«RAPSYSTEM» LLC

Rapid Pro RPR3-X-X-X Gas Detectors

Operation Manual

RPR3 OM

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The User manual is intended to provide information about the device, its operating principle, and to ensure the correct use of the Rapid Pro RPR3-X-X-X Gas Detectors (hereinafter referred to as the Gas Detector or GD).

1 Operating Description

1.1 Purpose

Fixed Gas Detectors are designed for continuous automatic monitoring and measuring of the monitored gas in the atmosphere and vapors of flammable liquids, including petroleum product vapors, when mixed with air at gas and oil refining enterprises, pipelines, as well as on gas pipeline fittings for industrial and domestic use.

Gas Detectors (GDs) are fitted with:

- output of unified analogue current signal 4-20 mA, proportional to the measured value of the monitored gas and (or) output of digital signal RS-485 (ModBus protocol).

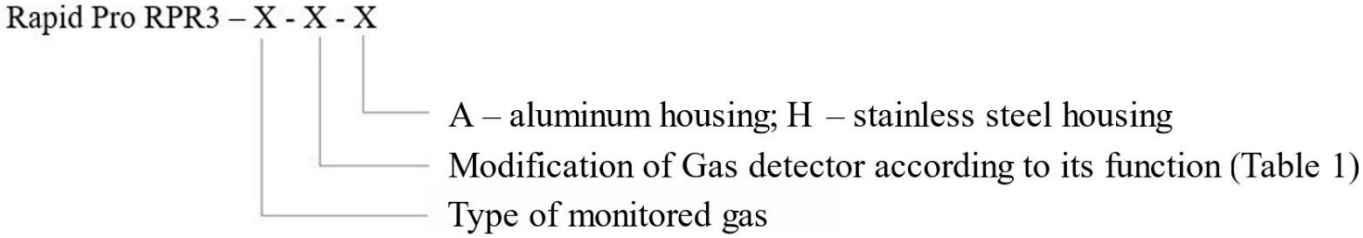
Additionally (in various modifications, which are detailed in Table 1), GDs may also have:

- an indication of the concentration of the controlled gas on a digital display panel;
- a rechargeable battery for uninterrupted operating;
- up to 4 relay outputs for 1st, 2nd, 3rd alarm and fault;
- heating capability;
- HART - protocol

Gas Detectors comply with the requirements of the technical documentation set КДГА.00.00.000 (КДГА- Gas Detector Documentation Set (hereinafter referred to as GDDS), ГОСТ 13320-81 (ГОСТ- State Standard (hereinafter referred to as GOST)), ТР ТС 012/2011 (ТР ТС - Technical Regulations of the Customs Union (hereinafter referred to as TR CU)), ГОСТ 31610.0-2019 (IEC 60079-0:2017), GOST 31610.11-2014 (IEC 60079-11:2011), GOST IEC 60079-1-2013, and the TYPE DESCRIPTION OF THE MEASURING INSTRUMENT Rapid Pro RPR3 Gas Detectors.

1.1.1 Gas detector is produced in various modifications depending on the set of components and functions.

Gas detector designations depending on the modification when ordering them



Example of Gas detector designation for carbon monoxide measurement, without a relay control signal

("dry contact" type), equipped with an LED display and a rechargeable battery power supply, with an aluminum housing: "Rapid Pro RPR3-CO-5-A".

1.1.2. Gas detectors are used to monitor explosion safety at general industrial facilities classified as class B-1a (according to ПУЭ classification (ПУЭ - Regulations on Electrical Installations), Chapter 7.3, 1985 edition), where the formation of explosive mixtures of industrial methane and other flammable gases of category IIC, group T6 is possible.

1.2 Technical characteristics

1.2.1 Gas detectors are manufactured in various modifications depending on their functional design (Table 1) and the types of gases being monitored (Table 1.1).

Table 1

Designation	Functional Design
Rapid Pro RPR3-X-1-X*	Measurement of monitored gas without LED indication, output of unified (standardized) 4-20 mA signal about the volume fraction of the controlled gas and (or) RS-485 protocol ModBus
Rapid Pro RPR3-X-2-X	Measurement of the monitored gas without LED indication. Built-in rechargeable battery. Output of a standardized 4-20 mA signal about the volume fraction of the controlled gas and (or) via RS-485 Modbus protocol
Rapid Pro RPR3-X-3-X	Control and indication of the monitored gas on LED indicator. Output of a standardized 4-20 mA signal about the volume fraction of the controlled gas and (or) via RS-485 Modbus protocol
Rapid Pro RPR3-X-4-X	Measurement of the monitored gas without LED indication. Output of a standardized 4-20 mA signal about the volume fraction of the controlled gas and (or) via RS-485 Modbus protocol. Availability of relay outputs.
Rapid Pro RPR3-X-5-X	Control and indication of the monitored gas on LED indicator. Built-in rechargeable battery. Output of a standardized 4-20 mA signal about the volume fraction of the controlled gas and (or) via RS-485 Modbus protocol
Rapid Pro RPR3-X-6-X	Control and indication of the monitored gas on LED indicator. Built-in rechargeable battery. Output of a standardized 4-20 mA signal about the volume fraction of the controlled gas and (or) via RS-485 Modbus protocol. Availability of relay outputs.
Rapid Pro RPR3-X-7-X	Control and indication of the monitored gas on LED indicator. Output of a standardized 4-20 mA signal about the volume fraction of the controlled gas and (or) via RS-485 Modbus protocol. Availability of relay outputs.
Rapid Pro RPR3-X-8-X	Measurement of the monitored gas without LED indication. Built-in rechargeable battery. Output of a standardized 4-20 mA signal about the volume fraction of the controlled gas and (or) via RS-485 Modbus protocol. Availability of relay outputs.

Note:

1) For all versions, the addition of the HART protocol is optionally available (by special order).

2) * For the Rapid Pro RPR3-X-1-X modification, the standardized 4-20 mA signal is output via a current loop (current consumer) or as a current source in a three-wire connection. For all other modifications, the

standardized 4-20 mA signal is output via a three-wire connection.

1.2.2 Continuous operation time without adjustment (stability of readings), months, not less than – 6; allowable deviation of the output signal into the negative region (zero drift) no more than – 0.4 mA (2.5% of Lower Explosive Limit) per month.

1.2.3 The return factor upon alarm activation shall be no less than – 0.8.

1.2.4 Warm-up time, minutes, no more than:

- For sensors: photoionization, thermocatalytic, infrared, semiconductor — 3;
- For electrochemical sensors — 10.

1.2.5 Limits of permissible additional error under operating conditions as fractions of the basic error:

- ±0.2 for every 10 °C change in ambient temperature;
- ±0.2 for every 10% change in the relative humidity of the gas mixture;

1.2.6 Number of digits of the digital display - 4

For Rapid Pro RPR3-X-1-X, RPR3-X-2-X, RPR3-X-4-X, RPR3-X-8-X - no indication is provided.

1.2.7 Parameters of the intrinsically safe circuit:

Version without heating: Ui = 5 V; Ii = 400 mA; Ci = 10 μF; Li = 1 mH

Version with heating: Ui = 24 V; Ii = 150 mA; Ci = 10 μF; Li = 1 mH

1.2.8 The Gas detector features:

a) explosion protection level and type: 1Ex db ib IIC T6 Gb X (photoionization, infrared, semiconductor, or electrochemical sensor); 1Ex db IIC T6 Gb X (thermocatalytic sensor).

b) Enclosure protection rating against external influences**:** IP66/IP68 according to GOST 14254–2015 (IEC 60529:2013) / depth: 1.5 meters; immersion duration: 30 minutes.

1.2.9 The Gas detector ensures:

a) zero reading adjustment;

b) sensitivity adjustment;

c) adjustment of alarm trigger thresholds;

d) continuous automatic monitoring of the volumetric concentration of the monitored gas at the Gas detector installation site:

- for the Rapid Pro RPR3-X-3-X, RPR3-X-5-X, RPR3-X-6-X, and RPR3-X-7-X modifications — display of current monitored gas concentration values on the LED indicator.
- output of the relay control signal rated for switching current of 1A at voltages up to 30V — for the Rapid Pro RPR3-X-4-X, RPR3-X-6-X, RPR3-X-7-X, and RPR3-X-8-X modifications.

- discharge monitoring, activation of discharge alarm, and disconnection of the discharged battery — for the Rapid Pro RPR3-X-2-X, RPR3-X-5-X, RPR3-X-6-X, and RPR3-X-8-X modifications.

e) formation and output of a standardized signal (4–20 mA) representing the volumetric concentration of the monitored gas for the Rapid Pro RPR3-X-1-X modifications — via two-wire or three-wire connection; for other modifications — via three-wire connection or RS-485 ModBus protocol;

f) for the Gas detector modification with a rechargeable battery (or upon request) — a “black box” function that records current values of the monitored gas volumetric concentration, temperature, and calendar time.

g) adjustment of trigger threshold range from 10% to 95% of the measurement range.

1.2.10 The Gas Detector has the following reliability indicators according to GOST 27.003-90:

- Mean Time Between Failures (MTBF) of the Gas detector, hours, not less than -30000;
- established trouble-free operating time, hours, not less than -3000;
- average service life, years, not less than -10;
- average time to restore operational condition, hours, not more than -0.6;
- average preservation period before commissioning, year, not less than -1.

1.2.11 Power supply voltage of the Gas detector from a Direct Current (DC) network: (24 ± 6) V, power consumption not exceeding 1.5 W (for the Arctic version, not exceeding 5 W).

1.2.12 The Gas detector meets the operational requirements specified in Table 2.

1.2.13 Overall dimensions of the Gas detector: no more than 213 mm × 140 mm × 93 mm — made of aluminum, and no more than 195 mm × 146 mm × 112 mm — made of stainless steel.

1.2.14 The mass of the Gas detector is no more than 2 kg for the aluminum version and 3.6 kg for the stainless-steel version.

1.2.15 A failure criterion is considered to be the gas detector’s inability to perform the following functions: monitoring the volumetric concentration of the monitored gas; outputting control signals (“dry contacts”) (for modifications with this function); basic measurement error exceeding allowable values and being non-adjustable; and cessation of transmission of the standardized signal to the communication line.

Reliability Parameters are ensured when following the transportation, storage, and operation rules outlined in the technical documentation.

Table 2

Influencing factor	Norm	
1. Ambient temperature, °C	Rapid Pro RPR3-X-2-X; RPR3-X-5-X; RPR3-X-6-X; RPR3-X-8-X (Version with rechargeable battery)	from -10 to +60
	Rapid Pro RPR3-X-1-X; RPR3-X-3-X; RPR3-X-4-X; RPR3-X-7-X	from -40* to +60
2. Atmospheric pressure, kPa (mmHg)	from 87.8 to 119.7 (660–900)	
3. Relative humidity, %, at 35 °C	to 95	

* Available as a special order — Arctic version operating from -60 °C to +60 °C;

1.3 Kit:

a) Rapid Pro RPR3-X-X-X gas detector – 1 pc.;
b) Software disk – upon request;
c) RPR3 Operation Manual – 1 pc. per delivery;
d) Calibration procedure MP-525/07-2023 – 1 pc. per delivery;
e) RPR3-X-X-X Passport – 1 pc.;
f) Gas inlet nozzle – 1 pc. per delivery;
g) Weather protection hood – available upon special order;
h) Pipe mounting kit – available upon special order;
i) Air duct mounting kit – available upon special order;
j) Cable gland – available upon special order;
k) Magnetic key – available upon special order.

1.4 Device Structure and Operation Principle

1.4.1 Figures 1 and 1.1 show the gas detectors. The processor unit is the main control component of the gas detector. The overall view of the processor unit is shown in Figures 1.2 and 1.3. For the Rapid Pro RPR3-X-1-X modification, the gas detector operates via a current loop or a three-wire connection, with an output signal of 4–20 mA. The processor unit manages data requests from the assembled sensor and generates output signals of 4–20 mA and RS-485 for the respective modifications. It also controls the operation of the battery and the display unit. Optionally, the processor unit includes a real-time clock and memory for data storage, which contains calendar time and information about alarm threshold exceedances.

For versions with a rechargeable battery: battery model: lithium-ion battery LP103454LC-PCM-LDA00596, 3.7 V DC, 2000 mAh (located inside the device housing behind the control board).

The processor unit monitors the supply voltage, automatically switches from mains power to the internal battery pack when necessary, and switches the battery pack to charging mode once mains power is restored.

For modifications with an indicator: The processor unit controls a 4-character LED indicator or, optionally, an OLED indicator. There is also a modification with an LCD indicator designed for connection via a two-wire scheme.

Table 3

Operating statuses of LEDs and current loop values

Operating mode	Current value	“П” LED Indicator	“БП” LED Indicator
Normal operating mode: powered from mains (12–32 V) / powered from battery	4–20 mA corresponding to the measured value	Not lit	Lit green/ Lit red
Reaching the concentration value of the first threshold	4–20 mA corresponding to the measured value	Lit yellow	No colour change
Reaching the concentration value of the second threshold	4–20 mA corresponding to the measured value	Lit red	No colour change
Transition of the battery to charging mode			Lit yellow
Service mode	3,5 mA	Lit yellow	Lit green/ Lit red
Values dropping below zero	3,7-4,0 mA	Not lit	Lit green/ Lit red
No connection with the sensor	2 mA	Lit yellow	Lit green/ Lit red

Magnetic sensors are located on the processor unit, marked on the front panel as  . The magnetic key supplied with the gas detector allows adjustment of sensitivity and zero settings without opening the housing.

The switching unit converts the 24 VDC input voltage into the required 5 V and 3.3 V voltages to power the electronics on the board and the sensor assembly. For modifications that include a battery unit for uninterrupted operation, the battery is connected to the motherboard connector X10. In the event of a power line failure, gas monitoring at the gas detector’s installation site and data recording in the “black box” will continue for at least 4 hours.

Connector X3 is used to connect the switching unit to the processor unit, providing power to the processor unit and enabling digital data exchange with the “intelligent sensor.”

The assembled sensor is an “intelligent sensor” connected to the switching unit connector X4 (for the two-wire connection modification with an LCD indicator – X7). The switching unit supplies 3.3 V

power to the assembled sensor, which exchanges data with the processor unit. The data includes: sensor type, measurement range, calibration data ("zero," sensitivity), correction coefficients, trigger thresholds, units of measurement, and other service information.

This architecture facilitates and simplifies the maintenance of gas detectors. Each unit is a standalone device, with the processor unit serving as the main component, to which peripheral devices such as the indicator and sensor are connected. Communication between these units is carried out via a digital interface.

The motherboard has reverse polarity and overvoltage protection.

In the Arctic version of the gas detector, there is a heating element assembly for the sensor chamber; the heating elements are activated when the temperature reaches -20 °C.

The kit includes software for working with the "intelligent sensor". Instructions for using the software are provided on the disc included in the package.

1.4.2 The operating principle of the oxygen and toxic gas concentration monitoring circuit is based on the electrochemical measurement method. The sensor converts the concentration value of the respective gas in the atmosphere into an electrical signal, the current or voltage of which is proportional to the concentration level.

The operating principle for monitoring methane, combustible gases, and fuel is based on the change in resistance of the thermocatalytic, semiconductor, photoionization, or optical sensor depending on the monitored gas and measurement range.

The operation of the gas detector involves:

- analysis of device operability;
- processing data received from the sensor;
- displaying readings on the indicator for the corresponding modification;
- comparing the current measured parameter value with a preset threshold value, upon exceeding which control signals are issued for the corresponding modification;
- generation of a standardized 4-20 mA signal or creation and transmission of a data packet via RS-485 communication line.

The gas detector is powered by a 24 ± 6 V direct current (DC) power supply.

1.4.3 The external electrical connection diagram is shown in Figure 2.

In the two-wire connection scheme, the 4-20 mA information signal is transmitted via the current loop. The switching unit terminals marked on the board as +24 V and -24 V are supplied with power at 24 (± 6) V.

When connecting the gas detector using a three-wire scheme, +24 V DC is applied to the processor unit terminals; the current output is marked on the board as 4-20 mA/HART.

The gas detector has an RS-485 output via a connector marked on the board as **A, B**.

1.4.4 Measuring instruments required for adjustment and calibration of the gas detector are specified in the calibration procedure “Gas detectors Rapid Pro RPR3 X-X-X. Calibration Procedure” МП-525/07-2023.

1.5 Labeling and Sealing

1.5.1 The gas detector is labelled as follows:

- trademark of the manufacturer;
- conventional name of the product (Rapid Pro RPR3-X-X-X);
- serial (sequential) number according to the manufacturer’s classification;
- month and year of manufacture;
- chemical formula of the monitored gas;
- measurement range;
- type of explosion protection: 1Ex db ib IIC T6 Gb X (photoionization, infrared, semiconductor, or electrochemical sensor); 1Ex db IIC T6 Gb X (thermocatalytic sensor) according to GOST 31610.0-2019 (IEC 60079-0:2017);
- degree of protection against external influences (IP66/IP68) according to GOST 14254–2015 (IEC 60529:2013);
- rated supply voltage;
- designation of technical specifications;
- unified EAC (Eurasian Conformity) mark for product circulation in the Customs Union member states (for sale within the Customs Union market);
- special Ex explosion safety mark according to Technical Regulations of the Customs Union 012/2011;
- certificate number of conformity with the requirements of TR CU 012/2011 (for sale in the market of the Customs Union member states).
- for products sold only within the Republic of Uzbekistan, the inscription in the state language: "O‘zbekistonda ishlab chiqarilgan", which means "Made in Uzbekistan" in Uzbek;
- for products supplied for export, the inscription in English "Made in Uzbekistan" or in the language of the importing country, as per the agreement.
- the approval mark for the type of measuring equipment (it may be placed in the operational documentation).
- the inscription: ‘Do not open in hazardous areas!" (“Ogohlantirish - elektr tarmog'idan uzib oching”).

The labelling must be retained throughout the lifetime of the product.

1.5.2 To prevent unauthorized opening of the gas detector during operation, the body of the gas detectors is sealed with a special screw or a seal.

1.6 Packaging

1.6.1 The packaging must ensure the safety of the gas detectors during transportation.

1.6.2 The method of packing, preparation for packing, transport container and materials used for packing of gas detectors shall comply with the design documentation and requirements set forth in GOST 23170.

1.6.3. Gas detectors should be packed in a polyethylene film bag according to GOST 10354 and placed in a cardboard box according to the current normative documentation of the manufacturer.

1.6.4 Group packaging is allowed, where the gas detectors are placed in a collective container (a box made of corrugated cardboard).

1.6.5 Upon agreement with the customer, it is allowed to deliver gas detectors in other types of packaging, as well as without packaging material (polyethylene film package), provided that the safety of products during transportation and storage is ensured.

2. Gas Detector Operation

2.1 Preparation for Operation.

Upon receipt of the gas detector from the manufacturer's factory, check the integrity of the package, absence of mechanical damage by external inspection; open the package, check the completeness, check the serial number of the gas detector with the number specified in the passport. Ensure the integrity of the gas analyzer's casing. Zero calibration is performed during startup and then whenever the readings deviate from zero by an amount exceeding the limits of the main error. Before putting the gas detector into operation and after it has been stored for more than three months, the gas detector should be checked for operability as per section 2.2.2.

2.2 Intended Use

2.2.1 Depending on the monitored gas, gas detectors are designed to measure the volumetric concentration of methane, combustible gases, oxygen, and toxic gases. If during operation the concentration of methane, combustible gases, or toxic gases exceeds the acceptable threshold value of the alarm trigger, or if the oxygen level falls below the permissible level, staff must leave the hazardous gas area.

Zero calibration is performed at startup and subsequently whenever the readings deviate from zero by an amount exceeding the limits of the primary measurement error.

2.2.2 Gas detector check.

Connect the gas detector to a 24 V power supply, and the segments of the LED indicators (if available) will light up. The unified current output signal will correspond to the readings on the indicators.

After the warm-up period is complete, apply the appropriate Calibration gas mixture of the

monitored gas — for example, for Rapid Pro RPR3-CH4-3-X, methane with a concentration exceeding the alarm threshold by the value of the basic error. The gas detector readings must correspond to the concentration of the Calibration gas mixture within the limits of the basic error, and for the respective modifications, the alarm must be triggered. The standardized output signal must correspond to the measured value.

2.2.3 During operation, do not allow dust, dirt, or moisture to enter the air intake holes of the gas-sensitive sensor of the gas detector. Periodically remove contaminants using a stream of dry compressed air (at low pressure). The installation should be done in such a way that the sensor chamber faces downward. The gas detector should be protected from impacts on the housing, vibrations, and mechanical damage. Dropping or falling the device from a height of more than 0.2 meters is prohibited.

2.2.4 Diagnostics of operation and condition of the gas detector is carried out when it is connected to 24 V power supply.

2.2.5 IT IS FORBIDDEN to open the gas analyzer's enclosure in explosive environments without disconnecting the power supply.

2.2.6 Attention! The inspection and maintenance of electrical installations must be carried out only by qualified personnel, whose training includes practical experience in working with electrical equipment and its installation methods, as well as studying the requirements of the GOST IEC 60079-17-2013 standard and the corresponding technical norms and regulations. This staff must undergo regular retraining and possess the appropriate certificates. When installing and operating gas detectors, the following regulations must be followed: GOST IEC 60079-14-2011, GOST 31610.17-2012 (IEC 60079-17:2002); “Rules for the operation of electrical installations of consumers” Chapter 3.4 “Electrical installations in explosive areas”; “Occupational Safety Rules for the Operation of Electrical Installations” and this Operation Manual.

2.2.7 Attention! The letter "X" following the Ex-marking indicates that the gas detectors must be operated under the following "special" conditions:

- gas detectors must be installed in a vertical position with the measuring head facing down;
- fire barrier must be protected against mechanical damage and impact;
- flameproof connections are not repairable;
- the viewing window of the gas detectors is designed with a low degree of danger of mechanical damage, it is necessary to protect it from mechanical damage and impacts;
- WARNING – DANGER OF POTENTIAL ELECTROSTATIC CHARGE;
- Only Ex cable glands of subgroup IIC with explosion protection type Ex d, which have a valid Certificate of Conformity to TR CU 012/2011 and are approved for use in hazardous (explosive) areas, may be installed on Rapid Pro RPR3-X-X-N and Rapid Pro RPR3-X-X-A gas detectors.

2.2.8 The gas detector should be installed with the sensor facing down (considering the possibility of future maintenance) in locations where the monitored gases are most likely to appear, and secured to a wall or other flat surface using screws or bolts through the holes in the housing.

2.2.9 The device should be installed in the controlled area and secured near the zone where gas emissions are likely to occur. The installation height of the device depends on the physical properties of the gases. Since gases that are heavier than air tend to accumulate at the lower part of the room, the sensors should be installed at a height of 30-50 cm from the floor. Lighter gases (such as H_2, CH_4, etc.) will rise to the upper part of the room, so the sensors should be installed at the top of the room. For gases with a density similar to that of air (e.g., CO), the placement is determined by the airflow characteristics in the controlled volume. The presence of forced ventilation or air conditioning systems can completely alter the natural flow direction, and consequently, the locations of the gas detector. With constantly operating exhaust ventilation, all airflows with a speed greater than 0.1 m/s will direct the air with impurities towards the exhaust point, following the shortest path from the leakage site, regardless of the gas density. This is especially true for gases with a density close to that of air, such as carbon monoxide, oxygen, and hydrogen sulfide.

The gas detector should be positioned in such a way as to allow easy access for maintenance and functionality checks.

2.2.10 The overall diameter of the incoming cable (including insulation/braiding) through the cable gland should be selected so that it tightly fits the rubber seal on the cable gland.

2.2.11 After installing and connecting the cable, the cover of the housing must be tightly closed.

2.3 Gas Detector Setup.

2.3.1 Gas Detector Setup.

The setup mode is intended for setting the initial parameters for the Gas detector operation.

The instructions for using the software to configure the gas detector are provided along with the software (SW) supplied with the gas detector.

The parameters of the sensor that can be adjusted:

- adjustment of zero readings;
- adjustment of sensitivity;
- setting the alarm trigger thresholds;
- data extraction from the “black box”;
- setting the temperature value for heater activation for the Arctic version;
- adjustment of the current output value;
- adjustment of the display resolution;
- changing the address of the device during digital communication;

- adjustment of the measurement scale of the device;

- adjustment of the units of measurement.

For setup, the following is required:

a) remove the gas detector cover;

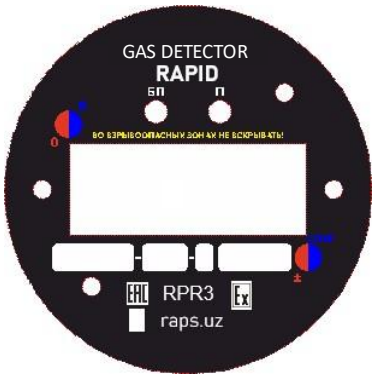
b) connect the PC (computer) to the sensor via the corresponding connector on the switching unit, marked with the symbols “**A**” and “**B**”. For the version with an LCD indicator and a two-wire connection scheme, press the SB1 button (to switch to the ON mode). After configuring the gas analyzer via the RS-485 interface, press the SB1 button again to switch to the OFF mode.

Attention – If the setup mode of the gas detector is not turned off, it may result in the inability to generate the output current value at the 4 mA level;

To set the zero readings, after warming up and purging the sensor with clean air or nitrogen (if permissible by the measurement principle), zero readings should be set via the software installed on the computer, according to the SW instructions.

Zero calibration is performed at startup and thereafter whenever the readings deviate from zero by an amount exceeding the limits of the main error.

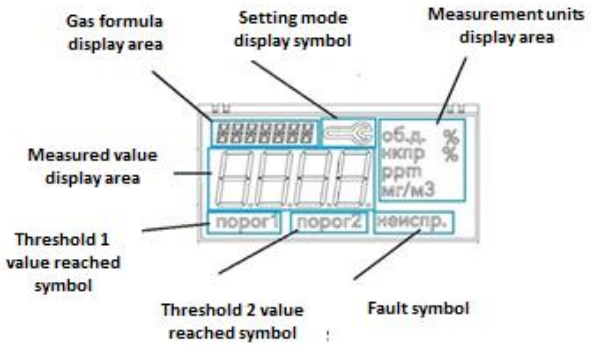
It is also possible to adjust the zero reading through the device's protective glass using a magnetic key, without opening the device. For this purpose, the magnetic key with the side marked in red color is brought to the indicator in the place of the corresponding marking 0 (the left upper corner above the digital indicator), and the message “CAL0” appears on the indicator, after that the magnetic key is brought to the field marked «СОХР» with the side of the key marked in blue color (the right lower corner below the indicator).



Indicator panel

The “zero” value appears on the indicator.

For the gas detector version with an LCD indicator for two-wire connection, the symbols of the indicator are shown in the figure below.



The symbols on the LCD screen for the two-wire connection modification.

c) When adjusting the alarm threshold, connect the computer to the sensor through the corresponding connector on the switching unit, and make the necessary adjustments to the alarm trigger values.

d) To adjust sensitivity, it is recommended to supply the sensor with Calibration gas mixture (hereinafter refers to as CGM) selected within 40–70% of the measurement range. For oxygen gas analyzers, ambient air can be used for sensitivity calibration until the readings stabilize, with a flow rate of 200–500 mL/min. Similarly, sensitivity can also be adjusted through the protective glass of the device using a magnetic key, without opening the device. For this purpose a magnetic key (with the side of the key marked with blue color) is brought to the indicator in the place of the corresponding marking S (the left upper corner above the digital indicator) and the message “CAL1” appears on the indicator, then the magnetic key (with the side of the key marked with red color) is brought to the field marked «+/-» (the right lower corner below the indicator), the value corresponding to the last calibration mixture appears on the indicator and the readings start to change up or down. To change the direction of the value remove the magnetic key and again bring it to the field «+/-», after which the reading changes in the opposite direction from the previous one. After setting the number corresponding to the applied CGM on the indicator, bring the magnetic key (with the side of the key marked in blue color) «СОХР».

e) after correcting the zero readings and sensitivity, check the output signal.

The output signal is calculated using the following formula:

$$I_{out} = (\text{gas analyser reading} / \text{end of scale value}) * 16 + 4$$

Then carry out the test. For example, carbon monoxide (CO) - end of scale value is 2000, the supplied CGM is 660 ppm, then the output signal value is 9.28 mA.

2.4 Explosion Protection Measures.

Annex A contains the gas detector Safety Drawing. The safety of the gas detector is ensured by the use of explosion-proof enclosures and is marked as 1Ex db ib IIC T6 Gb X (photoionization,

infrared, semiconductor, or electrochemical sensor); 1Ex db IIC T6 Gb X (thermocatalytic sensor) in accordance with GOST 31610.0-2019 (IEC 60079-0:2017).

The parts of the enclosures are made from materials that do not pose a risk of igniting a gas mixture due to sparks generated by friction or impact.

Flameproof enclosure type “d” explosion protection is achieved through the mechanical strength of the flameproof enclosure, the maintenance of proper clearances, and by ensuring that threaded flameproof joints have at least five full undamaged threads of engagement and an axial length in accordance with the requirements of GOST IEC 60079-1-2013. Current-carrying and grounding terminals are equipped with spring washers to prevent self-loosening.

The enclosure must be labelled with warning notices and a plate indicating the explosion protection marking.

Safety requirements must be observed when setting up, testing gas detectors, using cylinders with CGM, pressure cylinders.

Only personnel who have studied the occupational safety regulations at the enterprise and are familiar with the Operating Manual are allowed to work with the gas detector.

3. Technical Maintenance

3.1 Safety Measures

3.1.1 Maintenance work, scheduled maintenance and elimination of possible malfunctions and failures must be carried out only in rooms with supply and exhaust ventilation and control of the content of explosive substances in the atmosphere. It is not permitted to release CGM into the room air.

3.1.2 The size of the room where the work is carried out and the volume of the cylinder containing the diluted gas (methane) must be such that, in the event of cylinder depressurization, the released gas does not create a methane concentration in the air exceeding 0.5% by volume.

3.1.3 The premises where work with the gas detector is carried out must comply with the “Fire Safety Regulations for Industrial Enterprises” approved by the Fire Safety Authority.

3.1.4 When using cylinders containing pure methane or air, safety requirements specified in GOST 13320-81 must be observed.

3.1.5 It is PROHIBITED to operate the gas detector with a damaged housing or after the expiration of the last state verification. The gas detector must be protected from impacts to the housing, vibrations, and mechanical damage. Dropping or throwing the device is not allowed. It is also PROHIBITED to open the device housing in hazardous (explosive) areas.

3.1.6 To prevent damage to thermocatalytic sensors (for combustible gases), it is STRICTLY PROHIBITED to expose the sensors to pure methane, propane, butane, or other combustible gases and vapors at concentrations exceeding 100% of the Lower Explosive Limit (for example, supplying gas from a lighter).

3.1.7 Wiping the gas detector housing with alcohol, alcohol-based substances, or solvent-based compounds is NOT ALLOWED.

3.1.8 It is PROHIBITED to operate the gas detector in areas with elevated concentrations of acidic and alkaline vapors (above the maximum permissible concentration for these components) and vapors of organosilicon compounds.

It is not recommended to operate the gas detector at concentrations of the monitored gases exceeding the specified measurement ranges.

3.1.9 Operation of the gas detector for CO, H_2CO, H_2S, and NO gases is NOT ALLOWED:

• At elevated concentrations of sulfur-containing gases and vapors (exceeding 10 times the Maximum Permissible Concentration);

• in the presence of hydrogen at concentrations above 1000 mg/m³;

• in the presence of vapors of ethyl and other alcohols, as well as vapors of organosilicon compounds.

3.1.10 When disassembling the gas detector housing to access the sensor (e.g., for sensor replacement, filter cleaning, etc.), it is necessary to get acquainted with the structure of the gas detector components (Figures 1 and 1.1) **in advance**. Only the part called the **Sensor Bushing** should be unscrewed (counterclockwise — after loosening the bushing's locking mechanism). The **Sensor Housing** and the **Sensor Housing Retainer** **should not be** unscrewed to avoid damaging the electrical cable from the sensor module and the **Sensor module connection port** (see Fig. 1.5).

If it is necessary to remove the **Sensor Housing**, the following steps must be taken:

a) First, disconnect the electrical cable connector of the sensor module from the **Switching Module**;

b) Remove the **Switching Module**;

c) Unscrew the **Sensor Housing** after loosening the **Sensor Housing Retainer**.

3.2 Technical Maintenance of the Gas Detector.

3.2.1 Gas analyzer maintenance must be performed by specialized organizations in accordance with Guidance Document 16407-89.

3.2.2 Types of repairs (maintenance) possible under operating conditions are provided in Annex B.

3.2.3 After maintenance involving sensor replacement, adjust the zero readings and sensitivity, and perform the inspection as specified in section 2.2.2 of this Operation Manual.

4 Storage

4.1 The gas detector, sets of spare parts, as well as tools and accessories, must be stored in locked, ventilated warehouse premises only in packaged form—either in containers or without containers—at temperatures between 5°C and 40°C, with a relative humidity of up to 80% at 25°C, and in the absence of acidic, alkaline, or other aggressive impurities in the air. During winter, the transportation packaging must only be opened after the items have been kept for at least 2 hours in a dry, heated room.

The designated storage period is 12 months.

5 Transportation

5.1 Gas detectors must be transported by any type of covered transport, except maritime transport, under conditions not lower than group 5 (ОЖ4) according to GOST 15150-69. Gas detectors in packaging

must be protected from exposure to atmospheric precipitation.

5.2 The placement and securing of gas detectors packed in crates during transportation must be carried out in accordance with the requirements of the transportation regulations for the respective types of transport.

6 WARRANTY FROM THE MANUFACTURER

6.1 The manufacturer shall guarantee that the gas detector complies with the requirements of these technical specifications provided that the conditions of operation, transportation, and storage are observed.

6.2 The warranty period for the gas detector (excluding the sensor and battery pack) is 24 months from the date of sale. The warranty period for the sensor and battery pack is 12 months from the date of sale.

6.3 During the warranty period, the manufacturer undertakes to repair identified factory defects free of charge, or to replace faulty parts or the entire device if it cannot be repaired at the manufacturer's facility.

6.4 Claims will not be accepted in cases of mechanical damage to the gas detector (GD), presence of moisture or dirt inside the housing, clogging of the sensor intake port, reduced sensor sensitivity due to operation in environments with unacceptably high concentrations of active gases, modifications/changes to the GD design, or incorrect connection of power and interface lines. In such cases, the warranty becomes void, and repairs will be carried out on a chargeable basis.

6.5 Replacement of a lost certificate for the device and records of the state verification is a chargeable service.

6.6 The service life of the device, provided that the operating, transportation, and storage conditions specified in this document are followed, and with timely replacement of gas sensors, batteries, and consumables, is 10 years.

6.4 If the date of sale and the stamp of the trading company are missing on the warranty card, the warranty period shall be calculated from the date the gas detector was manufactured by the manufacturer.

6.5 Warranty and post-warranty repairs shall be carried out at the manufacturer's facility as well as at authorized service centers.

The address of the manufacturer is indicated in the gas detector's certificate.

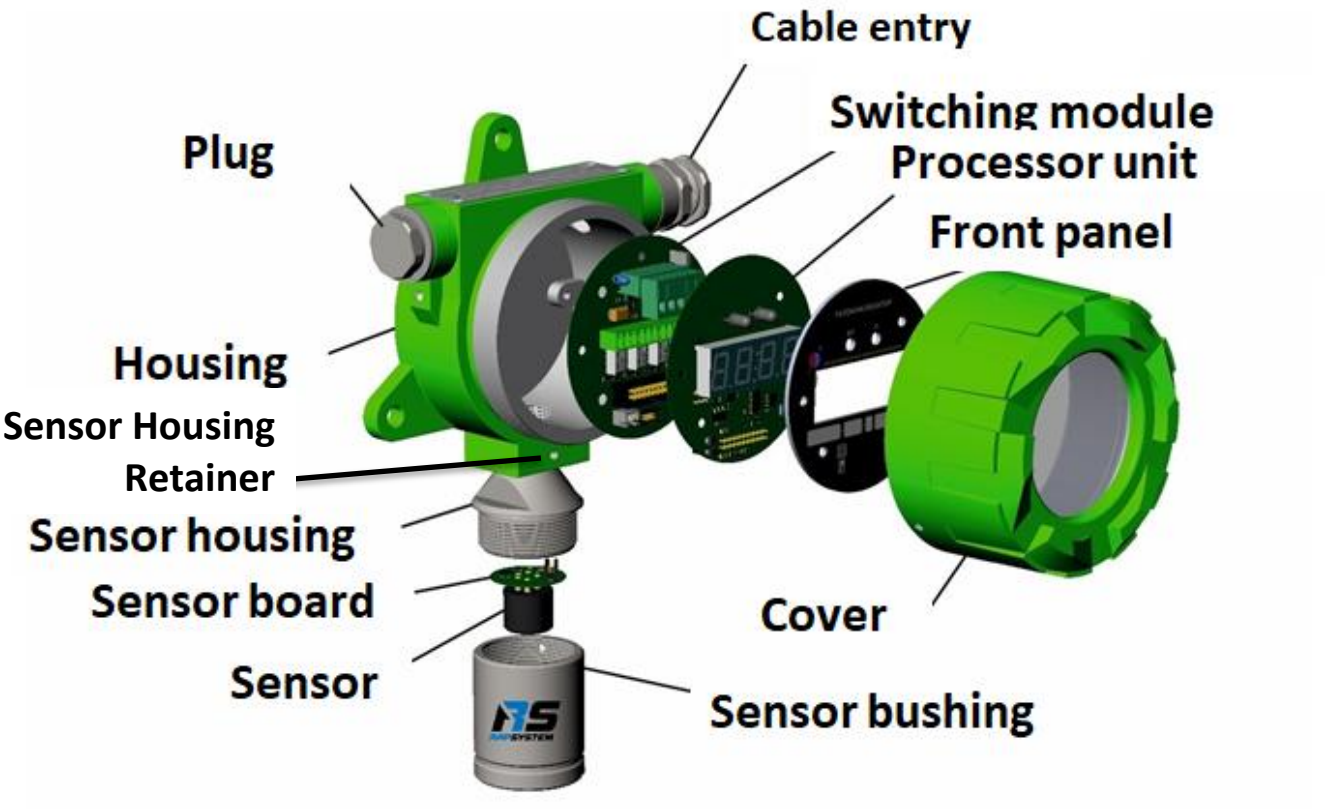


Figure 1
General view of the Rapid Pro RPR3-X-X-A gas detector

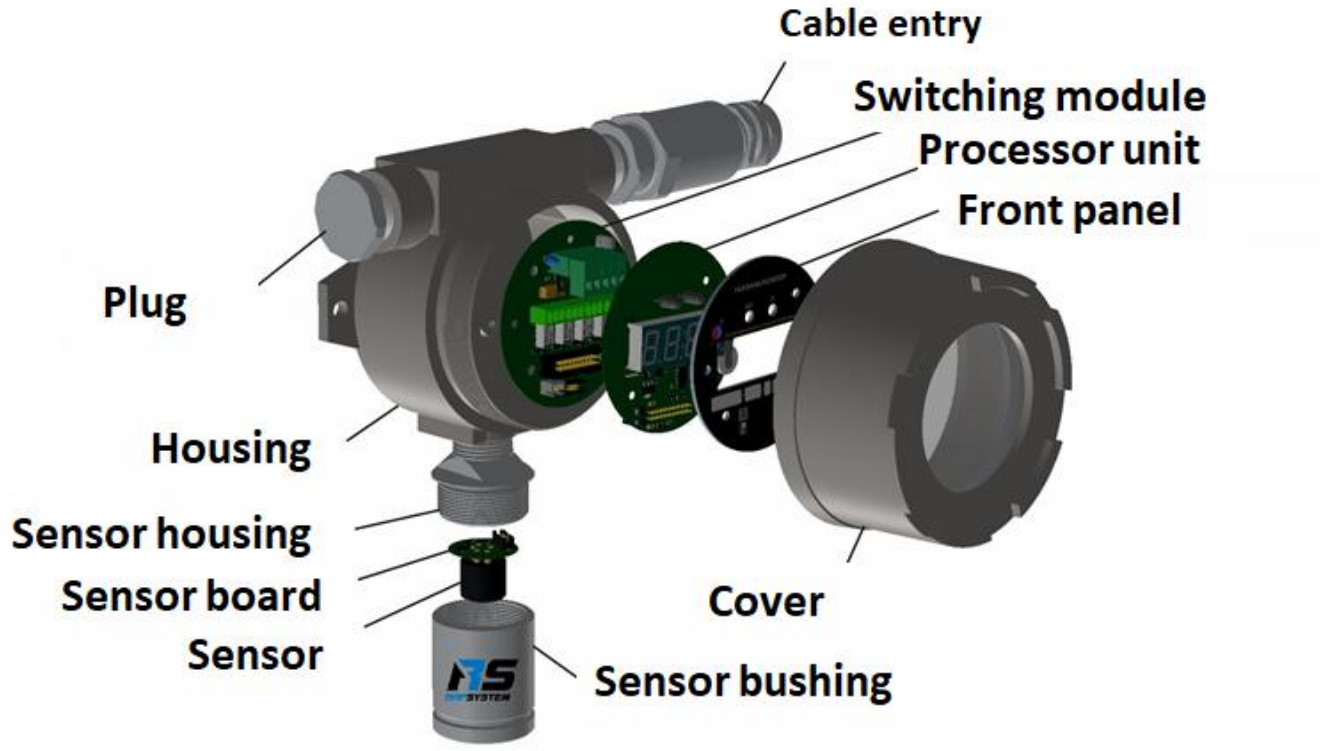


Figure 1.1
General view of the Rapid Pro RPR3-X-X-N Gas detector

Figure 1.2

General view of the processor unit, top view

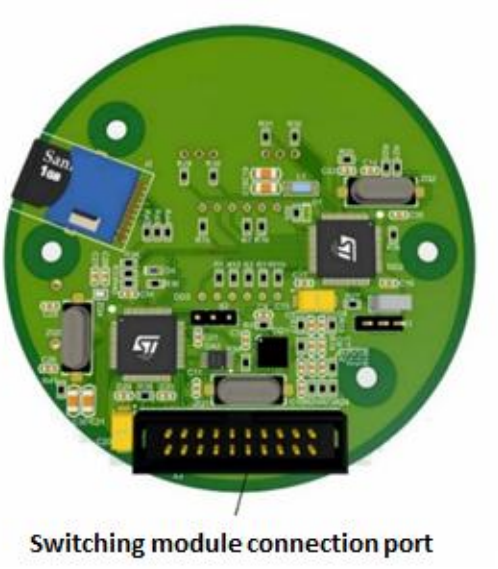


Figure 1.3

General view of the processor unit, top view

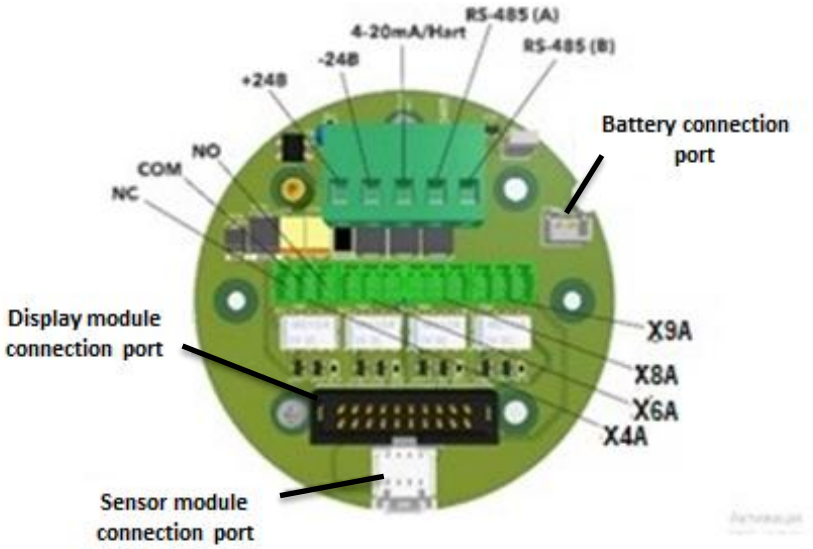


Figure 1.4

General view of the switching unit.

Connectors X4A, X6A, X8A, X9A for connection to relay contacts

Designations: NO – normally open, NC – normally closed, COM – common.

The purpose of the relay contacts of the switching unit for single-channel configuration is presented in Table 4.

Table 4

Connector	Thresholds	Normally open	Normally closed
X4A	1st threshold	1,2	2,3
X6A	2nd threshold	1,2	2,3
X8A	Fault	1,2	2,3
X9A	3rd threshold	1,2	2,3

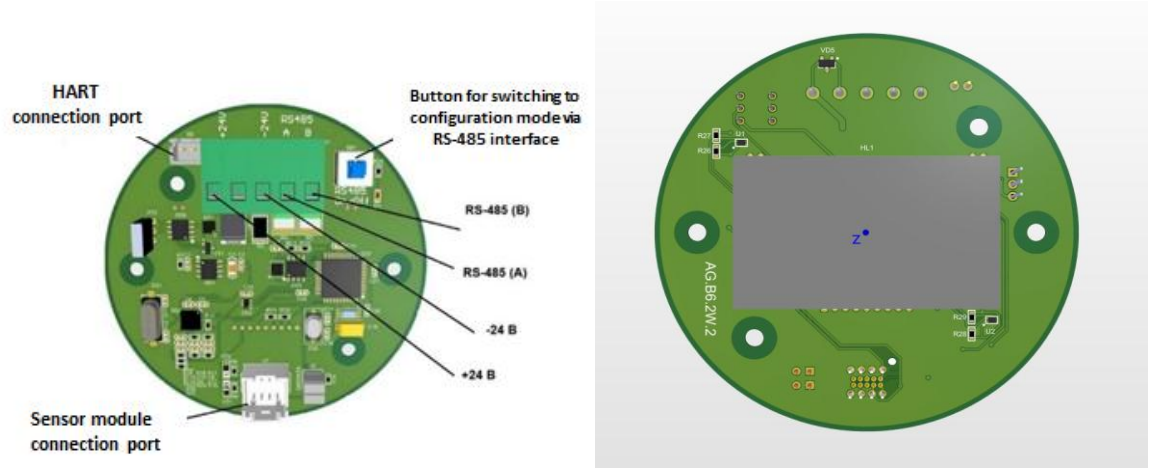


Figure 1.5 General view of the processor unit for the version with an LCD indicator for two-wire connection with a passive current output.

Gas detector has an RS-485 output via a connector labeled A, B on the board.

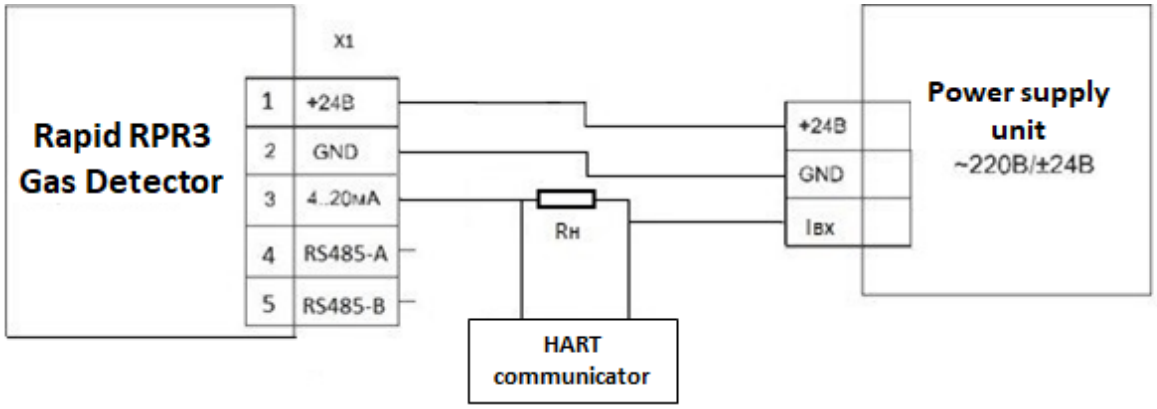


Figure 2. Wiring diagram for a 3-wire connection.

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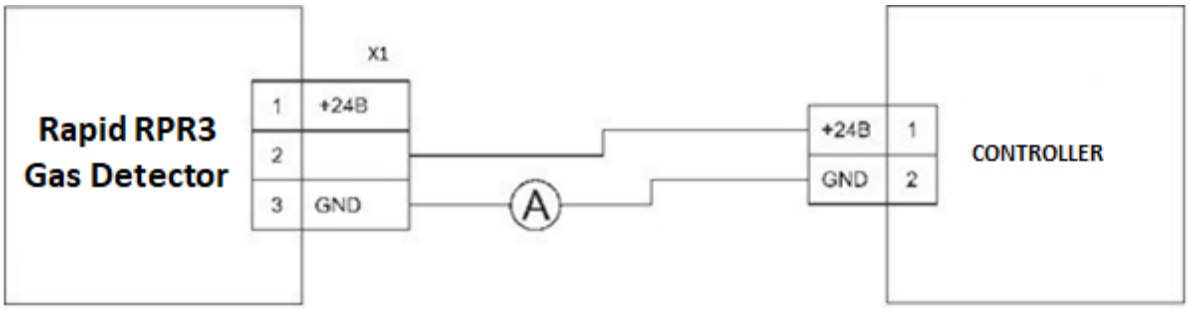


Figure 2.1. Wiring diagram for a 2-wire connection of the respective modification.

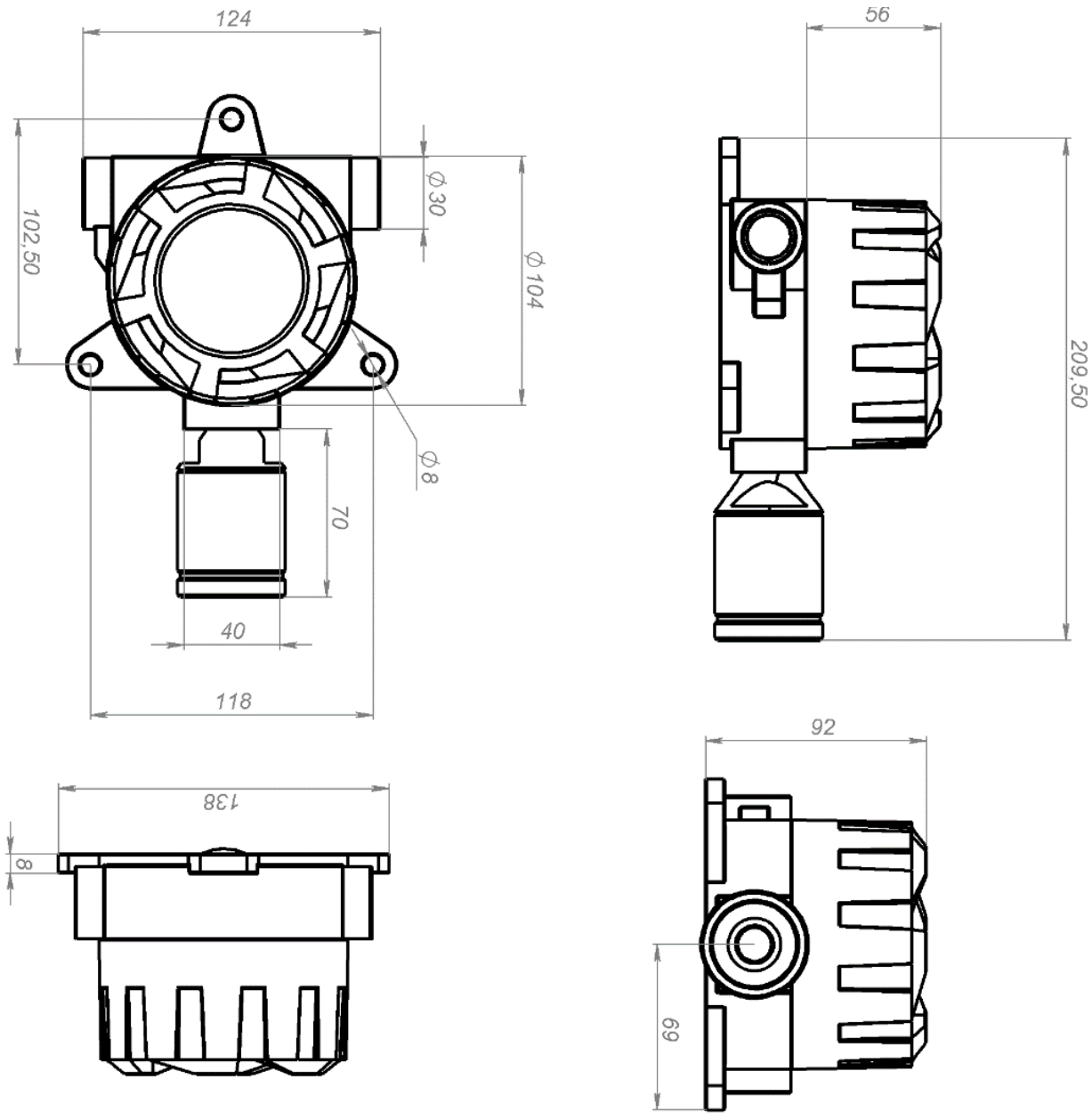


Figure 3. Mounting and overall dimensions

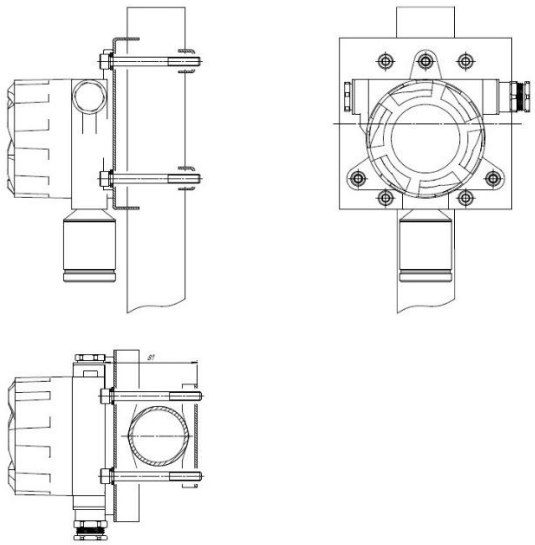


Figure 4. External view of the installation with Gas detector plate mounted on a pipe — Option 1

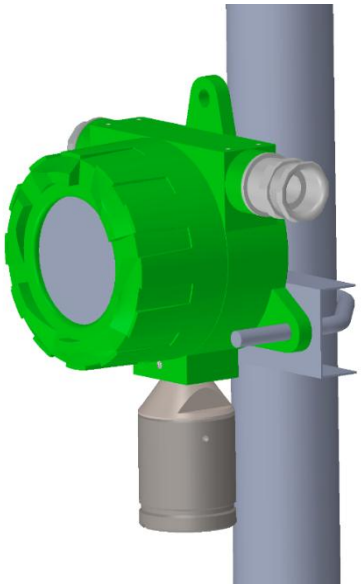


Figure 5. External view of the installation with Gas detector mounted on a bracket on a pipe — Option 2.

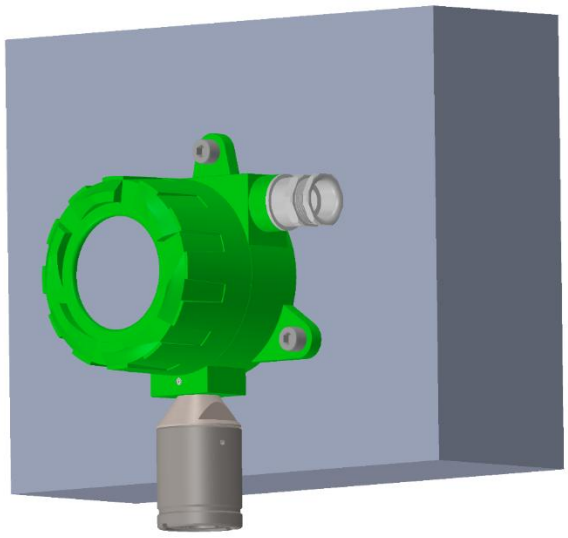


Figure 6. View of Gas detector mounted on a wall

When installing Gas detector on a pipe, a pipe mounting kit is used (supplied by separate order).

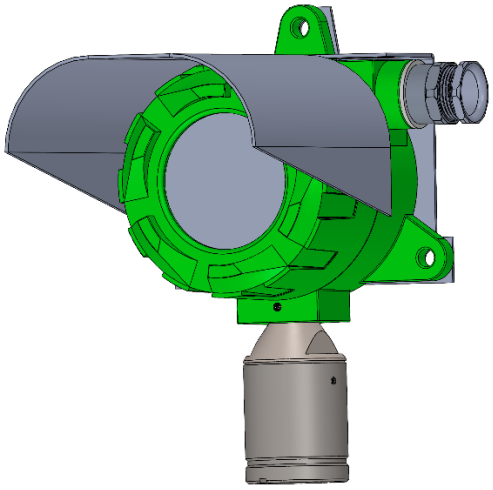


Figure 7. External view of the Rapid Pro RPR3-X-X-A Gas detector with protective hood

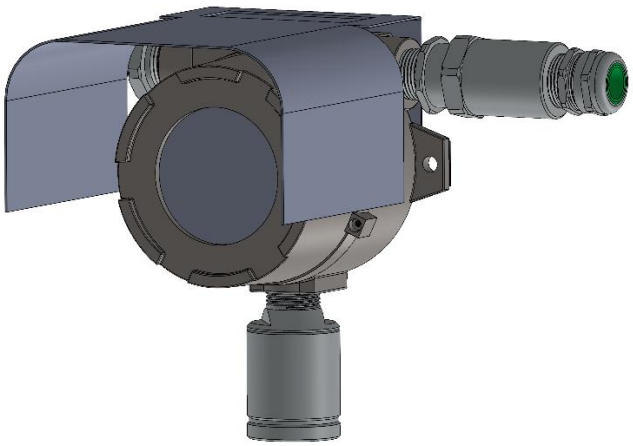
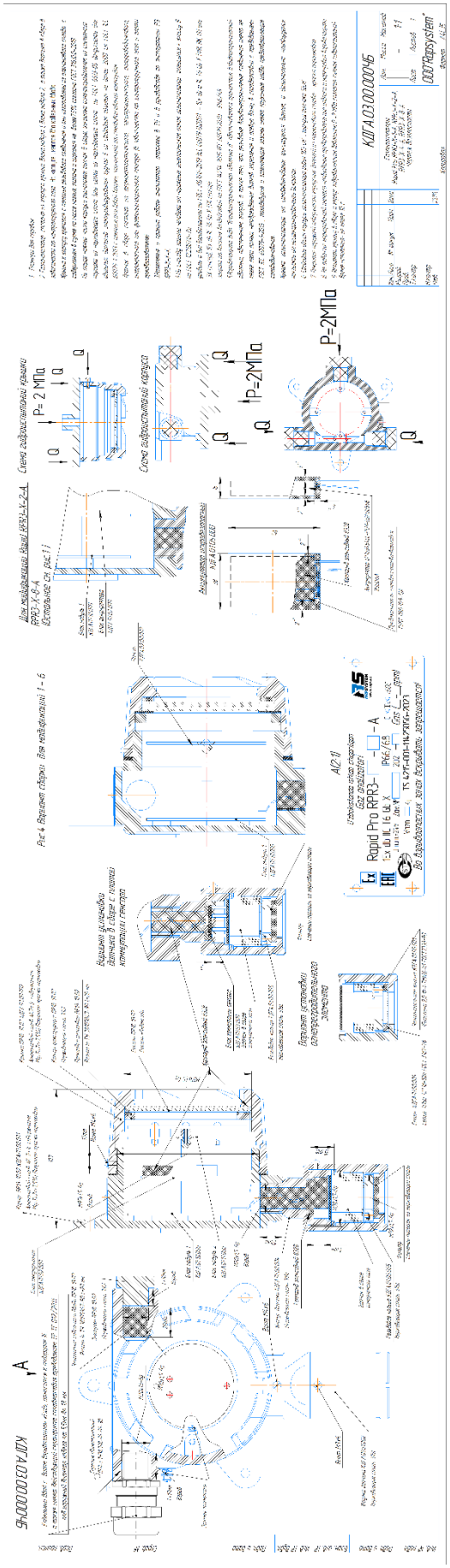


Figure 8. External view of the Rapid Pro RPR3-X-X-N Gas detector with protective hood

Annex A

Safety Drawing



Annex B

Routine maintenance of the Rapid Gas detector

1. Before repairing or servicing the gas detector, the housing must be cleaned of dirt using a wiping cloth. Moisture and dust must also be removed from the surface. It is NOT ALLOWED to wipe the body of the gas analyzer with alcohol or alcohol-containing compounds, as well as on the basis of solvents.

2. Repairs are carried out by an electrical fitter with a qualification of at least grade 4, who has undergone training and certification in the prescribed manner at the manufacturer's factory, or by the manufacturer's service department.

3. The list of possible malfunctions and methods for their elimination are indicated in Table 5.

Table 5

Name of the malfunction, external manifestations, and signs	Probable cause	Description of the sequence of operations during repair
1. No measurements	The sensor filter is clogged.	Clean the filter *
	The sensor has malfunctioned.	Replace the sensor *
2. False triggering of the alarm	The alarm trigger threshold is incorrectly set	Adjust the alarm trigger threshold.
3. No 4-20 mA data output signal from the gas detector	The line length is too long or the current output line is broken.	Check the contact at the connector. Measure the resistance of the data transmission line. Adjust the output signal on the gas detector.
4. Dashes (- - - -) appear in the middle of the indicator	No communication with the intelligent sensor	Check the integrity of the sensor cable, and check the cable connection with connector X2. *
5. Dashes (_ _ _ _) appear at the bottom of the indicator.	No sensor calibrations	Perform zero value settings and sensitivity adjustment.
6. Dots on the indicator "**ОБР**"	No communication between the "intelligent sensor" and the sensor, or sensor failure.	Unscrew the sensor's protective cap. Ensure there is contact between the sensor and the "intelligent sensor" module *

* - Before performing any actions, it is necessary to familiarize yourself with p. 3.1.10.

For other types of malfunctions, repairs are carried out at the manufacturer's facility or in specialized repair organizations.

Description of MODBUS RTU exchange protocol

BASIC COMMANDS

Commands and packet structure

0x03 reading rewritable registers Holding Registers

0x04 — Read Input Registers (read-only registers)

MODBUS Register

INPUT Registers (30 001 – 40 000)

Name	Register number	Read command	Record command	Description
Device Status	31001	4	-	Device status word 1st Byte: Bit 0: Onboard clock Bit 1: Onboard memory Bit 2: Temperature sensor presence Bit 3: Indicator Bit 5: Device battery 2nd Byte (sensor status, if only one sensor is connected): **0 bit: sensor not available** 1 bit: driver error 2 bit: sensor memory corrupted 3 bit: temperature sensor error 4 bit: sensor ADC is corrupted 5 bit: sensor has been initialised 6 bit: at least one measurement of this sensor type has been made **7 bit: sensor not configured / not calibrated**
Alarm Status	31002	4	-	Alarm Status Register 0 bit: warning threshold exceeded 1 bit: alarm threshold exceeded
Current loop value	31003	4	-	Current value in the current loop (Value*100)
Device Year	31005	4	-	Current device time in the format YYYY-MM-DD HH-mm-ss
Device Month	31006	4	-	
Device Day	31007	4	-	
Device Hour	31008	4	-	
Device Minute	31009	4	-	
Device Second	31010	4	-	
Board Temperature	31012	4	-	Motherboard temperature (Value*100)
Sensor Primary Signal High	32001	4	-	Signal from the main sensor (Integer32)
Sensor Primary Signal Low	32002	4	-	
Sensor Secondary Signal High	32003	4	-	Signal from sensor #2 (Integer32)
Sensor Secondary Signal Low	32004	4	-	
Sensor 3 Signal High	32005	4	-	Signal from sensor #3 (Integer32)
Sensor 3 Signal Low	32006	4	-	
Sensor 4 Signal High	32007	4	-	Signal from sensor #4 (Integer32)
Sensor 4 Signal Low	32008	4	-	
Sensor 5 Signal High	32009	4	-	Signal from sensor #5 (Integer32)
Sensor 5 Signal Low	32010	4	-	
Sensor 6 Signal High	32011	4	-	Signal from sensor #6 (Integer32)
Sensor 6 Signal Low	32012	4	-	

Sensor Primary Calc Zero Offset High	32101	4	-	Calculated current zero offset value (Integer32)
Sensor Primary Calc Zero Offset Low	32102	4	-	
Sensor Primary Calc Sensitivity Coef High	32103	4	-	Calculated current sensitivity coefficient value (IEEE754 binary32)
Sensor Primary Calc Sensitivity Coef Low	32104	4	-	
Sensor Secondary Calc Zero Offset High	32105	4	-	Calculated current zero offset value (Integer32)
Sensor Secondary Calc Zero Offset Low	32106	4	-	
Sensor Secondary Calc Sensitivity Coef High	32107	4	-	Calculated current sensitivity coefficient value (IEEE754 binary32)
Sensor Secondary Calc Sensitivity Coef Low	32108	4	-	
Sensor Primary Value High	33001	4	-	Concentration value of the main sensor (IEEE754 binary32)
Sensor Primary Value Low	33002	4	-	
Sensor Primary Status	33003	4	-	Sensor status word 1st byte: 0 bit: sensor not available 1 bit: driver error 2 bit: sensor memory corrupted 3 bit: temperature sensor error 4 bit: sensor ADC is corrupted 5 bit: sensor has been initialised 6 bit: at least one measurement of this sensor type has been made **7 bit: sensor not configured / not calibrated** 2nd byte: 0 bit: Threshold 1 (1 triggered) 1 bit: Threshold 2 (1 triggered) 2 bits: Additional threshold 5 bit: Sensor heating 7 bit: Heating on
Sensor Secondary Value High	33004	4	-	Concentration value of auxiliary sensor #2 (IEEE754 binary32)
Sensor Secondary Value Low	33005	4	-	
Sensor Secondary Status	31006	4	-	Sensor status word (see Sensor Primary Status)
Sensor 3 Value High	33007	4	-	Concentration value of auxiliary sensor #3 (IEEE754 binary32)
Sensor 3 Value Low	33008	4	-	
Sensor 3 Status	31009	4	-	Sensor status word (see Sensor Primary Status)
Sensor 4 Value High	33010	4	-	Concentration value of auxiliary sensor #4 (IEEE754 binary32)
Sensor 4 Value Low	33011	4	-	
Sensor 4 Status	31012	4	-	Sensor status word (see. Sensor Primary Status)
Sensor 5 Value High	33013	4	-	Concentration value of auxiliary sensor #5 (IEEE754 binary32)
Sensor 5 Value Low	33014	4	-	
Sensor 5 Status	31015	4	-	Sensor status word (see. Sensor Primary Status)
Sensor 6 Value High	33016	4	-	Concentration value of auxiliary sensor #6 (IEEE754 binary32)
Sensor 6 Value Low	33017	4	-	
Sensor 6 Status	31018	4	-	Sensor status word (see. Sensor Primary Status)
Sensor 7 Value High	33019	4	-	Concentration value of auxiliary sensor #7 (IEEE754 binary32)
Sensor 7 Value Low	33020	4	-	
Sensor 7 Status	33021	4	-	Sensor status word (see. Sensor Primary Status)
Sensor 8 Value High	33022	4	-	Concentration value of auxiliary sensor #8 (IEEE754 binary32)
Sensor 8 Value Low	33023	4	-	
Sensor 8 Status	33024	4	-	Sensor status word (see. Sensor Primary Status)

HOLDING Registers (40 001 – 50 000)

Name	Register number	Read command	Record command	Description
Sensor ID	40401-40416	3	-	Sensor identifier
Version	40417-40419	3	-	Firmware version
Calibration Zero Point for all sensors	40021	3	6	Calibration of all sensors (value "0" as a constant)
Calibration Zero Point for all sensors	40022	3	-	Calibration of all sensors (status of last calibration)
PRIMARY SENSOR				
Sensor Scale Min High	41001	3	-	Minimum range value (IEEE754 binary32)
Sensor Scale Min Low	41002	3	-	
Sensor Scale Max High	41003	3	-	Maximum range value (IEEE754 binary32)
Sensor Scale Max Low	41004	3	-	
Sensor Scale Dimension	41005	3	-	Dimension code
Sensor Threshold Warning High	41011	3	-	Warning threshold (IEEE754 binary32)
Sensor Threshold Warning Low	41012	3	-	
Sensor Threshold Alarm High	41013	3	-	Emergency threshold (IEEE754 binary32)
Sensor Threshold Alarm Low	41014	3	-	
Calibration Primary Zero	41021	3	6	Zero calibration (concentration value)
Calibration Primary Zero Status	41022	3	-	Zero calibration (status)
Calibration Primary Zero Signal High	41023	3	6	Zero calibration point, signal value
Calibration Primary Zero Signal Low	41024	3	6	
Calibration Primary Span	41026	3	6	Second point calibration
Calibration Primary Span Status	41027	3	-	Second point calibration (status)
Calibration Primary Span Signal High	41028	3	6	Second point calibration, signal value
Calibration Primary Span Signal Low	41029	3	6	
Sensor 1 substance code	41031-41046	3		Substance code in asci; if the character is insignificant, 0xff will be set
SECONDARY SENSOR				
Sensor Threshold Warning High	42011	3	-	Warning threshold (IEEE754 binary32)
Sensor Threshold Warning Low	42012	3	-	
Sensor Threshold Alarm High	42013	3	-	Emergency threshold (IEEE754 binary32)
Sensor Threshold Alarm Low	42014	3	-	
Sensor Scale Dimension	42005	3	-	Dimension code
Sensor 2 substance code	42031-42046	3		Substance code in asci; if a character is insignificant, it will be set to 0xff
3 SENSOR				
Sensor Scale Dimension	43005	3	-	Dimension code
Sensor 3 substance code	43031-43046	3		Substance code in asci; if a character is insignificant, it will be set to 0xff Substance code in asci; if a character is insignificant, it will be set to 0xff
4 SENSOR				
Sensor Scale Dimension	44005	3	-	Dimension code
Sensor 4 substance code	44031-44046	3		Substance code in asci; if a character is insignificant, it will be set to 0xff Substance code in asci; if a character is insignificant, it will be set to 0xff
5 SENSOR				
Sensor Scale Dimension	45005	3	-	Dimension code
Sensor 5 substance code	45031-45046	3		Substance code in asci; if a character is insignificant, it will be set to 0xff

				Substance code in asci; if a character is insignificant, it will be set to 0xff
6 SENSOR				
Sensor Scale Dimension	46005	3	-	Dimension code
Sensor 6 substance code	46031-46046	3		Substance code in asci; if a character is insignificant, it will be set to 0xFF Substance code in asci; if a character is insignificant, it will be set to 0xFF
7 SENSOR				
Sensor Scale Dimension	47005	3	-	Dimension code
Sensor 7 substance code	47031-47046	3		Substance code in asci; if a character is insignificant, it will be set to 0xff
8 SENSOR				
Sensor Scale Dimension	48005	3	-	Dimension code
Sensor 8 substance code	48031-48046	3		Substance code in asci; if a character is insignificant, it will be set to 0xff

Dimension

0x8B	ppm parts per million
0xA9	parts per billion
0xAA	milligrams per cubic meter
0xA1	%LEL
0x6A	percent solids per volume
0x69	percent solids per weight
0x5B	grams per cubic meter
0x5C	kilograms per cubic meter

Annex D

Description of the HART exchange protocol

Protocol: HART 7

List of commands

Command number	Command description
0	Read device identifier
1	Reading the main variable
2	Reading current output value and percent of range
3	Reading current output value and 4 dynamic variables
6	Recording a short address
7	Reading the current output configuration
8	Read dynamic variable class
9	Auxiliary device status
11	Reading the device identifier linked to the tag
12	Reading the message
13	Reading the tag, tag description, and date
14	Reading information from the PV sensor
15	Reading device information
16	Reading the final assembly number
17	Recording a message
18	Recording the tag, tag description, and date
19	Recording the assembly number
20	Reading the long tag
22	Recording the long tag
35	Recording the range value
40	Enter/exit fixed current mode
41	Perform self-diagnostics
43	Set zero for the main variable (zero readings)
44	Recording the primary variable
45	Zero adjustment of the DAC for the primary variable
46	Gain adjustment of the DAC for the primary variable
48	Additional sensor status

Annex E

Conversion coefficients for substances detected by the photoionization sensor

Table 5

№	Substance name	Conversion coefficient to isobutylene, **K**
1	Acetone	1,17
2	Arsine	2,5
3	Ammonia	8,5
4	Aniline	0,5
5	Benzene	0,5
6	Gasoline	0,9
7	1,2 - dichloroethane	1
8	Hexane	3
9	Hydrazine	3
10	Diesel fuel	0,8
11	Isobutane	8
12	Isobutylene	1
13	Isopentane	4
14	H-pentane	1,6
15	Octane	7
16	Methyl mercaptan	0,7
17	Kerosene	0,7
18	Xylene	0,53
19	Hydrocarbon vapours	0,5
20	Hydrogen peroxide	4
21	Pentane	7
22	Propylene	1,4
23	Propylene oxide	6
24	Carbon disulfide	1,4
25	Styrene	0,45
26	Toluene	0,56
27	White spirit	0,9
28	Phenol	1,2
29	Phosphine	2
30	Ethanol	11
31	Ethylene	8
32	Ethylene oxide	15

The concentration of the analyzed substance is determined by the formula:

$$\mathbf{C}_{\text{substance}} = \mathbf{K} * \mathbf{C}_{\text{isob}}$$

where $\mathbf{C}_{\mathbf{isob}}$ is the reading of the gas analyzer with a photoionization sensor calibrated for isobutylene