

# **ASTRO-PHYSICS**

## ***Mach1GTO German Equatorial Mount with GTOCP3 Control Box***

Includes GTO Keypad and PulseGuide software CDs



### **Why a Mach1GTO?**

#### **Design Goals:**

This is the first-generation, compact, light-weight mounting that was designed for utmost portability while maintaining extreme rigidity and excellent tracking accuracy. No shortcuts were taken to achieve these goals. From the highly accurate fine-pitch gearbox to the precision machine tool bearings, to the innovative worm wheel and clutch design, this mount represents a new approach to this vital part of the overall imaging train.

The advent of modern CCD cameras and telescopes with high resolution optics has placed greater demands on the ability of mountings to do their part to achieve precision tracking and guiding. At the same time, the mounting should be easy to use with adjustments and setups that are straight forward and accurate. We have done everything possible to eliminate the frustrations and limitations inherent in a lesser mounting and so put the fun back into the hobby of amateur astronomy.

#### **Principal features of the Mach1GTO Equatorial Mount:**

- The heart of this mount is a precision gearbox using high-quality fine-pitch gears, coupled to a highly accurate worm and worm wheel. These parts are manufactured and assembled at our facility and individually tested to meet or exceed our periodic error spec of 7 arc seconds (+/- 3.5 arc sec.). The servo drive uses the same Swiss motors found on our larger mounts. They are oversized and easily drive the mount at full slew speeds in below-freezing temperatures. The brass worm is machined to have a true helical thread, clean and accurate for minimum periodic error. The PE is smoothly variant with extremely

low ripple or moment to moment error.

- Although the mounting is very light for its size and load rating, it has been machined out of solid metal to withstand the high axial and thrust loads that a large telescope places on the mount under real-world observing conditions. It is solidly built and will withstand gusting winds without excessive shake or vibration. We used high-quality machine tool bearings, rated in excess of 400 lb. static and dynamic load, on the main axis shafts. Both worm wheels turn smoothly with no runout throughout their 360 degree range.
- This mount is light and portable enough to go into an airline overhead case that will be available as an option. It is the perfect travel mount, easily set up at a remote location on our lightweight aluminum tripod (SDS400) or our new folding pier (details will be available at a future time) for astrophotography with CCD or film cameras. It will handle pretty much any moderately-sized scope from short 4" - 6" Apo refractors, 6" - 8" Maksutovs, to the popular 8" - 10" SCTs.
- The mount comes apart into two light weight assemblies. Both axes have 2 inch clearance holes down the center with no shafts protruding into the holes so that wires from CCD cameras and accessories can be inserted from the bottom of the RA axis to emerge from the top of the Dec axis. There is no restriction of rotation with the wires inserted - one can rotate both axes more than 360 degrees without catching the wires on any parts. The gearboxes are identical and can be interchanged.
- The mount comes with our superb GTO Servo Drive and Keypad package and PulseGuide software for maximum performance during image acquisition. PulseGuide allows you to accurately track asteroids, comets and the Moon, which move relative to the stars. PEMPro (available as an option) is a very powerful program that allows the user to characterize the periodic error and to reduce it dramatically for long unguided exposures. It is especially useful for this mount since the average worm rotation error is already quite low, and the short term ripple error is almost nonexistent.
- The altitude adjustment allows the mount to be used from zero to about 70 degrees latitude, from the top of Finland to the coast of the Antarctica. There is a scale on the side for approximate adjustment in the field and the mount will have a bubble level in the base. The azimuth adjustment is approximately +/- 12.5 degrees.
- If you already own our previous 400 or 600E German Equatorials, you will be pleased to learn that the same accessories can be used with the *Mach1GTO*, including counterweights, mounting plates, polar alignment scope, piers and tripods.



## Flexibility

### Portable Enough for Airline Travel

Transport this rigid observing platform to your dream destination. A rugged carry-on case will roll easily through airports or to your car.

### Sophisticated Enough for Remote Operation

The *Mach1GTO* was designed from the ground up to take full advantage of the latest electronics. The integral internal cable channel allows multiple electronic devices to be used without the usual tangled cable nightmare. The *Mach1GTO* uses the same servo control box, the [GTOCP3](#), as its big brothers - the [900GTO](#) and [1200GTO](#) mounts. This cutting edge electronic marvel coupled with software like Ray Gralak's wonderful [PulseGuide](#) (included) and your PC make remote operation a pleasure.

### Operate with 12V battery or Regulated Power Supply

You can take it to the darkest skies and power it with a commonly available 12V battery. In the observatory, we suggest a minimum 5 amp filtered, regulated power supply.

### **Clutches and interchangeable motor / gear boxes**

Clutches allow manual operation if power is not available. If, heaven forbid, your RA motor fails, simply swap the Declination motor / gear box and resume tracking in RA. This will be a much appreciated backup procedure when you are far from home on an extended vacation.

### **Image Past the Meridian**

The mount will track and guide well past the meridian in either direction if the object is located such that the telescope will clear the pier. This allows the user to set up the mount for a long series of exposures without stopping in the middle to flip sides. One can start the telescope under the mount while pointing at an object in the eastern part of the sky and track it all the way deep into the western sky. This is very useful for long exposure H-alpha or in cases where a large number of individual exposures are needed for stacking.

### **Easy Alignment for Non-critical Observing**

You can align the *Mach1GTO* with a polar alignment scope (optional) to quickly zero in on the pole for most non-critical observing or to get close before tweaking in for CCD. You can even align it during the day with our clever Daytime Polar Alignment Routine (outlined in the Keypad Manual) for solar observing, viewing the planets at twilight, or just getting a jump start on a long night.

### **External Computer not Needed**

The Keypad is a handheld computer with all of the features, functions and databases you need to tour the universe night after night. The unique firmware allows you to precisely polar align your mount in the field, even in broad daylight! The vacuum-fluorescent display with a temperature range of -40 degrees F (and C, they are the same in this instance), allows hardy observers to use this mount on cold winter nights. You can't do that with a PC or PDA! As new firmware versions are released in the future, you can upgrade your keypad directly from the [download](#) section of our website - free of charge!

### **Control with personal computer, if desired.**

All functions of the servo drive can be commanded from a laptop or desktop computer using popular planetarium software. Depending on the features of the program, you can position your telescope, center your image and control tracking rate, remote focusing, reticle brightness and park at the end of your observing session. The *Mach1GTO's* unique 2 inch internal cable path allows a multitude of electronics to be routed THROUGH the mount where they won't tangle, snag, or otherwise cause problems. This innovative feature makes computer controlled imaging and guiding a pleasure. Examples of currently available software:

- [PulseGuide](#) by Ray Gralak (included with the Mach1GTO)
- [PEMPro](#) by Ray Gralak
- [Software Bisque's](#) suite which includes TheSky Astronomy Software, CCDSoft CCD Astronomy Software, TPoint Telescope Pointing Analysis Software and Orchestrate Scripting Software.
- [Desktop Universe](#) by Main Sequence Software
- [Earth Centered Universe \(ECU\)](#) by David Lane of Nova Astronomics
- [SkyMap Pro](#) by Chris Marriot
- [Starry Night Pro](#) by Imaginova
- [DigitalSky Voice Software](#) by Charles Sinsofsky
- Any software that is [ASCUM](#) compliant.

### **Write your own computer program.**

The [Astro-Physics GTO protocol for the GTOCP3 Control Box](#) is freely available to those who would like to write their own computer program for controlling the mount.

## **Precise Mechanical Fabrication**

### **Highly accurate mechanics**

Using modern CNC machining techniques, we make all components to a high precision level, which results in a final package that is solid and accurate in all respects. The critical angles are accurately machined so that the mount is orthogonal to a very high degree. This results in pointing accuracies well below 1 arc minute for a properly aligned mount.

### **Worm gear accuracy**

Critical worm gear accuracy is maintained by special machining techniques developed at Astro-Physics after

extensive studies and actual field operation. Our worm accuracies are second to none and are guaranteed to be 7 arc seconds (+/- 3.5 arc sec.) or less peak-to-peak for the Mach1GTO. The periodic error of each mount is verified during our extensive testing procedures. With good alignment and PEM training with the Keypad or [PEMPro](#) software, it is quite practical now to achieve unguided CCD images with today's hi-resolution cameras coupled to a 4" to 10" telescope.

## Mechanical Features

- All machined mounting made from aluminum barstock and stainless steel. All fasteners are stainless steel.
- Motors and all electronic components are enclosed
- Machine tool bearings achieve tremendous rigidity in a small package.
- Polar and declination axes come apart quickly for light-weight, easy handling and ease of transport in a carry-on luggage case.
- Fine altitude and azimuth adjustments for quickly and accurately zeroing in on the pole in the field
- Electronic components rated for industrial and automotive applications
- Pier Adapter (included) fits into 6" outside diameter pier with 0.083" wall thickness



**Mach1GTO** shown with SBIG STL-11000XM camera, ELPAC FW7212 Power Supply and a variety of cables

## Specifications of Equatorial Head

|                               |                                  |
|-------------------------------|----------------------------------|
| Worm Wheels - both axes       | 5.9" (150mm), 225 tooth aluminum |
| Worm gears                    | Brass, 0.709" (18mm) diameter    |
| R.A. and Dec. thrust surfaces | 4.1" (104mm) diameter            |
|                               |                                  |

|                           |  |
|---------------------------|--|
| Bearings                  | 3.1" (78mm) diameter   |
| Periodic Error Maximum    | 7 arc seconds (+/- 3.5 arc sec.) or less in one worm cycle (6.4 minutes)   |
| Axis Shaft Diameters      | 2.36" (60mm)   |
| Latitude range            | 0 to 70 degrees  |
| Azimuth adjustment        | 25 degrees (+/- 12.5 deg. from center)   |
| Motor Power Consumption   | 400 mA - tracking<br>2 Amps - both motors slewing  |
| Power Requirements        | 12V DC, 5 Amp. (Acceptable Range: 11.5 to 16V)   |
| Capacity                  | Approximately 45 lbs. (20kg) scope and accessories (not including counterweights), depending on length. Will accommodate Astro-Physics and similar fast refractors up to our 160mm f7.5 StarFire EDF, 8" - 10" SCT's and 6" - 8" Maks.<br>These are only guidelines. Some telescopes are long for their weight or very heavy for their size and will require a larger mount. Remember also that imaging requirements are more rigid than visual observation. |
| Weight of equatorial head | 26 lbs (11.8kg); Declination axis is 11 lbs. (5kg); Right Ascension axis is 14 lbs.(6.4kg); Pier adapter is 1 lb. (0.5kg)  |
| Counterweight Shaft       | 1.125" diameter X 12" long, 3.5 lb. (29mm X 305mm, 1.6kg)<br>Longer sizes available.   |

## Servo Motor Drive

The drive system uses a high-quality Swiss DC servo motor controlled by a microprocessor to an accuracy of 0.05 arc-seconds per step. Tracking is very smooth, noticeably smoother than any stepper motor drive or inexpensive servo motor. The system can be accurately controlled over a speed range of 4800:1 which allows 0.25x sidereal for guiding to 1200x sidereal for 5 degree per second slewing. The circuit draws only 0.4 amps when tracking the stars, 2 amps with both motors slewing and requires only 12 volts to operate. The servo drive will satisfy the requirements of the sophisticated, advanced astrophotographer, yet is easy for the casual, visual observer to use. Please refer to [GTOCP3 Control Box and Keypad for Servo Drive](#) for additional information.

## Pier / Tripod Mounting Options

The *Mach1GTO* can be mounted directly into the top of an [Astro-Physics 6" Portable Pier](#) or a new collapsible pier that is under development. It can also be mounted on the [Adjustable Wood Tripod \(AWT000\)](#) or the [Lightweight Adjustable Aluminum Tripod \(SDS400\)](#) using the [ADATRI](#) adapter (included with tripods purchased from us). The [ADATRI](#) adapter also allows the *Mach1GTO* to be mounted on your own custom pier or tripod and can be purchased separately.

## PulseGuide™ Software

PulseGuide is a stand-alone Windows (98, ME, 2000, NT4, XP only) utility that provides complete remote control of the Astro-Physics *Mach1GTO*, [400GTO](#), [600EGTO](#), [900GTO](#), and [1200GTO](#) 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. With just a few exceptions, it supports the entire serial Astro-Physics command protocol allowing full control of your mount through your PC. This program is indispensable for remote control of your mount. [More ....](#)

PulseGuide was written by Ray Gralak of Sirius-Imaging. Please refer to his web site <http://www.pulseguide.com> for further developments and enhancements. The software will be provided on a CD-ROM with your Mach1GTO mount. Previous owners of any Astro-Physics mounts can download the software free-of-charge, courtesy of Ray. Many, many thanks to Ray for this powerful program.

## PEMPro Software

PEMPro (Periodic Error Management Professional) is a Windows software application that makes it easy to characterize and reduce periodic error. It may be purchased separately as an option. While the periodic error of your *Mach1GTO* will be 7 arc seconds (+/- 3.5 arc sec.) or less, you can reduce it even further to maximize performance without auto-guiding. [More ...](#)

## Price and Delivery Information

The price has not been finalized, however the target price is \$ 5,950. Production will begin in February 2006. Estimated delivery of the first mounts is the summer of 2006.

In mid-January, we will contact all of the people on our existing 400GTO/600EGTO notification lists, which we have merged together. We will provide information regarding the new mount and ask each person to confirm their interest in the *Mach1GTO*. If you are not already on one of these lists, you can sign up on our [online notification form](#). A confirmation e-mail will be sent to you for your records.

## Recommended Accessories

- Mounting Plates- [FP1500](#), [DOVE15](#), [DOVELM2](#), [DOVE08](#) (requires [Q4047](#)), and [900RP](#) (with new adapter under development)
- [Kendrick Astro Instruments](#) 18 Amp-hr. 12 Volt Rechargeable Battery Pack
- [Astro-Physics Portable Pier](#) - 6 " diameter, heights 24",32",42",48",54",62
- [Santa Barbara Instrument Group](#) All CCD Star Tracker/Imaging Systems
- [Advanced Telescope Systems \(ATS\) Portable Piers](#) - 8" diameter with flat plate on top and [ADATRI](#) adapter
- Cable for SBIG Autoguiders and CCD Imaging Cameras
- [Stainless Steel Counterweights](#) - 6, 9 lbs
- [Pier Accessory Trays and Support Bar](#)
- [Cord for Pentax 6x7 camera \(CORD01\)](#)
- [Polar Alignment Scope \(PASILL3\)](#)
- [Tripod Adapter \(ADATRI\)](#) - attach to tripod or other flat surface.
- [Mounting Rings](#)

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