WARNING

Viewing the sun without proper equipment can cause permanent blindness.

NGT-12.5

Owner's Manual

JMI Telescopes
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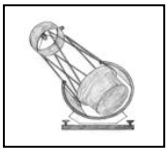
U.S.A.



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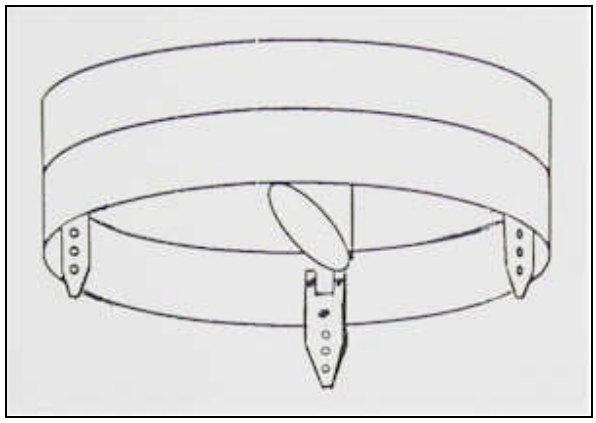
Introduction

The NGT (Next Generation Telescope) is the result of eight years of research and development, representing a radical departure from current trends in commercial telescopes. Rather than follow traditional paths in telescope design, we have explored new territory and adopted new designs whenever they have advanced our goals of precision, stability, portability and ease-of-use. Examples of our innovation include the distinctive split-ring design and our unique adjustable focal point system.

The split-ring design used in the NGT has been implemented in some of the world's largest telescopes, and this design also enables us to provide you with an observatory-quality telescope in an easily transportable package. When disassembled it can even fit in the back of a hatchback import-size car. Its low center-of-gravity offers inherent stability, and the 26" drive ring provides great mechanical advantage for smoother, more efficient operation.

The NGT also features adjustable focal points. Three screw holes in each foot of the nose assembly permit adjustment of the focal point of the telescope relative to the focuser. The placement depends on whether the scope is being used with a camera and off-axis guider, a camera without off-axis guider, a CCD camera or for visual work.



Nose assembly showing adjustable focal-point system

Many of our design innovations require that we not only machine the unique parts, but that we also design unique tooling to create the parts.

We make every effort to ensure that each NGT is built to be the best. We hope that your new telescope gives you many thousands of hours of enjoyment, and that your pleasure in this precision instrument matches the pride we take in our work.

Getting Started

We want you to begin enjoying your NGT as soon as possible, however you should carefully follow the uncrating and assembly instructions. (See the next two chapters.)

Although some owners assemble their NGT once, then seldom—if ever—move it, the NGT is designed to be easily disassembled, transported, and reassembled to let you take advantage of the dark skies away from city lights as well as celestial phenomena not visible from your home base. Once you are familiar with the steps, assembly can take less than ten minutes.

Warning

Sunlight magnified through the NGT can cause instantaneous and permanent blindness, severe burns, and even fire. Keep the dust cover in place and the aperture stop closed when the NGT is not in use.

Collimation

Each NGT is collimated before shipment and should require only minor adjustment from time-to-time. See page 16 for further information on collimation.

Optional Accessories

The following accessories extend the capabilities of your NGT-12.5. They can be ordered at any time, and you will find them easy to install.

Nose Assembly Light Baffle
A slide-on nose extension to prevent stray light from entering the focuser. It also helps slow the advance of dew (recommended for dew plagued sites if no dew removal device is present).

Telrad Adapter Plate
A mounting adapter for a Telrad reflex finder.

Truss Rod Sliding Counterweights
Available in sets of three, these weights slide along the Serrurier truss rods to counter the weight of cameras or additional equipment. One set is included as standard equipment.

Truss Rod Light Shroud
A lightweight, dew resistant, black fabric sleeve to block stray light, dust and air currents.

4" Aperture Stop Added to the Mirror Dust Cover
An aperture stop in the primary mirror dust cover to reduce glare when viewing planets or the moon.

CCD Counterweight
A center counterweight attaching between the normal mirror counterweights to counter the weight of a CCD camera or other heavy equipment.

EZAlign Polar Alignment Scope
After a one-time alignment, this unit simplifies the process of aligning on the celestial pole. The constellation reticle works in both the northern and southern hemispheres.

NGC-microMAX Computer with 245 Object Database
A small, lightweight unit with an eight-character red LED display that provides a real-time display of the telescope's right ascension and Declination. A guide feature assists the user in locating any of the 245 objects in its database, including 90 stars, the entire Messier catalog and 28 user-definable objects.

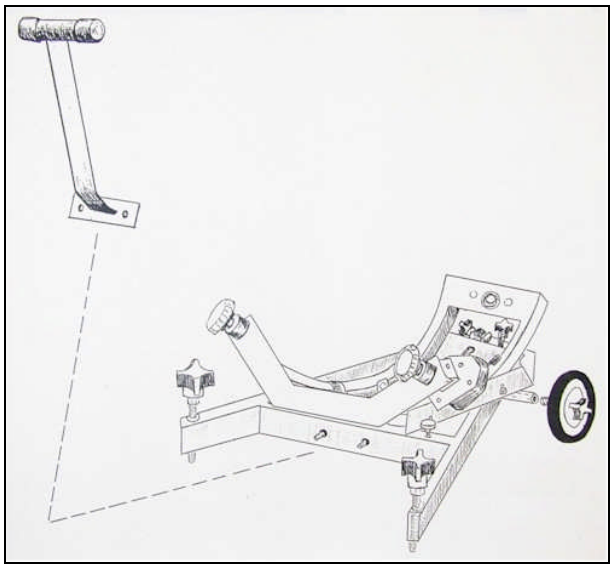
NGC-miniMAX Computer with 3900+ Object Database (Standard Equipment)
This unit is slightly larger than the NGC-microMAX, with a database which adds the brighter NGC and IC objects, the Sun and planets. Though not necessary to its operation, a polar align feature greatly eases the task of polar aligning the telescope. This unit is standard equipment unless ordered with one of the other optional computer units.

NGC-MAX Computer with 12000+ Object Database
This is our top-of-the-line in dedicated setting circle computers. In addition to those objects found in the NGC-miniMAX database, the NGC-MAX database contains nearly a thousand stars, the entire NGC catalog, and most of the IC catalog. An identification feature will search the internal database for the object nearest the telescope's current pointing position, assisting with identification of unfamiliar objects or suggesting possible new targets. A serial port allows a personal computer to obtain information about the telescope's current position—useful for applications such as Software Bisque's THESKY™.

SGT-MAX Desktop Planetarium with NGT Interface
This IBM PC compatible software beautifully represents the night sky on your computer screen, showing the position of the telescope and guiding you to any object. It provides extremely detailed information on each object, shows common names of objects, and allows you to toggle constellation lines on or off. The SGT-MAX plots current planetary positions, can zoom from 235° to one arc-minute fields of view, and is completely mouse-driveable. The software is available in assorted database sizes from 55,000 to over 19,000,000 objects!

Portable 12vDC Battery Pack
A 12vDC 17 amp-hour battery pack for field operation via the standard DC lighter plug.

Handlebar and Wheels
This option enables the fully assembled telescope to be rolled easily over most surfaces.



Observatory Mounting
This hardware option permits the NGT base to be secured to a concrete pad or pier for permanent or semi-permanent mounting.

Specifications

		Weight by Component (lbs)	(kg)
Standard Equipment	Nose assembly	7.5	3.4
	Truss rods (set of six)	4.5	2.0
	Sliding counterweight (ea.)	1.0	0.5
	Mirror and cell	30	13.5
	Primary dust cover:	3.25	1.5
	Ring/Tub assembly	40	18
	Mirror weights (set of three)	16.5	7.5
	Base/Rocker assembly	38	17
	Standard Accessories Box	10	4.5
Optional Equipment	CCD Counterweight	4.0	1.5
	Portable 12vDC Battery Pack	14	6.4
	Handlebar and Wheels	11	5
Power	12 volts DC (direct current)		

The NGT-12.5 may be powered by a portable source, such as the optional power pack or an automobile battery, via a cigarette lighter plug or from AC current via a 12 vDC 1000 mA transformer. The DC lighter plug and DC wall transformer are supplied as standard equipment.

Uncrating the NGT-12.5

Follow the steps below to uncrate the NGT-12.5. It is recommended that you review the instructions completely before beginning with step 1.

1. Remove the cardboard top from the shipping pallet. Remove the truss rods and any larger accessories. (You may wish to save the foam tubing that wraps the individual rods. Cut the tubing shorter and leave it on the rods during normal use to provide insulation—especially desirable on cold nights—and also to protect the finish during transport.)

2. Remove the shrink wrap that holds everything stationary.

3. Remove the two cords that tie the nose assembly to the spring clips on the tub. Remove the packing material then lift the nose assembly out and set it aside.

4. Remove the box of NGT-12.5 accessories.

5. Remove the two cords tying the tub to the handles of the base assembly.

6. Remove the dust cover from the primary mirror.

7. Remove the packing material from inside the tub, including the pieces of foam wedged between the edge of the mirror and the side of the tub. **Do not remove the fine tissue from the mirror at this time.**

8. Remove the packing material from between the bottom of the tub and the split-ring assembly.

9. Remove the protective wrapping of tape from around the three chromed counterweights located underneath the tub. Unscrew the counterweights by turning them counter-clockwise, taking care not to tip the tub too close to vertical, as these counterweights hold the mirror cell in place.

10. Grasp the mirror cell handles and lift the mirror and its cell out of the tub, setting it aside gently.

11. Carefully remove the protective tissue covering the primary mirror. Lift it straight up and off. **Do not drag the tissue across the face of the mirror. Do not touch the mirror.**

12. Remove the cord tied between the split-ring assembly and the latitude adjustment knob on the base assembly. Carefully remove the packing material from between the drive roller bearings and the drive ring. Do not allow the drive ring to drop on the drive roller bearings.

13. Remove the three bolts holding the base frame to the shipping pallet and remove the telescope from the crate.

Shipping Damage

In an effort to reduce in-transit damage, each NGT is shipped with a shock detection device called a Shockwatch™. If the shock indicator has turned red this shows that the crate has been handled more roughly than we like. In that case, make a notation on the delivery document (with the signature of the delivery person if possible) then contact the carrier and JMI directly.

Packing List

Refer to this list as you unpack your NGT-12.5. We recommend that you check off each item as you unpack and ensure that nothing is missing before you begin to assemble your telescope.

If any items appear to be missing, please contact your retailer or Jim's Mobile Incorporated (JMI). The original packaging material may be required to file any claims with the shipper so please do not discard it.

Standard Equipment

- Nose assembly
- Diagonal mirror and holder
- 2-inch NGF-DX2 focuser (see options)
- 2-inch extension tube
- 2-inch to 1.25-inch adapter
- 26mm 1.25-inch Plössl eyepiece
- 8x50 finder scope and mounting bracket
- Piggy-back camera mount and off-axis counterweight
- Three (3) vinyl nose assembly foot covers
- Six (6) Serrurier truss rods
- Four (4) truss rod thumbscrews (one spare)
- Three (3) truss rod sliding counterweights
- Tub/ring assembly
- Primary mirror (unless ordered without)
- Primary mirror dust cover
- 3-point flotation mirror cell
- Three (3) tub/mirror counterweights
- Base/rocker assembly
- Right ascension motor
- Declination motor
- Two (2) optical shaft encoders (4000 tic/rev)
- Dual-axis drive corrector with 12vDC and 110vAC adapters and Hand Unit
- NGC-miniMAX computer with manual (see options)
- Computer mounting bracket
- Encoder cable
- Three (3) leveling screw pads (metal discs)

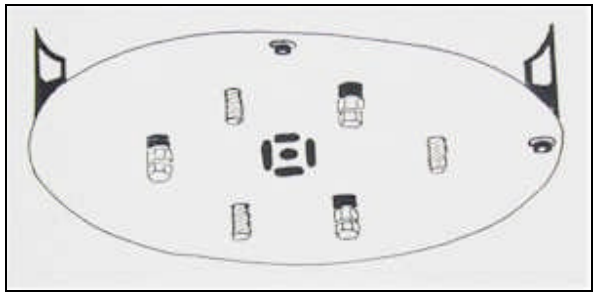
Optional Equipment

- Nose assembly light baffle
- Focuser upgrade
  - NGF-DX2M
  - NGF-DX1
  - NGF-DX1M
  - DRO or DFC option
- Telrad™ adapter plate
- Additional truss rod sliding counterweights
- Truss rod light shroud
- 4" aperture stop added to mirror dust cover
- Center counterweight for CCD Camera or other heavy equipment
- EZAlign polar alignment scope
- NGC-MAX computer upgrade
- SGT-MAX
  - Serial cable
  - Bbox serial interface (unless telescope was ordered with NGC-MAX)
  - TheSky™ software
- 12vDC 17 amp-hour portable battery pack
- Handlebar and Wheels
  - Handlebar
  - Two (2) 6-inch ball-bearing solid rubber wheels
- Observatory mounting hardware

Primary Mirror Installation

When installing the primary mirror, take care to align the studs on the underside of the mirror cell with the corresponding holes in the bottom of the tub. See the mirror cell illustration for help in locating the studs.

If the mirror cell is installed without the alignment studs in proper orientation, the mirror will rest at an angle in the tub, negating the collimation. When aligned properly, the studs are visible in their holes and can be felt underneath the tub. When replacing the three mirror cell counterweights, take special care to tighten them equally. Unequal tension will also affect positioning of the mirror cell and collimation.



Bottom view of mirror cell, showing alignment studs

Assembling the NGT-12.5

Using the following steps, the NGT-12.5 can be easily assembled by one person. However, until you are comfortable with the assembly steps, we recommend that you have another person on hand to help. You can see photos illustrating the assembly and disassembly procedures on our web site at jmitelescopes.com (select Pictures on the NGT-12.5 page in the On-Line Catalog)

1. Remove the primary mirror and cell from the tub (this step may be omitted for two-person setup).

2. Place the base/split-ring/tub assembly on a flat surface in its intended location for use, using the supplied ground pads if necessary. If the base is not level, you may adjust the leveling screws. For tracking purposes, point the command center side of the base toward the equator and the opposite end toward the pole.

   A quick-release feature allows the ring/tub assembly to be removed from the base by unscrewing the knob in the polar axis (at the south bearing) and pulling the ring/tub assembly off the polar axis stud. When replacing the ring/tub assembly, take special care in setting the ring down on the drive rollers. Be sure to detach the proper cables before attempting to remove the ring/tub assembly (see page 12).

3. Place the primary mirror and cell back in the tub, orienting the mirror cell alignment studs over the corresponding holes in the tub. Install the dust cover before continuing.

4. Screw the three counterweights onto the bottom of the mirror cell beneath the tub. Be sure to tighten them equally to assure correct positioning of the mirror cell.

5. Tighten the right ascension and declination tension knobs.

6. Three truss rod clips are located 120° apart around the rim of the tub. Each clip holds two rods. Any two neighboring truss rods located in **adjacent** clips (not the same clip) make up a pair and are joined together at their upper ends. The easiest way to insert the ball ends into the spring clips is by holding the opposing side of the tub with the knee (to keep it from rocking), slightly opening the spring clip, then pressing the rod straight into the clip by pushing down on the top end of the rod.

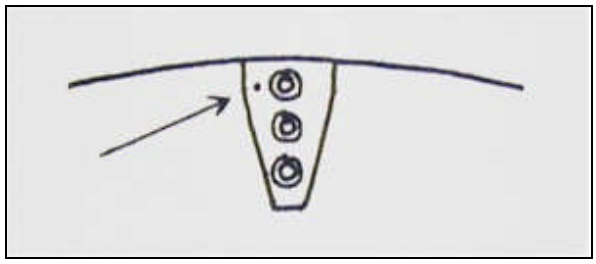
   When ready to disassemble, the ball ends of the truss rods are easily removed by slightly pressing on the spring clips while forcing the rods down toward the center of the tub. Placing a couple of fingers between a pari of rods allows for removal of both at the same time without scratching the paint. Most of the work should be done by leveraging the rods inward against the back of the spring clips rather than prying the spring clips open.

   After inserting a pair of truss rods, align the holes at their upper ends. Next, insert one of the three thumbscrews into the hole by pushing it from the outside toward the center of the telescope. When aligning the upper ends of the rods, note that the flat plastic ends are offset to allow the rods to be properly placed in the same plane—the offsets should be facing each other as shown on the next page. Repeat this procedure for the two remaining truss rod pairs being consistent with right-over-left or left-over-right orientation for all three pairs.

Upper ends of a pair of truss rods

7. Lift the nose assembly into position to permit the truss rod thumbscrews to be threaded into the nose assembly feet. (Use one arm to support the nose assembly from the bottom end, and the other hand to thread the thumbscrews.) Determine which screw-hole level is appropriate to adjust the focal point of the scope (see below). Be sure to secure all three pairs of truss rods at the same screw-hole level.

   For best results one of the three feet has been indexed with a small punch hole. This is the North foot. When attaching the nose assembly, this foot should be placed on the north side for best collimation throughout the rotation of the nose assembly. For the Southern Hemisphere this foot should be on the south side.



Indexed nose assembly foot

Focal Points and Eyepieces

The three screw holes in each foot of the nose assembly permit the nose assembly to be properly placed to adjust the focal point of the telescope relative to the focuser. The upper thumbscrew hole places the focal plane farthest from the diagonal (secondary) mirror, effective for use with a camera with off-axis guider. The middle hole is appropriate for a camera without off-axis guider as well as for visual focus. The lower hole, which places the focal plane closest to the diagonal mirror, is intended for visual work.

The NGT is ready for use with 2-inch eyepieces. A 1.25" adapter, included with the focuser, allows the use of smaller-diameter eyepieces. A 2-inch extension tube is also provided to extend the focuser's travel, if necessary. Note that if you cannot achieve focus with the additional travel, you may need to reposition the height of the nose assembly as described above.

Dual Tangent Arm System

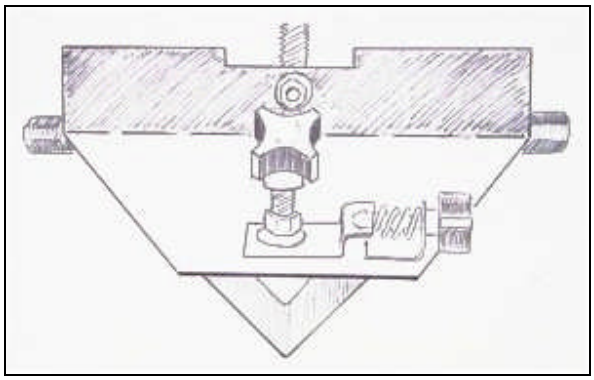
The NGT-12.5 includes declination tangent arms on both sides of the mirror tub. The declination drive tangent arm has a tension-adjusting knob designed for normal adjustments during use. The null tangent arm is for stability only and has no adjusting knob. Its tension is pre-set at the factory and should not be adjusted. **Any further tightening of this tension can cause damage to the declination motor and void the warranty.** If you determine that the null tangent arm needs to be adjusted, use the following procedure. First, loosen the declination drive tangent arm completely. Slightly release the tension on the null arm then tighten it very slowly until you feel only the slightest resistance. That is all that is required for this arm to provide the stability it is designed to give. **Remember, do <u>not</u> over tighten!**

Balancing the Telescope

The NGT-12.5 is designed to be balanced when all the standard accessories are in place. This includes the finder scope, two piggyback camera counterweights, three sliding truss-rod counterweights, the light shroud (or three extra sliding counterweights) and an eyepiece. When using a CCD camera, rotate the upper nose assembly until the camera is above the telescope, drop the sliding counterweights to their lowest position on the truss rods and attach the extra CCD camera counterweight to the bottom of the tub. Remember, a balanced telescope is a happy telescope.

Polar Alignment

For a surprisingly accurate and quick polar alignment, simply place the NGT-12.5 base on the ground and point the latitude adjusting screw at Polaris, or to be more precise, at that point 8/10ths of a degree to the proper side of Polaris where the true polar axis exists. The screw's reflective surface makes it easy to see in the dark. Take a few steps back from the base and further assess the alignment. Continue to adjust the base until you are satisfied that the polar axis is pointing at the pole. With a little practice this procedure can get you within ½ degree or better of polar alignment, in only a few seconds. An azimuth fine adjustment mechanism is provided on the base for small adjustments.



Azimuth fine adjustment

Importance of the MAX Computer "Dec=0" Setting

The first mechanical setting required by guiding computers (in the two-star alignment or GQ mode) is at zero declination. This position is very sensitive. The typical etch mark on the declination bearing is about 0.014" wide. Movements of 0.007" to the left or right of this mark <u>will</u> make a difference in the guiding accuracy. You may wish to experiment with this setting to find the best position. Remember that it will affect the guiding, but not necessarily the "warp" factor. The warp factor is affected more by the distance between the two alignment stars. Remember, <u>all</u> initial alignments are critical for good guiding.

Electrical Connections

The wiring for various electrical and electronic accessories is designed to be simple and straightforward. Your NGT-12.5 is shipped with the encoder and axis drive cables already plugged into their respective components. Refer to wiring descriptions below to learn the function and installation of each cable.

Connecting Auxiliary Devices

All other connections should be made prior to plugging in the power cable.

Right Ascension Motor Cable

This longest cable (30") is run from the Command Center's RA jack, along the frame, and terminates at the motor located next to the drive roller on the base assembly.

Declination Motor Cable

This cable runs from the Command Center's Dec jack, along one yoke arm, terminating at the motor located near the declination tension adjustment knob. Disconnect this cable at the Command Center prior to removing the ring assembly from the base assembly.

Right Ascension Encoder Cable (8192 tics/rev CW)

This shortest cable (9") terminates in a 4-conductor modular phone plug that connects to the right ascension encoder jack, attached to the polar bearing.

Declination Encoder Cable (8192 tics/rev CW)

This cable terminates near the declination bearing which is opposite the declination motor. It utilizes a 4-conductor modular phone plug that connects to the declination encoder jack. Disconnect this cable at the Encoder jack prior to removing the ring assembly from the base assembly.

Power Cable

A cigarette lighter cord is provided to permit connecting the NGT-12.5 to a 12- to 15-volt DC power supply (such as an automobile battery or portable power pack). A wall transformer is also included to provide 12vDC by connecting to a 110vAC/60Hz supply (220vAC/50Hz for appropriate destinations). The power input is reverse-polarity protected.

Optional Battery Pack

Although the batteries are charged at the factory just prior to shipment, we recommend that they be topped off with a one- to two-hour charge before their first use. Because these are lead-acid batteries (and not nickel-cadmium), they do not have a memory effect. While an 8-12 hour charge should be adequate after a single evening's use, 12-24 hours should restore their capacity after they have triggered the low-voltage alarm described on page 14.

If the batteries will not be used for an extended period, they should be recharged approximately every three months. If they are allowed to remain in a discharged state for too great a time (approximately four to six months), they may lose their ability to sustain a charge, and require replacement.

Using the Command Center

The electronics of the Command Center system consist of an open-loop stepper motor arrangement. A crystal-controlled microcontroller monitors and directs all the activities associated with the button and switch input, LED display, stepper motor operation and timing. The user may select any of four tracking rates, and any of six guide/slew rates. A declination backlash correction (TVC) mode is provided. The unit is powered by a source of regulated 12 volts DC, with a peak draw of 800mA.

Tracking Rates
When the unit is powered on, tracking is set for Sidereal operation. The user may press the **RATE** button to advance through the King, Lunar and Solar rates, then back to Sidereal. An internal 12MHz crystal provides accurate timing for each of these tracking rates.

Guide/Slew Rate
The guide/slew rate may be set by pressing the **G/S** button on the Command Center. When powered on, this rate is set to 30% of the tracking rate (.3x). Pressing the **G/S** button will advance through .5x, 2x, 4x, 8x and 16x, then back down to .3x. Both right ascension and declination are affected by this setting. Additionally, the user may immediately enter the 16x slew rate at any time by pressing the opposing slew button while holding down the button of the desired direction. For example, to momentarily jump to 16x in an Eastward direction, hold down the East button on the hand unit, then press the West button. Release the West button to return to the selected guide/slew rate. It is not possible to move in both right ascension and declination simultaneously. A speed of 4x is recommended for autoguider training.

PEC Operation
While the Command Center is equipped with Periodic Error Correction (PEC), the NGT-12.5's direct friction drive eliminates the need for this feature. PEC was designed to compensate for the non-linear tracking of a worm/gear mechanism whose period is typically four to ten minutes. Because the NGT-12.5 design has no such mechanism, and its direct-drive period is approximately 80 minutes, PEC is neither necessary, nor practical. Should you inadvertently enter the PEC mode (the LED to the right of the **PEC** button is flashing or lit continuously), you may exit to normal operation by pressing the **PEC** button once more.

TVC Operation
Declination motor backlash may be removed by using the Time Variable backlash Correction (TVC) feature. This feature allows the user to select the duration for which high-speed stepper motor operation is applied to dramatically reduce the delay which exists when declination movement is reversed. When powered on, the TVC duration is zero (disabled). Pressing the **B/C** button once will light the right-most of the bar LEDs, and the TVC duration will be set to 0.03 seconds. Pressing the **B/C** button again will light the next bar LED, and increase the duration by another 0.03 seconds to 0.06 seconds. Repeatedly pressing this button will advance the lit bar LED to the left (the right-most remains lit as well to aid in interpretation) and increase the TVC duration by 0.03 second increments. Once the duration is set to 0.30 seconds and the left-most bar LED is illuminated, the process will reverse—additional presses will decrease the duration. The duration is again zero when none of the bar LEDs is lit.

If reversing the declination guide direction results in a noticeable delay before the movement is observed, the TVC duration should be increased. If instead there is a brief burst of observable movement which causes the telescope to "overshoot" the object being tracked, the TVC duration should be decreased. When set properly, the TVC duration should be just sufficient to provide a smooth transition when reversing declination movement.

LED Brightness Control
All of the LEDs—those on the Command Center as well as that on the hand unit—may be dimmed from full brightness to completely off by pressing the **DIM** button on the Command Center. With each of the first eight presses of this button, the LEDs will decrease in brightness. On the eighth press, the LEDs will be off, and additional presses will reverse the process by brightening the display toward full.

Low Voltage Sensor
The microcontroller is continually measuring the power supply's voltage to ensure that adequate power is available to operate the tracking motor. If the voltage should drop below approximately 9 volts, the current tracking rate LED will blink from full brightness to off, twice each second. Note that continuing to operate the unit in a low-voltage condition may result in a loss of tracking accuracy, as the right ascension motor could miss step pulses due to insufficient current.

CCD Autoguider
An autoguider (such as the ST-4 from Santa Barbara Instrument Group) can be used to control the Command Center by connecting its relay output to the **HU/CCD** jack. If not provided with your autoguider, a cable suited to this purpose is available from JMI. For simultaneous manual and autoguider correction, a Y-adapter may be purchased from most electronics or telephone supply centers (Radio Shack #279-357).

WARNING: A relay adapter box is needed between the newer autoguiders with a digital interface (e.g. ST-7, ST-8, ST-9, ST-10, PixCel 255 and PixCel 237) and the NGT. It provides complete electrical isolation between the autoguider and the NGT. A relay box can be purchased from SBIG dealers. Failure to use a relay adapter box between an autoguider with digital interface and the NGT will void the warranty. No relay box is needed for the ST-4, ST-5 and ST-6.

If You Suspect Improper Tracking

If you suspect that your NGT is not tracking properly, check the following items.

Polar Alignment—If the telescope is not properly polar-aligned, it will not track properly. See the instruction manual for your computerized setting circles.

Adjusting for Latitude—To adjust the latitude, loosen the four zinc plated rocker clamps on the base and turn the adjustment screw. Since the ring/tub assembly can be easily removed and replaced, it is recommended (and is easier) to remove it before making the adjustment.

Hemisphere DIP Switch—If this internal switch is set incorrectly, the telescope will be driven in the same direction as the Earth's rotation, making the sky appear to drift at twice its actual rate. To change this setting, remove the four screws from the sides of the Command Center, remove the face plate, and find the switch located near the lower left corner of the circuit board (labeled SW8). Use a knife blade or other small instrument to throw the switch to the opposite setting.

Clutch Tension—If clutch tension is too loose, the drive ring may slip rather than be driven by the R. A. motor. Turn the clutch tension adjustment knob clockwise to increase tension and counterclockwise to decrease tension. Set the tension loose enough to permit the telescope to be moved manually, yet tight enough to allow the drive motor to function properly.

"Racking" the Motors—Due to the unique dual-motor design of the right ascension drive system on the NGT-12.5, the two motors can occasionally develop some slack or backlash between them. This will appear as a slight hesitation, after pushing one of the hand unit directional buttons, before the R. A. axis starts moving. The backlash can be removed by using the following procedure. There is a spring-loaded switch protruding from the vinyl cover of the right ascension motor. While holding the switch in the engaged position, run the motor west (or faster) at 16x for about 10 seconds. This should remove all the slack between the motors. If hesitation still exists, repeat the process. We suggest that you rack the motors for a few seconds before every session to eliminate any symptoms.

One way to reduce slack buildup during observing is to loosen the R. A. clutch slightly before manually moving to another position then re-tightening after acquiring the object. If symptoms of backlash begin to appear during an observing session, you can reduce the effects by using the right (west) button on the hand unit to center an object in right ascension. If you need to use the left (east) button, move the object past center and then re-center using the right (west) button.

Grease—Over time, grease can accumulate on the drive roller. Clean the drive ring surface and drive roller with alcohol as necessary to maintain proper friction.

Maintaining the NGT-12.5

The following maintenance routines will preserve the accuracy and reliability of your telescope and help prolong its life.

Cleaning Front-Surface Mirrors

Never wipe a dry mirror with a lens tissue or other material, as this will scratch the surface coating.

Follow these steps to properly clean the NGT mirror and preserve its life. Do not clean the mirror too frequently. If properly handled and protected from dirt, the mirror should require cleaning only once or twice a year. The mirror can be cleaned without removing it from the cell, however the cell should dry completely before it is returned to the telescope.

First, gather the following materials:

- A large box (50 count) of soft, absorbent cotton balls.
  Be sure the cotton is 100% pure (such as Red Cross). Other cottons may contain wood pulp or other foreign matter that will scratch the mirror surface.
- Mild detergent (such as Dawn)
- Distilled water
- Acetone, ethanol or compressed air in a can.
  Observe all cautions and warnings on the labels. Acetone and its vapors are harmful. Rubber gloves are recommended to prevent absorption of acetone through the skin. Acetone is available at most paint or hardware stores. (If acetone is used, remove the central dot prior to cleaning, as the acetone will dissolve the adhesive causing it to run and stain the mirror surface. The dot is required for collimation. Replace it after cleaning.) Ethanol—also known as ethyl alcohol, 200-proof alcohol or drinking alcohol—may be substituted for acetone. **Do not use rubbing alcohol on your mirror surface**, as it adversely reacts to the aluminized surface and can ruin the mirror coating over time. Compressed air can also be used as long as you are careful to keep any propellant from being discharged onto the mirror.
- A tub large enough to allow the mirror to be fully immerse.

Fill the tub with a solution of lukewarm distilled water and mild soap. Rinse the mirror by pouring distilled water, flooding the surface to remove loose dirt and dust—if large particles are not removed they will scratch the mirror during the cleaning process. Next, immerse the mirror in the tub and allow it to soak for 1.5 to 2 hours. Let the liquid do the work as much as possible to minimize contact with the mirror surface. Soaking overnight with pure distilled water will loosen almost any particles and will not hurt the glass or mirror surface.

After the mirror soaks, raise it to within 1cm (1/2-inch) of the water's surface and use the cotton balls to remove any remaining particles. It is best to roll the cotton ball over the mirror's surface—with the leading edge rolling upward—allowing the particles to be lifted away. Replace the cotton ball after one rotation, thus preventing the dirtied cotton from contacting the mirror surface. Do not apply pressure to the cotton—simply allow the weight of the wet cotton to do the work. Clean the entire surface of the mirror in this fashion. You may find it easiest to work from the mirror's center, spiraling outward.

Lift the mirror out of the tub and place it at an angle to drain as you rinse. Rinse with distilled water to remove all soap solution from the mirror surface.

Finally, before the mirror can dry, rinse again with acetone or ethanol or use compressed air to chase the water beads from the surface. Acetone and ethanol will evaporate to leave a pristine surface. (If necessary, remove any remaining water spots by dabbing them lightly with clean, dry Red Cross cotton. Dab, but do not wipe.)

If you have not removed the mirror from the mirror cell, be sure to allow the cell to dry completely before returning it to the telescope. A blow dryer can help speed the drying process. If the secondary mirror is not removed from its cell, position it during the drying process so the fiberfill in the holder can drain and dry—a minimum of 24 hours is recommended. If the fiberfill is not completely dry it can drip, leaving water spots on the primary mirror.

Collimating the NGT-12.5

Collimating is the process of aligning the optical components of the telescope for optimum performance. When a telescope is in need of collimating, you are likely to note that a star in the center of the eyepiece field will not focus precisely and will appear to be non-circular (elliptical or fan-shaped) when the image is out of focus (i.e. showing a larger image).

In a Newtonian reflector such as the NGT, there are three components to align: the eyepiece, the secondary mirror, and the primary mirror. All three must be accurately aligned with respect to each other. Information in this section will enable the NGT owner to align the secondary and primary mirrors of the telescope. The (eyepiece) focuser is permanently set at JMI prior to shipment, and should require no further adjustment.

The NGT is carefully collimated at the factory. Alignment between the focusing assembly and the diagonal (secondary mirror) is set to maintain a high degree of accuracy indefinitely, and rarely requires adjustment unless the focuser and/or diagonal are tampered with or severely jarred. If adjustment does become necessary, it is unlikely that the axial placement or the tilt of the diagonal will require correction.

The First Step in Collimating—Use of the Sight-Tube

A sight-tube with accurate crosshairs is essential to collimation of a Newtonian reflector. Accurate placement of the secondary mirror is the first step in collimating and absolutely crucial to the performance of the NGT. In Newtonian reflectors with fixed focusers, the diagonal (secondary) mirror can be slightly off without dramatically affecting collimation. The NGT's rotating nose assembly, however, requires that diagonal mirror placement be exact to maintain proper collimation—not too high, not too low, with tilt and rotation just right. The sight-tube is used to achieve accurate placement of the secondary.

First, adjust axial placement of the secondary by placing the sight-tube in the focuser and moving it in or out until the outside edge of the secondary mirror is just inside the bottom edge or rim of the sight-tube. The two circular images should be concentric. If the secondary is high or low, loosen the retaining nut and move the secondary axially (toward or away from the primary) until concentricity is achieved.

Next, adjust the rotation of the secondary by rotating left or right until the reflection of the primary mirror as seen in the secondary mirror is perfectly centered left to right. Gently tighten the retaining nut.

Finally, adjust the tilt by loosening one or two of the three screws on top of the secondary mirror cell, and carefully tightening the opposite one or two. (If you loosen one screw, you must tighten two; if you loosen two, you must tighten one.) The goal is to adjust the tilt of the secondary such that the bull's-eye, or target, on the primary mirror appears centered in the crosshairs of the sight-tube. When the secondary is properly adjusted, you will see the following (as described from the outside of the field of view toward the center).

- The rim of the sight-tube.
- The outside edge of the secondary mirror, concentric with the rim of the sight-tube all the way round.
- The reflection of the primary mirror perfectly centered in the secondary.
- The bull's-eye of the primary centered in the crosshairs of the sight-tube.

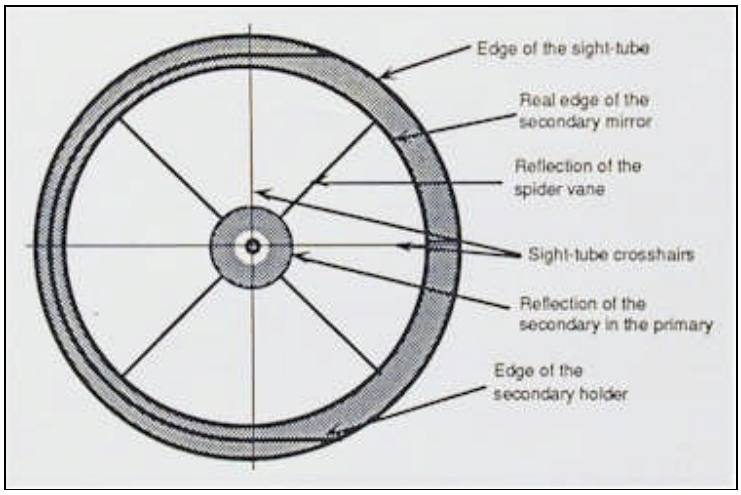


Image visible in the sight-tube

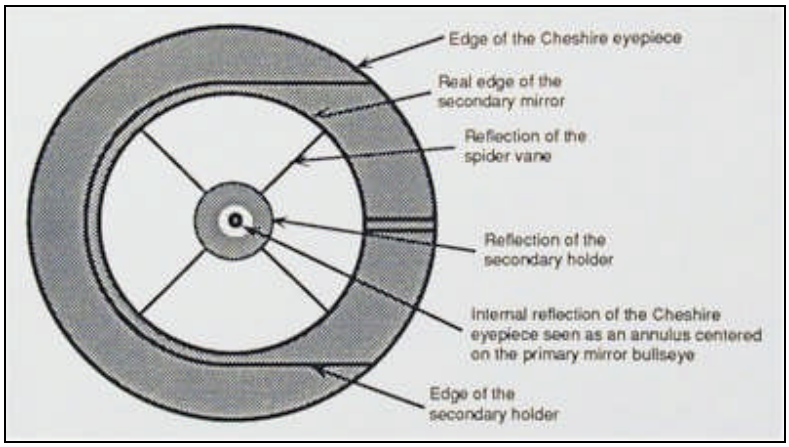
If the view does not match this description and illustration, then repeat the three adjustment steps until the view is correct.

The Second Step in Collimating—Use of the Cheshire Eyepiece

A Cheshire eyepiece is extremely useful for the next step in collimating, although the auto-collimator or star test can accomplish the same thing. Once the secondary mirror is adjusted by means of the sight-tube, insert the Cheshire eyepiece in the focuser. Do not push it all the way: the cutaway in the eyepiece must be exposed to a light source. (A red flashlight works well in the field at night.)

If you look through the eyepiece you will see the following (aside from the bull's-eye on the primary mirror):

- The reflection of the primary mirror in the diagonal.
- A generally dark field.
- A brightly lit annulus, or ring, in the center of the field.
- A dark spot, or bull's-eye, in the center of the annulus.



Detail of the image visible in the Cheshire eyepiece

Your goal is to bring the bull's-eye of the primary mirror into alignment with the central dot imaged by the Cheshire. Accomplish this by using the following steps to adjust the three collimating bolts of the primary mirror cell. Adjust in small increments while rotating the nose assembly and checking the alignment at various positions of the rotation.

First, loosen the jam-nut on each of the three collimating screws to make it possible to turn the collimating bolts. (Tighten the nuts again when collimation is complete.) Begin with the nose assembly at any position and adjust the bull's-eye toward the center of the illuminated annulus. Then rotate the nose assembly 180° and repeat the

adjustment, again moving the bull's-eye toward the center of the annulus. Repeat this rotation until the bull's-eye is similarly placed toward the central dot in both positions and as close to the center as possible. Then, rotate the nose assembly 90° and repeat the above procedure at 180° until you are satisfied that both positions are equally aligned with respect to the central dot of the Cheshire.

Continue to rotate the nose assembly and make adjustments until the bull's-eye of the primary mirror appears within the central dot of the annulus throughout a complete rotation. When you have achieved this, the telescope is collimated. (See the following illustration.)

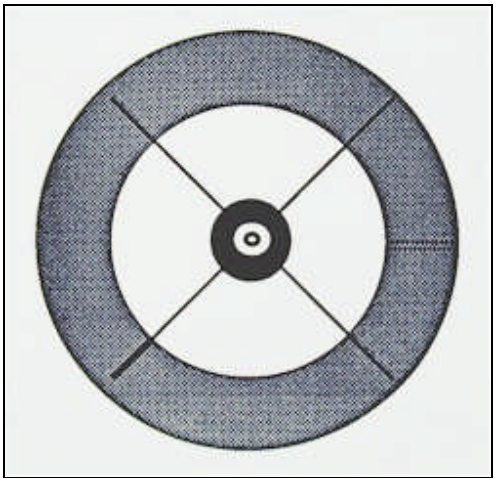


Image visible in Cheshire eyepiece when the system is properly collimated

If, after repeated adjustments you still cannot adjust the primary mirror into collimation, the problem is likely to be misalignment of the secondary. Check the secondary to determine whether it must be raised, lowered, rotated or tilted. While this process may require several repetitions the first few times, you will find that, with practice, you can quickly determine what adjustments to make to the secondary mirror by observing the location of the bull's-eye with respect to the central dot as you rotate the nose assembly. Once you are familiar with the process, fine-tuning the collimation can be accomplished in just a few minutes.

Use of the Auto-Collimator

An auto-collimator eyepiece is available from Tectron, along with three tools and an instruction booklet. By following instructions provided with the auto-collimator, you can make final, ever-so-slight adjustments to the secondary mirror, if necessary. The auto-collimator is not intended, however, for use in making adjustments to the primary mirror. To adjust the primary mirror, follow the steps outlined in the section above—**Use of the Cheshire Eyepiece**.

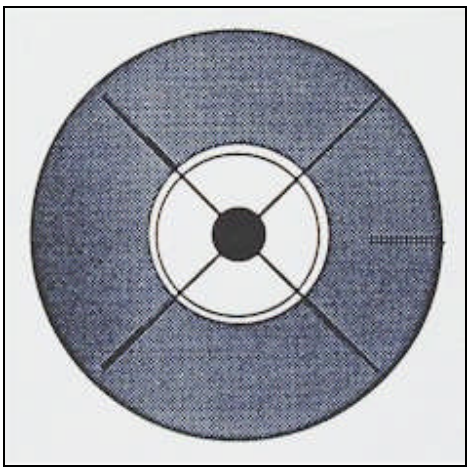


Image seen in the auto-collimator eyepiece when the NGT is properly collimated

Use of the Star Test

You can use the star test procedure to make adjustments to the primary mirror. The following method was suggested by Chris Jones of Essex, England.

1. Use the sight-tube to align the secondary mirror as described above.

2. Rotate the nose assembly until the focuser is vertically above a collimating bolt (this is not essential, but makes the process easier).

3. Loosen the lock nut on each of the collimation bolts.

4. Locate and center a star of about third magnitude in an eyepiece of about 300x. Put the star slightly out of focus to create a larger image.

5. Adjust the image, using the collimating bolts, until a series of concentric, perfectly circular rings is seen.

6. Rotate the nose assembly 180° about the tube. Relocate the star and observe the disk of the star. If necessary, adjust the secondary via the screw nearest the focuser (or **both** of the other two screws) and bring the image to the same set of concentric rings described in step 5.

7. Return to the first position and repeat steps 4 and 5.

8. After several repetitions of steps 4 through 6, the image should be perfectly circular on both sides of the optical axis. Check the image at 90° to the previous locations and, if necessary, adjust the image using the collimation bolts **only**. Repeat steps 4 through 8 as needed.

General Maintenance

Over time, grease can accumulate on the drive roller. Clean the drive ring surface and drive roller with alcohol as necessary to maintain proper friction.

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