iOptron® CEM120 Center-Balanced Equatorial Mount

Instruction Manual

Product #7300, #7301 & #7302
Read the Instruction BEFORE setting up and using the mount! Worm/gear system damage due to improperly use will not be covered by 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.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table of Contents</td>
<td>3</td>
</tr>
<tr>
<td>1. CEM120 Introduction</td>
<td>6</td>
</tr>
<tr>
<td>2. CEM120 Terms</td>
<td>7</td>
</tr>
<tr>
<td>2.1. Parts List</td>
<td>7</td>
</tr>
<tr>
<td>2.2. Identification of Parts</td>
<td>8</td>
</tr>
<tr>
<td>2.3. CEM120 Mount Basic Cable Connection</td>
<td>9</td>
</tr>
<tr>
<td>2.4. CEM120 Cable Management</td>
<td>9</td>
</tr>
<tr>
<td>2.5. Go2Nova® 8407+ Hand Controller</td>
<td>12</td>
</tr>
<tr>
<td>2.5.1. Key Description</td>
<td>12</td>
</tr>
<tr>
<td>2.5.2. The LCD Screen</td>
<td>13</td>
</tr>
<tr>
<td>2.6. Check the Battery</td>
<td>14</td>
</tr>
<tr>
<td>3. CEM120 Mount Assembly</td>
<td>15</td>
</tr>
<tr>
<td>4. Getting Started</td>
<td>23</td>
</tr>
<tr>
<td>4.1. Setting the Mount and Performing Polar Alignment</td>
<td>23</td>
</tr>
<tr>
<td>4.2. Manual Operation of the Mount</td>
<td>23</td>
</tr>
<tr>
<td>4.3. Push-to Operation of the Mount</td>
<td>23</td>
</tr>
<tr>
<td>4.4. The mount can now be used to observe astronomical objects using the HC. Use the arrow keys Initial Star Alignment</td>
<td>23</td>
</tr>
<tr>
<td>4.5. GOTO the Moon and Other Objects</td>
<td>24</td>
</tr>
<tr>
<td>4.6. Star Identification Function</td>
<td>24</td>
</tr>
<tr>
<td>4.7. Power-Down Memorization</td>
<td>24</td>
</tr>
<tr>
<td>4.8. Turning Off the Mount</td>
<td>24</td>
</tr>
<tr>
<td>5. Complete Functions of Go2Nova® 8407+ Hand Controller</td>
<td>25</td>
</tr>
<tr>
<td>5.1. Select and Slew</td>
<td>25</td>
</tr>
<tr>
<td>5.1.1. Solar System</td>
<td>25</td>
</tr>
<tr>
<td>5.1.2. Deep Sky Objects</td>
<td>25</td>
</tr>
<tr>
<td>5.1.3. Stars</td>
<td>25</td>
</tr>
<tr>
<td>5.1.4. Comets</td>
<td>25</td>
</tr>
<tr>
<td>5.1.5. Asteroids</td>
<td>25</td>
</tr>
<tr>
<td>5.1.6. Constellations</td>
<td>25</td>
</tr>
<tr>
<td>5.1.7. Custom Objects</td>
<td>25</td>
</tr>
<tr>
<td>5.1.8. Customer R.A. and DEC</td>
<td>26</td>
</tr>
<tr>
<td>5.2. Sync to Target</td>
<td>26</td>
</tr>
<tr>
<td>5.3. Alignment</td>
<td>26</td>
</tr>
<tr>
<td>5.3.1. Position of Polaris/SigmaOct</td>
<td>26</td>
</tr>
<tr>
<td>5.3.2. One Star Alignment</td>
<td>26</td>
</tr>
<tr>
<td>5.3.3. Two Star Alignment</td>
<td>26</td>
</tr>
<tr>
<td>5.3.4. Three Star Alignment</td>
<td>26</td>
</tr>
<tr>
<td>5.3.5. Solar System Align</td>
<td>27</td>
</tr>
<tr>
<td>5.3.6. Polar Iterate Align</td>
<td>27</td>
</tr>
<tr>
<td>5.3.7. View Model Error</td>
<td>27</td>
</tr>
<tr>
<td>5.3.8. Clear Alignment Data</td>
<td>27</td>
</tr>
<tr>
<td>5.4. Settings</td>
<td>28</td>
</tr>
<tr>
<td>5.4.1. Set Time and Site</td>
<td>28</td>
</tr>
<tr>
<td>5.4.2. Beep Settings</td>
<td>28</td>
</tr>
<tr>
<td>5.4.3. Display Settings</td>
<td>28</td>
</tr>
<tr>
<td>5.4.4. Set Guiding Rate</td>
<td>28</td>
</tr>
</tbody>
</table>
Instruction for CEM120 Gear Switch and Axle Locking Knob

Both RA and DEC have the same Gear Switch and Axle Locking Knob, the operations are the same.

As an example, here are the positions for the Gear Switch and Axle Locking Knob for RA axis:

A: When transferring or installing the mount, lock the Axle Locking Knob 🗝️ and disengage the Gear Switch 🕵️‍♂️ So the RA won’t swing and there is no force applied onto the worm/ring gear.

B: During mount balancing process, pull and turn the Axle Locking Knob to release it 🗝️ and leave the Gear Switch at disengaged position 🕵️‍♂️ Now the mount will swing freely in RA direction.

C: During normal operation of the mount, i.e., GOTO and tracking, turn the Gear Switch to locking position 🕵️ to engage the worm/ring gear while leave the Axle Locking Knob released 🗝️.

ONLY set the Gear Switch at locking position to engage the worm/ring gear during goto, slew or tracking.

ALWAYS lock the Axle Locking Knob during transferring and installing.

DO NOT lock both Gear Switch and Axle Locking Knob at the same time.
1. CEM120 Introduction

Welcome to a new type of equatorial mount – the iOptron® Center-Balanced Equatorial Mount, or CEM! It offers the benefits of our revolutionary "center balance" design: stability, accuracy, and smooth mechanical operation, while capable of carrying a payload up to 115 lbs (52 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 CEM120's performance is demonstrated by its low periodic tracking error: <±3.5 arc seconds for CEM120 and <0.15 arcsec RMS for CEM120EC/CEM120EC2. Along with the stability aspect, the CEM120 features an advanced cable management system consisting of more ports in more locations preventing tangle ups and reducing the chance of fractured cables. It also adds some new features to the CEM family like Wi-Fi and LAN for remote operation and easy to use, reliable clutches on both axes.

The CEM120 family has three versions: CEM120 standard version (#7300), CEM120EC (#7301) with high precision optical encoder on RA axis, and CEM120EC2 (#7302) with high precision optical encoders on both RA and DEC axes.

The CEM12 mount is equipped with the most advanced GOTO NOVA® GOTO technology, making it one of the most powerful and accurate GOTO mounts available. The Go2Nova® 8407+ hand controller has a database of over 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
- Observatory astrophotography mount ideal for both visual and Astro-photographers
- Payload of 115 lbs (52 kg) with the mount weight of 57 lbs (26 kg)
- Easy to use and reliable gear clutches
- Precision altitude and azimuth adjustment.
- Precision stepper motor with 0.07 arcsec accuracy for precise GOTO and accurate tracking
- Polar alignment routine for those who can’t see the Pole Star
- Go2Nova® 8407 V2 controller with Advanced GOTO NOVA® GOTO Technology with built in heater
- High precision tracking with low periodic error: PE<±3.5 arcsec for #7300, or PE <0.15 arcsec RMS for #7301/#7302
- Permanent periodic error correction (PPEC) (#7300) or Real-time periodic error correction (RPEC) (#7301/#7302)
- Push-to operation for CEM120EC and CEM120EC2
- Built-in 32-channel Global Positioning System (GPS)
- Built-in WiFi and LAN for remote operation
- 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
- Spring loaded, individual adjustable Losmandy saddle
2. CEM120 Terms

2.1. Parts List

SHIPPING CONTENTS

Your new CEM120 mount comes in two shipping boxes. One box contains either a CEM120 (#7300), CEM120EC (#7301) or CEM120EC2 (#7302) mount head, hand controller, and accessories. The other box contains a 22lb (10kg) counterweight and counterweight shaft. The contents are:

- 1X iOptron® CEM120 telescope mount (#7300, with silver adjustment knobs), iOptron® CEM120EC mount (#7301, high precision model with red adjustment knobs), or iOptron® CEM120EC2 mount (#7302, dual high precision model with red adjustment knobs)
- 1X Go2Nova® 8407 V2 Hand Controller
- 1X 22lb (10 kg) counterweight
- 1X Stainless steel counterweight shaft
- 1X 12V/5A AC/DC adapter (100V-240V, with 2.5mmX5.5mm plug)
- 1X Hand Controller Cable (6P6C RJ11 to RJ11, straight wired)
- 1X Serial cable (RS232 to RJ9)
- 4X Base mounting screws
- 1X external GPS antenna
- 1X Wi-Fi external antenna

OPTIONAL PARTS

- iPolar electronic polar scope (#3339A-120)
- Low latitude counterweight (#7326LL)
- Pier top mounting plate
- USB to RS232 Converter with FTDI chipset (#8435)

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

- Dovetail Saddle
- Dovetail Locking Knob
- DEC Gear Switch
- DEC Axle Locking Knob
- RA Axis
- CW Shaft Mounting House
- CW Shaft
- CW Shaft Safety Lock
- Counterweight
- AZI Adjustment Knob
- Base Mounting Screw
- Mount Base
- ALT Adjustment Knob
- Mount Basic Ports
- RA Axle Locking Knob
- RA Gear Switch
- ALT Locking Clamp
- Cable management Output Panel
- Cable management Input Panel

Figure 1. CEM120 mount assembly
2.3. CEM120 Mount Basic Cable Connection

The basic cable connection ports of a CEM120 mount are all located on the mount base, as shown in Figure 2.

![Figure 2. Ports on a CEM120 mount base](image)

- DC 12V 5A: DC power socket to power the mount (2.5mm x 5.5mm, 5525)
- ON/OFF: Power Switch
- HBX (Hand Box): For connecting to an 8407 Hand Controller
- RS232: Serial port for mount computer control and firmware upgrade
- USB: USB port for mount computer control
- LAN: network connection for remote control
- WiFi: Mini coaxial cable connector for WiFi antenna
- GPS: Mini coaxial cable connector for GPS external antenna

2.4. CEM120 Cable Management

The CEM120 mount has a pre-wired Cable Management System that allows the user to connect their accessories and imaging equipment without cables tangling or snagging when the mount is slewing or tracking. The Cable Management Outputs are located at the back of the dovetail saddle, as shown below.

![Figure 3. Connects at the end of the dovetail saddle](image)

- USB 2.0 x 4: 4 USB 2.0 ports with standard type A connectors for connecting accessories (un powered). They were connected to the USB2.0 input on Input Panel.
- GUIDE: port for autoguiding with ST-4 cable. The wiring is shown in Figure 4.
- AUX (OUT): A DIN-422 port for high power or other connection purpose. It is connected to the AUX (IN) port on Input Panel.
- **iPORT**: for iOptron compatible accessories, such as electrical focuser.
- **USB 3.0**: Powered USB 3.0 port. It is connected to the USB3.0 input on the Input Panel.
- **5521 5V1A socket**: a 2.1mmX5.5mm 5V DC power output for accessories. Maximum 1A, center positive. This is provided by mount DC 12V power.

On the side of the dovetail saddle, there are 4 power output sockets:

- **5521 12V1A socket X2**: There are two 12V1A DC output sockets on the right end side of the dovetail saddle, with 2.1mmX5.5mm, center positive sockets. They are provided by mount DC 12V power.
- **On the left end side of the dovetail saddle**, there are one 5525 (2.5mmx5.5mm) and one 5521 (2.1mmX5.5mm) DC output sockets for your accessories. The maximum specified current output is 5A. They are connected to the DC IN 10 port on the Input Panel. The voltage is determined by the input voltage, such as V, 12V or 24V.
The ports on the Cable Management Panel are connected to the Input Panel located at the end of the mount RA axis, as shown in Figure 7:

- 1X DC IN 10A power input (2.5mmX5.5mm, 10A max.)
- 1X USB 2.0 port with a standard type B connector
- 1X USB 3.0 port
- 1X AUX IN port (for data or extra power input)
- iPolarScope port for electronic polar scope connection
2.5. Go2Nova® 8407+ Hand Controller

The Go2Nova® 8407+ hand controller (HC) shown in Figure 8 is the standard controller used on the CEM120 mount. It has an integrated heater that ensures the LCD display will work at the temperature as low as -20°C(-4°F). It has a large LCD screen, function, direction, and number keys on the front; a red LED reading light on the back; and a HBX (6-pin) and a serial port (4-pin) at the bottom.

2.5.1. 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.
Serial port: connect the HC to a computer via a RS232 to 4P4C RJ9 cable. The pin-out of the serial port is shown in Figure 9.

![Serial port pin-out on an 8407+ hand controller](image)

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

### 2.5.2. The LCD Screen

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

![8407+ HC LCD Information Screen](image)

Figure 10. 8407+ HC LCD Information Screen

1. **Target Name/Mount Position:** displays the name of the target that telescope is currently pointed to or the current mount position.
   - Zero Position: The reference position for GOTO. The mount can move to Zero Position using “Goto Zero Position” or “Search Zero Position” command;
   - User Position: The mount is pointed to a user defined position, which could be a particular celestial object or simply a position determined by pressing an arrow key;
   - An object name, such as “Mercury” or “Andromeda Galaxy”: Name of the star or celestial object that the mount is currently slewing to or tracking.

2. **Target R.A.:** Right Ascension (R.A.) of the target object.
3. **Target Declination:** Declination (DEC) of the target object.
4. **Right Ascension:** Current R.A. of the telescope.
5. **Declination:** Current DEC of the telescope.
6. **Altitude:** Altitude of the telescope (degrees vertical from the local horizon - zenith is 90°).
7. **Azimuth:** Azimuth of the telescope (north is 0°, east is 90°, south is 180°, and west is 270°).
8. **Local Date and Time:** displays the local time in a format of YY-MM-DD HH:MM:SS.
9. **Mount Status:** Displays the current operational status of the mount.
   - Stop: mount is not moving;
- Slew: mount is moving with an arrow key is pressed or a GOTO command, such as “Select and Slew” or “Goto Zero Position”;
- Tracking: mount is at a tracking status.

10. GPS status: When the power is turned on, the initial GPS status will be “GPS ON”, which means that the mount is connected to its GPS receiver and is seeking a satellite signal. When the GPS receiver finds the satellites and receives the GPS signal the status will change to “GPS OK”.

11. PEC status: Display of “PEC” here Indicates the Periodic Error Correction playback is turned on. Default is off.

12. Tracking speed: Displays the current tracking rate of the mount.
   - SDRL: mount is tracking at sidereal speed;
   - Solar: mount is tracking at solar speed;
   - Lunar: mount is tracking at lunar speed;
   - King: mount is tracking at king speed;
   - CSTM: mount is tracking at a custom, user-defined speed.


14. Operation Mode: EQ indicates that the mount is operating in an equatorial mode.

### 2.6. Check the 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 battery is a 3V, CR1220 button battery.
3. CEM120 Mount Assembly

STEP 1. Attach the Mount

Make sure that the RA axle is at the locking position (*please refer to the charts on page 5*). Remove the mount from the package. Put it onto a pier/tripod top and secure it with four included Base Mounting Screws.

![Figure 11. (a) Attach the mount, and (b) mount base dimension](image)

Because of the total weight of the mount, counterweight and payload, we recommend use your own pier for the mount. The base dimension is shown in

STEP 2. Install the Counterweight (CW) Shaft

Hold the mount head with one hand. Pull the RA Axle Locking Knob outward to disengage the lock. Slowly rotate the mount RA 90 degree to level position. Release the RA Axle Locking Knob to lock the RA axis again.

![Figure 12. Install CW shaft](image)
Remove the CW shaft from the package and threaded it onto the CW shaft mounting house. **DO NOT** release the RA Axle Lock before the CW shaft is fully threaded in. The CW shaft is designed to balance the mount head weight.

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

**STEP 3. Adjust Altitude**

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

Slightly loosen the Altitude Locking Clamps about a quarter (1/4) turn with a 5mm 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 13. 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.

The mount latitude adjustment range is from 0° to 68°. **For those low latitude places between 0° to 10°, special low latitude CWs (#7326LL) are needed.**

When adjusting altitude, pay attention to the cables that go through under the mount. Make sure they are not jammed between the moving parts.
STEP 4. Install the Counterweight(s) and Telescope

Before installing the Counterweight(s), make sure that mount is at Zero Position, i.e., CW shaft is pointing to ground. Both R.A. and DEC Axle Locking Knobs are at the locking position (refer to Illustration A on page 5).

Remove the CW Safety Cap at the end of CW Shaft. Guide the CW over the shaft. Tighten the CW Locking Screw to hold the CW in place. Place the Safety Cap back onto the shaft.

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

![Figure 16. Loading counterweight](image)

You may need more CWs for heavier payload, or smaller size CW for lighter scope.

The CEM120 has a Losmandy-D dovetail saddle plate, as shown in Figure 17. Release the dovetail saddle locking knobs and slide the telescope dovetail plate into the saddle. Tighten the saddle locking knob.

![Figure 17. CEM120 dovetail saddle plate](image)
There are 3 sets of mounting holes on the dovetail saddle that you can move it back and forth in case something on the telescope, such as the mounting ring, is blocked by the dovetail locking screws.

Figure 18. CEM120 dovetail saddle position adjustment

STEP 5. 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 during the balancing process. Always hold on to the mount and/or telescope assembly before releasing the Axle Locking Knob and/or Gear Switches to prevent it from swinging, which can cause personal injury and/or equipment damage.

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

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

Return the mount to the Zero Position after balancing; i.e., the CW shaft points to ground, and the telescope tip is at its highest position.

STEP 6. Connect Cables

Plug in a 12V DC power supply to the DC12V POWER socket; connect the Go2Nova® 8407 Hand Controller to the HBX port on the mount side panel; and install Wi-Fi antenna (right angle one) and GPS antenna, as shown in .
STEP 7. Setup Hand Controller

The CEM120 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 which need to be entered to reflect your location, such as time zone information and whether daylight saving time is currently in effect. This information will be stored in the mount until they need be updated.

The GPS with an external antenna 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**”:

<table>
<thead>
<tr>
<th>Select and Slew</th>
<th>Sync. to Target</th>
<th>Alignment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Settings</strong></td>
<td>Electric Focuser</td>
<td>PEC Options</td>
</tr>
<tr>
<td>Park Telescope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edit User Objects</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Set Time and Site</th>
<th>Beep Settings</th>
<th>Display Settings</th>
<th>Set Guiding Rates</th>
<th>Set Tracking Rate</th>
<th>Set Parking Position</th>
<th>Meridian Treatment</th>
<th>Set Altitude Limit</th>
</tr>
</thead>
</table>

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

- **Daylight Saving Time**: Y
- **UTC -300 Minute(s)**: 2014-03-09 10:19:18
- **Longitude**: W071°08’50”
- **Latitude**: N42°30’32”
- **Northern Hemisphere**
**Set Local Time**

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

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

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

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

<table>
<thead>
<tr>
<th>Time Zone</th>
<th>Hawaii</th>
<th>Alaska</th>
<th>Pacific</th>
<th>Mountain</th>
<th>Central</th>
<th>Eastern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hour behind UT</td>
<td>-10</td>
<td>-9</td>
<td>-8</td>
<td>-7</td>
<td>-6</td>
<td>-5</td>
</tr>
<tr>
<td>Enter UTC</td>
<td>-600</td>
<td>-540</td>
<td>-480</td>
<td>-420</td>
<td>-360</td>
<td>-300</td>
</tr>
</tbody>
</table>

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

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

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

**Set Observation Site Coordinates**

The third and fourth lines display the longitude and latitude coordinates respectively. The longitude and latitude coordinates will be automatically updated when the GPS picks up a satellite signal. “W/E” means Western/Eastern Hemisphere; “N/S” means Northern/Southern Hemisphere; “d” means degree; “m” means minute; and “s” means second.

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

The site coordinates information can be found from your smart phone, GPS receiver or via the internet. Site information in decimal format can be converted into d:m:s format by multiplying the decimal numbers by 60. For example, N47.53 can be changed to N47°31’48": 47.53° = 47° +0.53°, 0.53°=0.53x60’=31.8’, 0.8’=0.8x60”=48”. Therefore, 47.53°=47°31’48” 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 North, or Southern Hemisphere if the polar axis is pointing to South.

STEP 8. Polar Alignment

In order for an equatorial mount to track properly, it has to be accurately polar aligned. A CEM120 mount does not come with an optical polar scope. There are a few ways to perform the polar alignment.

**Polar Alignment Software**

There are quite a few alignment software available or polar alignment, such as TPoint with The Sky software, PemPro, or Alignmaster

**Optional Electronic Polar Scope**

A CEM120 has a built-in USB connection (iPolarScope port) for an electronic polar scope. One can install iOptron iPolar electronic polar scope (#3339A-120) for quick polar alignment.

![Figure 20. CEM120 with an installed iPolar electronic polar scope](image)

**BrightStar Polar Alignment/Polar Iterate Align**

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

1. Level the CEM120 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.

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:** The movement of the alignment star in your eyepiece may not be perpendicular but crossed, depends on its location in the sky.
STEP 9. Return Mount to Zero Position

After polar alignment and balancing OTA, return the mount to the Zero Position. The Zero Position is achieved when the CW shaft is pointing towards the ground, with the OTA/dovetail at its highest position, its axis parallel to the polar axis, and the OTA pointing to the Celestial Pole.


Please set the zero position if it is the first time using the mount, or the firmware just being updated. You can always check the Zero Position by using MENU=>”Zero Position”=>”Goto Zero Position” before each session.
4. Getting Started

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

4.1. Setting the Mount and Performing Polar Alignment

Assemble your CEM120 mount according to Section Error! Reference source not found.. Make sure the mount is leveled. Mount an OTA and accessories, and carefully balance the mount on both R.A. and DEC axes. Turn the mount power switch on. When the GPS receiver is connected to satellites, the hand controller LCD will display GPS OK and the mount will have the correct time and site information (this can also be entered manually as previously described). Polar align the mount.

Always check if the mount is at the Zero Position when the mount is powered on, i.e. with the counterweight shaft pointing to ground, OTA at the highest position with its axis parallel to the polar axis and the telescope pointing to the Celestial Pole. Press MENU => “Zero Position” => “Goto Zero Position” to check it. If the mount is not at the Zero Position, press MENU => “Zero Position” => “Set Zero Position.” Release the Gear Switch to manually return the mount to Zero Position, or use the hand controller to slew the mount to Zero Position. Press ENTER to confirm the zero position.

4.2. Manual Operation of the Mount

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

4.3. Push-to Operation of the Mount

Both CEM120EC and CEM120EC2 can be operated for push-to on the axis that is equipped with a high precision encoder. You may push-to the RA axis of a CEM120EC mount, or both RA and DEC axes of a CEM120EC2 mount.

To operate the push-to function, make sure that the mount is not at the tracking status. If the mount is tracking, press STOP/0 button to stop tracking. Release the gear switch. Manually push the mount to a desired position. Lock the gear switch. Press the STOP/0 button to send the mount tracking again.

4.4. The mount can now be used to observe astronomical objects using the HC. Use the arrow keys Initial Star Alignment

Perform a simple one star alignment/synchronization after set up the hand controller to correct any pointing discrepancy of the Zero Position and to improve the GOTO accuracy.

To perform “One Star Align,” press MENU=>“Alignment”=>“One Star Align”=>ENTER. The screen will display a list of bright objects for you to select from. Select an object using ▲ or ▼ key. Then press ENTER. After the mount slews to the target, use the arrow keys to center it in your eyepiece. Then press ENTER. (More align details in 5.4)

An alternate way is to perform “Sync to Target.” Press MENU=>“Select and Slew”=>ENTER. Browse over the catalogs and select an object. Press ENTER. After the mount slews to the star, press MENU=>“Sync. To Target”, follow the on-screen instruction to center the star and press ENTER. You may need to use the number keys to change the slewing speed to make the centering procedure easier.
4.5. **GOTO the Moon and Other Objects**

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

To slew to the Moon press MENU=>"Select and Slew"=>"Solar System"=>Moon=>ENTER. The telescope will automatically slew to the Moon and lock on it. It will automatically begin to track once it locks on. If the Moon is not centered in your eyepiece, use the arrow keys to center the Moon. You may use “Sync to Target” to improve the tracking.

You may also select other bright celestial objects to start with, such as Jupiter or Saturn.

4.6. **Star Identification Function**

The 8407+ hand controller has a star identification function. After setting the correct local time and location and completing polar alignment, slew the telescope to a bright star manually or using the GOTO function. Press the Help(?) key to identify the star that the telescope is pointing to, as well as nearby bright stars if there is any.

4.7. **Power-Down Memorization**

The CEM120 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.

4.8. **Turning Off the Mount**

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

If the mount is set up on a pier or inside an observatory, it is recommended that you return the mount to the Zero Position or park the telescope. This will ensure that there is no need for you to perform the initial setup again.
5. Complete Functions of Go2Nova® 8407+ 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® 8407+ 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 E.
- 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 E.
- Double/Multi Stars: consists of 208 double/multi stars; a list is attached in Appendix E.
- 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 E.

5.1.7. Custom Objects

This allows the storage of up to 73 user-defined comets, and /or up to 64 stars/DSOs.
5.1.8. Customer R.A. and DEC

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

5.2. Sync to Target

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

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

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

5.3. Alignment

This function is used for aligning the telescope to the celestial pole and to create a sky model to calibrate the mount’s GOTONOVA® functionality. Please keep in mind that the sky can’t be modeled by only three stars. Choose different stars will result in different errors. For better results, planetarium software and/or plate solving is recommended.

The hand controller provides a polar alignment via “Polar Irate Align,” which uses a set of 2 bright. This also provides a viable polar alignment approach for those who can’t see the pole.

The system provides four alignment methods to calibrate the mount’s GOTO function: “Solar System Align”, “One Star Alignment”, “Two Star Alignment” and “Three Star Alignment”. The “Two Star Alignment” may be used to refine the polar alignment. The mount has to be at Zero Position before performing any alignment.

5.3.1. Position of Polaris/SigmaOct

This function displays the position of the Pole Star. In the Northern Hemisphere the position of Polaris is displayed, while in the Southern Hemisphere the position of Sigma Octantis is shown.

5.3.2. One Star Alignment

Press MENU => “Alignment” => “One Star Alignment.” A list of alignment stars that are above the horizon is computed based on your local time and location. With the mount in the Zero Position, use the▲ and ▼ buttons to select a star and press ENTER. Center the target in your eyepiece using the arrow keys. Press ENTER when finished. If your mount is set up correctly and polar aligned, one star alignment should be sufficient for good GoTo accuracy. Linear RA and DEC error will be displayed after one star alignment.

5.3.3. Two Star Alignment

Two Star Align can improve the accuracy of the mount’s polar alignment. Press MENU => “Alignment” => “Two Star Alignment” A list of alignment stars that are above the horizon is computed based on your local time and location. With the mount at the Zero Position, use the▲ and ▼ buttons to select the first alignment star and press ENTER. Center the target in your eyepiece using the arrow keys after the mount slews to it. Press ENTER when finished. The hand controller will prompt you to choose a second star. After centering the second star, the two-star alignment is finished.
After the two-star alignment, the altitude and azimuth errors will be displayed. This number can be used to fine tune the polar alignment.

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

5.3.4. Three Star Alignment

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

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

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

5.3.5. Solar System Align

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

5.3.6. Polar Iterate Align

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

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

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

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

5.3.7. View Model Error

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

5.3.8. Clear Alignment Data

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

5.4.1. Set Time and Site

Refer to STEP 7 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 allow 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.

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

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”.

Then the user can select “Sidereal Rate”, “Lunar Rate”, “Solar Rate”, “King Rate”, and “User Defined Speed”. The “User defined speed” can be adjusted from 0.1000X to 1.9000X of sidereal.

The “King Rate”, developed by Edward S. King, corrects the tracking rate of a telescope to account for atmospheric refraction. This is more useful for unguided tracking.

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 14° (1 hour) 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 a up position. The upward angle limit is same as the meridian flipping setting, or 14 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.

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 RA Guiding

The function is for CEM120EC only. You can turn off R.A. guiding by selecting “Filter R.A. Guiding” to allow the high precision encoder to correct the tracking error, or turn the R.A. guiding on by selecting “Allow RA Guiding” to allow the mount to receive guiding corrections from the guiding software. The power on default setting is “Allow RA Guiding”.

5.4.12. Network Options

This function will display WI-FI and LAN status.

- **Wireless Status**: displays WI-FI network parameter after a computer/tablet/SmartPhone connected to the mount. The CEM120 network SSID is HI-LINK_XXXX, password 12345678. If the status does not display, select and press Manual Refresh to refresh. Here is a example screen after connection:

  ```
  Wlan:AP
  SSID:HI-LINK_9E49
  IP:192.168.16.254
  PORT:8080
  MAC:08:EA:40:83:9E:48
  
  Press BACK to exit
  ```

- **Wired Status**: display LAN parameters after the mount is connected to a network/router. If the status does not display, select and press Manual Refresh to refresh. Here is a example screen after connection:

  ```
  ETH:AP
  IP:192.168.0.61
  PORT:8080
  MAC:08:EA:40:83:9E:49
  
  Press BACK to exit
  ```

- **Manual Refresh**: Refresh mount network parameter after connection.
- **Restart**: restart the network adapter
- **Restore to Factory**: restore the factory network setting

5.4.13. 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
5.4.14. Reset All Settings
Reset all the settings to factory default.

5.4.15. 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 standard CEM120 mount.

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

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

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

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

1. Setup the mount with a telescope in autoguiding configuration by connecting a guiding camera via the mount’s Guide Port or using the ASCOM protocol;
2. Select “MENU=>Settings => Set Guiding Rates”. Set a guiding speed from 0.10X to 0.90X. The default setting is 0.50X;
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 240 seconds to make one complete revolution. After 240 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:

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Year</th>
<th>M</th>
<th>Day</th>
<th>q</th>
<th>e</th>
<th>ω</th>
<th>Ω</th>
<th>i</th>
<th>H</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>C/2012 S1 ISON</td>
<td>2013</td>
<td>11</td>
<td>28.7960</td>
<td>0.0125050</td>
<td>1.0000030</td>
<td>345.5088</td>
<td>295.7379</td>
<td>61.8570</td>
<td>6.0</td>
<td>4.0</td>
<td></td>
</tr>
</tbody>
</table>

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:
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 CEM120 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 find
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

The CEM120 mount is designed to be maintenance free. Do not overload the mount. Do not drop the mount as this will damage the mount and/or permanently degrade GoTo performance and tracking accuracy. Use a wet cloth to clean the mount and hand controller. Do not use solvent.

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

6.2. iOptron Customer Service

If you have any question concerning your CEM120 mount contact iOptron Customer Service Department. Customer Service hours are from 9:00 AM to 5:00 PM, Eastern Time, Monday through Friday. In the event that the CEM120 requires factory servicing or repairing, write or call iOptron Customer Service Department first to receive an RMA# before returning the mount to the factory. Please provide details as to the nature of the problem as well as your name, address, e-mail address, purchase information and daytime telephone number. We have found that most problems can be resolved by e-mails or telephone calls, so please contact iOptron first to avoid returning the mount for repair.

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

6.3. Product End of Life Disposal Instructions

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

6.4. Battery Replacement and Disposal Instructions

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

<table>
<thead>
<tr>
<th>Mount</th>
<th>Center-balanced Equatorial Mount (CEM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payload</td>
<td>52kg (115 lbs), exclude counterweight*</td>
</tr>
<tr>
<td>Mount weight</td>
<td>26kg (57 lbs)</td>
</tr>
<tr>
<td>Payload/Mount weight ratio</td>
<td>2</td>
</tr>
<tr>
<td>Material</td>
<td>All metal</td>
</tr>
<tr>
<td>Latitude adjustment range</td>
<td>0°~ 68° (0.5 arcmin division)**</td>
</tr>
<tr>
<td>Azimuth adjustment range</td>
<td>± 5° (3 arcmin division)</td>
</tr>
<tr>
<td>Right Ascension worm wheel</td>
<td>Φ216mm, 360 teeth, zero backlash</td>
</tr>
<tr>
<td>Declination worm wheel</td>
<td>Φ216mm, 360 teeth, zero backlash</td>
</tr>
<tr>
<td>Worm</td>
<td>Φ26mm</td>
</tr>
<tr>
<td>PEC</td>
<td>PPEC/Real time PEC</td>
</tr>
<tr>
<td>PE</td>
<td>~±3.5 arcsec p-p (#7300) or &lt;0.15 arcsec RMS for 4 min (#7301)</td>
</tr>
<tr>
<td>Worm period</td>
<td>240 sec</td>
</tr>
<tr>
<td>Counterweight shaft</td>
<td>Φ 38, 540 mm (SS, anti-slip, 4.5kg)</td>
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<tr>
<td>Counterweight</td>
<td>10 kg (22 lbs)</td>
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<tr>
<td>Mount base size</td>
<td>210 x 230 mm</td>
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<tr>
<td>Motor drive</td>
<td>Stepper motor</td>
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<tr>
<td>Resolution</td>
<td>0.07 arc seconds</td>
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<tr>
<td>Slew speed</td>
<td>1x, 2x, 8x, 16x, 64x, 128x, 256x, 512x, MAX(~4°/sec)</td>
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<tr>
<td>Power consumption</td>
<td>0.7A(Tracking), 1.8A(GOTO)</td>
</tr>
<tr>
<td>Power requirement</td>
<td>12V DC 5A</td>
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<tr>
<td>AC adapter</td>
<td>100V ~ 240V (included)</td>
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<tr>
<td>Polar scope</td>
<td>Optional electronic polar scope</td>
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<tr>
<td>Hand Controller</td>
<td>Go2Nova® 8407+, 212,000+ objects database, star recognition</td>
</tr>
<tr>
<td>Meridian treatment</td>
<td>Stop (0-14° pass), auto flip</td>
</tr>
<tr>
<td>Zero position</td>
<td>Automatic zero search</td>
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<tr>
<td>Park position</td>
<td>Horizontal, vertical, current, alt/azi input</td>
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<tr>
<td>Level indicator</td>
<td>Yes</td>
</tr>
<tr>
<td>Dovetail saddle</td>
<td>Losmandy D, 17.2&quot; (437mm)</td>
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<tr>
<td>GPS</td>
<td>Yes</td>
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<tr>
<td>Autoguide port</td>
<td>ST-4</td>
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<tr>
<td>Communication port</td>
<td>RS232, USB, LAN, Wi-Fi</td>
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<tr>
<td>PC computer control</td>
<td>Yes (ASCOM)</td>
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<tr>
<td>Cable management</td>
<td>2xDC12V (1A), DC5V(1A), 2xDC (5A), ST4, 6P6C, 4xUSB2.0, USB3.0 (powered), USB for PS, AUX</td>
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<tr>
<td>Operation temperature</td>
<td>-10°C ~ +40°C</td>
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<tr>
<td>Pier/tripod</td>
<td>Optional Pier</td>
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<tr>
<td>Warranty</td>
<td>Two year limited</td>
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</table>

*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.

**For latitude below 10°, special CWs, #7326LL, are needed.
Appendix B. Go2Nova® 8407+ HC MENU STRUCTURE

MENU

Select and Slew

Solar System
- Mercury
- Venus
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune
- Sun
- Moon

Deep Sky Objects
- Named Object
- Messier Catalog
- NGC
- IC
- PGC
- Caldwell Catalog
- Abell Catalog
- Herschel Catalog

Stars
- Named Stars
- Double/Multi Stars
- SAO Catalog

Constellations

Comets

Asteroids

Custom Objects
- Objects Except Comet
- User Defined Comet

Custom R.A. and DEC

Sync. To Target
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. Firmware Upgrade

The firmware in the 8407+ Hand Controller and control boards can be upgraded by the customer. Please check iOptron’s website, www.iOptron.com, under Support Directory/CEM Mounts, select CEM120 for details.
Appendix D. Computer Control a CEM120 Mount

The CEM120 mount can be connected to a computer, a tablet, and/or a Smartphone via serial, USB, LAN or Wi-Fi connection.

Please refer to iOptron website, www.iOptron.com, under Support Directory/ASCOM Driver, iOptron Telescope ASCOM Driver, for more details.
Appendix E. Gear Switch Meshing Adjustment

CEM120 gear meshing is designed to be adjustable by customer based on the payload. If you experience 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 2.5mm hex key

**To Adjust DEC Gear:**

<table>
<thead>
<tr>
<th>Release DEC axle locking knob</th>
<th>Disengage DEC gear switch</th>
</tr>
</thead>
</table>

| Rotate DEC saddle 90 degrees to exposure two small holes next to DEC Gear Switch: one on the top cover (3mm diameter), one on the side (5mm). There is a set screw inside the 3mm hole to lock the gear adjustment screw, which is inside the 5mm hole. | Engage the worm/gear. |
Insert the 2mm hex key into the 3mm hole on the top. Gently turn the hex key until you feel it has been engaged with the screw. Turn the set screw half a turn counterclockwise.

Adjust the gear adjustment screw on the side inside 5mm hole by using the 3mm hex key. Turn counterclockwise to loosen the meshing or turn clockwise to tighten the meshing.

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 to LOCK the gear screw (important), then 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 set screw is inside a 3mm hole and the gear adjustment screw is inside a 5mm hole.

The adjustment is same as that for DEC gear/worm.
Appendix F. Go2Nova® Star List

## Named Deep Sky Object

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<thead>
<tr>
<th></th>
<th>Named Deep Sky Object</th>
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<td>1</td>
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<tr>
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<td>Andromeda Galaxy</td>
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<td>3</td>
<td>Antennae Galaxies</td>
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<tr>
<td>4</td>
<td>Barnard's Galaxy</td>
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<tr>
<td>5</td>
<td>Bear-Paw Galaxy</td>
</tr>
<tr>
<td>6</td>
<td>Beehive Cluster</td>
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<tr>
<td>7</td>
<td>Black Eye Galaxy</td>
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<tr>
<td>8</td>
<td>Blinking Planetary</td>
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<td>9</td>
<td>Blue Flash Nebula</td>
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<tr>
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<td>Butterfly Cluster</td>
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<td>Lambda Centauri Nebula</td>
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<td>Large Magellanic Cloud</td>
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Messier Catalog

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