



O.T.R. s.r.l.



**INCLINOMETER OG310T
USER MANUAL**



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Warnings

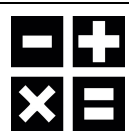
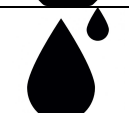
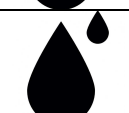
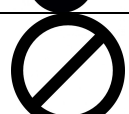
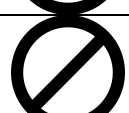
	This instrument must be utilized only for the application it has been designed for. OTR declines all responsibility for any improper use
	Do not let this instrument fall into the hole quickly
	Do not put this instrument in flammable liquids or potentially explosive gases
	Do not use this instrument in water where an electric dissipation is in progress
	Do not let the cable slide quickly in your hands. Use protective gloves.

Also

- Do not open this instrument, contact the manufacturer for checks and repairs;
- Keep out of reach of children;
- When recharging, insert protective caps on sensor and connectors;
- When recharging, do not touch the roll with wet hands;
- Do not recharge for more than 12 Hours;
- Use only original power supply unit to recharge the instrument;
- Clean this instrument and its cable with alcohol or water, do not use acetone or aggressive liquids for plastics or labels;

General Usage Notes

Inclinometer measurement, even if it might be considered a simple and repetitive task, needs basic knowledge.

	Have knowledge of basic trigonometric functions;
	Be aware of the type of calculation performed by the program (refer to our "Inclinometer Measurements Calculation Scheme");
	Any inclinometric measure needs a minimum of two opposite acquired slides (180°)
	It is not correct to execute an incliometric measure acquiring just one slide.
	It is necessary to have correct angle for slide 1 to obtain charts and results with a correct direction
	As a general rule, it is better to have slide 1 in the same direction of the expected movement (e.g. slide 1 directed orthogonal to excavation)
	Always test equipment in laboratory before starting measurements
	Charge the roll, avoid to completely discharge batteries.
	Always use dummy probe in new or deformed installations.
	After usage in sea water clean the bearings.
	If connector is wet, let it dry up before covering it with its protection caps.
	Do not drag the connector
	Do not utilize spray or oil on the connectors.



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	Do not utilize instrument where temperature is more than 50-60 °C. In this case take measures with circling water.
	O-rings do not need maintenance.
	Do not close app during measurements.

Application

Inclinometric system OG310T has been designed to execute measurements in inclinometer casings installed underground. Instrument, with differential measurements, can identify and quantify underground movements.

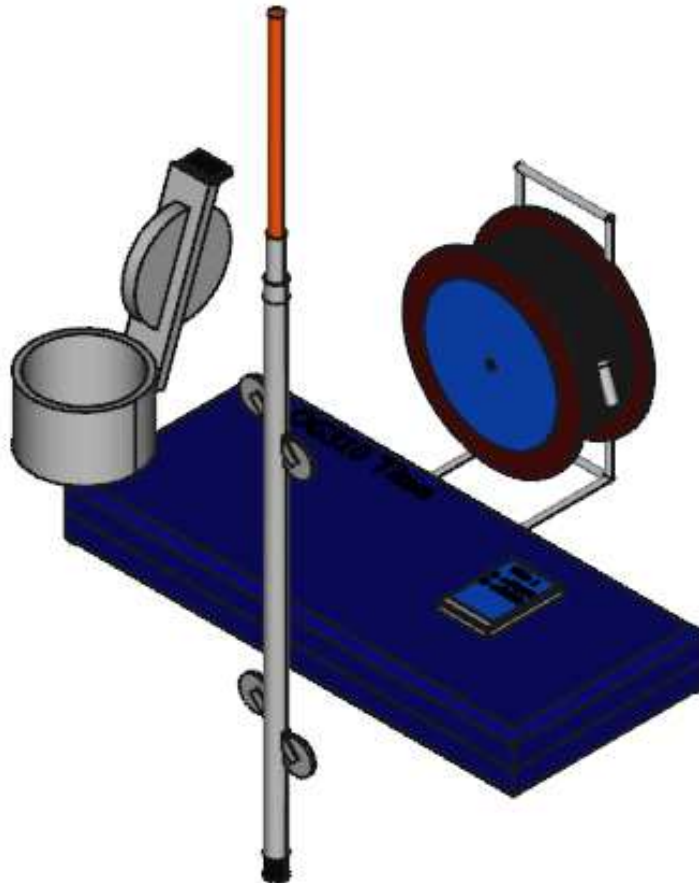
Model and Identification

Every inclinometric system is identified by:

- Serial number of inclinometric probe;
- Serial number of roll and cable;
- Serial number of PDA, Rugged Mobile;

Calibration parameters are stored onboard each probe. This makes rolls and probes interchangeable. It is recommended anyway to take measures with the same cable, probe and roll combination, when possible.

General Description



System is composed by:

- Titanium inclinometer probe, 500 mm or 24";
- Inclinometer cable and roll with 500 mm or 24" step;
- Pulley and extension;
- Rugged Mobile Bluetooth;
- Dummy probe on roll;
- Boxes and accessories;

Frontal Panel

Caricabatterie
Battery Charger

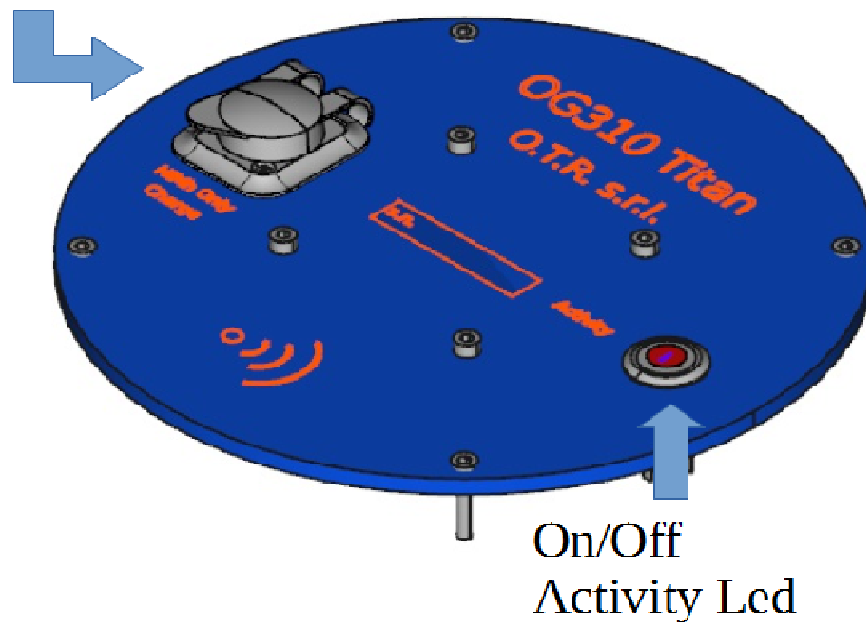


Image 1 Roll Frontal Panel

On/Off Activity Led

It is the On/off switch and indicates activity status of electronics parts:

- Led Off: System is completely off;
- Led Blinking: Roll is waiting for connection;
- Led On: Roll is connected to rugged mobile.

Battery Charger

Plug for the provided battery charger.

Note:

- Connector has a rubber cap that must be keep closed during measurements;
- It is not possible to charge instrument and make measurements at the same time;
- Use just the provided battery charger.

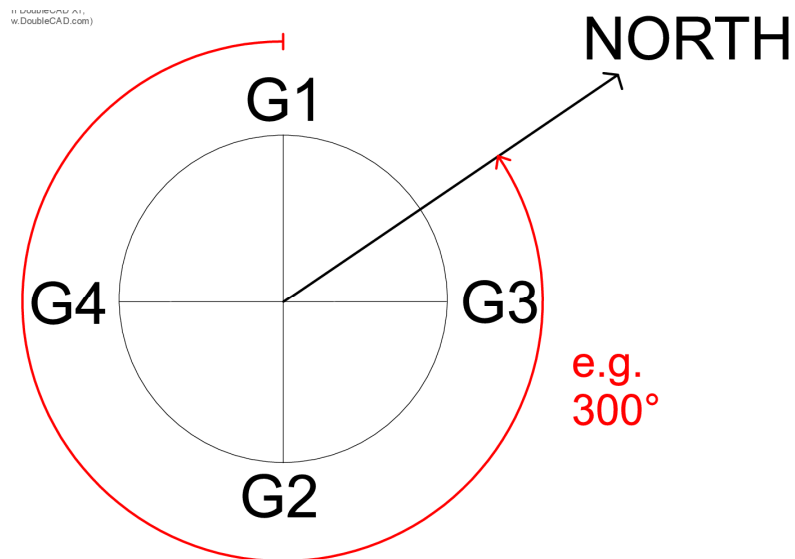


Selecting slide 1

Before taking the first mesure of a newly installed pipe, please make sure to clearly identify slide #1 for future reference.

Proceed as follows:

1. Select slide 1 and mark it with paint or any other durable way;
2. Identify the angle as follows:



Sequence of measures

Inclinometric measures must follow this simple rules to be compatible with OTR inclinometer software conventions:

Slide 1:

High wheel in the Slide 1. Measures must be executed from top to bottom or from bottom to top with 500 mm steps.

Slide 2:

High wheel must be inserted in Slide 2 (180° rotation, compared to how the probe was previously insterted in Slide 1).

Slide 3: (if needed)

High wheel must be inserted in Slide 3 (90° anticlockwise rotation, compared to how the probe was previously insterted in Slide 2)

Slide 4: (if needed)

High wheel must be inserted in Slide 4 (180° rotation, compared to how the probe was previously insterted in Slide 2).



If only 2 slides are measured, they must be at opposite directions (180°). It is not useful to take a single slide measure or a measure with 2 slides at 90°.

An origin set should always have 4 slides. 4 slides are recommended for a not expert operator



When measure is finished and the probe is disconnected, it is recommended to protect the connector during cable winding.

Do not leave the connector rub on the floor.

Instrument Positioning and usage of pulley and extensions

Instrument can be correctly positioned following one of these equivalent rules:

- Placing the first cable notch at the beginning of the tube;
- Placing the second cable notch on the pulley cleats (when using pulley and extension)

Measures can be executed:

- From the top lowering the probe at every step ;
- From the bottom, lifting the probe at every step..

It is recommended to wait for probe thermal stabilization before taking any measure



Before starting a measure it is recommended to use a dummy probe. If external temperature is higher than usual, increase thermal stabilization time.



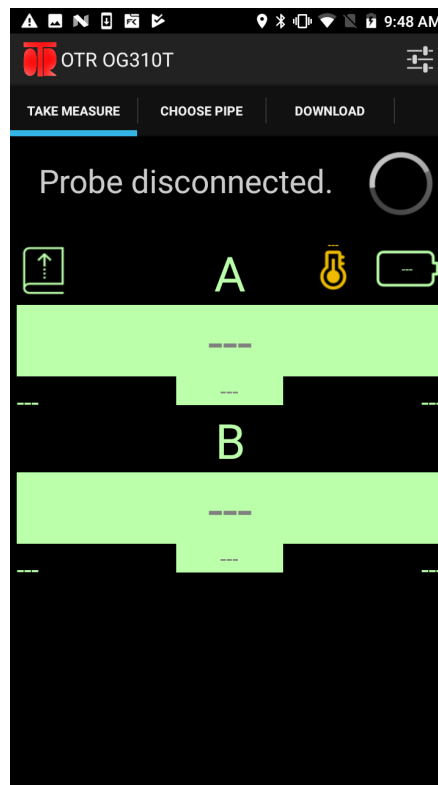
In order to obtain better results, probe wheels should be positioned at the same pipe depth when acquiring corresponding steps in different slides and in different measurements. Measures executed with different cable positioning could not be satisfactory.



Distance between first notch and high wheel pin in O.T.R. systems is 500 mm. Distance between first notch and low wheel pin in O.T.R. systems is 1000 mm. This scheme complies with the polygonal calculation of an inclinometer measurement.

Taking an inclinometric measure

1. Turn on your inclinometric probe pushing the button on the inclinometric roll.
After a few seconds the button will blink.
2. Open OTR OG310T app installed on Android device.



At each acquisition step, the app will save two values: A and B. Channel A stores inclination value for the current slide; channel B stores inclination for its perpendicular direction, with a clock-wise rotation of 90° from channel A.

The more your probe leans towards the direction of its higher wheel, the higher the value stored in channel A.

3. Open Settings to establish a Bluetooth connection with your probe.

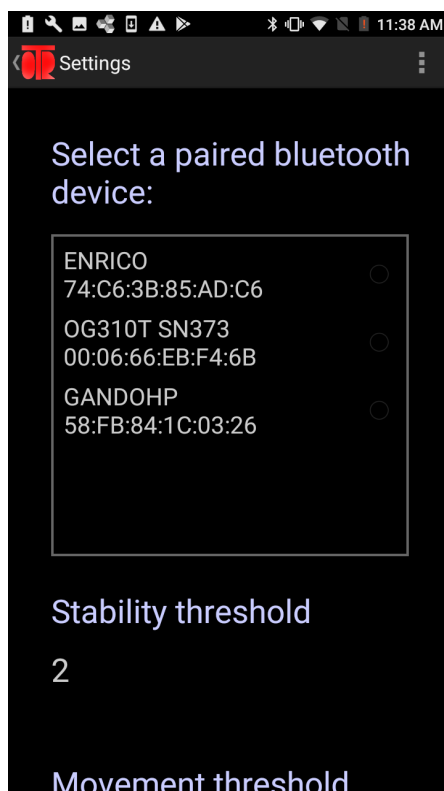


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Inclinometric Probe ID is always in the format OG310T SNxxx, where OG310T is the model and SNxxx is probe serial number.

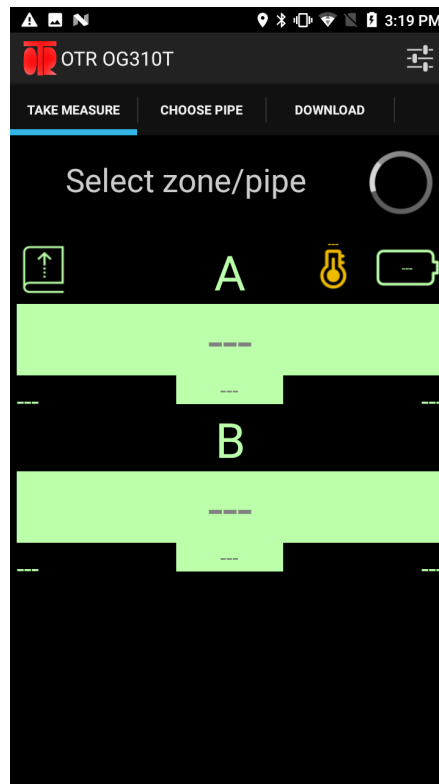
A blue dot next to probe ID indicates that connection between Android device and probe is correctly established.

When connection between Android device and probe is established, the button placed on inclinometric roll will stop blinking.

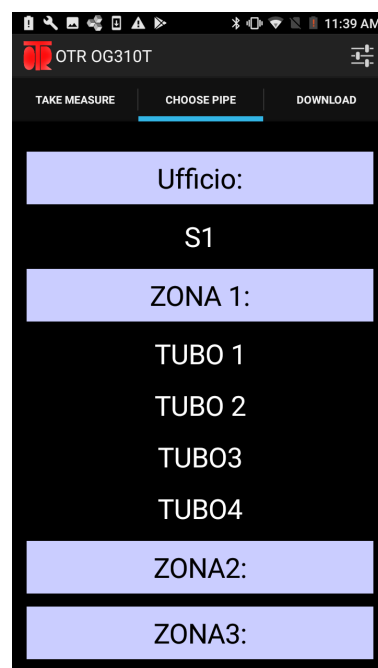


4. Exit Settings by pressing OTR icon at the top left corner of the screen.

In case you have not selected yet any pipe for the next measure, the warning “Select zone/pipe” will appear.

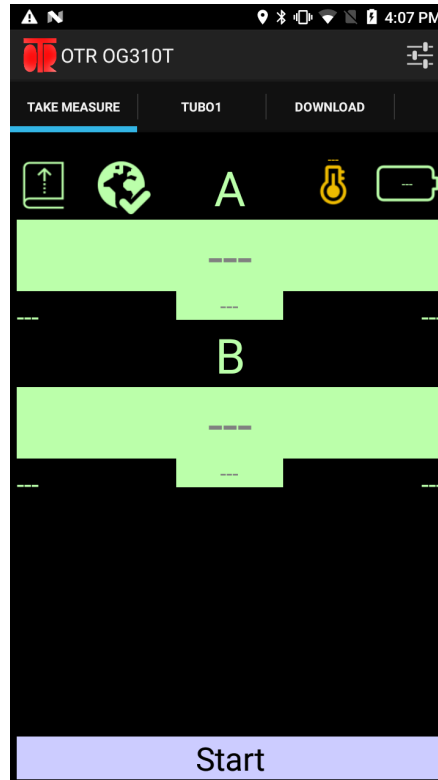


5. Select zone and pipe for the next measure, tapping on **ChoosePipe** tab.





6. Select the pipe for the next inclinometric measure.
*When pipe is selected, tab **Take Measure** will open.*



7. Tap on battery icon to check probe battery and on thermometer to check its temperature
If probe battery value is low, a warning will appear at the beginning of next inclinometric acquisition.
8. Long press on map save current GPS coordinates for current pipe.
Confirm operation to save. If GPS coordinates are available, a message in the lower half of the screen will appear to notify coordinates saving, and a check mark will appear on map icon
- A short tap on map icon will open maps app to navigate you to selected pipe.
9. Tap on book icon to load an old acquisition into memory.
This function is optional. Use it in case you want to compare values of each step you acquire to value of corresponding step of a previous acquisition you took in the same pipe.
10. Tap on **Start** to start acquisition.
Start button will change colour. Please wait for some seconds until values of A and B channels appear on screen..



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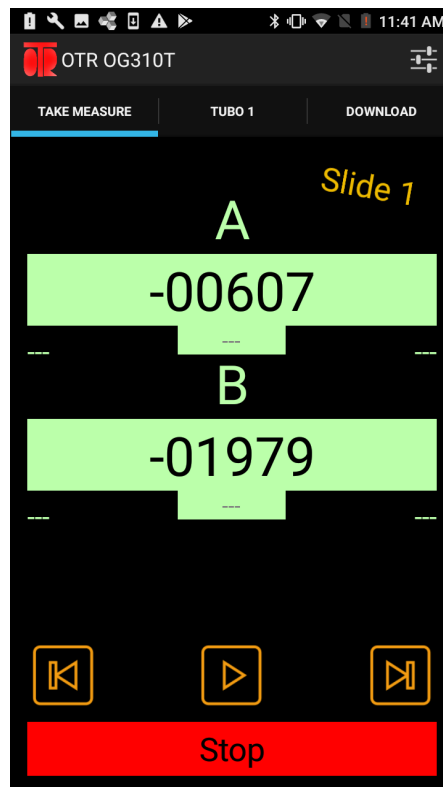
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*Values of both channels are continuously updated as they are received from the probe. Values are saved only when you tap on Play button (automatic acquisition) or **ACQ** button (manual acquisition)*

Automatic Acquisition

1. Tap on Play button



As soon as probe reads stable values, first step is acquired.

2. Move probe to the next acquisition step

As soon as probe stabilizes again, next step is acquired..

3. Proceed until you get to the last step of current slide

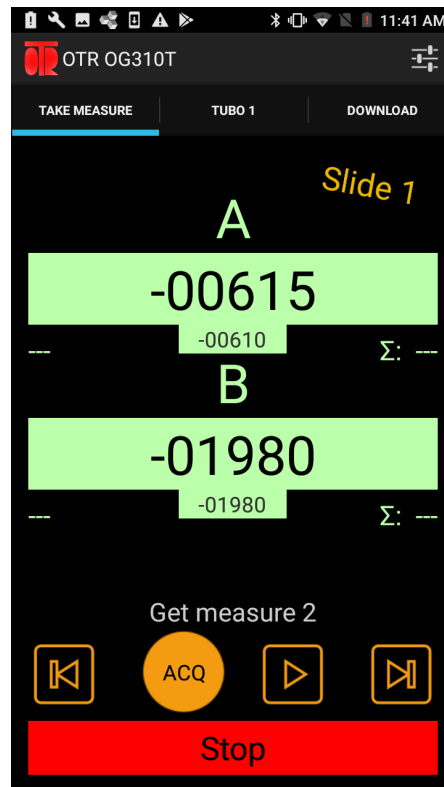
4. Once you acquire last step of current slide, tap on the Forward button to stop automatic acquisitions and shift to next slide.

In order to go back to the previous slide, tap on Back button instead. If you restart acquisition of a previously acquired slide, all steps of that slide will be erased from memory in order to allow new steps acquisition

5. Tap on Play button to start automatic acquisition on the new slide.

Manual Acquisition

1. Once automatic acquisition is started, tap on Pause to switch to manual acquisition mode.

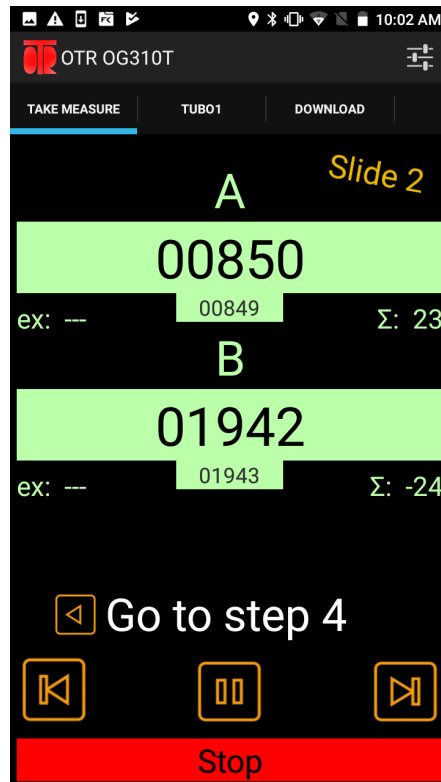


2. Tap on **ACQ** to acquire a new step.
Once the current step is acquired, you will be taken to the next acquisition step. To overwrite the last saved step, tap on "Back to step". To erase more steps, tap on "Back to step" multiple times until you get to the step you need.
3. Tap on Play button to switch back to automatic acquisition.

Note:

In case OG310T application is suspended during acquisition (i.e. you switch to another application), acquisition will automatically switch to manual mode and will be paused. Tap on Play button to switch back to automatic acquisition.

Measure window



Values of channel A and channel B are continuously updated on screen, as soon as received from probe.

Each time you acquire a step:

- Acquired values of both channels are conveniently displayed under live values (until you acquire a new step).
- Checksum of both channels are displayed on the right under current values (only during acquisition of slides 2 and 4)

Checksum (Σ), is the algebraic sum of a step value and its corresponding value taken on the opposite slide. Checksums can be calculated only on slides 2 (adding corresponding value of slide 1) and on slide 4 (adding corresponding value of slide 3)

Checksum is useful as a check of acquired values: its value should not vary significantly during acquisition. Bigger Checksum variations can be a symptom of temperature variations of the inclinometric probe during acquisition.



- In case you loaded a previous acquisition into memory, corresponding values saved in previous acquisition will appear at the left side of the screen.
Values acquired in previous acquisition are shown next to "ex: " for each step.
- The number of the next step to be acquired will appear at the center of the screen
For instance: "Go to step 3"
- A button will appear at the left of "Go to step". Tap it to erase last acquired step, in case you need to remove it from memory.

Each time you change slide:

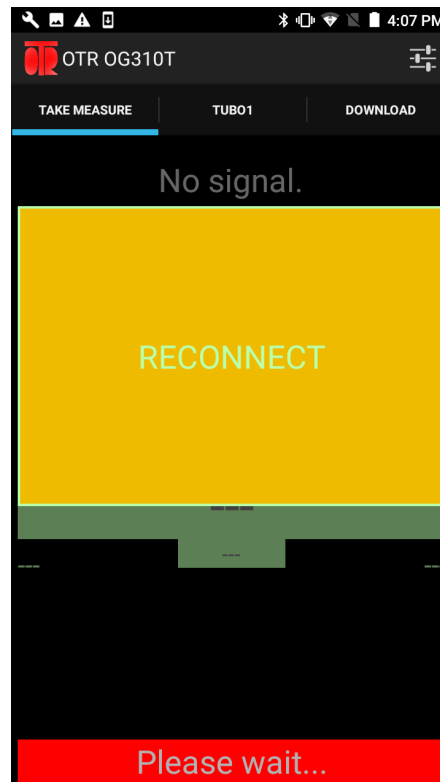
- You will be prompted to confirm your choice.
Tap on the yellow button that appears on screen for confirmation. If you do not confirm, after a few seconds the yellow button will disappear and operation will be canceled
- New slide number appears on the top right corner of the screen
- Steps count restart.
If you select an already measured slide (i.e. from slide 3 you go back to slide 2 tapping on the Back button), every step of the selected slide will be erased and you will need to acquire the entire slide once again.

At the end of the inclinometric measure:

- Tap on Stop and confirm your action.
*Please wait a few seconds until file is saved. **If you do not tap on Stop and confirm, file of full inclinometric measure will not be saved.***
Data are saved in temporary files for each slide. After tapping on Stop and confirming, a full measure file is created. Only full measure files can be directly exported to OG390WIN software on a PC.



It may happen that Bluetooth connection between Android device and inclinometric probe gets temporarily down while an inclinometric measure is under way. In this case, a warning appears on screen.



If connection is not automatically restored after a few seconds, please tap the warning message to restore connection, without stopping inclinometric acquisition.

After tapping, please wait for about 20 seconds until Bluetooth connection is restored.

If necessary, press the warning button again and wait for further 20 seconds. In case you can not restore connection repeatedly, turn off and on the inclinometric roll without stopping inclinometric acquisition. Wait for a few seconds until power button on roll panel stops blinking and tap again on the warning button.

Bluetooth Connection

Bluetooth connections are used to establish communication between your Android device and inclinometric probe, or between your Android device and your PC.

Bluetooth connection between Android device and probe is necessary to acquire new inclinometric data; connection between Android device and PC is necessary to export acquired data to OG390WIN software on your PC.

You can not be connected to probe and PC at the same time.

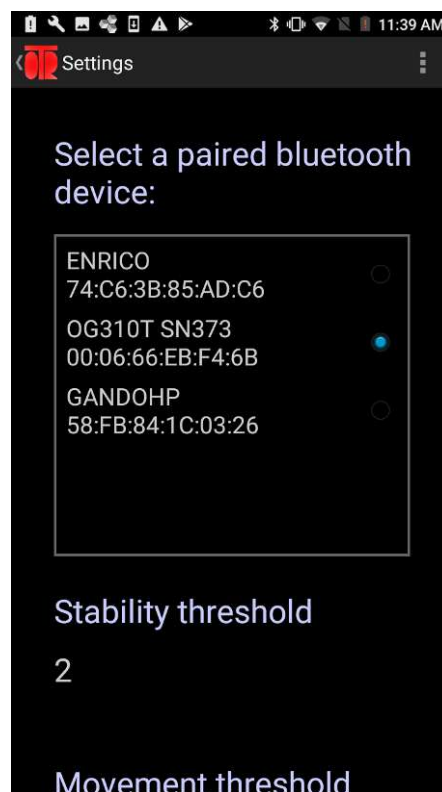
Do not close or suspend OG310T app while Bluetooth connection is active.

Do not use your Android device to place or receive calls while taking inclinometric measures.

- **Setting a Bluetooth connection between Android device and inclinometric probe**

1. Tap Settings icon at the top right corner of the screen

The following form will open.



2. Select OG310T probe from the list of paired BlueTooth devices.

Inclinometric probe ID has the following format: model (OG310T), followed by Serial Number (in the picture above SN373)

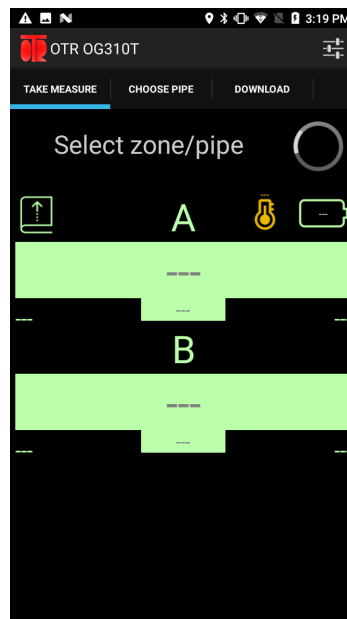


3. Verify that Bluetooth connection between Android device and probe is active: a blue dot will appear next to selected BlueTooth device in the app, and the power button on the inclinometric probe will stop blinking.

In case you can not immediately establish a BlueTooth connection to your probe, please wait for a few seconds and tap again on the probe name in the list. If again you can not establish a connection, please try and come closer to the roll and tap again. You might also turn off and on your inclinometric roll before tapping on the device name in the list.

4. Tap on the OTR red icon at the top left corner of the screen, to go back to the Measure tab.

*The “Probe disconnected” warning will not be present any more. A new warning reading “Select Zone/Pipe” will be shown instead. Tap on the Choose Pipe Tab to select the pipe you are going to measure. For further details please refer to chapter **Taking an inclinometric measure**.*



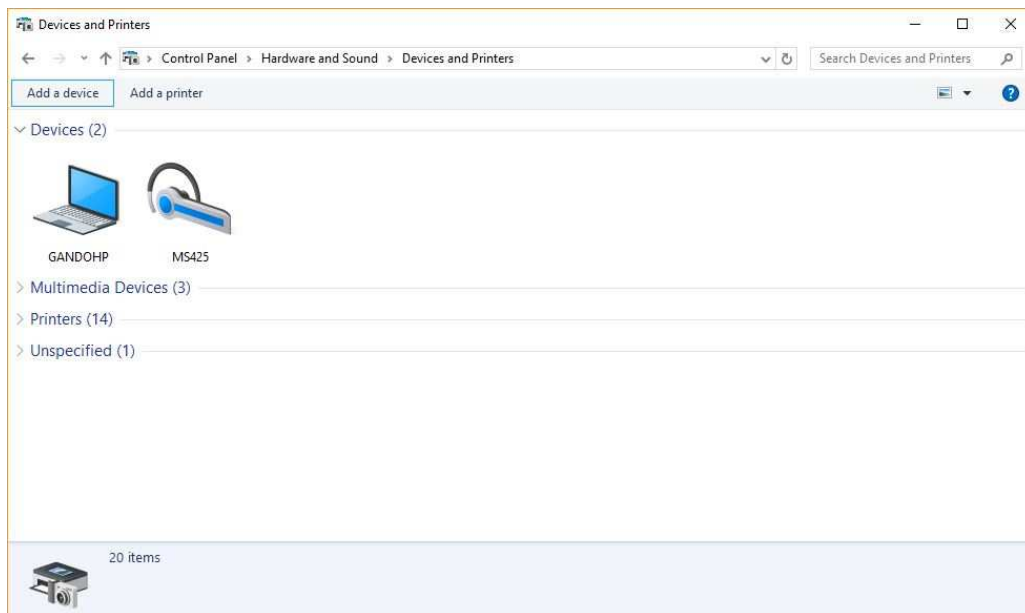
- **Setting a Bluetooth connection between Android device and PC.**

Bluetooth connection between Android device and PC is needed in order to send acquired data to OG390WIN software.

Android device and PC need to be paired, before establishing a Bluetooth connection for the first time.

Following procedure is based on Windows10.

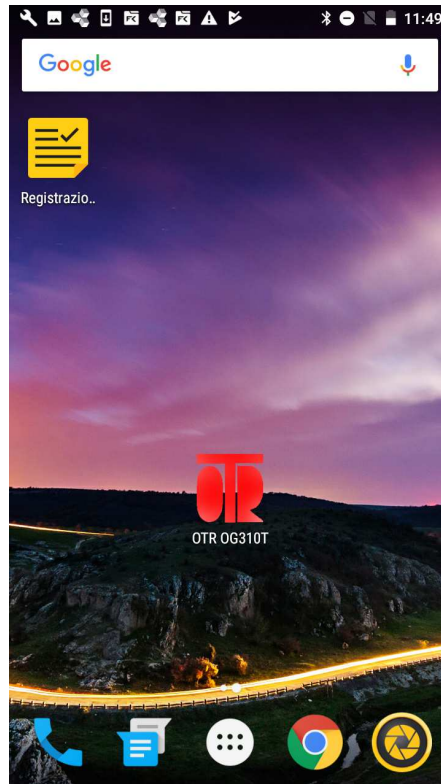
1. Open Control Panel. Select **Hardware and Sound** e poi **Devices and Printers**



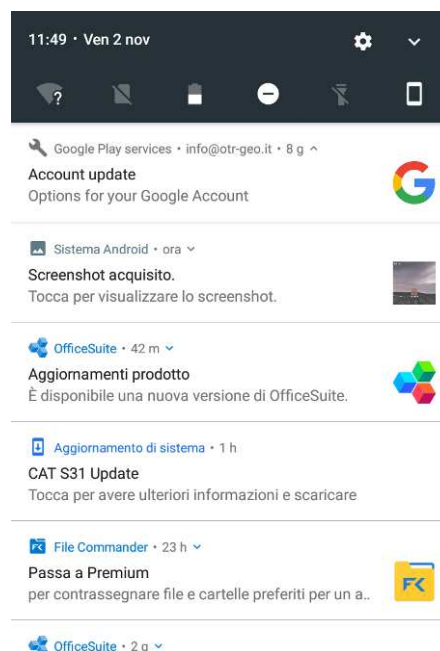
Your Android device can not be found yet in the list of paired Bluetooth devices.



2. Turn on and unlock your Android device.

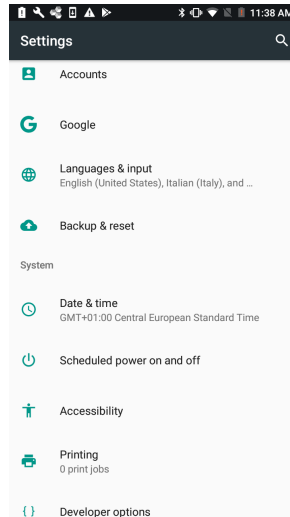


3. On your Android device, swipe down from the top of the screen.



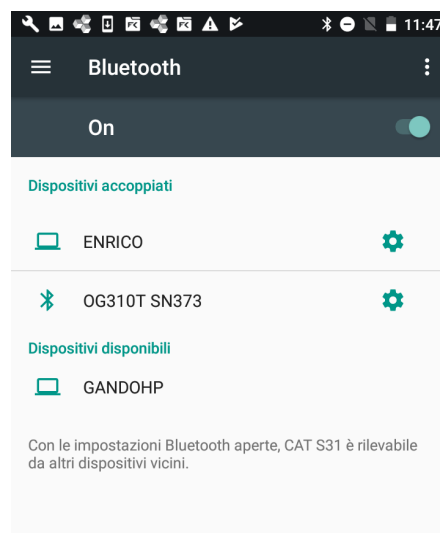
- Tap on the roller icon at the top right corner of the screen.

Settings will open



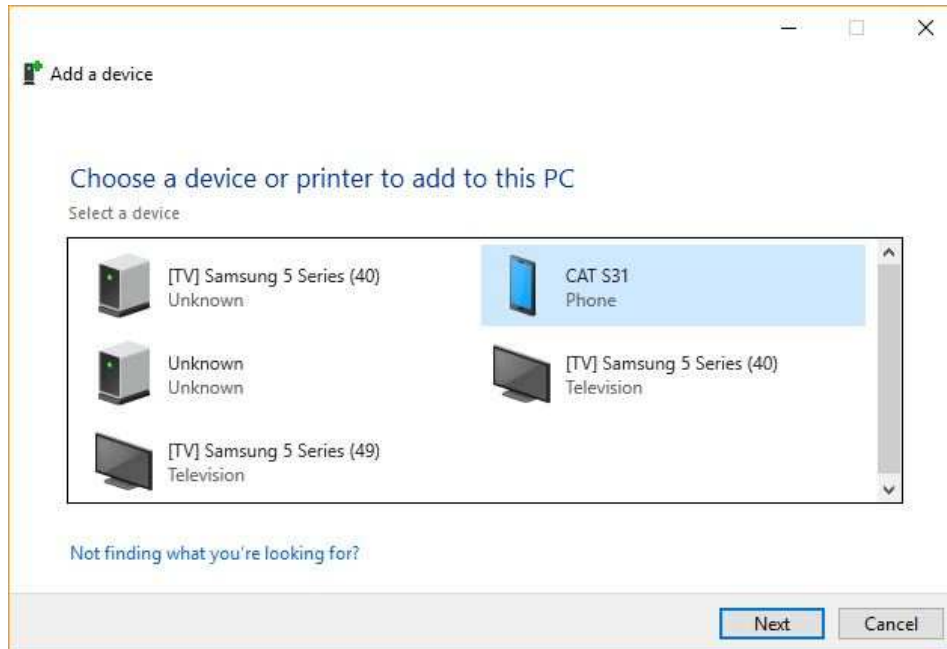
- Select Bluetooth.

The following screen will appear



Let this screen open until PC starts Bluetooth pairing. Proceed on your PC.

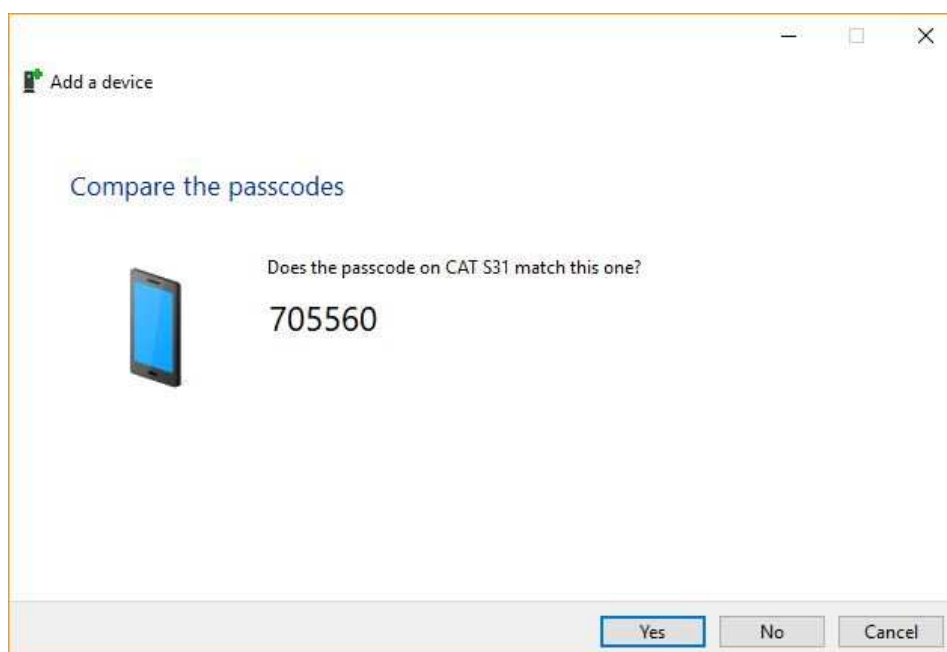
- On your PC, click on **Add a Device**



Wait for a few seconds until your device appears in the list of nearby Bluetooth devices.

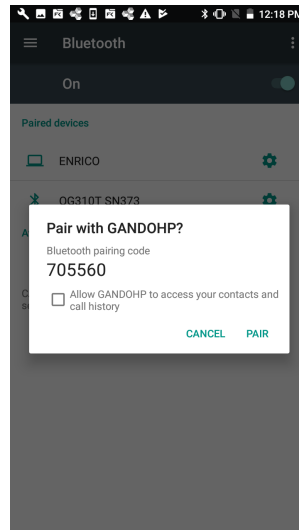
- On your PC, select CAT S31 device and click on **Next**

Wait for a few seconds until a passcode message appears:



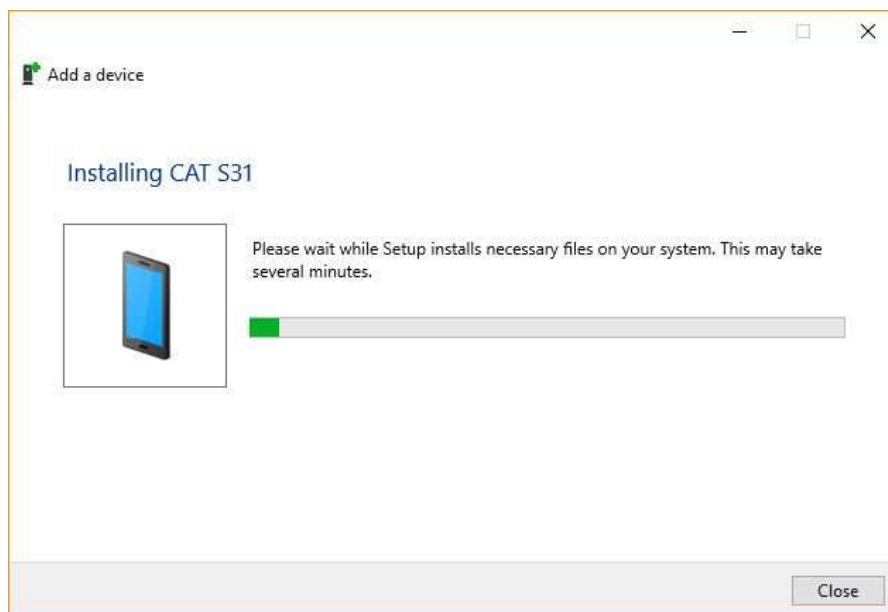
*Verify that the same code pops up on your device, and click **Yes** on your PC.*

- On your Android device, click on **Pair**

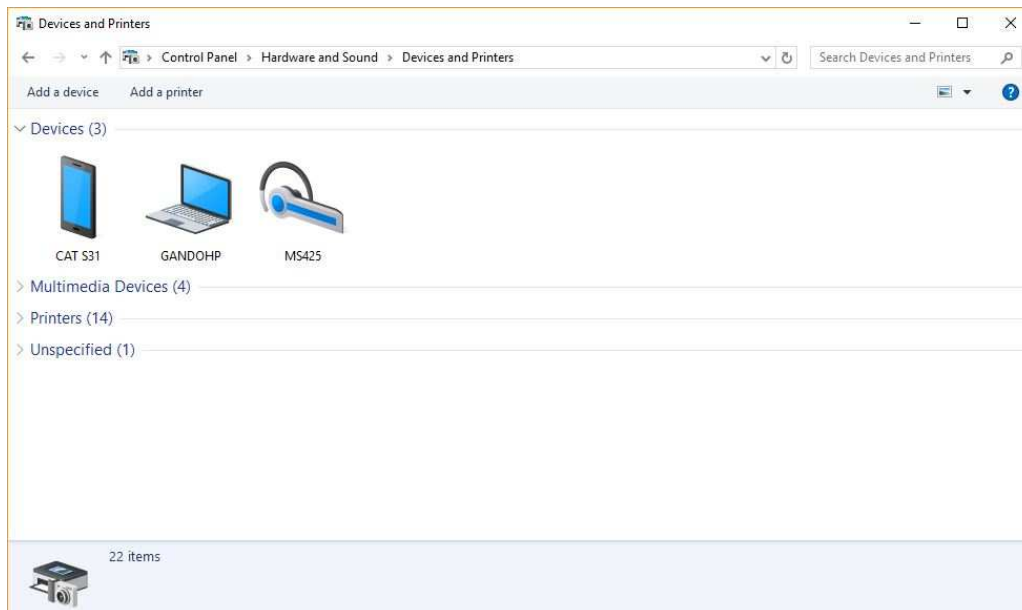


If you fail to accept pairing process in time, click on Cancel on your PC and repeat the procedure from start. Passcode changes at each pairing attempt.

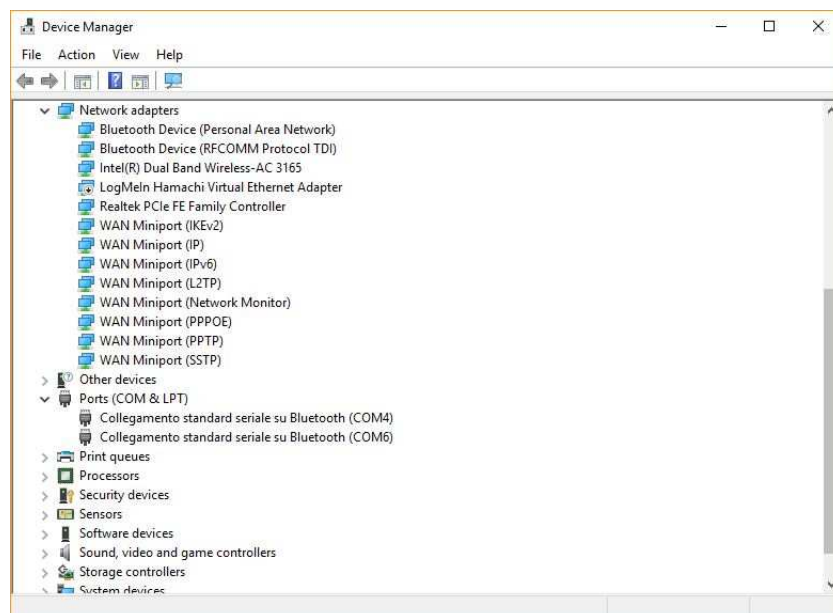
- Wait for drivers installation on your PC



- Verify that your Android device now appears in the list of paired Bluetooth devices on your PC



11. Verify which COM port your device is installed on



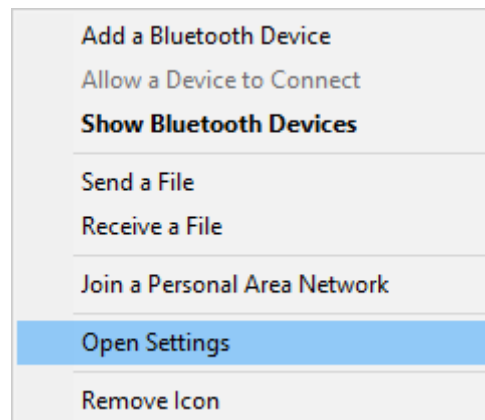
To verify COM port, open **Control Panel**. Select **Hardware and Sound** and then **Device Manager**. In the picture above, Android device is installed on COM4 port. If COM port is more than 4, manually change it and choose one of the first four COM ports .

If COM port is not automatically created, please follow these steps:

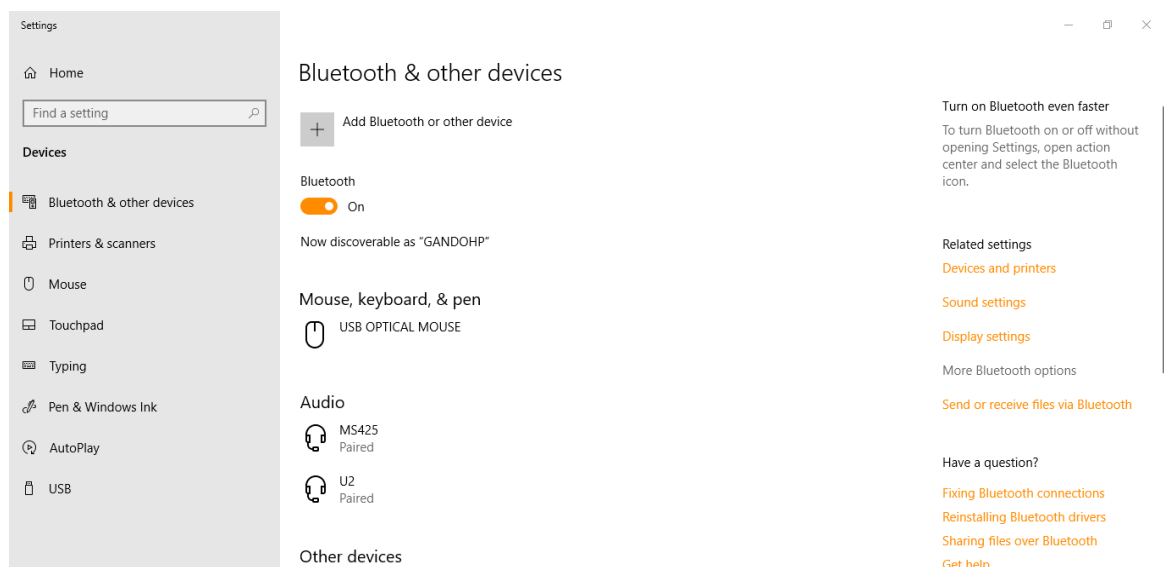
- *Locate Bluetooth icon in your Windows applications bar*



- *Click your Bluetooth icon to open menu*

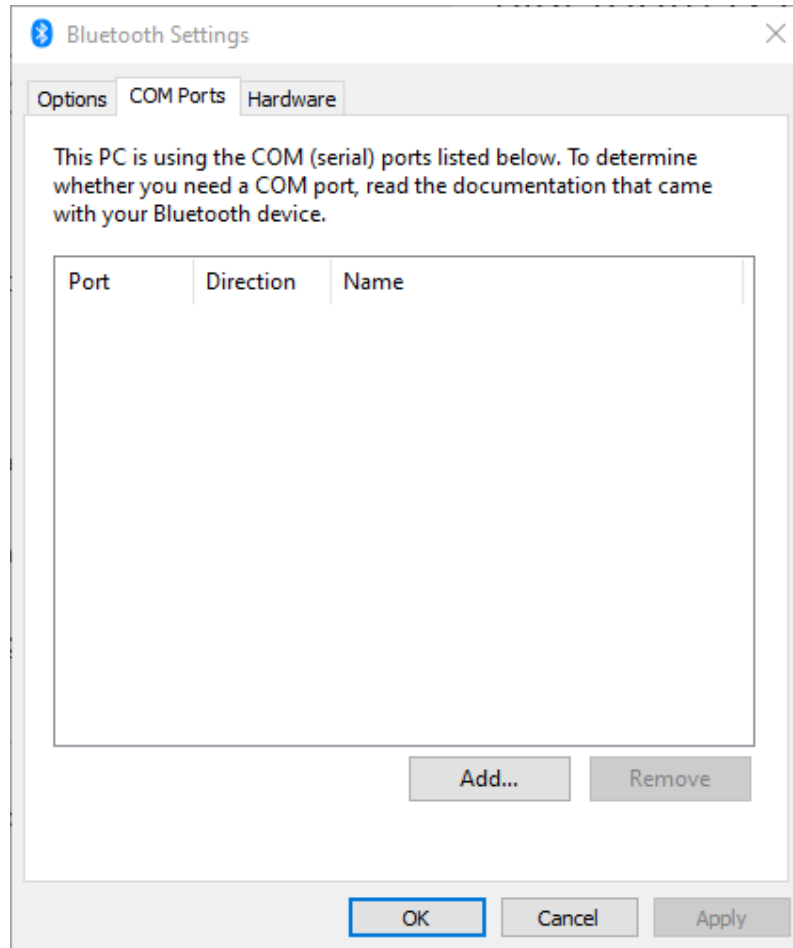


- *Click on **Open Settings***

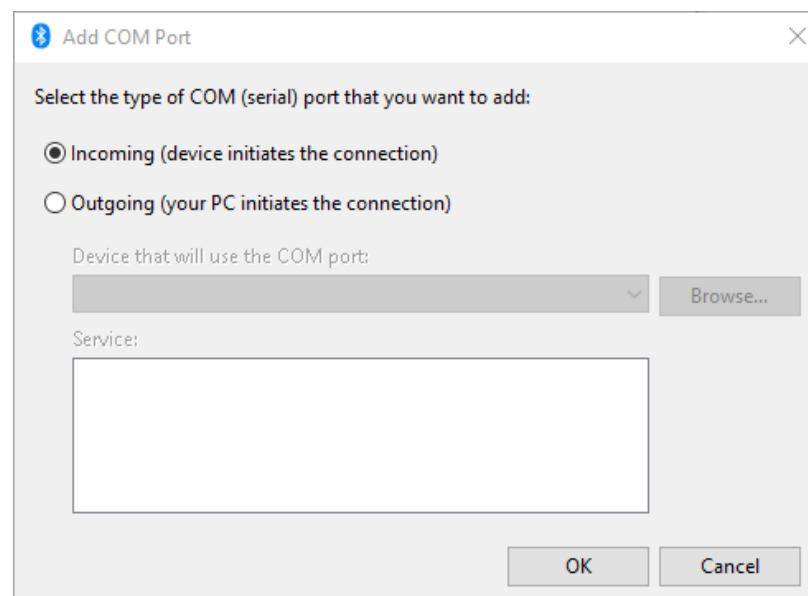


*Open full screen, and locate **More Bluetooth Options** in the right column*

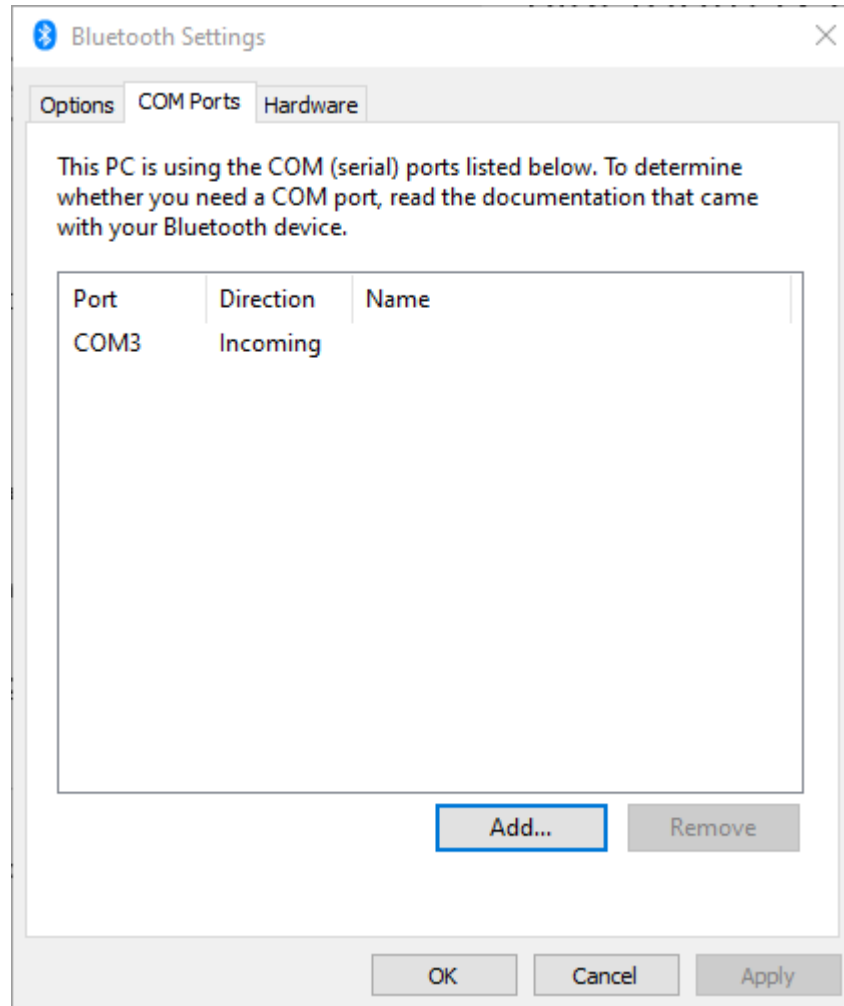
- Click **More Bluetooth Options**



- Select **COM Ports** tab and click **Add Button**



- Select **Incoming** and click **OK**



A new COM Port is now created.

- Confirm with OK and then turn off and on Bluetooth connection on your PC

Bluetooth



Bluetooth

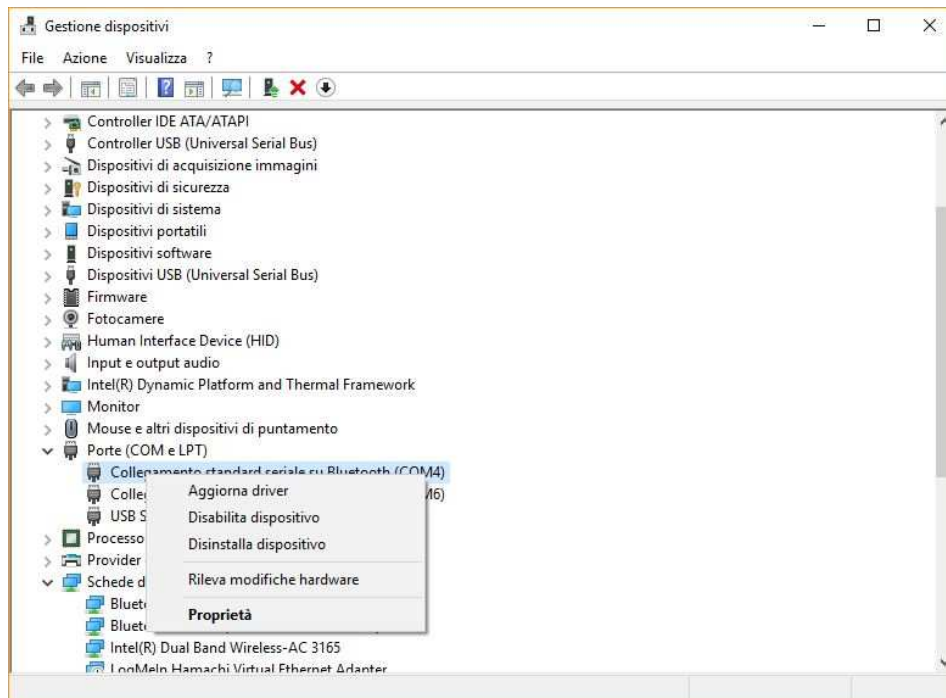


Bluetooth

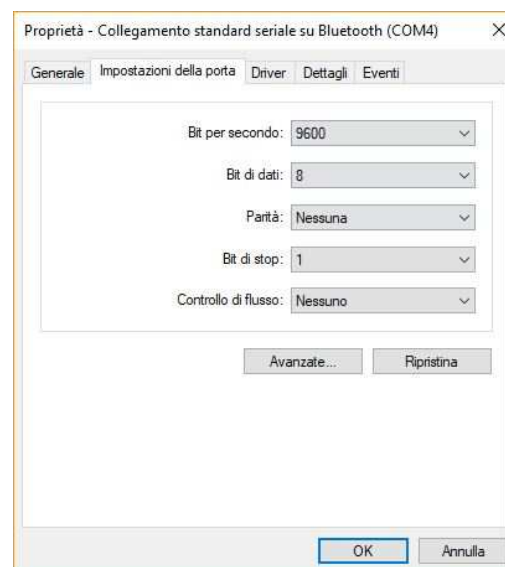


- If necessary, change COM port number for your Android device, in order to install it on a COM port between 1 and 4.

*To change COM port of your device, right click on the COM port and then click on **Settings**.*

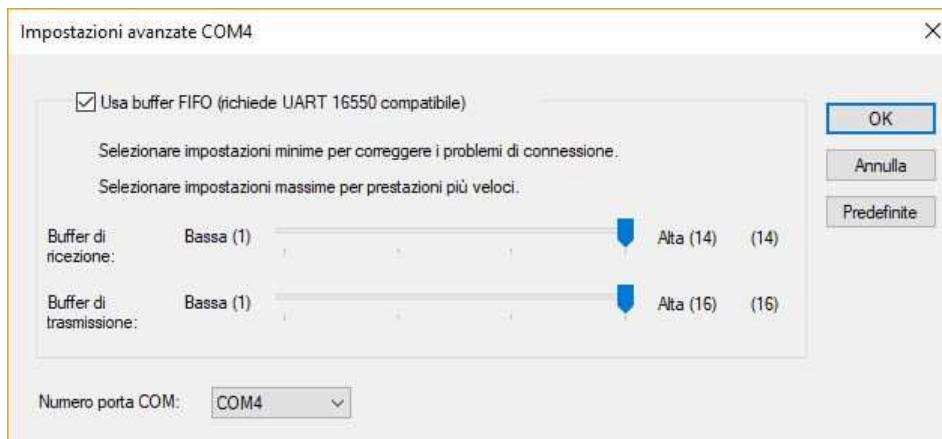


*In the new window, select **Port Settings** and click on **Advanced settings***





Select a COM port between 1 and 4 and then click **OK**



Turn off and on Bluetooth connection on your PC

Bluetooth



Bluetooth



Bluetooth



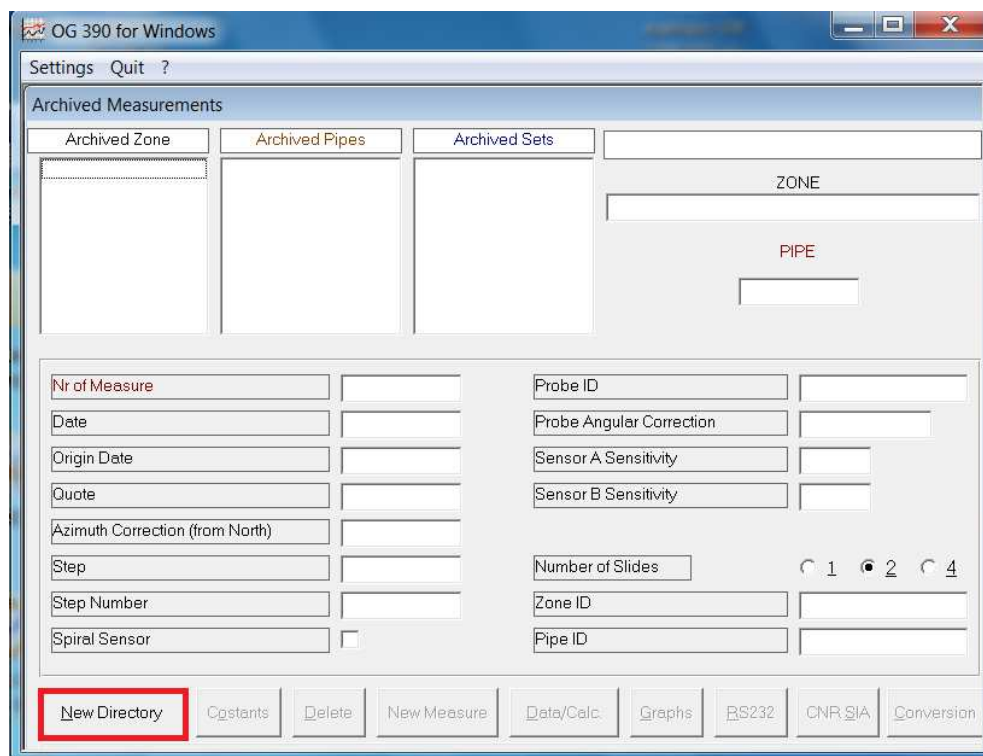
Data Download to OG390WIN software

1. Open OG390WIN software

In the following procedure, assumption is that Android device has been paired to PC and correctly set on COM3. To pair a Bluetooth device, please refer to the previous chapter.

2. Once the main form of OG390 is loaded, click on **New Directory** if you are starting to take measures in a new pipe.

If you are adding a new measure to an existing pipe, please go directly to step 4)

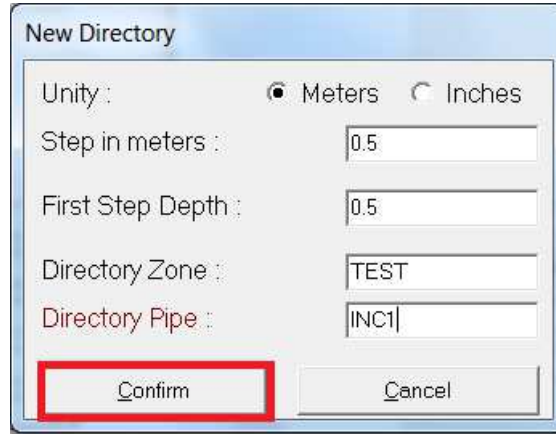


The screenshot shows the 'OG 390 for Windows' application window. The 'Settings' menu is open, and the 'New Directory' button is highlighted with a red box. The interface includes sections for 'Archived Measurements' (Archived Zone, Archived Pipes, Archived Sets), a 'ZONE' section, a 'PIPE' section, and a 'Measure' section with various input fields like 'Nr of Measure', 'Date', 'Origin Date', 'Quote', 'Azimuth Correction (from North)', 'Step', 'Step Number', 'Spiral Sensor', 'Probe ID', 'Probe Angular Correction', 'Sensor A Sensitivity', 'Sensor B Sensitivity', 'Number of Slides', 'Zone ID', and 'Pipe ID'. The 'New Directory' button is located at the bottom left of the window.

A new folder for the pipe will be created on disk and a window will pop up.

Insert the measuring unit (meters or inches), the measuring step, the depth of the first step, the Zone name, the Pipe name and click on confirm. To create a new pipe in an existing zone, type in the existing Directory Zone name and choose a new Directory Pipe name.

- Click on **Confirm**



New Directory

Unity : ☒ Meters ☐ Inches

Step in meters :

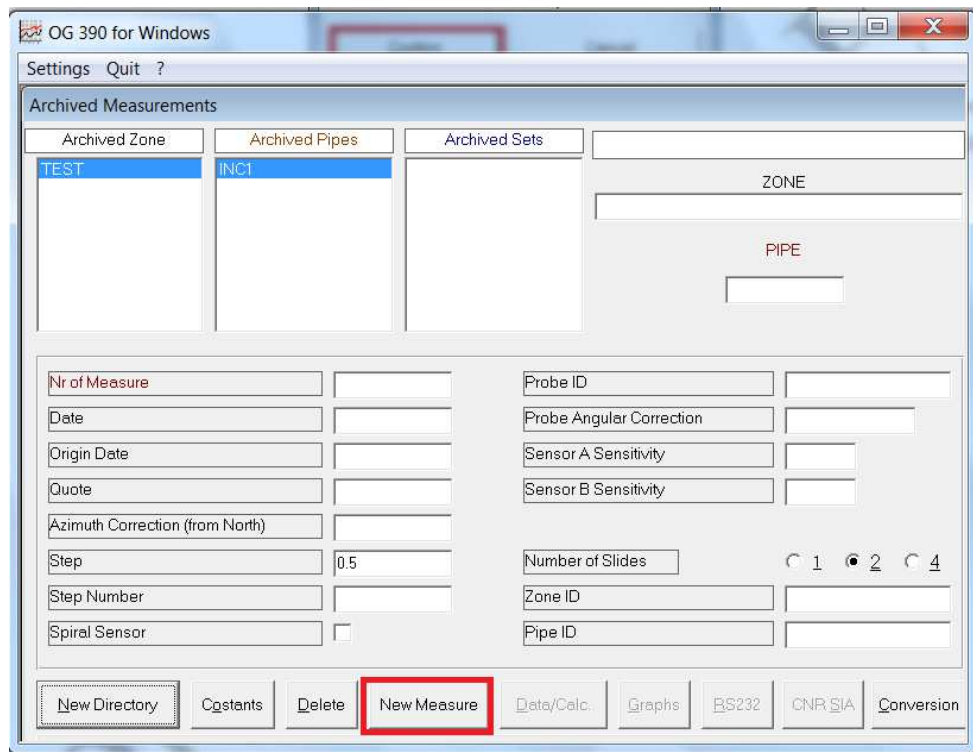
First Step Depth :

Directory Zone :

Directory Pipe :

Confirm **Cancel**

- In the main window, choose your Zone and your Pipe, then click on **New Measure**



OG 390 for Windows

Settings Quit ?

Archived Measurements

Archived Zone	Archived Pipes	Archived Sets
TEST	INC1	

ZONE

PIPE

Nr of Measure

Date

Origin Date

Quote

Azimuth Correction (from North)

Step

Step Number

Spiral Sensor ☐

Probe ID

Probe Angular Correction

Sensor A Sensitivity

Sensor B Sensitivity

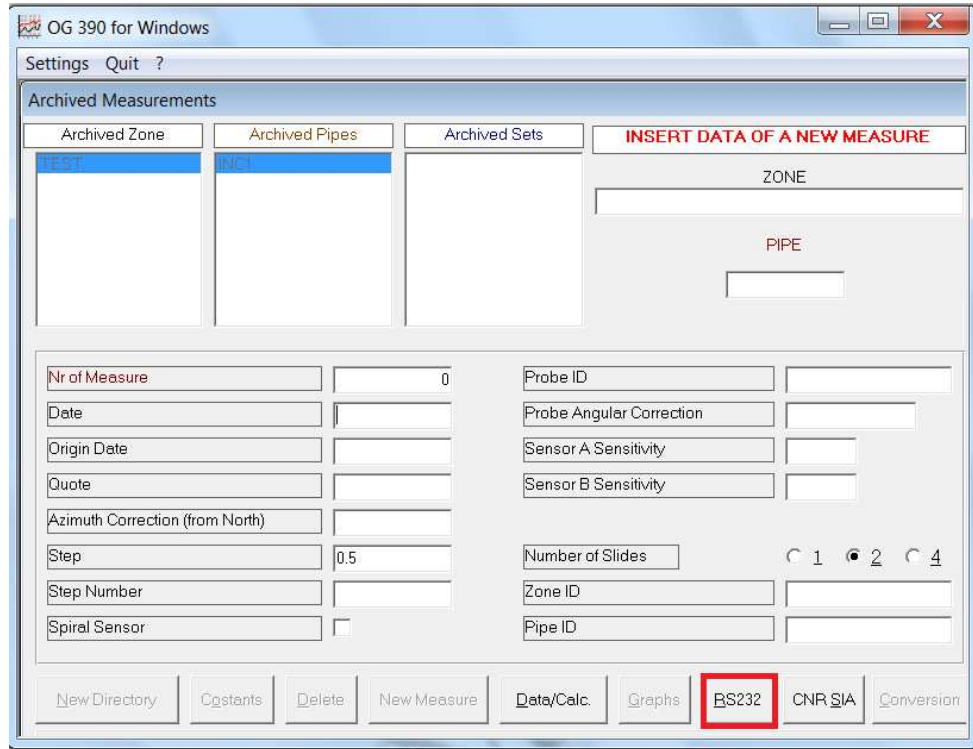
Number of Slides ☒ 1 ☐ 2 ☐ 4

Zone ID

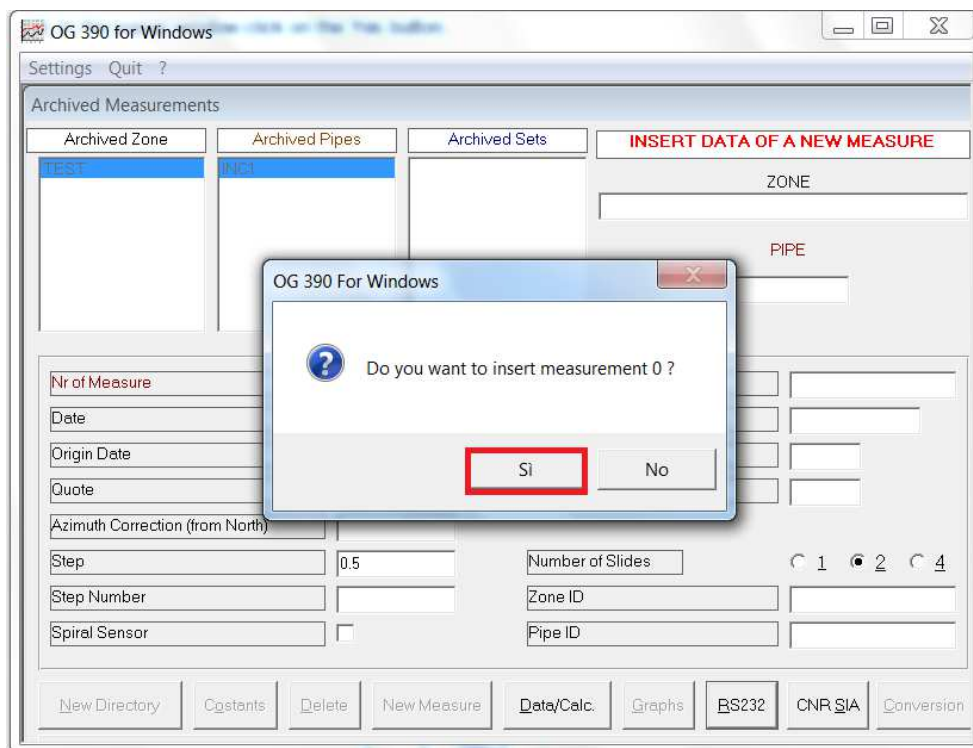
Pipe ID

New Directory **Constants** **Delete** **New Measure** **Data/Calc.** **Graphs** **BS232** **CNR SIA** **Conversion**

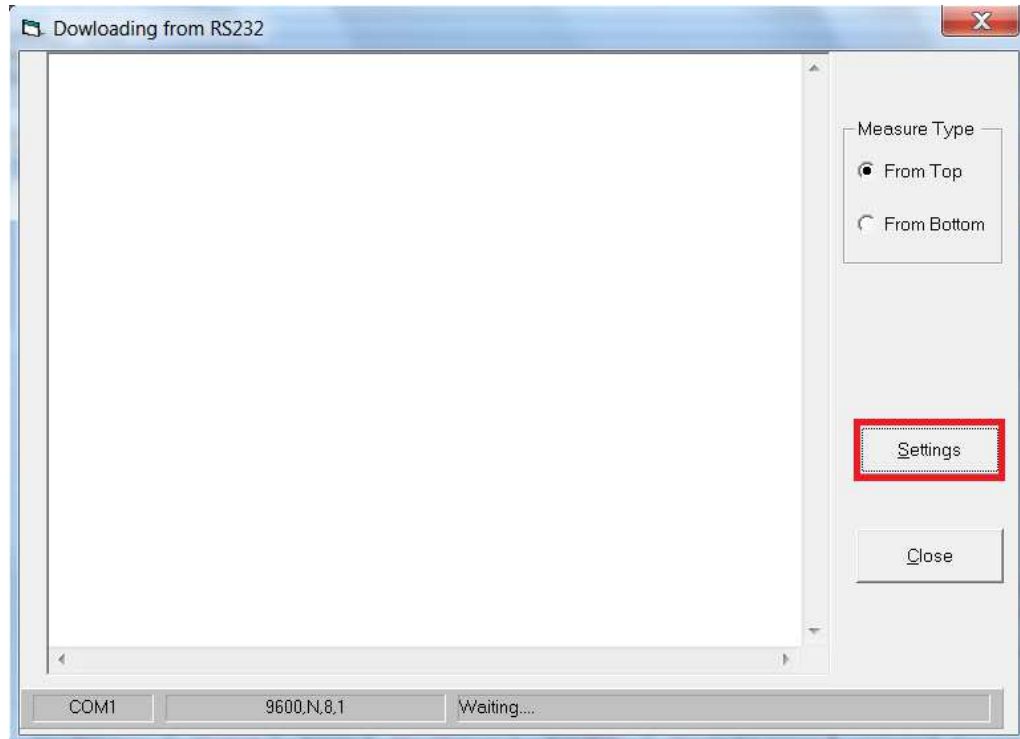
5. Click on **RS232**



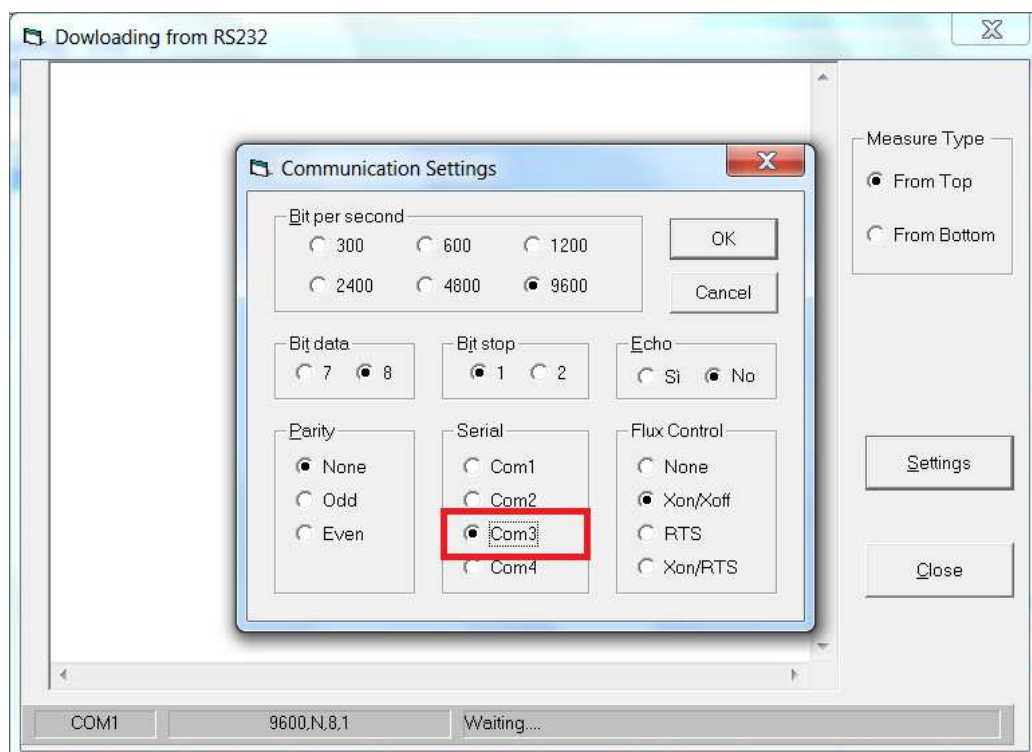
6. In the pop-up window, click on **Yes**.



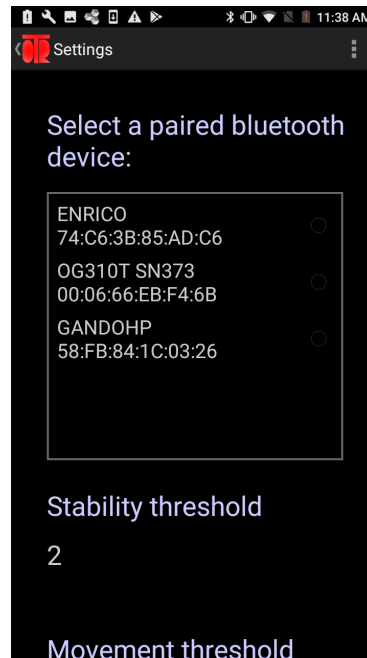
- A new window will open. Click on **Settings**



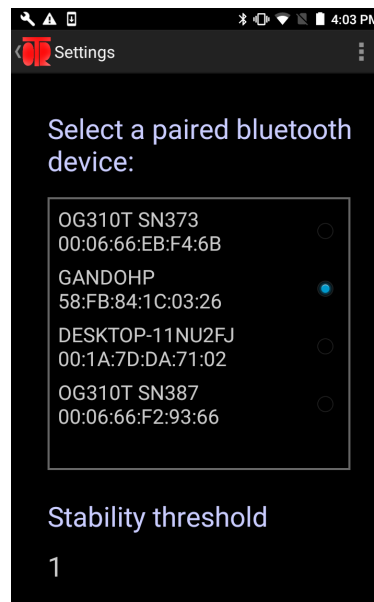
- Select the COM port the Datalogger is connected to. Then, confirm your choice by clicking on **OK**



9. On your Android device, tap on the Settings icon at the top right corner of the screen, to open Settings window in the app OG310T



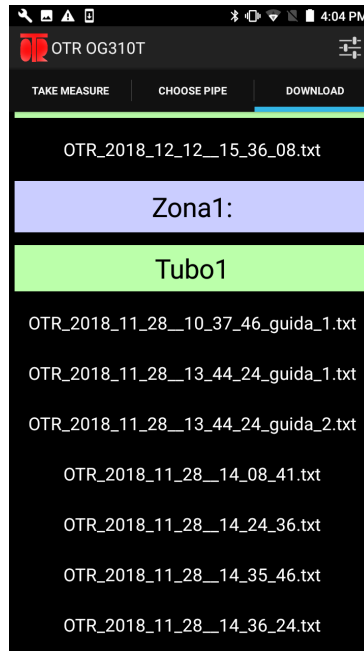
10. Select your computer



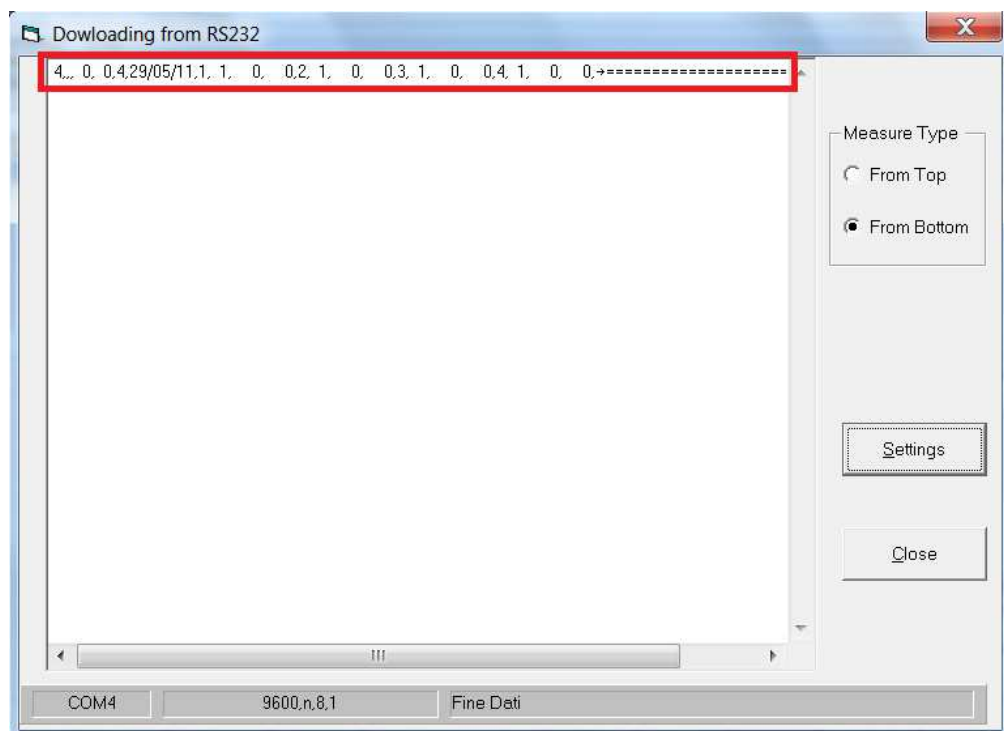
In the picture above, computer name is GANDOHP. When Bluetooth connection is correctly established, a blue dot will appear next to computer name

11. Tap on OTR icon at the top left corner of the screen.
App will take you to the Download tab directly.

12. Tap on the file name you want to download



Data are exported to OG390WIN software for further elaboration:



13. Click on **Close** button in the window of OG390 software



14. Fill in every field you need :

Origin date

Azimuth correction

Zone

Pipe

Probe angular correction : **0**

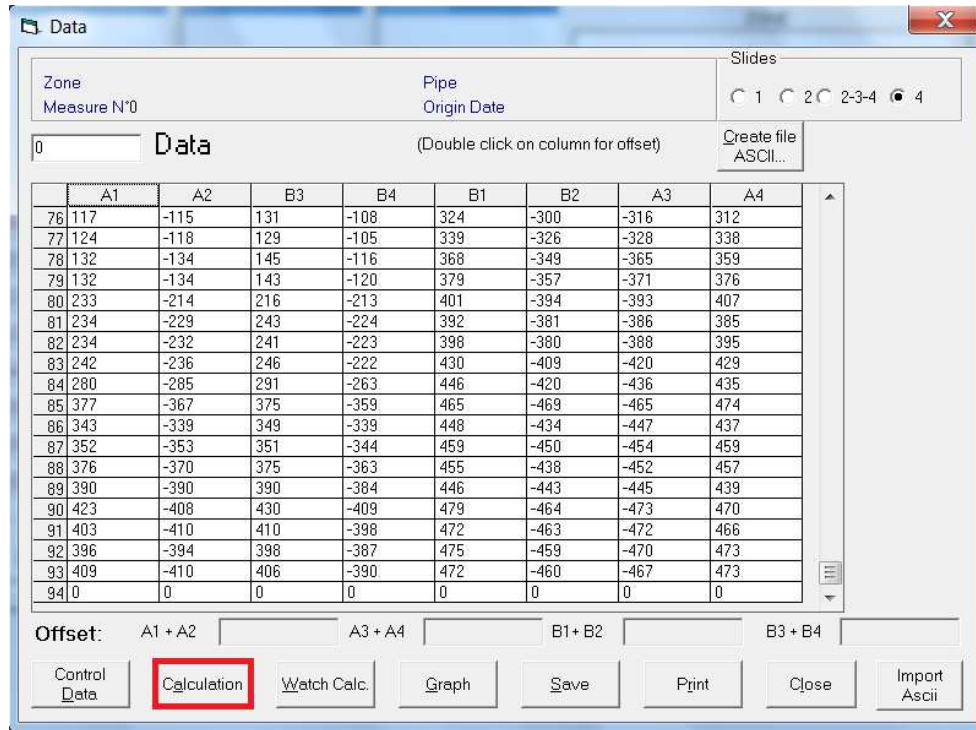
Sensor A sensitivity: **25000 (*)**

Sensor B sensitivity: **25000 (*)**

Click on **Data/Calc**

** Please refer to probe calibration chart.*

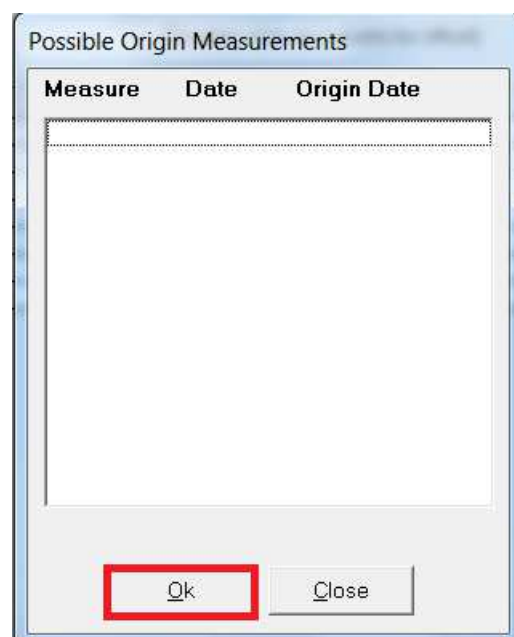
15. Click on **Calculation**



The 'Data' window displays a table with columns A1, A2, B3, B4, B1, B2, A3, and A4. The table contains 24 rows of data. Below the table, there are fields for 'Offset' with formulas A1 + A2, A3 + A4, B1 + B2, and B3 + B4. At the bottom, there are buttons: Control Data, **Calculation** (highlighted with a red box), Watch Calc., Graph, Save, Print, Close, and Import Ascii.

	A1	A2	B3	B4	B1	B2	A3	A4
76	117	-115	131	-108	324	-300	-316	312
77	124	-118	129	-105	339	-326	-328	338
78	132	-134	145	-116	368	-349	-365	359
79	132	-134	143	-120	379	-357	-371	376
80	233	-214	216	-213	401	-394	-393	407
81	234	-229	243	-224	392	-381	-386	385
82	234	-232	241	-223	398	-380	-388	395
83	242	-236	246	-222	430	-409	-420	429
84	280	-285	291	-263	446	-420	-436	435
85	377	-367	375	-359	465	-469	-465	474
86	343	-339	349	-339	448	-434	-447	437
87	352	-353	351	-344	459	-450	-454	459
88	376	-370	375	-363	455	-438	-452	457
89	390	-390	390	-384	446	-443	-445	439
90	423	-408	430	-409	479	-464	-473	470
91	403	-410	410	-398	472	-463	-472	466
92	396	-394	398	-387	475	-459	-470	473
93	409	-410	406	-390	472	-460	-467	473
94	0	0	0	0	0	0	0	0

A popup window will open to select the Origin measurement

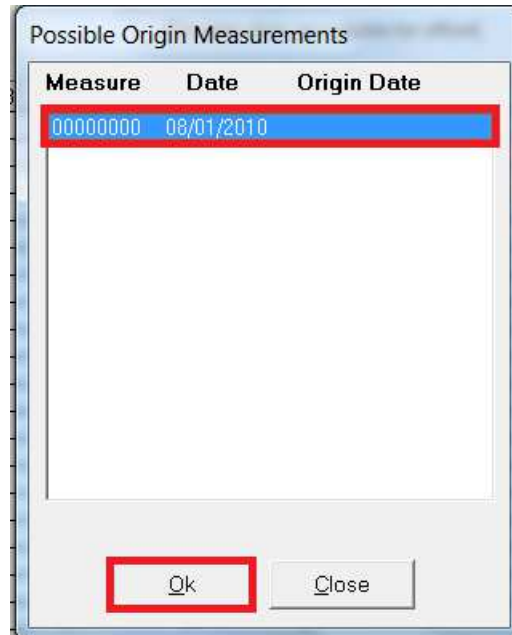


The 'Possible Origin Measurements' dialog box contains a table with columns Measure, Date, and Origin Date. The table is currently empty. At the bottom, there are buttons: **Ok** (highlighted with a red box) and Close.

Measure	Date	Origin Date
---------	------	-------------

If you are creating the Origin measurement, no previous measurement is listed. In that case, just click on **Ok**.

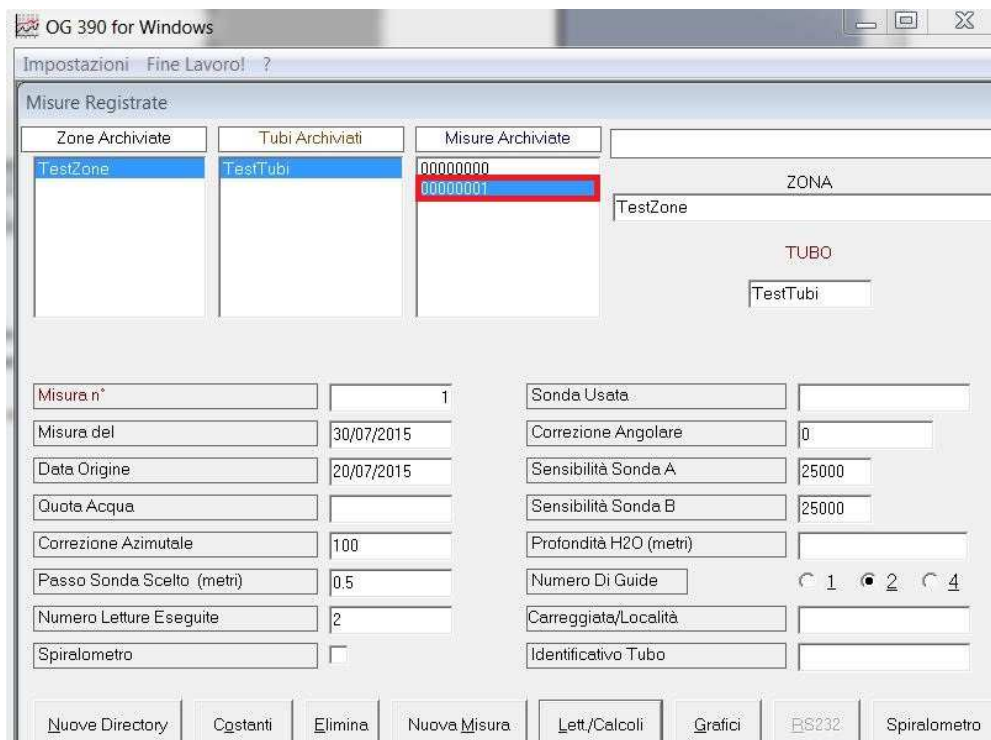
16. If you are not creating the Origin Measurement, select the Origin from the list and then click **Ok**



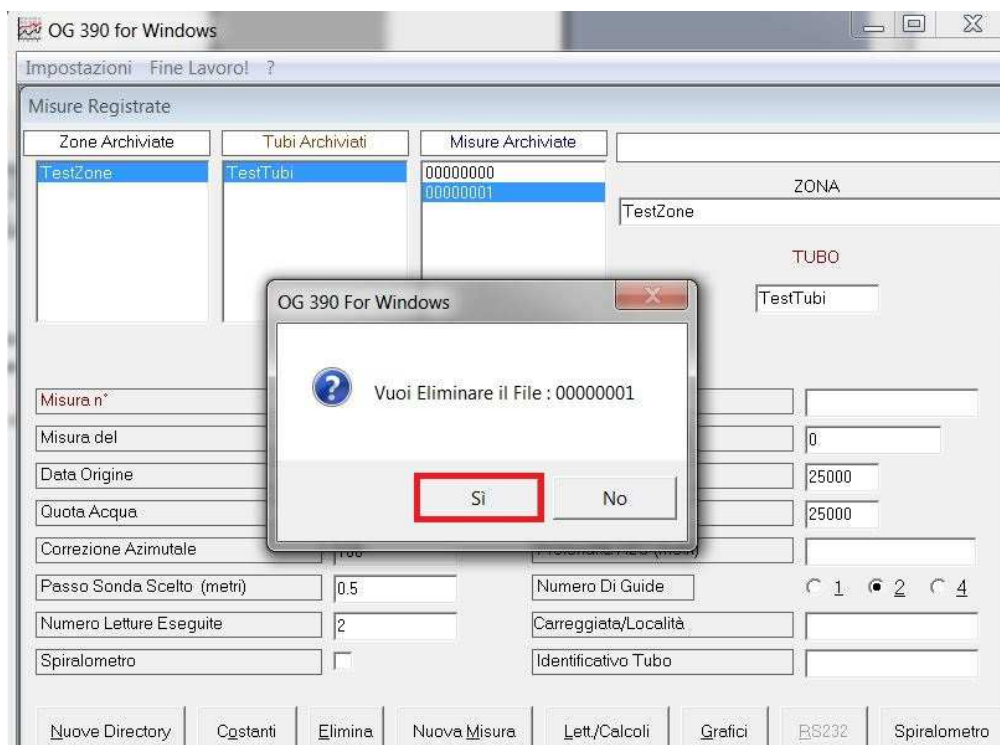
17. Data are now processed:

- In case you are creating an origin measure (misura 00000) only verticality and azimuth charts will be available.
- Following measures allow creation of all remaining charts.

18. In case you incorrectly add a new measure that needs to be erased, remove it from the list with a double click



Click **Yes** to confirm



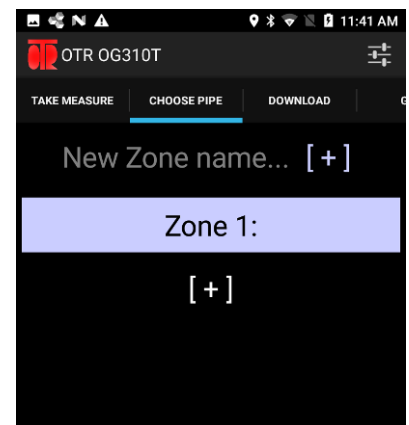
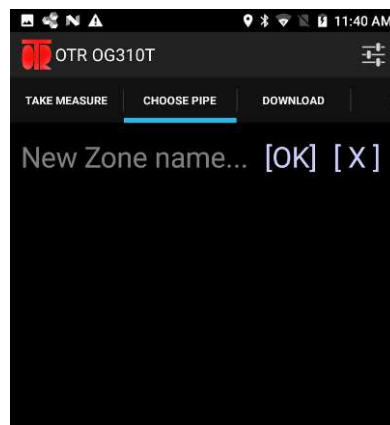
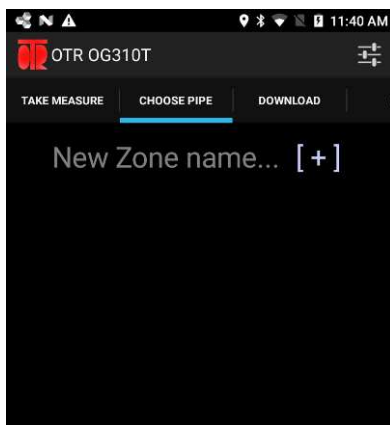


Create Zones and Pipes on Android device

Zones and Pipes can be created in the app, tapping on the **CHOOSE PIPE** tab

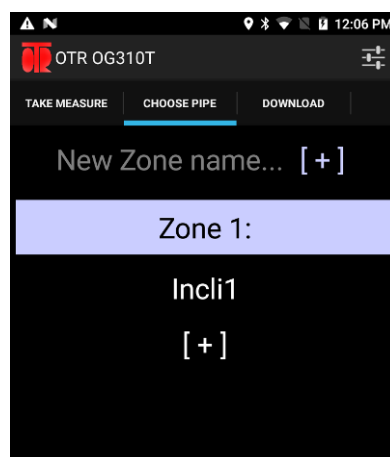
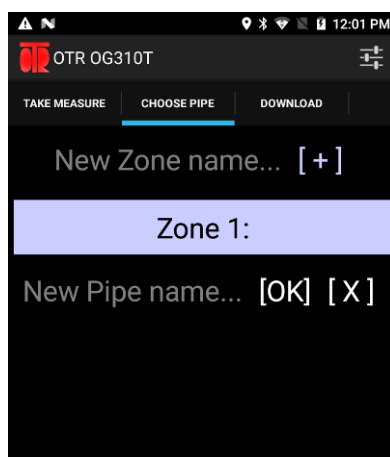
1. To create a new Zone: tap on [+] next to New Zone. Tap on **New Zone Name** and a keyboard will allow you to enter the name for your new Zone.

Confirm with a tap on [OK] or cancel with [X]



2. To create a new Pipe: tap on [+] in a Zone. Tap on **New Pipe name** and a keyboard will allow you to enter the name for your new Pipe.

Confirm with a tap on [OK] or cancel with [X]





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3. To delete a new Pipe: Lon press on Pipe's name.

You can not delete pipes containing inclinometric files. Only unse piped can be deleted..

4. To delete a new Zone: Lon press on Zone's name.

You can not delete zones containing pipes. Only empty zones can be deleted.

In order to manage Zones and Pipes from your PC, please refer to the following procedure:

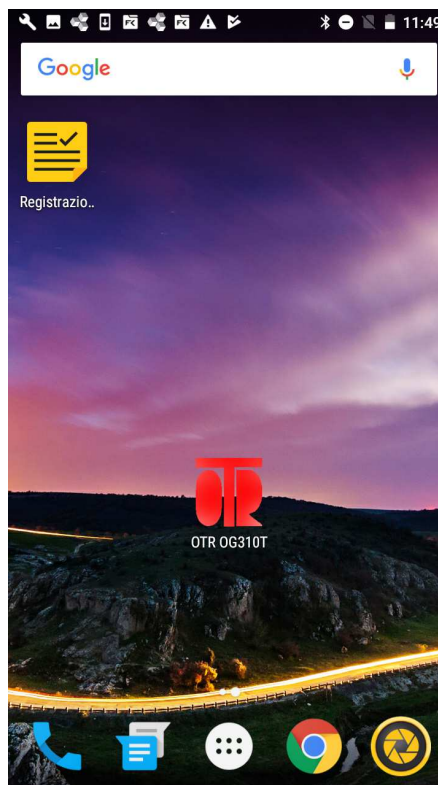
1. Connect Android device to PC with USB cable.

USB connection to PC allows battery recharge as default option.

2. Enable USB file transfers on your Android device.

To enable file transfer to PC via USB connection::

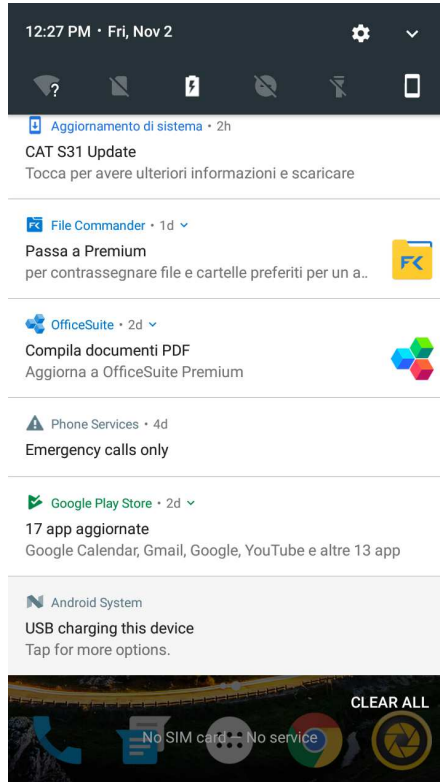
- *Unlock your Android device*



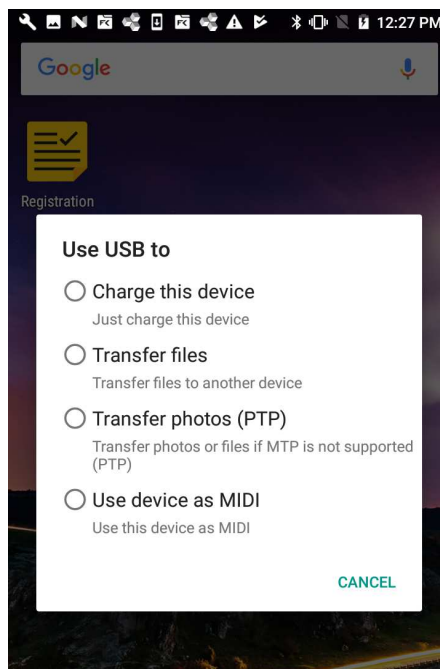
- *Swipe down from the top of the screen to show Android notifications.*



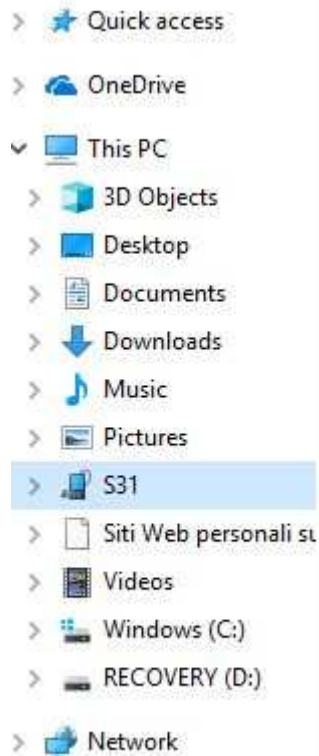
- Tap on notification **USB charging this device**



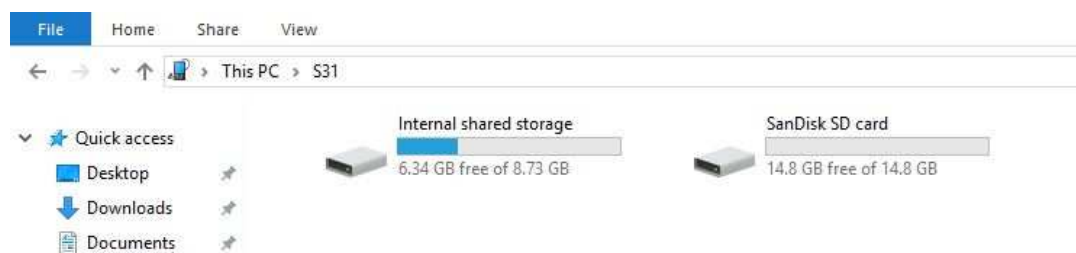
- Tap on option **Transfer files**



- On your PC, browse to **This PC** and open your Android folder (**S31**)



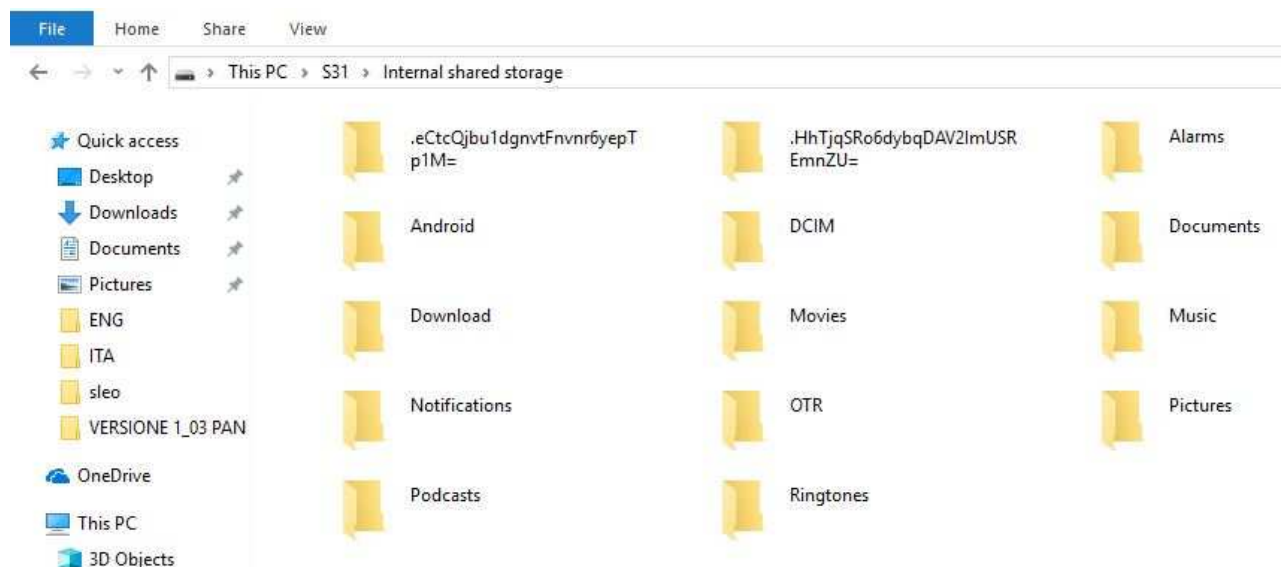
Android device S31 is listed in computer folders



You can now access internal archive of your Android device

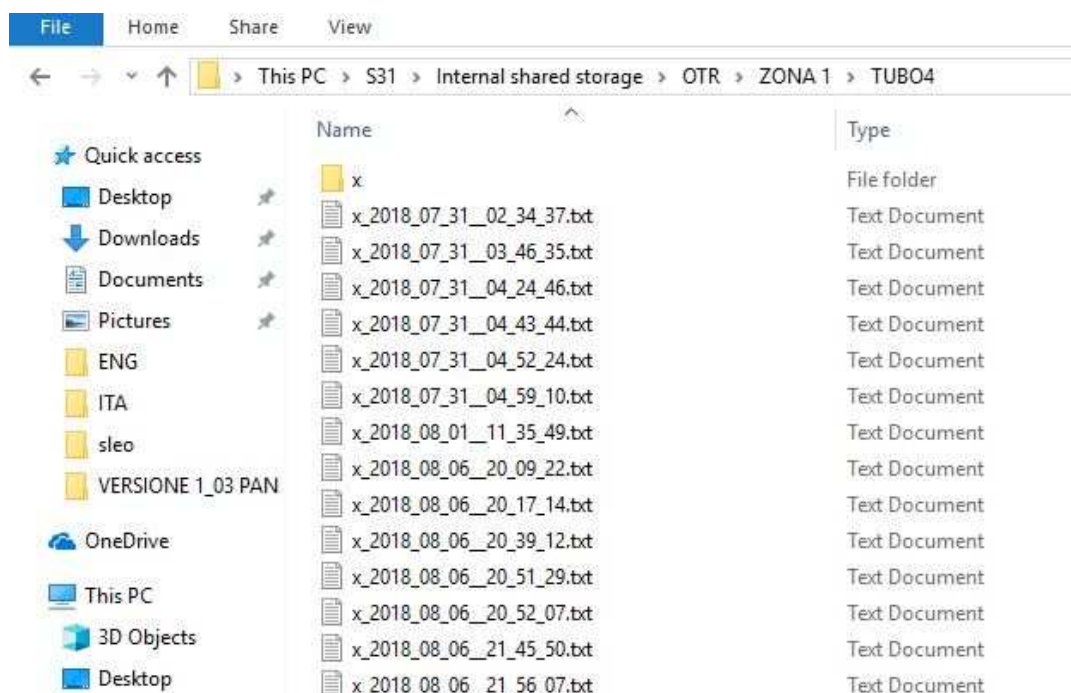


4. Open **OTR** folder in device internal shared storage.



5. In **OTR folder**, create a new folder for each Zone you want to list in the app.
6. In any new Zone folder, create a Pipe subfolder for each Pipe you need in that Zone.

Inclinometric measures will be saved in these Pipes subfolders.



Inclinometric measure files are named as follows: prefix_date_time.txt (you can change prefix in the Settings screen of the app. For instance, it can be changed to operator's name. Date and time refer to date and time of file creation..



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Zone folders and Pipes subfolders structure will be listed in the app after you close and reopen it .

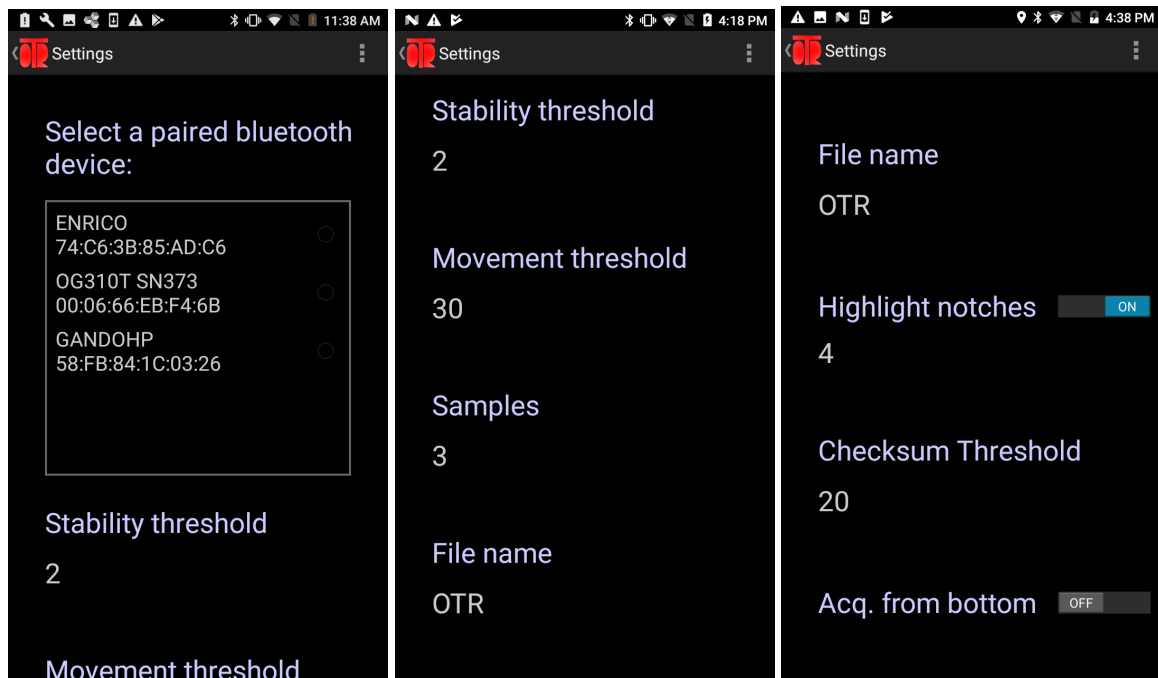
To modify name and/or number of Zones and Pipes, modify name and/or number of folders and subfolders.

Measure text files can be exported to OG390WIN software through data download procedure in the app.

*For further instructions about downloading inclinometric measures to OG390WIN software, please refer to chapter **Data Download to OG390WIN**.*



OG310T app Settings



In the Settings screen are listed the following settings:

- **Select Bluetooth Device**

List of Bluetooth devices paired to Android device.

In this list you can find one or more inclinometric probes, each one identifiable by its Serial Number, and one or more PCs for data download.

This is a read-only list.

*For further details about how pairing Bluetooth devices, please refer to chapter **Bluetooth Connection**.*

- **Stability Threshold**

Variation threshold for channels A and B, below which probe is considered stabilized during automatic acquisition.

Default value: 2

In case inclinometric pipe is poorly embedded in concrete, probe might not get stabilized due to undesired small pipe vibrations. It might be necessary to increase stability threshold value, or switch to manual acquisition mode.



- **Movement Threshold**

Variation threshold for channels A and B, above which probe is considered voluntarily moved between two steps of measures, during automatic acquisition.

Default value: 30

- **Samples**

Number of samples used to evaluate probe stabilization

Default value: 3

- **File name**

Prefix for saved files.

Default value: OTR

Prefix can be useful, in case you have more inclinometric systems or more Android devices, to identify measures acquired by different operators.

- **Highlight notches**

Activates/disactivates sound effect and visual notification for acquisition of colored notch steps.

Enter number of first colored notch on your inclinometric cable

Default value: Off

- **Checksum Threshold**

Threshold for checksums when loading file in Table view.

Checksum average is computed for each acquired slide. Steps are highlighted whenever their own checksum differs from slide average more than this threshold.

Default value: 40

- **Acq. from bottom**

Steps acquisitions order. Select ON in case you acquire steps from bottom up. Select OFF in case you acquire steps from top.

Affects in-app charts visualization only.

Default value: Off



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Data Table

The screenshot shows the OTR OG310T app interface. At the top, there's a status bar with the time 5:18 PM and various icons. Below the status bar is the app header with the OTR logo and the text 'OTR OG310T'. There are four tabs: 'PIPE', 'DOWNLOAD', 'GRID', and 'GRAPH'. The 'GRID' tab is currently selected. Below the tabs is a green button labeled 'Choose File'. Underneath the button, the file name 'OTR_2019_04_03_10_31_32.txt' is displayed. The main area of the screen shows a data table with 8 columns: A1, A2, B3, B4, B1, B2, A3, and A4. The table contains 20 rows of data, each representing a step measurement.

A1	A2	B3	B4	B1	B2	A3	A4
00333	-00319	-00364	00275	-00045	-00048	00006	00002
00317	-00306	-00348	00259	-00013	-00074	00031	-00020
00325	-00312	-00360	00266	-00007	-00079	00038	-00028
00211	-00206	-00248	00162	-00053	-00041	-00007	00011
00188	-00176	-00227	00132	-00045	-00049	00007	00003
00191	-00179	-00232	00136	-00035	-00058	00017	-00007
00194	-00182	-00235	00142	-00039	-00055	00014	-00006
00148	-00137	-00188	00092	-00006	-00087	00043	-00033
00127	-00115	-00167	00072	-00013	-00080	00041	-00029
00184	-00171	-00222	00129	-00073	-00021	-00015	00022
00177	-00163	-00210	00122	-00106	00014	-00054	00065
00138	-00125	-00175	00084	-00099	00004	-00045	00057
00121	-00108	-00155	00066	-00090	-00002	-00038	00048
00130	-00118	-00169	00077	-00084	-00009	-00034	00043
00135	-00121	-00171	00079	-00042	-00052	00008	00002
00272	-00248	-00293	00203	-00010	-00081	00037	-00025

1. Tap on Choose File button
2. Select file to load
3. Swipe down to check all steps.

Steps are checked as soon as they are loaded into table. Steps whose checksum differs from checksums average of their slide will be highlighted..

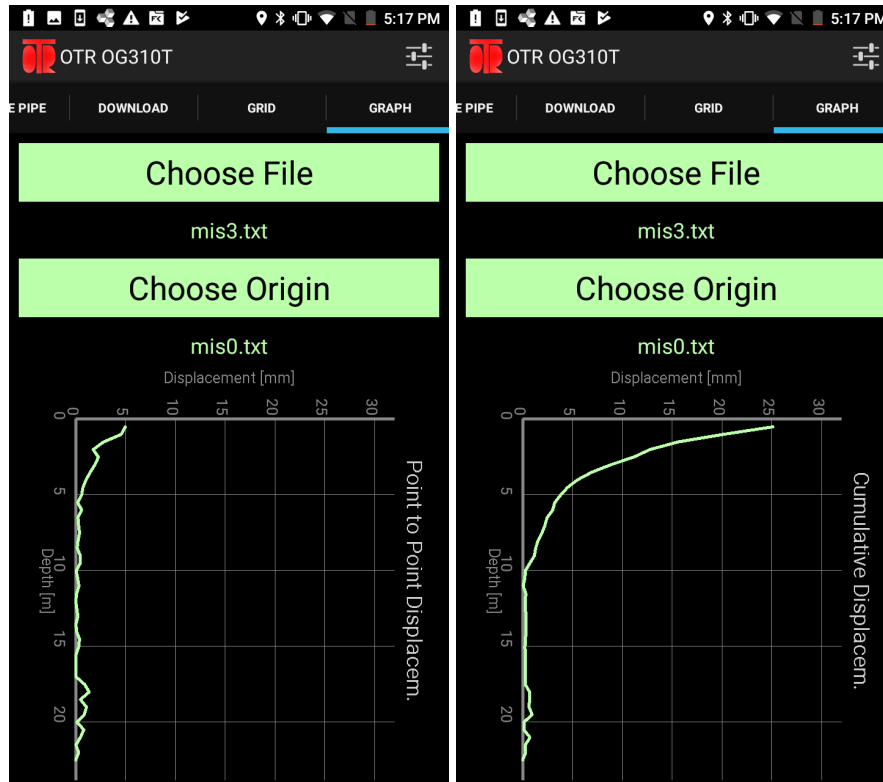
Threshold for checking checksum can be changed in app Settings. Please refer to previous chapter.



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Charts



1. Tap on Choose File button
2. Select acquisition to show
3. Tap on Choose Origin button
4. Select origin file.
5. Tap on chart to change chart type

Charts are computed against selected origine measure .

In-app charts are indicative of quality of acquired measure. Please refer to OG390WIN software for an accurate elaboration of acquired data.



Inclinometer Measurement Specifications

1.1 Generality

The aim of inclinometer measures is to find out with precision, in a probably instable side, possible sliding planes; to control during time the entity, the speed and direction of the movements, so gaining valid data on danger. The same data can be used also in planning a stabilizing process.

Measures are carried out with proper devices in inclinometer tubes, properly installed in the ground, in time interval established by the Customer.

1.2 Equipment used and requisite

1.2 a - Inclinometer probe

The inclinometer probe must be biaxial, use servo-inclinometers with FS of 14.5, 30 o 45 degrees.

The probe step, i.e. the distance between the wheels of the higher and lower part, must be 500 mm. (for probes with metrical steps) or 24 inches (for probes with English step).

Sensitivity of the oblique axis must not exceed the 0.015% of the FS, per degree.

Temperature variation of sensitivity must not exceed the 0.015% of the reading, per Celsius degree.

Temperature variation of zero must not exceed the 0.01% of the FS per Celsius degree.

Reading sensitivity must not be lower that $20,000 \times \sin \alpha$ (α = angle of inclination in respect to vertical line)

1.2 b - Control cable

Control cable, i.e. the cable with electrical conductors and the little strengthening cable to which is fastened the probe, must quote the notches of measure every 500 mm for metrical system or 24 inches for English measuring system.

The cable must guarantee no variation in the distance between the notches.

1.2 c - spiralometrical probe



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In some cases, when data elaboration gives movement directions hard to interpret or physically improbable, the use of a particular probe, "spiralometrical probe", can be requested to reveal the **spiral deformation** of the guides of the inclinometer tube, so that it is possible to adjust elaboration.

The spiralometrical probe can be :

- completely electronic with magnetic North sensor (flux gate);
- with rotating edges and electronic angular sensor (analogical or digital angle meter);
- completely mechanical with rods and goniometer.

In all cases the system of spiralometrical measure must allow to verify and measure **spiral deformation** of the guides with a minimal sensitivity of 0.1 degrees per meter of inclinometer tube.

1.2 d - Reading unit (Data Logger).

Reading unit can be manual, with one or two displays, or automatic (data acquisition).

In both cases the unit must be able to operate in a range of temperature from -5 to + 40 °C and respect the specifications of temperature variation, see 1.2a.

1.3 – How to execute measures

Original measures

1.3 a - Find on the inclinometer tube, among the four ones, the guide that more comes near to the direction of a probable movement (guide towards the max slope), name it "1" with a permanent marker.

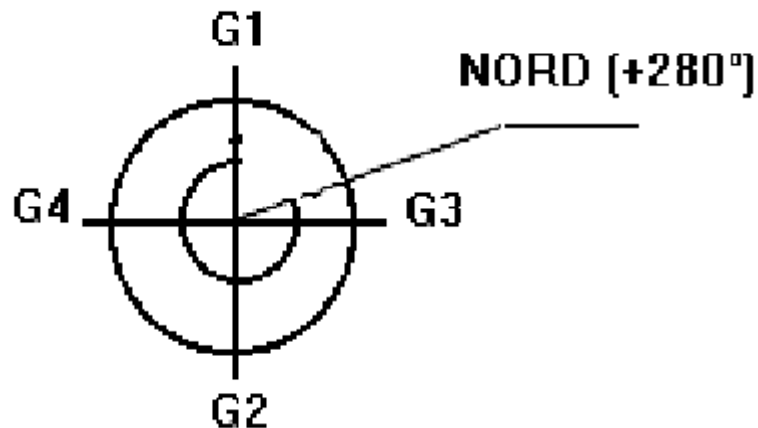


fig 1

1.3 b - Measure the height of the edge of the tube (or the depth, in the case of tubes in wells) in respect to the ground and take note of it on the proper module

1.3 c - Write on the parameter of walls the position and the name of the tube, when this is possible.

1.3 d - Read on a compass the angle between the magnetic North and the joining line between guide "1" and "2", guide "2" is the guide opposite to "1", and take note of it in a proper module with all data of the measured zone, inclinometer data of the tube (number, id.)

The lines joining guides "1"- "2", and guides "3"- "4", form a system of Cartesian axis, X-Y as in fig. 1.

For OG390WIN in the case of fig. 1 the correction of Azimuth must be entered with positive sign (the angle is positive if read in an anti-clockwise direction from Guide 1 to North).

1.3 e. - Prepare the devices of measures for starting the measure itself.



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1.3 f - Insert the inclinometer probe with the wheel of reference in the guide "1" (the wheel of reference for probes OG 310 is **the higher wheel**).

1.3 g - Lower the inclinometer probe until it reaches the bottom of the tube; wait some minutes for a correct thermal acclimatization and until the values read on the display of the unit are stable.

1.3 h - Raise the inclinometer probe at the edge of the tube and lower it again until the wheels of the higher trolley are at a probe step (50 cm or 24 inches) from the edge of the inclinometer tube.

Take note of the values read on the display in the proper module if you are using a manual reading unit or acquire data if the measuring unit is automatic.

1.3 l – Lower the inclinometer probe until you it reaches a probe step, taking note for each reached depth the values read on the display or acquiring them with the reading unit if it is automatic.

1.3 m – When the probe reaches the bottom of the tube, control that the last measure is carried out in a way that the inclinometer probe doesn't touch the bottom, also the last measure must be executed for an entire probe step.

1.3 n – Recover the inclinometer probe, insert it in guide "2" (opposite to "1") and follow the same instructions as in points from 1.3h to 1.3n.

1.3 p – Finished the measures on guide "2", it's the turn of guide "3", i.e. the guide placed 90 degrees in a clockwise direction in respect to "1", and then of guide "4" (opposite to "3").

At the end of the measure you will have 4 values of inclination on axis X (G3-G4) and 4 values of inclination on axis Y (G1-G2) for each probe step, this is because you have carried out a 4 guide precision measure.

Example: for an inclinometer tube, 20 meters long, measured with a probe with steps of 500mm, you will have 160 values of inclination along axis X and 160 values of inclination along axis Y, that is 320 collected number in total.

Measures of control.

Control measures must be executed in the same way than the original measures. In particular, you have to follow instructions form points 1.3d to 1.3n.



In the case that, during a control measure, you are no more able to carry out reading as far as the depth of origin, you will place the probe on the point of maximum reachable depth and you will accurately take note of the inclination data and of the distance in centimetres from the last complete reading (a probe step).

In the case that you find hard to interpret of physically improbable directions of movement in the elaboration of the previous measures, spiralometrical measures will be requested. These ones must be executed with a proper probe described at point 1.3c. The way to measure with spiralometrical probe will be suggested by the Producers.

1.4 – Example of files delivered to the customer

The files to be delivered to the customer will be numerical (tables) and graphical (graphs).

1.4 a – Tables for original measures.

Tables must have all data for the identification of the interested zone, Zone, place of the inclinometer tube measured, given name, direction in respect to the magnetic North of the guide “1”; data on sensitivity of the inclinometer probe expressed through the sine of the angle in respect to vertical line multiplied for the value of “sensitivity” and the date when the measure took place; then must be reported the data of the campaign, the reading on axis X and Y (8 values for each probe step) taken at various depths and the correspondent spiralometer reading, if requested.

Then, you have to report polar co-ordinates calculated (deviation in respect to the vertical line in mm. And direction in degrees) at various depths, in a system of axis which has the bottom of the inclinometer tube as origin and oriented according to the magnetic North.

1.4 b – Graphs for the original measures .

The graphs for the original measures will be the following ones:

- depth-deviation from vertical line graph through “summation from the lower part”, with zero point at the bottom of the inclinometer tube (maximum reading depth) and points calculated for each probe;
- graph of direction at various depths reporting the angle in respect to a Cardinal point of the deviation from the vertical line at various depths;

In the graphs will be reported all data concerning the zone and the inclinometer tube and the numerical values of the maximum shifting from the vertical line, of the shifting of the edge of the tube from the



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vertical line, in mm., of the relative direction in degrees and of the depth in meters from the edge of the tube of the point in which you have the maximum shifting from the vertical line.

**1.4 c – Tables for control measures.**

These tables must report all data concerning zone, inclinometer tube, sensitivity of the system of measure, direction of the magnetic North in respect to guide “1”, campaign data, as well as the movements calculated from the origin for each probe step, in polar co-ordinates through summation (vectorial summation of the movements starting from the bottom of the tube (“summation from the lower part”) expressing the values in meters for the depth, in mm. for the distance and in degrees for the direction); the values of the “variation of local inclination”, expressing them in mm./meter, reporting also the direction in degrees in respect to a cardinal point and the depths from the edge.

1.4 c – Graphs for control measures.

- depth-movement graph through “summation from the lower part” (vectorial summation), with zero point at the bottom of the inclinometer tube (maximum reading depth) and points calculated for each probe step, reporting the movement in respect to origin through summation from the lower part in 2:1 scale if possible;
- graph of the direction calculated at various depths, reporting the angle from the magnetic North of the movement from the origin.
- Graph of the “variation of the local inclination – depth” reporting the variation at various depths (every probe step) of the local inclination expressed in mm./m in 10:1 scale if possible;

In the graphs will be reported at least two previous curves (if they exist) besides the one under elaboration.

In the graphs will be accurately reported all data for the identification of the measure: Zone, place, name of the inclinometer tube, date of measure, date of the origin, etc.

You will report in numerical form:

- the maximum shifting expressed in mm. or mm./meter, the relative direction in degrees and the depth from the edge of the tube in meters of the maximum shifting.
- the shifting from the edge of the tube expressed in mm. or in mm./meter and the relative direction in the same way that has been described many times.

Both for original measure and for control measure is useful that the documents, (tables and graphs) are reported in A4 sheets, for comfortable reading and filing.

Calculation Scheme

This part is a simple description of calculation of inclinometer measurements, differential and absolute.

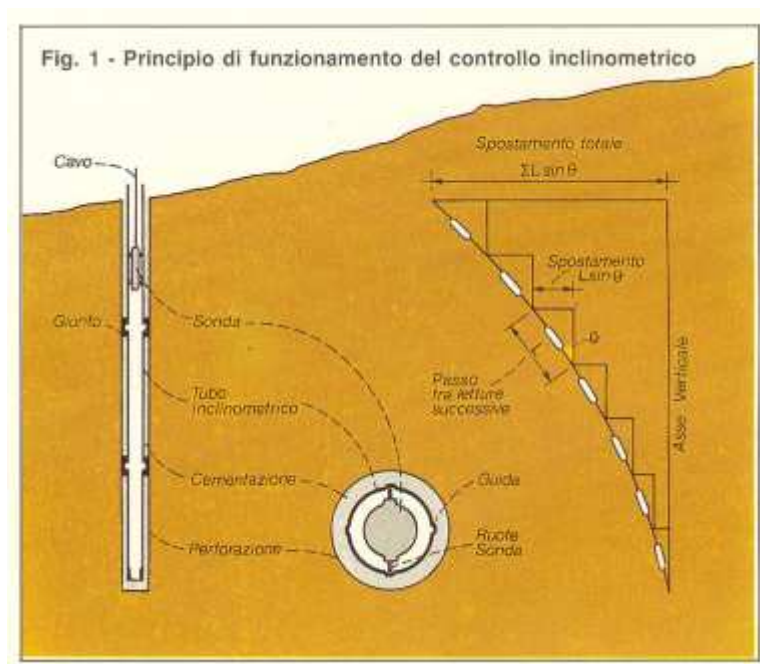


Figura 2 System Geometry

Consider this:

- Data processing, if it not expressly required, is always from bottom;
- In calculation the bottom part of inclinometer must be considered stationary;
- In OTR software the real depth is expressed (not the simple lenght)



Absolute Position

Proceed as follows:

- Mediate the A1 & A2 measures (or A1 & A2 with A3 & A4) for each inclination (e.g. A e B,

$$A_i = \frac{A1_i + (-A2_i)}{2};$$

- Convert data in angulus sine (utilize the probe sensivity;
- Utilize step probe L;
- Utilize the angle in sen θ and execute the Sum for every axis (A and B)

- o Sum $A_i = \sum L \times \text{sen}(\theta_i^A);$

- o Sum $B_i = \sum L \times \text{sen}(\theta_i^B).$

- In every step: Vertical displacement = $\sqrt{A_i^2 + B_i^2}$
- Execute rotation considering the slide 1 positioning.

Differential Position

Proceed as follows:

- Execute difference of A_i (measure) e A_i (origin) , B_i (measure) e B_i (origin) ;
- Calculate the sum of the movement on both axis;
- Execute rotaion considering slide 1 positioning.

Tables

- Tables of data:
 - Recorded data expressed in 25000 sen α . Sequence is:
 - 4 slides: A1 A2 B3 B4 B1 B2 A3 A4;
 - 2 slides: A1 A2 B1 B2;
- Processed tables:
 - Absolute/Vertical: data processing from bottom position of installation at every step starting from bottom;
 - Sum dDifferential processing: position of the pipe/ground compared to selected origin;
 - Local differential processing: position of the pipe/ground compared to selected origin in every single step



OG390 software shows the real depth of the considered step. Depth is not simply the wheel base X number of steps (eg: 40 x 0.5 m).



OG390 software can process data in different ways. This can be helpful if results are not easy to understand:

- 4 Slides (4 slide option **only for 4 slide data set**);
- On slides A1/A2/B1/B2 (2 Slides option, **it is the only one option if measures have been made with 2 slides**);
- On slides A3/A4/B3/B4 (option 2-3-4 slides **only for 4 slide data set**);
- On slides A1/B1, **(not recommende)** (opztion 1 slide);
- Using just A sensor **(only for 4 slide data set)** using sensitivity A=25000 B=0;
- Using just B sensor **(only for 4 slide data set)** using sensitivity A=0 B=25000;

Passo ↓

Inclinazione direzione scelta come G1

Inclinazione direzione ortogonale alla G1

N° numero del passo (1 valori di testa)

A1 e B1 misure asse A e B 1° calata
A2 e B2 misure asse A e B 2° calata
A3 e B3 misure asse A e B 3° calata
A4 e B4 misure asse A e B 4° calata

N°	A1	A2	B3	B4	B1	B2	A3	A4	Spira.
1	164	-170	-165	160	42	-52	44	-63	0
2	177	-175	-177	178	8	-15	12	-19	0
3	205	-232	-221	214	-17	5	-19	-8	0
4	248	-249	-249	248	18	-22	26	-24	0
5	244	-244	-244	239	45	-48	44	-45	0
6	231	-231	-232	230	57	-54	55	-52	0
7	217	-219	-216	220	64	-58	63	-62	0
8	207	-204	-207	199	51	-54	52	-56	0
9	154	-158	-157	157	52	-56	47	-54	0
10	134	-139	-128	137	69	-64	71	-66	0
11	159	-158	-163	154	60	-63	62	-65	0
12	171	-172	-173	176	74	-75	73	-72	0
13	186	-189	-184	188	76	-70	81	-75	0
14	206	-205	-208	204	80	-83	82	-81	0
15	215	-232	-214	212	44	-48	44	-62	0
16	218	-221	-219	222	17	-9	15	-8	0
17	217	-211	-216	214	0	-3	4	-3	0
18	219	-217	-222	221	-13	7	-9	8	0
19	216	-217	-216	216	-17	26	-16	22	0
20	220	-221	-219	220	-35	29	-28	31	0
21	171	-193	-197	178	8	-19	7	-37	0
22	191	-191	-189	188	27	-26	34	-28	0
23	194	-193	-192	199	30	-30	33	-31	0
24	197	-193	-196	193	32	-41	34	-38	0
25	215	-218	-215	212	44	-37	44	-39	0
26	228	-223	-219	229	43	-38	44	-41	0
27	254	-253	-259	252	141	-146	144	-147	0
28	246	-247	-250	249	135	-134	137	-130	0
29	257	-258	-255	252	126	-129	131	-132	0
30	258	-255	-260	257	131	-134	130	-132	0
31	258	-261	-258	261	126	-116	127	-122	0
32	290	-288	-277	294	137	-136	142	-137	0
33	364	-358	-371	366	290	-293	293	-294	0
34	358	-358	-358	364	289	-283	289	-286	0
35	0	0	0	0	0	0	0	0	0

Eventuali dati di spiralatura

Zeri di fondo

Image 3 General data set explanation

Charts

- Absolute Graphs: position of inclinometer casing in the ground (displacement from vertical and direction);
- Sum Differencial Graph: position of inclinometer casing compared to selected origin data set (the measure under the bottom step is considered stationary)
- Local differential Graph: local differential compared to origin data set (displacement and direction);
- Polar graph.



Main used graphs are differential sum and its direction. It can be helpful to print them side by side.



Polar graph cannot be helpful for understanding data.



Direction is expressed as the anticlockwise angle starting from North. If correction is zero slide 1 is Y and slide 3 is X.



If entity of movement is near to instrument error direction should not be considered.



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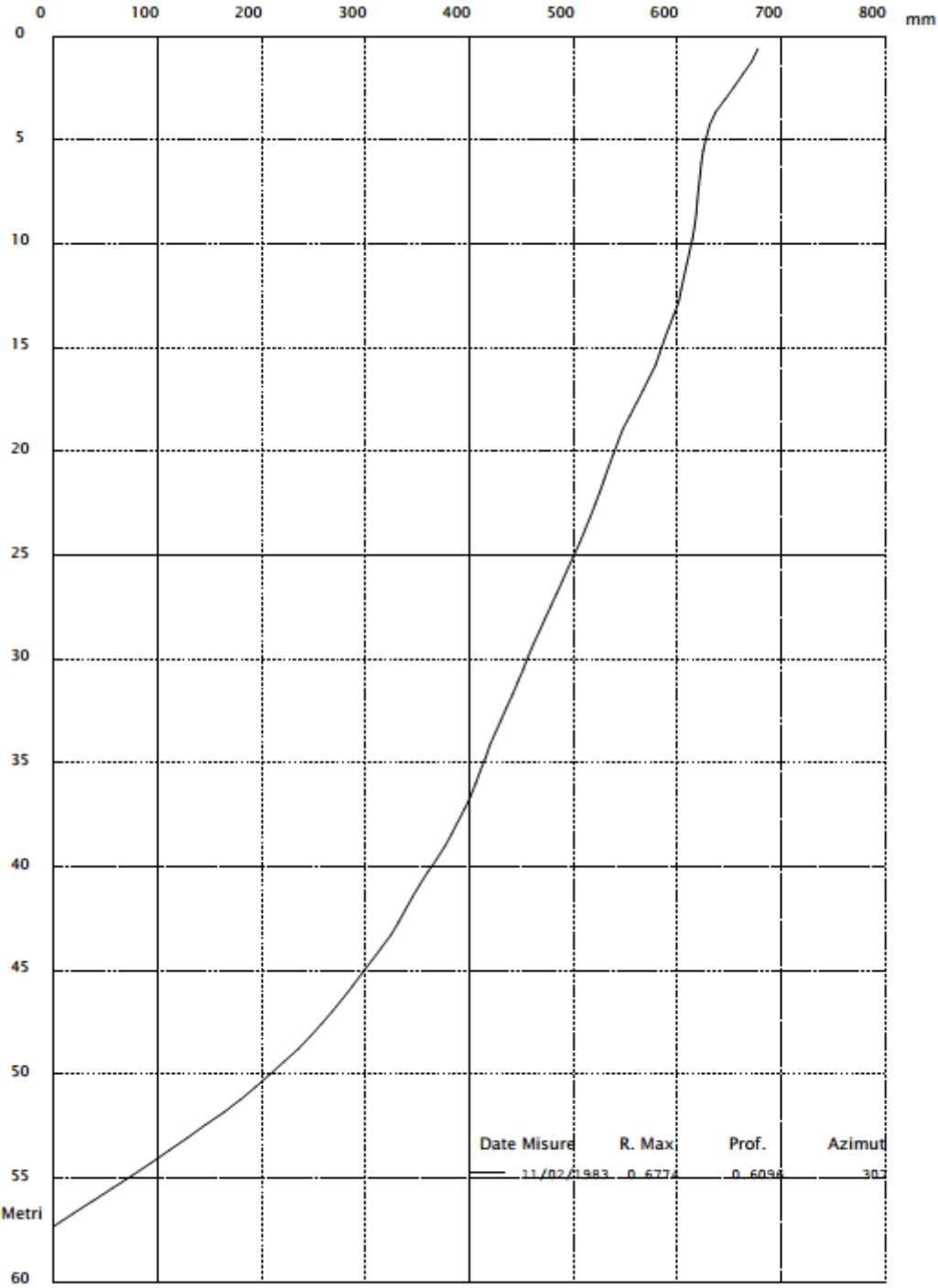


Image 4 Sample Absolute Graph



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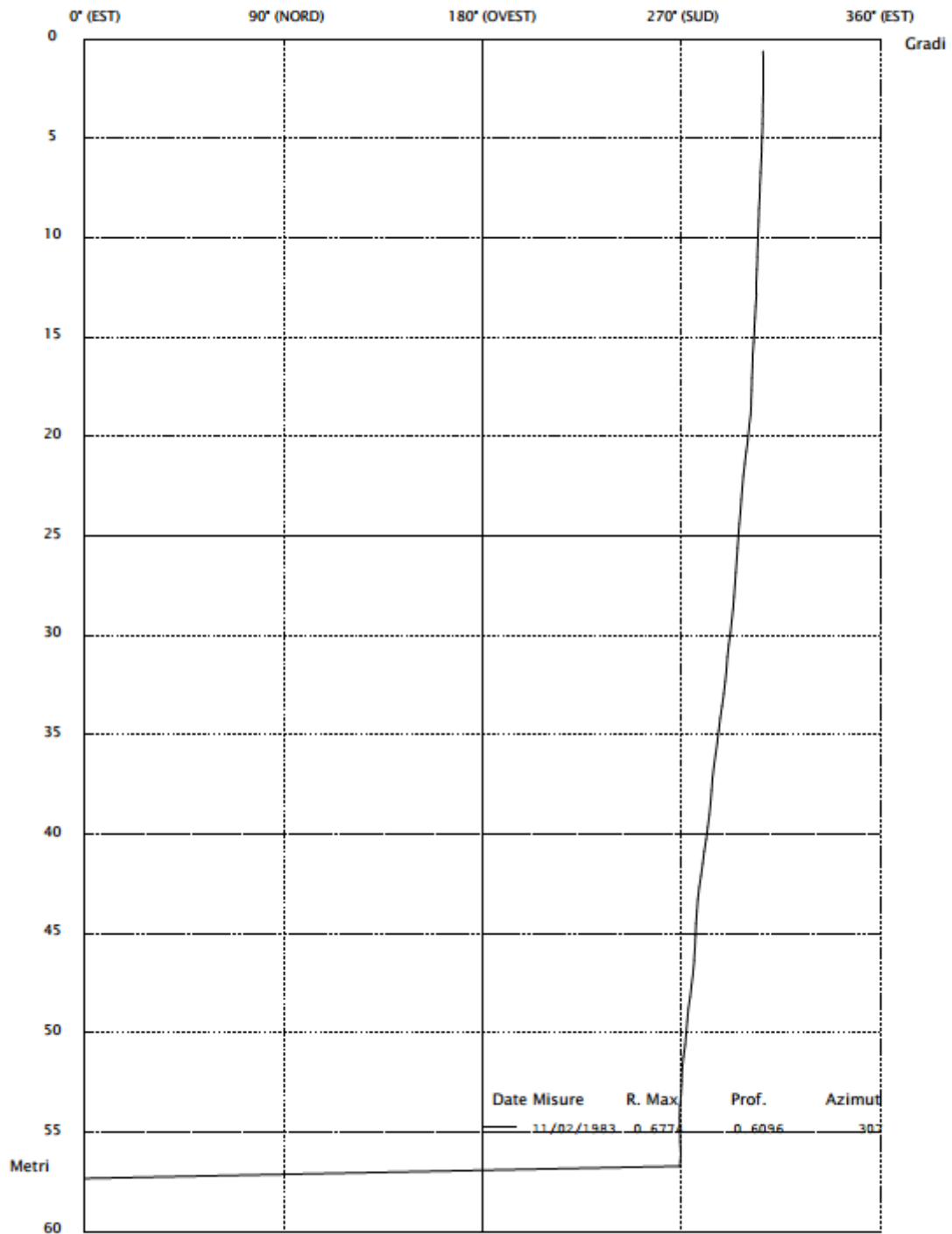
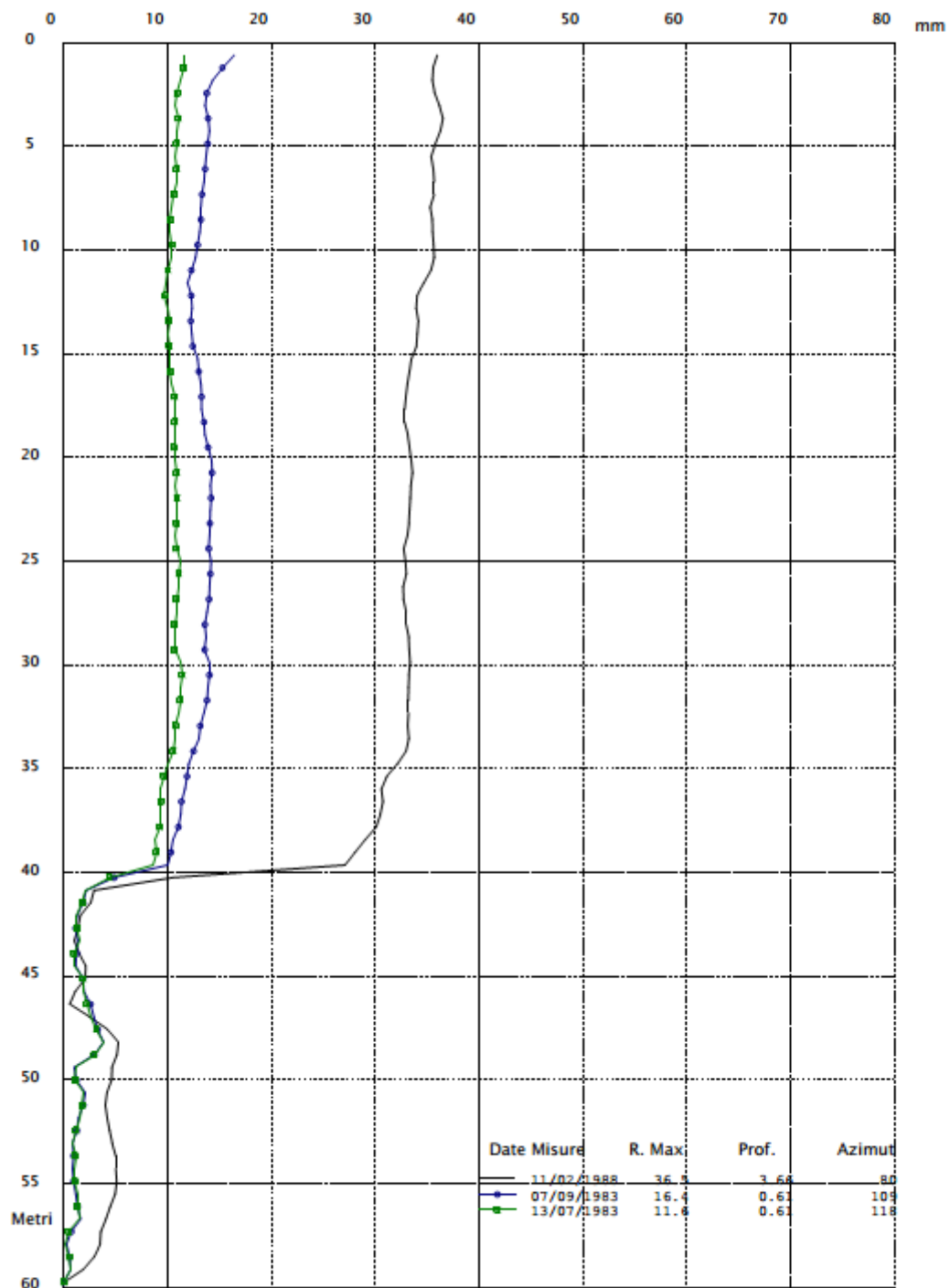


Image 5 Sample Absolute Direction



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Elaborazione rispetto all'origine del 18/02/1983

Image 6 Sample Movement, differential Sum

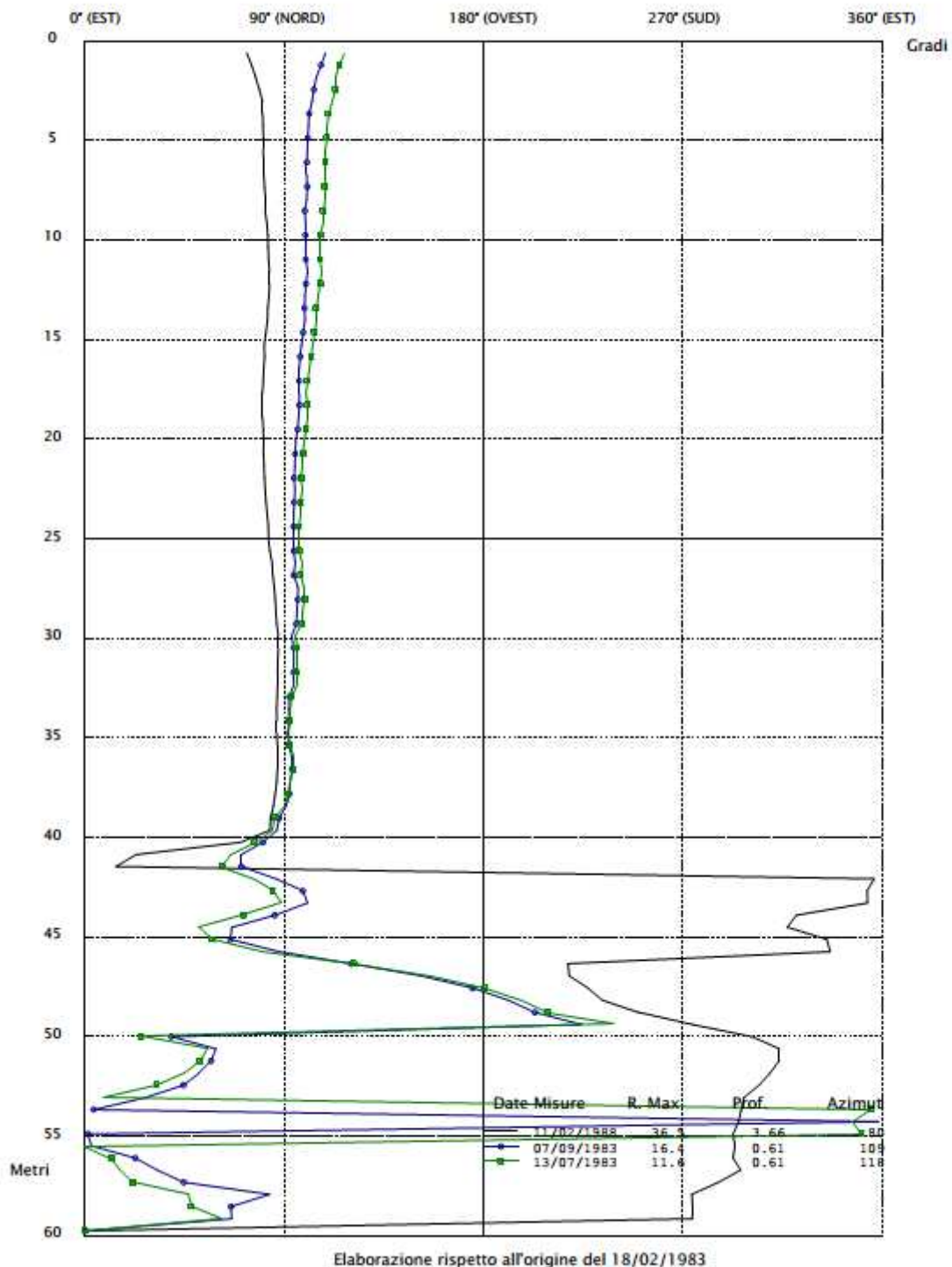
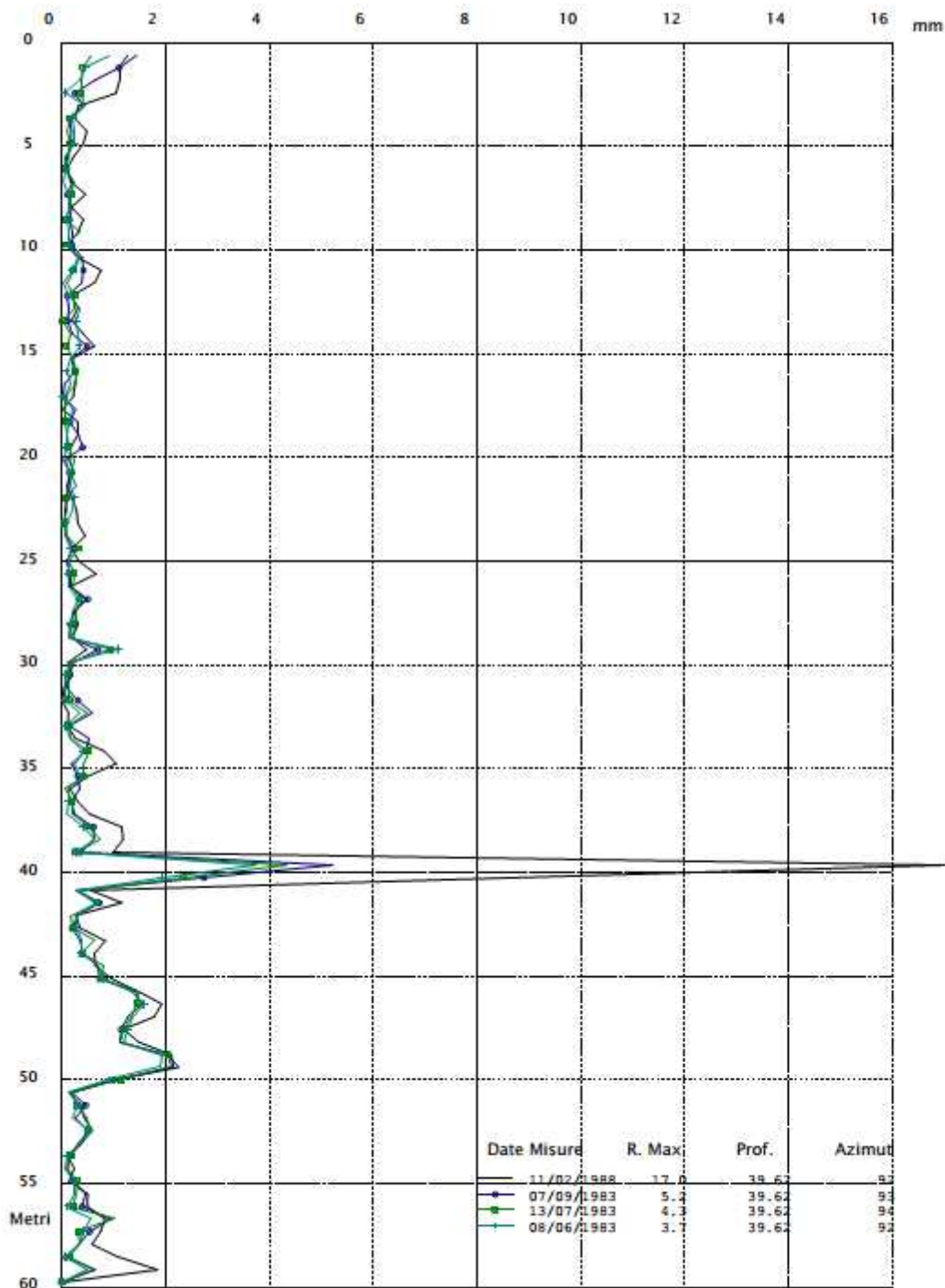


Image 7 Sample Direction of a movement



Elaborazione rispetto all'origine del 18/02/1983

Image 8 Sample Local Differential Graph



OG390 software can execute measures selecting a specific origin data set. Measure number 0 is default but it is possible to make differential calculations between other data sets.

Instrument Parameters

A & B Axis sensitivity

It is expressed in $\text{sen } \alpha$ and it is the angle measured by the instrument.

Angular Correction

Allow to execute a rotation of the probe sensors.

Nominal parameters are:

- A axis sensitivity -> 25000;
- B axis sensitivity -> 25000;
- Angular correction -> 0

These parameters must not be modified if not strictly necessary.



Precision and repeatability of the measure are influenced by mechanical features of the casing, e.g.:

- Depth and shape of the slides;
- Problems during installation;
- Cementation;
- Total verticality of the installation.



File Export

OG390 WIN allows file export in ASCII files:

- Enter in general menu and select the measure to export;
- Click on data/calculus;
- Click on "Create File ASCII";
- Appoint name file as <NOME-FILE>.txt:
 - NOME-FILE: max 8 characters;
 - Extension txt.
- An ASCII file will be created including:
 - Data, steps, dates;
 - Processed data.

Import a data set

OG390WIN allows to import a data set using Ms Excel:

- Import data in Excel;
- Position data as follows:
 - Two Slides:
 - A1 / A2 / B1 / B2 **considering OTR conventions;**
 - Four Slides:
 - A1 / A2 / B1 / B2 / B3 /B4 / A3/ A4 **considering OTR conventions;**
 - Excel sheet must contain data straining from A1 cell (nothing else);
 - Appoint name of the sheet (not name of the file);
 - Keep MS Excel open;
- Create a new measure in OG390WIN and enter in data/calculus;
- Click on "Import ASCII files" and insert **the name of the sheet;**
- Click on import key.



During import/export consider:

- Respect OTR conventions;
- Use UK number format:
 - decimal separator . (poiny);
- It is not possible compare measures with different steps (e.g.: 0.500 m / 1.000 m / 24" ...);
- It is not statisfactory to compare measures with different cable positioning;
- A comparison between different probes is not object of this user manual.