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ASTRO PHYSICS

State-of-the-Art Astronomical Instruments for Discriminating Astronomers

900GTO German Equatorial with GTOCP3 Servo Motor Drive

For Mounts Shipped Starting in May, 2008
Beginning with Serial Number 900706

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900GTO GERMAN EQUATORIAL WITH GTOCP3 SERVO MOTOR DRIVE

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PLEASE RECORD THE FOLLOWING INFORMATION FOR FUTURE REFERENCE

MOUNT SERIAL NUMBER: _____

KEYPAD SERIAL NUMBER: _____

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PURCHASE DATE: _____

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900GTO GERMAN EQUATORIAL WITH GTOCP3 SERVO MOTOR DRIVE

MODEL 900GTO PARTS LIST

1 Polar axis assembly (right ascension-R.A.) with GTO Control Box (Model GTOCP3)
1 Declination (Dec.) axis assembly
1 14" Stainless counterweight shaft (1.875" dia.) with machined, black-anodized, safety stop
1 Y cable – R.A. portion is 15.25" long and Dec portion is 40.25" long
1 D.C. power cord (cigarette lighter adapter on one end) - 8' long
1 GTO Keypad controller with 15' coiled cable and Instruction Manual
1 *PEMPro*™ v.2 – Full Version - Periodic Error Management software for Astro-Physics mounts (CD-ROM)
1 *PulseGuide*™ by Sirius Imaging – remote control utility for improved guiding (CD-ROM)
1 Hex key set
2 8-32 Thumbscrews (substitute for set screws to allow quick disconnect of GTO control box)

In order to assemble your mount fully, you will need the following items sold separately:

- Telescope mounting plate – many choices to fit your telescope and observing needs.
- 20° to 68° latitude: choose either the Standard Pier Adapter (900SPA) or the Precision Adjust Rotating Pier Adapter with Azimuth Bearing (900RPA). Either adapter will come with six 5/16 – 18 X 5/8" button head screws for attachment to the pier, four pier knobs for attaching the mount to the adapter, and the azimuth block for use with the Heavy Duty Azimuth Adjuster found on all 900GTO mounts produced after August, 2005 and available as an upgrade for earlier mounts.
- Tropical or extreme polar latitudes (0° to 20° or 68° to 88° North or South): choose the Hi-Lo Latitude Wedge Pier Adapter Assembly (900WDGA) Also – see below.
- 8" O.D. pier – Astro-Physics has several heights and styles to choose from.
- Counterweights – 5 lb. (5SCWT), 10 lb. (10SCWT) and 18 lb. (18SCWT) are available.
- Power supply. We offer 2 power converters (PS138V5A) and (PS15V10A) for converting household current to suitable DC current for your mount. Rechargeable 12 volt battery packs and deep cycle marine batteries are also available from other vendors.

Many of these items will be discussed throughout these instructions. Several additional options are available:

- Polar Alignment Scope with Illuminator (PASILL4) – for quick and easy polar alignment
- Pier accessory trays (TRAY08) and (TRAY08H) for 8" pier and support bars (TRAYSB) or (TRAYSB1) - handy to keep your eyepieces and other accessories close at hand!
- Longer counterweight shaft (M12601-C) – 19.5" (18.5" usable) stainless steel shaft
- 9" counterweight shaft extension (M12675)
- Hi-Lo Latitude Wedge (900WDG) – for those who already own one of our other adapters - allows use from tropical or polar latitudes: (+/- 0° to 20° or +/- 68° to 88°). Use the knobs & washers, azimuth adjuster block and center pivot screw from the other adapter. Complete Wedge Assembly is part # (900WDGA).
- 900 Flat Surface Adapter (900FSA) – for attaching one of our pier adapters to your own custom pier or tripod.
- Losmandy Tripod Adapter (LT2APM) – for attaching 900GTO to Losmandy Heavy Duty Tripod or Losmandy MA Meade Field Tripod Adapter.
- Santa Barbara Instrument Group CCD Imaging cameras, STV, ST-4 Autoguider or other imaging camera- if you plan to pursue CCD imaging or astrophotography

For a complete listing of our 900GTO accessories, visit our website – www.astro-physics.com

Note on Encoders: Mounted encoders can no longer be used with the 900GTO (for mounts shipped starting in October, 2005 – beginning serial number 900451) because of the R.A. shaft re-design. They are not needed since the go-to functions of the mount are so much more accurate. The encoder that is built into the servo motor itself has a resolution of 0.05 arc seconds vs. 324 arc seconds for mounted encoders.

FEATURES AND SPECIFICATIONS

R.A. worm wheel:	7.2”, (18.3 cm) 225 tooth aluminum
Dec. worm wheel:	6”, (15.2 cm) 225 tooth aluminum
Worm gear:	Brass
R.A. shaft:	2.2”, (5.6 cm) diameter
R.A. thrust surface:	7.0”, (17.8 cm) diameter
Dec. shaft:	1.75”, (4.4 cm) diameter
Dec. thrust surface:	6.0”, (15.2 cm) diameter
Counterweight shaft:	14”, (35.6 cm) overall, 13”, (33.0 cm) useable length, 1.875”, (4.8 cm) diameter, stainless steel, removable
Latitude range:	20 to 68 degrees with or without polar scope attached. You can achieve higher or lower latitudes with our Hi-Lo Latitude Wedge Assembly (900WDGA) or Hi-Lo Latitude Wedge (900WDG)
Azimuth adjustment:	Approximately 15 degrees
Setting circles:	Porter Slip Ring design, engraved
Right ascension:	4-minute increments, pointer, engraved both north and south
Declination:	1-degree increments, pointer
Motors:	Zero-cogging servo motors
Power Consumption:	0.4 amps at the sidereal rate
	2 amps both motors slewing
Power requirements:	12 VDC, range 11.5 to 16
Weight of mount:	Total -54 lbs. (24.5 kg)
	Dec axis - 17 lbs. (7.7 kg)
	R.A axis - 26.5 lbs. (12.0 kg)
	Counterweight shaft with safety stop -10.5 lbs. (4.8 kg)
Capacity of Mount:	Approximately 70 lbs. (31.8kg) - telescope and accessories (not including counterweights), depending on length. Will accommodate Astro-Physics and similar refractors up to 180mm f9, 12" Cassegrains, 12-14" Ritchey-Chretiens. These are only guidelines. Some telescopes are long for their weight or very heavy for their size and will require a larger mount. Note: As weight of scope and accessories increases, proper balancing becomes more critical. See section on balancing for more information.

INTRODUCTION

The 900GTO German equatorial was designed to meet the needs of the advanced observer who requires a mount with maximum strength and rigidity and minimum weight. The excess material in both axes has been carved out while retaining a heavily ribbed structure for internal strength and rigidity. A unique dovetail was machined into the mating surfaces of the R.A. and Dec axes. This feature allows quick and easy assembly in the field without any tools.

The DC servo motor drive with GTO computer system, the keypad with its digital display screen, and the included PulseGuide™ and PEMPro™ v.2 software all combine to offer extraordinary sophistication for today's observer. Whether you enjoy visual astronomy exclusively or plan an aggressive astrophotography or CCD imaging program, this mount will allow you to maximize your night out under the stars.

The advanced keypad features allow you to slew automatically to objects in a wide range of databases as well as any R.A./Dec coordinate. A large selection of common names for stars and other objects makes your selection a snap. The rapid slew rate of 5 degrees per second (1200x) allows you to locate objects very quickly and accurately. You will be very pleased with the intuitive operation of this keypad. There are no complicated sequences of keystrokes to remember. It is so easy to use that even if you don't use it for a few months, you will feel at home with the keypad very quickly.

PulseGuide™ is a stand-alone Windows (98, ME, 2000, NT4, XP, Vista) utility that provides complete remote control of all Astro-Physics GTO mounts. It derives its name from its most distinctive feature, pulse guiding, which can improve unguided tracking. Specifically, it can help correct tracking errors caused by polar misalignment and atmospheric refraction. You can also train PulseGuide™ to track objects moving relative to the stars, such as asteroids, comets, and the moon. In addition to pulse guiding, PulseGuide™ also has many useful utility features. PulseGuide™ was written by Ray Gralak of Sirius-Imaging. Please refer to his website *http://www.pulseguide.com* for further developments and enhancements.

PEMPro™ (Periodic Error Management Professional) is a Windows software application that makes it easy to characterize and reduce periodic error. PEMPro™ will analyze the performance of any mount that is equipped with a CCD camera and compatible camera control software. PEMPro™ gives you powerful tools to program your mount's periodic error correction firmware to achieve the best possible performance for your mount. PEMPro™ dramatically improves guided and unguided imaging resulting in better images and fewer lost exposures. PEMPro™ v.2 Full Version also adds a Polar Alignment Wizard and a video interface for using many webcams. PEMPro™ v. 2 Full Version began shipping with 900GTO mounts in May, 2008.

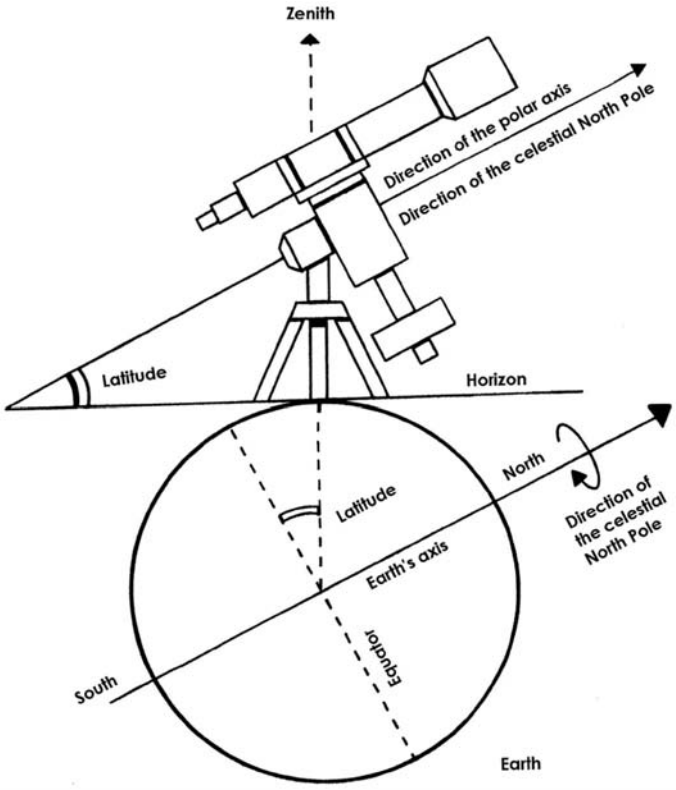
The periodic error of your 900GTO will be 7 arc seconds or less (before correction). We have already loaded the PEMPro curve that was generated during your mount's testing into the servo to reduce the error even further, and to give you a head start right out of the box. See additional information under "Servo Motor Drive."

The 900 is equally at home in a permanent observatory or as a portable mounting for remote star parties thanks to the ease with which the two axes come apart. This is the perfect mount for a mid-size refractor, Newtonian, Cassegrain or astrograph.

In order to maximize your pleasure on your first night out, we recommend that you familiarize yourself with the assembly and basic operation of the mount indoors. The temperature will be comfortable, the mosquitoes at bay, and you'll have enough light to see the illustrations and read the manual. Please take particular note of counter-balancing, use of the clutches and operation of the keypad controller.

Why Polar Alignment is Important

Polar alignment compensates for the Earth's rotation. If you were to take a long exposure photograph with Polaris (often called the North Star) in the center of the field, you would discover that all stars seem to revolve around Polaris. This effect is due to the rotation of the earth on its axis. Motor driven equatorial mounts were designed to compensate for the earth's rotation by moving the telescope at the same rate and opposite to the earth's rotation. When the polar axis of the telescope is pointed at the celestial pole (polar aligned) as shown in the diagram, the mount will follow (track) the motions of the sun, moon, planets and stars. As a result, the object that you are observing will appear motionless as you observe through the eyepiece or take astrophotos.



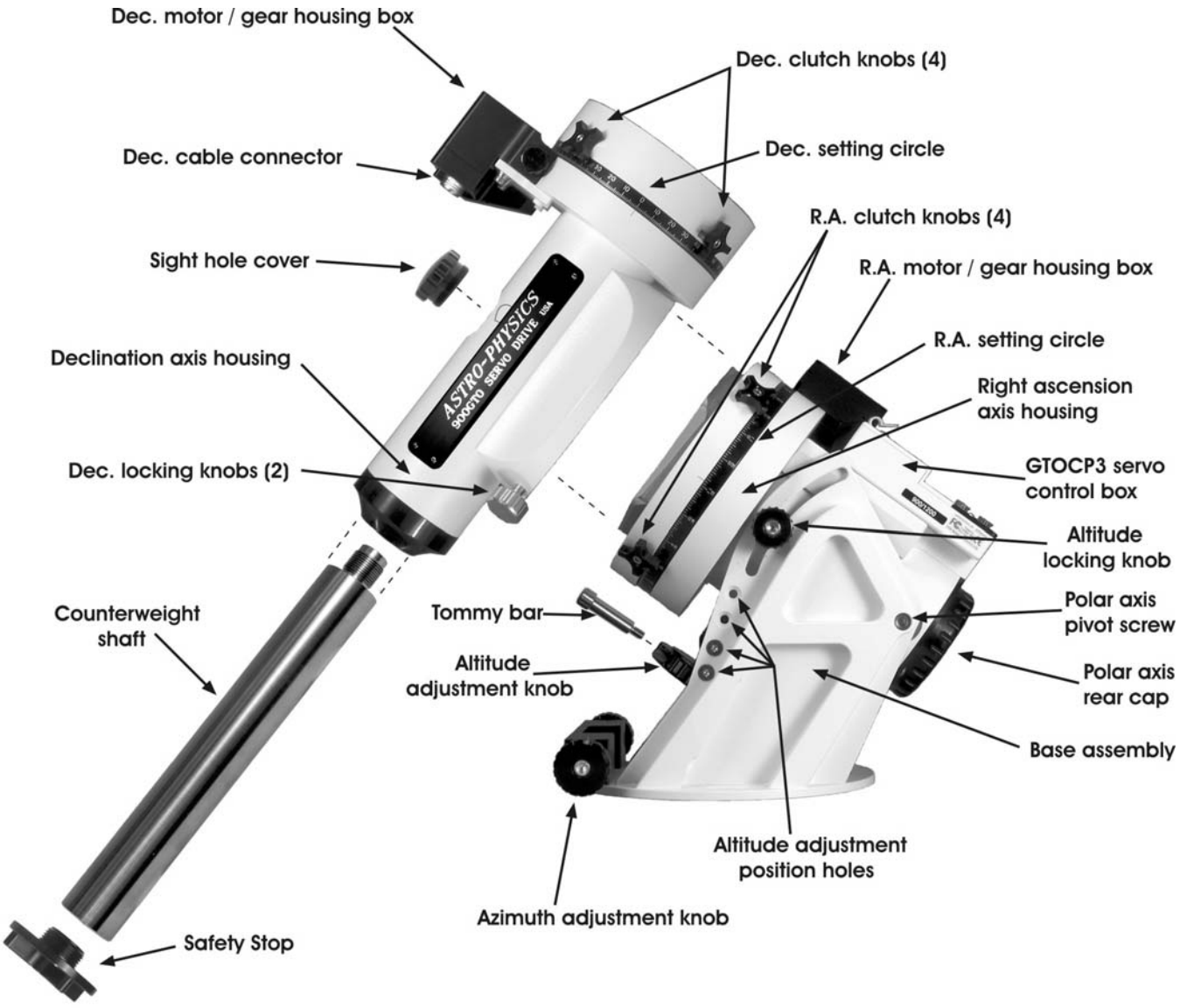
ASSEMBLY INSTRUCTIONS

Please read all instructions before attempting to set up your 900GTO mount. The model 900 is very rugged, however like any precision instrument, it can be damaged by improper use and handling. Please refer to the following illustrations. The parts are labeled so that we can establish common terminology.

NOTE: The following terms and abbreviations are used interchangeably in these instructions:

polar axis = right ascension axis = R.A. axis = R.A. housing

declination axis = dec. axis = dec. housing



Before You Leave Home

Since most of us must set up our instruments in the dark, in the cold or while battling mosquitoes, a bit of preplanning and organization is important. There are a few simple things that can be accomplished in the comfort of your home before heading outside.

Gross Latitude Adjustment

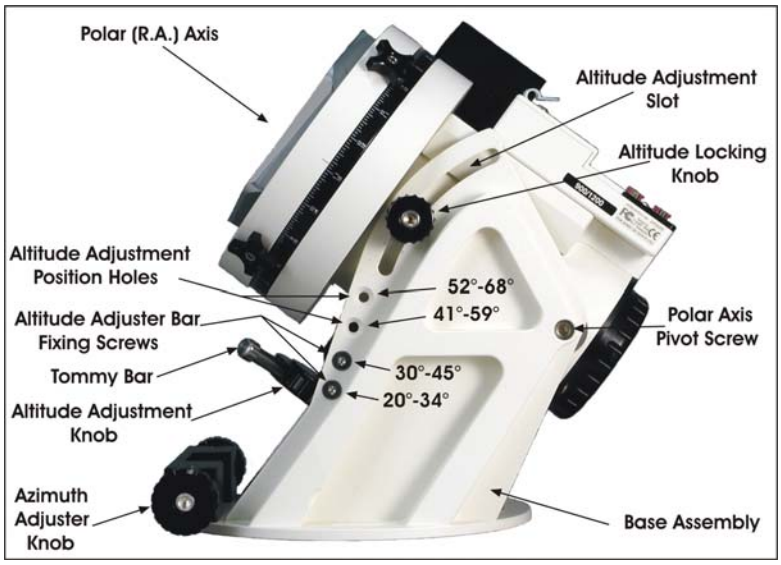
The latitude range of the 900 mount is approximately 20-68 degrees. Since most astronomers typically observe within one latitude range, this first adjustment is made just once, if at all. Prior to shipment, we preset the mount to your latitude range for your convenience. If you travel to another observing location, determine the latitude of your observing site and make the appropriate adjustment. If you live in or plan to travel to tropical locations that are 0 to 20 degrees latitude north or south, or extreme polar sites that are between 68 and 88 degrees north or south, we recommend our Hi-Lo Latitude Wedge Pier Adapter Assembly (900WDGA). Pier Adapters are discussed fully later in the manual.

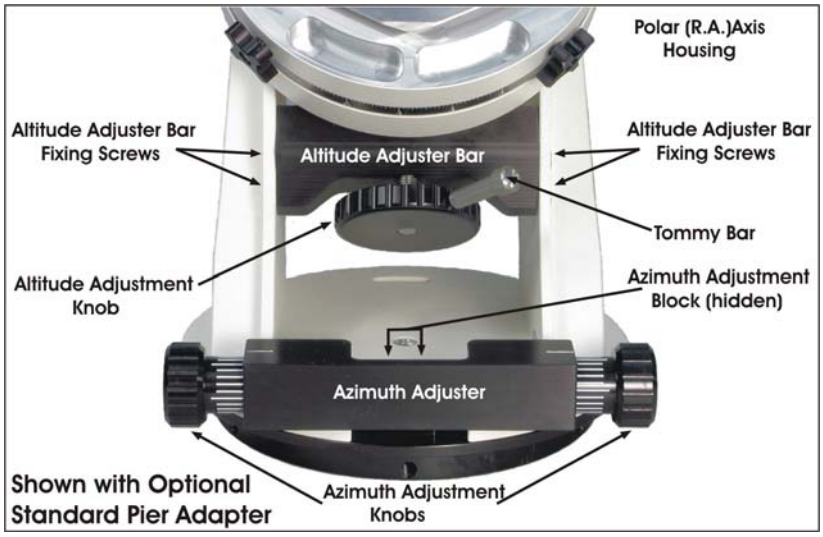
The four positions for the altitude adjustments have the following approximate ranges:

52 degrees to 68 degrees latitude - top position
41 degrees to 59 degrees latitude - third position
30 degrees to 45 degrees latitude - second position
20 degrees to 34 degrees latitude - bottom position

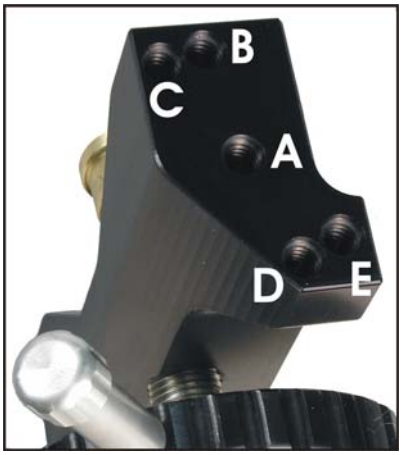
<u>How to change the position of the altitude adjuster</u>

1. Use only the R.A. axis. DO NOT attempt to make these adjustments with the declination axis in place and certainly not with an instrument fully mounted.
2. Loosen both altitude-locking knobs about 1 turn.
3. Locate the side of the polar axis that does not have the black motor/gear housing box. Loosen (about 1 turn) the polar axis pivot screw and altitude adjuster bar fixing screws on this side only. With your hand, push the polar axis upwards so that the altitude-locking knobs are positioned at the top of the altitude adjustment slot (this is the maximum altitude position). Some resistance will be felt with this operation as you are pushing against the weight of the polar housing and the resistance of the remaining polar axis pivot screw (which has not been loosened).
4. Before attempting to move the altitude adjuster bar, you must tighten the altitude-locking knob on the motor/gear housing side. This will prevent any downward movement of the polar axis during positioning of the altitude adjuster bar.
5. While supporting the altitude adjuster bar, remove the two altitude adjuster bar fixing screws that support it on each side (4 screws in all), but keep the two ends of the bar in contact with the side of the mount, don't remove it completely (this tip is for your convenience).





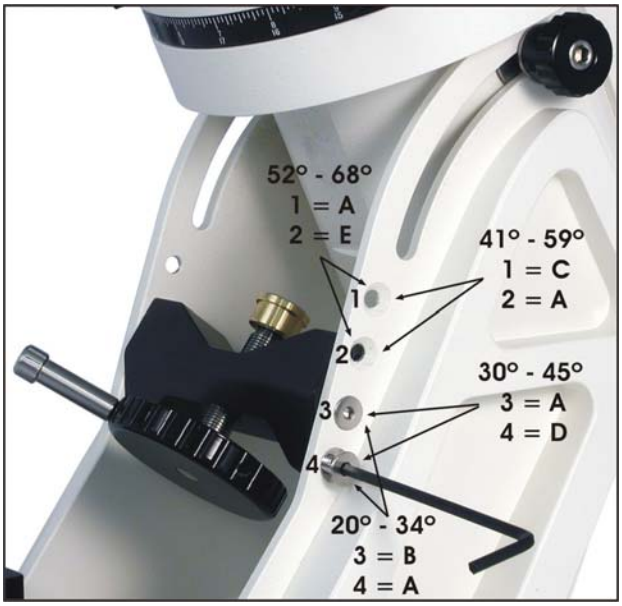
6. Determine the latitude range that you need and position the altitude adjuster bar so that the hole that is marked “A”, as shown in the diagram, is located at the appropriate hole position numbered 1-4 in the lower diagram. Note that hole “A” is located at the rounded part in the center of the altitude bar. Hole “A” is the “latitude hole.”



7. Attach two of the screws (one on either side of the adjuster bar) through the appropriate altitude adjustment position hole and into hole A of the adjuster bar, but do not tighten. Rotate the altitude adjuster bar around this pivot point until the corresponding hole lines up. Consult the labeled photo to determine which hole of the altitude adjuster bar should be used. Be very careful since the holes marked C and B are very close to one another, as are the holes marked D and E. The incorrect hole may appear to line up, however it will be slightly off. If you try to attach at the incorrect hole, you may strip the threads of the altitude bar. The correct hole will orient the adjuster to be roughly perpendicular to the axis once the axis is lowered into place.

8. Once you have located the correct hole, insert the remaining two screws, and lightly tighten so that you still have some ability to wiggle the bar.

9. Note that the altitude adjustment knob is attached to a threaded rod that travels through the altitude adjuster bar. Turn the knob so that the altitude adjuster bar is positioned approximately in the middle of the threaded rod. You should see about half of the threaded rod protruding from both sides of the altitude adjuster bar. This will allow you to move the mount fully within the altitude range.



10. At the end of the threaded rod mentioned in the last step, you will see a small brass altitude adjuster thrust pad. This is the part that will come in contact with the polar axis as you ease it back into position. Loosen the altitude-locking knob (motor/gear side) and lower the polar axis so that it rests comfortably on this pad. The threaded rod should be positioned at a right angle to the polar axis housing. Firmly tighten the altitude adjuster bar fixing screws.

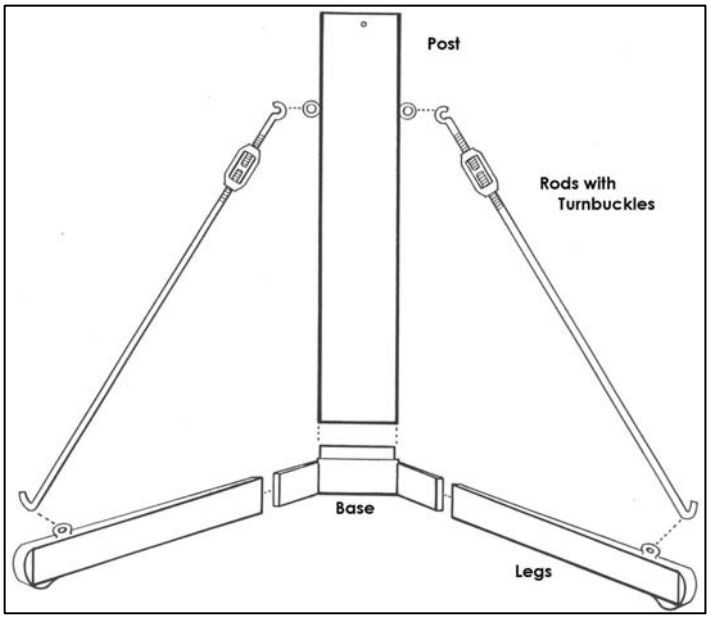
11. Turn the altitude adjustment knob to raise or lower the polar axis to your approximate observing latitude. Tighten the altitude locking knobs with finger pressure only. You do not need to tighten with the hex key.

12. Firmly tighten both polar axis pivot screws with the hex key.

Assemble Pier
(purchased separately)

Begin by assembling the portable pier at the desired observing location. Note which direction is north.

1. Slide the three legs onto the nubs of the base and rotate the assembly so that one of the legs points toward north (or south, if that is your preference).
2. Place the pier post on the base orienting the center azimuth block directly north. If you choose to have one leg north, then the pier adapter plate will have to be installed with the azimuth block directly over a turnbuckle. If you have one leg south, the pier adapter plate will have to be installed with the azimuth block over and between two of the pier post turnbuckles.
3. Attach the tension rods. The turnbuckles should be drawn tight until the whole assembly is stiff enough to support your weight without movement.

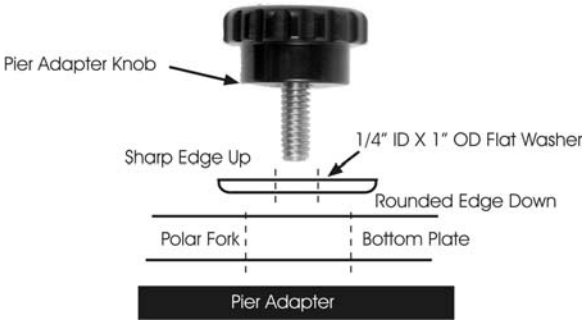


Attach Pier Adapter to Pier Post

The 900 Standard Pier Adapter (900SPA) was included with 900 mounts sold in the past. However, in 2005, we began offering three choices: the Standard Pier Adapter (900SPA), the Hi-Lo Latitude Wedge Assembly (900WDGA) for tropical latitudes (0° to 20° N or S) or polar latitudes (68° to 88° N or S), and the Precision Adjust Rotating Pier Adapter with Azimuth Bearing (900RPA). You probably added one of these options to your mount order. If you plan to have multiple pier installations, perhaps one permanent and another portable, you may wish to purchase an extra adapter to install on the second pier. This will make your setup and switch-over much quicker. Many customers have found this to be advantageous.

If you are constructing your own pier or tripod, you will need to incorporate one of our pier adapters. You may also wish to purchase our Flat Surface Adapter (900FSA) if your home-made pier has a flat surface on top. All three pier adapters were designed to fit into an 8" O.D. x 0.125" wall tube with 6 button head screws with washers threaded into the side. The Standard Pier Adapter can also be bolted onto a flat surface by using the four countersunk thru-holes. The Rotating Pier adapter, the Hi-Lo Latitude Wedge and pier adapters from earlier production runs do not have the thru-holes. They require the Flat Surface Adapter for mounting onto a flat surface. Note that with the Astro-Physics pier, you can orient the pier adapter so that one of the pier legs faces "north" or "south" as you prefer. If you need an extra Pier Adapter for a second pier, they are available for purchase.

If you did not purchase one of our pier adapters described below - for instance, if you purchased the Monolith Pier from Particle Wave Technologies, you will need to purchase the Pier Adapter Knob Kit (part# 9KBKIT) in order to attach your mount to the Pier. Additionally, outside manufacturers may not provide the Azimuth Adjuster Block (M12020-A) or the center pivot screw (M12330M). Both of these parts are vital to the correct performance of your mount (see note on center pivot below) and can be purchased by calling Astro-Physics.



Important notes for all three pier adapters or when using the Monolith Pier :

- The washers for the pier adapter knobs must be positioned with the smooth surface and rounded edge down so that the assembly can be adjusted back and forth.
- Do NOT remove the center pivot screw. Just as the name implies, this is the point around which the mount rotates (pivots) when making azimuth adjustments. The screw head has been machined to assure a close fit. Please do not replace it with another screw.

Standard Pier Adapter (900SPA)

This 900 Pier Adapter is similar to those that we have included with mounts in the past, however the azimuth adjuster block is slightly taller to accommodate the improved azimuth adjuster assembly on all 900GTO mounts produced after August, 2005 (and all upgraded older mounts). If you have a permanent installation, this base is a good choice since you will not have to set up every session.

The adapter includes the machined flat plate, four machined aluminum lock knobs with washers, the azimuth adjuster block, center pivot screw and six 5/16-18 x 5/8 button head screws and washers.

900SPA Standard Pier Adapter

Attach to an Astro-Physics pier: To attach the pier adapter to your Astro-Physics pier, simply set the adapter into the top of the pier post, make sure the azimuth adjuster block is on the north side, and fasten from the side with the six screws and washers provided.

Attach to a flat surface on your own pier: If you are mounting to a flat surface of your own design, simply use four 1/4–20 stainless steel cap screws of appropriate length, fastened through the top of your adapter. Refer to the diagram in the back of the manual for bolt pattern information.

If you prefer a more finished look, you may wish to consider using our 900 Flat Surface Adapter (900FSA). The Flat Surface Adapter bolts onto the flat plate on top of your pier or tripod, then the Standard Pier Adapter slips in (just as it fits into our pier) and you fasten from the side with the six screws and washers provided with the Standard Pier Adapter. The bolt circle for attaching the 900 Flat Surface Adapter to your pier is 7.230" diameter.

Using an ATS pier: The O.D. of the plate will need to be modified by ATS for an additional charge.

Precision Adjust Rotating Pier Adapter with Azimuth Bearing (900RPA)

This pier adapter was designed for very accurate and smooth adjustment of the azimuth angle without loosening the lock-down knobs on the base of the mount. The top plate of the adapter rotates through the 900GTO mount's full 15 degrees of azimuth motion. (It does **not** rotate through a full 360 degrees!) This Rotating Pier Adapter is the ideal choice for portable setups as it makes azimuth adjustment so easy. Upgrade your previous model 900 mount (any version) and enjoy the ease of use. Do a setup, followed by a fine polar alignment at a remote site just once, and you will wonder how you ever got along without this pier adapter!

900RPA Rotating Pier Adapter

The adapter includes two machined flat plates, four machined aluminum lock knobs with washers, a tall version of the azimuth adjuster block, center pivot screw and six 5/16-18 x 5/8 button head screws and washers.

Attach to an Astro-Physics pier: Simply fit the Rotating Pier Adapter into your Astro-Physics Portable Pier just like the Standard Pier Adapter and fasten it from the side with the six screws and washers provided. Again, make sure that the Azimuth Adjuster Block is on the north side.

Attach to a flat surface on your own pier: The Rotating Pier Adapter must fit inside another part and be bolted from the side. It cannot be bolted through the top as you can with the Standard Pier Adapter. We recommend our 900 Flat Surface Adapter (900FSA). The Flat Surface Adapter bolts onto the flat plate on top of your pier or tripod, then the Rotating Pier Adapter slips in (just as it fits into our pier) and you fasten from the side with the six screws and washers provided with the Rotating Pier Adapter. The bolt circle for attaching the 900 Flat Surface Adapter to your pier is 7.230" diameter.

Using an ATS pier: If you plan to use an ATS pier, the O.D. of the plate will need to be modified by ATS for an additional charge.

The two recessed screws (3/16 hex), shown by the arrows, adjust the tension between the two plates of the Rotating Pier Adapter. These are preset to an optimal tension and should rarely, if ever, need to be re-adjusted. You **do not** need to tighten or loosen these two screws as part of your normal polar alignment routine.

Hi-Lo Latitude Wedge Pier Adapter Assembly for 0 - 20° or 68° - 88° Latitude – North or South (900WDGA)

If your latitude is between 20° north and 20° south or between 68° and 88°, either north or south, this wedge assembly includes everything you need to place your 900 mount in the proper position.

This adapter includes the machined wedge and flat plate, the 1.2" Azimuth Adjuster Block, four Pier Adapter Knobs with 1/4" ID x 1" OD flat washers, the center pivot screw, six 5/16-18 x 5/8 socket buttonhead screws and six 5/16 x 9/16"OD x 0.060" flat washers, which enable you to attach the pier adapter to your Astro-Physics pier.

Please Note: 1.) If you already own another adapter, the Hi-Lo Latitude Wedge may be purchased alone, without the Pier Adapter Knobs, Azimuth Block or Center Pivot Screw. (900WDG)

2.) The photo shows the Hi-Lo Latitude Wedge ready to be used at tropical latitudes with the Azimuth Adjuster Block on the low side. For extreme polar latitudes, the plate on top of the wedge can be turned around to extend the useful range of your 900GTO above 68° latitude. Simply remove the two side knobs and then remove the six screws that attach the flat plate to the wedge. Rotate the flat plate 180° and re-assemble with the Azimuth Adjuster Block on the high side.

Attach to an Astro-Physics pier: To attach the Hi-Lo Latitude Wedge to your Astro-Physics pier, simply set the adapter into the top of the pier post, make sure the azimuth adjuster block is on the north side, and fasten from the side with the six screws and washers provided.

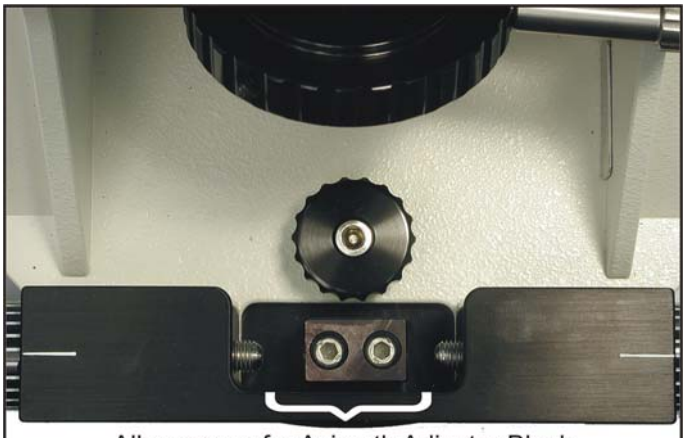
Attach to a flat surface on your own pier: The Hi-Lo Latitude Wedge must fit inside another part and be bolted from the side. It cannot be bolted through the top as you can with the Standard Pier Adapter. For custom installations, we recommend our 900 Flat Surface Adapter (900FSA). The Flat Surface Adapter bolts onto the flat plate on top of your pier or tripod, then the Hi-Lo Latitude Wedge Pier Adapter slips in (just as it fits into our pier) and you fasten from the side with the six screws and washers provided. The bolt circle for attaching the 900 Flat Surface Adapter to your pier is 7.230" diameter.

Using an ATS pier: The O.D. of the plate will need to be modified by ATS for an additional charge.

900WDGA
Wedge Pier Adapter Assembly

Assemble Polar Axis Assembly to Pier or Tripod

In order to track the motion of astronomical objects, the polar axis must be positioned so that an imaginary line drawn through the center of the axis points toward the celestial pole. At this stage of the assembly process, you want to position the pier and mount so that it points roughly north, if you have not already done so.

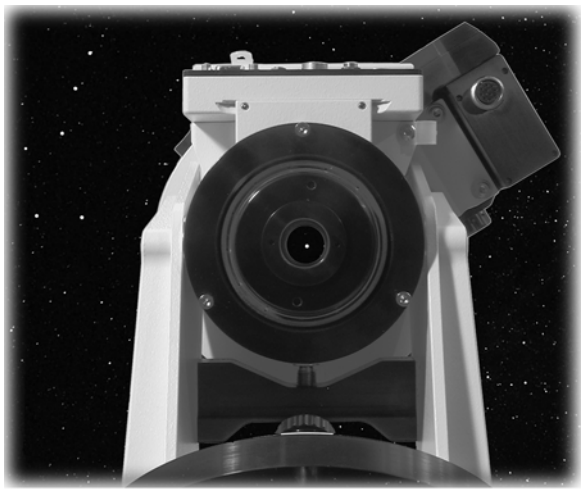


1. Remove the four (4) Pier Knobs on the Pier Adapter and keep them close at hand.
2. Prior to lifting the polar axis assembly into place, turn the fine azimuth adjustment knobs so that the space between them is wide enough to allow the center azimuth block to fit easily between them. See photo at right. Ensure both Pier Adapter top and polar axis assembly mating surfaces are clean and free of dirt. If you are using the Rotating Pier Adapter, make sure that the Altitude Adjuster Block is centered in the slot of the top plate.
3. Place the Polar Axis Assembly onto the Pier Adapter so that the Azimuth Adjuster Block fits between the fine Azimuth Adjustment Knobs. The Center Pivot Screw on the Pier Adapter (all models) will help you center the mount on the adapter.
4. Move the base of the polar axis assembly so that the threaded holes of the Pier Adapter top can be seen through each of the four slots.
5. For the Standard Pier Adapter or 900 Hi-Lo Latitude Wedge, thread the four Pier Knobs loosely in place (you will tighten these later after polar alignment). For the Rotating Pier Adapter, go ahead and tighten the four Pier Knobs securely.

Altitude and Azimuth Adjustments - Rough polar alignment

For rough polar alignment, your goal is to sight the celestial pole when looking through the polar alignment sight hole in the center of the polar axis. You will need to make altitude (up/down) and azimuth (side-to-side) adjustments to the position of the mount.

We recommend that you do your rough polar alignment with the R.A. axis only since you will be making major adjustments to the position of the mount at this time. The remainder of the mount, telescope and counterweights will add considerable weight and require more hand effort. Later, you will do your final polar alignment with the telescope and counterweights attached, but the adjustments will be small.



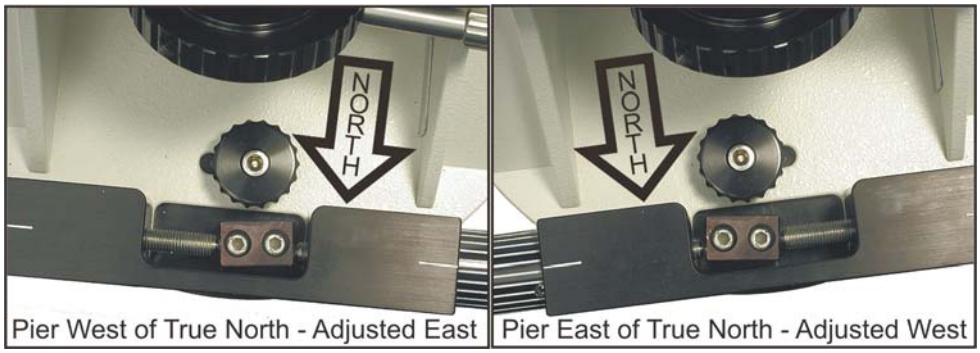
Sighting Polaris through Polar Alignment Sight Hole

1. If the Polar Scope (PASILL4) is installed, you may remove it to complete these steps. Alternatively, you can simply sight up the side of the polar axis to see Polaris.
2. If you examine the polar axis assembly, you will see that the center of the R.A. shaft is hollow. If you have the Standard Pier Adapter or the Hi-Lo Latitude Wedge Pier Adapter and have not done so already, loosen (1/2 turn) the four pier knobs. If you have the Rotating Pier Adapter you do NOT loosen the Pier Knobs.

   NOTE: If you have already attached the Dec. axis, remove the sight hole cover and rotate the internal Dec. shaft by moving the top of the Dec. axis (or the cradle plate if it is attached) to reveal the sight hole that has been drilled into it. Now, you can look through the shaft to the other side.

3. **Azimuth adjustments**: To begin with, move or turn the entire pier or tripod east or west until the mount is oriented approximately towards the pole (an imaginary line drawn through the hollow shaft). Once you are relatively close, use the two fine azimuth adjustment knobs, one on each side of the mount, to make adjustments. You must back off the opposing azimuth knob in order to move the other knob in that direction. Please refer to the photos below. These photos also illustrate the 15 degrees of azimuth adjustment possible with this mount.

<u>One full turn of the azimuth knob is approximately 0.63 degrees (38 arc minutes) Each long registration mark is about 7.6 arc minutes; each short mark is about 1.5 arc minutes.</u>



When designing the Heavy Duty Azimuth Adjusters for both the 900 and 1200 mounts, we debated using an azimuth adjuster with a single captured threaded rod passing through a stationary azimuth block to avoid the two step process of backing off one side, and then adjusting the other. However, we found that the inevitable backlash in this type of system made adjustment more problematic and less precise. The way to use the Astro-Physics Heavy Duty Azimuth Adjuster with its clear registration marks for fine adjustment is to back off one of the knobs by a set amount (a certain number of registration marks) and then to turn the other knob until you re-establish contact on both sides of the Azimuth Adjuster Block. You can very precisely zero in on the desired position with no backlash or ambiguity on the position. You can also always go back to the precise starting point if for some reason you overshot your mark (or if you adjusted the wrong way), because you know exactly how far you've gone.

4. **Altitude (latitude) adjustments**: Loosen the altitude locking knobs. Move the polar axis up or down with the large altitude adjustment knob located in the front of the polar axis assembly. The tommy bar can be positioned in any of the threaded holes located in the altitude adjustment knob. Use this bar to help you turn the knob. We have found that using the turnbuckle on the north leg of our pier also can make fine altitude adjustments, if used.

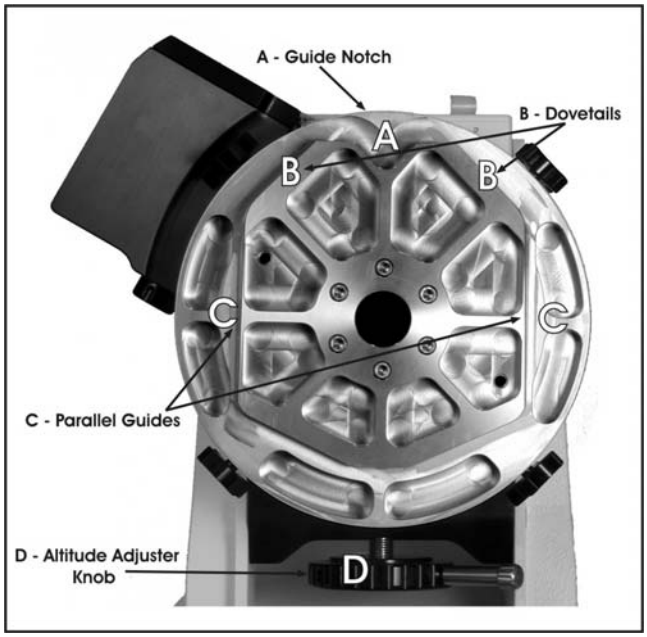
   <u>One full turn of the altitude knob is approximately 0.64 degrees (38 arc minutes).</u>

5. Continue your azimuth and altitude adjustments until you can sight Polaris in the polar alignment sight hole. At this point, you have achieved a rough polar alignment, which may be sufficient for casual visual observations, if you are not planning to slew to target objects with the keypad. When the R.A. motor is engaged (the power is plugged in), it will compensate for the rotation of the earth and keep the target object within the eyepiece field of view. Your target object will slowly drift since polar alignment at this stage is only approximate. However, you can make corrections with the N-S-E-W buttons of your keypad controller.

6. Tighten the altitude locking knobs by hand.

7. If you are using the Standard Pier Adapter or the Hi-Lo Latitude Wedge, tighten the pier knobs firmly by hand. On the Rotating Pier Adapter, the knobs will already be tight.

Assemble Declination Axis



1. <u>Do not</u> have your telescope or counterweights connected to the Dec. axis for either assembly or disassembly of the Dec. and R.A. axes.

2. Position the R.A. axis as shown in the diagram shown to the right with the guide notch "A" at the top, opposite the altitude adjuster knob. Firmly tighten R.A. clutch knobs.

3. During shipment, the Dec. axis assembly lock knobs will be fully screwed into the Dec. axis assembly. For correct assembly, these lock knobs should be unscrewed at least 7 full turns and <u>no more</u> than 8.5 full turns. This is between 5/16" and 3/8" out from the "shipped" tightened position. Note: These lock knobs can be completely removed from the Dec. axis assembly with about 9.5 full turns out.

4. Position the Dec. axis above the R.A. axis as shown in the diagram, a light movement (wiggle) in the downward direction (arrow "A") will help to correctly seat the principle dovetail(s) and parallel guides.

5. When both Dec. and R.A. assemblies are fully seated, hand tighten both Dec. lock knobs.

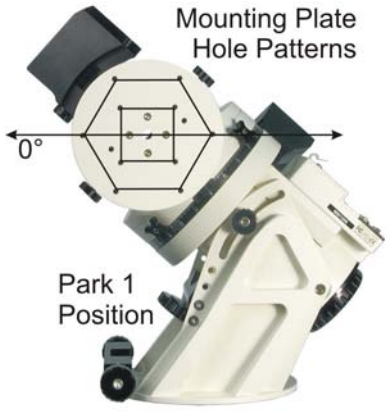
Removing Declination Axis at the End of your Observing Session

1. Move the telescope so that the counterweight shaft is pointing down and the telescope is horizontal (level) and pointing east. Carefully remove your telescope accessories, then the telescope, then counterweights, and finally the counterweight shaft.

2. Unscrew the lock knobs 5.5 to 7 full turns (this is still 5/16" to 3/8" out from the fully tightened position) and slide/tilt the Dec. axis assembly in an upward direction (arrow "B").

3. For transport/storage we recommend fully tightening the lock knobs.

Attach Mounting Plate
(purchased separately)

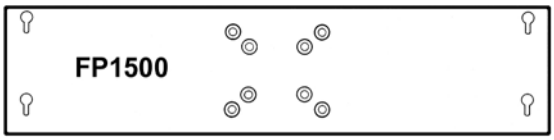


Several mounting plates (also called cradle plates) are available for the 900GTO mount. If you own more than one instrument, you may need more than one plate, or you may wish to use one of the dovetail mounting plate options with more than one male dovetail sliding bar. Attach your mounting plate with the screws provided with the plate using one of the hole patterns shown at right. It is important to use the proper screws, please refer to the instruction sheet entitled "*Mounting Plate Fastener Chart.*" This chart is available at the end of this manual and in the technical support section of our website.

15" FLAT MOUNTING PLATE (FP1500)

This plate is 15" long by 4.6" wide by 0.5" thick. Two pairs of keyhole slots that measure 3.2" between centers are provided. The pairs are 13.75" apart. You can drill additional holes to suit your needs. This plate also fits the *Mach1GTO*, 400 and 600E German Equatorial mounts.

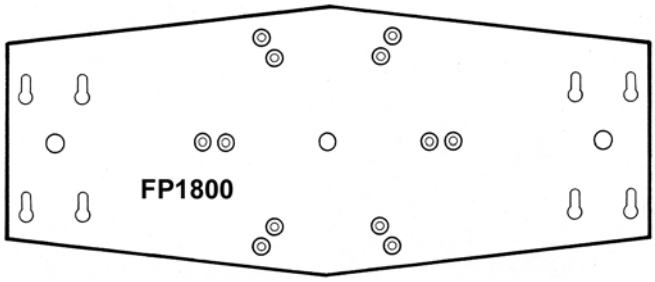
Attach this plate with four 1/4-20 x 5/8" socket head cap screws



18" FLAT MOUNTING PLATE (FP1800)

This plate is 18" long and 7.5" at its widest point in the center. The width of the plate tapers to 5.5" at each end. Four pairs of keyhole slots that measure 3.2" between centers are provided. The two inner pairs are 13.75" apart and the outer two pairs are 17" apart. You can drill additional holes to suit your needs. This plate also fits the *Mach1GTO* and 1200 German Equatorials.

Attach this plate with six 1/4-20 x 1" flat head socket cap screws.

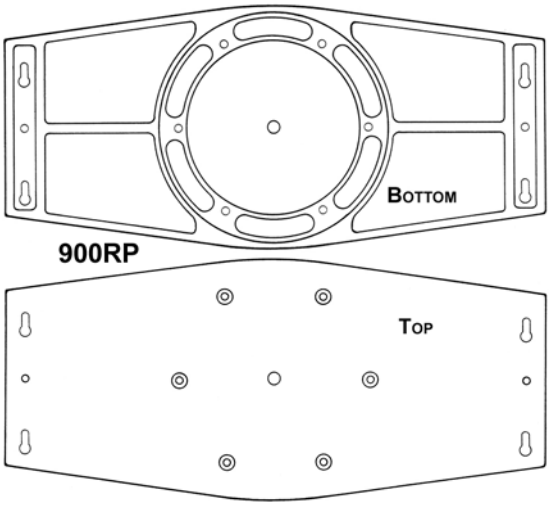


15" RIBBED MOUNTING PLATE (900RP)

The finished plate is 0.75" thick, 15" long and 6.5" at its widest point. The width of the plate tapers to 4.75". A pair of keyhole slots that measure 3.2" between centers are provided at each end. The distance between these pairs of holes is 13.75". Due to the ribbed structure, you may not be able to drill additional holes to suit your mounting rings. The plate weighs 2.3 lbs.

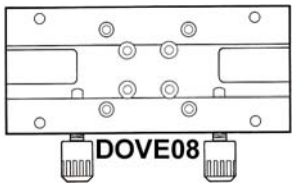
Attach this plate with four 1/4-20 x 1" flat head socket cap screws. Note that the plate is asymmetrical. In most cases, orient the plate so that the long end points toward the sky. You can also turn the plate in the other direction to balance your scope.

NOTE: All three of the above plates have a hole spacing of 13.75". This allows the use of the 15" dovetail plate (DOVE15) on top of your instrument as an accessory plate.



8" ASTRO-PHYSICS DOVETAIL MOUNTING PLATE (DOVE08) with Q4047 ADAPTER

This versatile plate is suited for the 105 f6 Traveler and 130 refractors (we prefer the 15" Dovetail Plate for most applications of the 130 f8 StarFire EDT) and other short instruments. The knob assembly features a brass pin with a tapered end to hold your sliding bar firmly without marring the aluminum. Use with the 7" or 10" sliding bars (SB0800 or SB1000), which are sold separately. Repositioning the sliding bar will aid in adjusting the balance of your instrument.

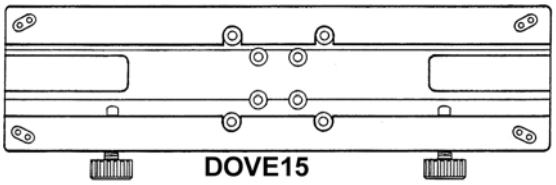


NOTE: This plate requires the use of the Q4047 adapter with the 900GTO mount to provide clearance for the knobs.

As an accessory plate - Attach to the top of our Astro-Physics mounting rings (tube diameters 5"-8") or rings from Parallax Instruments that have the Astro-Physics hole pattern (you can request it). **Note**, you must also use a sliding bar on the bottom of the rings with the same distance (6.3" from center to center), i.e. the SB0800 or SB1000.

Attach the Q4047 to the mount using the six outside holes and six 1/4-20 x 5/8" flat head socket cap screws. Attach the DOVE08 to the Q4047 with four 1/4-20 x 5/8" socket head cap screws.

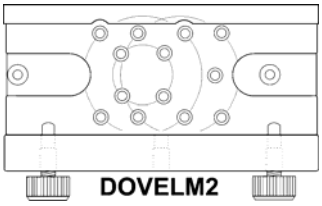
15" ASTRO-PHYSICS DOVETAIL (DOVE15) FOR 15" SLIDING BAR (SB1500)



The 15" version of our dovetail plate is suited for the 130 f8 StarFire EDT, 155 f7 StarFire EDFS, ARO Maksutovs, Takahashi scopes and other instruments of similar size. The knob assembly features a brass pin with a tapered end to hold your sliding bar firmly without marring the aluminum. Use with the 15" Sliding Bar (SB1500), which is sold separately (**NOT** for use with Losmandy "D" plates). Also makes a great accessory plate when used with either the 900RP, the FP1500 or FP1800 (with rings mounted to inside holes)

Attach with four 1/4-20 x 5/8" flat head socket cap screws.

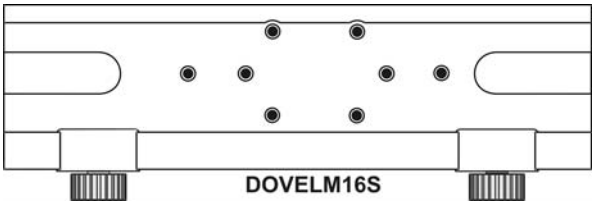
8.5" DOVETAIL FOR LOSMANDY D SERIES PLATE (DOVELM2)



This Astro-Physics plate attaches to the 400, 600E, 900, 1200 and *Mach1GTO* mounts. If you already own one of the Losmandy DAP series (fits Astro-Physics refractors), DC series (for Celestron 8" or 9.25" SCTs) or DM series (for Meade 8" and 10" SCTs) plates, you should consider this plate or the longer DOVELM16S. For larger size SCT's we recommend the longer DOVELM16S – see below.

Note that there are two bolt-hole patterns, each offset from the center. This allows you to position the plate either forward or backward depending on the balance point of your telescope. Attach this plate with four 1/4-20 x 5/8" socket head cap screws. This plate can also be attached using one 1/4-20 x 5/8" flat head socket cap screw and one 1/4-20 x 3/4" socket head cap screw using two opposite holes of the declination hub's six hole pattern.

16" DOVETAIL FOR LOSMANDY D SERIES PLATES (DOVELM16S)



This Astro-Physics plate attaches to the 900 and *Mach1GTO* mounts. If you already own one of the longer Losmandy DAP series (fits larger Astro-Physics refractors), DC series (for Celestron 8", 9.25" or 11" SCTs) or DM series (for Meade 8", 10" or 12" SCTs) plates, this is the mounting plate for you.

Note that the bolt-hole pattern is offset from the center. This allows you to position the plate either forward or backward depending on the balance point of your telescope. Attach this plate with four 1/4-20 x 1" socket head cap screws. This plate can also be attached using two 1/4-20 x 1" socket head cap screws using two opposite holes of the declination hub's six hole pattern.

Attach Counterweight Shaft and Counterweights

IMPORTANT: Always attach the counterweights before mounting the telescope to the cradle plate to prevent sudden movement of an unbalanced tube assembly, which may cause damage or injury. Remember counterweights are heavy and will hurt if they fall on your foot.

1. Thread counterweight shaft onto the Dec. axis. Turn it snug, but DO NOT overtighten!
2. Remove the one piece safety stop from the base of the counterweight shaft. Add sufficient counterweights (5, 10 or 18 lb. counterweights must be purchased separately) to the counterweight shaft to balance the telescope you intend to use. Always use two hands to attach or move them on the shaft.
3. **Reattach the safety stop to the end of the counterweight shaft.** This will help to prevent injury if someone accidentally loosens the counterweight knob.

NOTE: A firm tightening of the counterweight knob will not damage the surface of the counterweight shaft. The pin that tightens against the stainless counterweight shaft is constructed of brass. Likewise, the bronze sleeve that has been press fit into the center of the counterweight will prevent marring of the shaft as you move the counterweights up and down.

Attach Mounting Rings
(purchased separately)

Flat and ribbed plates: constructed with keyhole slots at the location where your mounting rings attach. This feature enables you to partially loosen the screws on your rings just enough to insert them into the larger part of the keyhole, then slide the rings to the narrow part and tighten them with a hex key. You can even accomplish this with the rings on the scope, although this maneuver may be difficult to accomplish with a large, heavy instrument.

We prefer this keyhole method to the standard way of completely removing the screws and possibly dropping them in the grass.

Astro-Physics or Losmandy Dovetail Plates: Attach the mounting rings to the male dovetail plate (sliding bar).

Fine Polar Alignment

For casual observation, you may skip this section and simply start observing. [Don't forget to tighten your altitude locking knobs (2) and pier knobs (4 – Standard Pier Adapter and Hi-Lo Latitude Wedge only) before you begin!]. Move the telescope manually or by using the N-S-E-W buttons of the keypad. The keypad and GTO Servo Control Box will function as soon as they are plugged in. That means that the R.A. axis will be tracking up to the limits of your polar alignment. However, if you plan to use any of the go-to functions of the 900GTO or do astrophotography, you must perform a more accurate polar alignment.

Methods for fine polar alignment

- **Polar Alignment Scope** – Our optional polar scope (PASILL4 or earlier models) will allow you to quickly align your mount on the pole stars. The reticle was designed for use in both the Northern and Southern hemispheres. Even users of the GTO computerized mounts will find these polar scopes useful, particularly if your telescope is not orthogonal to the mount (please refer to the keypad manual for a discussion of orthogonality). If you have a polar alignment scope, please read the instructions sheets that come with it.

- **GTO Keypad** – Please refer to the instruction manual for the GTO Servo Drive and read the section describing the startup sequence. For daytime setup, read the section entitled "Polar Aligning in the Daytime" in the GTO Keypad manual.

- **Star Drift method** – Traditionally, this has been regarded as the most accurate method of polar alignment, however it is also the most time consuming. If you are planning long exposure astrophotos, we suggest that you use the Polar Alignment Scope (see above), then tweak the final polar alignment by star drifting. Refer to the GTO Keypad manual for hints on polar aligning using a GTO quick star drift method. The current keypad manual has an expanded section on this useful alignment method. Also refer to the Technical Support section of our website for further information. For general information regarding traditional star drift alignment, please refer to the recommended reading list at the end of this manual and check the internet.

Altitude and Azimuth Adjustments

1. Loosen the altitude - locking knobs (2) and pier knobs (4 – Standard Pier Adapter and Hi-Lo Latitude Wedge only) and refer back to the section on "Altitude and Azimuth Adjustments – Rough Polar Alignment." **Do not** loosen the Pier Knobs of the Rotating Pier Adapter.

2. Follow one of the methods of polar alignment mentioned above.

3. When polar alignment has been achieved, tighten at these locations (note that the polar axis pivot screws should have been tight throughout the fine polar alignment process):

   Altitude locking knobs (2) – hand tighten
   Pier knobs (4 – Standard Pier Adapter and Hi-Lo Latitude Wedge only) – hand tighten

4. For a permanent installation, all knobs in step 3 above may be firmly tightened with the assistance of a hex wrench.

CLUTCH KNOBS AND BALANCING

R.A. and Dec. Clutch Knobs

1. What do they do?
   The four R.A. and four Dec. clutch knobs have the function of connecting the R.A. and Dec. axes to their respective drive worm wheel gears. Their function is progressive, from no tension (axes free to move - as required during correct balancing of the telescope) to a completely "locked up" state.

2. How can you find out what they really do?
   As shipped, all 900 mounts have all four R.A. and Dec. clutch knobs firmly hand tightened. This will give you a good idea of the maximum tightness (clutch action) that can be achieved by hand effort alone. At this point, you must bear in mind that for optimum performance all four clutch knobs on each axis (R.A. or Dec.) should be tightened evenly with the same tension (i.e. all four half tight, all four fully tight, etc.).

   In order to feel the effect of the clutch knobs, you may wish to partially assemble your mount. Fit together the R.A. and Dec. assemblies plus mounting plate and counterweight shaft. Do not put scope and counterweights on at this stage. With the above assembly (with the clutch knobs firmly hand tightened - "as shipped"), you can feel the amount of force needed to move each axis by hand. Grab each end of the telescope mounting plate and move it with a backward and forward movement of the Dec. axis. You will feel considerable resistance to this motion. Perform the same operation on the R.A. axis by moving the counterweight shaft backward and forward. With a well-balanced telescope, the above tightness of the clutch knobs will be sufficient for all normal conditions of use.

Now, mount up and balance your telescope so you can "feel" what this resistance in R.A. and Dec. (movement backwards and forwards) is like when you make these motions from the eyepiece end of your telescope as you would during normal use when slewing (pushing) by hand to acquire an astronomical object within the field of view of your finder or scope.

3. How tight can the clutch be and can you do any damage by pushing against them?
   The maximum tightness of this clutch system is 1/3 turn (with a 5/32 allen key) further in than the tension an average person can achieve with the knobs by hand. You will see that each clutch knob has a 5/32 hex socket for tightening with an allen key. With this extra 1/3 turn on each clutch knob, the axis (axes) will be considered completely "locked up" and you should not attempt to push your scope by hand against this "locked up" resistance, or undue stress will be placed on the worm wheel/worm and bearings.

   However, if you are undertaking a very long astrophoto exposure, it is advisable to increase the pressure on each clutch knob (with the 5/32 key) by about 1/8th turn on Dec. and 1/8th turn on R.A. You may safely slew the scope by hand with this tension, however you will notice considerably more effort is required to achieve movement. This is the absolute maximum tension that can be used for hand slewing. As a general rule, if you have a big scope (7" or 8" refractor) with all the accessories, you will need more clutch tension than a 5" or 6" scope.

WARNING It is also possible to over-tighten the clutch knobs and damage the underlying clutch plugs, so be careful – these are not lug nuts on your car! (see the troubleshooting section and the appendix for a further discussion of damaged clutch plugs.)

Balancing Your Telescope

For proper operation, the telescope must be adequately balanced along both axes. Start by balancing the tube assembly.

First, Balance the Declination Axis.

1. Position the mount for balancing. Move the R.A. axis so that the counterweight shaft is pointing down. The declination axis assembly will be in the meridian (this is the classic photographic pose for a German Equatorial). Position the Dec. axis so the telescope tube is horizontal and pointing east.
2. Tighten the 4 R.A. axis clutch knobs.
3. Loosen the 4 Dec. axis clutch knobs (about 3/4 to 1 turn) so that the telescope moves freely about the declination axis. Be careful because if your telescope is significantly out of balance, it may swing rapidly in the out-of-balance direction!
4. Loosen the tube mounting rings and slide the tube back and forth for balancing. This is best done with the tube in the horizontal position. If you are using a Losmandy mounting plate, loosen the hand knobs on the female dovetail plate and slide the Losmandy plate to the desired position.
5. The scope is balanced when it stays put (does not move) with the clutches loose and movement back and forth about the declination axis has the same feel in both directions. Be mindful of eyepieces, cameras and other accessories that are yet to be added and compensate accordingly.

Second, Balance the Polar Axis

1. Now, tighten the declination axis clutch knobs and position the mount with the telescope horizontal and the declination axis horizontal. The counterweight shaft is now horizontal with the center of the counterweights the same height as the middle of the tube.
2. Loosen the R.A. clutch knobs. Again, be careful because if your scope is significantly un-balanced, it may swing rapidly in the out-of-balance direction.
3. Move the counterweight(s) up or down to achieve the correct balance in R.A. Again, movement back and forth about the R.A. axis should have the same feel in both directions.
4. Re-set the tightness of all 8 clutch knobs to the resistance you want making sure that each axis' 4 clutches are evenly tightened. (See section on clutch knobs above.)

Try to anticipate any balance problems due to the extra weight of diagonals, heavy eyepieces, finders, solar filters, etc. If the scope moves by itself, when the clutches are loose, then the scope is not balanced adequately. You may want to "tweak" by carefully repeating steps 1 – 5 after everything has been attached to the telescope. Be especially careful loosening the Dec. clutch knobs.

Note: A small amount of imbalance on the East side of the mount is permissible and even desirable for astrophotography and imaging. This allows gravity to keep the drive train fully engaged while tracking throughout the exposure. If you intentionally create this small imbalance, you must remember to re-adjust the balance whenever you flip from one side of the mount to the other. Forgetting to re-adjust can result in a slight see-saw action in tracking that could spoil your next image.

SERVO MOTOR DRIVE

GTO Control Box – GTOCP3

The GTO control box contains all of the circuitry to drive the two servo motors and the logic required to navigate the sky. It will be operational and track at the sidereal rate when connected to both motors of the mount and a power source. In order to control the movement of the mount, you will need to connect at least one of these:

- GTO Keypad.
- Computer with PulseGuide by Sirius Imaging. The CD for this program is included with the mount. For the most updated version of the software, check out the website www.pulseguide.com.
- Computer with a planetarium program such as Software Bisque's *TheSky*™, Imaginova's *Starry Night*™, Nova Astronomics' *The Earth-Centered Universe (ECU)* version 3.1 or later, and Chris Marriot's *Sky Map Pro 6* or any ASCOM compatible telescope software (all purchased separately).

The GTO Servo Control Box is mounted directly onto the polar axis of the 900GTO mount. Please remember that this box contains advanced electronics and must be treated with the same care given to other fine equipment. You can see that the unit is built to be rugged, however it is not indestructible.

Lead-Free (RoHS compliant) Electronics

Starting in 2006, we began phasing in lead-free electronics for all of our mounts. In the first phase, all *GTO* mounts (and other electronics) shipped to customers in the European Union were built with lead-free electronic components due to RoHS regulations that went into effect on July 1, 2006. As of mid 2007, all of our electronics adhere to this safer and more environmentally responsible standard.

R.A. and Dec. Cable Connections

A "Y" cable with 10-pin connectors is included with your mount. Attach the connector from which the two cables emerge to the GTO Control Panel. Attach the short part of the "Y" cable to the R.A. motor housing and the long part of the cable to the Dec motor housing. Lock all connectors. Refer to the section below for further information about positioning the cables.

12V Connector

Place the DC power cord (included with your mount) into the DC power plug outlet marked 12V on the GTO Control Panel and lock in place. Plug the cigarette lighter plug end of the cord into your power source. The acceptable voltage range is 11.5 to 16. Suggested power sources include: portable rechargeable battery pack, auto or marine battery, or power supply (filtered and regulated) for standard household AC current (110-115 volt – 60 Hz in the US) with a minimum output of 5 amps at 12V DC. 13 to 16 volts is recommended for best performance. We also recommend that the mount have its own dedicated power supply and that other devices be powered from a separate source or sources.

There is no on-off switch. We recommend that you plug the power cable into the servo box after the keypad controller. To turn the unit off, simply disconnect the power cable.

Considerations for observatory installations: We suggest that you disconnect your GTO Control Box from 110V and any other device (CCD camera, computer, etc) when you are not using your mount so that if your observatory experiences a power surge or lightening strike, your mount electronics will not be damaged. If you operate your mount remotely, you will have to leave your power cable connected just as you do for the rest of your electronic equipment. You may want to consider surge protectors or other protective measures to protect from voltage spikes. A disconnect relay to remove power from both the 12-volt and ground wire is highly recommended in this situation.

POWER Indicator Light

This LED will remain illuminated when your power source has sufficient output to drive the motors. If the voltage falls below 10.5 volts, the power light will go out and the motors will stop. The keypad controller will not function properly.

For mounts shipped after 02-25-00: If the LED turns yellow, this means that your motors are overloaded, probably due to an unbalanced load on your mount. Refer to the troubleshooting section of the manual for the solution. Earlier control boxes do not have this feature.

KEYPAD Connector

Attach the 5-pin male connector of the keypad controller and lock in place (push in the knurled ring then turn).

RS-232 Connectors

These serial port connections are used to connect your mount to your PC computer. You may provide your own straight-through (non-crossing) cables with a 9-pin (DB9) male connector to interface with the GTO panel, or you can purchase them directly from us (and be assured that they are the correct type of cable!). We have provided the locking posts to secure the cable firmly onto the control box. If your serial cable does not have a 9-pin connector, you can use a gender changer or adapter to convert it. **Please note:** *the use of "crossing," "reversing," "null," or "null modem" cables is a frequent source of failure and frustration. Make sure that your serial cable is wired straight-through!*

When you are controlling the position of the mount with a computer program such as *PulseGuide*™, Software Bisque's *TheSky*™, or Imaginova's *Starry Night*™, the microprocessor chip located in the servo drive box will send continual RA and Dec. coordinate data via the cable connections to your computer. When you use the software to give instruction to slew to a new object, the commands (RA and Dec. coordinates) are sent to the mount.

We provide two serial port connections on the mount so that you can use two software programs simultaneously (in addition to any auto-guider software that may be sending signals to the mount through the Auto-guider Connector). For instance, you can use *PulseGuide* for advanced mount control, while using *TheSky* as a planetarium program. The telescope control functions of *TheSky* are more limited so using both in a remote application is advantageous. Since the mount will update the RA and Dec coordinates simultaneously, both programs are continually updated with the data from the mount. You can watch the screen display of *TheSky t*o see where your telescope is pointing as it slews. This is most effective if you have a reasonably fast computer with plenty of RAM. If you try this with a 100MHz processor and only 32 MB of RAM, the response time will be slow since both programs must be continuously updated with position data.

You must have two serial ports available on your computer to take advantage of this feature. If you use a laptop or a newer desktop computer, you may need to purchase a USB to Serial Adapter. Starting in the spring of 2008, Astro-Physics will begin offering single port and four port units made by *Keyspan*™ that we have found to work quite well on our own equipment. The serial ports on the GTOCP3 control box will even allow remote operation of your mount, a handy feature for catching those winter pretties from the warmth of the house. We have tested setups using an Ethernet based USB Server (also from *Keyspan*) coupled to the four port *Keyspan* USB to Serial Converter. The USB Server provided four USB ports, one of which was used by the four port USB to Serial Adapter, leaving 3 available USB and four available Serial ports at the mount. The computer was connected to everything via a single RJ45 Ethernet cable. For a more detailed discussion, go to the Yahoo ap-gto user's group (access it through our website) and type "pcmcia" "serial" or "usb" into the search box. Also, be sure to keep an eye on the "What's New?" pages of the website for further developments in this area.

FOCUS Connector

If you have a motorized focuser with a DC synchronous motor (like the JMI Motofocus), you can attach the 3.5mm phono plug connector here. This connector can NOT be used with motorized focusers that use stepper motors as they require their own separate drivers. Refer to the section regarding focus adjustment in the GTO Keypad Manual for instructions on using the keypad controller to adjust focus.

RETICLE Connector

If you wish to use the illuminator cable for our polar alignment scope or plug-in-type guiding eyepiece with an illuminated reticle (available from several manufacturers), insert the 3.5mm phono plug into this connector for power. Reticle brightness can be adjusted with the hand control. Refer to the section pertaining to reticle illuminator adjustment in the GTO Keypad manual for further information.

AUTOGUIDER Connector

This connector interfaces with the RJ-11-6 modular jack of an autoguider cable, purchased separately or as part of a CCD Imaging Camera or Autoguider. The autoguider will be functional and ready to go as soon as you plug it in. Please refer to the appropriate manual from the manufacturer for operation of the autoguider.

+6V Connector

This 6-volt output accepts 3.5mm phono plugs. It is used primarily to power the Pentax 6x7 camera directly from the mount with a cord sold for that purpose. As of mid 2007, we are no longer able to purchase these cables through Pentax, but they may be available on the internet.

N and S Switch

Select northern (N) or southern (S) hemisphere as needed. When you slide the switch to the opposite position, the tracking direction of the drive will reverse. The power cord must be removed and re-attached to make this work.

Drainage Holes

Two holes are drilled into the lower portion of the bottom of the control box. These holes allow excess moisture to drain from your control box, particularly useful on dewy nights. Please do not plug these holes.

Pre-loaded PEMPro Curve

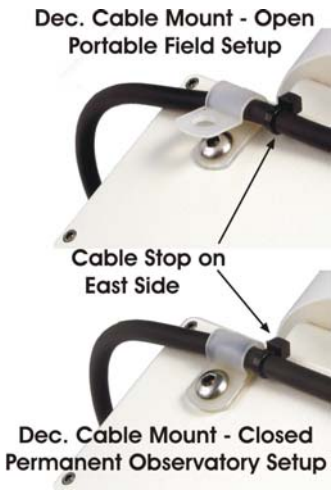
Your mount was tested at our production facility with a special version of PEMPro Periodic Error Management Software. After ensuring that the mount's uncorrected periodic error is within our specifications of 7 arc-seconds peak-to-peak, we generate a unique optimized PE curve for your specific mount, and then save the corresponding PE correction curve to the GTOCP3 control box for you to use. By turning PE on from the keypad, you can take advantage of this PE curve the very first time you use your mount. This PE curve should remain valid for several months as your gears "run in" and will probably suffice for many mount owners. Instructions for turning the PEM on in the keypad's "Tools" menu are found in the keypad manual.

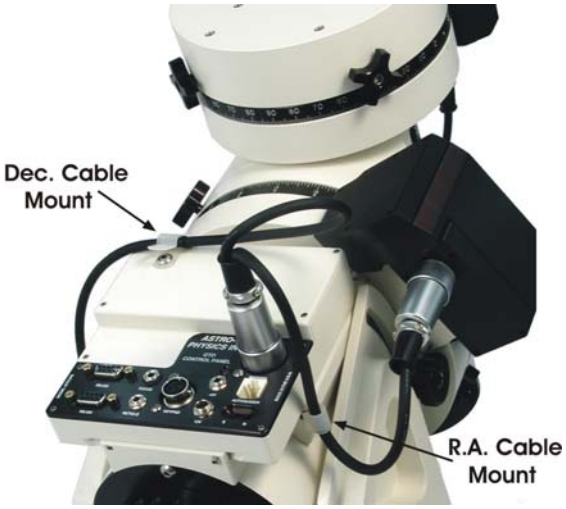
PEMPro v.2.0 has, of course, been included with your 900GTO, so you can actually produce an even more refined periodic error curve by using more worm cycles than we can do here at the factory. Although we can make no promises, we have heard numerous reports of sub-arc-second periodic error from experienced users running 6 or more worm cycles in PEMPro!

It is suggested that you save the existing curve to your computer before overwriting it in the control box with a new curve, just in case you do something wrong in your first attempt at a PEMPro run. That way, you can re-load the old data back to your control box if needed.

Prevent the Cables From Tangling

The movement of the mount across the meridian during slewing functions is calculated so that the cables will not tangle if they are set up properly. In addition to the motor and power cables that are provided with the mount, you may have additional cables for other accessories. These may be powered from the GTO Control Panel or from another power source. We suggest that you position your cabling carefully to avoid a tangled mess. When your cables are set up, move the telescope manually throughout the normal range of movement to be sure that the cables do not catch on anything and that you have enough length. Here are a few pointers:



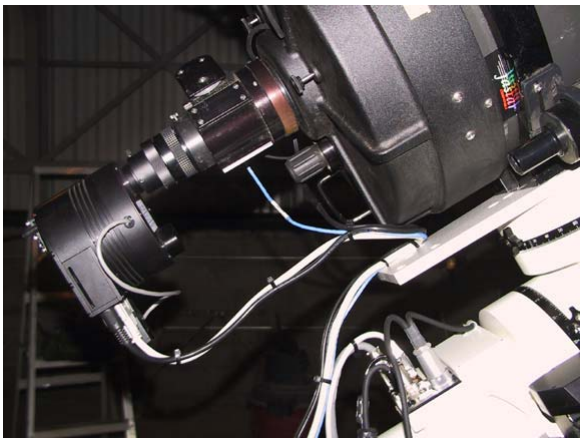


900 Motor Cables

Note that the "Y" cable for the 900 mount originates at the GTO Control Panel connector, and then splits into two. The short portion connects to the RA motor box and is not likely to be in the way because this axis remains in the same position. We have provided a cable mount to position the R.A. cable neatly. The longer Dec. portion of the cable must be set up properly to ensure that as the Dec. axis moves, the cable follows smoothly. Please insert this cable into the cable mount in the upper left corner of the GTO Servo Control Box as shown above. The cable stop should be on the east side of the cable mount (northern hemisphere – it will be on the west side in the southern hemisphere). This cable mount can be left "open" for portable use where the cables will be removed each night, or it can be "closed" for permanent installations in an observatory. When the connector is attached to the Dec. motor box, the cable should be positioned as shown in the photographs.

Accessory Cables

Accessories may include Kendrick Dew Removers, CCD cameras and autoguiders, focus motors, illuminated guiding eyepiece reticles, power cords for the Pentax 6x7 camera, etc. As you attach each accessory, carefully assess the best position to assure complete movement as your telescope slews from one side of the mount to the other. If an external power source is used, determine the optimum location for the battery. We prefer to use the included Velcro cable tie straps (not glamorous, but effective) or cable ties (from electronic supply store or catalog) to secure our cables to the mount, telescope, and rings or bind them together. Adhesive cable mounts similar to the one that we use for the Dec. cable are an alternative choice. These are available from electronic supply stores. We prefer to use the Velcro straps since we cannot bear to attach plastic adhesive cable mounts to our telescopes or mounts.



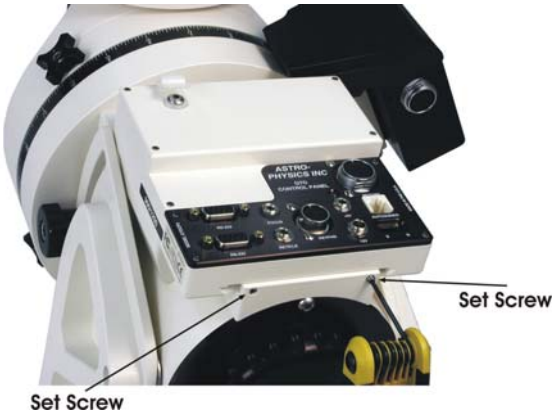
The photo on the left shows how the cables were arranged on the 1200GTO that was installed at a permanent observatory for the International Space Station – Amateur Telescope (ISS-AT) project. This mount is operated remotely and cable management is essential. The same principles apply to the 900GTO. The scope is a modified Celestron C-14 and the accessories included: CCD camera, color filter wheel, remote focuser and a Kendrick Dew Remover.

Note how the wire bundle is attached to the mounting plate before looping back to the pier. Attaching the wires securely to the plate prevents any kind of motion or disturbances to the camera during image acquisition and guiding. The loop is made long enough to allow the scope to reach all portions of the sky with plenty to spare. The people who installed the system ran the scope all over and reported zero interference.

This photo shows the mount and scope with the wire loop containing all the cables from the CCD camera, color filter wheel, remote focuser and Kendrick Dew Remover. If you look closely, you will notice that the two clutch knobs were removed and replaced with special Allen head bolts. This allowed the Dec cable to slide easily over the axis in all orientations and there was no snagging of the wire anywhere. Please call Astro-Physics if you would like to order these bolts. Do NOT try to install normal Allen head bolts, they must be modified.

For a portable setup, we keep the ties wraps in place as much as possible when we disassemble our equipment. The setup for the next session is much quicker.

Removing the GTO Control Box from the 900GTO Mount



The GTO control box can be removed easily from the R.A. axis. It is secured by two 8-32 set screws located at the base of the GTO Control Box. Loosen the screws with one of the hex keys from the set included with the mount. Lift the box up from the bottom and tilt so that it frees from the dovetail connection.

Some people have a permanent observatory, yet prefer to store their electronics in their home to keep them clean and free of cobwebs. If you do, you may wish to substitute the 8-32 thumbscrews (included with your mount) for the setscrews. This will allow you to remove and install your GTO control box without tools.

GTO KEYPAD CONTROLLER OPERATION

Please refer to the separate manual for the GTO Keypad for complete instructions.

SLEWING YOUR MOUNT IN BELOW FREEZING TEMPERATURES

Notes from Roland during a very cold spell in January 2005:

“There are several potential problems when slewing your mount in below freezing temperatures. The symptoms are a wavering or chattering sound from the motors, a slowing down of the slewing with a sudden jolting stop at the end of the slew, and in the worst case, a continuous running of the motors and loss of control. I have seen similar things on my own mounts when the temperature dips below zero F. There are three things that you can look at to alleviate the problem.

First, in cold weather it takes a very much larger amount of power to slew the motors than it does in the summer (see tests I ran below). This extra current drain can cause a voltage drop in the power cord running from the supply to the servo. If you have a long distance between the supply and servo, use a heavy wire to minimize the voltage drop. If the power drops below

about 11 volts at the servo terminal, the internal computer chips may reset with subsequent loss of control of the motors. If your supply is marginal, it may also not produce the voltage necessary for proper operation during slews. It is a good idea to limit the slew speed to 600x during real cold weather to reduce the power demand from the supply.

Second, it is very important to have the worm mesh not set overly tight. One symptom of overly tight worm is a chattering sound as the motors try to slew at 1200x or even as low as 600x. You can check to see if the worm turns easily with your finger by removing the motor covers and removing the large spur gear to get access to the worm end. Try turning it by hand. If it does not easily turn, then the motor will also have a difficult time turning it. Check in our technical section of the AP web site on how to set the worm mesh. In real cold weather, well below zero F, it might also be a good idea to lubricate each of the spur gears and their sleeve bearings with a light machine oil. When warmer weather returns, this can be replaced with a light grease, Lubriplate 105, which will reduce the wear factor in warm temperatures.

Third, under very extreme temperature conditions below -20F, it may be necessary to replace the grease on the worm wheel teeth with a lighter material. The mounts use a special formulation of Lubriplate 105 with a damping grease added. This combination is ideal for low wear since the damping grease portion allows the grease to stay on the teeth and not get wiped off by the motion of the worm. Although this combination works well even at temperatures below zero, it does get more viscous in really cold conditions. We have tried straight low temperature greases that work to -80F, and in each case, the worm gears get abraded very quickly. Using no grease at all is also not recommended for a GoTo system that slews at high speeds. The wear on the worm and wheel teeth is extremely high and can develop very high periodic error after a short time due to scratches and high spots that develop on the gear teeth. At this time we have no solution to ultra-low temperatures.

Last night it was -8 F here, and I tested several of our mounts in the observatory. Two are very old, from the original batch, and one is brand new. All worked well at 600x but showed signs of laboring at 1200x slewing. I use a 12-volt marine battery to power them. I replaced the marine battery with a variable power supply that I varied from 12 volts to 18 volts. At 12 volts when both motors were slewing at 1200x, the power draw was in excess of 8 amps (in summer this is around 2.5 amps). The motors were laboring and not running smoothly at full speed. I turned up the voltage to 15 volts, and the current draw dropped to around 5-6 amps. The motors worked smoothly at 1200x with no hesitation at that voltage level. I would recommend for cold weather work to get a supply that can deliver 15 - 16 volts at a rated current capacity of 10 amps. Higher than that is not necessary. Above 18 volts is not recommended."

It is possible that these recommendations may change over time due to new lubricating products or upgrades to the keypad program that will allow slewing at 300x (under development as of this writing). Please refer to the Technical Support section of our website for the latest recommendations.

MOUNT CARE, CLEANING AND MAINTENANCE

Like any fine piece of equipment, your mount's longevity and performance are directly correlated with the quality of the care that you give it. Handle it with respect, keep it as clean and dry as is practical, and perform a few minor maintenance tasks, and your 900GTO will give you many years of trouble-free service.

Care

Although we build it to be rugged enough for field use, your 900GTO is a precision instrument with very accurate worm and wheel adjustments. Please be careful if you place the mount on a flat surface, i.e. the ground or trunk of your car. The gear alignment may be affected if the R.A. and Dec. motor/gear box assemblies sustain undue lateral force. This is true of any fine instrument. We suggest that you transport and store the mount in a case or in a well-padded box. ALWAYS disassemble the mount before moving it or transporting it. More damage can be done in a few careless seconds in transit than in many hours of normal operation.

Try to keep your mount protected from dust and moisture when not in use. In warm, humid weather, be aware of the dew that may have formed on the mount while in the field and allow the mount to dry out before packing it away for storage once you get home. On the other hand, if it is cold and dry outside, keep the mount packed up when you bring it into the house until it reaches room temperature to avoid "fogging it up." (The same advice applies to telescopes, eyepieces and other equipment in your Astro-arsenal.)

Cleaning and Touch-up

Wipe your mount clean with a soft dry cloth. If needed, you can use a damp cloth or a cloth that has been sprayed with a mild, non-abrasive cleaner (window or all purpose cleaner – no bleach). Do not spray cleaners directly onto your mount. If you use a cleaning product, follow with a damp cloth to remove the chemicals from the mount.

The painted surfaces of your mount may end up with scuff marks from repeated transport and assembly / disassembly. Most of the time, these marks can be removed with a product like Color Back by Turtlewax (automotive product). Simply apply

with a paper towel and buff out the mark. If your paint becomes chipped, touch-up kits are available for purchase – please call us. NOTE: Paint touch-up kits can only be sold to U.S. customers because of regulations governing shipment of hazardous materials.

Mount Maintenance

Under normal operating conditions, minimal maintenance is required. Every 12 months the clutch knobs (4 for Dec. and 4 for R.A.) should be removed and 1 small drop of light oil (3 in 1 household oil) should be put in the exposed hole. If the R.A. and Dec. axes are attached together for a long time in outside conditions (i.e. in a permanent observatory) then the mating surfaces should be lightly oiled or greased - if you expect to get them apart again after 10 years.

Jostling and vibrations associated with transport to and from observing sites has had the effect of causing screws and fasteners to work their way loose over time. We have worked very hard in both the design and assembly of our mounts to alleviate this problem, but it is still a good idea to periodically (once or twice a year) inspect and if necessary re-tighten any easily accessible fasteners. Additional maintenance information can be found below in the troubleshooting section and in the Technical Support Section of our website.

ADDITIONAL TIPS AND SUPPORT

For additional information regarding the 900GTO, refer to the Technical Support Section of our website. We also encourage you to participate in the ap-gto user group. The members of this group are very knowledgeable about the operation of their mounts, CCD imaging and other related issues. The staff of Astro-Physics also participates and you will find a wealth of information in the archives. To find the group, link from User Groups in our website's sidebar.

We encourage you to submit your technical support questions directly to Astro-Physics by phone or e-mail: support@astro-physics.com.

TROUBLESHOOTING

Additional troubleshooting questions are in the GTO Keypad manual. Some of the issues discussed in the keypad manual relate to mount communication issues whether you use the keypad or control the mount with a planetarium program or PulseGuide. Please refer to them.

The Declination (or R.A.) axis is fairly tight, even with the clutch knobs fully loosened.

This occurs when the clutch plugs have been damaged from over-tightened clutch knobs. Please refer to the appendix at the end of this manual for detailed instructions on clutch plug removal and how to fabricate your own clutch plug tool.

The LED on the GTO Control Box changes from red to yellow and the motors stop or go out completely (for mounts shipped after 02-25-00).

1. The motors are overloaded, probably due to an unbalanced load on your mount.

   Rebalance your telescope, and then press one of the N-S-E-W buttons to reset the keypad. Re-enter the last object on your keypad and the scope will slew to the correct position. Even though your motors had stopped, the logic in the control box retained the scope position in memory. As long as you didn't change the pointing position of the scope, you are still calibrated.

   If the scope was moved during re-balancing, simply enter a nearby bright star on the hand controller, press GOTO and allow the mount to finish slewing. You can then move the scope manually or with the N-S-E-W buttons to center the star in the eyepiece, and press the #9 RECAL button. This will recalibrate the mount.

   Additional explanation: The GTO drive circuit includes logic for overload protection to prevent burning out the expensive servomotors in case of severe overload on the two axes. The primary cause is an unbalanced load in R.A. If the extra load opposes the motor rotation, the motor must work harder to track at the sidereal rate and the current will rise to high levels. If the current exceeds the trip point for more than a minute, the logic will shut the motor off and tracking stops. It typically takes about 4 lb. of unbalance to trip the overload, but a very heavy load of scopes, accessories and counterweights on the mount can decrease this unbalance threshold.

2. The voltage of your battery has probably gone below 10.5 volts.

3. The current rating of your AC-DC power supply is too low.

   Additional explanation: During slewing, the two motors draw up to 3 amps from a 12 volt source. This may increase when the temperature approaches freezing or below. It is recommended that your supply be rated at 5 amps, 12 volts DC minimum (18 volts max.). If you also power other equipment (CCD cameras, dew heaters, etc.) from the

same source, you will need a supply capable of up to 10 amps. The more equipment you have, the more current capability you will need. For portable applications, we recommend a heavy-duty marine battery designed for deep discharge applications. The most common problems are due to inadequate power supply.

The keypad reset (or locked up) when I plugged my CCD camera, PC (or other equipment) into the same battery as the GTO mount was using. The battery has a meter, which shows 12V.

The meter is reading an average and will not show dips. Gel cells have internal resistance, which will cause voltage drop when the load changes. When you connect an additional CCD camera and PC the load will drop below 9 volts and the keypad will reset or it may affect the GTO circuit itself and cause the keypad to lock up.

We recommend that you use a large marine battery that is not a gel cell and hook everything up to it before calibrating the GTO. Or, better yet, put the other equipment on a separate battery.

What is the maximum voltage that I can use to power the servo drive?

The servo drive of the *Mach1GTO*, 900GTO and 1200GTO will withstand up to 24 volts without any sort of damage to the internal electronics, according to our engineer. However, above about 17 volts, the motors may become a bit jittery because of the higher gain with this much voltage. The system works very well with 15 - 16 volts. Please note that for most applications, 12 volts works just fine.

For polar alignment, I am using declination drift technique with stars on east & south. Now, I do not see any drifts in declination on both sides (E & S), so the mount _should_ be properly aligned. However, I have still small drift in RA which looks like the RA motor is a bit faster than earth rotation. This drift is something like 1.5 arcsec during 1 minute or so and is accumulated over time, so it doesn't look like periodic error.

The sidereal tracking rate is exact in the mount (it is crystal controlled and checked here for accuracy). However, the stars do not move at exactly the sidereal rate everywhere in the sky. The only place they move at that rate is straight overhead. As soon as you depart from that point in the sky, the stars will be moving more slowly, especially as you approach the horizons. Thus, it looks like the mount is moving slightly faster than the sidereal rate. Just because you have done a classic drift alignment, does not mean that the stars will now be moving at the sidereal rate everywhere in the sky.

In order to increase the area of sky from the zenith that will give you fairly good tracking, you will need to offset the polar axis by a small amount. The amount will depend on what your latitude is. The other approach is to vary the tracking rate for different parts of the sky. Ray Gralak's Pulse Guide will allow you to dial in an exact tracking rate for any part of the sky.

Initially, the mount was working fine. Then, suddenly the mount stopped tracking altogether!

Chances are that the motor was turning properly and driving the worm gear, but that your clutches might have been loose and therefore the scope was not following the motion of the worm gear. The fact that the high slew rate did move the scope does not change this, because Roland has seen this himself where the tracking rate did not overcome the slipping clutches but the slew rate did.

If you are unsure of the motion of the motor, just remove the motor cover plate and look inside. You will see the motor turning. Sometimes when you have the clutches loosely engaged and the counterweights are somewhat out of balance, being heavy in the east, then the clutches might slip at the slow sidereal rate.

In any case, just to set your mind at ease, simply remove the motor cover next time something like this happens and look at the motor shaft. If the motor is not turning, you will have some kind of electrical problem. If it is turning, then it is mechanical.

The motors sound louder and more labored in cold weather.

As the temperature drops, we recommend that you reduce your slewing speed to the slowest slew rate. The cold causes the lubricants to get stiff in the gearboxes. This can make the high- speed gears resonate and sound screechy. Lowering the slew speed in winter will eliminate this. You might also want to add a drop or two of light machine oil to the center posts of the individual gears. Just remove the cover on the gearbox and add the oil drops. The noise is nothing to worry about. Refer to the section of this manual entitled: Slewing Your Mount in Below Freezing Temperatures.

The declination axis does not appear to be moving properly. How can I check it?

Please refer to the appendix for the instruction sheet: “Characterizing the Dec Axis Motions,” which explains how to use Maxim DL software to characterize your mount’s performance.

If any problems occur, please don't hesitate to contact Astro-Physics for assistance.

RECOMMENDED READING FROM OUR STAFF:

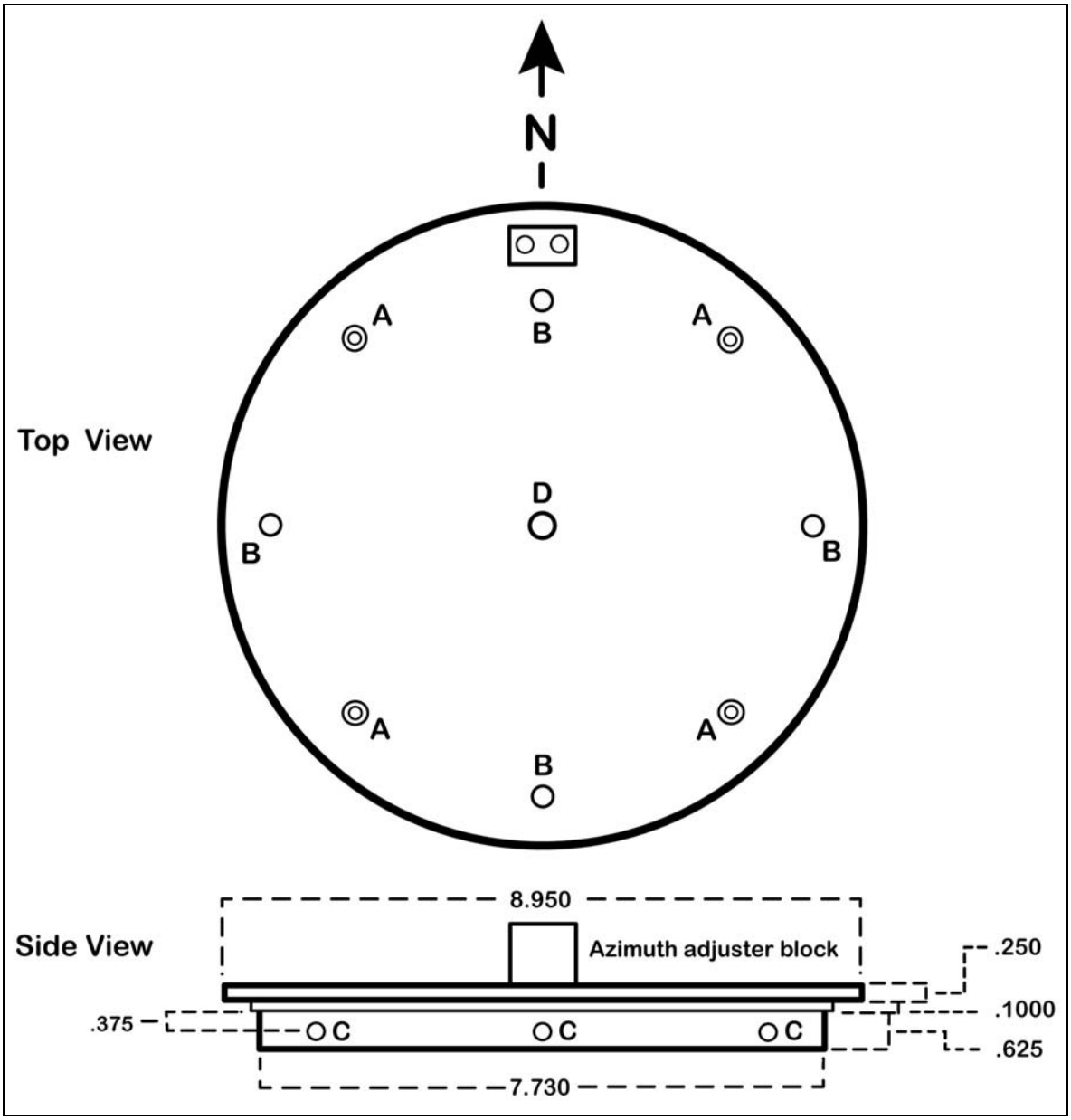
The Backyard Astronomer's Guide, Terence Dickinson and Alan Dyer, Firefly Books Ltd., Rev. Ed., Oct. 2002.
ISBN 155209507X
The authors, both former editors of *Astronomy* magazine, offer practical insight into astronomical equipment, finding your way around the sky, polar alignment, using setting circles, and astrophotography. This book provides excellent explanations and is well organized and illustrated.

All About Telescopes, Sam Brown, Edmund Scientific Company, 1975. Sky Pub Corp; 5th edition, June, 1981
ISBN 0933346204
Excellent information regarding the principles of mount construction and operation, using setting circles, eyepiece projection, etc. Illustrations and formulas galore. Many of the instruments pictured are outdated; however the underlying principles are timeless.

Norton's 2000.0 Star Atlas and Reference Handbook, edited by Ian Ridpath, Benjamin Cummings; 20th edition, October 7, 2003,
ISBN-10: 0131451642
ISBN-13: 978-0131451643
Star maps, information regarding polar alignment of German Equatorial and observing techniques.

There are many other excellent books about astronomy, astronomy equipment, astro-photography, CCD imaging and other related topics. If you need a recommendation for a particular application, pose your question to either of these user's groups: ap-ug or ap-gto; both are on Yahoogroups.

STANDARD PIER ADAPTER FOR THE 900GTO MOUNT



The 900 series mount is designed to fit into our 8" outside diameter pier which is available in several heights. The pier adapter of the 900 mount shown above fits into the post (aluminum tube) of the pier assembly and is secured with six (6) 5/16-18 screws at the location marked C.

If you want to make your own pier, you can either use these six side holes (marked C) or you can use the four countersunk through-holes (marked A) located on the top of the plate. You can also drill additional countersunk holes to fit your specific requirements.

A. - Countersunk through-holes for 1/4-20 cap screws - You can use these four (4) holes to attach the mount to a flat surface. The bolt circle radius is 3.615". (This gives a square 5.112" on a side)

B. - The rest of the mount attaches to this pier adapter with hand knobs at these locations.

C. - These six (6) 5/16-18 threaded holes are spaced every 60° on the circumference.

D. - The screw that is installed at this location is used to help center the rest of the mount during assembly. DO NOT remove or replace!

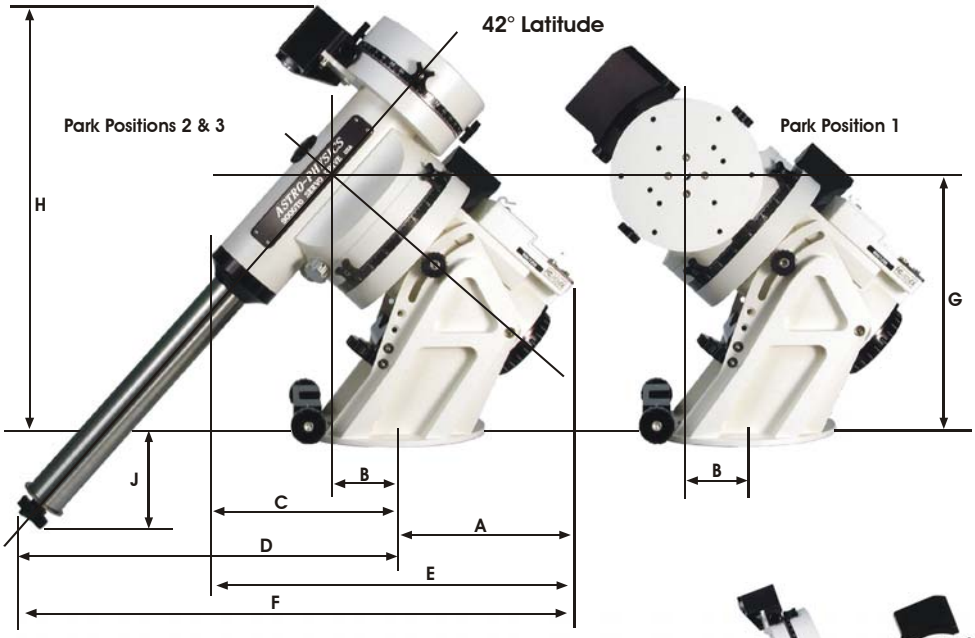
USEFUL DIMENSIONS FOR OBSERVATORY PLANNING

People often ask us what the 900GTO's dimensions are. The answer is: It depends. Different latitude settings can drastically affect the shape and dimensions of the mount. To answer this question we have prepared the following diagram. Your PulseGuide CD also has an Excel spreadsheet for calculating these and additional dimensions for your own latitude and system. Note: The photos below show the 900GTO with an older version of the counterweight shaft.

ASTRO-PHYSICS 900GTO

10/04/05

GERMAN EQUATORIAL MOUNT



ASTRO-PHYSICS 900GTO

Relevant Dimensions for Observatory Planning at Different Latitudes

Dim.	From:	To:	20°	42°	68°
	Horizontal dimensions				
A	Center of Baseplate	Back of Mount	6 7/8"	8"	8 3/4"
B	Center of Baseplate	Center of Dec. Axis	4 3/4"	2 1/2"	-1"
C	Center of Baseplate	Front of Mount	8 7/8"	8 1/2"	5 7/8"
D	Center of Baseplate	End of Counterweight Shaft	12 5/8"	17 1/8"	18 3/4"
E	Front of Mount	Back of Mount	15 3/4"	16 1/2"	14 5/8"
F	End of Counterweight Shaft	Back of Mount	19 5/8"	25 1/8"	27 1/2"
	Vertical Dimensions				
G	Bottom of Baseplate	Center of Dec. Axis	8 1/4"	11 3/4"	14 3/8"
H	Bottom of Baseplate	Top of Mount	15 7/8"	19 3/4"	21 3/4"
J	Bottom of Baseplate	End of Counterweight Shaft	-11 7/8"	- 4 1/4"	6"

The illustrations and accompanying table show the variations in certain important dimensions due to different latitude settings for the 900GTO.

These measurements may be useful for determining clearances when designing an observatory or deciding on an appropriate pier height.

The 900's latitude range is from 20° to 68°. The main image shows a mid-latitude setting of 42° (the latitude at ASTRO-PHYSICS). The smaller images show the mount set at 20° and 68° for comparison.

Horizontal dimensions will be the same for all 900 mounts. For mounts with older style fork assemblies, subtract 7/8" from the vertical dimensions.

CLUTCH PLUG REPLACEMENT FOR 900 OR 1200 MOUNT

Who needs clutch plug replacements?

If the clutch knobs of your 900 or 1200 mount are tightened down with excessive force, the plugs under the knobs may deform and splay out. This will cause your mount to feel very stiff and you will be unable to back off the pressure of the clutch knobs. Once this happens, the clutch plugs need to be replaced.

We have developed a tool, part #M0100, that will successfully remove the clutch plugs so that you can install new ones. If you prefer to make your own tool, we offer instructions in the Technical Support section of our website.

The part number of the clutch plugs is M12665-A. Please do not try to substitute your own clutch plugs since incorrect dimensions or composition of the material can impair the performance of your mount.

What you will find in this package:

- A special screwdriver that has been modified by Astro-Physics, if you ordered it. This screwdriver is marked with masking tape. DO NOT REMOVE this tape. Instructions for making your own tool can be found below and in the Technical Support section of our website.
- Replacement clutch plugs (M12665-A).

What you will need:

- ½ to 1 pound hammer
- A light machine oil (example: 3 in 1)

Replacement of "old" Clutch Plugs

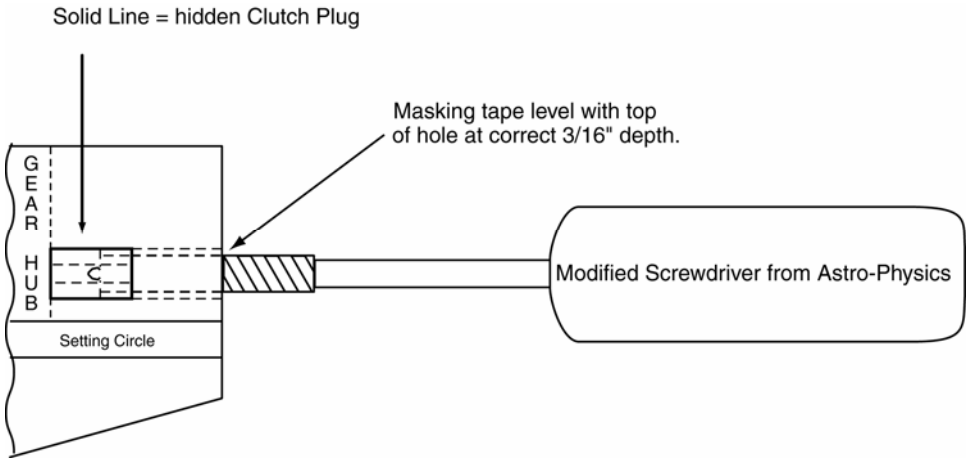
Removal of the old plugs will be done by, "hammering" the special "screwdriver" into the old plug. This will create a "driving" slot for the "screwdriver" blade.

Please follow the steps below.

Remove the clutch knob from the clutch plug hole

Insert the screwdriver into the clutch plug hole and press down firmly (make sure the guide point on the screwdriver is fully engaged in the center hole of the "old" clutch plug

Sharply hammer the screwdriver so as to drive its' blade about 3/16 of an inch into the old plug. The masking tape on the screwdriver shank will provide a good reference for this 3/16" depth. The tape will be "level" with the top of the clutch plug hole when the correct depth has been achieved (see the illustration below).



Maintaining a positive downward pressure, turn the screwdriver in a counter clockwise direction. This will cause the old clutch plug to "unscrewed" from the clutch hole. You may need to use considerable turning force at first to get the old plug to start to "unscrew" itself.

About 25 or so revolutions of the screwdriver will be needed to withdraw the plug completely.

Place a "new" clutch plug down the hole.

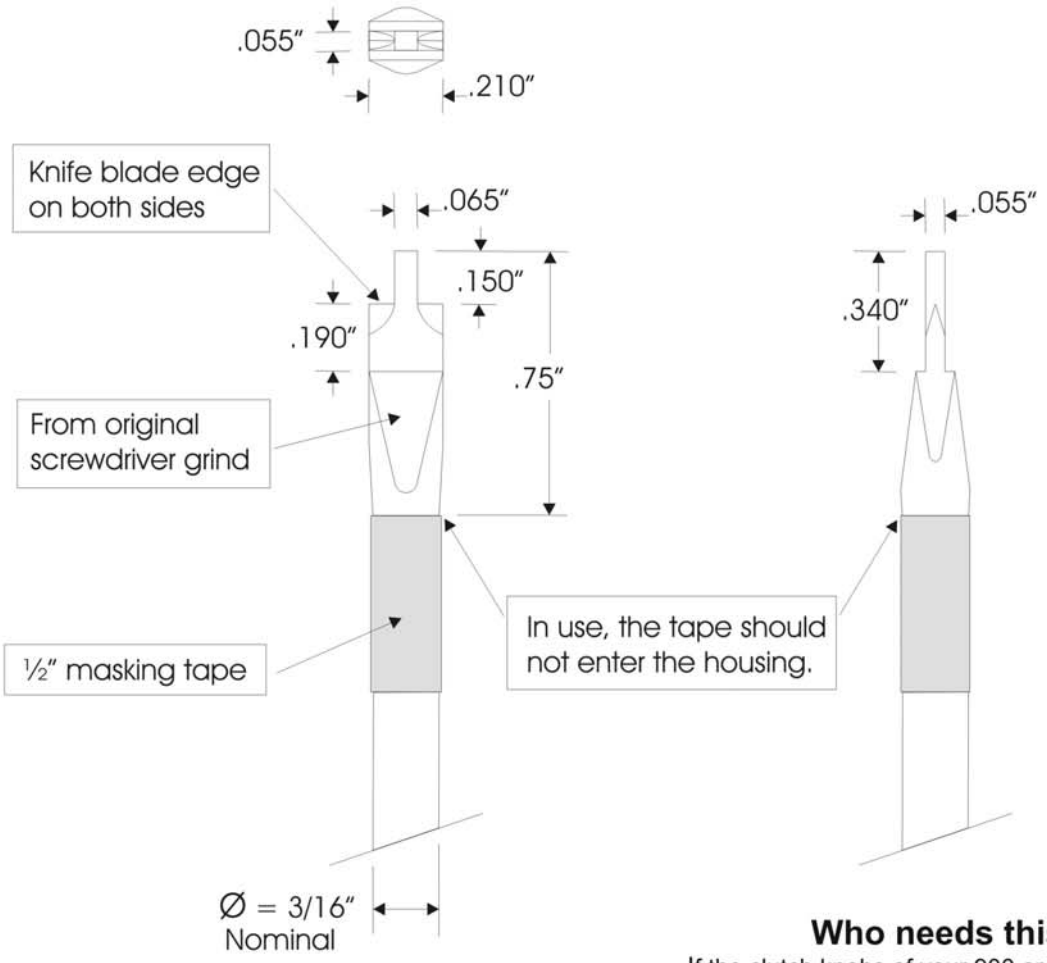
Place 2 – 3 drops of light machine oil down the hole.

Replace clutch knob.

Repeat above steps with the remaining seven "old" clutch knobs.

Updated: 08-08-05

Construct Your Own Clutch Plug Extraction Tool



Clutch Plug Extraction Tool

For 900 and 1200 Mounts

Tip Details

SCALE: 2 : 1
Dimensions ± .0025 inch
Date: 8-4-05

Drawn by: H.K.H.
Data by: W.A.P.

The tool is made from grinding the tip of standard 3/16 inch flat head screw-driver of 4 - 6 inch length.

Who needs this tool?

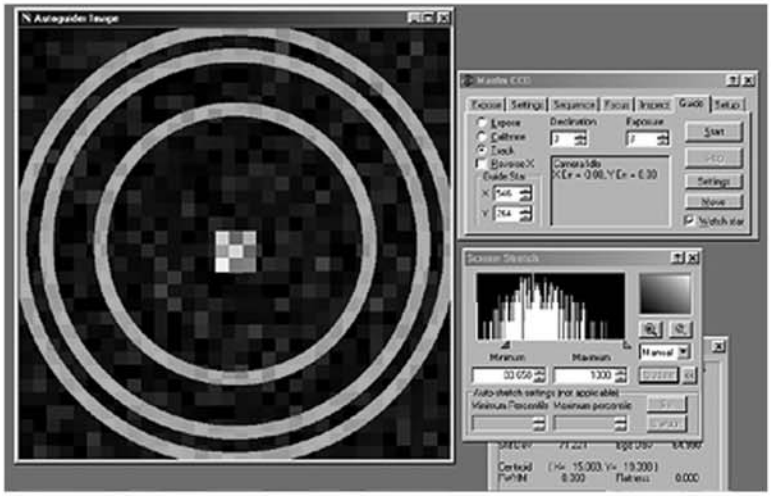
If the clutch knobs of your 900 or 1200 mount are tightened down with excessive force, the plugs under the knobs may deform and splay out. This will cause your mount to feel very stiff and you will be unable to back off the pressure of the clutch knobs. Once this happens, the clutch plugs need to be replaced.

Solution:
We have developed a tool that will successfully remove the clutch plugs so that you can install new ones. We offer this diagram for those people who wish to make their own tool. We also offer the tool for sale as part #M0100. Please call Astro-Physics for pricing.

Call Astro-Physics to order the clutch plugs, part # M12665-A. Please **do not** try to substitute your own clutch plugs since incorrect dimensions or composition of the material can impair the performance of your mount. Instructions will be provided with the new clutch plugs and are also available from the Technical Support section of our website.

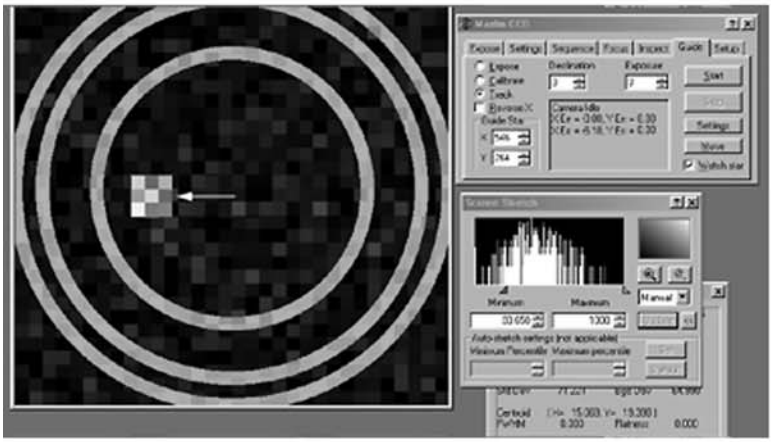
CHARACTERIZING THE DEC AXIS MOTIONS

These instructions explain how to use Maxim DL software as a tool for characterizing any problems with the Declination axis movements of your mount. However, Ray Gralak's PulseGuide software offers an easier and more extensive evaluation procedure. PulseGuide is available as a free download through our website.



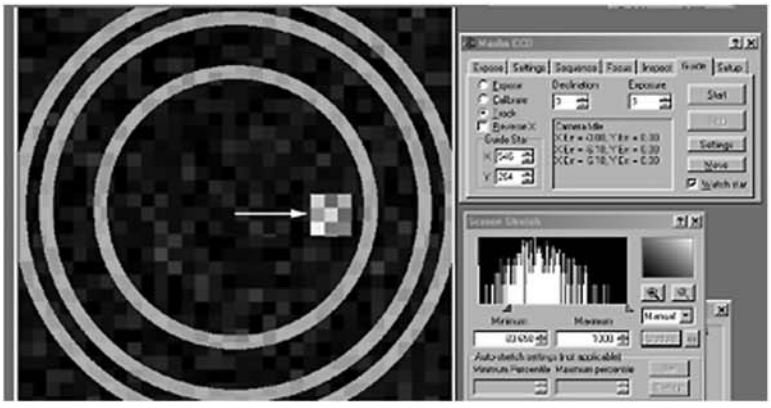
Step 1

Acquire a reasonably bright guide star and begin guiding in RA only - turn off Dec guiding (note X and Y are switched on the Maxim parameter page, as of v3.07). Use a 1 second or faster refresh rate so you can see the motion of the guide star as you begin to move it around. Magnify the screen to 1600x and place the cursor in the middle as shown. Check to make sure that the mount is guiding adequately in RA, and that the guide star is not bouncing around due to poor seeing. Best results will be achieved when the RA guiding is 0.5 pixels average in RA.



Step 2

Put the keypad button rate at 0.5x. Press the keypad North button until the guide star has moved approximately 6 pixels from the center. Now press the South button in very short pulses and note which direction the star moves. It should move back toward the middle after a few button presses. It might move slightly up or down, or it might continue to move further away from the middle, or any combination. Please note exactly how far, and in which direction, the guide star moves (pixel position is displayed in the guide box at right in Maxim). Please allow a moment for the star to settle down after each button press.



Step 3

Press the South keypad button until the star has moved 6 pixels off the center in the opposite direction. Repeat Step 2 and note exactly the motion of the guide star as you move it with the pulsed motion at 0.5x.

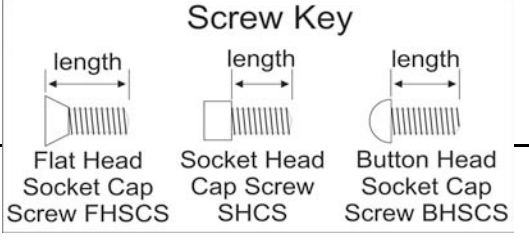
You may wish to enable Track Log to record the numbers for further study. Please note on the log what you did at what time so the results will be useful later.

You have now characterized the Dec axis.

09-15-03

Astro-Physics Mounting Plate Fastener Chart

A-P Part #	Description	Ships with:
FP1500	15" Flat Plate	(**4**) 1/4-20x5/8" SHCS [for mounting to 400, 900 or Mach1GTO] (**4**) M6-1.0x20mm SHCS [for mounting to 600E] (**4**) 1/4-20x3/4" SHCS [for mounting to 1200]
FP1800	18" Flat Plate	(**6**) 1/4-20x1" FHSCS [for mounting to 900 or 1200] (**4**) 1/4-20x1-1/4" FHSCS [Mach1GTO]
DOVE08	8" Dovetail Plate	(**4**) 1/4-20x1/2" SHCS [for mounting to 400] (**4**) M6-1.0x16mm FHSCS [for mounting to 600E] (**4**) 1/4-20x5/8" SHCS [for mounting to 900 or Mach1GTO, requires Q4047] (**4**) 10/32x3/4" SHCS [for mounting as Accessory Plate onto A-P rings]
DOVE 15	15" Dovetail Plate	(**4**) 1/4-20x1/2" FHSCS [for mounting to 400 or Mach1GTO] (**4**) M6-1.0x16mm FHSCS [for mounting to 600E] (**4**) 1/4-20x5/8" FHSCS [for mouting to 900 or 1200] (**4**) 10/32x3/4" SHCS [for mounting as Accessory Plate onto A-P rings]
DOVELM2	8.5" Dovetail Plate for Losmandy D Series Plate	(**4**) 1/4-20x5/8" SHCS [for mounting 400 or Mach1GTO] (**4**) M6-1.0x20mm SHCS [for mounting 600E] (**2**) 1/4-20x5/8" FHSCS [for mounting to 1200] ** (**4**) 1/4-20x3/4" SHCS [for mounting to 900 or 1200] **
DOVELM16/S	16" Dovetail Plate for Losmandy D Series Plate for 1200GTO - "S" version for 900 or Mach1GTO	(**6**) 1/4-20x1" SHCS [for mounting to 900 or 1200] (**4**) 1/4-20x7/8" SHCS [for Mach1GTO]
900RP	15" Ribbed Plate for 900 or Mach1GTO	(**6**) 1/4-20x1" FHSCS [for mounting to 900] (**4**) 1/4-20x1-1/4" FHSCS [for mounting Mach1GTO]
1200RP15	15" Ribbed Plate for 1200	(**6**) 1/4-20x3/4" SHCS [for mouting to 1200]
1200RP	24" Ribbed Plate for 1200	(**6**) 1/4-20x1" SHCS [for mounting to 1200]
Q4047	900/Mach1GTO Adapter for use with DOVE08	(**6**) 1/4-20x5/8" FHSCS [for mounting to 900] (**4**) 1/4-20x1" FHSCS [for mounting to Mach1GTO]
SB0800 *OR* **SB1000** *OR* **SB1500**	Sliding Bar	(**2**) 1/4-20X1/2" SHCS (**2**) Acorn Nuts (**2**) 1/4-20 Nuts (**2**) 1/4-20x3/8" SHCS (**1**) 10-32x5/8" FHSCS (**1**) 10-32 Nut
CABPT, TRAYSB & TRAYSB1	Control Box Adapter, Bi-Level Support Bar & Single Level Support Bar	**(1)** 1/4-20X3/4" FHSCS **(1)** 1/4-20X1" FHSCS **(1)** 5/16-18X1" BHSCS **(2)** 5/16-18X3/4" BHSCS



** DOVELM2 may also be attached to 900 mount with (1) 1/4-20x5/8" FHSCS and (1) 1/4-20x3/4 SHCS