like most of the laptops on the market today. Follow the adapter instructions to install the adapter driver. The mount can be controlled via ASCOM protocol (Windows OS), or directly by some software, such as Sky Safari (Mac OS)
- Connect wirelessly with iOptron StarFi adapter (#8434) or some other third party adapter (may with limited function). The mount can be controlled via ASCOM protocol (Windows OS), SmartPhone/Pad and Mac OS wirelessly. See StarFi Instruction Manual for detailed information.

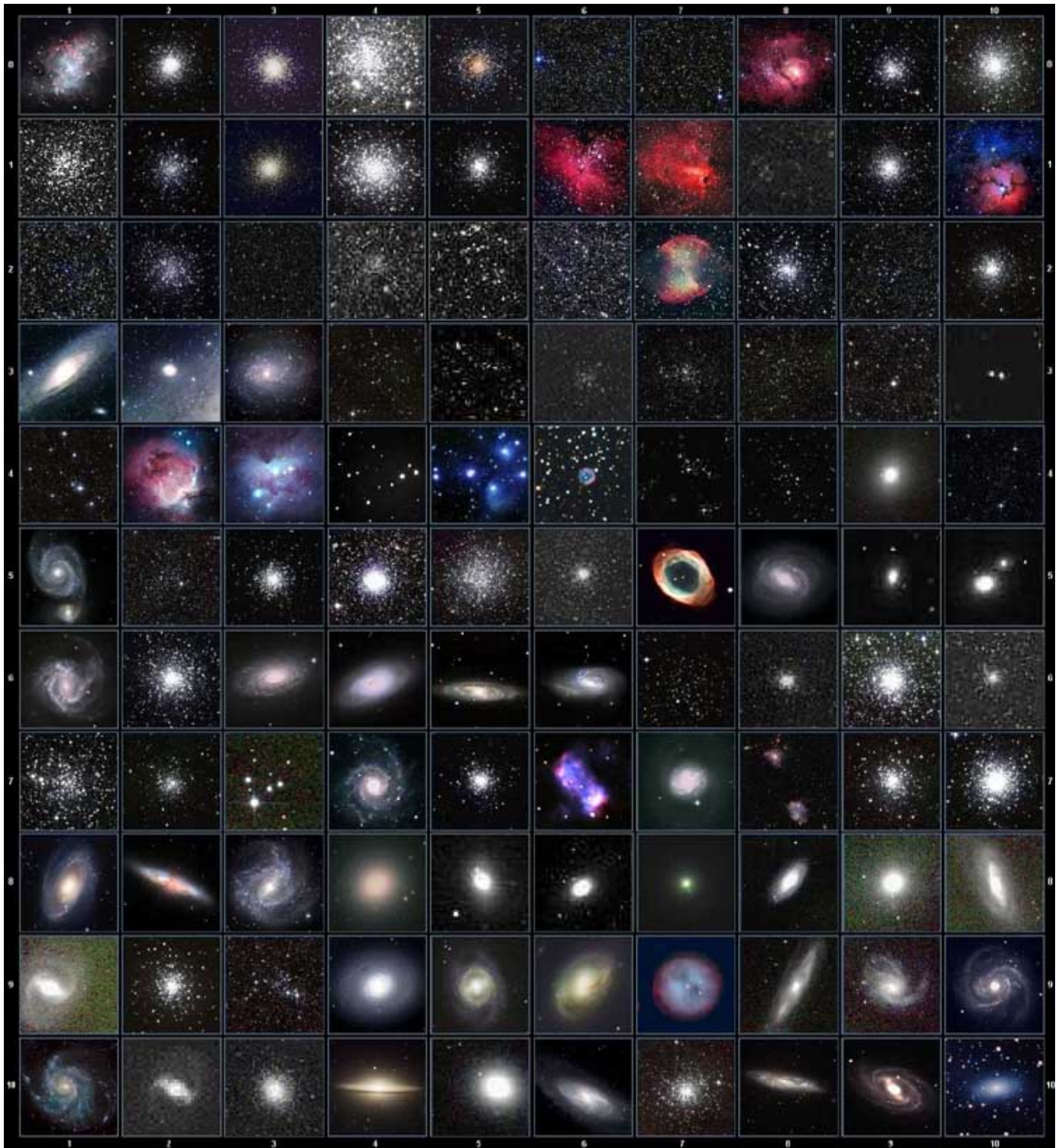
To control the mount via ASCOM protocol, you need:

1. Download and install the latest ASCOM Platform, currently 6.1 SP1, from <http://www.ascom-standards.org/>. Make sure your PC meets the software requirement. For 6.1 SP1, Windows XP users should install .NET Framework 4 (not the Client Profile). Windows Vista and Windows 7 users should install .NET Framework 4.5.2. Windows 8 and 8.1 users do not need install any additional components.
2. Download and install the latest iOptron Telescope ASCOM drive for CEM60 from iOptron website.
3. Planetarium software that supports ASCOM protocol. Follow software instructions to select the iOptron Telescope.

Please refer to iOptron website, www.iOptron.com, under Support Directory/ASCOM Driver, iOptron Telescope ASCOM Driver, for more detail.

Appendix E. Go2Nova[®] Star List

Messier Catalog



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

Named Star List

001 Acamar	050 Asellus Australis	099 Kaus Media	148 Rastaba
002 Achernar	051 Asellus Borealis	100 Keid	149 Regulus
003 Acrux	052 Aspidiske	101 Kitalpha	150 Rigel
004 Acubens	053 Atik	102 Kochab	151 Rigel Kentaurus
005 Adhafera	054 Atlas	103 Kornephoros	152 Ruchbah
006 Adhara	055 Atria	104 Kurhah	153 Rukbat
007 Al Na'ir	056 Avoir	105 Lesath	154 Sabik
008 Albali	057 Azha	106 Maia	155 Sadachbia
009 Alberio	058 Baten Kaitos	107 Marfik	156 Sadalbari
010 Alchibar	059 Beid	108 Markab	157 Sadalmelik
011 Alcor	060 Bellatrix	109 Matar	158 Sadalsuud
012 Alcyone	061 Betelgeuse	110 Mabsuta	159 Sadr
013 Aldebaran	062 Biham	111 Megrez	160 Saiph
014 Alderamin	063 Canopus	112 Meissa	161 Scheat
015 Alfirk	064 Capella	113 Mekbuda	162 Schedar
016 Algedi	065 Caph	114 Menkalinan	163 Seginus
017 Algenib	066 Castor	115 Menkar	164 Shaula
018 Algiebra	067 Celabrai	116 Menkent	165 Sheiak
019 Algol	068 Celaeno	117 Menkib	166 Sheratan
020 Algorab	069 Chara	118 Merak	167 Sirius
021 Alhena	070 Chertan	119 Merope	168 Skat
022 Alioth	071 Cor Caroli	120 Mesartim	169 Spica
023 Alkaid	072 Cursa	121 Miaplacidus	170 Sterope
024 Alkalurops	073 Dabih	122 Mintaka	171 Sulafat
025 Alkes	074 Deneb	123 Mira	172 Syrma
026 Almach	075 Deneb Algedi	124 Mirach	173 Talitha
027 Alnasl	076 Deneb Kaitos	125 Mirfak	174 Tania Australis
028 Alnilam	077 Denebola	126 Mirzam	175 Tania Borealis
029 Alnitak	078 Dubhe	127 Mizar	176 Tarazed
030 Alphard	079 Edasich	128 Muphrid	177 Taygeta
031 Alphecca	080 Electra	129 Muscida	178 Thuban
032 Alpheratz	081 Elnath	130 Nashira	179 Unukalhai
033 Alrakis	082 Eltanin	131 Nekkar	180 Vega
034 Alrescha	083 Enif	132 Nihal	181 Vindemiatrix
035 Alshain	084 Errai	133 Nunki	182 Wasat
036 Altair	085 Fomalhaut	134 Nusakan	183 Wazn
037 Altais	086 Furud	135 Peacock	184 Yed Posterior
038 Alterf	087 Gacrux	136 Phact	185 Yed Prior
039 Aludra	088 Giasar	137 Phecda	186 Zaniah
040 Alula Australis	089 Gienah	138 Pherkad	187 Zaurak
041 Alula Borealis	090 Gomeisa	139 Pleione	188 Zavijava
042 Alya	091 Graffias	140 Polaris	189 Zosma
043 Ancha	092 Groombridge 1830	141 Pollux	190 Zubenelgenubi
044 Ankaa	093 Grumium	142 Porrima	191 Zubeneschamali
045 Antares	094 Hamal	143 Procyon	192 Barnard's Star
046 Arcturus	095 Homan	144 Propus	193 Kapteyn's Star
047 Arkab	096 Izar	145 Rassalas	194 Kruger 60
048 Arneb	097 Kaus Australis	146 Rasagethi	195 Luyten's Star
049 Ascella	098 Kaus Borealis	147 Rasalhague	

Modern Constellations

No.	Constellation	Abbreviation
1	Andromeda	And
2	Antlia	Ant
3	Apus	Aps
4	Aquarius	Aqr
5	Aquila	Aql
6	Ara	Ara
7	Aries	Ari
8	Auriga	Aur
9	Boötes	Boo
10	Caelum	Cae
11	Camelopardalis	Cam
12	Cancer	Cnc
13	Canes Venatici	CVn
14	Canis Major	CMa
15	Canis Minor	CMi
16	Capricornus	Cap
17	Carina	Car
18	Cassiopeia	Cas
19	Centaurus	Cen
20	Cepheus	Cep
21	Cetus	Cet
22	Chamaeleon	Cha
23	Circinus	Cir
24	Columba	Col
25	Coma Berenices	Com
26	Corona Australis	CrA
27	Corona Borealis	CrB
28	Corvus	Crv
29	Crater	Crt
30	Crux	Cru
31	Cygnus	Cyg
32	Delphinus	Del
33	Dorado	Dor
34	Draco	Dra
35	Equuleus	Equ
36	Eridanus	Eri
37	Fornax	For
38	Gemini	Gem
39	Grus	Gru
40	Hercules	Her
41	Horologium	Hor
42	Hydra	Hya
43	Hydrus	Hyi
44	Indus	Ind

No.	Constellation	Abbreviation
45	Lacerta	Lac
46	Leo	Leo
47	Leo Minor	LMi
48	Lepus	Lep
49	Libra	Lib
50	Lupus	Lup
51	Lynx	Lyn
52	Lyra	Lyr
53	Mensa	Men
54	Microscopium	Mic
55	Monoceros	Mon
56	Musca	Mus
57	Norma	Nor
58	Octans	Oct
59	Ophiuchus	Oph
60	Orion	Ori
61	Pavo	Pav
62	Pegasus	Peg
63	Perseus	Per
64	Phoenix	Phe
65	Pictor	Pic
66	Pisces	Psc
67	Piscis Austrinus	PsA
68	Puppis	Pup
69	Pyxis	Pyx
70	Reticulum	Ret
71	Sagitta	Sge
72	Sagittarius	Sgr
73	Scorpius	Sco
74	Sculptor	Scl
75	Scutum	Sct
76	Serpens	Ser
77	Sextans	Sex
78	Taurus	Tau
79	Telescopium	Tel
80	Triangulum	Tri
81	Triangulum Australe	TrA
82	Tucana	Tuc
83	Ursa Major	UMa
84	Ursa Minor	UMi
85	Vela	Vel
86	Virgo	Vir
87	Volans	Vol
88	Vulpecula	Vul

Deep Sky Object List

ID No.	OBJECT	NGC #	Messier#	IC#	A(Abell)	U(UGC)	ID No.	OBJECT	NGC #	Messier#	IC#	A(Abell)	U(UGC)
1	Andromeda Galaxy	224	31				31	Hind's Variable Nebula	1555				
2	Barnards Galaxy	6822					32	Hubble's Variable Nebula	2261				
3	Beehive Cluster	2632	44				33	Integral Sign Galaxy					3697
4	Blackeye Galaxy	4926	64				34	Jewel Box Cluster	4755				
5	Blinking Planetary Nebula	6826					35	Keyhole Nebula	3372				
6	Blue Flash Nebula	6905					36	Lagoon Nebula	6523	8			
7	Blue Planetary	3918					37	Little Gem	6445				
8	Blue Snowball Nebula	7662					38	Little Gem Nebula	6818				
9	Box Nebula	6309					39	Little Ghost Nebula	6369				
10	Bubble Nebula	7635					40	North American Nebula	7000				
11	Bipolar Nebula	6302					41	Omega Nebula	6618	17			
12	Butterfly Cluster	6405	6				42	Orion Nebula	1976	42			
13	California Nebula	1499					43	Owl Nebula	3587	97			
14	Cat's Eye Nebula	6543					44	Pelican Nebula			5070		
15	Cocoon Nebula			5146			45	Phantom Streak Nebula	6741				
16	Cone Nebula	2264					46	Pinwheel Galaxy	598	33			
17	Cork Nebula	650-51	76				47	Pleiades		45			
18	Crab Nebula	1952	1				48	Ring Nebula	6720	57			
19	Crescent Nebula	6888					49	Ring Tail Galaxy	4038				
20	Draco Dwarf					10822	50	Rosette Nebula	2237				
21	Duck Nebula	2359					51	Saturn Nebula	7009				
22	Dumbbell Nebula	6853	27				52	Sextans B Dwarf					5373
23	Eagle Nebula		16				53	Small Magellanic Cloud	292				
24	Eight-Burst Nebula	3132					54	Sombrero Galaxy	4594	104			
25	Eskimo Nebula	2392					55	Spindle Galaxy	3115				
26	Flaming Star Nebula			405			56	Tank Track Nebula	2024				
27	Ghost of Jupiter	3242					57	Trifid Nebula	6514	20			
28	Great Cluster	6205	13				58	Ursa Minor Dwarf					9749
29	Helix Nebula	7293					59	Whirlpool Galaxy	5194	51			
30	Hercules Galaxy Cluster				2151		60	Wild Duck Cluster	6705	11			

Double Star List

No.	Object	Const	Sep.	Magitude	SAO	Comm. Name
1	Gam	And	9.8	2.3 / 5.1	37734	Almaak
2	Pi	And	35.9	4.4 / 8.6	54033	
3	Bet	Aql	12.8	3.7 / 11	125235	Alshain
4	11	Aql	17.5	5.2 / 8.7	104308	
5	15	Aql	34	5.5 / 7.2	142996	
6	E2489	Aql	8.2	5.6 / 8.6	104668	
7	57	Aql	36	5.8 / 6.5	143898	
8	Zet	Aqr	2.1	4.3 / 4.5	146108	
9	94	Aqr	12.7	5.3 / 7.3	165625	
10	41	Aqr	5.1	5.6 / 7.1	190986	
11	107	Aqr	6.6	5.7 / 6.7	165867	
12	12	Aqr	2.5	5.8 / 7.3	145065	
13	Tau	Aqr	23.7	5.8 / 9.0	165321	
14	Gam	Ari	7.8	4.8 / 4.8	92681	Mesartim
15	Lam	Ari	37.8	4.8 / 6.7	75051	
16	The	Aur	3.6	2.6 / 7.1	58636	
17	Nu	Aur	55	4.0 / 9.5	58502	
18	Ome	Aur	5.4	5.0 / 8.0	57548	
19	Eps	Boo	2.8	2.5 / 4.9	83500	Izar
20	Del	Boo	105	3.5 / 7.5	64589	
21	Mu 1	Boo	108	4.3 / 6.5	64686	Alkalurops
22	Tau	Boo	4.8	4.5 / 11	100706	
23	Kap	Boo	13.4	4.6 / 6.6	29046	
24	Xi	Boo	6.6	4.7 / 6.9	101250	
25	Pi	Boo	5.6	4.9 / 5.8	101139	
26	lot	Boo	38	4.9/7.5/13	29071	
27	E1835	Boo	6.2	5.1 / 6.9	120426	
28	44	Boo	2.2	5.3 / 6.2	45357	
29		Cam	2.4	4.2 / 8.5	24054	
30	32	Cam	21.6	5.3 / 5.8	2102	
31	Alp 2	Cap	6.6	3.6 / 10	163427	Secunda giedi
32	Alp 1	Cap	45	4.2 / 9.2	163422	Prima giedi
33	Pi	Cap	3.4	5.2 / 8.8	163592	
34	Omi	Cap	21	5.9 / 6.7	163625	
35	Alp	Cas	64.4	2.2 / 8.9	21609	Shedir

No.	Object	Const	Sep.	Magitude	SAO	Comm. Name
36	Eta	Cas	12.9	3.5 / 7.5	21732	Achird
37	lot	Cas	2.3	4.7/7.0/8.2	12298	
38	Psi	Cas	25	4.7 / 8.9	11751	
39	Sig	Cas	3.1	5.0 / 7.1	35947	
40	E3053	Cas	15.2	5.9 / 7.3	10937	
41	3	Cen	7.9	4.5 / 6.0	204916	
42	Bet	Cep	13.6	3.2 / 7.9	10057	Alfirk
43	Del	Cep	41	3.5 / 7.5	34508	
44	Xi	Cep	7.6	4.3 / 6.2	19827	Al kurhah
45	Kap	Cep	7.4	4.4 / 8.4	9665	
46	Omi	Cep	2.8	4.9 / 7.1	20554	
47	E2840	Cep	18.3	5.5 / 7.3	33819	
48	E2883	Cep	14.6	5.6 / 7.6	19922	
49	Gam	Cet	2.8	5.0 / 7.7	110707	Kaffaljdhma
50	37	Cet	50	5.2 / 8.7	129193	
51	66	Cet	16.5	5.7 / 7.5	129752	
52	Eps	CMa	7.5	1.5 / 7.4	172676	Adhara
53	Tau	CMa	8.2	4.4/10/11	173446	
54	145	CMa	25.8	4.8 / 6.8	173349	
55	Mu	CMa	2.8	5.0 / 7.0	152123	
56	Nu 1	CMa	17.5	5.8 / 8.5	151694	
57	lot	Cnc	30.5	4.2 / 6.6	80416	
58	Alp	Cnc	11	4.3 / 12	98267	Acubens
59	Zet	Cnc	6	5.1 / 6.2	97646	
60	24	Com	20.6	5.0 / 6.6	100160	
61	35	Com	1.2	5.1/7.2/9.1	82550	
62	2	Com	3.7	5.9 / 7.4	82123	
63	Zet	CrB	6.1	5.0 / 6.0	64833	
64	Gam	Crt	5.2	4.1 / 9.6	156661	
65	Del	Crv	24.2	3.0 / 9.2	157323	Algorab
66	Alp	CVn	19.4	2.9 / 5.5	63257	Cor caroli
67	25	CVn	1.8	5.0 / 6.9	63648	
68	2	CVn	11.4	5.8 / 8.1	44097	
69	Gam	Cyg	41	2.2 / 9.5	49528	Sadr
70	Del	Cyg	2.5	2.9 / 6.3	48796	

No.	Object	Const	Sep.	Magitude	SAO	Comm. Name
71	Bet	Cyg	34.4	3.1 / 5.1	87301	Albireo
72	Omi 1	Cyg	107	3.8 / 6.7	49337	
73	52	Cyg	6.1	4.2 / 9.4	70467	
74	Ups	Cyg	15.1	4.4 / 10	71173	
75	Mu	Cyg	1.9	4.7 / 6.1	89940	
76	Psi	Cyg	3.2	4.9 / 7.4	32114	
77	17	Cyg	26	5.0 / 9.2	68827	
78	61	Cyg	30.3	5.2 / 6.0	70919	
79	49	Cyg	2.7	5.7 / 7.8	70362	
80	E2762	Cyg	3.4	5.8 / 7.8	70968	
81	E2741	Cyg	1.9	5.9 / 7.2	33034	
82	Gam	Del	9.6	4.5 / 5.5	106476	
83	Eta	Dra	5.3	2.7 / 8.7	17074	
84	Eps	Dra	3.1	3.8 / 7.4	9540	Tyl
85	47	Dra	34	4.8 / 7.8	31219	
86	Nu	Dra	61.9	4.9 / 4.9	30450	
87	Psi	Dra	30.3	4.9 / 6.1	8890	
88	26	Dra	1.7	5.3 / 8.0	17546	
89	16&17	Dra	90	5.4/5.5/6.4	30012	
90	Mu	Dra	1.9	5.7 / 5.7	30239	
91	40/41	Dra	19.3	5.7 / 6.1	8994	
92	1	Equ	10.7	5.2 / 7.3	126428	
93	The	Eri	4.5	3.4 / 4.5	216114	Acamar
94	Tau 4	Eri	5.7	3.7 / 10	168460	
95	Omi 2	Eri	8.3	4.4/9.5/11	131063	Keid
96	32	Eri	6.8	4.8 / 6.1	130806	
97	39	Eri	6.4	5.0 / 8.0	149478	
98	Alp	For	5.1	4.0 / 6.6	168373	Fornacis
99	Ome	For	10.8	5.0 / 7.7	167882	
100	Alp	Gem	3.9	1.9 / 2.9	60198	Castor
101	Del	Gem	5.8	3.5 / 8.2	79294	Wasat
102	Lam	Gem	9.6	3.6 / 11	96746	
103	Kap	Gem	7.1	3.6 / 8.1	79653	
104	Zet	Gem	87	3.8/10/8.0	79031	Mekbuda
105	38	Gem	7.1	4.7 / 7.7	96265	

No.	Object	Const	Sep.	Magitude	SAO	Comm. Name
106	Del	Her	8.9	3.1 / 8.2	84951	Sarin
107	Mu	Her	34	3.4 / 9.8	85397	
108	Alp	Her	4.6	3.5 / 5.4	102680	Rasalgethi
109	Gam	Her	42	3.8 / 9.8	102107	
110	Rho	Her	4.1	4.6 / 5.6	66001	
111	95	Her	6.3	5.0 / 5.2	85647	
112	Kap	Her	27	5.0 / 6.2	101951	
113	E2063	Her	16.4	5.7 / 8.2	46147	
114	100	Her	14.3	5.9 / 5.9	85753	
115	54	Hya	8.6	5.1 / 7.1	182855	
116	HN69	Hya	10.1	5.9 / 6.8	181790	
117	Eps	Hyd	2.7	3.4 / 6.8	117112	
118	The	Hyd	29.4	3.9 / 10	117527	
119	N	Hyd	9.4	5.6 / 5.8	179968	
120		Lac	28.4	4.5 / 10	72155	
121	8	Lac	22	5.7/6.5/10	72509	
122	Gam 1	Leo	4.4	2.2 / 3.5	81298	Algieba
123	lot	Leo	1.7	4.0 / 6.7	99587	
124	54	Leo	6.6	4.3 / 6.3	81583	
125	Gam	Lep	96	3.7 / 6.3	170757	
126	lot	Lep	12.8	4.4 / 10	150223	
127	Kap	Lep	2.6	4.5 / 7.4	150239	
128	h3752	Lep	3.2	5.4 / 6.6	170352	
129	lot	Lib	57.8	4.5 / 9.4	159090	
130		Lib	23	5.7 / 8.0	183040	
131	Mu	Lib	1.8	5.8 / 6.7	158821	
132	Eta	Lup	15	3.6 / 7.8	207208	
133	Xi	Lup	10.4	5.3 / 5.8	207144	
134	38	Lyn	2.7	3.9 / 6.6	61391	
135	12	Lyn	1.7	5.4/6.0/7.3	25939	
136	19	Lyn	14.8	5.8 / 6.9	26312	
137	Bet	Lyr	46	3.4 / 8.6	67451	Sheliak
138	Zet	Lyr	44	4.3 / 5.9	67321	
139	Eta	Lyr	28.1	4.4 / 9.1	68010	Aldafar
140	Eps 1	Lyr	2.6	5.0 / 6.1	67309	Double dbl1

No.	Object	Const	Sep.	Magitude	SAO	Comm. Name
141	Eps 2	Lyr	2.3	5.2 / 5.5	67315	Double dbl2
142	Alp	Mic	20.5	5.0 / 10	212472	
143	Zet	Mon	32	4.3 / 10	135551	
144	Eps	Mon	13.4	4.5 / 6.5	113810	
145	Bet	Mon	7.3	4.7/4.8/6.1	133316	
146	15	Mon	2.8	4.7 / 7.5	114258	
147	70	Oph	4.5	4.0 / 5.9	123107	
148	67	Oph	55	4.0 / 8.6	123013	
149	Lam	Oph	1.5	4.2 / 5.2	121658	Marfic
150	Xi	Oph	3.7	4.4 / 9.0	185296	
151	36	Oph	4.9	5.1 / 5.1	185198	
152	Tau	Oph	1.7	5.2 / 5.9	142050	
153	Rho	Oph	3.1	5.3 / 6.0	184382	
154	39	Oph	10.3	5.4 / 6.9	185238	
155	Bet	Ori	9.5	0.1 / 6.8	131907	Rigel
156	Del	Ori	53	2.2 / 6.3	132220	Mintaka
157	lot	Ori	11.3	2.8 / 6.9	132323	Nair al saif
158	Lam	Ori	4.4	3.6 / 5.5	112921	Meissa
159	Sig	Ori	13	3.8/7.2/6.5	132406	
160	Rho	Ori	7.1	4.5 / 8.3	112528	
161	E747	Ori	36	4.8 / 5.7	132298	
162	1	Peg	36.3	4.1 / 8.2	107073	
163	Eps	Per	8.8	2.9 / 8.1	56840	
164	Zet	Per	12.9	2.9 / 9.5	56799	Atik
165	Eta	Per	28.3	3.3 / 8.5	23655	Miram in bevar
166	The	Per	18.3	4.1 / 10	38288	
167	E331	Per	12.1	5.3 / 6.7	23765	
168	Del	PsA	5.1	4.2 / 9.2	214189	
169	lot	PsA	20	4.3 / 11	213258	
170	Bet	PsA	30.3	4.4 / 7.9	213883	
171	Gam	PsA	4.2	4.5 / 8.0	214153	
172	Eta	PsA	1.7	5.8 / 6.8	190822	
173	Alp	Psc	1.8	4.2 / 5.2	110291	Alrisha
174	55	Psc	6.5	5.4 / 8.7	74182	
175	Psi	Psc	30	5.6 / 5.8	74483	

No.	Object	Const	Sep.	Magitude	SAO	Comm. Name
176	Zet	Psc	23	5.6 / 6.5	109739	
177	Kap	Pup	9.9	4.5 / 4.7	174199	
178	Eta	Pup	9.6	5.8 / 5.9	174019	
179	Eps	Scl	4.7	5.4 / 8.6	167275	
180	Bet	Sco	13.6	2.6 / 4.9	159682	Graffias
181	Sig	Sco	20	2.9 / 8.5	184336	Alniyat
182	Nu	Sco	41	4.2 / 6.1	159764	Jabbah
183	2	Sco	2.5	4.7 / 7.4	183896	
184		Sco	23	5.4 / 6.9	207558	
185	Hn39	Sco	5.4	5.9 / 6.9	184369	
186	12	Sco	3.9	5.9 / 7.9	184217	
187	Bet	Ser	31	3.7 / 9.0	101725	
188	Del	Ser	4.4	4.2 / 5.2	101624	
189	Nu	Ser	46	4.3 / 8.5	160479	
190	The	Ser	22.3	4.5 / 5.4	124070	Alya
191	59	Ser	3.8	5.3 / 7.6	123497	
192	Zet	Sge	8.5	5.0 / 8.8	105298	
193	Eta	Sgr	3.6	3.2 / 7.8	209957	
194		Sgr	5.5	5.2 / 6.9	209553	
195	Phi	Tau	52	5.0 / 8.4	76558	
196	Chi	Tau	19.4	5.7 / 7.6	76573	
197	118	Tau	4.8	5.8 / 6.6	77201	
198	6	Tri	3.9	5.3 / 6.9	55347	
199	Zet	UMa	14	2.4 / 4.0	28737	Mizar
200	Nu	UMa	7.2	3.5 / 9.9	62486	Alula borealis
201	23	UMa	23	3.6 / 8.9	14908	
202	Ups	UMa	11.6	3.8 / 11	27401	
203	Xi	UMa	1.8	4.3 / 4.8	62484	Alula australia
204	Sig 2	UMa	3.9	4.8 / 8.2	14788	
205	57	UMa	5.4	5.4 / 5.4	62572	
206	Alp	UMi	18.4	2.0 / 9.0	308	Polaris
207	Gam	Vir	1.4	3.5 / 3.5	138917	Porrima
208	The	Vir	7.1	4.4 / 9.4	139189	
209	Phi	Vir	4.8	4.8 / 9.3	139951	
210	84	Vir	2.9	5.7 / 7.9	120082	

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