

The Paramount Series 6 User Guide

Paramount MYT, ME and MX Series 6 German Equatorial Mounts

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SOFTWARE BISQUE

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Software Bisque, Inc.
862 Brickyard Circle
Golden, CO 80403-8058
USA
Website: https://www.bisque.com

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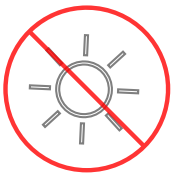
Telescope Operation Disclaimer

Robotic telescope mounts do not have an unlimited range of movement. The telescope's shape, the way it is mounted, or the addition of accessories can prevent it from pointing at certain parts of the sky. If the telescope is forced past these points, the telescope, its mounting, or accessories might be damaged.

TheSky Professional includes telescope limit features that let define these inaccessible positions; *TheSky Professional*, or the mount's control system, will try to prevent the telescope from entering or crossing them. This feature is provided as a *convenience*, not as a panacea. Since any telescope can run into its mechanical limits through accident, carelessness, or component failure, Software Bisque cannot be responsible for any damage to your telescope that occurs when using *TheSky Professional* to control it.

Furthermore, Software Bisque cannot be held responsible for damage caused by plugging cables into electronic devices. We strongly recommend turning off all electronic devices (computers, mobile devices, telescopes, focusers, dew heaters, CCD cameras, etc.) before attaching any cabling or power supplies.

Sun Warning



NEVER attempt to observe the Sun through your telescope! Without a specially designed solar filter, viewing the Sun – for even a fraction of a second – will cause instant, irreversible eye damage. When observing during the day, do not point the telescope near the Sun. Do not use *TheSky Professional's* automatic slew feature to find objects during the day.

TheSky emits an audible "Sun, sun, sun…" warning, when the telescope cross hairs come near the Sun.

The Paramount Robotic Telescope System

Thank you for purchasing the Paramount Robotic Telescope System. The Paramount mount is an ultra-precise German equatorial mount (GEM) that is designed to deliver unmatched pointing, tracking and stability for amateur or professional astronomers. These precision mechanics, when commanded by *TheSky Professional*, create a powerful imaging system that can help you achieve your most lofty observing goals.

This user guide covers the basic setup and use of the *Paramount MYT, Paramount MX*, and *Paramount ME* model mounts, as well as how to control your mount using *TheSky Professional*.

This document assumes you are familiar with many fundamental concepts in astronomy and are experienced using a telescope and/or camera in conjunction with a personal computer.

If a concept presented here is new to you, consider searching the Internet to find out more information. Unfortunately, there is simply no way that all the different facets of setting up and controlling a robotic telescope mount can be covered in a single document.

Features and Specifications By Model

Feature	MYT	MX	ME
Software Bisque's fifth generation dual-axis control system (MKS 6000™) provides dependable, precision performance.	✓	✓	✓
TheSky Universal bundle includes: • *TheSky Professional* for macOS, Linux (ARM32, ARM64, and x64 architectures), and Windows. • *Cameras+ module* software provides camera, focuser, filter wheel, rotator, weather stations and other device control. • *Domes module* keeps a motorized dome aligned with telescope. • The *Multi-OS+ module* lets you install *TheSky Professional* and related modules on up to six different computers on macOS, Linux ARM64, and x86_64 architectures, and Windows. • *TPoint™ module* with Super	✓	✓	✓

Feature	MYT	MX	ME
Model™ and ProTrack™ provides unmatched telescope pointing and tracking accuracy. • The *Weather module* reports the temperature, wind speed, and other weather-related data from supported weather stations.			
Research-grade right ascension gears with seven (7) arcsecond or less peak-to-peak periodic error *before* training PEC.[1]	✓	✓	✓
Optimal periodic error correction curve fitting that can produce "seeing indifferent" periodic error curves. [1]	✓	✓	✓
Direct Guide™ allows optimal autoguiding without an autoguider cable.	✓	✓	✓
The hour angle and declination axes include mechanical switches to easily disengage the worm for balancing the payload and engage the worm for normal operation.	✓	✓	✓
Clutch-free worm block design preserves the mount's physical orientation for accurate and repeatable TPoint modeled pointing and tracking. [1]	✓	✓	✓
The control system's right ascension and declination axes can be configured to slew and track over a wide dynamic range of tracking rates.	✓	✓	✓
Configurable acceleration and deceleration rates during slews.	✓	✓	✓
Integrated homing sensors allow rapid mount initialization to produce precision and reliable pointing repeatability from night to night, or if power is lost. [1]	✓	✓	✓
Extremely stable mechanical design that rapidly dampens external vibrations.	✓	✓	✓

Feature	MYT	MX	ME
Configurable slew limits prevent damage to the mount and telescope by slowly decelerating to limit regions.	✓	✓	✓
The integrated Cable Conduit™ allows adding custom through-the-mount cables.	✓	✓	✓
An integrated rotating base allows calibrated azimuth adjustments to be made without affecting the mount's altitude.	✓	✓	✓
Integrated altitude scale to provide a precise altitude starting point for polar alignment.	✓	✓	✓
Structural design is extremely rigid, even carrying the maximum payload capacity.	✓	✓	✓

[1] Out of the box, Paramounts equipped with the optional on-axis absolute encoders are calibrated so that they are free from periodic error and always sense the mount's mechanical orientation so that per session initialization (or *homing*) is unnecessary.

Paramount Series 6 Model Comparison

The Series 6 models have similar functionality and design. The table below lists the "significant" differences between each model.

Feature or Specification	MYT	MX	ME
Maximum payload capacity (total instrument capacity not including counterweights)	32 kg/70 lb.	56 kg/125 lb.	109 kg/240 lb.
Physical dimensions	See technical drawing references on page 189.	See technical drawing references on page 189.	See technical drawing references on page 189.

Feature or Specification	MYT	MX	ME
Versa-Plate dimensions and optional mounting accessories (page 52)	15 cm x 37.4 cm x 1.6 cm (5.95-in. x 14.75-in x 0.63 in.) • Four dovetail mounting knobs.	16 cm x 41 cm x 1.8 cm (6.4-in. x 16-in x 0.72 in.) • Four dovetail mounting knobs.	25 cm x 51 cm x 2.5 cm (9.9-in. x 20-in. x 1.0-in) • Four dovetail mounting knobs. • Optional mounting rails for attaching large telescopes.
Number of Altitude Adjuster Thrust Knobs (page 107)	Two (2)	Two (2)	Four (4)
Routing custom cabling through the mount	See "Through the Mount Cabling" on page 66 for details.	See "Through the Mount Cabling" on page 66 for details.	See "Through the Mount Cabling" on page 66 for details.
Mechanical switch on hour angle and declination axes (page 63)	The *Two Position Switch* engages the worm with the gear or permits payload balance by separating the worm from the gear. For each axis, the *Transportation Lock Knob* can be used to lock an axis in place to prevent rotation.	The *Two Position Switch* engages the worm with the gear or permits payload balance by separating the worm from the gear. For each axis, the *Transportation Lock Knob* can be used to lock an axis in place to prevent rotation.	The *Two Position Switch* engages the worm with the gear or permits payload balance by separating the worm from the gear. The hour angle and declination axes can be locked in place for transport, or when adding payload, by installing two locking bolts on each axis.
Physical hard stops to limit axis rotation	• Rotation of the hour angle axis is limited by a fixed, non-configurable mechanical hard stop at hour angle 2. • Rotation of the declination axis is limited by a fixed hard stop near the	• Rotation of the hour angle axis is limited by a fixed, non-configurable mechanical hard stop at hour angle 2. • Rotation of the declination axis is limited by a fixed	Five configurable hard stop positions located at a minimum of seven minutes to up to two (2) hours past the meridian.

Feature or Specification	MYT	MX	ME
	celestial pole.	hard stop near the celestial pole.	
Base Plate Micro Levelers	n/a	n/a	See "Micro Levelers (Paramount ME Only)" on page 109.

Getting Help

If you have questions about your Paramount, please first carefully review the *Paramount Quick Start Guide* (a printed copy is included in the mount's accessories box) and the information in this document. If you still cannot find an answer, please visit the Software Bisque website (https://www.bisque.com). Click ***My account***, ***Register*** if you have not registered, then click ***My account***, ***Log in*** to log in. For here, drop down the ***Support*** menu, navigate to the appropriate support forum and the click ***Create a New Topic*** graphic. Type your question in the ***Create New Topic*** form and click ***Submit*** when done. If your post does not immediately appear, you may need to wait for a moderator to approve it.

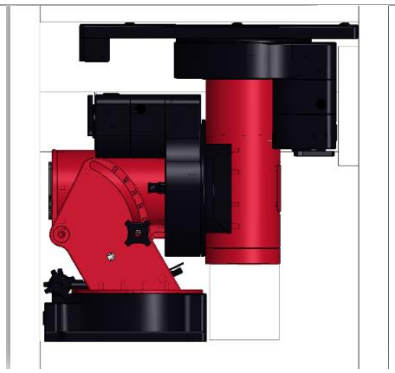
Software Bisque does its best to monitor our forums between 9 a.m. to 4 p.m. Mountain Time Monday-Friday and *tries to respond* to questions within 3-5 business days. Our knowledgeable community members are there to help outside regular office hours.

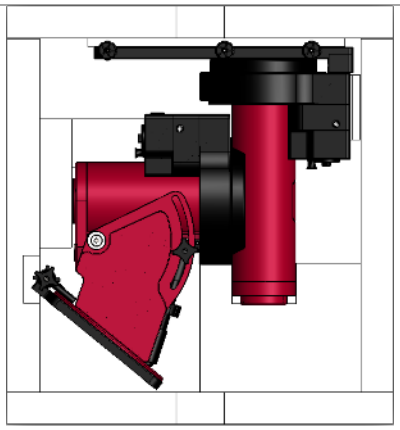
Packing List

The Paramount is shipped in two separate boxes. The larger box contains the Paramount mount itself; the smaller box contains the printed user guide, and mount accessories. Please make sure the following items are included in the Paramount boxes. In the event one or more items are missing, please contact Software Bisque (page 13) immediately to obtain a replacement.

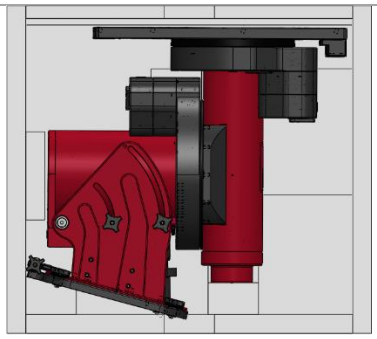
Box 1 Contents (Mount)

MYT		
Qty	**Photo**	**Description**

MYT		
Qty	**Photo**	**Description**
1		Paramount MYT Robotic Telescope Mount with Versa-Plate attached. **Box Dimensions:** 48 cm x 51 cm x 24 cm (19 in. x 20 in. x 9.5 in.) **Total Shipping Weight:** 22 kg (48 lb.)

MX		
Qty	**Photo**	**Description**
1		Paramount MX Robotic Telescope Mount with Versa-Plate attached. **Box Dimensions:** 33 cm x 62 cm x 66 cm (13 in. x 24.5 in. x 26 in.) **Total Shipping Weight:** 33 kg (74 lb.)

ME		
Qty	**Photo**	**Description**

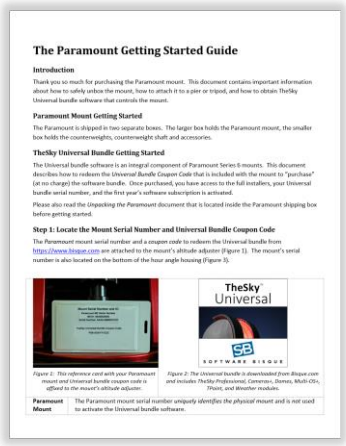
ME		
Qty	**Photo**	**Description**
1		Paramount ME Robotic Telescope Mount with Versa-Plate attached. **Box Dimensions:** 74 cm x 66 cm x 41 cm (29 in. x 26 in. x 16 in.) **Total Shipping Weight:** 43 kg (95 lb.)

Important Packing Material Notes

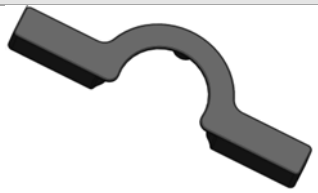
The Paramount is shipped encased in two ultra-dense white Styrofoam inserts inside two double-walled cardboard shipping boxes. Software Bisque strongly recommends that you keep both the shipping boxes, and the two Styrofoam inserts as these packing materials are specifically designed to protect your mount during transport.

Replacements can be purchased at the Software Bisque Store (https://www.bisque.com). Enter "box" into the product search field to find them.

Box 2 Contents (Accessories Box)

Qty	Photo	Description
1		The printed Paramount Getting Started Guide.
1		4.6 m (15-foot) USB-C cable.
1	 Paramount ME 220W PSU  Paramount MX and Paramount MYT 90W PSU	Power Supply Unit (PSU). See “Power Supply Unit (PSU)” on page 113 for the PSU power specifications. **Paramount ME (only)**: A separate *Power Supply Extension Cable* (shown in the row below) must be connected to the circular plug on the Paramount ME PSU before it can be used to supply power to the mount.

<table>
<tr><th>Qty</th><th>Photo</th><th>Description</th></tr>
<tr><td>1</td><td></td><td>Power Supply Extension Cable (Paramount ME only).</td></tr>
<tr><td>1</td><td></td><td>Power Cable for the Power Supply Unit (NEMA 5-15 male plug).</td></tr>
<tr><td>1</td><td></td><td>Hand Controller with joystick (page 109).</td></tr>
<tr><td>1</td><td></td><td>Counterweight Shaft (page 99).</td></tr>
<tr><td>1</td><td></td><td>Counterweight Safety Knob (page 104).</td></tr>
<tr><td>See table at right.</td><td></td><td>Counterweights (page 100).
<table>
<tr><th>Model</th><th>Number of counterweights</th></tr>
<tr><td>MYT</td><td>One 9 kg / 20 lb.</td></tr>
<tr><td>MX</td><td>Two 9 kg / 20 lb.</td></tr>
<tr><td>ME</td><td>Two 13.6 kg / 30 lb.</td></tr>
</table></td></tr>
<tr><td>1</td><td></td><td>Paramount ME (only) Altitude Adjuster Wrench (page 114).</td></tr>
</table>

Qty	Photo	Description
		
1		Paramount ME (only) Accessory Pouch This pouch can be used to conveniently store the following items: • Two (2) 3/8-in. shoulder bolt hole plugs for holding the two (2) 5/16 in. x 2-1/4 in. hour angle locking shoulder bolts and two (2) declination locking shoulder bolts. • Four (4) Delrin washers. When locking the Paramount ME's right axis (page 88), use two of these washers to protect the surface of the mount from being marred by the steel shoulder bolts. • Four (4) plastic plugs to cover the outer side of the hour angle axis locking holes (page 88) and the declination axis locking holes (page 108). The pouch can be stowed behind the altitude adjuster in the polar axis wedge.
1		Cable tie to help route cables through the mount.
1		The printed Paramount Getting Started Guide in the accessories box provides details how to download TheSky Universal bundle software. 

Qty	Photo	Description
1		13-piece SAE hex wrench set.

Locating Your Mount Serial Number and Universal Bundle Coupon Code

The *Paramount* mount serial number and a TheSky Universal Bundle Coupon Code are attached to the mount's altitude adjuster. The mount serial number is also located on the bottom of the hour angle housing.



A tag with your Paramount mount serial number and TheSky Universal bundle coupon code is affixed to the mount's altitude adjuster.



TheSky Universal bundle can be downloaded from the Software Bisque website and includes TheSky Professional, Cameras+, Domes, Multi-OS+, TPoint, and Weather modules.

Paramount and Software Serial Number Registration

Please follow the instructions at the URL below to register your Paramount mount serial number: https://www.bisque.com/register



The Paramount mount serial number must be registered to active the limited warranty.

On-Axis Absolute Encoders (Optional)

You can distinguish a Paramount that is equipped with on-axis absolute ring encoders by the rectangular encoder read-sensor cover on the top of each axis (Figure 1 and Figure 2).

When installed at the factory, the on-axis absolute encoders are calibrated, ready to use out of the box, and offer the following benefits:

- Homing the mount is not necessary.
- Encoder calibration means the mount's periodic error is effectively zero, so no PEC training required.
- The high-resolution encoders result in exceptional pointing and tracking results using fewer TPoint™ calibration points.
- The extended temperature range (ETR) Renishaw encoder read heads offer a wide operating temperature from – 40°C to +80°C.

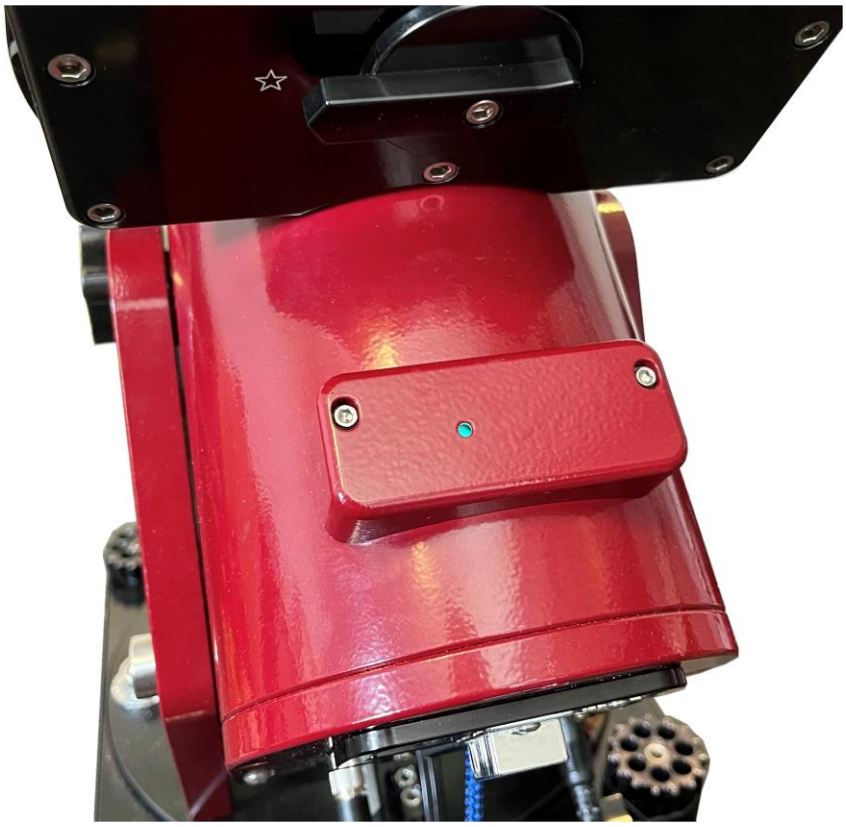


Figure 1: Hour angle axis with on-axis absolute encoder sensor cover.

If you purchase and perform a do-it-yourself encoder installation, the encoders will have to be calibrated using from the **Bisque TCS** window, **On-Axis Encoders** tab.

Encoder Status LED

The LED on the sensor cover shows the encoder read status:

- **Blue** – Optimal; strong signal.
- **Green** – Adequate; signal is good enough.
- **Orange** – Marginal; no errors, but the signal should be improved.
- **Red** – Error; the read head cannot track the encoder position.

If the LED shows orange or red, turn off the mount, remove the encoder sensor cover and spray compressed air on the read head.



Figure 2: Declination axis with on-axis absolute encoder sensor cover.

On-Axis Encoder Error Conditions

For mounts with on-axis encoder, rotating the mechanical switch to the balance position *always* causes the control system to emit successive beeps because the mount's absolute mechanical position has been lost. To return the mount to normal operation, engage the worm and gear, and restart the control system.

Optional Accessories

The table below lists optional accessories for each model.

Optional Accessory	MYT	MX	ME
TheSky Fusion	✓	✓	✓
Counterweight Shaft Extension Bar	n/a	8-in. long, 1.5-in. wide	8-in. long, 1.875-in. wide
Counterweights	9 kg/20 lb. and 4.5 kg/10 lb. 1.5-in. bore hole	9 kg/20 lb. and 4.5 kg/10 lb. 1.5-in. bore hole	14 kg/30 lb. and 18 kg/40 lb. 1.875-in. bore hole
Software Bisque Permanent Pier	✓	✓	✓
Base to Pier Adaptor Plate for mounting the Paramount to an existing pier	✓	✓	✓

Optional Accessory	MYT	MX	ME
Helium™ Tripod	✓	✓	✓
Latitude Adjustment Wedge for use below 10 degrees and above *about* 64 degrees latitude	n/a	✓	✓
On-axis absolute encoders	✓	✓	✓
Versa-Plate Spacers	✓	n/a	✓
EGO™ Battery to Paramount Power Adaptor	✓	✓	✓
Soft-sided Carrying Case	✓	n/a	n/a
C11 OTA Mounting Rings	✓	✓	✓
C14 OTA Mounting Rings	n/a	✓	✓
Meade 16-inch OTA Mounting Rings	n/a	n/a	✓
Mounting Ring Dovetail Accessory Plate	✓	✓	✓
PoleMaster™ Adapter	✓	✓	n/a

In the table above, n/a means not available.

Supplemental TheSky Databases

The optional *TheSky Databases* module offers over 180 GB of additional astronomical catalogs including the Gaia DR3 and APASS, and access to the complete 10x compression Digitized Sky Survey.

Unboxing the Paramount

We hope you are excited to unpack and start using your Paramount as soon as possible. Please resist the urge to simply remove everything from all the boxes, try to use the mount, and then consult the documentation only *after* something gets confusing. Taking a few moments now to understand the basic mount design will hopefully avoid personal injury or damage to your mount.

Your Safety is Paramount

The Paramount is designed to provide years of reliable service, but, like any precision instrument, you must become familiar with the basic features and operating procedures to ensure proper use and your personal safety.

When you remove the packing tape on the Paramount shipping box, and lift the cardboard flaps, please stop, and carefully read the enclosed insert *before removing the mount from the box!*

The insert describes important warnings as well as the correct procedure to prepare the mount for handling once it has been removed from the shipping box.

Paramount ME Unpacking Insert

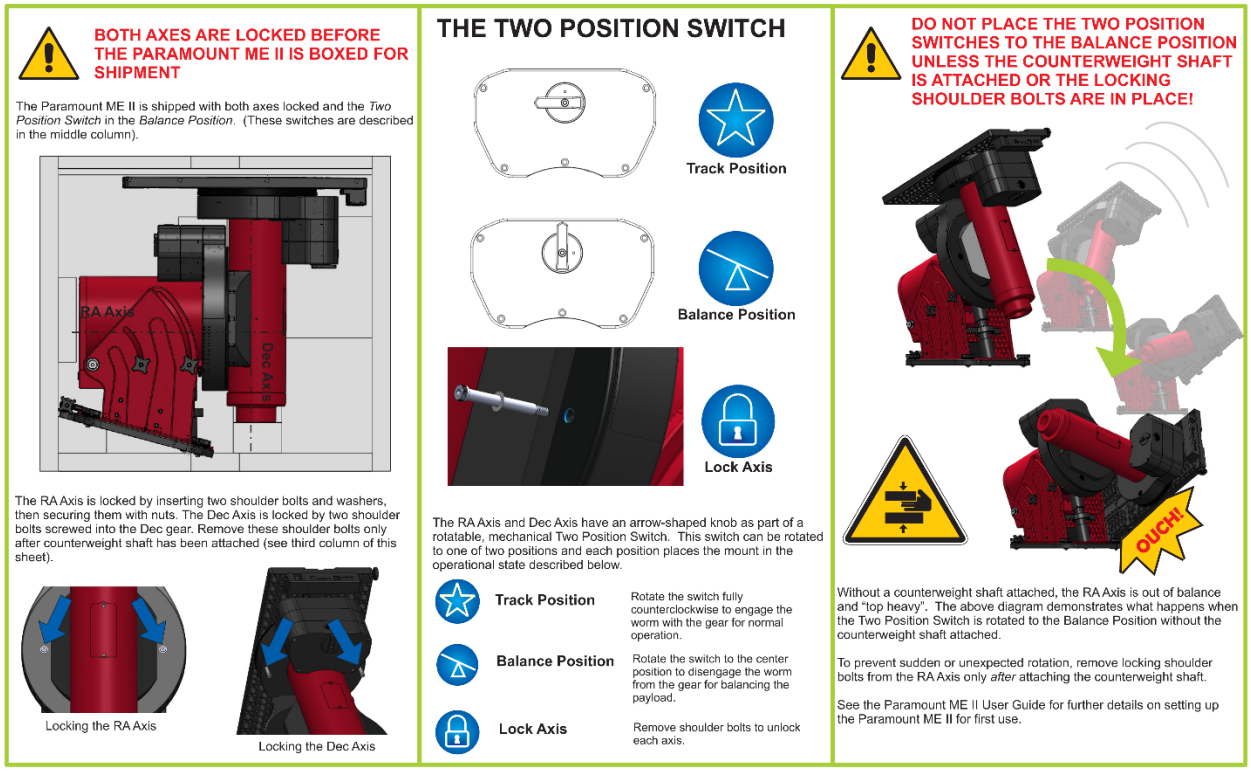


Figure 3: Please carefully read the above flyer and the warning below *before* unpacking the Paramount ME.

Please carefully read the *Paramount Getting Started Guide* before installing *TheSky Professional*.

A printed copy of The *Paramount Getting Started Guide* is inside the Paramount accessories box and can be downloaded in PDF format from https://www.bisque.com.

From the Software Bisque website, click **My account, Log in**, then click **Support**, **Downloads**, **Documentation** and enter ***Getting Stared*** in the ***Search*** field and press **<Enter>** to locate it.

TheSky Universal bundle serial number is used to activate TheSky Professional and the optional modules the first time it is launched. Your TheSky Universal serial number is registered to your Software Bisque account when you redeemed TheSky Universal bundle coupon code. To view your serial number registered to you Software Bisque account, click **My account, Log in**, then click **My account, My Serial Numbers**.



Paramount MX Unpacking Insert

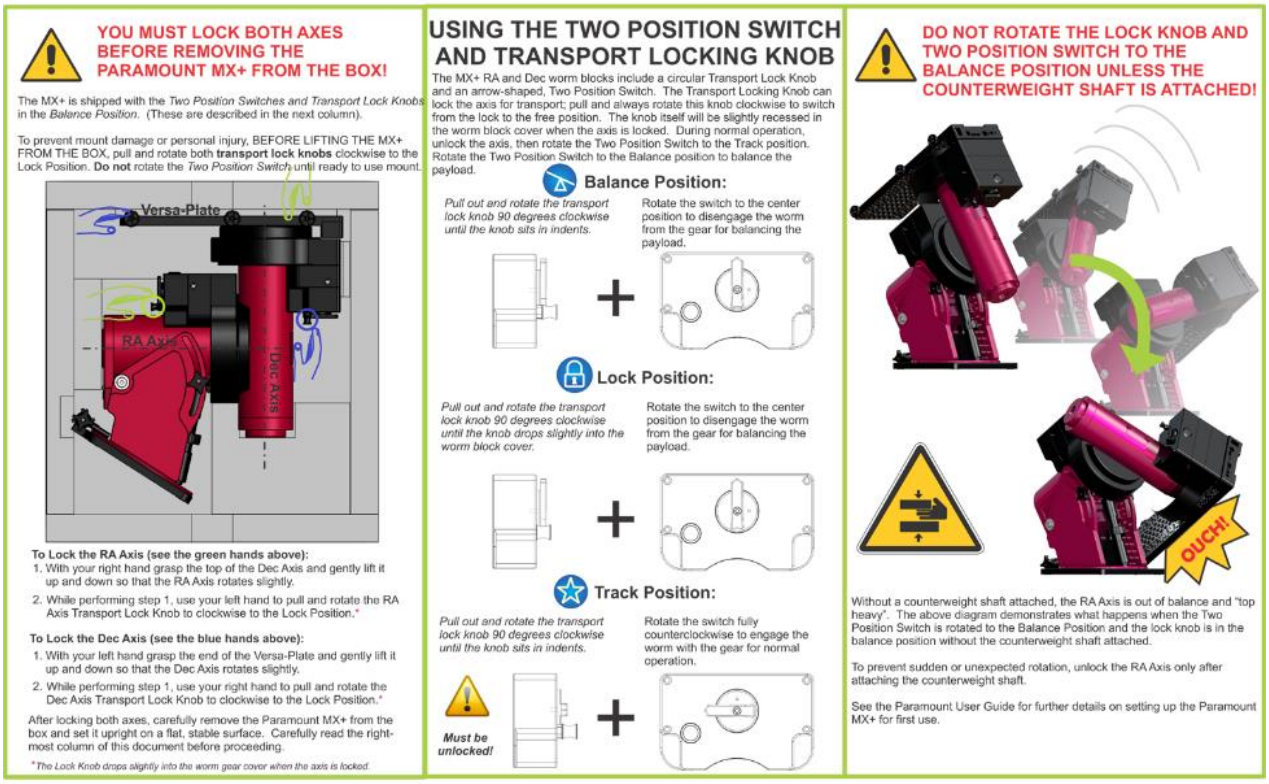


Figure 4: Please carefully read this flyer *before* unpacking the Paramount MX.

Please see the "HA Worm Block Switch" on page 63 for details about using the two-position switch.

Paramount MYT Unpacking Insert

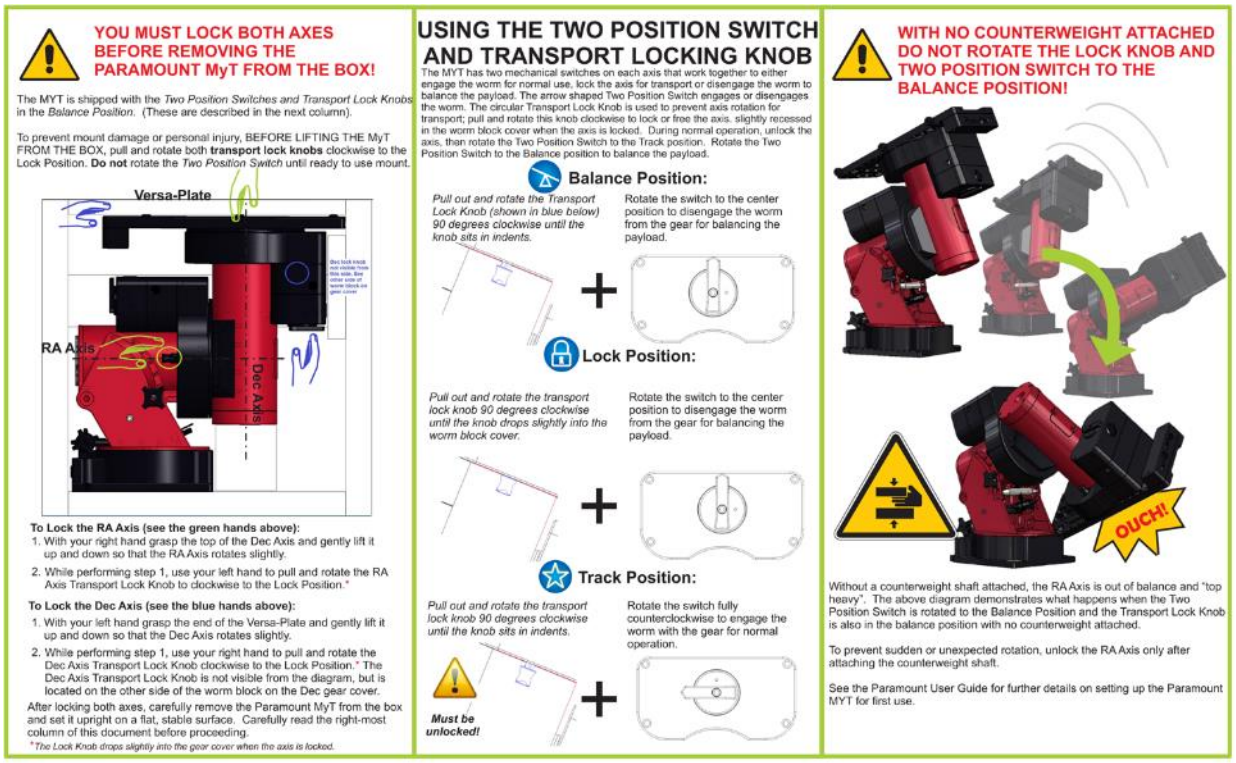


Figure 5: Please carefully read this flyer before unpacking the Paramount MYT.

The Paramount MYT hour angle axis includes locking holes at 10-degree increments.

Boxing the Paramount for Transport

To ensure your mount arrives undamaged at its destination, always perform the following steps when boxing the Paramount.

1. Place the hour angle axis mechanical switch in the balance position.
2. Rotate the hour angle axis so that the counterweight shaft is “down”.
3. Lock the hour angle axis so that it cannot rotate when the mount is lifted off the pier or tripod.

Model	How to lock axis…
MYT MX	Pull and rotate the transportation lock knob clockwise 90 degrees to the lock position and slowly rotate the axis until the internal plunger drops into one of the locking holes on the gear. The locking holes are spaced in 10-degree increments.
ME	Install the locking shoulder bolts (page 88).

4. Remove the payload from the Versa-Plate.
5. Remove the counterweight safety knob.
6. Remove the counterweights.

7. Remove the counterweight shaft.
8. Rotate the Versa-Plate *fully clockwise* to the hard stop position. In this position, the Versa-Plate is parallel to the sides of the mount so that the mount will lay flat in the box. Note the internal physical hard stops prevent the declination axis from fully rotating 180 degrees. If the declination axis is rotated fully *counterclockwise*, the edge of the Versa-Plate will not be parallel with the sides of the mount and will not lay flat in the box.
9. Remove the four base thrust mounting knobs.
10. Lift the mount off the pier or tripod and gently place it in the packing foam.
11. Unlock both axes before shipment. The shipping box may be dropped or experience other excessive jarring during shipment. Allowing the axes to rotate helps prevent possible damage to the locking mechanisms.

Model	How to unlock the axis…
MYT MX	Pull and rotate the transportation lock knob clockwise to the balance position and make sure the worm and gear are disengaged by rotating both axis a few degrees back and forth.
ME	Remove the locking shoulder bolts (page 88).

Fundamental Concepts

Successful operation of a Paramount requires a solid understanding of basic astronomy concepts, a familiarity with operating a GEM, as well as a working knowledge of *TheSky Professional*.

If you are new to the Paramount, operating a GEM, or just getting into astronomy, please peruse the following section. Based on years of support feedback, even experienced observers often do not understand fundamental concepts as they relate to operating a Paramount. After reading the following section, you should be able to answer the questions below.

- What are the differences between right ascension and hour angle?
- Why does the meridian matter when operating a GEM?
- What exactly is synchronization?
- What is homing and what does it do?
- What is mount parking?
- How does atmospheric refraction affect mount performance?
- Why is polar alignment so important?

In addition to these basic questions, if you have not controlled a “go to” German equatorial mount with *TheSky Professional*, please carefully read the following sections and then use *TheSky Professional’s* **Telescope Simulator** before setting up, connecting to, and operating the Paramount.

Coordinate Systems

The three most common coordinate systems used when working with equatorial mountings are described below. Making sure you understand the differences between each now can really help troubleshooting issues in the future.

The Horizon Coordinate System

The horizon or "horizontal" coordinate system is used to specify the position of celestial objects relative to the local horizon.

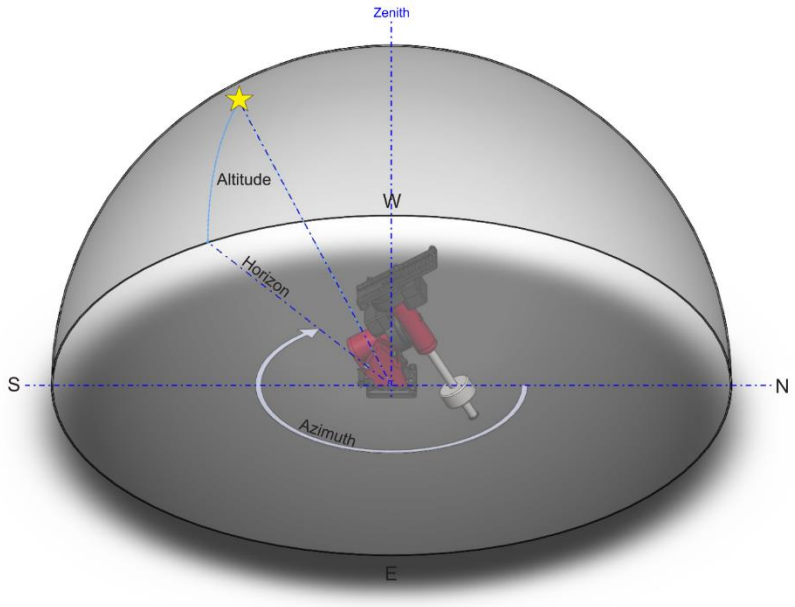


Figure 6: The horizon coordinate system.

Altitude

The altitude (alt for short) of an object is expressed as the number of degrees from the horizon (the ground at a far distance) to the object and is always between minus 90 and plus 90 degrees. Objects at an altitude less than zero are below the horizon. For example, the Sun just after sunrise is close to the horizon so it has an altitude of a few degrees, and just after sunset its altitude is few degrees negative.

Azimuth

The azimuth (az for short) of an object is generally reckoned from north, increasing in the clockwise direction, and ranges from 0 to 359 degrees. North is 0 degrees, east is 90 degrees, south is 180 degrees and west is 270 degrees.

When the Paramount is controlled by *TheSky Professional*, attempting to slew the mount below the local horizon is not permitted and results in an error message.

The Equatorial Coordinate System

The horizon coordinate system is not convenient for directing a telescope to a celestial object because, due to the rotation of the Earth, the coordinates continually change with time.

The exception occurs with objects near the north and south celestial poles. These positions are unique since they are near to the axis of rotation of the Earth and therefore move only in small circular paths. The altitude and azimuth of Polaris, for example, do not vary significantly. In the equatorial coordinate system, the coordinates of celestial objects remain fixed over time[2].

An object's equatorial coordinates remain the same regardless of the position on Earth the object is viewed. This allows astronomers to create star maps that apply to any place on Earth or publish the anticipated position of an upcoming comet so that astronomers everywhere know where it is located among the stars.

The equatorial coordinate system used to specify the positions of celestial objects is directly analogous to the latitude-longitude coordinate system used on Earth. In fact, if you were to expand the latitude and longitude grid of the Earth so that it is out beyond all stars, you would have a sphere with identical geometry to the celestial sphere.

We suppose that all stars and deep-sky objects are located on a very large sphere (out beyond all stars). We call this the celestial sphere. For purposes of describing the positions of celestial objects, we consider all stars and deep sky objects to be on the celestial sphere, when they are all positioned at varying distances from the Earth.

[2] *Equatorial coordinates change over extended periods due to precession (wobbling of the Earth). TheSky computes this change in stars' position for the current date. Precession, however, does not change the relative positions of objects with respect to one another.*

Right Ascension

The geometry of the right ascension (RA) lines on the celestial sphere is the same as the longitude lines on Earth. Longitude lines divide the Earth into 360 degrees. Right ascension lines divide the celestial sphere into 24 hours, based on one revolution of Earth. Therefore, one hour of right ascension equals 15 degrees (360 divided by 24). See the definition of Local Sidereal Time for additional information on why 24 hours are used for right ascension instead of 360 degrees.

Zero degrees longitude passes through Greenwich, England and is the designated reference line for longitude. What, then, is the reference line for 0 hours right ascension? Astronomers use the *vernal equinox*, the location where the Sun crosses the celestial equator during its apparent annual motion against the background stars, as a "starting point" for right ascension.

The term "right ascension" comes from the fact that when viewed from the equator, all stars rise (or ascend) at right angles to the horizon, so their times of rising are called their times of right ascension.

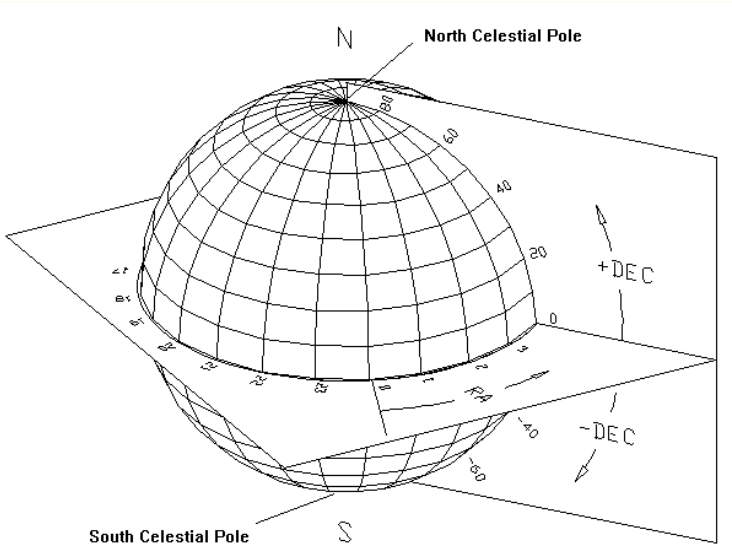


Figure 7: Right ascension and declination relative to the celestial sphere.

Declination

The declination (Dec) lines on the celestial sphere are like latitude lines on a globe of the Earth, ranging from –90 degrees to +90 degrees. The "declination" of an object is the angle measured from the celestial equator (0 degrees declination) along a meridian line through the object. Polaris has a declination of just over 89 degrees, placing it near the north celestial pole.

Hour Angle

Hour angle (HA) is measured from the meridian westward, along the celestial equator and uses the same units as right ascension (hours, minutes, and seconds). An object on the meridian is located at hour angle 0. Six hours of time later, the object is located at hour angle +6. When the object rises, its hour angle is –6.

Smaller hour angles equate to positions of optimal observing, so your telescope will likely spend the majority of time tracking objects near hour angle zero (near the meridian).

The telescope's hour angle is used to describe the mechanical orientation with respect to fixed horizon-based hemisphere. And the mechanical orientation of a Paramount without absolute on-axis encoders must be restored each session using a process called *homing*.

TheSky Professional can be used to configure the mechanical orientation at which the control system slews the telescope to the opposite side of the pier, or the "flip hour angle" to maximize the length of time an object can be tracked past the meridian (see page 124 for more information about configuring the flip hour angle).

Local Sidereal Time

Local sidereal time (LST) is always equal to the instantaneous right ascension of the local meridian. When you know the LST, you can look at star maps and determine which objects are near the meridian (those with a right ascension close to the LST). For example, if the LST is 6:10:00, this means that stars with a right ascension of about 6 hours are presently situated near the meridian.

If everyone reckoned time based on the Sun crossing the meridian, then each longitude on earth would have a different time of day. That means noon, or the time the Sun crosses the meridian, would come a few minutes earlier for someone living sixty miles to the east. Only those people living at the same longitude would share a common time.

In the late 1800's time zones were established to minimize the problem of having different time in populous regions. The time within each zone is called z*one time*. Zone time places all locations on Earth into various time zones. Time zone zero is at zero degrees longitude, and the time zone increases by one hour every 15 degrees longitude moving east or decreases by one hour moving west.

The Paramount orients itself by using *TheSky Professional*'s location, date, time, and time zone settings. If *TheSky Professional's* time zone is not correct, for example, the right ascension coordinate of the telescope cross hairs on the Sky Chart will be offset by the number of hours that the time zone is incorrect. Use the ***Tools, Verify TheSky Time*** command to compare *TheSky Professional's* time with an Internet-based time clock and make sure these settings are right.

Atmospheric Refraction

The effects of atmospheric refraction on the position of celestial objects, as well as its effect on the sidereal tracking rate, are often overlooked or even ignored by many amateur astronomers.

The refraction nuisance (and other system errors like tube flexure) means the "sidereal tracking rate" is simply not good enough to precisely track objects. Refraction also displaces the position of the celestial pole and makes precise polar alignment more difficult.

Some other interesting and significant facts about how refraction affects an object's apparent position include:

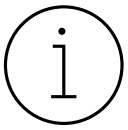
- For a sea-level site, the refraction at 45 degrees zenith distance (ZD) is about 60 arcseconds (one arcminute).
- Except low down in the sky, the refraction goes roughly as the tangent to ZD, so at ZD = 70 degrees, or, at 20 degrees above the horizon, it is up to 165 arcseconds. (It reaches *1800 arcseconds*, or 0.5 degrees at the horizon.)
- Refraction is proportional to pressure, so at high-altitude sites the refraction comes down significantly. For example, at Mauna Kea, 4,205 meters above sea level, the refraction is about 60 percent compared to sea level.

- Refraction is roughly inversely proportional to absolute temperature, so at –5 °C the refraction is about 10 percent more than at 20 °C.
- Humidity has little effect in the optical, though it matters a lot at radio wavelengths.
- The color of the observed object matters, blue being refracted a few arcseconds more than red at ZD 70.

Refraction also becomes an important consideration when taking unguided exposures at modest or longer focal lengths. It effectively alters the "sidereal tracking rate" and, left uncorrected, produces star elongation. The Paramount-specific ProTrack™ feature uses the TPoint pointing model to update the telescope's position to product pinpoint stars.

- TPoint's Super Model feature and Polar Alignment Report automatically determines the position of the refracted pole and gives recommendations on how to proceed, including how much to rotate the altitude and azimuth knobs when adjustment is necessary.
- TPoint accounts for and applies refraction when acquiring telescope calibration data as well as corrects the telescope's position when the mount is slewed.
- TPoint's ProTrack™, based on the point calibration data (page 182), continuously updates the mount's position in both *hour angle* and *declination* to compensate for tracking errors that are caused by refraction, tube flexure, and other systematic errors.

Polar Alignment Basics



For optimal tracking performance, the polar axis of a GEM should be aligned to the *refracted pole* to within about 100 arcseconds.

Without a TPoint model and ProTrack™ engaged, if the mount's equatorial axis is not "closely" aligned with the celestial pole…

- Stars will drift in of the field of view, mostly in declination; more quickly when polar alignment is particularly poor.
- *TheSky Professional* knows where the mount is pointing through a process called *pointing calibration* (or calibration for short). Telescope calibration is the process of slewing the mount to different mechanical positions and recording the pointing error at each position. Once at least six calibration points are collected, a TPoint model can be created to correct the telescope inherent pointing errors. With no calibration, the mount's position will be wrong, or "skewed" in part by the amount of the polar alignment error. (There are several other mount geometry errors that affect pointing and tracking performance.)

  For example, if the mount's polar axis is ten degrees below the celestial pole in altitude, then the resulting calibration positions computed by *TheSky Professional* will be wrong by at least this same amount in declination. The result is that the mount will not point or track stars accurately.

After collecting a minimum of six calibration points, a basic TPoint model comprised of the six fundamental geometric errors is generated and the pointing accuracy is greatly improved on subsequent slews. As more calibration points are collected, the TPoint model better characterizes the repeatable errors in the telescope. After about 50–100 calibration points, TPoint can create a model that produces exceptional pointing and tracking.

- With fewer than six calibration points, the mount's pointing accuracy will be disappointing, especially when the telescope changes sides of the pier.

These may make you frustrated with the performance of your Paramount and leave you wondering, "What am I doing wrong?" Mastering polar alignment techniques described below (or using your preferred polar alignment technique) and pointing calibration is crucial to achieve optimal mount performance.

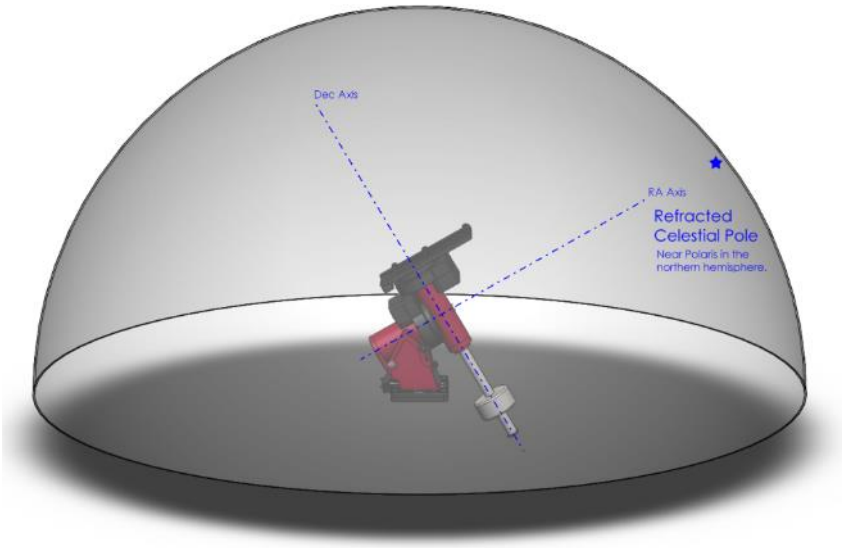


Figure 8: Paramount aligned with the refracted celestial pole in the northern hemisphere.

Software Bisque recommends the following polar alignment methods to ensure efficient and optimal polar alignment.

Step 1 Use *TheSky Professional's* "Rough Polar Alignment" feature (page 114) to align the mount's polar axis to within 10-15 arcminutes of the pole. This step can be performed during daylight hours using the Sun with proper solar filters on the telescope.

Step 2 Use the TPoint module's ***Accurate Polar Alignment*** feature to align the mount's polar axis to the pole using a fiducial star.

-Or-

If the celestial pole is visible, and you have a polar alignment scope, use it to roughly

align the mount to the celestial pole.

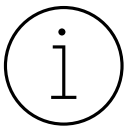
See "How to Polar Align" on page 114 for the best ways to achieve optimal polar alignment.

Homing

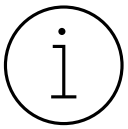
Homing is an automated process where the Paramount is slewed to a fixed mechanical orientation after the control system has been powered on. The homing process can be initiated from TheSky Professional by issuing the Find Home command, or by double-tapping the hand paddle's joystick button.

When the homing process is completed successfully, a fixed mechanical orientation of the mount is established to within a few arcseconds, and the control system initialized at this "zero point."

When the homing process is successful, a Paramount mount *must always point to the same hour angle*. If successful homing produces the unexpected mechanical orientation, then something is wrong with how the mount is attached to the pier, or how the telescope is attached to the mount, or the optical homing sensors are not operating normally, or the TheSky Professional's location and time settings do not match the observing site, and corrective measures must be taken.



Please carefully read the following to avoid falling into the common "*my mount is not homing to the correct position*" dilemma.



Homing is *not required* for Paramount mounts equipped with on-axis absolute encoders.

Once the mount is successfully homed, the previous session's pointing model is applied, and the mount knows its orientation and effectively has the same pointing accuracy as the last observing session.



For the Paramount Series 6 mounts, the home position varies by model.

Series 6 Model	Home Position
MYT MX	Hour angle: 0.0 Dec: 0.0
ME	Hour angle: 2.0 Dec: 0.0

The home position is a *fixed, mechanical orientation* and *cannot change*; it is defined by the *physical position* of the gears relative to fixed internal homing sensors. See "Physically Marking the Home Position" on page 37 for a simple procedure to demonstrate the mount's absolute home position.

- After successfully finding home, if the hour angle and declination axes are not correct,

then either the Versa-Plate, or telescope is mounted incorrectly, or the mount's polar axis is not oriented north-south.

- If, shortly after the homing process is completed, the coordinates of the telescope cross hairs displayed by *TheSky Professional* are other than what is listed above, then double check that *TheSky Professional's* location, date, time, or time zone settings are correct.



For Paramount's without on-axis absolute encoders, the mount must be successfully homed before it can be slewed. Also, the mount will not start tracking at the sidereal rate until it has been homed.

When the ***Find Home*** command is issued from the hand controller (by double-tapping the joystick button, see page 111 for details) or from *TheSky Professional* (page 121), the mount slews to the home position which establishes the baseline or "zero point" the control system uses going forward.

Subsequent observing sessions use *TheSky Professional*'s local sidereal time to determine the mount's equatorial coordinates. For optimal pointing accuracy, always make sure the computer's clock maintains accurate time (page 39).

For mounts not equipped with on-axis absolute encoders, homing provides the following benefits:

- Once a mount is aligned with the celestial pole and homed, repeatable and accurate pointing from night to night can be achieved using *TheSky Professional* and the *TPoint module*.
- After homing, the control system establishes the mechanical orientation of the mount and will only slew to the software slew limits (see "Mount Slew Limits" on page 165).
- The control system's periodic error correction (PEC) uses this information to calibrate the internal PEC table with the orientation of the worm gear.
- The mount's orientation can be restored after power outages or other communication malfunctions.
- The home position can be used to help roughly align the polar axis to the celestial pole (see "Rough Polar Alignment" on page 114).

Labeling the Home Position on the Sky Chart

Calibrating the mount (page 39) on the wrong star or configuring *TheSky Professional* to use the wrong location, date, time, or time zone for your location means the Paramount will be "lost in space." The telescope cross hairs on the Sky Chart appear at the "wrong" coordinates and the mount does not slew to the correct coordinates when commanded to do so.

If the coordinates of the telescope cross hairs do not match the actual physical orientation of the Paramount, or the mount does not slew to the correct coordinates, you will be scratching your head wondering what is wrong. The next step is to post a support question asking, "Why is my mount pointing to the wrong coordinates?"

For this reason, Software Bisque recommends creating a "user-defined" label on the Sky Chart that shows the location of the mount's *home position* (page 150) on the Sky Chart to serve as a visual reminder of where the telescope cross hairs *must be* after successfully finding home.

If, after homing the mount, the telescope cross hairs that are displayed on the Sky Chart are not, either *TheSky Professional's* site information is wrong.

To Label the Home Position in TheSky

1. From *TheSky Professional*, click **Input**, **Location** and make sure the settings on the **Custom** tab match your observing site.
2. Click **Tools**, **Verify TheSky Time** to make sure your computer's time matches an independent time source.
3. Click **Telescope**, **Connect** to establish communication with the mount. The mount's **Status** text on the **Telescope** window will show Not Homed.
4. On the **Telescope** window, click **Startup**, **Find Home** to slew to the home position.
5. From the **Telescope** window, click the **Tools**, **Turn Tracking Off**. This turns the mount's sidereal tracking off to keep the mount at the home position.
6. Click **Telescope**, **TPoint Module**.
7. On the **Setup** tab, turn off the **Apply Pointing Corrections** checkbox and click ***Close***. TPoint changes the position of the cross hairs based on the model, and the goal here is to display the telescope's unmodeled position.
8. Click on the center of the telescope cross hair and note the altitude and azimuth of this position. This is the horizon-based coordinate of the home position.
9. Click **Input**, **My Chart Elements**.
10. Click **Add Object**, then press the Command button + click (macOS) or the Control button + click (Windows/Linux) with the cursor on the desired position of the home position on the Sky Chart. This adds a Reference Point element to the My Chart Elements list and to the Sky Chart.
11. Highlight this element in the **My Chart Elements** list and click **Edit**. Select **Horizon** and enter the Alt/Az coordinates of the home position from step #8. For the label, enter **Absolute Home Position**. Click **OK** show this Reference Point on the Sky Chart.
12. Restore telescope modeling. Click **Telescope**, **TPoint Module**. On the **Setup** tab, turn on **Apply Pointing Corrections** and click **Close**.

The Sky Chart now shows a label at the home position. To make sure the label is in the right place, on the **Telescope** window, click **Tools**, **Find Home** again.

Physically Marking the Home Position

If, after finding the home position, the cross hairs that are displayed on the Sky Chart are at the wrong coordinates, one or more of the following is probably true:

- The mount is not aligned to the celestial pole. (Believe it or not, Software Bisque has had support cases claiming that the mount was unable to point the telescope correctly, only to discover the Paramount was attached to the pier 180 degrees off.)
- The optical tube assembly is mounted "backwards" on the Versa-Plate.
- TheSky Professional's location, date, time, time zone or daylight-saving time settings are wrong for your observing site.
- The wrong star was centered in the eyepiece when the mount was calibrated. Improper calibration results in the telescope cross hairs to be displayed at the wrong spot on the Sky Chart.

Many come to the incorrect conclusion when the telescope cross hairs on the Sky Chart are wrong, there must be something wrong with the homing process. The homing process is reliable and rarely fails. The procedure below demonstrates that, after homing, the Paramount is *always in the same mechanical position*.

1. Home the mount.
2. On each axis, place a piece of masking tape over the rotating portion and cut the tape between the rotating parts of the mount. The "vertical" edges of the tape mark the home position in that axis.
3. Use the joystick (or TheSky Professional) to slew the mount to any orientation.
4. Double tap the joystick to find home again.



Figure 9: If you think Find Home is not working, mark the home position on both axes with masking tape as shown.

The Paramount will dutifully return to the identical position.

This "homing repeatability test" will hopefully provide confidence that, after finding home, the mount is always pointing to hour angle 0 and declination 0 (in the northern hemisphere) and will help narrow down the *actual causes* of pointing errors (most commonly, incorrect settings in *TheSky Professional*, incorrect Versa-Plate or telescope mounting, or poor polar alignment).

Session-to-Session Pointing Repeatability

In subsequent observing sessions, *TheSky Professional* computes the current equatorial and horizon coordinates of the telescope using the stored hour angle and declination of the mount and the local sidereal time.

Please verify the *repeatability* of the Paramount pointing before proceeding (this test assumes that the mount's polar axis is aligned with the celestial pole):

1. Turn the mount off.
2. Turn the mount on (this terminates communication between *TheSky Professional* and the *Paramount*).
3. Home the mount and wait for the process to complete.
4. From *TheSky Professional*, click **Telescope**, **Connect**. The telescope cross hairs appear at the home position.
5. Slew the mount to a nearby star. The mount should slew back to this star; that is, it should return to the same position in the eyepiece, video, or CCD detector. In practice, there may be small pointing errors that are introduced by mirror flop, or slight differences in time, so the star may not be in *the same* position, but it should be very close.

Note that during the process of polar alignment, you will be required to synchronize the mount several times (each time the mount is adjusted to a new altitude and/or azimuth). For permanent installations, once the mount is sufficiently aligned with the celestial pole, it should not have to be synchronized again unless the optical tube assembly or the telescope's physical mounting changes.

Portable setups must be recalibrated using the **Portable Recalibration** option, as described in *TheSky Professional* User Guide.

TPoint Calibration

All mounts are mechanically imperfect; TPoint, used by virtually every professional observatory on the planet, is the ideal software to correct the repeatable mechanical errors that degrade pointing and tracking. TPoint also corrects errors that have nothing to do with the mount, such as errors caused by atmospheric refraction and tube flexure (where the telescope behaves exactly like a coiled spring as it tracks across the sky).

As every mount is imperfectly different, TPoint needs mount-specific pointing calibration data. Pointing calibration involves slewing the telescope to various positions in the sky, then recording the known coordinates and the actual position the telescope ended up at each position.

TPoint uses this data to intelligently generate the optimal pointing model (called a Super Model) for the telescope system. The model is comprised of geometric and harmonic terms that define how the telescope behaves and calculates the root mean square (RMS) pointing metric.

A rigid system comprised of a Paramount mount atop a solid pier or tripod, with a well-mounted telescope that has a fixed mirror system should produce RMS all-sky pointing accuracies of 15 arcseconds or less. With ProTrack, a pointing model based on 100 or more pointing samples on the same system should produce 5 minute or longer unguided photos with round stars.

Use TheSky's *Automated Pointing Calibration* feature (**TheSky**, **Telescope**, **TPoint module**, **Calibration Run**, **Automated Pointing Calibration**) to collect the pointing calibration data for your imaging system. See *TheSky Professional User Guide* for details about TPoint calibration.

Verify Mount Initialization

When connected to a Paramount, the Sky Chart provides feedback to help verify the mount has been initialized correctly and identifies the regions near the meridian that have unique behavior when tracking or slewing. These two regions are described below. If these regions are both centered on the meridian, then the mount has most likely been properly initialized.

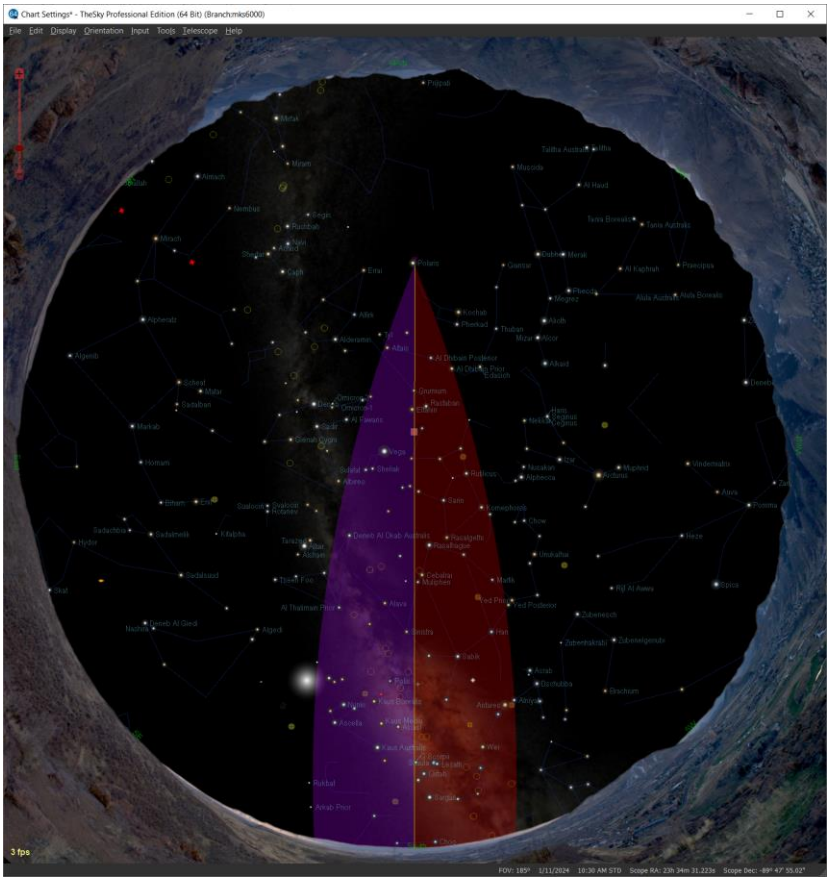


Figure 10: TheSky Professional showing overhead view with the purple and red meridian regions.

Purple Region

When the telescope is on the east side of the mount, the purple region (the region on the east side of the meridian) indicates the area where the mount can be slewed beyond the meridian without flipping sides. If the telescope is on the east side, and you attempt to slew beyond this region, the mount automatically flips sides.

Red Region

When the optical tube assembly is on the west side of the mount, the red region indicates how far past the meridian the mount can track before encountering a software or hardware limit. If the telescope remains on the west side and the mount tracks to the tracking limit, then mount tracking is turned off. Note that the Paramount will *not* automatically slew the telescope to the opposite side of the pier in this situation. The red region also indicates the area where, when the telescope is on west side, the mount can be slewed beyond the meridian, without requiring the telescope to slew to the opposite side of the pier.

The Local Celestial Meridian

The local celestial meridian is a great circle on the celestial sphere that runs from the zenith directly overhead to a point due South on the horizon, continuing around to the nadir (directly below) and back up to the zenith. This line divides the celestial sphere into east and west hemispheres.

To show the local celestial meridian in *TheSky Professional*, on the **Chart Elements** window, expand **Reference Lines and Photos** and turn on the **Meridian** checkbox.

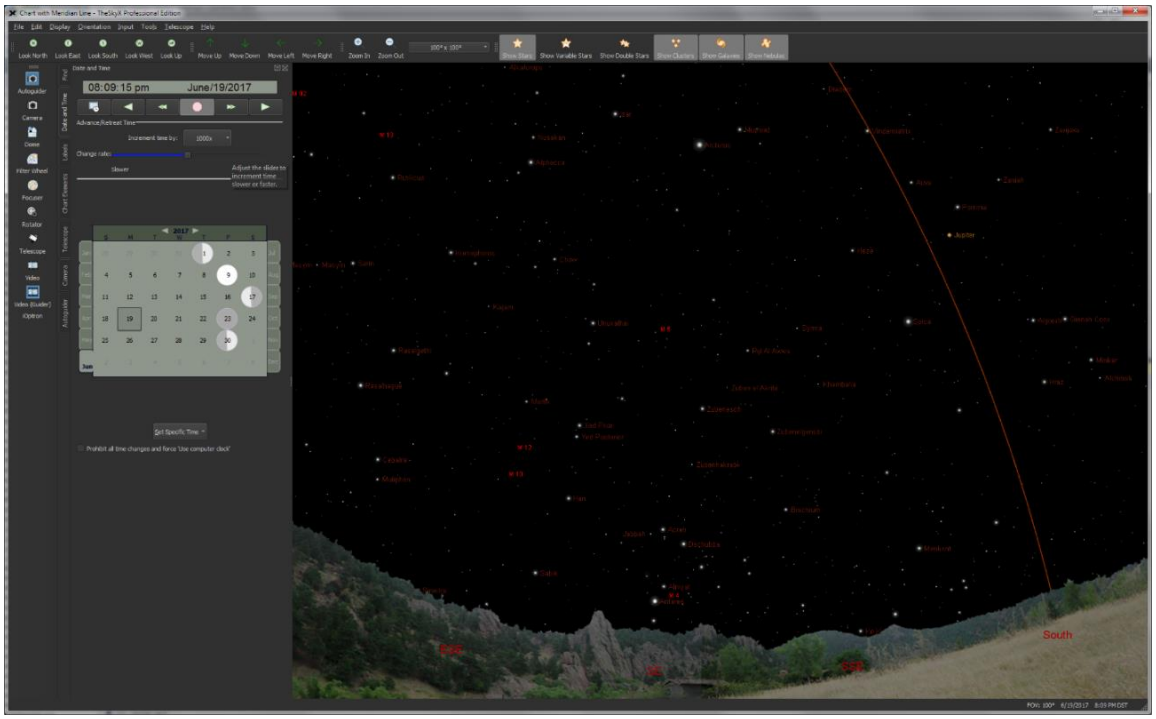


Figure 11: *TheSky Professional* with the meridian reference line turned on.

The arcing line on the Sky Chart in Figure 11 represents the local celestial meridian. When the Paramount MYT Series 6 and Paramount MX Series 6 are at the home position, the telescope is pointing directly at the meridian hour angle 0, declination 0 and the telescope is on the east side of the pier. The Paramount ME Series 6 home position is at hour angle 2, declination 0.

After successfully finding home, if the telescope is *not* in the expected mechanical orientation, or if the telescope cross hairs in the *TheSky Professional* are located elsewhere (by more than a few arcminutes or so), then one or more of the following may be wrong:

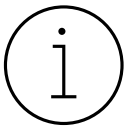
- *TheSky Professional* is not configured correctly for your location. Before continuing, make sure that *TheSky Professional's* location, date, time, time zone, and ***Daylight-Saving Option*** are correct.
- The Versa-Plate is mounted in the wide configuration (page 57) but the telescope is attached to the Versa-Plate in the standard orientation.
- The Versa-Plate is mounted 180 degrees off.

- The polar axis of the Paramount it not orientated north-south.

Make sure the mount is attached to the pier or tripod Versa-Plate is mounted in the correct orientation before proceeding.

Maintaining Accurate Time

The Paramount can provide accurate all-sky pointing during a single session without an accurate time base (that is, if the computer's clock is accurate to one or two minutes or so). However, *TheSky Professional* must make decisions on how to slew to various positions in the sky based on the local time. For example, an object that is on the east of the meridian may require the telescope to be slewed to west side of the pier and vice versa. So, maintaining accurate time is important.



Always perform "reality check" by comparing the coordinates of objects in TheSky Professional to objects in the night sky. If TheSky Professional's location or time is not accurate, the coordinates reported by TheSky Professional will not be accurate.

From TheSky Professional, click **Tools**, **Verify TheSky Time** to compare the computer's date, time, and time zone settings with an independent time source.

Initializing the Paramount requires accurate time. *TheSky Professional* uses the computer's clock to compute the local sidereal time (LST). When a connection is established between *TheSky Professional* and the "homed" Paramount, the LST is used to re-establish the synchronization between the Paramount's "electronic setting circles" and the celestial sphere to within a few arcseconds. Provided the computer's clock has been synchronized with a time server each night, you can power-up the mount, home, and then start observing.

Setting the Computer's Clock

The best method to maintain accurate time is to synchronize your computer's clock is with and external "time server." Remember, every *second of error in time* translates to *fifteen arcseconds of error in angular distance near the celestial equator*.

Inaccurate time causes the mount to slew to objects ahead or behind objects in right ascension by a consistent offset. Software that periodically synchronizes your computer's clock to an accurate time base solves this problem.

Applications that use the simple network time protocol (SNTP) can be used to maintain accurate time. Or most modern operating systems can be configured to maintain accurate time using an SNTP server. Windows users might consider Dimension 4 from Thinking Man Software. Search the web for "time server software" to locate alternatives.

Many SNTP applications can be used to maintain accurate time and most operating systems can be configured to update the computer's clock automatically. Windows users might consider Dimension 4 from Thinking Man Software. Search the web for "time server software" to locate alternatives.

Parking the Paramount

The ***Park*** command can be issued to the Paramount from *TheSky Professional* to perform the following:

1. The mount is slewed to the *park position*, which is a user-defined altazimuth mount orientation. Use the ***Set Park Position*** command to define the park position. See "*Defining the Park Position"* below for more information.
2. Once the park position is reached, sidereal tracking is turned off.

The ***Park*** command can be issued to the mount:

- Interactively from *TheSky Professional.* On the **Telescope** window, click **Shutdown**, **Park**. By default, when the Paramount is parked from *TheSky Professional*, the communication link between the Paramount and *TheSky Professional* is *not* automatically terminated. Click **Telescope**, **Connect** or, on the **Telescope** window, click **Shutdown**, **Disconnect Telescope** to terminate the connection
- From an external script using one of the two following methods:
    - The *sky6RASCOMTele::Park()* method slews the mount to the park position and terminates communication once the mount is successfully parked.

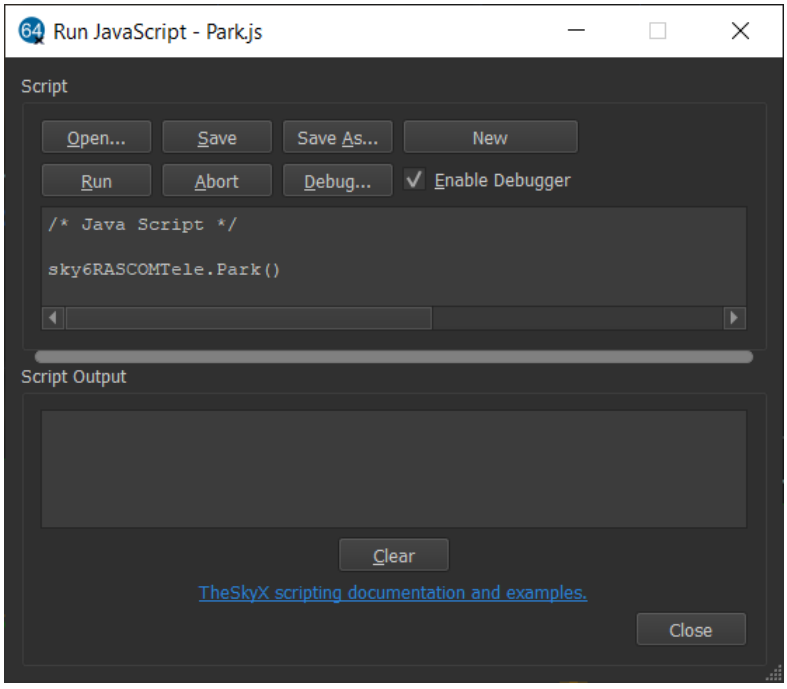


Figure 12: TheSky's Tools, Run JavaScript window showing a script calling the *sky6RASCOMTele.Park()* method.

    - The *sky6RASCOMTele::ParkAndDoNotDisconnect()* method slews the mount to the park position and *does not* terminate communication with the mount.

External scripts or third-party automation applications can customize the post-park behavior by calling the desired parking method above. For more information about scripted operation, see "*Script TheSky"* documentation at www.bisque.com/scriptthesky.

Parking Notes

- When connecting to a parked Paramount from TheSky, the **Unpark** is issued automatically. If a non-Paramount mount was parked using TheSky's ***Park*** command, it must be unparked first. On the **Telescope** window, click **Startup**, ***Unpark*** to do so.
- When unparked, the park position is *not* used to initialize the mount.

Defining the Park Position

Before the Paramount can be parked, a *park position* must be defined. The Paramount's park position is an absolute mechanical orientation the mount slews to when the ***Park*** command is issued.

1. Click ***Telescope, Connect*** to connect to the Paramount if necessary.
2. From the ***Telescope*** window, click ***Shutdown, Set Park Position***. When prompted to use the current telescope position as the park position, click ***Yes***.

The park position needs to be set once, and the mount is slewed there each time the ***Park*** command is issued.

Parking from TheSky Professional

To park the mount:

1. Click ***Telescope, Connect*** to connect to the Paramount if necessary.
2. From the ***Telescope*** window, click ***Shutdown, Park***. The mount immediately slews to the park position.

Unparking the Paramount

By default, when TheSky is connected to a parked Paramount, the mount is automatically unparked so that it can be homed.

Advanced Unpark Option

To prevent TheSky from automatically unparking the mount upon connection, open the current Imaging System Profile (by default, it is named ImagingSystem.ini) using a text editor. Under `[MKSDRIVER0]`, add the line `UnparkOnConnect=0`, then save the text file. The next time TheSky connects to the Paramount, you will be prompted to unpark the mount. To unpark the mount, from ***Telescope*** window click ***Tools*** pop-up menu, ***Shutdown*** (or ***Startup***), ***Unpark***.

Park Position Rules

The Paramount must be homed *before* the mount is parked and before the park position can be defied using the ***Set Park Position*** command. Otherwise, the mount will not return to the correct park position. See *TheSky Professional User Guide* for more information about telescope parking.

Audible Control System Feedback

Each time the mount is turned on the control system performs both an electronics and servomotor initialization, and emits different sounds based on the status of the control system.

- A short whistle is emitted immediately after the power switch is turned on and indicates successful initialization of the control system electronics.
- Two successive beeps (one for each axis) indicate successful motor initialization.

The three status LEDs on the electronics housing provide visual feedback of the control system initialization. See "Electronics Housing Components" on page 70 for details.

Control system initialization can be stopped by pressing and holding down the joystick button on the hand paddle when the mount is turned on, or by moving the joystick from the center position before the servomotor initialization is complete. In this situation, the mount emits a *single* beep. When initialization is interrupted for any reason, the mount will not slew or track. Before attempting to slew or home the mount after an interruption, return the joystick to the center position, power the mount off then on, and then wait for the two beeps that indicate the mount is ready for normal operation.

The table below describes the different sounds the mount may emit, when in the startup process each sound occurs, and describes what the sound means.

Sound	Occurs	Description
Short whistle	Immediately after turning the power on.	This sound indicates the control system has been successfully powered on.
Each axis emits a single beep	A few seconds or so after turning the mount on.	For each axis, a beep sound signals that the control system has successfully located the servomotor's starting index position. The mount is now ready to be homed. For each axis, exactly *when* the beep occurs depends on the angular distance between the motor's position when the mount was powered on and the motor index, or motor zero position. If both motors happen to be initialized simultaneously, you might hear

Sound	Occurs	Description
		only a single beep. When the three **Status** LEDs on the Electronics housing are illuminated (see "Visual Control System Feedback" on page 48), the control system is functioning nominally.
Single beep	When the servomotor initialization is interrupted, shortly after mount is powered on.	To initialize the control system, turn on the mount and listen for the whistle sound and two successive beeps, without attempting to control the mount via joystick or *TheSky Professional*. Servomotor initialization can be interrupted by the following actions. • Pressing and holding the joystick button down and turning on the mount. • Moving the joystick from its center position before the servomotors are initialized. • Attempting to slew or home the mount from *TheSky Professional* before servomotor initialization. • When one, or both, of the mount's axes is locked and prevents motor initialization (page 63).
One lower pitch tone and one higher pitch tone	Shortly after the mount has slewed to the home position in each axis.	Indicates that mount has successfully located the home position in both axes.
Continuous, successive, high-pitched beeps.	May occur when attempting to slew the mount or after issuing the Find Home command.	This sound indicates a control system error condition. *Something* is preventing the servomotors from rotating, so the motors cannot be initialized, or the mount cannot slew or track normally. Typical causes include: • The mount's axes are locked (pages 63, 88, 90). • The mount encountered a fixed object while slewing. For example, the counterweight shaft has run into a step stool that has been placed next to the pier.

Sound	Occurs	Description
		• The telescope is significantly out of balance and exceeds the maximum torque output of the motor. Make sure the telescope is balanced before proceeding. • Increased drive train torque demands during cold temperature operation can prevent slews. • The worm block spring plungers are too tight, causing the motors to stall.
Variable-pitched high-frequency hum	After motor initialization and whenever the mount is powered on and tracking, or when an external force is applied to either axis.	When the Paramount is turned on and initialized, the servomotors emit an audible, variable-pitched "humming" sound. This sound is the result of the control system checking and adjusting the position of the servomotors at 3,333 Hz and is normal. This sound and the pulsating TCS Status LED serve as audible and visual "heartbeats" of the mount and means that the electronics are powered and functioning normally. If you push against the mount, you can hear motors react and feel the control system pushing back in order to maintain the mount's current position.

Visual Control System Feedback

The three Status LEDs on the Electronics housing are illuminated based on the status of the control system. See "Electronics Housing Components" on page 70 for details.

Paramount Components

Please carefully review each Paramount component described below *before* attempting to operate the mount.

Paramount ME Front View

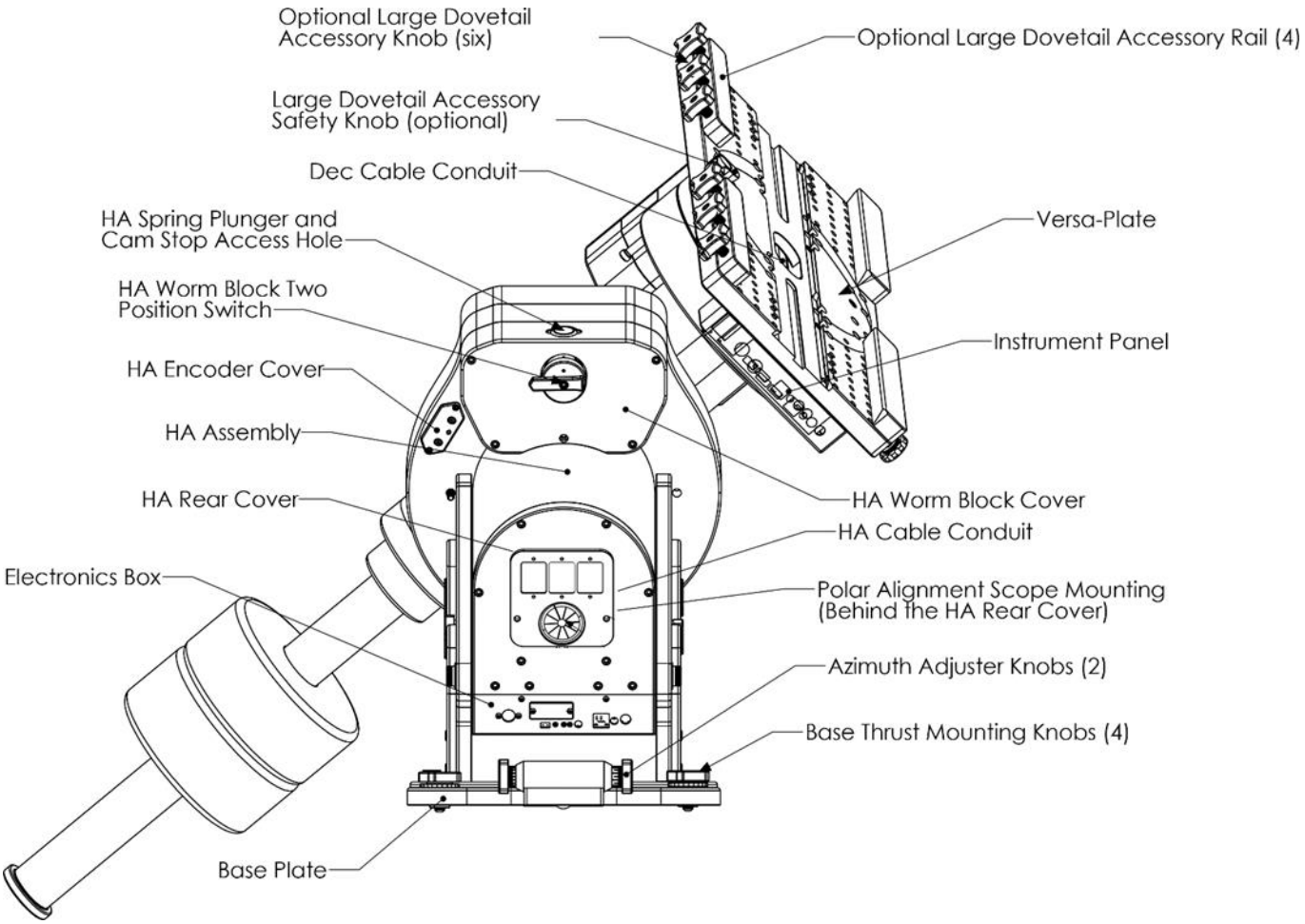


Figure 13: The Paramount ME front view.

Paramount MX Front View

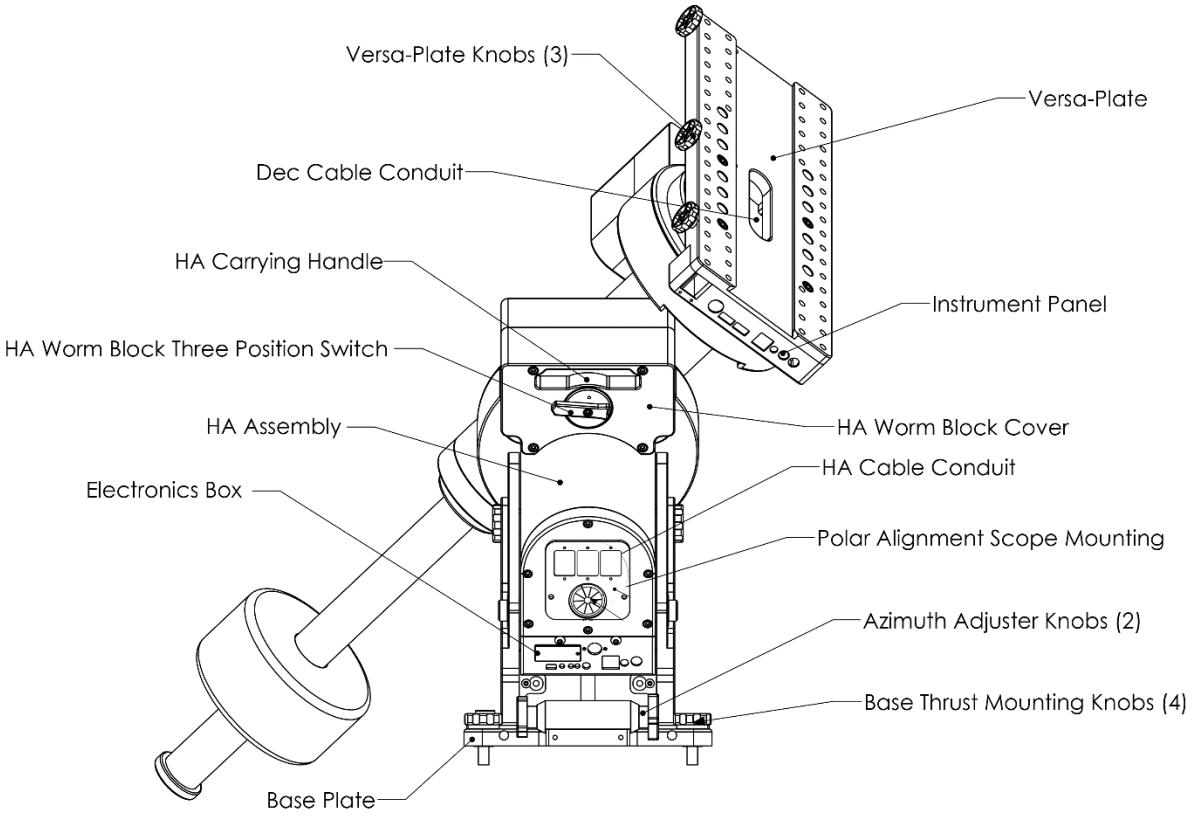


Figure 14: The Paramount MX front view.



Figure 15: The hour angle axis through-the-mount panel includes one XT60 power input connector, one passthrough Ethernet port and one customizable Keystone module.

Paramount MYT Front View

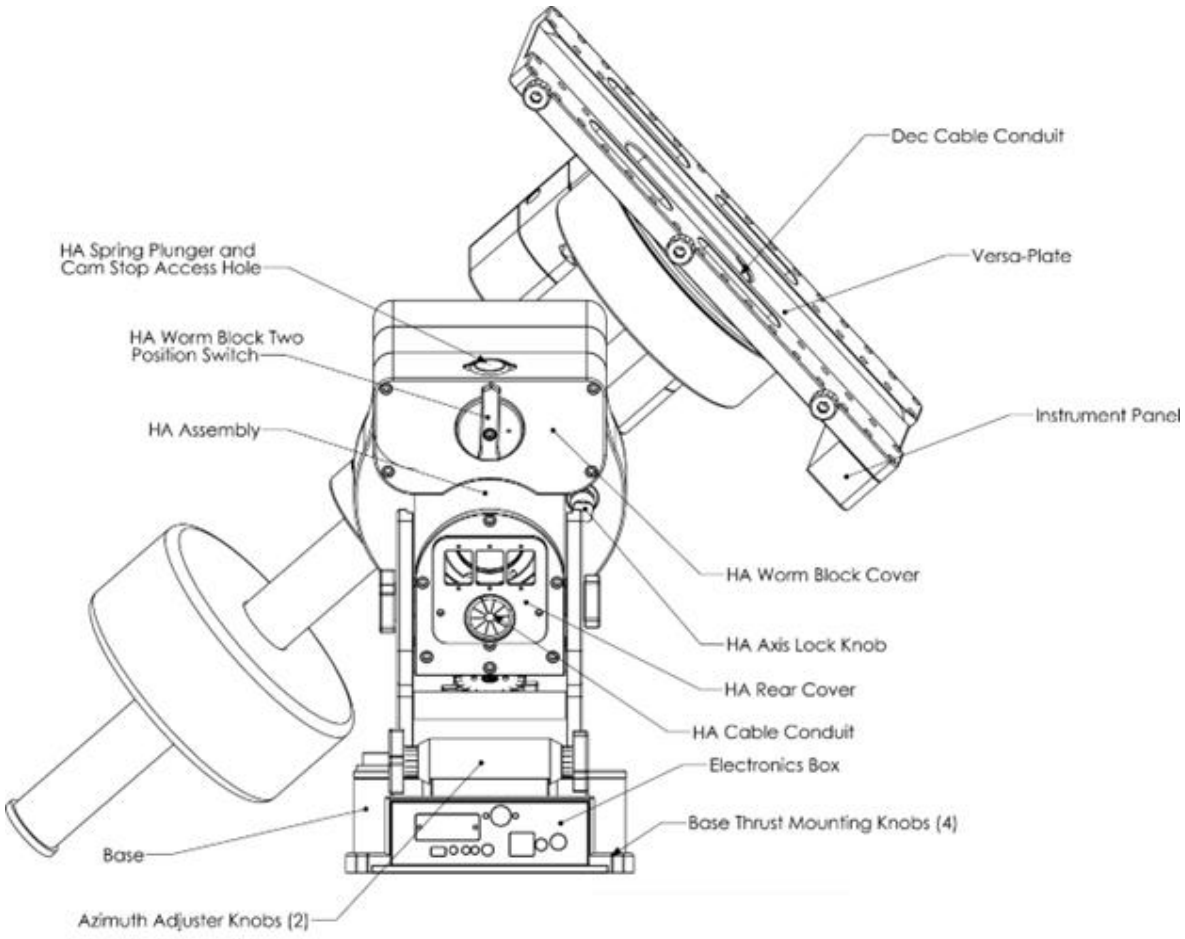


Figure 16: The front view of the Paramount MYT.

HA Worm Block Cover



Always keep hands and fingers away from the hour angle axis worm block cover!

A "pinch point" is created as the declination axis rotates past the hour angle axis worm block cover.

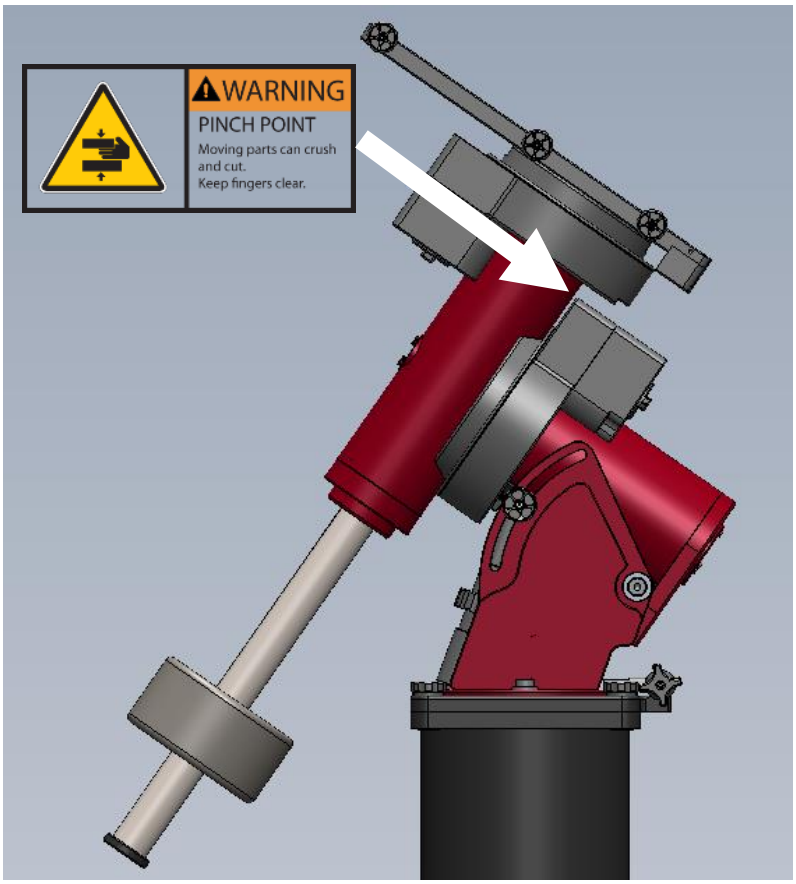


Figure 17: Caution: Always keep hands clear of this area!

Telescope Mounting Plate (Versa-Plate)

The Paramount comes with a Versa-Plate™ that provides a stable mounting platform for your telescope and other equipment. The telescope can be attached using the integrated, drop-in style Losmandy and Celestron dovetail, a telescope cradle, or telescope mounting rings. The Instrument Panel (page 58) mounted to the bottom rear of the Versa-Plate places three XT60 pass through power supply ports, and a pass-through Ethernet port near the telescope.

The Paramount ME offers optional Large Dovetail Rails for large telescopes. The rails attach to the top of the Versa-Plate and accept Planewave-compatible dovetails.

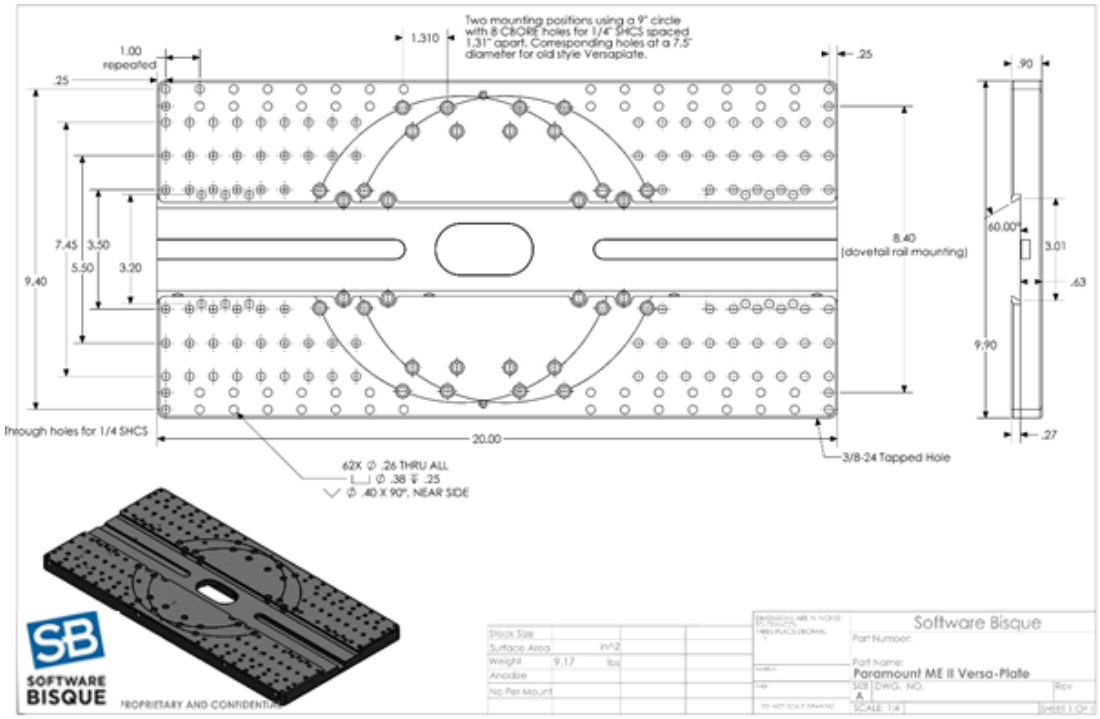


Figure 18: The Paramount ME Versa-Plate technical specifications.

The table below lists the most common hardware used to mount telescopes (or *optical tube assemblies*) and the advantages and disadvantages of each system.

Telescope Mounting	Advantages	Disadvantages

Losmandy-compatible Dovetail	• Mounting the telescope to the Versa-Plate is relatively simple.
	• Hardware is available, or integrated into telescopes from several different manufacturers, including:
	  ○ ADM Accessories
	  ○ Celestron International
	  ○ Losmandy Astronomical Products
	  ○ Meade Instruments
	  ○ Officina Stellare
		• Dovetails are not as rigid as telescope mounting rings. This can introduce flexures that may degrade overall pointing accuracy and repeatability.

Software Bisque OTA Mounting Rings	• Extremely rigid mount-to-telescope attachment. • Allows multiple optics to be rigidly attached to the Versa-Plate. • Accurate, reliable, and repeatable all sky pointing and tracking.	• More expensive.

Paramount Versa-Plate Knobs

There are four Versa-Plate knobs (up to six on a Paramount ME the optional Large Dovetail Accessory Rail) are designed to securely captivate a male Losmandy-compatible dovetail. Rotating each knob clockwise advances an angled brass plunger on the inside of the dovetail. The angled brass plunger wedges the male dovetail to the opposite side of the female dovetail to prevent any slippage or rocking of the payload, regardless of the mount's orientation.

To mount a telescope with a male dovetail to the Versa-Plate:

1. With the counterweight shaft oriented vertically, lock the hour angle axis in place.

Model	How to lock the axis…
MYT MX	Rotate the hour angle axis two position switch to the balance position (page 63) and pull and rotate the transport lock knob to the Lock position (page 63).
ME	Install the hour angle locking bolts and rotate the hour angle two position switch to the balance position (page 88).



The female dovetail on the Paramount MYT and MX Series 6 Versa-Plate is wider than the male dovetail that is attached to the telescope. This allows the telescope dovetail to be set on one edge of the Versa-Plate dovetail and secured with the brass plungers (without having to slide the dovetail on the telescope inside the length of the female dovetail).

When attaching the telescope, make sure to rotate the brass plungers on the Versa-Plate knobs are sufficiently tight so that the telescope is securely captivated before letting go of the telescope. If at least two of the Versa-Plate plungers are not sufficiently tight, the telescope can rotate and fall out!

2. After carefully reading the above warning, carefully lower the telescope's dovetail into Versa-Plate's dovetail and tighten the knobs.



Figure 19: The brass plunger compresses the male dovetail against the opposite side (from left to right in the above diagram).

3. *Tighten* each Versa-Plate knob by hand until the brass plungers securely hold the dovetail in place. While tightening the knobs, push the telescope dovetail in the same direction as the advancing brass plungers to make sure the dovetail plate is securely compressed against opposite side of the dovetail wedge (Figure 19). Also make sure the male dovetail plate is securely captivated by ***at least three*** of the four Versa-Plate Knobs before letting go of the telescope or testing balance in declination. Securing a heavy or expensive payload with fewer knobs may not be sufficient to hold the telescope in place. The length of the male dovetail varies by manufacturer. For best results and when the length of the male dovetail permits, always tighten all of the knobs to the hold the dovetail securely in place.
4. Test the declination axis balance, then slide the telescope as needed.
5. After the telescope is balanced and the knobs are hand tightened, re-secure each knob by inserting a 1/4-in hex wrench and tighten it an additional *one-quarter turn* ***only***. ***Do not over tighten these knobs or the internal threads can be damaged.*** Note that when two or three of the knobs are "hand tight", the dovetail will not slide. The final 1/4 turn with the hex wrench ensures that your heavy and expensive payload is mounted securely and will not move when the mount slews to different mechanical orientations.

Versa-Plate Mounting Positions

The Paramount MYT, MX, and ME Versa-Plate can be mounted to the top of the declination axis in four different positions to move the balance point for different payloads. The gray circles in Figure 20 represent the top of the declination axis at each mounting position.

If your payload is "camera-end heavy," attach the Versa-Plate at the forward most position so that the payload can be more easily balanced. Remove the six 1-inch socket head cap screws (SHCS) using a 3/16-in hex wrench, then adjust the position of the Versa-Plate accordingly. The mounting position depends on your equipment, so there may be a bit of trial and error to find the optimal position. The four SHCS should be tightened snugly so that the Versa-Plate cannot wiggle or shift when carrying the payload, but not overly tight.

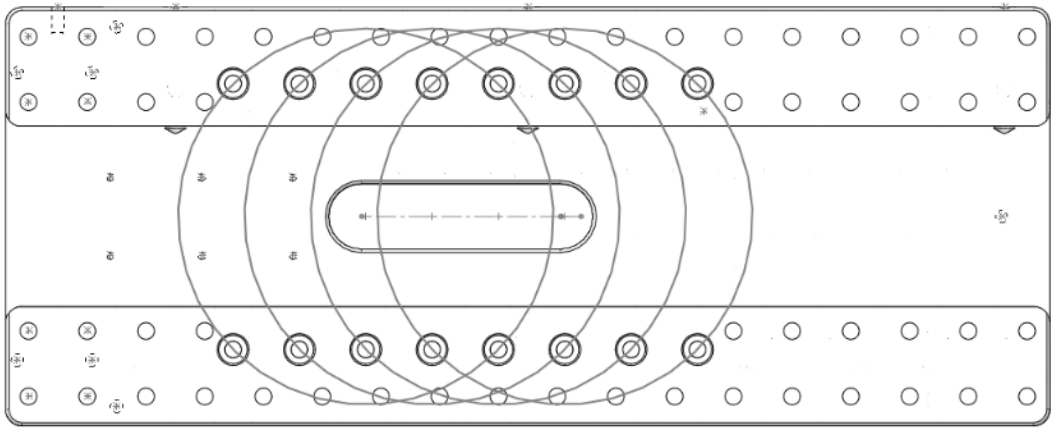


Figure 20: Machined circles mark the four mounting positions on the Paramount MYT and MX Versa-Plate. The Paramount ME's Versa-Plate has two mounting positions.

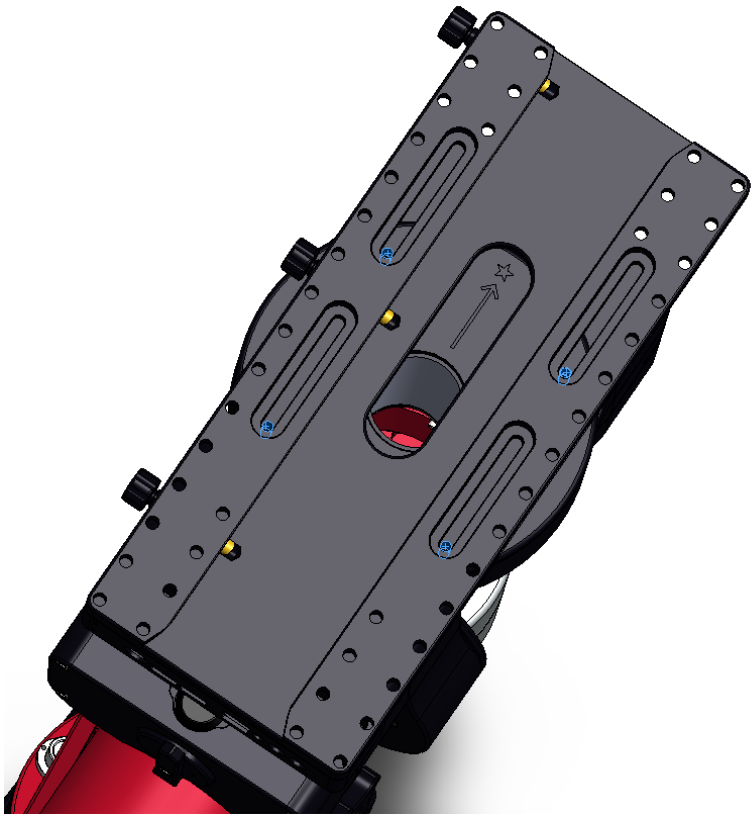
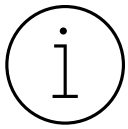


Figure 21: The machined slots in the Paramount MYT and MX Versa-Plates allow the payload to slide fore and aft to achieve balance in declination.

The Paramount MYT and MX Versa-Plate is slotted to change the balance point of the payload in declination. To do so, loosen the four ¼-20 SHCS screws using a 3/16-in. hex wrench, then slide the Versa-Plate to the desired position. Once balance has been achieved, snugly tighten each screw enough so that the Versa-Plate does not rotate or shift during mount slews, but not so tight as to deform the washers.

Standard Versus Wide Mounting Versa-Plate Orientation

The Paramount is shipped with the Versa-Plate in the *standard orientation*. In this orientation, the optical axis of the telescope is parallel to the long axis of the Versa-Plate. In the wide orientation, the Versa-Plate is rotated 90 degrees from the standard orientation, so that the telescope's optical axis is perpendicular to the long axis of the Versa-Plate. This orientation can accommodate side-by-side telescopes.



The Instrument Panel is attached to the end of the Versa-Plate. Typically, you will want to mount the optical tube assembly to the Versa-Plate so that the eyepiece or camera end is as close to the Instrument Panel as possible. Doing so offers the shortest cable route between powered accessories that are mounted to the draw tube and the power ports on the Instrument Panel.

The standard Versa-Plate mounting configuration works well for Schmidt-Cassegrain, Ritchie-Chretien, and refracting telescopes where the "business end" naturally places equipment near the Instrument Panel.

For Newtonian telescopes and other optical designs, where the camera and other accessories are located toward the "front" of the telescope, the Instrument Panel can be attached to the opposite end of the Versa-Plate.

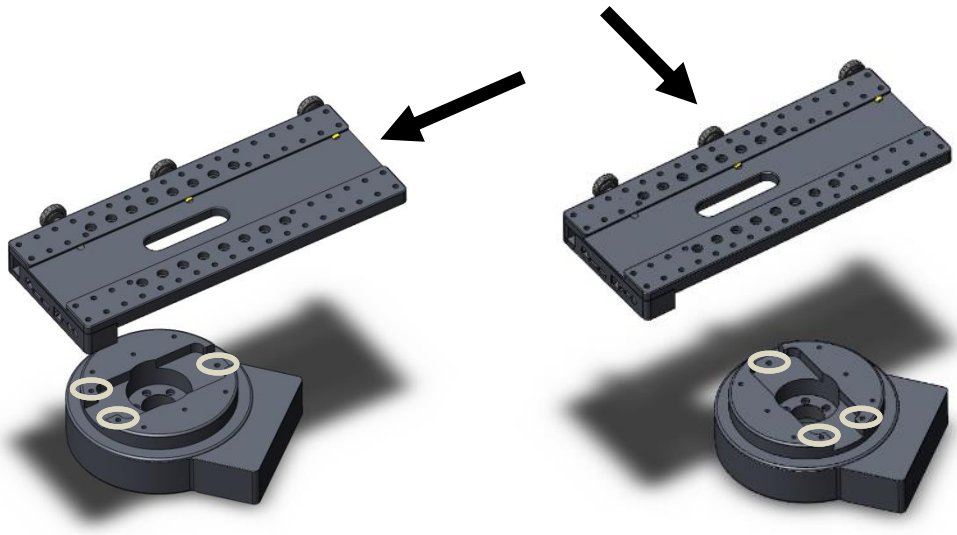


Figure 22: The standard (left) and wide (right) Versa-Plate mounting orientations for the Paramount MX.

Figure 22 shows one standard and one wide orientation of the Versa-Plate, relative to the top of the Paramount MX declination axis. For each orientation, the black arrow shows the direction that *incoming light* from stars will pass through the telescope.

When mounting the Versa-Plate on the Paramount MX, pay very close attention to the mounting holes on the top of the declination axis. The three circled holes in Figure 22 form a triangle that must point toward the stars, or, in the *opposite* direction of the telescope's incoming light.

Notice that for the both the standard and wide orientations, there are symmetrical mounting holes on the top of the declination axis that allow the Versa-Plate to be attached 180 degrees apart; either one can be used, depending on your needs. However, when mounting the telescope, make sure to maintain the relative orientation between the top of the declination axis and the direction of incoming light described above. Otherwise, the telescope will not point in the correct direction.

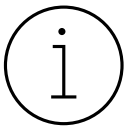
To help make sure the Versa-Plate is mounted properly, early model Paramount mounts had an arrow machined into the top of the declination axis that represented the *direction of incoming light*. The top of the declination axis on later model Paramount ME, Paramount MX mounts, and all Paramount MYT mounts have an *arrow and star* machined into the top of the declination axis (Figure 22). The *arrow points at the stars.* The optical tube must be mounted parallel to this arrow, with the light gathering end (the *entrance pupil*) of the telescope located in the direction the arrow is pointing.



If the telescope is attached to the Versa-Plate such that the light-gathering end is not parallel to the direction of incoming light for the declination axis, the mount will not be at the correct home position.

To change the orientation of the Versa-Plate from the standard to the wide configuration:

1. Remove the six 1-inch ¼-20 3/16 socket head cap screws on the top of the Versa-Plate.
2. Rotate the Versa-Plate 90 degrees. The top of the declination axis has "indentations" to accommodate the Instrument Panel-specific and custom through the mount cabling.
3. Align the mounting holes on the Versa-Plate with the mounting holes at the top of the declination axis and replace four of the six screws. Only four socket head cap screws are used in the wide orientation.
4. When mounting the telescope, make sure that the direction of incoming light for the telescope corresponds with the required direction of incoming light for the declination axis as described above.



Mounting the Versa-Plate in the wide orientation reduces the cross-sectional area for cabling to pass through on the top of the declination axis by about one-third. While there is still some space for the standard cables and a few custom cables, be aware that there is less "wiggle room" compared to the standard orientation.

Software Bisque manufactures and sells an optional *Paramount ME Dec Axis to Versa-Plate Spacer* that provides additional room for through the mount cabling. See *Versa-Plate Spacers (Paramount MYT and ME only, Optional* Accessory) on page 59 for details.

A simple test to make sure the telescope is attached properly is to home the mount. Once the homing process is completed, if the telescope is not pointing at the correct hour angle and declination, the telescope is attached incorrectly. To correct this situation,

1. Remove both the telescope and the Versa-Plate.
2. Double-check the orientation of the Versa-Plate with the top of the declination axis.
3. Double-check the direction of incoming light with the orientation of the three holes on the top of the declination axis (Paramount MYT) or the machined arrow on the top of the declination axis (Paramount ME and Paramount MX).
4. Rotate the telescope and/or Versa-Plate and remount them so that these three components are properly aligned. If necessary, home the mount with no payload and no Versa-Plate attached, then appropriately reattach both.

Versa-Plate Spacers (Paramount MYT and ME only, Optional Accessory)

Software Bisque offers optional spacers that can be used when the Paramount MYT or ME Versa-Plate is mounted in the wide orientation. When mounted to the top of the declination axis, the spacers create a channel through which instrument cabling can be passed. Spacers can also be used in the standard position allowing more "clearance" for instrument cabling. To find this accessory on the Software Bisque Store, in the ***Product Search*** field at www.bisque.com enter ***Spacer***.

Large Dovetail Rail (Paramount ME only, Optional Accessory)

The Paramount ME can accept optical tube assemblies with a PlaneWave Instruments dovetail mounting plate using the optional Large Dovetail Accessory Rails. Four "rails" and the rotating safety knob mount directly to the existing Versa-Plate and offer six mounting knobs to securely attach and carry 20-inch class optical tubes. The safety knob allows a heavy optical tube assembly to be mounted by placing one edge of the male side of the dovetail into place, then rotating the telescope to meet the other side, rather than having to slide the entire payload along the length of the dovetail. Once the telescope is in place, rotate the safety knob to *temporarily* captivate the telescope and then proceed to tighten each Versa-Plate knob until the telescope is secure.

HA Rear Panel Components



Figure 23: The Paramount MX HA rear panel components.

Table 1: The through-the-mount panel components.

Number	Description
1	When connected to an external power source, the yellow male XT60 plug supplies power to the three female XT60 connectors on the Instrument Panel. The power supply unit must have a female XT60 connector for the output.
2	The RJ-45 port accepts a CAT6 cable to provide pass-through Ethernet to the Instrument Panel's Ethernet port.
3	This is a customizable L-COM Keystone connector.

Number	Description
4	Access hole for custom through-the-mount cables.

L-COM Keystone Panel Adaptors

The L-COM Keystone connector on the HA Rear Panel is designed to make adding a custom through mount cable easier to install, and simpler to disconnect from the mount. The L-com webpage (http://www.l-com.com/Adaptors) has cables, connectors and adaptors that can be used to tailor this port to your needs.

Instrument Panel



Figure 24: Photograph of the Instrument Panel connectors.

Instrument Panel Housing

Compared to the Paramount MYT and MX, Paramount ME's Versa-Plate includes a physical pass-through hole that can be used to house additional cables that run from the declination axis to the telescope.

Model	Instrument Panel
MYT MX	Integrated circular cable pass through hole.
ME	Integrated cable pass through with two 4-40 threaded holes to secure the cabling to the Instrument Panel.

Instrument Panel Ports

The Instrument Panel has three XT60 pass through power ports that can be used to power devices at the telescope, and a pass-through Ethernet port to connect, for example, a single-board computer to your local network.

Powering Devices (Power Out 1, 2, and 3)

The female XT60 connectors on the Instrument Panel are powered by plugging a 12V DC power supply into the male XT60 connector located on the through-the-mount panel. These ports are not powered otherwise.

XT60 connectors are rated up to 500V at 30A DC (15,000W maximum) and can be used to power a variety of DC-powered astronomical devices, including dew heaters, video cameras, and other instruments.



The Paramount external power ports and through the mount cabling are intended to be used with direct current (DC) power sources only.

Never attempt to power devices through the mount with an alternating current (AC) power source.

HA Worm Block Cover

The HA worm block cover incorporates the following features:

- Protects the internal hour angle worm block components from dust and debris.
- Provides a convenient handle to grasp when lifting the mount.
- Houses the hour angle axis two position switch (page 63).

HA Cable Conduit

This access hole in the hour angle shaft allows custom cables to be passed through the mount. See "Through the Mount Cabling" on page 48 for more information.

This access hole is dome-shaped to serve as an integrated carrying handle and is covered by the RA Gear Cover.

HA Gear Cover (ME Only)

The HA gear cover provides an access hole for through the mount cables.

Dec Cable Conduit

This access hole in the declination shaft allows custom cables to be passed through the mount. See "Through the Mount Cabling" on page 48 for more information.

Hour Angle Carrying Handle

Use the integrated carrying handle to lift the mount. On the Paramount MX, place the two-position switch in the lock position before lifting the mount. The Paramount ME's HA cable conduit access hole is dome-shaped and serves as the integrated carrying handle (remove the HA Gear Cover to access it). The Paramount MX has no integrated carrying handles but the space underneath the electronics housing is a convenient place to grasp when lifting and carrying the mount.

HA Worm Block Switch

The Paramount's HA and Dec Axis have an arrow-shaped knob as part of a rotatable, mechanical two-position switch. Each position places the mount in a different operational state as shown in the figures below and described in the table below.

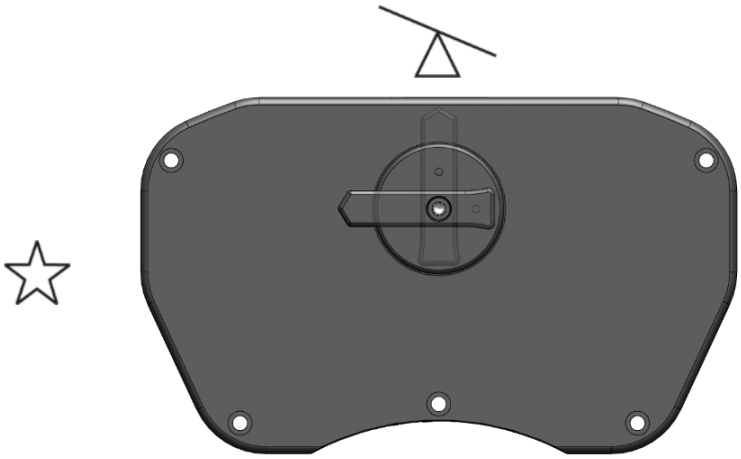


Figure 25: The Paramount ME two position switch.

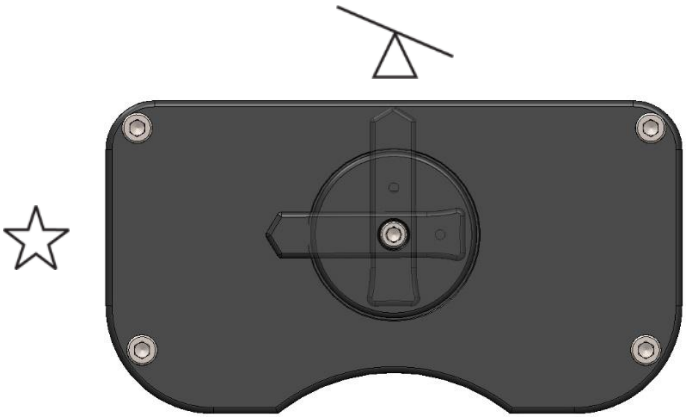


Figure 26: The Paramount MYT and MX two position switch.

Model	Mechanical Switches

MYT MX	When the two-position switch (Figure 26) is in the balance position, the worm and gear are separated, so the axis can rotate freely. When the switch is rotated to point at the star (Track position), *and* the transport lock knob is in the unlock position, the mount is ready for normal operation. Notes: • The transport lock knob is slightly recessed in the lock position. • The transport lock knob should always be rotated clockwise when locking or unlocking the axis.
ME	When the two-position switch (Figure 25) is in the balance position, the worm and gear are separated so the axis can rotate freely. When the switch is rotated to point at the star, the mount is ready for normal operation. For the Paramount ME, separate locking bolts must be installed to lock the axis in place. See "Hour Angle Axis Locking Holes (Paramount ME Only)" on page 88 and "Declination Axis Locking Hole (Paramount ME Only)" on page 108 for details about locking the Paramount ME axes.



ADJUSTING THE PARAMOUNT'S MECHANICAL SWITCHES <u>ALWAYS</u> REQUIRES BOTH HANDS!

Rotating the Two or Three Position Switch for both the RA axis and the Dec axis requires the use of both hands to prevent sudden or unexpected rotation of the mount.

- Before rotating the Dec Axis Two or Three Position Switch with your right hand, firmly grasp the Versa-Plate with your left hand to prevent sudden rotation of this axis from an unbalanced payload.
- Before rotating the RA Axis Two or Three Position Switch with your right hand, firmly grasp the Counterweight Shaft with your left hand to prevent sudden rotation of this axis from an unbalanced payload.

When the switch is rotated to, or passes through the balance position, the axis will rotate freely. Unexpected rotation of either axis due to an unbalanced payload can cause personal injury or serious damage to the mount!

Always use extreme caution and please, always use BOTH HANDS!



Track Position: Rotate the arrow on the switch fully counterclockwise to engage the worm with the gear. This position is used during normal mount operation.

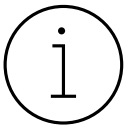


Balance Position: Rotate the arrow on the switch to the center position to disengage the worm from the gear so that the axis rotates freely.



Balancing either the hour angle or declination axis of the Paramount always requires both hands!

This position is for balancing the payload and is the recommended position to place the switch *after* the mount has been placed inside the shipping container box and while the mount is being transported. If the mount is subjected to a severe impact during shipping, both axes will rotate freely. Unrestricted motion in each axis can help minimize damage to the worms and gears.



For Paramount's without absolute on-axis encoders, the mount must always be homed after balancing either axis! Otherwise, the mount will be "lost in space" and potentially slew beyond the mount's slew limits.

Lock Position (Paramount MX and MYT): Rotate the Three Position switch fully clockwise to separate the worm from the gear *and* lock the axis in place. Always lock both axes before lifting the mount.



An axis can be locked to any position, at 10-degree increments. Note that physically rotating the switch to the lock position inserts an internal *locking shaft* into one of 72 *locking holes* that are machined into the internal gear. You will usually need to wiggle the axis a few degrees back and forth to align the locking shaft with one of the locking holes. When the shaft enters the hole, the entire Three Position Switch will drop slightly into worm gear cover. Once locked, the axis can no longer rotate.

Rotating the switch away from the lock position causes the locking shaft to be removed from locking hole and the axis will rotate freely. Note that the entire switch itself will rise slightly out of the worm block cover as a result.

Unlock Position (Paramount MX and MYT): Pull out and rotate the transportation lock knob 90 degrees ***clockwise*** to lock/unlock the axis. While this knob can be rotated in either direction, always rotate it clockwise as *counterclockwise rotation may cause the knob head to become loose*. Always lock both axes before lifting the mount.



Each axis can be locked at any position, in five-degree increments. Note that physically rotating the switch to the lock position inserts an internal *locking shaft* into one of seventy-two *locking holes* that are machined into the internal gear. You will usually need to gently rotate the axis a few degrees back and forth to align the locking shaft with one of the locking holes. When the shaft enters the locking hole, the entire transport lock knob will drop slightly into worm gear cover. The axis will not rotate when the knob is in the lock position, even if the two-position switch is in the Track position.

Pulling out and rotating the knob 90 degrees allows the axis to rotate freely. Note that the entire knob will rise slightly out of the worm block cover in the unlocked position.

HA Spring Plunger and Cam Stop Access Hole (Paramount ME and MX Only)

This hole provides access to the spring plunger and cam stop adjustment. To access this document, visit www.bisque.com, ***My account, Log in***, then click ***Support, Downloads, Documentation,*** and search for *Paramount MX Cam Stop Adjustment Instructions*.

HA Encoder Cover (Paramount ME Only)

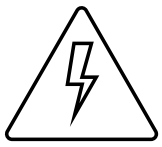
This cover provides access to the absolute encoder module.

HA Assembly

The hour angle assembly houses an internal shaft that can be used to install custom cables through the mount.

Through the Mount Cabling

Digital imagers are familiar with the cabling "madness" that occurs when a myriad of devices, including cameras, focusers, filter wheels, focusers, rotators, dew heaters, etc., are connected to the telescope. The Paramount mount's standard through the mount cabling, and through the mount cabling conduits can be used to help tame cabling chaos.



The Paramount cable conduits are intended to house cables that carry *low voltage* and relatively *low direct current* (DC) power, only.

- Software Bisque recommends 12 AWG through the mount cables that carry a maximum of +12V DC, 5.0A (60W max).
- ***Never install through the mount cabling that carries an alternating current (AC) power source; for example, +120V or greater at any amperage.***



Always keep fingers clear from the cable conduit access hole!

- As the declination axis rotates, an internal shaft inside the declination assembly is also being rotated by a high-torque servomotor.
- When balancing the declination axis (page 63), this internal shaft can rotate freely, and may do so with a high angular velocity when the mount's payload is even slightly out of balance.

In both cases, the rotating internal shaft creates a potentially dangerous pinch point with the outer declination axis assembly that can cut, crush, or sever fingers.

Always keep fingers clear during mount slews and use extreme caution when routing cables through the mount or aligning the declination shaft's "through-hole" during polar scope alignment.

The Paramount is designed for custom cables to be passed through the mount, entering at the cable conduit through the hour angle and declination axis up to the top of the declination axis and out to the Instrument Panel. Routing cables through the mount has many advantages, particularly during remote operation.

Many imaging systems have multiple cables draped from somewhere near the telescope to the observatory floor. These cables are prone to snag on "something" as the telescope slews from one part of the sky to another and often cause problems that require human intervention. Running the cables through the mount mitigates these and other cable-related issues.

Routing Cables through the Paramount ME

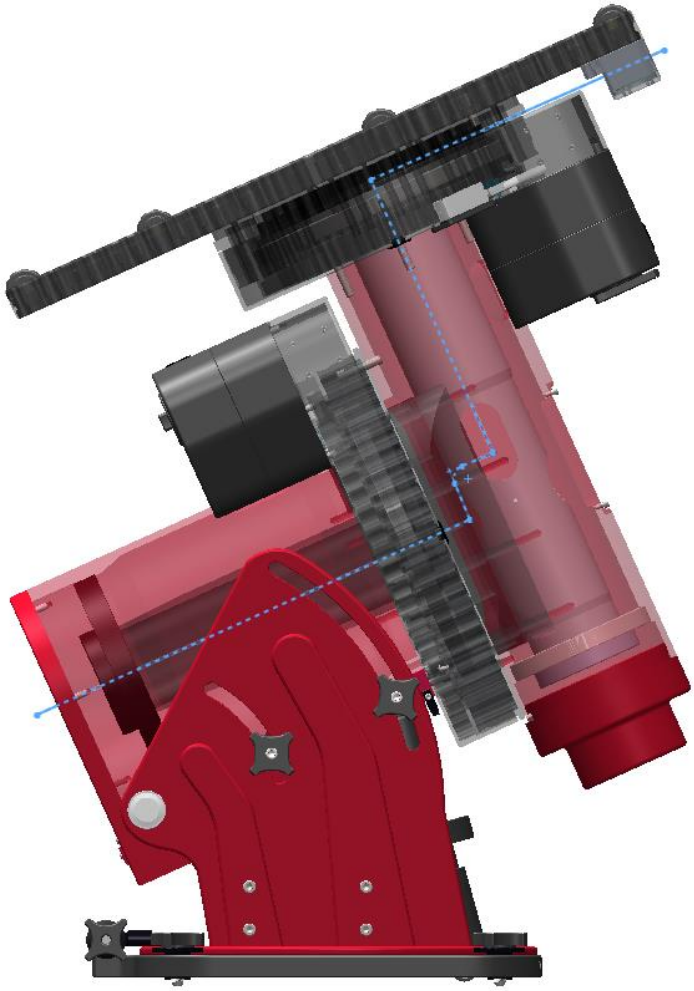


Figure 27: Paramount ME cross section showing path of cable through the mount.

Routing custom cables through the Paramount ME is a relatively straightforward procedure.

1. Remove the RA Rear Cover (Figure 13) by hand-loosening the two knobs that hold the cover in place.
2. Remove the Cable Conduit Cover (Figure 56) using a 3/32-inch hex wrench to remove the two mount mounting screws.
3. Attach the supplied cable tie to the end of the cable to be installed.
4. Insert the pointed end of the cable tie into the hour angle axis cable conduit and continue threading the cable upward, through the access hole in the declination axis until the cable tie can be grasped by hand, or by a flexible wire grabber inserted into the cable conduit access hole on the declination axis housing.
5. Pull the cabling up and into the declination axis.

6. Thread the cable tie up the declination shaft until it exits the top. Once the cable tie can be grasped, gently pull it upward until the cable itself exits the top of the axis. For cables with wide ends, some coaxing may be necessary to snake it completely through.
7. Thread the cable through the Instrument Panel access hole.
8. Once the cable has been passed entirely through the mount, make an 8-inch diameter loop in the cable, and carefully tuck this loop inside the outer shaft of the declination assembly to allow the declination axis to rotate completely without any interference from the cable itself. Rotating the declination axis from hard stop to hard stop does the work for you but allowing additional slack in the cable is recommended.

Note that this procedure can be performed with a telescope in place.

Routing Cables through the Paramount MX and MYT

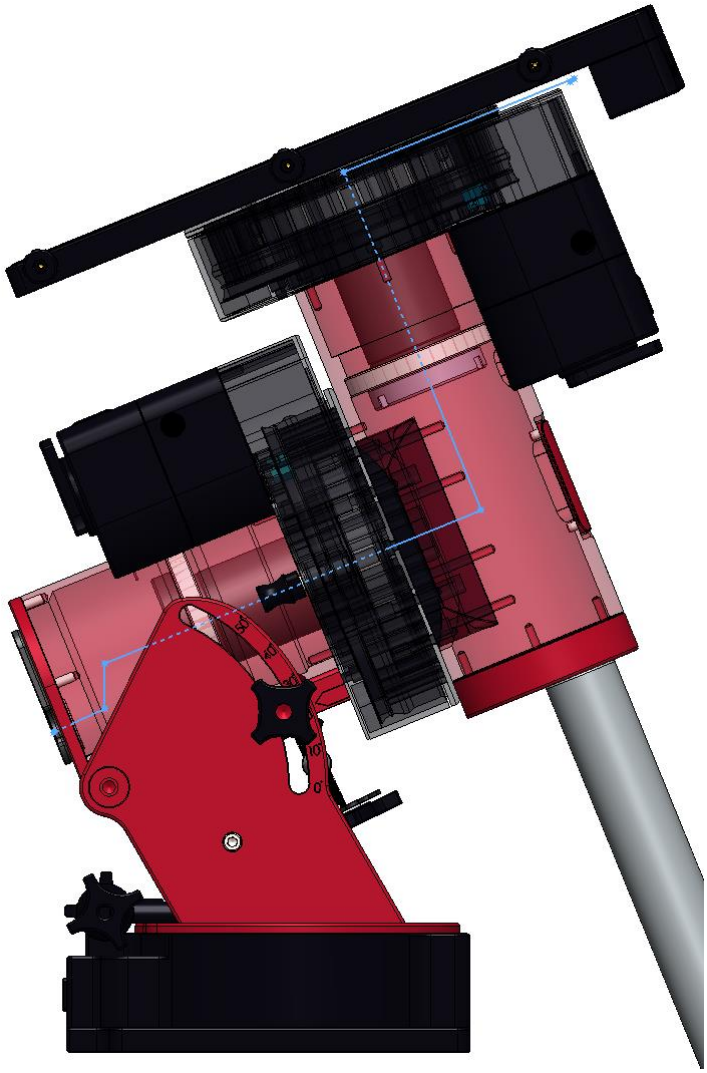


Figure 28: Paramount MYT cross section showing path of cable through the mount.

Routing custom cables through the Paramount is relatively straightforward.

1. Remove the two HA rear cover (Figure 16) mounting screws and the cover.
2. Remove the two cable conduit cover screws (Figure 58) and the cover.
3. Attach a cable tie to the end of the cable to be installed.
4. Insert the pointed end of the cable tie into the hour angle axis cable conduit and continue threading the cable upward, through the access hole in the declination axis until the cable tie can be grasped by hand, or by a flexible wire grabber inserted into the cable conduit access hole on the declination axis housing.
5. Pull the cabling up and into the declination axis.
6. Thread the cable tie through the declination shaft until it exits the top of the declination shaft. Once the cable tie can be grasped, continue pulling it outward until the cable itself exits the top of the axis.
7. Thread the cable through the gap between the Versa-Plate and gear. There are two 4-40 threaded holes on the instrument panel that can be used to create a strain relief for cables ran.
8. Unlike the Paramount ME, there is no need to create an excess cable loop around the declination shaft. The internal shafts have been designed so that cables have a more direct path to the Instrument Panel.

Note that this procedure can be performed with a telescope in place.

Electronics Housing

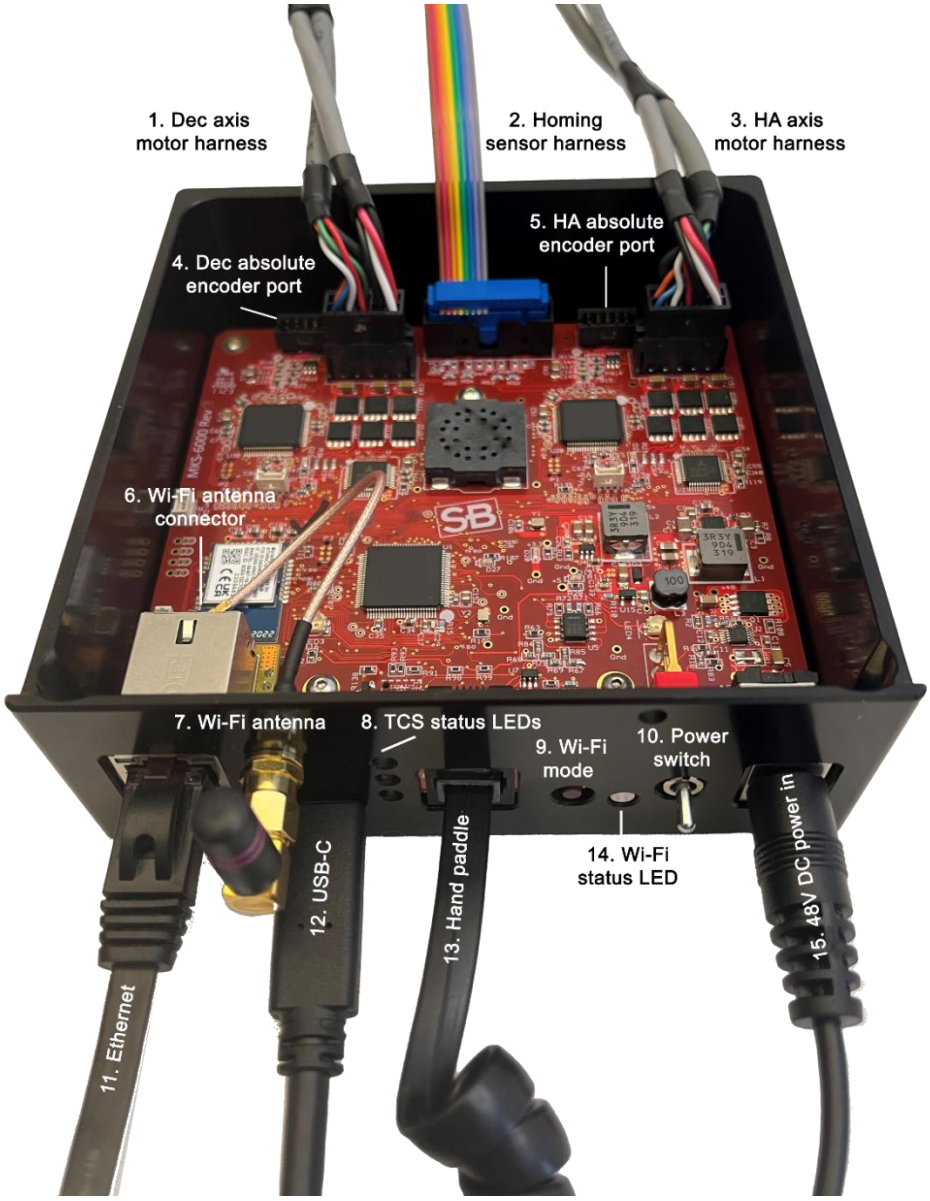
The electronics housing includes the mount power switch, power in port, PC to mount communication ports, status LEDs, Wi-Fi antenna, and the hand paddle port.



Figure 29: Electronics housing components.

Electronics Housing Components

igure 30 shows a Paramount MX electronics housing with the harnesses attached to MKS 6000 printed circuit board.

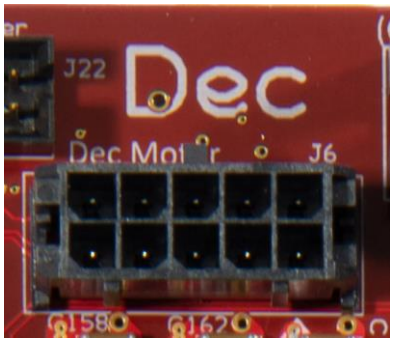


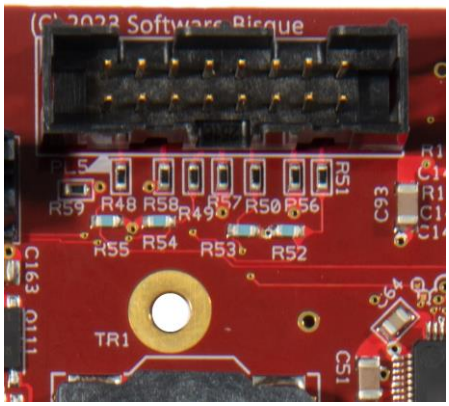
igure 30: Electronics housing with the MKS 6000 PCB cables and components.

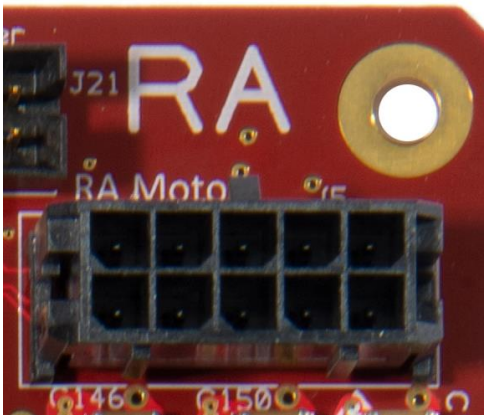
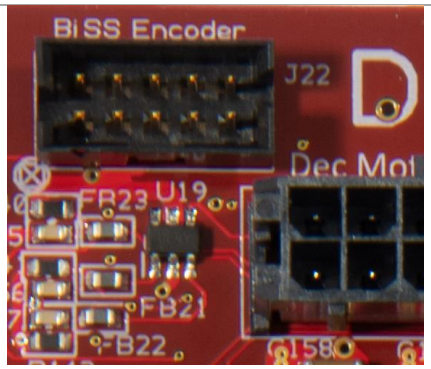
Table 2 below lists each of the numbered components in igure 30, describes each cable, and how to plug each cable into the MKS 6000 PCB.

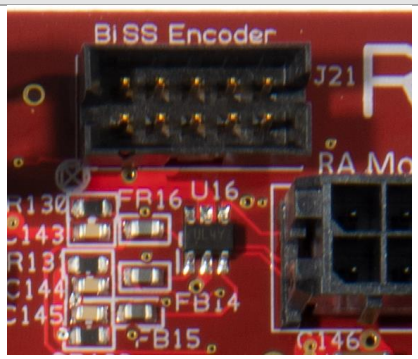
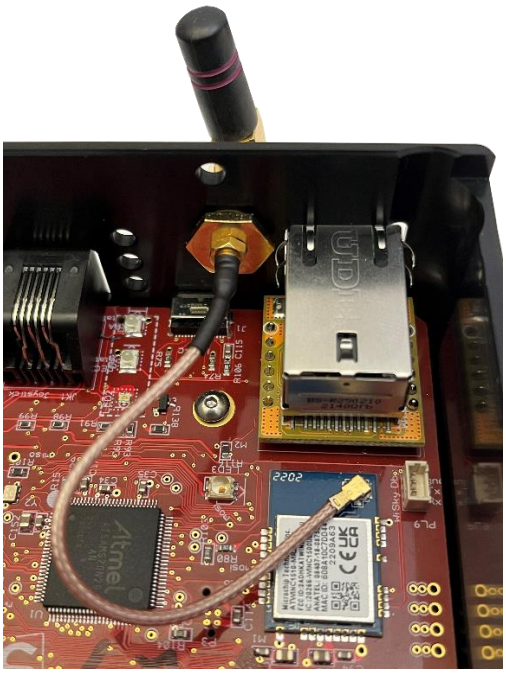
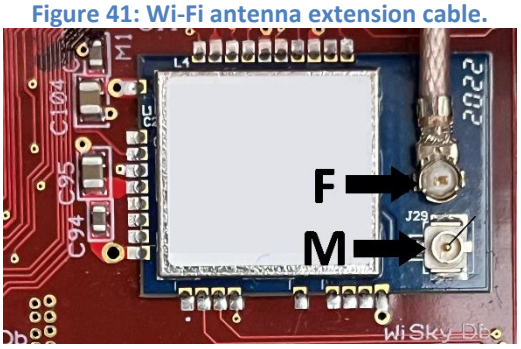
Table 2: The Paramount Electronics housing Components

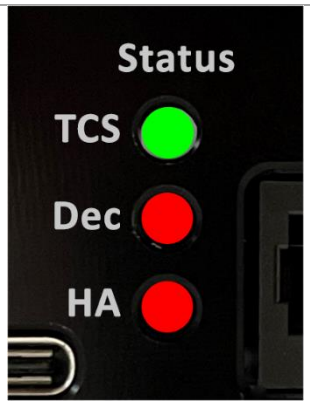
Number	Photos	Description

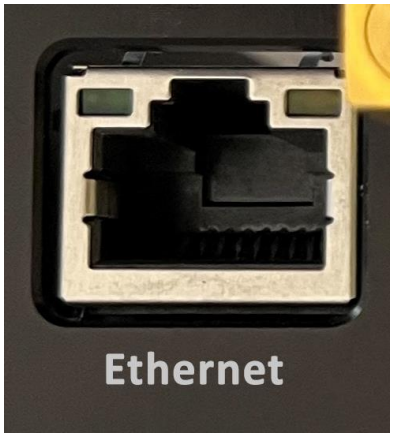
Number	Photos	Description
1	 **Figure 31: The 10-pin dec motor extension cable connector plugs into the port labeled Dec Motor.**  **Figure 32: The 10-pin declination axis motor plug. The tab on the male connector is oriented toward the top of the female connector in this photo.**  **Figure 33: 16-pin female motor extension cable.**  **Figure 34: 16-pin male motor harness connector.**	The 10-pin motor extension cable on the declination axis plugs into the MKS 6000 port labeled **Dec Motor** on the PCB (Figure 32). The 16-pin female connector (Figure 33) plugs into the declination axis motor harness (Figure 34).

Number	Photos	Description
2	 **Figure 35: 16-pin homing sensor cable.**  **Figure 36: 16-pin homing sensor cable plug.**	The homing sensor harness connects the HA and Dec homing sensors to the MKS 6000 home sensor port.

Number	Photos	Description
3	 **Figure 37: The hour angle (HA) axis is labeled RA, for right ascension, on the MKS 6000 PCB.**  **Figure 38: The gray dot on the hour angle connector differentiates it from the dec motor extension cable connector.**	The 10-pin hour angle motor extension cable connects the MKS 6000 to the hour angle motor.
4	 **Figure 39: 10-pin Dec axis BiSS absolute encoder port.**	The 10-pin male **Dec** axis absolute encoder cable is plugged into the 10-pin female plug labeled **BiSS Encoder** on the PCB.

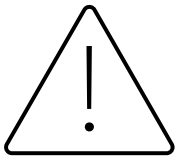
Number	Photos	Description
5	 **Figure 40: HA on-axis encoder plug.**	The 10-pin male hour angle axis absolute encoder cable is plugged into the 10-pin female plug labeled **BiSS Encoder** on the PCB.
6	 **Figure 41: Wi-Fi antenna extension cable.**  **Figure 42: Close up of the Wi-Fi antenna extension cable's small coaxial connectors.**	The external Wi-Fi antenna is connected to the Wi-Fi chipset using a short extension cable. In Figure 42, the coaxial female connector labeled **F** must be rotated 180 degrees and then plugged into the coaxial connector on the Wi-Fi module labeled **M**.

Number	Photos	Description
7		The right-angle Wi-Fi antenna screws into the electronics housing faceplate.
8		The three Status LEDs provide visual feedback on the state of the TCS. LED normal operation: • TCS LED is green • Dec LED is red • HA LED is red LED error condition: • TCS flashes white • Dec flashes red • HA flashes red
9 and 14		Press and release the circular **Wi-Fi Mode** button to toggle between each of the five Wi-Fi profiles. • Regardless of the current active profile, pressing this button once shows Profile 1, pressing again shows Profile 2 and so on. • The color of the Wi-Fi status LED corresponds to the mode that was configured in TheSky Professional. See “Wi-Fi or WLAN Configuration Settings (WiSky)” on page 170 for more information.

Number	Photos	Description
10		The chrome-plated on/off switch controls power the TCS. Up is on, down is off.
11		The Ethernet port is used to control the TCS over a network using TCP/IP. See “Wi-Fi or WLAN Configuration Settings (WiSky)” on page 170 for more information.
12		The USB-C port is used to communicate with the TCS using a serial command protocol.

Number	Photos	Description
13		Plug the RJ12 on the end of the hand controller's curly coil into the hand controller port.
14		The **Wi-Fi Mode** button and Wi-Fi status LED are described in number 9 above.
15		The 48V DC **Power In** jack. **Please read the "Important MKS 6000 Power Jack Notes" below about the new power supply unit included with the MKS 6000 Upgrade Kits.**

Important MKS 6000 Power Jack Notes



Do not use the MKS 5000 power supply for the MKS 6000!

The MKS 5000 should never be plugged into the MKS 6000 Power In port even

though both plugs appear similar.

If plugged into the MKS 6000, the MKS 5000 PSU connector will have intermittent connection with the center pin and may damage the MKS 6000 electronics.

The MKS 6000 **Power In** DC jack is different from all earlier versions (MKS 3000-MKS 5000). While the power supply units for the MKS 6000 supply 48V DC, the new power supply units incorporate a different DC connector that is designed to properly mate with the MKS 6000 DC power jack. The new style connectors *do not use a locking collar*. They are designed grip firmly but allow pulling out if the cable inadvertently gets snagged and pulled.



Figure 43: The MKS 6000 PSU power connector.



Figure 44: Note that the MKS 5000 PSU plug is *not* compatible with the MKS 6000.

A newer style connector from Switchcraft, part number 760Z-765Z_CD (mouser.com), is not compatible either as it only makes momentary contact.



Figure 45: Do not use this Switchcraft connector.



Figure 46: MKS 6000 power connector. Note the two spring contacts inside the tip.



Figure 47: MKS 6000 power jack (DigiKey part number 839-1249-ND).

Figure 46 shows the correct DC plug for the MKS 6000 with spring contacts. The MYT/MX/ME Series 6 power supplies come with this connector. Note the two "spring" metal contacts in the center of the connector that are held in place by two rectangular grooves.

MKS 6000 DC Extension Cables

The standard length of the MKS 6000 PSU power out cable is 36 in. (91 cm). If you need a longer cable, so that, for example, the PSU can rest on the floor of the observatory, MKS 6000-compatible DC extension cables are available at Amazon for a reasonable price. Click the link below or enter the URL into your browser: https://tinyurl.com/6K-DC-Extension

Six-foot DC extension cables with the spring contacts are available from DigiKey and Tensility. The right-angle version with the additional cable covering is the better option.



Figure 48: DigiKey part number 839-1625-ND (mfg. #10-02221)



Figure 49: DigiKey part number 839-1249-ND (mfg# 10-01935)



Figure 50: Tensility part number: 10-02574

Instrument Panel

The Paramount Instrument Panel includes a pass-through Ethernet port, three XT60 power out ports and a cover for the through-the-mount cable access hole. Remove this cover when running custom cables through the mount.



Figure 51: The Paramount MX Instrument Panel components.

Through-the-Mount Panel



Figure 52: The through-the-mount panel components.

Table 3: Through-the-mount Panel Components

Number	Description
1	When connected to an external DC power source, the male XT60 plug supplies power to the three female XT60 connectors on the Instrument Panel. The DC power supply's output connector must be equipped with a female XT60 connector. See "XT60 Connectors" below for more information. XT60 port specifications: • Rated for 30A, 500V (15,000W maximum) • The internal cabling is 12 AWG. • The leads on the Instrument Panel are rated to carry 30A maximum.
2	This RJ-45 port accepts a CAT6 cable to provide pass-through Ethernet to the Instrument Panel's Ethernet port.
3	This is a customizable L-COM Keystone connector.
4	This access hole can be used to pass custom cables through the mount to the top of the declination axis.

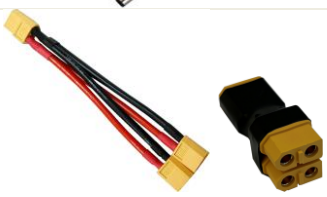
XT60 Connectors

The Paramount power connectors and through the mount cabling are intended to be used with direct current (DC) power sources only.

Never power devices through the mount with an alternating current (AC) power source.

XT60 power connectors are commonly used for recharging batteries in e-bikes, RC cars and drones. They also excel at supplying power to astronomical equipment. Rated at 500V up to 30A (15KW maximum), they accept 12 AWG wires, and can provide sufficient power to all the direct-current astronomical devices on the telescope.

A variety of pre-made cables and cable adapters using these connectors are readily available and relatively inexpensive. The table below shows several pre-made cables that use XT60 connectors.

XT60 Cable Type	Example Photo
Input Power • XT60 Connecter Cable with DC 12V Battery Alligator Clips • XT60 to O-Ring Terminal Cable, 12AWG XT60 Male to O-Ring Connector Cable	
Power Cables • XT60 m/f to 2.1 mm m/f jack power adapter • XT60 m/f to 2.5 mm m/f jack power adapter • XT60 m/f to Anderson Powerpole™	
Y-Splitters • M/F Y-splitters • M/F parallel adapters (bottom)	
Extension Cables • XT60 M/F to XT60 M/F cables	

XT60 Cable Type	Example Photo
Gender Changers and Extenders • M/F, F/F extenders	

The simple and robust XT60 connectors are well-suited for making custom, do-it-yourself cables.

Jacketed XT60 Cables

The spacing between the Power Out 2 and Power Out 3 ports is based on the XT60 15.5 mm width specification. Third-party XT60 cables may have come with an extra jacket that makes the connector wider, about 19 mm total width. The extra width of the jacket prevents two of these cables from being plugged in to the Power Out 2 and Power Out 3 ports at the same time.



Figure 53: A wider jacketed XT60 connector.

If two jacketed connectors must be plugged in to Ports 2 and 3, plug a short female-to-female XT60 extender into one of the ports so that there is sufficient width for both jacketed cables to fit.



Figure 54: A female-to-female XT60 extender plugged into the Instrument Panel's Power Port 3.

L-com Keystone Panel Adaptors

The three L-com keystones on the front panel are designed to make through mount cabling easier to install, more accessible and simpler to connect and disconnect the through-the mount cables. The L-com

webpage (http://www.l-com.com/adaptors) offers cables, connectors and adaptors that can be used to customize the mount for your astro-accessories.

Polar Axis Adjustments

A common problem with many commercial mounts when making polar alignment adjustments is that changes to the position of the altitude axis also changes the position of the azimuth axis, and vice-versa.

In other words, the basic mechanical design is compromised in that independent motion in azimuth and altitude is not possible. This makes polar alignment more difficult than it should be.

The Paramount base consists of an outer, fixed plate that is mounted to the pier, and an inner rotating plate on which the mount sits. Adjustments in azimuth are achieved by rotating the Azimuth Adjustment Knobs at the front of the mount (Figure 55). For a level mount, rotation of this plate does not affect the altitude of the polar axis.

The altitude axis is held in place using a separate mechanical system that includes the Altitude Adjuster Thrust Knobs and the Altitude Adjuster. For a level mount, adjustments in altitude will not significantly change the azimuth of the polar axis.

Keystone Modules

Commonly used in wall plates for network and coaxial cabling connections, the L-com keystone adapters on the HA axis panel provide a convenient means to hold and terminate custom through the mount cables. A variety of low-voltage snap-in connectors are available, including coaxial, RJ45/Ethernet, BNC, USB 3.0 and more.

Azimuth Adjuster Knobs

The base of the Paramount incorporates a circular plate inside the mount's rectangular base and allows the mount to rotate about a vertical axis through the center of the mount. This rotation permits the azimuth of the polar axis to be changed when aligning the mount to the celestial pole. The Azimuth Adjustment Knobs push against a bar that is mounted to the circular plate and provide the means to rotate the plate, even when the mount if fully loaded.

The Azimuth Adjustment Knobs work in *opposition* – one must be loosened before the other can be tightened. The knob that is tightened rotates the azimuth axis; the knob that is loosened provides "clearance" for the axis to rotate.

Provided the opposite knob is sufficiently loose, the azimuth axis can be rotated by tightening the opposite knob, without applying excessive force. Note that a fully loaded mount may make rotating the base plate, and the knobs, more difficult. If necessary, insert a 5/32 hex wrench into the center of the adjustment knob to assist rotation.

- Tightening the right knob moves azimuth east.

- Tightening the left knob moves azimuth west.

Before making any adjustments to the azimuth of the polar axis:

- Make sure the rotating plate is close to its center position so there is a maximum amount of rotation in both directions.
- Rotate both knobs counterclockwise until both are just tight. This effectively squeezes the rotating bar and serves as a good zero point. To avoid deforming the rotating bar, do not over-tighten the knobs.
- First loosen the knob on the opposite side of the direction of rotation the suggested number of tics, then tighten the other knob until it is "just tight" again.

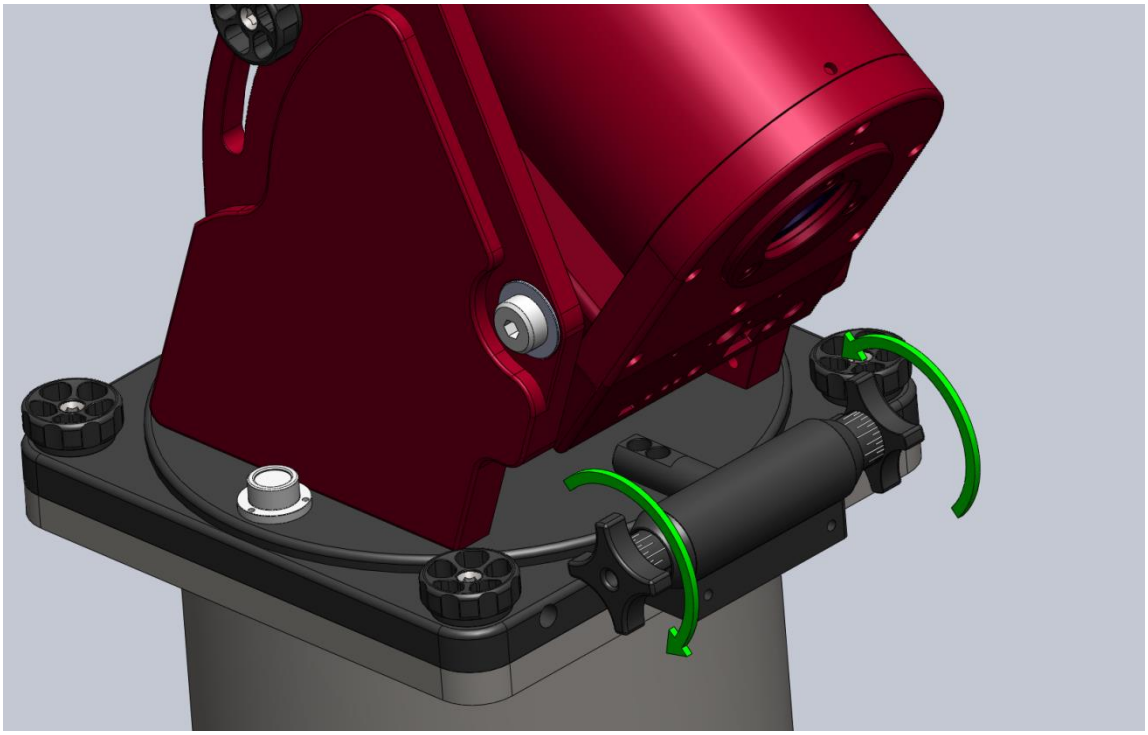


Figure 55: Rotate the Azimuth Adjuster Knobs to adjust the azimuth axis (Paramount MX pictured above).

Azimuth Vernier Scale

Both azimuth adjuster knobs include a Vernier scale to set the position of the azimuth axis. The longest tic marks represent *approximately* 4 arcminutes rotation in azimuth. The medium length marks are *approximately* 2 arcminutes rotation, and the shortest tics marks are *approximately* 1 arcminute.

So, for example, if *TPoint's* Polar Alignment Report suggests to "rotate the azimuth axis 180 arcseconds east," you would have to rotate the right knob clockwise three tics (about three arcminutes) on the Vernier scale.

The azimuth axis polar axis adjustment range is plus or minus seven (7) degrees from center position. To be safe, make sure to orient your permanent pier within three (3) degrees (or so) of the celestial pole so that polar alignment can be achieved without having to rotate the permanently mounted pier itself.

- Software Bisque Permanent piers have slotted mounting holes that provide additional azimuth rotation (plus or minus five degrees from the center position).
- The Software Bisque tripods allow unlimited rotation in azimuth, so the mount's initial orientation does not matter.

Base Thrust Mounting Knobs

The four base-thrust mounting knobs are used to securely attach the base of the Paramount to the top of the pier, tripod, or other mounting surface.

Always secure the Paramount to a pier or tripod *before* attaching the counterweight shaft, adding counterweights, or optical equipment! Forgetting to do so is relatively easy and can have disastrous results.

Model	Total Length	Thread Specification
MYT	3.8 cm (1.5 in.)	3/8-inch, 24 threads per inch UNF
MX	3.8 cm (1.5 in.)	3/8-inch, 24 threads per inch UNF
ME	5 cm (2 in.)	3/8-inch, 24 threads per inch UNF

The Paramount ME base plate also includes integrated micro levelers than can help level the Base Plate on slightly uneven mounting surfaces. Please carefully read "Micro Levelers (Paramount ME Only)" on page 109 for details about using this component.

Base Plate

The base plate incorporates four precision thrust mounting knobs that are used to attach the Paramount mount to top of the pier or tripod.

There are two set screws located on the side of the Base Plate that compress a Delrin plunger against the side of the integrated rotating plate and prevent lateral motion of the plate.

These set screws should normally never be adjusted unless instructed to do so by a Software Bisque technician.

The set screw access holes on the Paramount MX, Paramount MX and Paramount MYT are located on the *same side* of the Base Plate as the Altitude Adjuster Knobs. (One is shown to the left of the Azimuth Adjuster Knob in Figure 55.). On the Paramount ME, they are located on the opposite side of the Altitude Adjuster Knobs.

Paramount ME Rear View

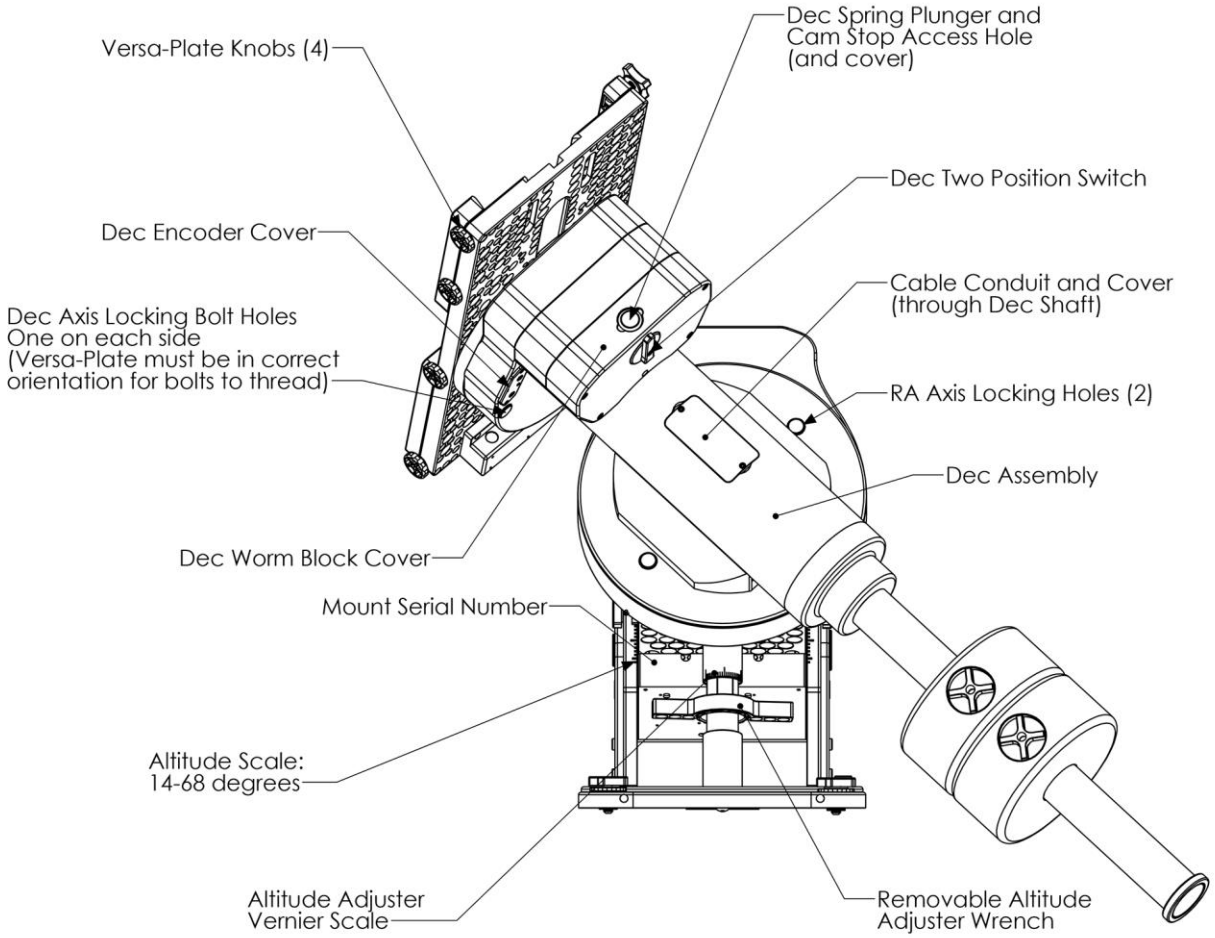


Figure 56: The rear view of the Paramount ME.

Hour Angle Axis Locking Holes (Paramount ME Only)

The Paramount ME's hour angle axis can be locked into one, and only one, position by orienting the counterweight shaft vertically and then inserting two shoulder bolts (supplied with mount) into both hour angle locking holes and through the gear. The bolts can be permanently mounted (before shipment, for example) by threading a nut on end of the bolt that protrudes through the back side of hour angle gear housing.

The reason the hour angle axis can only be locked when the counterweight shaft is vertical is to prevent unbalanced payloads from damaging the mount. If the mount's hour angle axis were to be locked in any other orientation, unbalanced payload could potentially exert destructive torque on the locking mechanism.

When installed, the hour angle and declination axis locking bolts are designed to prevent the axis from rotating during shipment or while adding payload to the mount.

As a best practice, always try to maintain a relatively balanced payload, even when mounting equipment.

The shoulder bolts are not designed to carry the mount's entire payload. If you mount an excessively unbalanced payload on the declination axis, for example, you run the risk of bending one or both bolts, making removal difficult.

The specifications for hour angle axis locking shoulder bolt are:

- 18-8 stainless steel shoulder screw
- 5/16-in. shoulder diameter
- 2-1/4-in. long shoulder
- 1/4 in.-20 TPI

The 1-3/4 in. long declination axis locking shoulder bolt has the same specifications.

Declination Axis Locking Holes (Paramount ME Only)

Figure 56 shows the location of Paramount ME declination axis locking holes on the bottom of the declination axis, near the optical encoder access panel. When the Versa-Plate is rotated to the orientation shown in Figure 56, the declination axis locking holes are aligned threaded holes in the fixed side of the declination axis.

To lock the declination axis at this position, insert a declination axis locking bolt (described above) into each hole, then slightly wiggle the Versa-Plate back and forth to locate the threaded hole, and rotate the bolt clockwise until it is tight.

Relative to the orientation in Figure 56, the Versa-Plate can be rotated 90 degrees in either direction and the axis can be locked by installing the declination axis locking bolts as described above. *Always use both locking bolts when locking the axis.*

Paramount MX Rear View

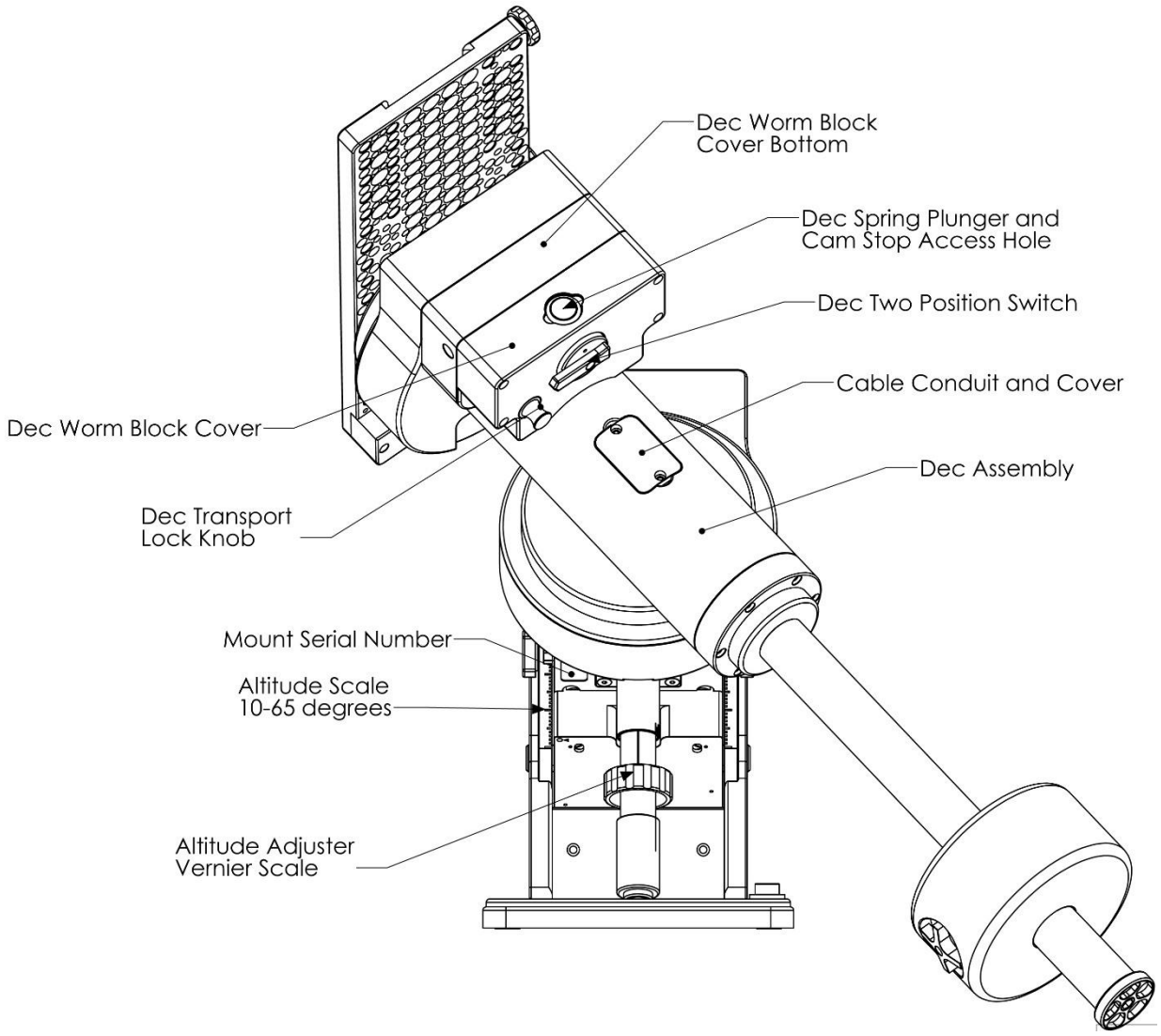


Figure 57: The rear view of the Paramount MX.

Declination Carrying Handle (Paramount MX Only)

Use the integrated carrying handle (located above the Declination Three Position Switch) to lift the mount. Remember to always place both Three Position Switches in the Lock position before lifting the mount (page 63).

Declination Axis Two-Position Switch

See the “HA Worm Block Switch” description on page 63 for details about using this component.

Paramount MYT Rear View

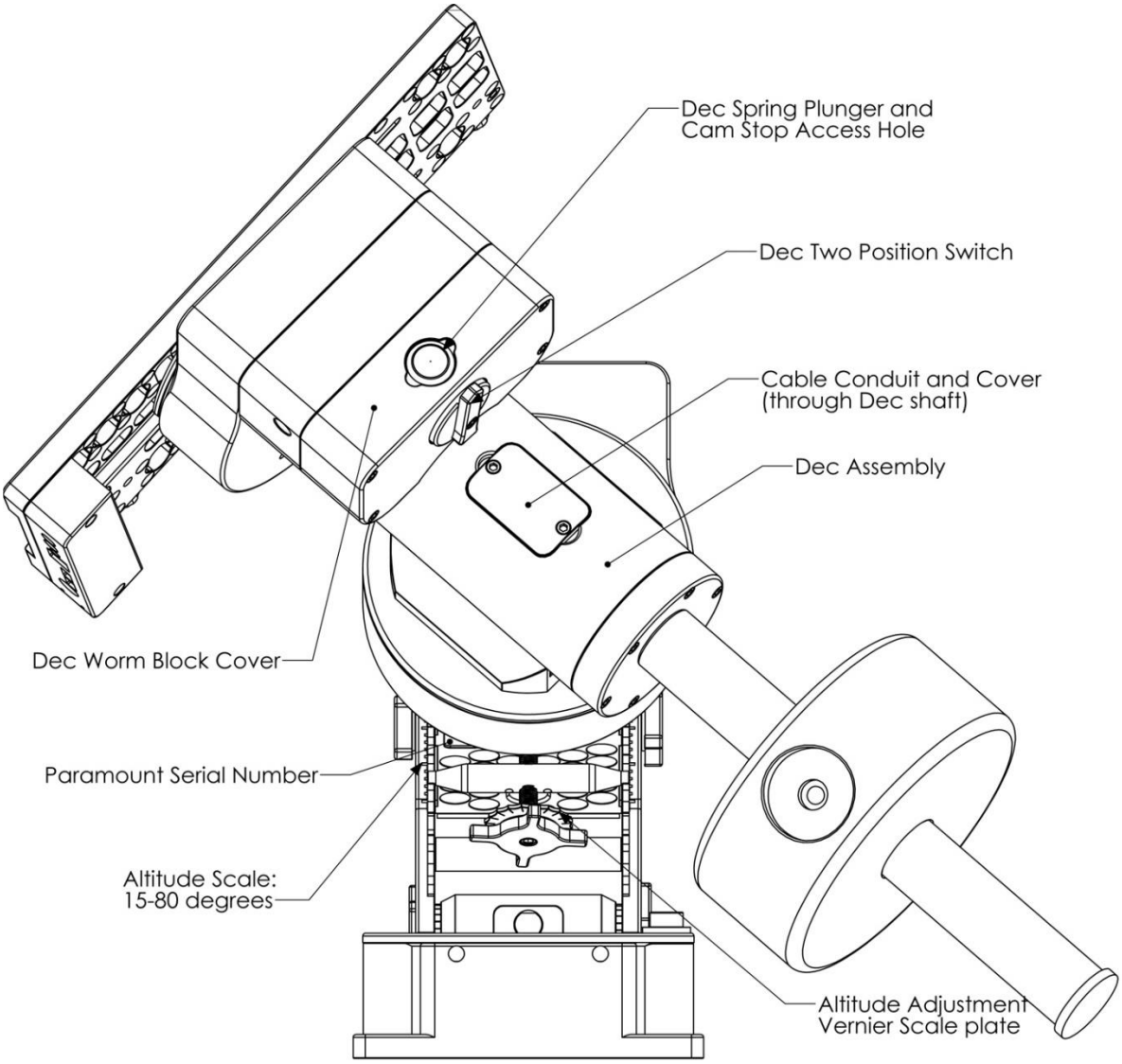


Figure 58: The rear view of the Paramount MYT.

Cable Conduit Access Hole and Cover



Always keep fingers clear from the cable conduit access hole!

- While the declination axis rotates during mount slews, an internal shaft in the declination assembly is also being rotated by a very high torque servomotor.
- When the declination axis' two position switch is in the balance position (page 63), the internal shaft can rotate

freely and may do so with a high angular velocity when the mount's payload is even slightly out of balance.

In both cases, the rotating internal shaft creates a potentially dangerous pinch point with the outer declination axis assembly that can cut, crush, or sever fingers.

Always keep fingers clear during mount slews and use extreme caution when routing cables through the mount or aligning the declination shaft's "through-hole" during polar scope alignment.

Declination Axis Encoder Cover

Paramount ME mounts shipped after about mid-2017 have small aluminum cover attached to bottom of the declination axis that can be used to access the optional absolute on-axis encoder module.

- If your Paramount ME is equipped with absolute on-axis encoders, the encoder cover incorporates a small slit that allows light from the encoder module LED to be visible without removing the cover. Green light emitted from the encoder module's LED indicates the encoders are functioning normally; yellow means the encoder is operational, but the signal from the module is not ideal; red means the module is not working properly and may need alignment. Contact Software Bisque support for information how to proceed.
- If your Paramount ME is not equipped with absolute on-axis encoders, the encoder cover is solid and does not incorporate the light-emitting slit. The cover need not be removed, unless you are curious to see what is underneath.

Configurable Hard Stop Positions (Paramount ME Only)

The Hour angle locking holes also provide access bolts that define the Paramount ME's configurable hard stop position. For each "side of the meridian", there are six different positions where a physical hard stop mounting bolt can be installed.

After placing the two-position switch in the Balance mode, rotate the hour angle access and look down one of the hour angle locking holes. As the axis is rotated, you see five threaded holes, and the sixth, at the maximum hard stop limit, with a bolt installed. The position of this bolt defines the maximum allowable rotation for the axis in this direction.

Normally, the hard stop position need not be altered, and the configurable slew limits (page 165) are used to prevent the mount from slewing to undesired positions.

To change the position of the hard stop, remove the hard stop bolt using a square-ended hex wrench. A square-ended hex wrench bolt captivates the socket head cap screw so that it can be extracted from the Hour angle locking hole. Once removed, the socket head cap screw can be placed at the desired hard stop position.

Declination Axis Assembly (Dec Assembly)

The declination assembly is a permanent component of the Paramount and cannot be removed.

Paramount Serial Number (Serial Number)

The Paramount's serial number is permanently affixed to the base of the hour angle assembly before shipment (page 19).

Altitude Scale

The Altitude Scale is a series of tic marks machined into the edge of both altitude wedge plates. On the Paramount ME, the longer tic marks represent *approximately* ten-degree increments, the medium tics are *approximately* five-degree increments, and the shorter tics are *approximately* one-degree increments. The short tic marks on the Paramount MYT and MX altitude scale represent approximately two degrees in elevation; longer tic marks represent about ten-degree increments.

When the mount's base is close to level, this scale can be used to set the altitude of the polar axis to plus or minus fifteen arcminutes or so.

The altitude of the mount's polar axis can be determined by looking at the intersection of the bottom of the altitude reference block and the nearest tic mark on the altitude scale (Paramount ME, Figure 60), or the machined arrow on the base of the Paramount MYT and MX hour angle housing Figure 61.

MYT	MX	ME

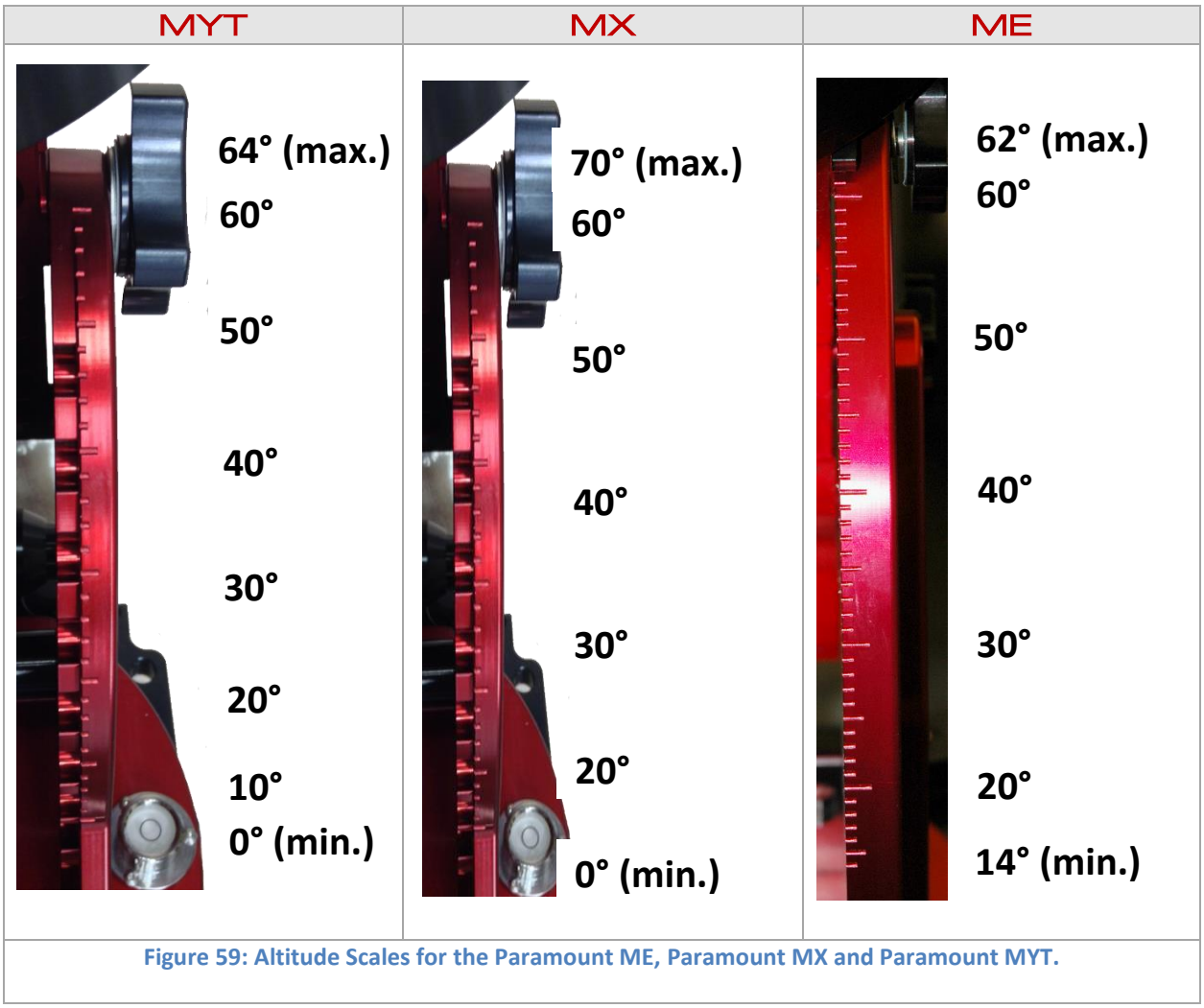


Figure 59: Altitude Scales for the Paramount ME, Paramount MX and Paramount MYT.

Model	Minimum Elevation (°)	Maximum Elevation (°)
MYT	0	64
MX	0	70
ME	14	62

An optional Paramount ME or Paramount MX *Latitude Adjustment Wedge* can be purchased to allow the mount's polar axis to reach lower or higher polar elevations.

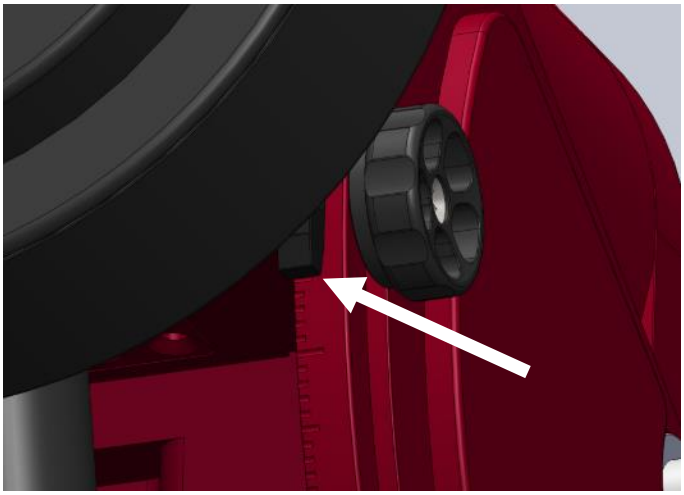


Figure 60: The tic mark that is aligned with the bottom of the altitude reference block marks the Paramount ME polar axis altitude.

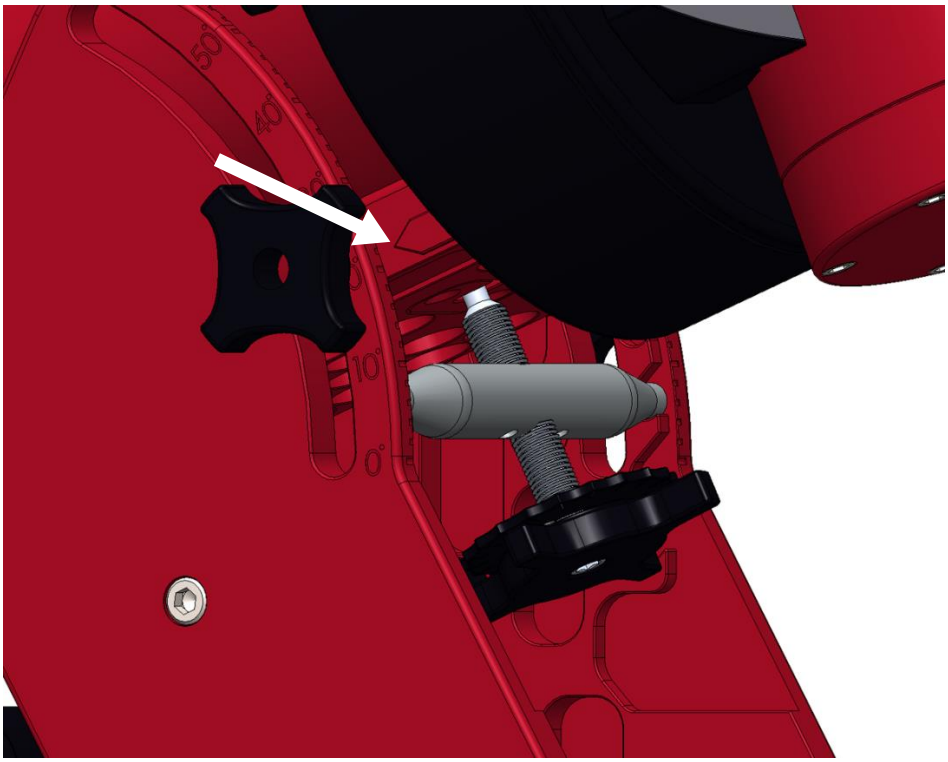


Figure 61: The arrow machined into the hour angle base plate points to the altitude of Paramount MYT and MX polar axis.

Altitude Adjuster (Paramount ME only)

The altitude adjuster is used to make fine adjustments to the mount's altitude axis during polar alignment. The elevation of this axis should be close to the *latitude* of your observing site.

Remember the "Right Hand" Rule

The altitude adjuster uses "right-handed" threads. If you want to increase the altitude of the polar axis, point your right-hand thumb upward and rotate the altitude adjuster in the direction your fingers naturally curl.

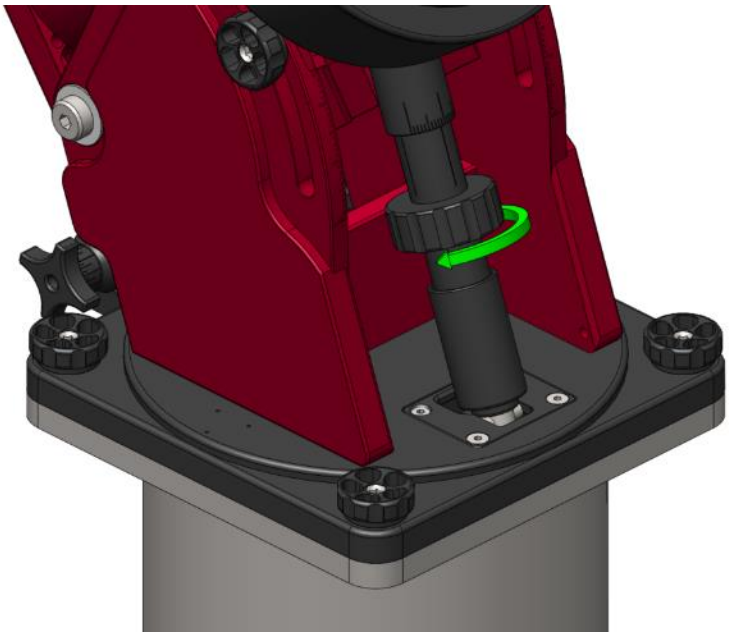


Figure 62: Rotating the altitude adjuster in the direction of the arrow lowers the Paramount ME axis (right hand rule applies).

Polar Axis Elevation Adjustment

The table below describes how to make coarse and fine polar elevation adjustments to the Paramount MYT and MX.

Model	Description
MYT MX	1. Loosen the Altitude Adjuster Thrust Knobs (page 107). 2. Rotate the large central knob (near the arrow in Figure 62) to raise or lower the polar axis. The Paramount MYT and Paramount MX have both coarse and fine altitude adjustments and requires a *two-step process* when setting the polar axis altitude. The coarse adjustment mechanism incorporates a horizontal bar that can be placed into slots that are machined on the inside of the wedge plates. Each slot raises or lowers the polar altitude by eight degrees. The coarse elevation adjustment should be done *before* any equipment is attached to the Versa-Plate. Once the polar axis has been placed at the approximate latitude using the coarse adjustment, the fine adjustment can be used to refine the polar axis altitude when the

mount is loaded with equipment and counterweights.

1. **Important!** As shown in Figure 63, rotate the fine elevation adjustment knob until the stainless-steel bar is about in the middle of the threaded rod. Doing so ensures there will be sufficient fine adjustment to achieve polar alignment when the bar is placed in a given elevation slot (described below).

   If the bar is not centered in the threads initially, there may not be enough travel to reach the desired altitude in one direction. If you run out of travel when making fine adjustments, start by centering the bar in the threads, then move the bar to a higher or lower slot.
2. Loosen both of the altitude retaining knobs on the wedge side plates, then gently lift the hour angle axis until the bar becomes unseated from the slots on the inside of the wedge plates. The entire fine altitude adjustment mechanism can now swing out from the wedge.
3. Align the arrow that is machined either side of the hour angle housing base (Figure 61) with the tic mark that is close to the observing site's latitude, and then insert the stainless-steel bar into the nearest slot.

   The threads on the fine adjustment mechanism allow the altitude of the polar axis to be moved up or down about 8 degrees from the center position. Provided the bar is in the right slot, there should be ample "overlap" to get to the desired polar axis elevation using the fine adjustment mechanism.

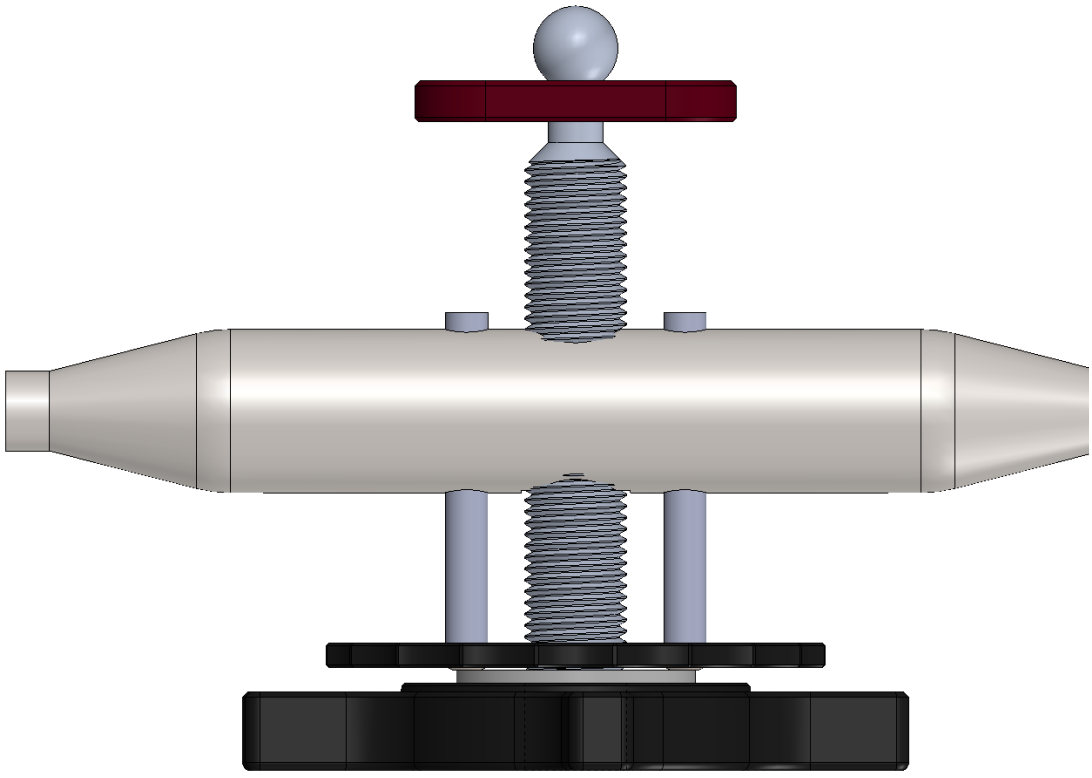


Figure 63: The Paramount MYT and MX fine altitude adjustment assembly at the *mid-travel* position.



Figure 64: The Paramount MYT and MX coarse altitude adjustment mechanism when lifted out of a mounting slot.

From here, you can attach the telescope and other your equipment and get ready to precisely align the mount with the refracted pole. See "How to Polar Align" on page 113 for details.

Paramount ME Altitude Scale

In addition to the altitude scale tic marks on the wedge, the altitude adjuster knob has a fine-position Vernier scale that allows the mount's elevation to be adjusted to an accuracy of plus or minus 15 arcseconds (Figure 65).

So, for example, when *TPoint's* Polar Alignment Report states "raise the mount's polar axis 62 arcminutes," it means that one complete revolution of the Altitude Adjuster, plus two positive tic marks on the Vernier scale from the vertical line labeled 'A' should place the elevation of the mount close to the refracted pole.

The arrow on Figure 65 shows the location of the fine-position Vernier scale for the Paramount MX, Paramount MX and Paramount ME. This scale shows elevation adjustments from approximately +10 to –10 arcminutes. The medium height tick marks represent approximately 5 arcminute divisions; the small tic marks represent approximately 1 arcminute divisions.

One rotation of the Altitude Adjuster knob is about one degree of elevation adjustment. The rotating knob directly beneath the Vernier scale has four vertical lines labeled with the letters A, B, C, and D that

can be used to make absolute elevation adjustments. These vertical lines are 90 degrees apart and represent increments of fifteen arcminutes in elevation.

The vernier scale also allows the mount's elevation to be placed at a specific position and is useful for restoring a specific elevation if the mount is used at multiple observing sites. For example, suppose your observatory's elevation is 39 degrees plus "an additional rotation that aligns the vertical B line with the –4.5 tic mark on the Vernier scale". You can subsequently use this position to precisely restore the altitude of the polar axis each time the mount is setup.

The Paramount ME includes a removable Altitude Adjuster Wrench (page 114) to help rotate the Altitude Adjuster Knob with the heavy payloads.

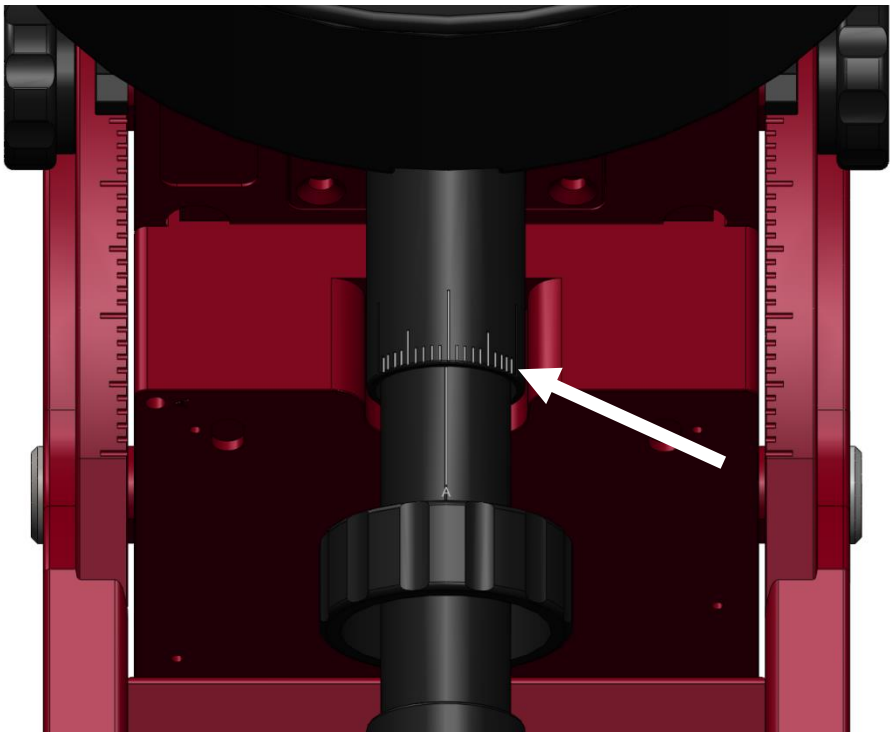
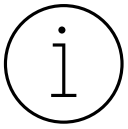


Figure 65: The Paramount ME altitude adjuster vernier scale.

Counterweight Shaft

Before attaching the counterweight shaft, *secure the mount to the pier or tripod*. The weight of the counterweight shaft changes the mount's center of mass so it may want to tip over. Once the mount is secure, insert the threaded end into the bottom of the declination assembly and rotate the shaft clockwise until it is hand tight.

Model	Length	Diameter	Weight	Maximum Number of Counterweights
MYT	33 cm (13 in.)	3.8 cm (1.5 in.)	3.2 kg (7 lb.)	Four 9 kg (20 lb.) or five 10 lb.
MX	41 cm (16 in.)	3.8 cm (1.5 in.)	4 kg (9 lb.)	Six 9 kg (20 lb.)
ME	47 cm (18.5 in.)	4.763 cm (1.875 in.)	6.7 kg (14.75 lb.)	Six 30 lb. or six 40 lb.



Always ensure the counterweight shaft is attached ***before operating the mount***. The weight of the counterweight shaft helps balance the unloaded hour angle axis. Attempting to slew the mount when either axis is severely out of balance may cause the motors to stall and the control system will emit successive beeps.

Counterweight Shaft Extension Bar (Optional)

The optional counterweight shaft extension bar (sold separately) threads into the end of the Paramount standard counterweight shaft. This bar both extends the moment arm and allows up to two additional counterweights for ultra-heavy payloads.

Model	Counterweight Shaft Extension Bar Specifications	Description
ME	Length: 24.6 cm (9.7 in.) Diameter: 4.763 cm (1.875 in.) Weight: 3.2 kg (7 lb.) Capacity: 2 counterweights	See “Appendix A: Paramount Technical Drawings” on page 189 for details where to find technical drawings on the Software Bisque webpage. *In addition to the 1.875-in. diameter counterweight shaft, the Paramount ME also accepts 3.8 cm (1.5-in.) diameter counterweight shafts.*
MYT MX	Length: 17.8 cm (7 in.) Diameter: 3.8 cm (1.5 in.) Weight: 1.4 kg (3 lb.) Capacity: 2 counterweights	See “Appendix A: Paramount Technical Drawings” on page 189 for details where to find technical drawings on the Software Bisque website.

Counterweights

One counterweight is included with the Paramount MYT; two counterweights are included with the Paramount ME, and Paramount MX models. Counterweights are secured to the counterweight shaft to balance the mount’s payload. Insert the counterweight shaft into the counterweight bore, and slide the counterweight to the approximate balance position, and then rotate the counterweight knob until the

knob is hand tight. The softer-metal brass plunger on the end of the knob secures the counterweight and should not score or gouge the stainless-steel shaft.

The table below shows the counterweight specifications by model.



The total weight of the counterweights that are included with the Paramount mount are ***not sufficient*** to balance the maximum payloads. If the total weight of the instruments attached to the Versa-Plate exceeds the total weight of the standard counterweights that come with the mount as shown in the table below, you will need to purchase and add more counterweights to achieve balance.

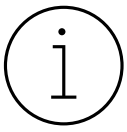
Model	Counterweight Specifications	Quantity Included	Total weight
MYT	20 lb. (9 kg), 1.5 in. bore; the height is approximately 2.9 in. (7.3 cm)	1	20 lb. (9 kg)
MX	20 lb. (9 kg), 1.5 in. bore; the height is approximately 2.9 in. (7.3 cm)	2	40 lb. (18 kg)
ME	30 lb. (14 kg), 1.875 in. bore; the height is approximately 2.9 in. (7.3 cm)[2]	2	60 lb. (28 kg)

[2] *The Paramount ME accepts the 1.5-in. diameter Paramount ME/MX counterweight shaft.*

The weight of the counterweights that are required to achieve balance depends on the total weight of the optical tube assembly and accessories, and how the weight is distributed. Before adding any counterweights to the counterweight shaft, first estimate the required weight is required for counterbalance, and then add this amount to the counterweight shaft. Err on the heavy side. If the weight of the equipment exceeds the weight of the supplied counterweights, additional counterweights must be purchased.

Initially, the counterweights should be placed a bit too far down the counterweight shaft so that counterweight shaft rotates downward, instead of your expensive equipment.

Once enough counterweights are added, the hour angle axis should be very bottom heavy. At this point, adding the telescope should result in a system that is close to balanced.



To avoid damaging the precision worm gear, before attaching any counterweights to a Paramount mount, please thoroughly read the following section.



Counterweights are extremely heavy! Please use extreme caution handling them during installation and removal.

After the counterweights are added, firmly tighten each of the counterweight knobs to ensure they do not slip. Also, make sure to install the counterweight safety knob on the bottom of the counterweight shaft.

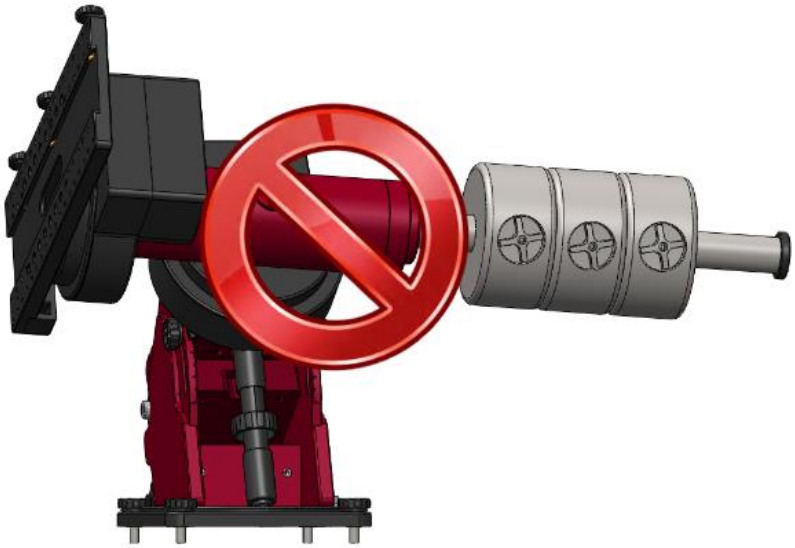


Figure 66: As shown in the figure above, *when the worm is engaged* and *no telescope or other equipment attached to the Versa-Plate*, please, *never ever* place any model Paramount mount in this orientation, not even with a single counterweight as it will permanently damage the worm.

Figure 66 shows an *extreme example of an out of balance German equatorial mount*:

- The worm is engaged with the gear.
- The counterweight shaft is loaded with 27 kg (60 pounds) of counterweights.
- The Versa-Plate does not have a telescope or other equipment attached to offset the weight of the counterweights.

If the RA worm and gear are engaged in this orientation, with this much counterweight, the resulting extreme torque against the worm will either bend the precision worm gear and the enormous force between the worm and gear teeth would cause the axis to rotate clockwise quickly and dangerously as the teeth of the worm and main gear skip past each other.



Never place a Paramount that does not have any telescope or other equipment attached in the above orientation!

Figure 66 shows the Paramount in an ***unstable*** configuration that places extreme and potentially destructive lateral force on the teeth of the hour angle worm and gear. The

counterweight shaft should always remain in the vertical position (Figure 67) while the attaching counterweights and instrumentation (telescope, camera, etc.).

If you must orient the mount's payload in a severely out of balance position, for the Paramount MX, place the Three Position Switch in the Lock position first (page 63), for the Paramount ME install the locking bolts and place the two-position switch to balance, and for the Paramount MX place the two-position switch to balance and pull and rotate the transport lock knob 90 degrees to a lock position.

Even if the mount's axis is locked in place, the excessive imbalance demonstrated above could bend, the locking mechanism. Please do not abuse your precision mount in this manner.



Figure 67: Before attaching a telescope to the Versa-Plate, orient the Paramount to its "happy place" with the counterweight shaft oriented vertically. In this orientation, the counterweights do not impart any lateral forces on the worm and gear.

Payload Imbalance Cause and Effect

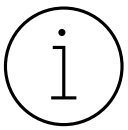
When the counterweight shaft is oriented "non-vertically" *and* one or more counterweights are on the counterweight shaft, *and* the worm is engaged with the gear, extreme lateral forces are placed on the worm teeth and causes them to separate. Once partially separated, the hour angle axis quickly rotates until the counterweights are at their lowest position, and you will hear a disturbing grinding noise as the teeth of the precision gear bounce past the teeth of the precision worm gear.

Despite the gut wrenching feeling this sound brings on, damage to the worm and gear is usually minimal. The recommended procedure is to exercise the mount for several cycles (page 157) and to try avoid this from occurring again.

Balancing the Payload

After attaching the counterweights, mount your optical tube assembly, camera, and all other equipment (focuser, filter wheel, field rotator, dew heater, etc.) to the Versa-Plate, then begin balancing each axis, starting with hour angle. The Paramount operates best when the payload is properly balanced, which means that, when the worm and gear are separated for a given axis, the axis does not tend to rotate in either direction. An unbalanced payload can cause numerous problems, such as stalling or "gear chattering" described above.

By design, there is no clutching mechanism on the Paramount. To freely rotate the axis when balancing the payload, the worm must be completely disengaged from the gear. When balancing the hour angle axis, orient the counterweight shaft vertically, then slide the counterweights up or down on the counterweight shaft to change the balance point.



Always use extreme care when balancing the telescope!

- ***Make note of the weight distribution on the telescope before placing the mount's mechanical switch in the balance position.***
- ***Always firmly grasp the telescope or counterweight shaft so that you can maintain control of the payload to avoid sudden unexpected rotation.***

To balance the hour angle axis, slide the counterweights up or down the counterweight shaft until the system has no tendency to rotate in either direction. To balance the declination axis, either adjust the position of the Versa-Plate, or slide the telescope forward or backward.

If you routinely swap cameras or other components, the difference in weight might be enough to cause slewing problems. In this situation, you can rebalance the system by marking the positions of counterweights on the counterweight shaft for each configuration.

Counterweight Safety Knob

The counterweight safety knob screws into the threaded hole on the end of the counterweight shaft. Always attach the counterweight safety knob immediately after adding counterweights to prevent an improperly mounted counterweight from sliding off the end of the shaft.

Paramount ME Side View

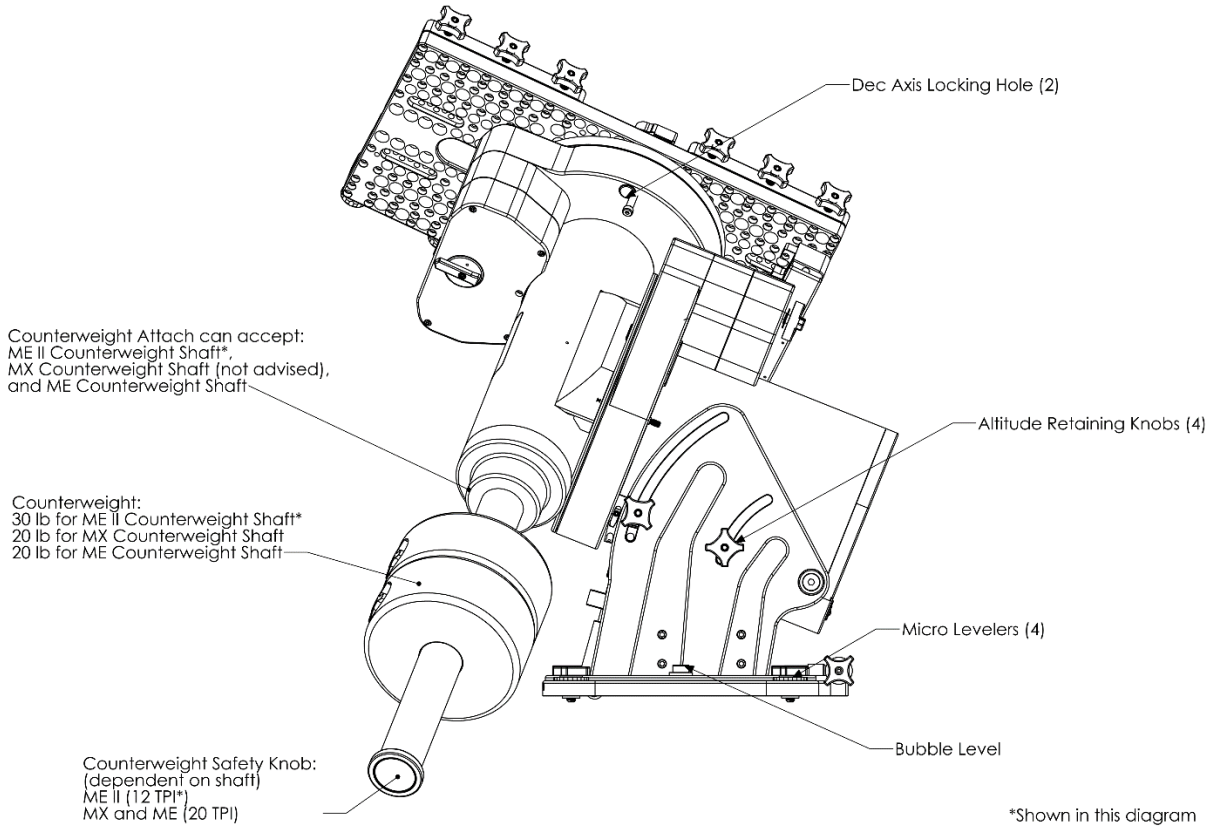


Figure 68: The side view of the Paramount ME with the optional large dovetail accessory.

Paramount MX Side View

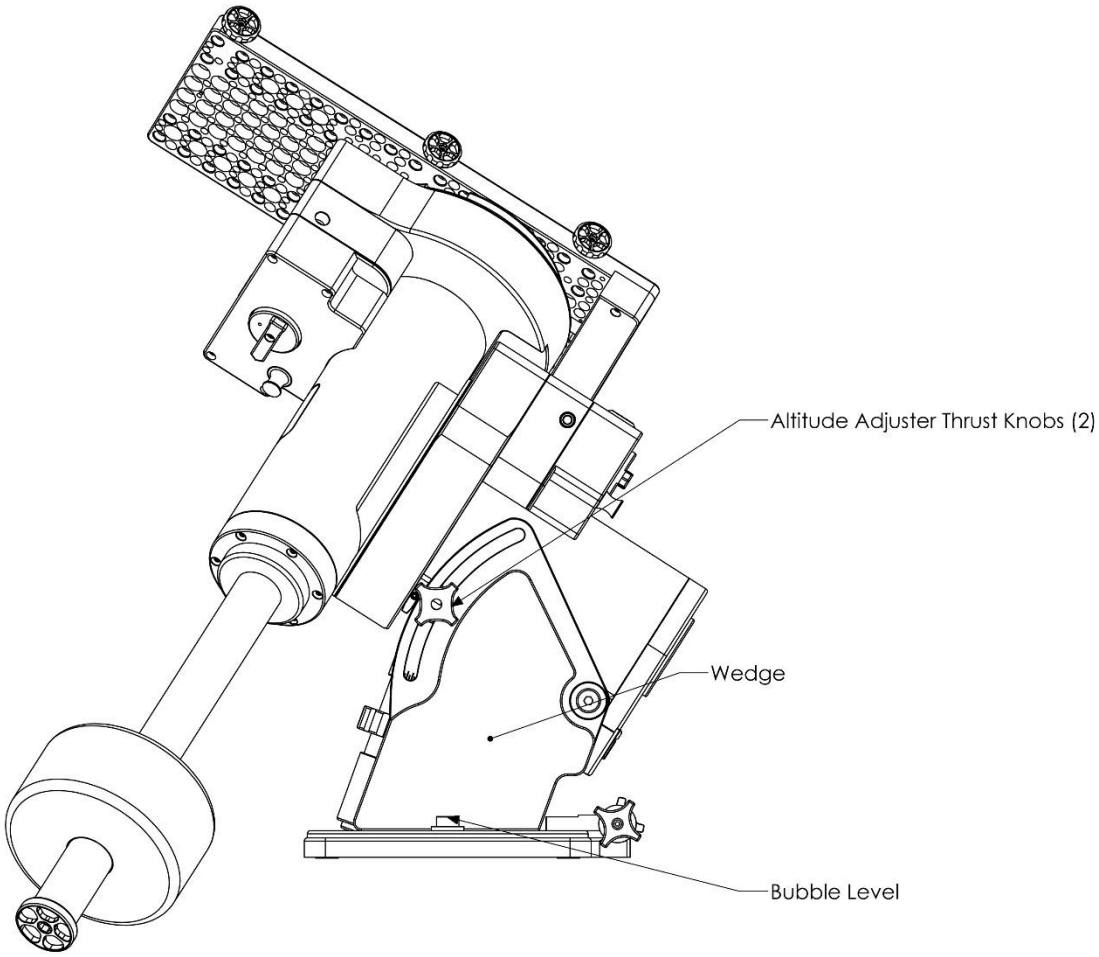


Figure 69: The Paramount MX side view.

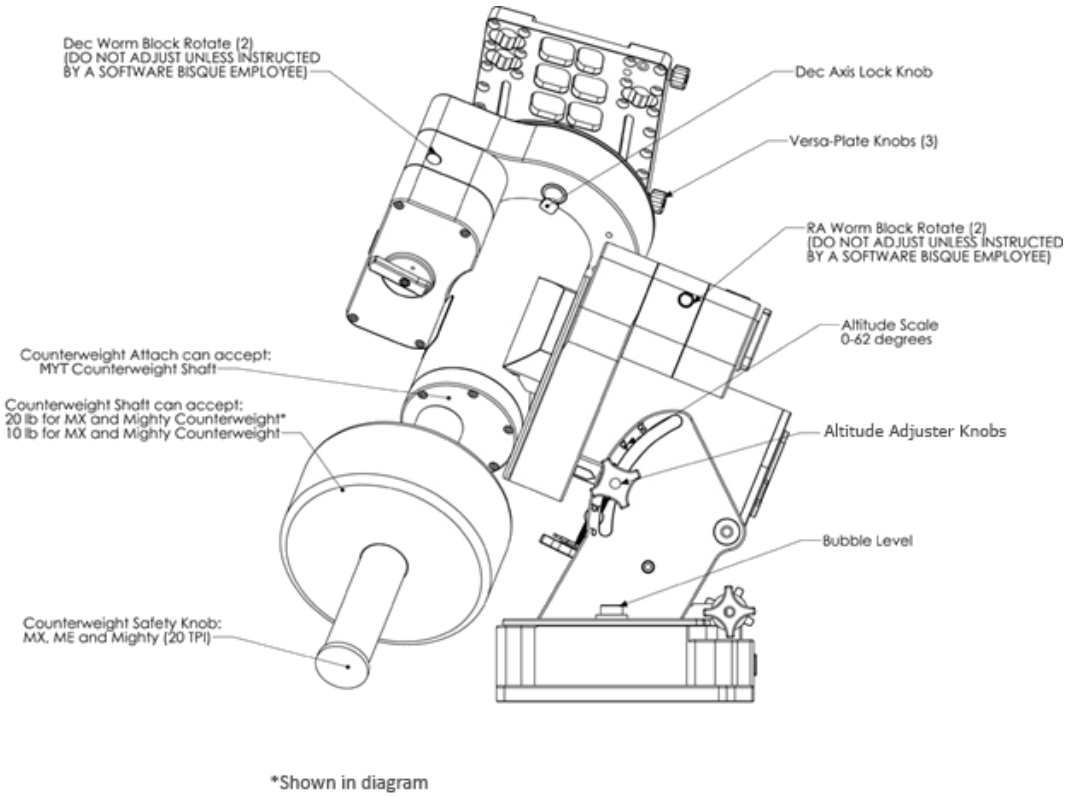


Figure 70: Paramount MYT side view.

Altitude Adjustment Thrust Knobs

The altitude adjustment thrust knobs on the side wedges lock the mount's altitude axis in place, without changing the position of the azimuth axis. (Adjusting either axis during polar alignment for some commercial mounts can be a frustrating trial and error process when trying to tighten on one axis moves the position of the other.)

Make sure to completely loosen all of the knobs before attempting to raise or lower the polar axis. The Paramount ME has two knobs on each side, the Paramount MYT and MX have one knob on each side.

Integrated Wedge

The integrated Paramount wedge allows the altitude of the mount's polar axis to be adjusted to match the celestial pole. The table below shows the minimum and maximum elevation for each model. Software Bisque manufactures and sells Paramount Latitude Adjustment wedges if astronomy takes you outside these latitudes.

Model	Minimum and Maximum Altitude of Wedge
MYT	0° – 64°
MX	0° – 70°
ME	14° – 68°

Bubble Level

The Paramount bubble level is suitable for the most demanding astronomy work and can make polar alignment easier when no polar alignment scope is available.

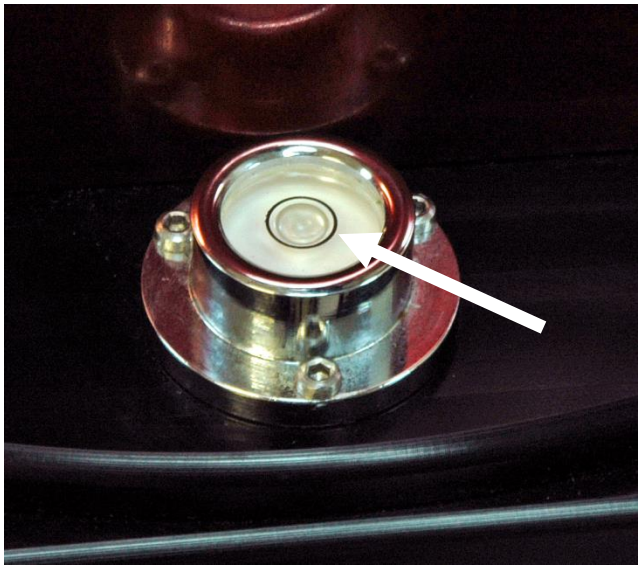


Figure 71: Center the bubble in the black ring for best results.

One-tenth of one-inch motion in the level bubble's level equates to 45 arcminutes of angular "tilt." Positioning the bubble in the center of the black ring means the mount is level to within about 5 arcminutes.

Remember, the base of a GEM does not *have to be* perfectly level to achieve precision tracking. As an extreme example, provided the equatorial axis is pointed to the refracted celestial pole, the base of a GEM could be vertical and still follow the stars.

If the mount's base is not close to horizontal, adjusting one axis pollutes the position of the other axis and makes the process of polar alignment more difficult.

TheSky and TPoint's **Accurate Polar Alignment** is a convenient means to achieve optimal polar alignment.

Declination Axis Locking Hole (Paramount ME Only)

The Paramount ME's declination axis can be locked into position by screwing two shoulder bolts (supplied with mount) into these holes.

When installed, the hour angle and declination axis locking bolts are designed to prevent the axis from rotating during shipment and while adding payload. As a best practice, always try to maintain a balanced payload, even when mounting equipment.

The shoulder bolts are not designed to carry the mount's entire payload. If you mount an excessively unbalanced payload on the declination axis, for example, you run the risk of bending one or both bolts, making removal difficult.

The specifications for hour angle axis locking shoulder bolt are:

- 18-8 stainless steel shoulder screw
- 5/16-in. shoulder diameter
- 2-1/4-in. long shoulder
- 1/4 in.–20 thread

The 1-3/4-in. long declination axis locking shoulder bolt has the same specifications.

Micro Levelers (Paramount ME Only)

The Paramount ME uses integrated Micro-Levelers and Base Plate Attachment Knobs to level and secure the mount to the pier or base plate. Please carefully read the following section before continuing.

Adjusting the Micro-Levelers

The Paramount ME's Micro-Levelers are used to fine-tune mount leveling. The maximum amount of adjustment for each leveler is approximately 3 mm or 1/8-inch. The Micro-Levelers are also used to ensure that the base plate of the Paramount ME is in direct contact with, and not distorted by an uneven mounting surface.

Important note: The Micro-Levelers *must* protrude slightly below the surface of the Base Plate and contact the mounting surface *before* tightening the Base Plate Attachment Knobs. See the "Critical Micro Leveler Note" below for more information.

The best approach for leveling the mount is to simultaneously rotate two Micro-Levelers so that the mount is tilted either north/south or east/west. The accuracy of the leveling required depends on the long-term use of the mount. If the mount is attached to a permanent pier, without the intent of portable use, leveling is less important. When used in a portable sense, a level mount helps speed the polar alignment process.



Figure 72: Micro-Leveler (lower left arrow) and Base Plate Attachment Knob (upper right arrow).



Critical Micro Leveler Note

The Micro-Levelers and Base Plate Attachment Knobs both serve different purposes. The Micro-Levelers stabilize and level the Base Plate on the mounting surface.

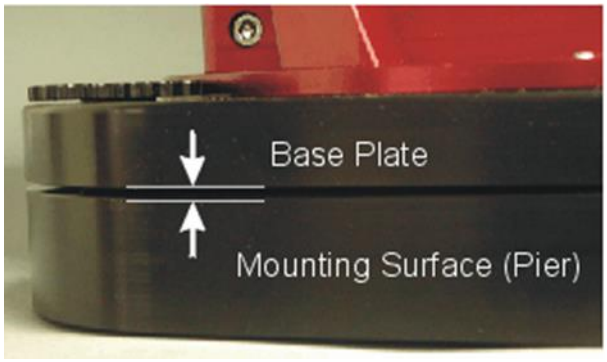


Figure 73: Adjusting Micro-Levelers.

The Base Plate Attachment Knobs secure the Base Plate to the pier. Both components have unique thread patterns, and the two *will bind together* when improperly adjusted.

The weight of the mount must rest on all four Micro-Levelers, and *not* against the surface of the Base Plate. In other words, the Base Plate should sit at least one millimeter (or so) above the mounting surface (such as the top of the pier or, or the pier adaptor plate).

To make sure this occurs, *before* tightening the Base Plate Attachment knobs, rotate each Micro-Leveler clockwise until it contacts the mounting surface. Then tighten it about 1/16 of a turn (or so) more. Additional adjustment may be required to

accommodate uneven mounting surfaces. You might also want to gently lift the mount when tightening the Micro-Levelers.

If all four Micro-Levelers are not in contact with the mounting surface, when you attempt to loosen a Base Plate Attachment Knob, both will turn together and bind. They *cannot* be turned in unison because the threads on the Micro-Leveler are larger than the threads on the Base Plate Attachment Knob. If the two become bound, **do not try to force them apart!** Instead *tighten* (yes, tighten) both knobs a small amount until they are no longer bound. At this point, rotate the Micro-Leveler clockwise until it is in full contact with the mounting surface.

Hand Controller

The Paramount includes a hand controller that can be used to slew and home the mount without the need of *TheSky Professional*, as well as turn on mount lighting and an integrated LED flashlight.

To use the joystick, plug the RJ12 phone-type connector on the end of the hand controller's 15-foot coiled cable into the Joystick port on the Electronics housing (page 66). The hand controller includes an integrated mini joystick and a large five position rate switch that allows single-handed slews and slew rate control. Double-tap the joystick to optionally issue the ***Find Home*** command (no external software required).



Figure 74: The Paramount hand controller.

Joystick Controller

The mechanical joystick controller has two functions:

- As a standard joystick controller, push the joystick left or right to slew the mount in hour angle. Up and down slews the declination axis. Move the joystick diagonally to slew both axes at the same time.

- As a mechanical button, place your thumb on the top of the joystick knob. Without moving the joystick from the center position, push the knob straight "down" (toward the hand controller body) and release to click the button. Repeat this process twice in succession, like double-clicking a mouse button, to issue a Find Home command.

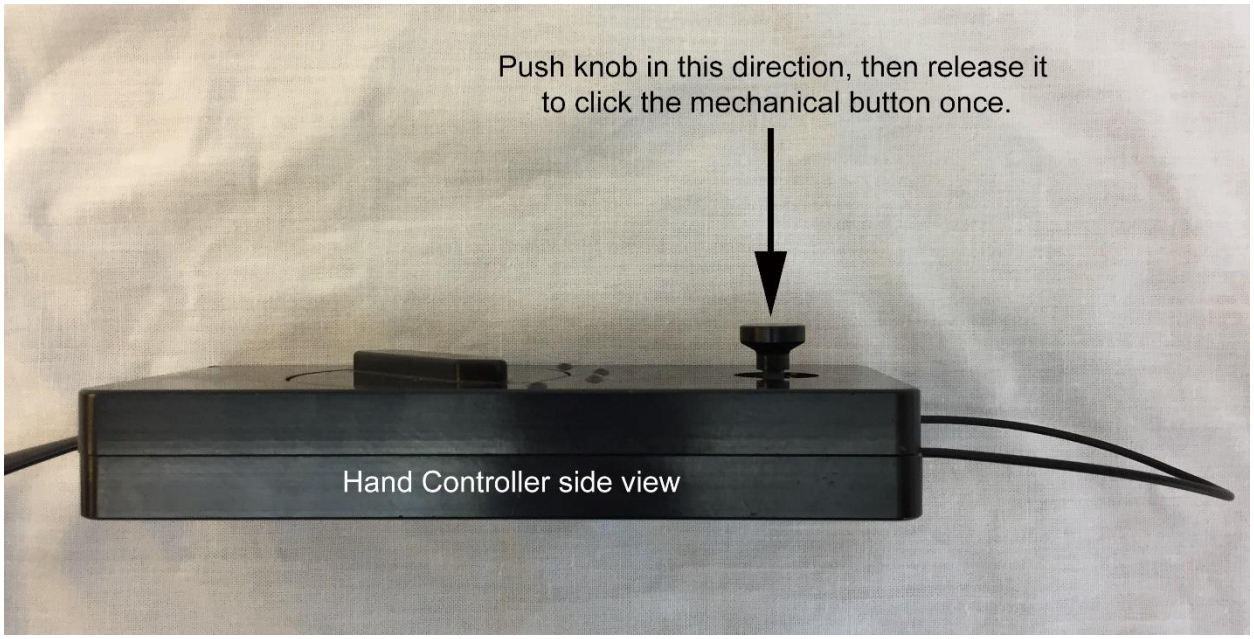


Figure 75: Double-click the mechanical joystick button to issue the Find Home command.

Rocker Switch

A three-position rocker switch is located on the side of the hand controller. It turns the mount's lighting features on or off.

- Rock and click the switch downward (toward the bottom of the hand controller) to turn on and illuminate the bright red LED located on the top of the hand controller housing. The hand controller now acts as a night-vision preserving flashlight. Return the switch to the center position to turn the LED off.
- Rock the switch upward (toward the top of the hand controller) to turn on several bright LEDs in the Electronics housing and Instrument Panel. These "landing lights" can be handy to illuminate your working area when setting up, during polar alignment or shutting down for the night. When released, the switch automatically returns to the center position and does not stay in the forward position. (Note that a Paramount ME equipped with the MKS 4000 control system does not have landing lights.)
- Press and hold the switch upward to turn on the LED flashlight (while the switch is held in the forward position) and the landing lights simultaneously.

The large cable loop on the top of the hand controller can be used to hang it in a convenient location when not in use.

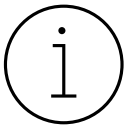
Slew Rate Switch

The slew rate switch can be adjusted to five positions. Positions 1-4 are labeled on the hand controller cover and by default the higher the number, the faster the rate. Rotating this switch counterclockwise to the unmarked position disables slewing via the joystick. The default slew rates are shown below.

Switch Position	Default Slew Rate (x Sidereal)
Fully counterclockwise (not labeled)	0x*
1	0.33x
2	3x
3	600x
4	1200x

* The rate for this switch position is not configurable.

The rates for slew rate switch positions 1-4 can be configured when the hand controller is plugged into the MKS 6000 joystick port. See “Hand Controller Settings” on page 168 for information how to do so.



The Paramount Series 6 hand controller is backward compatible with the Paramount ME (specifically, MKS 4000 control systems using firmware version 2.8.6 or later). However, the hand controller’s slew rates are not configurable when used in conjunction with the MKS 4000. In other words, the default slew rates are configurable only via the MKS 6000 control system.

Paramount Accessories

USB Cable

The USB cable has USB C style connector that plugs into USB port on the Electronics housing and a standard USB-A plug that plugs into the PC.

Hex Wrenches

The Paramount mount includes a set of SAE hex wrenches that can be used to tighten the Versa-Plate knobs (page 54), loosen the base mounting knobs (page 87), adjust the altitude thrust knobs (page 107), and other common setup tasks.

Power Supply Unit (PSU)

The Paramount power supply unit is compatible with either +120 or +240V power sources and includes a NEMA 5-style three-pronged connector. Country-specific power plugs can be purchased at many hardware or electronics shops. The table below shows the PSU specifications for each model.

Model	Power output (max)	Input	Output

MYT MX	80W	100-240VAC ~47-63 Hz 1.9A	48V 1.66A max.
ME	221W	100-240VAC 50/60 Hz 4.0A	48V 4.6A max.

The Paramount MX and Paramount MYT include an 80W power supply which allows slew rates up to six degrees per second. The optional 221W can be purchased separately to achieve slew rates of 10 degrees per second.

Altitude Adjuster Wrench (Paramount ME Only)

The Paramount ME includes a removable Altitude Adjuster Wrench that makes rotating the Altitude Adjuster Knob easy, even with heavy a payload attached to the mount.

The circular section of this wrench fits over the Altitude Adjuster Knob and will drop into place on the top of the knob when the wrench and knob tics are aligned. Once seated, you can rotate the knob using the increased leverage from the protruding arms to make polar axis elevation adjustments.

How to Polar Align the Paramount

Once the Paramount has been securely mounted to the pier or tripod, the next step is to align the mount's polar axis with the celestial pole.

Software Bisque recommends starting with the rough polar alignment method, then using either the polar alignment 'scope or *TheSky Professional's* ***Accurate Polar Alignment*** feature to refine the alignment. Note that the accurate polar alignment procedure requires a TPoint model; please refer to the telescope modeling section of *TheSky Professional User Guide* to learn more about telescope calibration and modeling. If a different polar alignment technique works well for you, please use it!

Rough Polar Alignment

When the base of the Paramount is approximately level, and the Paramount is at the home position, this fixed mechanical orientation of the mount can be used in conjunction with *TheSky Professional* to polar align the mount to within about 10 arcminutes of celestial pole (which is a good *starting point*).

When the Paramount is positioned at the home position, the mount's mechanical orientation is always the same. In the northern hemisphere, the Paramount MYT and MX Series 6 point to hour angle 0 and declination 0. The Paramount ME Series 6 points to hour angle 2, declination 0.

Provided the base of the mount is fairly close to level, and the altitude of the polar axis matches the observing site's latitude, *TheSky Professional* (configured with accurate location, date, time, and time zone settings) can be used to slew the mount to the *computed* position of an object (usually a star or other bright object) on the celestial sphere.

Once the telescope has been slewed to the object, the mount's ***mechanical azimuth axis*** (not the telescope's position) can be adjusted until the object is centered in the eyepiece. This technique relies on the home position and the computed equatorial coordinates of an object to approximately align the mount's polar axis to the celestial pole.

The rough polar alignment method can be performed during the daylight hours by slewing to a planet, bright star or even the Moon or Sun (provided the proper solar filters are used). Another advantage to this technique is that the celestial pole need not be visible.

Note that while the home position is mechanically fixed, the telescope itself will not necessarily precisely point to hour angle 0 and declination 0. This is mostly due to optical and mechanical non-perpendicularities. For this reason, the rough polar alignment method should be deemed a "rough" not a "precise" polar alignment technique.

After performing a rough polar alignment, use *TheSky Professional's* **Tools**, **Accurate Polar Alignment** command to achieve exceptional polar alignment .

Step-By-Step Rough Polar Alignment

To begin a rough polar alignment, from *TheSky Professional,* click **Tools**, **Rough Polar Alignment** and follow the step-by-step instructions. Note that the *Rough Polar Alignment* window can be resized larger to make the graphics larger and easier to read.

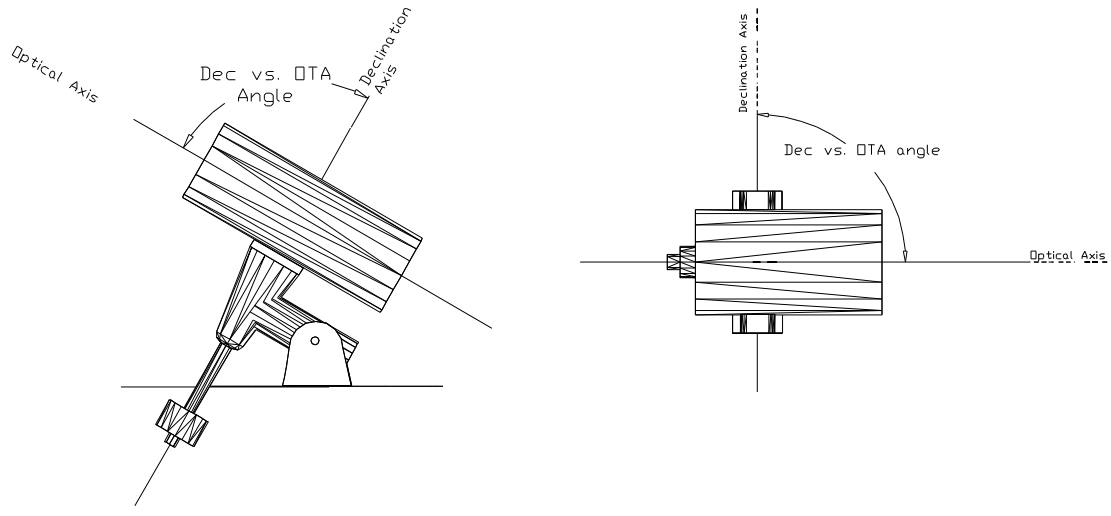


Figure 76: The telescope's optical and mechanical non-perpendicularity errors degrade the accuracy of the rough polar alignment method.

Note that optical and mechanical non-perpendicularities in the telescope and the declination axis play a key factor in the accuracy of the rough polar alignment method. If these misalignments are large (in the order of 30 arcminutes or greater), the initial polar alignment will not be as accurate.

Accurate Polar Alignment

For most amateurs, optimal tracking performance can be achieved when an equatorially mounted telescope is aligned to within about 100 arcseconds of the refracted pole. Coupled with a TPoint model, TheSky's *Accurate Polar Alignment* command makes getting there much less difficult.

The Accurate Polar Alignment Command

TPoint author Patrick Wallace developed an ingenious method to align an equatorial mount's polar axis accurately, and relatively painlessly with the celestial pole. Figure 77 shows the accurate polar alignment workflow.

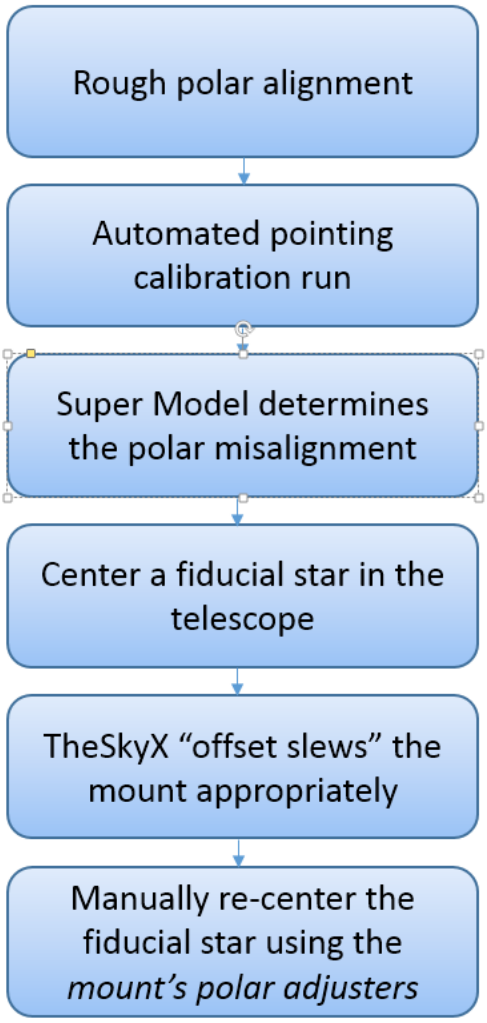


Figure 77: The Accurate Polar Alignment workflow.

Once a telescope has been set up, roughly aligned with the pole, and calibrated, TPoint's Super Model determines the mount's polar misalignment in the TPoint Polar Alignment Report. The "closed loop feedback" of the **Accurate Polar Alignment** procedure ensures an accurate alignment.

After verifying there is sufficient pointing calibration data, the **Accurate Polar Alignment** wizard instructs you to identify a star located near the meridian, in the north or south, and then center this star in the eyepiece. Once this step is confirmed, the wizard performs an offset slew based on the TPoint polar misalignment, so that the star can be re-centered using the mount's ***mechanical polar alignment adjusters***.

If you are not familiar with TPoint, pointing calibration, or Super Model, please refer to the latest revision of *TheSky Professional User Guide*. From TheSky, click **Telescope, TheSky User Guide** to view the PDF document. The latest revision can be downloaded from the Software Bisque website by clicking **Downloads**, **Documentation** then enter ***TheSky User Guide*** in the ***Search*** field.

Polar Alignment Quick Start Guide

1. Use the "Rough Polar Alignment" procedure (page 113) to approximately align the mount with the celestial pole.
2. As described in the *TheSky Professional User Guide*, perform an automated pointing calibration run to collect pointing data so that an accurate estimate of the polar misalignment can be determined.

   The number of points used in the initial calibration can vary depending on your needs. As few as 12 calibration points can be used to characterize the polar misalignment on portable setups, or if you are just getting started. For permanent installations, or portable setups where you want to completely characterize the mount's errors, you might opt to collect 150 or more calibration points before generating the Super Model. If the equipment on the system, or the polar alignment changes in the future, or you're setting up the mount each night, a portable *recalibration* can be done to reestablish the pointing accuracy in the original model.

3. When the pointing calibration is complete, create the Super Model based on this data. The polar misalignment details are available on the **Polar Alignment** tab of the **TPoint Module** window.
4. From *TheSky Professional*, click **Tools**, **Accurate Polar Alignment** and follow the step-by-step instructions.

After completing the Accurate Polar Alignment wizard, the mount is accurately aligned with the pole. The polar alignment terms (ME and MA) in the TPoint model automatically changed to reflect the new position of the polar axis.

Going forward, each time your portable system is set up, perform a ***Recalibration*** using the ***Portable*** option on the ***Calibration*** tab of the TPoint module window so that the new polar alignment offsets can be determined.

Using the PoleMaster

QHYCCD's PoleMaster™ is an easy-to-use electronic polar scope, and an alternative to the traditional polar alignment scope. Software Bisque offers a Paramount MYT/MX *PoleMaster Adaptor* that can be used to attach the PoleMaster to the declination axis and assist with polar alignment.

The Paramount and TheSky Professional

The Paramount Series 6 Robotic Telescope Mount utilizes the MKS 6000 telescope control system (TCS). The MKS 6000 offers ultra-precise pointing and tracking, with configurable slew limits, current limited motor shutdown, auto homing, high-frequency position monitoring, easy firmware updates, and more.

Minimum System Requirements

The Paramount requires the following minimum hardware and software to operate:



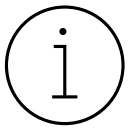
A Mac, Windows, or Linux ARM64 or x86_64 computer running *TheSky Professional* or a Software Bisque *TheSky Fusion*. See *TheSky Professional User Guide* for TheSky's minimum computer hardware requirements for additional information.





For *USB to mount* communication, there must be one free USB port on the computer and a USB cable connected to the computer and the Paramount USB port, or .

Optional USB cable extenders can be used to allow the length of the USB cable to be increased to 30 meters or so. If the distance between the computer and mount is greater than 30 meters, consider using a high-quality USB Ethernet Extender.



Extending the length of the USB cable between the mount and computer using inexpensive USB cable extenders, or plugging in a second, inexpensive USB hub to the USB hub on the Instrument Panel will, most likely, introduce inconsistent and unreliable communication between either the mount or the camera or other USB device. See "USB Hubs and USB Extenders" on page 186 for more information.

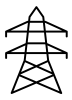


For *Ethernet to mount* communication, a network interface controller (NIC) on the computer that is running TheSky, with a CAT 6 Ethernet cable plugged into the NIC and the mount's Ethernet port is required.



For *Wi-Fi or wireless local area network (WLAN)* communication, a Wi-Fi-enabled computer running TheSky must be connected to the Paramount's connection point (or "hot spot").





The Paramount PSU (included) plugged into mains power.

-or-



MYT and MX: A 1.66A 48V DC battery or other power source.
ME: A 4.6A 48V DC battery or other power source.

Software Bisque sells an *EGO™ Battery to Paramount Power Adaptor* that can be connected to a 56V Lithium-Ion EGO™ battery (adapter and battery sold separately).

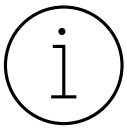
First Time Paramount Setup

Please make sure to carefully read both the *Paramount Unpacking* insert and the Paramount Quick Start Guide in the Paramount boxes before using the mount.

After the Paramount has been unboxed and safely attached to your tripod or pier, the next step is to connect the power and communication cables to the Electronics housing so that the mount can be turned on.

1. Plug the round end of the Paramount power cable into the port labeled *48V Power In* on the Electronics housing and the other into an electric outlet.
2. Plug the USB-C end of the USB cable into the Electronics housing port labeled ***USB*** and USB A connector into a free USB port on the computer.
3. Flip the On/Off switch upward to the on position.

When the Paramount is turned on, three LEDs on the Electronics housing are illuminated, and a short "whistle" is emitted to indicate the control system has been successfully initialized. (The LEDs labeled ***HA*** and ***Dec*** are red; LED labeled ***TCS*** is white). Two successive beeps are emitted shortly afterward indicating the servomotors have been initialized.



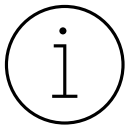
Exactly *when* the two motor initialization beeps occur may be *different for each mount* and will *vary depending on the mount's current mechanical orientation*. The beeps may even occur simultaneously so that only a single beep is audible.

If the LEDs on the electronics housing are illuminated, and the mount successfully finds the home position, control system is functioning nominally.

Controlling the Paramount with TheSky Professional

After plugging the USB cable into the mount and computer, you must configure *TheSky Professional* to control the *Paramount*.

1. Make sure the mount is turned on so that the computer recognizes the Paramount USB port.



The Paramount must be turned on before the operating system can discover the Paramount's USB port.

2. From *TheSky Professional*, choose the ***Telescope Setup*** command from the ***Telescope*** menu.
3. On the ***Imaging System Setup*** window, ***Imaging System*** list, highlight ***Mount***.
4. Click the ***Mount Setup*** pop-up menu, then the ***Choose*** command.
5. Expand ***Software Bisque***, select ***Paramount ME Series 6, Paramount MX Series 6*** or ***Paramount MYT Series 6*** and click ***OK***.
6. On the ***Mount Setup*** pop-up menu, click ***Settings***.
7. Choose the Port or Device Name (macOS) with the Software Bisque MKS 6000 description and click ***OK***.
8. Click the ***Connect*** command from the ***Telescope*** menu and then click the ***Close*** button on the ***Imaging System Setup*** window.
9. The ***Telescope*** window's ***Status*** text shows the current state of the mount, which is ***Not Homed*** for mounts with motor-based encoders. In this case, click ***Startup***, ***Find Home*** to start the homing process. If your mount has absolute encoders, the mount does not need to be homed.

Getting Started with TheSky Professional

If you are not familiar with *TheSky Professional's* basic telescope controls, please refer to *TheSky Professional* User Guide for details about basic mount control features, including:

Feature	Quick Start Reference
Add a *TPoint* pointing sample	**Telescope** window, **Add Pointing Sample** button.
Centering the telescope cross hairs	**Telescope** window, **Center Cross Hairs** button.
Clear the park position	**Telescope** window, **Shutdown** pop-up menu, **Clear Park Position** command.
Connect or disconnect the mount	**Telescope** menu, **Connect**, **Disconnect** commands from the.
Finding home (motor-based encoders, only)	**Telescope** window, **Startup** pop-up menu, **Find Home** command, or double tap the joystick. See .
Mount status	**Telescope** window, **Status** text.
Moving or jogging the mount	**Telescope** window, **Move** and **Jog** controls
Parking	**Telescope** window, **Shutdown** pop-up menu, **Park** command.
Setting the park position	**Telescope** window, **Shutdown** pop-up menu, **Set Park**

Feature	Quick Start Reference
	Position command.
Slewing	**Telescope** window, **Slew** button.
Star searching	**Telescope** window, **Tools** pop-up menu, **Star Search** command.
Telescope configuration	**Telescope** menu, **Telescope Setup** command.
Tracking spacecraft	**Telescope** window, **Track Satellite** button.
Tracking planets, comets, or asteroids	**Telescope** window, **Set Track Rates** button.
Turning sidereal tracking on	**Telescope** window, **Tools** pop-up menu, **Turn Sidereal Tracking On** command.
Turning tracking off	**Telescope** window, **Tools** pop-up menu, **Turn Sidereal Tracking Off** command.
Unparking	**Telescope** window, **Shutdown** pop-up menu, **Unpark** command.
Graphic Showing Virtual Paramount	**Telescope** window, **Tools** pop-up menu, **Virtual Mount.**

The Bisque TCS Window

The ***Bisque TCS*** window can be used to set every Bisque TCS parameter directly from *TheSky Professional*. Earlier versions of *TheSky* required a separate application to view and configure advanced settings.

The ***Bisque TCS*** window also allows saving and restoring the mount's current firmware settings, provides advanced periodic error correction curve fitting, shows mount status, synchronization history and offers many other useful tools for monitoring the mount's status and providing troubleshooting information.

To view the ***Bisque TCS*** window, connect to the mount by choosing the ***Connect*** command from the ***Telescope*** menu. Next, choose the ***Bisque TCS*** command from the ***Tools*** pop-up button on the ***Telescope*** window. If the ***Telescope*** window is hidden, click the ***Telescope*** command from the ***Display*** menu to show it.

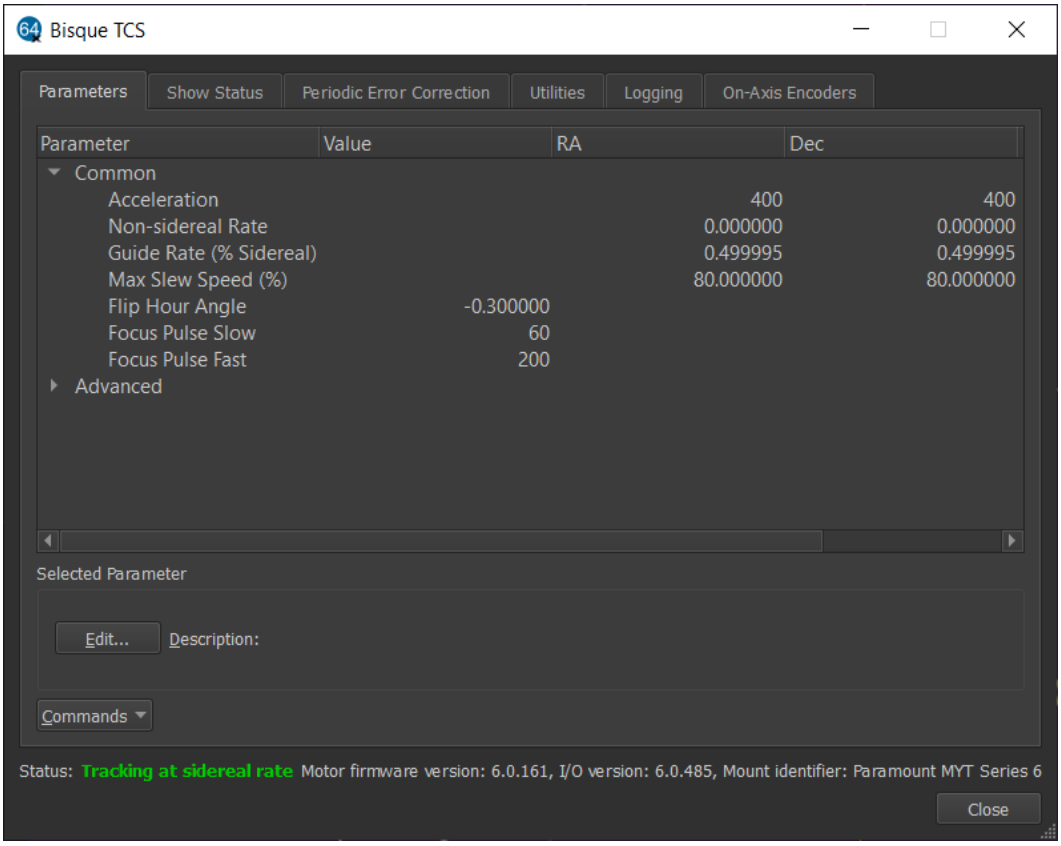


Figure 78: The Bisque TCS Status tab.

The ***Bisque TCS*** window includes the ***Parameters***, ***Show Status***, ***Periodic Error Correction***, ***Utilities*** and ***Logging*** tabs.

Status Messages (Status Text)

The always visible ***Status*** message on the bottom of the window shows color-coded text about the mount's current state. (Mount status messages are repeated on the ***Telescope*** window.) See "Mount and Status" in *TheSky Professional User Guide's* Telescope documentation for a detailed explanation of each status message.

Firmware Versions and Mount Identifier

The bottom of the Bisque TCS window shows the current motor firmware and I/O firmware versions of the Bisque TCS, as well as the mount identifier.

Parameters Tab

The ***Parameters*** tab shows the various Bisque TCS settings that can be modified. Parameters are divided into ***Common*** and ***Advanced*** categories. The common parameters, such as the mount's acceleration, are commonly changed to accommodate heavier payloads or other personal preferences (for example, you might want to lower the maximum slew rate because, *"I don't want my expensive equipment slewing around too fast!"*).

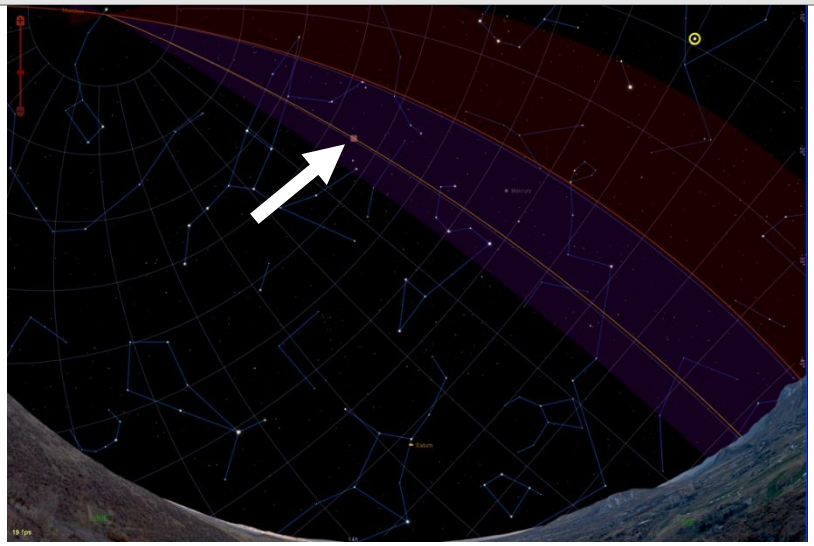
The advanced settings are mount-specific control system configuration options that are used for custom (non-Paramount) mounts. Most advanced parameters ***should not be modified for Paramount ME or Paramount MX mounts***. Each parameter is displayed in the ***Description*** text box at the boom of the window. Click the parameter's name in the tree list to view its current value. Click the ***Edit*** button to change the value for this parameter; altered parameters appear in red text.

Common Parameters

The more commonly modified Bisque TCS parameters are described below.

Common Parameter Name	Description
Acceleration	The motor's relative acceleration/deceleration setting. Lower numbers (for example, 250) yield slower acceleration and deceleration while higher numbers (for example, 750) yield faster acceleration and deceleration.
Non-sidereal Rate	The non-sidereal rate, in arcseconds per second, is the rate added to or subtraced from the sidereal tracking rate. Although this rate can be set manually, *TheSky Professional* can set the rate automatically. See the ***Set Track Rates*** button documentation for details how to do this.
Guide Rate (Fraction of Sidereal)	This value reflects the rate at which the telescope is moved when autoguider corrections are made. The general rule of thumb is that the fewer number of corrections to the mount's position that are made during autoguided exposures, the better the resulting star profile. So, a the guide rate of 0.5 sidereal rate (the default setting) is the optimal value to achieve this goal.
Max Slew Speed (%)*	The percentage of the mount's maximum slew rate that is used when slewing the mount. The default is 80 percent. • The Paramount ME maximum slew rate in hour angle is 3.5 degrees per second and 5 degrees per second in declination, so the default maximum slew rate is approximately 3.2 and 4.5 degrees per second. • The Paramount ME maximum slew rate is about 4 degrees per second in both axes. • The Paramount MX maximum slew rate in both hour angle and declination is 4 degrees per second. The default maximum slew rate in both axes is 3.6 degrees per second. • The Paramount MX maximum slew rate and default maximum slew rate in both hour angle and declination is the same as the

Common Parameter Name	Description
	Paramount MX, with the included power supply unit. ○ A higher wattage power supply unit can be purchased separately which gives the Paramount MX the abilities to slew up to 10 degrees per second. The default maximum slew rate in both axes is 3.6 degrees per second. • The Paramount MyT's *maximum* slew rate is 6 degrees per second; the default rate is 5.4 degrees per second. ****Maximum Slew Speed Disclaimer*** The factory default of 80% maximum slew rate works well with most payloads over a wide range of temperatures. Paramount mounts can slew at the *maximum slew rate* with a balanced payload that is approximately 50% or less of the total rated capacity, and when the spring plunger pressure is adjusted to factory standards, at moderate ambient temperatures. As the mass of the payload increases, and/or the ambient temperature decreases, the mount may not be able to maintain maximum slew speeds. When near or above the stated capacity of the mount, or during cold temperature operation, slower maximum slew speeds and lower accelerations are required.
Flip Hour Angle (HA)	When slewing to a target object, the *Flip Hour Angle* parameter defines when the optical tube assembly changes sides of the pier. When a slew command is issued from *TheSky Professional*: • If the hour angle of both the telescope and the target are *less than* the Flip Hour Angle, the telescope remains on the same side of the pier when slewing to the target. • If the hour angle of the telescope is less than the hour angle of the target, and hour angle of the target is *greater than or equal to* the Flip Hour Angle, the telescope changes sides of the pier when slewing to the target. Configuring Flip Hour Angle Graphically When *TheSky Professional* connects to the Paramount, the current flip hour angle is represented on the Sky Chart as an orange line drawn from the horizon to 90 degrees declination.

Common Parameter Name	Description
	 **Figure 79: The orange line on the Sky Chart represents the current flip hour angle.** To dynamically change the flip hour angle, click and drag the orange handle square on the flip hour angle line (see the white arrow on Figure 79). • The mount automatically performs a meridian flip when the target object is beyond this line. • When the mount tracks to the flip hour angle, sidereal tracking is turned off automatically. At this point, the mount is in a "wait for the next slew" or a find home command to proceed. • The mount does not automatically flip sides during normal operation, unless instructed by an external automation sequence (including an LTI dither move, command from a script or a third-party automation software). The default value of this parameter is –0.3 for the Paramount MYT, Paramount MX, Paramount MX, and Paramount ME, and –3.0 for the Paramount ME.
Focus Pulse Slow	The number of milliseconds the built-in focuser is pulsed when the SLOW focus button is pressed.
Focus Pulse Fast	The number of milliseconds the built-in focuser is pulsed when the FAST focus button is pressed.

Advanced Parameters

The MKS 6000 advanced parameters are divided into the following categories:

- User-Defined
- Axis
- System
- Homing
- Initialization
- Motor Parameters
- Periodic Error Correction
- On-Axis Encoders

You may wish to change certain parameters based on the mount's payload or to suit your personal preferences. For example, lowering the maximum acceleratiohn and slew speed for heavier telescopes, or changing the slew limit to prevent a longer telescope from hitting the side of the pier.

Axis-Related Parameter	Description
Unit Identifier	This number relates to the TCS version and cannot be changed.
Non-sidereal Rate	The non-sidereal rate, in arcseconds per second, is the rate added to or subtraced from the sidereal tracking rate. Although this rate can be configured manually, *TheSky Professional* can perform this automatically. See the ***Set Track Rates*** button documentation for details how to do this.
Guide Rate	When the Bisque TCS guiding lines are activated, the increase or decrease in control system's position occurs at this rate. The general rule of thumb is that the fewer number of corrections to the mount's position that are made during autoguided exposures the better the resulting star profile. So, a guide rate of fifty-percent of sidereal rate (the default setting) is the optimal value to achieve this goal.
Maximum Speed (%)	The percentage of the mount's maximum slew speed.
Track Rate	The sidereal tracking rate in control system tracking units.
Min Position Limit	The Bisque TCS will not drive the motors beyond this minimum encoder value (decelerating stop).
Max Position Limit	The Bisque TCS will not drive the motors beyond this maximum encoder value (decelerating stop).
Joystick Center	The calibrated center position of the joystick.

Homing-Related Parameter	Description
Relative Home Sensor	The *relative* home sensor position is computed using both the mount's

Homing-Related Parameter	Description
Position	fixed homing sensor location ***and*** the equatorial coordinates supplied to *TheSky Professional* when the mount was synchronized on a star. For a perfect mount that has no optical or mechanical misalignments, mechanical flexures or polar alignment errors, the relative home position would identically match the absolute mechanical home position. This is never the case. Misalignments in the mount's mechanical axis and the telescope's optical axis, for example, always introduce telescope pointing errors so there will always be a difference between the relative and absolute home position after synchronization. When the mount is synchronized to a known star, the "relative location of the home position" changes based on the pointing error introduced by the mechanical and optical misalignments. When the relative and absolute home sensor positions are equal, it means the mount has not yet been synchronized on a star. After synchronizing the mount, choose the ***Get All Bisque TCS Parameters*** command from the ***Commands*** pop-up menu on the ***Parameters*** tab (see page 135) to retrieve the control system's current settings. Retrieving all the settings takes several seconds, so their values are not updated in "real time".
Home Required?	If set to 1, homing is required before slewing will occur (as with the joystick, etc.).
Home Direction	Initial direction to slew when searching for the home position "interruptor" (that is, the physical component on the gear that blocks the optical path of the homing sensor to signal the homing position).
Home Sense	Specifies whether the control system is looking for line high versus line low from the homing sensor.
Home Mode	1 = None, 2 = One sensor.
Home In-Out-In	Always set to 1.
Home Velocity High	This is the rate at which the homing process begins looking for the home sensor.
Home Velocity Medium	After the first pass of the interruptor, the motor reverses direction and searches at this rate.
Home Velocity Low	After the second pass of the interruptor, the motor searches at this rate.
Home from Joystick?	When set to 0, double-tapping the joystick button will not find the home

<table>
<tr><th>Homing-Related Parameter</th><th>Description</th></tr>
<tr><td></td><td>position. Set this value to 1 to allow homing with the joystick.</td></tr>
<tr><td>Home Index Offset</td><td>When the home position interrupter is near the motor home index, this offset is used to ensure the home function is consistent. The default value for Paramounts is 0.</td></tr>
<tr><td>Absolute Home Sensor Position</td><td>These values represent the coordinates of the home position based on the mount's mechanical homing sensor location.

<table>
<tr><th>Series 6 Model</th><th>Home Position</th></tr>
<tr><td>MYT
MX</td><td>Hour angle: 0.0
Dec: 0.0</td></tr>
<tr><td>ME</td><td>Hour angle: 2.0
Dec: 0.0

HA –2.0 and declination 0.0 when the mount is configured for the southern hemisphere (see “Hemisphere Setup” on page 149).</td></tr>
</table>
These values cannot be changed.</td></tr>
</table>

Initialization-Related Parameter	**Description**
Focus Multiplier	A number between 1 and 100 that can be used to increase the mount’s pulse focuser adjustment. The default value is 1.
Flip Hour Angle	See Flip Hour Angle on page 125 for a description of this parameter.
Temperature Slew Rate Reduction Percentage	Reduce the slew rate by this percentage when the ambient temperature drops below the *Temperature Slew Rate Threshold* value.
Temperature Slew Rate Threshold	When the ambient temperature, in Celcius, drops below this value, reduce the slew rate by the *Temperature Slew Rate Reduction Percentage*.
Kernel State	The state of the ProTrack kernel. 0 – Tracking adjustments off. 1 – Tracking adjustments on. See “Activating ProTrack” on page 183 for more information.
Call Level Logging	When turned on, all call level functions will be logged and displayed on

Initialization-Related Parameter	**Description**
	the Logging window.
Packet Level Logging	When turned on, all packet level communications will be logged and displayed on the Logging window.
Focus Pulse Slow	The number of milliseconds the built in focuser is pulsed when the ***Slow*** focus button is clicked.
Focus Pulse Fast	The number of milliseconds the built in focuser is pulsed when the ***Fast*** focus button is clicked.
Home After Connect	If set to 1, the mount will be homed after connecting if it is not already homed.
Show Limits	If set to 1, the telescope limits will be drawn either side of the meridian.
Log Slews	If set to 1, slewing information will be logged and displayed on the Logging window.
Prohibit Tracking Below the Lower Altitude Limit	When set to 1, the mount will stop tracking at the lower altitude limit defined in *TheSky Professional's* ***Telescope, Telescope Limits, Lower Altitude Limit*** tab. When set to 0, the mount will continue tracking until tracking is turned off, or the mount encounters a physical hardware limit which causes tracking to turn off automatically.

Motor Parameters	
Index Angle	The Paramount's DC servomotors require a unique motor index angle that is used during motor initialization. The motor index angles are preset at the factory, and should not be altered unless instructed to do so by Software Bisque. • For the Paramount ME, the motor's index angle is affixed to a sticker on the motor, and can also be viewed on the Control System Parameters report (page 137). • For the Paramount ME, Paramount MX, Paramount MX, and Paramount MYT, the motor index angles are 200 for the hour angle axis, and 3850 for the declination axis. Replacement MKS 6000 boards are normally pre-programmed with the correct motor index angles before the mount is shipped.
EMF Constant	This value is based on DC servo motor type and motor size.

Max Voltage	The maximum voltage the control system can supply to the motors before an error condition occurs. 15 for the Paramount ME, MX, and MYT. 30 for the Paramount ME Series 6 and Paramount ME II.
Max Gain	Always set to 150.
Max Position Error	The maximum number of encoder tics from target before the Bisque TCS aborts slewing or tracking and begins to emit position error beeps.
Motor Field Voltage	A motor-specific parameter that should not be changed.
Motor Pole Count	Internal control system motor parameter that should not be changed.
Motor Encoder Count	The resolution of the encoder on the motor, after quadrature. Do not change this value for Paramount mounts.
CoefD	A motor-specific parameter that should not be changed.
Max Integral	A motor-specific parameter that should not be changed.
Small Step	A motor-specific parameter that should not be changed.
Coeff I	A motor-specific parameter that should not be changed.
Coeff P	A motor-specific parameter that should not be changed.
Deriv Max	A motor-specific parameter that should not be changed.
Motor Torque Advance	A motor-specific parameter that should not be changed.
Max Current (mA)	The maximum current supplied to the motors. The default is 950 mA.

On-Axis Encoders	
On-Axis A1	Axis 1 on-axis motor parameter. Do not modify.
On-Axis M1	Motor 1 on-axis motor parameter. Do not modify.
On-Axis A2	Axis 1 on-axis motor parameter. Do not modify.
On-Axis M2	Motor 1 on-axis motor parameter. Do not modify.
On-Axis LP Coeff	Cut-off frequency for on-axis encoders.
On-Axis Max Pos Error	The maximum number of encoder tics between the motor encoders and the on-axis encoders before an error condition is emitted.
On-Axis PEC Step Small P8	On-axis encoder periodic error correction parameter.
On-Axis PEC Step Big P8	On-axis encoder periodic error correction parameter.
On-Axis PEC Above-Cutoff	On-axis encoder periodic error correction parameter.

Deadband	
On-Axis PEC Above-Cutoff Deadband	On-axis encoder periodic error correction parameter.
On-Axis PEC Small Step Deadband	On-axis encoder periodic error correction parameter.
On-Axis PEC Small Step Prop Gain	On-axis encoder periodic error correction parameter.
On-Axis PEC Trans-Speed	On-axis encoder periodic error correction parameter.
On-Axis Encoder Count	On-axis encoder periodic error correction parameter. **Out of range** is displayed in the **Message** column when no on-axis encoders are detected.
On-Axis Ecc Angle	On-axis encoder periodic error correction parameter. **Out of range** is displayed in the **Message** column when no on-axis encoders are detected.
On-Axis Ecc Dist	On-axis encoder periodic error correction parameter. **Out of range** is displayed in the **Message** column when no on-axis encoders are detected.
On-Axis Direct Enc Dist	On-axis encoder periodic error correction parameter. **Out of range** is displayed in the **Message** column when no on-axis encoders are detected.
On-Axis Direct Enc Posn	On-axis encoder periodic error correction parameter. **Out of range** is displayed in the **Message** column when no on-axis encoders are detected.

Periodic Error Correction Parameters	
PEC Motor to Worm Gear Ratio	Specifies the gear ratio between the motor and the worm gear.
PEC Cutoff Speed	Set to two times the sidereal rate, this insures periodic error correction is not applied to higher slew rates. Attempting to apply periodic corrections at high slew speed results in very labored sounding slews.
PEC Harmonics	The number of harmonics to use when TheSky computes optimal PEC curve.
PEC Ratio 1	The first gear ratio between the motor and worm.

<table>
<tr><td>PEC Ratio 2</td><td>The second gear ratio between the motor and worm.</td></tr>
<tr><td>PEC Ratio 3</td><td>The third gear ratio between the motor and worm.</td></tr>
<tr><td>PEC Scale</td><td>The scale in arcseconds per pixel of the imaging system used to generate the PEC tracking log file.</td></tr>
<tr><td>PEC Teeth on Gear</td><td>The number of teeth on the mount’s main gear. This value defines the length of time for one revolution of the worm when the mount is tracking at the sidereal rate.
<table>
<tr><td>ME</td><td>• Tracking at the sidereal rate, one revolution of the worm takes 149.6 seconds (2 minutes 29 seconds).
• The hour angle gear has 576 teeth.
• The declination gear has 375 teeth.</td></tr>
<tr><td>MEII</td><td>• Tracking at the sidereal rate, one revolution of the worm takes 149.6 seconds (2 minutes 29 seconds).
• The hour angle gear has 576 teeth.
• The declination gear has 475 teeth.</td></tr>
<tr><td>MX
MX+</td><td>• Tracking at the sidereal rate, one revolution of the worm takes about 230 seconds (3 minutes 50 seconds).
• Both the hour angle and declination gears have 375 teeth.</td></tr>
<tr><td>MYT</td><td>• Tracking at the sidereal rate, one revolution of the worm takes 269 seconds (4 minutes 29 seconds).
• Both the hour angle and declination gears have 320 teeth.</td></tr>
</table></td></tr>
<tr><td>PEC Worm Periods</td><td>Number of worm revolutions to use in PEC curve determination.</td></tr>
</table>

System Parameters	
Mount Type	Defines the physical telescope mounting type: 0 = German Equatorial Mount. 1 = Asymmetric equatorial fork mount.
Sync Version	0 = Paramount ME, Paramount ME, Paramount MX, Paramount MX, Paramount MYT and Bisque TCS mounts. 1 = Paramount GT-1100S mount.
User Space Version	Shows the current version for the format of the user-defined data that is saved to the control system’s flash memory.

Focus Axis	MKS 3200. MKS 4000, MKS 5000, MKS 6000 should be set to 1. Otherwise, set this value to 0.
Mount Identifier	One of the following: • Paramount ME • Paramount ME • Paramount MX • Paramount MX • Paramount MYT • Bisque TCS
Debug Output?	Set this value to 1 to show control system diagnostics.
Startup Test Joystick RA	If set to 1, then Bisque TCS will abort startup and emit a single beep if the joystick is not centered when power is turned on.
Startup Test Joystick Dec	If set to 1, then Bisque TCS will abort startup and the control system's speaker will emit a single beep if the joystick is not centered when power is turned on.
Startup Test Joystick Button	If set to 1, then Bisque TCS will abort startup and the control system's speaker will emit a single beep if the joystick button is pressed when power is turned on.
Startup Test Guider	If set to 1, then Bisque TCS will abort startup and the control system's speaker will emit a single beep if any of the guider lines are high when power is turned on.
Play Guider Sound	If set to 1, the Bisque TCS speaker will emit a single "click" each time the guider state changes.
IR Enabled	If set to 1, then the infrared communications port is enabled (MKS 4000 only).
Hand controller rate 1	Hand controller rate for switch position number 1.
Hand controller rate 2	Hand controller rate for switch position number 2.
Hand controller rate 3	Hand controller rate for switch position number 3.
Hand controller rate 4	Hand controller rate for switch position number 4.
General Purpose I/O 1	General purpose output direction 1.
General purpose I/O 2	General purpose input/output toggle.
General Purpose I/O 3	General purpose output direction 2.
General purpose I/O 4	General purpose input/output toggle.

User-Defined Parameters	
Acceleration	The motor's relative acceleration/deceleration setting. Lower numbers (for example, 250) will yield slow acceleration/deceleration while higher numbers (for example, 750) will yield very fast acceleration.
Max Slew Speed (%)	The percentage of the mount's maximum slew rate that is used to slew the mount.
Track Rate (% Sidereal)	The mount's tracking rate, based on the percentage of the sidereal rate.
Non-sidereal Rate	The non-sidereal tracking rate in arcseconds/second.
Guide Rate (% Sidereal)	See page 127 for a description of this parameter.
Tics/Revolution	The total number of encoder tics per one complete revolution of the RA axis, computed by multiplying the gear ratio by 2000. For mounts located in the southern hemisphere, the RA value must be negative. See Hemisphere Setup in the ***Utilities*** Tab on page 149 for details about configuring the mount for the southern hemisphere.
Relative Home Sensor Position	See page 127 for a description of this parameter.

Commands Pop-up Menu

Use the ***Commands*** pop-up menu on the ***Parameters*** tab to retrieve the current settings from the Bisque TCS and to set the Bisque TCS settings.

Restore Defaults

Choose this command to display the ***Restore Bisque TCS Defaults*** window that can reset all the mount's parameters to default values. Note that the mount's synchronization history and periodic error correction table are preserved.

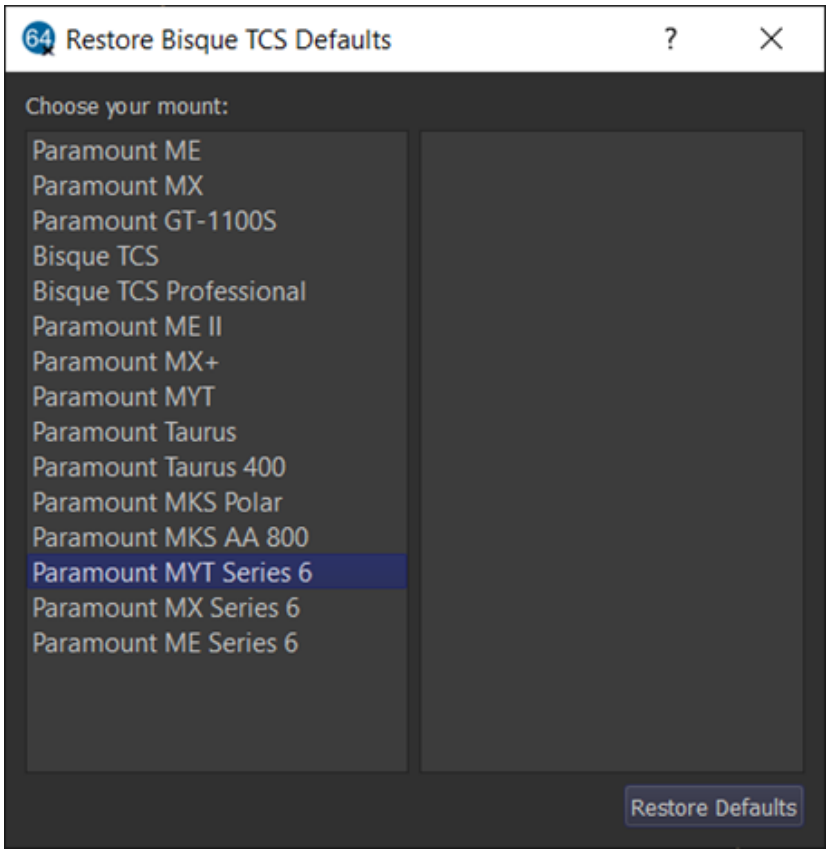


Figure 80: The Restore TCS Defaults window.

The right side of the Bisque TCS Configuration window lists the mount models that use the MKS control system.

- Paramount ME
- Paramount MX
- Paramount GT-1100S
- Bisque TCS
- Bisque TCS Professional
- Paramount ME II
- Paramount MX+
- Paramount MYT
- Paramount Taurus (gear driven models 500 and 600)
- Paramount MKS Polar
- Paramount Taurus model 400 and 400 OAE
- Paramount MYT Series 6
- Paramount MX Series 6
- Paramount ME Series 6

The default parameters differ for each model mount, so make sure to choose the right one before clicking the ***Restore Defaults*** button. After restoring the default settings, they must be saved to the control system's non-volatile memory. To do so, click ***Commands***, ***Save All Parameters to Mount***.

Restore Defaults Button

Click this button to reset the mount's parameters to default settings. When prompted, click ***Yes*** to save the settings to the control system's flash memory.

Read All Parameters from Mount

Retrieves the mount's parameters from the control system and updates the ***Bisque TCS*** window.

Save All Parameters to Mount

Choose this command to save the current mount parameters to the control system's permanent flash memory.

Save the Bisque TCS Configuration File (Save As Command)

Choose this command to save the current Bisque TCS parameters to a file. (Files are saved using the extension `.tcs`). This command allows you to store different mount configurations and retrieve them as necessary using the ***Open*** command on the ***Commands*** pop-up menu.

Open a Bisque TCS Configuration File (Open Command)

This command allows you to open a Bisque TCS configuration file to set the Bisque TCS parameters.

Copy Parameters (From this Window to Clipboard)

Choose this command to copy a report of the current Bisque TCS parameters to the Clipboard in ASCII text format. Use the ***Paste*** command from any text editor to view and save this report.



Software Bisque strongly recommends printing a copy of your mount's Bisque TCS Parameters and storing it with your permanent records. The values for the MKS_INDEX_ANGLE (both RA and Dec) are required if the control system electronics need to be replaced for any reason.

Example Bisque TCS parameters text file for the Paramount MX:

```
Bisque TCS Parameter              RA Value      Dec Value
-------------------------- ------------- --------------
MKS_INDEX_ANGLE           ,         3978 ,           375
MKS_UNIT_ID_              ,            5 ,             5
MKS_ACCELERATION          ,          800 ,           800
MKS_HOME_VEL_HI           ,   1600000000 ,   1600000000
MKS_HOME_VEL_MED          ,    150000000 ,    150000000
MKS_HOME_VEL_LOW          ,      5900000 ,      5900000
MKS_HOME_REQD             ,            1 ,             1
MKS_HOME_JOYSTICK         ,            1 ,             1
MKS_HOME_INDEX_OFFSET     ,            0 ,             0
MKS_CREEP_RATE            ,            0 ,             0
MKS_GUIDE_RATE            ,      -700964 ,        700964
MKS_EMF_CONSTANT          ,           30 ,            30
MKS_MAX_SPEED             ,   1080000000 ,   1080000000
MKS_BASE_RATE             ,    -44861734 ,             0
MKS_MIN_POS_LIMIT         ,     -6250000 ,     -8500000
```

```
MKS_MAX_POS_LIMIT            ,      2250000 ,      2500000
MKS_PEC_RATIO                ,            8 ,            8
MKS_HOME_DIR                 ,            1 ,            1
MKS_HOME_SENSE               ,            1 ,            1
MKS_HOME_MODE                ,            2 ,            2
MKS_HOME_IN_OUT_IN           ,            1 ,            1
MKS_PEC_CUTOFF_SPEED         ,     89723468 ,            0
MKS_MAX_VOLTAGE              ,           15 ,           15
MKS_MAX_GAIN                 ,          150 ,          150
MKS_MAX_POS_ERROR            ,         2000 ,         2000
MKS_JOY_CENTER               ,         2184 ,         2184
MKS_USER1_TICS360            ,     12000000 ,    -12000000
MKS_USER1_dEXPECTED_HOME     ,    2.0000000 ,    0.0000000
MKS_USER1_dHOME_SENSOR       ,    2.0000000 ,    0.0000000
MKS_USER1_dBASE_RATE_PERC    ,  100.0000000 ,    0.0000000
MKS_USER1_dCREEP_RATE_ASPS   ,    0.0000000 ,    0.0000000
MKS_USER1_dGUIDE_RATE_FACT   ,    0.5000000 ,    0.5000000
MKS_USER1_dMAX_SLEW_PERC     ,   90.0000000 ,   90.0000000
MKS_USER1_NMOUNT_TYPE        ,            0
MKS_USER1_SYNC_VERSION       ,        10000
MKS_USER2_NVERSION           ,            0
MKS_USER2_FOCUS_AXIS         ,            1
MKS_OTHER_MOUNT_ID           , Paramount MX
MKS_OTHER_DEBUG_OUTPUT       ,            0
MKS_OTHER_STARTUP_JS_RA      ,            0
MKS_OTHER_STARTUP_JS_DEC     ,            0
MKS_OTHER_STARTUP_JS_BUTTON  ,            0
MKS_OTHER_STARTUP_JS_GUIDER  ,            0
MKS_OTHER_SOUND_GUIDER       ,            0
MKS_OTHER_GP_IO_1            ,            0
MKS_OTHER_GP_IO_2            ,            0
MKS_OTHER_GP_IO_3            ,            0
MKS_OTHER_GP_IO_4            ,            0
MKS_OTHER_JOY_RATE_1         ,       277581
MKS_OTHER_JOY_RATE_2         ,      2523471
MKS_OTHER_JOY_RATE_3         ,     66123104
MKS_OTHER_JOY_RATE_4         ,   1322462080
MKS_INI_FOCMULT              ,            1
MKS_INI_FLIPHA               ,  -18.0000000
MKS_INI_SPEEDPERC            ,           60
MKS_INI_SPEEDTHRESH          ,            5
MKS_INI_KERNEL_STATE         ,            1
MKS_INI_CALLLEVELLOGGING     ,            0
MKS_INI_PACKETLEVELLOGGING   ,            0
MKS_INI_FOCUSPULSESLOW       ,           60
MKS_INI_FOCUSPULSEFAST       ,          200
MKS_INI_HOMEAFTERCONNECT     ,            0
MKS_INI_SHOW_LIMITS          ,            0
MKS_INI_LOG_SLEWS            ,            0
MKS_INI_PPEC_HARMONICS       ,            2
MKS_INI_PPEC_RATIO1          ,    1.0000000
MKS_INI_PPEC_RATIO2          ,    8.0000000
MKS_INI_PPEC_RATIO3          ,    1.0000000
MKS_INI_PPEC_SCALE           ,    1.0000000
MKS_INI_PPEC_TEETH           ,          375
MKS_INI_PPEC_PERIODS         ,            1
```

Paste Parameters (From Clipboard to this Window)

Choose this command to import the Bisque TCS parameters from the Clipboard. If the Clipboard holds the appropriately formatted text, the parameters displayed in the ***Bisque TCS*** window are changed

based on the contents of the file. Choose the ***Save All Parameters To Mount*** command to save the parameters to the mount's flash memory.

How to Configure the Mount Settings Using a Bisque TCS File

Use the procedure below to open a previously saved Bisque TCS parameters file and save these parameters to the mount:

1. From *TheSky Pro*, choose the ***Connect*** command from the ***Telescope*** menu to connect to the mount.
2. Choose the ***Bisque TCS*** command from the ***Telescope*** menu.
3. On the ***Parameters*** tab, choose the ***Open*** command from the ***Commands*** pop-up menu.
4. Navigate to and highlight the file that contains the Bisque TCS parameters report and click ***Open***. All the Bisque TCS parameters on the ***Parameters*** tab are not set based on the contents of the parameters file but need to be saved to the mount to make them permanent.
5. Choose the ***Save All Parameters to Mount*** command from the ***Commands*** pop-up menu to save the parameters to the mount's permanent flash memory.

Show Status Tab

The spreadsheet on the top of ***Status*** tab shows the current control system and motor status values for both the hour angle and declination axes. These values are useful for verifying the current tracking rate, slew limit conditions and other control system settings.

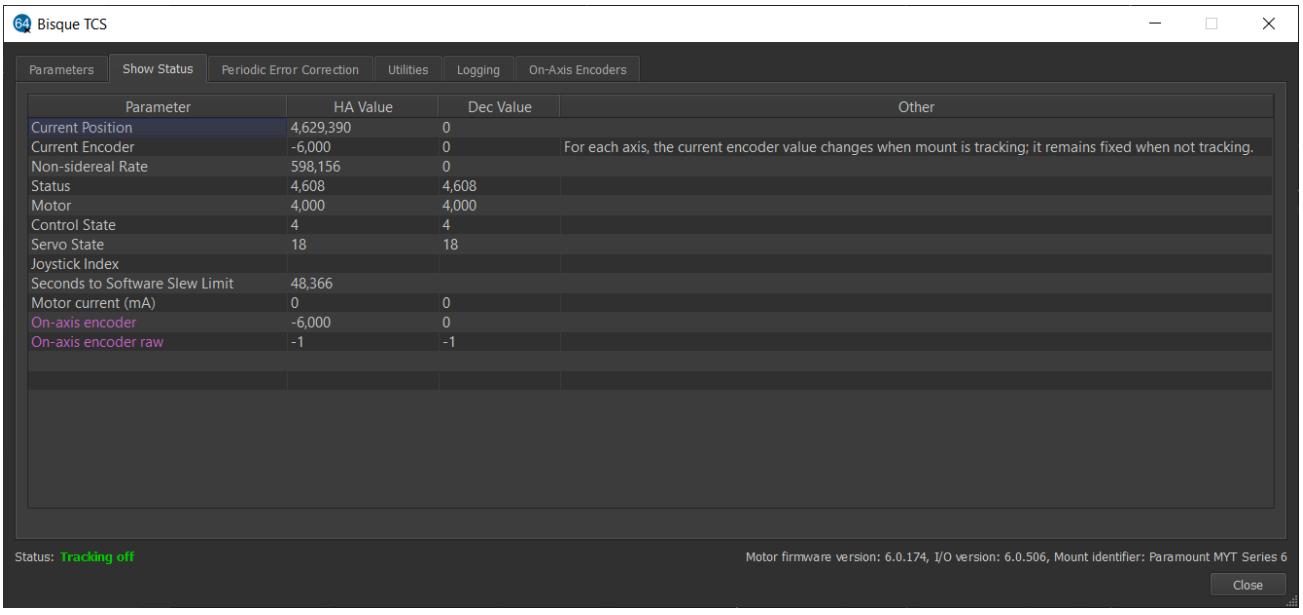


Figure 81: The Show Status tab on the Bisque TCS window.

Show Status Tab Parameter	Description
Current Position	Shows the mount's current position as an encoder value.

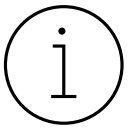
Show Status Tab Parameter	Description
Current Encoder	Shows the current encoder position for both axes. For each axis, the current encoder value changes when mount is tracking and remains fixed when not tracking.
Non-sidereal Rate	Shows a number that represents the incremental non-sidereal tracking rate (above or below the sidereal rate). When the mount is tracking at the sidereal rate, the HA and Dec values are zero. If either rate is non-zero, the mount is tracking at a non-sidereal rate. See the ***Set Track Rates*** command in *TheSky Professional* User Guide details about setting tracking rates for objects such as comets, satellites and minor planets.
Status	Shows an internal motor status number.
Motor	Shows the motor status number.
Control State	A number that indicates the current "state" of the control system.
Servo State	A number value that indicates the current "state" of the DC Servo motor.
Joystick Index	A number that shows the joystick's index position.
Seconds to Software Limit	The number of seconds of time until the mount tracking to a slew limit. At that point, sidereal tracking is turned off. Slew the mount away from the limit to resume tracking.
On-Axis Encoder	The value of the hour angle and declination on-axis encoder. Text is purple no on-axis encoder is present.
On-Axis Encoder Raw	The encoder value read directly from the encoder read head. Text is purple no on-axis encoder is present.

Periodic Error Correction Tab

The ***Periodic Error Correction*** tab is used to generate and manage periodic error curves for the Bisque TCS control system. The ***Bisque TCS PEC Table*** tab is used to retrieve, save, delete, and view the periodic error correction curve. The ***Compute PEC Curve*** tab is used to determine the optimal periodic error curve based on mount tracking data.

The Paramount has precision worms and gears that slew the mount's axes and track the earth's relative motion compared to the stars. As the worm rotates, imperfections in the drive system (on the order of *one **twenty-millionths** of one inch*) introduce a predictable "back and forth" drift at the eyepiece.

This drift is called *periodic error* and is present in all worm and gear drive systems. The mount's periodic error can be virtually eliminated using *periodic error correction*. Here is an overview of the periodic error correction process.



Note that periodic error correction does not apply to and is *not necessary* for Paramount mounts equipped with on-axis absolute encoders.

How to Train and Apply Periodic Error Correction

1. Use the ***Train PEC*** button (see page 146) to automatically create a *tracking log* with the mount's periodic error over three or more revolutions of the worm.
2. Open the tracking log in the ***Compute PEC Curve*** tab.
3. Fit an optimal periodic error curve to the tracking log data.
4. Save and permanently store the optimized periodic error curve to the mount's firmware.
5. Turn on the ***Apply PEC*** checkbox to apply periodic error corrections.

The importance of applying periodic error correction to tracking depends on several factors:

- The magnitude of the mount's periodic error. All mounts have slightly different periodic error due to machining variations. The greater the periodic error, the more noticeable the back and forth "drift" in hour angle and more elongated stars in photos.
- The scale of the imaging system. Tracking demands for an imaging system with an image scale of four arcseconds per pixel or larger are less demanding than on a system with an image scale of one arcsecond per pixel or less.
- The local seeing and weather conditions. A turbulent jet stream caused by nearby mountain ranges (here in Golden, Colorado, for example) can produce average seeing errors from three to five arcseconds per pixel and rarely better. A laminar, more stable atmosphere in regions like Florida or Southern New Mexico in the USA often produce periods of sub arcsecond seeing.

As an example of periodic error versus seeing versus image scale, if the mount's peak to peak periodic error is two arcseconds, and the local seeing conditions average three arcseconds, then the tracking error caused periodic error is *less than* the tracking errors caused by seeing conditions, so correcting the mount's periodic error is not critical.

However, if the local seeing averages one arcsecond and the optical system's image scale is one arcsecond per pixel or smaller, you want to make sure that the periodic error is as small as possible for optimal results.

TheSky Professional is used to compute, retrieve, and save a periodic error correction curve to the Bisque TCS firmware.

When the ***Apply PEC*** checkbox is turned on, the resulting corrected periodic error of the mount should be less than one arcsecond (usually 1 arcsecond peak to peak error or less), which is normally less than

the errors introduced by local seeing conditions (typically 1-5 arcseconds, depending on the location, weather conditions, etc.).

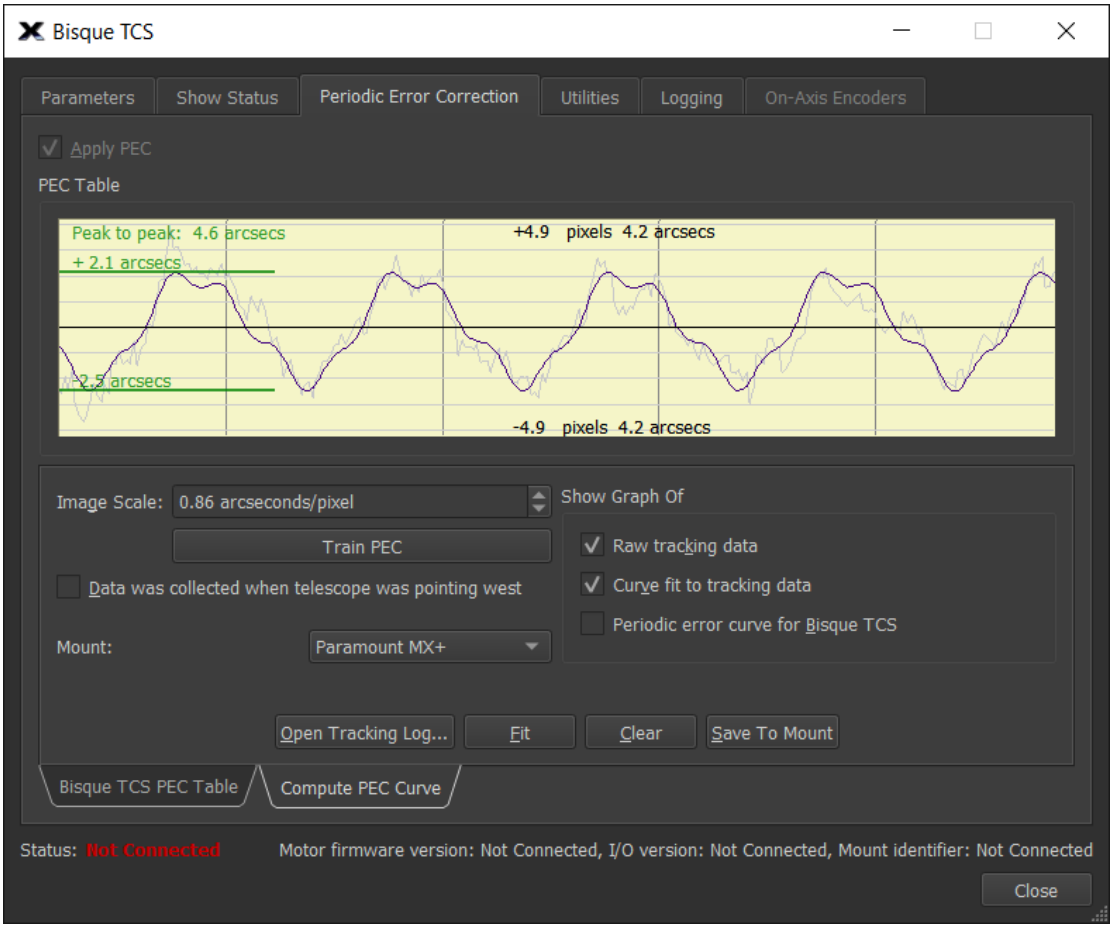


Figure 82: The Bisque TCS PEC Table tab on the Periodic Error Correction tab (Bisque TCS window).

Apply Periodic Error Correction (Apply PEC Checkbox)

Turn this checkbox on to correct periodic error correction sidereal tracking. Note that periodic error correction is not applied when tracking fast moving objects, such as spacecraft.

Bisque TCS PEC Table Tab

The central portion of the ***Bisque TCS PEC Table*** tab on the ***Periodic Error Correction*** tab shows a graph of the mount's periodic error correction table. Note that you must first retrieve or ***Get*** the periodic error table that is stored in the mount's firmware. The message ***No Table Present*** is displayed on the graph if the periodic error data has not been retrieved from the mount, or the mount does not have a periodic error curve. The green line on the graph shows the corrections that are applied over one period of the worm. The vertical black line shows the current position of the worm in the PEC table.

The shaded purple region shows a graph of the mount's periodic error or PEC table. The X-axis represents the time for one revolution of the worm. The Y-axis shows the magnitude of the correction

at a given worm position. The red line shows the actual periodic error correction, in arcseconds, that is applied over one revolution of the worm.

Retrieve PEC Table from Telescope Control System (Get Button)

Click the ***Get*** button to retrieve the PEC table that has been saved to the mount's firmware. The ***PEC Table*** graph shows the text ***Reading PEC Table…*** while the data is being retrieved from the Bisque TCS.

Remove the PEC Table from Telescope Control System (Clear Button)

Click the ***Clear*** button to permanently remove the PEC table stored in the Bisque TCS non-volatile memory. The PEC Table graph shows the text ***Clearing PEC Table…*** while the data is being deleted from the Bisque TCS.

Paste PEC Table (Paste Button)

Click this button to retrieve the periodic error correction table values that have been previously copied to the Clipboard and graph them in the ***PEC Table***.

Copy Custom PEC Table (Copy Button)

Click this button to copy the current periodic error correction table values from the graph to the Clipboard in ASCII text format. The format of the ASCII text data is two space delimited columns:

- The zero-based PEC table index.
- The relative mount-specific periodic error correction.

Column values must be separated by a minimum of one space character (no tabs), with carriage return line feed pairs at the end of the line.

The following text shows an example ASCII PEC table.

```
0<0x20><0x20><0x20>-9<CR><LF>
   1   -9<CR><LF>
   2   -9<CR><LF>
   3  -10<CR><LF>
   4  -10<CR><LF>
   5  -10<CR><LF>
   6  -10<CR><LF>
   7  -11<CR><LF>
   8  -11<CR><LF>
   9  -11<CR><LF>
  10  -11<CR><LF>
. . .
1248   -8<CR><LF>
1249   -9<CR><LF>
```

PEC Table Index

The number in the first column is the PEC table index that represents a relative position of the worm. The second column in the table is the periodic error at that position.

Model	Number of PEC Table Entries
MYT	0 – 499

Model	Number of PEC Table Entries
MX	0 – 499
ME	0 – 1249

Compute PEC Curve Tab

The table below lists the maximum peak-to-peak periodic error *specification* for each model Paramount mount.

Model	Maximum Peak to Peak Periodic Error (arcseconds)
MYT MX ME	7

The gear-induced periodic error can be effectively eliminated using a process called periodic error correction (PEC). With PEC enabled, the tracking error introduced by mechanical periodic error is "in the noise" and not readily detectable at the eyepiece or in the measured FWHM of stars on a CCD photo.

Under all but extremely exceptional seeing conditions, measuring periodic error can be difficult, even using an autoguider, because the random errors caused by local seeing conditions can be larger than the actual periodic error of the worm and gear.

The ***Compute PEC Curve*** tab provides an extremely powerful utility that can precisely determines the mount's periodic error, independent of the errors introduced by local seeing conditions.

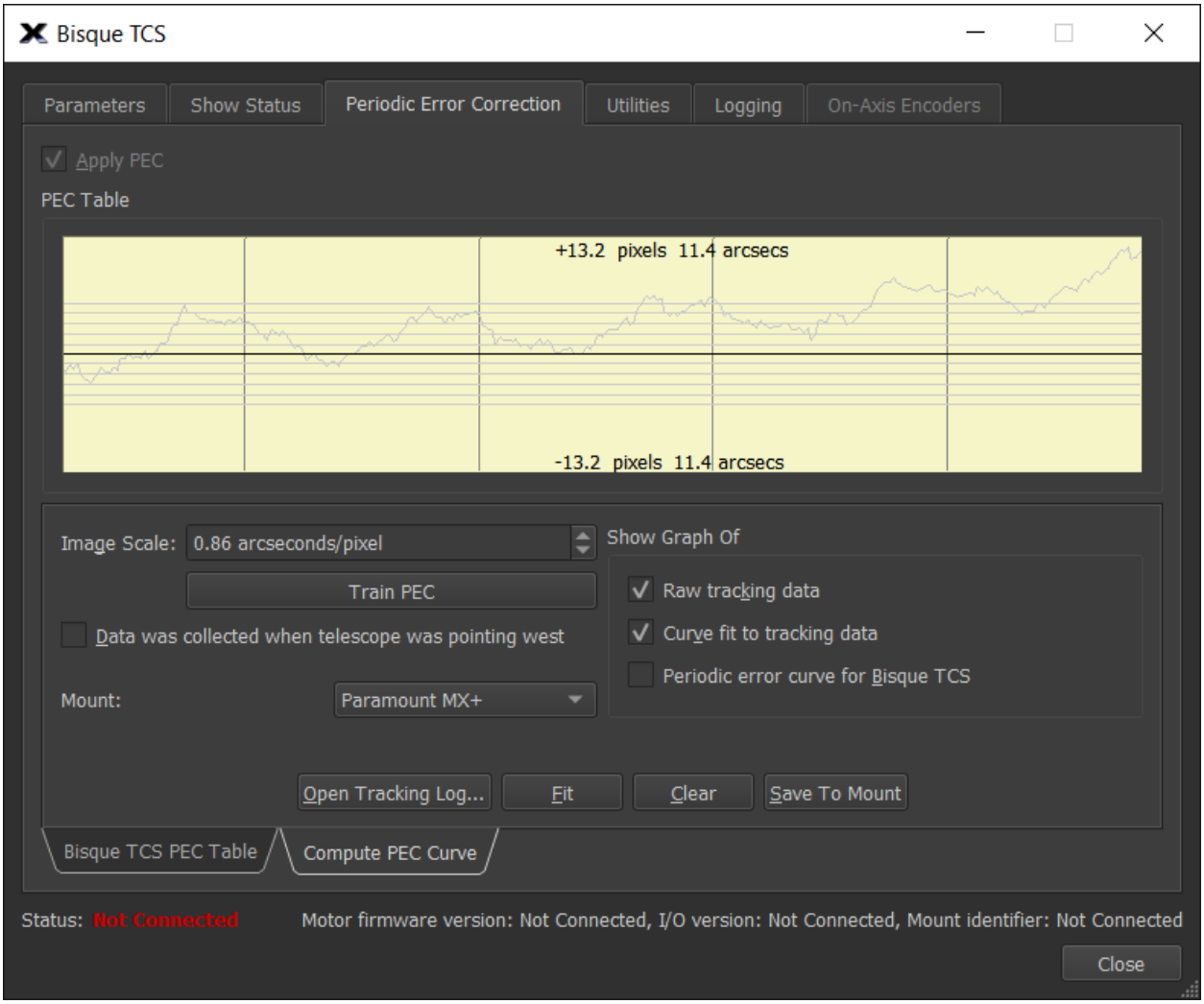


Figure 83: The Compute PEC Curve tab on the Periodic Error Correction tab (Bisque TCS window).

PEC Table Graph

The yellow shaded region can be used to show a graph of the tracking log data, the "best fit" curve to that data and the actual periodic error curve derived from the best fit curve that is stored to the Bisque TCS flash memory.

Use the mouse scroll wheel to adjust the relative scale of the graph. Scrolling forward expands the scale on the graph, scrolling backward magnifies the graph.

Image Scale

Enter the image scale of the optical system, in arcseconds per pixel. Image scale is critical for computing the correct periodic error from the tracking log data. If you are unsure of the photo's image scale, use *TheSky Professional's* Image Link feature to compute it for you.

Train PEC Button

After connecting to the mount and finding home, click the ***Train PEC*** button to start the periodic error correction training process.

Train PEC Procedure

1. Choose your camera. For the best experience, use the imaging camera instead of the autoguiding camera. Be sure to configure the camera's advanced settings to enable the autoguiding-related capabilities as this is normally not required when taking photos. You will also need to connect to the camera before proceeding.
2. Carefully read and follow the instructions on the ***Train PEC Requirements*** window (Figure 85). There are a number of important items that must be addressed before the mount's periodic error correction can be trained, including:
    - The mount must be polar aligned well enough so that the star does not drift significantly over multiple revolutions of the worm.
    - The optical system must be at focus and produce sharp, round stars.
    - The camera must be calibrated. Failure to calibrate will result in the error message shown in Figure 84.
    - The ***Bin Mode*** must be set to ***1 x 1***. Enter the image scale of the optical system at 1 x 1 binning into the ***Image Scale*** text box located on the ***Periodic Error Correction*** tab of the ***Bisque TCS*** window. The image scale that is displayed on the bottom of the ***Train PEC Settings*** window is for reference purposes and cannot be modified.
    - Using an appropriate exposure length so that the reference star has sufficient brightness, but not so long that it becomes saturated.
    - Selecting a suitable reference star that is near 0 degrees declination. See "Choosing a Good Autoguider Calibration Star" in *TheSky User Guide* for details how.
    - Selecting an appropriately sized subframe that bounds the reference star. Failure to perform this step will result in the error message shown in Figure 84.

    If the subframe is too small, or the polar alignment is poor, the star may drift outside the subframe while collecting the tracking log data and render the data useless. If this happens, improve the polar alignment to limit drift, or use a larger subframe, or use ProTrack to improve the unguided tracking and start the process over.

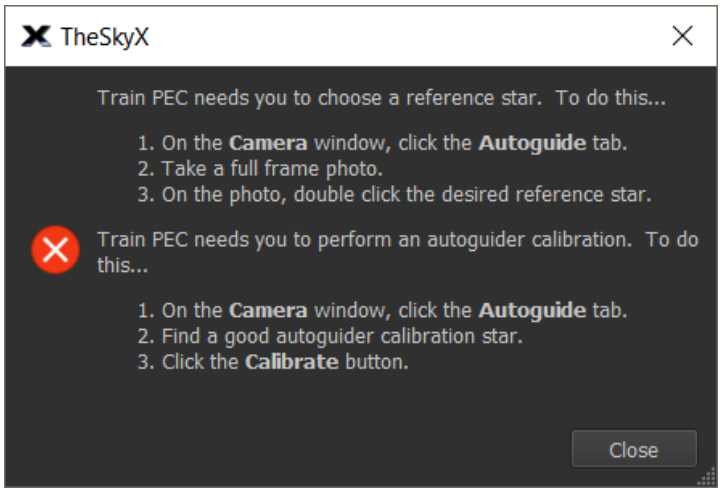


Figure 84: Error message displayed when Train PEC is not ready to proceed.

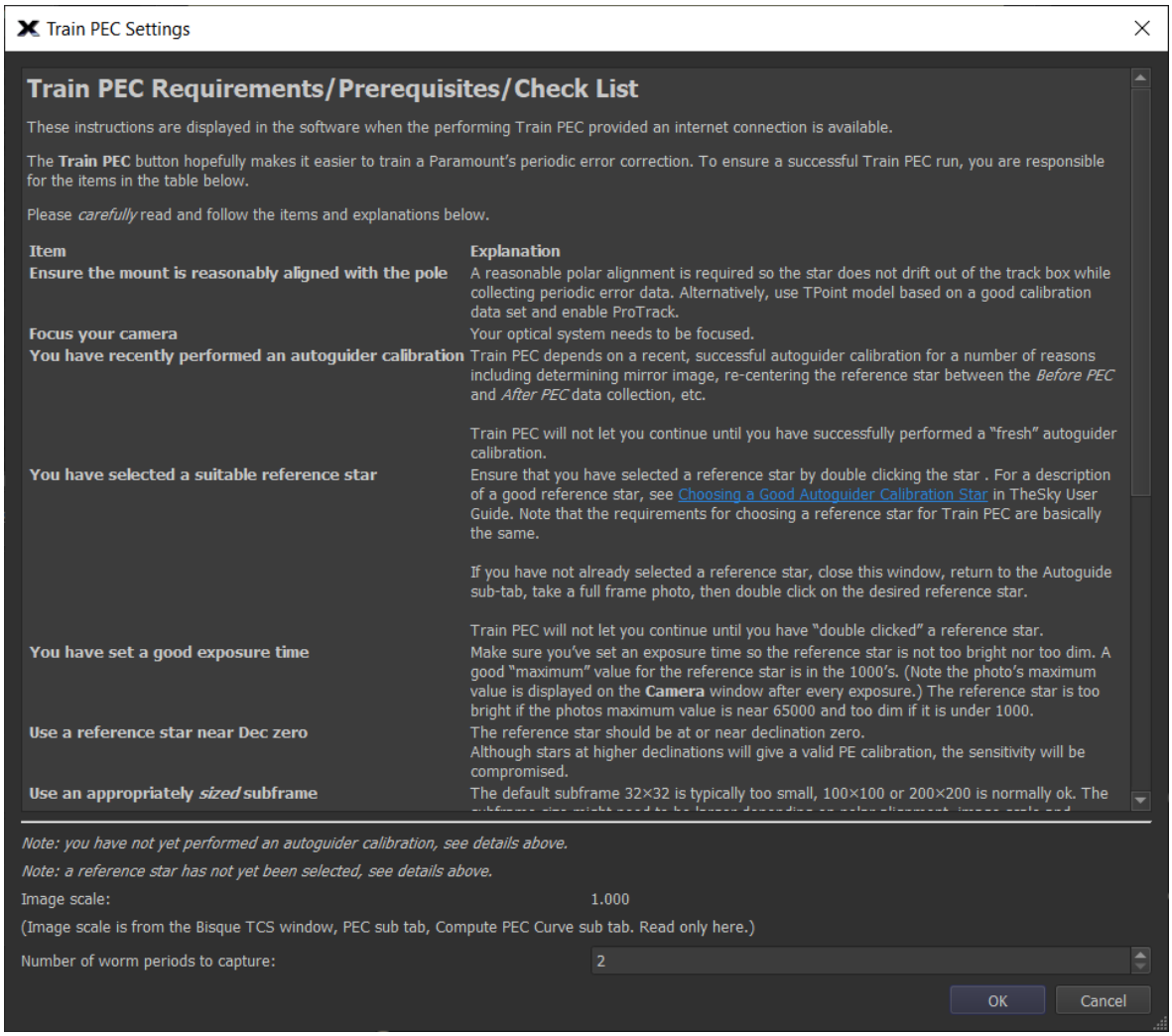


Figure 85: Follow the Train PEC Requirements instructions to proceed.

Once the train PEC process is completed, a window showing the results of the process is displayed. Figure 86 shows the results of training the periodic error on a Paramount MX. In this example, the green status message text shows the results of the process, the before and after periodic error as well as graphs of the before and after PEC tracking logs.

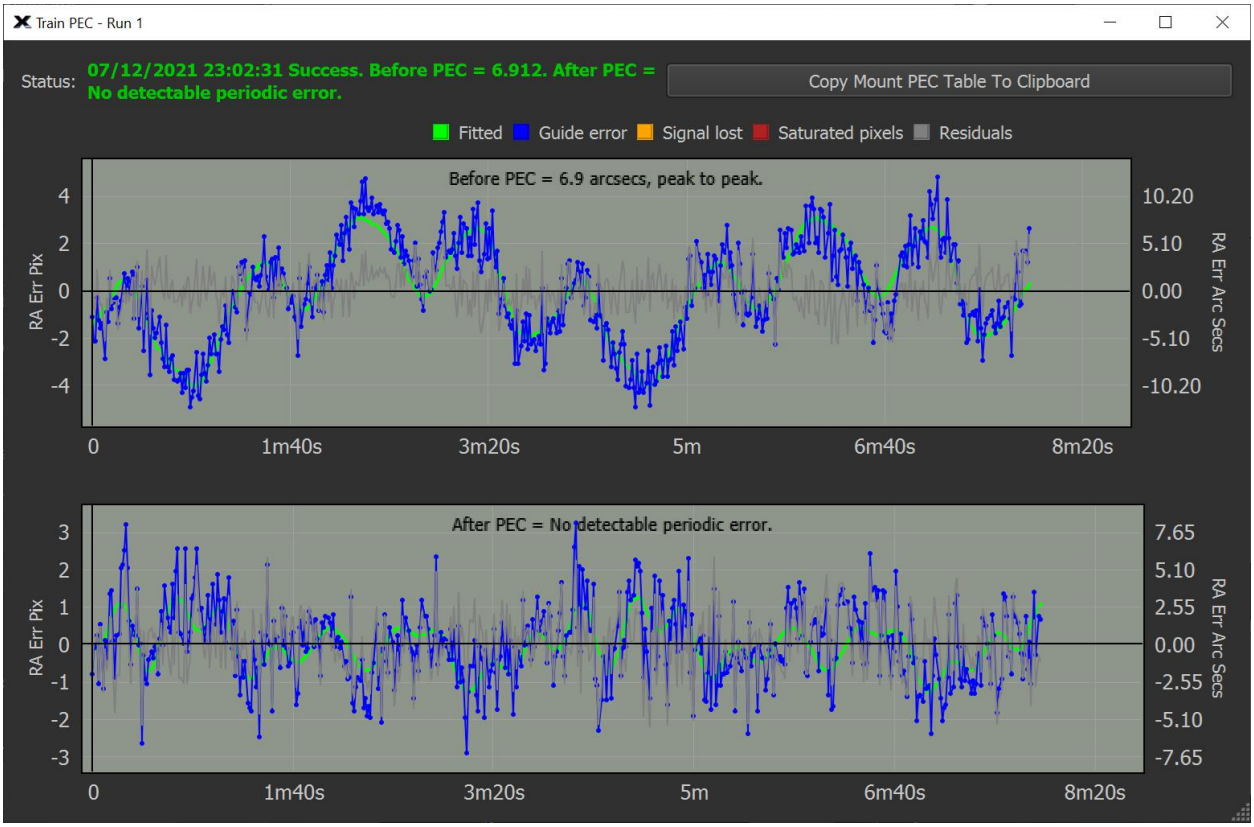


Figure 86: The results of the Train PEC process.

Train PEC Status

This text describes the results of the Trian PEC process. If the before PEC is less than 7 arcseconds per pixel, the Paramount maximum specification, and the after PEC shows no detectable periodic error, PEC training was successful, and you are ready to observe.

Before and After PEC Graphs

The two graphs are displayed on the Trian PEC window so the motion of the reference star before PEC is applied, and after PEC is applied.

Data Was Collected When Telescope Was Pointing West

This legacy option was used when manually training the mount's periodic error and is no longer necessary. The ***Train PEC*** button's functionality supersedes manual PEC training.

Turn this checkbox on if the tracking log data was collected when the telescope was pointing to the West side of the meridian.

Raw Tracking Data

Turn on this checkbox to show the positions of the star's centroid from the tracking log data as a light gray line.

Curve Fit to Tracking Data

Turn on this checkbox to show the optimal periodic error curve computed by clicking the ***Fit*** button.

Periodic Error Curve for Bisque TCS

Turn on this checkbox to show a graph of the periodic error curve to be saved to the Bisque TCS control system's flash memory. Turning this checkbox on automatically hides the raw and fit graphs.

Open Tracking Log

Click this button to open a tracking log that was generated by the *Camera module*.

Fit

Click this button to compute and display the graph of an optimal periodic error curve for the tracking log data.

Clear

Click this button to remove or delete the existing tracking log.

Save To Mount

Click this button to save the fit periodic error curve to the Bisque TCS.

Utilities Tab

The Utilities tab provides access to high-level control system settings.

Hemisphere Setup

Click the ***Hemisphere Setup*** text on the right side of the ***Utilities*** tab to configure the mount's tracking direction and show hemisphere-specific mount status. (The home sensor values are shown only when the mount is connected.)

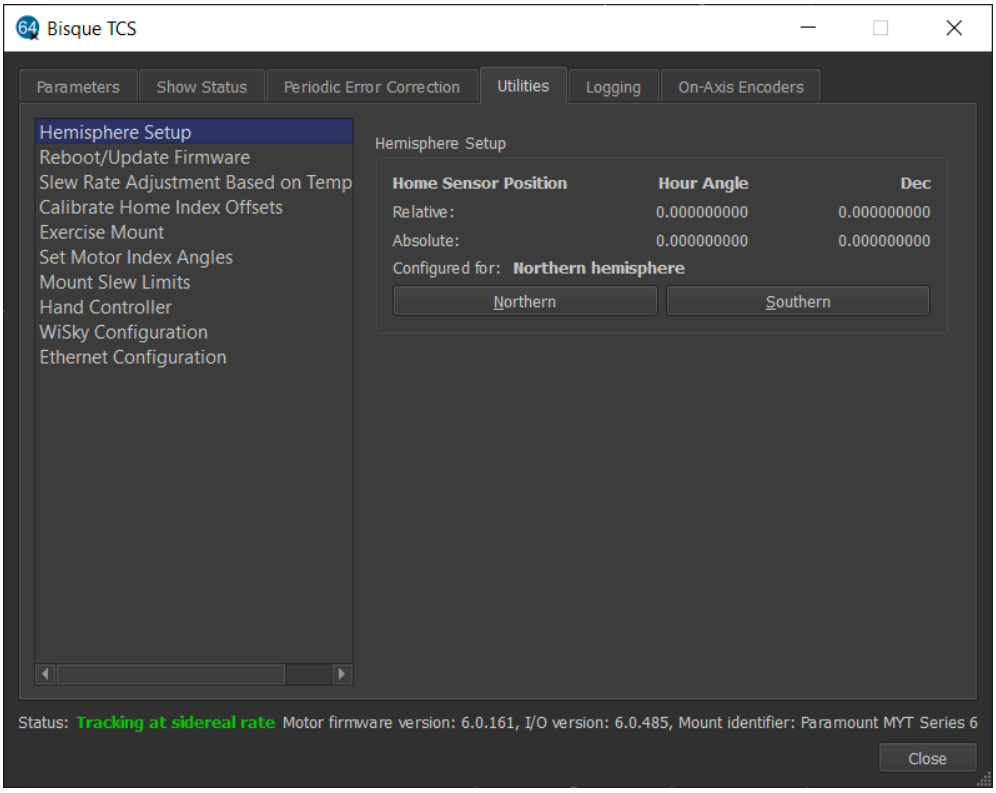


Figure 87: Example Hemisphere Setup for the northern hemisphere.

Relative Home Sensor Position (Hour Angle)

Shows the hour angle of the homing sensor based on the mount's synchronization information.

Relative Home Sensor Position (Declination)

Shows the declination of the homing sensor based on the TPoint model .

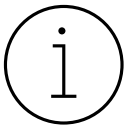
Absolute Home Sensor Position (Hour Angle)

This text box shows the mechanically fixed hour angle of the homing sensor. This value cannot be changed and is always HA = 0.0 and Dec = 0.0 in the northern hemisphere; hour angle 12.0, declination 180.0 in the southern hemisphere.

Absolute Home Sensor Position (Declination)

This text box shows the mechanically fixed declination of the homing sensor. This value cannot be changed for the Paramount ME, MX or MYT mounts.

See "Advanced Parameters" on page 126 for a discussion of the differences between the relative and absolute homing position.



Note on Southern Hemisphere Hour Angle and Declination Values

For the southern hemisphere, home sensor's *absolute position* and *relative position* are displayed. Both values reflect the *mechanical position of the mount*, not actual *sky coordinates*. This convention allows *TheSky Professional* to know which side of the pier the telescope resides.

To convert the mechanical hour angle to the sky hour angle, subtract 12. Take 180 minus the declination to convert the mechanical declination to sky declination.

Configured For Text Box

This text box shows the current hemisphere configuration.

Northern and Southern Buttons

The Northern and Southern buttons are used to configure the mount for operation in either hemisphere. The default configuration is for the northern hemisphere. When the mount is in the southern hemisphere, click the ***Southern*** button so that the sidereal tracking direction is reversed, and the homing sensor positions can be updated. The control system is automatically "rebooted" so that these changes take effect.

Reboot/Update Firmware

If the MKS 6000 is emitting continuous beeps (for example the mount has encountered a fixed object like the side of the pier so that the motors have stopped), it should be restarted and then the mount homed.

To restart the control system, on the right side of the ***Utilities*** tab, click the ***Reboot/Update Firmware*** text, then, under ***Reboot Bisque TCS*** on the left side of the window, click the ***Reboot Normally*** button.

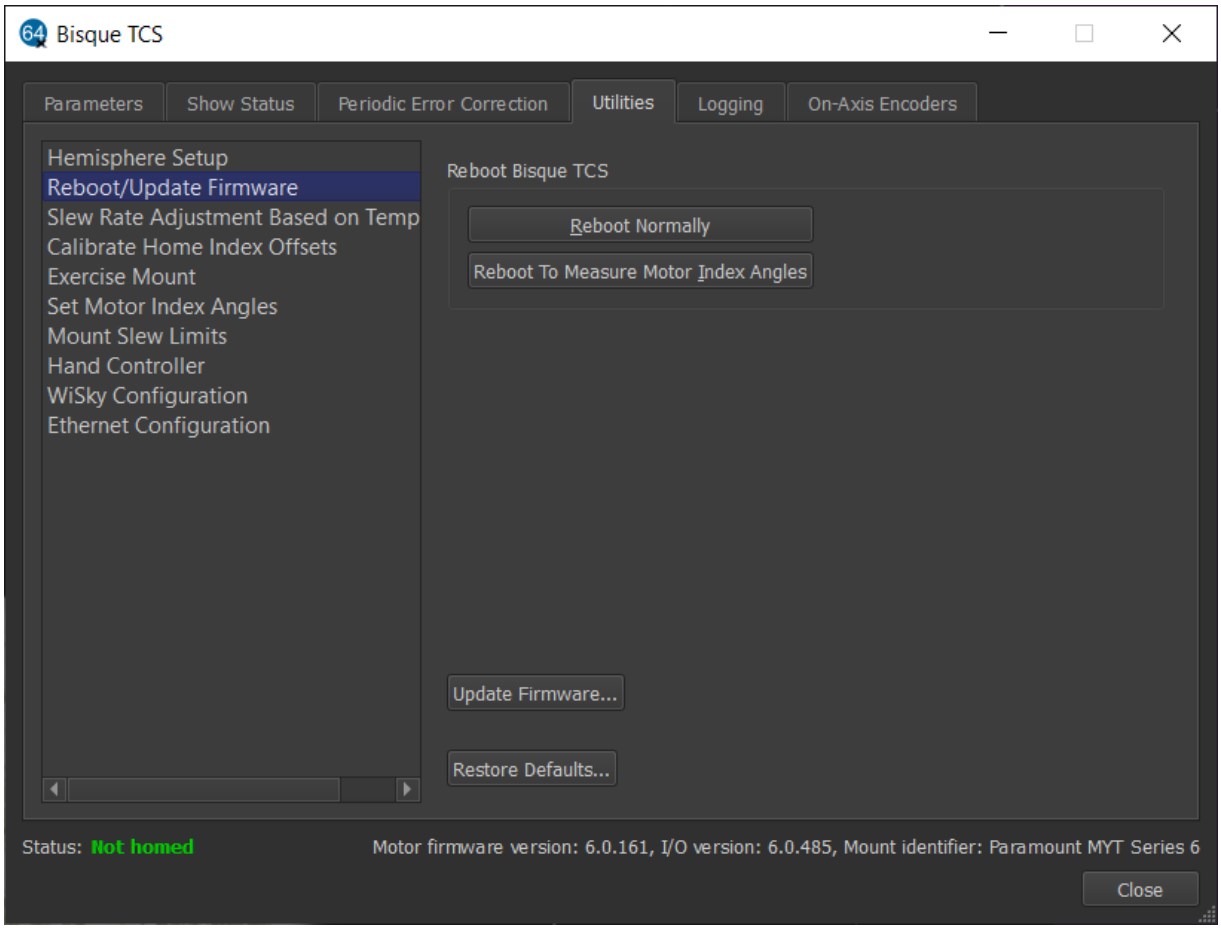


Figure 88: The Reboot/Update Firmware settings on the Utilities tab.

Reboot Normally

Click this button, then click the ***Yes*** button on the confirmation window to restart the control system for normal operation. Rebooting the control system can be used to reset the mount after an error condition has occurred, or after the control system has been restarted to measure the motor index angles as described below.

Reboot to Measure Motor Index Angles

Click this button to restart the control system so that the mount's motor index angles can be measured. The control system's motor index angles must be re-measured after installing a new control system, or installing a new worm block that has a new motor.

Control System Firmware Updates

While every attempt is made to apply the latest firmware to the MKS 6000 control system before the mount is shipped, Software Bisque may periodically release a new firmware version. The motor firmware version that is used by the control system is listed on the bottom left of the Bisque TCS window.

Updating the Firmware (Update Firmware Button)

MKS 6000 firmware updates are included with the latest release of TheSky so there is no need to download firmware files.

Updating the MKS 6000 Firmware

TheSky for Windows is required to update the MKS 6000 firmware.

Do not update the MKS 6000 firmware using TheSky for macOS or TheSky for Linux.

1. Download and install the latest TheSky for Windows (Version 10.5.0 build 13829 or later).
2. Click **Telescope**, **Connect**.
3. On the **Telescope** window, click **Tools**, **Bisque TCS**.
4. On the **Utilities** tab, click the **Update Firmware** button.
5. When prompted, click **Yes** to start the firmware update.

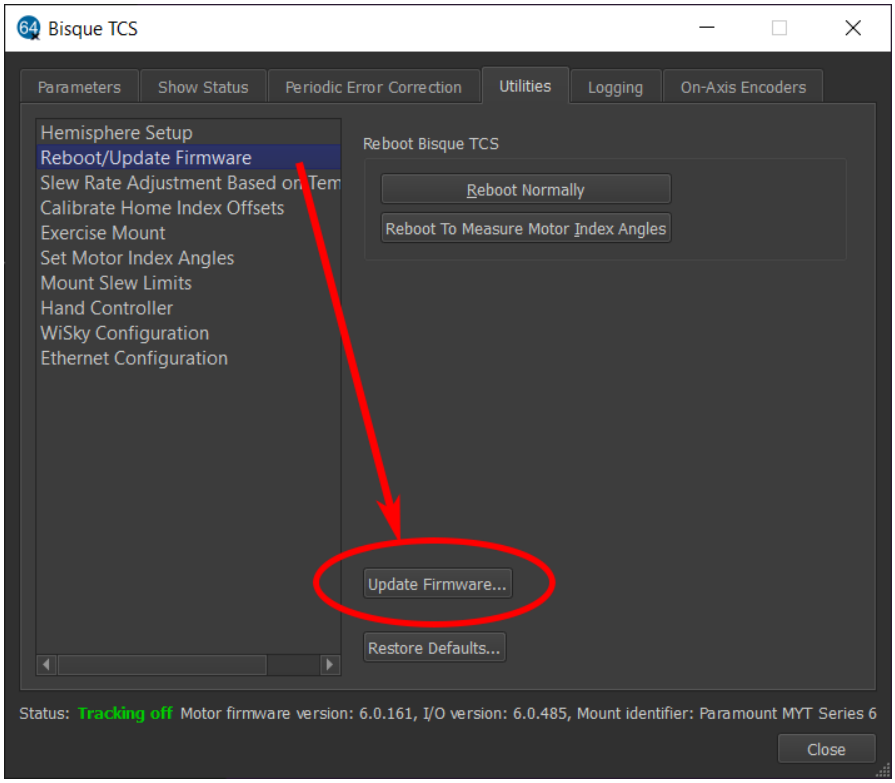


Figure 89: Click the Update Firmware button to start the process.

The six-step firmware upgrade process takes about three minutes to complete and periodically reboots the MKS 6000. Please do not turn off the mount or the computer while the new firmware is being installed.

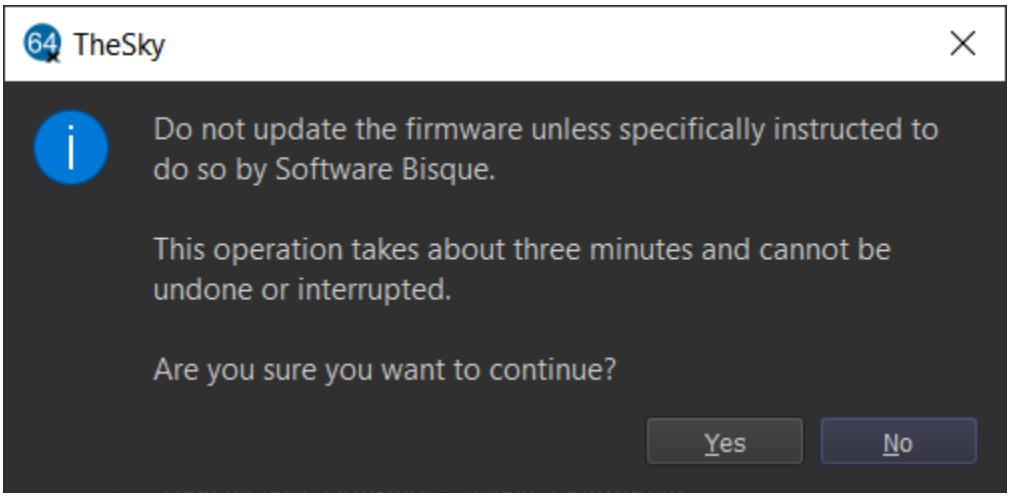


Figure 90: Firmware update warning message.

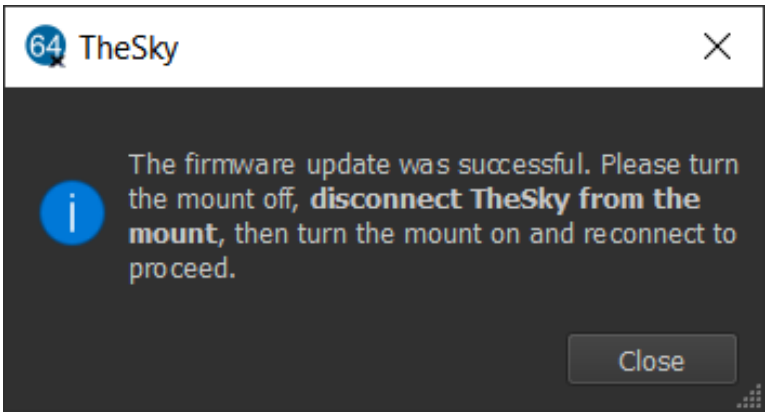


Figure 91: This window is displayed when the firmware has been successfully updated.



TheSky is not automatically disconnected from the mount after the firmware has been updated. From Telescope window, click **Tools**, **Shutdown**, **Disconnect Telescope** before proceeding.

Restore Defaults

Click this button to restore the default Bisque TCS settings (page 135).

Slew Rate Adjustment Based On Temperature

The Paramount's slew rate is automatically lowered when the ambient temperature drops below this value. (Lowering the slew rate provides more torque to the servomotors. This additional torque can minimize potential motor stalls from increased frictional forces at colder temperatures.)

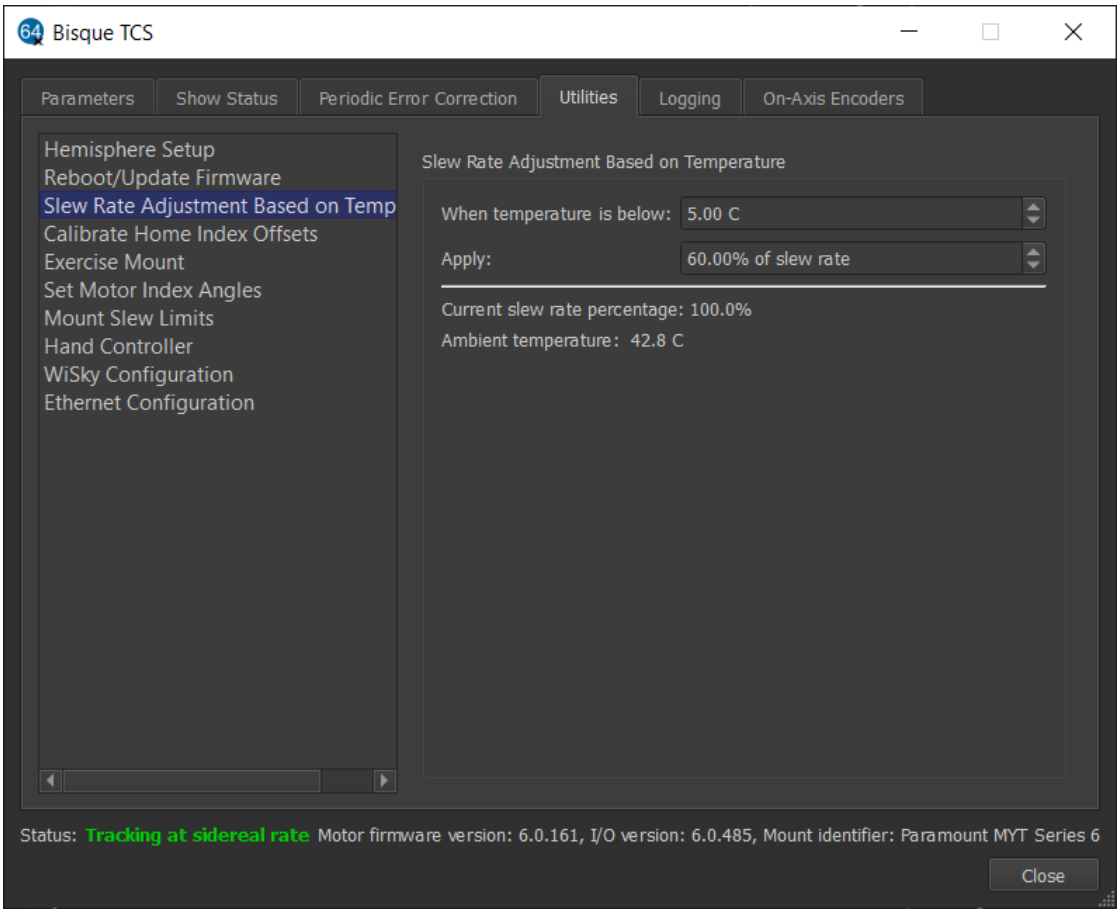


Figure 92: The Slew Rate Adjustment Based on Temperature settings on the Utilities tab.

Click ***Slew Rate Adjustment Based On Temperature*** on the right side of the ***Utilities*** tab to change the maximum slew rate and the temperature below which this slew rate is applied.

When the Temperature Is Below (C)

Enter the temperature, in degrees Celsius, below which the maximum slew rate of the mount will be reduced.

Apply (Percentage of Slew Rate)

Enter the percentage of the maximum slew rate to apply at lower temperatures.

Suppose the slew rate is set at 2 degrees per second for “normal operating temperatures”. Then, based on the values in Figure 92, when the temperature drops below 0C the slew rate is set to 60 percent of 2 degrees per second, or 1.2 degrees per second.

Current Slew Rate Percentage

This text shows the current temperature-adjusted slew rate percentage. A value of 100 percent means the temperature inside the mount is above the ***When the Temperature Is Below*** value.

Ambient Temperature

Shows the ambient temperature measured by the mount's internal temperature sensor.

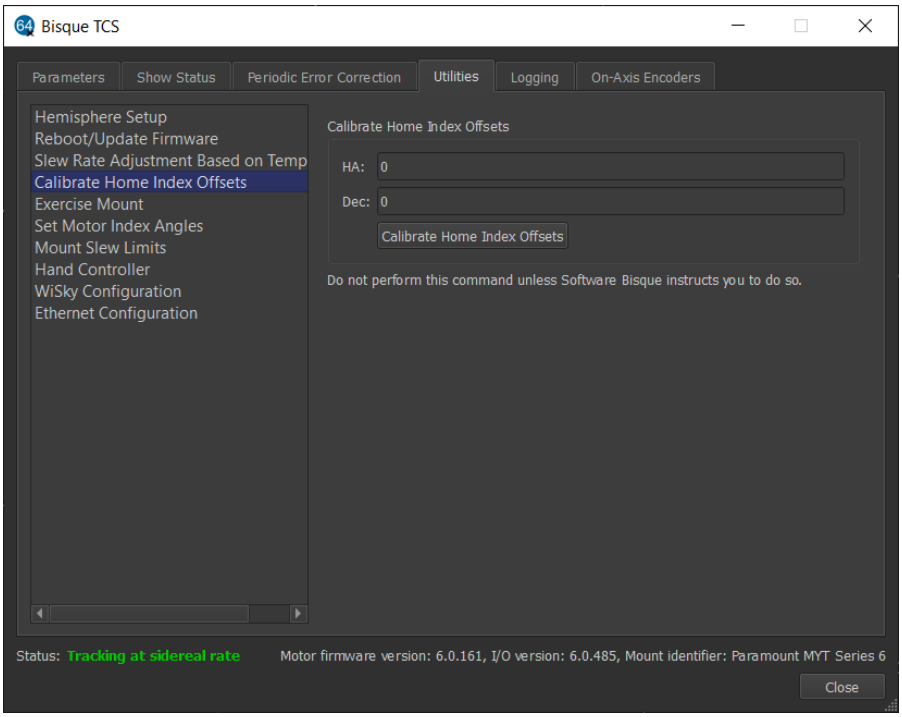


Figure 93: The Calibrate Home Index Offsets pane.

Calibrate Home Index Offsets

In rare cases, the home position may not be consistent due to small changes in the mechanical position of the home sensor and homing mark caused by temperature variations. In this case, the home position can differ by one turn of the motor when the mount is homed (from 3 to 6 arcminutes, depending on mount model and axis).

On the ***Bisque TCS*** window, highlight ***Calibrate Home Index Offsets*** on the left side of the ***Utilities*** tab and click the ***Calibrate Home Index Offsets*** button to have the control system measure the motor's home index offset.

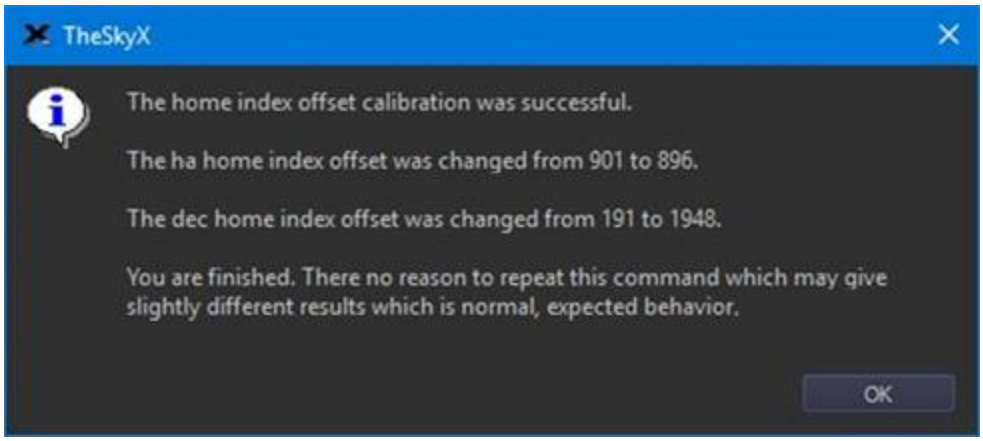


Figure 94: Window showing successful home index offset calibration.

Calibration ensures minor mechanical motions due to temperature changes do not cause the home position to change from session to session. The results are automatically saved to the mount's flash memory and applied when finding the home position. After calibrating the home index offsets, one or both axes may locate the home position in a slightly different mechanical position than before the calibration (by one motor turn). In this case, a TPoint pointing recalibration should be performed after calibration (a new pointing calibration is *not* required).

Please do not click the ***Calibrate Home Index Offsets*** button unless specifically instructed to do so by Software Bisque.

Exercise Mount

Every Paramount undergoes a factory "run in" or exercise procedure that slews the mount between the slew limits to ensure that the gear train, motors, and electronic systems are functioning normally. The Use the ***Exercise Mount*** command can be used to perform the same procedure.

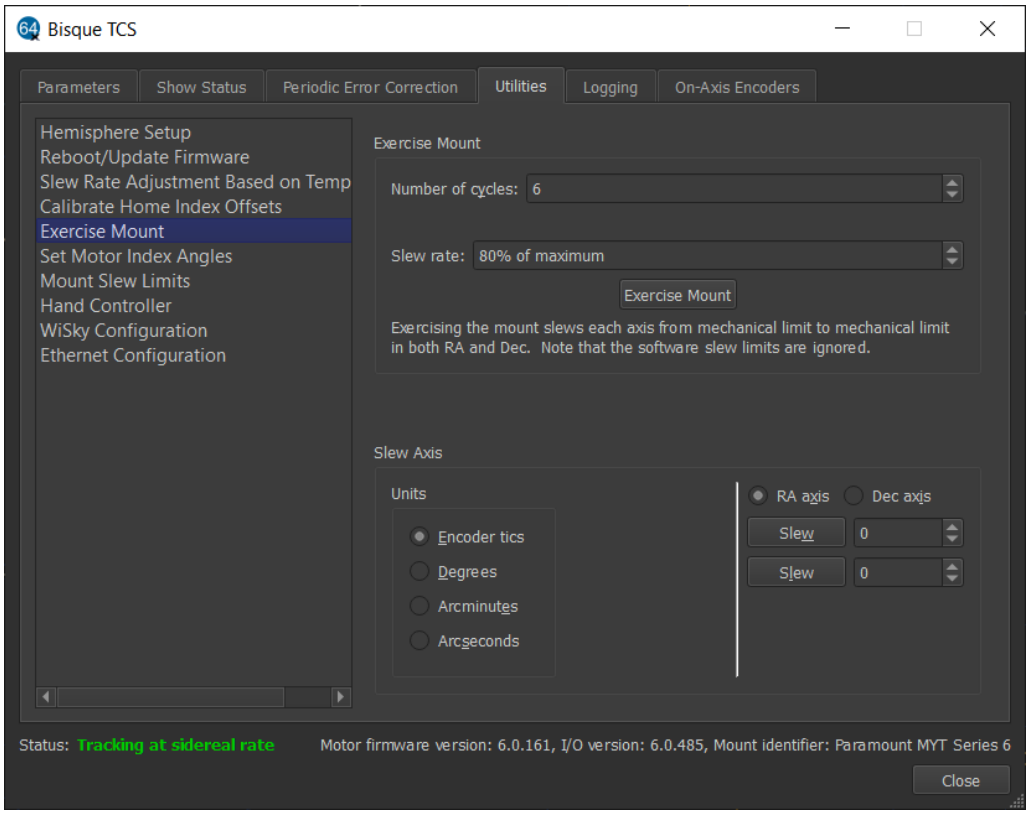


Figure 95: The Exercise Mount settings window on the Utilities tab.

For example, you may wish to exercise the mount after the gears have been re-lubricated, or after installing through the mount cabling to make sure there are no stalling issues when the mount slews from slew limit to slew limit in both axes and after installing a replacement worm block to repair a damaged worm.

- The exercise process slews both mount axes from limit to limit at the current ***Slew Rate***, specified as a percentage of the maximum slew rate.
- The telescope cross hairs displayed on the Sky Chart will not follow the position of the telescope during the exercise process.

Number of Cycles

Enter the number of times to slew the mount between the software limits.

Slew Rate

Enter the rate, as a percentage of the mount's maximum slew rate, at which the mount is slewed during the exercise process.

Exercise Mount/Abort

Click this button to begin exercising the mount. While the mount is slewing, the text changes to ***Abort***. Click ***Abort*** to end the exercise process.

Slew Axis Settings

These settings can be used to slew the RA or Dec axis using four different “slew units”.

Units

Enter the unit of measurement to slew the selected axis.

- ***Encoder Tics****:* slew the specified number of motor-based encoder tics.
- ***Degrees****:* slew the mount in angular degrees.
- ***Arcminutes****:* slew the mount in arcminutes.
- ***Arcseconds****:* slew the mount in arcseconds.

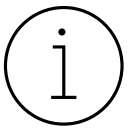
Slew

After entering the number of units to slew the mount in the adjacent text box, click the ***Slew*** button to start slewing the mount.

By design, two different ***Slew*** buttons and two text boxes appear so that slews using two different units may be performed for each axis.

MKS 6000 Motor Index Angles, Motor Current and Power Requirements

The MKS control system uses a *motor index angle* that is stored in the control system’s firmware to initialize the DC servo motors each time the mount is turned on. The ***Motor Index Angle*** settings allow the control system to display, measure and record these values for the motors in your mount.



Installing a new control system requires measuring the mount’s motor index angles. Otherwise, the motor index angles that are saved to the firmware should not need to be changed.

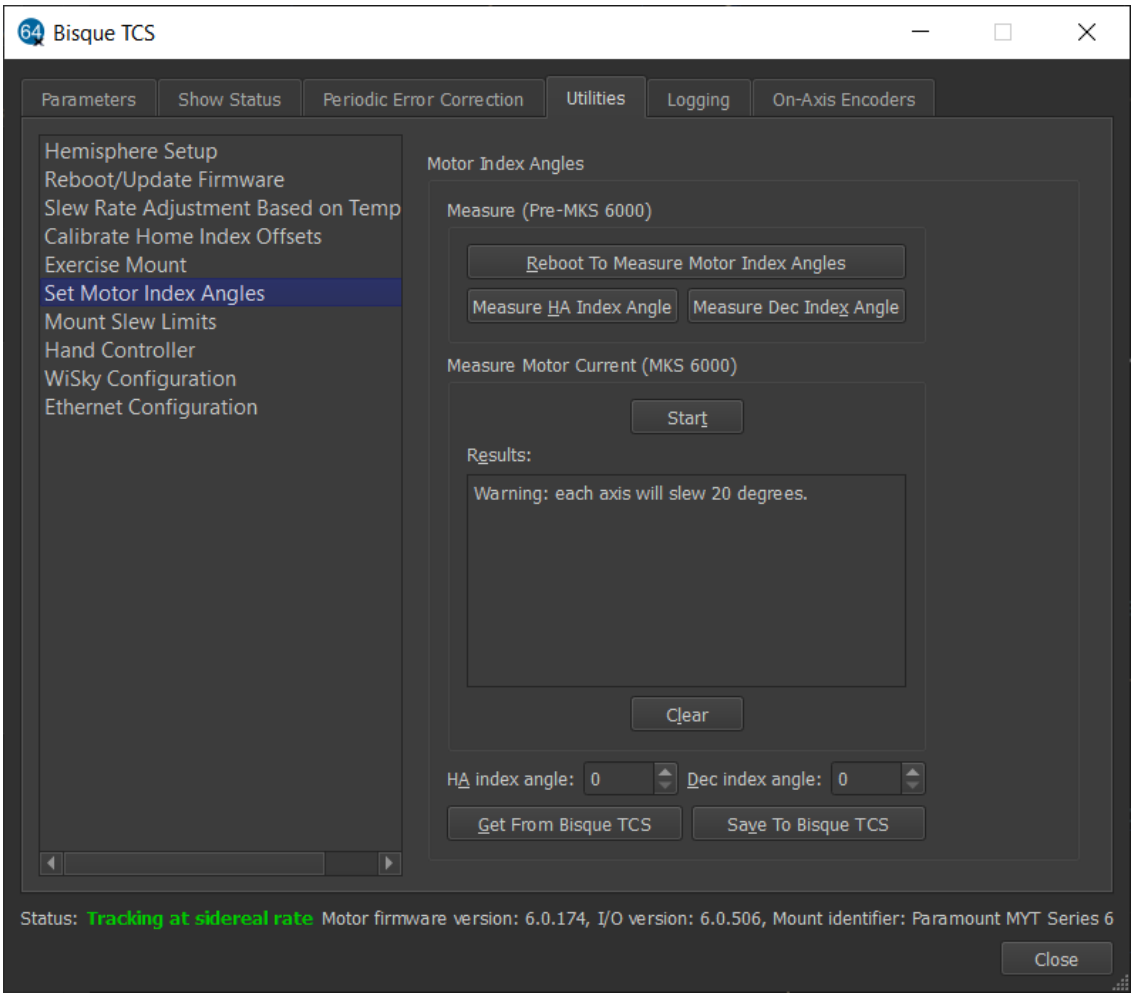


Figure 96: The Set Motor Index Angles settings on the Utilities tab.

Before the MKS 6000 telescope control system, TheSky used a functional but less than optimal means of measuring the motor index angles. While sufficient, this technique required separating the worms from the gears (by rotating the mechanical switches to the balance position) before measuring the motor index angles.

A secondary but related issue, the MKS 6000 can slew at higher speeds and consumes more power than earlier MKS control systems which means the power supply unit (PSU) may not always be able to keep up and the control system emits an error.

The MKS 6000 uses an iterative method to determine the optimal motor index angles and also mitigates potential control system errors caused by slewing at high speeds.

Firmware version 6.0.506 and later, the MKS 6000 can measure and limit the maximum motor current draw for each motor. The motor current, in milliamps, is shown on the **Status** tab of the **Bisque TCS** window. (Note that the mount must be homed before these values are updated.) The instantaneous

motor current fluctuates quite a bit, but taking an average current reading over time is accurate. Note that both the HA and Dec current values read zero when the motors are not slewing.

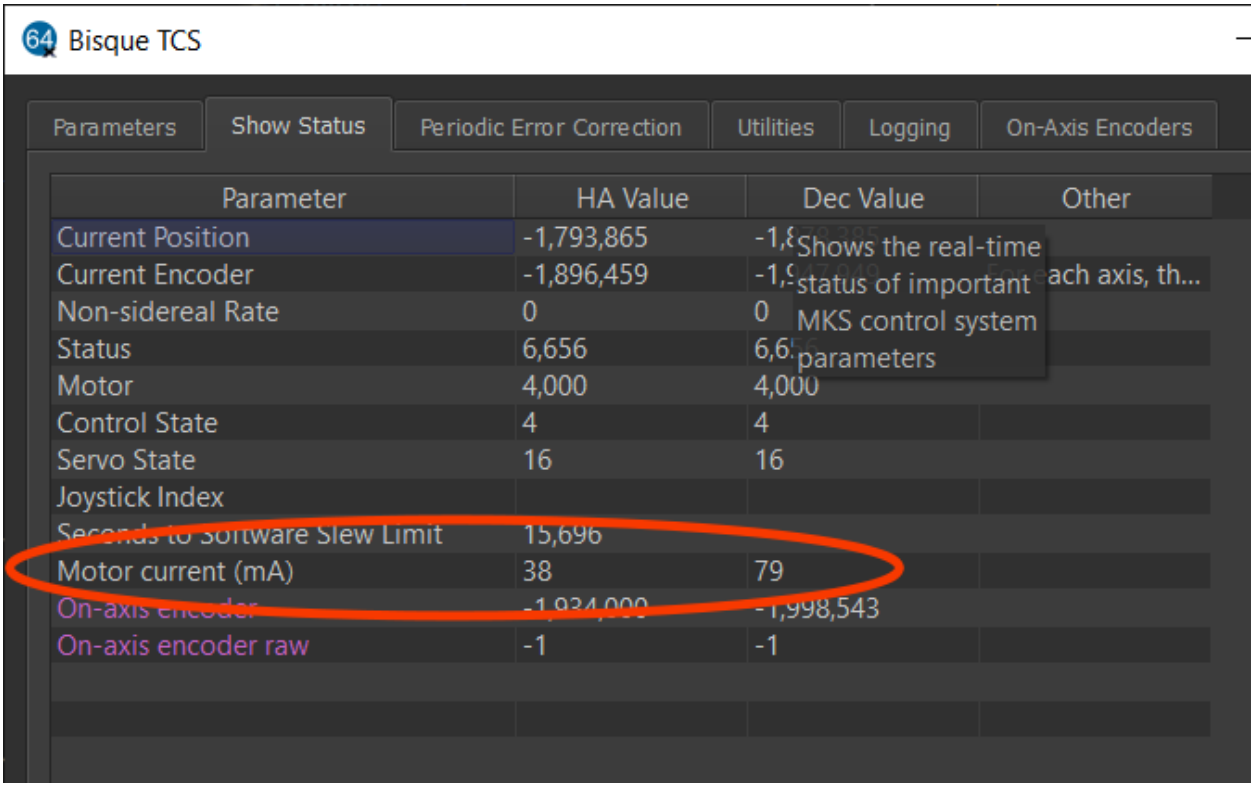


Figure 97: Show Status window displays the motor current when the motors rotate.

The method to determine the optimal motor index angle is to slew the motor in both directions while measuring the average current draw and adjusting the motor index angle accordingly. This process can take place when the mount is fully loaded, and the worm and gear need not be separated.

The **Measure Motor Current** options on the **Bisque TCS** window, **Utilities** tab, **Set Motor Index Angles** pane must be used to iteratively determine the optimal motor index angles as described below.

1. From the **Set Motor Index Angles** pane, (
2.) click the **Get from Bisque TCS** button to retrieve the motor index angles from the control system.
3. On the **Telescope** window, click **Tools**, **Startup**, **Find Home** to find the home position if necessary.
4. Click **Start** to have TheSky rotate both motors 20 degrees in each direction while measuring the motor current at about 20 Hz. When complete, the results are displayed in the **Measure Motor Current** report.
5. Inspect the measured motor current in HA.
    - If the result is positive, the current required to rotate the motor clockwise is greater than counterclockwise. Subtract 5 from the HA motor index angle number then enter this value into the **HA Index Angle** text box.

- If the result is negative, the current required to rotate the motor counterclockwise is greater than clockwise. Add 5 to the HA motor index angle number and enter this value into the **HA Index Angle** text box.

6. Repeat Step 4 until the difference between the measured current in each direction is less than 50 mA.
7. Repeat the above steps for the **Dec Index Angle**.
8. Click **Save to Bisque TCS**.

The goal is to determine the motor index angle value that produces a 50 mA or smaller difference in motor current in each direction. This ensures optimal mount performance, particularly when the control system is configured to slew above about seventy percent of the maximum slew rate.

Measuring Motor Current Example

Each time the **Start** button is clicked, the current draw is measured while the mount is slewed 20 degrees in each direction. In the example below, for the first run, both the HA and Dec index angles are set to a value of 180. The results indicate that there is a big disparity between slewing in the plus motor direction (20 milliamps) and the minus motor direction (318 milliamps).

The index angles were then adjusted to 170, and 175 and the control system restarted. The difference in current draw when slewing each direction is improved (that is, less) after adjusting the index angles, and the adjustment was in the correct direction. For this example, if, after adjusting the motor index angle, the result was a *larger difference*, then the index angle value should be increased, not decreased.

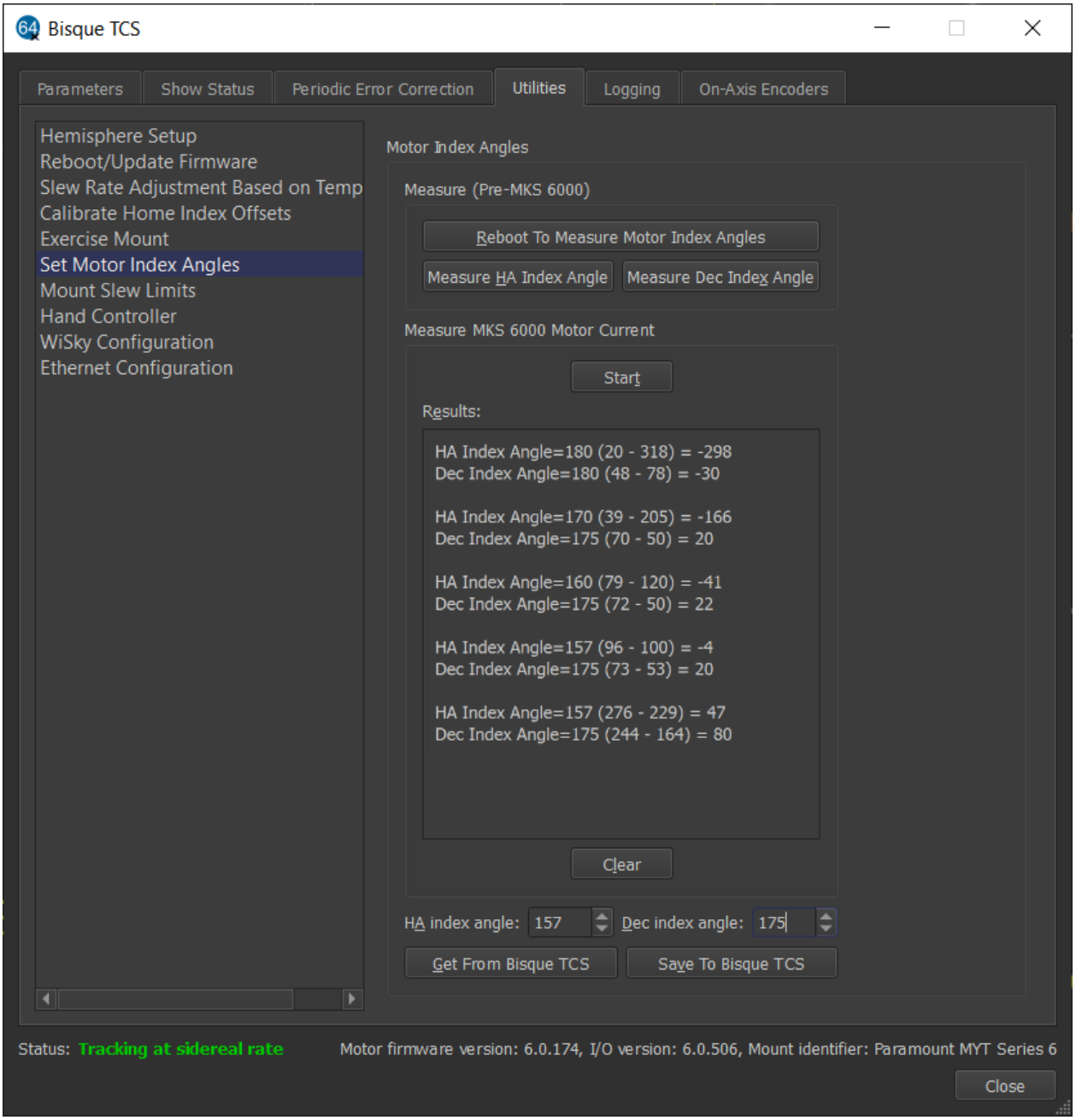
With a couple more iterations, the measured current difference continues to get smaller. If the difference is less than about 50 milliamps, the procedure can be considered complete. Note the HA values should trend towards zero.

HA Index Angle=180, (20 - 318) = -298
Dec Index Angle=180, (48 - 78) = -30

HA Index Angle=170, (39 - 205) = -166
Dec Index Angle=175, (70 - 50) = 20

HA Index Angle=160, (79 - 120) = -41
Dec Index Angle=175, (72 - 50) = 22

HA Index Angle=157, (96 - 100) = -4
Dec Index Angle=175, (73 - 53) = 20



Note: The results in the table below show that configuring the mount to slew at 70% of maximum produces more consistent motor index measurement results compared to slews at 100%.

Slew Rate at 70% of Maximum	Slew Rate at 100%
HA Index Angle=157, (102 - 100) = 2 Dec Index Angle=175, (78 - 65) = 13	HA Index Angle=157, (296 - 224) = 72 Dec Index Angle=175, (269 - 173) = 96
HA Index Angle=157, (101 - 104) = -3 Dec Index Angle=175, (79 - 67) = 12	HA Index Angle=157, (286 - 240) = 46 Dec Index Angle=175, (252 - 181) = 71

Slew Rate at 70% of Maximum	Slew Rate at 100%
HA Index Angle=157 (101 - 110) = -9 Dec Index Angle=175 (75 - 66) = 9	HA Index Angle=157 (285 - 229) = 56 Dec Index Angle=175 (262 - 172) = 90

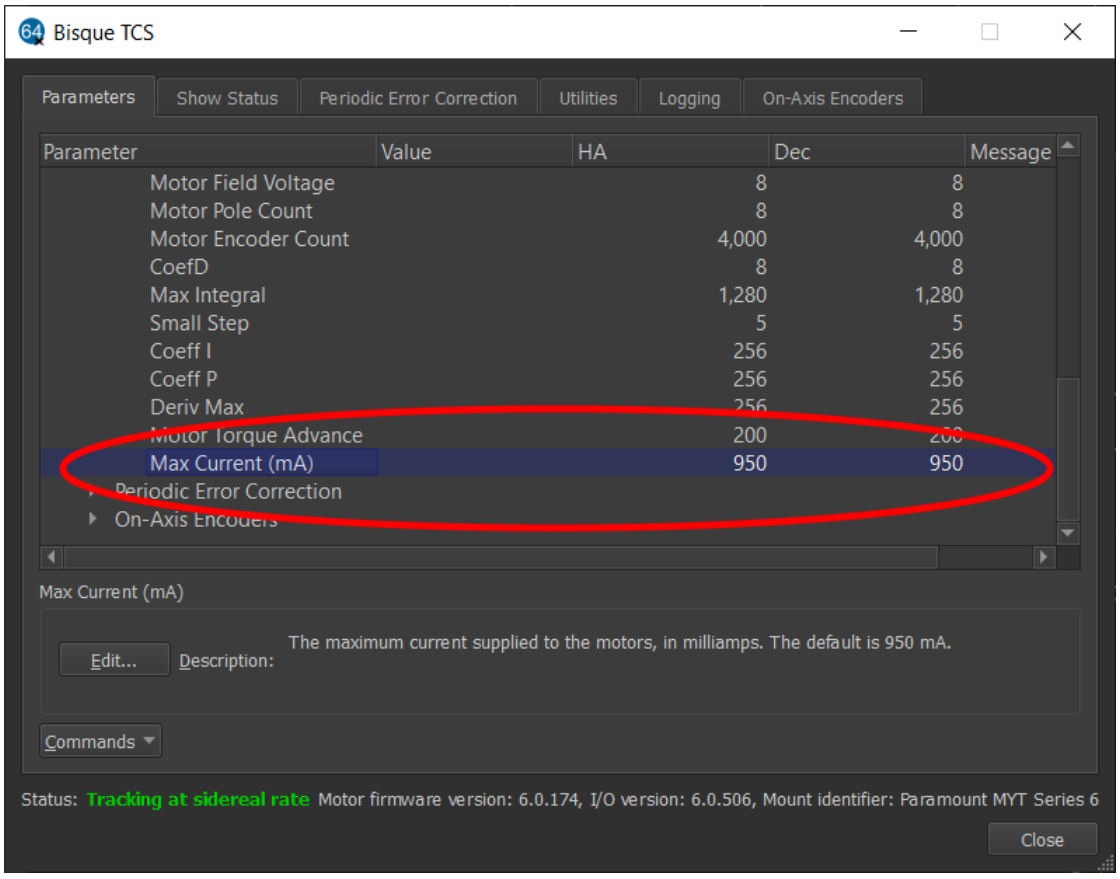


Figure 98: The Motor Parameters Maximum Current setting.

The MKS 6000 has higher current throughput which is a benefit for heavier payloads. However, under certain conditions the controller can demand more current than the power supply unit's maximum power rating.

This can cause an undesirable failure mode. For example, if the mount is operated remotely and the control system restarts due to insufficient power from the power supply unit, a reboot of the controller appears as a communication failure, which makes troubleshooting the actual root cause of the issue difficult.

The MKS 6000 **Max Current** Motor Parameter limits maximum current the controller demands. When configured properly, the control system will recognize an overcurrent event, and issue an error rather than demanding too much power from the power supply and causing a control system reboot. The default Paramount ME value is 950 mA.

Mounts with the MKS 5000 control system must use the **Measure (Pre-MKS 6000)** options described below.

Reboot To Measure Motor Index Angles

Click this button to restart the Bisque TCS so that DC servomotor's *motor index angle* can be measured.

Measure HA Index Angle

Click this button to measure the home index offset on the hour angle axis. This value will be applied when the Find Home command (page 121) is issued.

Measure Dec Index Angle

Click this button to measure the home index offset on the declination axis.

Measure Dec (Dec Button)

Click this button to measure the declination motor index angle.

Save To Bisque TCS

Click the button to save the ***RA Index*** and ***Dec Index*** motor index angles to the Bisque TCS permanent memory. The motors and control system will not operate normally if the wrong motor index angles are saved, so please double-check these values before proceeding.

Get Current

Click this button to read the current motor index angles from the control system.

Mount Slew Limits

The typical mechanical orientation of a GEM is when the optical tube assembly end of the declination axis is on one side of the pier when the observed object is on the opposite side of the meridian. In this orientation, the end of the counterweight shaft that holds the counterweights is below horizontal and the mount's payload cannot collide with the side of the pier, so there is little risk of damaging your equipment.

Operating a GEM in an "atypical" orientation (see Figure 99), that is, when the optical tube assembly end of the declination axis and the observed object are on the same side of the meridian, offers several advantages:

- An observed object can be tracked across the meridian without having to flip sides during the exposure. This maintains the orientation of the field of view. For a GEM, when the telescope changes sides of the pier, the image plane to rotate 180 degrees.
- Guide stars do not have to be reacquired. Flipping sides requires reacquisition of the guide star when the mount slews to the other side of the pier.

However, the significant disadvantage of operating a GEM in an atypical orientation is that the mount's payload can collide with the side of the pier. While the Paramount's motors are current limited, which

means that running into a fixed object will automatically stop slewing and tracking, it is always best to keep your optical equipment from running into *anything*.

The ***Mount Slew Limits*** options allow the Bisque TCS software limits to be configured such that the payload of a GEM cannot encounter the side of the pier.

After mounting the payload (camera, optical tube assembly and other equipment) to the Versa-Plate, use the hand controller or joystick to orient the mount in the atypical GEM orientation. The counterweight end of the counterweight shaft will be above horizontal, and the payload will run into the side of the pier at some declinations.

To properly configure the software slew limits the mount must be oriented at the maximum slew position in both hour angle and declination. Start by turning tracking off (choose the ***Turn Tracking Off*** command from the Tools pop-up menu on the ***Telescope*** window) to ensure the mount stays at the limit position.

Next, use the hand controller or joystick to carefully slew the hour angle axis until the mount is in the atypical position, without running the equipment into the side of the pier. You know the hour angle axis is oriented at the maximum slew position after slewing the declination axis 180 degrees always clears the side of the pier; we recommend a minimum of 1 inch (2-3 cm).

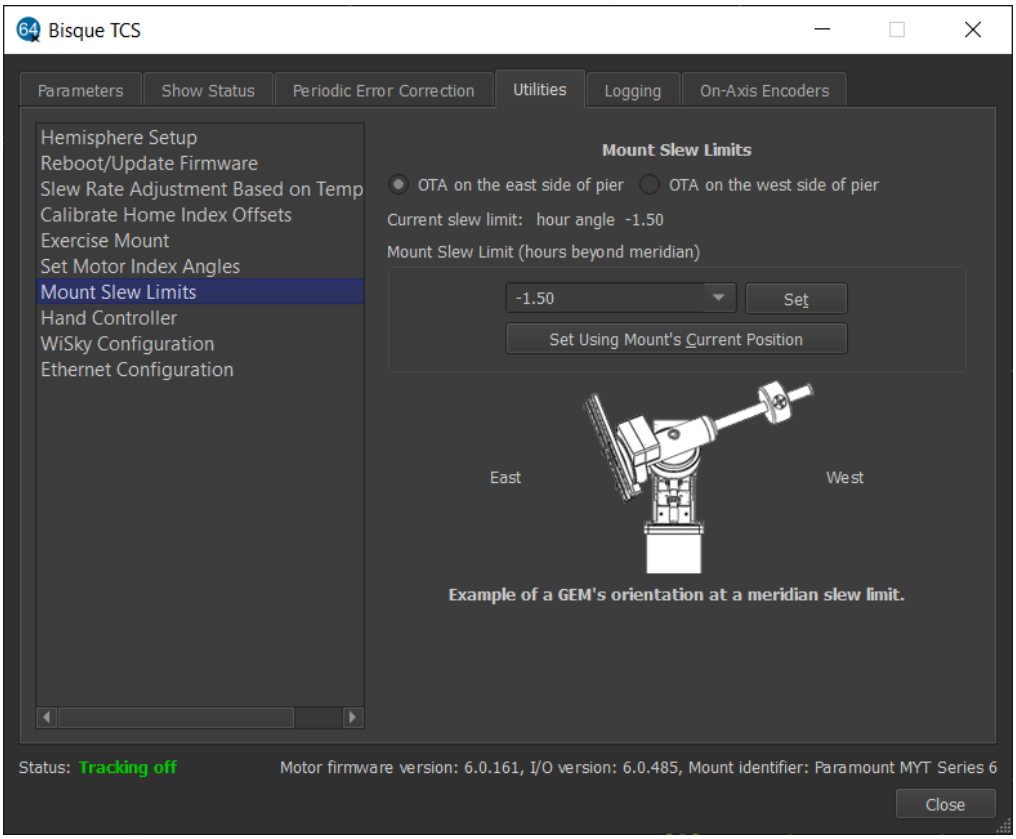


Figure 99: The Mount Slew Limits settings on the Utilities tab.

OTA on the East Side of Pier

Turn this option on to the set the slew position limit when the optical tube assembly is on the East side of the pier. Once the desired slew limit position is determined, click the ***Set to Current Position*** button to save this limit to the mount's firmware.

OTA on the West Side of Pier

Turn this option on to the set the slew position limit when the optical tube assembly is on the West side of the pier. Once the desired slew limit position is determined, click the ***Set to Current Position*** button to save this limit to the mount's firmware.

Limit Currently Set To Hour Angle

This text box shows the control system's current hour angle for the software slew limit for the selected axis.

Reset Software Slew Limit (Hours Beyond Meridian)

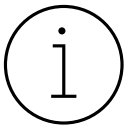
Use this group of controls to configure the mount's software slew limit hour angle. For example, when a GEM is tracking near the meridian, at what hour angle should tracking be halted to prevent the possible collisions or equipment damage? Additionally, when commanded to slew from *TheSky Professional*, should the telescope switch sides of the pier when the destination of a target object is on the opposite side of the meridian.

Hours Beyond Meridian Pop-Up Menu

The combination text box and pop-up menu, immediately to the left of the ***Set To This Value*** button, can be used to enter either manually the hour angle for the software slew limit, or to choose from one of the default values in the list. Click the ***Set To This Value*** button to permanently save this setting to the control system's firmware.

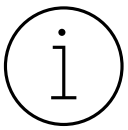
The table below lists the maximum hour angle for each Paramount Series model. The Paramount ME has configurable "hard stop positions" (page 92) and the maximum hour angle depends on the position of the hard stop bolts.

Series 6 Model	Hard Stop Position	Maximum Hour Angle
ME	Paramount ME Hard Stop Position 1 2 3 4 5 6 Hard stop bolt removed	 2.8 2.3 1.8 1.3 0.8 0.3 3.2
MX	Not configurable	2.5
MYT	Not configurable	2.1



To save the slew limit settings:

1. ***Telescope*** window, ***Tools*** pop-up menu, ***Bisque TCS*** command.
2. On the ***Parameters*** tab, click the ***Commands*** pop-up menu, then ***Save All Parameters To Mount***.



The software slew limits must be reconfigured when the ***Restore Defaults*** command (page 135) is issued. You may wish to permanently record the software slew limit hour angle setting so that it can be restored later.

Set To This Value

Click this button to use the mount's current position to define the software slew limit.

Set To Current Position

Click this button to use the mount's current mechanical position to define the slewing and tracking limit. If the payload might collide with the side of the pier, for example, first slew the mount to the "post collision" position, then click the button. To gain confidence that the slew limit is working, use the hand controller to try to slew the mount (at the slowest slew rate) past the limit. A properly defined software limit will automatically stop the slew, even when the mount is commanded from the hand controller.

Mount At Slew Limit Graphic

The mount graphic on the bottom of the ***Software Slew Limits*** pane is intended to convey an *example* of the orientation of the Paramount mount at the east and west meridian slew limits. This graphic is *not* intended to be "model specific" (in other words, the graphic that represents the mount will be the same for any Paramount model mount selected in the *TheSky Professional's* ***Telescope Setup*** window).

Hand Controller Settings

The four slew rates on the Hand Controller slew rate switch can be configured from the ***Hand Controller*** settings on the ***Utilities*** tab.

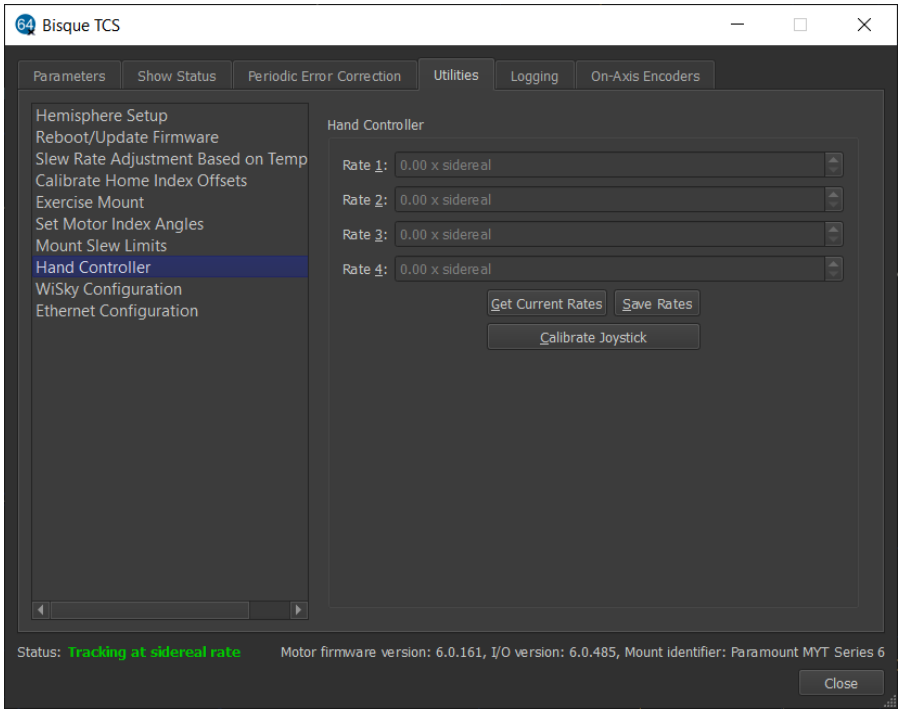


Figure 100: The Hand Controller settings on the Utilities tab.

Rate 1-4

Enter the desired slew rate for the corresponding rate position, based on the sidereal rate. For example, to configure switch Position 3 to slew the mount at 2 x sidereal, enter the number ***2*** in the ***Rate 3*** text box, then click the ***Save Current Rates*** button.

Get Current Rates

Click this button to retrieve the current slew rates from the control system.

Save Rates

Click this button to permanently save the current slew rates to the control system's firmware.

Calibrate Joystick

The MKS 4000 versus the MKS 5000 and MKS 6000 control systems all employ a mechanical joystick that can be used to slew the mount after homing, however, the purpose of joystick calibration differs significantly between these two control systems.

MKS 5000 and MKS 6000 Joystick Calibration

The MKS 5000 and MKS 600 have an internal sensor that detects input from the joystick on the hand controller. Clicking the ***Calibrate Joystick*** button initializes this sensor and saves the results to the mount's permanent internal memory.

When the joystick sensor is not properly calibrated, the ***Find Home*** command may fail unexpectedly and the telescope status text on the **Telescope** window reads *Not Homed*.

- MKS 5000 and MKS 6000 joystick calibration is performed at the factory and should not need to be recalibrated unless you are instructed to do so by Software Bisque.
- The hand controller does *not* need to be plugged in to the Electronics Box for successful joystick calibration.
- Before calibration can be performed, the mount should be turned on and connected to *TheSky Professional*. No other mount or software initialization is necessary.

MKS 4000 Joystick Calibration

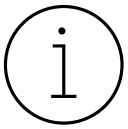
The ***Calibrate Joystick*** button determines the center position of the hand controller's joystick. If you plug in a new hand controller, or the homing process fails unexpectedly, joystick calibration may be necessary.

Note that the MKS 4000 control system stops the homing process whenever the joystick is moved from the center position. When the joystick is not calibrated properly, homing will also fail because the control system "thinks" the joystick is not centrally located.

To calibrate the joystick

1. Plug the hand controller cable into the ***Joystick*** port on the Adaptor Panel.
2. Launch TheSky Professional.
3. Click the ***Connect*** command from the ***Telescope*** menu to connect to the Paramount.
4. Choose the ***Bisque TCS*** command from the ***Tools*** pop-up menu on the ***Telescope*** window.
5. Highlight ***Hand Controller*** in the list on the left side of the ***Utilities*** tab on the ***Bisque TCS*** window.
6. Click the ***Calibrate Joystick*** button.
7. ***Important!*** Choose the ***Save All Parameters To Mount*** command from the ***Commands*** pop-up menu on the ***Parameters*** tab of the ***Bisque TCS*** window.

Wi-Fi or WLAN Configuration Settings (WiSky)



The WiSky module is a *standard feature* on the Paramount Series 6 mounts with the MKS 6000 control system.

Wireless mount control using the earlier model MKS 5000 telescope control system require installation of a separate Wi-Fi module called *WiSky*.

The MKS 6000 Wi-Fi interface can be configured to set up an *ad hoc* network access point, or to join an existing *infrastructure* network.

- When configured as an ad hoc network, other Wi-Fi enabled devices can connect to WiSky's private access point. When configured as an ad hoc network, WiSky does not provide Internet access.
- When configured to join an infrastructure network, you must specify the network name (SSID) and pass phrase.

The WiSky's default network configuration is to set up an ad hoc access point, where the WiSky creates a hotspot that Wi-Fi enabled devices can connect to. A Wi-Fi enabled desktop or laptop, or TheSky Fusion can connect to this access point and wirelessly control the Paramount with TheSky Professional.

WiSky can also be configured as *Inactive* that prevents any wireless access.

Each network connection setup is described below. The WiSky can use one of five different profiles based on your operating environment (permanent pier, portable, etc.).

Wi-Fi Quick Start

If you are familiar with TheSky and setting up network, use the following quick start guide to wirelessly control the Paramount.

Configuring the WiSky Control

To view the WiSky configuration settings, you must be connected to the Paramount through the USB port.

On the ***Telescope*** window, click ***Tools***, ***Bisque TCS***, click the ***Utilities*** tab and highlight ***WiSky Configuration***.

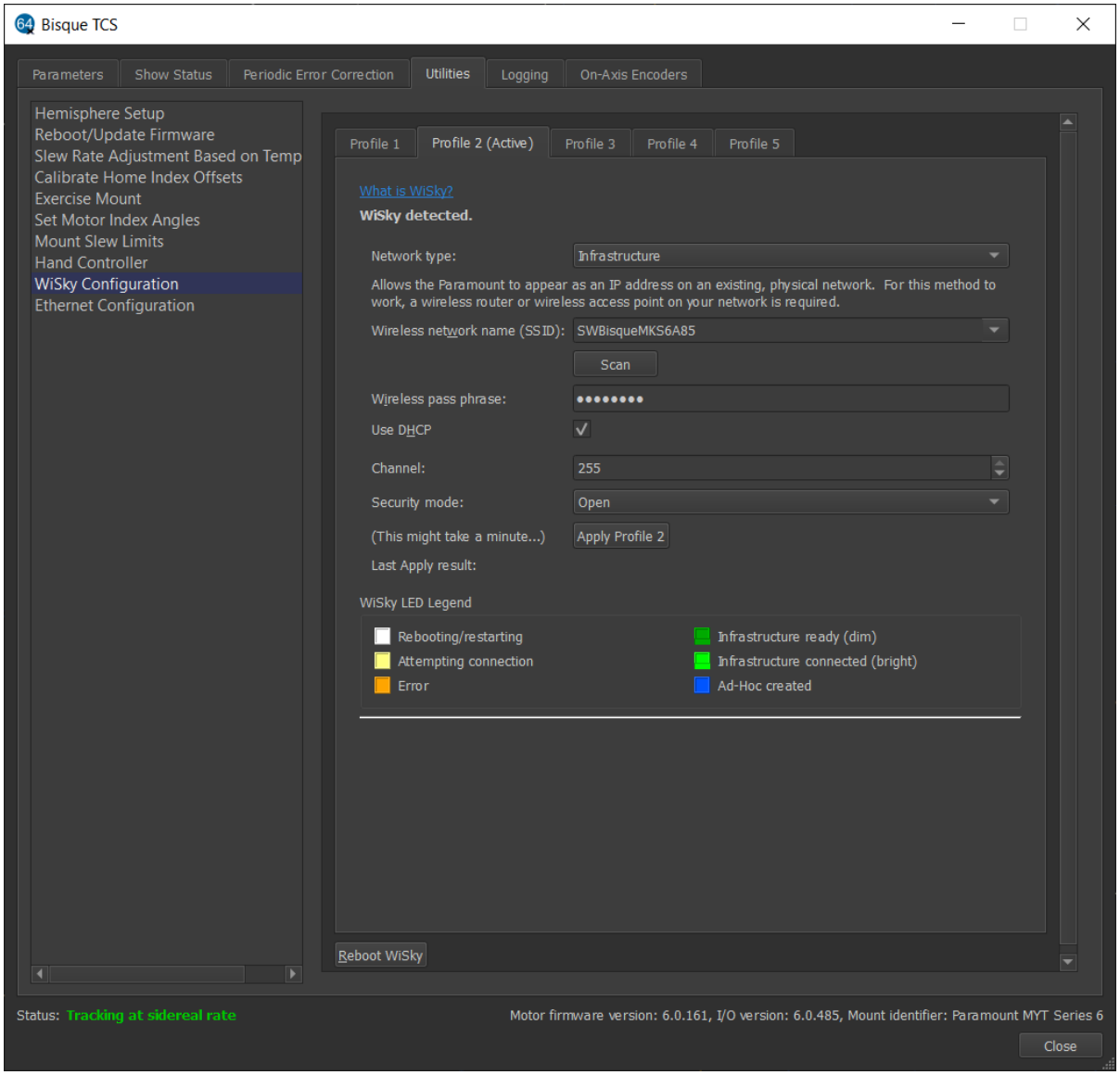
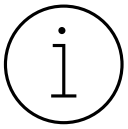


Figure 101: WiSky Profile 2 (Active) for an infrastructure network.

The ***WiSky Configuration*** window includes five ***Profile*** tabs that can be used to configure WiSky for different networks.

By default, *Profile 1* is configured as an ad hoc network, and the Wi-Fi LED on the outside of the Electronics Box emits dark blue. If the LED is any color other than dark blue, the Wi-Fi is not configured as an ad hoc network. The ***WiSky LED Legend*** shows the what each LED color means. Click the ***Apply Profile 1*** button to make the ad hoc mode active.



The settings from the **(Active)** profile are applied when the Paramount is powered on.

Click the ***Reboot WiSky*** button to restart the Wi-Fi controller.

The default ad hoc network created by the WiSky board is named **SWBisqueMKS5xxx**, where XXX represents three numbers. The name will differ slightly in your list of available Wi-Fi networks.

When the WiSky is in the active broadcast mode, you can then see the name of the ad hoc network in your list of available Wi-Fi networks within range.

Although Windows shows this ad hoc network by name, (for example, SWBisqueMKS5616), you cannot simply click on this network to join. Doing so results in the error message *"**Cannot Connect**."*. You must configure Windows to permit access to ad hoc networks.

Connecting the WiSky to a Mac

The Paramount mount using the MKS 6000 control system coupled can communicate wirelessly with any Wi-Fi enabled Mac computer.

The following describes how to configure the WiSky to use an ad hoc network and configure a computer running macOS.

macOS WLAN Minimum System Requirements

Before getting started, make sure your system is capable of wireless telescope control. You'll need the following components:

- A computer running macOS version 11 or later
- A wireless network adaptor on the desktop or laptop computer
- TheSky Professional Edition version 10.5.0 build 13787 or later
- A USB cable to connect the MKS 6000 to the computer so that the WiSky can be configured.

Configuring the WiSky Connection Point

The WiSky, by default, is configured as an ad hoc network. If you have changed the default WiSky configuration (by clicking the button on the WiSky unit which toggles through each of five different configuration options, or changed the configuration using TheSky Pro), the following procedure must be performed when the Paramount is connected to the Mac using a *USB cable*.

Step-by-Step WiSky Configuration (from TheSky Pro)

1. When the Paramount is connected to TheSky Pro using the USB port, on the ***Telescope*** window, click ***Tools***, ***Bisque TCS***.
2. On the ***Utilities*** page, highlight ***WiSky Configuration***.
3. Click the ***Profile 1*** tab. WiSky can be configured with one of five different profiles (Profile 1-Profile 5). The text ***(Active)*** appears next to the active profile.

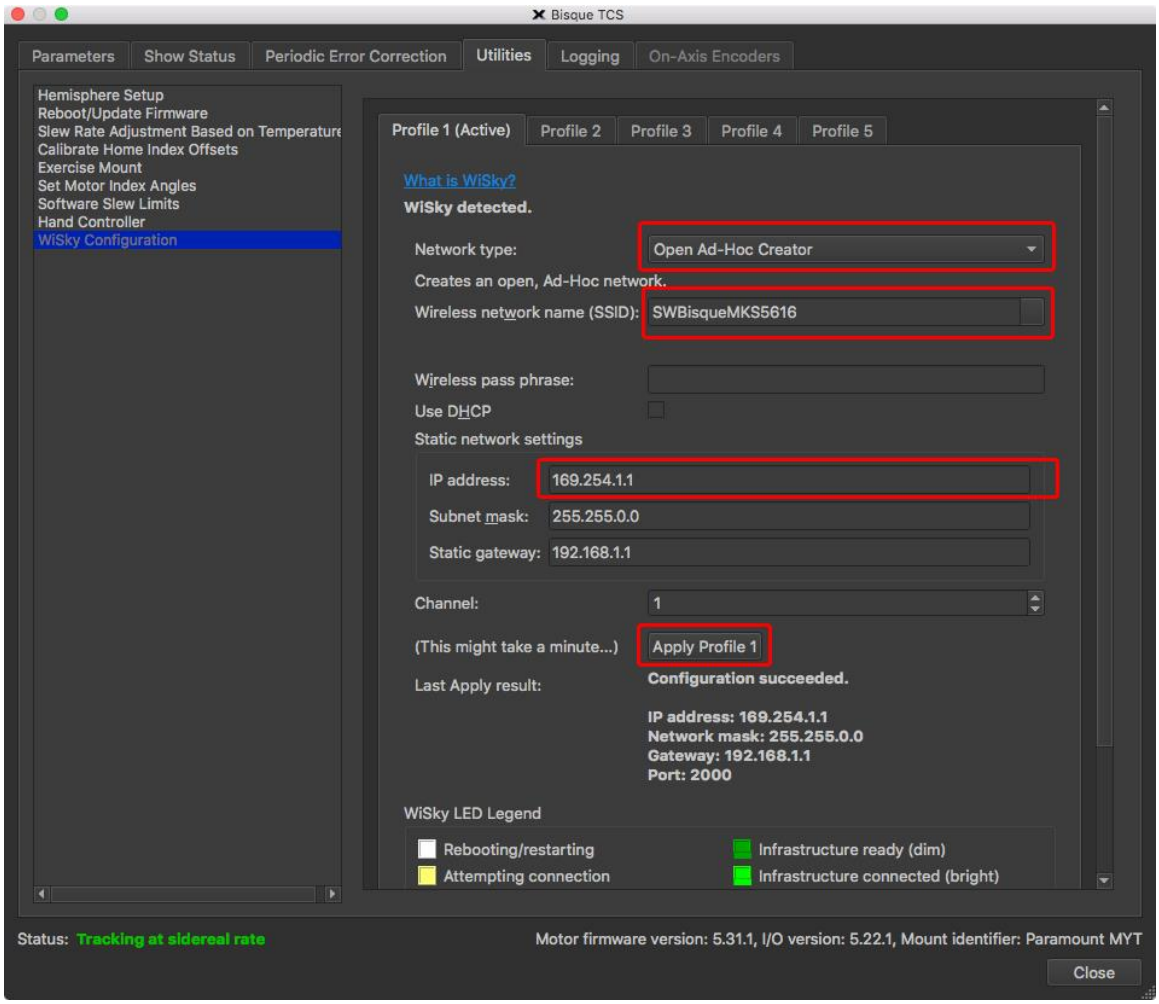


Figure 102: Configuring the WiSky as an ad hoc network.

Ensure the following settings are selected for **Profile 1**:

- *Network Type*: Open Ad-Hoc Creator
- *Wireless Network Name (SSID)*: SWBisqueMKS5616 (or you can type any allowable network name; make sure to remember this name, as it will be required later)
- *IP Address*: 169.254.1.1

Once these options are set, click ***Apply Profile 1*** near the bottom of the ***Profile 1*** pane (you may need to scroll down on the window to see this button). When the configuration is complete, a pop-up window and the ***Last Apply Result*** reads, "*Configuration succeeded.*" followed by the ***IP address***, ***Network Mask***, ***Gateway***, and ***Port*** for the ad hoc network access point.

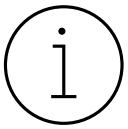
When ***Profile 1*** is the active profile, the text ***Profile 1 (Active)*** appears as the title of the pane, and the LED on the WiSky emits a blue color. The WiSky is now configured to communicate with a Wi-Fi enabled device.

Configuring the Mac's Network Settings

The Mac computer's network settings must be configured correctly before connecting to the WiSky's ad hoc network.

Step-by-Step Mac Network Configuration

1. Make sure the Paramount is turned on, and the LED located between the profile button and the antennae is blue.
2. Click the ***System Preferences*** command from the ***Apple*** menu.
3. Double-tab the ***Network*** icon to access the computer's network settings.
4. Highlight Wi-Fi from the networks listed on the left side of the Networks window.
5. Turn on the computer's Wi-Fi by clicking the ***Turn On Wi-Fi*** button, if necessary.
6. Select the WiSky's ad hoc network (the default name is ***SWBisqueMKS5616***; if you entered a different name when configuring the ad hoc network, select that name instead) as the ***Network Name***.



When the computer is connected to an ad hoc network, access to the web or other networks is not possible.

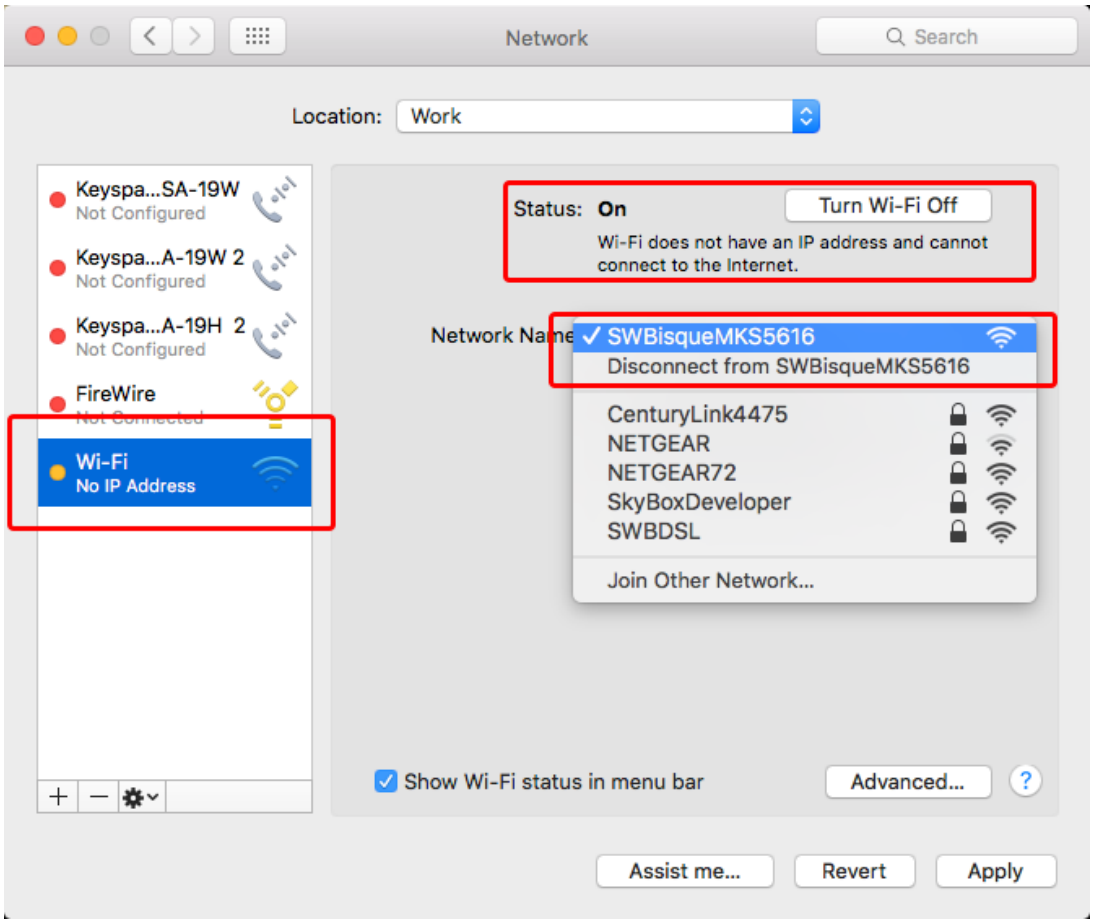


Figure 103: Connecting to the Mac WiSky ad hoc network from the Network settings window.

7. **Important!** Click the ***Advanced*** button on the ***Network*** window to manually configure the networks settings.

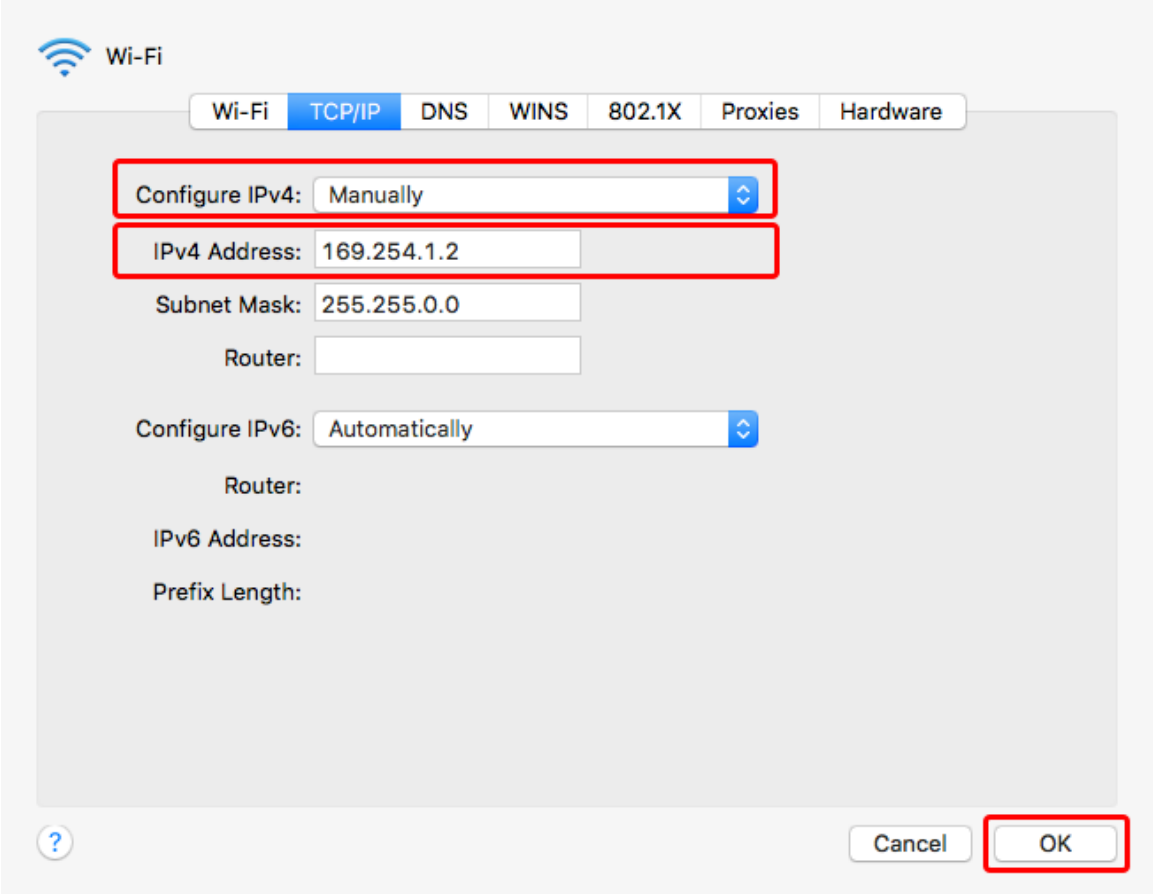


Figure 104: Manually configure the network's IP address.

a. Choose ***Manually*** from the ***Configure IPv4*** pop-up menu.
b. Enter ***169.254.1.2*** for the ***IPv4 Address*** and click ***OK***.

8. Click the ***Apply*** button to join this ad hoc network.

Joining the Paramount's ad hoc network can take a minute or so. While the device is connecting to the network, the ***Status*** text on the ***Network*** window reads, ***Wi-Fi does not have an IP address and cannot connect to the Internet.***

Once connection is established, the status message reads, ***Wi-Fi has the self-assigned IP address 169.254.1.2 and will not be able to connect to the Internet.***

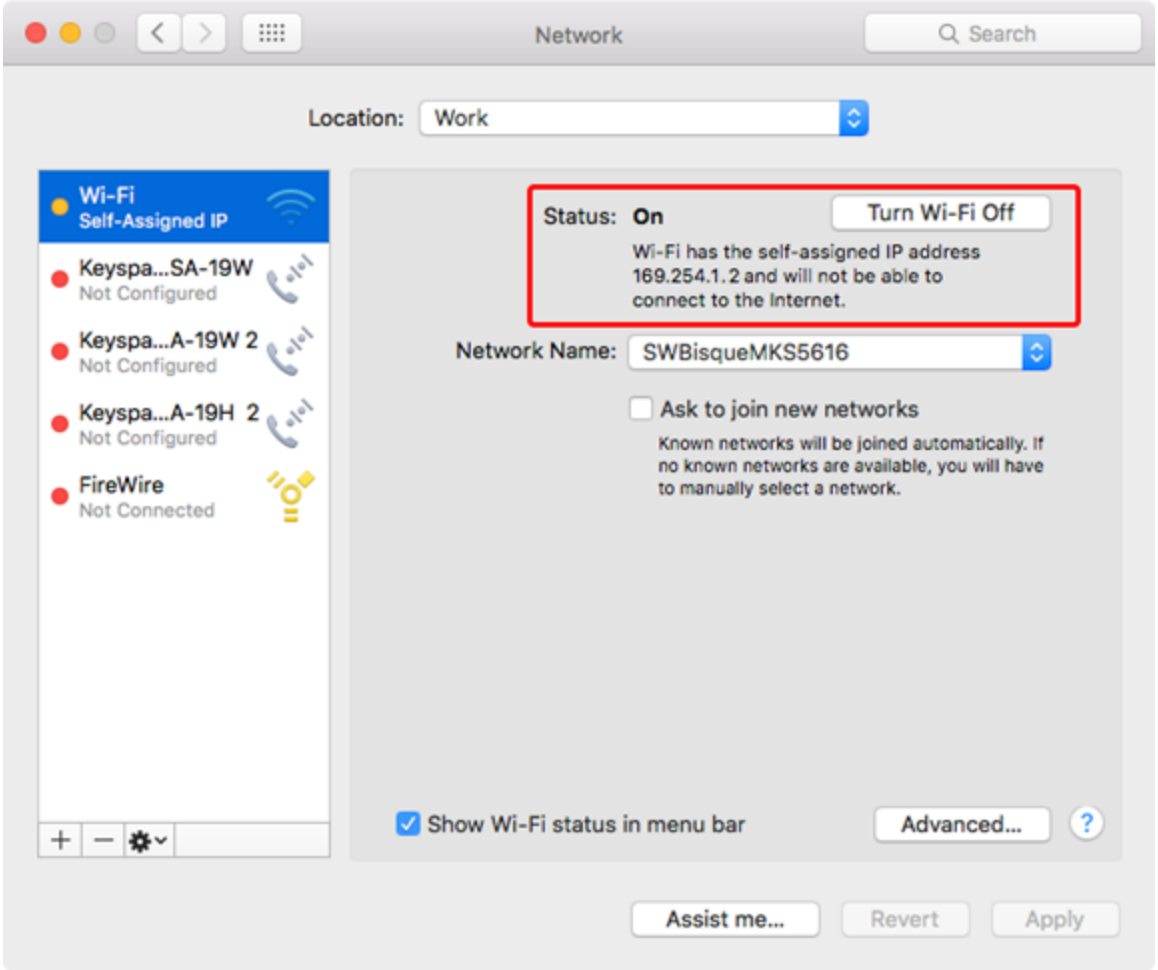


Figure 105: The Status text shows the IP address that is assigned to the ad hoc network.

The Mac is now successfully connected to the WiSky's ad hoc network. The next step is to configure TheSky Pro to communicate with the mount through the WiSky's IP address on this ad hoc network.

9. If necessary, from TheSky Pro, click the ***Connect*** command from the ***Telescope*** window to terminate the USB-based connection with the Paramount.
10. Click the ***Telescope Setup*** command from the ***Telescope*** window, then click the ***Settings*** command from the ***Mount Setup*** pop-up menu.
11. On the ***Serial Device*** window, choose ***TCP/IP*** from the ***Serial Device*** list.
12. For the ***TCP/IP Host*** enter ***169.254.1.1*** (a unique address on the ad hoc network; do not use the IPv4 address that was used to connect the Mac computer to the network), and enter ***2000*** for the ***TCP/IP*** port, then click ***OK***.
13. Choose the ***Connect*** command from the ***Telescope Setup*** pop-up menu to connect to the Paramount wirelessly.

Ethernet Configuration Options

On the **Utilities** tab, highlight the **Ethernet Configuration** option, then click the **Edit Ethernet Configuration** button to display the Ethernet settings.

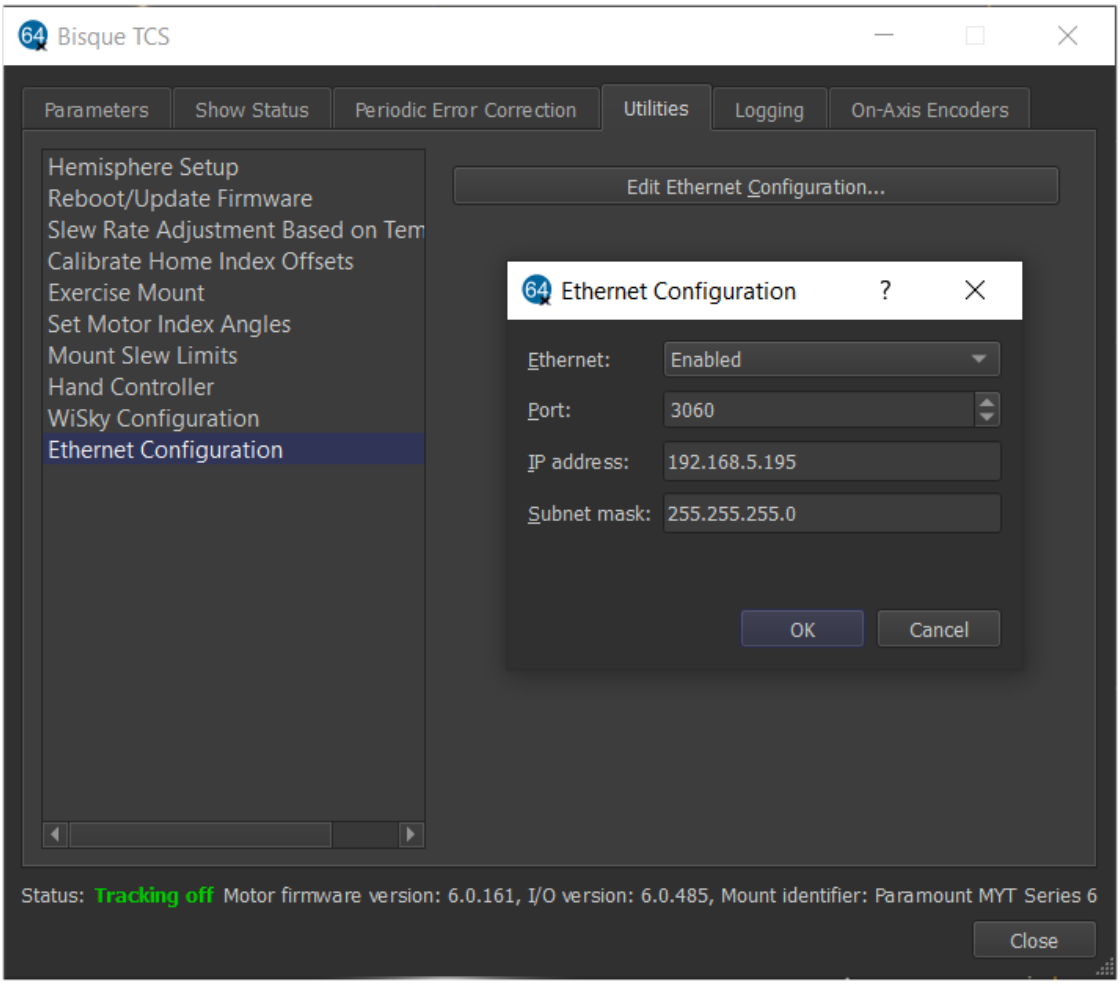


Figure 106: The Ethernet Configuration window.

Ethernet Configuration

Use the settings on the **Ethernet Configuration** window to enable the Ethernet port and define the MKS 6000's Ethernet port settings.

Ethernet Pop-Up Menu

Enable the MKS 6000 Ethernet port choosing the **Enabled** option. The default setting is **Disabled**.

Port

Specify the port number to use for the TCP/IP communication. The default port value is 3060.

IP Address

The MKS 6000 does not support Dynamic Host Configuration Protocol (DHCP) which means the network will not automatically assign an IP address to this device when it is plugged in to a router. You must

enter an unused, static IP address on the network for the MKS 6000's Ethernet port. See "*How Do I Find a Static IP Address on My Network?*" below for details.

If your mount is located at a remote site, contact the local network administrator, and request a static IP address for the mount. Note that the IP address of the MKS 6000 must be on the *same network* as the network it is connected to.

After the Ethernet port settings are configured, the next step is to configure TheSky to use the Ethernet port.

1. Click **Telescope**, **Telescope Setup**,
2. Highlight **Mount**, then click the **Mount Setup** pop-up, **Settings** to display the **Serial Port Settings** window (Figure 107).
3. On the **Serial Port Settings** window, click the **Serial Port** pop-up menu, and choose TCP/IP.
4. Enter the mount's static IP address into the **TCP/IP Host** text box.
5. The default **TCP/IP Port** is 3060 and normally does not need to be changed. Make sure your firewall does not block this port.

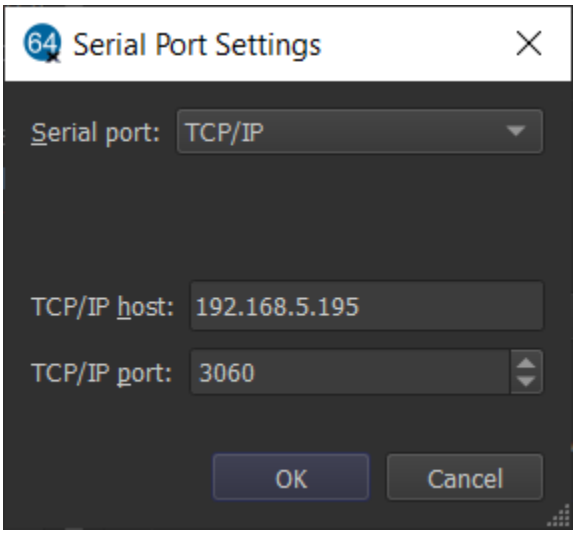


Figure 107: TheSky's Serial Port Settings window.

How Do I Find a Static IP Address on My Network?

Windows

1. Type **command** in the Search box and press the **Enter** key.
2. In the command prompt, type in the command **ipconfig** and press the **Enter** key.

```
C:\ipconfig
```

In the Terminal window, look for the output similar to that below. Note, if you have two or more network cards (NICs) on the computer, then this information is presented for each one.

```
Ethernet adapter Ethernet:
```

```
Connection-specific DNS Suffix  . :
IPv4 Address. . . . . . . . . . . : 192.168.5.11
Subnet Mask . . . . . . . . . . . : 255.255.255.0
Default Gateway . . . . . . . . . : 192.168.5.1
```

In the example above, the IPv4 address of this computer is 192.168.5.11. You will need to choose a unique IP address that is on the same network as this IP address (that is, the first three numbers separated by a period must be the same as the computer's IP address), but one that is not already assigned to a different device on the network. For example, choose **192.168.5.12**. To make sure that address is not in use, type the command:

```
C:\Users\Myname>ping 192.168.5.12

Pinging 192.168.5.12 with 32 bytes of data:

Reply from 192.168.5.12: bytes=32 time<1ms TTL=128
Reply from 192.168.5.12: bytes=32 time<1ms TTL=128
…
```

If a response comes back from that address as shown above, then you will need to choose a different address (such as 192.168.5.5)

```
C:\>ping 192.168.5.5

Pinging 192.168.5.5 with 32 bytes of data:

Reply from 192.168.5.11: Destination host unreachable.
Reply from 192.168.5.11: Destination host unreachable.
…
```

The message "Destination host unreachable" means this address is available to use for the MKS 6000 IP address.

If the above does not work, consider using the cross-platform apps Angry IP Scanner (https://angryip.org/) or NMAP app (www.nmap.org) to scan your network and list all assigned IP addresses on the network.

Use the command:

```
nmap -sn -PR MY.IP.ADDRESS.HERE.*
```

For example,

```
nmap -sn -PR 192.168.100.* <ENTER>
```

Lists all the IP addresses on the network.

Network administration, DHCP and assigning static IP addresses is beyond the scope of this user guide. ChatGPT is an excellent resource to get answers.

On-Axis Encoders Tab

Paramount Series 6 models are available with absolute, on-axis encoders. Absolute on-axis encoders offer the following benefits:

- Eliminate the need to home the mount.
- Eliminates periodic error.
- Produces exceptional telescope models with fewer pointing calibration samples.

The ***On-Axis Encoder*** tab provides a report that shows the status of the on-axis encoders, and the angular difference between motor's encoders and the on-axis encoders. These values can be helpful to make sure the on-axis encoders are enabled and operational, as well as troubleshooting issues.

Using ProTrack™

ProTrack™ is *TPoint-specific* software and *Paramount-specific* hardware technology that improves the Paramount's tracking accuracy. ProTrack uses a pointing model to periodically issue small corrections telescope's position that compensate for mechanical tracking errors, such as tube flexure and out of round gears as well as other systematic errors, such as atmospheric refraction and flexure of the declination axis. This same tracking enhancement technology is used on many of the world's largest telescopes, such as the 8-meter Gemini telescope.

ProTrack enables the Paramount to acquired long unguided exposures (up to 15 minutes or longer at 100-inch focal length are possible) with pinpoint stars. *Unguided exposures* of this duration at moderate to long focal lengths, with pinpoint stars, are simply not possible without *TheSky Professional* software, Paramount control system hardware and control system firmware integration.

ProTrack works best with a Super Model that is created from an extensive set of pointing calibration samples (100-300). However, ProTrack can provide useful tracking corrections using a smaller number of pointing samples, making it useful for semi-portable or mission critical portable setups.

ProTrack Minimum Requirements

ProTrack requires the following minimum hardware and software.

- A Paramount MYT, Paramount MX, Paramount MX, Paramount ME, Paramount ME, or MKS Series Software Bisque Telescope Control System (Bisque TCS).
- TheSky Professional.
- TheSky Professional's *TPoint module* (included with the Paramount mount).
- A telescope with a mechanically fixed mirror. (Errors due to mirror flop make high accuracy tracking nearly impossible.)
- An extensive set of TPoint modeling data (100 to 200 stars or more recommended for Paramount mounts that do not use on-axis absolute encoders).

Getting Started with ProTrack

Here are the keys to getting excellent ProTrack results:

- Make sure every component of the imaging system is robust, from the pier mounting to the camera mounting and everything in between. Loose mechanics, or even poorly mounted cabling can introduce random errors that cannot be corrected by TPoint and therefore degrade ProTrack's performance.
- Use the ***Telescope, TPoint Module, Calibration Run, Automated Calibration*** button to obtain an accurate pointing calibration data set.
- Calibrate the mount using a TPoint Super Model that is based on 100 or more pointing calibration samples.

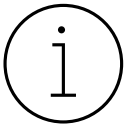
Activating ProTrack

1. From *TheSky Professional*, choose the ***Connect*** command from the ***Telescope*** menu to connect to the Paramount.
2. Turn on the ***Activate ProTrack*** checkbox on the ***ProTrack*** tab of the ***TPoint Module*** window to view a table of ProTrack corrections that will be applied to tracking.
3. Turn on the ***Enable Tracking Adjustments*** checkbox to apply the corrections to the mount's position while tracking.

Details about the ***ProTrack*** tab on the ***TPoint Module*** window can be found in the *TheSky Professional* User Guide.

Troubleshooting Mount Operation

Problem	Solutions
TheSky Professional* cannot communicate with the Paramount, or displays communication error messages,** ***"Error, poor communication, connection automatically terminated, Error = 213."	Communication between a personal computer and hardware device requires that the software and hardware be properly configured. If you cannot establish a link to the telescope, please try the following: 1. Make sure the mount is powered on. 2. Make sure the plugs on each end of USB 2.0 cable are seated properly. 3. Make sure the software settings are correct. 4. See "USB Hubs and USB Extenders" on page 186.
Or, when attempting to reconnect to the device, the error message: ***"Could not open communications port. The port is either in use by another application or not recognized by the system, Error = 201."***	By default, Microsoft Windows 7's (and later) *power management plan* can suspend power to one or more USB devices connected to the computer (called *USB Selective Suspend*). Once power to the USB port is suspended, TheSky Pro will report communication errors, time out errors and potentially other unexpected device to PC transmission errors for any mount, camera, hub, or other USB device that is connected to this USB port. Edit the computer's power management settings to disable the USB Selective Suspend setting. 1. Click ***Start, Control Panel*** and double-click the ***Power Options*** icon. 2. Click ***Edit Power Plan*** from the list of ***Power Options***. 3. Click ***Change Advanced Power Settings*** on the ***Edit Plan Settings*** window. 4. On the ***Advanced Settings*** tab, expand ***USB Settings***. 5. Expand ***USB Selective Suspend Setting***. 6. Choose ***Disabled*** from the ***Settings*** pop-up menu. Power management settings can be configured for individual USB ports. 1. Click ***Start, Control Panel, Device Manager***. 2. Expand ***Universal Serial Bus Controllers*** on the ***Device Manager*** window. 3. For the ***Generic USB Hub,*** you wish to manage power settings, right-click, and choose the ***Properties*** command. 4. Click the ***Power Management*** tab on the ***Generic USB Hub Properties*** window.

Problem	Solutions
	5. Turn off the ***Allow the Computer to Turn Off this Device to Save Power*** checkbox and click ***OK***.  The *Power* tab on the *Generic USB Hub Properties* window lists the current power consumption requirements for the connected USB device. This information can be useful to ensure a USB device that is connected to the Paramount's Instrument Panel's USB hub does not exceed the maximum power specifications. Note that some users report that the above settings can change after a Windows update, so you may need to reapply these settings occasionally. To minimize issues related to operating-specific power management features, Software Bisque strongly recommends reviewing your computer's power plan before attempting to automate observatory control.
Paramount does not find the home position reliably. Sometimes the home position is successfully located, other times not (resulting in successive beeps emitted by the control system).	The center position of the joystick on the hand controller may need to be calibrated. **To Calibrate the Joystick** 1. Download and install TheSky Pro Latest Update. Visit ***www.bisque.com, My account, Log in***, then ***My accounts, My Subscriptions***. 2. Launch TheSky Pro. 3. Choose the ***Connect*** command from the ***Telescope*** menu. If prompted to find the home position, click ***No***. 4. Choose the ***Bisque TCS*** command from the ***Tools*** menu on the ***Telescope*** window. 5. Click the ***Utilities*** tab. 6. Click ***Hand Controller*** on the left side of this window to reveal the Hand Controller pane. 7. Click the ***Calibrate Joystick*** button.
The Paramount will not slew.	Make sure the two position switches in both hour angle and declination are in the Track position (page 63).
The Paramount emits continuous, successive, high pitch "beeps" shortly after	• Check that the balance knobs are adjusted properly. If the balance knobs are too tight, then the worm is forced against the gear, and the mount will not slew.

Problem	Solutions
startup and will not slew.	• Check the mount balance in both axes. If the Paramount stalls or sounds labored while slewing, check to make sure both axes are properly balanced. Balance becomes more critical with heavier loads. While the control system has sufficient torque to lift heavy loads, tracking performance, and slewing, may suffer when the payload is greatly out of balance.

USB Hubs and USB Extenders

To achieve reliable communications between a computer and a USB device, the USB 2.0 specification states that the maximum cable length is about 16 feet (5 m). Longer cables introduce delays in the USB communication and means the computer cannot reliably "talk to" the attached device.

The Paramount is supplied with a standard USB cable that is 15 feet (4.6 m) long and will reliably control the Paramount mount. Any other cable configuration can introduce unwanted behavior.

To control CCD cameras, Software Bisque strongly recommends using a dedicated 5 m (16 ft.) USB cable plugged directly into the camera's USB port and the computer's USB port.

If you need longer USB cable runs, consider the following:

- USB extension solution from Icron Technologies (http://www.icron.com). They are expensive, but they work. Software Bisque has experimented with many inexpensive USB extenders and most of them just *do not work*. Even worse, some work "some of the time" but often result in strange or unpredictable behavior.
- USB 3.Optical Cables™ by Corning® permit long USB cable runs with high-speed connectivity.
- Power-line communication or carrier (PLC) technology that uses mains power cables to transmit Ethernet.

After adding *any* USB extension technology to communicate with the Paramount, be sure to some perform reliability tests before observing. if you encounter *any* unusual behavior with the Paramount or device connected to the USB ports on the Instrument Panel, please see "Troubleshooting Communication Problems" below.

Controlling Multiple USB Devices with USB Hubs

Software Bisque cannot guarantee the Paramount will work with every possible USB/USB Hub/USB Extension/USB Device configuration. The number of hardware permutations is virtually unlimited, and, based on Software Bisque's experience, USB extenders and USB hubs, even "industrial grade" hubs, can introduce communication problems.

For example, Software Bisque has encountered configurations where an "innocent looking" USB hub in the chain of computer/Paramount/ CCD camera not only caused artifacts on the CCD photos, *TheSky*

Professional would lose communication when the camera downloads photos. No USB hub, no problems.

In another observatory, two of the ports on a four-port "industrial-grade" hub began to fail, and the driver would then terminate communications with the camera and focuser. Again, removing the hub and connecting all devices directly to the computer's USB port solved the communication issue.

Again, Software Bisque has positive results powering multiple USB devices using the USB 2.0 Ranger Extenders from Icron Technologies. Expensive, but worth the investment.

Troubleshooting Communication Problems

Problem	How to Troubleshoot
After adding a USB hub, USB cable extender or any other USB peripheral device to the Paramount USB cable, if *TheSky Professional* is unable to connect to the Paramount (with frequent timeout errors or poor communication errors).	• Remove the USB hub, or USB cable extender, and plug the 15-foot USB cable supplied with the Paramount directly into the computer's USB port and port labeled USB on the Electronics Box. Be very wary of USB hubs, especially inexpensive or unpowered hubs. They can introduce intermittent communication failures and wreak havoc with your observing sessions.

Windows OS and USB Port Power Settings

To minimize issues related to operating-specific power management features, Software Bisque strongly recommends reviewing your computer's power options before attempting to automate observatory control.

By default, Microsoft Windows can suspend power to USB devices connected to the computer. Once power is suspended, mounts, cameras and other USB devices that are connected to TheSky Professional or the Camera module will report communication errors, time out errors and potentially other unexpected device to PC transmission errors.

To avoid this, edit the computer's power management settings and disable the USB Selective Suspend setting.

- Launch the Windows Control Panel and double-click the ***Power Options*** icon.
- Click ***Edit Power Plan*** from the list of ***Power Options***.
- Click ***Change Advanced Power Settings*** on the ***Edit Plan Settings*** window.
- On the ***Advanced Settings*** tab, expand ***USB Settings***.
- Expand ***USB Selective Suspend Setting***.
- Choose ***Disabled*** from the ***Settings*** pop-up menu.
- Power management settings can be configured for individual USB ports.

- Click ***Start, Control Panel, Device Manager***.
- Expand ***Universal Serial Bus Controllers*** on the ***Device Manager*** window.
- For the ***Generic USB Hub,*** you wish to manage power settings, right-click, and choose the ***Properties*** command.
- Click the ***Power Management*** tab on the ***Generic USB Hub Properties*** window.
- Turn off the ***Allow the Computer to Turn Off this Device to Save Power*** checkbox and click ***OK***.

Tips:

1. The ***Power*** tab on the ***Generic USB Hub Properties*** window lists the current power consumption requirements for the connected USB device. This information can be useful to ensure a USB device that is connected to the Paramount's Instrument Panel's USB hub does not exceed the maximum power specifications.
2. Some users report that the above settings can be changed after a Windows update, so you may need to occasionally reapply these settings.

Appendix A: Paramount Technical Drawings

Technical drawings of many Paramount components are available in PDF format on the Software Bisque website. A SolidWorks eDrawing can also be used to determine many "non-standard" mount dimensions.

The table below lists the names of the common drawings. Note that you must log in to the Software Bisque site to access these files. An application that can display the Portable Document Format (PDF) must be installed on Windows.

Technical Drawing Document Name	Where to find
Base Plate to Pier Adaptor Plate	1. Visit www.bisque.com. 2. ***My account, Log in***. 3. Click **Products, Paramount Model, Technical drawings** tab.
Basic Dimensions	
Counterweight Shaft Extension Bar	
Electronics Box	
Instrument Panel	
Paramount Wedge Assembly and Base Plate	
Permanent Pier	
Pier Mounting Options	
Pier Top Plate	
Paramount SolidWorks eDrawing	
Versa-Plate	

Computing Dome Offset Distance

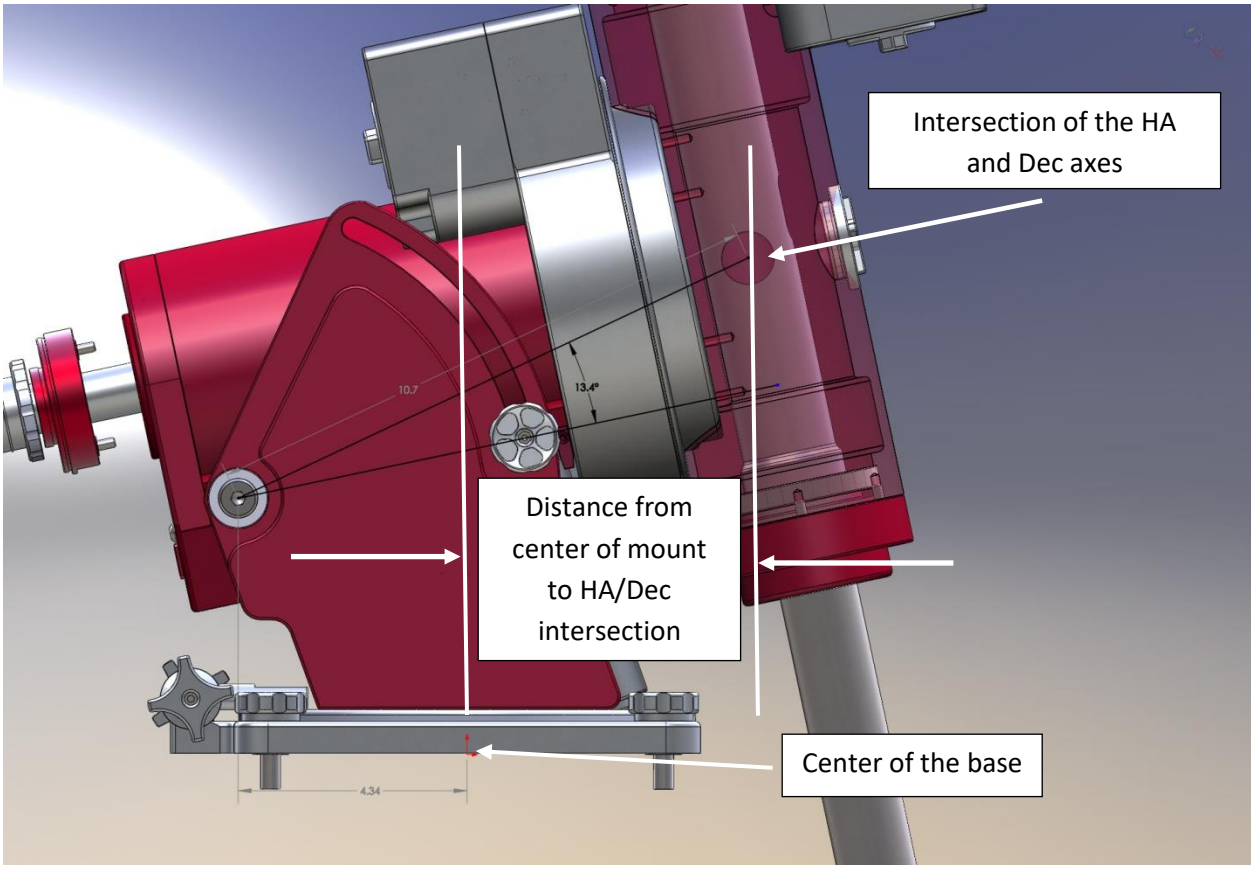


Figure 108: Diagram showing the derivation of dome offset equation for the Paramount MX or Paramount MX.

You may wish to permanently mount your Paramount so that the center of the intersection of the mount's hour angle and declination axes is aligned vertically with the center of the dome.

One of the required measurements to do so is the distance from the center of the Paramount base to the intersection of the mount's hour angle and declination axes, which changes with latitude.

Use the equations in the table below to compute this distance or use the following table to determine find this distance for your model mount.

Model	Equation to compute the distance (D) between the base center to HA/Dec intersection based on your latitude	
	in.	**cm**
ME Classic	D = 14 * cos((π/180) * (lat. + 15.7°)) – 4.8	D = 35.6 * cos((π/180) * (lat. + 15.7°)) – 12.2
ME II **ME Series 6**	D = 14 * cos((π/180) * (lat. + 15.8°)) – 5.66	D = 35.6 * cos((π/180) * (lat. + 15.8°)) – 14.4
MX Classic **MX+** **MX Series 6**	D = 11 * cos((π/180) * (lat. + 13.7°)) – 4.3	D = 27.9 * cos((π/180) * (lat. + 13.7°)) – 10.9
MYT Classic **MYT Series 6**	D = 9.4 * cos ((π/180) * (lat. + 14.7°)) – 3.65	D = 23.9 * cos ((π/180) * (lat. + 14.7°)) – 9.3

The table below shows the distance to the base center over a range of latitudes.

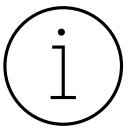
Latitude (°)	Distance to base center from RA/Dec intersection (cm/in.)			
	ME Classic	**ME II** **ME Series 6**	**MX Classic** **MX+** **MX Series 6**	**MYT Classic** **MYT Series 6**
10	19.9/7.8	17.6/6.9	14.7 /5.8	12.4/4.9
13	19/7.5	16.8/6.6	14.0/5.5	11.9/4.7
16	18.1/7.1	15.8/6.2	13.3/5.3	11.3/4.4
19	17.1/6.7	14.8/5.8	12.6/5.0	10.6/4.2
22	16/6.3	13.7/5.4	11.8/4.6	9.9/3.9
25	14.8/5.8	12.5/4.9	10.9/4.3	9.1/3.6
28	13.5/5.3	11.3/4.4	9.9/3.9	8.3/3.3
31	12.2/4.8	10.0/3.9	8.9/3.5	7.4/2.9
34	10.8/4.3	8.6/3.4	7.9/3.1	6.5/2.6
37	9.4/3.7	7.1/2.8	6.8/2.7	5.5/2.2
40	7.9/3.1	5.6/2.2	5.6/2.2	4.5/1.8
43	6.3/2.5	4.0/1.6	4.4/1.7	3.5/1.4
46	4.7/1.8	2.4/1.0	3.2/1.2	2.4/1.0

Latitude (°)	**Distance to base center from RA/Dec intersection (cm/in.)**			
49	3/1.2	0.8/0.3	1.9/0.7	1.3/0.5
52	1.3/0.5	-0.9/-0.4	0.6/0.2	0.2/0.1
55	–0.4/–0.2	-2.7/-1.1	–0.8/–0.3	-1.0/-0.4
58	–2.2/–0.9	-4.5/-1.8	–2.1/–0.8	-2.2/-0.9
61	–4.0/–1.6	-6.3/-2.5	–3.5/–1.4	-3.4/-1.3
64	–5.8/–2.3	-8.1/-3.2	–5.0/–2.0	-4.6/-1.8
67	–7.7/–3.0	-9.9/-3.9	–6.4/–2.5	-5.8/-2.3

For the northern hemisphere, a positive value indicates that the intersection of the hour angle and declination axes is north of the center of the mount. A negative value indicates the intersection of the hour angle and declination axes is south of the center of the mount.

Appendix B: Motor Index Angles

The Paramount's hour angle and declination axis servomotors require a unique *motor index angle* that is required for motor initialization when the mount is turned on. These motor-specific motor index angles are normally measured and saved to the control system at the factory. For the MKS 6000, they must be measured and saved before the mount can operate normally.



Follow the steps below to measure and save the motor index angles to the MKS 6000.

Important: After installing a replacement MKS 6000 control system and powering the mount on for the first time, ~~it~~ the control system may emit successive beeps because the mount's motor index angles have not yet been measured and saved to the MKS 6000 permanent memory.

The MKS 6000 uses a different convention for measuring motor index angles compared to earlier control systems. The measured motor index angle value for both the hour angle and declination axes will be approximately 200.

The MKS 6000 requires TheSky Professional version 10.5.0 build 13787 or later. If you have an active subscription, the latest release must be downloaded from www.bisque.com and installed. To do so, click ***My account, Log In*** to log in, then click ***My account, My Downloads.*** If your subscription has expired, you must renew it to access the latest release.

Measuring and Saving the Motor Index Angles

Use TheSky to measure and save the motor-specific motor index angles to the control system's permanent memory. This one-time initialization process is only required after installing a new control system, or after installing a replacement worm block assembly (with a new motor).

1. With the mount turned off, connect the supplied USB cable to the computer.
2. During the index angle measurement process, for a given axis, the MKS 6000 rotates the motor to find the motor index angle, and then reports the value. Note that the motors must be free to rotate, or the process will fail. Before proceeding, double-check the following:

    - Make sure to disengage the locking plungers in both axes on the Paramount MYT and Paramount MX mounts. For the Paramount ME II, be sure to remove the axis locking bolts so that both axes can rotate.
    - For the Paramount MYT, MX, MX+ and ME II mounts, the worm and gear must be disengaged by rotating the mechanical switch in both axes to the balance position.
    - For the Paramount ME and Paramount GT-1100S mounts, only, the motor drive belts must be removed before the motor index angles can be accurately measured.

3. Turn the mount on. The control system uses the factory default motor index angles to initialize the motors, and this may cause the motor initialization to fail. When motor initialization fails, the control system emits continuous audible beeps. Note that even if there are no audible beeps, you should still follow the steps below.
4. Launch TheSky Professional Edition.
5. Click **Telescope**, **Telescope Setup**. Under **Imaging System**, double-click **Mount** and select the name of your original model mount. For example, choose *Paramount ME II* for the *Paramount ME II* mount, not *Paramount ME* or *Paramount ME Series 6*. Click **OK** and **Close** the **Imaging System Setup** window.
6. Click **Telescope, Connect**. When prompted if you want to slew the mount to the home position, click **No** (see Figure 109).

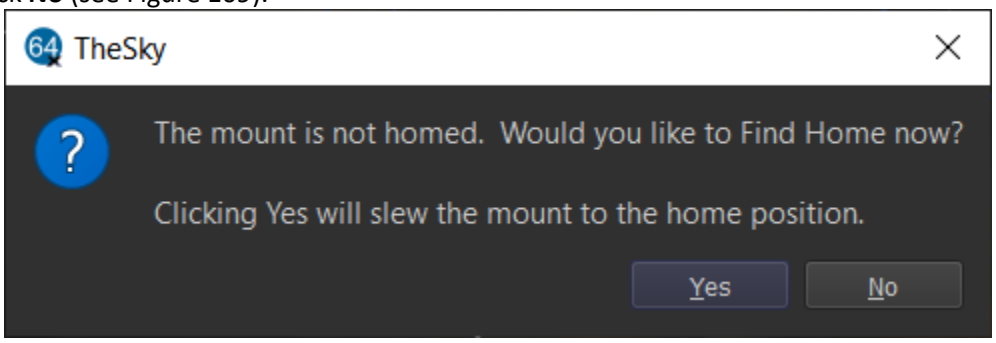


Figure 109: Slewing the mount to the home position is *not* required when measuring the motor index angles.

7. From the ***Telescope*** window, click ***Tools***, ***Bisque TCS***.
8. Click the ***Utilities*** tab and highlight the ***Set Motor Index Angles*** option on the left side of the window. The steps below are highlighted in Figure 111.
    a. Click the ***Reboot To Measure Motor Index Angles*** button and click ***Yes*** when prompted. Rebooting the MKS 6000 takes about 15 seconds or so.
    b. After double-checking that both axes are in the **Balance** position, click the ***Measure HA Index Angle*** button. When prompted, click **Yes** (Figure 112). The HA motor will rotate briefly as the motor index angle is measured, and a window showing the result is displayed.

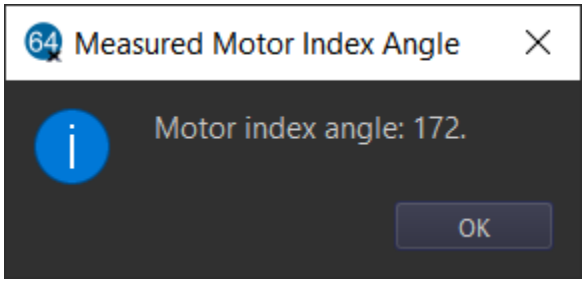


Figure 110: Enter the measured motor index angle into *HA* or *Dec Index Angle* text box.

    c. Enter this number into the ***HA Index Angle*** text box.
    d. Click the ***Measure Dec Index Angle*** button and wait for the result to be displayed.
    e. Enter this number into the ***Dec Index Angle*** text box.
    f. Click the ***Save to Bisque TCS*** button to permanently save these values to the control system.

9. Restart the mount or highlight the ***Reboot/Update Firmware*** option on the left side of the ***Utilities*** tab, then click the ***Reboot Normally*** button.

The motor index angles have now been permanently saved and the mount is ready for normal operation.

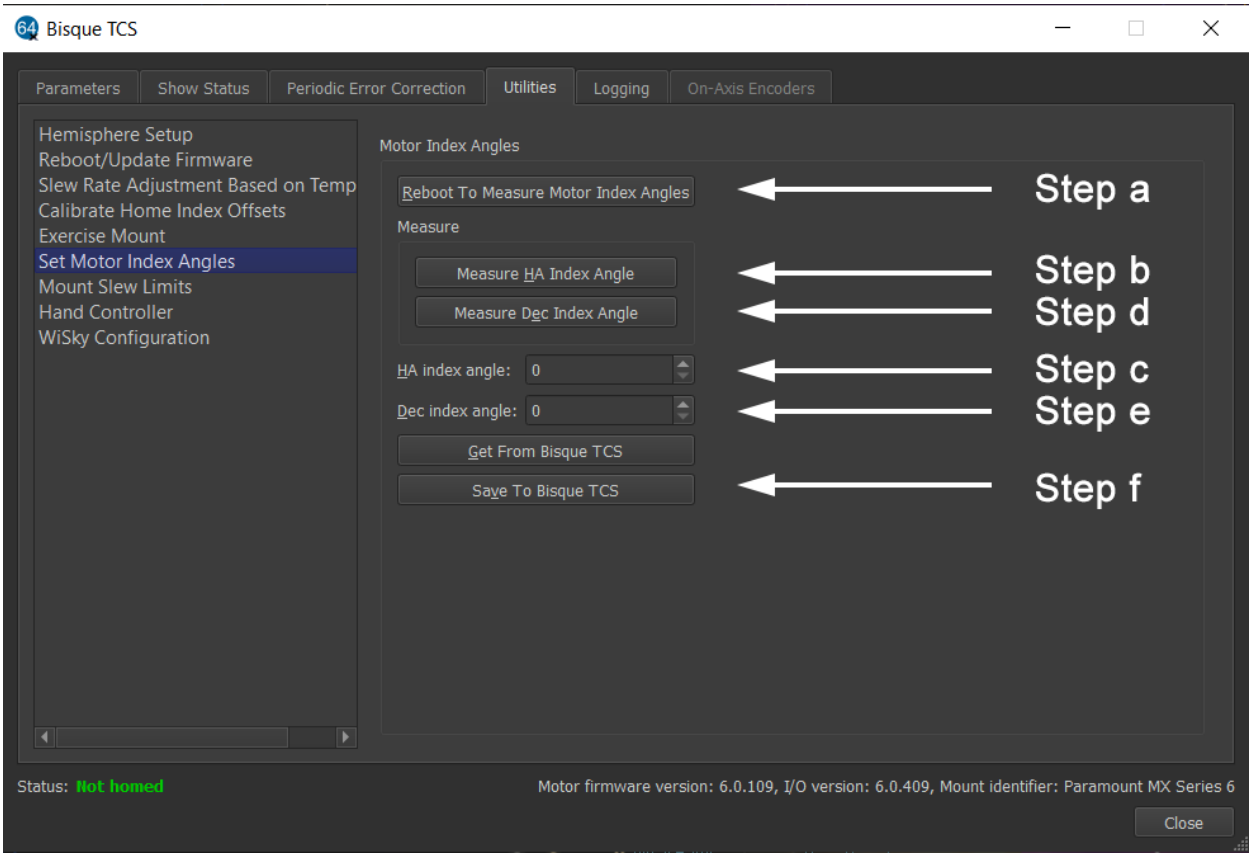


Figure 111: Follow Steps *a-f* to measure and save the motor index angles for both axes.

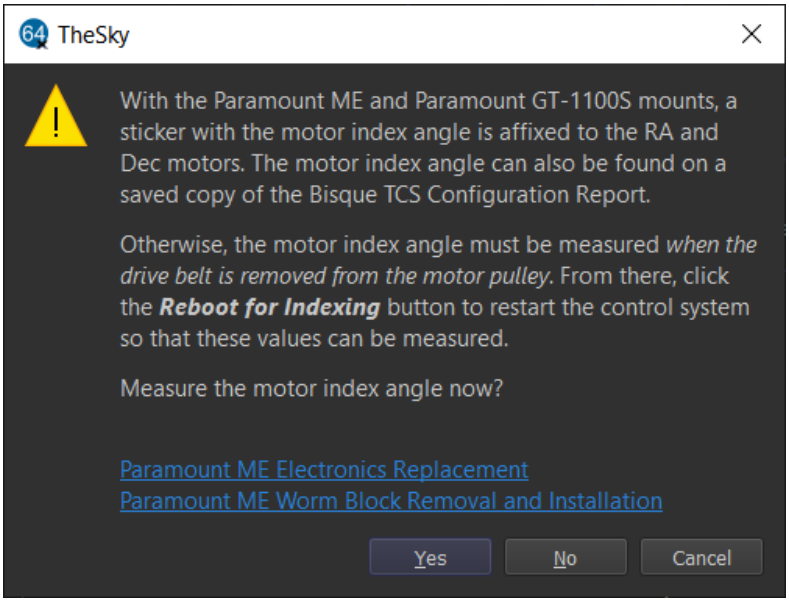


Figure 112: Prompt to measure the motor index angle.

Appendix C: Optional Paramount Accessories

The table below lists optional accessories for each Paramount model.

Optional Accessory	MYT	MX	ME
TheSky Fusion Imaging Appliance	✓	✓	✓
Counterweight Shaft Extension Bar	n/a	8-in. long, 1.5-in. wide	8-in. long, 1.875-in. wide
Counterweights	9 kg/20 lb. and 4.5 kg/10 lb. 1.5-in. bore hole	9 kg/20 lb. and 4.5 kg/10 lb. 1.5-in. bore hole	14 kg/30 lb. and 18 kg/40 lb. 1.875-in. bore hole
Software Bisque Permanent Pier	✓	✓	✓
Power supply cables to use in conjunction with the mount's built-in through the mount power cabling (page 192)	✓	✓	✓
Base to Pier Adaptor Plate for mounting the Paramount to an existing pier	✓	✓	✓
Helium™ Tripod	✓	✓	✓
Latitude Adjustment Wedge for use below 10 degrees and above *about* 64 degrees latitude	n/a	✓	✓
On-axis absolute encoders	✓	✓	✓
Versa-Plate Spacers	✓	n/a	✓
EGO™ Battery to Paramount Power Adaptor	✓	✓	✓
Soft-sided Carrying Case	✓	n/a	n/a
C11 OTA Mounting Rings	✓	✓	✓
C14 OTA Mounting Rings	n/a	✓	✓
Meade 16-inch OTA Mounting Rings	n/a	n/a	✓

Optional Accessory	MYT	MX	ME
Mounting Ring Dovetail Accessory Plate	✓	✓	✓
PoleMaster™ Adapter	✓	✓	n/a

In the table above, n/a means not available.

Optional Databases

TheSky Databases module (https://www.bisque.com/product/theskyx-pro-database-add-on/) offers over 180 GB of additional astronomical catalogs, astronomical data, and photos, including 1.8 billion stars from the Gaia Data Release 3.

Appendix D: Paramount Limited Warranty

Software Bisque warrants to the original owner that the Paramount will be free from defects in mechanical parts and all electrical parts for two years from the date of delivery.

Software Bisque's limited warranty covers only those defects that are the result of normal use and does not apply to any improper or inadequate maintenance or modification or operation outside the product's specifications.

If any component on the Paramount fails for any reason, please submit a post to the appropriate Paramount support forum at: www.bisque.com/support so that a support technician can assist in troubleshooting. Please also include the exact description of the problem as well as the exact wording of any error messages you encountered when connecting to or controlling the mount from TheSky Professional.

If Software Bisque determines a replacement component is necessary, we will email you a Returned Merchandise Authorization (RMA) form. Once this form has been completed and returned, you will be issued an RMA number. When returning items, please clearly print the RMA number on the outside of shipping boxes; shipments received without an RMA number will be rejected.

The following section describes the warranty and non-warranty replacement policy and procedure for the MKS 6000 PCB.

Product Return for Service Procedure

Please visit www.bisque.com/warranty to read the Paramount warranty, and for details how to proceed if you need a replacement component or have a Paramount service request.

Appendix E: User Guide Revision History

The table below describes the changes in each revision of this user guide.

Revision Number	Changes
1.1	• Initial Paramount Model 6 Series User Guide publication.
1.2	• Updated MKS 6000 LED status documentation.
1.3	• Added details on the electronics housing components. • Updated the minimum version of TheSky required to control the Paramount Series 6.
1.4	• Corrected the MKS 6000 firmware update procedure.
1.5	• Updated references to the Paramount MYT hard stop hour angle. • Added a section for mounts with on-axis absolute encoders.
1.6	• Updated the MKS 6000 PSU-compatible connectors documentation.
1.7	• Documented changes based on the I/O firmware version 6.0.506. • Corrected homing position references for the Paramount ME Series 6. • Spelling corrections. • Updated descriptions for the Bisque TCS window Parameters and Status tabs.
1.8	• Added more details about how to connect the MKS 6000 to a computer using Ethernet.

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