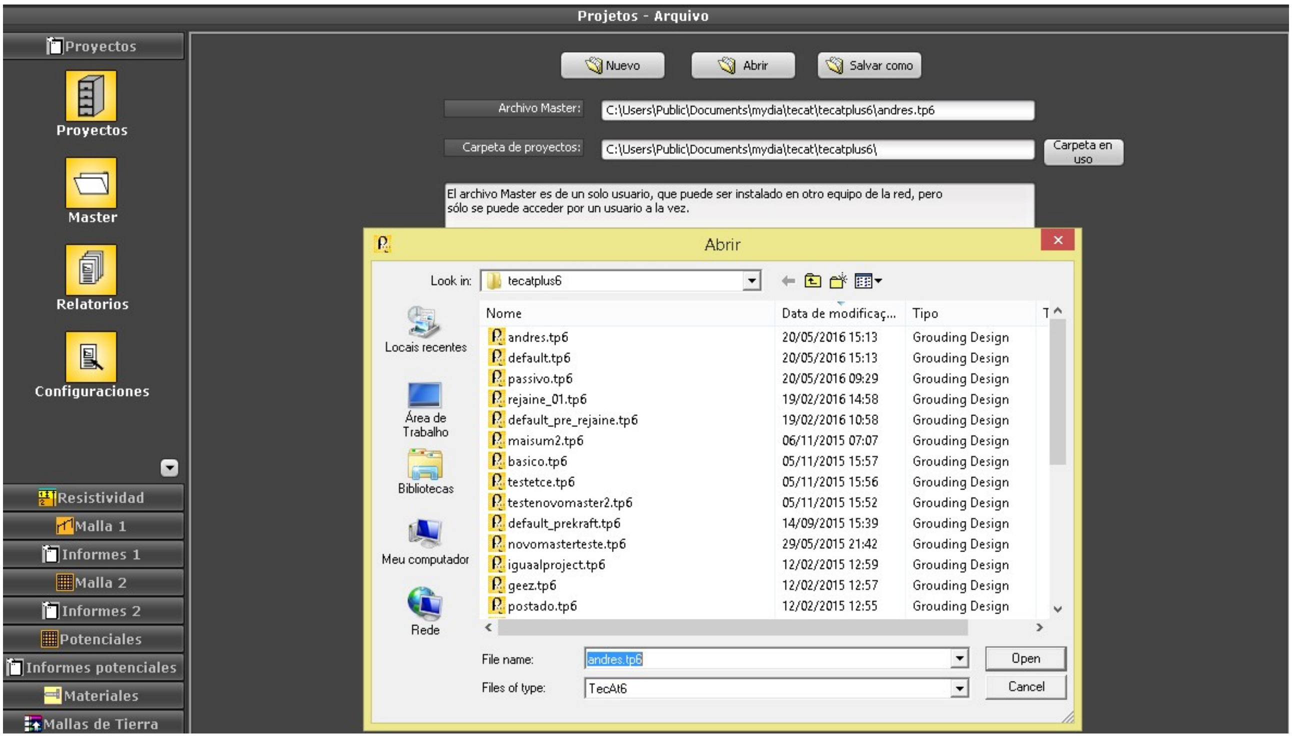
TecAt Plus 6

Example: Distribution Voltage consumer substation
preliminary edition 28/06/2016

1. Creating a new Master file

A Master file can have several projects; besides better organization, the advantage on grouping related projects on the same file is the ability to perform extensive comparative analysis between grids calculated with the Grid 2 module (complex grids in multi-layer soil).

To create a new Master file, select Projects / Master / New:



Editing the descriptive Project data:

When starting a new project - or selecting an existing one on the Master and clicking on Edit button - you can enter or modify the project's descriptive data:

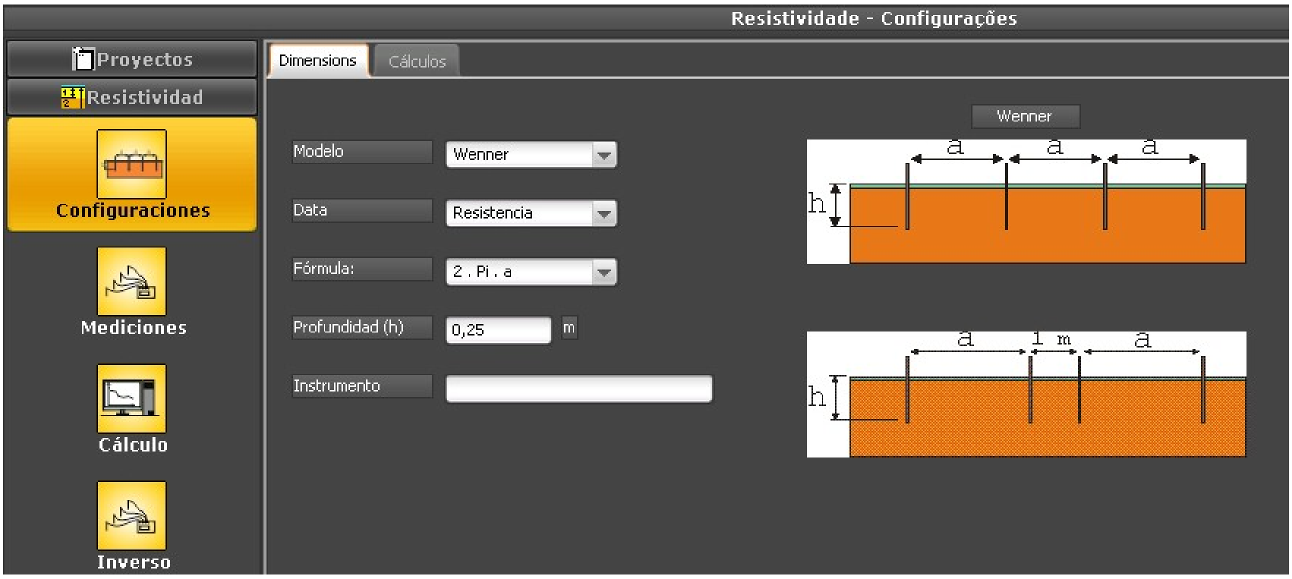
2. Resistivity

Select the desired project at the projects table and click on Load: note that the name of the current project always appear at the top of the windows, example: “TecAt Plus 6 - currentproject” - if it’s not there, you forgot to click on the Load button!

Resistivity module configuration:

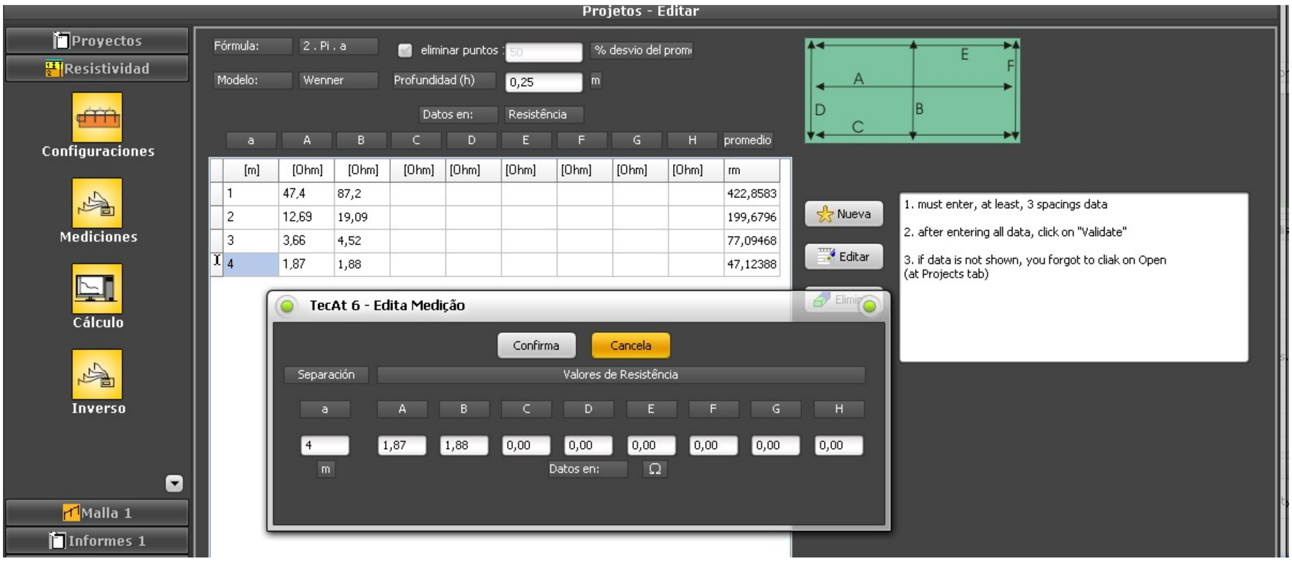
Before entering the field data, select the parameters at the configuration screen, particularly:

- Field data in resistance or resistivity
- Depth of metter rod (for complete formula, ignore for reduced)
- Formula: complete (more prcise, need depth of measures) or reduced (2 . π . R . a).



Field data from meter:

At Resistivity / Measures, click at New button to enter all the field measurements for a given spacing:



a	A	B	C	D	E	F	G	H	promedio
[m]	[Ohm]	[Ohm]	[Ohm]	[Ohm]	[Ohm]	[Ohm]	[Ohm]	[Ohm]	rm
1	47,4	87,2							422,8583
2	12,69	19,09							199,6796
3	3,66	4,52							77,09468
4	1,87	1,88							47,12388

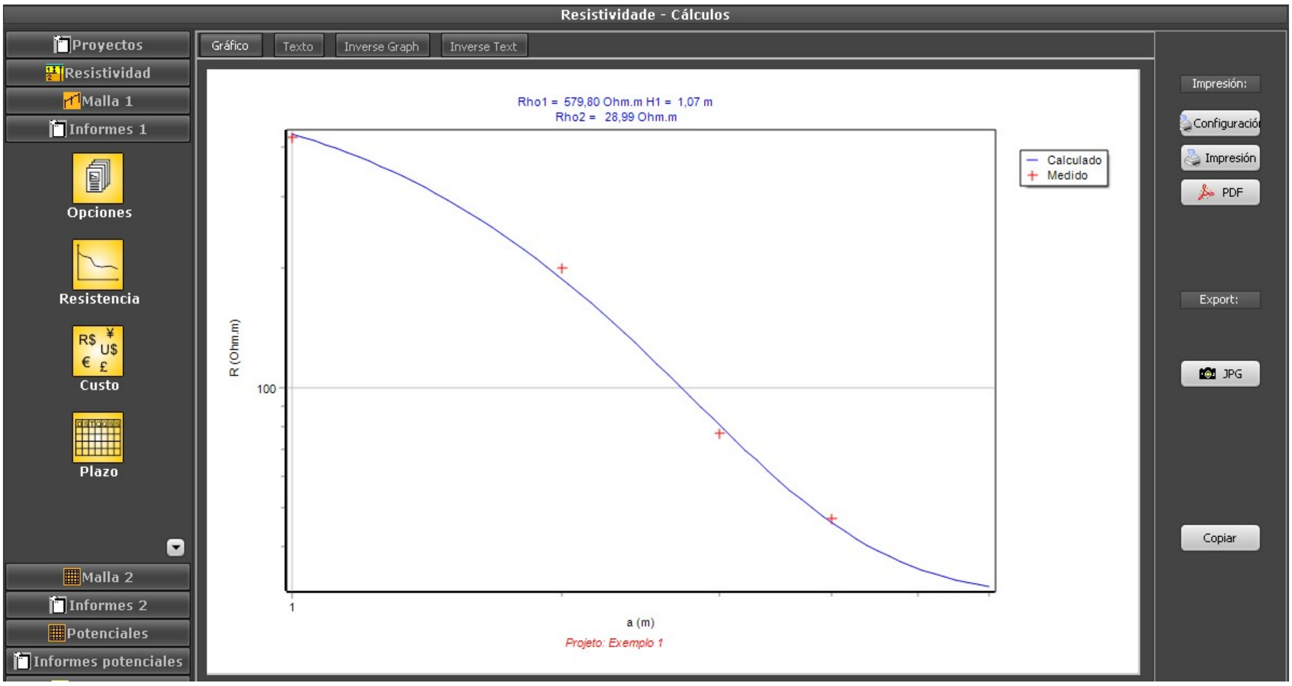
a	A	B	C	D	E	F	G	H
4	1,87	1,88	0,00	0,00	0,00	0,00	0,00	0,00

After entering all the measurements, click at Validate - if the data isn't validated, the Calculate button (see next) won't appear.

At Resistivity / Calculation, select the desired number of layers; it's possible to repeat this step several times to find the number of layers that gives the better adjustment, but please note that, to get a 3- or 4-layer soil, you'll need at least 5 spacings, otherwise, the program will reverse to 2-layer model:

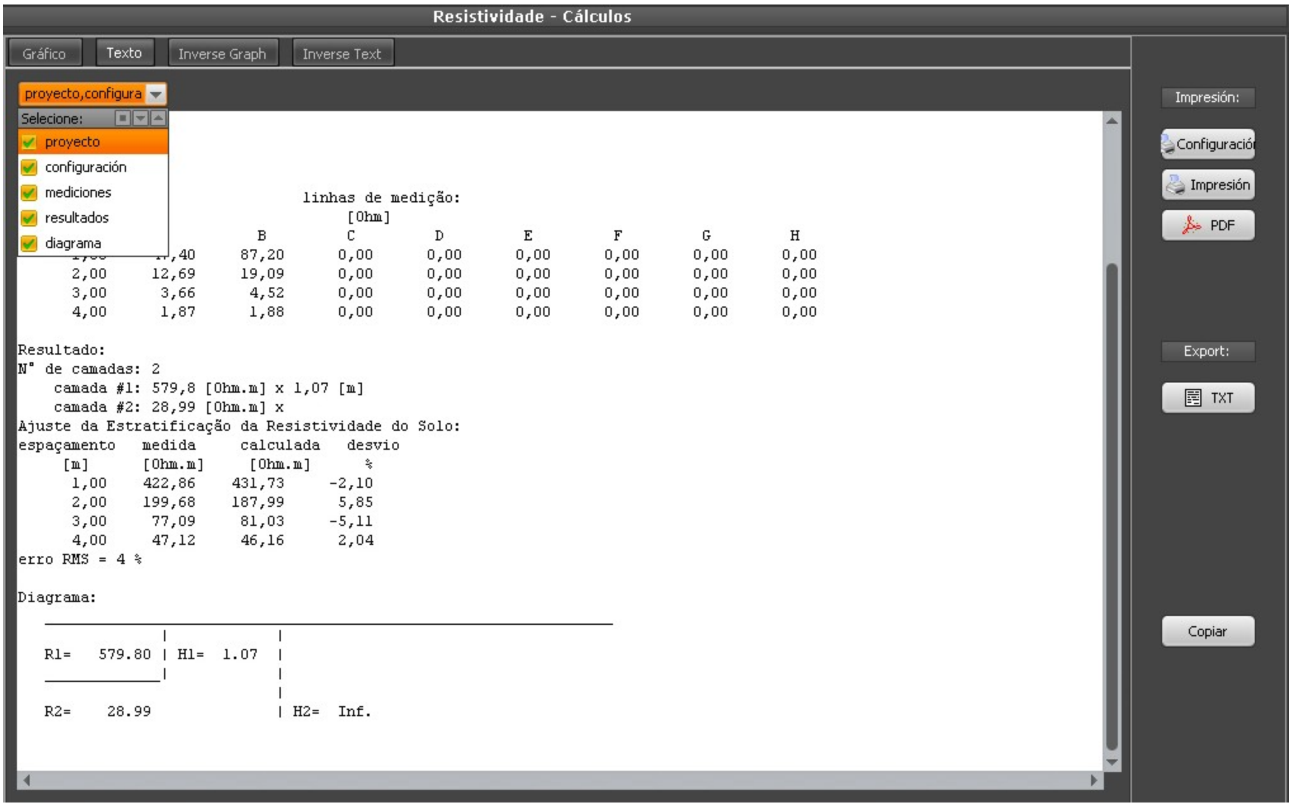
Chart with the field data points and the resistivity curve found:

When you click on Calculate on the previsous screen, TecAt makes the curve adjustment and changes to the Resistivity / Reports / Chart screen:



Descriptive report for Resistivity:

Click at the Text tab and select, at the box, the desired items for the report:



The stratification is considered satisfactory when none of the measurements have deviation greater than 15-20% and the full set of measurements has a RMS error bellow 10-15%.

3. Resistance and Potentials

We will use for this example the module Grid 2, for calculating grids one at a time, but with any grid geometry and up to 4-layer soil - in comparison, module Grid 1 is for a quick comparative of several small grids but only for resistance in 2-layer soil, and it doesn't have potentials calculation.

Cálculo dos potenciais admissíveis:

First, we determine the admissible (tolerable) potentials for Touch and Step, as we will need them later; also, it's on this screen that we enter the grid current and the time for the protection actuation - please find at the documentation and on applicable standards more details on these data, as they are very important.

Select Potentials / Admissible:

If you want a gravel layer, click on Select to choose one from the materials database and enter the gravel layer depth; enter the values for time of protection and grid current and choose the operator's weight.

Notes:

- The grid current is the portion of the fault (short-circuit) current that will effectively transferd to the earth by the grid; in High Voltage substations, for example, is probable that some of the total current will return by the cables to the first towers and then to their grids.

- Some standards have the two values - 50 and 70 kgf - for the operator weight, while others use only the 50 kgf value.

- A concrete floor in contact with the soil can not be used as insulation layer! On this condition, the concrete absorbs humidity and presents a very low resistivity; if you have a concrete floor, it's possible to use a welded grid of rebars to unify the potentials.

Click at Update and, then, at Calculate, to get the Touch and Step admissible potentials.

Configuration of module Grid 2 (substations and other complex grids on 2-, 3- and 4-layer soil):

Select Grid 2 / Configurations:

The resistivity values are the same as the last stratification or you can enter your own here.

Configuration of “wizards” (automatic generators of grids):

It’s always possible to enter the electrodes one by one but, as most grids have regular division (at least some part) and the same cable section, for example, it’s faster, easier and you get less data errors if you use the TecAt wizards.

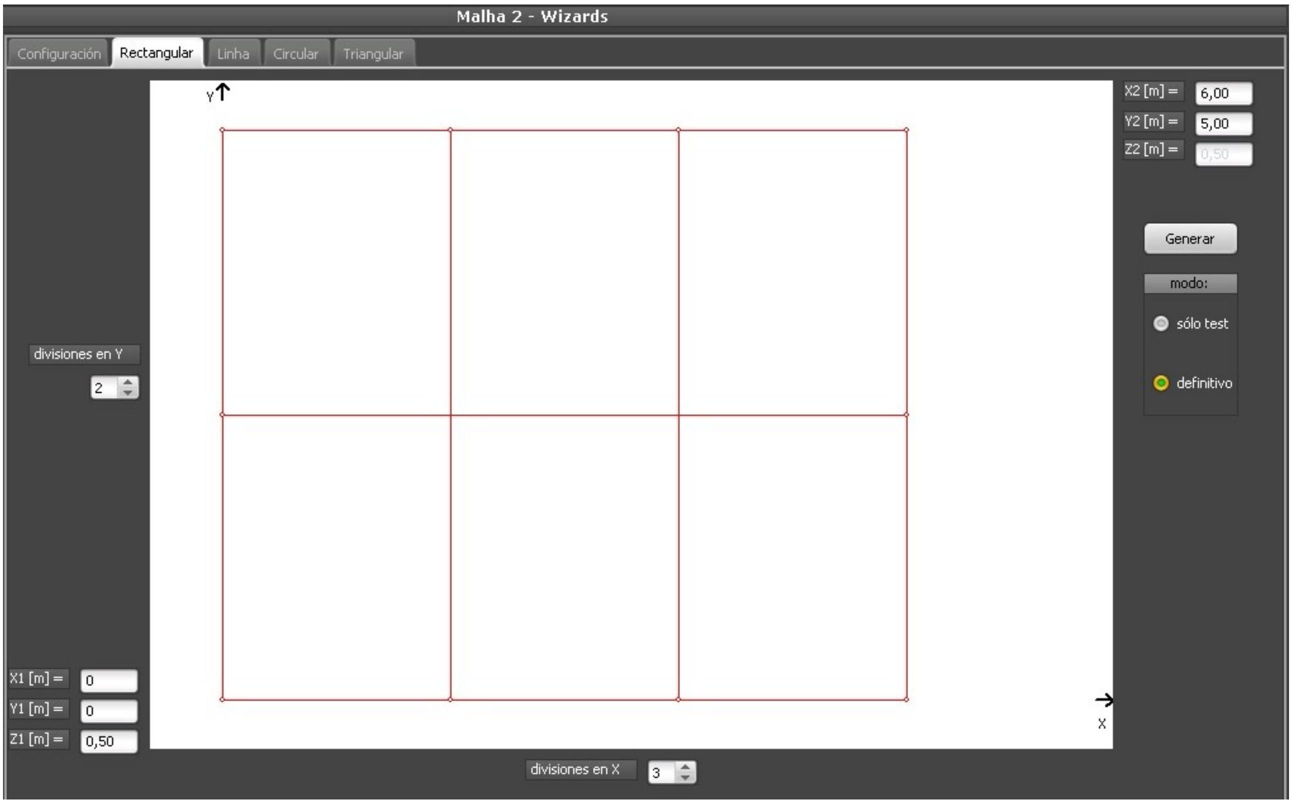
At Grid 2 / Wizards, select the Configuration tab:

For this example, let’s generate cables + rods, with rods only at the border (perimeter) cable, active electrodes (see our tutorial on metallic fence for use of passive electrodes) and regular meshes (geometric division is used only in bigger grids.

TecAt has a set of default materials stored on a file, click on Read default, then in Update; the wizard uses one cable dimension and one rod dimension each time - but you can run the wizards several times to build an irregular grid, just un-check the box “erase existing grid”.

Grid gerated on the rectangular wizard:

For our example of a small grid of 5x6 meters, let’s initially use the wizard Rectangular, with 3 divisions on the X direction and 2 divisions on the Y:

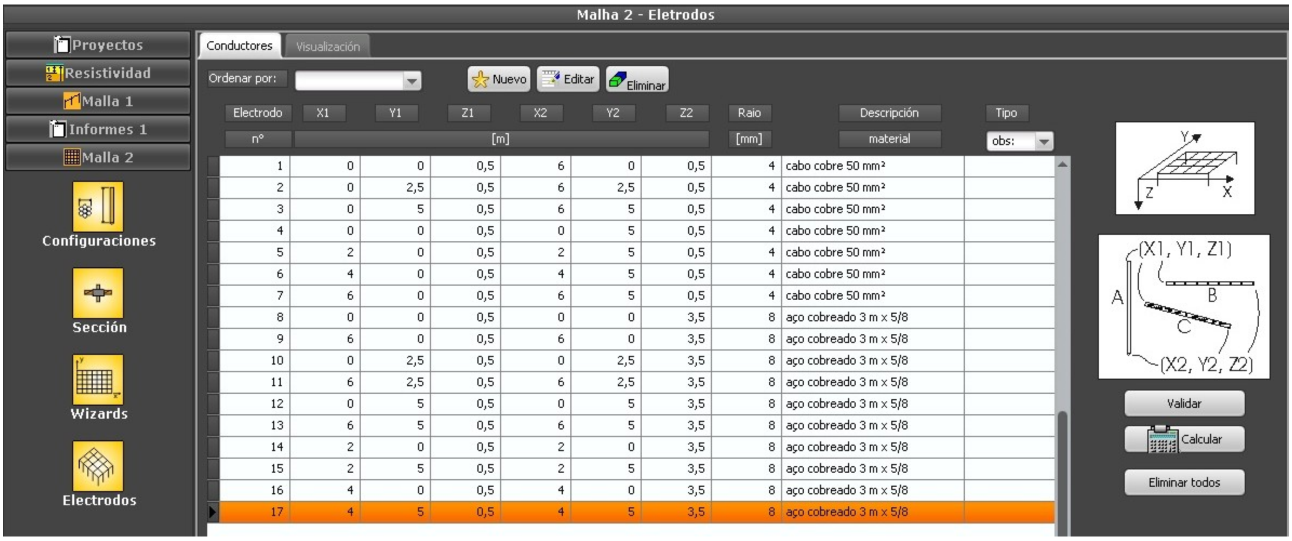


Note that some energy companies demand that you install a minimum number of rods, according to the installed power.

Select “test only” and click in Generate to see the generated grid; if it’s correct, select “definitive” and click again at Generate.

Table of grid electrodes:

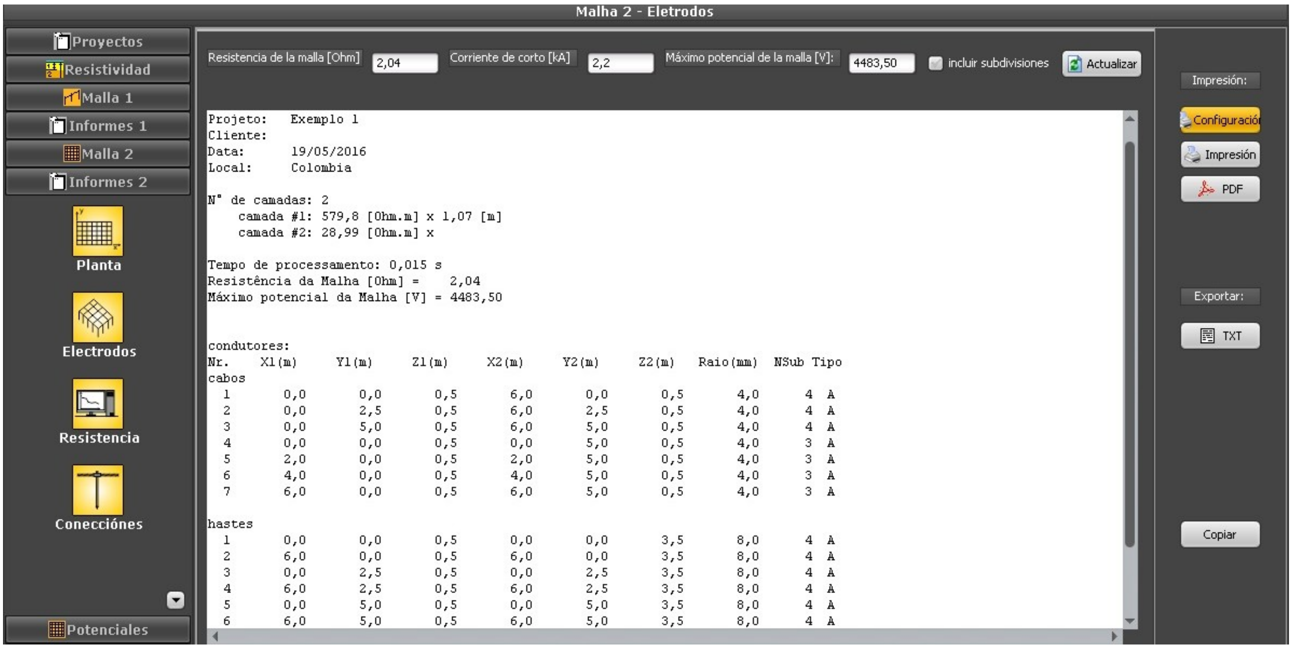
Select Grid 2 / Electrodes to see the table:



Note that, also here, the button Calculate isn't visible until you click at Validate - do that, then click on Calculate to get the grid resistance.

Grid resistance report:

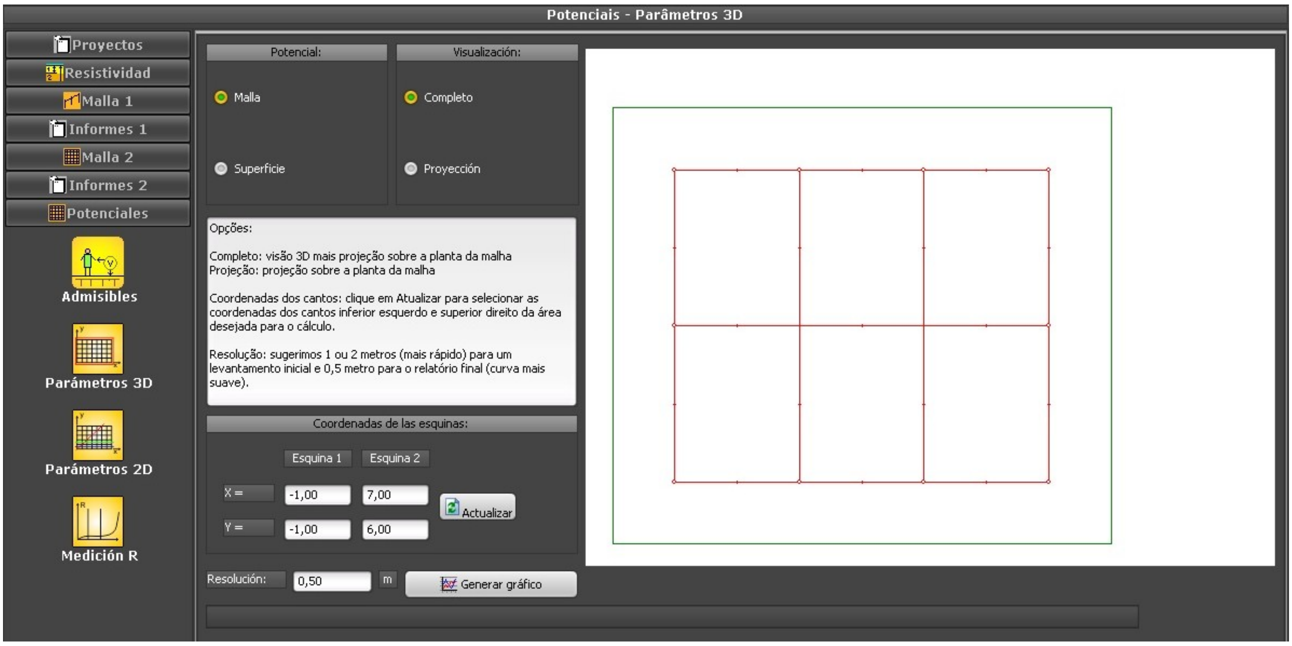
Select Reports 2 / Resistance to get the report:



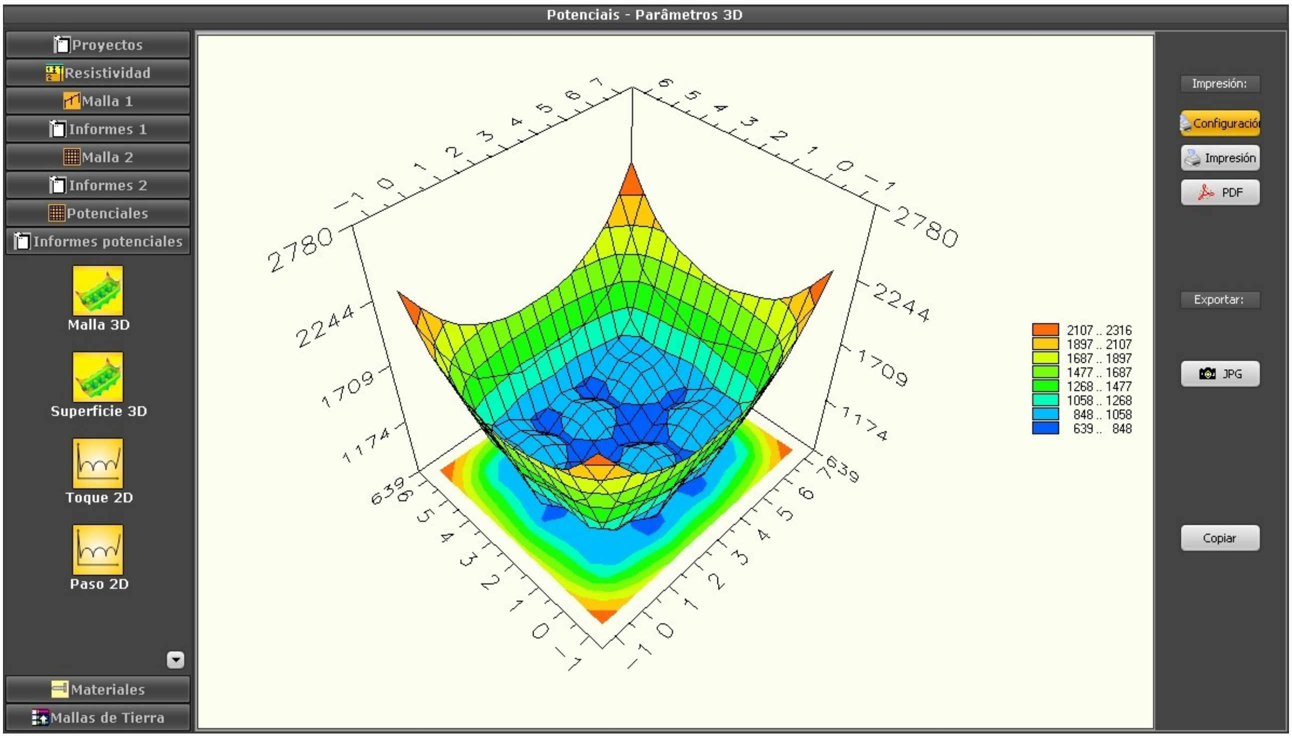
Note that the GPR (maximum grid potential) is obtained with the resistance and fault current values - if the current value isn't shown (or is the default of 1 kA), you have not entered it yet - go back to the admissible potentials screen, enter the value, then get to the electrodes table and click again on Calculate.

Parameters to generate the 3 Dimension potentials charts:

Select Potentials / 3D Parameters, click at Update to enter the coordinates of the desired area; on cases like our small grid here, one meter off the grid for all sides is normally OK; as the grid goes from (0,0) to (6,5), enter the values (-1,-1) to lower left corner and (7,6) to upper right corner:

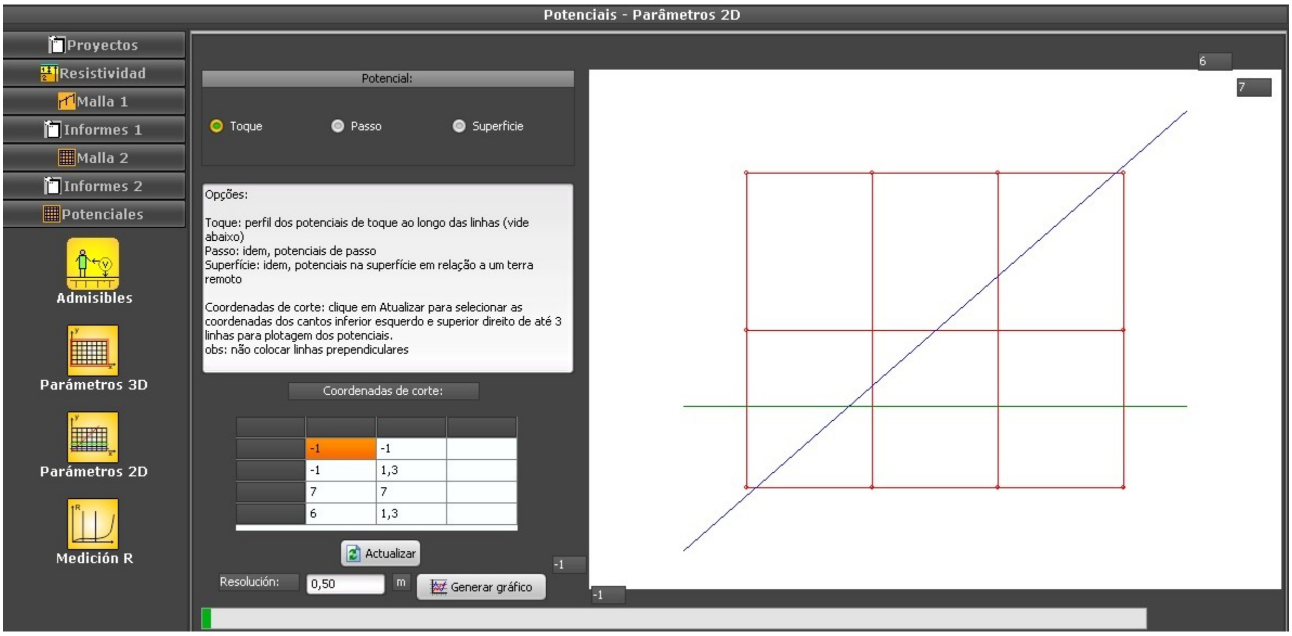


3D view of grid potentials - also available the surface potentials and, for both, the projection view:

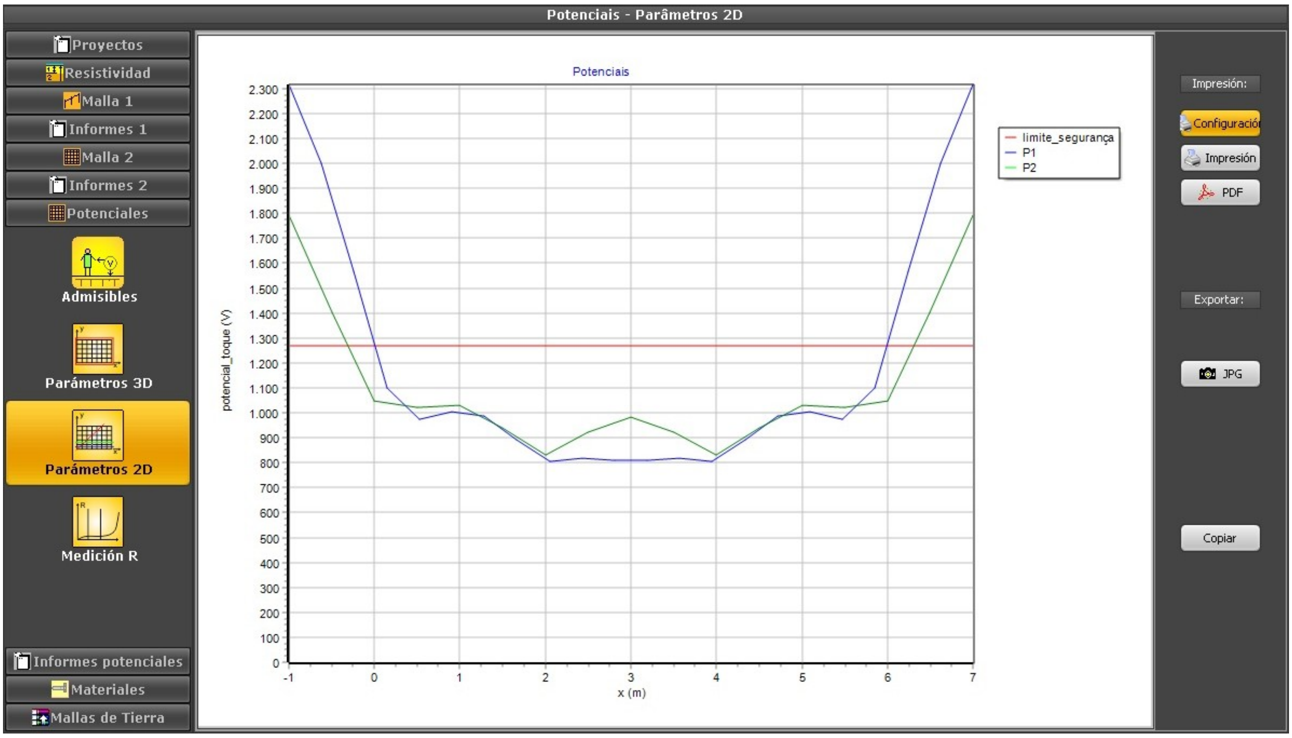


Parameters for 2D charts:

To get the 2D charts of Touch, Step and Surface potentials, we must enter the coordinates of one to three lines to "cut" the grid; let's place one diagonal line and other parallel to X axis, again with one meter outside the grid (so we can check the potentials from the outside if someone touches a metallic fence):



2D view of Touch potentials (Step and Surface also available):



As can be seen, if the grid is for a closed brick structure with no metallic door, this grid is safe. If it's for an open substation with metallic fence, or a closed one with grounded metallic door, someone who touches these exposed parts from the outside would be in danger, even with the gravel layer. Let's see next what can be done to fix this.

4. Solutions:

On this specific case, with such low resistivity soil, it's not difficult to get a good result - we could use longer rods, for example, using the smaller second layer resistivity to better dissipate the current at the border and also to obtain a smaller resistance that would result in smaller GPR.

If we had a soil with medium to migh resistivity values, this small substations don't have enough area to get a good result for the potentials; one common solution is to calculate the grid for the resistance criterion only, then get rid of the potentials with the installation of an additional equipotential grid with connections to the grounding cables - if the floor is concrete, the rebars or a welded grille reinforcement can be used for that - but not for this high current dissipation, you'll still need the grounding grid.

As for the access to metallic parts from outside, it will depend on the environment: for example, in urban areas, with the substation at the property limit, one must check also the step potentials around it and avoid metallic parts that could be touched by someone on the sidewalk, or add an asphalt layer on the sidewalk as isolation

Note: on this example, for clarity and size, we didn't show the charts of surface potentials on 3D and also the step and surface potentials on 2D, we've shown only the touch potential as it's normally the critic one but, in some situations like the mentioned sidewalk, the step could be important. So, on a real project, we should always present all the charts and reports, even running again the 2D charts for specific location of grounded equipments and structures.

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