iOptron® CEM70 Center-Balanced Equatorial Mount

Instruction Manual

Product CEM70, CEM70G, CEM70W, CEM70EC, CEM70EC2 and CEM70-NUC

Please read the included CEM70 Quick Setup Guide (QSG) BEFORE taking the mount out of the case!

This product is a precision instrument. 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 the gear switches. Otherwise personal injury and/or equipment damage may occur. Any worm system damage due to improper operation 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. CEM70 Introduction

Welcome to a new type of equatorial mount – the iOptron® Center-Balanced Equatorial Mount, or CEM! CEM70 mount offers the benefits of our revolutionary "center balance" design: stability, accuracy, and smooth mechanical operation, while capable of carrying a payload up to 70 lbs (31.8 kg). The "center balance" design's natural stability is due to its focusing the mount along with payloads weight directly over the center of the pier or tripod.

The CEM70's performance is demonstrated by its low periodic tracking error: <±5 arc seconds for CEM70 and CEM70G, and <0.3 arcsec RMS for CEM70EC and CEM70EC2. Along with the stability aspect, the CEM70 features an advanced cable management system consisting of more ports in more locations preventing tangle ups and reducing the chance of fractured cables.

This mount also has an integrated electronic polar finder scope known as the iPolar. This tool ensures the accurate alignment of a telescope, even when the pole star is obscured. There are large levers on the quick-lock drive engagement system; these large levers make it easy to snap the gears into place.

The CEM70 family currently has the following members:

- CEM70 standard version (#C70A)
- CEM70W with USB3.0 and Wi-Fi (#C70AW)
- CEM70G with iGuider, USB3.0 and Wi-Fi (#C70AG)
- CEM70EC with RA high precision encoder (#C704A0)
- CEM70EC with USB3.0 and Wi-Fi (#C704AW0)
- CEM70EC2 with high precision encoders on both RA and DEC, with USB3.0 and Wi-Fi (#C706AW0)
- CEM70 w/Intel NUC ready, include CEM70-NUC(#C70AN),CEM70EC-NUC (#C704AN0) and CEM70EC2-NUC (#C706AN0)

The CEM70 mount is equipped with the most advanced GOTONOVA® GOTO technology, making it one of the most powerful and accurate GOTO mounts available. TheGo2Nova® 8410 hand controller has a database of over 212,000 objects making it easy to locate even the faintest celestial objects.

Features:

- A new design, center-balanced equatorial mount (CEM) for maximum payload with natural stability
- Ideal for both visual observation and astrophotography
- Payload of 70 lbs (31.8 kg) with the mount weight of only 30 lbs (13.6 kg)
- Large easy to use quick-lock gear clutches
- Precision altitude and azimuth adjustment.
- Precision stepper motor with 0.07 arcsec accuracy for precise GOTO and accurate tracking
- Integrated iPolar™ electronic polar finder
- Go2Nova® 8410 controller with Advanced GOTONOVA® GOTO Technology with built in heater
- High precision tracking with low periodic error
- Permanent periodic error correction (PPEC) (CEM70/CEM70G) or Real-time periodic error correction (RPEC) (CEM70EC/CEM70EC2)
- Built-in 32-channel Global Positioning System (GPS)
- Integrated ST-4 autoguiding port
- AutoZero™ technology for mount remote operation
- Power-down memorization of GOTO and tracking position
- Advanced cable management system with more choices
- Dual saddle, Losmandy and Vixen style
- USB communication port standard
- Wi-Fi and USB3.0 connection (**for some models**)
- Built in optical guiding system, iGuider (**CEM70G only**)

2. CEM70 Terms

2.1. Parts List[1]

SHIPPING CONTENTS

Your new CEM70 mount comes in two shipping boxes. One box contains a CEM70 mount head, counterweight shaft, hand controller, and accessories. The other box contains one 21lb (9.5kg) counterweight (#7226). The contents are:

- iOptron® CEM70 telescope mount
- Go2Nova® 8410 hand controller
- Stainless steel counterweight shaft
- 12V/5A AC/DC adapter (100V-240V, with **2.5mm**X5.5mm plug, for indoor use only)
- Hand Controller Cable (6P6C RJ11 to RJ11, straight wired)
- USB cable
- Wi-Fi external antenna (for models with Wi-Fi)
- Aluminum carrying case
- 1X 21lb (9.5 kg) counterweight (#7226)

OPTIONAL PARTS

- LiteRoc™ 1.75" tripod (#8023ACC)
- Tri-pier (#8034, #8034-RC)
- Tri-pier 360 (#8037A)
- Permanent Pier (#8038)

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

- Quick Start Guide
- 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

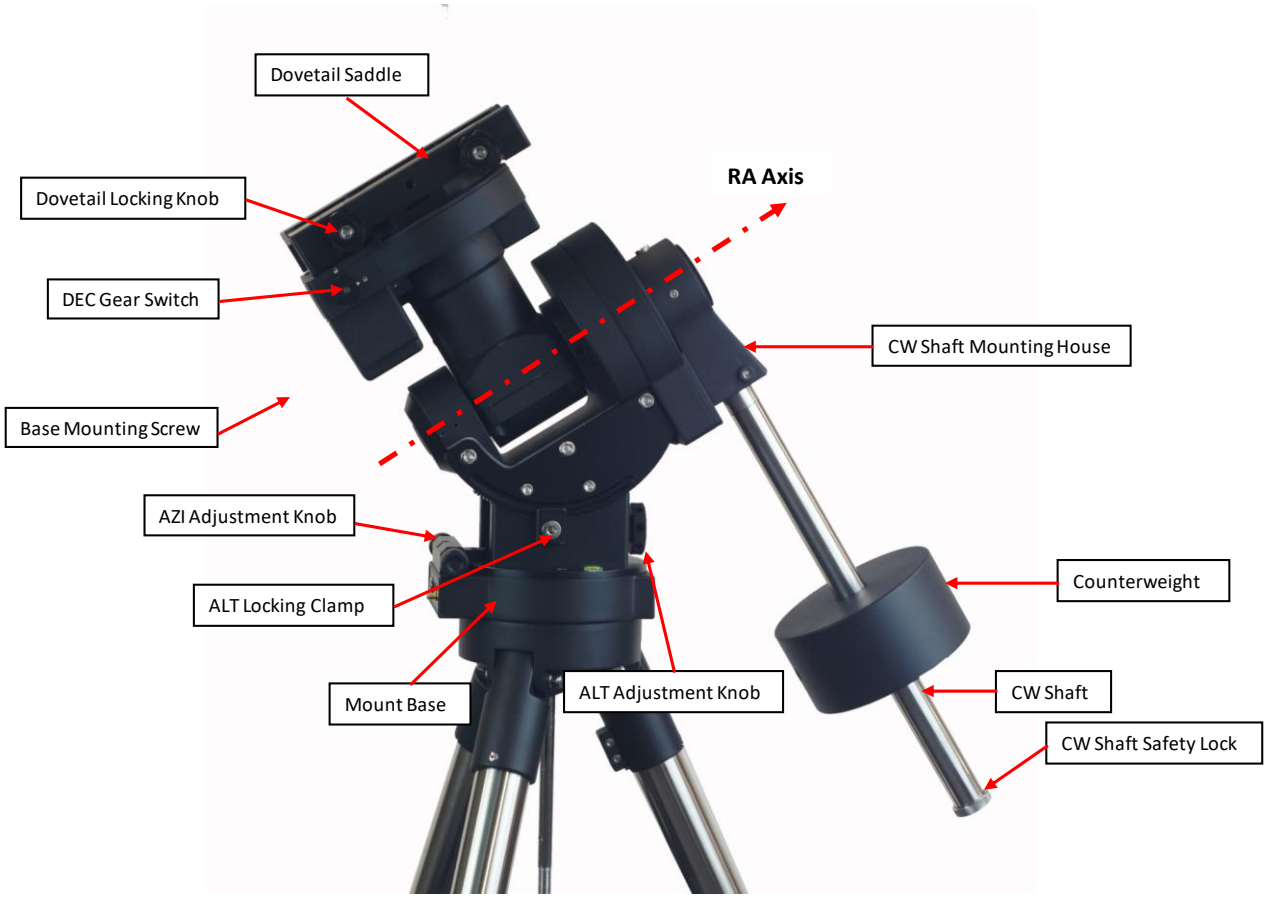


Figure 1.CEM70 mount assembly

2.3. CEM70 Mount Ports

CEM70/CEM70EC

On Mount Base Main Panel:

The main cable connection ports of a CEM70 are shown in Figure 2.

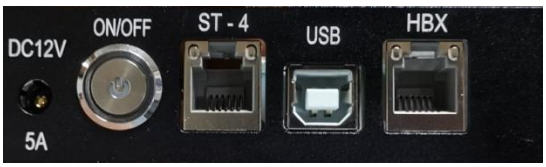


Figure 2. Ports on a CEM70 mount base

- DC 12V 5A: DC power socket to power the mount (**2.5mmX5.5mm**, 5525)
- ON/OFF: Power Switch
- ST-4: Autoguide port
- USB: USB port for mount firmware upgrade and computer control
- HBX (Hand Box): For connecting to an 8410 Hand Controller

On Dovetail Saddle:

Shown in Figure 3 are the ports on dovetail saddle of a CEM70.

Figure 3. Ports on CEM70 dovetail saddle

- iPORT: Auxiliary port for connecting to other iOptron accessories, such as an electronic focuser or for observatory dome control. **DO NOT** plug ST-4 guiding camera cable into this port. It will damage the guide camera electronics.
- DC 5521: 2.1mmX5.5mm DC output sockets for your accessories. The maximum specified current output is 5A. It is connected to the DC IN on the rear end of RA axis (Figure 6). The voltage is determined by the input voltage, such as 5V or 12V.
- USB2.0 port: 2X powered USB2.0 port and 1X unpowered USB 2.0 ports. It is connected to the iPolar/USB input on the rear end of RA axis (Figure 4).
- 5521 12V socket X2: These two 12V DC output sockets are powered by mount main DC 12V power. The combined maximum power output is 3A.

On Rear End of RA axle:

Figure 4. iPolar/USB and DC input on the rear end of RA axle

- DC input (2.5mmX5.5mm) to power 5521 (2.1mmX5.5mm) DC output sockets located next to iPort on the dovetail saddle
- iPolar/USB port: This port is for iPolar connection to computer, and 3XUSB2.0 hub on dovetail saddle connection

CEM70G

On Mount Base Main Panel:

The main cable connection ports of a CEM70G are shown in Figure 5:

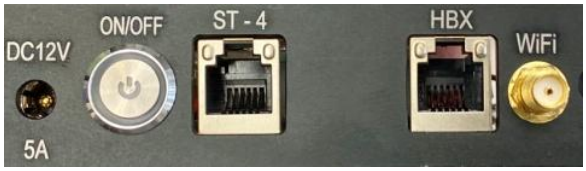


Figure 5. Ports on a CEM70G mount base

- DC 12V 5A: DC power socket to power the mount (**2.5mmX5.5mm**, 5525)
- ON/OFF: Power Switch
- ST-4:Autoguide port
- HBX (Hand Box): For connecting to an 8410 Hand Controller
- WiFi: Mini coaxial cable connector for WiFi antenna

On Rear End of RA axle:

- DC IN 5525 (2.5mmX5.5mm) to power 1X5525 (2.5mmx5.5mm) and 1X5521 (2.1mmX5.5mm) DC output sockets located on front panel of the dovetail saddle
- USB3.0 port: This port is all computer connection, include mount itself, iPolar, iGuider and 3XUSB3.0 hub on dovetail saddle

Figure 6. DC input on the rear end of RA axle

On Dovetail Saddle Front Panel (Figure 7a)

Shown in Figure 7 are the ports on dovetail saddle of a CEM70G.

(a) Front (b) Back

Figure 7. Ports on CEM70G dovetail saddle

- iPORT: Auxiliary port for connecting to other iOptron accessories, such as an electronic focuser or for observatory dome control. **DO NOT** plug ST-4 guiding camera cable into this port. It will damage the guide camera electronics.
- 1X5525 (2.5mmx5.5mm) and 1X5521 (2.1mmX5.5mm) DC output sockets for your accessories. The combined maximum specified current output is 5A. They are connected to the DC IN on the rear end of RA axis (Figure 6). The voltage is determined by the input voltage, such as 5V or 12V.

On Dovetail Saddle Back Panel (Figure 7b):

- USB3.0 port X3: Powered USB 3.0 ports. It is connected to the USB3.0 input on back of RA axis.
- 5521 12V socket X2: These two 12V DC output sockets are powered by mount main DC 12V power. The combined maximum power output is 3A.

CEM70W/CEM70WEC/CEM70EC2

On Mount Base Main Panel:

The main cable connection ports of a CEM70W/CEM70WEC/CEM70EC2 are shown in Figure 8:

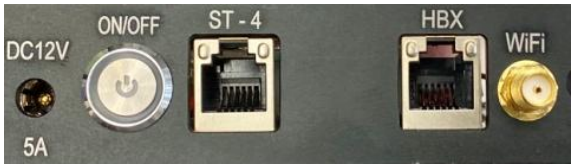


Figure 8. Ports on a CEM70W/CEM70WEC/CEM70EC2 mount base

- DC 12V 5A: DC power socket to power the mount (**2.5mmX5.5mm**, 5525)
- ON/OFF: Power Switch
- ST-4:Autoguide port
- HBX (Hand Box): For connecting to an 8410 Hand Controller
- WiFi: Mini coaxial cable connector for WiFi antenna

On Rear End of RA axle:

- DC IN 5525 (2.5mmX5.5mm) to power 1X5525 (2.5mmx5.5mm) and 1X5521 (2.1mmX5.5mm) DC output sockets located on front panel of the dovetail saddle
- USB3.0 port: This port is all computer connection, include mount itself, iPolar and 3XUSB3.0 hub on dovetail saddle

Figure 9. DC input on the rear end of RA axle

On Dovetail Saddle

Shown in Figure 10 are the ports on dovetail saddle of a CEM70W/CEM70WEC/CEM70EC2.

Figure 10. Ports on CEM70W/CEM70WEC/CEM70EC2 dovetail saddle

- iPORT: Auxiliary port for connecting to other iOptron accessories, such as an electronic focuser or for observatory dome control. **DO NOT** plug ST-4 guiding camera cable into this port. It will damage the guide camera electronics.
- DC12V 3A: The 12V DC output socket is powered by mount main DC 12V power. The maximum power output is 3A. The DC socket is 5521 ((2.1mmX5.5mm)

- USB3.0 port X3: Powered USB 3.0 ports. It is connected to the USB3.0 input on mount RA axis.
- 2X5521 (2.1mmX5.5mm) DC output sockets for your accessories. The combined maximum specified current output is 5A. They are connected to the DC IN on the rear end of RA axis. The voltage is determined by the input voltage, such as 5V or 12V.

CEM70-NUC

On Mount Base Main Panel:

The main cable connection ports of a CEM70-NUC are shown in Figure 11:

Figure 11. Ports on a CEM70-NUC mount base

- DC 12V 5A: DC power socket to power the mount (**2.5mmX5.5mm**, 5525)
- ON/OFF: Power Switch
- ST-4:Autoguide port
- HBX (Hand Box): For connecting to an 8410 Hand Controller

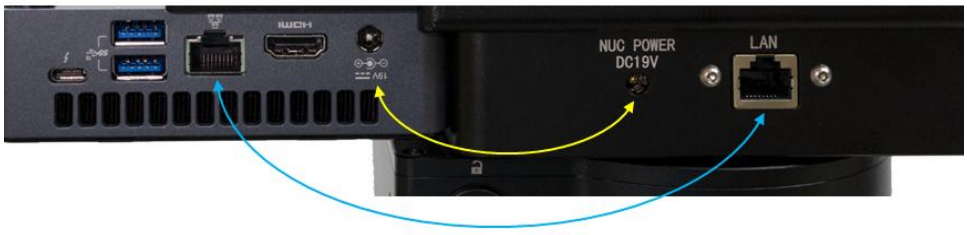
On Rear End of RA axle:

- DC 12V IN 5525: Optional 12V power input, 2.5mm/5.5mm, for the 3X power outlets on the dovetail saddle. Total current 5A.
- NUC Power DC 19V: Pass through for NUC power input. Connect the AC adapter come with NUC, 19V, or 12V for some later model.
- LAN: Pass through Ethernet input to LAN port on dovetail saddle

Figure 12. Ports on the rear end of RA axle

Cable/Port Connection on Dovetail Saddle

Shown in Figure 13 are cable connection between an Intel NUC and the mount.



- NUC POWER DC19V：NUC power to power the NUC minicomputer through the mount cable management system (Yellow line)

- LAN：Ethernet ports (blue line)

- DC12V OUT 5521：Power outlets from the mount main power, up to 3A
- USB2.0: USB2.0 Hub for other USB devices
- USB IN: USB port for mount computer controller, which will be connected to a NUC USB port (red line)

Figure 13. Cable/Ports connection of a CEM70-NUC

- DC OUTX3：DC outlets，total current 5A, 2.1/5.5 mm plug, powered by cable management input
- iPORT: Auxiliary port for connecting to other iOptron accessories, such as an electronic focuser or for observatory dome control. **DO NOT** plug ST-4 guiding camera cable into this port. It will damage the guide camera electronics.

Suggested Intel NUC

Those NUC with thickness less than 38mm with be fit onto the mount without interference with the mount body, such as Intel Frost Canyon or Tiger Canyon with “Slim” K chassis.

2.4. Go2Nova® 8410 Hand Controller

The Go2Nova® 8410 hand controller (HC) shown in Figure 14 is the standard controller used on the CEM70 mount. It has an integrated heater that ensures the LCD display will work at the temperature as low as -20ºC (-4ºF). 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) at the bottom.

A CEM70 mount can be operated without the hand controller attached if it is controlled via a SmartPhone/Tablet/Computer.

Figure 14. Go2Nova® 8410 hand controller

2.4.1. 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 a mount using a 6P6C RJ11 cable.

2.4.2. The LCD Screen

The 8410 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 15.The user interface is simple and easy to operate.

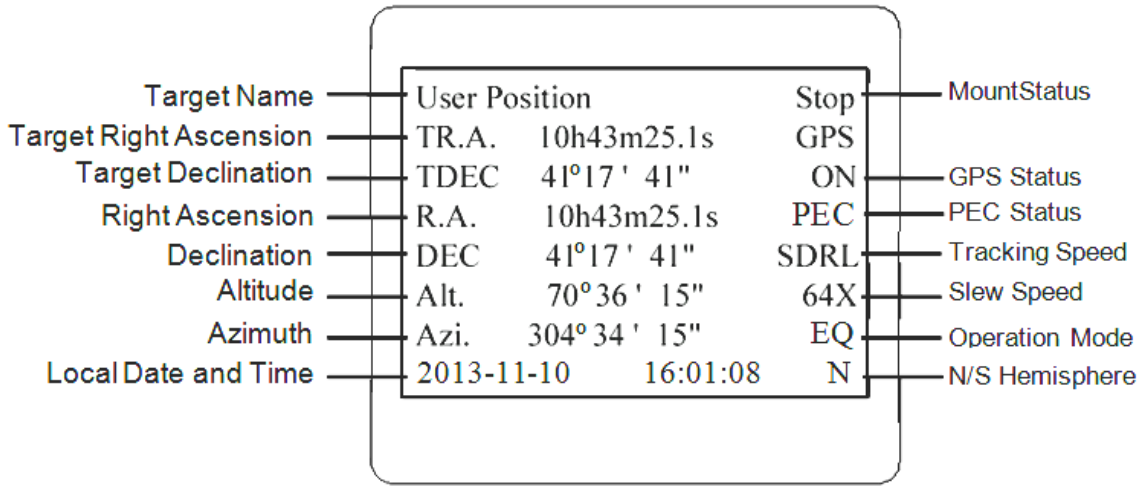


Figure 15. 8410 HC LCD Information Screen

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 90º).
7. Azimuth: Azimuth of the telescope (north is 0º, east is 90º, south is 180º, and west is 270º).
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: "GPS ON" indicates the mount is connected to its GPS receiver and is seeking a satellite signal. "GPS OFF" indicates either the mount does not have a GPS installed/connected or the GPS is malfunction. 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;
- 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.

2.4.3. Install and Check the Hand Controller Battery

The hand controller has a real time clock (RTC) 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 needed.

The hand controller uses a CR2032 button battery to keep the Real Time Clock running. The HC is shipped without battery installed due to shipping restrictions. Open the HC back cover using a good size #1 Phillips driver. With battery + sign facing up, slide the battery under two small metal hooks on the positive side first. Then push the battery down to make a good contact.

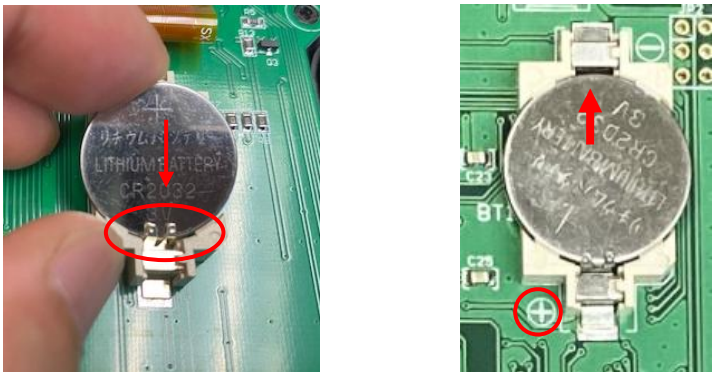


Figure 16. Install a CR2032 battery

If the hand controller can't display the correct date and time, most likely the battery power is low and needs be replaced.

2.5. 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. Slewing the mount without the CW shaft installed ***is not recommended***.

NEVER operate the mount with only the counterweight or OTA on it. It may damage the mount drive system.

3. CEM70 Mount Assembly

STEP 1. Remove mount head from package

Remove mount head from package: The RA axle is locked by an Allen wrench. Make sure it is inserted all the way in. Check the R.A. Gear Switch and turn it to unlocking position before removing it from the box.

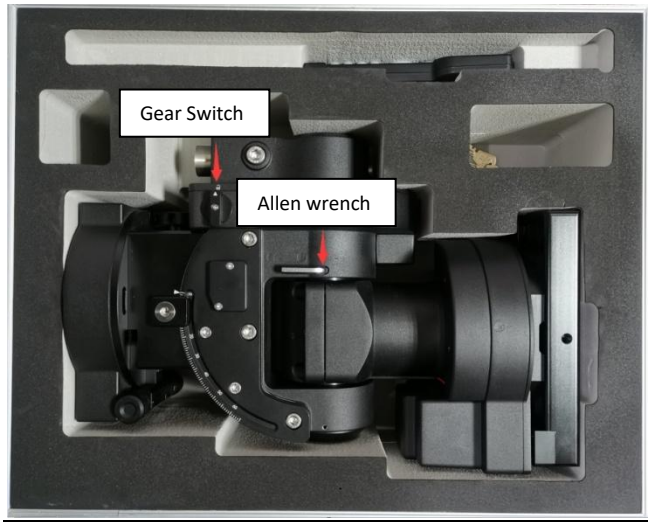


Figure 17. Remove the mount

STEP 2. Attach the mount

The mount has a 152mm base, which can be mounted onto an iOptron Tri-pier, LiteRoc™ tripod (light payload), or your own tripod/pier with two M8 threaded mounting holes separated 130mm in diameter.

Figure 18. Tripod top

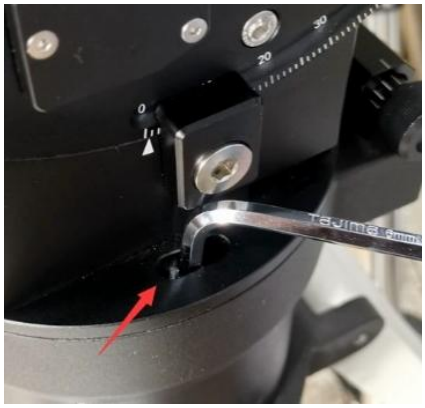


Figure 19. Locking the mount

Figure 20. Store the wrench

Hold mount head while remove the Allen wrench from the RA yoke. Turn the RA gear switch to locking position to prevent RA free swing.

Two mounting screws are pre-installed on the base. Rotate the mount to align the screws to the tripod mounting holes. Insert the wrench into the holes on the base where azimuth locking screws are located. Tighten the screws.

Store the wrench inside the base. The wrench size is 6mm.

Level the mount by adjusting the tripod legs. Use the build-in Bubble Level Indicator or an external level for this purpose.

STEP 3. Adjust Altitude

This step requires you to know the latitude of your current location. This can be found from your 8410 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.

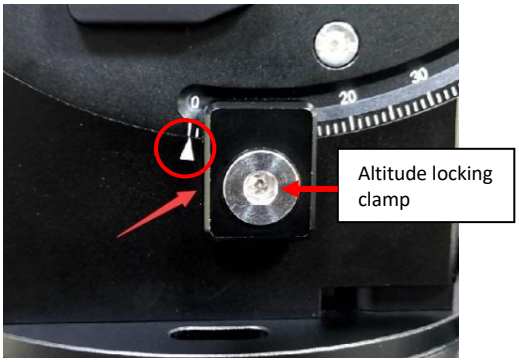


Figure 21. Setting the latitude

Figure 22. Latitude Adjustment Knob

Slightly loosen the Altitude Locking Clamps about a quarter (1/4) turn with the Allen wrench, on both side of the mount. Turn the Altitude Adjustment Knob until the arrow points to your current latitude on the Latitude Scale, as shown in Figure 21. Tighten the Altitude Locking Clamps when done.

The altitude adjustment employs worm gear system and can be adjusted precisely when turn in one direction. The fine adjustment is 0.5 arcmin. Use the wrench as a lever for better control of the knob.

STEP 4. Install the Counterweight (CW) Shaft

The 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.

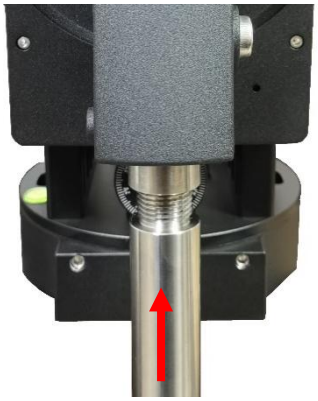


Figure 23. Install CW shaft

At very low-latitudes (<10°), you may tilt the CW shaft to accommodate it. There are three screws on CEM70 CW Mounting Housing: A Shaft Locking Screw, a Shaft Position Screw on the other side, and a Low-Latitude Set Screw, as shown in Figure 24.

Loosen the Shaft Position Screw first. Then loosen Shaft Locking Screw. Turn the Low Latitude Position Screw into the CW Mounting Housing to tilt the CW shaft so that the CW does not foul your tripod/pier (Figure 25). Then tighten the CW Shaft Positioning Screw and Shaft Locking Screw.

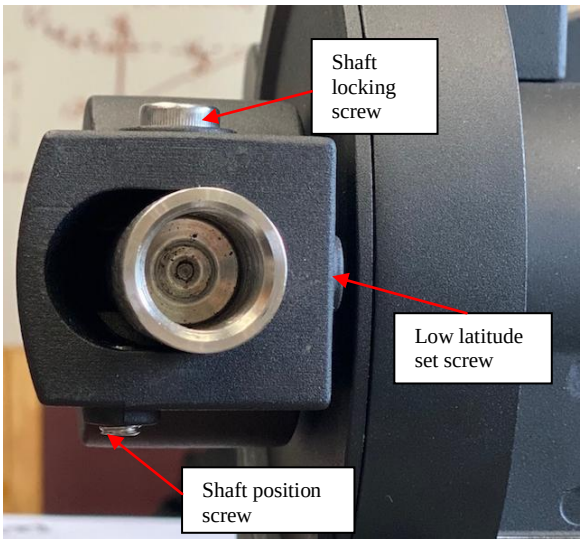


Figure 24. Screws for CW shaft tilting

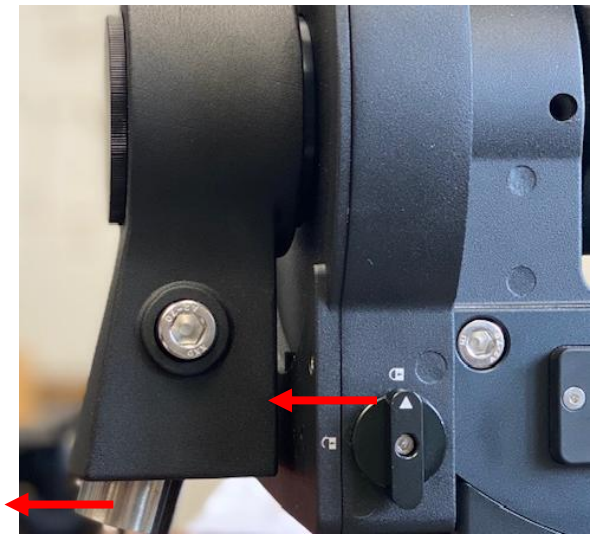


Figure 25. Tilt the counterweight shaft for low altitude

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

STEP 5. Install the Counterweight(s) and Telescope

Before putting on CW, make sure the mount is at its zero position, i.e., CW shaft points to the ground. **Disengage the R.A. Gear Switch and insert the Allen wrench to lock the RA axis before loading the CW.** Remove the CW Safety Cap at the end of CW Shaft. Glide the CW over the shaft with the larger hole opening facing down. Place the Safety Cap back onto the shaft. Move the CW to the bottom of the shaft and tighten the CW locking Screw.

Figure 26. Loading counterweight

You may need more CW for heavier payloads, or a smaller CW for lighter scopes.

CEM70 is equipped with a Vixen/Losmandy-D dual saddle. It can receive either a Vixen or a Losmandy-D plate. Release the dovetail saddle locking knobs and slide the telescope dovetail plate into the saddle. Tighten the saddle locking knobs.

STEP 6. Balance the Payload

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

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

Set the mount at Zero Position. Disengage both RA and DEC gear switches and move the mount to horizontal position to check balance. Return to Zero Position for balance adjustment. Balance the DEC axis by moving the scope with accessories back and forth in the mount saddle or within the scope mounting rings. Balance the assembly in R.A. axis by moving CW along its shaft. Repeat the process until both DEC and RA axes are balanced.

CAUTION: The balancing process MUST be done with Gear Switch at the total disengaged position! Otherwise it might damage the worm system.

Figure 27. Balance a mount

Return the mount to Zero Position after balancing and engage gear switches.

STEP 7. Connect Cables

Plug in a 12V DC power supply to the DC12V power socket (size 5.5mm/2.5mm). Connect the Go2Nova® 8410 Hand Controller to the HBX port on the mount base panel.

Figure 28. DC12V power and HBX port on mount base

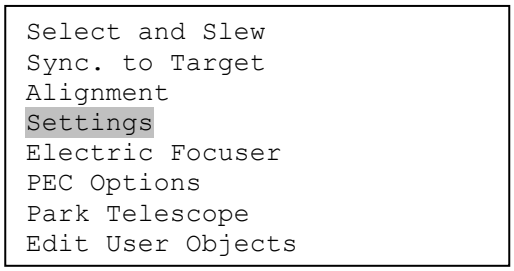
STEP 8. Setup Hand Controller

The CEM70 mount is equipped with a GPS receiver which will receive the UTC time, longitude and latitude information for your current location from satellites after a link is established. However, there are still some parameters need to be entered to reflect your location, such as time zone information and whether

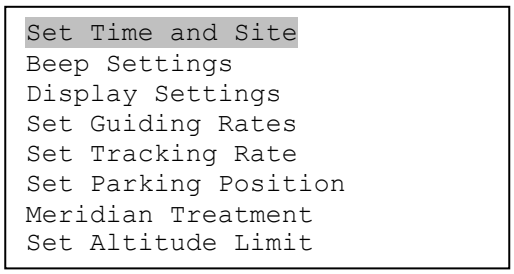
daylight saving time is currently in effect. This information will be stored in the mount until they need be updated.

The GPS should make the mount to connect the satellites in a few minutes. If the GPS module has difficulty receiving the satellite signal, you may manually enter the information.

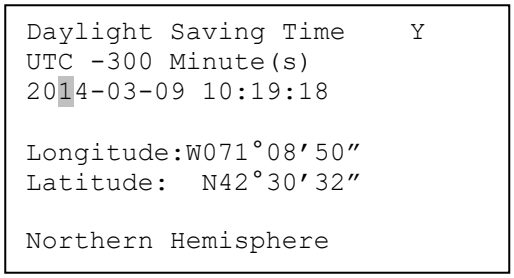
To set up the controller, press **MENU** =>"**Settings**":



Press **ENTER** and select "**Set Time & Site**"



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



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 (UTC) and Daylight Saving Time (DST)** has to be entered **CORRECTLY!** 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 fifth and sixth 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 N47º31'48": 47.53º = 47º +0.53º, 0.53º=0.53x60'=31.8', 0.8'=0.8x60''=48''. Therefore, 47.53º=47º31'48'' or 47d31m48s.

Select N/S Hemisphere

The Northern/Southern Hemisphere will be selected automatically when the latitude is set, unless the latitude is near the equator. When the latitude is between -10° ~ +10°, set it to Northern Hemisphere if the polar axis is pointing to Northern, or Southern Hemisphere if the polar axis is pointing to South.

STEP 9. Set the Zero Position

Zero Position is the mount starting reference point which ensures the GOTO performance. Press **MENU** => "**Zero Position**" => "**Search Zero Position**" to let the mount search the Zero Position. Follow the instruction on hand controller display to adjust the Zero Position if RA or DEC is not aligned. Or press **MENU** => "**Zero Position**" => "**Set Zero Position**", to manually set the mount to Zero Position. Loosen the DEC and R.A. Gear Switches in turn to adjust the mount to the Zero Position. Engage the clutches after each adjustment.

STEP 10. Polar Alignment

In order for an equatorial mount to track properly, it has to be accurately polar aligned. CEM70 mounts are equipped with an iPolar™ electronic polar.

For CEM70/CEM70EC, plug a USB cable into the iPolar port on the rear end of mount RA axis to connect the iPolar to a computer.

Figure 29. Connect CEM70/EC iPolar to a computer

For all other CEM70 mounts with a USB3.0, plug a USB cable into the USB3.0 port on the rear end of the mount RA axis to connect the iPolar to a computer.

Figure 30. Connect CEM70G iPolar to a computer

To perform polar alignment, please refer to online **iPolar Operation Menu**. It is simple and fast, even the pole star or part of the sky is blocked. Steps are briefly outlined below:

- Download and install iPolar Software (first time use)
- Connect a USB cable between the iPolar port on the mount and a computer USB port
- Start polar alignment by following on screen instructions

Polar Alignment Software

There are quite a few alignment software available or polar alignment, such as PHD2 guiding, TheSky software, PemPro, or Alignmaster.

BrightStar Polar Alignment/Polar Iterate Align

BrightStar Polar Alignment allows you to perform coarse polar align the mount even if you cannot view the Celestial Pole.

(1) Level the CEM70 mount and set it at Zero Position. Make sure the telescope is parallel to the pole axis (R.A. axis) of the mount. If a finder scope is used, adjust it to be parallel to the telescope optical axis. Turn the mount power on. Check HC to make sure it displayed Zero position.

(2) Pressing **MENU=>**"***Alignment***"**=>**"***Polar Iterate Align***". The HC will display the azimuth and altitude position of several bright stars near meridian. Select one that is visible with high altitude as Alignment Star A. Follow the HC instruction to move the Star A to the center of the eyepiece with the combination of Latitude Adjustment Knob and "◄" or "►" button. Press **ENTER** to confirm. Next, select a bright star that is close to the horizon as the Alignment Star B. Center it using the Azimuth Adjustment Knob and "◄" or "►" button *(The "▲" and "▼" buttons are not used here).* Press **ENTER** to confirm.

(3) The telescope will now slew back to Star A to repeat above steps. The iteration can be stopped when it is determined that the alignment error is at the minimum. Press **BACK** button to exit 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 but crossed, depends 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. Please check the zero position after set up the mount or firmware update.

4. CEM70 Operation

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. Set Up the Mount and Perform Polar Alignment

Assemble your CEM70 mount according to Section 3. Please make sure the following:

1. Mount are setup and balanced.
2. Both **UTC offset** and **DST** are set correctly.
3. Longitude, latitude, date and time are all correct, with or without GPS module.
4. Polar alignment is performed.
5. Mount is set at Zero Position physically and registered in hand controller. The simplest way is to perform **MENU** => "**Zero Position**" => "**Search Zero Position**".

The Zero Position is the starting reference for GOTO. It is a position that 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.

4.2. Go To a Celestial Object

Press **MENU=> "Select and Slew"** to perform the GOTO. 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.

Any object with a " $\overline{\diamond}$ " symbol next to it is currently below the horizon and the mount will not slew to it.

4.3. Manual Operation of the Mount

You may use the arrow keys (►, ◄, ▼, and ▲) to point the telescope to celestial object. Center it in the eyepiece. ***Use the number keys to change the slewing speed.*** Press the **STOP/0** button to start tracking.

4.4. Star Identification Function

The 8410 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.

4.5. Power-Down Memorization

The CEM70 mount can memorize its R.A. and DEC positions if the mount loses its power by accident, even during high speed slewing. After the power is back, just do a ***Select and Slew*** to the same star when the power is lost. The mount will continue to track the star.

4.6. Turn 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.

4.7. Put the mount back into the carrying case

It is recommended to return the mount to Zero Position at the end of the observing session. Lay the mount into the carrying case. Disengage the gear system for transportation and insert the Allen wrench into RA yoke to lock the RA axis.

5. Complete Functions of Go2Nova® 8410 Hand Controller

5.1. Select and Slew

Press **MENU** => "***Select and Slew***." Select an object that you would like to observe and press the **ENTER** key.

The Go2Nova® 8410 hand controller has a database of over 212,000 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 92 popular deep sky objects with their common names. A list of named deep sky objects is included in Appendix H.
- Messier Catalog: consists of all 110 Messier objects.
- NGC Catalog: consists of 7,840 objects.
- IC Catalog: consists of 5,386 objects.
- PGC Catalog: consists of 73,197 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 259 stars with their common names. They are listed alphabetically; a list is included in Appendix H.
- Double/Multi Stars:: consists of 208 double/multi stars; a list is attached in Appendix H.
- Hipparcos Catalog: the new HIP catalog consists of 120,404 records (2008).

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.

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.

"**Sync to Target**" will 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

5.3.1. Position of Polaris/SigmaOct

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. 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.

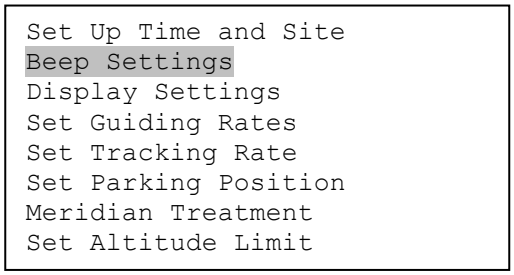
5.4. Settings

5.4.1. Set Time and Site

Refer to STEP 8 in Section 3.

5.4.2. Beep Settings

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** =>**Beep Settings**",

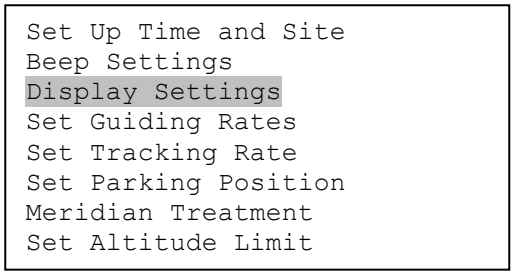


Select one of three available modes:

- "**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. Display Settings

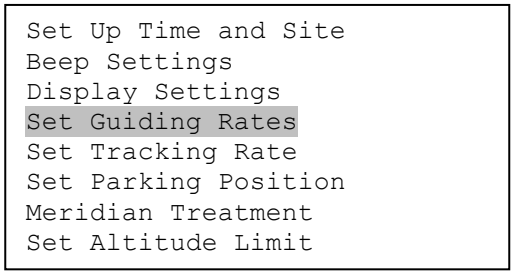
Press **MENU => "*Settings*" => "*Set Display*"**,



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

5.4.4. Set Guiding Rate

Press **MENU => "*Settings*" => "*Set Guiding Rates*"**,



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 latest firmware allows you to set the R.A. and DEC guiding speed differently. The R.A. guiding speed can be set between ±0.01X to ±0.90X sidereal rate. The DEC guiding speed can be set between ±0.10X to ±0.99X sidereal rate. Follow the instructions of your autoguiding software for detailed guiding operation.

CEM70G has an integrated guiding camera iGuider for ASCOM pulse guiding. Both CEM70G and CEM70 have an ST-4 guiding port on mount base panel.

The ST-4 guide port wiring is shown in Figure 31, which has the same pin-out as that from a Celestron / Starlight Xpress / Orion Mount / Orion Autoguider/ QHY5 autoguider.

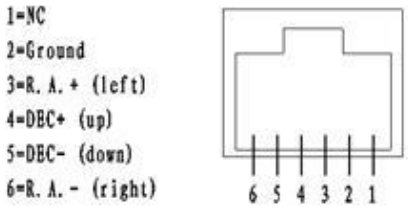


Figure 31. ST-4 port wiring

If you have an autoguider which has the same pin-out 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 iPORT 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***".

```
Set Up Time and Site
Beep Settings
Display Settings
Set Guiding Rates
Set Tracking Rate
Set Parking Position
Meridian Treatment
Set Altitude Limit
```

The mount will determine the tracking rate automatically. The tracking rate can be adjusted manually using "**Customer Rate**". The adjustment range is 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 six parking positions. Two positions that park the scope horizontally (**Horizon Position**). Two positions that park the scope vertically (**Zenith Position**). "**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 10° pass meridian.
- "**Set Behavior**" will tell the mount if a meridian flip will be performed.

5.4.8. Set Altitude Limit

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 range can be set from -89° to +89°. The default limit is 00°. ***Be careful when setting this limit.*** It may cause mount goto problems.

5.4.9. Enable CW Up Position

This setting will allow the CW moving to an up position. The upward angle limit is same as the meridian flipping setting, or 10 degree at maximum. When this set is enabled, the mount will goto pass the meridian if an object is close to the meridian, within the angle limit. There will be no meridian flip when pass the meridian.

Warning: Use at your own risk when you let the CW shaft point up!

5.4.10. HC Heating Switch

Turn on/off the controller LCD back heater. When "**Heating ON**" is selected, 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 Maximum Slew Rate

This function will help the mount to slew properly under low temperature or extreme payload condition (extra long or large diameter scope). Press **MENU** => "***Settings***" => "***Set Maximum Slew Rate***,." You can select one of three slew rates. The default is MAX.

5.4.12. Set RA Guiding

The function is for the EC version of a CEM70 mount only. You can turn off R.A. guiding by selecting "**Inhibit R.A. Guiding**" to stop sending the RA guiding signal to the mount, or turn the R.A. guiding on by selecting "**Allow RA Guiding**" to allow the mount to receive guiding corrections from the guiding software. The power on default setting is "***Allow RA Guiding***".

5.4.13. Wi-Fi Options

This function will display Wi-Fi module functions:

```
Wi-Fi Status
IP Address & Socket
SSID
Wi-Fi ON/OFF
Restart
Restore to factory
```

- ***Wi-Fi Status:*** displays WI-Fi network current status
- ***IP Address and Socket:*** IP: 010.010.100.254, Socket 08899
- ***SSID:*** is ***CEM70_XXXXXX***, password ***12345678***.
- ***Wi-Fi ON/OFF:*** turn the Wi-Fi on or off
- ***Restart***: restart the network adapter
- ***Restore to Factory***: restore the factory network setting

5.4.14. Power LED Switch

Use this setting to keep the mount power indicator (LED) on during the operation, or turn it off automatically after 1 minute

5.4.15. Reset All Settings

Reset all the settings to factory default.

5.4.16. Language

Select one of supported menu languages. Currently it has English and Chinese.

5.5. Electric Focuser

This function controls an iOptron electric focuser.

5.6. PEC Option

This function only works for a non-EC version CEM70 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 Rate**s". Set a guiding speed from 0.10X to 0.90X. The default setting is 0.50X;

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 348 seconds to make one complete revolution. After 348 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

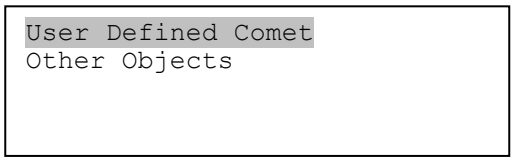
This function parks the scope to one of four preset park positions.

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.

5.8.1. Enter a New Comet

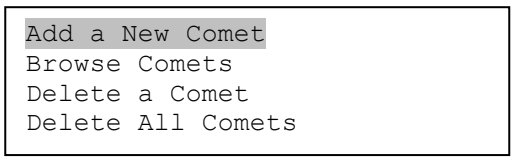
Press "**MENU** =>**Edit User Objects"** to set user objects.



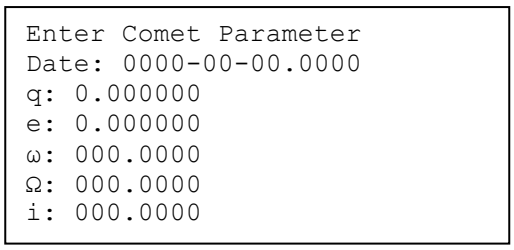
Select "**User Defined Comet**" to add/browse/delete the user-defined comet list. Find the orbit parameters of a comet in the SkyMap format. For example, the C/2012 ISON has an orbit parameter:

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:



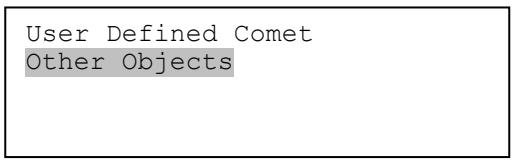
The hand controller will display the parameter entry screen:



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.



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), DEC board (DEC) and star catalog.

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 CEM70 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. Use the arrow keys to fine adjust the zero position. This will correct any discrepancy in the Zero Position. Alternatively, press **BACK** to cancel.

6. Maintenance and Servicing

6.1. Maintenance

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.

The mount worm/gear meshing can be adjusted to accommodate payload or temperature changed. An instruction is listed in Appendix**.**

The real time clock battery in the hand controller needs be replaced if it can't keep the time after power off the mount.

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 CEM70 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 a mount requires factory servicing or repairing, contact iOptron Customer Service Department at support@ioptron.com first to receive a 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, so please contact iOptron first to avoid returning the mount for repair.

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

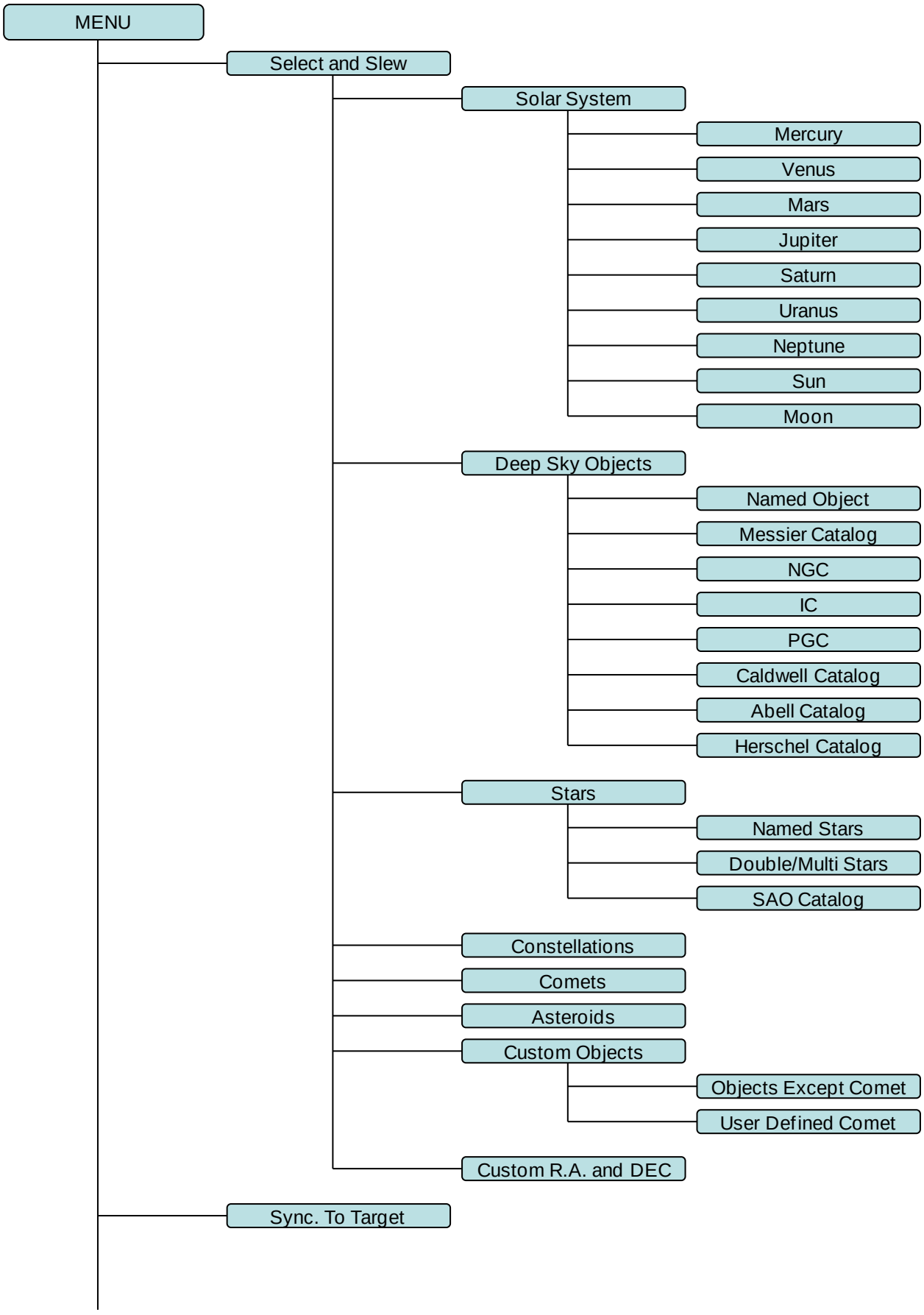
Mount	Center-balanced Equatorial Mount (CEM)
Payload*	31.8kg (70 lbs), exclude counterweight
Mount weight	13.6kg (30 lbs)
Payload/Mount weight ratio	2.33
Material	All metal
Latitude adjustment range	0°~ 65°
Azimuth adjustment range	± 4°
Right Ascension worm wheel	Φ151mm, 248 teeth, M=0.6, zero backlash
Declination worm wheel	Φ151mm, 248 teeth, M=0.6, zero backlash
Worm	Φ21.2mm
PEC	Permanent PEC for CEM70/CEM70G, Real-time PEC for CEM70EC
PE**	<±5 arcsec p-p for CEM70/CEM70G, <0.3 arcsec rms for CEM70EC
Worm period	348 sec
Counterweight shaft	Φ28, 415 mm (SS, 1.9kg)
Counterweight	9.5 kg (21 lbs)
Mount base size	Φ152mm
Motor drive	Stepper motor
Resolution	0.07 arc seconds
Slew speed	1×,2×,8×,16×,64×,128×,256×,512×,MAX(~3.5°/sec, 900X)
Power consumption	0.6A(Tracking), 0.8A(GOTO)
Power requirement	12V DC 5A
AC adapter***	100V ~ 240V with 5.5mm/2.5mm DC plug (included)
Polar scope	iPolar™ Internal electronic polar scope
Hand Controller	Go2Nova® 8410,212,000+ objects database, star recognition
Meridian treatment	Stop (0-10° pass), auto flip
Zero position	Automatic zero search
Park position	Horizontal, vertical, current, alt/azi input
Level indicator	Yes
Dovetail saddle	8" Losmandy D & Vixen
GPS	Yes
Autoguide port	ST-4
Communication port	USB 3.0, Wi-Fi for **CEM70G, CEM70W, CEM70ECW and CEM70EC2** USB2.0 for CEM70 and CEM70EC
PC computer control	Yes (ASCOM)
Intel NUC Ready	For NUC model, NUC chassis thickness <38mm
Cable management	Yes
Guiding scope/camera	iGuider™ Built in guiding scope and camera (**CEM70G** only)
Aluminum carrying case	Yes
Operation temperature	-10°C ~ +40°C
Pier/tripod	Optional LiteRoc™ tripod or Tri-pier/Pier
Warranty	Two year limited

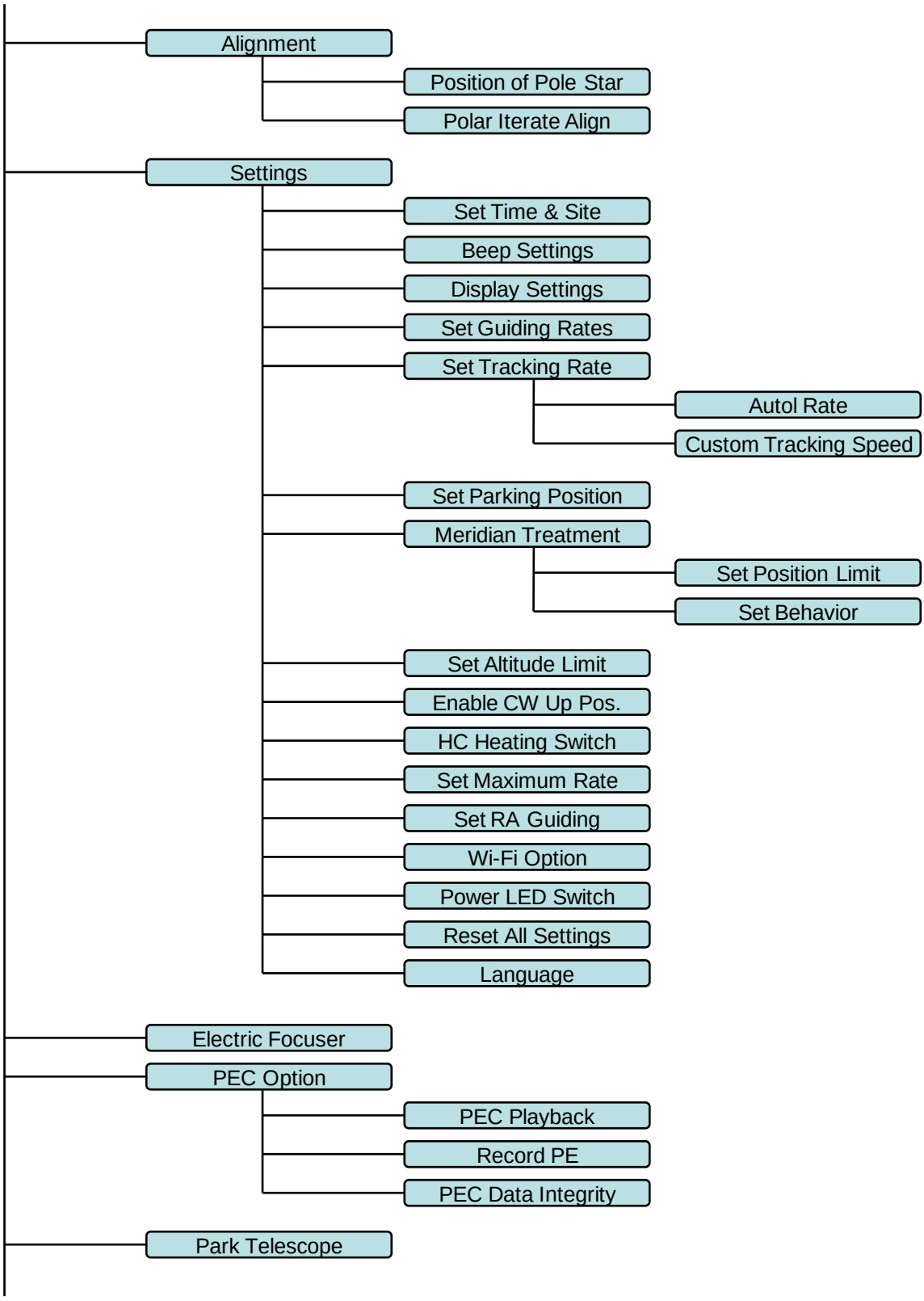
*These are only guidelines. Some telescopes are very long or very big for their weight and may require a larger mount. Remember also that imaging requirements are more rigid than visual observation.

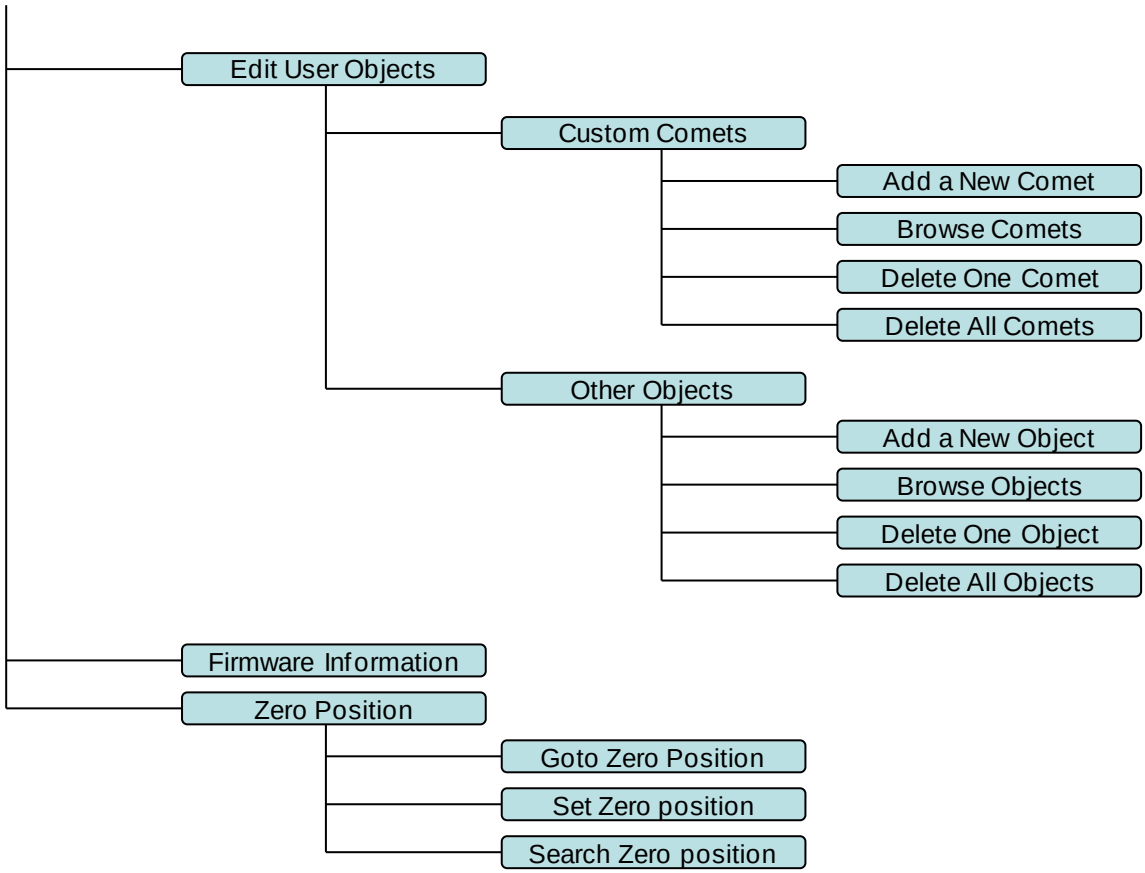
**Measured with encoder on the bench, 348 seconds.

*** For indoor use only

Appendix B. Go2Nova® 8410 HC MENU STRUCTURE




Alignment
Position of Pole Star
Polar Iterate Align
Settings
Set Time & Site
Beep Settings
Display Settings
Set Guiding Rates
Set Tracking Rate
Autol Rate
Custom Tracking Speed
Set Parking Position
Meridian Treatment
Set Position Limit
Set Behavior
Set Altitude Limit
Enable CW Up Pos.
HC Heating Switch
Set Maximum Rate
Set RA Guiding
Wi-Fi Option
Power LED Switch
Reset All Settings
Language
Electric Focuser
PEC Option
PEC Playback
Record PE
PEC Data Integrity
Park Telescope

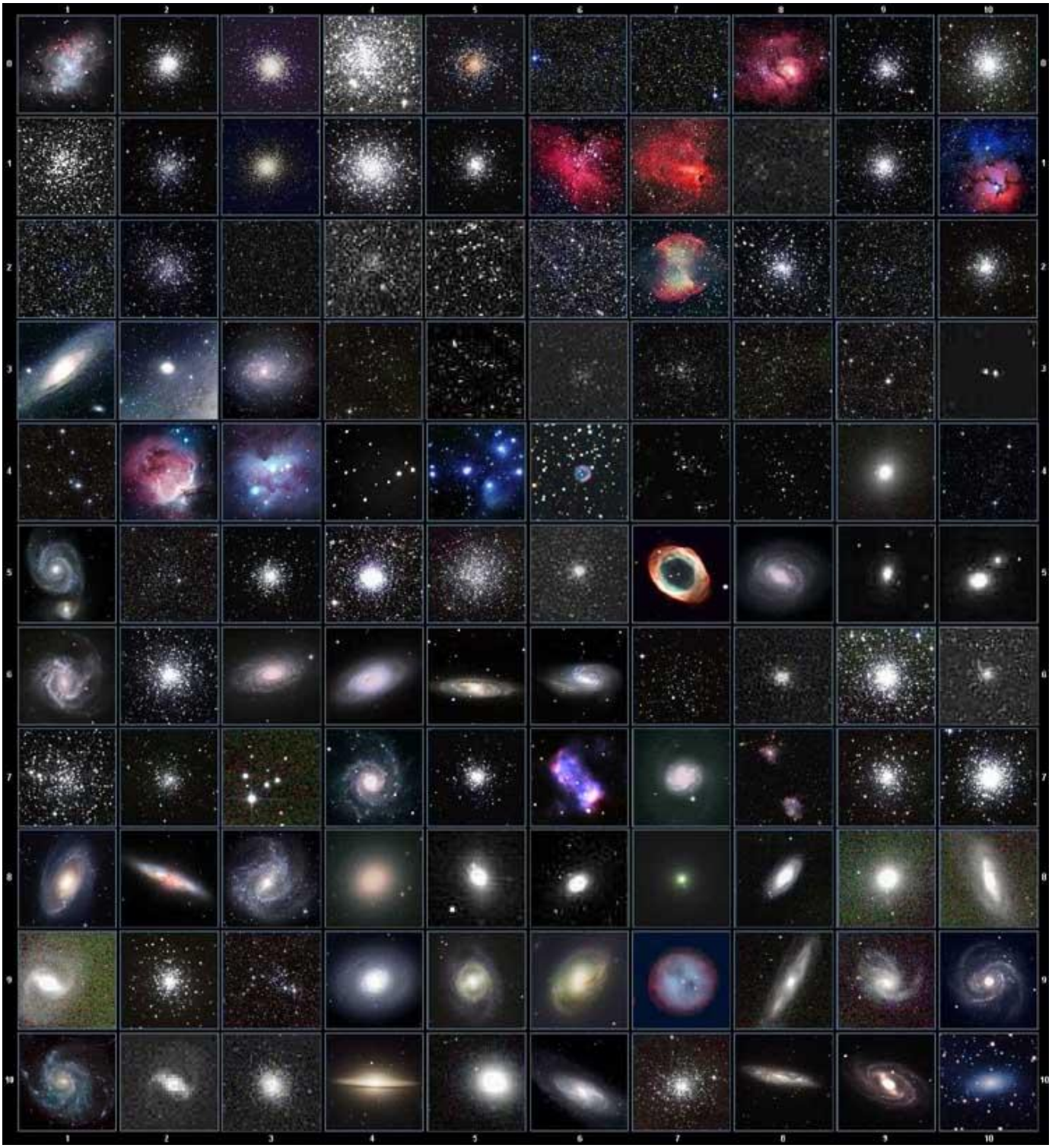

Edit User Objects
Custom Comets
Add a New Comet
Browse Comets
Delete One Comet
Delete All Comets
Other Objects
Add a New Object
Browse Objects
Delete One Object
Delete All Objects
Firmware Information
Zero Position
Goto Zero Position
Set Zero position
Search Zero position

Appendix C. Go2Nova® Star List

Named Deep Sky Object

1	47 Tucanae	47	Integral Sign Galaxy
2	Andromeda Galaxy	48	Iris Nebula
3	Antennae Galaxies	49	Jellyfish Nebula
4	Barnard's Galaxy	50	Jewel Box Cluster
5	Bear-Paw Galaxy	51	Lagoon Nebula
6	Beehive Cluster	52	Lambda Centauri Nebula
7	Black Eye Galaxy	53	Large Magellanic Cloud
8	Blinking Planetary	54	Leo Triplet
9	Blue Flash Nebula	55	Little Dumbbell Nebula
10	Blue Planetary	56	Little Gem Nebula
11	Blue Snowball Nebula	57	Little Ghost Nebula
12	Bode's Galaxy	58	Mice Galaxies
13	Box Nebula	59	Monkey Head Nebula
14	Bubble Nebula	60	North America Nebula
15	Bug Nebula	61	Northern Jewel Box
16	Butterfly Cluster	62	Omega Nebula
17	Butterfly Galaxies	63	Orion Nebula
18	California Nebula	64	Owl Nebula
19	Carina Nebula	65	Pacman Nebula
20	Cat's Eye Nebula	66	Pelican Nebula
21	Cave Nebula	67	Phantom Streak Nebula
22	Christmas Tree Cluster	68	Pinwheel Galaxy
23	Cigar Galaxy	69	Pleiades
24	Cocoon Nebula	70	Ring Nebula
25	Coma Pinwheel	71	Rosette Nebula
26	Copeland Septet	72	Saturn Nebula
27	Crab Nebula	73	Sextans B
28	Crescent Nebula	74	Small Magellanic Cloud
29	Draco Dwarf Galaxy	75	Sombrero Galaxy
30	Dumbbell Nebula	76	Soul Nebula
31	Eagle Nebula	77	Southern Pinwheel Galaxy
32	Eight-Burst Nebula	78	Spindle Galaxy(3115)
33	Elephant Trunk Nebula	79	Spindle Galaxy(5866)
34	Eskimo Nebula	80	Stephan's Quintet
35	Eyes Galaxies	81	Sunflower Galaxy
36	Flame Nebula	82	Tarantula Nebula
37	Flaming Star Nebula	83	The Witch Head Nebula
38	Ghost of Jupiter	84	The Wizard Nebula
39	Heart Nebula	85	Thor's Helmet
40	Helix Nebula	86	Triangulum Galaxy
41	Hercules Globular Cluster	87	Trifid Nebula
42	Hind's Variable Nebula	88	Ursa Minor Dwarf Galaxy
43	Hockey Stick Galaxies	89	Veil Nebula
44	Horsehead Nebula	90	Whale Galaxy
45	Hubble's Variable Nebula	91	Whirlpool Galaxy
46	Hyades Cluster	92	Wild Duck Cluster

Messier Catalog



Named Stars

1	Acamar	50	Alrescha	99	Deneb el Okab	148	Lalande 21185
2	Achernar	51	Alshain	100	Deneb Kaitos	149	Lesath
3	Achird	52	Altair	101	Denebakrab	150	Mahasim
4	Acrab	53	Altais	102	Denebola	151	Maia
5	Acrux A	54	Alterf	103	Dschubba	152	Marfik
6	Acrux B	55	Aludra	104	Dubhe	153	Marfikent
7	Acubens	56	Alula Australis	105	Edasich	154	Markab
8	Adhafera	57	Alula Borealis	106	El Rehla	155	Markeb
9	Adhara	58	Alya	107	Electra	156	Matar
10	Adid Australis	59	Ancha	108	Elnath	157	Mebsuta
11	Ahadi	60	Ankaa	109	Eltanin	158	Megrez
12	Al Dhanab	61	Antares	110	Enif	159	Meissa
13	Al Dhibain Prior	62	Apollyon	111	Errai	160	Mekbuda
14	Al Kab	63	Arcturus	112	Fomalhaut	161	Menkalinan
15	Al Nair	64	Arkab Prior	113	Furud	162	Menkar
16	Al Nair al Baten	65	Arneb	114	Gacrux	163	Menkent
17	Al Niyat(Sigma)	66	Ascella	115	Gatria	164	Menkib
18	Al Niyat(Tau)	67	Asellus Austral	116	Giausar	165	Merak
19	Albaldah	68	Asellus Boreali	117	Gienah Corvi	166	Merope
20	Albali	69	Aspidiske	118	Gienah Cygni	167	Mesartim
21	Albireo	70	Atik	119	Girtab	168	Miaplacidus
22	Alchiba	71	Atlas	120	Gliese 1	169	Mimosa
23	Alcor	72	Atria	121	Gomeisa	170	Mintaka
24	Alcyone	73	Avior	122	Graffias(Zeta)	171	Mira
25	Aldebaran	74	Azha	123	Groombridge 1830	172	Mirach
26	Alderamin	75	Barnard's Star	124	Gruid	173	Mirfak
27	Alfirk	76	Baten Kaitos	125	Grumium	174	Mirzam
28	Algenib	77	Beid	126	Hadar	175	Mizar
29	Algenubi	78	Bellatrix	127	Hamal	176	Mu Velorum
30	Algieba	79	Beta Hydri	128	Han	177	Muhlifain
31	Algiedi Secunda	80	Betelgeuse	129	Hatsya	178	Muphrid
32	Algol	81	Betria	130	Head of Hydrus	179	Muscida
33	Algorab	82	Biham	131	Homam	180	Naos
34	Alhakim	83	Birdun	132	Iritjinga(Cen)	181	Nashira
35	Alhena	84	Canopus	133	Izar	182	Navi
36	Alioth	85	Capella	134	Kakkab Su-gub Gud-Elim	183	Nekkar
37	Alkaid	86	Caph	135	Kapteyn's Star	184	Nihal
38	Alkalurops	87	Castor A	136	Kaus Australis	185	Nunki
39	Alkes	88	Castor B	137	Kaus Borealis	186	Nusakan
40	Almaaz	89	Cebalrai	138	Kaus Media	187	Palida
41	Almach	90	Chara	139	Keid	188	Peacock
42	Alnasl	91	Chertan	140	Kekouan	189	Phact
43	Alnilam	92	Choo	141	Kitalpha	190	Phecda
44	Alnitak	93	Cor Caroli	142	Kochab	191	Pherkad
45	Alpha Muscae	94	Cursa	143	Koo She	192	Polaris
46	Alpha Tucanae	95	Dabih	144	Kornephoros	193	Pollux
47	Alphard	96	Deltotum	145	Kraz	194	Porrima
48	Alphecca	97	Deneb	146	Kurhah	195	Procyon
49	Alpheratz	98	Deneb Algedi	147	Lacaille 9352	196	Propus

197	Proxima Centauri	213	Sadalbari	229	Sulafat	245	Vindemiatrix
198	Rasalas	214	Sadalmelik	230	Syrma	246	Vrischika
199	Rasalgethi	215	Sadalsuud	231	Talitha	247	Wasat
200	Rasalhague	216	Sadr	232	Tania Australis	248	Wazn
201	Rastaban	217	Saiph	233	Tania Borealis	249	Wei
202	Regor	218	Sargas	234	Tarazed	250	Wezen
203	Regulus	219	Scheat	235	Taygeta	251	Yed Posterior
204	Rigel	220	Schedar	236	Tejat Posterior	252	Yed Prior
205	Rigel Kentaurus A	221	Seginus	237	Thuban	253	Zaniah
206	Rigel Kentaurus B	222	Shaula	238	Thusia	254	Zaurak
207	Ruchbah	223	Sheliak	239	Tien Kwan	255	Zavijava
208	Rukbat	224	Sheratan	240	Turais	256	Zeta Persei
209	Rukh	225	Sirius	241	Unukalhai	257	Zosma
210	Rutilicus	226	Skat	242	Vasat-ul-cemre	258	Zubenelgenubi
211	Sabik	227	Spica	243	Vathorz Posterior	259	Zubeneschamali
212	Sadachbia	228	Suhail	244	Vega		

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

Double/Multi Stars

No.	HC Item		Constellation	Name	HIP	WDS	SAO
1	Rigel Kentaurus A	Alpha Centauri	Centaurus		71683	14396-6050	252838
2	Rigel	Beta Orionis	Orion		24436	05145-0812	131907
3	Gacrux	Gamma Crucis	Crux		61084	12312-5707	240019
4	Sargas	Theta Scorpii	Scorpius		86228	17373-4300	228201
5	Castor A	Alpha Geminorum	Gemini		36850	07346+3153	60198
6	Mizar	Zeta Ursae Majoris	Ursa Major		65378	13239+5456	28737
7	Almach	Gamma Andromedae	Andromeda		9640	02039+4220	37735
8	Algieba	Gamma Leonis	Leo		50583	10200+1950	81298
9	Aludra	Eta Canis Majoris	Canis Major		35904	07241-2918	173651
10	Iritjinga (Cen)	Gamma Centauri	Centaurus	Muhlifain	61932	12415-4858	223603
11	Zubenelgenubi	Alpha Librae	Libra		72603	14509-1603	158836
12	Alcyone	Eta Tauri	Taurus		17702	03475+2406	76199
13	Cor Caroli	Alpha Canum Venatico	Canes Venatici		63125	12560+3819	63257
14	Acamar	Theta Eridani	Eridanus		13847	02583-4018	216113
15	Adhafera	Zeta Leonis	Leo		50335	10167+2325	81265
16	Rasalgethi	Alpha Herculis	Hercules		84345	17146+1423	102680
17	Meissa	Lambda Orionis	Orion		26207	05351+0956	112921
18	Graffias	Beta1 Scorpii	Scorpius		78820	16054-1948	159682
19	Alya	Theta Serpentis	Serpens		92946	18562+0412	124068
20	HIP 48002	Upsilon Carinae	Carina	Vathorz Prior		09471-6504	250695
21	HIP 95947	Beta1 Cygni	Cygnus	Albireo		19307+2758	87301
22	HIP 20894	Theta2 Tauri	Taurus			04287+1552	93957
23	HIP 74395	Zeta Lupi	Lupus			15123-5206	242304
24	HIP 27072	Gamma Leporis	Lupus			05445-2227	170759
25	HIP 26549	Sigma Orionis	Orion			05387-0236	132406
26	HIP 85667	HD 158614	Ophiuchus			17304-0104	141702
27	HIP 74376	Kappa1 Lupi	Lupus			15119-4844	225525
28	HIP 34481	Gamma2 Volantis	Carina			07087-7030	256374
29	HIP 53253	u Carinae	Carina			10535-5851	238574
30	HIP 99675	Omicron1 Cygni	Cygnus	31 Cyg		20136+4644	49337
31	HIP 63003	Mu1 Crucis	Crux			12546-5711	240366
32	HIP 43103	Iota Cancri	Cancer	48 Cnc		08467+2846	80416
33	HIP 110991	Delta Cephei	Cepheus	27 Cep		22292+5825	34508
34	HIP 20635	Kappa1 Tauri	Taurus	65 Tau		04254+2218	76601
35	HIP 88601	70 Ophiuchi	Orion			18055+0230	123107
36	HIP 2484	Beta1 Tucanae	Horologium			00315-6257	248201
37	HIP 91971	Zeta1 Lyrae	Cygnus	6 Lyr		18448+3736	67321
38	HIP 79374	Nu Scorpii	Scorpius	Jabbah		16120-1928	159764
39	HIP 102532	Gamma2 Delphini	Pegasus	12 Del		20467+1607	106476
40	HIP 52154	x Velorum	Vela			10393-5536	238309
41	HIP 37229	HD 61555	Canis Major			07388-2648	174198
42	HIP 30419	Epsilon Monocerotis	Orion	8 Mon		06238+0436	113810
43	HIP 108917	Xi Cephei	Cepheus.	Al kurhah		22038+6438	19827
44	HIP 53417	54 Leonis	Leo			10556+2445	81584
45	HIP 65271	J Centauri	Centaurus			13226-6059	252284
46	HIP 67669	3 Centauri	Centaurus			13518-3300	204916
47	HIP 105319	Theta Indi	Indus			21199-5327	246965
48	HIP 80582	Epsilon Normae	Norma			16272-4733	226773
49	HIP 8832	Gamma Arietis	Aries			01535+1918	92680
50	HIP 69483	Kappa Boötis	Boötes	Asellus Tertius		14135+5147	29045
51	HIP 92946	Theta Serpentis	Serpens			18562+0412	124068
52	HIP 86614	Psi1 Draconis	Draco	31 Draconis		17419+7209	8890

No.	HC Item		Constellation	Name	HIP	WDS	SAO
53	HIP 95771	Alpha Vulpeculae	Vulpecula	Anser		19287+2440	87261
54	HIP 30867	Beta Monocerotis	Monoceros			06288-0702	133316
55	HIP 35363	NV Puppis	Puppis			07183-3644	197824
56	HIP 94761	Gliese 752	Aquila	Wolf 1055, Ross 652		19169+0510	
57	HIP 21683	Sigma2 Tauri	Taurus			04393+1555	94054
58	HIP 8497	Chi Ceti	Cetus	53 Cet		01496-1041	148036
59	HIP 26199	HD 36960	Orion			05350-0600	132301
60	HIP 104521	Gamma Equulei	Equuleus	5 Equ		21103+1008	126593
61	HIP 116389	Iota Phoenicis	Phoenix			23351-4237	231675
62	HIP 17797	HD 24071	Eridanus			03486-3737	194550
63	HIP 21036	83 Tauri	Taurus			04306+1343	93979
64	HIP 107310	Mu1 Cygni	Cygnus	78 Cyg		21441+2845	89940
65	HIP 72659	Xi Boötis	Boötes	37 Boo		14514+1906	101250
66	HIP 21029	HD 28527	Taurus			04306+1612	93975
67	HIP 42726	HY Velorum	Vela			08424-5307	236205
68	HIP 18255	32 Eridani	Eridanus			03543-0257	130806
69	HIP 9153	Lambda Arietis	Aries			01580+2336	75051
70	HIP 88267	95 Herculis	Hercules			18015+2136	85648
71	HIP 85829	Nu2 Draconis	Draco	25 Dra		17322+5511	30450
72	HIP 43937	V376 Carinae	Carina	b1 Carinae		08570-5914	236436
73	HIP 71762	Pi2 Boötis	Boötes	29 Boo		14407+1625	101139
74	HIP 80047	Delta1 Apodis	Apus			16203-7842	257380
75	HIP 58484	Epsilon Chamaeleontis	Chamaeleon			11596-7813	256894
76	HIP 25142	23 Orionis	Orion			05228+0333	112697
77	HIP 54204	Chi1 Hydrae	Hydra			11053-2718	179514
78	HIP 76669	Zeta Coronae Borealis	Corona Borealis	7 CrB		15394+3638	64833
79	HIP 99770	b3 Cygni	Cygnus	29 Cyg		20145+3648	69678
80	HIP 101027	Rho Capricorni	Capricornus	11 Cap		20289-1749	163614
81	HIP 74911	Nu Lupi	Lupus			15185-4753	225638
82	HIP 35210	HD 56577	Canis Major			07166-2319	173349
83	HIP 26235	Theta2 Orionis	Orion	43 Ori		05354-0525	132321
84	HIP 40321	OS Puppis	Puppis			08140-3619	198969
85	HIP 70327	HD 126129	Boötes			14234+0827	120426
86	HIP 26221	Theta1 Orionis	Orion	Trapezium		05353-0523	132314
87	HIP 80473	Rho Ophiuchi	Ophiuchus	5 Oph		16256-2327	184381
88	HIP 78105	Xi1 Lupi	Lupus			15569-3358	207144
89	HIP 79043	Kappa Herculis	Hercules	7 Her		16081+1703	101951
90	HIP 61418	24 Comae Berenices	Coma Berenices			12351+1823	100160
91	HIP 91919	Epsilon Lyrae	Lyra	4 Lyr		18443+3940	67309
92	HIP 41639	HD 72127	Vela			08295-4443	219996
93	HIP 104214	61 Cygni	Cygnus			21069+3845	70919
94	HIP 23734	11 Camelopardalis	Camelopardalis			05061+5858	25001
95	HIP 60189	Zeta Corvi	Corvus	5 Crv		12206-2213	180700
96	HIP 66821	Q Centauri	Centaurus			13417-5434	241076
97	HIP 14043	HD 18537	Perseus			03009+5221	23763
98	HIP 5737	Zeta Piscium	Pisces	86 Psc		01137+0735	109739
99	HIP 84626	Omicron Ophiuchi	Ophiuchus	39 Oph		17180-2417	185238
100	HIP 60904	17 Comae Berenices	Coma Berenices			12289+2555	82330
101	HIP 58684	67 Ursae Majoris	Ursa Major			12021+4303	44002
102	HIP 5131	Psi1 Piscium	Pisecs	74 Psc		01057+2128	74482
103	HIP 115126	94 Aquarii	Aquarius			23191-1328	165625
104	HIP 62572	HD 112028	Camelopardalis			12492+8325	2102

No.	HC Item		Constellation	Name	HIP	WDS	SAO
105	HIP 40167	Zeta1 Cancri	Cancer	Tegmen		08122+1739	97645
106	HIP 40817	Kappa Volantis	Volans			08198-7131	256497
107	HIP 81292	17 Draconis	Draco			16362+5255	30013
108	HIP 80197	Nu1 Coronae Borealis	Corona Borealis			16224+3348	65257
109	HIP 88060	HD 163756	Sagittarius			17591-3015	209553
110	HIP 42637	Eta Chamaeleontis	Chamaeleon			08413-7858	256543
111	HIP 21039	81 Tauri	Taurus			04306+1542	93978
112	HIP 100965	75 Draconis	Draco			20282+8125	3408
113	HIP 25768	HD 36553	Pictor			05302-4705	217368
114	HIP 93717	15 Aquilae	Aquila			19050-0402	142996
115	HIP 79980	HD 148836	Scorpius			16195-3054	207558
116	HIP 12086	15 Trianguli	Triangulum			02358+3441	55687
117	HIP 90968	Kappa2 Coronae Austra	Corona Australis			18334-3844	210295
118	HIP 22531	Iota Pictoris	Pictor			04509-5328	233709
119	HIP 34065	HD 53705	Puppis			07040-4337	218421
120	HIP 79607	Sigma Coronae Boreali	Corona Borealis			16147+3352	65165
121	HIP 109786	41 Aquarii	Aquarius			22143-2104	190986
122	HIP 56280	17 Crateris	Hydra			11323-2916	179968
123	HIP 51561	HD 91355	Vela			10320-4504	222126
124	HIP 107930	HD 208095	Cepheus			21520+5548	33819
125	HIP 97966	57 Aquilae	Aquila			19546-0814	143898
126	HIP 117218	107 Aquarii	Aquarius.			23460-1841	165867
127	HIP 82676	HD 152234	Scorpius			16540-4148	227377
128	HIP 111546	8 Lacertae	Lacerta			22359+3938	72509
129	HIP 29151	HD 42111	Orion			06090+0230	113507
130	HIP 107253	79 Cygni	Cygnus			21434+3817	71643
131	HIP 88136	41 Draconis	Draco			18002+8000	8996
132	HIP 81702	HD 150136	Ara			16413-4846	227049
133	HIP 97423	HD 186984	Sagittarius			19480-1342	162998
134	HIP 30444	HD 45145	Columba			06240-3642	196774
135	HIP 66400	HD 118349	Hydra			13368-2630	181790
136	HIP 17579	21 Tauri	Taurus	Asterope		03459+2433	76159
137	HIP 35785	19 Lyncis	Lynx			07229+5517	26312
138	HIP 81641	37 Herculis	Hercules			16406+0413	121776
139	HIP 7751	p Eridani	Eridanus			01398-5612	232490
140	HIP 21148	1 Camelopardalis	Camelopardalis			04320+5355	24672
141	HIP 9021	56 Andromedae	Andromeda			01562+3715	55107
142	HIP 97816	HD 187420	Telescopium			19526-5458	246311
143	HIP 88818	100 Herculis	Hercules			18078+2606	85753
144	HIP 36817	HD 60584	Puppis			07343-2328	174019
145	HIP 25695	HD 35943	Taurus			05293+2509	77200
146	HIP 98819	15 Sagittae	Sagitta			20041+1704	105635
147	HIP 61910	VV Corvi	Corvus			12413-1301	157447
148	HIP 111643	Sigma2 Gruis	Grus			22370-4035	231217
149	HIP 80399	HD 147722	Scorpius			16247-2942	184368
150	HIP 83478	HD 154228	Hercules			17037+1336	102564
151	HIP 101123	Omicron Capricorni	Capricornus			20299-1835	163626
152	HIP 28271	59 Orionis	Orion			05584+0150	113315
153	HIP 64246	17 Canum Venaticicoru	Canes Venatici			13101+3830	63380
154	HIP 96895	16 Cygni	Cygnus			19418+5032	31898
155	HIP 35564	HD 57852	Carina			07204-5219	235110
156	HIP 37843	2 Puppis	Puppis			07455-1441	153363

No.	HC Item		Constellation	Name	HIP	WDS	SAO
157	HIP 28790	HD 41742	Puppis			06047-4505	217706
158	HIP 4675	HD 5788	Andromeda			01001+4443	36832
159	HIP 31676	8 Lyncis	Lynx			06377+6129	13897
160	HIP 10176	59 Andromedae	Andromeda			02109+3902	55330
161	HIP 25950	HD 36408	Taurus			05322+1703	94630
162	HIP 117931	AL Sculptoris	Sculptor			23553-3155	214860
163	HIP 81914	HD 150591	Scorpius			16439-4107	227123
164	HIP 21242	m Persei	Perseus			04334+4304	39604
165	HIP 86831	61 Ophiuchi	Ophiuchus			17446+0235	122690
166	HIP 115272	HD 220003	Grus			23208-5018	247838
167	HIP 46657	Zeta1 Antliae	Antlia			09308-3153	200444
168	HIP 41404	Phi2 Cancri	Cancer			08268+2656	80188
169	HIP 29388	41 Aurigae	Auriga			06116+4843	40925
170	HIP 49321	HD 87344	Hydra			10040-1806	155704
171	HIP 84054	63 Herculis	Hercules			17111+2414	84896
172	HIP 39035	HD 66005	Puppis			07592-4959	219249
173	HIP 25303	Theta Pictoris	Pictor			05248-5219	233965
174	HIP 52520	HD 93344	Carina			10443-7052	256750
175	HIP 95398	2 Sagittae	Sagitta			19244+1656	104797
176	UCAC4 277-135548						
177	HIP 32609	HD 48766	Lynx			06482+5542	25963
178	HIP 101765	48 Cygni	Cygnus			20375+3134	70287
179	HIP 24825	YZ Leporis	Lepus			05193-1831	150335
180	HIP 31158	21 Geminorum	Gemini			06323+1747	95795
181	HIP 3885	65 Piscium	Pisces			00499+2743	74295
182	HIP 93371	HD 176270	Australis			19011-3704	210816
183	HIP 36345	HD 59499	Puppis			07289-3151	198038
184	HIP 108364	HD 208947	Cepheus			21572+6609	19760
185	HIP 50939	HD 90125	Sextans			10242+0222	118278
186	HIP 76603	HD 139461	Libra			15387-0847	140672
187	HIP 32269	HD 49219	Carina			06442-5442	234683
188	HIP 42516	39 Cancri	Cancer			08401+2000	80333
189	HIP 62807	32 Comae Berenices	Coma Berenices			12522+1704	100309
190	UCAC4 226-128246						
191	HIP 94913	24 Aquilae	Aquila			19188+0020	124492
192	HIP 94336	HD 179958	Cygnus			19121+4951	48193
193	HIP 107299	HD 206429	Indus			21440-5720	247151
194	HIP 59984	HD 106976	Virgo			12182-0357	138704
195	HIP 16411	HD 21743	Taurus			03313+2734	75970
196	HIP 23287	HD 32040	Orion			05006+0337	112305
197	HIP 105637	HD 203857	Cygnus			21238+3721	71280
198	HIP 108925	HD 209744	Cepheus			22039+5949	34016
199	HIP 103814	HD 200011	Microscopium			21022-4300	230492
200	HIP 58112	65 Ursae Majoris	Ursa Major			11551+4629	43945
201	HIP 109354	V402 Lacertae	Lacerta			22093+4451	51698
202	HIP 43822	17 Hydrae	Hydra			08555-0758	136409
203	HIP 21986	55 Eridani	Eridanus			04436-0848	131442
204	HIP 17470	HD 23245	Taurus			03446+2754	76122
205	HIP 35960	V368 Puppis	Puppis			07248-3717	197974
206	HIP 42936	HD75086	Carina			08451-5843	236241
207	HIP 19272	SZ Camelopardalis	Camelopardalis			04078+6220	13031
208	HIP 76143	HD 138488	Libra			15332-2429	183565

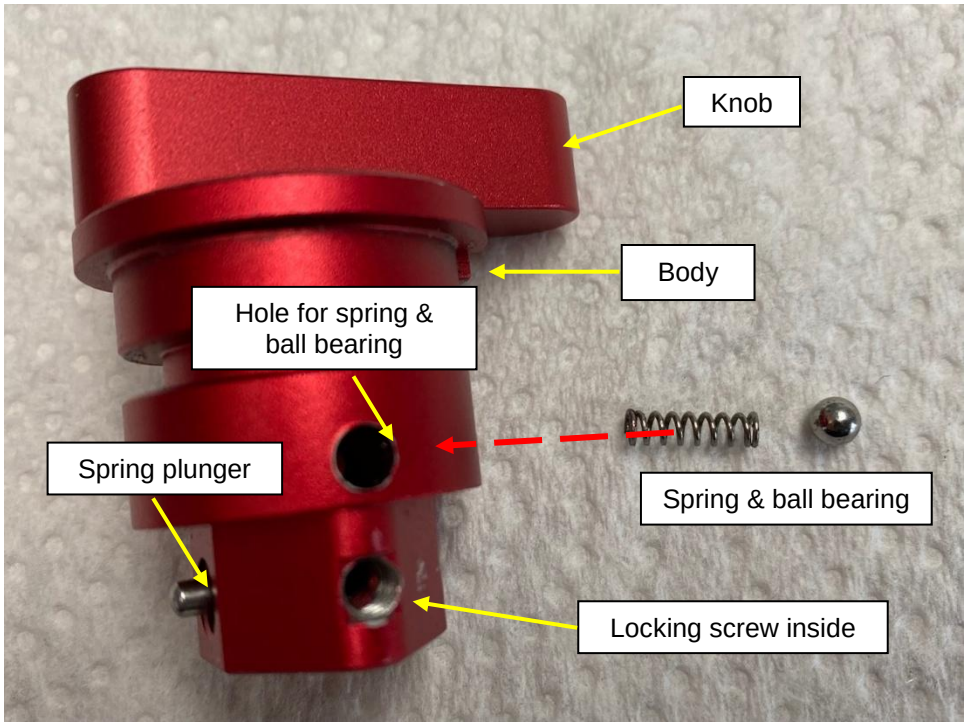
Appendix D. Gear Meshing Adjustment

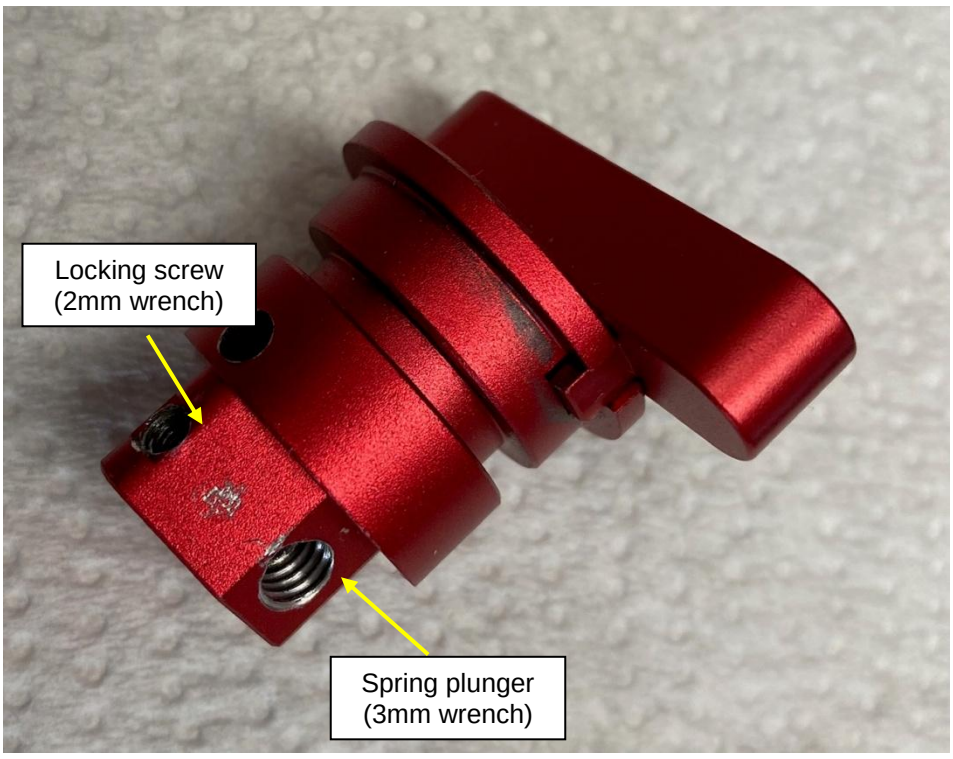
CEM70 gear meshing is designed to be adjustable by customer based on the payload. If you experiences a DEC/RA motor stall occasionally, or there is free play between the worm and ring gear, follow this instruction to adjust the gear meshing.

Toll needed: 2mm and 3mm hex key

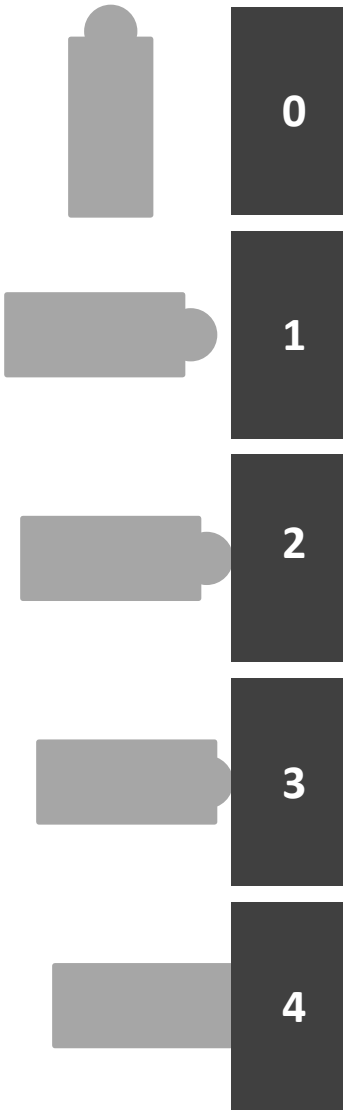
1. Gear Switch

iOptron Gear Switch uses a spring plunger to apply the force on worm assembly to push the worm against the ring gear for gear meshing. It has a tuning knob, body, threaded spring plunger, positioning spring and ball bearing.





2. Spring plunger position related to meshing result



Disengaged position

Not touched. There will be free play

Just touched. Minimum meshing force. No free play

Engaged position. Normal operation position

Plunger adjusted too much. Ball had been pushed all the way in and no spring loading power

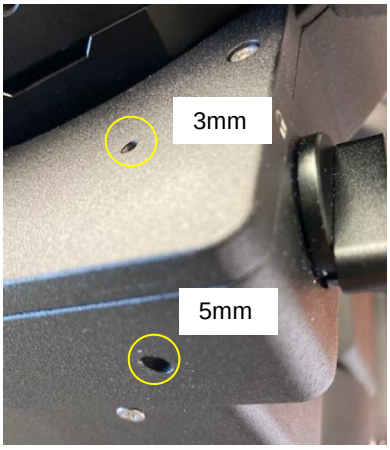
The gear switch should be adjusted to a position that between 2 and 4.

3. Gear Switch Meshing Adjustment

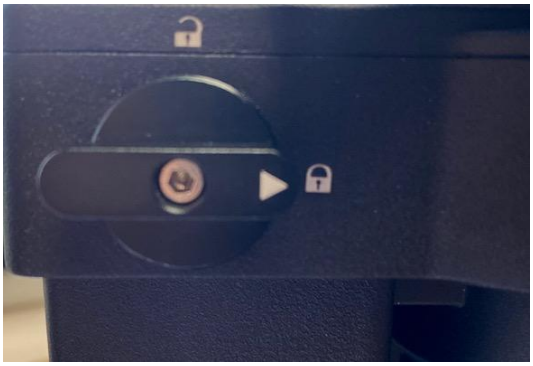
To Adjust DEC Gear:

Disengage DEC gear switch

Rotate DEC saddle to exposure the small hole (3mm in diameter) that is blocked by the dovetail saddle. Another larger hole (5mm) is located on the side of the DEC gear housing. There is a **set screw** inside the 3mm hole which locks the **gear meshing adjustment screw**, which is inside the larger hole.



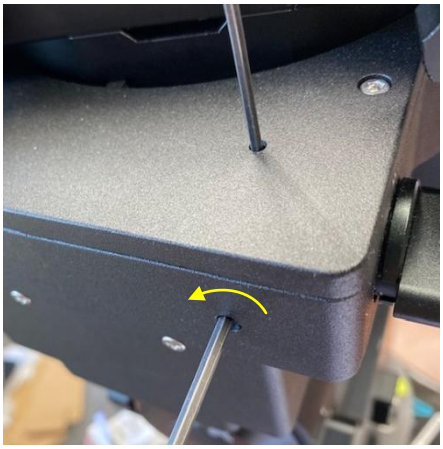
Engage the worm/gear by turn the gear switch to locking position.



Insert the 2mm hex key into the small hole on the top. Gently turn the hex key until you feel it is engaged to the set screw inside. You may turn the gear switch further in the lock position if the wrench can't engage the set screw. Turn the **set screw** half a turn counterclockwise to release it.

Adjust the **gear adjustment screw** on the side inside the large hole by using the 3mm hex key. Turn counterclockwise to loosen the meshing or turn clockwise to tighten the meshing.

DO NOT over tighten the gear meshing adjustment plunger to avoid damage it.

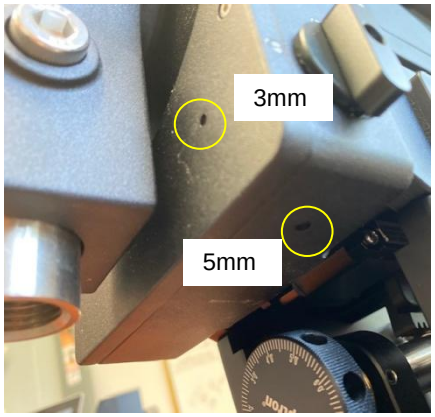


If the motor stalls or the mount does not tracking smoothly, most likely the meshing is too tight. You may loosen it by about 1/8 turn (or less for tracking). ***Tighten the set screw in the small hole to LOCK the gear screw (important) before test the mount.*** Adjust again if needed, but no more than ¼ turn in total.

If you feel there is free play between the worm and gear, you may tighten the gear screw to eliminate it.

To Adjust RA Gear:

The RA gear meshing adjustment screw is located next to the RA Gear Switch. The adjustment is same as that for DEC gear/worm.



Please contact support@ioptron.com if you need more information.

Appendix E. Polar Alignment using iPolar Electronic Polar Scope

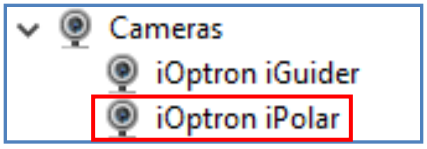
Connect iPolar to a PC and Download iPolar Software

(1) Connect the iPolar Electronic Polar Scope to your PC USB port;

For CEM70 mount with USB 3.0, plug a USB cable into the USB3.0 port on the rear end of mount RA axis or on the mount base panel to connect the iPolar to a computer.

For CEM70/CEM70EC, plug a USB cable into the iPolar port on the rear end of mount RA axis to connect the iPolar to a computer.

(2) The iPolar driver will be automatically installed if it is the first time connecting to the computer;
(3) You should see “iOptron iPolar” under Camera catalog in computer Device Manager;



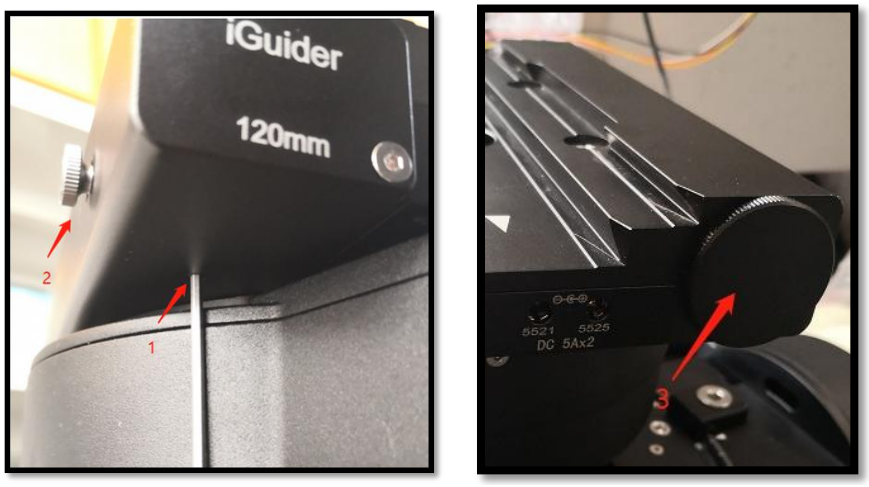
(4) Goto www.ioptron.com to download iPolar software and save on your computer;
(5) The iPolar software needs Windows 7, 8.1, 10 or later version, 64 bit operation system, with .NET Framework 4.8 or later version installed and .Net 3.5 enabled.

Please refer to iPolar #3339 product page for latest firmware and Instruction Manual:

iPolar Software: https://www.ioptron.com/v/firmware/3339_iOptron_iPolar.exe
Instruction Manual: https://www.ioptron.com/v/manuals/3339_iPolarOperationManual.pdf

Appendix F. iGuider for CEM70G

CEM70G has a built-in iOptron iGuider™ guiding system. It includes a 30mm diameter and 120mm focal length guiding scope and a Windows based driverless guiding camera.



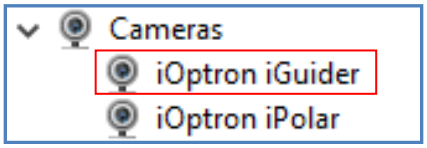
1. Focus adjuster locking screw (2mm hex), 2.Focus adjuster, 3.Lens cover

The iGuider only support ASCOM guiding (**no ST-4 connection**). Please install iGuider ASCOM driver from iOptron website. PHD2 guiding software also has the camera included.

1. Connect iGuider to a PC

The iGuider guiding system is connected internally to through USB3.0 port.

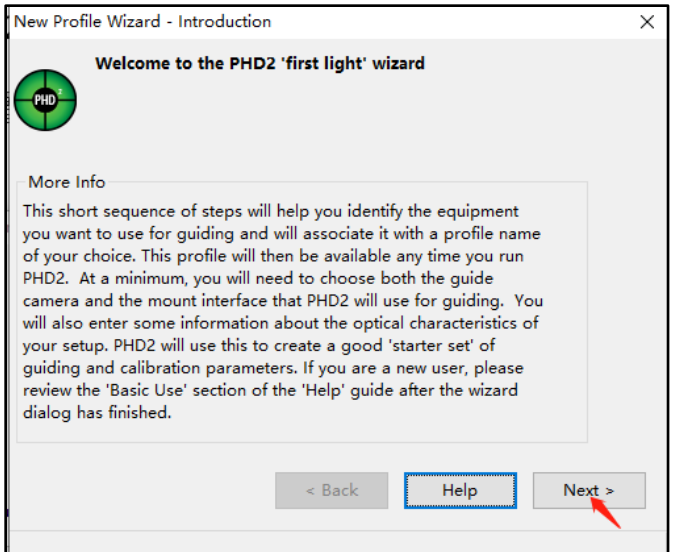
Connect the mount to a PC via main USB port. Check your PC device list via Device Manager, you should see an iOptron iGuider under the Camera.



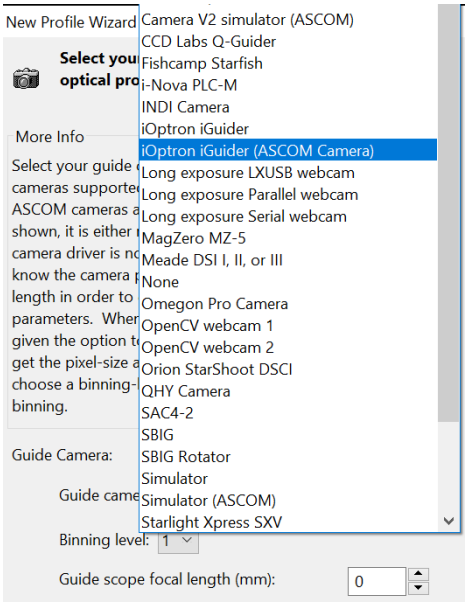
2. Setup PHD2 Guiding

Download freeware PHD2 autoguiding software from https://openphdguiding.org/downloads/. Please select V2.6.7 or later version.

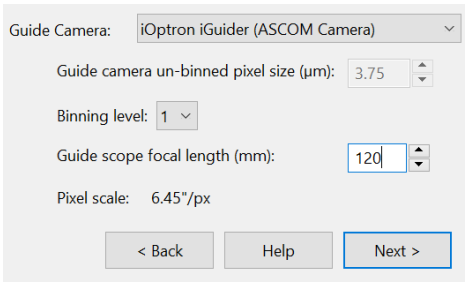
Start the PHD2 to start New Profile Wizard:



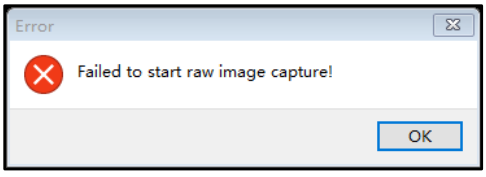
Click on Next. Select “iOptron iGuider (ASCOM Camera)” from the camera selection menu.



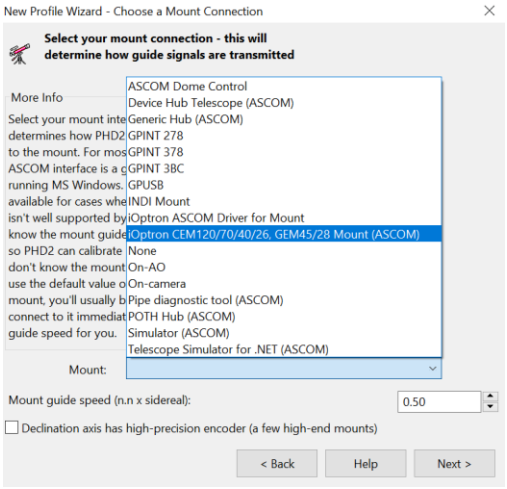
PHD2 will fill the pixel size (3.75um) automatically, if the camera is connected to the computer Enter 120mm into guide scope focal length tab, and click ***Next***.



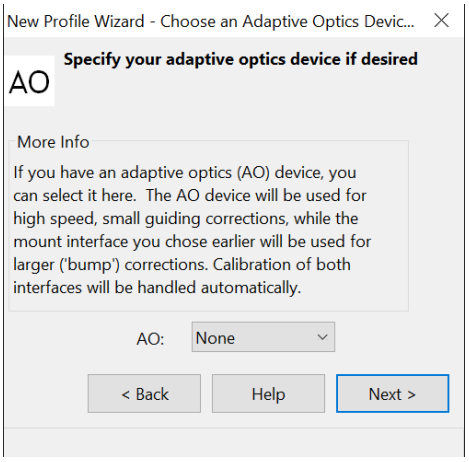
If the program displays the following error, please exit “iOptron iPolar” software.



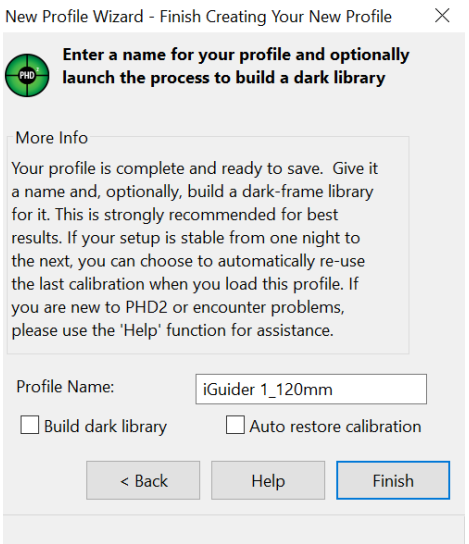
Select a mount that connected to the computer via ASCOM from the dropdown menu. Here "***iOptron CEM120/70/40/26,GEM45/28 Mount (ASCOM)***" is selected. A default guiding speed is 0.5X. Click ***Next***.



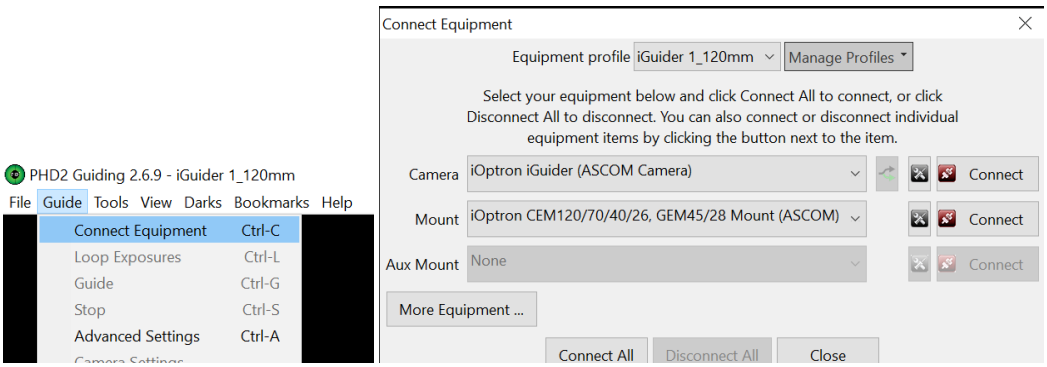
In next Adaptive Optics Device setting window, select ***None*** and go to ***Next***.



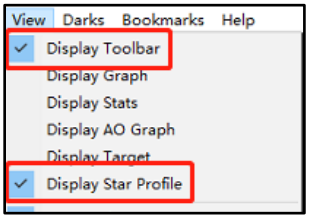
Save the Profile Name. Do not check ***Build dark library***. You may do it at a late time. Click ***Finish*** to complete the Profile setup.



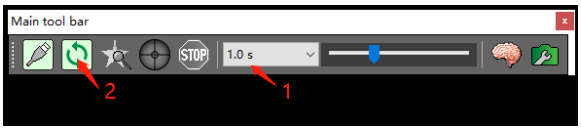
Click on Guide/Connect Equipment and connect all the devices.



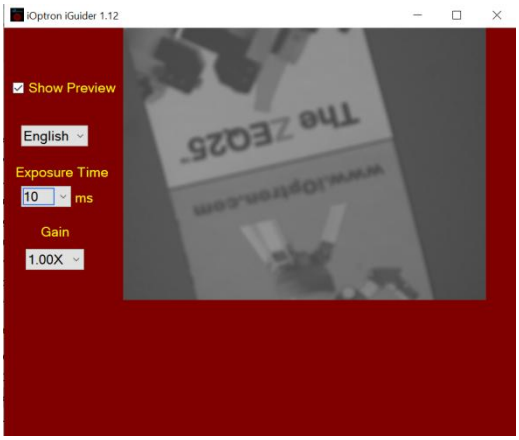
To view the image via iGuider, check "***Display Toolbar***" and "***Display Star Profile***" in ***View*** menu.



Select proper "***Exposure Time***" in ***Main tool bar*** and click on "***Continues Exposure***", you should see star images in the main window. Make sure you remove the lens cover.



You may also check the iGuider camera during daytime by checking ***Show Preview*** in iOptron iGuider ASCOM window. Adjust ***Exposure Time*** and focuser to show the image.



3. iGuider Focus Adjustment

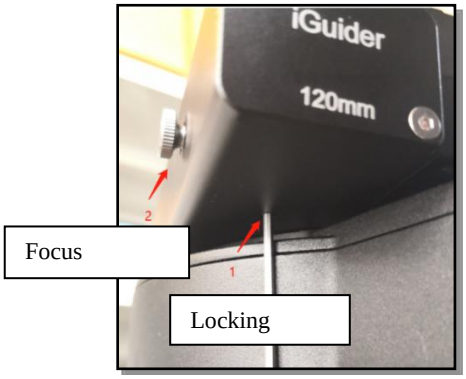
If you are using the iGudier the first time, you may need to adjust the guiding camera focusing.

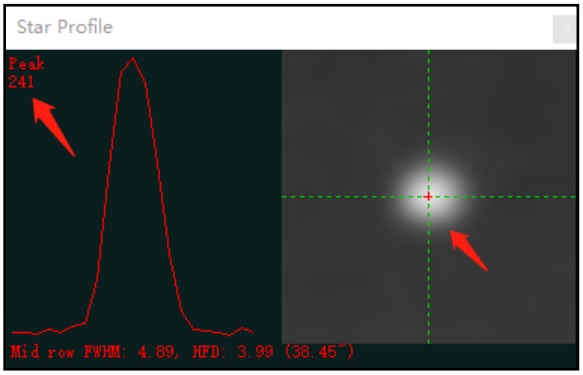
Set up the mount. Connect the mount to a computer. Perform polar alignment. Set the Zero Position.

To adjust iGuider focus:

(1) Manually slew in DEC to expose the Locking Screw. Loosen it first.
(2) Remove iGuider lens cover.
(3) Run PHD2 software and select "***iOptron iGuider (ASCOM Camera)***"

(4) Go to a bright star
(5) Turn the Focus Adjuster CCW to loosen it a little bit. Slide the Focus Adjuster to adjust the focus and bring the star to be shown in the main window.
(6) Click on the star to look at the ***Star Profile***. Fine adjusting the Focus Adjuster to bring the ***Peak*** to maximum value. Turn Focus Adjuster CW to tighten it.
(7) Slew the DEC to expose the Locking Screw if it is blocked by the DEC gear box. Tighten the Locking Screw.





4. Specifications

Guiding scope aperture	30mm
Focal length	120mm
Imaging sensor	1/3 in CMOS
Pixel size	3.75µm
Resolution	1280X960
Operation system	Windows (driverless)

Appendix G. Firmware Upgrade

The firmware in the 8410 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 CEM70 for details.

Both mount and hand controller firmware is upgraded via USB port on the mount.

Appendix H. Computer Control a CEM70 Mount

A CEM70 mount can be connected to a computer via the USB connection. If the mount has a built-in Wi-Fi, it can be connected via Wi-Fi connection as well. A mount can be connected to a SmartPhone, a Tablet, or a Computer via the USB and/or Wi-Fi connection

- Connect to a computer via USB port on the mount main board using a USB cable. You may need to install a FTDI USB to RS232 VCP driver (https://www.ftdichip.com/Drivers/VCP.htm). The mount can be controlled via ASCOM protocol (Windows OS), or directly by some software, such as Sky Safari (Mac OS).
- Connect wirelessly via a CEM70 mount internal Wi-Fi adapter. The mount can be controlled via ASCOM protocol (Windows OS), SmartPhone/Pad and Mac OS wirelessly.

To control the mount via ASCOM protocol, you'll need:

1. Download and install the latest ASCOM Platform, currently 6.6 SP1, from http://www.ascom-standards.org/. Make sure your PC meets the software requirement.
2. Download and install the latest iOptron Telescope ASCOM/Commander for CEM70 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 details.

IOPTRON TWO YEAR TELESCOPE, MOUNT, AND CONTROLLER WARRANTY

A. iOptron warrants your telescope, mount, or controller to be free from defects in materials and workmanship for two years. iOptron will repair or replace such product or part which, upon inspection by iOptron, is found to be defective in materials or workmanship. As a condition to the obligation of iOptron to repair or replace such product, the product must be returned to iOptron together with proof-of-purchase satisfactory to iOptron.

B. The Proper Return Merchant Authorization Number must be obtained from iOptron in advance of return. Contact iOptron at support@ioptron.com to receive the RMA number to be displayed on the outside of your shipping container.

All returns must be accompanied by a written statement stating the name, address, and daytime telephone number of the owner, together with a brief description of any claimed defects. Parts or product for which replacement is made shall become the property of iOptron.

The customer shall be responsible for all costs of transportation and insurance, both to and from the factory of iOptron, and shall be required to pre-pay such costs.

iOptron shall use reasonable efforts to repair or replace any telescope, mount, or controller covered by this warranty within thirty days of receipt. In the event repair or replacement shall require more than thirty days, iOptron shall notify the customer accordingly. iOptron reserves the right to replace any product which has been discontinued from its product line with a new product of comparable value and function.

This warranty shall be void and of no force of effect in the event a covered product has been modified in design or function, or

subjected to abuse, misuse, mishandling or unauthorized repair. Further, product malfunction or deterioration due to normal wear is

not covered by this warranty.

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Some states do not allow the exclusion or limitation of incidental or consequential damages or limitation on how long an implied warranty lasts, so the above limitations and exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

iOptron reserves the right to modify or discontinue, without prior notice to you, any model or style telescope.

If warranty problems arise, or if you need assistance in using your telescope, mount, or controller contact:

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Woburn, MA01801
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Tel. (781)569-0200
Fax. (781)935-2860
Monday-Friday 9AM-5PM EST

NOTE: This warranty is valid to U.S.A. and Canadian customers who have purchased this product from an authorized iOptron dealer in the U.S.A. or Canada or directly from iOptron. Warranty outside the U.S.A. and Canada is valid only to customers who purchased from an iOptron Distributor or Authorized iOptron Dealer in the specific country. Please contact them for any warranty.