

At this point I assume that you have downloaded and set up SONNE on your computer. If not please read “Getting Started with SONNE”. These instructions are not exhaustive and you should read the Help file provided with SONNE.

Initiate the program SONNE. Figure 1 shows the SONNE introductory screen that appears when you start up the program. Check the language the program has started up in. “Ctrl+E” will initiate English and “Ctrl+D” German.

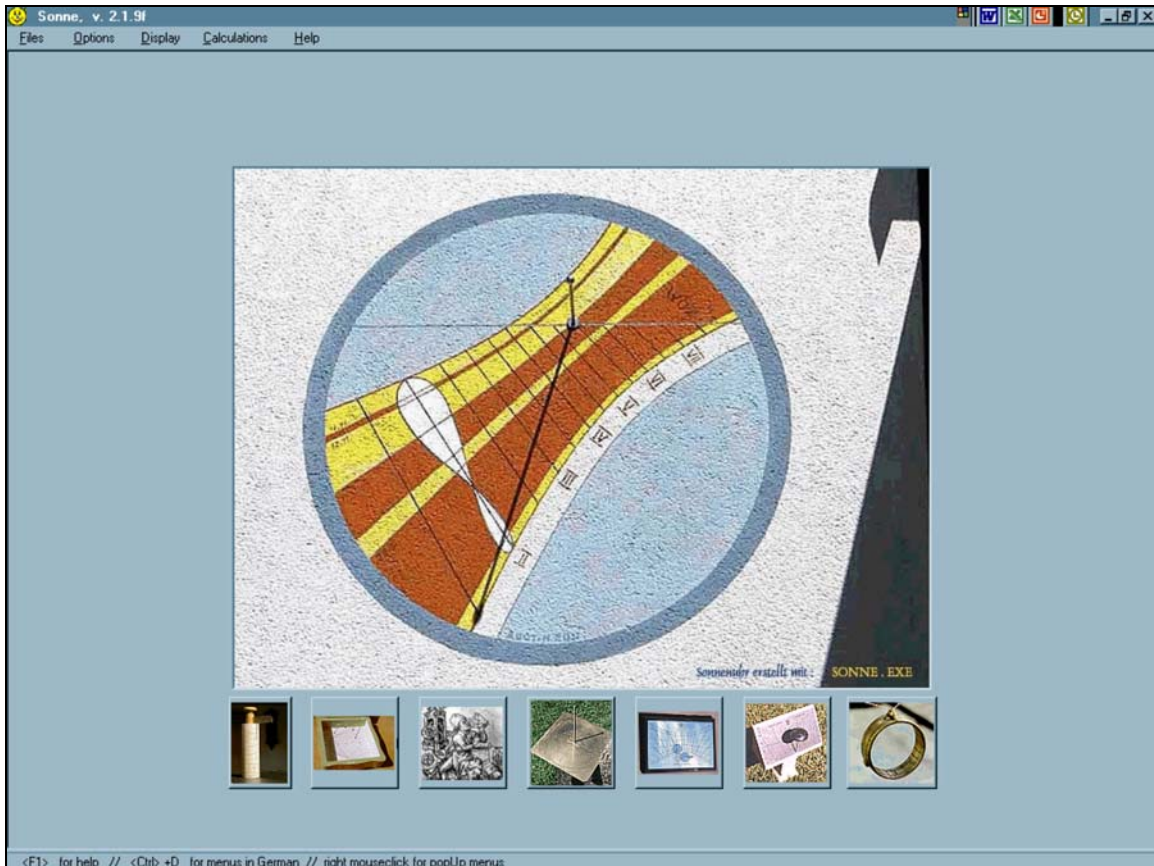


Figure 1: SONNE Intro Screen

If you are starting a new project then initiate the “Generate Dial Wizard”. The Wizard will take you through a 3-step process that ends with the design of a sundial. This Wizard is available by selecting “File” or “Help” or the keyboard shortcut “Alt+F1”.

The following three screens can also be initiated in any order by selecting “Options” and then the following items or by selecting the indicated keyboard shortcut.

- Step 1: Location and Reference Year F5
- Step 2: Type of Sundial F6
- Step 3: Parameters of Sundials F7

The window in Figure 2 will appear. This is the first step of the sundial design. Here you enter the location of the sundial.

Latitude

This is the latitude where the sundial is located. The latitude is entered in degrees, minutes and seconds. Entries must be integers, no decimals allowed, with a range of 0° to 90°. “North” is selected for latitudes in the Northern Hemisphere and “South” for latitudes in the Southern Hemisphere.

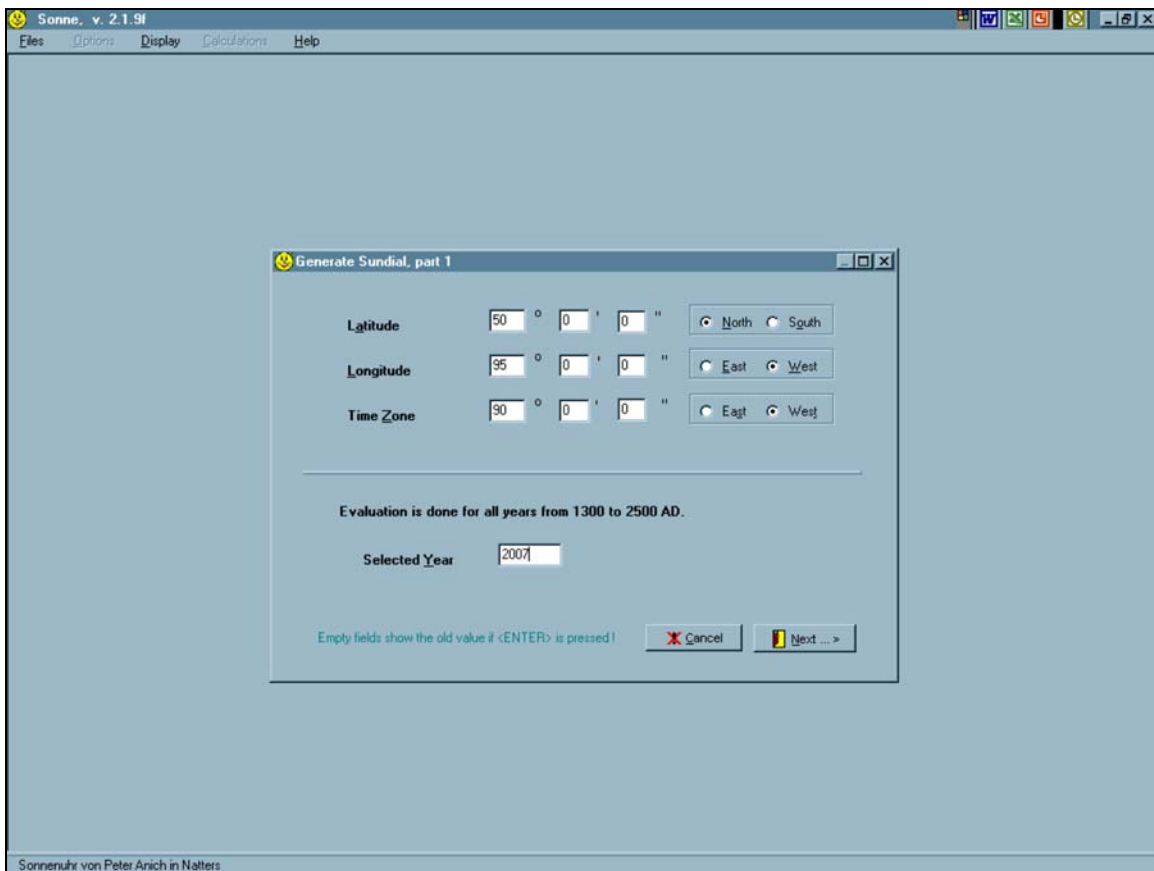


Figure 2: Generate Dial Wizard – Part 1 (Location and Reference Year)

Longitude

This is the longitude where the sundial is located, where Greenwich is equal to 0°. The longitude is entered in degrees, minutes and seconds. Entries must be integers, no decimals allowed, with a range of 0° to 180°. “East” is selected for longitudes east of Greenwich and “West” is selected for longitudes west of Greenwich.

Time Zone

This is the standard meridian of the time zone where the sundial is located, where Greenwich is equal to 0. Entries must be integers, no decimals allowed, with a range of 0° to 180°. “East” is selected for longitudes east of Greenwich and “West” is selected for longitudes west of Greenwich. The value will usually be 0° or 15, 30, 45, 60, 75, 90, 105, 120, 135, 150, 165, or 180°.

Selected Year

The year is used to calculate the Equation of Time required for the design of some sundials, for example a sundial that has an analemma on the hour lines. It is also used for other calculations available within SONNE. Any year from 1300 to 2500 AD can be entered but choose one in future and in the middle of a leap year period. This will provide a more average calculation.

When all the data has been entered on this screen select the “Next” button. Selecting the “Cancel” button will close the Wizard. The window in Figure 3 will appear. This is the second step of the sundial design. Here you will select the type of sundial you will design.

There is a large selection of sundials available in the “Select the Type of Sundial” section including:

- Horizontal Sundial
- Vertical Sundial
- Inclining/Reclining Sundial
- Umbrella Sundial (Horizontal, Inclined, Vertical)
- Quadrant Sundial
- Azimuthal Sundial (Horizontal)
- Cylinder Sundial (Shepherd)
- Horizontal Altitude Dial (Hidokei)
- Ring Dial

Some of these sundials are described in “The Sundial Primer”.

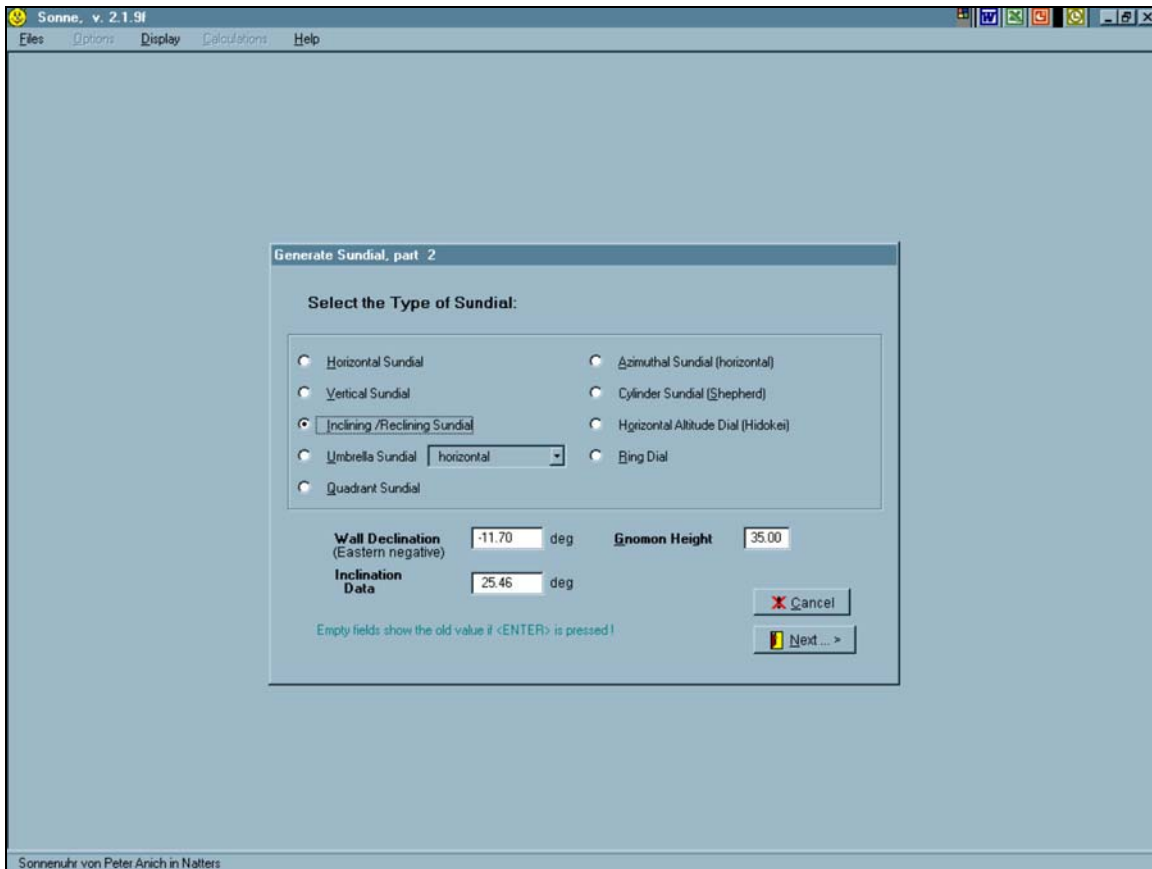


Figure 3: Generate Dial Wizard – Part 2 (Type of Sundial)

Notice that depending upon the type of sundial selected all, some or none of the three data boxes in the bottom portion of the window become available. Those that are available can be changed to meet your design requirements. This information can also be changed in future windows. The information that can be entered here includes:

Wall Declination

If the sundial does not lie in one of the cardinal directions, which include north, south, east and west it is a declining sundial. South is a declination of 0° . If the pole gnomon is rotated to the west the declination is positive and if the pole gnomon is rotated to the east the declination is negative. The declination range is $-180^\circ \leq d \leq 180^\circ$

The “dial declination” is normally used when designing a vertical declining sundial. It is equal to the declination of the wall where the sundial will be located as long as the signs are maintained as defined above.

Inclination Data

If the sundial does not lie on the horizontal or vertical plane it is an inclined sundial. SONNE uses the inclination of the back of the dial plate relative to a horizontal surface. The inclination range is $0^\circ \leq i < 180^\circ$.

The following are the two “dial inclination” values that would be used in the designs that will be considered:

- 0° - horizontal sundial
- 90° - vertical sundial

By selecting a horizontal or vertical sundial during the design these values are automatically assumed by SONNE.

Gnomon Height

This is the length of the pin gnomon perpendicular to the dial’s plane. The tip of the gnomon casts the shadow and this length is used to determine the position of the analemma and declination lines when they are displayed on the sundial. The range for this length is 5 to 120. The length being entered here is in millimetres. This length defines the position of a “nodus” that is used to calculate the position of date and declination lines.

Converting Degrees/Minutes/Seconds to Decimal Degrees

The standard meridian, local meridian and latitude must be entered in decimal format. The local meridian is usually a whole number. The conversion is made as follows:

Decimal Degrees = Degrees + [Minutes + (Seconds / 60)] / 60

Example: $95^\circ 52' 31''$ or 95 Degrees 52 Minutes 31 Seconds

$$\text{Decimal Degrees} = 95 + [52 + (31/60)] / 60 = 95 + [52 + 0.5167] / 60 = 95 + 52.5167 / 60 = 95 + 0.8753 = 95.8753^\circ$$

Maintain at least 4 decimal places for accuracy. The reason for this can be demonstrated by converting the decimal degrees back to degrees, minutes and seconds.

$0.8753 \times 60 = 52.518$ minutes and $0.518 \times 60 = 31.08$ seconds

or $95^\circ 52' 31.08''$ that is very close to what we started with.

When all the data has been entered on this screen select the “Next” button. Selecting the “Cancel” button will close the Wizard. The window in Figure 4 will appear. This is the third and final step of the sundial design. Here you will enter parameters specific to the type of sundial you are designing. Select the appropriate tag and all the sundial information will be displayed.

Some of the information displayed may have been entered on a previous screen but there is an opportunity here to change them. Don't worry if you don't get it right. They can still be changed later.

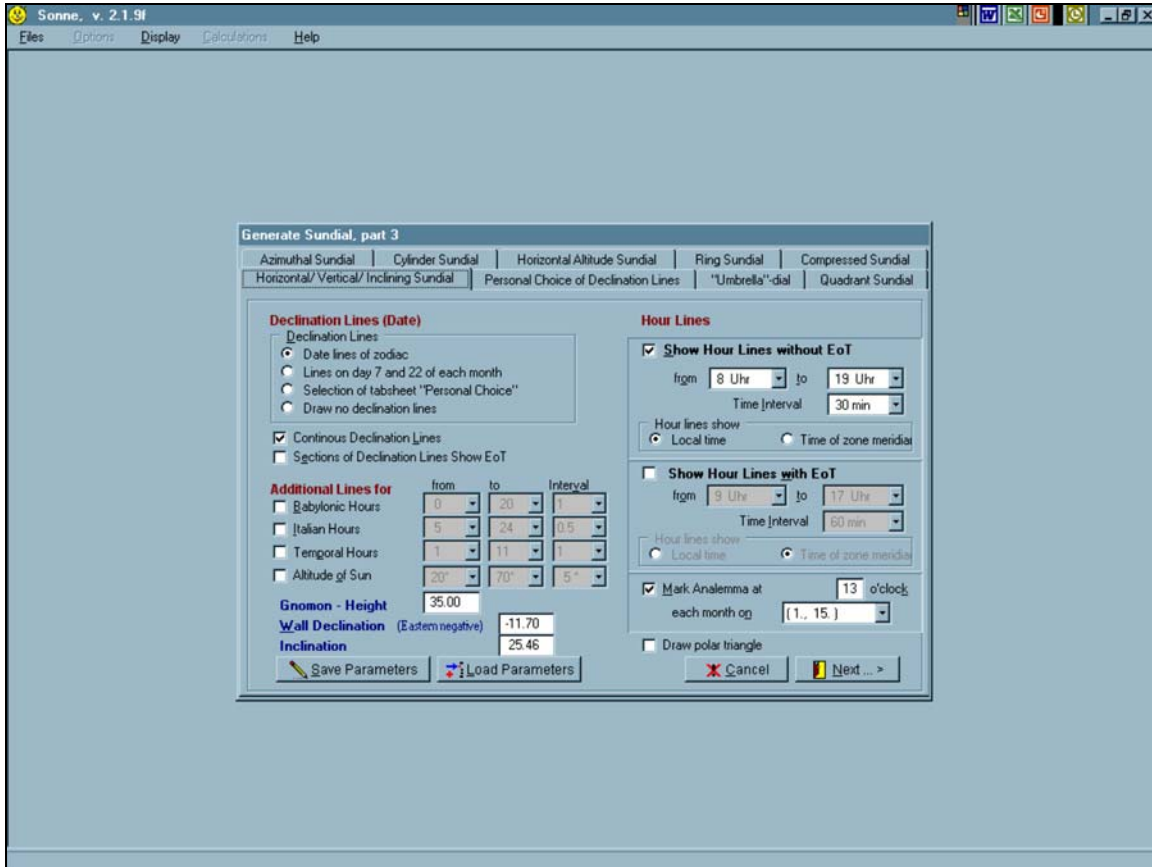


Figure 4: Generate Dial Wizard – Part 3 (Parameters of Sundials)

Please refer to the “SONNE Glossary” at the end of these instructions for the definition of the various parameters.

When all the information for you sundial is entered select the “Save Parameters” button and all you sundial inputs will be saved. Otherwise they may have to be re-entered during subsequent iterations. What you will discover later is that making changes to the parameters is very quick and easy. This will allow you to evaluate numerous designs on screen in a very short time. You will find this very useful.

The final step is to generate a drawing of the sundial. Select “Display” and the “Drawing the Sundial” or the keyboard shortcut “F8”. The next screen displayed will depend upon the type of sundial selected. Some sundials will be drawn immediately. Others require that you fix the position of the gnomon or select the “Display” button and the gnomon will be automatically

positioned at the small square. The gnomon position can be moved anywhere on the screen by positioning the cross hairs and then left click.

Figure 5 illustrates a horizontal sundial design produced using SONNE. There are a number of buttons located on the left of the screen. Not all will be active for every sundial.

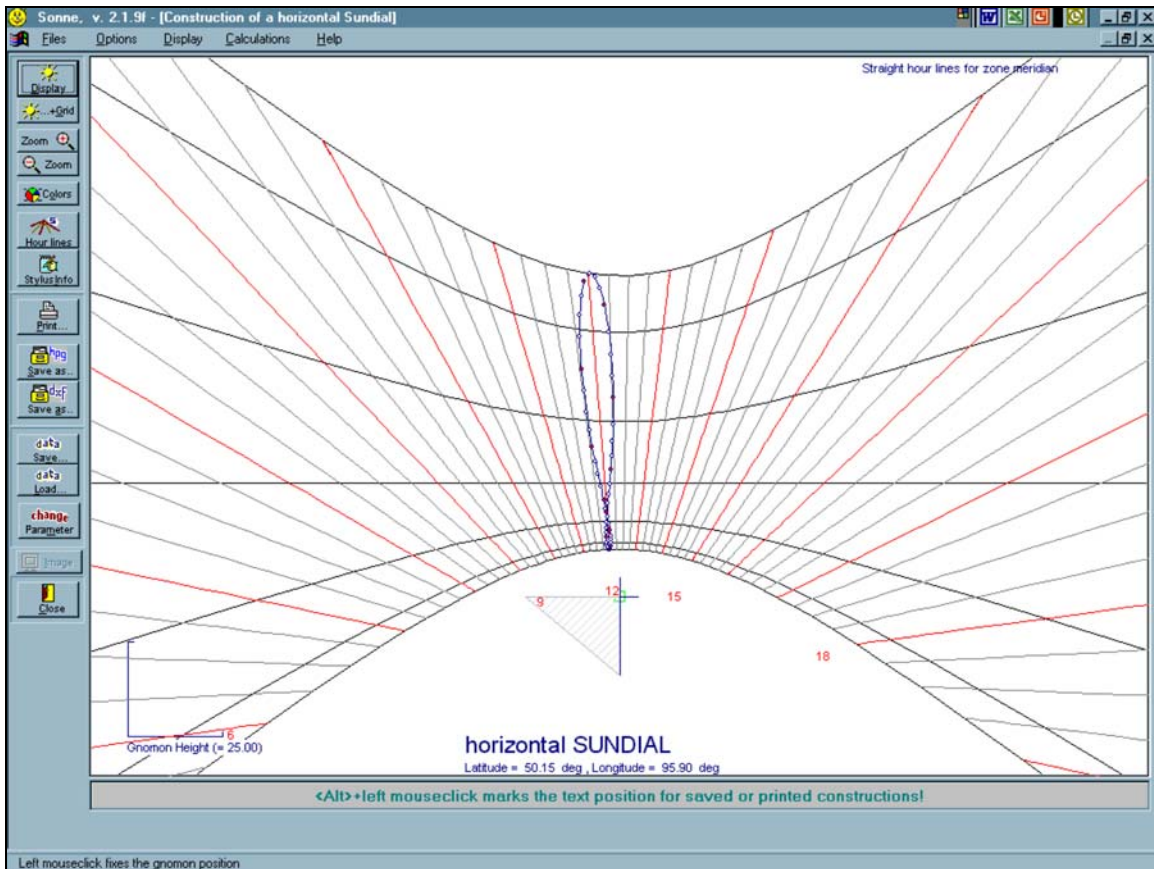


Figure 5: Horizontal Sundial Design

The following describes the function of each of these buttons.

Display: will return the sundial display back to its original form after any of the “Grid”, “Zoom +” or “Zoom -” buttons are used. It can be used to automatically display the sundial when the screen is first entered and it is blank.

Grid: displays a grid with 10 mm spacing between the lines.

Zoom +: will zoom in on the sundial.

Zoom -: will zoom out from the sundial.

Colors: will bring up a screen that allows you to change the colours of the various lines. Note that the line types are numbered. Each number is the layer name for the lines when a dxf is created and opened in a CAD program. The thickness of “all” the lines can be changed between thin, medium and thick.

Hour Lines: will display data for the hour lines.

Stylus Info: will display detailed information about the gnomon.

Print: will display the “Print Setup” screen for your printer.

Save as hpg: will save the sundial design as an hpgl (Hewlett-Packard Graphics Language) or “*.plt” file. The “Coordinates of Construction” can be printed or saved to a text file. This will provide the x and y co-ordinates for all the lines. The text file is saved as a *.dta” file. I have nothing that will open this file but by changing the extension from “dta” to “txt” the file can be opened in a text editor.

Save as dxf: will save the sundial as a Drawing Interchange File or “*.dxf” file. The comments regarding the “Coordinates of Construction” above also apply here.

data Save: will save the “Construction Data” for this particular sundial as a “*.son” file.

data Load: will load the “Construction Data” saved as a “*.son” file.

change Parameter: will open the “Parameters of Sundials” screen. Press “F8” to return to the “Drawing the Sundial” screen.

Image: will show an image of the sundial being designed if one exists.

Close: will display the SONNE start up screen.

Practice using the following keyboard shortcut keys:

- F5 Reference Year and Location
- F6 Type of Sundial
- F7 Parameters of Sundials
- F8 Drawing the Sundial

When the drawing of the sundial is displayed right click anywhere on the screen. A list of various commands will appear. The best thing is to try out the commands and see what the results are. You can't break anything.

Various sundials are examined in greater detail in separate instruction sets. Check them out!

Be sure to check out the “Calculations” section of the program. This section will provide you with a lot of useful information that is helpful for designing a sundial including:

- Sun Rise and Set
- Position of Sun
- Time for Given Sun Position
- Equation of Time and Declination
- Graph of the Equation of Time

Happy Dialling!

SONNE Glossary

NOTE: This "Glossary" was extracted from the SONNE "Help" file. (Those parts out of the "Sundial Glossary" from one of the websites of the British Sundial Society are put between quotation marks.)

altitude (of the Sun) {elevation} = "the angular distance of the (center of) the Sun's disk above the observer's horizon (negative values indicate that the sun is below the horizon). ... It is part of the horizon co-ordinate system."

altitude sundial = uses the Sun's altitude for indicating time. This is possible, if the Sun's declination (or the date) is known. Examples are shepherd's sundials, farmers rings and quadrant sundials. Shepherd's sundials have a vertical face and a horizontal gnomon. Often the shepherd's sundial is called a cylinder sundial.

In horizontal altitude sundials a vertical gnomon is showing the time on a horizontal dial face.

analemma = "in modern use it is a graphical plot with the Equation of Time on one axis and the Sun's declination on the other. In appearance, a tall thin figure of eight. The dates of various points around the curve are often shown. The shadow of a point falling onto an arbitrary plane at the same clock time each day will trace out an analemma over the course of the year. Normally seen on the noon line of a dial, but can be on any hour line."

angles of hour lines : In plane sundials with a polar style all hour lines have one single intersection point S.

- In vertical or inclining sundials the angles of the hour lines are measured from the vertical line or the line of steepest slope through S. Positive angles have counter clockwise direction, negative angles are clockwise. So all angles are within -180 degrees and +180 degrees.
- in horizontal sundials the angles are measured from direction North-South. For Northern latitudes this direction is from S to North, in Southern (negative) latitudes direction from S to South has 0 degrees. Positive angles are counter clockwise, negative angles clockwise.

azimuth (of the Sun) = "the angle of the Sun, measured in the horizontal plane from true south. Angles to the west are positive, those to the east, negative."

north= -180°...<...east= -90°...<...south=0°...<...west= +90°...<...north= +180°.

Nowadays often the azimuth is measured from direction North. This angle is 180 degrees bigger than the angle used in the program.

Babylonian hours = "number of hours elapsed since sunrise, with 24 equal hours per day".

co-ordinate system of the dial face: In horizontal / vertical / inclining dials or in umbrella dials the base point of the gnomon / the shadow-casting object is the origin of the co-ordinate - system. The positive x-axis is horizontal to the right, the positive y-axis goes upwards from the origin. The system is counter clockwise oriented.

declination of a sundial = "the angle measured in the horizontal plane, that a wall's perpendicular makes with true south. (i.e. a wall facing S has $d = 0^\circ$). Walls declining westward have positive declinations."

declination of the Sun = "the angular distance of the Sun above or below the celestial equator. At the equinoxes $d = 0^\circ$ at the solstices 23.44° (approx.). It has positive values when the Sun is above the celestial equator (summer in Northern hemisphere)."

declination lines = "lines on a dial showing the Sun's declination on a particular date. They are read by observing the shadow of a nodus."

ecliptic = imaginary band across the celestial sphere, where the Sun is found during the year.

Equation of Time (EoT) = "time difference between Local Apparent Time (apparent solar time) and mean solar time at the same location. Its value varies between extremes of about +14 minutes in February and -16 minutes in October. It arises because of the elliptical orbit of the Earth, and the tilt of the Earth's axis to the ecliptic." The most common usage is:

apparent solar time = mean solar time + EoT

The program SONNE uses formulas by Meeus, where the error of EoT is always exact within 3 seconds of time.

Farmers Ring (= ring sundial): often they are called "simple ring dials". They are belonging to the class of portable altitude sundials. "The ring is suspended in a vertical place such that the small aperture faces the Sun. The time is then indicated on a time/date scale on the inside of the dial." The scale on the inside of the ring consists of vertical date lines, crossed by the different hour lines in different angles (Image here). The sunlight through a small ring hole on the opposite side of the scale casts a spot on the scale. In more simple ring constructions no date lines are used. Then of course no exact time reading all over the year is possible.

gnomon = here in the program it is a rod, which is normal (orthogonal) to the plane of the dial. Its endpoint is used as "nodus" or "node". [Reading the time in horizontal / vertical / inclining dials means reading the position of the node's shadow.] Sometimes a polar-pointing rod is called gnomon, but here "gnomon" and "polar-pointing style" are used with two different meanings. The tip of the gnomon lies in the polar-pointing style.

If you select any point B outside the dial plane as the node, then the polar-pointing style through B must be parallel to the earth's axis. The gnomon through B is orthogonal to the dial plane. The distance from B to the dial plane is the gnomon's height (or length).

horizon co-ordinates = "the simplest celestial co-ordinate system. It is based on altitude and azimuth."

horizontal altitude sundials = This type of sundial is sometimes called "Basho Hidokei". That is the name of a portable Japanese sundial. The dial shows the time by measuring the horizontal length of the shadow of a vertical shadow-casting object. The principle is the same as in Cylinder Sundials, but the face of this sundial is horizontal and the shadow-casting gnomon is vertical. Horizontal altitude sundials cannot show the time near sun set or rise, because the shadow gets then longer than the dial face.

inclination = "the angle between the back of the dial plane and the horizontal for inclining or reclining dials. Equivalently, it is the angle between the zenith and the perpendicular direction of the dial plane (= positive z-coordinate of the dial plane). $i = 0^\circ$ implies a horizontal dial." The program always expects the inclination to be positive. (Instead of negative values please use positive ones by adding 180° .)

Italian hours = "number of hours that have elapsed since the most recent sunset (hour 0), with 24 equal hours per day. The two terms 'Italian' and 'Italic' hours are often used synonymously in modern works but there is some evidence in older works that Italian hours were counted from 30 minutes after sunset."

local apparent time = WOZ = (apparent) "solar time as derived from the real Sun at any particular location."

local mean time = MOZ = "solar time which has been corrected for the EoT but not for the longitude."

longitude correction = "the correction required to local apparent time to translate it to the local apparent time for the central meridian of that time zone." For the difference of every 1° the correction is 4 minutes.

mean solar time = "a measure of time based conceptually on the diurnal motion of the fictitious mean Sun, under the assumption that the Earth's rate of rotation is constant."

nodus = "a point which casts a shadow to indicate the time and/or date on a dial face." In this program it is the tip of the gnomon, vertical to the plane of the dial. Here instead of "nodus" also "node" is used.

polar-pointing style = style parallel to the earth's axis, passing through the tip of the gnomon. The height of the polar-pointing style is the angle between the dial face and the polar-pointing style. If it is positive, then the polar-pointing style shows the direction to the North pole (seen from the dial face along the style), if negative it shows the direction to the South pole. "Gnomon" and "polar-pointing style" are used here in two different meanings.

ring dial = look at "Farmers Ring"

Standard Time = "mean solar time at the central meridian of a given time zone" = mean time of the zone meridian.

sunrise, sunset = "the first (last) appearance of the Sun above the horizon each day. This occurs when the Sun's altitude reaches $-50'$. Note that the astronomers define the rising of an object as an altitude of 0° . The difference is due to the combined effects of the Sun's mean diameter (16 arcmin) and atmospheric refraction (34 arcmin)".

sub-style (line) = "the line lying in the dial plane which is perpendicularly below (or behind for a vertical dial) the style." The sub-style of a polar-pointing style passing through the nodus is displayed on horizontal / vertical / inclining dials beginning at the base point of the gnomon until the intersection point of the polar-pointing style and dial plane. The angle is measured counter clockwise in the base point of the gnomon from the negative y-axis to the sub-style.

temporal hours (or temporary ...) = "an unequal hour system with 12 hours from sunrise to sunset, and 12 hours (of different duration) from sunset to sunrise." Therefore in the Northern Hemisphere one temporal hour lasts longer in summer than in winter. Temporal hours can be drawn in all types of sundials in this program.

twilight = "the interval after sunset or before sunrise when the Sun illuminates the upper atmosphere and hence it is not completely dark. It is determined by the Sun's altitude falling within a given range, as follows:

civil twilight	...Sun is not more than 6° below the horizon
nautical twilight	...Sun between 6° and 12° below horizon
astronomical twilight	...Sun between 12° and 18° below horizon

These values reflect the need for decreasing light levels for various activities."

"umbrella sundial" = Umbrella sundials are a special type of bifilar sundials. They have been discussed and for some special types also realized by Rafael Soler Gaya. The two shadow casting objects are a straight rod and a disk. The rod (straight line) is the normal axis of the disk. Time has to be read at the intersection of the shadows of the straight line and the circular edge of the disk. There are two points of intersection. One point is the intersection of the shadow of the disk and the upper part of the rod (above the disk). The second point is at the intersection of the shadows of the disk and of that part of the rod, which is below the disk. The height of the rod is defined as the distance between the disk and the dial plane, measured along the rod. The whole length of the rod may be different, because there also can be a part of it above the disk. In this program we call these sundials "umbrella-dials" (German: "Schirmsonnenuhren") because of the similarity of the shadow casting object(s) with umbrellas.

The face of the dial can be horizontal, inclining or vertical. If the face is horizontal or inclining then the rod is vertical, if the face is vertical then the rod is horizontal, i.e. normal to the plane

of the dial. The construction of inclining umbrella dials with declination $\neq 0$ is also possible. The Reutte dial has the declination 0° .

zodiac = "an imaginary band, centred on the ecliptic, across the celestial sphere and about 16° wide, in which the Sun, Moon and the planets Mercury, Venus, Mars, Jupiter and Saturn are always located. The band is divided in 12 intervals of 30° , each named (the Signs of the Zodiac) after the constellation of stars which it contains. The names (and/or signs) of the constellations are given in Appendix I and are often used in sundials, instead of the date, to specify declination lines." (BSS glossary)

zone meridian = standard meridian of a time zone = meridian for Standard Time.