Kit for seismic research performance

User manual

LLC "ETMS"

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Introduction

The present User manual describes operating principles of the kit for seismic research performance (also referred to as “Kit”) designed by LLC “ETMS”.

Only qualified technicians or engineers can use the kit for seismic research performance. When operating the kit it is necessary to observe the procedures specified in the present User manual.

ZETLAB Software delivered together with the kit for seismic research performance is used for configuring the kit hardware as well as for analysis of the recorded data. To access ZETLAB Software manual, you can use “F1” key.

The Manufacturer hereby reserves the right to introduce minor changes into the kit for seismic research performance structure, which do not affect the technical characteristics of the Product and do not require any amendments into operational and technical documentation.

List of the abbreviations used:

OS – operating system.

PC – personal computer (laptop or other computer used together with the hardware of the seismic streamer).

LLC «ETMS» – Limited Liability Company «Electronic Technologies and Metrological Systems».

1 Description

1.1 Functions of the kit for seismic research performance

Kit for seismic research performance is a mobile system used for seismic survey performance purposes. The kit is based on ZET 7155 digital geophones, which are sequentially connected by cable sections. The kit for seismic research performance is used for seismic survey performance in various climatic zones by means of refracted and reflected waves.

Seismic exploration works methodology is based on waves velocity analysis or analysis of the time, which is necessary for the waves to go from the impact point up to the seismic recorders. The seismic event is registered by the kit in the following way: the geophones register mechanical oscillations in the seismic research performance area, convert them into digital format and transmit the digital data to the seismic recorder via the cable for the purpose of further storage.

PC with ZETLAB Software is used for the registered signals processing and analysis. Signals analysis allows to determine the depth of geological boundaries, their form, waves velocity. This information, in its turn, enables understanding the geological nature of the seismic boundaries.

Depending on the particular waves propagation environment, the research depth is up to 250 meters. In order to increase the accuracy of the data obtained it is recommended to use a longer sensing line with a bigger amount of the measuring channels.

1.2 Kit for seismic research performance: basic characteristics

Metrological specifications of the seismic kit are shown in *Table. 1.1*.

Table. 1.1 Metrological specifications

Parameter	Value
Measured physical value	Vibration velocity
Frequency range, Hz	1…1000
Depicted values	Instant
Measurements range, mm/s	from 0,0006 up to 60

Technical specifications are shown in *Table. 1.2*.

Table. 1.2 Technical specifications

Parameter	Value
Primary transducer type	geophone
Amount of sensors in the system	Up to 24
Max. integrated memory volume, Gb	32
Programmable gain ratio	128, 64, 32, 16, 8, 1
GPS Synchronization	Yes
Trigger	Yes
Data transfer interface	CAN 2.0
Exchange speed, kb/sec	300 100
PC connection interface	USB/Ethernet
Data format	Seg-Y

Kit for seismic research performance: operational specifications. *Table. 1.3*.

Table. 1.3 Operational specification

Parameter	Value
Indicator type	Graphical, black and white
Resolution, px	98x32
Control	2 mechanical keys
Cable line length, m	Up to 240
Battery type	Li-ion, replaceable
Battery capacity, mAh	3400
Operation in off-line mode, h	4
Power supply voltage of the seismic streamer, V	18-21
Consuming power, W	10
Battery charge voltage, V	28
Operating temperature range, ºC	-10…40
Guaranteed use period, (years)[1]	10

[1] The guaranteed use period duration is valid in the case if the integrated software is updated at least 2 times a year. The guaranteed use period is not applicable to the integrated battery of the recorder.

1.3 Kit for seismic research performance: hardware configuration

Description of hardware configuration is shown in *Table. 1.4*:

Table. 1.4 Hardware configuration

№	Item	Amount
1.	ZET 7155 digital geophone	Up to 24 pcs[2]
2.	Recorder	1 pc
3.	Cable line for digital geophones connection – 120 m	2 pcs
4.	Cable adapter for connecting cable line to the recorder	1 pc
5.	Socket for connecting trigger to elastic oscillations source	1 pc
6.	ZETKEY	1 pc
7.	Cable HightSpeed USB 2.0 / Cable Patch Cord UTP cat. 5e[3]	1 pc
8.	Charging device	1 pc
9.	Set for digital sensors diagnostics	1 pc
10.	ZETLAB Software (delivered on a CD)	1 pc
11.	User manual	1 pc
12.	Product certificate	1 pc
13.	Line terminator	1 pc
14.	Crosshead screwdriver	1 pc
15.	Notebook, pen	1 set
16.	Case for storage of the kit for seismic research performance	1 pc
17.	laptop (option)	1 pc

[2] The amount is determined by purchase agreement provisions
[3] Cable type depends on particular recorder version option

Recorder hardware configuration is shown in *Table. 1.5*:

Table. 1.5 Recorder hardware configuration

№	Item	Amount
1	ZET 7174 or ZET 7176[4] Interface converter	1 pc
2	ZET 7173 Off-line recorder	1 pc
3	ZET 7178 Digital indicator	1 pc
4	ZET 7175 Synchronization device	1 pc
5	ZET 7160 Digital port	1 pc
6	Integrated battery	1 set

[4] Depending on particular product version

1.4 Kit for seismic research performance: connection diagram

Figure 1.1 shows connection diagram of the kit for seismic research performance.

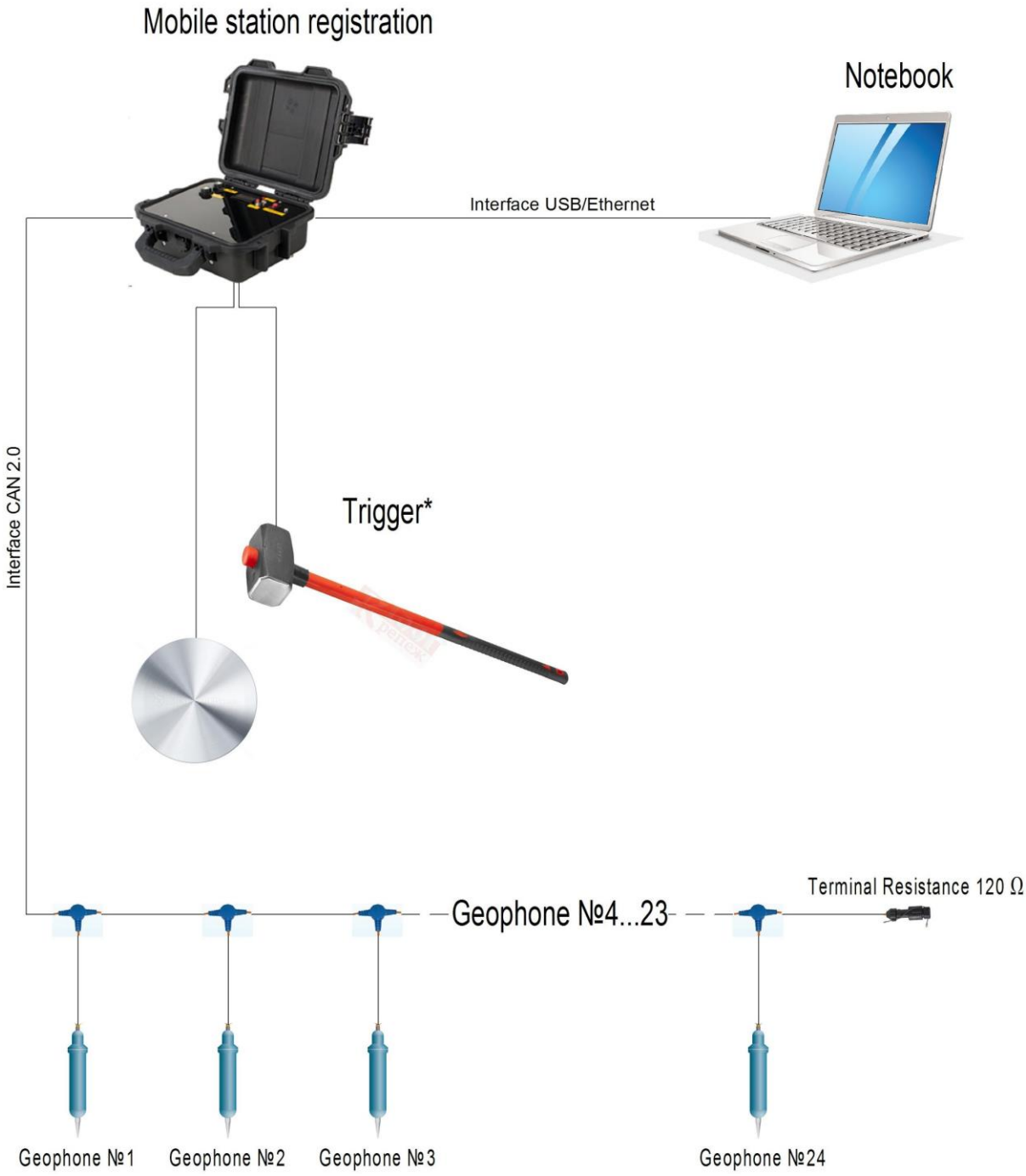


Figure 1.1 Connection diagram

* – The delivery scope includes only mating connector for connecting the trigger to the elastic oscillations source.

The recorder is a kind of connecting link between the digital geophones and a PC. The recorder provides power supply and synchronization of the devices included in the kit for seismic research performance hardware configuration as well as elastic oscillations recording to the integrated memory and displaying the parameters of the devices included in the scope of the kit.

Connection of the digital geophones to the recorder is performed by means of a cable connector and the cable line included into the delivery scope. One should connect the digital geophones to corresponding GSC-4H (Herma-4) connectors. The maximum amount of the digital geophones is 24. As all the geophones are interconnected, one should connect the cable line to the “CAN” port of the recorder by means of cable connector.

It is necessary to install a plug with 120 Ohm terminal resistance at the last GSC-4H (Herma-4) connector of the measuring line.

In the course of the seismic survey performance, a hummer is normally used as elastic oscillations source. Elastic waves are formed as the hummer strikes the metal plate. Digital geophones detect the elastic waves and transform mechanical oscillations into electrical signal, and send it to the recorder.

There is a cable between hummer, metal plate and the trigger. Thus, as the hummer strikes the plate, the trigger enables the recorder to start signals recording process.

Configuration of the devices included into seismic kit configuration as well as recorded signals data processing is performed by means of the PC (laptop). Depending on the particular product version, it is possible to connect the recorder to the PC via USB or Ethernet interface. In order to perform devices configuration or data processing, one should install ZETLAB Software to the PC (Section 2.4) and connect ZETKEY (with the corresponding firmware version) to the USB port of the PC.

1.5 Recorder structure

Hardware components of the recorder are placed inside of a package, which is made in the form of a case. The hardware components of the seismic recorder include:

1. ZET 7174/ZET 7176 interface converter

ZET 7174 (ZET 7176) interface converter is used for connecting the digital sensors of the seismic kit to the PC via USB (Ethernet) interface for the purpose of further configuration.

2. ZET 7173 off-line recorder

ZET 7173 off-line recorder is used for recording the data received from ZET 7155 digital geophones. The signals recording process is started automatically as the recorder is turned on. All the data is recorded to microSD card as a group of files in special format.

3. ZET 7175 synchronization module

ZET 7175 synchronization module is used for timing synchronization of the digital geophones.

4. ZET 7178 digital indicator

ZET 7178 digital indicator is used for displaying the data received from the digital sensors of the kit for seismic research performance.

5. ZET 7160 digital port

ZET 7160 digital port serves as a trigger, which activates as the contacts are closed, thus allowing to identify the strike of a hummer as a seismic impact.

6. In-built battery

Integrated battery is necessary for measurements performance in off-line mode. The recorder is equipped with 6 Panasonic NCR18650B LI-ion batteries 3400 mAh, which are placed at the power control board of the seismic streamer. Battery capacity enables uninterrupted measurements performance during 4 hours.

Note: it is possible to increase off-line operation time by connecting 24V battery or any other DC power supply source in the range 21-28V to the "Charge" port of the recorder or to "GND" and "+U" contacts (at the point of terminal resistance connection to the cable line).

1.6 Recorder: overview

The recorder's package is made in the form of a case (see the Figure 1.2)

Figure 1.2 Recorder's overview

Figure 1.3 shows view of the recorder's front panel

Figure 1.3 Recorder's front panel

Top surface of the recorder has connectors for connecting external devices to the recorder. Detailed information of the connectors' designation is shown in *Table 0.1*.

Table 0.1 Connectors' designation

№	Name	Function
1	SD	The connector is used for recorded data transfer to PC via USB interface.
2	LAN	The connector is used for connecting the recorder to PC via local Ethernet network.
3	CAN	The connector is used for connection of the cable line with ZET 7155 geophones to the recorder via cable connector.
4	TRIGGER	The connector is used for connection of elastic oscillations source to the recorder.
5	Charge	The connector is used for charging device connection.

Designation of control keys and indicators is specified in *Table 0.2*.

Table 0.2 Designation of control elements and indicators

View	Name	Function
	Power	The control key is used for switching on/ off the recorder: I – switch on the recorder; O – switch off the recorder.
	Control	The key is used for graphical indicator control. By changing its position "Up" and "Down" it is possible to select a particular digital sensor, parameters of which will be shown at the display.
	Red indicator	Indicates integrated battery charging process
	Green indicator	Indicates completion of the integrated battery charging process

1.7 Digital geophone: overview

Figure 1.4 shows the view of ZET 7155 digital sensor. Installation of the digital sensor into the ground is performed in vertical direction by means of metal pins located at the bottom of sensor's package. It is necessary to push the sensor into the ground by 2/3 of its length.

Figure 1.4 View of ZET 7155 digital sensor

Digital geophones ZET 7155 have an integrated cable with a splash-proof connector GSC-4H (Herma-4).

The digital geophones are connected to the seismic streamer via T-piece with GSC-4H (Herma-4) mating connection.

Figure 1.5 shows GSC-4H connector and pins assignment of the integrated cable.

	Contact number	**Connection to the measuring network**
	(B)	CAN2.0 line «H»
	(A)	CAN2.0 line «L»
	(1)	+U 9...28 V
	(2)	GND

Figure 1.5 Pins assignment of GSC-4H connector

Digital geophone is a vibration transducer with an integrated sensing element, which converts the vibration velocity, detected by the primary transducer in Z axis into a digital signal (Figure 1.6).

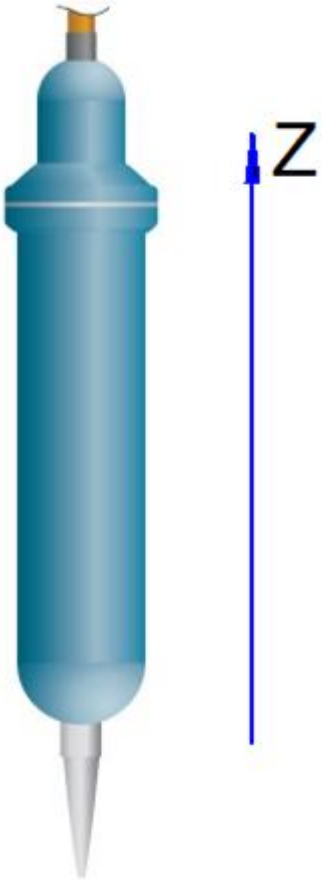


Figure 1.6 Direction of vibration axis

2 Kit for seismic research performance: set-up procedures

2.1 Unboxing, preparation

Transport packing should be removed on a flat stable surface without any foreign objects in close vicinity. As the transport packing is removed, one should:

- Perform configuration check of the kit in accordance with the instructions specified in the Section 1.3 of the present document;
- Perform visual check for the presence of any mechanical defects.

Prior to starting operation of the recorder, make sure that the integrated batteries are charged. If it is necessary, charge the integrated battery module in accordance with the instructions provided in the Section 2.2.

2.2 Integrated battery operation procedures

The recorder has 6 Panasonic NCR18650B (LI-ion) 3400 mAh batteries. Table 2.1 specifies operational parameters of the batteries.

Table 2.1 Batteries operational parameters

Parameter	Value
Storage temperature range, ºC	-35…60
Operational temperature range, ºC	-20…60
Batteries estimated service life (years)	5

Integrated battery charging should be performed in the following sequence:

1. Connect the battery charger (included into the delivery scope) to the "Power" connector of recorder's panel. Connect the battery charger to 220 V AC.
2. "Power" red indicator should be on during batteries charge process.
3. Green indicator means that the charge process of the integrated battery is complete. Disconnect the battery charger from the 220 V AC.

Attention! To increase the battery lifetime in the case of recorder's long-term storage, perform the battery charging at least once in 6 month.

Attention! Battery charging should be performed at positive ambient temperature.

Attention! It is allowed to use the battery module at negative ambient temperatures; however, it may lead to a decrease of the off-line operation time.

2.3 Integrated battery: replacement procedure

The sequence of the integrated battery replacement procedure is as follows:

1. Disconnect the charge module (included into delivery scope) from the “Power” connection by putting the “Power” switch to “0” position.
2. Disconnect 4 screws of the recorder’s upper panel, move it aside (do not damage the attached wires).
3. Remove six Panasonic NCR18650B batteries attached to the seismic streamer power control board.
4. Install new Panasonic NCR18650B batteries (or equivalent) to the seismic streamer power control board (observe the polarity).
5. Fix 4 screws of the recorder’s upper panel.

Note: to extend the lifetime of the batteries, it is recommended to replace all the batteries at one time.

Note: batteries replacement is not considered to be a warranty event – hence, it is to be performed by the user.

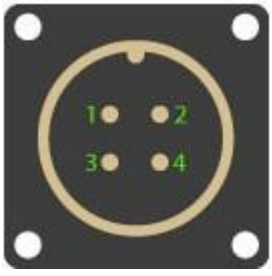
2.4 Connection of elastic oscillation source to PC: connection of the cable

Recorder’s panel has “TRIGGER” connector, which initiates signals recording process. Activation of the connector is performed by means of hummer strike against a metal plate.

To enable operation of “TRIGGER” contact, one should prepare a connecting cable. The cable is connected to the recorder with FQ14-4TJ-7 connector, while two remaining connections of the cable are connected to the plate and the hummer correspondingly.

Figure 0.1 shows contacts designation for connection of elastic oscillations source to the recorder.

«TRIGGER» port of the recorder



FQ14-4TJ-7 connection of the cable

Contact #	Designation of the contact
1	Not used
2	Not used
3	To be connected with the impact part of the hummer
4	To be connected with the metal plate

Figure 0.1 Contacts designation

Note: there are no particular requirements in terms of cable type and length – these parameters are selected by the user.

2.5 Installation of the software to the PC

To install ZETLAB Software to the PC one should:

1. Put the Software CD (included into delivery scope) into the PC;
2. Run «ZetLab.msi», follow the instructions and complete installing ZETLAB Software to the PC;

Attention! You should be logged-in as an administrator to install the software.

Note: the following system requirements should be met for proper operation of the software:

- *Dual-core processor (or more);*
- *Core speed – over 1,6 GHz;*
- *RAM – over 2 Gb;*
- *HD free space– over 20 Gb;*
- *Video-controller: 3D-graphics acceleration, support of OpenGL, DirectX, memory: over 128 Mb;*
- *Resolution: min. 1280×1024;*
- *Mouse or any other pointing device;*
- *Standard keyboard or any other entry device;*
- *CD-ROM for programs installation;*
- *Supported OS versions:*
    - *Microsoft® Windows® 7 32/64 with SP1;*
    - *Microsoft® Windows® 8 32/64;*
    - *Microsoft® Windows® 8.1 32/64;*
    - *Microsoft® Windows® 10 32/64.*

2.6 Connection of the recorder to the PC

Depending on the particular product version, the recorder can be connected to the PC via USB or Ethernet interface.

In order to connect the recorder to the PC via USB interface, connect High Speed USB 2.0 cable (included into delivery scope) to USB-port of the recorder and the PC. Upon completion of these steps, enable the “Power” key at the recorder’s front panel.

In order to connect the recorder to the PC via Ethernet interface, connect PatchCord UTP cat. 5e cable (included into delivery scope) to the Ethernet port of the PC and LAN port of the recorder. Configure the networking port of the PC – make sure that the PC and the recorder belong to the same subnet. Upon completion of these steps, enable the “Power” key at the recorder’s front panel.

The PC should have Windows OS and ZETLAB software as well as ZETKEY hardware key (included into delivery scope) connected to the USB port of the PC.

As the recorder is connected to the PC, the system will find and install the driver necessary for interaction on a software level.

Configuration of the seismic streamer hardware elements is to be performed in “Service” tab of ZETLAB panel (see the Figure 2.1).

Figure 2.2 ZETLAB panel

***Attention**! It is possible to configure devices within the scope of the recorder and digital geophones only as the connection to interface converter by USB or Ethernet is established (depending on the particular product version of the recorder).*

2.6.1 Connecting the recorder to PC via USB interface

The program window “ZET device manager” depicts icon of interface converter ZET 7174 of the recorder (Figure 2.3).

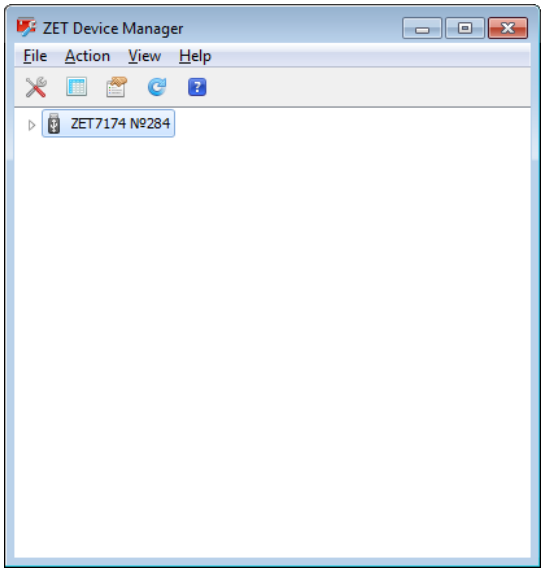


Figure 2.3 Program «ZET device manager»

In order to see the list of the devices connected to the interface converter and included into the scope of the recorder (digital geophones, connected to CAN port and other recorder's modules), one should enable the pop-up list by clicking the interface converter identifier (Figure 2.4).

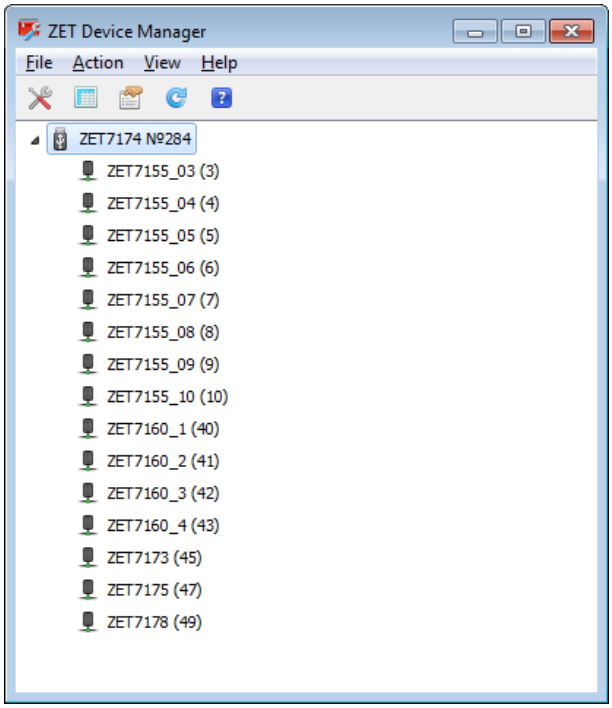


Figure 2.4 List of the devices connected to the interface converter

Attention! *List of the devices will be available only in the case if the configuration requirements specified in Clause 2.8 are observed.*

The left section of the window depicts hierarchy tree of the devices connected to the PC. The top level shows all the interface converters and devices connected to the PC. The

second level depicts the digital sensors connected to the selected interface converter. To the right from the digital sensor one can see its address in the measuring network (Figure 2.5).

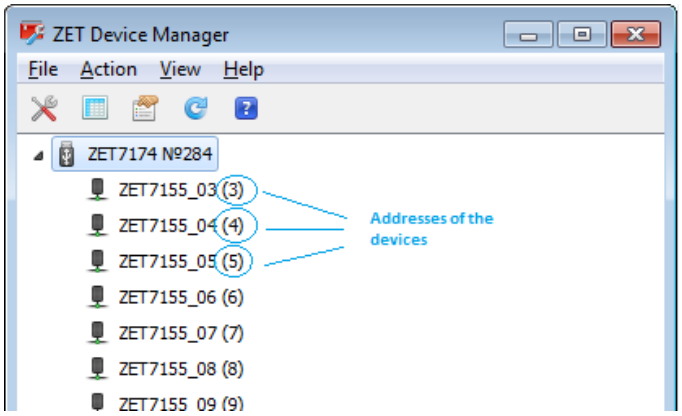


Figure 2.5 Devices addresses in the measuring networks

In the case if a detailed view mode is active, the second part of the window will depict a table with basic parameters of the measuring channels.

Selection of the digital sensor to be configured is performed by left-clicking its name. (For more details, please, see "ZETLAB Software. User manual").

2.6.2 Connecting the recorder to PC via Ethernet interface

Attention! *IP-address of the PC should be in the same subnet with those of the recorder and ZET 7176 interface converter. Local network should not block UDP (multicast).*

Note: *By default, interface converter has IP-address 192.168.1.76 with mask 255.255.255.0.*

The program "ZET Device manager" will search for available devices in the local network and depict them in the list of devices (*Figure 0.2*).

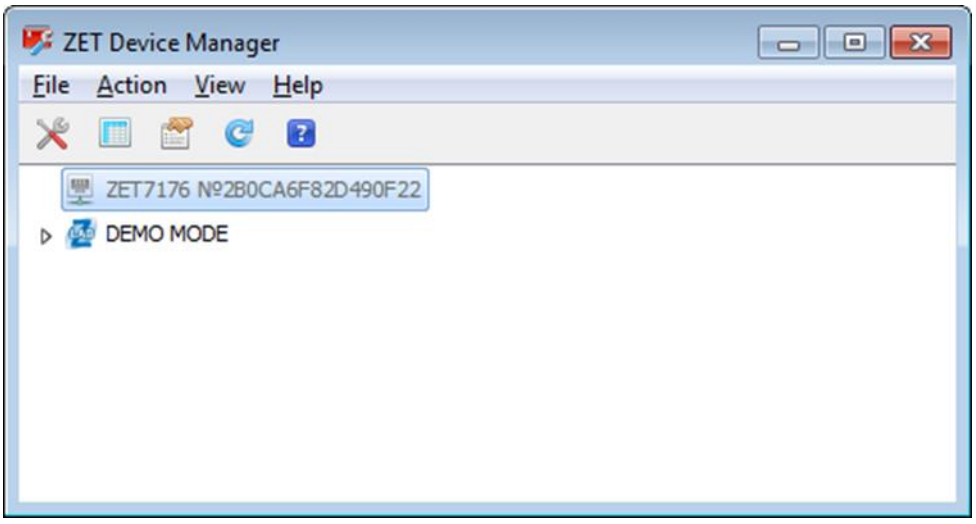


Figure 0.2 "ZET Device manager: list of the devices"

The devices in the list are shown in grey color, which means that they are available, but not active. In order to connect to the interface converter, activate it from the menu with right click on the serial number of interface converter. (Figure 0.3).

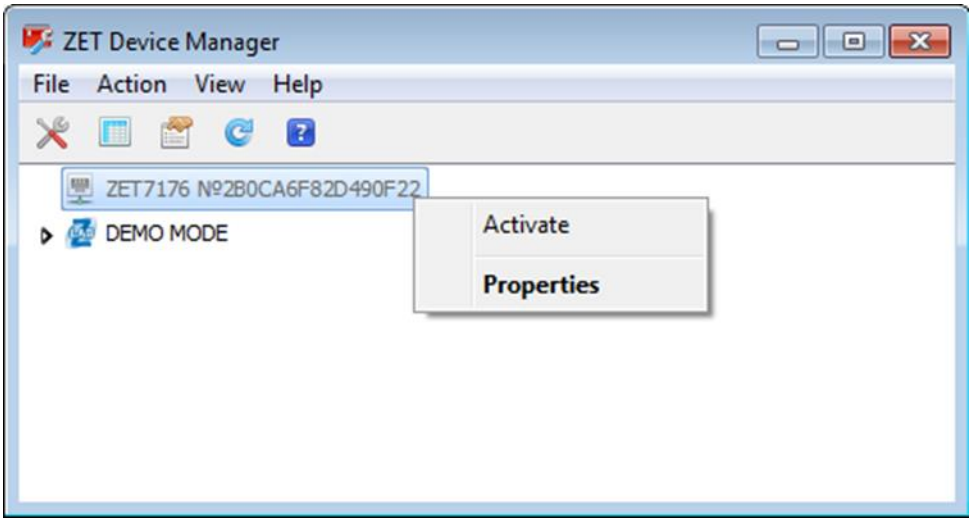


Figure 0.3 Connecting to the interface converter

Note: Serial number of interface converter is specified in its product certificate.

During connection process, the device name will be highlighted with bold type. If the device name is depicted in bold type for a long time, it means that it is impossible to establish connection. Main reasons for connection failure are as follows:

- IP-address of the PC connected to the recorder is not in the same subnet with IP-address of the interface converter;
- There is a conflict of IP-addresses: in the local network there is a device with IP-address, identical with that of the interface converter.

In the case if the IP-address of the interface converter has been changed (i.e. it does not correspond to factory settings), you can check the current IP-address of the interface converter, enter the menu (with right click on the interface converter icon), enter “Properties” menu and go to “Device” tab (*Figure 0.8*). The parameter «IPv4 Address» will indicate the current IP-address of the interface converter.

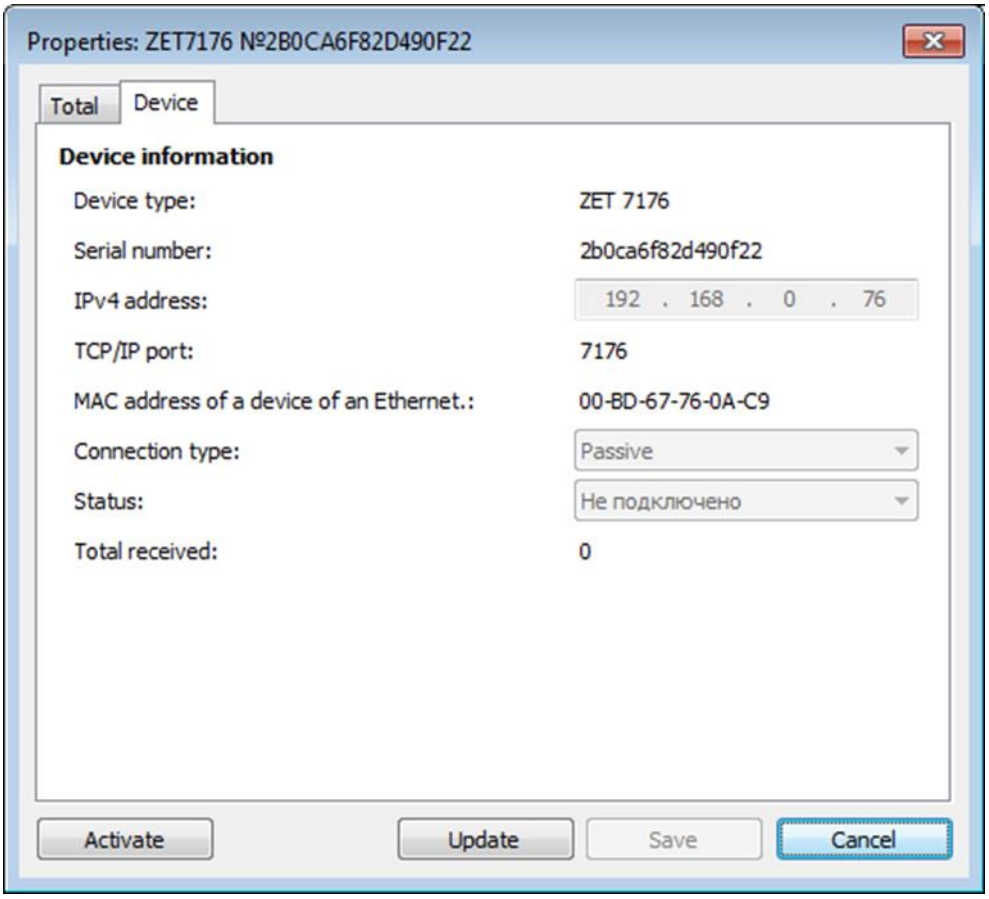


Figure 0.8 "Device" tab

As the connection is established, there will be formed a list of digital sensors connected to the interface converter (**Ошибка! Источник ссылки не найден.**).

2.7 Configuring interface converter ZET 7176

In order to configure interface converter ZET 7176, one should:

- Set the network address in accordance with applicable requirements in the fields "Ipv4 address", "Subnet mask", "Default gateway" of "Ethernet" tab (*Figure 0.9*).

Note! *IP address of the interface converter can be set arbitrary in the range from 1 up to 254 (in this example IP address is "45"). IP address should not have identical value with that of any other device in the network.*

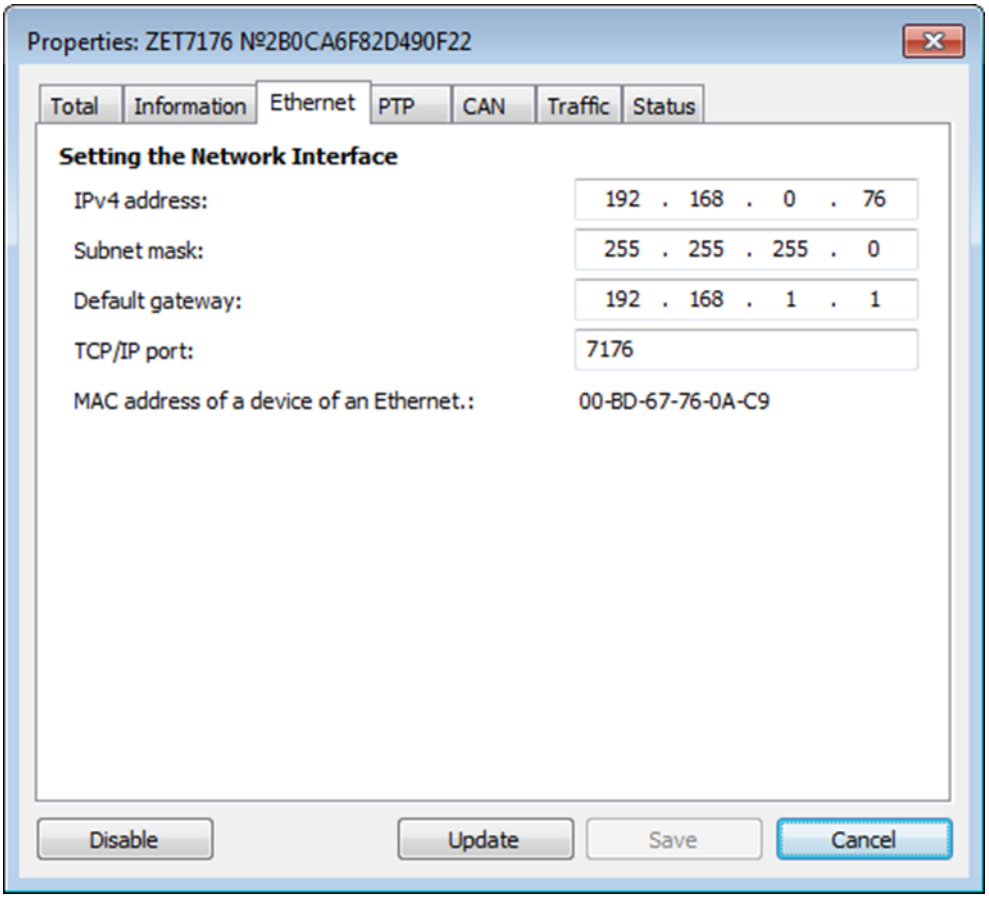


Figure 0.9 «Ethernet» tab

Attention! *It is possible to configure interface converter parameters only in the case if IP address of the Ethernet port of the PC is in the same network with that of the interface converter (e.g., you can set IP address 192.168.1.76 with mask 255.255.255.0 for Ethernet port of the PC used for configuring of the interface converter parameters).*

- Select the bit rate in accordance with the applicable requirements in the “Bit rate, kbps” field of “CAN” tab (*Figure 0.10*).

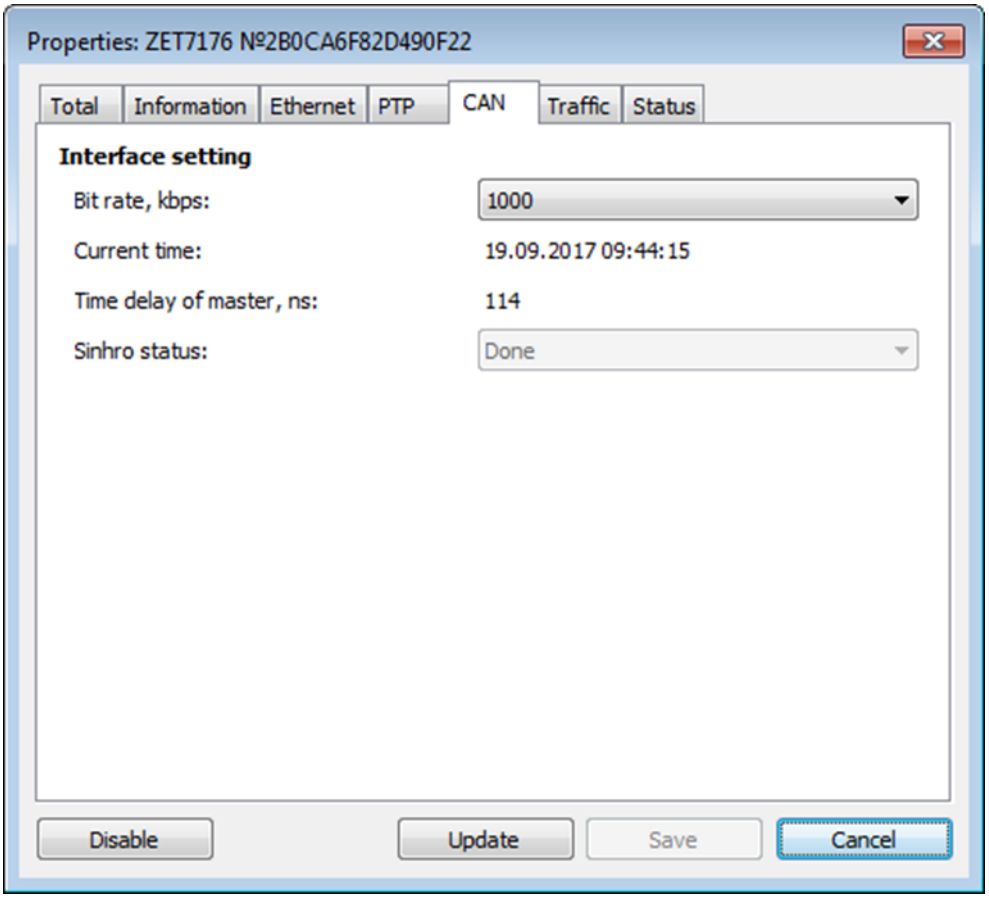


Figure 0.10 «CAN» tab.

Attention! *It is necessary to set the value “100” for the parameter “Bit rate, kbps”.*

Attention!*: After changing the bit rate of interface converter it is necessary to cycle power the recorder. The system will automatically change the bit rate of digital sensors, which are connected to the interface converter.*

Note*: additional information regarding configuration of ZET 7176 interface converter is available in the document “ZET 7176 User Manual”.*

2.8 Configuring digital sensors of the kit for seismic research performance

Before starting using the seismic kit, one should configure its digital sensors.

Note: the “Node 2-63” field of “Information” tab of each digital sensor specifies the unique device address in the measuring network. For the proper operation of the seismic kit all the devices within the recorder system should have different addresses. The device address is set

within the range from 3 to 63. *Figure 2.11* shows an example of "Information" tab: ZET 7155 digital geophone has "3" address.

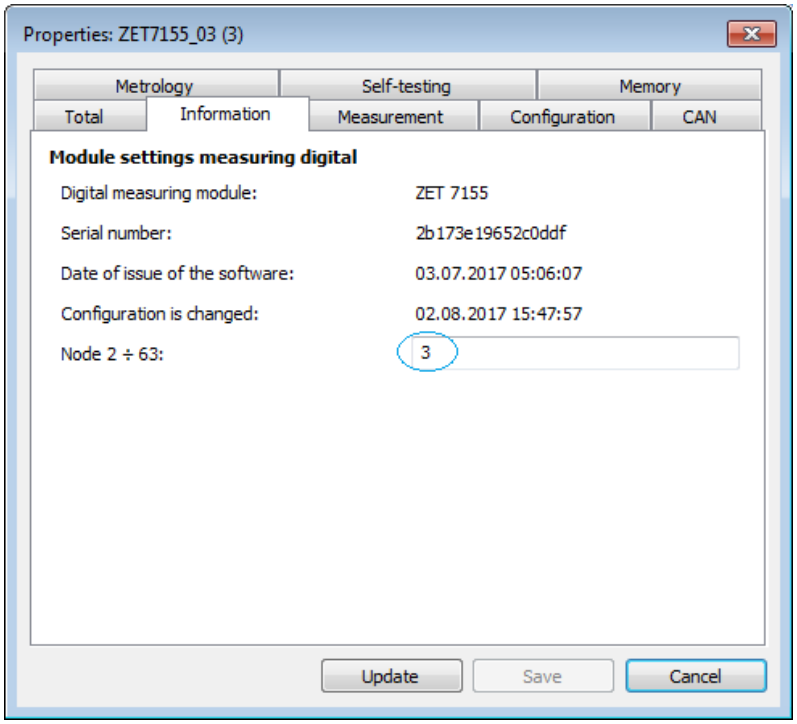


Figure 2.11 «Information» tab.

The devices have the following addresses:

- ZET 7155 digital geophones– addresses «3» - «30»;
- ZET 7160 digital port – «40», «41», «42», «43», «44»;
- ZET 7173 off-line recorder– «45», «46»;
- ZET 7175 synchronization device – «47», «48»;
- ZET 7178 digital indicator– «49».

Note: ZET 7160 digital port has 5 channels (by default they are named as follows: «ZET7160_1», «ZET7160_2», «ZET7160_3», «ZET7160_4»), with 5 addresses in the measuring system (the fifth channel is not displayed in the system, but it still has an address). It is possible to change digital sensor's parameters only in the first channel's tab «ZET7160_1». As the device address for the first channel is changed, the system will automatically change the addresses of the remaining channels by "1" in relation to each other.

Note: ZET 7173 off-line recorder and ZET 7175 synchronization device both have 2 channels and two addresses in the measuring network (the second channel is not displayed in the system, but still has an address).

2.8.1 Configuring ZET 7155 digital geophones

Configuration of ZET 7155 digital geophones is performed in "Configuration" tab of the "Properties" menu (*Figure 2.12*).

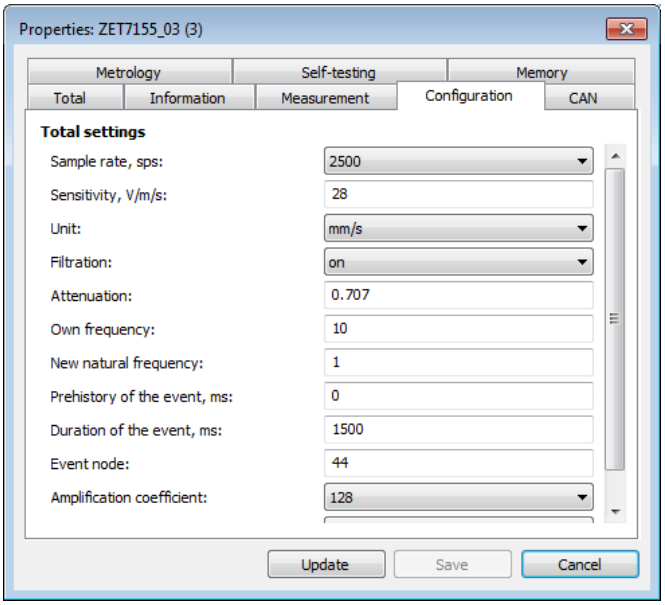


Figure 2.12 ZET 7155 "Configuration" tab

In order to configure ZET 7155 digital geophones it is necessary to set the following parameters in the "Settings" tab (Figure 2.12):

1. Set the values of the fields «Sensitivity», «Attenuation», «Own frequency» in accordance with the information, specified in the digital geophone's certificate.
2. It is recommended to disable the «Filtration» option.
3. In the field «Prehistory of the event», it is recommended to set signal recording duration by ZET 7155 digital sensor prior to digital event.
4. In the field «Duration of the event», one should set the duration of signal recording by ZET 7155 digital sensor after beginning of the digital event.
5. Set "44" value in the section «Event node ».
6. Set value "Event" in the field «Event mode»
7. In the section "Amplification coefficient" one should set ADC amplification ratio, which is most suitable for the position of a particular digital geophone (the longer is the distance between elastic oscillations source and the geophone, the higher amplification ratio should be set).

Note: duration of the prehistory of the events cannot be set less than 500 ms, while the total duration of the parameters "Prehistory of the event" and "Event duration" at the refresh rates of 100, 200, 500 and 1000 Hz cannot exceed 4000ms, and 1600 ms at the refresh rate of 2500 Hz respectively.

Note: more detailed information regarding ZET 7155 digital geophone configuration is available in "ZET 7155 user manual".

2.8.2 Configuring ZET 7160 digital port

Configuring ZET 7160 digital port is possible in the “Configuration” tab of “Properties” menu (*Figure 2.13*).

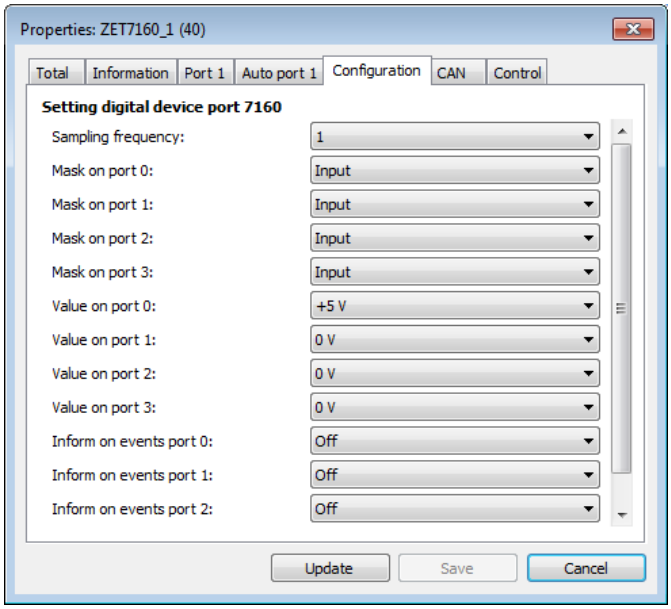


Figure 2.13 ZET 7160 “Configuration” tab

In order to configure ZET 7160 digital port, one should introduce the following parameters in the “Configuration” tab (*Figure 2.13*):

1. Set value “1” in the field “Sampling frequency”.
2. Set “input” value in the field “Mask on port 3”.
3. Enable the option «Inform on events port 3».

Note: more information relating to ZET 7160 digital port configuration is available in “ZET 7160 User Manual”.

2.8.3 Configuring ZET 7173 off-line recorder

In order to configure ZET 7173 off-line recorder, one should:

- Select “All addresses” in the field “Data recording mode” of the “Recording” tab (*Figure 2.14*).

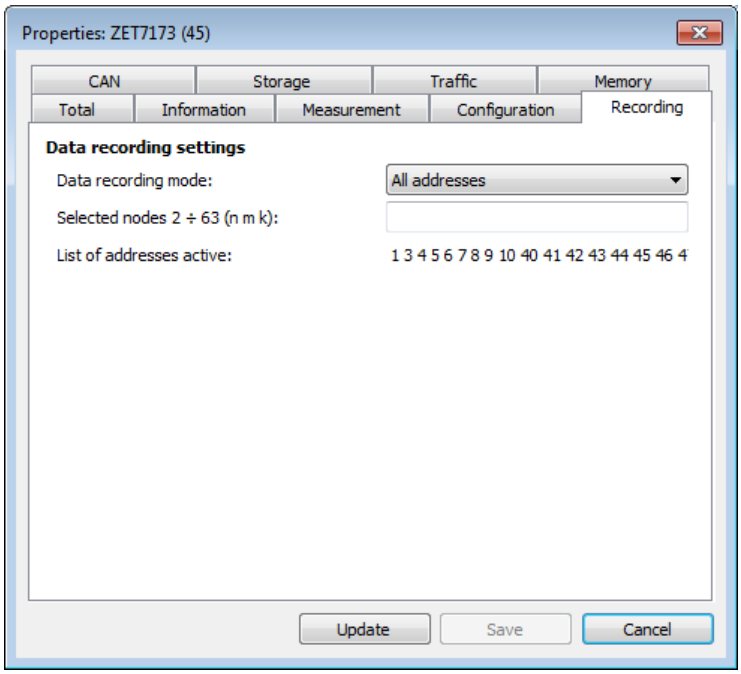


Figure 2.14 ZET 7173 – “Recording” tab

- select “ Linear ” property in the field “ Type of record ” of the “ Storage” tab (*Figure 2.15*).

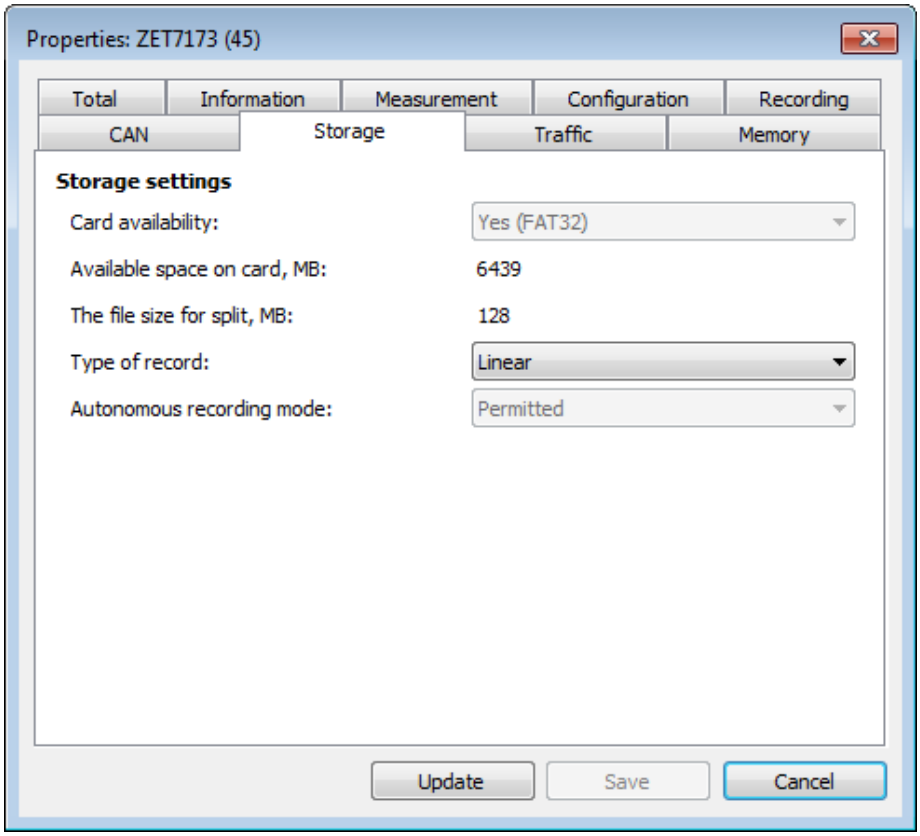


Figure 2.15 ZET 7173 “Storage” tab

<u>Note:</u> more detailed information regarding configuration of ZET 7173 off-line recorder is available in “ZET 7173 User Manual”.

2.8.4 Configuring ZET 7175 synchronization module

Configuration of ZET 7175 is performed in “Configuration” tab of “Properties” menu (Figure 2.16).

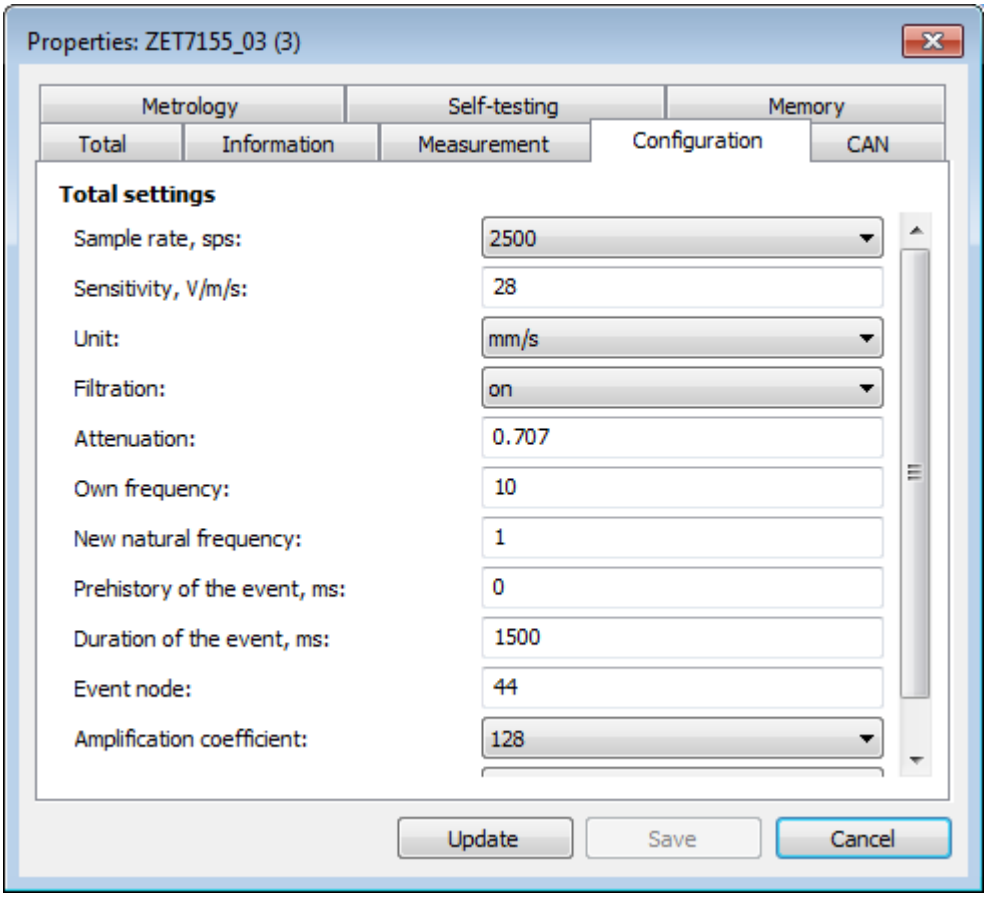


Figure 2.16 ZET 7175 “Configuration” tab

In order to configure ZET 7175 synchronization module, one should set the following parameters in the “Configuration” tab (*Figure 2.16*):

1. Enable option «GPS receiver activation».
2. It is recommended to disable the option «LED indication for receiver status».

Note: more information relating to ZET 7175 synchronization module configuration is available in “ZET 7175 User Manual”.

2.8.5 Configuring ZET 7178 digital indicator

Configuration of ZET 7178 digital indicator is performed in “Transfer” tab of the “Properties” menu (Figure 2.17).

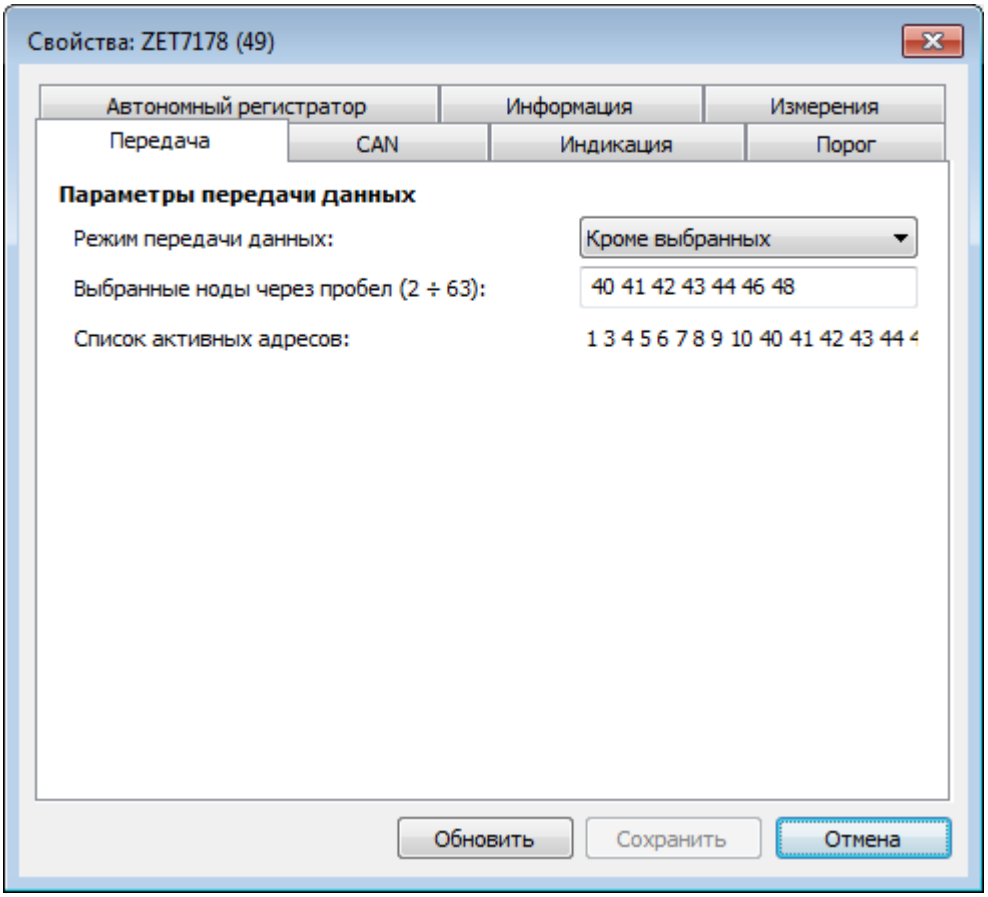


Figure 2.17 ZET 7178 “Transfer” tab

In order to configure ZET 7178 one should set the following parameters in “Transfer” tab (*Figure 2.17*):

1. In the field «Data transfer mode» select the property «Except chosen».
2. Set the values «40», «41», «42», «43», «44», «46», «48» in the field “Selected nodes separated by space”.

Note: more detailed information regarding ZET 7178 digital indicator configuration is available in “ZET 7178 User Manual”.

3 Operation of the kit for seismic research performance

3.1 Seismic survey performance by means of reflected waves method (common reflection point, compressional waves)

3.3.1 Set-up procedures

Prior to starting seismic research activities one should arrange the network in accordance with *Figure 1.1*. The digital geophones are connected to the GSC-4H (Herma-4) connectors of the cable line in accordance with the marking shown in the diagram (seismic streamer's electrical connection scheme is shown in the Annex A). The beginning of the cable line is connected to the CAN port of the recorder. At the end of the cable line (i.e. at the last free GSC-4H (Herma-4) connector) one should install a plug with terminal resistance 120 Ohm.

Attention! *Beginning and end of the cable line have "BEGIN" and "END"marking correspondingly. When the cable line is connected to the recorder, it is necessary to connect the recorder to the beginning of the cable. In the case if it is necessary to connect another measuring line, its beginning ("BEGINNING" mark) should be connected to the end ("END" mark) of the first cable line. If these requirements are not observed, it may result in damage of the equipment!*

The amount of the digital geophones connected to the seismic streamer is determined individually for every project at the design stage; however, the total amount of the geophones within one seismic streamer should not exceed 24 pcs.

It is reasonable to perform survey works with compressional waves using end-on-spread operations method. Thus, elastic waves impact point is located at some distance from the first digital geophone. The particular distance to the first geophone depends on seismic research performance environment. The distance should enable good tracking of the reflected waves by maximum possible amount of traces. However, the reflection curvature should be sufficient, so that to estimate the velocity of reaching the reflective surface. In order to choose optimal offset distance one should perform preliminary experimental and methodological works.

The digital geophones are placed at the elastic oscillations detection points of the researched object in accordance with the design documentation. The geophones are installed into the ground in vertical direction by means of the pins at the bottom of sensors packages. It is necessary to push the geophones into the ground at least by 2/3 of its length.

Upon completion of seismic kit deployment in accordance with the diagram shown in the *Figure 1.1* and installation of digital geophones, switch on the recorder by placing "Power" switch into "I" position.

Before starting seismic research works performance one should install and configure "Universal oscillograph" program from "Display" menu of ZETLAB panel.

Figure 3.1 Starting the program "Universal oscillograph"

In the "Seismograph" window (*Figure 3.2*) one can select ZET 7155 digital geophone channels to be depicted in the oscillograph chart (in the right part of the program window).

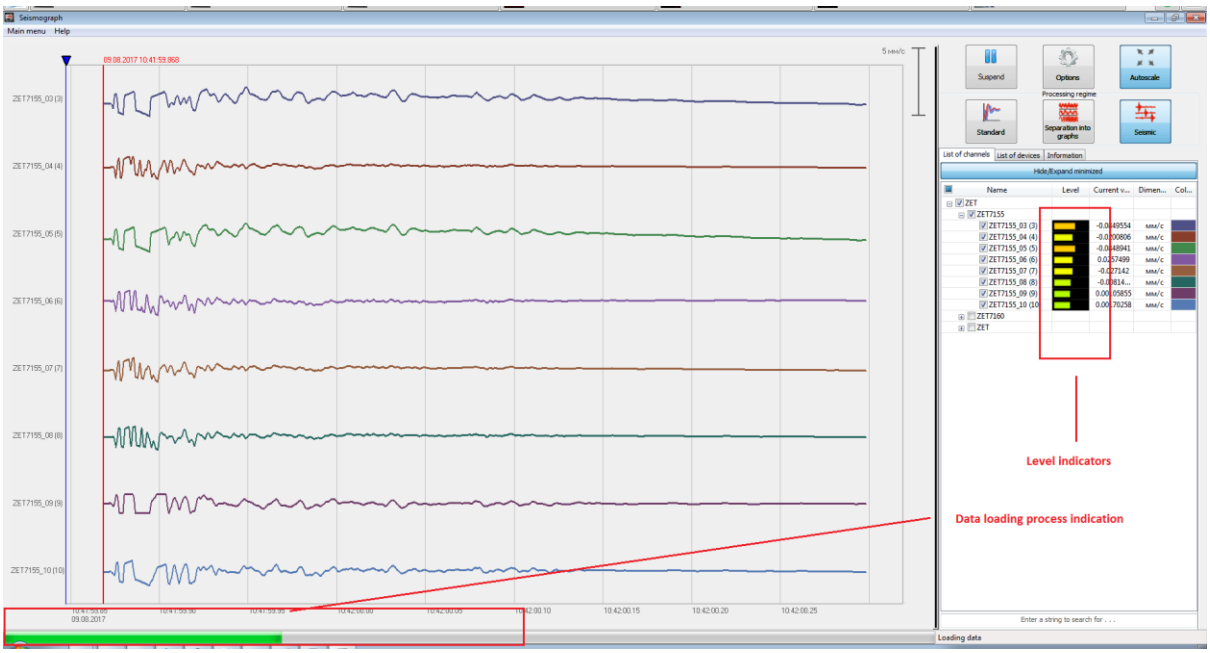


Figure 3.2 "Universal oscillograph" program window

It is also recommended to set signals display shape in the oscillograph chart ("Seismic" or "Separation into Graphs") by using corresponding keys (*Figure 3.3*).

Figure 3.3 Selection of signals display shape

One should also configure the "*Universal oscillograph*" program to enable synchronization by an external event. To do this, enter "Options" menu (*Figure 3.4*).

Figure 3.4 "Options" menu

You will see the window “Channels display parameters” – enable the “External synchronization” option (Figure 3.5). The values of the parameters “Displayed time before the event” and “Displayed event duration” should not be changed.

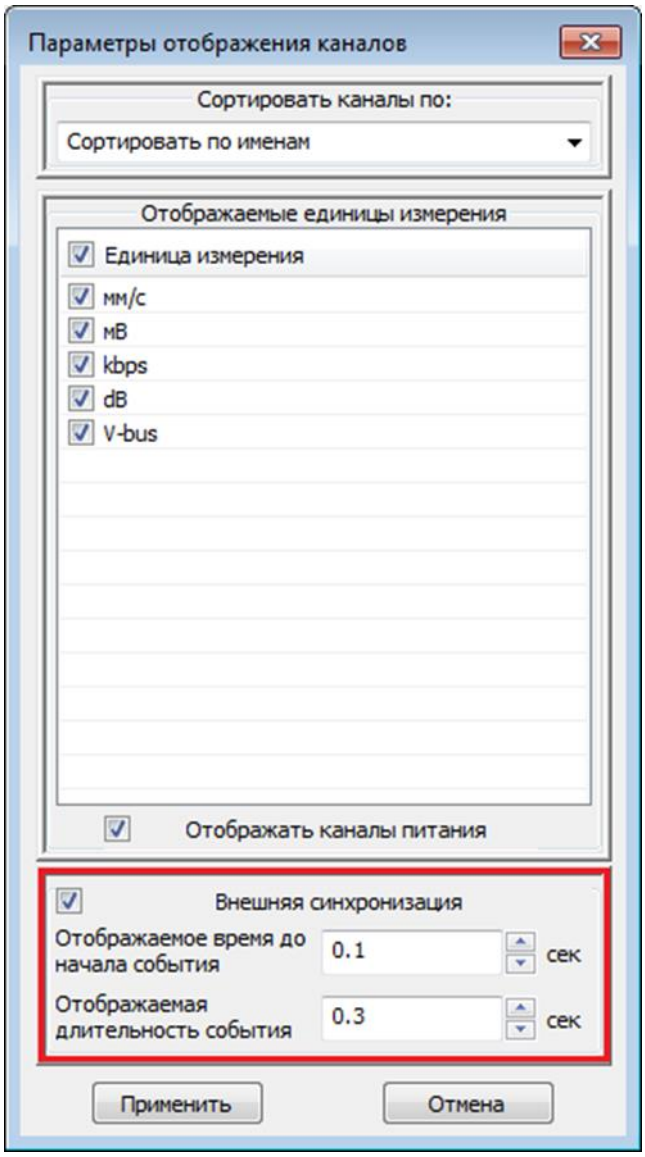


Figure 3.5 “Channels display parameters” menu

Before starting the measurements process, one should perform several calibrating hummer strikes at the elastic waves source position in order to select suitable amplification ratio of the digital geophones. The amplification ratio should be selected in such a way, so that at the moment of the hummer strike the digital geophones indicators level (in the “Universal oscillograph” program) would be within the range of 40%-60% (See the *Figure 3.2*).

In the case if the indicators level is below the specified range, the amplification ratio for the particular digital geophone should be increased. If the indicators level is above the specified range, the amplification ratio should be decreased. The procedure of setting amplification ratio of a digital geophone is described in the Section 2.8.1. After having changed

the amplification ratio parameter one should repeat the calibrating test in order to make sure that the optimal amplification ratio has been set.

3.3.2 Seismic survey performance

Upon completion of the set-up procedures (Clause 3.3.1) one can start seismic survey performance. Seismic survey by means of reflected waves method has several stages. Each of the stages includes installation of the digital geophones on the researched object, causing elastic oscillations with a hummer, saving the measured data to the PC. Upon completion of each stage, the seismic impact point as well as the digital geophones are relocated to the next measurements area. The total amount of measurements depends on the researched area size.

The hummer strike against the metal plate starts the recording process and measured data transfer from the geophones to the PC. Due to the risk of data loss, it is not recommended to switch-off the seismic streamer components during data loading. Data loading process state can be controlled in the "Universal oscillograph" program (*Figure 3.2*) or at the recorder's indicator. A round light indicator at the top part of the recorder flashes with the frequency of 1 Hz in the course of data loading process. Besides, if digital geophones parameters indication at recorder's indicator is enabled, at the bottom part of the indicator there will be depicted a status bar of the data loading.

As the SP point is moved to the next position, the measuring line is shifted at the same distance too. Thus, the distance between the SP and the receivers is the same at all stages of the seismic survey performance. *Figure 3.6* shows an example of the digital geophones positioning in the course of seismic survey performance by means of reflection waves method.

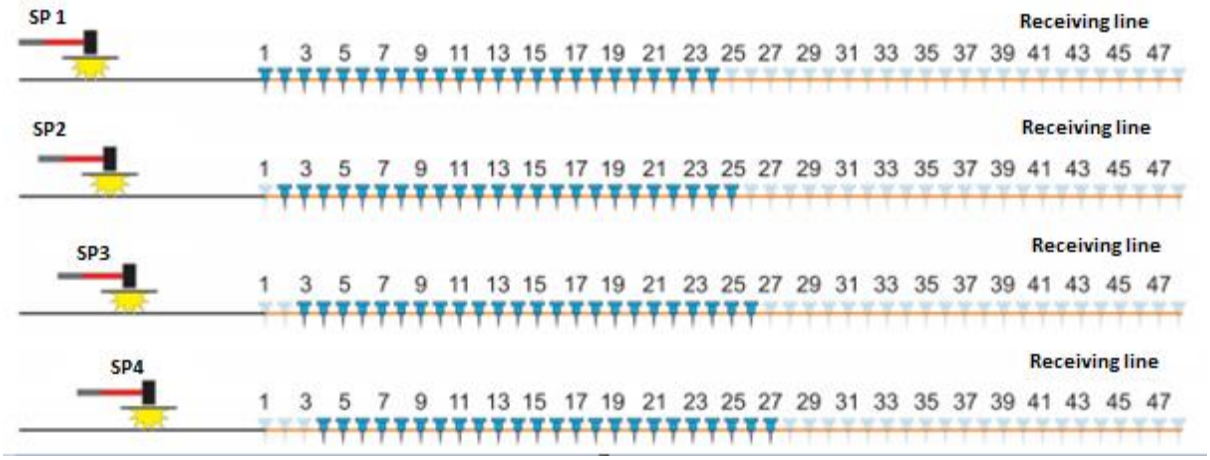


Figure 3.6 Seismic survey performance: digital geophones positioning

3.2 Seismic survey data processing

Seismic survey data processing is performed by means of PC with ZETLAB software. In order to use ZETLAB Software one have to connect ZETKEY hardware key to the USB port of the PC.

For the purpose of the obtained data analysis, one should start the program “View historical events” from the “Register” menu of ZETLAB panel (*Figure 3.7*).

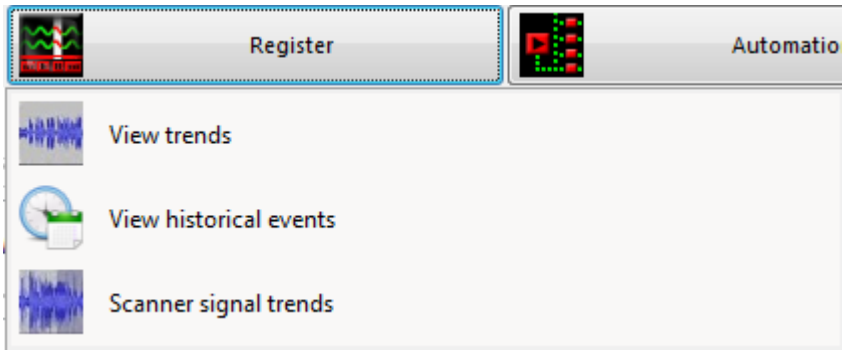


Figure 3.7 “View historical events” program

In the “View historical events” window select “Modbus_Window_Result” to be displayed at the diagram (*Figure 3.8*).

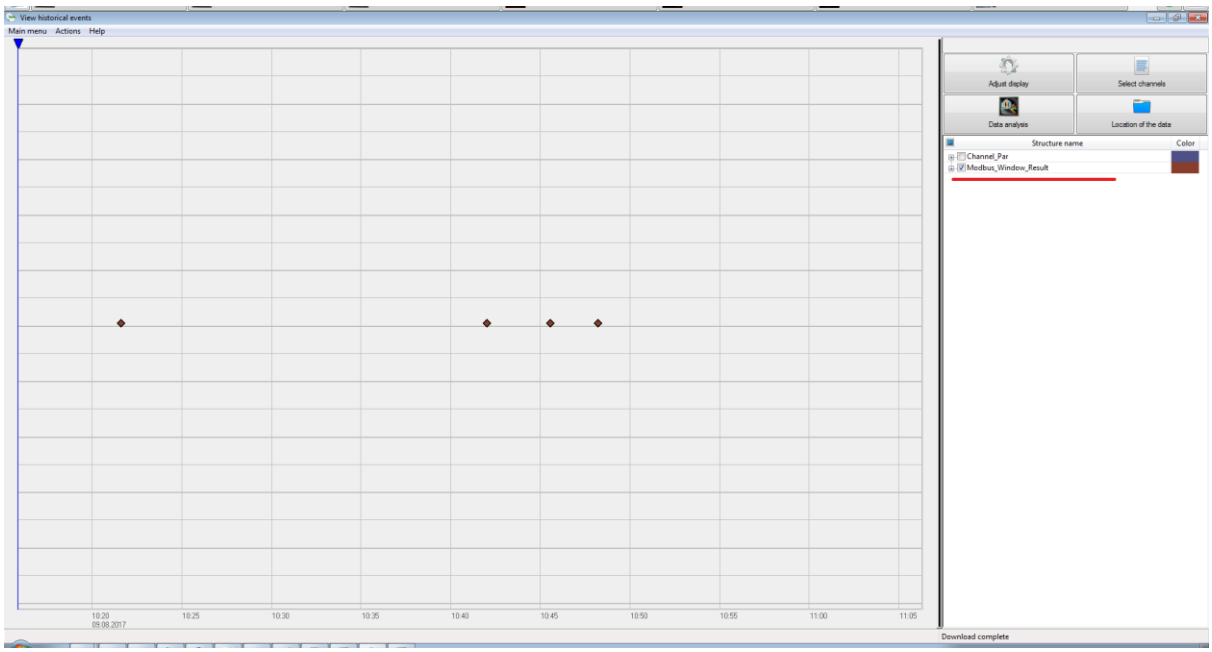


Figure 3.8 “View historical events” program window

The diagram will depict the registered events structures for a certain period of time. It is also possible to select a particular time span to be displayed at the diagram:

1. In order to change the scale by time axis, mouse over horizontal axis till there appears “increase” (to the right) or “decrease” (to the left) option.

2. In order to move the display area along the time axis, mouse over horizontal axis until there appears “increase” (to the right) or “decrease” (to the left) option, left-click the option you need.

3. Mouse over the bottom left section of the diagram until there appears auto-scale option – left-click it to perform auto-scaling of the diagram.

By clicking the right section of the “View historical events” program window it is possible to see the information of a particular event: event date, signal oscillograph chart, devices addresses, etc. As the event to be analyzed is found, select it and use the option “Save to Segy file the selected range” from “Actions” menu (*Figure 3.9*).

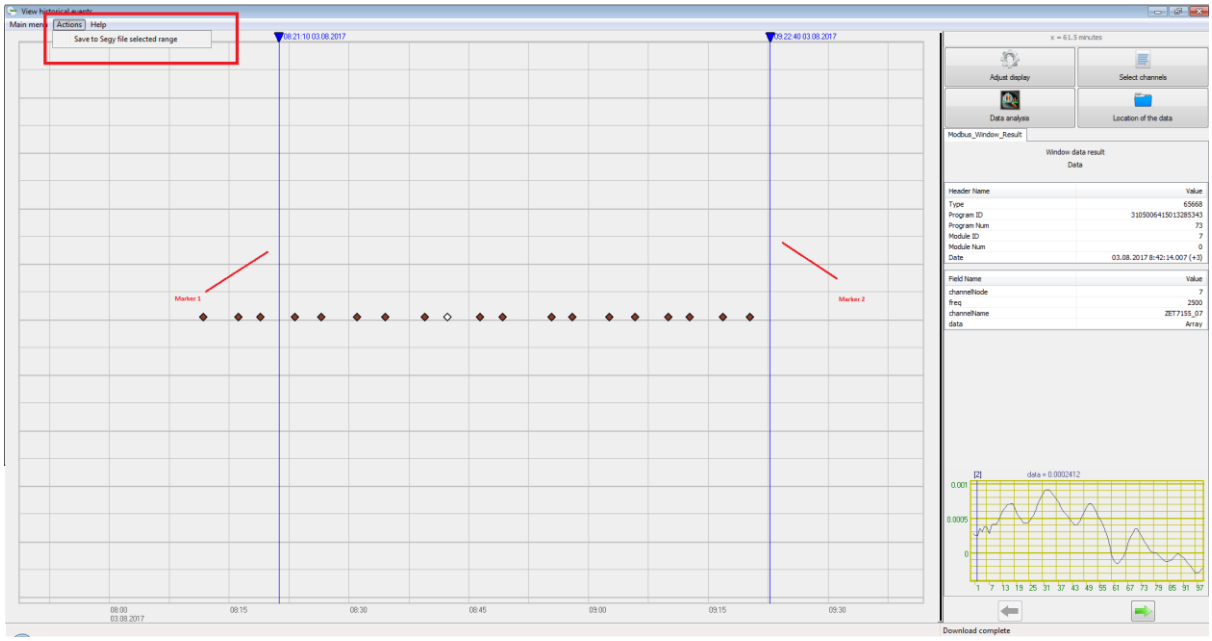


Figure 3.9 “View historical events”: selecting an event to be analyzed

In the window “Select the fields to be stored in SEGY” click “Apply” key (Figure 3.10).

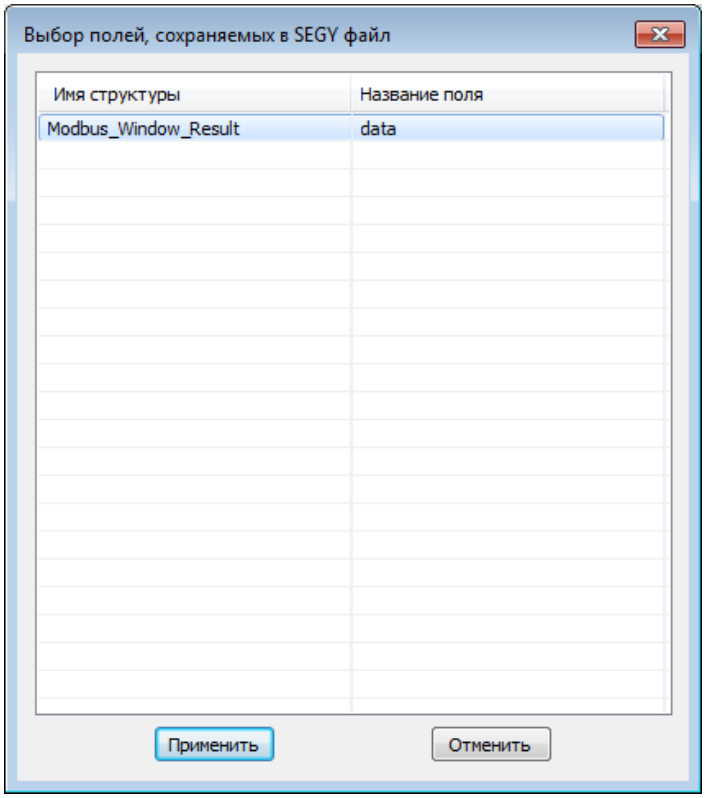


Figure 3.10 "Select the fields to be stored in SEGY "Window

As a result, there will appear a folder with "data.sgy" file. To open this file, use the program "ResultViewer" (*Figure 3.11*).

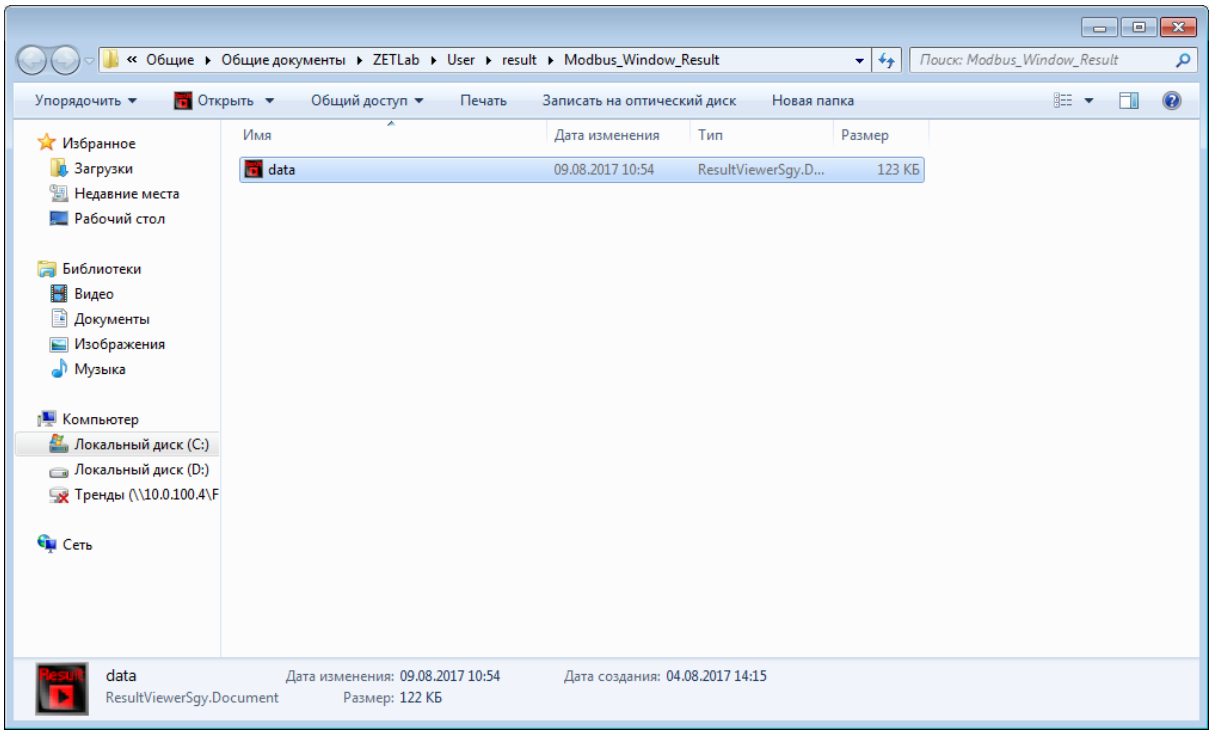


Figure 3.11 Opening the "data.sgy" file with "ResultViewer"program

The "ResultViewer" program depicts spectral pattern of the recorded event (*Figure 3.12*). The vertical scale – the time scale, depicts the time, during which the geophone records

the event. The horizontal scale is divided into sections, each of which corresponds to a particular digital geophone.

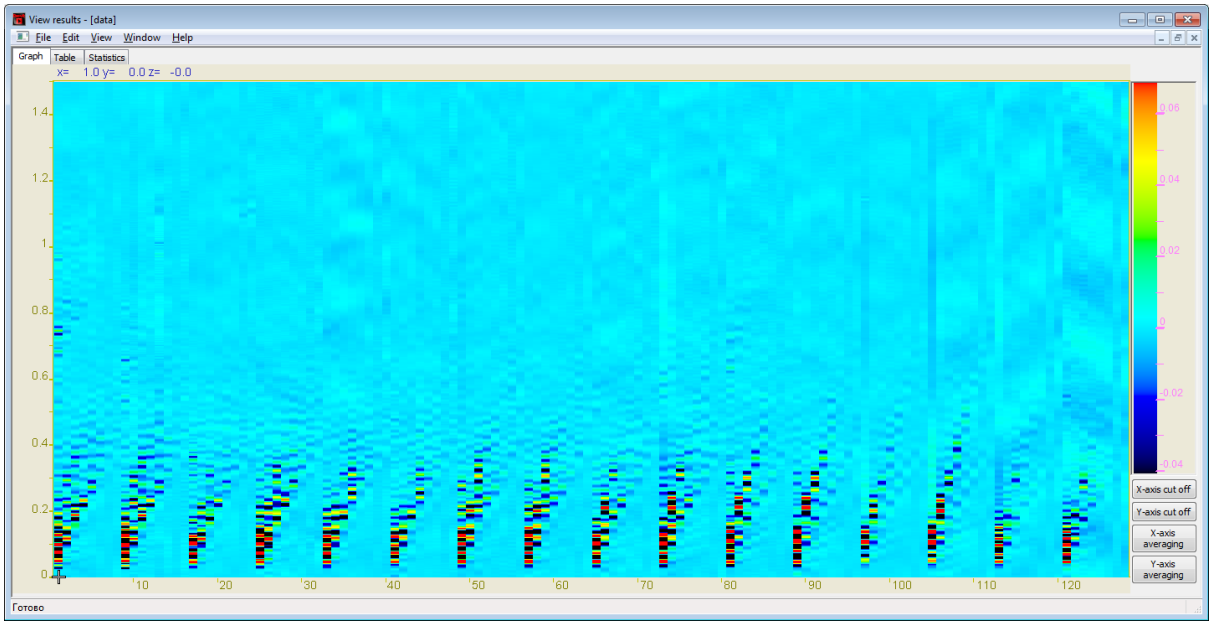


Figure 3.12 Spectral pattern of the event

3.3 Copying recorded signals data to PC

Attention! This operation should be performed only in the case if the events have been saved to the recorder without connection to PC.

In order to save the recorded signals to PC memory, ZETLAB Software uses two directories – one for saving the signals and one for saving the compressed signals.

In order to set directories configuration, it is necessary to activate ZETLAB icon and enable the panel «User's path configuration» in the window «Main menu of the control panel» (*Figure 3.13*).

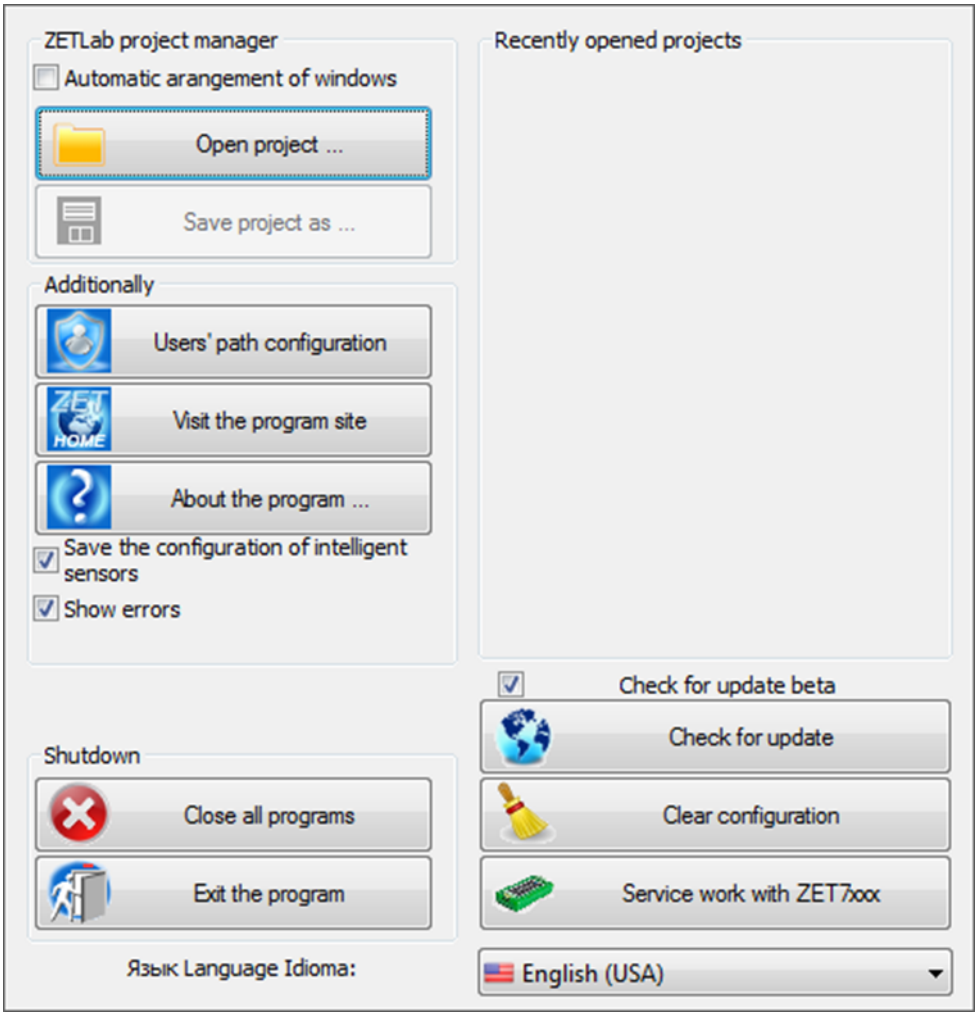


Figure 3.13 Main menu of ZETLAB control panel

In the «Adjusting configuration access» window (*Figure 3.14*) it is possible to enable the panel «...» for each of the directories (signals, compressed signals). This will activate the window «Select directory», in which you can set the necessary configuration directory. Save the changes by clicking "Apply" key.

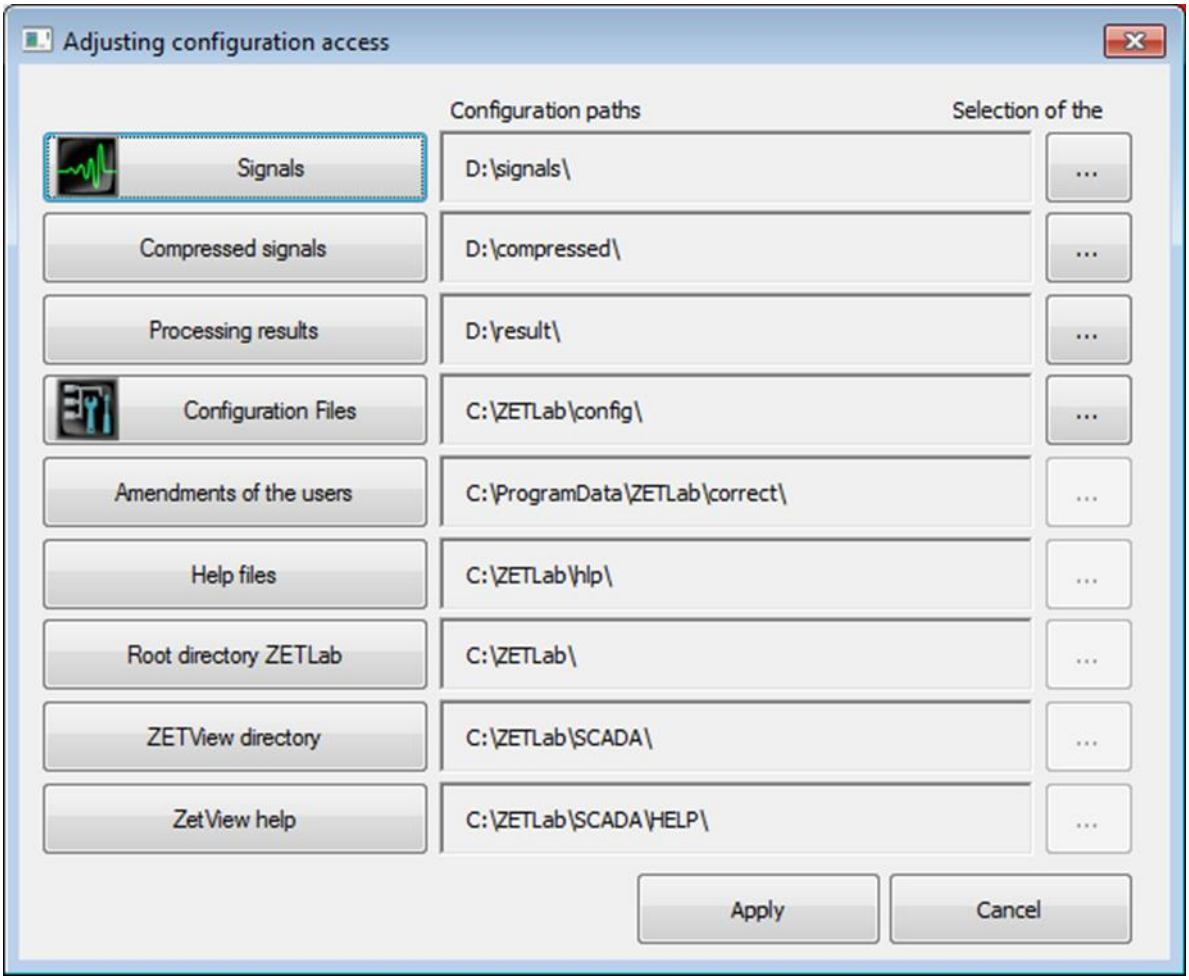


Figure 3.14 "Adjusting configuration access" window

The sequence of copying the recorded signals from the recorder to PC is described below:

1. The PC should have ZETLAB software as well as ZETKEY hardware key connected to the USB port.
2. In order to copy the recorded signals from the recorder's integrated memory to the PC, connect the recorder to the PC. Connect the USB cable to "SD" port at the upper panel of the recorder.
3. The PC will automatically start the program «Select files to convert». This program is used for copying and converting the files from the recorder's integrated memory to the PC (*Figure 3.15*).

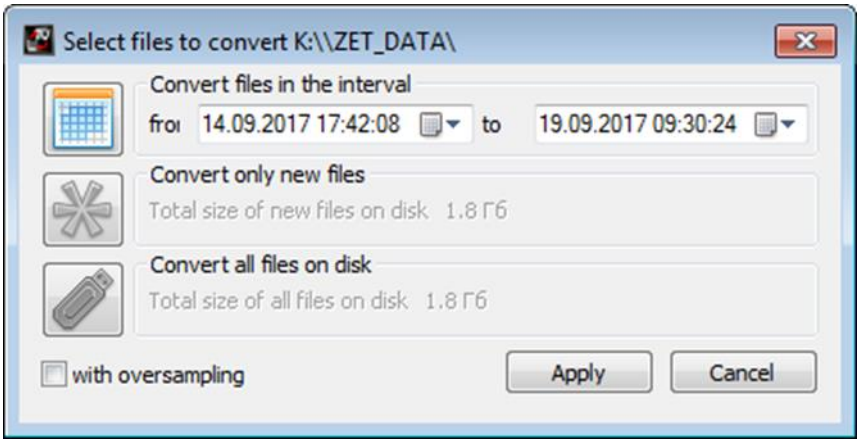


Figure 3.15 "Select files to convert" program window

4. Select the time span you need and click "Apply". This will start saving and conversion of the files to the PC directories selected for signals saving (*Figure 3.16*).

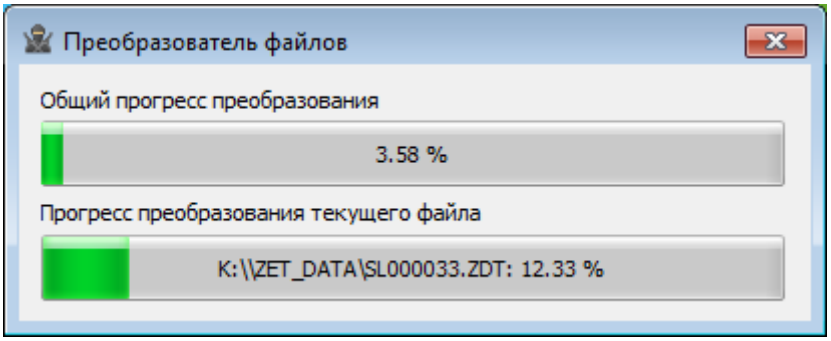


Figure 3.16 Conversion process of the recorded signals

In the case if "Cancel" option of the «Select the files for conversion» window is selected, the corresponding window will be closed. The next start of the program for files copying and conversion requires power cycling of the recorder.

Attention! Interruption of the files copying and conversion process may lead to necessity of PC or analyzer's reloading.

As the file conversion process is over, one can start data processing in accordance with the instructions specified in *Section 3.2*.

4 Maintenance operations

It is recommended to perform technical maintenance of the kit for seismic research performance at least one time in 6 months. Integrated battery charging instructions are specified in the Clause 2.2.

5 Storage and transportation rules

In accordance with the applicable requirements, it is recommended to store the kit for seismic research performance in the package set and in heated space at the temperature of 5-40°C and air humidity up to 80%.

There should not be any acid or caustic fumes or any other chemically active substances and their fumes, which may cause corrosion in the room, where the kit for seismic research performance is stored.

In the course of the kit for seismic research performance loading and transportation, the handling marks and symbols requirements should be observed.

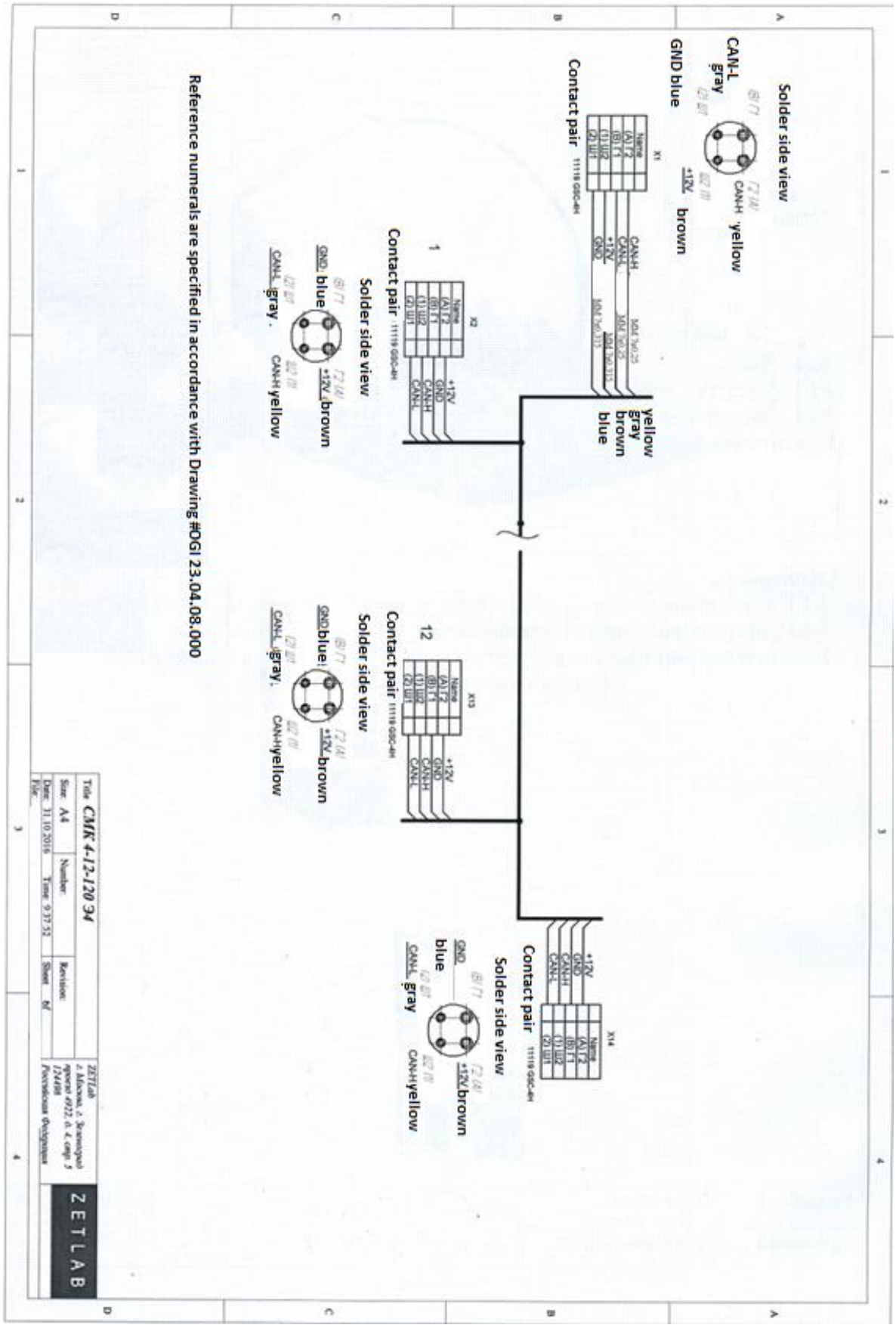
Fastening and securing of the kit package inside of the vehicles used for its transportation should guarantee its stable position as well as prevent it from shifting during transportation process.

In the course of transportation process, it is necessary to protect the package of the kit for seismic research performance from atmospheric precipitation and solar radiation impact.

The packaged kit for seismic research performance can be transported in accordance with applicable requirements:

- Vehicular transportation: at the distance up to 1000 km at the speed of 60 km/h by highways or at the distance up to 500 km at the speed of up to 20 km/h by unimproved roads;
- Railroad transportation: at the distance up to 10000 km in accordance with the applicable requirements of Ministry of Railways (the recorder can be transported in any section of the train);
- Transporting by air: at any distance and at any speed (inside of a pressurized section).

Annex A


Solder side view
CAN-L gray
CAN-H yellow
GND blue
+12V brown
Contact pair 11119 GISC-4H
X1
Name
(A) 1*2
(B) 1*1
(1) U2
(2) U1
CAN-H
CAN-L
+12V
GND
M04.740.25
M04.740.115
yellow
gray
brown
blue
X2
1
Contact pair 11119 GISC-4H
Solder side view
GND blue
+12V brown
CAN-L gray
CAN-H yellow
X13
12
Contact pair 11119 GISC-4H
Solder side view
GND blue
+12V brown
CAN-L gray
CAN-H yellow
X14
Contact pair 11119 GISC-4H
Solder side view
GND
blue
+12V brown
CAN-L gray
CAN-H yellow
Reference numerals are specified in accordance with Drawing #OGI 23.04.08.000
Title CMK 4-12-120 34
Size A4
Number
Revision
Date 31.10.2016
Time 9:17:52
Sheet of
File
ZETLab
ZETLAB

Record of changes

Amendment #	Number of sheet(s) (page(s))				Total number of sheet(s) (page(s))	Document number	File # and date of accompanying document	Signature	Date
	Amended	Substituted	New	Void					