GM 2000 HPS
High Precision – for your astronomical future

10 MICRON astro-technology
by COMEC-TECHNOLOGY

baader planetarium
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WWW.10MICRON.DE
GM 2000 HPS II

This mount knows that it is a mount

The GM 2000 HPS II mount is built for the demanding observer using photographic instruments up to a weight of 50kg – 110 lbs (counterweights not included).

The mount is driven by two AC servo motors with timing belt reduction and zero-backlash. Both axes feature a classic worm to wormwheel pairing. The wormwheels are made of bronze (B14), have a diameter of 172mm and 215 teeth. 24mm alloy steel is used for the worms. The axes themselves are made of 50mm diameter alloy steel for maximum rigidity.

NGC 891. Unguided exposure of 400s. Scale of 0.7”/pixel.

The complete electronics is integrated into an easily removable, independent control box. All connectors of motors, encoders and hand pad are fixed with security lock screws.

The mount can be fully controlled with the included professional 4-lines standalone keypad, no external PC needed, not even for highly demanding jobs like satellite tracking.

The internally heated keypad is optimized for all light conditions – day and night – and for deep temperatures. It can be operated with gloves. Both the display and the ergonomic keys feature a red backlight.

The mount can be controlled with common software packages by connecting it to a PC with RS-232 serial port, Ethernet or WiFi, via the proprietary 10micron ASCOM driver or conventional compatible command protocols. Furthermore, a dedicated software (included) can be used to create a “virtual keypad”, replicating exactly the functions of the physical keypad. The RS-232 port also allows the direct control of Baader Domes without PC.
This flexibility makes the GM2000 HPS an ideal mount for remote-controlled observatories. This mount knows that it is a mount.

The object database contains many star catalogs and deep-sky objects up to 16th magnitude. Solar system objects can be tracked with non-sidereal speed. Orbital elements of comets, asteroids and artificial satellites can be loaded into the mount, so that these objects can be tracked directly using the standalone keypad (without an external PC).

The usage of a model containing up to 100 stars makes the pointing accurate (visit www.10micron.de/downloads for the “Automated model maker for 10Micron GM mounts” by Per Freijvall). Modeling allows correction of classical polar alignment and conic errors, and also of the most important flexure terms of the optical tube. This way it is possible to obtain pointing accuracies in the order of 20 arcseconds RMS. The same model can be used in order to obtain the maximum tracking accuracy, compensating also for the atmospheric refraction (depending on local atmospheric pressure and temperature).

A series of auxiliary functions provide automated align procedures for precisely aligning the mount to the celestial pole.

You may save and recover the alignment data of different observing sessions. This function is very useful if you have many instruments in different setups, each one requiring different flexure corrections (mount models).

Tracking through the meridian – a typical problem with german mounts – is solved by allowing tracking for up to 30° past the meridian (configurable) in both directions. In this way any object can be tracked for at least four hours.

The resulting tracking accuracy makes autoguiding unnecessary for most projects. The absolute encoders on both axes allow to obtain a typical tracking error below 1 arcsecond. However it is still possible to autoguide using the ST4-compatible port or through the serial/Ethernet connection, with a guide rate configurable from 0.1x to 1x. The guide rate can be automatically corrected for the target declination, there is no need of recalibrating the autoguiding parameters when observing at different declination.

Designed for field use, the ultraportable version of GM2000HPS is easily divided into two parts. By assembling the mount all electrical components are automatically connected. The larger piece weighs only 18.5kg - 40 lbs. In combination with the Centaurus II tripod (21kg - 46 lbs) you gain a perfect combination for the mobile observer.
All functions of the mount are targeted to obtain maximum flexibility for actual field conditions. The mount can be switched on and off using the dedicated connector on the control box panel and it can be parked in different user-defined positions.

You can use the electronic balance functions in order to balance your instrument without unlocking the clutches.

A Baader-dome can be controlled without an external PC or Laptop via RS-232 serial port. Once configured with your instrument parameters, the firmware is able to make all the calculations required for positioning the dome slit in front of your optical tube for almost all instrument configurations.

### GM 2000 HPS II INCLUDED ITEMS

- embedded Computer-Controller with Linux Management System for complete remote use of the mount incl. all functions such as satellite tracking, lunar features and more
- Interface: RS232, Ethernet, Wi-Fi
- Connectors for: GPS, Autoguider, Keypad, Mount, Aux and Remote Switch
- Latest QCI software (Version 2.x)
- Connection cables, counterweight bar
- PC Software: Virtual Keypad, Clock Sync Tool, Mount Logger, Mount Configurator, ASCOM Driver
- Instruction manual
- #1452059: 4-Lines Stand-Alone Keypad with metal housing and heated screen
- #1452095: Standard base adapter flange
- #1452066: Special foam fitted transport cardboard box

### GM 2000 Ultraportable:

Mount dimensions (mm) at latitude 45°

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#### THE HPS TECHNOLOGY

HPS stands for **High Precision and Speed**, representing the essence of the latest 10micron mounts. **High precision**, thanks to an innovative and exclusive absolute encoder paired with 10micron manufacturing. **High speed**, thanks to high performance electronics and AC servo motors.

The HPS-series mounts are equipped with a pair of ultra-high resolution absolute encoders, directly mounted at the right ascension and declination axis.

This technology has already been used in professional observatories, where high costs and complexity is not an issue. Measuring the rotation angles of the axes directly allows to compensate for most of the mechanical errors, such as periodic errors and transmission backlash. However, this requires systems with very high resolution.

In the past few years this technology could also be found in amateur astronomers’ instruments, often paired with the use of direct drive technology where motors are mounted directly on the mount’s axes – without any mechanical reduction gear.

10Micron GM mounts continue to feature the traditional worm to wormwheel drive solution, while pairing it with state of the art encoder technology. The encoders do their job with 1/10 arcsecond resolution. This enables GM mounts to perform at the same level of precision as professional direct-drive mounts (without any mechanical drive) but without all the downsides of a mount only controlled by electronically manipulating magnetic fields.

10micron mounts need no homing and are much less prone to motor stall and adverse balancing conditions or heavy windload/gusts than direct-drive mounts.

10Micron GM mounts: Delivering results, reliability & rock solid dependability, also for your remote observatory.

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Tracking error profile measured with an encoder coupled to the r.a. axis. Jupiter and Ganymede are shown as they appear from Earth, at the same scale.
GM 2000 HPS II

MAIN ACCESSORIES

Counterweights 6kg / 12kg
Stainless steel
#1452075 / #1452080

Stabilized power supply AC
Converts 240 V input into 27V
#1452070

3" dovetail bars w/o holes
Heavy duty dovetail bars in 400 and 500mm length (fits 4" clamp #1452135)
#1452140 / #1452141

4" dovetail bars w/o holes
Heavy duty dovetail bars in 400 and 500mm length (fits 4" clamp #1452135)
#1452140 / #1452141

GM 2000 HPS II

4" MAXIDUAL double mounting plate incl. 4" clamp
Balancing design, with 2 pcs. 3" dovetail clamps #1452085 for mounting of two telescopes. Maximum Center-to-center distance 27 cm.
#1452105

Steel pier Adapter
for existing pillar adaption
#2451171

4" MAXIDUAL double mounting plate incl. 4" clamp
Balancing design, with 2 pcs. 3" dovetail clamps #1452085 for mounting of two telescopes. Maximum Center-to-center distance 27 cm.
#1452105

3" LODUAL double mounting plate
Balancing design, with 2 pcs. 3" dovetail clamps #1452085 for mounting of two telescopes. Maximum Center-to-center distance 27 cm
#1452105

3" dovetail single clamp
Losmandy-style, Length: 300 / 400 / 500mm
#1452125 / #1452130 / #1452131

3" dovetail bars w/o holes
Losmandy-style, Length: 300 / 400 / 500mm
#1452125 / #1452130 / #1452131

Baader Pan EQ dual clamps
to hold 44mm EQ dovetails, bottom has 3" dovetail built-in with brass clamping blocks 230 / 370 mm long
#2451566 / #2451565

3" LODUAL double mounting plate
Balancing design, with 2 pcs. 3" dovetail clamps #1452085 for mounting of two telescopes. Maximum Center-to-center distance 27 cm
#1452105

Baader Pan EQ dual clamps
to hold 44mm EQ dovetails, bottom has 3" dovetail built-in with brass clamping blocks 230 / 370 mm long
#2451566 / #2451565

3" LODUAL double mounting plate
Balancing design, with 2 pcs. 3" dovetail clamps #1452085 for mounting of two telescopes. Maximum Center-to-center distance 27 cm
#1452105

CENTAURUS II Tripod,
Aluminium
including accessory tray and waterproof cordura carrying bag. 90 – 135cm, 200kg payload, weight: 21kg
#1452057

Stabilized power supply AC
Converts 240 V input into 27V
#1452070

More accessories on next page and www.10micron.de

Missing something?
**ADDITIONAL ACCESSORIES**

*Everything you need for your GM 2000 HPS II mount*

- **#1452062H** (for Monolith)
  - Prof. Flight-Case (2 pcs)
  - Head- and Counterweight-Flight-Case set (trolley + hand case).
  - Total protection against water, dust, chemicals, impact & drop.

- **#1452063H** (for Ultraport)
  - Prof. Flight-Case (3 pcs)
  - Head- and Counterweight-Flight-Case set (2x trolley + hand case).
  - Total protection against water, dust, chemicals, impact & drop.

- **#2457577A**
  - Power converter 12V/24V
  - Converts 12 V input into 24 V 5A output, for field use. Suitable ONLY for car batteries with 12V. Not to use with 12V power supplies.

- **#1452062H (for Monolith)**
  - Prof. Flight-Case (2 pcs)
  - Head- and Counterweight-Flight-Case set (trolley + hand case).
  - Total protection against water, dust, chemicals, impact & drop.

- **#1452066**
  - Special foam fitted transport cardboard box
  - Shaped inner padding and sturdy cardboard box with handles.

- **#1452065**
  - Mount protective cover
  - Cordura cover with upper zip, can be placed on the mount even with payload attached.

- **#1452069**
  - Professional 4-Lines Keypad
  - From aluminium with heated screen to equip any old mount with firmware 2.x and higher. Stand-Alone!

- **#1455005**
  - WiFi Upgrade board
  - Wi-Fi connection with access point and routing function. Included with HPS mounts from 11/15.

- **#1455030**
  - Remote module switch
  - Including cable, manual, power supply, web interface and smartphone app. A must for observatories.

- **#1454105**
  - GPS receiver module
  - Directly connected to the mount, provides the exact time and coordinates of the observation site.

**GM 2000 HPS UPGRADE-PACKAGES**

*The perfect addition to complete your GM 2000 HPS II mount*

- **#1452026**
  - Professional Upgrade-Package “Monolith” for GM 2000 HPS
    - #1452075 / #1452080  | 2pc counterweight set of 6kg and 12kg - stainless steel with 40mm diameter
    - #1452085 | 3” Losmandy dovetail clamp for GM2000, 200mm long
    - #1452057 | CENTAURUS II tripod, aluminium, complete with upholstered Cordura transport-bag
    - #1452062H | very durable professional “flight case” for mount and accessories (2pc: trolley and hardcase) made of TTX01
    - #1452070 | Power-Supply outdoor type 230V / 24V - 6A 150W
    - #1455010 | PERSEUS Software Package

- **#1452026U**
  - Professional Upgrade-Package “Ultraport” for GM 2000 HPS
    - #1452075 / #1452080  | 2pc counterweight set of 6kg and 12kg - stainless steel with 40mm diameter
    - #1452085 | 3” Losmandy dovetail clamp for GM2000, 200mm long
    - #1452057 | CENTAURUS II tripod, aluminium, complete with upholstered Cordura transport-bag
    - #1452063H | For Ultraport: very durable professional “flight case” for mount (RA/DEC) and accessories (3pc: 2x trolley and hardcase) made of TTX01
    - #1452070 | Power-Supply outdoor type 230V / 24V - 6A 150W
    - #1455010 | PERSEUS Software Package

**Please note:**
- Mount is not included in the Upgrade Packages.

**Attention:**
- All 10 MICRON mounts should ONLY be used with approved power supplies from this brochure or our price list. Damages induced by using third party power supplies may result in loss of warranty! For more Information visit [www.10micron.de/warranty](http://www.10micron.de/warranty).
PUSHING THE PERFORMANCE ENVELOPE

The effort to improve performances never stops

The most important features defining the performance of an astronomical mount are the **tracking accuracy** and **maximum slew speed**. Constant technological evolution allows to continuously improve these numbers. From the first GM2000 FS2 mounts with stepper motors to the GM3000 HPS, tracking accuracy has been improved by an order of magnitude and the pointing speed has been improved by a factor of three.

High slew speed is required for many astronomical applications. Searching for supernovae, asteroids or exoplanets, where images from a large number of different objects are required in minimum time, as well as tracking artificial satellites.

On the other hand an excellent tracking accuracy is required for high-resolution deep-sky imaging, in order to simplify or completely get rid of complex autoguiding systems, which can be a killing source of errors or breakdowns for remote controlled observatories.

FIFTEEN YEARS OF HISTORY

More than fifteen years of experience in astronomical manufacturing

The 10micron mount line was born in 2000 with the clear aim of providing products with high quality standard: equatorial mounts, altazimuth mounts and tripods – always designed for best performance.

The complete range of traditional german equatorial mounts from GM 1000/2000/3000/4000 HPS, up to the special application AZ2000 HPS and AZ5000 / AZ8000 DDS altazimuth mounts, the 10micron product range is dedicated to serve the most demanding imagers and university level observeratories as well.
**High Precision – for your astronomical future**

### TECHNICAL DATA

<table>
<thead>
<tr>
<th>Specification</th>
<th>GM 1000 HPS</th>
<th>GM 2000 HPS</th>
<th>GM 3000 HPS</th>
<th>GM 4000 HPS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mount Type</strong></td>
<td>German Equatorial Mount</td>
<td>German Equatorial Mount</td>
<td>German Equatorial Mount</td>
<td>German Equatorial Mount</td>
</tr>
<tr>
<td><strong>Weight (mount w/o acc.)</strong></td>
<td>~ 19.5 kg (~ 43 lbs)</td>
<td>~ 35 kg (~ 77 lbs)</td>
<td>~ 65 kg (~ 143 lbs)</td>
<td>~ 125 kg (~ 276 lbs)</td>
</tr>
<tr>
<td><strong>Weight, Ultraviolet exposure (mount)</strong></td>
<td>~ 19.5 kg (~ 43 lbs)</td>
<td>~ 15 kg (~ 33 lbs)</td>
<td>~ 40 kg (~ 88 lbs)</td>
<td>~ 75 kg (~ 165 lbs)</td>
</tr>
<tr>
<td><strong>Instrument payload capacity</strong></td>
<td>25 kg ~ 55 lbs</td>
<td>50 kg ~ 110 lbs</td>
<td>100 kg ~ 220 lbs</td>
<td>150 kg ~ 330 lbs</td>
</tr>
<tr>
<td><strong>Latitude range</strong></td>
<td>0° ~ 90° (90° optional)</td>
<td>0° ~ 70°</td>
<td>20° ~ 70°</td>
<td>20° ~ 70°</td>
</tr>
<tr>
<td><strong>Azimuth fine adjustment range</strong></td>
<td>± 7.5°</td>
<td>± 10°</td>
<td>± 10°</td>
<td>± 10°</td>
</tr>
<tr>
<td><strong>Counterweight shaft</strong></td>
<td>30 mm diameter, stainless steel, weight 1.7 kg (~ 3.7 lbs)</td>
<td>40 mm diameter, stainless steel, weight 4.5 kg (~ 9 lbs)</td>
<td>50 mm diameter, stainless steel, weight 6 kg (~ 13 lbs)</td>
<td>60 mm diameter, stainless steel, weight 13 kg (~ 29 lbs)</td>
</tr>
<tr>
<td><strong>Bears</strong></td>
<td>Pre-loaded tapered roller bearings</td>
<td>Pre-loaded tapered roller bearings</td>
<td>Pre-loaded tapered roller bearings</td>
<td>Pre-loaded tapered roller bearings</td>
</tr>
<tr>
<td><strong>Worm wheels</strong></td>
<td>210 teeth, 125 mm diameter, B14 bronze</td>
<td>210 teeth, 244 mm diameter, B14 bronze</td>
<td>320 teeth, 244 mm diameter, B14 bronze</td>
<td>320 teeth, 244 mm diameter, B14 bronze</td>
</tr>
<tr>
<td><strong>Worms</strong></td>
<td>20 mm diameter, tempered alloy steel, grinded and tapped</td>
<td>24 mm diameter, tempered alloy steel, grinded and tapped</td>
<td>32 mm / 24 mm diameter, tempered alloy steel, grinded and tapped</td>
<td>32 mm / 24 mm diameter, tempered alloy steel, grinded and tapped</td>
</tr>
<tr>
<td><strong>Motors</strong></td>
<td>2 axes AC servo brushed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power supply</strong></td>
<td>24 V DC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power consumption</strong></td>
<td>0.5 A while tracking</td>
<td>0.7 A while tracking</td>
<td>1 A while tracking</td>
<td>1.5 A while tracking</td>
</tr>
<tr>
<td><strong>Go-to speed</strong></td>
<td>Adjustable from 2% to 15%</td>
<td>Adjustable from 2% to 20%</td>
<td>Adjustable from 2% to 12%</td>
<td>Adjustable from 2% to 8%</td>
</tr>
</tbody>
</table>

### General Specifications

- **Transmission system**: Backlash-free system with timing belt and automatic backlash recovery
- **Go-to accuracy**: < 2° with 25 stars software mapping - max.100 stars; possibility to use the Model Maker software for automated alignment operation.
- **Average tracking accuracy**: ~ 1° typical for 15 minutes
- **Security stop**: ± 30° past meridian in r.a. (software) ± 45° past meridian in r.a. (mechanical)
- **Communication ports**: RS-232 port, GPS port, autoguide ST-4 standard port, Ethernet 10/100/1000 port
- **Database**: Stars by Common Names, Bayer designation, Flamsteed designation, Bright Star Catalogue, SAO, HIP, HD, PPM, ADS, GCVS. Deep-sky: M, NGC, IC, PGC, UGC limited up to mV = 16. Solar system: Sun, Moon, planets, asteroids, comets, artificial satellites. Equatorial and altazimuthal coordinates. User defined objects. Quick slew positioning recalls for frequent focusing or useful operation.
- **Firmware features**: User defined mount parking positions, 2stars and 3stars alignment function, up to 100 alignment stars for modeling, correction of polar alignment and orthogonality errors, estimate of average pointing error, storage of multiple pointing models, sidereal, solar and lunar tracking speed adjustable on both axes, declination-based autoguide speed correction, adjustable horizon height limit, pointing and tracking past meridian, assisted electronic balance adjustment, automatic (Clock/Sync proprietary software) manual or GPS time & site coordinates synchronization, leap seconds support and full accounting for the UT1-UTC timescale, configurable atmospheric refraction, direct Baader domes control via RS-232, network settings, comets and asteroids filter, multi-language interface, remote assist via internet connection w/o disconnected server.
- **Keypad control**: Hugged keypad with metal housing and reliable professional micro switches. Large graphic display – heated for operation under lowest temperatures, dimmable display and keyboard with backlit keys, five information menu lines for coordinates, object information and symbols showing mount status and active external connections and accessories. At the functionality of the mount is available through the keypad without requiring an external PC.
- **PC control**: Remote control via RS-232, Ethernet, proprietary 10Micron ASCOM driver, LX200 compatible protocol, update of firmware and orbital elements of comets, asteroids and artificial satellites via RS-232 or Ethernet, PC virtual KeyPad control panel via RS-232 or Ethernet, Integrated Wi-Fi for connection with smartphones and tablets and any wireless network.

### Firmware

- Dual Tracking, automatic refraction (configurable) and flexures correction functions implemented – the only way for perfect unguided tracking during long exposures
- Intuitively operated V.2 software, proprietary motor control system with temperature compensated clock and integrated into an onboard Linux computer – intelligence built-in
- No external PC or laptop mandatory in the field – all functions in the onboard computer can be accessed via stand-alone hand control unit (HC)
- Precise multi-star pointing models, entering satellite and comet trajectories, programming individual observing sessions and much more
- Well documented firmware and drivers, working automatically w/o additional planetarium software, without need for external RS-232 converters / USB ports
- Excellent documentation in English and German
- Electronic balance - requiring one time balancing only
- Ultra stable pointing models for safe East/West load reversal – no change of pointing model necessary when changing accessories. Recordable models database for different telescope setups
- Precise polar alignment – software aided and accomplished within minutes
- Fully remote controlled via your observatory PC with 10/100/1000LANandWiFi/option included–perfectly prepared for your future Internet observatory
- Manual, automatic (Clock Sync proprietary software) or GPS based time; leap seconds support for the different timescales of UT1 and UTC
- Remote diagnostics web assist option w. dedicated server
The development of 10micron products is aimed to provide both the best performances and the maximum ease of use.

The availability of more and more advanced and flexible astronomical imaging systems opens new ways to work on the sky: today, ultra-high definition and ultra-high speed imaging is within the amateur's reach, way more as predicted ten years ago. 10micron's products evolved at the same pace, in terms of tracking, pointing accuracy and speed. The HPS-series mounts are at the peak of this process.

Every observer knows that when you are under the sky you have little time and each set up operation comes with the risk of compromising the night. Having excellent performance on paper means nothing if you need too many complex set up operations.

This is the reason why 10micron mounts are designed for the user's needs, and not to enforce the mount's way of operation onto the user.

10micron mounts are now used in open field as well as in remotized sites, in educational observatories as well as in the extreme climates of northern Canada and the Atacama desert.