Microsense
Portable Multigas Detectors

Instruction Manual
MICROSENSE 001.001.001.IM

Russia

Contents

General information

This Instruction Manual, combined with a certificate, is a guide to operation and maintenance of Microsense Portable Multigas Detectors (hereinafter - the detectors), and contains a description of operating principles, technical specifications, and other information necessary to ensure the use of technical capabilities, as well as correct operation.

The detectors are designed to measure the volume ratio of methane, oxygen, carbon monoxide and carbon dioxide and other toxic gases in air of the working area.

The detectors bear explosion protection marks - P0 Ex ia I X /0 Ex ia IIC T4 X, and they can be applied gas (methane) and dust-hazardous coal mines at ambient temperatures of - 20 °C - + 50 °C in accordance with this Instruction Manual.

The manufacturer guarantees regular operation of the detector, only if the requirements of this document are observed.

This Manual must be carefully read before using the detectors. Prior to operation or maintenance of the detectors, make sure that you read and understood the content of the Manual in full. This condition is obligatory to ensure safe operation and proper functioning of the detectors.

1 Description and Operation

1.1 Function and Application Range

Depending on the type, the detectors are designed to measure the volume ratio of methane, oxygen, carbon monoxide and carbon dioxide and other toxic gases. The detectors can be used while running sanitary and hygienic or technical control of air environment in the coal mining industry to monitor the maximum allowable concentration of methane, oxygen, carbon monoxide and carbon dioxide and other toxic gases in air of the working area in accordance with the requirements of PB 05-618-03 «Safety Regulations in Coal Mines». The detectors' types are specified in Table 1.

Table 1

Type	Controlled gas			
	Methane	Carbon monoxide	Carbon dioxide	Oxygen
Microsense M1	+	+	+	+
Microsense M2	+	+	+	-
Microsense M3	+	+	-	+
Microsense M4	+	+	-	-
Microsense M5	+	-	+	+
Microsense M6	+	-	+	-
Microsense M7	+	-	-	+
Microsense M8	+	-	-	-

Note: the sign «+» means availability of the measuring channel, the sign «-» means its absence.

The detector performs the following functions:

- continuous monitoring and digital indication of controlled gas components;

- light and sound alarm when concentration of controlled gases reaches the set (alarm) level;

- recording and subsequent display of extreme concentration values for the period after switching-on;

- «black-box» function – recording of measurement results by means of non-volatile memory;

- transfer of measurement results to a PC;

- date and time display;

- atmospheric pressure display;

- fault indication;

- LED flashlight.

1.2 Design and Operating Principle

The general view of the detector is shown in Figure 1. The front panel of the case includes:

- colour LCD display (3);

- «CardioLight» (1) - a light panel, which serves to notify about the state of the atmosphere and the detector. Green colour flashing means that concentration of measured gas is normal. Flashing with greater frequency of red colour means that one or more gases have reached the alarm level or low battery;

- keypad (4);

- sensors of controlled gases (2).

The following items are located on the back panel of the case:

- clip (5);

- LED flashlight (6);

- warranty sticker (7);

- nameplate (8);

- speaker of sound alarm (9).

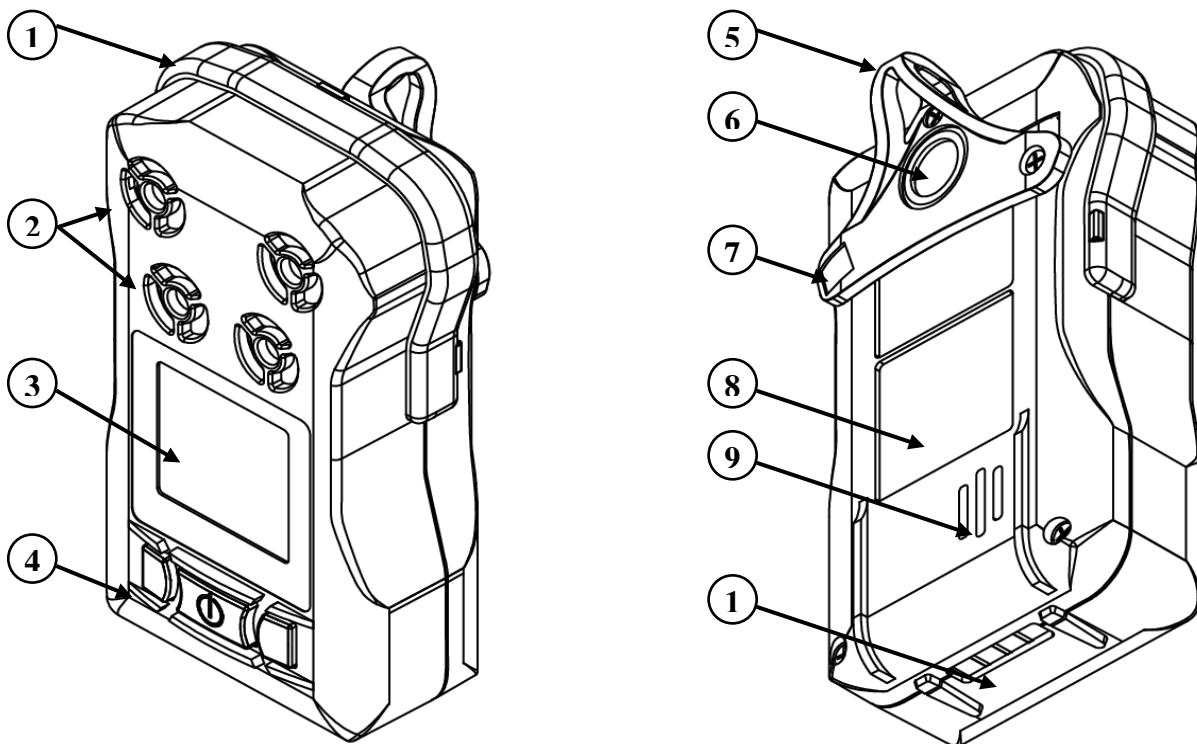At the bottom of the case there is a connector (10) to plug the device to the docking station.

Figure 1. External view of the detectors

The detectors are equipped with optic sensors to measure the volume ratio of methane and carbon dioxide. The major advantages of the sensors are the following:

- ultralow power consumption (as a consequence - increased operation time without battery recharging);

- high-precision measurement;

- zero cross-sensitivity to unmeasured components;

- resistance to gas overload regardless the exposure time;

- long-term operation of the detector without adjusting the methane and carbon dioxide measuring channels.

To detect the volume ratio of oxygen and carbon monoxide, the detectors use sensors,

which measuring principle is based on electrochemical method. This measuring method also allows reducing power consumption of the device.

1.3 Technical Specifications

1.3.1 Dimensions, Weight, Power Supply and Power Consumption of Detectors

The overall dimensions, weight, power supply source and power consumption of the detectors are specified in Table 2.

Table 2

Dimensions (L x W x H), mm	Weight, kg	Electric power source	Power consumption (max.), VA
115x70x35	0.25	rechargeable Li-ion battery	5

1.3.2 Operating Conditions

Operating conditions of the detectors are specified in Table 3.

Table 3

Parameters	Value	Unit of measure
Ambient temperature range	2 to 35	$^\circ$C
Atmospheric pressure range	84 to 106.7	kPa
Humidity range	25 to 95	% (at 25 $^\circ$C)

1.3.3 Technical Characteristics in Brief

A brief description of technical characteristics of the detectors is specified in Table 4.

Table 4

Parameters	Value	Unit of measure
Rated voltage of DC power	4.2	V
Explosion protection marking	Ex ia I Ma	-
Dust and moisture protection	IP 54	-
Warm-up time and preparation for the operating mode (max.)	120	sec.
Battery life at 25 $^\circ$C (min.)	48	hour
Operating time without adjusting the measuring channels of: - methane and carbon dioxide - carbon monoxide and oxygen	12 3	month
Calibration period	12	month
Service life (min.)	5	year

1.3.4 Metrological Characteristics

Metrological characteristics of the detectors are specified in Table 5.

Table 5

Parameter	Value
Measurement range of volume ratio of the measured component: CH_4, % CO, ppm CO_2, % O_2, %	0 to 2.5 0 to 100 0 to 3 0 to 25
Indication range of volume ratio of the measured component: CH_4, % CO_2, %	0 to 100 0 to 5
Permissible absolute measurement error: CH_4, % - within 0 to 2% range CO, ppm - within 0 to 50 ppm range CO_2, % - within 0 to 1% range O_2, %	±0.1 ±5 ±0.1 ±0.5
Permissible relative measurement error: CH_4, % - within 2 to 2.5% range CO, % - within 50 to 100 ppm range CO_2, % - within 1 to 3% range	±5 ±10 ±10
Permissible auxiliary measurement error rated over ambient and analyzed medium temperature change in reference to conditions under which the basic error of measurement is determined across the methane measuring channel: - absolute, % (within 0 to 2% range) - relative, % (within 2 to 2.5% range)	±0.2 ±10
Permissible auxiliary measurement error rated over ambient and analyzed medium temperature change by every 10 °C in reference to conditions under which the basic error of measurement is determined across the carbon dioxide measuring channel:	±1
Absolute pressure indication range, kPa	84 to 106.7
Response time t_{90}, sec.(max.) CH_4 CO, CO_2, O_2	30 60
Response time t_{50}, sec. (max.) CH_4	10

1.3.5 Power Supply

The source of electric power of the detector is integral Li-ion battery U_0:4.2V; I_0: 1.2A. The number of charge/discharge cycles of the battery is at least 500 under compliance with the operating conditions (see Section 1.3.2), and the rules of the battery charging (see Section 2.2). The battery exchange is made only by the manufacturer.

1.3.6 Software

The integrated software of the detector is tree-structured. The menu navigation is performed with the help of buttons on the front panel of the device. Identification data of the integrated software is specified in Table 6.

Table 6

Software name	Software identification	CRC checksum	Software version (ID)	Cyclic redundancy check
Microsense	Microsense 1.bin	0xF1A42C35	1.0	CRC32

The name and version of software are shown on the integrated display of the detector when it is switched on. The structure and functions of software, as well as description of user's interface, menu and dialog are listed in Subsections 1.3.7.1, 1.3.7.2 and 3.

1.3.7 Keypad and Display
1.3.7.1 Keypad

The keypad is on the front panel of the detector and contains three buttons. «▲» and «▼» buttons serve for menu navigation; **«OK»** button is used for switching on/off the detector or selecting the parameters' values.

1.3.7.2 Display and Menu Navigation

Integrated LCD display indicates data in the following modes:

1. MEASURED DATA DISPLAY MODE (see Figure 2)
- carbon monoxide (CO) concentration, ppm – upper left corner of the display;
- oxygen (O_2) concentration, Vol.%. – upper right corner of the display;
- carbon dioxide (CO_2) concentration, Vol.% - lower left corner of the display;
- methane (CH_4) concentration, Vol. % - lower right corner of the display.

This mode displays the measured parameter (1 - in Figure 2), the value of the measured parameter (2), units of measure (4), the remaining time of the device operation from the battery (3), and current time (5) in the format «HH:MM». To switch to another mode unlock the display by holding «▲» and «▼» buttons simultaneously until the loading bar disappears and you hear a beep. Then press «▼» to switch to the following mode, or «▲» button to return to the previous mode. The display is locked and switched to the measured data display mode, if no button is pressed for 30 seconds.

Figure 2. Display in Measured Data Mode

In the absence of the measuring channel depending on the detector's type, the sections 1, 2 and 4 (in Figure 2) will be empty.

2. DATE AND TIME MODE (see Figure 3) displays current time (1), date (2), day of the week (3), and absolute pressure (4).

Figure 3. Display in Date and Time Mode

3. FLASHLIGHT. Use «OK» button to switch on/off the flashlight.

4. SETUP MODE. Hold the «OK» button on the keypad until the loading bar disappears and you hear a beep. Then, enter the password from 1 to 65535, using the «▲» and «▼» buttons. The password is disabled by default. The setup menu is shown in Figure 4. Press the «OK» button to select a parameter, and «▼» and «▲» buttons to switch between the parameters.
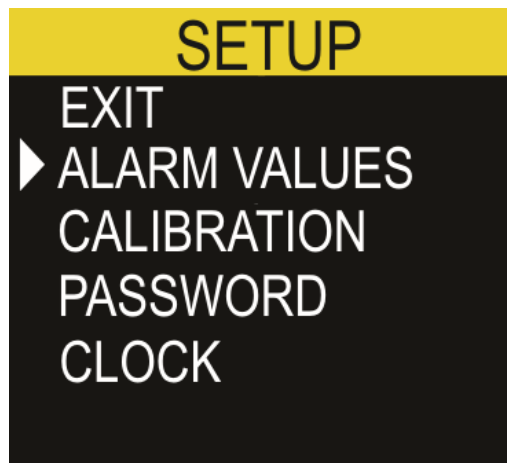

Figure 4. Display in Setup Mode

ALARM VALUES. This section is for setting the thresholds for light and sound alarm. Upon opening this section, you will see the type of gas for which the threshold is set on the left of the display, and the set threshold (alarm) value on the right (see Figure 5a). To set the threshold (alarm) value, select the type of gas using navigation buttons «▼» and «▲», and enter the sub-section to choose the threshold value (see Figure 5b) by pressing «OK» button. Use «▼» and «▲» buttons to set threshold (alarm) value and press «OK». For saving threshold (alarm) values, select «SAVE» in Alarm Values Section and press «OK» button. To exit the section without saving the settings - select «EXIT».
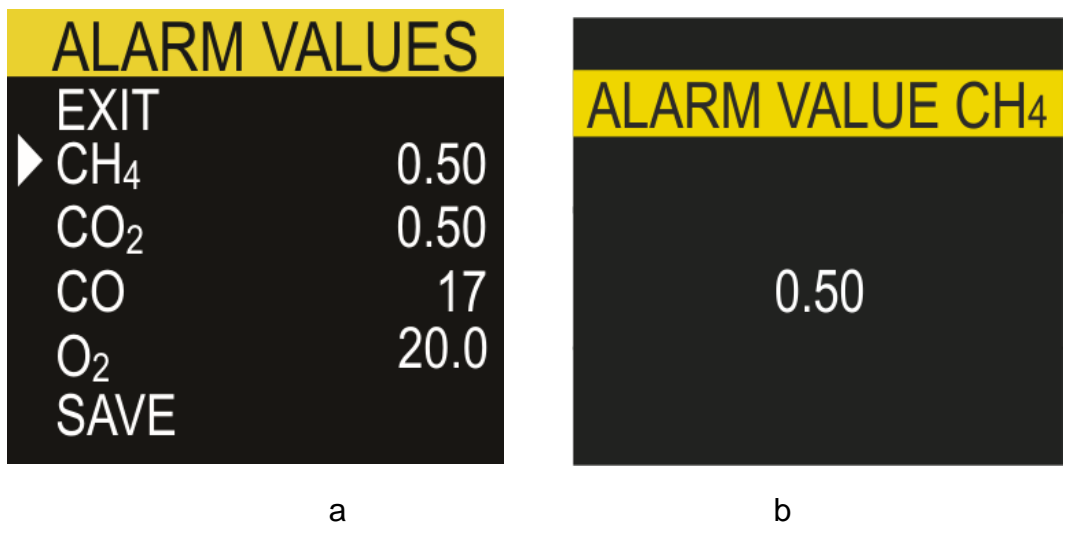

a   b

Figure 5. Display in Alarm Values Mode

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CALIBRATION. The process of calibration is described in Section 3.

PASSWORD. The section is aimed for changing the password. Entering this section, it is necessary to set a new password using «▼» and «▲» buttons, and pressing «OK» button, after which it is required to repeat the procedure to confirm the password. In case the password is correct, «PASSWORD IS CHANGED» sign will be displayed, otherwise – «PASSWORDS DO NOT MATCH» will be shown.

CLOCK. The section is aimed for setting the time and date. The «▼» and «▲» buttons are used to set time/date, «OK» button - to confirm it and move to the next parameter. The adjustable parameter is highlighted blue (See Figure 6).
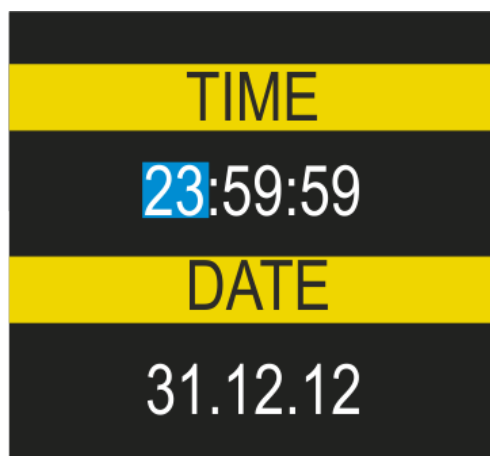

Figure 6. Display in Clock Mode

5. EXTREME MEASURED VALUES DISPLAY MODE. This mode displays the maximum (for methane, carbon monoxide and carbon dioxide channels) and minimum (for oxygen channel) measured values during the period after switching on the detector (See 1 in Figure 7). In this mode «▼» and «▲» symbols (2) are displayed next to the measured parameter (3), while time indication is replaced by «Min/Max» sign (5). Background light is changed to blue in order to distinguish this mode from Measured Data Mode. In case the maximum permissible concentration is exceeded, «▼» or «▲» symbols will turn red (4).
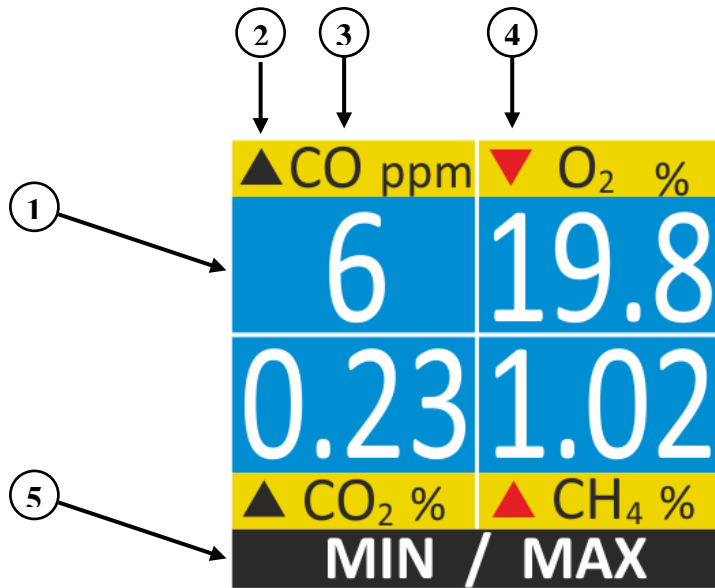
Figure 7. Extreme Measured Values Display Mode

1.4 Explosion Protection

The detectors comply with the requirements of GOST R MEK 60079-0, GOST R MEK 60079-11, GOST R 52350.29.1, GOST 24754, PB 05-618-03 and the design documents validated and approved in accordance with established procedure.

Explosion protection of the detectors is provided by «ia» intrinsically safe electrical circuit in accordance with GOST R MEK 60079-11;

The level of «ia» intrinsically safe circuit is ensured by:

- compliance with the requirements to electric strength of insulation under Section 6.3.13 of GOST R MEK 60079-11;
- compliance with the requirements of GOST R MEK 60079-11 to leakage path and electric clearance;

Explosion proof detectors with «ia» intrinsically safe electrical circuit under GOST R MEK 60079-11 have the following characteristics:

• the diameter of connecting wires of electric circuits is no less than 0.1 mm, the conductor width of electronic circuits is 0.3 mm in accordance with GOST R MEK 60079-11;

• secure levels of inductance and capacitance of the circuit elements: $L_\Sigma \leq 15$ uH , $C_\Sigma \leq 470$ mfd ;

• electric strength of insulation between intrinsically safe electrical circuit and the casing is not less than 500 V;

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- leakage paths and electric clearance between intrinsically safe electrical circuit and the casing, as well as between input and output circuits are not less than 2 mm;

- heating of elements and connectors must be lower than 150 °C, heating of control elements – not higher than 45°C at 35 °C ambient temperature;

- frictional intrinsic safety of the detector is ensured by absence of components made of light alloys;

- electrostatic intrinsic safety of GaSense detector is provided by limited surface area of nonmetallic shell of the detector in accordance with Section 7.4.2 of GOST R MEK 60079-0-2007;

- in accordance with GOST 14254, the level of the detector's ingress protection must be at least IP 54;

- intrinsically safe elements must be used at no more than 2/3 of permissible voltage and power capacity in accordance with the requirements of Subsections 7.1, 8.5 of GOST R MEK 60079-11;

- charging of the battery is allowed only by special charger;

- electric power supply of the detector must be performed from rechargeable Li-ion 1800 battery of U_0: 4.2V; I_0: 1.36A and non-rechargeable lithium battery CR1632FH of U_0=3V, I_0=165mA. The battery life should be at least 10 hours, the battery charge time is no more than 4 hours;

- tracking resistance of electric insulating materials is not lower than 100V in accordance with Table 5 (line 7) of GOST R MEK 60079-11.

1.5 Marking and Packaging

1.5. 1 Marking

Marking of the detector is made on the nameplate located on the back panel of the casing (see Figure 1 – 8). The nameplate is composed in accordance with Figure 8 and contains data specified in Table 7.

Figure 8. Detector's Nameplate

Table 7

No. in figure	Description
1	Name of the manufacturer
2	Detector's name
3	Model type
4	Conformity mark of GOST 50460 with MG07 code
5	TU 4215-001-16713073-2012, sign OS VRE VostNII No. ROSS.Ru.MG07. B00386, GOST R 52350.29.1-2010
6	GOST R 52350.29.1-2010 sign
7	Explosion protection marks - Ex ia I Ma, dust and moisture protection – IP54
8	Factory serial number, year (last two digits) and production quarter
9	Approval mark for measuring instruments in accordance with PR 50.2.107-09
10	Ambient temperature range

1.5.2 Packaging

The method of packaging, preparation for packaging, shipping containers, materials used for packaging, and layout shall comply with the manufacturer's drawings.

The detectors must be packed in a corrugated cardboard box in accordance with GOST 7376. Accompanying documents must be enclosed.

1.6 Delivery Set

The delivery set of the detector is listed in Table 8.

Table 8

Name	Quantity
Packaging	1 pcs
Detector	1 pcs.
Calibration cap, strap	1 pcs.
USB-cable	upon request
Charger	upon request
Docking station	upon request
Calibration procedure	1 copy
Instruction Manual	1 copy
Compliance Certificate (a copy)	1 copy
Permit for use issued by the Russian Federal Service for Environmental, Technological and Nuclear Supervision (Rostekhnadzor) (a copy)	1 copy

2 Setting-Up Procedures and Operation

All activities related to operation and calibration of the detector must be performed in accordance with the requirements for electrostatic protection.

The detector secures safety under compliance with the requirements (rules, conditions) stipulated by the service documentation. The detector meets the safety requirements prescribed by GOST 12.2.007.0 and GOST 12.2.003. The device belongs to the III class of electrical products by the method of protection against electric shock according to GOST 12.2.007.0.

Before using the detector, ensure the integrity of the casing, keypad, display and the «CardioLight» panel.

2.1 Functioning Test

Switch on the detector in clean air* by holding the «OK» button on the front panel, a short sound signal will be heard, which means that the sound alarm is properly functioning. After the detector is switched on, the signs and parameters must be displayed in the following order:
- name of the manufacturer (logo) and the detector;
- factory serial number of the detector;

- software name;
- CRC checksum;
- measured data, remaining battery charge and current time (see Figure 2).

Note: «Clean air» means atmospheric air without combustible gases, as well as influencing and polluting substances.

After it, the detector should be switched on for warm-up period – 2 minutes. Make sure that the detector's battery is fully charged (the remaining time is not less than 48 hours), and the «CardioLight» panel is flashing green.

In case the maximum permissible concentration is exceeded, the background of the corresponding measuring channel will turn red (See Figure 9), the «CardioLight» panel will flash red and the alarm will sound.
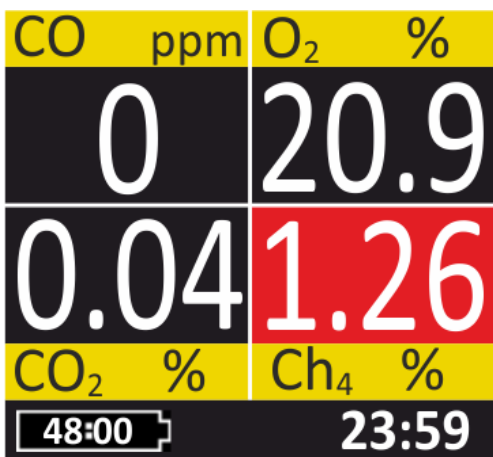
Figure 9. Display when maximum permissible
concentration of methane is exceeded

To switch off the detector, unlock the display by holding both «▼» and «▲» buttons until the loading bar disappears and you hear a beep, then press «OK» button.

2.2 Battery Charging

Charging of the detector's battery must be performed in explosion non-hazard zone using the docking station (See Figure 10a) or automatic charging set ZS-GS20. To charge the battery, plug the charger to the docking station using the corresponding connector (1) in Figure 10b.
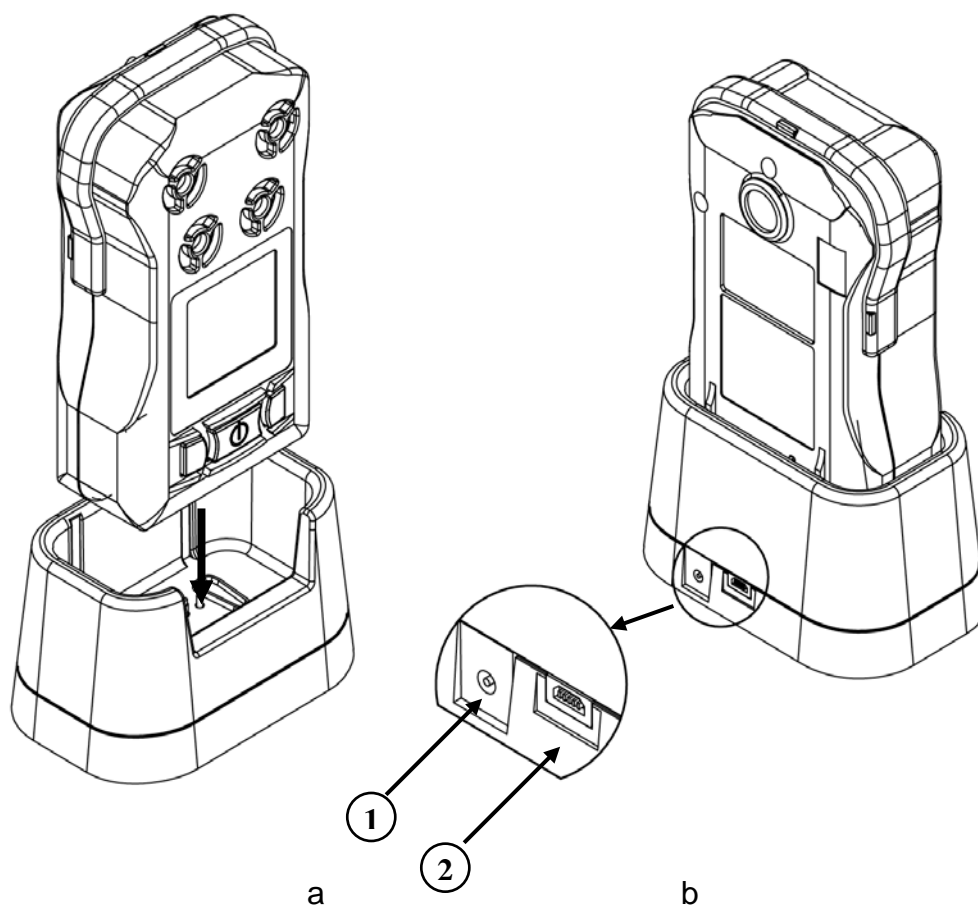
Figure 10. Plugging the detector to the docking station

The charger is powered by an AC mains of 220V, and its output voltage is 5V of DC (use only the charger included in the delivery set).

In the process of charging, the «CardioLight» panel turns red, the display shows the sign «Battery charging». When the charging is completed, the «CardioLight» panel turns green, the display shows «Battery is charged».

When the battery is expired, the detector gives long beeps, while the «CardioLight» panel and the bottom line of the display turn red. The detector will shut down in 10 minutes.

2.3 Data Transfer to PC

While connecting to a Personal Computer (PC), place the detector in the docking station, and plug USB-cable to the connector (2) in Figure 10b.

3 Calibration

Every three months the detector should pass a calibration check across the measuring channels of oxygen and carbon monoxide with the help of control gas mixtures. In case the battery was charged more than a month ago, it is necessary to calibrate methane and carbon dioxide measuring channels.

Calibration requires measuring equipment and tools specified in Table 9.

Using vessels with control gas mixtures requires the compliance with the requirements stipulated by the «Design and safety operation of the pressure vessels» (PB-10-115-96).

Table 9

No.	Item
1	Vessel with zero gas – air (hereinafter ZG air) in accordance with TU 6-21-5-82
2	Control gas mixtures. Components: methane-air (methane volume ratio is 1.5-2.5%), oxygen-nitrogen (oxygen volume ratio is 0-5%), carbon monoxide-air (carbon monoxide volume ratio is 80-120 ppm), carbon dioxide-air (carbon dioxide volume ratio is 2-3%)
3	Pressure regulator with fixed flow rate of 0.5±0.2 l/min or pressure regulator and flow meter, which allow setting the flow rate at the level of 0.5±0.2 l/min
4	Graduation cap injecting gas mixtures to the measuring section of the detector. It is supplied with the detector (See Section 1.6 of the Instruction Manual)

3.1 Procedure of methane sensor calibration is the following:

3.1.1 Assemble the calibration circuit as shown in Figure 11.
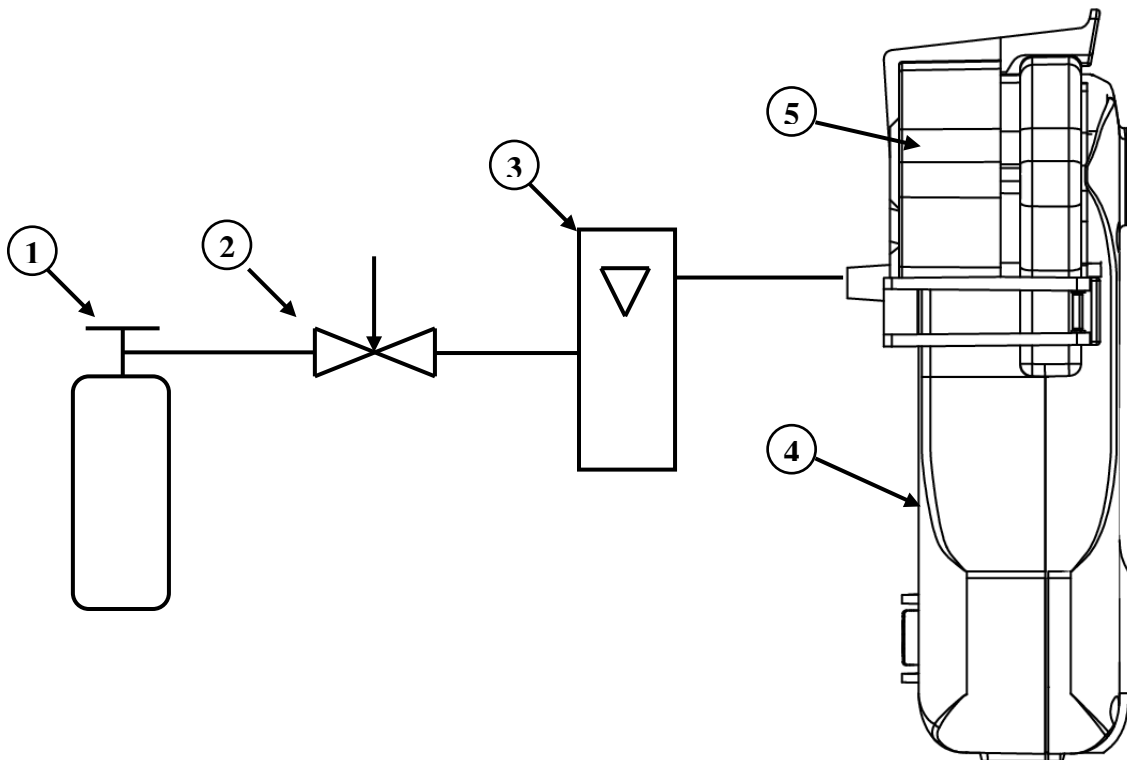

Figure 11. Calibration circuit

1- vessel with control gas mixture, 2- pressure regulator, 3- flow meter, 4- detector, 5-calibration cap

3.1.2 Connect the detector to the calibration cap, fixing the latches until they click (See Figure 12).
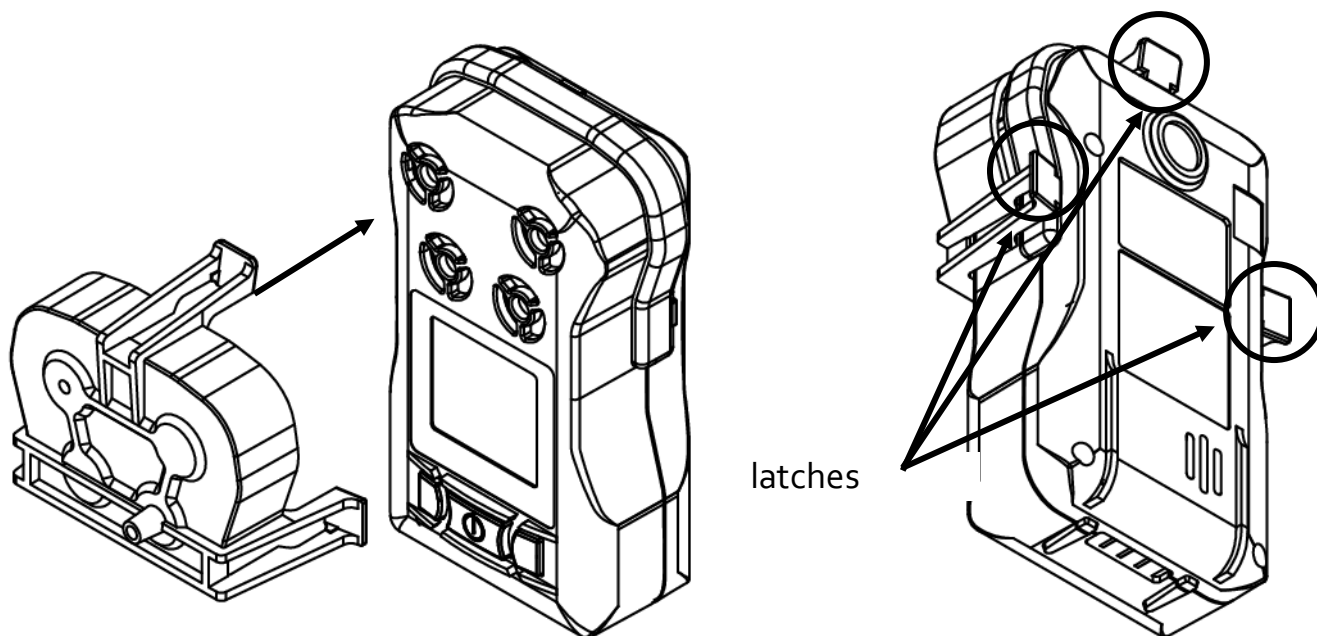

latches

Figure 12. Connecting the detector to the calibration cap

3.1.3 Switch on and warm-up the detector for about two minutes at constant ambient temperature.

3.1.4 Enter the menu of the detector calibration from the main menu, choosing «SETUP» → «CALIBRATION» (See Section 1.3.7.2-4). Enter the password in SETUP section. After that, select the measuring channel for calibration check. The display will show the calibration menu (See Figure 13a).
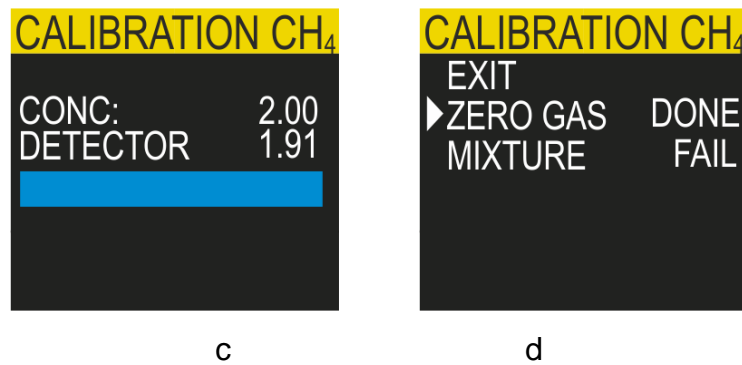

| CALIBRATION CH$_4$ |
| EXIT |
| ▶ZERO GAS |
| MIXTURE |

a

| CALIBRATION CH$_4$ |
| CONC: 2.00 |
| DETECTOR   0.08 |
| START |
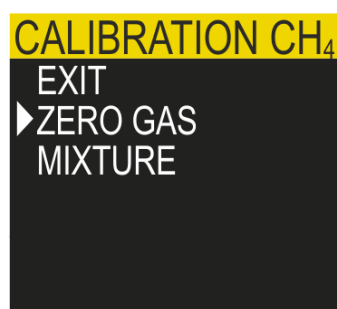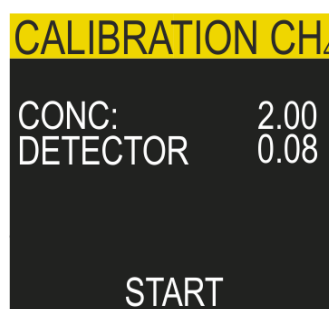
b

Figure 13. Calibration Menu

3.1.5 The next step is to select "ZERO GAS" and adjust to zero, or choose "MIXTURE" and set the concentration value.

WARNING! Setting the concentration value must be carried out only after adjusting to zero or making sure that there is no need to adjust to zero!

The concentration of the control gas mixture may be changed with «▼» and «▲» buttons (only after setting the concentration value in «MIXTURE» submenu) – See Figure 13b.

3.1.6 Start filing control gas mixture through a cap of the device and press «OK» button to launch the calibration. The flow rate of the control gas mixture must be regulated by a flow meter at the level of 0.5±0.2 l/min. Control gas mixture must be supplied during the period of time equal to triple value of t(90) for a selected gas (methane - 90 seconds, for the remaining gases - 180 seconds) until the loading bar disappears (See Figure 13c), and the display returns to the first stage of calibration (See Figure 13d). In case the calibration is successful, the display shows «Done» in front of «Zero Gas» and «Mixture» signs, otherwise it shows «Fail», which means that calibration must be carried out again.

4 Maintenance and Verification

4.1 Maintenance

All maintenance operations on the detector must be performed in compliance with the requirements for electrostatic protection. It should also be guided by the requirements of the «Instructions for inspection and audit of mining explosion-proof equipment» (Safety Regulations in Coal Mines).

Maintenance of the detector must be carried out before each use.

Maintenance of the device falls into external inspection and preventive maintenance. External inspection requires visual examination of the detector to determine faults and malfunctions.

Preventive maintenance includes the following activities:
- cleaning the keypad, display, signs on the nameplate from dust and dirt;
- checking structural elements for mechanical damage;
- checking the sealing.

4.2   Verification

Verification is performed in accordance with MP 2012-1 «GaSense portable Multigas detectors. Verification procedure» developed and approved by the State Centre for Testing Measuring Instruments the Federal Unitary Enterprise All-Russian Research Institute of Physical and Radio Technical Measurement (VNIIFTRI) dated August 10, 2012.

Verification period is 12 months.

5 Storage and Shipment
5.1   Storage

The detector should be stored in a heated room at 2-35°C and the maximum relative humidity of 80%.

5.2 Shipment

The detector can be transported in containers by all types of transport without limitation of distance, speed and flight altitude at the ambient temperature from -50°C to 60 °C, and relative humidity of 25-95% at 25 °C.

The detector in the shipping container sustains transport vibration with 30 m/s^2 acceleration at impacts frequency of 80-120 per minute.

6 Troubleshooting

The detector is equipped with a self-diagnostics system which allows detecting malfunctions. If the device functions irregularly or does not work, check possible problems listed in Table 10.

Table10

Problem	Possible cause of trouble	Reaction
Nothing is displayed when the power is turned on	Low battery charge	Charge the battery in accordance with Section 2.1 of Instruction Manual
The detector displays «Malfunction» when the power is turned on	Internal problem of the detector	Address the maintenance department of the manufacturer

7 Warranty and Repair

The manufacturer guarantees that the detector complies with the technical specification requirements TU 4215-001-16713073-2012 upon condition that a consumer observes the terms of transportation, storage and use.

The guaranteed service life is 12 months from the purchase date. During the warranty period, the manufacturer is obliged to assist in operation of the detector, and rectify any faults found, provided that a consumer observes the terms of transportation, storage and use. Warranty and post-warranty repairs are carried out by the manufacturer:

Kuzbass Regional Mining Center of Labour Safety (Gorniy TSOT Ltd.), 1 Sosnovy Boulevard, Kemerovo, 650002

Unauthorized access inside the casing of the detector may result in loss of the right for manufacturer's warranty maintenance.

WARNING! THE DEVICE SHOULD BE PROTECTED FROM SHOCKS AND DROPS AND EXPOSURE OF SENSORS AND THE SPEAKER OF SOUND ALARM TO WATER AND DIRT.

8 Acceptance Certificate

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GaSense Portable Multigas detector; factory serial No. _____ complies with the technical specifications TU 4215-001-16713073-2012 and is classified as fit for operation.

Date of manufacture: _____20__

Stamp here   Responsible for acceptance _____\