

SoilSpy

Seismic acquisition system: portable, multichannel and digital

USER'S MANUAL





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Table of Contents

INTRODUCTION	6
HANDLING CARE	9
MAINTENANCE	10
WARRANTY	11
DISCLAIMER	12
DEVICE DESCRIPTION	13
SYMBOLS.....	14
CONNECTORS.....	15
AMPLIFICATION/DIGITIZATION MODULES	17
ACCESSORIES.....	18
<i>Sensors</i>	18
<i>Wire extension</i>	18
RELATED PRODUCTS.....	19
<i>Software</i>	19
<i>PC and interface</i>	19
FIRST STEPS	20
PHYSICAL CONNECTIONS	21
INITIAL PC SETTINGS	25
FUNCTION DESCRIPTION.....	28
PARAMETER WINDOW	29
ACQUISITION PARAMETERS.....	33
<i>REFRESH</i>	35
<i>SET TRIGGER</i>	35
<i>SET GAIN (Man.)</i>	36
<i>SET GAIN (Auto.)</i>	36
<i>SET MAX. (All)</i>	37
<i>SET GEOMETRY X</i>	37

SET GEOMETRY Y.....	38
GET SERIAL N.	38
RESET (All).....	38
CHECK SENSOR.....	39
SHIFT NUMBER	39
SET BAUD RATE.....	41
ID START	42
ID INIT. MODULE	42
MAIN WINDOW	44
MESSAGE BAR.....	44
TOOLBAR.....	45
MENU BAR.....	49
TRACE WINDOW.....	49
DATA ACQUISITION	52
ON LINE PROCEDURES	52
STARTING AN ACQUISITION.....	53
GENERAL SETTINGS	53
CONTINUOUS MODE.....	55
STACKING MODE	57
HOW TO SET THE TRIGGER THRESHOLD IN STACKING MODE.....	61
PRE-PROCESSING OFF-LINE PROCEDURES	64
AVERAGE MODE	65
PICKING MODE.....	70
FILE NAME AND MANAGEMENT	75
FILE NAME	76
FILE MANAGEMENT	78
TRIGGER.....	80
CALIBRATION PROCEDURES AND GENERAL SYSTEM CHECK.....	82
BASELINE CORRECTION OR CALIBRATION	83

AMPLIFIER TEST	83
PROBLEMS	85
MANUAL INITIALIZATION OF MODULES	86
<i>When to apply the procedure</i>	<i>86</i>
<i>Manual initialization procedure</i>	<i>87</i>
TECHNICAL SPECIFICATIONS.....	89

INTRODUCTION

SoilSpy is an ultra-portable multichannel digital seismic acquisition system which can be used for passive and active seismic array surveys, both on surface on in-hole.

7

SoilSpy is composed of a data transmission wire along which the amplification/digitization modules are deployed. The modules transmit data from sensors (usually geophones) to a host (PC or recorder) through the USB port interface.

The main advantages of a multichannel digital acquisition system are easily summarized:

- 1) light weight, allowed by very thin digital wiring, lack of external batteries and of bulky acquisition systems,
- 2) **higher signal to noise ratios** (no cross talk among channels, no external signals transmitting to the long cables before digitization),
- 3) real synchronization of the signal among channels.

The additional features which make **SoilSpy** unique in its field are:

- 1) **no need for external batteries.** **SoilSpy** runs on the power supplied by the USB port of the PC used to store the data,
- 2) **ultralow weight.** Each amplification/digitization module and standard 5 m length wire weight less than 200 g, which means that a standard 12 channel system weights less than 2.4 kg (geophones excluded),

- 3) **unlimited recording duration.** This is an essential feature for passive seismic surveys and monitoring,
- 4) **threshold triggering.** Each channel can be set as a trigger channel. No need for separate trigger cables,
- 5) **extreme flexibility of use.** The system can be used for any kind of passive and active seismic survey (P, S-wave refraction, reflection, down-hole, cross-hole, ReMi™, MASW, SASW, SPAC, ESAC etc.), adopting the sensors suited to the specific task.

HANDLING CARE

- **SoilSpy** is intended for outdoors use. It is splash proof but it should not be submerged in water or other liquids for extended times.
- Avoid strong pulls on the wire. This could compromise its integrity and the robustness of the connectors.
- Avoid stepping on the wire and on the other system components.
- Do not connect the device sockets to any electrical source. The device inputs are sensitive to strong electrostatic shocks.
- Radio and mobile communication systems may affect the device functionality.
- In order to ensure that electric safety and electromagnetic compatibility requirements are satisfied, connect the device to the PC by using exclusively the USB interface provided.
- Avoid violent mechanical shocks/falls. In case these unfortunately happen, check the instrument functionality. In presence of any irregularity **never open the device** but contact the producer (MoHo s.r.l.) for assistance. Opening the device will immediately void the warranty.

MAINTENANCE

- Inspect the single modules, container, the USB interface, the wire and the accessories to verify the presence of possible damage caused by transport. Such problems should be reported to MoHo s.r.l. representatives before using the unit.
- Do not open the digitization modules nor the USB interface. Do not expose the device to abnormal conditions (high temperatures or excessive humidity).
- Before cleaning the device make sure that it is turned off.
Do not use abrasives or solvents of any type.
- Avoid spilling any materials, in particular liquids, on the device electronic components and if this were to happen **do not use the device** and contact the producer for assistance.
- Clean the device using a dry or 'humid' cloth (not wet). Clean the connection wires also with a humid cloth.
- Make care that the sockets of the digitization modules are always clean. In case of presence of dirt, remove it with a dry cloth or brush.
- Do not attempt any repair or substitute any part and always refer to MoHo s.r.l. for any problem.
- Contact MoHo s.r.l. to organize a maintenance check on a 2 year basis.

WARRANTY

Remind that in order to be covered by warranty, the following rules must be respected:

- do not open the device
- do not submerge the device in water
- do not put any weight on the device
- do not stretch the wire
- do not connect the device to electrical sources unless through the wires provided by MoHo s.r.l.
- keep all the external parts and plugs clean with dry clothes or brushes. Do not use abrasives or solvents of any type

DISCLAIMER

SoilSpy is intended to be used by qualified personnel in the field of geophysical seismic prospection. The user should be capable to understand the meaning of the different parameters/settings and to check their correctness as a function of the task to achieve.

In general, ask for competent advice unless you are sure to understand the theory behind the different procedures. Seismology is a complex branch of Physics and using any computer code without fully understanding its assumptions and its unavoidable limitations is a quick route to wrong results.

In no case will MoHo s.r.l. or anyone distributing its product be liable for any damage, improper use or other liability arising from, out or in connection with the device.

MoHo s.r.l. reserves the right to modify products, specifications or manuals whenever necessary without prior notice.

MoHo s.r.l. declines any responsibility regarding the safety, reliability and services if the device is mishandled or repaired by non-authorized personnel. For all modifications regarding wires and accessories please contact MoHo s.r.l. in order to guarantee the device compatibility.

DEVICE DESCRIPTION

SYMBOLS



“WARNING!”. This operation could cause damage/malfunctioning. Carefully follow the indication provided.

14



Note to remember.



2005/96/EC Directive (Waste of electrical and electronic equipment): at the end of its use life the device must be disposed separately from domestic waste to allow components recycling.



Manufacturing date: device expected lifetime is 10 years; maintenance is due every two years.

CONNECTORS

SoilSpy is endowed with the following connectors (Figure 1, Figure 2).

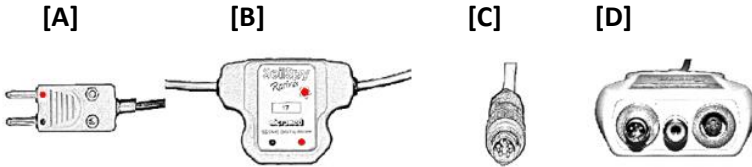


Figure 1. Connectors of **SoilSpy**. [A] geophone connector, [B] amplification-digitization module, [C] **SoilSpy** head connector, [D] USB interface.

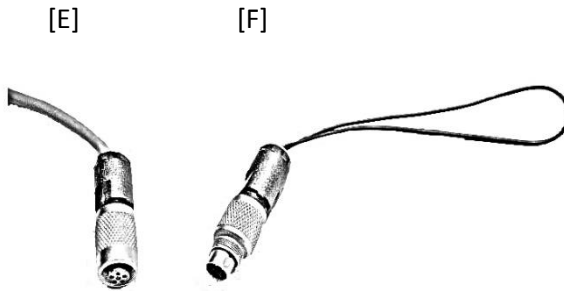


Figure 2. **SoilSpy** wire end [E] opposite to the acquisition PC. End of line connector [F].

With reference to Figure 1 and Figure 2, [A] is to be plugged in [B]. [C] is to be plugged in [D]. [D] is to be plugged to the PC. [F] is to be plugged in [E].

- *USB connector* (not shown in Figure 1): end of the USB interface (Figure 5) to be connected to the PC,
- *Panel connector FB 5P (female)* (element D in Figure 1): to be connected to the head of the array wire (element C in Figure 1),
- *Flying connector FB 5P (male)* (element C in Figure 1): to be connected to:
 - the USB interface (element D in Figure 1) or
 - to the flying end of another **SoilSpy** system (element E in Figure 2),
- *Flying connector FB 5P (female)* (element E in Figure 2): set at the end of the **SoilSpy** wire, opposite to the PC. It must always be terminated with a flying *FB 5P* male connector (element F in Figure 2) in order to avoid malfunctioning of the system. As an alternative, it can be wired to another **SoilSpy** system,
- *Connector for sensor (female)* (element B in Figure 1): two female connectors $\varnothing$ 4 mm for signal input to be connected to sensors, respecting polarity (red/red, black/black, Figure 4),
- *Connector for digitization module (male)* (element A in Figure 1): two male connectors $\varnothing$ 4 mm for signal input to be connected to digitization modules, respecting polarity (red/red, black/black, Figure 4).



AMPLIFICATION/DIGITIZATION MODULES

Each amplification/digitization module (Figure 3) is equipped with a LED. Its flashing allows to check the answer of the module to the commands given through the PC. The LED is hidden inside the logo (flower) of **SoilSpy**, .

17

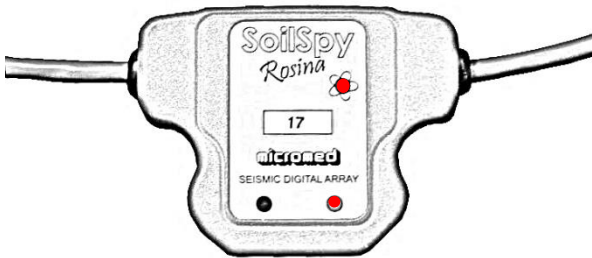


Figure 3. Amplification/digitization module.

ACCESSORIES

Sensors

Sensors (usually geophones) must be connected to **SoilSpy** through the digitization modules, respecting polarity (red/red, black/black, Figure 4). Any kind of *passive* sensor can be connected. In case of doubt and to optimize system response consult MoHo s.r.l.

18

Wire extension

A 20 m long wire is provided with **SoilSpy**, which can be used as an extension for trigger or for 2D array configurations. Insert it between the sensor and the digitization module (Figure 4).

Any number of extension wires can be purchased on demand and used for 2D array configurations and/or for remote triggering purposes. However, remind that the signal produced at the geophones travels in analog form along the extension wires and is digitized only at the amplification/digitization modules (Figure 3). Using long analog extension wires lowers the overall signal quality of the system.

RELATED PRODUCTS

Software

The software provided with **SoilSpy** allows the user to acquire recordings and to pre-process them. Data are saved in the standard format of MoHo s.r.l. (called .trc) and in and international standard format (SEG-2) and can be viewed, stored, analyzed and exported to additional formats through the software *Grilla*.

19

SoilSpy software runs any kind of MS Windows® operating system. For use under Windows® emulators in other operating systems, please contact MoHo s.r.l. assistance at support@moho.world

PC and interface

The **SoilSpy** - to - PC interface is called USB interface (Figure 5).

FIRST STEPS

PHYSICAL CONNECTIONS

- 1) deploy the **SoilSpy** wire on the ground,
- 2) firmly couple the sensors (geophones) to the soil at the selected interdistance¹ and connect each sensor to the digitization module. Respect polarity (red pin in red socket, black pin in black socket) as shown in Figure 4,
- 3) connect the **SoilSpy** wire to the USB interface. Insert the plug in the socket and turn the screw to make the connection tight (Figure 5),
- 4) connect the **SoilSpy** USB interface to a USB port of your PC. The USB port is powered at 5 V, which is the default setting on most PCs. Since **SoilSpy** is internally powered at 3.3 V only, a voltage reducer is present inside the USB interface.

21

Once mounted, the **SoilSpy** system appears as in Figure 6.

¹ The standard interdistance between digitization modules in **SoilSpy** is 5.30 m. The red ring on the wire is set at 5 m interdistance. Extra 0.30 m are provided to allow for reparation in case of wire breakings and to guarantee a true 5 m interdistance also in presence of small obstacles (tall grass etc.).

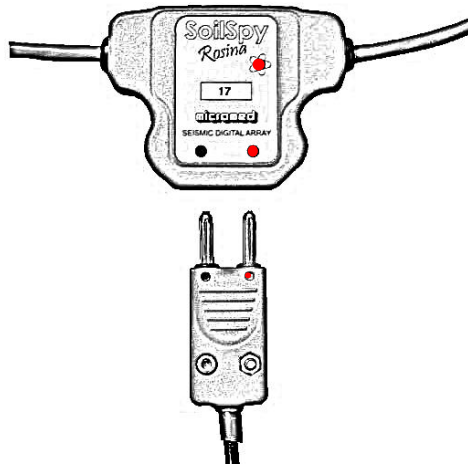


Figure 4. Connection between a sensor (bottom) and a digitization module (top). Respect polarity: red pin in red socket, black pin in black socket.



Please note that each end of **SoilSpy** must be terminated in order for the system to work: at the head the termination is provided by the PC, at the other end the termination is provided by a specific connector (Figure 7). If this be missing the system will not work.



23

SoilSpy WIRE HEAD

Figure 5. Connection between the **SoilSpy** head and the USB interface.



Figure 6. A complete **SoilSpy** system.

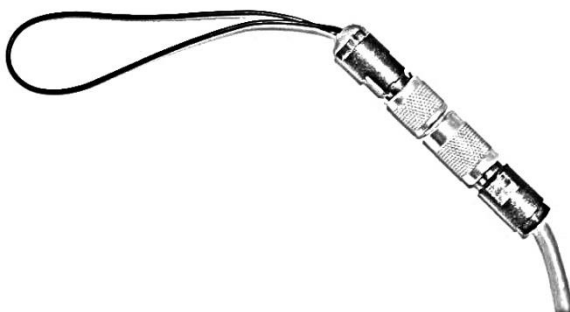


Figure 7. End-of-line connector of **SoilSpy**.

INITIAL PC SETTINGS

- 1) Install the *USB interface driver* provided in the installation CD you received with the instrument,
- 2) install the **SoilSpy** software provided in the installation CD you received with the instrument,
- 3) run the **SoilSpy** software by double clicking its icon  from your PC desktop,
- 4) the first time you will be asked to select the folders where the data will be stored (Figure 9). The *Log* and *Ini* folders will contain the configuration files: we call these folders [Your Config folder(s)]. The *Trace* folder will contain the instrumental recordings: we call this folder [Your folder],
- 5) connect **SoilSpy** to the PC. After a few seconds, **SoilSpy** will automatically be assigned a COM (communication) port number²,

25

² In case of doubts, to check whether the **SoilSpy** USB interface is correctly installed on your PC, connect the interface to the PC and select START >> SETTINGS >> CONTROL PANEL >> SYSTEM >> HARDWARE >> DEVICE MANAGER >> PORT (COM and LPT) (Figure 8). You should find the item “MoHo USB Interface (COM##)”, where COM## stands for the number of the communication port assigned to the USB interface (possible values range from 1 to 16).

A different COM## number could be assigned when **SoilSpy** is plugged into different USB ports. The software automatically manages this event. In case you need to manually change the COM number assigned to the system, select SET UP >> OPTIONS >> COM from the Options window (Figure 9).

- 6) click the  LINK button from the toolbar and the PARAMETER window will appear (Figure 10, Figure 11),
- 7) If your **SoilSpy** USB interface is not recognized after clicking LINK  in the **SoilSpy** software, please follow the suggestions in the footnote 2.

26

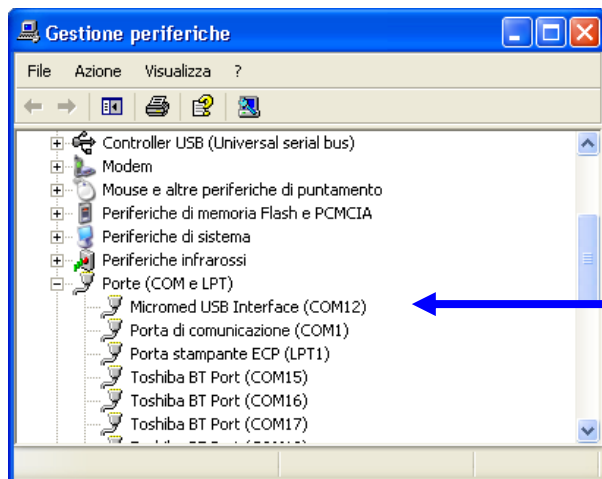
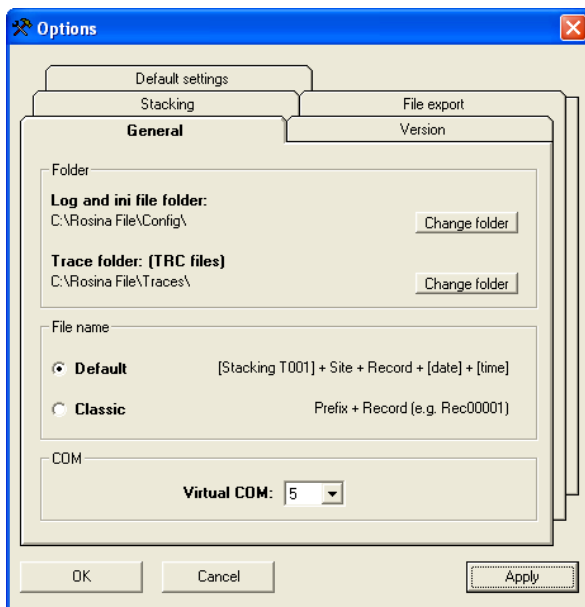


Figure 8. COM port number assigned to **SoilSpy** (START >> SETTINGS >> CONTROL PANEL >> SYSTEM >> HARDWARE >> DEVICE MANAGER).



27

Figure 9. Set-up panel which allows to set the COM port number and the [Your folder] path to store data acquired from **SoilSpy**.

FUNCTION DESCRIPTION

PARAMETER WINDOW

Click LINK  on the main window toolbar (Figure 10) to let the PARAMETER window appear.

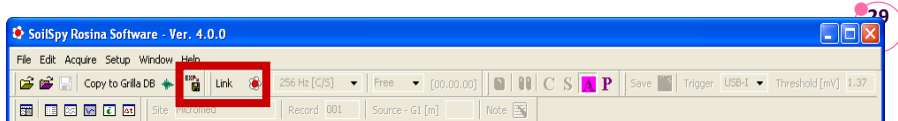


Figure 10. Main window toolbar.

The PARAMETER window (Figure 11) is composed of a COMMAND list box to select the property to view/set, a SEND button to send the command and a frame with 10 columns.

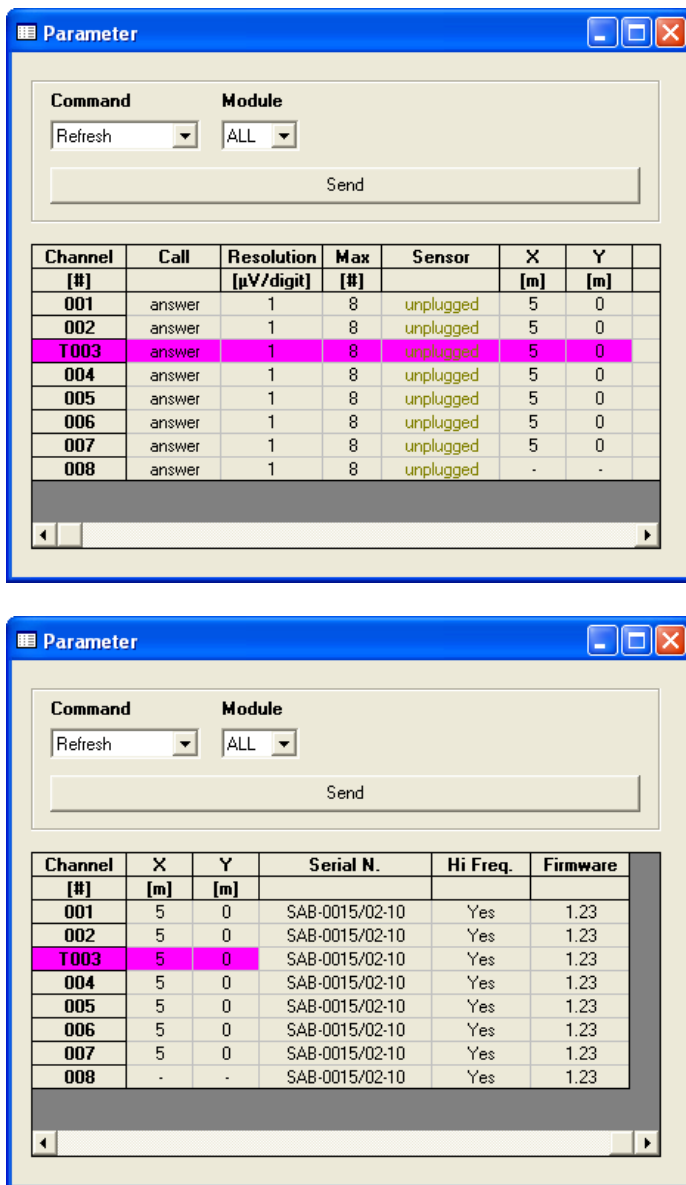


Figure 11. PARAMETER window to manage the SoilSpy acquisition settings.

The meaning of each column is described below:

CHANNEL indicates the ordinal number of the sensors (geophones).

CALL indicates whether the digitization module is responding or is in an error status. Possible messages are:

Answer	the module answers correctly,
Error	the module is not responding.

RESOLUTION indicates the amplification level of the channel (default values is 10^{-6} V/digit). Possible values are:

0.1 μ V/digit corresponding to a maximum input signal ± 3.2 mV,

0.2 μ V/digit corresponding to a maximum input signal ± 6.5 mV,

0.5 μ V/digit corresponding to a maximum input signal ± 16.3 mV,

1 μ V/digit corresponding to a maximum input signal ± 32.7 mV,

2 μ V/digit corresponding to a maximum input signal ± 65.5 mV,

5 μ V/digit corresponding to a maximum input signal ± 163 mV,

10 μ V/digit corresponding to a maximum input signal ± 327 mV,

20 μ V/digit corresponding to a maximum input signal ± 665 mV,

No Scale no gain is assigned to this module,
Error the module is not responding.

MAX indicates the total number of channels which must acquire. Note that this number can be equal to or less than the total number of digitization modules present along the wire.

SENSOR indicates whether a sensor (geophone) is connected to the digitization module, whether it is working or not (possible values are plugged-in, unplugged, short circuit, error).

X indicates the distance (in [m]) between sensors (geophones) along the X axis. Note that this parameter can be modified any time in the analysis performed through *Grilla* software.

Y indicates the distance (in [m]) between sensors (geophones) along the Y axis. Note that this parameter can be modified any time in the analysis process performed through *Grilla* software.

SERIAL N. indicates the serial number of the linked *SoilSpy* system.

HI FREQ. indicates whether the module can record the signal at sampling rates higher than 1kHz in STACKING mode (p. 57).

FIRMWARE indicates the firmware version installed in the digitization module. Note: in order for *SoilSpy* to work properly, all the digitization modules should run on the same firmware version.

The description of all possible parameter settings (element [1] in Figure 11) is given on p. 33.

In this step-by-step guide let us assume that the default setting is fine, that you get the “answer” message on all channels (column 2 in Figure 11), that all sensors are “plugged-in” (column 5 in Figure 11) and you want to start an acquisition. Let us see how to proceed.

33

ACQUISITION PARAMETERS

To access the PARAMETER window, run the **SoilSpy** software, connect **SoilSpy** to the PC and click LINK  in the main window (Figure 10).

The setup panel will appear (Figure 12). The meaning of each column was given on p. 28. In the following pages, an explanation of the functions of the available commands is provided.

Some parameters are present both in the SET and GET format. SET is used to change a property, GET is used to check/read the value of a variable.

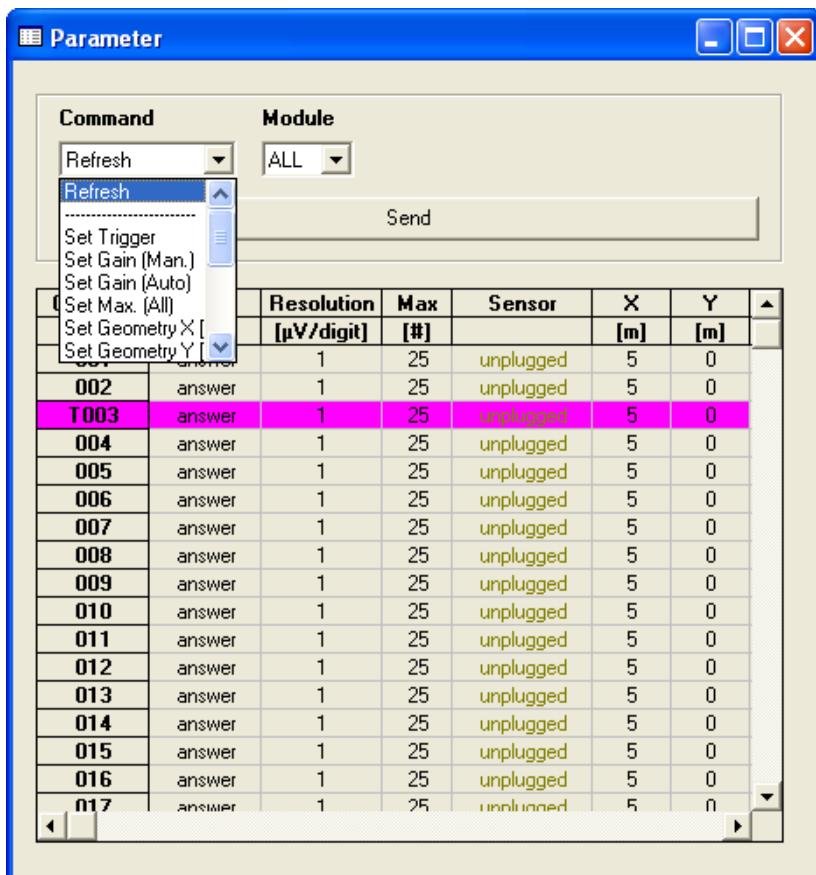
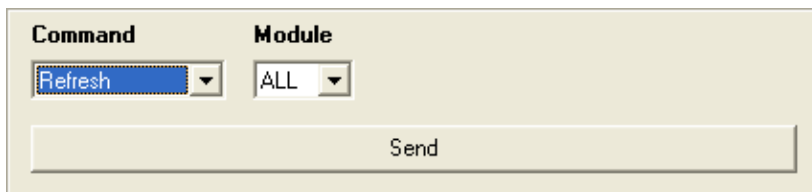


Figure 12. PARAMETER window. The pink T003 line indicates that channel 3 is set to act as a trigger channel.

REFRESH



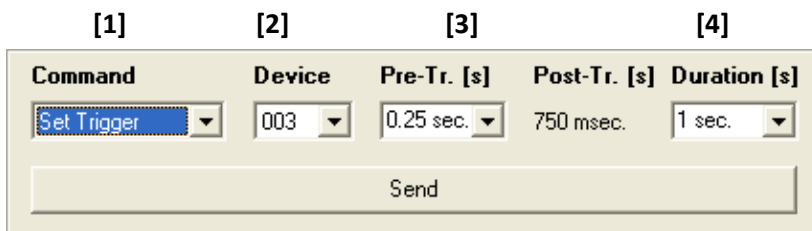
The interface for the REFRESH command. It features a 'Command' dropdown menu with 'Refresh' selected, a 'Module' dropdown menu with 'ALL' selected, and a 'Send' button at the bottom.

35

Updates the PARAMETER table (Figure 12).

Click Send to transmit the selected command to **SoilSpy**.

SET TRIGGER



The interface for the SET TRIGGER command. It includes five labeled list boxes: [1] Command (Set Trigger), [2] Device (003), [3] Pre-Tr. [s] (0.25 sec.), and [4] Duration [s] (1 sec.). The Post-Tr. [s] field is set to 750 msec. A 'Send' button is located at the bottom.

Sets the number of the channel to be used as trigger. Act on the list box [2] in the figure above to select the trigger channel or the triggering device (USB-interface or radio trigger). The selected channel will be indicated by the label T## and the corresponding line in the PARAMETER panel will be highlighted in pink (Figure 12).

Use list box [3] in the figure above to set the pre-trigger duration.

Use the list box [4] to set the total duration of acquired signal. This is equal to the sum of the pre-trigger and post-trigger durations.

Click Send to transfer the selected command to **SoilSpy**.

SET GAIN (Man.)

[1] Command	[2] Module	[3] Resolution	Full scale
Set Gain (Man.)	ALL	1 $\mu\text{V}/\text{digit}$	$\pm 32.8 \text{ mV}$
Send			

36

Sets the amplification level of each module manually. The selected value (list box [3] in the figure above) can be applied to all or single modules (list box [2] in figure above). The selected value will appear in the column RESOLUTION of the PARAMETER panel (Figure 12). The default value for both active and passive surveys is $1 \mu\text{V}/\text{digit}$.

Click Send to transmit the selected command to **SoilSpy**.

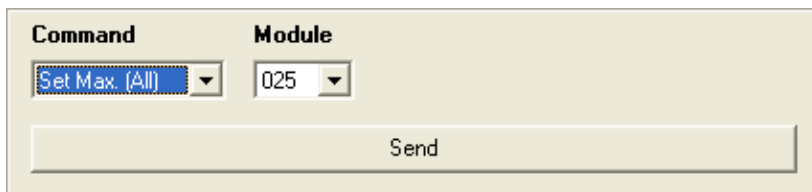
SET GAIN (Auto.)

[1] Command	[2] Gain law	[3] Resolution	Full scale
Set Gain (Auto.)	Body wave: $1/r$	1 $\mu\text{V}/\text{digit}$	$\pm 32.8 \text{ mV}$
<div style="border: 1px solid black; padding: 2px;"> Body wave: $1/r$ Surface wave: $1/r^{1/2}$ </div>			
Send			

Sets the amplification level of each module automatically, according to the body $\frac{1}{r}$ or surface $\frac{1}{\sqrt{r}}$ wave amplitude attenuation law summarized in the list box [2], where r indicates distance from the trigger channel T##.

Click Send to transmit the selected command to **SoilSpy**.

SET MAX. (All)

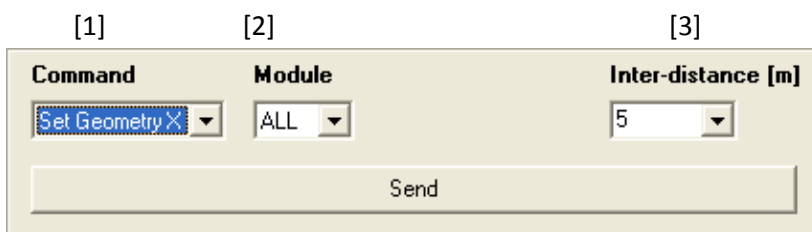


Command: Set Max. (All) Module: 025 Send

Sets the total number of acquisition channels. The number can be lower than or equal to the total number of physical modules deployed along **SoilSpy**. In the example of the figure above, acquisition will be performed from 25 channels.

Click Send to transmit the selected command to **SoilSpy**.

SET GEOMETRY X



[1] Command: Set Geometry X [2] Module: ALL [3] Inter-distance [m]: 5 Send

Sets the distance (in [m]) between sensors (geophones). The distance value can be selected from the list box [3] in figure above or can be edited in the list box itself. The distance value can be applied to all modules or to single modules by acting on the list box [2].

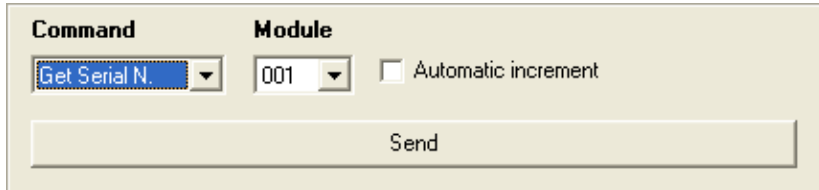
When working with linear arrays, set the inter-geophone distance as X-axis values.

Click Send to transmit the selected command to **SoilSpy**.

SET GEOMETRY Y

As SET GEOMETRY X but for 2-D array deployments.

GET SERIAL N.



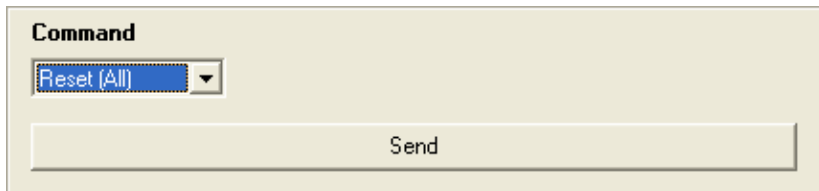
The dialog box has a title bar. Inside, there are two labels: "Command" and "Module". Under "Command" is a dropdown menu showing "Get Serial N.". Under "Module" is a dropdown menu showing "001". To the right of the "Module" dropdown is a checkbox labeled "Automatic increment" which is currently unchecked. At the bottom of the dialog is a large button labeled "Send".

38

Get the serial number of the **SoilSpy** system inked to the PC. The serial number can be provided for every single module manually or automatically. The answer appears in the bottom part of the main window (element [1] in Figure 14).

Click Send to transmit the selected command to **SoilSpy**.

RESET (All)



The dialog box has a title bar. Inside, there is a label "Command" above a dropdown menu showing "Reset (All)". At the bottom of the dialog is a large button labeled "Send".

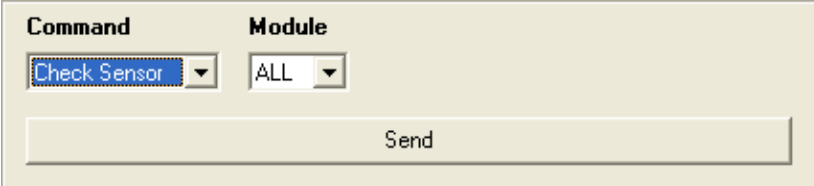
Resets all the internal variables of all modules.

Click Send to transmit the selected command to **SoilSpy**.

CHECK SENSOR

[1]

[2]



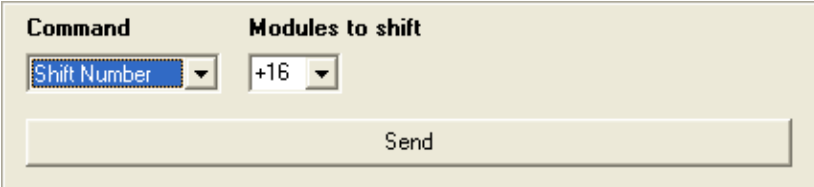
Check the sensor (geophone) status (plugged-in, unplugged, short-circuit, error).

Click Send to transmit the selected command to SoilSpy.

SHIFT NUMBER

[1]

[2]



This command is to be used when 2 or more SoilSpy are linked to form a single acquisition line. In this case the modules of the complete acquisition line must be numbered in sequential order, without repetitions.

For example, imagine that we have three 8-channel SoilSpy wires which we want to connect in a 24-channel system. Imagine also that the modules of each wire were previously assigned the numbers 1-8.

- 1) Connect the first segment to the PC, click SHIFT NUMBER and Send. The system will check the ID numbers

previously assigned to those modules (and will find them to be 1-8) and will show the possible options on the list box [2]. These options are +8, +16, +24 which mean, respectively, that we can assign the number 9-16, 17-24 or 25-32 to the modules of this first wire. We don't want to shift the numbers assigned to these modules, therefore we unplug the first wire from the PC,

40

- 2) We now connect the second segment *alone* to the PC, we select SHIFT NUMBER and click Send³. The system will recognize that also these modules have the internal numbers 1-8. We need to shift them 8 units forward, therefore we select +8 in the list box [2] and click Send. The internal number assigned to the modules of this second wire are now 9-16. We can unplug it from the PC.
- 3) We now connect the third segment *alone* to the PC, we select SHIFT NUMBER and click Send. The system will recognize that also these modules have the internal numbers 1-8 but we need to shift them 16 units forward, therefore we select +16 in the list box [2] and click Send. The internal number assigned to the modules of this third wire are now 17-24. We can unplug it from the PC.

We are now ready to connect the three segments and work with a 24-channel system. Note that the three segments must be

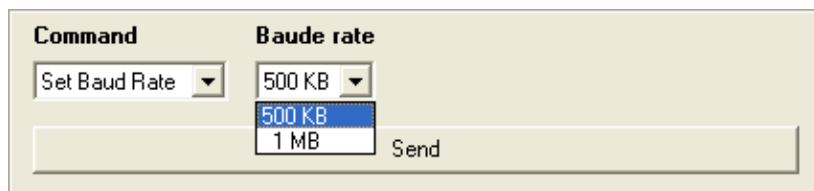
³ In case power supply to **SoilSpy** is interrupted or insufficient during the plug-in, plug-out operation it could be necessary to click LINK  again.

connected in the same order specified before. The first segment is the one connected directly to the PC.

Each time you arrange different segments in a different order you need to repeat the procedure.

41

SET BAUD RATE



Change the data transmission velocity along the **SoilSpy** cables.

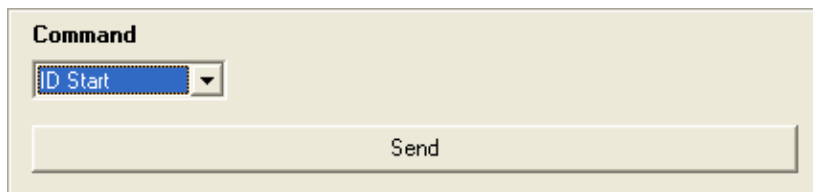
By default the 500 kB allows to acquire in continuous mode on 32 channels with a maximum sampling rate of 512 Hz.

Set 1 MB to acquire in continuous mode with a sampling rate of 1024 Hz. This baud rate is marked by a green lighting (right in **Figure 13**) which appears in the bottom right part of the main window (element [5] in Figure 14).



Figure 13. Left: baud rate of 500 kB. Right: the green lightning indicates the 1 MB rate. These symbols appear on frame 5 of the main window (Figure 14).

ID START



Command

ID Start

Send

42

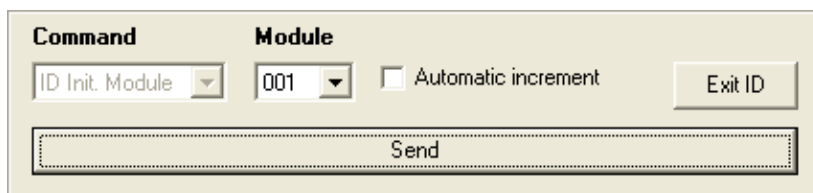


Run this command with caution only when **ERROR** messages in the ID numbering of the digitization modules appear that cannot be corrected in alternative ways.

Read WHEN TO APPLY THE PROCEDURE on p. 86 for details. This command runs the first of the 3 phases necessary to re-set manually the module ID numbers.

Click Send to transmit the selected command to **SoilSpy**.

ID INIT. MODULE



Command

ID Init. Module

Module

001

☐ Automatic increment

Exit ID

Send



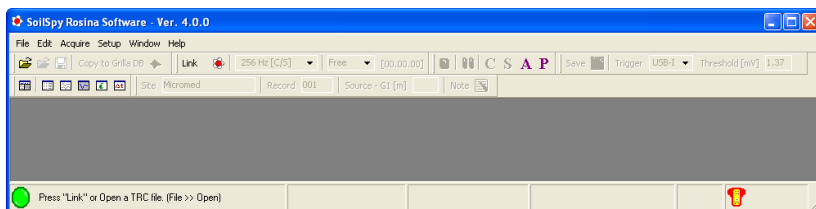
Run this command with caution only when **ERROR** messages in the ID numbering of the digitization modules appear that cannot be corrected in alternative ways

Read WHEN TO APPLY THE PROCEDURE on p. 86 for details. This command runs the second of the 3 phases necessary to re-set manually the module ID numbers.

Click Send to transmit the selected command to **SoilSpy**.

Click EXIT ID when the operation is completed.

MAIN WINDOW



44

- [1] [2] [3] [4] [5]

Figure 14. Main window message boxes (bottom).

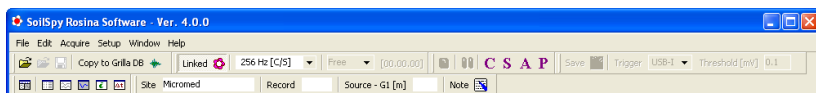


Figure 15. Toolbar of the main window (detail of the top of Figure 14).

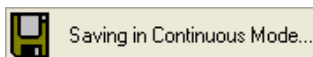
The **SoilSpy** main window (Figure 14) is composed of a menu bar, a toolbar (Figure 15) and a message bar on the bottom.

MESSAGE BAR

With reference to Figure 14 (bottom part):

- [1] the green/yellow/red light signals if the command/acquisition is working or if any problem is encountered. Green indicates OK status, yellow signals warnings and red signals errors. The caption on the right describes, when present, the nature of the problem,
- [2] indicates which among the CONTINUOUS (C), STACKING (S), AVERAGING (A) and PICKING (P) mode is active (see p. 55 onwards for the mode description),

- [3] [applies to CONTINUOUS mode, p. 55]. Indicates whether the recordings are being saved on the PC.



- [4] [applies to STACKING mode, p. 57]. Indicates whether the recordings are being saved on the PC.



- [5] indicates the number of modules physically linked to the PC.

TOOLBAR

The different parts of the main window toolbar (Figure 15) are described below. The corresponding menu commands are also listed below.

PART 1

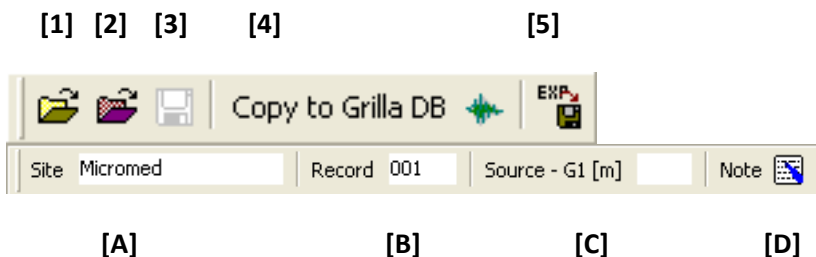


Figure 16. Detail of the main window toolbar (Figure 15).

- [1] **OPEN** use this command to open a .TRC file acquired with **SoilSpy**. From the menu bar you can access this command by clicking FILE >> OPEN,

- [2] **OPEN LAST** opens the last .TRC file created. From the menu bar you can access this command by clicking FILE >> OPEN LAST,
- [3] **SAVE** saves the file “Average[...].trc” file created under the AVERAGE (A) mode or the file “Dromochrone[...].txt” created under the PICKING (P) mode (see p. 70). From the menu bar you can access this command by clicking FILE >> SAVE,
- [4] **COPY TO GRILLA DB** copies the acquired file in the *Grilla* DB for processing,
- [5] **EXPORT** exports the last opened “Average##.trc” file to another file format (usually SEG-2). This operation is done as default in the corresponding “Stacking##.trc” file,
- [A] **SITE** allows to enter a name to identify the recording. This is the [Your site] folder in which data will be saved. The following characters are not allowed in this field: \ / : * ? “ <> |
- [B] **RECORD** allows to enter a second name/number to identify the recording. The record number can be incremented automatically by setting the CLASSICAL name convention from the SETUP >> OPTIONS, GENERAL tab (**Figure 33**).
- [C] **SOURCE – G1** allows to enter the source offset (distance between the shot and the first geophone) for active seismic surveys,
- [D] **NOTE** allows to enter 1024 text characters (comments).

PART 2

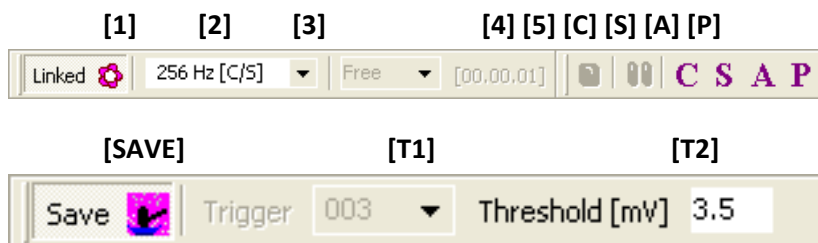


Figure 17. Detail of the main window toolbar (Figure 15).

- [1] LINK(ED)** establishes the communication with **SoilSpy** and shows the PARAMETER window (Figure 11),
- [2] SAMPLING RATE** allows to set the sampling frequency. The command is enabled only when data saving is not active,
- [3] hh:mm:ss** displays the time elapsed from the beginning/saving of the acquisition (SAVE button),
- [4] STOP** stops the acquisition and saving,
- [5] PAUSE** arms/disarms the trigger channel,
- [C] CONTINUOUS (C)** displays the windows for the CONTINUOUS mode described on p. 55. Note that this command does not save the data to the PC. It just shows them on the screen,
- [S] STACKING (S)** displays the windows for the STACKING mode (p. 57),
- [A] AVERAGE (A)** displays the windows for the AVERAGE mode (p. 65),

[P] PICKING (P) displays the windows for the PICKING mode (p. 70),

[SAVE] SAVE saves the data to the PC,

[T1] TRIGGER sets the trigger channel (or the triggering device),

[T2] THRESHOLD sets the trigger threshold in mV (see also p. 61).

48

PART 3



Figure 18. Detail of the main window toolbar (Figure 15).

[1] SPLIT splits the screen to optimize the visualization of the windows. From the menu bar you can access this command by clicking WINDOW >> SPLIT,

[2] PARAMETER displays the PARAMETER window. From the menu bar you can access this command by clicking WINDOW >> PARAMETERS,

[3] CONTINUOUS [C] displays the CONTINUOUS window (p. 55). From the menu bar you can access this command by clicking WINDOW >> CONTINUOUS,

[4] STACKING [S] displays the STACKING windows (p. 57). From the menu bar you can access this command by clicking WINDOW >> STACKING,

- [5] **FILE INFO** displays the FILE INFO window. From the menu bar you can access this command by clicking WINDOW >> FILE INFO,
- [6] **PICKING [P]** displays the PICKING windows (p. 70). From the menu bar you can access this command by clicking WINDOW >> PICKING.

MENU BAR

With reference to the items of the menu bar not described so far (Figure 15):

EDIT >> BEEP ON SHOT enables/disables a beep when the trigger threshold is passed and data are saved for the set number *N* of seconds,

HELP >> USER MANUAL loads the **SoilSpy** user's manual,

HELP >> ROSINA HOME PAGE redirects to the **SoilSpy** web page,

HELP >> ABOUT ROSINA displays information about the **SoilSpy** software version.

TRACE WINDOW

In the trace window (Figure 19), the recording channels are displayed in order from top (channel closest to the PC) to bottom. Black and blue and blue colors are used to represent odds and even channel numbers.

The vertical dashed lines indicate time steps of 1 second. The vertical dotted lines indicate time steps of 20 ms. The horizontal dashed lines indicate the gain level.

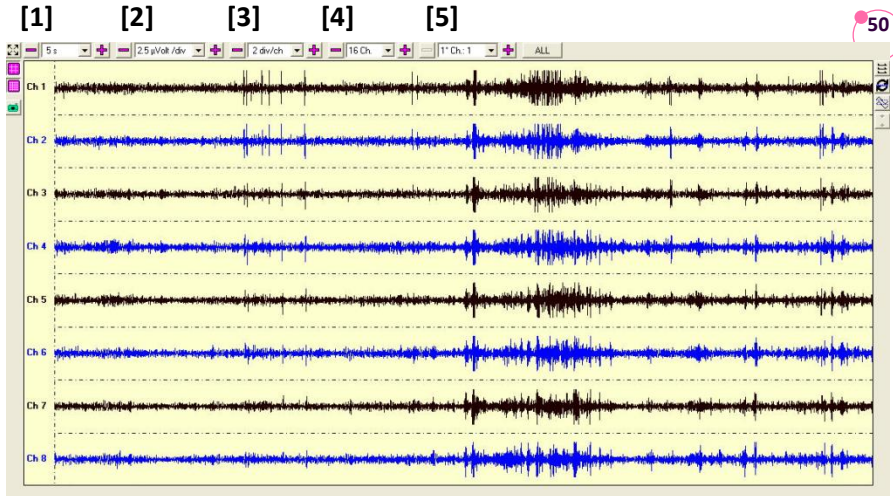


Figure 19. Trace window showing the electronic noise of the channels (no geophone is linked to the digitization modules).

- [1] 5 sec.** changes the total number of seconds of recording displayed on the screen,
- [2] 2.5 μ Volt / div** sets the amplitude (in volt) for each division. This is only a graphic tool, no amplitude change will affect the data. This settings do not apply when data are shown normalized,
- [3] 2 div/ch** sets the number of divisions per channel. This is only a graphic tool, no amplitude change will

affect the data. This settings do not apply when data are shown normalized.

Note: visual amplification can be increased and decreased by using the keyboard +/- buttons.

51

[4] 16 Ch. changes the total number of channels displayed on the screen (this is only a graphic tool and does not affect the acquisition settings),

[5] 1° Ch:1 changes the ordinal number of the first channel displayed on the screen (this is only a graphic tool and does not affect the acquisition settings).

The buttons on the right and left side of trace window (Figure 19) will be described for each acquisition mode, CONTINUOUS and STACKING.

DATA ACQUISITION ON LINE PROCEDURES

STARTING AN ACQUISITION

GENERAL SETTINGS

- 1) If the button LINK  has not been pressed yet, go back to p. 29,
- 2) to set the geometry of the deployment follow the instruction on p. 37,
- 3) set a name for the acquisition folder by filling the text box *Site* and *Record* in the main window toolbar (Figure 16). In this manual we call this folder [Your site]⁴,
- 4) set the sampling frequency by acting on the corresponding list box in the main window toolbar (Figure 15, element 2 in Figure 17),

53

There are 2 modes of data acquisition in **SoilSpy**. Connect **SoilSpy** to the PC and click LINK  to enter on of the two modes.

CONTINUOUS MODE (C). Continuous (i.e. long duration) recordings are recommended for 1D and 2D *passive* seismic surveys (ReMi™, passive MASW, SPAC, ESAC, etc.) or vibration monitoring. There is no time-limit in the length of the acquisition except the physical memory capacity of the PC used to store data or the maximum file length allowed by the operating system.

⁴ The following characters \ / : * ? " < > | are not allowed in the file name.

To enter this acquisition mode, click the button “C” in the main window toolbar (Figure 15, Figure 17).

STACKING MODE (S). Stacking (i.e. the sum of the recordings every time the acquisition is triggered by a signal above a specified threshold) is a standard procedure to increase the signal-to-noise ratio, since it cancels the random signal and enhances the coherent signal. This is commonly used in any *active* seismic survey (refraction, reflection, MASW, downhole, crosshole, etc.) and has a typical duration of a few seconds. Some pre-trigger signal is also saved to ensure that no useful signal is lost.

54

To enter this acquisition mode, click the button “S” in the main window toolbar (Figure 15, Figure 17).

Stacked acquisitions require to set a trigger level. How to set this value is described in the following page.

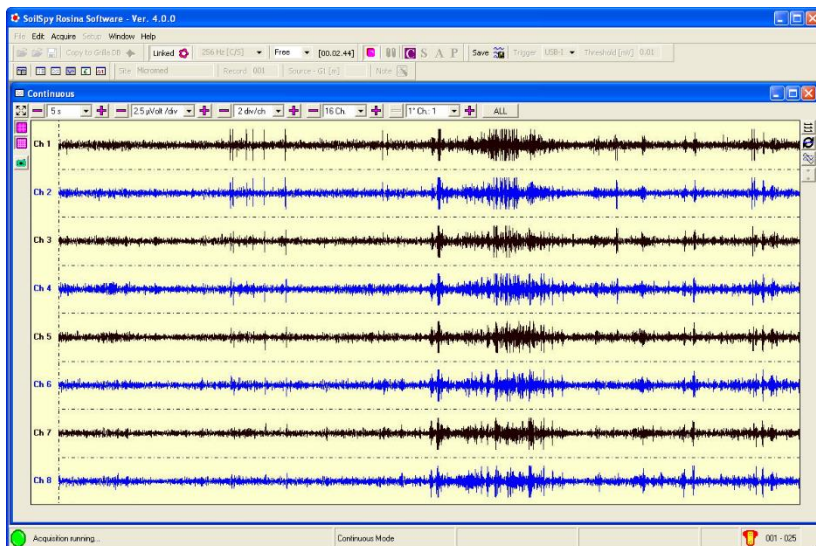
Acquisition mode	Applications
CONTINUOUS (C)	<p>All passive seismic surveys and continuous vibration monitoring:</p> <ul style="list-style-type: none"> □ to check the overall noise level □ ReMi™ (Refraction Microtremor) □ passive MASW (Multichannel Analysis of Surface Waves), □ SPAC (Spatial Autocorrelation) □ ESAC (Extended Spatial Autocorrelation) □ etc.
STACKING (S)	<p>All active seismic surveys:</p> <ul style="list-style-type: none"> □ refraction □ reflection □ MASW (Multichannel Analysis of Surface Waves) □ downhole, □ crosshole, □ etc.

Table 1. Summary of the acquisition modes suited for different seismic surveys.

CONTINUOUS MODE

Click RUN on the main window toolbar (Figure 16) to start visualizing the recordings, which will appear as in Figure 20.

Recordings will be saved only when the button CONTINUOUS is clicked (element [C] in Figure 17) and its background color is switched to magenta.



56

Figure 20. Main window during the acquisition. Note that the data are not saved at this stage but only displayed on the screen. Click “Save” from the toolbar to save the data.

The length of the saved recording is shown in the [hh:mm:ss] field of the main window toolbar (Figure 17).

Recordings will be saved in [Your folder], under the “[Your site] \ CONTINUOUS” subfolder. The .trc file name is composed of the following strings: “Continuous [Your Site] date time.trc”, where date is in the format dd-mm-yyyy and time in the format hh-mm-ss.

The full path to your file is therefore:

[Your folder] \ [Your site] \ CONTINUOUS \ Continuous [Your Site] date time.trc

A summary of file and folders organization is given on p. 76.

To modify the path of [Your folder] select SET UP >> FOLDER >> NEW FOLDER from the main window menu.

Recordings saved under this mode can be copied to and analyzed with the *Grilla* software. Copy single .trc files by using the *Copy to Grilla DB* button (element [4] in Figure 16).

57

To modify the trace view, use the side buttons (Figure 20):



Toggle frame



Show the main grid divisions



Show the secondary grid divisions



Take a screenshot



Continuously moving traces



Rotate traces (swap vertical and horizontal axis)



Normalize the trace amplitude (i.e., scale each trace to its maximum value). It applies only off-line.

STACKING MODE

In the STACKING mode, recordings are saved (both separately and stacked) when the threshold is exceeded on the channel selected as trigger. Set the trigger channel from the SET TRIGGER function of the PARAMETER window (Figure 12) or straight from item [T1] in main window toolbar (Figure 17).

To set different amplification levels (if needed) on different channels (e.g., incremental gain), follow the instruction on p.36. The default resolution of 1 $\mu\text{V}/\text{digit}$ on all channels is normally adequate for standard mid-size acquisitions (~100 m array aperture).

58

When you are ready to start the acquisition, click RUN [] from the main toolbar to monitor the overall noise level (left panel in Figure 21), then click the button [S] until its background color is switched to magenta. You are now ready to shot the ground.

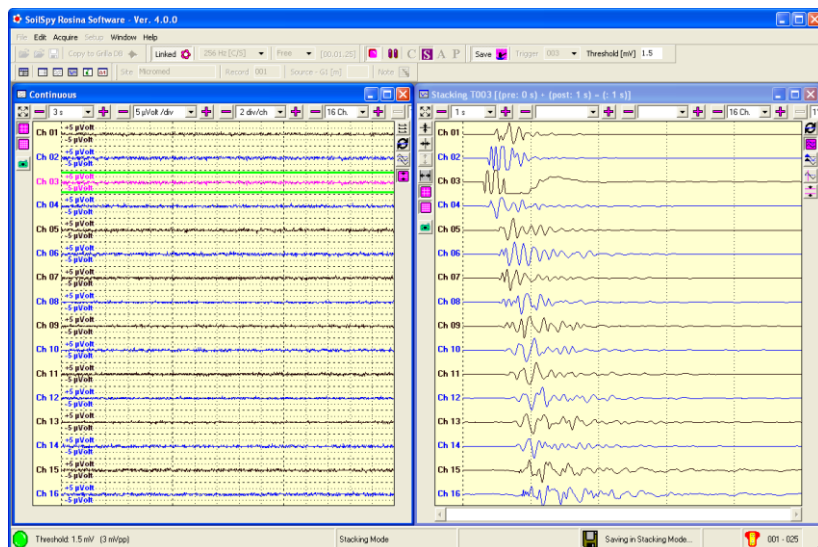


Figure 21. Under STACKING mode (S) the continuous signal is shown on the left panel, while the stacked signal is shown on the right panel. To improve the visualization of the stacked signal, normalize the amplitude of the recordings and use the wiggle option (p. 61).

The stack (sum) of the triggered signals is displayed on the right panel in Figure 21. When the seismic source is repeatable (same

location and approximately same source function), the stacked signals become clearer and clearer, since random noise tends to cancel out in the summation.

Each recording passing the trigger can be stacked automatically (default) or on demand. To switch between these options, click SETUP >> OPTIONS from the **SoilSpy** main menu (Figure 22).

59

Select AUTOMATIC PAUSE to disarm the trigger automatically after each shot.

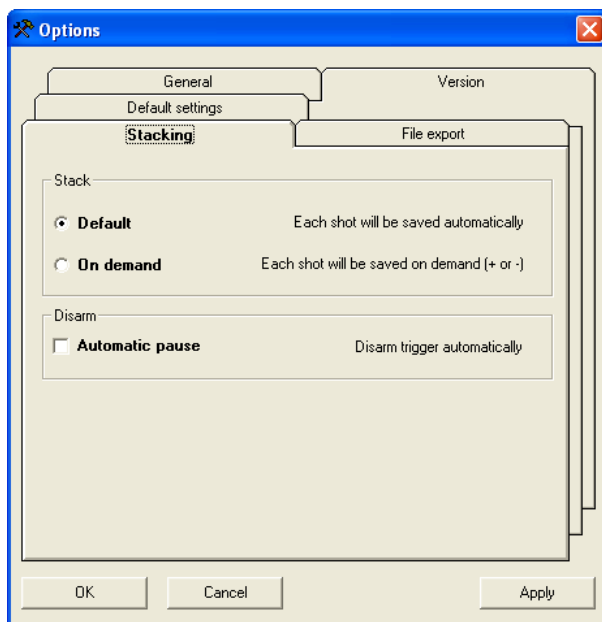


Figure 22. OPTIONS window, STACKING tab.

The file containing the stacked signal is saved in [Your folder], under the “[Your site] \ STACKING T##” subfolder, where T## indicates the number of the trigger channel.

The recording .trc file name is: “Average (**) Stacking T## [Your Site] date time.trc”, where date is in the format dd-mm-yyyy, time in the format hh-mm-ss and (**) indicates the ordinal number of the “Average[...].trc” file, since different average files can be obtained by adding/removing single stacks (see p. 65).

60

The full path is therefore:

[Your folder] \ [Your site] \ STACKING T## \ Average (**) Stacking T## [Your Site] date time.trc

The path [Your folder] \ [Your site] \ STACKING T## contains the files “Stacking T## [Your Site] date time.trc”, where all the single *N* second length segments used to produce the “Average[...].trc” files are saved. These are stored in a way to be reviewed one by one. Retaining different combinations of triggered recordings produce different “Average[...].trc” files (see also p. 65).

Note: as an alternative to the default file name convention described above, the classical file name convention can be used, by selecting the corresponding item in the SETUP >> OPTIONS window (Figure 9), FILE NAME tab. The classical file name convention consists in a prefix (the Site name) and an incremental number. This is particularly useful, e.g., in the down-hole surveys (Rec01.trc, Rec02.trc, Rec03.trc, etc.).

A summary of the file and folder organization is given on p. 75.

To modify the trace view, use the side buttons (Figure 21):



Toggle frame



Show the main grid divisions



Show the sub grid divisions



Take a screenshot



Rotate traces (vertical – horizontal)



Normalize the trace amplitude (i.e., scale each trace to its maximum value).



Wiggle



Show the trigger time line



Show the trigger threshold

61

HOW TO SET THE TRIGGER THRESHOLD IN STACKING MODE

SoilSpy supports different triggering options, all based on the ‘threshold’ concept, i.e., signal will be acquired for the selected duration after a threshold is passed.

When running the STACKING mode (p. 57), two horizontal green lines appear above and below the trigger channel in the CONTINUOUS window (left panel in Figure 24). These lines represent the level to be met on that channel to start the acquisition. The threshold level should be set to a value larger enough than the background seismic noise in order to prevent accidental triggering.

Since background seismic noise varies considerably from site to site, to change the trigger threshold drag and drop the green lines to the desired level.

The threshold level can also be set manually specifying its value in milliVolts (mV) in the text box shown in Figure 24 (yellow frame).

62

The threshold level should remain the same during a specific survey, in order for the recordings to be started all at the same amplitude level.

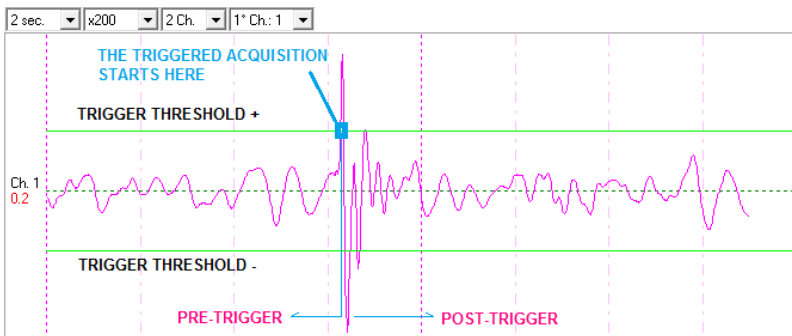


Figure 23. TRIGGER SETTINGS. The green lines indicate the threshold level after which the signal will be acquired in STACKING mode.

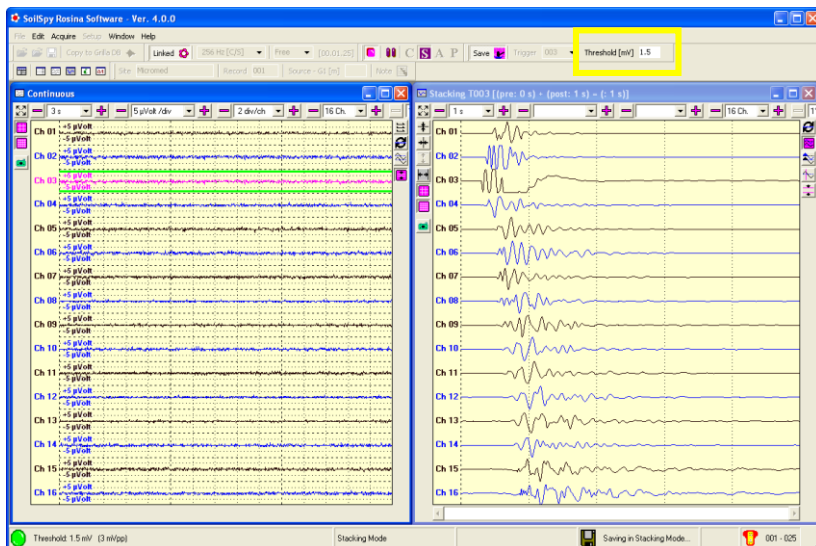


Figure 24. TRIGGER SETTINGS. The threshold can be moved to the desired level (above background seismic noise) by simply dragging and dropping the horizontal green lines up and down with the mouse or by modifying the TRIGGER THRESHOLD [mV] level in the yellow framed text box. In this example the trigger channel is the number 3.

PRE-PROCESSING OFF-LINE PROCEDURES

AVERAGE MODE

In the AVERAGE mode [A] the recordings from different shots acquired under the stacking mode (S, p. 57) can be reviewed and selected/deselected to produce different stacks (here called ‘averages’) or to reverse the signal phase in S-wave refraction/in-hole surveys.

65

To enable this function on the last acquired set of recordings, click the button [A] in the main window toolbar (Figure 17).

To enable this function on set of recordings acquired previously, select FILE >> OPEN from the main window menu and open the desired⁵ stacking .trc file, whose path has the following format: [Your folder] \ STACKING T## \ “Stacking T## [Your Site] date time.trc”. You will be directed to a screen split into 3 parts (Figure 25), described below.

⁵ Note that only “Stacking[...].trc” files can be opened. Opening an “Average[...].trc” file will simply produce a averaged file with no chance to select/deselect/reverse the single shots.

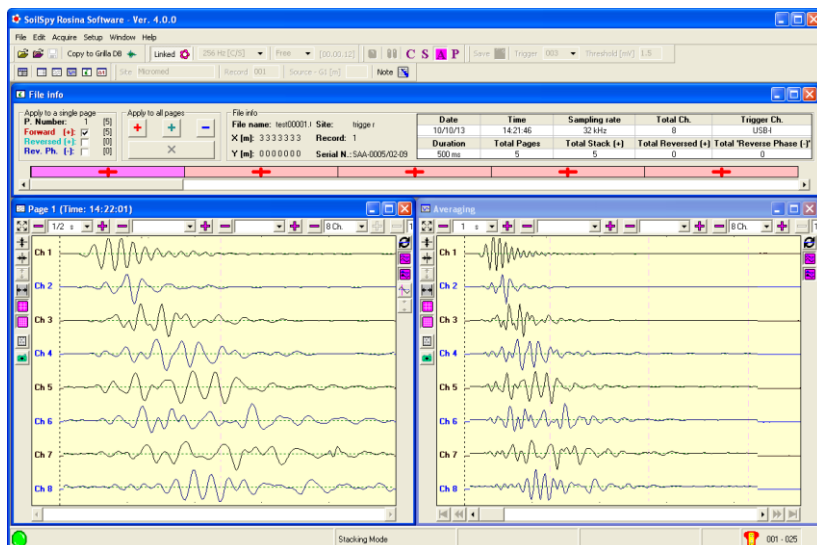


Figure 25. AVERAGE mode. FILE INFO frame (top), PAGE frame (left), AVERAGE frame (right).

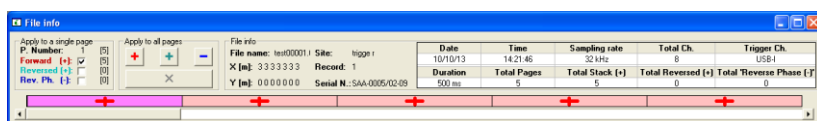


Figure 26. File Info frame in the AVERAGE mode.

FILE INFO, which is in turn composed of 3 parts (Figure 26):

FILE INFO shows the file information (file name, site name, record name, geometry x, geometry y, device serial number, acquisition date, acquisition time, sampling rate, total number of channels, trigger channel, length in seconds of each stack window, number of triggered windows available (Total Pages), number of windows selected for stacking (Total Stack +), number of selected windows acquired with reverse source (Total Reversed +) which will

be summed to Total Stack (+), number of selected windows which will be reversed (Total “Reverse Phase” -) before being summed to the Total Stack (+) windows. See Figure 27 and Figure 28 to better understand the nomenclature.

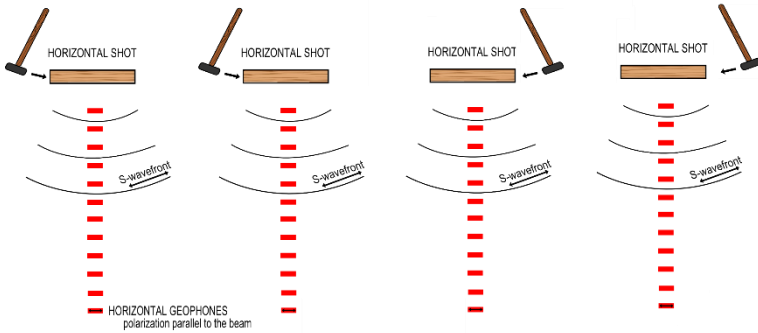
Note that since this information is saved in the file header, this will not change until you do not save file changes.

67

Active seismic surveys performed with vertical geophones for P-waves or Rayleigh waves (e.g., MASW) relies on the stack of the signal triggered from several shots. In this case all the good windows (pages) will just be stacked (+, +, +...). Active seismic surveys dealing with S or Love waves need a separate discussion. Figure 27 and Figure 28 illustrate two common ways of producing the horizontal waves (also note the polarization of the horizontal geophones in respect to the array line and the source).

CASE 1 (Figure 27): N_1 shots are produced in one direction, N_2 shots are produced in the opposite direction. In this case the P-wave arrivals have the same shape, the S-wave arrivals have opposite phase. The sequence in **SoilSpy** should therefore be STACK +, STACK +, STACK +, ... (N_1 times), REVERSED +, REVERSED +, REVERSED +, ... (N_2 times).

CASE 2 (Figure 28): N horizontal shots are produced in the same direction. In this case both the P and S-wave arrivals have the same shape. The sequence in **SoilSpy** should therefore be STACK +, STACK +, STACK +, ... ($N/2$ times), REV. PHASE -, REV. PHASE -, REV. PHASE -, ... ($N/2$ times).



68

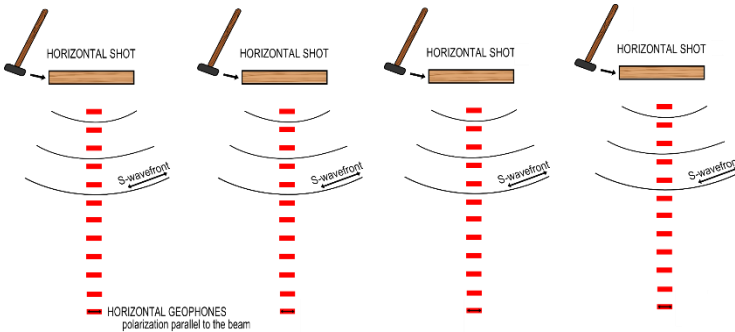
STACK+

STACK+

REVERSED+

REVERSED+

Figure 27. Example of S-wave acquisition. Note the polarization of the horizontal geophones and their alignment perpendicular to the source. In this examples 2 horizontal shots are produced in one direction (left) and 2 more in the opposite direction (right). The sequence of shots in the AVERAGE mode should be STACK +, STACK +, REVERSED +, REVERSED +.



STACK+

STACK+

REV. PHASE-

REV. PHASE-

Figure 28. Example of S-wave acquisition. Note the polarization of the horizontal geophones and their alignment perpendicular to the source. In this examples 4 horizontal shots are produced in the same direction. The sequence of shots to produce a clear S-wave onset in the AVERAGE mode should be STACK +, STACK +, REV. PHASE -, REV. PHASE -.

APPLY TO A SINGLE PAGE the actions STACK +, REVERSED + and REVERSE PHASE - can be applied to each shot separately by checking the corresponding box within the “Apply to single page” frame. In order to discard a page (shot) deselect all the options for that page (shot).

69

APPLY TO ALL PAGES the actions STACK +, REVERSED + and REVERSE PHASE - can be applied to all shots together by checking the corresponding box within the “Apply to all pages” frame. In order to discard all pages (shots), click the cross x button.

The actions STACK +, REVERSED + and REVERSE PHASE - can be applied to each shot separately by clicking on the pink-shaded buttons (Figure 26):



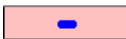
STACK +



REVERSED +, i.e. stacks the signal by considering that the source was reversed (Figure 27)



Discards the corresponding shot/page/window



REVERSE PHASE+, i.e. stacks the signal by considering that the source was always the same (Figure 28)

The result of the window selection is automatically updated in the AVERAGE panel (bottom right panel in Figure 25).

Once the selected stacking sequence is satisfactory, click FILE >> SAVE on the main window toolbar and the corresponding final file will be saved as

[Your folder] \ [Your site] \ STACKING T## \ Average (**) Stacking T## [Your Site] date time.trc

70

where (**) is an ordinal number. For example, if 3 “Average[...].trc” files are already present, the following file will be named “Average (04) [...].trc”.

This action also creates a file in the standard SEG-2 format, with the same name convention described above and .sg2 extension.

The final file is now ready to be analyzed in the PICKING mode (P) or to be viewed/analyzed with *Grilla* or other software.

PAGE (##) this panel (bottom left in Figure 25) shows the single shot/page (with ordinal number ##) selected by clicking the pink-shaded buttons of the FILE INFO frame.

AVERAGING this panel (bottom right in Figure 25) shows the result of the stack-actions selected in the FILE INFO frame and summarized by the pink-shaded buttons (+, -, x).

PICKING MODE

The picking mode [P] is a tool which allows to perform the time-picking of the P-S wave first breaks. This finds its application in the seismic refraction and reflection methods.

At the end, a file containing the couples (Δt -distance), where Δt is the time from the trigger and distance is the distance of the receiver from the source, will be saved.

To enable this mode click the button [P] in the main window toolbar (Figure 17). You will be asked to select and open a file “Average [...] .trc”.

71

The screen will be again divided into 3 frames (Figure 29).

FILE INFO (as described on p. 66)

AVERAGING this window shows the recording saved in the selected file. The original trigger line (t_0) is appears as a vertical blue line. If you need to adjust its position, select the trigger T## channel on the PICKING panel (right) and scroll the vertical magenta line to the new position by clicking the right mouse button and dragging the mouse. This will be the new time t_0 in respect to which Δt will be computed in the PICKING form.

PICKING to start picking the wave arrival times of the other channels:

- click the left mouse to select the channel (click close to the line of the desired channel),
- click the right mouse button to pick the desired time t_i . The time difference $\Delta t_i = t_i - t_0$ will be saved as first arrival times of the corresponding channel and will be updated in the right panel.

Repeat the procedure for all channels. The selected times will appear as green vertical line in the AVERAGING panel.

Further options:

TRIGGER HOME resets the trigger to its original position,

LOCK TRIGGER lock/unlock the trigger position. Unlock it if you need to adjust t_0 .

SHOW TIME LINES displays/hides the picking lines (green vertical dashes).

72

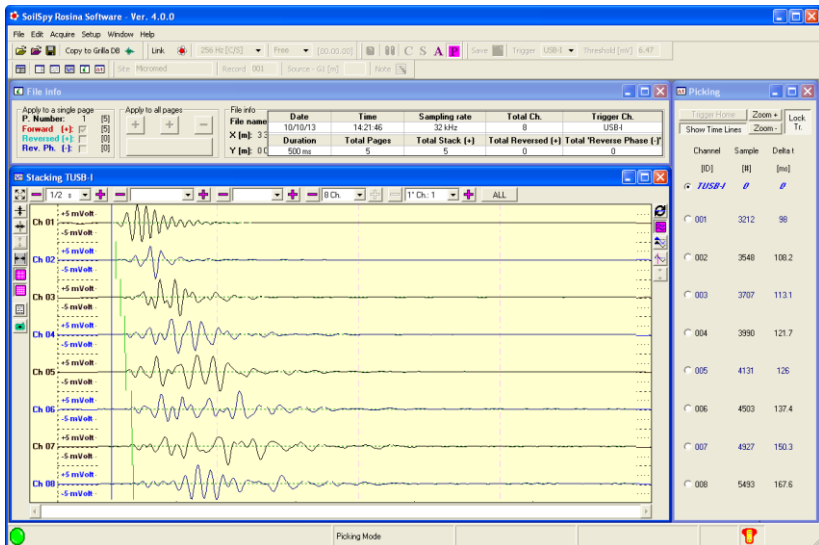


Figure 29. PICKING mode. FILE INFO (top) panel: displays information saved in the “Average [...]trc” file. AVERAGE (bottom) panel: shows the traces saved in the “Average [...]trc” file. PICKING (right) panel: shows Δt times (and number of samples) between the trigger time (t_0) and the selected arrival on each channel (t).

Click FILE >> SAVE from the main window menu or SAVE from the main window toolbar to save the file as “DROMOCHROME [...] .txt”. The full path this file is therefore:

[Your folder] \ [Your site] \ STACKING T## \ Dromochrone Average (**) Stacking T## [Your Site] date time.trc

73

A summary of file and folders organization is given on p. 75.

The “Dromochrone[...] .txt” file contains a number of header lines (Figure 30), file name, serial number of the instrument used, date of acquisition, time of acquisition, number of channels, sampling rate, length in seconds of the stacked (average) file, x and y coordinates of the receivers (in terms of distances $x_{i+1}-x_i$, $y_{i+1}-y_i$), trigger channel, pre-trigger duration in samples and [ms].

A table reporting for each channel (row) the Δt_i time elapsed from the trigger (t_0) to the picked phase t_i ($\Delta t_i = t_i - t_0$), both as number of samples and time [ms], follows.

```

File version:
1.0

Original File Name:
test00001.trc

Serial N.:
SAA-0000/00-15

Date [dd/mm/yy]:
23/01/2015

Time [hh.mm.ss]:
15.27.27

Total Ch. [#]:
008

Sampling rate [Hz]:
32768

Seconds/Page [s]:
0.5

Geometry X (inter-receiver distance) [m]:
3 3 3 3 3 3 3

Geometry Y (inter-receiver distance) [m]:
0 0 0 0 0 0 0

Trigger Ch. [ID]:
USB-I

Pre-Trigger sample [#]:
0

Pre-Trigger time [ms]:
0.00

```

Channel [ID]	Sample [#]	Delta t [ms]
001	3212	98
002	3548	108.2
003	3707	113.1
004	3990	121.7
005	4131	126
006	4503	137.4
007	4927	150.3
008	5493	167.6

Figure 30. Typical content of a picking file ("Dromochrone [...].txt").

FILE NAME AND MANAGEMENT

FILE NAME

Remember that the following characters \ / : * ? " < > | are not allowed in any file name.

Figure 31 shows how files acquired in the CONTINUOUS mode (p. 55) are stored.

76

[Your folder] is the directory selected by the user to store recordings.

[Your site] is the name given by the user in the *Site* text box.

The “Continuous[...].trc” files are stored in the CONTINUOUS subfolder.

The full name of the “Continuous[...].trc” file is “Continuous [Your site] date time.trc”



Figure 31. Folder tree for the “Continuous[...].trc” files.

Figure 32 shows how files acquired in the STACKING/AVERAGE/PICKING (p. 57, 65, 70) modes are stored.

[Your folder] is the directory selected by the user to store recordings.

[Your site] is the name given by the user in the *Site* text box.

The “Stacking T##[...].trc” files are stored in the STACKING T## subfolder, where T## is the number of the trigger channel.

The full name of the “Stacking T##[...].trc” file is “Stacking T## [Your site] date time.trc”.

A standard SEG-2 file will also be saved in the same folder, with the same name and extension .sg2.

77

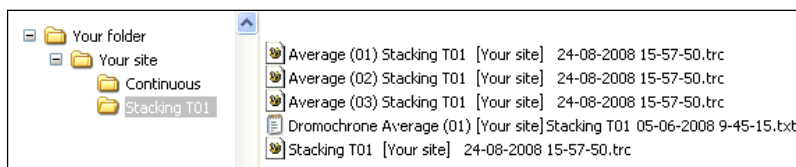


Figure 32. Folder tree for the “Stacking/Average[...].trc” files.

The “Average (**)[...].trc” files are stored in the STACKING T## subfolder, where (**) is the ordinal number of the Average file. Average files are obtained from “Stacking[...].trc” files through the AVERAGE tool described on p. 65. The full name of the Average (**)[...].trc file is “Average (**)” + the full “Stacking[...].trc” file name from which the Average file is computed.

A standard SEG-2 file will also be saved in the same folder, with the same name and extension .sg2.

The “Dromochrone[...].txt” files are stored in the STACKING T## subfolder. Dromochrone files are obtained from “Average[...].trc” files through the PICKING tool described on p. 70. The full name of the “Dromochrone [...].txt” file is “Dromochrone” + the full “Average[...].trc” file from which the Dromochrone file is derived.

Example 1: “Continuous Venice 26-08-2008 15-26-59.trc” indicates a file acquired in the CONTINUOUS mode, in Venice (Italy) on August 26th 2008 at 15:26:59.

Example 2: “Stacking T11 London 24-01-2012 03-18-12.trc” indicates a file acquired in the STACKING mode, with the 11th channel as trigger channel, in London (UK) on January 24th 2012 at 03:18:12.

78

FILE MANAGEMENT

The file format of **SoilSpy** recordings is the .TRC MoHo s.r.l. format. This file can be read from the *Grilla* software and extracted to other ASCII/binary formats from there.

Recordings acquired in the STACKING and AVERAGING mode are also saved, as default settings, in the international standard SEG-2 format (.sg2 extension).

By exporting the SEG-2 files, additional settings can be applied, that is:

- the trigger channel can be removed
- the DC offset can be removed (note that the DC offset can be removed also during the preliminary operations of system calibration, p. 82).

To access these functions, click SETUP >> OPTIONS and select the FILE EXPORT tab (Figure 33).

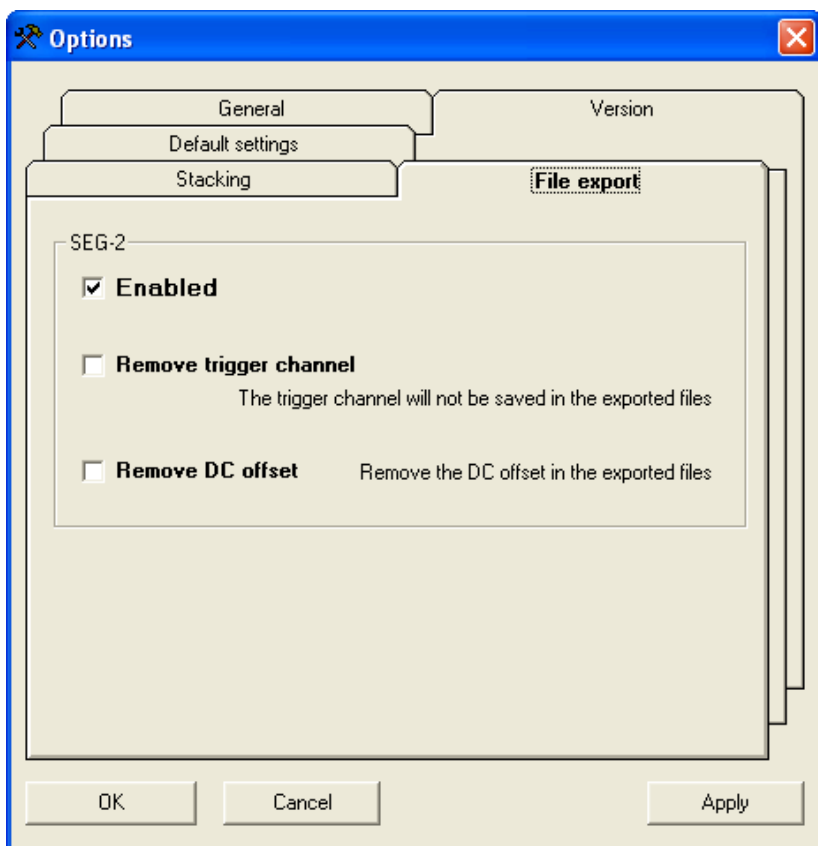


Figure 33. SETUP > OPTIONS window. FILE EXPORT tab.

TRIGGER

SoilSpy allows any geophone/channel to be used as a trigger. The trigger channel can be set by following the instruction on p. 35. The Δt time of arrival of the wave of interest to the triggering channel is obviously zero. Using an internal channel of **SoilSpy** as a trigger has the advantage of reducing the number of cables. Consult p. 61 for instruction on how to set the trigger threshold.

81

Traditional analog triggers (e.g., hammer-starters as in Figure 34, left) can still be used and should be connected to the central plug-in of the USB-interface (Figure 34, right). In this case all the picked wave arrival times Δt to the geophones will be larger than zero. Pre-trigger data can be saved also in this case. From the PARAMERT window, SET TRIGGER >> USB-I(nterface), as described on p. 35.



Figure 34. Connection of an external (analog) trigger to the USB-Interface of **SoilSpy**.

CALIBRATION PROCEDURES AND GENERAL SYSTEM CHECK

BASELINE CORRECTION OR CALIBRATION

Removing the DC offset from each channel is a recommended operation to do on the first use of **SoilSpy** or whenever there appears to exist a non-negligible offset on some channels.

83

This operation takes a few seconds and can be started by clicking SETUP >> BASELINE correction from the main window menu. It is recommended to perform this operation with all the sensors unplugged from the system. If the sensors are not unplugged, it is recommended to avoid the generation of noise close to some sensors. If this is not possible, repeat the operation at a quieter time.

Note that the correction values will be stored in the PC and it is not necessary to perform the calibration before any system use.

AMPLIFIER TEST

The functionality of the amplification-digitization modules (Figure 3) can be checked by clicking SETUP >> RUN TEST 1 or SETUP >> RUN TEST 2 from the main window menu.

A box function (1 Hz) will be injected in each amplifier (TEST 1: 5 mV p.p.; TEST 2: 20 mV p.p.) and - in a correctly working system - should appear with the same amplitude, duration and frequency on all channels, as in Figure 35.

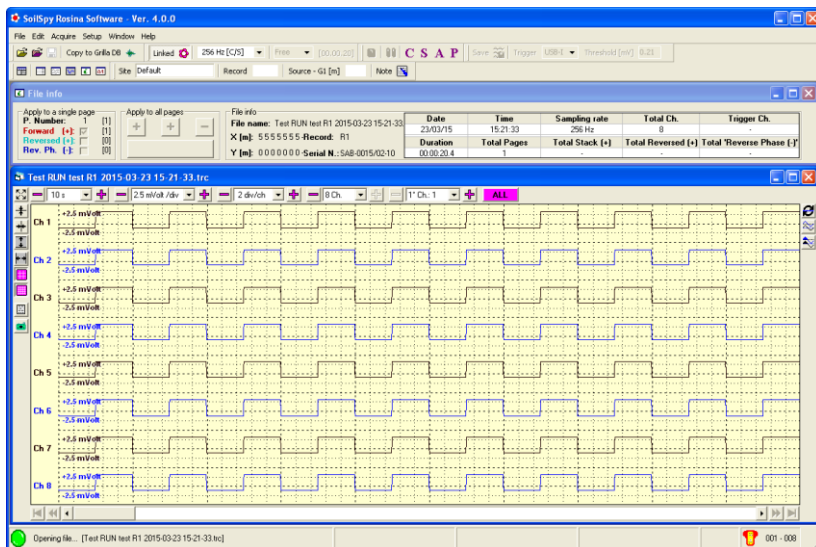


Figure 35. Typical screen appearance during a regular amplifier test.

PROBLEMS

MANUAL INITIALIZATION OF MODULES

Each digitization module is identified by an *internal number*, ranging from 1 to the maximum number of digitization modules installed in **SoilSpy**.

86

In order to avoid confusion we recommend that you keep as internal number of each module the same number displayed on the external yellow sticker, whenever possible.

The procedure we are going to describe should only be used to reset the *internal number* of any module when it has accidentally been lost due to communication problems between the PC and **SoilSpy**.



Extreme attention must be paid when applying the following procedure in order to avoid the malfunctioning of the device.

When to apply the procedure

The manual initialization of the modules must be applied when:

1. one or more modules do not answer the REFRESH command and/or other commands, persistently being in an **Error** status,
2. after clicking the RUN button the acquisition does not start or stop without any reason (red light, "**Acquisition error**").

However note that these are necessary but not sufficient conditions to apply the manual initialization procedure.

Should the manual initialization procedure of modules be necessary, proceed as follows:

- A. exit the **SoilSpy** software (menu FILE >> EXIT in the main form),
- B. unplug the USB interface from the PC and *wait at least 1 minute before proceeding*,
- C. plug the USB interface to the PC,
- D. launch the **SoilSpy** software,
- E. click LINK  in the main window toolbar,
- F. check the PARAMETER window. Should **Error** messages be present again in the ID column, then proceed with the Manual Initialization Procedure, otherwise the problem has been solved.

Manual initialization procedure

To be applied only if the attempts done in the section “When to apply the procedure” (p. 86) were unsuccessful.

1. **Unplug all the sensors (geophones) from the array. All digitization modules must be free from their sensors,**
2. Launch the **SoilSpy** software and click LINK  in the main window toolbar,
3. select ID START from the command list (p. ID START42) and click Send. The LED of all modules will start flashing once a second. This signals that the modules are ready for the next stage. Each module is now ready to change its *internal number*,

4. short-circuit the module which you want to change the internal number of. The short-circuit must be applied on a single module at a time. To short-circuit the module you can use the specific connector provided with SoilSpy (Figure 36).

88



Figure 36. Connector for short-circuit.

5. select ID INIT. MODULE from the command list (p. 42), set the *internal number* of the module and click Send,
6. the short-circuited module will signal if the procedure succeeded (flashing LED lasting less than one second). After that, the LED will be switched off and the module will be “sleepy” until the user exits the procedure (ID END button). Should you wish to reset the *internal number* of the same module, you need to exit the procedure (click ID END) and start again from item 1 above,
7. should you wish to reset the internal number of a different module, restart from item 4 above,

to end the procedure, click ID END and Send. All modules will signal the end of the process with a double flash.

TECHNICAL SPECIFICATIONS

Name:	SoilSpy
Description:	portable multichannel digital seismic acquisition system
Array-PC connection:	via USB interface
Sensor-Array connection:	bipolar, one for each module
Input impedance:	20 k Ω (12 k Ω attenuated mode)
Dynamic range:	142 dB, from ± 3.2 mV to ± 665 mV (8 options)
Resolution:	from 0.1 μ V/digit to 20 μ V/digit (8 options)
Sampling rate:	89 kHz on <i>each</i> channel, undersampling through averaging
Data output:	[C/S]: 256 Hz, 512 Hz, 1 kHz on each channel [S]: from 2 kHz to 32 kHz on each channel
Conversion:	synchronized on each channel
Maximum continuous recording time:	limited only by PC memory storage capability
Data transmission:	asynchronous bidirectional serial, 1Mbaud
Cross-talk:	non-existent

Status indicators:	LED on each module
Average consumption:	<p>7.5 mA @256 Hz per channel (120 mA @256 Hz on 16 channels)</p> <p>8.1 mA @512 Hz per channel (130 mA @512 Hz on 16 channels)</p> <p>9.4 mA @1024 Hz per channel (130 mA @1024 Hz on 16 channels)</p>
Power supply:	Powered directly from the PC via USB. <i>No external additional batteries</i>
Internal Voltage:	+3.3V
Number of channels:	1 for each module, analog band DC-360 Hz
Number of modules:	group of 8 or multiples (8, 16, 24, 32...). Other combinations on demand
Distance among modules:	typical distance is 5.3 m. The red rings along the wire mark the 5 m interdistance. 0.3 m are left free to repair possible wire breakings or to overcome obstacles
System Size:	Single module: 53(L) x 63(W) x 22(H) mm

Wire winder (external rim):
typical for a 16 channel system:
0.24(L) x 0.24(W) x 0.22(H) m

Weight: < 200 g per module + 5 m wire.
~3.2 kg for a 16 module, 5 m interspace system (sensors and wire winder excluded)

92

Length: 75 m + 5 m x 2 (terminations) =
85 m for a typical 16 module –
5 m interspace system. Other
length/interspace available on
demand

Operating environmental conditions:

temperature 0-50°C, humidity
0-100%

Storage and transport conditions:

Temperature –20-50°C,
humidity 0-95% without
condensation

Impermeability: IP protection index 65 (dust
proof, splash proof)

Manufacturer: MoHo s.r.l.
c/o VEGA – building Lybra
via delle Industrie 17/A
30175 Marghera (Venice) - Italy
tel. +39 041 509 4004
fax +39 041 509 4007
web: www.tromino.eu
e-mail: info@moho.world

A

amplifier

test; 82

AVERAGE

mode; 45; 64; 67; 75

window; 65; 69

B

baseline

removal; 82

C

calibration; 82

CALL MODULES; 31

CHECK SENSOR; 39

connections; 21

connector; 15

digitization module; 16; 21

flying; 16

panel; 16

sensor; 16; 21

termination; 22

USB; 16

CONTINUOUS

mode; 46; 75

cross talk; 7; 89

crosshole; 8; 54

D

downhole; 8; 54

dromochrone; 73; 75; 76

E

ESAC; 8; 54

F

file

format; 77

open; 64

save; 69; 71

FILE INFO; 65; 70

window; 65

file name

continuous; 55; 58

stacking; 58

frequency

sampling; 46

G

GAIN; 31

GEOMETRY

x; 32

y; 32

geophone; 7; 18; 21; 32; 86

GET SERIAL NO.; 38

Grilla; 77

Grilla; 19; 32; 69

import data; 56

I

ID START; 42; 86

interface

USB; 16; 19; 21

L

LED; 17; 87

length

of a recording; 55

logo; 17

M

MASW; 8; 54

MAX; 31

message bar; 43

mode

AVERAGE; 45; 46; 64; 75

CONTINUOUS; 46; 75

PICKING; 45; 47; 69; 75

STACKING; 46; 56; 75

module

internal number; 40; 85

manual initialization; 85

not responding; 31

N

No Scale; 31

number

serial; 72

O

open

.trc file; 44

last; 45

OPTIONS

window; 58

P

PAGE

window; 69

PARAMETER

window; 26; 29; 33; 52

PICKING

mode; 45; 69; 75

polarity; 21

pre-trigger; 35

problem

solver; 85

R

reflection; 8; 54

refraction; 8; 54

ReMi; 8; 54

RESET; 38

REVERSE PHASE; 68
 REVERSED +; 68

S

sampling frequency; 46
 SASW; 8
 save
 file; 45
 sensor; 86
 SENSOR; 32
 error; 32
 plugged-in; 32
 short-circuit; 32
 unplugged; 32
 SET GAIN
 automatic; 36
 manual; 36
 SET GEOMETRY
 x; 37
 y; 38
 SET TRIGGER; 35
 SHIFT NUMBER; 39
 site
 default; 45
 name; 45
 SPAC; 8; 54
 split
 view; 47
 STACK +; 68
 STACKING
 mode; 46; 53; 56; 75

START; 26; 29; 33; 46

T

t_0 ; 70; 71; 72
 time; 46
 time line
 show/hide; 71
 trace
 name; 45
 trigger; 72; 80
 extension (wire); 18
 home; 71
 lock; 71
 post-; 35
 pre-; 35
 set; 80
 threshold; 60

U

USB
 connector; 16
 interface; 16; 19; 21
 interface driver; 25

V

view
 split; 47

W

warranty; 9; 11

window

CONTINUOUS; 47

FILE INFO; 48

OPTIONS; 58

PARAMETER; 26; 29; 47;

52

PICKING; 48

STACKING; 47

Y

Your folder; 55; 58; 59; 69;

72; 75

Your site; 45; 55; 58; 75

□

Δt ; 70; 71; 72