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# Gemini G-42 German Equatorial Telescope Mount

User's manual rev. Nov. 2007.

## 1 Main features and parameters

- **Capacity:** approximately 40 kg, depending on tube length.
- **Weight:** 22 kg (without cw. shaft)
- **Power:** 2A@12V or preferably 3A@24V (the values represent the recommended power supply rating, not the actual consumption)
- Wide range of **polar elevation** adjustment (0 - 35, 35 - 57, 45-67 degree latitude)
- Adjustable, stick-free **slip clutches**
- Removable **counterweight shaft** (30.5mm counterweight bore required)
- max 7deg/sec **slewing speed** (with Pulsar and 24V only)
- 200 step, 1Nm, 1,32 Ohm-2A/phase **stepper motors** in both axes
- **single cable** connection from mount to driver
- **PE** of  $\pm 5$  arcseconds (without P.E.C.) , cca 2" total with PEC (Pulsar only)
- **Worm** rotation period 200 sec
- **Elevation** screw pitch/turn: 2mm  $\times$  cos [latitude], radius: 80mm
- **Azimuth** screw pitch/turn: 1,25mm, radius: 60mm
- **Mounting OTAs:** (A) tube rings attached using the existing platform holes (304x85mm spacing), (B) tube rings or other hardware attached to the optional universal adapter plate (you provide fixing holes), (C) optional Losmandy (3" size) adapter fixed to the mount platform.

A precision **drive system** comprising ground steel worms, large 217 mm brass (RA) and anodised aluminium (DEC) gear and microstepped stepper motors are standard. The worms are hardened ground steel (18mm diameter), lapped in RA. Only high grade aluminium alloys, brass and stainless steel are used for the machined parts. The RA and DEC heads are CNC machined from an oversized solid block. 2x2pc tapered roller bearings hold the axes.

## 2 Safe use

Make sure that the power source used is stable! Noisy power will cause malfunctions and may eventually damage the Driver (Pulsar, FS2 or other). Switching Mode (e.g. laptop) power supplies may (but not necessarily do) interfere with the Pulsar driver.

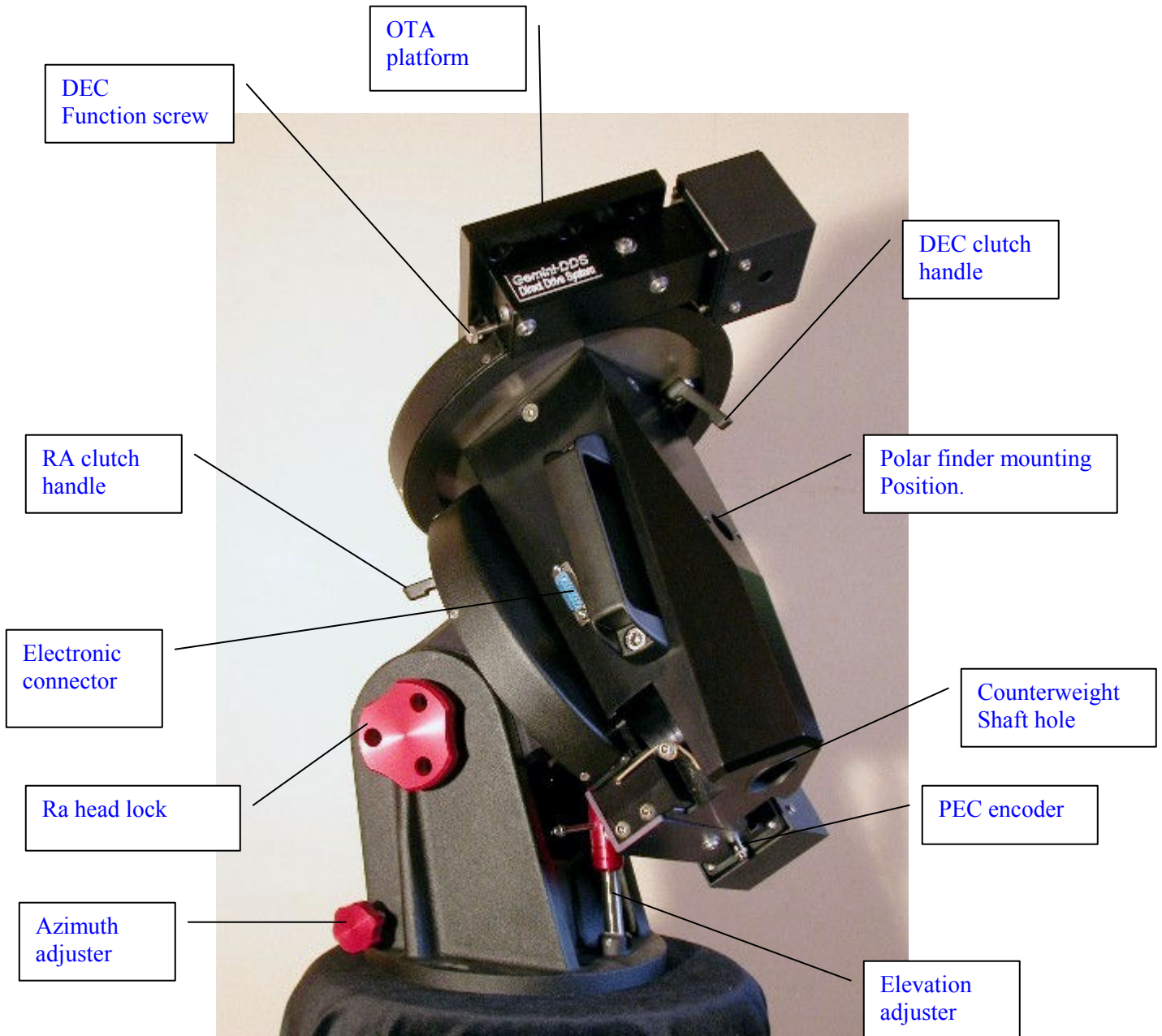
When rotating the telescope, watch the motor cable! It should never be stressed!

Keep the mount away from dust, sand and other kinds of dirt! Protect it from rain!

The mount should NEVER rest on the motors when stored or transported! Use your transport case!

During transport the slip clutches should NOT be locked! The worm may suffer damage otherwise.

### 3 Overview



## 4 Setup

1. Polar align roughly,
  2. Connect the mount to the Driver Unit,
  3. Put the counterweight(s) on (**RA slip clutch released**),
  4. Mount the telescope (**dec motor towards the sky end**),
  5. Release the slip clutches and balance the telescope. (Remember that finders, guidescopes, large focussers may introduce significant unbalanced weight, especially with Newtonians.),
  6. Check and adjust polar alignment (see section 8 and 9),
  7. Adjust the DEC function screw (see section 6),
  8. Check Driver setup! (please read the Quickstart section of the Pulsar manual)
- The mount is ready for use.

### 4.1 Pulsar Controller Setup

Please set the parameters in the *Mount Parameters* menu as follows. For a more complete guide see the Pulsar Manual!

Total reduction RA/DEC 432

Main Gear 432

RA Rotation the correct value is to be found by trial (worm rotates clockwise when viewed from motor end)

TrackCurr 800mA @12V or 1000mA @24V

GoToCur 1200mA (max 1400mA)

Stop Curr 100-300mA (or same as tracking current for autoguiding)

MotFreq 255 for most quiet operation, cca 190 for smoothest tracking

These current settings give low noise and consumption (0,5A @ tracking, 0,9A@ GoTo) If you want to use higher GoTo speeds increase the GoTo current!

### 4.2 Boxdörfer Dynostar Controller Setup

Motor Current: Slow - Dec 0800 - Ra 0800 Fast - Dec 1000 - Ra 1000

Frequency: RA Slow 000.200548 Dec Slow 000.200548

Set Gearing: RA -005.529.600 (if the mount tracks incorrectly please change the sign)

Dec +005.529.600

### 4.3 FS2 Controller Setup

**Note: the FS2 is not a supported driver and while it can drive the mount under most circumstances no responsibility will be accepted for any malfunctioning.**

Please set the parameters in the *Mot1* and *Mot2* menu as follows!

Curr1	0.7 A	F*4	0%
Curr2	1.4 A (maximum)	Offset	0.01
Freq1	20 Hz	Accel	5 or best value
Freq2	0 Hz	Clear	usually 0
Offset	0.02 A	Freq3	40Hz
S/Rev	200	L/R	Left
Gear	432	EncR	none
Wave	micro	EncD	none

Please set *Misc/Teeth* at 432!

**Rate 5**, which will be used for the GoTo function also, depends on the load and the power supply. Try 500 and decrease if the drive fails! The maximum slewing speed depends also on supply voltage. Acceleration (*Accel*) should be slow for heavy loads. For *autoguiding* select rate 1 which should be set below 1 (siderial) to exclude any backlash.

To use any other controller that can drive bipolar stepper motors with at least 1A/phase you can prepare your cable based on the DB15 connector (on the side of the DEC head of the mount) pinout below.

RA	phase1 pins 4,5	phase2 pins 7,8
DEC	phase1 pins 1,2	phase2 pins 9,10

**The illustration below shows a typical physical setup of the mount, tripod and driver. Please note the correct position of the declination motor (toward the sky end of the tube)!**



### **5 Slip Clutch Operation**

(RA. and DEC.)

Turn the handle right to lock, left to release!

Do NOT use excessive force on the locking handle! Lock it gently!

The slip clutch may be adjusted by lifting and turning the handle.

Please remember that the slip clutch is also a **protection feature** that prevents excessive force from acting on the **worm and gear!** When the clutch is too tight and the telescope cannot slip when accidentally bumped, the worm and gear will suffer damage.

## 6 DEC function screw

To obtain the highest precision in autoguiding you can adjust the DEC function screw that acts against the worm tensioning spring. To have no **lost motion** in DEC during guiding:

- 1) center your guidestar,
- 2) start with turning the screw out until it is definitely not acting against the spring. Now turn the screw in about  $\frac{1}{4}$  turn after you feel resistance (when the screw touches the worm bearing) OR watch the guidestar on the computer display while turning the screw in and stop after the star moves a few arcseconds. The second method is more sensitive.
- 3) Now the drive will respond instantly to changes in direction (it is necessary to slightly unbalance the OTA in dec to obtain the best result).

Please note:

1 each time you change the position of the telescope the function screw has to be withdrawn several turns and the above procedure repeated.

2 For visual observing and GoTo the screw should be withdrawn 2-3 turns.

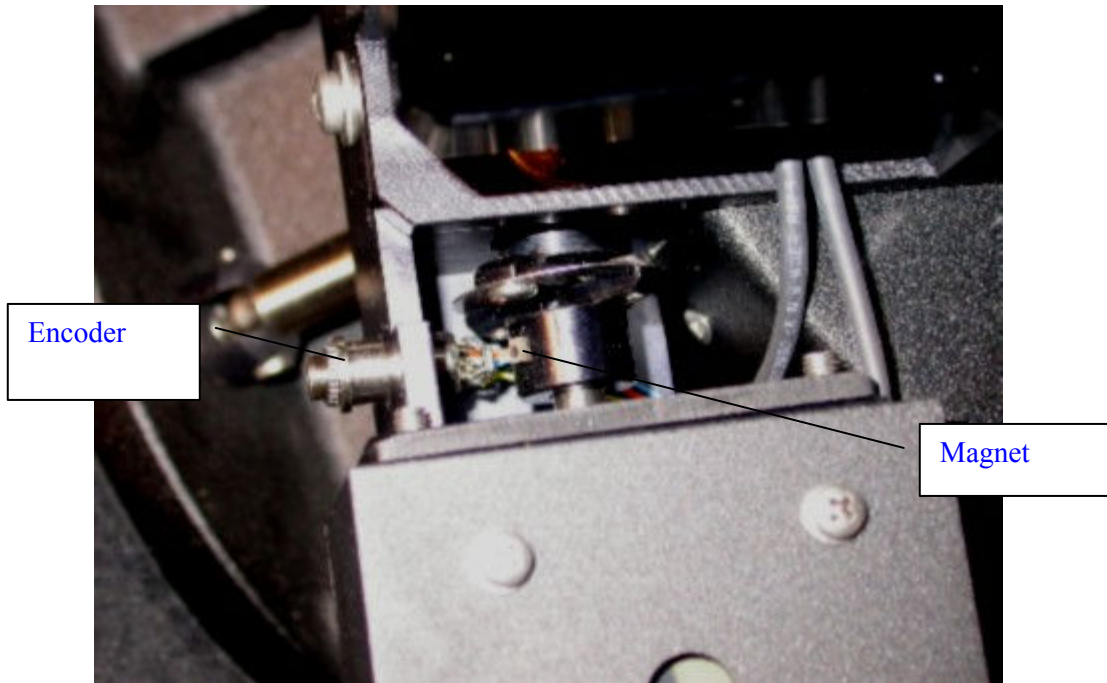
**Explanation:** lost motion is the amount of rotation eaten up by small flexures in a mechanical system. It is not backlash. Backlash is when there is play between two parts.

## 7 PEC operation

The PEC function is available with the Pulsar driver only. The PEC encoder is wired internally to the electronic connector, there is no need to plug any cable in it.

To program PEC use a high magnification crosshair eyepiece (600x-800x) or a CCD autoguider with about 1sec integration time. PEC can also be programmed using PemPro (CCDSOFT). For more details on programming see the Pulsar manual!

Once programmed, the PEC is kept accurate by the encoder, which uses a magnet glued to the RA coupling and an encoder.



## 8 Polar alignment

Elevation can be adjusted after slightly releasing the two handknobs (one on either side) locking the polar or RA head. The elevation of the polar shaft can be adjusted by the right/left handed screw mechanism. To adjust azimuth the central (on pier or tripod) locking screw (and the lateral ones when fitted) must be slightly released

Tip: Adjust slightly above the pole and fine adjust after loading OTA and counterweight! Lock the hand knobs firmly. Do not use tools other than your hands on the handknob!

There are three elevation ranges of the mount. The difference is in the length of the longer (right hand) screw. **Attention:** the (lower) elevation screw safety mark indicates 8mm safety margin! Turning it more out risks failure of the support mechanism and a serious injury.

Standard: 35 – 54 degrees latitude (shipped unless specified otherwise).

Low: 0 – 35 degrees latitude.

High: 45 – 67 degrees latitude.

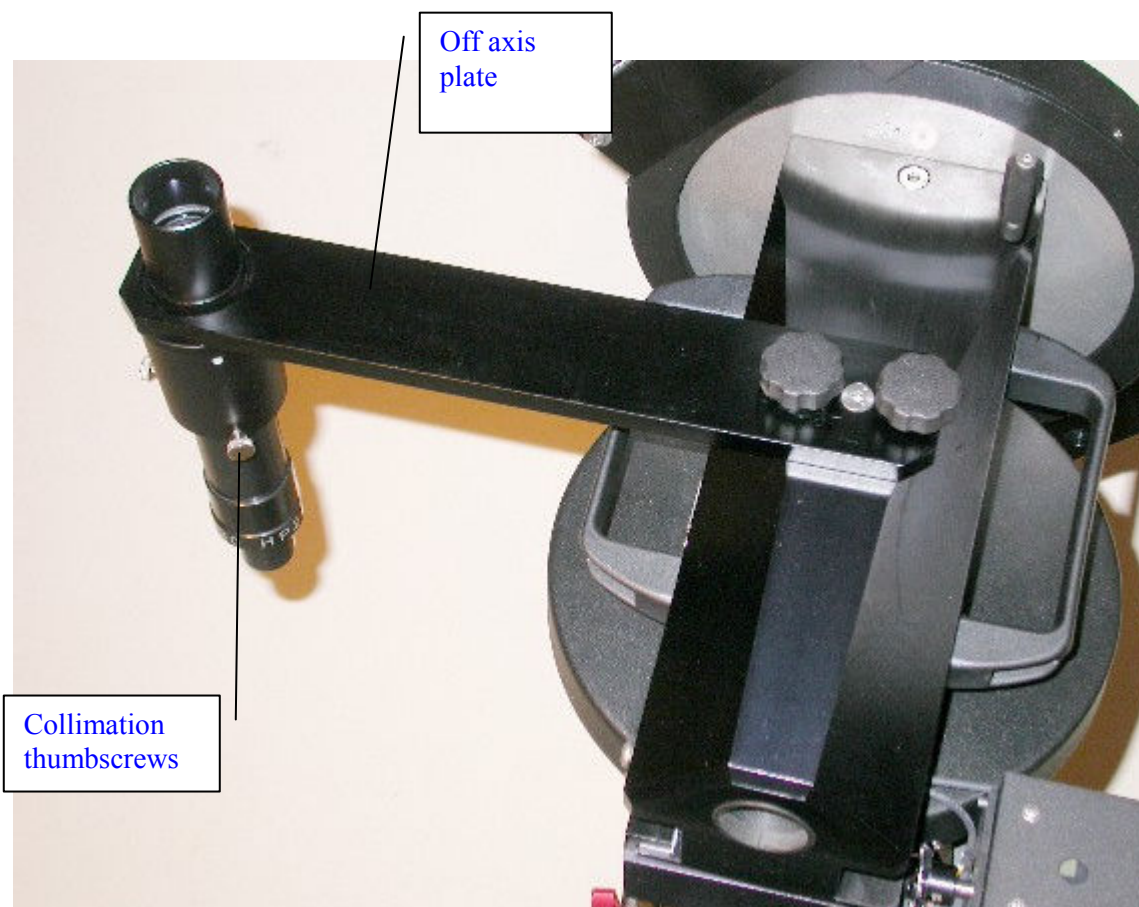
To make a drift alignment use the screw pitch values given in the first paragraph!

To use the mount in the Low range, the RA head must be reversed in the base!

The elevation scale will not work in this position unless the mount was ordered for low elevation originally.

## 9 Polar Scope (optional)

The G-42 can be equipped with an optional high precision, bright field **Polar scope**. This 12x30 finder uses a 20mm Plössl eyepiece and offers a smaller than usual field but provides better precision than most other models. The **large objective** permits seeing faint stars that make the alignment very accurate. The first time the mount is used the Polar scope should be collimated with the Hour Axis using the 3 small thumbscrews (M4) in its adapter.

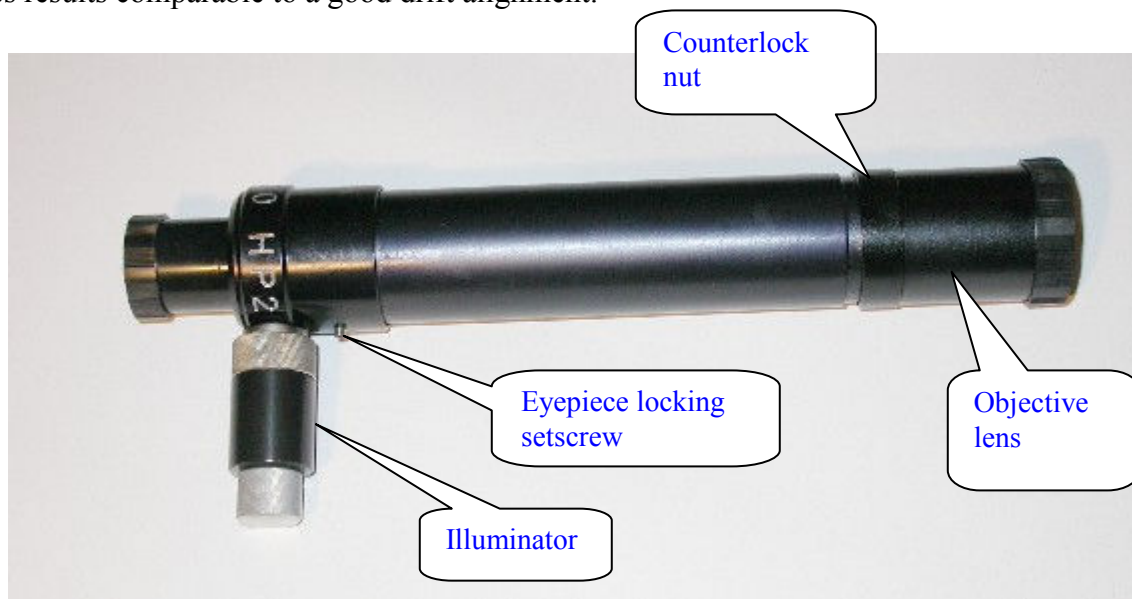


The 3 allen screws (1 spring loaded) hold the polar scope centered in the adapter, the 3 thumbscrews are for collimation.

The 2 handknobs of the off axis plate should be turned a small amount at a time, one after the other to avoid seizing of the positioning pin.

## 9.1 Getting to know your Polar Scope

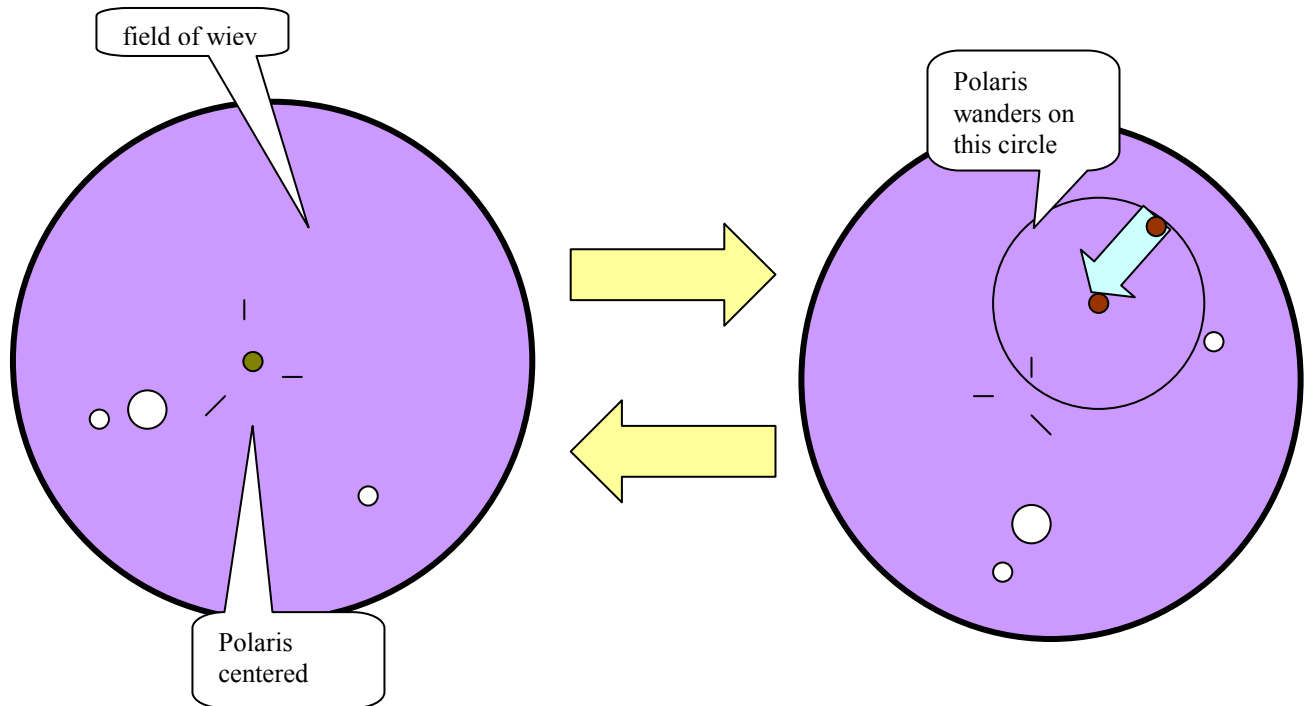
To take advantage of the GoTo function of a transportable mount, Gemini have developed a high precision Polar Scope (HP2). Compared to the previous model it has better eye relief and two concentric circles in the center to make the collimation easier. When used with care this product gives results comparable to a good drift alignment.



**To focus the reticle** remove the eyepiece and rotate the threaded ring that holds the reticle glass. but mark the position first with a piece of tape! You must put it back exactly where it was, otherwise the stars (Polaris and the two companions) will not match the circles on the reticle.

**To focus the polar scope** release the counterlock nut and rotate the objective lens!

## 9.2 Collimating the Polar Scope



0. Sight Polaris through the Hour Axis bore! Attach the Polar Scope with the off-axis plate!
1. Center Polaris and focus the polar scope (by rotating the objective lens)! Use the **elevation and azimuth controls** only! (see fig. above, left) Fix the objective lens (counternut). Rotate the Hour Axis cca.180 degrees! Stop where Polaris goes farthest from the center!
2. Move Polaris halfway towards the center as shown (above, right)! Use only the **Polar Scope collimation thumbscrews** now!
3. Repeat from 1 (except focusing) until Polaris stays in the center when the Hour axis is rotated 180 degrees! Until now you have been collimating the Polar Scope.
  
- 5 **Rotate and adjust** (in Az and Elev.) the Hour Axis until Polaris is in the large circle and the two fainter stars around are in the smaller circles. Pay particular attention to the correct position of the far-off-the pole star!

**Note:** you can go through steps 1-4 in daytime using a terrestrial object a few hundred meters away. Do NOT remove or rotate the polar finder's eyepiece after the alignment was done! You will lose collimation. If the polar finder is stored carefully it will keep good collimation for a long period. In this case you need to repeat step 5 only during the next setup. There is small video file to help you with the collimation/alignment downloadable from the G42 site.

## 10 Notes on the pointing accuracy of the mount

The pointing accuracy with a given setup is ensured by paying attention to the following:

1. **Polar alignment** The final alignment must be made with the telescope on the mount. Otherwise mechanical effects will jeopardise accuracy. Polar finders without a collimation feature will not give good results.

2. **OTA optical axis** (not mechanical) **perpendicular to the Declination axis**

It is not always enough to use two identical tube rings. With reflecting and catadioptric telescopes you should always make sure that the orthogonality is correct. After collimation of the optics it will be necessary to repeat the test.

### To check the orthogonality do the following:

- 1 Collimate your polar scope as described above!
- 2 Center Polaris in the field!
- 3 Align the telescope parallel with the Hour axis (should point to the Pole, or 90deg DEC)!
- 4 When you swing the tube in RA, Polaris should cross in the center of the field! If not, adjust the tube on the platform! (put spacers under one end)

The DEC head of the G42 is milled from a solid block of aluminium on a CNC machine and the axes are perpendicular to each other within a few arcminutes. In practice most of the GoTo pointing error comes from the optical axis misalignment. Inaccurate coordinate databases are also to blame sometimes. Rotating a diagonal mirror after a GoTo for comfortable viewing can also push the object off center.

**Alternative method** (without touching the polar alignment)

- 1 Center a bright star near the Meridian and preferably between 40-60 deg DEC!
- 2 Now slew to the North until you cross the Pole, then start to slew in RA towards the Meridian (yes, about 12h in RA)!
- 3 when you are close to the target make a GoTo to the same star or slew manually to the coordinates noted before so that the OTA is on the other side of the meridian! (Steps 2, 3 can be done by activating a meridian flip with the Pulsar controller. Read the relevant section of the Pulsar manual before proceeding!)
- 4 Ideally the star should be in the center of the field again (no star diagonals please!). If it is not, correct **half** of the error **in RA** with spacers under the tube rings/adapter plate!

**Note:** it is important to have a good polar alignment when doing this test.

## 11 Gemini GHS 140 MkII tripod



This tripod was designed using my experience with several traditional models (pier with legs at the bottom, surveyor's type tripod, SC field tripods, etc.). The most common problems of these designs are: backlash at leg junctions, weak legs, small resistance to torsion, difficult setup, interference with long OTAs. To overcome all these shortcomings I have developed the GHS (Gemini High Stability) design which does not save on material where there is need for it (the legs and the column have 5mm wall) but is still easily transportable (15.5kg). This design uses the weight you put on it to stabilize itself due to a favorable geometry. It is constructed out of

aluminium and stainless steel and resists the test of time (I have left an example outside for 2 years and had to change the rubber grommets only, which are not UV resistant).

The tripod is in folded position for transport and the 3 collar handles are removed. Before first use screw them in place (use the supplied washers)! Release all handles (2 black, 1 red) at the collar and 3 black handknobs at the limiters! The **collar** on the **column** and the legs are free now. To adjust height slide the column in the collar! To do so grab and fix one leg between your thighs!

To compensate ground slope adjust leg angle and/or length one by one!  
Put the mount on the head so that the azimuth adjusters meet the azimuth pin!  
Rotate the Qlock handknob to the right until the central screw holds the mount firmly!

The red handle has double function: locks the collar on the column and a leg also. **Do not release the red handle when the mount is on the tripod!**



The limiters stabilize the tripod. Release 1/2 turn for adjustment and lock for use!





**The above photos illustrate the high (left) and low position of the GHS 140 tripod.**

## **12 Troubleshooting**

*Drive does not start.*

Incorrect polarity,\* insufficient current, \* unstable/noisy power, \*broken power cable, \* electronic transient, \* fuse blown .

*Motors vibrate and do not turn the telescope.*

Large unbalanced mass. Rebalance the telescope! \* Motor cables broken. Repair or replace!  
Cable connector became loose at mount or driver end. \* Incorrect cable pinout.

*Motors run but do not turn the telescope.*

Motor/worm coupling became loose. Tighten setscrews!

*No PEC encoder signal arrives.*

Magnet missing. Encoder broken. (The signal can be observed at tracking speed only.)

## **13 Options**

### 13.1 RA head lock

The mounts ordered with the GHS tripod are shipped with the handknob shown in the overview section. The mounts ordered for permanent setup are shipped with an M10 allen head screw. This version allows more overhang after the meridian has been crossed.



### 13.2 Colour

Black mount with red handknobs and elevation adjuster.

Red mount with red handknobs and elevation adjuster.

Natural (silver) mount with red handknobs and elevation adjuster.

Blue mount with red handknobs and elevation adjuster.

The base, gear covers, worm blocks and platform are always black.

## 14 Maintenance

Anodised aluminium surfaces must be protected from the UV radiation by silicone or paraffin oil a few times a year, or when dry. Use a soft cloth to apply the oil to the surface!

Apply silicone oil (aerosole) to the rubber grommets of the tripod regularly! Avoid prolonged exposure to direct sunlight!

### Acknowledgements

Special thanks to Dr. Dietmar Hager, Eiji Mori and Maarten Vanleenhove for their valuable advice on the details of this manual.