



SUDOS – mini 2
Level gauge
OPERATING MANUAL



TOMSK

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**SIAM COMPANY IS GRATEFUL TO YOU FOR ACQUIRING
SIAM-MASTER –MINI GSM AND ASKS YOU TO ADHERE TO
THE FOLLOWING MAJOR REQUIREMENTS WHEN
OPERATING THE DEVICE:**

- The level gauge is an electronic microcontroller device with internal battery, keyboard, storage, etc.. When operating the device, do not hit it or expose it to severe vibrations, acids, alkalis and strong solvents. Do not submerge the device into liquid!
- Before switching on the device for the first time or after prolonged storage, charge the accumulators and only after it switch on the device. Always charge the battery until it is fully charged. The charging process must not be interrupted. Do not charge the accumulators at negative temperatures since it results into their premature failing!
- Do not carry out initialization when the battery is discharged (the LED flashes) and do not switch off the instrument after the initialization process has started until it is complete.
- When clearing the storage it is possible to reset the date and time in the device, but this erases all accumulated information from the level gauge's memory without the possibility of restoring it. It is therefore recommended to save the measurement results in the "SIAM database" before carrying out the storage clearance.
- This type of level gauge can transfer information to a personal computer (PC). In order to avoid errors and information losses, when transferring the data to these tools, read attentively and strictly follow the operational requirements of corresponding software products and tools. Pay attention to the version of the installed software. This tool operates in combination with "DB SIAM" of a V2.5-version and above.
- While tightening up the well sounder on the measuring connection of the wellhead tree, use the standard clamps on the case. No impact drivers or level gauge body are allowed.
- Do not rotate the valve of the well sounder at excessive pressure in the working volume of the sensor! After mounting the sensor gage, turn the valve to the desired position, and only then open the valve on the

measuring connection. Failure to observe this requirement drastically reduces the life of the moving seals.

- When operating level gauge, follow the requirements of the Maintenance section of this document. Avoid severe contamination of components, especially the acoustic sensor, the valve and the tapered connecting thread of the gage as it leads to its malfunction and reduction in the service life.
- Maintenance of the device is to be performed only by SIAM Service Company or by certified specialists. Unauthorized opening of the device, as well as violation of operation rules, entails loss of warranty!

1. GENERAL PRODUCT INFORMATION

The document presents two versions of the level gauge:

- 1) **SUDOS - mini 2** (standard version),
- 2) **SUDOS - mini 2 wideband.**

The “SUDOS – mini 2” level gauge (hereinafter the level gauge) is intended for prompt monitoring of the fluid level in oil producing wells.

The level gauge provides the monitoring of a static and dynamic level, recording of curves of the fluid level fall and recovery, automatic recording of gas pressure in the annulus at the wellhead.

The level gauge can be used to observe a fluid level while operating the wells, as well as while putting them into operation after their repair or outage.

The wideband Level gauge SUDOS-mini 2 (hereinafter the wideband level gauge) can be used for recording wideband echograms which are used to determine the sound speed in oil wells in a computer.

The device is explosion-proof designed (intrinsically safe circuit type of protection) and have 1ExibIIBT3 $-40^{\circ}\text{C} \leq t_a < +50^{\circ}\text{C}$ explosion proof mark. The device is designed for indoor and outdoor installation in 1 and 2 hazardous areas classes, where atmospheric explosives of IIA, IIB categories and T1, T2, T3 groups can form according to GOST R IEC 60079-20-1-2011 in the operating temperature range from -40°C to $+50^{\circ}\text{C}$. The device design is comply with the assigned explosion proof mark, with the requirements of GOST IEC 60079-10-1-2011, GOST 30852.0-2002 (IEC 60079-0:1998), GOST 30852.10-2002 (IEC 6—79-11:1999) and other regulatory documents governing the use of electrical equipment in hazardous areas.

2. BASIC SPECIFICATIONS

Table 1.

Parameter name	Norm on specifications
1 Explosion proof mark according to GOST 31610.0-2014 (IEC 60079-0:2011)	1Ex ib IIB T3 X
2 Range of monitored levels, m	(20 ÷ 6000)
- monitoring resolution, m	1

Parameter name	Norm on specifications
3 Range of monitored pressures, kilogauss/cm ²	(0 ÷ 100)
- monitoring resolution, kilogauss/cm ²	0.1
4 Non-volatile storage capacity	
- for symbol reports	12064
-for graphs	2605
5 Non-volatile storage capacity *	
- for symbol reports	8512
- for graphs	400
- for wideband echograms	261
6 Time of continuous operation under normal climatic conditions and after the battery cell has been fully charged, not less than, hours	14
Time of charging of a discharged battery, hours	4
Non-volatile memory-backup time, years, not less	5
Operating temperature ranges, °C	(-40 ÷ +50)
Service life, years	5
Weight, max., kg	2,9

Notice: * - for the wideband level gauge only.

Warning:
Please do not forget to update the software
on your personal computer.
Information can be obtained at
www.siamoil.ru

3. DELIVERY SET

The device is supplied according to the set shown in Table 2
Table 2.

Title	Q-ty	Notice
1. Level gauge (echometer) SUDOS-mini 2	1	
2. Interface cable USB	1	
3. Power unit with USB	1	
4. Automobile power unit with USB	1	*
5. Ball-type nozzle / rubber sphere	1	
6. Device bag	1	
7. Personal computer software:		
Flash drive with DB "SIAM" version 2.5 (and above).	1	
8. Operation documentation:		
• SUDOS-mini 2. Certificate	1	
• SUDOS-mini 2. Operating manual	1	
• DB "SIAM" v 2.5 User's Guide	1	
9. Spare parts and accessories		
• Handle to install the tool on a well	1	
• For the valve unit:		
- Ring 020-024-25-2-3	1	
- Cone IZM 8.323.011	1	

Notice 1:

* - Optional

Acoustic pulse generator GAI-01, Multiple-function Valve, GBO-02 conversion kit are supplied on request.

Notice 2:

The manufacturer reserves the right to make changes in the design and completeness of the product not worsening characteristics (in connection with modifications of both the device itself and its software) without prior notice and without making changes to the product certificate and other operating documentation.

4. SAFE OPERATION INSTRUCTIONS

4.1. General Provisions (normative codes)

- The construction of the wellhead equipment should correspond to the scheme approved by the Federal Mining and Industrial Supervision of Russia.
- Preparation of a well for tests and carrying out of the tests should be performed in accordance with the requirements of the Instruction and internal well servicing and tests instructions approved by the head of your company.
- Test equipment should be operated according to the operating manual delivered with the equipment by the manufacturing company.
- Safety measures are regulated by instructions of labor protection for appropriate types of work, approved by the labor protection department of the enterprise and by "Safety regulations for the oil and gas industry" approved by the Federal Mining and Industrial Supervision of Russia.

4.2. Requirements to the personnel

- Only people who are 18 years and older, who have a secondary or higher education and are in health conditions allowing them to work in this area are permitted to carry out well test.
- The personnel should be professionally trained, examined and have a special permission to conduct the works in accordance with qualification requirements: not below category 5 for oil and gas production operators; not below category 4 for well test operators.
- The personnel should be trained to operate on the test-equipment. The training is performed by personnel of the manufacturing company directly or by authorized representative of SIAM Company directly on the working place.

4.3. Test object

Such tests as pressure measuring and fluid level monitoring are carried out on oil and gas producing wells of different operation types (flowing, gas-lift, artificial lift and other), as well as on injection, water-intake, monitor and otherwells.

4.3.1. Requirements to the test object

- Construction and operation of a well should be performed in accordance with "Safety rules in the oil and gas industry".
- All Tested well, irrespective of its application and operation mode, should have a technological tap equipped with a valve and a wave metering tool seating nipple. A fluid level determination is possible only in that space of the well (tubular, tubular annulus, hole annulus, string annulus) which connects with the operating technological tap. While carrying out the measurements, there should not be any neckings (connections, dosimeters and similar tools) in the tap. The nipple of the technological tap should be placed at the height of 0.2 - 1.8 m above the ground. Taper joining thread should be 60 according to GOST 633-80. When the nipple is at the height of more than 1.8 ft above the ground, it is necessary to use stationary or portable platforms if they are appropriate to the "Safety regulations for the oil and gas industry". The nipple which is not being used at the moment should be blanked off.
- In the way of an acoustic pulse, not more than two bends of the tubing at the angle of 90° and at the distance of 65.6 ft away from the nipple are admissible.

4.4. Requirements to the test object

4.4.1. Surface equipment preparation

- Make sure that the valve of the technological tap and a pressure gauge are in running order.
- Check that the pressure in the well tested annulus is in the range of maximum permissible pressure of the tool. **When using the exhaust receiver supplied with the level gauge, ensure that its operating pressure does not exceed the maximum response pressure of the solenoid (electromagnetic) valve.**
- Remove the end cap from the technological nipple. Clean the taper thread from sludge, oil, sand and etc. Check the compliance of the tread with the requirements mentioned above. In cases when a thread type does not comply with the requirements, as well as if there is an undue wear,

massive corrosion or damages of the nipple's thread, carrying out tests is prohibited.

- Clean the inner space of the nipple from paraffin, hydrates, ice and other.

4.4.2. The level gauge assembly sequence

- Clean the thread part of a coupling of the level gauge from sludge and check it. If there is an undue wear, massive corrosion or damages of the thread, the assembly of the level gauge is not permitted.
- Open the valve in the technological tap for a while (for 1-2 sec.) in order to blow it through (to clean it from condensate, ice, sludge and other plugs).
- Install the level gauge screwing it on as far as it will go on the nipple and turn it tight in order to avoid a displacement of the level gauge when it is under pressure. A tightening torque should be not less than 200 ± 30 psi. To tighten the thread, use the clips on the thread coupling of the level gauge and a wrench for adapting pipe from atool set. It is possible to use any convenient lever instead of the handle.
- **ATTENTION! When tightening, it is prohibited to use impact tools and the rotating body of the level gauge as a lever.**
- Turn the outlet valve of the gauge in such a way that gas escape hole is not towards you.
- Check whether the nut of the level gauge's outlet valve is tightened well, if not, turn it tight.
- Turn the tool's body with the display and keyboard in a position comfortable for access and observation.
- **ATTENTION! It is allowed to rotate the rotating body and valve only if there is no pressure in the working body of the level gauge.**
- Lift off the front panel cover and set up the tool in a pressure monitoring mode.
- Gradually, not causing a pneumatic or hydraulic impact, open a gate valve until gas starts entering the level gauge. Stop the gate valve opening for a while in order to smooth the pressure in the well and in the tool's working body, and, then, open the gate valve completely. A pressure smoothing process should be controlled with the tool's display in pressure monitoring mode.

- In order to avoid a thread joint gas leakage, use thread sealing lubrication R-402 (TU 38.101.330-73) or a sealing tape FUM 0,1x20 (TU 6-05-1388-86).

4.4.3. Level gauge disassembly

- Turn off the tool.
- Close the gate valve of the technological tap.
- Open an outlet valve of the tool and let the excessive pressure out of the working body.
 - Screw out the level gauge and take it off the nipple. Drain the working body off the condensate, clean a thread part and house the tool in its bag.
 - Place the end cap on the nipple.

5. ARRANGEMENT AND OPERATION OF THE TOOL

5.1. General information

The “**SUDOS-mini 2**” level gauge is a compact electronic mono-unit tool. It is a completely self-contained tool and provides all functional abilities of a well level gauge. The tool is capable to display all basic monitoring parameters and results immediately.

The level gauge provides level control for wells with low annular pressure with the acoustic pulse generator **GAI-01**.

The tool supports export of information to a computer. An applied software **DB "SIAM"** included in the delivery set, makes it possible to create and add computer data bases, to process and analyze measurement results in more detail.

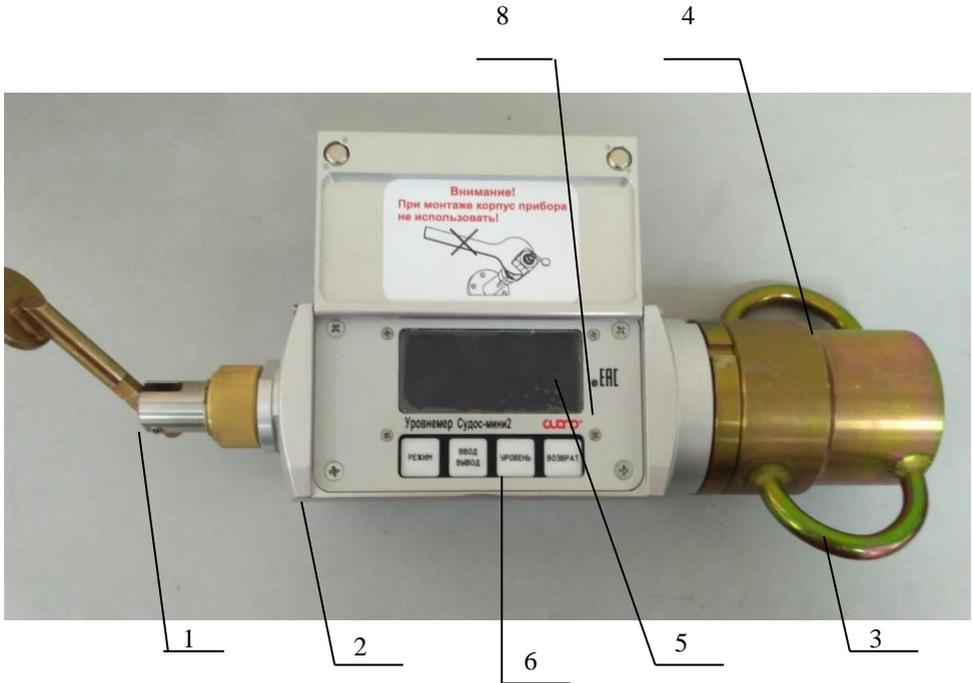
5.2. Arrangement, application and operation of components

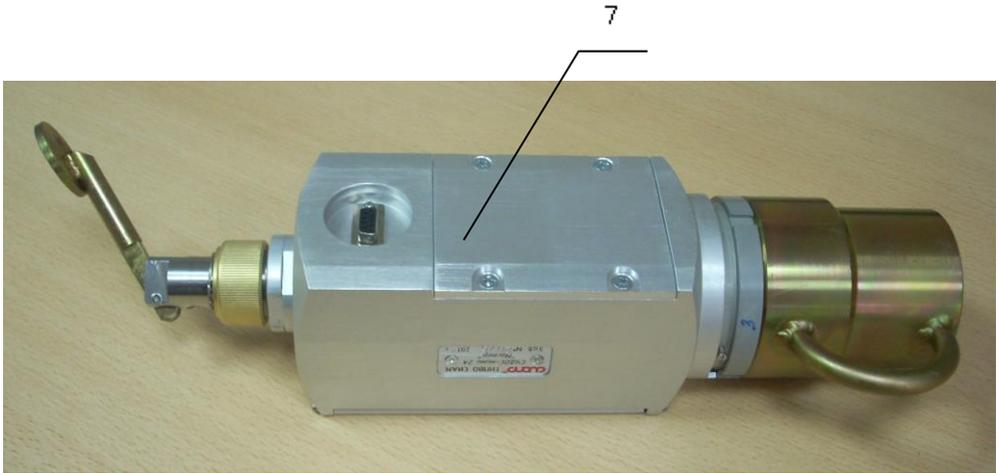
5.2.1. SUDOS-mini 2 level gauge

The level gauge is intended to generate acoustic pulses in the annulus, to receive and convert an acoustic response (an acoustic signal), as well as to determine the fluid level and to monitor pressure at the well head. The tool operates according to its internal program controlled with a built-in microprocessor controller which synchronizes the operation of all the components, processes the data transferred from primary transducers,

performs a level calculation, displays the operation modes and monitoring results on a digital display, as well as it registers measurement parameters and results in its fixed storage, and ensures a communication with the computer.

The level gauge is powered by a built-in battery with a minimum of 1000 charge-discharge cycles. To charge the battery, there is a built-in programm controlled battery charger allowing to service the battery cell correctly.





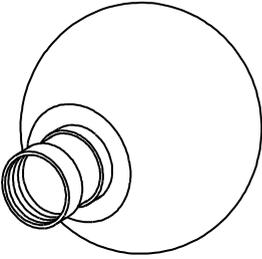
The level gauge consists of:

- 1 – outlet valve (rotating, removable);
- 2 – rotating tool body;
- 3 – two install clips;
- 4 – a thread jointing coupling;
- 5 – a symbol display;
- 6 – keyboard;
- 7 – an auxiliary slot to connect external devices such as a mains-operated adapter, a cable for charging from car power, a micro printer, a computer, and a visual monitoring unit;
- 8 – charge indicator.

When monitoring the fluid level, the level gauge is installed directly on a measuring nipple of the well Christmas tree, and measuring cables are not required. The control and display units are placed on the rotating body and have a protective cover. The body with the valve and control and display units can be positioned conveniently by rotating it about its longitudinal axis in any direction and at any angle (up to 225°). The outlet valve can also be rotated freely about its longitudinal axis in order to fix an outlet hole in a position not towards an operator.

ATTENTION! Do not rotate the body and the outlet valve if there is excessive pressure in the working body of the level gauge.

5.2.2. Ball-type Nozzle



The ball-type nozzle (the rubber sphere) is designed for generating an acoustic impulse when there is no excessive gas pressure in the annular space of the well. The ball-type nozzle is made up of the rubber sphere and the coupling. The ball-type nozzle is actuated by a violent blow of the hand on the sphere. An acoustic impulse, sufficient for positive control of the fluid level in wells up to 600...800 m, is formed. After the acoustic impulse is generated, the rubber sphere should be kept in the position which it took immediately after the blow until the value of the measured level pops up on the screen. The ball-type nozzle is screwed on the well sounder instead of the retrievable manual valve by using the reduction sleeve supplied with the device.

5.2.3 Power supply with USB connector

The power supply with USB connector is designed to power the charger integrated in the device. The power supply unit is connected to the 220 V/50 Hz mains, the device is connected to the USB slot of the power supply unit via a USB interface cable.

The power supply unit ensures the normal parameters of the charging process at mains voltages of 190 to 240V, with a DC voltage of 5V at a load current of at least 500 mA at its output.

5.2.4 A car power supply unit with USB slot

A car power supply unit is intended for charging the level gauge with a fixed voltage of 12V from the car power supply in the field environment.

The car power supply unit is connected to the on-board power supply of the vehicle, the appliance is connected to the USB slot of the power supply via the USB interface cable.

ATTENTION! The battery cell's temperature should be in the range of + 5 °C up to +30 °C.

Note - A car power supply with USB connector is available as an option.

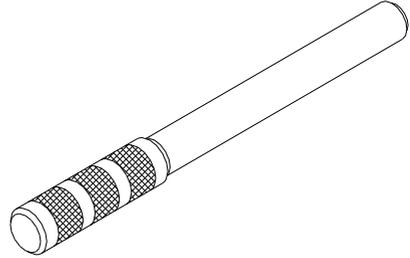
5.2.5 Interface USB cable USB

The interface USB cable is intended to connect the level gauge to a computer and to transfer data from the tool to a computer database, and

also to connect the appliance to a power supply with USB connector or to a car power supply unit with USB connector to charge the appliance battery.

5.2.6. Handle

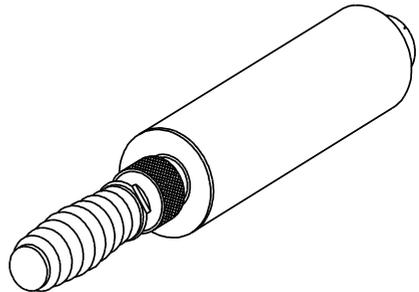
The handle ensures convenient assembly and disassembly of the level gauge on a well; and the handle is of a great length and strength that makes it possible to tighten (with an adequate moment) (see Section 4.4.2) the level gauge on a measuring nipple with the help of install clips on a rubber jointing coupling of the level gauge without the use of any other tools.



5.2.7. Additional accessories

- **GAI-01 Acoustic Pulse Generator**

GAI-01 acoustic impulse generator is supplied separately and is designed for generating an acoustic impulse when there is no excessive gas pressure in the annular space of the well. GAI-01 can be used at low annular pressure for controlling fluid level up to 1800... 2500 m.



GAI-01 is a unit which combines a container for accumulating excessive air pressure, a manual pump, a shipping lock pin and a valve for quick bleeding off. The handle has spare rubber gaskets for GAI-01.

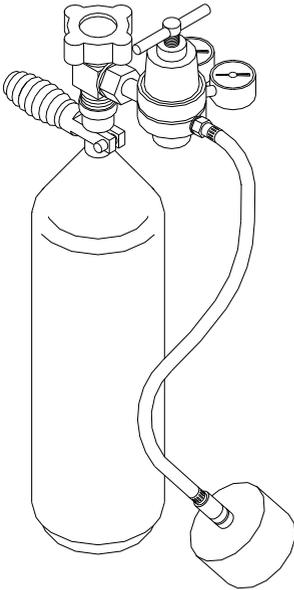
GAI-01 is to be installed on the well sounder instead of the removable manual valve using the reduction sleeve in the gage package.

- **Multiple-function Valve**

The Multiple-function valve is designed for use in level gauges of the SUDOS series, for generating an acoustic pulse by launching gas into a well or releasing gas from a well. The valve is installed in place of the conventional manual valve. If there is a significant excess annular pressure, the valve is used as a conventional manual valve to generate an acoustic

pulse by releasing a portion of gas into the annular space. At low overpressures and under vacuum, the valve can be used to generate an acoustic signal by letting a portion of high-pressure gas into the annulus. In this case, a set of gas-balloon equipment GBO-02 filled with nitrogen is used as a source of excess pressure. When gas is released from the annulus with a universal valve, the receiver, from the GBO-02 set, can be used to change the shape of the acoustic package. In this case, gas equipment is not connected.

▪ GBO-02 Conversion Kit



A set of gas-balloon equipment (gas - nitrogen) "GBO-02" is used when refitting level gauges of the "SUDOS" series to ensure level control in the absence and low excess pressures (2 - 4 atm.) in the annulus of the well. GBO-02 consists of a cylinder, a reducer, a receiver and a connecting hose. The hose is equipped with a connector that allows you to connect (disconnect) gas-cylinder equipment to the level gauge receiver. A cylindrical receiver from the GBO-02 set is screwed (threaded connection) onto a specialized manual valve of the level gauge. Gas from a BC-type cylinder is supplied through the VK94 valve, BK-50-4 reducer (reduces pressure to 15 atm) and through a hose into the storage receiver. When

the level gauge valve is opened, a portion of the gas accumulated in the receiver enters the annulus of the well and thereby an acoustic signal is formed to control the liquid level in the well in the absence of excess pressure in the well (or low pressure, up to 4 atm). One filling of the cylinder is sufficient for up to 250 level measurements, provided that the pressure in the cylinder is 150 atm.

5.3. Level gauge operation

5.3.1. Function

When monitoring the fluid level, a wave metering method is used. The operation process is rendered automatically. The participation of the operator (after mounting the device) is required only to generate an acoustic pulse using the level gauge outlet valve, or additional devices for generating acoustic pulses (ball-type nozzle, GAI-01).

After an acoustic pulse is generated by a solenoid or manual valve, the acoustic signal travels down the wellbore, is reflected off the liquid level and returns to the wellhead, the signal is amplified and stored. The tool monitors an acoustic signal during 20 seconds, amplifies it and records it in its storage. Simultaneously the gas pressure in the annulus is also determined and recorded in the storage. While analyzing and processing the recorded data, the fluid level in the well is determined, then shown on the display, and automatically stored in a nonvolatile memory of the tool as a symbol report. Recorded results including a complete echogram of the acoustic signal can be transferred to a computer database.

When calculating the fluid level, the tool automatically selects an acoustic pulse velocity according to one of the sound velocity tables recorded in it. The number of the correction table is selected by the operator. In addition to it, it is possible not to use the tables, but to set a sound speed (irrespective of pressure and level) manually using the keyboard.

According to our experience, the sound speed in wells can greatly vary even within one and the same field. Therefore, it is highly recommended to use the correction table applied for your region for an individual field or a group of wells within the field. In any case, the tool will display a level based only on the sound speed that has been set in it!

The tool automatically analyses the level of all signals including noise signals, as well as it evaluates a degree of an interference effect, and, when it is necessary, automatically activates (or deactivates) a program interference filter.

5.3.2. Control and display units

The control and display units are the following:

a symbol display of operation modes, parameters and measurement results and a four-key keyboard.



The display is used to show the tool's operation modes, to control the input of initial parameters (reference data) of a test, to monitor the test in progress and to display basic numerical results of the test. The indicator provides the minimum required functionality that fully supports the autonomous operation of the appliance.

The four-key keyboard provides an input (a change) of necessary parameters, input of operator's commands, control of all the operation modes including both a mode of the independent operation of the tool and a mode of its communication with peripherals. A general view, layout and notation of the keyboard's keys are shown in the picture.

The functional duties of the keys are described in more detail in the next section.

5.3.3. Basic functions of the keys



- Turn on the tool.
- Consecutively look through (in a closed cycle) the operation modes.
- Consecutively look through a number of flashing (changeable) digit place position on the digital display when entering (orchanging) parameters



- Turn on the tool.
- Change a value of a set parameter step-by-step (cycling) looking through the provided alternatives. The set

parameter (being changed) is displayed as a flashing sign. This means that a parameter may be entered.

- Navigation to the previous dimension through the measurement database.

УРОВЕНЬ

- Turn on the tool.
- Starts a fluid level measuring process.
- Change any tool mode from back to the initial one by consecutive pressing the LEVEL and MODE keys (move back/ reset).
- Turn the tool off by consecutively pressing the LEVEL and INPUT/OUTPUT keys.

ВОЗВРАТ

- This special service key is used as a prefix key. It changes direction of the operation of the MODE and INPUT/OUTPUT keys (only if the BACK key is pressed at that moment). The BACK key significantly simplifies the procedures of selection of a required digit when setting a well and a well cluster number and other parameters, as well as it makes it possible to correct a mistaken keystroke.

5.3.4. Operation modes of the tool

General notes

- In this section the operation modes and their symbol display are described. They are presented in the same order as they are initiated when pressing the MODE key several times.
- All parameters mentioned in this section (a number of well and well cluster, test parameters) can be set in any order irrespective of each other and they are stored in the tool's storage automatically (even if the tool is turned off) until they are changed.

- Word records made to the set parameters are automatically recorded in a symbol report of each measurement and, then, they can be read in all records (including when transferring data to a stationary computer, etc.).
- In order to save time when carrying out the work directly on a well, it is recommended to set necessary parameters beforehand.

Modes description

1. The measurement of the pressure and the battery voltage.

Indication of time and date. The device starts operating in this mode immediately after switching on. Example:

Е	М	К	О	С	Т	Ь	А	К	К	.	9	5	%	
Д	А	В	Л	Е	Н	И	Е	1	0	.	6	А	Т	М
							1	2	:	2	0	:	2	6
							2	4	/	0	9	/	1	2

1. Battery voltage – 95%,
2. Pressure - 10,6 kilogauss/cm²,
3. Current time - 12 h. 20 m. 26 sec
4. Current date – 24 September 2012 года.

2. Indication and setting up the number of well, cluster and field. In order to change the number press «INPUT/OUTPUT» button — the six bits of the well number start flashing. Using «MODE» button, choose what to correct: the well number, the well cluster number or the field number. Then press «INPUT/OUTPUT» button. The high-order digit starts flashing. Correct the necessary value by the consecutively pressing of «INPUT/OUTPUT» button. Pressing «MODE» button you can choose next digit or digits of number of the well/cluster to correct. All correction is stored into the tool memory automatically. There is a possibility to put the letters from the Cyrillic alphabet as the last two bits in the number of well and the well cluster. The maximum quantity of places for the well number is 6 bits, for the well cluster number- 5 bits, for the field number-3 bits. Example:

С	К	В	А	Ж	И	Н	А	4	3	2	1	0	4		
К	У	С	Т	5	2	8	1	4							
М	Е	С	Т	О	Р	0	0	3							
Я	Р	К	О	С	Т	Ь	И	Н	Д	5	0	%			

1. Well number – 432104,
2. Cluster number – 52814,
3. Field number 003.
4. Display brightness – 50%.

3. Type of survey. Automatic valve. The period of impulse.

This mode makes it possible to indicate and choose the type of survey. In the tool the following conditional abbreviations of the types of survey are taken:

- (measuring or detection) of static level (STAT.)
- determination of dynamic level (DYN.)
- recording of the curve of the level build-up (KVU)
- recording of the curve of the level decreasing (KPU)
- automatic registration of the gas pressure (KVD)

In order to choose the type of survey press «INPUT/OUTPUT» button consecutively. The example demonstrates the determination of dynamic level; automatic valve operation is not allowed.

В	И	Д	И	С	С	Л	Е	Д	Д	И	Н
---	---	---	---	---	---	---	---	---	---	---	---

4. **Period and number of measurements** (mode is active only for the automatic pressure logging test type). The "DURATION" line specifies the duration (in seconds) of the acoustic impulse. In the window of the type of survey the time interval (in minutes) for automatic annulus pressure recording is displayed and set. Possible options are: 1, 2, 3, 4, 5, 7, 10, 15, 20, 30, 40, 60, 90, 120, 180, 240,

300, 420, 600, 720. The period is selected by using the brute force method, by pressing the "INPUT/OUTPUT" key. In the same window, the number of measurements for automatic pressure recording is displayed and set. Possible choices are: 1, 2, 3, 4, 5, 7, 10, 15, 20, 30, 40, 50, 70, 100, 150, 200, 300, 400, 500, 600, 700, 800, 900, "-". The "-" sign indicates an infinite number of measurements. In this case, the level gauge will operate in automatic mode until the operator switches the type of measurement to dynamic or static or until the battery runs out. Example:

В И Д И С С Л Е Д . К В Д	
П Е Р И О Д	7 2 0
К О Л . И З М Е Р .	9 0 0

1. Survey type – KVD,
2. Period – 720 minutes,
3. Number of measurements 900.

5. Indication and setting up the number of the table of corrections and sound speed.

This mode makes it possible to indicate and choose the number of the working table for the sound speed. The factory basic version contains three alternatives.

- 0 — there is no table at all (sonicvelocity has to be set manually)
- 1 — there is a table appropriate for Siberian region (Supplement 3)
- 2 — there is a table appropriate for Tatarstan region (Supplement 3)

In addition to it, using computer and database «SIAM», it is possible to create and install to device any of four user tables (for details see Supplement 2). The user table (from the already installed in the tool), is selected by pressing "INPUT/OUTPUT" button consecutively.

Example: the operating table № 1 is chosen.

С К О Р О С Т Ь З В У К А

П О П Р А В К А 1

When the mode 0 is chosen, the manual input of the sound speed is activated. Indicator shows the previously set sound speed (in m/s). Setting up of the required speed is to be done in the same way as in the case with setting up the number of well or well cluster. The speed range, available for manual input, is from 200 to 499 m/s.

Example: the sound speed is 330 m/s

С К О Р О С Т Ь З В У К А

П О П Р А В К А Ф И К С

3 3 0 М / С

6. Gas outlet and additional gain

This mode makes it possible to change the level determination program in the case of the gas outlet from well (working with outlet valve) "GAS OUTLET YES" or the gas inlet into the well (working with GAI) "GAS OUTLET NO". To work on the wells where there is no pressure at all (working with GAI), use the "INPUT" button to set the mode "GAS OUTLET NO". When setting on the new well or on the new well cluster, the mode "GAS OUTLET YES" is automatically set ON. Also in this window the additional gain is shown. The additional gain is used if reflection of the acoustic signal is low. To switch the additional gain on, press "Input" button when parameters "ADD. GAIN" is active to set it YES. When setting on the new well or on the new well cluster, the mode "ADD. GAIN NO" is automatically set on. In the example the gas outlet mode is set on and additional gain is off.

ВЫПУСК ГАЗА ДА
ДОП. УСИЛЕНИЕ НЕ Т

1. **Wideband echogram** (*for wideband level gauge*). Mode to enable recording of wideband echograms. Wideband echograms are used to determine the speed of sound after transmission to a computer. To enable wideband echogram recording, set "YES" so that the display shows "BAND ECHOGRAM YES". In the example wideband echogram recording is switched on.

ВЫПУСК ГАЗА ДА
ДОП. УСИЛЕНИЕ НЕ Т
ШП. ЭХОГРАММА ДА

2. Storage capacity and storage cleaning

The vacant storage capacity left to record the measurements results is indicated on two counters. The first counter shows free storage for the symbol reports (RECORD №) (numerical parameters and the level control results), and keeps decrementing by one with every new measurement. The second counter shows free storage for the graphs of measurements (ECHOGRAM №) and also keeps decrementing by one with every new measurement. Example: storage is enough to record 3008 symbol reports and 310 graphs.

3.

СИМВ. ОТЧЕТ 3008
ЭХОГРАММ 310
ОЧИСТКА ПАМЯТИ НЕ Т

The total capacity of the storage is adequate for 12064 symbol reports and 2605 graphs. Counters return to the initial storage capacity when they are initialized or data are transferred to computer.

As the entire allocated storage fills up, as each subsequent result is recorded, the first measurement is automatically 'erased' and so on. For example, 310 echograms and 2268 character reports are recorded (SI740GR 0). Then the information of the first recorded graph is erased and a new graph is written in its place, and the symbol counter continues to run until it is full, and so on in a circle. After the next level measurement, the display will show the following information SI739GRR0. And so on SI738GR0, SI737GR0....CI0GR0, SI0GR0.

The mode of clearing the device storage and setting (changing) the time and date is described in detail in Appendix 8.

4. **Wideband echogram storage capacity.** *For wideband level gauge.*

The free storage capacity for wideband echograms is displayed. The maximum storage capacity after memory initialization is 261 wideband echograms. In the example, the remaining memory is sufficient to record 261 wideband echograms.

СИМВ. ОТЧЕТ	3 0 0 8
ЭХОГРАММ	3 8 4
ШП ЭХОГРАММ	2 6 1
ОЧИСТКА ПАМЯТИ НЕ Т	

5. **Indication and setting up the operator number, workshop number.**

Pressure sensor adjustment procedure. Time correction procedure

Operation in this mode is described in detail in Supplement 10.

О П Е Р А Т О Р	1 0 4
Ц Е Х	5 2 8
Н О Л Ь Д А Т	- 1 0 . 6 А
А К 4 . 0 0	1 2 : 2 0 : 2 6

- 6. List of measurements.** In this mode up to the three measurements for the current date and well number can be shown in the title. In the each line of measurements the time of measurement, quantity of reflections and the measured fluid level are indicated. Pressing "INPUT/OUTPUT" button — jump to the next measurement. Pressing BACK and "INPUT/OUTPUT" button simultaneously— jump to the previous measurement. Symbol > indicates the cursor. Pressing "MODE" button activates the graph of measurement, marked with cursor.

2 6 / 0 9 C K B 6 7 8 9 4 3

1 6 : 5 1 Y P 2 1 0 2 7 M

> 1 6 : 5 3 Y P 2 1 0 3 0 M

7. In the example the measurements are shown for date the 26th of September and number of well 678943. The measurement, marked with cursor, has been carried out at 16: 53, the measured fluid level was 1030 meters and 2 reflections have been determined. The previous measurement had been carried out at 16: 51, the fluid level was 1027 meters and 2 reflections had been determined.
- 8. Visualisation of the echogram graph.** The operation in this mode is described in detail in Supplement 7.

5.3.5. Turning the tool on and turning it off

ATTENTION! Before turning on the tool for the first time after it has been stored for a long time or transported, it is necessary to fully charge the battery cell (see Supplement 4). Only after having charged the battery the tool may be turned on. Otherwise, the tool cannot be switched on or it can switch off immediately after having been turned on. But this does not mean that the tool has any default.

Switching on

Pressing one of the three keys (MODE, INPUT/OUTPUT, LEVEL) turns on the tool.

After being turned on the tool remains in the same operation mode as it was in before turning off.

Switching off

The tool can be turned off from any operation mode by pressing consecutively the keys LEVEL and INPUT/OUTPUT. To turn the tool off from the annulus pressure monitoring mode, press the key INPUT/OUTPUT. The tool goes off automatically:

- If none of the keys are pressed within a period of longer than 100 sec.;
- If any malfunctions accompanied with displayed notes like ERROR occur (in this case the tool goes off within a 20-second period);
- If the battery cell's voltage decreases down to 2.5 V.
- In the last case all the information stored in the tool is saved, but you should charge it in order to prevent a full discharge of the battery cell (see Supplement 4).

5.3.6 Explosion-proofness of the device

Explosion-proofness of the device is provided by the type of protection "intrinsically safe electric circuit" "ib" level, according to the requirements of GOST 31610.11-2014 (IEC 60079-11:2011), which is achieved by the following:

- Basic circuit diagram includes the protective component "Fib".

The protective component "Fib" is an intact spark protection unit with the short-circuit current limitation at 2.25 A (maximum), using current limiting resistors and semiconductor fuses in series. Double redundancy is used in the "Fib" protective component to ensure greater reliability. The "Fib" component is integrated into the battery compartment

of the device. The design of the protective component “Fib” is met with the requirements of GOST 31610.11-2014 (IEC 60079-11:2011), including leakages and clearances. Thus, the electrical circuit coming out of the battery compartment of the device is intrinsically safe.

- The electrical circuit principal and applied third party components provide maximum power consumption not more than 0.45 W from the internal battery with maximum possible voltage on it 4.5 V. The total maximum capacity of the electrical circuit is 380 μ F, maximum inductance is not more than 20 μ Gn. The maximum current in the circuit during normal operation is not more than 100 m.

- The echometer uses EEMB LP103450LC-PCM-LD battery cell, prism size, with a total voltage of 3.7 V and a capacity of at least 1.85 Ah. The battery has special made contacts which exclude the possibility of its incorrect switching on (polarity reversal) and is located in the internal battery compartment of the device. The design of the battery compartment ensures that the battery does not fall out of the device. Do not replace the battery and do not charge it in the hazardous area. For this reason, in order to inform the user about special conditions of use of the device, the identification plate of the device is marked with an "X" sign indicating special conditions of safe operation.

- The maximum temperature of overheating of components and connections in the circuit diagram during normal operation is 15 °C max. Thus, the surface temperature of conductors and elements during operation and at maximum operating temperature plus 50 ° C is not more than 65 ° C.

- There are no plastics in the shells of the device that can accumulate electrostatic charges. Device enclosures are made with the degree of protection against external influences not lower than IP54 according to GOST 14254-2015.

- The minimum width of conductors on the PCB is 0.2 mm, copper thickness is not less than 18 μ m.

5.3.7 Measures to ensure and keep the device explosion-proofness during the assembly, disassembly and repair of the device.

5.3.7.1. Measures to ensure explosion-proofness before the production process:

- The elements used in the protective component of “Fib” are subjected to an acceptance test:
 - resistors are tested for their nominal resistance;
 - the fuses are checked against the short-circuit current limit;
- Materials used for casting the protective component “Fib” are subjected to an acceptance test according to the certificates presented.

5.3.7.2 Measures to ensure explosion-proofness before the production process:

- The elements used in the protective component of “Fib” are subjected to an acceptance test:
 - resistors are tested for their nominal resistance;
 - the fuses are checked against the short-circuit current limit;

5.3.7.3 Measures to ensure explosion-proofness during operation:

- control the presence of mechanical damage and corrosion on the cover or outer shells of the device. In the event of corrosion or mechanical damage, the operation of the device is prohibited.
- self-disassembly of the device is also not allowed.
- it is forbidden to exceed the operating temperature range of the level gauge. In the event of an overload of the instrument, the battery protection board is activated, providing automatic shutdown of the instrument, thus preventing a critical equipment failure due to self-ignition of the battery.

5.3.7.4 Measures to ensure explosion-proofness during repair:

- the device must be repaired only by the employees of the manufacturer. Repair by third parties or individuals is prohibited.
- the protective component “Fib” is not to be repaired. It is made intact and must be replaced in case of failure. Repair of the “Fib” component is not permitted.
- after repair, the device must be tested according to the test procedure, with the “Fib” component tested for short-circuit current and open-circuit voltage (together with the battery installed).

5.3.8 Safety and environmental instructions

5.3.8.1 When operating the device, it is mandatory to comply with the requirements of the following regulatory documents: GOST 12.1.019, GOST 12.2.003, GOST 12.2.007.0, GOST IEC 60079-14-2013, GOST 31610.0 (IEC 60079-0:2011), GOST 31610.11 (IEC 60079-11:2011), Technical Regulations of the Customs Union CU TR 012/2011 "On the safety of equipment for operation in explosive environments".

5.3.8.2 Do not operate the tool in any of the following cases: - The outer shell of the device is damaged; - The lid of the appliance is damaged. - The appliance lid is not closed

5.3.8.3 It is allowed to mount and dismount the device at the object of study only if the shut-off valves are in full working order. When installing and dismantling the device, the shut-off valves must be carefully closed.

5.3.8.4 It is forbidden to use the level gauge if the device exceeds the parameters of limit states. The limit states of the device include:

- Achievement of assigned indicators;
- Violation of the geometric shape and dimensions of parts, preventing normal functioning;
- Irreversible destruction of parts caused by corrosion, erosion and aging of materials.

5.3.8.5 The device does not use life-threatening voltage. During operation, the device does not emit harmful substances and does not have harmful effects on the environment.

6. PREPARING FOR WELL TEST

ATTENTION! When preparing tests, assembling and disassembling equipment, please strictly follow the requirements of the Safe Operating Instruction (Section 4).

Warning:

In case of touching the body of the device with your hands, it may turn on abnormally due to static electricity. This is not a malfunction and does not affect the performance of the device. The device will turn off automatically after 100 seconds. It is recommended

to observe antistatic protection measures when using the device in office and technological premises, as well as during its storage.

Preparation sequence for tests are is given below with references to the appropriate sections of this manual:

1. Preparation of the tool for service — see Section 6.1
2. Checking of the surface equipment to be available for service (preparation for service) — see Section 4.4.1.
3. The level gauge assembly — see Section 4.4.2.
4. Setting of test parameters — see Section 5.3.4:
 - setting of well cluster and well number, field number and test type, required parameters of the test.

6.1. Preparation of the tool for service

The procedure of preparation of the tool for service is rather simple and it involves the following operations:

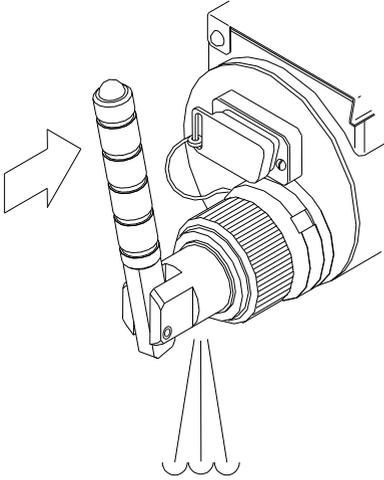
1. Turn on the tool (see Section 5.3.5).
2. Check voltage of the cell and, when necessary, charge it (Supplement 4).
3. Check a current time and, when necessary, correct it.) or to a visual monitoring
4. Check the vacant storage capacity. If there is not enough room for results of forthcoming work and data stored in the storage are still important, it is necessary to save them by transferring them to a computer (Supplement 5) unit.
5. Turn off the tool.

The steps mentioned above take minimal time and it is recommended to carry them out every day (every shift) before a working shift. It is highly recommended to check the battery cell's voltage beforehand in order to have time to charge it if necessary.

7. MEASURING

ATTENTION! While performing work on a well, strictly follow the requirements and provisions of the Safe operating Instruction (Section 4).

7.1. Fluid level monitoring



Press the LEVEL key and keep it pressed for about one second until the **I** symbol appears on the display. It means that the tool is ready for level measuring. During this one-second pause the level gauge measures a noise level in the well and automatically determines a necessary operation threshold.

The digit place in which the **I** symbol is displayed depends on the noise level: the higher the noise, the more right the **I** symbol appears.

During a pause, the indicator displays the inscription "NOISE AMPLITUDE ANALYSIS". After two symbols (**I**) appear on the indicator, generate an acoustic pulse by briefly pressing the handle of the level gauge manual valve to the stop.

7.1.1. Echogram recording and level determination

The next 20 seconds after an acoustic transient pulse has been generated the tool detects and records acoustic data from the well. Acoustic data detection can be observed on the display showing the signal peak level in 50 gradations (the more right the symbol moves the higher the noise level is).

After 20 seconds the **Level determination** symbol appears on the display. This symbol shows that the detection and recording of acoustic transient data have been finished and the tool is in mode of echo-gram analysis and level calculation.

In 1 or 2 sec. after the beginning of calculations, a level measurement result is displayed. E.g.:

2 6 / 0 9 C K B 6 7 8 9 4 3

1 6 : 5 1 Y P 2 1 0 2 7 M

> 1 6 : 5 3 Y P 2 1 0 3 0 M

The example shows the fluid level has been measured at the depth of 1030 m., and 2 reflections of an acoustic transient signal from the fluid level have been recorded. Measure time is 16 hours 53 minutes.

For each calculation the calculated value of the fluid level, the number of reflections, research parameters and a graph are automatically recorded into the tool's storage for symbol reports and into the storage for echo-grams combined with symbol reports. Hence, symbol reports are recorded into the echograms storage and are duplicated in the storage for symbol reports.

To make the monitoring results more reliable, it is highly recommended to reconduct the level measurement.

If the measurement results significantly differ from each other, it testifies that the tool cannot determine the fluid level automatically. This can be caused by different reasons (some of them are considered in Supplement 1). In this and as well as in other doubtful and necessary cases, it is recommended to determine the fluid level according to an acoustic transient signal graph. One can get an acoustic transient signal graph when transferring measurement data to one of the tools, i.e. a personal computer, a visual monitoring unit (see Supplement 7).

7.1.2. Recording a wideband echogram (for a wideband level gauge)

To record wideband echograms from a manual valve, press the LEVEL button. The "I" symbol will appear on the indicator. The digit of the indicator in which the symbol appears depends on the noise level: the higher the noise level, the more right the symbol. The level gauge will measure the noise amplitude in the well for 2 seconds and after 2 seconds it

will immediately switch to the echogram recording mode. Therefore, after the appearance of the inscription "RECORDING ECHOGRAM", immediately generate an acoustic impulse by briefly pressing the handle of the level gauge manual valve to the stop. 20 seconds after the beginning of the recording of the echogram, the inscription "FILTERING" will appear, which will be displayed for 9 seconds. In this mode, the level transmitter generates a conventional echogram for level determination from a broadband echogram. Next, the inscription " LEVEL DETERMINATION" will appear. And after 1..2 seconds the result of the level determination will appear.

7.2. Automatic recording of gas pressure in the wellhead annulus

Install the level gauge on the nipple of the technological tap (see Section 4.4.2).

After having placed the tool in a position comfortable for access to the keys and observation of the display, turn it on and set (if they have not been set beforehand) a number of a well and a well cluster, an automatic gas pressure recording test type (**KVD** mode) (Mode 3) and an interval of the tool's operation. Press the LEVEL key. The display will show:

СТАРТ КВД

The level gauge starts its operation in 5 seconds and it will automatically come on in a set time period, operate during 0.2 sec. (it measures the pressure and records the measurement result in the storage), automatically go off, and so on.

It is recommended to select such a period of measurements so that within a total operation period the tool makes not more than 12064 measurements.

8. MAINTENANCE

8.1. Schedule of maintenance

The tool's maintenance (M) is subdivided into 4 groups depending on an operation interval and is presented in the table below.

Work type	M 1 Once a week	M 2 Once a month	M3 Once in 6 months	M 4 Once in 12 months
Cleaning of the taper joining thread, the acoustic transducer, the pressure gauge, the face panel and the body.	+	+	+	+
Flushing and lubricating the solenoid valve assembly ¹⁾	-	+	+	+
Flushing and lubricating the manual valve	-	+	+	+
Cleaning of the interface slot	-	+	+	+
Operation monitoring ¹⁾	-	-	+	+
Pressure test ¹⁾	-	-	+	+
Replacement of sealing rings	-	-	-	+
Notes: 1) maintenance work is carried out by a service center of the "SIAM" company or by certified specialists of the Company. It is possible to replace the rubber ring of the exhaust valve (pos. 15 p.5) by direct users				

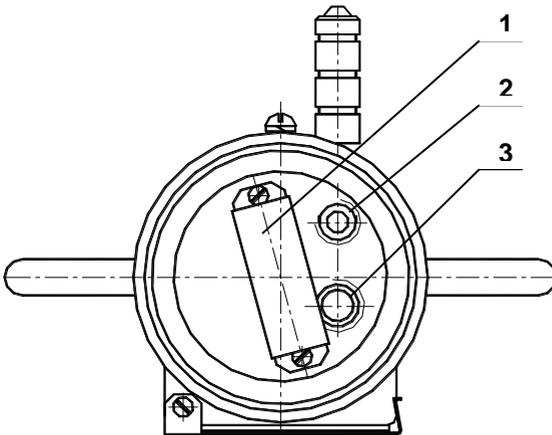
8.2. Maintenance procedure

ATTENTION! When using HFL follow the rules of fire prevention! Carry out the work only in well-ventilated rooms.

8.2.1. Cleaning the tapered connection thread, flushing the inside of the level gauge. Cleaning the face panel and housing

Clean with diesel fuel or kerosine using a brush and a rag. It is permissible to pour a small quantity (100...200ml) of diesel fuel or kerosine inside the cavity of the threaded coupling during flushing. However, do not immerse the level gauge body in the flushing liquid or allow it to come into contact with the keypad and display panel and connector. Metal tools (awl, screwdriver, etc.) may be used when cleaning heavily soiled threads, but do not use excessive force to avoid damaging the threads.

It is strictly forbidden to use a metal tool for cleaning the acoustic and pressure sensors. The body of the acoustic sensor is coated with a protective varnish, do not damage it! Do not insert any objects into the opening of the pressure sensor!



The illustration shows the arrangement of the components in the internal cavity of the threaded coupling of the level gauge. 1 - acoustic sensor, 2 - pressure sensor, 3 - connector.

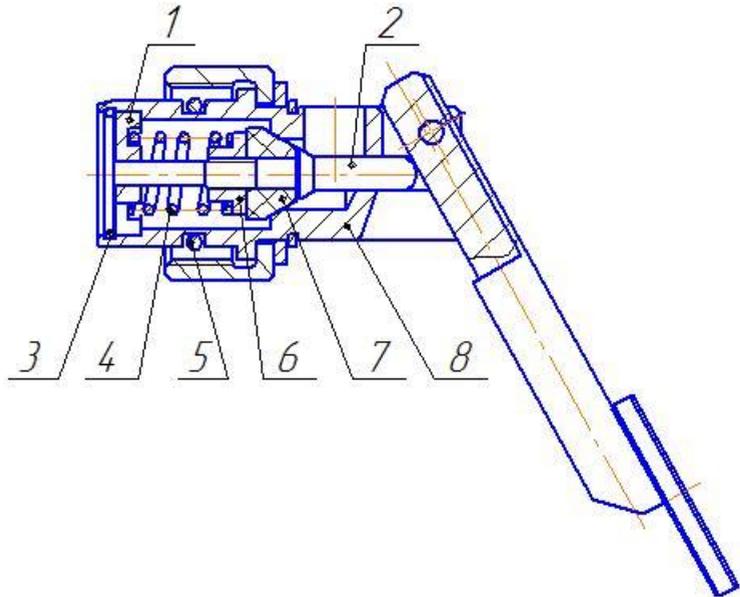
The face panel may be wiped with a clean cloth dampened with a small quantity of isopropyl alcohol (glass cleaner). Afterthat, wipe over the panel. In order to avoid scratches on the glass (the lightfilter of the display), not make great efforts while cleaning and wiping it over.

External surfaces of the tool (except of the face surface) are wiped over with clean cleaning cloth slightly wetted with petrol and then, are wiped dry.

8.2.2. Maintenance of the manual valve

The outlet valve is cleaned with clean petrol, a brush and cleaning cloth. Before cleaning, remove the valve from the level gauge, place it into a clean reservoir and pour out a little petrol. Not taking the valve out of the reservoir, push the handle several times.

Clean the external surfaces with a brush. Do not leave the valve into petrol for a long time. After washing the valve, wipe it dry with clean cleaning cloth. Before placing the valve back into the level gauge, lubricate slightly the rubber sealing ring with surface of a rubber sealing ring (7) with



lubrication CIATIM GOST 6267-80. After mounting the valve on the well sounder, install the latter on the Inspection bench for well sounders SKU-1 IZM 4.137.003 (SIAM Company) and purge the valve at pressure of 5...8 atm, using clean air. Test for pressure integrity with a soap solution. A slight "seepage" is allowed with small bubbles in the discharge hole area. In case of a high "seepage", repeat the valve washing process.

If the valve continues to "bleed" heavily, replace the valve pair (tappet and ball (4) and seating (3)). To do this, gently squeeze the retaining ring (5) and remove it from the valve body. Remove the guide sleeve (1), the spring (6) and the pusher with ball (4) from the valve body. Remove the seating

(3) with sealing ring (2) from the body. If necessary, clean the valve body (8) contact chamfer of the valve couple using a cloth.

Replace the valve couple and reassemble in reverse order, applying a small amount of CYATIM ST 6267-80 lubricant to the rubber sealing ring surface of the seating.

(The seating is chamfered on one side at the outside diameter. The chamfer is small so it must be determined accurately prior to assembly. The seat must be chamfered to the inside of the body).

8.2.3. Flushing and lubricating the interface connector

Flushing is performed with pure ethyl alcohol or alcohol-gasoline mixture using a brush (1 part ethyl alcohol, 1 part petrol "Kalosha" or "Nefras", no other petrol allowed). Alcohol consumption is 30g per month of use. After washing, apply a small amount of CYATIM lubricant GOST 6267-80 to the connector surface.

8.2.4. Operation monitoring

The main parameters of the level gauge are monitored for the following operating modes:

- 1) checking the setting of the setting and display modes,
- 2) checking in mode Level and pressure monitoring,
- 3) checking of sensitivity and noise level of the acoustic path,
- 4) check in mode Automatic Pressure Registration,
- 5) Test of the maximum working pressure control (max 100 atm),
- 6) check in the mode of the battery capacity control.

Methodology of checks is presented in the "Manual on conducting verification tests of devices and complexes manufactured by TSIIC "SIAM" LLC in operation". Tests 2 and 3 are performed at the Level gauge control test bench SKU-1 IZM 4.137.003 (SIAM company). Test 5 is carried out on the hydraulic test bench SGI-1 IZM 4.137.002 (SIAM company).

8.2.5. Pressure testing

Level gauge is pressurized with oil at 100 atm pressure for 10 minutes on hydraulic test bench SGI-1 IZM 4.137.002. Oil leakage from the tool is not allowed.

8.2.6. Replacement of the manual valve sealing ring

The sealing ring of the outlet valve (a rubber ring on the valve body) and sealing rings of the thread jointing coupling (one rubber ring and two guard split fluoroplastic rings) are subject to replacement.

To replace the manual valve sealing ring, the latter must be removed from the transmitter, remove the ring from the groove with a sharp instrument, clean the groove of dirt (petrol, rags) and put a new ring in place of the old one. Lubricate the ring with CYATIM lubricant GOST 6267-80 before assembly. Then put the valve back in its place.

After the level gauge has been assembled completely, it is obligatory to test its body for leak-proofness and strength. To do this, assemble the level gauge on a level gauge tests bench SKU-1 IZM 4.137.003 and test it for leak-proofness with soap solution (suds) at the pressure of 5.....8 atm. Slight leak of the valve with formation of small air bubbles around the outlet hole is permissible. Leak around the movable *coupling- body* is not permissible. Perform a pressure test of the tool according to Section 8.2.5. of this Instruction. If requirements of leak-proofness have been met, the tool is allowed for service, otherwise, it is not allowed for service and should be sent back to "SIAM Company" in order to avoid trouble.

9. STORING AND TRANSPORTATION OF THE TOOL

It is necessary to store the level gauge in a special package in dry heated rooms; the ambient temperature should be in the range from $-10\text{ }^{\circ}\text{C}$ up to $+40\text{ }^{\circ}\text{C}$ and the air humidity content should be not more than 80%.

It is permitted to transport the tool in a special package with any type of transportation when the ambient temperature is in less than $-50\text{ }^{\circ}\text{C}$ or more than $+50\text{ }^{\circ}\text{C}$.

While transportation, avoid strong vibration and impacts.

When storing the tool, it is necessary to inspect the voltage of the built-in battery cell once per month and, if necessary, to charge it. The cell charging is allowed only when the ambient temperature is above zero!

SUPPLEMENTS

Supplement 1.level monitoring under complicated conditions

In some situations it is difficult to detect an acoustic signal reflected from the fluid level accurately and, consequently, it is difficult for the tool to render automatic determination of the fluid level reliably. Some reasons for this, recommended measurement techniques and modes and methods of result analysis are described in the given supplement.

Supplement 1.1. Recommendations on measurements under complicated conditions

Factors making automatic determination of a level to be more difficult are as follows:

1.	A high fluid level (not deeper than 30 m) from the wellhead makes a period of acoustic transient signal response to be shorter than the duration of the signal itself	A response arrives on the initial signal background, and, therefore, it is difficult to detect it.
----	---	--

2.	In the well annulus there is great interference caused by too strong vibration of the tubing and casing string, vibration of an electrical submersible pump (EPS), leaks from valves and other reasons.	The returning acoustic signal has a lower amplitude than that of the noise level.
3.	There is much foam in the annulus.	The foam absorbs the acoustic transient signal, and, therefore, it arrives at the wellhead significantly alleviated/ at a significantly lower level.
4.	Either the valve is not open completely, or the space between the tubing string and the casing string is too narrow because of hydrate and paraffin plugs	The response acoustic transient signal is scattered in multiple changes of gaps.
5.	There is a very low (less than 0.5 kilogauss/cm ²) or a zero excessive pressure in the annulus whereas the fluid level is at a great depth (deeper than 1000 m)	The acoustic transient signal that is generated and returns is of very low amplitude.

A low fluid level. It is recommended to generate an acoustic pulse of a shorter duration.

Strong interference, much foam, significant necking of an annulus gap, low gas pressure in the annulus. It is recommended to generate an acoustic pulse of a **longer** duration.

Very often, especially on wells equipped with an electrical submersible pump (ESP), the source of very strong interference is acoustic noise from a delivery line. In this case it is recommended to turn off the valve on the delivery side of the Christmas tree, if it does not conflict with safety requirements and the technological process of oil production. Furthermore it is necessary to place a note warning that the valve is turned off.

After measurements have been made, the valve should be turned on. It is necessary to turn on the valve in several stages in order to smooth the pressure gradually and to prevent breakdown of the pump delivery. When the valve is opened completely, take the warning note away.

Supplement 2. Setting of a user sound speed correction table

When monitoring the fluid level, an operator can select and set a user correction table according to which the tool determines an acoustic wave velocity which is either a function of a just measured annulus pressure or a function of the pressure and the level. In addition to it, it is possible to select tables recorded in the tool's storage as well as tables transferred to the tool's storage from a computer database.

Warning! According to our data, the sound velocity in wells can greatly vary even within one and the same field. Therefore, it is highly recommended to use your (applied for your region) correction table for an individual field or a group of wells within the field. In any case, the tool will display a level basing only on the sound velocity that has been set in it!

In the fixed storage of the tool there are tables constructed according to averaged data of appropriate regions and intended for general use. They can be used only for a rough level evaluation. The tables are marked with conventional codes and titles (see Supplement 3):

Table 1 titled "Langepas" is intended for Siberian regions;

Table 2 titled "Tartaria" is intended for Tatarstan.

In addition to the above mentioned general tables, user tables (up to 4 pcs.), adopted for specific NGDU, field conditions, etc., can be written into the level gauge's RAM. The numbers of user tables can be from 10 to 63. The user tables are recorded in a computer session simultaneously with the transfer of parameters and level control results to the measurement and echogram database. (Work with the database, including creation and use of user tables, is described in detail in the document SUDOS DB-Graph Measurement and Echogram Database. User Manual" included in the device delivery set). The sound speed in the custom tables can be from 250m/s to 505m/s.

Enter mode 7) **Correction** (table) to set the working correction table. The previously set work table number is shown in the display in flashing digits.

С К О Р О С Т Ь З В У К А

П О П Р А В К А 1

Select the desired table number from those stored in the unit by pressing the **INPUT/OUTPUT** button repeatedly. Then press the **MODE** button to set the level gauge to any desired operating mode. The table with the set number will be operative for all subsequent level measurements, until the next selection.

Setting **FIX** and subsequent pressing **MODE** button activates the mode of manual entry of sound speed 8. Correction (speed). The display will show a caption showing the sound speed (in m/s) previously entered in manual mode, e.g:

С К О Р О С Т Ь З В У К А

П О П Р А В К А Ф И К С

3 3 0 М / С

Press the **INPUT/OUTPUT** button - the first speed digit (hundreds) starts flashing, inviting you to enter. Change it to the required value by successive pressing of the **INPUT/OUTPUT** button. Press the **MODE** button to move to the next speed digit and so on. When all digits are set, press **MODE** button to set the transmitter to any required operating mode - speed input is completed. The speed setting range in manual input is from 200 to 499 m/s.

The speed set is stored in the instrument's memory and is used for all subsequent level measurements (**regardless of borehole pressure**) until a new speed is entered or a different operating table is selected.

Supplement 3. Dependence of sound speed on annular pressure
(tables for general use)

Table 1 - "Langepas" (averaged data for Siberia)

Pressure, kgf/cm ²	Sound speed, m/s						
0	320	2,0	337	4,7	354	8,7	371
0,1	321	2,1	338	4,9	355	8,9	372
0,2	322	2,2	339	5,1	356	9,2	373
0,3	323	2,3	340	5,3	357	9,5	374
0,4	324	2,4	341	5,5	358	9,9	375
0,5	325	2,6	342	5,7	359	10,2	376
0,6	326	2,7	343	5,9	360	10,6	377
0,7	327	2,8	344	6,1	361	10,9	378
0,8	328	3,0	345	6,3	362	11,2	379
1,0	329	3,1	346	6,6	363	11,5	380
1,1	330	3,3	347	6,9	364	11,9	381
1,2	331	3,5	348	7,1	365	12,3	382
1,3	332	3,7	349	7,5	366	12,8	383
1,5	333	3,9	350	7,7	367	13,5	384
1,6	334	4,1	351	8,0	368	>14,6	385
1,7	335	4,3	352	8,2	369		
1,8	336	4,5	353	8,4	370		

Table 2 Tatarstan" (for Tatneft fields)

Pressure, kgf/cm ²	Sound speed, m/s						
0	300	2,0	322	4,7	336	9,2	346
0,1	302	2,1	323	4,9	336	9,5	347
0,2	303	2,2	324	5,1	337	9,9	347
0,3	305	2,3	324	5,3	338	10,5	348
0,4	306	2,4	325	5,5	339	11,2	349
0,5	307	2,6	326	5,9	339	11,9	349
0,6	309	2,7	326	6,1	340	12,3	350
0,7	310	2,8	327	6,3	340	13,5	351
0,8	311	3,0	329	6,6	341	14,0	352
1,0	313	3,1	329	6,9	341	15,0	353
1,1	314	3,3	330	7,1	342	17,0	354
1,2	315	3,5	331	7,5	343	20,0	356
1,3	316	3,7	332	7,7	343	26,0	358
1,5	318	3,9	332	8,0	344	34,0	360
1,6	319	4,1	333	8,4	344	48,0	362
1,7	320	4,3	334	8,7	345	60,0	363
1,8	321	4,5	335	8,9	345	81,0	364

Supplement 4. Charging the battery

To charge the battery, connect the switched off device either to the 220 V/50 Hz mains using the USB interface cable and a power supply unit with USB socket or to the vehicle electrical system using the USB interface cable and a power supply unit with USB socket. A red light will illuminate to the right of the indicator to indicate that the battery is being charged. When the battery is fully charged, the light will turn green and the unit can be disconnected from the mains.

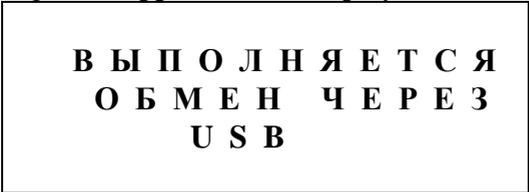
On average it takes 4 hours to charge the battery.

Charging is recommended at positive temperatures (+ 5 to + 30 C).
Do not charge the battery at temperatures below 0 °C!

Supplement 5. Transferring data to a computer

Attention! To avoid errors when transferring data to a computer, carefully read and strictly follow the requirements of the "SIAM Database v2.5" User's Manual.

- 1) Perform the data transfer to a computer in the following sequence:
- 2) Connect the tool with the interface cable to the computer, the message will appear on the display:



**ВЫПОЛНЯЕТСЯ
ОБМЕН ЧЕРЕЗ
USB**

This mode can be exited and re-entered by pressing the MODE button.

3) If this is your first connection to a computer, install the USB driver. In the "New Hardware Wizard" window check "Yes, only this time" as shown in Figure 2, click "Next".

Check "Install from Specified Location" (see Figure 3), click "Next" button.

Check the 'Include next search location' box (see figure 4), specify the path to the driver information. Specify the folder where the drivers `atmel_devices_cdc.cat` and `atmel_devices_cdc.inf` are located, click the "Next" button.

In the window shown in Figure 6 click "Continue Anyway".

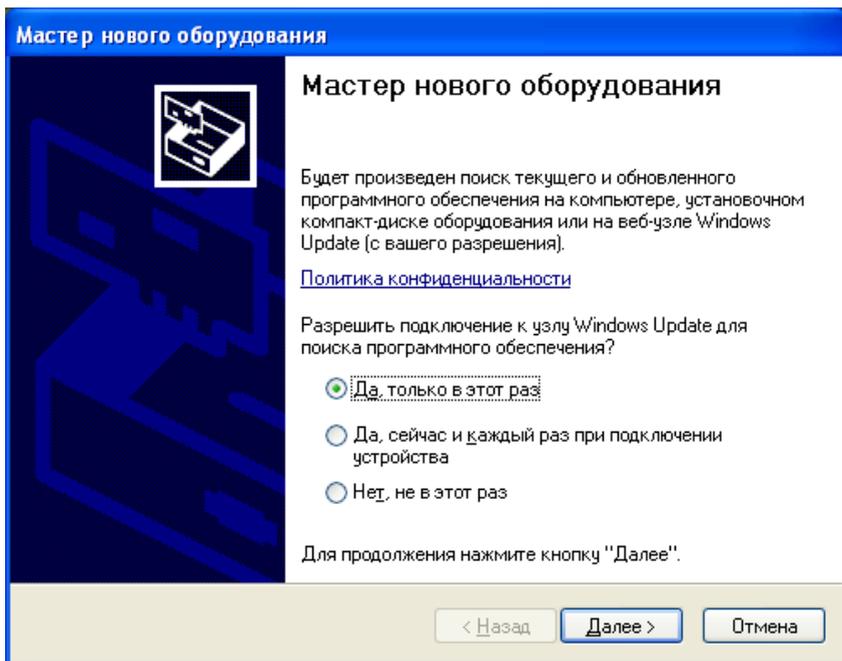


Figure 2

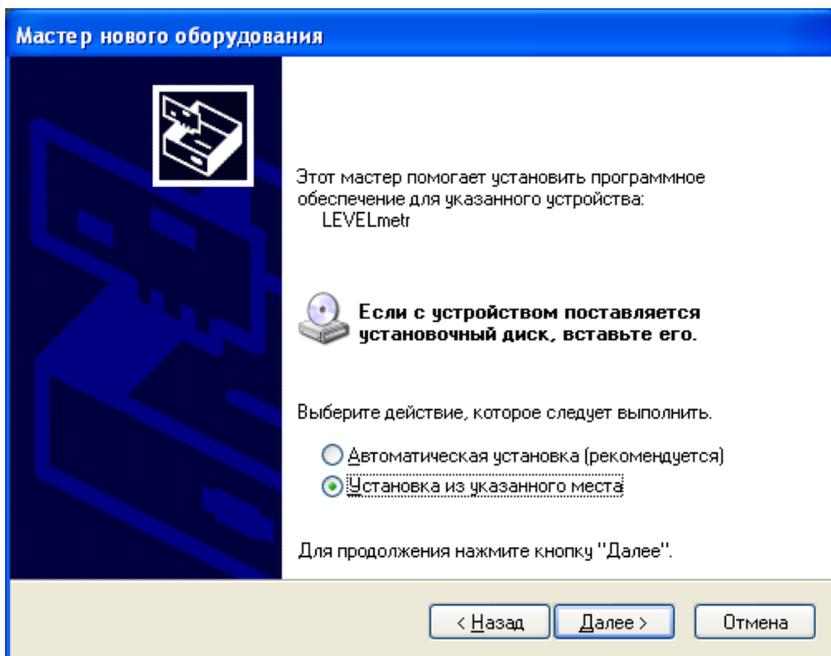


Figure 3

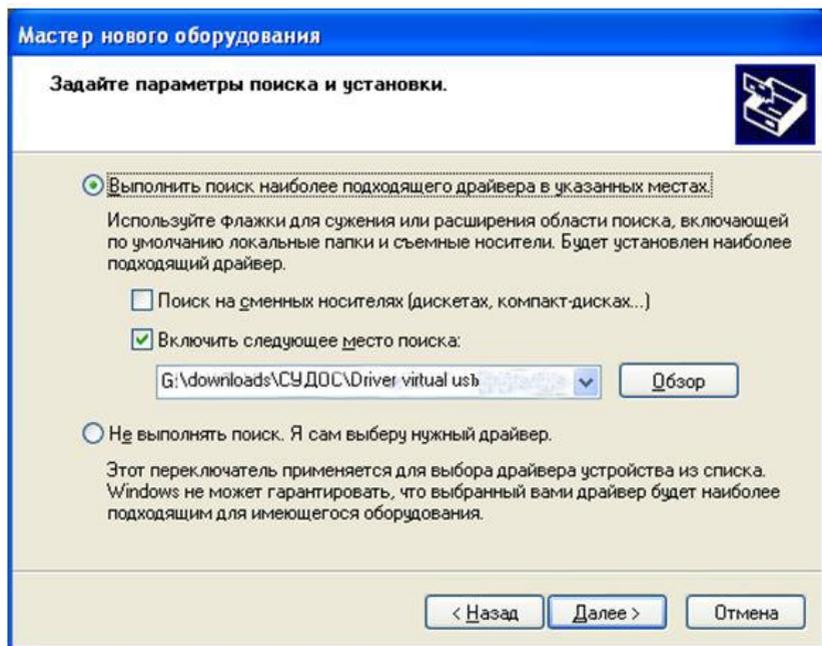


Figure 4

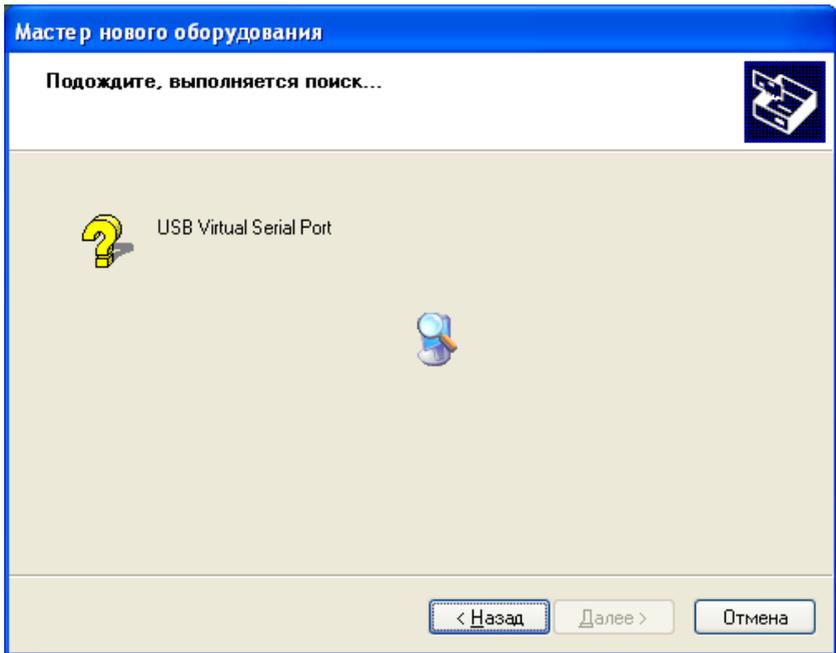


Figure 5

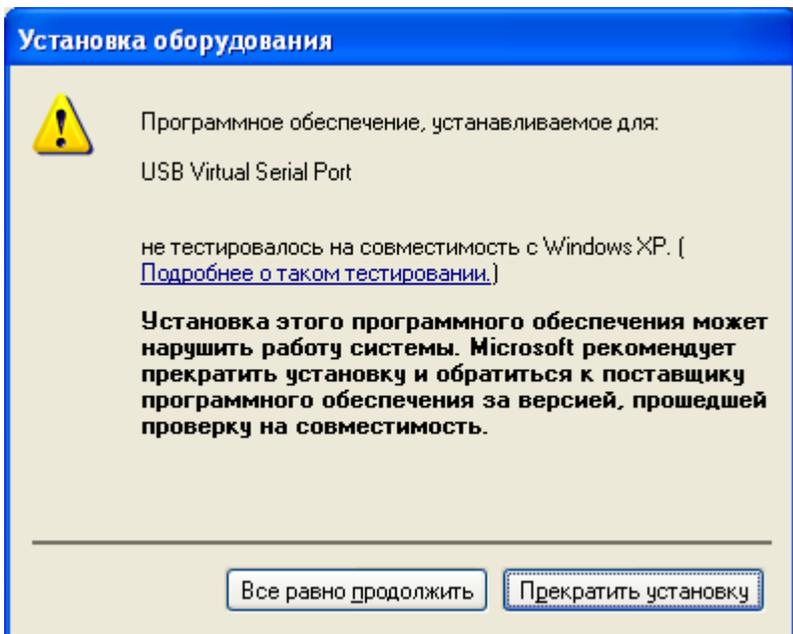


Figure 6

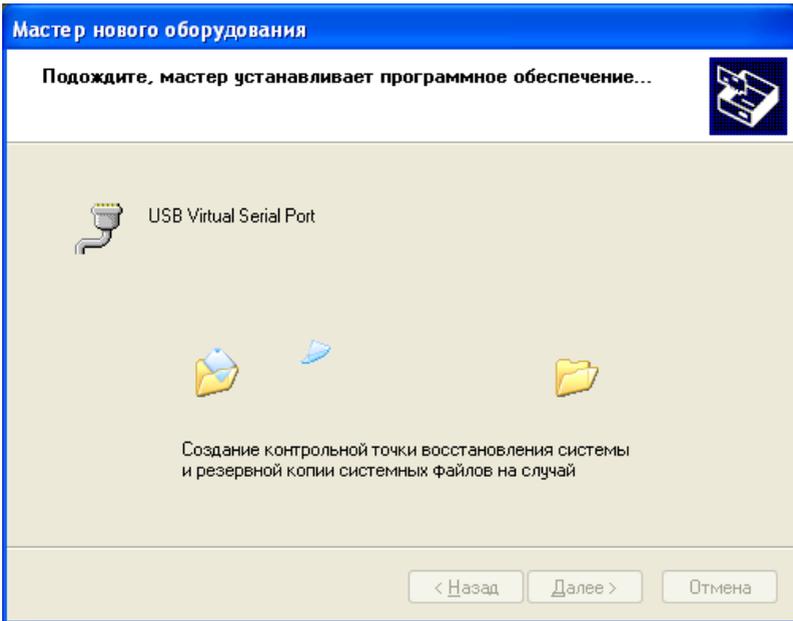


Figure 7

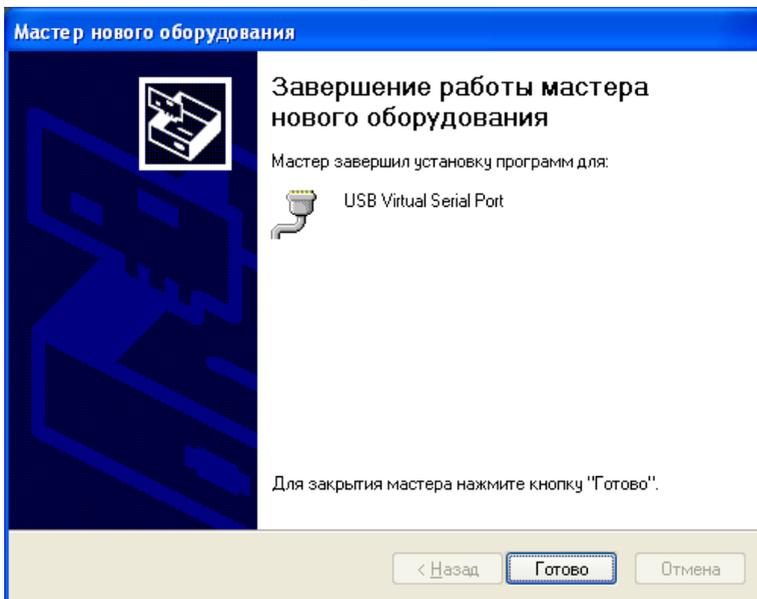


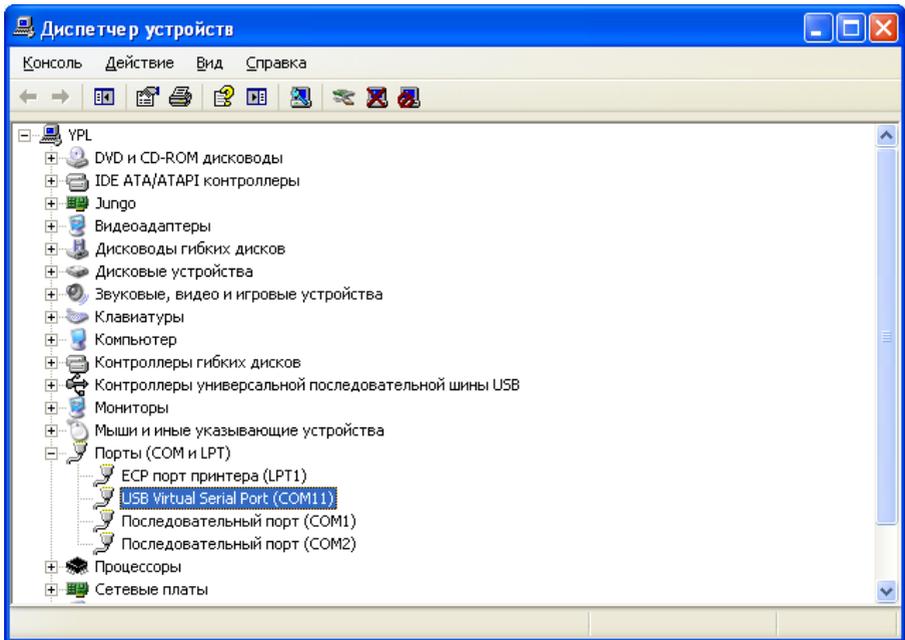
Figure 8

Open the "Control Panel" → "System" → "Device Manager" tab.

Locate the newly created COM port. In the example it is USB Virtual Serial Port (COM11), see Figure 9.

3) Start "SIAM DB v2.5" database on computer.

4) In the computer database, start the import procedure. Select the number of COM port corresponding to the connected USB. In the example it is COM3 (see Figure 10).



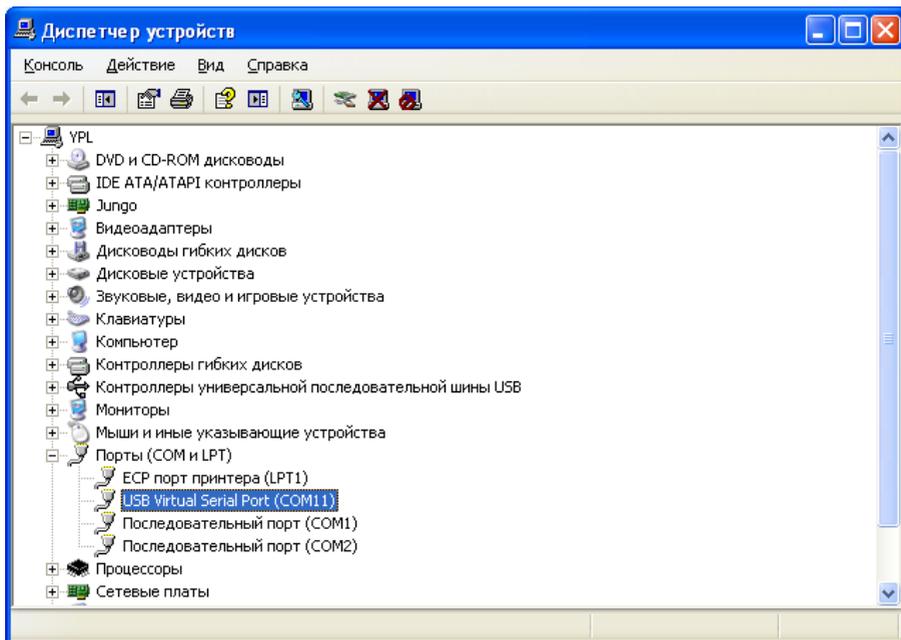


Figure 9

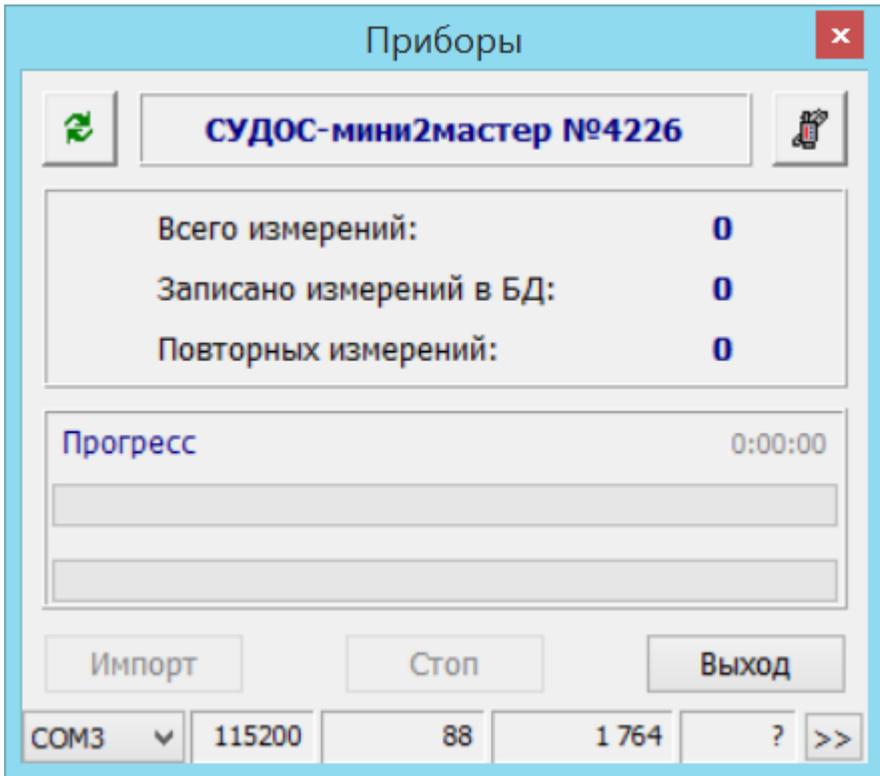


Figure 10

Supplement 7. The echogram visualization in the graphic display

"INPUT/OUTPUT" button — jump to the previous graph.

Pressing "BACK" and "INPUT/OUTPUT" buttons simultaneously — jump to the next graph. Pressing "MODE" button — jump to correct the left border of the graph. With each new pressing of the "INPUT/OUTPUT" button, the border will be changed for approximately 150 meters (depending on the velocity of sound). Pressing "MODE" button — jump to correct the right border of the graph. Pressing "MODE" button — jump to the mode of the annulus pressure control.

While correcting, the graph borders will be displayed in numbers in the upper line. Left border — on the left side, right border — on the right side. Also in the upper line there will be shown maximum amplitude of

echogram (in conventional units) and distance (in meters) between lines of the vertical grid. In the bottom line there will be shown: date of monitoring (day, month), time of monitoring (hour, minutes), quantity of reflections, liquid level, and annulus pressure.



0М АМПЛ761 С100М 657М
ГРАФИК
ЭХОГРАММЫ
 20/03 15:36 УР27 115М Д 9.5А

Upper line: left border — 0 meters, maximum amplitude 761 conventional units, grid — 100 meters, right border— 657 meters.

Bottom line: date — the 20th of March, time — 15 hours 57 min., 27 reflections from the fluid level, fluid level is 115 meters, pressure – 9.5 atm.

Supplement 8. Setting the time and date. Initialing the storage

In this mode it is possible to set time, date and clean the memory of the tool.

Warning! The deleted contents of the storage cannot be restored in this case!!

In order to save the valuable data — transfer it to the computer database before initialization of memory.

The initialization process does not change the current time and date and they can be left without correction or changed partly.

Attention! Initialing cannot be conducted, if the battery cell is discharged (the indicator is flashing). Besides, the device cannot be switched off during the process of initialing before its completion.

In order to clean memory — press "MODE" consequently until the window of the memory capacity and cleaning appears on the indicator. Press "INPUT/OUTPUT" button (word "NO") starts flashing). In order to clean memory — set "YES" as it is shown in exam

Then press "MODE" button. There will appear the following window on the display:

<p>СИМВ.ОТЧЕТ 3008 ЭХОГРАММ 310</p> <p>ОЧИСТКА ПАМЯТИ ДА</p>
--

In order to cancel the cleaning process — press "MODE" button.

<p>ОЧИСТИТЬ ПАМЯТЬ ? ВЫ УВЕРЕНЫ ?</p>
--

In order to clean storage— press "INPUT/OUTPUT" button. The storage cleaning process will start. After the storage is cleaned — there appears the window to correct time and date.

<p>12 : 20 : 26 24 / 09 / 08</p>

You can choose not to edit the time and date by pressing the "MODE" button. To repeat the time and date correction — press "MODE" button. To correct time and date — press "INPUT/OUTPUT" button. Seconds start flashing. In order to set seconds to zero — press "INPUT/OUTPUT" button.

In order to correct time — press "MODE" button and then use "INPUT/OUTPUT" button to correct the flashing tens digit of hour. Then press "MODE" button to jump to the unit digit of hour and correct it in the same way. Date is changed in the same way as well.

Supplement 9. Setting the operator and workshop number and resetting the seconds.

To view and set the operator number, press the "MODE" button to reach the operator and workshop number display window.

О П Е Р А Т О Р	1 0 4
Ц Е Х	5 2 8
Н О Л Ь Д А Т	- 1 0 . 6 А
А К 4 . 0 0	1 2 : 2 0 : 2 6

In the example: Operator number 104 is recorded, workshop number 528.

Press the INPUT/OUTPUT button to change the number - the three digits of the operator number will start flashing. Press the "MODE" button to select whether you want to edit the operator or plant number. Then press the INPUT/OUTPUT button. The high digit will flash. Change it to the desired value by successive presses of the INPUT/OUTPUT button.

To set the seconds to zero, press the MODE button until the seconds digits start flashing. Then press the INPUT/OUTPUT button to zero the seconds. Zeroing the seconds is necessary to synchronise the instrument with external devices: computer and visual inspection unit.

Supplement 10. Setting the pressure sensor at zero

This mode corrects the zero drift of the pressure sensor and is intended to compensate for possible temporary zero drift and to adapt the pressure sensor to different temperature conditions. In this mode, a correction for pressure sensor zero drift is written into the level gauge storage, which is automatically taken into account for all further measurements to determine the actual pressure value.

Zero adjustment is only made when the level gauge is exposed to atmospheric (zero overpressure) pressure. If the gauge is already mounted at the wellhead, the annular valve must be closed and the outlet valve kept open during the zero adjustment.

To zero the pressure sensor, switch on the tool. Press the "MODE" button to reach the operator and shop number display window.

```

О П Е Р А Т О Р      1 0 4
  Ц Е Х              5 2 8
Н О Л Ь   Д А Т   - 1 0 . 6 А
  А К 4 . 0 0   1 2 : 2 0 : 2 6
  
```

Press the "INPUT / OUTPUT" button and successively pressing the "MODE" button, reach the pressure sensor zero, when the pressure gauge correction will flash. The correction value is taken into account (in this case, added) in all measurements to determine the actual pressure value. In the example, the correction is -10.6kilogauss/cm2. Press the "INPUT / OUTPUT" button, while a new offset correction will be written to the instrument's memory and the pressure readings will be reset to zero in the pressure control mode. The recorded correction is stored in the instrument's memory (including during initialization) until the next zero correction and the recording of a new correction.

Supplement 11. Testing the level gauge

The level gauge test will reveal any hidden faults that may be preventing normal operation of the level gauge. After an unsuccessful test, the display may show an indication such as:

```

СБОЙ ЧАСОВ
НЕИСПРЧАСЫ
  
```

This means that the test process has detected:

- loss of information caused by mishandling of the level transmitter;
- a malfunction of the level transmitter itself.

The inscription that appears on the display indicates the type of fault. A list of possible faults is described in Supplement 11.

Supplement 11.1. Restarting the level gauge

Press the **MODE** and **LEVEL** buttons simultaneously to restart the level gauge. The message is displayed for 1 second:

СУДОС

Then the level gauge is set to the borehole pressure monitoring mode.

Supplement 11.2. Recorded echogram test

The recorded echogram test is activated by simultaneously pressing the **MODE**, **INPUT-OUTPUT**, **LEVEL** buttons and releasing the **LEVEL** button. The message is displayed for 1 second:

СЕРВИС

The level gauge then performs a direct test of the recorded character and echogram reports. The test can take up to 30 seconds.

The time to complete the test depends on the number of echograms recorded after the transmitter is initialized. Upon successful completion of the test, the device will enter Annular Pressure Monitor mode and will not shut off after a 100 second delay from the last press of any button. To reset the 100 second delay function, turn the gauge off and on again.

Supplement 12. Malfunctions detected by testing the level gauge

During the testing of the level gauge (Supplement 11), there can be identified the following failures which are not cause the transmitter to malfunction and allow you to work with the device:

:

- **СБОЙ FRAM** - loss of previously entered information - cluster number, well number, survey type and system parameters. When the MODE button is pressed (when this fault is indicated), the system parameter area is filled with initial values.
- **СБОЙFRAM14** - loss of user-defined tables of sound speed vs. pressure.
- **СБОЙFRAM16 (СБОЙFLES16)** - partial loss of character reports.
- **СБОЙFLES17 (СБОЙFLES18)** - partial loss of acoustic signal plots.

Malfunctions such as СБОЙFRAM14, СБОЙFRAM16, СБОЙFLES16, СБОЙFLES17, СБОЙFLES18 can occur because of faulty handling of the level gauge, e.g. - connection of the AC adapter or computer while the level gauge is powered up. These faults will be indicated each time the gauge is switched on until the memory is initialized, however, in order to preserve the information in the instrument memory, the data must be imported into the computer before initialization is carried out. If the above faults cannot be eliminated by initializing the gauge, the device must be sent for repair.

During the self-test, other faults may be detected that need to be repaired:

- **НЕИСПPFRAM** - the ferromagnetic memory malfunction;
- **НЕИСПPFLES** - flash storage malfunction;
- **НЕИСП FL4** - the inability to write the character report to the non-volatile memory
- **НЕИСП FL5** - inability to record the echogram in non-volatile memory.

While the echograms are being recorded, the level gauge checks the correctness of the recording by reading the recorded echogram from the memory and checking its checksum. If the checksum does not match, four more attempts are made to write the echogram to the next readout-controlled memory area. If the echogram cannot be correctly written to the non-volatile memory even after four attempts, НЕИСП FL4, НЕИСП FL5 are displayed. НЕИСП FL4 is displayed when the transmitter cannot record a symbol report. НЕИСП FL5 is displayed when the transmitter cannot record an echogram. FL4 and FL5 can be exited by pressing the MODE button. In AUTO mode KVVU, KPUP, KVD the check for НЕИСП

FL4, HEИСПP FL5 is deactivated. If in this case no echogram or symbol report is recorded, СБОУ FL16 or СБОУ FL16 will be displayed when the unit is initialised. If faults HEИСПP FL4, HEИСПP FL5, HEИСПPFLES, СБОУ FL16, СБОУ FL17 are displayed, the device must be sent for repair.

Supplement 13. List of possible malfunctions and methods of rectification
--

Description of defects, external manifestations and additional signs	Probable cause	Rectification method
1. No indication on the display	The battery cell is discharged	Charge the battery (see Supplement 4)
2. Strong backwardness of the date and time from the current	Very deep discharge of the battery cell when the tool has been stored in a storehouse without charging the battery	Charge the battery cell (see Supplement 4), transfer information to computer, initial the tool, set the current date and time
3. A slight time lag from the current	Power outage of the watch during battery replacement	Clear the device storage, set the current date and time

Description of defects, external manifestations and additional signs	Probable cause	Rectification method
4. The level gauge does not does not react to pressing the keys. The same note is displayed for a long time.	Malfunctioning of the controller program because of unforeseen situation, e.g. in the level determination program	Restarting the device by simultaneously pressing the LEVEL and MODE buttons (Supplement 14.1)
5. Loss of echograms when transferring into the computer	The non-volatile storage has been partly damaged.	To eliminate these defects, the tool should be repaired.

