M-due

SINGLE ARM EQUATORIAL MOUNT
(Made in Italy)

USER MANUAL

Version 1.0.0. June 2021

SAFETY RECOMMENDATIONS AND WARNINGS

- **Read carefully the manual before installing and using the mount.**
- **Use the power cable supplied with the mount or a 12V- 3A stabilized power supply as suggested in the manual.**
- **Connect the power cable correctly and securely to the power socket.**
- **Do not bend, pull or press the cable as this may damage it.**
- **For any assistance or repair, please contact only the manufacturer.**
- **Be sure to remove the power supply at the end of its use or before any cleaning or maintenance.**
- **This mount must be used exclusively by adults, do not allow use to children or to people with reduced mental capacity.**
- **Avoid to operate the mount except as strictly indicated in the manual.**
- **Modifying or altering in any way the characteristics of the mount will void the manufacturer's limited warranty.**
- **Never modify the tension of the belts (by dedicated screw), these is set in the factory and any unauthorized change will void the manufacturer's limited warranty.**
- **After using it, avoid to store the mount 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.

Technical Specifications

Type of mount	Single Arm Equatorial Fast-Reverse
Head weight	22,4 Kg
Maximum load	25 kg single telescope setup, 32 kg double telescope setup
Motion System	Four-step reducer via pulley timing belt system on ball bearings, with zero play on both axis. (Belt Drive System)
Construction Materials	Machined from solid blocks of anodized aluminum with high precision CNC machines
Transmission System	Pulleys made with special polymer + fiber glass and high quality toothed belts
Encoder	21 bit Absolute encoders
Polar Scope	Skywatcher
Control System	StatGo2 Pro Multiplatform Astronomical Control System
Dovetail Plate	Losmandy, 3" (75mm) dovetail, single knob with 2 tightening points
Warranty	2 years from the purchase date, 5 years for the transmission system (Belt Drive System)

Forewords

This manual describes the Avalon M-Due mount, the procedures for its mounting and tuning on the tripod and for the installation of a telescope. Additional Information on the M-Due mount and on the StarGO2 Pro control system, containing also the procedures for the use with third-party software and in particular with the INDI and ASCOM and Alpaca ASCOM drivers, are reported in the StarGO2 Pro manual which is part of the mount supply.

A careful reading of this manual will enable the use of your mount safely and with the maximum satisfaction.

The mount design and its configuration could be subject to modifications, without prior notification, based upon designer's improvements and the requests, if applicable, by the mount users.

1. Packing Content

Open the box to take all the content out. Extract all the components from the small cardboard box and from the mount bag side pocket putting them on a clean, flat surface.

<table>
<tr><th colspan="2">Component List</th></tr>
<tr><td>

- Mount Head
- StarGo2 Pro Box
- StarGO control Keypad
- Losmandy saddle
- T-pod adapter flange
- 0,5 Kg counterweight with support shaft
- 80 mm counterweight shaft
- 125/240 VAC / 12 VDC power supply
- Metric Hexagonal key set
- RS232 Cables
- USB Flash drive with softwares and manuals
- RJ11 RA/DEC motor cables
- Attachment screes

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<tr><td colspan="2">

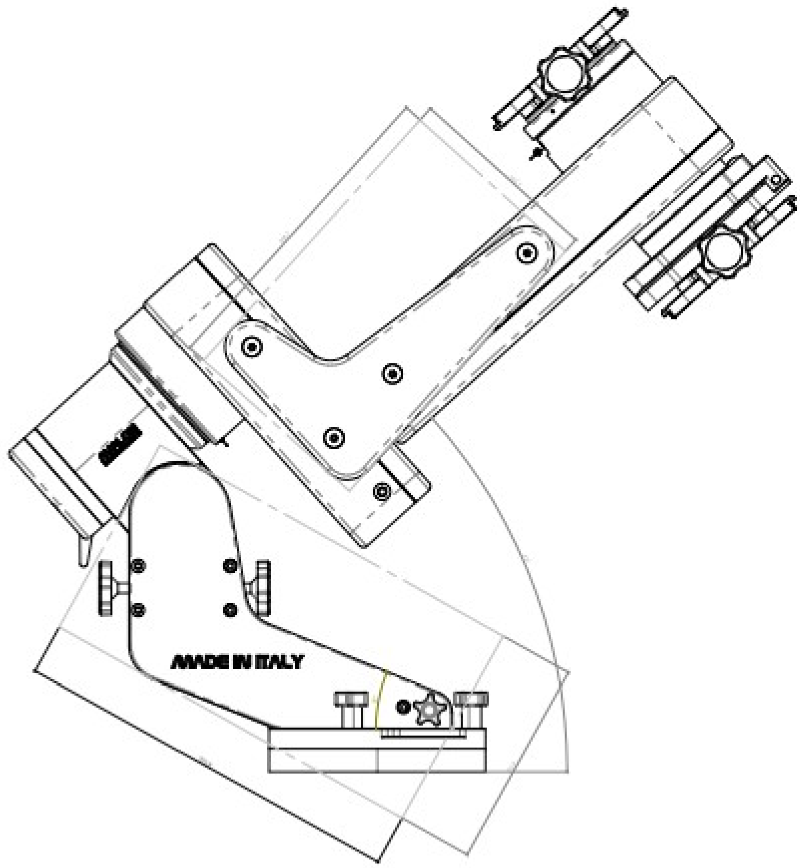
Package picture

</td></tr>
</table>

2 Mount Description

The M-due mount is a single arm fork mount devoted to deep-sky imaging in the capacity range up to 25 kg single telescope setup and 32 kg in double telescope setup.

The following drawing show the M-due mount dimensional characteristics. Dimensions are in mm.



The M-due design was developed on the basis of the M-uno, 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-due 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-due is the ideal tool to shoot deepsky 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-due is mainly designed for astroimaging with high focal length catadioptric tubes (such as SC-Maksutov, RC, SC cameras, Cassegrain, DK, etc), according to the tube length. It is possible to use the M-due with Newton optics (for example 8" f4) and even with short refractors (400-500 mm), with a piggyback or parallel guidescope.

To allow the use of refractors, an optional accessory has been realized allowing to distance the telescope from the mounting flange in order to allow the passage over the RA axis. It is also available a special kit that, in addition to distance the telescope from the mount, allows the housing of a small guide-scope obtaining also a better telescope balancing. With this configuration it could be necessary to perform the telescope inversion at the meridian passage in the case of the telescope striking the tripod.

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

Another M-due basic advantage is that counterweights may be not required.

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 three possible positions and to make the fine balance using a very small counterweight.

The M-due mount, is equipped with the new StarGo2 Pro Multiplatform Astronomical Control System.

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-due 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-due 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 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-due 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. M-due Initial Setup

The M-due can work at latitudes range from about 15° to about 60°. This mount comes with the latitude preset adjusted at 45°, so the first operation to perform, is the regulation of the latitude to the value related to the site in which the mount will be used. The same operations will be carried out in the case the mount is transferred in a site with a different value of latitude. This operation will be described in the section 3.1 below.

It is strongly recommended that the M-due mount is used with the Avalon Instruments T-pod tripod which has been designed to guarantee maximum performance. If a different kind of tripod is used, it must have dimensions and characteristics compatible with the mount weight and with the astronomical load to be installed. Section 3.2 describes the mount installation on T-Pod tripod.

For compactness purposes, the mount comes in the package with the t-pod adapter flange already assembled.

In order to put the mount on the tripod and, in case a latitude range switch will be required (see section 3.1) the adapter flange must be first disassembled from the mount as described below.

Release the two adjustment azimuth knob and remove the three flange fixing knob.	

Remove the flange from the mount bottom.	

The installation of suitable optical tube will be described in section 3.3.

3.1 Latitude Range Setting

This section describes in detail the procedures to set the correct range of latitudes of the site where the mount will be used. The latitude range setting must be performed before installing the mount on the tripod.

As said, the M-uno can be used in a wide range of latitudes from about 15° to 60°. This range is divided into three different ranges of latitude.

- Position 1 between 15° and 50°,
- Position 2 between 30° and 55°
- Position 3 between 45° and 60°.

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

Observe that the values of the three latitude ranges partially overlap. The choice of latitude setting should be made considering the greatest numerical distance between the latitude of the observation site and the closest range choice. For example, if the site latitude is 53°, it would be best to choose the third range. This is because there is an angular distance of 8° between latitude 53 and the third range value of 45°. Using second range setting would be less desirable because there are only 2° between the site latitude of 53° and the largest value of the second range of 55°.

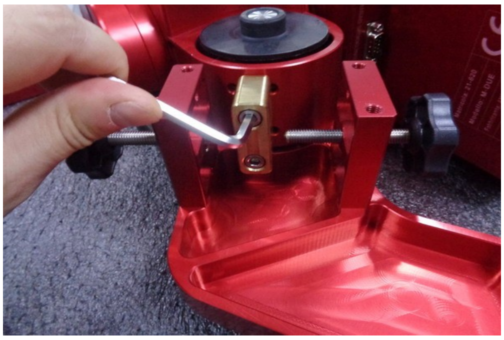
The steps needed for establishing the correct latitude operating range are as follows:

Remove the screws under the base

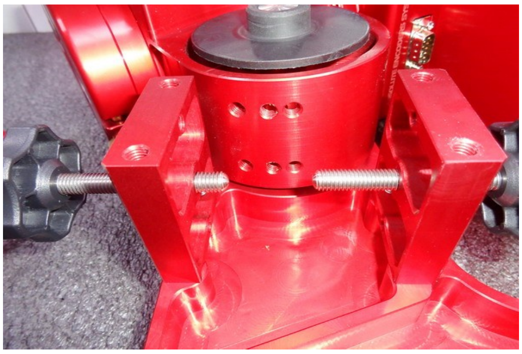
Remove the 5 screws from the side plate.

Remove the plate to expose the brass plug.

Remove the two screws from the brass latitude adjustment plug.



Place the brass latitude adjustment plug over the set of holes 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 the middle position.

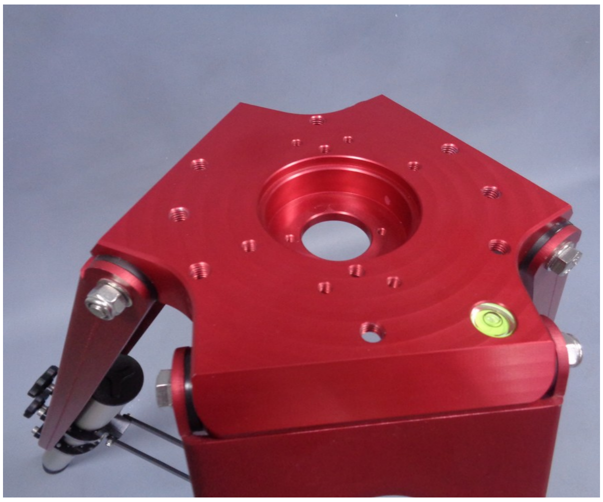
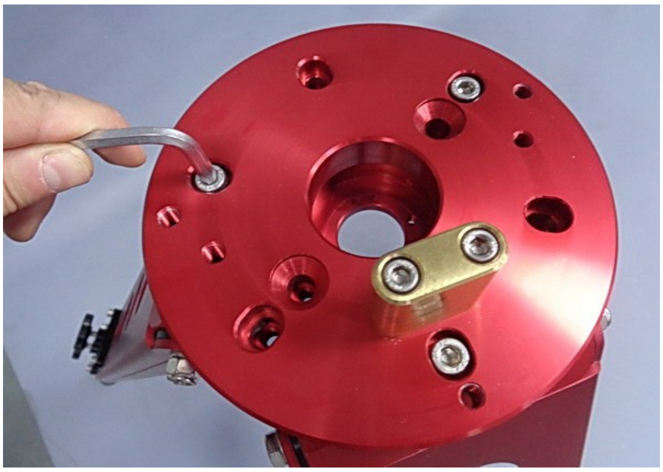


Re-attach the side plate using the five screws previously removed.

3.2 Installing the M-due on the Tripod

Whatever type of tripod is used it must be mounted with the right orientation. This need that the brass contrast block which is installed over the tripod mounting plate, is oriented to the North with sufficient approximation. A mechanical or digital compass can be used to perform this task.

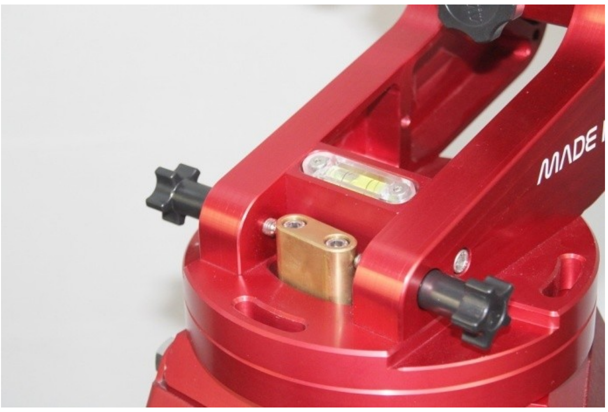
The M-due comes with a plate for attaching the mount on the tripod. It is shipped with the correct holes for most of the tripods available on the market. The following figure shows how to mount it on a T-Pod:

Place the plate on the top of the tripod and rotate it until the brass is aligned with the north leg, the one that match with the centering bubble. This leg will be designated the "North Leg" because it must be pointed to the North to achieve a polar alignment.	
	
Attach the plate with the three 8x16 screws provided for that purpose.	
	

The following are the steps necessary to install the M-Due mount on a T-Pod tripod:

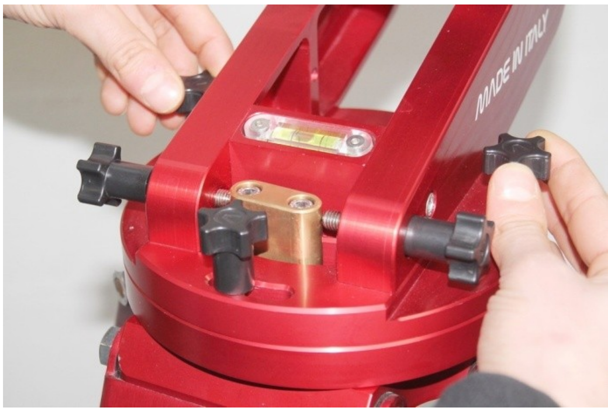
Unscrew the azimuth adjustment knobs a few turns by rotating the azimuth adjustment knobs in opposite directions.

Put the mount on the base plate so that the brass adjustment plug projecting up from the plate will fit in the proper space between the two azimuth adjustment screws.



Turn the azimuth regulation knobs until the screws touch the brass contrast plug

Tighten the three fixing screws equipped with plastic knobs in the three elongated lateral holes to keep the mount firmly in position.

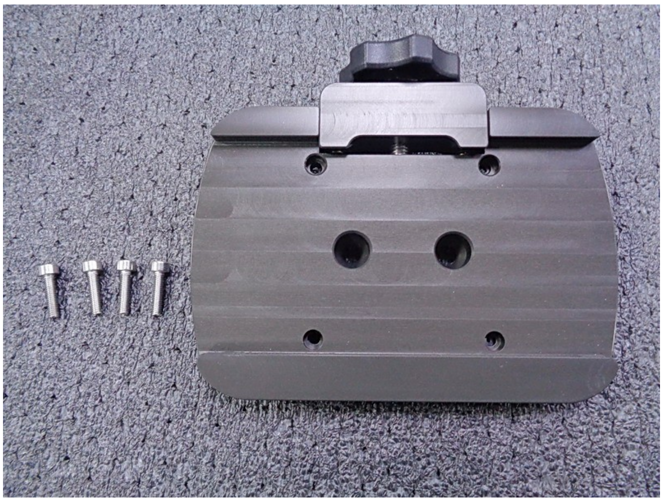
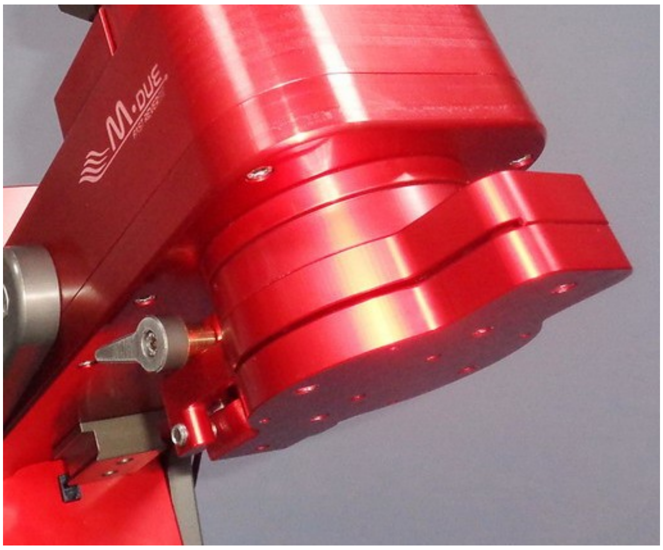


Note: *During the azimuth regulation for polar alignment, these three screws must be slightly loosened just enough to allow the mount to rotate on the base.*

When alignment is achieved, tighten the screws again.

3.3 Telescope installation

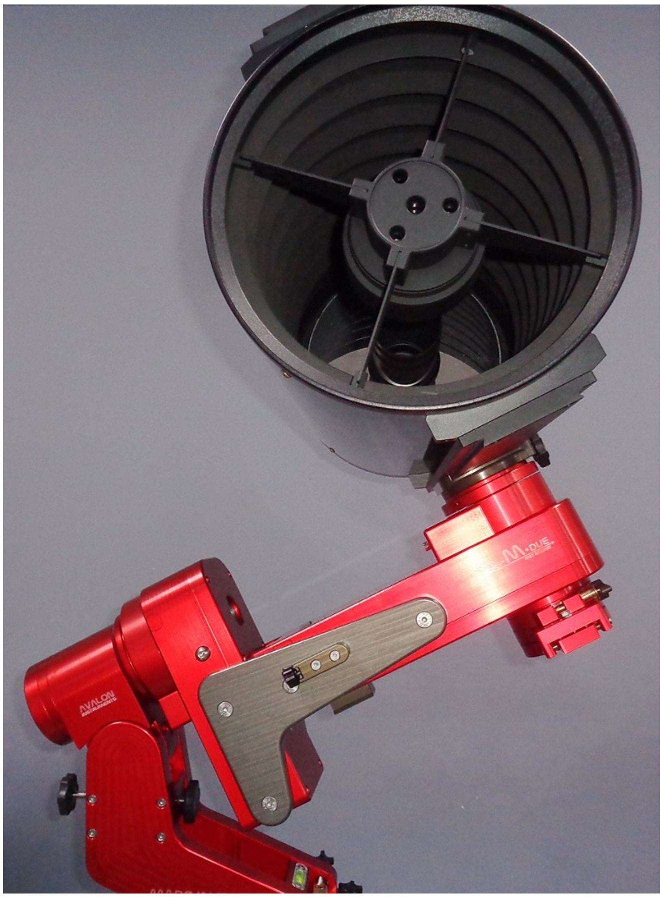
After the mount has been placed and secured on the T-pod, the next step will be the positioning of the Telescope on the M-due. In order to do this operation, the Losmandy saddle that comes with the package must be placed on the DEC axis top

Take off from the packaging the Losmandy saddle, and the four 4x16 bolts that can be found in the screws small plastic bag.	
The M-due comes provided with Absolute Encoders. So, the mount already has a home position saved. The secondary saddle support must be placed as shown in the picture on the right.	

After the direction has been positioned, the Losmandy saddle will be fixed by using the four M4 threaded holes available on the DEC axis top. This is the top axis position.	
The Losmandy saddle must be fixed has shown in the picture on the right. **NOTE: if any other position will be used, wrong pointing may occur.**	

After securely attaching the mount to the tripod and the clamp on the DEC axis top, the next step is to install the telescope and to perform the Polar Alignment.

Place the mount arm in the position shown on the right picture, unlock the declination knob and rotate the axis until the female dovetail saddle is horizontal. Firmly lock both the axis knobs. Firmly keep the OTA and insert its male dovetail plate into the female saddle, making sure that the side closer to the ground goes in first, as shown in the picture.



While holding the telescope with one hand, use your other hand to rotate the knob on the dovetail saddle clamp, as shown in the right picture, until it is firmly locked.

Before leaving the telescope, be sure it has been securely attached by making certain that the male dovetail bar is in close contact with the female saddle and there is no space between them.

Test the saddle's locking knobs as well as the RA and DEC clutch levers to make sure they are tight

4. Telescope Balancing

To guarantee a precise mount tracking it is necessary to correctly balance the telescope in both the rotation axes. To perform this operation is needed to move manually and freely the telescope in RA and DEC. As anticipated, the M-due is provided of latches in both axes. To freely move the telescope, the latches need to be released by rotating the related levers in the counter clockwise direction.

Note: Before performing the balancing of the telescope be sure to have the full control of it before releasing the latches. An over unbalanced mount can move very quickly causing damages to the optical tube or to the mount itself.

4.1 Dec Balancing

To obtain the best tracking performance from the mount, the telescope must be balanced in both axes. Even if the telescope does not track in Declination, it must be balanced on this axis to avoid sudden movements when the declination knob is unlocked. Good balance also helps to prevent vibrations and overly-quick responses while guiding and reduces strain on the motors. With the M-due mount it is better to start balancing the DEC axis rather than the RA axis. The M-due is unique in that it allows the RA axis to be almost automatically balanced with any telescope.

Before beginning the balancing operation, it is worthwhile to test the saddle locking knobs to make sure they are tight. Telescopes do not like to being dropped!

Perform the following operations:

- Unlock the RA axis knob and move the arm of the mount to an equilibrium position, as seen in the image, and re-tighten the RA axis knob.
- Loosen the DEC knob and move the telescope parallel to the ground as seen in left picture, but do not let go of the telescope.
- Move the tube SLOWLY and CAREFULLY – to see in which direction, if any, it rotates around the DEC axis. If the front end moves down, the telescope must be moved backwards in the mount. If the front end moves up, the telescope must be moved forwards. To do either of these, maintain a good grasp of the OTA and slowly loosen the dovetail knob on the mounting saddle.
- Move the tube back or forth in the saddle, depending on whether it moved up or down, until it stays in a horizontal position by itself when you remove your hand.

Note: Always lock the clamp before checking the balance with the new tube position! If the tube remains stable in a horizontal position when the DEC knob unlocked, the DEC axis will be balanced. Tighten the dovetail clamp to firmly lock the telescope tube in its new position. Do NOT leave the telescope while the dovetail clamp is loose. In the unlikely event that your telescope should fall off the mount onto the ground, it could ruin your entire day.

4.2 RA Balancing

Balancing the M-due mount in the Right Ascension axis is different from the other German Equatorial Mounts, but it is quite easy to do. The balance is performed in two phases, one raw and the other more precise.

Raw Balancing

After having placed the telescope on the clamp and having found the fine DEC balancing, the user should have noticed the balancing behaviour on the RA axis.

The M-due (as the M-zero and the M-due mount) allow to move the DEC arm in several positions toward the RA axis. This feature help to find a fine balancing by using as less as counterweight possible.

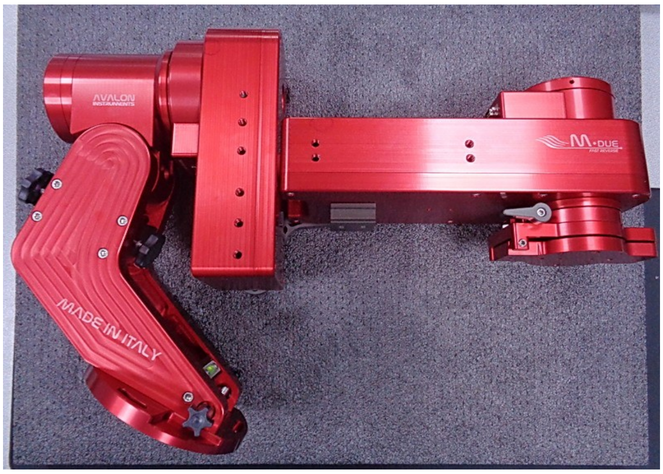
On depending on the unbalancing level noticed in the previous operation, the user can be aware about the best DEC arm position to use for his setup.

Normally, the more the telescope weight, the lower should be the DEC position.

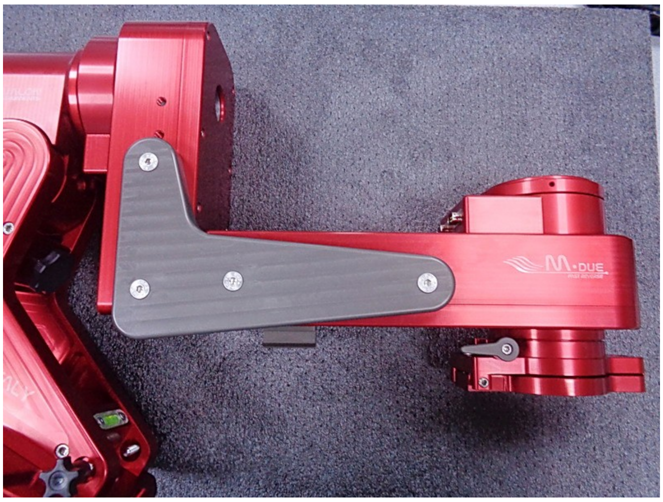
In case the user needs to change the DEC arm position from the one provided, the following procedure must be followed.

Place the mount on a flat and anti-scratch surface. The foam cover that comes with the packaging may be useful for this purpose.
Put the arm of the mount parallel to the ground as seen on the right picture.

Unscrew and set aside the four screws holding the lateral bracket on both sides of the mount. Then remove the lateral bracket.



In case the lowest position will be required, it is possible to reverse the lateral bracket, as for the M-zero mount.



Warning: do not use different screws other than those supplied or serious damage to the gear system may occur!!

Precise balancing

Once the mount arm has been set in the correct position for approximate balancing, tighten all screws and, if necessary, perform the fine balancing. This is performed by mounting the small counterweight, its shaft and the female dovetail as shown in the previous picture above. Insert the counterweight in the shaft and slide it in the equilibrium position. When that is accomplished, firmly tighten the counterweight locking knob and the shaft end knob. Of course all the precise balancing operations should be performed with the telescope installed.

NOTE: Most German Equatorial mounts are based on worm gear technology. They need to be slightly unbalanced in the easterly direction to avoid any unwanted pendulum-like behaviour when crossing the meridian. The M-due's toothed-belt transmission technology eliminates the need for this small amount of east-bias unbalance. This is a major improvement because once the M-due is balanced, the counterweights do not need to be moved at all. The design provides a level of stability that is most appreciated during long exposures and remote observing sessions.

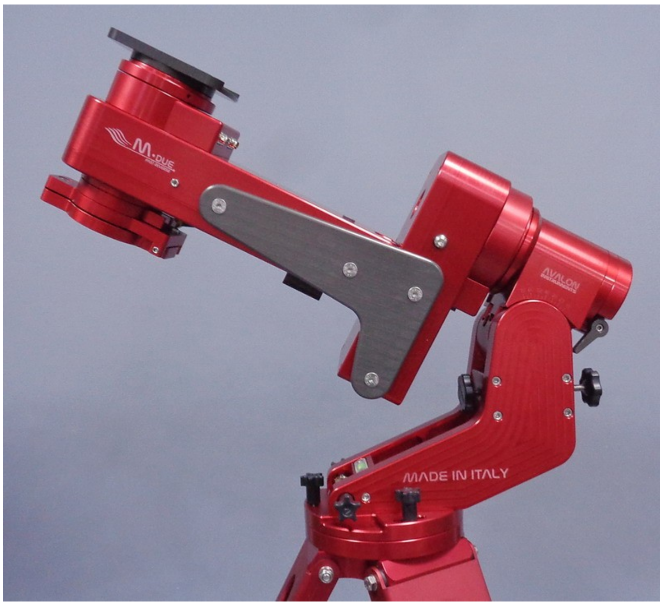
5. M-due mount stationing

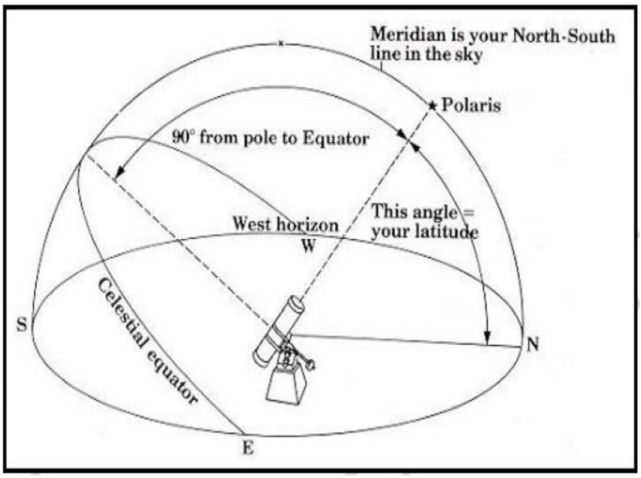
Before using the M-due mount it is necessary to position its polar axis parallel to the earth's axis of rotation.

In this chapter the operations to trim the latitude and the azimuth and to perform the mount alignment to the celestial pole using the standard polar scope (or the optional alternative) will be described.

5.1 Latitude Fine Adjustment

During this operation the mount arm must be kept in its equilibrium positiont. 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 Regulation

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.

Remember that setting up the mount in both Latitude and Azimuth should be performed only during the important phase of precise polar alignment, before starting an observation or photographic session. Once the polar alignment has been reached, THE MOUNT SHOULD NOT BE MOVED FOR ANY REASON USING ALTITUDE OR AZIMUTH KNOBS OR THE ALIGNMENT WILL BE LOST. After the alignment has been established, moving the mount in Right Ascension and Declination and pointing the telescope to celestial objects should be performed only by using the keypad or the software commands.

5.4 StarGo2 Pro installing

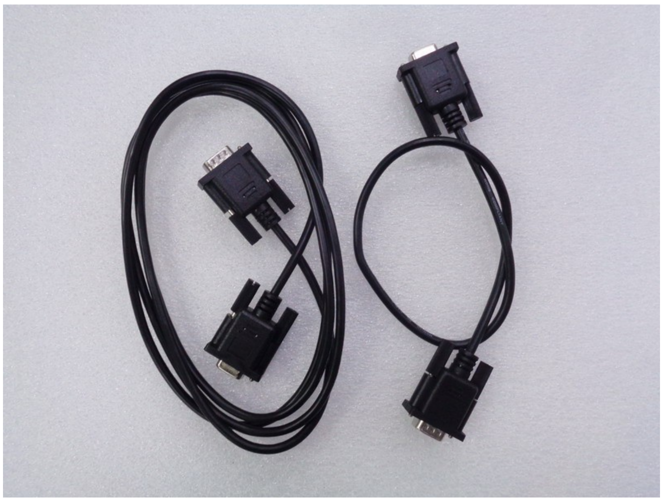
The First step to be performed in the cables connection procedure, is the StarGo2 Pro box assembling. The porocedure is described with picture sequence below.


StarGo2 Pro
Multiplatform
Astronomical Control System
AVALON
INSTRUMENTS

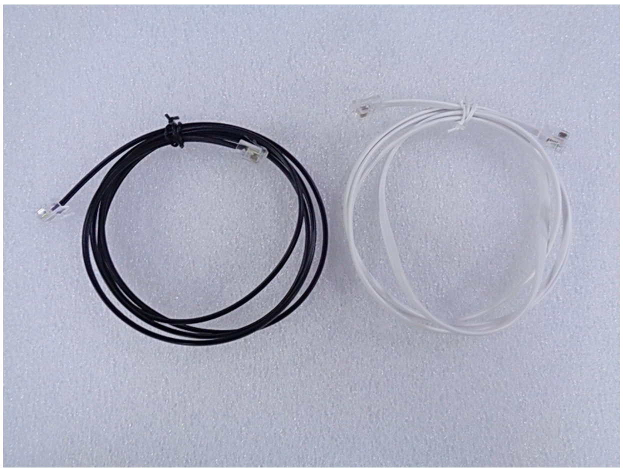
5.5 Cables connection

After the StarGo2 Pro box assembling, it is possible to plug the cables required to connect the encoders ad the RA/DEC motors with the box.

Encoders cable connection. In the picture below are shown the encoder connectors on DEC and RA axis.	
	
The mount package comes provided with the two RS232 cables required to connect the StarGo2 Pro box with the corresponding connector.	
	

	The shortest cable (0,5 meter length) must be used to connect the RA axis male connector to the DEC female conncetor. As shown in the left picture.
	The longest, must be used to connect the StarGo encders connector to the DEC axis male conncetor. As shown in the picture on the left.

After the encoders has been connected, the RA and DEC motors must be connected with the corresponding plug placed in the bottom side of the StarGo2 Pro box.

<table>
<tr><td colspan="2">The packaging comes provided with two RJ11 cables. The white one it is the one available to connect the RA motor to the StarGo2 Pro RA plug, whereas the black one must be used to connect the DEC motor to the corresponding plug on the StarGo2 box, as shown in the pictures below.</td></tr>
<tr><td></td><td>
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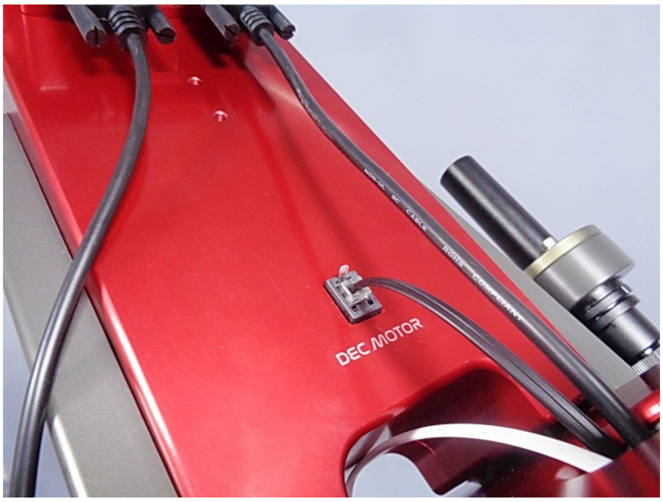
<tr><td>
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5.3 M-due Polar Alignment

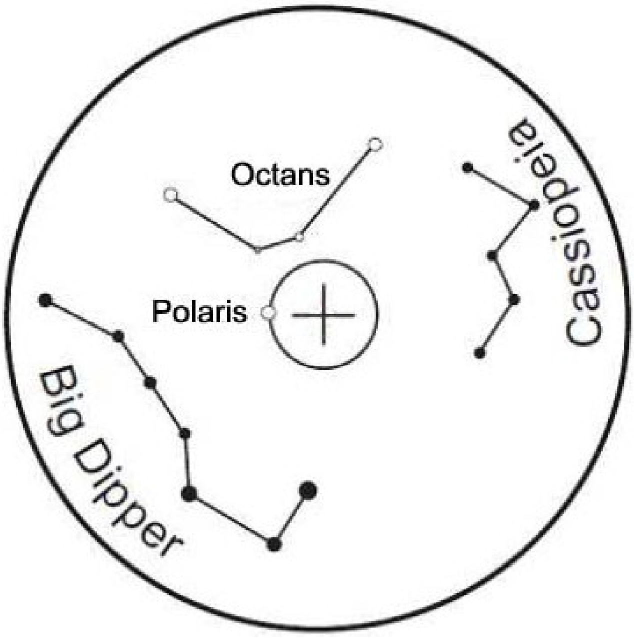
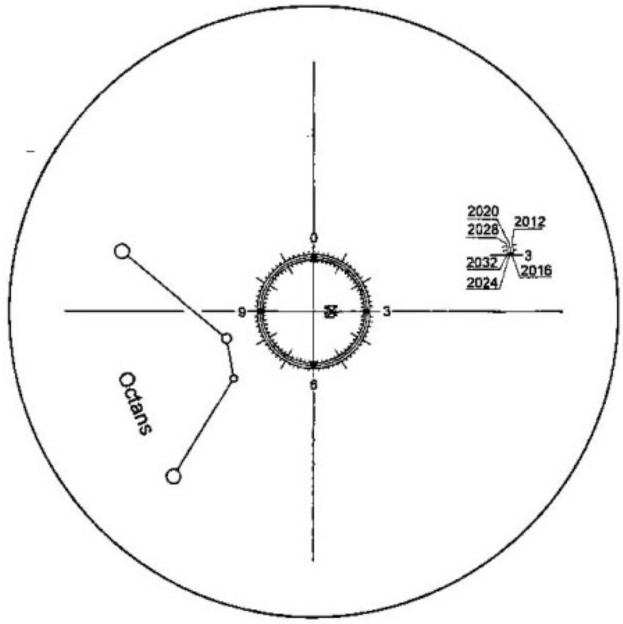
The M-due mount comes with the Skywatcher Polar-scope placed in the provided External Polar Finder kit

Polar-scope with the optional external mounting kit

Starting from the 2016, the Skywatcher polar-scope included with the mounts have a different reticle view than earlier models. However the Polar Alignemnt procedure with the M-due mount remains the same and is explained in the following paragraphs.

5.3.1 Polar Alignment with a Skywatcher polar-scope

The Skywatcher type of polar scope is normally included with the Avalon Instruments mounts. The first series of Avalon Instruments mounts was provided with a classical reticle having the engraving reported as shown below. Mounts produced later are instead provided with a newer type of reticle with a different engraving. The two pictures below show two kind of skywatcher polarscope model: the classical reticle (with Octans, Big Dipper and Cassiopeia) and the new one (with the only Octans constellation). 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.

	
Skywatcher polarscope view with classical reticle	Skywatcher polarscope view with new reticle

As it is known the Polaris is several tens of seconds from the Celestial Pole and therefore it appears to orbit around the pole at a given distance, making a full orbit, every 24 hours. The circle in the reticle centre represents the Polaris orbit. On the left, the small one, with the name of the star, represents the position of the Polaris. The problem here is to turn the reticle around the small cross in the centre, to put the small circle in the position where the Polaris is seen from a given observation site, at a specified date and time. In the past this position was obtained using several types of graduated circular scales. The Avalon mounts are not provided of these scales.

Presently the most suitable method to get the exact Polaris position is the use of one of the several computer programs or mobile devices applications, both for Apple iOS or Android as, for example, “Scope Help” for iOS or “Polar Finder” for Android. These programs, that provide the Polaris position both visually and in the hour form, are briefly described in section 4.3.2.

NOTE: Once the Polaris position has been determined and the telescope has been mounted with the contrast blocks oriented to the North the following operation are needed, if using the left polar-scope:

In case of use of the default reticle (that of the left) the operations to be performed are the following:

1. Loosen the DEC latch and rotate the axis until the hole in the axis is in the front of the polar scope, allowing it to see the sky and the Polaris in the field of view. Tight the DEC latch in this position.
2. Loosen the RA latch and rotate the axis until the small circle in the reticle is in the position indicated by the used application. Tight the RA latch in this position. It is possible to have a

small help verifying that the position of the figures of the Big Dipper and Cassiopeia roughly correspond to the real position in the sky.

3. Loosen slightly the two screws that fix the mount to the tripod to allow the mount base to rotate respect to the tripod mounting plate.
4. Acting on the two azimuth regulation knobs bring the Polaris under or over the small circle. Acting on the two altitude regulation knobs bring the Polaris inside the small circle.
5. Repeat this operation until the Polaris is centered in the circle.
6. Tight the Azimuth and Altitude knobs against the contrast blocks.
7. Firmly tight the screw that lock the mount movement respect to the tripod.

In case of use of the new reticle (on the right figure) the only difference is that the operation number 2 is not more necessary. The position of the Polaris on the circle can be defined with the help of the circle gradations and therefore is not more necessary to move the RA axis.

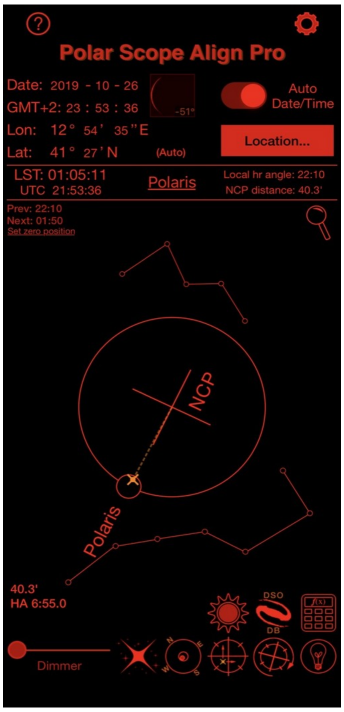
5.3.3 External programs for Polaris Finding

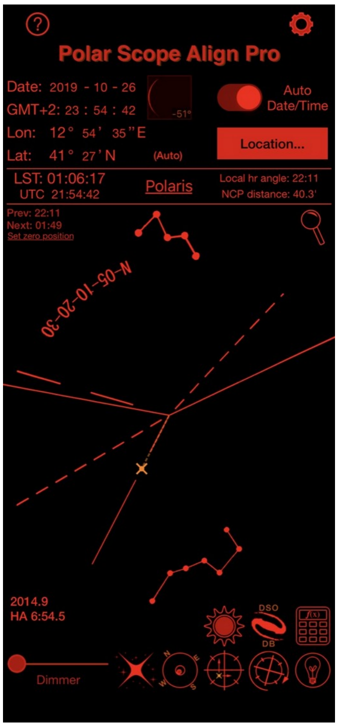
Several applications exist to help executing a good Polar Alignment using PC (Windows and Mac) and mobile devices (iOS and Android). All of them are based on a similar concept: A virtual reticule, often representing the real reticule present in the Polarscopes, with the position of the Polaris in function of the observation site coordinates, the local date and time.

In this section we present an application available for iOS but with very common feature that are easily applicable to all other applications with the same purpose.

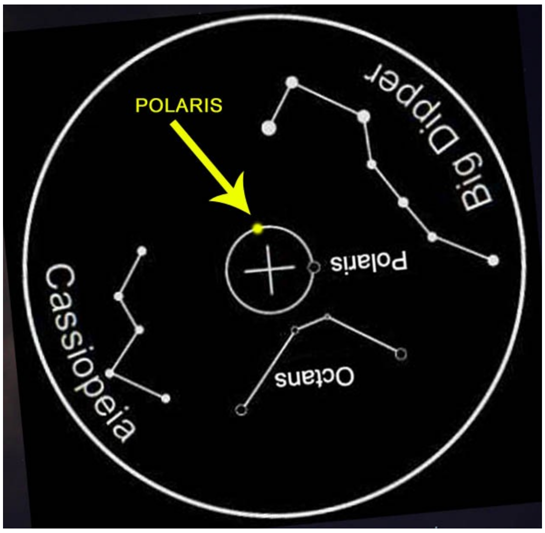
Polar Scope Align Pro allows the choice of a large number of reticules, used by almost all commercial mounts developed in the last ten years. The three reticules presented here represent those discussed in the previous sections (old Skywatcher, new Skywatcher and Losmandy).

The first is the very simple Skywatcher reticule described in section 4.3.1 representing the approximate position of the Big Dipper and Cassiopeia asterisms



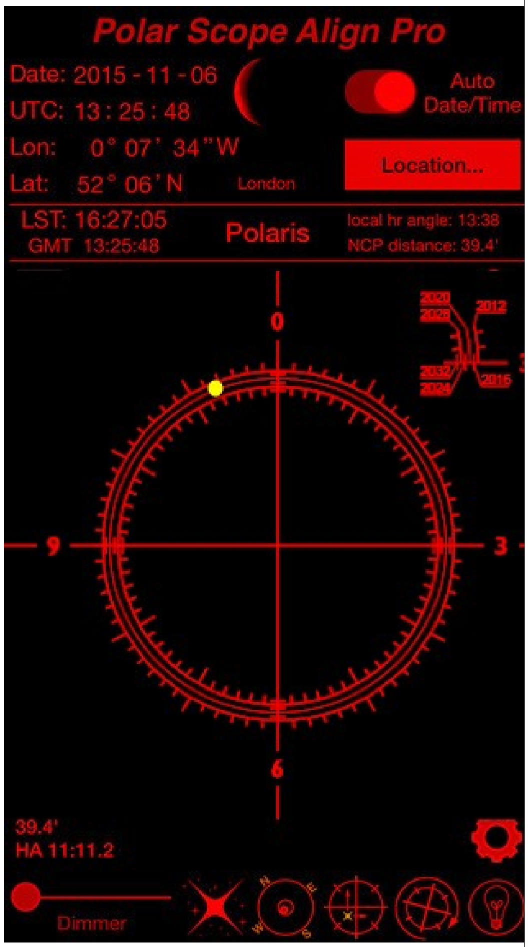
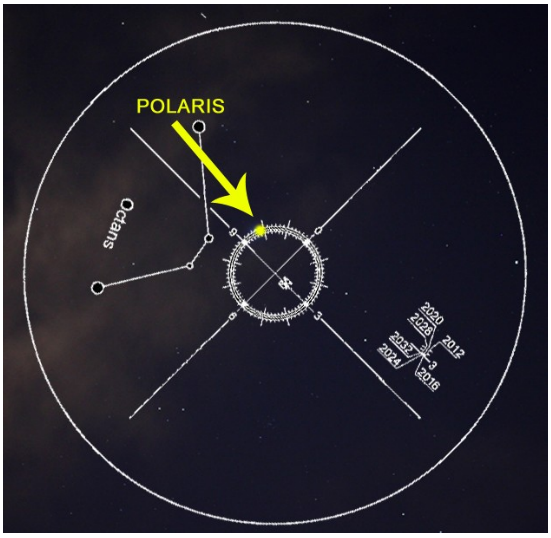


Using it is very simple, rotate the RA axis until the polar-scope reticule is oriented as the virtual one and operate on the Alt and Az Knobs to bring the Polaris inside the small circle located on the star route around the North Pole. A simpler alternative is not to rotate the axis and put the Polaris in the same position it appears in the application screen. This is done with much more precision with the new type of reticle. Below is reported one example where the Polaris is located at about hour 11:15.



Example with old Skywatcher reticle.

As previously said it doesn't matter how the reticle is rotated. If Polaris is in the same position on the orbit indicated by the chosen Polar Finder app, an accurate Polar

Alignment has been accomplished	
 **Example with new Skywatcher reticle** It is the same as described above. As long as the position of the star Polaris in the polar-scope reticle is in the same position indicated by the smartphone or PC app a good polar alignment will be achieved.	**As it appears in the application** The graduated circle represen the Polaris orbit in 24 hours. The yellow dot represents the polaris position at the observation time. In this example the polaris is located at 11:15 position considering a 12 hours watch dial.

5.3.4 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.