

- **Non-contacting inductive technology to eliminate wear**
- **Travel set to customer's requirement**
- **Compact and self-contained**
- **High durability and reliability**
- **High accuracy and stability**
- **Sealing to IP65/IP67 as required**



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 P101 LIPS® (Linear Inductive Position Sensor) is an affordable, durable, high-accuracy position sensor designed for industrial and scientific feedback applications. The unit is highly compact and space-efficient, being responsive along almost its entire length.

The P101, like all Positek® sensors, provides a linear output proportional to travel. Each unit is supplied with the output calibrated to the travel required by the customer, any stroke from 0-5mm to 0-800mm and with full EMC protection built in. The sensor is very robust, the body and push rod being made of stainless steel for long service life and environmental resistance. It is particularly suitable for OEMs seeking good sensor performance for arduous applications such as industrial machinery where cost is important.

Overall performance, repeatability and stability are outstanding over a wide temperature range. The sensor is easy to install with mounting options including M5 rod eye bearings and body clamps. The push rod can be supplied free or captive, with female M5 thread, an M5 rod eye, or dome end, Captive push rods can be sprung loaded, in either direction, on sensors up to 250mm of travel. The P101 also offers a wide range of mechanical and electrical options, environmental sealing is to IP65 or IP67, depending on selected cable or connector options.

## SPECIFICATION

### Dimensions

Body diameter	35 mm
Body length (Axial version)	calibrated travel + 163 mm
Body length (Radial version)	calibrated travel + 186 mm
Push rod extension	calibrated travel + 9 mm, OD 9.5 mm

For full mechanical details see drawing P101-11

### Independent Linearity

≤ ± 0.25% FSO @ 20°C - up to 450 mm
≤ ± 0.5% FSO @ 20°C - over 450 mm
≤ ± 0.1% FSO @ 20°C* available upon request.

\*Sensors with calibrated travel from 10 mm up to 400 mm.

### Temperature Coefficients

< ± 0.01%/°C Gain &
< ± 0.01%FS/°C Offset

### Frequency response

> 10 kHz (-3dB)
> 300 Hz (-3dB) 2 wire 4 to 20 mA

### Resolution

Infinite

### Noise

< 0.02% FSO

### Environmental Temperature Limits

Operating	-40°C to +125°C standard
	-20°C to +85°C buffered
	-40°C to +125°C

Storage

### 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

P101-11

Sensor Outline

Drawings, in AutoCAD® dwg or dxf 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.**



## LIPS® P101 STAND-ALONE LINEAR POSITION SENSOR

Position feedback for industrial and scientific applications

### How Positek's PIPS® technology eliminates wear for longer life

Positek's **PIPS®** technology (Positek Inductive Position Sensor) is a major advance in displacement sensor design. PIPS®-based displacement transducers have the simplicity of a potentiometer with the life of an LVDT/RVDT.

PIPS® technology combines the best in fundamental inductive principles with advanced micro-electronic integrated circuit technology. A PIPS® sensor, based on simple inductive coils using Positek's ASIC control technology, directly measures absolute position giving a DC analogue output signal. Because there is no contact between moving electrical components, reliability is high and wear is eliminated for an exceptionally long life.

PIPS® overcomes the drawbacks of LVDT technology – bulky coils, poor length-to-stroke ratio and the need for special magnetic materials. It requires no separate signal conditioning.

Our LIPS® range are linear sensors, while RIPS® are rotary units and TIPS® are for detecting tilt position. Ask us for a full technical explanation of PIPS® technology.

We also offer a range of ATEX-qualified intrinsically-safe sensors.

### TABLE OF OPTIONS

**CALIBRATED TRAVEL:** Factory set to any length from 0-5mm to 0-800mm (e.g. 254mm)

#### ELECTRICAL INTERFACE OPTIONS

OUTPUT SIGNAL	SUPPLY INPUT	OUTPUT LOAD
Standard: 0.5-4.5V dc ratiometric	+5V dc nom. ± 0.5V.	5kΩ min.
Buffered: 0.5-4.5V dc	+24V dc nom. + 9-28V.	5kΩ min.
±5V dc	±15V dc nom. ± 9-28V.	5kΩ min.
0.5-9.5V dc	+24V dc nom. + 13-28V.	5kΩ min.
±10V dc	±15 V dc nom. ± 13.5-28V.	5kΩ min.
Supply Current	10mA typical, 20mA maximum.	
4-20mA (2 wire)	+24 V dc nom. + 18-28V.	300Ω @ 24V.
(3 wire sink)	+24 V dc nom. + 13-28V.	950Ω @ 24V.
(3 wire source)	+24 V dc nom. + 13-28V.	300Ω max.

Axial sensors supplied with access to output 'zero' and 'span' calibration adjustments as standard. No access option available.

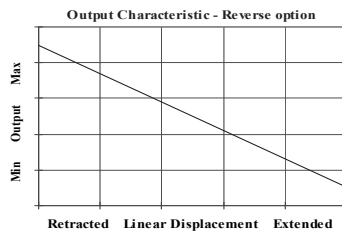
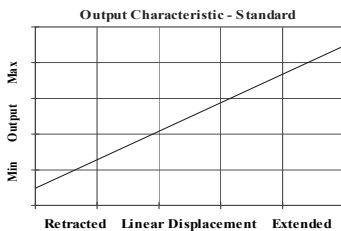
#### CONNECTOR/CABLE OPTIONS

Connector - Hirschmann GD series	Axial, IP65
Connector - Hirschmann ELWIKA 4102	Radial, IP67
Cable with M12 gland or short gland	Axial, IP67
Cable with Pg 9 gland	Radial, IP67
Cable length >50 cm – please specify length in cm	

#### MOUNTING OPTIONS

M5 rod eye bearing ( radial versions), Body Tube Clamp/s (axial or radial versions).

**PUSH ROD OPTIONS** – standard retained with M5x0.8 female thread, M5 rod eye bearing, Dome end, Sprung loaded (retraction or extension) or Free.



LIPS® SERIES P101 Stand-Alone Linear Position Sensor

a	b	c	d	e	f	g	h	j
P101 . Displacement Output Adjustments Connections Option Option Option Option Z-code								

a Displacement (mm)	Value	
Displacement in mm	e.g. 0 - 254 mm	<b>254</b>
b Output	Code	
Supply V dc V <sub>s</sub> (tolerance)	Output	Code
+5V (4.5 - 5.5V)	0.5 - 4.5V (ratiometric with supply)	<b>A</b>
±15V nom. (±9 - 28V)	±5V	<b>B</b>
+24V nom. (13 - 28V)	0.5 - 9.5V	<b>C</b>
±15V nom. (±13.5 - 28V)	±10V	<b>D</b>
+24V nom. (18 - 28V)	4 - 20mA 2 wire	<b>E</b>
+24V nom. (13 - 28V)	4 - 20mA 3 wire Sink	<b>F</b>
+24V nom. (9 - 28V)	0.5 - 4.5V	<b>G</b>
+24V nom. (13 - 28V)	4 - 20mA 3 wire Source	<b>H</b>
c Calibration Adjustments	Code	
Accessible - default <sup>†</sup>	<sup>†</sup> Axial body style only. Radial body style sealed by default.	blank
Sealed		<b>Y</b>
d Connections Cable* or Connector	Code	
Cable Gland - Radial	IP67 Pg9	<b>Ixx</b>
Connector - Axial	IP65 DIN 43650 °C'	<b>J</b>
Connector - Radial	IP67 M12 IEC 60947-5-2	<b>K</b>
Cable Gland - Axial	IP67 M12	<b>Lxx</b>
Cable Gland - Axial	IP67 Short	<b>Mxx</b>
<small>*Supplied with 50 cm as standard, specify required cable length specified in cm. e.g. L2000 specifies cable gland with 20 metres of cable. Nb: restricted cable pull strength.</small>		
e Body Fittings	Code	
None - default		blank
M5 Rod-eye Bearing	Radial body style only	<b>N</b>
Body Clamps - 1 pair		<b>P</b>
Body Clamps - 2 pairs		<b>P2</b>
f Sprung Push Rod	Code	
None - default		blank
Spring Extend	Up to 300mm displacement.	<b>R</b>
Spring Retract	Captive push rod only.	<b>S</b>
g Push Rod Fittings	Code	
None - default	Female Thread M5x0.8x9 deep	blank
Dome end	Required for option 'R'	<b>T</b>
M5 Rod-eye Bearing		<b>U</b>
h Push Rod Options	Code	
Captive - default	Push rod is retained	blank
Non-captive	Push rod can depart body	<b>V</b>

j Z-code	Code
Connector IP67 M12 IEC 60947-5-2 must have options 'Y' & 'J'	<b>Z600</b>
Connector IP67 M12 IEC 60947-5-2 must have option 'J'	<b>Z601</b>
≤± 0.1% @20°C Independent Linearity displacement between 10mm & 400mm only!	<b>Z650</b>
Connector with cable option 'J' or 'K' with length required in cm i.e. J100 specifies connector with 100cm of cable.	<b>Z999</b>

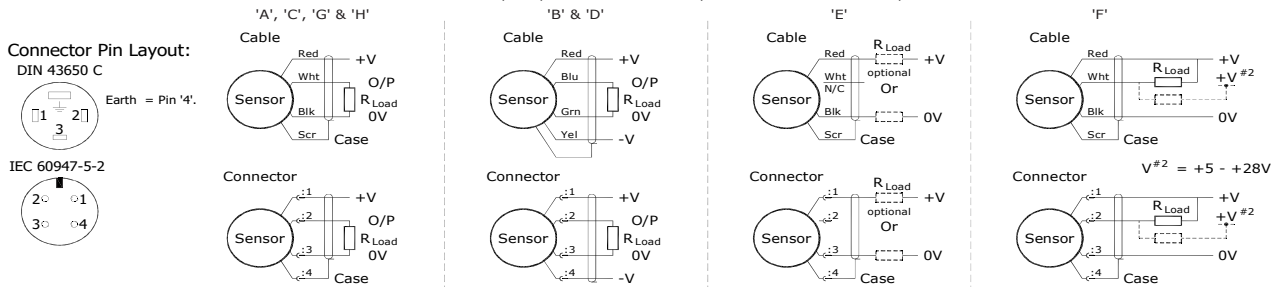


# Installation Information

## LIPS<sup>®</sup> P101 STAND-ALONE LINEAR POSITION SENSOR

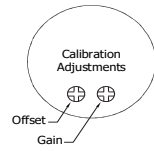
Output Option	Output Description:	Supply Voltage: $V_s$ (tolerance)	Load resistance: (include leads for 4 to 20mA O/Ps)
<b>A</b>	0.5 - 4.5V (ratiometric with supply)	+5V (4.5 - 5.5V)	$\geq 5k\Omega$
<b>B</b>	$\pm 5V$	$\pm 15V$ nom. ( $\pm 9 - 28V$ )	$\geq 5k\Omega$
<b>C</b>	0.5 - 9.5V	+24V nom. (13 - 28V)	$\geq 5k\Omega$
<b>D</b>	$\pm 10V$	$\pm 15V$ nom. ( $\pm 13.5 - 28V$ )	$\geq 5k\Omega$
<b>E</b>	4 - 20mA 2 wire Current Loop	+24V nom. (18 - 28V)	$\approx 0 - 300\Omega$ max. @24V $\sim 1.2$ to 6V across 300 $\Omega$ { $R_L$ max. = $(V_s - 18) / 20^{-3}$ }
<b>F</b>	4 - 20mA 3 wire Sink	+24V nom. (13 - 28V)	$\approx 0 - 950\Omega$ max. @24V $\sim 3.8$ to 19V across 950 $\Omega$ { $R_L$ max. = $(V_s - 5) / 20^{-3}$ }
<b>G</b>	0.5 - 4.5V	+24V nom. (9 - 28V)	$\geq 5k\Omega$
<b>H</b>	4 - 20mA 3 wire Source	+24V nom. (13 - 28V)	$\approx 0 - 300\Omega$ max. $\sim 1.2$ to 6V across 300 $\Omega$

Not all output options available - see product datasheet for full options list



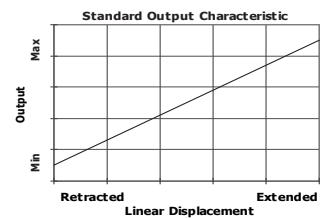
### Gain and Offset Adjustment: (Where accessible - Typically $\pm 10\%$ Min available)

To adjust the gain or offset use a small potentiometer adjuster or screwdriver 2mm across. Do not apply too much force on the potentiometers.



**Mechanical Mounting:** Depending on options; Body can be mounted by M5x0.8 male thread, M5 rod eye or by clamping the sensor body - body clamps are available, if not already ordered. Target by M5x0.8 female thread or M5 rod eye. It is assumed that the sensor and target mounting points share a common earth.

**Output Characteristic:** Target is extended 9 mm from end of body at start of normal travel. The output increases as the target extends from the sensor body, the calibrated stroke is between 5 mm and 800 mm.



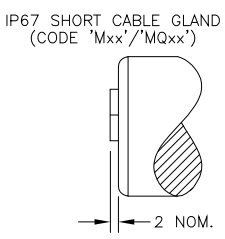
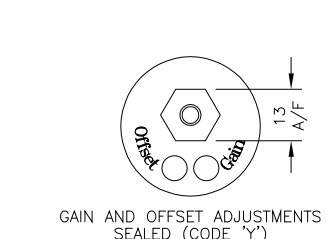
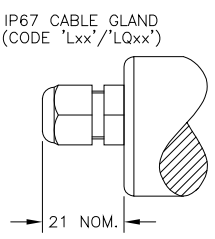
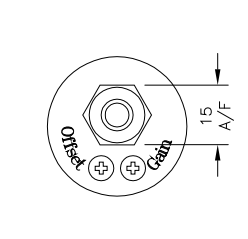
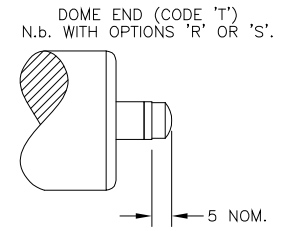
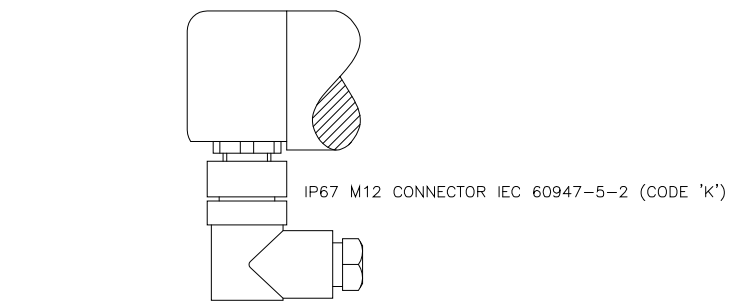
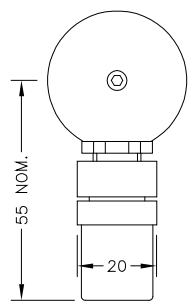
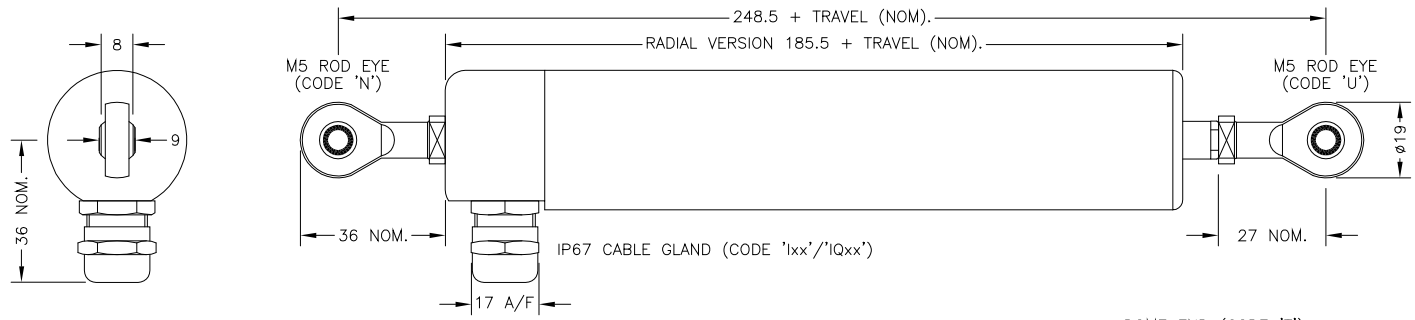
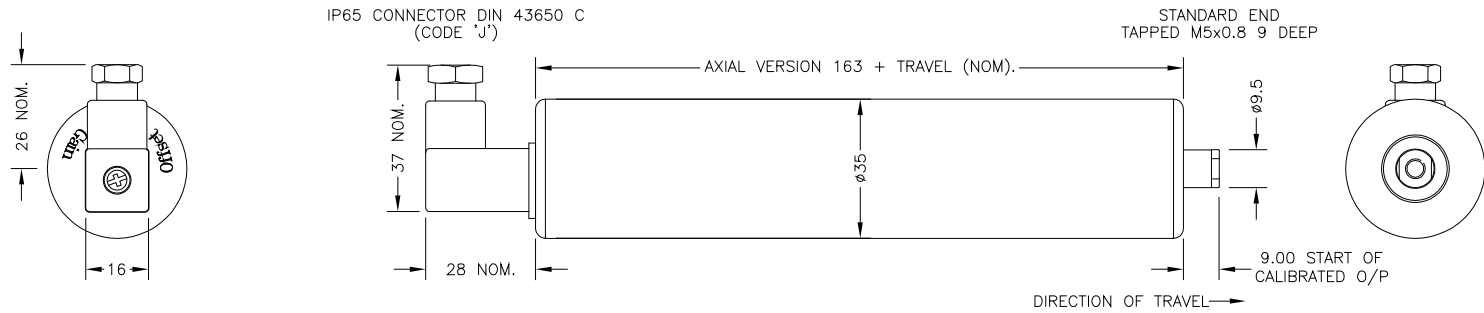
**Warning -** The M12 IEC 60947 connector may be rotated for purposes of convenient orientation of the connector and cable, however rotating the connector more than one complete revolution is not recommended.

**Repeated rotation of the connector will damage the internal wiring!**

### Incorrect Connection Protection levels:-

- A **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.
- B & D Supply leads diode protected. Output must not be taken outside  $\pm 12V$ .
- C & G Supply leads diode protected. Output must not be taken outside 0 to 12V.
- E, F & H Protected against any misconnection within the rated voltage.

N.b. ROD-EYE ORIENTATION NOT GUARANTEED.



P	ADDITIONAL DIMS/VIEWS ADDED.	PDM
Q	RADIAL ENDCAP MODIF'D - RAN 335	PDM
R	SPRUNG OPTIONS 300 WAS 250 - RAN 473.	PDM
S	OPTIONS 'R' & 'S' OVER TRAVEL DIMS MODIFIED - RAN1030.	PDM
T	RANGE WAS 50-600mm RAN1056	RDS
U	RANGE NOTE AMENDED ~ RAN1200	PDM



THE PUSH-ROD RETRACTS A FURTHER 4mm NOM. FROM START OF CALIBRATED TRAVEL. STANDARD VERSIONS THE PUSH-ROD EXTENDS A FURTHER 8mm NOM. FROM END OF CALIBRATED TRAVEL, FOR SPRUNG VERSIONS: 'R': 1mm, 'S': 2mm. 'V' CODED PUSH-ROD WILL DEPART SENSOR BODY.

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.

OUTPUT OPTION	OUTPUT	SUPPLY	
A	0.5 TO 4.5V RATIO METRIC	5V	STANDARD
B	±5V	±15V	
C	0.5 TO 9.5V	24V	BUFFERED
D	±10V	±15V	
E	0.5 TO 4.5V	24V	
F	SUPPLY CURRENT 12mA TYP. 20mA MAX.	24V	
G	4 TO 20mA 2-WIRE	24V	
H	4 TO 20mA 3-WIRE SINK	24V	
	4 TO 20mA 3-WIRE SOURCE	24V	
	SINK VERSION OUTPUT COMPLIANCE 5-28V		
	SOURCE VERSION DRIVE 300Ω MAX TO OV		

CABLE: 0.2mm<sup>2</sup>, O/A SCREEN, PUR JACKET - SUPPLIED WITH 50cm OR REQUIRED LENGTH IN cm. e.g. 'L50'

3-CORE: JACKET Ø4mm  
4-CORE: JACKET Ø4.6mm

CABLE/CONNECTOR\* CONNECTIONS;  
3 CORE 4 CORE CONNECTOR

RED	RED	:1	+Ve
BLACK	GREEN	:3	OV
	YELLOW	:4	-Ve - OPTIONS: B OR D
WHITE	BLUE	:2	OUTPUT
SCREEN	SCREEN	:4	BODY - OPTIONS: A, C, E-H

\*CONNECTORS; MAXIMUM CONDUCTOR CROSS SECTION 0.75mm<sup>2</sup>  
RANGE OF DISPLACEMENT FROM 0-5mm TO 0-800mm e.g.76, IN INCREMENTS OF 1mm.

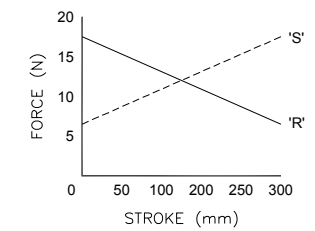
BODY MATERIAL: STAINLESS STEEL.  
FURTHER OPTIONS:

SINGLE PAIR OF BODY CLAMPS 'P'  
TWO PAIRS OF BODY CLAMPS 'P2'

SPRING RETURN PUSH-ROD, TRAVEL ≤300mm  
RETURN TO EXTENDED POSITION (CODE 'R')  
RETURN TO RETRACTED POSITION (CODE 'S')

PUSH-ROD FREE (CODE 'V') - NOT AVAILABLE WITH SPRUNG OPTIONS.

GAIN AND OFFSET ADJUSTMENTS NOT AVAILABLE WITH RADIAL BODY, CODE 'lxx' AND 'K', OPTIONS.



SPRING FORCE v STROKE (CODE 'R' OR 'S')



P	05/07/11		CHECKED BY	X	±0.4
Q	07/03/13		RDS	X.X	±0.2
R	08/04/14			X.XX	±0.1
S	28/07/15	DESCRIPTION			
T	9/11/15	P101 LIPS STAND ALONE			
U	29/08/17	LINEAR POSITION SENSOR			
SCALE 12.5mm					
DRAWING NUMBER			P101-11		REV U
					SHEET 1 OF 1

## LIPS<sup>®</sup> X101 STAND-ALONE LINEAR POSITION SENSOR INTRINSICALLY SAFE FOR HAZARDOUS GAS/VAPOUR ATMOSPHERES

- **Intrinsically safe for Gas to: Ex II 1G**
- **Non-contacting inductive technology to eliminate wear**
- **Travel set to customer's requirement**
- **High durability and reliability**
- **High accuracy and stability**
- **Sealing to IP65/IP67 as required**



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

Our intrinsically safe X101 LIPS<sup>®</sup> (Linear Inductive Position Sensor) incorporates electronics system EX07 which is ATEX / IECEx approved for use in potentially explosive **gas/vapour** atmospheres. The X101 is designed for industrial and scientific feedback applications and is ideal for OEMs seeking good sensor performance for arduous applications in hazardous areas. The unit is highly compact and space-efficient, being responsive along almost its entire length.

The X101, like all Positek<sup>®</sup> sensors, provides a linear output proportional to travel. Each unit is supplied with the output calibrated to the travel required by the customer, any stroke from 0-5mm to 0-800mm and with full EMC protection built in. The sensor is very robust, the body and push rod being made of stainless steel for long service life and environmental resistance.

Overall performance, repeatability and stability are outstanding over a wide temperature range. The sensor is easy to install with mounting options including M5 rod eye bearings and body clamps. The push rod can be supplied free or captive, with female M5 thread, an M5 rod eye, or dome end, Captive push rods can be sprung loaded, in either direction, on sensors up to 250mm of travel. The X101 also offers a wide range of mechanical options, environmental sealing is to IP65 or IP67, depending on selected cable or connector options.

### SPECIFICATION

#### Dimensions

Body diameter	35 mm
Body length (Axial version)	calibrated travel + 163 mm
Body length (Radial version)	calibrated travel + 186 mm
Push rod extension	calibrated travel + 9 mm, OD 9.5 mm

For full mechanical details see drawing X101-11

#### Power Supply

+5V dc nom.  $\pm 0.5V$ , 10mA typ 20mA max

0.5-4.5V dc ratiometric, Load: 5k $\Omega$  min.

$\leq \pm 0.25\%$  FSO @ 20°C - up to 450 mm

$\leq \pm 0.5\%$  FSO @ 20°C - over 450 mm

$\leq \pm 0.1\%$  FSO @ 20°C\* available upon request.

\*Sensors with calibrated travel from 10 mm up to 400 mm.

#### Temperature Coefficients

$< \pm 0.01\%$ /°C Gain &

$< \pm 0.01\%$ FS/°C Offset

$> 10$  kHz (-3dB)

#### Frequency Response

#### Resolution

Infinite

#### Noise

$< 0.02\%$  FSO

#### Intrinsic Safety

Ex II 1G

Ex ia IIC T4 Ga (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  $\leq 21\%$

#### Sensor Input Parameters

U<sub>i</sub>: 11.4V, I<sub>i</sub>: 0.20A, P<sub>i</sub>: 0.51W.

C<sub>i</sub>: 1.16 $\mu$ F, L<sub>i</sub>: 50 $\mu$ H

(cable option/s) C<sub>i</sub>: 1.36 $\mu$ F, L<sub>i</sub>: 860 $\mu$ H 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

IEC 68-2-29: 40 g

MTBF 350,000 hrs 40°C Gf

#### Drawing List

X101-11 Sensor Outline

Drawings, in AutoCAD<sup>®</sup> dwg or dxf 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.**



**LIPS® X101 STAND-ALONE LINEAR POSITION SENSOR  
INTRINSICALLY SAFE FOR HAZARDOUS GAS/VAPOUR 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."

ATEX / IECEx approved to;  
Ex II 1G  
Ex ia IIC T4 Ga (Ta = -40°C to +80°C)

Designates the sensor as belonging to; Group II: suitable for all areas **except mining**, Category 1 G: can be used in areas with continuous, long or frequent periods of exposure to hazardous gas (Zone 0).

Protection class ia, denotes intrinsically safe for all zones Apparatus group IIC: suitable for IIA to IIC explosive gas. Temperature class T4: maximum 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 X005 Galvanic Isolation Amplifier is purpose made for Positek IS sensors making it the perfect choice. Refer to the X005 datasheet for product specification and output configuration options.

**Safety Parameters:-**

Ui: 11.4V, Ii: 0.20A, Pi: 0.51W  
Ci = 1.36µF\* Li = 860µH\* (cable option/s)  
Ci = 1.16µF Li = 50µH (connector option/s)

\*Figures for 1km cable where: Ci = 200pF/m & Li = 810nH/m

Sensors can be installed with a maximum of 1000m of cable.

Cable characteristics must not exceed:-  
Capacitance: ≤ 200 pF/m for max. total of: 200 nF.  
Inductance: ≤ 810 nH/m for max. total of: 810 µH

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

ATEX / IECEx approved sensors suitable for dust (E series) and mining (M series) applications, are also available from Positek.

**TABLE OF OPTIONS**

**CALIBRATED TRAVEL:** Factory set to any length from 0-5mm to 0-800mm (e.g. 254mm)

**ELECTRICAL INTERFACE OPTIONS**

Axial sensors supplied with access to output 'zero' and 'span' calibration adjustments as standard. No access option available.

The Positek® X005 Galvanic Isolation Amplifier is available with the following output options;

Standard: 0.5 - 9.5V or 4 - 20mA.  
Reverse: 9.5 - 0.5V or 20 - 4mA.

**CONNECTOR/CABLE OPTIONS**

Connector - Hirschmann GD series	Axial, IP65
Connector - Hirschmann ELWIK 4102	Radial, IP67
Cable <sup>1</sup> with M12 gland or short gland	Axial, IP67
Cable <sup>1</sup> with PG9 gland	Radial, IP67

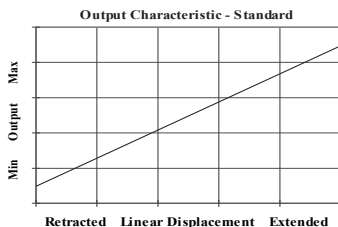
<sup>1</sup>Three core (black jacket) or five core (blue jacket) cable options available. Cable length >50 cm – please specify length in cm up to 15000 cm max.

We recommend all customers refer to the 3 or 5-Wire Mode Connection page.

**MOUNTING OPTIONS**

M5 rod eye bearing ( radial versions), Body Tube Clamp/s (axial or radial versions).

**PUSH ROD OPTIONS** – standard retained with M5x0.8 female thread, M5 rod eye bearing, Dome end, Sprung loaded (retraction or extension) or Free.





## 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.

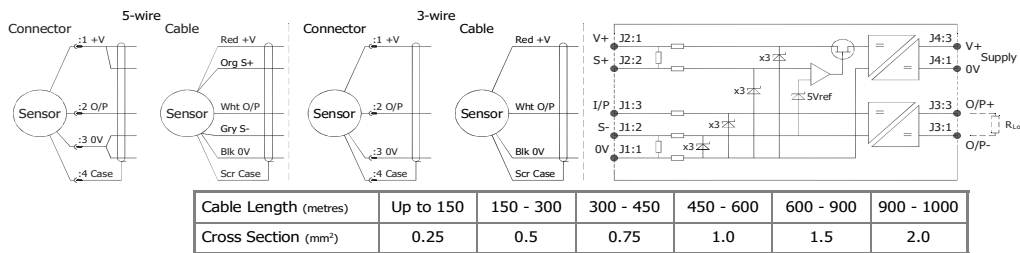
This is important because the effects of volts drop can significantly alter the perceived accuracy of the sensor which is ratiometric i.e. the output signal is directly affected by the voltage across the sensor. Changes in temperature will also be seen as gain variation in the sensor output.

**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.



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.



**Intrinsically Safe - Gas/Vapour Atmospheres**  
**LIPS® SERIES X101 Stand-Alone Linear Position Sensor**

X101	a	b	c	d	e	f	g	h	j
X101	Displacement	A	Adjustments	Connections	Option	Option	Option	Option	Z-code

a Displacement (mm)		Value
Displacement in mm	e.g. 0 - 254 mm	<b>254</b>
b Output		
Supply V dc V <sub>s</sub> (tolerance)	Output	Code
+5V (4.5 - 5.5V)	0.5 - 4.5V (ratiometric with supply)	<b>A</b>
c Calibration Adjustments		Code
Accessible - default†	†Axial body style only. Radial body style sealed by default.	blank
Sealed		<b>Y</b>
d Connections Cable* or Connector		Code
Cable Gland - Radial	IP67 Pg9 - 3-core cable	<b>Ixx</b>
Cable Gland - Radial	IP67 Pg9 - 5-core cable	<b>IQxx</b>
Connector - Axial	IP65 DIN 43650 'C'	<b>J</b>
Connector - Radial	IP67 M12 IEC 60947-5-2	<b>K</b>
Cable Gland - Axial	IP67 M12 - 3-core cable	<b>Lxx</b>
Cable Gland - Axial	IP67 M12 - 5-core cable	<b>LQxx</b>
Cable Gland - Axial	IP67 Short - 3-core cable	<b>Mxx</b>
Cable Gland - Axial	IP67 Short - 5-core cable	<b>MQxx</b>
<small>*Supplied with 50 cm as standard, specify required cable length specified in cm. e.g. L2000 specifies cable gland with 20 metres of cable. Nb: restricted cable pull strength.</small>		
e Body Fittings		Code
None - default		blank
M5 Rod-eye Bearing	Radial body style only	<b>N</b>
Body Clamps - 1 pair		<b>P</b>
Body Clamps - 2 pairs		<b>P2</b>
f Sprung Push Rod		Code
None - default		blank
Spring Extend	Up to 300mm displacement.	<b>R</b>
Spring Retract	Captive push rod only.	<b>S</b>
g Push Rod Fittings		Code
None - default	Female Thread M5x0.8x9 deep	blank
Dome end	Required for option 'R'	<b>T</b>
M5 Rod-eye Bearing		<b>U</b>
h Push Rod Options		Code
Captive - default	Push rod is retained	blank
Non-captive	Push rod can depart body	<b>V</b>

j Z-code	Code
Calibration to suit X005 - Default	<b>Z000</b>
Connector IP67 M12 IEC 60947-5-2 must have options 'Y' & 'J'	<b>Z600</b>
Connector IP67 M12 IEC 60947-5-2 must have option 'J'	<b>Z601</b>
≤ ± 0.1% @20°C Independent Linearity displacement between 10mm & 400mm only!	<b>Z650</b>
Connector with cable option 'J', 'JQ', 'K' or 'KQ' with length required in cm i.e. J100 specifies connector with 100cm of cable.	<b>Z999</b>

**Note!**

All Intrinsically Safe (IS) sensors must have a Z-code suffix.  
IS sensors must be used in conjunction with a Galvanic Isolation Amplifier - See X005 for Output options.



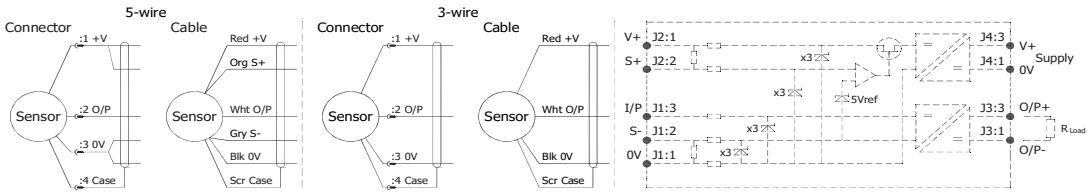
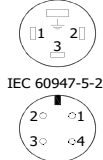
## Installation Information

### LIPS® X101 STAND-ALONE LINEAR POSITION SENSOR INTRINSICALLY SAFE FOR HAZARDOUS GAS/VAPOUR ATMOSPHERES

For certificate number and safety parameters information for product marked EX04, see next page.

ATEX /IECEx Qualified to Intrinsic Safety Standard Certificate numbers SIRA 13ATEX2371X IECEx SIR 13.0154X		Ex II 1G Ex ia IIC T4 Ga (Ta = -40°C to +80°C)	
Electronics Version	Output Description:	Supply Voltage: $V_s$ (tolerance)	Load resistance:
EX07	0.5 - 4.5V (ratiometric with supply) [Output code 'A']	+5V (4.5 - 5.5V)	5kΩ min

Connector Pin Layout:  
DIN 43650 C



**Putting Into Service:** 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<sub>i</sub> = 11.4V**      **I<sub>i</sub> = 0.20A**      **P<sub>i</sub> = 0.51W**  
**C<sub>i</sub> = 1.36µF\***      **L<sub>i</sub> = 860µH\***      (\*Ixx', 'IQxx', 'Lxx', 'LQxx', 'Mxx' or 'MQxx' options) \*Figures for 1km cable  
**C<sub>i</sub> = 1.16µF**      **L<sub>i</sub> = 50µH**      (\*J' or 'K' options)

The sensor is certified to be used with up to **1000m** of cable, cable characteristics must not exceed:-

Capacitance: ≤ 200 pF/m for max. total of: 200 nF  
 Inductance: ≤ 810 nH/m for max. total of: 810 µH

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

The performance of the sensor may be affected by voltage drops associated with long cable lengths; For cable lengths exceeding 10 metres a five wire connection is recommended to eliminate errors introduced by cable resistance and associated temperature coefficients.

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

**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.

**Warning** - The M12 IEC 60947 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!**

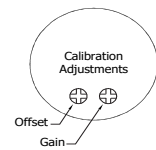
**Use:** The sensor is designed to measure linear displacement and provide an analogue output signal.

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

**Maintenance:** No maintenance is required. Any cleaning must be done with a damp cloth.

**Gain and Offset Adjustment:** (Where accessible - Typically ± 10% Min available)

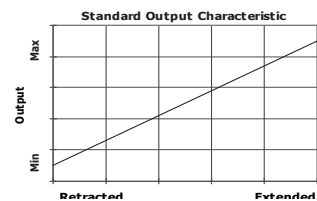
To adjust the gain or offset use a small potentiometer adjuster or screwdriver 2mm across. Do not apply too much force on the potentiometers.



**Mechanical Mounting:** Depending on options; Body can be mounted by M5x0.8 male thread, M5 rod eye or by clamping the sensor body - body clamps are available, if not already ordered. Target by M5x0.8 female thread or M5 rod eye. It is assumed that the sensor and target mounting points share a common earth.

**Output Characteristic:** Target is extended 9 mm from end of body at start of normal travel. The output increases as the target extends from the sensor body, the calibrated stroke is between 5 mm and 800 mm.

**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.





## Installation Information

### LIPS<sup>®</sup> X101 STAND-ALONE LINEAR POSITION SENSOR INTRINSICALLY SAFE FOR HAZARDOUS GAS/VAPOUR ATMOSPHERES

For certificate number and safety parameters information for product marked EX07, see previous page.

ATEX Qualified to Intrinsic Safety Standard Certificate numbers SIRA 00ATEX2076X		Ex II 1G EEx ia IIC T4 (Ta = -40°C to +80°C)	
Electronics Version	Output Description:	Supply Voltage: <i>V<sub>s</sub></i> (tolerance)	Load resistance:
<b>EX04</b>	0.5 - 4.5V (ratiometric with supply) [Output code 'A']	+5V (4.5 - 5.5V)	5kΩ min

The barrier parameters must not exceed:-

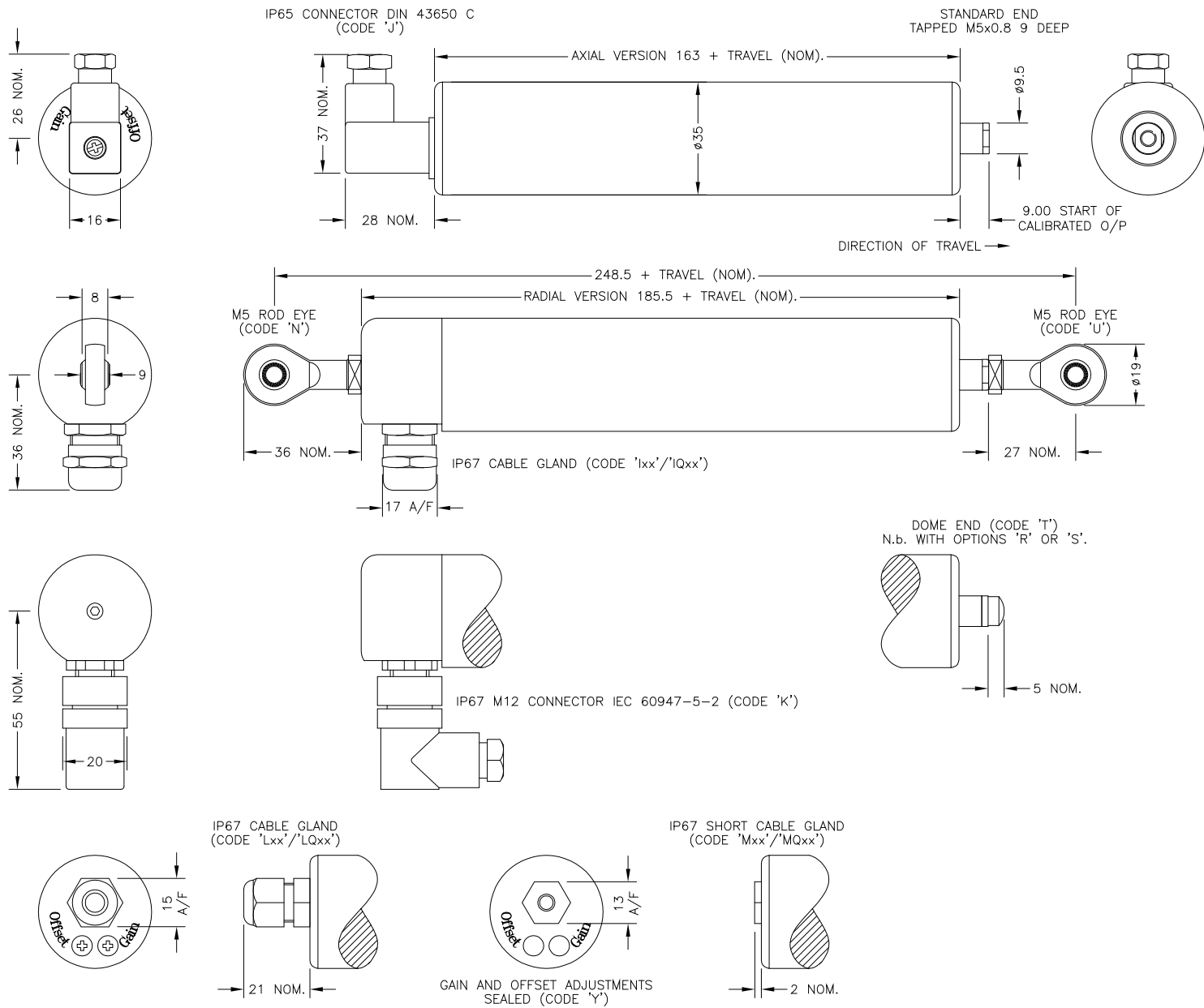
**U<sub>i</sub> = 11.4V**      **I<sub>i</sub> = 0.20A**      **P<sub>i</sub> = 0.51W**  
**C<sub>i</sub> = 1.36μF\***    **Li = 710μH\***    ('Ixx', 'Lxx' or 'Mxx' options) \*Figures for 1km cable  
**C<sub>i</sub> = 1.16μF**      **Li = 50μH**      ('J' or 'K' options)

The sensor is certified to be used with up to **1000m** of cable, cable characteristics must not exceed:-

Capacitance: ≤ 200 pF/m for max. total of: 200 nF  
 Inductance: ≤ 660 nH/m for max. total of: 660 μH

With the exception of the certificate number and safety parameters above, all other notes regarding Putting Into Service, Use, Assembly and Dismantling etc. on previous page apply to sensors marked EX04 or EX07.

N.b. ROD-EYE ORIENTATION NOT GUARANTEED.



N	OPTIONS 'R' & 'S' OVER TRAVEL DIMS MODIFIED - RAN1030.	PDM
O	RANGE WAS 50-600mm RAN1056	RDS
P	5-CORE OPTION ADDED ~ RAN1102	PDM
Q	RANGE NOTE AMENDED ~ RAN1200	PDM



THE PUSH-ROD RETRACTS A FURTHER 4mm NOM. FROM START OF CALIBRATED TRAVEL. STANDARD VERSIONS THE PUSH-ROD EXTENDS A FURTHER 8mm NOM. FROM END OF CALIBRATED TRAVEL, FOR SPRUNG VERSIONS: 'R': 1mm, 'S': 2mm. 'V' CODED PUSH-ROD WILL DEPART SENSOR BODY.

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.

**ELECTRICAL OPTIONS/ SPECIFICATIONS**

OUTPUT	SUPPLY
0.5 TO 4.5V RATIOMETRIC	5V
SUPPLY CURRENT	12mA TYP. 20mA MAX.

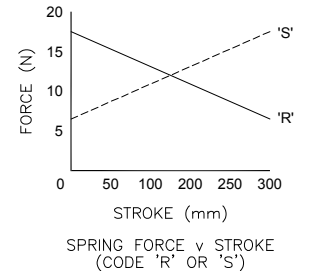
CABLE: 0.2mm<sup>2</sup>, O/A SCREEN, PUR JACKET - SUPPLIED WITH 50cm OR REQUIRED LENGTH IN cm (15000cm MAX).  
STANDARD 3-CORE: JACKET Ø4mm BLACK e.g. 'L50'  
OPTIONAL 5-CORE: JACKET Ø4.6mm BLUE e.g. 'LQ50'

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 0-5mm TO 0-800mm e.g.76, IN INCREMENTS OF 1mm.

BODY MATERIAL: STAINLESS STEEL.  
FURTHER OPTIONS:  
SINGLE PAIR OF BODY CLAMPS 'P'  
TWO PAIRS OF BODY CLAMPS 'P2'  
SPRING RETURN PUSH-ROD, TRAVEL ≤300mm  
RETURN TO EXTENDED POSITION (CODE 'R')  
RETURN TO RETRACTED POSITION (CODE 'S')  
PUSH-ROD FREE (CODE 'V') - NOT AVAILABLE WITH SPRUNG OPTIONS.  
GAIN AND OFFSET ADJUSTMENTS NOT AVAILABLE WITH RADIAL BODY, CODE 'lxx' AND 'k', OPTIONS.



NOTE:- READ INSTALLATION SHEET X101-19 FOR FULL INSTRUCTIONS FOR USE.

ATEX / IECEx APPROVED TO

II 1G

Ex ia IIC T4 Ga (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!



N	27/07/15		CHECKED BY	X	±0.4	
O	9/11/15		RDS	X.X	±0.2	
P	10/04/17			X.XX	±0.1	
Q	29/08/17	DESCRIPTION				
X101 INTRINSICALLY SAFE STAND ALONE LINEAR POSITION SENSOR						
SCALE 1:2.5mm			DRAWING NUMBER X101-11 REV Q			
SHEET 1 OF 1						