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FIXED GAS DETECTORS IGM-10IR AND IGM-10TOX

(self-contained battery power supply)

USER MANUAL

MRBP.413347.010-02UM

Saint-Petersburg
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1 Description and operation 5
1.1 Intended use 5
1.2 Application scope 6
1.3 Design and overall dimensions 6
1.4 Technical and metrological specifications 11
1.5 Resources, lifetime and warranties 12
1.6 Contents of delivery 13
1.7 Marking and sealing 14
1.8 Packaging 15
2 Safety precautions 16
3 Correct use 17
3.1 Operation hints 17
3.2 Operation limits 17
3.3 Preparation 17
3.4 Mounting 18
3.5 Wires connection 19
3.6 Power on and operation 20
4 Maintenance service 21
4.1 General hints 21
4.2 Maintenance service routine 22
4.3 Gas sensor changing 23
4.4 Gas sensor protective filter cleaning 25
5 Storage and transportation 27
5.1 Transportation 27
5.2 Storage 28
5.3 Preservation and storage 29
6 Utilization 30
6.1 Precious metal content 30
6.2 Mercury-containing materials and components 30
Appendix A IGM-10 Ex equipment 31
Appendix B IGM-10 indication description 332
Appendix C Wireless communication 33
Appendix D IGM-10 metrological specifications 35
Appendix E RS-485 exchange protocol (MODBUS RTU) 37
Appendix F «Current loop» interface 41
Appendix G IGM-10 connection diagrams 43

This user manual (UM) is intended to describe design, principle of operation and operating routine of fixed gas detectors IGM-10IR and IGM-10Tox.

The Um contents basic technical data, guidelines for connection, maintenance service, as well as other information, necessary for the correct operation, storage and repair of fixed gas detectors IGM-10IR and IGM-10Tox.

Warning!

Gas detectors IGM-10IR and IGM-10Tox are explosion-proof devices.

Applied types of explosion protection:

- enclosure type d (GOST 30852.1-2002);
- intrinsically safe electrical circuit (GOST 30852.10-2002).

Ex equipment detailed description is given in Appendix A.

Warning!

Study this manual before mounting and operating gas detectors IGM-10IR and IGM-10Tox.
Operating not in accordance with the requirements of this UM may lead to the failure of the gas detector.

Warning!

Before getting started, testing or turn on the device after long-term storage it is recommended to perform zeroing and calibration according to this UM.
It is necessary to carry out calibration only after zero adjustment!

Identification when ordering: IGM-10IR-X-Y(T) and IGM-10Tox-X-Y(T), where

IR – infra-red optical sensor;

Tox – toxic sensor;

X – target component [from 01 to 15];

Y – power source identification [(1) – wired supply, external circuits switching through cable gland; (2) – built-in power source – battery, external circuits switching through connector];

T – measurement temperature range.

***Identification example**: IGM-10IR-01-2(-60) – stationary gas detector IGM-10 with installed infra-red optical sensor, target component- methane (CH_4), battery supply, measurement temperature range from -60 to +60 °C.*

List of abbreviations and terms

CAM – computer aided manufacturing;

GD – gas detector(s);

GM – gas mixture;

RPTA – replacement parts, tools and accessories;

HIL – highly inflammable liquid;

LEL – lower explosive level;

CGM – control gas mixture;

LOC – level of concern;

PC – personal computer;

SW – Software;

DS – datasheet;

SP – safety precautions;

OCEI – operational code for electrical installations;

UM – user manual;

MS – maintenance service.

Measuring instrument graduation – metrological operation, by means of which a measuring instrument (measure or measuring device) is supplied with a scale or calibration table (waveform).

Measuring instrument calibration – a set of operations performed in order to determine and confirm the actual values of metrological characteristics and (or) fitness for purpose of a measuring instrument that is not subject to state metrological control and supervision.

Measuring instrument verification – a set of operations performed in order to confirm the compliance of measuring instruments with metrological characteristics.

1 Description and operation

1.1 Intended use

1.1.1 Fixed gas detectors IGM-10IR and IGM-10Tox (hereinafter – IGM-10) are intended for automatic continuous concentration of explosive hydrocarbon gases, hydrocarbon, carbon dioxide, oxygen and toxic gases measurement (depending on modification) in the atmosphere.

In IGM-10, depending on target gas, one of listed gas sensor types can be installed: optical, toxic.

Only ex-proof sensors, that ensure intrinsically safe connection, are allowed to be used as components of IGM-10.

IGM-10 transmits measurement information to external devices as digital signal (RS-485 MOD-BUS®), DC unified analog signal (4 ÷ 20) mA and two logic signals. Indication description is given in Appendix B.

Notice:

IGM-10 is capable of data transmission via radio channel LoRa WAN. It is necessary to install radio module to enable this option. Wireless connection description and exchange protocol are given in Appendix C.

1.1.2 IGM-10 meets the requirements of the regulatory documents, listed in table 1.

Table 1 – List of regulatory documentation

Identification	Document name
TR CU 012/2011	Technical Regulation of Customs Union «On safety of equipment for operation in hazardous areas».
GOST 31610.0-2012	Electrical apparatus for explosive gas atmospheres. Part 0. General requirements.
GOST 31610.11-2012	Electric equipment for explosive atmospheres. Part 11. Equipment protection by intrinsic safety "i".
GOST IEC 60079-29-1-2013	Hazardous areas. Part 29-1. Gas detectors. Performance standards for gas detectors for combustible gases.
GOST 13320-81	Industrial automatic gas detectors. General technical requirements.
GOST R 52931-2008	Process monitoring and control instruments. General technical conditions.

Identification	Document name
GOST 15150-69	Categories, operating, storage and transportation conditions as to environment climatic aspects influence.
TR CU 020/2011	Technical Regulation of Customs Union. Electromagnetic compatibility of technical equipment.
GST R MEK 61326-1-2014	Electrical equipment for measurement, control and laboratory use. EMC requirements. Part 1. General requirements.

Certificates and Approval Documentation are available on the website - www.igm-pribor.ru.

1.2 Application scope

Hazardous areas classes 1 and 2 according to GOST IEC 60079-10-1-2011 atmospheric explosive categories IIA, IIB, IIC according to GOST R MEK 60079-20-1-2011, in compliance to Ex-marking.

Oil and gas fields, oil and gas processing plants, oil and gas storages, chemical industries, environmental services etc.

Typical facilities demanding gas pollution control:

- raw materials loading/unloading areas;
- raw materials and manufactured goods storages;
- pumping stations;
- compressor stations;
- industrial work areas.

1.3 Design and overall dimensions

1.3.1 Design

IGM-10 design is shown in figure 1. Housing material - aluminium, weighing not more than 1,5 kg.

Figure 1 – IGM-10 design

1.3.2 Overall dimensions

IGM-10 overall dimensions (w/o cable gland) are shown in figure 2. All dimensions are given in mm.

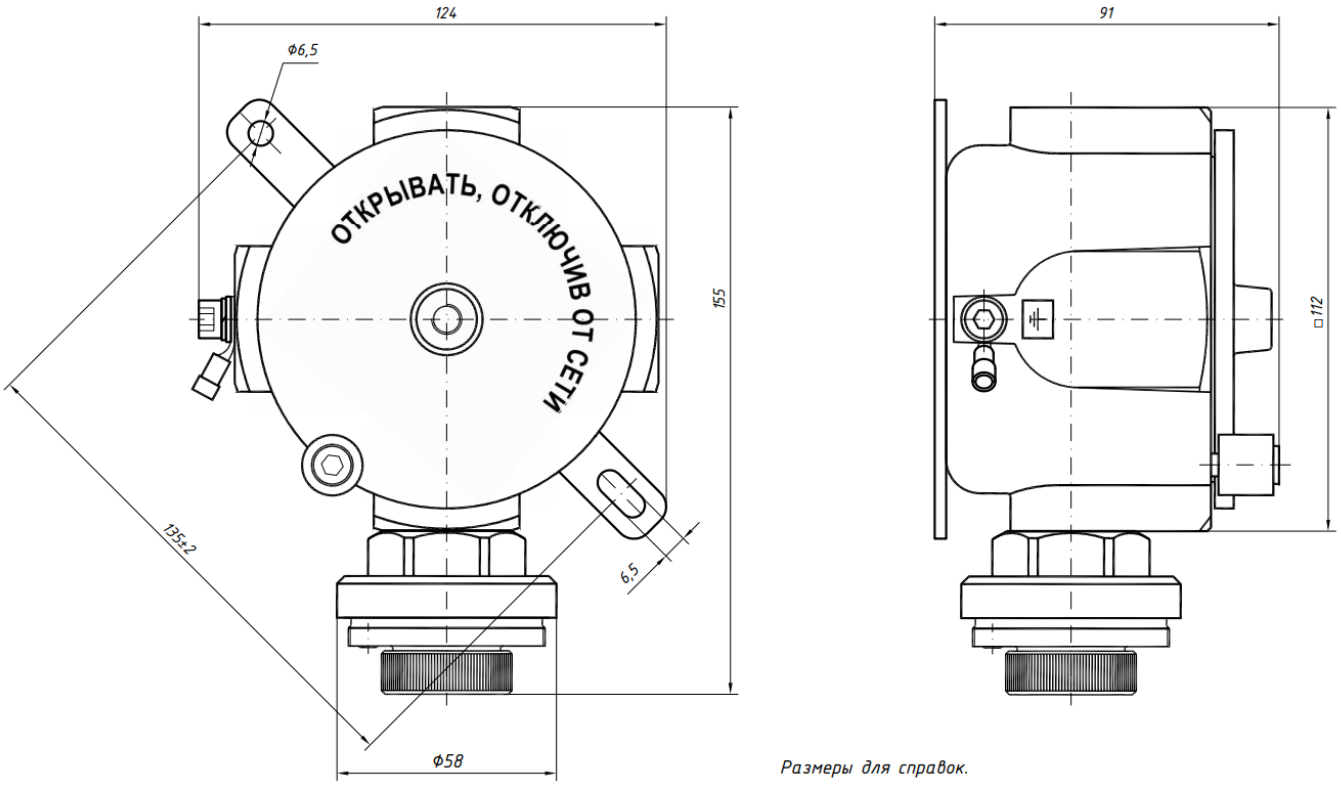


Figure 2 – IGM-10 overall dimensions

1.3.3 IGM-10 construction

Constructionally IGM-10 is performed in aluminium housing with a cover.

Device housings are equipped with holes for connection of explosion-proof cable glands and explosion-proof plugs of various types.

A locking screw is provided to prevent the cover from being unscrewed. Locking screw is unscrewed with a hex wrench.

IGM-10, regardless of installed gas sensor type, can be conveniently classified into 2 units by functionality (figure 3):

- processing unit;
- sensor installation unit.

Sensor installation unit is intended for:

- placement of the gas sensor and ensuring its intrinsically safe connection to the device;
- storage of metrological coefficients and settings;
- mathematical processing of signals received from the gas sensor;
- calculating the concentration of the monitored gas;
- transmission of data on the calculated concentration of the monitored gas to the processing unit.

Processing unit (figure 4) is intended for:

- IGM-10 external cables connection;
- providing the necessary levels of power supply for the electronic boards of the gas detector;
- generating output digital and analog interfaces signals;
- receiving and processing control signals from external devices.

IGM-10 can be equipped with optical щк toxic gas sensor depending on controlled gas type.

To turn the device on, it is necessary to put the SW1 switch in the "ON" position.

Sample injection to IGM-10 gas sensor in normal mode is carried out by means of free diffusion. Forced sample injection is allowed through calibration cap.

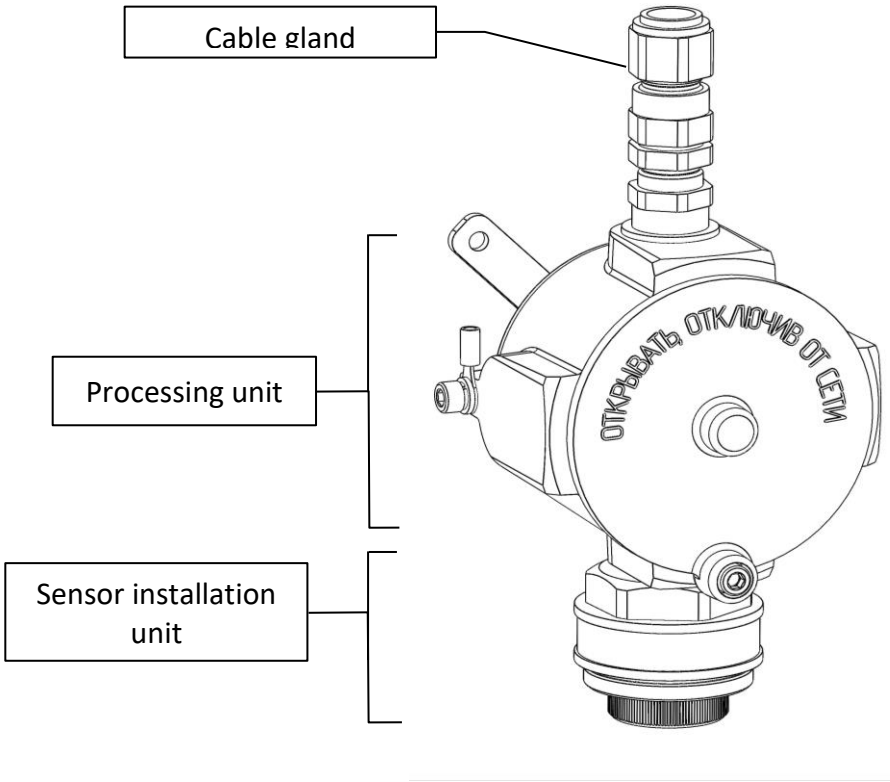


Figure 3 – IGM-10 basic functional structure

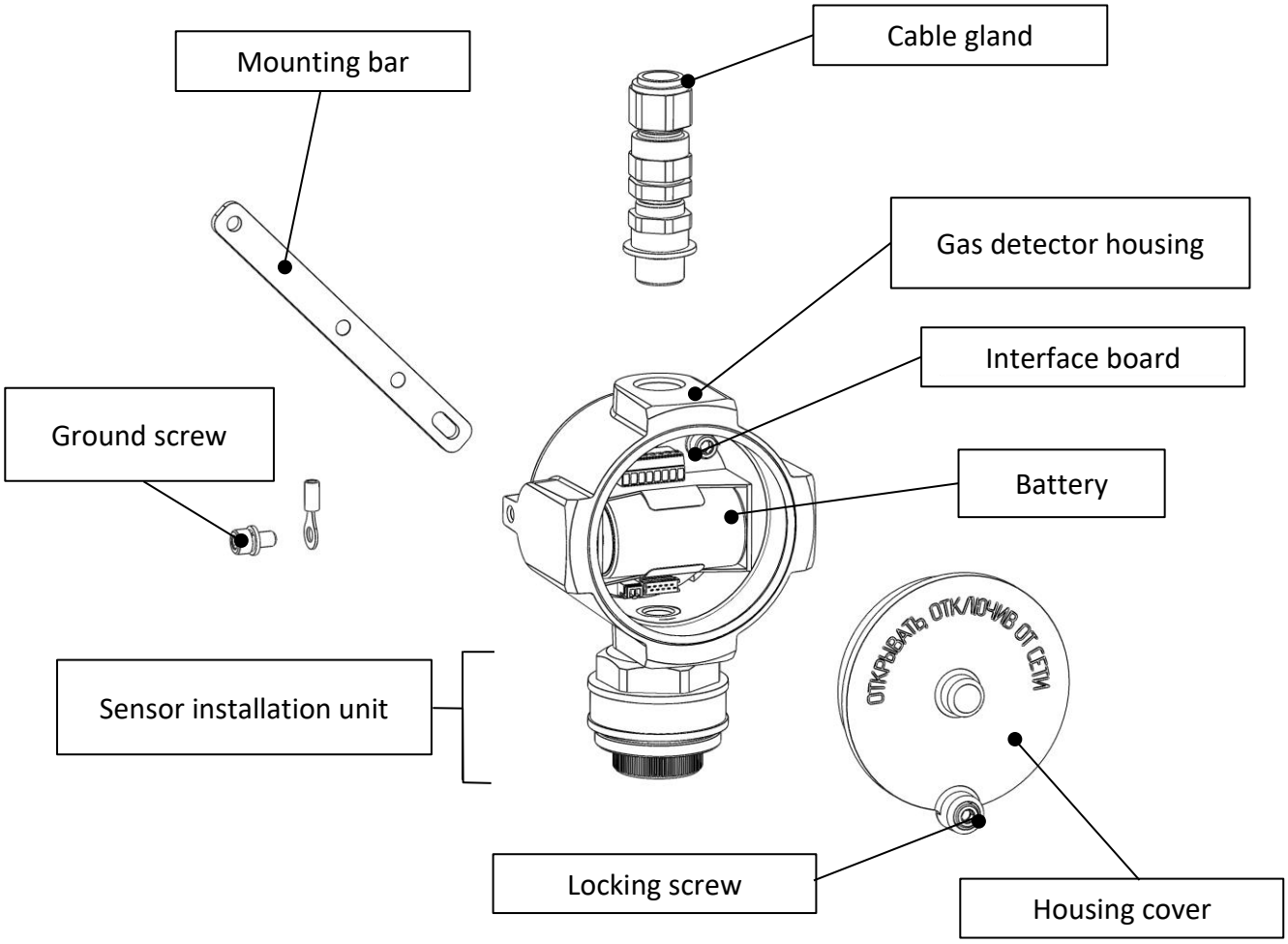


Figure 4 – IGM-10 functional structure

1.3.4 Interface board description

IGM-10 external circuits are connected to interface board, installed in the device. Connection terminals design and functionality are shown in figure 5.

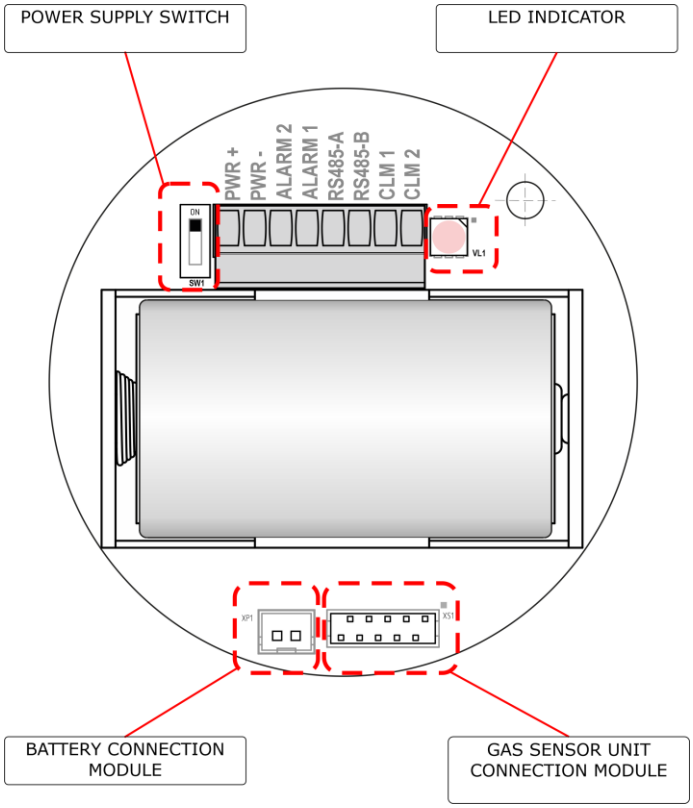


Figure 5 – IGM-10 interface board functionality

On IGM-10 interface board there are:

- power supply switch;
- indicator LED;
- battery connection module;
- gas sensor unit connection module;
- power supply terminals;
- current loop terminals;
- RS-485 interface terminals;
- transistors «Threshold 1», «Threshold 2» terminals.

1.4 Technical and metrological specifications

1.4.1 IGM-10 technical specifications are given in table 2.

Table 2 – IGM-10 technical specifications

1 POWER SUPPLY PARAMETERS	
Supply voltage	3 - 3,6 V
Power consumption, not more than:	0,05 W
Battery type	Li-ion battery type D-ER34615
2 OPERATION SPECIFICATIONS	
Sampling method	diffusive
Working position	unspecified
Operation mode	continuous
Ex-marking	1Ex d ib IIC T6 X
Electroconvulsive shock personal protection	class III
Water, dust and foreign solid particles intrusion protection	IP67
Output signals	- RS-485 - «current loop» - RS-232, UART (option)
Validation period: -optical sensor -toxic sensor	 2 years 1 year
Heating time: - IGM-10IR - IGM-10Tox	 not more than 60 s not more than 120 s
3 ENVIRONMENT STABILITY	
Ambient temperature range[1)]: - IGM-10Tox-X-Y (-30) - IGM-10IR-X-Y (-60) (except IGM-10IR -04-Y (-10)) - IGM-10IR -X-Y (-40) (except IGM-10IR -04-Y (-10)) - IGM-10IR -X-Y (-10) (except IGM-10IR -04-Y (-10)) - IGM-10IR -04-Y (-10)	 -30°C … +50°C -60°C … +60°C -40°C … +60°C -10°C … +60°C -10°C … +40°C
Atmospheric pressure range	80-120 kPa
RH (w/o condensation), not more than	95 %
1) According to certificate of conformity № TS RU c-RU.MU62.B.05698 from 22.12.2017, provided by certification body LLC «ПРОММАШ ТЕСТ», gas detectors are approved for use in temperature range -60°C … +60°C, while gas detectors metrological specifications are limited by temperature ranges according to this table.	

1.4.2 IGM-10 metrological specifications are given in Appendix D.

1.5 Resources, lifetime and warranties

1.5.1 The manufacturer guarantees device compliance with the requirements of the technical conditions MRBP.413347.010TU provided that the consumer follows operating, transportation and storage terms.

Average lifetime – 10 years.

MTBF:

- optical sensor – 60 000 h;

- toxic sensor – 30 000 h.

Notice:

While performing the overhaul (the repair method is proprietary in accordance with paragraph 2.4.11 GOST 18332-2016) with a complete resource repair – average lifetime is extended by 10 years.

1.5.2 Device warranty period – 24 months since manufactured, but not more than 18 months since placed in service.

Table 3 – Sensor warranty period

Sensor type	Warranty period
Optical	24 months since manufactured, but not more than 18 months since placed in service
Toxic	24 months since manufactured, but not more than 18 months since placed in service

1.5.3 The warranty remains subject to the maintenance of the device described in this UM. During warranty period the manufacturer is responsible for detected malfunctions reparation provided that the consumer follows operating, transportation and storage terms.

1.5.4 Unauthorized access inside the Device may cause the loss of the right to warranty service on the part of the manufacturer.

1.6 Contents of delivery

1.6.1 IGM-10 typical delivery set is shown in table 4.

Table 4 – IGM-10 typical delivery set

Name	Identification	Number
Fixed gas detector	MRBP.413347.010-02	1 pcs
Packaging	MRBP.413935.013	1 pcs
Datasheet	MRBP.413347.010-02DS	1 pcs
Verification certificate		1 pcs
Appended accessories*		
*- according to IGM-10 datasheet.		

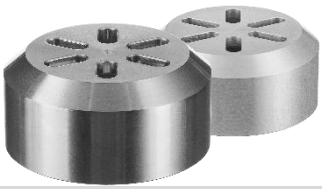
1.6.2 IGM-10 appended accessories

Calibration cap*

For device tuning and verification by means of control gas mixtures.

Protection nozzle

Additionally protects device unit with a sensor from shocks, mechanical damage, severe contamination ingress.



EX-proof end plug

EX-proof cable gland*

PTFE+synthetic fiber

For use in conditions of high humidity (steam). Best used in conjunction with a rain nozzle.

Rain nozzle

Prevents drips, water jets and debris from entering the sensor unit. An additional remedy for moisture condensation in combination with PTFE+synthetic fiber.

*- Included in delivery set.

1.6.1 IGM-13M has interfaces for external equipment connection shown in table 1.

Table 1 – Interfaces for external equipment connection

<table>
<tr><th>#</th><th>Type</th><th>Name</th><th colspan="4">General parameters</th></tr>
<tr><td>1</td><td>Digital</td><td>RS-485</td><td colspan="4">Exchange protocol: MODBUS (RTU)
Max number of devices on single line: 256
Max voltage: (between A and B lines and between signal lines and interface ground) ±12 V
*On request, instead of the MODBUS exchange protocol, the device can implement non-standard exchange protocols compatible with systems of various manufacturers (OAO «Avangard», AO «Electronstandart-pribor» and others)</td></tr>
<tr><td>2</td><td>Analog</td><td>«Current loop»</td><td colspan="4">Passive</td></tr>
<tr><td>3</td><td>Analog</td><td>2 transistors (схема с общим током)</td><td colspan="4">2 транзистора включенных по схеме с общим током: «Порог 1»; «Порог 2».
Нагрузочная способность каждого из транзисторов:</td></tr>
<tr><td></td><td></td><td></td><td>Постоянный ток:</td><td>Максимальное коммутируемое напряжение</td><td>30 В</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Максимальный коммутируемый ток</td><td>250 мА</td></tr>
<tr><td></td><td></td><td></td><td>Переменный ток:</td><td>Максимальное коммутируемое напряжение</td><td>30 В</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Максимальный коммутируемый ток</td><td>250 мА</td></tr>
</table>

Параметры работы с интерфейсами ИГМ-10 описаны в приложениях к настоящему руководству:

- RS-485 (MODBUS RTU) – Appendix E;
- «Current loop» - Appendix F.

1.7 Marking and sealing

1.7.1 IGM-20 marking contains information about:

- manufacturer;
- device;
- explosion safety.

Manufacturer information includes registered trademark.

Device information contains:

- gas detector name (IGM-10);
- device serial number;
- measured component (name and chemical formula);
- measurement range;
- measurement units (according to factory default);

- device operation temperature range;
- device supply voltage permissible values range.

Explosion safety information contains:

- device explosion safety level (1: Nonincendiery equipment);
- explosion safety types, user in the device (explosion-proof enclosure type d; intrinsically safe electrical circuit ia);
- electric equipment group (IIC);
- temperature class;
- special conditions for ensuring safety during operation (sign X) *
- warning note: "Open after disconnecting"

* - Unique operation requirements: it is forbidden to open the housing cover of the gas detector without disconnecting the power supply in hazardous areas.

1.7.2 Sealing

IGM-10 is sealed at the manufacturer. IGM-10 is sealed by non-removable tags.

1.8 Packaging

IGM-10 is packed in the manufacturer shipping box in compliance with the requirements of GOST 23170-78. The accompanying documents for the delivery set are also placed in the box.

Represervation protection period – 1 year.

2 Safety precautions

Warning!

All mounting, dismounting and maintenance service work, related to the removal of the device housing cover in hazardous areas must be carried out only with the power supply disconnected.

While mounting gas detectors in hazardous areas, it is necessary to be guided by the requirement of chapter 7.3 Regulations for electrical installations («Electrical installations in hazardous areas»).

Warning!

Any person who has studied this UM and has been briefed on safety precautions is admitted to operate the gas detector.

IGM-13M operation is forbidden if the housing is severely damaged or corroded due to which its integrity is compromised.
Access to the IGM-13M internal parts for performing any work should be carried out only by trained personnel.

IGM-13M mounting should be performed in compliance with the design documentation requirements.
While mounting and operation, it is necessary to be guided by the requirements of:

- chapter 3.4 of the Operational Code for Electrical Installations (OCEI);
- Safety Rules for Operation of Customers' Electrical Installations.

2.1 Before IGM-13M mounting and connection, it is necessary to check external damage absence, seals safety, the presence of all fastening elements.

2.2 IGM-13M housing must be grounded. A grounding bolt is provided for IGM-13M grounding.

2.3 Ex equipment description can be found in Appendix A.

2.4 Repair of IGM-13M is allowed only to the personnel of the manufacturer's enterprise or to persons authorized by the manufacturer to carry out repair work.

3 Correct use

3.1 Operation hints

3.1.1 IGM-10 operation must be carried out in accordance with this UM.

3.1.2 Connection and disconnection of IGM-10 must be performed only after disconnecting power circuits.

Notice:

In the event of using IGM-10 with installed radio channel module, it is allowed to uncover the device in hazardous area.

3.1.3 IGM-10 power supply circuits and interfaces circuits should be performed in compliance with the diagrams mentioned in Appendix G of this manual, while the voltages in the circuits should not exceed U_m:

- for power supply circuits (external supply) U_m = 28 V;
- for power supply circuits (battery supply) U_m = 3,6 V;
- for «current loop» interface circuits U_m = 28 V;
- for RS-485 MODBUS interface circuits U_m = 12 V.

Warning!

Manufacturer is not responsible for IGM-10 fault or for damage, resulting from improper or not specified in this UM use of the device.

3.2 Operating limits

3.2.1 Operation conditions are given in table of this UM.

3.3 Preparation

3.3.1 After IGM-10 unpacking, it is necessary to check the completeness, seals presence, to make sure that there is no mechanical damage to gas detector housing and to explosion-proof elements included in the kit (plugs and cable glands).

If IGM-13M was stored under refrigeration, it is necessary to keep the device under normal conditions for at least 2 hours before uncovering it to avoid condensation on the printed circuit.

3.3.2 If the delivery set includes cable glands and explosion-proof plugs - install them in the

corresponding holes in the housing.

3.3.3 Fill in the field on the transfer to the responsible person in the device datasheet.

Notice:

It is possible to adjust device factory defaults, if necessary, by using the Software (SW) "IGM-10Tool".
SW "IGM-10Tool" and user manual are presented on the website - www.igm-pribor.ru.
For convenience, it is recommended to make adjustments before mounting the device on site.

3.4 Mounting

3.4.1 Selecting of location

IGM-13M should be located in places with maximum likelihood of monitored gas occurring, according to design documentation.

While selection of location for IGM-10 without forced sample feeding devices, the density of the target gas relative to the surrounding atmosphere must be taken into account. For gases lighter than air, it is required to place gas detectors in the upper part of the controlled area; for gases heavier than air, it is required to locate the gas detectors in the lower part of the protected area.

IGM-10 ensures safe operation in any position of the housing, however, it is recommended to place gas detector with the gas sensor opening straight down to avoid water film or icing on the sensor filters, since this can prevent free gas diffusion into the sensor and lead to reduction of device response speed. When installing IGM-10 in places subject to precipitation and if there is a possibility of water droplets or other liquids getting on the gas sensor filters, it is recommended to use rain nozzles.

Notice:

Rain nozzle is not part of the standard delivery set. Additional options must be specified when ordering gas detectors or can be ordered separately from the main delivery.

Temperature and humidity operating conditions in places of IGM-10 installation shouldn’t exceed operational temperature and RH limit values, indicated in table of this UM.

Wherever possible, the installation locations should be vibration-free. If it is impossible to avoid the occurrence of vibrations in the supporting structures, it is recommended to take additional measures to prevent the bolts that fasten the device to the supporting structure from loosening during operation.

It is recommended, if possible, to place gas detectors in places with convenient access for

mounting and maintenance.

3.5 Wires connection

Warning!

All mounting and dismounting work, related to uncovering device's housing in hazardous areas, should be performed with power off.

Warning!

While wires connection at low temperatures, insulation crazing is possible when bending the wires supplied to the gas detector. In the event of insulation damage, it is necessary to remove the damaged section of the wire or take measures for additional insulation of the damaged section.

Observe the mounting guidelines of the cable manufacturers.

3.5.1 Recommended connections diagrams are given in Appendix G.

3.5.2 Wires connection to IGM-10 algorithm:

1) Loosen housing cover stop screw.

2) Unscrew housing cover.

3) Pull the cable inside the device housing through the cable gland. Strip the inner cores of the cable to the necessary length. When connecting the cable to the device, it is recommended to make a loop or «slack» of the connected cable in front of the cable entry in order to prevent water leakage along the cable surface to the device housing.

4) Connect GD power supply wires and interface wires to the corresponding terminals. Connector terminals are detachable and have supplied conductor screw fastening. Permissible conductor section for secure retention in the terminal block: 0,5 mm^2 - 2,5 mm^2.

5) Carefully tuck the stripped wires excess into the device housing and tighten cable gland seals.

6) Screw the housing cover.

7) Tighten the housing cover stop screw.

3.5.3 Wires dismounting should be carried out in the opposite order.

3.6 Power on and operation

After mounting the wires and closing the housing cover, gas detector is ready for operation. To turn on the device, it is necessary to the SW1 switch in the position «ON».

4 Maintenance service

4.1 General hints

4.1.1 Maintenance service (MS) is carried out to ensure IGM-13M normal operation during its lifetime. MS must be carried out by trained personnel, acknowledged with safety precautions for with electric installations and studied this UM.

4.1.2 System maintenance service involves:

- IGM-10 visual inspection
- gas sensor protective filter cleaning;
- operation testing by CGM feed (GM №2 according to device verification procedure);
- zeroing and sensitivity calibration (if required based on testing results).

Maintenance service interval – at least every 12 months (it is recommended to carry out maintenance service every 6 months or more often in the event of operation in dusty conditions or if the device is periodically exposed to corrosive liquids and/or vapors).

Warning!

All maintenance work, related to device's housing uncovering in hazardous areas should be performed with power off.

Warning!

Before testing, zeroing and/or calibration, it is recommended to inform the work shift personnel about the work being performed, and if possible, put the device into «maintenance» mode in the CAM system. If otherwise device calibration work can cause protective automation systems actuation.

Warning!

For IGM-10 models with installed toxic gas sensors, it is forbidden to use alcohols, solvents and other HIL as cleaning agents, because it can cause gas sensor failure. For these sensor types, it is possible to use clear water and suds as cleaning agents.

For IGM-10 models with set optical gas sensors, it is possible to use alcohols and solvents as cleaning agents from contamination, provided that these cleaning agents do not come into contact with protective filters or optical gas sensor.

4.2 Maintenance routine

IGM-10 maintenance service must be carried out as follows:

1) Make sure that IGM-10 is installed in accordance with the requirements of this manual and of gas contamination control system of the controlled object design documentation.

2) Clear IGM-10 housing from dust and other contamination, using water-wet rags. In case of severe contamination, it is recommended to use suds for clearing. For IGM-10 with installed toxic gas sensor, it is forbidden to use alcohol or other solvent and HIL to avoid sensors breakdown.

3) Examine the housing. If IGM-10 housing has undergone severe mechanical damage or corrosion that has violated its integrity or tightness, it is necessary to replace the gas detector from RPTA.

4) Examine detachable connections for oxide or corrosion. In the event of oxide or corrosion signs on the detachable joints, it is necessary to replace gas detector from the RPTA. Condensation inside the housing may indicate that the cable gland is not fully tightened.

5) Examine protection nozzle (or rain nozzle if present), that protects gas sensor unit. If the protective nozzle has undergone severe mechanical damage or corrosion that caused its crippling, it is necessary to replace it from the RPTA. This procedure can be performed without disconnecting the device, because the integrity of the ex-proof enclosure type d is not affected by stated acts.

6) Unscrew protection nozzle (or rain nozzle if present) and inspect it from the inside. If protective nozzle openings are filled with dirt or there is dirt inside, it is necessary to rinse it with water until the contamination is eliminated. If the protective nozzle is corroded from the inside, it is necessary to replace it from the RPTA. This procedure can be performed without disconnecting the device, because the integrity of the ex-proof enclosure type d is not affected by stated acts.

7) Examine the sensor unit. If the mesh filter is dirty, it is necessary to unscrew the filter fixing nut and rinse the filter mesh with water or blow it out with compressed air.

In the event of corrosion signs on the mesh filter or impossibility of its complete cleaning, it is necessary to replace the mesh filter from the RPTA. This procedure can be performed without disconnecting the device, because the integrity of the ex-proof enclosure type d is not affected by stated acts.

8) After the sensor unit examination, rescrew up the protective nozzle.

9) Inspect nameplates for integrity and legibility. If a nameplate is damaged, it is necessary to replace it from the RPTA.

10) Check IGM-10 ex-proof cable glands and plugs tightness. Loose cable glands and plugs should be tightened by an appropriate tool. If a cable gland or a cable plug has undergone severe mechanical damage or corrosion that compromised its integrity or it is impossible to tighten, replace the

damaged element from the RPTA.

11) Examine the fasteners fixing IGM-10 to the supporting structure for their integrity, and check their tightness. Loose fasteners should be tightened by an appropriate tool. If fasteners are damaged or have undergone corrosion – it is necessary to replace them from RPTA.

12) Examine IGM-10 housing grounding marking for its integrity and legibility. If the grounding marking is missing or damaged - it is necessary to restore it, using a grounding marking from the RPTA.

13) Make sure there is reliable housing grounding:

- make sure the ground wire is in contact with gas detector housing;
- check the ground screw tightness. If the screw is loose, it is necessary to tighten it using an appropriate tool. Contact elements exposed to corrosion or mechanical damage must be replaced from the RPTA;
- inspect the ground wire from gas detector housing to ground bus for its continuity. If ground wire breakage or insulation fault is detected – replace this wire.

It is recommended to grease the joints of the ground wire with the IGM-10 housing ground screw and the screw fastening to the ground bus to reduce weather influences on contact reliability.

14) After performing MS, it is recommended to calibrate the «zero» and check the device calibration by supplying a test CGM.

4.3 Gas sensor changing

Notice:

IGM-10 equipped with toxic gas sensor requires periodic sensor replacement, since toxic gas sensors have a limited resource of use and also are susceptible to «poisoning» at exceedance of the measuring range or exposure to alcohols and other aggressive vapors and gases.

IGM-10 equipped with optical gas sensor don't require sensor maintenance, since the sensor is able to compensate for most of the influences with its work physics and mathematical algorithms. Optical gas sensor should be changed only in case of failure.

Warning!

When changing PID or toxic gas sensors, it is necessary to protect them from the effects of alcohols, solvents and other corrosive environment, as well as from gases and vapors that tend to form polymer films. Work on gas sensor changing must be carried out in a well-ventilated area.

4.3.1 Required equipment and tools list:

- screwdrivers set;
- interchangeable filters set;
- rags, water (if extra protective mesh filter clearing is required);
- replacement gas sensor.

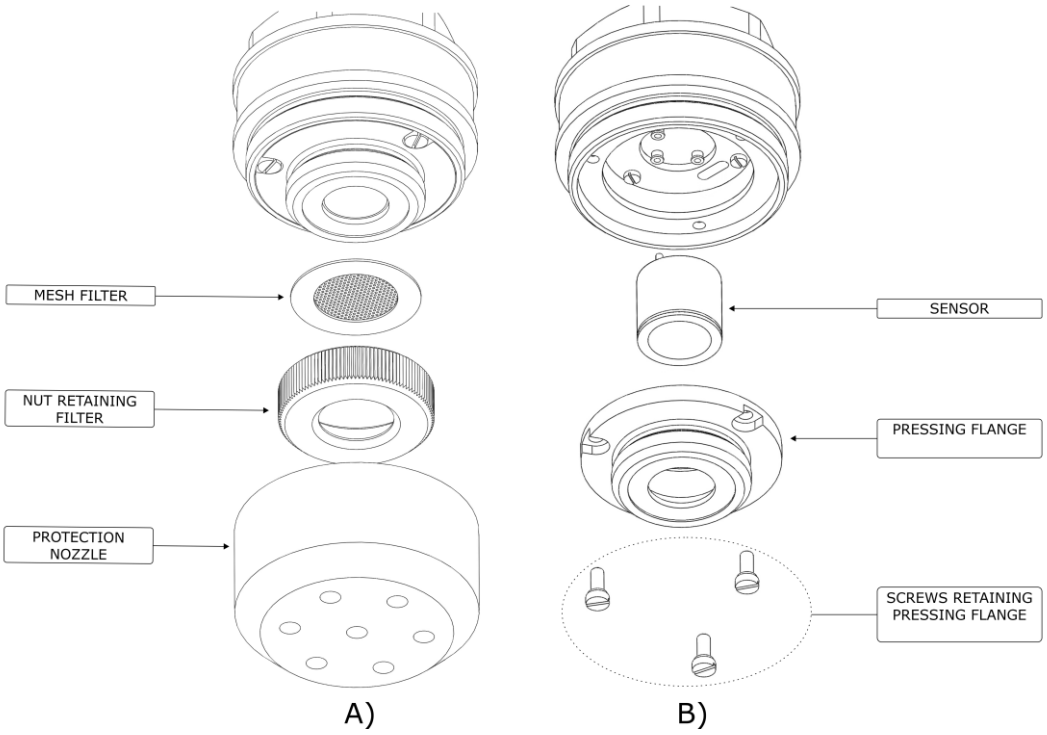


Figure 6:

A) Gas sensor protective filter parts location
B) Parts location when changing gas sensor

4.3.2 Gas sensor removing algorithm:

1) Make sure that gas detector is disconnected.

2) Unscrew the nut retaining the protective filter.

3) Remove the mesh filter. If it is dirty, rinse it in water and wipe it dry with rags. If the filter is obstructed, it is allowed to wash it with solvents or alcohol (this work must be carried out away from the gas sensor which is about to be installed in the gas detector), then rinse it with flowing water and soak the filter in clean water for at least 15 minutes.

4) Remove the three screws retaining the pressing flange.

5) Remove the pressing flange.

6) Remove the former gas sensor. Oxygen and toxic gases toxic sensors utilization must be carried out in environmentally friendly manner in accordance with local waste collection/disposal regulations and environmental legislation.

4.3.3 Gas sensor installation algorithm:

1) Install a new (or maintained) gas sensor in the IGM-10 mounting seat. Sensors terminal leads location excludes incorrect installation possibility.

2) Install the pressing flange.

3) Start the three screws retaining the pressing flange.

4) Tighten the pressing flange retaining screws. It is recommended to tighten the screws sequentially and then check the tightness.

5) Install the protective filter and press it with the protective filter retaining nut.

4.4 Gas sensor protective filter cleaning

Warning!

When replacing toxic gas sensors, it is required to protect them from the effects of alcohols, solvents and other corrosive environment, as well as from gases and vapors that tend to form polymer films.

4.4.1 Work on gas sensor filters clearing is allowed to be performed at the place of IGM-10 installation without disconnecting and dismounting it. The work on filters clearing don't violate gas detector ex-protection ensuring type and methods.

4.4.2 Required equipment and tools list:

- rags, water;
- mechanical cleaning brush with fine bristles (hard pile art brush is allowed for use);
- replacement mesh filter (if contamination cleaning is impossible)
- replacement fluoroplastic gas sensor membrane filter (if gas sensor fluoroplastic filter is also dirty).

4.4.3 While changing gas sensor and clearing protective filter, follow the diagram shown in figure 6 (see section 4.3 «Gas sensor changing»).

4.4.4 Protective filters cleaning/changing algorithm:

1) Unscrew the protective mesh filter fastening nut.

2) Remove the mesh filter. If it is dirty – rinse it in water and wire it dry with rags. If the filter is obstructed, it is allowed to wash it with solvents or alcohol (this work must be carried out away from the gas sensor which is about to be installed in the gas detector), then rinse it with flowing water and soak the filter in clean water for at least 15 minutes.

When it is impossible to clean the mesh filter, replace it with a new one.

3) If there is a dirty fluoroplastic filter – replace it with a new filter. If it is necessary to remove gas sensor to replace fluoroplastic membrane filter – see section 4.3 «Gas sensor changing».

4) Make sure the protective mesh filter is completely dry after clearing and reinstall it.

5) Tighten the nut fastening the protective mesh filter.

5 Storage and transportation

5.1 Transportation

5.1.1 IGM-10 in the manufacturer's box can be transported by avia, railway, water, vehicle or other enclosed types of transport, as well as in pressurized sections in accordance with the rules in force on appropriate types of transport.

5.1.2 During the transportation in the manufacturer's shipping box IGM-10 retains its specifications after exposure to the following climatic factors:

- ambient temperature: -60°C … +60°C;
- relative humidity: 0% … 100% w/o condensation.

Notice:
It is not recommended to keep devices with toxic sensors at temperatures below -20°C and RH below 20% or above 85% even during transportation.

When it is impossible to observe these conditions, it is required to keep the device at temperature from +10°C to +35°C and RH 20-85% for at least 24 hours before turning IGM-10 on for chemical processes stabilization in gas sensor electrolyte.

5.1.3 Packed IGM-10 retain their characteristics after the following mechanical factors impact:

- sinusoidal vibration (design category F2 GOST R 52931-2008);
- single impacts with acceleration up to 30 g.

5.1.4 While loading and unloading operations and transporting, packed IGM-10 shouldn't undergo shocks, athmospheric precipitation, solvent, other corrosive liquids and vapors impact.

5.2 Storage

5.2.1 IGM-10 and operating documentation are packed in a foamed PVC lodgement. The lodgement is packed in a cardboard box. The cardboard box with the gas detector is covered with polyethylene tape with an adhesive layer.

5.2.2 It is recommended to store IGM-10 in the manufacturer's packaging in supplier's and consumer's warhouses under storage conditions not lower than 3 in accordance with GOST 15150-69. During storage it is necessary to keep IGM-10 and packaging away from water, solvents and other corrosive liquids and vapors impact.

5.2.3 Distance between the storage facilitiesa heating devices and IGM-13M must be at least 0,5 m.

Notice:

IGM-13M storage should take into account that recommended storage conditions differ between installed gas sensor type. IGM-13M with toxic sensors are the most susceptible to the environment influence.

5.2.4 IGM-10 recommended storage conditions are given in table 6.

Table 6 – IGM-10 storage conditions

Installed gas sensor type	Temperature, °C	RH, % (w/o condensation)
Optical	-60 ... +60	0 - 100
Toxic	-20 … +50	20 - 85
Notice: 1) IGM-10 storage (regardless of installed gas sensor type) at temperatures above +60°C or below -60°C is not allowed. 2) It is allowed to store IGM-10 equipped with toxic gas sensor at temperatures below -20°C (but not below -60°C). The fact that electrolyte can freeze in toxic sensor should be taken into account. 3) In the event of IGM-10 with installed toxic gas sensor storage at temperatures below -20°C, it is necessary to keep IGM-10 at temperatures above +10°C for at least 24 hours before power on.		

5.2.5 After the expiration of the protection period without represervation, IGM-10 must be represerved.

5.3 Preservation and storage

5.3.1 Preservation is carried out before device decommissioning for a long period.

5.3.2 Preservation routine:

- remove the device off the regular position and replace it in a heated space. The space, where the preservation is carried out, must be free of solvent vapors and other corrosive substances;
- keep the device at temperature from +10°C to +35°C for at least 12 hours;
- clear device housing external surface from contamination. To clear the external surface, it is recommended to use dry rags. In case of severe contamination clear the device housing with suds, then wipe it with water-wet rags. Dry the device after housing external surface clearing;
- open the device housing cover and remove contamination and dust inside the device with dry rags. If there is moisture or condensation inside the housing, dry the device;
- grease gas detector cover thread with antifriction lubricant;
- close the device housing cover and place the device in the manufacturer's packaging. If the original packaging has not been preserved, place the device in a cardboard box of suitable size and seal with any moisture-free filler (for example sheets of crumpled wax paper or bubble pack). The filler must prevent free movement of the device inside packaging box while storage and transportation;
- close the box and tape it over;
- store the device that has passed conservation under conditions similar to those specified in section «STORAGE».

6 Utilization

Warning!

While IGM-13M utilization, it is necessary to be guided by the requirements of GOST 55102-2012 («Resource-saving. Waste treatment. Guideline on the safe collection, storing, transporting and disassembling of the waste electrical and electronic equipment except mercury-containing devices and appliances»).

If applicable, local/regional codes should also be respected.

6.1 Precious metal content

Gas detector IGM-10 regardless of the model and installed gas sensor type doesn't content precious metals.

6.2 Mercury-containing materials and components

Gas detector IGM-10 regardless of the model and set gas sensor type doesn't contain mercury and/or mercury-containing components.

IGM-10 models equipped with optical gas sensors don't contain harmful, toxic, self-igniting, carcinogenic and other substances and components hazardous to the environment and human health. These GD modifications belong to hazardous waste class V (practically non-hazardous waste) and can be transferred for disposal without additional preparation.

Gas detectors IGM-10 modifications with toxic gas sensors contain acids and/or lead. It is recommended to remove toxic gas sensor before transferring for disposal. After toxic gas sensor removal, the device belongs to hazardous waste class V (practically non-hazardous waste).

Removed toxic sensors contain acids and/or lead and must be utilized in accordance with the requirements of the sensor manufacturers or in accordance with the requirements for waste management of class III (moderately hazardous), unless otherwise specified.

Appendix A

IGM-10 ex-equipment

IGM-10 ex-equipment is shown in figure A.1

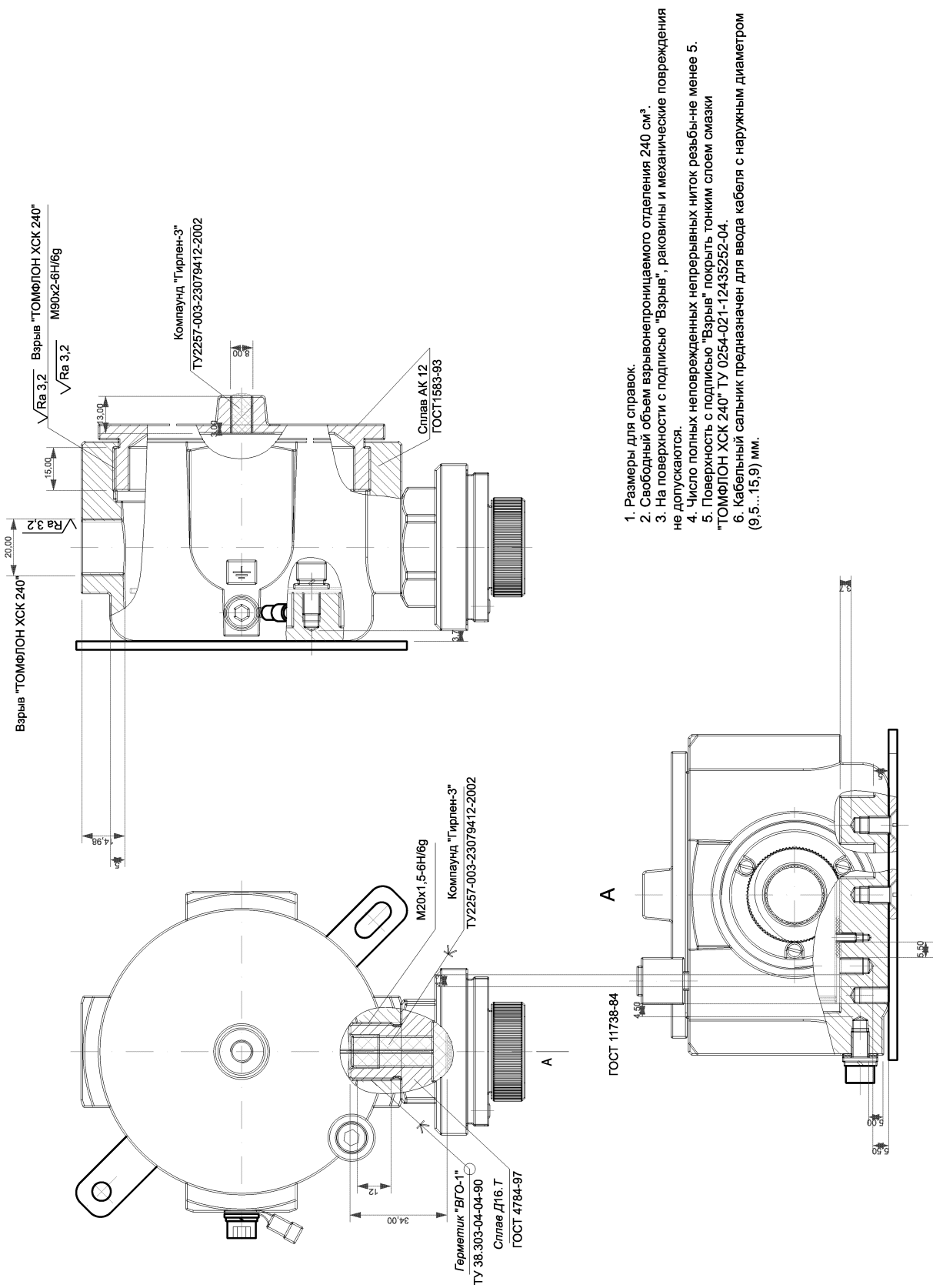


Figure A.1 – IGM-10 ex-equipment drawing

Appendix B

IGM-10 indication description

Table B.1 – Table of status indication for modifications IGM-10IR-X-2 (T) and IGM-10Tox-X-2 (T) with battery supply.

Gas detector status	Current loop (4-20 mA)	RS-485 / RS-232 / UART (MODBUS protocol)	Logic level «THRESHOLD 1»	Logic level «THRESHOLD 2»
Gas detector is failed, supply voltage is low or absent.	0 mA	not present	1	1
Supply voltage is within normal limits, gas detector is fault-free, measured concentration value is below threshold value	4- 20 mA	concentration values	1	1
Supply voltage is within normal limits, gas detector is fault-free, measured concentration value is above threshold №1 value, but below threshold №2 value	4-20 mA	concentration values	0	1
Supply voltage is within normal limits, gas detector is fault-free, measured concentration value is above threshold №2 value, but below gas detector measurement range	4-20 mA	concentration values	0	0
Measurement range is exceeded	20-22 mA	concentration values	0	0
Optical sensor is failed, dirty optics.	2 mA	value «AAAA»	1	1
Magnetic zeroing timing (30 sec.)	4-20 mA	concentration values	X	X
Magnetic calibration timing (30 sec.)	4-20 mA	concentration values	X	X
Magnetic field response	4-20 mA	concentration values	X	X
Data transmission via RS-485 interface	4-20 mA	concentration values	X	X

Appendix C

Wireless communication

IGM-10 is capable of data transmission via radio channel LoRa WAN. It is necessary to install radio module to enable this option.

Radio module data transmission center frequency – 868 MHz.

Radio module radiation power – 22 MW.

Notice:

Radio module frequencies range and radiation power are within allowed range for use without certification within Russia.

Max number of gas detectors connected to one base station – up to 1000 pcs

Max distance for data transmission – 3 km line of sight.

Wireless system operation diagram is shown in figure C.1.

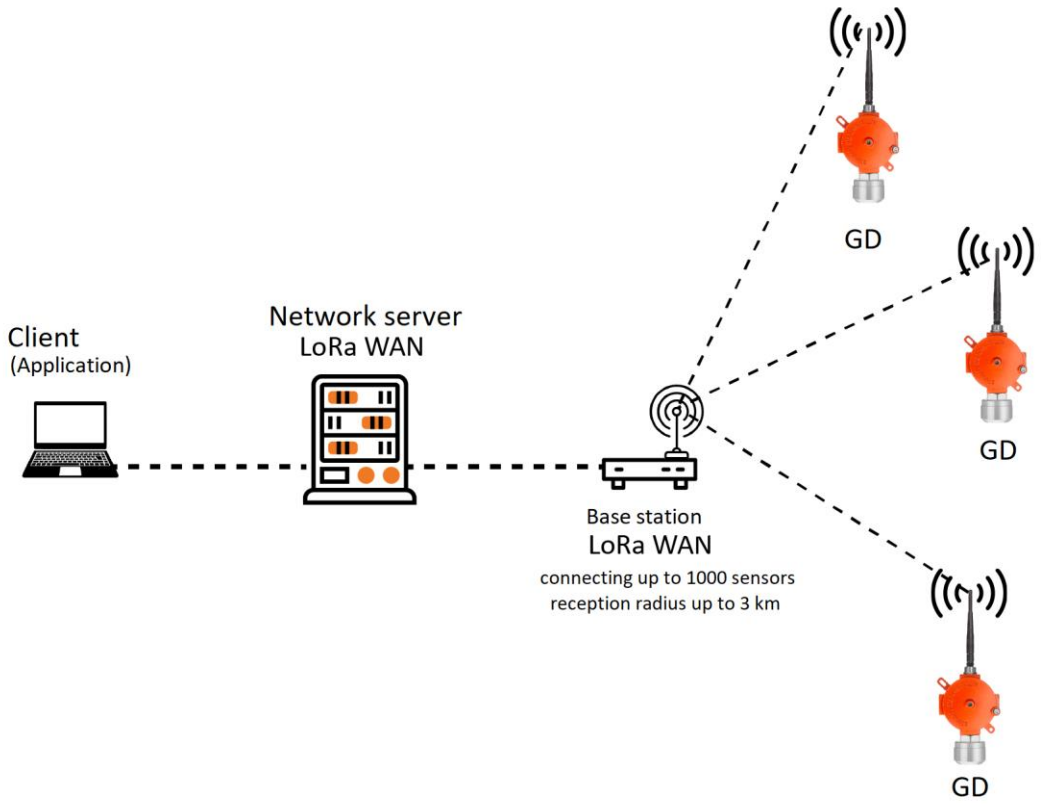


Figure C.1 – Wireless devices operation diagram

Data format sent by IGM-10 via LoRa

- Authorization – only automatic transfer switch.
- Frame format – standard.
- Sent data – 10 bytes.

Table 1 Packet format

7	6	5	4	3	2	1	0
Byte 0							
Temperature, upper part							
Byte 1							
Температура, lower part							
Byte 2							
Gas type							
Byte 3							
Concentration, upper part							
Byte 4							
Concentration, lower part							
Byte 5							
Concentration measurement units							
Byte 6							
				ERR_MEM	**IMIT**	**THRESHOLD2**	**THRESHOLD1**
Byte 7							
SPECIAL	**ERR_DAT**	**START**	~~**ERR_CO**~~	**ERR_SNR**	**ERR_OPT**	**RANGE**	**ERR**
Byte 8							
							ERR_REL2
Byte 9							
ERR_REL1	~~**EN_EBUS**~~	**MAGNET**	~~**WARN**~~	**ERR_PWR**	**LOCKED**	**MANUAL**	**FIX_CO**

Temperature:	int	°C * 100
Gas type:	1..32	CH_4 (1) / C_3H_8 (2) …
Concentration:	word	Value * accuracy (depends on gas type, for CH_4 – 0,01%vol)
Measurement unit:	0/1/3/4	%vol / ppm / %LEL / g/sm^3
ERR_MEM:	0 / 1	None / EEPROM record error
IMIT:	0 / 1	None / Values emulation mode
THRESHOLD2:	0 / 1	None / Threshold №2 concentration exceeded
THRESHOLD1:	0 / 1	None / Threshold №1 concentration exceeded
SPECIAL:	0 / 1	None / Device is in special mode
ERR_DAT:	0 / 1	Norm / Optical sensor data error
START:	0 / 1	Norm / Start
ERR_SNR:	0 / 1	Norm / Optical sensor error (communication)
ERR_OPT:	0 / 1	Norm / Optical sensor error (optics)
RANGE:	0 / 1	None / Concentration measurement range exceeded
ERR:	0 / 1	The device is inoperative / in operation mode
ERR_REL2:	0 / 1	Norm / Threshold №1 relay error
ERR_REL1:	0 / 1	Norm / Threshold №2 relay error
MAGNET:	0 / 1	None/ Magnet is put to the sensor
ERR_PWR:	0 / 1	Norm / Low power supply
LOCKED:	0 / 1	Norm / Values are fixed before reset
MANUAL:	0 / 1	Automatic / Manual values deblocking
FIX_CO:	0 / 1	None / Current output is fixed at one level

Appendix D

IGM-10 metrological specifications

Table D.1 – Target components names, measurement ranges, permissible intrinsic error limits

Modification	Target component	Target component volume fraction values range	Target component volume fraction measurement range	Permissible intrinsic error limits		Permissible indications setting time limits, $T_{0,9D}$
				absolute	relative	
1	2	3	4	5	6	7
IGM-10Ir						
-01-Y	methane (CH_4)	0 - 4,4 % (0 - 100 % LEL)	0 - 4,4 % (0 - 100 % LEL)	±(0,09%+ 0,03·C[1)]) (±(2 % LEL +0,03·C[1)])	-	5
-02-Y	propane (C_3H_8)	0 - 1,7 % (0 - 100 % LEL)	0 - 1,7 % (0 - 100 % LEL)	±(0,03%+ 0,03·C[1)]) (±(2 % LEL +0,03·C[1)])	-	5
-03-Y	n-hexane (C_6H_{14})	0 - 1,0 % (0 - 100 % LEL)	0 - 0,5 % (0 - 50 % LEL)	±0,05 % (±5 % LEL)	-	5
-04-Y	carbon dioxide (CO_2)	0 - 2,5 %	0 - 2,5 %	±0,15 %	-	5
IGM-10Tox						
-01-Y	oxygen (O_2)	0 - 30 %	0 - 30 %	±0,5 %	-	30
-02-Y	carbon oxide (CO)	0 - 2000 ppm	0 - 40 (incl.) ppm	±4 ppm	-	30
			40 (excl.) - 2000 ppm	-	±10 %	
-03-Y	hydrogen sulfide (H_2S)	0 - 100 ppm	0 - 7,5 (incl.) ppm	±1,5 ppm	-	30
			7,5 (excl.) - 100 ppm	-	±20 %	
-04-Y	hydrogen sulfide high concentrations	0 - 500 ppm	0 - 10 (incl.) ppm	±2 ppm	-	45
			10 (excl.) - 500 ppm	-	±20 %	
-05-Y	sulfide dioxide (SO_2)	0 - 20 ppm	0 - 2,5 (incl.) ppm	±0,5 ppm	-	30
			2,5 (excl.) - 20 ppm	-	±20 %	
-06-Y	sulfide dioxide high concentrations	0 - 2000 ppm	0 - 10 (incl.) ppm	±2 ppm		40
			10 (excl.) -2000 ppm	-	±20 %	
-07-Y	nitrogen oxide (NO)	0 - 250 ppm	0 - 10 (incl.) ppm.	±2 ppm	-	40
			10 (excl.) - 250 ppm	-	± 20 %	
-08-Y	nitrogen dioxide (NO_2)	0 - 30 ppm	0 - 1 (incl.) ppm	±0,2 ppm	-	30
			1 (excl.) - 10 ppm	-	±20 %	
-09-Y	ammonia (NH_3)	0 - 30 ppm	0 - 1 (incl.) ppm	±0,2 ppm	-	40
			1 (excl.) - 10 ppm	-	±20 %	
-10-Y	ammonia high concentrations	0 - 100 ppm	0 - 10 (incl.) ppm	±2 ppm	-	90
			10 (excl.) - 100 ppm	-	±20 %	
-11-Y	hydrogen (H_2)	0 - 1000 ppm	0 - 30 (incl.) ppm	±6 ppm		60
-12-Y	Hydrogen cyanide (HCN)	0 - 4 %	30 (excl.) - 1000 ppm	-	±20 %	70
			0 - 2 %	±0,1 %	-	

Modification	Target component	Target component volume fraction values range	Target component volume fraction measurement range	Permissible intrinsic error limits		Permissible indications setting time limits, $T_{0,9D}$
				absolute	relative	
1	2	3	4	5	6	7
-13-Y	methanol CH_3OH	0 - 30 ppm	0 - 10 (incl.) ppm	±2 млн$^{-1}$	-	200
			10 (excl.) - 30 ppm	-	±20 %	
-14-Y	ethanol (C_2H_6O)	0 - 200 ppm	0 - 10 (incl.) ppm	±2 млн$^{-1}$	-	30
			10 (excl.) - 200 ppm	-	±20 %	
-15-Y	hydrogen fluoride (HF)	0 - 200 ppm	0 - 10 (incl.) ppm	±2 млн$^{-1}$	-	90
			10 (excl.) - 200 ppm		±20 %	

[1)] C- feed component volume fraction value, %LEL.

Notice:

1) LEL values according to GOST 30852.19-2002;
2) Due to the fact that gas detectors are sensitive to a wide range of organic substances in addition to those indicated, the limits of the basic permissible error of gas detectors are standardized only for mixtures containing only one combustible component.

Table D.2 – Metrological specifications

Specification	Value
Permissible output signal variations limits, in fractions of permissible intrinsic error limits	0,5
Permissible additional error from changes in ambient temperature from normal for every 10 °C limits, in fractions of the limit of permissible basic error for gas detectors IGM-10Tox for temperature range from -30 to +15 and above +25 to +50 ºC	±1,0
Limits of permissible additional error from changes in ambient temperature from normal, in fractions of permissible basic error limit for gas detectors IGM-10IR (except IGM-10IR-04-Y (T) for temperature range: -from -10 to +15 ºC (incl.) and +25 to +40 ºC (excl.) -from -40 to -10 ºC (incl.) and +40 to +60 ºC (excl.) -from -60 to -40 ºC (incl.)	 ±2,0 ±4,0 ±6,0
Limits of permissible additional error from changes in ambient temperature from normal, in fractions of permissible basic error limit for gas detectors IGM-10IR-04-Y (T): - for temperature range from -10 to +15 ºC and from +25 to +40 ºC	±2,0
Limits of permissible additional error from changes in RH from normal in a range up to 95 % (w/o condensation) for every 10 %, in fractions of permissible basic error limit	±0,1
Limits of permissible additional error from changes in atmospheric pressure from normal for every 3,3 kPa within operating conditions, in fractions of permissible basic error limit	±0,5

Appendix E

RS-485 exchange protocol (MODBUS RTU)

Interface: RS-485.
Protocol: MODBUS RTU with the following commands support:
- register reading. Command code 0x03 (Read Holding Registers),
- writing to register. Command code 0x10 (Write Multiple registers),
- writing a word to register. Command code 0x06 (Write Single Register).

Interface settings at start: 9600, 8-N-1.

After power supply and initialization completion IGM-10 displays information about software and interface RS-485 user settings. Initial interface settings are saved for 5 seconds, then IGM-10 reconfigures the interface according to user settings (factory settings – 19200/8-E-1).

Table E.1 - Registers INPUT (all 16 bit)

Address	№	Description	Notice	Access
Common registers INPUT				
256	0	Module ID	= 1001 / = 1020	Rd
257	1	Manufactory number (LO)		Rd
258	2	Manufactory number (HI)		
259	3	Software version	HiByte[3].LoByte[3]	Rd
260	4	SW checksum		
261	5	SENSOR. Type **HiByte. Sensor type:** 0 – Mipex 1 – Toxic **LoByte. Gas type:** 1 - CH		Rd
262	6	Status №1: bit 0 – no errors bit 1 – measurement range exceeded bit 2 – dirty optics bit 3 – no connection with the sensor bit 4 – always 0 bit 5 – module initialization bit 6 – sensor data error bit 7 – mode 0 – operation, 1 - service bit 8 – threshold 1 exceeded bit 9 – threshold 2 exceeded bit 10 - mode 0 – operation, 1 - emulation bit 11 – constant memory error bit 15 – magnet presence		Rd
263	7	Status №2: bit 0 – current output fixed bit 1 – values manual deblocking bit 2 – values blocked bit 3 – low power supply bit 4 – not determined bit 5 – magnetic sensor went off (option)		
264	8	Temperature * 10	°C * 10	Rd
265	9	Concentration	%vol*100, %LEL*10, ppm	Rd
266	10	Current output. Current value *100	mA * 100	Rd
267	11	Operation time (HI)	Seconds	Rd

Address	№	Description	Notice	Access
268	12	Operation time (LO)		Rd
269	13	Concentration time (HI)		Rd
270	14	Concentration time (LO)		Rd
271	15	SENSOR. Communication quality, %		Rd
Additional registers INPUT				
272	16	Wired supply V * 10	V * 10	Rd
273	17	Power supply +3.3V * 10		
274	18	Power supply +5.0V * 10		
275	19	Current output. Current value *100	mA * 100	Rd
276	20	Current output. Measured current *100	mA * 100	Rd
277	21	Current output. Measured current, ADC reading		Rd
278	22	Measured current at point 1 mA: ADC reading	Calibration value	Rd
279	23	Measured current at point 4 mA: ADC reading	Calibration value	Rd
280	24	Measured current at point 20 mA: ADC reading	Calibration value	Rd
281	25	Measured current at point 1 mA: DAC reading	Calibration value	Rd
282	26	Measured current at point 4 mA: DAC reading	Calibration value	Rd
283	27	Measured current at point 20 mA: DAC reading	Calibration value	Rd
284	28	Current output fixed: DAC reading		Rd
285	29	RESERVE		Rd
286	30	RESERVE		Rd
287	31	RESERVE		Rd
Mipex information				
288	32	SENSOR. Serial number (HI)		Rd
289	33	SENSOR. Serial number (LO)		Rd
290	34	SENSOR. SW version		Rd
291	35	SENSOR. SW build		Rd
292	36	SENSOR. Temperature	°C * 10	Rd
293	37	SENSOR. Coded status word		Rd
294	38	Current sensor concentration		Rd
295	39	ADC readout temperature		Rd
296	40	Sensor specification		Rd
297	41	Converter type (HI)		Rd
298	42	Converter type		Rd
299	43	Converter type (LO)		Rd
300	44	Serial number, ASCII (HI)	Example: “08006797”	Rd
301	45	Serial number, ASCII		
302	46	Serial number, ASCII		
303	47	Serial number, ASCII (LO)		
Mipex text information				
304	48	SW version, ASCII (HI)	Example: “MIPEX-2_24.3”	Rd
305	49	SW version, ASCII		
306	50	SW version, ASCII		
307	51	SW version, ASCII		
308	52	SW version, ASCII		
309	53	SW version, ASCII		
310	54	SW version, ASCII		
311	55	SW version, ASCII (LO)		
312.. 319	56.. 63	Gas text descriptor, ASCII[0..15]	Example: “Methane”	Rd
Device text information				
320.. 335	64.. 79	Device text descriptor, ASCII[0..31]	Example: “IGM-Detector IGM10-X-X1 NDIR CHx”	Rd

Table E.2 - Registers Hold (all 16 bit)

Address	№	Description	Notice	Access
0	0	External interface settings bit 0..3 – rate code: 1 – 1200 2 – 2400 3 – 4800 4 – 9600 5 – 19200 6 – 38400 7 – 57600 8 – 115200 bit 4..5 – parity code: 0 – non 1 – odd 2 - even bit 6..7 – stop bit number bit 8..15 –Modbus address(1 ÷ 247)	The settings are changed by recording the corresponding values (service mode only)	Rd/Wr
1	1	Status №1: bit 0 – no errors bit 1 – measurement range exceeded bit 2 – dirty optics bit 3 – no connection with the sensor bit 4 – always 0 bit 5 – module initialization bit 6 – sensor data error bit 7 – mode 0 – operation, 1 - service bit 8 – threshold 1 exceeded bit 9 – threshold 2 exceeded bit 10 - mode 0 – operation, 1 - emulation bit 11 – constant memory error bit 15 – magnet presence	Record: 128 – switching to service mode 1024 – switching to values emulation mode 0 - return to operation mode	Rd/Wr
2	2	Status №2: bit 0 – current output fixed bit 1 – values manual deblocking bit 2 – values blocked bit 3 – low power supply bit 4 – not determined bit 5 – magnetic sensor went off (option)	Record (service mode): bit 1 = 1 / 0 – values manual/automatic deblocking bit 2 = 0 – reset blocked values	Rd/Wr
3	3	Concentration	Record: - Values calibration (service mode), - Values emulation (emulation mode).	Rd/Wr
4	4	Temperature	°C * 10	Rd
5	5	Measurement range	%vol*100, ppm	Rd
6	6	Manufactory number (LO)		Rd
7	7	Manufactory number (HI)		
8	8	Concentration value for magnetic calibration (option)	Record (service mode)	Rd/Wr
9	9	Threshold 1, %vol/%LEL/ppm	Change only in service mode	Rd/Wr
10	10	Threshold 2, %vol/%LEL/ppm	Change only in service mode	Rd/Wr
11	11	Current output. Current value, mA * 100	Record (emulator mode): Values calibration 4mA, 20mA	Rd/Wr
12	12	Operation time (HI)	Секунды	Rd
13	13	Operation time (LO)		
14	14	SW version		Rd
15	15	SW checksum		Rd
16	16	Relay adjustment bit 0 = 0/1 - relay 1 normally open / closed	Change only in service mode	Rd/Wr

Address	№	Description	Notice	Access
		bit 1 = 0/1 - relay 2 normally open / closed		
17	17	Thresholds hysteresis bit 0..7 - Hysteresis 1, %vol bit 8..15 - Hysteresis 2, %vol	Change only in service mode	Rd/Wr
18	18	Concentration zero value area, %vol	Change only in service mode	Rd/Wr
19	19	Delays in thresholds triggering when concentration is exceeded bit 0..7 - Delay in threshold 1 triggering, seconds bit 8..15 – Delay in threshold 2 triggering, seconds	Change only in service mode	Rd/Wr
20	20	Automatic reset of the failure flag time, seconds	Time w/o failure, after which failure flag is reset. Change only in service mode.	Rd/Wr
21	21	Calibration mode	Reading: 0 – operation mode 1 – zero calibration 2 – concentration calibration 7 – sensor test	Rd

Appendix F

«Current loop» interface

F.1 Nominal static conversion function.

To output current loop information nominal static conversion function is shown as output signal electric current dependance on target component concentration:

$$I_{nom} = 16 \cdot \frac{C_i}{C_{max}} + 4\,, \qquad \text{(F.1)}$$

where:

I_{nom} – output current, mA;

C_i – measured concentration, % vol;

C_{max} – max value of the target component volume fraction, corresponding to output current 20 mA.

Measured concentration is calculated according to the formula:

$$C = \frac{I_j - I_0}{e}\,, \qquad \text{(F.2)}$$

where:

I_j – gas detector output current at check point (mA);

I_0 – gas detector initial output current 4 mA;

e – conversion efficiency:

$$E = \frac{16\ \text{мА}}{\text{C}_{max} - \text{C}_{min}}\,, \qquad \text{(F.3)}$$

where:

C_{max} – max concentration of measurement range;

$C_{min} = 0$ – min concentration of measurement range.

F.2 «Current loop» interface tuning with Modbus RTU protocol guide.

F.2.1 Required equipment:

- PC equipped with RS-232 interface module or USB;
- power source;
- multimeter (milliamperemeter);
- RS-232 / RS-485 interface or USB / RS-485 converter.

F.2.2 Required tools and materials:

- SW with MODBUS protocol support for PC.

F.2.3 Procedure description

The following sequence of actions is suggested:

- connect input power;
- connect RS-485 sensor output through the converter to the following port of the PC. Connect current output to load;
- run the SW. Find the device's address;
- put the device in emulation mode by writing the value 0x0200 to register №4. Concentration values = 0;
- measure current output values. Write this value (uA*10) to register №18 (for example, 4.15 mA corresponds to number 0415). Current output values must be = 4 mA;
- write the value equal to gas detector max measured concentration to register №6. Concentration values 0999;
- measure current output values. Write this value to current output register №18 (for example, 20.10 mA corresponds to number 2010). Values must be = 20 mA;
- put the device in operation mode by writing the value 0x0000 to register №4.

Appendix G

IGM-10 connection diagrams

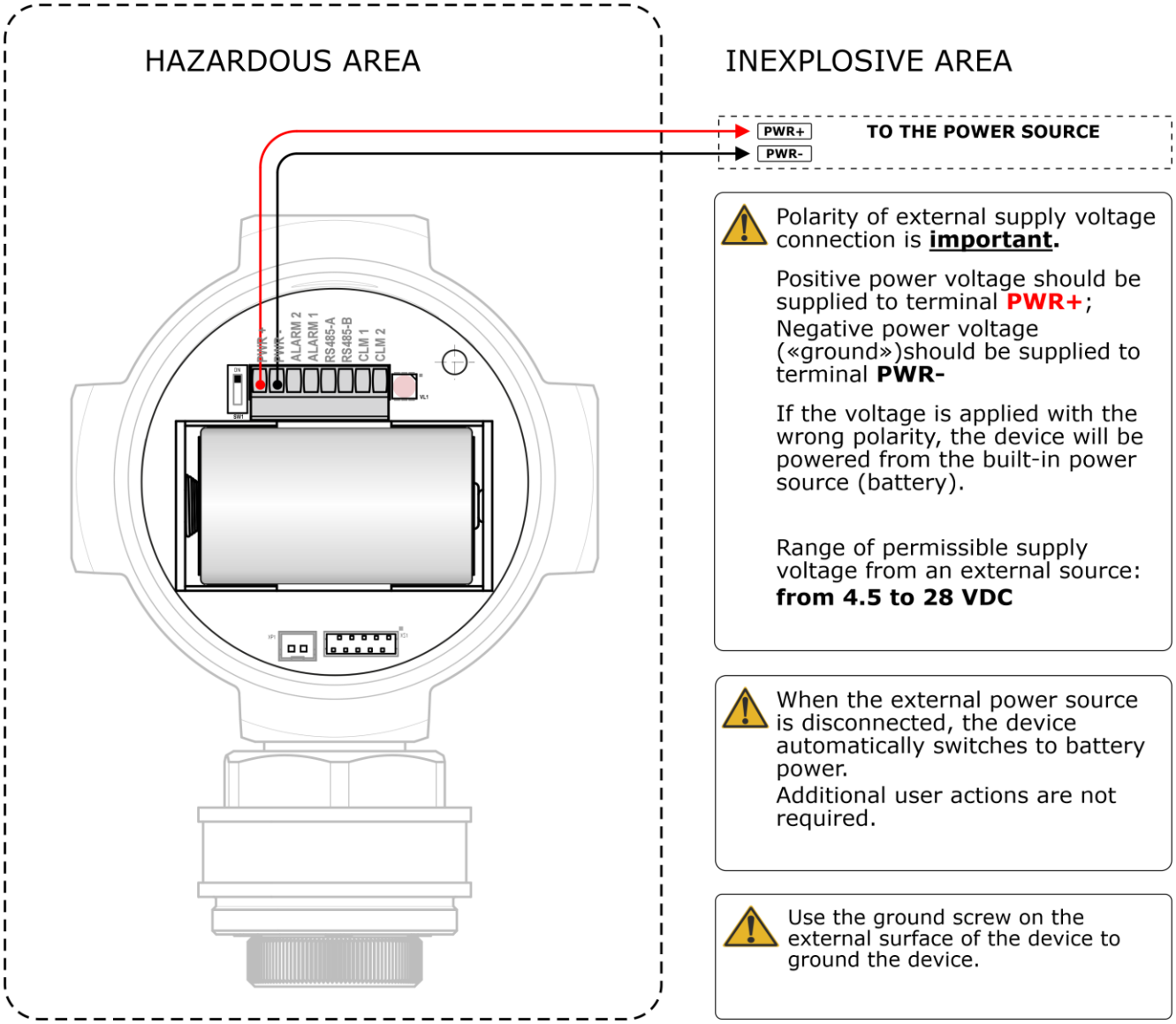


Figure G.1 – Supply voltage connection options

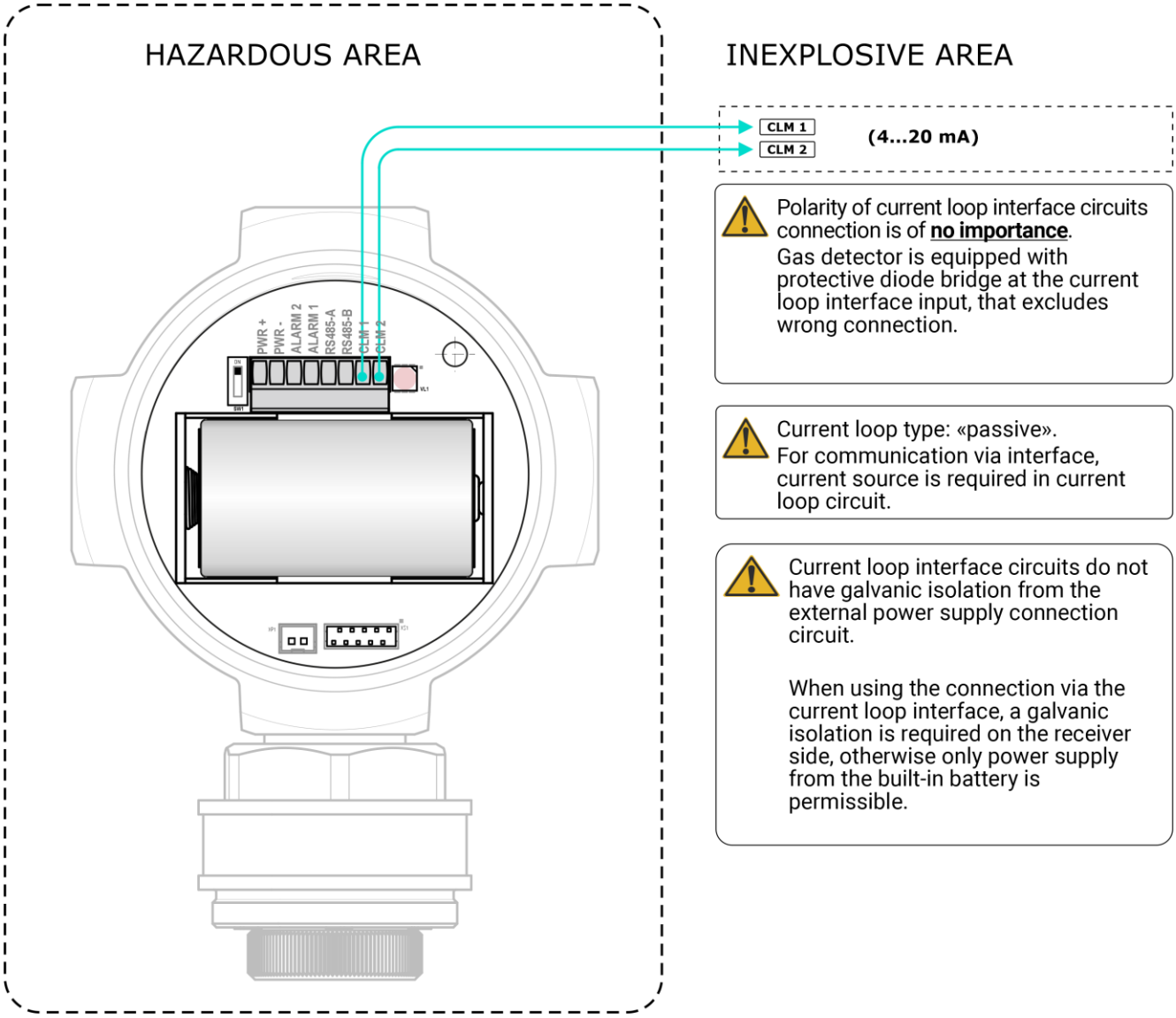


Figure G.2 – IGM-10 connection via «current loop» interface

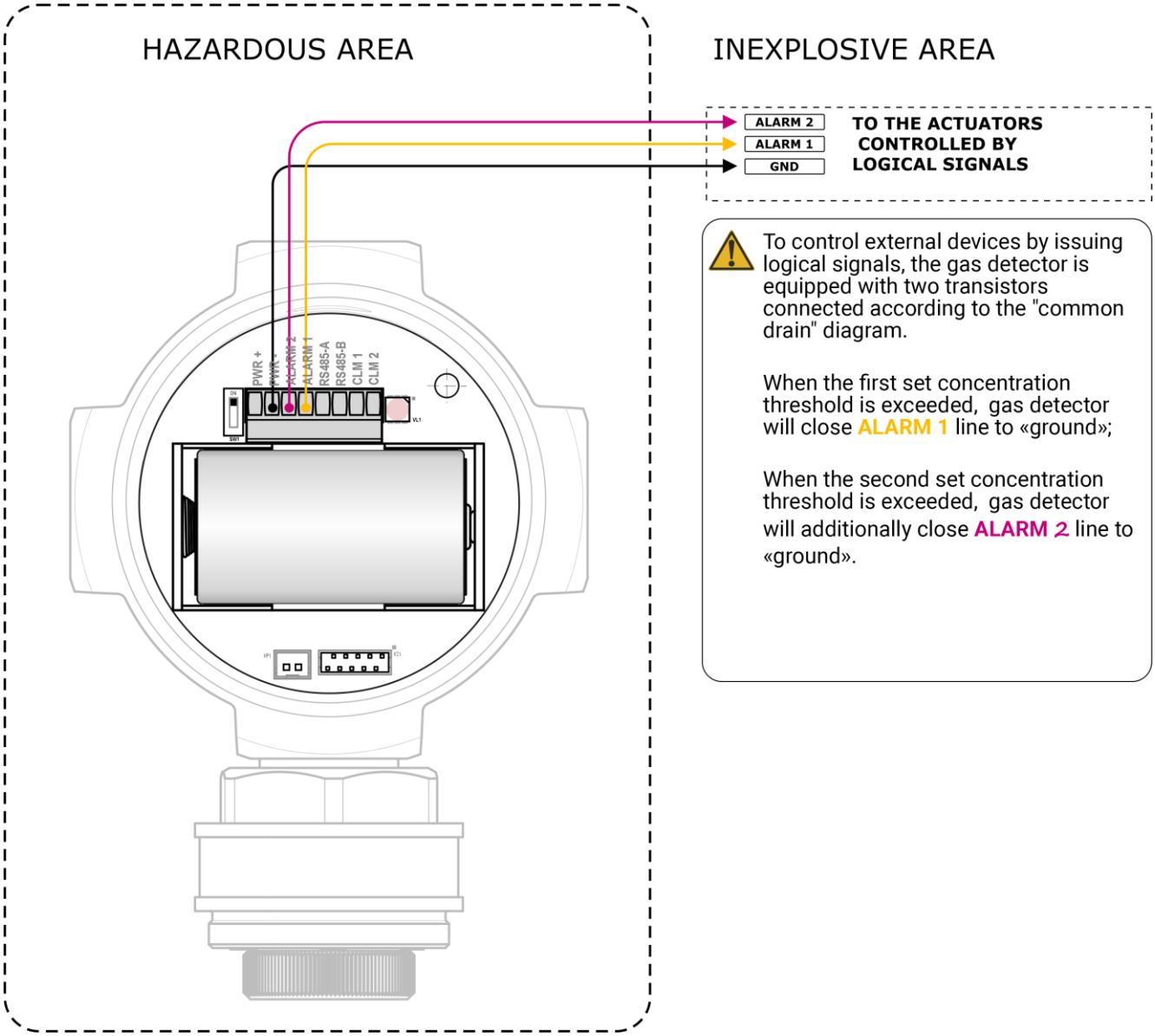


Figure G.3 – IGM-10 connection to the actuators, controlled by logical signals

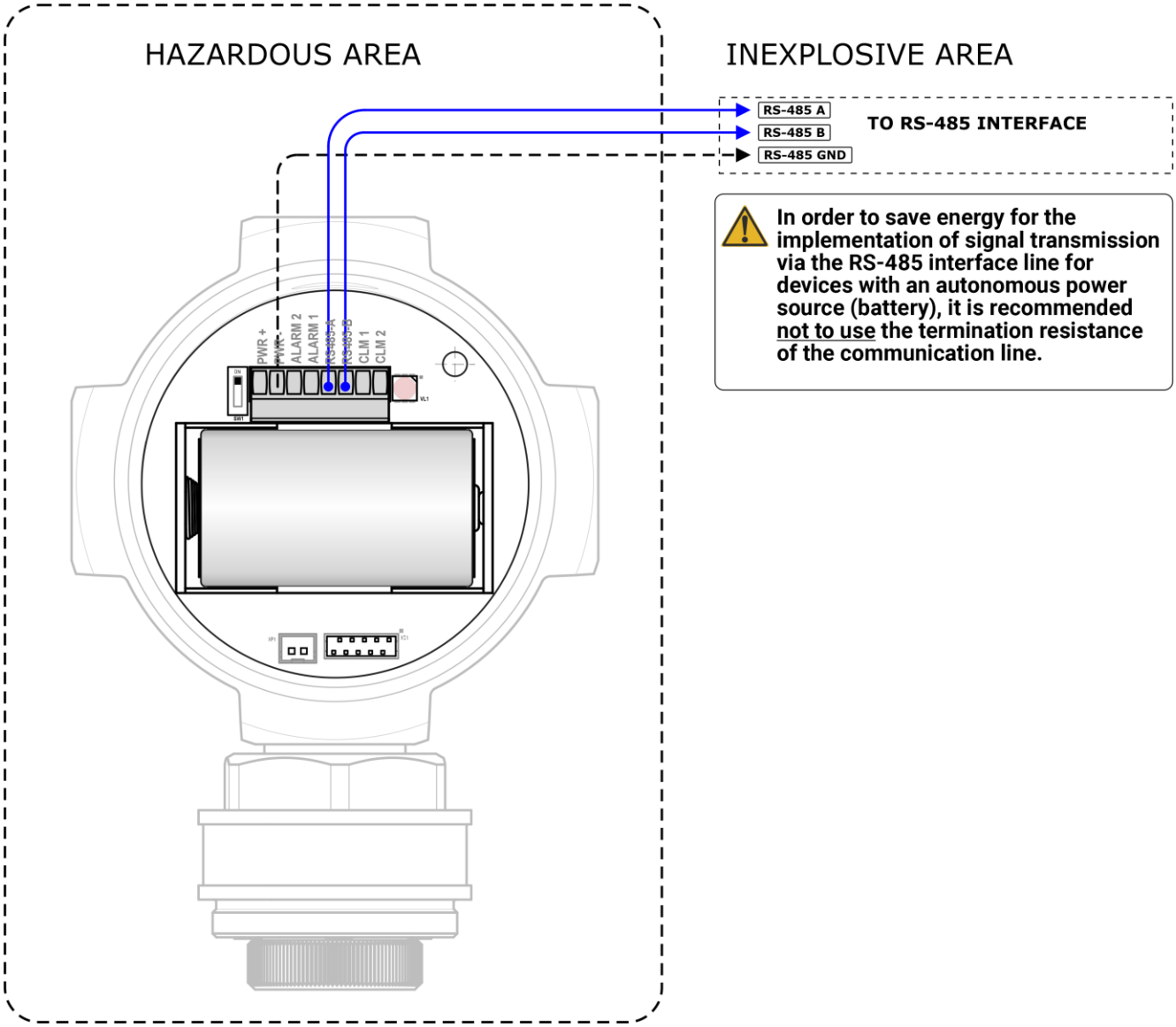


Figure G.4 – IGM-10 connection via RS-485 interface

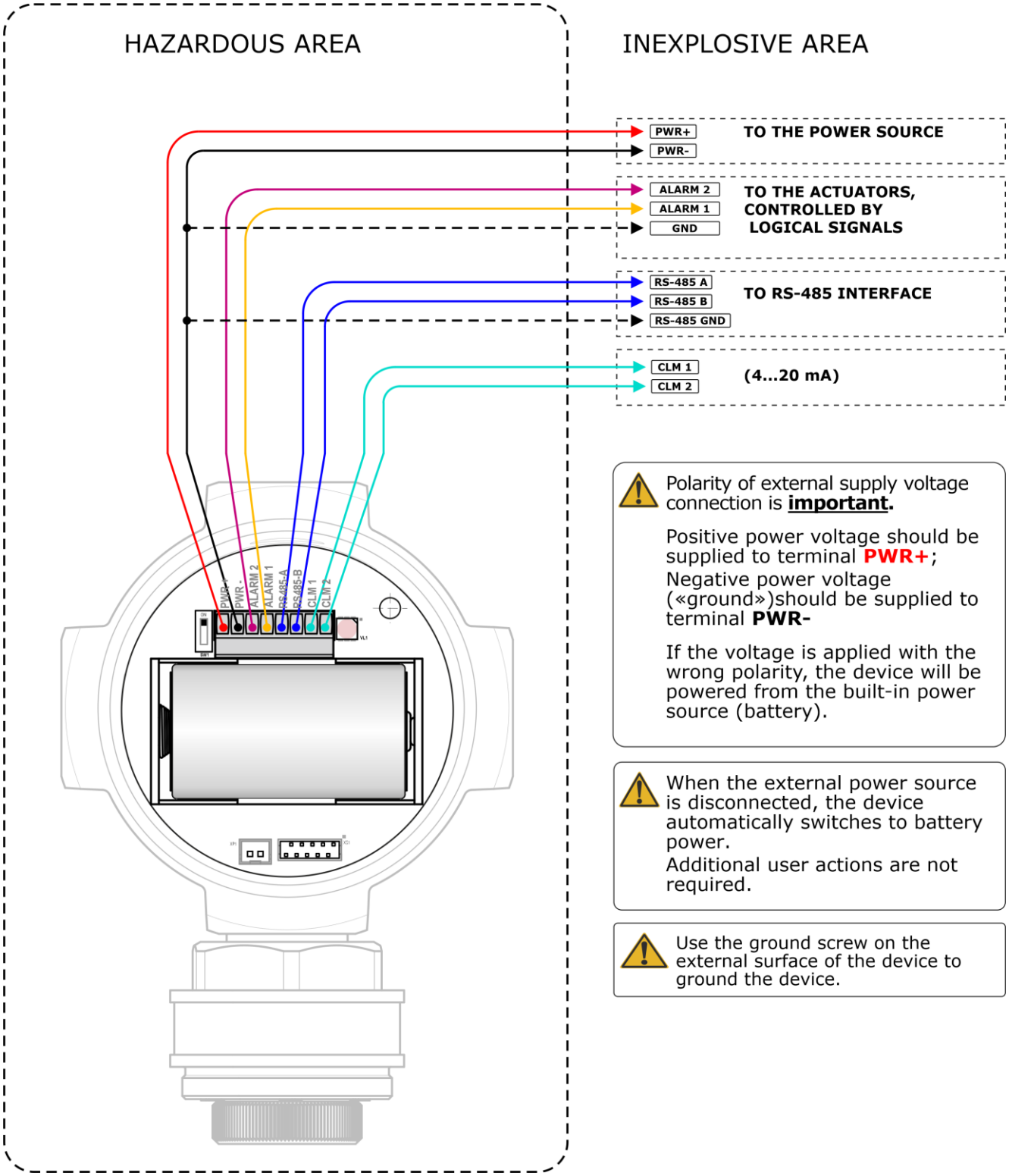


Figure G.5 – Simultaneous connection to IGM-10 via current loop interface, RS-485 interface and logical signals.