SW -X

Concentration transmitter for flammable/toxic gases
Zone 1 / Zone 21 ATEX (Cat. 2GD)

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USER AND MAINTENANCE MANUAL

* In this user and maintenance manual, the parts with * on a grey rectangle, are referred to the Methane (CH4) gas transmitter.

OVERVIEW

The concentration gas transmitters **Series SW-X** consist of the following components:

- the gas sensor.
- the electronic conversion circuit.
- the terminals for the electrical connection of power supply and signal output.
- the metal housing and relevant sensor holder with sintered filter that ensure the ATEX protection mode for the entire device.

The gas sensors that fit inside the ATEX protective housing can be of various types, either for gas fuel or for toxic gases as well as for Oxygen.
The output signal can be, depending on the version, analog type in current (4..20mA) or digital (Modbus® or S-Bus - optional interfaces).

IDENTIFICATION OF THE TRANSMITTER

The code of the transmitter indicates which gas it detects, as well as the measurement full scale and the output interface installed.
The characteristics of the device are in any case explicitly described on the label mounted on the product.
Sensors for other gases can be manufactured on specific request to the manufacturer.

OPERATION

This sensor is a gas concentration transmitter which measures the concentration of the gas for which it has been calibrated and converts it into an analog or digital electrical signal whose characteristics depend on the version of the model (4..20mA, Modbus ® or S-Bus).
It is composed of a metal case with Ex d protection mode which houses the electronic board and the gas sensor, properly protected with a sintered filter, assembled on the bottom side of the case itself (see the assembly instructions).
The sensing element can be catalytic or electrochemical, according to the model and the type of gas detected.

MECHANICAL INSTALLATION

Since the mechanical installation must comply with constraints that may affect the ATEX safety of the device and of the environment itself, these instructions are provided in section 'Mechanical Installation' in the ATEX Safety Instructions.

FUNCTIONAL INSTALLATION

About the precautions to be taken to achieve a proper functional behavior of the device, it is important to notice that regarding the location of the sensors in the environment to be controlled, particular attention must be paid to:

- Density of the gas (heavier or lighter than air)
- Speed of release of the gas (flow)
- Possible openings in walls and ceilings and air streams
- Arrangement and shape of the environment
- Dimensions of the protected area

The response time of the sensor is strictly related to its position in the environment as well as to the type of gas to detect. For heavy gases like LPG it is advisable to install the transmitter at 20 cm above the ground, while for light gases like Methane the correct position is 20 cm below the ceiling. For other gases it is necessary to evaluate the relative density to air (available on standard EN60079-20-1) and place the device consequently.

OUTPUT SIGNAL (Base version 4..20mA)

General Concentration vs. Current chart

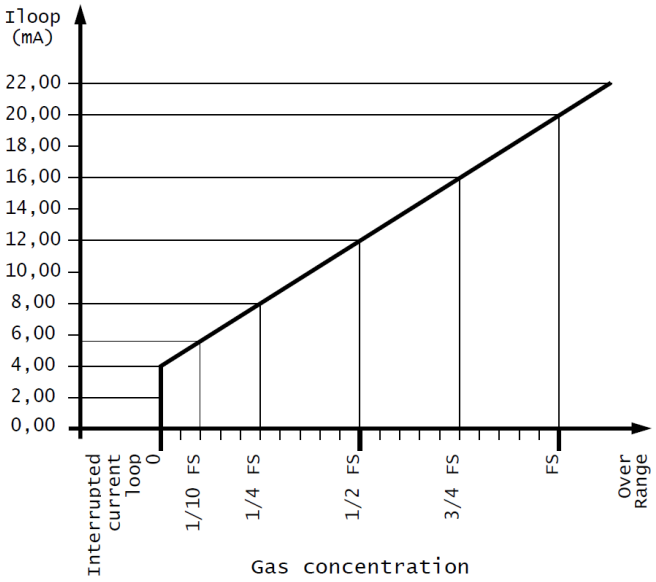


Fig. 1: Generic example of the relationship between Concentration and Output Current for a transmitter with 4..20mA output and full scale defined by FS.

Relationship between a generic gas concentration in fractions of Full Scale (F.S.) and relevant output current (mA)	
Concentration	**Output (mA)**
Current loop interrupted	**0.0**
0	**4.0**
1/4 Full Scale	**8.0**
1/2 Full Scale	**12.0**
3/4 Full Scale	**16.0**
Full Scale	**20.0**

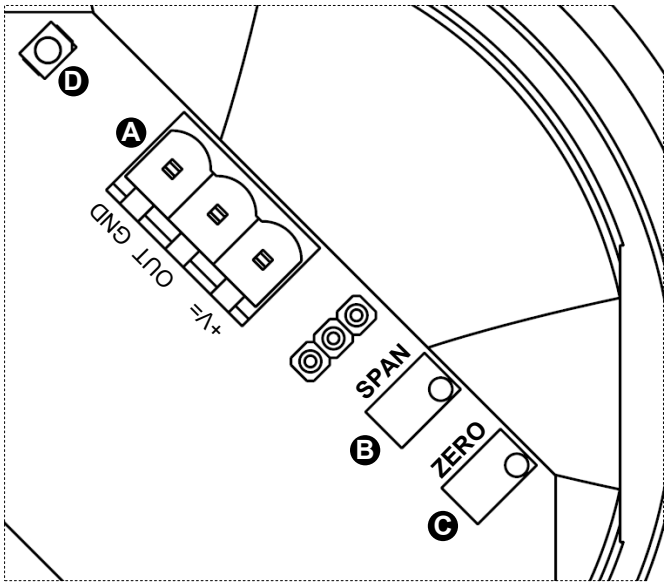
Tab. 1: Relationship between the gas concentration gas (in fractions of Full Scale) and relevant output current.

Pre-warmup phase: As soon as the sensor is powered, it starts a pre-warmup phase which lasts about 30 seconds; during this phase the output signal is set to 0.0 mA.

Fault condition: If the sensor inside the transmitter is faulty, the electronic part detects the error and sets the output current at 0.0 mA or to the maximum value (22 mA) depending on which element is damaged.

Over-range condition: If the gas concentration exceeds the limit of the measurement field, the current value will rise proportionally even more than 20 mA from the bottom of the full-scale and up to about 22 mA, allowing to detect an over-range condition through the central unit to which the sensor is connected.

INTERNAL ARRANGEMENT



A Output signal 4 .. 20 mA
B Trimmer for the calibration of the Span value
C Trimmer for the calibration of the Zero value
D Status LED

Fig. 4: Internal arrangement.

ELECTRICAL WIRINGS

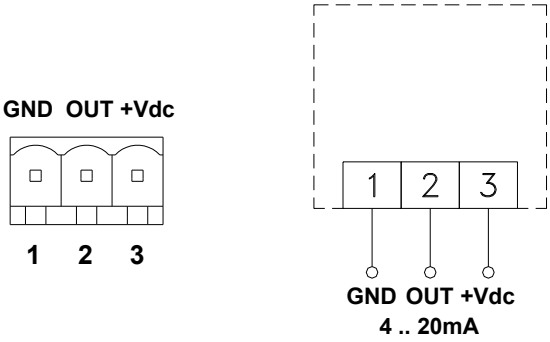


Fig.5: Arrangement and function of the power supply and output terminals.

The electrical wiring is made with tripolar copper wire in accordance with the distances shown in the table.
It is not necessary to use shielded wire, however it is appropriate to lay the signal wires properly separated from the mains power wires and/or other power cables.

⚠ WARNING

- ***All electrical wirings must be carried out with tripolar wire having 1.5 mm^2 minimum cross section and recommended length of 25 m. Although a shielded cable is not mandatory, it is strongly recommended to lay the transmitter wires in different ducts from those used for the mains wires and/or other power lines.***
- ***The use of wires longer than the suggested value or with smaller cross-section can lead to poor operation due to the excessive voltage drop that may occur along the cable. This could, in turn, lead to a value for the supply voltage of the transmitter lower than acceptable. As an example in the table below some values of electrical resistance for copper wires are shown.***
- ***The maximum applicable load resistance at the output line (4..20mA) when supply voltage is 12V = -15% is 250 Ohm.***

Resistance of insulated strand wire per km (according to CEI 20-29 1997)	
Wire section	Electrical resistance (ohm / km)
0.50 mm^2	36.5 (x 2)
0.75 mm^2	24.5 (x 2)
1.00 mm^2	18.1 (x 2)
1.50 mm^2	12.1 (x 2)
2.50 mm^2	7.41 (x 2)

Tab. 4: Typical values of resistance for stranded copper wires.

START-UP

In order to start-up the device please complete in order:
- Mechanical Installation
- Electrical Installation
- As soon as the power is applied a stabilization phase will begin, lasting 30 seconds, indicated by the red LED located on the base board, during which the sensor will not be able to detect any gas.
- After this time the LED will turn green, indicating normal operation.

FUNCTIONAL MAINTENANCE

Periodic monitoring of the transmitter aims to verify the correct efficiency of both the basic operation and the measurement accuracy (i.e. the current set in the output loop as a function of the measured gas concentration).
The procedure for verification with a calibrated gas bottle is described in a separate paragraph.

In addition to controlling the concentration value of the gas being measured, it is mandatory to check periodically the following points:

- Accurate control of the type and amount of potentially contaminating substances (usually compounds based on organic solvents) which may be present in the area in which the sensor is installed; the presence of such substances may adversely affect the operation of the sensor or lead, more generally, to inaccurate operation, or even require a more frequent recalibration.
- Visual inspection of each device which is part of the gas detection system. Pay special attention to dust, dirt, contaminants, solvents and accumulation of condensate, which could affect the correct operation of the sensor.
- The frequency of checks and recalibrations is under the responsibility of the manager of the detection system, who is also compelled to verify the requirements of eventual national standards. As an example, the following is a summary of what the Italian standard CEI 31-35 requires:
  "The time interval between checks and recalibrations should be determined by the user according to the actual operating conditions and the manufacturer's instructions; in any case this must be at least:
  - every three months for systems monitoring areas with emissions of first degree (i.e. that may occur in normal operation)
  - every six months: for systems monitoring areas with emissions of second degree (i.e. that is unlikely to occur in normal operation). "
- It is necessary to periodically clean the equipment to avoid the formation of layers of dust thicker than 5mm.

VERIFICATION - Overview

The control of the correct operation of the transmitter is made by applying to the transmitter a sample gas whose concentration is known and certified, and measuring at the same time the output signal.

In detail, the procedure consists of the following points:
- Application of Zero gas
- Zero signal verification
- Application of Span gas
- Span signal verification

Applying the Zero gas
Applying the Zero gas means to leave the transmitter in air which is certainly clean and to check that the output signal indicates null concentration.
The transmitter must have been working for at least 48 hours in clean air and should be placed in its usual operating position.

Applying Span gas
Applying the Span gas means to apply to the transmitter a known gas with certified concentration and whose value is as much as possible close to the center of the scale measured by the transmitter.
Proper range for the calibration gas is from 20% L.E.L. to 30% L.E.L. CH4 with air as balance*.
In case of flammable gases it is mandatory, for safety reasons, to use concentrations below 50% of the LEL.

To apply the Span gas is necessary to convey to the sensor of the transmitter the certified gas from the cylinder as shown in the following picture.

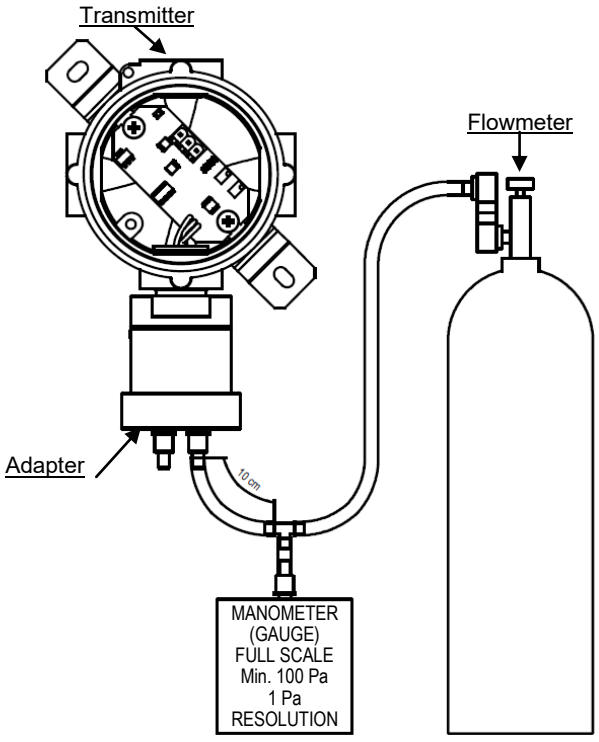


Fig. 6: How to apply gas to the transmitter for verification or calibration.

The pressure gauge is required to verify that no excessive pressure is created on the sensor, because this condition could cause a wrong measurement of the concentration.
The transmitter must have been powered for at least 48 hours in clean air and it must be placed in the position of its usual operation.

Adjust the gas flow to the sensor until reading on the manometer the value of 10 Pa (about 0.2 l/min.) which must remain constant during the whole test.
Check for the pressure on the manometer to stay below 20 Pa for the whole test duration.
From the moment the gas reaches the sensor, the driving voltage of the current loop will gradually increase until it stabilizes after about 5 minutes, around a certain value.

The easiest way to measure the current in the output loop in order to perform the verification consists in 'cutting' the loop close to the transmitter and insert a multimeter in series, as shown in the following picture.

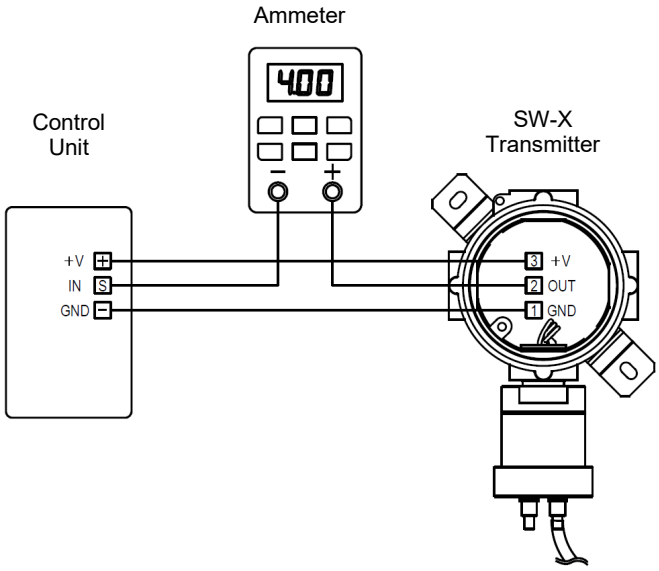


Fig. 7: How to connect the multimeter to measure the output current while verifying Zero and Span.

VERIFICATION - Flammable and Toxic Gases

Verification of Zero level
When Zero gas (clean air) is applied, the output current measured with the multimeter must be 4.0mA ± 0.2mA.
In case the measured value does not fall in this range, an adjustment is needed (calibration) to restore the correct value (see below).

For versions with digital output on bus, the concentration value read by the control unit must be null.

Verification of Span level
From the moment the Span gas reaches the sensor the output current will gradually increase until it stabilizes around a value (after about 5 minutes).
At this point, for versions with current output 4..20mA you must write down the value of the current measured with the multimeter and, referring to the table or chart concentration-current, convert it to a corresponding value of gas concentration.
For versions with digital output on bus you have to write down the value (directly in ppm or% LEL) indicated by the control unit connected to the transmitter.
The measured current value can differ from the theoretical (i.e. the value of the calibrated bottle) by ± 0.4 mA.
In case the measured value does not fall in this range you must calibrate the Span as described in the next section.

If the outcome of the previous checks is positive then it is not necessary to proceed with the calibration.

CALIBRATION - Overview

The term 'calibration' refers to the procedure that must be performed on the transmitter, possibly with the help of a tool, in order to bring the output signal within the stated accuracy every time this becomes necessary.
A certain drift over time of the output current is to be considered unavoidable, being this caused by small drifts of the sensor itself, both for Zero and for Span.
The calibration of the transmitter takes place by applying to the transmitter a sample gas whose concentration is known and certified, and adjusting the output signal with the proper controls located inside the transmitter.

In details, the procedure is split in the following points:
- Application of Zero gas
- Zero signal calibration (internal voltage)
- Application of Span gas
- Span signal calibration (internal voltage)

Application of Zero gas
Proceed as explained in paragraph 'VERIFICATION'.

Application of Span
Proceed as explained in paragraph 'VERIFICATION'.

⚠ WARNING

- ***The complete adjustment necessarily involves the calibration of both parameters (first 'Zero' and 'Span' after).***
- ***The transmitter must have been powered for at least 48 hours in clean air and must be placed in its usual operative position.***

CALIBRATION - Flammable Gases

In order to perform this procedure it is necessary to connect an ammeter as shown in Fig. 7.

Calibration of the Zero level

- With the transmitter in clean fresh air, rotate the trimmer 'ZERO' (identified by the letter **C** in Fig. 4) very slowly until the measured current is as close as possible to 4.0 mA ±0.2mA.
- This operation is the same for all versions of the transmitter, regardless of the type of output (current or digital).

⚠ WARNING

This operation requires to reach 4.0 mA ±0.2mA with a very accurate adjustment, otherwise an offset error will arise.

Calibration of the Span level

- Apply the Span gas as explained in paragraph '***Application of Span gas***, waiting for the stabilization time of at least 5 minutes.
- Calculate, keeping in mind the following formula, the Span calibration current according to the concentration of the calibrated gas bottle used and considering the Full Scale range of the Transmitter:

$$Ispan\ (mA) = \left[16 * \frac{Conc.\ Bomb.\ (ppm)}{F.S.\ (ppm)}\right] + 4$$

Where:

BottConc(ppm):	Concentration of the sample gas applied to the detector (in ppm). This value can be found on the certificate of the bottle.
F.S.(ppm):	Value in ppm of full scale of the transmitter you are calibrating. This data can be found on the product label.

- Adjust the 'SPAN' trimmer (identified by the letter **B** in Fig. 4) until you read on the multimeter a current equal to the one calculated with the formula. In case the operation does not succeed on the first try, repeat the procedure again, leaving first the sensor in clean air and powered for at least 10 minutes.
- Verify on the control unit that the value of concentration (in % LEL) measured from the transmitter is equal to the value of the gas used for the test with a tolerance of ± 2%.
- Reapply the cover and screw it, checking the tightness of the closure and the state of good conservation of the seal.

⚠ WARNING

- **Time interval between calibrations should never be longer than 12 months, provided no reasons for additional calibrations arise, such as gas overrange, mechanical or environmental shocks.**
- **Should the measuring range be exceeded for any reason, it is recommended to perform the calibration of the device in order to be confident of its operation.**
- **In order to check the reaction time of the device (t90) perform first calibration of Zero and Span with exactly the same instruments arrangement as described earlier, then apply a gas step to the transmitter with the calibration cap available from the manufacturer and start measuring time elapsing with a chronometer.**
  Once the current indication reaches the expected value for the 90% of the calibration gas value stop the chronometer and read the time elapsed.
- Please refer to the procedures described in the standard EN 60079-29-2 for any other reference*.
- ***It is possible to repeat this step as often as necessary, before completing the calibration procedure.***
- ***It is strongly recommended to make a verification after the calibration in order to check for the correct setting.***
- ***In case the current values of Zero or Span and/or the concentration value measured do not fall within the expected values even after the calibration, and subsequent verification, the transmitter is to be considered faulty, thus it must be returned to an authorized center for servicing or replacement.***
- ***Verification and calibration procedures cannot be performed using pure gases; the complement to the certified gas must be air (possibly synthetic) because, for example, catalytic sensors need oxygen to work properly. Never use the gas contained in the lighters.***
- ***The gas flow applied to the transmitter sensor must remain constant during the entire test in the range of 0.2 .. 0.4 l / min.***
- ***For the calibration procedure it is necessary to open the explosion proof housing; therefore it is necessary to follow all the safety directions explained below.***
- ***When, in order to carry out the maintenance procedure, the detection devices must be disabled, even temporarily, special care must be taken in order to activate an alternative detection system which could in turn give continuity to the safety against gas leakages. As an alternative countermeasure during the maintenance operations, either the gas leakage and ignition sources removal or an increased ventilation can be adopted.***
- ***Since for the verification and calibration procedures it is necessary to open the housing of the device, losing in this way the ATEX protection, it is absolutely mandatory to proceed as follows:***
  a. Remove the explosion risk by cutting the flow from any possible source of gas.
  b. After double checking that atmosphere is safe, open the case.
  c. Perform the verification and/or calibration procedures.
  d. Once the correct functionality of the detection system has been checked close the case.
  e. The area is now protected again.
- ***Maintenance operations must never jeopardize the safety of the area under protection. In case of doubts contact the distributor or the manufacturer before proceeding.***
- ***It is the system manager responsibility to adopt all countermeasures which might grant an acceptable safety level for people involved as well as for the environment itself.***
- ***Never open the case unless the explosion risk has been previously removed and no residual risk is present.***
- ***It is strongly recommended to log the results of the maintenance operations in a specific register, according to the standard and current national regulations.***
- ***All operations described in the User Manual and Safety Instructions must be performed by qualified and properly trained personnel.***
- ***The installation and maintenance of the transmitter must be performed in accordance with EN 60079-14 (installation) and EN60079-17 (maintenance), and be limited to what is expressly stated in the instructions of use and safety of the manufacturer.***

TRAINING INSTRUCTIONS

It is mandatory to verify both at the startup and periodically, that the personnel assigned to the use of this device have fully understood the content of this User Manual and observe it.

CHARACTERISTICS AND OPERATIONAL LIMITATIONS

- This transmitter must be used for the measurement of gas for which it has been calibrated (see the marking on the device for the type of gas and the flow rate).
- Response time $T_{90:}$ < 60 s (CH4) flow method.
- Temperature operating range: -20°C .. +55°C.
- Humidity operating range: 20% .. 90% RH (non condensing).
- Pressure operating range: 800 .. 1100 hPa.
- Supply voltage range: 12V= -10% .. 24V=+10%.
- Power absorption: 4W max.
- Sample flow rate: 0.2 l/min. ±0.1 l/min.
- Warm-up time: 30 s.
- Stabilization time: 48 h.
- Test gas application time for calibration: 5 min.
- Nominal orientation: sensing element facing downwards
- Air velocity: <6.0 m/s
- Output:
  (4..20mA version): 4 .. 20 mA (range of measurement)
  0 mA: loop fault
  2 mA: sensor fault
  22 mA: over range
  (digital versions): See the relevant document
- Protection level: IP 6X (according to EN 60529)
- Dimensions: 168 x 138 x 89 mm.

- ***Long term stability:*** In normal operating conditions and in absence of potential toxic substances in the area, which could alter the operation, the catalytic sensor features a good long-term stability of five years starting from installation and initial operation.

SPECIAL CONDITION OF USE

This section deals with the special conditions that could correspond to improper use and therefore must be carefully avoided in order not to run into incorrect or dangerous use of the device.

- It is extremely important to stress that all catalytic sensors can properly operate only in presence of oxygen (O2); for this reason and in order to get a proper measurement from the device, the installer must be absolutely sure that in the area in which the sensor is installed there is a sufficient concentration of oxygen, equal to the normal concentration in the atmosphere (20.9% $^{V}/_{v}$).
- Both during normal operation and during the maintenance, the presence in the atmosphere of other gases, different from those that are being detected, could affect the measurement accuracy or operation. Please consider that all catalytic sensors have a variable cross sensitivity with different gases. If in doubt please contact your distributor.
- Since the sensor can detect different types of hydrocarbons (HC) at the same time, it is essential for the user to consider the resulting cumulative effect as well as to evaluate the cross sensitivity of the sensor to other gases.
- As soon as power is applied a pre-heating phase is started during which the sensor is not able to detect gas.
- The response of the sensor may be temporarily compromised in case it detects substances called 'inhibitors': among these you can find halogenated gases, Sulphur Dioxide, Chlorine, Chlorinated Hydrocarbons (Trichlorethylene and Carbon Tetrachloride). Ask your distributor in case of any doubt.
- The response of the sensor, instead, may be permanently damaged in case it detects substances called 'contaminants': among these you can find several Silicone compounds, Tetraethyl Lead and Phosphate Esters.

STORAGE

Temperature:	-20°C .. +55°C.
Humidity:	20% .. 90% RH (non condensing)
Pressure:	800 .. 1100 hPa.
Time:	n.a.
Long term output drift in air:	typ. -5% signal / year

CONVERSION FROM % L.E.L. TO % v/v

The value of L.E.L (Lower Explosion Level) varies for each individual detected gas. These values can be found in the harmonized standard EN60079-20-1 and are shown in the next table for reference.

SENSITIVITY TO OTHER GASES

The cross-sensitivity (K in the table below) of the catalytic type sensor (version for FLAMMABLE gases) to the most common gases is shown in the following table using Methane as reference (CH4 = 1).

	CAS number	K*	L.E.L. (% v/v)
CH4 (Methane)	74.82.8	1.00	4.4
LPG (n-Butane)	106.97.8	1.94	1.4
CO (Carbon Monoxide)	630.08.0	1.79	10.9
Gasoline Vapors	8006.61.9	2.50	1.4
C3H8 (Propane)	74.98.6	1.79	1.7
H2 (Hydrogen)	1333.74.0	1.21	4.0
NH3 (Ammonia)	7664.41.7	n.a.	15.0
SO2 (Sulphur Dioxide)	7446.09.5	n.a.	n.a.

Tab. 5: Indicative values of cross-sensitivity to various gases for catalytic sensors (CH4=1).

⚠ WARNING

: The value of K shown in the table has to be considered purely indicative. For other K values for other gases please ask the manufacturer.

ALARM AND FAULT SIGNALS

Since this transmitter is simply a converter of the concentration of a gas in the corresponding current level, the function of detecting the alarm, fault and over-range events is devoted to the control unit, on which these threshold levels are set. Please also refer to the User Manual of the control unit.

TROUBLESHOOTING

- **Problem.**
  The control unit reads a null value of current from the transmitter.
  Possible cause:
  The connection between the transmitter and the control unit is faulty.
  Remedy:
  Check for integrity of electrical wirings between transmitter and central unit. Check for correct insertion of terminal block inside its socket. Check with a multimeter for presence of power supply on terminals '+' and '-' of the sensor.
- **Problem.**
  The concentration of gas measured from the transmitter is incorrect.
  Possible cause:
  The transmitter requires recalibration.
  Remedy:
  Proceed with the calibration and verification as described in the relevant paragraphs. If this doesn't resolve the problem, contact the distributor.

Possible cause:
The sensor filter is dirty or wet.
Remedy:
Remove dirt and/or condensate. If this does not solve the issue please contact the distributor.

SPARE PARTS

This device offers the possibility to replace only the internal sensor module:
- Passive sensor module (catalytic) for Methane (CH4).
- Passive sensor module (catalytic) for GPL.
- Passive sensor module (catalytic) for fuel Vapors (n-octane).
- Passive sensor module (electrochemical) for Carbon monoxide (CO).

About the replacement procedure, refer to the operative instructions of the module itself.

ACCESSORIES

The only available accessory is the kit for the calibration in the field, which allows to correctly apply the test gas to the sensor. Contact the distributor in case of need.

PERFORMANCE CERTIFICATION DETAILS*

Performance certification for this equipment has been issued as follows:

• Issuing organization:	IMQ
• Date:	see relevant certificate
• Gas:	CH4
• Range:	0 .. 50% LEL
• Marking:	EN 60079-29-1 Year of construction is encoded in the Serial Number

INGRESS PROTECTION STATEMENT

- The stated IP rating does not imply that the equipment will detect gas during and after exposure to those conditions.
- When the device is exposed to the environmental conditions representative of its IP rating it is recommended to determine appropriate calibration interval and maintenance requirements.
- In order to grant the stated IP rating special attention must be paid to correct tightening of all threaded parts as well as to the use of a cable gland for the cable entry with at least the same IP rating as that of the transmitter.

COMPLIANCE WITH STANDARDS

The transmitter complies with the standards described in the relevant ATEX Certificate provided with each package of this product.

WARRANTY

In order to constantly develop their products, the manufacturer reserves the right to modify the technical data and features without prior notice.
The consumer is guaranteed against any lack of conformity according to the European Directive 1999/44/EC as well as to the manufacturer's document about the warranty policy. The full text of warranty is available on request from the seller.

PRODUCT LABEL

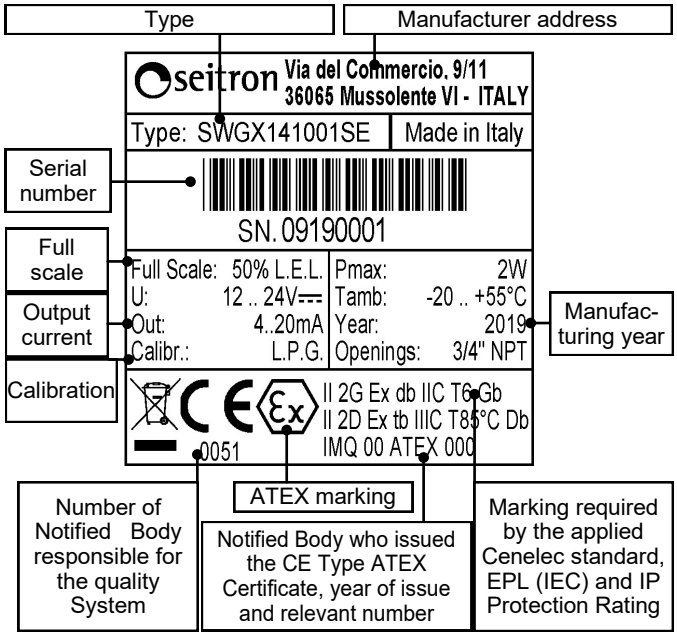


Fig.10: Example of a product label.

Where:

CE	Symbol indicating compliance with the applicable European Directives (CE).
Ex	Symbol indicating compliance with European Directive 94/9 / EC (ATEX).
0051:	Number of the Notified Body responsible for the Quality System (IMQ).
II 2G:	Equipment for surface plants (II) with the presence of gas (G) Category 2 suitable for zone 1 and, with redundancy, for zone 2.
II 2D:	Equipment for surface plants (II) with the presence of dust (D) of Category 2 suitable for zone 21 and, with redundancy, for zone 22.
Ex db:	Equipment with ATEX Ex db protection mode (flameproof housing).
IIC:	Equipment of group IIC suitable for all gas substances of group IIC. A device of group IIC is also suitable for areas with gas of group IIA and IIB.
T6:	Temperature class of equipment (maximum surface temperature 85° C). A device with temperature class T6 is also suitable for substances with higher temperature class (T5 .. T1).
Gb:	EPL: Equipment Protection Level according to IEC. 'Gb' stands for 'high protection level (b) for areas with Gas (G)'.
Ex tb:	Equipment with ATEX Ex tb type of protection for dusts (with housing - high level of protection).
IIIC:	Equipment suitable for the use in presence of conductive powder of the group IIIC.
85°C:	Temperature class of the equipment for use with powders: maximum surface temperature: 85 ° C.
Db:	EPL: Equipment Protection Level. 'Db' stands for 'high level of protection (b) for areas with dust (D)'.
IP6X:	Level of protection according to EN60529.
IMQ 00:	Notified Body that issued the Certificate of Compliance of the Type (IMQ) and year of issuance.
ATEX 0000:	Number of certificate in the year of issue.
X:	Special conditions of use (see Safety Instructions ATEX).