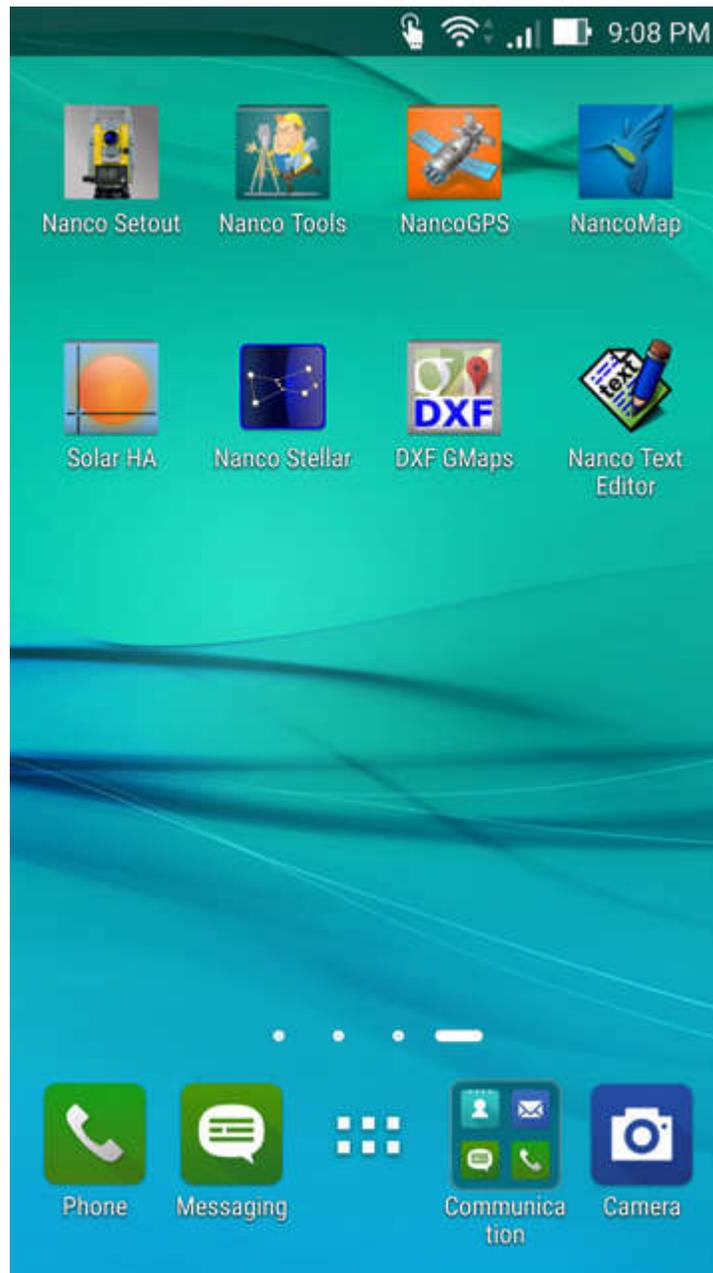


Nanco SolarHA & Nanco Stellar Hour Angle Azimuth Android Apps User's Guide

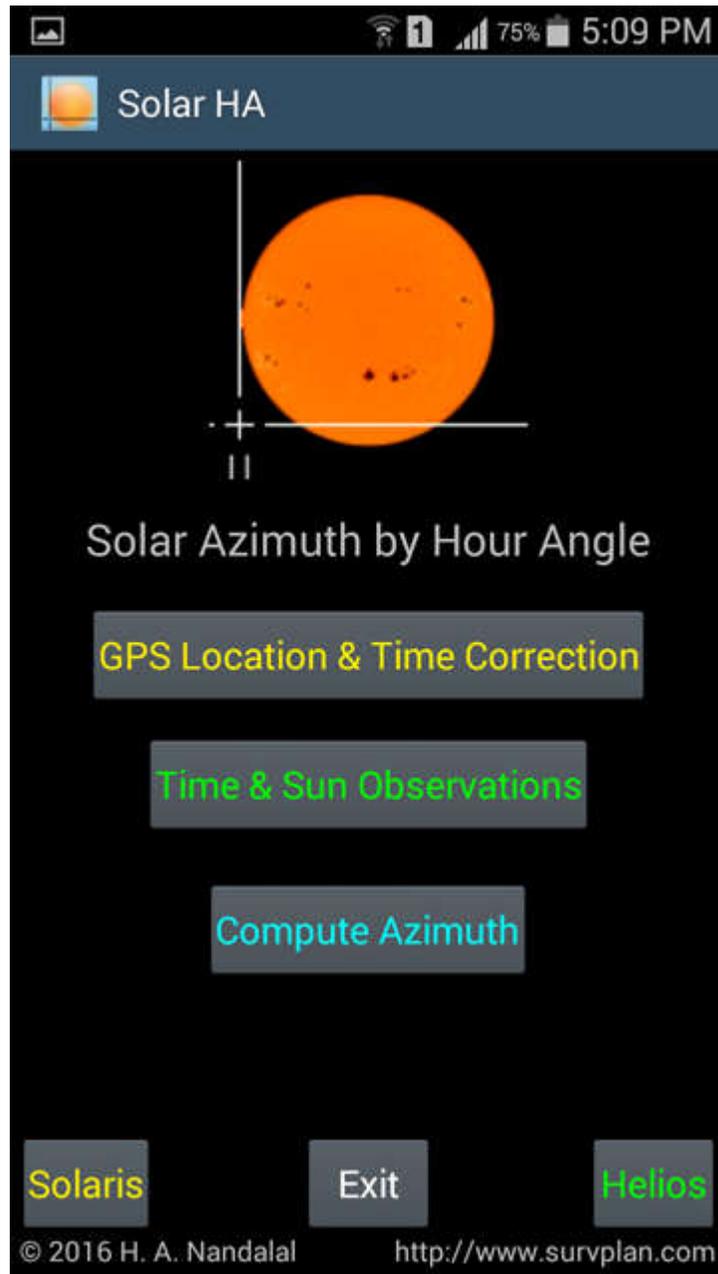
H.A. Nandalal, Trinidad & Tobago Land Surveyor - March 2016



00-Nanco Android Apps

The latest versions of the Nanco SolarHA & Nanco Stellar Android Apps can be downloaded for free from <http://www.survplan.com/android>

SolarHA Manual



01-SolarHA Main Screen

The SolarHA App offers three methods of obtaining Grid Bearings using the Sun and Hour Angle spherical trigonometry. This manual will discuss only two of those methods called “Helios” and “Solaris” because both of these methods obviate recording sun observations and post-obs computations. Pressing the buttons labelled “Helios” or “Solaris” on the Main Screen will activate the respective function. We will start with “Helios”.

SolarHA: Helios Method

The screenshot shows the Helios app interface on an Android device. At the top, the status bar displays the time as 5:10 PM and 74% battery. The app title "Helios" is centered, with three circular icons (L, G, R) to its right. Below the title is a table of astronomical data:

GPS Local Date/Time Date: 01 Mar 2016 Time: 17:10:10	Naparima Datum ϕ 10° 43' 26" N λ 61° 28' 22" W
Hour Angle GHA: 134° 30' 12" LHA: 73° 01' 51"	Ephemeris Dec: -7° 10' 00" R.A.: 22h 52m 33.0s
Altitude Elev: +15° 08' 52" Zenith: 74° 51' 08"	Azimuth Sun Left Limb Cas: 259° 12' 49" UTM: 258° 54' 13"

Below the table, the "Projection" section shows "UTM Grid" selected with a green dot and "Cassini Grid" unselected. The "Projected Azimuth Sun Left Limb at 17:11:00" is displayed in large green text as **258° 57' 10"**. A "Press to Lock" button is visible below this. The "Projected Azimuth in 1-Minute Intervals" section shows a large cyan "50" seconds remaining.

02-Helios Unlocked

The "Helios" method dictates to the Surveyor the Time Instance when to take the observation on the Sun via a 1-minute countdown. The timer is controlled directly by the GPS time signals received by the Android device. Predicted Grid Bearings are computed at exact 1-minute marks and updated every minute while the Grid Bearing is "Un-Locked".

SolarHA Helios: Locking the Predicted Grid Bearing & Settings



03-Helios: Grid Bearing Locked

Touching the “Press to Lock” button “locks” the given predicted Grid Bearing and prevents it from being updated after the countdown reaches zero. This allows the Surveyor to read the value to be set on the Total Station from the Sun pointing at the Zero Time Instance.

Before locking, the Surveyor can select the Sun’s Left Limb (left edge default), the Sun’s Centre (requires a Roloff Prism) or the Sun’s Right Limb (right edge) as well as the UTM Grid (default) or the Cassini Grid. The App makes the adjustments for the six different Grid Bearing values.

SolarHA Helios: Using the Audible Timer Hints



04-Helios: “BBC Pips” Start at the 5-Second Mark

To aid the Surveyor in accurately pointing the Total Station at the Sun, an audible signal is made at the 10-Second Mark (a brief dull beep) and then the well-known “BBC Pips” from the 5-Second Mark all the way to the Zero Mark (pip-pip-pip-pip-pip-beeeeeep). The first five pips have a duration of 0.1 seconds each and the final beep has a duration of 0.5 seconds.

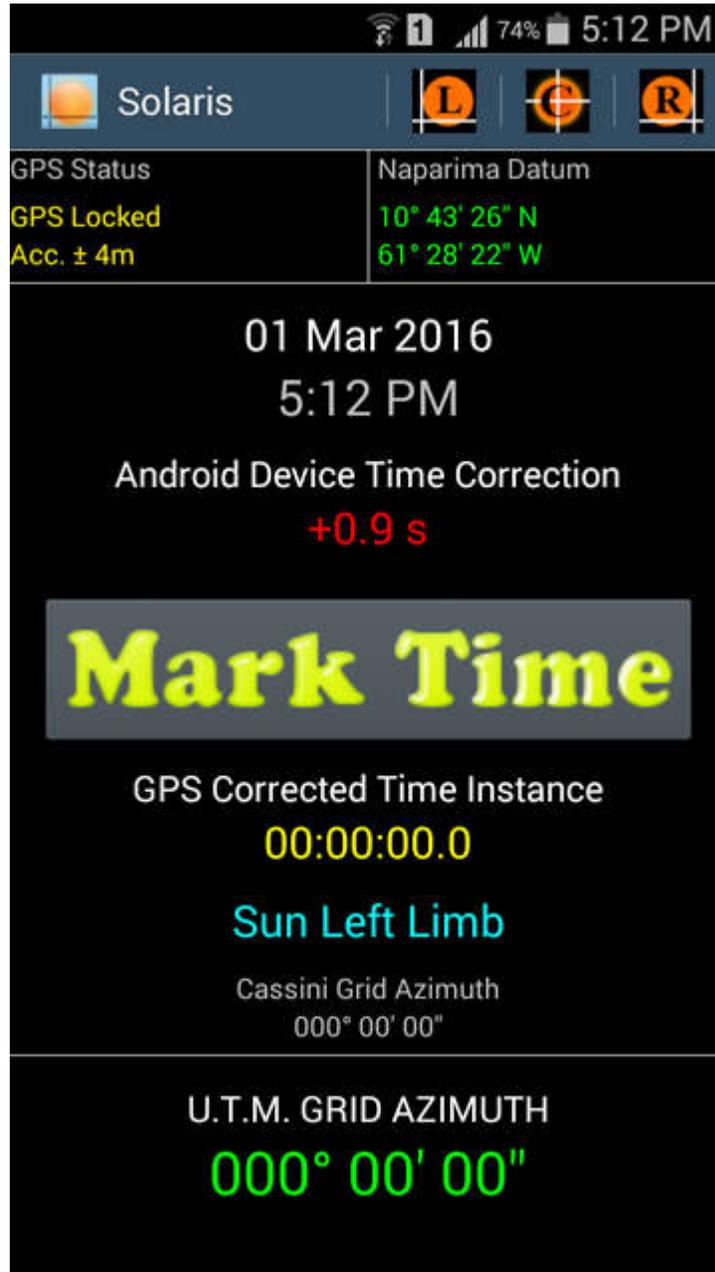
SolarHA Helios: Setting the Grid Bearing



05-Helios: The Zero-Second Mark

At the Zero Mark it is essential that the Grid Bearing be locked or else it will be replaced by the next predicted value for the following even-minute mark. Having pointed the instrument at the Sun correctly, the Surveyor now enters the displayed Grid Bearing ensuring that the instrument is not moved until the Horizontal Reading has been set. The instrument is now oriented to the preferred Map Projection Grid and the R.O. can now be observed. Repeat the procedure to get a mean Grid Bearing on the R.O.

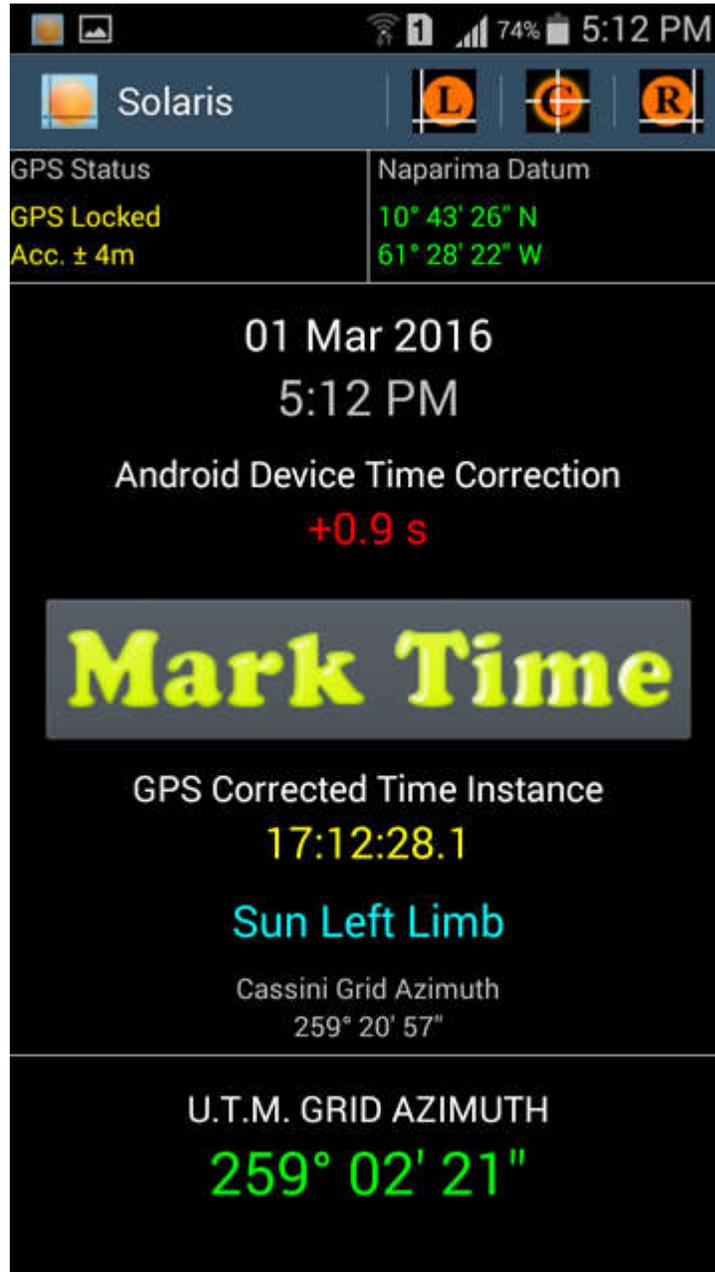
SolarHA Solaris Method



06-Solaris' Initial Screen

Using the “Solaris” method, the Surveyor dictates the Time Instance when the observation to the Sun is taken for near-instantaneous processing by the App to get the Grid Bearing of the Sun pointing. On first run, Solaris takes continuous GPS observations until 1. A positional error of less than 15m is achieved (0.5” in Lat/Long) and 2. The Clock Error of the Android device is computed from the GPS atomic clock time signals. After this Solaris emits a short beep and is ready for deployment.

SolarHA Solaris: Marking a Time Instance



07-Solaris: Sun's Left Limb Timemark

Pressing the “Mark Time” button triggers the App to get the Android Clock Time, correct it and then compute the Grid Bearings (UTM & Cassini) to the chosen limb or centre of the Sun. Note the Sun's Left Limb is the default.

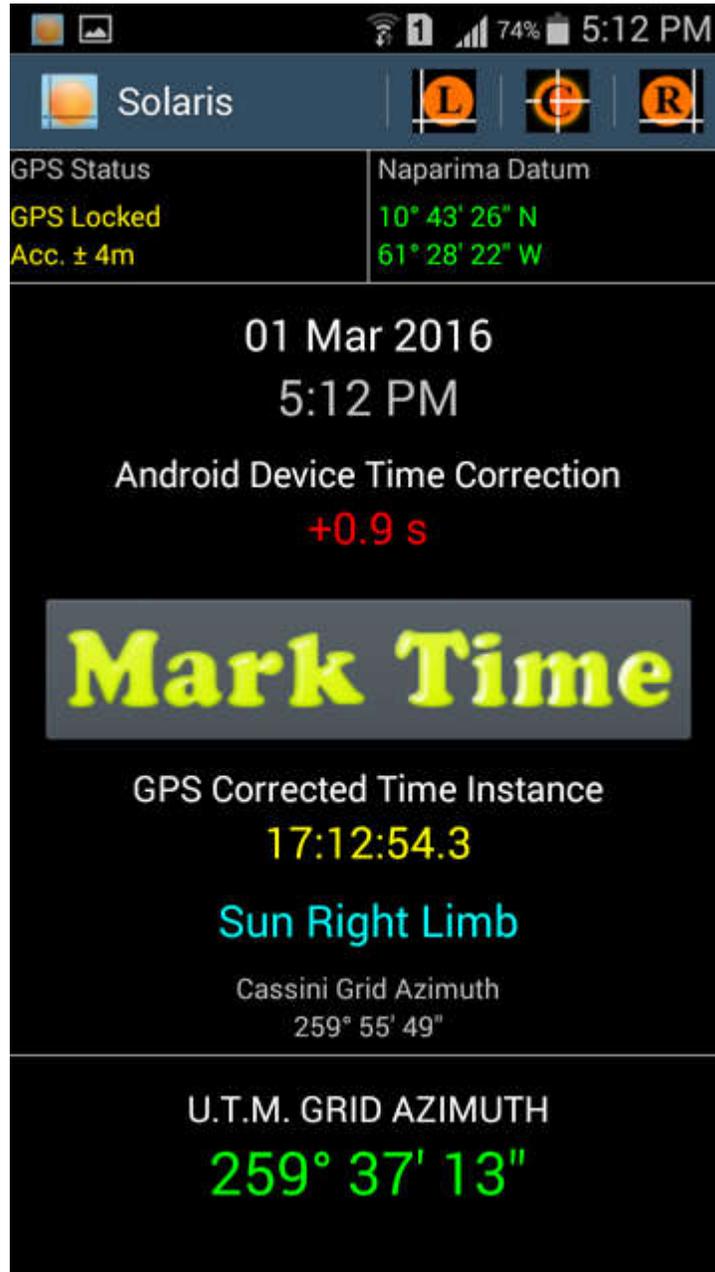
SolarHA Solaris: Sun's Centre Pointing



08-Solaris: Sun's Centre Timemark

If a Roloff Prism is used, the Sun's Centre can be selected via the respective icon from the three at the top-right of the screen.

SolarHA Solaris: Sun's Right Limb Pointing

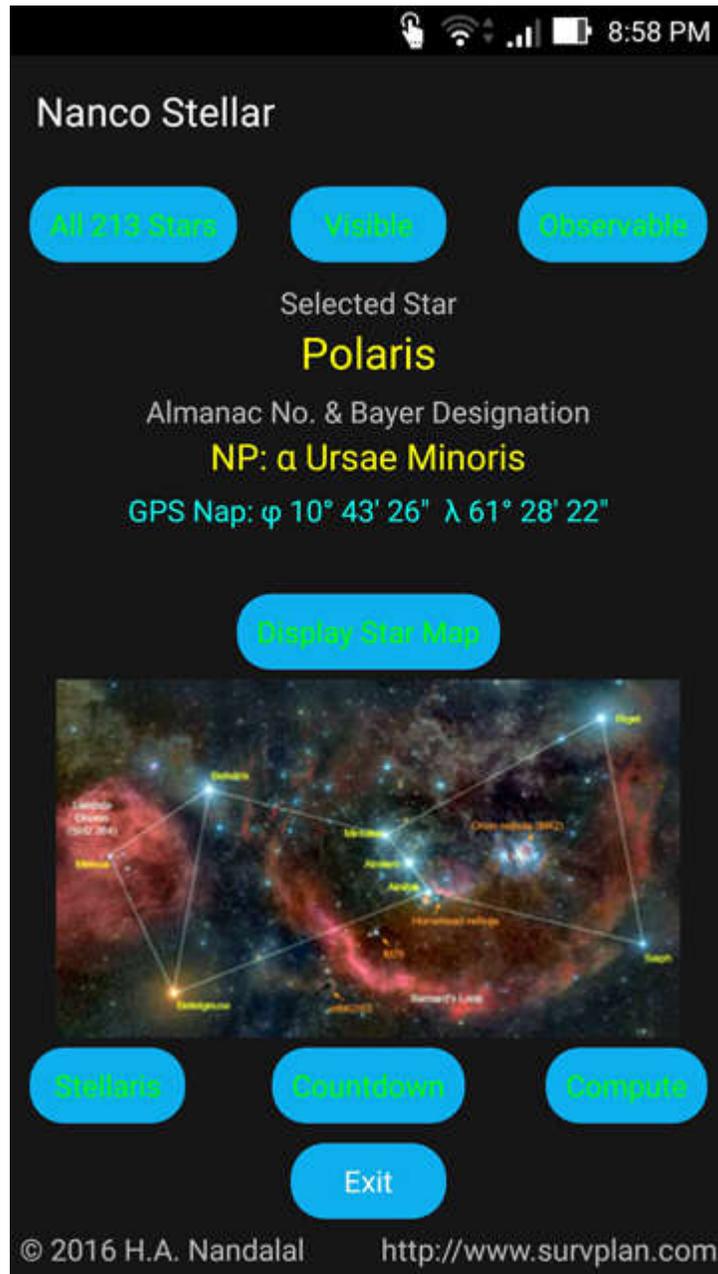


09-Solaris: Sun's Right Limb Timemark

Additionally the Sun's Right Limb can be selected via the respective icon from the three at the top-right of the screen.

Using the displayed Grid Bearing the instrument can be oriented and the R.O. repeatedly observed to get a mean value using the procedure on Page 6. ■

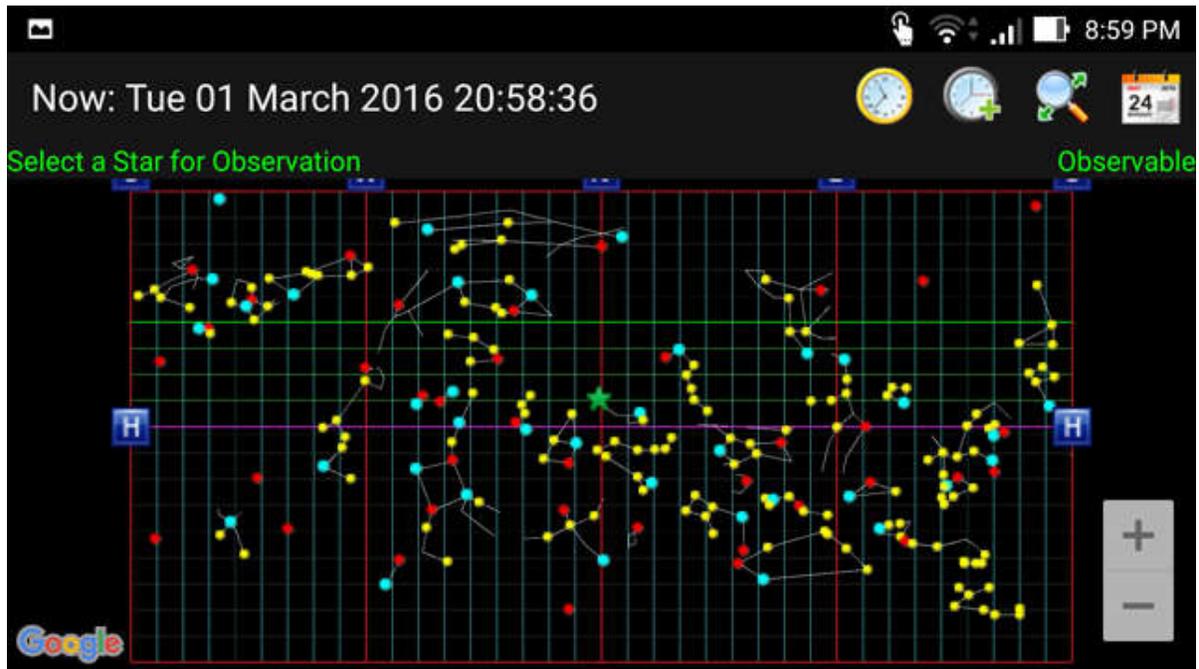
Stellar Manual



10-Stellar Main Screen: Polaris is the Default Star

The Stellar App offers three methods of obtaining Grid Bearings using the Stars and Hour Angle spherical trigonometry. This manual will discuss only two of those methods called “Countdown” and “Stellaris” because both of these methods obviate recording star observations and post-obs computations. Pressing the buttons labelled “Countdown” or “Stellaris” on the Main Screen will activate the respective function. Before either however we need to select a Star using the Star Map. Start by pressing the “Display Star Map” button.

Stellar: The Star Map



11-Stellar: Initial Star Map

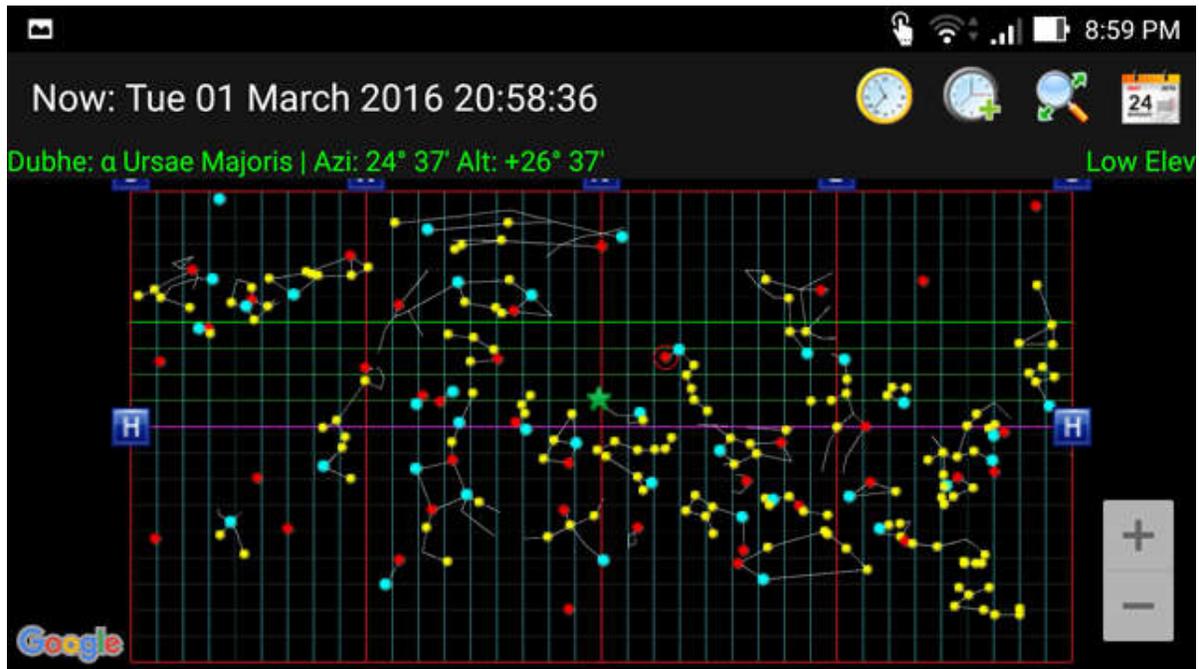
When first run, the Star Map shows the current position (relative to the Surveyor's position on the Earth) of 213 Bright Stars all of which can be found in the *Star Almanac for Land Surveyors*. The Star Map is an Elevation View with the vertical centreline pointing North with bearings $0^{\circ} \rightarrow 180^{\circ}$ increasingly going to the right-of-centre and bearings $360^{\circ} \rightarrow 180^{\circ}$ decreasingly going to the left-of-centre. Therefore both the extreme right and left edges of the map are due South.

Polaris is shown as a green star-shaped marker and will always be roughly close to North and have the same elevation (roughly) as the Surveyor's latitude. Vertical lines represent bearings 10° apart while horizontal lines represent elevation also 10° apart. The horizon (zero elevation) is shown as a magenta line between two "H" markers and stars below it cannot be seen.

The ideal stars to be observed are the ones above the horizon but under 40° elevation. The rule-of-thumb is the lower the elevation of the star, the more accurate the azimuth because the change-in-azimuth with time increases with elevation.

At the time of writing this manual, the App has 213 stars from 45 constellations. From the Bayer designation, "alpha" stars are coloured red while "beta" stars are coloured cyan. Generally alpha stars are the brightest of a given constellation and the beta is the second brightest (but not always). All other designations (gamma, delta, epsilon etc.) are coloured yellow.

Stellar: Selecting a Star on the Star Map



12-Stellar: Selecting a Star on the Star Map

To select a star for observation just touch the star marker. In figure 12 the star “Dubhe” from the constellation Ursea Majoris has been selected. Note the red circle around the marker to indicate the selection. Additionally a rough azimuth and elevation of the star for the current time is given above the Star Map. This information should help the Surveyor to point the instrument at the correct star.

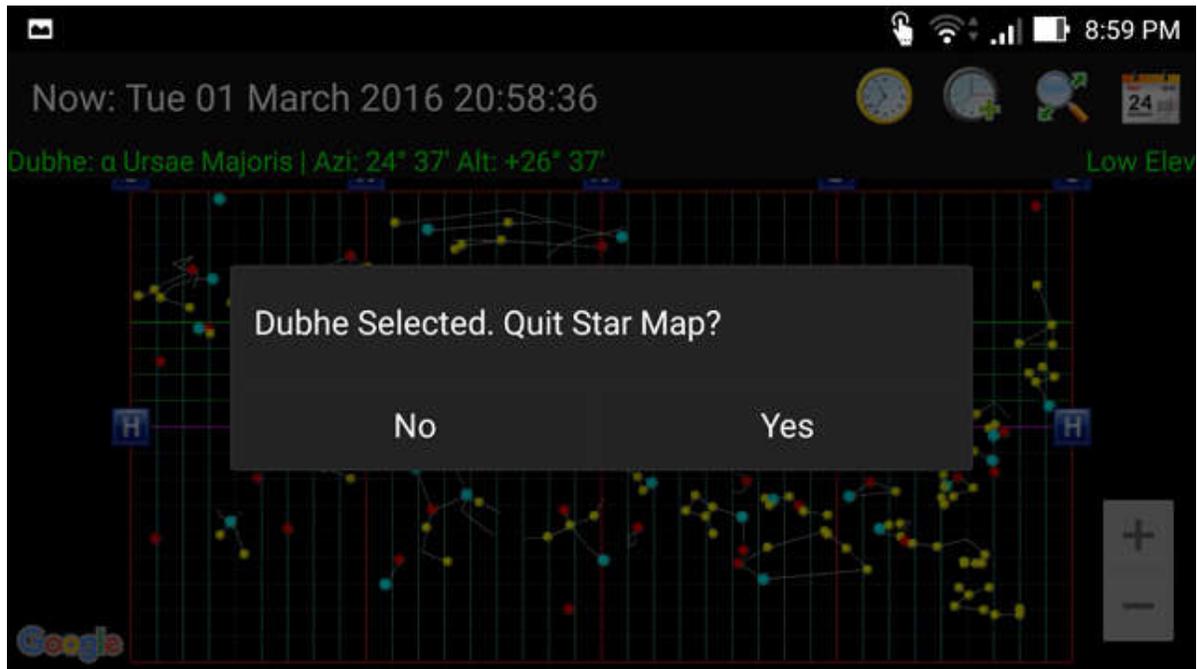
The Star Map can be zoomed using the zoom controls or by using two fingers directly on the screen.

The four icons at the top-right of the screen do the following:

1. Show stars at the current time
2. Show stars in one-hour time jumps
3. Zoom extents
4. Show stars at a future date & time up to the year 2050

Icons 2 & 4 allow for observation planning for a future date and time.

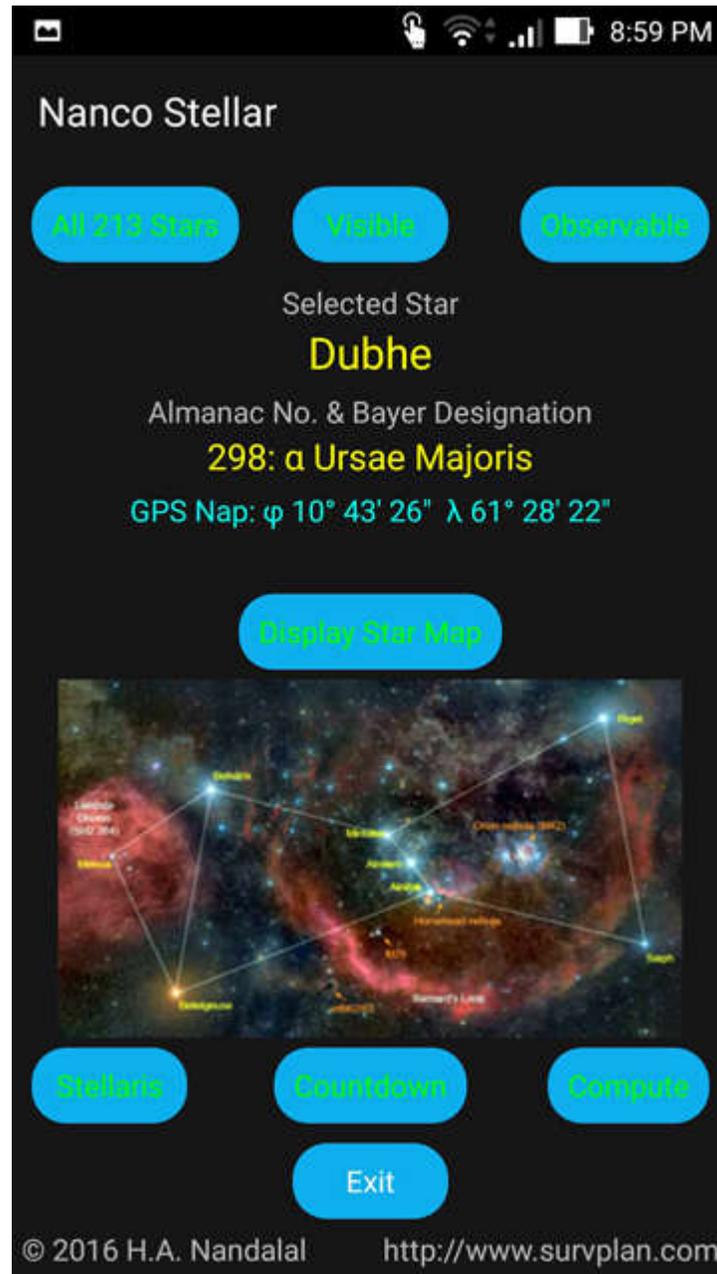
Stellar: Exiting the Star Map & Confirming the Star Selection



13-Stellar: Confirming the Star Selection on Exiting the Star Map

Use the Android “Back” button to exit the Star Map. The App will state the selected star and confirm that the user wants to exit. If the wrong star has been selected touch “No” to remain on the map screen in order to select the right star. Touch “Yes” to return to the Stellar Main Screen.

Stellar Main Screen: The Selected Star



14-Stellar: Showing the Selected Star on the Main Screen

On return to the Stellar Main Screen, the selected star is shown by Proper Name, Star Almanac Number, Bayer Greek Letter and Latin Constellation Name. Now we are ready to observe the star by either of our two methods: “Countdown” or “Stellaris”. We will start with “Countdown”.

Stellar: Countdown Method

The screenshot shows the Stellar Countdown app interface. At the top, the title "Stellar Countdown" is displayed. Below it, the star name "Dubhe" and its identifier "298: α Ursae Majoris" are shown in green. The interface is divided into several sections:

GPS Local Date/Time Date: 01 Mar 2016 Time: 21:00:39	Naparima Datum φ 10° 43' 26" N λ 61° 28' 22" W
Hour Angle GHA: 9° 14' 05" LHA: 307° 45' 43"	Ephemeris Dec: +61° 39' 41" R.A.: 11h 04m 44.3s
Altitude Elev: +26° 42' 16" Zenith: 63° 17' 44"	Grid Bearing Cas: 24° 51' 54" UTM: 24° 33' 18"

Below the table, there is a "Projection" section with two radio buttons: "UTM Grid" (selected) and "Cassini Grid". Underneath, it says "Dubhe Predicted Grid Bearing at 21:01:00" followed by the value "24° 31' 55" in large green text. A "Press to Lock" button is located below the bearing. At the bottom, it says "Predicted Grid Bearing in 1-Minute Intervals Seconds Remaining" followed by the number "21" in large cyan text.

15-Stellar: Countdown Unlocked

The "Countdown" method dictates to the Surveyor the Time Instance when to take the observation on the Star via a 1-minute countdown. The timer is controlled directly by the GPS time signals received by the Android device. Predicted Grid Bearings are computed at exact 1-minute marks and updated every minute while the Grid Bearing is "Un-Locked". Note: The star is the one selected from the Star Map.

Stellar Countdown: Locking the Predicted Grid Bearing & Settings

The screenshot shows the Stellar Countdown app interface. At the top, the title "Stellar Countdown" is displayed. Below it, the star name "Dubhe" and its identifier "298: α Ursae Majoris" are shown in green. The interface is divided into several sections:

GPS Local Date/Time Date: 01 Mar 2016 Time: 21:00:56	Naparima Datum φ 10° 43' 26" N λ 61° 28' 22" W
Hour Angle GHA: 9° 18' 20" LHA: 307° 49' 59"	Ephemeris Dec: +61° 39' 41" R.A.: 11h 04m 44.3s
Altitude Elev: +26° 44' 01" Zenith: 63° 15' 59"	Grid Bearing Cas: 24° 50' 47" UTM: 24° 32' 11"

Below the table, there is a "Projection" section with two radio buttons: "UTM Grid" (selected) and "Cassini Grid". Underneath, it displays "Dubhe Predicted Grid Bearing at 21:01:00" and the value "24° 31' 55" in large green text. A grey button labeled "BEARING LOCKED" is visible, and below it, a countdown timer shows "BEARING LOCKED" and "Seconds Remaining" with the number "04" in large cyan text.

16-Stellar Countdown: Grid Bearing Locked

Touching the “Press to Lock” button “locks” the given predicted Grid Bearing and prevents it from being updated after the countdown reaches zero. This allows the Surveyor to read the value to be set on the Total Station from the Star pointing at the Zero Time Instance.

Before locking, the Surveyor can select the UTM Grid (default) or the Cassini Grid. The App makes the adjustments for the two different Grid Bearing values. This function has the identical audible signals for accurate pointing/timing as those explained on Page 5.

Stellar Countdown: Setting the Grid Bearing

The screenshot shows the Stellar Countdown app interface. At the top, it displays the title "Stellar Countdown" and the star name "Dubhe" in green, followed by "298: α Ursae Majoris". Below this is a table of astronomical data:

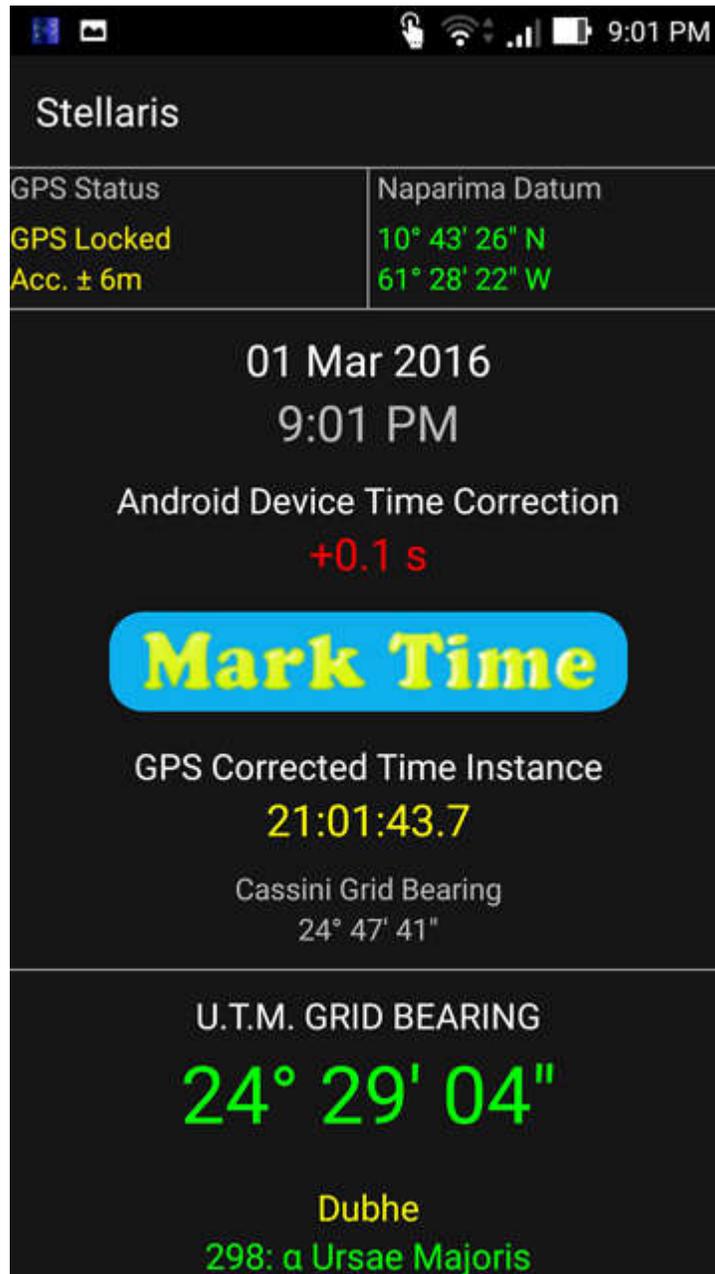
GPS Local Date/Time Date: 01 Mar 2016 Time: 21:01:03	Naparima Datum φ 10° 43' 26" N λ 61° 28' 22" W
Hour Angle GHA: 9° 20' 06" LHA: 307° 51' 44"	Ephemeris Dec: +61° 39' 41" R.A.: 11h 04m 44.3s
Altitude Elev: +26° 44' 45" Zenith: 63° 15' 15"	Grid Bearing Cas: 24° 50' 20" UTM: 24° 31' 43"

Below the table, there is a "Projection" section with two radio buttons: "UTM Grid" (selected) and "Cassini Grid". Below this, it says "Dubhe Predicted Grid Bearing at 21:01:00" followed by "24° 31' 55" in large green text. A grey button labeled "BEARING LOCKED" is visible, and below it, the text "BEARING LOCKED Seconds Remaining" is shown above a large cyan "00" indicating the countdown has reached zero.

17-Stellar Countdown: 00-Second Timemark

At the Zero Mark it is essential that the Grid Bearing be locked or else it will be replaced by the next predicted value for the following even-minute mark. Having pointed the instrument at the Star correctly, the Surveyor now enters the displayed Grid Bearing ensuring that the instrument is not moved until the Horizontal Reading has been set. The instrument is now oriented to the preferred Map Projection Grid and the R.O. can now be observed. Repeat the procedure to get a mean Grid Bearing on the R.O.

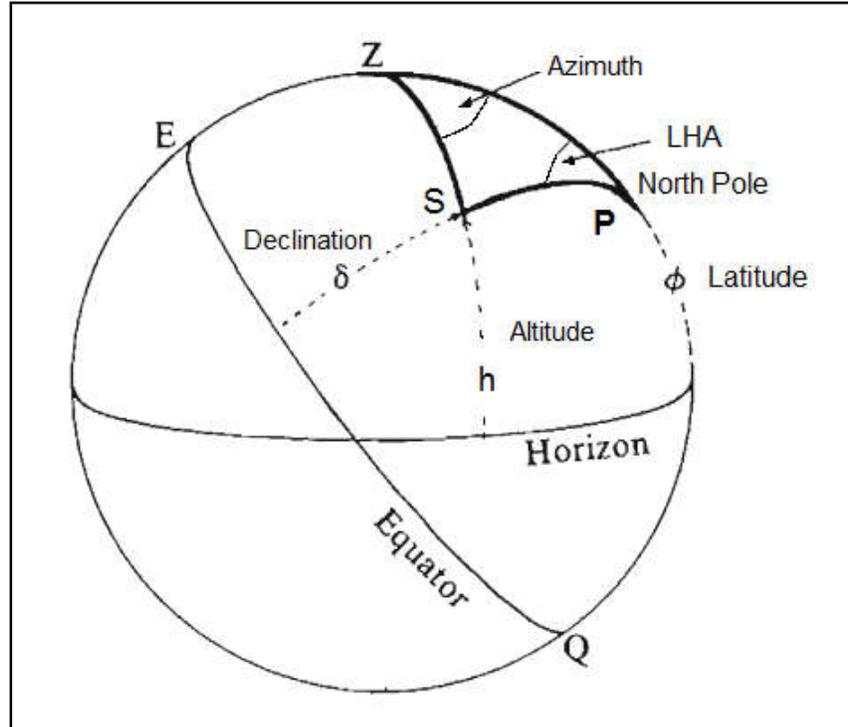
Stellar: Stellaris Method



18-Stellar: Stellaris Timemark

Using the “Stellaris” method, the Surveyor dictates the Time Instance when the observation to the Star is taken for near-instantaneous processing by the App to get the Grid Bearing of the Star pointing. On first run, Stellaris takes continuous GPS observations until 1. A positional error of less than 15m is achieved ($0.5''$ in Lat/Long) and 2. The Clock Error of the Android device is computed from the GPS atomic clock time signals. After this Stellaris emits a short beep and is ready for deployment. Note: The star is the one selected from the Star Map. Using the displayed Grid Bearing the instrument can be oriented and the R.O. repeatedly observed to get a mean value using the procedure on Page 6.

Hour Angle Method: Spherical Trigonometry



19-The Astronomical Triangle

Since a spherical triangle is comprised of six angles (three sides & three internal angles), to solve for any unknown requires just three known values.

For the Hour Angle Method the three knowns are co-declination (SP in Fig.19), co-latitude (ZP) and Local Hour Angle (ZPS) from which we solve for True Azimuth by:

$$A = \tan^{-1} [(\sin LHA / (\cos LHA \sin \phi - \tan \delta \cos \phi))]$$

Where $0^\circ < LHA < 180^\circ$ & A is +ve : Add 180° to A

Where $0^\circ < LHA < 180^\circ$ & A is -ve : Add 360° to A

Where $180^\circ < LHA < 360^\circ$ & A is -ve : Add 180° to A

$$GHA_{Aires} = UT + R$$

$$GHA_{Sun/Star} = GHA_{Aires} - RA_{Sun/Star}$$

$$LHA = GHA_{Sun/Star} - Longitude_w$$

Traditionally values for Declination (δ), R and Right Ascension (RA) were obtained from the Star Almanac but the Declination and Right Ascension of the Sun and Stars can now be computed accurately to $1''$ & $1s$ respectively by the SolarHA and Stellar Apps. ■