

How to design a reflection sundial  
by means of the  
**Orologi Solari**  
program

*... e allora ?*

In order to design a reflection sundial you need to know the basic concepts of gnomonics and you should also know how to use Orologi Solari to perform basic operations as f.i. to find and to introduce the local geographical coordinates or the declination of the wall.

Moreover it's very useful to work on the image of the wall so that the optimal orientation of the mirror can be found and the available surface is fully consumed.

It is so advisable to read the following documents :

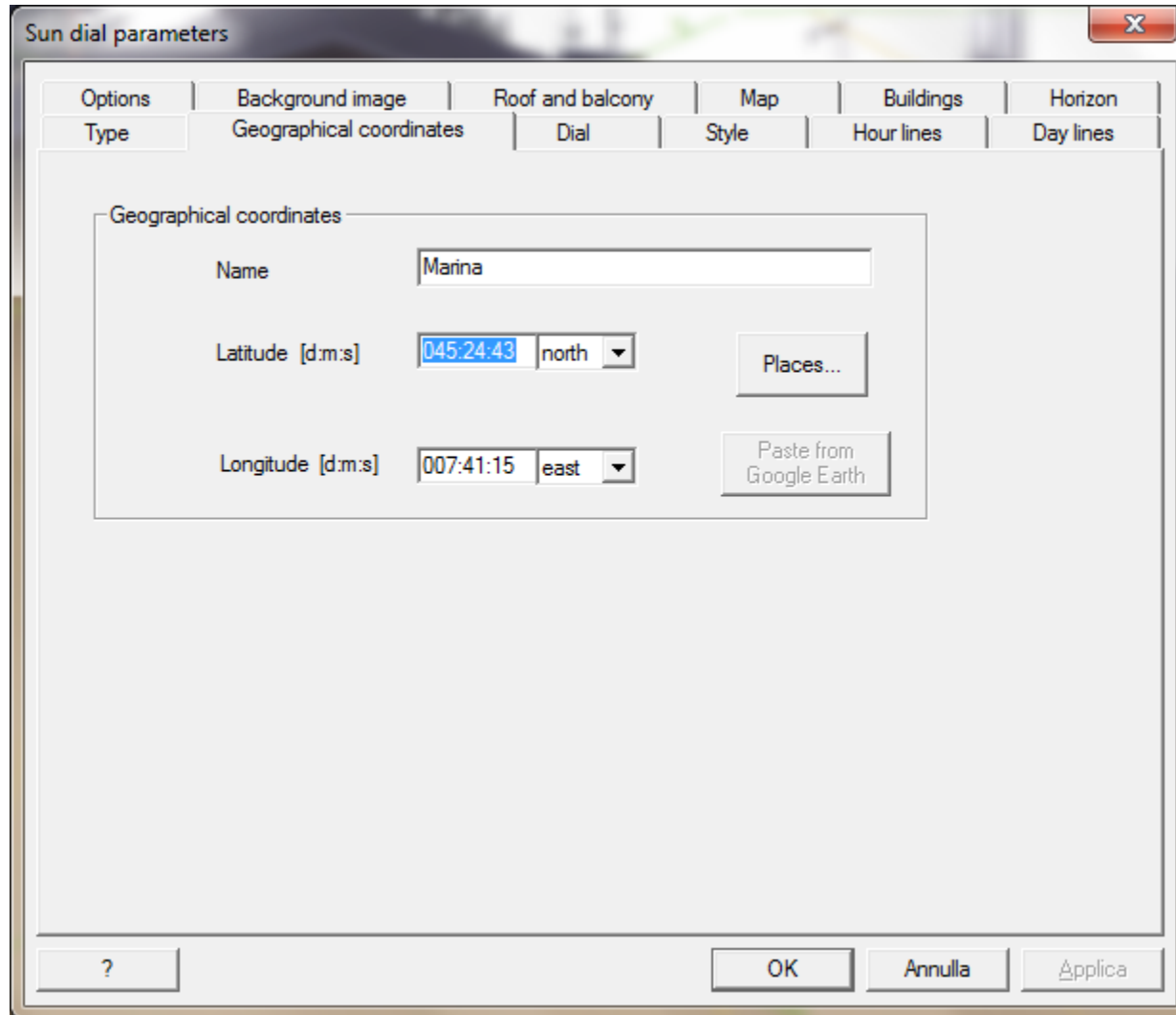
- [How to... design a new dial](#)
- [How to... measure the declination of a wall](#)
- [How to... choose the best position for a new dial](#)

The following pages are mainly devoted to the new aspects of reflection sundials design and implementation with respect to the design of a classic sundial where a style instead of a mirror shows the time.

## Latitude and longitude

There is no difference in the definition of latitude and longitude with respect to classic sundials.

These parameters can be directly introduced in the following window or they can be pasted from a Google Earth bookmark or finally they can be obtained by selecting a place in the OS data base.



The image shows a software window titled "Sun dial parameters" with a standard Windows-style title bar (minimize, maximize, close buttons). The window contains several tabs: "Options", "Background image", "Roof and balcony", "Map", "Buildings", and "Horizon". The "Options" tab is active, and within it, the "Geographical coordinates" sub-tab is selected. The main area of the window is titled "Geographical coordinates" and contains the following fields and buttons:

- Name:** A text input field containing the word "Marina".
- Latitude [d:m:s]:** A field with a text input showing "045:24:43" and a dropdown menu set to "north".
- Longitude [d:m:s]:** A field with a text input showing "007:41:15" and a dropdown menu set to "east".
- Buttons:** To the right of the latitude field is a "Places..." button. Below the longitude field is a "Paste from Google Earth" button.

At the bottom of the window, there is a row of four buttons: a help button with a question mark "?", and three standard action buttons labeled "OK", "Annulla", and "Applica".

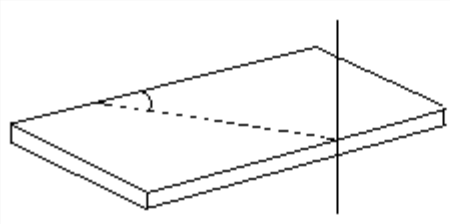
## Wall declination

This parameter too is defined in the same way as for classic sundials.

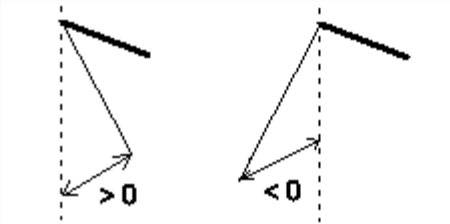
Therefore the instruments available in Orologi Solari (horizontal plane method and ortho-style method) can be used.

Of course measurements should be taken when the wall is lighted by the sun, however this is not trivial as reflection dials are made on walls that are in the shadow the major part of the day.

Wall declination : measurement

☒ 

Insert measured angle (in decimal degrees) :

☐ 

Insert measured distance :

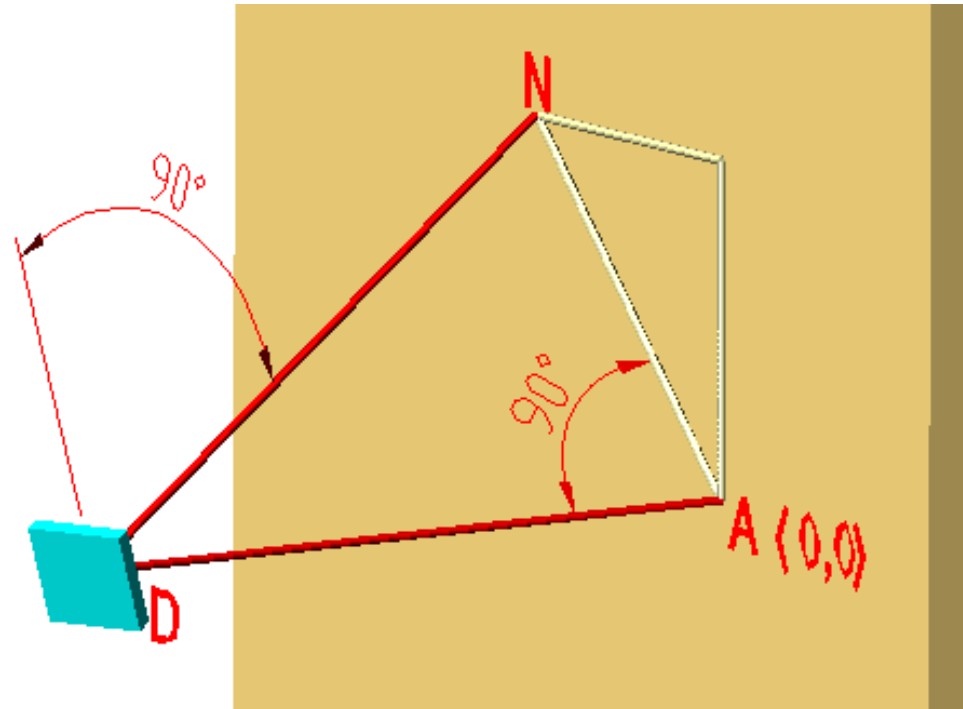
and style length :

? < Indietro Avanti > Annulla

## Mirror parameters

The position and the orientation of the mirror are defined through the following parameters :

- The ortho-style (or ortho-mirror) AD is the distance between the center of the mirror and the wall. Its value determines the dimension of the sundial. We will see later that it can be optimized working on the dial picture directly.
- The orientation of the mirror is defined by its declination (with respect to south) and its inclination (0 for horizontal upward mirror, 90 for vertical mirror, 180 for horizontal downward mirror). The estimation of these values can again be operated directly on the sundial picture.
- The line perpendicular to the mirror crosses the wall in the point N. The knowledge of N can be useful for the correct installation of the mirror. Orologi Solari provides the coordinates of N.



## Mirror parameters

The parameters previously described can be introduced in the «style» page of the «Sundial parameters» window.

One more parameter «mirror diameter» is only used in simulation when drawing the reflected light spot.

The screenshot shows the 'Sundial parameters' dialog box with the 'Style' tab selected. The 'Type' sub-tab is also active. The 'Extreme points of the style (x, y, z)' section contains two rows: 'P1' with values (0, 0, 0) and 'P2 (ortostyle)' with values (0, 0, 100). Below these are 'POLAR' and 'ORTHO' buttons. The 'Mirror diameter' is set to 9.5. The 'Limit for substyle height' is set to 28 (0-45 deg.). The 'Mirror' section has 'declination' set to 006:08:06 west and 'inclination' set to 092:20:56. The bottom of the dialog has a '?' button, an 'OK' button, an 'Annulla' button, and an 'Applica' button.

Options	Background image	Roof and balcony	Map	Buildings	Horizon
Type	Geographical coordinates	Dial	Style	Hour lines	Day lines

Extreme points of the style (x, y, z)

P1 = ( 0 , 0 , 0 )

P2 (ortostyle) = ( 0 , 0 , 100 )

POLAR ORTHO

Mirror diameter 9.5

Limit for substyle height < 28 (0-45 deg.)

Mirror

declination [d:m:s] 006:08:06 west ▼

inclination [d:m:s] 092:20:56

? OK Annulla Applica

## Mirror parameters

Mirror parameters can be directly modified in the sundial picture:

- ortho-mirror : keys «+» and «-» increase/decrease the value by 1%
- position : when the left key is pressed, mouse movements change the position of the mirror (and of the hour lines) within the defined rectangle
- declination/inclination : when the mouse left key and the shift key are pressed, mouse movements change declination (horizontal movements) and inclination (vertical movements) of the mirror.

Attention: for each mouse movement all the displayed lines must be re-computed; in order to obtain a smooth refresh only leave the essential lines (f.i. the french lines only).



## Mirror installation

The installation of the mirror in accordance with the design parameters (declination and inclination) can be a hard task.

The «Compute selected points» tool can be useful to this purpose.

In the following window the required starting time and time step are inserted. The program will then compute and show the coordinates of the reflected light spot for each required time instant.

Mirror must then be installed in such a way that the reflected light spot is in the computed position on the wall at each time instant.

Selected points computation

n. of points    

starting date and time

☐ DST

time zone  for non-standard time zones :  + minutes

step

☐ days

☐ hours

☒ minutes

date	time	azimuth	elevation	x	y
04 November 2014	16:00:00	55.07	10.40	-144.75	42.13
04 November 2014	16:10:00	57.02	8.95	-155.33	38.90
04 November 2014	16:20:00	58.93	7.46	-166.78	35.27
04 November 2014	16:30:00	60.81	5.94	-179.23	31.18
04 November 2014	16:40:00	62.67	4.39	-192.88	26.56



## Mirror parameters re-computation

At the end of the previous step the mirror should be installed in the correct position as required by the design. Actually only an approximation of the required orientation can be obtained. Therefore it is advisable to measure the actual values of declination and inclination and then to compute again the resulting hour lines.

The following window allows to insert up to 5 light spot measured positions together with the corresponding times in the day. The program will then compute the best possible approximation of the declination and inclination values that can provide those measurements.

These resulting values can then be inserted in the project by means of the button «Put into project»

**Find mirror orientation**

measurement date

mardi 4 novembre 2014 ☐ DST Today

timezone GMT +1 (TMEC) for non-standard timezones : + minutes 0

results

declination 6.135 inclination 92.349 error 0.000060

Compute Put into project ?

measurements

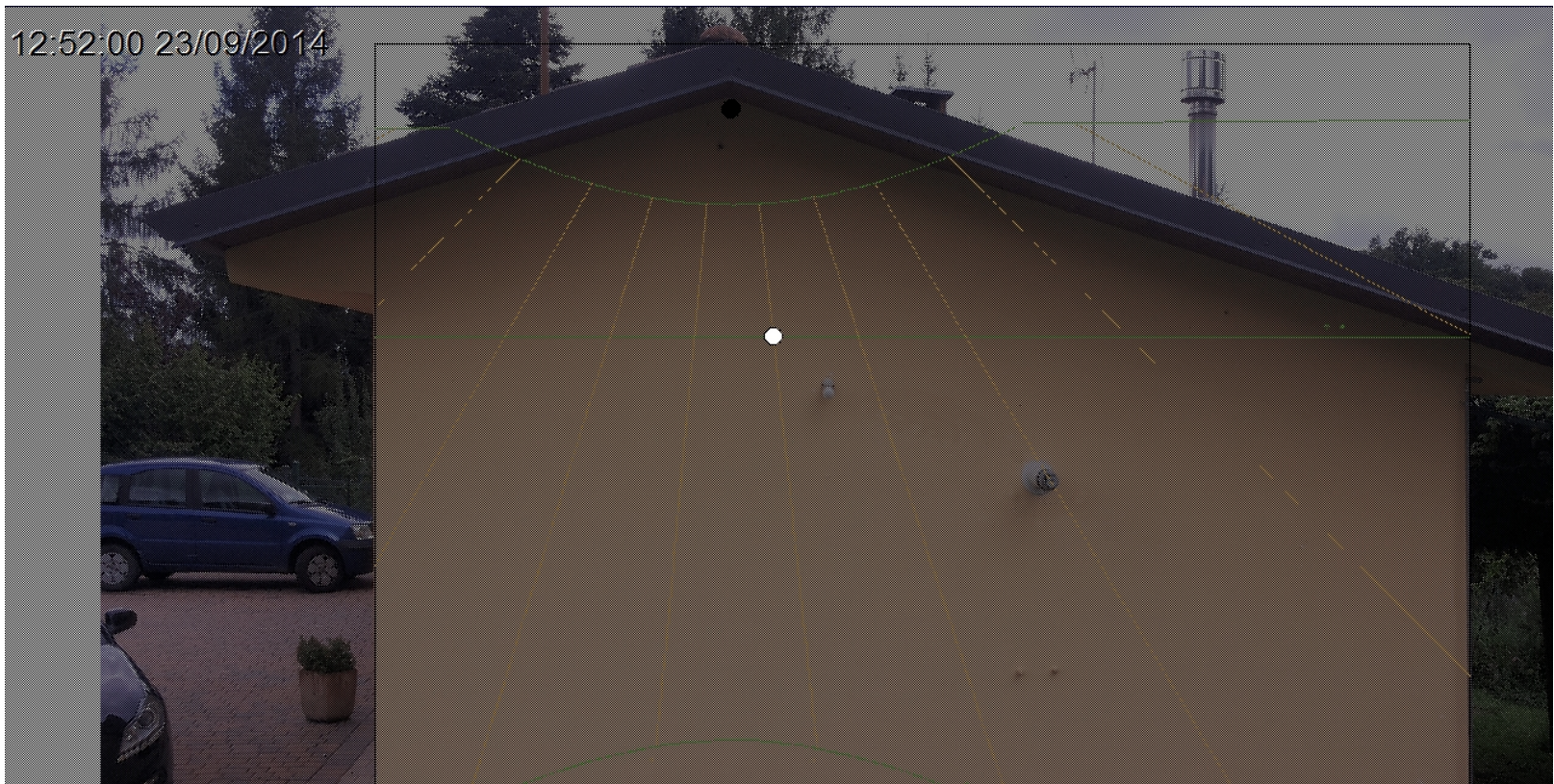
<input checked="" type="checkbox"/> 1	16:00:00	x	-144.75	y	42.13
<input checked="" type="checkbox"/> 2	16:10:00	x	-155.33	y	38.9
<input type="checkbox"/> 3	22:41:18	x	0	y	0
<input type="checkbox"/> 4	22:41:18	x	0	y	0
<input type="checkbox"/> 5	22:41:18	x	0	y	0

## Simulation

All the features of Orologi Solari can still be used with reflection sundials.

It is so possible to simulate the behavior of the sundial in the same way as for classic sundials.

It is also possible to evaluate the effect of walls, roofs, balconies, buildings both with the simulation both with the computation of the lighting conditions of the sundial.





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