

At this point I assume that you have downloaded and set up ZW2000 on your computer and have also read the overview document. If not please read "Getting Started with ZW2000" and "ZW2000 and Your Sundial".

These instructions will help you learn how to use ZW2000 to design a vertical "Hours Til Sunset" sundial. This sundial is a very interesting dial and will make a unique piece in your yard. This sundial tells you how many hours are left until sunset. To design this sundial all you need is the latitude and declination of the wall it will be mounted on. It is a solar time sundial and is not affected by longitude or the Equation of Time. This design will be for a direct south sundial located in the Northern Hemisphere. The steps are similar for a direct north sundial located in the Southern Hemisphere.

Initiate the program ZW2000 and select "New Sundial". Figure 1 shows the ZW2000 data input screen that will be produced for a vertical "Hours Til Sunset" sundial that will display the number of hours left until sunset.

The screenshot shows the 'Data Input' window of the ZW2000 software. The window is divided into several sections:

- general input:** filename without extension (TEMP), kind of sundial (flat sundial selected), year (2007), standard meridian (90), local meridian (95), latitude (90), dial inclination (90), dial declination (0), gnomon (15).
- constants of flat sundial:** styleheight (-40), stylelength (23.34), x style perforation (0), y style perforation (17.88), hourangle substyle (0), angle substyle / y-ans (180).
- points every 3 days:** draw substyle (unchecked), draw points on half analemmas (unchecked).
- kind of lines:** A (local time, checked), B (local time + full analemma), C (local time + half analemma 21 dec - 21 jun), D (local time + half analemma 21 jun - 21 dec), E (standard time), F (standard time + full analemma), G (standard time + half analemma 21 dec - 21 jun), H (standard time + half analemma 21 jun - 21 dec), I (sidereal time 21 dec - 21 jun), J (sidereal time 21 jun - 21 dec), K (date lines), L (declination lines, checked), M (altitude lines), N (azimuth lines), O (babylonian hour lines), P (italian hour lines, checked), Q (antique hour lines), R (islamic prayer lines), S (planetary hour lines 21 dec - 21 jun), T (planetary hour lines 21 jun - 21 dec), U (ascendants 21 dec - 21 jun), V (ascendants 21 jun - 21 dec), W (astrological houses), X (CheckBox24), Y (CheckBox25), Z (CheckBox26).
- begin, end, step table:**

	begin	end	step
A	12	12	1
B	0	0	1
C	0	0	1
D	0	0	1
E	0	0	1
F	0	0	1
G	0	0	1
H	0	0	1
I	0	0	1
J	0	0	1
M	0	90	1
N	0	90	1
O	0	24	1
P	0	24	.5
Q	0	12	1
S	0	12	1
T	0	12	1
U	0	12	1
V	0	12	1
W	6	12	1

Figure 1: ZW2000 Data Input Screen

In this example the design information for the vertical "Hours Til Sunset" sundial entered in the "general layout" section is:

filename without extension	TEMP
kind of sundial	flat sundial
year	2007
standard meridian	90° West
local meridian	95° West
latitude	50° North
dial inclination	90 (vertical)
dial declination	0 (south/Northern Hemisphere, north/Southern Hemisphere)
gnomon	15

As this data is entered the information in the next section is automatically being updated as the calculations are performed. The final information presented in the "constants of flat sundial" section is:

styleheight	-40 (equal to the co-latitude for a vertical sundial)
stylelength	23.34 (gnomon / sin (styleheight) = 15 / sin 40)
x style perforation	0 (style on the y axis)
x style perforation	17.88 (gnomon / tan (styleheight) = 15 / tan 40)
hourangle substyle	0 (sub-style on the y axis)
angle substyle / y-axis	180 (sub-style on the y axis)

In the "kind of lines" section the following information is entered:

A local time	Select this box and a check mark will appear.
A local time begin	24
A local time end	24
A local time step	1
L declination lines	Select this box and a check mark will appear.
L declination lines 3 lines	Select this box and a check mark will appear.
P italian hour lines	Select this box and a check mark will appear.
P italian hour lines time begin	24
P italian hour lines end	24
P italian hour lines step	1

The following is the definition of Italian hours taken from the British Sundial Society Sundial Glossary.

Italian hours: the number of hours that have elapsed since the most recent sunset (hour 0), with 24 equal hours. The two terms Italian and Italic are often used synonymously in modern works.

Think about this carefully. According to this definition a sundial showing Italian hours would have the hour line occurring one hour before sunset labelled "23", two hours before sunset "22" and so on. To have the sundial indicate how many hours are left until sunset the hour lines

only need to be labelled in reverse. The hour line occurring one hour before sunset is labelled "1", two hours before sunset "2" and so on.

An "Hours Til Sunset" sundial requires a pin or perpendicular gnomon. Only the tip of the shadow coming from the nodus is used to indicate the number of hours left until sunset.

The entire 24-hour day was entered with time intervals of 30 minutes between hour lines for the Italian hour lines. ZW2000 does not include hour lines that are before sunrise and after sunset for the selected latitude. The declination lines for the solstices and equinoxes will appear on the sundial. They will be used to determine where the nodus will cast a shadow on the sundial.

Notice that the "kinds of line" section is configured to display local apparent or solar noon. This hour line is included to point out an interesting hour line numbering fact. It can be removed in the final design.

It is a good idea to record this information, as you may need to reference it later. A table is provided at the end of this document for you to do just that.

Now select "calculate and draw". You may be warned that you are about to overwrite an existing file if you have not entered a new file name. Select the appropriate response. Figure 2 shows the completed sundial. The design consists of the hour lines and the declination lines. The horizontal red line at the top of the screen represents the "gnomon", that is the length of the pin gnomon perpendicular to the sundial's plane. The red cross above the upper declination line is the location of the "foot point" of the gnomon. This is where the pin gnomon with a length of 15 units is located. The hour lines and declination lines are not labelled. However because this sundial indicates the number of hours left until sunset the horizontal line at the right is sunset and would be "0". This makes it relatively easy to find the full hour lines and the 30-minute interval lines. Also, the solar noon line and the equinox line will always intersect an hour line, even in a vertical declining sundial. This hour line is always labelled "6" hours before sunset. As this sundial is designed for the Northern Hemisphere the hour lines are numbered decreasing from left to right. The numbering is reversed for the Southern Hemisphere. The upper curved line is the declination line for the winter solstice, the lower curved line is the summer solstice and the horizontal line is the spring and fall equinoxes. These are reversed for the Southern Hemisphere.

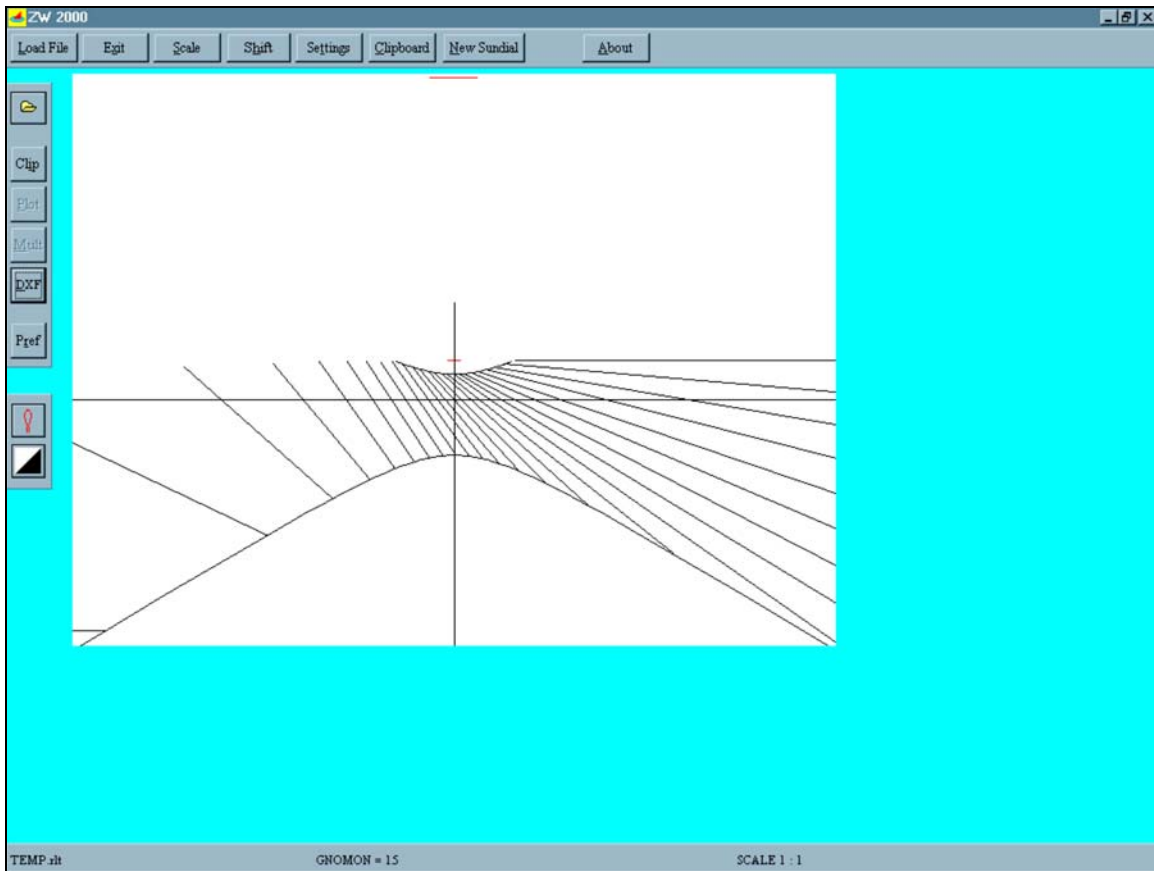


Figure 2: Vertical "Hours Til Sunset" Sundial Design

None of the configurations described above can be done using ZW2000. The sundial design can be saved as a dxf file as shown in Figure 3. Select the "DXF" button on the left of the screen and save the sundial design. The dxf file can now be opened in a computer aided design (CAD) software package such as DeltaCad. The drawing can be modified to remove or add anything you like.

The effects of changing "Scale" and "Shift" are obvious when you use them. Normally these settings do not need to be adjusted. Selecting "Settings" will allow you to change the colours of the lines. The selections made in the "kind of lines" will be highlighted in green in this screen. Select the box to the right of one of the highlighted items and a window will appear that will allow you to change the colour of that particular item. The lines do not change colour until you leave this window. Try these features out...you won't break anything!

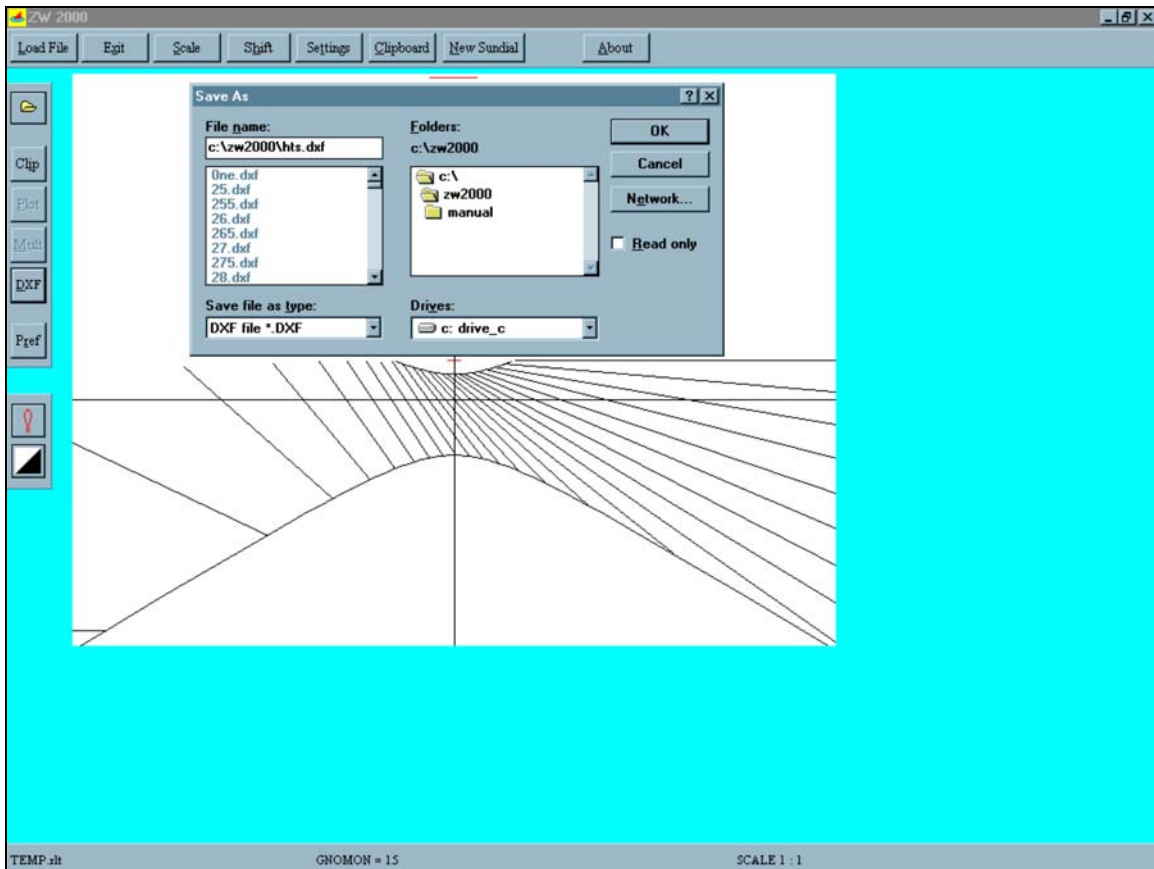


Figure 3: Vertical "Hours Til Sunset" Sundial DXF

There is one slight problem with the direct south (north) "Hours Til Sunset" sundial. Assuming a dial plate is the size shown in Figure 2 the shadow of the pin gnomon will move off the dial plate early in the spring, and as summer approaches the number of usable hours decreases. Look at the horizontal declination line that represents the equinoxes. At that time of the year the sundial will indicate approximately half an hour before sunset. At the summer solstice, represented by the lower solstice line, the sundial will indicate almost four hours before sunset and no more. This can be resolved if the dial is free standing.

Figure 4 shows such an "Hours Til Sunset" sundial. This sundial is the same design as the one in Figure 2 but it declines to the west by 45° . This results in the declination line for the summer solstice being moved on to the dial plate. The sundial does not have the same range as the previous one but it will always count down to 0. Trying designs at various sundial declinations is very easy. Just change the "dial declination" entry. You can design a free standing "Hours Til Sunset" sundial that you will like even if it doesn't always count down to zero.

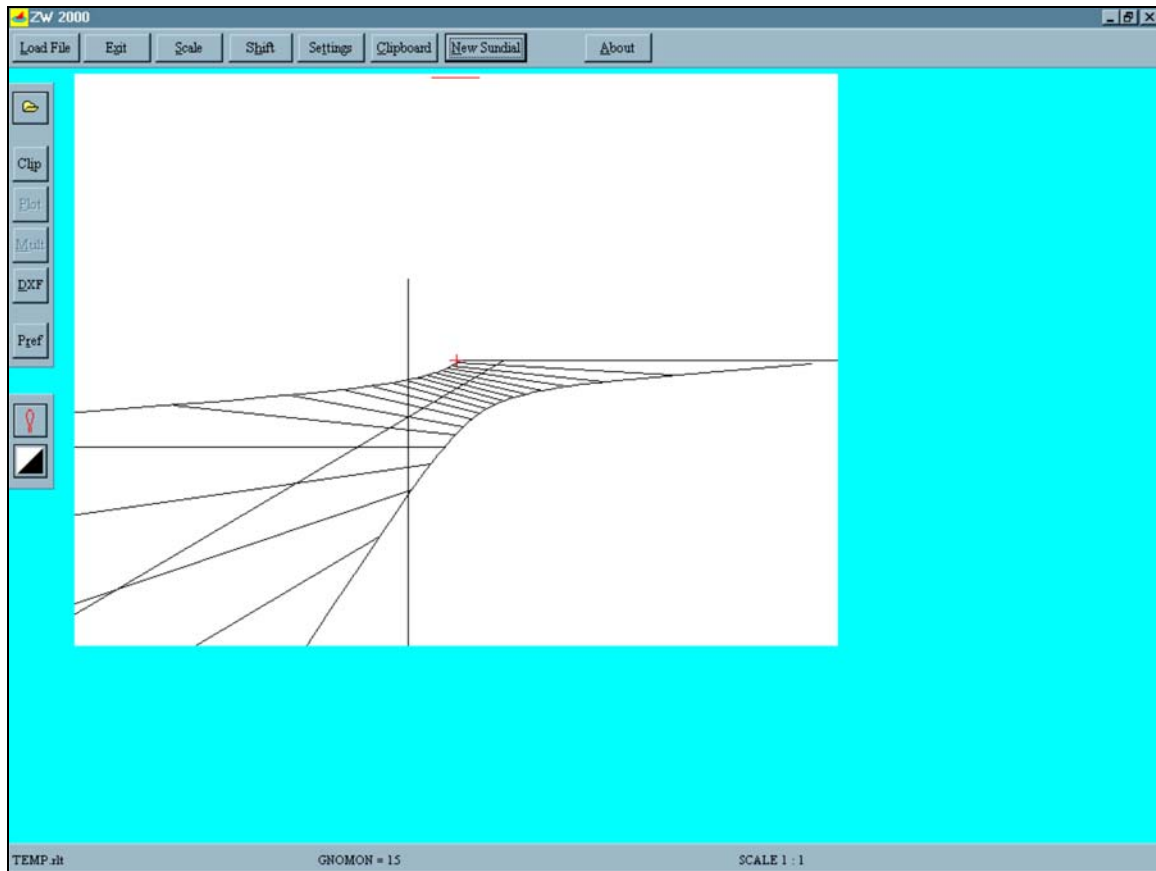


Figure 4

Notice that the local apparent noon line and the straight equinox line intersect the hour line that represents 6 hours before sunset. The horizontal line is sunset.

HAPPY DIALLING!

ZW2000 Data Input Reference Table

general input			
filename without extension (8 characters max.)			
kind of sundial	flat sundial		
year (1900 – 2200)			
standard meridian ($-180^\circ \leq SM \leq 180^\circ$)			
local meridian ($-180^\circ \leq LM \leq 180^\circ$)			
latitude ($-90^\circ \leq \phi \leq 90^\circ$)			
dial inclination ($0^\circ \leq i \leq 180^\circ$)			
dial declination ($-180^\circ \leq d \leq 180^\circ$)			
gnomon ($1 \leq g \leq 100$)			
constants of flat sundial			
styleheight (degrees)			
stylelength			
x style perforation			
y style perforation			
hourangle substyle (degrees)			
angle substyle – y-axis (degrees)			
points every ? days	3 days	1 day	
draw substyle	yes	no	
draw points on half analemma (list dates)	yes	no	
kind of lines			
	begin	end	step
A local time			
B local time + full analemma			
C local time + half analemma 21/12 – 21/6			
D local time + half analemma 21/6 – 21/12			
E standard time			
F standard time + full analemma			
G standard time + half analemma 21/12 – 21/6			
H standard time + half analemma 21/6 – 21/12			
M altitude lines			
N azimuth lines			
P italian hours			
L declination lines	3 lines	7 lines	
choose			