Guidebook

Sigma Gas

Gas Detection & Safety System

POD-070-ENG R01

Reliable and Innovative Gas Detection & Safety Systems

We design, manufacture, implement and support:
Systems for Monitoring, Detection and Reduction of gas hazards

For more details please visit our website **www.atestgaz.pl**

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Remarks and reservations

- Read and understand this manual prior to connection and operation of the device. Keep the User Manual with the device for future reference.
- The manufacturer shall not be held responsible for any errors, damage or defects caused by improper selection of suitable devices or cables, errors in installation of equipment or any misuse due to failure to understand the document content.
- Engineering of a gas detection&safety system for any specific facilities to be safeguarded may need consideration of other requirements during the entire lifetime of the product.
- Use of unauthorized spare parts different from the ones listed in project is strictly forbidden.

How to use this manual?

- Important fragments of the text are highlighted in the following way:

Pay extreme attention to information provided in such framed boxes.

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1 General information

Sigma Gas system is a unique combination of functionalities of devices such as gas detectors, control units, object indicators (optical and acoustic signallers), accessories. Together, they create a complex and integrated "Gas Safety System" for any industrial installations in which hazardous volatile substances may occur.

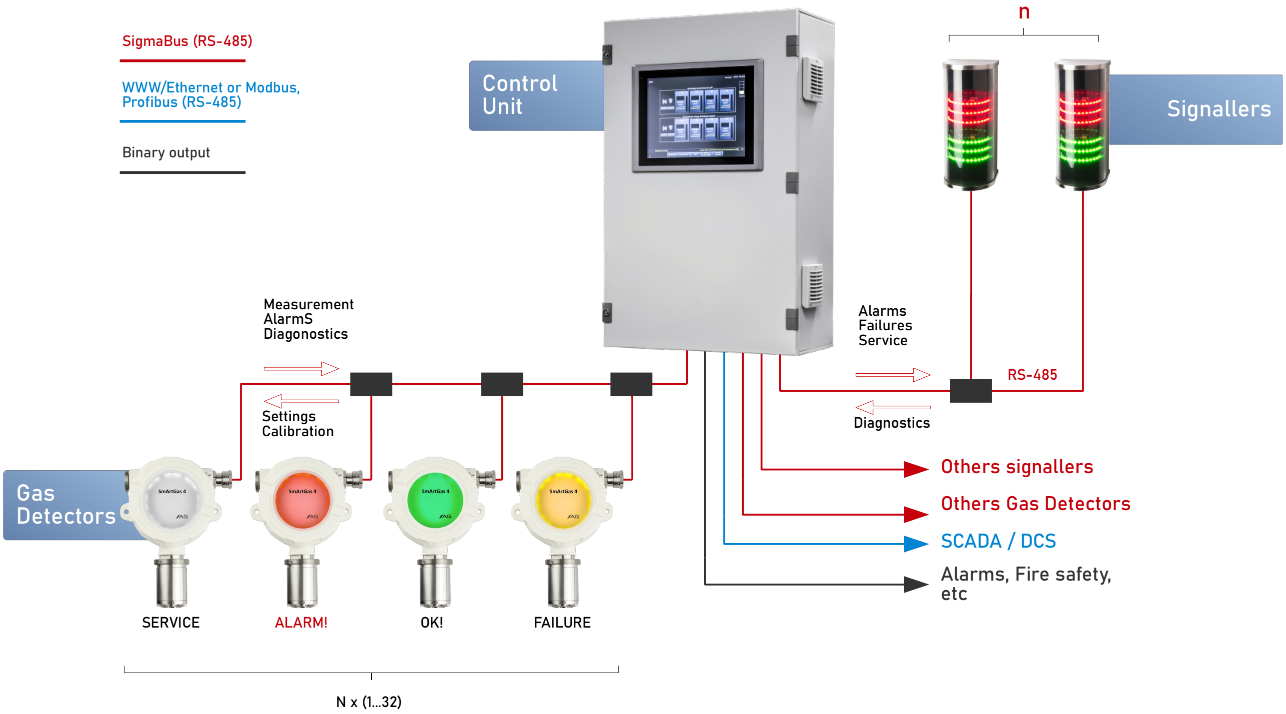

Figure 1: Sigma Gas Detection & Safety System

The Gas Detection & Safety Systems include the following equipment

Product code	Description
	Control unit modules
PW-027-A	Sigma MOD DRV Control Unit Module
PW-033-A	Sigma MOD LED Control Unit Module
PW-033-B	Sigma MOD LCD Control Unit Module
PW-033-C	Sigma MOD DO Control Unit Module
PW-072-A	Sigma Control L Unit
PW-120-X	MOD BUS Creator Bus Controller
	Detectors
PW-017-PG4	ProGas 4 Gas Detector
PW-044-SG4	SmArtGas 4 Gas Detector
PW-076-X	RapidGas E Gas Detector
PW-119-X	RapidGas S Gas Detector
PW-093-RA4	ReAct 4 Gas Detector

Product code	Description
Signalling devices	
PW-081-A	SOLED3 Warning Beacon
PW-089-X	LTT4 Warning LED Tower with Sounder
PW-091-X	LTT2 Warning LED Tower with Sounder
Junction box	
EXGRJ_167555	ExGRJ 167555 Junction box (3 cable glands)

Table 1: Device of Sigma Gas System

2 Input-output interfaces

The Sigma Gas Detection & Safety System serve as a source information for both the system operator and for other automation systems deployed within the building.

Gas Detection & Safety System	Fire protection system	Ventilation system	Other systems	User
Control unit	Yes	Yes	Yes	Yes
Detectors	Yes	Yes	Yes	Yes
Signalling devices	No	No	No	Yes

Table 2: Gas Detection & Safety System output interface

Information about current status on the facility area is disseminated by means of the following methods:

- detectors and the control unit module – by means of indicator lamps (LEDs) provided on the device enclosure (see details in appropriate User Manual for a specific device),
- signalling devices – optical and acoustic.

The control unit module receives information transmitted by detectors and in response, send signals that are necessary to control other devices or systems for alarm systems (sound and light warning beacons) or yet other automation systems deployed within the building.

2.1 Binary inputs DI

These inputs are meant to affect operation of the system by means of external signals, for instance signals received from other automation systems or pushbuttons. Depending on the signal voltage delivered to any specific inputs, these inputs can be considered as two logic levels.

These inputs are galvanic separated from other circuits of the device, although no galvanic separation between individual inputs is provided. An input is activated when voltage of any polarity is delivered across the terminal 1 to 4 appropriate for a specific input and COM terminal. It is illustrated on the drawing below:

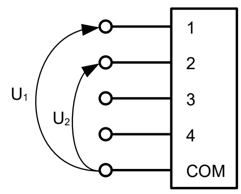

Figure 2: Delivery of input signals to logic inputs DI 1 and DI 2

Any input can operate as a non-inverted one (delivery of voltage activates the input) or an inverted one (the input in inactive when voltage is supplied to the input).

2.2 Current output

- The level of output current is in proportion to the gas concentration measured by the detector (constant output signal). Possible signal levels are listed in the table below.

Current output	Status
2 mA	Critical failure
From 4 mA to 20 mA	The signal level is in proportion to the gas concentration: 4 mA – 0% of the full range 20 mA – 100% of the full range
22 mA	Detector overloaded

Table 3: Constant output signals

- The level of output current may also correspond to warning of alarm thresholds (stepped intervals). Levels of output current for specific degrees of gas hazard are listed in the table below.

Current output	Status
2 mA	Critical failure
4 mA	No alarm
9 mA	Warning 1
11 mA	Warning 2
13 mA	Alarm
22 mA	Detector overloaded

Table 4: Intervals of the output current according to the detector status

The specific operation mode with respect to information provided at the 4..20 mA current output can be set upon configuration detectors by means of dedicated software – for details see Section 3.

2.3 Relays output

For details about the functions of relays outputs of the system devices please refer to user manual for the specific device.

These outputs can adopt one of the two statuses: active or inactive (the active state means that the voltage has been given to the relay coil). Terminals of relays can switch over to the following positions:

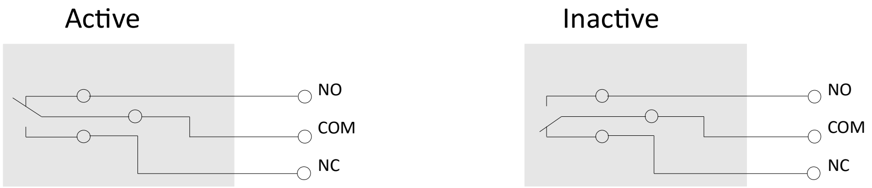

Figure 3: Relay in active and inactive state

The relay outputs offer various configuration options. Some of them are listed below:

- by a whichever combination of alarm thresholds signals received from whichever detectors (alarm zones can be customized as desired),

- by a failure signal received from a whichever detector,
- by a collective failure signal (including a defect of the control unit itself),
- by signals assigned to special statuses, e.g. “maintenance”, “measurements” (a common user interface device can be used to indicate status of the system)
- from Digital Inputs (DI) and/or External Digital Inputs (ExDI).

2.4 RS-485 output

Communication via the RS-485 employs either the Modbus ASCII or the Sigma Bus protocol (when the detector communicates with other devices of the Sigma system).

2.5 SBUS communication port

The communication port is meant to exchange information between individual devices within the Sigma Gas system. It is a serial port for digital transmission based on RS-485 link and Sigma Bus protocol.

2.6 ExBUS communication port

A communication port designed for exchange of information between the Sigma Gas system and external environment (e.g. PLCs, SCADA, etc.). The port is bidirectional and can be used both to read information about current status of the Sigma Gas system e.g.: statuses of detectors.

It is also possible to affect operation of the system by means of dedicated digital inputs. Purpose of those inputs is exactly the same as in case of DI lines.

Exchange of information is carried out by means of the RS-485 digital link and MODBUS protocol.

2.7 Bluetooth wireless interface (WI=BT)

Wireless interface enables the operator to control gas detectors from remote locations by means of dedicated software (see details in Section 3).

3 Software

Parameters of gas detectors are configured using dedicated software:

- Sigma Toolbox package for PCs with the Windows system,
- Detector Toolbox for Android devices.

This software can be downloaded from the manufacturer's website https://www.atestgaz.pl/en/category/software/sigma-systems/all

4 Engineering of Gas Detection & Safety Systems

4.1 Detected gases

Depending on the gas to which the gas detector is intended, the manufacturer configures the device's measurement parameters – selects the type and range sensor used (to avoid confusion, it is assumed that the sensor is an element which converts the gas concentration into an electronic signal, and the gas detector is the entire unit).

Information about detectors measurement parameters configuration can be found in document “Measurement parameters configuration document” (DOK-6073-ENG).

Information about sensors properties can be found in User Manual "Sensors used in gas detectors produced by Atest Gaz" (POD-062-ENG).

4.2 Conditions of the working environment

Any design of the gas detection system must take account of the following factors:

- corrosion aggressiveness of ambient atmospheres – the device must be installed and operated in environments that are not corrosive for materials applied. Although all possible efforts were undertaken to use only corrosion-resistant materials and suitable protection against corrosion was applied, it is the responsibility scope of a user or a system designer to investigate ambient conditions with consideration to the following factors:
  - presence of corrosive gases, such as SO_2, HCl, H_2S, NH_3 and similar ones, in particular in humid atmospheres,
  - possible variations of ambient temperature and impact of such variations onto stability of parameters declared in this manual,
  - under harsh ambient conditions with presence of corrosive gases we recommend use of equipment with housings made of stainless steel (E=SS),
  - for detectors designed for monitoring of corrosive agents their time of exposition to concentrations above the permissible measurements range must be reduced to indispensable limits, in particular under humid ambient conditions,
- in the case of reactive substances – such as HCl, Cl_2 – note the danger of adsorption of a particular substance on the detector surface, particularly in humid environments,
- the probability of deposition of dust, grease and other "clogging" substances, especially on the sinter of the gas inlet to the measuring chamber, which can lead to blocking gas access to the detector,
- ambient temperature – ambient temperature should be in line with the values declared by the manufacturer. Especially during the start-up of the technological installation and in the case of technological failures, attention should be paid to whether there is any temporary exceeding of the temperature range, and when it occurs – please contact the manufacturer,
- if the detector operates at an ambient temperature higher than the maximum permissible ambient temperature, the effect may be twofold:
  - a thermal detector failure can occur, or
  - the detector may become a potential source of ignition for potentially explosive atmospheres,
- danger of flooding the detector with water or other substance – it may lead to the inhibit of the detector,
- the detectors should be protected against exposure to direct flow of water or other chemicals – e.g. washing liquids being splashed when the plant facilities are cleaned. For applications where splashes are possible, relevant splash-protecting covers, hydrophobic membranes or "weather cabinets" should be applied,
- if the detector is to be installed outdoors, the device should not be exposed to direct impact of environmental factors, therefore installation of adequate splash-protection covers, hydrophobic membranes or "weather cabinets" is indispensable,
- possible outdoor mounting – for outdoor mounting the device must protected against condensation of moisture inside the housing since water may blocking the inlet of a sinter sensor.

To protect against moisture condensation the detector interior can be heated by several centigrades,

- the oxygen content in the environment:
  - especially in the case of catalytic detector (pellistor type), oxygen content less than 18% significantly reduces the sensitivity of the detector,
  - it should be borne in mind that the admission of explosion-proof equipment concerns atmospheres of oxygen concentration up to 21%. In larger concentrations the device loses its explosion-proof properties and can become a source of ignition,
- the presence of other gaseous substances which can cause:
  - false alarms – e.g. the presence of aerosols in the case of semiconductor gas detectors – see User Manual – Sensors used in gas detectors produced by Atest Gaz (POD-062-ENG),
  - pollution of the detector – e.g. the presence of silicone can cause damage to catalytic detector – see User Manual – Sensors used in gas detectors produced by Atest Gaz (POD-062-ENG),
  - crossover effect – the sensor also reacts to other gases, e.g. an electrochemical sensor of carbon monoxide can also react with hydrogen – see User Manual – Sensors used in gas detectors produced by Atest Gaz (POD-062-ENG),
  - masking effect – a reaction of the sensor to the working gas can be reduced in the presence of other interfering gases (e.g. in the presence of nitrogen dioxide, the sensor of sulphur dioxide reacts weaker to the working gas),
- vibrations:
  - may reduce the explosion protection, therefore, in case of such a situation, it is necessary to include appropriate recommendations for more frequent inspections in the project documentation,
  - incorrect detector indications or sensor damage – see User Manual – Sensors used in gas detectors produced by Atest Gaz (POD-062-ENG).

4.3 Equipment layout

4.4 Gas detectors

4.4.1.1 Location

Deployment of gas detectors must be determined by the system designed with consideration to the following rules:

- medium density detected in relation to density of air:
  - detectors of gases with densities less than air density must be mounted nearby the room ceiling with the maximum distance between the face of the measuring head to the room ceiling from about 20 to 30 cm,
  - detectors of gases heavier than air must be mounted nearby the room floor with the maximum distance between the face of the measuring head to the room floor from about 20 to 30 cm,
- detectors should me mounted at locations where gathering (accumulation) of gas is expected due to architectural properties of the facility (e.g. in the facility part that is separated from the entire space by means of walls or other structural components),
- the influence of the gas temperature – a substance heavier than air when heated becomes lighter and migrates upwards, but after cooling, it can flow down toward the floor,

- pressure and the expected nature of outflow (leakage / gush),
- volatility of gas – in the case of substances of low volatility, the detector should be located as close as possible to the expected leak,
- the impact of environmental conditions – see Chapter 4.2,
- direction of ventilation
    - the detectors should be located in areas in the ventilation path from the place of leakage to the extraction unit,
    - in the event that the route may be variable, four detectors should be provided so as to "circumnavigate" a potential source of emissions,
    - in the case of outdoor installation, it is necessary to take into account the expected direction of the wind,
- likely whereabouts of the people in relation to emission sources – detectors should "fence off" the personnel from the source,
- mechanical shock – the detector is made in high strength aluminium casing, resistant to very high mechanical shocks. However, it is necessary to protect the detector from damaging exposures,
- locations of detectors must enable easy checks and adjustments as well as replacement or disconnection of each detector.

Where it is necessary to detect only the escape of gas from within a given area, then detectors or sample points may be placed at intervals around the perimeter of the site.

Detectors or sample points should also be located in all areas where hazardous accumulations of gas may occur.

Such areas might not necessarily be close to potential sources of release but might, for instance, be areas with restricted air movement.

4.4.1.2 Quantity of sample points

Analysis:

- how the monitored substances spread on a given facility
- the size of the rooms
- likely places of gas leakage and accumulation
- the amount of monitored substances

should indicate the number of sample points needed, so that the Gas Safety System ensures monitoring of each part of the object or rooms where a hazard may occur.

4.4.2 Location for a control unit module

The location of the device should take into account the environmental conditions and ensure access for authorized personnel.

4.4.3 Location for sound and light warning beacons

Sound and light warning beacons shall be mounted at such locations that guarantee:

- good visibility of messages,
- proper sound propagation.

4.5 Power source

> The power supply line should be designed in such a way that, at the lowest expected supply voltage the measured voltage at the gas detector terminals does not drop below the permissible value.

On the side of the power source, the least favourable conditions should be considered. It must be assumed that in failure situation – at the time of power failure – the supply voltage from the battery terminals falls below the nominal value.

Please refer to the documentation concerning the uninterrupted power supply (for installation with 24 V (48 V) power supply typical minimum supply voltage during operation on an emergency power supply battery is 21 V (42 V); below this value the system disconnects).

4.6 Device power supply

When selecting the cable, it is assumed that the supply voltage at the end of the cable must not fall below 60% of the value at the power source terminals.

As a standard, it is assumed that the supply voltage cannot drop below the permissible value (see the device documentation).

The power consumption of the detector is constant within the range of acceptable voltages. With the decrease of supply voltage, the current consumption from the power supply increases.

For example, if the sensor consumes 1 W

- when powered by 48 V, the supply current will be 1 W / 48 V ≈ 20 mA
- when powered by 24 V, the supply current will be 1 W / 24 V ≈ 40 mA
- when powered by 15 V, the supply current will be 1 W / 15 V ≈ 67 mA

4.6.1 Example – a system with a single device

Task: Select the sensor power cable under the following conditions:

Data:

- power consumption of the device: 2 W
- min. power supply voltage: 24 V
- min. UPS supply voltage: 21 V
- min. permissible device supply voltage: 15 V
- distance between the control unit and the device: 800 m

Calculations:

- min. power supply voltage at the end of the cable: 24 V*60% = 14.4 V
- min. UPS supply voltage at the end of the cable 21 V*60% = 12.6 V
- voltage comparison 14.4 V < 15 V and 12.6 V < 15 V

  min. supply voltage lower than min. allowable supply voltage of the device, so we take the highest value of 15 V for calculations
- max. current consumption of the device: 2 W / 15 V = 0.133 A

- permissible voltage drop on the line: 21 V – 15 V = 6 V
- maximum allowable line resistance: 6 V / 0.133 A = 45 Ω

Cable selection:

- cable with the cross-section of 0.5 mm^2: R(2x800 m) = 36 / 1000 * 1600 = 57.6 Ω > 45 Ω

  The cable has a resistance greater than the maximum permissible line resistance, so it does not meet the requirements and cannot be used in the system.
- cable with the cross-section of 1.0 mm^2: R(2x800 m) = 18 / 1000 * 1600 = 28.8 Ω < 45 Ω

  The resistance of the cable is less than the maximum acceptable line resistance – the requirements are satisfied so the cable can be applied to the above system.

4.7 Power

The power supply unit selected for the system must deliver sufficient power to cover power consumption of all devices.

The demand for power consumption of specific devices can be found in relevant user manuals for these devices.

To calculate the overall power necessary to cover the system demand the consumption of all system devices must be added up and then doubled.

4.8 Connection cable

> The choice of the connection cable is up to the designer and should take into account the legal requirements and conditions prevailing in the facility (e.g. oil-resistant, mechanically resistant, UV-resistant, unplaned or food approved cables).

> The diameter of the cable should be matched to the size of the cable gland of a specific device.

- Use cables with a more accurate, round cross-section, made with the use of pressure (better sealing in the Ex glands).

4.8.1 RS-485 interface

- The data transmission line for the gas detectors working in the RS-485 standard should be performed only with the use of a shielded twisted pair cable.
- The design line data transmission can not be longer than 1200 m (details see 4.8.1.1).

An example of a cable symbol		Approximate outer diameter [mm]
Outdoor installations	Indoor installations	
-	Bit 500 (St) 2x2x1	10.5
YvKSLYekw-P 300 / 300 V 2x2x1.5	YKSLYekw-P 300/300 V 2x2x1.5	10.8

An example of a cable symbol		Approximate outer diameter [mm]
Outdoor installations	Indoor installations	
-	BiT 1000 (St) FR 2x2x1.5	13,7
-	LiYCY-P 300 / 500 V 2x2x1.5	11.7
-	BiT Black FR 500 300 / 500 V 3x2x0.75	10.6
-	BiT Black FR 500 300 / 500 V 3x2x1	11.1

Table 5: Examples of cable types that can be used in RS-485 systems

4.8.1.1 Using branches in the RS-485 bus

When there is a need to use branches on the RS-485 bus, the main bus should be designated (the longest section between devices using RS-485 – most often it will be the distance from the control unit to the most distant device). The other connections are bus branches.

To determine the total length of the branches, add up all the branches of the bus.

The total length of the branches should not be longer than 300 m

4.8.2 4 – 20 mA interface

An example of a cable symbol		Approximate outer diameter [mm]
Outdoor installations	Indoor installations	
LiYCYv 300/500 V 3x1.0	LiYCY 300/500 V 3x1.0	9.1
LiYCYv 300/500 V 3x1.5	LiYCY 300/500 V 3x1.5	9.8

Table 6: Examples of cable types that can be used in 4 – 20 mA systems

4.8.3 Relay interface

An example of a cable symbol		Approximate outer diameter [mm]
Outdoor installations	Indoor installations	
YnvKSLY-P 300/500 V 3x2x0.5 + YnvKSLY-Nr 300/500 V 2x1.0 (power supply)	YnKSLY-P 300/500 V 3x2x0.5 + YnKSLY-Nr 300/500 V 2x1.0 (power supply)	7.4 5.4
YnvKSLY-P 300/500 V 3x2x1.0 + YnvKSLY-Nr 300/500 V 2x1.0 (power supply)	YnKSLY-P 300/500 V 3x2x1.0 + YnKSLY-Nr 300/500 V 2x1.0 (power supply)	8.9 5.4
-	BiT 500 Black FR 300/500 V 4x0.75	8.1
-	BiT 500 Black FR 300/500 V 4x1	8.4
YnvKSLY-P 300/500 V 4x2x1.0	YnKSLY-P 300/500 V 4x2x1.0	10.0
LiYCYv-Nr 300/500 V 6x1.0 + LiYCYv-Nr 300/500 V 2x1.0 (power supply)	LiYCY-Nr 300/500 V 6x1.0 + LiYCY-Nr 300/500 V 2x1.0 (power supply)	7.9 5.8
LiYCYv 300/500 V 6x1.0 + LiYCYv 300/500 V 2x1.0 (power supply)	LiYCY 300/500 V 6x1.0 + LiYCY 300/500 V 2x1.0 (power supply)	7.9 5.8
LiYCYv-Nr 300/500 V 6x0.5 + LiYCYv-Nr 300/500 V 2x1.0 (power supply)	LiYCY-Nr 300/500 V 6x0.5 + LiYCY-Nr 300/500 V 2x1.0 (power supply)	6.8 5.8
LiYCYv 300/500 V 6x0.5 + LiYCYv 300/500 V 2x1.0 (power supply)	LiYCY 300/500 V 6x0.5 + LiYCY 300/500 V 2x1.0 (power supply)	6.8 5.8
LiYCYv-Nr 300/500 V 8x1.0	LiYCY-Nr 300/500 V 8x1.0	8.5

An example of a cable symbol		Approximate outer diameter [mm]
Outdoor installations	Indoor installations	
LiYCYv 300/500 V 8x1.0	LiYCY 300/500 V 8x1.0	8.5
-	BiT 500 Black FR 300/500 V 8x1	10.5

Table 7: Examples of cable types that can be used in relay systems

5 Lifetime cycle

5.1 Installation

⚠ Mounting of devices is allowed only after full completion of all civil engineering works.

⚠ The electric network must be deployed according to the engineering documentation.

⚠ The electric system must be designed in conformity to general rules for engineering of A&C[1] systems.

⚠ Electric cables and conductors shall be routed in a safe manner to have then protected against possible damage.

⚠ Incorrect routing of cables may result in impairment of the equipment immunity to electromagnetic interferences.

For more details about mechanical installation of individual components of the system please refer to relevant user manuals or data sheets.

1 Automation and Control Systems

5.2 Commissioning of the Gas Detection & Safety System

After having the electric network complete and power voltage supplied to all devices carry out the following operations:

- configure and assign addresses to all detectors (see user manual of dedicate gas detector),
- configure the control unit,
- make sure that the system works according to the underlying logic flow chart – execute a test of safety functions – see details in Section 5.3.3.

> If any civil engineering or building (finishing) jobs could have been performed yet after installation of the Gas Detection & Safety System a test of all detectors is mandatory to make sure that detectors correctly respond to presence of hazardous gases.

> The gas monitoring system can be approved for operation only after passing results of all aforementioned checks and verifications.

5.3 Maintenance schedule

5.3.1 Calibration

Please refer to relevant User Manuals for specific equipment for detailed information about calibration.

5.3.2 Replacement of fast wearing parts

Please refer to relevant User Manuals for specific equipment for detailed information about replacement of wearing parts and consumables.

5.3.3 Test of safety functions

Execution of the test for safety functions is recommended once a year. Test gas is supplied to one unit of each detector type and response of all components within the Gas Detection & Safety System is checked together with all collaborating systems (e.g. ventilation).

Notes

Notes

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