AVALON INSTRUMENTS

M-zero obs

Observatory
(Made in Italy)

INSTRUCTION MANUAL

Version 1.0.7 April 2021

SAFETY STANDARDS AND WARNINGS

- **Read the manual carefully before installing and using the mount.**
- **To make the document easier to read in the field, we recommend to copy all documentation files from the supplied USB drive to a smartphone or, even better, to a computer or tablet.**
- **Use the power cable supplied with the mount or else a 15V- 3A stabilized power supply as suggested in the manual.**
- **Make sure that the power cable is connected correctly and securely to the power socket.**
- **Do not bend, pull or press the cable as this may damage it.**
- **For any assistance or repairs, please contact only the manufacturer.**
- **Be sure to remove the power supply at the end of an observing or imaging session or before performing cleaning or maintenance. When removing from a power outlet, pull on the plug, not the cable.**
- **This mount is intended for use exclusively by adults. Do not allow it to be used by children under 12 or by people with impaired mental faculties.**
- **Operate the mount only as indicated in the manual.**
- **Modifying or altering the characteristics of the mount in any way will void the manufacturer's limited warranty.**
- **Never modify the tension of the belts (governed by a dedicated screw). These are set in the factory and any unauthorized change will void the manufacturer's limited warranty.**
- **After using the mount, avoid storing it in areas exposed to sunlight or in wet places.**

IMPORTANT NOTE: DO NOT USE ANY KIND OF LUBRICANT, SPRY, LIQUID OR OIL ON THE BELT DRIVE SYSTEM !!!
Any use of lubricants will void the manufacturer's limited warranty.

Summary

Technical Specifications

Type	Equatorial Single-Arm mount with Fast-Reverse technology
Weight	17,6 kg (38,8 lbs.)
Load Capacity	One Telescope setup 8 kg (17.6 lbs.) – Double telescope setup 12,9 kg (28,6 lbs.)
Transmission	Four-step reducer via pulley-toothed belt system on ball bearings, with no play in the axis
Construction material	Anodized aluminum, machined from single blocks with high precision CNC machines
Motion system	Pulleys made with special glass fiber polymer and high precision toothed belts
Polar finder	Celestron standard, others optional
Goto system	StarGO GOTO System
Counterweight bar	W= 16 mm (0.63 inch) / L = 85 mm (3.34 inches)
Counterweight	0.5 kg (1.1 lbs.)
Mounting Saddle	Vixen style
Warranty	2 years from the purchase date, extended to 5 years for the transmission system

Foreword

This manual describes the mounting, operation and correct setup of the M-zero obs, including the proper installation of a suitable optical tube.

Please read this manual carefully to guarantee that you can use the M-zero obs mount in complete safety and with the maximum satisfaction.

The instructions related to the StarGO control system and related software are described in separate Instruction Manuals:

Avalon Instruments - StarGO Control System

The instructions for using the M-zero obs with third party software are contained in the following Instruction Manual:

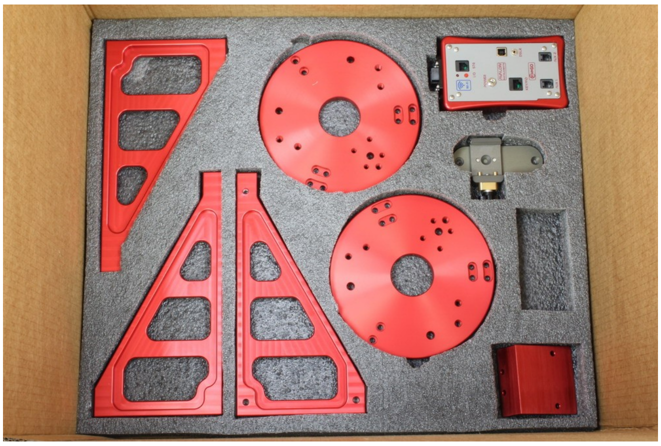
Avalon Instruments – Avalon StarGO: Third Party Software Use

Both the above manuals are included in **the flash drive supplied with the mount**.

The images published in the manual refer to the early versions of the mount and therefore small differences could exist between these illustrations and your own mount. Furthermore, the design and the configuration of the mount can be subject to modifications without prior notice, based on design decisions leading to continuous improvements and on the suggestions of mount owners.

1. Packing Content

Open the box and take out all the contents. Remove all the components from the small cardboard box and from the mount bag side pocket, and place them on a clean, flat surface.

<table>
<tr><th colspan="2">Component List</th></tr>
<tr><td>Aluminum Pier
StarGO control box
Motor’s connecting cable
Mount Head
Mount Head and accessory transport bag
Counterweight rod
StarGO Keypad
0.5 kg Counterweight</td><td>Polar scope with support
Power cable
Warranty & Testing Certificates
Declaration of Conformity
Allen wrench
USB flash drive with manuals and software
Ra/Dec motor cables</td></tr>
<tr><td colspan="2">In order two ship the product as safe as possible, with the most compact package, the mount, the pier and all the accessories come all packaged in one only box with two different foam layer, as shown in the pictures below.</td></tr>
<tr><td></td><td></td></tr>
</table>

2 Mount Description

Strong, light and smart, with a total weight of 5.5 kg (12 lb), this very special version, being one of the few equatorial mount suitable for very low latitude areas till 0° in the market, it is the perfect instrument for the travelling astronomy, suitable for deep-sky imaging in the capacity range up to 10 kg (22 lb).

The M-zero OBS design was developed on the basis of the M-zero standard version, making use of the same technical concepts:

- Fast Reverse technology
- Computer aided design (CAD)
- High quality manufacturing with digital control 5 axes CNC machines (CNC + CAM)
- Absolute quality materials: Anodized aluminium from milled mono-bloc, stainless steel components and screws, brass components, techno-polymers

The M-zero obs motion transmission technology is based on pulley-tooth belt without play, while its peculiar geometry makes easy the imaging at the meridian crossing regardless the typical problem affecting the classic German Equatorial Mounts, for both the risk of touching the tripod and the need of waiting for the object cross the meridian.

Moreover, considering that at the meridian the sky is less subject to light pollution and to atmospheric turbulence, the M-zero LHQ is the ideal tool to shoot deep-sky objects in their best conditions, close to the meridian, especially when the time is short and the sky is not so dark and clear.

The M-zero obs is mainly designed for astro-imaging with medium-short length tubes (such as SC-Maksutov, RC up to 6-8″ aperture and 10 kg (22 lb) weight, according to the tube length). It is possible to use the M-zero obs even with refractors (400-500 mm), with a piggyback or parallel guidescope that can act also as an active counterweight.

The larger overhang of the single arm system will allow a greater pointing angle compared to the classic German Equatorial Mounts.

Another M-zero obs basic advantage is that it doesn't need heavy counterweights, nor the long bar. Its declination axis can be quickly balanced like in an equatorial mount, while, for the RA axis, it is possible to fix the arm on six possible positions and to make the fine balance using a very small counterweight.

The use of pulleys and toothed belts has allowed to obtain several advantages: a really steady motion without play (no backlash) and sudden peaks, factors of paramount relevance for long guided exposures and during high magnification visual observations. These features are of particular relevance especially for the declination axis motor that can now quickly reverse the motion without breaks to recover the plays: from here the mount name FAST REVERSE. The toothed belts used in the M-zero obs have the structure made of special material with steel strands to avoid any deformation, elongation and stress, much better than those used in the automotive engine distribution system (which are generally made of rubber with nylon strands). Considering that the service time for the automotive toothed belts is around 100.000 km (60.000 miles), assuming a medium regime of 2.000 rpm and thermal stress from 0 to 90°C (30 to 195 F) in a few minutes, we can think that the life cycle of the M-zero obs toothed belts will be extremely long! It is important to underline that in the gear-worm systems the motion transmission has only one tangent point of contact, any errors on each of the two components will, sooner or later, result into a tracking errors. On the contrary, in the pulley-toothed belt system, no direct contact occurs between the pulley and the motion is transmitted by the belt engaging from 50% to 90% of the girth surface. Consequently any error, eventually present, is averaged among the cogs, moreover soft, greatly reducing the tracking error.

No wearing effects since no relevant frictions occur. In fact, all the pulleys and the axes rotate on roller bearings, 13 for the RA axis and 13 for the DEC axis that allow to reduce the total friction almost to zero.

Another significant advantage of very low frictions is that the risks of motor slipping during GOTO operation is virtually null. On the contrary, it is well known the difficulty to regulate the coupling between gear and worm in the conventional mounts. If the coupling is tight the motors can stuck with consequent loss of the position, if the coupling is too loose the plays increase. On the other hands, the absence of significant play in the M-zero makes the initial calibration of guiding CCD quick and easy.

Since there are no gears, there is no need of periodical lubrication of the internal components and therefore the maintenance is extremely reduced and limited to the external cleaning.

3. Initial M-zero obs Setting

The M-zero obs can works within a latitude range from about 15° till 70°. Therefore the first operation to be performed is to set the latitude range and scale for the location where the mount will be used. The same operations must be performed when the mount is moved to a site with latitude outside the range originally set.

Latitude range degrees for M-zero obs standard version:

- Position 1 between 15° and 40°
- Position 2 between 32° and 55°
- Position 3 between 45° and 70°

Latitude range degrees for M-zero obs with Motorized Polar Alignment kit

- Position 1 between 15° and 48°
- Position 2 between 26° and 63°
- Position 3 between 41° and 70°

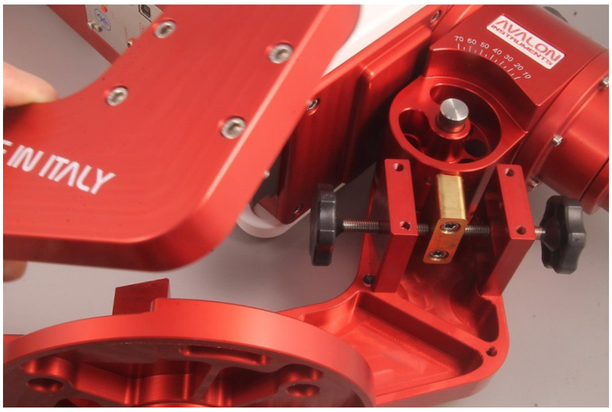
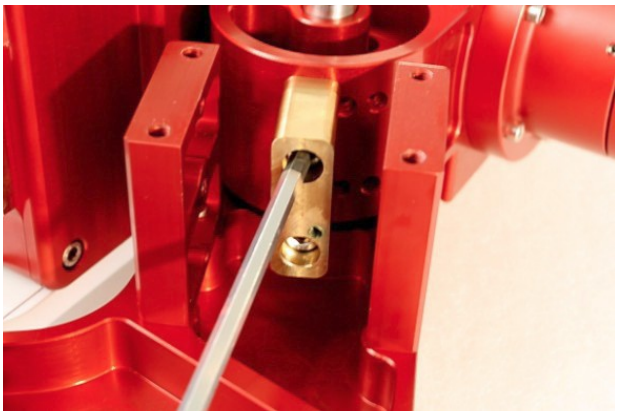
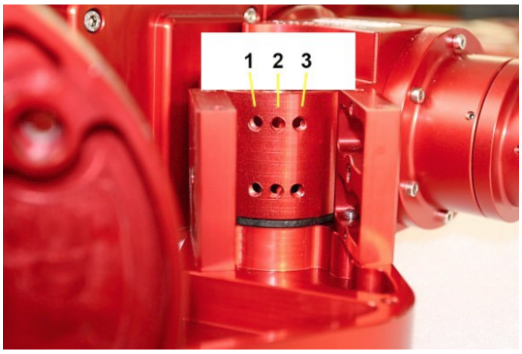
These values correspond to the three latitude setting holes on the underside of the mount.

3.1 Altitude Range Setting

As previously stated, the M-zero Obs can be used in a range of latitudes starting from 0° to 70°. The total amplitude of the operating range is about 70°, subdivided into 3 sub-intervals as follows:

NOTE: the following operation describe the latitude range adjustment of the M-zero obs standard version. The M-zero obs with the Motorized Polar Alignment Kit latitude range settings adjustment, it is performed from the factory at the range noticed by the user before the purchase.

Remove the screws (1) and (2) under the base	

Remove the screws numbered 1, 2, 3 and 4 from the side plate.	
Remove the plate to expose the brass plug.	
Unscrews the two screws and remove the brass latitude adjustment plug.	
Place the brass latitude adjustment plug over the set of holes (1, 2 or 3) corresponding to the needed latitude range as described on the previous page. Re-attach the brass plug in the preferred latitude range position using the screws removed earlier. The mount is shipped from the factory with the brass post in position 2.	

Re-attach the side plate using the four screws 1, 2, 3 and 4, previously removed. Next, replace the two screws previously removed from under the mount	

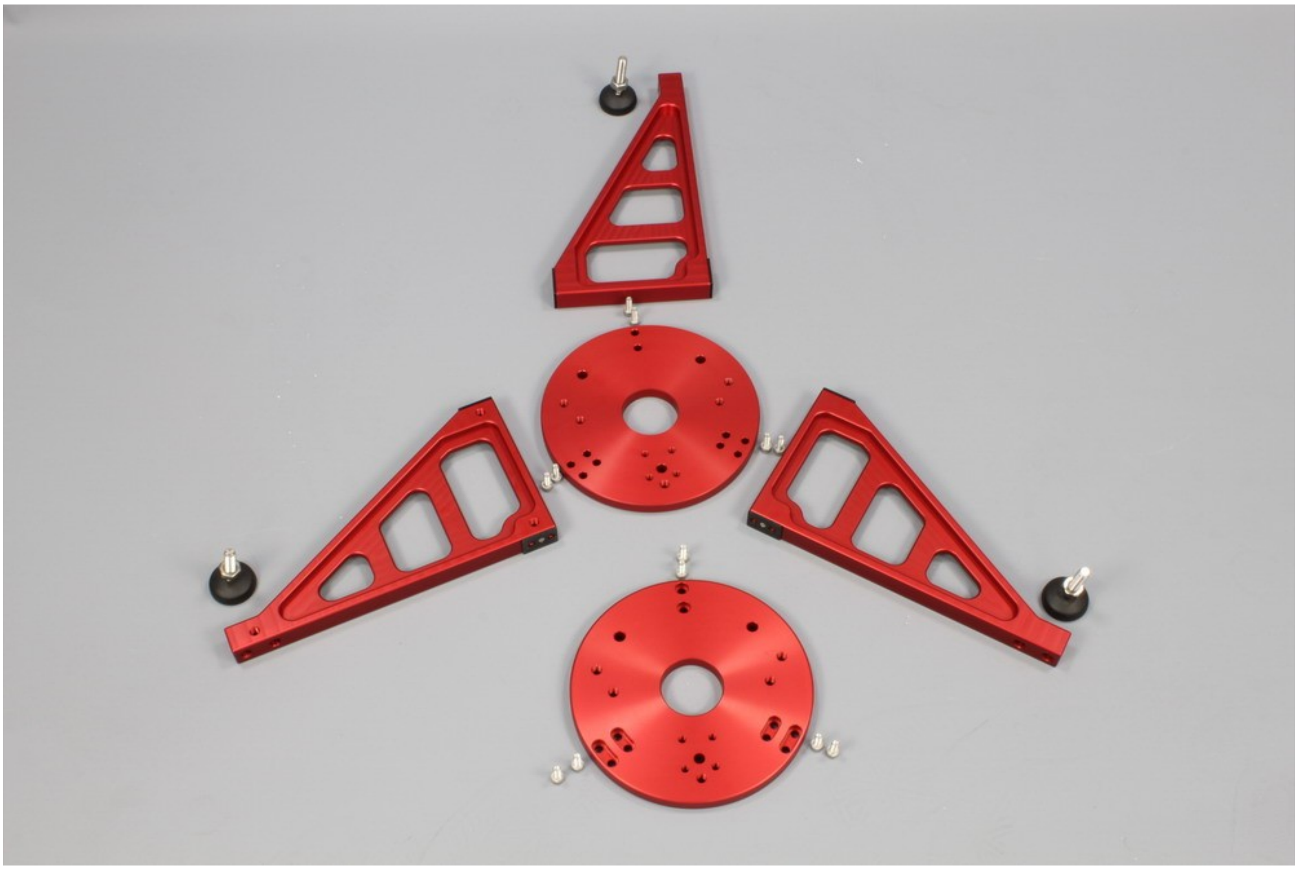
NOTE: The Alt/az configuration is not available in the M-zero obs mount.

3.2 Pier Mounting

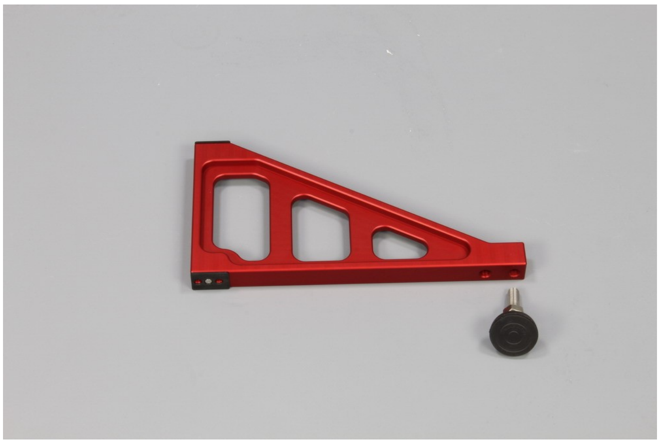
To allow a safe shipping, the pier comes completely disassembled, protected with a special packaging foam.

In order to assemble the pier, take out all the pier parts from the box and place them on safe and flat surface. In order to avoid scratching it is suggested to place everything on a rigid foam surface.

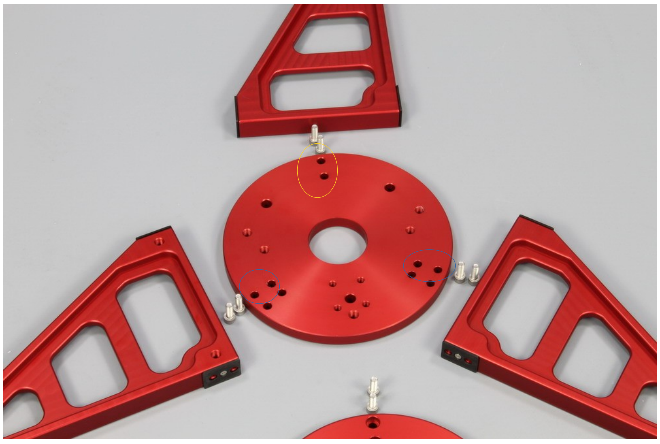
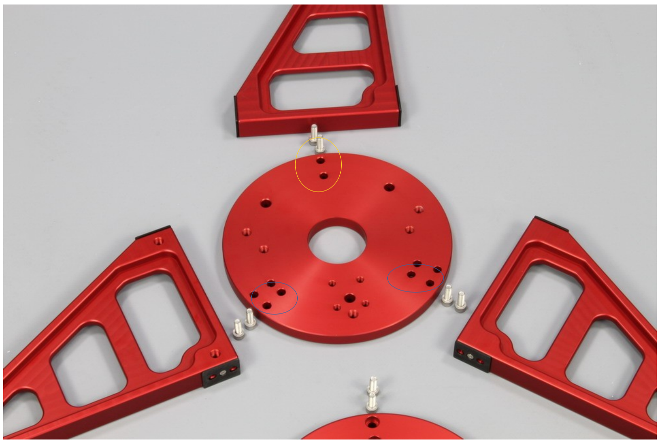
The pier is composed by 2 flange, three legs and three feet as shown in the picture below.



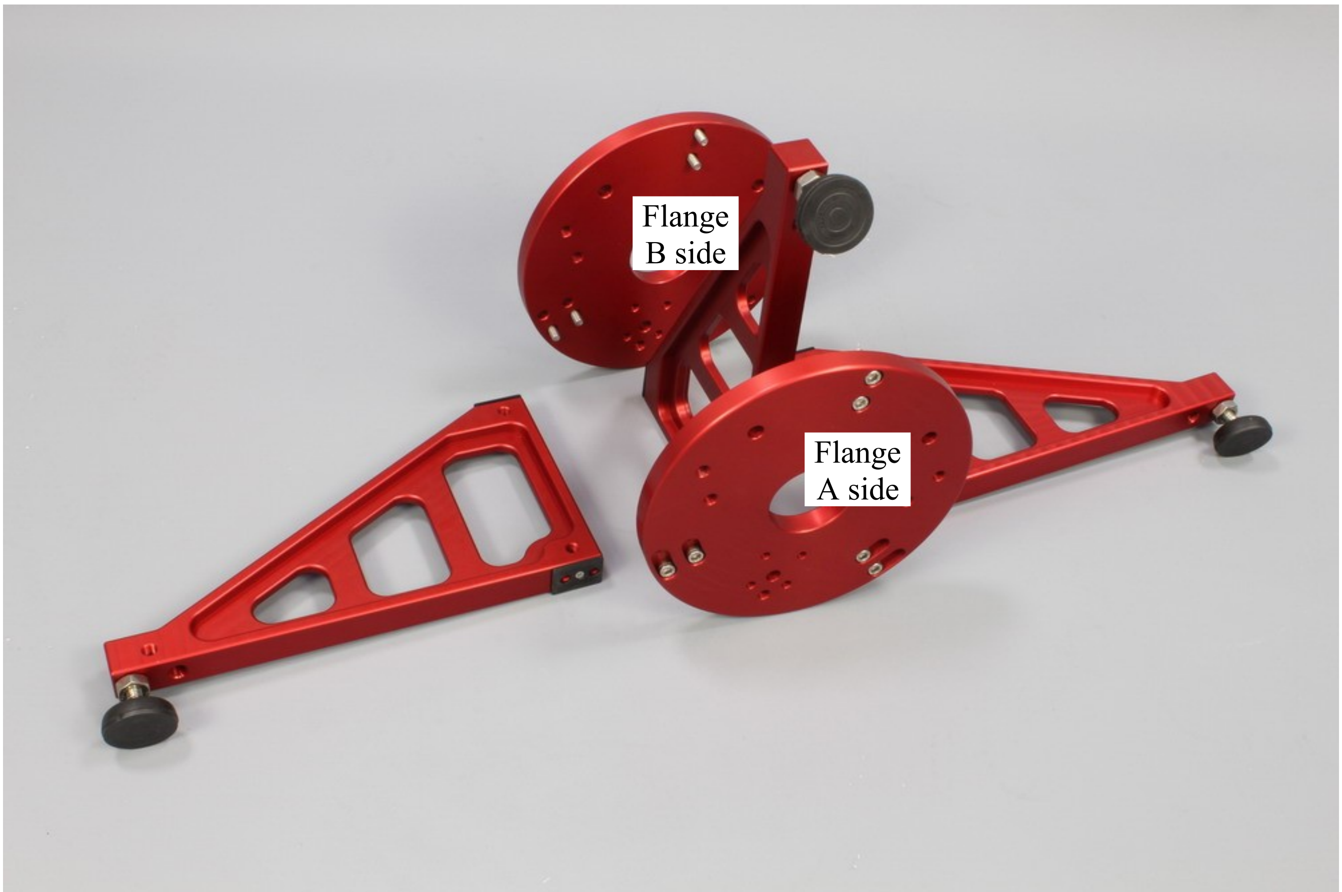
As a first operation it is suggested to screw the feet on the pier leg, as shown in the pictures below.



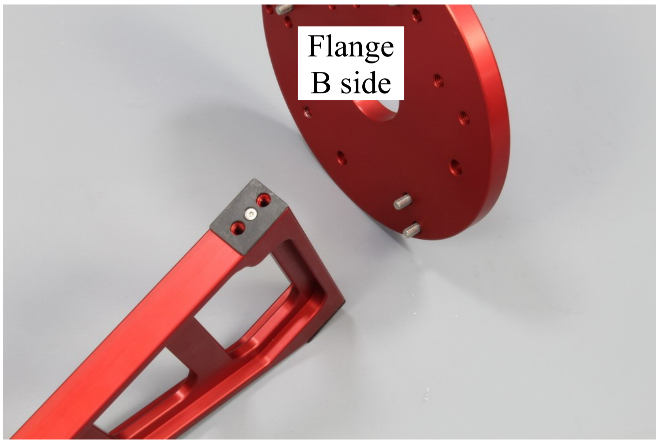
The pier leg can be assembled in two different configuration, with a distance of 100° or 120° between each leg. In both the configuration the leg pointing the north must be assembled by using the two holes circled in yellow in the pictures below.

Configuration A: leg distance 120°	Configuration B: leg distance 100° *(suggested for latitude higher than 60°)*
	
	NOTE: *The configuration B it is suggested for latitude higher than 60°, with the two rear legs closer, the basement stability get more reliable.*

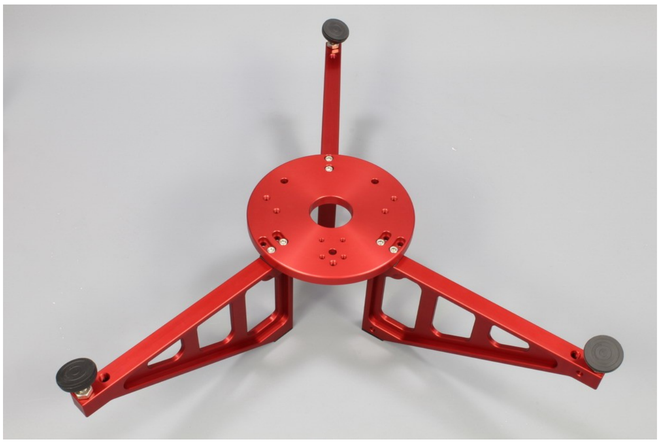
Note that the two flange composing the pier are equal, but they have two different side. The flange that must be place on the bottom side of the pier should have the A side toward down while the flange on the upper side should have the B side toward down. As shown in the picture below.



After the choice between the Configuration A and Configuration B has been made and the correct flange side has been set, it is possible to go forward with the pier assembling as shown in the following steps:

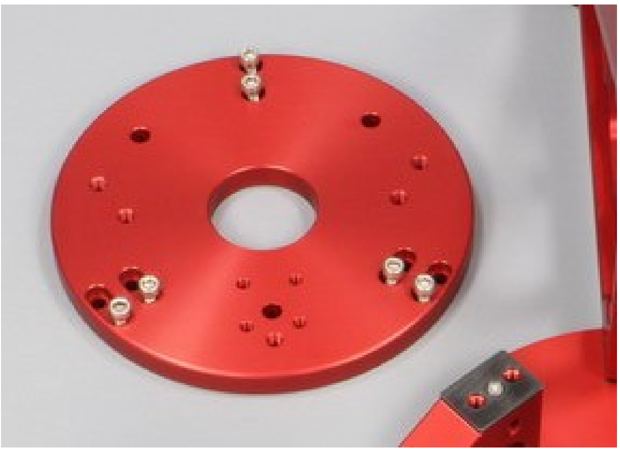
By using the provided 6x16 screws, attach one by one the leg on the pier base flange, taking care to attach the leg on the correct flange side, as shown in the picture on the right.	

After having assembled all the three legs on the pier base flange, the pier will look as the picture on the right, if placed upside down.



At this point, when all the three legs are assembled on the pier base flange, it is possible to place the pier in the correct side.

In this condition it is possible to mount the pier top flange on the upper side of the three legs, and, by screwing the provided screws, close the pier.



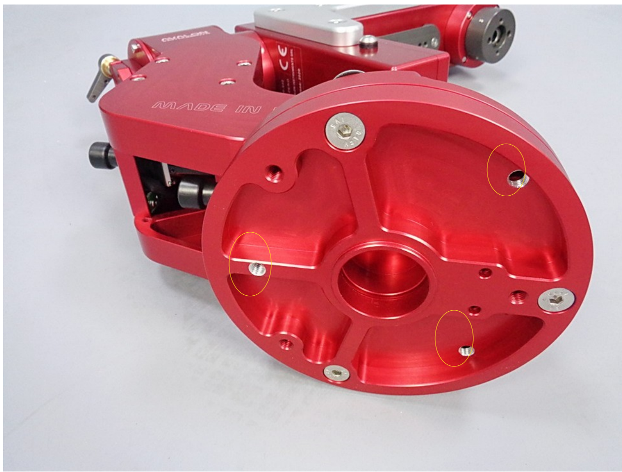
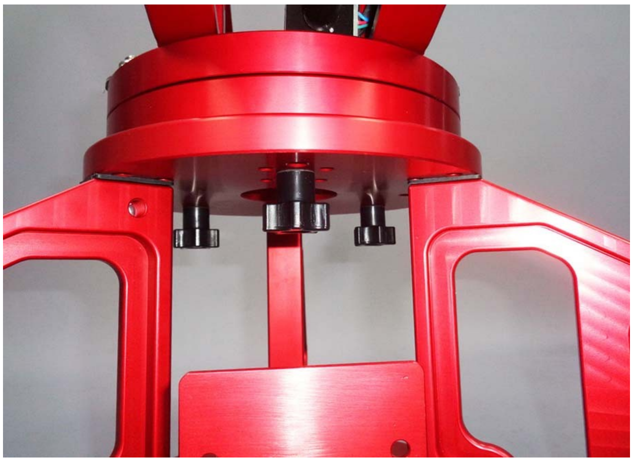
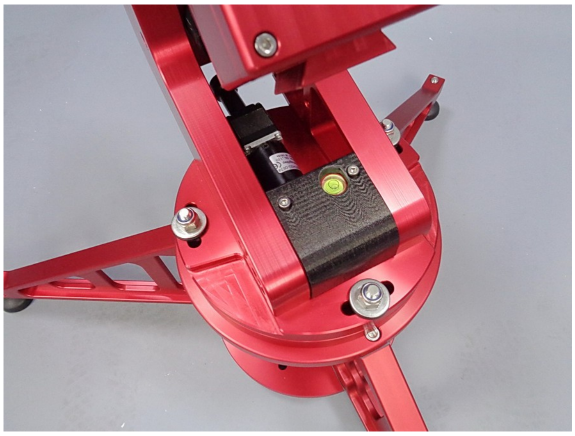
The pier completely assembled will look as one shown in the picture below.

3.3 Installing the M-Zero obs on the Pier

After the pier has been completely and safely assembled, by simply following the procedure shown below, it is possible to install the mount on it.

The following procedure is the same for both the M-zero obs standard version and for the M-zero obs with the Optional Motorized Polar Alignment kit.

The mount fixed flange must be assembled by using the three **8x35** knobs shown in the picture on the right.	
In order to correctly place the mount on the pier the three 8x35 knobs must be screwed in the corresponding holes circled in yellow in the following pictures, from the bottom side of the pier top flange, as shown in the pictures below.	

	
M-zero obs	M-zero obs with Optional Polar Alignment Kit
	

3.4 - StarGo box installing

With the M-zero obs the StarGo box can be assembled in two different positions on depending on the setup used by the user. When a single telescope setup is equipped it can be more comfortable to place the StarGo box on the bottom side of the DEC arm. When a double telescope setup is equipped, in order to allow a more safe rotation of the second telescope and avoid collision, the StarGo board can also be assembled directly on the pier.

StarGo box installing on a Double Telescope setup

<table>
<tr><td>In case a double telescope setup is required, the male dovetail adapter plate must be disassembled from the bottom side of the DEC arm and should be placed directly on the pier.</td><td></td></tr>
<tr><td colspan="2">To perform this operation it is first required to mount the L bracket provided with the mount on the bottom pier flange. By using the stainless screws provided, fix the L bracket on the pier bottom flange.</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">By using the stainless steel screws provided, fix the male dovetail adapter plate on the L bracket.</td></tr>
</table>

	
At this point it is possible to adapt the StarGo box directly on the pier.	

StarGo box installing on a Single Telescope setup

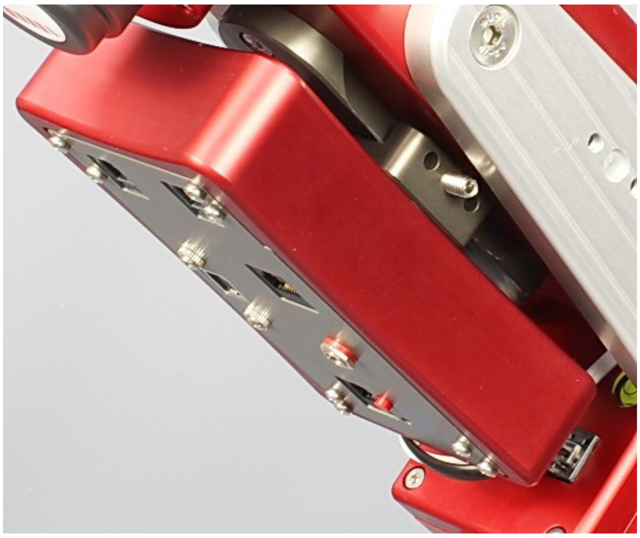
This operations can be made thanks the special StarGo Quick clamp that comes provided with the mount. In order to allow the Quick Clamp to be comfortably attach to the M-zero obs lower side of the DEC arm, it is required the replacement of the knob with a 6x20 screw provided

StarGo Quick Clamp with the knob to be attached on the M-zero obs pier.	
StarGo Quick Clamp with the knob to be attached on the M-zero obs pier.	

This kit is composed of two parts: a male dovetail adapter plate and a female dovetail clamp. In order to ship the mount in the most safe conditions, the male dovetail adapter plate comes already assembled on the bottom side of the DEC arm.

In order to attach the StarGo box on the male dovetail adapter, the female dovetail clamp must be assembled on the StarGo box rear surface.

In case the StarGo box must be equipped on the bottom side of the DEC arm it is only required to attach the male dovetail clamp on the female dovetail plate adapter.



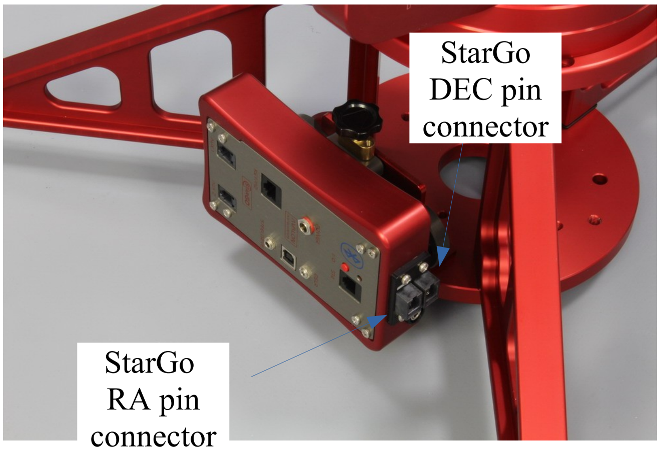
3.5 Motor Cable Connections

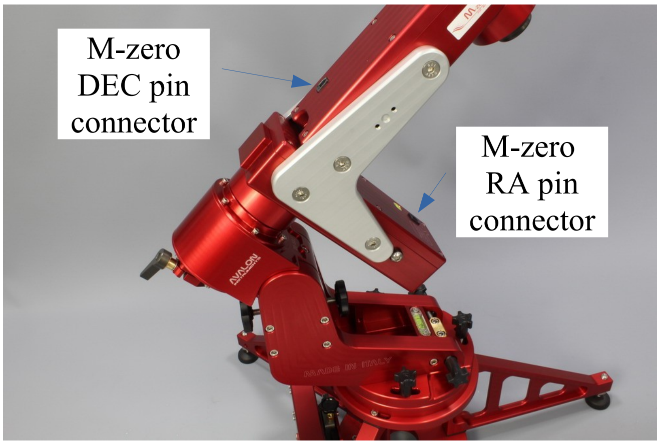
Once the mount has been installed on the pier, it is necessary to connect the electrical cables from the StarGO to the motors and to the polar scope illuminator (if one is being used). The StarGO is provided with two RJ11 female connectors for DEC and RA motors and a pin jack socket for the polar scope illuminator.

The provided cable set is provided with two RJ11, 4 pin cables and one cable with pin jack connectors. The two RJ11 cables should be connected to the StarGO and to the mount DEC, RA motor connectors.

The third cable, with the pin-jack connector, must be connected to the illuminator**.**

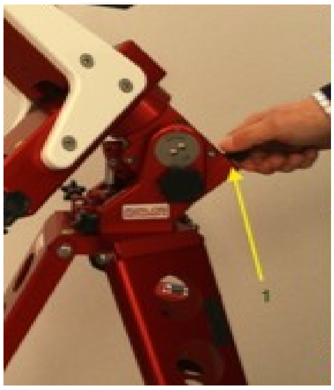
The motor cable connection must be connected as follows:





3.6 Optical Tube Mounting

The optical tube to mount on the M-zero must be provided with a male Vixen-type dovetail bar (standard width 50 mm) to fit the M-zero mounting saddle.



- Place the mount arm in a perfectly leveled position and firmly tighten the RA axis clutch knob (indicated with 1 in the side picture).

- Turn the DEC axis clutch knob (#1 in the right picture) and rotate the female dovetail plate until it is parallel to the mount arm.
- Firmly lock both axis clutch knobs.
- Loosen the dovetail saddle plate lock using the knob #2 in the picture at right.
- Insert the dovetail bar of the optical tube in the saddle and, while safely holding the optical tube with one hand, firmly tighten the knob #2 with the other hand. The assistance of another person could be helpful in performing this operation, especially if the tube is particularly heavy and/or oversized.

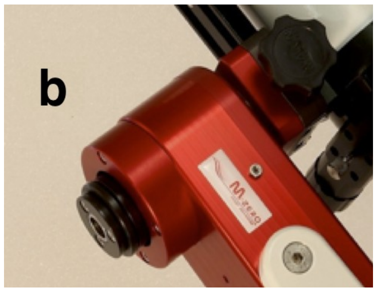
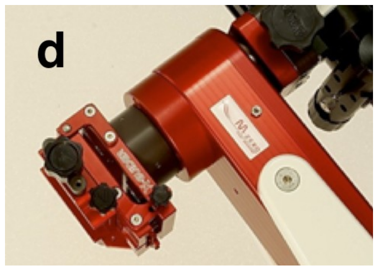
Note: Before taking your hands off the tube, make certain that the OTA is firmly seated in the mounting saddle with no wobbling.

3.7 Choosing the Telescope

The M-zero obs is an extremely versatile mount and can carry several varieties of telescopes, it can be set for continuous operation without the need to perform the "meridian flip". This can be facilitated by the appropriate choice of a telescope.

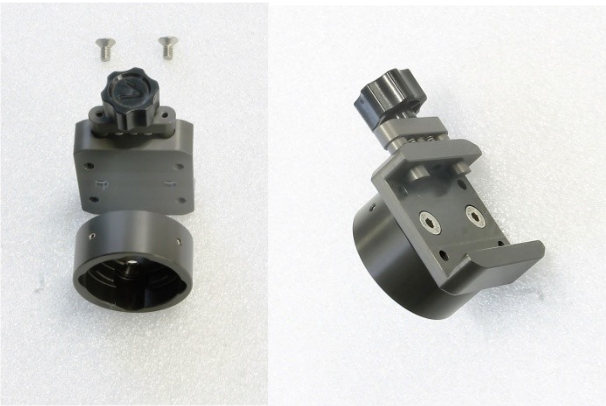
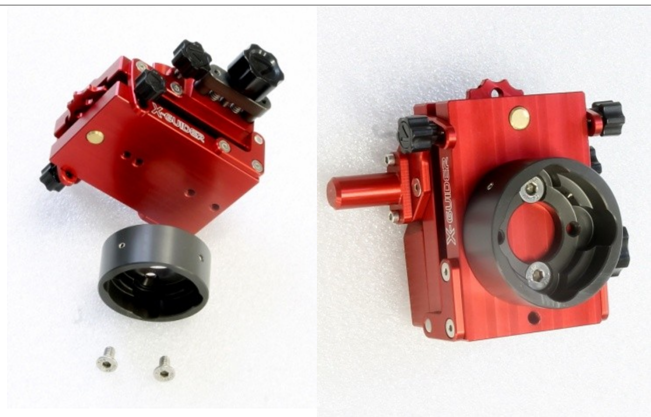
Another benefit of the M-zero is its ability to mount two parallel telescopes. This feature offers a wide range of advantages, such as simultaneous observation with different filters or auto-guiding.

A simple optional accessory is required to mount a parallel telescope.

	In order to install this accessory it is necessary to remove the plastic plug that has the Avalon logo (fig. a). This removal enables the mounting flange (fig. b) to be inserted.	
	This flange holds the Dual-DEC accessory for mounting the Secondary Vixen dovetail saddle (fig. c) or the X-Guider (fig. d).	

The X-Guider is moveable in two directions, which allows perfect alignment of two telescopes. When used with a second telescope for auto-guiding, it also allows the slight misalignment required to search for a suitable guide star.

The figures below show the optional kit components described above.

	
Secondary Vixen Saddle kit components	Avalon X-Guider kit components

The following table illustrates the M-zero obs possible configurations (operating mode and telescope type):

Telescope type	**Picture**	**Note**
One telescope setup		This setup allows the use of any telescope type (<u>within the allowable weight limits</u>). Medium length refractors are possible because the arm position permits the telescope rotation without obstacles. In this configuration the StarGo box can be comfortably assembled on the bottom side of the DEC arm.

Two parallel tubes: An 8" f/10 SC weighting about 7 kg and a 70 mm secondary refractor weighting about 3 kg.		In this setup a secondary optical is mounted on the optional X-Guider, permitting precise alignment of the two optics.
DSLR Camera		A DSLR camera can be installed on the M-zero mount, allowing it to perform wide and extra-wide field imaging. It can be mounted as a stand-alone or in parallel with a telescope. In this case the telescope can be used as a guide-scope for longer exposures. With this setup a counterweight is not necessary

4 Telescope Balancing Operations.

To correctly balance the telescope it must be free to move manually around both rotational axes.

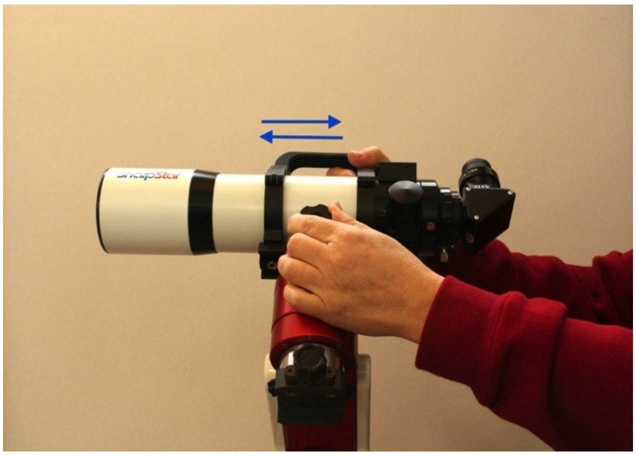
A significantly unbalanced mount can cause the telescope to drop quickly with potential damage to the tube or to the mount itself. To prevent this from happening when using the mount in Equatorial mode, be sure to hold onto the tube with the hands before loosening the clutch knobs if the telescope has not been balanced, especially in the DEC axis.

To guarantee correct and reliable mount tracking it is necessary to balance the telescope in both rotational axes. Even if the telescope is not intended to track in Declination, the optical tube must still be balanced in this axis to avoid sudden movements when the DEC clutch is loosened. This precaution also helps to limit vibrations and to provide immediate response during auto-guided photographic sessions.

4.1 Declination Axis Balancing

With the M-zero LHQ mount it is better to balance the DEC axis first because the RA axis will already be almost balanced.

1. Put the telescope in a horizontal position.
2. Loosen the DEC axis clutch knob and allow the tube to move – **GRADUALLY** – to verify in which direction it tends to move.
3. Slightly loosen the knob on the mounting saddle that keeps the dovetail bar and the telescope fixed to the mount. Next slide the tube forward or backward and tighten the saddle knob. Repeat this action until the mount stays in the same horizontal position even with the DEC axis clutch completely loosened. This stability indicates that the telescope is balanced in the DEC axis.



4. Tighten the mounting saddle knob and the DEC clutch knobs to lock the telescope in the balanced position.
5. **DO NOT** let go of the tube until the mounting saddle knob and DEC clutch knobs are firmly tightened.

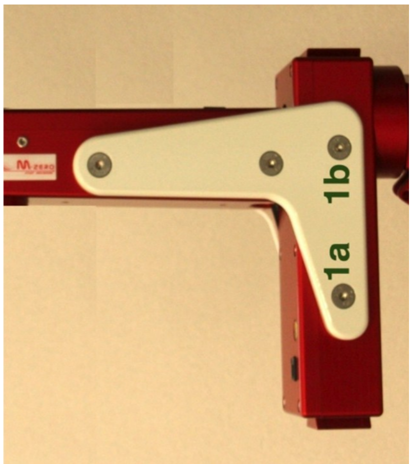
4.2 Right Ascension Axis Balancing:

The M-zero LHQ mount has a system of RA axis balancing which is different from that of German Equatorial Mounts but still very simple.

The balancing is performed in two phases, approximate and precise. The approximate balancing, which is performed less frequently, requires some working on the mount and it is better to carry it out at home. The precise balancing can be performed in the field.

Approximate Balancing

To perform an approximate balancing of the mount in the RA axis:



1. The optical tube must first be removed from the mount.
2. Unscrew and remove the Allen screws (1a) and (1b) on both the L shaped lateral brackets and set them aside. Removal of the screws leaves the DEC arm completely free from the rest of the mount and therefore it is necessary to hold onto the arm by hand during removal of the second bracket.

The illustration at right shows the holes drilled in the RA arm to position the DEC arm at different distances from the RA rotational axis. These changes in the DEC arm position allow a rough approximation of the balancing of the whole system. The picture right shows the two arms without the bracket for purposes of clarity

The position of the hole pair (A-a) corresponds to the minimum distance from the axis and is used for lighter telescopes. The pair (C-c) corresponds to the maximum distance and is used for heavier telescopes.

Choose the hole pairing that is most suitable for the telescope you intend to mount. Align the holes in the brackets you previously removed with the desired pair of holes in the RA arm. Use the Allen screws you also removed previously to attach the bracket to the horizontal arm.

Firmly tighten all bracket screws to guarantee maximum rigidity of the mount during operation.

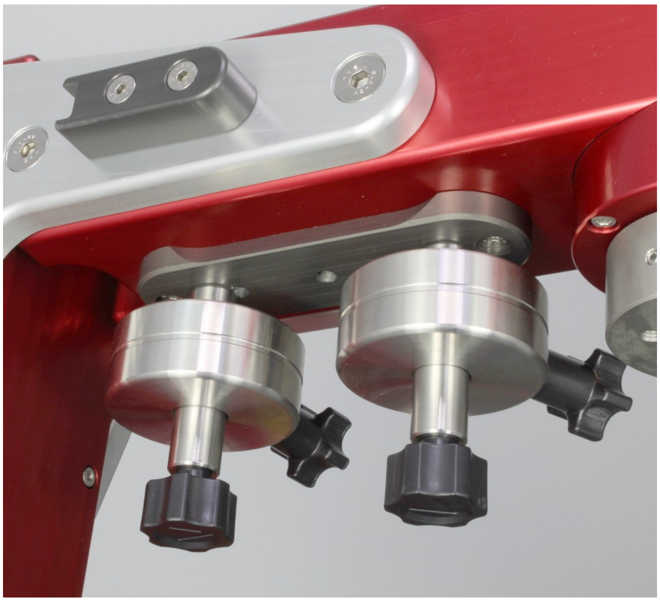
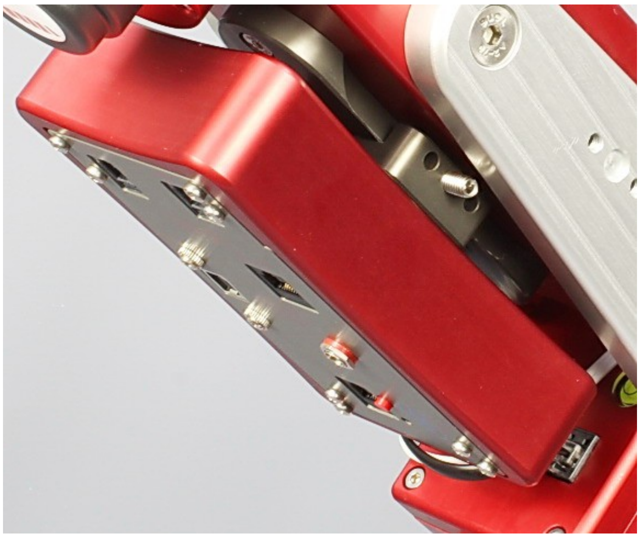
Precise balancing

The M-zero obs comes provided with several way to balance the setup. There are three possible positions for the counterweight:

- On the male dovetail placed on the bottom side of the RA arm
- On the male dovetail placed on the top side of the RA arm
- On the counterweight/StarGo Board dovetail adapter plate placed on the bottom side of the DEC arm.

These positions can be used depending on the setup assembled by the user. T

<table>
<tr><td colspan="2">The dovetail adapter plate, when used on the M-zero obs bottom side of the DEC arm, can works both, as a counterweight adapter or as a StarGo box adapter.</td></tr>
<tr><td>
</td><td>Assemble the counterweight shaft on the counterweight fixing plate on the bottom of the DEC arm by screwing the small screw in one of the three trheated holes available.
There are five available position to fix the counterweight shaft, depending on the setup.
It is also possible to assemble two counterweight shafts.</td></tr>
<tr><td></td><td>For the single counterweight shaft configuration, the most common position is the number 3.</td></tr>
</table>

	By using simultaneously the position 1 and the position 5, a double counterweight shaft configuration is also available. This configuration it is recommended for heavier setup. **NOTE: additional counterweight shaft is optional**
	When the telescope balancing doesn't require many counterweights, and the M-zero obs works ina single telescope setup, the StarGo box can be comfortably placed on the bottom side of the DEC arm by using the StarGo quick clamp that comes provided with the mount.

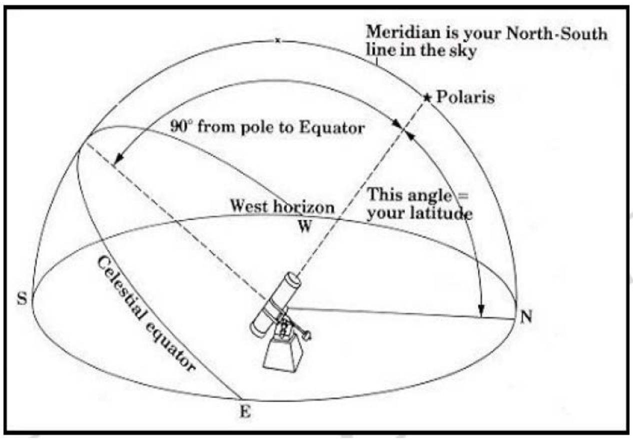
NOTE: ***Other mounts, based on geared wheel and worm drive systems, must be slightly unbalanced in the direction of celestial movement to obtain precise tracking. Such mounts may require occasional re-balancing by moving the counterweight. In contrast, the M-zero obs mount is well balanced in every position to guarantee the absence of backlash, hysteresis and pendulum effects around the meridian. This difference proves to be a significant advantage. Due to the M-zero's toothed belt transmission system, once balanced, it is no longer necessary to change the weight position. This is a valuable feature for long term Astrophotography around the meridian and is essential for the remote use of the mount.***

5. M-zero obs Alignment.

The mount alignment consists of adjusting the mount's altitude and latitude such that its declination axis points exactly to the celestial North Pole.

To perform such an adjustment, the actions necessary to set the altitude and the latitude of the mount to those of the observation site are described here. For more precise alignment, the polar-scope provided with the mount (or a different type of optional polar-scope) is used.

5.1 Precise Latitude Adjustment

After leveling the mount base using built-in the bubble level, the next step in this process consists of approximately setting the polar axis at an angle equivalent to the latitude of the observation site. For example Rome is about 42° North, Milan and Venice 45° North and Palermo 38° North. Refer to the latitude scale on the side of the mount.	
The latitude adjustment must be performed using both hands to turn the two latitude adjustment knobs in conjunction with each other. While one hand is tightening the front knob, the other hand should be loosening the rear knob and vice-versa. To increase the latitude (i.e. raise the polar axis), the rear knob must be turned in the clockwise direction while the front one is turned in the counterclockwise Direction. To lower the axis, the opposite actions are performed.	

NOTE: It is generally better to perform the fine latitude operations against the force of gravity, that is, by raising the mount.

5.2 Azimuth adjustment

<table>
<tr><th colspan="2">M-zero obs standard</th></tr>
<tr><td>
The azimuth regulation is performed in a similar manner, using both hands to turn the other two adjustment knobs in opposite directions simultaneously. When a knob is rotated in one direction the other is rotated in the opposite direction. Turn them so that the screws attached to the knobs press against the brass adjustment post and move the mount to the right or left by a small amount. The azimuth adjustment knobs are those positioned on both sides of the mount as seen in the picture on the right.

NOTE: in order to allow the amount rotation for the Azimuth adjustment, the three mount fixing knobs must be slightly loosened.
</td><td>

</td></tr>
<tr><th colspan="2">M-zero obs with Optional Motorized Polar Alignment kit</th></tr>
<tr><td>
In order to move the Alt/Az motors it is required the connection between the motors plug and the StarGo aux 1 and aux 2 connectors. For sample puropse, the image on the right show the cable connection with the StarGo Control Box placed on the pier.

The Alt/Az motors can be controlled:

- with the FOCUS +/- buttons on the StarGo keypad. The keypad also allow the to switch directly from the keypad the control from the Aux 1 to the Aux 2 port (see page 11 StarGo User Manual).

- With the StarGo software by using the AUX panel and the POLAR ALIGNMENT tool (see page 30 StarGo User Manual and APPENDIX A of the M-zero OBS User Manual)
</td><td>


</td></tr>
<tr><td colspan="2">
NOTE for the M-zero obs with the Optional Motorized Polar Alignment kit: In order to allow the mount free rotation on the Azimuth, being at the same time firmly assembled on the base flange, the three bolts must be tightned with the correct pressure. This adjustment it is performed from the factory. So in case the mount will be disassembled
</td></tr>
</table>

from its base, it must be reassembled taking care to adjust the three knobs with the same pressure. To check that the system is fine adjusted, it is just necessary to try to move the mount on the azimuth with the keypad and verified that a smooth rotation is achieved without play.

5.3 - Alt-Az Polar Alignment

The following table shows the amount of rotation for precise Alt-Az alignment of the Avalon Linear, M-Uno, M-Zero and M-Zero LHQ mounts. Each full turn of the Altitude and Azimuth knobs moves the mount in the exact amount, shown in arc-minutes, for the particular mounts listed.

Mount	Linear		M-uno		M-zero	
Mount Axis	ALT	AZ	ALT	AZ	ALT	AZ
Arc minutes per knob turn	91,2	79,2	78,74	79,2	61,8	110,4

5.4 M-zero Polar Alignment

5.4.1 Polar Kit Installation

The precise polar alignment of the M-zero LHQ mount is performed with the polar scope installed externally on the mount.

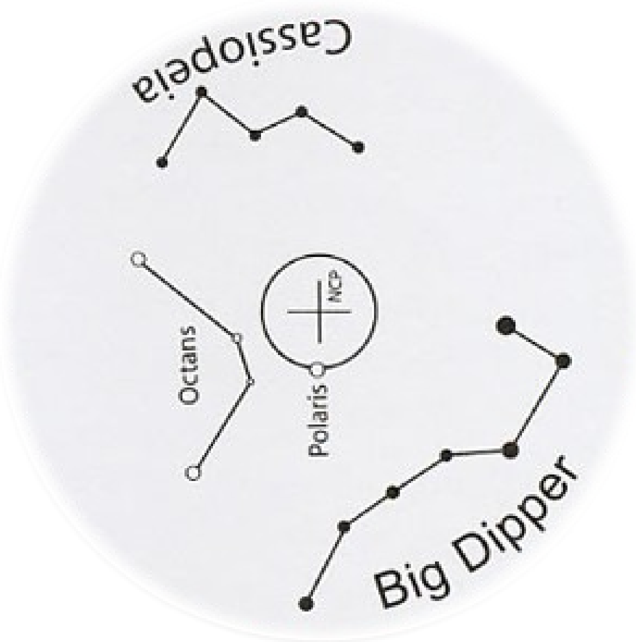
The standard kit for the precise polar alignment consists of the following components:

1. Celestron Polarfinder and Polarfinder adapter with the fixing knob.
2. Polarfinder adapter fixing dowel already assembled on the M-zero LHQ lateral bracket
3. External illuminator cap with a red LED and connection cable to the StarGO.

The polarscope comes with the mount already assembled with it’s own adapter. To fix the Polarscope on the mount lateral bracket dowel, place the Polarscope adapter male dovetail on the female dowel dovetail, and tight the fixing knob.

5.4.2 Polar alignment with the provided Polarscope

The M-zero LHQ comes provided with a Celestron Polarscope. The picture below shows the polarscope reticle. For an accurate polar alignment with Avalon Instruments mounts it doesn't matter for the constellation position. The reference point it will be the small circle that represent the Polaris position or a defined degree in the graduated circle.



Celestron polarscope reticle

It is well known that the Polaris is at about 40 arcmin distance from the Celestial Pole and therefore it orbits around the pole at that distance every about 24 hours. The cross in the reticle center indicates the position of the Pole. The circle around it represents the orbit of Polaris. The small circle on the orbit represents the variable Polaris position. The problem here is to position the smaller circle at the correct Polaris angle as it is seen from the observation site at the observation date and time. Years ago this position was obtained using several types of circular dials and performing few calculations.

Currently the most common method to get the exact position of Polaris is using one of several available computer programs or, better, mobile device applications. These programs provide the position of Polaris both visually and in the hourly format as described in section 5.3.3. Once the Polaris position has been determined in terms of hour angle, the polar scope should be rotated to bring the small circle in that position. With this type of reticle this operation is approximate, but is accurate enough and is satisfactory for most applications.

The small circle representing Polaris must be put in the annulus corresponding with that hour, starting with the 0 of the annulus in the upper position.

Once the correct position of the small Polaris circle has been established, the following operations should be performed:

Once the correct position of the small Polaris circle has been established, the following operations should be performed:

1. Slightly loosen the knob that keeps the mount fixed to the tripod base to allow its

Azimuth rotation, while still keeping it safely on the tripod.

2. Slightly loosen the black knurled side knobs to allow the Latitude (altitude) movement.

3. Once you are confident that the polar scope is correctly oriented, use small movements of the Azimuth and Altitude adjustment knobs to place Polaris exactly in the center of the classical reticle's corresponding small circle in or in the defined hour position for the newer type reticle.

4. When finished, firmly re-tighten the Altitude and Azimuth knobs as well as those fixing the mount to the tripod. The mount is now aligned to the celestial North Pole.

In case of use of the new reticle (on the right figure) the only difference is that, being missing the small circle correspondent to the Polaris, the star must be brought to the position in the graduated circle defined by the specific application.

5.4.3 External Programs for Finding Polar Position

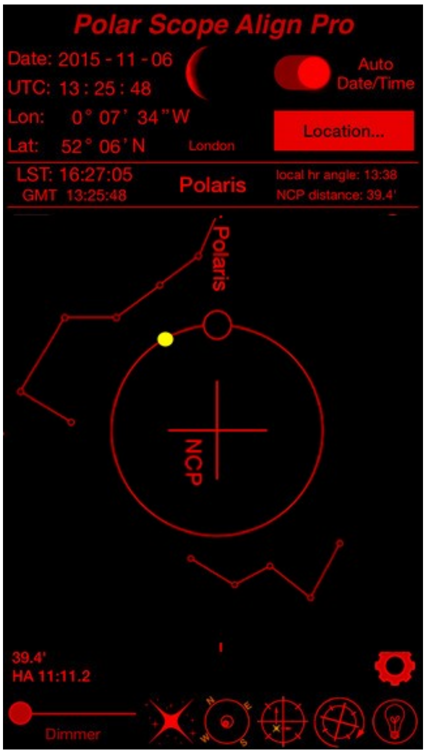
Many apps exist to determine the position of Polaris compared to the exact position of the celestial North Pole. Only two of these apps are discussed in this section. However the same concepts described here are applicable to all other existing apps.

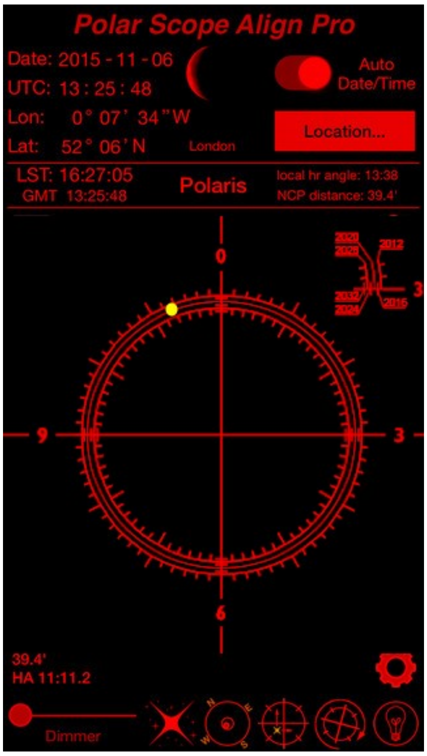
“Polar Scope Align” is an app which runs on iOS smart devices. This program uses the device’s internal GPS to evaluate the geographical coordinates of the observation site to calculate the exact position of Polaris around the North Celestial Pole. It also provides some additional information that can be useful for correct setup of the telescope.

With his application it is possible to interchange the kinds of reticles to be used for the polar alignment, including the Skywatcher classic reticle, as well as the newer version and the Losmandy type.

The position of Polaris is represented by a small yellow circle on a larger circular reticulum. To effectively use this app with the older Skywatcher reticle or with the newer type, it is necessary to take note of the hour angle where Polaris is located and rotate the Polarscope reticle to the same angle, bringing the Polaris circle around to the correct position. You will observe that the reticle reproduces exactly the same optical inversion caused by the Polar-scope optics.

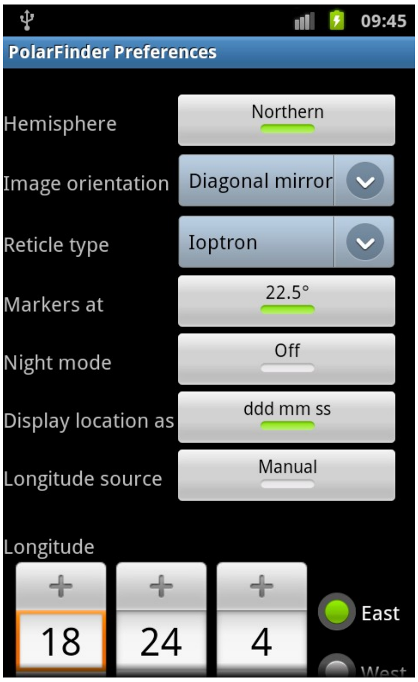
The following figures illustrate the screenshot of the Polar Scope Align app with the classic and new polar-scope reticles.

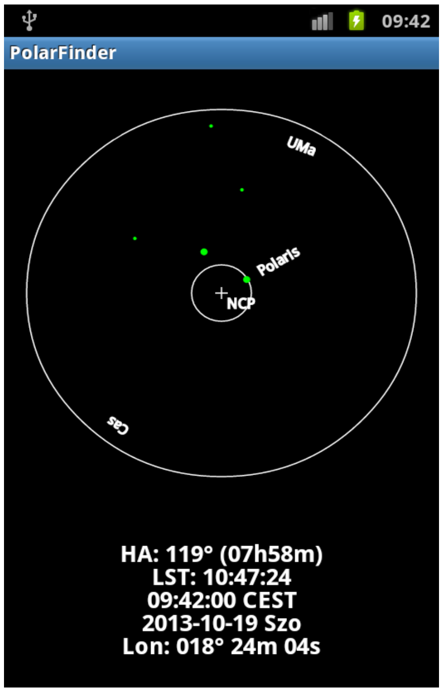




The “Polar Finder” is a similar application available for Android smartphones and tablets of different brands. This app and others that can be downloaded are able to accurately reproduce the reticle of the M-zero's polar-scope as well as the reticle of the optional Losmandy polar-scope. The "Polar Finder" app is flexible and able to replicate a variety of the more common reticles suitable for use in the Northern or Southern Hemisphere, including the types of reticles available for the M-zero.

The following figures illustrate the Android "Polar Finder" app replicating M-zero and Losmandy polar-scope reticles.





Polar Finder Preferences Classical Reticle Layout

The "Polar Finder" app also takes the observation site's geographical coordinates from the Android device's internal GPS if available. If the device has no internal GPS the geographical coordinates of the site must be manually entered. The additional features of the Android app are similar to those provided by the iOS app but the reticules more closely resemble those available for the M-zero.

5.4.4 More modern and precise approaches to Polar Alignment

In the last years a special CCD camera has been commercialised, called Polemaster, to perform a very precise polar alignment using an expressly developed software (requiring therefore a Windows or Mac PC that, however should be available for the successive astrophotography session).
That CCD must be firmly installed on the mount keeping a good parallelism with the polar axis of the mount itself.

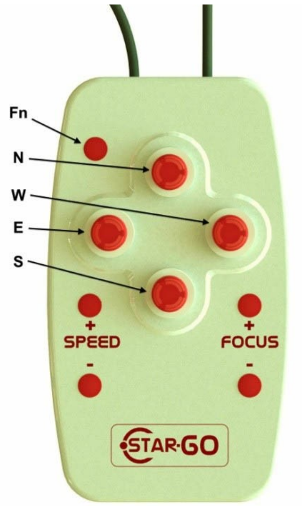
The Avalon Instruments has also developed a special software that, among several others functions, has a tool to perform a precise polar alignment using the "plate solving" algorithm which is shipped together with all other software for the StarGO included in the supplied USB pendrive. Detaile description of this tool in done in the StarGO User Guide.

APPENDIX A

Alt/Az motors control with the StarGo GUI

The kit is composed by two motors: the Altitude motor and the Azimuth motor, they are controlled by the AUX1 and AUX2 port of the StarGo.

Alt/Az motors control with the StarGo Keypad:



With the StarGo Keypad it is possible to move the motors one by one. Before to start moving one of them, it must be chosen the AUX port to use first. Normally the first enabled is the AUX1, so by pressing FOCUS +/- the motor connected with the AUX1 will move on depending on the button pressed up or down in case of Latitude motor or left/right in case of Azimuth motor.
By holding pressure on the Fn key and then pressing the FOCUS+ key, it is possible to switch the control from the AUX1 to AUX2.

Alt/Az motors control with the StarGo GUI

With the StarGo.exe Software via StarGo GUI, it is possible to manage the Alt/Az motors connected via AUX1 and AUX2 port.

The StarGo AUX1 port must be connected to the AZ motor connector via Rj cable while the StarGo AUX2 port must be connected with the LAT motor connector via Rj cable. In order to be as much as intuitive possible, the M-zero OBS comes provided of two couple of Rj cables, each couple is composed by one white cable for the AZ motor and one black cable for the LAT motor.

Starting from the StarGo_620_SP4 software version, it is available an intuitive tool that allow more controls on the Alt/Az motors.

To enable this software version it must be checked the AUX as Motorized Polar Alignment option in the AUX tab, as shown in the picture below.

This tool allow to move the selected motor with the ArcMin unit, allowing also to perform GoTo by simply typing the choosen value in ArcMin and pressing on the GOTO button.