



mm X138 Mid Stroke Slim-Line Linear Position Sensor

Intrinsically Safe For Hazardous
Gas/Vapour Atmospheres

FEATURES

- Intrinsically safe for Gas to: Ex II 1G
- Non-contacting inductive technology to eliminate wear
- Travel set to customer's requirement
- Compact 19 mm diameter body
- High durability and reliability
- High accuracy and stability
- Sealing to IP67

Our intrinsically safe X138 LIPS® (Linear Inductive Position Sensor) incorporates electronics system EX07 which is ATEX / IECEx approved for use in potentially explosive gas/vapour atmospheres. The X138 is designed for a wide range of industrial applications and is ideal for OEMs seeking good sensor performance in situations where a small diameter, short-bodied sensor is required for operation in hazardous areas.

The unit is compact and space-efficient, being responsive along almost its entire length, and like all sensors provides a linear output proportional to travel. Each unit is supplied with the output calibrated to the travel required by the customer, from 51 to 100mm and with full EMC protection built in.

Overall performance, repeatability and stability are outstanding over a wide temperature range. The sensor has a compact 19 mm diameter stainless steel body, is easy to install and set up. Mounting options include body clamps or a stainless steel mounting flange with two 3.2 mm by 30 degree wide slots on a 25 mm pitch. The stainless steel plunger can be supplied free or captive, with female M4 thread, or spring-loaded with a ball end. The X138 also offers a range of mechanical options, environmental sealing is to IP67.



X138-17c

SPECIFICATION

Dimensions	
Body diameter	19 mm
Body Length:	Dependant on calibrated travel & mounting option
Calibrated Travel	Standard Flange mounted
51 mm to 70 mm	132.5 mm 138 mm
71 mm to 100 mm	162.5 mm 168 mm
Plunger	Ø 6mm
For full mechanical details see	drawing X138-11
Power Supply	+5V dc nom. $\pm 0.5V$, 10mA typ 20mA max
Output Signal	0.5-4.5V dc ratiometric, Load: 5k Ω min.
Independent Linearity	$\leq \pm 0.25\%$ FSO @ 20°C $\leq \pm 0.1\%$ FSO @ 20°C available upon request.
Temperature Coefficients	$< \pm 0.01\%$ /°C Gain & $< \pm 0.01\%$ FS /°C Offset
Frequency Response	> 10 kHz (-3dB)
Resolution	Infinite
Noise	$< 0.02\%$ FSO
Intrinsic Safety	Ex II 1G Ex ia II C 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	Ui: 11.4 V, Ii: 0.20A, Pi: 0.51W.
(connector option/s)	Ci: 1.16 μ F, Li: 50 μ H
(cable option/s)	Ci: 1.36 μ F, Li: 860 μ H with 1km max. cable
Environmental Temperature Limits	
Operating	-40°C to +80°C
Storage	-40°C to +125°C
Sealing	IP67
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	
X138-11	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.

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 intrinsically safe sensors be used in conjunction with a galvanic barrier to meet the requirements of the product certification. The X005 Galvanic Isolation Amplifier is purpose made for 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.

TABLE OF OPTIONS

CALIBRATED TRAVEL: Factory set to any length from 0-51mm to 0-100mm (e.g. 76mm).

ELECTRICAL INTERFACE OPTIONS

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 - M8 IEC 60947-5-2 IP67

Cable† with M8 gland IP67

†Three core (black jacket) or five core (blue jacket) cable options available.

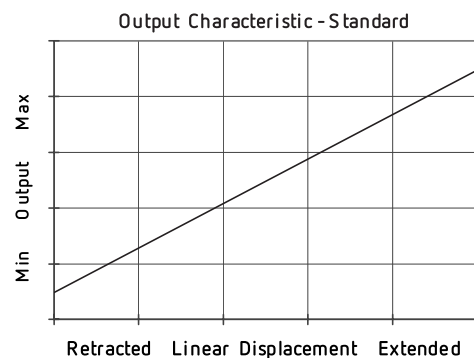
Cable length >50 cm – please specify length in cm up to 15000 cm max.

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

MOUNTING OPTIONS

Flange, Body Tube Clamp.

PUSH ROD OPTIONS – standard retained with M4x0.7 female thread
Sprung loaded (spring supplied loose), Dome end (sprung loaded) or Free.

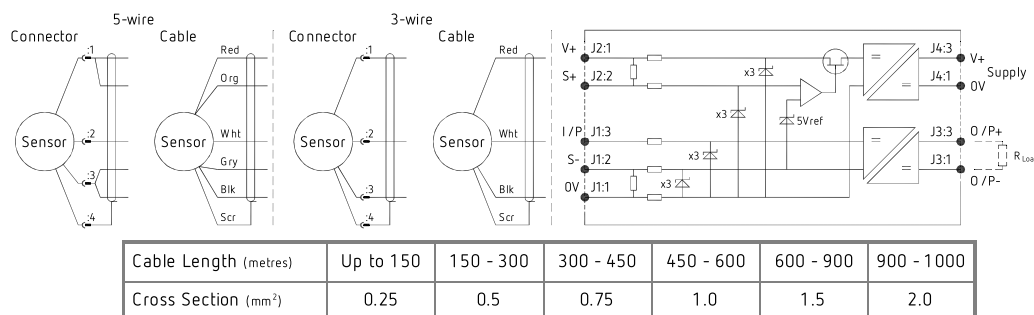


The aim of this document is to help readers who do not understand what is meant by three or five wire modes of connection between the galvanic isolation amplifier and sensor, and the factors behind them. It is by no means an in-depth technical analysis of the subject. Whether opting for a pre-wired Intrinsically 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 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 15 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 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.



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 $\pm 1\%$ temperature dependence of gain over the range -40°C to $+80^{\circ}\text{C}$ for the cable temperature. (i.e. about -150 ppm/ $^{\circ}\text{C}$ 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. The 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

[†] $R = L/A$ is the resistivity of the conductor (Ωm) L is the length of conductor (m) A is the conductor cross-sectional area (m²). [‡] 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.



HOW TO ORDER

	a	b	c	d	e	f	g	h	j
X138 .	Displacement	A	Connections	Option	Option	Option	Option	Option	Z-code

a	Displacement (mm)	Value
Displacement in mm	e.g. 0 - 66 mm	66
b	Output	
Supply V _{dc} V _s (tolerance)	Output	Code
+5V (4.5 - 5.5V)	0.5 - 4.5V (ratiometric with supply)	A
c	Connections Cable* or Connector	Code
Connector	IP67 M8 IEC 60947-5-2	J
Cable Gland	IP67 M8 - 3-core cable	Lxx
Cable Gland	IP67 M8 - 5-core cable	LQxx
*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.		
d	Housing	Code
Standard - default		blank
Flange Mount		N
e	Body Fittings	Code
None - default		blank
Body Clamps - 1 pair		P
f	Sprung Plunger	Code
None - default		blank
Spring Extend	Captive plunger only.	R
g	Plunger Fittings	Code
None - default	Female Thread M4x0.7x7 deep	blank
Dome end	Required for option 'R'	T
h	Plunger Options	Code
Captive - default	Plunger is retained	blank
Non-captive	Plunger can depart body	V
j	Z-code	Code
Calibration to suit X005 - Default		Z000
± 0.1 % @20°C Independent Linearity displacement between 10mm & 50mm only!		Z650
Connector with cable option 'J' with length required in cm i.e. J100 specifies connector with 100cm of cable. n.b. 5-core cable option not available.		Z999

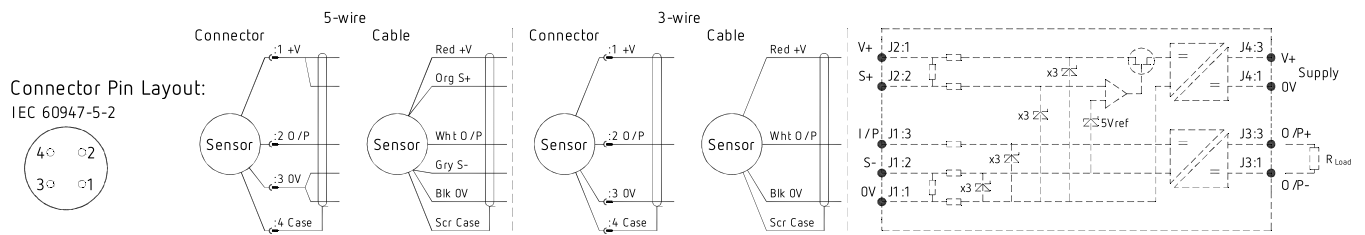
Note!

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

ATEX /IECEX Qualified to Intrinsic Safety Standard Certificate numbers SIRA 13 ATEX2371X IECEX SIR 13.01 54X		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



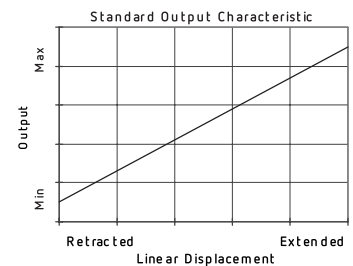
Putting Into Service: The sensor must be used with a galvanic isolation barrier designed to supply the sensor with a nominal 5V and to transmit the sensor output to a safe area. The barrier parameters must not exceed:

$U_i = 11.4V$ $I_i = 0.20A$ $P_i = 0.51W$
 $C_i = 1.36\mu F^*$ $L_i = 860\mu H^*$ ('Lxx' or 'LQxx' options) *Figures for 1km cable
 $C_i = 1.16\mu F$ $L_i = 50\mu H$ ('J' option)

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. **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. **Mechanical Mounting:** Flange mounted or by clamping the sensor body - body clamps are available, if not already ordered. The flange slots are 3.2 mm by 30 degrees wide on a 28 mm pitch. **Output Characteristic:** Plunger extended, at start of normal travel, from mounting face by: Standard body : 36.5 mm* Flanged body : 34 mm* *Note: where dome end option is fitted add 5 mm. The output increases as the plunger extends from the sensor body, the calibrated stroke is between 51 mm and 100 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.

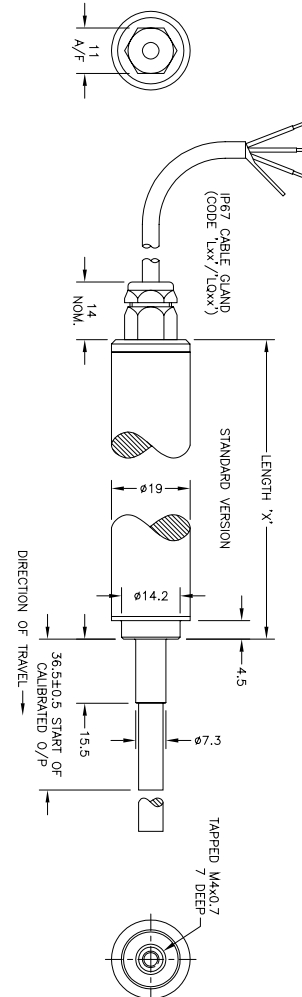
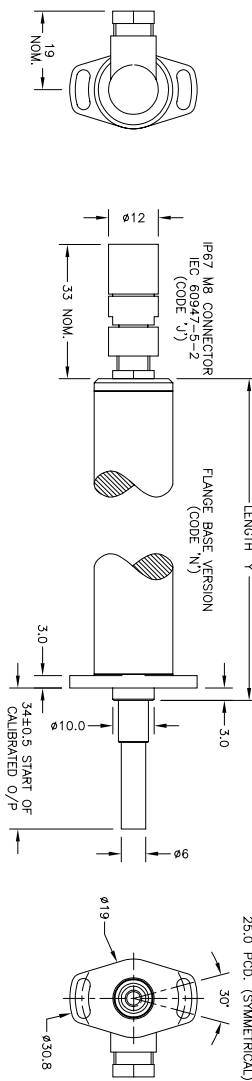
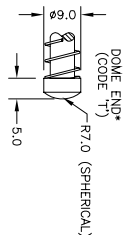


ELECTRICAL OPTIONS / SPECIFICATIONS

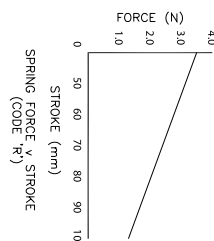
A	FIRST ISSUE - RAN1063/RAN1068	PDM
B	5-CORE OPTION ADDED - RAN102	PDM
C	RANGE NOTE AMENDED - RAN1200	PDM

CE
THE PLUNGER RETRACTS 8mm FROM START OF CALIBRATED TRAVEL (2mm FOR SPRING VERSIONS) AND EXTENDS 11mm* BEYOND END OF MECHANICAL TRAVEL. *DOES NOT INCLUDE DIFFERENCE BETWEEN CALIBRATED AND MECHANICAL TRAVEL. DIMENSIONS ARE NOMINAL.
V CODED PLUNGER 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.
THIS IS A UNICONTROLLED PART AND WILL NOT BE UPDATED.

NOTE: SENSORS ARE MADE IN FOUR STANDARD LENGTHS.
TRAVEL: (mm)
CALIBRATED MECHANICAL
0-51 TO 0-70 70
0-71 TO 0-100 100
BODY LENGTH: (mm)
X' STANDARD 132.5
Y' FLANGE 138.0
Y' ELANGE 162.5
Y' ELANGE 168.0



ELECTRICAL OPTIONS / SPECIFICATIONS
OUTPUT SUPPLY
0.5 TO 4.5V BATTERY SUPPLY
SUPPLY CURRENT 120mA TYP. 200mA MAX.
CABLE: 0.2mm² O/A SCREEN, PUR JACKET - SUPPLIED WITH 100m COILS OR 10m COILS (15000' MAX).
STANDARD 5-CORE: JACKET 0.4mm BLACK e.g. 1050°
OPTIONAL 5-CORE: JACKET 0.4mm BLUE e.g. 1050°
CABLE/CONNECTOR CONNECTIONS:
3 CORE 5 CORE CONNECTOR
RED RED +VE
ORNG ORNG +SENSE (5-WIRE ONLY)
BLACK BLACK 0V
WHITE WHITE SENSE (5-WIRE ONLY)
SCREEN SCREEN 2 BODY
SCREEN SCREEN 4 BODY
*CONNECTORS: MAXIMUM CONDUCTOR CROSS SECTION 0.25mm²
RANGE OF DISPLACEMENT FROM 0-51mm TO 0-100mm e.g. 7/6.
BODY MATERIAL: STAINLESS STEEL
FLANGE BASE MATERIAL: STAINLESS STEEL
FURTHER OPTIONS:
SINGLE PART OF BODY CLAMPS (CODE P)
SPRING PLUNGER, TO EXTENDED POSITION (CODE R)
DOME END (CODE T) IN CONJUNCTION WITH SPRUNG PLUNGER (CODE R)
PLUNGER FREE (CODE V)
NB: NOT AVAILABLE WITH SPRUNG OPTIONS.



NOTE:-- READ INSTALLATION SHEET X138-19 FOR FULL INSTRUCTIONS FOR USE.

ATEX / IECEx APPROVED TO
II 1G
EX II CT4 Gb (Ta= -40 to +80 C)
UL100A, ILO2A, PLO5IW
APPROVED FOR USE IN CONJUNCTION WITH A GALVANICALLY ISOLATED BARRIER.
NOTE: APPROVAL ONLY APPLIES AT NORMAL ATMOSPHERIC PRESSURE!

A	25/11/15	CHECKED BY	X	XX	±0.4
B	26/04/17	RDS	XX	±0.1	
C	06/09/17			±0.1	
		DESCRIPTION			
		X138 INTRINSICALLY SAFE			
		SHORT STROKE SLIM-LINE			
		LINEAR POSITION SENSOR			
		DRAWING NUMBER	X138-11	REV	C
		SHEET	1	OF	1