W2Z24
SEISMOGRAPH
From 1 to 24 ch

User Manual

General Index

1 Software Installation

Refer to the folder / directory of the installation file , whose name is:

Installation Disk **W2Z24**

In this directory there is a file with the name :

Installing USB Drivers **FTDI.pdf**

Open it and follow the guide to install the USB drivers needed to operate the equipment.

After installation of the driver, run the installation file:

SETUP W2Z24.exe

2 Preview

W2Z24 is a single Unit/Geophone Seismograph.

This wireless seismic system is composed of:

- one unit connected to the PC by USB wire and its tripod (MOM unit)
- one geophonic unit disposed on the ground following a geometry (GU unit)
- one trigger unit, equipped with a triggering wire system (TRG unit)

After you have installed the USB driver and application (see file "Install USB Driver FTDI.pdf"), connect the MOM unit to your PC, using the USB wire.
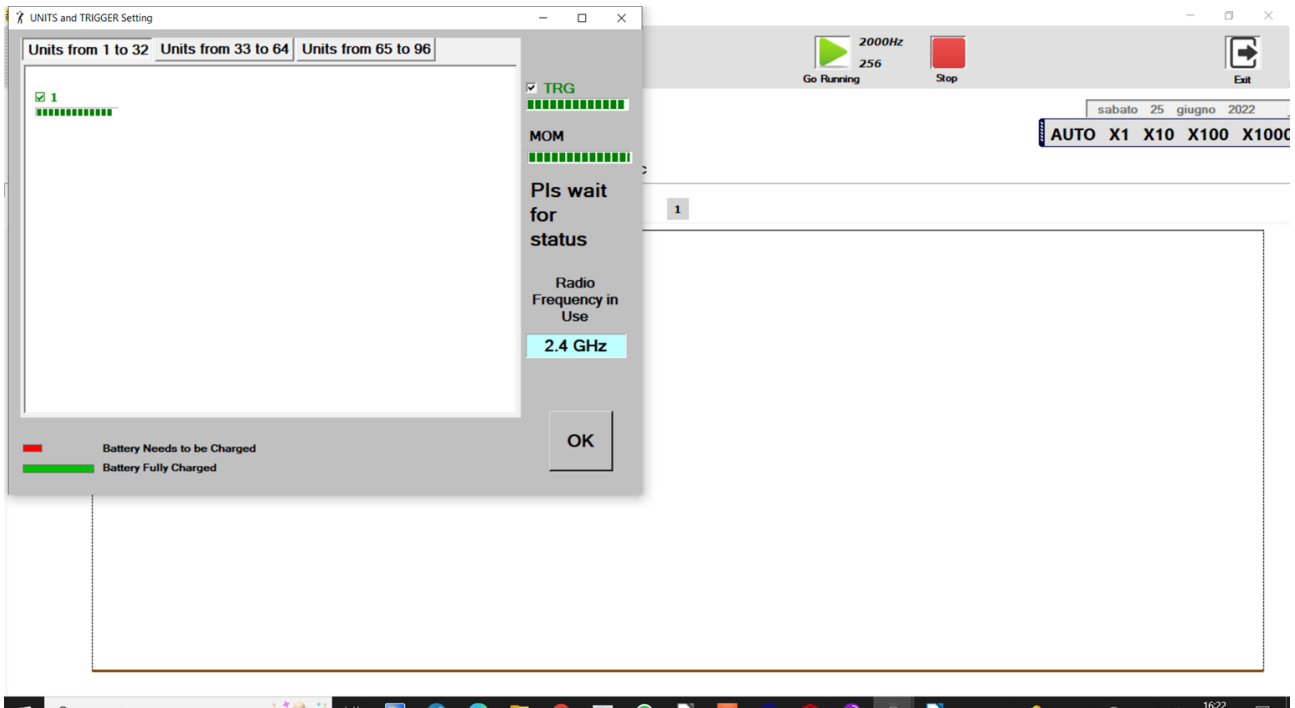
2.1 Units Status

Each Unit has a led on top of the box.

When powered on, led blinks rapidly for some flash, then keeps blinking more slowly.

If Unit is powered and is under control of the application running on PC (and the MOM is

USB connected and powered), leds will keep blinking slowly.

If the Unit is powered and no application is running, after about 15 sec Unit automatically resets itself. You will notice reset from rapid flashing of led .

Before proceeding in operation with W2Z, you have to verify the correct functionality of all units, to check their ability in radio transmission in your environment and their battery state.

Set all Units on the field as required and follow rules dictated on **Layout of W2Z in field operations**; switch them on and verify that the led is flashing. If PC App is not running, Units will reset about every 15 seconds. Reset is indicated by 5 rapid flashes.

Pressing UNITS STATUS you can verify the battery charge, looking at the length of the green line on bottom of each box representing a Unit of your system.
If the line is red, a charge will be needed, but much time is yet allowed for working.

Fig 2 shows Unit 1 with poor signal, Unit 2 and 3 ok, Unit 4 no radio comunication.
On the right, trigger status is ok.
Unit 4 may be off.
Trigger Unit is fully charged.

If all Units are on, you are in range and lines are not green, it may be that some disturbance is interfering.
W2Z is using free ISM (Industrial, Scientific, Medical) frequency band, this can be occupied by WIFI devices if in some populated zone.

You can try to change operating Radio Frequency.
In Fig 2 you can see that Radio Frequency is 2.45GHz.
To change this value, click on this label to open frequency choice as shown on Fig 3.

Set a different frequency and verify if radio transmission is improved (lines are green).
Remember that frequency can be changed if Units can receive this order from MOM unit.
If some line is black, this can not happen.
In order to allow frequency change, move closer to units, to make their status line green.

2.2 Acquisition - Running

Once you have entered the correct number of the communication port, enter the number of units (for ex. 24) in the box: Geophones Number.

If this is the first acquisition, after you have positioned all units, you can verify the signal strength.

Activate the menu: UNITS STATUS; see paragraph before.

Pressing the green arrow ▶ starts Running mode. W2Z will acquire at pre set sampling frequency and Samples number.

Fs and N will be shown at the top on the wright of ▶
To vary this setting go to: Initialisation Parameters, see the paragraph down; this setting will be remembered every time you open the application.

This function is useful to see if all is working. On the right a panel you can change the amplitude of the signals acquired.

By default, the amplification   is "auto-ranging", then you will see even the slightest signal.
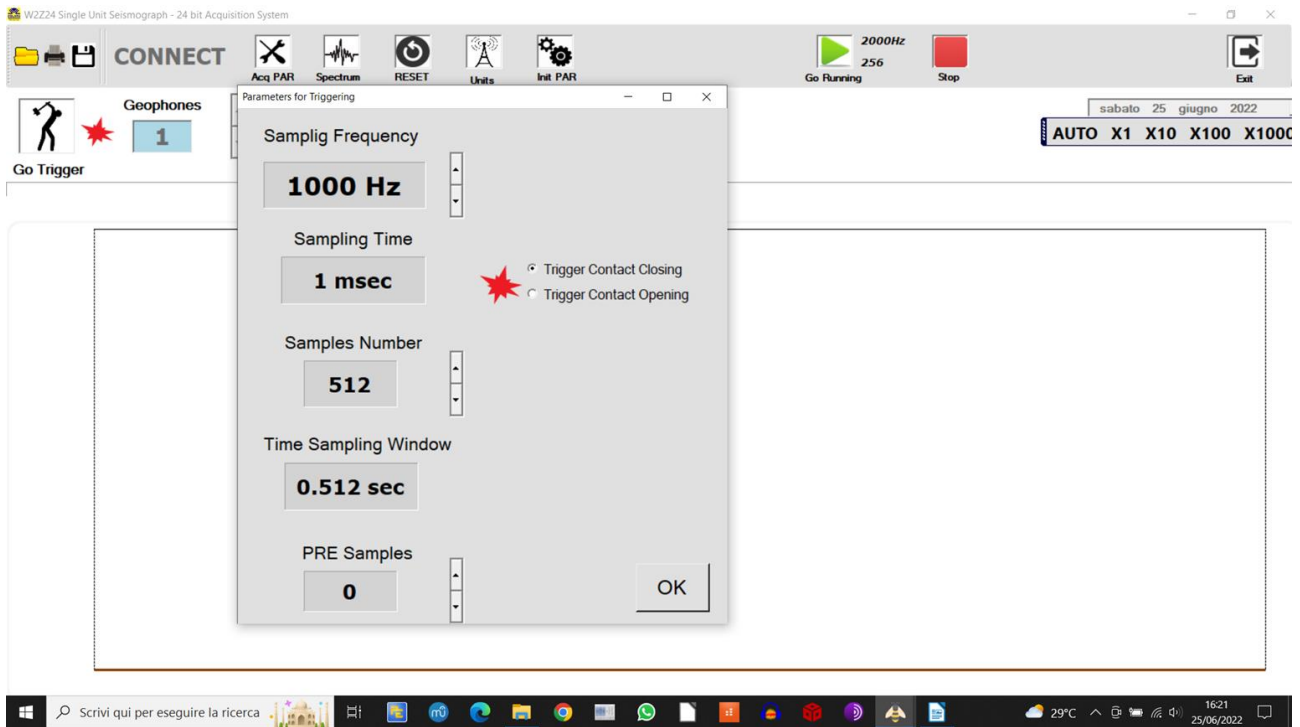
If there are not connected geophones, what you will see is the electronic noise of the apparatus.
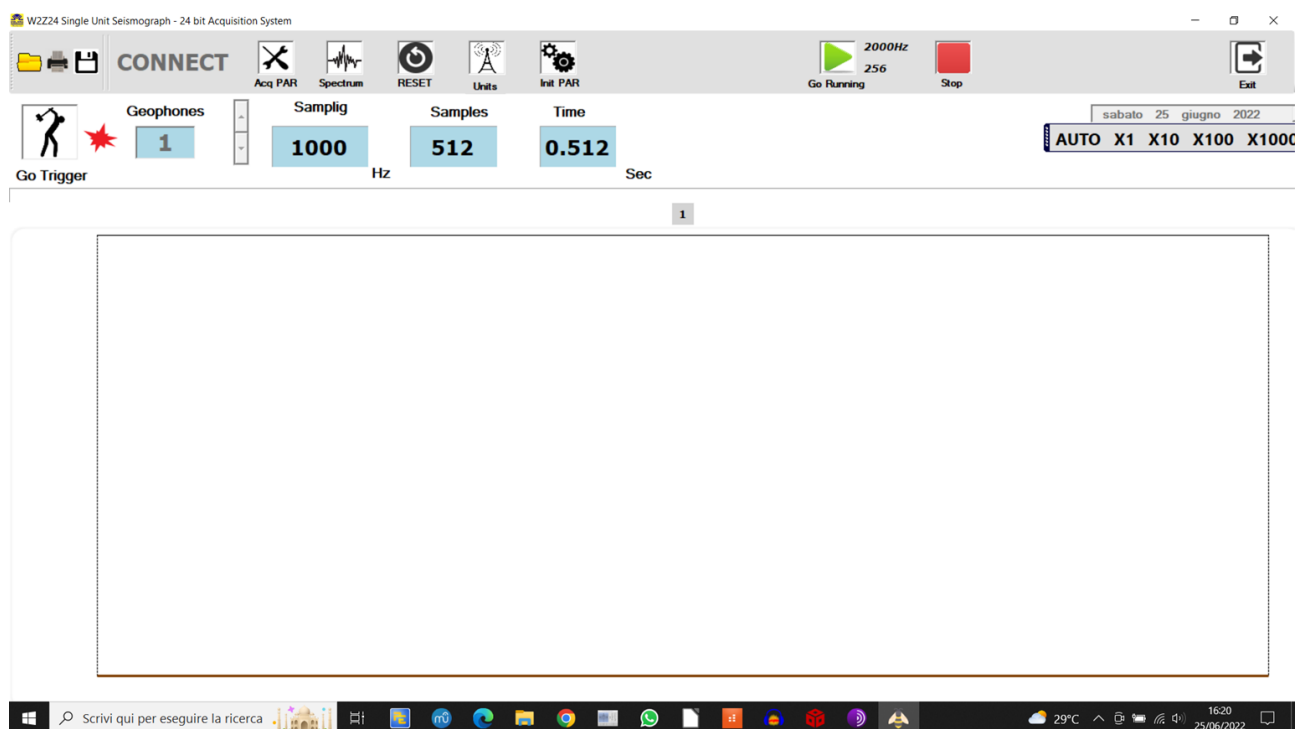
3 Working with W2Z24

Once you have verified correct working of Geophonic Unit and Trigger Unit as described in paragraph 2.1, you must set the Acquisition Parameters.

Sampling Frequency can have these values: 125, 250, 500, 1000, 2000, 4000, 8000, 16000 Hz

Sampling Time is the inverse (1/Sampling Frequency)

Samples Number can have these values: 256, 512, 1024, 2048, 4096, 8192, 16384

Time Sampling Window is the time that acquisition process will last. Is is Obtained multiplying Samples Number x Sampling Time.

Pre Samples is the number of samples that will be acquired before trigger event. Be careful to set this, because all will be saved at the end.

When Acquisiton Parameters are set, you can start the acquisition process. Think about the layout of geometry you intend to do.

Then click on:
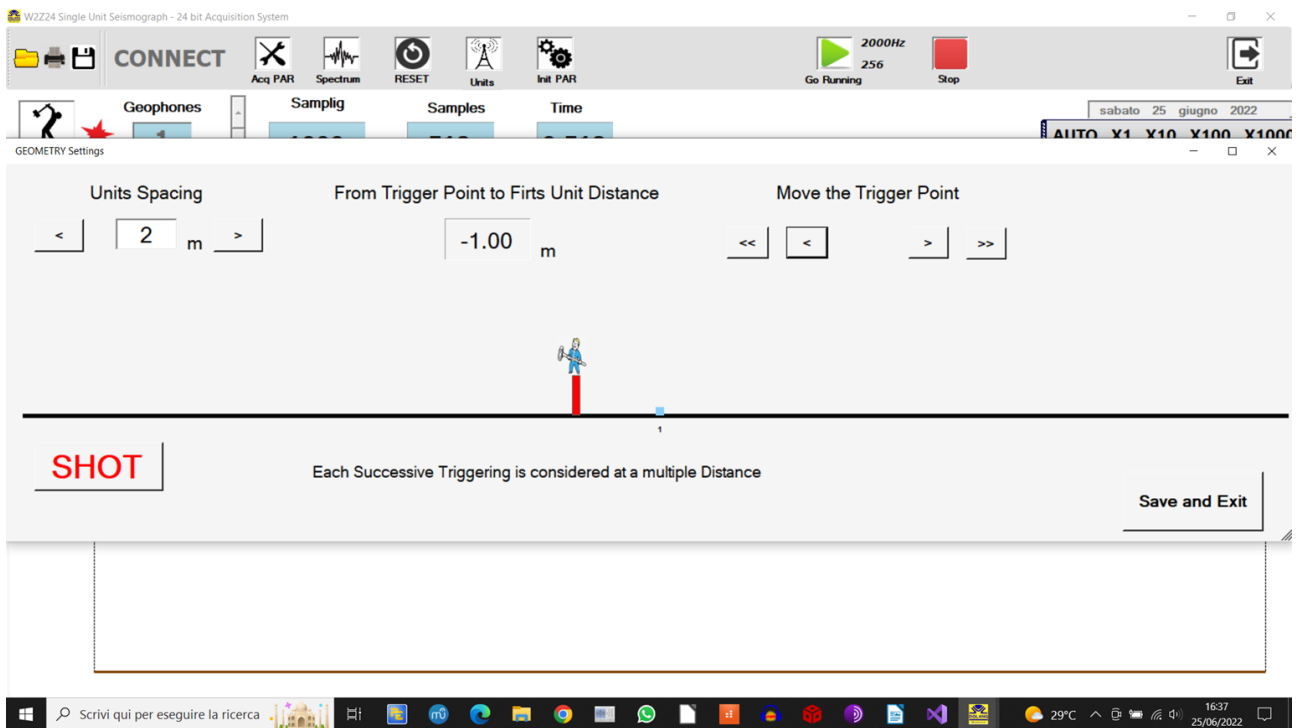
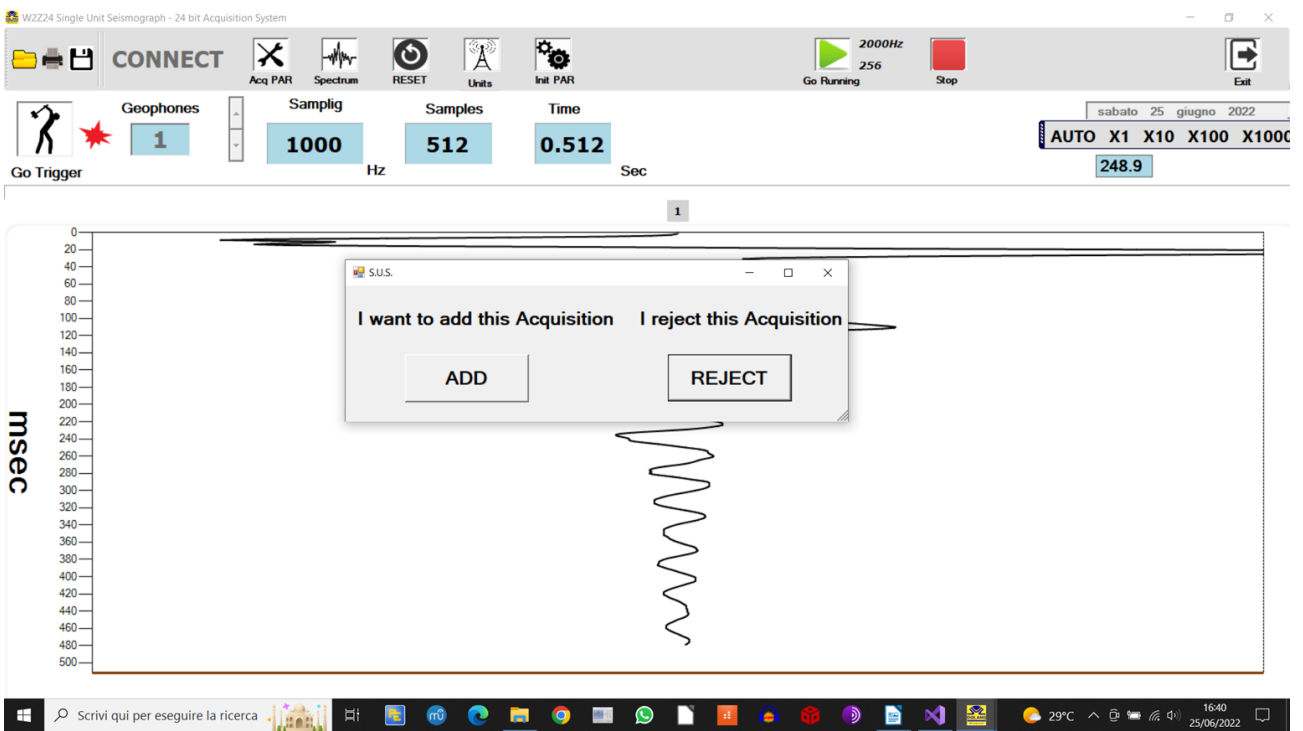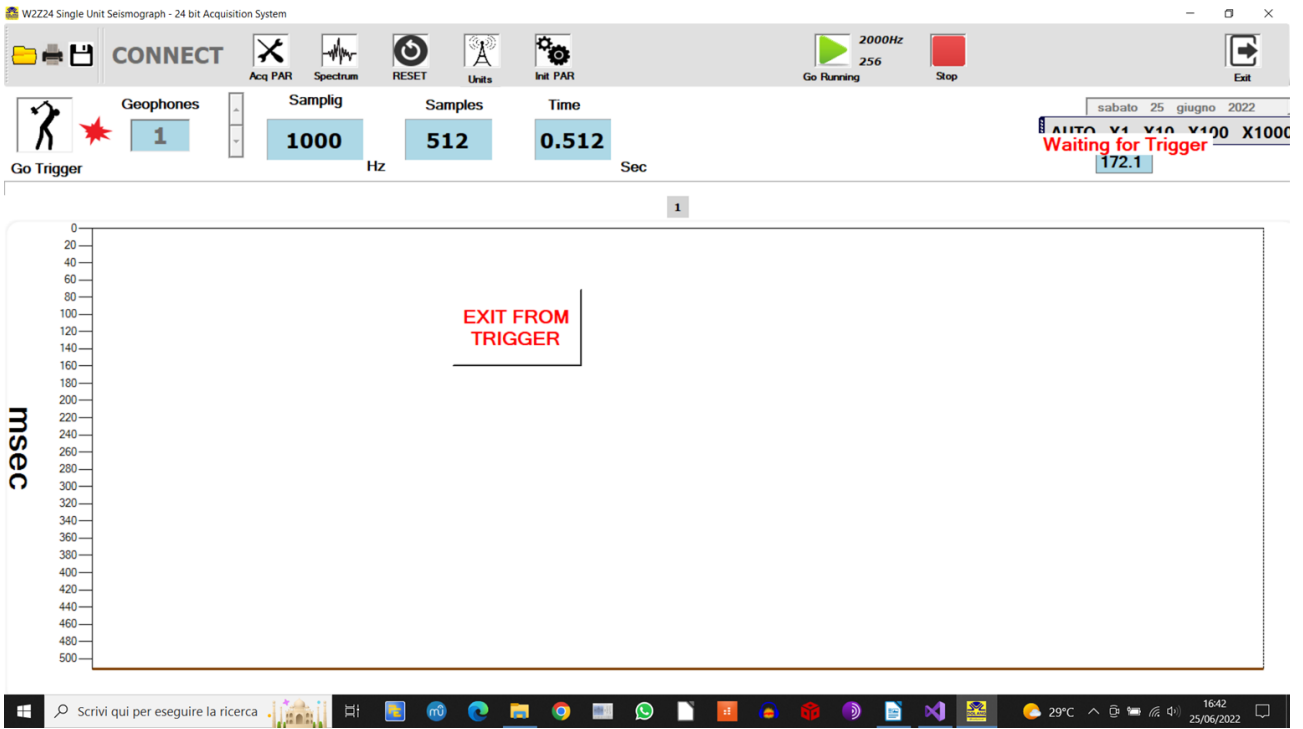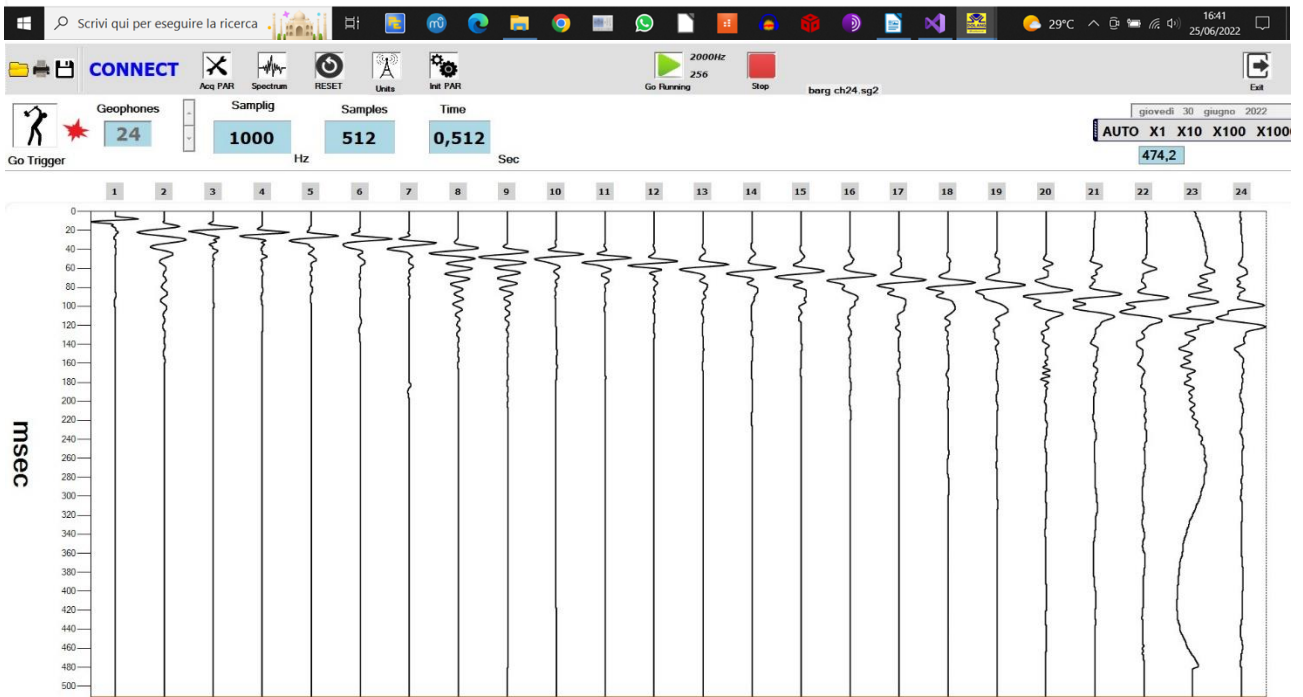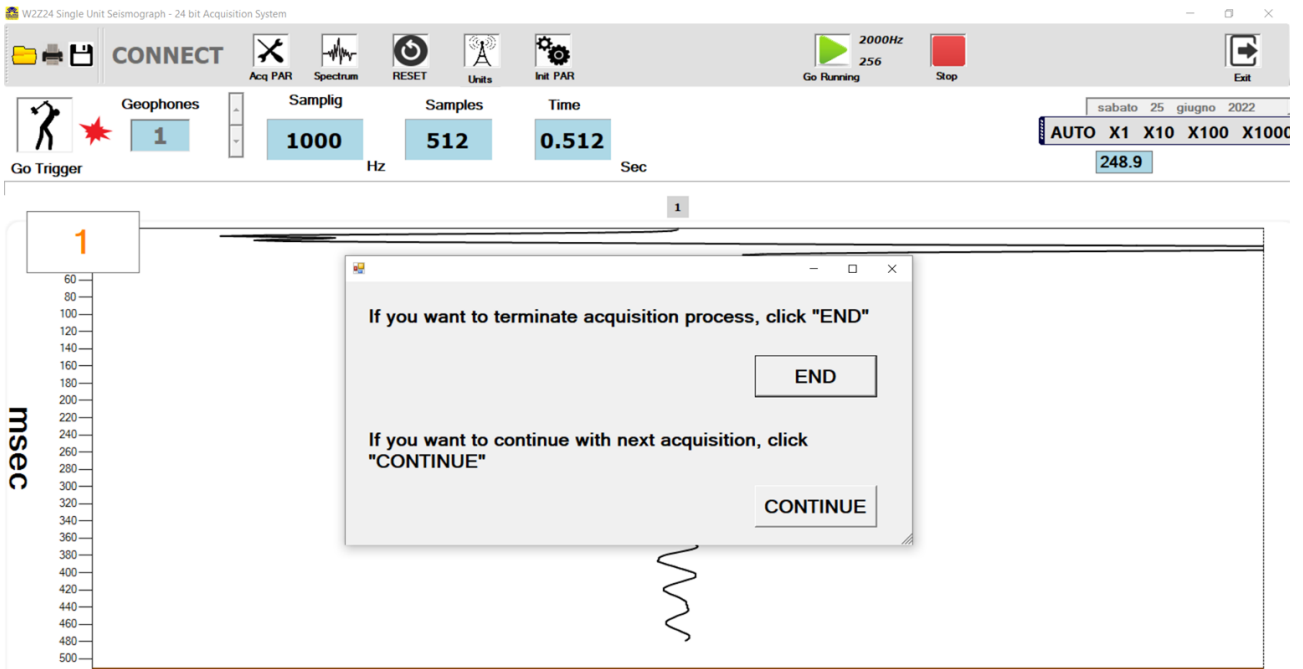You are asked to set interspace distance (Unit Spacing) between geophones and the position of Trigger Point respect to first Geophone Unit.

Once set Unit Spacing, next positions of geophone will be at a multiple of this measure.

Click "Shot" and the system will wait for the trigger:

Result of 24 shots – last shots in concrete

When the trigger acquisition is finished, the application will ask whether to save the acquired data. If you decide to save, 3 versions of the file will be saved: one with extension sg2, another with extension segy and one with extension txt. Data format will be sg2, segy and txt (text file).

Just after trigger acquisition a window will appear for saving the file.
The format of files saved is:

txt
sg2
sgy

They are as default saved in "data" directory, located in directory where your application has been installed.
The data saved is what is shown on the display. If a pretrigger has been set, data will be saved with that pretrigger time.

Moving the mouse over a track and clicking, in the CH box will be displayed its number.

Moving the mouse over a point in a track, in a upper box will be visible the relative time from trigger instant.

4 Spectrum

In the menu you can select "Spectrum", to carry out the spectral analysis of a signal.

Moving the mouse over the graph, we can determine the value of the frequency accurately.
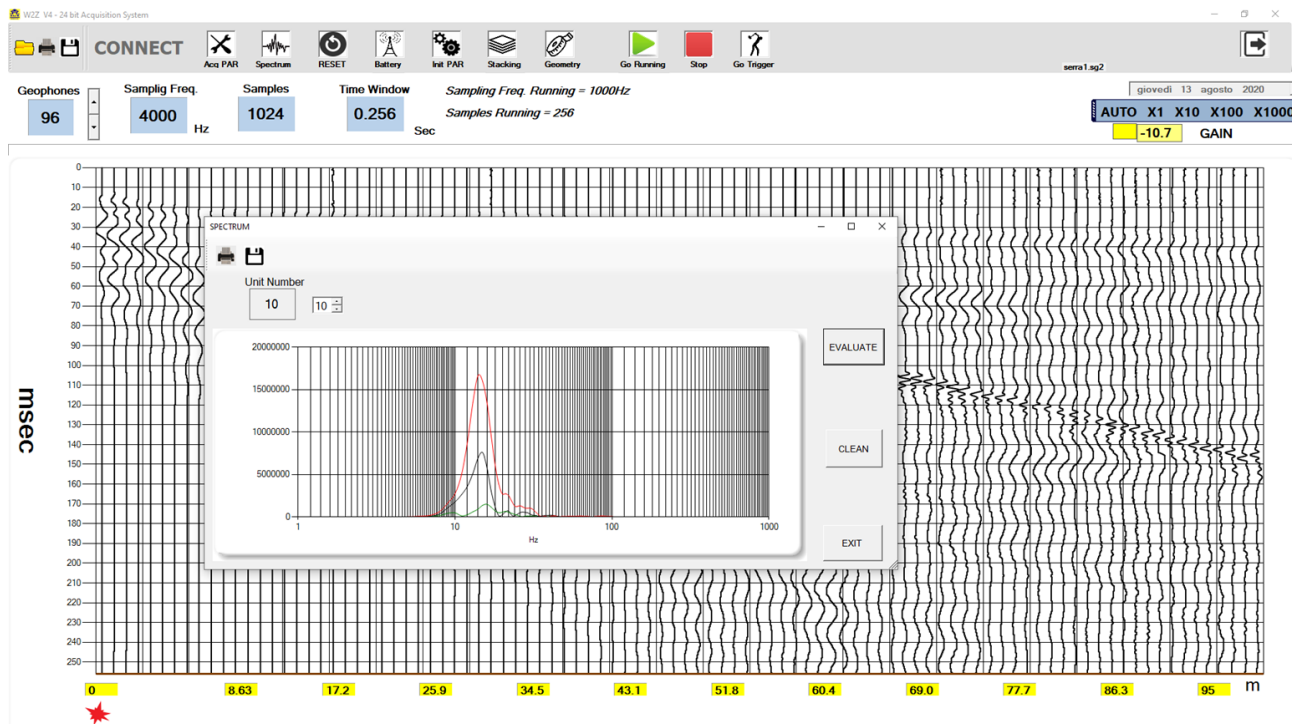
Each graph has a different colour.
Being 4000Hz the acquisition frequency, the maximum frequency of 1000Hz is displayed in the graph, well below Nyquist frequency limit (2000Hz).

5 Graph Display

Go to "Init PAR" and select "GRAPHIC".
You have several ways of showing the signals acquired, changing its colour, the background, the grid.
Some examples follow: *for only 24 ch in this new software*

White on black:

Red and Blue :

No grid:

6 Sampling Rate

To perform a correct acquisition should be thoroughly learned what it means "signal", what is its spectrum, filtering, reconstruction of signal from its samp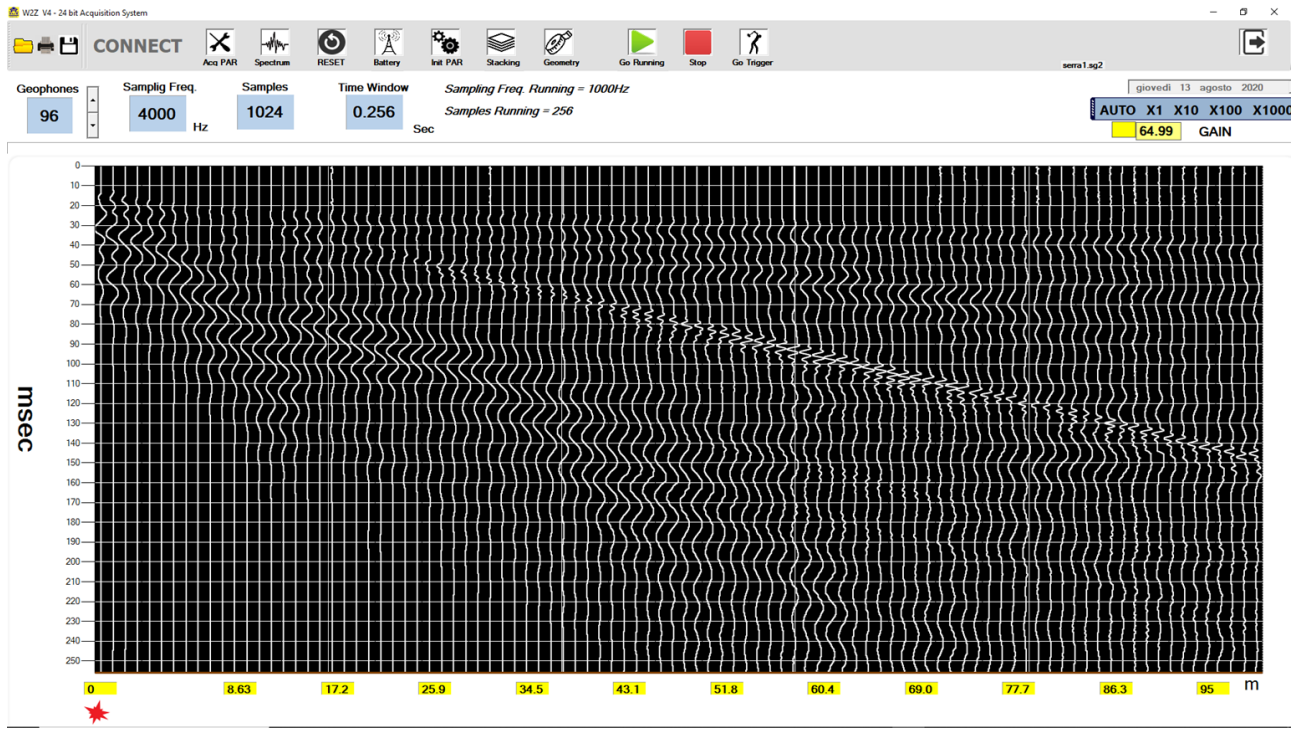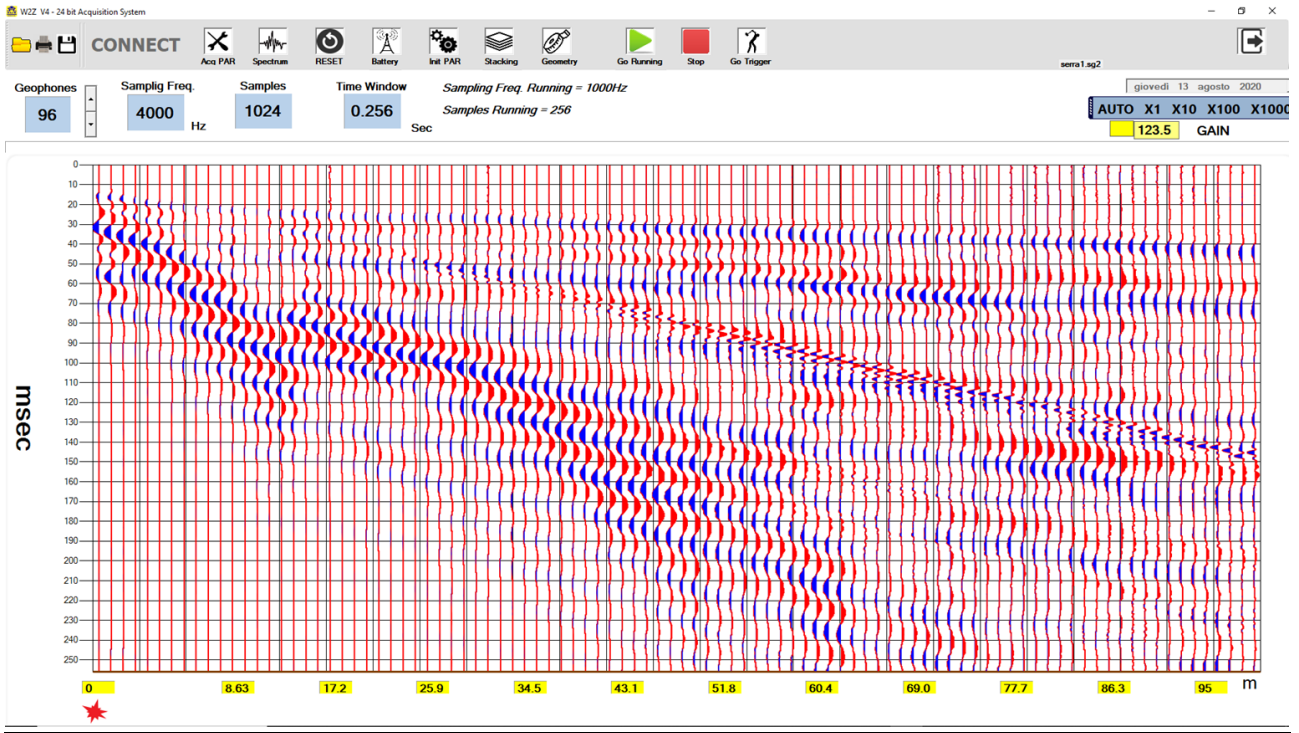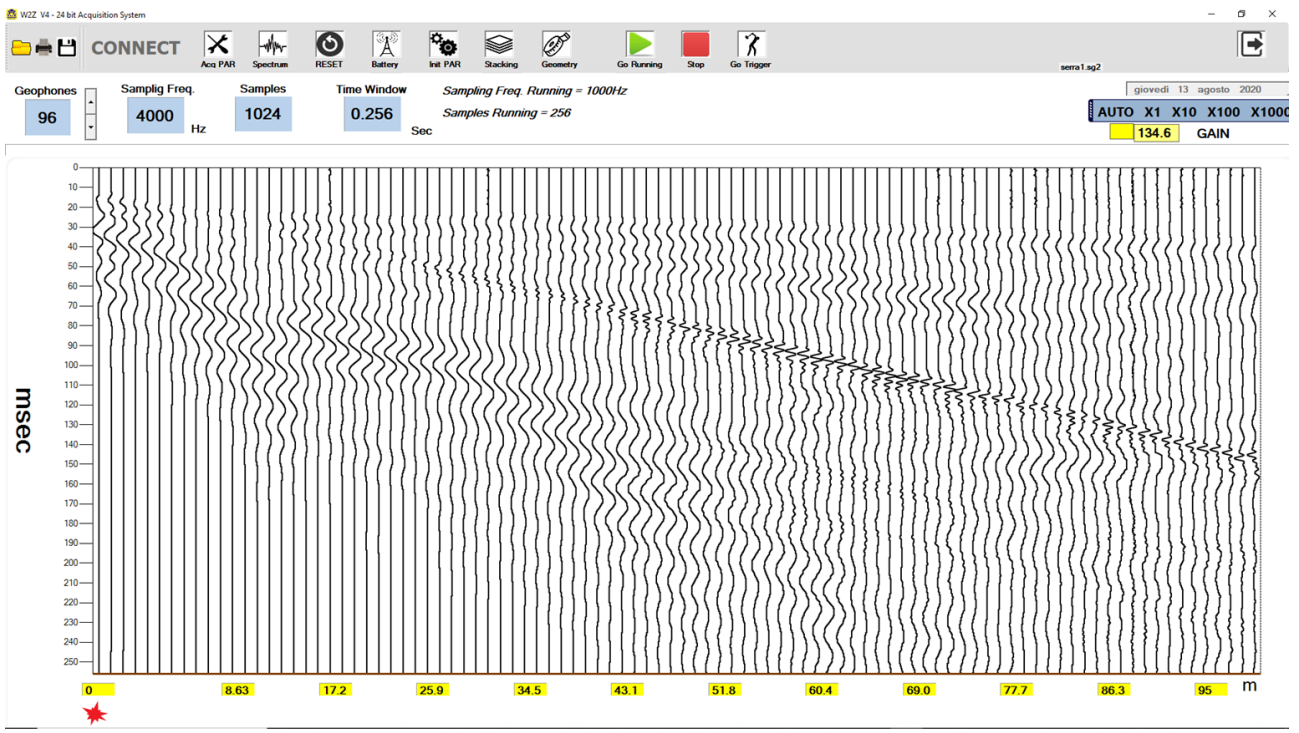les, sample rate etc ...., otherwise you may set the parameters without understanding why and do not correctly interpret what happens.

The basic parameters of the process of acquisition is the sampling frequency (Fs, from sampling frequency) and resolution (see below).

The reciprocal value of Fs is the sampling interval (Ts, by sampling time).

In the application, in the Parameters window, it acts directly on Fs (Hz) and as a result, of Ts (milliseconds).

To find out how long is the acquisition process, the formula is as follows:

Acquisition Time = Number of samples / Fs

           or

Acquisition Time = Number of samples x Ts

For example, if I want a long acquisition time at a high Fs, I expect a large number of samples.

It is not simple to deal with a large number of samples; for cases where it is required a long period of acquisition, a low Fs is used.

A basic rule of sampling is that Fs must be at least twice the highest frequency contained in the signal to be acquired (Nyquist theorem).

If the rule is broken, the acquired signal contains errors (aliasing).

By the nature of the signals to be acquired, which are coming from a geophone, the spectrum barely reaches a few hundred Hz, starting from a minimum of a few Hz, depending on the geophone used (see its resonant frequency), thus not requiring a high Fs.

So in the case of a geophone that, when triggered, it is expected to provide signals until 300/400Hz, the sampling frequency, following Nyquist, should be at least twice that value.

This consideration is only theoretical, because in reality, to acquire a signal that has any practical value, you must acquire a much higher frequency. Otherwise, the available samples would be too few to easily reconstruct the original signal. In practice, a sampling frequency of at leat 1000Hz is used.
The application JEA247E500 acquires always at Fs = 16000Hz and the lower sample rates are derived from the actual 16000Hz averaging.

For example the frequency of 2000 Hz is obtained from the average of 8 samples.
This process of "downsampling" carries out an average on the signal that corresponds to a low pass filtering, which is useful to diminish any higher frequencies and noise present.

A hardware filter on each unit helps to eliminate / mitigate upper frequencies coming from geophone.

7 Initialisation Parameters

With this menu you have to choose between;

- Running
- TRG Setup
- GRAPHIC
- Enumeration

7.1 Running

Clicking on running it will be shown:
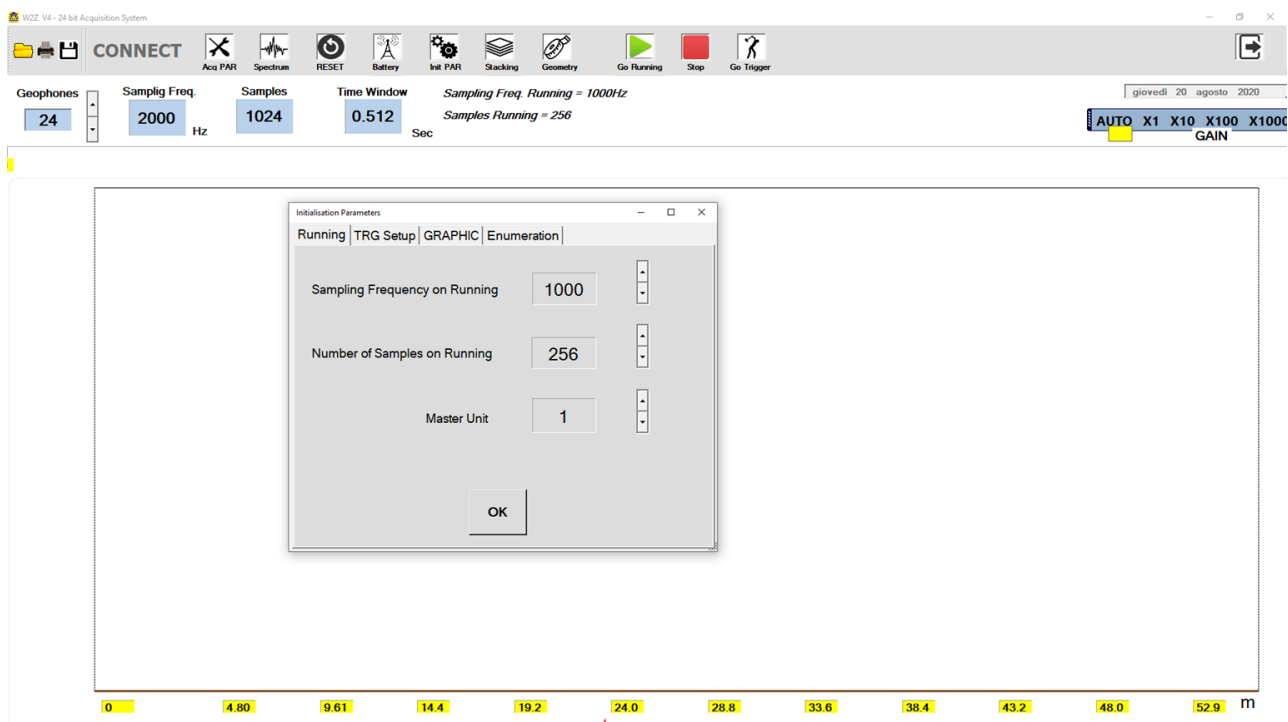
You can predispose what will be the sampling frequency and the number of samples, when you hit the command "RUN".
Master Unit is a number of an existing Unit (generally 1). It is used and necessary when in running mode; the software waits for a signal from unit xx, telling that data are ready to be collected.

When in trigger mode, software is informed by trigger unit that trigger is executed and after, data are ready to be collected.

7.2 Trigger Setup

This procedure allow you to change the time of triggering!
Do not effect any change if you have not understood your problem !

Triggering is a mechanical operation that is not fast and clean as an electronic one.
You can expect some randomness of the fraction of millisecond in the trigger event.

Triggering with hammer and plate has not any delay as in the case when a separate geophone/accelerometer is used for this purpose.

This procedure is not necessary if PC comes from factory; triggering time is correct.
In case you are installing the application in another PC, you have to check for exact trigger event.

If you really want to execute this procedure, set the sampling frequency you intend to work with. To help you to visibly appreciate the beginning of the wave you will acquire, set 256 samples and some pre trigger (red line).
Pre trigger line will help you to appreciate the delay.

For this test, only Unit 1 can be used. Others Units are not necessary.

Start a trigger acquisition and put the triggering plate **close** to this unit, to expect zero delay from the zero time line (for that Unit).

Hit the plate and verify the acquired signal of the unit.
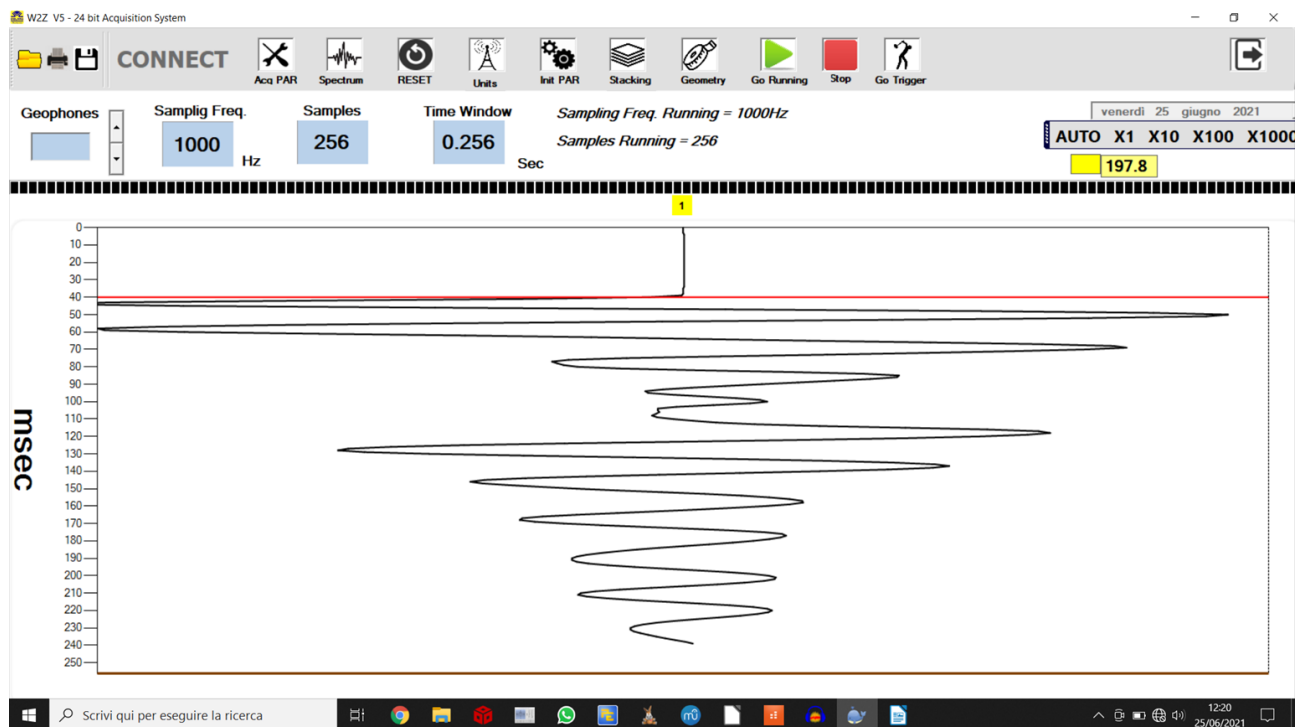
In this case, trigger time can be considered correct.
If the beginning of signal does not correspond to red pre-trigger line, go to: Init PAR –> TRG Setup and shift waveform:
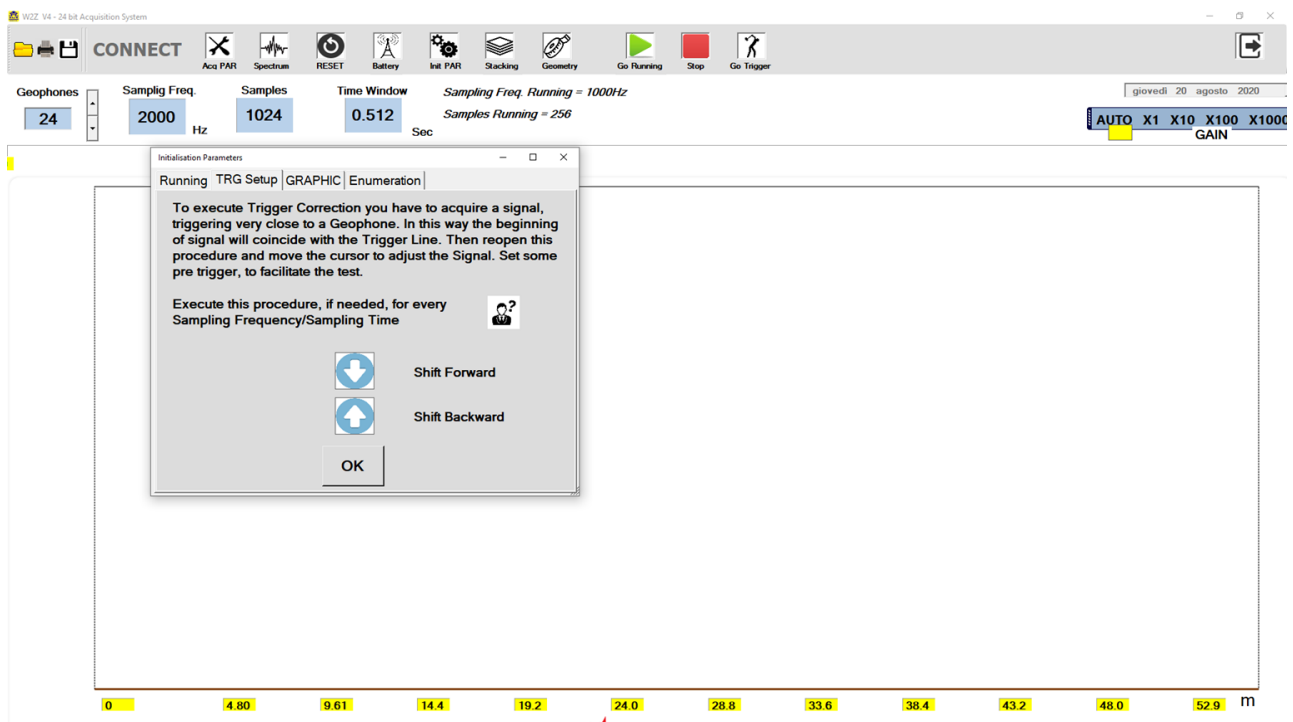
Click OK and correction will be saved in file ini.txt.
This verification must be executed for all sampling frequencies (from 250Hz to 16000Hz).

7.3 GRAPHIC

You can change the colour of signal as well as the background.

You can visualize graphic lines.

You can fill the shape of signal with some colour.

The button "Cursor Calibration" is used if you think that, when showing signals and moving on them with the cursor, the time shown in upper right box is not correct. (This may happen if you change some aspect of PC display resolution).

7.4 Enumeration

This procedure is exceptionally required when you have to change the number or function of some unit.

This procedure is generally never required, because units have already their number and function.

Anyway, to execute enumeration, connect a unit by its USB cable to PC and run the application.

Please do not execute this procedure if you have not understood the problem.

Changing the number and function of a unit in a wrong way, stops the functioning of all the system.

Use only one USB device connected to PC to avoid confusion.

Go to "Init PAR" then to "Enumeration". It will appear the type/number of Unit connected.

Change its behaviour and verify it.

Power off then on the unit to enable its new type/number.

8 Resolution

The resolution is determined by the number of bits of the AD converter.

The higher the resolution, the more the sampling system can "see" small signals.

W2Z uses a 24-bit converter, so if it is assumed that the geophone can give a maximum signal between 1V and -1V, matching the range of AD converter, the theoretical minimum measurable signal is:

2volt / 2 ^ 24 = 119 nV = 0.119 microvolts = 0.000119 millivolts = 0.000000119 volts

It corresponds to 84 nV of effective value.

Although this measure is theoretical and is incredibly low, the amount of bits of the word produced by the Ad converter gives us another factor to measure the goodness of an acquisition.

An acquisition at 16-bit, at least theoretically, is 256 times worse than at 24-bit.

9 Signal / Noise Ratio

This parameter is very important , as it can measure and tell us when is actually possible to discriminate a signal acquired in the presence of noise.

The problem to recover a signal from the noise is universal and always present in every practical situation .

If you remove the geophone and short-circuit the inputs of the unit , the only input signal is the noise generated internally the equipment, or from electromagnetic interference , and eventually due to the digital conversion process , which gives rise to the quantization noise. The quantization noise decreases with the increase of the number of bits of conversion.

We can see that even with no geophone inserted, a signal (noise) will be always present.

Here we can appreciate the goodness of the hardware and the fact that the geophone is connected directly to the acquisition board, avoiding an analogic dangerous electric path, needed in conventional seismic systems.

Another way of reducing noise is performing averages of data acquired.

This reduces Fs. For example, at 4000Hz there is a quantization noise slightly lower than 8000Hz and even less than 16000Hz.

Four samples al 16000Hz are required to get a sample at 4000Hz.

The real sampling frequency of the Ad converter is higher than that showed in the application software.

This process of noise reduction is called " Noise Shaping " .

The equipment in question provides a value for this ratio , better than 124dB for Fs = 1 kHz or so, which is a very good result .

If the noise was completely not existent, except the quantization noise , with a 24 bits converter we get approximately 144dB of signal/noise, which is a theoretical ideal value , even remotely achievable.

This value is often not very seriously declared on many devices , along with other parameters more or less invented.

10 Battery & Recharging

Before using W2Z for a seismic survey, verify the state of charge of all the units.
You must switch them on and open the software application; than open: CHANNEL STATUS and verify the length of the segment under each unit, proportional to the charge level.
When it is red, system can work for some time yet, with no problem.

The time of charge depends on the state of the battery; if completely discharged, consider at lest 8h of charging.

Units can be charged connecting them through their Mini USB port to the charging hub, that has 8 ports. A display cyclically shows the charging current of Unit connected.
When a battery is charged, the corresponding charging unit stops automatically.

You can connect the Unit to a PC as well, but the charging current will be lower and the time needed to recharge greater.

Units switched on but not operating, will have an autonomy of at least 2.5 days.

Units switched on and in continuous acquisition (in running mode), will have an autonomy of at least 15 hours.

In normal operations, you will be in running mode only for the time requested to verify the proper working of the system. When in trigger mode, you will acquire the data packet only once each time.

In conclusion, the system is capable to work for many field sessions before recharging.

W2Z is equipped with a DC/AC converter (optional) that could be useful in case you need to charge Units and you are away from 220v power source.
The DC/AC converter can be plug to a 12v power source of a car, for example.

11 Limits of W2Z

W2Z operates with radio transmission in the ISM (industrial, scientific and medical) band.
The frequency span is from 2.4Ghz to 2.525Ghz.
The characteristic of ISM band is that it could be disturbed by other devices that are operating in the range of the W2Z.
This is a situation that must be taken in account and can interfere with the correct function of W2Z.
Anyway, this may happen very rarely and only in very populated areas.

Other situation in which W2Z can have malfunctions depend on the wrong geometrical disposition of the units.

You must know that W2Z is equipped with directional antennas, so radio transmission is directional; units must be oriented in the correct position, they must face the MOM, otherwise the signal could be too low.

MOM is on a tripod, to let it direct more easily to Units.

See paragraph 3 for other details.

12 Technical Data

Structure	2.4 GHz multichannel seismic system
Antenna	Directional Antenna inside box
Working Range	500m in open field, in optical sight.
Resolution in Acquisition	24 bit
AD Converter	Successive Approximations with downsampling and averages
Sampling Frequency (Fs)	125Hz, 250Hz, 500Hz, 1000Hz, 2000Hz, 4000Hz, 8000Hz, 16000Hz
Number of samples in trigger mode	256, 512, 1024, 4096, 8192, 16384
Trigger	A dedicated radio unit works for triggering; it works in opening or closing contact.
Power	Each unit is equipped with a Li-Ion battery. MOM unit is powered by USB and battery.
Autonomy	Some days of normal operations in seismic campaign
Recharging	Common wall adaptor with USB port. At least 8 hours for completely discharged battery
Battery Control	Charge state visible on software. Hardware equipped to prevent battery damage.
Bandwidth	Up to 590Hz, 3 poles low pass filter 250Hz Software Filter Optional
Input impedance	47K ohm/can be changed according to costumer
Nyquist frequency	8000Hz at every Fs
Signal/RSM noise ratio measured	>124dB at Fs=1000Hz, geophonic input shorted
Software	Application for Windows XP, 7, 8 and 10 allows easy setting of all acquisition parameters and produces a seg2 file for further analysis
Weight	467 g
Size	Length=120mm Width=110mm Height=55mm With spike, Length=340mm

In the same installation directory, a sub-directory includes files related to Radio Equipment Directive (RED), for the transceiver module used in each unit.