AVALON INSTRUMENTS

LINEAR FAST REVERSE

EQUATORIAL MOUNT
(Made in Italy)

USER MANUAL
Version 2.0 November 2019

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.**
- **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 .**
- **For any assistance or repair, please contact only the manufacturer.**
- **After using it, avoid to store the mount in areas exposed to sunlight or in wet places.**
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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.

Table of Contents

Technical Specifications

Type of mount	German Equatorial
Head weight	12 kg (27.5 lb) without counterweight and bar
Maximum load	20 kg (44 lb) for photographic use, 25 kg (55 lb) for visual
Motion System	Four-step reducer via pulley-tooth belt system on ball bearing, with no play on both the axes.
Construction Material	Anodized aluminium, worked out from single blocks with high precision CNC machines
Transmission System	Pulleys made with special glass fiber polymer and high precision tooth belts
RA Axis	Heavy duty steel, diam. 35mm; all roller bearing axis movement
DEC Axis	Heavy duty steel, diam. 35mm; all roller bearing axis movement
Polar Scope	Skywatcher (optionally Losmandy)
Control System	Avalon StarGO goto system
Counterweight Bar	Quick release, 30mm diam. (1,181 "), stainless steel bar
Counterweight	One, 6 kg (13,2 lb) stainless steel
Dovetail Plate	Losmandy, 3" (75mm), dovetail, single knob with 2 tightening points
Warranty	2 years from the purchase date, extended to 5 years for the transmission system

Forewords

This manual describes the Avalon LineAR mount, the procedures for its mounting and tuning on the tripod and for the installation of a telescope. Additional Information on the LineAR mount and on the StarGO control system, containing also the procedures for the use with third-party software and in particular with the ASCOM driver, are reported in the StarGO 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

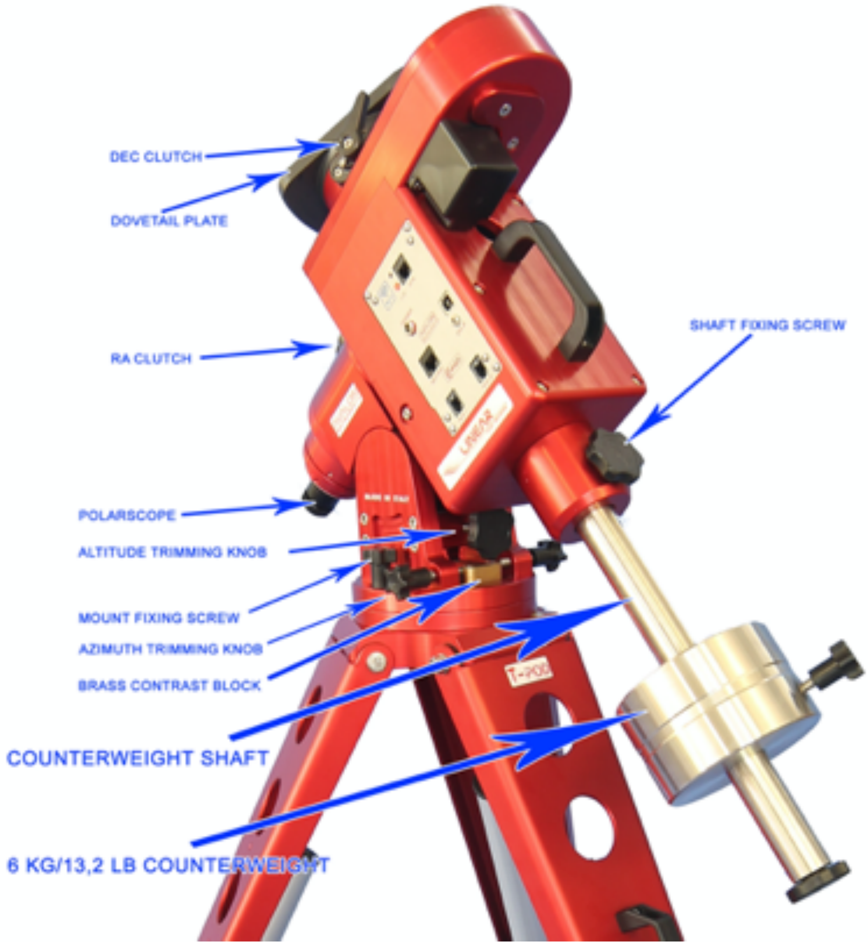
Open the box to take all the content out. Extract all the components from the small cardboard box and from the mount bag side pocket putting them on a clean, flat surface.

<table>
<tr><th colspan="2">Component List</th></tr>
<tr><td>
• Mount Head with StarGO GoTO control system.
• Polar scope installed in the mount
• Losmandy type dovetail plate for the telescope installation.
• Tripod plate and screws for fixing the mount to the tripod.
• Counterweight shaft
• 6 kg stainless steel counterweight
</td><td>
• StarGO Control Keypad
• Keypad connecting cable
• Power cable
• Warranty Certificate & Testing Certficate
• Declaration of Conformity
• Metric Allen Wrench key set
• M8 screw for extreme latitudes regulation
• USB flash drive with manuals and software
</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Box Content</td><td>Accessories</td></tr>
</table>

2 Mount Description

The Linear Fast Reverse is an innovative mount that accomplishes the movements of right ascension and declination by means of pulleys and tooth belts in the place of the classic worms and gears. This choice has allowed to obtain several advantages such as 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 LineAR have the structure made of special material with steel strands to avoid any deformation, elongation and stress. It is important to underline that 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, pledged over the pulley, greatly reducing the tracking error. On the contrary, in the classical worm–gear systems the motion transmission is performed in a single contact point between the worm and the gear thread and therefore any error in one of the contact surfaces is taken into account as a tracking error.



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.

The picture shows all the main items of the mount. Their use is described in detail in Section 3.

3. LineAR initial Setup

The LineAR can work at latitudes range from 10° to 70°. For compactness purposes, the supplied is mount preset at about 40° and therefore 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.

It is strongly recommended that the LineAR mount is used with the Avalon Instruments T-pod tripode which has been designed to guarantee maximum performance. If a different kind of tripode 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. Finally, the installation of suitable optical tube will be described in section 3.3.

3.1 Latitude Range Adjustment

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

As mentioned, the LineAR is designed to work at latitudes between 10° and 70°. To obtain such a wide range of latitudes, the mount is provided with a gusset with three positions enabling different ranges of latitude.

- Position 1 between 10° and 31°,
- Position 2 between 32° and 55°
- Position 3 between 56° and 70°.

On delivery, the gusset plug is set for the Central Europe and North-Central United States latitudes.

Should it be necessary to change the latitude beyond these limits - for example, to use the mount in Northern Europe or in the Tropics, it is necessary to perform the repositioning of the metallic gusset placed under the mount.

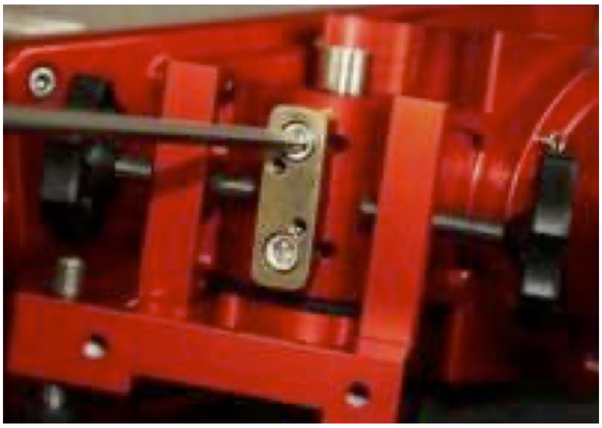
This adjustment requires a 5 mm Allen wrench and the M8 hex head screws supplied as standard.

The operations required to adjust the range of useful latitudes are as follows:

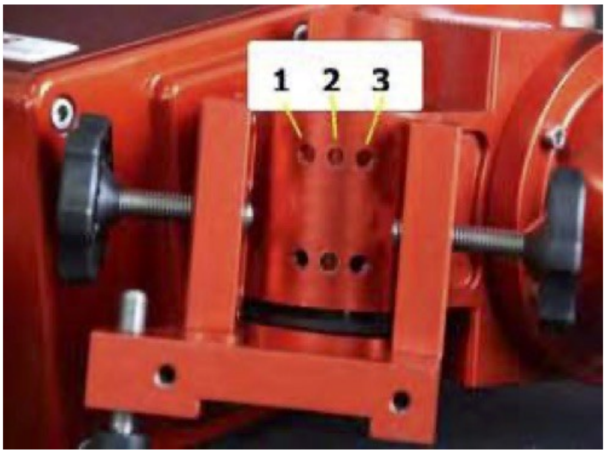
1) Unscrew the 2 screws under the base

2) Unscrew the 4 screws of the side bracket

3) Remove the bracket



4) Unscrew the brass item



5) Screw the brass item in position 1 for latitudes from 10° to 40° or in position 3 for latitudes from 45° to 70°

6) Remount the side bracket and tight all screws

7) For latitudes from 45° to 70° insert the hex head M8 screw in the polar scope side as in the picture

8) For latitudes from 10° to 31° insert the hex head M8 screw in the polar scope side as in the picture

3.2 Installing the LineAR on the Tripod

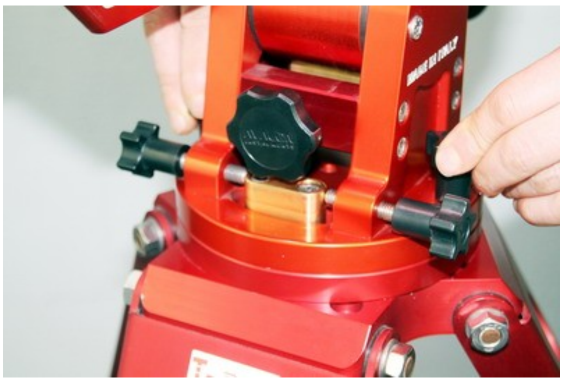
Whatever type of tripod is used it must be mounted with the right orientation. This need that the brass contrast block which is installed over the tripod mounting plate, is oriented to the North with sufficient approximation. A mechanical or digital compass can be used to perform this task.

The LineAR comes with the plate for attaching the mount on the tripod but the plate must be assembled on the tripod according to the instructions below.

The plate is shipped with the correct holes for mounting it on 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 one of the legs, chosen arbitrarily. 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 3 screws provided for that purpose.

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

Rotate the mount azimuth knobs of a few turns to make enough space for the insertion of the tripod brass contrast block.	
Put the mount on the tripod plate, so that the mount bottom plate will fit perfectly with it and the brass contrast block is in between the two azimuth screws. The mount body will remain well balanced over the tripod.	
Tighten the two fixing screws equipped with plastic knobs in the two elongated holes to maintain the mount firmly in position. Rotate the azimuth knobs until they touch the contrast block. **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 the polar alignment is reached tighten the screws again.*	

3.3 Bar and Counterweight

NOTE: Installing the telescope without counterweigh, even with the AR and Dec latches well tight is unsafe. There is the risk of a sudden rotation of the telescope around the axis leading to hit the tripod legs with consequential damages.

The counterweight shaft has a special groove to allow a quick setup and a safe usage.

- Unscrew the knob at the bottom of the dec axis, place the shaft in the hole and push until the shaft is fully inserted; at this point tight the knob to properly fix the shaft.

Depending on the telescope you want to use, one or more counterweights will be needed.

- Completely unscrew both the security screw at the bottom of the counterweight shaft and the fixing screw on the counterweight.
- Insert the counterweight on the shaft, placing it at about the centre. Firmly tighten the counterweigh knob and then re-screw the security screw on the end of the shaft.

3.4 Installing the Optical Tube

The LineAR, as before mentioned, is provided of a Losmandy type (75 mm) dovetail plate (saddle) to install the telescope. Therefore the telescope must be provided of a male dovetail bar of the same type.

Note: Before installing the tube, make sure you already installed both the shaft and the counterweight and that the shaft is vertical and pointing to the ground (Counter Weight Down - CWD position).

Unlatch the DEC axis and rotate it until the dovetail plate is in horizontal position, then re-block the latches on both axis.

Open the dovetail clamp by rotating its own knob. Firmly take the OTA, insert its male dovetail plate in the mount dovetail saddle, putting the side closer to the ground first. Then, while still keeping the OTA with one hand, screw with care the clamp until the OTA is firmly locked on the mount.

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 LineAR 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 RA Balancing

1. Make sure the telescope is firmly set on the mounting platform.
2. Loosen the latch of the RA shaft and place the telescope on one of the sides of the frame. The counterweight bar will extend horizontally on the opposite side of the mount.
3. Let go the telescope SLOWLY to see which way the telescope tends to "fall."
4. Loosen the lock screw of the counterweight, so that it can slide along the bar.
5. Move the counterweight towards the position in which it balances the telescope (i.e. the position in which the telescope remains stationary when the RA latch is loose).
6. Tighten the counterweight screw to lock it in the new position.

4.2 Dec Balancing

Even if the telescope should not move in Declination during an ideal tracking, it telescope must be balanced in this axis to prevent any sudden motions when the DEC latch is loose and particularly to ensure the absence of vibrations and a quick response during the photo autoguiding. To balance the telescope in DEC:

1. Loosen the RA axis latch and position the telescope horizontally on one of the sides of the mount
2. Tighten RA latch to keep the telescope in position.
3. Loosen the DEC axis latch and rotate the telescope to make the tube parallel to the ground.
4. Release the tube - GRADUALLY - to see which way the tube tends to rotate with respect to the Declination axis.
5. Slightly loosen the mount dovetail clamp knob and slide the telescope either forwards or backwards until it will not remain in equilibrium when the DEC latch is loose. DO NOT let go the telescope tube while the dovetail clamp knob of the mounting platform is loose!
6. Tighten the dovetail clamp knob to lock the telescope in place.

NOTE: It should be emphasized that the LineAR mount, on the contrary of the mounts based on worms and gears, that must be slightly biased in the direction of motion to obtain a more regular tracking, must be accurately balanced to guarantee, in every position, the absence of hysteresis effects and oscillations around the meridian. This difference is due to the toothed belts transmission system and proves to be a significant advantage because, once balanced, it is not necessary to change the position of the weights during sessions, a valuable feature for long exposure photography even at the meridian pass, as well as very useful also for remote telescopes.

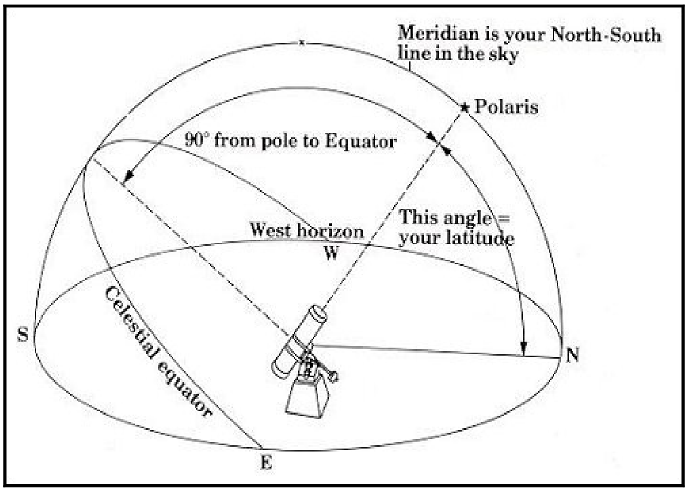
5. LineAR Mount Stationing

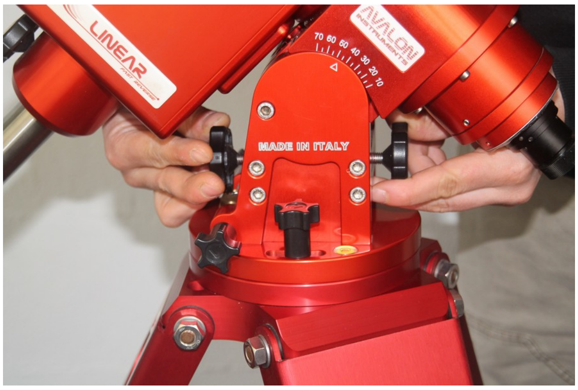
The LineAR is an equatorial mount and therefore it is necessary to make its polar axis parallel with the Earth rotation axis.

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

The first operation to perform (after the tripod has been "levelled" using the appropriate spherical bubble level installed on the base plate) consists on inclining the polar axis at the latitude of the observation site (for example Milan and Venice are at 45 °, Rome at 42 °, Palermo at 38 °) using the two Altitude knobs (acting in push-pull arrangement) and the indication of the scale latitude, engraved on the left side of the mount. As mentioned, the mount adjustment range in latitude goes from about 10 ° to 70 °.





The latitude adjustment is accomplished with both hands: when you screw the back knob, unscrew the same number of laps (or fraction) the front knob or vice versa.

- To increase the latitude (lift) of the polar axis, turn the rear latitude adjustment knob clockwise.
- To decrease the latitude (lower) of the polar axis, turn the rear latitude adjustment knob counter clockwise.

Note: In general it is better to make fine adjustments in latitude by moving the mount in contrast with gravity, i.e. raising the polar axis of 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.

Alt-Az Polar Alignment

The following table shows the knobs rotation arc-minutes amount for a fine Polar Alignment adjustment with one full knob turn.

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

5.3 LineAR Polar alignment

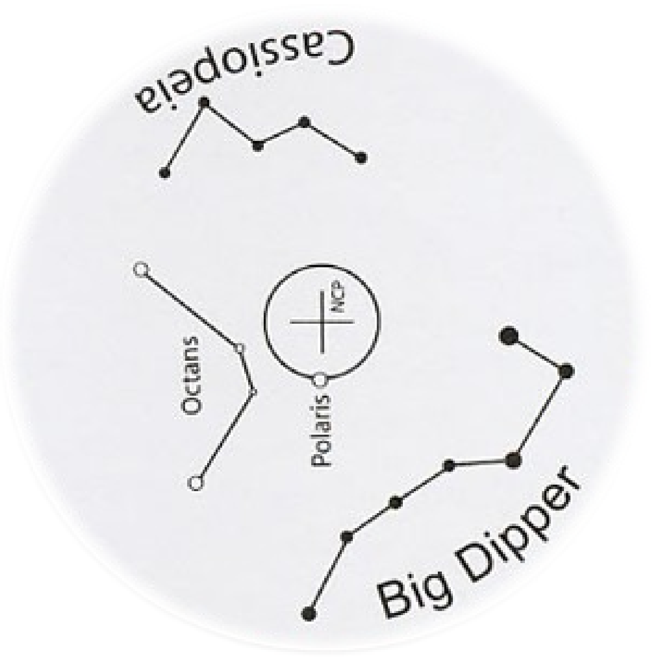
The procedure for Polar Alignment with the LineAR mount depends on the Polar-scope model. The M-uno mount comes with the Skywatcher Polar-scope inserted on the RA axis. The optional Polar-scope external mounting kit is also available the for using an alternate Polar Alignment procedure and/or polar scope use. Furthermore a Losmandy polar-scope is also available as an option.

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

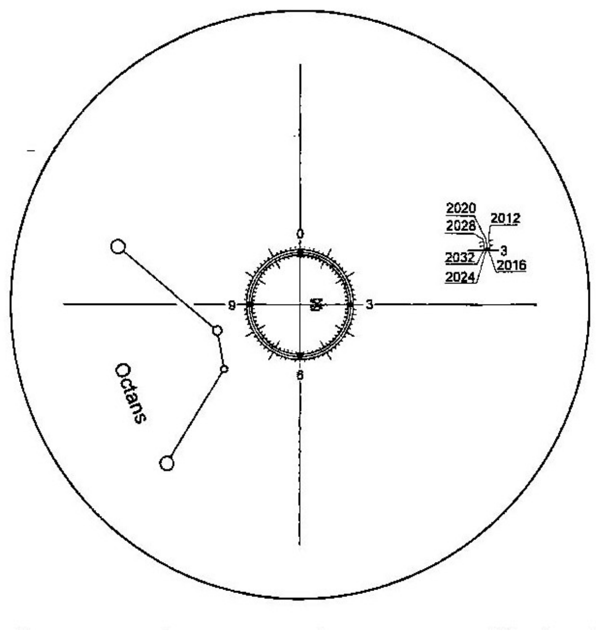
5.3.1 Polar alignment with a Skywatcher Polar-scope

Looking though this scope, with the reticle well lighted internally, it is possible to se a reticle layout similar to that on the right.

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 classical 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. The Avalon mounts are not provided of these kinds of circular dials. 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 orbit.



Polarscope view with classical reticle



Skywatcher polarscope view with new reticle

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 new reticle has a different and more efficient engraving, as shown on the figure on the right. The Cassiopeia and Big Dipper asterisms are missing and the Polaris orbit circle has a different appearance. The circle has been replaced by a graduated annulus made up three concentric circles. To obtain a precise polar position with this type of reticle, it is necessary to determine the Polaris hour angle with any of the programs or applications mentioned above. 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. The diagram on the right side of the figure provides information for a more precise positioning of Polaris in the annulus, depending on the selected year. The Octans asterism is present, but only for use in the southern hemisphere.

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

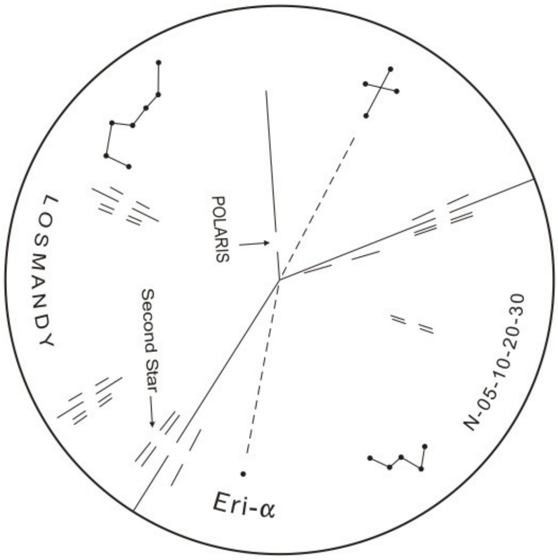
Once the correct position of the small Polaris circle has been established, the following operations should be performed:

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. Put the polar scope's star diagonal in a comfortable position and tighten all knobs in this position.
4. 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.
5. 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.

5.3.2 Polar Alignment with a Losmandy polar scope

he Losmandy polar scope, which is provided as an option, allows a more precise alignment because it is based upon the positioning of three stars (Polaris, δUMi, OV Cep) in concurrence with the corresponding locations in the scope reticle which looks like the illustration on the right.



If you are located in the northern hemisphere, ignore the dotted lines because they pertain only to the Southern Hemisphere.

The alignment operations with this kind of polar scope are the following:

1. Slightly loosen the knob that keeps the mount attached 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. Put the polar scope's star diagonal in a comfortable position and tighten its latches in this position.
4. Rotate the polar scope around its axis until the gap related to Polaris is oriented at the hour angle previously determined. To help to make this operation more precise, the dial attached

to polar scope can also be used. As a final check, verify that the constellations Ursa Major and Cassiopeia engraved in the reticle are in the same orientation as those two asterisms appear in the sky.

5. Continue turning the Azimuth adjustment knobs as directed earlier, as well as the toothed altitude adjustment wheel and rotating the polar scope until all three stars, Polaris, e-UMi and OV Cep, are exactly in the centers of their corresponding gaps in the reticle.
6. When finished firmly re-tighten the altitude and Azimuth knobs as well as the knob which attaches the mount to the tripod. The mount is now aligned to the north celestial pole.

Note: In case of difficulty to correctly orientate the constellation in the right position it is possible to get the help of a PC, smartphone or tablet applications to perform the initial orientation of the Polaris axis, as explained below.

5.3.3 External programs for Polaris Finding

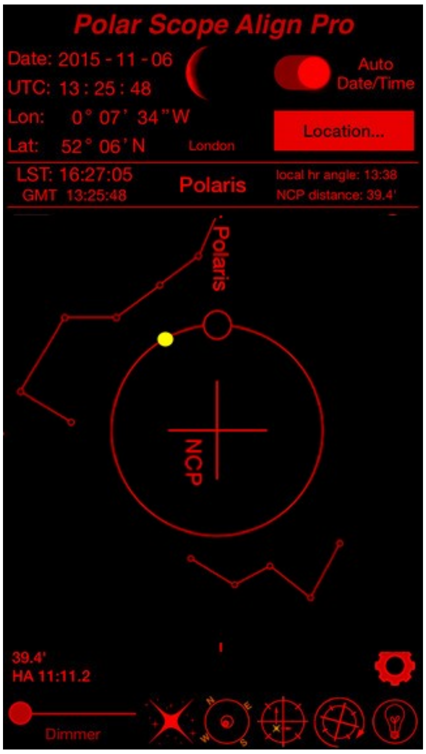
Many apps exist to determine the position of Polaris compared to the exact position of the celestial North Pole. Only two of these apps are discussed in this section. However the same concepts described here are applicable to all other existing apps.

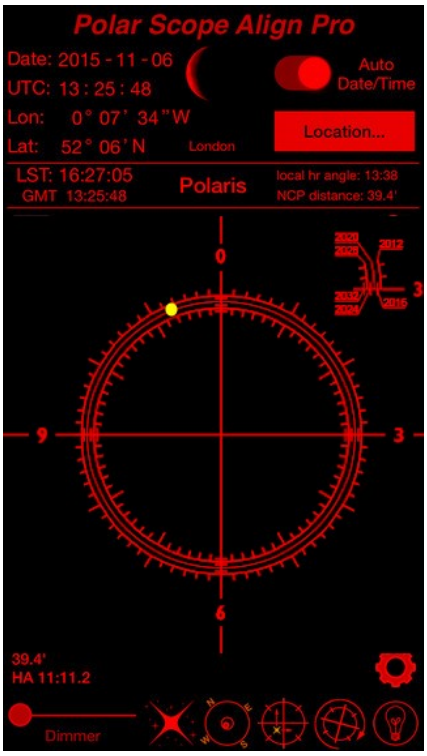
"Polar Scope Align" is an app which runs on iOS smart devices. This program uses the device's internal GPS to evaluate the geographical coordinates of the observation site to calculate the exact position of Polaris around the North Celestial Pole. It also provides some additional information that can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

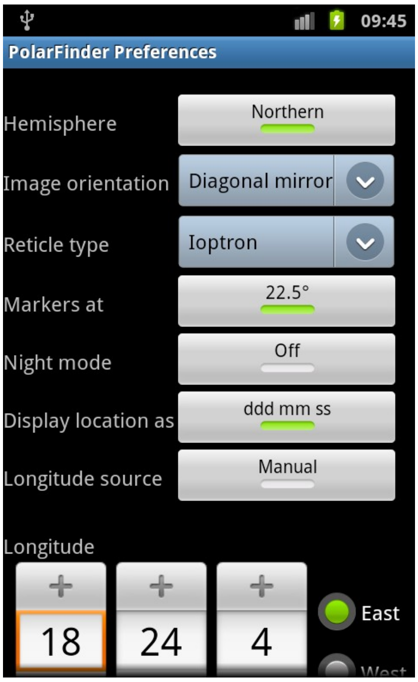
The following figures illustrate the screenshot of the Polar Scope Align app with the classic and new polar-scope reticles.



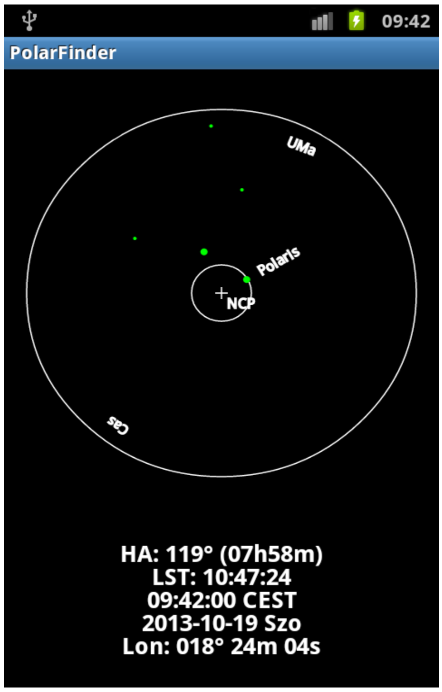


The “Polar Finder” is a similar application available for Android smartphones and tablets of different brands. This app and others that can be downloaded are able to accurately reproduce the reticle of the LineAR’s polar-scope as well as the reticle of the optional Losmandy polar-scope. The “Polar Finder” 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 LineAR.

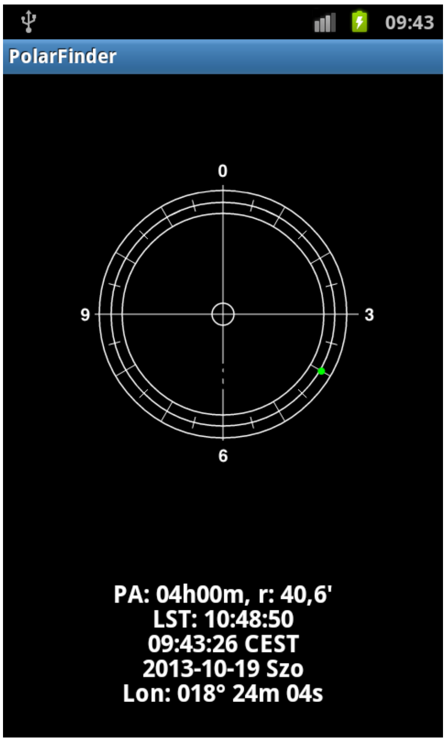
The following figures illustrate the Android “Polar Finder” app replicating LineAR and Losmandy polar-scope reticles.



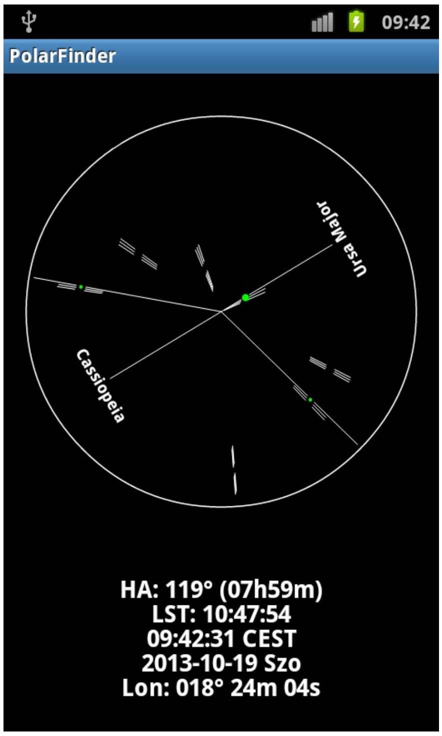
Polar Finder Preferences



Classical Reticle Layout



New Reticle Layout



Losmandy 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 LineAR.

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. Avalon Instrument has developed an adapter for fixing the CCD to the LineAR body. This adapter is provided as an optional one among the several accessories for the mount.
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 pen-drive. Detailed description of this tool in done in the StarGO User Guide.