User Manual

Gas Detector

Teta EcoTerm / Teta EcoH

Product code: PW-113-NG / PW-123-H2

POD-054-ENG R03

Reliable and Innovative Gas Detection & Safety Systems

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

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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.
- Unauthorised repairs and modifications of the device are not allowed. The manufacturer shall discard any responsibility for consequences of such actions.
- Exposure of the device to the impact of excessive mechanical, electric or environmental factors may lead to damage of the device.
- Operation of damaged or incomplete devices in not allowed.
- Engineering of a gas 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 Table 6 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.

This User Manual consists of a main text and attached appendices. The appendices are independent documents and can be used separately from this Manual. Page numbering of appendices starts anew with no relationship to pare numbering of the main document and appendices may have their own tables of contents. In the right bottom corner of each page you can find the name (symbol) of any document included into the User Manual package with its revision (issue) number.

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1 Preliminary information

1.1 Purpose

Gas Detectors Teta EcoTerm and Teta EcoH are designed as crucial components of the Teta Gas system for monitoring of hazardous gas concentrations and are dedicated to detect excessive (hazardous) concentrations of natural gas and hydrogen in the surrounding atmosphere, primarily in facilities heated with natural gas (e.g. boiler rooms or industrial halls heated with heaters) or in battery rooms.

> ⚠ Teta EcoTerm and Teta EcoH Gas Detectors are not designed for operation in areas with potentially explosive atmospheres.

Key features of gas detectors:

- Power supply and data transmission via a single two-core cable.
- Safe installation with low power supply voltage of any polarization.
- Easy assembling and networking.
- Simple and clear procedure to assign and verify addresses of individual detectors within a gas monitoring network.
- Possibility to verify status of individual detectors by means of the supervising control unit.
- Optional calibration of the detector parameters by replacement of the Measuring Head MiniPel – very short time of calibration.
- Three alarm thresholds.
- Indication of detector faults.

1.2 Operation principle

Gas detectors are crucial components of any system for gas detection. They are designed for periodical measurements of gas concentration in ambient air. Information that the settings for concentration thresholds are exceeded is shown by means of dedicated light indicators (LEDs) provided on the side wall of the detector housing (see Figure 1) and transmitted via a digital output line.

Presence of hazardous gases is detected by means of catalytic sensors. Such a solution enables high insensitivity to variations of ambient conditions, such as temperature, humidity or pressure. The sensor also distinguishes with high immunity to presence of disturbing chemical compounds (e.g. methane, isobutene or carbon dioxide), which eliminates occurrence of faked alarms.

Please refer to Appendix [2] for more details about catalytic sensors.

> ⚠ Types of monitored gas and tripping thresholds are specified in its calibration certificate.

Operation of gas detectors consists in periodical measurements of hazardous gases in their vicinity with continuous averaging of measurement results. Momentary concentration of gases are measured with the time period of 1 second and average concentrations are calculated. These measurements enable reporting of warnings or alarms:

- Conditions for Alarm 1 and Alarm 2 are established against average concentration for the most recent one minute.
- Alarm 3 is generated when any momentary concentration exceeds the threshold limit.

Depending on results of the foregoing actions the system may adopt various statuses that are described in subsequent paragraphs.

1.2.1 Operation

It is the status when the gas detector is in sound working conditions and takes regular measurements.

Measurement results for the monitored gas still remain below threshold limits and no irregularities in operation of the equipment are detected. The detector needs no particular attention of personnel beside:

- regular and frequent verification of indications, preferably under daily basis,
- periodical inspection and calibration (see Section 7.7.1).

1.2.2 Alarm 1 (threshold 1) / Alarm 2 (threshold 2)

It is the device status when only slight concentrations of hazardous gases are detected and advising the personnel is needed.

Under such circumstances the operator should undertake the following actions:

- check possible reasons that may include:
  - appearing of gas in facilities monitored by the system,
  - interference of the detector operation by foreign substances (e.g. solvents of high concentration or fuel fumes) – such substances must be expelled from monitored facilities,
  - of the null point. Therefore detectors must be regularly calibrated, otherwise the warning threshold may offset to the area of pure air, i.e. the situation when competent inspectors have checked by means of appropriate instruments that no gas or interfering substances are present at the facilities.

1.2.3 Alarm 3 (threshold 3)

This status is adopted when concentration of hazardous gases exceeds the third threshold during the time period longer than one minute. If so, the necessary actions shall include:

- evacuation of third persons from the endangered area,
- if possible, enable ventilation of endangered confined spaces, e.g. open windows and doors (unless the control unit automatically switched the ventilation system on).

1.2.4 Failure

In parallel to measurements of gas concentration the detector carries out a series of self-test measurements to verify fault-free operation of the sensor and the gas monitoring system as a whole.

The defects indicated by the gas detectors may include:

- problems with built-in gas sensors,
- error of communication with the control unit.

1.2.5 Warm – up

After power on the detector need some time to stabilize operation parameters of sensors. It is the time period when no measurements are taken. Such a warm-up procedure takes about two minutes and the detector starts normal operation.

2 Safety

⚠ Do never install gas detectors at locations exposed to direct effect of water (moisture) or direct sunlight.

⚠ When defects are revealed switch the detector off, secure connection cables and contact maintenance staff or a service team.

⚠ Despite the power supply voltage for the Gas Safety System is off, dangerous voltage may persist across terminals of the Control Unit. Such a voltage may come from another system controlled by the same unit, for instance ventilation, that use one output pin of the Control Unit.

⚠ The gas detector must be reliably secured during any repair, installation or maintenance works.

⚠ Before painting the facility walls make sure that the device is properly secured against unintentional painting or paint splashing.

⚠ Before painting the facility floor make sure that the device is properly secured against unintentional painting or paint splashing.

Before use of silicon or silicon-based materials (paints, adhesives, sealant, etc.), make sure that the device is properly secured against unintentional coating.

3 Description of the construction

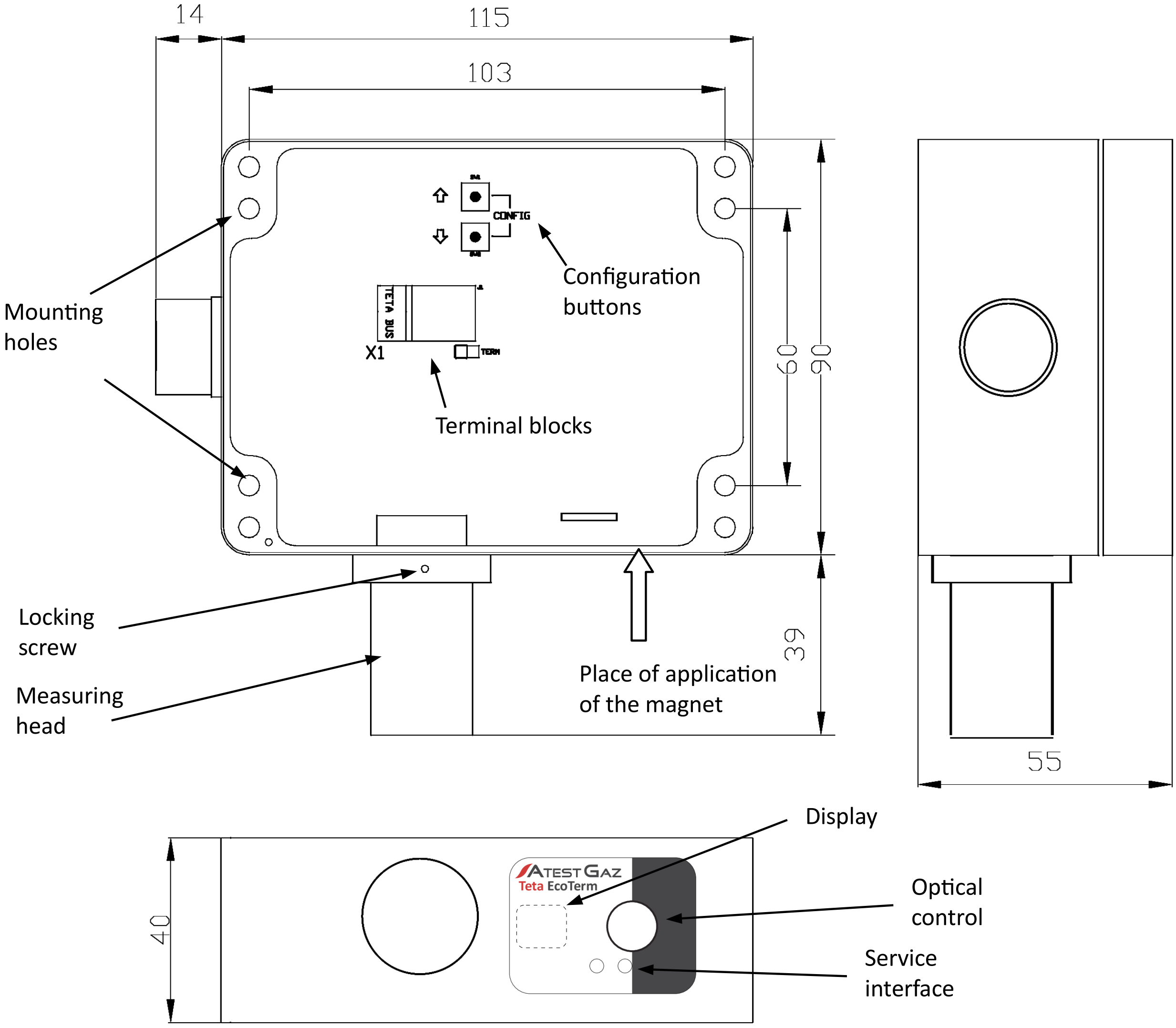


Figure 1: The construction of the devices and its dimensions

4 Input-output interfaces

4.1 Electric interface

Locations and arrangement of terminal blocks is shown on Figure 1.

Port designation	Name	Terminal	Description
X1	TETA BUS		Teta Bus port. Parameters – see section 8
			Supply / signal line
			Supply / signal line

Table 1: Electric connections

5 User interface

5.1 Indication of the device status

Gas detectors are provided with LED indicator to show status of the device. This LED is located on the bottom of the device housing (see Figures 1).

It is also possible to adjust light intensity of LEDs designed to indicate normal operation of the device (see details in Section 7.5.2).

Table 2 summarizes how status of the gas detector is indicated by means of individual LEDs.

LED indication	Detector status		Operation mode
	Related to measurement line	Not related to the measurement line	
G Y R G Y R [1]	Warm – up	-	Start – up of the detector
G G G [2]	OK	OK	Regular operation of the detector, gas concentration below the established thresholds
R R	Alarm 1	OK	Alarm 1
R R R R	Alarm 2	OK	Alarm 2
R R R R R R	Alarm 3	OK	Alarm 3
Y Y	Failure	OK	Failure – defect of the measuring detector
G Y Y G Y Y G Y Y G Y Y [2]	OK	Failure	Normal operation of the detector, gas concentration below the established thresholds. The detector also indicates that there are no interrogation from a control unit or a detector defect not related to the measurement line – see details in Section 7.6
R Y Y R Y Y	Alarm 1	Failure	Alarm threshold 2 is exceeded. The detector also indicates that there are no interrogation from a control unit or a detector defect not related to the measurement line – see details in Section 7.6

1 G – green, Y – yellow, R – red.
2 Low intensity of light– L.

LED indication	Detector status		Operation mode
	Related to measurement line	Not related to the measurement line	
R R Y Y R R Y Y	Alarm 2	Failure	Alarm threshold 3 is exceeded. The detector also indicates that there are no interrogation from a control unit or a detector defect not related to the measurement line – see details in Section 7.6
R R R Y Y R R R Y Y	Alarm 3	Failure	Alarm threshold 3 is exceeded. The detector also indicates that there are no interrogation from a control unit or a detector defect not related to the measurement line – see details in Section 7.6
Y Y Y Y Y Y	Failure	Failure	Detector defect. The detector also indicates that there are no interrogation from a control unit or a detector defect not related to the measurement line – see details in Section 7.6

Table 2: Indication of the gas detector operation modes

5.2 Display

On the bottom of the device enclosure comprises also a display module (see Figure 1). The display panel is designed to show information that is explained in subsequent sections.

5.2.1 Detector address

The detector address can be displayed with no need to open the device enclosure, it is just enough to approach a permanent magnet to a specific location on the housing (this location is shown in Figure 1). Depending on the operation mode of the detector the following details are displayed:

- regular operation of the detector – the display presents sequentially the detector address (Ad), its setting and tE,
- failure or warm-up – the sequence of address (Ad) and setting.

The device address can be also displayed by means of configuration buttons.

5.2.2 Information about tests /simulations

The configuration buttons can be also used to display details related to operation modes of the detector (HE) – see more in Section 7.7.3.

6 System architectures

6.1 Data bus architecture

In this system gas detectors are connected to the bus via T-connectors S2.

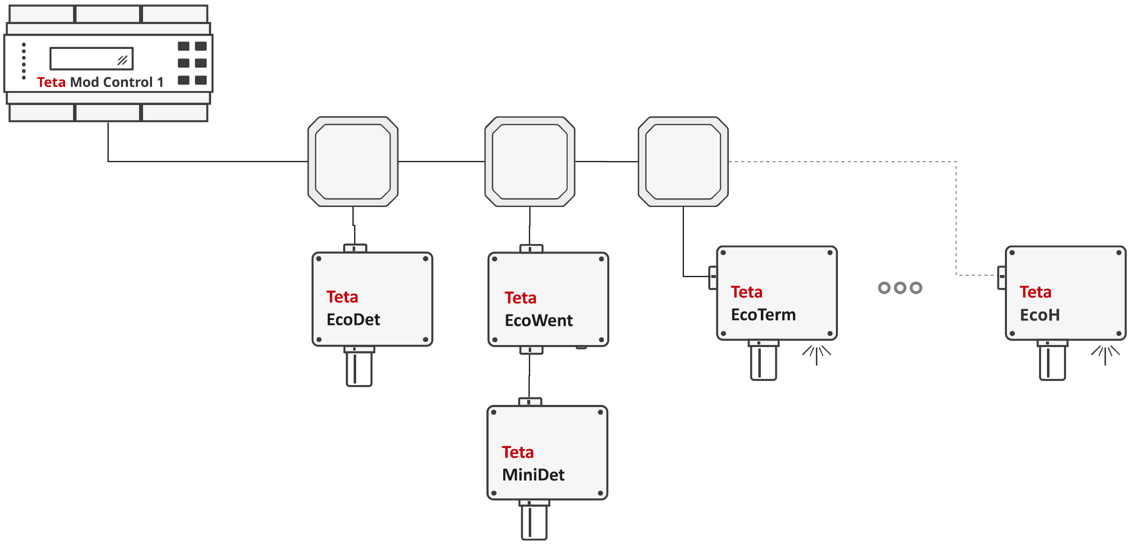


Figure 2: Arrangement of gas detectors according to the data bus architecture

Detailed schematic diagrams in an editable format can be found on our website.

7 Life cycle

7.1 Transportation

The device can be shipped in the same way as new equipment of that type. If the original package or another protecting means (e.g. corks) is unavailable the conveyed equipment must be secured against shocks, vibrations or moisture by means of adequate methods and material at the own responsibility of the sender.

The device can be conveyed under environmental conditions as described in Table 5.

7.2 Installation

7.2.1 Deployment of gas detectors

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

- installation of detectors is recommended somewhere 30 cm below the topmost point of the ceiling – methane is lighter than air and tends to migrate upwards,
- 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),
- detectors must not be exposed to direct effect of water (moisture) or other chemicals (e.g. cleaning chemicals when the facilities are being cleaned), as well as to direct effect of sunlight, rain or wind,

- detectors must be secured against damaging mechanical impacts,
- locations of detectors must enable easy checks and adjustments as well as replacement or disconnection of each detector.

7.3 Mechanical mounting of detectors

> Mounting of gas detector is allowed only after full completion of all civil engineering works.

- Spring clamps of terminal blocks are released by depression of the button with a screwdriver.
- Detectors must be fixed by means of mounting holes that are visible after opening of the housing. Make sure that the gas inlet looks downwards. Dimensions of the housing, arrangement of mounting holes and layout of internal components is shown in Figure 1. Drilling of mounting holes in walls or other permanent structures is easier with use of a drilling pattern attached to the device package.

7.3.1 Electric network

> 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[3].

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

When two conductors are to be connected to a single terminal clamp of the device they must be encapsulated first within a common clamping bushing (lug) – see details in Table 5.

> Combining two or more wires at a single terminal is not allowed if such wires are not clamped in a common cable lug.

> Do never leave spare lengths of cables inside the device. Bare wires or wires surplus may lead to a hazard of electric shock or equipment damage.

3 Automation and Control Systems

Do never leave redundant cable cores not terminated inside the device.

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

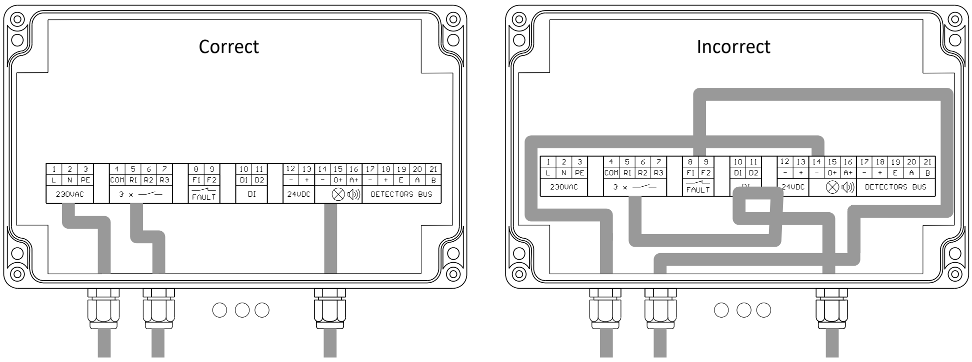


Figure 3: An example of cable termination inside a gas detector

7.3.2 Types of suitable cables and conductors

Connection type	Recommended cable type	Example of a suitable cable designation
Connections between T-connectors and gas detector	Two-core cable	YDY 2 x 1 mm^2

Table 3: Types of suitable cables

7.4 Commissioning of the gas monitoring system

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

- assign addresses to all detectors (see details in section 7.5.1),
- configure the control unit (see User Manual for the Teta MOD Control 1 Unit),
- simulate generation of alarms signals S1 – see details in section 7.7.3.2,
- make sure that the system works according to the underlying logic flow chart – execute a test of safety functions – see details in section 7.7.3.3.

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

> ⚠ In case of improper operation of the system recheck all wiring and connections or contact the system provider /equipment manufacturer.

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

7.5 Configuration of gas detectors

Reliable operation of gas detector needs preliminary configuration of the device parameters. The configuration is performed with the use of two buttons ⇩⇧(CONFIG) that are available after opening of the device housing (see Figure 1). These buttons enable also displaying of the detector settings.

Information about the detector settings is displayed on bottom wall of the device housing (see Figure 1).

7.5.1 Assigning addresses to gas detectors

Depress the arrow buttons ⇩⇧ (see Figure 1) and hold them about one second to enter the mode of address assignment (the 'Ad' message appears on the device display). Release the buttons with the 'Ad' message active and the message starts blinking slowly – the desired address can now be set by means of the arrow buttons ⇩⇧. Finally, depress the both arrow buttons ⇩⇧ simultaneously to confirm the address and store it into the device (the setting continues blinking for about two seconds). Finally, the device quits the procedure of address assignment.

Should the selected address is not confirmed and stored, the old address remains intact and after 15 seconds the detector quits the mode of address assignment.

The default address is 99.

7.5.2 Adjustment of light intensity

Intensity of light indicators can be adjusted according to local conditions at the facility where the system is operated.
The way how detector status is indicated according to the settings of the light intensity is explained in Table 2.
Simultaneous depressing of the arrow buttons ⇧⇩ (see Figure 1)and holding them about two seconds makes it possible to enter the mode of light intensity adjustment (the 'Li' message appears on the device display). Releasing of the buttons with the 'Li' message active leads to slow blinking of the 'Li' message and the desired intensity of indicator lights can be adjusted by means of arrow ⇧⇩ buttons:

- H stands for high intensity of light (recommended for rooms or confined areas substantial height),
- L stands for low intensity of light (recommended for small room, such as boiler houses),

Upon completion of the adjustment procedure depress the both arrow buttons ⇧⇩ simultaneously to confirm the settings (the setting continues blinking for about two seconds) and the device quits the procedure of parameter adjustment.

7.6 Troubleshooting

When a detector reports problems with its operation (see Table 2) the information about a reason for malfunctioning of the detector is provided by means of the supervising control unit (see the relevant

Operation Manual for the control unit). If communication with the detector is the point, the possible reason should be sought with the use of guidelines summarized in Table 4.

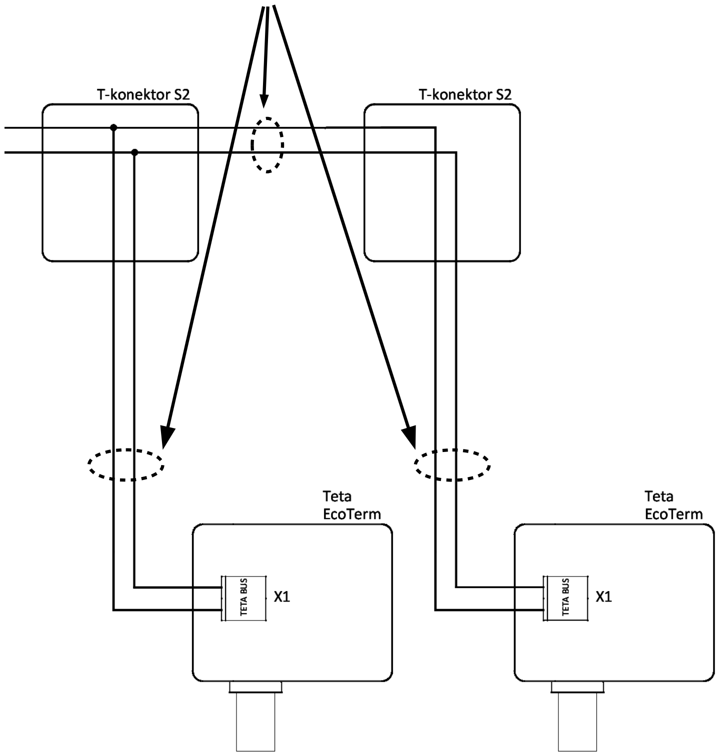
LED indication	Possible reason for the problem
Indications according to the sequence of indicator LEDs illustrated in Table 2 (self-test status – failure)	Defective T-connector of S2 type of improper (mismatched) connections at locations indicated on the drawing below: Possible mismatched connections 
	No requests from the Control Unit – the control unit is configured with insufficient number of gas detectors
	Poor quality of electric connection (high level of interferences)
	Improper power voltage for the detector

Table 4: Possible reasons for error signals

7.7 Maintenance schedule

Each user must be aware of the fact that operation of any gas monitoring system leads to inevitable ageing of equipment, in particular gas sensors, due to detrimental impact of environmental factors. Therefore the systems must undergo regular and scheduled maintenance.

Maintenance operations shall include:

- calibration of gas detectors,
- replacements of fast-wearing parts,
- scheduled inspections.

7.7.1 Calibration

Gas sensor incorporated into the device is a component that subject to ageing due to environmental factors, which inevitably leads to deterioration of its sensitivity.

To compensate the deterioration effect the gas detectors must be calibrated on the regular basis (calibration frequency is specified in the Calibration Certificate – see Table 5) by authorized personnel of the equipment manufacturer. The calibration procedure can be carried out in several manners:

- dismounting of the gas detector to send it to the manufacturer for calibration,
- removing only sensor plates to send them to the manufacturer for calibration (see Section 7.7.2.1),
- sending a request to authorized service team of the manufacturer to come and calibrate the detectors on site.

7.7.2 Replacement of fast wearing parts

Please refer to Table 6 for the recommended lifetime and replacement schedule of fast wearing parts.

7.7.2.1 Replacement of Measuring Head MiniPel

Operation of gas detector leads to natural deterioration of metrological parameters of gas sensors. That effect can be compensated by regular and scheduled adjustment of the detector indication up to the moment when the sensor is completely exhausted and must be replaced. It is assumed that replacement of a gas sensor should take place when its sensitivity drops below 50% of the initial one.

Replacement of a sole sensor is infeasible. The replaceable unit is the whole submodule – the measuring head – see Table 6.

To replace the head proceed in the following way:

- switch off the power voltage for the gas detector,
- loosen the locking screw (see Figure 1)
- disconnect the measuring head from its socket,
- reconnect a new head,
- switch on the power voltage for the gas detector.

7.7.3 Test / simulation

Tests of the gas monitoring systems are necessary to make sure that the gas monitoring system is in sound operating condition. Please contact the equipment manufacturer in case of any irregular response of gas detectors.

The following tests can be distinguished:

- tests with the use of a standardized gas – test gas is supplied to inlet of the gas detector – the message ‘tE’ should appear on the device display,
- simulation of alarms for NG or H_2 concentration – the ‘S1’ message should appear on the device display,
- test of safety functions.

7.7.3.1 Test with standardized gas

Upon making sure that the detectors is operable it is possible to carry out a test of its parameters to confirm its performance.

Test mode is initiated by approaching a permanent magnet to the detector, the display shows the 'Ad' message, the detector address stored in its memory and the 'tE' message.

Test mode is quitted upon removing of the magnet or within five minutes after test initiation.

The location where the magnet is to be approached is shown in Figure 1.

Test of gas detector with the use of standardized gas is initiated after supplying test gas with specific concentration to the detector inlet with observation of the detector response (correct indication that alarm thresholds is exceeded).

Tests assume that momentary concentration of the test gas are measured and alarms are generated without any delay.

> ⚠ Correct execution of the test needs application of a calibration kit with the proper standardized reference gas – with concentration of 30 – 40% LEL (see Table 7).

> ⚠ Unauthorized tests of gas detectors when gas with unknown composition and concentration is supplied to the detectors is prohibited. Under such circumstances the gas sensor can be damaged, which leads to loss of the detector calibration.

7.7.3.2 Simulation of alarms for gas (S1)

Simultaneous depressing the arrow buttons ⇩⇧ (see Figure 1) and holding them depressed for about three seconds switches the detector over to the simulation mode for detected gas (S1). Z Releasing of these buttons in the simulation mode initiates consecutive simulation of alarms for NG or H_2 concentration.

The simulation makes it possible to check response of input relays at the Control Unit. In case of no response or improper operation of the Control Unit it must be inspected with correction of erroneous connections, if any. Contact the equipment manufacturer if the subsequent simulation, after making corrections, is also unsuccessful.

The simulation mode (S1) is quitted automatically after the simulation is completed or upon depressing any of the arrow buttons ⇩⇧.

7.7.3.3 Test of safety functions

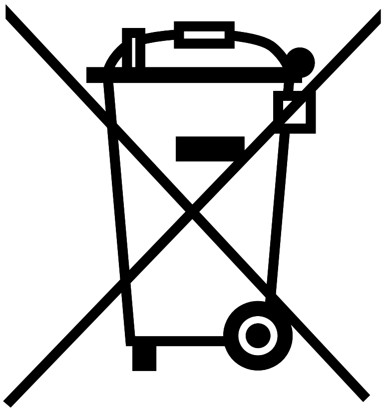
Execution of the test for safety functions is recommended once a year. Test gas is supplied to one unit of each detector type and response of all components within the Gas Safety System is checked together with all collaborating systems (e.g. ventilation, signalling or cutting off the gas supply).

> ⚠ Test of safety function must be executed without approaching of a magnet to gas detector or initiation of alarm simulations.

7.7.4 Maintenance

The only manner of cleaning the device is to wipe it with a damp soft cloth. Agents containing solvents, petrol or alcohols cannot be used to clean the detector

7.8 Utilization



This symbol on a product or on its packaging indicates that the product must not be disposed of with other household waste. Instead, it is the user's responsibility to ensure disposal of waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The proper recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. Information about relevant designated collection points can be obtained from the Local Authority, waste disposal companies and in the place of purchase. The equipment can also be returned to the manufacturer.

8 Technical specification

Power supply • V_{CC} • Power consumption	 12 – 50 V ⎓ 1.8 W	
Environment	In-operation	Storage
• Ambient temperatures • Humidity • Pressure	-20 – 50°C 10 – 90% long term 0 – 99% short term 1013 ± 10% hPa	0 – 50°C 30 – 90% long term
Detected substance	Methane (CH_4) Hydrogen (H_2)	
Measuring range	0 – 50% LEL	
IP	IP 43	
Digital communication parameters • Communication protocol	 Teta BUS	
Integrated signalling equipment (visual)	LED controls 7-segment LED display	
Protection class	III	
Dimension	See figure 1	
Cable glands (cable diameter range)	Gland pressed into the installation pipe – diameter of the pipe 16 mm. Glands multiband – diameter of wire 3.5 – 12 mm	
Acceptable cable cores	0.2 – 2.5 mm^2 – solid wire 0.2 – 2.5 mm^2 – stranded cores	
Enclosure material	ABS	
Weight	0.3 kg	
Lifetime	-	
Mandatory periodic inspection	Every 12 months (Calibration Certificate validity)	

Lifetime of consumables	See table 6
Mounting	4 holes for the pin with diameter 4 mm, hole spacing see figure 1

Table 5: Technical specification

9 List of consumables

No.	Consumables	Lifetime	Manufacturer	Product code
{1}	Measuring head MiniPel	Up to 5 years	Atest Gaz	PWS-016-NG
{2}	Measuring head MiniPel	Up to 5 years	Atest Gaz	PWS-016-H2

Table 6: List of consumables

10 List of accessories

Product code	Description
PW-112-S2	T-connector S2
PW-064-WM1	Mounting bracket WM1 (for wall-mounted installation)
PW-064-WM2	Mounting bracket WM2 (for installation under the ceiling)
PW-092-B	Calibration kit
-	Standardized reference gas – methane CH_4 with concentration 40% LEL
-	Standardized reference gas – hydrogen H_2 with concentration 40% LEL

Table 7: List of accessories

11 Product marking

Product code	Device
PW-113-NG	Gas Detector Teta EcoTerm
PW-123-H2	Gas Detector Teta EcoH

Table 8: Method of product's marking

12 Appendices

[1] DEZG121-ENG – EC Declaration of Conformity – Teta EcoDet, Teta EcoN, Teta EcoTerm, Teta EcoWent, Teta MiniDet, Teta EcoH

[2] PU-Z-054-ENG – Parameters of gas detectors with catalytic sensor

[3] PU-Z-039-ENG – Classification of chemicals used at Atest Gaz

EU Declaration of Conformity

Atest Gaz A. M. Pachole sp. j. declares with full responsibility, that the product:

(Product description)	(Trade name)	(Type identifier or Product code)
Gas Detector	**Teta EcoDet**	**PW-106**
	Teta EcoN	**PW-111**
	Teta EcoTerm	**PW-113**
	Teta EcoWent	**PW-105**
	Teta MiniDet	**PW-107**
	Teta EcoH	**PW-123**

complies with the following Directives and Standards:

- in relation to Directive 2014/30/EU – on the harmonisation of the laws of the Member States relating to electromagnetic compatibility:
  - EN 50270:2015
- in relation to directive 2011/65/EU – on the restriction of the use of certain hazardous substances in electrical and electronic equipment
  - EN IEC 63000:2018

This declaration of conformity is issued under the sole responsibility of the manufacturer.

This EU Declaration of Conformity becomes not valid in case of product change or rebuild without manufacturer's permission.

Gliwice, 08.04.2022

(Name and Signature)
Managing Director
Aleksander Pachole

Parameters of gas detectors with catalytic sensors

1 Detected substances

Detectors equipped with catalytic sensors are used for measuring and detecting the presence of gases and flammable gases in the range of up to 100% LEL.

2 Principle of operation

The catalytic sensor (figure 1) consists of two components: an active and a passive one, heated to a high temperature. They are both constructed of a very thin coiled platinum wire, however, the active element (figure 2) is additionally coated with a catalyst (e. g. palladium, platinum). A combustion reaction occurs on the active element. Heat is generated as a result, which causes an increase in the temperature of this element and a resultant change in its resistance. Whereas combustion is not possible on the passive element, therefore, its properties do not change under the influence of a combustible substance. This allows the passive element to compensate for the impact of ambient temperature. The same resistance change of both elements occurs when the ambient temperature changes. The passive and active elements are integrated in the Wheatstone bridge circuit, which ensures conversion of the change of resistance to voltage.

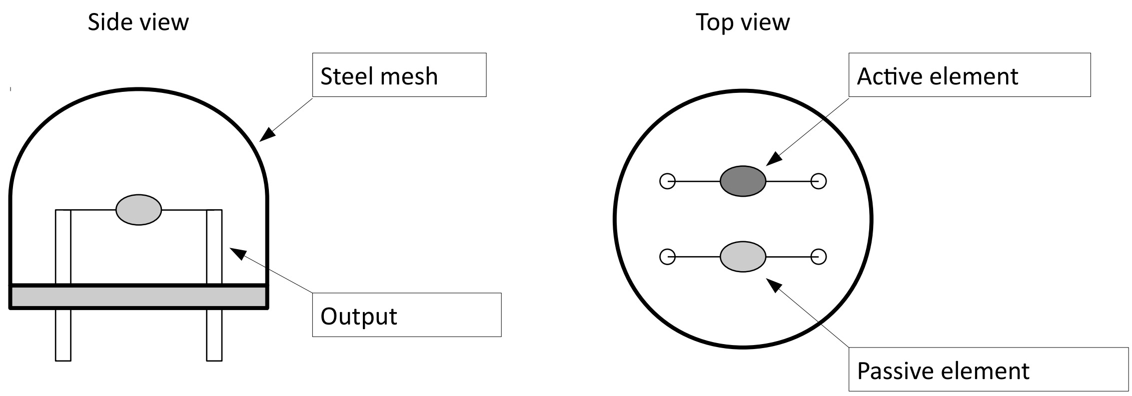


Figure 1: Sample view of catalytic sensor

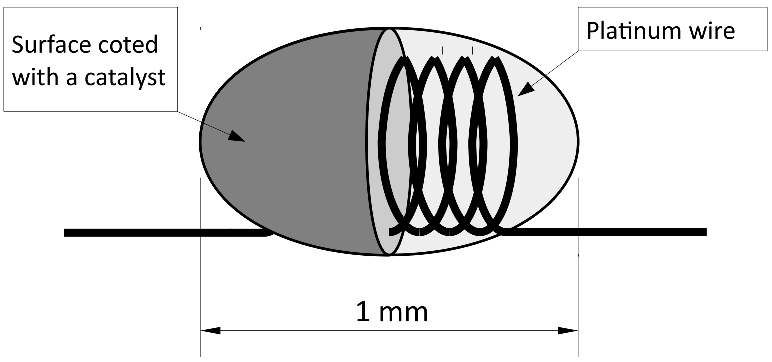


Figure 2: Active element construction

3 Impact of environmental conditions

> Never exceed the rated operating parameters of the detector. These parameters can be found in the detector calibration certificate.

> The detector must be used in accordance with the provisions in the User's Manual.

3.1 Composition of the controlled atmosphere

It is assumed that the standard composition of the atmosphere is a mixture of gases with the proportions indicated in table 1.

Ingredient	C [% vol]	C [ppm]
Nitrogen	78.084	780 840
Oxygen	20.946	209 460
Argon	0.934	9 340
Carbon dioxide	0.0360	360
Neon	0.00181	18.18
Helium	0.00052	5.24
Methane	0.00017	1.70
Krypton	0.00011	1.14
Hydrogen	0.00005	0.50
Xenon	0.000008	0.087

Table 1: Typical composition of atmospheric air

When gas concentrations in the atmosphere differ significantly from those indicated in the table 1, it is necessary to conduct the analysis of the impact of such a situation on the detector operation.

> Catalytic sensor working properly at an oxygen concentration of about 21%.

3.1.1 Impact of the presence of a working gas or other reaction gas

Catalytic sensor isn't selective – it reacts (with different sensitivity) to most flammable substances appearing in its surroundings. Because of that it is necessary to consider their presence when the sensor is operating.

When using detectors with catalytic sensors, it is necessary to be aware that:

- long-term presence of significant concentrations results in faster sensor wear. Basically, catalytic sensors are used to detect the incident presence of combustible gases. They should not work in atmospheres in which flammable gases at concentrations greater than about 20% LEL occur in a continuous or prolonged manner, as it may lead to a rapid reduction of their sensitivity and the appearance of a zero drift,

- concentrations over 100% LEL, even temporarily persistent ones, can lead to a physical wear of the sensor. For these reasons, detectors operating in places where such conditions may occur are / should be equipped with mechanisms to prevent the negative effects of high concentrations,
- a very high concentration of combustible gas (well above 100% LEL) leads to a decrease in oxygen concentration – thereby lowering the sensor's indication. Volumetric concentrations close to 100% can result in a zero sensor response, as shown in the figure (example: a small room and a large amount of flammable gas released into the atmosphere). See section 3.1.2.

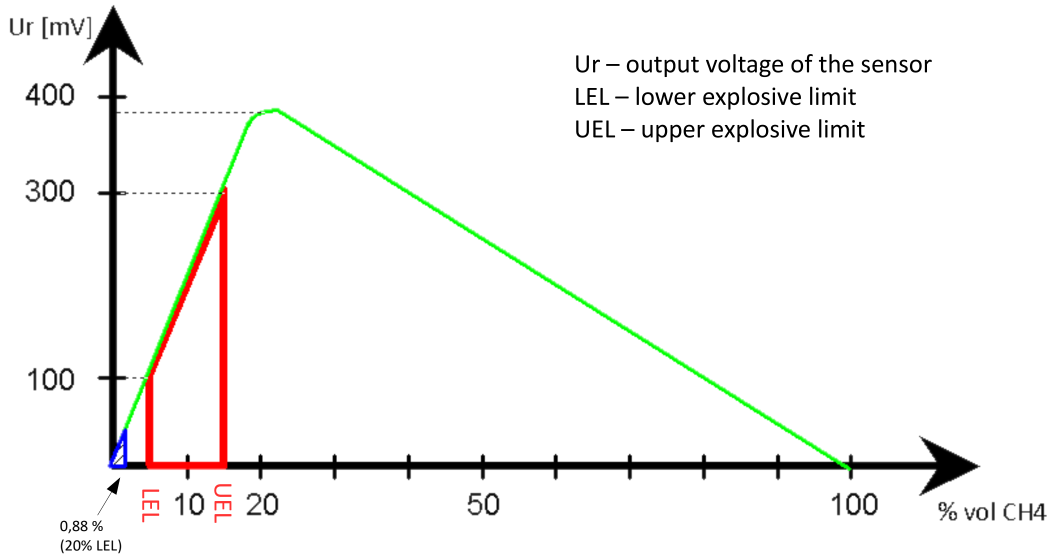


Figure 3: Sample characteristic of catalytic sensor

3.1.2 Effect of oxygen concentration value

Oxygen is required for a proper operation of the catalytic sensor. If the monitored atmosphere contains gas or gases that dilute or replace air (thereby reducing the oxygen concentration), for example, nitrogen or carbon dioxide, then the catalytic detector can give a low or even zero response.

A similar effect can occur when large amounts of reaction gas are released to the atmosphere(creating a concentration over the measurement range) – due to a too low amount of oxygen, the concentration indication of the detector will be lower than it actually is, and it may even be zero.

3.2 Influence of temperature

The temperature can have an influence on the sensor's characteristics. Within the scope of the detector's environmental parameters, its influence is compensated electronically.

3.3 Influence of pressure

Within the environmental parameters of the sensor, the influence of pressure on the measurement is negligible.

3.4 Influence of moisture

Within the environmental parameters of the sensor the influence of moisture on the measurement is negligible.

3.5 Influence of vibrations, impacts

Vibrations and impacts affect the detector's operation, as they may cause:

- damage to delicate parts of the sensor (e. g. detector element, compensation element),
- shift of the sensor's zero.

It should be ensured that the detector is not exposed to shock and vibration in excess of the amplitude of vibrations amounting to 0.15 mm of the frequencies of over 10 Hz. Under no circumstances should the peak acceleration exceed the value of 19.6 m/s^2.

3.6 Influence of physicochemical phenomena

- In the case of chemical compounds with high flash point (approx. 50°C and above) it is necessary to remember that in typical environmental conditions (ambient temperature below 40°C), it is unlikely that they will be able to produce atmospheres close to 100% LEL. Particularly in the case of ambient temperatures below 0°C it may occur that achieving measurable concentrations by the catalytic sensor (of 10% LEL) is impossible. Another measurement method is required in this case.
- High concentration**s** of inserting gases (e. g. argon, helium) can change the thermal equilibrium of the sensor, resulting in the apparent reading of the presence of a combustible substance.

4 Factors shortening the lifetime of the sensor

4.1 Poison and inhibitors

For every reaction with the presence of a catalyst that cause permanent (poisons) or temporary deceleration (inhibitors) of this reaction, which results in reduced sensor sensitivity – in particular the lack of reaction to a combustible substance.

For catalytic sensors, on the active element side, we distinguish the following poisons:

- silicons (organosilicone compounds) – e. g. PDMS (polydimethylsiloxane), HDMS (hexamethyldisiloxane), sealants, adhesives, raising agents, specific oils and lubricants, some medical supplies,
- organometallic compounds – e. g. Grignard compounds, lead tetrachloride (leaded petrol, certain aviation fuels),
- organophosphorus compounds – e. g. in herbicides, insecticides, phosphoric esters in fire-proof hydraulic fluid,

and inhibitors:

- sulfur compounds – e. g. hydrogen sulfide, mercaptans, carbon disulphide, sulfur dioxide,
- halogen compounds – e. g. methyl chloride, some freons (among others R134a), vinyl chloride,
- olefins – e. g. styrene, propylene, acrylonitrile.

Acetylene is a poison for the passive element of the catalytic sensor.

Classification of chemicals used at Atest-Gaz

Because of the need to present a **consistent and high level of maintenance services**, to ensure **the safety of the calibration process** and to **create a basis for a rational calculation of the costs** of this process, Atest-Gaz developed the "Classification of Chemical Substances" described below.

The classification determines the complexity of the calibration process of a particular detector type, consider two criteria:

- stability of the calibration mixture (criterion **A**):
  - ease of generate and its stability,
  - ergonomic complexity of operations,
  - required experience and knowledge of the employee performing the calibration,
  - required equipment,
  - environmental requirements for the process (e.g. weather conditions).
- safety / potential hazard generated by the mixture (criterion **B**).

These both criteria have an impact on the final cost of the calibration services and level of competence required from the employee conducting the calibration.

This classification is applied both by Atest-Gaz and the entities cooperating with it – distributors, authorized service providers and users of the systems.

In the case of calibration with the "crossover" substances, the classification is made in accordance with the substance category that is applied (e.g. for the detector with a PID sensor this substance is isobutylene, i.e. B0 A0).
The detector are classified on the stage of offer.

On the next page we present tables showing the above relationships.

Category	Description	Terms of facility calibration
A0	Cylinder gases, stable environment	No precipitations, and no strong winds, and temperature over **– 10°C**[1]. In other cases, calibration at a location that meets the above conditions (necessary to remove the detectors).
A1	Cylinder gases, unstable environment or absorption by the moisture	No precipitations, and no strong winds, and temperature over **+ 10°C**[1], and relative humidity under 70%. In other cases, calibration at a location that meets the above conditions (necessary to remove the detectors).
A2	Gases not available in cylinders can be generated at the relevant facilities	like **A1** In other cases, calibration at a location that meets the above conditions (necessary to remove the detectors).
A3	Laboratory calibration	Facility calibration impossible, laboratory calibration only, probably at the manufacturer's. This group also includes conditions resulting from other reasons, e.g. the need for temperature compensation, non-linearity of the sensor, the need for calculation, the use of special tools, etc.

Table 1. Classification of chemicals used at Atest-Gaz. Criterion A: mixture stability

Category	Description	Classification criteria
B0	Safe substances	concentration of flammable components **< 60% LEL**, and concentration of toxic components ≤ **NDSCh**[2], and oxygen concentration **< 25% vol**, and tank **< 3 dm³** (water capacity) and **p ≤ 70 atm**, or specified liquid chemical compounds, e.g.: glycerol, 1,2-propanediol.
B1	Low-risk substances	concentration of flammable components **< 60% LEL**, and concentration of toxic components ≤ **NDSCh**[2], and oxygen concentration **< 25% vol**, and tank **> 3 dm³** (water capacity) or **p > 70 atm**, or toxic gases with the concentration of **STEL ÷ 15 x NDSCh**, or specified liquid chemical compounds, e.g.: petrol, acetone, 1-methoxy-2-propanol.
B2	High-risk substances	inert gases having an oxygen concentration **> 25% vol**, or flammable gases with a concentration **> 60% LEL**, or specified liquid chemical compounds, e.g.: styrene, methanol, xylene, toluene, methyl methacrylate.
B3	Extremely dangerous or extremely flammable substances	toxic gases with the concentration of **> 15 x NDSCh**[2], or specified liquid chemical compounds, e.g.: benzene, formaldehyde, formic acid, epichlorohydrin.

Table 2. Classification of chemicals used at Atest-Gaz. Criterion B: OHS

1 Is allowed to perform calibrations at lower temperatures, if they meet the conditions of operation of the detector, e.g. ammonia refrigeration units.
2 In the absence of determined NDSCh it is necessary to adopt 2 x NDS as a criterion.

Reliable and Innovative Gas Detection & Safety Systems

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