Getting the most from your Meade Scope:
Polar Alignment

Introduction
This is the first in a series of articles designed to help you get the most out of your Meade telescope by providing you with hint, tips, and some “Best Practices” that will improve your overall experience and help you use your scope to its greatest potential. Let me start by saying that many of the concepts presented here and in the rest of this series are not invented or thought up by me. Like so many other things in this great hobby of ours, most of these ideas have come from many other sources that have freely given of their time to help others. Hopefully you will find these guides to be useful and help add to the enjoyment of using your scope.

Overview
This article will present several methods to help you achieve a perfect or near perfect Polar Alignment with your telescope. While the topics and images will primarily deal with fork mounted telescopes such as the ETX, LX200’s and others, the application of these principles apply equally to equatorial mounted scopes as well. These techniques are also geared towards the individual without a permanently mounted scope to help you get setup in the field as quickly and accurately as possibly, but, they will also be of help in initially setting up your observatory mounted scope.

Setting your scope up with a good polar alignment is generally not critical for casual observing, but for imaging, it is one of the most important things you can do to improve your chances of success. Regardless of whether you are imaging or simply viewing, if your scope is mounted on an equatorial wedge or on a German Equatorial Mount (GEM), it is still important that the alignment of the scope be as close to perfect as possible. This will improve not only the tracking of objects but will vastly improve the GOTO capabilities as well. Even for the casual observer, a good Polar Alignment will go far in adding to your overall enjoyment of your evening out under the stars.

The Basics
If you are a fairly experienced astronomer and are simply looking for a few ideas on improving your polar alignment, you may wish to skip this section of the article. If not, or if you just want a refresher course, in this section I will describe the basic mechanics of polar alignment and define some of the terms we will use throughout this article.

In a standard Alt / Az setup, the telescope must make corrections to not only track an object thru the skies with respect to its Right Ascension (RA), but also with respect to its declination. This is because the base of the telescope, where the RA is turning is not parallel to the poles of the earth. As can be seen in Figure 1 below, as objects are tracked throughout an evening, the scope will constantly need to alter its declination in order to keep those objects in the FOV. This results in those objects rotating about a point and over time and will cause them to visibly rotate in the FOV. For imaging, this precludes the use of long exposures and even if you are able to de-rotate between individual exposures, you will still lose portions of the image after a certain amount of time.

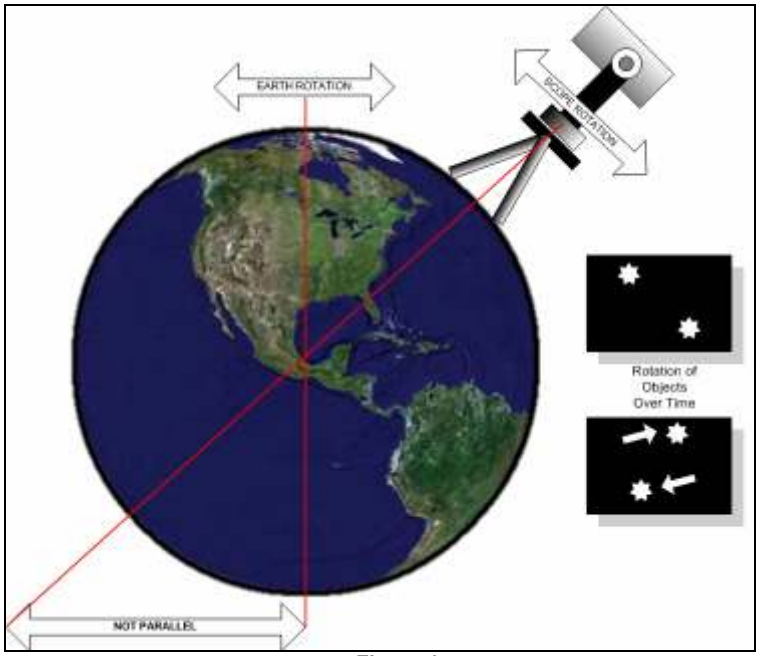


Figure 1

To alleviate this, telescopes can be mounted such that their center of rotation about the RA axis is parallel to the poles of the earth. As can be seen in Figure 2 below, the results of this are that only the RA axis must change its position over time. By matching the speed of the rotation of the earth and with the RA axis parallel to the poles of the earth, long exposure is made possible without the rotation that results from an Alt / Az setup.

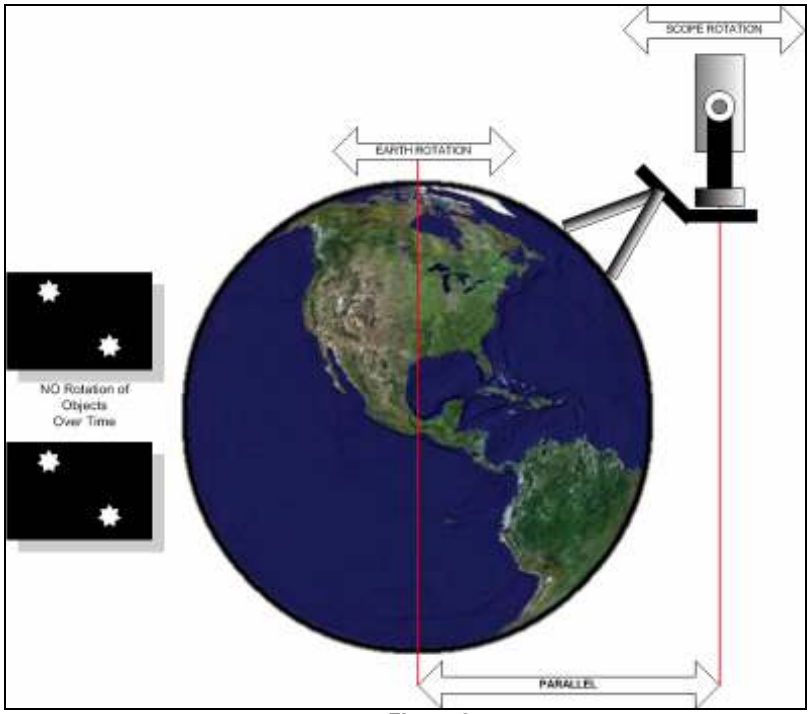


Figure 2

The caveat to this of course, is that the polar alignment, to an even greater degree then in Alt / Az, must be very precise to gain the benefits from it. While pointing accuracy may still be somewhat usable with a quick polar setup, imaging requires that the scope be nearly perfectly mounted such that is aligned not only to the correct latitude from which you are viewing, but also parallel to the pole itself (East / West). In the remainder of this article, I will document steps you may take to ensure your polar alignment is as close to "perfect" as possible.

Getting Started – Setup

As with all other aspects of Polar Alignment, setting up the scope properly is critical to achieving an exact alignment. Thankfully, some of these steps do not need to be done very often and once set should work reasonably well for some time. Others, however, should be completed each time the scope is broken down and set up again.

The first step is to setup the OTA itself correctly. When polar aligning the scope, it is very important that the OTA be parallel to the fork arms. To achieve this, start by setting the scope on a flat level surface with the OTA pointing up and locked in that position. Next, using a level (I'm using a Magnetic Angle Locator here), loosen the declination clutch knob and adjust the OTA till it is exactly perpendicular to the flat surface and re-tighten the clutch. On the opposite fork arm from the clutch, loosen the knob over the declination circle and move the circle until the 90 is directly over the small arrow on the arm itself (as seen in Figure 3 below). Lock the declination circle knob back down.

Figure 3

As noted, I have chosen to use a Magnetic Angle Locator for setting up the scope. Along with being able to serve as a very precise level, it also will indicate any other angle you wish to set which comes in very handy in the next steps. These can be picked up at most hardware stores or home centers for less then $15 and are well worth the cost.

Just as you would do with an Alt / Az setup, the next step is to ensure the tripod is level. First, place the wedge on the tripod and face the tripod towards North (front face of the wedge pointed North). Next, using your level or angle Locator (see Figure 4), ensure that the tripod is level in all directions by moving it around on the top of the wedge base. Note that you may need to slightly move the scope later and may need to re-adjust the legs at that time.

Figure 4

Figure 5

Once the tripod is level and pointed roughly towards the NCP (North Celestial Pole), the next step is to make your first adjustment to the wedge itself. Since the angle of the wedge is equal to the latitude from which you are viewing, the simplest way to do this is to loosen the lower retaining bolts on the sides of the wedge and turn the altitude adjuster (back of wedge) until the angle roughly reads your latitude. I have personally found that the latitude indicator on the wedge itself can be difficult to precisely read and so I once again turn to my Angle Locator which provides a very precise indication (as seen in Figure 5). Once you have positioned the latitude as closely as possible, tighten the retaining bolts back down. Note: You will be making adjustments to the altitude in later steps, do not over tighten these bolts.

Figure 6

The final step in your basic preparation is to mount the scope on the wedge. Although I will not go into great detail here about weight and balance (a future article), it is critical to ensure that the scope is properly balanced in all axis. I generally do this in the configuration that I will be ultimately using, even if I may change it temporarily during alignment.

Once you have mounted the scope on the wedge and performed your balance checks, ensure that the scope is pointing as close to the NCP as possible (rough at this time) and again check your tripod to ensure it is still level and has not settled. Next, rotate the scope on the RA axis and with a level across the fork arms, ensure that the fork arms are level with the ground. Finally, ensure that the scope is pointing directly towards the NCP (as seen in Figure 6 above) and that the 90º position on the declination wheel is lined up with the arrow on the scope. It is also not a bad idea at this time to again look at the angle of the scope with the Angle Locator to ensure it is still set the angle you previously set the wedge up to. It is not unusual for this to have possibly settled some if the bolts were too tight before from the weight of the scope.

At this point, the scope is setup with all preliminary work done and you are ready to begin the actual alignment procedures. In the following sections of this article, I will step thru 3 different approaches you may take for polar aligning your scope. These are the Kochab Clock method, the Iterative Method, and finally the Drift Method of alignment. While any of these methods may suffice in and of themselves to achieve a good polar alignment, I will use them to build on each other to achieve a near perfect polar alignment every time you set up.

Dr. Clay's Kochab's Clock

Like everything else in this article, the information presented here is not original to me and can be viewed as more of a single point compilation. This particular method, Kochab's Clock was designed by Dr. Clay Sherrod and is presented here with his permission. I will give an overview of its use with a slightly shorted explanation then he gives on his website. If you would like to view his complete document, you may read it here: http://www.arksky.org/Kochab.htm

The real beauty of Clay's Kochab clock is its sheer simplicity and how quickly it can be accomplished once you have tried it a couple of times. After practicing this approach a few times you will find that the initial alignment of your telescope takes les then a minute and the other methods discussed later in this article will also proceed much more quickly and smoothly.

In the Northern Hemisphere we are fortunate to have a fairly bright star that is very close to the North Celestial Pole, this star is Polaris. However, while this may give a good base to start from, it is actually removed from the true NCP by approximately 42 arc minutes. Simply aligning your scope on Polaris will get you close to a decent polar alignment, but in fact, this small deviation from the true NCP is more then enough to cause your scope to not track correctly if this was the only step you took for polar alignment.

So, we know that Polaris is close to the NCP and that being as close as it is, it will circle the NCP throughout the night. But how do we find the Pole without having to watch Polaris for several hours to see the center of the circle. Well, we are fortunate enough to have a "sign post" as such out there to point the way and this sign post is Kochab. Kochab is one of the other bright stars in the Little Dipper and is actually on the upper side of the dipper closest to the "handle". In a interesting twist, it turns out that is you draw a line directly from Polars (at the end of the little dipper's handle) back to Kochab, it nearly dissects the NCP as can be seen in the image (Figure 7) on the following page.

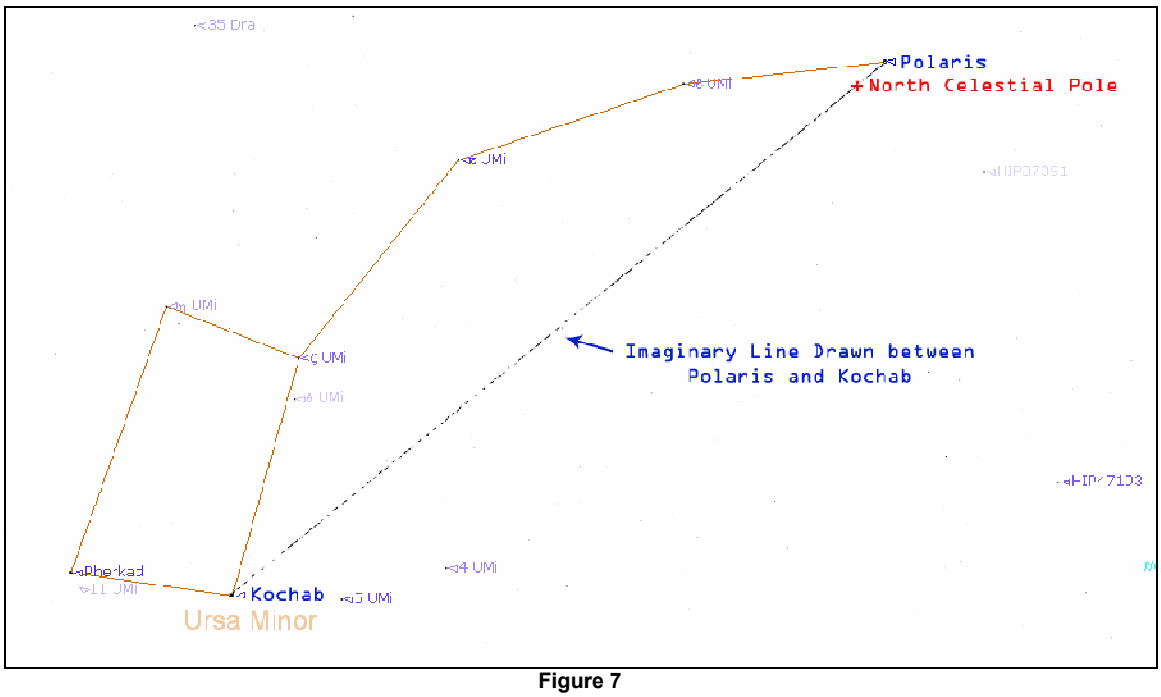
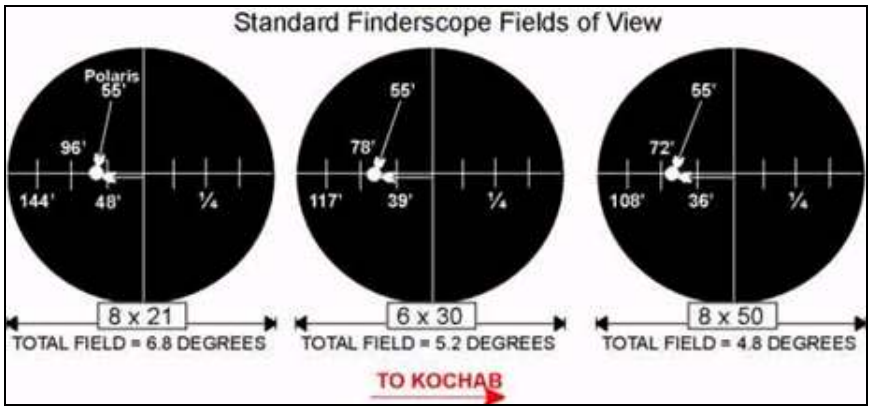


Figure 7

So, based on this information, you now have one of the questions answered which is the direction from Polaris in which to go to find the NCP. The next question of course becomes determining the distance form Polaris to the NCP and finding that in your telescope.

At 42 arc minutes, many telescopes, especially those with a long focal length, might have trouble actually seeing both Polaris and the location of the NCP in the eyepiece. But, almost any finder is able to do this easily and if you are using cross-hairs that are rotatable, this job is made even easier. As I said, Dr. Clay goes into this in far more detail on his site and you may wish to reference that document for further study. I will present my procedures for performing this setup in an abbreviated manner.

Since we know that the NCP is 42 Arc minutes away from Polaris, what we must do is determine what 42 Arc minutes looks like in our finder scope. The image below shows how far to move Polaris away from the center on many of the common sizes of finder scopes.



As can be seen then, by simply lining up the cross hairs of your finder scope with Polaris and Kochab and then putting Polaris at the appropriate position off center in the finder scope, we can achieve a fairly quick polar alignment the is very close to the NCP. Also, at certain times, this is made easier by the fact that the angel to follow to Kochab is on the cardinal headings (N,S,E,W). If you are able to setup during one of these times, your adjustments are slightly easier since you must only make the final wedge adjustment in one direction as can be seen below:

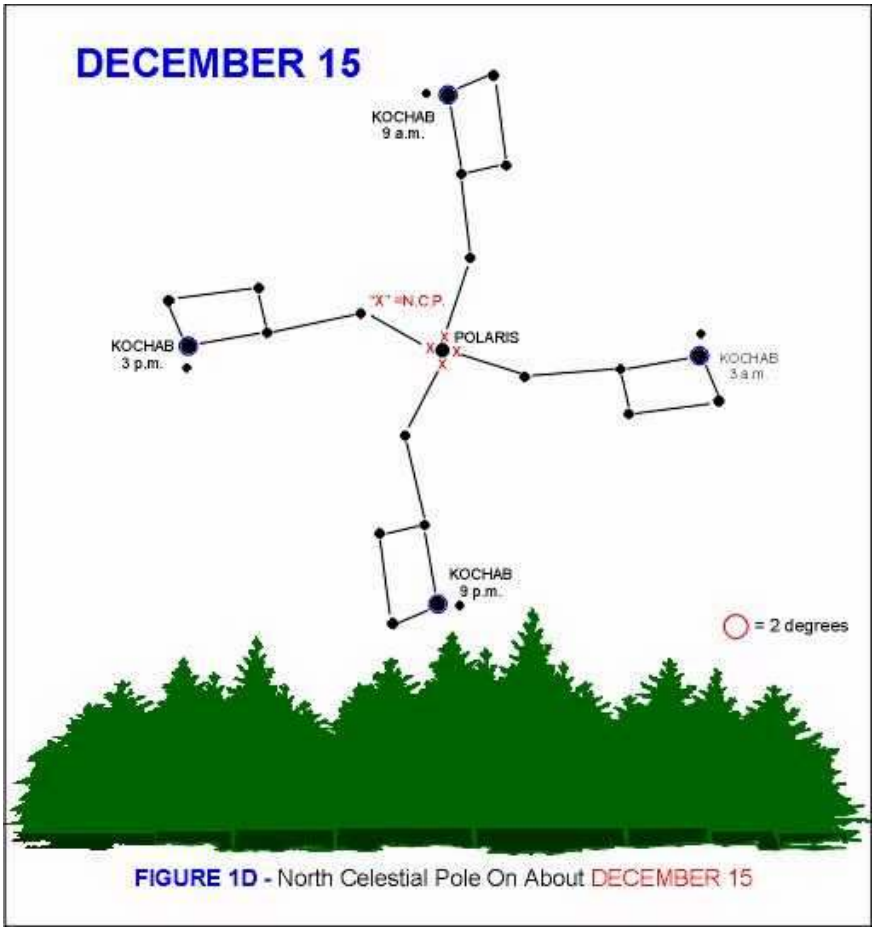


FIGURE 1D - North Celestial Pole On About DECEMBER 15

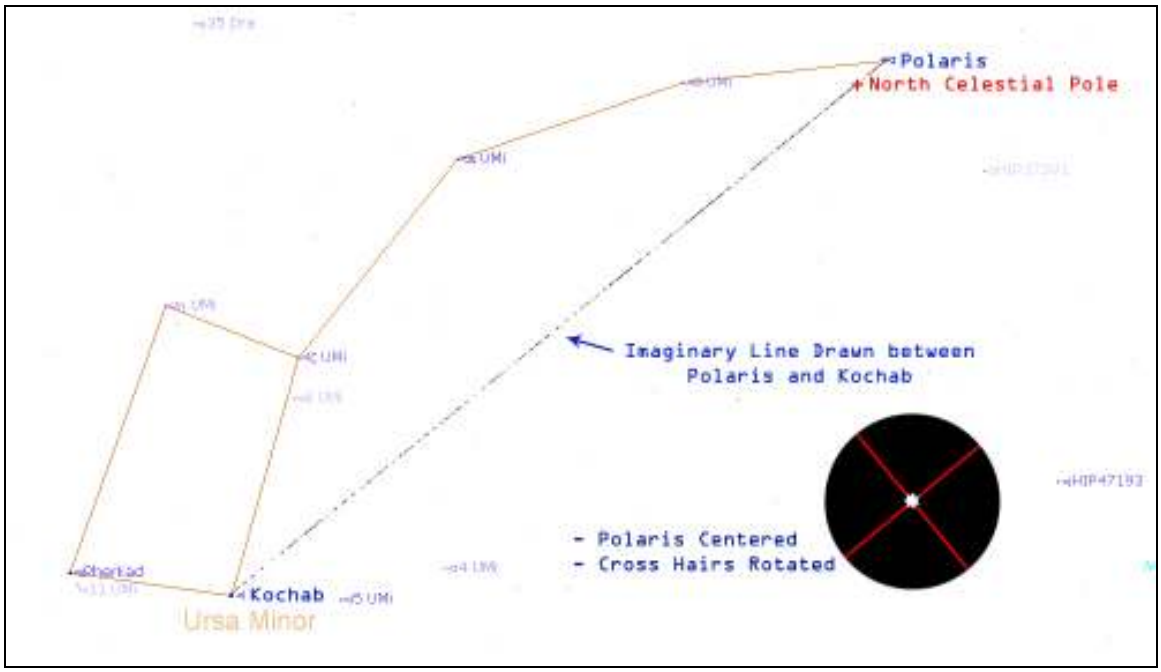
In the image above, you can see that if you setup your scope on December 15th around 9:00pm, you would start by centering Polaris in your view finder. Then, by simply adjusting the latitude of your wedge down and offsetting Polaris by the estimated distance, you will be very near to the NCP. Obviously though, we are not always able to setup at these exact times and therefore must make adjustments the direction of the offset. Regardless, the following steps will walk you thru the entire setup that may be used any time of the year.

The first step is to ensure your finder scope and eyepieces are centered with each other. This is simplified by the fact that we are starting out centered on Polaris, but just as a reminder, it is always wise to do so after any break down and setup. I generally place the scope on the wedge, ensuring it is set at 90° and that he fork arms are level. Next, using the wedge only, point the telescope directly at Polaris using your finder scope. It is

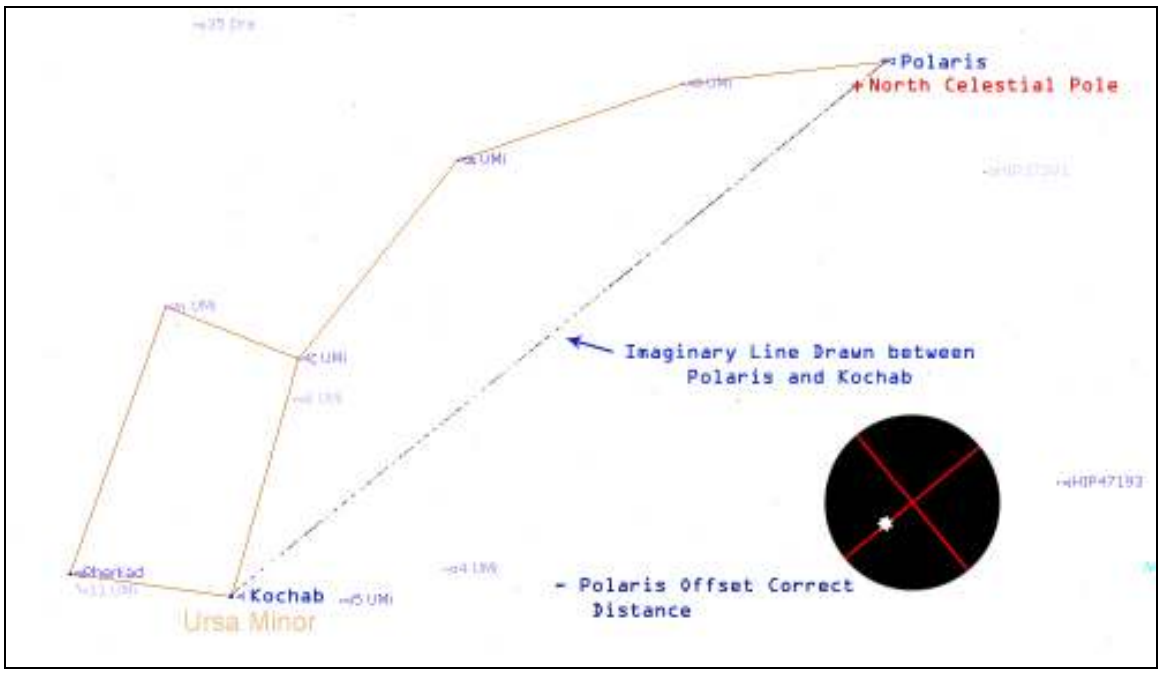
at this time that I make adjustments as required to ensure the finder scope and eyepiece are both exactly centered.

Next, locate Kochab in the sky. Depending on your sky conditions, horizon, or time of year, this may be tougher to find. If you cannot see Kochab, you may need to reference a planetarium program or find some other means to determine the location of Kochab in reference to Polaris. Due to my poor lighting conditions, I will sometimes print out a page from my computer that shows the Little Dipper for the time I am setting up and use this as a reference.

This next step is somewhat easier if you have a straight thru finder but if using an RA finder you can still accomplish it as well. For a straight thru, using two eyes, one in the finder, one looking straight ahead, rotate the cross hairs of your finder scope such that one of the lines is pointed towards Polaris. Using two eyes is helpful as it gives you the ability to see both Polaris and Kochab at the same time. For a RA finder scope, you may need to simply take a couple of glances along the scope and make adjustments to the angle of your cross hairs to match the position of the stars as seen in the image below.



The final step is to offset Polaris in the finder scope the distance we have determined based on the type of finder scope you are using and its Field of View. For my 8x50 finder scope, this distance is just shy of half way across the FOV as can be seen in the image on the following page.



At this point, your telescope is probably within less then 5 arc seconds of the NCP and is ready for your normal alignment.

Notes on this procedure:

1. Ensure you have determined the correct offset direction for your finder scope by testing it against a known star. Depending on your type of finder scope, Polaris may either go towards or away from Kochab when making your adjustments.

2. If you have the time to wait, especially if this is being used for an initial alignment for a permanent setup, you may want to watch Polaris for a little while to ensure it is circling the cross hairs. Small adjustments may be made if it appears to be circling an area off center.

3. Ensure that the scope is not tracking during this procedure. If need be, perform this procedure before powering up the scope, switch to terrestrial mode, or turn off sidereal tracking. If the scope is attempting to track it will throw off your setup.