

**ELECTRICAL OPTIONS/ SPECIFICATIONS**

**OUTPUT** 0.5 TO 4.5V RATIO METRIC  
**SUPPLY** 5V  
 SUPPLY CURRENT 12mA TYP. 20mA MAX.

CABLE: 0.2mm<sup>2</sup>, 0/A SCREEN, PUR JACKET – SUPPLIED WITH 50cm OR REQUIRED LENGTH IN cm (15000cm MAX).  
 STANDARD 3-CORE: JACKET Ø4mm BLACK e.g. 'L50'  
 OPTIONAL 5-CORE: JACKET Ø4.6mm BLUE e.g. 'LQ50'

CABLE/CONNECTOR\* CONNECTIONS;

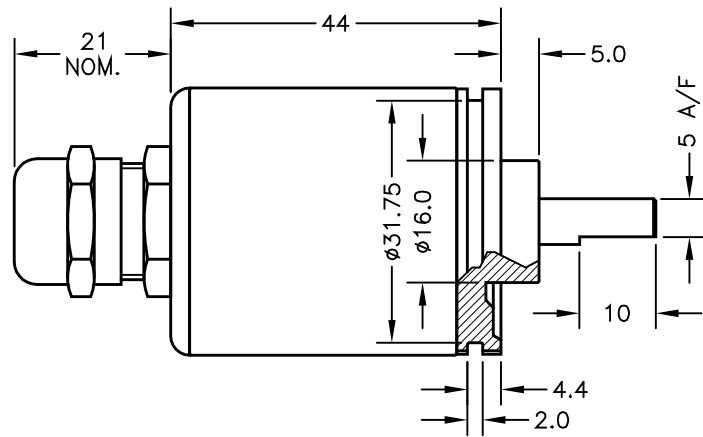
3 CORE	5 CORE	CONNECTOR	
RED	RED	:1	+Ve
-	ORG	:1	+SENSE (5-WIRE ONLY)
BLACK	BLACK	:3	0V
-	GRY	:3	-SENSE (5-WIRE ONLY)
WHITE	WHITE	:2	OUTPUT
SCREEN	SCREEN	:4	BODY

\*CONNECTORS; MAXIMUM CONDUCTOR CROSS SECTION 0.75mm<sup>2</sup>  
 RANGE OF DISPLACEMENT FROM 0-5° TO 0-15° e.g.12°, IN INCREMENTS OF 1°.

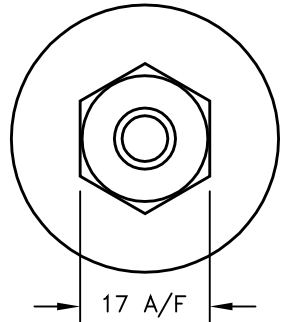
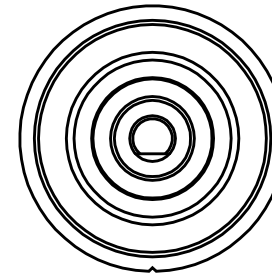
BODY MATERIAL:- STAINLESS STEEL.  
 FLANGE BASE MATERIAL:- STAINLESS STEEL.  
 SERVO MOUNT MATERIAL:- STAINLESS STEEL.

FURTHER OPTIONS:  
 SPRING RETURN (CODE 'N') AVAILABLE UP TO ±50°  
 CALIBRATED OUTPUT, PHYSICAL STOPS ±55°  
 NOTE STANDARD DEVICE HAS NO STOPS.

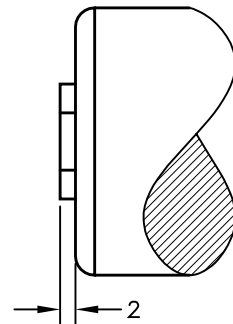
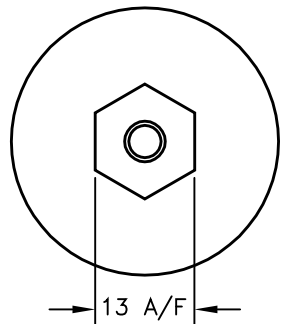
IP67 M12 CONNECTOR IEC 60947-5-2 (CODE 'J')



SERVO MOUNT (CODE 'P')



IP67 SHORT CABLE GLAND – AXIAL (CODE 'Mxx'/'MQxx')



NOTE:- READ INSTALLATION SHEET H000-19 FOR FULL INSTRUCTIONS FOR USE.

CSA APPROVED TO  
 Class I Zone 0  
 Ex/AEx ia IIC T4 (Ta= -40 to 80°C)  
 Ex iaD 20 T93°C(Ta= -40 to 80°C)  
 Ui 11.4V, Ii 0.2A, Pi 0.51W

APPROVED FOR USE IN CONJUNCTION WITH A GALVANICALLY ISOLATED BARRIER.

NOTE: APPROVAL ONLY APPLIES AT NORMAL ATMOSPHERIC PRESSURE!

A	FIRST ISSUE.	PDM
B	DISP. 5 TO 15° WAS 5 TO 20° RAN442	PDM
C	5-CORE OPTION ADDED ~ RAN1102	PDM
D	OPTION 'M' ADDED ~ RAN1166, RANGE NOTE AMENDED ~ RAN1200	PDM



DRAWINGS NOT TO BE CHANGED WITHOUT REFERENCE TO THE CHANGE PROCEDURE. CHANGES TO PARTS USED IN INTRINSICALLY SAFE PRODUCT MUST BE APPROVED BY THE AUTHORISED PERSON  
 THIS IS AN UNCONTROLLED PRINT AND WILL NOT BE UPDATED.



A	19/03/13		CHECKED BY	X	±0.4
B	07/11/13		RDS	X.X	±0.2
C	26/04/17			X.XX	±0.1
D	11/09/17				DIMS mm
		DESCRIPTION	H502 INTRINSICALLY SAFE SMALL ANGLE ROTARY SENSOR		
SCALE	10mm	DRAWING NUMBER	H502-11	REV	D
					SHEET 1 OF 1



# H502 SMALL ANGLE ROTARY SENSOR

## INTRINSICALLY SAFE FOR HAZARDOUS DUST ATMOSPHERES

- **Intrinsically safe for Gas and Dust to:**  
**Class I, Zone 0 Ex ia / AEx ia**  
**Zone 20 Ex ia / AEx ia**  
**Class I, Division 1; Class II, Division 1;**  
**Class III, Division 1**
- **Non-contacting inductive technology to eliminate wear**
- **Angle set to customer's requirement**
- **Compact, durable and reliable**
- **High accuracy and stability**
- **Sealing to IP67**

As a leading designer and manufacturer of linear, rotary, tilt and intrinsically safe position sensors, Positek® has the expertise to supply a sensor to suit a wide variety of applications.

Our H502 incorporates electronics system EX08 which is CSA approved for use in potentially explosive **gas/vapour and dust** atmospheres. The H502 is designed for industrial and scientific feedback applications, like the H500 but with better resolution at smaller angles of deflection, and is ideal for OEMs seeking good sensor performance for arduous applications in hazardous areas. The H502, like all Positek® sensors, is supplied with the output calibrated to the angle required by the customer, between 16 and 160 degrees and with full EMC protection built in. The sensor provides a linear output proportional with input shaft rotation, which has full 360 degree rotational freedom.

There is a machined registration mark to identify the calibrated mid point. Overall performance, repeatability and stability are outstanding over a wide temperature range.

The H502 has long service life and environmental resistance with a rugged stainless steel body, shaft, flange or servo mount. The flange or servo mounting options make the sensor easy to install, it also offers a range of mechanical options. Environmental sealing is to IP67.



### SPECIFICATION

#### Dimensions

Body diameter	35 mm
Body Length (to seal face)	44 mm
Shaft	15 mm Ø 6 mm

*For full mechanical details see drawing H502-11*

#### Independent Linearity

≤ ± 0.25% FSO @ 20°C

#### Temperature Coefficients

< ± 0.01%/°C Gain &

< ± 0.01%FS/°C Offset

> 10 kHz (-3dB)

#### Frequency Response

Infinite

#### Resolution

#### Noise

< 0.02% FSO

#### Torque

< 20 mNm Static

#### Intrinsic Safety

Class I, Zone 0

Ex ia IIC T4 Ga AEx ia IIC T4 Ga

Class I, Zone 20

Ex ia IIIC T135°C Da AEx ia IIIC T135°C Da

Class I, Division 1, Groups A, B, C, D; T4

Class II, Division 1, Groups E, F, G, T135°C

Class III Division 1;

(Ta = -40°C to +80°C)

Approval only applies to the specified ambient temperature range and atmospheric conditions in the range 0.80 to 1.10 Bar, oxygen ≤ 21%

#### Sensor Input Parameters

Ui: 11.4V, Ii: 0.20A, Pi: 0.51W.

#### (connector option/s)

Ci: 1.16µF, Li: 50µH

#### (cable option/s)

Ci: 1.36µF, Li: 860µH with 1km max. cable

#### Environmental Temperature Limits

##### Operating

-40°C to +80°C

##### Storage

-40°C to +125°C

#### Sealing

IP65/IP67 depending on connector / cable option

#### EMC Performance

EN 61000-6-2, EN 61000-6-3

#### Vibration

IEC 68-2-6: 10 g

#### Shock

IEC 68-2-29: 40 g

#### MTBF

350,000 hrs 40°C Gf

#### Drawing List

H502-11

Sensor Outline

3D models, step or .igs format, available on request.

**Do you need a position sensor made to order to suit a particular installation requirement or specification? We'll be happy to modify any of our designs to suit your needs - please contact us with your requirements.**



For further information please contact:

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# H502 SMALL ANGLE ROTARY SENSOR

## INTRINSICALLY SAFE FOR HAZARDOUS DUST ATMOSPHERES

Intrinsically safe equipment is defined as "equipment which is incapable of releasing sufficient electrical or thermal energy under normal or abnormal conditions to cause ignition of a specific hazardous atmosphere mixture in its most easily ignited concentration."

CSA approved to;

- Class I, Zone 0      Ex ia IIC T4 Ga      AEx ia IIC T4 Ga
- Class I, Zone 20    Ex ia IIIC T135°C Da    AEx ia IIIC T135°C Da
- Class I, Division 1, Groups A, B, C, D; T4
- Class II, Division 1, Groups E, F, G, T135°C;
- Class III Division 1;
- (Ta = -40°C to +80°C)

Designates the sensor as belonging to; Class I, Zone 0 / Class I, Zone 20: can be used in areas with continuous, long or frequent periods of exposure to hazardous gas or dust.

Gas:

Protection class ia IIC, denotes intrinsically safe for Zones 0, 1 & 2 and IIA, IIB and IIC explosive gases.

Temperature class T4: maximum sensor surface temperature under fault conditions 135°C.

Dust:

Protection class ia IIIC, denotes intrinsically safe for Zones 20 & 21 explosive dust.

T135°C: maximum sensor surface temperature under fault conditions 135°C.

Ambient temperature range extended to -40°C to +80°C.

It is imperative Positek® intrinsically safe sensors be used in conjunction with a galvanic barrier to meet the requirements of the product certification. The Positek G005 Galvanic Isolation Amplifier is purpose made for Positek IS sensors making it the perfect choice. Refer to the G005 datasheet for product specification and output configuration options.

For cable lengths exceeding 10 metres a five wire connection is recommended to eliminate errors introduced by cable resistance and associated temperature coefficients.

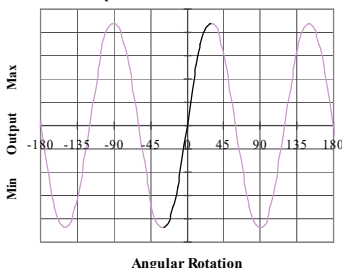
CSA approved sensors suitable for gas (G series) applications, are also available from Positek.

H502	a	b	c	d	e	f	g
	Displacement	A	Y	Connections	Option	Option	Z000

a Displacement	Value
Factory set to any angle from 0-5° (±2.5°) to 0-15° (±7.5°) (e.g. 0-8°)	<b>8</b>
b Output	Code
Supply V <sub>dc</sub> (tolerance)	<b>Output</b>
+5V (4.5 - 5.5V)	0.5 - 4.5V (ratiometric with supply)
Supply Current 10mA typical, 12mA max.	<b>A</b>
c Calibration Adjustments	Code
Sealed	<b>Y</b>
d Connections	Code
Connector IP67 4 pin M12 IEC 61076-2-101, metal	<b>J</b>
Connector IP67 4 pin M12 IEC 61076-2-101, metal, pre-wired 3-core cable	<b>Jxx</b>
Connector IP67 4 pin M12 IEC 61076-2-101, metal, pre-wired 5-core cable	<b>JQxx</b>
Cable gland IP67 Pg9, metal, 3-core cable	<b>Lxx</b>
Cable gland IP67 Pg9, metal, 5-core cable	<b>LQxx</b>
Cable gland, short <sup>†</sup> IP67, metal, 3-core cable	<b>Mxx</b>
Cable gland, short <sup>†</sup> IP67, metal, 5-core cable	<b>MQxx</b>
Specify required cable length 'xx' in cm. e.g. L2000 specifies axial cable gland with 20 m of cable, 50 cm supplied as standard. <b>Note!</b> maximum length supplied 15000cm. <sup>†</sup> Nb: restricted cable pull strength.	

e Shaft Option	Code
None default	blank
Sprung to stop up to 100° maximum	<b>N</b>
f Sensor Mounting	Code
Flange default	blank
Servo Mount	<b>P</b>
See drawing H502-11 for details.	
g Z-code	Code
Calibration to suit G005 required	<b>Z000</b>

Output Characteristic - Standard



For further information please contact:

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H502-17j



# 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® Intrinsicly 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<sup>†</sup> depends on conductors resistivity, which changes with temperature, cross sectional area<sup>‡</sup> 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 0.75mm<sup>2</sup>, copper prices and ease of installation are other considerations.

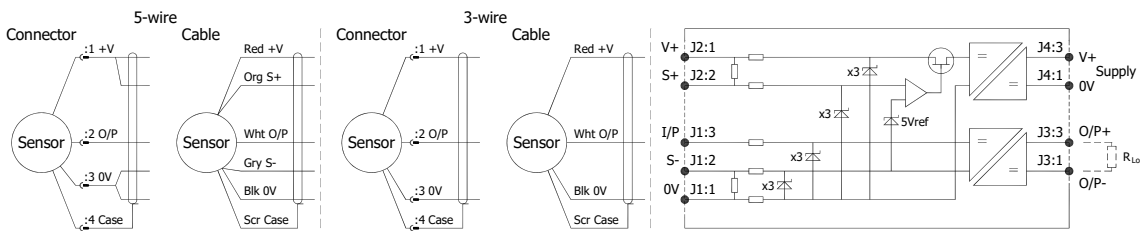
This is important because the effects of volts drop can significantly alter the perceived accuracy of the sensor which is ratiometric i.e. the output signal is directly affected by the voltage across the sensor. Changes in temperature will also be seen as gain variation in the sensor output.

**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 be 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 mm<sup>2</sup> cable, longer lengths will require larger conductors.

**For this reason Positek® recommends five wire connections for cable lengths exceeding 10 metres in 0.25 mm<sup>2</sup> 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 (mm <sup>2</sup> )	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 0.25 mm<sup>2</sup> cable as standard, however five core 0.25 mm<sup>2</sup> cable can be supplied on request. The galvanic isolation amplifier is available as;

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

<sup>†</sup>  $R = \rho L/A$   $\rho$  is the resistivity of the conductor ( $\Omega m$ )  $L$  is the length of conductor (m)  $A$  is the conductor cross-sectional area (m<sup>2</sup>).

<sup>‡</sup> It is presumed that direct current flow is uniform across the cross-section of the wire, the galvanic isolation amplifier and sensor are a dc system.



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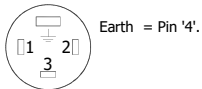
# Generic Installation Information

## H SERIES SENSORS

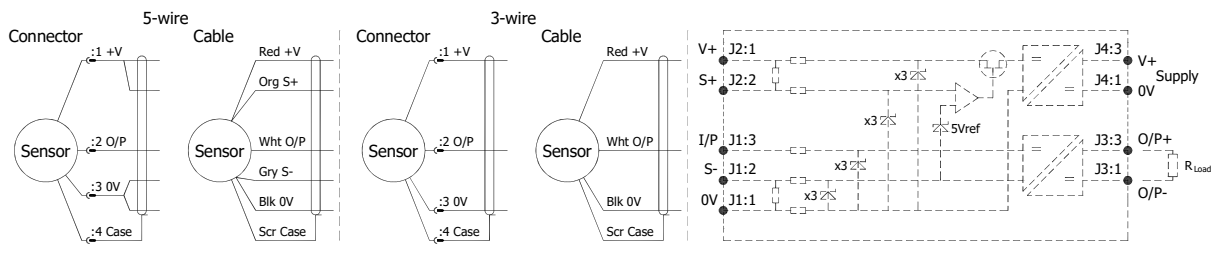
INTRINSICALLY SAFE FOR HAZARDOUS GAS/VAPOUR & DUST ATMOSPHERES

CSA Qualified Intrinsically Safe Device Certificate number 13.2588225		Ex ia IIC T4 Ga Class I, Zone 0, AEx ia IIC T4 Ga Class I, Division 1, Groups A, B, C, D; T4 Ex ia IIIC T135°C Da Zone 20, AEx ia T135°C Da; Class II, Division 1, Groups E, F, G, T135°C; Class III Division 1; (Ta = -40°C to +80°C)	
Electronics Version	Output Description:	Supply Voltage: V <sub>s</sub> (tolerance)	Load resistance:
EX08	0.5 - 4.5V (ratiometric with supply)	+5V (4.5 - 5.5V) 10mA Nom.	5kΩ min

Connector Pin Layout:  
DIN 43650 C



IEC 60947-5-2



### Putting Into Service:

This sensor must only be installed, operated and maintained by competent and suitably trained personnel. The installation and maintenance must be carried out in accordance with all appropriate international, national and local standard codes of practice and site regulations for intrinsically safe apparatus. The use, installation, or maintenance of the sensor, in any other way than intended, may impair its operation or the protection it provides. The sensor must be used with a galvanic isolation barrier designed to supply the sensor with a nominal 5V and to transmit the sensor output to a safe area. The barrier parameters must not exceed:-

$$U_i = 11.4V \quad I_i = 0.20A \quad P_i = 0.51W$$

$$C_i = 1.36\mu F^* \quad L_i = 860\mu H^* \quad (\text{with maximum length integral cable})$$

$$C_i = 1.16\mu F \quad L_i = 50\mu H \quad (\text{without integral cable})$$

\*Figures for 1km cable where:  $C_i = 200\text{pF/m}$  &  $L_i = 810\text{nH/m}$

Cable characteristics must not exceed:-

$$\text{Capacitance: } \leq 200 \text{ pF/m or max. total of: } 200 \text{ nF}$$

$$\text{Inductance: } \leq 810 \text{ nH/m or max. total of: } 810 \mu H$$

Approval only applies to specified ambient temperature range and atmospheric conditions in the range: 0.80 to 1.10 Bar, oxygen  $\leq 21\%$ .

**Markings and safety parameter information for product marked EX06, see annex 1.**

### Environmental Conditions

Pollution degree: 2

Installation category: I

Humidity 80% to temperatures up to 31 °C decreasing linearly to 50% rH at 40 °C; /// max 80% rh, non condensing. The sensor has been assessed for indoor use only. Where used outdoors suitable environmental protection **must** be provided.

### Special Condition for Safe Use:

The apparatus does not meet the 500 V r.m.s dielectric strength test between circuit and frame, in accordance with clause 6.3.13 of IEC 60079-11:2011. This must be taken into consideration on installation.

When using a Sensor that has an integral cable in a dust application, the free end of the cable shall be appropriately terminated for the zone of use.

Under certain extreme circumstances, the non-metallic and isolated metal parts incorporated in the enclosure of this equipment may generate an ignition-capable level of electrostatic charge. Therefore the equipment shall not be installed in a location where the external conditions are conducive to the build-up of electrostatic charge on such surfaces. This is particularly important if the equipment is installed in a zone 0 location. In addition, the equipment shall only be cleaned with a damp cloth.

P.T.O.



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H000-19d

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# Generic Installation Information

## H SERIES SENSORS

INTRINSICALLY SAFE FOR HAZARDOUS GAS/VAPOUR & DUST  
ATMOSPHERES

### Use:

The sensor is designed to measure Linear or rotary displacement and provide a proportional analogue output signal.

### Assembly and Dismantling:

The unit is not to be serviced or dismantled and re-assembled by the user.

WARNING: Substitution of components may impair intrinsic safety

AVERTISSEMENT: La substitution de composants peut altérer la sécurité intrinsèque.

### Maintenance:

Accumulated dust layer must not exceed a depth of 200mm.

### Annex 1 - Markings and Entity Parameters for product with EX06 electronics system.

Class I, Zone 0

Ex ia IIC T4 (Ta= -40 to 80°C)

AEx ia IIC T4 (Ta= -40 to 80°C)

AEx iaD IIIC T93°C (Ta= -40 to 80°C)

**Ui = 11.4V**      **Ii = 0.20A**      **Pi = 0.51W**

**Ci = 1.36µF\***      **Li = 710µH\***      (with maximum length integral cable)

**Ci = 1.16µF**      **Li = 50µH**      (without integral cable)

\*Figures for 1km cable where: Ci = 200pF/m & Li = 660nH/m

Cable characteristics must not exceed:-

Capacitance: ≤ 200 pF/m or max. total of: 200 nF

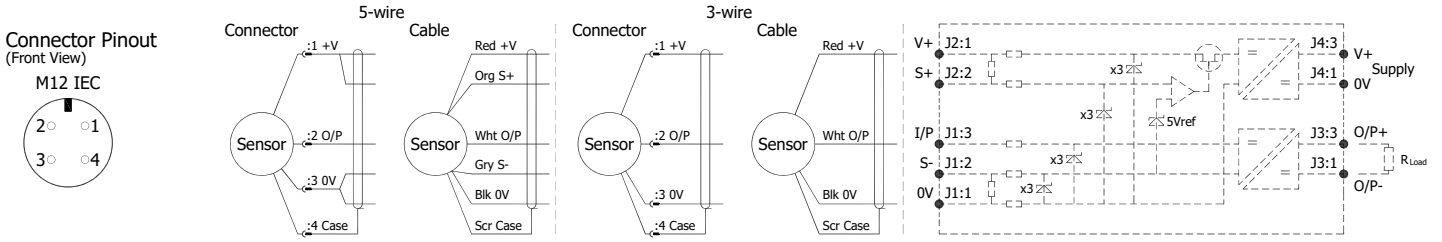
Inductance: ≤ 660 nH/m or max. total of: 660 µH



# Installation Information

## H502 SMALL ANGLE ROTARY SENSOR

### INTRINSICALLY SAFE FOR HAZARDOUS DUST ATMOSPHERES

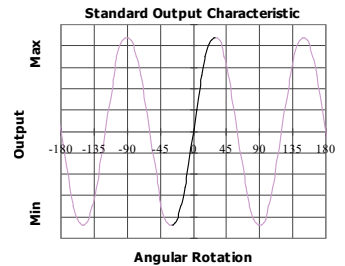


N.b. sensors supplied with cable, the free end must be appropriately terminated.

**Warning** - The M12 IEC connector may be rotated for purposes of convenient orientation of the connector and cable, however rotating the connector more than one complete revolution is not recommended. **Repeated rotation of the connector will damage the internal wiring!**

**Mechanical Mounting:** Flange mounted or servo mount, with appropriate clips - see drawing H502-11. The sensor should be mounted with minimal axial and radial loading on the shaft for optimum life. It is recommended that the shaft is coupled to the drive using a flexible coupling. Tests indicate that life in excess of 16 million cycles can be achieved with 1kg side and end load.

**Output Characteristic:** The sensor has full rotational freedom and six sectors, 60° apart, over which linear response can be achieved. At the mid point of the calibrated range the output signal will be half full scale deflection, and the flat on the shaft is aligned with the registration mark in the base of the sensor. In the calibrated range the output increases as the shaft is rotated in an anti-clockwise direction viewed from the shaft. The calibrated output is factory set to be between 5° and 15°.



**Incorrect Connection Protection levels: Not protected** – the sensor is **not** protected against either reverse polarity or over-voltage. The risk of damage should be minimal where the supply current is limited to less than 50mA.