POSITEK
LIMITED

X005 GALVANIC ISOLATION AMPLIFIER

FOR INTRINSICALLY SAFE SENSORS IN HAZARDOUS ATMOSPHERES

- **Approvals** **ATEX and IECEx**
- **Certified** **Ex I(M1)**
  Ex II (1)GD
- **Super fast 4.7kHz (-3dB) bandwidth**
- **Wide power supply range**
- **Voltage and current output options**
- **Three or Five wire mode connection**

The **X005** Galvanic Isolation Amplifier has been designed specifically for use with Positek® Intrinsically Safe position sensors and is certified intrinsically safe [Ex ia Ma] I and [Ex ia Ga Da] IIC.

Positek® IS sensors are ratiometric i.e. the output signal scales with the supply voltage, to ensure the safe area signal accurately corresponds with sensor displacement it is important that the sensor supply is correct.

The **X005** Galvanic Isolation Amplifier provides a regulated and resistively limited +5V dc power supply required by Positek® IS sensors, it can be connected in three or five wire modes. Used in five wire mode positive and negative sense inputs enable the **X005** to dynamically adjust the sensor supply thus ensuring the correct voltage across the sensor. Connected in this way the **X005** can compensate for 15Ω conductor resistance. The sense terminals are linked internally so the end user can use the **X005** in three wire or five wire mode without the need to fit or remove external links.

The **X005** has an input power supply range of 12 to 30 volts dc, making it suitable for a wide range of hazardous area applications. It is tri-port isolated providing isolation between the amplifier power supply, the hazardous area and the **X005** output signal. The sensor supply and output are transformer coupled providing 2.5kV isolation between the safe and hazardous area circuits eliminating the requirement for a high-integrity earth.

The output of the **X005** is factory configured to either 0.5 to 9.5V or 4-20mA and has a bandwidth of 4.7kHz, making it ideal for servo control loops.

Output options available;

X005-545	0.5 to 9.5V
X005-546	9.5 to 0.5V
X005-425	4 to 20mA
X005-426	20 to 4mA

Versions are also available for potentiometer inputs.

The screw terminal connector plugs are coded to eliminate cross connection.

Specification

Power Supply	(J4 pins 1 {0V} and 3 {+V})
Voltage:	24V dc Nom. 12V - 30V
Current consumption (24V supply)	approx. 50mA [Voltage O/P]
	approx. 70mA [Current O/P]
Input Circuit	(J1 pins 1,2,3 & J2 pins 1 & 2)
	Transformer isolated

Intrinsic Safety

Ex I(M1)	Ex II (1)GD
[Ex ia Ma] I	[Ex ia Ga Da] IIC
Ta = -20°C ≤Ta ≤+60°C	Ta = -20°C ≤Ta ≤+60°C

Safety Parameters

Uo: 10.66V Io: 50.5mA Po: 121mW Li: 0 Ci: 0 Um: 253 V

Sensor supply:	5V @15mA max.
Lead resistance compensation:	15Ω maximum (15mA) all connections
Input resistance (J1 pin 3)	>5MΩ
Output Circuit	(J3 pins 1 {O/P-} and 3 {O/P+})
Voltage	0.5 to 9.5V
Output resistance	5Ω
Current loop	4 to 20mA
Load resistance	0 - 1kΩ
Transfer Characteristics	
Non-linearity:	< ± 0.1% FS
Temperature drift:	< 0.01% FS/°C for voltage outputs
Settling time to 1% of span:	< 300µs for 10-90% step change
Rise time:	< 200µs 10-90% of step change
Bandwidth	dc to 4.7kHz (-3dB)
Isolation:	2500V between safe area terminals and hazardous area terminals, 50V between power rail (J4) and output (J3)
Electromagnetic Compatibility	
	EN561236-2-1:2006 (EN31326-1:2006)
Ambient temperature range:	-20° to 60°C working
	-40°C to +100°C storage
Housing:	97.3 mm x 22.5 mm x 111.9 mm
Protection class:	IP20
Mounting:	35x7.5 mm top-hat rail (DIN 46277-3)
Connector Conductor Size:	0.2 to 2.5mm^2 (26-12 AWG)
Weight:	120g approx.

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Three or Five-Wire Mode Connection

FOR INTRINSICALLY SAFE SENSORS IN HAZARDOUS ATMOSPHERES

The aim of this document is to help readers who do not understand what is meant by three or five wire modes of connection between the galvanic isolation amplifier and sensor, and the factors behind them. It is by no means an in-depth technical analysis of the subject.

Whether opting for a pre-wired Positek® Intrinsically Safe sensor or one with a connector, choosing the right mode of connection and cable to suit the application requires careful consideration.

Interconnecting cables are not perfect conductors and offer resistance to current flow, the magnitude of resistance† depends on conductors resistivity, which changes with temperature, cross sectional area‡ and length. If the voltage were to be measured at both ends of a length of wire it would be found they are different, this is known as volts drop. Volts drop changes with current flow and can be calculated using Ohm's law, it should be noted that volts drop occurs in both positive and negative conductors. The effects of volts drop can be reduced by increasing the conductors cross sectional area, this does not however eliminate the effects due to temperature variation. There are instances where large cross-section cables are not practical; for example most standard industrial connectors of the type used for sensors have a maximum conductor capacity of 0.75mm², copper prices and ease of installation are other considerations.

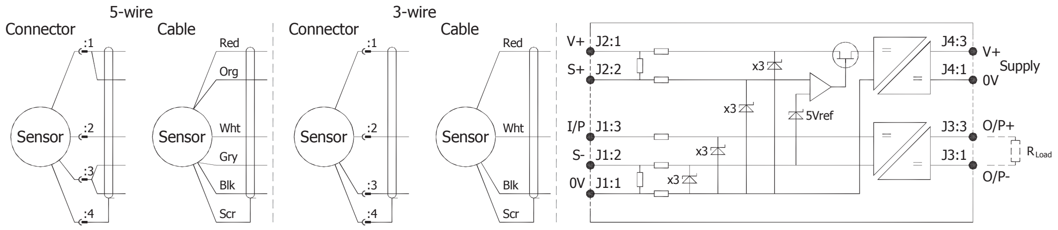
This is important because the effects of volts drop can significantly alter the perceived accuracy of the sensor which is ratiometric i.e. the output signal is directly affected by the voltage across the sensor. Changes in temperature will also be seen as gain variation in the sensor output.

Three wire mode connections are common and are suitable in most cases with short or moderate cable runs. Applications that do not require a high degree of accuracy but have cable runs, say in excess of 10m, volts drop can reduced by introducing a terminal box close to the sensor and using a larger cross-section cable for a majority of the cable run. Sensors supplied with three core cable are calibrated with the cable fitted which largely eliminates errors due to conductor resistance at room temperature however, as mentioned above, small gain errors due to temperature fluctuations should be expected.

Five wire mode connections have significant benefits as losses in the positive and negative conductors are compensated for by the galvanic isolation amplifier which can 'sense' the voltage across the sensor and dynamically adjust the output voltage so that the voltage across the sensor is correct. The effects of cable resistance and associated temperature coefficients are eliminated allowing for smaller conductors than a three wire connection for the same cable run. The amplifier can compensate for up to 15Ω per conductor with a current flow of 15mA, which is more than adequate for 150m of 0.25 mm² cable, longer lengths will require larger conductors.

For this reason Positek® recommends five wire connections for cable lengths exceeding 10 metres in 0.25 mm² cable to preserve the full accuracy of the sensor.

See illustrations below for examples of connecting a sensor to the galvanic isolation amplifier.



Cable Length (metres)	Up to 150	150 - 300	300 - 450	450 - 600	600 - 900	900 - 1000
Cross Section (mm²)	0.25	0.5	0.75	1.0	1.5	2.0

The table above shows recommended conductor sizes with respect to cable length for both three and five wire connections, based on copper conductors. Three wire connections will introduce a gain reduction of 5% and a ±1% temperature dependence of gain over the range -40°C to +80°C for the cable temperature. (i.e. about –150 ppm/°C for the maximum lengths shown and less pro rata for shorter lengths.)

It should be noted that the maximum cable length, as specified in the sensor certification, takes **precedence** and **must not** be exceeded.

Positek® sensors are supplied with three core cable as standard, however five core cable can be supplied on request. The galvanic isolation amplifier is available as;

A005-*** for 'A' prefix sensors
G005-*** for 'G' and 'H' prefix sensors
X005-*** for 'E', 'M' and 'X' prefix sensors

† $R = \rho L/A$ ρ is the resistivity of the conductor (Ωm) L is the length of conductor (m) A is the conductor cross-sectional area (m^2).

‡It is presumed that **d**irect **c**urrent flow is uniform across the cross-section of the wire, the galvanic isolation amplifier and sensor are a dc system.

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