PASI

User Manual

GEA RM1 1.0

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1.Important Notice

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This guide refers to "GEA RM1-PC" SW version 1.0.0, firmware version 1.2.

Torino, ITALIA 2018

2.Warranty and safety instructions

CAUTION

In the appliance connected to the energizer circulating potentially lethal voltages and currents, you are requested, for your safety, to observe the electrical safety standards, make all connections always with the energizer turned off, never leave the instrument unattended and keep away inexperienced staff, children and animals.

This equipment allows you to perform measurements of electrical resistivity of the ground, measures of induced polarization (IP) and measures of spontaneous potential (SP). Using the instrument for other uses for which it was not designed may void the warranty and generate hazardous situations.

In order to use the equipment properly and correctly, it is necessary to have geological and geophysical skills. On request we can provide a bibliography containing the titles of some texts to be consulted, if necessary.

Read the instructions carefully before using the product:

- This device has been designed and built to make electrical ground resistivity measurements possible for geophysical / geological purposes. A careful reading of this manual is recommended before proceeding with use.

- Warranty will be void if the product is used in any ways that is in contradiction with the instructions given in this manual.

- Warranty will be void if the instrument has been tampered with.

- The device must only be used only according to the instructions described in this manual. Faultless and safe operation of the device can be guaranteed only if the transport, storage, handling and operation of the device is appropriate.

- To avoid damage, use only original accessories or approved by PASI srl.

- The box is waterproof only if closed. When a suitable location has been selected for the device, it must be ensured that no water can get into the device under any conditions. Direct sunlight is also to be avoided for long periods. It is not recommended that the instrument is installed on a strongly vibrating surface.

3.Introduction

The instrument GEA RM1 is a device designed and assembled by P.A.S.I. srl, a leading company in Italy in the production of instruments for geology and geophysics.

This guide details the technical specifications and how to use the device. Please follow these guidelines.

Contents

- Chapter 5, How to use, describes how to use the system from the hardware point of view.
- Chapter 6, To begin with, describes how to perform some basic operations using the Gea RM1 system and the Gea RM1-PC program, referring to the following chapters of the manual and allowing the operator to begin to know and use the system.
- Chapter 7, Description of the interface in standalone mode, describes the operating mode of the system used in standalone mode, this means without the connection to a PC, illustrating in detail all the features offered by the system.
- Chapter 8, Description of the Gea RM1-PC program, describes the operating mode of the control program on the PC and the use of the system, illustrating in detail all the features provided by the program and their interaction with the system.
- Chapter 9, Software System Update, describes how to perform the update of the systems software using the Gea RM1-PC program.
- Chapter 10, Appendix, shows the technical characteristics of the system and the definition of the GPD owner format (Geophysics Pasi Data) used for storing on a file the results of a measurement session.

4.How to use

Hardware elements

Notice, the content of the package depends on what you ordered, if in doubt contact our service after sales.

A standard supply could contain the following parts:

1. GEA RM1 standard version device from 1 A full scale (optional from 5 A).
2. P200 Energizer (200 V max 1 A) or P100-2-N Energizer (200 V 500 mA)
3. 3 Sets of connection cables
4. Cables for connecting current electrodes AB (or C1C2) 300 m (other sizes optional)
5. Cables for connecting potential electrodes MN (or P1P2) 100 m (other sizes optional)
6. Potential electrodes MN (or P1P2) non polarizable (optional)
7. Potential electrodes MN (0 P1P2) copper
8. Current electrodes (AB or P1P2)
9. 1 kg hammers for electrode piling
10. Device for controlling its functioning and calibration (optional)

Hardware connections

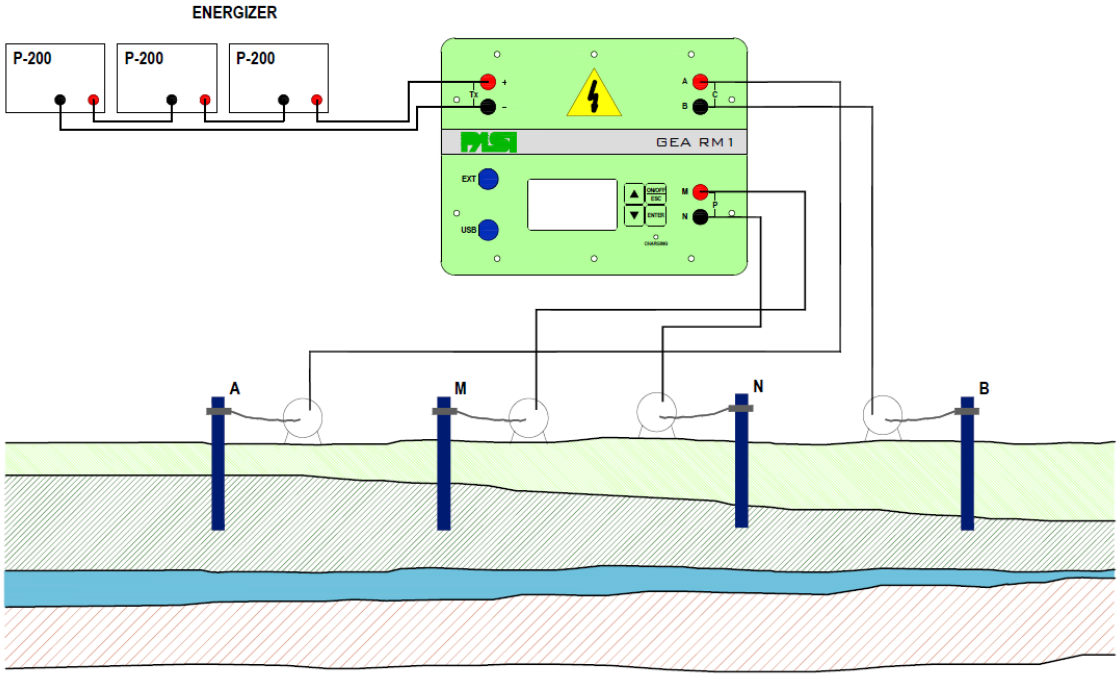


FIGURE 1 - HARDWARE CONNECTIONS

Figure 13 shows the connection diagram of the various hardware elements to the GEA RM1 instrument. To the left at the top of the panel are the connection connectors for the energizers (TX + and -), top right the connectors for the peaks of current input in the ground (A and B), bottom right there are the connectors for measuring the ground voltage (M and N), bottom left we find the USB connector for connection to the PC and the internal battery charge and the EXT expansion connector that allows you to connect external accessories.

Attention: when setting up the connections always pay the utmost attention to the electrical risks, make the connections always with the energizer turned off and disconnected; before starting the measurements, make sure that all the connections have been correctly carried out and that everybody has moved away from the measuring pegs.

For the preparation and use of the non polarizable electrodes (optional), refer to the instructions attached to them.

The energizer has its own user manual to be read.

5.A first rewarding example

In the device you will find a Schlumberger table (ExampleSCH) that we will use for this example.

A few premises before starting:

operations performed in sequence by the instrument:

1. transmits current between the two current electrodes (AB or C1C2) connected to the ground;

2. measures the potential difference between the potential electrodes (MN or P1P2) once the measurements have reached the set Sigma;

3. calculates the apparent resistance as K x V / I (where K is the geometric factor);

4. memorizes the data of the measurement.

The operator moves the electrodes up to the new measuring point and starts a new sequence, the instrument performs the operations again a b c d

The operator intervenes again and proceeds to the end of the measurements indicated in the table.

Once the measurements are complete, they transfer to the inversion software to obtain a stratigraphy that will then be correlated to the geology of the ground.

In the paragraph Hardware connections in Figure 13, the appliance-cable-ground connections to be performed are indicated.

Practical information for use:

• The GEA RM1 resistance meter is placed at the center of the laying;

• To reduce contact resistance, the electrodes must be inserted as deeply as possible into the ground; if necessary, the piling point must be wet with salt water and if this is not sufficient, several electrodes must be connected in parallel to increase the contact surface.

The connection cables between the electrodes must be kept distant from one another to avoid problems of insulation and mutual coupling.

Before starting the measurements it is necessary (if you have not already) to prepare the tables. The example is shown in the following images

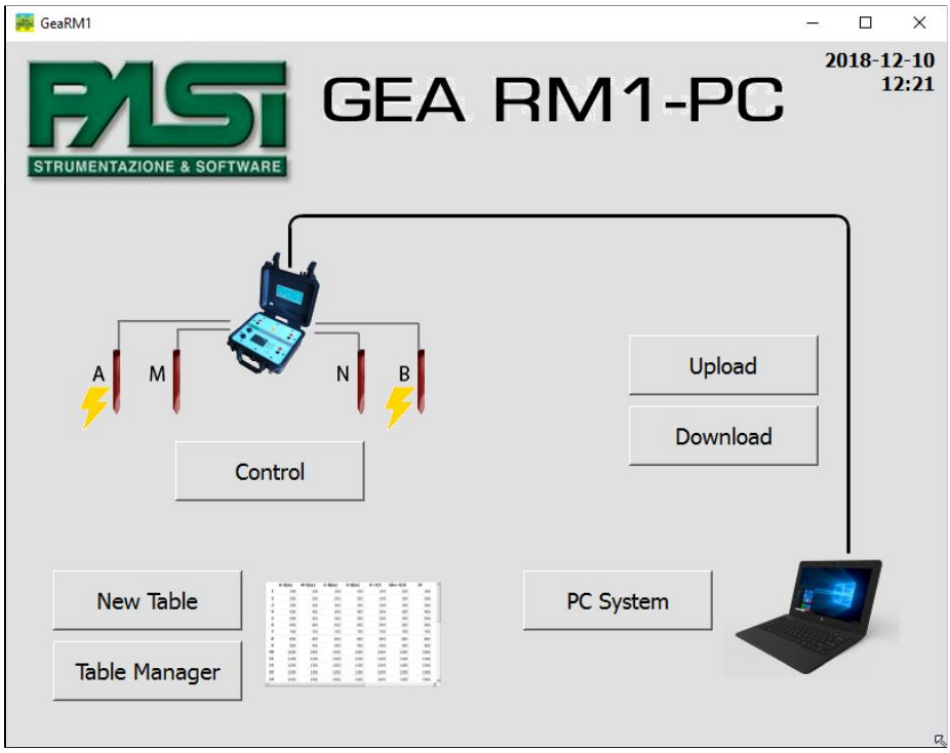


FIGURE 2 - CONNECT THE INSTRUMENT TO THE PC AND RUN THE SOFTWARE. CLICK ON "NEW TABLE" TO CREATE A NEW TABLE

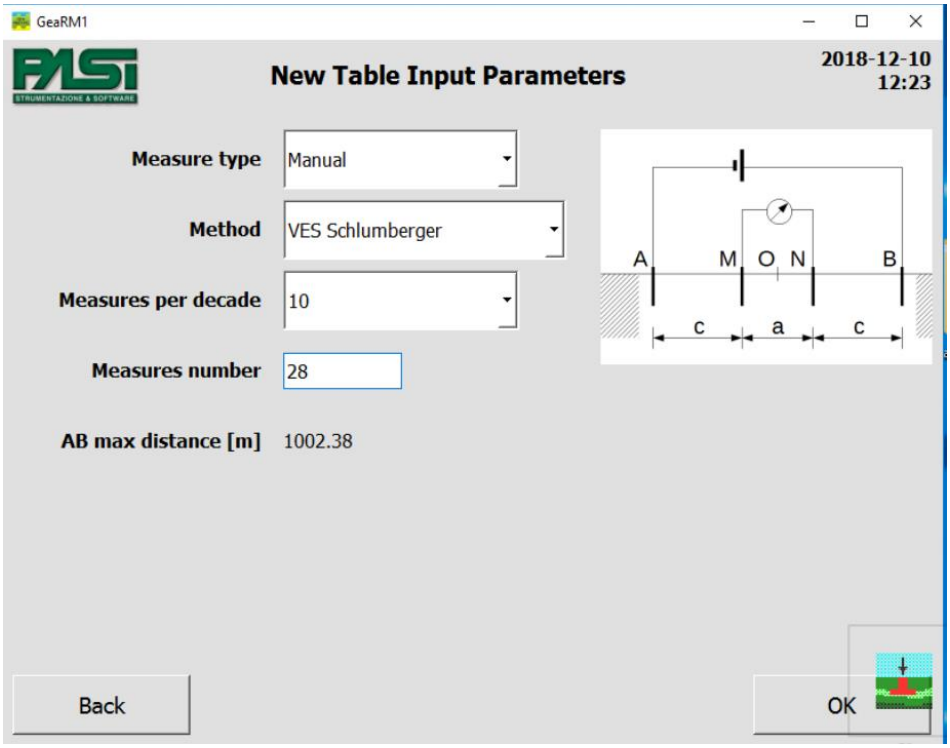
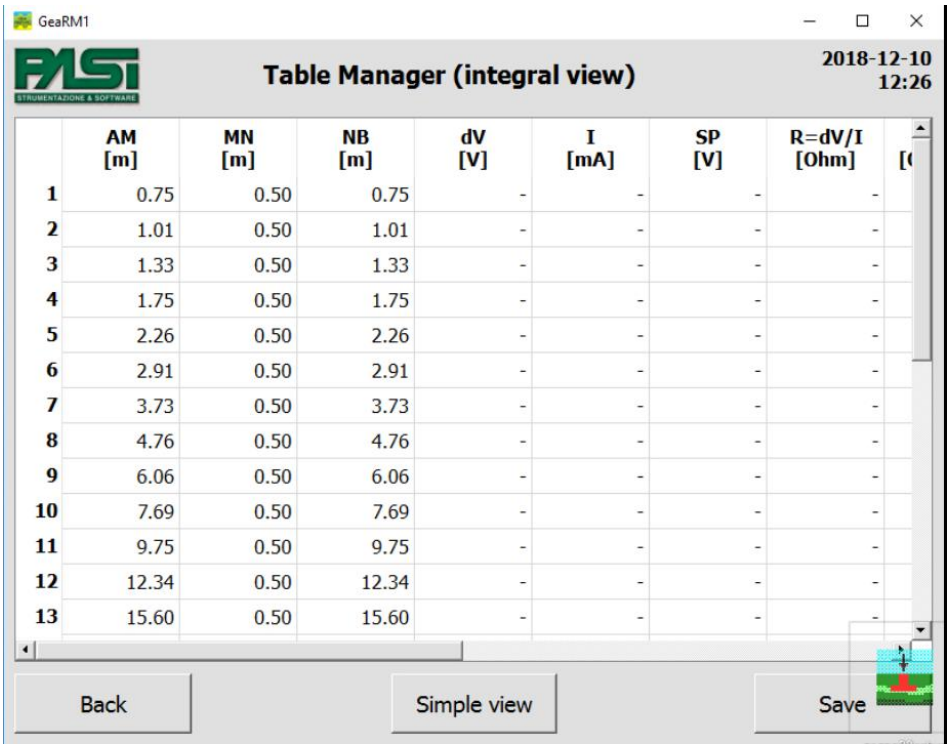
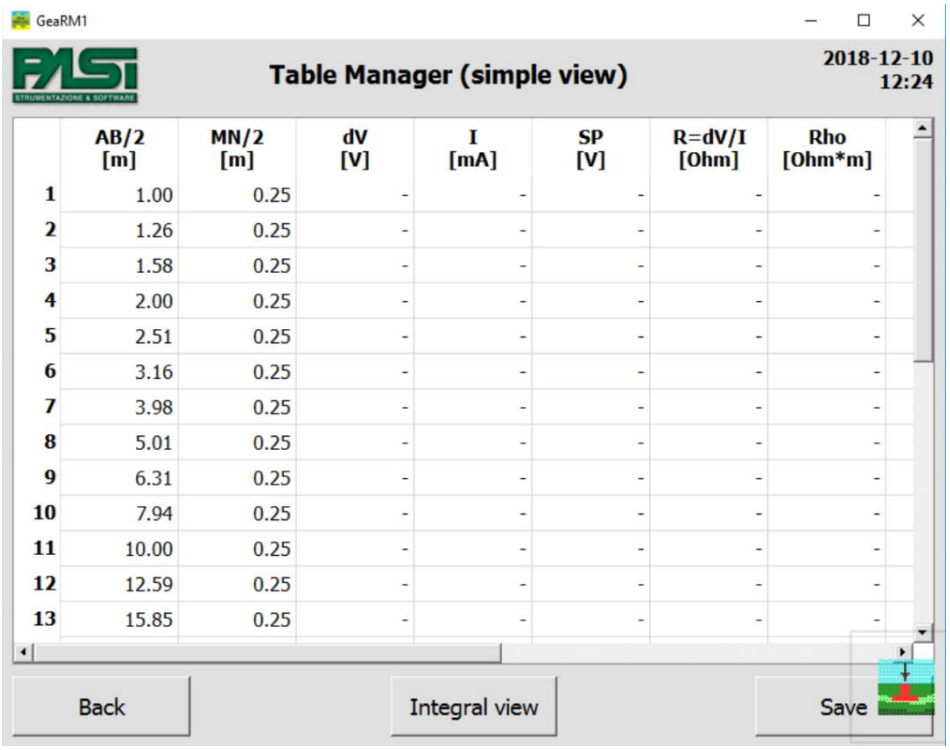


FIGURE 3 - INSERT THE DESIRED PARAMETERS FOR THE CREATION OF A NEW TABLE



	AM [m]	MN [m]	NB [m]	dV [V]	I [mA]	SP [V]	R=dV/I [Ohm]	[(
1	0.75	0.50	0.75	-	-	-	-	
2	1.01	0.50	1.01	-	-	-	-	
3	1.33	0.50	1.33	-	-	-	-	
4	1.75	0.50	1.75	-	-	-	-	
5	2.26	0.50	2.26	-	-	-	-	
6	2.91	0.50	2.91	-	-	-	-	
7	3.73	0.50	3.73	-	-	-	-	
8	4.76	0.50	4.76	-	-	-	-	
9	6.06	0.50	6.06	-	-	-	-	
10	7.69	0.50	7.69	-	-	-	-	
11	9.75	0.50	9.75	-	-	-	-	
12	12.34	0.50	12.34	-	-	-	-	
13	15.60	0.50	15.60	-	-	-	-	

FIGURE 4 - EXAMPLE OF INTEGRAL TABLE



	AB/2 [m]	MN/2 [m]	dV [V]	I [mA]	SP [V]	R=dV/I [Ohm]	Rho [Ohm*m]
1	1.00	0.25	-	-	-	-	-
2	1.26	0.25	-	-	-	-	-
3	1.58	0.25	-	-	-	-	-
4	2.00	0.25	-	-	-	-	-
5	2.51	0.25	-	-	-	-	-
6	3.16	0.25	-	-	-	-	-
7	3.98	0.25	-	-	-	-	-
8	5.01	0.25	-	-	-	-	-
9	6.31	0.25	-	-	-	-	-
10	7.94	0.25	-	-	-	-	-
11	10.00	0.25	-	-	-	-	-
12	12.59	0.25	-	-	-	-	-
13	15.85	0.25	-	-	-	-	-

FIGURE 5 - EXAMPLE WITH SIMPLIFIED VIEW

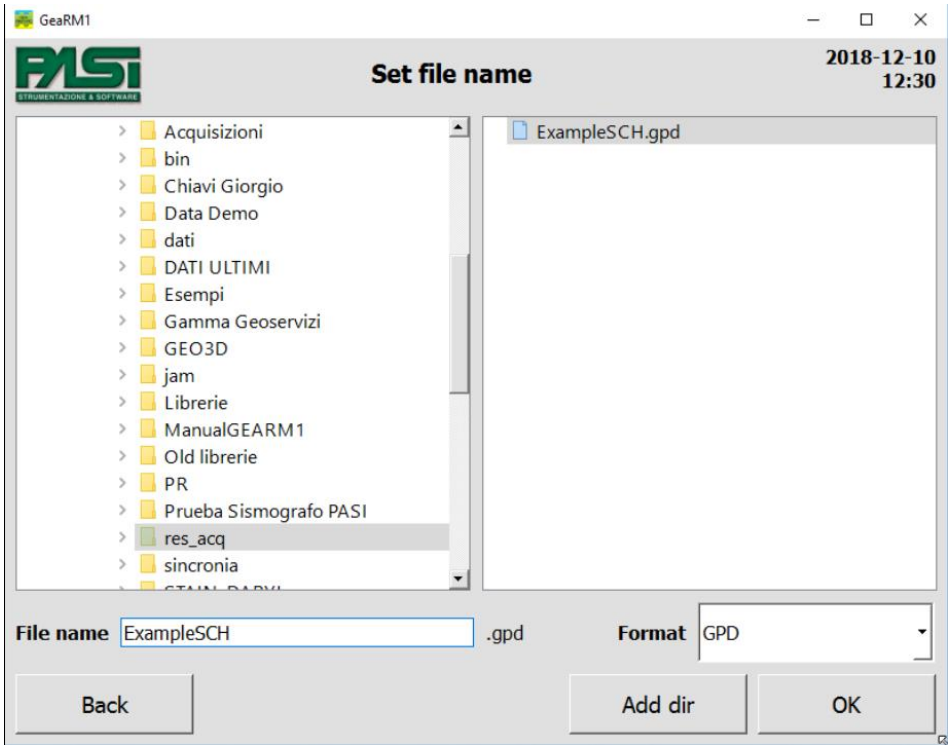


FIGURE 6 - SAVING THE TABLE

Measurements are started from low AB values (see Table ExampleSCH Figure 7 and Figure 8) and we proceed by enlarging the measure, for some AB / 2 values (when the Sigma value is too high) to avoid certain problems from lateral variations of surface resistance it is appropriate to re-execute the measurement by increasing the value of MN / 2 (re-tie, see Figure 9 and Figure 10 Figure 9), ideally the two measurements should be the same.

As you can see from the attached table the values of AB / 2 are spaced logarithmically with 10 values per decade (1-10 m; 10-100m; 100-1000 m; etc.) and initially all MN values are equal, (Figure 4).

When the measurements begin to be noisy (standard deviation> 5% the contact resistance must be decreased with the methods indicated above to allow greater current flow and simultaneously increase the MN / 2 distance, as the measurement proceeds if the Sigma is to exceed at the prefixed value it will be possible to press the execute / modify / repeat key (Figure 11) and the software (if the measurement had already been performed it will increase all the values of MN following one of a value equal to ¼, will be simultaneously updated the values of K from the modification point, we will proceed as above until the Sigma will again be> 5% and then again it will be necessary to increase MN, pressing the repeat key measures all the data from the point of modification forward will be increase by ¼ and proceed until the end of the measures.

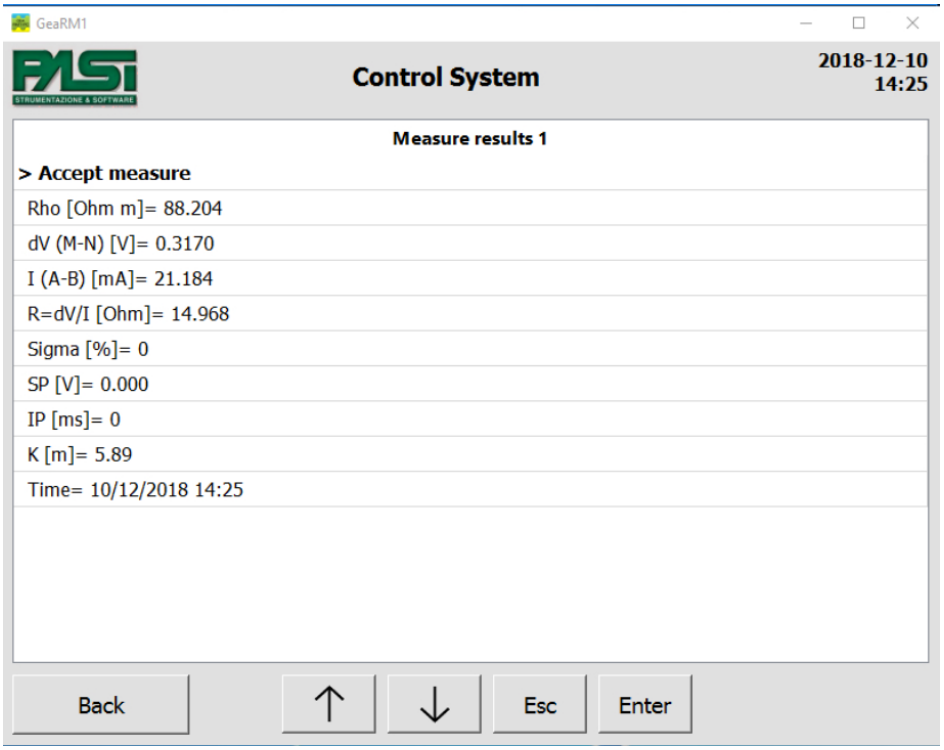


FIGURE 7

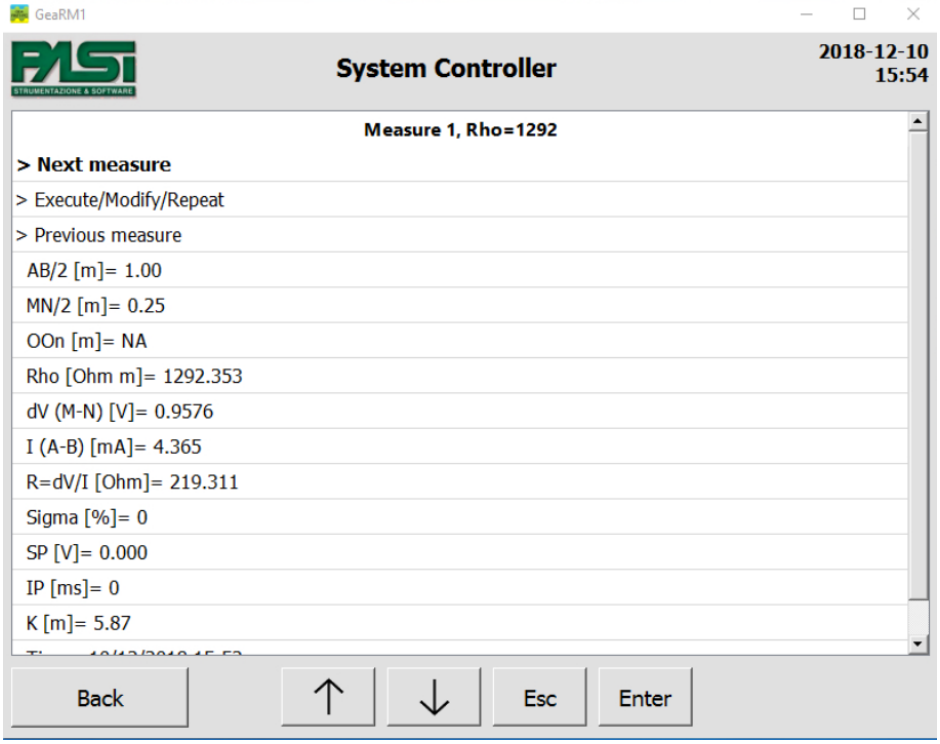


FIGURE 8

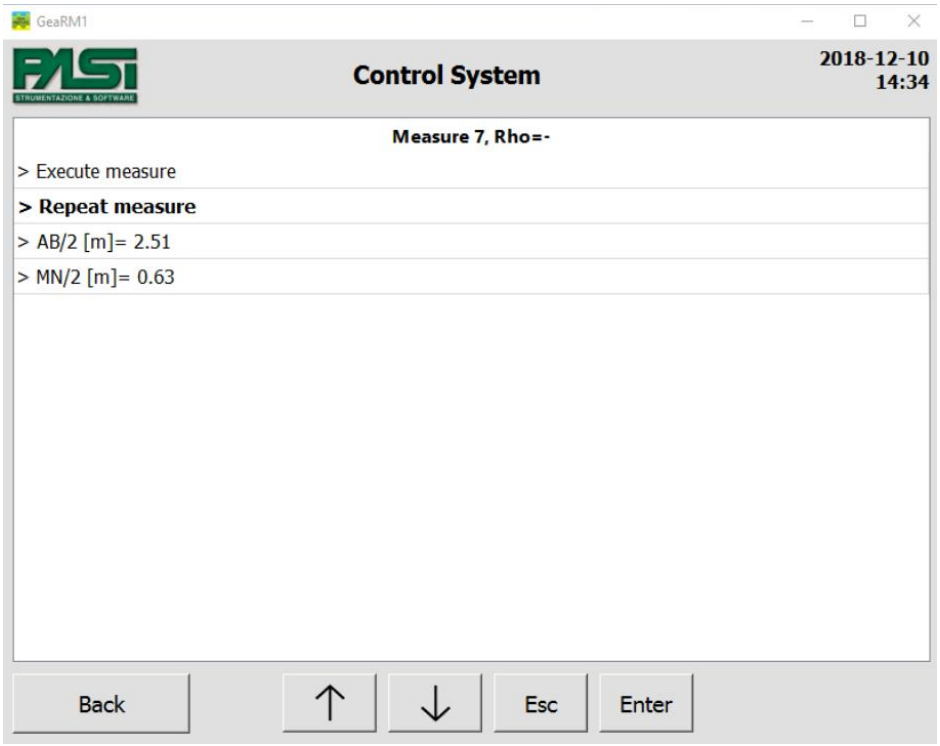


FIGURE 9 - MEASURE WITH INCREASED MN

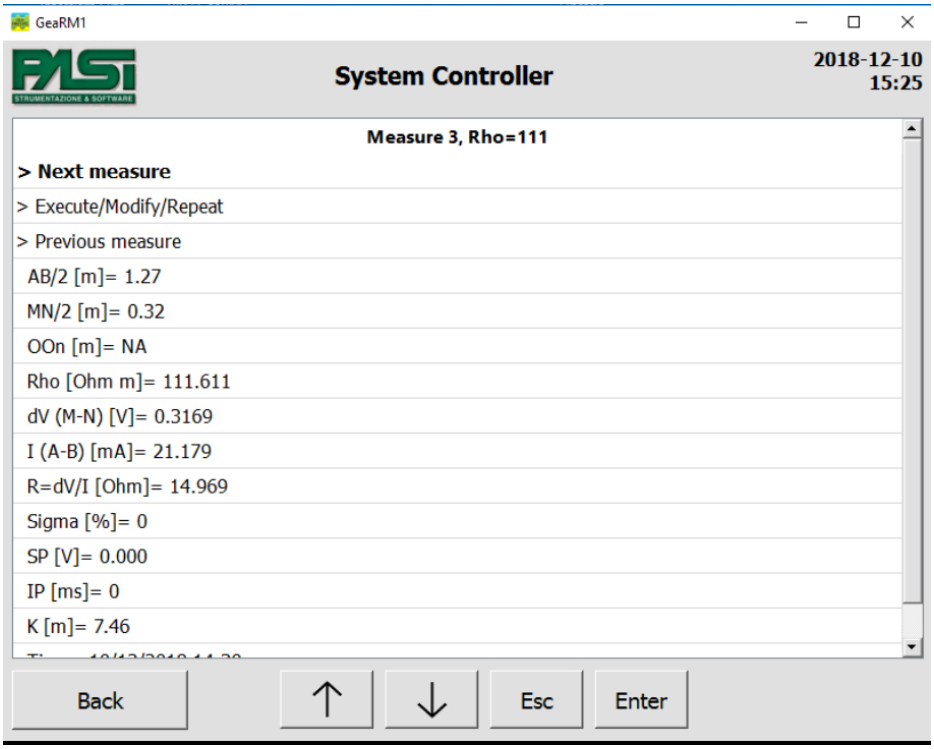


FIGURE 10 - REPEAT MEASURE

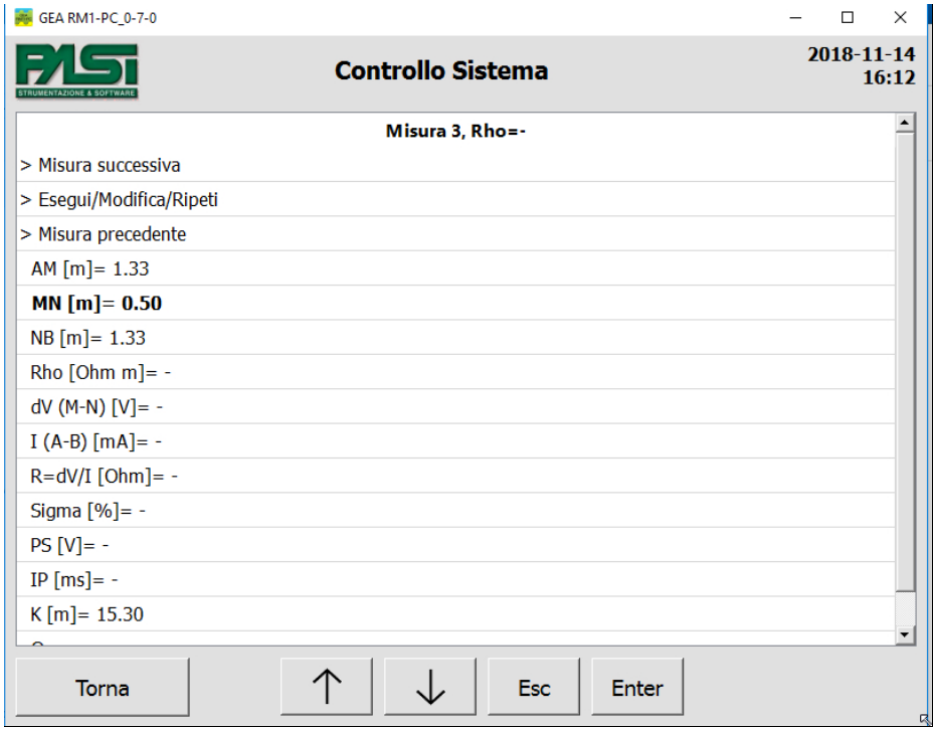


FIGURE 11 - EXECUTE, MODIFY, REPEAT

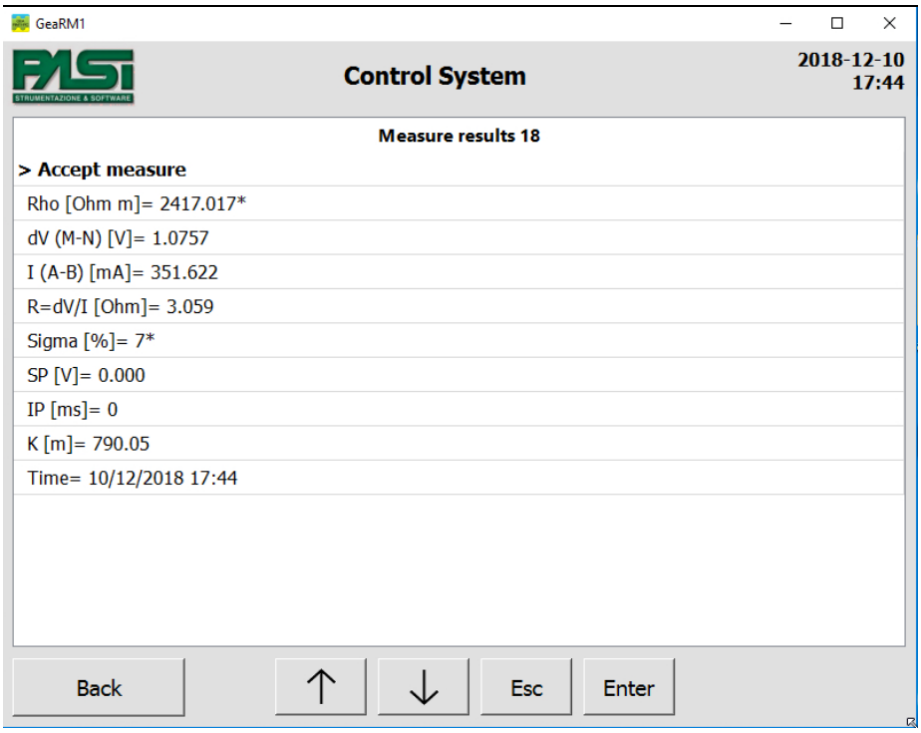


FIGURE 12 - MEASURING EXAMPLE WITH SIGMA> 5

Remember, in the selection of the tables, that the depth of investigation with the Schlumberger quadriple is worth about a fifth of the distance AB.

1. insert the current electrodes (AB or C1C2) externally to the SEV spacing according to the first distance in the table (it is advisable to use the simplified view which makes more immediate the comprehension, arrangement and use of the metric wheel to measure the points driving the pegs on the ground;

2. insert the potential electrodes (MN or P1P2) inside the SEV spacing to the second the first distance in the table (we recommend using the simplified view which makes the comprehension, arrangement and use of the metric wheel for measuring the piling points on the ground;

3. Connect the longest cable with the red connectors to the red socket (A or C1) of the instrument and spread the cable, letting the reel to scroll up to the rod A (or C1) conventionally the one to the left of the SEV laying;

4. Connect the shorter cable with the red connectors to the red socket (M or P1) of the instrument and lay the cable running on the reel up to the rod M (or P1) conventionally the one to the left of the SEV spread;

5. Connect the longest cable with the black connectors to the black socket (B or C2) of the instrument and lay the cable by letting the reel A to the peg A (or C1) conventionally the one to the left of the SEV laying.

6.To begin with

This chapter lists the steps that must be performed on the Gea RM1 system or on the Gea RM1-PC program, in order to describe how to operate on the system and carry out some common operations. For the description of the single steps, please refer to chapters 4 and 5, which respectively describe the operation of the Gea RM1 system and the Gea RM1-PC program.

Terminology: Session, Table and File

In the manual and on the interfaces of the Gea RM1 system and the Gea RM1-PC program the three terms are used to identify three different aspects of the same basic concept.

The basic concept that we want to identify is the software container that is used to store data related to a sequence of homogeneous measurements, and must be managed in a coherent way to allow a subsequent effective analysis. The informations kept in this container are:

- distinguishing features of the measurement sequence (type of measurement, algorithm used to calculate the measurement sequence);
- geographical references of the position in which the sequence of measures is carried out;
- input parameters for the algorithm used for the calculation of the measurement sequence;
- placing of the electrodes for each measurement;
- electrical quantities detected during the measurement;
- Moment in which the measure is carried out.

The informations of a measurement sequence is called in different ways to highlight the different characteristics: Session, when it is used by the Gea RM1 system, Table when it is used by the Gea RM1-PC program, File when you are in saving mode on PC .

Session

“Session” is when this container is stored on the Gea RM1 system, to indicate its characteristic of being able to be executed by the system during a measurement session and to be populated with the detected electrical quantities.

A session can be created, performed, viewed, modified, copied and renamed, but it is not directly accessible to the operator as it is stored in the system in proprietary mode. To be able to make the session available to the operator, you will have to transfer it to a PC, connecting it to the Gea RM1 system using the USB cable and linking it through the Gea RM1-PC program. Having made this connection, two features will be available:

- Download: allows you to transfer a session from the Gea RM1 system to the PC (when it is on the PC it will be called a table);
- Upload: allows you to transfer a table from the PC to the Gea RM1 system (when it is on the system it will be called a session).

The session name is set by the operator when creating, copying or uploading, and must be univocal to his system.

A particular type of session is called "Template", it has the same characteristics of the session except that the measures contained in it cannot be performed. The template serves as a model for the sessions, and has to be duplicated to be used. The functioning of the templates is described in chapter 7 in Sessions and Templates

Table

“Table” is when this container is stored on the PC and used by the Gea RM1-PC program, it indicates the form of the table with which it is displayed and managed by the Gea RM1-PC program where to each line corresponds a measure.

A table can be created by the operator through the functions of the Gea RM1-PC program choosing among some algorithms defined in literature that will populate the table rows with the geometric position data of the electrodes for each measurement.

The name of the table is set by the operator when the table is saved on the hard disk of the PC, after a creation, a copy or a download from the system, and it will coincide with the name of the file through which the table is saved.

File

"File" is when the container is stored on the PC hard disk or on other hardware support. It comes in the form of a text file with a GPD proprietary file format defined to keep all the information of the table used by the Gea RM1-PC program.

The file should not be modified manually outside the Gea RM1-PC program, because any inconsistent change/modification would render unusable the table contained in the modified file. Any changes that will be necessary will therefore have to be carried out on the table through the functions of the Gea RM1-PC program and not directly on the file using a text editor.

The file name will coincide with the table name, and will be set by the operator when creating, copying or downloading a table. If a copy of a GPD file is made outside the Gea RM1-PC program, as a normal Windows file, this will be same as having copied a table on the new file.

Execution of a single measurement

The execution of a single measurement can be made by operating only on the Gea RM1 system. The result of the single measurement can not be stored on the system, but the measured values will be showed on video and must be copied by the operator.

- To perform a single measurement: run the "Single measurement" command on the main menu of the Gea RM1 system, choose whether to perform a complete measurement or a measure of only spontaneous potential and follow the instructions in chapter 7 in **Executing a single measurement**.

Creation of a generic measurement session

The creation of a generic session of measurements can be carried out by operating only on the Gea RM1 system. The session file is stored on the system and can be executed or modified afterwards.

The geometrical positions of the electrodes for each individual measurement can be entered on the system by the operator before executing the measurement, after having made the measurement or not be entered and, if necessary, recorded externally to the system.

- To create a generic session: run the "Session management" command on the Gea RM1 system, followed by the "New session" command, choose "New complete session" or "New session PS" (see chapter 7 in **Session management**).
- Enter the name of the session you want to create (see chapters 7 in **Entering a string**).
- View the session you just created by going to the home page of the Gea RM1 system, and executing the "Measure sessions" command, select the name of the

new session created and press Enter (see chapters 7 in **Measurement sessions** Entering a string).

- Display the individual measurements by running the "Measurements" command and moving using the "Next measurement" and "Previous measurement" keys (see chapter 7 in **Display of the measurements of the session**).
- Choose a given measurement and select a line relating to a geometric distance between electrodes to insert or modify the value (see chapter 7 in **Execution, editing and repetition of a measure in session**).

Running a measurement session on the system

The fulfillement of a measurement session can be achieved by operating only on the Gea RM1 system. The result of the measurement session is stored on the system and can be read later or downloaded to the PC for further viewing and analysis.

The geometrical positions of the electrodes for each individual measurement can be entered on the system by the operator before carrying out the measurement, after having made the measurement or outside the system after the measurement.

- View the session you just created by going to the home page of the Gea RM1 system, press the "Measure sessions" command, and select the name of the new session you created then press the Enter key (see chapters 7 in **Measurement sessions**).
- Display the single measurements by running the "Measurements" command (see chapter 7 in **Display of the measurements of the session**
- Select a given measure and press the "Execute / Modify" command followed by the "Execute measurement" command to actually perform the measurement, or select a line concerning a geometric distance between electrodes to be able to insert or modify the contained value (see chapter 7 in **Execution, editing and repetition of a measure in session**).
- After having performed the measurement, display the measured electrical parameters and accept or not the measurement (see chapter 7 in **Execution, editing and repetition of a measure in session**).
- Repeat the operations for selecting the measurement, variating the geometric positions of the electrodes and carrying out the measurement until the desired session is completed.

Create a measurement table from a PC and upload to the system

The creation of a measurement table using the Gea RM1-PC program allows to define the geometric positions of the electrodes in a simple way and using algorithms present in literature, by choosing only the measurement method and by providing little input data to the program.

Sessions can be manual, in which the operator has to place and connect the electrodes before performing any single measurement, or automatic, in which the operator must apply an array of electrodes on the ground, he connects them to a multiplexer instrument controlled by the Gea RM1 system, after which the system will make a series of measurements memorizing them automatically without further action from the operator.

- To create a new table: on the Gea RM1-PC program press the "New Table" button and enter all the data relating to the desired table, then press the Ok button to create the table (see chapter 8 **Creating a table**).
- If the desired table is Manual or Spontaneous Potential only, it will be possible to view all the lines required for the requested measurement and manually change the geometric positions of the electrodes. Press the "Save" button to continue operations. If the desired table is Automatic, the rows of the individual measures are not displayed and the program goes directly to the saving window .
- In the save window, enter the name of the file on which you will save the table you just created (see chapter 8 in **View and save the table created**).
- To upload the table from PC to the system: using the USB cable, connect the Gea RM1 system to the PC, press the "Upload" button on the Gea RM1-PC program. Choose the file to be transferred, press the "Upload" button, enter the name with which you want to save the session on the Gea RM1 system and press "Ok" (see chapter 8 in **Tables upload**).

Transferring a measurement session from the system to the PC

The transfer of a measurement session allows you to export a measurement session that has been completely executed, only started or not yet performed, on the PC to then memorize it or carry out further analysis.

To download the session from the system to PC: connect the Gea RM1 system via USB cable to the PC, press the "Download" button on the Gea RM1-PC program. Select the session or sessions that you want to download to your PC, press the "Download" button, enter the name of the file with which you want to store the session on the PC and press "Ok" (see chapter 8 in ***Download sessions***).

7. Description of the systems interface in standalone mode

The Gea RM1 system can be used in standalone mode or controlled by a PC.

- Standalone mode: the Gea RM1 system is controlled by the operator using the buttons located on the systems control panel, the information is shown on the panel display.
- Controlled by the PC (PC controlled mode): the Gea RM1 system must be connected via USB cable to a computer with a Windows operating system on which the Gea RM1-PC program has been installed and launched. All operations available in standalone mode are available in PC controlled mode, controlled by the keyboard and displayed on the PC screen. Further functionalities for the preparation of campaigns measurements and the visualization of the results obtained are offered by the Gea RM1-PC program.

In this chapter we will describe how the Gea RM1 system should be used in standalone mode. The system is considered correctly powered and functioning, and with all the hardware connections necessary for its use, as described in chapter 4.

Switching on the system and control panel

Figure 1 shows the front panel of the system, reference will be made in the document.

The control buttons operate in accordance to the information submitted on the system display and perform the following functions.

- Button (Up): moves the selected line on the display to the line above.
- Button (Down): moves the selected line on the display to the line below.

- Button (Esc - Exit): moves the screen to the previous list (if available) without executing the command. By keeping the button (Esc – Exit) pressed for a few seconds it also has the function of turning on and off.

FIGURE 13 - FRONT PANEL OF THE GEA RM1 SYSTEM

- Button (Enter - Accept): carries out the command selected on the line of the display.

The display allows you to visualize the informations and commands of the menus.

The system, properly powered, must be switched on by pressing the Exit button until the display lights up. The system will show the main menu on the display.

The menu items shown on the display can come before a symbol that indicates the type, below are explained the meanings of the different symbols.

- ">": anticipates the menu items by pressing the Accept key it leads to a more detailed menu page.
- "-": anticipates the menu items that stand for a command which, by pressing the Accept button, is performed. Pressing the Exit button you return to the previous menu page (if available) and the command is not carried out.
- " "(space character): anticipates the menu items that are merely informative, pressing the Accept button nothing happens. And by pressing the Exit button you return to the previous menu page (if available).

- For all menu items, pressing the esc button from any item on a menu page returns to the previous menu pages (if any). This also applies to pages where a confirmation is required by the operator: in these cases, to cancel the request, there is no specific menu item, but i twill be necessary to press the Exit button.

On the top left of the display, near the title menu, the letter "C" (Connected) may be displayed to indicate that the system is connected via a USB to a Windows PC running the Gea RM1-PC program. In case the system is not connected to the PC the "C" does not appear.

On the top right of the display there is the battery symbol, indicating the level of the charge of the Gea RM1 system.

In Figure 2 and Figure 3 are shown the two portions of the systems main menu, in this situation the system is connected to a PC.

FIGURE 14 - MAIN MENU, FIRST PART

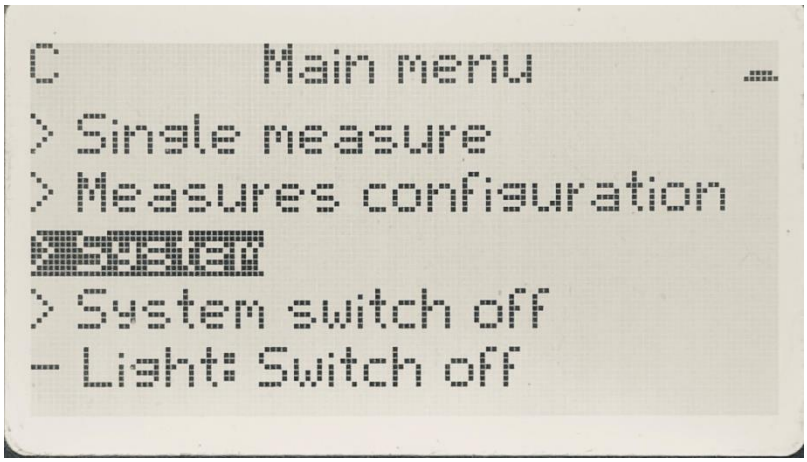


FIGURE 15 - MAIN MENU, SECOND PART

The display has a backlight that stays on for a few seconds after pressing any key. After the backlighting goes off, pressing any key will turn the light back on (in this case, the

key command is not performed). You can turn off the screen if you have sufficient light or turn it on in case of poor visibility through the "Light" command on the main menu.

List of commands in the Main menu

The commands included in the menu of the main page allow to perform all the operations offered by the system. These commands are listed below

- > Sessions measure.
- > Resume last session.
- > Sessions management.
- > View Templates.
- > Templates management.
- > Single measure.
- > Measures configuration.
- > System.
- > System switch off.
- - Light: switch off

In the following chapters the operations related to each menu item will be described.

Sessions and Templates

Before proceeding, it is necessary to describe the difference between sessions and templates. Both the sessions and the templates are containers kept in the permanent memory of the system, and are used to store the information related to sequences of coherent and homogeneous measurements, thus informations about the type of measurement (for example if it is a sequence in which the electrodes are managed manually by the operator, or if he makes use of an electrode management automation multiplexer, of the type of algorithm used for the calculation of electrode spreading, etc.) and the electrode positioning information (as a consequence of the algorithm cited above, or with a generic definition created by the operator).

The session can be performed by the system, ie the operator can control the execution of each of the measures of which a manual session is composed, and store the result, or perform the entire sequence of measurements in an automatic session.

The template vice versa depletes its task by maintaining and allowing the display to visualize such information, thus beeing only a structure of definition of how a sequence of measures is to be performed.

A template therefore serves as a stable model and usable repeated times to maintain a given sequence of measures. When you want to perform the measurements of a sequence in a template, the operator must first copy the template in a session, and only then the session runs. The template, as mentioned, will continue to remain available on the system and to be used as a model for other sessions.

Measurement sessions

The Gea RM1 system is able to save on its mass storage the information related to the measurement sessions, that is, to a sequence of measures useful to carry out a survey (general information of the session, number of measures planned and, for each measure, the position of the electrodes, the values of the measurements carried out for the various electrical parameters, the accuracy of the measurement, the instant in which the measurement is carried out: see chapter 6 in **Execution of a single measurement**).

These sessions can be generated on the Gea RM1 system using the commands used for creating a new session or copying an existing session (see section **Session management**), using the copy command of an existing template in a session, or generating them on the Gea RM1 program. -PC (see paragraph**Creating a table**) and transferring them to the Gea RM1 system using the upload command (see paragraph **Tables upload**).

The measurement session files can be displayed directly on the Gea RM1 system or can be transferred back to the PC via the download function of the Gea RM1-PC program (see paragraph **Download sessions**) for ease of analysis or subsequent processing using software tools .

By executing the command, the names of the session files present in the system's memory will be displayed in alphabetical order. Each stored session name is preceded by a letter:

- - "M" a session concerning manual measures;
- - "A" a session concerning automatic measurements;
- - "P" a session of measurement of spontaneous Potential.

FIGURE 16 - SESSIONS LIST

By selecting the name of a session you will go to the Display window of the session information (see section Displaying session informationDisplay of the measurements of the session).

Displaying session information

The session file name is shown in the menu title. The window shows detailed information related to the entire session, allowing to request the next display of the information of each individual measure belonging to the session,. whether these are measures that have been implemented or already carried out.

The first menu line for manual and spontaneous potential sessions shows the "See measurements" command, and allows you to view the individual measurements in the session using the session measurement display window (see section **Display of the measurements of the session**).

The first line of the manu for the automatic sessions shows the command "See automatic parameters", and allows you to view the parameters that have been set for the session (see paragraph **Viewing the parameters of an automatic session**)

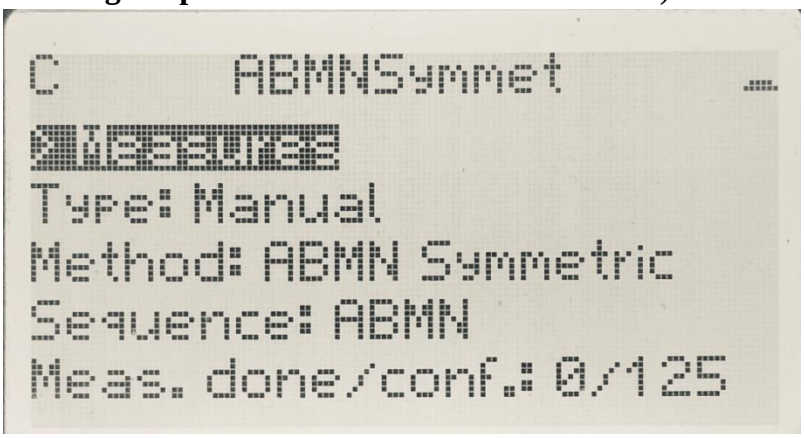


FIGURE 17 - VISUALIZE MANUAL SESSION

The following lines allow you to view some important information regarding the session. List of all the menu items.

- > See measurements: allows you to display the individual measurements of the session if this is a manual or spontaneous Potential, or> See automatic parameters: allows the display of the set parameters if the session is Automatic.
- Type of measure: indicates if the session is related to Automatic, Manual or PS measures.
- Measurement method: indicates whether the session was constructed using algorithms to choose the geometric position of the electrodes (SEV Wenner, SEV Schlumberger, etc.).
- Order: indicates the order in which the electrodes for the measurement must be positioned (ABMN, AMNB, etc.).
- Number of measures taken according to the number of measures planned by the session.
- Date of creation of the session.
- Date of last edit of the session.
- Full view / Simplified view: if the system is set to "Simplified view if possible" (see paragraph **Simplified display of geometric measurement data**) the command allows to choose for the specific session whether to display the geometry information in integral format. If the system setting is "Integral View" the command is not present.

By pressing the "See measurements" command, it is possible to view the individual measurements contained within the session file.

Display of the measurements of the session

The number of the displayed measurement is shown in the screen title, also in the case of complete measurements the value of R is shown (when there are no geometrical values relating to the position of the electrodes for the measurement) or the value of Rho (Rho = K * R, when the geometrical values associated with the position of the electrodes are present for the measurement and it is possible to calculate the geometric coefficient K). In this way it is possible to understand immediately whether the displayed measurement has already been performed and with what result (R or Rho with numerical value), or if the measurement has yet to be carried out (value of R or of Rho = "- ").

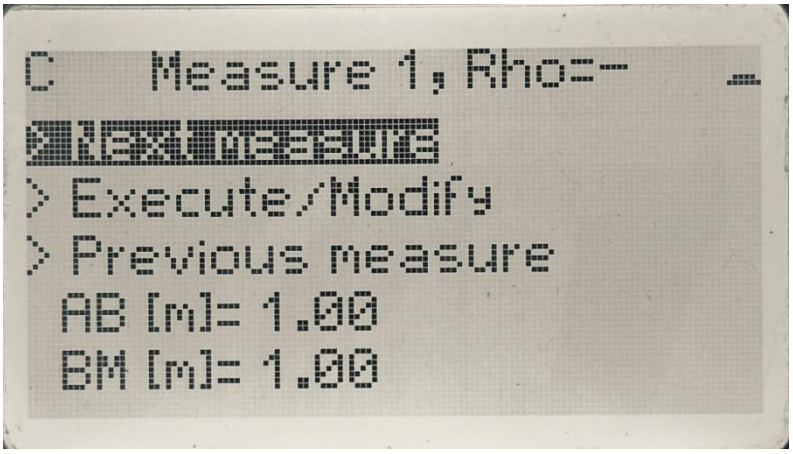


FIGURE 18 - VISUALIZING THE MEASURE,FIRST PART

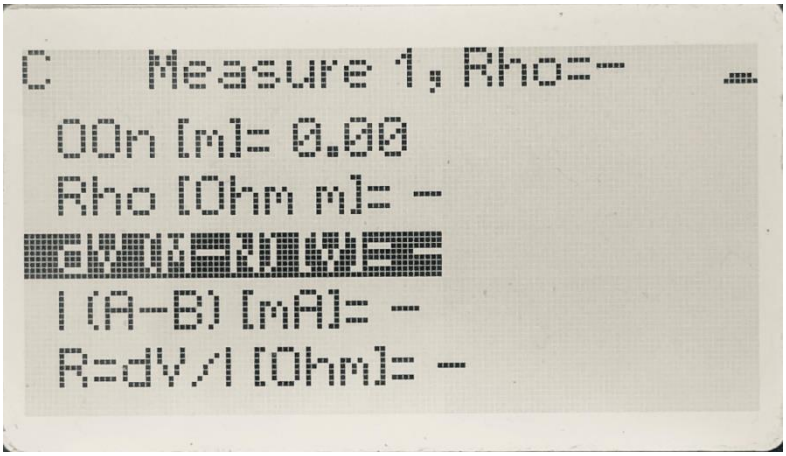


FIGURE 19 - VISUALIZING THE MEASURE,SECOND PART

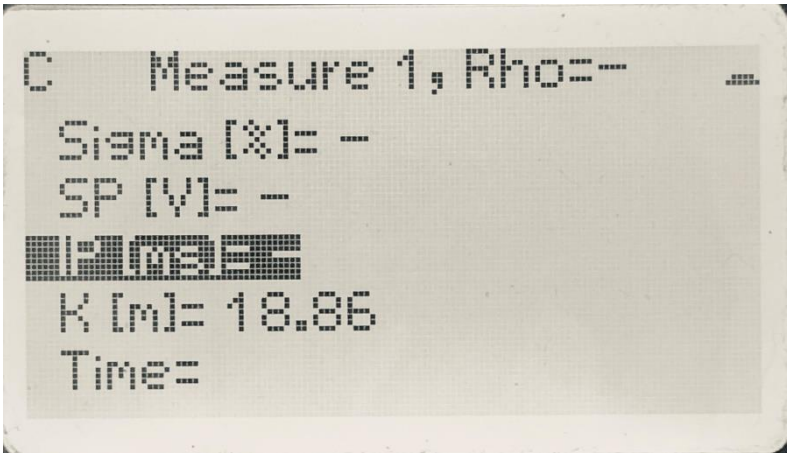


FIGURE 20 - VISUALIZING THE MEASURE,THIRD PART

The commands at the top of the menu are associated with a single measure in the session, and are listed below.

-> Next measure: allows the scrolling of the session lines and showing, in the same way, the next measure contained in the session.

-> Execute / Modify or Execute / Modify / Repeat: the command allows to enter in a further menu that will allow: the fullfillment of the measure under examination, overwriting the results already obtained if present; the change of the geometric values associated with the electrodes; the repetition of a measurement by varying the positions of the electrodes M and N (only for sessions performed with the Schlumberger method and only for the last measure acquired correctly). By carrying out the command, you enter the execution / modification window and possibly repeat the measurement (see paragraph **Execution, editing and repetition of a measure in session**).

-> Previous measure: allows the scrolling of the lines of the session by displaying, in the same way, the previous measure contained in the session.

The following lines show all the parameters relating to the measure under examination:

- Position of the electrodes, or indication "TBD" (To Be Defined) if the position has not yet been entered, or indication "TBM" (To Be Measured) if you are using a session with the Schlumberger method and the positions of the electrodes have not yet been calculated.

- Measured electrical parameters, or indication of parameters not present via "-".
- Sigma value percentage of the measurement performed, or indication of parameter not present via "-".
- Date and time of execution of the measure, or indication of information not present via "-".

Execution, editing and repetition of a measure in session

The window allows to perform the operations indicated on the data related to a single measure of the session.

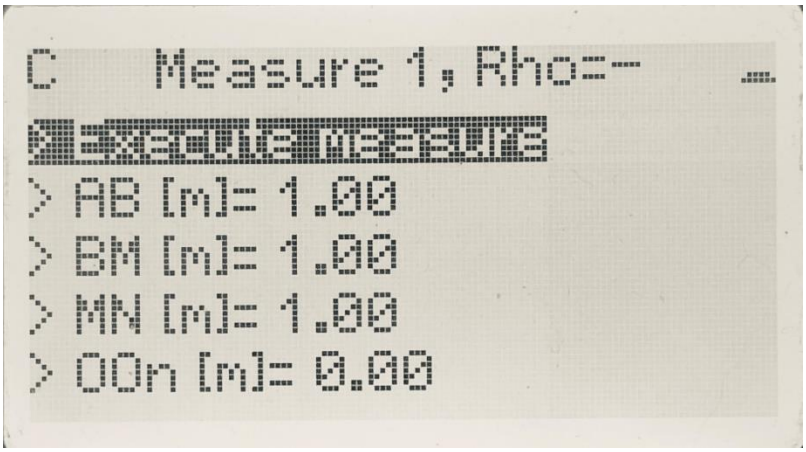


FIGURE 21 - EXECUTION COMMAND OF THE MEASSURE IN SESSION

The commands are as follows.

- > Execute: it allows the execution of the measure as described in paragraph 4.7, with the difference that the result of the measure, being associated with a session, can be accepted or not, and if so it will be memorized in the session. However, it is also possible to perform a measurement that has already been carried out previously, in this case accepting the result would overwrite the old value and replace it with the new one.
- > Repeat: the command is active only in the case of measurements taken with the SEV Schlumberger method, and for the last measurement of the session performed correctly (therefore, if a measure did not reach the Sigma value required, it would be possible to repeat the previous measure). It allows to add a measurement to the session in order to have the same geometrical values for the electrodes A and B with respect to the previous measurement, but to recalculate the geometrical values for the electrodes M and N so as to bring them to the value of a quarter with respect to the distance AB. Once added, this measurement will be displayed and executed as a normal session measurement.
- > The command for changing/modifying the geometric parameters does not have a specific command line but is achieved by going to one of the following lines which show the geometric values of the electrodes that you want to change and, after pressing the "Set" key, proceed in entering a string (see paragraph **Entering a string**). The geometrical positions of the electrodes can be changed whether they already have a predefined value (as part of a measurement session SEV Wenner or SEV Schlumberger for measurement with defined electrode position), and if they are valued at TBD (for example for a session of Generic SEV measures). It is not possible to insert position values for the data evaluated at TBM (in the case of SEV Schlumberger only for measurements with undefined electrode position).

  This command allows the operator, in addition to inserting the geometric values of the actual position of the electrodes used for a generic measurement, also to keep track of any deviations of the default position of the electrodes that are necessary during the actual field measurement due to the presence of obstacles.

Viewing the parameters of an automatic session

The window allows you to view the parameters that were associated with an automatic session during the session creation phase. The parameters come after the two possible commands: "View Results" and "Run Session".

The command "See results" to visualize the results already acquired for this session, this command is available only if the session has been completely or partially executed. By

executing this command, the results are displayed analogously to the Manual or spontaneous Potential type sessions, therefore refer to paragraph **Display of the measurements of the session,** the only difference is that the command of Execute / Modify a measurement is not active.

The Run Session command allows to carry out the measures envisaged for the automatic session (see paragraph **Perform the measurements of an automatic session**).

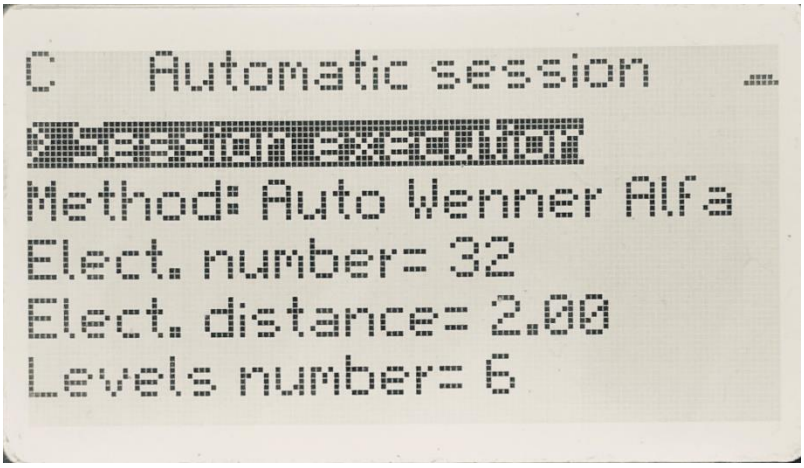


FIGURE 22 - PARAMETERS OF AN AUTOMATIC SESSION, FIRST PART

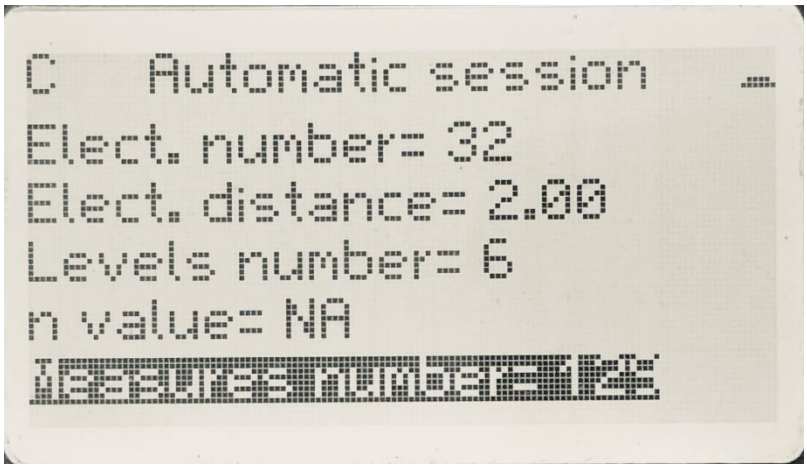


FIGURE 23 - PARAMETERS OF AN AUTOMATIC SESSION, SECOND PART

Perform the measurements of an automatic session

After the request to execute an automatic measurement, the operator is asked to select the sorting of the measurement lines or to confirm the default. The system considers that the electrodes have dispositions from 1 to 16 for the first 26, and from 17 to 32 for the second sixteen; if the arrangement is reversed, the operator has the possibility to overturn the arrangement for one or both groups of electrodes.

FIGURE 24 - SELECTION OF THE ORDER OF THE ELECTRODES

After having confirmed or changed the arrangement of the electrodes, the operator must execute the "Continue" command and confirm that he wants to carry out the automatic measurements.

At this point the system will proceed with the execution of the entire sequence of the measures envisaged for the session, one after the other. During each individual measurement, the trend of the measuring cycles and the measured sigma value will be displayed, as described in section **Complete Measure**. When the maximum sigma value requested is reached, or when the configured maximum number of cycles is reached, the measurement will end and the main measured parameters will be presented on video for a few seconds. Then, and without the operator's intervention, the next measurement will be performed, and so on until all the planned measures are performed.

The operator can interrupt the sequence of automatic measurements by pressing the Esc button during the execution of a measurement.

A session of automatic measurements interrupted prematurely can be completed at a later time simply by choosing from the menus to perform the measurements (see paragraph **Viewing the parameters of an automatic session**), in this case the values you measured up to that point will be maintained and the automatic execution will be resumed starting from the first missing measure.

Last session

The command allows you to directly open the last session on which you worked, facilitating the recovery of a temporarily interrupted job. The system will go to the

Display window of the session information (see section **Displaying session information**) of the last session on which you worked.

Session management

Through this command you access an additional menu that allows you to choose between some commands to be applied to a session and, to choose a session from the list on the systems memory to which apply this function.

FIGURE 25 - SESSIONS MANAGEMENT

The possible commands are as follows.

-> New session: creates a new empty generic session, the position of the electrodes can be defined by the operator, through which the measurements can be stored.

-> Cancel session: it removes a session from the memory of the instrument, freeing up space for the storage of further sessions.

-> Copy session: creates a session identical to the original session, keeping the results of the measurements already made. You are asked to enter the name you want to give to the copy.

-> Copy and clean session: creates a session identical to the original session, erasing all the measurements already made and maintaining the geometric information of the electrodes. You are asked to enter the name you want to give to the copy. It basically allows you to use the original session as a template, and to generate a second session that has the same measurements and positions of the configured electrodes of the first one.

> Rename session: change the name of a session leaving the other information unchanged.

Template view

The command is similar to that of Session Manager, with the difference that it operates on templates

FIGURE 26 - VIEW TEMPLATE

The possible commands are as follows.

-> Delete template: it deletes a template from the memory of the instrument, freeing up space for the storage of further sessions and templates.

-> Copy template-> session: create a session starting from the original template, with the same measurement information and positioning of the electrodes. You are asked to enter the name you want to give to the copied session.

-> Rename template: change the name of a template leaving the other information unchanged.

Executing a single measurement

To perform a single measurement, the complete or spontaneous potential type, it will be sufficient to select the item "Single measurement" from the main menu and, in the following menu, choose one of the commands "Single complete measurement" or "Single measurement PS"

A page will be displayed and will include the request to confirm the execution of the measurement. Pressing the Accept button the measurement will be performed, by pressing the Exit button the measurement will not be performed and you will return to the systems main menu.

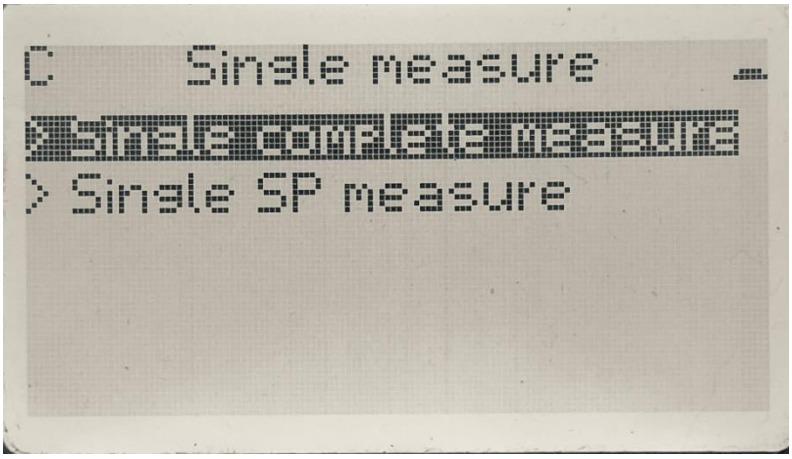


FIGURE 27 - EXECUTION OF A SINGLE MEASURE

The execution of a single measure, unlike the execution of a session, does not require the instrument to memorize the result, therefore the measured electrical parameters will only be shown on the display and must be used by the operator to copy them if necessary.

If you want to perform individual measurements and store the result on the system, it is advisable to create a "Generic" session and perform the measurements, possibly taking note of the position of the electrodes for each individual measurement, this way the system will be able to memorize the electrical parameters measured for all the achieved measurements that will be accepted by the operator.

Complete Measure

The complete measurement is made with a sequence of cycles, the results of these cycles will be treated mathematically by Gea RM1 to provide the final result of the measurement with the degree of accuracy required by the operator.

By carrying out the measurement, the progress dialog of the execution of the measurement cycles shown in Figure 16 will be shown.

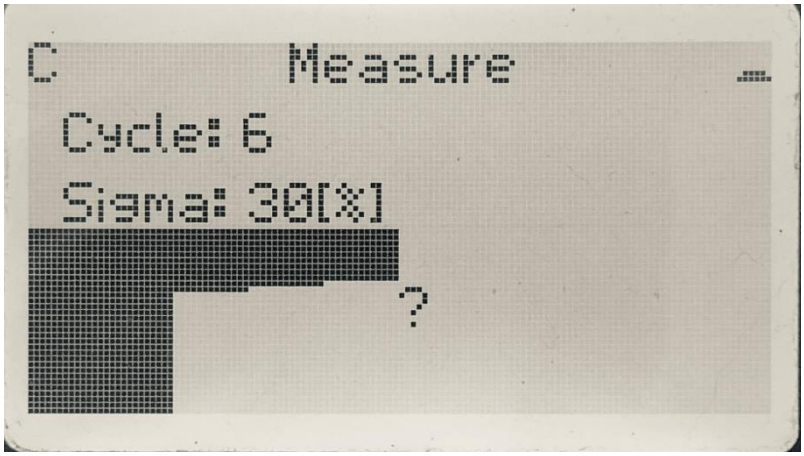


FIGURE 28 - IMAGE OF A MEASURE IN PROGRESS

The information on the execution screen of a single measurement is shown below.

- Cycle: reports the cycle number within the measurement that is automatically performed by the system at that time, so that the required accuracy calculated as maximum Sigma is reached, or up to the maximum number of cycles set on the system. In Figure 16 the system is performing the sixth cycle on a configured maximum of eleven cycles.

- Sigma: shows the Sigma value calculated on the completed measuring cycle and reported as a percentage of the measured value. In Figure 16, the percentage value of Sigma calculated for the first seven completed cycles is 27%. In the first two cycles of execution of a measurement the Sigma value is not shown on the display.

- Graph below: expresses the two previous values graphically and intuitively: the horizontal axis is divided into equal parts by a number equal to the maximum cycle value set on the system for the measurement, the vertical axis shows the calculated Sigma value for completed cycles. If the measurement is correctly executed without problems at each cycle the sigma value will decrease and the graph will decrease to a curve with the black part getting smaller at each repetition, otherwise the curve could have a more random variation.

At the end of the measurement, which can occur when a Sigma value is lower than that configured on the system, or when the configured maximum number of cycles is reached,

the system will show the set of measured values, as shown in Figure 17 for the complete measure.

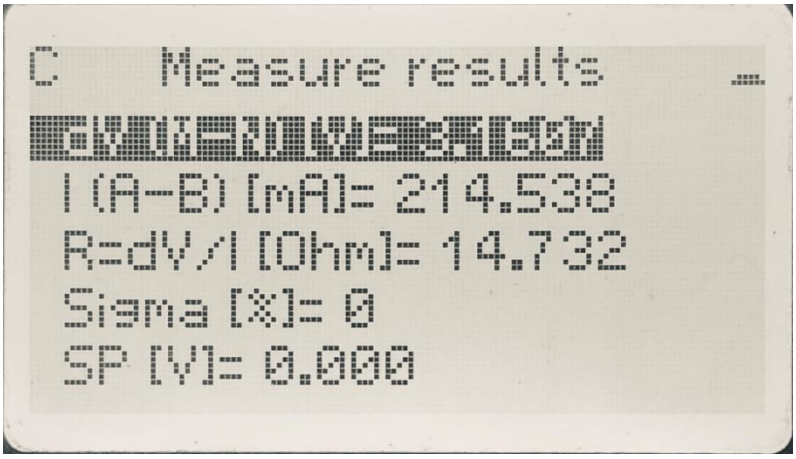


FIGURE 29 - RESULTS OF A COMPLETE SINGLE MEASURE, FIRST PART

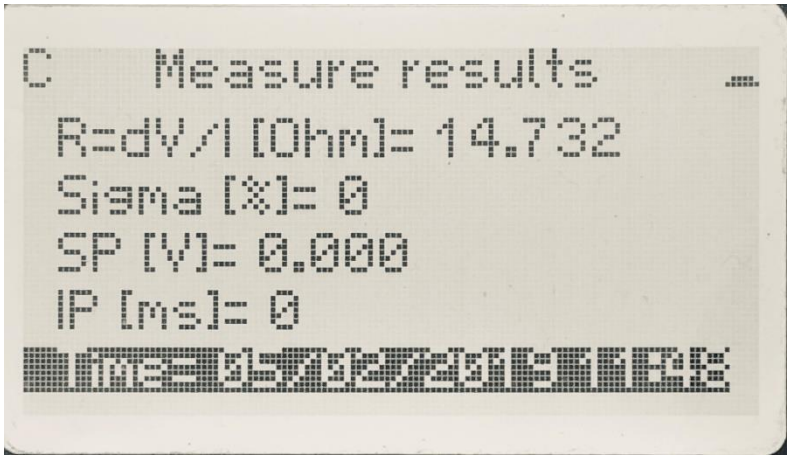


FIGURE 30 - RESULTS OF A COMPLETE SINGLE MEASURE, SECOND PART

Below are the values shown following a complete measurement.

- Rho: resistivity value calculated as R for K. It is not possible to calculate the value if the positions of the electrodes used for the measurements are not known, in this case the Rho value will not be shown on the display.

- V (M-N): potential difference measured between the two measuring electrodes, in Volts.

- I (A-B): electric current measured between the two stimulation electrodes, in milliAmpere.

- Sigma: Sigma value (average quadratic deviation) calculated as a percentage of the resistance value at the end of the measurement repetitions. If the Sigma value is higher than the maximum Sigma value set by the operator, the value will be followed by an asterisk '*', for more details see paragraph **Meaning of the Sigma value for a complete measurement**.

- PS: Spontaneous Potential, automatically measured by the system and used to purify the final measurement of the resistance, in Volts.
- IP: decay time measured in milliseconds.
- K: geometric constant dependent on the relative positions of the electrodes used for the measurement and used for the calculation of Rho. It is calculated by the application in the cases in which measurement campaigns supported by tables are carried out, it is not possible to calculate it in the case of a single measurement in which the positions of the electrodes are not known. In the second case the value of K is not shown on the display.
- R = V / I: Resistance measured as a ratio between V (M-N) and I (A-B), in Ohms.

Measurement of spontaneous potential

Spontaneous Potential measurement is performed as a single measure, the result of which is presented to the operator on the video as shown in Figure 19.

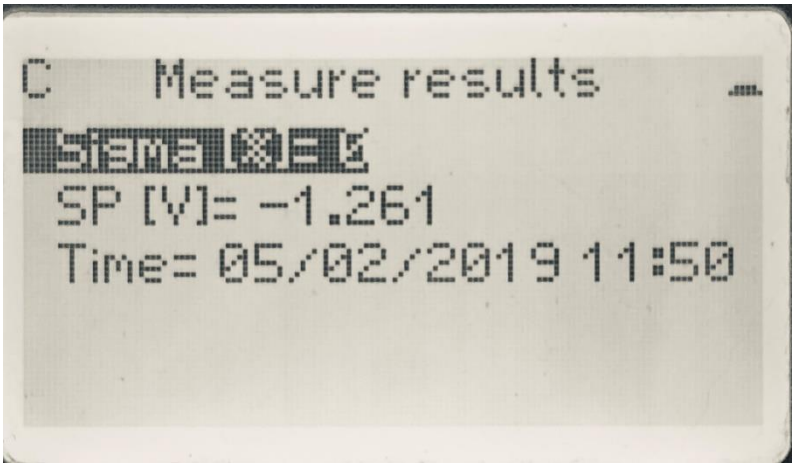


FIGURE 31 - RESULTS OF A SPONTANEOUS POTENTIAL SINGLE MEASURE

Below are listed the values done after a measure of only spontaneous potential.

- PS: Spontaneous Potential, automatically measured by the system, in Volts.

If the measurement is made as an effective single measurement and without the aid of a measurement session, the operator must copy the electrical parameters obtained with the measurement, if deemed necessary, as the single measurement mode does not allow the measurement memory storage of the result tool.

In case the measurement execution is controlled through the execution of a measurement session (see paragraph **Execution, editing and repetition of a measure in session**) after visualizing the measurement result, the operator must accept or reject the measurement result on the instrument. In the first case the measured electrical parameters will be

memorized and saved on the session, in the second case they will instead be discarded and no trace of the execution of the measurement will remain. Even after acceptance of the measurement result, the operator can subsequently decide to make another one on the same position of the session (and therefore with the same positions of the electrodes); in this case, by accepting the result of the measurement, the result of the previous measurement will be overwritten.

Use and acceptance of a measure

If the measurement, complete or of spontaneous potential, is carried out as a single measurement and without the aid of a measurement session, the operator must copy the electrical parameters obtained with the measurement, if deemed necessary, as the modality single measurement does not allow memory storage of the result instrument

If the measure, complete or of spontaneous potential, is part of a measurement session, the first line of the screen showing the result of the measurement will be the command "Accept measurement". By carrying out this command the electrical parameters measured in the session will be copied and will therefore be available for subsequent visualizations and treatments. It is also possible to accept a measure that has not reached a Sigma value lower than the maximum Sigma set by the operator, in this case the measurement will be memorized with an asterisk "*" at the bottom. Pressing the Esc button does not accept the result of the measurement, which will then be discarded without being stored in session, and there will not be any trace of the carrying out of the measure not accepted.

Even after acceptance of the measurement result, the operator can decide in a second moment to make another one on the same position of the session (and therefore with the same positions of the electrodes); in this case, by accepting the result of the measurement, the result of the previous measurement will be overwritten.

Measurements configuration

The measurement configuration menu allows you to configure the values of some parameters used by the system to make the measurements.

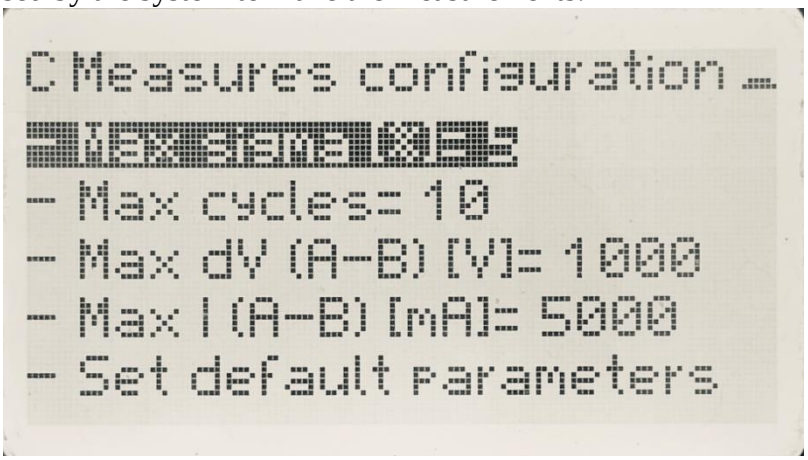


FIGURE 32 - MEASURE CONFIGURATION

These parameters are shown below.

-> Maximum Sigma: determines the mean square deviation value as a percentage of the value of the measurement at which the system will assume the obtained value as sufficient, and will not carry out further measurement repetitions.

-> Maximum number of cycles: defines the maximum number of cycles to be performed for a measurement, when this number of cycles is reached, the measurement will still be terminated, even if the maximum Sigma value has not been reached.

-> Max V (A-B):

-> Max I (A-B):

- - Default parameters: through this command it is possible to configure all the parameters to the factory default values.

By executing the commands you get the screens on which the minimum, maximum and default values are displayed for each of the parameters, by commanding the variation of the value, you can enter the chosen value.

System configurations and information

The system configuration menu allows you to view and configure the values of some variables used to operate the system.

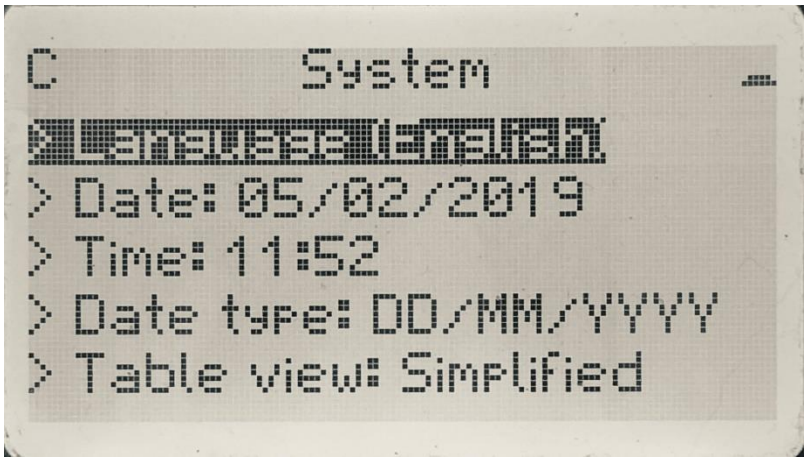


FIGURE 33 - CONFIGURATION AND SYSTEM INFORMATION, FIRST PART

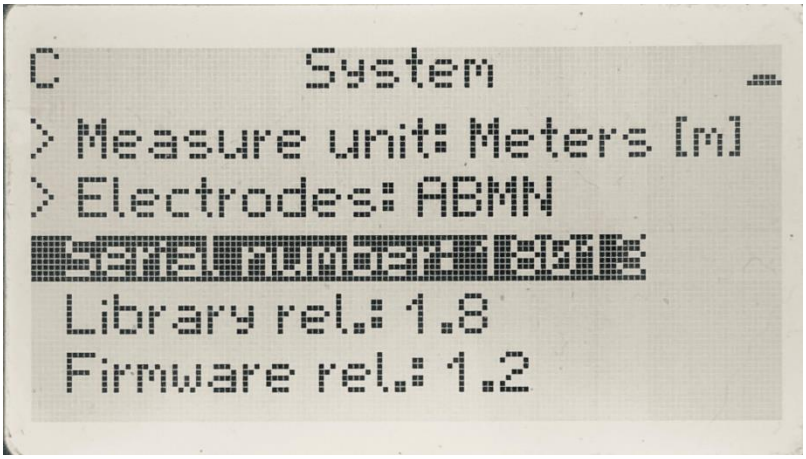


FIGURE 34 - CONFIGURATION AND SYSTEM INFORMATION, SECOND PART

These variables are shown below.

-> Language.

-> Date setting.

-> Time setting.

-> Date format: "yyyy-mm-dd", "dd / mm / yyyy" or "mm / dd / yyyy" formats can be chosen. The date format affects only the display modes and not the format within the GPD file for storing session measurements.

-> Display format of the geometry values for the sessions: you can pick the complete display of the geometric data of the electrodes or the simplified view when possible can be selected. See section **Simplified display of geometric measurement data** for further information on the subject.

-> Linear measurement unit: meters or yards can be chosen. The chosen linear unit of measure also applies to all the derived quantities, then to K and to Rho (which will be reported as Ohm * m or Ohm * yd). It affects only the view modes and not the format within the GPD file stored on the session measurements.

-> Name of electrodes: the names A, B, M and N or the names C1, C2, P1 and P2 can be chosen. It only affects the view modes and not the format within the GPD file, where the electrodes are stored as A, B, M and N.

Information about the system components is also viewed. This information is listed below.

- Serial number of the Gea RM1 system.

- Library version.

- Firmware version.

- Hardware version.

-> Clear memory: this allows you to delete all the sessions and measurement templates on the systems memory.

Switching off the system

The Gea RM1 system can be switched off using the "System Shutdown" command button on the main menu. Switching off the system in this way, all the data processed will be correctly saved on the permanent memory of the system.

The system can also be switched off by keeping the "Esc" button pressed for a few seconds or by removing the power cable from the system, but in this case the data that has not yet been saved by the system on the permanent memory may be lost, so we strongly recommend you not to use this procedure.

Entering a string

The entry window of a string is presented to the operator every time an input to the system is requested, for example when the name is requested for a new session, or during the edit phase of the geometric position of an electrode.

In the case of editing a numeric parameter, the screen looks like in Figure 23

FIGURE 35 - ENTRY OF A NUMERIC VALUE

When the input field is selected, the "Up" and "Down" buttons can be used to move to the "Confirm" key and vice versa.

Having selected the input field and pressing the "Enter" button, you go to the Data entry mode, and a single character will be highlighted using the black rectangles above and below.

By pressing the "Up" and "Down" button it is possible to change the selected character, by pressing the "Set" button the next character can be selected.

When the last character to be entered is selected, pressing the "Enter" button you will be selecting the entire input field, and you return to the initial situation in which, pressing the "Up" and "Down" buttons, you can move to the "Confirm" key and accept the change.

At any point in the operation by pressing the "Esc" button it is possible to return to the upper menu level.

In entering a string, the initial string is empty, it is not possible to insert an empty character, and by pressing the "Enter" button when the selected character is empty will lead to the initial situation of the entire input field.

Simplified display of geometric measurement data

The geometric position data of the electrodes in the different measurements are kept inside the file in the mode called "Integral", ie with the positions of the different electrodes maintained in the most flexible and complete way possible. In this mode, the positions of each individual electrode are compared to a point of origin without taking into account symmetries imposed by the use of a measurement method (SEV Wenner or SEV Schlumberger).

With this view mode, it is possible to change the position of a single electrode independently of the symmetry rules imposed by the used method, and this modification will be displayed and stored on the session file.

In the view mode called "Simplified, if possible", a partial view of the contents of the session file is shown to the operator, the "Simplified" view, in such a way that the redundant information due to the symmetry imposed by the method is hidden to the operator.

With this view mode, only the parameters displayed are allowed to be changed, and the program will take care to maintain the symmetries imposed by the measurement method used for the session.

The "Simplified" view, being constructed from the complete data of the table, will be used by the system only in cases where the following two conditions are met.

- You are working on a session using a symmetric electrode position method (SEV Wenner and SEV Schlumberger for complete measurements).

- For the geometric positions of the electrodes, the conditions for the simplification of the values must be respected.

So, for the measurement sessions carried out with the SEV Wenner or SEV Schlumberger method and that comply both conditions: distance between the electrode M and the origin equal to the distance between the origin and the electrode N, the session will only display the AB / 2 distances (half the distance between electrodes A and B) and MN / 2 (half the distance between the electrodes M and N).

Meaning of the Sigma value for a complete measurement

The Sigma value associated with the measurements is calculated as the average square deviation of the measured value of R and then reported as a percentage on the value of R itself. It gives an indication of the variability of the repetitions of the measure with respect to the average value, and therefore a measure of the goodness of these measures: the lower the calculated Sigma, the more the measurements are close to the average R value and therefore the measurement is precise.

The maximum accepted Sigma value can be configured by the operator in the Measurement configuration section (see chapter **Measurements configuration**). As mentioned, the higher the value of accepted Sigma is, the more quickly the measurement is made (with fewer repetitions) and with less accuracy; the lower the value of Sigma accepted, the more slowly the measurement is made (with a greater number of repetitions) and with greater precision.

GEA RM1 automatically manages the correct measurement term when the Sigma value calculated on the repetitions made is lower than the maximum Sigma value set by the operator. In any case, at least three repetitions are always performed before the Sigma calculation (for the first two repetitions of the series the calculated Sigma value is not shown on the screen, but only from the third repetition onwards) in order to be sure to have a number of congruous values for the calculation of Sigma.

If, after completing the maximum number of cycles (set by the operator), the Sigma value remains above the maximum accepted Sigma value, the measurement will end and the measured electrical parameters will be submitted, but the title in the window will indicate that the Sigma value requested has not been reached, an asterisk "*" will be added at the end of the Sigma value calculated for the measurement, in order to make it clear to the operator that, within the session, the specific measurement has not reached the required accuracy value at the measurement configuration level.

8. Description of the Gea RM1-PC program

The Gea RM1-PC program can run on Windows computers and is essential if yo want to carry out the following functions.

- Gea RM1 system software updates. For this important function refer to chapter 9.

- Download to PC the GPD files containing the tables and used to memorize the measurements made by the Gea RM1 system.

In addition to this, the Gea RM1-PC program allows you to perform the following functions.

- Control of the Gea RM1 system by remote control of the screen on the PC.

- Creation and management of the measurement session tables on the PC, loading on the Gea RM1 system so to perform the measurements.

Some of the functions offered by the Gea RM1-PC program are always available (creation and management of tables, system functions), other functions are only available if the Gea RM1 system is connected to the PC (Gea RM1 system software update, control of the Gea RM1 system, uploading and downloading of tables on and from the Gea RM1 system). When a function is not available, the corresponding button is deactivated on the GUI interface.

Figure 24 shows the initial page with the system disconnected from the PC.

Figure 25 shows the initial page of the program when the Gea RM1 system is connected to the PC and switched on, therefore with all the functionalities of the Gea RM1-PC program active.

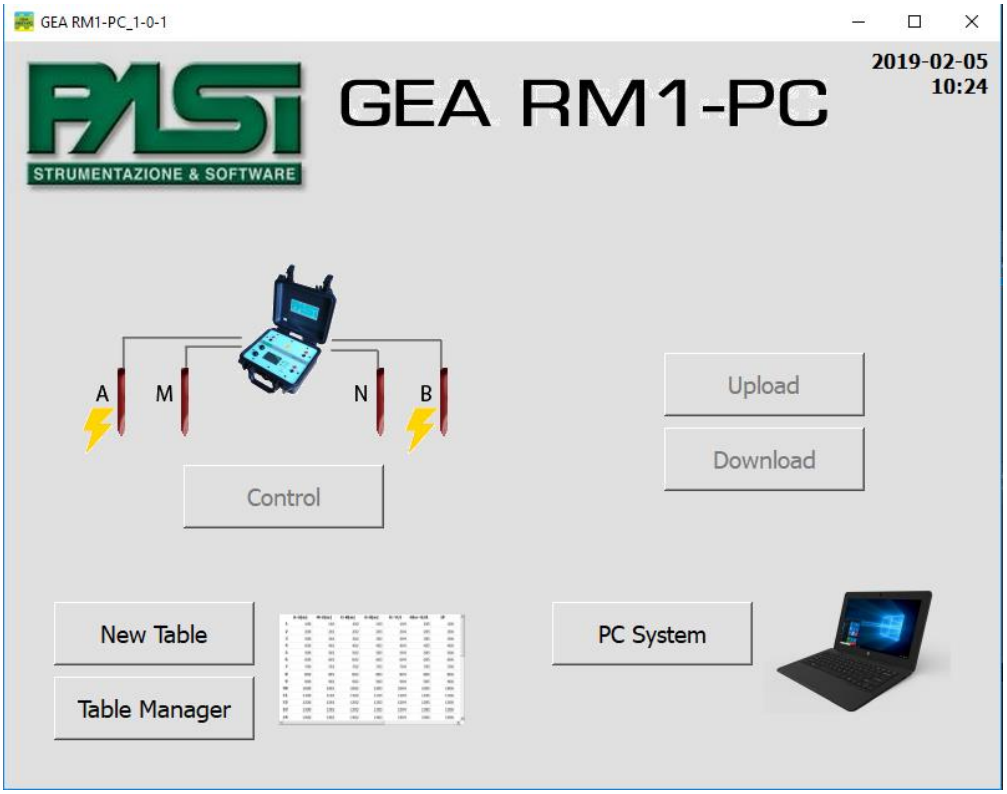


FIGURE 36 - INITIAL PAGE WITH DISCONNECTED SYSTEM

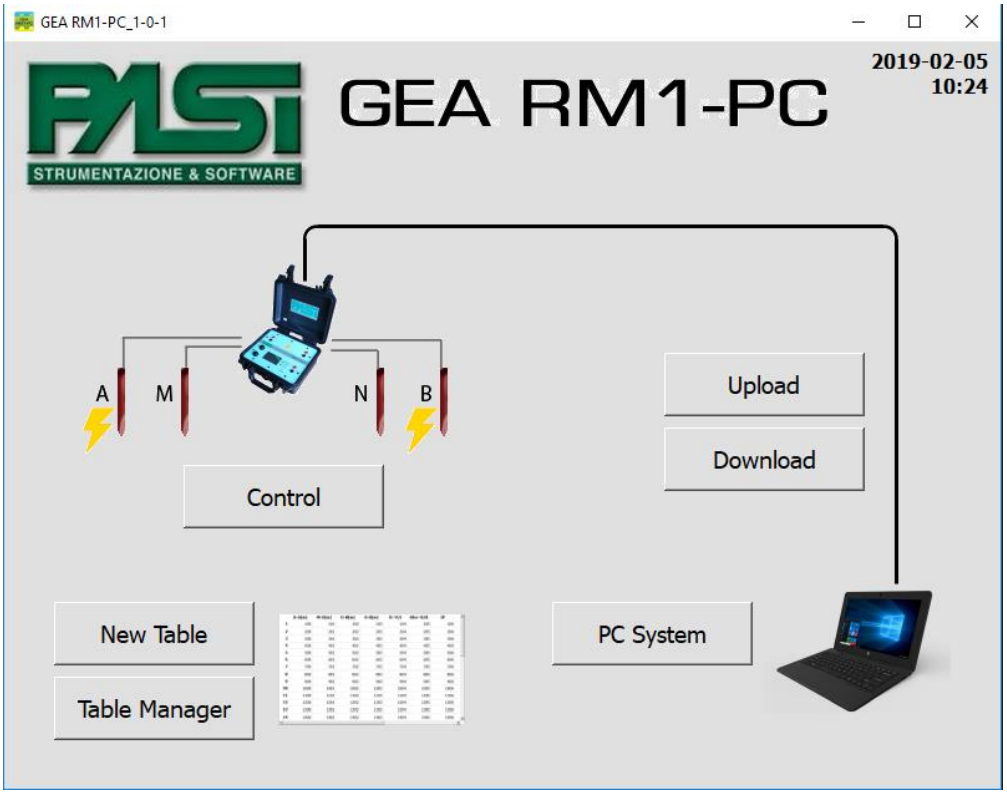


FIGURE 37 - INITIAL PAGE WITH CONNECTED SYSTEM AND SWITCHED ON

Creating a table

The word “table” will be used to identify the contents of the files created and processed by the Gea RM1-PC program, and are called, when they are on the Gea RM1 system, sessions or templates.

The function of creating a new table allows the creation of tables that can be executed manually or automatically on the system; to fill in the table, standard algorithms are used to calculate the sequence of geometric positions of the electrodes as a consequence of the measurement method chosen by the operator. The operator can manually change the positions of the electrodes to adapt them to his needs.

In addition, you can store the table built as a normal GPD file (equivalent to a session on the system) or as a write-only GPD file (equivalent to a template on the system).

By pressing the New Table button a window will open that will show some options for the operator in order to guide him in the automatic construction of the table. Figure 26 shows an example of page configuration.

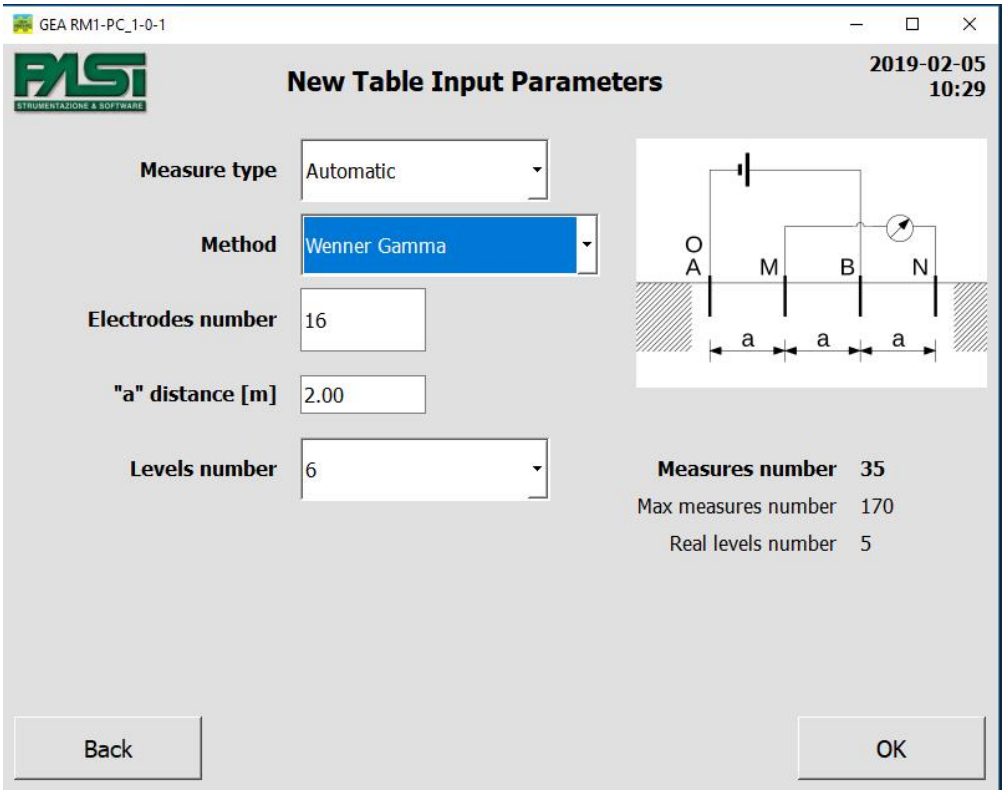


FIGURE 38 - CREATION PAGE NEW MANUAL TABLE WENNER GAMMA

Below are the fields in which the operator must indicate the features of the table.

- Type of measure: the following cases can be chosen:

1. Manual: carries out the construction of a real table, with valorization of the individual positions of the electrodes, for the execution of the session manually by the operator;

2. Automatic: foresees the storage on file of the parameter dei parametri caratteristici della sessione di misura, so that during the automatic execution by the system and using the multiplexer component it is possible to apply the chosen measurement algorithm;

3. Only PS: carries out the construction of a real simplified table to be able to execute the Spontaneous Potential measurement from a system in manual mode.

- Measurement method: defines the laying method of the electrodes on the ground and depends on the type of measurement previously chosen.

If the type of measure is Manual the choices of the method can be the following: SEV Wenner, SEV Schlumberger, SEV Generic, Dipole-dipole Wenner Beta, Dipolo-dpolo Wenner Gamma, Dipole-generic dipole and Polo-dipole.

If the type of measurement is Automatic, the method can be as follows: Wenner Alfa, Wenner Beta, Wenner Gamma, Wenner-Schlumberger, Dipole-dipole.

If the type of measurement is the PS one, it will not be possible to choose a measurement method.

The additional parameters change with the type of measurement method chosen, and will be described for each indivudual case in the following paragraphs.

hereafter we will describe how to create tables for the different types, at the end of the operation the Ok button must be pressed to save the table on the file.

Creation of a table for SEV manual measurements

The table of manual measurements implies that the operator must place the electrodes and connect them to the Gea RM1 system for each single measurement, then he will proceed in carrying out the single measurement by controlling it from the system.

By picking the Manual option as the Measurement type, it will be possible to choose only among the methods available for this type.

The following data entry fields depend on the measurement method, and are displayed on the window only if they are used for the application of the table construction algorithm with respect to the chosen method.

I campi successivi di immissione dei dati sono dipendenti dal metodo di misura, e vengono visualizzati sulla finestra unicamente nel caso servano per l'applicazione dell'algoritmo di costruzione della tabella rispetto al metodo scelto.

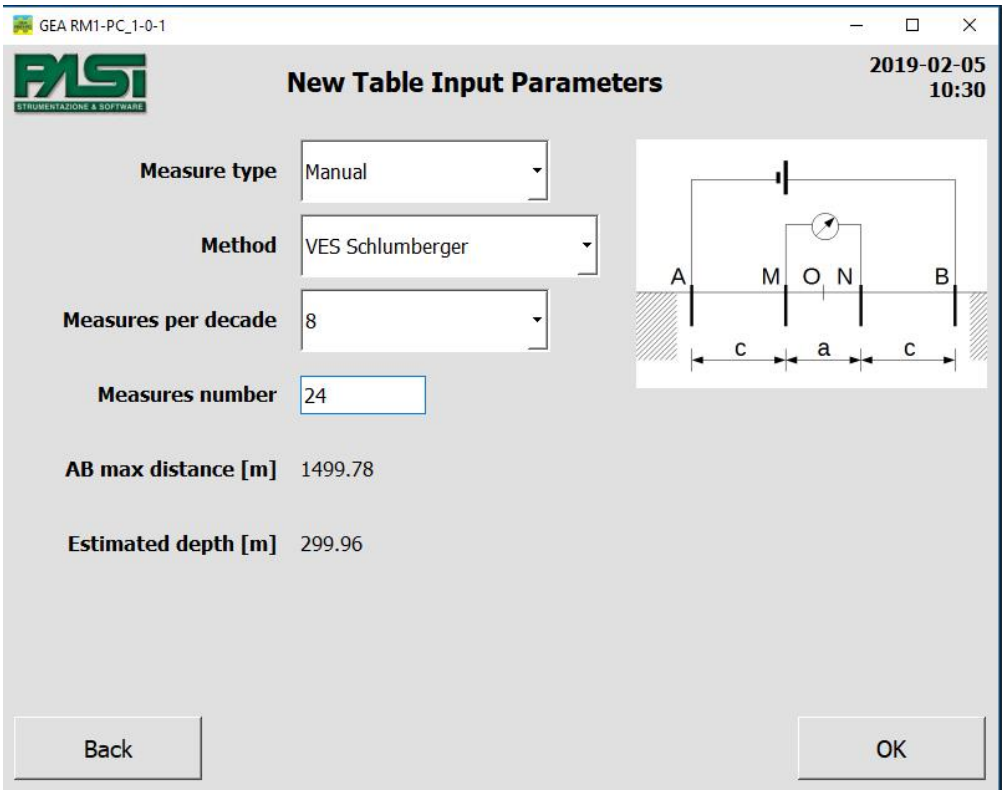


FIGURE 39 - PAGE CREATION NEW MANUAL TABLE WITH SEV SCHLUMBERGER METHOD

In detail, the SEV Wenner and SEV Schlumberger measurement methods foresee the placing of the following parameters.

- Number of measurements per decade: defines the resolution of the measure, the more measures are taken per decade the higher the resolution of the ground analysis will be. The operator must enter the number of measures he intends to make for each decade.

- Total number of measurements: in combination with the number of measurements per decade data, this parameter will influence the maximum distance at which the electrodes will be placed and, consequently, the depth of the soil analysis.

The program calculates, given the two values, which is the maximum distance AB that must be reached to completely achieve the measurements of the set session and shows it on the video.

The manual session with the Generic SEV measurement method only allows the number of measurements to be set. In this case the program will create a table with the required number of measures, not calculating the geometric positions of the electrodes but setting the value to TBD (To Be Defined) and leaving the operator to complete the position values of the electrodes, if deemed necessary.

Table creation for non-SEV manual measurements

The table of manual measurements implies that the operator must place the electrodes and connect them to the Gea RM1 system for every single measurement, after which he will proceed with the execution of the measurement by controlling it from the system.

The tables for manual non-SEV measurements, the Dipole-dipole cases (Wenner Beta, Wenner Gamma and generic) or Pole-dipole, are constructed by the Gea RM1-PC program using an algorithm defined by the operator.

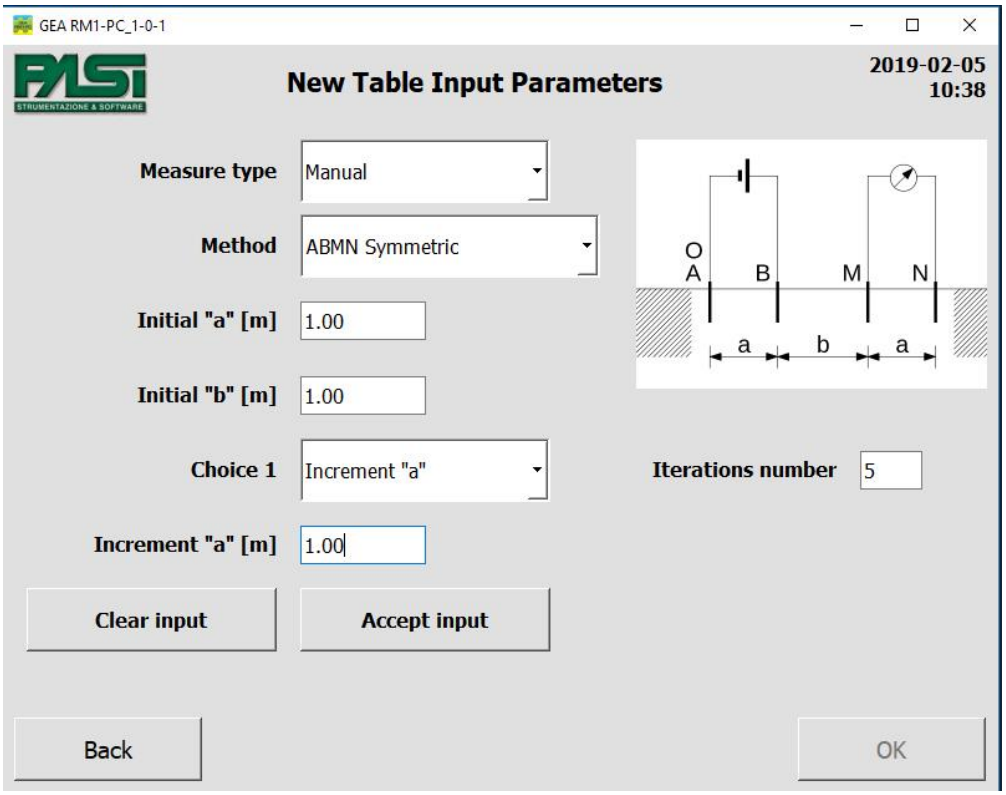


FIGURE 40 - PAGE CREATION NEW MANUAL TABLE WITH DIPOLO-DOPOLO

Figure 28 shows the data entry screenshot valid for the generic Dipole-dipole and Polo-dipolo cases. The dipole-dipole cases Wenner Beta and Dipolo-dipole Wenner Gamma do not have the input field of the initial value of "b" seen that this parameter has no use for these two cases, but the operation is similar to the one explained in this paragraph.

The two input fields named "a" initial and "b" initial allow to enter the minimum value to be applied to the parameters of distances "a" and "b", as they are identified in the picture/figure.

For the Dipole-dipole Wenner Beta and Dipole-dipole Wenner Gamma methods the two possible choices that can be applied to the table generation algorithm are: Increment "a" and Displacement/shifting "O". For the Generic Dipole-dipole and Polo-dipolo methods the possible choices that can be applied to the table generating algorithm are three: Increment "a", Increment "b" and Displacement/shifting "O".

The selectable field of Choice 1 allows to define which will be the first parameter that must change in the construction of the algorithm table. Once you have decided, below the selectable field an input field is shown where you will be able to enter the increment value to be applied to the parameter to be modified. The Number of iterations field allows the operator to define for how many measures the increment value must be applied to the chosen parameter. Once the parameters have been completed, you must click on the accept button to be able to accept and to move to the next decision.

Once you have made a choice and pressed the Accept button, some informations on the table will be shown on the window.

Let’s assume that, in the situation described in Figure 29, as first choice we picked increment "b", and to have set the increment of "b" to 1.50 meters and to have set 12 Number iterations.

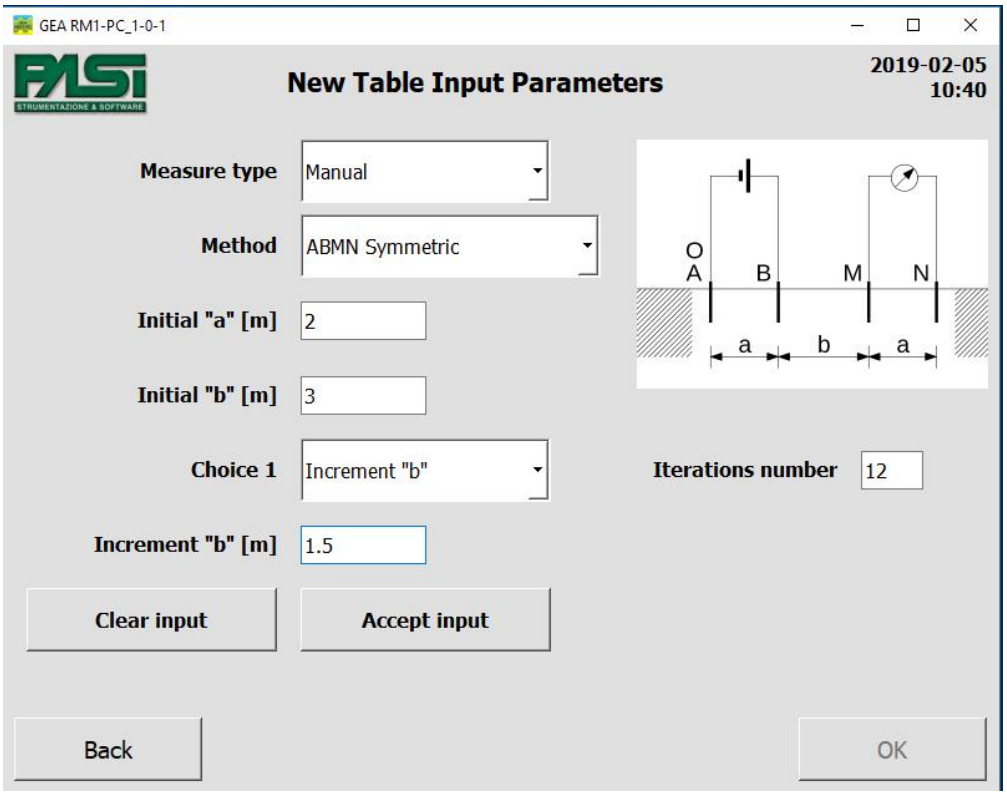


FIGURE 42 - CONSTRUCTION OF A MANUAL TABLE , FIRST PART

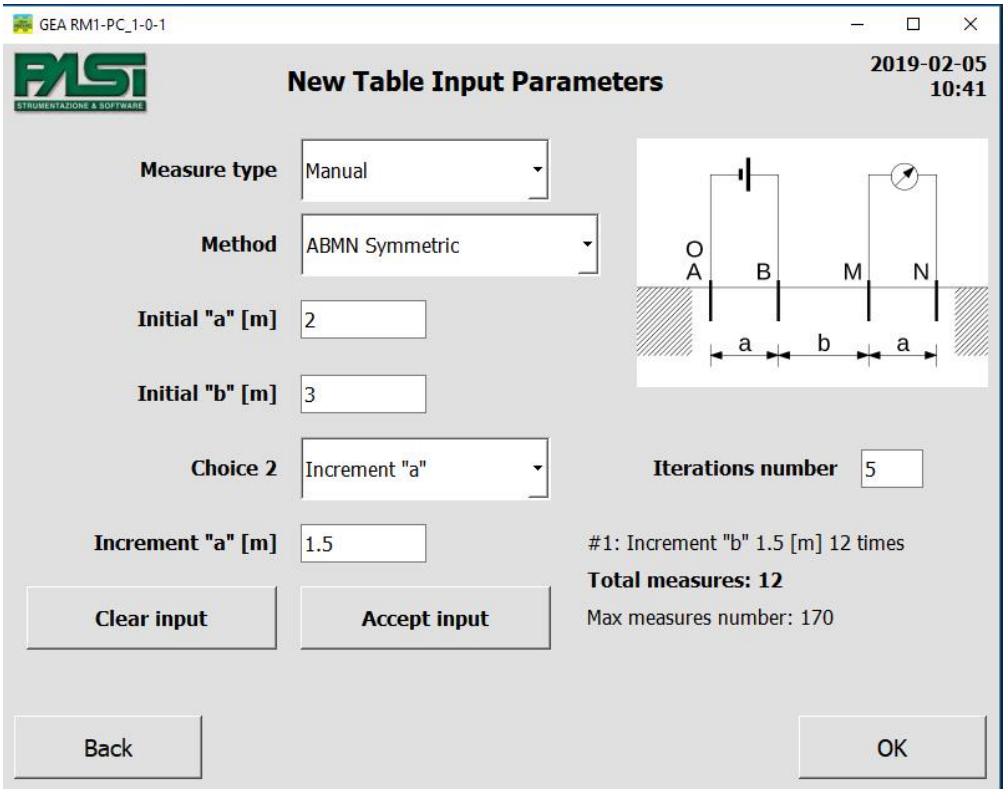


FIGURE 41 - CONSTRUCTION OF A MANUAL TABLE, SECOND PART

When you press the Accept button the program will show the screen as in Figure 30

On the bottom right of the screen is shows the information on the first choice you made to define the algorithm: this is an increase in the "b" parameter, the chosen value of 1.50 m and to be carried out 12 times. The total measurements for this table in the current situation are 12 out of a maximum of 170 measures managed for a single session. If you choose to end the construction of the algorithm at this point, by pressing the Ok key, the table will be constructed as indicated starting from the initial value of "b" of 3.00 m (the initial values used are those set on the screen at the time in which the Ok button was pressed) and would consist of 12 measures in total.

The table would have configured, for the 12 measures provided by the algorithm, these values (this is an explanatory table, the format of the real table stored on GPD file is different):

Indice misura	Valore “a”	Valore “b”	Posizione “O”
1	2.00	3.00	0.00
2	2.00	4.50	0.00
3	2.00	6.00	0.00
…	…	…	…
12	2.00	19.50	0.00

In the case of constructing a table having given only one choice (Choice 1) as input, it will be performed by scanning all the required iterations, calculating the parameters for each single measure using the algorithm associated with the choice. In pseudolinguaggio di programmazione si potrebbe scrivere:
for any value of i between 1 and the number of interactions for Choice 1
calculates parameters of the measure by applying the index i to the algorithm of Choice
If the operator decides to insert a further cycle of variation of the parameters to the algorithm, he could do so by selecting a new choice in the list (which is now called Choice 2). The possible choices in this case are reduced to two, the increase of the "a" parameter and the displacement of the "O" point, since it is no longer possible to choose the increment of the "b" parameter already used. Suppose that the "0" point displacement of 1.00 m is chosen at each iteration, and 6 iterations are performed. After pressing the Accept button, the window will appear as in Figure 31.
On the bottom right of the page are the characteristics of the second choice, while the total number of measures becomes 72 (ie 12 measures of the first choice multiplied 6 measures of the second choice).

The table would have configured these values for the 72 measures provided by the algorithm (this is an explanatory table, the format of the real table stored on GPD file is different).

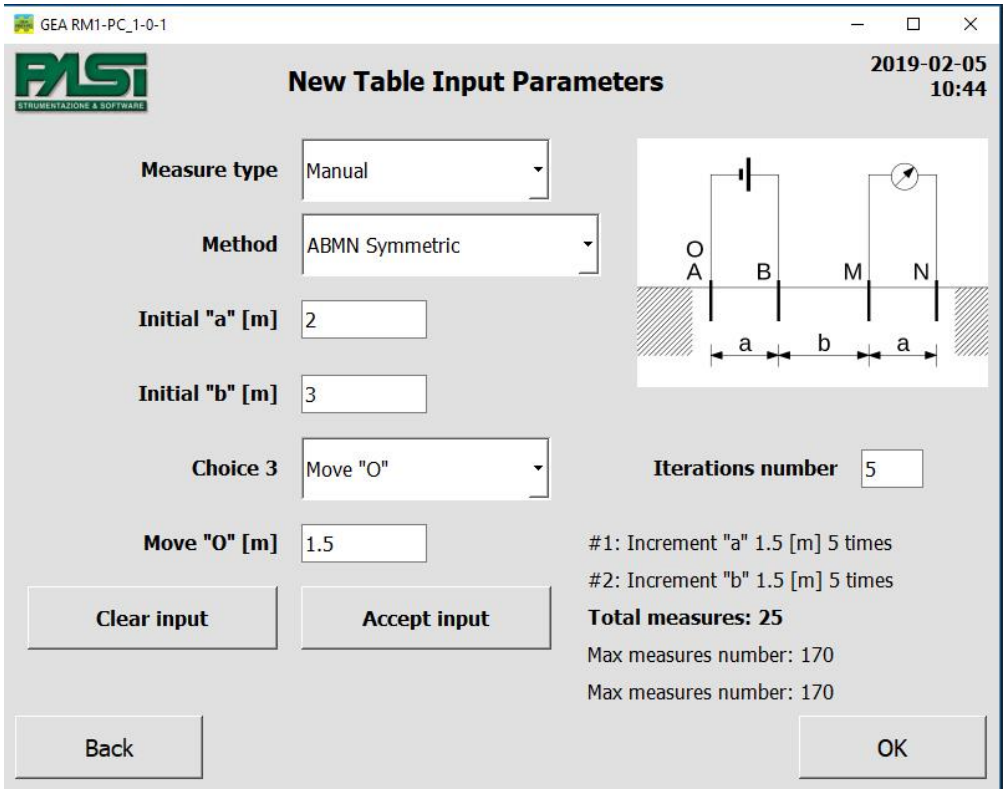


FIGURE 43 - CONSTRUCTIONA OF A MANUAL TABLE, THIRD PART

Indice misura	Valore “a”	Valore “b”	Posizione “O”
1	2.00	3.00	0.00
2	2.00	4.50	0.00
3	2.00	6.00	0.00
…	…	…	…
12	2.00	19.50	0.00
13	2.00	3.00	1.00
14	2.00	4.50	1.00
…	…	…	…
24	2.00	19.50	1.00
25	2.00	3.00	2.00
…	…	…	…
61	2.00	3.00	5.00
62	2.00	4.50	5.00
…	…	…	…
72	2.00	19.50	5.00

When constructing a table, and having provided two choices as inputs (Choice 1 and Choice 2), it is then set by setting the first value for choice 2 using the algorithm associated with choice 2 and then scanning all the iterations required for the Choice 1, calculating the parameters for each single measure using the algorithm associated with choice 1; then the second value for choice 2 is set using the algorithm associated with choice 2 and then scanning all the iterations required for Choice 1, calculating the parameters for each single measurement using the algorithm associated with choice 1; after this the third value for the choice three is set and so on, until all the iterations of the choice have been scanned. In programming pseudo-language one could write:

for any value of j between 1 and the number of interactions for Choice 2

for any value of i between 1 and the number of interactions for Choice 1

calculates parameters of the measure by applying the index/rate j to the algorithm of Choice 2 and the index i to the algorithm of Choice 1.

Similarly if three choices are made the operation of the algorithm is described in programming pseudo-language as follows:

for any value of z between 1 and the number of interactions for Choice 3

for any value of j between 1 and the number of interactions for Choice 2

for any value of i between 1 and the number of interactions for Choice 1

it calculates parameters of the measure by applying the z-index/rate to the algorithm of Choice 3, the index/rate j to the algorithm of Choice 2 and the index/rate i to the algorithm of Choice 1.

At the end of the creation procedure, the Gea RM1-PC program will save in the hard disk folder a file in GPD proprietary format/owner format containing/holding the geometric parameters concerning each measurement to be carried out, the table contained/held in this file will be displayable and editable using the Table Management feature, described in **Table management**.

Creation of tables for automatic measurements

The automatic measurement table involves the use of the multiplexer which will allow the Gea RM1 system to automatically control an electrode array positioned according to the positions defined by the chosen measurement method. In this way, with a single spread of the desired electrodes, the system will automatically and sequentially perform all the measurements envisaged by the chosen method, storing the results in the session file.

The creation of a table for automatic sessions is carried out starting from input parameters set by the chosen measurement method

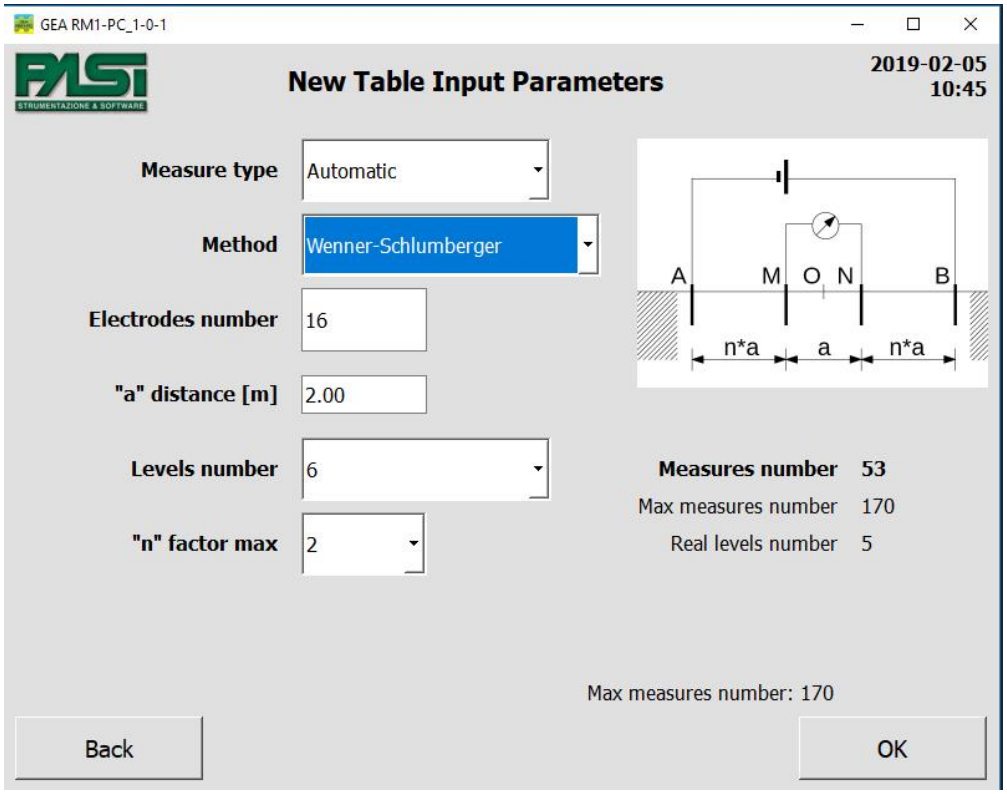


FIGURE 44 - CREATION PAGE OF A NEW AUTOMATIC PAGE WENNER-SCHLUMBERGER

The automatic measurements expects the entry of the following parameters.

- Number of electrodes: defines the number of electrodes that will be used for the measurement, the maximum configurable value is 32.

- Distance "a": defines the distance value "a" between two contiguous electrodes that must be used by the operator to lay the electrodes.

- Number of levels: defines the maximum number of levels that will be applied to the table construction algorithm. If the number of electrodes is too low, it may happen that the maximum number of levels requested by the operator can not be reached, in this case a value of "Real number of levels" will be shown on the right which will be lower than the one set.

- Maximum factor "n": the parameter is used only in the Wenner-Schlumberger method, and defines the maximum value that the "n" parameter can assume within the table's construction algorithm.

Pressing the Ok button will end the automatic table creation procedure, the Gea RM1-PC program will save a file in GPD proprietary format/owner format containing the parameters used by the automatic measurements table construction algorithm in the hard disk folder.

Unlike the case of tables with manual or spontaneous potential measurements, the table containing all the measurements and the relative geometric positions of the electrodes is not saved, as for the automatic session case the actual geometrical positions of each electrode will be calculated through an algorithm from the Gea RM1 system only at the time of automatic measurement performance.

The file in owner GPD format can therefore be viewed using the Table Management feature, described in chapter **Table management**, but it will not be possible to display the table of geometric positions of the electrodes for each measurement up until the automatic measurement will be performed. Furthermore, it will not be possible to change the input parameters chosen by the operator at the time of creation.

Creation of a table for measures of spontaneous potential

This is a type of manual measurement, ie the operator must place the electrodes and connect them to the Gea RM1 system for each individual measurement, after which he will proceed with the execution of the measurement by controlling it from the system.

The creation of the Spontaneous Potential type measurement table expects the entry of the following parameters

- Distance between the MN electrodes: defines the distance between the MN electrodes that will be maintained for all the measurements in the table.

- Distance between two successive origins OO ': defines the displacement of the origin to be applied to carry out the next measurement. This value will be applied for each measure of the session, carrying out a series of measurements in which the MN electrode pair keep their relative position unchanged and move along a line of a fixed value to each measurement.

- Total number of measurements: it allows to construct a table with the number of rows equal to the number of measures to be carried out.

At the end of the procedure to create the spontaneous Potential measures table, the Gea RM1-PC program will save a file in GPD owner format containing the geometric parameters concerning each measurement to be carried out in the hard disk folder, editable using the Table Management feature, described in chapter **Table management**.

View and save the table created

After pressing the Ok button so to complete the creation of the table, the program can behave in two different ways.

- It will display the table with a line for measurement and with the geometric positions of the electrodes defined by the algorithms for cases of manual and Spontaneous Potential

measurements. The operator can change the geometric positions of the electrodes if he thinks it's appropriate. From this window, by pressing the Save button, you will be able to go to the save window, containing the file with the data of the new table created, displayed and possibly modified;

- It will show/display the saving window of the file containing the data of the new table created for the case of automatic measures.

The save window allows you to choose the directory and the name of the file in which to save the newly created table.

The file can only be saved in the proprietary/owner GPD format, but the operator can choose, using the Format field, whether to save the file in normal mode (reading and writing) or in read-only mode (read only). The read-only mode allows you to create a template that, once loaded on the Gea RM1 system, will not be used to perform measurements and store the results as a normal session, but will act as a model from which to copy the sessions that will be then executable. In any case, the geometric positions of the electrodes can be modified and saved even on the templates.

Table management

The tables show informations on what will be a measurement session on the Gea RM1 system. Each row of a table relates to a measurement and shows the useful values, ie the set of geometric positions of the electrodes and the measured electrical parameters, if already exsisting. The table management function is therefore used to display the tables you have just created and without measured parameters or tables containing measurements already taken and therefore containing the measured electrical parameters.

In the event of tables for automatic measurements, if it is a table whose measurements have not been performed, no row will be displayed, because this type of measurement the rows of the table will be created only when the table is actually executed measure.

The tables relating to manual measurements with SEV Wenner and SEV Schlumberger methods and for spontaneous Potential measurements can be viewed in full mode or in simplified mode. The simplified mode uses the symmetries in the position of the electrodes provided by the methods, reporting the distances between the electrodes with respect to a central point. The full mode shows all the distances between the electrodes, leaving greater freedom to the operator who wanted to modify the expected positions, also not to maintain the symmetry expected for these methods.

The simplified view will then be offered only when the symmetries provided by the position of the electrodes are fulfilled by the positions of the electrodes in the table, otherwise it will not be offered.

In the System window the operator can decide whether to always use the full view of a table or if, when possible, to use the simplified view as the first choice. In any case, the operator can switch from the simplified view to the full view by pressing the appropriate button/key. If the simplified view is not allowed due to the absence of the required symmetries, the button/key will not be activated.

Within the table it is possible to insert or change the values of the geometric positions of the electrodes, the value of K will be recalculated if required by the type of measurement used. It is not possible to enter or change the measured electrical parameters.

The Details button allows you to view information related to the entire measurement session. In particular, for automatic measurements in this section are reported the input values that have been entered by the operator and needed by the Gea RM1 system to calculate the position of the electrodes when the automatic session has to be performed.

The Save and Save as ... buttons allow you to save the table on your PC's hard disk, possibly changing its name and format.

By displaying an automatic table that has been totally or partially executed, choosing the Save as ... command activates the possibility to choose the format RES2DINV as backup format, in this case a further file will be saved in which the results of the table will be stored and made available for further analysis using external programs.

Control of the Gea RM1 system

The Gea RM1 system control function is only available when the system is connected to the PC and allows you to control all the functions of the Gea RM1 system via a PC, making it easier to use the interface and a larger screen size.

When you entered in the Control window, the Gea RM1 system buttons are deactivated, and a fixed screen showing the PC Control status is displayed on the system video. Normally leaving the Gea RM1-PC program control window, the functions of the Gea RM1 system are reactivated.

The menu structure of the commands and information shown on the Gea RM1-PC are the same as those on the Gea RM1 system, and the screens are substantially the same, so we refer to chapter 6 of this manual to describe how to use the control function the system from the PC.

The commands applied from PC are identical to the four of the Gea RM1 system, and are described below.

- "Up" button of the Gea RM1 system: the command can be executed using the "Up" button of the GUI of the Gea RM1-PC program, with the "Up arrow" or "Page up" keys of the PC keyboard.

- "Down" button of the Gea RM1 system: the command can be executed using the "Down" button of the GUI of the Gea RM1-PC program, with the "Down arrow" or "Page down" keys on the PC keyboard.

- "Esc" button of the Gea RM1 system: the command can be executed using the "Esc" button of the GUI of the Gea RM1-PC program, with the "Arrow left" or "Esc" keys on the PC keyboard.

- "Accept" button of the Gea RM1 system: the command can be executed using the "Accept" button of the GUI of the Gea RM1-PC program, with the "Arrow right" or "Enter" keys on the PC keyboard.

Figure 33 shows the control page on the initial system screen.

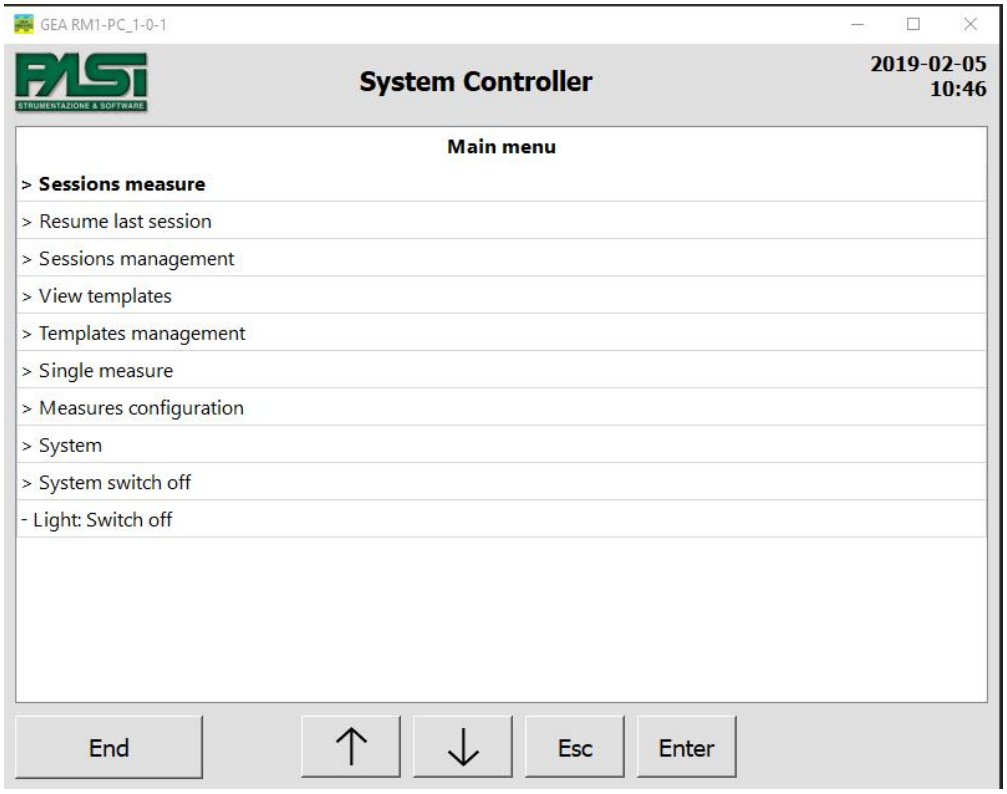


FIGURE 45 - CONTROL PAGE OF THE INITIAL SCREEN OF THE SYSTEM

Tables upload

The table upload function on the Gea RM1 system is only available when the system is connected to the PC and allows you to send GPD files on the PC hard disk to the Gea RM1 system.

When you enter the table Upload window, the Gea RM1 system keys are deactivated and a fixed screen showing the status of the Upload from the PC is displayed on the system. Normally leaving the Gea RM1-PC program upload window the functions of the Gea RM1 system are reactivated.

The function opens a window to browse the files on the hard disk of the PC in order to allow the choice of files to be uploaded. Then, for each file selected for upload, you are asked to enter the name you want to use for the session copy on the Gea RM1 system. Before copying, the system will check the existance of a session on the Gea RM1 system with the same name, and eventually report it to the operator asking if he wants to insert a different session name or if he wants to overwrite the session.

Download sessions

The Download Session function from the Gea RM1 system is only available when the system is connected to the PC and allows to obtain GPD files on the memory of the Gea RM1 system and store them on the PC hard disk.

When you enter the table download window, the Gea RM1 system keys are disabled, and a fixed screen showing the Download status to the PC is displayed on the system video. By exiting the Gea RM1-PC program download window normally, the functions of the Gea RM1 system are reactivated.

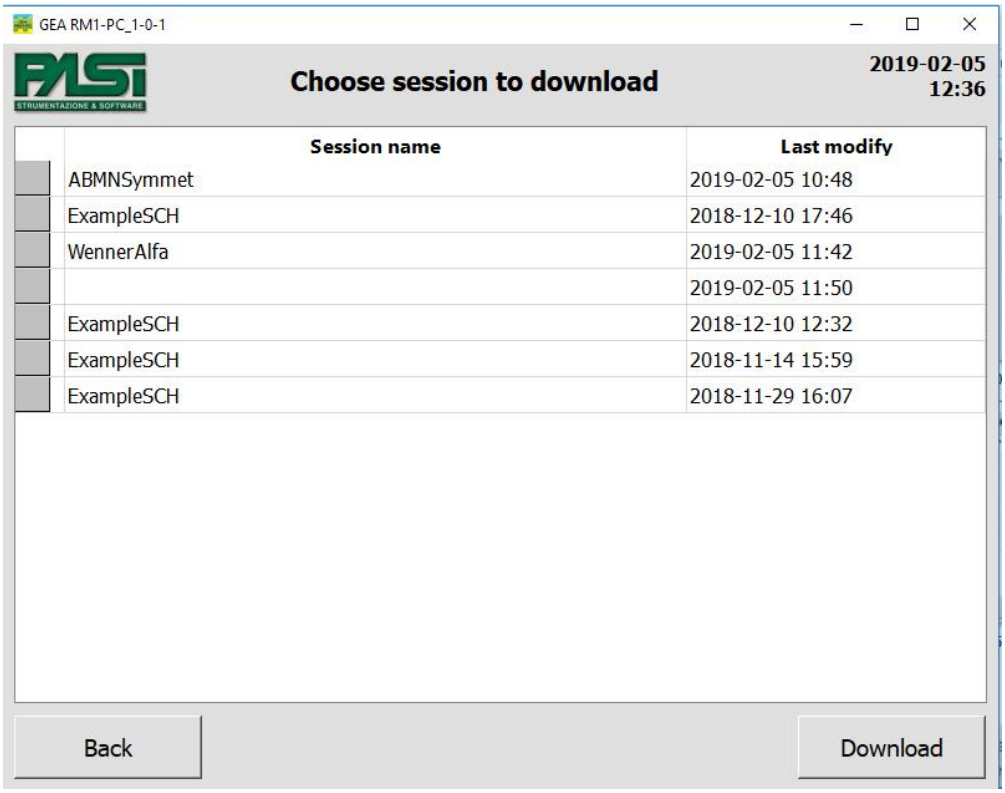


FIGURE 46 - SESSIONS DOWNLOAD

The function opens a window that displays the sessions on the memory of the Gea RM1 system in order to allow the selection of the sessions to be downloaded. Then, for each session selected for the upload, you are asked to enter the name you want to use for the copy of the GPD file on the PC hard disk. The system will check before copying the presence of a file on the PC with the same name, and eventually report it to the operator asking him if he wants to insert a different file name or if he wants to overwrite the file already present on the system.

System functions

The System screen is used to obtain information about the system versions, the update status (only if the PC has an internet connection) and to configure some parameters of the Gea RM1-PC program.

The configurations that can be made are the following.

- Interface language. After the language changes, the program must be restarted for the variation to be applied. However, the language used on the GPD file is in English.

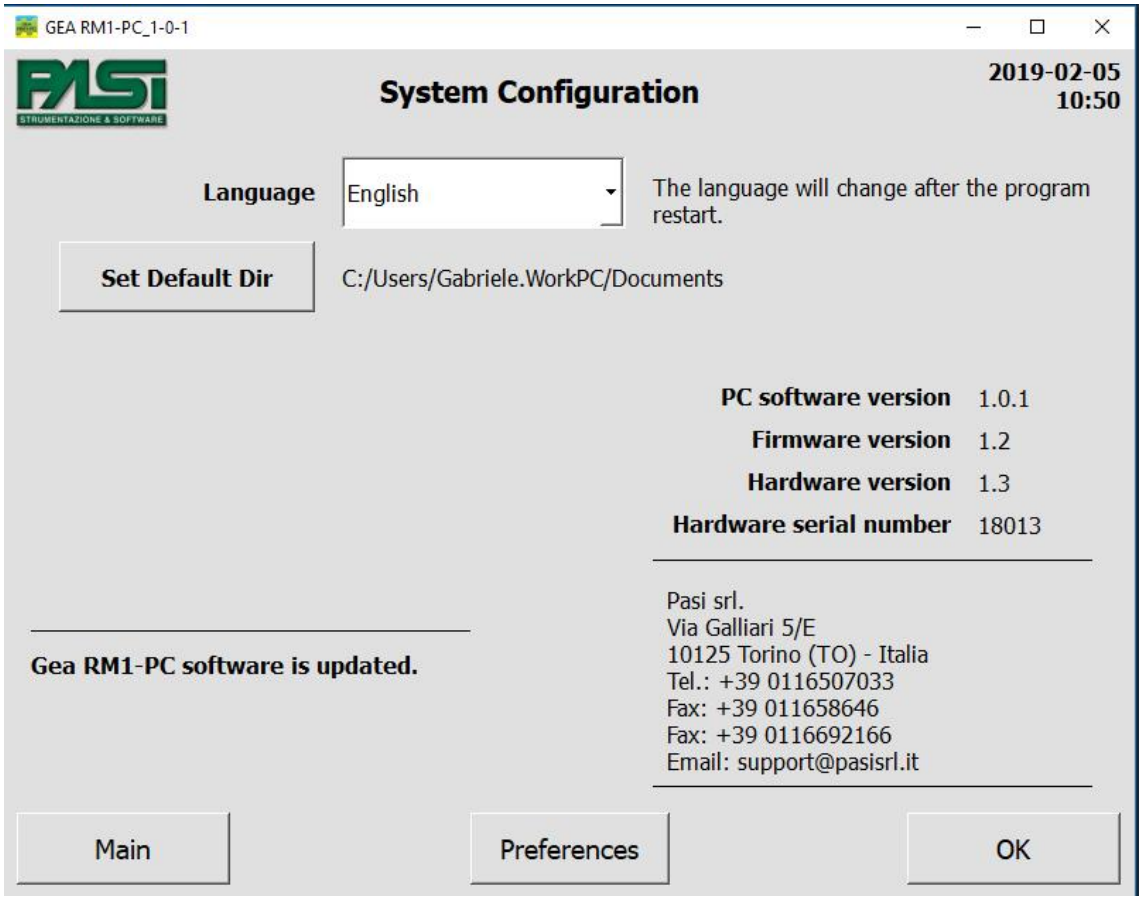


FIGURE 47- SYSTEM CONFIGURATION, FIRST PAGE

Default directory for saving and retrieving GPD files of measurement sessions. The program will still allow to save or read GPD files from different directories.

By pressing the "Preference" button you can reach the page for the configuration of further parameters related to the GUI of the Gea RM1-PC system, listed below.

- Linear measurement unit: the operator can choose whether to display the measurements in meters or in yards. The saving of the measurements on GPD file is however done in meters.

- Choice on the simplified table view. The operator can request that the Gea RM1-PC program always displays the files in full mode or, when possible, display them in simplified mode. The operator will however have the possibility to change the view mode for each table using the "Full / simplified view" button in the Table management window.

- Date format: the operator can choose the date display format, choosing between the three proposed formats: "yyyy-mm-dd", "dd / mm / yyyy" or "mm / dd / yyyy". Saving dates on a GPD file is done in "yyyy-mm-dd" format.

- Electrode names: the names A, B, M and N or the names C1, C2, P1 and P2 can be chosen. It only affects the display modes and not the format inside the GPD file, where the electrodes are still stored as A, B, M and N

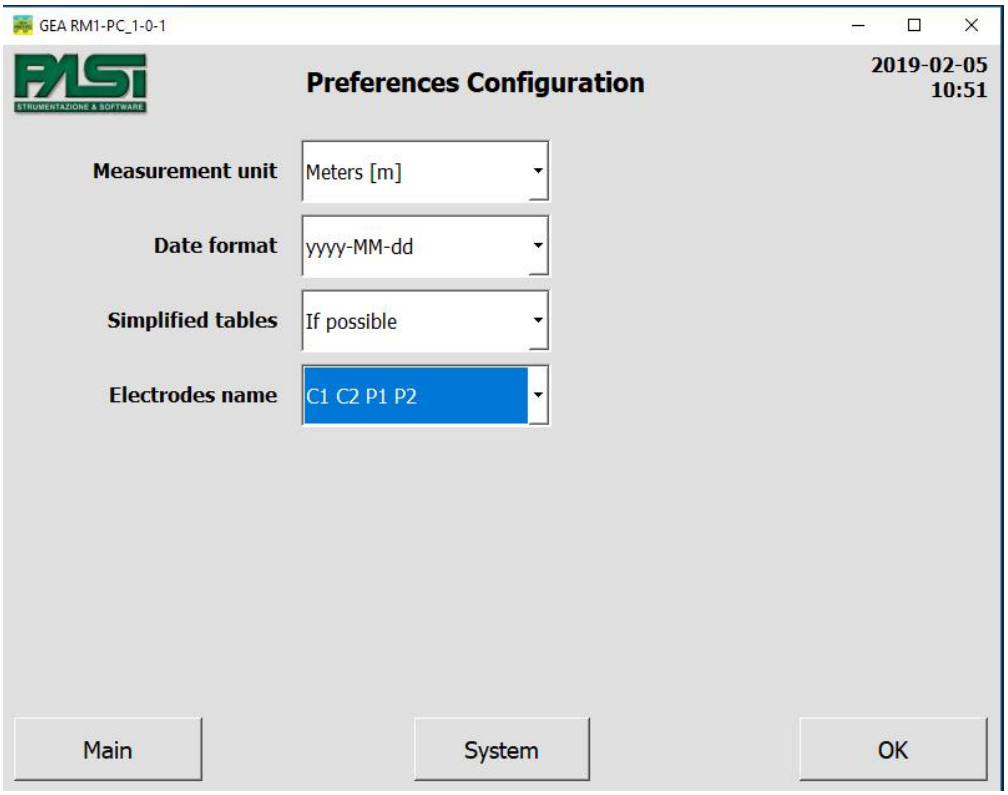


FIGURE 48 - PREFERENTIAL CONFIGURATION OF A SYSTEM

9.Software update

Update of the Gea RM1-PC program

The Gea RM1-PC program needs to be periodically updated by the operator.

The Gea RM1-PC program has a mechanism that, if the PC is connected to the network, the update status of the program is verified and the operator is notified of the presence of a more recent version of the program, upgrade is requested.

The operations to be performed are as follows.

- Download the self-installing file from the manufacturer's website to the page indicated on the System page of the Gea RM1-PC program.

- Switch off the Gea RM1-PC program.

- Execution of the self-installing program downloaded from the manufacturer's website.

- Execution of the newly installed Gea RM1-PC program in the new version.

10. Appendix

Technical features

A-B (C1-C2) Current Circuit

SWITCHING SECTION

Insulation: 2500 V galvanic insulation from M-N Unit and USB

Max. Switching Voltage: 1000 V (2000 Vpp)

Max. Switching Current: Autoranging 1 A (2000 mApp), optional 5 A

Fully protected with Diagnostic: Input Overvoltage (Power Unit supplies more than 1000 V)

Bad Polarity (Power Unit wrong connection)

Internal Fuse blown

Output Overcurrent (short on A-B electrodes or similar)

CURRENT MEASURING SECTION

Technology: High Resolution 24 bit SigmaDelta ADC

Oversampling for noise reduction

High rejection for 50 and 60 Hz noise

Maximum Measurable Current: 5A (10000 mApp)

Theoretical Resolution: 1 nA

M-N (P1-P2) Potential Circuit

Insulation: 2500 V galvanic isolation from A-B Unit and USB

Technology: High Resolution 24 bit SigmaDelta ADC

Oversampling for noise reduction

High rejection for 50 and 60 Hz noise

Automatic ranging

Maximum Applicable Voltage: +/-1500 V

Maximum Measurable Voltage: +/-250 V (500 Vpp)

Theoretical Resolution: 2 nV

Input Impedance 10 MOhm

System

Technology: Solid State (no moving parts)

High Performance 32 bit Microprocessor

Display: Graphical Transflective LCD with white Led backlight

Work mode: Stand-alone or PC connected on USB

Artificial Intelligence for the best setting of all measurement parameters

Power Supply: Internal lithium battery rechargeable via USB connector

Measure results: VMN, IAB, VMN/IAB, Resistivity, Self Potential, Induced Polarization

Dynamic Automatic set of all Parameters: Input Ranges, Current Pulse Length, Integration Intervals,

Number of Stackings, Power Unit Voltage Output (only if connected to a compatible

PASI device)

Precision: Better than 0.5%

Better than 0.1% in the range 1 – 1000 Ohm

Case: Shock resistant PELI case IP 67 (270x246x123 mm - 2.9 kg)

Ambient Working Temperature Range: from -10°C to 50°C,

Storage Temperature Range: from -20°C to +80°C

TEST circuit diagram

Wiring diagram for GEORESISTIVITYMETER BOX TESTING

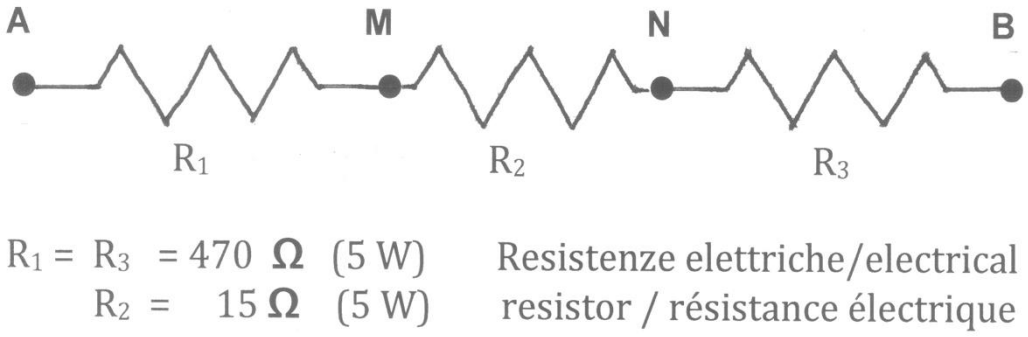


FIGURE 49 - ELECTRICAL DIAGRAM FOR TESTING BOX

Performing the measurement (after connecting A, B, M, N to the respective sockets on the Resistivity Meter and the energizer to its socket) the ratio ΔV / I must be equal to the value of R2 then 15 Ω (± 10%)

CAUTION:

the tensions produced by the energizer are potentially lethal!