

Research and Production Company

Sib Geofiz Pribor

**SGD-EEM «MEDUSA»
GEOELECTRICAL MULTIFUNCTION
RECEIVER**

**Version V2.2
OPERATIONS MANUAL**

2012

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1. PRODUCT OVERVIEW

1.1. Introduction

1.1.1. The geoelectrical receiver SGD-EEM «MEDUSA» SGFP 121.00.00-05 version V2.2 (hereinafter receiver) is designed to measure values of the electric potential and current for slowly varying signals, as well as to measure the amplitude and phase characteristics of the harmonic components of the periodic signal. It can also control an external switching device for tomographic surveys.

1.1.2. Application area is geophysical exploration by methods of direct current, electrical resistivity, induced polarization, self potential, stray currents, frequency sounding.

1.1.3. The geoelectrical receiver SGD-EEM «MEDUSA» **should not be subjected obligatory certification** according to Government Resolution of the Russian Federation dated December 1, 2009 N 982 "About approval of the single list of products subjected to obligatory certification, and a single list of products, which conformity assessment takes the form of acceptance of the declaration of conformity".





Picture. 1. The geoelectrical receiver **SGD-EEM «MEDUSA»**

1.2. Design and operation

1.2.1. The receiver is made in a metal case on the front panel of which are placed:

- 1) graphic display OLED-type with a resolution of 128x64 pixels;
- 2) controls;
- 3) sockets of receiver line MN and feed line AB.

There are two connectors on side face of box: «**POWER**» and «**USB**».

1.2.2. Graphic display is designed to show the settings menu and measured values, as well as to display saved results of measurement in nonvolatile memory.

1.2.3. Controls of the meter are presented by six button:

ON/OFF - switch on/off the receiver;

START/STOP - enter to mode of measurement, start/stop measurement;

MEMORY - save the results of measurement in nonvolatile memory in the measuring mode and switch to view saved measurements in menu mode ;

ENTER - enter to the submenu, enter to the parameter edit mode of the menu item, exit the parameter edit mode of menu item with saving of its new value;

ESC - exit out of the submenu, exit the parameter edit mode of menu item without saving of its new value, exit out of the measuring mode, exit out of display mode of saved measurements;

▲ ▼ - navigating a menu items, making changes in the menu item.

Ω - enter and exit of resistance estimation mode for source of signal in receiver line or increase the order of changes making in editable numeric parameters;

I ON/OFF - switching current in feed line.

1.2.4. The receiver has two connectors. One connector, labeled «**POWER**», used to connect the receiver power. Another second connector, labeled «**USB**», used to connect the receiver to your computer, device of switching ABMN lines, source of external synchronization.

1.2.5. The receiver has two pairs of terminals for receiver line and transmitter line. A pair of blue terminals, labeled «**MN**», used to connect receiver line. Terminal **M** is plus and terminal **N** is minus for indication of positive voltage value. A pair of red terminals, labeled «**AB**», used to connect commutated part of transmitter line. Terminal **A** is plus and terminal **B** is minus for indication of positive current value.

1.2.6. The receiver has four basic operating modes:

- 1) menu mode;
- 2) measurement mode;
- 3) view mode of saved measurements;
- 4) PC connection mode.

1.2.7. In menu mode, on the instrument display is shown the menu of settings. These settings can be changed using the control buttons.

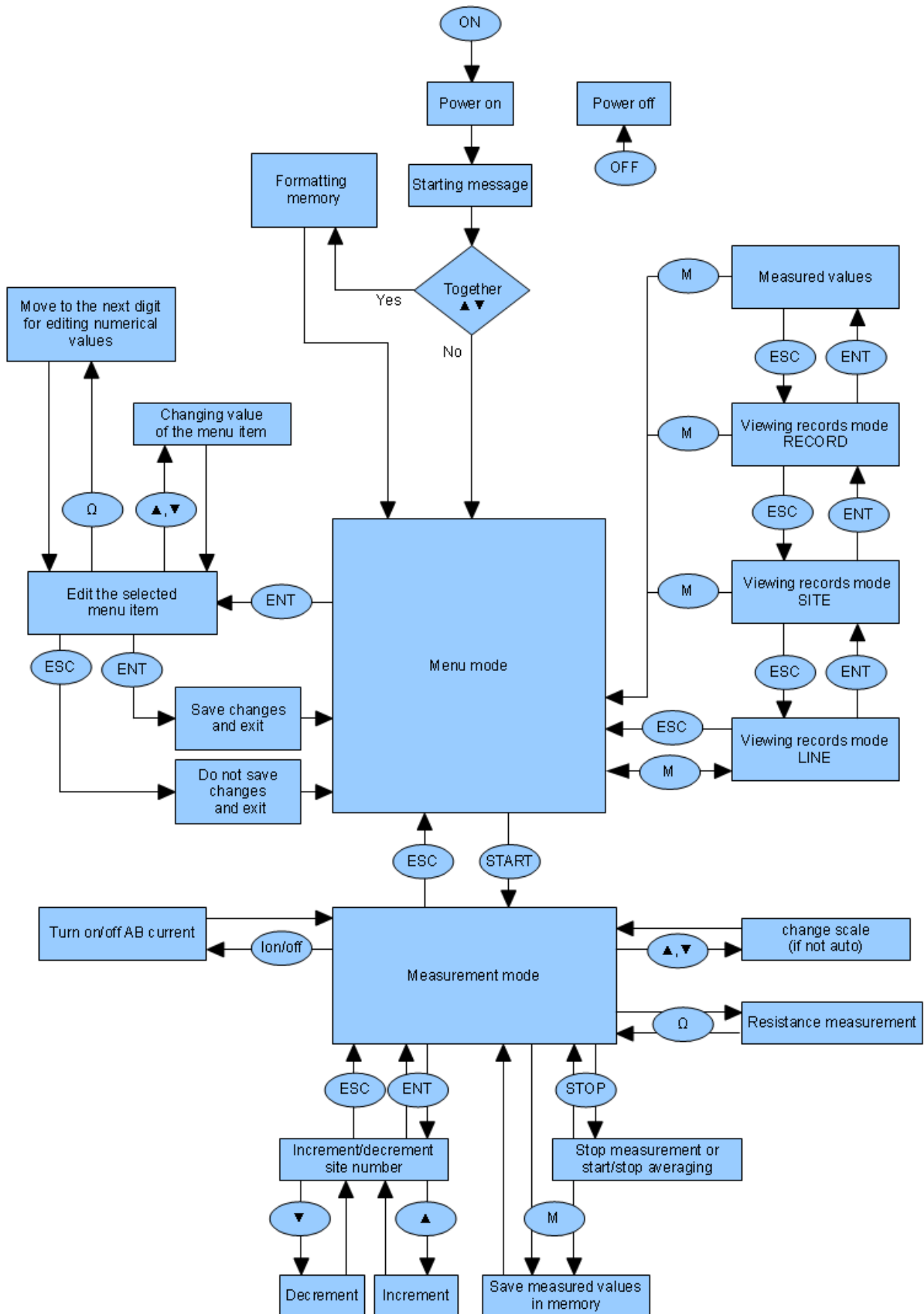
1.2.8. In the measurement mode, there is a continuous display of measured values. In addition, for direct current mode, value of current of transmitter is displayed.

The control of current commutation, measurement of source resistance and saving the measured values is performed using the corresponding buttons.

1.2.9. The structure of the data in view mode of saved measurements is as follows: lines → **sites** → **records** → **measured values**.

1.2.10. In PC connection mode the receiver becomes a slave and only responds to pressing ON/OFF button or termination the USB connection. The receiver enters this mode automatically when the usb connection is established.

1.2.11. Scheme of basic modes of operation.



1.3. Preparation for use

1.3.1. Inspect the receiver and make sure that there is no any mechanical damage.

1.3.2. Apply power to the connector "24V". The assignment of connector pins are shown below:

Description	Pin number
+12V	1
Ground	2
+12V	3
Ground	4

1.3.3. To connect the receiver to computer through usb interface, to device of switching ABMN lines through RS-232 interface, to source of external synchronization is used connector with label «USB». The assignment of connector pins are shown below:

Pin number	Description	USB wire color
1	RS232 «Tx»	
2	RS232 «Rx»	
3	USB D-	White
4	GND	Black
5	Synchronization	
6	USB D+	Green
7	USB +5V	Red

1.4. Operating procedure

1.4.1. Power on/off the transmitter is made by briefly pressing on the button «**ON/OFF**». Within seconds after the transmitter was turn on, the display shows a welcome message with the name of the manufacturer, the product name, version of hardware implementation and software products, the serial number of the product. It is displayed for three seconds, and then the device enters the menu mode.

If before the end of welcome message to press simultaneously the «**▲**» and «**▼**», the receiver will go into formatting nonvolatile memory mode.

The process of memory formatting is accompanied by displaying information about performed work. Once the formatting is done, the receiver switches to the menu mode. Memory formatting mode should be used only in case of damaging of data integrity, when further work with the receiver is impossible.

1.4.2. The menu consists of items of the two types. The first type includes an editable parameter, the second type contains a submenu. The first type is displayed as «**name of parameter**»+ «**value of parameter**». The second type is displayed as "**name of submenu**" + «...».

1.4.3. Navigating a menu items can be done by buttons «**▲**» и «**▼**». Selected menu item is marked on the display by sign «**▶**». Navigating to submenu or enter to parameter edit mode of the menu item is called by pressing button «**ENTER**». Exit of submenu is called by pressing button «**ESC**».

1.4.4. After enter to parameter edit mode of the menu item (button «**ENTER**»), the choice of required value is made by buttons «**▲**» and «**▼**».

To increase a step of change in numeric parameters ten times, press button Ω . Exit of the edit mode with saved the selected value is called by pressing the button «**ENTER**».

To exit of edit mode of the menu item without changes press button «**ESC**».

1.4.5. Settings menu includes following items:

Line	0000	- line number (from 0 to 9999);
Site	0000	- site number (from 0 to 9999);
Freq.	4.882 Hz	- frequency a measurement ;
General ...		- submenu of general settings;
Erase		- choose « YES » for memory erasing;
Date & Time ...		- submenu for date and time setting;
Main settings ...		- submenu of main settings;
Ext.Commutator ...		- settings submenu of commutator work;

Type **ComDD2** - type of commutator;

Mode. **Auto** - control mode of commutator;

Δ A1 **0.1%** - is necessary condition to save the result of the measurement automatically and to change electrodes (the degree of instability of the first harmonic);

Min. A1 **1 mV** - is necessary condition to save the result of the measurement automatically and to change electrodes (the minimum amplitude of the first harmonic);

A1/A340% - is necessary condition to save the result of the measurement automatically and to change electrodes (the degree of difference between the first and third harmonics);

Δ φ **0.1%** - is necessary condition to save the result of measurement automatically and to change electrodes (the degree of instability phase);

Gain **Auto** - a choice of gain in MN channel;

Umn form **V 7dig** - a choice of displaying the measured values;

IP phase **φ1** - a choice of measurement phase shift in harmonics;

Site ++ **+1** - a choice of value for autoincrement the site number after its value was saved (If zero, then do not perform);

Records **4** - number of records after which autoincrement of picket number will be done (If zero, then do not perform);

0Hz settings ... - settings submenu for direct current mode;

OffSet **Auto** - switch on/off autocompensation voltage, which is not related to the current.

LPF **Off** - switch on/off additional RC-filter on input MN;

AdaptLPF **On** - a choice of digital **LF filter** operating mode;

Scale **Auto** - a choice of scale to display;

StrayCur No - switch on/off measurement mode of stray currents.

1.4.6. In menu mode in the bottom string of display are shown current time and supply voltage. If the cursor is on the menu item «**Line**», then the bottom string shows the number of sites and records saved in the memory for this line. If the cursor is on the menu item «**Site**», then the bottom string shows the number of records saved in the memory for this site.

1.4.7. Transition to measurement mode is done by pressing button «**START**». Exit this mode is made by pressing button «**ESC**». In the measurement mode DC (0 Hz) at the top of the screen displays the voltage of MN in the form of a numerical value and a level. The bottom side of screen displays numeric value of current in **AB**, the actual number of site and the number of entries made in the site. In measurement mode with alternating current in the screen center are displayed amplitudes of 1st, 3th and 5th harmonics normalized to meander, and also a phase parameter if it is allowed. When using frequencies ranging from 4.88 Hz and above, in the lower left of the screen displays the amplitude of the 50Hz component of the signal receiving line (that includes not only industrial frequency but also some part of the 9,765Hz harmonic).

To stop measurement process and fixation of measured values and also to continue measurement process, press button «**START/STOP**». In AC mode stop the measurement does not occur, but starts continuous accumulation-averaging. When the receiver performs accumulation-averaging, the measured values are displayed with a vertical stripe. If measurement is done in automatic mode (stray currents or work with commutator), the button «**START/STOP**» starts and stops the automatic operation.

1.4.8. Pressing button «**Ω**» starts and stops the measurement of resistance of signal source **MN**, with its value displayed on the screen. This procedure has only evaluative, and is done through the measurement of the voltage difference for open and shunted input MN. If absolute values of input voltage were small, then measurement can not be executed and the screen displays the message «**???**».

1.4.9. Buttons «**ENT**», «**ESC**», «**▲**» and «**▼**» are used for easy change of site number in measurement mode.

1.4.10. In the measurement mode DC (0 Hz) when not using the automatic scaling voltage level, you can change the measuring range using the buttons «**▲**» and «**▼**».

1.4.11. In the measurement mode DC (0 Hz) switching on and off of the current is done with the button «**I ON/OFF**». When the current is switched on and autocompensation is permitted in the menu, the measured (displayed) MN voltage is compensated by the value of the last voltage MN with the current switched off.

1.4.12. Saving measured values in the form of a new record in this line and site performed by pressing «**MEMORY**».

1.4.13. Transition to display mode of results is performed from menu mode. To enter this mode press button «MEMORY». When you enter this mode, the screen displays all the lines stored in the memory. Selecting the required line is made by the buttons «▲» and «▼». To look at the contents of the selected line press the button «ENT». The contents of the line is presented as a list of its sites. After selecting a site (buttons «▲», «▼», «ENT»), you can go to list of records of the site, and then go to the contents of the recording. Return to the previous list is made by the button «ESC». To quickly return to the main menu from the viewing records mode press the button «MEMORY».

1.4.14. To read the stored data to a computer or a software update, you must connect the meter and a PC with a USB cable and run the appropriate program.

Previously on the computer must be installed device driver

1.5. Measurement modes

1.5.1. To use the methods of direct currents, it is necessary to select the frequency equal to 0 Hz in the settings menu. This mode allows you to measure the slowly varying voltage at the terminals of the **MN** and the current in the line **AB** continuously. In addition, the receiver in this mode allows you to turn on and off the current in the line **AB**, as well as perform automatic compensation of the current measured with the switched on current at voltage value **MN**, which was at the terminals **MN** when current was switched off. Transition to measurement mode is done by press button «**START**». Exit of this mode is done by press button «**ESC**». Current commutation in **AB** line is done by button «**I ON/OFF**».

The same measurement mode can be used for natural electrical field method.

1.5.2. To use the method of stray currents it is necessary to set the frequency of 0 Hz in the settings menu, and in «**0Hz settings... → StrayCur**» select «**Yes**». This mode allows you to measure the slowly varying voltage at the terminals of the **MN** continuously and stores it in the nonvolatile memory every 10 seconds for 10 minutes automatically. Total turns 60 records for the one site.

Transition to measurement mode is done by press button «**START**». Exit of this mode is done by press button «**ESC**». When enter to the measurement mode, automatic operation is stopped and the message «**stop**» on the display of the receiver indicates it. Start and stop of automatic measurement is done by pressing button «**START|STOP**». In this mode, the screen displays the number of pickets, a number of records in the picket, and number of records made during the current session. When all the 60 measurements in the automatic mode will be done, a beep sounds and the receiver switches to the main menu mode.

1.5.3. To use the method of alternating current it is necessary to set the frequency which is different from the frequency of 0 Hz. This mode allows you to measure the amplitude of the 1st, 3rd and 5th harmonics of the signal at the terminals **MN** continuously.

The displayed values of all three harmonics are normalized to the amplitude of the meander. Addition, the 3rd and 5th harmonics are normalized to the amplitude of the 1st. This means that if the signal on terminals **MN** has the form of a meander, then the displayed values of the amplitudes of the all three harmonic will be equal to amplitude of meander.

This measurement mode can be also used for IP mode (induced polarization), which is performed in the frequency domain and involves measurement of the amplitudes and phases of the harmonics. For this it is necessary, that at the setting menu «**Main settings ... → IP phase**» was not selected «**No**». There are two options to select: the first one - the measurement of the absolute phase shift of the first harmonic signal MN relative to the current of the feed line (method INFAZ-VP); the

second - the measurement of the difference between the phase shifts of the 1st and 3rd harmonic of the signal MN (method presented in MARY-24).

In the selection menu, the options are indicated as φ_1 and $\Delta\varphi_{13}$ respectively.

To measure the absolute value of the phase shift it is necessary to synchronize the measurement with the current of the feed line. The receiver allows to do it in the traditional style, using the synchronization from the transmitter, and using a special algorithm which makes recovery of the phase of current from the input signal

The recovery algorithm of synchronization is activated automatically when there is no external synchronization on the corresponding pin of the «USB» connector. In the measurement mode the presence of external or restored synchronization signal indicated by the sign «*» before line « $\varphi_1=...$ ».

Recovery of synchronization allows to eliminate wires connecting the receiver and transmitter, but in the conditions of small signal level and/or a relatively large interference it can takes more time than one period of operating frequency.

To obtain absolute values of phase shift with a minimum induction component, the receiver uses the values of two harmonics, calculating the result according to the formula:

$$\varphi = (3 \cdot \varphi_1 - \varphi_3) / 2 ,$$

where φ_1 is the value of absolute phase shift of the 1st harmonic and φ_3 is the value of absolute phase shift of the 3rd harmonic normalized to frequency of the first harmonic. At low inductive component and correctly chosen frequency, the values of φ_1 and φ_3 are approximately equal. Obtaining differential value of the phase, which is the difference of the relative phase shifts of the 1st and 3rd harmonics, is done the same way as in the receiver MARY-24, according to the formula:

$$\Delta\varphi_{13} = (3 \cdot \varphi_1 - \varphi_3) / 2 ,$$

where φ_1 is the value of the relative phase shift of the 1st harmonic, and φ_3 is the value of the relative phase shift of the third harmonic.

Note. To ensure an acceptable accuracy of measurement of the phase shift of the harmonic components of the signal, it is necessary that the amplitude of the first harmonic of the signal was not to be less than 5 mV.

1.5.4. To use the receiver in cooperation with commutator of electrodes it is necessary to set the following settings:

1. to set operating frequency that is different from 0 Hz;

2. to select the type of commutator in the menu item «**Main settings ...→ Ext.Commutator ...→ Type**»;

3. to select the manual or automatic mode in the menu item «**Main settings ...→ Ext.Commutator ...→ Mode**» ;

4. In the case of the automatic control of commutator, it is necessary to set the conditions when the measurement will be completed.

There are four items in the menu settings that are needed to set the conditions for completion of the measurement. You can select the desired value from the list for each of them. The sign «-» means not to use this condition. Item «**ΔA1**» determines the necessary level of stability of the measurement result of the amplitude of the 1st harmonic. Item «**Min.A1**» determines the minimum required value of the amplitude of the first harmonic. Item **A1 / A3** determines the maximum allowed difference between the amplitudes of the 1st and 3rd harmonics. Item «**Δφ**» determines the required level of stability of the measurement results of the phase parameter.

Transition to measurement mode is done by pressing button «**START**». Exit out of this mode is done by pressing button «**ESC**». If the commutator is not ready to work then transition to measurement mode does not occur. When enter to the measurement mode, automatic operation is stopped and the message «**stop**» on the display of the receiver indicates it. Start and stop of automatic operation is done by pressing buttons «**START|STOP**». In manual mode, the commutator changes the electrode only when will be saved in the memory the measurement results by pressing the button «**MEMORY**». In automatic mode, saving of the measurement result and moving to the next electrode occurs when the conditions selected in the menu are realized.

If within a certain period of time all the selected conditions are not satisfied, then the receiver stops its automatic operation and beeps. If at the next change of electrodes need to change the electrode of feed line, the receiver stops, beeps, shows message, and waits ready from the commutator. When the commutator is finished, the receiver emits a long beep and will switch to the menu mode.

1.6. USB driver installation.

1.6.1. Instructions for USB driver installation is on the CD-ROM, which is included in the contents of delivery (SGD-EEM_MEDUSA meter electroprospecting / sgfp_usb_drivers / how_to_use_driver).

1.7. Reading the records from the receiver to the computer

1.7.1. Switch on the power of the receiver.

1.7.2. Connect the receiver to a computer by USB-cable.

Note. If the driver is not installed yet, install driver according to instruction (folder sgfp_usb_drivers).

1.7.3. Run the program «MEDUSA_Reader_V2», which is located in the folder «MEDUSA_Reader_V2».

If connection was not set automatically, press on the main form of the programm the button «usb» to set a connection and read all the records. When connection was set, the button «usb» is highlighted in green.

1.7.4. Select the records which should be saved.

1.7.5. Save the selected data in the required format by clicking the button marked with "floppy".

1.7.6. To exit the program, click "Exit".

1.8. Update the embedded software

1.8.1. Switch on the power of the receiver.

1.8.2. Connect the receiver to a computer by USB-cable.

Note. If the driver is not installed yet, install driver according to instruction (folder sgfp_usb_drivers).

1.8.3. Run the program «Reprog», which is located in the folder «MEDUSA_Reprogrammer».

If connection was not set automatically, press on the main form of the programm the button «usb» to set a connection. When connection was set, the button «usb» is highlighted in green.

1.8.4. Select and open the bin-file to update the software of the receiver.

1.8.5. Press button "Start reprogramming".

1.8.6. To exit the program, click "Exit".

1.8.7. Disconnect the receiver from the computer.

1.8.8. Switch off the power of the receiver.

1.8.9. The next time you switch on the power, the receiver will work with the new program.

2. TECHNICAL SPECIFICATIONS

2.1. The number of measurement channels (MN and AB) – **two**.

2.2. The available frequency measurements – **0 (direct current), 0.0190735, 0.038147, 0.076294, 0.152588, 0.3052, 0.6104, 1.2207, 2.4414, 4.8828, 9.7656, 19.531, 39.063, 78.125, 156.25, 312.5 и 625.0 Hz.**

Note. Additional measurement of 50 Hz component of signal is done during the work with frequency of 4,88 Hz and above.

2.3. Measurement of amplitude of industrial frequency equal to 50 Hz.

2.4. Voltage noise of the channel MN ($K_u = 8$, $F\Delta = 0,1...10$ Hz) is **no more than 1 μ V.**

2.5. Resolution of the channel MN - **1 μ V.**

2.6. Maximum value of measured voltage of the channel MN - **± 5 V.**

2.7. Maximum common-mode voltage of the channel MN - **± 10 V.**

2.8. Gain of channel MN - **1 and 8.**

2.9. Input impedance for direct current in channel MN - **at least 60 M Ω .**

2.10. Absolute error of voltage measurement of channel MN (from 500 μ V to 5 V), is **no more than 1%.**

Note. Typical value of absolute error for voltage more than 10 mV is 0,1%.

2.11. Measurement range of harmonics phase is **$\pm 45^\circ$.**

2.12. The measurement error of the phase parameter for a signal with a frequency f Hz and an amplitude of the first harmonic of 100mV is **$\pm 0.0025^\circ \cdot (f/0.0191\text{Hz})$.**

2.13. Maximum value of measured current in channel AB - **± 5 A.**

2.14. Resolution of the channel AB - **1 μ A.**

2.15. Absolute error of current measurement of channel AB (from 500 μ A to 5 A) is no more than 1%.

Note. Typical value of absolute error for current value more than 10 mA is 0,1%.

2.16. Maximum value of commutate current in AB line is **4,5 A.**

2.17. Maximum value of commutating voltage in AB line is **1 kV.**

2.18. Resolution of A/D converter is 24bit.

2.19. The maximum number of measurement records in memory is 131072.

2.20. Absolute frequencies error of signal sampling is **$\pm 1 \cdot 10^{-6}$.**

2.21. Relative frequencies instability of signal sampling is **$\pm 1 \cdot 10^{-6}$.**

2.22. Internal clock and calendar.

2.23. Galvanically isolated computer interface - **USB 1.1. (USB 2.0 compatible).**

2.24. Reliability:

1) mean time to failure, at least **2000 h;**

2) mean life time, at least **6 years;**

3) mean shelf life, at least **3 years**.

2.25. Supply voltage of the receiver from direct current source is **from 10,5 to 30 V**.

2.26. Nominal power consumption in measurement mode and maximum display brightness is 4,5 W.

2.27. Maximum power consumption is no more than **5 W**.

2.28 IP Code according to GOST14254-96 (MEK 529-89 CE I70-1 EN 60529) is **IP64**.

2.29. Operation temperature range is **from -40 to +70°C**.

2.30. Overall dimensions of the receiver are no more than **210•110•70 mm**.

2.31. Weight of the receiver is not more than **1,2 kg**.

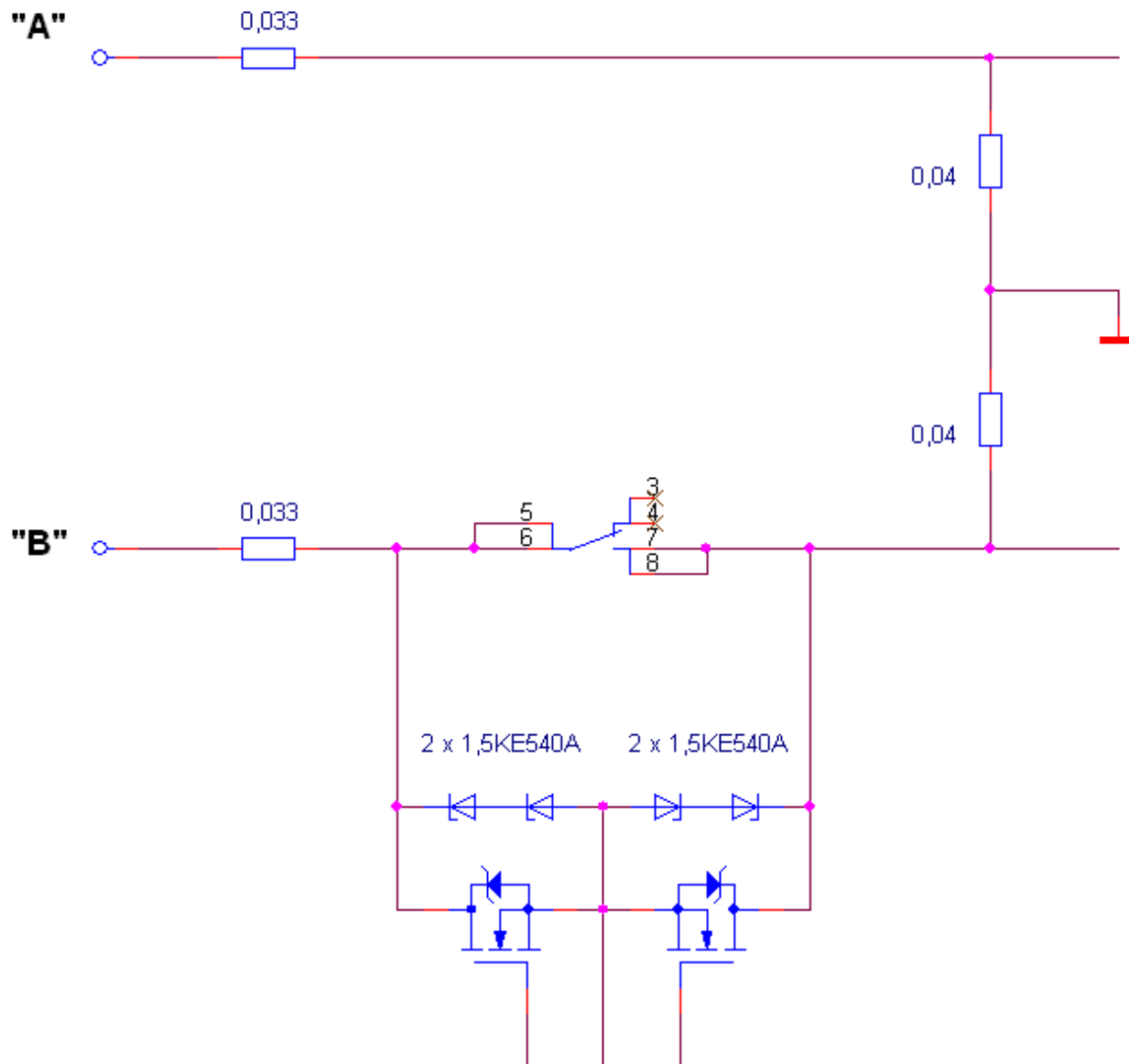
2.32. Weight of the receiver and special vest with rechargeable battery «12 V, 8.5 A•h» is no more than **4,3 kg**.

3. ACCESSORIES

3.1. Contents of delivery for the geoelectrical receiver SGD-EEM «MEDUSA» SGFP 121.00.00-05 is shown in Table 1.

Table 1.

Name	Item	Quantity	Note
<u>DOCUMENTS</u>			
SGFP 121.00.00-05 RE	Geoelectrical receiver SGD-EEM «MEDUSA» . Operations manual.	1	
SGFP 121.00.00-05 OD	Geoelectrical receiver SGD-EEM «MEDUSA» .	1	CD-ROM
<u>UNITS</u>			
SGFP 121.00.00-01	Geoelectrical receiver SGD-EEM « MEDUSA ».	1	№ 030
SGFP 121.51.00	Power cable « SUPPLY 12V »	1	1,2 m
SGFP 121.53.00	Cable interface « USB »	1	
	High-voltage terminal LAS S W «HIRSCHMANN» («RED»)	2	«Red»
	High-voltage terminal LAS S W «HIRSCHMANN» («BLUE»)	2	«Blue»
GEO.364.126 TY	Connector 2RM14KNP4G1V1	1	
GEO.364.126 TY	Connector 2RM18KNP7SH1V1	1	
SGFP 121.71.00	Special vest	1	
SGFP 121.73.00	Sealed lead battery « 12 V, 8.5 A•h »	2	
SGFP 443.00.00-01	Battery charger SGD-BC3502	1	№



NOTES

