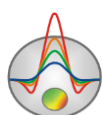


Program for protocol creating and electrical tomography data preprocessing and visualizing.

ZONDPROTOCOL

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Program main purpose and functionality

«ZONDPROTOCOL» is intended to create measurement protocols, preprocess and visualize electrical tomography data obtained through variable electrical exploration equipment. User-friendly interface and powerful capabilities of data representation allows you to carry out the electrical tomography surveys effectively.

«ZONDPROTOCOL» complex is an out-of-the-box solution for electrical tomography and it solves a wide range of problems from mathematical modelling and measurement protocols setting to field data processing and interpretation. Owing to simplicity of its usage and complete compatibility with ERA, COMx64, SYSCAL, ABEM, Omega48, «ZONDPROTOCOL» allows you to obtain qualitative result right on the profile. Depending on qualifications of the operator, you can choose from various operating modes. The complex supports the following electrical tomography methods of observation: surface 2D electrical tomography, surface 2D electrical tomography, cross-borehole electrical tomography, marine electrical tomography.

«ZONDPROTOCOL» allows you to create protocols of any complexity combining any types of arrays. Depending on the average rocks resistivity and the minimum signal level, the system chooses array parameters on itself.

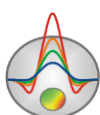
To display measured and synthetic values or measurement dispersion, there are two types of displaying in the program – graphs plan and pseudosection.

«ZONDPROTOCOL» uses simple and clear data file format allowing you to combine several types of arrays on one profile. There is also a support of other hardware complexes data formats in the program.

«ZONDPROTOCOL» program is a convenient instrument for electrical tomography surveys and it can be used on IBM personal computers with Windows operating system.

Software requirements

«ZONDPROTOCOL» can be installed on a computer with Windows 98 and later versions of Windows. Recommended system parameters are processor P IV-2 GHz, 512 Mbytes of memory, screen resolution 1024 X 768, colour mode – True color. (You should not change screen resolution while working with data).




Open protocol and data file

Project file	Open program project file *.zmm.
Zond, Res2DInv, Omega, Abem, SysCal	Open ZondRes2d, ZondCHT, ZondRes3d data file. *.z2d, *.cht, *.z3d and various types of equipment.

*While opening data file of ERA or MARY, user is offered to choose a set of measurements (number of cable layout), if there are several in the file and set (or read from the file) current strength, if necessary.


Before opening the data file, it is necessary to load the project by which the measurement protocol was created. Otherwise, it will be impossible for protocols with complicated geometry to set real electrode positions since there are only commutation indexes for electrodes in the data file. This is why after protocol creating make sure that you save the working project where the data will be exported then.

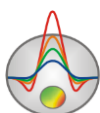
To provide access to each data set, upload data file over again. The file must be downloaded preliminary from a device with this program, the  button or a special program for this type of equipment.

After uploading data file, there will be a dialog offering user to choose data set and set or read current strength. If measurements were being taken with source electrodes commutation (blue cable), you do not need to set current (box is unchecked). In case of measurements only with the orange cable (receiver electrodes commutation), you need to set current for each source electrode/line position (box is checked and the current value which was used the most frequently when measuring is set). Editing of current strength values is conducted on the next stage.

It is desirable that a summary number of measurements in one file is not more than 5000 and a number of unique electrodes positions is not to exceed 500.

Save data

The result of operating is stored in the project file (*.zmm extension). You can save the result of operating by pressing the  button of the toolbar.



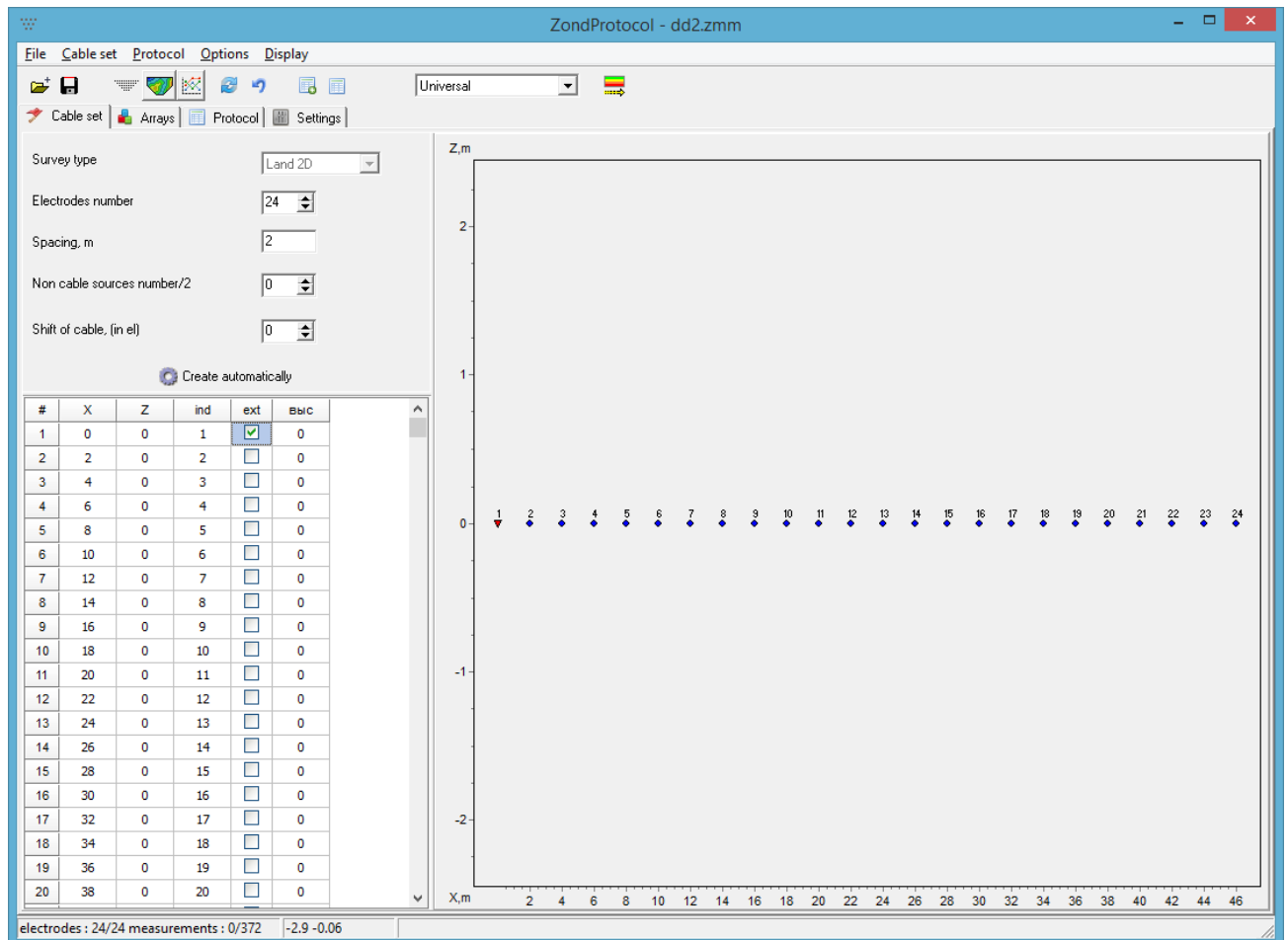
Project file*	Save program project file *.zmm. In this file all the settings and changes being made during processing are stored.
Zond program file	Save ZondRes2d program file. *.z2d
COM 64 protocol file	Save COM 64 protocol file. *.swi
Res2dInv program file	Save Res2dInv program data file. *.dat

*You are strongly encouraged to save processing results in the project file frequently. It is also desirable to store raw projects (with set current and filled journal) apart.

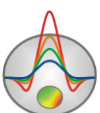
Program operational procedure

Program main window tabs

Cable tab contains the main options for operating with cable. It allows you to set geometry and indexing of cable, add, remove or disable certain electrodes and also set a measurement profile.



The first thing that you must choose in this tab is a type of works. Type of works sets user degree of freedom in changing cable electrodes coordinates. For two-dimensional electrical



exploration it is possible to set XZ (z – depth) electrodes coordinates, for three-dimensional – XY.

Number of electrodes option sets a number of jumper cable electrodes. If you use outer electrodes when carrying out survey (outer electrodes are usually used to commutate only measuring cable), you should set their number in the **number of outer electrodes** option. Thereat additional outer electrodes are added on either side of the cable. You can also select outer electrodes in the table. Unlike the switched electrodes, outer ones have free indexation. **Distance between electrodes** option sets the distance between electrodes of jumper cable (survey interval). It must be set when reading file in the **data protocol** mode.

It sometimes happens that inner indexation of cables does not match electrodes positions on the profile. Then the real electrode position on the profile must be associated with the commutation index. For this reason, there is a free electrodes indexation and measurement profile setting in the program.

The necessity of measurement profile setting and a free indexation is due to the following reasons:

Free indexation

The distinction between cable interval and survey interval (using cable with interval 2 meters when survey interval is 4 meters. Thereat even electrodes are excluded from the protocol).

Nonsequential electrode indexation in the cable (mistakes in the pinout).

Outer electrode usage.



Measurement profile

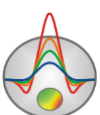
Nonworking electrodes on the cable.









For separated examination of the results obtained through various arrays.

Three-dimensional surveys usage with single cable.

The **Cable** tab toolbar contains the following functional buttons:

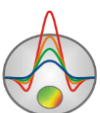
	Add an electrode. An electrode is added from the current position in the cable table. For example, if you need to append an additional outer electrode but in the majority of cases there is no necessity in this option, so the cable can be created automatically.
	Remove an electrode. An electrode selected in the cable table is removed. For example, some electrode is broken or an extra is set but in the majority of cases there is no necessity in this option, so the cable can be created automatically.



	Create a cable automatically. A cable is created automatically using parameters described above.
	Activate a mode of electrodes selection using mouse. You can select electrodes with a rectangle in a section of cable graphical display (used to create measurements profile). When operating in a regular 2D electrical survey mode there is no need for this option.
	Activate a mode of electrodes selection using mouse (with adding to already selected). You can select electrodes with a rectangle in a section of cable graphical display (used to create measurements profile). When operating in a regular 2D electrical survey mode there is no need for this option.
	Sort cable electrodes in ascending order. Using this option before starting to work with protocols, especially if electrodes positions were set manually is strongly recommended..
	Rotate a cable (and data protocol) at 180 degrees. Option is intended for “sewing-up” layouts obtained through diverse cables orientation.
	Create a new measurement profile. Only selected electrodes will take part in protocols creating for the new profile. Do not forget to press this button before starting operating with the protocol. A window with a pop-up list  should get coloured blue  .

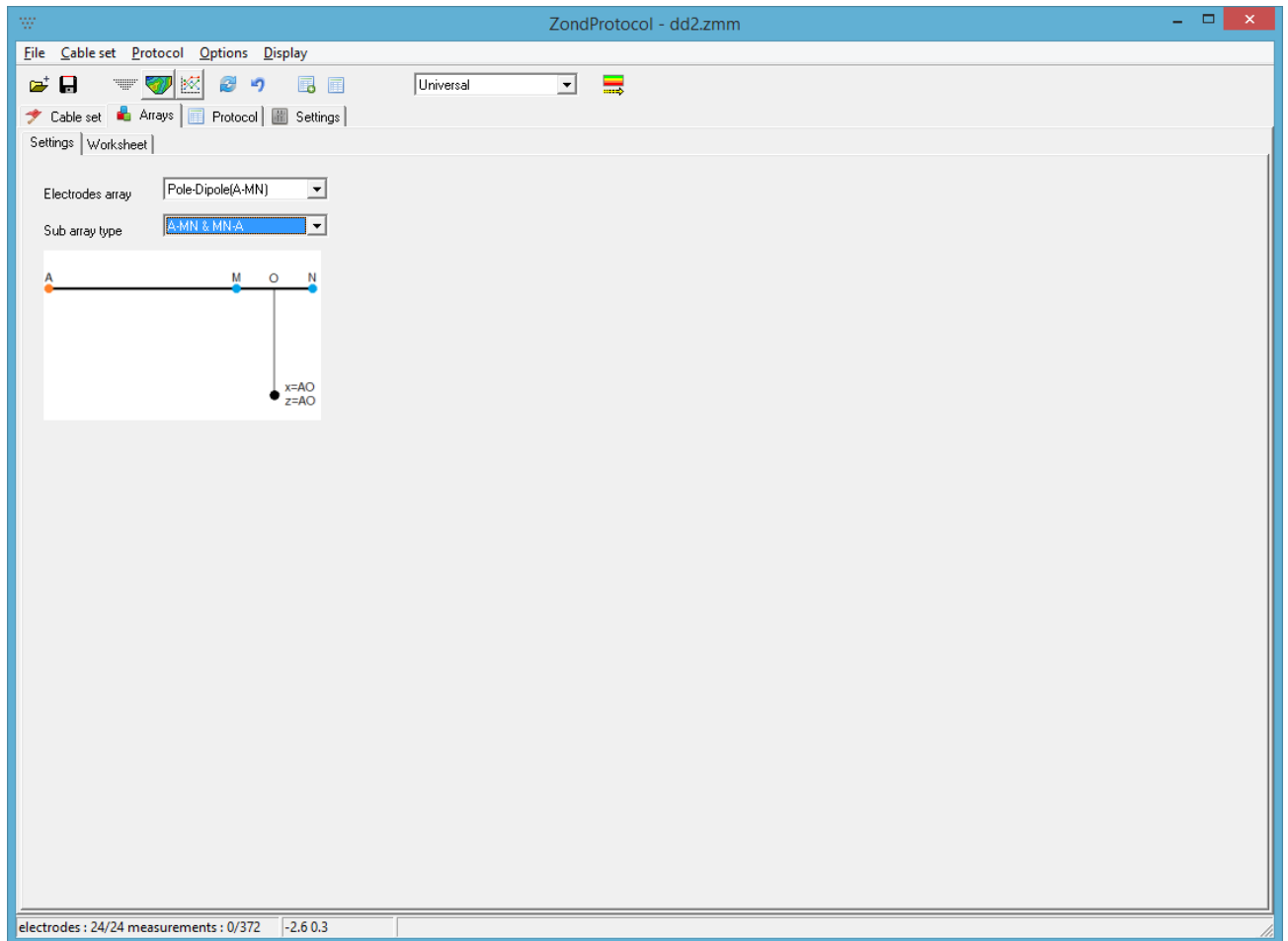
Cable description table allows you to edit electrodes positions and commutation indexes. Electrodes positions are set in first three columns **X Y Z**. Clicking the right mouse button on an any cell runs dialog allowing you to set the electrode coordinates automatically for all the subsequent cells in a set increment. Commutation index is specified in the **ind** column. Right-click on an any cell runs a dialog allowing you to set electrode index for all the subsequent cells in a set decrement. Clicking the right mouse button on the **ind** cell arranges commutation indexes automatically. The **external** column is used to set and indicate outer electrodes (usually they are not commutated and not used when working with a three-electrode array, they are displayed as inverted triangles).

The **Z** column is used for borehole measurements, to input topography data use **height** column (heights are input with “+” sign). It allows you to set altitude for every electrode. Topography data can also be imported from a text file using the **Relief import** option (a number of strings in this file must correspond to a number of electrodes in the protocol).



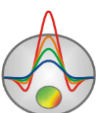
In the section of cable graphical display you can select or deselect electrode with right mouse button click. The selected electrode is displayed in blue.

The **Arrays** tab contains various options for automatic measurement protocol creation and includes the most spread types of electrical exploration arrays.



When automatically building the protocol, MN length is chosen on the assumption of synthetic value of signal for this array. MN length increases starting from the specified value as long as the needed signal level will not be reached or MN length will not exceed the specified value. To calculate synthetic signal, in the **settings/general** tab you need to set approximate values of the following parameters: **resistivity**, **minimum current**, **maximum current**, **minimum signal** and **maximum signal**.

Pole-dipole array – a wide spread three-electrode array frequently used when commutating receiver cables. **Initial MN value** – sets a minimum MN value in indexes. **Maximum MN value** – sets a maximum MN value in indexes. **Array type** - right-sided + left-sided, right-sided, left-sided. **A interval** – source electrode interval in indexes. Without overlaps – if this option is activated, MN lines move without overlaps.




Dipole-dipole array - a wide spread four-electrode array generally used when commutating source and receiver cables. **Initial MN value** – sets a minimum MN value in indexes. **Maximum MN value** – sets a maximum MN value in indexes. **Array type** - right-sided + left-sided, right-sided, left-sided. **AB length** – the source dipole length in indexes. Without overlaps – if this option is activated, MN lines move without overlaps.

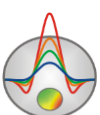
Wenner array – a wide spread four-electrode array used only when commutating source and receiver cables. Distances between adjoining electrodes are equal for Wenner array. **Initial MN value** – sets a minimum MN value in indexes. **Maximum MN value** – sets a maximum MN value in indexes. For this array MN values are not set automatically. **Array type** - Wenner-alpha, Wenner-beta, Wenner-gamma.

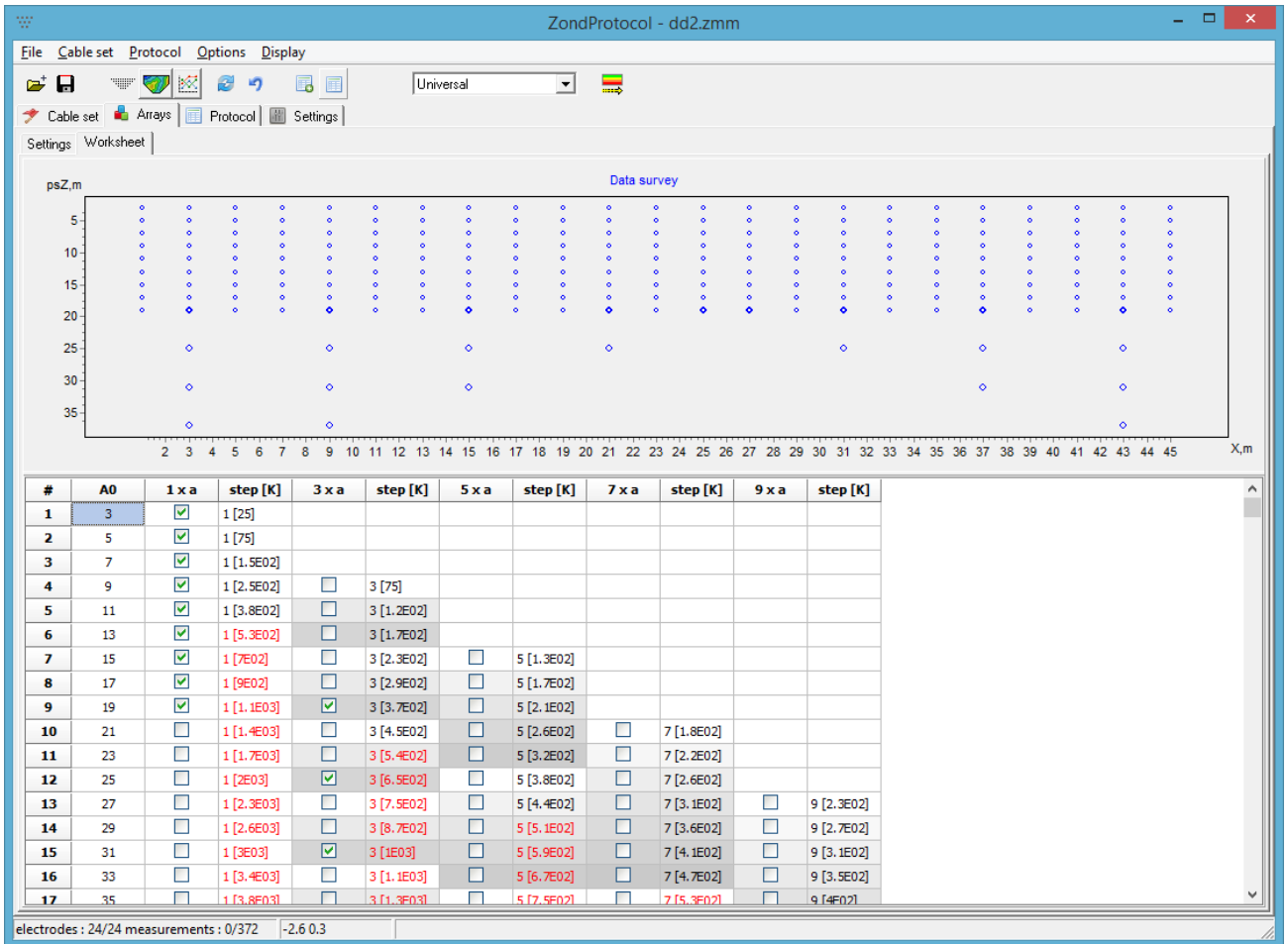
Gradient array – a wide spread four-electrode array used only when commutating source and receiver cables. Source line length is greater than receiver line for gradient array. Receiver line moves inside and out the source line. **Initial MN value** – sets a minimum MN value in indexes. **Maximum MN value** – sets a maximum MN value in indexes. For this array MN values are not set automatically. **AB length** – the source dipole length in indexes. **Array type** – outer and inner gradient, inner gradient.

VES array – a wide spread four-electrode array used only when commutating source and receiver cables. Source line length is greater than receiver line and their centres are coincident for VES array. **Initial MN value** – sets a minimum MN value in indexes. **Maximum MN value** – sets a maximum MN value in indexes.


VES-M array – a special modification of VES array developed by B.G. Sapojnikov.

For pole-dipole, dipole-dipole and VES arrays there are options for manual setting of measurement system. Setting dialog runs when pressing the  button and allows you to choose measurement system spans in table mode.



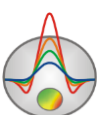


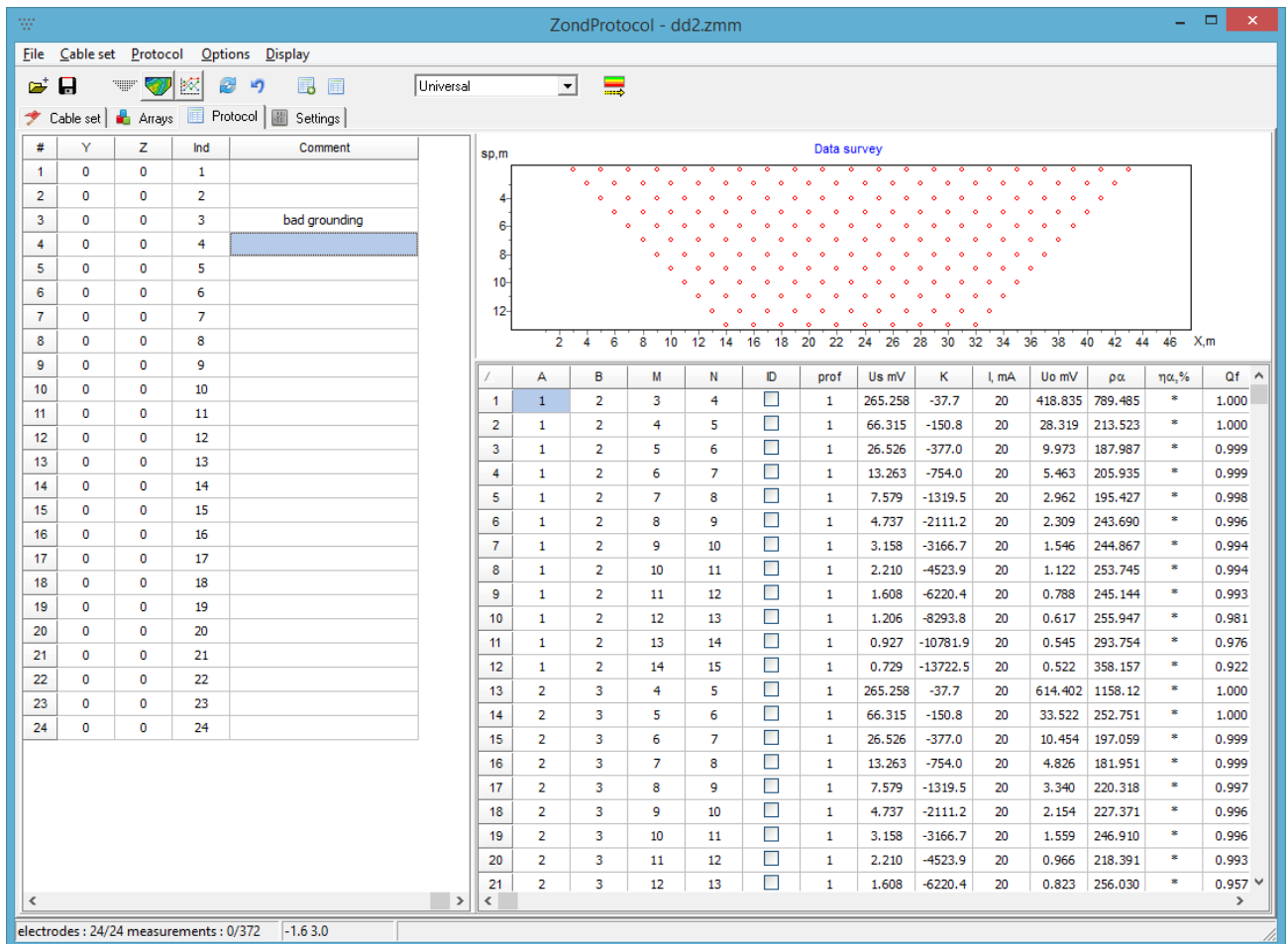
In the second table column spans (within the meaning of a VES curve) are displayed

corresponding to  MN value chosen in the top window panel. In the **Interval** option the source electrode (line) interval along the cable is set (for dipole-dipole array interval can be set for each size of the receiver line).

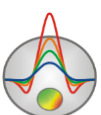
In the third column you can choose spans which are necessary to for creating the measuring system. In the last but one and the last columns the synthetic signal and a number of measurements for this span are shown.

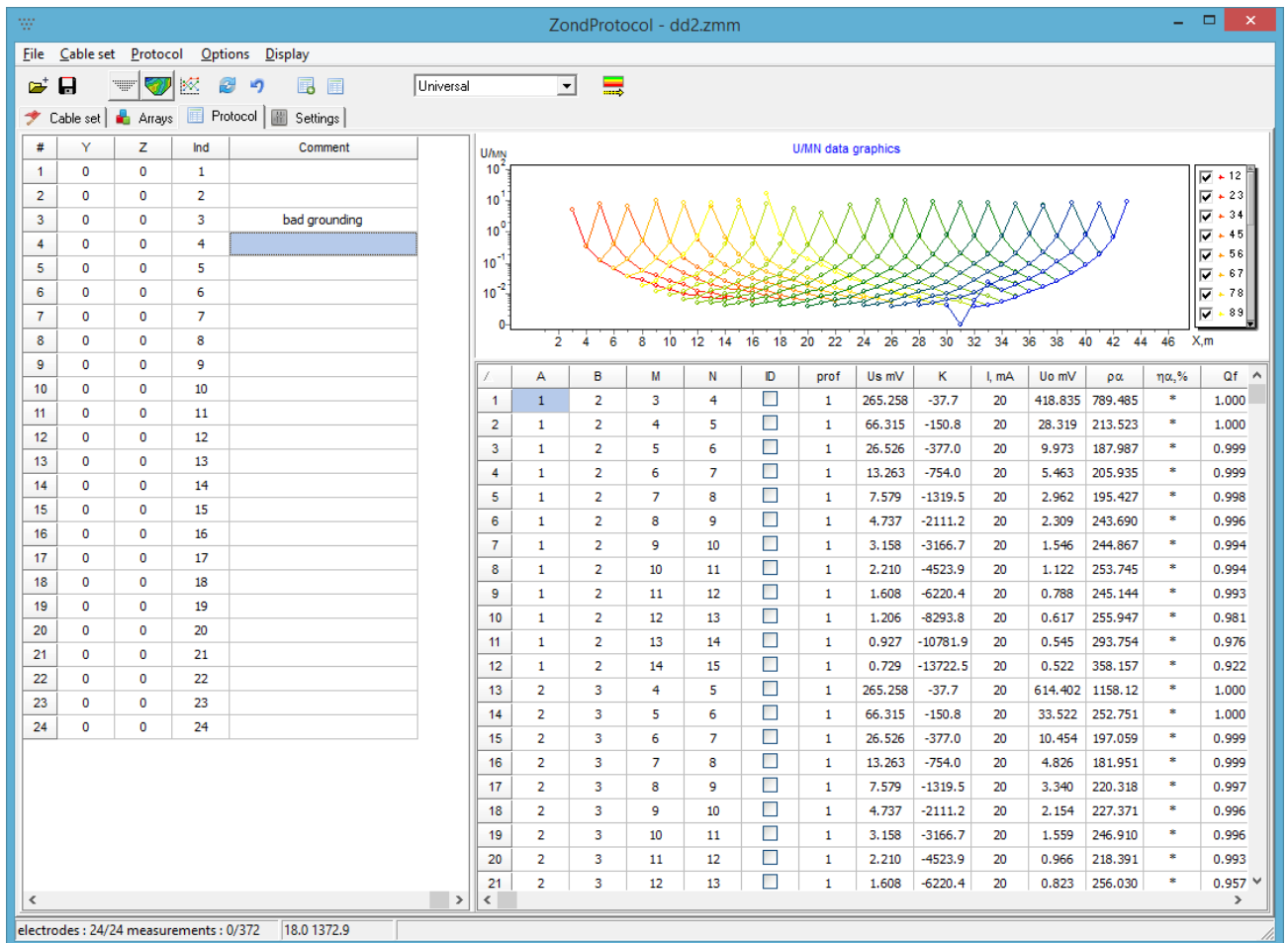
Protocol tab contains various options for protocol parameters setting, processing and data visualization in a graphical and table form.



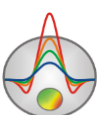


In the left part of the window the cable is displayed in a graphical or table form depending on the mode . In the table a new **Comment** column appears where you can add various information, for example, quality of electrode earth contact. When right-clicking on any of electrodes, the pop-up menu appears which lets user to select all the measurements in which the electrode was involved. For example, if it is known that some electrode was detached during measurements, all the measurements with its involvement are selected at first and then removed.





When moving in the protocol table, active electrodes ABMN are marked with bold circles. In the top right-hand part of the tab the active measurement profile data are displayed in a form of observing system, pseudosection or graph plan depending on chosen mode. In the bottom right-hand part of the tab there is a protocol table. The protocol table shows commutation indexes for **A B M N** electrodes in first four columns. While there is no one of the source electrodes (in the infinity), its index is replaced with * symbol. Input index values must correspond to cable electrode commutation indexes (the same as in the cable table) while editing. The **Measure** column shows whether this measurement is selected (specifies if it is necessary to make a measurement for this row when creating the protocol file). The **Profile** column shows measurement profile corresponding to this row. The following columns are **Ut** – values of the synthetic signal in mV (calculated for average resistivity and desirable current which are set in the settings section), **K** – array factor and measurement results **U** – measured signal in mV, **Current** – current in mA, ρ_k - apparent resistivity, η_k - apparent polarizability in percentage, **Weight** – weight of measurements (parameter of measurement quality 0-1, for the latest versions of equipment it is calculated from the difference between the first and the third norm harmonic). If the data is imported from the file in which information about current is missing, for example,



Zond or Res2dInv files, then norm values R of the signal will be displayed in the column U instead of signal itself.

Table row are highlighted in different colours if there are any mistakes in the protocol.

Red font colour – ABMN index coincidence.

Blue font colour – this measurement already exists in the protocol or there is a similar on the reversibility principle.

Grey background colour – measured value correspond to the criterion set in **settings/errors/remesurements** (exceed the set range).

To set the current strength value (in case of receiver electrodes commutation), click the corresponding cell in the **Current** column and select the value. The current strength value is selected from the list of values corresponding to the set generator. To set the current strength for the group of measurements, click the right mouse button on one of the cells of Current column. In the pop-up menu you can choose the following options:

Increase current for all selected: increase current strength for all selected (in the **Measure** column) measurements. It is generally used when making repeated measurements.

Decrease current for all selected: decrease current strength for all selected (in the **Measure** column) measurements. It is generally used when making repeated measurements.

Increase current for all below: increase current strength for all selected measurements below the current.

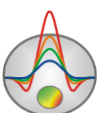
Decrease current for all below: decrease current strength for all selected measurements below the current.










Set AB current: set AB current for all the measurements for this AB position. It is generally used after uploading data from the measuring instrument in case of commutation of the receiver line. It is the most frequently used option because current is usually changed when the source electrode positions change.

Input of current strength values is performed in the following manner. At first, protocol is sorted by source line position. Then values for every unique position of the source line are set sequentially. Thereat norm signal graphs will shift along the vertical axis. If one of the graphs (isosources) is severely biased relative to adjoining – probably, the current input is wrong.

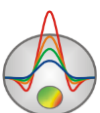
Do not forget to write down the current strength (in case of receiver cable commutation) in the field book – without these values results of measurements are useless.

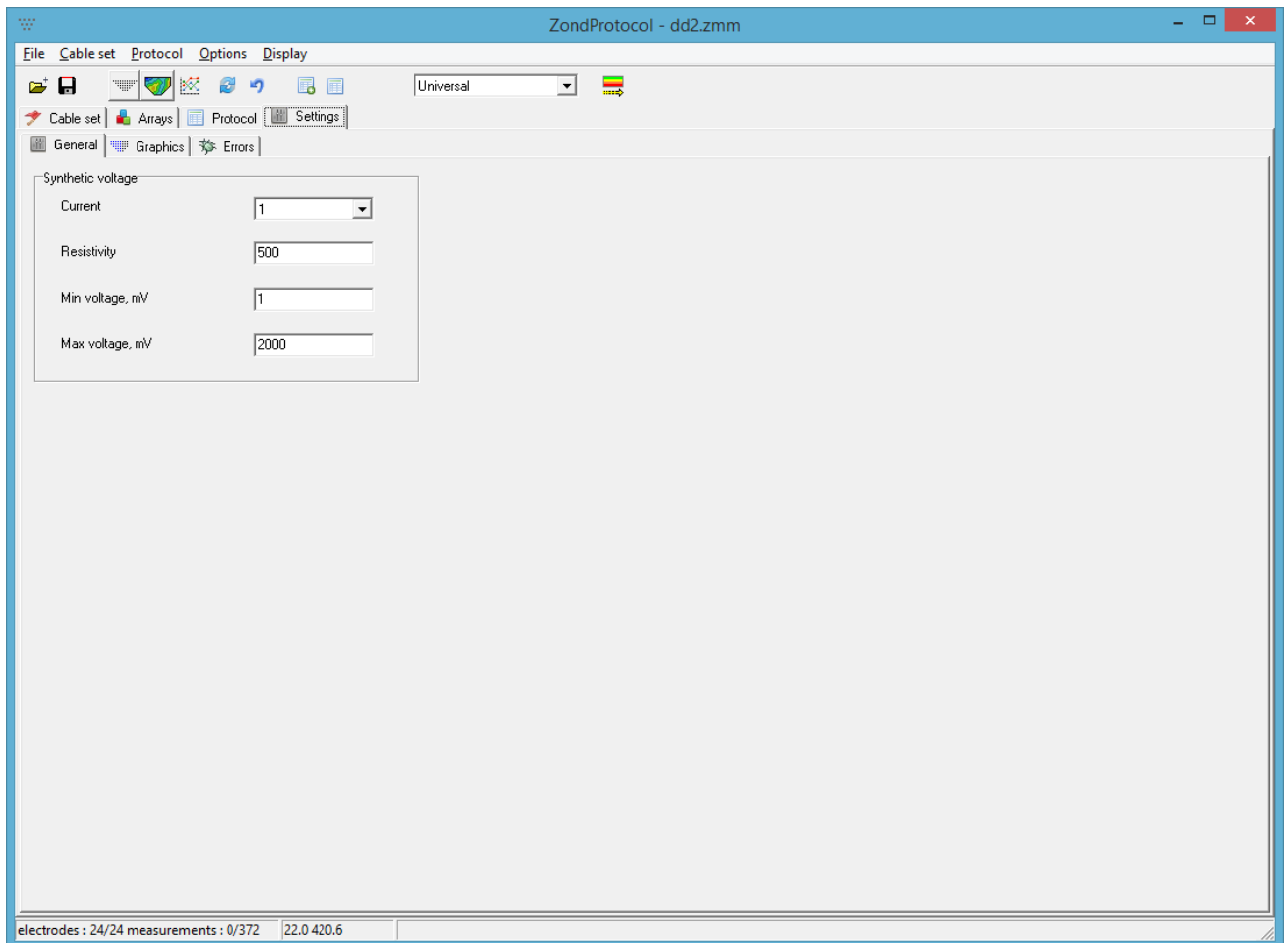
The toolbar of **Protocol** tab contains the following functional buttons:



	Add measurement. Measurement is added from the current position in the protocol table. In the majority of cases there is no necessity in this option because the protocol can be created automatically.
	Remove measurement. The selected in the protocol table measurement is removed. It is not convenient to remove measurements one by one. It is better to select poor data at first and then remove them using Remove selected measurements option. Selected measurements will be highlighted.
	Highlight/no highlight for mistakes in the protocol setting.
	Display the cable in a form of a table or a graph.
	Append to the table additional measurements corresponding to the reversibility principle, i.e. substitution of the source and the receiver electrode positions. Reverse measurements allow you to estimate the data quality objectively but two times increase the overall registration time. It is used only for four- or two-electrodes arrays.
	Select a chunk of a data corresponding to the criterion set in settings/errors/remeasurements for repetitive measurements or removal.
	Sort the current protocol by the source positions. Make sure that you use this option before recording the protocol in the file in the measuring device.
	Search and remove errors in the protocol. The criterion of errors are set in the settings/errors/select section.
	This option changes object positions in the tab sections clockwise.

The **Settings** tab contains various options for measurement parameters setting, protocol creating and data visualization.





Subtab **General**

Maximum current – set the assumed current strength maximum value. Option is used when automatically setting the protocol (to calculate the synthetic signal).

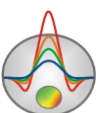
Minimum current – set the assumed current strength minimum value. Option is used when automatically setting the protocol (to calculate the synthetic signal). It is usually equal to the maximum.

Frequency – generator frequency.

Resistivity – the assumed average resistivity of the area of work. Option is used when automatically setting the protocol (to calculate the synthetic signal).

Minimum signal – minimum signal level (1 mV). The signal threshold reaching which MN length or current increases. Option is used when automatically setting the protocol (for MN length correction).

Maximum signal – maximum signal level (2 V). The signal threshold reaching which MN length or current decreases. Option is used when automatically setting the protocol (for MN length correction) and to cut off measurements with a signal superior to 2-2.5 V.



Connection port – COM port to connect the device (check in the Windows device manager). If the connection is failed when importing/exporting data to the device, use program (ERA-MultiMax equipment).

Protocol name – protocol file name which will be recorded in the device.

First source electrode – first source electrode index. It is input if the source and the receiver cables are commutated. If a number of source and receiver electrodes is different, it is necessary to input the receiver electrode index corresponding to the first source. **Using this option and different positions of source and receiver cables is not recommended because it may lead to a confusion and a loss of data.**

Subtab **Graphics**

Section **Show** options allow you to choose array types which will be displayed on a pseudosection or a contour plan. For example, reversed pole-dipole and dipole-dipole arrays are more convenient to analyze separately. This option also shows which array types exist in the protocol. If the program could not subsume the measurement into any type of arrays, it will be labelled as **Other** type.

Isospans – a way of a graph plan construction in which every graph corresponds to the certain pseudodepth (array factor).

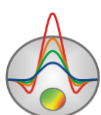
Isosources - a way of a graph plan construction in which every graph corresponds to the certain position of a source line.

Coincident isosources - a way of a graph plan construction in which every graph corresponds to the certain position of a source line. Thereat centres of graphs (source lines) are matched. This way of displaying is convenient to analyze spikes.

Isoreceivers - a way of a graph plan construction in which every graph corresponds to the certain position of a source line.

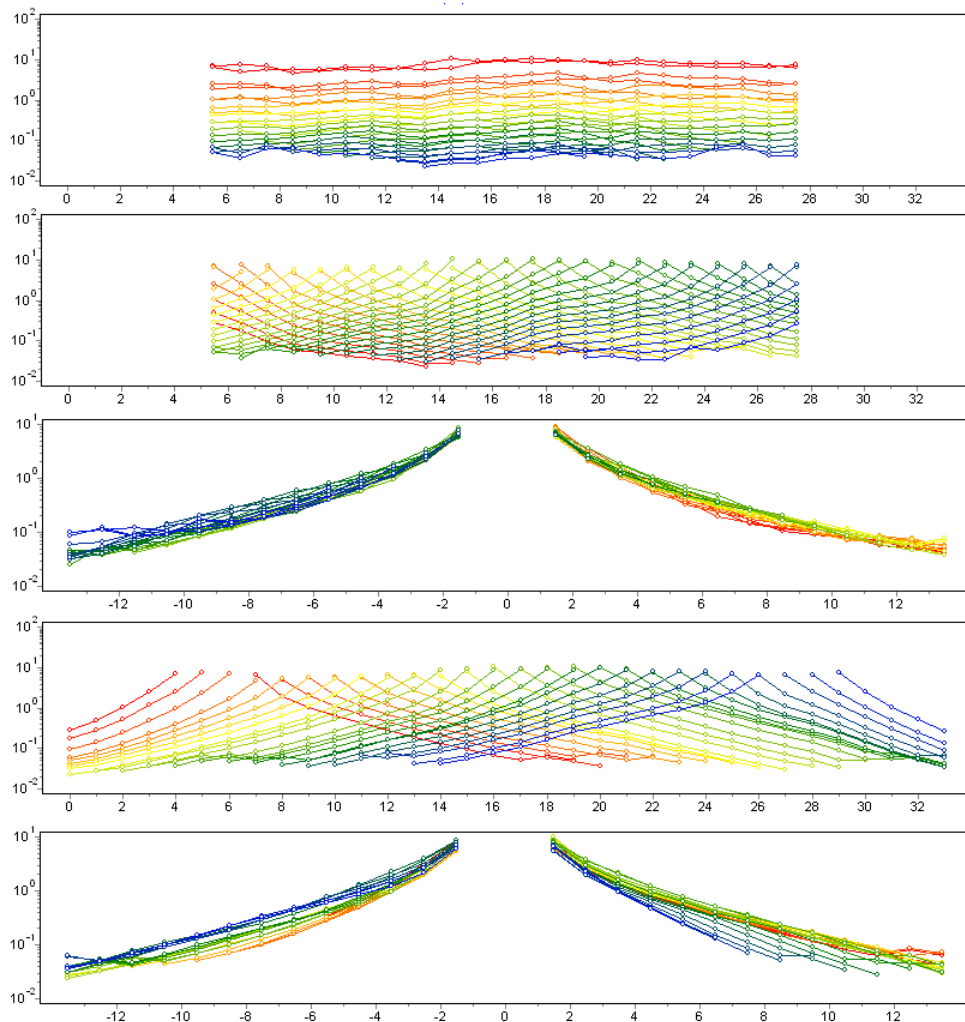
Coincident isoreceivers - a way of a graph plan construction in which every graph corresponds to the certain position of a source line. Thereat centres of graphs (source lines) are matched. Graphs are sounding curves. This way of displaying is convenient to analyze quality. This is the best way to analyze data for three-electrode array.

Normalize – the option is used when displaying graphs in a coincident isosources and coincident isoreceivers mode. Graphs are average level aligned. It is more convenient to select “jumped away points” because in reality graphs are often shifted relative to each other due to geological conditions.



In the picture below there are all the five variants of normalized signal displaying for reversed three-electrodes arrays. In the first picture (isospans) there are two graphs for every span – for a forward and a reverse array.

As you can see from the pictures, the spikes are recognizable the best on the combined graphs and the smoothest curves are for isosources.



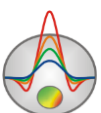
IP option – allows you to specify IP parameter – chargeability or time delay (unavailable for this type of equipment).

The pop-up list allows you to select the data type which will be displayed on the graph plan/pseudosection.

The following variants are available:

Synthetic values U/I – this image type is necessary only when creating the protocol to estimate the signal level in a graphic form.

Apparent resistivities – display data in a form of graphs or pseudosection of apparent resistivities.




Observed U/I – display data in a form of graphs or pseudosection of norm signal values. This is the most convenient data type to reveal spikes and defects because the data is divided by the signal level. It is better to use this type on the screen in the stage of processing and rejection.

Dispersions – display data in a form of graphs or pseudosection of measurement values. It allows you to select and remove bad quality measurements quickly.

Apparent polarizabilities – display data in a form of graphs or pseudosection of apparent polarizability. In the latest versions of the equipment by apparent polarizability it is meant frequency effect PFE.

MF - display data in a form of graphs or pseudosection of metal-factor, parameter which characterizes the ore degree for the object.

Voltage - display data in a form of graphs or pseudosection of voltage. This variant allows you to select measurements with very low (for example, lower than equipment sensitivity level) voltage quickly.

The  button – runs the graph plan setting dialog.

Display active profile – this option allows you to choose data displaying mode – the active profile or all the data (available for the protocol table and graph plan/pseudosection).

SubTab **Errors**

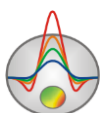
Section **Select** options specify which error types in the array assignment will be highlighted in red in the protocol table.















Section **Remeasurements** options set the criterion based on which the result of measurement will be considered as a defect (the row background is grey). It can be anomalous signal values, apparent resistivity or dispersion (low weight).

Section **Record in the interpretation file Zond** specifies which measurements will be recorded in the Zond file. **Not record errors** – measurements highlighted in red are not recorded in the file. **Record only displayed graphs** – only displayed graphs are recorded in the file. Not record selected – selected in the table measurements are not recorded in the file. **Reverse array** – invert electrode positions.

The program main window toolbar

Toolbar serves for the most frequently used program functions shortcut. It contains the following functional buttons (from left to right):

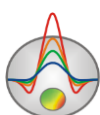


	Open a project file, a protocol file, a data file or a program ZondRes2d file.
	Run a saving dialog for a project file, a protocol file or a program ZondRes2d file.
	Display a measurement protocol in a form of observing system.
	Display data (of chosen type) for the current profile in a form of a pseudosection.
	Display data (of chosen type) for the current profile in a form of graphs plan.
	Redraw an observing system, a pseudosection or a graphs plan.
	Add a protocol created with a usage of the chosen array to the table (the measurements will correspond to the current profile).
	Replace a table by a protocol created with a usage of the chosen array (the measurements will correspond to the current profile).
	Protect the cable and protocol settings from accidental changes.
	Choose the current measurement profile. One profile (current) is usually used for 2D electrical tomography.
	Load the current protocol in the device. It must be sorted previously. Then connect the device to the computer, turn it on and set the number of COM port. It is available for Era-MultiMax and COMx64.
	Load the measured data from the device. Before using this option, it is necessary to connect the device to the computer, turn it on and set the number of COM port. Also, the project in which the measurement protocol was created is desired to be previously opened. Otherwise, it is better to use this option right after the program loading (without cable and protocol) with the cable interval previously set.
	Show electrode resistance. Unavailable for the certain types of equipment. Available for Era-MultiMax and COMx64.
	Open synthetic or observed data (if it exists) in the ZondRes program.

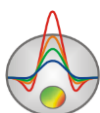
The program main window functions menu

Names of menu items and their assignment are listed below:

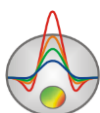
File/Open	Open a project file, a protocol file, a data file or a program
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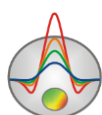
	ZondRes2d file.
File/Recent	Open one of recently opened files.
File/Add to project	Add data from another project to the current one. If profile segments are stored in different project files (it is more convenient to process them this way), it is necessary to unit them before interpretation or in advance. To do this, the second layout is added to the first, then the third and so on. Before adding the program requires the offset interval between the current layout and the first. When projects are combined, it is convenient to input topography and control repeated measurements, if cables have an overlay.
File/Second set	The option is used when you need to compare data received for the same protocol (adjoining layouts, parallel profiles, data received with different equipment). Comparison is made in a graph mode. Thereat graph from the second set is added to every current graph. You can as well use the Two data sets option where pseudosections for every set and pseudosections of misfits between them are displayed.
File/Save	Run a project file, a protocol file or a program ZondRes2d file saving dialog. Always save project file after creating protocol of measurements.
File/Import topography	Open file with measurement profile topography. The file contains altitudes (in meters, positive) for every electrode. A number and an order of recordings in the file must correspond to a number and an order of electrodes in the project.
File/Edit	Open used data file in Notepad.
File/Close	Close the current project.
File/Print	Run print dialog.
File/Registration file	Create registration file necessary to get a unique password.
File/Registration	Input the password to get a full version.
File/Quit	Quit the program.
Cable/Add electrode	Add new electrode.
Cable/Remove electrode	Remove active electrode.
Cable/Create automatically	Create cable automatically.



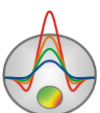
Cable/Set the profile	Select the current measurement profile.
Protocol/Add measurement to protocol	Add a measurement. A measurement is added from the current position in the protocol table. In the majority of cases there is no necessity in this option because the protocol can be created automatically.
Protocol/remove measurement from protocol	Remove a measurement. The measurement selected in the protocol table is removed. It is better to use Remove selected option.
Protocol/Add array to protocol	Add measurements automatically created for the selected array type to the protocol. The current array is that which tab is active.
Protocol/Sort protocol	Sort protocol by source and receiver electrode positions. Use this option before uploading data in the device.
Protocol/Pin protocol	Protect cable and protocol settings from accidental changes.
Protocol/Remove errors from the protocol	Remove measurements which do not correspond to the error criterion described in the settings/errors/select section from the protocol.
Protocol/Highlight errors	Highlight in colour measurements corresponding to the error criterion.
Protocol/Add reverse measurements	Append additional measurements corresponding to the reversibility principle, i.e. substitution of the source and the receiver electrode positions. Reverse measurements allow you to estimate the data quality objectively but two times increase the overall registration time. It is used only for four- or two-electrodes arrays.
Protocol/Set repetitive measurements	Select a chunk of data corresponding to the criterion set in the settings/errors/remeasurements section for repetitive measurements or removal.
Protocol/Highlight measurements	The option serves to highlight special points in the graphs. <i>Selected</i> – bullets in the graphs will be for selected (checkbox in the Measure column) measurements. <i>Non-selected</i> – bullets in the graphs will be for non-selected (checkbox in the Measure column) measurements. <i>Remeasurements</i> – bullets in the graphs will be for rows highlighted in dark grey.
Options/Transform into	Transform a protocol contains reverse three-electrode arrays into



symmetric	symmetric array.
Options/Sum up span with following	Sum up measurements for the selected span with the following (adjacent to receiver line). On the distant spans data quality usually falls so in some cases it is helpful to sum the last two spans up in one. This operation smooths the data but, when using it, the resolution falls.
Options/Remove selected measurements	Remove all the selected in the Measure column measurements from the protocol.
Options/Remove selected IP	Remove all the selected in the Measure column apparent polarizability values from the protocol. The measurement itself is not removed.
Options/Remove hidden graphs	Remove all the measurements which is not displayed in the graphs plan from the protocol. For example, for isospans you can hide graphs of the last spans, if they are very noisy. To hide graphs, the legend in the left part of section is used.
Options/Observing scheme	Display a measurement protocol in a form of observing system. Measurement point radius determines size of a receiver line, colour shows whether it is selected in the table.
Options/Pseudosection	Display data (of selected type) for the current profile in a form of pseudosection.
Options/Graphs	Display data (of selected type) for the current profile in a form of graphs.
Options/Reverse three-electrode	Run the window of separated displaying of reverse three-electrode array pseudosections and their difference pseudosection*. Difference pseudosection determines the degree to which the section differs from horizontally-stratified.
Options/Reverse dipole-dipole	Run the window of separated displaying of reverse dipole-dipole array pseudosections and their difference pseudosection. If measurements are reversible, the misfit values between reversed arrays equal to zero. This is a good criterion of measurements quality control.
Options/Two data sets	Display pseudosections of two data sets and a pseudosection of the misfit between them. The option is used when it is necessary to compare data received for the same protocol (adjoining

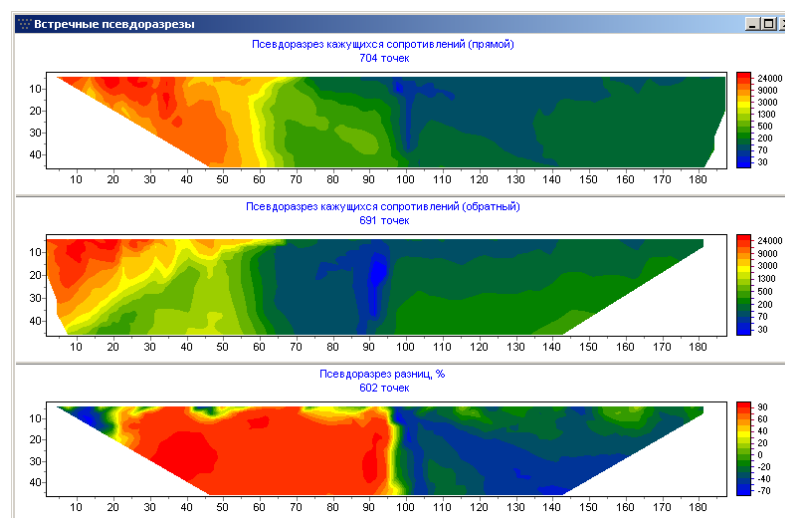


	layouts, parallel profiles, data received with different equipment). **
Options/transformants (Schlumb. and D)	The option is used only when operating with reversed three-electrode arrays. The first section is a pseudosection of measurements transformed into symmetric array. The second is a pseudosection of measurements transformed into D-array. (two positive source electrodes). The first pseudosection contains horizontally-stratified section mode, the second stresses local inhomogeneities. ***
Options/Select P-effect	Select measurements (spikes) far different from the average norm signal curve for coincident isosources. If the value of norm signal is different from the average curve more than the set threshold (in decimal logarithm units), the measurement is selected.
Options/Select C-effect	Select measurements (spikes) far different from the average norm signal curve for coincident isoreceivers. If the value of norm signal is different from the average curve more than the set threshold (in decimal logarithm units), the measurement is selected.
Options/Average reversible measurements	Average reversible measurements values.
Options/Average span error	Run the window which shows distribution of measurement errors depending on a span. The measurement error is calculated based on the reversibility principle for four-electrode and some combinations of three-electrode arrays.
Options/Average electrode error	Run the window which shows distribution of measurement from electrode. The measurement error is calculated based on the reversibility principle for four-electrode and some combinations of three-electrode arrays. The option allows you to find the broken electrode quickly.
Options/Average measurement error	Run the window which shows distribution of measurement depending on a measurement number. The measurement error is calculated based on the reversibility principle for four-electrode and some combinations of three-electrode arrays. Clicking the left mouse button on the error column chooses the current

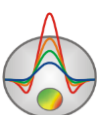


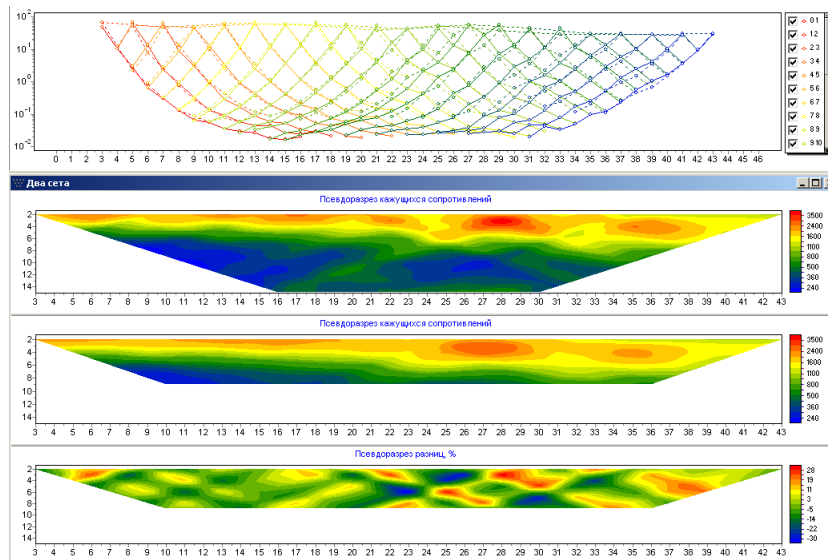
	measurement, right-clicking highlight the current measurement. Different measurements taking part in error calculations are highlighted in different colours. ****
Options/Average electrode dispersion	Run the window which shows distribution of measurement depending on an electrode. The measurement error is calculated based on measurements weights. The option allows you to find the broken electrode quickly.
Options/Parameter histogram	Show active parameter histogram. Histogram allows you to determine the parameter range of variation and separate anomalously high and low values.
Options/Show SP	Available for SysCal and ABEM.
Options/Export to ZondIP1D	Run the dialog of data export to the ZondIP1d format for 1D interpretation.
Options/Open in ZondRes	Open synthetic or observed data (if they exist) in ZondRes2d program.

* In the reversible pseudosections window the data for forward and reverse arrays are displayed in the first and the second sections and their difference is in the third one.

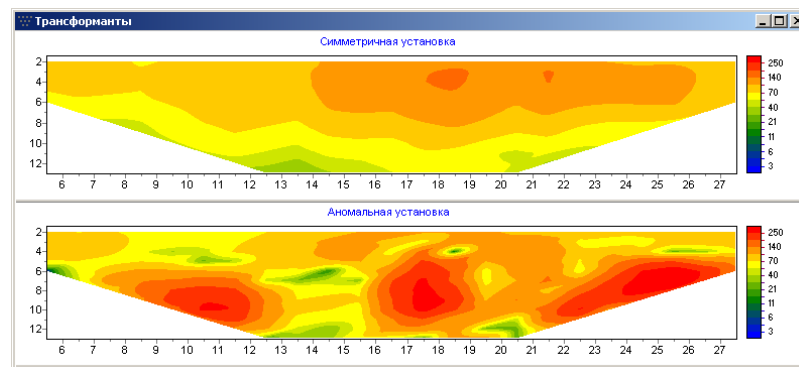


** In the **Two data sets** pseudosections for the first and the second data sets are displayed in the first and the second sections and their difference is in the third section. In the top part the graphs for both sets are displayed simultaneously.



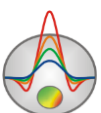


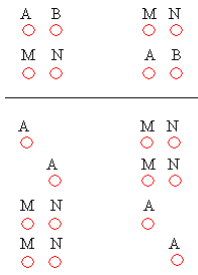
*** Transformants. The first section performs a measurement pseudosection transformed into symmetric array. The second one is a measurement pseudosection transformed into D-array (two positive source electrodes). The first pseudosection contains horizontally-stratified section mode, the second stresses local inhomogeneities.




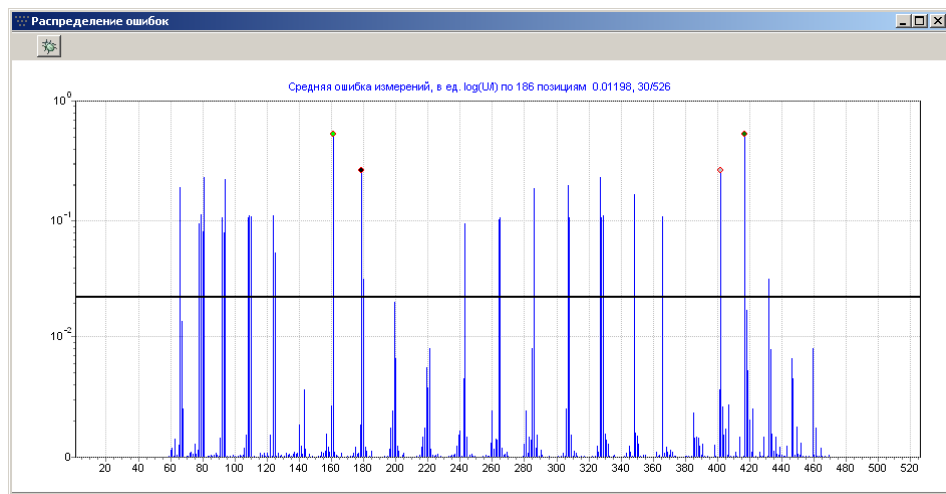
**** The fairly objective criterion which allows you to evaluate the quality of the data is the reversibility principle. The reversibility principle consists in permanence of the potential value when the source and the receiver positions are changed.

For systems with two-electrodes or dipole-dipole array the difference between reversible measurements can be used as the evaluation criterion. Three-electrode array must be transformed into dipole-dipole previously. To do this, you need two measurements of the forward array and two of the reverse array. When using this algorithm, you can calculate errors for every measurement, span or cable electrode and reject data.

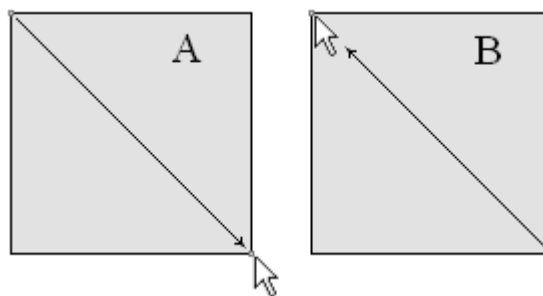




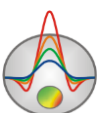
In the errors distribution window you can set the maximum error level (in the decimal logarithm units) (using slider). Measurements with the error value higher than the set level are selected with the  button. Then selected measurements can be analyzed and removed.



Zooming in or dragging some part is performed with pressed button (“rubber rectangular” tool). To zoom in a segment, move mouse cursor down and to the right with left button pressed (A). To return to primary scale, do the same but with mouse cursor moving up and to the left (B).



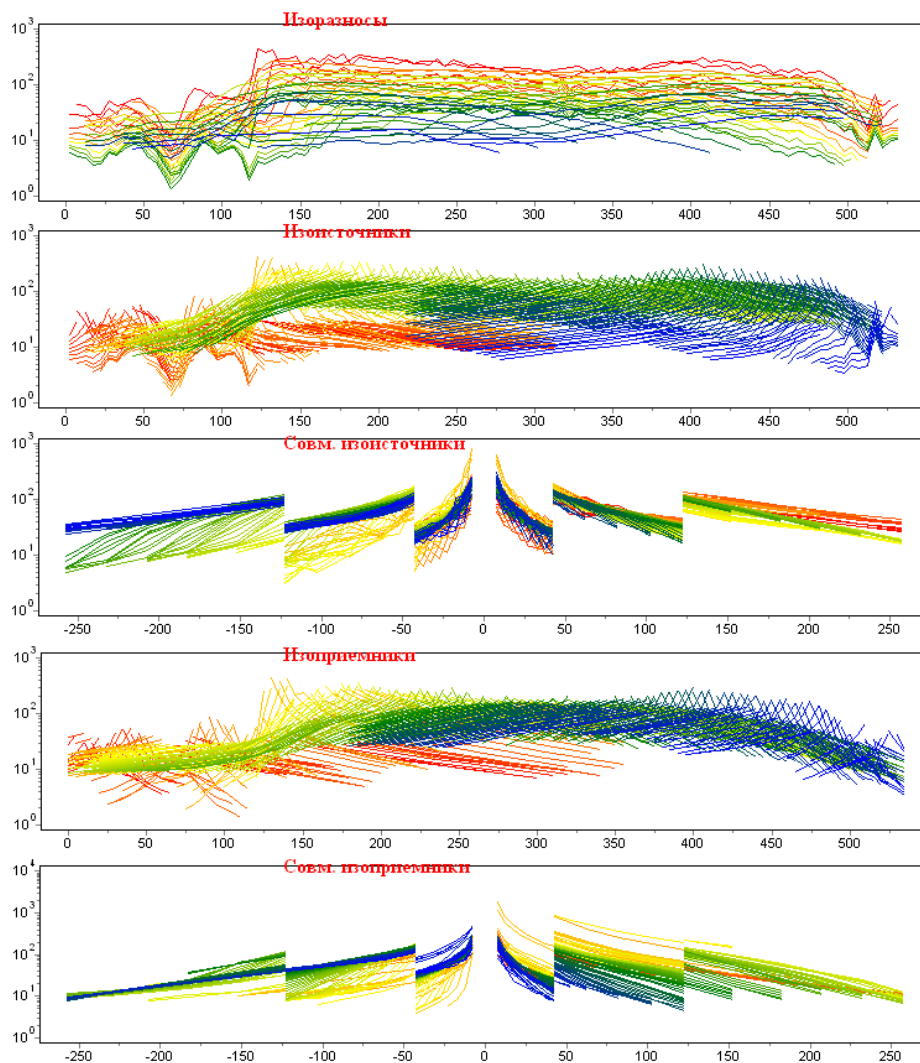
Pressing the left mouse button on the error column selects the current measurement, right-click highlights the current measurement in the table. Different measurements taking part in error calculations based on the reversibility principle are highlighted in different colours (from 2 to 6).



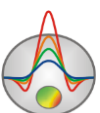
Graphs plan

Graphs plan serves to display apparent resistivity values along the profile in a form of graphs.

In the **settings/graphic** tab you can choose a way of graph construction or by a certain pseudodepth – isospans depending on the array factor, by a certain position of a source line – isosources, or by a certain position of a receiver line – isoreceivers. For protocols with changing MN line the isosources and isoreceivers graphs are displayed as separated segments.

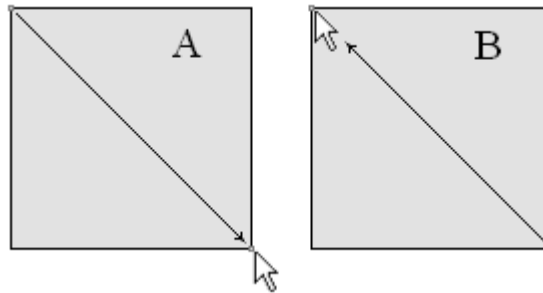


Operating with graphs plan is performed using mouse: zooming a certain segment in or its moving is done with a pressed mouse button. To select the segment which you want to zoom in, move mouse cursor down and to the right with left button pressed. To return to primary scale, do the same but with mouse cursor moving up and to the left.

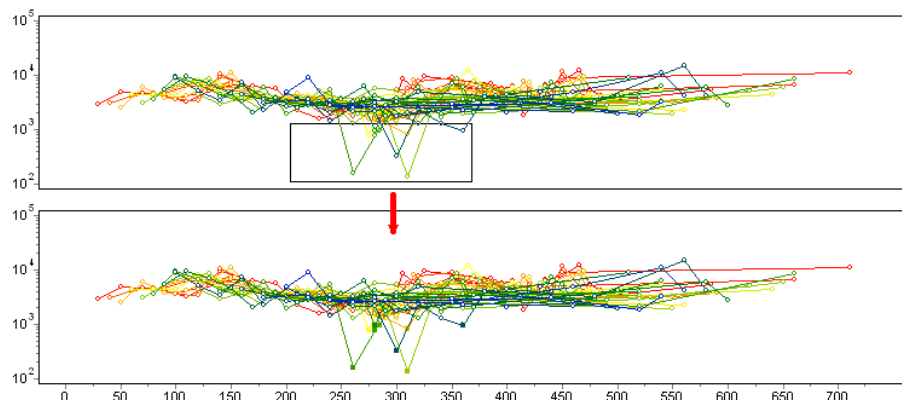


When the left mouse button is pressed on the point of the graph, the following operations perform: the rest of graphs are hidden and the electrode positions for the active point are displayed (until the mouse button is up).


Zooming in or dragging some part is performed with pressed button (“rubber rectangular” tool). To select the segment which you want to zoom in, move mouse cursor down and to the right with left button pressed (A). To return to primary scale, do the same but with mouse cursor moving up and to the left (B).



If selecting is performed with CTRL pressed, the measurements in the rectangular area will be selected in the table.

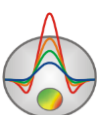


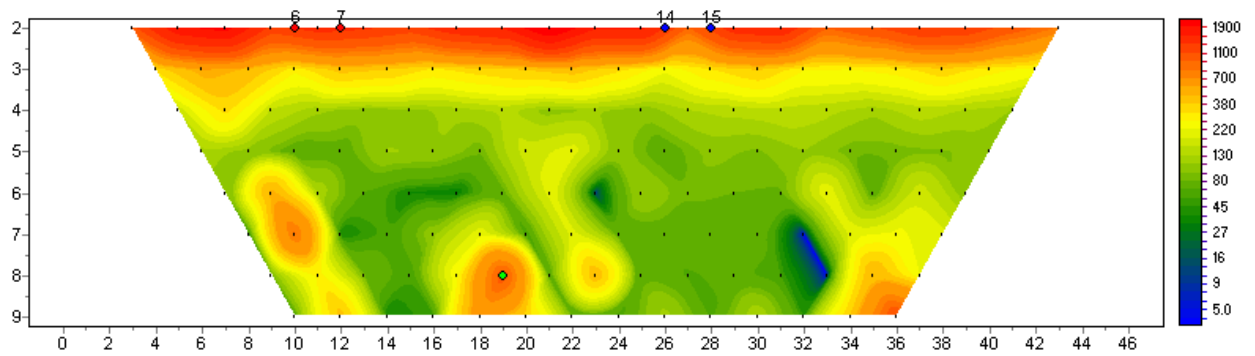
Selection of one and also removing all the rest of the graphs is performed with mouse button on the legend and SHIFT pressed. If you press the button again, the inverse operation is performed. To scroll the graphs, use the mouse wheel. To do this, it is necessary to select several adjoining graphs (in the legend) and scroll the mouse wheel hovering the cursor on the legend. Active graphs indexes will be changing. When pressing the right mouse button on the graph point, the measurement will be selected in the table.

Graph setting dialog runs when pressing the  button.

Pseudosection

Pseudosection serves to display various parameters values along the profile in a form of contours.





Left mouse button clicking on a pseudosection point selects this measurement in the table. When clicking again, the cursor goes to the next measurement which have the same position in the pseudosection. Right mouse button clicking marks the measurement on the pseudosection.

Construction is performed in measurement profile coordinate and span axes. Colour scale sets a relation between the displayed value and the colour.

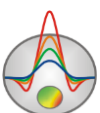
Double click on the axes area runs the context menu with the following options:

Log data scale	Use logarithmic scale for the colour bar.
Display grid point	Mark points of measurements.
Display ColorBar	Show colour bar.
Setup	Run pseudosection parameters setting dialog.
Print preview	Print pseudosection.
Save picture	Save pseudosection in the image file.
Save XYZ file	Save pseudosection in Surfer format.
Default	Set pseudosection parameters as default.

Zooming in or dragging some part is performed with pressed button (“rubber rectangular” tool). To select the segment which you want to zoom in, move mouse cursor down and to the right with left button pressed. To return to primary scale, do the same but with mouse cursor moving up and to the left.

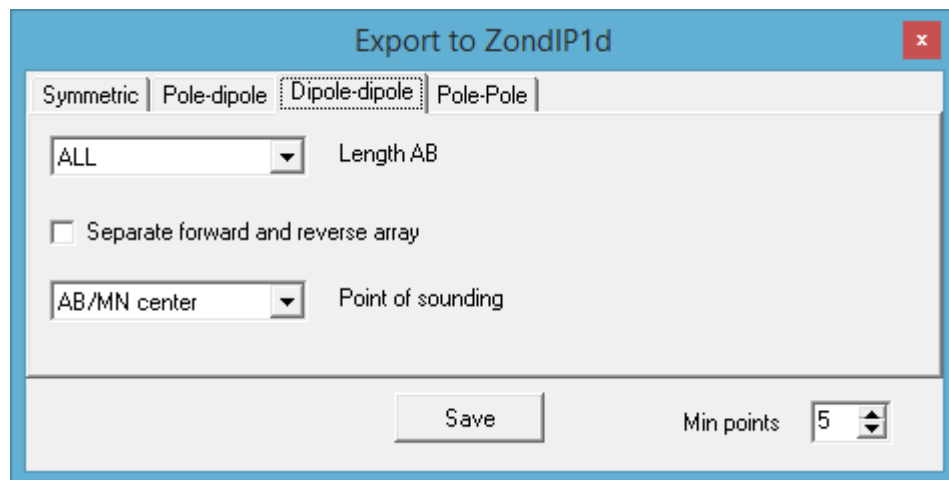
The way of the pseudosection constructing is different for different arrays. Pseudosection points positions correspond:

1. for Wenner array along X axis – to the centre of the array, along Y axis – to $\frac{1}{4}$ of the span from the outermost electrode to the array centre;
2. for pole-dipole array along X axis – to the centre between receiver electrodes, along Y axis – to the span from the source electrode to the centre between receiver electrodes;
3. for dipole-dipole array along X axis – to the centre of the array, along Y axis – to the $\frac{1}{2}$ of the distance between centres of dipoles (receiver and source electrodes);



4. for gradient array along X axis – to the centre between receiver electrodes, along Y axis – to $\frac{1}{2}$ of the span from the nearest source electrode to the centre between receiver electrodes;
5. for two-electrodes array along the X axis – to the centre of the array, along Y axis – to the centre of the array.
6. for VES array along X axis – to the centre of the array, along Y axis – to $\frac{1}{4}$ of the span between the outermost electrodes.

Data export to ZondIP1d



Data export is performed by choosing the corresponding tab of dialog for three types of arrays: symmetric (Schlumberger, Wenner), three-electrode and dipole-dipole. Dialog options allow you to choose how VES curves will be constructed.

Tab symmetrical

The **change AB↔MN** option changes receiver and source electrodes positions.

Tab Pole-Dipole

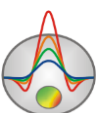
Transform into four-electrode – transforms two reverse three-electrode arrays into classical four-electrode VES array. Profile coordinate of the VES curve is the receiver line centre position.

Forward and reverse arrays – measurements of forward and reverse arrays – separated VES curves. Profile coordinate of the VES curve is the source electrode position.

Bottom measurements – activate if the measurements were at the bottom of a basin.

Tab Dipole-Dipole

AB length option – set the length of the source dipole from the list (if there are several of them).

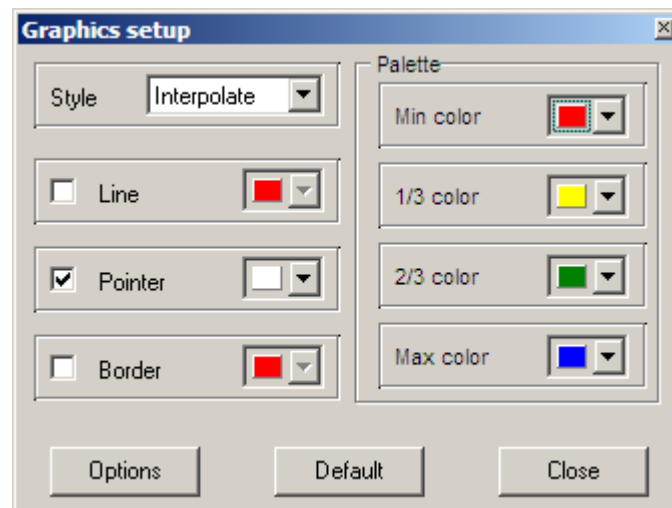


Separate forward and reverse motion – creates two VES curves for the forward and reverse arrays.

For MN position option – plots VES curve for every MN position in other words for every position of the source line.

Sounding site option – set the characteristic which is a sounding site.

Graphs set editor



Graphics set editor serves to set the colour sequence of the graphs set. You can run the editor through the main menu .

The **Style** option defines the algorithm of graph colour palette specification.

If **Interpolate** is selected, the interpolated palette is used which is created using colours specified in fields **min colour**, **1/3 colour**, **2/3 colour** and **max colour**. The **const** value sets the same colour (**colour** option) for all the graphs. The **random** value sets random colours for all the graphs.

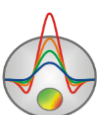
The **Line** option sets colour for graph connecting lines. If this function is deactivated, palette colour is used otherwise specified in **Line** field colour is used.

The **Pointer** option sets colour for graph pointer colour fill. If this function is deactivated, palette colour is used otherwise specified in **Pointer** field colour is used.

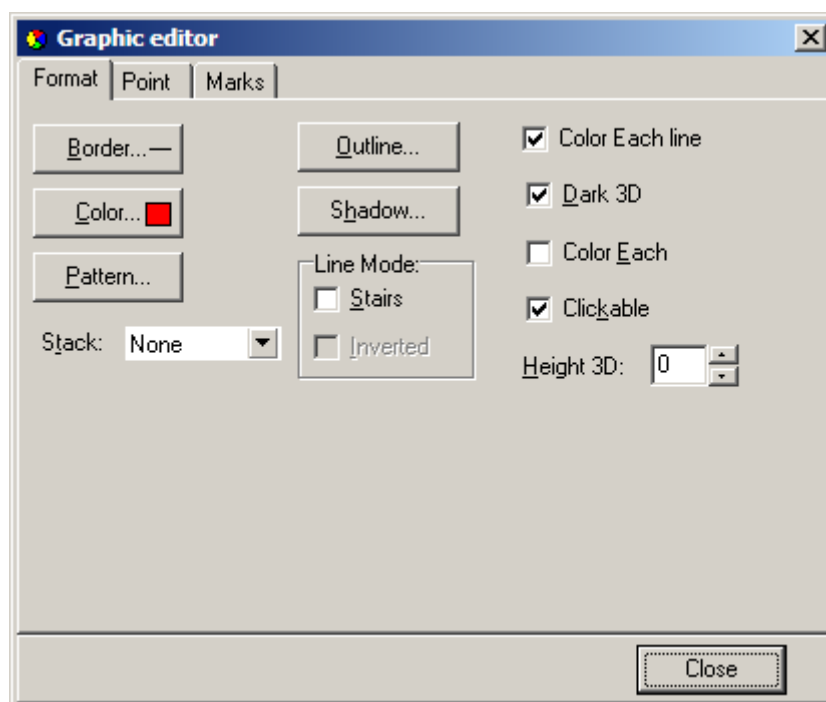
The **Border** option sets graph pointer outline color. If this function is deactivated, palette colour is used otherwise specified in **Border** field colour is used.

The **Options** button runs graph setting dialog.

The **Default** button returns graph default settings.



Graph editor



Editor serves to set the appearance of the graph. It can be run by right-clicking with SHIFT pressed on the graph.

The **Format** tab contains settings of connecting lines.

The **Border** button runs connecting lines parameters setting dialog.

The **Colour** button runs colour selecting dialog.

The **Pattern** button runs filling parameters setting dialog.

The **Outline** button runs setting dialog for outline parameters of connecting lines.

The **Shadow** button runs shadow appearance setting dialog.

The **Point** tab contains settings of graph pointers.

The **Visible** option allows you to show/hide graph pointers.

The **Style** option sets shape of the pointer.

The **Width** option sets width of the pointer in screen units.

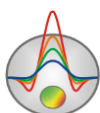
The **Height** option sets height of the pointer in screen units.

The **Inflate margins** option determines whether the image size will increase in accordance with the pointer size.

The **Pattern** button runs filling parameters setting dialog.

The **Border** button runs pointer outline parameters setup dialog.

The **Gradient** button runs gradient filling parameters dialog for the pointer.



The **Marks** tab contains graphic pointer labels settings.

The **Style** tab.

The **Visible** option allows you to show/hide graphic pointer labels.

The **Draw every** option allows you to draw every second, third and so on label depending on the selected value.

The **Angle** option determines the pointer label rotation angle.

The **Clipped** option determines whether pointer label is drawn if it is beyond graphic borders.

The **Arrows** tab allows you to set appearance of the arrow from the label to the point.

The **Border** button runs arrow line parameters setting dialog.

The **Pointer** button runs arrowhead shape setting dialog (options in the Point tab).

The **Length** option sets the arrow length.

The **Distance** option sets the distance between the arrowhead and the graph pointer.

The **Arrow head** option determines appearance of arrowhead. **None** – arrowhead set by the **Pointer** button is used. **Line** – classic thin arrowhead is used. **Solid** - classic thick arrowhead is used.

The **Size** option sets arrowhead size, if classic arrow is used.

The **Format** tab contains graphic settings for the frame of the pointer label.

The **Colour** button runs frame background colour selection dialog.

The **Frame** button runs frame line setting dialog.

The **Pattern** button runs background parameters setting dialog.

The **Bevel** option sets frame style: usual, elevated or submerged.

The **Size** option sets elevation or submergence level.

The **Transparent** and **Transparency** options set frame transparency degree.

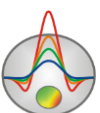
The **Text** tab:

The **Font** button runs pointer labels font setting dialog.

The **Outline** button runs pointer label letter outline setting dialog.

The **Inter-char spacing** option sets letter spacing for pointer label text.

The **Gradient** button runs label text gradient filling setting dialog.



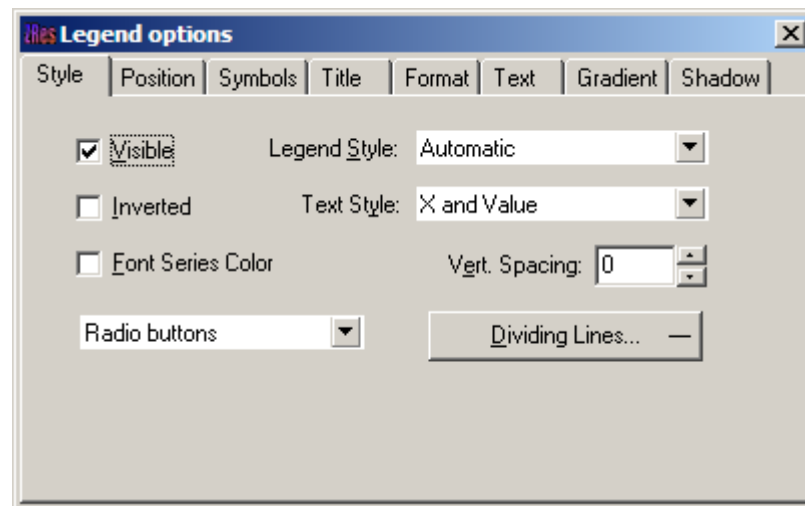
The **Outline gradient** option specifies where gradient filling is used in outline or interior of letters.

The **Shadow** button runs label text shadow setting dialog.

The **Gradient** tab contains gradient filling settings for the frames around labels.

The **Shadow** tab contains shadow settings of the frames around labels.

Graph legend editor



Editor is intended to set the appearance of graphs and legend. It can be run by right-clicking with SHIFT PRESSED on the legend on the right to the graph.

Thereat the pop-up menu with a set of tabs appears.

The **Style** tab allows you to set the style of the legend display, choose data label format and show boundaries between legend labels etc.

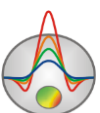
The **Position** tab allows you to choose legend position relative to graphics plan.

The **Symbols** tab sets legend symbols display parameters.

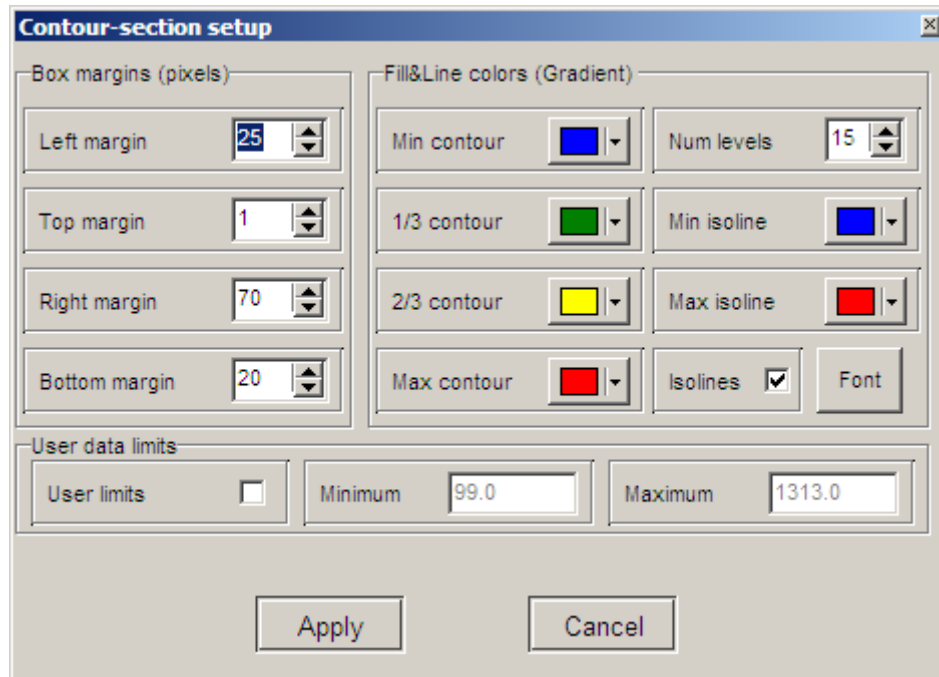
The **Title** tab specifies legend title and allows you to set its format.

The **Text** tab allows you to set legend label format.

The **Format**, **Gradient** and **Shadow** tabs contain settings of legend window, its gradient fill, and shadow.



Pseudosection parameters setting dialog



Dialog serves to set pseudosection parameters setting.

The **Box margins** section

Left margin – sets image margin (in pixels) from window left edge.

Right margin – sets image margin (in pixels) from window right edge.

Top margin – sets image margin (in pixels) from window top edge.

Bottom margin – sets image margin (in pixels) from window bottom edge.

The **Fill&Line colours** option

The **Min contour**, **1/3 contour**, **2/3 contour** and **Max contour** options set an interpolated colour sequence from **Min contour** to **Max contour** through **1/3 contour** and **2/3 contour**. Palette created so is used to fill the space between adjoining contours.

The **Num levels** field – determines a number of contour intervals. Contour intervals are set with even linear or logarithmic interval depending on the data type.

The **Min isoline** and **Max isoline** options set the interpolation colour sequence from **Min isoline** to **Max isoline**. Palette created so is used when plotting contours.

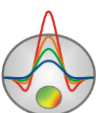
The **Isolines** option – tells the program whether to draw contours.

The **User data limits** section

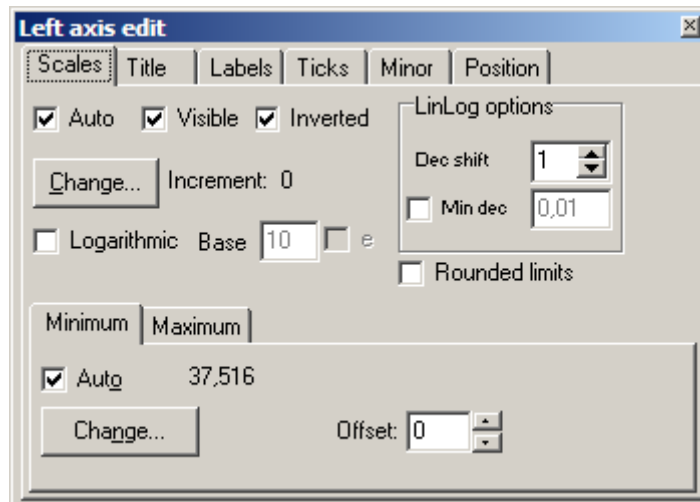
The **User limits** option – indicates to use whether the minimum and maximum data values or use values of **Minimum** and **Maximum** fields when setting the contour interval.

The **Minimum** field – sets minimum value when specifying contour interval.

The **Maximum** field – sets maximum value when specifying contour interval.



Axes editor



Axes editor is intended to set graphic and scale axes parameters. Right-click on desirable axis with SHIFT pressed will run it. Thereat, the pop-up menu with two items **options** and **defaults** appears. The first one runs dialog, the second one sets values equal to the default.

The first dialog tab **Scales** contains scale axis parameters setting options.

The **Auto** option tells the program how to determine axis minimum and maximum. If this option is activated, the limits are found automatically, otherwise they are set in Minimum and Maximum sections.

The **Visible** option allows you to show/hide the chosen axis.

The **Inverted** option determines axis orientation.

The **Increment change** button runs the dialog of axis tick interval setting.

The **Logarithmic** option sets axis scale – logarithmic or linear. In case the axis is alternating, you can additionally use **LinLog options** section options.

The **Base** option determines the logarithm base for a logarithmic axis.

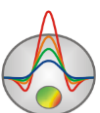
The **LinLog options** section contains options intended to set a linear-logarithmic axis. Linear-logarithmic scale allows you to present alternating or zero containing data in logarithmic scale.

The **Dec Shift** option sets the shift (in logarithmic decades) relative to the maximum axis modulo to the zero. Minimum (prezero) decade has linear scale, the rest of decades have logarithmic.

The **Min dec** option sets and fixes the minimum (prezero) decade value, if the option is activated.

The **Rounded limits** option tells the program whether to round minimum and maximum axis values.

The **Minimum** and **Maximum** fields contain set of options for axis limits setting.



The **Auto** option determines how the axis limit is defined automatically or using the **Change** button.

Option **Offset** sets a percentage axis limit shift relative to its actual value.

The **Title** tab contains options for axis title setting.

The **Style** tab:

The **Title** option defines the axis title text.

The **Angle** option defines the axis title text rotation angle.

The **Size** option defines the axis title text shift. If 0 is set, the shift will be selected automatically.

The **Visible** option allows you to show/hide axis title.

The **Text** tab:

The **Font** button runs the font setting dialog for axis title.

The **Outline** button runs outline setting dialog for axis title letters.

The **Inter-char spacing** option sets letter spacing for axis title text.

The **Gradient** button runs gradient filling setting dialog for axis title text.

The **Outline gradient** option defines where to apply gradient text filling, to the outlines or to the letter interior.

The **Shadow** button runs shadow appearance setting dialog for axis title text.

The **Labels** tab contains options for axis labels setting.

The **Style** tab:

The **Visible** option allows you to show/hide axis labels.

The **Multiline** option is used to set multiline axis labels.

The **Round first** option rounds the first axis label.

The **Label on axis** option removes labels which are beyond axis limits.

The **Alternate** option arranges axis labels in two lines.

The **Size** option determines axis labels shift. If 0 is set, the shift will be selected automatically.

The **Angle** option determines axis labels rotation angle.

The **Min separation %** option sets the minimum percentage labels spacing.

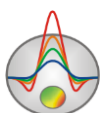
The **Text** tab:

The **Font** button runs axis labels font setting dialog.

The **Outline** button runs outline setting dialog for axis labels letters.

The **Inter-char spacing** option sets letter spacing for axis labels text.

The **Gradient** button runs gradient filling setting dialog for axis labels text.



The **Outline gradient** option defines where to apply gradient text filling, to the outlines or to the letter interior.

The **Shadow** button runs shadow appearance setting dialog for axis labels text.

The **Ticks** tab contains options for axis major ticks setting.

The **Axis** button runs axis line setting dialog.

The **Grid** button runs setting dialog for axis major tick grid lines.

The **Ticks** button runs setting dialog for axis major tick outer lines. The **Len** option sets its length.

The **Inner** button runs setting dialog for axis major tick inner lines. The **Len** option sets its length.

The **Centered** option – centres axis ticks grid.

The **At labels only** option tells program to draw the major ticks only if axis labels exist.

The **Minor** tab contains options for axis minor ticks setting.

The **Grid** button runs setting dialog for axis minor tick grid lines.

The **Ticks** button runs setting dialog for axis minor tick outer lines. The **Length** option sets its length.

The **Minor** button runs setting dialog for axis minor tick inner lines. The **Len** option sets its length.

The **Count** option sets a number of minor ticks between major.

The **Position** tab contains options which define axis size and position.

The **Position %** option sets axis shift relative to its standard position on graph (in percent of graph size or in screen units depending on value selected by Units option).

The **Start %** option sets axis start shift relative to its standard position on graph (in percent of graph size).

The **End %** option sets axis end shift relative to its standard position on graph (in percent of graph size).

